Final Report

LOWER PATAPSCO RIVER SMALL WATERSHED ACTION PLAN

Volumes I and II

Prepared for

Baltimore County Department of
Environmental Protection and Sustainability

Prepared by

VERSAR

with

Coastal Resources, Inc. McCormick Taylor

May 2012

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LOWER PATAPSCO RIVER SMALL WATERSHED ACTION PLAN

Prepared for

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CHAPTER 1: INTRODUCTION

1.1 Purpose

The purpose of the Lower Patapsco Small Watershed Action Plan (SWAP) is to provide guidance on the restoration of the Lower Patapsco Watershed. This report outlines a series of strategies for watershed restoration, describes management strategies for each of the sixteen subwatersheds within the Lower Patapsco Watershed, and identifies priority projects for implementation. The SWAP includes the identification of potential stormwater management conversion sites, capital projects, as well as citizen-based stream restoration opportunities, operational program implementation, and an implementation schedule. Planning-level cost estimates are provided where feasible and a preliminary schedule for implementation over a ten-year horizon is outlined. Financial and technical partners for plan implementation are suggested for various strategies and projects. The watershed plan is intended to assist Baltimore County and other organizations, such as the Friends of Patapsco Valley and Heritage Greenway (FPVHG) and Friends of Patapsco Valley State Park, in moving forward with restoration of the Lower Patapsco Watershed.

1.2 Background

In 2005, Baltimore County initiated a new round of watershed planning, to develop Small Watershed Action Plans (SWAPs). A SWAP identifies strategies for bringing a small watershed into compliance with water quality standards and to meet other watershed management goals. Strategies include a combination of government capital projects, actions in partnership with local watershed associations, educational outreach, and volunteer activities. Effective implementation of watershed restoration strategies will require the coordination of all watershed partners and the participation of many stakeholders.

Baltimore County's SWAP planning process is intended to address the many mandates that the County is charged to meet in each individual watershed. These include the requirements of the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit, watershed-specific Total Maximum Daily Loads (TMDLs), the Chesapeake Bay TMDL, and goals related to Maryland Tributary Strategy. The small watershed action planning process is designed to bring all these individual mandates together at a subwatershed level that will facilitate implementation. The SWAP will inform residents about the intent of each program, examine how to most efficiently meet the goals, and define the roles of the partners. The SWAPs will build on the previously completed technical Water Quality Management Plans. Specifically, the Lower Patapsco SWAP will build upon the Patapsco River Water Quality Management Plan (Tetra Tech 2000).

Over the past year, Lower Patapsco River watershed partners have worked together conducting assessments, identifying restoration opportunities, and engaging the community, in order to build a successful plan. A Steering Committee, consisting of various watershed partners, was formed to aid in developing the Lower Patapsco SWAP.

This includes Baltimore County personnel, Maryland Department of Natural Resources (DNR), members of the local watershed organization (FPVHG), and leaders from the local community. The Steering Committee met regularly throughout SWAP development. Lower Patapsco SWAP Steering Committee members are listed below:

- Baltimore County Department of Environmental Protection and Sustainability (EPS)
  - Nathan Forand
  - Nancy Pentz
  - Steve Stewart
- Friends of Patapsco Valley and Heritage Greenway
  - Betsy McMillion
  - Kit Valentine
- Maryland Department of Natural Resources
  - Robin Melton
  - Catherine Shanks
- Community College of Baltimore County (Catonsville)
  - Sonja Schmitz
- Baltimore County Department of Planning
  - Dennis Wertz
- Girl Scouts / Friends of Patapsco Valley and Heritage Greenway
  - Theresa Spliedt
- Concerned Citizen
  - Sabina Fu

In addition, because the participation of many stakeholders is an essential component for effective watershed restoration, three stakeholder meetings were held during SWAP development. Stakeholder meetings were intended to raise citizen awareness and solicit feedback from residents, local community leaders, institutions, and business associations regarding watershed restoration strategies. A description of each stakeholder meeting held including date, approximate number of attendees and topics covered, is provided below.

1) ***Stakeholder Meeting #1*** (May 24, 2011; 24 attendees): A presentation was given by Baltimore County staff to explain why a SWAP is developed and why

watersheds are important to communities and the environment. A representative of the Versar consultant team then presented a general review of existing conditions, including photographs of watershed features, and maps of subwatersheds and land use characteristics. This was followed by a presentation of work to date on the SWAP, including the status of field work, analysis, and reporting. The Friends of Patapsco Valley and Heritage Greenway then gave a presentation on ongoing restoration projects in the SWAP area. The consultant team then led a visioning exercise for stakeholders to describe what they want the watershed to be ideally. Participants were asked to fill out a card with their vision for the watershed. This was followed by a short 12-question survey in which participants were asked to rate potential elements of the vision and goals that the SWAP should address. The team also presented the project schedule, "next steps", and plans for future stakeholder meetings. A final exercise, guided by the team, asked participants to provide other information on improvements in the watershed that should be addressed, either generally or at specific locations in the watershed.

2) ***Stakeholder Meeting #2*** (October 25, 2011; 30 attendees): Baltimore County staff presented about capital projects in the Lower Patapsco SWAP area within the last decade. A representative of the Versar consultant team then gave a brief overview of the SWAP process and presented the general findings of the 2011 field work, listing recommendations for different types of assessments. The consultant team then administered a Citizens Action Survey to learn which types of citizen environmental actions people would like to learn more about. Due to the high level of interest in dam removals on the mainstem Patapsco River at the previous meeting, representatives from American Rivers and Maryland Department of Natural Resources were present to give a presentation on the two recent dam removals. Each presentation was accompanied with maps, photos and visuals, and questions from the audience were addressed by each speaker. The team concluded the meeting with next steps and schedule information for the third and final stakeholder meeting.

3) ***Stakeholder Meeting #3*** (February 27, 2012; 26 attendees): A representative from the Versar consultant team gave a presentation about the goals of the SWAP process, Lower Patapsco watershed characterization, and restoration strategies. Baltimore County staff then presented about citizen actions and explained the implementation process. Both presenters stressed the importance of citizen participation in conjunction with County and partner organization efforts. Each presentation was accompanied with maps, photos and visuals. Questions from the audience were addressed by each speaker. Afterward, participants viewed maps displaying the locations of specific actions in the Lower Patapsco watershed, along with boards from Baltimore County EPS and partner organizations about their needs and ways to get involved.

1.3 Environmental Requirements

This SWAP was developed to satisfy various regulatory drivers. They include:

- Baltimore County's NPDES municipal stormwater permit (MS4) assessment and planning requirements;
- Watershed-specific TMDLs for nutrients, sediment, and other impairments in the Patapsco River and Baltimore Harbor; and
- TMDL for the Chesapeake Bay for nutrient (nitrogen and phosphorus) and sediment reductions to meet water quality standards.

1.3.1 NPDES MS4 Permits

Baltimore County's NPDES permit (99-DP-3317, MD0068314) requires the systematic assessment of water quality and development of restoration plans for all watersheds within the County, including the following:

- Source identification information based on GIS data;
- Determination of current water quality conditions;
- Identification and ranking of water quality problems;
- Results of visual watershed inspections;
- Identification of some structural and non-structural water quality improvement opportunities; and
- Specification of overall watershed restoration goals.

The County's NPDES permit also requires the County to treat 10 percent of the untreated impervious area during the 5-year permit term. It is anticipated that the future permit will have a requirement for treatment of an additional 20%. This SWAP meets the systematic assessment and planning requirements of the NPDES permit and provides strategies for how Baltimore County will meet the goals for addressing impervious cover.

1.3.2 Watershed-Specific TMDLs for Impaired Waterways

Section 303(d) of the 1972 Clean Water Act requires states to develop (and periodically update) a list of impaired waters that fail to meet applicable state water quality standards which are defined by their designated uses. States must also establish priority rankings and develop Total Maximum Daily Loads (TMDLs) for waters on the 303(d) list. According to USEPA, a TMDL is a calculation of the maximum amount of a pollutant that a water body can receive in a day and still safely meet state water quality standards. TMDLs can be developed for a single pollutant or group of pollutants of concern which generally include sediment, metals, bacteria, nutrients, and pesticides.

The Lower Patapsco SWAP area (also known as Baltimore County's SWAP Area A) is within the Patapsco River Lower North Branch (LNB), one of Maryland's 8-digit watersheds. Patapsco River Lower North Branch watershed also includes additional area in Baltimore, Anne Arundel, and Howard Counties. The Patapsco River Lower North Branch is listed as impaired in the Maryland 303(d) list of impaired waters for various pollutants of concern including: total suspended solids (1996 listing), biological impairment (2008 listing), fecal coliform (2008 listing), polychlorinated biphenyls in fish tissue (PCBs, 2008 listing), chlorides (2010 listing), and sulfates (2010 listing). In addition, the Baltimore Harbor is listed as impaired for nutrients (phosphorus and nitrogen), whose source includes the Patapsco LNB watershed.

The Patapsco River LNB mainstem is designated as Use IV: Recreational Trout Waters, except for the lower portion in the County which is designated as Use I: Water Contact Recreation, and Protection of Non-tidal, Warm-water Aquatic Life and Use II: Support of Estuarine and Marine Aquatic Life, according to Maryland water quality standards. The Patapsco LNB tributaries in the County are designated as Use I, except for Brice Run (outside of SWAP Area A), which is designated as Use III Non-tidal Cold Water.

Impairment listings reflect the inability to meet water quality standards for these designated uses. Impairment in the tidal receiving waters is related to pollutants coming from the entire watershed; therefore, TMDLs developed for this segment will require watershed pollutant load reductions. Water Quality Assessments (WQAs) are performed by the state to determine if the pollutant of concern is actually impairing the waters. If it is determined that the pollutant of concern is not contributing to water impairment, a WQA report documenting the findings is submitted to USEPA for concurrence. Table 1-1 summarizes the status of the various impairment listings for the Patapsco River.

Table 1-1: Patapsco River Water Quality Impairment Listings and Status

Impairment	Applicable Segment	Regulatory Status	Approval Date
PCB in fish Tissue	Patapsco LNB	Listed as Impaired	
Chlorides	Patapsco LNB	Listed as Impaired	
Sulfates	Patapsco LNB	Listed as Impaired	
Biological	Patapsco LNB	Listed as Impaired	
Heavy Metals	Patapsco LNB	WQA completed	January 2005
Phosphorus	Patapsco LNB	WQA completed	September 2009
Fecal coliform	Patapsco LNB	TDML completed	December 2009
TSS	Patapsco LNB	TMDL completed	September 2011
Nitrogen/Phosphorus	Baltimore Harbor	TMDL completed	December 2007

PCBs – Polychlorinated Biphenyls (toxic organic compounds that were widely used for applications such as transformers, capacitors, and coolants);
TSS – Total Suspended Solids

As shown in the table above, the Patapsco River watershed had nine impairment listings. Three TMDLs and two WQAs have been completed. TMDLs or WQAs will be developed at some point in the future for PCBs, chlorides, sulfates, and biological impairment listings.

The changes in the biological listing criteria in the 2008 Integrated Report of Surface Water Quality in Maryland resulted in the entire Patapsco River watershed being designated as biologically impaired.

The listing for nutrients is based on the Baltimore Harbor listing. A Total Maximum Daily Load (TMDL) has been completed for the nutrients nitrogen and phosphorus, and approved by EPA in December 2007. This TMDL covers all of the watersheds draining to Baltimore Harbor. The TMDL has estimated that a 15% reduction in urban non-point source load will be needed, along with upgrades to the Patapsco WWTP to meet water quality standards for tidal Baltimore Harbor.

A Water Quality Analysis for metals was submitted to EPA and received concurrence in January 2005, with the exception of Herbert Run. Herbert Run will remain on Part 3 (waterbodies that have insufficient data to define the impairment status) of the 303(d) list with copper as the impairing substance.

A TMDL for fecal coliform bacteria was submitted and approved by EPA in December 2009 (EPS 2010). A TMDL for Total Suspended Sediments (TSS) was submitted to EPA for review in December 2009.

1.3.3 Chesapeake Bay TMDL

The Lower Patapsco drains to the Chesapeake Bay, the largest estuary in North America. In 1975, the United States Congress directed the Environmental Protection Agency (EPA) to conduct a comprehensive study of the most important problems affecting the Chesapeake Bay. The findings of this study formed the crux of the first Chesapeake Bay Agreement, signed in 1983 by Maryland, Virginia, Pennsylvania, Washington DC, the Chesapeake Bay Commission and the EPA. Additional scientific information gained from monitoring data and modeling efforts was used to amend that Agreement, resulting in the 2000 Chesapeake Bay Agreement and the interagency efforts that continue today with the development of the Chesapeake Bay TMDL and Watershed Implementation Plans (WIPs).

Scientific studies have shown that three of the biggest problems facing the health of the Chesapeake Bay and its tributaries (the rivers and streams that flow into the Bay) are excess nitrogen, phosphorus, and sediments. The nutrients nitrogen and phosphorus fuel excessive algae growth. These algae, as well as suspended sediments, cloud the water and prevent bay grasses from getting enough light. When healthy, bay grasses provide essential habitat for crabs and fish as well as food for waterfowl. When algae die, they decompose using up essential oxygen. This lack of oxygen kills bottom-dwellers such as clams and sometimes fish. In addition, excess nutrients sometimes favor the growth of harmful algae. Harmful algae can be toxic to aquatic animals and even humans.

EPA established the Chesapeake Bay TMDL, a historic and comprehensive “pollution diet” with rigorous accountability measures to initiate sweeping actions to restore clean water in the Chesapeake Bay and the region’s streams, creeks, and rivers.

Concurrent with the development of the Bay TMDL, EPA charged the Bay watershed states and the District of Columbia with developing watershed implementation plans (WIPs) to provide adequate “reasonable assurance” that the jurisdictions can and will achieve the nutrient and sediment reductions necessary to implement the TMDL within their respective boundaries.

Maryland’s Phase I WIP provided a series of proposed strategies that will collectively meet the 2017 target (70% of the total nutrient and sediment reductions needed to meet final 2020 goals). After more than a year of cooperative work, MDE and the Departments of Natural Resources, Agriculture, and Planning, submitted Maryland’s Final Phase I WIP to EPA in December 2010. Baltimore County’s Phase I plan required reductions equivalent to retrofit of 30% of pre-1985 developed land.

MDE is now working with the other Maryland Bay agencies and many partners in local jurisdictions to develop Phase II WIPs with more detailed reduction targets and specific strategies to further ensure that the water quality goals of the Bay TMDL will be met. Current reduction targets for the Patapsco watershed urban areas are: 29.0 percent for nitrogen, 45.1 percent for phosphorus based on the Bay TMDL, and 21.2 percent for sediment loads based on the local Patapsco TMDL. The Phase II process will continue through 2017.

1.4 U.S. EPA Watershed Planning "A-I Criteria"

This watershed plan is written to meet EPA guidance published in the October 23, 2003 Federal Register. The guidance requires watershed-based plans to restore waters impaired by nonpoint source pollution using incremental Section 319 funds to include particular "components of a watershed based plan". Baltimore County will request EPA review and acceptance of this watershed plan based on their A-I Criteria, so that NPS implementation projects consistent with this watershed plan will be eligible for 319(h) Grant funding. The watershed plan components listed in EPA's guidance, which are commonly called the "A-I Criteria", are summarized below:

a) Identification of the causes and sources that will need to be controlled to achieve the load reductions estimated in the watershed plan;

b) Estimates of pollutant load reductions expected through implementation of proposed nonpoint source (NPS) management measures;

c) A description of the NPS management measures that will need to be implemented;

d) An estimate of the amount of technical and financial assistance needed to implement the plan;

e) An information/education component that will be used to enhance public understanding and encourage participation;

f) A schedule for implementing the NPS management measures;

g) A description of interim, measurable milestones;

h) A set of criteria to determine load reductions and track substantial progress towards attaining water quality standards; and

i) A monitoring component to determine whether the watershed plan is being implemented.

This watershed plan meets the a-i criteria. Table 1-2 shows where these criteria are addressed throughout this watershed plan.

Table 1-2: Where to Locate Information for USEPA's A-I Criteria

Report Section	USEPA Criteria A	B	C	D	E	F	G	H	I
Chapter 1		✓							
Chapter 2		✓							
Chapter 3	✓	✓	✓		✓				
Chapter 4			✓		✓				
Chapter 5							✓	✓	✓
Appendix A			✓	✓	✓	✓	✓		
Appendix B									
Appendix C				✓					
Appendix D		✓						✓	
Appendix E	✓								

1.5 Partner Capabilities

In order to achieve effective watershed restoration, the capabilities of many organizations must be brought together and coordinated. Within the Baltimore region, a great deal of cooperation and coordination has been advancing in recent years as common goals in water quality improvement in local streams and rivers are sought.

1.5.1 Baltimore County

Baltimore County has a waterway restoration program to implement restoration projects, including stream restoration, stormwater conversions and retrofits, reforestation, and shoreline enhancement projects. The Patapsco River Water Quality Management Plan was submitted to Maryland Department of the Environment in 2000. Since then, five stream restoration projects have been completed in the Herbert Run East, Herbert Run West, and Patapsco A-5 subwatersheds. A retrofit project was also completed in conjunction with the County's Department of Public Works. An additional stream restoration and retrofit project at Catonsville Park is in the design and construction phase. A total of 4,250 linear feet of stream channel has either been restored or are in the design phase. Additional funding for projects is allocated in the capital budget through FY2016 (EPS 2010).

Baltimore County has an extensive monitoring program that assesses the current ambient water quality, efficiency of various restoration projects in relation to pollutant removal efficiency and biological community improvement, and tracks trends over time. The

County also has an Illicit Connection Program that monitors storm drain outfalls, tracks pollution sources, and coordinates remediation.

Baltimore County is under a consent decree to address Sanitary Sewer Overflows (SSOs). The consent decree has specific requirements for improvements to pumping stations, remediation of sanitary sewer lines, maintenance, and inspection. Implementation of the consent decree requirements will help reduce bacteria contamination, as well as reduce nitrogen and phosphorus in the streams.

The County operates street sweeping and inlet cleaning programs throughout the county that remove sediment, nitrogen, and phosphorus before they reach the waterways. These programs are tracked and estimates of the pollution removal are calculated (EPS 2010).

1.5.2 Friends of Patapsco Valley and Heritage Greenway (FPVHG)

The Friends of Patapsco Valley and Heritage Greenway, Inc. (FPVHG) is an organization dedicated to preserving, protecting, interpreting and restoring the environment, history and culture of the Patapsco Valley between Daniels and Elkridge, Maryland.

FPVHG has been working for almost a decade to protect the Patapsco River Valley and its associated watershed. Their major concern has been the impact within the watershed that development has had on increasing storm water runoff and pollutants. FPVHG has established good working relationships with Baltimore, Anne Arundel, and Howard Counties, the State of Maryland, and various land preservation/environmental organizations. They are working to identify and encourage the acquisition of additional environmentally sensitive lands for the State Park system. They have removed several earlier era dumpsites from within the Patapsco Valley State Park - concentrating on sites in the headwaters of streams leading to the Patapsco River. Volunteers conduct stream reconnaissance visits ("recons") to identify environmental trouble spots along streams and are implementing a Stream Watch Program. They use the information they receive to prioritize and conduct monthly stream cleanups and periodic tree plantings. Finally, FPVHG has invested time and effort to alert the community to the harm that comes from the trash and oil that goes into storm drain systems as well as the dangers from various invasive plants.

1.6 The Lower Patapsco River Watershed Overview

The Lower Patapsco River watershed is within the Eastern Piedmont region of Maryland, located south and west of the City of Baltimore (Figure 1-1). Table 1-3 summarizes key watershed characteristics of the Lower Patapsco River. It is one of three county planning areas that drain to the mainstem freshwater Patapsco River. The 375,000 acres of the Patapsco River Watershed (including the tidal portions) are located within Anne Arundel, Baltimore, Carroll, and Howard counties, as well as Baltimore City, Maryland. The South Branch of the Patapsco River (and thus the main stem of the Patapsco) flows about 35 miles from Parr's Spring in Carroll County to Baltimore City. The North Branch of the Patapsco is formed at the confluence of the East and West branches, flows through Liberty Reservoir and then joins the South branch near Sykesville. The Lower Patapsco

Figure 1-1: Lower Patapsco River SWAP Area

Table 1-3: Key Characteristics of Lower Patapsco Watershed, Baltimore County, MD.

Drainage Area	17,520 acres (27.4 sq. mi.)	
Stream Length	216.4 miles	
Subwatersheds	16	
Jurisdictions	Baltimore County	
Population	85,602 (2000 census)	
Land Use/Land Cover	Very Low Density Residential:	1.7%
	Low Density Residential:	3.9%
	Medium Density Residential:	28.7%
	High Density Residential:	8.3%
	Commercial:	3.5%
	Industrial:	6.5%
	Institutional:	6.6%
	Extractive:	0.1%
	Open Urban Land:	5.0%
	Agriculture:	2.2%
	Forest:	27.9%
	Barren Land:	0.2%
	Water/Wetlands:	1.9%
	Transportation	3.5%
Impervious Cover	3,758 acres (21.4% of watershed)	
Soils	A Soils (low runoff potential):	5.7%
	B Soils:	52.5%
	C Soils:	20.3%
	D Soils (high runoff potential):	21.5%

area comprises the southern portion of the watershed, including the areas from Catonsville to Arbutus, and is approximately 17,520 acres (27 square miles) or 51 percent of the County's portion of the Patapsco River watershed. In Baltimore County, along with the Lower Patapsco watershed area, the Upper Patapsco and Liberty Reservoir watersheds compose the Patapsco River watershed. SWAPs for these areas will be completed in upcoming years.

This SWAP focuses on all sixteen subwatersheds in the Lower Patapsco watershed within Baltimore County, which are predominantly urban land types. The area of the Lower Patapsco in Baltimore County represents 51% of the total Lower Patapsco watershed (Figure 1-1). A detailed review of the natural resources and landscape of the watershed is provided in the Lower Patapsco River Watershed Characterization report (Appendix E).

The Lower Patapsco River watershed is divided into smaller drainage areas called sub-watersheds. In addition to characterizing the entire watershed, analyses were conducted on a subwatershed scale to provide detailed information for smaller areas and to focus restoration and preservation efforts. Also, success of restoration efforts can be more easily monitored and measured on this smaller scale. As shown in Figure 1-2, the Lower Patapsco River watershed consists of 16 separate subwatersheds.

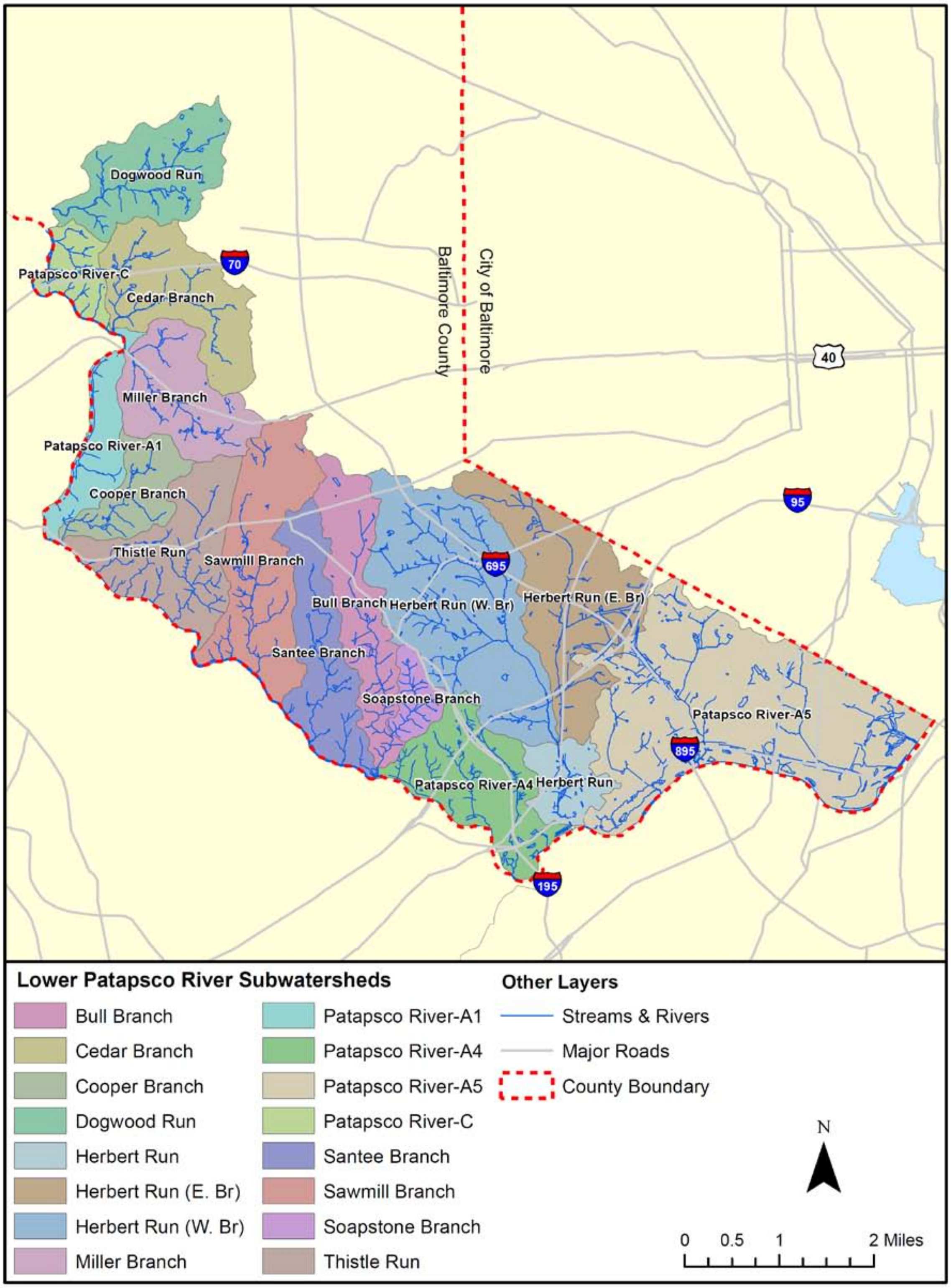

Figure 1-2: Lower Patapsco River Subwatersheds

1.7 Report Organization

The SWAP consists of two volumes. Volume 1 is the Small Watershed Action Plan and is organized into 5 major chapters. Volume 2 includes supporting materials as appendices.

1.7.1 Volume 1: The SWAP

Chapter 1 is a short introduction chapter explaining the background and purpose of the Small Watershed Action Plan (SWAP), the environmental mandates, partner organizations, and an overview of the report and the planning area.

Chapter 2 covers the Vision, Goals, and Objectives for the SWAP agreed upon by the steering committee and the stakeholders.

Chapter 3 describes the restoration strategies deemed as feasible by the steering committee and the stakeholders. Those strategies are categorized based upon municipal actions and citizen-based actions. Computations for estimating nutrient and sediment reductions from the proposed actions across the entire watershed are included in this section. Identified stream enhancement and restoration projects are also included, along with corresponding estimated loading reductions.

Chapter 4 presents restoration strategies by subwatershed and ranks the subwatersheds based on various evaluation criteria. A map showing the location of proposed restoration strategies, photos, and supporting narrative for the recommendations is included here.

Chapter 5 details how implementation of the SWAP will be evaluated long-term via monitoring and includes a discussion of performance measures.

This volume also includes the following appendices with additional, detailed information used to develop and support this SWAP.

- Appendix A consists of a table of all actions identified for implementation towards meeting goals divided into four categories: Restoration, Outreach and Awareness, Funding, and Reporting. The table includes the action, the performance measure, and schedule for implementation, unit cost, and the responsible party. The goal and objective of each action is described here.

- Appendix B provides information on how the development of the SWAP addresses EPA “a through i” criteria for watershed planning and serves as a guide to the location within the document where each criterion is addressed.

- Appendix C provides an analysis of the potential cost of implementation of the plan and a list of potential funding sources.

- Appendix D includes a table showing the most current Chesapeake Bay Program BMP reduction efficiencies.

1.7.2 Volume 2: Characterization Report

This volume includes the following appendices with supporting documentation related to the current conditions of the Lower Patapsco River watershed.

- Appendix E contains the Lower Patapsco River Watershed Characterization report.
- Appendix F describes methods used by the 2000 Patapsco Water Quality Management Plan for selecting stream restoration sites.
- Appendix G contains stream reconnaissance reports from FPVHG on stream sections with possible stream restoration opportunities, based surveys performed 2006-2009.
- Appendix H contains Upland Survey Data Summaries.
- Appendix I contains supporting calculations for NSA Analyses.
- Appendix J provides copies of current TMDLs applicable to the planning area.
- Appendix K contains photographs taken during 2011 field assessments of storm-water management facilities.
- Appendix L contains Access databases, scanned copies of Upland Assessment field datasheets, and digital photographs from Upland Assessment field visits.

CHAPTER 2: VISION, GOALS, AND OBJECTIVES

2.1 Vision Statement

The Lower Patapsco River Watershed Steering Committee adopted the following vision statement that served as a guide in the development of the SWAP:

> *We envision healthy stream systems leading to the Lower Patapsco River, with good water quality and diverse aquatic life. Our watershed conserves treasured natural resources including the rivers, streams, waterways, wetlands, wildlife, forests and parkland. Even with the area's intensive residential, commercial, institutional and industrial uses, the watershed provides opportunities for outdoor recreation in sustainable natural ecosystems. Citizens, businesses and institutions are involved in stewardship of land and water to help protect and maintain the watershed for generations to come.*

2.2 Lower Patapsco River SWAP Goals & Objectives

A total of nine goals were identified for restoring the Lower Patapsco River watershed based on the vision statement and input from both Steering Committee and Stakeholder meetings. The goals were developed through discussions with the Lower Patapsco River SWAP Steering Committee and refined based on feedback from watershed residents at the stakeholder meetings. Stakeholders were given the opportunity to rank the importance of goals developed by the Steering Committee, raise any additional issues that are important to the community, and indicate the type of restoration activities that are of interest to achieve watershed goals. Stakeholder participation is important to ensure the implementation and success of the plan.

The following sections present a discussion of each of the nine goals for restoring the Lower Patapsco River watershed. For each goal, a series of objectives was developed to ensure that the plan will meet each goal. An objective is a measurable statement such as "reduce Total Phosphorus loading in the watershed by 45.1%." Action strategies describe the method that will be used to achieve the objective and ultimately, the water quality goal. An example of an action strategy for phosphorus reduction could be "reforestation of 25 acres of open pervious area" in a given subwatershed. The action strategies developed to achieve these objectives and goals are summarized in Appendix A and discussed further in Chapter 4.

When possible, action strategies are expressed as quantifiable measures (e.g., linear feet of forested buffer planted). However, the numeric values assigned to these actions are intended to serve as a guide, rather than an absolute measure, in achieving watershed goals and objectives. Many actions address multiple watershed goals and objectives. Appendix A provides a table that lists the action strategies proposed for the Lower Patapsco River watershed and their applicable goals and objectives.

The general types of restoration strategies proposed for the Lower Patapsco River watershed are discussed further in Chapter 3. The Steering Committee has determined that an adaptive management approach will be emphasized as SWAP implementation progresses. This approach includes evaluating the success of SWAP implementation over time (see Chapter 5) and modifying action strategies based on community acceptance and availability of funding.

2.2.1 Goal 1: Improve and Maintain Clean Water

The Lower Patapsco River is identified as being impaired by nutrients, sediment, and bacteria, as indicated in the Maryland 303 (d) list of impaired waters. To rectify these impairments, a TMDL analysis has been completed for nitrogen, phosphorus, total suspended solids (TSS), and bacteria. The objectives below are designed to meet the TMDL reduction requirements in the Lower Patapsco River watershed.

Objectives:

1. Reduce annual average Total Nitrogen (TN) and Total Phosphorus (TP) loadings in the Lower Patapsco SWAP area by 29% and 45.1%, respectively, compared to the loadings estimated for the baseline period to meet the requirements developed by the Chesapeake Bay TMDL analysis.
2. Reduce annual average sediment loadings to the Lower Patapsco SWAP area by 21.2% compared to the loading estimated for the baseline period to meet the requirements developed by the Patapsco watershed sediment TMDL analysis.
3. Reduce annual average bacteria to the Lower Patapsco SWAP area by 16% compared to the loading estimated for the baseline period to meet the requirements developed by the Patapsco watershed TMDL analysis.
4. Improve water quality to the point where the Lower Patapsco will be safe for recreation.

2.2.2 Goal 2: Reduce Trash and Promote Recycling

Trash is one of the most noticeable pollutants in the Lower Patapsco River. Trash is generated throughout the watershed and readily moves through storm drains, entering small streams and the Patapsco River, and ultimately the Chesapeake Bay. Besides the glaring visual detriment to the River's natural beauty, trash contributes toxins and presents a hazard to water fowl, other wildlife and people. Reducing trash and increasing recycling is mainly an issue of public awareness and stewardship. By engaging citizens of all ages to help clean up the trash and to dispose of trash responsibly, the stage will be set to change behaviors, leading to other positive actions for a healthier Lower Patapsco River.

Objectives:

1 Reduce trash in upland areas identified in the field assessments.
2. Continue funding for community clean-ups.
3. Reduce trash in waterways.
4. Increase participation in single stream recycling.

2.2.3 Goal 3: Increase Citizen Participation with Restoration Projects

People are empowered when they can physically make a difference and improve their community in a way that benefits everyone. Clean-ups and other restoration projects are great opportunities for education. Students, families, and community groups (civic, corporate, religious, etc.) are readily available labor sources. All restoration projects should be recognized as celebrations of our natural heritage.

Objectives

1. Increase the number and variety of watershed restoration projects.
2. Continue funding for community restoration projects.
3. Use public facilities as examples for restoration projects.

2.2.4 Goal 4: Restore and Maintain Fisheries and Habitat

Physical damage to aquatic and terrestrial habitats has resulted over time from development of land and shorelines, poor land management practices, introduction of exotic invasive species and obstructions to upstream breeding sites, etc. The objectives for this goal relate to the improvement of degraded river conditions that result in poor conditions for aquatic life.

Objectives

1. Implement habitat restoration projects to remove the biological impairment in the Patapsco watershed.
2. Create riparian buffers and enhance existing buffers to quality forests to filter runoff and provide habitat.
3. Assure that fish caught in the Patapsco are safe to eat.
4. Identify and remove barriers to fish migration.

2.2.5 Goal 5: Encourage Environmentally Friendly, Low-Impact Recreation

Participation in outdoor recreation allows citizens to develop an appreciation for the beauty and value of the natural resources available to them. When people have hiked along a trail or paddled a stream, and seen firsthand the impact of trash and pollution, they may feel greater motivation to participate in clean-ups and become advocates for the health of the Lower Patapsco River. However, it is necessary to balance the benefits of outdoor recreation with the toll it can take on the environment. Proper planning and education can minimize these drawbacks and maximize the educational value and enjoyment of the outdoor experience.

Objectives

1. Promote existing and develop new connections for communities and schools to parks and natural areas.
2. Develop and promote awareness of 'leave no trace' principles.

2.2.6 Goal 6: Enhance Unused Open Space and Increase Urban Tree Cover

Land management principles and community design have come a long way over the past several decades. However, even areas that were developed prior to the implementation of environmentally-friendly design philosophies still hold opportunities for becoming "greener". For example, underutilized space may be used for planting trees. Whether planting trees along a strip of grass between a neighborhood sidewalk and a road or planting a random pocket of mowed lawn next to a parking lot, tree-planting is a low-cost and efficient way to provide both environmental and aesthetic benefits. Tree planting and other open space events are excellent ways to promote community involvement and provide outreach on other ways they can help control stormwater in one's neighborhood and improve stream health.

Objectives

1. Convert open pervious areas identified in the upland assessments to forest by planting trees to increase natural habitat and stormwater benefits.
2. Promote tree planting on residential properties.
3. Increase number of street trees to provide water quality, aesthetic and energy benefits.
4. Develop natural play areas to promote awareness and appreciation of the natural world at an early age.

2.2.7 Goal 7: Improve and Maintain Healthy Forests and Wildlife Habitat

Healthy forests contribute to healthy streams and a healthy Chesapeake Bay. Forests are a multi-functional part of any landscape, as they reduce high stormwater flows that cause erosion in streams, remove nutrients and pollutants from stormwater runoff, and provide shade and food to aquatic animals living in streams and rivers. By considering wildlife and their habitat needs, strong, robust ecosystems are promoted and protected and animals are provided areas to exist within an urbanized landscape.

Objectives

1. Control exotic invasive species in forested areas.
2. Raise community awareness regarding invasive species identification, control or removal.
3. Protect and maintain healthy forests.

2.2.8 Goal 8: Conduct Public Education to Raise Awareness About Water Quality in the Lower Patapsco River Watershed

There is no substitute for engaged and involved citizens participating in the protection of their local watersheds. However, the first step to engaging citizens is making them aware of the problems particular to the Lower Patapsco River watershed. In a modern, urbanized landscape, it is easy to become disconnected from the natural environment, since few people have a stream running through their backyard. In addition, the thought of tackling challenges, like those faced by the Chesapeake Bay, can be overwhelming for most people. By raising awareness about the issues facing a nearby stream, citizens are given an opportunity to take action on a local, more manageable scale, where they are more likely to see the positive effects their actions produce, and thus continue their efforts.

Objectives

1. Raise community members' awareness concerning the causes and effects of watershed and habitat degradation and encourage behavior modifications.
2. Identify opportunities for demonstration projects and practices relevant to homeowners, local businesses, and churches.

2.2.9 Goal 9: Promote and Encourage Environmentally Sensitive Development

The old saying goes that an ounce of prevention is worth a pound of cure. This is especially true in respect to environmental protection, where, for example, implementing stormwater controls and other protective measures in the design and building phase are far less costly than the stream restoration projects needed to repair damage from uncontrolled stormwater runoff. Environmental Site Design (ESD) provides a complete toolbox of tried and true methods, as well as innovative technologies, to minimize the impact of stormwater on nearby streams and rivers.

1. Continue to apply Baltimore County's forest buffer regulations to enhance and protect streams.

2. Continue to enforce sediment control practices and, when required by MD law, apply new sediment control regulations to projects.
3. Continue to apply forest conservation regulations to enhance and protect natural resources.
4. Continue implementing stormwater management regulations that increase the use of non-structural techniques using ESD guidelines to increase infiltration.
5. Improve internal coordination mechanisms for County building projects (to include schools and colleges) to assure projects lead by example and provide demonstration opportunities.
6. Encourage park and playground development to develop or enhance natural play spaces.

CHAPTER 3: RESTORATION STRATEGIES

3.1 Introduction

This chapter presents an overview of the key restoration strategies and associated pollutant load reductions proposed for restoring the Lower Patapsco River watershed. A complete list of actions proposed for the watershed including goals and objectives targeted, timelines, performance measures, cost estimates, and responsible parties is included in Appendix A. Although only key, quantifiable restoration strategies are the focus of this chapter, it is important to remember that a combination and variety of restoration practices, from capital stream restoration projects to public education and outreach, are needed to engage citizens and meet watershed-based goals and objectives.

The Lower Patapsco River watershed restoration will occur as a partnership between the local government, watershed groups, and citizens. The actions of each partner are critical to the success of the overall watershed restoration strategy. Local governments are able to implement large capital projects such as stream restoration, large-scale stormwater retrofits, changes in municipal operations, and large-scale public awareness campaigns. Watershed groups and citizens are able to implement locally-based programs such as tree plantings and downspout disconnection. Therefore, key restoration strategies are divided into two broad categories: municipal strategies (Chapter 3.2) and citizen-based strategies (Chapter 3.3). It is important that restoration occurs at all levels to ensure that a wide range and variety of projects is implemented. This will encourage citizen participation and awareness, which is also critical to the success of restoration efforts.

The watershed pollutant loading analysis performed to estimate current nutrient loads generated by the various non-point sources within the Lower Patapsco River watershed is discussed in Chapter 3.3. Chapter 3.4 discusses the pollutant removal calculations for proposed BMPs (i.e., key restoration strategies discussed in Chapters 3.2 and 3.3) to ensure that TMDL requirements are met in Lower Patapsco River.

3.2 Municipal Strategies

Baltimore County is working to improve watershed health and water quality by restoring local streams, through capital improvement projects and municipal management activities (e.g., development review, street sweeping, illicit connection programs, etc.). Key municipal strategies proposed for restoring the Lower Patapsco River are discussed in the following sections.

3.2.1 Stormwater Management

Increased importance of water quality and water resource protection led to the development of the Maryland Stormwater Design Manual, which provided BMP design standards and environmental incentives (MDE 2000; 2009 revisions). There has been a general shift toward adopting practices that mimic natural hydrologic processes, are low impact, and achieve pre-development conditions. Building upon the approaches in the 2000 Manual, the Maryland Stormwater Act of 2007 (and 2009 revisions to the Manual) takes those principles one step further and requires that Environmental Site Design (ESD) be implemented to the maximum extent practicable (MEP) via the comprehensive use of non-structural BMPs and/or other better site design techniques that mimic predevelopment. The intent of ESD is to distribute flow throughout a development site and reduce stormwater runoff leaving that site. This will also reduce pollutant loads and prevent stream channel erosion.

A total of 230 existing SWM facilities are located within the Lower Patapsco River watershed including dry and wet ponds, wetlands, infiltration/filtration practices, extended detention, and proprietary BMPs. Existing SWM facilities treat a total drainage area of approximately 2,795 acres of urban land or 23.8 percent of the total urban land use in the watershed.

3.2.2 Stormwater Management Conversions

Detention ponds are typically designed to address water quantity only (channel protection and/or flood control) and therefore provide almost no pollutant removal. Because they have already been created for water treatment purposes, and because they have established maintenance agreements they are excellent candidates for conversion to a type of facility that provides pollution control benefits in addition to quantity control. Conversion is relatively simple and certainly cheaper than permitting and constructing a new BMP. For example, dry extended detention ponds are designed to capture and retain stormwater runoff from a storm to allow sediment and pollutants to settle out while also being able to simultaneously provide flood control. Baltimore County identified 51 existing stormwater management facilities in the Lower Patapsco River watershed for evaluation of their conversion potential. Four of these facilities were recommended as those with the highest priority for conversion.

3.2.3 Stormwater Retrofits

Stormwater management retrofits involve implementing BMPs in existing developed areas where SWM practices do not currently exist in order to help improve water quality. Stormwater retrofits improve water quality by capturing and treating runoff before it reaches receiving water bodies. For example, based on initial field and desktop evaluations, Neighborhood Source Assessments identified five sites as having sufficient open space for stormwater retrofits to treat runoff from impervious parking lots or alleys. Candidate sites for stormwater retrofits will be drawn from all four upland components surveyed: neighborhoods, hotspots, institutions, and pervious areas.

Impervious surfaces, including roads, parking lots, roofs and other paved surfaces, prevent precipitation from infiltrating into the ground as it would naturally in a forest or meadow in good condition. As a result, impervious surface runoff can result in decreased times of concentration of stormwater to receiving streams (“flashy flows”) leading to erosion, flooding, habitat destruction, and increased pollutant loads to receiving water bodies. Subwatersheds with high proportions of impervious cover are more likely to have degraded stream systems and be significant contributors to water quality problems in a watershed than those that are less developed. Removing impervious cover and converting it to pervious or forested land will help promote infiltration of runoff and reduce pollutant loads.

Unused or unmaintained (broken, crumbling) impervious surfaces with the potential for removal were identified at four institutional locations. The areas of these impervious surfaces were used to estimate potential pollutant load reductions as a result of impervious cover removal activities.

While not included in pollutant reduction calculations, education and outreach tools could be used to inform residents of the water quality impacts associated with large impervious parking lots, driveways or patios and options available for conversion to or incorporating more permeable surfaces.

3.2.4 Stream Restoration

Stream restoration practices are used to enhance the appearance, stability and aquatic function of urban stream corridors. Stream restoration practices range from routine stream cleanups and simple stream repairs, such as vegetative bank stabilization and localized grade control, to comprehensive repairs, such as full channel redesign and realignment. Analysis of previous studies completed in the Lower Patapsco River watershed showed opportunities for stream restoration. Stream corridors noted to have significant erosion and channel instability were used to estimate pollutant load reductions for potential stream repair efforts. Stabilizing stream channels improves water quality by preventing eroded soils, and the pollutants contained in them, from entering the stream and making their way to the Patapsco River and Chesapeake Bay.

3.2.5 Street Sweeping and Trash Reduction

Street sweeping removes floatables, sediment, heavy metals and nutrients associated with sediment particles, petroleum associated with sediment, and organic matter such as leaves and twigs from the curb and gutter system, preventing them from entering storm drains and nearby streams. Decay of a disproportionate amount of organic matter in the stream can take away oxygen needed for supporting aquatic life. Additionally, excessive organic matter can clog streams and storm drains, causing flooding resulting in costly maintenance.

Neighborhoods with significant trash and/or organic matter build-up along curbs were recommended for street sweeping during neighborhood source assessments (NSAs). Baltimore County Department of Environmental Protection and Sustainability will be collaborating with the County's Department of Public Works to determine the amount of increased street sweeping that would be possible for the recommended neighborhoods. Adding a targeted neighborhood to the sweeping route or increasing frequency of sweeping would address build- up of excessive curb and gutter material.

Baltimore County's approach to trash and litter reduction is a multi-faceted approach. This effort includes public service advertising, a trash treaty, celebrity encouragement, clean-ups, and enforcement.

A citizen awareness campaign is part of the overall strategy, and focuses on better stewardship regarding trash issues. Advertising includes different media for different audiences. Videos using images that resonate with teens are to be posted on YouTube or similar electronic distribution networks. Other elements include trash can signs, point-of-sale displays and print ads.

A trash treaty encourages citizens to vow not to litter. Volunteers lead the effort by gathering the signatures. Those that sign up receive a gift such as a reusable grocery bag or recycling & litter bags for cars. Data indicates that if someone signs a petition they are much more likely to act upon the issue.

Celebrities have an extremely strong influence on the public. They can easily motivate both children and adults to change behaviors. A "Trash Talkin' with the Ravens" campaign led by a Ravens player is expected to have a substantial impact with the public.

Clean-ups, promoted as Quick Pick-It-Ups, include all audiences. Groups may include recreation councils, scout troops, businesses and religious organizations. A model used in Howard County was very successful where specific dates and times are promoted, however it is clear that any clean-up will be counted towards the goal. Additional clean-ups are encouraged through Project Clean Stream, Stream Watch and the County's Adopt-a Road program.

Enforcement is the stick that every institution hopes is unneeded, but recognizes is necessary. Baltimore County uses local police and staff from its Code Enforcement unit. Enforcement actions usually address businesses or apartments with consistent litter problems, overflowing dumpsters and dumping.

3.2.6 Illicit Connection Detection/Disconnection

An Illicit Discharge Detection and Elimination program has been developed by Baltimore County to find and stop discharges into streams that are harmful to aquatic life and water quality or that are causing erosion/sedimentation problems. The County will continue its Illicit Discharge Detection and Elimination program, seeking to improve techniques and methodologies for more effective reductions of these discharges. Pollutant reductions associated with this program are not included in pollutant removal analyses due to the uncertainty in the contribution of illicit connections to overall pollutant loading rates. However, this program will provide a margin of safety in the overall nutrient reduction strategy.

3.2.7 Sanitary Sewer Consent Decree

In September 2005, USEPA and MDE issued a consent decree to Baltimore County with deadlines to reduce and eliminate sanitary sewer overflows (SSOs). Implementation of work (capital projects, equipment, operations and maintenance improvements) in compliance with the consent decree will result in a reduction of nutrients and bacteria entering streams in the Lower Patapsco River watershed.

3.3 Citizen-Based Strategies

The participation of citizens in watershed restoration is an essential part of the SWAP process. When large numbers of individuals become involved in citizen-based water quality improvement initiatives, changes can be made to the aesthetic and chemical aspects of waterways within the watershed that would not be possible without public participation. Citizen participation is critical to the implementation and long-term maintenance of restoration activities. Key citizen-based strategies proposed for restoring Lower Patapsco River are discussed in the following sections.

3.3.1 Reforestation

Trees help improve water quality by capturing and removing pollutants in runoff including removal of excess nutrients through their roots before the pollutants enter groundwater and streams. Tree leaves and stems also intercept precipitation which helps to reduce the energy of raindrops and prevent any erosion resulting from their impact on the ground. In addition to water quality improvement, trees provide air quality, aesthetic and economic benefits. For example, trees strategically planted around a house can form windbreaks to reduce heating costs in the winter and can provide shade reducing cooling costs in the summer. Incentive programs, such as Tree-Mendous Maryland and State Highway Administration's (SHA) Partnership Program for public property, can help increase the success of planting efforts. Several areas throughout the watershed are targeted for reforestation opportunities and are described below.

3.3.1.1 Riparian Buffer

Stream and shoreline riparian buffers are critical to maintaining healthy streams and rivers. Forested buffer areas along streams and shorelines can improve water quality and prevent flooding since they can filter pollutants, reduce surface runoff, stabilize stream banks, trap sediment, and provide habitat for various types of terrestrial and aquatic life including fish. Buffer encroachment as a result of development was noted during uplands and stream surveys conducted throughout the watershed. Areas on privately-owned land (e.g., residential properties) can be targeted for buffer awareness initiatives to encourage landowners to plant trees and/or create a no-mow area adjacent to streams and shorelines. Open pervious areas identified within the 100-foot stream and shoreline buffer areas via a GIS analysis in the Watershed Characterization Report (Appendix E) are good candidates for tree planting and are targeted for initial buffer reforestation efforts.

3.3.1.2 Upland Pervious Areas

Converting open areas in the upland portion of the watershed to forested areas through tree plantings can also reduce nutrient inputs to nearby streams and reduce erosion. Large open areas identified in the pervious area assessments (PAAs) should be further investigated for tree planting potential. Publicly-owned lands requiring minimal site preparation are targeted for initial reforestation efforts.

3.3.1.3 Street and Shade Tree Plantings

Several opportunities for neighborhood street tree plantings were identified during NSAs. Opportunities for open space, shade tree plantings were also identified at several institutional sites and in some multi-family neighborhoods. Street trees and open space shade trees provide aesthetic value and air and water quality benefits. They provide shade thereby reducing urban heat-island effect while also providing habitat for wildlife. They also absorb nutrients through their root systems.

Canvassing residents and/or contacting homeowner associations can be effective techniques for implementing a street tree planting program within a neighborhood. Tree planting incentive programs mentioned previously can also help increase the success of planting efforts.

3.3.2 Downspout Disconnection

Downspout disconnection can help reduce runoff and pollutants introduced to local streams. This can be achieved through downspout redirection (from impervious to pervious areas), rain barrels, and/or rain gardens. A combination of outreach/awareness techniques and financial incentives can be used to implement a downspout disconnection program in neighborhoods identified as potential candidates during NSAs. Pilot disconnection programs have been conducted in Upper Back River by Blue Water Baltimore and the Center for Watershed Protection (CWP). Results from these programs can be used to determine successful techniques and strategies for Lower Patapsco River.

3.3.3 Urban Nutrient Management

Raising awareness among citizens about some of the common activities around their homes and how those activities can negatively affect water quality is an excellent citizen-based strategy. Yards and lawns typically represent a significant portion of the land cover in an urban subwatershed and therefore, can be a major source of nutrients, pesticides, sediment, and runoff. Fertilization, pesticide use, watering, landscaping, and trash/yard waste disposal all impact subwatershed quality. Urban nutrient management efforts related to lawn maintenance and using natural “Bayscaping” (defined below) as opposed to manicured monocultures of lawn grass can help reduce nutrient inputs to nearby streams.

3.3.3.1 Lawn Maintenance Education

Lawn maintenance activities often involve over-fertilization, poor pest management, and over-watering resulting in excess pollutant runoff to local streams. Lawns with a dense, uniform grass cover or signs designating chemical lawn care treatment indicate high-maintenance lawn care activities. Neighborhoods identified as having high lawn maintenance issues should be targeted for awareness programs emphasizing responsible fertilizing techniques such as proper application, proper time of year for fertilization, soil testing for nutrient requirements and keeping fertilizers away from impervious surfaces. Lawn maintenance education can be achieved through door-to-door canvassing, informational brochures/mailings, excerpts in community newsletters, or demonstrations at community meetings. Information on organic alternatives to chemical lawn treatments should also be included in these outreach efforts.

3.3.3.2 Bayscaping

Reducing the amount of mowed lawn and increasing landscaping features provides water quality benefits through interception and filtration of stormwater runoff. Bayscaping refers to the use of plants native to the Chesapeake Bay watershed for landscaping. Because they are native to the region, these plants require less irrigation, fertilizers, and pesticides to maintain as compared to non-native or exotic plants. This means less maintenance and therefore less stormwater pollution. Bayscaping is also beneficial to wildlife because it creates pockets of native habitat. Similar to lawn maintenance education, Bayscaping awareness can be raised through informational brochures/mailings, excerpts in community newsletters, or demonstrations at community meetings. A combination of outreach/ awareness techniques and financial incentives can be used to implement a Bayscaping program in neighborhoods identified as potential candidates during NSAs.

3.4 Pollutant Loading and Removal Analyses

This section presents results of the watershed pollutant loading analysis performed to estimate current nutrient loads generated by the various non-point sources within the Lower Patapsco watershed. Also discussed are the pollutant removal calculations for proposed BMPs to ensure the TMDL requirements are met in the Lower Patapsco watershed.

3.4.1 Pollutant Loading Analysis

A pollutant loading analysis was performed to estimate total nitrogen, phosphorus, and sediment loads currently generated by all non-point sources (i.e., runoff from all land uses) present within the Lower Patapsco watershed. Estimates were based on Maryland Department of Planning's (MDP) 2007 Land Use/Land Cover (LU/LC) GIS layer and pollutant loadings rates developed by CBP for all land uses. The pollutant loading analysis is described in detail in Chapter 3.3 of the Watershed Characterization Report (Appendix E). Table 3-1 summarizes results from the watershed pollutant loading analysis including areas, nutrient loadings rates, and annual nutrient loads for each nonpoint source/land use type.

Table 3-1: Lower Patapsco Watershed Nitrogen, Phosphorus, and Sediment Loads Estimated Using 2007 MDP Land Use/Land Cover (see Appendix E for details)

Source	Area (acres)	Nitrogen		Phosphorus		Sediment	
		Rate (lbs/ac)	Load (lbs/yr)	Rate (lbs/ac)	Load (lbs/yr)	Rate (lbs/ac)	Load (lbs/yr)
Impervious Urban	3,599	12.56	45,203	1.05	3,795	1,242	4,470,121
Pervious Urban	7,984	7.86	62,728	0.19	1,538	167	1,329,514
Cropland	198	20.73	4,106	1.27	251	1,648	326,426
Pasture	232	5.94	1,379	0.60	140	357	82,971
Forest	5,091	2.70	13,734	0.04	193	106	541,471
Water	68	10.26	697	0.61	41	-	
Bare Soil	35	14.95	517	1.61	56	3,643	126,058
Totals	17,206		128,364		6,014		6,876,560

As discussed in Chapter 1, a TMDL analysis showed stormwater runoff is the primary contributor to nutrient and sediment inputs to the Lower Patapsco watershed. The bulk of the nitrogen, phosphorus, and sediment reductions required to meet the Chesapeake Bay TMDL and water quality standards for the Lower Patapsco watershed will come from control of stormwater runoff. The Chesapeake Bay TMDL analysis determined that a 29 percent reduction in nitrogen and a 45.1 percent reduction in phosphorus loads from urban stormwater discharges are necessary to meet Bay water quality standards. The Patapsco LNB sediment TMDL requires a 21.2 percent reduction in sediment from the urban Baltimore County portion of the watershed to meet water quality standards in the Patapsco River. The load reductions needed within the urban portion of Lower Patapsco watershed to achieve these reductions are summarized in Table 3-2.

Table 3-2: Lower Patapsco Watershed Nitrogen, Phosphorus, and Sediment Load Reductions

Source	Area (acres)	TN Load (lbs/yr)	TP Load (lbs/yr)	Sediment Load (lbs/yr)
Urban	11,583	107,931	5,333	5,799,635
Reduction Goal:		31,300	2,405	1,229,523

3.4.2 Pollutant Removal Analysis

The following sections present a quantitative analysis of pollutant removal capabilities of the proposed BMPs to ensure that the required reduction in nutrient loads from urban runoff in the Lower Patapsco watershed is achieved. Note that many of the removal efficiencies used to estimate pollutant reductions are based on peer-reviewed and CBP-approved nonpoint source BMP tables developed for the Phase 5.3 CBP Watershed Model. These tables are included in Appendix D. Also note that the calculations and estimates presented in the following subsections represent maximum potential pollutant capabilities. A summary of overall pollutant load reduction estimates is presented at the end of this section for two scenarios: a maximum implementation scenario and one based on projected participation for each BMP.

3.4.2.1 Implemented Capital Improvement Projects

Baltimore County has implemented many capital improvement projects in the county's various watersheds including stream restoration, stormwater facility conversions and retrofits, and shoreline enhancements. The County has implemented one filtration capital improvement project and five stream restoration projects (totaling 2,150 linear feet of stream) in the Lower Patapsco watershed. Pollutant loads were estimated by the County based on the contributing drainage area (DA) and the corresponding project type's land use-specific pollutant loading rates. Load reduction is calculated as the product of the pollutant load and removal efficiency. For the BMP retrofit, filtration pollutant removals are 40% for nitrogen, 60% for phosphorus, and 80% for sediment per the values shown in Appendix D under Urban and Mixed Open BMPs, Stormwater Management. For stream restoration projects, nutrient reduction credits are based on the length of stream restored. A summary of existing load reductions are shown in the Table 3-3.

Table 3-3: Load Reductions Estimated for BMP Retrofit and Stream Restoration Projects in Lower Patapsco Watershed

Project	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	Sediment Reduction (lbs/yr)
Retrofit			
Bloomsbury, Retrofit	35.6	2.0	2,703
Stream Restorations			
Herbert Run @ Selma Ave	11.0	1.9	1,403
Herbert Run @ Leeds Ave	6.0	1.1	765
2203 Sulphur Spring Rd	4.0	0.7	510
Halethorpe Streambank	2.0	0.4	255
Herbert Run @ Paradise Ave	20.0	3.5	2,550

3.4.2.2 Existing Stormwater Management (SWM)

As described in detail in Section 2.3 of the Watershed Characterization Report (Appendix E), there are 223 existing SWM facilities in the Lower Patapsco watershed including dry ponds, infiltration/filtration practices, extended detention, proprietary BMPs and other types of SWM facilities (i.e., underground detention). The pollutant removal capability of the existing SWM in the watershed is not fully accounted for in the pollutant loading analysis; therefore, it is included in the pollutant removal analysis.

Pollutant reductions for existing SWM are calculated based on the approximate pollutant load received from the drainage area (DA) and removal efficiencies (RE) recommended by CBP for the various types of SWM faculties. The equation used to estimate total nitrogen (TN) load reductions for a particular type of SWM facility is expressed as:

$$[9.32(\text{lbs/ac/yr}) * \text{DA (acres)}] * \text{RE (\%)}$$

The equation used to estimate total phosphorus (TP) load reductions for a particular type of SWM facility is expressed as:

[0.46(lbs/ac/yr)*DA (acres)]* RE (%)

The equation used to estimate sediment load reductions for a particular type of SWM facility is expressed as:

[500.67(lbs/ac/yr)*DA (acres)]* RE (%)

The pollutant load received from the drainage area contributing to the SWM facility is denoted by the first expression in brackets in the above equations. The pollutant loading rates shown, 9.32 lbs TN ac/yr, 0.46 lbs TP ac/yr, and 500.67 lbs sediment ac/yr, represent the weighted average of impervious and pervious urban rates used in the pollutant loading analysis (Table 3-2) since this represents the likely sources of runoff being treated. Note that impervious and pervious urban loading rates are based on CBP's Watershed Model Phase 5.3. The percent pollutant removal efficiency depends on the type of facility and is based on the values shown in Appendix D under Urban and Mixed Open BMPs, Stormwater Management. The total pollutant load reduction expected from existing SWM is a sum of the removal capacities of the individual facilities. A summary of existing SWM load reduction calculations and results are shown in the Table 3-4.

Table 3-4: Existing SWM Load Reductions

SWM Facility Type	#	DA (acres)	Total Nitrogen			Total Phosphorus			Sediment		
			Load from DA (lbs/yr)	RE	Max Potential Load Reduction (lbs/yr)	Load from DA (lbs/yr)	RE	Max Potential Load Reduction (lbs/yr)	Load from DA (lbs/yr)	RE	Max Potential Load Reduction (lbs/yr)
Bioretention	1	0.75	6.99	25%	1.75	0.34	45%	0.16	375	55%	206
Dry Pond	52	1,476	13,755	5%	688	679	10%	67.89	738,926	10%	73,893
Dry Well	6	0.14	1.29	80%	1.03	0.06	85%	0.05	69	95%	66
Extended Detention	61	553	5,149	20%	1,030	254	20%	50.83	276,628	60%	165,977
Infiltration Basin	16	310	2,888	85%	2,455	143	85%	121	155,162	95%	147,404
Infiltration Trench	6	45.65	426	80%	340	21.00	85%	17.85	22,857	95%	21,714
Oil/Grit Separator	6	12.88	120	5%	6.00	5.93	10%	0.59	6,449	10%	645
Permeable Pavement*	2	1.64	15.31	15%	2.30	0.76	20%	0.15	822	55%	452
Sand Filter	22	111	1,035	40%	414	51.07	60%	30.64	55,591	80%	44,472
Shallow Marsh	2	177	1,653	20%	331	81.57	45%	36.71	88,783	60%	53,270
Stormceptor	2	1.78	16.58	5%	0.83	0.82	10%	0.08	891	10%	89
Swale	13	6.53	60.86	70%	42.60	3.00	75%	2.25	3,269	80%	2,615
Underground Structure	24	60.10	560	5%	28.01	27.65	10%	2.76	30,091	10%	3,009
Wet Pond	10	202	1,879	20%	376	92.75	45%	41.74	100,952	60%	60,571
Total	**223**	**2,958**	**27,566**		**5,716**	**1,361**		**372.89**	**1,480,865**		**574,383**

*For Permeable Pavement (PP), the removal rate of nitrogen used was a calculated average of the removal rates for PP-with sand and vegetation and PP-without sand and vegetation. Both categories of PP included c/d soils and underdrains.

3.4.2.3 Stormwater Management Conversions

Thirty-nine dry ponds could be converted to facilities with higher capacity for nutrient removal. Pollutant reductions for SWM conversions are calculated based on the approximate pollutant load received from the drainage area (DA) and the increase in removal efficiency (RE) based on BMP efficiencies by CBP for detention and extended detention facilities (Simpson and Weammert 2009). The equation used to estimate total nitrogen (TN) load reductions for SWM conversion is expressed as:

[9.32(lbs/ac/yr)*DA (acres)]*RE (%)

The equation used to estimate total phosphorus (TP) load reductions for SWM conversion is expressed as:

[0.46(lbs/ac/yr)*DA (acres)]* RE (%)

The equation used to estimate sediment load reductions for SWM conversion is expressed as:

[500.67(lbs/ac/yr)*DA (acres)]* RE (%)

The pollutant load received from the drainage area contribution to the SWM facility is denoted by the first expression in brackets in the equations above. Similar to existing SWM, the pollutant loading rates, 9.32 lbs TN/ac/yr, 0.46 lbs TP/ac/yr, and 500.67 lbs Sediment ac/yr, represent the weighted average of impervious and pervious urban rates in the pollutant loading analysis (Table 3-2) since this represents the likely sources of runoff being treated. The increased pollutant removal capacity is represented by the second expression in the equations above. This is the difference between percent pollutant removal efficiencies of the facilities, based on CBP guidance shown in Appendix D under Urban and Mixed Open BMPs, Stormwater Management. A summary of SWM conversion load reduction calculations and results are shown in Tables 3-5a and 3-5b.

Table 3-5a: SWM Conversion Load Reductions

Pollutant	Total DA for SWM Conversion (acres)	Original RE	New RE	Increase in Efficiency	Max Potential Load Reduction (lbs/yr)
Dry Extended Detention Pond convert to non-mowing and add planting (1 site)					
TN	23.89	20%		N/A	0
TP	23.89	20%		N/A	0
Sediment	23.89	60%		N/A	0
Convert 39 Dry Ponds to Dry Extended Detention Ponds					
TN	614.8	5%	20%	15%	859
TP	614.8	10%	20%	10%	28
Sediment	614.8	10%	60%	50%	153,906

Table 3-5b: SWM Conversion Load Reductions for Individual Ponds

		Total Nitrogen				Total Phosphorus				Sediment			
Pond #	Total DA for SWM Conversion (acres)	Original RE	New RE	Increase in Efficiency	Max Potential Load Reduction (lbs/yr)	Original RE	New RE	Increase in Efficiency	Max Potential Load Reduction (lbs/yr)	Original RE	New RE	Increase in Efficiency	Max Potential Load Reduction (lbs/yr)
298	17.9	5%	20%	15%	25.0	10%	20%	10%	1.2	10%	60%	50%	288
355	25	5%	20%	15%	35.0	10%	20%	10%	1.6	10%	60%	50%	402
356	29	5%	20%	15%	40.5	10%	20%	10%	1.9	10%	60%	50%	467
907	10	5%	20%	15%	14.0	10%	20%	10%	0.6	10%	60%	50%	161
122	12.5	5%	20%	15%	17.5	10%	20%	10%	0.8	10%	60%	50%	201
292	16.6	5%	20%	15%	23.2	10%	20%	10%	1.1	10%	60%	50%	267
323	29.1	5%	20%	15%	40.7	10%	20%	10%	1.9	10%	60%	50%	468
360	12.8	5%	20%	15%	17.9	10%	20%	10%	0.8	10%	60%	50%	206
391	2.3	5%	20%	15%	3.2	10%	20%	10%	0.1	10%	60%	50%	37
444	1	5%	20%	15%	1.4	10%	20%	10%	0.1	10%	60%	50%	16
640	53.8	5%	20%	15%	75.2	10%	20%	10%	3.5	10%	60%	50%	866
808	12	5%	20%	15%	16.8	10%	20%	10%	0.8	10%	60%	50%	193
891	2.7	5%	20%	15%	3.8	10%	20%	10%	0.2	10%	60%	50%	43
710	2.6	5%	20%	15%	3.6	10%	20%	10%	0.2	10%	60%	50%	42
3260	3.9	5%	20%	15%	5.5	10%	20%	10%	0.3	10%	60%	50%	63
322	17.4	5%	20%	15%	24.3	10%	20%	10%	1.1	10%	60%	50%	280
377	4.2	5%	20%	15%	5.9	10%	20%	10%	0.3	10%	60%	50%	68
688	15.8	5%	20%	15%	22.1	10%	20%	10%	1.0	10%	60%	50%	254
747	23.6	5%	20%	15%	33.0	10%	20%	10%	1.5	10%	60%	50%	380
788	2.5	5%	20%	15%	3.5	10%	20%	10%	0.2	10%	60%	50%	40
361	2.5	5%	20%	15%	3.5	10%	20%	10%	0.2	10%	60%	50%	40
415	8	5%	20%	15%	11.2	10%	20%	10%	0.5	10%	60%	50%	129
421	14	5%	20%	15%	19.6	10%	20%	10%	0.9	10%	60%	50%	225
358	9.3	5%	20%	15%	13.0	10%	20%	10%	0.6	10%	60%	50%	150

Table 3-5b. (Continued)

		Total Nitrogen				Total Phosphorus				Sediment			
Pond #	Total DA for SWM Conversion (acres)	Original RE	New RE	Increase in Efficiency	Max Potential Load Reduction (lbs/yr)	Original RE	New RE	Increase in Efficiency	Max Potential Load Reduction (lbs/yr)	Original RE	New RE	Increase in Efficiency	Max Potential Load Reduction (lbs/yr)
417	13.2	5%	20%	15%	18.5	10%	20%	10%	0.8	10%	60%	50%	213
521	8.6	5%	20%	15%	12.0	10%	20%	10%	0.6	10%	60%	50%	138
596	25.8	5%	20%	15%	36.1	10%	20%	10%	1.7	10%	60%	50%	415
784	13.7	5%	20%	15%	19.2	10%	20%	10%	0.9	10%	60%	50%	221
994	6.3	5%	20%	15%	8.8	10%	20%	10%	0.4	10%	60%	50%	101
278	9.5	5%	20%	15%	13.3	10%	20%	10%	0.6	10%	60%	50%	153
364	9.6	5%	20%	15%	13.4	10%	20%	10%	0.6	10%	60%	50%	155
781	6.6	5%	20%	15%	9.2	10%	20%	10%	0.4	10%	60%	50%	106
782	8	5%	20%	15%	11.2	10%	20%	10%	0.5	10%	60%	50%	129
785	47.6	5%	20%	15%	66.5	10%	20%	10%	3.1	10%	60%	50%	766
991	13.8	5%	20%	15%	19.3	10%	20%	10%	0.9	10%	60%	50%	222
995	0.9	5%	20%	15%	1.3	10%	20%	10%	0.1	10%	60%	50%	14
1132	2.2	5%	20%	15%	3.1	10%	20%	10%	0.1	10%	60%	50%	35
1189	98	5%	20%	15%	137.0	10%	20%	10%	6.3	10%	60%	50%	1,578
1237	22.5	5%	20%	15%	31.5	10%	20%	10%	1.4	10%	60%	50%	362

3.4.2.4 Stormwater Retrofits

Proposed stormwater retrofits for the purposes of this SWAP refer to implementing BMPs to capture and treat runoff from impervious surfaces (i.e., parking lots, alleys) which are currently untreated. This includes sites identified for retrofit potential during uplands surveys for neighborhoods, institutions, hotspots, and pervious areas. Pollutant reductions for stormwater retrofits are calculated based on the approximated pollutant load received from the impervious drainage area (DA) and removal efficiency (RE) of bioretention and underground structure type BMPs. The equation used to estimate total nitrogen (TN) load reductions for stormwater retrofits is expressed as:

$$[12.56\ (\text{lbs/ac/yr}) * \text{DA}\ (\text{acres})] * \text{RE}\ (\%)$$

The equation used to estimate total phosphorus (TP) load reductions for stormwater retrofits is expressed as:

$$[1.05(\text{lbs/ac/yr}) * \text{DA}\ (\text{acres})] * \text{RE}\ (\%)$$

The equation used to estimate sediment load reductions for stormwater retrofits is expressed as:

$$[1{,}242.0\ (\text{lbs/ac/yr}) * \text{DA}(\text{acres})] * \text{RE}(\%)$$

The pollutant load received from the drainage area contributing to the SWM facility is denoted by the first expression in brackets in the equation above. The pollutant loading rates shown, 12.56 lbs TN/ac/yr, 1.05 lbs TP/ac/yr, and 1,242.0 lbs sediment/ac/yr, are the impervious urban rates used in the pollutant loading analysis (Table 3.2) since this represents the source of runoff being treated. Pollutant removal efficiencies are those reported for bioretention and underground structure, based on CBP guidance shown in Appendix D under Urban and Mixed Open BMPs, Stormwater Management. A summary of stormwater retrofit load reduction calculations and results are shown in Table 3-6.

Table 3-6: Stormwater Retrofit Load Reduction

Pollutant	Impervious Urban Loading Rate (lbs/ac/yr)	Impervious Area for SW Retrofit (acres)	Load for DA (lbs/yr)	RE	Max Potential Load Reduction (lbs/yr)
TN	12.56	18.3	230	25%	57
TP	1.05	18.3	19	45%	8.65
Sediment	1,242	18.3	22,729	55%	12,501

3.4.2.5 Impervious Cover Removal

Potential sites for impervious cover removal were identified at several institutions. Pollutant reductions for impervious cover removal are calculated based on a land conversion from impervious to pervious urban. The equation used to estimate total nitrogen (TN) load reductions for stormwater retrofit is expressed as:

[12.56 (lbs/ac/yr) - 7.86 (lbs/ac/yr)]*Impervious Area (acres)

The equation used to estimate total phosphorus (TP) load reductions for stormwater retrofits is expressed as:

[1.05(lbs/ac/yr) - 0.19(lbs/ac/yr)]*Impervious Area (acres)

The equation used to estimate sediment load reductions for stormwater retrofits is expressed as:

[1,242.0 (lbs/ac/yr) - 166.5 (lbs/ac/yr)]*Impervious Area (acres)

Impervious cover removal would involve converting impervious surfaces to pervious surfaces. Therefore, the loading rate would be reduced by a factor equal to the difference between impervious and pervious urban loading rates in the watershed pollutant loading analysis as shown in the first expression in brackets in the equations above. The approximate reduction in pollutant load is then the reduced loading rate multiplied by the area proposed for impervious cover removal. A summary of impervious cover removal reduction calculations and results are shown in the Table 3-7.

Table 3-7: Impervious Cover Removal Load Reductions

Pollutant	Impervious Urban Loading Rate (lbs/ac/yr)	Pervious Urban Loading Rate (lbs/ac/yr)	Reduction in Loading Rate (lbs/ac/yr)	Impervious Area (acres)	Max Potential Load Reduction (lbs/yr)
TN	12.56	7.86	4.70	0.358	1.68
TP	1.05	0.19	0.86	0.358	0.31
Sediment	1242	167	1,071	0.358	385

3.4.2.6 Stream Buffer Reforestation

The current vegetative condition of the stream riparian buffer (100 feet on either side of the stream system (2,687 acres)) was analyzed in Chapter 2 of the Watershed Characterization Report (Appendix E). Buffer conditions were classified as impervious, open pervious, or forested areas. Open pervious areas are the best areas to initially target for restoration. Approximately 632 acres of open pervious area were identified within the stream buffer zone.

Pollutant reductions for stream buffer reforestation are calculated based on a land use conversion from pervious urban to forest plus an additional reduction efficiency per BMP performance guidance from CBP (Appendix D). The equation used to estimate total nitrogen (TN) load reductions for the land use conversion portion of stream buffer reforestation is expressed as:

Land Use Conversion (TN) = [7.86 (lbs/ac/yr) - 2.70(lbs/ac/yr)]* Open Pervious Area (acres)

The equation used to estimate total phosphorus (TP) load reductions for the land use conversion portion of stream buffer reforestation is expressed as:

Land Use Conversion (TP) = [0.19(lbs/ac/yr) – 0.04(lbs/ac/yr)]* Open Pervious Area (acres)

The equation used to estimate sediment load reductions for the land use conversion portion of stream buffer reforestation is expressed as:

Land Use Conversion (sediment) = [167(lbs/ac/yr) – 106.4(lbs/ac/yr)]* Open Pervious Area (acres)

The first expression in brackets in the equation above represents the difference between pervious urban and forest loading rates used in the watershed pollutant loading analysis. This reduction in loading rate is then multiplied by the available open pervious area for reforestation to determine the loads from land use conversion.

An additional pollutant removal factor is added to the land use conversion to determine the total removal capacity of buffer reforestation. Per the BMP performance guidance in Appendix D, one acre of buffer treats approximately1 acre of upland area for nitrogen with an efficiency of 25 percent for urban and mixed open buffers. The total nitrogen (TN) load reduction for the removal efficiency portion of buffer reforestation can be expressed as:

Buffer BMP Removal (TN) = [Open Pervious Area (acres)]*7.46(lbs/ac/yr]*25%

Similarly, <u>one acre of buffer treats approximately one acre of upland area for phosphorus</u> with an efficiency of 50 percent for urban and mixed open buffers. The total phosphorus (TP) load reductions for the removal efficiency portion of buffer reforestation can be expressed as:

Buffer BMP Removal (TP) = [Open Pervious Area (acres) 0.35(lbs/ac/yr]*50%

Similarly, <u>one acre of buffer treats approximately one acre of upland area for sediment</u> with an efficiency of 50 percent for urban and mixed open buffers. The sediment load reductions for the removal efficiency portion of buffer reforestation can be expressed as:

Buffer BMP Removal (sediment) = [Open Pervious Area (acres) 399.66(lbs/ac/yr]*50%

The loading rates shown in the equation above, 7.46 lbs TN/ac/yr, 0.36 TP/ac/yr, and 399.66 lbs sediment/ac/yr, represent overall watershed loading rates. This is estimated as the total watershed nutrient load (128,364 lbs TN/yr, 6,014 lbs TP/yr, and 6,876,560 lbs sediment/yr) divided by the total area (17,206 acres), which is the area used to calculate the pollutant load from the upland area that would be treated by buffer reforestation. As mentioned, the land use conversion and additional removal efficiency are added to yield a total pollutant load reduction. A summary of stream buffer reforestation reduction calculations and results are shown in Table 3-8.

Table 3-8: Stream Buffer Reforestation Load Reductions

		LU Conversion		Buffer BMP Removal				
Pollutant	Open Pervious Area (aces)	Reduced Loading Rate (lb/ac/yr)	Land Use Conversion Reduction (lbs/yr)	Reduction Efficiency (%)	Overall Watershed Loading Rate (lbs/ac/yr	Efficiency Load Reduction (lbs/yr)	Max Potential Load Reduction (lbs/yr)	Total
TN	632	5.16	3,261	25%	7.46	4,715	1,179	4,440
TP	632	0.15	95	50%	0.35	221	111	205
Sediment	632	60.6	38,299	50%	400	252,800	126,400	164,699

3.4.2.7 Urban Nutrient Management

Urban nutrient management is typically described as public education and awareness programs to reduce fertilizer application to lawns and other pervious urban areas. While most jurisdictions, including Baltimore County, have education programs as required in our MS4 permits, we have been unable to formulate a mechanism for tracking, reporting, and validating nutrient reduction credits. For the purposes of this SWAP, reduction credits for the Fertilizer Act of 2011 will be applied to all pervious urban land. Those credits, which are 1% for nitrogen and 15% for phosphorus, are under review by the CBP and are likely to change in the summer of 2012. The current credits for urban nutrient management education and outreach are 17% for nitrogen and 22% for phosphorus. Enhanced credits based on the CBP review will be applied using the difference between the 17% and 22% credits and the original reductions.

Pollutant reductions for urban nutrient management are calculated based on the pollutant load received from the urban pervious drainage area (DA) and removal efficiency. (The urban pervious area is defined as the total DA for the watershed, minus the areas that are impervious, forested, or agricultural.) The State of Maryland has mandated reduced fertilizer nutrients for nitrogen (1 percent reduction) and phosphorus (15 percent reduction). The equation used to estimate total nitrogen (TN) load reduction for urban nutrient management is expressed as:

$$[7.86(\text{lbs/ac/yr}) * \text{DA(acres)}] * 1\%$$

The equation used to estimate total phosphorus (TP) load reductions for urban nutrient management is expressed as:

$$[0.19(\text{lbs/ac/yr}) * \text{DA(acres)}] * 15\ (\%)$$

The pollutant load received from the urban pervious area is denoted by the first expression in brackets in the equations above. The pollutant loading rates shown (7.86 lbs TN/ac/yr and 0.19 lbs TP/ac/yr) are the pervious urban rates used in the pollutant loading analysis

(Table 3-17) since this represents the source of runoff being addressed. A summary of these urban nutrient management reduction calculations and results are shown in Table 3-9a.

The Fertilizer Act of 2011 goes further and requires the use of fertilizer with a greater portion of slow release nitrogen and bans phosphorus altogether, except for establishing new lawns and based on soil test results. To account for this, an additional credit is provisionally included as shown in Table 3-9b. Based on the Maryland Phase 2 WIP, the reduction rates applied are the difference from the original reduction credit and the enhanced credits of17% for nitrogen and 22% for phosphorus.

Table 3-9a: Urban Nutrient Management Load Reductions

Pollutant	Pervious Urban Loading Rate (lb/ac/yr)	Total Pervious DA	Removal Efficiency	Max Potential Load Reduction (lbs/yr)
TN	7.86	7,984	1%	628
TP	0.19	7,984	15%	228

Table 3-9b: Additional Urban Nutrient Management Load Reductions

Pollutant	Pervious Urban Loading Rate (lb/ac/yr)	Total Pervious DA	Additional Removal Efficiency	Additional Max Load Reduction (lbs/yr)	Additional Max Potential Load Reduction (lbs/yr)
TN	7.86	7,984	16%	10,041	10,668
TP	0.19	7,984	7%	106	334

3.4.2.8 Pervious Area Reforestation

Open pervious areas with reforestation potential have been identified in the Lower Patapsco watershed equaling 207.11 acres. Pollutant reductions for pervious area reforestation are calculated based on land use conversion from pervious urban to forest. The equation used to estimate total nitrogen (TN) load reductions for pervious area reforestation is expressed as:

Land Use Conversion (TN) = [7.86 (lbs/ac/yr) - 2.70(lbs/ac/yr)]* Open Pervious Area (acres)

The equation used to estimate total phosphorus (TP) load reductions for the land use conversion portion of stream buffer reforestation is expressed as:

Land Use Conversion (TP) = [0.19(lbs/ac/yr) – 0.04(lbs/ac/yr)]* Open Pervious Area (acres)

The equation used to estimate sediment load reductions for the land use conversion portion of stream buffer reforestation is expressed as:

Land Use Conversion (sediment) = [166.5 (lbs/ac/yr) – 106.4(lbs/ac/yr)]* Open Pervious Area (acres)

Pervious area reforestation would involve converting open pervious area to forest. Therefore, the loading rate would be reduced by a factor equal to the difference between pervious urban and forest loading rates used in the watershed pollutant analysis as shown in the first expression in brackets in the equations above. The approximate reduction in pollutant load is then the reduced loading rate multiplied by the open pervious area available for reforestation. A summary of pervious area reforestation reduction calculations and results are shown in Table 3-10.

Table 3-10: Pervious Area Reforestation Load Reductions

Pollutant	Pervious Urban Loading Rate (lbs/ac/yr)	Forest Loading Rate (lbs/ac/yr)	Reduced Loading Rate (lbs/ac/yr)	Open Pervious Area (acres)	Max Potential Load Reduction (lbs/yr)
TN	7.86	2.7	5.16	207	1,069
TP	0.19	0.04	0.15	207	31.07
Sediment	167	106	60.10	207	12,447

3.4.2.9 Stream Corridor Restoration

Several potential stream restoration sites were identified during the stream corridor assessments to address stream stability issues (i.e., significant erosion and channel alterations) and improve water quality. These sites are discussed in Section 3.6 of the Watershed Characterization Report (Appendix E). Pollutant load reduction estimates in pounds per linear foot of stream restoration were developed by MDE (2011). These were also used to calculate load reductions for proposed stream restoration activities (i.e., restoration lengths (RL)) in the Lower Patapsco watershed. The equation used to estimate total nitrogen (TN) reductions for stream restoration is expressed as:

0.02(lbs/ft)*RL (ft)

The equation used to estimate total phosphorus (TP) load reductions for stream restoration is expressed as:

0.0035 (lbs/ft)*RL (ft)

The equation used to estimate sediment load reductions for stream restoration is expressed as:

$$2.55\ (\text{lbs/ft}) * \text{RL}\ (\text{ft})$$

Potential stream restoration sites were identified for stream lengths totaling up to 70,524 feet. A summary of stream corridor restoration reduction calculations and results are shown in Table 3-11a.

Additional credits for stream restoration are based on Schueler (2011). Schueler recommends using an interim load reduction of 0.20 pounds/linear foot for nitrogen, 0.068 pounds/linear foot for phosphorus and 310 pounds/linear foot for sediment. These proposed interim credits are applied minus the existing credit to develop the "Additional Credits' in Table 3-11b. There is an existing expert panel working under the Chesapeake Bay Program – Urban Stormwater Workgroup that will be considering revisions to the stream restoration credits. Currently additional data is being gathered and summarized. That panel is scheduled to have a final determination by midsummer 2012.

Table 3-11a: New Stream Corridor Restoration Load Reduction

Pollutant	Reduction in Loading Rate (lbs/ft)	Total Stream Length in Watershed	Potential Stream Restoration Length (ft)	Max Potential Load Reduction (lbs/yr)
TN	0.02	632,491	70,524	1,410
TP	0.0035	632,491	70,524	247
Sediment	2.55	632,491	70,524	179,836

Table 3-11b: New Stream Corridor Restoration Load Reduction with Additional Credits

Pollutant	Reduction in Loading Rate (lbs/ft)	Total Stream Length in Watershed	Potential Stream Restoration Length (ft)	Max Potential Load Reduction (lbs/yr)
TN	0.18	632,491	70,524	12,694
TP	0.0645	632,491	70,524	4,549
Sediment	307.45	632,491	70,524	21,682,604

3.4.2.10 Downspout Disconnection

A total of 27 neighborhoods (out of 90 surveyed) have potential for downspout disconnection. A neighborhood is recommended for disconnection if at least 25 percent of the downspouts are directly and/or indirectly connected to the storm drain system and the average lot has at least 15 feet of pervious area available down gradient from the downspout. During the uplands survey, the percentage of homes with connected downspouts was noted. This percentage was used to determine the rooftop area that could be addressed by disconnection in recommended neighborhoods. This is explained in further detail in Chapter 4 of the Watershed Characterization Report (Appendix E).

Pollutant reductions for downspout disconnection are calculated based on the pollutant load received from the total rooftop drainage area (DA) recommended for disconnection and the removal efficiency (RE) of filtration type BMPs. The equation used to estimate total nitrogen (TN) load reductions for downspout disconnection is expressed as:

$$[12.56\ (\text{lbs/ac/yr}) * \text{DA (acres)}] * \text{RE}\ (\%)$$

The equation used to estimate total phosphorus (TP) load reduction for downspout disconnection is expressed as:

$$[1.05\ (\text{lbs/ac/yr}) * \text{DA (acres)}] * \text{RE}\ (\%)$$

The equation used to estimate sediment load reduction for downspout disconnection is expressed as:

$$[1242\ (\text{lbs/ac/yr}) * \text{DA (acres)}] * \text{RE}\ (\%)$$

The pollutant load received from the impervious rooftop drainage area recommended for disconnection is denoted by the first expression in brackets in the equations above. The pollutant loading rates shown (12.56 lbs TN/ac/yr, 1.05 lbs TP/ac/yr, and 1242 lbs sediment/ac/yr) are the impervious urban rates used in the pollutant loading analysis. Pollutant removal efficiencies are those reported for filtration practices, based on CBP guidance shown in Appendix D under Urban and Mixed Open BMPs, Stormwater Management. A summary of downspout disconnection load reduction calculations and results are shown in Table 3-12.

Table 3-12: Downspout Disconnection Load Reductions

Pollutant	Impervious Urban Loading Rate (lbs/ac/yr)	DA (Rooftop Area Recommended for Downspout Disconnect) (acres)	Removal Efficiency (%)	Max Potential Load Reduction (lbs/yr)
TN	12.56	106	40%	532
TP	1.05	106	60%	67
Sediment	1242	106	80%	105,302

3.4.2.11 Tree Plantings

Several opportunities for planting street and open space shade trees were identified in neighborhoods throughout the watershed. Similarly, tree planting opportunities were also identified at many institutional sites. For both neighborhood and institutional tree planting opportunities, the number of trees was estimated based on a spacing of one tree per 15 to

20 feet. Pollutant reductions for pervious area reforestation are calculated based on a land use conversion from pervious urban to forest. An approximation of 100 trees per acre is used to calculate the area available for conversion. The equation used to estimate total nitrogen (TN) load reductions for tree plantings is expressed as:

[7.86 (lbs/ac/yr) - 2.70(lbs/ac/yr)] * [# Trees * (1 acre/100 trees)]

The equation used to estimate total phosphorus (TP) load reductions for tree plantings is expressed as:

[0.19(lbs/ac/yr) – 0.04(lbs/ac/yr)] * [# Trees * (1 acre/100 trees)]

The equation used to estimate sediment load reductions for tree plantings is expressed as:

[166.5 (lbs/ac/yr) – 106.4(lbs/ac/yr)] * [# Trees * (1 acre/100 trees)]

Tree plantings would involve converting open pervious area to forest. Therefore, the loading rate would be reduced by a factor equal to the difference between pervious urban and forest loading rates used in the watershed pollutant loading analysis, as shown in the first expression in brackets in the equations above. The approximate reduction in pollutant load is then the reduced loading rates multiplied by the open pervious available for reforestation (i.e., the expression in the second brackets in the equations above). A summary of tree planting load reduction calculations and results are shown in Tables 3-13 and 3-14.

Table 3-13: Neighborhood Tree Planting Load Reductions

Pollutant	Pervious Urban Loading Rate (lb/ac/yr)	Forest Loading Rate (lbs/ac/yr)	Reduced Loading Rate (lbs/ac/yr)	Estimated # Trees	Equivalent Forest Area (acres)	Max Potential Load Reduction (lbs/yr)
TN	7.86	2.7	5.16	869	8.7	45
TP	0.19	0.04	0.15	869	8.7	1.30
Sediment	167	106	60.1	869	8.7	530

Table 3-14: Institution Tree Planting Load Reductions

Pollutant	Pervious Urban Loading Rate (lb/ac/yr)	Forest Loading Rate (lbs/ac/yr)	Reduced Loading Rate (lbs/ac/yr)	Estimated # Trees	Equivalent Forest Area (acres)	Max Potential Load Reduction (lbs/yr)
TN	7.86	2.7	5.16	3,775	37.8	195
TP	0.19	0.04	0.15	3,775	37.8	5.66
Sediment	167	106	60.1	3,775	37.8	2,303

3.4.2.12 Street Sweeping

Thirty-two neighborhoods, containing approximately 94.9 miles of road, were recommended for street sweeping in the Lower Patapsco watershed. Records from the Department of Public Works (DPW) Street Sweeping Program (NPDES 2010) showed that 1,917 lbs of material were removed per mile of street sweeping in Lower Patapsco in 2010. Based on the average removal rate, there is potential for approximately 181,847 lbs of material to be removed from the proposed roadways in the lower Patapsco watershed via street sweeping (i.e., 1,917lbs/mi/yr * 94.86miles = 181,874lbs/yr). The amount of material removed is converted to total nitrogen (TN) load removed using a concentration of 1,825.95 mg/kg, which is expressed by the following equation:

181,874(lbs/yr)*1,825.92(mg/kg TN)*[(1 (kg)/10^6(mg)]

The amount of material removed is converted to total phosphorus (TP) load removed using a concentration of 707.95 mg/kg, which is expressed by the following equation:

181,874 (lbs/yr)*707.95(mg/kg TP)*[(1 (kg)/10^6(mg)]

The amount of material removed is converted to sediment load removed using a concentration of 54,554 mg/kg (based on a 30% sediment factor), which is expressed by the following equation:

181,874 (lbs/yr)*54,554(mg/kg TN)*[(1 (kg)/10^6(mg)]

A summary of street sweeping reduction calculations and results are shown in Table 3-15.

Table 3-15: Street Sweeping Load Reductions

Pollutant	Street Sweeping Bulk Removal Rate (lbs/mi/yr)	Proposed Miles of Street Sweeping (miles)	Total Bulk Load (lbs/yr)	Pollutant Concentration (mg/kg)	Max Potential Load Reduction (lbs/yr)
TN	1917	95	181,847	1,826	332
TP	1917	95	181,847	708	129
Sediment	1917	95	181,847	54,554	9,920

3.4.2.13 Sanitary Sewer Overflows

As described in Chapter 3 of the Watershed Characterization Report (Appendix E), sanitary sewer overflows over the past 11 years are estimated to contribute 84.77 pounds per year of TP and 255.34 pounds per year of TN. These are assumed to be eliminated by sewer line upgrades occurring as a result of the consent decree.

A total of 120 sanitary sewer overflow (SSO) events were documented between 2000 and 2010 within Lower Patapsco watershed. An estimated 11,235,037 gallons were discharged over this 11-year period. Pollutant loads associated with these SSO events and volume were calculated based on the following assumptions (more detail can be found in Chapter 3.5 of the Watershed Characterization Report):

- Total Phosphorus (TP): A conversion factor of 8.3×10^{-5} was used to convert gallons of overflow to pounds of pollutant. This is based on a 10 mg/L TP concentration for raw sewage and a multiplier of 8.3×10^{-6} lb•L/mg•gal.

- Total Nitrogen (TN): A conversion factor of 2.5×10^{-4} was used to convert gallons of overflow to pounds of pollutant. This is based on a 30 mg/L TN concentration for raw sewage and a multiplier of 8.3×10^{-6} lb•L/mg•gal.

- Fecal Coliform (FC): A conversion factor of 2.4×10^{8} was used to convert gallons of overflow to MPN fecal coliform. This is based on a multiplier of 6.4×10^{6} MPN/100 mL.

Based on these conversion factors, approximately 2,808.7 lbs of total nitrogen and 932.5 lbs of total phosphorus were released over the 11-year period as a result of SSOs. This is equivalent to pollutant reduction capabilities of 255.34 lbs TN/yr (i.e., 2,553.4 lbs TN/10 yrs) and 84.77 lbs TP/yr (i.e., 847.7 lbs TP/10 yrs). Note that TN and TP concentrations shown above are values for waste and wash water combined from CWP's Watershed Treatment Model version 3.1.

3.4.2.14 Overall Pollutant Load Reductions

The sum of maximum potential pollutant load reductions calculated for individual BMPs represent the overall pollutant removal capacity for a maximum implementation scenario (i.e., 100% of the projects implemented). A practicable pollutant load reduction was estimated for each BMP as the maximum potential load reduction multiplied by a projected participation factor. An overall projected pollutant removal capacity is the sum of practicable pollutant load reductions for individual BMPs. Projected participation factor assumptions are described in Table 3-16.

Table 3-17 presents a summary of estimated pollutant load reductions for both scenarios – maximum implementation and projected practicable – including how reductions were credited, pollutant removal efficiencies, maximum potential load reductions, units available for restoration, projected participation, and projected load reductions.

The projected, practicable implementation of proposed restoration BMPs, shown in Table 3-17, will meet the 29 percent reduction for nitrogen, the 45.1 percent reduction for phosphorus, and 25.1 percent reduction for sediment loads needed to meet water quality standards for the Lower Patapsco watershed as specified by Chesapeake Bay TMDL for nutrients and the Lower Patapsco TMDL for sediment (Appendix J), There is opportunity to achieve greater reductions if more stormwater retrofit opportunities are identified or are implemented to a greater extent than those assumed by projected participation factors. Greater reductions may also be achieved through restoration actions not included in this analysis such as public education/outreach efforts (e.g., watershed trash and recycling campaign and tours of completed projects). These types of actions are not included in the pollutant removal analysis because reductions efficiencies are not well known and are difficult to estimate.

Table 3-16: Projected Participation Factors

BMP	Projected Participation	Basis of Assumption
Capital Investment – Filtration	100	Existing - pond retrofits already implemented
Existing SWM	100	Existing - BMP already implemented
SWM Conversion	100	Completion of 39 conversions recommended
SW Retrofits (NSA, ISI, PAA, HSI)*	50	General estimate to achieve reduction goal
ISI Impervious Cover Removal	50	General estimate to achieve reduction goal
Reforest Stream Buffer	65	General estimate to achieve reduction goal
Pervious Area Reforestation	50	General estimate to achieve reduction goal
Stream Restoration	75	General estimate to achieve reduction goal
NSA Downspout Disconnection	33	33% willingness factor
NSA Tree Plantings	33	33% willingness factor
ISI Tree Plantings	66	66% of estimated trees located on public lands
Urban Nutrient Management	100	State Mandate
Street Sweeping	100	General estimate to achieve reduction goal
SSO Reduction/Elimination	100	Consent Decree requirements
* NSA (Neighborhood Source Assessment); ISI (Institutional Site Investigation); PAA (Pervious Area Assessment); HSI (Hotspot Investigation)		

Table 3-17: Summary of Pollutant Load Reduction Estimates

BMP	How Credited	TN Efficiency	TP Efficiency	Sediment Efficiency	Max Potential TN Load Reduction (lbs/yr)	Max Potential TP Load Reduction (lbs/yr)	Max Potential Sediment Load Reduction (lbs/yr)	Units Available		Projected Participation (%)	Projected TN Load Reduction (lbs/yr)	Projected TP Load Reduction (lbs/yr)	Projected Sediment Load Reduction (lbs/yr)
Existing Capital Project - Filtration	Efficiency	40%	60%	80%	36	1.98	2,703	10.41	acres	N/A	36	1.98	2,703
Existing Stream Restoration Projects	lbs per Ln Ft	0.02	0.0035	2.55	43	7.53	5,483	2150	feet	100	43	7.53	5,483
Enhanced Credit for Existing Stream Rest.	Additional lbs per Ln Ft	0.18	0.0645	307	387	139	661,018	2150	feet	100	387	139	661,018
Existing SWM	Efficiency	varies	varies	varies	5,716	373	574,383	2,958	acres	N/A	5,716	373	574,383
SWM Conversion	Efficiency	varies	varies	varies	815	26	146,729	639	acres	100	815	26	146,729
SW Retrofits (NSA, ISI, PAA, HIS)	Efficiency	varies	varies	varies	57	8.65	12,501	18	acres	50	29	4.32	6,250
ISI Impervious Cover Removal	LU Conversion	N/A	N/A	N/A	1.68	0.31	385	0.358	acres	50	0.84	0.15	193
Reforest Stream Buffer	LU Conversion + Efficiency	25%	50%	50%	4,440	205	164,699	632	acres	65	2886	134	107,054
Pervious Area Reforestation	LU Conversion	N/A	N/A	N/A	1,069	31	12,447	207	acres	50	534	16	6,224
Stream Restoration	lbs per Ln Ft	0.02	0.0035	2.55	1,410	247	179,836	70,524	feet	75	1,058	185	134,877
Enhanced Stream Restoration Credit	Additional lbs per Ln Ft	0.18	0.0645	307	12,694	4,549	21,682,604	70,524	feet	75	9,521	3,412	16,261,953
NSA Downspout Disconnection	Efficiency	40%	60%	80%	532	67	105,302	106	acres	33	176	22	34,750
NSA Tree Plantings	LU Conversion	N/A	N/A	N/A	45	1.30	530	8.69	acres	33	15	0.43	175
ISI Tree Plantings	LU Conversion	N/A	N/A	N/A	195	5.66	2,303	38	acres	66	129	3.74	1,520
Urban Nutrient Management	Efficiency	1%	15%	N/A	628	228	N/A	7984	acres	100	628	228	N/A
Enhanced Urban Nutrient Management Credit	Additional Efficiency	16%	7%	N/A	10041	106	N/A	7984	acres	100	10041	106	N/A
Street Sweeping	Direct Removal	N/A	N/A	N/A	332	129	9,920	95	miles	100	332	129	9,920
SSO Reduction/Elimination	Direct Removal	N/A	N/A	N/A	255	84.8	N/A	11,235,037	gallons	100	255	85	N/A
				Total	38,697	6,209	23,560,843				32,600	4,871	17,953,231
				Total Existing Urban Load (lbs/yr)	107,931	5,333	5,799,635				107,931	5,333	5,799,635
				Reduction Achieved	36%	116%	406%				30%	91.3%	309.6%

CHAPTER 4: SUBWATERSHED MANAGEMENT STRATEGIES

4.1 Introduction

This chapter describes the criteria and methodology used to rank the 16 subwatersheds within the Lower Patapsco River watershed (Figure 4-1). The subwatershed ranking provides a tool for targeting restoration actions by location/waterbody. This chapter also summarizes management strategies and implementation priorities within each subwatershed.

Individual subwatershed summaries include key subwatershed characteristics. More detailed information on a subwatershed basis can be found in the Watershed Characterization Report, included as Appendix E.

4.2 Subwatershed Prioritization

A ranking methodology was developed to prioritize subwatersheds in terms of restoration need and potential. Subwatersheds are represented by an overall prioritization score on a scale of 48, where 0 denotes the least significant impacts to water quality and 48 corresponds to the greatest water quality improvement potential. The total prioritization score for a subwatershed is comprised of the following ranking criteria:

- Phosphorus and Nitrogen Loads;
- Impervious Surfaces;
- Neighborhood Restoration Opportunity/Pollution Source Indexes;
- Neighborhood Downspout Disconnection;
- Institutional Site Investigations;
- Pervious Area Assessments;
- Municipal Street Sweeping;
- Municipal Stormwater Conversions;
- Illicit Discharge Data;
- Stream Buffer Improvement; and
- Stream Restoration Potential.

Each criterion has a maximum possible score of 4. In general, subwatersheds were grouped into quartiles based on supporting criterion data to yield an even distribution of the number of watersheds per possible score (i.e., 1, 2, 3, and 4). In some cases, criterion data did not support dividing the subwatersheds into four equal parts. Examples include a distribution of data that is too narrow or clustered, or cases where zero values were assigned to subwatersheds with no recommended action for a particular criterion.

Criteria used to calculate overall prioritization scores were selected considering SWAP goals and information compiled during watershed characterization and field efforts. Criteria and scoring designations are described in the sections below. Subwatershed restoration prioritization scoring and ranking results are summarized at the end of this section.

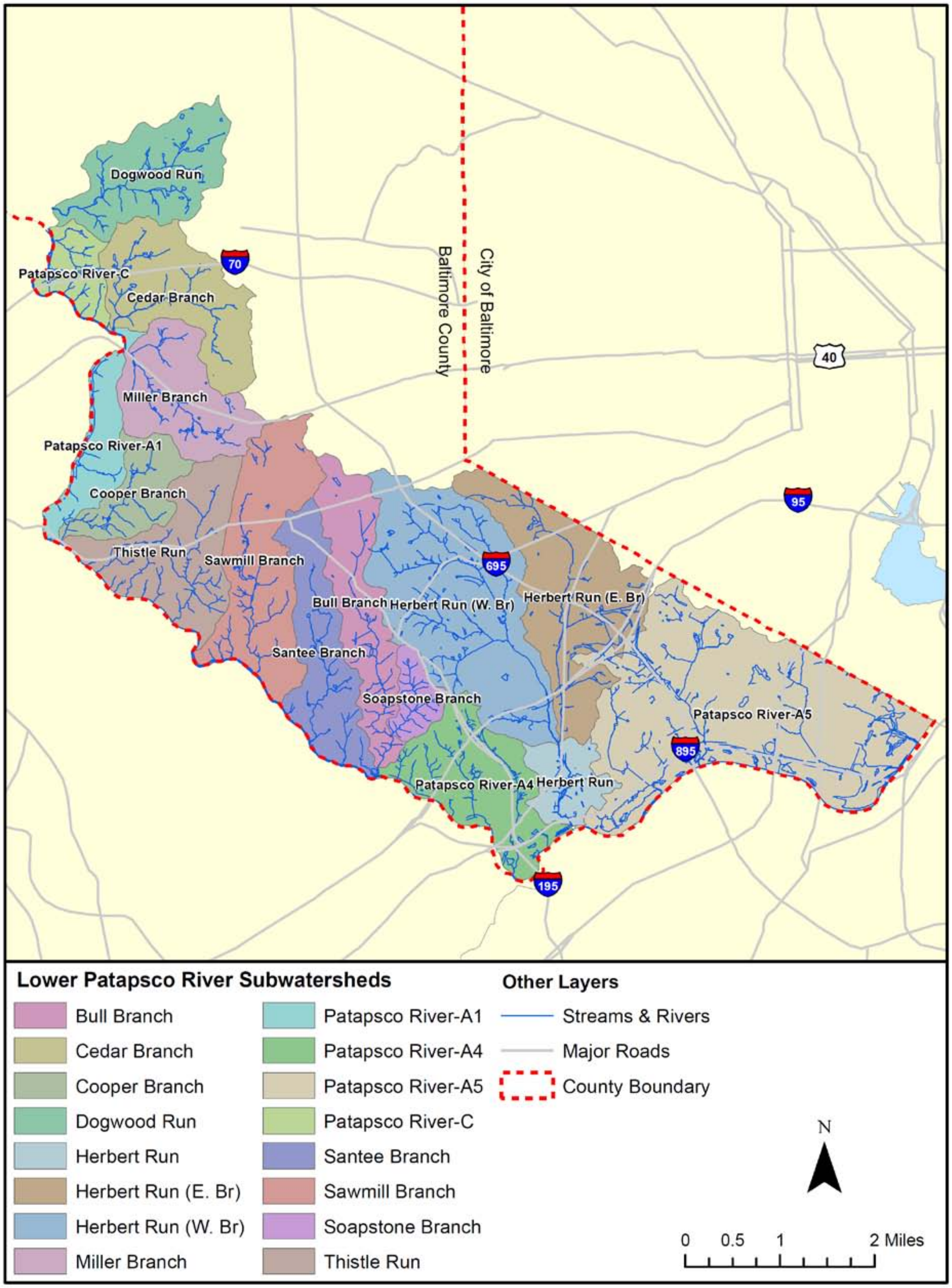

Figure 4-1: Lower Patapsco River Subwatersheds

4.2.1 Phosphorus and Nitrogen Loads

One of the objectives to improve and maintain water quality in the Lower Patapsco River and meet the Chesapeake Bay TMDLs is to reduce annual average total phosphorus and nitrogen loads. Annual pollutant loads (lbs/year) for total nitrogen and total phosphorus were calculated for each subwatershed based on loading rates established by MDE and Chesapeake Bay Program (CBP) for various land use types and subwatershed land use distributions. The pollutant loading analysis for Lower Patapsco River watershed is explained in further detail in Section 3.3 of the Watershed Characterization Report (Appendix E).

For each subwatershed, annual nitrogen and phosphorus loads were divided by the subwatershed's area. This represents pollutant loading rates (lbs/acre/year) and allows a direct comparison among the 16 subwatersheds since they vary greatly in size. Subwatersheds with higher pollutant loading rates are higher priorities for restoration within the Lower Patapsco River watershed. Therefore, higher pollutant loading rates are assigned high scores to denote greater water quality impacts and restoration needs.

Subwatershed nitrogen loading rates ranged from 2.7 to 6.4 lbs/acre/year. The following point system was used to assign nitrogen load scores to the 16 subwatersheds based on the range and distribution of subwatershed nitrogen loading rates:

- ≥ 5.8 lbs/acres/year = 4 pts;
- 5.0 – 5.7 lbs/acre/year = 3 pts;
- 4.0 – 4.9 lbs/acre/year = 2 pts;
- ≤ 3.9 lbs/acre/year = 1 pt.

Subwatershed phosphorus loading rates ranged from 0.03 to 0.13 lbs/acre/year. The following point system was used to assign phosphorus load scores to the 16 subwatersheds based on the range and distribution of subwatershed phosphorus loading rates:

- ≥ 0.12 lbs/acres/year = 4 pts;
- 0.10 – 0.11 lbs/acre/year = 3 pts;
- 0.07 – 0.09 lbs/acre/year = 2 pts;
- ≤ 0.06 lbs/acre/year = 1 pt.

Nitrogen and phosphorus loading rates and corresponding scores are summarized in the Table 4-1 by subwatershed.

Table 4-1: Nitrogen and Phosphorus Load Scores

Subwatershed	Nitrogen Loading Rate (lbs/acre/yr)	Nitrogen Load Score	Phosphorus Loading Rate (lbs/acre/yr)	Phosphorus Load Score
Bull Branch	5.3	3	0.10	3
Cedar Branch	5.3	3	0.09	2
Cooper Branch	4.8	2	0.07	2
Dogwood Run	6.3	4	0.13	4
Herbert Run	5.8	4	0.13	4

Table 4-1: (Continued)

Subwatershed	Nitrogen Loading Rate (lbs/acre/yr)	Nitrogen Load Score	Phosphorus Loading Rate (lbs/acre/yr)	Phosphorus Load Score
Herbert Run (E. Br.)	6.4	4	0.13	4
Herbert Run (W. Br.)	5.6	3	0.10	3
Miller Branch	5.5	3	0.11	3
Patapsco River-A1	3.5	1	0.04	1
Patapsco River-A4	4.6	2	0.08	2
Patapsco River-A5	5.3	3	0.11	3
Patapsco River-C	2.7	1	0.03	1
Santee Branch	4.1	2	0.06	1
Sawmill Branch	4.2	2	0.06	1
Soapstone Branch	2.8	1	0.06	1
Thistle Run	4.1	2	0.06	1

4.2.2 Impervious Surfaces

Various studies have shown a correlation between the amount of impervious surface within a watershed and water quality degradation. Impervious surfaces prevent precipitation from naturally infiltrating into the ground, which prohibits the natural filtration of pollutants and conveys concentrated, accelerated stormwater runoff directly to the stream system. Consequently, stormwater runoff from impervious surfaces can cause stream erosion and habitat destruction from the high energy flow, and is likely more polluted than runoff generated from pervious areas. Undeveloped watersheds with small amounts of impervious cover are more likely to have better water quality in local streams than urbanized watersheds with greater amounts of impervious cover.

As described in the Watershed Characterization Report, roads and buildings data layers were used to derive impervious surface areas and the percent impervious area for each subwatershed. Similar to the pollutant load criteria, percentages of impervious area for subwatersheds were used to assign scores, as this indicator allows a direct comparison between the 16 subwatersheds. Subwatersheds with higher percentages of impervious cover are higher priorities for restoration and were assigned high scores to denote greater water quality impacts and restoration needs.

Impervious surfaces cover about 21 percent of the overall Lower Patapsco River watershed. Subwatershed impervious values range from approximately 4 to 38 percent. The following point system was used to assign percent impervious scores to the 16 subwatersheds based on CWP's Impervious Cover model (see Chapter 2.3.3 of Appendix E) and subwatershed impervious surface percentages:

- > 25% = 4 pts;
- 16 – 25% = 3 pts;
- 11 – 15% = 2 pts;
- < 11% = 1 pt.

Percent impervious values and corresponding scores are summarized in Table 4-2 by subwatershed.

Table 4-2: Percent Impervious Cover Scores

Subwatershed	% Impervious	% Impervious Score
Bull Branch	20	3
Cedar Branch	20	3
Cooper Branch	14	2
Dogwood Run	15	2
Herbert Run	38	4
Herbert Run (E. Br.)	36	4
Herbert Run (W. Br.)	23	3
Miller Branch	31	4
Patapsco River-A1	9	1
Patapsco River-A4	16	3
Patapsco River-A5	29	4
Patapsco River-C	7	1
Santee Branch	11	2
Sawmill Branch	13	2
Soapstone Branch	4	1
Thistle Run	11	2

4.2.3 Neighborhood Restoration Opportunity/Pollution Source Indexes

As described in the Watershed Characterization Report, neighborhood pollution severity and restoration potential were rated during neighborhood source assessments (NSA). The severity of pollution generated by a neighborhood is denoted by the Pollution Severity Index (PSI) and was rated as severe, high, moderate, or none. A neighborhood's potential for residential restoration projects was also rated as high, moderate, or low according to the Restoration Opportunity Index (ROI). Out of the 90 neighborhoods assessed, seven were rated as high for both PSI and ROI, and six neighborhoods were rated as a high PSI with a moderate ROI. Neighborhoods with high PSI and high ROI ratings represent the best areas to initially target for restoration. Neighborhoods that had PSI ratings of low were discarded from this ranking. Note that neither the Patapsco River-C nor the Soapstone Branch subwatersheds contained any neighborhoods, and therefore had no NSAs completed for them.

Subwatersheds with the most neighborhoods rated as high for both pollution severity and restoration potential received the highest score (4 points). Subwatersheds with a single neighborhood rated as high for both pollution severity and restoration received the second highest score (3 points). Subwatersheds with no neighborhoods rated as high for both PSI and ROI but with neighborhoods rated as high for pollution severity and moderate for restoration potential, or moderate for pollution severity and high for restoration potential, were assigned the third highest score or moderate for (2 points). All other subwatersheds were assigned the lowest score (1 point).

The following point system summarizes PSI/ROI rating scores to the 16 subwatersheds:

- High/High; ≥2 NSAs = 4 pts;
- High/High; 1 NSA = 3 pts;
- High/Moderate or Moderate/High = 2 pts;

- All other ratings = 1 pt;
- No NSAs performed in subwatershed = 0 pts.

The number of NSAs associated with various PSI/ROI ratings and corresponding PSI/ROI scores are summarized by subwatershed in Table 4-3.

Table 4-3: NSA PSI/ROI Scores

	# of NSAs by PSI/ROI Rating			
Subwatershed	**High/High**	**High/Moderate**	**Moderate/High**	**NSA PSI/ROI Score**
Bull Branch			1	2
Cedar Branch			2	2
Cooper Branch		1	1	2
Dogwood Run			1	2
Herbert Run			1	2
Herbert Run (E. Br.)		1	1	2
Herbert Run (W. Br.)	2	1	4	4
Miller Branch				1
Patapsco River-A1			1	2
Patapsco River-A4				1
Patapsco River-A5	3	3		4
Patapsco River-C				0
Santee Branch			1	2
Sawmill Branch	1		1	3
Soapstone Branch				0
Thistle Run	1		2	3

4.2.4 Neighborhood Downspout Disconnection

Connected downspouts discharge rooftop runoff either directly to the storm drain system or to impervious surfaces. In either case, there is little to no treatment of stormwater runoff before it reaches the stream system. Disconnected downspouts drain to pervious areas such as yards and lawns, rain barrels, or rain gardens, all of which allow rooftop runoff to infiltrate into the ground and enter streams through the groundwater system in a slower, more natural fashion. Downspout disconnection is desirable because it decreases flow and reduces pollutant loads to streams during storm events.

Downspout disconnection was recommended for neighborhoods where at least 25 percent of the downspouts are connected to impervious area or directly to the storm drain system and where the average lot has at least 15 feet of pervious area available down gradient from the connected downspout for redirection. Similar to lawn fertilizer reduction, this criterion is used for subwatershed prioritization because it has a quantitative pollution reduction efficiency related to nutrient reduction goals.

The acres of rooftop addressed if downspout disconnection were initiated in the recommended neighborhoods were calculated in the Watershed Characterization Report. The percentage of subwatershed rooftop area addressed was also calculated and was used to compare the restoration potential among the 16 subwatersheds. Subwatersheds with the highest percentages of impervious rooftop acres addressed through downspout disconnection denote the greatest restoration potential and therefore, received the highest scores. Percentages of subwatershed areas addressed through downspout disconnection range from approximately 0 to 34 percent.

The following point system was used to assign downspout disconnection scores to the 16 subwatersheds based on the distribution and range of percentages of subwatershed rooftop area addressed:

- ≥ 20% = 4 pts;
- 10 - 19% = 3 pts;
- 2 - 9% = 2 pts;
- 1% = 1 pt;
- 0% = 0 pts.

Percentage of rooftop area addressed by downspout disconnection and corresponding scores are summarized by subwatershed in Table 4-4.

Table 4-4: NSA Downspout Disconnection Scores

Subwatershed	% Rooftop Area Addressed	NSA Downspout Disconnection Score
Bull Branch	0	0
Cedar Branch	1	1
Cooper Branch	10	3
Dogwood Run	0	0
Herbert Run	0	0
Herbert Run (E. Br.)	4	2
Herbert Run (W. Br.)	4	2
Miller Branch	1	1
Patapsco River-A1	25	4
Patapsco River-A4	0	0
Patapsco River-A5	3	2
Patapsco River-C	0	0
Santee Branch	34	4
Sawmill Branch	13	3
Soapstone Branch	0	0
Thistle Run	20	4

4.2.5 Institutional Site Index

Institutions offer unique opportunities for watershed restoration. Typically, institutional properties encompass considerable portions of land that contain various natural resources. In addition, they offer the opportunity to engage a wide range of citizens in restoration activities. This raises community awareness while also providing water quality improvement benefits in the watershed. A total of 40 community-based facilities were surveyed during Institutional Site Investigations (ISIs) including faith-based facilities, hospitals/care centers, public schools, colleges/research centers, municipal facilities (e.g., public libraries), golf courses, and other facilities. The focus of an ISI is to identify potential restoration opportunities, particularly those with opportunities both for community education and water quality benefits. Subwatersheds with more institutional sites present more opportunities for implementing restoration actions (e.g., tree planting, stormwater retrofits, community cleanups, etc.) and encouraging citizen participation. Public institutional sites are good candidates for initial restoration efforts because there are opportunities to make use of and build upon existing partnerships, and in many cases, incorporate student projects. While private institutions also have restoration potential, they will require a different approach and the development of new partnerships to implement restoration efforts.

For all of these reasons, prioritization for this criterion was based on the number of institutions and ownership (public versus private), according to the following point system:

- 2 public ISIs, at least 1 private ISI = 4 pts;
- 2 public ISIs, no private ISIs = 3 pts;
- 1 public ISI, at least 1 private ISI = 2 pts;
- Only private ISIs = 1 pt;
- No ISIs = 0 pts.

The total numbers of institutions, including ownership and corresponding institutional site index scores, are summarized by subwatershed in Table 4-5.

Table 4-5: ISI Scores

Subwatershed	# of Public ISIs	# of Private ISIs	Total # of ISIs	ISI Score
Bull Branch	2	5	7	4
Cedar Branch	2	2	4	4
Cooper Branch	2	1	3	4
Dogwood Run	2	0	2	3
Herbert Run	0	1	1	1
Herbert Run (E. Br.)	1	1	2	2
Herbert Run (W. Br.)	2	1	3	4
Miller Branch	1	2	3	2
Patapsco River-A1	0	2	2	1
Patapsco River-A4	2	0	2	3
Patapsco River-A5	2	1	3	4
Patapsco River-C	0	0	0	0
Santee Branch	2	0	2	3
Sawmill Branch	0	2	2	1
Soapstone Branch	0	0	0	0
Thistle Run	0	4	4	2

4.2.6 Pervious Area Reforestation

The most likely candidates for successful pervious area reforestation efforts are those on public lands with minimal site preparation required. Public sites are eligible for tree planting through DNR's "Tree-Mendous Maryland" program and are good opportunities for volunteer or community projects. Privately-owned lands are often planned for future development or expansion of an existing facility. In addition, larger open parcels have greater potential for reforestation and water quality benefits than smaller areas.

Subwatershed prioritization related to pervious area reforestation was based on the total acres of reforestation recommended during PAAs. Recommended acres for reforestation within the 16 subwatersheds range from 0 to 81.4 acres. Scoring for this criterion is as follows:

- ≥ 40 acres = 4 pts;
- 5 – 39 acres = 3 pts;
- 2 – 4 acres = 2 pts;
- < 2 acres = 1 pt;
- 0 acres = 0 pts.

Pervious reforestation acreages and corresponding scores are summarized by subwatershed in Table 4-6.

Table 4-6: Pervious Area Reforestation Scores

Subwatershed	Acres Recommended for Reforestation	Pervious Area Reforestation Score
Bull Branch	0.0	0
Cedar Branch	1.3	1
Cooper Branch	2.4	2
Dogwood Run	11.9	3
Herbert Run	0.0	0
Herbert Run (E. Br.)	1.2	1
Herbert Run (W. Br.)	50.3	4
Miller Branch	5.5	3
Patapsco River-A1	1.2	1
Patapsco River-A4	6.3	3
Patapsco River-A5	43.6	4
Patapsco River-C	0.0	0
Santee Branch	0.0	0
Sawmill Branch	2.0	2
Soapstone Branch	0.0	0
Thistle Run	81.4	4

4.2.7 Municipal Street Sweeping

Baltimore County provides street sweeping services throughout the jurisdiction to help remove trash, sediment and other organic matter such as leaves and grass clippings from the curb and gutter system and prevent them from entering the storm drain system and nearby streams. Street sweeping also reduces sediment and other pollutant loads such as oil and metals to the stream system. During the NSAs, neighborhoods where 20 percent or more of the curbs and gutters were covered with excessive trash, sediment, and/or organic matter were recommended for street sweeping. As described in the Watershed Characterization Report, the miles of street addressed if street sweeping were implemented in the recommended neighborhoods was estimated by subwatershed. Subwatersheds with more miles of road that could be addressed through street sweeping denote the greatest restoration potential and therefore, were scored the highest. Miles addressed through street sweeping range from 0 to 27.8.

The following point system was used to assign street sweeping scores to the 16 subwatersheds based on the distribution and range of miles addressed:

- ≥ 14 miles = 4 pts;
- 5.0 – 13 miles = 3 pts;
- 1 – 4 miles = 2 pts;
- < 1 mile = 1 pt;
- 0 miles = 0 pts.

Miles that could be addressed by municipal street sweeping and corresponding scores are summarized by subwatershed in Table 4-7.

Table 4-7: Street Sweeping Scores

Subwatershed	Miles of Road Addressed	Street Sweeping Score
Bull Branch	6.2	3
Cedar Branch	4.7	2
Cooper Branch	11.2	3
Dogwood Run	0.0	0
Herbert Run	0.0	0
Herbert Run (E. Br.)	15.3	4
Herbert Run (W. Br.)	10.6	3
Miller Branch	0.0	0
Patapsco River-A1	0.0	0
Patapsco River-A4	0.4	1
Patapsco River-A5	27.8	4
Patapsco River-C	0.0	0
Santee Branch	14.5	4
Sawmill Branch	0.8	1
Soapstone Branch	0.0	0
Thistle Run	3.3	2

4.2.8 Stormwater Conversions

Existing dry detention ponds within the Lower Patapsco River watershed were investigated for potential conversion to water quality management facilities. Dry ponds were assessed since they have the greatest potential for conversion to a type of facility, such as a dry extended detention facility, that provides water quality benefits in addition to quantity control. Dry extended detention ponds are designed to capture and retain stormwater runoff from a storm for a minimum duration, in order to allow sediment and pollutants to settle out while also providing flood control.

Forty-eight existing dry detention ponds were assessed for their potential to be converted to an extended detention facility. Information and measurements collected at each facility included: orifice, riser, ponding, debris, vegetation, adjacent land use, physical expansion capabilities, outfall, and downstream conditions. Out of the 48 detention ponds assessed, four were considered as having the greatest potential for conversion to an extended detention facility. However, 21 other ponds were considered to have high or moderate potential for conversion.

The following point system was used to assign stormwater conversion scores to the 16 subwatersheds based on conversion potential of ponds within the subwatershed:

- $>$1 pond ranked Very High = 4 pts;
- $\geq$2 ponds ranked High = 3 pts;
- 1 pond ranked High = 2 pts;
- $\geq$1 pond ranked Moderate = 1 pt;
- 0 ponds ranked Moderate or above = 0 pts.

Number of dry ponds and their conversion potential, along with corresponding scores are summarized by subwatershed in Table 4-8.

Table 4-8: Stormwater Conversion Scores

Subwatershed	# of Dry Ponds by Conversion Potential			Stormwater Conversion Score
	Very High	High	Moderate	
Bull Branch		1	1	2
Cedar Branch				0
Cooper Branch		1		2
Dogwood Run		2		3
Herbert Run			1	1
Herbert Run (E. Br.)	2		1	4
Herbert Run (W. Br.)			1	1
Miller Branch		3	1	3
Patapsco River-A1				0
Patapsco River-A4		1	1	2
Patapsco River-A5	2	4	1	4
Patapsco River-C				0
Santee Branch			1	1
Sawmill Branch			1	1
Soapstone Branch				0
Thistle Run				0

4.2.9 Illicit Discharge Data

Baltimore County tracks illicit discharges through a program of routine outfall screening. Illicit discharges refer to leaking pipes or incorrectly connected pipes. The County has an outfall prioritization system based on data from the outfall screening. Under this system, major outfalls are assigned one of the following priority ratings: none, low, high, or critical. Critical outfalls are those with major problems that require immediate correction and/or close monitoring, or outfalls with recurring problems. These are sampled the most frequently (four times per year). On the other end of the rating scheme, outfalls that are not prioritized have insufficient data to determine a priority rating. More information regarding the County's outfall screening and prioritization system is included in the Watershed Characterization Report.

There are 71 major outfalls in the Lower Patapsco River watershed. Subwatersheds with the most illicit discharge data and highest prioritization ratings represent the best areas to target for restoration initially. The following point system was used to rank illicit discharge connection data scores in the 16 subwatersheds based on the number of major outfalls and their prioritization rankings:

- ≥1 outfalls ranked critical = 4 pts;
- ≥1 outfalls ranked High = 3 pts;
- 2 - 7 outfalls ranked Low = 2 pts;
- 1 outfall ranked Low = 1 pt;
- 0 outfalls = 0 pts.

The number of major outfalls associated with various County outfall prioritization ratings and corresponding illicit discharge data scores are summarized by subwatershed in Table 4-9.

Table 4-9: Illicit Discharge Data Scores

Subwatershed	County Outfall Prioritization Rankings				Illicit Discharge Data Score
	Critical	High	Low	None	
Bull Branch			2		2
Cedar Branch			7		2
Cooper Branch			2		2
Dogwood Run			1	1	1
Herbert Run	1		3	1	4
Herbert Run (E. Br.)		4	2	1	3
Herbert Run (W. Br.)			7		2
Miller Branch			6		2
Patapsco River-A1			1		1
Patapsco River-A4			1	1	1
Patapsco River-A5		5	16	1	3
Patapsco River-C					0
Santee Branch			1		1
Sawmill Branch		2	4		3
Soapstone Branch					0
Thistle Run			1		1

4.2.10 Stream Buffer Improvements

Forested buffers along streams play a crucial role in improving water quality and flood mitigation. They can reduce surface runoff and pollutant loads, stabilize stream banks, trap sediment, and provide habitat for various types of terrestrial and aquatic life, including fish. Maintaining healthy streams and forest buffers is important for reducing nutrient and sediment loadings to the Lower Patapsco River and the Chesapeake Bay. When forested stream buffers are developed, their beneficial functions are lost and stream health declines. Riparian buffer zones can be re-established or preserved as a BMP, reducing land use impacts by intercepting and controlling pollutants entering a water body.

In the Watershed Characterization Report, the vegetative condition of a 100-foot buffer zone on either side of the stream system was analyzed. Three conditions were used to classify stream buffer conditions: impervious, open pervious, or forested. For each subwatershed, acreages and percentages of stream buffer area were determined for the three conditions. Open pervious areas (e.g., mowed lawns) represent the greatest potential for stream buffer reforestation. Subwatersheds with greater percentages of open pervious buffer areas denote the greatest potential for stream buffer improvement and were scored the highest.

Open pervious buffer area ranges from 4 to 36% of the buffer zone. The following point system was used to assign stream buffer improvement scores to the 16 subwatersheds based on the distribution and range of open pervious buffer area percentages:

- > 25% = 4 pts;
- 16 - 25% = 3 pts;
- 10-15% = 2 pts;
- <10% = 1 pt.

Percentages of open pervious stream buffer areas and corresponding scores are summarized by subwatershed in Table 4-10.

Table 4-10: Stream Buffer Improvement Scores

Subwatershed	% Open Pervious Stream Buffer Area	Stream Buffer Improvement Score
Bull Branch	14	2
Cedar Branch	17	3
Cooper Branch	9	1
Dogwood Run	30	4
Herbert Run	21	3
Herbert Run (E. Br.)	26	4
Herbert Run (W. Br.)	25	3
Miller Branch	13	2
Patapsco River-A1	31	4
Patapsco River-A4	18	3
Patapsco River-A5	36	4
Patapsco River-C	16	3
Santee Branch	13	2
Sawmill Branch	12	2
Soapstone Branch	4	1
Thistle Run	15	2

4.2.11 Stream Restoration Potential

Eroding stream banks are a clear, visible sign of stream impairments. In preparing the Watershed Characterization Report, past studies and reports were reviewed and compiled in an effort to map where streambank erosion has occurred and been noted throughout the Lower Patapsco River watershed. The stabilization of streambanks and other restoration measures can provide numerous benefits, including nutrient and sediment load reductions and improved habitat health for aquatic biota. Subwatersheds with a higher percentage of eroding stream miles present a greater opportunity for restoration and pollutant load reductions and are therefore ranked higher than those with a lower percentage of eroding stream miles.

The percentage of stream miles with potential for restoration ranges from 0 to 91%. The following point system was used to assign stream restoration potential scores to the 16 subwatersheds base on the distribution and range of percentage of stream miles in need of restoration:

- >60% = 4 pts;
- 50 - 60% = 3 pts;
- 40 - 49% = 2 pts;
- 1 - 39% = 1 pt;
- 0% = 0 pts.

Percentages of stream miles exhibiting erosion and channel instability, which may have potential for restoration, are summarized by subwatershed in Table 4-11 along with corresponding scores.

Table 4-11: Stream Restoration Potential Scores

Subwatershed	% Stream Miles in Need of Restoration	Stream Restoration Potential Score
Bull Branch	42	2
Cedar Branch	61	4
Cooper Branch	63	4
Dogwood Run	32	1
Herbert Run	44	2
Herbert Run (E. Br.)	54	3
Herbert Run (W. Br.)	56	3
Miller Branch	91	4
Patapsco River-A1	17	1
Patapsco River-A4	53	3
Patapsco River-A5	40	2
Patapsco River-C	0	0
Santee Branch	62	4
Sawmill Branch	67	4
Soapstone Branch	37	1
Thistle Run	13	1

4.2.12 Subwatershed Prioritization Summary

The Lower Patapsco River watershed comprises 16 subwatersheds that are ranked according to the total prioritization score (i.e., the sum of prioritization criterion scores). Subwatershed ranking results are summarized in Table 4-12 including criterion scores, total scores, and rankings by subwatershed.

Table 4-12: Subwatershed Ranking Results

Subwatershed	Nitrogen Load	Phosphorus Load	% Impervious	NSA PSI/ROI	NSA Downspout Disconnection	ISI Site Index	Pervious Area Reforestation	Street Sweeping	Stormwater Conversion	Illicit Discharge Data	Stream Buffer Improvement	Stream Restoration Potential	TOTAL SCORE	SUBWATERSHED RANK
Bull Branch	3	3	3	2	0	4	0	3	2	2	2	2	26	9
Cedar Branch	3	2	3	2	1	4	1	2	0	2	3	4	27	7
Cooper Branch	2	2	2	2	3	4	2	3	2	2	1	4	29	4
Dogwood Run	4	4	2	2	0	3	3	0	3	1	4	1	27	6
Herbert Run	4	4	4	2	0	1	0	0	1	4	3	2	25	11
Herbert Run (E. Br.)	4	4	4	2	2	2	1	4	4	3	4	3	37	2
Herbert Run (W. Br.)	3	3	3	4	2	4	4	3	1	2	3	3	35	3
Miller Branch	3	3	4	1	1	2	3	0	3	2	2	4	28	5
Patapsco River-A1	1	1	1	2	4	1	1	0	0	1	4	1	17	14
Patapsco River-A4	2	2	3	1	0	3	3	1	2	1	3	3	24	13
Patapsco River-A5	3	3	4	4	2	4	4	4	4	3	4	2	41	1
Patapsco River-C	1	1	1	0	0	0	0	0	0	0	3	0	6	15
Santee Branch	2	1	2	2	4	3	0	4	1	1	2	4	26	8
Sawmill Branch	2	1	2	3	3	1	2	1	1	3	2	4	25	10
Soapstone Branch	1	1	1	0	0	0	0	0	0	0	1	1	5	16
Thistle Run	2	1	2	3	4	2	4	2	0	1	2	1	24	12

Subwatersheds were placed into one of four priority categories based on ranking results: very high, high, medium, and low. These results are summarized in Table 4-13 and illustrated in Figure 4-2. Subwatersheds with a total prioritization score greater than 30 received a priority rating of Very High. These three subwatersheds (Patapsco River-A5, Herbert Run (E. Br.) and Herbert Run (W. Br.)) have scores that are much higher than the remaining subwatersheds. A rating of High was assigned to the next logical grouping of subwatersheds with total prioritization scores of 27 – 30 (Cooper Branch, Miller Branch, Dogwood Run and Cedar Branch). A rating of Medium was assigned to the subwatersheds with total prioritization scores of 24 – 26. The remaining three subwatersheds (Patapsco River-A1, Patapsco River-C and Soapstone Branch), with total prioritization scores less than 20, were assigned a priority rating of Low. Restoration actions will have to occur throughout the entire Lower Patapsco River watershed in order to meet environmental goals and requirements. However, subwatershed prioritization provides a tool/framework for focusing initial restoration efforts.

Table 4-13: Subwatershed Prioritization

Rank	Subwatershed	Total Score	Prioritization Category
1	Patapsco River-A5	41	Very High
2	Herbert Run (E. Br.)	37	Very High
3	Herbert Run (W. Br.)	35	Very High
4	Cooper Branch	29	High
5	Miller Branch	28	High
6	Dogwood Run	27	High
7	Cedar Branch	27	High
8	Santee Branch	26	Medium
9	Bull Branch	26	Medium
10	Sawmill Branch	25	Medium
11	Herbert Run	25	Medium
12	Thistle Run	24	Medium
13	Patapsco River-A4	24	Medium
14	Patapsco River-A1	17	Low
15	Patapsco River-C	6	Low
16	Soapstone Branch	5	Low

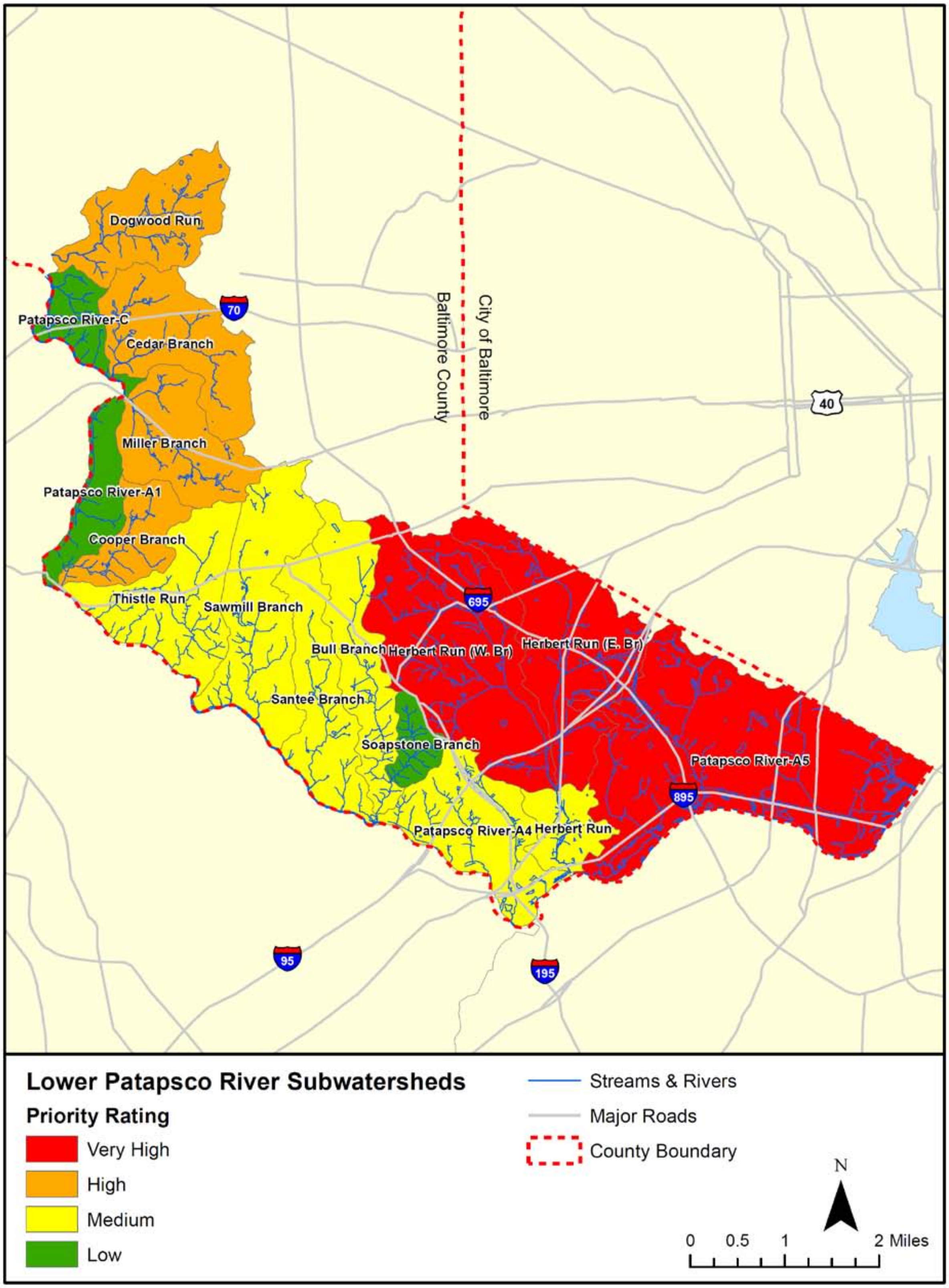

Figure 4-2: Lower Patapsco River Subwatershed Prioritization

4.3 Subwatershed Restoration Strategies

Restoration strategies for each subwatershed are presented in the following subsections. Subwatersheds are presented in order of their "Subwatershed Code," a number assigned to the watershed by Baltimore County. A description of key watershed characteristics is presented for each subwatershed including drainage area, stream length, population, land use/land cover, impervious cover, soils, and stormwater management (SWM) facilities. Assessment results for neighborhoods, hotspots, institutions, pervious areas, potential stream restoration sites, illicit discharges, and stormwater conversions are also summarized for each subwatershed. Finally, a subwatershed management strategy including recommended citizen and municipal actions is presented at the end of each subsection.

Note that because there are numerous operations in the Lower Patapsco River watershed that qualify as stormwater hotspots, not all could be individually evaluated during the uplands survey. HSIs were focused on 25 sites that had previously been identified as potential hotspots by Baltimore County (although assessments were not possible at five of these sites). An additional eight previously unvisited sites were identified in the field. This sample assessment is intended to represent common types of hotspot operations located throughout the watershed and help develop an overall strategy to encompass all hotspot operations occurring in the watershed.

On a similar note, there are various open pervious areas throughout the watershed with reforestation potential. Twenty-five pervious area assessments (PAAs) were conducted, all of which are large open parcels, and most with minimal site preparation required for reforestation. Eighteen of these PAAs were judged to represent the best available opportunities for reforestation, although there are likely many more opportunities throughout the watershed.

4.3.1 Dogwood Run (Subwatershed code 100)

Dogwood Run is the most northern subwatershed in the Lower Patapsco River watershed and the eighth largest subwatershed in the SWAP area. Dogwood Run has the highest proportion of high density residential land use in the entire Lower Patapsco River watershed (24%). However, it is also made up of nearly 28% forested lands and 22% agricultural lands. Table 4-14 summarizes key subwatershed characteristics of Dogwood Run.

Neighborhoods

A total of four distinct neighborhoods were identified and assessed within Dogwood Run during the uplands assessment of the Lower Patapsco River watershed. Recommendations for addressing stormwater volume and pollutants within this subwatershed include storm drain marking, use of rain barrels and rain gardens, increasing lot tree canopy, and a parking lot retrofit. A summary of neighborhood recommended actions is presented in Table 4-15.

Table 4-14: Key Subwatershed Characteristics – Dogwood Run

Drainage Area	988.4 acres (1.54 sq. mi.)	
Stream Length	7.1 miles	
Population	7,076 (2000 Census) 7.2 people/acre	
Land Use/Land Cover	Very Low Density Residential:	3.5%
	Low Density Residential:	4.2%
	Medium Density Residential:	1.8%
	High Density Residential:	24.0%
	Commercial:	0.8%
	Industrial:	1.0%
	Institutional:	5.3%
	Extractive:	0.0%
	Open Urban Land:	10.0%
	Agriculture:	21.6%
	Forest:	27.7%
	Barren Land:	0.0%
	Water/Wetlands:	0.0%
	Transportation	0.0%
Impervious Cover	15% of subwatershed	
Soils	A Soils (low runoff potential):	21.7%
	B Soils:	44.0%
	C Soils:	9.6%
	D Soils (high runoff potential):	24.7%
SWM Facilities	36% of urban land use treated	
Priority Rating	High	

Table 4-15: NSA Recommendations – Dogwood Run

		RECOMMENDED ACTIONS													
Site ID	Lot Size (acres)	% Opportunity for Downspout Disconnection	Rain Barrels	Rain Gardens	Storm Drain Marking	Bayscaping	Increase Lot Canopy	Pet Waste	Trash Management	Buffer Improvement	Parking Lot/Alley Retrofit	Street Sweeping	# of Street Trees	# of Shade Trees	Notes
NSA-A-1001	1/4		✓		✓								5		
NSA-A-1037	<1/8		✓	✓	✓		✓						2		
NSA-A-1038	1/8		✓		✓		✓				✓			65	
NSA-A-1039	1/8			✓			✓								

Each of the neighborhoods assessed within Dogwood Run had opportunities for improvement. Storm drain marking was recommended in three of the neighborhoods. This relatively easy and inexpensive action can have a great effect by reminding residents not to dump potentially dangerous materials into the storm drain. Rain barrels were also recommended in three neighborhoods to serve as temporary storage of roof runoff, decreasing the volume of stormwater running off site. One parking lot retrofit was suggested in NSA-A-1038, at the end of Flaxton Court, meaning implementing a BMP to capture and treat runoff from this impervious surface. Adding a bioretention area, a depressed area with native plants and filter media, could enable runoff from this lot to be captured and treated prior to entering the storm drain/stream system. Open space for shade tree planting was identified in NSA-A-1038, at the end of Flaxton Court and behind Chippenham Place (Figure 4-3), while opportunities for street trees were identified in NSA-A-1001 and NSA-A-1037.

Figure 4-3: Opportunities for Shade Trees in NSA-A-1038

Hotspots

No hotspot investigations were performed within Dogwood Run during the uplands assessments.

Institutions

A total of two (2) institutions were assessed for restoration opportunities in Dogwood Run during the uplands assessment of Lower Patapsco River. These included one public school and one public golf course. Table 4-16 summarizes recommendations for institutional sites assessed in Dogwood Run.

Table 4-16: ISI Recommendations – Dogwood Run

RECOMMENDED ACTIONS										
Site ID	Name	Public/ Private	Storm Drain Marking	# Trees for Planting	Downspout Disconnection	Stormwater Retrofit	Impervious Cover Removal	Buffer Improvement	Trash Management	Notes
ISI-A-101	Dogwood Elementary School	Public	✓	100					✓	Future education opportunity
ISI-A-102	Woodlands/ Diamond Ridge Golf Course	Public	✓	255				✓	✓	Develop Pollution Prevention plan if one does not already exist

Both of the institutional sites were recommended for storm drain marking, trash management, and tree planting, which all serve as good opportunities to engage citizens while raising awareness and providing water quality benefits. A stormwater pollution prevention plan should be developed for ISI-A-102, as material storage was noted to be a problem at this site, and a consultation with the facilities director revealed that no stormwater pollution plan had already been prepared (Figure 4-4). In addition, improving the buffer along portions of the stream at ISI-A-102 would serve as a water quality benefit, since stream buffers function to maintain stream stability and filter out pollutants.

Figure 4-4: Material Storage was Observed as a Potential Pollution Problem at ISI-A-102.

Pervious Areas

Pervious area restoration has the potential to convert areas of turf, often with high nutrient inputs to forest, which can instead absorb and filter nutrients. Three pervious areas were assessed for restoration potential in Dogwood Run. These sites include Health Services

Administration; Woodland Golf Course; and Stony Barr Road. The Health Services Administration facility is located south of Dogwood Road, and is maintained by Baltimore County. Although the facility footprint is relatively large, there is only one moderately-sized parcel that would be appropriate for tree planting. This site was recommended for reforestation with minimal site preparation to buffer the existing non-forested stream buffer in the northwestern part of the property. The Woodlands and Diamond Ridge Golf Courses are located off of Ridge Road, near its intersection with Dogwood Road. It is publicly-owned and maintained and is easily accessible by foot, vehicle, or heavy equipment. It is mostly covered by turf (80%) with some existing small trees as part of the golf course. One relatively small area most suitable for tree planting exists in the southern-most part of the golf course. The Stony Barr site is located off Flaxton Court, near where it meets Stony Barr Road. It is privately owned and maintained and is easily accessible by foot, vehicle, or heavy equipment. It is mostly covered by turf (90%), but is surrounded to the north, south, and west by existing forested lands. One area suitable for tree planting is located in the western part of the site. A summary is provided in the Table 4-17 below.

Table 4-17: PAA Summaries – Dogwood Run

Site ID	Location	Description	Acres	Ownership
PAA-A-101	Health Services Administration	Government office	Parcel - 34.40 Recommended planting – 1.86	Public
PAA-A-102	Woodlands and Diamond Ridge Golf Course	Golf course	Parcel - 81.80 Recommended planting – 8.98	Public
PAA-A-103	Stony Barr Open Space	Neighborhood open space	Parcel - 9.03 Recommended planting – 1.10	Public

Stream Restoration Potential

Eroding stream banks are a clear, visible sign of stream impairment. In preparing the Watershed Characterization Report, past studies and reports were reviewed and compiled in an effort to map where streambank erosion has occurred and been noted throughout the Lower Patapsco River watershed. The stabilization of streambanks and other restoration measures can provide numerous benefits, including nutrient and sediment load reductions and improved habitat health for aquatic biota. In Dogwood Run, erosion and channel stability problems were noted along 2.29 miles of stream (32% of the total stream miles in this subwatershed). 1.18 miles (6,252 feet) of specific stream reaches were recommended for stream restoration by the 2000 Water Quality Management Plan (Tetra Tech 2000) and are detailed in Section 3.6.5 of the Watershed Characterization Report (Appendix D).

Illicit Discharges

Dogwood Run contains two outfalls, one of which is rated a priority 0, the other a priority 2. Priority 0 outfalls are outfalls with insufficient data to determine a priority rating. This may be due to inaccessibility or if there has been only a single screening. Priority 2 outfalls have minor to moderate problems that have the potential to become severe. Baltimore County will continue its Illicit Discharge Detection and Elimination program while seeking to improve techniques for more effective reductions of these discharges.

Stormwater Conversions

Baltimore County EPS identified two stormwater management ponds in Dogwood Run as part of a list of 51 existing stormwater management facilities in the Lower Patapsco watershed to be evaluated for their conversion potential. Both ponds were ranked High for their potential conversion to improve water quality.

Subwatershed Management Strategy

Figure 4-5 provides a visual summary of restoration opportunities in the watershed.

<u>Engaging Citizens & Watershed Groups</u>

1. Conduct appropriate downspout rain barrel installation measures in neighborhoods according to Table 4-15.
2. Engage citizens in a storm drain marking program and conduct marking activities in the neighborhoods indicated in Table 4-15.
3. Educate citizens about the benefits and importance of rain gardens and their effects on water quality.
4. Increase tree canopies on private lots by educating citizens and homeowner groups on the benefits of trees.
5. Encourage communities and neighborhoods to plant street and shade trees. Table 4-15 shows a potential for 7 street trees and 65 shade trees.
6. Educate staff and members of institutional sites about the importance of proper trash management and outdoor material storage techniques at sites listed in Table 4-16.
7. Engage institutional sites listed in Table 4-16 in other recommended restoration actions.
8. Investigate the pervious areas described in Table 4-17 for potential tree planting.

<u>Municipal Actions</u>

1. Investigate parking lot stormwater retrofit opportunities identified in neighborhoods as listed in Table 4-15.
2. Work with the institution owners and managers at ISI-A-102 to develop a Storm Water Pollution Prevention Plan (SWPPP).
3. Investigate stream restoration potential at sites in Dogwood Run as described in Section 3.6.5 of the Watershed Characterization Report.
4. Continue to monitor illicit discharges.

5. Conduct follow-up investigations of outfalls with insufficient data for priority rating and those with minor to moderate problems that have the potential to become severe as described above and in the Watershed Characterization Report.
6. Consider retrofitting the two stormwater management ponds described above that were ranked High for their potential conversion to improve water quality.

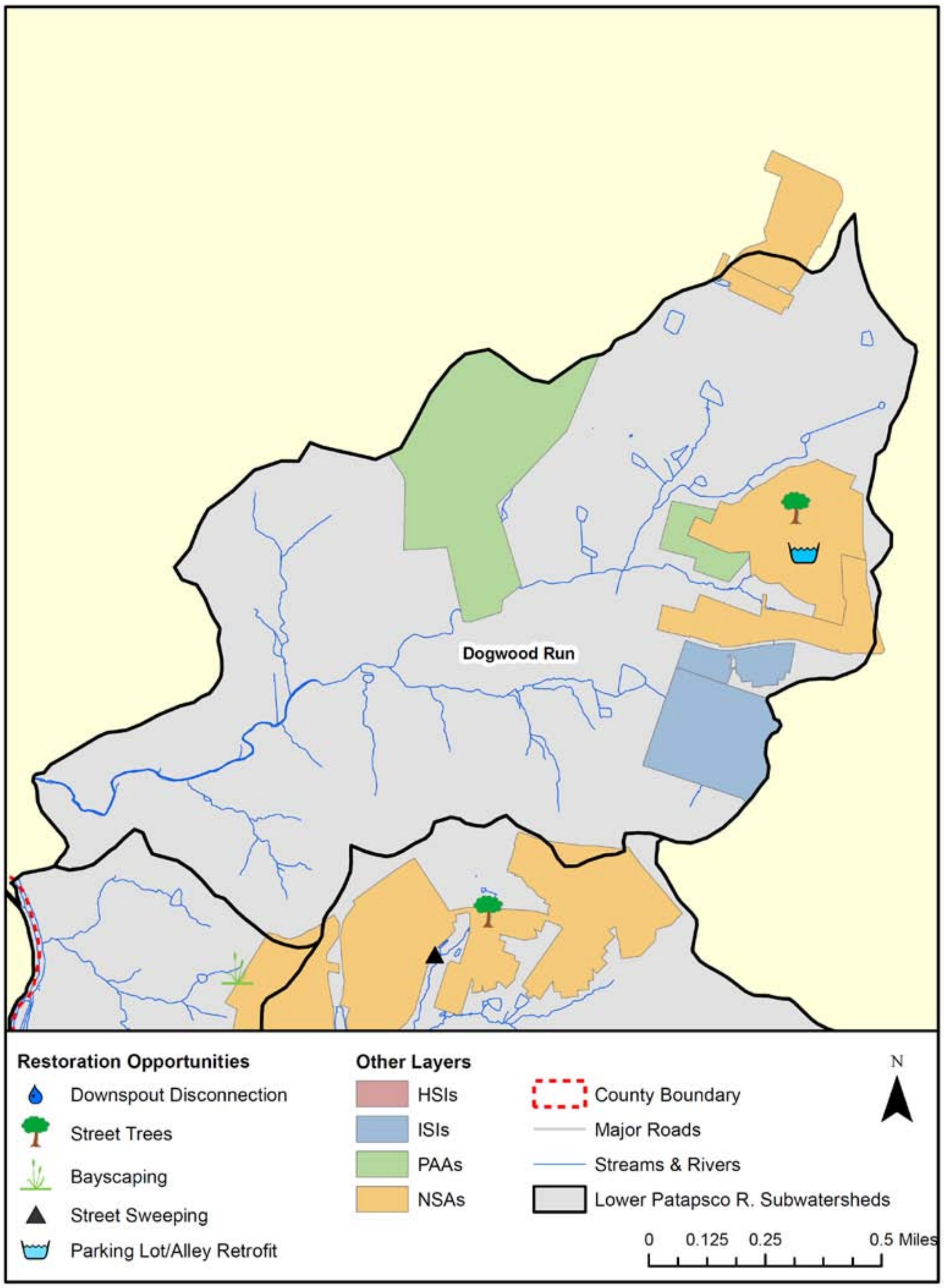

Figure 4-5: Restoration Opportunities in Dogwood Run

4.3.2 Patapsco River-C (Subwatershed code 200)

Patapsco River-C is the second smallest subwatershed in the Lower Patapsco River watershed, and is located in the northwestern portion of the watershed along the Patapsco River. This subwatershed drains the hill slopes underneath the I-70 overpasses. Land use in the Patapsco River-C subwatershed is primarily forest, as much of this subwatershed contains state park lands. This subwatershed and the Soapstone Branch subwatershed have the highest percentage of forested land use in the entire Lower Patapsco River watershed (79% in each). Patapsco River-C has small amounts of residential land use (including very low density, medium density, and high density residential areas). Transportation and open urban land uses are also present in small amounts. Table 4-18 summarizes key subwatershed characteristics of Patapsco River-C.

Table 4-18: Key Subwatershed Characteristics – Patapsco River-C

Drainage Area	351.9 acres (0.55 sq. mi.)	
Stream Length	4.1 miles	
Population	0 (2000 Census) 0.0 people/acre	
Land Use/Land Cover	Very Low Density Residential:	3.8%
	Low Density Residential:	0.0%
	Medium Density Residential:	3.1%
	High Density Residential:	0.9%
	Commercial:	0.0%
	Industrial:	0.0%
	Institutional:	0.0%
	Extractive:	0.0%
	Open Urban Land:	5.3%
	Agriculture:	2.2%
	Forest:	79.6%
	Barren Land:	0.0%
	Water/Wetlands:	0.0%
	Transportation	5.3%
Impervious Cover	7% of subwatershed	
Soils	A Soils (low runoff potential):	3.6%
	B Soils:	71.8%
	C Soils:	11.1%
	D Soils (high runoff potential):	11.1%
SWM Facilities	0% of urban land use treated	
Priority Rating	Low	

Neighborhoods

Since much of the Patapsco River-C subwatershed is made up of state park lands, and residential land use is negligible, assessments of neighborhoods were not conducted in this subwatershed.

Hotspots

No hotspot investigations were performed within Patapsco River-C during the uplands assessments since much of the subwatershed contains state park lands, and very few locations where hotspots could be present.

Institutions

No institutional site investigations were performed within Patapsco River-C during the uplands assessments, as state park lands comprise much of this subwatershed.

Pervious Areas

Since much of the Patapsco River-C subwatershed is made up of state park lands that are dominated by forest, no pervious area assessments were performed in this subwatershed as part of the uplands assessments.

Stream Restoration Potential

Eroding stream banks are a clear, visible sign of stream impairment. In preparing the Watershed Characterization Report, past studies and reports were reviewed and compiled in an effort to map where streambank erosion has occurred and been noted throughout the Lower Patapsco River watershed. The stabilization of streambanks and other restoration measures can provide numerous benefits, including nutrient and sediment load reductions and improved habitat for aquatic biota. In Patapsco River-C, erosion and channel stability problems were noted along 0.01 miles of stream (0.3% of the total stream miles in this subwatershed). Within the subwatershed, no specific stream reaches were recommended for stream restoration by the 2000 Water Quality Management Plan (Tetra Tech 2000), as noted in Section 3.6.5 of the Watershed Characterization Report (Appendix D).

Illicit Discharges

No prioritized outfalls are present in the Patapsco River-C subwatershed. Baltimore County will continue their Illicit Discharge Detection and Elimination program while seeking to improve techniques for more effective reductions of these discharges.

Stormwater Conversions

No stormwater management ponds were identified by Baltimore County EPS in Patapsco River-C on their list of 51 existing stormwater management facilities in the Lower Patapsco watershed to be evaluated for their conversion potential.

Subwatershed Management Strategy

This subwatershed is primarily state park land, and as Figure 4-6 shows, restoration opportunities are limited.

<u>Engaging Citizens & Watershed Groups</u>

1. Encourage watershed and volunteer groups to organize regular clean-ups to maintain parklands in good condition.

Municipal Actions

1. Investigate stream restoration potential in Patapsco River-C as described in Section 3.6.5 of the Watershed Characterization Report.
2. Encourage park managers to continue to manage the park in an environmentally-friendly way, to minimize potential stormwater impacts.

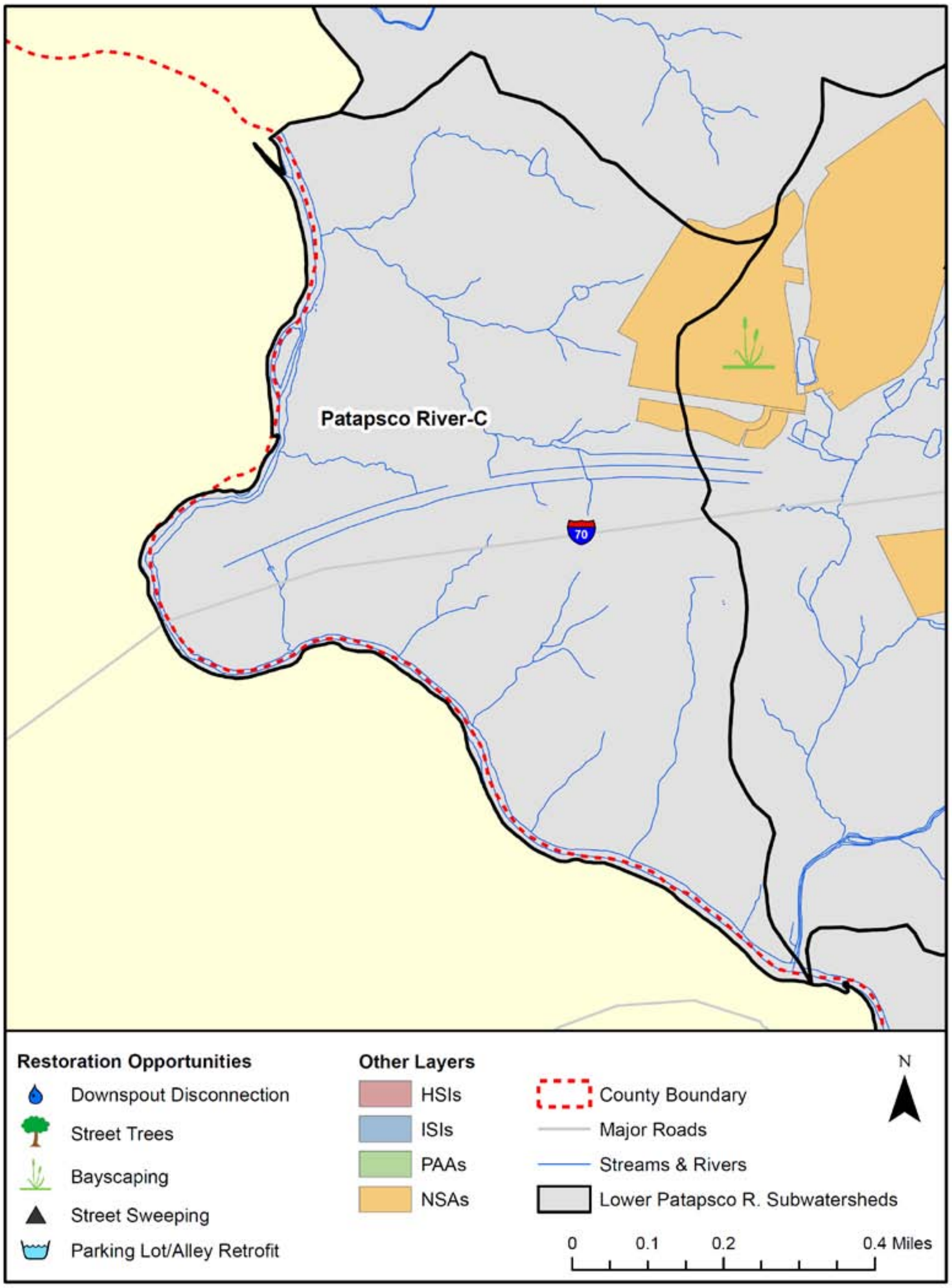

Figure 4-6: Restoration Opportunities in Patapsco River-C

4.3.3 Cedar Branch (Subwatershed code 300)

Cedar Branch is a moderately-sized subwatershed in the Lower Patapsco River watershed with a drainage area of 1.7 square miles. Cedar Branch drains the western edges of Catonsville, with primarily residential land uses in its headwaters and portions of the Patapsco Valley State Park in its lower reaches near its confluence with the Patapsco River. Residential land use comprises almost two-thirds of the subwatershed, including very low, low, medium, and high density areas, with medium density the most prevalent (38.4% of the subwatershed). Some forest land use is present (22% of the subwatershed), along with very small amounts of commercial, institutional, transportation-related, and agriculture land uses. Table 4-19 summarizes key subwatershed characteristics of Cedar Branch.

Table 4-19: Key Subwatershed Characteristics – Cedar Branch

Drainage Area	1,086.3 acres (1.70 sq. mi.)	
Stream Length	7.4 miles	
Population	8,993 (2000 Census) 8.3 people/acre	
Land Use/Land Cover	Very Low Density Residential:	1.6%
	Low Density Residential:	6.8%
	Medium Density Residential:	38.4%
	High Density Residential:	19.3%
	Commercial:	2.9%
	Industrial:	0.0%
	Institutional:	2.1%
	Extractive:	0.0%
	Open Urban Land:	1.1%
	Agriculture:	2.7%
	Forest:	22.2%
	Barren Land:	0.0%
	Water/Wetlands:	0.0%
	Transportation	2.9%
Impervious Cover	20% of subwatershed	
Soils	A Soils (low runoff potential):	23.0%
	B Soils:	24.1%
	C Soils:	30.7%
	D Soils (high runoff potential):	22.1%
SWM Facilities	56% of urban land use treated	
Priority Rating	High	

Neighborhoods

A total of 10 distinct neighborhoods were identified and assessed within Cedar Branch during the uplands assessment of the Lower Patapsco River watershed. Recommendations for neighborhoods in this subwatershed included actions to reduce the volume of storm-water including downspout disconnection, use of rain barrels, and installation of rain gardens. Storm drain marking was recommended in each neighborhood assessed to not only engage residents, but to serve as a visual reminder of the downstream effects of residents' actions. A summary of neighborhood recommended actions is presented in the Table 4-20.

Table 4-20: NSA Recommendations – Cedar Branch

		RECOMMENDED ACTIONS													
Site ID	**Lot Size (acres)**	**% Opportunity for Downspout Disconnection**	**Rain Barrels**	**Rain Gardens**	**Storm Drain Marking**	**Bayscaping**	**Increase Lot Canopy**	**Pet Waste**	**Trash Management**	**Buffer Improvement**	**Parking Lot/Alley Retrofit**	**Street Sweeping**	**# of Street Trees**	**# of Shade Trees**	**Notes**
NSA-A-1002	< 1/4			✓	✓		✓			✓					
NSA-A-1003	< 1/4		✓	✓	✓										
NSA-A-1004	1/4	25	✓	✓	✓										
NSA-A-1005	1/4		✓	✓	✓		✓			✓			10		
NSA-A-1006	< 1/4		✓	✓	✓										
NSA-A-1007	< 1/4				✓		✓						54		
NSA-A-1008	< 1/4		✓		✓								21	9	Some wide open spaces for shade plantings
NSA-A-1009	< 1/4	25	✓	✓	✓		✓						10	20	Open space around pond good for planting
NSA-A-1040	1/4		✓		✓	✓	✓								
NSA-A-1041	1/8		✓		✓		✓					✓	11	40	Open swales could be planted, currently turf

Most of the neighborhoods in Cedar Branch are recommended for downspout disconnection and public education related to increasing lot tree canopy. While most neighborhoods in this subwatershed have curb and gutter systems, several did not have adequate space between the street and sidewalk for the planting of street trees.

Hotspots

No hotspot investigations were performed within Cedar Branch during the uplands assessments.

Institutions

A total of four institutions were assessed for retrofit opportunities in Cedar Branch during the uplands assessment of Lower Patapsco River. These included two churches, one public school and one municipal maintenance facility. Table 4-21 summarizes recommendations for institutional sites assessed in Cedar Branch.

Table 4-21: ISI Recommendations – Cedar Branch

			RECOMMENDED ACTIONS							
Site ID	**Name**	**Public/ Private**	**Storm Drain Marking**	**# Trees for Planting**	**Downspout Disconnection**	**Stormwater Retrofit**	**Impervious Cover Removal**	**Buffer Improvement**	**Trash Management**	**Notes**
ISI-A-303	Inwood Maintenance Shop	Public	✓	14					✓	Miscellaneous materials (garbage, construction materials and hazmats) stored onsite, near stream
ISI-A-304	Celebration Church	Private		30						Grassy area along parking lot for tree planting
ISI-A-305	Grace Baptist Church	Private	✓	15	✓	✓			✓	Possible bioretention area at southern end of parking lot
ISI-A-306	Woodbridge Elementary School	Public	✓	107			✓		✓	One unused sidewalk; excess leaves and grass clippings accumulated on impervious surfaces

Material and waste storage and management were a major concern at ISI-A-303. This maintenance and fuel center included piles of tires, drums, propane tanks, uncovered waste oil tanks, picnic tables, and metal bleachers, as well as piles of stones, dirt, mulch, and tree debris (Figure 4-7). Vehicles stored on the property included county vehicles for maintenance and landscaping, buses, tractors, and construction equipment. A stream is present on the property, and is buffered by a very thin border of riparian cover, and thus is extremely susceptible to stormwater runoff from the site. The aforementioned poor material storage threatens this stream, making this institution one of the worst observed in the uplands assessment of Lower Patapsco River.

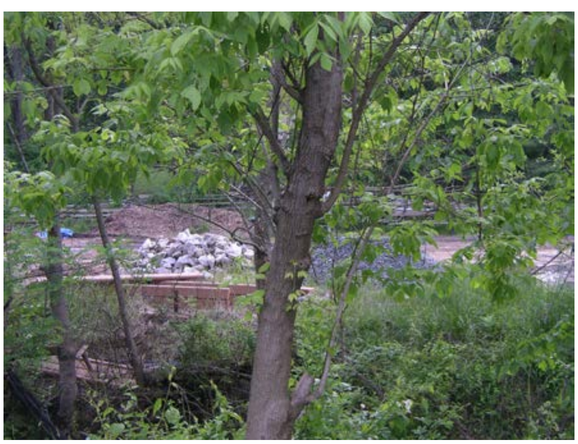

Figure 4-7: Material and Waste Storage was Observed as a Potential Pollution Problem at ISI-A-303.

At the public school (ISI-A-306), tree planting and storm drain marking were recommended as opportunities to combine water quality improvement measures with student education and outreach. Impervious cover removal was recommended at this site, where a small sidewalk that is no longer used could be removed. Decreasing impervious cover allows for better infiltration of stormwater on-site. A leaky dumpster was observed at the school, and accumulated grass clippings and leaves were observed on impervious surfaces on school grounds (Figure 4-8). Cleanup of these stormwater threats is an opportunity to educate students and staff of the importance of trash and materials management.

Figure 4-8: A Leaky Dumpster and Excessive Grass Clippings Accumulated on the Parking Lot were Observed at ISI-A-306.

Tree planting was recommended at the two churches assessed in this subwatershed to improve water quality, stabilize soils, and for nutrient uptake. Tree plantings are a way to engage the community in improving watershed health. In addition, at ISI-A-305, a storm-water retrofit was suggested at the southern end of the parking lot. By adding a biore-tention area, runoff can be captured and treated from approximately 1.35 acres of impervious surface prior to entering the storm drains and stream network.

Pervious Areas

Pervious area restoration has the potential to convert areas of turf, often with high nutrient inputs to forest, which can absorb and filter rather than contribute nutrients. Two pervious areas were assessed for restoration potential in Cedar Branch, including Grace Baptist Church and Woodbridge Elementary School. The Grace Baptist Church site is located off North Rolling Road, south of King William Drive. It is privately owned and maintained and is easily accessible by foot, vehicle, or heavy equipment. It is mostly covered by turf (95%), with scattered medium and large-sized shade trees throughout. While there is no visible stream buffer in the vicinity of the site, benefits of tree planting here would include slowing of surface flow runoff. Woodbridge Elementary School is located off Pleasant Valley Drive, and is owned and maintained by Baltimore County. This site was recom-mended for reforestation with minimal site preparation mostly for stream buffer improvement purposes, but tree planting would need to be balanced with school uses. The selected planting area is located in the western part of the school grounds. A summary is provided in the Table 4-22.

Table 4-22: PAA Summaries – Cedar Branch

Site ID	Location	Description	Acres	Ownership
PAA-A-304	Grace Baptist Church	Church grounds	Parcel - 2.40 Recommended planting – 0.46	Private
PAA-A-305	Woodbridge Elementary School	Public school grounds	Parcel - 16.78 Recommended planting – 0.87	Public

Stream Restoration Potential

Eroding stream banks are a clear, visible sign of stream impairment. In preparing the Watershed Characterization Report, past studies and reports were reviewed and compiled in an effort to map where streambank erosion has occurred and been noted throughout the Lower Patapsco River watershed. The stabilization of streambanks and other restoration measures can provide numerous benefits, including nutrient and sediment load reductions and improved habitat for aquatic biota. In Cedar Branch, erosion and channel stability problems were noted along 4.57 miles of stream (61% of the total stream miles in this subwatershed). 2.55 miles (13,475 feet) of specific stream reaches were recommended for stream restoration in the 2000 Water Quality Management Plan (Tetra Tech 2000) and are detailed in Section 3.6.5 of the Watershed Characterization Report (Appendix D).

Illicit Discharges

Cedar Branch subwatershed contains a total of seven priority 3 outfalls. These are low priority outfalls with minor or no problems that do not require close monitoring. These outfalls are sampled on a 10-year cycle, as Baltimore County continues their Illicit Discharge Detection and Elimination program. The County continues seeking to improve techniques for more effective reductions of these discharges.

Stormwater Conversions

Baltimore County EPS identified three stormwater management ponds in Cedar Branch as part of a list of 51 existing stormwater management facilities in the Lower Patapsco watershed to be evaluated for their conversion potential. Each pond was ranked Low for its potential conversion to improve water quality, and therefore none were selected as one of the highest ranking candidates recommended for conversion.

Subwatershed Management Strategy

Figure 4-9 provides a visual summary of restoration opportunities in the watershed.

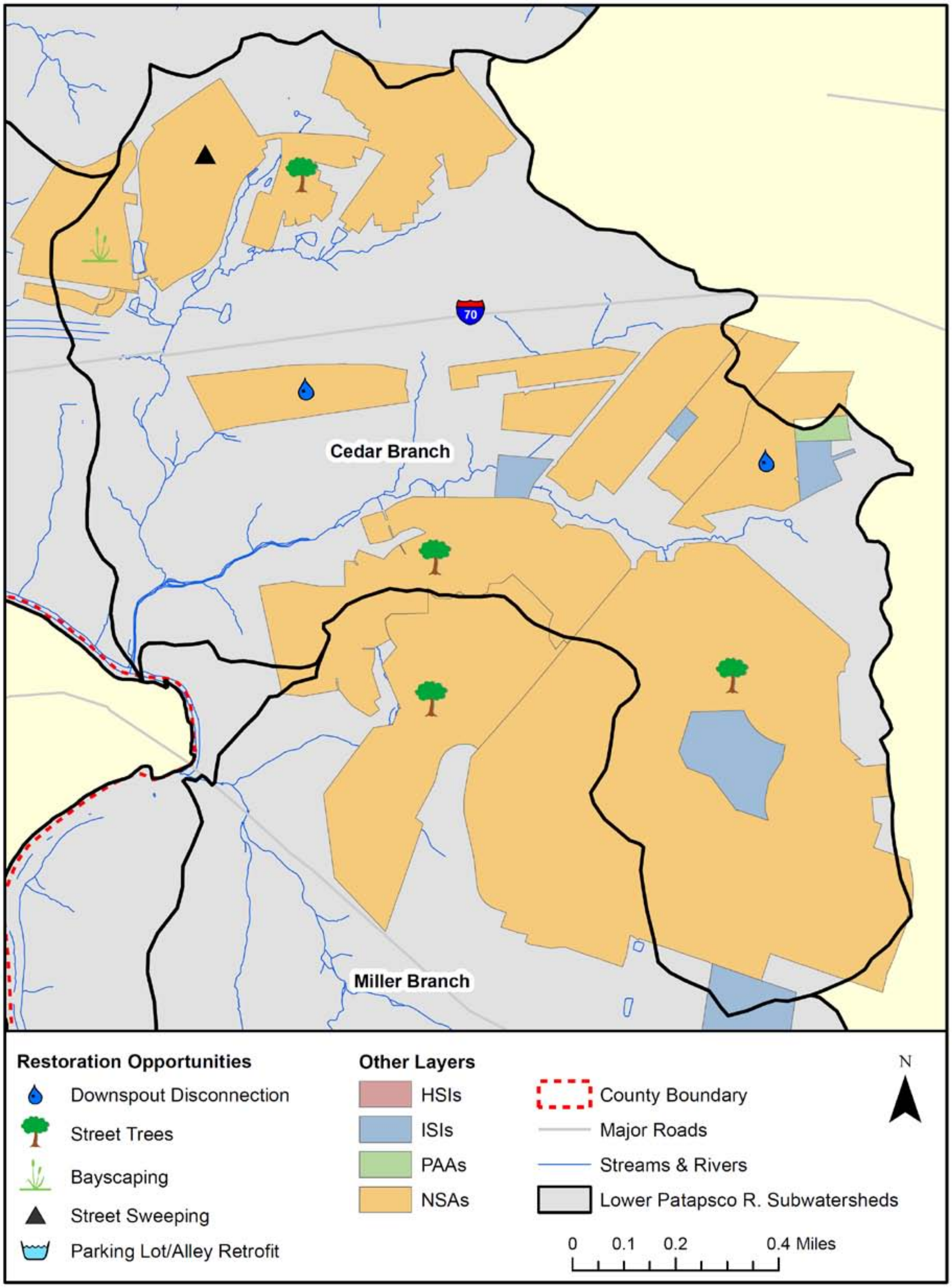

Figure 4-9: Restoration Opportunities in Cedar Branch

Engaging Citizens & Watershed Groups

1. Conduct appropriate downspout disconnection measures in neighborhoods according to Table 4-20.
2. Conduct appropriate downspout rain barrel installation measures in neighborhoods according to Table 4-20.
3. Engage citizens in a storm drain marking program and conduct marking activities in the neighborhoods indicated in Table 4-20.
4. Educate citizens about the benefits and importance of proper lawn care maintenance and Bayscaping.
5. Educate citizens about the benefits and importance of rain gardens and their effects on water quality.
6. Increase tree canopies on private lots by educating citizens and homeowner groups on the benefits of trees.
7. Encourage communities and neighborhoods to plant street and shade trees. Table 4-20 shows a potential for 106 street trees and 69 shade trees.
8. Educate residents about the importance of streamside buffers and encourage more environmentally friendly buffer treatments in the neighborhoods indicated in Table 4-20.
9. Educate staff and members of institutional sites about the importance of proper trash management and outdoor material storage techniques at sites listed in Table 4-21.
10. Engage managers of institutional sites listed in Table 4-21 in other recommended restoration actions.
11. Investigate the pervious areas described in Table 4-22 for potential tree plantings.

Municipal Actions

1. Investigate current street sweeping measures in NSA-A-1041 and increase frequency or implement program as necessary.
2. Investigate stream restoration potential at sites in Cedar Branch as described in Section 3.6.5 of the Watershed Characterization Report.
3. Further investigate the stormwater retrofit opportunities (rain gardens) at ISI-A-305.
4. Continue to monitor illicit discharges.

4.3.4 Patapsco River-A1 (Subwatershed code 400)

Patapsco River-A1 is fifth smallest subwatershed in the Lower Patapsco watershed. It is located on the very western edge of Catonsville, sandwiched between Cedar Branch and Cooper Branch. It includes the historic town of Oella and also part of Patapsco Valley State Park. Forested land dominates the area, with almost 60% of the land use in this category. The remaining land is primarily residential, with medium density residential land use accounting for 21.6%, low density residential occupying 9.7%, and very low density and high density occupying 2 to 4 % each. Table 4-23 summarizes key subwatershed characteristics of Patapsco River-A1.

Table 4-23: Key Subwatershed Characteristics – Patapsco River-A1

Drainage Area	511.5 acres (0.80 sq. mi.)	
Stream Length	3.3 miles	
Population	809 (2000 Census) 1.6 people/acre	
Land Use/Land Cover	Very Low Density Residential:	2.3%
	Low Density Residential:	9.7%
	Medium Density Residential:	21.6%
	High Density Residential:	3.4%
	Commercial:	0.0%
	Industrial:	1.2%
	Institutional:	2.2%
	Extractive:	0.0%
	Open Urban Land:	0.0%
	Agriculture:	0.0%
	Forest:	59.4%
	Barren Land:	0.0%
	Water/Wetlands:	0.0%
	Transportation	0.1%
Impervious Cover	9% of subwatershed	
Soils	A Soils (low runoff potential):	2.7%
	B Soils:	79.5%
	C Soils:	10.6%
	D Soils (high runoff potential):	3.2%
SWM Facilities	4% of urban land use treated	
Priority Rating	Low	

Neighborhoods

A total of four distinct neighborhoods were identified and assessed within Patapsco River-A1 during the uplands assessment of the Lower Patapsco River watershed. The primary recommendations for neighborhoods in this subwatershed included: downspout disconnection, rain barrels, rain gardens, storm drain marking, and increasing lot canopy. A summary of neighborhood recommended actions is presented in the Table 4-24.

Table 4-24: NSA Recommendations – Patapsco River-A1

		RECOMMENDED ACTIONS													
Site ID	**Lot Size (acres)**	**% Opportunity for Downspout Disconnection**	**Rain Barrels**	**Rain Gardens**	**Storm Drain Marking**	**Bayscaping**	**Increase Lot Canopy**	**Pet Waste**	**Trash Management**	**Buffer Improvement**	**Parking Lot/Alley Retrofit**	**Street Sweeping**	**# of Street Trees**	**# of Shade Trees**	**Notes**
NSA-A-1028	1/8	50		✓	✓		✓				✓		5	5	Community parking area could use trees along the curbs
NSA-A-1029	1/8	50	✓		✓		✓				✓		3	3	Very steep slopes behind homes, almost no backyards
NSA-A-1030	<1/4		✓		✓		✓						2		
NSA-A-1093	1/4	50	✓	✓	✓	✓	✓								Some septic systems immediately next to flowing streams

Lot sizes tend to be smaller in this watershed, so a combined effort of downspout disconnection and rain barrel education programs would work well. The small lot sizes also limited opportunities for planting shade trees (Figure 4-10). There was very little space between the street and the sidewalk in the neighborhoods surveyed, so areas for planting street trees was limited, as well. Two neighborhoods were recommended for parking lot retrofits, meaning implementing BMPs to capture and treat runoff from these impervious surfaces (Figure 4-11).

Figure 4-10: Small Lot Sizes and a Lack of Yard Space are Characteristic of NSA-A-1030.

Figure 4-11: There was an Opportunity for Parking Lot Retrofits in NSA-A-1028.

Hotspots

No hotspot investigations were performed within Patapsco River-A1 during the uplands assessments.

Institutions

A total of two institutions were assessed for restoration opportunities in Patapsco River-A1 during the uplands assessment of Lower Patapsco River. These included one municipal facility and one church. Table 4-25 summarizes recommendations for institutional sites assessed in Patapsco River-A1.

Table 4-25: ISI Recommendations – Patapsco River-A1

			RECOMMENDED ACTIONS							
Site ID	Name	Public/ Private	Storm Drain Marking	# Trees for Planting	Downspout Disconnection	Stormwater Retrofit	Impervious Cover Removal	Buffer Improvement	Trash Management	Notes
ISI-A-407	Westchester Community Center	Private	✓	27	✓	✓				Dumpster located on top of stormwater inlet
ISI-A-408	Full Gospel Pentecostal Church	Private		30						Dry detention area present for flood control

Tree plantings were recommended for both institutions assessed in Patapsco River-A1. Additional trees at these sites can help improve stream quality and watershed health primarily by decreasing the amount of stormwater runoff and pollutants that reach local waters. Trees reduce stormwater runoff by capturing and storing rainfall in the tree canopy and by promoting infiltration of water into the soil. At the municipal site, several other recommendations were made. Storm drain marking is an excellent activity for all types of organizations. By participating, the members of the group will become more aware of the close link between their streets and properties and waterways, and they will also leave behind a reminder for others not to pollute. At this site, another adjustment would be to relocate their dumpster, which currently sits directly above a stormwater inlet (Figure 4-12). Currently, any pollutants that leak out or blow out of the dumpster will immediately enter the stormwater network, and quickly enter local streams. Relocating the dumpster to an area away from the inlet reduces the chances for stormwater pollution. Finally, the community center could consider options for reducing stormwater impacts by disconnecting rooftop downspouts on their building and redirecting flow. At this site, some downspouts are directly connected to the storm drain network, and some discharge their flow onto impervious parking lots. By disconnecting the downspouts and redirecting their flow to a pervious area, stormwater volume will be reduced and water quality will be improved.

Figure 4-12: A Dumpster Sits Perilously Above a Stormwater Inlet at ISI-A-407.

Pervious Areas

Pervious area restoration has the potential to convert areas of turf, often with high nutrient inputs to forest, which can absorb and filter rather than contribute nutrients. Two pervious areas were assessed for restoration potential in Patapsco River-A1; these include the

Westchester Community Center and the Full Gospel Pentecostal Church. The Westchester Community Center is located off Westchester Avenue in Oella, and is owned by Baltimore County and maintained by the Westchester Center Foundation. While there is no visible stream buffer in the vicinity of the site, benefits of tree planting here would include slowing of surface flow runoff, especially to the existing stormwater facility. The Full Gospel Pentecostal Church site is located off Westchester Avenue in Oella, and is privately owned and maintained. While there is no visible stream buffer in the vicinity of the site, benefits of tree planting here would include slowing of surface flow runoff and would add to the existing forested buffers on all sides of the site. A summary is provided in Table 4-26.

Table 4-26: PAA Summaries – Patapsco River-A1

Site ID	Location	Description	Acres	Ownership
PAA-A-406	Westchester Community Center	Recreational facility	Parcel - 5.63 Recommended planting – 0.54	Public
PAA-A-407	Full Gospel Pentecostal Church	Church grounds	Parcel - 9.60 Recommended planting – 0.62	Private

Stream Restoration Potential

Eroding stream banks are a clear, visible sign of stream impairment. In preparing the Watershed Characterization Report, past studies and reports were reviewed and compiled in an effort to map where streambank erosion has occurred and been noted throughout the Lower Patapsco River watershed. The stabilization of streambanks and other restoration measures can provide numerous benefits, including nutrient and sediment load reductions and improved habitat health for aquatic biota. In Patapsco River-A1, erosion and channel stability problems were noted along 0.58 miles of stream (17% of the total stream miles in this subwatershed). 0.19 miles (1,000 feet) of specific stream reaches were recommended for stream restoration in the 2000 Water Quality Management Plan (Tetra Tech 2000) and are detailed in Section 3.6.5 of the Watershed Characterization Report (Appendix D).

Illicit Discharges

The Patapsco River-A1 subwatershed has one priority 3 outfall. Priority 3 outfalls are low priority outfalls with minor or no problems that do not require close monitoring. These outfalls are sampled on a 10-year cycle, as Baltimore County continues their Illicit Discharge Detection and Elimination program. The County continues seeking to improve techniques for more effective reductions of these discharges.

Stormwater Conversions

No stormwater management ponds were identified by Baltimore County EPS in Patapsco River-A1 on their list of 51 existing stormwater management facilities in the Lower Patapsco watershed to be evaluated for their conversion potential.

Subwatershed Management Strategy

Figure 4-13 provides a visual summary of restoration opportunities in the watershed.

Engaging Citizens & Watershed Groups

1. Conduct appropriate downspout disconnection measures in neighborhoods according to Table 4-24.
2. Conduct appropriate downspout rain barrel installation measures in neighborhoods according to Table 4-24.
3. Engage citizens in a storm drain marking program and conduct marking activities in the neighborhoods indicated in Table 4-24.
4. Educate citizens about the benefits and importance of Bayscaping and rain gardens and their potential to improve water quality.
5. Increase tree canopies on private lots by educating citizens and homeowner groups on the benefits of trees.
6. Encourage communities and neighborhoods to plant street and shade trees. Table 4-24 shows a potential for 10 street trees and 8 shade trees.
7. Engage institutional sites listed in Table 4-25 in other recommended restoration actions.
8. Investigate the pervious areas described in Table 4-26 for potential tree planting.

Municipal Actions

1. Investigate parking lot stormwater retrofit opportunities identified in neighborhoods as listed in Table 4-24.
2. Further investigate the stormwater retrofit opportunities (rain gardens) at ISI-A-407.
3. Investigate stream restoration potential at sites in Patapsco River-A1 as described in Section 3.6.5 of the Watershed Characterization Report.
4. Continue to monitor illicit discharges.

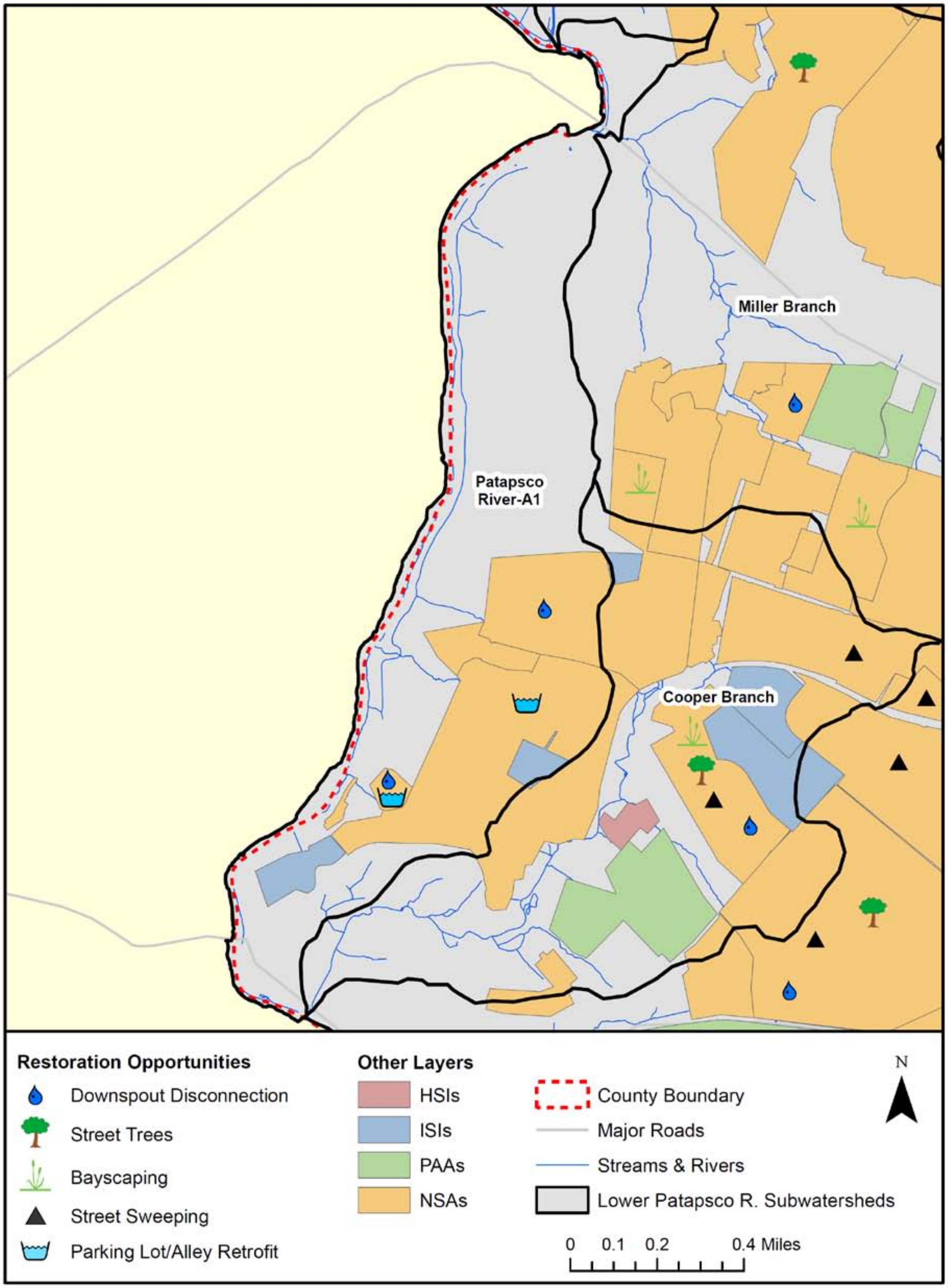

Figure 4-13: Restoration Opportunities in Patapsco River-A1

4.3.5 Miller Branch (Subwatershed code 500)

Miller Branch is a relatively small subwatershed which drains approximately 1.43 square miles (913 acres). The Miller Branch drainage is a mix of heavy commercial land uses located along the Rt. 40 corridor (22.2%), as well as some middle- to high-density residential development in its headwaters. Medium- and high-density residential land uses make up 32.5% and 13.9% of the land use in the watershed, respectively. Lands near the Patapsco State Park are mostly wooded, and forested land occupies more than a quarter of the subwatershed. Table 4-27 summarizes key subwatershed characteristics of Miller Branch.

Table 4-27: Key Subwatershed Characteristics – Miller Branch

Drainage Area	913.4 acres (1.43 sq. mi.)	
Stream Length	5.5 miles	
Population	5,576 (2000 Census) 6.1 people/acre	
Land Use/Land Cover	Very Low Density Residential:	0.6%
	Low Density Residential:	1.4%
	Medium Density Residential:	32.5%
	High Density Residential:	13.9%
	Commercial:	22.2%
	Industrial:	0.0%
	Institutional:	0.5%
	Extractive:	0.0%
	Open Urban Land:	0.9%
	Agriculture:	0.0%
	Forest:	25.3%
	Barren Land:	0.0%
	Water/Wetlands:	0.0%
	Transportation	2.7%
Impervious Cover	31% of subwatershed	
Soils	A Soils (low runoff potential):	2.3%
	B Soils:	37.8%
	C Soils:	14.7%
	D Soils (high runoff potential):	45.2%
SWM Facilities	58% of urban land use treated	
Priority Rating	High	

Neighborhood

A total of eight distinct neighborhoods were identified and assessed within Miller Branch during the uplands assessment of the Lower Patapsco River watershed. The primary recommendations for neighborhoods in this subwatershed included storm drain marking, rain gardens, Bayscaping, and increasing lot canopy size. A summary of neighborhood recommended actions is presented in Table 4-28.

Table 4-28: NSA Recommendations – Miller Branch

		RECOMMENDED ACTIONS													
Site ID	Lot Size (acres)	% Opportunity for Downspout Disconnection	Rain Barrels	Rain Gardens	Storm Drain Marking	Bayscaping	Increase Lot Canopy	Pet Waste	Trash Management	Buffer Improvement	Parking Lot/Alley Retrofit	Street Sweeping	# of Street Trees	# of Shade Trees	Notes
NSA-A-1000	<1/8				✓		✓						16	24	
NSA-A-1010	1/4				✓	✓	✓						4		
NSA-A-1011	1/4		✓	✓	✓	✓	✓								
NSA-A-1013	1/4				✓									4	Better placement of landscaping and better choice of plants needed
NSA-A-1014	<1/4				✓								3	5	
NSA-A-1015	1/4			✓	✓	✓									
NSA-A-1016	<1/4													1	
NSA-A-1019	<1/4	75		✓	✓										

Storm drain marking was recommended for all but one of the neighborhoods in this subwatershed, which offers an opportunity to not only engage residents, but to serve as a visual reminder of the downstream effects of residents' actions. Several townhome communities, particularly in NSA-A-1000, have patches of unused green space that provide excellent opportunities for planting street and shade trees (Figure 4-14).

Figure 4-14: Green Space Within a Townhome Community Provides an Opportunity to Plant Street and Shade Trees in NSA-A-1000.

Hotspots

There were five potential hotspots and one confirmed hotpot identified and assessed within Miller Branch during the uplands assessment of the Lower Patapsco River watershed. Table 4-29 summarizes Miller Branch potential pollution sources from facilities visited.

The Miller Branch watershed had one confirmed pollution hotspot in the form of uncovered grease drums owned by a restaurant in a shopping center (HSI-A-505; Figure 4-15). This was one of two restaurants in the watershed demonstrating poor waste management. The second restaurant (HSI-A-504) showed evidence of grease disposal into its stormwater sewer. The issues noted at both of these facilities were reported to Baltimore County EPS on April 25, 2011.

Also noteworthy was an automobile repair facility (HSI-A-506) with unlabeled and unsealed 55-gallon drums which were exposed to precipitation (Figure 4-16). The watershed's hotspot investigations demonstrated potential stormwater pollution from vehicle operations, physical plant and poor outdoor materials storage practices. The issues noted at this facility were reported to Baltimore County EPS on April 25, 2011.

Table 4-29: Hotspot Summaries – Miller Branch

			POTENTIAL POLLUTION SOURCES						
Site ID	**HSI Status (# filled circles)**	**Description**	**Vehicle Operations**	**Outdoor Materials**	**Waste Management**	**Physical Plant**	**Turf / Landscaping**	**Stormwater**	**Notes**
HSI-A-501	Potential (8)	Commercial – automobile dealership	✓	✓					
HSI-A-502	Potential (9)	Commercial – restaurant		✓	✓				
HSI-A-503	Potential (6)	Commercial – automobile dealership	✓						Cars tracking wash water onto asphalt.
HSI-A-504	Potential (9)	Commercial - restaurant			✓				Evidence of grease being poured into trench drain adjacent to dumpster
HSI-A-505	Confirmed (16)	Commercial - strip mall with various retailers		✓	✓				Uncovered 55-gallon, ¾ full grease drums exposed to precipitation.
HSI-A-506	Potential (10)	Commercial – automobile repair	✓	✓					Unsealed white drums with unknown liquid, uncovered/ outdoors. Could be antifreeze. Plus rusty fuel or petroleum tank outdoors without secondary containment.

Figure 4-15: Uncovered Grease Drums at HSI-A-505

Figure 4-16: Automobile Repair Facility (HSI-A-506) With Unlabeled and Unsealed 55-Gallon Drums

Institutions

Three institutions were assessed for restoration opportunities in Miller Branch during the uplands assessment of Lower Patapsco River. These included one church, one municipal facility, and one hospital/health care center. Table 4-30 summarizes recommendations for institutional sites assessed in Miller Branch.

Table 4-30: ISI Recommendations – Miller Branch

			RECOMMENDED ACTIONS							
Site ID	**Name**	**Public/ Private**	**Storm Drain Marking**	**# Trees for Planting**	**Downspout Disconnection**	**Stormwater Retrofit**	**Impervious Cover Removal**	**Buffer Improvement**	**Trash Management**	**Notes**
ISI-A-510	Baltimore County Water Tower	Public	✓	102					✓	Chlorine storage on property; may consider a storm-water pollution prevention plan
ISI-A-511	St. Agnes Medical Center	Private	✓	60						Building façade appears recently refreshed
ISI-A-528	Deliverance Temple	Private		6						Parking lot is break-ing up in some areas

As identified at many of the institutional sites throughout Lower Patapsco River watershed, institutional sites assessed in Miller Branch subwatershed were each identified as good candidates for tree plantings. The presence of trees helps to slow down and temporarily store stormwater runoff, which further promotes infiltration, and decreases flooding and erosion downstream. Trees reduce pollutants by taking up nutrients and other pollutants from soils and water through their roots, and by transforming pollutants into less harmful substances. Storm drain marking was also recommended at two of the sites, including the municipal facility and the health care center. While many people would never consider polluting a lake or stream, some might pour antifreeze, fertilizer, paint or used motor oil, or toss pet waste, cigarette butts or litter down storm drains. Storm drain marking is a simple way to prevent this kind of pollution from occurring. Citizens can be reminded that anything dumped in the street will wind up in local waterways by including a “Do Not Dump” message next to storm drains.

The Baltimore County Water Tower (ISI-A-510) is an institutional site with multiple opportunities for improving the on-site management of stormwater and runoff. As mentioned above, tree plantings and storm drain marking can be undertaken. In addition, materials stored on site should be covered or relocated, in order to reduce the threat of pollution from stormwater runoff. Field crews observed pipes, bricks, pipe connectors, and piles of dirt uncovered at the site, as well as two uncovered dumpsters full of construction materials, all of which were indirectly connected to stormwater inlets downslope (Figure

4-17). Also, a chlorine storage facility was observed at the site, which could have dangerous effects on watershed health were a spill or other emergency to occur. For these reasons, developing a stormwater pollution prevention plan (if one does not already exist) is another recommendation at ISI-A-510.

Figure 4-17: Material Clean-up is Recommended at ISI-A-510.

Pervious Areas

Pervious area restoration has the potential to convert areas of turf, often with high nutrient inputs to forest, which can absorb and filter rather than contribute nutrients. Two pervious areas were assessed for restoration potential in Miller Branch, including the Horticultural Skill Center and the Baltimore County Water Tank site. The Horticultural Skill Center is located within the George F. Bragg Nature Center off Baltimore National Pike in Catonsville; it is owned and maintained by Baltimore City. This site was recommended for reforestation with minimal site preparation mostly for stream buffer improvement purposes. Tree planting would likely be most appropriate in the southern-most part of the site. The Baltimore County Water Tank site is located off Powers Lane in Catonsville; it is owned and maintained by Baltimore County. This site was recommended for reforestation with moderate site preparation primarily for stream buffer improvement purposes. The selected planting area is located in the southeastern part of the site, around an existing man-made depression. A summary is provided in Table 4-31.

Table 4-31: PAA Summaries – Miller Branch

Site ID	Location	Description	Acres	Ownership
PAA-A-508	Horticultural Skill Center	Educational facility	Parcel - 28.55 Recommended planting - 3.41	Public
PAA-A-509	Baltimore County Water Tank	Infrastructure facility	Parcel - 17.86 Recommended planting – 2.13	Public

Stream Restoration Potential

Eroding stream banks are a clear, visible sign of stream impairment. In preparing the Watershed Characterization Report, past studies and reports were reviewed and compiled in an effort to map where streambank erosion has occurred and been noted throughout the Lower Patapsco River watershed. The stabilization of streambanks and other restoration measures can provide numerous benefits, including nutrient and sediment load reductions and improved habitat health for aquatic biota. In Miller Branch, erosion and channel stability problems were noted along 4.97 miles of stream (91% of the total stream miles in this subwatershed). Within the subwatershed, no specific stream reaches were recommended for stream restoration in the 2000 Water Quality Management Plan (Tetra Tech 2000). The stream reaches surveyed by Friends of Patapsco Valley and Heritage Greenway in recent years are noted in Section 3.6.5 of the Watershed Characterization Report (Appendix D).

Illicit Discharges

There are six priority 3 outfalls located within Miller Branch. These outfalls are low priority outfalls with minor or no problems that do not require close monitoring. These outfalls are sampled on a 10-year cycle, as Baltimore County continues their Illicit Discharge Detection and Elimination program. The County continues seeking to improve techniques for more effective reductions of these discharges.

Stormwater Conversions

Baltimore County EPS identified nine stormwater management ponds in Miller Branch as part of a list of 51 existing stormwater management facilities in the Lower Patapsco watershed to be evaluated for their conversion potential. Five ponds were ranked Low for their potential conversion to improve water quality, one ranked Medium, and three ranked High for their potential conversion to improve water quality.

Subwatershed Management Strategy

Figure 4-18 provides a visual summary of restoration opportunities in the watershed.

<u>Engaging Citizens & Watershed Groups</u>

1. Conduct appropriate downspout disconnection measures in neighborhoods according to Table 4-28.
2. Conduct appropriate downspout rain barrel installation measures in neighborhoods according to Table 4-28.
3. Engage citizens in a storm drain marking program and conduct marking activities in the neighborhoods indicated in Table 4-28.
4. Educate citizens about the benefits and importance of Bayscaping and rain gardens and their effects on water quality.
5. Increase tree canopies on private lots by educating citizens and homeowner groups on the benefits of trees.

6. Encourage communities and neighborhoods to plant street and shade trees. Table 4-28 shows a potential for 23 street trees and 34 shade trees.
7. Educate staff and members of institutional and commercial sites about the importance of proper trash management and outdoor material storage techniques at sites listed in Table 4-30.
8. Engage institutional sites listed in Table 4-30 in other recommended restoration actions.
9. Investigate the pervious areas described in Table 4-31 for potential tree planting.

Municipal Actions

1. Investigate stream restoration potential at sites in Miller Branch as described in Section 3.6.5 of the Watershed Characterization Report (Appendix E).
2. Evaluate the need for development of a Storm Water Pollution Prevention Plan (SWPPP) at ISI-A-510, if one does not already exist.
3. Distribute pollution prevention material to commercial property owners about the importance of proper trash management and outdoor material storage techniques at hotspot sites similar to those identified in Table 4-29.
4. Continue to monitor illicit discharges.
5. Continue to consider retrofitting the three stormwater management ponds described above that were ranked High for their potential conversion to improve water quality.

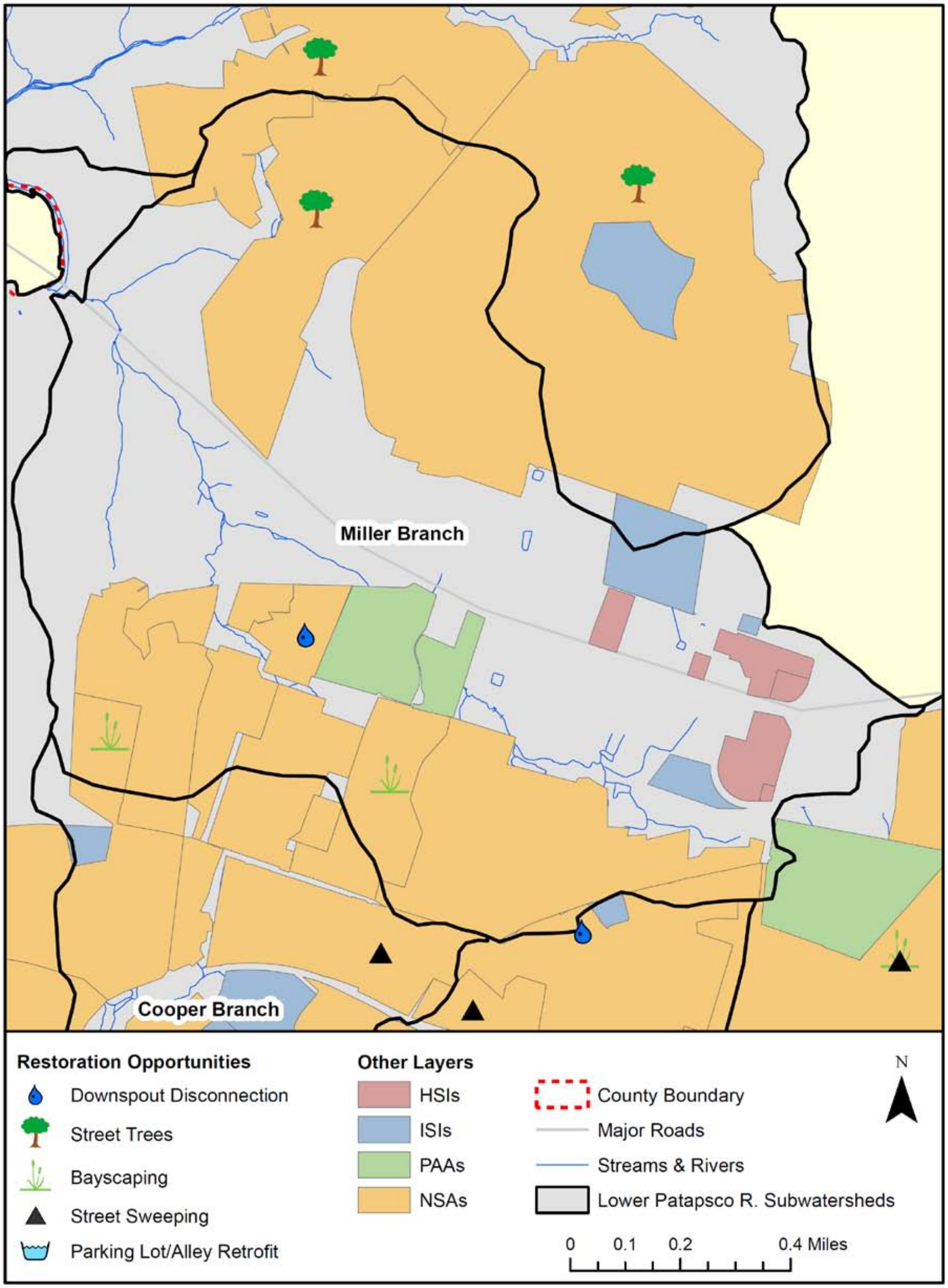

Figure 4-18: Restoration Opportunities in Miller Branch

4.3.6 Cooper Branch (Subwatershed code 600)

Cooper Branch is located on the west side of the community of Oella. Much of the lower southeast side of the watershed is part of the Benjamin Banneker Historical Park. Medium density residential land use comprises over half of the subwatershed, while 28.5% of the watershed contains forested lands. Table 4-32 summarizes key subwatershed characteristics of Cooper Branch.

Table 4-32: Key Subwatershed Characteristics – Cooper Branch

Drainage Area	505.2 acres (0.79 sq. mi.)	
Stream Length	3.5 miles	
Population	2,028 (2000 Census) 4.01 people/acre	
Land Use/Land Cover	Very Low Density Residential:	4.2%
	Low Density Residential:	6.2%
	Medium Density Residential:	51.5%
	High Density Residential:	1.5%
	Commercial:	0.0%
	Industrial:	0.0%
	Institutional:	3.5%
	Extractive:	0.0%
	Open Urban Land:	4.6%
	Agriculture:	0.0%
	Forest:	28.5%
	Barren Land:	0.0%
	Water/Wetlands:	0.0%
	Transportation	0.0%
Impervious Cover	14% of subwatershed	
Soils	A Soils (low runoff potential):	0.0%
	B Soils:	62.6%
	C Soils:	22.4%
	D Soils (high runoff potential):	15.0%
SWM Facilities	16% of urban land use treated	
Priority Rating	High	

Neighborhoods

A total of six distinct neighborhoods were identified and assessed within Cooper Branch during the uplands assessment of the Lower Patapsco River watershed. The primary recommendations for neighborhoods in this subwatershed included storm drain marking and rain gardens. A summary of neighborhood recommended actions is presented in Table 4-33.

Table 4-33: NSA Recommendations – Cooper Branch

Site ID	Lot Size (acres)	RECOMMENDED ACTIONS: % Opportunity for Downspout Disconnection	Rain Barrels	Rain Gardens	Storm Drain Marking	Bayscaping	Increase Lot Canopy	Pet Waste	Trash Management	Buffer Improvement	Parking Lot/Alley Retrofit	Street Sweeping	# of Street Trees	# of Shade Trees	Notes
NSA-A-1012	<1/4			✓	✓										Street trees are already present along most roads
NSA-A-1017	1/4			✓	✓										
NSA-A-1018	1/4	35			✓								2		
NSA-A-1023	1/4	55	✓	✓	✓	✓	✓					✓	46		
NSA-A-1031	<1/8				✓		✓						3	19	
NSA-A-1091	1/4		✓	✓	✓										Streets have no sidewalks

NSA-A-1023 (Figures 4-19) was recommended for a variety of actions, including downspout disconnection, rain barrels, rain gardens, storm drain marking, Bayscaping, increasing lot cover, street sweeping and street tree planting. This neighborhood would be ideal for creating an integrated management plan that demonstrates how all of the various strategies can work together in one locale.

Figure 4-19: NSA-A-1023 is Recommended for a Variety of Actions.

Hotspots

There was only one facility assessed in the Cooper Branch watershed during the uplands assessment of the Lower Patapsco River watershed. This slaughterhouse and retail store was classified as a potential hotspot. Table 4-34 summarizes Cooper Branch potential pollution sources from facilities visited.

Table 4-34: Hotspot Summary – Cooper Branch

			POTENTIAL POLLUTION SOURCES						
Site ID	HSI Status (# filled circles)	Description	Vehicle Operations	Outdoor Materials	Waste Management	Physical Plant	Turf / Landscaping	Stormwater	Notes
HSI-A-607	Potential (8)	Industrial – slaughterhouse and retail store	✓	✓					Unmarked 55 gallon drums exposed to precipitation.

The one HSI in the watershed was a slaughterhouse which was generally quite orderly with the exception of some unmarked 55 gallon drums that were exposed to precipitation (Figure 4-20). The facility also has large fuel tanks. If those tanks exceed 1320 gallons in total, the facility would need a Spill Prevention Control and Countermeasures (SPCC) plan as per the Maryland regulations.

Figure 4-20: Unmarked Drums Exposed to Precipitation

Institutions

Three institutions were assessed for restoration opportunities in Cooper Branch during the uplands assessment of Lower Patapsco River. These included two public schools and one church. Table 4-35 summarizes recommendations for institutional sites assessed in Cooper Branch.

At the church, opportunities exist for tree planting, downspout disconnection, and the creation of rain gardens to serve as bioretention areas for temporary storage of storm-water. Each of these actions will reduce the inputs of stormwater to the storm drain and stream networks. Additional trees will slow down and temporarily store stormwater runoff, reducing volume and nutrient inputs. By disconnecting downspouts, roof downspouts are separated from the sewer system and roof runoff is instead directed onto pervious surfaces.

At both of the public schools, storm drain marking and tree planting offer excellent opportunities to combine water quality improvement measures with student education and outreach. At Westchester Elementary School (ISI-A-641), downspout disconnection and the addition of a bioretention area to temporarily detain storm flows are recommended to reduce stormwater volume, peak flows, and nutrient inputs to the storm drains and nearby streams (Figure 4-21). Also at this site, some significant areas of bare ground are present in the rear of the school, and drain toward a stormwater inlet. Re-vegetating these bare areas can be an educational experience for the students and faculty of the school while also providing water quality benefits.

Table 4-35: ISI Recommendations – Cooper Branch

			RECOMMENDED ACTIONS							
Site ID	**Name**	**Public/ Private**	**Storm Drain Marking**	**# Trees for Planting**	**Downspout Disconnection**	**Stormwater Retrofit**	**Impervious Cover Removal**	**Buffer Improvement**	**Trash Management**	**Notes**
ISI-A-612	Trinity United Methodist	Private		18	✓	✓				
ISI-A-613	Catonsville Middle School	Public	✓	77						Dry detention with wetland present, treating west parking area near tennis courts
ISI-A-641	Westchester Elementary School	Public	✓	3	✓	✓			✓	Some bare ground present in rear of school that drains to stormwater inlet

Figure 4-21: Potential Location for Inclusion of a Bioretention Area at ISI-A-641

Pervious Areas

Pervious area restoration has the potential to convert areas of turf, often with high nutrient inputs to forest, which can absorb and filter rather than contribute nutrients. A single pervious area was assessed for restoration potential in Cooper Branch, including Benjamin Banneker Park. The Benjamin Banneker Park site is located off Oella Avenue in Oella; it is owned and maintained by Baltimore County. There are two separate moderate-sized parcels that would be appropriate for tree planting; both are in the northeastern part of the site. This site was recommended for reforestation with minimal site preparation to bolster the existing partially forested stream buffer in the northeastern part of the property. A summary is provided in Table 4-36.

Table 4-36: PAA Summary – Cooper Branch

Site ID	Location	Description	Acres	Ownership
PAA-A-623	Benjamin Banneker Historical Park and Museum	Park lands	Parcel - 40.58 Recommended planting – 2.35	Public

Stream Restoration Potential

Eroding stream banks are a clear, visible sign of stream impairment. In preparing the Watershed Characterization Report, past studies and reports were reviewed and compiled in an effort to map where streambank erosion has occurred and been noted throughout the Lower Patapsco River watershed. The stabilization of streambanks and other restoration measures can provide numerous benefits, including nutrient and sediment load reductions and improved habitat health for aquatic biota. In Cooper Branch, erosion and channel stability problems were noted along 2.20 miles of stream (63% of the total stream miles in this subwatershed). 0.96 miles (5,052 feet) of specific stream reaches were recommended for stream restoration in the 2000 Water Quality Management Plan (Tetra Tech 2000) and are detailed in Section 3.6.5 of the Watershed Characterization Report (Appendix D).

Illicit Discharges

Within Cooper Branch, there are two outfalls rated as priority 3. These priority 3 outfalls are low priority outfalls with minor or no problems that do not require close monitoring. These outfalls are sampled on a 10-year cycle, as Baltimore County continues their Illicit Discharge Detection and Elimination program. The County continues seeking to improve techniques for more effective reductions of these discharges.

Stormwater Conversions

Baltimore County EPS identified two stormwater management ponds in Cooper Branch as part of a list of 51 existing stormwater management facilities in the Lower Patapsco watershed to be evaluated for their conversion potential. One pond was ranked High for its potential conversion to improve water quality, while the other was ranked Low.

Subwatershed Management Strategy

Figure 4-22 provides a visual summary of restoration opportunities in the watershed.

<u>Engaging Citizens & Watershed Groups</u>

1. Conduct appropriate downspout disconnection measures in neighborhoods according to Table 4-33.
2. Conduct appropriate rain barrel installation measures in neighborhoods according to Table 4-33.
3. Engage citizens in a storm drain marking program and conduct marking activities in the neighborhoods indicated in Table 4-33.
4. Educate citizens about the benefits and importance of bayscaping and rain gardens and their effects on water quality.
5. Increase tree canopies on private lots by educating citizens and homeowner groups on the benefits of trees.
6. Encourage communities and neighborhoods to plant street and shade trees. Table 4-33 shows a potential for 51street trees and 19 shade trees.
7. Educate staff and members of institutional sites about the importance of proper trash management and outdoor material storage techniques at sites listed in Table 4-35.
8. Engage institutional sites listed in Table 4-35 in other recommended restoration actions.
9. Investigate the pervious areas described in Table 4-36 for potential tree planting.

Municipal Actions

1. Increase current street sweeping measures in recommended neighborhoods listed in Table 4-33 and increase frequency or implement program as necessary.
2. Investigate stream restoration potential at sites in Cooper Branch as described in Section 3.6.5 of the Watershed Characterization Report.
3. Educate commercial property owners about the importance of proper trash management and outdoor material storage techniques at hotspot sites similar to those identified in Table 4-34.
4. Continue to monitor illicit discharges.
5. Continue to consider retrofitting the stormwater management pond described above that was ranked High for its potential conversion to improve water quality.

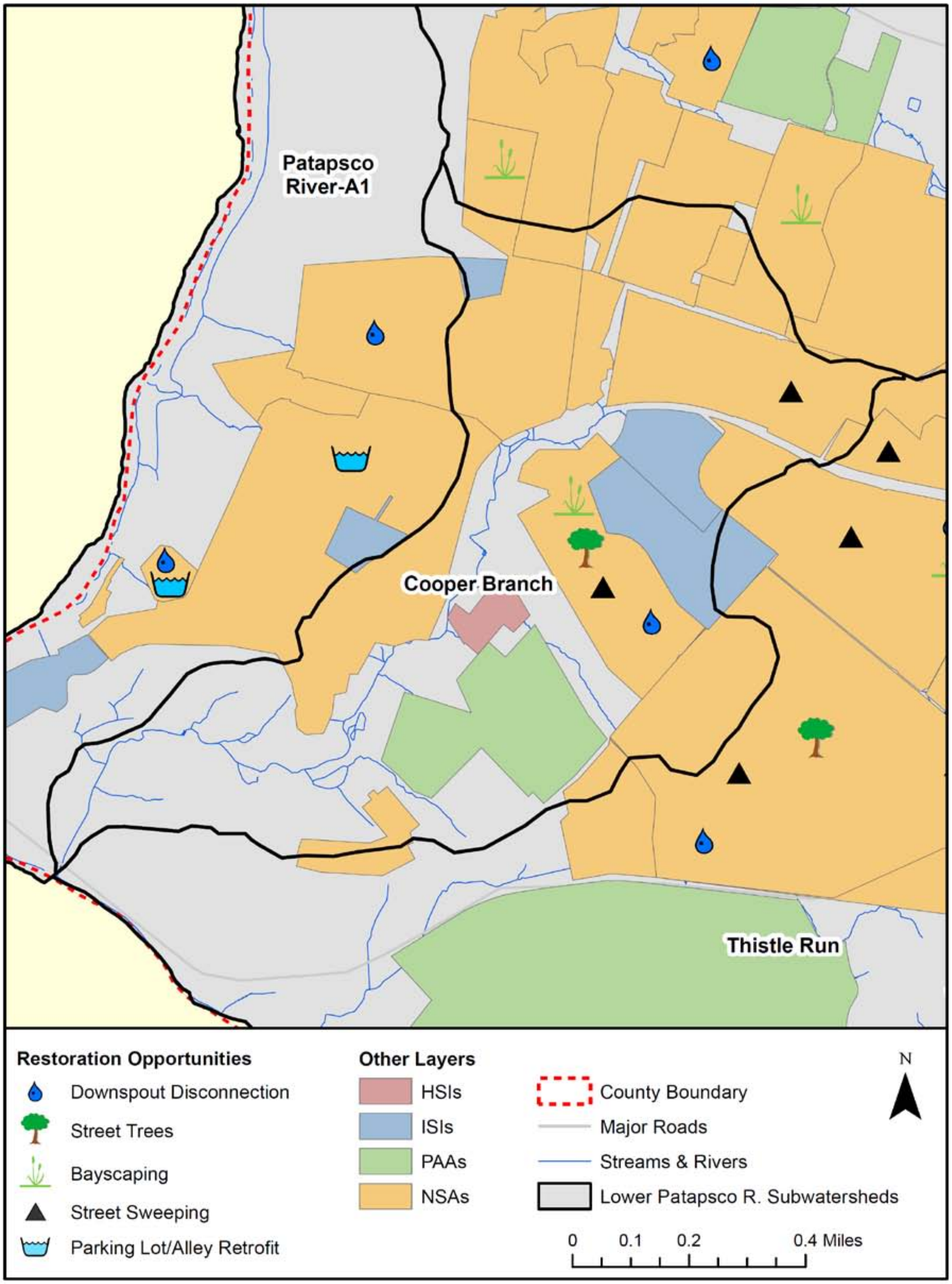

Figure 4-22: Restoration Opportunities in Cooper Branch

4.3.7 Thistle Run (Subwatershed code 700)

Thistle Run is the fifth largest subwatershed in the SWAP area (with 1,223 acres) and drains the south central portion of Catonsville. The headwaters begin near the intersection of Old Frederick and Rolling Roads. The dominant land uses in Thistle Run are forest (44.3%) and medium density residential (37.6%). Some open urban land is also present. Table 4-37 summarizes key subwatershed characteristics of Thistle Run.

Table 4-37: Key Subwatershed Characteristics – Thistle Run

Drainage Area	1,092.3 acres (1.71 sq. mi.)	
Stream Length	8.9 miles	
Population	2,411 (2000 Census) 2.2 people/acre	
Land Use/Land Cover	Very Low Density Residential:	1.5%
	Low Density Residential:	1.4%
	Medium Density Residential:	37.6%
	High Density Residential:	0.5%
	Commercial:	0.6%
	Industrial:	0.0%
	Institutional:	0.5%
	Extractive:	0.0%
	Open Urban Land:	13.6%
	Agriculture:	0.0%
	Forest:	44.3%
	Barren Land:	0.0%
	Water/Wetlands:	0.0%
	Transportation	0.0%
Impervious Cover	11% of subwatershed	
Soils	A Soils (low runoff potential):	0.5%
	B Soils:	80.2%
	C Soils:	10.9%
	D Soils (high runoff potential):	8.1%
SWM Facilities	4% of urban land use treated	
Priority Rating	Medium	

Neighborhoods

A total of six distinct neighborhoods were identified and assessed within Thistle Run during the uplands assessment of the Lower Patapsco River watershed. The primary recommendations for neighborhoods in this subwatershed included downspout disconnection, rain gardens, storm drain marking, increasing lot canopy, street sweeping, and the planting of street trees. A summary of neighborhood recommended actions is presented in the Table 4-38.

Table 4-38: NSA Recommendations – Thistle Run

		RECOMMENDED ACTIONS													
Site ID	Lot Size (acres)	% Opportunity for Downspout Disconnection	Rain Barrels	Rain Gardens	Storm Drain Marking	Bayscaping	Increase Lot Canopy	Pet Waste	Trash Management	Buffer Improvement	Parking Lot/Alley Retrofit	Street Sweeping	# of Street Trees	# of Shade Trees	Notes
NSA-A-1021	<1/4	25		✓	✓		✓					✓	15	4	
NSA-A-1022	1/2	55				✓						✓	15		
NSA-A-1024	1/2			✓			✓			✓		✓	5		Almost every house could have a rain garden
NSA-A-1027	<1/4	50	✓	✓	✓		✓					✓	20	2	
NSA-A-1090	1/4	25	✓	✓	✓		✓						2		Trees planted in parking islands shade out areas where there is space for street trees
NSA-A-1094	1/4		✓	✓	✓		✓					✓			

Opportunities for action are plentiful in most of the neighborhoods in the Thistle Run subwatershed, particularly NSA-A-1021 and NSA-A-1027. Leaves were clogging many of the curb and gutter systems in the subwatershed during initial fall visits in 2006, providing an ideal opportunity for a street sweeping program (Figure 4-23). Removing organic matter and loose sediment from the streets prevents it from reaching the Lower Patapsco River and Chesapeake Bay, and can be an important measure for reducing pollutant loads and reaching TMDL goals.

Figure 4-23: Neighborhoods, Like NSA-A-1094, Have Opportunities for Rain Gardens, Street Trees, and Other Improvements.

Hotspots

No hotspot investigations were performed within Thistle Run during the uplands assessments.

Institutions

Four institutions were assessed for restoration opportunities in Thistle Run during the uplands assessment of Lower Patapsco River. These were all faith-based facilities (i.e., churches). Table 4-39 summarizes recommendations for institutional sites assessed in Thistle Run.

Table 4-39: ISI Recommendations – Thistle Run

			RECOMMENDED ACTIONS							
Site ID	**Name**	**Public/ Private**	**Storm Drain Marking**	**# Trees for Planting**	**Downspout Disconnection**	**Stormwater Retrofit**	**Impervious Cover Removal**	**Buffer Improvement**	**Trash Management**	**Notes**
ISI-A-714	Cummins Church	Private		25	✓	✓				Dumpster open, but no inlets nearby. Uncovered pile of mulch observed
ISI-A-729	St. Paul Lutheran Church	Private		24	✓	✓				Covered dumpster located near stormwater inlet
ISI-A-730	Immanuel United Church	Private		10	✓	✓				
ISI-A-731	Catonsville Assembly of God	Private		0	✓	✓				Covered dumpster located near stormwater inlet. Plenty of trees, nicely landscaped.

Three of the four church facilities assessed in Thistle Run offer opportunities to engage the community in tree planting activities (Figure 4-24). Trees are crucial to the overall health of the watershed—they slow down runoff and the erosion of soil, and they absorb the nutrients that are the main cause of pollutants in local streams and the Chesapeake Bay. Trees also provide habitat for wildlife and help to cool stream temperatures. Involving parishioners in tree planting events can pique interest in watershed stewardship and provide watershed benefits as well.

Figure 4-24: Potential Tree Planting Areas at Faith-Based Facilities in Thistle Run

Stormwater management at the church facilities can additionally be improved in several ways. Reductions in stormwater can be attained by disconnecting downspouts and creating bioretention areas (rain gardens). Bioretention areas are depressed swatches of land with native plants and filter media that enable roof runoff to be captured and treated prior to entering the storm drain/stream system. Signage can be erected with the rain gardens to educate the churches' communities as to the benefits of these practices to watershed health. Education related to proper material and waste management should also be provided, as an uncovered dumpster and uncovered pile of mulch were observed at ISI-A-714 (Figure 4-25), and covered dumpsters located just upslope of stormwater inlets were observed at ISI-A-729 and ISI-A-731. Keeping covers on these dumpsters and material piles, and moving dumpsters away from stormwater inlets are good precautions to undertake to improve watershed health.

Figure 4-25: An uncovered pile of mulch at ISI-A-714 could wash away during high storm-flows and provide unnecessary nutrient inputs to downstream waters.

Pervious Areas

Pervious area restoration has the potential to convert areas of turf, often with high nutrient inputs to forest, which can absorb and filter rather than contribute nutrients. A single pervious area was assessed for restoration potential in Thistle Run, the Patapsco Horse Center. The Patapsco Horse Center site is located within Patapsco Valley State Park off Frederick Road in Catonsville; the land is owned by the state of Maryland Department of Natural Resources. Because of the number of small headwater tributaries (often with almost no riparian buffers) and the quantity of open unforested land, this site presents some of the best forest planting opportunities in the entire Lower Patapsco River watershed. These unnamed site tributaries drain south directly to the Patapsco River. This site generally receives full sun exposure and is easily accessible by foot, vehicle, and heavy equipment over farm lanes. Large areas of the site could be planted, and a significant part of this area was recently planted by the FPVHG, although it is currently an active horse farm. Site planning would require verification that additional tree planting would not interfere with the current uses of the site. A summary is provided Table 4-40.

Table 4-40: PAA Summary – Thistle Run

Site ID	Location	Description	Acres	Ownership
PAA-A-710	Patapsco Horse Center	Equestrian facility	Parcel - 207.91 Recommended planting – 81.38	Public

Stream Restoration Potential

Eroding stream banks are a clear, visible sign of stream impairment. In preparing the Watershed Characterization Report, past studies and reports were reviewed and compiled in an effort to map where streambank erosion has occurred and been noted throughout the Lower Patapsco River watershed. The stabilization of streambanks and other restoration measures can provide numerous benefits, including nutrient and sediment load reductions and improved habitat health for aquatic biota. In Thistle Run, erosion and channel stability problems were noted along 1.17 miles of stream (13% of the total stream miles in this subwatershed). 0.66 miles (3,463 feet) of specific stream reaches were recommended for stream restoration in the 2000 Water Quality Management Plan (Tetra Tech 2000) and are detailed in Section 3.6.5 of the Watershed Characterization Report (Appendix D).

Illicit Discharges

Thistle Run contains one outfall rated as priority 3. This outfall is considered a low priority outfall with only minor or no problems that do not require close monitoring. These outfalls are sampled on a 10-year cycle, as Baltimore County continues their Illicit Discharge Detection and Elimination program. The County continues seeking to improve techniques for more effective reductions of these discharges.

Stormwater Conversions

Baltimore County EPS identified two stormwater management ponds in Thistle Run as part of a list of 51 existing stormwater management facilities in the Lower Patapsco watershed to be evaluated for their conversion potential. Both ponds were ranked Low for their potential conversion to improve water quality.

Subwatershed Management Strategy

Figure 4-26 provides a visual summary of restoration opportunities in the watershed.

Engaging Citizens & Watershed Groups

1. Conduct appropriate downspout disconnection measures in neighborhoods according to Table 4-38.
2. Conduct appropriate rain barrel installation measures in neighborhoods according to Table 4-38.
3. Engage citizens in a storm drain marking program and conduct marking activities in the neighborhoods indicated in Table 4-38.
4. Educate citizens about the benefits and importance of Bayscaping and rain gardens and their effects on water quality.
5. Increase tree canopies on private lots by educating citizens and homeowner groups on the benefits of trees.
6. Encourage communities and neighborhoods to plant street and shade trees. Table 4-38 shows a potential for 57 street trees and 6 shade trees.
7. Educate residents about the importance of streamside buffers and encourage more environmentally friendly buffer treatments in the neighborhoods indicated in Table 4-38.
8. Engage institutional sites listed in Table 4-39 in recommended restoration actions.
9. Investigate the pervious areas described in Table 4-40 for potential tree planting.

Municipal Actions

1. Investigate current street sweeping measures in recommended neighborhoods listed in Table 4-38 and increase frequency or implement program as necessary.
2. Investigate stream restoration potential at sites in Thistle Run as described in Section 3.6.5 of the Watershed Characterization Report.
3. Continue to monitor illicit discharges.

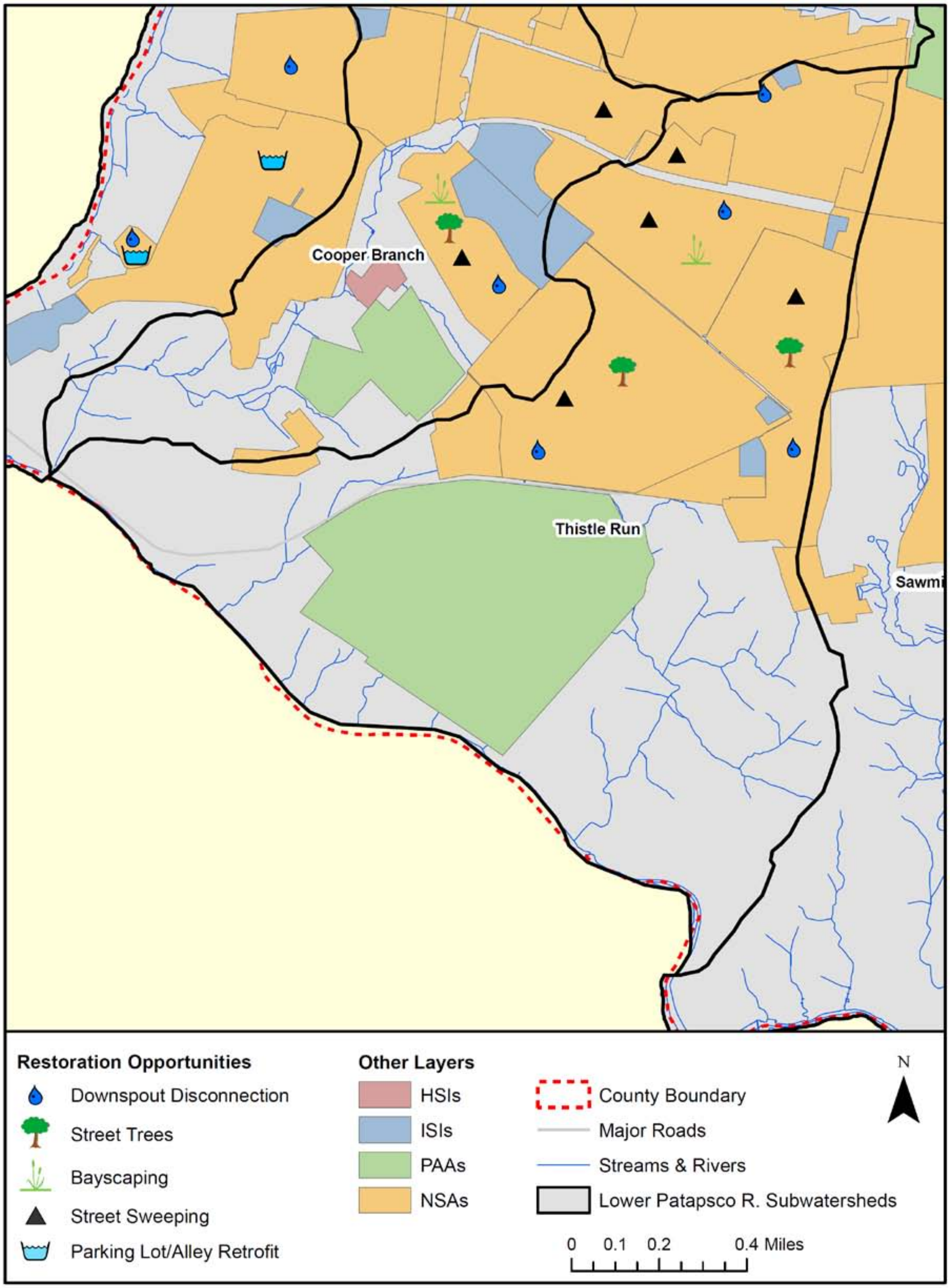

Figure 4-26: Restoration Opportunities in Thistle Run

4.3.8 Santee Branch (Subwatershed code 800)

The Santee Branch subwatershed has a drainage area of 948 acres. The top of the subwatershed is in Catonsville, near the intersection of N. Beaumont and Summit Avenues. The majority of land use in Santee Branch is forested (47.8%), and there is also a significant proportion of medium-density residential land use (39.4%). Table 4-41 summarizes key subwatershed characteristics of Santee Branch.

Table 4-41: Key Subwatershed Characteristics – Santee Branch

Drainage Area	947.7 acres (1.48 sq. mi.)	
Stream Length	6.7 miles	
Population	3,366 (2000 Census) 3.6 people/acre	
Land Use/Land Cover	Very Low Density Residential:	2.9%
	Low Density Residential:	2.4%
	Medium Density Residential:	39.4%
	High Density Residential:	0.0%
	Commercial:	0.1%
	Industrial:	0.0%
	Institutional:	7.5%
	Extractive:	0.0%
	Open Urban Land:	0.0%
	Agriculture:	0.0%
	Forest:	47.8%
	Barren Land:	0.0%
	Water/Wetlands:	0.0%
	Transportation	0.0%
Impervious Cover	11% of subwatershed	
Soils	A Soils (low runoff potential):	4.7%
	B Soils:	71.5%
	C Soils:	15.8%
	D Soils (high runoff potential):	7.2%
SWM Facilities	18% of urban land use treated	
Priority Rating	Medium	

Neighborhood

A total of five (5) distinct neighborhoods were identified and assessed within Santee Branch during the uplands assessment of the Lower Patapsco River watershed. The primary recommendations for neighborhoods in this subwatershed included rain barrels, rain gardens, and storm drain marking. A summary of neighborhood recommended actions is presented in Table 4-42.

Table 4-42: NSA Recommendations – Santee Branch

		RECOMMENDED ACTIONS													
Site ID	**Lot Size (acres)**	**% Opportunity for Downspout Disconnection**	**Rain Barrels**	**Rain Gardens**	**Storm Drain Marking**	**Bayscaping**	**Increase Lot Canopy**	**Pet Waste**	**Trash Management**	**Buffer Improvement**	**Parking Lot/Alley Retrofit**	**Street Sweeping**	**# of Street Trees**	**# of Shade Trees**	**Notes**
NSA-A-1034	1/4	40	✓	✓	✓	✓				✓		✓			Older, mature trees, lots of ornamentals
NSA-A-1050	1/2			✓	✓										Street trees not necessary due to size and number of front yard trees near sidewalk
NSA-A-1051	<1/4	25	✓	✓	✓		✓					✓			Rain gardens are possible on end lots, neighborhood likely receptive based on landowner conversations
NSA-A-1078	1/4	80	✓	✓	✓					✓			21		Buffer encroach-ment
NSA-A-1079	1/2		✓	✓	✓		✓							29	Opens spaces generally well planted

Rain gardens and storm drain marking programs were recommended for all neighborhoods (Figure 4-27). Both action strategies involve a strong educational component, and may pay off beyond their initial pollutant load reductions. Citizens may begin to develop a sense of how their actions and conditions on their property relate to the health of the Chesapeake Bay, giving them a stronger sense of connection and ownership that may result in additional restoration and protection activities.

Figure 4-27: Neighborhoods With Large Yards, Like NSA-A-1050, May Have Available Space for Creating Rain Gardens.

Hotspots

No hotspot investigations were performed within Santee Branch during the uplands assessments.

Institutions

Two institutions were assessed for restoration opportunities in Santee Branch during the uplands assessment of Lower Patapsco River. These included one municipal facility and one public school. Table 4-43 summarizes recommendations for institutional sites assessed in Santee Branch.

Table 4-43: ISI Recommendations – Santee Branch

			RECOMMENDED ACTIONS							
Site ID	Name	Public/ Private	Storm Drain Marking	# Trees for Planting	Downspout Disconnection	Stormwater Retrofit	Impervious Cover Removal	Buffer Improvement	Trash Management	Notes
ISI-A-817	Catonsville Branch of Baltimore County Public Library	Public	✓							Highly visible project site.
ISI-A-818	Hillcrest Elementary School	Public	✓	6						Some uncovered dumpsters but not near inlets.

The Catonsville Branch of the Baltimore County Public Library offers a highly visible platform to share the message of the importance of stormwater management to watershed health. At this site, storm drain marking is recommended, as it could be seen by the large numbers of children and adults visiting the library each day. Citizens can be reminded that anything dumped in the street will wind up in local waterways by including a "Do Not Dump" message next to storm drains.

Storm drain marking is also recommended at the public school assessed in this sub-watershed, again offering an excellent opportunity to engage students and teachers in an activity promoting watershed stewardship. While many trees have recently been planted by the school's PTA, some additional opportunities for tree plantings were identified here and could offer students further hands-on opportunities to improve watershed health (Figure 4-28).

Figure 4-28: Potential Tree Planting Site at ISI-A-818

Pervious Areas

No pervious area assessments were performed within Santee Branch during the uplands assessments.

Stream Restoration Potential

Eroding stream banks are a clear, visible sign of stream impairment. In preparing the Watershed Characterization Report, past studies and reports were reviewed and compiled in an effort to map where streambank erosion has occurred and been noted throughout the Lower Patapsco River watershed. The stabilization of streambanks and other restoration measures can provide numerous benefits, including nutrient and sediment load reductions and improved habitat health for aquatic biota. In Santee Branch, erosion and channel stability problems were noted along 4.11 miles of stream (62% of the total stream miles in this subwatershed). Within the subwatershed, no specific stream reaches were recommended for stream restoration by the 2000 Water Quality Management Plan (Tetra

Tech 2000). Stream reaches surveyed by the Friends of Patapsco Valley and Heritage Greenway in recent years are noted in Section 3.6.5 of the Watershed Characterization Report (Appendix D).

Illicit Discharges

A single priority 3 outfall is present within Santee Branch. This outfall is considered a low priority outfall with only minor or no problems that do not require close monitoring. Priority 3 outfalls are sampled on a 10-year cycle, as Baltimore County continues their Illicit Discharge Detection and Elimination program and seeks to improve techniques for more effective reductions of these discharges.

Stormwater Conversions

Baltimore County EPS identified two stormwater management ponds in Santee Branch as part of a list of 51 existing stormwater management facilities in the Lower Patapsco watershed to be evaluated for their conversion potential. While one pond was ranked Medium for its potential conversion to improve water quality, the other pond was ranked Low.

Subwatershed Management Strategy

Figure 4-29 provides a visual summary of restoration opportunities in the watershed.

Engaging Citizens & Watershed Groups

1. Conduct appropriate downspout disconnection measures in neighborhoods according to Table 4-42.
2. Conduct appropriate rain barrel installation measures in neighborhoods according to Table 4-42.
3. Engage citizens in a storm drain marking program and conduct marking activities in the neighborhoods indicated in Table 4-42.
4. Educate citizens about the benefits and importance of Bayscaping and rain gardens and their effects on water quality.
5. Increase tree canopies on private lots by educating citizens and homeowner groups on the benefits of trees.
6. Encourage communities and neighborhoods to plant street and shade trees. Table 4-42 shows a potential for 21 street trees and 29 shade trees.
7. Educate residents about the importance of streamside buffers and encourage more environmentally friendly buffer treatments in the neighborhoods indicated in Table 4-42.
8. Educate staff and members of institutional sites about the importance of proper trash management and outdoor material storage techniques at sites listed in Table 4-43.
9. Engage institutional sites listed in Table 4-43 in other recommended restoration actions.

Municipal Actions

1. Investigate current street sweeping measures in recommended neighborhoods listed in Table 4-42 and increase frequency or implement program as necessary.
2. Investigate stream restoration potential at sites in Santee Branch as described in Section 3.6.5 of the Watershed Characterization Report.
3. Continue to monitor illicit discharges.

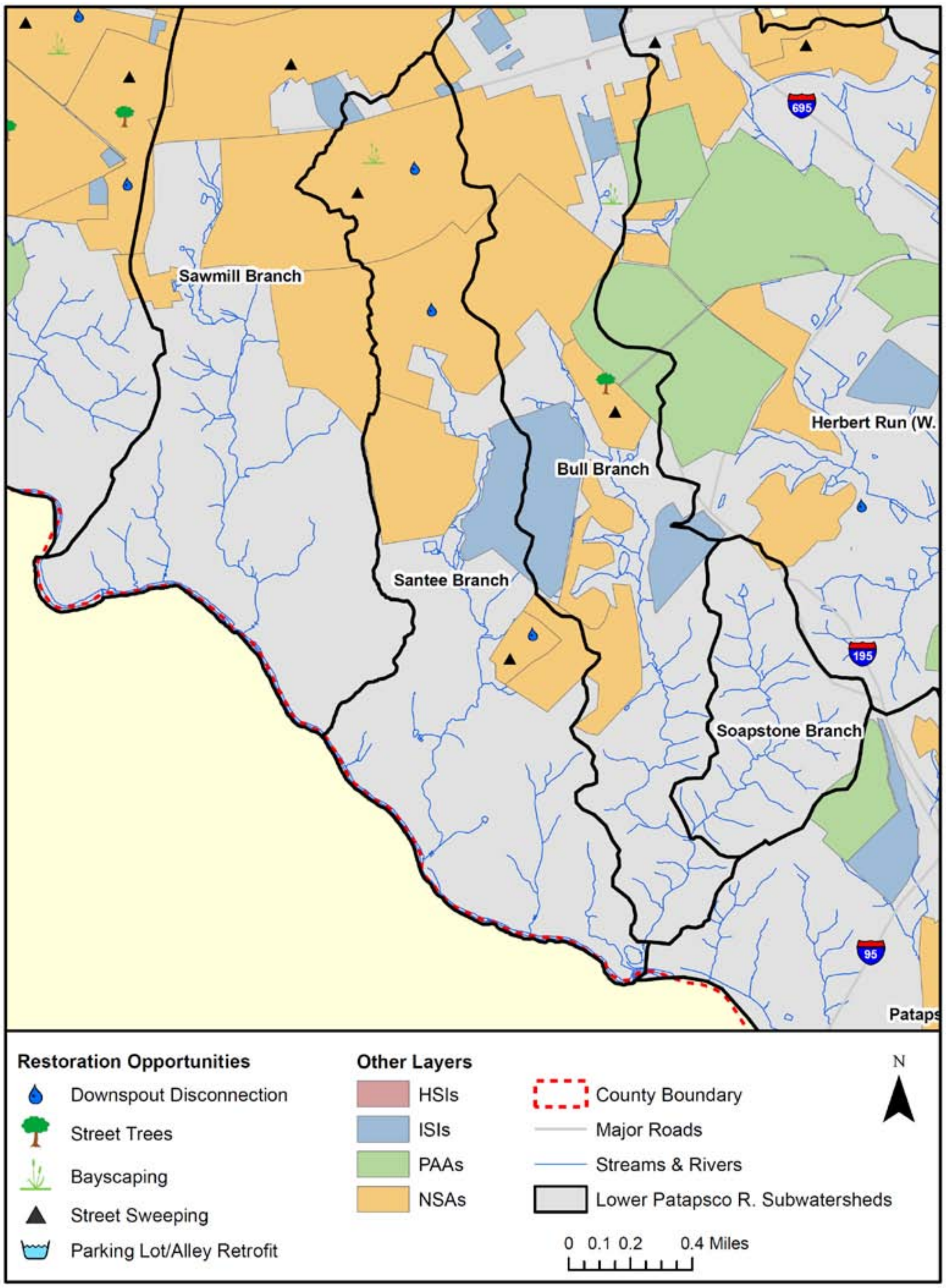

Figure 4-29: Restoration Opportunities in Santee Branch

4.3.9 Bull Branch (Subwatershed code 900)

Bull Branch lies in the center of the Lower Patapsco River watershed, and at 944.3 acres it is a medium-sized subwatershed in the SWAP area. Bull Branch is primarily composed of three land use types: medium density residential land use (37.7%) followed by forest (20%) and institutional land use (14.2%). Impervious cover makes up 20% of total land cover. Table 4-44 summarizes key subwatershed characteristics of Bull Branch. 30% of urban lands are currently treated by stormwater management facilities.

Table 4-44: Key Subwatershed Characteristics – Bull Branch

Drainage Area	944.3 acres (1.48 sq. mi.)	
Stream Length	4.7 miles	
Population	3,558 (2000 Census) 3.8 people/acre	
Land Use/Land Cover	Very Low Density Residential:	2.1%
	Low Density Residential:	2.8%
	Medium Density Residential:	37.7%
	High Density Residential:	6.3%
	Commercial:	6.5%
	Industrial:	0.0%
	Institutional:	14.2%
	Extractive:	0.0%
	Open Urban Land:	2.3%
	Agriculture:	6.8%
	Forest:	20.6%
	Barren Land:	0.8%
	Water/Wetlands:	0.0%
	Transportation	0.0%
Impervious Cover	20% of subwatershed	
Soils	A Soils (low runoff potential):	5.6%
	B Soils:	62.4%
	C Soils:	13.0%
	D Soils (high runoff potential):	19.0%
SWM Facilities	30% of urban land use treated	
Priority Rating	Medium	

Neighborhoods

A total of two distinct neighborhoods were identified and assessed within Bull Branch during the uplands assessment of the Lower Patapsco River watershed. The primary recommendations for neighborhoods in this subwatershed included rain barrels, rain gardens, and storm drain marking. A summary of neighborhood recommended actions is presented in Table 4-45.

Table 4-45: NSA Recommendations – Bull Branch

		RECOMMENDED ACTIONS													
Site ID	**Lot Size (acres)**	**% Opportunity for Downspout Disconnection**	**Rain Barrels**	**Rain Gardens**	**Storm Drain Marking**	**Bayscaping**	**Increase Lot Canopy**	**Pet Waste**	**Trash Management**	**Buffer Improvement**	**Parking Lot/Alley Retrofit**	**Street Sweeping**	**# of Street Trees**	**# of Shade Trees**	**Notes**
NSA-A-1049	1/8		✓	✓	✓								6	6	Open spaces are already planted
NSA-A-1080	1/4		✓	✓	✓							✓	8		Common spaces are planted

NSA-A-0080 (Figure 4-30) was recommended for street sweeping. Removing organic matter and loose sediment from the streets prevents it from reaching the Lower Patapsco River and Chesapeake Bay, and can be an important measure for reducing pollutant loads and reaching TMDL goals.

Figure 4-30: Neighborhoods, Like NSA-A-1080, Present a Range of Opportunities for Improving Water Quality.

Hotspots

There was only one (1) facility assessed in the Bull Branch watershed during the uplands assessment of the Lower Patapsco River watershed. This automobile repair facility was classified as a potential hotspot. Table 4-46 summarizes Bull Branch potential pollution sources from facilities visited.

Table 4-46: Hotspot Summary – Bull Branch

Site ID	HSI Status (# filled circles)	Description	POTENTIAL POLLUTION SOURCES: Vehicle Operations	Outdoor Materials	Waste Management	Physical Plant	Turf / Landscaping	Stormwater	Notes
HSI-A-908	Potential (9)	Commercial – automotive repair	✓	✓		✓			Cars in disrepair stored outdoors, although no sign of staining on asphalt.

Two to three repair facilities located adjacent to one another were storing perhaps two dozen cars, some which were clearly not driveable, on a crumbling asphalt surface with no stormwater controls. Ownership of the vehicles was unclear. Although active leaking of vehicles was not found at the time of the field visit, the county could provide some education and outreach to these businesses to preempt petroleum and coolant spills and leaks and assure that all parties storing cars had spill countermeasures available (Figure 4-31).

Figure 4-31: Damaged Vehicles Awaiting Repair in Front of Automobile Repair Shops

Institutions

A total of seven institutions were assessed for retrofit opportunities in Bull Branch during the uplands assessment of Lower Patapsco River. These included five churches (one with a school), a municipal facility, and a community college. Table 4-47 summarizes recommendations for institutional sites assessed in Bull Branch.

Table 4-47: ISI Recommendations – Bull Branch

			RECOMMENDATIONS							
Site ID	**Name**	**Public/ Private**	**Storm Drain Marking**	**# Trees for Planting**	**Downspout Disconnection**	**Stormwater Retrofit**	**Impervious Cover Removal**	**Buffer Improvement**	**Trash Management**	**Notes**
ISI-A-916	St. Mark's Church	Private	✓	53	✓	✓	✓			Many good downspout rain garden opportu-nities
ISI-A-923	CCBC Catonsville	Public	✓	178	✓	✓				Loading dock near inlet
ISI-A-924	Bloomsbury Community Center	Public	✓	39	✓	✓			✓	Uncovered construction materials staged on lot
ISI-A-925	St. Timothy's	Private		27	✓	✓				
ISI-A-932	Amazing Grace Church	Private		3	✓	✓				Rain barrels would be appropriate for some downspout disconnects
ISI-A-934	Catonsville United Methodist	Private	✓		✓	✓				Covered dumpster located upslope of inlet
ISI-A-935	St. John's Church and Overhill's Mansion	Private	✓	202	✓	✓				

All of the institutional sites assessed in Bull Branch are recommended for downspout disconnection and stormwater retrofits. At each of these sites, some downspouts are directly connected to the storm drain network, and/or some discharge their flow onto impervious areas. By simply disconnecting the downspouts and redirecting their flow to a pervious area or a newly installed bioretention area (rain garden), stormwater volume will be reduced and water quality will be improved. Planting trees was recommended at all but one of the institutions assessed in Bull Branch. Additional trees at these sites can help improve stream quality and watershed health primarily by decreasing the amount of stormwater runoff and pollutants that reach local waters. Trees reduce stormwater runoff by capturing and storing rainfall in the tree canopy and by promoting infiltration of water into the soil. Storm drain marking was suggested at all but two of the institutions; this is an excellent activity for all types of organizations. By participating, the members of the group will become more aware of the close link between their streets and properties and waterways, and they will also leave behind a reminder for others not to pollute.

Along with many ideal opportunities for downspout rain gardens, several additional opportunities were identified at ISI-A-916, St. Mark's Catholic Church and School. Some excess impervious cover was noted which could be removed to improve stormwater management. Small impervious areas including concrete gutters at downspouts and an asphalt walkway adjacent to the gym are good candidates for removal (Figure 4-32). This is another good opportunity to engage parishioners and students with vegetation planting while providing education about the importance of filtration for water quality benefits. An uncovered pile of dirt and cobble was seen on the grass, and appeared to be the result of a recent repair. Materials such as dirt and rock stored on site should be covered at all times, to avoid runoff into the storm and stream networks.

Figure 4-32: Downspouts at ISI-A-916 Could be Redirected to Improve Stormwater Infiltration.

Similarly, several additional opportunities were identified at ISI-A-923, the Community College of Baltimore County, Catonsville Campus. A loading dock and dumpster were identified just above a stormwater inlet with no diversion methods present (Figure 4-33). In addition, a temporary dumpster was noted uncovered at this site. Maintaining covers on dumpsters and taking precautions near inlets are relatively simple actions that can serve as educational opportunities.

Figure 4-33: Additional Opportunities for Action at ISI-A-923.

The Bloomsbury Community Center, ISI-A-924, offers an educational opportunity on the importance of trash and materials management and their effects on water quality. This location had uncovered dumpsters and piles of uncovered construction material present on site. In some places, gravel, dirt, and other materials for construction had no silt fence barrier; other piles were contained within a silt fence, staged uncovered on an unused parking lot (Figure 4-34).

Figure 4-34: Uncovered Gravel, Dirt, and Other Construction Materials at ISI-A-924 Can Have Significant Effects on Water Quality During a Runoff Event. At This Location, Some Piles Were Properly Surrounded by Silt Fences but Others Were Left Uncontrolled.

Pervious Areas

Pervious area restoration has the potential to convert areas of turf, which often contribute high nutrient inputs, to forest, which can absorb and filter nutrients. A single pervious area, an Unknown Government Parcel, was assessed for restoration potential in Bull Branch. This dry stormwater pond site is located off Fusting Avenue in Catonsville; according to our GIS analysis, it is owned and maintained by the federal government. Upon inspection during the field visit, no areas of the site were deemed appropriate for tree planting. This is because of the extensive work that would likely be required to make this small stormwater facility suitable for planting (e.g., fix steep-sloped berms, unsuitable compacted soils, etc.). A summary is provided in Table 4-48.

Table 4-48: PAA Summary – Bull Branch

Site ID	Location	Description	Acres	Ownership
PAA-A-912	Government-owned parcel	Open urban land	Parcel - 3.60 Recommended planting – 0.00	Public

Stream Restoration Potential

Eroding stream banks are a clear, visible sign of stream impairment. In preparing the Watershed Characterization Report, past studies and reports were reviewed and compiled in an effort to map where streambank erosion has occurred and been noted throughout the Lower Patapsco River watershed. The stabilization of streambanks and other restoration measures can provide numerous benefits, including nutrient and sediment load reductions and improved habitat health for aquatic biota. In Bull Branch, erosion and channel stability problems were noted along 1.99 miles of stream (42% of the total stream miles in this subwatershed). 1.56 miles (8,255 feet) of specific stream reaches were recommended for stream restoration in the 2000 Water Quality Management Plan (Tetra Tech 2000) and are detailed in Section 3.6.5 of the Watershed Characterization Report (Appendix D).

Illicit Discharges

Bull Branch contains two outfalls, both are low priority outfalls meaning that they are outfalls that show no problems and therefore require only sampling at ten year intervals. Baltimore County will continue their Illicit Discharge Detection and Elimination program while seeking to improve techniques for more effective reductions of these discharges.

Stormwater Conversions

Baltimore County EPS identified 3 stormwater management ponds in Bull Branch as part of a list of 51 existing stormwater management facilities in the Lower Patapsco watershed to be evaluated for their conversion potential. One pond was ranked as high, another as medium and the third as low priority for potential conversion to improve water quality.

Subwatershed Management Strategy

Figure 4-35 provides a visual summary of restoration opportunities in the watershed.

Engaging Citizens & Watershed Groups

1. Conduct appropriate downspout rain barrel installation measures in neighborhoods according to Table 4-45.
2. Educate citizens about the benefits and importance of bayscaping and rain gardens, and their effects on water quality.
3. Take advantage of the opportunity for 15 street tree plantings identified in neighborhoods as listed in Table 4-45.
4. Engage citizens in a storm drain marking program and conduct marking activities in the neighborhoods indicated in Table 4-45.
5. Increase tree canopies on private lots by educating citizens, and homeowner groups on the benefits of trees.
6. The chance to increase tree canopy on institutional properties by over 450 trees exists as indicated in Table 4-47.
7. Engage citizens and private property owners in a storm drain marking program and conduct marking activities in the neighborhoods indicated in Table 4-45.
8. Engage institutional sites in stormwater management retrofits as listed in Table 4-47.
9. Engage St. Marks Church (ISI-A-916) and the Bloomsbury Community Center in (ISI-A-924) about impervious cover removals listed in Table 4-47.

Municipal Actions

1. Investigate current street sweeping measures in NSA-A-1080 and increase frequency or implement program as necessary.
2. Investigate the stormwater pollution hotspot described in Table 4-46 and educate business owner(s) on pollution prevention countermeasures.
3. Investigate stream restoration potential at sites in Bull Branch as described in Section 3.6.5 of the Watershed Characterization Report.

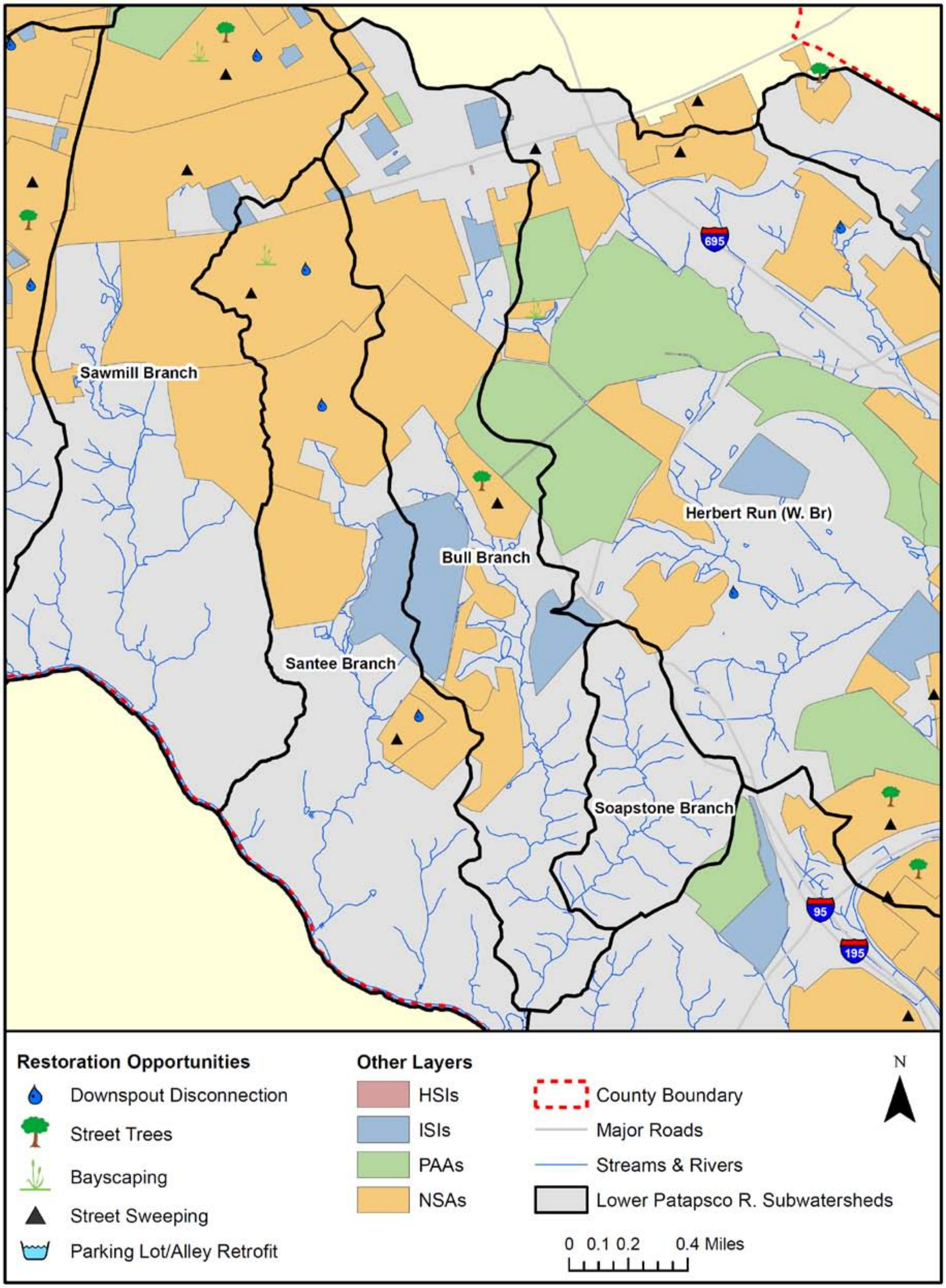

Figure 4-35: Restoration Opportunities in Bull Branch

4.3.10 Soapstone Branch (Subwatershed code 1000)

Soapstone Branch lies in the south central part of the Lower Patapsco River watershed. At 239.6 acres, it is one of the smallest watersheds in the SWAP area. Soapstone Branch is primarily composed of four land use types but is dominated by forest (60.4%), followed by agriculture (22.9%) and followed by very low density residential and low density residential (9.8% and 5.2% respectively). Impervious cover makes up 4% of total land cover. Table 4-49 summarizes key subwatershed characteristics of Soapstone Branch. None of urban lands in the Soapstone are currently treated by stormwater management facilities.

Table 4-49: Key Subwatershed Characteristics – Soapstone Branch

Drainage Area	239.6 acres (0.37 sq. mi.)	
Stream Length	2.6 miles	
Population	11 (2000 Census) 0.05 people/acre	
Land Use/Land Cover	Very Low Density Residential:	9.8%
	Low Density Residential:	5.2%
	Medium Density Residential:	0.0%
	High Density Residential:	0.0%
	Commercial:	0.0%
	Industrial:	0.0%
	Institutional:	0.0%
	Extractive:	0.0%
	Open Urban Land:	0.0%
	Agriculture:	22.9%
	Forest:	60.4%
	Barren Land:	0.0%
	Water/Wetlands:	0.0%
	Transportation	1.6%
Impervious Cover	4% of subwatershed	
Soils	A Soils (low runoff potential):	0.0%
	B Soils:	86.7%
	C Soils:	9.7%
	D Soils (high runoff potential):	3.6%
SWM Facilities	0% of urban land use treated	
Priority Rating	Low	

Neighborhoods

Soapstone Branch consists primarily of state park lands. No distinct neighborhoods were present in this subwatershed, and therefore no Neighborhood Source Assessments were performed.

Hotspots

There were no facilities assessed in the Soapstone Branch watershed during the uplands assessment of the Lower Patapsco River watershed.

Institutions

No institutional site investigations were performed within Soapstone Branch during the uplands assessments of Lower Patapsco watershed.

Pervious Areas

No pervious area assessments were performed within Soapstone Branch during the uplands assessments.

Stream Restoration Potential

Eroding stream banks are a clear, visible sign of stream impairment. In preparing the Watershed Characterization Report, past studies and reports were reviewed and compiled in an effort to map where streambank erosion has occurred and been noted throughout the Lower Patapsco River watershed. The stabilization of streambanks and other restoration measures can provide numerous benefits, including nutrient and sediment load reductions and improved habitat health for aquatic biota. In Soapstone Branch, erosion and channel stability problems were not noted in this watershed. No specific stream reaches were recommended for stream restoration by the 2000 Water Quality Management Plan (Tetra Tech 2000). Stream reaches surveyed by the Friends of Patapsco Valley and Heritage Greenway in recent years are noted in Section 3.6.5 of the Watershed Characterization Report (Appendix D).

Illicit Discharges

Soapstone Branch contains no major outfalls.

Stormwater Conversions

The Soapstone Branch currently has no stormwater management practices draining urban lands

Subwatershed Management Strategy

This subwatershed is primarily state park land, and as Figure 4-36 shows, restoration opportunities are limited.

<u>Engaging Citizens & Watershed Groups</u>

1. Repair small areas of trail erosion, conduct trash clean up, and remove debris blocking culverts as found in 2006 by FPVHG.

<u>Municipal Actions</u>

1. Review other observations made by FPVHG, as described in Section 3.6.5 of the Watershed Characterization Report.

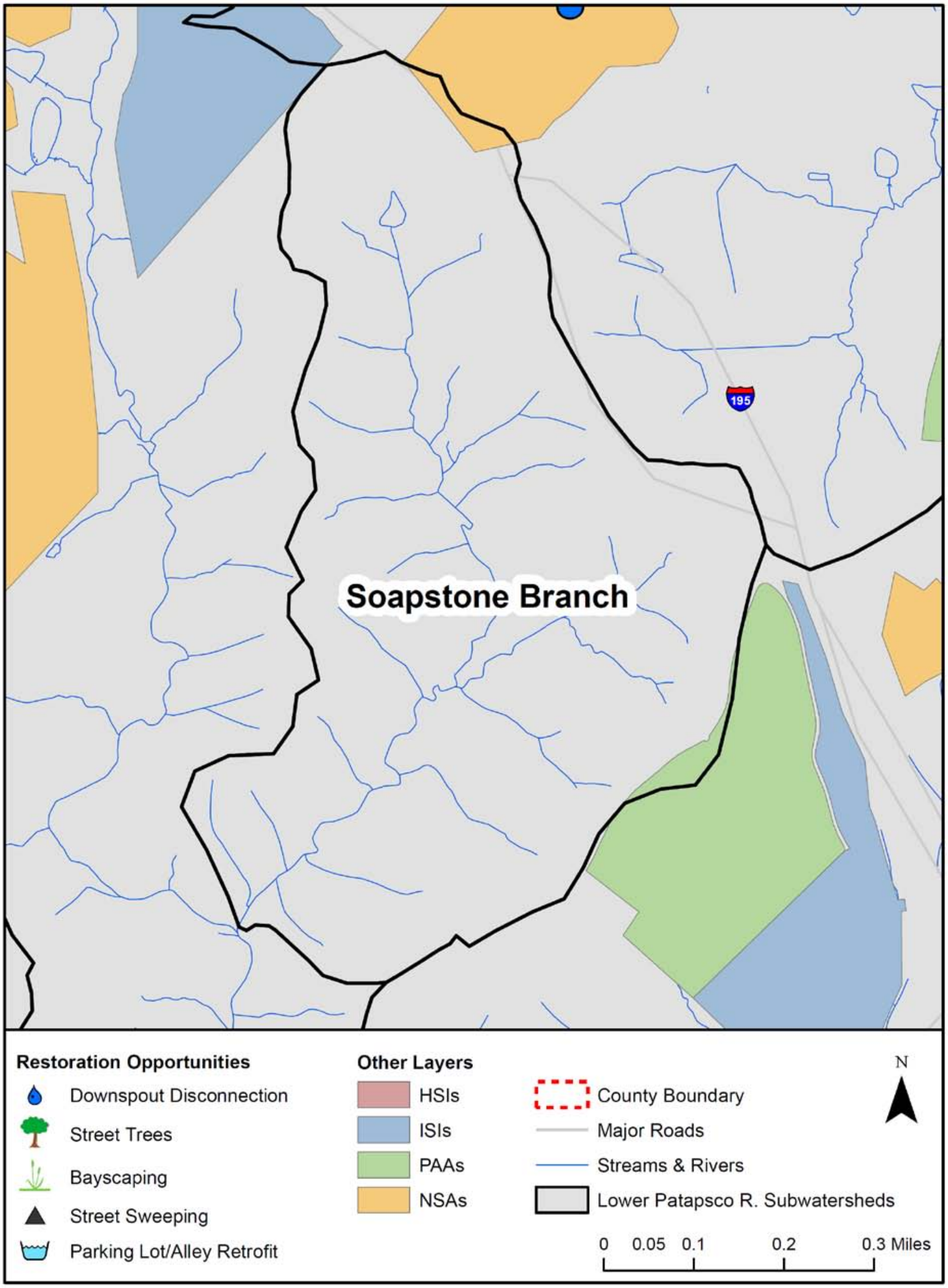

Figure 4-36: Restoration Opportunities in Soapstone Branch

4.3.11 Herbert Run West Branch (Subwatershed code 1100)

Herbert Run (W. Br.) lies in the central part of the Lower Patapsco River watershed. At 2,223.1 acres it is one of the larger watersheds in the SWAP area. Herbert Run (W. Br.) is primarily a mix of medium density residential (25.4%), institutional (21.7%), forest (16.5%), high density residential (12%) and open urban land (12.5%). Twenty-three percent of total land cover is categorized as impervious. Twenty-five percent of urban lands in Herbert Run (W. Br.) are currently treated by stormwater management facilities. Table 4-50 summarizes key subwatershed characteristics of Herbert Run (W. Br.).

Table 4-50: Key Subwatershed Characteristics – Herbert Run (W. Br.)

Drainage Area	2,223.1 acres (3.47 sq. mi.)	
Stream Length	16.6 miles	
Population	13,836 (2000 Census) 6.2 people/acre	
Land Use/Land Cover	Very Low Density Residential:	1.7%
	Low Density Residential:	3.9%
	Medium Density Residential:	25.4%
	High Density Residential:	12.0%
	Commercial:	2.4%
	Industrial:	0.0%
	Institutional:	21.7%
	Extractive:	0.0%
	Open Urban Land:	12.5%
	Agriculture:	0.1%
	Forest:	16.5%
	Barren Land:	0.0%
	Water/Wetlands:	0.0%
	Transportation	3.8%
Impervious Cover	23% of subwatershed	
Soils	A Soils (low runoff potential):	13.9%
	B Soils:	32.2%
	C Soils:	32.0%
	D Soils (high runoff potential):	21.8%
SWM Facilities	25% of urban land use treated	
Priority Rating	Very High	

Neighborhoods

A total of sixteen (16) distinct neighborhoods were identified and assessed within Herbert Run (W. Br.) during the uplands assessment of the Lower Patapsco River watershed. The primary recommendations for neighborhoods in this subwatershed included rain barrels, rain gardens, storm drain marking, increasing lot canopy, street sweeping, and street tree plantings. A summary of neighborhood recommended actions is presented in Table 4-51.

Table 4-51: NSA Recommendations – Herbert Run (W. Br.)

		RECOMMENDED ACTIONS													
Site ID	Lot Size (acres)	% Opportunity for Downspout Disconnection	Rain Barrels	Rain Gardens	Storm Drain Marking	Bayscaping	Increase Lot Canopy	Pet Waste	Trash Management	Buffer Improvement	Parking Lot/Alley Retrofit	Street Sweeping	# of Street Trees	# of Shade Trees	Notes
NSA-A-1044	1/4		✓	✓	✓		✓								Lots of space for rain gardens
NSA-A-1045	1/4	35	✓	✓	✓		✓								
NSA-A-1047	1/8			✓	✓		✓					✓	8		Car maintenance being performed in backyards
NSA-A-1048	<1/4		✓		✓		✓					✓			
NSA-A-1052	1/4	30	✓	✓	✓										
NSA-A-1053	1/8		✓	✓	✓		✓						8	18	
NSA-A-1054	1/8			✓	✓		✓					✓	11		
NSA-A-1057	<1/4		✓		✓		✓					✓	53		This area needs street trees
NSA-A-1058	1/4	40	✓	✓	✓	✓	✓			✓		✓	23		
NSA-A-1059	<1/4		✓		✓		✓					✓	111	10	
NSA-A-1065	<1/4		✓									✓	16	10	This entire development is well planted, rain barrels needed
NSA-A-1082	1/4		✓		✓					✓			3		Duplex homes
NSA-A-1083	1/8		✓		✓		✓						41		
NSA-A-1087	1/4		✓	✓	✓	✓	✓								Street trees are planted, landscaping needed as it is a very new development
NSA-A-1089	1/4		✓	✓	✓	✓	✓								
NSA-A-1095	1/4	25		✓	✓	✓	✓		✓						Storm drains and curbs are new

This subwatershed offers a large number of opportunities for street tree plantings (Figure 4-37), and most neighborhoods were recommended for increasing lot canopy. These types of actions provide an opportunity for widespread citizen engagement, and help to develop community relationships that might allow for education about practices such as rain gardens and rain barrels.

Figure 4-37: Neighborhoods, Like NSA-A-1057, Have Wide Swaths of Unplanted Turf Between the Sidewalk and the Street and Provide Prime Opportunities for Community Street Tree Plantings.

Hotspots

There were no facilities assessed in the Herbert Run (W. Br.) watershed during the uplands assessment of the Lower Patapsco River watershed.

Institutions

A total of three institutions were assessed for retrofit opportunities in Herbert Run (W. Br.) during the uplands assessment of Lower Patapsco River. These included two educational facilities and one church. Table 4-52 summarizes recommendations for institutional sites assessed in Herbert Run (W. Br.).

Table 4-52: ISI Recommendations – Herbert Run (W. Br.)

			RECOMMENDED ACTIONS							
Site ID	**Name**	**Public/ Private**	**Storm Drain Marking**	**# Trees for Planting**	**Downspout Disconnection**	**Stormwater Retrofit**	**Impervious Cover Removal**	**Buffer Improvement**	**Trash Management**	**Notes**
ISI-A-1121	Arbutus Middle School	Public	✓	397	✓	✓		✓		Disintegration of curbs producing erosion points and sediment transport to inlets in rear lot. Gabion baskets in stream failing.
ISI-A-1140	Arbutus United Methodist Church	Private	✓	84	✓	✓				Concrete trough on west side of building could be diverted to storm swale.
ISI-A-1142	UMBC Campus	Public		635				✓		

Planting trees was recommended at all of the institutions assessed in Herbert Run (W. Br.). Additional trees at these sites can help improve stream quality and watershed health primarily by decreasing the amount of stormwater runoff and pollutants that reach local waters. Trees reduce stormwater runoff by capturing and storing rainfall in the tree canopy and by promoting infiltration of water into the soil. The planting activity can be an educational experience and engage citizens and students alike (Figure 4-38).

Figure 4-38: Tree Planting Opportunities Exist at the Institutions Investigated in Herbert Run (W. Br.), Including this Open Space at ISI-A-1121.

At ISI-A-1121, Arbutus Middle School, parking lot repair was recommended as curbs have begun to disintegrate and are producing erosion points and sediment transport to inlets, especially in the rear parking lot. At the front entrance of the school, two downspouts discharge to impervious surface and would be good candidates for downspout disconnection to a bioretention area/rain garden. This would be a highly visible project that could serve as an educational opportunity for all who enter the main doors of the school. Along the rear property, a stream is present. Gabion baskets line the banks downstream of the bridge crossing and have failed, spilling riprap and large cobble into the stream (Figure 4-39). In addition, other large trash items, including some large barrels, were visible in the stream. The riparian buffer in this area is thin and adding additional trees is recommended. Along with riparian buffer planting, a stream clean-up would be an excellent opportunity to engage the students and teachers in a hands-on activity, and would serve as an educational experience regarding proper trash disposal and management, and of the importance of riparian buffers to stream systems.

Figure 4-39: Gabion Baskets Line the Stream Banks Below the Bridge Crossing at ISI-A-1121. Some Baskets Have Failed, as Shown in the Photo on the Left. In Addition, Drums and Other Trash Litter the Stream and Offer an Excellent Opportunity for Student Involvement in a Stream Clean-up.

Downspout disconnection was recommended at ISI-A-1140, including the installation of a bioretention area (rain garden) along the eastern side of the annex buildings, and diverting a concrete trough on the northwestern side of the main church building to a sloped area on the west side (Figure 4-40). Adding bioretention areas, depressed areas with native plants and filter media, could enable runoff to be captured and treated prior to entering the storm drain/stream systems.

Figure 4-40: A Concrete Trough Adjacent to the Main Church Building Could be Removed and the Downspouts Redirected at ISI-A-1140.

The UMBC campus (ISI-A-1142) offers additional opportunities for engaging students and faculty in activities to improve watershed health. As previously mentioned, tree plantings are a great way to involve volunteers in a hands-on activity, and many opportunities for tree plantings exist at the UMBC Campus. In fact, the largest number of tree planting opportunities was identified at this institution among all institutions assessed in the Lower Patapsco watershed. A stream runs through campus and in some areas, the riparian buffer surrounding the stream is too narrow. Adding trees to this buffer will benefit stream water quality and stream stability.

Pervious Areas

Pervious area restoration has the potential to convert areas of turf, often with high nutrient inputs to forest, which can absorb and filter rather than contribute nutrients. A total of seven pervious area sites were assessed for restoration potential in Herbert Run (W. Br.), including The Children's House; Rolling Road Country Club; Catonsville High School; Arbutus Memorial; Technology Education Center; Spring Grove Hospital; and University of Maryland Baltimore County property.

The Children's House site is located off Bloomsbury Avenue in Catonsville; it is privately owned and maintained. There are two separate moderate-sized parcels that would be appropriate for tree planting; one is in the northern part, and the other is in the southeastern part, of the site. These two sites were recommended for reforestation with minimal site preparation to add to the existing forest in these areas of the property.

The Rolling Road Country Club golf course is located off Valley Road, near its intersection with South Rolling Road, in Catonsville. It is privately owned and maintained and is easily accessible by foot, vehicle, or heavy equipment. It is mostly covered by turf (90%), with some existing small and moderately-sized trees as part of the golf course. Because of its tight layout and from conversations with course personnel, however, there are no areas where multiple tree plantings would not affect golf course play. There are some areas where a few individual trees could be planted. This, however, was deemed not to meet the watershed goals.

Catonsville High School is located off South Rolling Road, and is owned and maintained by Baltimore County. One site within this large complex was recommended for reforestation with minimal site preparation to enhance existing wooded areas, but tree planting would need to be balanced with school uses. The selected planting area is located in the central part of the school grounds.

The privately-owned cemetery, Arbutus Memorial, is located off Sulphur Springs Road in Arbutus. This site was originally planned as an opportunity for bolstering the existing adjacent forest buffer. Upon inspection during the field visit and after conversations with cemetery workers, however, no areas of the site were deemed appropriate for tree planting. Most all areas of the site either possessed graves or were surveyed and marked for new ones.

The University of Maryland Technology Education Center is located near the corner of Shelbourne Road and Poplar Avenue on the campus; it is owned and maintained by the State of Maryland. One long, narrow site was recommended for reforestation with minimal site preparation to enhance existing wooded areas.

The Spring Grove Hospital is located off of Valley Road in Catonsville; it is owned and maintained by the State of Maryland. Two small sites and two larger sites were recommended for planting along the existing narrow riparian buffers of unnamed tributaries at the site. The sites present a very good opportunity for improvement of existing riparian forest resources, but there may be a need to balance these opportunities with existing uses by the hospital.

The University of Maryland Baltimore County (UMBC) property is located off of Hilltop Circle in Arbutus; it is owned and maintained by the State of Maryland. Two small sites and one larger site were recommended for planting along the existing narrow riparian buffers of unnamed tributaries in the northern, central, and southern parts of the campus. A summary is provided in Table 4-53.

Table 4-53: PAA Summaries – Herbert Run (W. Br.)

Site ID	Location	Description	Acres	Ownership
PAA-A-1113	The Children's Home	Residential care facility	Parcel - 42.75 Recommended planting – 9.79	Private
PAA-A-1114	Rolling Road Country Club	Golf course	Parcel - 92.52 Recommended planting – 0.00	Private
PAA-A-1115	Catonsville High School	Public school grounds	Parcel - 64.40 Recommended planting – 8.06	Public
PAA-A-1117	Arbutus Memorial Gardens	Cemetery	Parcel - 71.43 Recommended planting – 0.00	Private
PAA-A-1118	UMBC - Technology Education Center	University facility	Parcel - 18.18 Recommended planting – 1.08	Public
PAA-A-1121	Spring Grove Hospital	Mental health facility	Parcel - 152.95 Recommended planting – 26.97	Public
PAA-A-1122	UMBC – Main Campus	University campus	Parcel - 75.48 Recommended planting – 4.38	Public

Stream Restoration Potential

Eroding stream banks are a clear, visible sign of stream impairment. In preparing the Watershed Characterization Report, past studies and reports were reviewed and compiled in an effort to map where streambank erosion has occurred and been noted throughout the Lower Patapsco River watershed. The stabilization of streambanks and other restoration measures can provide numerous benefits, including nutrient and sediment load reductions and improved habitat health for aquatic biota. In Herbert Run (W. Br.), erosion and channel stability problems were noted along 9.33 miles of stream (56% of the total stream miles in this subwatershed). 1.47 miles (7,766 feet) of specific stream reaches were recommended for stream restoration in the 2000 Water Quality Management Plan (Tetra Tech 2000) and are detailed in Section 3.6.5 of the Watershed Characterization Report (Appendix D).

Illicit Discharges

Herbert Run (W. Br.) has seven major outfalls, all listed as low priority. If no pollution problems were indicated, then the outfall is considered a low priority. This allows more focus on outfalls with greater potential of an illicit connection.

Stormwater Conversions

The Herbert Run (W. Br.) has 4 stormwater management ponds which were evaluated for conversion. None of those were ranked high enough to be considered for conversion at this time (one ranked Medium, three Low).

Subwatershed Management Strategy

This subwatershed is primarily state park land, and as Figure 4-41 shows, has limited restoration opportunities.

<u>Engaging Citizens & Watershed Groups</u>

1. The opportunity for downspout disconnection measures exist in four neighborhoods of Herbert Run (W. Br.) according to Table 4-51.
2. Engage property owners in retrofit of rain barrels as indicated in Table 4-51.
3. Educate property owners about the benefits and importance of rain gardens and Bayscaping and their positive effects on water quality at the locations indicated in Table 4-51.
4. Take advantage of the >250 opportunities to plant street trees at the locations indicated in Table 4-51.
5. Engage citizens in a storm drain marking program and conduct marking activities in the neighborhoods at locations indicated in Table 4-51.
6. Encourage communities and neighborhoods to increase the tree canopy of their lots. Table 4-51 shows a potential for 7 street trees and 65 shade trees.

7. Educate local citizens about the importance of proper trash management at sites listed in Table 4-52 and engage in a trash clean up as per ISI-A-1121 on Arbutus Middle School.
8. Engage property owners in better stream buffer management at locations indicated in Table 4-51 and at Arbutus Middle School and the UMBC Campus (ISI-A-1121 and 1142) as per Table 4-52.
9. Take advantage of the approximately 40 opportunities to plant shade trees in neighborhoods as indicated in Table 4-51.
10. Engage Arbutus Middle School and UMBC in order to mark private storm drains.
11. Investigate the recommended pervious areas described in Table 4-53 for potential tree planting.

Municipal Actions

1. Investigate current street sweeping measures at locations indicated in Table 4-51 and increase frequency or implement program as necessary.
2. Investigate the opportunity to plant over 1000 trees on the combined properties of Arbutus Middle School, Arbutus United Methodist Church and UMBC.
3. Engage the property managers at the Arbutus Middle School and at the United Methodist Church in order to disconnect downspouts.
4. Investigate stream restoration potential at sites in Herbert Run (W. Br.) as described in Section 3.6.5 of the Watershed Characterization Report.

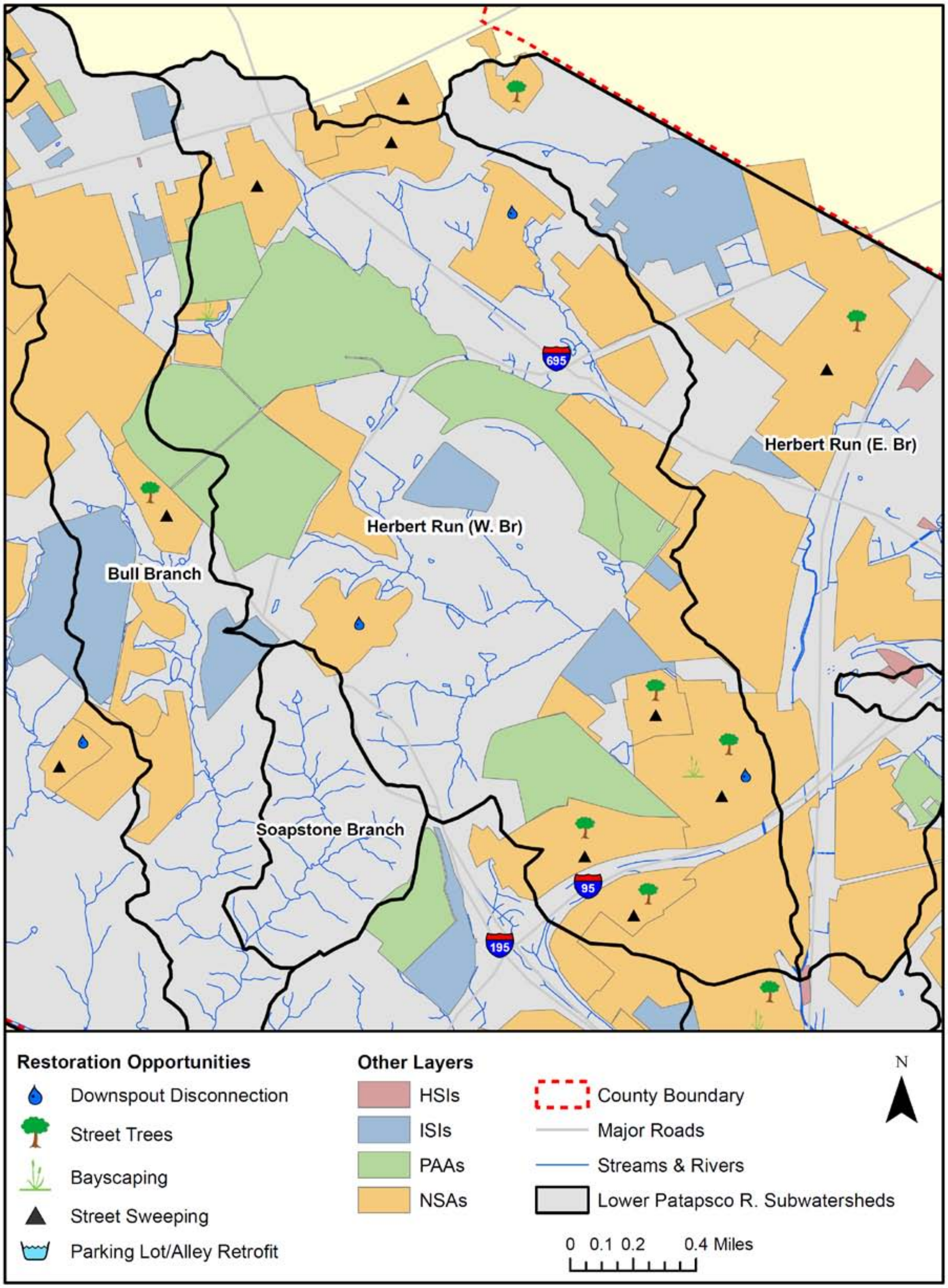

Figure 4-41: Restoration Opportunities in Herbert Run (W. Br.).

4.3.12 Patapsco River-A4 (Subwatershed code 1200)

The 1,075.1 acre Patapsco River-A4 watershed lies in the very southern limits of the Lower Patapsco River watershed. The Patapsco River-A4 watershed is one third forest (37.6%), one third residential (very low density residential 4.6%, low density residential 16.7%, medium density residential 10.8%, and high density residential 5.0%) followed by 9.9% transportation. 16% of total land cover is categorized as impervious. Sixteen percent of urban lands in Patapsco River-A4 are currently treated by stormwater management facilities. Table 4-54 summarizes key subwatershed characteristics of Patapsco River-A4.

Table 4-54. Key Subwatershed Characteristics – Patapsco River-A4

Drainage Area	1,075.1 acres (1.68 sq. mi.)	
Stream Length	7.8 miles	
Population	2,371 (2000 Census) 2.2 people/acre	
Land Use/Land Cover	Very Low Density Residential:	4.6%
	Low Density Residential:	16.7%
	Medium Density Residential:	10.8%
	High Density Residential:	5.0%
	Commercial:	1.1%
	Industrial:	3.8%
	Institutional:	4.0%
	Extractive:	0.0%
	Open Urban Land:	3.9%
	Agriculture:	0.0%
	Forest:	37.6%
	Barren Land:	2.5%
	Water/Wetlands:	0.0%
	Transportation	9.9%
Impervious Cover	16% of subwatershed	
Soils	A Soils (low runoff potential):	2.0%
	B Soils:	38.6%
	C Soils:	29.5%
	D Soils (high runoff potential):	29.8%
SWM Facilities	16% of urban land use treated	
Priority Rating	Medium	

Neighborhoods

A total of three (3) distinct neighborhoods were identified and assessed within Patapsco River-A4 during the uplands assessment of the Lower Patapsco River watershed. The primary recommendations for neighborhoods in this subwatershed included rain barrels and buffer improvements. A summary of neighborhood recommended actions is presented in Table 4-55.

Table 4-55: NSA Recommendations – Patapsco River-A4

		RECOMMENDED ACTIONS													
Site ID	Lot Size (acres)	% Opportunity for Downspout Disconnection	Rain Barrels	Rain Gardens	Storm Drain Marking	Bayscaping	Increase Lot Canopy	Pet Waste	Trash Management	Buffer Improvement	Parking Lot/Alley Retrofit	Street Sweeping	# of Street Trees	# of Shade Trees	Notes
NSA-A-1036										✓					Subdivision not yet built
NSA-A-1062	<1/4		✓		✓		✓			✓		✓	3		Some mowing close to stream buffer, worth contacting HOA
NSA-A-1064	1/4		✓	✓									7	2	This neighborhood is very old and established, well-wooded

NSA-A-1062 (Figure 4-42) was recommended for a variety of actions, including rain barrels, storm drain marking, increasing lot cover, street sweeping and buffer improvements. This neighborhood would be ideal for creating an integrated management plan that demonstrates how all of the various strategies can work together in one locale.

Figure 4-42: Neighborhoods, Like NSA-A-1062, Have Some Existing Street Trees.

Hotspots

There was only one (1) facility assessed in the Patapsco River-A4 watershed during the uplands assessment of the Lower Patapsco River watershed. This automobile repair facility was not classified as a hotspot. Table 4-56 summarizes Patapsco River-A4 potential pollution sources from facilities visited.

Table 4-56: Hotspot Summary – Patapsco River A4

			POTENTIAL POLLUTION SOURCES						
Site ID	HSI Status (# filled circles)	Description	Vehicle Operations	Outdoor Materials	Waste Management	Physical Plant	Turf / Landscaping	Stormwater	Notes
HSI-A-1209	Not a Hotspot (3)	Commercial – used car dealership							

Cars were parked right up to the property line at this used car dealer and immediately to the entrance to a public park; nonetheless, the facility appeared to be tidy and no poor practices were noticed by field crews.

Institutions

A total of two institutions were assessed for retrofit opportunities in the Patapsco River-A4 subwatershed during the uplands assessment of Lower Patapsco River. These included a university technology center and a public elementary school. Table 4-57 summarizes recommendations for institutional sites assessed in Patapsco River-A4.

Table 4-57: ISI Recommendations – Patapsco River-A4

			RECOMMENDED ACTIONS							
Site ID	Name	Public/ Private	Storm Drain Marking	# Trees for Planting	Downspout Disconnection	Stormwater Retrofit	Impervious Cover Removal	Buffer Improvement	Trash Management	Notes
ISI_A_1220	UMBC Technology Center	Public	✓	9			✓			Uncovered cinder blocks and snowplow blades stored on parking lot
ISI_A_1226	Relay Elementary School	Public	✓	147	✓	✓			✓	Leaky dumpster. Staff complained of flooding in breezeway.

At both institutions, storm drain marking and tree planting were recommended. Additional trees at these sites can help improve stream quality and watershed health primarily by decreasing the amount of stormwater runoff and pollutants that reach local waters. Trees reduce stormwater runoff by capturing and storing rainfall in the tree canopy and by promoting infiltration of water into the soil. The planting activity can be an educational experience and engage citizens and students alike. Storm drain marking is another excellent activity for all types of organizations. By participating, the members of the group will become more aware of the close link between their streets and properties and waterways, and they will also leave behind a reminder for others not to pollute.

Excess impervious cover could possibly be removed at ISI-A-1220, where a southern-most parking lot seems to be underutilized. This is another good opportunity to engage staff in vegetation planting while providing education about the importance of filtration for water quality benefits. Also at this site, uncovered materials, including cinder blocks, and snowplow blades were stored on a parking lot with indirect connection to the storm drain, and one dumpster was observed without a cover. Cleanup of these stormwater threats is an opportunity to educate citizens of the importance of trash and materials management.

Trash management was also recommended for ISI-A-1226 (Relay Elementary School) where a dumpster showed evidence of past leakage (Figure 4-43) and where trash, including plates and cups were present in cans adjacent to the baseball diamond and could leave the site with wind or rain. Cleanup of these stormwater threats is an opportunity to engage students and staff in a hands-on environmental activity while also educating them of the importance of trash and materials management. Staff at this school complained about flooding that occurred in a breezeway connecting an annex building to the main school. Downspout disconnection in these areas and in others was recommended (Figure 4-44). At this site, some downspouts are directly connected to the storm drain network. By simply disconnecting the downspouts and redirecting their flow to a pervious area, stormwater volume will be reduced and water quality will be improved. Installation of bioretention areas (i.e., rain gardens - depressed areas with native plants and filter media), could enable runoff from this lot to be captured and treated prior to entering the storm drain/stream system, as the roughness of the vegetation can help slow down flows. This could help with the flooding concerns expressed by the school staff members, and maintenance of the rain gardens could serve as an educational experience for students and teachers alike.

Figure 4-43: Dumpsters at ISI-A-1226 Show Evidence of Leakage and Should be Repaired, Kept Covered, and Checked Frequently to Ensure Pollutants are Not Leaking Out.

Figure 4-44: Staff at Relay Elementary School Complained of Flooding that Occurs at the Low Spot of this Breezeway. A Connected Downspout is Present Here and May be Redirected to a Newly Installed Rain Garden that Could Help Remedy the Localized Flooding.

Pervious Areas

Pervious area restoration has the potential to convert areas of turf, which often contribute nutrients to stormwater runoff, to forest, which can absorb and filter nutrients. A single pervious area was assessed for restoration potential in the Patapsco River-A4, the Oblate Sisters of Providence site. This site is located off Gun Road in Catonsville; it is privately owned and maintained. There is one large parcel and one smaller parcel that would be appropriate for tree planting; the large one is in the southwestern part, and the smaller is in the northern part, of the site. These two sites were recommended for reforestation with minimal site preparation. Establishment of additional forest in the large southwestern parcel would provide additional buffer to the existing headwater stream that flows off the site to the south. Planting of the northern parcel would add to the existing margin of forest in this part of the site. A summary is provided in Table 4-58.

Table 4-58: PAA Summary – Patapsco River-A4

Site ID	Location	Description	Acres	Ownership
PAA-A-1216	Oblate Sisters of Providence	Convent	Parcel - 40.72 Recommended planting – 6.34	Private

Stream Restoration Potential

Eroding stream banks are a clear, visible sign of stream impairment. In preparing the Watershed Characterization Report, past studies and reports were reviewed and compiled in an effort to map where streambank erosion has occurred and been noted throughout the Lower Patapsco River watershed. The stabilization of streambanks and other restoration measures can provide numerous benefits, including nutrient and sediment load reductions and improved habitat health for aquatic biota. In Patapsco River-A4, erosion and channel stability problems were noted along 4.13 miles of stream (53% of the total stream miles in this subwatershed). 0.97 miles (5,103 feet) of specific stream reaches recommended for stream restoration in the 2000 Water Quality Management Plan (Tetra Tech 2000) and are detailed in Section 3.6.5 of the Watershed Characterization Report (Appendix D).

Illicit Discharges

The Patapsco River-A4 has two major outfalls; one is listed as low priority. If no pollution problems were indicated, then the outfall is considered a low priority. The other outfall has insufficient data to determine a priority rating. This may be due to inaccessibility or if there has been only a single screening.

Stormwater Conversions

The Patapsco River-A4 has three stormwater management practices which were evaluated for conversion. One was ranked High, one Medium, and one Low.

Subwatershed Management Strategy

Figure 4-45 provides a visual summary of restoration opportunities in the watershed.

Engaging Citizens & Watershed Groups

1. Engage property owners in retrofit of rain barrels as indicated in Table 4-55.
2. Educate property owners about the benefits and importance of rain gardens and their positive effects on water quality at the locations indicated in Table 4-55.
3. Take advantage of the opportunity to plant ten street trees at the locations indicated in Table 4-55.
4. Encourage communities and neighborhoods to increase the tree canopy of their lots. The opportunity for planting of shade trees exists, as indicated in Table 4-55, and greater than 150 trees at UMBC Technology Center and Relay Elementary School, as shown in Table 4-57.
5. Engage property owners in better stream buffer management at locations indicated in Table 4-55.
6. Engage UMBC Technology Center and Relay Elementary School in order to mark private storm drains, as per Table 4-57.
7. Investigate the pervious area described in Table 4-58 for potential tree planting.

Municipal Actions

1. Investigate current street sweeping measures at locations indicated in Table 4-55 and increase frequency or implement program as necessary.
2. Educate Relay Elementary School physical plant staff about the importance of proper trash management as indicated in Table 4-57.
3. Engage property manager at Relay Elementary School to build a stormwater management retrofit and use the project as a teaching tool for the students, as indicated in Table 4-57.
4. Investigate stream restoration potential at sites in Patapsco River-A4 as described in Section 3.6.5 of the Watershed Characterization Report (Appendix E).

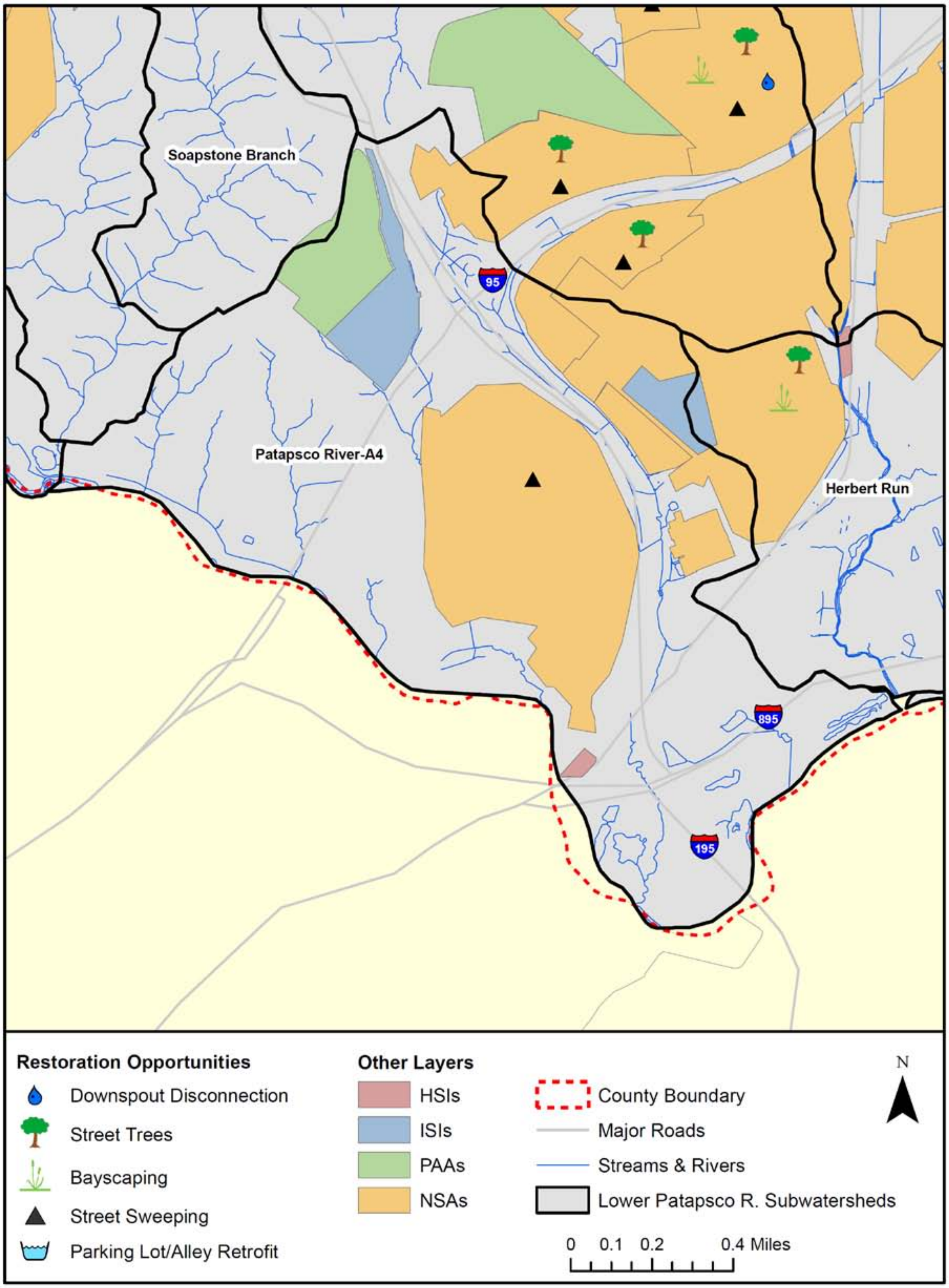

Figure 4-45: Restoration Opportunities in Patapsco River-A4

4.3.13 Herbert Run (Subwatershed code 1300)

Herbert Run watershed, one of the smaller watersheds (393.1 acres) in the SWAP area, lies in the very southern limits of the Lower Patapsco River watershed. In terms of land use / land cover, Herbert Run is dominated by three types; industrial (41.6%), medium density residential (26.2%) and forest cover (24.1%). The total land cover categorized as impervious is very high at 38%. Eleven percent of urban lands are currently treated by stormwater management facilities. Table 4-59 summarizes key subwatershed characteristics of Herbert Run.

Table 4-59: Key Subwatershed Characteristics – Herbert Run

Drainage Area	393.1 acres (0.61 sq. mi.)	
Stream Length	1.3 miles	
Population	1,098 (2000 Census) 2.89 people/acre	
Land Use/Land Cover	Very Low Density Residential:	0.0%
	Low Density Residential:	0.0%
	Medium Density Residential:	26.2%
	High Density Residential:	0.0%
	Commercial:	0.0%
	Industrial:	41.6%
	Institutional:	2.0%
	Extractive:	0.0%
	Open Urban Land:	0.0%
	Agriculture:	0.0%
	Forest:	24.1%
	Barren Land:	0.0%
	Water/Wetlands:	0.0%
	Transportation	6.1%
Impervious Cover	38% of subwatershed	
Soils	A Soils (low runoff potential):	0.0%
	B Soils:	35.6%
	C Soils:	16.8%
	D Soils (high runoff potential):	47.6%
SWM Facilities	11% of urban land use treated	
Priority Rating	Medium	

Neighborhoods

One distinct neighborhood was identified and assessed within Herbert Run during the uplands assessment of the Lower Patapsco River watershed. Recommendations for this neighborhood included rain barrels, rain gardens, storm drain marking, increase lot canopy, buffer improvements and street tree plantings A summary of neighborhood recommended actions is presented in Table 4-60.

Table 4-60: NSA Recommendations – Herbert Run

		RECOMMENDED ACTIONS													
Site ID	Lot Size (acres)	% Opportunity for Downspout Disconnection	Rain Barrels	Rain Gardens	Storm Drain Marking	Bayscaping	Increase Lot Canopy	Pet Waste	Trash Management	Buffer Improvement	Parking Lot/Alley Retrofit	Street Sweeping	# of Street Trees	# of Shade Trees	Notes
NSA-A-1060	1/4		✓	✓	✓	✓	✓			✓			30	1	Front yards need trees and landscaping

Herbert Run's single neighborhood, NSA-A-1060 (Figure 4-46), provides opportunities for a wide variety of actions. The relatively large yard size, and lack of landscaping, allows for options like Bayscaping and rain garden installation. A program that helps with planting street trees may engage the community with an introduction to their place in their watershed, and encourage them to take next steps, such as installing rain barrels on their property.

Figure 4-46: Neighborhoods, Like NSA-A-1060, that Have Large Turf Lawns Provide Ideal Opportunities for Bayscaping and the Installation of Rain Gardens.

Hotspots

There were two facilities assessed in the Herbert Run watershed during the uplands assessment of the Lower Patapsco River watershed. Neither the doctor's office, nor the automotive repair shop, was classified as a hotspot. Table 4-61 summarizes Herbert Run potential pollution sources from facilities visited.

Table 4-61: Hotspot Summaries – Herbert Run

			POTENTIAL POLLUTION SOURCES						
Site ID	**HSI Status (# filled circles)**	**Description**	**Vehicle Operations**	**Outdoor Materials**	**Waste Management**	**Physical Plant**	**Turf / Landscaping**	**Stormwater**	**Notes**
HSI-A-1310	Not a Hotspot (1)	Institutional – doctor's office and medical laboratory			x				
HSI-A-1328	Not Hotspot (4)	Commercial – automotive repair	x			x			Include in future education. Auto body shop with messy storage yard and vehicles in disrepair exposed to rain with storm drain directly in front of shop.

The automobile facility in this industrial area of Herbert Run had cars in various states of disrepair in an uncovered storage area with a storm drain immediately outside of the front gate. Field crews did not necessarily note active polluting but the yard was messy and cars were being worked on outdoors as well as being picked up with a forklift and dragged into the shop (Figure 4-47).

Figure 4-47: Automobile Repair Facility at HSI-A-1328

Institutions

A single institution was assessed for retrofit opportunities in the Herbert Run subwatershed during the uplands assessment of Lower Patapsco River. This site was a municipal facility that is a food distribution warehouse. Table 4-62 summarizes recommendations for the institutional site assessed in Herbert Run.

Table 4-62: ISI Recommendations – Herbert Run

			RECOMMENDED ACTIONS							
Site ID	**Name**	**Public/ Private**	**Storm Drain Marking**	**# Trees for Planting**	**Downspout Disconnection**	**Stormwater Retrofit**	**Impervious Cover Removal**	**Buffer Improvement**	**Trash Management**	**Notes**
ISI-A-1338	Maryland Food Bank	Private	✓	90						Grease receptacle near swale

Several opportunities exist at ISI-A-1338 to improve the on-site conditions for stormwater management. First, storm drain marking and tree planting were recommended at this site, activities that could engage employees or volunteers in actions that can have positive effects on water quality. Storm drain marking can serve as a visual reminder of the downstream effects of local actions. On the west side of the property, a large open field would be an ideal location for planting trees. Trees reduce stormwater runoff by capturing and storing rainfall in the tree canopy and by promoting infiltration of water into the soil. One grease receptacle was present on the western portion of the property, adjacent to a swale (Figure 4-48). This swale leads to a headwater stream just outside of the property. Proper precautions should be taken for this receptacle in case of a spill, leak, or puncture, as no secondary containment was evident. Other materials stored onsite included wooden pallets which were observed on grassy areas and asphalt and were indirectly connected to the storm drain network. Providing education regarding the potential water quality effects of this improper material storage to the managers and employees at the site is recommended. Finally, a head cut is forming at the edge of the gutter that serves the swale from the site. This head cut should be repaired to reduce sediment inputs downstream.

Figure 4-48: A Grease Receptacle Sits Adjacent to a Stormwater Swale, With No Secondary Containment, at ISI-A-1338. Precautions Should be Taken for This Receptacle in Case of a Spill, Leak, or Puncture to Avoid Polluting the Swale and Stream Below.

Pervious Areas

No pervious area assessments were performed within the Herbert Run subwatershed during the uplands assessments.

Stream Restoration Potential

Eroding stream banks are a clear, visible sign of stream impairment. In preparing the Watershed Characterization Report, past studies and reports were reviewed and compiled in an effort to map where streambank erosion has occurred and been noted throughout the Lower Patapsco River watershed. The stabilization of streambanks and other restoration measures can provide numerous benefits, including nutrient and sediment load reductions and improved habitat health for aquatic biota. In Herbert Run, erosion and channel stability problems were noted along 0.58 miles of stream (44% of the total stream miles in this subwatershed). Within the subwatershed, no specific stream reaches were recommended for stream restoration by the 2000 Water Quality Management Plan (Tetra Tech 2000). Stream reaches surveyed by the Friends of Patapsco Valley and Heritage Greenway (FPVHG) in recent years are noted in Section 3.6.5 of the Watershed Characterization Report (Appendix D). FPVHG recommended tree plantings along the streams and the repair of disintegrating Gabion baskets.

Illicit Discharges

Herbert Run has five major outfalls; one is listed as priority 0 (not prioritized), another as critical (priority 1) and three outfalls listed as priority 3 (low). Priority 0 outfalls have insufficient data to determine a priority rating. This may be due to inaccessibility or because there has been only a single screening. If no pollution problems were indicated, then the outfall is considered a low priority. Critical outfalls have major problems that require immediate correction and/or close monitoring, or are outfalls with recurring problems. Critical outfalls are sampled four times each year.

Stormwater Conversions

Herbert Run has two stormwater management facilities which were evaluated for conversion. Neither of those was ranked high enough to be considered for conversion at this time (one ranked Medium, one Low).

Subwatershed Management Strategy

Figure 4-49 provides a visual summary of restoration opportunities in the watershed.

Engaging Citizens & Watershed Groups

1. Engage property owners in retrofit of rain barrels as indicated in Table 4-60.
2. Educate property owners about the benefits and importance of rain gardens and Bayscaping and the positive effects on water quality, at the locations indicated in Table 4-60.
3. Take advantage of the opportunity to plant 30 street trees at the locations indicated in Table 4-60.
4. Encourage communities and private landowners to increase the tree canopy of their lots. The opportunity for planting 90 trees exists at the Maryland Food Bank as per ISI-A-1338, and for planting of shade trees in neighborhood NSA-A-1060, as indicated in Table 4-62.
5. Engage property owners in better stream buffer management at locations indicated in Table 4-60.
6. Encourage the Maryland Food Bank to mark its storm drains at ISI-A-1338, as per Table 4-62.

Municipal Actions

1. Educate the business owners about the importance of proper waste management as indicated in Table 4-61.
2. Educate the business owner about the importance of proper vehicle operations and proper physical plant upkeep as indicated in Table 4-61. Conduct follow-up investigations of the critical outfall to find the source(s) of illicit discharges and retest outfalls with insufficient data for a priority rating and those with minor to moderate problems that have the potential to become severe as described above and in the Watershed Characterization Report (Appendix E).
3. Investigate stream restoration potential at sites in Herbert Run as described in Section 3.6.5 of the Watershed Characterization Report (Appendix E).

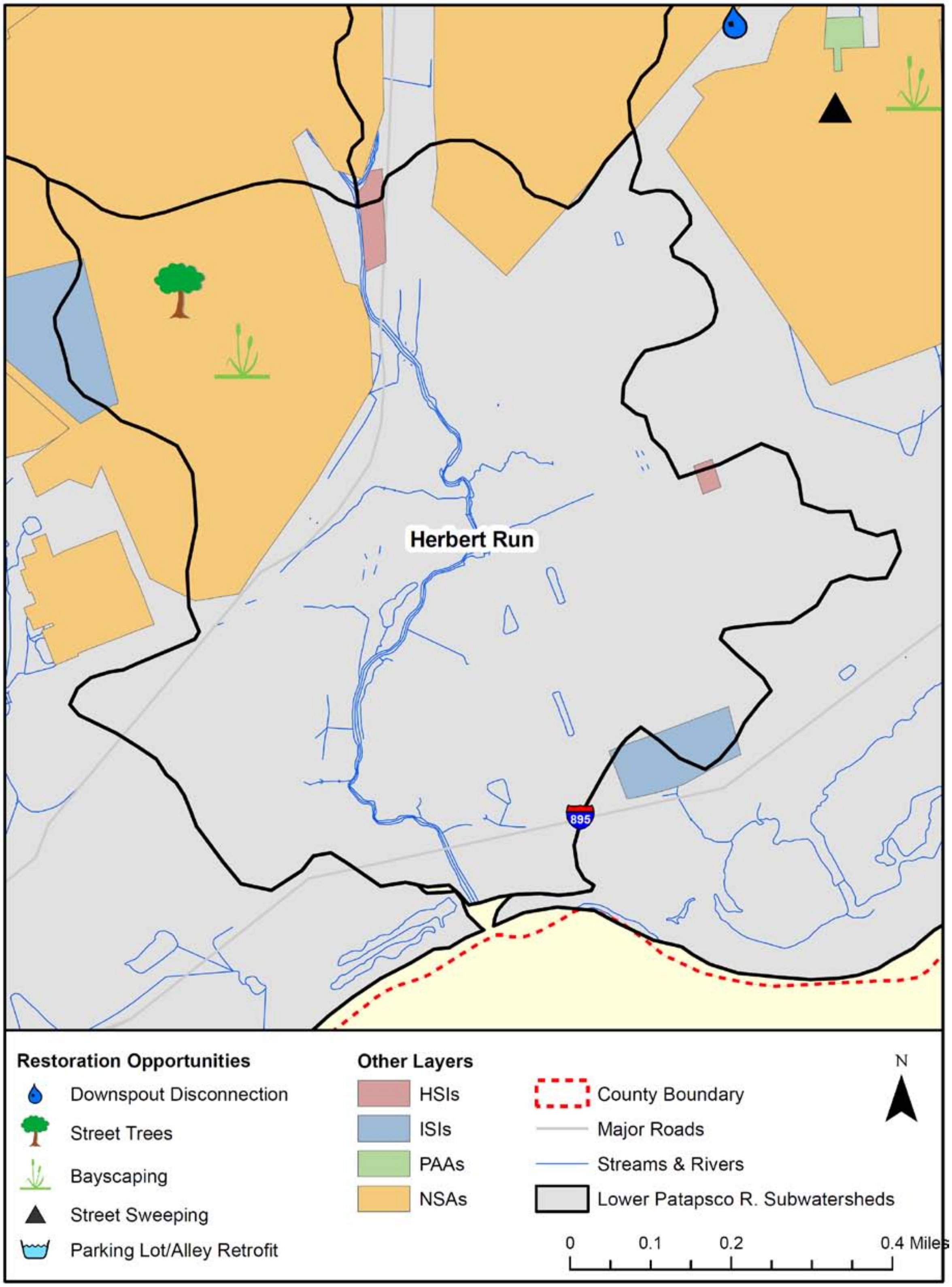

Figure 4-49: Restoration Opportunities in Herbert Run.

4.3.14 Herbert Run East Branch (Subwatershed code 1400)

Herbert Run (E. Br.) watershed at 1,521.3 acres, occupies much of the eastern portion of the Lower Patapsco River watershed along the Baltimore City border. In terms of land use/land cover, Herbert Run (E. Br.) is dominated by medium density residential at 36.2% followed by industrial land use (15%) and high density residential (12.3%). The total land cover categorized as impervious is very high at 36%. Thirteen percent of urban lands are currently treated by stormwater management facilities. Table 4-63 summarizes key sub-watershed characteristics of Herbert Run (E. Br.).

Table 4-63: Key Subwatershed Characteristics – Herbert Run (E. Br.)

Drainage Area	1,521.3 acres (2.38 sq. mi.)	
Stream Length	10.0 miles	
Population	11,931 (2000 Census) 7.8 people/acre	
Land Use/Land Cover	Very Low Density Residential:	0.0%
	Low Density Residential:	0.6%
	Medium Density Residential:	36.2%
	High Density Residential:	12.3%
	Commercial:	4.9%
	Industrial:	15.0%
	Institutional:	7.1%
	Extractive:	0.0%
	Open Urban Land:	7.2%
	Agriculture:	0.0%
	Forest:	6.6%
	Barren Land:	0.0%
	Water/Wetlands:	0.7%
	Transportation	9.4%
Impervious Cover	36% of subwatershed	
Soils	A Soils (low runoff potential):	7.0%
	B Soils:	23.4%
	C Soils:	31.7%
	D Soils (high runoff potential):	37.9%
SWM Facilities	13% of urban land use treated	
Priority Rating	Very High	

Neighborhoods

A total of seven (7) distinct neighborhoods were identified and assessed within Herbert Run (E. Br.) during the uplands assessment of the Lower Patapsco River watershed. The primary recommendations for neighborhoods in this subwatershed included rain barrels, rain gardens, and storm drain marking. A summary of neighborhood recommended actions is presented in Table 4-64.

Table 4-64: NSA Recommendations – Herbert Run (E. Br.)

		RECOMMENDED ACTIONS													
Site ID	**Lot Size (acres)**	**% Opportunity for Downspout Disconnection**	**Rain Barrels**	**Rain Gardens**	**Storm Drain Marking**	**Bayscaping**	**Increase Lot Canopy**	**Pet Waste**	**Trash Management**	**Buffer Improvement**	**Parking Lot/Alley Retrofit**	**Street Sweeping**	**# of Street Trees**	**# of Shade Trees**	**Notes**
NSA-A-1046	1/8		✓	✓	✓		✓					✓	40		Most rain-spouts go to the alley
NSA-A-1055	<1/4		✓		✓		✓					✓	3		No room for rain gardens
NSA-A-1056	1/8		✓	✓	✓					✓		✓	15		Some areas could use street trees
NSA-A-1066	1/4	25		✓	✓					✓			3		
NSA-A-1067	<1/4	25	✓	✓	✓										Old, heavily vegetated neighborhood
NSA-A-1084	<1/4		✓		✓					✓					
NSA-A-1085	1/4	25	✓	✓	✓		✓						2	16	Mature and young trees present, but more needed

Some neighborhoods consist of mowed lawn adjacent to the stream corridor rather than dense vegetation or forested buffer which provides more water quality treatment of runoff. These neighborhoods present a good opportunity to educate residents about the benefits and importance of planting and maintaining a riparian stream buffer for aesthetic and water quality purposes. Several neighborhoods also have the potential for street and/or open space, shade trees. Community tree and buffer plantings and storm drain marking are good ways to engage citizens in these neighborhoods and raise awareness.

Hotspots

There were six (6) facilities assessed in the Herbert Run East Branch watershed during the uplands assessment of the Lower Patapsco River watershed. Four of the six were classified as potential hotspots and the remaining two were not classified as potential pollution sources. Table 4-65 summarizes Herbert Run East Branch potential pollution sources from facilities visited.

Table 4-65: Hotspot Summaries – Herbert Run (E. Br.)

Site ID	HSI Status (# filled circles)	Description	Vehicle Operations	Outdoor Materials	Waste Management	Physical Plant	Turf / Landscaping	Stormwater	Notes
			POTENTIAL POLLUTION SOURCES						
HSI-A-1411	Potential (9)	Industrial - design and fabrication of aluminum structures		x	x	x			
HSI-A-1412	Potential (7)	Institutional – adult day care with buses and food services	x		x			x	Include in future education. Food dumpster uncovered with crows picking food out of it.
HSI-A-1413	Potential (8)	Commercial - plumbing	x	x	x				Include in future education for proper cleaning and control of sediment from excavating equipment which is ending up on asphalt and for uncovered dumpsters (2).
HSI-A-1415	Not a Hotspot (3)	Commercial – equipment rental, storage, repair, fueling		x	x	x			Secondary containment for oil and coolant is cracked
HSI-A-1416	Potential (9)	Commercial – automotive repair	x			x			Outdoor used auto parts transfer. Uncovered dumpster with entire car inside.
HSI-A-1427	Not a Hotspot (1)	Commercial – equipment rental, storage, repair, fueling				x			Large stain on asphalt near garage door looks fresh. Likely from washing floor.

At a rental facility, HSI-A-1415, large pieces of equipment are maintained, repaired, fuled and stored. This facility also houses between 20 and 50 fleet vehicles. Figure 4-50 shows a cracked containment unit for oil storage at the site.

Figure 4-50: Equipment Rental Company With Cracked Containment for Oil Storage at HSI-A-1415

A metal recycling facility, HSI-A-1416 (Figure 4-51), with both indoor and outdoor operations, showed no signs of active spills on the asphalt surface. However, this location had active outdoor parts trading and an entire car inside an open dumpster. With a storm drain proximate to the parts trading, the chance of spilled material entering the MS4 system is quite high.

An adult day care and a commercial plumbing repair facility, HSI-A-1412 and HSI-A-1413 (Figure 4-52), located in the same commercial complex, were found to be sources of "dumpster juice" and sediment, respectively. Note that it appeared to field crews that the entire complex is served by a stormwater pond. Both facilities should be included in future education efforts.

Figure 4-51: Metal Recycling Facility at HSI-A-1416

Figure 4-52: Sediment From Excavating Equipment Being Stored in Rear Parking Lot of Plumbing Repair Facility at HSI-A-1413

Institutions

Two institutions were assessed for retrofit opportunities in the Herbert Run (E. Br.) subwatershed during the uplands assessment of Lower Patapsco River. This included one retirement community and one school for students with special needs. Table 4-66 summarizes recommendations for the institutional sites assessed in Herbert Run (E. Br.).

Table 4-66: ISI Recommendations – Herbert Run (E. Br.)

			RECOMMENDED ACTIONS							
Site ID	Name	Public/ Private	Storm Drain Marking	# Trees for Planting	Downspout Disconnection	Stormwater Retrofit	Impervious Cover Removal	Buffer Improvement	Trash Management	Notes
ISI-A-1422	Charlestown Retirement Community	Private	✓	83	✓	✓			✓	Variety of uncovered materials stored outside
ISI-A-1439	Maiden Choice School	Public	✓	204	✓	✓	✓		✓	Concrete swale servicing tennis court could be removed

Both of the institutions assessed in Herbert Run (E. Br.) exhibited opportunities to engage citizens in activities that will result in water quality improvements in their subwatershed. Storm drain marking and tree planting were recommended at both sites. These activities offer educational, hands-on experience if the students, faculty, and/or residents are able to participate in them. Storm drain marking can serve as a visual reminder of the downstream effects on water quality of actions on site. Trees reduce stormwater runoff by capturing and storing rainfall in the tree canopy and by promoting infiltration of water into the soil. Downspout disconnection and addition of rain gardens for bioretention was also recommended. At both sites, downspouts discharge to impervious surfaces and/or are directly connected to storm drains (Figure 4-53). Disconnecting downspouts and redirecting their flows to a permeable area, such as a rain garden, decreases stormwater volume, nutrients, and rates of flow and leads to decreased erosion.

At ISI-A-1422, field teams observed evidence that maintenance or wash water was discharged to storm drains near the Brookside Building loading dock. Educating the facility staff about water quality detriments that can come about from this sort of practice is an important action that should be undertaken. Maintenance/wash water could have chemicals, grease, dirt, etc. in it, which can unknowingly enter the storm system due to this practice. Educating the facility staff as to the importance of keeping trash dumpsters and waste receptacle covered is also recommended. Uncovered dumpsters and overflowing dumpsters were observed at this site, and were located near storm drain inlets with no runoff diversion methods present. Thus, trash or leachate from the dumpsters could easily find its way into the storm drain network. Dumpsters should be covered and should be moved to areas where they are not in direct line with storm drain inlets. In addition, some uncovered materials (sand, bricks, appliances, 5-gallon buckets, drums) were observed being stored outside, which also should be attended to (Figure 4-54). Educating the facility staff as to the importance of proper material and waste management will provide benefits to this subwatershed's stormwater quality.

Figure 4-53: Opportunities Exist for Downspout Disconnection and Creation of Rain Gardens at ISI-A-1422 (left) and ISI-A-1439 (right).

Figure 4-54: Poor Materials Storage Practices Were Observed at ISI-A-1422.

Trash management should also be taken into consideration at ISI-A-1439. At this school for special needs students, the dumpster was observed uncovered and had some evidence of leaking/rusting. Newspapers and bottles were present on the tennis courts and could mobilize with wind or rain. Grass clippings had accumulated in the concrete gutter servicing the tennis courts, and could wash into the storm and stream network during a storm (Figure 4-55). This concrete gutter that services the tennis courts could be removed and replaced with pervious surface. This is another good opportunity to engage staff and students with vegetation planting while providing education about the importance of filtration for water quality benefits.

Figure 4-55: Grass Clippings Accumulate in a Concrete Gutter at ISI-A-1439. During Storms, These Clippings Will be Washed Away and Contribute to Nitrification in Downstream Waters. Removal of This Impervious Gutter is Recommended, as it Could be Converted to a Pervious Swale.

Pervious Areas

Pervious area restoration has the potential to convert areas of turf, which often contribute nutrients to stormwater runoff, to forest, which can absorb and filter nutrients. A single pervious area was assessed for restoration potential in the Herbert Run (E. Br.) at Halethorpe Elementary School. Halethorpe Elementary School is located off Maple Avenue in Halethorpe, and is owned and maintained by Baltimore County. One long, narrow planting site was recommended for reforestation with minimal site preparation along the northeastern boundary of the school. The site presents a reasonably good opportunity for establishment of additional forest buffer along the unnamed stream along the northern part of the school. A summary is provided in Table 4-67.

Table 4-67: PAA Summary – Herbert Run (E. Br.)

Site ID	Location	Description	Acres	Ownership
PAA-A-1420	Halethorpe Elementary School	Public school grounds	Parcel - 15.34 Recommended planting – 1.21	Public

Stream Restoration Potential

Eroding stream banks are a clear, visible sign of stream impairment. In preparing the Watershed Characterization Report, past studies and reports were reviewed and compiled in an effort to map where streambank erosion has occurred and been noted throughout the Lower Patapsco River watershed. The stabilization of streambanks and other restoration measures can provide numerous benefits, including nutrient and sediment load reductions and improved habitat health for aquatic biota. In Herbert Run (E. Br.), erosion and channel stability problems were noted along 5.36 miles of stream (54% of the total stream miles in this subwatershed). Within the subwatershed, no specific stream reaches were recommended for stream restoration in the 2000 Water Quality Management Plan (Tetra Tech 2000). 983 feet of stream were surveyed by the Friends of Patapsco Valley and Heritage Greenway (FPVHG) in recent years and were noted in Section 3.6.5 of the Watershed Characterization Report (Appendix E). FPVHG recommended day-lighting a section of piped stream.

Illicit Discharges

Herbert Run (E. Br.) has seven major outfalls, one is listed as priority 0 (not prioritized), another four are listed as priority 2 (high) and two outfalls listed as priority 3 (low). Priority 0 outfalls have insufficient data to determine a priority rating. This may be due to inaccessibility or because there has been only a single screening.

If no pollution problems were indicated, then the outfall is considered a low priority. High priority outfalls have moderate to minor problems with the potential to become severe. High priority outfalls are sampled once a year.

Stormwater Conversions

Herbert Run (E. Br.) has four stormwater management facilities which were evaluated for conversion. Two of those were ranked Very High priority in the Watershed Characterization Report and the other two were ranked Low and Medium. The two ponds recommended for conversion (rank of Very High) are Pond 355 which is located within a commercial business park off of Vero Road and Pond 356 which is located within the same commercial business park as Pond 355, but is located off John Avenue. Photographs and other information on these ponds are included in Section 3.7 and Appendix K of the Watershed Characterization Report. These ponds were ranked highest since water quality benefits could be significantly increased in these ponds with minimal effort and cost. The ponds have a high impervious area percentage within their contributing drainage areas, are located off-line, and appear in fairly good condition due to regular maintenance. Improvements may include addition of a small forebay or micropools in order to capture sediments before they enter the main body of the pond in order to make maintenance easier; removal of concrete or riprap pilot “low flow” channels, and/or replacing or redesigning existing riser structures in order to treat high pollutant containing storm events (“first flush”). Both ponds are privately owned. For this SWAP, ownership was not a criterion for the priority ranking of facilities.

According to the County GIS information, Pond 355's drainage area is 24.95 acres and appears to be mainly impervious area comprised of commercial buildings and associated parking lots. The pond bottom is well maintained grass; however the low flow pipe trash rack is more than half clogged. The riser appears in good condition. Access to the pond from Vero Road is fairly easy.

Pond 356 is located within the same commercial business park as Pond 355, but is located off John Avenue. According to the County GIS information, the drainage area is 28.97 acres and appears to be mainly impervious area comprised of commercial buildings and associated parking lots. The pond bottom side slopes are well maintained grass; however the bottom of the facility has some wetland vegetation. The low flow pipes and trash racks have accumulated a significant amount of debris and would need to be cleaned. The flow path within the facility is relatively short. Access to the pond from the commercial parking lot is easy.

Prior to design of any pond conversions, further analysis should be completed to determine the existing pond storage and freeboard.

Subwatershed Management Strategy

Figure 4-56 provides a visual summary of restoration opportunities in the watershed.

<u>Engaging Citizens & Watershed Groups</u>

1. Engage property owners in downspout disconnection onto adjacent impervious surfaces or into retrofitted rain barrels as indicated in Table 4-64 as well as at the Maiden Choice School and at the Charlestown Retirement Community as indicated in Table 4-66.
2. Educate property owners about the benefits and importance of rain gardens, and their positive effects on water quality, at the locations indicated in Table 4-64.
3. Take advantage of the opportunity to plant over 60 street trees at the locations indicated in Table 4-64.
4. Encourage the homeowners to mark storm drains in their neighborhoods as per Table 4-64 in addition to the facility managers at the Maiden Choice School and at the Charlestown Retirement Community, as indicated in Table 4-66. The latter would make a great learning opportunity for students and community residents.
5. Encourage communities and private landowners to increase the tree canopy of their lots. The opportunity for planting 16 trees exists in the neighborhood indicated in Table 4-64. An additional opportunity exists to convert 15.34 acres, at Halethorpe Elementary School, from pervious area to meadow or tree planting as per Table 4-67. The opportunity for planting almost 300 trees exists at the Maiden Choice School and Charlestown Retirement Community, combined, as indicated in Table 4-66. The Maiden Choice School also showed an opportunity to reduce impervious cover by removing the concrete swale serving the tennis courts (ISI-A-1439).

6. Engage property owners in better stream buffer management at locations indicated in Table 4-64.

Municipal Actions

1. Investigate current street sweeping measures at locations indicated in Table 4-64 and increase frequency or implement program as necessary.
2. Investigate the possibility of stormwater retrofits at the Maiden Choice School and at the Charlestown Retirement Community as indicated in Table 4-66. The former location would allow for a great long-term learning opportunity for the students at the school.
3. Educate the facility managers at the Maiden Choice School and the Charlestown Retirement Community about the importance of proper trash management as indicated in Table 4-66.
4. Investigate conversion of private stormwater ponds 355 and 356, ranked Very High priority in the Watershed Characterization Report (Appendix E).
5. Conduct follow-up investigations of the 4 high priority outfalls to find the source(s) of illicit discharges and retest outfalls with insufficient data for a priority rating that have the potential to become severe as described above and in the Watershed Characterization Report (Appendix E).
6. Investigate stream restoration potential at sites in Herbert Run (E. Br.) as described in Section 3.6.5 of the Watershed Characterization Report (Appendix E).

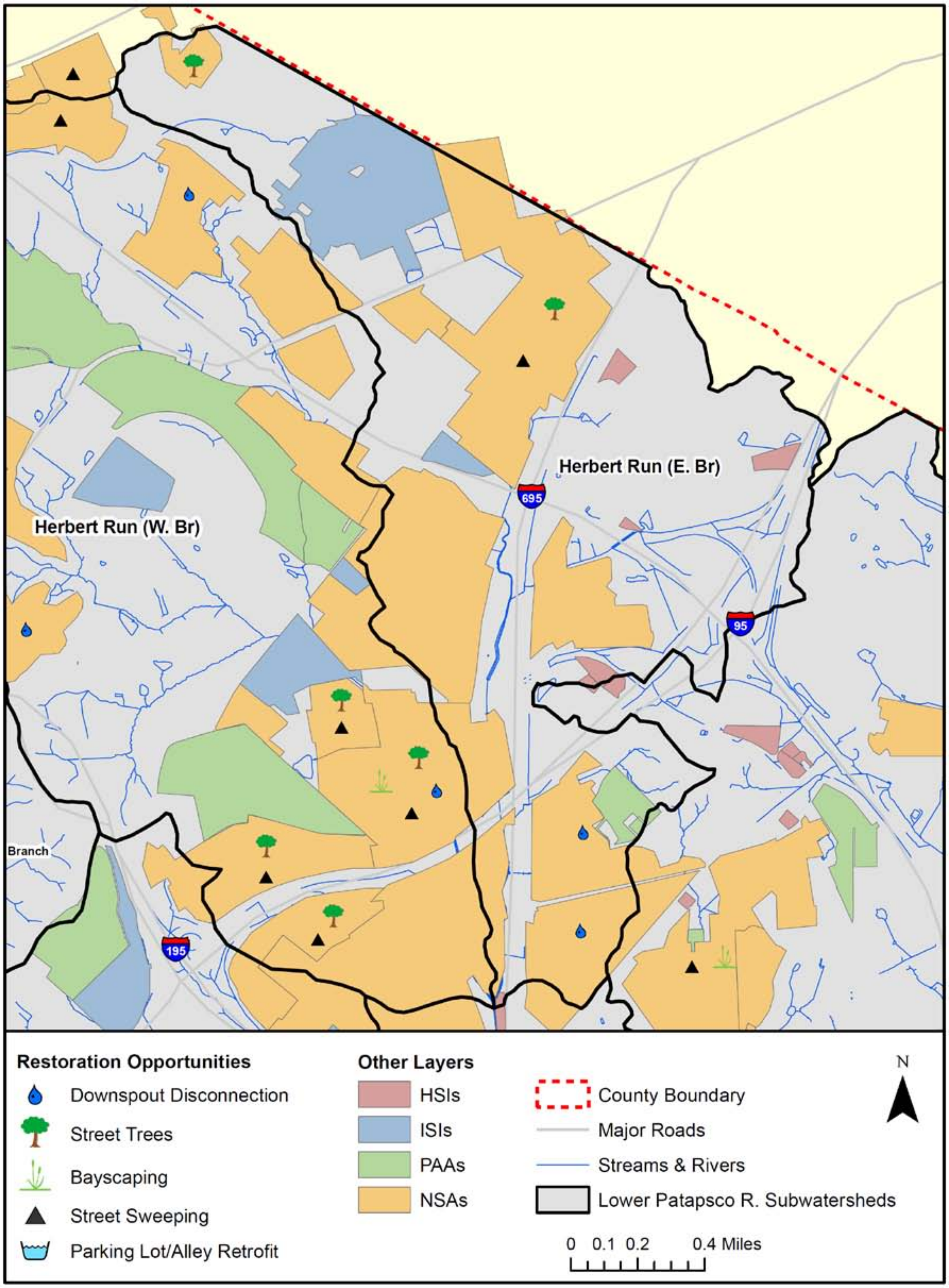

Figure 4-56: Restoration Opportunities in Herbert Run (E. Br.).

4.3.15 Patapsco River – A5 (Subwatershed code 1500)

The Patapsco River-A5 watershed is by far the largest within the Lower Patapsco River watershed, at 3,391.7 acres. It occupies the eastern portion of the Lower Patapsco River watershed along the Baltimore City border. In terms of land use / land cover, the Patapsco River-A5 is comprised primarily of medium density residential (26.5%) and industrial land uses (17%), and forest cover (17%). The total land cover categorized as impervious is high at 29%. Twenty percent of urban lands are currently treated by stormwater management facilities. Table 4-68 summarizes key subwatershed characteristics of Patapsco River-A5.

Table 4-68: Key Subwatershed Characteristics – Patapsco River-A5

Drainage Area	3,391.7 acres (5.30 sq. mi.)	
Stream Length	21.7 miles	
Population	17,605 (2000 Census) 5.2 people/acre	
Land Use/Land Cover	Very Low Density Residential:	0.0%
	Low Density Residential:	1.2%
	Medium Density Residential:	26.5%
	High Density Residential:	7.7%
	Commercial:	3.7%
	Industrial:	20.4%
	Institutional:	5.3%
	Extractive:	0.5%
	Open Urban Land:	3.2%
	Agriculture:	0.0%
	Forest:	17.0%
	Barren Land:	0.0%
	Water/Wetlands:	9.3%
	Transportation	5.1%
Impervious Cover	29% of subwatershed	
Soils	A Soils (low runoff potential):	2.4%
	B Soils:	12.3%
	C Soils:	50.1%
	D Soils (high runoff potential):	35.1%
SWM Facilities	20% of urban land use treated	
Priority Rating	Very High	

Neighborhoods

A total of 12 distinct neighborhoods were identified and assessed within Patapsco River-A5 during the uplands assessment of the Lower Patapsco River watershed. The primary recommendations for neighborhoods in this subwatershed included rain barrels, rain gardens, storm drain marking, increasing lot canopy, and street sweeping. A summary of neighborhood recommended actions is presented in Table 4-69.

Table 4-69: NSA Recommendations – Patapsco River-A5

		RECOMMENDED ACTIONS													
Site ID	Lot Size (acres)	% Opportunity for Downspout Disconnection	Rain Barrels	Rain Gardens	Storm Drain Marking	Bayscaping	Increase Lot Canopy	Pet Waste	Trash Management	Buffer Improvement	Parking Lot/Alley Retrofit	Street Sweeping	# of Street Trees	# of Shade Trees	Notes
NSA-A-1068	1/4		✓	✓	✓					✓		✓			Stream buffer needs lots of work
NSA-A-1069	1/4		✓	✓	✓	✓	✓								
NSA-A-1070	1/2	25	✓	✓	✓	✓	✓		✓			✓			Lots of oily spots on roadside gravel
NSA-A-1071	1/4		✓	✓	✓	✓	✓								This area could use landscaping
NSA-A-1072	1/4		✓		✓	✓	✓					✓	12		
NSA-A-1073	1/8		✓		✓		✓						3	5	Heavily vegetated around ponds
NSA-A-1074	1/8		✓		✓		✓		✓			✓	23		
NSA-A-1075	1/4				✓	✓	✓		✓		✓	✓	65	5	Bare lawns, heavy traffic, pet waste, trash dumping
NSA-A-1076	1/4		✓		✓					✓		✓			Areas with new curbs
NSA-A-1077	1/8		✓		✓		✓		✓			✓	45		Bare soil in yards and lots of sediment along the street
NSA-A-1081	<1/4	25	✓	✓			✓					✓			
NSA-A-1086	1/4		✓		✓		✓								

Many of the neighborhoods had opportunities for a variety of actions to be implemented in one locale. Patapsco River-A5 was the only subwatershed in the Lower Patapsco with neighborhoods that were recommended for trash management. In addition, two parking lot retrofits were recommended, meaning the implementation of BMPs to capture and treat runoff from these impervious surfaces (Figure 4-57). Two neighborhoods also were recommended for a large number (> 40) of street trees and may provide excellent opportunities for involving a large group of citizens and educating them about their role in the health of their local watershed and the Chesapeake Bay.

Figure 4-57: Multi-family Parking Lots, Like This One in NSA-A-1075, Provide an Opportunity to Control Stormwater Runoff From a Single, Large Area of Impervious Surface, and Could Result in Pollutant Load Reductions.

Hotspots

There were nine facilities assessed in the Patapsco River-A5 watershed during the uplands assessment of the Lower Patapsco River watershed. One was a severe hotspot, two were confirmed hotspots, five were potential hotspots and the remaining facility was not classified as a potential pollution source. Table 4-70 summarizes potential pollution sources in the Patapsco River-A5 watershed from facilities visited.

Table 4-70: Hotspot Summaries – Patapsco River-A5

Site ID	HSI Status (# filled circles)	Description	Vehicle Operations	Outdoor Materials	Waste Management	Physical Plant	Turf / Landscaping	Stormwater	Notes
			POTENTIAL POLLUTION SOURCES						
HSI-A-1517	Confirmed (13)	Commercial – truck sales, rental, repair, fueling	✓	✓	✓	✓			Include in future education
HSI-A1518	Potential (7)	Industrial – food production	✓	✓	✓			✓	
HSI-A-1519	Not a Hotspot (3)	Commercial – heavy equipment rental, repair, fueling	✓			✓			Secondary containment for oil/coolant storage is cracked.
HSI-A-1520	Potential (9)	Industrial – furniture manufacturer and sales	✓	✓	✓			✓	White staining present on asphalt at back loading dock as per last inspection by County.
HSI-A-1522	Potential (8)	Commercial – storage and offices for paving & excavating business	✓	✓	✓	✓			Include in future education.
HSI-A-1523	Confirmed (13)	Industrial - brewery	✓	✓		✓		✓	
HSI-A-1524	Potential (9)	Commercial – insulation products warehouse	✓	✓	✓	✓			Outdoor storage of liquid foam in 55 gallon barrels.
HSI-A-1525	Severe (17)	Commercial – fleet rental, repair, fueling	✓	✓	✓	✓		✓	Evidence of past leakage near large fuel storage tanks.
HSI-A-1526	Potential (6)	Commercial – primarily vehicle storage	✓	✓	✓	✓			

The Patapsco River-A5 watershed showed a diversity of potential pollution sources from hotspots, with the exception of sources from landscaping which were not noted by field crews at the sites visited. Site visits found two confirmed hotspot; a tractor/truck sales, rental and repair facility with an outdoor/uncovered fueling station as well as a brewery with vehicles being repaired outdoors and outdoor liquid storage without secondary containment.

Some severe hotspots were also observed in the watershed, including a furniture maker with uncovered 55-gallon drums and staining from a loading dock to a storm drain (Figure 4-58).

Figure 4-58: White Staining From Loading Dock and 55-Galllon Drums, Both Proximate to Storm Drain at HSI-A-1520

A truck rental, repair and fueling facility was also categorized as a severe hotspot for reasons which included rusting fuel delivery lines and signs of staining on pavement (Figure 4-59), as well as outdoor storage of truck parts, asphalt in bad condition and open 55-gallon drums exposed to rain. This facility was not previously reported to Baltimore County EPS. Note that the above ground fuel storage tanks definitively exceed the 1,320 gallon threshold requiring a SPCC plan. The facility is drained by what appears to be a small channel protection or flood control stormwater management pond.

Figure 4-59: Rusting fuel lines and signs of past spills at above ground fuel storage tanks at HSI-A-1525

Institutions

Three institutions were assessed for retrofit opportunities in the Patapsco River-A5 subwatershed during the uplands assessment of Lower Patapsco River. These included two public elementary schools and an American Legion facility. Table 4-71 summarizes recommendations for the institutional site assessed in Patapsco River-A5.

Storm drain marking was recommended at all three institutions. Storm drain marking can serve as an educational opportunity for the students and faculty of the schools and the members of the American Legion, as well as a visual reminder of the downstream effects on water quality of actions on site. At both of the schools, tree planting was recommended (Figure 4-60). Trees reduce stormwater runoff by capturing and storing rainfall in the tree canopy and by promoting infiltration of water into the soil. Tree planting is an excellent activity to engage students and staff in a hands-on educational opportunity that will result in water quality improvements.

Table 4-71: ISI Recommendations – Patapsco River-A5

			RECOMMENDED ACTIONS							
Site ID	Name	Public/ Private	Storm Drain Marking	# Trees for Planting	Downspout Disconnection	Stormwater Retrofit	Impervious Cover Removal	Buffer Improvement	Trash Management	Notes
ISI-A-1527	American Legion	Private	✓						✓	Porous pavement – parking lot. Grease receptacle on pervious area with no secondary containment
ISI-A-1536	Baltimore Highlands Elementary School	Public	✓	105		✓				Rain garden potential at an already disconnected downspout
ISI-A-1537	Lansdowne Elementary School	Public	✓	580					✓	Leaky dumpster observed


Figure 4-60: Potential Tree Planting Sites are Present at ISI-A-1536 and ISI-A-1537.

The American Legion facility is surrounded by a porous parking lot that allows storm water to infiltrate instead of running off (Figure 4-61). This is an excellent step toward improving the handling of stormwater on site. One area in which this facility could improve is in its handling of trash and materials. A grease receptacle was observed on the pervious area adjacent to a parking area and upslope of a stormwater inlet (Figure 4-62). Proper precautions should be taken for this receptacle in case of a spill, leak, or puncture, as no secondary containment was evident. A discarded propane tank was seen on site and a shipping container is being stored on the property. In addition, a pile of blocks and Styrofoam and small articles of trash were observed piled up in the rear of the building. These trash items should be moved to a closed/covered receptacle, and the members and staff of the facility should be educated as to the importance to water quality of trash and materials management.

Figure 4-61: A Porous Parking Lot Surrounds ISI-A-1527.

The elementary schools in this subwatershed offer educational opportunities for students and staff to learn about stormwater management. At ISI-A-1536, there is an opportunity for a connected downspout to be disconnected on the east side of the building and for a rain garden bioretention area to be added below an already disconnected downspout at the breezeway leading to the new addition. Disconnecting downspouts and redirecting their flows to a permeable area, such as a rain garden, decreases stormwater volume, nutrients, and rates of flow, and leads to decreased erosion. Maintenance of the rain garden could serve as an educational experience for students and teachers alike. At ISI-A-1537, a leaking dumpster was observed on site, and was located near a storm drain inlet with no runoff diversion methods present (Figure 4-63). Leachate from the dumpsters will easily get into the storm and stream networks and have negative effects on water quality. This dumpster should be repaired or replaced and should be moved to an area not in direct line with storm drain inlets. In addition, students and staff should be educated about the importance of preventing pollution such as this from entering the storm and stream networks and of the negative effects it can have on water quality.

Figure 4-62: A Grease Receptacle Sits Above Porous Pavement at ISI-A-1338. Precautions Should be Taken for This Receptacle in Case of a Spill, Leak, or Puncture, as the Porous Pavement it Sits on Would Absorb any Spills and Allow Them to Seep into the Ground, Eventually Entering Nearby Streams.

Figure 4-63: A Leaking Dumpster at ISI-A-1537

Pervious Areas

Pervious area restoration has the potential to convert areas of turf, which often contribute nutrients to stormwater runoff, to forest, which can absorb and filter nutrients. Three pervious area sites were assessed for restoration potential in the Patapsco River-A5, including the Southwest Area Park, United Hebrew Cemetery, and an unnamed Baltimore County property. The Southwest Area Park is located in the far southeastern part of Baltimore County, between Patapsco Avenue and I-895; the park is owned and operated by Baltimore County. The park comprises large non-forested wetland and tributary complexes, and likely presents some of the best forest planting opportunities in the entire Lower Patapsco River watershed. The privately-owned United Hebrew Cemetery is located off Old Washington Boulevard in Halethorpe. This site was originally considered as an opportunity for bolstering the existing adjacent forest buffer. Upon inspection during the field visit, however, no areas of the site were deemed appropriate for tree planting. Most all areas of the site either possessed graves or were surveyed and marked for new ones. The Baltimore County Property site is a stormwater facility located immediately north of Spencer Street in Lansdowne; it is owned and maintained by Baltimore County. Tributaries on the unnamed Baltimore County property site drain east directly to the mainstem Patapsco River. This site is currently a wet retention facility that is dominated by broadleaf cattails. It is possible that hydrophytic tree species could be planted throughout this facility. It is not clear, however, whether this stormwater facility could remain functional if it were primarily treed. Further, access from the Spencer Street (flag lot) side could be difficult for any machinery at the existing tall concrete weir structure, potentially forcing access from adjacent private property. A summary is provided in Table 4-72.

Table 4-72: PAA Summaries – Patapsco River-A5

Site ID	Location	Description	Acres	Ownership
PAA-A-1524	United Hebrew Cemetery	Cemetery	Parcel - 22.17 Recommended planting – 0.00	Private
PAA-A-1525	County-owned parcel	Open urban land	Parcel - 1.32 Recommended planting – 0.00	Public
PAA-A-1526	Southwest Area Park	Park and recreational lands	Parcel - 95.88 Recommended planting – 42.77	Public

Stream Restoration Potential

Eroding stream banks are a clear, visible sign of stream impairment. In preparing the Watershed Characterization Report, past studies and reports were reviewed and compiled in an effort to map where streambank erosion has occurred and been noted throughout the Lower Patapsco River watershed. The stabilization of streambanks and other restoration measures can provide numerous benefits, including nutrient and sediment load reductions and improved habitat health for aquatic biota. In Patapsco River-A5, erosion and channel stability problems were noted along 8.67 miles of stream (40% of the total stream miles in this subwatershed). 3.09 miles (16,292 feet) of specific stream reaches were recommended for stream restoration in the 2000 Water Quality Management Plan (Tetra Tech 2000) and are detailed in Section 3.6.5 of the Watershed Characterization Report (Appendix D).

Illicit Discharges

The Patapsco River-A5 has 22 major outfalls. One is listed as priority 0 (not prioritized), 5 are listed as priority 2 (high) and 16 outfalls are listed as priority 3 (low). Priority 0 outfalls have insufficient data to determine a priority rating. This may be due to inaccessibility or because there has been only a single screening.

If no pollution problems were indicated, then the outfall is considered a low priority. High priority outfalls have moderate to minor problems with the potential to become severe. High priority outfalls are sampled once a year.

Stormwater Conversions

The Patapsco River-A5 has 12 stormwater management facilities which were evaluated for conversion. Two of those were ranked Very High priority in the *Watershed Characterization Report*. Four were ranked High, one Medium, and five Low. The two ponds slated for conversion are Pond 298 which is located behind a commercial development on Washington Boulevard, just south of Lansdowne Boulevard and Pond 907 is located within a commercial business park off Sulphur Spring Road. These ponds were ranked highest since water quality benefits could be significantly increased in these ponds with minimal effort and cost. The ponds have a high impervious area percentage within the contributing drainage area, are located off-line, and appear in fairly good condition due to regular maintenance. Improvements may include addition of a small forebay or micropools in order to capture sediments before they enter the main body of the pond in order to make maintenance easier; removal of concrete or riprap pilot "low flow" channels, and/or replacing or redesigning existing riser structures in order to treat high pollutant containing storm events. Both ponds are privately owned. For this SWAP, ownership was not a criterion for the priority ranking of facilities. Photographs and other information on these ponds are included Section 3.7 and Appendix K of the Watershed Characterization Report.

According to the County GIS information, the drainage area for Pond 298 is 17.87 acres and appears to be mainly impervious area comprised of commercial buildings and associated parking lots. Pockets of wetland vegetation were observed in the pond bottom, and bare soil erosion has occurred along the bottom edge of the embankment and side slopes. The riser appears to be in good condition although geotextile was placed in front of the low flow pipe. It was not clear why the geotextile was placed in front of the pipe; however, the geotextile was partially ripped allowing flow to enter the pipe. The access road to the pond is long and fairly steep but well maintained.

According to the County GIS information, the drainage area for Pond 907 is 9.5 acres and appears to be mainly impervious area comprised of commercial buildings and associated parking lots. The pond bottom is well maintained grass and concrete pilot channels. The inflow pipes appear clean and in good condition. The low flow pipes and trash racks have accumulated some debris and would need to be cleaned. Access to the pond from the commercial parking lot is easy.

Prior to design of any pond conversions, further analysis should be completed to determine the existing pond storage and freeboard.

Subwatershed Management Strategy

Figure 4-64 provides a visual summary of restoration opportunities in the watershed.

Engaging Citizens & Watershed Groups

1. Engage property owners in downspout disconnection onto adjacent impervious surfaces or into retrofitted rain barrels as indicated in Table 4-69.
2. Educate property owners about the benefits and importance of rain gardens and bayscaping, and their positive effects on water quality at the locations indicated in Table 4-69.
3. Take advantage of the opportunity to plant over 130 street trees at the locations indicated in Table 4-69.
4. Encourage homeowners to mark storm drains in their neighborhoods, as per Table 4-69, and the facility managers at the American Legion, Baltimore Highlands Elementary School and Lansdowne Elementary School, as indicated in Table 4-71. Storm drain marking at the two schools would make for a great class project opportunity for students.
5. Encourage communities and private landowners to increase the tree canopy of their lots. The opportunity for planting 10 trees exists in the neighborhood, as indicated in Table 4-69. An additional opportunity for planting of almost 700 additional trees exists at the Baltimore Highlands Elementary School and Lansdowne Elementary School, combined, as indicated in Table 4-71. Conversion of 22.17 acres from pervious area to meadow or tree planting exists at United Hebrew Cemetery, as per Table 4-72.

10. Investigate the Southwest Area Park pervious area, described in Table 4-71, for potential tree planting.

Municipal Actions

1. Investigate current street sweeping measures at locations indicated in Table 4-69 and increase frequency or implement program as necessary.
2. Educate neighbors about the importance of proper trash management, as indicated in Table 4-69, and the facility managers at the American Legion and Lansdowne Elementary School, as indicated in Table 4-71.
3. Investigate the possibility of installing a rain garden to capture roof runoff at the Baltimore Highlands Elementary School at ISI-A-1536, as indicated in Table 4-71.

4. Engage and educated business owners at the locations indicated in Table 4-70 about proper vehicle operations, outdoor materials storage , waste management, physical plant operations, and appropriate care of the existing stormwater infrastructure and BMPs
5. Investigate conversion of private stormwater ponds 298 and 907, ranked Very High priority in the Watershed Characterization Report (Appendix E).
6. Conduct follow-up investigations of the five high priority outfalls to find the source(s) of illicit discharges and retest the outfall with insufficient data for a rating and which has the potential to become severe, as described above and in the Watershed Characterization Report (Appendix E).
7. Investigate stream restoration potential at sites in Patapsco River-A5 as described in Section 3.6.5 of the Watershed Characterization Report (Appendix E).

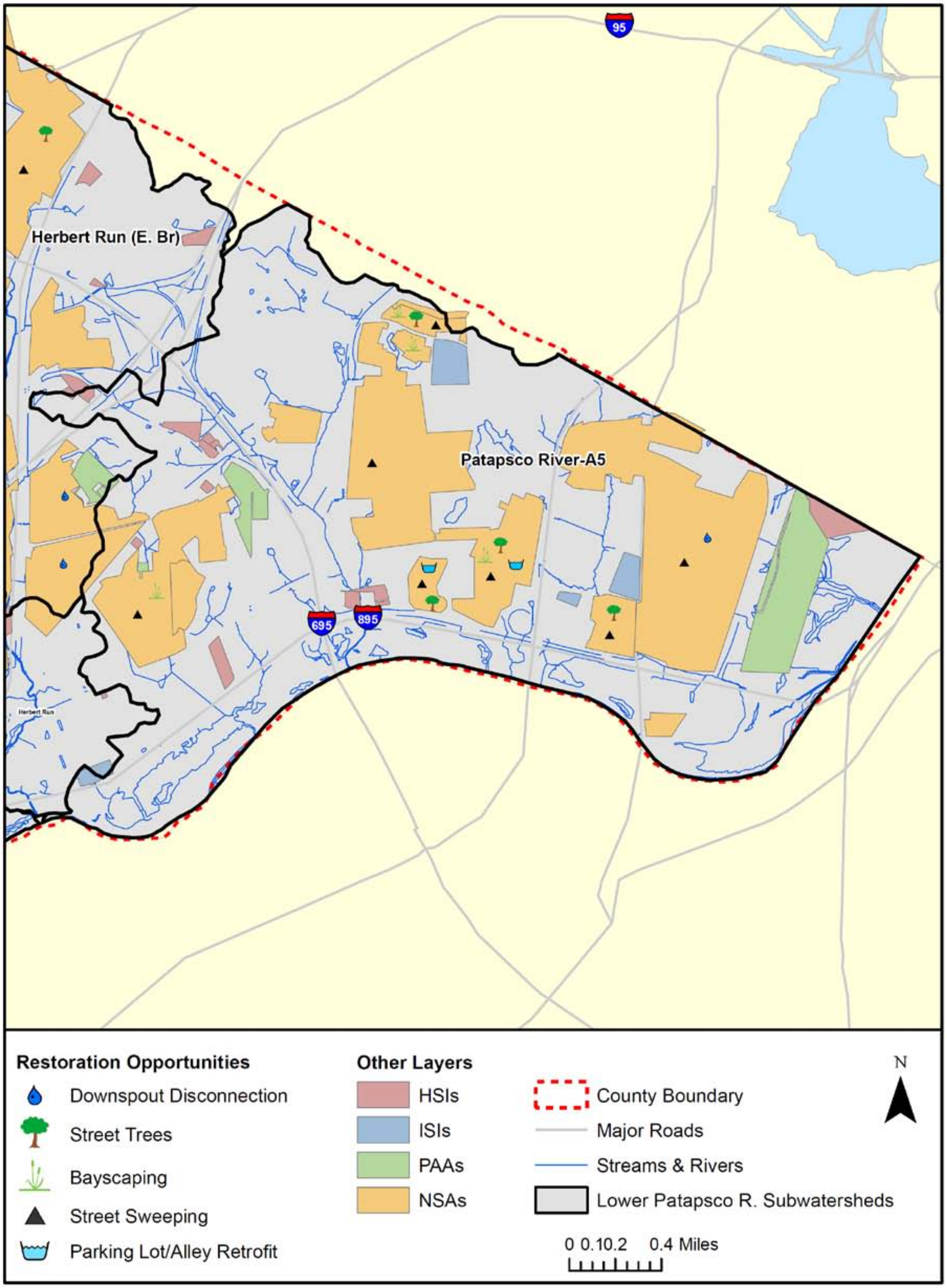

Figure 4-64: Restoration Opportunities in Patapsco River-A5

4.3.16 Sawmill Branch (Subwatershed code 1600)

The Sawmill Branch watershed occupies 1,335.7 acres in the central Lower Patapsco River watershed. In terms of land use / land cover, the Sawmill Branch is comprised primarily of forest cover (46.1%) and medium density residential (40.3%). Total land cover categorized as impervious is 13%. Sixteen percent of urban lands are currently treated by stormwater management facilities. Table 4-73 summarizes key subwatershed characteristics of Sawmill Branch.

Table 4-73: Key Subwatershed Characteristics – Sawmill Branch

Drainage Area	1,335.7 acres (2.09 sq. mi.)	
Stream Length	8.6 miles	
Population	4,933 (2000 Census) 3.7 people/acre	
Land Use/Land Cover	Very Low Density Residential:	1.9%
	Low Density Residential:	6.7%
	Medium Density Residential:	40.3%
	High Density Residential:	0.4%
	Commercial:	2.9%
	Industrial:	0.0%
	Institutional:	1.4%
	Extractive:	0.0%
	Open Urban Land:	0.2%
	Agriculture:	0.0%
	Forest:	46.1%
	Barren Land:	0.0%
	Water/Wetlands:	0.0%
	Transportation	0.2%
Impervious Cover	13% of subwatershed	
Soils	A Soils (low runoff potential):	0.3%
	B Soils:	75.3%
	C Soils:	13.4%
	D Soils (high runoff potential):	10.4%
SWM Facilities	16% of urban land use treated	
Priority Rating	Medium	

Neighborhoods

A total of six distinct neighborhoods were identified and assessed within Sawmill Branch during the uplands assessment of the Lower Patapsco River watershed. The primary recommendations for neighborhoods in this subwatershed included rain barrels, rain gardens, storm drain marking, downspout disconnection, Bayscaping, increasing lot canopy cover, and street sweeping. A summary of neighborhood recommended actions is presented in Table 4-74.

Table 4-74: NSA Recommendations – Sawmill Branch

		RECOMMENDED ACTIONS													
Site ID	Lot Size (acres)	% Opportunity for Downspout Disconnection	Rain Barrels	Rain Gardens	Storm Drain Marking	Bayscaping	Increase Lot Canopy	Pet Waste	Trash Management	Buffer Improvement	Parking Lot/Alley Retrofit	Street Sweeping	# of Street Trees	# of Shade Trees	Notes
NSA-A-1025	<1/4			✓	✓		✓						8	3	Neighborhood is clean and neat, but has almost no vegetation
NSA-A-1026	1/4	45	✓	✓	✓	✓	✓						3		All commercial properties along Route 40 West
NSA-A-1032	1/4	35	✓	✓	✓	✓						✓	28	5	
NSA-A-1043	<1/4		✓	✓						✓		✓	8		Few storm drain inlets in this older area
NSA-A-1088	1/4	50	✓	✓	✓	✓	✓						8		Street trees already planted in new section
NSA-A-1092	<1/4		✓		✓					✓		✓			Common parking area at end of streets stain with oil, trash around

Several neighborhoods, particularly NSA-A-1026, NSA-A-1032, and NSA-A-1088 were recommended for a variety of actions, including downspout disconnection, rain barrels, rain gardens, storm drain marking, Bayscaping, increasing lot cover, and street sweeping (Figure 4-65). These neighborhoods would be ideal for implementing integrated management that demonstrates how all of the various strategies can work together in one locale.

Figure 4-65: Neighborhoods, Like NSA-A-1032, Provide Good Opportunities for Water Quality Improvements.

Hotspots

No hotspot investigations were conducted in the Sawmill Branch watershed during the upland assessment.

Institutions

Two institutions were assessed for retrofit opportunities in the Sawmill Branch sub-watershed during the uplands assessment of Lower Patapsco River. These included two churches. Table 4-75 summarizes recommendations for the institutional site assessed in Sawmill Branch

At New Life Ministries (ISI-A-1615), two small areas for tree plantings were identified, one in a parking lot island in front of a church and another in the rear of the church building. Additional trees in these locations can help improve stream quality and watershed health primarily by decreasing the amount of stormwater runoff and pollutants that reach local waters. Tree planting events are great ways to engage the church members in an activity that will not only educate them as to the benefits of trees to the watershed, but also benefit water quality. Trees reduce stormwater runoff by capturing and storing rainfall in the tree canopy and by promoting infiltration of water into the soil. A partially uncovered dumpster was observed at the site and appeared damaged and in poor condition. It was unable to be closed all the way due to some tires in the dumpster. Church members and staff should be educated about the importance of keeping dumpsters closed in order to prevent pollution from entering the storm drain and stream networks and of the negative effects it can have on water quality.

Table 4-75: ISI Recommendations – Sawmill Branch

			RECOMMENDED ACTIONS							
Site ID	Name	Public/ Private	Storm Drain Marking	# Trees for Planting	Downspout Disconnection	Stormwater Retrofit	Impervious Cover Removal	Buffer Improvement	Trash Management	Notes
ISI-A-1615	New Life Ministries	Private		5					✓	Dumpster overflowing with tires
ISI-A-1633	Morning Star Baptist	Private								Gabion basket grassy swale. Church parking lot.

The site ISI-A-1633 consisted of a large parking area for Morning Star Baptist Church. Besides the parking area, two receptacles for recycling and clothing donations were present as well as a small building in the corner of the property that functions as a snowball stand. Church vehicles were maintained and stored on the lot and all conditions at this site were good. A gabion-basket lined grassy swale provides stormwater treatment practices on site (Figure 4-66). Care should be taken when maintaining the vehicles that no materials or liquids spill on the parking lot, as they could be transported into the grassy swale during storm flows.

Figure 4-66: A Gabion-lined, Grassy Swale Runs Parallel to the Parking Lot at ISI-A-1633.

Pervious Areas

Pervious area restoration has the potential to convert areas of turf, often with high nutrient inputs, to forest which can absorb and filter rather than contribute nutrients. A single pervious area was assessed for restoration potential in Sawmill Run, including parts of Catonsville Park. The Catonsville Park site is located off North Rolling Road in Catonsville; it is owned and maintained by Baltimore County. There are three separate moderate-sized parcels that would be appropriate for tree planting; all three are in the western (un-forested) part of the park. This site was recommended for reforestation with minimal site preparation to reinforce the existing partially forested stream buffers in the western part of the property. A summary is provided in Table 4-76.

Table 4-76: PAA Summary – Sawmill Branch

Site ID	Location	Description	Acres	Ownership
PAA-A-1611	Catonsville Park	Park and recreational lands	Parcel - 35.22 Recommended planting – 1.95	Public

Stream Restoration Potential

Eroding stream banks are a clear, visible sign of stream impairment. In preparing the Watershed Characterization Report (Appendix E), past studies and reports were reviewed and compiled in an effort to map where streambank erosion has occurred and been noted throughout the Lower Patapsco River watershed. The stabilization of streambanks and other restoration measures can provide numerous benefits, including nutrient and sediment load reductions and improved habitat health for aquatic biota. In Sawmill Branch, erosion and channel stability problems were noted along 5.74 miles of stream (67% of the total stream miles in this subwatershed). 0.92 miles (4,866 feet) of specific stream reaches were recommended for stream restoration in the 2000 Water Quality Management Plan (Tetra Tech 2000) and are detailed in Section 3.6.5 of the Watershed Characterization Report (Appendix D).

Illicit Discharges

Sawmill Branch has six major outfalls. Two are listed as priority 2 (high) and 4 outfalls are listed as priority 3 (low). If no pollution problems were indicated, then the outfall is considered a low priority. High priority outfalls have moderate to minor problems with the potential to become severe. High priority outfalls are sampled once a year.

Stormwater Conversions

Sawmill Branch has three stormwater management practices which were evaluated for conversion. None was ranked high enough to be considered for conversion at this time (one ranked Medium, two Low).

Subwatershed Management Strategy

Figure 4-67 provides a visual summary of restoration opportunities in the watershed.

Engaging Citizens & Watershed Groups

1. Engage property owners in downspout disconnection onto adjacent impervious surfaces or into retrofitted rain barrels at 130 locations as indicated in Table 4-74.
2. Educate property owners about the benefits and importance of rain gardens and Bayscaping, and their positive effects on water quality at the locations indicated in Table 4-74.
3. Take advantage of the opportunity to plant around 50 street trees at the locations indicated in Table 4-74.
4. Encourage and work with homeowners to mark storm drains in their neighborhoods as per Table 4-74.
5. Encourage communities and private landowners to increase the tree canopy of their lots. The opportunity for planting trees exists in the neighborhood indicated in Table 4-74 and at the New Life Ministries, as indicated in Table 4-75.
6. Investigate the pervious area described in Table 4-76 for potential tree planting.
7. Explore the possibility of improving stream buffers in communities and with private landowners identified in Table 4-74.

Municipal Actions

1. Investigate current street sweeping measures at locations indicated in Table 4-74 and increase frequency or implement a program as necessary.
2. Educate the facility managers at New Life Ministries about the importance of proper trash management as indicated in Table 4-75.
3. Conduct follow-up investigations of the two high priority outfalls to find the source(s) of illicit discharges, as described above and in the Watershed Characterization Report (Appendix E).
4. Investigate stream restoration potential at sites in Sawmill Branch as described in Section 3.6.5 of the Watershed Characterization Report (Appendix E).

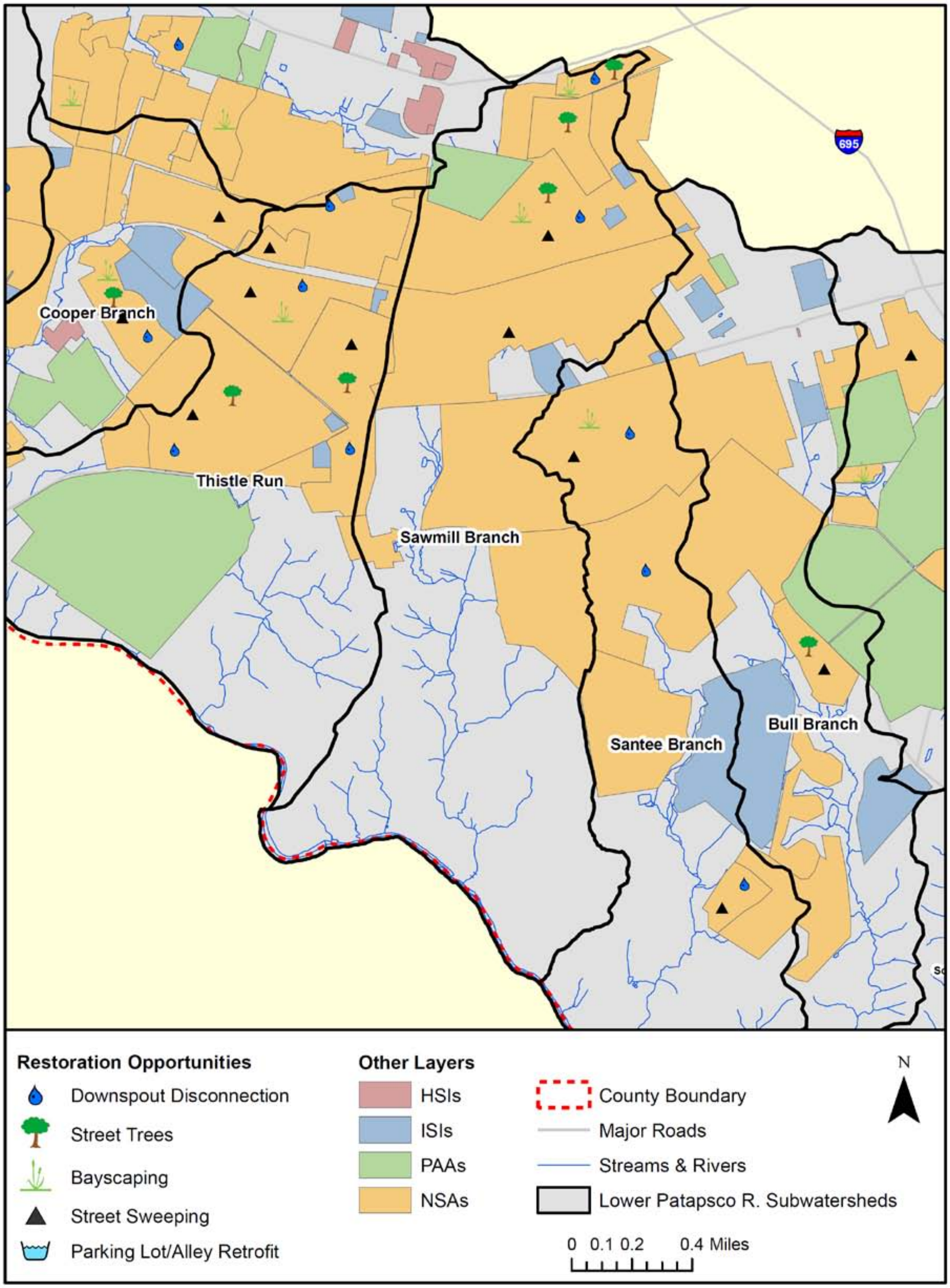

Figure 4-67: Restoration Opportunities in Sawmill Branch

4.4 Watershed-Wide Strategies

Some of the action strategies described in Chapter 3 and Appendix A apply to the entire Lower Patapsco River watershed and were not included under the specific subwatershed management strategies. This is because these actions are recommended for the watershed as a whole in order to be effective and help achieve restoration goals and objectives.

County Strategies: One example of a county action is the work implemented under the 2005 consent decree issued by USEPA and MDE to eliminate sanitary sewer overflows (SSOs). The capital improvement projects, operations improvements, and maintenance programs will result in a reduction of nutrients and bacteria entering streams throughout the entire Lower Patapsco River watershed.

Citizen-based Strategies: Actions associated with citizen awareness and participation also relate to the entire watershed in order to promote a positive perception of the Lower Patapsco River and to effectively meet water quality goals and objectives. Examples of watershed-wide citizen actions include conducting tours of completed water quality BMP and stream restoration projects and encouraging community stream clean-ups.

CHAPTER 5: PLAN EVALUATION

5.1 Introduction

The Lower Patapsco River SWAP is based on a 10-year implementation schedule (2021 endpoint). This timeframe is necessary to implement restoration measures and meet the Chesapeake Bay nutrient TMDL and the Patapsco River bacteria and sediment TMDLs. The ability to implement this plan within the 10-year timeframe is dependent upon the availability of staff and sufficient funding. The Lower Patapsco River SWAP Implementation Committee (an outgrowth of the Steering Committee) will meet twice per year to assess progress in meeting watershed goals and objectives and to discuss funding options. In addition, an annual progress report and a biennial report on water quality monitoring results will be produced. An adaptive management approach will be used to meet watershed goals and objectives based on SWAP evaluation data. Adaptive management will allow the committee to discuss changes to the action schedule depending on the success of individual actions and the overall progress with the plan. As the Phase II Watershed Implementation Plan (WIP) addressing the Chesapeake Bay TMDL is implemented, or if other water quality issues arise, the Lower Patapsco River SWAP Implementation Committee will initiate a revision of the plan within six months of new TMDL approval or when a water quality issue arises.

Progress and success of the Lower Patapsco River SWAP will be evaluated during implementation based on the following: interim measurable milestones, pollutant load reduction criteria, implementation tracking, and monitoring. These evaluation components are described in the following sections.

5.2 Interim Measurable Milestones

Performance measures have been developed for each action listed in Appendix A and will be used to gage the progress and success of proposed restoration strategies. Actions will be organized into two year milestones, with the first interval being July 1, 2011 – June 30, 2013, and the final interval being July 1, 2019 – June 30, 2021. The progress and success of actions in Appendix A will be evaluated on an annual basis. Action strategies may be modified and/or new actions may be proposed based on this annual evaluation. New actions proposed will also be evaluated on an annual basis and modified as necessary to meet watershed goals and objectives.

5.3 Pollutant Load Reduction Criteria

Current pollutant load reduction scenarios and calculations for proposed actions are presented in Chapter 3. These are mainly based on pollutant removal efficiencies used in the Chesapeake Bay Program's (CBP) Phase 5.3 Watershed Model for various nonpoint source BMPs. These pollutant removal efficiencies will continue to be used to measure progress in meeting the TMDL reduction goals (i.e., 29% reduction in Total Nitrogen (TN) loads from urban stormwater discharges). CBP-approved BMP removal efficiencies are summarized in the tables included as Appendix D. Actions and associated pollutant load reductions will be reevaluated if CBP revises/updates pollutant removal efficiencies within the 10-year timeframe to ensure that the nutrient TMDL reductions are met.

5.4 Implementation Tracking

An implementation tracking tool that accounts for all restoration activities is being developed in conjunction with the Baltimore Watershed Agreement to produce a consistent tracking system for use by Baltimore City and Baltimore County governments and local watershed organizations. This tracking tool will also be used by the Lower Patapsco River SWAP Implementation Committee to assess annual progress through a comparison between completed restoration activities and the performance measures detailed in Appendix A. The tracking tool will also provide information regarding pollutant load reductions that have been accomplished through implementation of various restoration projects.

5.5 Monitoring

Baltimore County currently conducts water quality monitoring programs within the Lower Patapsco River watershed. Additional monitoring is anticipated to assess the effectiveness of restoration projects and progress in meeting nutrient TMDL reductions.

5.5.1 Existing Monitoring

Baltimore County conducts chemical, biological, and illicit connection monitoring within the Lower Patapsco River watershed. These are described in detail in Chapter 3.4 of the Lower Patapsco River Watershed Characterization report (Appendix E) and listed below:

- County Recreational Water Sampling Program – 7 sampling locations in freshwater and tidal portions of Patapsco River to measure bacteria levels
- County Baseflow Monitoring Program – 3 sampling locations (Cooper Branch, Bull Branch, and western branch of Herbert Run), measuring baseflows, suspended solids, nutrients, metals, and chloride
- County Biological Monitoring Program – Randomly selected locations in the Lower Patapsco River watershed using characteristics of benthic macroinvertebrates as a water quality indicator
- Illicit Discharge Detection and Elimination Program – Routine outfall screening and prioritization system to track and reduce illicit connections and discharges

5.5.2 SWAP Implementation Monitoring

SWAP implementation monitoring activities will focus on project specific monitoring and targeted subwatershed monitoring. Project specific monitoring will be identified as restoration progresses. It will not be possible to monitor all restoration projects due to the number of actions proposed. Project specific monitoring will target activities with limited data regarding removal efficiencies, such as street sweeping. Subwatershed monitoring will measure overall improvement in water quality as a result of multiple restoration activities within a subwatershed. There is potential to coordinate a citizen-based stream monitoring program, as the County has an active and interested partner in The Friends of Patapsco Valley and Heritage Greenway. The group currently organizes a volunteer "Stream Watch Program", through which members of the community take responsibility for cleaning up trash, and walking streams and reporting any major problems, within their designated areas. Monitoring activities will be coordinated among SWAP participants (Baltimore County and FPVHG) through participation in the Lower Patapsco SWAP Implementation Committee.

CHAPTER 6: REFERENCES

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APPENDIX A:

Lower Patapsco River Watershed Action Strategies

Appendix A

Lower Patapsco River Watershed Action Strategies

This appendix presents the actions related to the goals and objectives presented in Chapter 2 of the Lower Patapsco River SWAP. A complete list of actions proposed for the watershed including timelines, performance measures, unit cost estimates, and responsible parties is included in Table A-1. In many cases, actions relate to multiple goals and objectives, as indicated in the table. Some of the key columns included in Table A-1 are briefly described below.

Goals and Objectives

Overall goals and objectives are listed in Chapter 2 of the SWAP report, and are referred to by number in Table A-1.

Action

Actions developed to achieve watershed goals and objectives are grouped in Table A-1 according to the type of activity. Actions are grouped according to the following categories (and subcategories for restoration actions):

- Restoration Actions
  - Nutrient Reduction
  - Stormwater Management
  - Urban Tree Canopy
  - Trash Management
  - Stream Corridor Restoration
- Outreach & Awareness
- Monitoring
- Funding
- Reporting

Basis for Performance Measure

This column describes how performance measures were developed for each action. Performance measures were developed using the information in this column in conjunction with the action timeline.

Timeline

This column denotes the timeline over which an action will be performed.

Performance Measure

This column describes how the success/completion of a given action will be measured. In many cases, it is the numeric basis of the performance measure divided by the proposed timeline.

Unit Cost

Unit costs are used to develop overall cost estimates for proposed watershed action strategies (see Appendix B).

Partners

Those tasked with a given action are denoted by a numeric code in this column. This does not imply a legal obligation. Partners are indicated by numerals as follows:

1. Baltimore County EPS
2. Friends of Patapsco Valley & Heritage Greenway (FPVHG)
3. Lower Patapsco River SWAP Implementation Committee

Table A-1: Lower Patapsco River Action Strategies

Goal	Objective	Action	Basis for Performance Measure	Timeline	Performance Measure	Unit Cost	Partners
RESTORATION ACTIONS							
Nutrient Reductions							
1 2	1,2 3	Continue municipal road maintenance street sweeping activities; investigate the 32 neighborhoods recommended for street sweeping to implement activities and/or adjust frequency as needed	94.9 miles of road identified; Existing Operations – bulk removal rates reported	On-going	Pounds removed	Existing staff	1
1 8	1 1	Develop a community awareness program which discusses the impacts of nutrients to the watershed, Baltimore Harbor and Chesapeake Bay	Community awareness work plan developed	2 years	Awareness program developed	Existing staff	1, 2
1 4	All 3	Continue to meet the requirements of the consent decree for the elimination of sanitary sewer overflows	Status report	On-going	Status Report	Existing staff	1
Stormwater Management							
1 8 9	1,2 2 2,4	Investigate and convert existing dry detention ponds identified for water quality treatment (among the 48 sites investigated)	16 existing detention ponds identified as having physical expansion capability (rated as Very High and High) x 100% projected participation = 16 conversions	10 years	4 conversions per 2 year period	$3,200 per acre	1
1 8 9	2 2 2,4	Work with institutional partners to reduce impervious cover at the 5 institutional sites identified	Maximum potential of 0.4 acre of impervious cover removal identified x 50% participation rate (assumes 50% of acreage) = removal of 0.20 acres	5 years	1 institution per year	$25,000 per acre	1, 2

Goal	Objective	Action	Basis for Performance Measure	Timeline	Performance Measure	Unit Cost	Partners
1 3 8	2,3,4 1,2 All	Develop and implement a downspout disconnection program; promote redirection of downspouts for downspout disconnection in the 27 recommended neighborhoods	69 acres of impervious rooftop identified x 10% participation rate = 6.9	7 years	Address 1 rooftop acre per year	$152,374/acre	2, 3
1 3 8	1,2 1,2 1	Promote rain barrel and/or rain garden use in the 80 neighborhoods where such actions were recommended	Conduct 16 rain barrel and/or rain garden awareness seminars targeting 5 neighborhoods per event (620 acres of area of impervious rooftop identified x 10% participation rate = 62 acres)	8 years	2 event per year	$500 / event	2, 3
1 4 8 9	1,2 1 2 2,4	Investigate the feasibility of implementing stormwater retrofits to treat runoff from impervious surfaces (parking lots) at the 8 hotspots identified as having retrofit potential	8 Hotspot sites investigated for feasibility of stormwater retrofits	2 years	Feasible retrofit sites identified	Existing staff	1
1 3 4 8 9	1,2 3 1 2 2,4,5	Investigate the feasibility of implementing stormwater retrofits to treat runoff from impervious surfaces (parking lots) at the 21 institutional sites identified	21 Institutional sites identified as being possible for stormwater retrofits	2 years	Feasible retrofit sites identified	Existing staff	1, 2
1 3 8 9	1,2 3 2 2,4,5	Design and implement stormwater retrofits at all feasible sites	21 Institutions + 8 Hotspots x 25% participation rate = 8 stormwater retrofits	4 years	2 retrofits per year	$3,200 per acre	1, 2
1 8 9	All All 2,4	Inspect and maintain stormwater conversions and retrofits	24 conversions + 8 retrofits = 32 projects	10 years	11 inspections per year	Existing staff	1

Goal	Objective	Action	Basis for Performance Measure	Timeline	Performance Measure	Unit Cost	Partners
Urban Tree Cover							
1 3 4 6 7 9	1,2,3 1,2 2 1 3 1,3	Investigate the feasibility of planting riparian stream buffers on open pervious land	632 acres of open pervious land identified within the 100-foot stream buffer through GIS analysis	2 years	Feasible buffer planting sites identified	Existing staff	1, 2
1 3 4 6 7 9	1,2,3 1,2 2 1 3 1,3	Reforest stream buffer at feasible sites with a minimum width of 35 feet	632 acres of open pervious land identified in the GIS analysis x 10% participation rate = 63.2 acres	10 years	Reforest 6.5 acres per year	$15,000 per acre	1,2
1 3 6	1,2,3 3 1	Plant trees on Pervious Area Assessment (PAA) sites, focusing efforts on sites identified as mostly open pervious cover type requiring minimal site preparation; this includes working with MD SHA to plant trees in suitable medians and rights-of-way	186.5 acres of public PAA sites x 50% = 93.3 acres and 20.6 acres of private PAA sites x 50% = 10.3 acres (103.6 total acres combined)	10 years	Reforest 10.4 acres per year	$6,000 per acre	1,2
1 3 6 8	1,2,3 1,2 2,3 1	Encourage street and shade tree planting in the 34 recommended neighborhoods	Maximum potential of 869 trees x (1 acre/100 trees) = 8.7 acres x 33% participation rate = 2.9 acres (or 290 trees)	10 years	Plant 30 trees per year	$175 per tree	1,2,3
1 3 6	1,2,3 3 1	Encourage institutions to plant trees on available open space at the 35 sites identified	Maximum potential of 3,775 trees x (1 acre/100 trees) = 37.8 acres x 66% participation rate = 24.9 acres (or 2,492 trees)	10 years	Plant 250 trees per year	$175 per tree	1,2,3

Goal	Objective	Action	Basis for Performance Measure	Timeline	Performance Measure	Unit Cost	Partners
1 7 9	1,2,3 3 1,3	Baltimore County shall continue to require riparian buffers and forest conservation for all new and re-development	On-going, keep track of existing riparian buffer and forest preserved	On-going	Acres preserved	Existing staff	1
1 6 7 8	1,2,3 1,2,3 1,2,3 1	Maintain trees planted at reforestation/tree planting sites	Tree maintenance (watering, mowing, weeding, etc.) is required for the first 5 years to ensure successful growth; projected number of acres to be reforested = 139.3 acres	5 years	Maintain 139.3 acres per year	$1300 per acre per year	1,2,3
3 7	1,2 1,2,3	Improve forest habitat by organizing exotic invasive species removal activities every year	Organize 1 exotic species removal activity addressing 1 acre per year	10 years	Exotic species removed from 1 acre per year	$500 per year	2
1 7 9	1,2 3 3	Support the state's No-Net-Loss of Forest Policy	On-going, keep track of existing forest coverage; prioritize forest conservation; off-set all forest losses	On-going	Stabilization of the rate of loss by 2020 with the goal of maintaining the County's existing forest coverage	Existing staff	1
Trash Management							
1 2 4 8	4 All 3 1	Develop a trash and litter management work plan	Work plan developed	2 years	Plan completed	Existing staff	1
1 2 4 8	4 All 3 2	Investigate hotspots and institutions identified as having trash management related problems and identify areas where additional trash cans, covered receptacles, and/or better maintenance measures are needed; enforce additional measures and better maintenance where necessary	15 hotspots and 5 institutions with trash management problems identified, schedule site visits to discuss/review trash management solutions	5 years	Perform 4 site visits per year	Existing staff	1

Goal	Objective	Action	Basis for Performance Measure	Timeline	Performance Measure	Unit Cost	Partners
2	1,3,4	Implement recycling and add separate receptacles for recycling on public properties such as parks and county-owned golf courses	Add recycling receptacles at public parks, county-owned golf courses, and other feasible sites	5 years	Recycling implemented at feasible sites	Existing staff	1
2 8	1,3 1	Post no dumping signs in problem areas identified and enforce no dumping	Signs posted at 15 hotspots, 5 institutions, and 5 neighborhoods (25 locations total) identified as having trash management/dumping issues	2 years	Post 15 signs per year	$40 per sign	1
		Stream Corridor Restoration					
1 4	2 1,2,	Evaluate the restoration potential and feasibility of restoring eroded stream banks and channel alterations identified in the stream corridor assessments	Identify feasible restoration projects within the 40.5 miles of stream with eroding/unstable banks	2 years	Feasible restoration projects identified	Existing staff	1
1 3	All 3	Conduct a follow up inspection of the outfalls rated as potentially severe or severe-moderate issues identified during outfall screening in the Illicit Discharge and Elimination Program	1 outfall locations rated as Priority 1 (Critical) and 11 outfall locations rated as Priority 2 (High) = 12 locations total	3 years	Conduct 4 inspections per year	Existing staff	1
1 4 8	2,4 1,3,4 1	Complete stream restoration projects recommended in TetraTech's Patapsco River Watershed Water Quality Management Plan	Stabilize and restore 33% (4.4 miles) of unstable streams in the Lower Patapsco River watershed to provide water quality improvement	10 years	2,323 Ln ft per year	$350 / Ln ft	1
		OUTREACH & AWARENESS					
1 2 4 8 9	2,4 1,3,4 2,3 1,2 1,2,4	Distribute pollution prevention information to facilities falling within hotspot categories identified in the watershed and provide guidance/workshops; include working with business partners to cut off stream access in areas with dumping issues and encourage them to keep parking lots free of trash and debris	28 potential hotspot sites assessed; Categories identified: Business centers, industrial services, and commercial services; Conduct 4 workshops and distribute outreach material	6 years	Conduct 1 workshop every 18 months	$500 /workshop	1,2,3

Goal	Objective	Action	Basis for Performance Measure	Timeline	Performance Measure	Unit Cost	Partners
1 6 8	1 2,3 1,2	Develop a community outreach campaign to raise awareness about homeowner actions aimed towards nutrient reduction	Publicize several actions in E-News Stream and other media, and at environmental events	On-going	4 announcements per year	Existing staff	1,2,3
1 2 6 8 9	All All 1 1 2,4,5,6	Form partnerships with institutions and discuss the best management practice (BMP) recommendations from the institutional assessments and implementation options; include implementing/enhancing recycling programs on their properties	20 institutions assessed with potential for stormwater management retrofit	5 years	4 institution meetings per year	Existing staff	1,3
1 2 3 8	All 3 1,2 1,2	Work with community groups to install storm drain markers in the 81 recommended neighborhoods.	Mark storm drains in 20 of the 81 potential neighborhoods identified	10 years	2 neighborhoods per year	$400 /neighborhood	2,3
1 2 3 8	All 3 1,2 1,2	Work with the institutional sites to install storm drain markers at the 14 recommended sites	Mark storm drains at the 14 institutional sites identified	7 years	2 institutions per year	$400 /institution	1,2,3
2 3 5 8	All All 2 All	Develop and implement signs and educational material for a recycling campaign in the watershed	Develop signs and post throughout watershed	3 years	Develop material, post signs	Existing staff	1,3
2 3 5 8	All All 2 1	Implement trash and litter management work plan	Submit in the NPDES Report the progress toward implementing the trash and litter work plan	5 years	Annual	Existing staff	1

Goal	Objective	Action	Basis for Performance Measure	Timeline	Performance Measure	Unit Cost	Partners
1 2 3 5 8	4 All 1,3 2 1	Encourage institutional partners, community groups, and patrons of public properties to sign and support a trash treaty (a pledge to implement strategies aimed at reducing litter and promoting awareness on the effects of pollution)	Have sign-up events	10 years	1 sign-up event per year	Existing staff	1,3
2 3 8	All 1,2 1	Encourage and support community cleanups in the 5 neighborhoods identified	5 neighborhoods identified as having trash management issues	5 years	1 community cleanup per year	Existing staff	1,2,3
1 2 3 4 5 8	4 3 1,2 1,3 All 1	Encourage and support waterway cleanups in streams	Conduct at least three waterway cleanups per year; cost includes supplies and tire removal	10 years	3 waterway cleanups per year	$1000 per cleanup	1,2,3
3 8 9	1,3 All 2,4,5	Conduct a tour of a completed water quality project/BMP on public property	Conduct two tours of completed watershed restoration projects (e.g., stormwater retrofit, stormwater conversion)	10 years	1 tour per 5 years	Existing staff	1
3 5 6 8	3 All 4 1	Using various media, develop and distribute information about public access points along the Lower Patapsco River for recreational purposes	Distribute information to the public on access points.	10 years	1 per year	Existing staff	1,2,3

Goal	Objective	Action	Basis for Performance Measure	Timeline	Performance Measure	Unit Cost	Partners
1 2	1,2 1	Encourage lawn reduction and promote Bayscaping in the 21 neighborhoods identified	Conduct 15 Bayscaping awareness events targeting 5 recommended neighborhoods per event (167 acres of lawn identified for Bayscaping x 5% participation rate = 8.4 acres)	5 years	1 event every 18 months	$500 per event	2,3
MONITORING							
1 4	All 3	Continue to remove illicit connections when discovered through the Illicit Connect Program	As per NPDES Permit, perform 150 screenings county-wide per year	On-going	Reported annually in NPDES Permits	Existing staff	1
1 4	All 3	Continue the illicit connection monitoring at the major outfalls in the watershed and complete one inspection at each of the minor outfalls	71 major outfall locations and 188 minor outfall locations = 259 outfall inspections	10 years	26 outfalls per year	Existing staff	1
1 2 3 4 8	All 1,2,3 2 All 1	Continue to implement the citizen-based stream watch program to increase the ability to monitor/identify sources of water quality and habitat degradation	Promote watershed awareness and additional identification on sources of impairment, and potential restoration locations	10 years	Number of stream watcher volunteers	Existing staff	1,2,3
1 4 8 9	1,2,4 2,3 1 2,4	Conduct periodic inspection of BMPs and provide on-going maintenance to assure their continued proper functioning	Assure that each facility is inspected every 3 years	On-going	Inspections completed	Existing staff	1
4 8	1,3,4 1	Continue probabilistic biological monitoring program	Biological monitoring stations in the Lower Patapsco River watershed are monitored in odd-numbered years – report produced	Odd-numbered years	Stations monitored, report produced	Existing staff	1

Goal	Objective	Action	Basis for Performance Measure	Timeline	Performance Measure	Unit Cost	Partners
1 3 8 9	All 3 1,2 2,3,4,5	Work with teachers to develop meaningful watershed environmental education (MWEE) activities for students at Baltimore County public schools	3 public schools identified as having education opportunities for possible BMP monitoring (among other potential action opportunities at these sites)	10 years	1 school every 3 years	Existing staff	2,3
FUNDING							
1 3 6 9	1 All 1,2,3 1,4	Coordinate grant funding requests to secure funding and implement restoration projects to meet TMDL nutrient reduction requirements	Seek a minimum of 1 grant per year to meet the TMDL requirements within 10 years	10 years	1 grant proposal per year	Existing staff	3
1 3 8 9	1,2 1 2 4,5	Increase applications for the Baltimore County – Green Building Tax Credit Program	Provide incentive for landowners to install BMPs to address water quality and habitat	5 years	# of applications	Existing staff	3
REPORTING							
All	All	Lower Patapsco River SWAP Implementation Committee will meet to discuss implementation progress and assess any changes needed to meet the goals	Meet on a semi-annual basis	10 years	2 meetings per year	Existing staff	3
All	All	Coordinate restoration activities between and among Baltimore County and FPVHG	Documented in NPDES annual report	On-going	NPDES annual report	Existing staff	1,2
1	1,3,4	Designate county personnel to provide updates to the SWAP Implementation Committee on the status of the consent decree projects for sewer infrastructure repair	Present updates at the semi-annual SWAP Implementation Committee meetings	10 years	2 meetings per year	Existing staff	1
All	All	Produce State of Our Watersheds report	Report is produced bi-ennially	2 years	Report is produced every 2 years	$11,000 per 2 years	1

Goal	Objective	Action	Basis for Performance Measure	Timeline	Performance Measure	Unit Cost	Partners
All	All	Implement a unified restoration tracking system to track progress toward meeting TMDL reduction requirements	Tracking systems currently being developed for similar SWAPs (e.g., Tidal Back River, Upper Gwynns Falls, etc.)	2 years	Tracking system developed	Existing staff	3
1 2 3 6 8	All All All All All	Update the status of citizen-based restoration projects and BMPs	Provide update of progress made in annual NPDES report	On-going	NPDES annual report	Existing staff	1,2
1 3 4 6 5 6 9	All 3 All All All All 5,6	Continue to update status of county capital budget restoration projects and BMPs	Provide update of progress made in annual NPDES report	On-going	NPDES annual report	Existing staff	1

APPENDIX B:

U.S. Environmental Protection Agency
A Through I Criteria for Watershed Planning

Appendix B

U.S. Environmental Protection Agency
A Through I Criteria for Watershed Planning

Background

EPA's Section 319 Grant program was established to provide funding for efforts to reduce nonpoint source (NPS) pollution, including that which occurs though stormwater runoff. The EPA provides funds to state and tribal agencies, which are then allocated via a competitive grant process to organizations to address current or potential NPS concerns.

Section 319 funds may be used to demonstrate innovative best management practices (BMPs), support education and outreach programs, establish TMDLs for a watershed, or to restore impaired streams or other water resources. 303(d) listed waters approved by the EPA are the top priority for incremental funds.

The EPA requires that nine elements (labeled "a" though "i") be included in a watershed plan for impaired waters funded using Section 319 funds. Although there is no formal requirement for EPA to approve watershed plans, the plans must address the nine elements discussed below if they are developed in support of a section 319-funded project (EPA 2009). Below, we review how the development of the Lower Patapsco Small Watershed Action Plan addresses each of the nine elements.

Addressing the Nine Elements for the Lower Patapsco Watershed

The County's progress in addressing the nine elements ("a" thru "i") required for 319 funding is described below:

a) ***Causes of Impairment:*** *Identification of causes of impairment and pollutant sources or groups of similar sources that need to be controlled to achieve needed load reductions, and any other goals identified in the watershed plan. Sources that need to be controlled should be identified at the significant subcategory level along with estimates of the extent to which they are present in the watershed.*

This element will usually include an accounting of the significant point and nonpoint sources in addition to the natural background levels that make up the pollutant loads causing problems in the watershed. If a TMDL exists, this element may be adequately addressed. (EPA 2008)

Impairments to Chesapeake Bay are well recognized and are being addressed by multiple agency efforts under the Chesapeake Bay TMDL for nitrogen, phosphorus, and sediment. Several watershed-specific impairments have also been listed for the area covered by the

Lower Patapsco SWAP. The causes of impairment are well understood for the Patapsco River Lower North Branch (LNB), listed in the Maryland 303(d) list of impaired waters for various pollutants of concern including: total suspended solids (1996 listing), fecal coliform (2008 listing), polychlorinated biphenyls in fish tissue (PCBs, 2008 listing), chlorides (2010 listing), and sulfates (2010 listing). In addition, the Baltimore Harbor is listed as impaired for nutrients phosphorus and nitrogen, whose source includes the Patapsco LNB watershed. In addition to the Bay TMDL, three watershed-specific TMDLs (fecal coliform, TSS, nitrogen/phosphorus) have been submitted and or approved by USEPA and two WQAs have been completed (heavy metals & phosphorus). TMDLs or WQAs will be developed at some point in the future for PCBs, chlorides, sulfates, and biological impairment listings.

Section 1.3.1 of the SWAP contains further information on TMDLs. Chapter 3 of the Characterization Report includes estimates of pollutant loads. Copies of TMDLs are included in Appendix J.

b) ***Estimate Load Reductions:*** *On the basis of the existing source loads estimated for element "a" above, you will similarly determine the reductions needed to meet the water quality standards. You will then identify various management measures (see element "c" below) that will help to reduce the pollutant loads and estimate the load reductions expected as a result of these management measures to be implemented, recognizing the difficulty in precisely predicting the performance of management measures over time. In cases where a TMDL for affected waters has already been developed and approved or is being developed, the watershed plan should be crafted to achieve the load reductions called for in the TMDL.* (EPA 2008)

Expected nitrogen and phosphorus load reductions were calculated based on the EPA - Chesapeake Bay Program load reduction criteria used in their Phase 5.3 model. These load reduction criteria are presented in Appendix D. The nitrogen, phosphorus, and sediment load reductions for the various proposed actions in Lower Patapsco were calculated and summarized in Chapter 3 of the SWAP.

The TMDLs for TSS, fecal coliform and nitrogen/phosphorus provide required load reductions for these 4 parameters. TMDLs are provided in Appendix J of the Characterization Report. Estimated load reductions needed are as follows:

- Reduce annual average sediment loadings to the Lower Patapsco SWAP area by 18.2% compared to the loading estimated for the baseline period to meet the requirements developed by the Patapsco watershed sediment TMDL analysis.
- Reduce annual average bacteria to the Lower Patapsco SWAP area by 16% compared to the loading estimated for the baseline period to meet the requirements developed by the Patapsco watershed TMDL analysis.
- Improve water quality to the point where the Lower Patapsco will be safe for recreation

- Reduce annual average Total Nitrogen (TN) and Total Phosphorus (TP) loadings to the Lower Patapsco SWAP area by 29% and 45.1%, respectively, compared to the loadings estimated for the baseline period to meet the requirements developed by the Chesapeake Bay TMDL analysis.

CBP-approved BMP removal efficiencies are summarized in the tables included as Appendix D. These pollutant removal efficiencies will continue to be used to measure progress in meeting the nutrient TMDL reduction goal. Actions and associated pollutant load reductions will be reevaluated if CBP revises/updates pollutant removal efficiencies within the 10-year timeframe to ensure that the TMDL reductions are met.

c) ***Description and location of NPS management measures:*** *A description of the NPS management measures that will need to be implemented to achieve load reductions, and a description of the critical areas in which those measures will be needed to implement this plan. This description should be detailed enough to guide implementation activities and can be greatly enhanced by identifying on a map priority areas and practices.* (EPA 2008)

This Small Watershed Action Plan, by definition, identifies strategies for bringing a small watershed into compliance with water quality criteria. The strategies employed in this SWAP include a combination of government capital projects, actions in partnership with local watershed associations, citizen awareness campaigns and volunteer activities. Chapter 3 summarizes restoration strategies / NPS management measures. Specifically, information on the achievement of the phosphorus and nitrogen reduction goals is provided in Section 3.4. Chapter 4 specifies implementation locations, by subwatershed, detailing management measures recommended for each subwatershed in the SWAP study area. The management measures that will need to be implemented to achieve the goals are detailed further in Appendix A.

Note that the projected, practicable implementation of proposed restoration BMPs, shown in Table 3-17, will not meet the 29 percent reduction for nitrogen, 45.1 percent reduction for phosphorus, and 25.1 percent reduction for sediment loads needed to meet water quality standards for the Lower Patapsco watershed as specified by Chesapeake Bay TMDL for nutrients and the Lower Patapsco TMDL for sediment (Appendix E).

There is the opportunity to achieve greater reductions if restoration BMPs are implemented to a greater extent than those assumed by the projected participation factors (See Table 3-16). Greater reductions may also be achieved through restoration actions not included in this analysis such as public education/outreach efforts (e.g., watershed trash and recycling campaign and tours of completed projects). However, these types of actions are not included in the pollutant removal analysis because reductions efficiencies are not well known and difficult to estimate.

d) ***Estimate of the amounts of technical and financial assistance*** *needed associated costs, and/or the sources and authorities that will be relied upon to implement this plan. This includes implementation and long-term operation and maintenance of* *management measures, information/education activities, monitoring, and evaluation activities. You should also document which relevant authorities might play a role in implementing the plan. Plan sponsors should consider the use of federal, state, local, and private funds or resources that might be available to assist in implementing the plan. Shortfalls between needs and available resources should be identified and addressed in the plan. The estimate of financial and technical assistance should take into account the following* (EPA 2008)*:*

- *Administration and management services, including salaries, regulatory fees, and supplies, as well as in-kind services efforts, such as the work of volunteers and the donation of facility use;*
- *I/E efforts;*
- *The installation, operation, and maintenance of management measures; and*
- *Monitoring, data analysis, and data management activities.*

Appendix A details the anticipated cost for each action on an annual or unit basis and details the organizations that will be responsible for implementation of the each action. Appendix C provides a cost analysis and anticipated funding sources to implement the actions.

Baltimore County's NPDES program generally, as well the program infrastructure needed to implement this SWAP, is already well-established as demonstrated by previously completed technical Water Quality Management Plans, such as the 2000 Patapsco Plan, which this effort builds upon. Additionally, Lower Patapsco River watershed partners have worked together over the past year, conducting assessments, identifying restoration opportunities, and engaging the community, in order to build a successful SWAP.

A Lower Patapsco Steering Committee, consisting of various watershed partners, was formed to develop the Lower Patapsco SWAP. This includes Baltimore County EPS and Department of Planning personnel, Friends of Patapsco Valley and Heritage Greenway, staff from Maryland Department of Natural Resources, and a stakeholder representative from the Community College of Baltimore County (Catonsville) and concerned citizens. The Steering Committee met regularly throughout the SWAP development and will form the basis for a similar group to carry out SWAP implementation.

e) ***An information and education component*** *used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the NPS management measures that will be implemented*. (EPA 2008)

The participation of citizens in watershed restoration is an essential part of the SWAP process. Citizen participation is critical to the implementation and long-term maintenance of restoration activities. Three citizen stakeholder meetings were held as part of the SWAP process (see Chapter 1). Key citizen-based strategies proposed for restoring Lower Patapsco River including nutrient management, lawn maintenance education, Bayscaping, downspout disconnection, tree planting, stream buffer management (see Chapter 3). This demands continued participation by citizen stakeholders. Specific strategies by subwatershed which include an information and education component are detailed in Chapter 4. Outreach and awareness components by action are detailed in Appendix A.

*f) **Schedule for implementing the NPS management measures** identified in this plan that is reasonably expeditious. The schedule should reflect the milestones you develop in measure "g".* (EPA 2008)

Each action strategy listed in Appendix A has a timeline and where appropriate, a temporal performance measure. It is anticipated that the restoration will require a 10-year timeframe. Some actions have a shorter time frame based on sequencing of actions, or on the urgency of the actions. However, most management measures have annual performance measures that will determine if the restoration is on pace to be completed within the time frame. The limitations on the pace of the implementation include staffing, and funding. Increases in staffing and funding will be used to accelerate the restoration timeline. Chapter 5 presents an adaptive management approach to implementation.

*g) **A description of interim measurable milestones** for determining whether NPS management measures or other control actions are being implemented. These milestones will measure the implementation of the management measures, such as whether they are being implemented on schedule, whereas element h (see below) will measure the effectiveness of the management measures, for example, by documenting improvements in water quality. (EPA 2008)*

Actions will be organized into two year milestones, with the first interval being July 1, 2011 - June 30, 2013, and the final interval being July 1, 2019 – June 20, 2021. Additionally, most action strategies (listed in Appendix A) have an associated time-sensitive performance measure. Additionally each will be evaluated on an annual basis and may be modified and/or new actions may be proposed based on this annual evaluation. New actions proposed will also be evaluated on an annual basis and modified as necessary to meet watershed goals and objectives and if new TMDLs are approved.

Chapter 5 provides a plan for evaluation of NPS management measures implementation. This includes formation of The Lower Patapsco River SWAP Implementation Committee which will meet twice per year to assess progress in meeting watershed goals and objectives and generation of an annual progress report. A biennial report on water quality monitoring results will be produced as well.

Additionally, an implementation tracking tool that accounts for all restoration activities is being developed in conjunction with the Baltimore Watershed Agreement to produce a consistent tracking system for use by Baltimore City and Baltimore County governments and local watershed organizations as part of the Upper Back River SWAP. This tracking tool will also be used by the Lower Patapsco River SWAP Implementation Committee to assess annual progress through a comparison between completed restoration activities and the performance measures detailed in Appendix A. The tracking tool will also provide information regarding pollutant load reductions that have been accomplished through implementation of restoration projects.

h) ***A set of criteria that can be used to determine whether loading reductions are being achieved*** *over time and substantial progress is being made toward attaining water quality standards (WQS). The criteria in element h (not to be confused with water quality criteria in state regulations) are the benchmarks or waypoints to measure against through monitoring. These interim targets can be direct measurements (e.g., fecal coliform concentrations) or indirect indicators of load reduction (e.g., number of beach closings). You should also indicate how you'll determine whether the watershed plan needs to be revised if interim targets are not met. (EPA 2008)*

Appendix A gives a "performance measure" which describes how the success/completion of a given action will be measured. In many cases, it is the numeric basis of the performance measure divided by the proposed timeline.

Current pollutant load reduction scenarios and calculations for proposed actions are presented in Chapter 3. These are mainly based on pollutant removal efficiencies used in the Chesapeake Bay Program's (CBP) Phase 5.3 Watershed Model for various nonpoint source BMPs. These pollutant removal efficiencies will continue to be used to measure progress in meeting the nutrient TMDL reduction goals. Actions and associated pollutant load reductions will be reevaluated if CBP revises/updates pollutant removal efficiencies within the 10-year timeframe to ensure that the nutrient TMDL reductions are met.

As mentioned in element "g" above, the Lower Patapsco River SWAP Implementation Committee will generate a biennial report on water quality monitoring results and action strategies will be modified as required to respond to a lack of substantial progress and/or new TMDL.

i) ***A monitoring component*** *to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item h immediately above. The monitoring component should be designed to determine whether loading reductions are being achieved over time and substantial progress in meeting water quality standards is being made. (EPA 2008)*

Chapter 5 details the monitoring that will occur to evaluate the effectiveness of implementation. The monitoring results will be compared to the predicted load reductions determined under item (h), above. Baltimore County conducts chemical, biological, and illicit connection monitoring within the Lower Patapsco River watershed which are appropriate for measuring changes in loading. Additional monitoring is anticipated in order to assess the effectiveness of restoration projects and progress in meeting nutrient TMDL reductions. Current applicable monitoring is described in detail in Chapter 3.4 of the Watershed Characterization Report (Appendix E) and listed below:

- County Baseflow Monitoring Program – 3 sampling locations (Cooper Branch, Bull Branch, and western branch of Herbert Run), measuring baseflows, suspended solids, nutrients, metals, and chloride
- County Recreational Water Sampling Program - 7 sampling locations in freshwater and tidal portions of Patapsco River to measure bacteria levels
- County Biological Monitoring Program – Randomly selected locations in the Lower Patapsco River watershed using characteristics of benthic macroinvertebrates as a water quality indicator
- Illicit Discharge Detection and Elimination Program – Routine outfall screening and prioritization system to track and reduce illicit connections and discharges

Project specific monitoring will be identified as restoration progresses. It will not be possible to monitor all restoration projects due to the number of actions proposed. Project specific monitoring will target activities with limited data regarding removal efficiencies such as lawn care education. Subwatershed monitoring will measure overall improvement in water quality as a result of multiple restoration activities within a subwatershed. This will also be developed as restoration progresses.

Monitoring activities will be coordinated among SWAP participants (e.g., Baltimore County, Maryland DNR, and FPVHG) through participation in the Lower Patapsco SWAP Implementation Committee. There is potential to coordinate a citizen-based stream watch program since the existing water quality monitoring stations are limited in the Lower Patapsco watershed.

APPENDIX C:

Cost Analysis and Potential Funding Sources

APPENDIX C:

Cost Analysis and Potential Funding Sources

This appendix presents cost estimates and potential funding sources for the implementation of proposed restoration BMPs in the Lower Patapsco River SWAP. Each is described below. The cost analysis is based on the actions detailed in Appendix A. Cost estimates are summarized in Tables C-1 and C-2.

Table C-1 presents cost estimates based on the maximum implementation scenario described in Chapter 3. Table C-2 presents costs estimates based on the projected participation rates needed to achieve the reduction in nutrient loads and sediment from urban runoff, also described in Chapter 3.

For both scenarios, estimates provided are in current dollars and represent total cost estimates for the anticipated 10-year implementation timeframe. Unit costs are based on a combination of local information and previous SWAPs completed for other local watersheds (e.g., Upper Back River, Tidal Back River, and Upper Gwynns Falls). BMP costs are not annualized over the 10-year implementation timeframe and do not include costs of existing staff. Costs are also presented in dollars per pound of nitrogen, phosphorus and TSS removal for those BMPs where pollutant removal calculations were possible (refer to Chapter 3). This provides an additional tool for the assessment and selection of BMPs.

The total cost of implementation exclusive of staffing costs is approximately **$54,397,664** for maximum implementation and **$30,642,091** based on projected participation rates. This does not include cost associated with sanitary sewer overflow prevention.

Potential Funding Sources

Funding sources for the implementation of the Lower Patapsco River SWAP include local government funding for Baltimore County, monetary and time contributions to the Lower Patapsco River SWAP Implementation Committee, and various grants as described below. Baltimore County uses general funds to support staff, whose responsibility is to monitor and improve water quality through implementation of various programs including capital restoration projects. Baltimore County has a Waterway Improvement Capital Program that is funded by a combination of general funds and bonds. Approximately $4 million per year is allocated for various restoration projects throughout the county. The capital budget is projected for six years, with a two-year cycle for changes. The Lower Patapsco River watershed as a whole currently has $1.1 million allocated for restoration projects over the six-year period. Baltimore County provides grants to local watershed organizations through its Watershed Association Citizen Restoration Planning and Implementation Grant Program. These funds provide staffing for restoration project implementation and education and outreach programs.

In order to implement all of the actions listed in Appendix A and to meet the anticipated funding needs summarized in Table C-2, additional funding from grants will be required. Table C-3 presents potential funding sources to support the implementation of the Lower Patapsco River SWAP including funding source, applicant eligibility, eligible projects, funding amount, cost share requirements, and grant cycle. The anticipated major grant funding sources include the following:

- **The Chesapeake and Atlantic Coastal Bays Trust Fund (Trust Fund):** Established during the 2008 Legislative Session by Senate Bill 213 to provide financial assistance to local governments and political subdivisions for the implementation of nonpoint source pollution control projects. These are intended to achieve the state's tributary strategy developed in accordance with the Chesapeake 2000 Agreement and to improve the health of the Atlantic Coastal Bays and their tributaries. The BayStat Program directs the administration of the Trust Fund, with multiple state agencies receiving moneys from the Trust Fund, including Maryland Department of Environment (MDE), Department of Natural Resources (DNR), Maryland Department of Agriculture (MDA), and Maryland Department of Planning (MDP).

- **319 Non-point Pollution Grants:** Approximately $1,000,000 of federal money for restoration implementation is available annually through MDE.

- **Bay Restoration Fund (MDE):** The Bay Restoration Fund offers financial assistance to local governments for voluntary stream and creek restoration projects that improve water quality and restore habitat. Funds are targeted to seriously degraded water bodies in Maryland. Types of projects funded include: stream channel reconstruction, stream bank stabilization, vegetative buffers, wetlands creation, treatment of acid mine drainage, and dredging.

- **Stormwater Pollution Control Cost Share Program (MDE):** The Maryland Stormwater Pollution Control Cost-Share Program provides grant funding for stormwater management retrofit and conversion projects in urban areas developed prior to 1984. These projects reduce nutrients, sediments and other pollutant loads entering the state's waterways through the use of infiltration basins, infiltration trenches, vegetated swales, extended detention ponds, bioretention basins, wetlands and other innovative structures.

- **Innovative Nutrient and Sediment Reduction Program (National Fish and Wildlife Foundation):** The National Fish and Wildlife Foundation (NFWF), in partnership with U.S. Environmental Protection Agency (USEPA) and the Chesapeake Bay Program, will award grants on a competitive basis of between $200,000 and $1,000,000 each to support the demonstration of innovative approaches to expand the collective knowledge about the most cost effective and sustainable approaches to dramatically reduce or eliminate nutrient and sediment pollution to the Chesapeake Bay and its tributaries.

- **Chesapeake Bay Stewardship Fund:** The goal of the Chesapeake Bay Stewardship Fund is to accelerate local implementation of the most innovative, sustainable and cost effective strategies to restore and protect water quality and vital habitats within the Chesapeake Bay watershed. The Stewardship Fund offers four grant programs: the Chesapeake Bay Small Watershed Grant Program, the Chesapeake Bay Targeted Watersheds Grant Program, the Chesapeake Bay Conservation Innovation Grant Program and the Innovative Nutrient and Sediment Reduction Program. Major funding for the Chesapeake Bay Stewardship Fund comes from the USEPA, the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS), and the U.S. Department of Administration (NOAA).

- **MD State Highway Administration (SHA) Transportation Enhancement Program (TEP):** This is a reimbursable, federal-aid funding program for transportation-related community projects designed to strengthen the intermodal transportation system. The TEP supports communities in developing projects that improve the quality of life for their citizens and enhance the travel experience for people traveling by all modes. Among the qualifying TEP categories is environmental mitigation to address water pollution due to highway runoff or to reduce vehicle-caused wildlife mortality while maintaining habitat connectivity.

- **Chesapeake Bay Trust:** Provides grants through a variety of grant programs that focus on environmental education, urban greening, fisheries, and remediation of water quality issues. Specifically the Targeted Watershed Grant Program provides funding for on-the ground solutions that address the most pressing nonpoint source pollution challenges facing a small watershed, and that result in measurable improvements in water quality and wildlife habitat. The program also seeks to support cost effective approaches to Chesapeake Bay restoration actions at the small watershed scale and establish a replicable model of restoration that can be transferred and used throughout the region.

Table C-1. Maximum Estimated Costs for Lower Patapsco SWAP Implementation

BMP or Action	Cost	Unit	Projected	Quantity	Proj. Total Cost	Proj. TN Load Reduction (lbs/year)	Proj. Cost/ lb of TN Removal*	Proj. TP Load Reduction (lbs/year)	Proj. Cost/Lb of TP Removal*	Proj. TSS Load Reduction (lbs/year)	Proj. Cost/lb of TSS Removal*
Dry pond Conv.	$3,200	/acre	614.8	Acres	$1,967,360	859	$2,290	28	$70,263	153,906	$13
Stormwater Retrofits: Bioretention	$3,200	/acre	18.3	Acres	$58,560	57	$1,027	8.65	$6,770	12,501	$5
Stream Buffer Reforestation (pervious areas)	$15,000	/acre	632	Acres	$9,480,000	4,715	$2,011	221	$42,896	252,800	$38
Pervious Area Reforestation	$6,000	/acre	207	Acres	$1,242,000	1,069	$1,162	31.07	$39,974	12,447	$100
Stream Corridor Restoration	$350	/Linear foot	70,524	Linear feet	$24,683,400	2,549	$17,506	446	$99,933	324,992	$137
Downspout Disconnection	$152,374	/acre	106	Acres	$16,151,644	532	$30,360	67	$241,069	105,302	$153
Neighborhood Tree Plantings	$175	/tree	869	Trees	$152,075	45	$3,379	1.3	$116,981	530	$287
Institution Tree Plantings	$175	/tree	3,775	Trees	$660,625	195	$2,288	5.66	$116,718	2,303	$287
Bayscaping Education	$500	/event	4**	Events	$2,000	12.42	$161	4.5	$444	-	-
Street Sweeping	***	/mile	95	Miles	***	332	***	129	***	9,920	***
				Total:	**$54,397,664**						

* This projected cost is for the first year. Cost per pound removed decreases for every subsequent year the device is functioning.
** @31.8 acres drainage area per event, on average. 127 acres /4 events = 31.8 acres
*** Street sweeping does not add to the cost of the SWAP Implementation. It is assumed that existing Baltimore County staff would be responsible for the action, and therefore not additional cost would be incurred.

Table C-2. Projected Estimated Costs for Lower Patapsco SWAP Implementation

BMP or Action	Cost	Unit	Projected	Quantity	Proj. Total Cost	Proj. TN Load Reduction (lbs/year)	Proj. Cost / Lb of TN Removal*	Proj. TP Load Reduction (lbs/year)	Proj. Cost/Lb of TP Removal*	Proj. TSS Load Reduction (lbs/year)	Proj. Cost/lb of TSS Removal*
Dry pond Conv.	$3,200	/acre	614.8	Acres	$1,967,360	859	$2,290	28	$70,263	153,906	$13
Stormwater Retrofits: Bioretention	$3,200	/acre	9.2	Acres	$29,280	28.5	$1,027	4.33	$6,770	6,251	$5
Stream Buffer Reforestation (pervious areas)	$15,000	/acre	410.8	Acres	$6,162,000	3,064.75	$2,011	143.65	$42,896	164,320	$38
Pervious Area Reforestation	$6,000	/acre	103.5	Acres	$621,000	534.5	$1,162	15.535	$39,974	6,224	$100
Stream Corridor Restoration	$350	/Linear foot	52,893	Linear feet	$16,044,210	1,057.5	$17,506	185.3	$99,933	134,877	$137
Downspout Disconnection	$152,374	/acre	34.98	Acres	$5,330,043	175.56	$30,360	22.11	$241,069	34,750	$153
Neighborhood Tree Plantings	$175	/tree	286.77	Trees	$50,185	14.85	$3,379	0.429	$116,981	175	$287
Institution Tree Plantings	$175	/tree	2491.5	Trees	$436,013	128.7	$2,288	3.736	$116,718	1,727	$287
Bayscaping Education	$500	/event	4**	Events	$2,000	9.94	$161	3.6	$444	-	-
Street Sweeping	***	/mile	95	Miles	***	332	***	129	***	9920	***
				Total:	**$30,642,091**						

*This projected cost is for the first year. Cost per pound removed decreases for every subsequent year the device is functioning.
** @31.8 acres drainage area per event, on average. 127 acres /4 events = 31.8 acres
Projections for participation can be found in Table 3-16: Projected Participation Factors
***Street sweeping does not add to the cost of the SWAP Implementation. It is assumed that existing Baltimore County staff would be responsible for the action, and therefore not additional cost would be incurred.

Table C-3: Tidal Back River SWAP Potential Funding Sources

Managing Agency	Funding Source	Application Eligibility	Eligible Projects	Funding Amount	Cost Share / In – Kind	Project Period
American Forests	Global ReLeaf Program (American Forests)	All public lands or public accessible lands Local government State government	Public Lands Restoration Projects which include local organizations; use innovative restorative practices with potential for general application; minimum 20 acre project area	$1 per tree planted	Covers tree planting costs / YES	1 Year
Chesapeake Bay Trust	Targeted Watershed Initiative Grant Program	Non-profits 501(c) Institutions Soil/-Water Conservation Districts Local government	Involve local organizations; address non-point source pollution; projects related to water quality and habitat restoration	$50 to $200,000	0% / YES	1-2 years
Chesapeake Bay Trust	Capacity Building Initiative Grant Program	Non-profit 501(c) with a board on which half the members participate meaningfully and at least one paid staff (or a part-time paid volunteer)	Strengthen an organization through management operations, technology, governance, fundraising and communications	$15,000 per year	0% / YES	3 years
Chesapeake Bay Trust	Stewardship Grant Program	Non-profits 501(c) Schools/universities Soil/Water Conservation Districts Local government State government	Raise awareness about watershed restoration; design plans which educate citizens on things they can do to aid watershed restoration; educate students about local watersheds, projects geared towards watershed restoration and protection	$5,000 to $25,000	0% / YES	1 year

Table C-2: Tidal Back River SWAP Potential Funding Sources (Cont.)

Managing Agency	Funding Source	Application Eligibility	Eligible Projects	Funding Amount	Cost Share / In – Kind	Project Period
DNR	Clean Water Action Plan Nonpoint Source Program 319 Grant	Non-profits 501(c) Universities Soil/Water Conservation Districts Local government State government	Located in a Category I and Category III watershed as outlined in the MD unified watershed assessment; establish cover crops; address stream restoration and riparian buffers	$5,000 to $40,000	40%	Annual
MDE	Bay Restoration Fund	Local Government	Green restoration projects	None specified	50% / YES	None specified
MDE/DNR	Chesapeake and Atlantic Coastal Bays Trust Fund	Non-profits 501(c) Local government	Non-point source best management practices reducing nitrogen, phosphorous and sediment	None specified	Unknown	Annual
NFWF	Chesapeake Bay Small Watersheds Grant Program	Non-profits 501(c) Local government	Community-based projects that improve the condition of local watersheds while building stewardship among citizens; watershed restoration, conservation, and planning	$20,000 to $200,000	25%	1-5 years
NFWF	Chesapeake Bay Targeted Watersheds Grant Program	Non-profits 501(c) Universities Local government State government	Innovative demonstration type restoration projects	$ 400,000 to $1,000,000	25% / YES	2-3 years
NRCS	Watersheds Operations Program	Local government State government Tribes	Address watershed protection, flood mitigation, water quality, soil erosion, sediment control, habitat enhancement, and wetland creation and restoration	None specified	Unknown	None specified
USEPA	Targeted Watersheds Grant Program – Capacity Building Grant Program	Non-profits 501(c) Institutions Local government State government	Promote organizational development of local watershed partnerships; provide training and assistance to local watershed groups	$400,000 to $800,000	25% / YES	2 years

Table C-3: Tidal Back River SWAP Potential Funding Sources (Cont.)

Managing Agency	Funding Source	Application Eligibility	Eligible Projects	Funding Amount	Cost Share / In – Kind	Project Period
USEPA	Targeted Watersheds Grant Program – Implementation Grant Program	Non-profits 501(c) Universities Local government State government	Watershed restoration and/or protection projects (must include a monitoring component)	$600,000 to $900,000	25% / YES	3-5 years

APPENDIX D:

Chesapeake Bay Program
Pollutant Load Reduction Efficiencies

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Non-Point Source Best Management Practices and Efficiencies currently used in Scenario Builder
Values in parentheses are in progress of official approval

Agriculture BMPs		How Credited	TN Reduction Efficiency	TP Reduction Efficiency	SED Reduction Efficiency
Nutrient Management		Landuse Change	N/A	N/A	N/A
Forest Buffers (varies by region; see Appendix 2)		Efficiency, Landuse Change	19-65%	30-45%	40-60%
Wetland Restoration (varies by region; see Appendix 2)		Efficiency	7-25%	12-50%	4-15%
Land Retirement		Landuse Change	N//A	N/A	N/A
Grass Buffers (varies by region; see Appendix 2)		Efficiency, Landuse Change	13-46%	30-45%	40-60%
Non-Urban Stream Restoration		Mass reduction/length	0.02 lb/ft	0.003 lb/ft	2 lb/ft
Tree Planting		Landuse Change	N/A	N/A	N/A
Carbon Sequestration/Alternative Crops		Landuse Change	N/A	N/A	N/A
Conservation Tillage		Landuse Change	N/A	N/A	N/A
Continuous No-Till (varies by region; see Appendix 2)		Efficiency	(10-15%)	(20-40%)	(70%)
Enhanced Nutrient Management		Efficiency	(7%)	(N/A)	(N/A)
Decision Agriculture		Efficiency	(4%)	(N/A)	(N/A)
Conservation Plans	High-till	Efficiency	8%	15%	25%
	Low-till	Efficiency	3%	5%	8%
	All hay	Efficiency	3%	5%	8%
	Pasture	Efficiency	5%	10%	14%
Cover Crops (see Appendix 1)		Efficiency	Varies	Varies	Varies
Commodity Cover Crops (see Appendix 2)		Efficiency	Varies	Varies	Varies
Stream Access Control with Fencing		Landuse Change	N/A	N/A	N/A
Alternative Watering Facility		Efficiency	5%	8%	10%
Prescribed Grazing/PIRG		Efficiency	9%	24%	30%
Horse Pasture Management		Efficiency	N/A	20%	40%
Animal Waste Management Livestock		Efficiency	75%	75%	N/A
Animal Waste Management Poultry		Efficiency	75%	75%	N/A
Barnyard Runoff Control		Efficiency	20%	20%	40%
Loafing Lot Management		Efficiency	20%	20%	40%
Mortality Composters		Efficiency	40%	10%	N/A
Water Control Structures		Efficiency	33%	N/A	N/A
Poultry Phytase		Application Reduction	N/A	N/A	N/A
Swine Phytase		Application Reduction	N/A	N/A	N/A

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Dairy Precision Feeding and Forage Management	Application Reduction	N/A	N/A	N/A
Poultry Litter Transport	Application Reduction	N/A	N/A	N/A
Ammonia Emissions Reduction (interim)	Application Reduction	15-60%	N/A	N/A
Poultry Litter Injection (interim)	Efficiency	25%	0%	0%
Liquid Manure Injection (interim)	Efficiency	25%	0%	0%
Phosphorus Sorbing Materials in Ditches (interim)	Efficiency	40%	0%	0%
Resource BMPs	***How Credited***	***TN Reduction Efficiency***	***TP Reduction Efficiency***	***SED Reduction Efficiency***
Forest Harvesting Practices	Efficiency	50%	60%	60%
Dirt & Gravel Road Erosion & Sediment Control – Driving Surface Aggregate + Raising the Roadbed	Mass reduction/length	0	0	2.96lb/ft
Dirt & Gravel Road Erosion & Sediment Control – with outlets	Mass reduction/length	0	0	3.6lb/ft
Dirt & Gravel Road Erosion & Sediment Control – outlets only	Mass reduction/length	0	0	1.76lb/ft
Urban BMPs	***How Credited***	***TN Reduction Efficiency***	***TP Reduction Efficiency***	***SED Reduction Efficiency***
Forest Conservation	Landuse Change	N/A	N/A	N/A
Urban Growth Reduction	Landuse Change	N/A	N/A	N/A
Impervious Urban Surface Reduction	Landuse Change	N/A	N/A	N/A
Forest Buffers	Efficiency, Landuse Change	25%	50%	50%
Tree Planting	Landuse Change	N/A	N/A	N/A
Abandoned Mine Reclamation	Landuse Change	N/A	N/A	N/A
Wet Ponds and Wetlands	Efficiency	20%	45%	60%
Dry Detention Ponds and Hydrodynamic Structures	Efficiency	5%	10%	10%
Dry Extended Detention Ponds	Efficiency	20%	20%	60%
Infiltration Practices w/o Sand, Veg.	Efficiency	80%	85%	95%
Infiltration Practices w/ Sand, Veg.	Efficiency	85%	85%	95%
Filtering Practices	Efficiency	40%	60%	80%
Erosion and Sediment Control	Efficiency	25%	40%	40%
Nutrient Management	Efficiency	17%	22%	N/A
Street Sweeping	Efficiency	3%	3%	9%
Urban Stream Restoration	Load reduction/length	0.02lb/ft	0.003lb/ft	2lb/ft
Septic Connections	Systems Change	N/A	N/A	N/A

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Septic Denitrification		Efficiency	50%	N/A	N/A
Septic Pumping		Efficiency	5%	N/A	N/A
Bioretention	C/D soils, underdrain	Efficiency	25%	45%	55%
	A/B soils, underdrain	Efficiency	70%	75%	80%
	A/B soils, no underdrain	Efficiency	80%	85%	90%
Vegetated Open Channels	C/D soils, no underdrain	Efficiency	10%	10%	50%
	A/B soils, no underdrain	Efficiency	45%	45%	70%
Bioswale		Efficiency	70%	75%	80%
Permeable Pavement w/o Sand, Veg.	C/D soils, underdrain	Efficiency	10%	20%	55%
	A/B soils, underdrain	Efficiency	45%	50%	70%
	A/B soils, no underdrain	Efficiency	75%	80%	85%
Permeable Pavement w/ Sand, Veg.	C/D soils, underdrain	Efficiency	20%	20%	55%
	A/B soils, underdrain	Efficiency	50%	50%	70%
	A/B soils, no underdrain	Efficiency	80%	80%	85%

Appendix 2 **BMPs**	**Hydrogeomorphic Region(s)**	***TN Reduction Efficiency***	***TP Reduction Efficiency***	***SED Reduction Efficiency***
Forest Buffers	Appalachian Plateau Siliciclastic Non-Tidal	54%	42%	56%
	Blue Ridge Non-Tidal; Mesozoic Lowlands Non-Tidal; Valley and Ridge Carbonate Non-Tidal	34%	30%	40%
	Coastal Plain Dissected Uplands Non-Tidal	65%	42%	56%
	Coastal Plain Dissected Uplands Tidal; Coastal Plain Lowlands Tidal; Coastal Plain Uplands Tidal; Piedmont Crystalline Tidal	19%	45%	60%
	Coastal Plain Lowlands Non-Tidal	56%	39%	52%
	Piedmont Crystalline Non-Tidal	56%	42%	56%
	Coastal Plain Uplands Non-Tidal	31%	45%	60%
	Piedmont Carbonate Non-Tidal	46%	36%	48%
	Valley and Ridge Siliciclastic Non-Tidal	46%	39%	52%
Grass Buffers	Appalachian Plateau Siliciclastic Non-Tidal	38%	42%	56%
	Blue Ridge Non-Tidal; Mesozoic Lowlands Non-Tidal; Valley and Ridge Carbonate Non-Tidal	24%	30%	40%
	Coastal Plain Dissected Uplands Non-Tidal	46%	42%	56%
	Coastal Plain Dissected Uplands Tidal; Coastal Plain Lowlands Tidal; Coastal Plain Uplands Tidal; Piedmont Crystalline Tidal	13%	45%	60%

	Coastal Plain Lowlands Non-Tidal	39%	39%	52%
	Piedmont Crystalline Non-Tidal	39%	42%	56%
	Coastal Plain Uplands Non-Tidal	21%	45%	60%
	Piedmont Carbonate Non-Tidal	32%	36%	48%
	Valley and Ridge Siliciclastic Non-Tidal	32%	39%	52%
Wetland Restoration (Ag & Urban)	Appalachian Plateau Siliciclastic Non-Tidal	7%	12%	4%
	Coastal Plain Dissected Uplands Non-Tidal; Coastal Plain Dissected Uplands Tidal; Coastal Plain Lowlands Tidal; Coastal Plain Uplands Tidal; Coastal Plain Lowlands Non-Tidal; Coastal Plain Uplands Non-Tidal	25%	50%	15%
	Blue Ridge Non-Tidal; Mesozoic Lowlands Non-Tidal; Valley and Ridge Carbonate Non-Tidal; Piedmont Crystalline Tidal; Piedmont Crystalline Non-Tidal; Piedmont Carbonate Non-Tidal; Valley and Ridge Siliciclastic Non-Tidal	14%	26%	8%
Continuous No-till	Coastal Plain Dissected Uplands Non-Tidal; Coastal Plain Dissected Uplands Tidal; Coastal Plain Lowlands Tidal; Coastal Plain Uplands Tidal; Coastal Plain Lowlands Non-Tidal; Coastal Plain Uplands Non-Tidal	10%	20%	70%
	Appalachian Plateau Siliciclastic Non-Tidal; Blue Ridge Non-Tidal; Mesozoic Lowlands Non-Tidal; Valley and Ridge Carbonate Non-Tidal; Piedmont Crystalline Tidal; Piedmont Crystalline Non-Tidal; Piedmont Carbonate Non-Tidal; Valley and Ridge Siliciclastic Non-Tidal	15%	40%	70%
Cover Crop Early Drilled Rye (Low-till gets only TN efficiency)	Coastal Plain/Piedmont Crystalline/Karst Settings*	45%	15%	20%
	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	34%	15%	20%
Cover Crop Early Other Rye (Low-till gets only TN efficiency)	Coastal Plain/Piedmont Crystalline/Karst Settings*	38%	15%	20%
	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	29%	15%	20%
Cover Crop Early Aerial Soy Rye (Low-till gets only TN efficiency)	Coastal Plain/Piedmont Crystalline/Karst Settings*	31%	15%	20%
	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	24%	15%	20%
Cover Crop Early Aerial Corn Rye (Low-till gets only TN efficiency)	Coastal Plain/Piedmont Crystalline/Karst Settings*	18%	15%	20%
	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	14%	15%	20%
Cover Crop	Coastal Plain/Piedmont Crystalline/Karst Settings*	41%	7%	10%

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Standard Drilled Rye (Low-till gets only TN efficiency)	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	31%	7%	10%
Cover Crop Standard Other Rye (Low-till gets only TN efficiency)	Coastal Plain/Piedmont Crystalline/Karst Settings*	35%	7%	10%
	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	27%	7%	10%
Cover Crop Late Drilled Rye (Low-till gets only TN efficiency)	Coastal Plain/Piedmont Crystalline/Karst Settings*	19%	N/A	N/A
	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	15%	N/A	N/A
Cover Crop Late Other Rye (Low-till gets only TN efficiency)	Coastal Plain/Piedmont Crystalline/Karst Settings*	16%	N/A	N/A
	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	12%	N/A	N/A
Cover Crop Early Drilled Wheat (Low-till gets only TN efficiency)	Coastal Plain/Piedmont Crystalline/Karst Settings*	31%	15%	20%
	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	24%	15%	20%
Cover Crop Early Other Wheat (Low-till gets only TN efficiency)	Coastal Plain/Piedmont Crystalline/Karst Settings*	27%	15%	20%
	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	20%	15%	20%
Cover Crop Early Aerial Soy Wheat (Low-till gets only TN efficiency)	Coastal Plain/Piedmont Crystalline/Karst Settings*	22%	15%	20%
	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	17%	15%	20%
Cover Crop Early Aerial Corn Wheat (Low-till gets only TN efficiency)	Coastal Plain/Piedmont Crystalline/Karst Settings*	12%	15%	20%
	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	10%	15%	20%
Cover Crop Standard Drilled Wheat (Low-till gets only TN	Coastal Plain/Piedmont Crystalline/Karst Settings*	29%	7%	10%
	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	22%	7%	10%

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efficiency)				
Cover Crop Standard Other Wheat (Low-till gets only TN efficiency)	Coastal Plain/Piedmont Crystalline/Karst Settings*	24%	7%	10%
	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	18%	7%	10%
Cover Crop Late Drilled Wheat (Low-till gets only TN efficiency)	Coastal Plain/Piedmont Crystalline/Karst Settings*	13%	N/A	N/A
	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	10%	N/A	N/A
Cover Crop Late Other Wheat (Low-till gets only TN efficiency)	Coastal Plain/Piedmont Crystalline/Karst Settings*	11%	N/A	N/A
	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	9%	N/A	N/A
Cover Crop Early Drilled Barley (Low-till gets only TN efficiency)	Coastal Plain/Piedmont Crystalline/Karst Settings*	38%	20%	20%
	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	29%	20%	20%
Cover Crop Early Other Barley (Low-till gets only TN efficiency)	Coastal Plain/Piedmont Crystalline/Karst Settings*	32%	15%	20%
	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	25%	15%	20%
Cover Crop Early Aerial Soy Barley (Low-till gets only TN efficiency)	Coastal Plain/Piedmont Crystalline/Karst Settings*	27%	15%	20%
	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	20%	15%	20%
Cover Crop Early Aerial Corn Barley (Low-till gets only TN efficiency)	Coastal Plain/Piedmont Crystalline/Karst Settings*	15%	15%	20%
	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	12%	15%	20%
Cover Crop Standard Drilled Barley (Low-till gets only TN efficiency)	Coastal Plain/Piedmont Crystalline/Karst Settings*	29%	7%	10%
	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	22%	7%	10%

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Cover Crop Standard Other Barley (Low-till gets only TN efficiency)	Coastal Plain/Piedmont Crystalline/Karst Settings*	24%	7%	10%
	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	19%	7%	10%
Commodity Cover Crop Early Drill Wheat	Coastal Plain/Piedmont Crystalline/Karst Settings*	17%	(N/A)	(N/A)
	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	15%	(N/A)	(N/A)
Commodity Cover Crop Early Other Wheat	Coastal Plain/Piedmont Crystalline/Karst Settings*	12%	(N/A)	(N/A)
	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	7%	(N/A)	(N/A)
Commodity Cover Crop Early Aerial Soy Wheat	Coastal Plain/Piedmont Crystalline/Karst Settings*	15%	(N/A)	(N/A)
	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	12%	(N/A)	(N/A)
Commodity Cover Crop Early Aerial Corn Wheat	Coastal Plain/Piedmont Crystalline/Karst Settings*	7%	(N/A)	(N/A)
	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	6%	(N/A)	(N/A)
Commodity Cover Crop Standard Drill Wheat	Coastal Plain/Piedmont Crystalline/Karst Settings*	15%	(N/A)	(N/A)
	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	11%	(N/A)	(N/A)
Commodity Cover Crop Standard Other Wheat	Coastal Plain/Piedmont Crystalline/Karst Settings*	12%	(N/A)	(N/A)
	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	7%	(N/A)	(N/A)
Commodity Cover Crop Late Drill Wheat	Coastal Plain/Piedmont Crystalline/Karst Settings*	7%	(N/A)	(N/A)
	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	6%	(N/A)	(N/A)
Commodity Cover Crop Late Other Wheat	Coastal Plain/Piedmont Crystalline/Karst Settings*	13%	(N/A)	(N/A)
	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	11%	(N/A)	(N/A)
Commodity Cover Crop Early Drill Barley	Coastal Plain/Piedmont Crystalline/Karst Settings*	9%	(N/A)	(N/A)
	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	6%	(N/A)	(N/A)

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Commodity Cover Crop Early Aerial Soy Barley	Coastal Plain/Piedmont Crystalline/Karst Settings*	6%	(N/A)	(N/A)
	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	5%	(N/A)	(N/A)
Commodity Cover Crop Early Aerial Corn Barley	Coastal Plain/Piedmont Crystalline/Karst Settings*	13%	(N/A)	(N/A)
	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	11%	(N/A)	(N/A)
Commodity Cover Crop Standard Drill Barley	Coastal Plain/Piedmont Crystalline/Karst Settings*	15%	(N/A)	(N/A)
	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	11%	(N/A)	(N/A)
Commodity Cover Crop Standard Other Barley	Coastal Plain/Piedmont Crystalline/Karst Settings*	12%	(N/A)	(N/A)
	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	10%	(N/A)	(N/A)
Commodity Cover Crop Standard Other Rye	Coastal Plain/Piedmont Crystalline/Karst Settings*	18%	(N/A)	(N/A)
	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	14%	(N/A)	(N/A)
Commodity Cover Crop Early Other Barley	Coastal Plain/Piedmont Crystalline/Karst Settings*	15%	(N/A)	(N/A)
	Mesozoic Lowlands/Valley and Ridge Siliciclastic**	11%	(N/A)	(N/A)

*Coastal Plain Dissected Uplands Non-Tidal; Coastal Plain Dissected Uplands Tidal; Coastal Plain Lowlands Tidal; Coastal Plain Uplands Tidal; Coastal Plain Lowlands Non-Tidal; Coastal Plain Uplands Non-Tidal; Valley and Ridge Carbonate Non-Tidal; Piedmont Carbonate Non-Tidal
** Appalachian Plateau Siliciclastic Non-Tidal; Mesozoic Lowlands Non-Tidal; Piedmont Crystalline Tidal; Piedmont Crystalline Non-Tidal; Valley and Ridge Siliciclastic Non-Tidal; Blue Ridge Non-Tidal