# Middle River and Tidal Gunpowder Small Watershed Action Plan

Volume I

**Prepared for:**

Department of Environmental Protection and Sustainability

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Final Report

Baltimore County Executive Kevin Kamenetz and the Baltimore County Council

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# ACKNOWLEDGEMENTS


## MIDDLE RIVER AND TIDAL GUNPOWDER STEERING COMMITTEE

The Middle River and Tidal Gunpowder Small Watershed Action Plan was developed with cooperation and input from citizen organizations and local agencies that represent the interests of the Middle River and Tidal Gunpowder watersheds.

| *Organization* | *Representative* |
|---|---|
| Blue Water Baltimore/Best Management Products, Inc. | T.J. Mullen |
| Bowley's Quarters Improvement Association | Mike Vivirito |
| Community College of Baltimore County (CCBC) | Jim Fitch |
| Essex Middle River Civic Council (EMRCC) | Bob Bendler, George Frangos |
| Baltimore County Soil Conservation District (SCD) | Charlie Conklin |
| Gunpowder Valley Conservancy (GVC) | Peg Perry |
| MD State Parks – Gunpowder | Sarah Witcher |
| Neighbor Space of Baltimore County | Barbara Hopkins |
| Baltimore County Marine Trades Association | Raymond Porter, Robert Palmer |
| Essex Chamber of Commerce (Ultimate Watersports) | Hal Ashman |
| Upper Western Shore Tributary Team | Jim Bailey, Steve Witt |
| Baltimore County Recreation & Parks | F. Kirk Dreier |
| Baltimore County Department of Environmental Protection and Sustainability (EPS) | Candace Croswell, Regina Esslinger, Pat Farr, Nancy Pentz, Dave Riter, Steve Stewart |
| Parsons Brinckerhoff | Everett Gupton, Kelly Lennon, Regina Razon |

## TECHNICAL ASSISTANCE/REPORTS

Development of the Middle River and Tidal Gunpowder Small Watershed Action Plan was supported technically by the following assessments and technical reports:

| *Technical Report* | *Representative* |
|---|---|
| Upland Surveys (Neighborhood Source Assessments, Hotspot Assessments, Pervious Area Assessments, and Institutional Site Assessments) and Stormwater Facility Assessment | Nathan Forand, Nancy Pentz, Dave Riter - EPS<br>Charlie Conklin - Gunpowder Valley Conservancy<br>Bob Bendler - Essex-Middle River Civic Council<br>Parsons Brinckerhoff, Inc. in association with NMP Engineering Consultants, Inc. |
| Stream Corridor Assessments | Parsons Brinckerhoff, Inc. in association with Coastal Resources |
| Watershed Characterization | Parsons Brinckerhoff, Inc. |

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Although this project is funded in part by the Environmental Protection Agency, it does not necessarily reflect the opinion or position of the EPA.

# CHAPTER 1: INTRODUCTION

## 1.1 Purpose

This Small Watershed Action Plan (SWAP) is a strategy for the restoration of the Middle River and Tidal Gunpowder River watersheds. This report presents recommendations for watershed restoration, describes management strategies for each of the 15 subwatersheds comprising Middle River and Tidal Gunpowder River, and identifies priority projects for implementation. A schedule for implementation through 2020 is presented in addition to planning level cost estimates where feasible. Financial and technical partners for plan implementation are suggested for the various recommendations. This SWAP is intended to assist the Baltimore County Department of Environmental Protection and Sustainability (EPS) and other partners to keep moving forward with restoration of the Middle River and Tidal Gunpowder River.

## 1.2 Background

A SWAP identifies strategies for bringing a small watershed into compliance with water quality criteria. Strategies include a combination of government capital projects, actions in partnership with local watershed associations, citizen awareness campaigns and volunteer activities. Effective implementation of watershed restoration strategies requires the coordination of all watershed partners and the participation of many stakeholders.

Over the past year, Middle River and Tidal Gunpowder 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 key watershed partners, was formed to develop the Middle River and Tidal Gunpowder River SWAP. This includes Baltimore County personnel and leaders from the local community. The Steering Committee met regularly throughout SWAP development. Middle River and Tidal Gunpowder River Steering Committee members are listed below:

| | | |
|---|---|---|
| Best Management Products, Inc./Blue Water Baltimore | ..... | T.J. Mullen |
| Bowley's Quarters Improvement Association | ..... | Mike Vivirito |
| Community College of Baltimore County (CCBC) | ..... | Jim Fitch |
| Essex Middle River Civic Council (EMRCC) | ..... | Bob Bendler<br>George Frangos |
| Gunpowder Valley Conservancy (GVC) | ..... | Charlie Conklin<br>Peg Perry |
| MD State Parks – Gunpowder | ..... | Lance Langrehr<br>Sarah Witcher |
| Neighbor Space of Baltimore County | ..... | Barbara Hopkins |
| Balt. Co. Marine Trade Assoc. (MTABC) / Porter's Seneca Marina | ..... | Raymond Porter |
| Ultimate Watersports (Essex Chamber of Commerce) | ..... | Hal Ashman |

| | | |
|---|---|---|
| Upper Western Shore Tributary Team | ..... | Jim Bailey (Aberdeen Proving Ground)<br>Steve Witt |
| Baltimore County Recreation & Parks | ..... | F. Kirk Dreier |
| Baltimore County Department of Environmental Protection and Sustainability (EPS) | ..... | Candace Croswell<br>Dave Riter<br>Regina Esslinger<br>Pat Farr<br>Nancy Pentz<br>Steve Stewart |
| Parsons Brinckerhoff | ..... | Everett Gupton<br>Kelly Lennon<br>Regina Razon |

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

- *Stakeholder Meeting #1* (March 29, 2011; 21 attendees): This meeting included an introduction of the SWAP process and the Middle River and Tidal Gunpowder River SWAP Steering Committee members. A description of watersheds, County goals, environmental requirements (see Section 1.3), and a SWAP framework were presented. The current conditions of the Middle River and Tidal Gunpowder River watersheds were also presented based on desktop analyses and field assessments conducted. The County described the Capital Improvement Program including environmental restoration projects such as shoreline enhancement and protection, waterway dredging, stream restoration and submerged aquatic vegetation (SAV) and those projects already completed within the Middle River and Tidal Gunpowder River watersheds. A Vision & Goals Questionnaire was conducted during the meeting where attendees were asked to rate the importance of a list of eleven watershed goals. Attendees were also given an opportunity to fill out a "blue card" to report the type and location of environmental problems (e.g., dumping, erosion, illicit discharges, etc.) in the watershed.
- *Stakeholder Meeting #2* (July 25, 2011; 24 attendees): This meeting included an update on the SWAP development process including a presentation by Constellation Energy, an update on the Uplands Assessment, a discussion of restoration options, a presentation on Aberdeen Proving Ground, and an educational presentation on SAVs and Living Shorelines. Introductions were made by the Baltimore County EPS Natural Resource Specialist, Nancy Pentz. Josh Sawyers, an Environmental Technician from Constellation Energy spoke about the current operations taking place at their Middle River facility and the environmental mitigation projects being undertaken to date. Jim Bailey from Aberdeen Proving Ground pointed out the significant wildlife and habitat that exists on the property and outlined several restoration projects that have been completed. The

Upland Assessment update included a discussion of the methods and results for neighborhoods, institutions, open spaces, hotspots, marinas and industrial sites. Potential restoration actions appropriate for the watershed based on data collected were presented (e.g., downspout disconnection, bayscaping, tree planting, etc.). A citizen actions survey was conducted to gage interest in the potential restoration options and help build a successful SWAP.

- Candy Croswell of EPS gave an educational presentation on SAVs and Living Shorelines, discussing beneficial and invasive aquatic vegetation in the watersheds along with the benefits of non-structural shoreline restoration techniques. Attendees were then invited to participate in a field trip scheduled for September 12, 2011. The field trip was attended by 34 people and included a boat tour of portions of the Middle River watershed to identify and learn more about SAVs and Living Shorelines.
- *Stakeholder Meeting #3* (November 16, 2011; 25 attendees): An overview of the Draft SWAP developed for Middle River and Tidal Gunpowder was presented at this meeting including the SWAP process, watershed vision and goals, watershed profile, key municipal citizen-based strategies (e.g., stormwater management, reforestation, etc,), pollutant removal analysis results, subwatershed prioritization, and SWAP implementation and evaluation. In addition, watershed-wide strategies were discussed including a trash campaign and a campaign to promote the Clean Marina and Boater Programs. Citizen actions that residents can participate with in their community, with GVC, in neighborhoods, and at individual homes to assist with SWAP implementation were also discussed. A representative from the GVC presented on the activities the organization is involved with along with educational and environmental awareness events that the citizens of the watershed can participate in the future. Following the presentation, citizen action displays and sign-ups were setup for attendees to obtain more information regarding storm drain marking, proper pet waste management, downspout disconnection and rain barrels, and composting.

## 1.3 Environmental Requirements

The SWAP was developed to satisfy environmental program requirements while also meeting citizen needs for a healthy environment, clean water, and an aesthetically pleasing community. The following environmental program requirements were considered during the development of this SWAP and are briefly described in the subsequent sections:

- National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit assessment and planning requirements
- Total Maximum Daily Load (TMDL) reductions for Middle River and Tidal Gunpowder
- TMDLs for the Chesapeake Bay for nutrient and sediment reductions to meet water quality standards
- Targets for submerged aquatic vegetation (SAV) and water clarity

### 1.3.1 NPDES MS4 Permits

Many requirements of Baltimore County's NPDES permit (99-DP-3317, MD0068314) will be addressed by this plan. One of these requirements is the systematic assessment of water quality and development of restoration plans for all watersheds within the County. This assessment must include 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 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 address 10 percent of the impervious cover during each 5-year permit term. It is anticipated that future permits will have the same requirement. To date, SWAPs completed by the County have addressed 25% of impervious area in the County according to Baltimore County's 2011 NPDES Annual Report. The Middle River and Tidal Gunpowder SWAP addresses an additional 4.8% of the County's impervious area.

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.

### 1.3.2 303(d) Listing and Total Maximum Daily Loads (TMDLs)

According to the United States Environmental Protection Agency (USEPA), a TMDL is a calculation of the maximum amount of a pollutant that a water body can receive 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.

Currently, there are no impairment lists for non-tidal waters corresponding to the 8-digit Middle River and Tidal Gunpowder River watersheds. There are five impairment listings on the Maryland 303d listing for the corresponding tidal waters – three for Middle River and two for Gunpowder River. 303d impairments related to nutrients (nitrogen and phosphorus) and PCBs have been identified for both Middle River and Gunpowder River. Sediment has also been identified as an impairment within Middle River. No specific TMDLs have been developed for the Middle River or the Tidal Gunpowder River.

Note that in 2003, a WQA was submitted for Middle River in response to impairment listings for copper and nickel in 1998, and cadmium and lead in 2002 (MDE 2003). The WQA justified the removal of copper and nickel from the list because Middle River is defined as a fresh water body in COMAR, and these pollutants did not exceed impairment levels under freshwater water quality criteria. The document also provided analyses showing that aquatic life criteria and designated uses associated with cadmium and lead were being met in Middle River and that TMDLs were not necessary to achieve water quality standards. However, the state reserves the right to impose pollution control requirements if these pollutants contribute to downstream water quality problems in the future.

### 1.3.3 Chesapeake Bay Nutrient and Sediment Impairment

The Chesapeake Bay Program (CBP) has developed the Phase 5 Watershed Model. This model, in conjunction with the Estuary Model, is used to determine the sources and reductions of nitrogen, phosphorus, and sediment needed to meet Chesapeake Bay tidal water quality standards. The Phase 5 model was used to develop a Chesapeake Bay-wide TMDL and to assign nutrient and sediment load reductions to individual states and ultimately local jurisdictions based on the segment loads. In Maryland, nutrient and sediment load reductions were assigned on a County basis for achievement by a 2020 timeframe. 2017 was established as an intermediary milestone with specific targeted load reductions to be achieved. Table 1-1 below lists the pollutant load reduction requirements for Baltimore County, and in turn the Middle River and Tidal Gunpowder watersheds, under the Chesapeake Bay TMDL.

Table 1-1: Baltimore County Pollutant Load Reductions

| TMDL Pollutant | % Pollutant Load Reduction Requirements for Baltimore County | |
|---|---|---|
| | 2017 | 2020 |
| Nitrogen | 20.3% | 29.0% |
| Phosphorous | 31.6% | 45.1% |

### 1.3.4 SAV and Water Clarity

MDE has established targets for submerged aquatic vegetation (SAV) and water clarity since these are both indicators of good water quality and habitat. SAV coverage of 879 acres and water clarity to 1.4 meters (4.6 feet) are proposed for Middle River. SAV coverage of 572 acres and water clarity to 1.4 meters (4.6 feet) are proposed for Lower Gunpowder River. This SWAP encompasses the southern portion of the Upper Gunpowder River for which SAV coverage of 1,860 acres and water clarity to 0.4 meters (1.3 feet) are proposed.

## 1.4 USEPA Watershed Planning A-I Criteria

The Clean Water Act (CWA) was amended in 1987 to establish Section 319 Nonpoint Source Management Program, after recognizing the need for federal assistance with focusing state and local nonpoint source efforts. Under this section, states, tribes, and territories can receive grant money for the development and implementation of programs aimed at reducing nonpoint source (NPS) pollution. NPS pollution comes from many different sources and is a result of human activities on the land. It is caused by pollutants from human activities and atmospheric deposition that are deposited on the ground and eventually carried to receiving waters by stormwater runoff. Common NPS pollutants and sources include:

- Excess fertilizers, herbicides, and insecticides from agricultural lands and residential areas
- Oil, grease, and toxic chemicals from urban runoff and energy production
- Sediment from improperly managed construction sites, crop and forest lands, and eroding stream banks
- Salt from irrigation practices and acid drainage from abandoned mines
- Bacteria and nutrients from livestock, pet wastes, and failing septic systems

CWA Section 319 grant funds can be requested to support various activities such as technical assistance, financial assistance, education, training, technology transfer, restoration projects, and monitoring to assess the success of specific nonpoint source implementation projects. Watershed-based plans to restore impaired water bodies and address nonpoint source pollution using incremental Section 319 funds must meet USEPA's A through I criteria for watershed planning:

A. An identification of the causes and sources or groups of 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 amounts of technical and financial assistance 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 for the NPS management measures

H. A set of criteria to determine load reductions and track substantial progress towards attaining water quality standards.

I. A monitoring component to evaluate effectiveness of the implementation records over time.

Table 1-2 summarizes the location(s) within this document where each criterion is addressed.

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 | ✓ | | ✓ | | | | | | |
| Appendix F | | | | | | | | | |
| Appendix G | | | | | | | | | |

## 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, the cooperation and coordination has been advancing in recent years as common goals in water quality improvement in local streams and tidal waters 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. In the Middle River and Tidal Gunpowder watershed, over four miles of shoreline have been restored, 970 acres of urban land has been either addressed with new stormwater management (SWM) practices or existing SWM has been retrofitted (enhanced) to provide additional water quality improvements. Approximately $3 million have been spent to date on restoration activities within the entire Middle River and Tidal Gunpowder watershed. An additional $0.5 million has been allocated for restoration in Middle River between 2012 and 2014.

Baltimore County EPS has extensive stream monitoring programs. These include, ambient trend monitoring, biological community monitoring, bacteria monitoring, measuring efficiency of restoration projects and 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 bacterial contamination, as well as, reduce nitrogen and phosphorus in streams.

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

The County also initiated a comprehensive dredging program in 1987 to address the need for access to waterways and to identify and control the sources of sedimentation. Dredging of tidal waterways to restore or enhance use and navigability for both recreational and commercial boat traffic is an integral component in the management of the County's 219 miles of shoreline. Baltimore County EPS administers the dredging program which includes: collecting the necessary data to determine the need for dredging; identifying environmental constraints; evaluating dredged material placement opportunities; applying for State and Federal Permits; assisting spur applicants with permit applications; and the design and construction management for the project. Baltimore County also identifies problems and implements necessary corrections to improve water quality for each creek through water quality improvement projects. Baltimore County EPS has planned, designed, permitted and overseen the construction of dredging projects on several tributaries in Middle River and the Tidal Gunpowder River including:

- Sue Creek
- Middle River
- Norman Creek
- Hopkins Creek

- Greyhound Cove
- Hogpen Creek
- Frog Mortar Creek
- Chestnut Cove
- Galloway Creek
- Browns Cove and Breezy Point
- Goose Harbor
- Seneca Creek

Baltimore County EPS also maintains aids to navigation on the aforementioned waterways and conducts annual spring and summer submerged aquatic vegetation surveys. Bathymetry surveys in the next several years will help to determine the need and frequency of future maintenance dredging.

### 1.5.2 Gunpowder Valley Conservancy (GVC)

The Gunpowder Valley Conservancy (GVC) is a local, not-for-profit organization working for a cleaner Gunpowder River. Its mission statement reads as follow:

> *The Gunpowder Valley Conservancy, a non-profit organization, mobilizes people and resources to care for the lands, waters and character of the Gunpowder Watershed. Its emphasis is on land preservation, restoration, stream cleanups and education.*

The GVC is volunteer-based and has conducted a variety of restoration projects in the watershed including working with communities, corporate partners, service clubs, Master Gardeners, churches, educational institutions, and government agencies to plant 19,000 trees, sponsoring trash pick-ups that have removed 150 tons of trash and debris from area streams, and establishing stream buffers; best management practices including rain gardens, rain barrels, Bay Wise lawn practices, and edible landscaping; and sediment and erosion control. GVC has also been heavily involved with land preservation in the watershed, preserving 1,500 acres through conservation easements. Its Coastal Rural Legacy Area, in partnership with Baltimore County, encompasses the Middle River and Tidal Gunpowder watersheds.

With a $100,000 grant from National Fish and Wildlife Found, GVC is leading an effort to educate residents in the Jennifer Branch watershed on residential best management practices and covering a majority of the implementation costs. GVC applied and did not receive similar funding for Middle River and Tidal Gunpowder in June 2011. They will reapply once the plan has been completed next year.

### 1.5.3 Local Businesses and Civic Organizations

A variety of community businesses and civic organizations in the Middle River and Tidal Gunpowder have a vested interest in improving water quality in the watershed. Each of these organizations will have an important role in achieving the goals and objectives of the SWAP.

The Essex-Middle River Civic Council (EMRCC) is a local civic organization promoting the interests of the local community and representing the citizens on the Middle River and Tidal Gunpowder Steering Committee. Part of their mission is promoting the preservation and improvements of natural resources within the organization's boundaries. In addition, EMRCC provides educational materials and workshops to members, represents the community on public policy decisions, and supports community programs and activities. This infrastructure will be an ideal means to educate community members on practices they can follow and activities they can participate in to improve water quality in Middle River and Tidal Gunpowder.

Community Associations are local organizations that have the insight and will to implement improvements within the Middle River and Tidal Gunpowder watersheds. For example, the Bowleys Quarter Improvement Association (BQIA) is a local organization promoting the proper development and maintenance of the Bowleys Quarter area of the watershed. With over 100 members and potential volunteers, this group has the potential to organize and conduct citizen-based activities within their specific area. BQIA produces regular newsletters, host annual community clean-ups, promotes recycling, and advertises for meetings in the area. The Essex-Middle River-White Marsh Chamber of Commerce is another example of a local community organization dedicated to improving residents' quality of life.

With 31 marinas located in the study area, the Baltimore County Marine Trade Association (BCMTA) is another important stakeholder representing the interests of the community. Boating is a popular recreational activity and important economic driver in the area, and BCMTA has the ability to promote cleaner boating practices with area marinas as well as local and visiting boaters.

### 1.5.4 Industrial Facilities

21% of the Middle River and Tidal Gunpowder watersheds consist of property occupied by six (6) industrial landowners. They include:

- Lockheed Martin
- Martin State Airport
- Maryland Air National Guard
- Constellation Energy
- LaFarge Quarry
- Aberdeen Proving Ground

Currently, each of these facilities is required to maintain a National Pollutant Discharge Elimination System (NPDES) permit for their operations. The facilities, in accordance with the NPDES permits, are undertaking processes to prevent stormwater pollutants from reaching adjacent waterways in the area.

EPS and PB staff conducted site visits to each of the large landowners. More details regarding the findings of the site visits can be found in Section 4.7 of the *Middle River and Tidal Gunpowder River Watershed Characterization Report* and in Section 4.3 of this report. During the visits, it was noted that each of the facilities has undertaken additional activities in an effort to be more environmentally sustainable. By continuing to expand environmental programs and mitigating pollution-causing practices on-site, industrial facilities within the watershed can assist in the effort to meet pollution reduction goals.

## 1.6 Middle River and Tidal Gunpowder Watershed Overview

The total study area of the SWAP including both the Middle River and Tidal Gunpowder River watersheds is comprised of 15 subwatersheds and approximately 12,324 acres (19.3 square miles) as shown in Table 1-3. The Middle River contains approximately 6,468 acres (10.1 square miles) and the Tidal Gunpowder River contains approximately 5,856 acres (9.2 square miles).

Table 1-3: Middle River and Tidal Gunpowder River Subwatershed Areas

| Subwatershed | Area (Acres) | Area (Sq Miles) |
|---|---|---|
| Darkhead Creek | 1,139.6 | 1.78 |
| Frog Mortar Creek | 1,191.8 | 1.86 |
| Galloway Creek | 371.5 | 0.58 |
| Browns Cove | 611.8 | 0.96 |
| Hogpen Creek | 262.3 | 0.41 |
| Hopkins Creek | 604.6 | 0.94 |
| Middle River | 674.0 | 1.05 |
| Norman Creek | 311.4 | 0.49 |
| Stansbury Creek | 345.8 | 0.54 |
| Sue Creek | 955.0 | 1.49 |
| *Middle River Subtotal* | *6,467.9* | *10.1* |
| | | |
| Aberdeen Proving Ground | 1,280.9 | 2.00 |
| Dundee Creek | 920.4 | 1.44 |
| Gunpowder River | 745.4 | 1.16 |
| Saltpeter Creek | 1,902.2 | 2.97 |
| Seneca Creek | 1,007.2 | 1.57 |
| *Tidal Gunpowder Subtotal* | *5,856.1* | *9.2* |
| | | |
| *Total* | *12,323.9* | *19.3* |

As shown in Figure 1-1, the Middle River and Tidal Gunpowder watersheds were subdivided for planning and management purposes into 10 and 5 subwatersheds, respectively. The smaller drainage areas are intended to focus restoration, preservation and monitoring efforts. The *Middle River and Tidal Gunpowder River Watershed Characterization Report* includes detailed analyses and descriptions of the current watershed conditions and potential water quality issues. This is included as Appendix D of this report. A summary of the key watershed characteristics for Middle River and Tidal Gunpowder River based on the characterization report is provided in the Table 1-4.

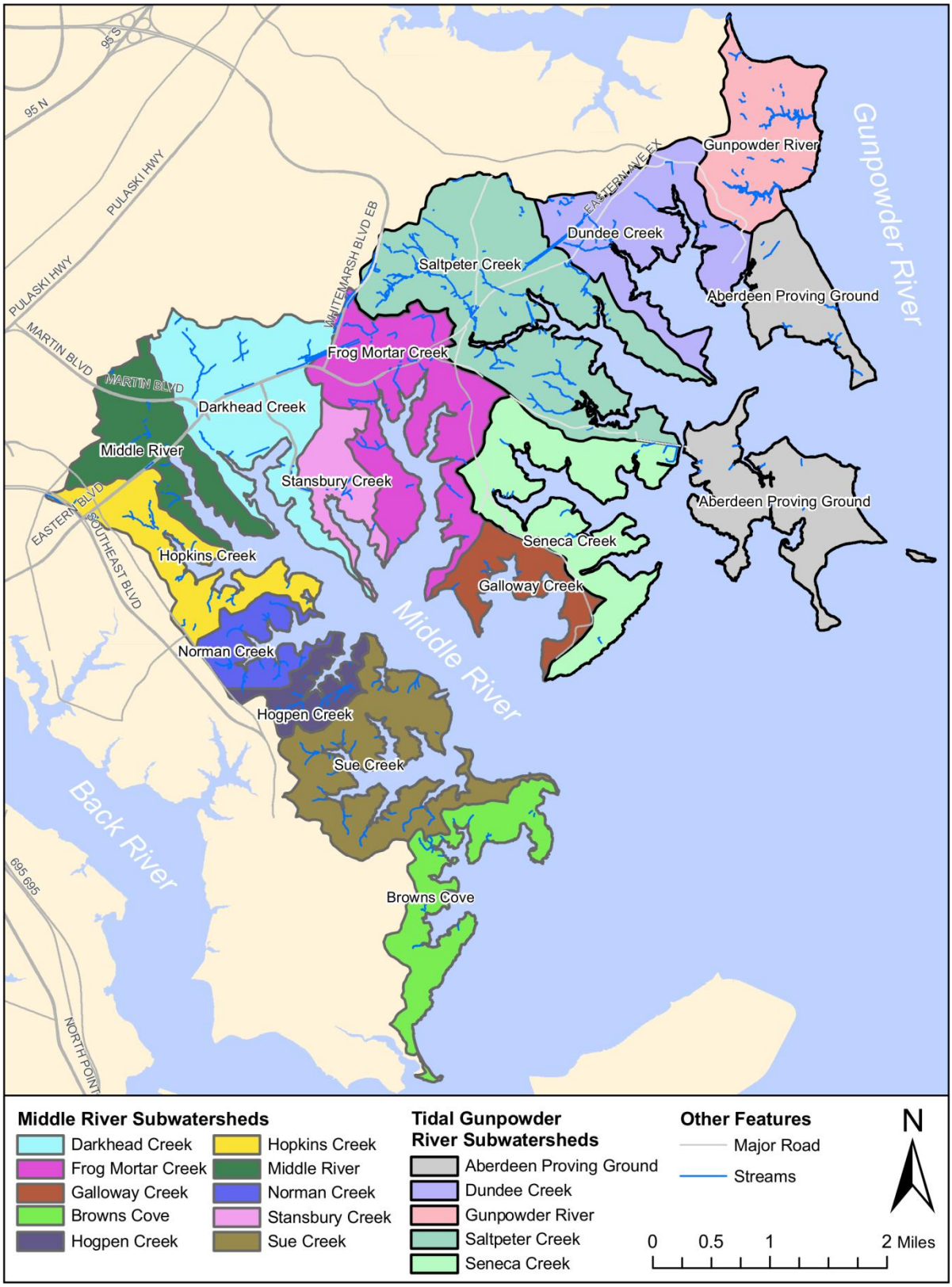


Figure 1-1: Middle River and Tidal Gunpowder SWAP Planning Area and Subwatersheds

Table 1-4: Middle River and Tidal Gunpowder River Key Watershed Characteristics

| | | |
|---|---|---|
| Drainage Area | 12,324 acres (19.3 sq. mi.) | |
| Stream Length | 39.2 miles | |
| Coastline Length | 105.6 miles | |
| Tidal Waters | 14,351 acres (22.4 sq. mi.) | |
| Jurisdictions | Baltimore County | |
| Population | 34,700 (2000 Census) | |
| Land Use/Land Cover | Very Low Density Residential: | 2.0% |
| | Low Density Residential: | 2.7% |
| | Medium Density Residential: | 19.0% |
| | High Density Residential: | 8.9% |
| | Commercial: | 8.7% |
| | Industrial: | 2.9% |
| | Extractive | 2.2% |
| | Institutional: | 3.2% |
| | Open Urban: | 2.5% |
| | Forest: | 34.2% |
| | Agriculture: | 4.1% |
| | Water/Wetlands: | 9.5% |
| | Transportation | 0.1 |
| Impervious Cover | 16.7% of watershed | |
| Soils | A Soils (low runoff potential): | 6.9% |
| | B Soils: | 18.9% |
| | C Soils: | 45.1% |
| | D Soils (high runoff potential): | 28.6% |

## 1.7 Report Organization

This report is organized into the following five major chapters:

Chapter 1 explains the purpose of this report including underlying environmental requirements and key watershed characteristics.

Chapter 2 presents the watershed vision, goals and objectives for restoring the Middle River and Tidal Gunpowder watersheds.

Chapter 3 describes the types of watershed restoration practices recommended for Middle River and Tidal Gunpowder and estimated pollutant load reductions.

Chapter 4 discusses prioritization of the 15 subwatersheds in the Middle River and Tidal Gunpowder watersheds and summarizes subwatershed-specific restoration strategies.

Chapter 5 presents the implementation plan restoration evaluation criteria and monitoring framework.

This volume (Volume I) also includes the following appendices with additional, detailed information used to develop and support this SWAP:

- Appendix A: Middle River and Tidal Gunpowder Action Strategies
- Appendix B: Cost Analysis and Potential Funding Sources
- Appendix C: Chesapeake Bay Program Pollutant Load Reduction Efficiencies and Maryland *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated.*
- Appendix D: Middle River and Tidal Gunpowder SWAP Uplands Assessment Map

A second volume (Volume II) includes the following appendices with supporting documentation related to the current conditions of the Tidal Back River watershed:

- Appendix E: Middle River and Tidal Gunpowder Watershed Characterization Report (PB 2011)
- Appendix F: Chesapeake Bay TMDL Executive Summary
- Appendix G: Water Quality Analysis of Cadmium and Lead for the Middle River in Baltimore County, Maryland

# CHAPTER 2: VISION, GOALS AND OBJECTIVES

## 2.1 Vision Statement

The Middle River and Tidal Gunpowder Steering Committee adopted the following vision statement that served as a guide in the development of the SWAP:

> *Our vision for the Middle River/Tidal Gunpowder watersheds in 2020 is to have a healthy, sustainable network of natural resources, native habitats, and people that will support: our local communities, institutions, and businesses; all types of waterfront recreation for Baltimore County residents and visitors from other regions; and the larger effort to restore and protect the Chesapeake Bay.*

## 2.2 Middle River and Tidal Gunpowder River SWAP Goals & Objectives

A total of eleven goals were identified for restoring the Middle River and Tidal Gunpowder watersheds based on the vision statement and input from both Steering Committee and Stakeholder meetings. The goals were developed through discussions with the Middle River and Tidal Gunpowder 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 eleven goals for restoring the Middle River and Tidal Gunpowder watersheds. Each of the goals is categorized under one of four headings: Clean Water, Forests and Habitat, Preservation, or Recreation. For each goal, a series of objectives was developed to ensure that the plan will meet each goal. 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 “implement stormwater retrofits to treat runoff” in a given watershed. The action strategies developed to achieve these objectives and goals are summarized in Appendix A and discussed further in Chapter 3.

When possible, action strategies are expressed as quantifiable measures (e.g., linear feet of forested buffer planted). However, the numerical 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, Table A2 lists the action strategies proposed for the Middle River and Tidal Gunpowder and their applicable goals and objectives.

The general types of restoration strategies proposed for the Middle River and Tidal Gunpowder watersheds 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 Clean Water

#### *2.2.1.1 Goal 1: Improve and Maintain Clean Water*

As part of the bay-wide Chesapeake Bay TMDL requirements, Baltimore County is required to reduce the nutrient and sediment loadings into the Middle River and Tidal Gunpowder River by the year 2020, with intermediate milestones established for 2017. The objectives below are designed to meet the nitrogen, phosphorous, and sediment TMDL reduction requirements in the watershed. As of the date for this report, sediment targets have not been determined for Baltimore County.

Objectives:

1. Reduce annual average Total Nitrogen loads (urban stormwater) by 20.3% in 2017 and 29.0% in 2020 compared to loading estimated for the baseline period.
2. Reduce annual average Total Phosphorous loads (urban stormwater) by 31.6% in 2017 and 45.1% in 2020 compared to loading estimated for the baseline period.
3. Effectively communicate the mission of the SWAP and the importance of a healthy watershed to all community groups and leaders.
4. Raise awareness among community members concerning the causes and effects of watershed and habitat degradation and encourage positive behavioral modifications.
5. Reduce fertilizer/pesticide/herbicide use throughout the watershed.
6. Increase stream and shoreline restoration projects to stabilize banks, reduce pollutant laden sediment from eroding, and reconnect streams to floodplains.

#### *2.2.1.2 Goal 2: Reduce Pollution from Stormwater Runoff*

The development and construction of impervious surfaces within a watershed contribute to increased stormwater runoff volume and flow, carrying nutrients and sediment to downstream water bodies and their tributaries at a rate higher than in the natural environment. Preventing pollution from being transported to downstream waters can provide a noticeable improvement to water quality.

Objectives:

1. Implement stormwater control practices throughout the watershed to incorporate new technologies to the maximum extent practicable.
2. Reduce impervious coverage in the watershed.
3. Promote and increase use of rain barrels, rain gardens and bayscaping in the uplands areas identified in the field assessments.

#### *2.2.1.3 Goal 3: Reduce Trash and Dumping*

Trash is generated throughout the watershed and readily moves through storm drains and tributaries and is carried by wind into the rivers. Trash is also thrown directly into the water. 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 dumping 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 Middle River and Tidal Gunpowder.

Objectives:

1. Reduce trash in the upland areas identified in the field assessments.
2. Reduce dumping of trash and other materials.
3. Support and increase community clean-ups.
4. Increase recycling of bottles, cans, plastic bags and paper.

### 2.2.2 Forests and Habitat

#### *2.2.2.1 Goal 4: Increase Buffer Zones along Streams and Shorelines*

Bands of vegetation bordering streams and shorelines filter runoff, trap pollutants, and increase aquatic habitat. By establishing healthy, vegetated buffers along waterways nutrients conveyed by stormwater runoff can be removed prior to reaching streams while slowing large, sediment-stirring flows. The objectives below are intended to increase the amount of buffers in the Middle River and Tidal Gunpowder watersheds while informing local citizens of their importance.

Objectives:

1. Increase the quantity of forest buffer zones on waterfront property.
2. Increase riparian buffer where it is lacking and enhance existing stream buffers to improve the quality of underbrush and forest for filtering runoff and providing habitat.

#### *2.2.2.2 Goal 5: Increase Tree Cover and Promote Healthy and Sustainable Forests*

Healthy, vibrant forests create a significant ecological impact on a watershed through influences on air quality, water quality, and wildlife habitat. From absorbing pollutants in the air to pollutants in rainfall and runoff, trees are a vital part of decreasing nutrient loads in watersheds. In addition, planting trees in neighborhoods can increase property values and reduce energy use. The objectives below promote tree health in the watershed including neighborhoods, businesses, and institutions.

Objectives:

1. Increase forest cover in the watersheds.
2. Reduce the amount of exotic invasive species.
3. Promote deer population control strategies.

#### *2.2.2.3 Goal 6: Increase Tidal and Non-tidal Wetlands for Improved Terrestrial Habitat*

Wetlands are a naturally occurring ecosystem providing many benefits to a community. Acting as a filter, wetlands provide flood control, and the plant species located within can remove nutrients and sediment from storm flows prior to reaching streams and tidal areas. As part of the natural ecosystem, wetlands are vital to the biodiversity of stream and tidal communities, providing a home to organisms on each end of the food chain. Protecting and expanding existing wetlands within the watershed will

help to preserve the area's natural beauty, support the tidally-based economy, and increase water quality in streams and tidal waters.

Objectives:

1. Increase wetland creation projects to increase wildlife habitat and improve water quality.
2. Improve monitoring of acreage to assess trends over time.

#### *2.2.2.4 Goal 7: Improve Shallow Water Habitat along Shorelines*

Physical damage to shallow water habitats has resulted over time from development along shorelines, poor land management practices, introduction of exotic invasive species, bulkheading along shorelines, boating in shallow water, and other human interactions. The objectives for this goal relate to the improvement of degraded shallow waterways that result in poor conditions for habitat.

Objectives:

1. Increase shoreline stabilization and habitat restoration projects to reduce sediment erosion and increase native habitat.
2. Promote living shorelines instead of structural controls where practicable.
3. Support channel marking to keep boats in channel while protecting sensitive shoreline habitat.

#### *2.2.2.5 Goal 8: Protect and Maintain Submerged Aquatic Vegetation (SAV)*

Bay grasses or submerged aquatic vegetation (SAV) serve many purposes in a tidal ecosystem including improving water quality, reducing the stirring of bottom-sediments, and providing food and cover for aquatic life. The objectives for this goal relate to maintaining and increasing the SAV coverage, a key indicator of the health of a tidal water body.

Objectives:

1. Increase public awareness of involvement in SAV protection and restoration.
2. Encourage boaters use of marked channels and increase their awareness about the benefits of SAV protection.
3. Continue to monitor SAV to help evaluate water clarity.

### 2.2.3 Preservation

#### *2.2.3.1 Goal 9: Increase the Amount of Land in Preservation*

The permanent protection of natural resources within a watershed is vital to maintaining and improving its health. By placing natural areas such as forests and wetlands into permanent preservation, citizens can ensure the continuation of the natural beauty in the watershed along with the watershed benefits that these areas provide.

Objectives:

1. Increase the identification and preservation of riparian forests, wetlands, and greenways to buffer the Middle River and Tidal Gunpowder and its tributaries from pollution run-off.
2. Encourage private preservation and stewardship through the Rural Legacy Preservation, MD Environmental Trust, and Baltimore County Programs.

### 2.2.4 Recreation

#### *2.2.4.1 Goal 10: Improve and Maintain Access to Waterways for Recreational Boating*

The Middle River and Tidal Gunpowder community relies upon the recreational boating industry to support its local economy and way of life. Waterways act as the lifeline to one of this area's most important traditions. This goal relates to the need for public access to waterways and safe boating conditions.

Objectives:

1. Promote and increase the use of public access points to waterways.
2. Create safer navigation on the water.

#### *2.2.4.2 Goal 11: Promote the Region as a Desirable Waterfront Destination for Residents, Boaters and Visitors*

With over 100 miles of coastline in the Middle River and Tidal Gunpowder watersheds, the waterfront is a scenic resource unique to this area. The objectives below relate to improving and promoting the waterfront to realize all the economic and recreational opportunities it can provide.

Objectives:

1. Promote boating practices that promote a safer and cleaner environment.
2. Increase support for the implementation of the Eastern County Bike and Pedestrian Plan.

# 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 Middle River and Tidal Gunpowder watersheds. A complete list of actions proposed for the watersheds 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 restoration of the Middle River and Tidal Gunpowder watersheds will occur as a partnership between the local government, watershed groups, businesses, 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. Watershed groups and citizens are able to implement locally-based programs such as tree plantings storm drain marking, 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 Middle River and Tidal Gunpowder watersheds 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 the Chesapeake Bay TMDL requirements are met in the Middle River and Tidal Gunpowder.

## 3.2 Municipal Strategies

Baltimore County works to restore local streams and improve water quality through capital improvement projects and municipal management activities (e.g., development review, street sweeping, illicit connection programs, etc.) This plays an important role in the SWAP implementation process. Key municipal strategies proposed for restoring Middle River and Tidal Gunpowder are discussed in the following sections.

### 3.2.1 Stormwater Management

Increased importance of water quality and water resource protection has led to the development of the Maryland Stormwater Design Manual which provided BMP design standards and environmental incentives (MDE 2000). Since that time there has been a general shift toward adopting low-impact practices that mimic natural hydrologic processes and achieve pre-development conditions. The Maryland Stormwater Act of 2007 takes those principles one step further and requires that environmental site design (ESD) be implemented to the maximum extent practicable via nonstructural BMPs and/or other better site design techniques. The intent of ESD best management practices (BMPs)

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 111 existing SWM facilities are located within the Middle River and Tidal Gunpowder watersheds including dry and wet ponds, wetlands, infiltration/filtration practices, extended detention, proprietary BMPs, grassed swales, and underground detention facilities. Existing SWM facilities treat a total drainage area of approximately 970 acres of urban land or 16 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 (flood control) and therefore, provide almost no pollutant removal. Therefore, they are good candidates for conversion to a type of facility that provides water quality benefits in addition to quantity control. Nine existing detention ponds within the Middle River and Tidal Gunpowder watersheds were investigated for potential conversion to stormwater quality management facilities. For example, dry extended detention ponds are designed to capture and retain stormwater runoff to allow sediment and pollutants to settle out while also providing flood control. Out of the nine (9) detention ponds assessed, three (3) were considered to have potential for conversion for water quality.

### 3.2.3 Stormwater Retrofits

Stormwater retrofits involve implementing BMPs in existing developed areas where SWM practices do not exist to help improve water quality. Stormwater retrofits improve water quality by capturing and treating runoff before it reaches receiving water bodies. Based on initial field and desktop evaluations, several sites with sufficient open space for stormwater retrofits to treat runoff from impervious parking lots or alleys were identified. These sites were located in three (3) of the four (4) upland components surveyed: neighborhoods, institutions and pervious areas.

Impervious surfaces including roads, parking lots, roofs and other paved surfaces prevent precipitation from naturally seeping into the ground. As a result, impervious surface runoff can result in erosion, flooding, habitat destruction, and increased pollutant loads to receiving water bodies. Subwatersheds with higher amounts of impervious cover are more likely to have degraded stream systems and contribute significantly to water quality problems in a watershed. Removing impervious cover and converting to pervious or forested land promotes infiltration of runoff and reduces pollutant loads. Unused or unmaintained impervious surfaces with the potential for removal were identified at several institutions, mostly on school properties. 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 Shoreline Enhancement Projects

The Middle River and Tidal Gunpowder watersheds consist of tidal waters and shoreline areas that have numerous benefits and uses for recreation, wildlife habitat, aquatic life, and water quality. Baltimore County EPS has a well established program for waterway improvement and coastal management to

protect these and other County resources while meeting public demands for access and recreation. The County has implemented six (6) shoreline enhancement projects within Middle River and one (1) in Tidal Gunpowder between 1990 and 2002. These include the following projects (more detail is provided in Chapter 3.4.2.1):

1. Carrollwood Shoreline
2. Turkey Point
3. Dark Head Park
4. Pottery Farm Park
5. Hawthorne Park
6. Rocky Point Beach

EPS also completed a shoreline enhancement study to support shoreline management and the integration of watershed management, resource conservation, and waterway improvements (EPS 1998). In the study, conceptual shoreline enhancement projects were developed including erosion protection, ecological and recreational benefits. The following conceptual shoreline enhancement project was developed to protect shoreline resources within Middle River and Middle River and Tidal Gunpowder:

1. Darkhead Creek Park– Shoreline protection retrofit and ecological enhancement

### 3.2.5 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, simple stream repairs such as vegetative bank stabilization and localized grade control to comprehensive repairs such as full channel redesign and realignment. Stream corridor assessments (SCAs) performed in Tidal Gunpowder showed opportunities for stream repair, stream cleanups, and buffer reforestation. Stream corridors noted as having significant erosion and channel alteration during the SCAs are used to estimate pollutant load reductions for potential stream repair efforts. For both cases, stabilizing the stream channel improves water quality by preventing eroded soils, and the pollutants contained in them, from entering the stream and Gunpowder River.

### 3.2.6 Street Sweeping

Street sweeping removes trash, sediment and organic matter such as leaves and twigs from the curb and gutter system, preventing them from entering storm drains and nearby streams. This helps reduce sedimentation and pollutants, such as nutrients, oil and metals, in the stream. Excessive organic matter clogs streams and storm drains resulting in costly maintenance. In addition, decay of a disproportionate amount of organic matter in the stream takes away oxygen needed for supporting aquatic life.

Neighborhoods with significant trash and/or organic matter build-up along curbs were recommended for street sweeping during neighborhood source assessments (NSAs). These areas will be referred to Baltimore County Department of Public Works (DPW) staff to determine whether street sweeping is

conducted there and at what frequency. Adding a targeted neighborhood to the sweeping route or increasing frequency of sweeping would address build-up of excessive curb and gutter material.

### 3.2.7 Illicit Connection Detection/Disconnection

An Illicit Discharge Detection and Elimination program has been developed by Baltimore County to find and remediate discharges into streams that are harmful to aquatic life and water quality or that are causing erosion/sedimentation problems. The County will continue their 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.

### 3.2.8 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 Middle River and Tidal Gunpowder watersheds. A summary of the SSOs in Middle River and Tidal Gunpowder can be found in the *Watershed Characterization Report.*

## 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 watersheds that would not be possible otherwise. Citizen participation is critical to the implementation and long-term maintenance of restoration activities. Key citizen-based strategies proposed for Middle River and Tidal Gunpowder are discussed in the following sections.

### 3.3.1 Reforestation

Trees improve water quality by capturing and removing pollutants in runoff including excess nutrients through their roots before the pollutants enter groundwater and streams. Tree leaves and stems also intercept precipitation, reducing the energy of raindrops and preventing any erosion 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 and the Growing Home Campaign for private property, can help increase the success of planting efforts. Several areas throughout the watershed are targeted for reforestation opportunities and are described below.

*Riparian Buffer*

Stream and shoreline riparian buffers are critical to maintaining healthy streams and rivers. Forested buffer areas along streams and shorelines improve water quality and prevent flooding by filtering pollutants, reducing surface runoff, stabilizing stream banks, trapping sediment, and providing habitat for various types of terrestrial and aquatic life. 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 GIS analysis in the *Watershed Characterization Report* are good candidates for tree planting and are targeted for initial buffer reforestation efforts.

*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 should be targeted for initial reforestation efforts.

*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 and absorb nutrients through their root systems while also providing habitat for wildlife. 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

Disconnected downspouts that direct rooftop runoff to impervious surfaces 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 (BWB) and Center for Watershed Protection (CWP). Results from these programs can be used to determine successful techniques and strategies for Middle River and Tidal Gunpowder.

### 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 a vital, citizen-based strategy. Yards and lawns typically represent a significant portion of the pervious cover in an urban subwatershed and therefore,

can be a major source of polluted runoff. Maintenance behaviors tend to be similar within individual neighborhoods and certain activities can impact subwatershed quality such as fertilization, pesticide use, watering, landscaping, and trash/yard waste disposal. Urban nutrient management efforts related to lawn maintenance and bayscaping can help reduce polluted runoff to nearby streams.

*Lawn Maintenance Education*

A well-maintained lawn can be beneficial to the watershed. However, lawn maintenance activities often involve over-fertilization, poor pest-management, and over-watering resulting in polluted stormwater runoff to local streams. Lawns with a dense, uniform grass cover or signs designating poisonous lawn care indicate high lawn maintenance activities. Neighborhoods identified as having high lawn maintenance practices should be targeted for awareness programs emphasizing responsible fertilizing techniques such as proper application amounts, 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.

*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 stormwater pollution and lawn maintenance requirements. Bayscaping is also beneficial to wildlife. 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 & 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 Middle River and Tidal Gunpowder watershed. Also discussed are the pollutant removal calculations for proposed BMPs to ensure that TMDL requirements are met in Middle River and Tidal Gunpowder.

### 3.4.1 Pollutant Loading Analysis

A pollutant loading analysis was performed to estimate total nitrogen and phosphorus loads currently generated by all non-point sources present within the Middle River and Tidal Gunpowder watershed. Non-point sources discussed in this section include pollutants from urban and non-urban land uses as well as septic systems.

*Land-Use Pollutant Loading*

Land-use pollutant loading estimates were based on Maryland Department of Planning's (MDP) 2007 Land Use/Land Cover (LU/LC) GIS layer and pollutant loading rates developed by MDE and Baltimore County for non-urban land uses and CBP for urban land uses. The pollutant loading analysis is described in detail in Chapter 3.3 of the *Watershed Characterization Report* (Appendix D). Tables 3-1 through 3-3 summarize the results from the watershed pollutant loading analysis including areas, nutrient loading rates, and annual nutrient loads for each nonpoint source/land use type. Table 3-1 provides the summary for Middle River while Table 3-2 shows the Tidal Gunpowder pollutant loading values. Table 3-3 shows the total pollutant loading for each watershed with pollutant loading values weighted based upon the distribution of land-use types.

Table 3-1: Middle River Land-Use Nitrogen and Phosphorus Loads

| | | NITROGEN | | PHOSPHORUS | |
|---|---|---|---|---|---|
| WRE Land Use | Area (acres) | Loading Rate (lbs/ac) | Load (lbs) | Loading Rate (lbs/ac) | Load (lbs) |
| Impervious Urban | 1,467.3 | 8.85 | 12,985 | 1.31 | 1,921 |
| Pervious Urban | 2,919.5 | 5.64 | 16,465 | 0.23 | 685 |
| Cropland | 249.9 | 11.90 | 2,974 | 1.24 | 310 |
| Pasture | 31.8 | 3.24 | 103 | 0.58 | 18 |
| Livestock | 0.0 | 34.37 | 0 | 6.07 | 0 |
| Forest | 1,602.1 | 1.49 | 2,380 | 0.03 | 56 |
| Wetlands | 120.9 | 1.49 | 180 | 0.03 | 4 |
| Water | 76.4 | - | - | - | - |
| Extractive | 0.0 | 0.00 | 0 | 0.00 | 0 |
| *Total* | *6,467.9* | | *35,086* | | *2,995* |

Table 3-2: Tidal Gunpowder Land-Use Nitrogen and Phosphorus Loads

| | | NITROGEN | | PHOSPHORUS | |
|---|---|---|---|---|---|
| WRE Land Use | Area (acres) | Loading Rate (lbs/ac) | Load (lbs) | Loading Rate (lbs/ac) | Load (lbs) |
| Impervious Urban | 368.3 | 8.82 | 3,248 | 1.30 | 480 |
| Pervious Urban | 1,194.7 | 5.59 | 6,682 | 0.23 | 277 |
| Cropland | 260.5 | 12.05 | 3,139 | 1.25 | 325 |
| Pasture | 13.7 | 3.28 | 45 | 0.59 | 8 |
| Livestock | 0.0 | 34.52 | 0 | 6.08 | 0 |
| Forest | 2,777.1 | 1.56 | 4,339 | 0.04 | 103 |
| Wetlands | 887.8 | 1.56 | 1,387 | 0.04 | 33 |
| Water | 81.3 | - | - | - | - |
| Extractive | 272.6 | 8.92 | 2,432 | 2.59 | 705 |
| *Total* | *5,856.0* | | *21,271* | | *1,931* |

Table 3-3: Middle River and Tidal Gunpowder Land-Use Nitrogen and Phosphorus Loads

| Source | Area (acres) | Nitrogen Rate (lbs/ac) | Nitrogen Load (lbs/yr) | Phosphorus Rate (lbs/ac) | Phosphorus Load (lbs/yr) |
|---|---|---|---|---|---|
| Impervious Urban | 1,836 | 8.84 | 16,233 | 1.31 | 2,402 |
| Pervious Urban | 4,114 | 5.63 | 23,146 | 0.23 | 962 |
| Cropland | 510 | 11.98 | 6,113 | 1.24 | 635 |
| Pasture | 45 | 3.25 | 148 | 0.58 | 27 |
| Livestock | 0 | 34.44 | 0 | 6.08 | 0 |
| Forest | 4,379 | 1.53 | 6,719 | 0.04 | 159 |
| Wetlands | 1,009 | 1.55 | 1,567 | 0.04 | 37 |
| Water | 158 | - | - | - | - |
| Extractive | 273 | 8.92 | 2,432 | 2.59 | 705 |
| *Totals* | *12,324* | | *56,357* | | *4,926* |

*Septic System Pollutant Loading*

Dwellings, businesses, and institutions which manage wastewater from their site through the utilization of septic systems contribute nitrogen loading within a watershed through the groundwater deposition of nitrogen. Septic systems are classified by their location in the watershed as either within 1,000 feet of a stream, within the Critical Area buffer, or greater than 1,000 feet of a stream. Unique loading rates were developed for each category to determine the nitrogen loading from individual septic systems. Table 3-4 displays the estimated nitrogen pollutant loading from septic systems in Middle River and Tidal Gunpowder developed by CBP, MDE and EPS.

Table 3-4: Middle River and Tidal Gunpowder Nitrogen Loads from Septic Systems

| Pollution Source | Middle River Nitrogen (lbs/year) | Middle River Phosphorus (lbs/year) | Tidal Gunpowder Nitrogen (lbs/year) | Tidal Gunpowder Phosphorus (lbs/year) |
|---|---|---|---|---|
| Septic Systems | 3,286 | 0 | 2,427 | 0 |

### 3.4.2 Pollutant Removal Analysis

As discussed in Chapter 1, as part of the Chesapeake Bay TMDL, a reduction in nitrogen and phosphorus loads from urban stormwater discharges and septic systems is necessary to meet water quality standards. The load reductions needed within Middle River and Tidal Gunpowder to achieve this are summarized in the Table 3-5. Note that percent reductions were applied to the pollutant load from urban runoff sources (i.e., impervious and pervious urban), since the nutrient TMDL relates to urban sources only. For a summary of the percent load reductions required by Baltimore County to meet Chesapeake Bay TMDL requirements for nitrogen and phosphorous, see Table 1-1.

Table 3-5: Middle River and Tidal Gunpowder Nitrogen and Phosphorus Load Reductions

| Source | Area (acres) | TN Load (lbs/yr) | TP Load (lbs/yr) |
|---|---|---|---|
| Urban | 5,950 | 39,379 | 3,363 |
| *2017 Reduction Goal:* | | *7,994* | *1,063* |
| *2020 Reduction Goal:* | | *11,420* | *1,517* |

The following sections present a quantitative analysis of pollutant removal capabilities of proposed BMPs to ensure that the required reductions in nutrient loads from urban runoff in the Middle River and Tidal Gunpowder watershed are achieved. Note that many of the removal efficiencies used to estimate pollutant reductions are based on the peer-reviewed and CBP-approved nonpoint source BMP tables developed for the Phase 5.0 CBP Watershed Model. Additional pollutant reductions from the 2011 Maryland Draft *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated* were used if values were not available in the BMP tables. The BMP tables and *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated* are included in Appendix C. Also note that the calculations and estimates presented in the following subsections represent maximum potential pollutant removal capabilities.

Pollutant loading values varied slightly between Middle River and Tidal Gunpowder; therefore calculations using pollutant loading rates were performed separately for pollution reduction measures in Middle River and Tidal Gunpowder and then combined to account for the entire SWAP study area. A summary of overall pollutant load reduction estimates is presented at the end of this section for three scenarios: a maximum implementation scenario, the projected implementation schedule to meet the 2017 milestone and the projected implementation schedule to meet the 2020 milestone.

#### *3.4.2.1 Implemented Capital Improvement Projects*

Baltimore County has implemented several capital improvement projects in the Middle River and Tidal Gunpowder watershed including shoreline enhancements, stream restoration, stormwater retrofits and stormwater wetlands. Because nutrient reductions based on existing stormwater treatment facilities such as ponds and wetlands are calculated in Section 3.4.2.2, they were not counted in this section. Nutrient reductions associated with shoreline enhancement and stream restoration capital improvement projects were taken from the Baltimore County *NPDES – Municipal Stormwater Discharge Permit 2011 Annual Report*. A summary of the pollutant load reductions from these projects is seen in Table 3-6.

Table 3-6: Completed Shoreline Enhancement Projects in Middle River and Tidal Gunpowder

| Capital Improvement Projects | | | | | | | |
|---|---|---|---|---|---|---|---|
| Middle River Watershed | | | | | | | |
| | | | | | Removal Rate (lbs/year) | | |
| Project | Facility Type | Linear Feet | Cost | Date | TN | TP | Impervious Acres |
| Turkey Point | SE | 1,000 | $127,539 | 1997 | 112.7 | 74.1 | 32.8 |
| Dark Head Park | SE | 780 | $168,000 | 1990 | 426.2 | 280.2 | 124 |
| Pottery Farm Park | SE | 1,700 | $351,000 | 1995 | 190.5 | 125.3 | 55.4 |
| Hawthorne Park | SE | 350 | $64,000 | 1995 | 39.1 | 25.7 | 11.4 |
| Tall Trees | SR | 1,000 | *$1,100,000 | 2006 | 202 | 10.7 | |
| Rocky Point Beach | SE | 1,110 | $324,945 | 1993 | 1319.7 | 867.7 | 383.9 |
| Tidal Gunpowder Watershed | | | | | | | |
| | | | | | Removal Rate (lb./year) | | |
| Project | Facility Type | Linear Feet | Cost | Date | TN | TP | Impervious Acres |
| Carrollwood Shoreline | SE | 150 | $150,000 | 1992 | 20.5 | 13.5 | 6 |
| Totals | | 6,090 | $2,285,484 | | 2,311 | 1,397 | 614 |

SE – Shoreline Enhancement; SR – Stream Restoration
* – Cost is combined stream restoration and pond, individual SR costs are not available

### 3.4.2.2 Existing Stormwater Management (SWM)

As described in detail in Section 2.3 of the *Watershed Characterization Report* (Appendix D), there are 111 existing SWM facilities in the Middle River and Tidal Gunpowder watershed including dry and wet ponds, wetlands, infiltration/filtration practices, extended detention, proprietary BMPs and other types of SWM facilities (i.e., underground detention, stilling basin). The pollutant removal capability of existing SWM in the watershed is not 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 recommended by CBP for the various types of SWM facilities. The equation used to estimate total nitrogen (TN) load reductions for a particular type of SWM facility is expressed as:

$$[6.71(lbs/ac/yr) \times DA(acres)] \times efficiency(\%) \quad \text{(Middle River)}$$

$$[6.35(lbs/ac/yr) \times DA(acres)] \times efficiency(\%) \quad \text{(Tidal Gunpowder)}$$

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

$$[0.59(lbs/ac/yr) \times DA(acres)] \times efficiency(\%)$$ (Middle River)

$$[0.48(lbs/ac/yr) \times DA(acres)] \times efficiency(\%)$$ (Tidal Gunpowder)

The pollutant load received from the drainage area contributing to the SWM facility is denoted by the first expression in brackets in both of the above equations. The pollutant loading rates shown, 6.71 lbs TN/ac/yr and 0.59 lbs TP/ac/yr for Middle River and 6.35 lbs TN/ac/yr and 0.48 lbs TP/ac/yr for Tidal Gunpowder, represents the weighted average of impervious and pervious urban rates used in the pollutant loading analysis (Tables 3-1 and 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 5.3.2. The percent pollutant removal efficiency depends on the type of facility and is based on the values shown in Appendix C 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 below. The results from both watersheds have been combined into one table.

Table 3-7: Existing SWM Load Reductions

| SWM Facility Type | No. (#) | DA (acres) | TN Load from DA (lbs/yr) | TN Removal Efficiency (%) | Max Potential TN Load Reduction (lbs/yr) | TP Load from DA (lbs/yr) | TP Removal Efficiency (%) | Max Potential TP Load Reduction (lbs/yr) |
|---|---|---|---|---|---|---|---|---|
| Dry Pond | 20 | 296.8 | 1,972 | 5% | 99 | 170 | 10% | 17 |
| Wet Pond | 16 | 352.8 | 2,344 | 20% | 469 | 202 | 45% | 91 |
| Wetland | 16 | 98.2 | 648 | 20% | 130 | 55 | 45% | 25 |
| Infiltration/Filtration | 39 | 139.1 | 918 | 80% | 735 | 78 | 85% | 66 |
| Extended Detention | 9 | 37.3 | 247 | 20% | 49 | 21 | 20% | 4 |
| Proprietary BMP | 3 | 2.5 | 17 | 5% | 1 | 1 | 10% | 0 |
| Grassed Swale/Channel | 4 | 34.8 | 233 | 70% | 163 | 20 | 75% | 15 |
| Other | 4 | 8.4 | 56 | 5% | 3 | 5 | 10% | 0.5 |
| *Totals:* | 111 | 970 | 6,434 | - | *1,647* | 553 | - | *219* |

### 3.4.2.3 Stormwater Management Conversions

As described previously, three of the 10 existing detention ponds surveyed have the potential for horizontal expansion and conversion to an extended detention facility that has a 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 based on BMP efficiencies recommended by CBP for detention and extended detention facilities. The equation used to estimate total nitrogen (TN) load reductions for SWM conversions is expressed as:

$$[6.71(lbs/ac/yr) \times DA(acres)] \times 25\%$$ (Middle River)

$$[6.35(lbs/ac/yr) \times DA(acres)] \times 25\%$$ (Tidal Gunpowder)

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

$$[0.59(lbs/ac/yr) \times DA(acres)] \times 10\% \text{ (Middle River)}$$

$$[0.48(lbs/ac/yr) \times DA(acres)] \times 10\% \text{ (Tidal Gunpowder)}$$

The pollutant load received from the drainage area contributing to the SWM facility is denoted by the first expression in brackets in the equations above. Similar to existing SWM, the pollutant loading rates shown, 6.71 lbs TN/ac/yr and 0.59 lbs TP/ac/yr for Middle River and 6.35 lbs TN/ac/yr and 0.48 lbs TP/ac/yr for Tidal Gunpowder, represent the weighted average of impervious and pervious urban rates used in the pollutant loading analysis (Tables 3-1 and 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 extended detention and detention facilities, based on CBP guidance shown in Appendix C under Urban and Mixed Open BMPs, Stormwater Management. A summary of SWM conversion load reduction calculations and results are shown in Table 3-8.

Table 3-8: SWM Conversion Load Reductions

| TOTAL SWAP STUDY AREA | | | | | | |
|---|---|---|---|---|---|---|
| | | | REMOVAL EFFICIENCY | | | |
| Pollutant | DA for SWM Conversion (acres) | Load from DA (lbs/yr) | Detention Pond (%) | Extended Detention (%) | Increase in Efficiency (%) | Max Potential Load Reduction (lbs/yr) |
| TN | 28.91 | 187.6 | 5% | 20% | 15% | 28.1 |
| TP | 28.91 | 15.2 | 10% | 20% | 10% | 1.5 |
| **MIDDLE RIVER** | | | | | | |
| | | | REMOVAL EFFICIENCY | | | |
| Pollutant | DA for SWM Conversion (acres) | Load from DA (lbs/yr) | Detention Pond (%) | Extended Detention (%) | Increase in Efficiency (%) | Max Potential Load Reduction (lbs/yr) |
| TN | 11.05 | 74.2 | 5% | 20% | 15% | 11.1 |
| TP | 11.05 | 6.6 | 10% | 20% | 10% | 0.7 |
| **GUNPOWDER RIVER** | | | | | | |
| | | | REMOVAL EFFICIENCY | | | |
| Pollutant | DA for SWM Conversion (acres) | Load from DA (lbs/yr) | Detention Pond (%) | Extended Detention (%) | Increase in Efficiency (%) | Max Potential Load Reduction (lbs/yr) |
| TN | 17.86 | 113.5 | 5% | 20% | 15% | 17.0 |
| TP | 17.86 | 8.7 | 10% | 20% | 10% | 0.9 |

#### 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 indentified for retrofit potential during the uplands surveys for neighborhoods, institutions, hotspots, and pervious areas. Pollutant reductions for stormwater retrofits are calculated based on the approximate pollutant load received from the impervious drainage area (DA) and removal efficiency of infiltration type BMPs. The equation used to estimate total nitrogen (TN) load reductions for stormwater retrofits is expressed as:

$$[8.85(lbs/ac/yr) \times DA(acres)] \times 50\%$$ (Middle River)

$$[8.82(lbs/ac/yr) \times DA(acres)] \times 50\%$$ (Tidal Gunpowder)

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

$$[1.31(lbs/ac/yr) \times DA(acres)] \times 70\%$$ (Middle River)

$$[1.30(lbs/ac/yr) \times DA(acres)] \times 70\%$$ (Tidal Gunpowder)

The pollutant load received from the drainage area contributing to the SWM facility is denoted by the first expression in brackets in the equations above. The pollutant loading rates shown, 8.85 lbs TN/ac/yr and 1.31 lbs TP/ac/yr for Middle River and 8.82 lbs TN/ac/yr and 1.30 lbs TP/ac/yr for Tidal Gunpowder, are the impervious urban rates used in the pollutant loading analysis (Table 3.20) since this represents the source of runoff being treated. Pollutant removal efficiencies are those reported for infiltration practices, based on CBP guidance shown in Appendix C under Urban and Mixed Open BMPs, Stormwater Management. A summary of stormwater retrofit load reduction calculations and results for Middle River, Tidal Gunpowder, and the combined SWAP area are shown Table 3-9.

Table 3-9: Stormwater Retrofit (Infiltration Practices) Load Reductions

| TOTAL SWAP STUDY AREA | | | | | |
|---|---|---|---|---|---|
| Pollutant | | NSA Impervious Area Recommended for SW Retrofit (acres) | Load from DA (lbs) | Removal Efficiency (%) | Max Potential Load Reduction (lbs/yr) |
| TN | | 23.0 | 204 | 50% | 102 |
| TP | | 23.0 | 30 | 70% | 21 |
| **MIDDLE RIVER** | | | | | |
| Pollutant | Impervious Urban Loading Rate (lbs/ac/yr) | NSA Impervious Area Recommended for SW Retrofit (acres) | Load from DA (lbs) | Removal Efficiency (%) | Max Potential Load Reduction (lbs/yr) |
| TN | 8.85 | 19.3 | 171 | 50% | 86 |
| TP | 1.31 | 19.3 | 25 | 70% | 18 |
| **TIDAL GUNPOWDER** | | | | | |
| Pollutant | Impervious Urban Loading Rate (lbs/ac/yr) | NSA Impervious Area Recommended for SW Retrofit (acres) | Load from DA (lbs) | Removal Efficiency (%) | Max Potential Load Reduction (lbs/yr) |
| TN | 8.82 | 3.7 | 33 | 50% | 16 |
| TP | 1.30 | 3.7 | 5 | 70% | 3 |

### 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 use conversion from impervious to pervious urban. The equation used to estimate total nitrogen (TN) load reductions for impervious cover removal is expressed as:

$$[8.85(lbs/ac/yr) - 5.64(lbs/ac/yr)] \times impervious_area(acres)$$ (Middle River)

$$[8.82(lbs/ac/yr) - 5.59(lbs/ac/yr)] \times impervious_area(acres)$$ (Tidal Gunpowder)

The equation used to estimate total phosphorus (TP) load reductions for impervious cover removal is expressed as:

$$[1.31(lbs/ac/yr) - 0.23(lbs/ac/yr)] \times impervious_area(acres)$$ (Middle River)

$$[1.30(lbs/ac/yr) - 0.23(lbs/ac/yr)] \times impervious_area(acres)$$ (Tidal Gunpowder)

Impervious cover removal involves 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 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 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 below.

Table 3-10: Impervious Cover Removal Load Reductions

| TOTAL SWAP STUDY AREA | | | | | |
|---|---|---|---|---|---|
| Pollutant | | Pervious Urban Loading Rate (lbs/ac/yr) | Reduction in Loading Rate (lbs/ac/yr) | Impervious Area Removed (acres) | Max Potential Load Reduction (lbs/yr) |
| TN | | 5.63 | 3.21 | 0.41 | 1.32 |
| TP | | 0.23 | 1.07 | 0.41 | 0.44 |
| MIDDLE RIVER | | | | | |
| Pollutant | Impervious Urban Loading Rate (lbs/ac/yr) | Pervious Urban Loading Rate (lbs/ac/yr) | Reduction in Loading Rate (lbs/ac/yr) | Impervious Area Removed (acres) | Max Potential Load Reduction (lbs/yr) |
| TN | 8.85 | 5.64 | 3.21 | 0.31 | 1.01 |
| TP | 1.31 | 0.23 | 1.07 | 0.31 | 0.34 |
| TIDAL GUNPOWDER | | | | | |
| Pollutant | Impervious Urban Loading Rate (lbs/ac/yr) | Pervious Urban Loading Rate (lbs/ac/yr) | Reduction in Loading Rate (lbs/ac/yr) | Impervious Area Removed (acres) | Max Potential Load Reduction (lbs/yr) |
| TN | 8.82 | 5.59 | 3.23 | 0.10 | 0.31 |
| TP | 1.30 | 0.23 | 1.07 | 0.10 | 0.10 |

### 3.4.2.6 Stream Buffer Reforestation

The current vegetative condition of the stream riparian buffer (100 feet on either side of stream system) was analyzed in Chapter 2 of the *Watershed Characterization Report*. Buffer conditions were classified as impervious, open pervious, or forested areas. Open pervious areas are the best areas to initially target for restoration. Approximately 317 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 C). The equation used to estimate total nitrogen (TN) load reductions for the land use conversion portion of stream buffer reforestation is expressed as:

$$\text{Land Use Conversion (TN)} = \left[5.64(lbs/ac/yr) - 1.49(lbs/ac/yr)\right] \times OpenPerviousArea(acres)$$

(Middle River)

$$\text{Land Use Conversion (TN)} = \left[5.59(lbs/ac/yr) - 1.56(lbs/ac/yr)\right] \times OpenPerviousArea(acres)$$

(Tidal Gunpowder)

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

$$\text{Land Use Conversion (TP)} = \left[0.23(lbs/ac/yr) - 0.03(lbs/ac/yr)\right] \times OpenPerviousArea(acres)$$

(Middle River)

$$\text{Land Use Conversion (TP)} = \left[0.23(lbs/ac/yr) - 0.04(lbs/ac/yr)\right] \times OpenPerviousArea(acres)$$

(Tidal Gunpowder)

The first expression in brackets in the equations 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 reductions 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 C, 1 acre of buffer treats approximately 1 acre of upland area for nitrogen with an efficiency of 25 percent for urban and mixed open buffers. The weighted loading rate for the entire watershed is used to represent this upland area and is the final number in brackets in the equations below. The total nitrogen (TN) load reductions for the removal efficiency portion of buffer reforestation can be expressed as:

$$\text{Buffer BMP Removal (TN)} = \left[OpenPerviousArea(acres) \times \frac{1(uplandacres)}{1(bufferacre)} \times 5.42(lbs/ac/yr)\right] \times 25\%$$

(Middle River)

$$\text{Buffer BMP Removal (TN)} = \left[OpenPerviousArea(acres) \times \frac{1(uplandacres)}{1(bufferacre)} \times 3.63(lbs/ac/yr)\right] \times 25\%$$

(Tidal Gunpowder)

Similarly, 1 acre of buffer treats approximately 1 acre of upland area for phosphorus 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:

$$\text{Buffer BMP Removal (TP)} = \left[OpenPerviousArea(acres) \times \frac{1(uplandacres)}{1(bufferacre)} \times 0.46(lbs/ac/yr)\right] \times 50\%$$

(Middle River)

$$\text{Buffer BMP Removal (TP)} = \left[OpenPerviousArea(acres) \times \frac{1(uplandacres)}{1(bufferacre)} \times 0.33(lbs/ac/yr)\right] \times 50\%$$

(Tidal Gunpowder)

The loading rates shown in the equations above represent overall watershed loading rates. This is estimated as the total watershed nutrient load divided by the total watershed area. These are 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 the table below.

Table 3-11: Stream Buffer Reforestation Load Reductions

| TOTAL SWAP STUDY AREA | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | LU CONVERSION | | BUFFER BMP REMOVAL | | | |
| Pollutant | Open Pervious Area (acres) | Reduced Loading Rate (lbs/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) |
| TN | 317 | 4.10 | 1,301 | 25% | 4.65 | 369 | 1,669 |
| TP | 317 | 0.20 | 63 | 50% | 0.41 | 64 | 127 |
| **MIDDLE RIVER** | | | | | | | |
| | | LU CONVERSION | | BUFFER BMP REMOVAL | | | |
| Pollutant | Open Pervious Area (acres) | Reduced Loading Rate (lbs/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) |
| TN | 180 | 4.15 | 747 | 25% | 5.42 | 244 | 991 |
| TP | 180 | 0.20 | 36 | 50% | 0.46 | 42 | 78 |
| **TIDAL GUNPOWDER** | | | | | | | |
| | | LU CONVERSION | | BUFFER BMP REMOVAL | | | |
| Pollutant | Open Pervious Area (acres) | Reduced Loading Rate (lbs/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) |
| TN | 137 | 4.03 | 554 | 25% | 3.63 | 125 | 679 |
| TP | 137 | 0.19 | 27 | 50% | 0.33 | 23 | 49 |

#### *3.4.2.7 Shoreline Buffer Reforestation*

The current vegetative condition of the shoreline riparian buffer (100 feet from shoreline) was analyzed in Chapter 2 of the *Watershed Characterization Report*. Shoreline buffer conditions were classified as impervious, open pervious, or forested areas. Open pervious areas are the best areas to initially target for restoration. Approximately 641 acres of open pervious area were identified within the shoreline buffer zone.

Pollutant reductions for buffer reforestation are calculated based on a land use conversion from pervious urban to forest per BMP performance guidance from CBP (Appendix C). The equation used to estimate total nitrogen (TN) load reductions for shoreline buffer reforestation is expressed as:

$$\text{Land Use Conversion (TN)} = \left[5.64(lbs/ac/yr) - 1.49(lbs/ac/yr)\right] \times OpenPerviousArea(acres)$$

(Middle River)

$$\text{Land Use Conversion (TN)} = \left[5.59(lbs/ac/yr) - 1.56(lbs/ac/yr)\right] \times OpenPerviousArea(acres)$$

(Tidal Gunpowder)

The equation used to estimate total phosphorus (TP) load reductions for shoreline buffer reforestation is expressed as:

$$\text{Land Use Conversion (TP)} = \left[0.23(lbs/ac/yr) - 0.03(lbs/ac/yr)\right] \times OpenPerviousArea(acres)$$

(Middle River)

$$\text{Land Use Conversion (TP)} = \left[0.23(lbs/ac/yr) - 0.04(lbs/ac/yr)\right] \times OpenPerviousArea(acres)$$

(Tidal Gunpowder)

The first expression in brackets in the equations 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 reductions from land use conversion. A summary of shoreline buffer reforestation reduction calculations and results are shown in the table below.

Table 3-12: Shoreline Buffer Reforestation Load Reductions

| TOTAL SWAP STUDY AREA | | | | | |
|---|---|---|---|---|---|
| Pollutant | Open Pervious Area (acres) | | | Max Potential Load Reduction (lbs/yr) | |
| TN | 641 | | | 2,633.6 | |
| TP | 641 | | | 126.8 | |
| **MIDDLE RIVER** | | | | | |
| Pollutant | Open Pervious Area (acres) | Pervious Urban Loading Rate (lbs/ac/yr) | Forest Loading Rate (lbs/ac/yr) | Reduced Loading Rate (lbs/ac/yr) | Max Potential Load Reduction (lbs/yr) |
| TN | 415 | 5.64 | 1.49 | 4.15 | 1,725.1 |
| TP | 415 | 0.23 | 0.03 | 0.20 | 82.9 |
| **TIDAL GUNPOWDER** | | | | | |
| Pollutant | Open Pervious Area (acres) | Pervious Urban Loading Rate (lbs/ac/yr) | Forest Loading Rate (lbs/ac/yr) | Reduced Loading Rate (lbs/ac/yr) | Max Potential Load Reduction (lbs/yr) |
| TN | 225 | 5.59 | 1.56 | 4.03 | 908.5 |
| TP | 225 | 0.23 | 0.04 | 0.19 | 43.9 |

#### 3.4.2.8 Pervious Area Reforestation

Fifteen (15) open pervious areas with reforestation potential were identified in the watershed. Pollutant reductions for pervious area reforestation are calculated based on a 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:

$$\text{Land Use Conversion (TN)} = \left[5.64(lbs/ac/yr) - 1.49(lbs/ac/yr)\right] \times OpenPerviousArea(acres)$$

(Middle River)

$$\text{Land Use Conversion (TN)} = \left[5.59(lbs/ac/yr) - 1.56(lbs/ac/yr)\right] \times OpenPerviousArea(acres)$$

(Tidal Gunpowder)

The equation used to estimate total phosphorus (TP) load reductions for pervious area reforestation is expressed as:

$$\text{Land Use Conversion (TP)} = \left[0.23(lbs/ac/yr) - 0.03(lbs/ac/yr)\right] \times OpenPerviousArea(acres)$$

(Middle River)

$$\text{Land Use Conversion (TP)} = \left[0.23(lbs/ac/yr) - 0.04(lbs/ac/yr)\right] \times OpenPerviousArea(acres)$$

(Tidal Gunpowder)

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 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 open pervious area available for reforestation. A summary of pervious area reforestation reduction calculations and results are shown in Table 3-13.

Table 3-13: Pervious Area Reforestation Load Reductions

| TOTAL SWAP STUDY AREA | | | | | |
|---|---|---|---|---|---|
| Pollutant | | Open Pervious Area (acres) | | | Max Potential Load Reduction (lbs/yr) |
| TN | | 69.5 | | | 283 |
| TP | | 69.5 | | | 14 |
| **MIDDLE RIVER** | | | | | |
| 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 | 5.64 | 1.49 | 4.15 | 21.0 | 87 |
| TP | 0.23 | 0.03 | 0.20 | 21.0 | 4 |
| **TIDAL GUNPOWDER** | | | | | |
| 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 | 5.59 | 1.56 | 4.03 | 48.5 | 196 |
| TP | 0.23 | 0.04 | 0.19 | 48.5 | 9 |

### 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., channel alterations) and improve water quality. Pollutant load reduction estimates in pounds per linear foot of stream restoration were developed by the County based on a re-analysis of Spring Branch data presented in the NPDES 2006 Annual Report and also used in the Upper Back River SWAP. In the June, 2011 draft document of *Accounting For Stormwater Wasteload Allocations and Impervious Acres Treated* produced by MDE, another method of calculating pollution reductions for stream restoration was presented. For the purpose of this report, both methods are presented but only the method provided by MDE is used to calculate the total pollution reductions in the Middle River and Tidal Gunpowder watershed.

Baltimore County's method derived from the Spring Branch data used a baseline reduction factor based on the linear footage of stream restoration that is proposed. The equation from Baltimore County used to estimate total nitrogen (TN) load reductions for stream restoration is expressed as:

$$0.202(lbs/\ ft) \times RL(\ ft)$$

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

$$0.0107(lbs/\ ft) \times RL(\ ft)$$

Channel alteration was noted for approximately 1 percent of the surveyed stream length. Because only a portion of the watershed's streams were surveyed, this percentage was extrapolated to the total stream length in the Tidal Gunpowder (21.3 miles or 112,464 feet) to estimate the total stream length with restoration potential (i.e., 1% x 112,464 feet = 1,125 feet). Streams within the Middle River watershed were not considered for stream restoration. A summary of stream corridor restoration reduction calculations and results based on the Baltimore County method are shown in the table below.

Table 3-14: Stream Corridor Restoration Load Reductions (Baltimore County Method)

| Pollutant | Reduction in Loading Rate (lbs/ft) | Length of Erosion/ Channel Alteration (ft) | % of Length Surveyed (ft) | Estimated Stream Restoration Length (ft) | Max Potential Load Reduction (lbs/yr) |
|---|---|---|---|---|---|
| TN | 0.202 | 132 | 1% | 1,125 | 227 |
| TP | 0.0107 | 132 | 1% | 1,125 | 12 |

MDE's method derived from the 2011 draft document of *Accounting For Stormwater Wasteload Allocations and Impervious Acres Treated* used a baseline reduction factor based on the linear footage of stream restoration that is proposed. This is calculated in the first set of brackets in the equation below. In addition, for every 100 linear feet of stream restoration, credit was given for treatment of 1 acre of impervious area. This credit is accounted for as a change from the impervious urban land use to the forest land use loading rate. This is calculated in the second set of brackets in the equation below. The equation from MDE used to estimate total nitrogen (TN) load reductions for stream restoration is expressed as:

$$\{0.02(lbs/ft)\times RL(ft)\}+\{[8.82(lbs/ac/yr)-1.56(lbs/ac/yr)]\times RL(ft)\div 100\}$$

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

$$\{0.0035(lbs/ft)\times RL(ft)\}+\{[1.304(lbs/ac/yr)-0.037(lbs/ac/yr)]\times RL(ft)\div 100\}$$

Table 3-15: Stream Corridor Restoration Load Reductions (MDE Method)

| Pollutant | Reduction in Loading Rate (lbs/ft) | Estimated Stream Restoration Length (ft) | Stream Load Reduction (lbs/yr) | Impervious Urban Loading Rate (lbs/ac/yr) | Forest Loading Rate (lbs/ac/yr) | Reduced Loading Rate (lbs/ac/yr) | Impervious Area Treatment Credit (lbs/yr) | Max Potential Load Reduction (lbs/yr) |
|---|---|---|---|---|---|---|---|---|
| TN | 0.02 | 1,125 | 22 | 8.82 | 1.56 | 7.26 | 82 | 104 |
| TP | 0.0035 | 1,125 | 4 | 1.3038 | 0.0370 | 1.27 | 14 | 18 |

### *3.4.2.10 Downspout Disconnection*

A total of 44 neighborhoods (out of 59 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*.

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 of filtration type BMPs. The equation used to estimate total nitrogen (TN) load reductions for downspout disconnection is expressed as:

$$[8.85(lbs/ac/yr) \times DA(acres)] \times 50\%$$ (Middle River)

$$[8.82(lbs/ac/yr) \times DA(acres)] \times 50\%$$ (Tidal Gunpowder)

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

$$[1.31(lbs/ac/yr) \times DA(acres)] \times 60\%$$ (Middle River)

$$[1.30(lbs/ac/yr) \times DA(acres)] \times 60\%$$ (Tidal Gunpowder)

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, 8.85 lbs TN/ac/yr and 1.31 lbs TP/ac/yr for Middle River and 8.82 lbs TN/ac/yr and 1.30 lbs TP/ac/yr for Tidal Gunpowder, 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 C under Urban and Mixed Open BMPs, Stormwater Management. A summary of downspout disconnection load reduction calculations and results are shown in Table 3-16.

Table 3-16: Downspout Disconnection Load Reductions

| TOTAL SWAP STUDY AREA | | | |
|---|---|---|---|
| Pollutant | DA (Rooftop area recommended for downspout disconnect) (acres) | Removal Efficiency (%) | Max Potential Load Reduction (lbs/yr) |
| TN | 106 | 50% | 471 |
| TP | 106 | 60% | 84 |
| **MIDDLE RIVER** | | | |
| 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 | 8.85 | 91 | 50% | 402 |
| TP | 1.31 | 91 | 60% | 71 |
| **TIDAL GUNPOWDER** | | | |
| 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 | 8.82 | 16 | 50% | 69 |
| TP | 1.30 | 16 | 60% | 12 |

### *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 investigated. 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 400 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:

$$\left[5.64(lbs/ac/yr) - 1.49(lbs/ac/yr)\right] \times \left[\#Trees \cdot \frac{1(acre)}{400(trees)}\right] \text{ (Middle River)}$$

$$\left[5.59(lbs/ac/yr) - 1.56(lbs/ac/yr)\right] \times \left[\#Trees \cdot \frac{1(acre)}{400(trees)}\right] \text{ (Tidal Gunpowder)}$$

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

$$\left[0.23(lbs/ac/yr) - 0.03(lbs/ac/yr)\right] \times \left[\#Trees \cdot \frac{1(acre)}{400(trees)}\right] \text{ (Middle River)}$$

$$\left[0.23(lbs/ac/yr) - 0.04(lbs/ac/yr)\right] \times \left[\#Trees \cdot \frac{1(acre)}{400(trees)}\right] \text{ (Tidal Gunpowder)}$$

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 rate multiplied by the open pervious area 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 Table 3-17 and Table 3-18.

Table 3-17: Neighborhood Tree Planting Load Reductions

| TOTAL SWAP STUDY AREA | | | |
|---|---|---|---|
| Pollutant | Estimated # Trees for NSAs (#) | New Forested Area (acres) | Max Potential Load Reduction (lbs/yr) |
| TN | 4,931 | 12 | 50.8 |
| TP | 4,931 | 12 | 2.4 |

| MIDDLE RIVER | | | | | | |
|---|---|---|---|---|---|---|
| Pollutant | Pervious Urban Loading Rate (lbs/ac/yr) | Forest Loading Rate (lbs/ac/yr) | Reduced Loading Rate (lbs/ac/yr) | Estimated # Trees for NSAs (#) | New Forested Area (acres) | Max Potential Load Reduction (lbs/yr) |
| TN | 5.64 | 1.49 | 4.15 | 3,481 | 8.7 | 36.1 |
| TP | 0.23 | 0.03 | 0.20 | 3,481 | 8.7 | 1.7 |

| GUNPOWDER RIVER | | | | | | |
|---|---|---|---|---|---|---|
| Pollutant | Pervious Urban Loading Rate (lbs/ac/yr) | Forest Loading Rate (lbs/ac/yr) | Reduced Loading Rate (lbs/ac/yr) | Estimated # Trees for NSAs (#) | New Forested Area (acres) | Max Potential Load Reduction (lbs/yr) |
| TN | 5.59 | 1.56 | 4.03 | 1,450 | 3.6 | 14.6 |
| TP | 0.23 | 0.04 | 0.19 | 1,450 | 3.6 | 0.7 |

Table 3-18: Institution Tree Planting Load Reductions

| TOTAL SWAP STUDY AREA | | | |
|---|---|---|---|
| Pollutant | Estimated # Trees for ISIs (#) | New Forested Area (acres) | Max Potential Load Reduction (lbs/yr) |
| TN | 2,365 | 6 | 24.3 |
| TP | 2,365 | 6 | 1.2 |

| MIDDLE RIVER | | | | | | |
|---|---|---|---|---|---|---|
| Pollutant | Pervious Urban Loading Rate (lbs/ac/yr) | Forest Loading Rate (lbs/ac/yr) | Reduced Loading Rate (lbs/ac/yr) | Estimated # Trees for ISIs (#) | New Forested Area (acres) | Max Potential Load Reduction (lbs/yr) |
| TN | 5.64 | 1.49 | 4.15 | 1,410 | 3.5 | 14.6 |
| TP | 0.23 | 0.03 | 0.20 | 1,410 | 3.5 | 0.7 |

| GUNPOWDER RIVER | | | | | | |
|---|---|---|---|---|---|---|
| Pollutant | Pervious Urban Loading Rate (lbs/ac/yr) | Forest Loading Rate (lbs/ac/yr) | Reduced Loading Rate (lbs/ac/yr) | Estimated # Trees for ISIs (#) | New Forested Area (acres) | Max Potential Load Reduction (lbs/yr) |
| TN | 5.59 | 1.56 | 4.03 | 955 | 2.4 | 9.6 |
| TP | 0.23 | 0.04 | 0.19 | 955 | 2.4 | 0.5 |

### *3.4.2.12 Urban Nutrient Management*

Urban nutrient management refers to educating citizens about environmentally friendly lawn care techniques. This includes the reduction/elimination of fertilizer and pesticide use and reducing the amount of mowed lawn via bayscaping. Because of the implementation of the Fertilizer Act of 2011 in Maryland (discussed in Section 3.4.2.17), nutrient reductions for neighborhoods targeted for fertilizer reduction/education were not calculated. Neighborhoods targeted for bayscaping education were those where the typical lot was at least ¼ acre in size, was less than 25 percent landscaped, and where there was sufficient grass area available (27 out of 59 NSAs). The total acres of lawn that could be addressed through bayscaping is based on NSA results which are explained in Chapter 4 of the *Watershed Characterization Report.*

Pollutant reductions for bayscaping are calculated based on the pollutant load received from the total lawn drainage area (DA) recommended for bayscaping and removal efficiency. The equation used to estimate total nitrogen (TN) load reductions for bayscaping is expressed as:

$$[5.64(lbs/ac/yr) \times DA(acres)] \times 17\%$$ (Middle River)

$$[5.59(lbs/ac/yr) \times DA(acres)] \times 17\%$$ (Tidal Gunpowder)

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

$$[0.23(lbs/ac/yr) \times DA(acres)] \times 22\%$$ (Middle River)

$$[0.23(lbs/ac/yr) \times DA(acres)] \times 22\%$$ (Tidal Gunpowder)

The pollutant load received from the lawn area recommended for bayscaping is denoted by the first expression in brackets in the equations above. The pollutant loading rates shown, 5.64 lbs TN/ac/yr and 0.23 lbs TP/ac/yr for Middle River and 5.59 lbs TN/ac/yr and 0.23 lbs TP/ac/yr for Tidal Gunpowder, are the pervious urban rates used in the pollutant loading analysis (Table 3-1) since this represents the source of runoff being addressed. Pollutant removal efficiencies are those reported for bayscaping, based on CBP guidance shown in Appendix C under Urban and Mixed Open BMPs. A summary of urban nutrient management reduction calculations and results are shown in Table 3-19.

Table 3-19: Urban Nutrient Management Load Reductions

| TOTAL SWAP STUDY AREA | | | | |
|---|---|---|---|---|
| Pollutant | Estimated Area Available for Bayscaping (acres) | | Removal Efficiency (%) | Max Potential Load Reduction (lbs/yr) |
| TN | 223.8 | | 17% | 214 |
| TP | 223.8 | | 22% | 11 |
| **MIDDLE RIVER** | | | | |
| Pollutant | Pervious Urban Loading Rate (lbs/ac/yr) | Estimated Area Available for Bayscaping (acres) | Removal Efficiency (%) | Max Potential Load Reduction (lbs/yr) |
| TN | 5.64 | 130.9 | 17% | 125 |
| TP | 0.23 | 130.9 | 22% | 7 |
| **TIDAL GUNPOWDER** | | | | |
| Pollutant | Pervious Urban Loading Rate (lbs/ac/yr) | Estimated Area Available for Bayscaping (acres) | Removal Efficiency (%) | Max Potential Load Reduction (lbs/yr) |
| TN | 5.59 | 93.0 | 17% | 88 |
| TP | 0.23 | 93.0 | 22% | 5 |

### *3.4.2.13 Street Sweeping*

Nineteen (19) neighborhoods were recommended for street sweeping in the Middle River and Tidal Gunpowder watershed and contain approximately 31.5 miles of road. A review of the aerial mapping of the SWAP study area and specifically the neighborhoods recommended for street sweeping was conducted and an average street width of 30 feet was assumed to determine the total area of street sweeping

Pollutant reductions for street sweeping are calculated based on the pollutant load received from the total street area (DA) recommended for sweeping and removal efficiency. The equation used to estimate total nitrogen (TN) load reductions for street sweeping is expressed as:

$$[8.85(lbs/ac/yr) \times DA(acres)] \times 3\%$$ (Middle River)

$$[8.82(lbs/ac/yr) \times DA(acres)] \times 3\%$$ (Tidal Gunpowder)

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:

$$[1.31(lbs/ac/yr) \times DA(acres)] \times 3\%$$ (Middle River)

$$[1.30(lbs/ac/yr) \times DA(acres)] \times 3\%$$ (Tidal Gunpowder)

A summary of street sweeping reduction calculations and results are shown in Table 3-20.

Table 3-20: Street Sweeping Load Reductions

| TOTAL SWAP STUDY AREA | | | | |
|---|---|---|---|---|
| Pollutant | Proposed Miles of Street Sweeping (miles) | Proposed Area of Street Sweeping* (acres) | Removal Efficiency (%) | Max Potential Load Reduction (lbs/yr) |
| TN | 31.5 | 114.6 | 3% | 30 |
| TP | 31.5 | 114.6 | 3% | 5 |

| MIDDLE RIVER | | | | | |
|---|---|---|---|---|---|
| Pollutant | Impervious Urban Loading Rate (lbs/ac/yr) | Proposed Miles of Street Sweeping (miles) | Proposed Area of Street Sweeping* (acres) | Removal Efficiency (%) | Max Potential Load Reduction (lbs/yr) |
| TN | 8.85 | 31.5 | 114.6 | 3% | 30 |
| TP | 1.31 | 31.5 | 114.6 | 3% | 5 |

| TIDAL GUNPOWDER | | | | | |
|---|---|---|---|---|---|
| Pollutant | Impervious Urban Loading Rate (lbs/ac/yr) | Proposed Miles of Street Sweeping (miles) | Proposed Area of Street Sweeping* (acres) | Removal Efficiency (%) | Max Potential Load Reduction (lbs/yr) |
| TN | 8.82 | 0.0 | 0.0 | 3% | 0 |
| TP | 1.30 | 0.0 | 0.0 | 3% | 0 |

#### 3.4.2.14 Sanitary Sewer Overflows

A total of 20 sanitary sewer overflow (SSO) events were documented between 2000 and 2009 within Middle River and Tidal Gunpowder. An estimated 6,969 gallons were discharged over this 10-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 $8.3 \times 10^{-5}$ was used to convert gallons of overflow to pounds of pollutant. This is based on a 10 mg/L TP concentration and a multiplier of $8.3 \times 10^{-6}$ lb·L/mg·gal.

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

Based on these conversion factors, approximately 0.6 lbs of total nitrogen and 1.7 lbs of total phosphorus were released over the 10-year period as a result of SSOs. This is equivalent to pollutant reduction capabilities of 0.06 lbs TN/yr (i.e., 0.6 lbs TN/10 yrs) and 0.17 lbs TP/yr (i.e., 1.7 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 (Table 7-6).

#### 3.4.2.15 Proposed Shoreline Enhancements

Shoreline enhancement concepts were developed for one reach in Middle River and Tidal Gunpowder as part of EPS's Shoreline Feasibility Study (DEPS 1998). Nutrient reductions associated with the proposed shoreline enhancement project are estimated based on length of reach and nutrient removal rates from the *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated*. Shoreline lengths were estimated from project concept plans in the feasibility study. The equation used to estimate total nitrogen (TN) load reductions for shoreline enhancement is expressed as:

$$\left[0.16(lbs/linearfoot) \times reach_length(feet)\right]$$

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

$$\left[0.11(lbs/linearfoot) \times reach_length(feet)\right]$$

A summary of potential shoreline enhancement project reduction calculations and results are shown in Table 3-21.

Table 3-21: Shoreline Enhancement Load Reductions

| Proposed Project Location | Proposed Length (ft) | Reduction TN in Loading Rate (lbs/ft) | Reduction TP in Loading Rate (lbs/ft) | Max Potential TN Reduction (lbs/yr) | Max Potential TP Reduction (lbs/yr) |
|---|---|---|---|---|---|
| Darkhead Creek Park | 2,500 | 0.16 | 0.11 | 400 | 275 |
| *Totals:* | 2,500 | 0.16 | 0.11 | *400* | *275* |

### 3.4.2.16 Potential Redevelopment of Urban Areas

Development of natural areas to impervious urban landscapes causes an increase in pollutant loading through changes in land use. Redeveloping these urban areas back into a more natural setting can provide nutrient load reductions. In the Water Resources Element of its Master Plan 2020, Baltimore County has analyzed redevelopment scenarios and identified potential land for redevelopment in each of its watersheds.

Pollutant reductions for redevelopment are calculated based on the pollutant removal efficiencies from the current urban nutrient loading developed by Baltimore County during their analysis. The equation used to estimate total nitrogen (TN) load reductions from redevelopment is expressed as:

$$[6.71(lbs/ac/yr) \times DA(acres)] \times 59\%$$ (Middle River)

$$[6.35(lbs/ac/yr) \times DA(acres)] \times 59\%$$ (Tidal Gunpowder)

The amount of material removed is converted to total phosphorus (TP) load removed from redevelopment is expressed as:

$$[0.59(lbs/ac/yr) \times DA(acres)] \times 55\%$$ (Middle River)

$$[0.48(lbs/ac/yr) \times DA(acres)] \times 55\%$$ (Tidal Gunpowder)

A summary of potential urban redevelopment reduction calculations and results are shown in Table 3-22.

Table 3-22: Load Reductions from Redevelopment of Urban Land

| TOTAL SWAP STUDY AREA | | | | |
|---|---|---|---|---|
| Pollutant | Weighted Urban Loading Rate (lbs/ac/yr) | Estimated Area Available for Redevelopment (acres) | Removal Efficiency (%) | Max Potential Load Reduction (lbs/yr) |
| TN | 6.69 | 829.0 | 59% | 3,272 |
| TP | 0.59 | 829.0 | 55% | 268 |
| **MIDDLE RIVER** | | | | |
| Pollutant | Pervious Urban Loading Rate (lbs/ac/yr) | Estimated Area Available for Redevelopment (acres) | Removal Efficiency (%) | Max Potential Load Reduction (lbs/yr) |
| TN | 6.71 | 774.0 | 59% | 3,064 |
| TP | 0.59 | 774.0 | 55% | 251 |
| **TIDAL GUNPOWDER** | | | | |
| Pollutant | Pervious Urban Loading Rate (lbs/ac/yr) | Estimated Area Available for Redevelopment (acres) | Removal Efficiency (%) | Max Potential Load Reduction (lbs/yr) |
| TN | 6.35 | 55.0 | 59% | 206 |
| TP | 0.48 | 55.0 | 55% | 15 |

### *3.4.2.17 Fertilizer Act of 2011*

On May 19, 2011, Governor Martin O'Malley signed the Fertilizer Use Act of 2011, an environmental law designed to reduce the amount of nutrients washing into the Chesapeake Bay from lawns, golf courses, parks, recreation areas and other non-agricultural sources. The law limits the amount of phosphorus contained in lawn fertilizer products sold to the public, establishes a training, certification and licensing program for people who are hired to apply fertilizer to non-agricultural landscapes, limits fertilizer amounts applied to turf, and requires the implementation of a homeowner education program about best management practices to be followed when using fertilizers (MDA 2011). The Fertilizer Act will be fully implemented in October 2013 and contains new content requirements and labeling instructions including restricting phosphorous and decreasing nitrogen amounts in fertilizer sold in Maryland.

Pollutant reductions from the Fertilizer Act of 2011 are calculated based on the pollutant removal efficiencies from the current pervious urban nutrient loading developed by Baltimore County during their analysis. The equation used to estimate total nitrogen (TN) load reductions from redevelopment is expressed as:

$$\left[5.64(lbs/ac/yr)\times Open_Pervious_Area(acres)\right]\times 17\% \text{ (Middle River)}$$

$$\left[5.59(lbs/ac/yr)\times Open_Pervious_Area(acres)\right]\times 17\% \text{ (Tidal Gunpowder)}$$

The amount of material removed is converted to total phosphorus (TP) load removed from redevelopment is expressed as:

$$[0.23(lbs/ac/yr) \times Open_Pervious_Area(acres)] \times 22\%$$ (Middle River)

$$[0.23(lbs/ac/yr) \times Open_Pervious_Area(acres)] \times 22\%$$ (Tidal Gunpowder)

Calculations and results of the nutrient reductions derived from the Feritilizer Act of 2011 are summarized in Table 3-23.

Table 3-23: Load Reductions from Fertilizer Act of 2011

| TOTAL SWAP STUDY AREA | | | | |
|---|---|---|---|---|
| Pollutant | Pervious Urban Loading Rate (lbs/ac/yr) | Pervious Urban Area (acres) | Removal Efficiency (%) | Max Potential Load Reduction (lbs/yr) |
| TN | 5.63 | 4114.2 | 17% | 3,935 |
| TP | 0.23 | 4114.2 | 22% | 212 |
| **MIDDLE RIVER** | | | | |
| Pollutant | Pervious Urban Loading Rate (lbs/ac/yr) | Pervious Urban Area (acres) | Removal Efficiency (%) | Max Potential Load Reduction (lbs/yr) |
| TN | 5.64 | 2919.5 | 17% | 2,799 |
| TP | 0.23 | 2919.5 | 22% | 148 |
| **TIDAL GUNPOWDER** | | | | |
| Pollutant | Pervious Urban Loading Rate (lbs/ac/yr) | Pervious Urban Area (acres) | Removal Efficiency (%) | Max Potential Load Reduction (lbs/yr) |
| TN | 5.59 | 1194.7 | 17% | 1,136 |
| TP | 0.23 | 1194.7 | 22% | 60 |

### *3.4.2.18 Overall Pollutant Load Reductions*

The sum of maximum potential pollutant load reductions calculated for individual BMPs represents the overall pollutant removal capacity for a maximum implementation scenario (i.e., 100% of 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 3-24.

Table 3-24: Projected Participation Factors

| BMP | Projected Participation | Basis of Assumption |
|---|---|---|
| Existing SWM | 100% | Existing – BMPs already implemented |
| SSO Reduction/Elimination | 100% | Consent Decree requirements |
| CIP - Shoreline Enhancement | 100% | Existing – shoreline enhancement already implemented |
| CIP - Stream Restoration | 100% | Existing – stream restoration already implemented |
| SWM Conversions | 100% | Complete 3 conversions |
| SW Retrofits | 50% | General estimate to achieve reduction goal |
| ISI Impervious Cover Removal | 50% | General estimate to achieve reduction goal |
| Reforest Stream Buffer | 35% | General estimate to achieve reduction goal |
| Reforest Shoreline Buffer | 35% | 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 | 55% | 56% willingness factor * |
| NSA Tree Plantings | 40% | 44% willingness factor* |
| ISI Tree Plantings | 40% | 79% of estimated trees located on public lands |
| Bayscaping Education | 5% | 10% recall rate (workshop/public meeting) x 54% willingness factor* |
| Street Sweeping | 100% | General estimate to achieve reduction goal |
| Redevelopment | 50% | General estimate to achieve reduction goal |

Notes:

* Willingness factors are based on a citizens action survey conducted at a Middle River and Tidal Gunpowder Stakeholder Meeting held on July 25, 2011 to gage interest in proposed restoration actions.

Table 3-25 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. Currently, the project implementation plan shown in Table 3-24 meets with 2017 and 2020 goals for nitrogen and phosphorous reduction.

There is opportunity to achieve greater reductions if restoration BMPs 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, marina environmental education, tours of completed projects and water trails). These types of actions are not included in the pollutant removal analysis because reduction efficiencies are not well known and difficult to estimate.

Table 3-25: Summary of Pollutant Load Reduction Estimates

| BMP | How Credited | TN Efficiency | TP Efficiency | Max Potential TN Load Reduction | Max Potential TP Load Reduction | Units Available | | Projected Participation | Projected 2017 TN Load Reduction | Projected 2017 TP Load Reduction | Projected 2020 TN Load Reduction | Projected 2020 TP Load Reduction |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Completed Measures | | | | | | | | | | | | |
| Existing SWM | Efficiency | varies | varies | 1,647 | 219 | 970 | acres | 100% | 1,647 | 219 | 1,647 | 219 |
| SSO Reduction/Elimination | Direct Removal | N/A | N/A | 0.06 | 0.17 | 223,390 | gal | 100% | 0.06 | 0.17 | 0.06 | 0.17 |
| Shoreline Enhancement | NPDES Permit | N/A | N/A | 2,109 | 1,387 | 5,090 | ft | 100% | 2,109 | 1,387 | 2,109 | 1,387 |
| Stream Restoration | NPDES Permit | N/A | N/A | 202 | 11 | 1000 | ft | 100% | 202 | 11 | 202 | 11 |
| Proposed Measures | | | | | | | | | | | | |
| SWM Conversions | Efficiency | 50% | 70% | 28 | 2 | 29 | acres | 100% | 19 | 1 | 28 | 2 |
| SW Retrofits (NSA, ISI, PAA) | Efficiency | 50% | 70% | 102 | 21 | 23 | acres | 50% | 28 | 6 | 51 | 11 |
| NSA SW Retrofit | Efficiency | 50% | 70% | 31 | 6 | 7 | acres | 50% | 8 | 2 | 15 | 3 |
| ISI SW Retrofit | Efficiency | 50% | 70% | 67 | 14 | 15 | acres | 50% | 18 | 4 | 33 | 7 |
| HSI SW Retrofit | Efficiency | 50% | 70% | 0 | 0 | 0 | acres | 50% | 0 | 0 | 0 | 0 |
| PAA SW Retrofit | Efficiency | 50% | 70% | 5 | 1 | 1 | acres | 50% | 1 | 0 | 2 | 0 |
| ISI Impervious Cover Removal | LU Conversion | N/A | N/A | 1 | 0 | 0.4 | acre | 50% | 1 | 0 | 1 | 0 |
| Reforest Stream Buffer | LU Conversion + Efficiency | 25% | 50% | 1,669 | 127 | 317 | acres | 35% | 334 | 25 | 584 | 44 |
| Reforest Shoreline Buffer | LU Conversion | 25% | 50% | 2,634 | 127 | 641 | acres | 35% | 527 | 25 | 922 | 44 |
| Pervious Area Reforestation | LU Conversion | N/A | N/A | 283 | 14 | 69 | acres | 50% | 81 | 4 | 141 | 7 |
| Stream Restoration (Baltimore County) | Lbs per Ln Ft | 0.202 | 0.0107 | 227 | 12 | 1,125 | ft | 75% | 34 | 2 | 170 | 9 |
| Stream Restoration (MDE) | Lbs per Ln Ft | 0.02 | 0.0035 | 104 | 18 | 1,125 | ft | 75% | 16 | 3 | 78 | 14 |
| NSA Downspout Disconnection | Efficiency | 50% | 60% | 471 | 84 | 106 | acres | 55% | 162 | 29 | 259 | 46 |
| NSA Tree Plantings | LU Conversion | N/A | N/A | 51 | 2 | 12 | acres | 40% | 12 | 1 | 20 | 1 |
| ISI Tree Plantings | LU Conversion | N/A | N/A | 24 | 1 | 5.913 | acres | 40% | 6 | 0 | 10 | 0 |
| Shoreline Enhancement | Lbs per Ln Ft | 0.16 | 0.11 | 400 | 275 | 2,500 | ft | 100% | 133 | 92 | 400 | 275 |
| NSA Bayscaping Education | Efficiency | 17% | 22% | 214 | 11 | 224 | acres | 5% | 11 | 1 | 11 | 1 |
| Street Sweeping | Direct Removal | 3% | 3% | 30 | 5 | 32 | miles | 100% | 30 | 5 | 30 | 5 |
| Redevelopment of Urban Areas | Efficiency | 59% | 55% | 3,270 | 266 | 829 | acres | 50% | 930 | 76 | 1,635 | 133 |
| Credits for Fertilizer Act of 2011 | Efficiency | 17% | 22% | 3,935 | 208 | 4,114 | acres | 100% | 3,935 | 208 | 3,935 | 208 |
| Additional Retrofits to be Identified | Efficiency | POLLUTION REDUCTION PROJECTS TO BE INDENTIFIED AND QUANTIFIED IN THE FUTURE | | | | | | | | | | |
| Adjusted Credits for Stream Restoration | Lbs per Ln Ft | POLLUTION REDUCTION PROJECTS TO BE INDENTIFIED AND QUANTIFIED IN THE FUTURE | | | | | | | | | | |
| | *Total Load Reduction (lbs/yr):* | | | *17,174* | *2,777* | | | | *10,180* | *2,091* | *12,063* | *2,406* |
| | Total Existing Urban Load (lbs/yr) | | | 39,379 | 3,363 | | | | 39,379 | 3,363 | 39,379 | 3,363 |
| | *Reduction Achieved:* | | | *44%* | *83%* | | | | *26%* | *62%* | *31%* | *72%* |
| | | | | | | *Chesapeake Bay TMDL Goals* | | | *7,994* | *1,063* | *11,420* | *1,517* |

# CHAPTER 4: SUBWATERSHED MANAGEMENT STRATEGIES

## 4.1 Introduction

This chapter describes the criteria and methodology used to rank the 15 subwatersheds comprising the Middle River and Tidal Gunpowder watersheds (see 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 *Middle River and Tidal Gunpowder Watershed Characterization Report* included as Appendix D.

## 4.2 Subwatershed Prioritization

A ranking methodology was developed to prioritize subwatersheds within this study in terms of restoration need and potential. Subwatersheds are represented by an overall prioritization score on a scale of 60, where 0 denotes the least significant impacts to water quality and 60 corresponds to the greatest water quality improvement potential. The total prioritization score for a subwatershed is comprised of the following ranking criteria:

- Nitrogen Loads
- Phosphorus Loads
- Impervious Surfaces
- Neighborhood Restoration Opportunity/Pollution Source Indexes
- Neighborhood Lawn Fertilizer Reduction/Education
- Neighborhood Downspout Disconnection
- Neighborhood Trash Management
- Institutional Site Index
- Pervious Area Restoration
- Municipal Street Sweeping
- Municipal Stormwater Conversions
- Illicit Discharge Data
- Stream Buffer Improvement
- Shoreline Buffer Improvement
- Stream Corridor Restoration

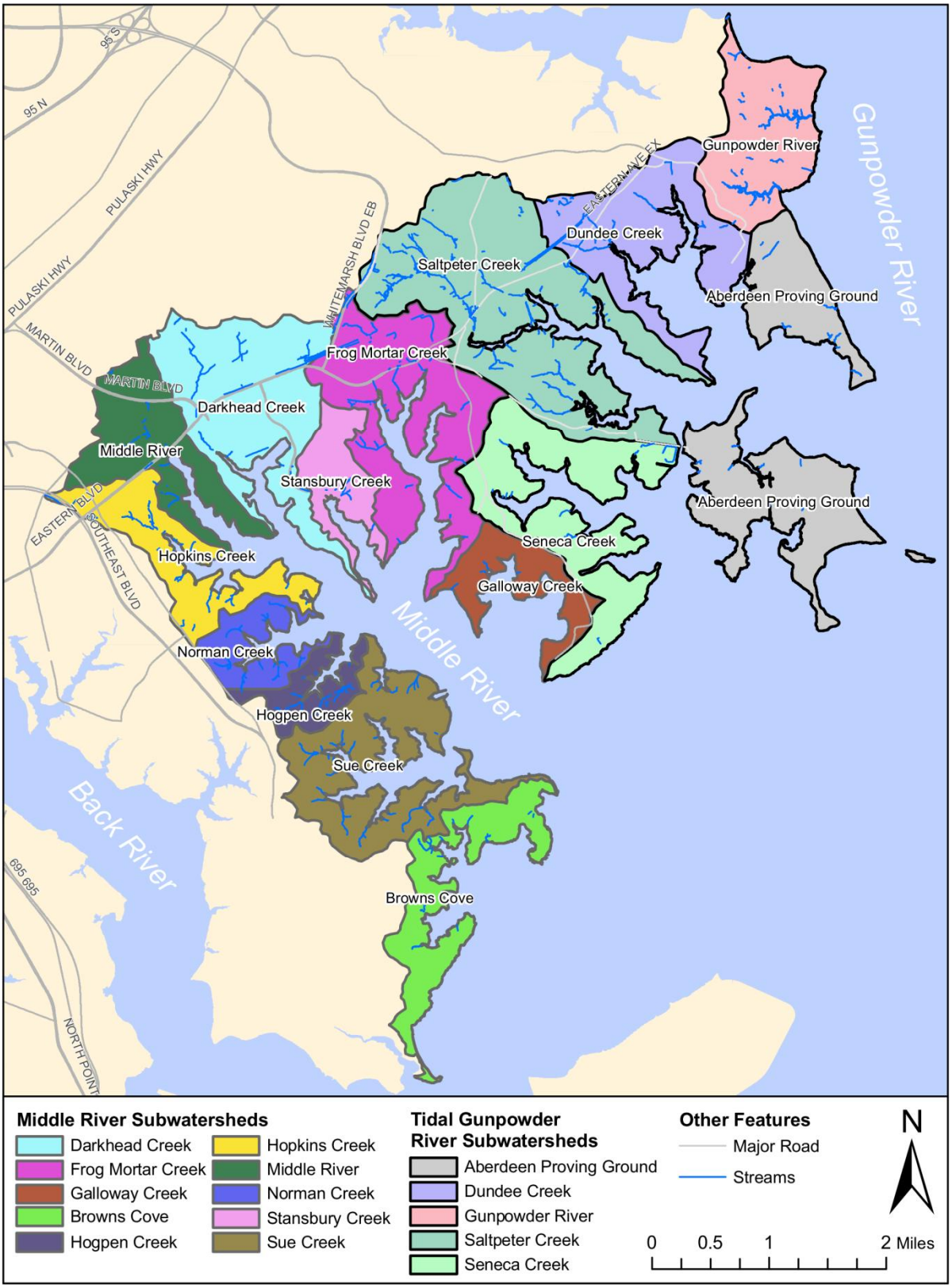


Figure 4-1: Middle River and Tidal Gunpowder Subwatersheds

Each criterion has a maximum possible score of 4. In general, subwatersheds were divided 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, 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/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.

### 4.2.1 Phosphorus and Nitrogen Loads

One of the objectives to improve and maintain water quality and meet pollution reduction requirements in the Middle River and Tidal Gunpowder 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 the Middle River and Tidal Gunpowder watersheds is explained in further detail in the *Watershed Characterization Report* (Appendix D).

For each subwatershed, annual nitrogen and phosphorus loads were divided by the subwatershed's area. This represents pollutant loadings rates (lbs/acre/year) and allows a direct comparison between the 15 subwatersheds since they vary greatly in size. Subwatersheds with higher pollutant loading rates are higher priorities for restoration within the Middle River and Tidal Gunpowder watersheds. Therefore, higher pollutant loading rates are assigned high scores to denote greater water quality impacts and restoration need.

Subwatershed nitrogen loading rates ranged from 1.8 to 6.3 lbs/acre/year. The following point system was used to assign nitrogen load scores to the 15 subwatersheds based on the range and distribution of subwatershed nitrogen loading rates:

- ≥ 5.86 lbs/acres/year = 4 pts
- 5.11 – 5.85 lbs/acre/year = 3 pts
- 4.20 – 5.10 lbs/acre/year = 2 pts
- ≤ 4.19 lbs/acre/year = 1 pt

Subwatershed phosphorus loading rates ranged from 0.05 to 0.59 lbs/acre/year. The following point system was used to assign phosphorus load scores to the 15 subwatersheds based on the range and distribution of subwatershed phosphorus loading rates:

- ≥ 0.51 lbs/acres/year = 4 pts
- 0.46 – 0.50 lbs/acre/year = 3 pts

- 0.31– 0.45 lbs/acre/year = 2 pts
- ≤ 0.30 lbs/acre/year = 1 pt

Nitrogen and phosphorus loading rates and corresponding scores are summarized in 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 |
|---|---|---|---|---|
| Darkhead Creek | 5.53 | 3 | 0.53 | 4 |
| Frog Mortar Creek | 5.86 | 4 | 0.53 | 4 |
| Galloway Creek | 6.06 | 4 | 0.49 | 3 |
| Browns Cove | 5.11 | 3 | 0.41 | 2 |
| Hogpen Creek | 4.23 | 2 | 0.31 | 2 |
| Hopkins Creek | 6.05 | 4 | 0.51 | 4 |
| Middle River | 6.31 | 4 | 0.59 | 4 |
| Norman Creek | 4.60 | 2 | 0.34 | 2 |
| Stansbury Creek | 5.63 | 3 | 0.46 | 3 |
| Sue Creek | 4.20 | 2 | 0.29 | 1 |
| Aberdeen Proving Ground | 5.42 | 3 | 0.05 | 1 |
| Dundee Creek | 1.82 | 1 | 0.46 | 3 |
| Gunpowder River | 4.38 | 2 | 0.23 | 1 |
| Saltpeter Creek | 3.78 | 1 | 0.49 | 3 |
| Seneca Creek | 3.92 | 1 | 0.34 | 2 |

### 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 it allows a direct comparison between the 15 subwatersheds. Subwatersheds with higher percentages of impervious cover are higher priorities for restoration within the Middle River and Tidal Gunpowder watersheds. Therefore, higher percentages of imperviousness are assigned high scores to denote greater water quality impacts and restoration need.

Impervious cover represents about 8.4 percent of the overall Middle River and Tidal Gunpowder watersheds. Subwatershed percent impervious values range from approximately 2 to 36 percent. The following point system was used to assign percent impervious scores to the 15 subwatershed based on CWP's Impervious Cover model (see Chapter 2.3.3 of Appendix D) and subwatershed impervious surface percentages:

- > 60% = 4 pts
- 26 – 60% = 3 pts
- 11 – 25% = 2 pts
- ≤ 10% = 1 pt

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

Table 4-2: Percent Impervious Scores

| SUBWATERSHED | % Impervious | % Impervious Score |
|---|---|---|
| Darkhead Creek | 33% | 3 |
| Frog Mortar Creek | 31% | 3 |
| Galloway Creek | 15% | 2 |
| Browns Cove | 6% | 1 |
| Hogpen Creek | 15% | 2 |
| Hopkins Creek | 29% | 3 |
| Middle River | 36% | 3 |
| Norman Creek | 17% | 2 |
| Stansbury Creek | 24% | 2 |
| Sue Creek | 13% | 2 |
| Aberdeen Proving Ground | 2% | 1 |
| Dundee Creek | 5% | 1 |
| Gunpowder River | 8% | 1 |
| Saltpeter Creek | 10% | 1 |
| Seneca Creek | 16% | 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 59 neighborhoods assessed, 21 were rated as high for both PSI and ROI, 19 were rated as a high PSI with a moderate ROI, 5 were rated as a moderate PSI with a high ROI, and 12 were rated as a moderate PSI with a moderate ROI. Neighborhoods with high PSI and high ROI ratings represent the best areas to initially target for restoration. Because some neighborhoods were encompassed within two separate

subsheds, those neighborhoods were counted for both subsheds to portray a more accurate subshed ranking.

Subwatersheds with at least four (4) neighborhoods rated as high for both pollution severity and restoration potential received the highest score (4 points). Subwatersheds with more than one (1) but less than four (4) neighborhoods rated as high for both pollution severity and restoration received the second highest score (3 points). Subwatersheds with one (1) neighborhood rated as high for both PSI and ROI were assigned the third highest score (2 points). Subwatersheds with no neighborhoods rated as high for both PSI and ROI were assigned the lowest possible score (1 point). The number of neighborhoods associated with various PSI/ROI ratings and corresponding NSA PSI/ROI scores are summarized in Table 4-3 below by subwatershed. One watershed (Aberdeen Proving Ground) had no neighborhoods and was thus assigned a score of zero (0).

Table 4-3: NSA PSI/ROI Scores

| | # of NEIGHBORHOODS FOR PSI/ROI RATINGS | | | | | | NSA |
|---|---|---|---|---|---|---|---|
| SUBWATERSHED | High/ High | High/ Mod | High/ Low | Mod/ High | Mod/ Mod | Mod/ Low | PSI/ROI Score |
| Darkhead Creek | 6 | 3 | 0 | 1 | 2 | 0 | 4 |
| Frog Mortar Creek | 1 | 2 | 0 | 1 | 4 | 0 | 2 |
| Galloway Creek | 1 | 0 | 0 | 0 | 1 | 0 | 2 |
| Browns Cove | 1 | 2 | 0 | 0 | 0 | 0 | 2 |
| Hogpen Creek | 2 | 4 | 0 | 0 | 0 | 0 | 3 |
| Hopkins Creek | 6 | 5 | 0 | 0 | 1 | 0 | 4 |
| Middle River | 5 | 3 | 0 | 1 | 2 | 0 | 4 |
| Norman Creek | 3 | 1 | 0 | 0 | 0 | 0 | 3 |
| Stansbury Creek | 2 | 0 | 0 | 0 | 0 | 0 | 3 |
| Sue Creek | 4 | 2 | 0 | 0 | 1 | 0 | 4 |
| Aberdeen Proving Ground | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dundee Creek | 0 | 1 | 0 | 0 | 1 | 0 | 1 |
| Gunpowder River | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| Saltpeter Creek | 1 | 0 | 0 | 1 | 2 | 0 | 2 |
| Seneca Creek | 1 | 4 | 0 | 0 | 2 | 0 | 2 |

### 4.2.4 Neighborhood Lawn Fertilizer Reduction/Education

Lawn maintenance activities often involve-over-fertilization, poor pest-management, and over-watering resulting in polluted stormwater runoff entering local streams. Lawns with a dense, uniform grass cover or signs designating poisonous lawn care were indicators of high lawn maintenance activities and sources of nutrients originating from lawn fertilizer. Neighborhoods where 20 percent or more of the homes appeared to employ high lawn maintenance practices were identified as having more pollution potential than areas with lawns that are less intensely managed.

Maryland's Fertilizer Use Act of 2011 limits the amount of phosphorous in fertilizer products and requires implementation of an education program on best management practices to be followed when using fertilizers. Although pollution reductions for fertilizer reduction for this SWAP are based on a

uniform reduction from implementation of the Fertilizer Use Act, education on proper fertilizer use is still an important aspect of informing the public on nutrients in relation to the Chesapeake Bay.

The acres of lawn identified as "high maintenance" were calculated in the *Watershed Characterization Report*. The percentage of each subwatershed area identified as "high maintenance" was also calculated and used to compare the restoration potential among the 15 subwatersheds. Subwatersheds with the highest percentages of lawn addressed through this action denote greatest restoration potential and therefore, were scored the highest. Percentages of subwatershed areas identified as "high maintenance" range from approximately 0 to 4.1 percent. One subwatershed had no NSAs and was assigned no score. The following point system was used to assign fertilizer reduction scores to the 15 subwatershed based on the distribution and range of percentages of subwatershed area addressed:

- ≥ 2.8% = 4 pts
- 2.0– 2.7% = 3 pts
- 1.2 – 1.9% = 2 pts
- 0.2 – 1.1% = 1 pt
- 0% = 0 pts

Percentage of area addressed by lawn fertilizer reduction and corresponding scores are summarized in the Table 4-4 by subwatershed.

Table 4-4: NSA Lawn Fertilizer Reduction Scores

| SUBWATERSHED | % Area Addressed | NSA Lawn Fertilizer Reduction Score |
|---|---|---|
| Darkhead Creek | 0.4% | 1 |
| Frog Mortar Creek | 3.4% | 4 |
| Galloway Creek | 2.3% | 3 |
| Browns Cove | 1.2% | 2 |
| Hogpen Creek | 1.9% | 2 |
| Hopkins Creek | 2.0% | 3 |
| Middle River | 2.0% | 3 |
| Norman Creek | 1.2% | 2 |
| Stansbury Creek | 0.7% | 1 |
| Sue Creek | 4.1% | 4 |
| Aberdeen Proving Ground | 0.0% | 0 |
| Dundee Creek | 0.2% | 1 |
| Gunpowder River | 0.0% | 0 |
| Saltpeter Creek | 0.3% | 1 |
| Seneca Creek | 2.8% | 4 |

### 4.2.5 Neighborhood Downspout Disconnection

Connected downspouts discharge rooftop runoff either directly to the storm drain system or to impervious surfaces. In both cases, 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 to local streams during storm events and reduces pollutant loads to streams.

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 15 subwatersheds. Subwatersheds with the highest percentages of impervious rooftop acres addressed through downspout disconnection denote the greatest restoration potential and therefore, were scored the highest. Percentages of subwatershed areas addressed through downspout disconnection range from approximately 0 to 38 percent. One subwatershed had no NSA and was assigned no score. The following point system was used to assign downspout disconnect scores to the 15 subwatershed based on the distribution and range of percentages of subwatershed rooftop areas addressed:

- ≥ 31% = 4 pts
- 20 – 30% = 3 pts
- 12 – 19% = 2 pts
- 1 11% = 1 pt

Percentage of rooftop area addressed by downspout disconnection and corresponding scores are summarized in Table 4-5 by subwatershed.

Table 4-5: NSA Downspout Disconnect Scores

| SUBWATERSHED | % Rooftop Area Addressed | NSA Downspout Disconnect Score |
|---|---|---|
| Darkhead Creek | 11% | 1 |
| Frog Mortar Creek | 8% | 1 |
| Galloway Creek | 12% | 2 |
| Browns Cove | 18% | 2 |
| Hogpen Creek | 20% | 3 |
| Hopkins Creek | 33% | 4 |
| Middle River | 21% | 3 |
| Norman Creek | 34% | 4 |
| Stansbury Creek | 17% | 2 |
| Sue Creek | 38% | 4 |
| Aberdeen Proving Ground | 0% | 0 |
| Dundee Creek | 0% | 0 |
| Gunpowder River | 15% | 2 |
| Saltpeter Creek | 1% | 1 |
| Seneca Creek | 19% | 2 |

### 4.2.6 Neighborhood Trash Management

Trash is one of the major pollutants of concern in the Middle River and Tidal Gunpowder watersheds. For this reason, NSA results for trash pollution sources and management opportunities were used as a criterion for prioritizing subwatershed. Trash management initiatives involve raising awareness of the trash issue and ways to solve it. Some ways to raise citizen awareness of trash as a problem include community cleanups, trash management education (e.g., presentations about recycling, reuse, and disposal options), storm drain markers, a watershed trash campaign, and/or targeted trash can inspection throughout a neighborhood.

Neighborhoods where junk or trash was observed in 25 percent of yards were recommended for trash management initiatives. Neighborhoods with less than 25 percent of yards with junk/trash but had other warning signs such as overflowing dumpsters or dumping in alleys or other common areas were also included as a potential source of trash pollution. The acres of land addressed if trash management was implemented in the recommended neighborhoods was calculated for each subwatershed in the *Watershed Characterization Report*. The percentages of subwatershed areas addressed via neighborhood trash management were also calculated. This was used to directly compare restoration potential among the 15 subwatersheds with respect to addressing trash. Subwatersheds with the highest percentages of area addressed through neighborhood trash management denote the greatest restoration potential and therefore, were scored the highest.

Percentages of subwatershed areas addressed through neighborhood trash management range from approximately 0 to 44 percent. The following point system was used to assign trash management scores to the 15 subwatershed based on the distribution and range of percentages of subwatershed areas addressed:

- ≥ 30% = 4 pts
- 20 – 29% = 3 pts
- 10 – 19% = 2 pts
- 1 – 9% = 1 pt

Percentage of area addressed by neighborhood trash management and corresponding scores are summarized in Table 4-6 by subwatershed. Subsheds with an area addressed value of 0% were assigned no score.

Table 4-6: NSA Trash Management Scores

| SUBWATERSHED | % Area Addressed | NSA Trash Management Score |
|---|---|---|
| Darkhead Creek | 14% | 2 |
| Frog Mortar Creek | 0% | 0 |
| Galloway Creek | 1% | 1 |
| Browns Cove | 0% | 0 |
| Hogpen Creek | 0% | 0 |
| Hopkins Creek | 38% | 4 |
| Middle River | 27% | 3 |
| Norman Creek | 44% | 4 |
| Stansbury Creek | 5% | 1 |
| Sue Creek | 25% | 3 |
| Aberdeen Proving Ground | 0% | 0 |
| Dundee Creek | 4% | 1 |
| Gunpowder River | 0% | 0 |
| Saltpeter Creek | 0% | 0 |
| Seneca Creek | 28% | 3 |

### 4.2.7 Institutional Site Index

Institutions offer unique opportunities for watershed restoration. Typically, institutional properties encompass considerable portions of land including various natural resources. In addition, they offer the opportunity to engage a wide range of citizens in restoration activities. This raises citizen awareness while also providing water quality improvement benefits in the watershed. A total of 34 community-based facilities were surveyed during Institutional Site Investigations (ISIs) including faith-based facilities, community centers, municipal facilities (e.g, fire and rescue stations), schools, and care centers (e.g., nursing homes). The focus of ISIs is to identify potential restoration opportunities, educate the community and provide 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, subwatershed prioritization for this criterion was based on the number of institutions and considering public versus private ownership.

For purposes of this prioritization, publicly owned ISIs are given a greater score because they have the greatest restoration potential. The number of publicly owned institutions were summed and then multiplied by two to give them a weighted score. The number of privately owned institutions were then added to this number to give a total weighted number. The following point system was used to assign institutional site scores to the five subwatersheds based on the distribution and range ISIs addressed:

- ≥ 9 = 4 pts
- 6 – 8 = 3 pts
- 4 – 5 = 2 pts
- 1 – 3 = 1 pt

The total number of institutions including public versus private ISIs and corresponding institutional site index scores are summarized by subwatershed in Table 4-7. Subwatersheds with no assessed institutions were assigned a score of 0.

Table 4-7: ISI Scores

| SUBWATERSHED | # of Public ISIs | Weighted # of Public ISIs (x2) | # of Private ISIs | Total Weighted # of ISIs | ISI Score |
|---|---|---|---|---|---|
| Darkhead Creek | 4 | 8 | 1 | 9 | 4 |
| Frog Mortar Creek | 0 | 0 | 3 | 3 | 1 |
| Galloway Creek | 0 | 0 | 1 | 1 | 1 |
| Browns Cove | | Not Assessed | | 0 | 0 |
| Hogpen Creek | | Not Assessed | | 0 | 0 |
| Hopkins Creek | 2 | 4 | 3 | 7 | 3 |
| Middle River | 1 | 2 | 2 | 4 | 2 |
| Norman Creek | 2 | 4 | 2 | 6 | 3 |
| Stansbury Creek | | Not Assessed | | 0 | 0 |
| Sue Creek | 2 | 4 | 0 | 4 | 2 |
| Aberdeen Proving Ground | | Not Assessed | | 0 | 0 |
| Dundee Creek | 2 | 4 | 0 | 4 | 2 |
| Gunpowder River | 1 | 2 | 0 | 2 | 1 |
| Saltpeter Creek | 3 | 6 | 3 | 9 | 4 |
| Seneca Creek | 2 | 4 | 0 | 4 | 2 |

*'Not Assessed' denotes institutional site investigations not conducted within subwatershed.

### 4.2.8 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 number of possible sites, the acreage of land, and ownership of land found in each subwatershed as described in the *Watershed Characterization Report*. Percentages of subwatershed areas available for pervious area reforestation range from approximately 0 to 8.3 percent.

For purposes of this prioritization, sites that are in public ownership are given a greater score because of the greater likelihood that they can be converted to tree cover. The acres of PAAs in public ownership were summed and then multiplied by two to give them a weighted score. The acres of PAAs in private ownership were then added to this number to give a total weighted acreage. The total weighted acreage was then divided by the total acres of the subwatershed to normalize the acreage across the five subwatersheds. The following point system was used to assign pervious area scores to the five subwatersheds based on the distribution and range of percentages of subwatershed areas addressed:

- ≥ 3% = 4 pts
- 2.1 – 3.0% = 3 pts
- 1.1 – 2.0% = 2 pts
- ≤ 1.0% = 1 pt

Public pervious area acreages and corresponding scores are summarized in Table 4-8 by subwatershed. Subwatersheds with no assessed pervious areas were assigned a score of 0.

Table 4-8: Pervious Area Reforestation Scores

| SUBWATERSHED | Public Acres | Weighted Public Acres (x2) | Private Acres | Total Weighted Acres | % Acres Per Subwatershed | PAA Score |
|---|---|---|---|---|---|---|
| Darkhead Creek | 3.4 | 6.8 | 0.0 | 6.8 | 0.6% | 1 |
| Frog Mortar Creek | 2.7 | 5.3 | 0.0 | 5.3 | 0.4% | 1 |
| Galloway Creek | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0 |
| Browns Cove | 7.0 | 14.1 | 0.0 | 14.1 | 2.3% | 3 |
| Hogpen Creek | 0.2 | 0.5 | 0.0 | 0.5 | 0.2% | 1 |
| Hopkins Creek | 1.8 | 3.7 | 0.0 | 3.7 | 0.6% | 1 |
| Middle River | 2.7 | 5.4 | 2.0 | 7.4 | 1.1% | 2 |
| Norman Creek | Not Assessed | | | | 0.0% | 0 |
| Stansbury Creek | Not Assessed | | | | 0.0% | 0 |
| Sue Creek | 0.0 | 0.0 | 1.1 | 1.1 | 0.1% | 1 |
| Aberdeen Proving Ground | Not Assessed | | | | 0.0% | 0 |
| Dundee Creek | 5.6 | 11.2 | 0.0 | 11.2 | 1.2% | 2 |
| Gunpowder River | 30.9 | 61.7 | 0.0 | 61.7 | 8.3% | 4 |
| Saltpeter Creek | 10.9 | 21.9 | 0.0 | 21.9 | 1.1% | 2 |
| Seneca Creek | 1.1 | 2.3 | 0.0 | 2.3 | 0.2% | 1 |

### 4.2.9 Municipal Street Sweeping

Baltimore County provides street sweeping services throughout their 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 12.7. The following point system was used to assign street sweeping scores to the 15 subwatershed based on the distribution and range of miles addressed:

- ≥ 10 miles = 4 pts
- 5.0 – 9.9 miles = 3 pts
- 2.0 – 4.9 miles = 2 pts
- 0.1 – 1.9 miles = 1 pt

Subwatersheds with no street sweeping recommended were assigned a score of 0. Miles addressed by municipal street sweeping and corresponding scores are summarized in Table 4-9 by subwatershed.

Table 4-9: Municipal Street Sweeping Scores

| SUBWATERSHED | Miles of Road Addressed | Street Sweeping Score |
|---|---|---|
| Darkhead Creek | 8.7 | 3 |
| Frog Mortar Creek | 0 | 0 |
| Galloway Creek | 0 | 0 |
| Browns Cove | 0 | 0 |
| Hogpen Creek | 0.6 | 1 |
| Hopkins Creek | 5.2 | 3 |
| Middle River | 12.7 | 4 |
| Norman Creek | 0 | 0 |
| Stansbury Creek | 1.0 | 1 |
| Sue Creek | 3.3 | 2 |
| Aberdeen Proving Ground | 0 | 0 |
| Dundee Creek | 0 | 0 |
| Gunpowder River | 0 | 0 |
| Saltpeter Creek | 0 | 0 |
| Seneca Creek | 0 | 0 |

### 4.2.10 Municipal Stormwater Conversions

Existing dry detention ponds within the Middle River and Tidal Gunpowder watersheds 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 that provides water quality benefits in addition to quantity control such as an extended detention facility. Dry extended detention ponds are designed to capture and retain stormwater runoff from a storm for a minimum duration to allow sediment and pollutants to settle out while also being able to provide flood control.

Ten (10) existing dry detention ponds were assessed for their potential to be converted to an extended detention facility. Information collected at each facility included the following: orifice, riser, ponding, debris, vegetation, adjacent land use, physical expansion capabilities, outfall, and downstream conditions. Out of the ten (10) detention ponds assessed, nine were considered as having either horizontal or vertical potential for conversion to an extended detention facility.

Subwatershed scoring for stormwater conversion potential is based upon the potential for horizontal and vertical expansion at ponds in the 15 subwatersheds. Subwatersheds with multiple ponds with the potential for horizontal expansion were given the highest score (4 points). Subwatersheds with only a single pond with horizontal expansion potential were given a score of 3 points. Subwatersheds with multiple ponds with the potential for vertical expansion but having no horizontal expansion potential were given a score of 2 points. Subwatersheds with only a single pond with the capability for vertical expansion but no horizontal expansion were given 1 point. Subwatersheds with no ponds or with ponds that only have the potential for maintenance and not expansion (vertical or horizontal) were given a score of 0 points.

Frog Mortar Creek contains three (3) detention ponds, only one (1) having horizontal expansion potential. All 3 ponds have the potential for vertical excavation and maintenance. SWM_F_1358 is a privately-owned detention pond off of Carroll Island Road. There is open space north of the pond for horizontal expansion, however, due to its location adjacent to a gas station facility, expansion may be limited due to contaminated soils. SWM_F_731, located in a residential area on Tearose Drive, was recommended for tree removal, construction of access roads and signage, installation of pretreatment bays and consideration for native vegetation planting. SWM_F_988, located off of Eastern Boulevard is constrained horizontally but recommended for consideration of native vegetation planting. Frog Mortar Creek was assigned a score of 3 points.

Hopkins Creek consists of three (3) detention ponds, with one (1) considered as having potential for horizontal expansion, and two (2) having potential for vertical expansion. SWM_F_711, is located at the southeast corner of Middleborough Road and Back River Neck Rd and receives stormwater runoff from a 10-acre residential area. This pond is adjacent to a meadow, providing room for horizontal expansion. Vertical expansion is also possible through excavation of the existing pond bottom. SWM_F_591 in Hopkins Creek is constrained on all sides by a residential neighborhood (NSA_F_13B), leaving no room for horizontal expansion. There is potential for vertical expansion through excavation of the pond bottom along with maintenance of trees of the embankment and invasive vegetation on the pond bottom. SWM_F_914 has no expansion for horizontal or vertical expansion, and no maintenance is required. Hopkins Creek was given a score of 3 points.

The Gunpowder River subwatershed contains one (1) detention pond with potential for horizontal and vertical expansion and was assigned the a score of 3 points. Detention pond, SWM_F_449, is located behind a residential area along Cunninghill Cove Rd. This pond is recommended for replacement of its principal spillway and outlet protection. In addition, because of erosion and displacement of outlet protection, the receiving stream at the outlet of the pond is recommended for restoration. Gunpowder River was given a score of 3 points.

Darkhead Creek, Middle River, and Dundee Creek subwatersheds all contained 1 pond with vertical expansion potential but no potential for horizontal expansion. All three subwatersheds were assigned a score of 1 point. One detention pond, SWM_F_950 at the intersection of Pawnee Road and Choctaw Court, was assessed in the Darkhead Creek subwatershed. SWM_F_950 was recommended for tree and invasive species removal, installation of pretreatment bays, vertical excavation, and landscaping updates with native vegetation.

SWM_F_586 in the Middle River subwatershed off of Windlass Drive was recommended for tree removal, removal of vegetation from the low-flow outlet, installation of pretreatment bays, vertical excavation, and landscaping updates with native vegetation.

SWM_F_435, the only detention pond assessed in Dundee Creek, is located near the intersection of Ebenezer Road and Cunninghill Cove Road. The existing pond is constrained horizontally on all sides, so there is no potential for horizontal expansion. It was recommended for replacement of the low flow pipe, rehabilitation of the principal spillway, tree removal, installation of pretreatment bays, vertical excavation, and landscaping updates with native vegetation. Dundee Creek was assigned a score of 1 point.

The remaining subwatersheds without dry detention pond assessments were given a score of zero. Municipal stormwater conversion scores are summarized in Table 4-10 by subwatershed.

Table 4-10: Municipal Stormwater Conversion Scores

| SUBWATERSHED | # of Ponds Assessed | # of Ponds with Conversion Potential (Horizontal Expansion) | # of Ponds with Conversion Potential (Vertical Expansion) | # of Ponds with Maintenance Needed | Municipal Stormwater Conversion Score |
|---|---|---|---|---|---|
| Darkhead Creek | 1 | 0 | 1 | 1 | 1 |
| Frog Mortar Creek | 3 | 1 | 3 | 3 | 3 |
| Galloway Creek | 0 | 0 | 0 | 0 | 0 |
| Browns Cove | 0 | 0 | 0 | 0 | 0 |
| Hogpen Creek | 0 | 0 | 0 | 0 | 0 |
| Hopkins Creek | 3 | 1 | 2 | 2 | 3 |
| Middle River | 1 | 0 | 1 | 1 | 1 |
| Norman Creek | 0 | 0 | 0 | 0 | 0 |
| Stansbury Creek | 0 | 0 | 0 | 0 | 0 |
| Sue Creek | 0 | 0 | 0 | 0 | 0 |
| Aberdeen Proving Ground | 0 | 0 | 0 | 0 | 0 |
| Dundee Creek | 1 | 0 | 1 | 1 | 1 |
| Gunpowder River | 1 | 1 | 1 | 1 | 3 |
| Saltpeter Creek | 0 | 0 | 0 | 0 | 0 |
| Seneca Creek | 0 | 0 | 0 | 0 | 0 |

### 4.2.11 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 (greater than 3 feet in diameter) are assigned one of the following priority ratings: critical, high, low, or none. Critical outfalls are those with problems that require immediate correction and/or close monitoring, or outfalls with recurring problems. These are sampled the most frequently (4 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 18 major outfalls in the Middle River and Tidal Gunpowder watersheds. Subwatersheds with the most illicit discharge data and highest prioritization ratings represent the best areas to target for restoration initially. Therefore, subwatersheds with major outfalls rated as critical received the highest scores (4 points). Subwatersheds with multiple major outfalls rated as high priority received the second highest scores (3 points). Subwatersheds with only one high rated major outfall were assigned the third highest scores (2 points). Subwatersheds with major outfalls only listed as low or not a priority were assigned a score of 1 point. Lastly, subwatersheds with no major outfalls received the lowest score (0 points)

The number of major outfalls associated with various County outfall prioritization ratings and corresponding illicit discharge data scores are summarized Table 4-11 by subwatershed.

Table 4-11: Illicit Discharge Data Scores

| SUBWATERSHED | COUNTY OUTFALL PRIORITIZATION RATINGS | | | | Illicit Discharge Data Score |
|---|---|---|---|---|---|
| | Critical | High | Low | None | |
| Darkhead Creek | - | 1 | 3 | - | 2 |
| Frog Mortar Creek | - | 4 | 1 | - | 3 |
| Galloway Creek | - | - | - | - | 0 |
| Browns Cove | - | - | - | - | 0 |
| Hogpen Creek | - | - | - | - | 0 |
| Hopkins Creek | - | 1 | 1 | - | 2 |
| Middle River | 3 | 1 | - | - | 4 |
| Norman Creek | - | - | - | - | 0 |
| Stansbury Creek | - | - | - | - | 0 |
| Sue Creek | - | - | - | - | 0 |
| Aberdeen Proving Ground | - | - | - | - | 0 |
| Dundee Creek | - | - | - | 1 | 1 |
| Gunpowder River | - | - | - | - | 0 |
| Saltpeter Creek | - | - | - | - | 0 |
| Seneca Creek | - | - | - | 2 | 1 |

### 4.2.12 Stream Buffer Improvements

Forested buffer areas along streams play a crucial role in improving water quality and flood mitigation since they can reduce surface runoff, stabilize stream banks, trap sediment, and provide habitat for various types of terrestrial and aquatic life including fish. They protect water bodies from pollutant loads while also providing bank stabilization and habitat. Maintaining healthy streams and forest buffers are important for reducing nutrient and sediment loadings to the Middle River, Tidal Gunpowder, and Chesapeake Bay. When stream buffers are converted from forest to developed areas, many of these benefits are lost and stream health declines. Inadequate stream buffers (less than 50 feet wide) were the most commonly observed environmental problem within the Gunpowder River stream corridor assessment area. Riparian buffer zones can be re-established or preserved as a BMP to reduce land use impacts by intercepting and controlling pollutants entering a water body.

In the *Watershed Characterization Report*, the vegetative condition of stream buffer was analyzed based on a 100-foot buffer on either side of the stream system. 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. Therefore, the percentages of open pervious buffer area were used to prioritize restoration potential among subwatersheds. 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 percentages range from approximately 11% to 66%. The following point system was used to assign stream buffer improvement scores to the 15 subwatersheds based on the distribution and range of open pervious buffer area percentages:

- ≥ 50% = 4 pts
- 35 – 49% = 3 pts
- 20 – 34% = 2 pts
- ≤ 19% = 1 pt

Percentages of open pervious stream buffer areas and corresponding scores are summarized in Table 4-12 by subwatershed.

Table 4-12: Stream Buffer Improvement Scores

| SUBWATERSHED | % Open Pervious Stream Buffer Area | Stream Buffer Improvement Score |
|---|---|---|
| Darkhead Creek | 44% | 3 |
| Frog Mortar Creek | 53% | 4 |
| Galloway Creek | 37% | 3 |
| Browns Cove | 11% | 1 |
| Hogpen Creek | 22% | 2 |
| Hopkins Creek | 50% | 4 |
| Middle River | 45% | 3 |
| Norman Creek | 30% | 2 |
| Stansbury Creek | 62% | 4 |
| Sue Creek | 20% | 2 |
| Aberdeen Proving Ground | 26% | 2 |
| Dundee Creek | 45% | 3 |
| Gunpowder River | 19% | 1 |
| Saltpeter Creek | 26% | 2 |
| Seneca Creek | 66% | 4 |

### 4.2.13 Shoreline Buffer Improvements

Similar to stream buffers, forested buffer areas along the shoreline play a crucial role in improving water quality. They protect surface water bodies from watershed pollutant loads while also providing bank stabilization and habitat. A portion of the coastal area within the watersheds is developed which limits water quality benefits and contributes to surface water degradation. Re-establishing or preserving shoreline buffer areas can be used as a BMP to reduce land use impacts by intercepting and controlling pollutants before they enter the Middle River or Tidal Gunpowder River.

In the *Watershed Characterization Report*, the vegetative condition of the shoreline buffer was analyzed using GIS based on a 100-foot buffer from the tidal waters. Similar to the stream buffer analysis, three conditions were used to classify stream buffer conditions: impervious, open pervious, or forested. For each subwatershed, acreages and percentages of shoreline buffer area were determined for the three conditions. Since open pervious areas represent the greatest potential for shoreline buffer reforestation, the percentages of open pervious buffer area were used to prioritize restoration potential

among subwatersheds. Subwatersheds with greater percentages of open pervious buffer areas denote the greatest potential for shoreline buffer improvement and were scored the highest.

Open pervious buffer area percentages range from approximately 23% to 76%. The following point system was used to assign shoreline buffer improvement scores to the 15 subwatersheds based on the distribution and range of open pervious buffer area percentages:

- ≥ 70% = 4 pts
- 60 – 69% = 3 pts
- 50 – 59% = 2 pts
- < 50% = 1 pt

Percentages of open pervious shoreline buffer areas and corresponding scores are summarized in Table 4-13 by subwatershed.

Table 4-13: Shoreline Buffer Improvement Scores

| SUBWATERSHED | % Open Pervious Shoreline Buffer Area | Shoreline Buffer Improvement Score |
|---|---|---|
| Darkhead Creek | 73% | 4 |
| Frog Mortar Creek | 66% | 3 |
| Galloway Creek | 76% | 4 |
| Browns Cove | 61% | 3 |
| Hogpen Creek | 58% | 2 |
| Hopkins Creek | 69% | 3 |
| Middle River | 69% | 3 |
| Norman Creek | 69% | 3 |
| Stansbury Creek | 52% | 2 |
| Sue Creek | 61% | 3 |
| Aberdeen Proving Ground | 29% | 1 |
| Dundee Creek | 23% | 1 |
| Gunpowder River | 74% | 4 |
| Saltpeter Creek | 30% | 1 |
| Seneca Creek | 69% | 3 |

### 4.2.14 Stream Corridor Restoration

Stream Corridor Assessments (SCAs) were conducted based on the Maryland Department of Natural Resources (DNR) survey protocols to quickly assess physical stream conditions and identify common environmental problems in the stream corridor. This included documentation of erosion sites, inadequate stream buffers, fish migration barriers, exposed or discharging pipes, channelized or altered stream sections, trash dumping sites, in or near stream construction, and unusual conditions (e.g., invasive species). SCAs were focused in two subwatersheds with the greatest length of wadeable, non-tidal streams best suited for the survey method and for identifying stream corridor restoration efforts:

Saltpeter Creek and Dundee Creek, both located in the Tidal Gunpowder River watershed. As previously mentioned, maintaining healthy streams is fundamental to improving water quality in the Tidal Gunpowder River. This criterion relates other watershed goals such as restoring and maintaining fisheries and habitat, reducing trash, and improving water quality.

Along the 2.7 miles of stream walked in the Tidal Gunpowder River watershed, a total of 27 potential environmental problems were observed. The most frequently observed problems were inadequate stream buffers, trash dumping, fish barriers, pipe outfalls, channel alteration, and other unusual conditions. Because stream buffer improvement is addressed in a separate criterion, it is not included in the stream corridor restoration ranking criterion. The remaining four frequently observed problems were evaluated/scored separately and then combined to determine an overall stream corridor restoration score. Trash dumping, channel alteration, erosion, and discharging/exposed pipes all relate to multiple watershed goals and are good indicators of restoration need and potential. Each problem category and overall stream corridor restoration criterion scoring are described below.

*Trash Dumping*

Trash dumping sites are places where large amounts of trash have been dumped or have accumulated inside the stream corridor. Identifying these sites helps identify areas where limiting access is necessary to reduce trash dumping and locations suitable for stream clean-ups. Trash dumping sites were frequently located near industrial sites and consisted of heavy materials that were determined not suitable for volunteer clean-up. During the SCAs, field teams estimated the number of pick-up truck loads they deemed necessary to remove all trash/debris from a given site. Greater numbers of pick-up truck loads denote greater amounts of trash within a stream and a higher need for restoration. Subwatersheds were ranked according to the total number of estimated pick-up truck loads, where 4 points were assigned to the subwatershed with the most pick-up truck loads and 3 points were assigned to the subwatershed with the second highest amount of pick-up truck loads. Table 4-14 summarizes the total number of pick-up truck loads estimated to remove trash/debris in stream corridors and the corresponding trash dumping sub-criterion scores by subwatershed.

Table 4-14: SCA Trash Dumping Scores

| SUBWATERSHED | # TRUCK LOADS | Trash Dumping Score |
|---|---|---|
| Saltpeter Creek | 3 | 3 |
| Dundee Creek | 10 | 4 |

*Fish Migration Barriers*

Fish migration barriers are obstacles or impediments that interfere with the upstream movement of fish. Many species of fish depend upon the ability to migrate into the upper reaches of streams to spawn. By limiting the length of streams available to these species, fish barriers decrease the population size of fish and in turn the health and biodiversity of aquatic habitats. Fish barriers include any manmade or natural structure that prevents fish from swimming over or through. During the SCAs, three (3) fish barriers were identified, all within Saltpeter Creek. The subwatersheds were ranked based on the number of fish barriers found during the SCAs.

Because fish barriers were only found in Saltpeter Creek, it was assigned a score of three (3). Dundee Creek was assigned a score of zero (0) as summarized in Table 4-15.

Table 4-15: SCA Fish Barrier Scores

| SUBWATERSHED | # FISH BARRIERS | Fish Barrier Score |
|---|---|---|
| Saltpeter Creek | 3 | 3 |
| Dundee Creek | 0 | 0 |

*Pipe Outfalls*

Pipe outfalls refer to storm drain outfalls or small manmade channels that discharge stormwater into a stream corridor. Pipe outfalls are considered a potential water quality problem since they can carry untreated runoff and pollutants such as oil, heavy metals, and nutrients to a stream system. During the SCAs, the field team documented the pollution severity of pipe outfalls based on discharge presence, color, odor, amount, and downstream impacts. For example, outfalls with a strong discharge relative to the normal stream flow, a distinct color and/or odor, and where discharge was causing significant impacts downstream were considered severe problems.

The total number of severe and moderately severe outfalls observed during the SCAs were used to rank subwatersheds for this sub-criterion. Subwatersheds with more occurrences of severe to moderately severe discharging pipes represent a greater need and potential for stream corridor restoration.

Because the three (3) exposed pipes that were found during the SCAs were all in Saltpeter Creek, the subwatershed was given a score of three (3). Dundee Creek was given a score of zero (0).

Table 4-16: SCA Pipe Outfall Scores

| SUBWATERSHED | # PIPE OUTFALLS | Pipe Outfall Score |
|---|---|---|
| Saltpeter Creek | 3 | 3 |
| Dundee Creek | 0 | 0 |

*Channel Alteration*

Sections of stream where the banks or channel have been significantly modified from their naturally occurring structure or condition can have adverse impacts on stream health. This includes channels that have been dredged, widened, straightened, and/or covered with concrete. While often intended to convey more water and prevent flooding, habitat impairments and downstream instabilities may result. During the SCAs, the field team documented three channel alteration lengths at Saltpeter Creek. The total length of channel alteration observed and percentage of the total stream length surveyed that is altered were calculated in the *Watershed Characterization Report*. Altered stream length percentages (based on surveyed stream miles) were used to directly compare and rank subwatersheds. A higher percentage of stream length that is significantly altered represents a greater need and potential for stream corridor restoration. Subwatersheds were ranked according to this percentage, where 4 points was assigned to the subwatershed with the highest and 1 point was assigned to the subwatershed with

the lowest percentage of altered stream length. Because Saltpeter Creek was the only stream to have channel alterations, it was assigned 3 points. No score of 4, 2, or 1 point was assigned since there were no altered stream lengths found in Dundee Creek. Table 4-17 summarizes the percentages of altered stream lengths in surveyed stream corridors and the corresponding channel alteration sub-criterion scores by subwatershed.

Table 4-17: SCA Channel Alteration Scores

| SUBWATERSHED | % Altered* | Channel Alteration Score |
|---|---|---|
| Saltpeter Creek | 3% | 3 |
| Dundee Creek | 0 | 0 |

* % Altered based on altered length observed in the field divided by total stream length surveyed.

*Overall Stream Corridor Restoration Score*

Stream corridor restoration may involve addressing all four environmental problem categories. Therefore, to determine the overall score for the stream corridor restoration criterion, subwatersheds were ranked according to the sum of the sub-criterion scores. The subwatershed with the highest total sub-criteria score received the highest ranking (4 points). The subwatershed with the lowest total sub-criteria score received the lowest ranking for this criterion (2 point). Table 4-18 summarized sub-criteria totals and overall stream corridor restoration scores by subwatershed.

Table 4-18: SCA Stream Corridor Restoration Scores

| SUBWATERSHED | Total of Sub-Criteria Scores | Overall Stream Corridor Restoration Score |
|---|---|---|
| Saltpeter Creek | 12 | 4 |
| Dundee Creek | 4 | 2 |

### 4.2.15 Subwatershed Prioritization Summary

The 15 subwatersheds comprising the Middle River and Tidal Gunpowder watersheds are ranked according to the total prioritization score (i.e., the sum of prioritization criterion scores). Subwatershed ranking results are summarized in Table 4-19 including criterion scores, total scores, and rankings by subwatershed.

Subwatersheds were placed into one of four priority categories based on ranking results: very high, high, medium, and medium-low. These results are summarized in Table 4-20 and illustrated in Figure 4-2. Subwatersheds with a total prioritization score greater than 32 received a very high priority rating. These four subwatersheds (Hopkins Creek, Middle River, Darkhead Creek and Frog Mortar Creek) have scores that are higher than the remaining subwatersheds. A high rating was assigned to the next logical grouping of subwatersheds with total prioritization scores of 26 and 31 (Sue Creek, Seneca Creek, Norman Creek, and Galloway Creek). A medium rating was assigned to the four subwatersheds with total prioritization scores between 22 and 24 (Saltpeter Creek, Stansbury Creek, Dundee Creek, and Gunpowder River). The remaining three subwatersheds (Hogpen Creek, Browns Cove, and Aberdeen Proving Ground) with total prioritization scores less than 22 were assigned a medium-low priority rating.

Restoration actions will have to occur throughout the entire Middle River and Tidal Gunpowder watersheds in order to meet environmental goals and requirements. However, subwatershed prioritization provides a tool/framework for focusing initial restoration efforts.

Table 4-19: Subwatershed Ranking Results

| SUBWATERSHED | Nitrogen Load | Phosphorus Load | % Impervious | NSA PSI/ROI | NSA Lawn Fertilizer Reduction | NSA Downspout Disconnect | NSA Trash Management | ISI Site Index | Pervious Area Reforestation | Municipal Street Sweeping | Municipal Stormwater Conversion | Illicit Discharge Data | Stream Buffer Improvement | Shoreline Buffer Improvement | Stream Corridor Restoration | TOTAL SCORE | SUBWATERSHED RANK |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Darkhead Creek | 3 | 4 | 3 | 4 | 1 | 1 | 2 | 4 | 2 | 3 | 1 | 2 | 3 | 4 | 0 | *37* | *3* |
| Frog Mortar Creek | 4 | 4 | 3 | 2 | 4 | 1 | 0 | 1 | 1 | 0 | 3 | 3 | 4 | 3 | 0 | *33* | *4* |
| Galloway Creek | 4 | 3 | 2 | 2 | 3 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 3 | 4 | 0 | *26* | *8* |
| Browns Cove | 3 | 2 | 1 | 2 | 2 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 3 | 0 | *17* | *14* |
| Hogpen Creek | 2 | 2 | 2 | 3 | 2 | 3 | 0 | 0 | 1 | 1 | 0 | 0 | 2 | 2 | 0 | *20* | *12* |
| Hopkins Creek | 4 | 4 | 3 | 4 | 3 | 4 | 4 | 3 | 4 | 3 | 3 | 2 | 4 | 3 | 0 | *48* | *1* |
| Middle River | 4 | 4 | 3 | 4 | 3 | 3 | 3 | 2 | 2 | 4 | 1 | 4 | 3 | 3 | 0 | *43* | *2* |
| Norman Creek | 2 | 2 | 2 | 3 | 2 | 4 | 4 | 3 | 0 | 0 | 0 | 0 | 2 | 3 | 0 | *27* | *7* |
| Stansbury Creek | 3 | 3 | 2 | 3 | 1 | 2 | 1 | 0 | 0 | 1 | 0 | 0 | 4 | 2 | 0 | *22* | *10* |
| Sue Creek | 2 | 1 | 2 | 4 | 4 | 4 | 3 | 2 | 3 | 2 | 0 | 0 | 2 | 3 | 0 | *32* | *5* |
| Aberdeen Proving Ground | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 2 | 1 | 0 | *11* | *15* |
| Dundee Creek | 1 | 3 | 1 | 1 | 1 | 0 | 1 | 2 | 4 | 0 | 1 | 1 | 3 | 1 | 2 | *22* | *10* |
| Gunpowder River | 2 | 1 | 1 | 1 | 0 | 2 | 0 | 1 | 4 | 0 | 3 | 0 | 1 | 4 | 0 | *20* | *12* |
| Saltpeter Creek | 1 | 3 | 1 | 2 | 1 | 1 | 0 | 4 | 3 | 0 | 0 | 0 | 2 | 1 | 4 | *23* | *9* |
| Seneca Creek | 1 | 2 | 2 | 2 | 4 | 2 | 3 | 2 | 2 | 0 | 0 | 1 | 4 | 3 | 0 | *28* | *6* |

* NA denotes that corresponding category 'Not Assessed' within the subwatershed indicated.

Table 4-20: Subwatershed Prioritization

| Rank | Subwatershed | Total Score | Prioritization Category |
|---|---|---|---|
| 1 | Hopkins Creek | 48 | Very High |
| 2 | Middle River | 43 | Very High |
| 3 | Darkhead Creek | 37 | High |
| 4 | Frog Mortar Creek | 33 | High |
| 5 | Sue Creek | 32 | High |
| 6 | Seneca Creek | 28 | Medium |
| 7 | Norman Creek | 27 | Medium |
| 8 | Galloway Creek | 26 | Medium |
| 9 | Saltpeter Creek | 23 | Medium-Low |
| 10 | Stansbury Creek | 22 | Medium-Low |
| 10 | Dundee Creek | 22 | Medium-Low |
| 12 | Hogpen Creek | 20 | Medium-Low |
| 12 | Gunpowder River | 20 | Medium-Low |
| 14 | Browns Cove | 17 | Low |
| 15 | Aberdeen Proving Ground | 11 | Low |

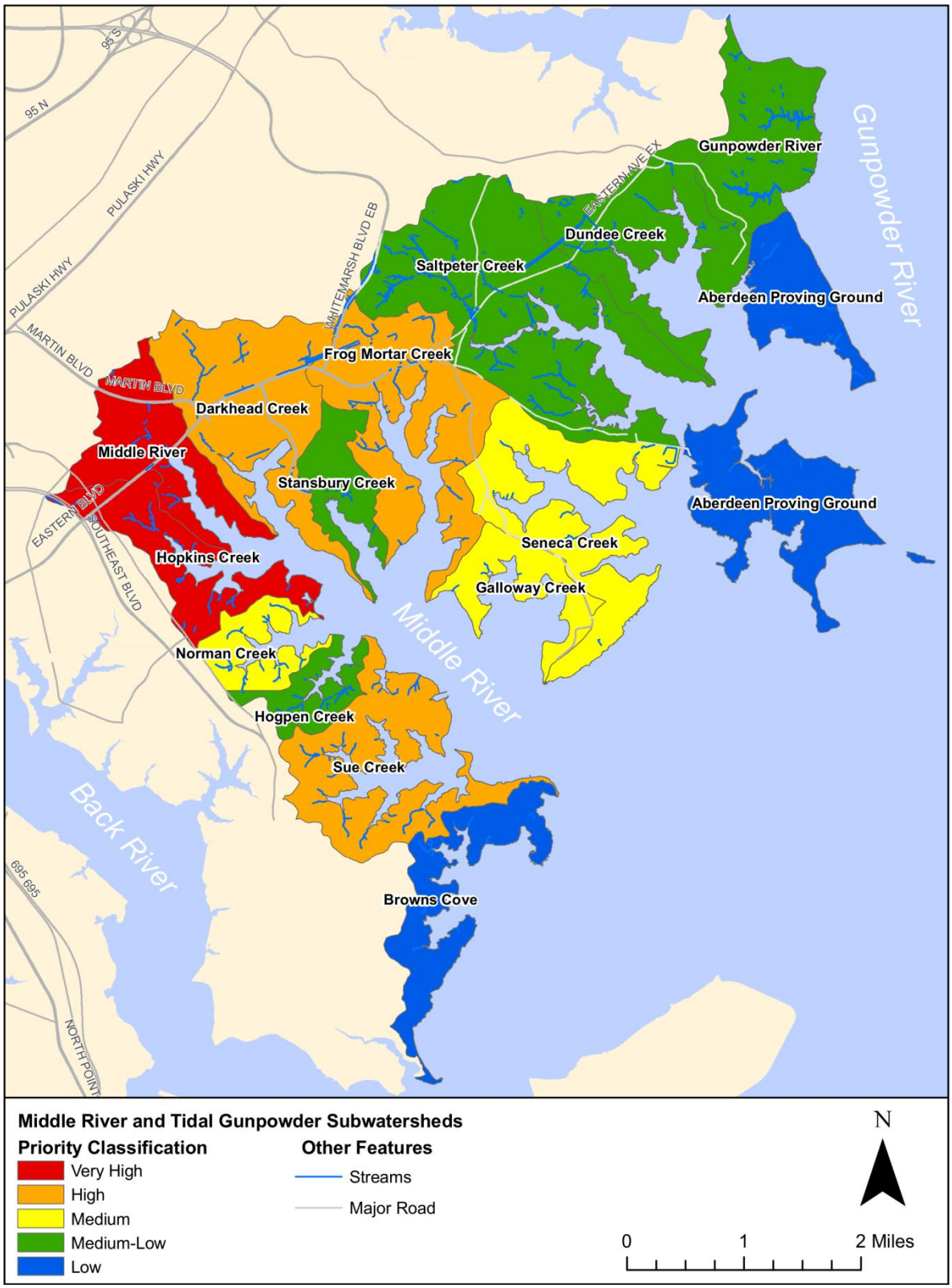


Figure 4-2: Tidal Back River Subwatershed Prioritization

## 4.3 Subwatershed Restoration Strategies

Restoration strategies for each subwatershed are presented in the following subsections. Subwatersheds are presented in alphabetical order. A description of key watershed characteristics is presented for each subwatershed including drainage area, stream length, coastline length, population, land use/land cover, impervious cover, soils, and stormwater management (SWM) facilities. Assessment results for neighborhoods, hotspots, institutions, pervious areas, stream corridors, illicit discharges, and stormwater conversions are also summarized for each subwatershed. Finally, a subwatershed management strategy including recommended citizen and municipal actions are presented at the end of each subsection.

Several of the assessment categories that were assessed only examined a percentage of opportunities within a given subshed. These categories include hotspots, institutions, marinas, and pervious areas. The objective of the assessments is to review a representative sample of the businesses, institutions, and open space in the watershed to identify the most likely opportunities to limit pollution sources and implement pollution reduction measures.

For example, because there are numerous operations that qualify as stormwater hotspots, not all could be individually evaluated during the uplands survey. The assessments are intended to represent common types of hotspot operations located throughout the watershed and help develop an overall strategy to encompass all hotspot operations. Because marinas are a significant portion of the local economy in this area, a separate assessment was completed for 10 marinas in the SWAP study area. Similarly, six large industrial landowners compromising 21% of the SWAP study area and impacting several subwatersheds were each assessed and site visits taken when possible.

There are several open pervious areas throughout the watershed with reforestation potential, including over 500 acres of publicly-owned lands for recreation and parks. 19 pervious area assessments (PAAs) were conducted, all of which are large open parcels with minimal site preparation required for reforestation. The total acres of publicly-owned lands with restoration potential is considered in the subwatershed prioritization and discussed in subwatershed descriptions.

### 4.3.1 Darkhead Creek

Darkhead Creek is the fourth largest subwatershed in the Middle River and Tidal Gunpowder watersheds. Encompassing a large amount of industrial area, the majority of Darkhead Creek is occupied by urban development (nearly 75%) including industrial, institutional, commercial, open urban, and residential uses. Forested areas make up the majority of the remaining subwatershed area. Table 4-21 summarizes key subwatershed characteristics of Darkhead Creek.

Table 4-21: Key Subwatershed Characteristics - Darkhead Creek

| | | |
|---|---|---|
| Drainage Area | 1,139.6 acres (1.78 sq. mi.) | |
| Stream Length | 3.6 miles | |
| Coastline Length | 4.5 miles | |
| Population | 5,289 (2000 Census)<br>4.6 people/acre | |
| Land Use/Land Cover | Very Low Density Residential:<br>Low Density Residential:<br>Medium Density Residential:<br>High Density Residential:<br>Commercial:<br>Industrial:<br>Institutional:<br>Extractive:<br>Open Urban:<br>Forest:<br>Agriculture:<br>Water/Wetlands:<br>Transportation | 1.7%<br>0.0%<br>18.0%<br>15.6%<br>16.1%<br>18.6%<br>1.7%<br>0.0%<br>2.7%<br>22.9%<br>0.4%<br>2.3%<br>0.0% |
| Impervious Cover | 33% of subwatershed | |
| Soils | A Soils (low runoff potential):<br>B Soils:<br>C Soils:<br>D Soils (high runoff potential): | 5.5%<br>10.1%<br>21.5%<br>62.4% |
| SWM Facilities | 24% of urban land use treated | |
| Priority Rating | High | |

*Neighborhoods*

A total of six (6) distinct neighborhoods were identified and assessed within Darkhead Creek during the uplands assessment of Middle River and Tidal Gunpowder. Characteristics such as lot size, age, and type were used to delineate neighborhoods rather than subwatershed boundaries. As a result, some neighborhoods overlap multiple subwatersheds. For example, NSA_F_36 encompasses portions of Stansbury Creek. Qualitative descriptions of this neighborhood and recommendations are included within this section. While descriptions are not repeated for neighborhoods overlapping multiple subwatersheds, calculations presented in the *Watershed Characterization Report* were based on the fraction of the NSA area within respective watersheds.

Recommendations for addressing stormwater volume and pollutants within this subwatershed include downspout disconnection, storm drain marking, buffer improvement, and public education (i.e., bayscaping, increasing lot tree canopy, lawn care, pet waste management, and pool maintenance). A summary of neighborhood recommended actions is presented in Table 4-22.

Table 4-22: NSA Recommendations – Darkhead Creek

| | | RECOMMENDED ACTIONS | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NSA_ID | Lot Size (acres) | % Opportunity for Downspout Disconnection | Rain Barrels | Rain Gardens | Storm Drain Stencils | Bayscape | Increase Lot Canopy | Fertilizer Reduction | Pet Waste | Trash Management | Buffer Improvement | Miles of Street Sweeping | # of Street Trees | # of Common Area Shade Trees | Notes |
| NSA_F_32 | <1/4 | 40% | X | | X | | X | X | | | | | 45 | | |
| NSA_F_33 | <1/8 | 55% | X | | X | | X | | X | | | 1.66 | 275 | | Pet Waste Education |
| NSA_F_34 | >1 | 50% | | X | X | X | X | | | | X | | | 235 | Plant Forest Buffer Along Stream |
| NSA_F_35 | 1/2 | 20% | X | X | | X | X | | X | X | X | | | | Improve Outdoor Storage, Stabilize Driveways, Boat and Car Maintenance Education |
| NSA_F_36 | <1/4 | 40% | X | | X | | X | | | X | | 3.5 | | | Stabilize Offstreet Parking<br>Boat Maintenance Education |
| NSA_F_37 | <1/4 | 25% | X | X | X | | X | X | | | X | | | | Stabilize Bare Earth & Deteriorated Driveways |

Most of the neighborhoods in Darkhead Creek are recommended for downspout disconnection, public education related to increasing lot tree canopy, and storm drain stenciling. Three (3) neighborhoods, NSA_F_34, NSA_F_35, and NSA_F_37 are recommended for buffer improvement that may be achieved through public education about the benefits of providing a stream and shoreline buffer by reducing the amount of mowed lawn through tree and vegetation planting. Several deteriorated cars and stored boats were seen in NSA_F_35 and NSA_F_36 as seen in Figure 4–3 . This provides an opportunity for education on proper vehicle and boat maintenance and storage.

Figure 4-3: Vehicle Storage in NSA_F_35 and NSA_F_36

*Hotspots*

One (1) hotspot investigation was performed within Darkhead Creek on a moving and storage facility. Table 4-23 summarizes the potential pollution sources found at HSI_F_701.

Table 4-23: HSI Results Summary – Darkhead Creek

| | | | POTENTIAL POLLUTION SOURCES | | | |
|---|---|---|---|---|---|---|
| HSI_ID | HSI Status* | Description | Vehicle Operations | Outdoor Materials | Waste Management | Notes |
| HSI_F_701 | Potential | Moving and Storage | X | X | X | |

*Notes:
Potential – pollution not observed, potential pollutant sources

Vehicle operations, storage of outdoor materials, and waste management were noted at the hotspot assessed in Darkhead Creek including storage of vehicles and materials outdoors with no runoff diversions and dumpsters with no covers. Education and outreach at similar transport-related facilities would help address these potential pollution sources.

There are currently three (3) NPDES-permitted facilities for general stormwater discharges within Darkhead Creek. Two of the facilities are industrial landowners which are addressed later in this section. Compliance with permit requirements should be verified for all of these facilities.

*Institutions*

A total of five (5) institutions were assessed for retrofit opportunities in Darkhead Creek during the uplands assessments. This includes two (2) schools, two (2) fire and rescue facility, and a faith-based facility. Table 4-24 summarizes recommendations for these institutional sites.

Table 4-24: ISI Recommendations – Darkhead Creek

| | | | RECOMMENDATIONS | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Site ID | Name | Public/ Private | Nutrient Management | # of Trees Recommended for Planting | Stormwater Retrofit | Impervious Cover Removal | Trash Management | Storm Drain Marking | Notes |
| ISI_F_701 | Vol Ambulance Rescue Co. | Public | | 30 | | X | | | Outdoor material storage education; concrete pad removal |
| ISI_F_702 | Faith Lutheran | Private | | 10 | | | | | All downspouts redirected to pervious area |
| ISI_F_705 | Middle River Vol Fire Co 22 | Public | | | | | | | Contains PAA_F_703 |
| ISI_F_703 | Martin Boulevard Elementary School | Public | | 75 | X | | X | X | Parking lot retrofit; erosion/bare ground |
| ISI_F_704 | Hawthorne Elementary School | Public | X | 100 | X | X | X | X | Litter near storm drains; Parking lot /alley retrofit |

Public schools represent unique opportunities to combine water quality improvement measures with student education/outreach. All of the schools assessed are recommended for tree planting, storm drain marking, and trash management which are both ways to engage teachers and students. Impervious cover removal of 0.02 acres and 0.16 acres was recommended at one (1) fire and rescue facility and one (1) of the public school sites assessed, respectively. Figure 4-4 shows the potential impervious cover removal opportunities in the Darkhead Creek subwatershed.

Figure 4-4: Impervious Cover Removal Opportunities at ISI_F_701 (left) and ISI_F_704 (right)

Both schools have potential for stormwater retrofits. In particular, ISI_F_704 (Hawthorne Elementary) is recommended for a stormwater management retrofit to collect sediment that is currently built up along

the curb line and ultimately discharging to a stream. Similarly, a stormwater retrofit is recommended to treat parking adjacent to a baseball field in ISI_F_703. Stormwater retrofits can be a means to educate students about water quality and stormwater management. Figure 4-5 shows the potential stormwater retrofit opportunities at public schools in the Darkhead Creek subwatershed.

Figure 4-5: Stormwater Retrofit Opportunities at ISI_F_703 (left) and ISI_F_704 (right)

*Pervious Areas*

Three (3) pervious areas were assessed for restoration potential in Darkhead Creek including an EPS-owned open space near the Village of Pawnee, Wilson Point Park, and an unnamed park on Dogwood Road. Two sites are maintained by Baltimore County while PAA_F_703 is owned by the MD Department of Transportation (DOT). The sites range from a turf coverage of approximately 38% at PAA_F_701 to 70% and 85% at PAA_F_702 and PAA_F_703, respectively. All three sites are classified as open pervious with minimal site preparation needed to conduct tree planting. In addition, trash dumping was noted along the edge of the existing forest at PAA_F_701. This presents an opportunity to conduct a neighborhood cleanup and to post signs educating users of the facility to dispose of trash in a proper manner. Table 4-25 provides a description of the PAAs located in Darkhead Creek. Figure 46 shows evidence of dumping at PAA_F_701 and potential planting sites at PAA_F_702 and PAA_F_703.

Table 4-25: PAA Descriptions – Darkhead Creek

| Site ID | Location | Description | Site Size (acres) | Ownership |
|---|---|---|---|---|
| PAA_F_701 | Village Of Pawnee | EPS-owned open space | 7.01 | Public |
| PAA_F_702 | Beech Drive | Wilson Point Park | 19.89 | Public |
| PAA_F_703 | Dogwood Road | Unnamed Park | 7.67 | Public |

Figure 4-6: Dumping at PAA_F_701 (left) and Planting Opportunities at PAA_F_702 (middle) and PAA_F_703 (right)

*Marinas*

No marinas were assessed in Darkhead Creek. In addition, the subwatershed does not contain any marinas with an NPDES stormwater discharge permit. A review of aerial photography along the shoreline of the watershed revealed several areas where a high density of boats were being stored on land along with several docks with numerous slips. It is recommended that a review of potential "bootleg" marinas be undertaken in Darkhead Creek to ensure that proper zoning laws are followed and stormwater discharge requirements are being met.

*Industrial Landowners*

Three (3) large industrial landowners properties are contained in Darkhead Creek including the entirety of the Lockheed Martin Corporation (LMC) facility and portions of the Martin State Airport (MSA) and Maryland Air National Guard (MANG) facility. Table 4-26 provides information on these facilities.

Table 4-26: Industrial Landowners – Darkhead Creek

| Site ID | Name | Total Acres |
|---|---|---|
| IND_F_701 | Lockheed Martin | 176 |
| IND_F_801 | Martin State Airport | 585 |
| IND_F_901 | Maryland Air National Guard | 156 |

Because the operations of all the industrial landowners in Middle River are based on aviation and centered around the runway at MSA, the facilities must comply with the Federal Aviation Administration (FAA) Advisory Circular 150/5200-33B. This Circular provides guidance on stormwater management facilities to reduce or eliminate hazardous wildlife attractants on or within a 3 mile radius of the airport. The guidance prevents the use of any stormwater management facilities that detain standing water for greater than 48 hours, specifically wet detention ponds and other "wet" stormwater facilities. All the industrial landowners in Darkhead Creek have NDPES stormwater discharge permits and have undertaken additional measures to limit pollutant discharges from their sites. Additional information on assessments performed at these facilities can be found in the *Watershed Characterization Report*.

LMC has voluntarily conducted extensive environmental investigations of both the Martin State Airport (to determine environmental impacts during the time LMC or its predecessor companies owned the airport property) and the Middle River complex properties since the late 1990s. It should also be noted that LMC has also developed a stormwater guidance document (last revised in 2009) which provides

detailed guidance for designated employees to conduct a compliant stormwater management program including sampling and analyses of discharge water and identification of potential pollution sources that may affect quality of stormwater discharges from permitted outfalls.

The MSA facility is owned by the Maryland Aviation Administration (MAA) and has undertaken measures to ensure that operations and maintenance practices are done indoors or in areas that do not drain to storm systems or surface waters. Similarly, the MANG property, which is adjacent to the airport and is leased from MAA has a number of safeguard to prevent the release of pollutants into surface waters.

It is recommended that Baltimore County continue to have an open dialog with each of these facilities to determine what future restoration activities are feasible on these sites in Darkhead Creek.

*Stream Corridor Assessments*

Stream corridor assessments (SCAs) were not conducted in Darkhead Creek. Streams within this subwatershed are mostly tidal, marshy areas and not appropriate for a walking field survey utilizing Maryland DNR's SCA Survey Protocols. Therefore, no stream restoration opportunities have been identified in Darkhead Creek.

*Illicit Discharges*

Baltimore County tracks illicit discharges through a program of routine outfall screening. The County uses a prioritization system based on this data where outfalls are assigned one of the following priority ratings: none (priority 0), low (priority 3), high (priority 2), critical (priority 1). Priority 1 outfalls have major problems that require immediate correction and/or close monitoring, or have recurring problems. These outfalls are sampled four times each year. Priority 2 outfalls have moderate to minor problems with the potential to become more severe. These are sampled once a year. There is one (1) priority 2 outfall and three (3) priority 3 outfalls within Darkhead Creek. 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*

Darkhead Creek contains one detention pond, located at the intersection of Pawnee Road and Choctaw Court. The pond is a publicly-owned facility and collects drainage from a 122-acre development of single family homes. While lateral expansion is constrained, the pond has a large surface area, conducive to providing water quality treatment. In addition, there are maintenance opportunities that can increase water quality improvement capacity of the pond. One is to replace the current vegetation (invasive) with more dense, native vegetation to provide enhanced water quality benefits. In addition, trees can be removed from the embankment and the fence repaired. The Table 4-27 below summarizes the field survey results.

Table 4-27: Detention Pond Conversion - Darkhead Creek

| Site ID | Riser | Embankment | Vege-tation | Gate | Water Quality Potential | Access | Flow Path | Expansion Potential |
|---|---|---|---|---|---|---|---|---|
| SWM_F_950 | Good | Trees | Wetland Veg. | Unlocked | Y | Easy | Long | No |

Figure 4-7 shows the riser structure and vegetation contained within SWM_F_950.

Figure 4-7: Existing Detention Pond SWM_F_950

*Shoreline Restoration*

Darkhead Creek has 4.52 miles of shoreline of which almost 73% (38.4 acres) of the 100-foot shoreline buffer is classified as open, pervious area. In 1990, a shoreline enhancement project was conducted on 780 linear feet of shoreline at Dark Head Park. In 1999, Baltimore County performed a repair and restabilization effort on the project. No other shoreline enhancement projects were identified in EPS's Shoreline Enhancement Feasibility Study (EPS 1998).

*Subwatershed Management Strategy*

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

1. Conduct appropriate downspout disconnection measures in neighborhoods according to Table 4-22 and educate citizens on the benefits of rain barrels and rain gardens.
2. Engage citizens in a storm drain marking program and conduct marking activities in the neighborhoods indicated in Table 4-22.
3. Increase tree canopies on private lots by educating citizens on the benefits of trees and about programs such as The Growing Home Campaign.
4. Educate citizens about the benefits and importance of proper lawn care and pool maintenance techniques and bayscaping.
5. Educate residents of NSA_F_34, NSA_F_35, and NSA_F_37 about the importance of shoreline buffers and encourage more environmentally friendly shoreline treatments.
6. Educate residents on proper techniques for vehicle and boat storage and maintenance.

Municipal Actions

1. Work with HSI_F_701 and similar businesses to implement appropriate practices for vehicle operations, outdoor materials storage and waste management.
2. Conduct tree plantings and impervious cover removal at the institutional sites list in Table 4-24.
3. Investigate the potential for installation of stormwater retrofits and conduct programs with teachers and students to provide education install retrofits and storm drain stencils at the school facilities in Table 4-25.
4. Identify open pervious shoreline areas in Darkhead Creek for the potential for reforestation and preservation.
5. Investigate potential bootleg marinas along Darkhead Creek.
6. Work with LMC, MSA, and MANG to identify potential water quality projects at industrial facilities in Darkhead Creek.
7. Perform maintenance on SWM_F_950 to replace invasive vegetation, remove trees from the pond embankment, and repair the perimeter fencing.

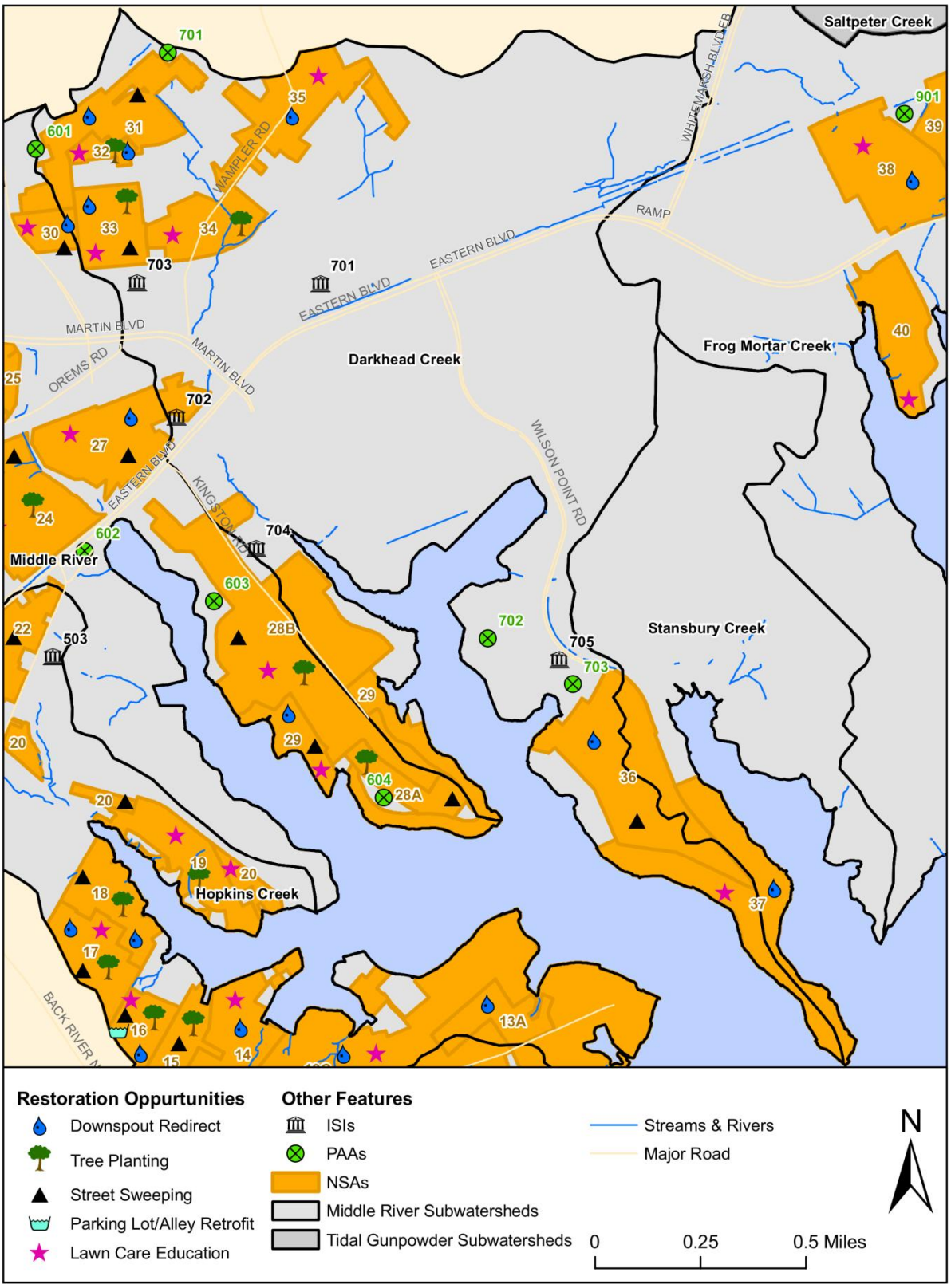


Figure 4-8: Restoration Opportunities in Darkhead Creek

### 4.3.2 Frog Mortar Creek

Frog Mortar Creek is the third largest subwatershed in the Middle River and Tidal Gunpowder watersheds. 83% of Frog Mortar Creek is occupied by urban development including institutional, commercial, open urban and residential uses. Forested areas make up the majority of the remaining subwatershed area. Table 4-28 summarizes key subwatershed characteristics of Frog Mortar Creek.

Table 4-28: Key Subwatershed Characteristics - Frog Mortar Creek

| | | |
|---|---|---|
| Drainage Area | 1,191.8 acres (1.86 sq. mi.) | |
| Stream Length | 4.02 miles | |
| Coastline Length | 7.76 miles | |
| Population | 3,249 (2000 Census)<br>2.7 people/acre | |
| Land Use/Land Cover | Very Low Density Residential:<br>Low Density Residential:<br>Medium Density Residential:<br>High Density Residential:<br>Commercial:<br>Industrial:<br>Institutional:<br>Extractive:<br>Open Urban:<br>Forest:<br>Agriculture:<br>Water/Wetlands:<br>Transportation | 0.0%<br>6.0%<br>22.2%<br>13.7%<br>33.0%<br>0.0%<br>7.2%<br>0.0%<br>0.4%<br>15.2%<br>0.8%<br>1.4%<br>0.0% |
| Impervious Cover | 31% of subwatershed | |
| Soils | A Soils (low runoff potential):<br>B Soils:<br>C Soils:<br>D Soils (high runoff potential): | 3.2%<br>11.0%<br>42.5%<br>43.3% |
| SWM Facilities | 13% of urban land use treated | |
| Priority Rating | High | |

*Neighborhoods*

A total of eight (8) distinct neighborhoods were identified and assessed within Frog Mortar Creek during the uplands assessment of Middle River and Tidal Gunpowder. Recommendations for addressing stormwater volume and pollutants within this subwatershed include downspout disconnection, storm drain marking, buffer improvement, and public education (i.e., bayscaping, increasing lot tree canopy, lawn care, pet waste management, and pool maintenance). A summary of neighborhood recommended actions is presented in Table 4-29 below.

Table 4-29: NSA Recommendations – Frog Mortar Creek

| | | | RECOMMENDED ACTIONS | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NSA_ID | Lot Size (acres) | % Opportunity for Downspout Disconnection | Rain Barrels | Rain Gardens | Storm Drain Stencils | Bayscape | Increase Lot Canopy | Fertilizer Reduction | Pet Waste | Buffer Improvement | Parking Lot Retrofit | # of Street Trees | # of Common Area Shade Trees | Notes |
| NSA_F_48 | 1/4 | 20% | X | X | X | X | X | | | X | | | | Boater education |
| NSA_F_38 | >1 | 35% | X | | X | X | X | X | X | | | | | Retrofit SWM_F_731 with vegetation and micropools. |
| NSA_F_39 | >1 | 35% | X | | X | X | X | X | | | | | | |
| NSA_F_40 | <1/4 | 10% | X | | X | | X | X | | | | | | |
| NSA_F_41 | 1/4 | 5% | X | X | X | X | X | X | | | | 34 | | Clear/remove phragmites from pond |
| NSA_F_43 | <1/8 | 20% | X | | X | | X | X | | | | 32 | | |
| NSA_F_44 | >1 | 100% | | | X | X | X | X | | | X | | 500 | Retrofit opportunities to treat parking lot with bioswale and enlarge existing treatment wetland. |
| NSA_F_45 | <1/4 | 25% | X | | X | | X | X | | | | 542 | | Pool maintenance education |

All the neighborhoods in Frog Mortar Creek are recommended for storm drain stenciling and increasing lot canopy. In addition, most neighborhoods are recommended for downspout disconnection, public education related to bayscaping and lawn maintenance, and storm drain stenciling. One (1) neighborhood, NSA_F_48, is recommended for buffer improvement.

One potential stormwater retrofit site was identified at NSA_F_44. In this neighborhood consisting of residential apartments, there is potential to disconnect downspouts in the rear of the apartment buildings and construct grass swales (bioswales) to provide water quality treatment. In addition, an existing parking lot could be treated by removing the existing curb line, allowing runoff to sheet flow to existing grass areas or a constructed bioswale. Figure 4-9 shows the two potential stormwater retrofits at this neighborhood.

Figure 4-9: Stormwater Retrofit Potential at NSA_F_44 (downspout disconnection on left, parking lot treatment on right)

*Hotspots*

Four (4) hotspot investigations were performed within Frog Mortar Creek. This included an auto service facility, gas station and car wash, maintenance shop, and a shopping center. Table 4-30 summarizes the potential pollution sources found at each of the sites.

Table 4-30: HSI Results Summary – Frog Mortar Creek

| | | | POTENTIAL POLLUTION SOURCES | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| HSI_ID | HSI Status* | Description | Vehicle Operations | Outdoor Materials | Waste Management | Physical Plant | Turf/Landscape Management | Stormwater Infrastructure | Notes |
| HSI_F_901 | Severe | Auto Service | X | X | X | X | | | Oil spill in ramp outside of garage; Check general NPDES industrial permit; general housekeeping education |
| HSI_F_902 | Potential | Gas Station/ Carwash | X | | X | X | | | |
| HSI_F_903 | Potential | Maintenance Shop/Storage Yard | X | X | X | | | | |
| HSI_F_904 | Potential | Shopping Center | X | X | X | X | X | X | The back of the building (loading area and dumpster location) is in poor condition (bare unprotected earth being used as a driveway). |

*Notes:
Potential – pollution not observed, potential pollutant sources
Severe – multiple polluting activities observed

Because of the nature of the operations at each of the hotspots, vehicle operations were listed as a pollutant category of concern. In particular, storage of vehicles outdoors was observed at most of the sites. At HSI_F_901, vehicles were being repaired outside with oil spills and leaks evident. Figure 4-10 illustrates some of the vehicle operations issues found in Frog Mortar Creek.

Figure 4-10: Outdoor Vehicle Operations and Stockpiling at HSI_F_901 (left) and HSI_F_903 (right)

Waste management was another potential pollutant source at all of the hotspots in Frog Mortar Creek. Dumpsters at all of the sites were either lacking proper cover or drained directly to storm drains or adjacent wetlands. At 3 of the 4 sites, handling of outdoor materials was listed as an issue. At HSI_F_901, an overflowing barrel was seen at the site being stored outside. At HSI_F_903, a large amount of tires and old lawn equipment was being stored outside as evidenced in Figure 4-11. At HSI_F_904, a road salt was being stored in the parking with a cover of insufficient size to encompass the entire pile. Figure 4-11 illustrates some of the outdoor storage issues in Frog Mortar Creek.

Figure 4-11: Overflowing Barrel at HSI_F_901 (left) and Salt Stockpile at HSI_F_904 (right)

In addition to the issues discussed above, breaking of asphalt was an issue at each of the hotspots in Frog Mortar Creek. HSI_F_904 also showed evidence of bare soil on 5% of the site. For the hotspots assessed in Frog Mortar Creek, and similar sites in the SWAP area, it is recommended that education be given on proper vehicle operations, storage of outdoor materials, waste management, and parking lot condition.

There are currently five (5) NPDES-permitted facilities for general stormwater discharges in Frog Mortar Creek. Two of these facilities are covered under the Marina section, while another is residential. The two remaining sites are gas station facilities. Compliance with permit requirements should be verified for these facilities.

*Institutions*

Three (3), private institutional sites were assessed for retrofit opportunities in Frog Mortar Creek during the uplands assessment of Middle River and Tidal Gunpowder. Table 4-31 summarizes recommendations for the institutional sites assessed in Frog Mortar Creek.

Table 4-31: ISI Recommendations – Frog Mortar Creek

| | | | RECOMMENDATIONS | | | |
|---|---|---|---|---|---|---|
| Site ID | Name | Public/ Private | # of Trees Recommended for Planting | Stormwater Retrofit | Trash Management | Notes |
| ISI_F_901 | Peninsula House Of Prayer | Private | 30 | X | | Parking lot conversion - permeable pavement |
| ISI_F_902 | Piney Grove Methodist | Private | 30 | X | | Parking lot retrofit - permeable pavement; Recycling on site |
| ISI_F_903 | St Matthew Lutheran | Private | 100 | X | X | Outdoor material education; parking lot retrofit; Boy scout project opportunity |

All three (3) institutions in Frog Mortar Creek are faith-based and have tree planting opportunities, providing a good opportunity to engage citizens while raising awareness of water quality issues and improvement methods. ISI_F_903 also has an opportunity for education on waste management as storage of trash in plastic bags was observed outdoors without a cover.

All three (3) institutions have potential stormwater retrofit opportunities. There is potential for installation of permeable pavements at parking lots on ISI_F_901 and ISI_F_902. At ISI_F_903, there is the potential to treat parking lot runoff through the installation of a bioretention area or grassed swale. Pictures of potential stormwater retrofit sites can be seen in Figure 4-12.

Figure 4-12: Potential for Permeable Pavement at ISI_F_902 (left) and Vegetative Retrofit at ISI_F_903 (right)

*Pervious Areas*

One (1) pervious area was assessed for restoration potential in Frog Mortar Creek: Bengies Trailer Village. A summary is provided in Table 4-32.

Table 4-32: PAA Descriptions – Darkhead Creek

| Site ID | Location | Description | Site Size (acres) | Ownership |
|---|---|---|---|---|
| PAA_F_901 | Bengies Road & Honeysuckle Lane | Bengies Trailer Village | 3.62 | Private |

Privately owned, PAA_F_901 consists of 3.62 acres of park area completely covered in turf. An existing channel surrounds the site, where erosion and soil dumping is evident. The surrounding neighborhood has recently constructed a new storm drain outfall into the channel, which was not stabilized. In addition to approximately 2 acres of tree planting potential on site, the existing channel provides an opportunity for a stabilization project to prevent erosion and provide some water quality benefits. Figure 4-13 shows area for tree planting potential at PAA_F_901 along with the existing eroded channel.

Figure 4-13: Planting (left) and Channel Stabilization (right) Sites at PAA_F_901

*Marinas*

Because marinas are a prominent and integral part of the economy of the watershed, a separate assessment was made on ten (10) marinas within Middle River and Tidal Gunpowder. Marina owners typically gave a walking tour of the site and helped the field team answer the marina review checklist. Basic information was gathered including type of marina, clean marina status, and contact information. Then, a series of yes/no questions was answered for each of the following operation categories:

- Vessel Maintenance & Repair
- Petroleum Control
- Sewage Handling
- Waste Management
- Marina Management
- Stormwater Management
- Turf/Landscaping Areas

For each of the operation categories, a score (out of a maximum of 100) was calculated based on the number of yes responses divided by the number of applicable questions. The total score was calculated by dividing all of the yes answers by the number of applicable questions in the entire checklist. Parameters evaluated within each operation category are described in the *Watershed Characterization Report*.

Three (3) marina facilities were assessed during the uplands assessment of Frog Mortar Creek. Characteristics for these can be found in Table 4-33.

Table 4-33: Marina Recommendations – Frog Mortar Creek

| Site ID | Type | Clean Marina | Maintenance/ Repair | Petroleum | Sewage | Waste Management | Marina Management | Stormwater Management | Turf | Total Score | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MAR_F_901 | Marina | N | 60 | 75 | 100 | 80 | 67 | 67 | 100 | 75 | Started clean marina process before hurricane Isabel but did not follow up; No recycling; Willing to hand out educational brochures to clients if provided by county. |
| MAR_F_902 | Marina/ Boatyard | Y | 40 | NA | 100 | 80 | 100 | 75 | 100 | 76 | Leases restaurant on site; Living shoreline overtaken by phragmites; grassed swale; Recommends phasing out heavy metal based paints rather than treating wastewater |
| MAR_F_903 | Marina/ Boatyard | Y | 100 | NA | 100 | 80 | 67 | 75 | 0 | 81 | Recommends checking bootleg marinas with zoning & Lower Back River Neck Master Plan; Issue with shrink wrap recycling & trash from Royal Farm outfall. |

Two of the three marinas that were assessed were certified Clean Marinas. MAR_F_901 was not certified and will be part of the County's effort to encourage all marinas to obtain Clean Marina Status.

*Industrial Landowners*

Two (2) large industrial landowners properties bisect a portion of Frog Mortar Creek: MSA and MANG. Information on recommendations and potential restoration opportunities at these sites can be found in Section 4.3.1 under Industrial Landowners.

Table 4-34: Industrial Landowners – Frog Mortar Creek

| Site ID | Name | Acres |
|---|---|---|
| IND_F_801 | Martin State Airport | 585 |
| IND_F_901 | Maryland Air National Guard | 156 |

*Stream Corridor Assessments*

Stream corridor assessments (SCAs) were not conducted in Frog Mortar Creek. Streams within this subwatershed are mostly tidal, marshy areas and not appropriate for a walking field survey utilizing Maryland DNR's SCA Survey Protocols. Therefore, no stream restoration opportunities have been identified in Frog Mortar Creek.

*Illicit Discharges*

There are four (4) priority 2 outfalls and three (3) priority 3 outfalls within Frog Mortar Creek. 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*

Frog Mortar Creek contains three (3) detention ponds assessed during the study. Information on the ponds can be found in Table 4-35.

Table 4-35: Detention Pond Conversion - Frog Mortar Creek

| Site ID | Riser | Embankment | Vege-tation | Gate | Water Quality Potential | Access | Flow Path | Expansion Potential |
|---|---|---|---|---|---|---|---|---|
| SWM_F_731 | Good | Trees | Turf | No Gate | Y | Easy | Long | No |
| SWM_F_988 | Good | Good | Turf | Unlocked | Y | Easy | Long | No |
| SWM_F_1358 | Good | Good | Wetland Veg. | Locked | Y | Easy | Long | Yes |

Detention Pond, SWM_F_731, is a privately-owned facility, located at the intersection of Tearose Drive and Raspberry Court. Lateral expansion is constrained on all sides. The entire pond footprint is high maintenance turf grass. It appears that this area may receive chemical lawn treatment (fertilizer and herbicide). The pond is recommended for vertical expansion, installation of pretreatment forebays, and removal of the concrete pilot channel flowing into the pond. In addition, routine maintenance is recommended including removing trees from the embankment, installing pet waste signage, and reducing the chemical lawn treatment.

Detention Pond, SWM_F_988, is a privately-owned dry detention pond off of Eastern Boulevard. The existing pond is constrained horizontally on all sides, so there is no potential for horizontal expansion. There also does not appear to be adequate space or access for a pretreatment forebay. However, the pond has a very large surface area, conducive to providing water quality treatment; therefore, horizontal expansion may not be needed. The entire pond footprint is high maintenance turf grass. It appears that this area may receive chemical lawn treatment (fertilizer and herbicide). Key recommendations for this pond include vertical excavation to provide water quality volume. In addition, routine maintenance is recommended including landscaping updates and reducing the chemical lawn treatment.

Detention Pond, SWM_F_1358, is a privately-owned detention pond off of Carroll Island Road. There is room north of the pond for horizontal expansion. This area is currently open space. However, this area may have underground storage tanks for gasoline which would preclude this area for pond expansion. Key recommendations for this pond include horizontal and vertical expansion. Routine maintenance needs for this pond include landscaping updates and inspection and cleaning of water quality inlets as needed.

Figure 4-14: Detention Ponds SWM_F_731 (left), SWM_F_988 (center), and SWM_F_1358 (right)

*Shoreline Restoration*

Frog Mortar Creek has 7.76 miles of shoreline of which 66% (61.1 acres) of the 100-foot shoreline buffer is classified as open, pervious area. No shoreline enhancement projects were identified in EPS's Shoreline Enhancement Feasibility Study (EPS 1998). Planting of the open pervious shoreline buffer in Frog Mortar Creek is recommended.

*Subwatershed Management Strategy*

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

1. Conduct appropriate downspout disconnection measures in neighborhoods according to Table 4-29 and educate citizens on the benefits of rain barrels and rain gardens.
2. Engage citizens in a storm drain marking program and conduct marking activities in the neighborhoods indicated in Table 4-29.
3. Increase tree canopies on private lots by educating citizens on the benefits of trees and about programs such as The Growing Home Campaign.
4. Educate citizens about the benefits and importance of proper lawn care, bayscaping, and proper pet waste management in the neighborhoods indicated in Table 4-29.

5. Educate residents of NSA_F_48 about the importance of stream buffers and encourage more environmentally friendly stream treatments.
6. Educate ISI_F_903 on implementing proper waste management practices.

Municipal Actions

1. Work with HSI_F_701 and similar businesses to implement appropriate practices for vehicle operations, outdoor materials storage, waste management, and parking lot maintenance.
2. Conduct tree plantings and impervious cover removal at the institutional sites list in Table 4-31.
3. Investigate the potential for installation of stormwater retrofits and conduct programs with members of faith-based institutions to provide education install retrofits at the facilities in Table 4-31.
4. Investigate the potential for tree planting and channel stabilization at the privately-owned PAA_F_901.
5. Encourage MAR_F_901 to obtain a Clean Marina certification.
6. Investigate potential bootleg marinas along Frog Mortar Creek and ensure marinas have proper NSPDES general stormwater permits.
7. Work with MSA, and MANG to identify potential water quality projects at industrial facilities in Frog Mortar Creek.
8. Identify open pervious shoreline areas in Frog Mortar Creek for the potential for reforestation and preservation.
9. Perform recommended retrofits and maintenance on detention ponds in Table 4-35.

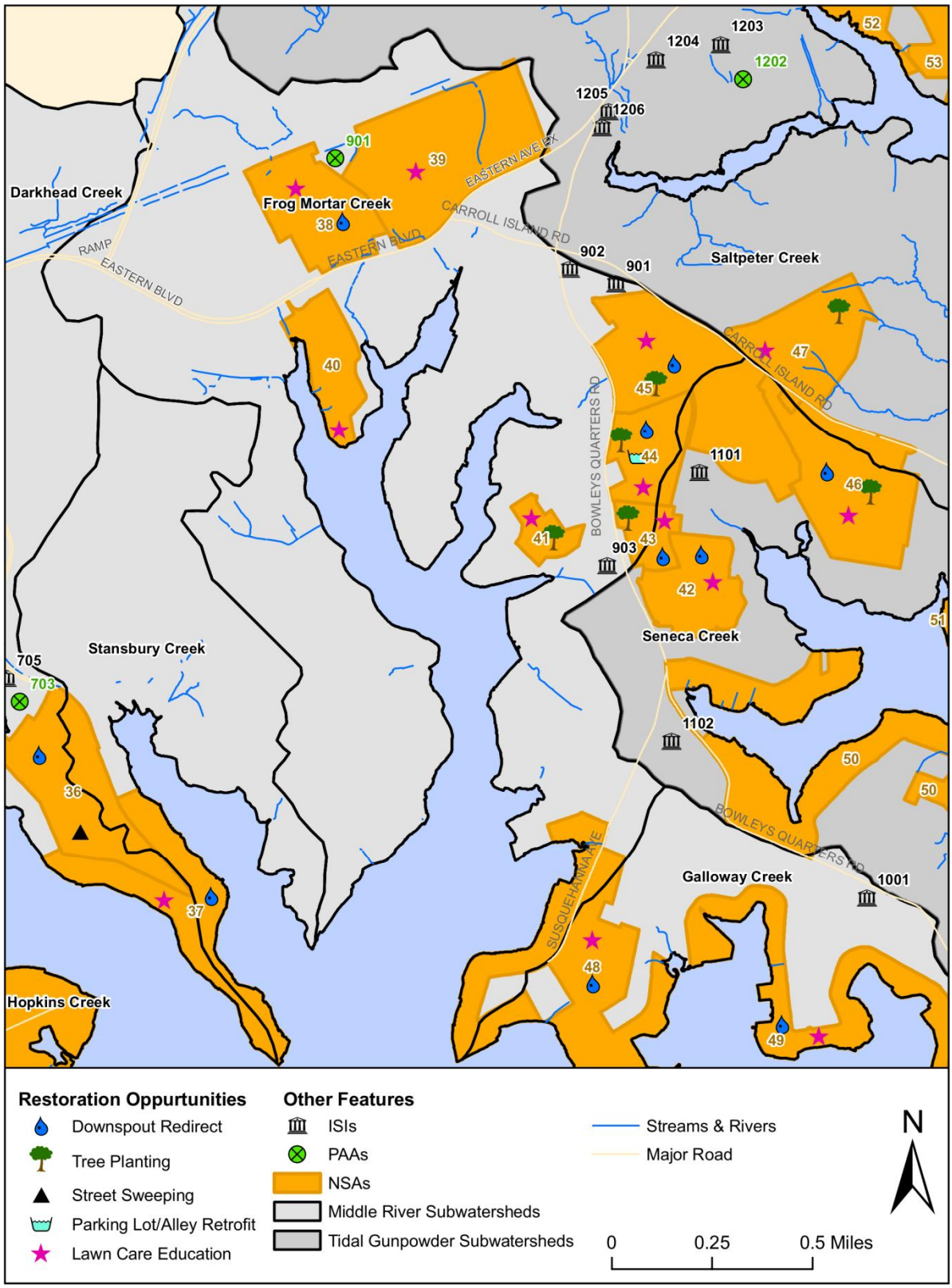


Figure 4-15: Restoration Opportunities in Frog Mortar Creek

### 4.3.3 Galloway Creek

Galloway Creek is the fourth smallest subwatershed in the Middle River and Tidal Gunpowder watersheds. Over half of Galloway Creek is occupied by residential area with the majority of the remaining area falling under forest or agriculture land uses. Table 4-36 summarizes key subwatershed characteristics of Galloway Creek.

Table 4-36: Key Subwatershed Characteristics - Galloway Creek

| | | |
|---|---|---|
| Drainage Area | 371.5 acres (0.58 sq. mi.) | |
| Stream Length | 0.23 miles | |
| Coastline Length | 4.70 miles | |
| Population | 637 (2000 Census)<br>1.71 people/acre | |
| Land Use/Land Cover | Very Low Density Residential:<br>Low Density Residential:<br>Medium Density Residential:<br>High Density Residential:<br>Commercial:<br>Industrial:<br>Institutional:<br>Extractive:<br>Open Urban:<br>Forest:<br>Agriculture:<br>Water/Wetlands:<br>Transportation | 1.8%<br>0.0%<br>55.9%<br>0.0%<br>1.9%<br>0.0%<br>0.0%<br>0.0%<br>0.0%<br>21.5%<br>17.0%<br>1.8%<br>0.0% |
| Impervious Cover | 15% of subwatershed | |
| Soils | A Soils (low runoff potential):<br>B Soils:<br>C Soils:<br>D Soils (high runoff potential): | 0.0%<br>13.3%<br>66.9%<br>19.3% |
| SWM Facilities | 0% of urban land use treated | |
| Priority Rating | Medium | |

*Neighborhoods*

One (1) distinct neighborhood was identified and assessed within Galloway Creek during the uplands assessment of Middle River and Tidal Gunpowder. Recommendations for addressing stormwater volume and pollutants within this subwatershed include downspout disconnection, storm drain marking, buffer improvement, and public education (i.e., bayscaping, increasing lot tree canopy, and boat maintenance). A summary of neighborhood recommended actions is presented in Table 4-37 below.

Table 4-37: NSA Recommendations – Galloway Creek

| | | RECOMMENDED ACTIONS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NSA_ID | Lot Size (acres) | % Opportunity for Downspout Disconnection | Rain Barrels | Rain Gardens | Storm Drain Stencils | Bayscape | Increase Lot Canopy | Fertilizer Reduction | Buffer Improvement | Notes |
| NSA_F_49 | 1/4 | 9% | X | X | X | X | X | X | X | Boat education |

NSA_F_49 is comprised of single-family detached homes, most with garages. With 65% percent of lots comprised of turf coverage, there is an opportunity for education on proper lawn car, creation of bayscapes, and increasing lot tree canopy. In addition, there is room to direct connected downspouts to rain barrels or rain gardens. Numerous boats were seen in the neighborhood which provides an opportunity for education on proper boat storage and maintenance.

Figure 4-16: Outdoor Boat Storage at NSA_F_49

*Hotspots*

No hotspots were assessed in Galloway Creek. Two NPDES-permitted facilities reside in Galloway Creek, both marinas.

*Institutions*

One (1), private institutional site was assessed for retrofit opportunities in Galloway Creek during the uplands assessment of Middle River and Tidal Gunpowder. Table 4-38 summarizes recommendations for the institutional sites assessed in Galloway Creek.

Table 4-38: ISI Recommendations – Galloway Creek

| | | | RECOMMENDATIONS | | |
|---|---|---|---|---|---|
| Site ID | Name | Public/ Private | # of Trees Recommended for Planting | Trash Management | Notes |
| ISI_F_1001 | Bowleys Quarters Improvement Association | Private | 40 | X | Open space in rear potentially used for parking |

ISI_F_1001 is a 1.65 acre property containing a community center for the Bowley's Quarter area. At the site, area was identified for tree planting. In addition, a dumpster with no lid and trash susceptible to leaving the site was seen, providing an opportunity for waste management education.

Figure 4-17: Tree Planting (left) and Waste Management Education (right) Opportunities at ISI_F_1001

*Pervious Areas*

No pervious areas were assessed in Galloway Creek.

*Marinas*

One (1) registered marina was assessed in Galloway Creek and is summarized in Table 4-39.

Table 4-39: Marina Recommendations – Galloway Creek

| Site ID | Type | Clean Marina | Maintenance/ Repair | Petroleum | Sewage | Waste Management | Marina Management | Stormwater Management | Turf | Total Score | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MAR_F_1001 | Marina | N | 0 | 100 | 100 | 67 | 67 | 40 | 100 | 56 | Abandoned boat issues; No store just slips; Hands off owner |

During the site assessment at this marina, no follow-up action was indicated. This marina, along with the other marina in Galloway Creek will be encouraged to obtain Clean Marina status.

*Industrial Landowners*

None of the large industrial landowners reside in Galloway Creek.

*Stream Corridor Assessments*

Stream corridor assessments (SCAs) were not conducted in Galloway Creek. Streams within this subwatershed are mostly tidal, marshy areas and not appropriate for a walking field survey utilizing Maryland DNR's SCA Survey Protocols. Therefore, no stream restoration opportunities have been identified in Galloway Creek.

*Illicit Discharges*

Galloway Creek does not contain any rated outfalls. 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 dry detention pond assessments were conducted in Galloway Creek.

*Shoreline Restoration*

Galloway Creek has 4.70 miles of shoreline of which 76% (41.0 acres) of the 100-foot shoreline buffer is classified as open, pervious area. No shoreline enhancement projects were identified in EPS's Shoreline Enhancement Feasibility Study (EPS 1998). Planting of the open pervious shoreline buffer in Galloway Creek is recommended.

*Subwatershed Management Strategy*

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

1. Conduct appropriate downspout disconnection measures in NSA_F_49 and educate citizens on the benefits of rain barrels and rain gardens.
2. Engage citizens in a storm drain marking program and conduct marking activities in NSA_F_49.
3. Increase tree canopies on private lots by educating citizens on the benefits of trees and about programs such as The Growing Home Campaign.
4. Educate citizens about the benefits and importance of proper lawn care, bayscaping, and proper boat maintenance in NSA_F_49.
5. Educate residents of in NSA_F_49 about the importance of stream buffers and encourage more environmentally friendly stream treatments.
6. Educate ISI_F_1001 on implementing proper waste management practices.

Municipal Actions

1. Conduct tree plantings at the institutional site listed in Table 4-38.
2. Encourage MAR_F_1001 and other marinas in Galloway Creek to obtain a Clean Marina certification.
3. Investigate potential bootleg marinas along Galloway Creek and ensure marinas have proper NSPDES general stormwater permits.
4. Identify open pervious shoreline areas in Galloway Creek for the potential for reforestation and preservation.

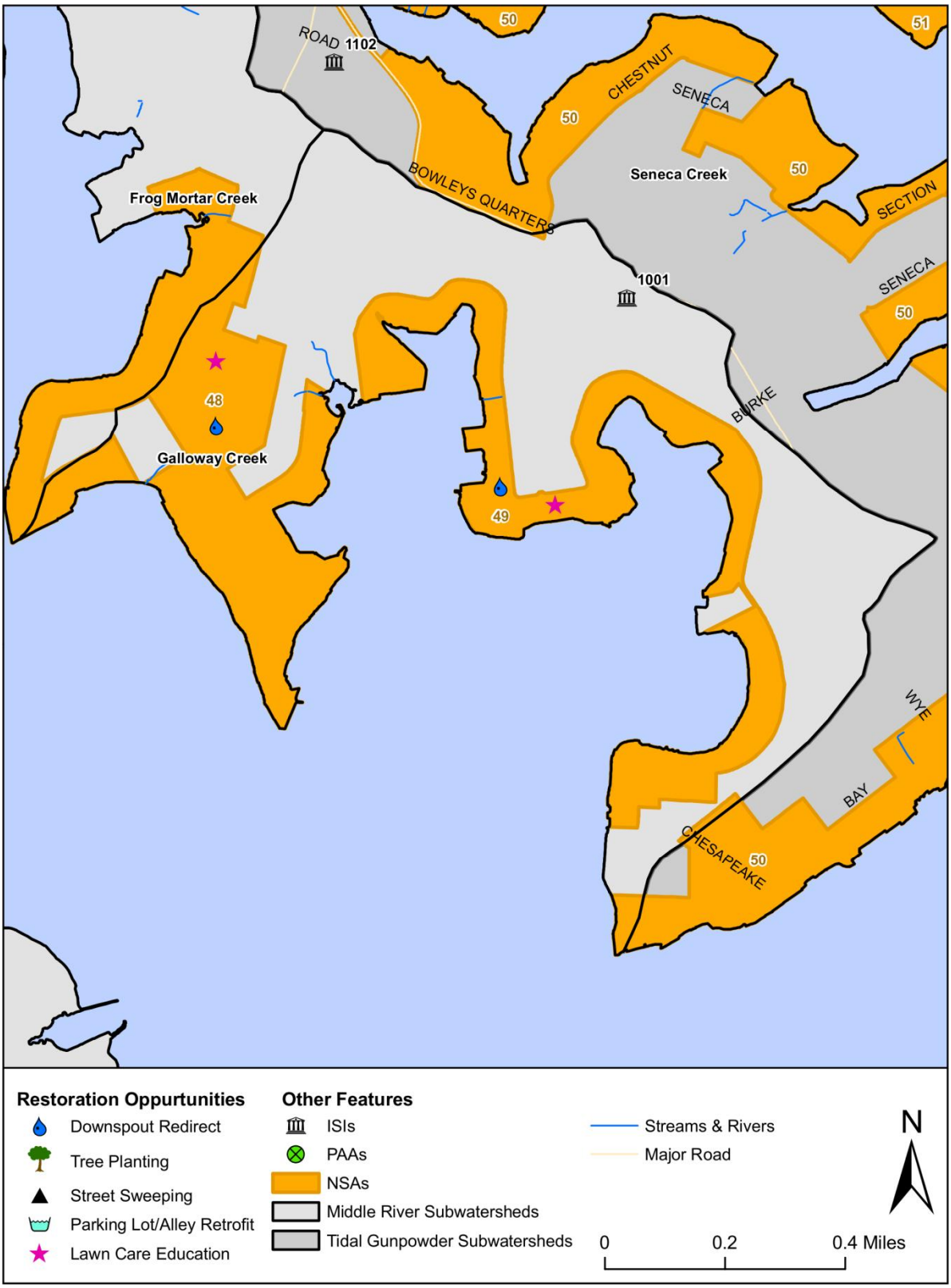


Figure 4-18: Restoration Opportunities in Galloway Creek

### 4.3.4 Browns Cove

Table 4-40: Key Subwatershed Characteristics - Browns Cove

| | | |
|---|---|---|
| Drainage Area | 611.8 acres (0.96 sq. mi.) | |
| Stream Length | 0.94 miles | |
| Coastline Length | 8.89 miles | |
| Population | 299 (2000 Census)<br>0.49 people/acre | |
| Land Use/Land Cover | Very Low Density Residential:<br>Low Density Residential:<br>Medium Density Residential:<br>High Density Residential:<br>Commercial:<br>Industrial:<br>Institutional:<br>Extractive:<br>Open Urban:<br>Forest:<br>Agriculture:<br>Water/Wetlands:<br>Transportation | 0.6%<br>10.8%<br>8.8%<br>0.0%<br>0.0%<br>0.0%<br>1.6%<br>0.0%<br>0.0%<br>45.0%<br>24.8%<br>8.5%<br>0.0% |
| Impervious Cover | 6% of subwatershed | |
| Soils | A Soils (low runoff potential):<br>B Soils:<br>C Soils:<br>D Soils (high runoff potential): | 0.2%<br>20.2%<br>70.6%<br>8.9% |
| SWM Facilities | 0% of urban land use treated | |
| Priority Rating | Low | |

*Neighborhoods*

A total of three (3) distinct neighborhoods were identified and assessed within Browns Cove during the uplands assessment of Middle River and Tidal Gunpowder. Recommendations for addressing stormwater volume and pollutants within this subwatershed include downspout disconnection, storm drain marking, buffer improvement, and public education (i.e., bayscaping, increasing lot tree canopy, lawn care, trash management, and boater education). A summary of neighborhood recommended actions is presented in Table 4-41.

Table 4-41: NSA Recommendations – Browns Cove

| | | | RECOMMENDED ACTIONS | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NSA_ID | Lot Size (acres) | % Opportunity for Downspout Disconnection | Rain Barrels | Storm Drain Stencils | Bayscape | Increase Lot Canopy | Fertilizer Reduction | Trash Management | Buffer Improvement | Notes |
| NSA_F_01 | 1/4 | 40% | X | | X | X | X | X | X | Boater Education |
| NSA_F_02 | 1/4 | 50% | X | | X | X | X | | X | |
| NSA_F_03 | 1/4 | 70% | X | X | X | X | X | | X | Boater Education |

All of the neighborhoods in Browns Cove are recommended for downspout disconnection and buffer improvements. In addition, with the size of lots within Browns Cove and presence of detached homes, all the neighborhoods are recommended for public education related to increasing lot tree canopy, bayscaping, and lawn care. Buffer improvement may be achieved through public education about the benefits of providing a stream and shoreline buffer by reducing the amount of mowed lawn through tree and vegetation planting. Boat education was recommended for NSA_F_01 and NSA_F_02 while trash management and storm drain stenciling were recommended for NSA_F_01 and NSA_F_03, respectively.

Figure 4-19: NSA_F_01 (right), NSA_F_02 (center), and NSA_F_03 (left)

*Hotspots*

No hotspots were assessed in Browns Cove.

*Institutions*

No institutions were assessed in Browns Cove.

*Pervious Areas*

One (1) pervious area was assessed for restoration potential in Browns Cove: a County-owned easement. A summary is provided in Table 4-42.

Table 4-42: PAA Descriptions – Browns Cove

| Site ID | Location | Description | Site Size (acres) | Ownership |
|---|---|---|---|---|
| PAA_F_101 | 1600 SW Holly Neck Road | County-Owned Easement | 32.27 | Public |

Publicly-owned, PAA_F_101 consists of 32.27 acres of vacant land completely covered in turf. A sign was seen on the site indicating that the area falls under DNR's Coastal Rural Legacy Area which protects large, contiguous tracts of lands. Figure 4-13 shows area for tree planting potential at PAA_F_901 along with the existing eroded channel. Although a large portion of the property is forested, almost 13 acres of land was identified in person and through GIS mapping as being open. The land showed evidence of former agricultural activities. This site is recommended for investigation of current use and feasibility for reforestation. Images of the site can be seen in Figure 4-18.

Figure 4-20: Planting Opportunity at PAA_F_101

*Marinas*

No marinas were assessed in Browns Cove. In addition, the subwatershed does not contain any marinas with an NPDES stormwater discharge permit.

*Industrial Landowners*

None of the large industrial landowners reside in Browns Cove.

*Stream Corridor Assessments*

Stream corridor assessments (SCAs) were not conducted in Browns Cove. Streams within this subwatershed are mostly tidal, marshy areas and not appropriate for a walking field survey utilizing Maryland DNR's SCA Survey Protocols. Therefore, no stream restoration opportunities have been identified in Browns Cove.

*Illicit Discharges*

Browns Cove does not contain any rated outfalls. 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 dry detention pond assessments were conducted in Browns Cove.

*Shoreline Restoration*

Browns Cove has 8.89 miles of shoreline of which 61% (61.2 acres) of the 100-foot shoreline buffer is classified as open, pervious area. No shoreline enhancement projects were identified in EPS's Shoreline Enhancement Feasibility Study (EPS 1998). Planting of the open pervious shoreline buffer in Browns Cove is recommended.

*Subwatershed Management Strategy*

Engaging Citizens & Watershed Groups

1. Conduct appropriate downspout disconnection measures in neighborhoods according to Table 4-41 and educate citizens on the benefits of rain barrels and rain gardens.
2. Engage citizens in a storm drain marking program and conduct marking activities in the neighborhoods indicated in Table 4-41.
3. Increase tree canopies on private lots by educating citizens on the benefits of trees and about programs such as The Growing Home Campaign.
4. Educate citizens about the benefits and importance of proper lawn care and bayscaping.
5. Educate residents of NSA_F_01, NSA_F_02, and NSA_F_03 about the importance of shoreline buffers and encourage more environmentally friendly shoreline treatments.
6. Educate residents on proper techniques for vehicle and boat storage and maintenance.

Municipal Actions

1. Investigate the potential for tree planting at PAA_F_101.
2. Identify open pervious shoreline areas in Browns Cove for the potential for reforestation and preservation.

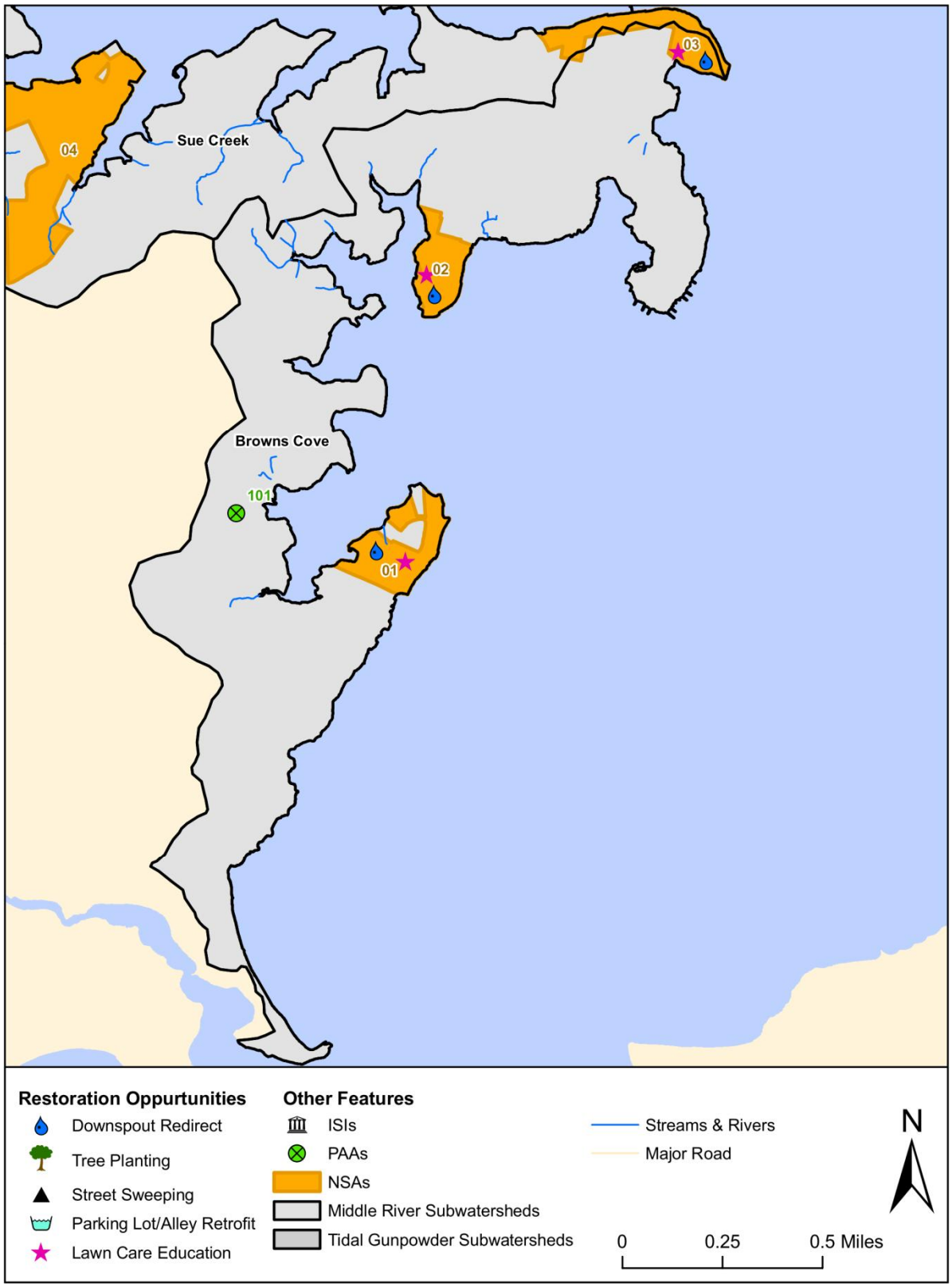


Figure 4-21: Restoration Opportunities in Browns Cove

### 4.3.5 Hogpen Creek

Hogpen Creek is the smallest subwatershed in the Middle River and Tidal Gunpowder watersheds. 65% of Frog Mortar Creek is occupied by residential uses. Forested areas make up the majority of the remaining subwatershed area. Table 4-43 summarizes key subwatershed characteristics of Hogpen Creek.

Table 4-43: Key Subwatershed Characteristics - Hogpen Creek

| | | |
|---|---|---|
| Drainage Area | 262.3 acres (0.41 sq. mi.) | |
| Stream Length | 1.27 miles | |
| Coastline Length | 2.75 miles | |
| Population | 826 (2000 Census)<br>3.15 people/acre | |
| Land Use/Land Cover | Very Low Density Residential:<br>Low Density Residential:<br>Medium Density Residential:<br>High Density Residential:<br>Commercial:<br>Industrial:<br>Institutional:<br>Extractive:<br>Open Urban:<br>Forest:<br>Agriculture:<br>Water/Wetlands:<br>Transportation | 26.8%<br>4.8%<br>26.7%<br>7.1%<br>0.0%<br>0.0%<br>7.2%<br>0.0%<br>2.4%<br>22.8%<br>0.0%<br>2.1%<br>0.0% |
| Impervious Cover | 15% of subwatershed | |
| Soils | A Soils (low runoff potential):<br>B Soils:<br>C Soils:<br>D Soils (high runoff potential): | 5.0%<br>10.7%<br>81.0%<br>3.2% |
| SWM Facilities | 1% of urban land use treated | |
| Priority Rating | Medium-Low | |

*Neighborhoods*

A total of three (3) distinct neighborhoods were identified and assessed within Hogpen Creek during the uplands assessment of Middle River and Tidal Gunpowder. Recommendations for addressing stormwater volume and pollutants within this subwatershed include downspout disconnection, storm drain marking, buffer improvement, and public education (i.e., bayscaping, increasing lot tree canopy, lawn care, pet waste management, trash management, boat maintenance and construction equipment). A summary of neighborhood recommended actions is presented in Table 4-44.

Table 4-44: NSA Recommendations – Hogpen Creek

| | | | RECOMMENDED ACTIONS | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NSA_ID | Lot Size (acres) | % Opportunity for Downspout Disconnection | Rain Barrels | Rain Gardens | Storm Drain Stencils | Bayscape | Increase Lot Canopy | Fertilizer Reduction | Pet Waste | Trash Management | Buffer Improvement | Miles of Street Sweeping | # of Common Area Shade Trees | Notes |
| NSA_F_08 | <1/8 | 50% | X | | | | X | X | | | | X | 25 | Retrofit drainage ditch; Plant trees in common area; Car maintenance education |
| NSA_F_11 | 1/4 | 30% | X | X | X | X | X | X | | X | X | | | Pave/clean stone on Weir Lane; Boat and car maintenance education |
| NSA_F_12 | 1/4 | 40% | X | | | X | X | X | X | X | X | | | Pet education, boat and construction equipment maintenance education |

All of the neighborhoods in Hogpen Creek are recommended for downspout disconnection and public education related to increasing lot tree canopy, lawn care, and storage of cars and boats. Two (2) neighborhoods, NSA_F_11 and NSA_F_12 are recommended for buffer improvement that may be achieved through public education about the benefits of providing a stream and shoreline buffer by reducing the amount of mowed lawn through tree and vegetation planting. These two (2) neighborhoods are also recommended for education on proper trash management and bayscaping.

At NSA_F_08, consisting of attached homes, open space in the rear of a group of homes on New Haven Drive was identified for potential shade tree planting or the installation of a drainage ditch for water quality treatment. At NSA_F_11, Weir Lane showed signs of sediment pollution from the road surface. The recommendation here is to place new stone or repave Weir Lane. Education on proper construction techniques is recommended at NSA_F_12.

Figure 4-22: Retrofit at NSA_F_08 (right), Weir Lane in NSA_F_11 (center), and Construction Equipment at NSA_F_12 (left)

*Hotspots*

No hotspots were assessed and no NPDES-permitted facilities reside in Hogpen Creek.

*Institutions*

No institutions were assessed in Hogpen Creek.

*Pervious Areas*

No pervious areas were assessed in Hogpen Creek.

*Marinas*

No marinas were assessed in Hogpen Creek. In addition, the subwatershed does not contain any marinas with an NPDES stormwater discharge permit. A review of aerial photography along the shoreline of the watershed revealed several areas where a high density of boats were being stored on land along with several docks with numerous slips. It is recommended that a review of potential "bootleg" marinas be undertaken in Hogpen Creek to ensure that proper zoning laws are followed and stormwater discharge requirements are being met.

*Industrial Landowners*

None of the large industrial landowners reside in Hogpen Creek.

*Stream Corridor Assessments*

Stream corridor assessments (SCAs) were not conducted in Hogpen Creek. Streams within this subwatershed are mostly tidal, marshy areas and not appropriate for a walking field survey utilizing Maryland DNR's SCA Survey Protocols. Therefore, no stream restoration opportunities have been identified in Hogpen Creek.

*Illicit Discharges*

Hogpen Creek does not contain any rated outfalls. 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 dry detention pond assessments were conducted in Hogpen Creek.

*Shoreline Restoration*

Hogpen Creek has 2.75 miles of shoreline of which 58% (18.9 acres) of the 100-foot shoreline buffer is classified as open, pervious area. No shoreline enhancement projects were identified in EPS's Shoreline Enhancement Feasibility Study (EPS 1998). Planting of the open pervious shoreline buffer in Hogpen Creek is recommended.

*Subwatershed Management Strategy*

Engaging Citizens & Watershed Groups

1. Conduct appropriate downspout disconnection measures in neighborhoods according to Table 4-44 and educate citizens on the benefits of rain barrels and rain gardens.
2. Engage citizens in a storm drain marking program and conduct marking activities in the neighborhoods indicated in Table 4-44.
3. Increase tree canopies on private lots by educating citizens on the benefits of trees and about programs such as The Growing Home Campaign.
4. Educate citizens about the benefits and importance of proper lawn care and bayscaping.
5. Educate residents of NSA_F_11, and NSA_F_12 about the importance of shoreline buffers and encourage more environmentally friendly shoreline treatments.
6. Educate residents of NSA_F_11, and NSA_F_12 on proper trash management
7. Educate residents on proper techniques for vehicle and boat storage and maintenance.
8. Educate residents in NSA_F_12 on proper construction practices.

Municipal Actions

1. Investigate potential for installation of a stormwater retrofit at NSA_F_08.
2. Investigate the potential to resurface Weir Lane in NSA_F_11.
3. Investigate potential bootleg marinas along Hogpen Creek.

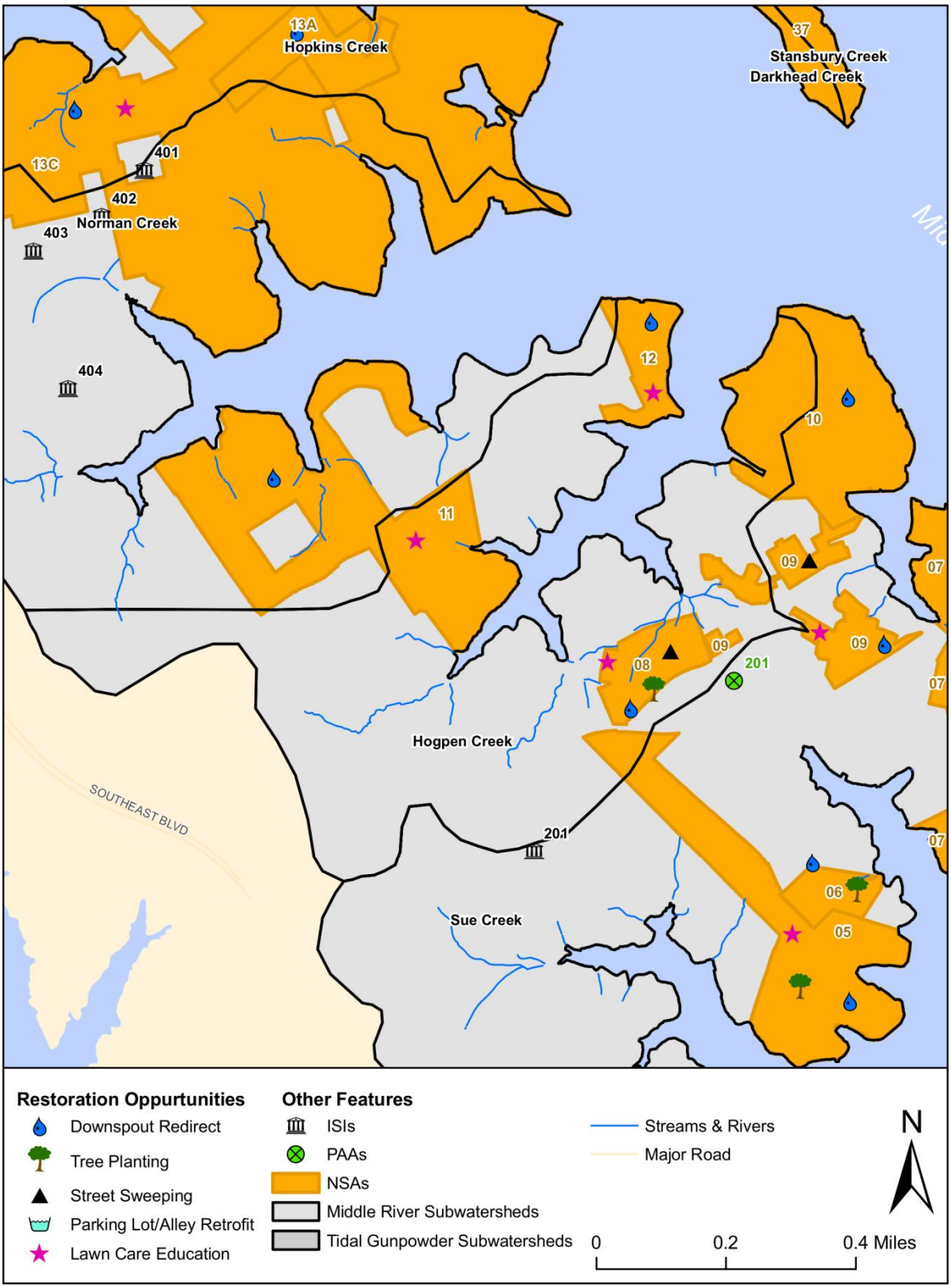


Figure 4-23: Restoration Opportunities in Hogpen Creek

### 4.3.6 Hopkins Creek

Hopkins Creek is the fifth smallest subwatershed in the Middle River and Tidal Gunpowder watersheds. Nearly 65% of Hopkins Creek is occupied by residential area with the remaining area comprised of mostly commercial, industrial and forest uses. With a population of 5,706, Hopkins Creek has second highest population density of the subwatersheds in the study. Table 4-45 summarizes key subwatershed characteristics of Hopkins Creek.

Table 4-45: Key Subwatershed Characteristics - Hopkins Creek

| | | |
|---|---|---|
| Drainage Area | 604.6 acres (0.94 sq. mi.) | |
| Stream Length | 2.11 miles | |
| Coastline Length | 4.49 miles | |
| Population | 5,706 (2000 Census)<br>9.44 people/acre | |
| Land Use/Land Cover | Very Low Density Residential:<br>Low Density Residential:<br>Medium Density Residential:<br>High Density Residential:<br>Commercial:<br>Industrial:<br>Institutional:<br>Extractive:<br>Open Urban:<br>Forest:<br>Agriculture:<br>Water/Wetlands:<br>Transportation | 0.0%<br>3.3%<br>34.1%<br>30.5%<br>6.1%<br>0.0%<br>5.8%<br>0.0%<br>7.9%<br>9.0%<br>0.0%<br>1.4%<br>1.9% |
| Impervious Cover | 29% of subwatershed | |
| Soils | A Soils (low runoff potential):<br>B Soils:<br>C Soils:<br>D Soils (high runoff potential): | 10.4%<br>31.8%<br>43.1%<br>14.7% |
| SWM Facilities | 38% of urban land use treated | |
| Priority Rating | Very High | |

*Neighborhoods*

A total of eleven (11) distinct neighborhoods were identified and assessed within Hopkins Creek during the uplands assessment of Middle River and Tidal Gunpowder. Recommendations for addressing stormwater volume and pollutants within this subwatershed include downspout disconnection, storm drain marking, buffer improvement, parking lot/alley retrofits, tree planting and public education (i.e., bayscaping, increasing lot tree canopy, lawn care, pet waste management, trash management, car maintenance and boat maintenance). A summary of neighborhood recommended actions is presented in Table 4-46.

Table 4-46: NSA Recommendations – Hopkins Creek

| | | | RECOMMENDED ACTIONS | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NSA_ID | Lot Size (acres) | % Opportunity for Downspout Disconnection | Rain Barrels | Rain Gardens | Storm Drain Stencils | Bayscape | Increase Lot Canopy | Fertilizer Reduction | Pet Waste | Trash Management | Buffer Improvement | Parking Lot Retrofit | Alley Retrofit | Miles of Street Sweeping | # of Street Trees | # of Common Area Shade Trees | Notes |
| NSA_F_13A | <1/4 | 65% | | | X | | X | | | | X | | | | | | Boat education |
| NSA_F_13B | <1/4 | 40% | X | | X | | X | | | | | | | | | | Pond maintenance, and car maintenance education |
| NSA_F_14 | 1/2 | 30% | X | X | X | X | | | | X | X | | | | | | Some driveways were bare earth/spotty gravel contributing sediment to the waterfront; Boat education |
| NSA_F_15 | >1 | 60% | X | X | X | X | X | | | | X | X | | X | | 60 | Car maintenance education to address oil/gas, bare ground |
| NSA_F_16 | <1/8 | 60% | X | | X | X | X | | | X | | | X | X | 160 | 50 | Boat and car maintenance education; Dumping in commons areas |
| NSA_F_17 | <1/4 | 35% | X | | X | | X | X | | | | | | X | 75 | | |
| NSA_F_18 | <1/8 | 80% | X | | X | | X | | | X | X | | | X | | 37 | Waste management education; Turf management at playground; Cleanout inlets without trash collector |
| NSA_F_19 | <1/4 | 5% | X | | X | | X | X | X | | | | | | | 103 | Dog waste bag and trash can stations |
| NSA_F_20 | >1 | 100% | X | | X | X | X | X | X | | | | | X | | | Dog waste bag and trash can stations |
| NSA_F_21 | >1 | 50% | X | X | X | X | X | | X | | | | | | | 69 | Sediment stabilization between sidewalk and parking lot, rain garden in common area |
| NSA_F_22 | <1/4 | 50% | X | | X | | X | | | X | | | | X | | | Boat and car maintenance education; Household storage education; Driveway maintenance is needed |

All but one of the neighborhoods assessed in Hopkins Creek are recommended for downspout disconnections. In neighborhoods with larger lots such as NSA_F_14, NSA_F_15, and NSA_F_21, there is sufficient space for construction of rain gardens to accept drainage from downspouts. All the neighborhoods are recommended for storm drain stenciling, and all but NSA_F_14 are recommended for increasing their lot canopy. Several neighborhoods were recommended for public education on lawn care, pet waste, trash management, buffer improvement, car maintenance, and boat maintenance.

Two neighborhoods were recommended for stormwater retrofits: NSA_F_15 and NSA_F_16. At NSA_F_15 which is occupied by multi-family attached dwellings, the entire roadway and parking footprint of the neighborhood drains to inlets which outlet into a concrete channel at the north side of the property. This concrete channel could be converted into a bioswale to provide water quality treatment. At NSA_F_16, an alley at the rear of properties on the east side of Poles Road is recommended for replacement with permeable pavement Figure 4-24 shows the two potential stormwater retrofits at this neighborhood.

Figure 4-24: Stormwater Retrofit Potential at NSA_F_15 (left) and NSA_F_16 (right)

At six (6) of the neighborhoods in Hopkins Creek, street sweeping is recommended due to accumulation of sediment and organic matter on streets. In addition, five (5) neighborhoods were recommended for either street tree or shade tree planting. Neighborhoods recommended for street sweeping or tree planting can be seen in Table 4-46.

*Hotspots*

One (1) hotspot investigation was performed within Hopkins Creek on a gas station and automobile repair facility. Table 4-473 summarizes the potential pollution sources found at HSI_F_501.

Table 4-47: HSI Results Summary – Hopkins Creek

| | | | POTENTIAL POLLUTION SOURCES | | | | |
|---|---|---|---|---|---|---|---|
| HSI_ID | HSI Status* | Description | Vehicle Operations | Outdoor Materials | Waste Management | Physical Plant | Notes |
| HSI_F_501 | Confirmed | Gas Station/Auto Repair | X | X | X | X | Overflowing parking lot trash can; Outdoor tire storage; Long term car parking show evidence of stains flowing to the street. |

*Notes:
Confirmed – pollution observed, many potential sources

Vehicle operations, storage of outdoor materials, waste management, and the physical plant were noted at the hotspot assessed in Hopkins Creek. Pollution was observed at HSI_F_501 due to maintenance and fueling operations for vehicles. In addition, tires were being stored outdoors with no cover, overflowing trash cans were observed, and staining was seen on pavement areas. Education and outreach at similar transport-related facilities would help address these potential pollution sources.

There are currently three (3) NPDES-permitted facilities for general stormwater discharges within Darkhead Creek. All of these facilities are marinas. It is recommended that the County ensure compliance with permit requirements for all facilities that should have an NPDES permit.

*Institutions*

A total of five (5) institutions were assessed for retrofit opportunities in Hopkins Creek during the uplands assessments. This includes one (1) public school, one (1) public community center, two (2) private faith-based institutions, and one (1) private senior living facility. Table 4-48 summarizes recommendations for these institutional sites.

Table 4-48: ISI Recommendations – Hopkins Creek

| | | | RECOMMENDATIONS | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Site ID | Name | Public/ Private | Nutrient Management | # of Trees Recommended for Planting | Stormwater Retrofit | Downspout Disconnection | Impervious Cover Removal | Trash Management | Storm Drain Marking | Notes |
| ISI_F_501 | Church Of Jesus Christ Of Latter Day Saints | Private | | 10 | X | | | | | Existing permeable pavement; Retrofit 3 existing stormwater facilities |
| ISI_F_502 | Stemmers Run Middle School | Public | X | 100 | X | | X | | X | Concrete channel removal; Retrofit northeast parking lot |
| ISI_F_503 | Lighthouse Senior Living | Private | | | | | | | X | Detention pond maintenance needed; Dumping at edge of site |
| ISI_F_504 | Our Lady Of Mt Carmel | Private | | 80 | X | X | | X | X | Interest in water quality projects; Parking lot retrofit |
| ISI_F_505 | Stembridge Community Center | Public | | 150 | X | X | | X | X | Parking lot retrofit; Dumpster leaks to concrete channel |

Publicly-owned institutions provide the best opportunity for implementation of pollution reduction measures. Both public facilities, ISI_F_502 and ISI_F_505, were recommended for tree planting, stormwater retrofits, and storm drain marking. At ISI_F_502, a concrete channel with potential for retrofitting into a vegetative BMP was also observed. See Figure 4-25 for photographs of the retrofit opportunities at the site. Open turf areas on the property were recommended for tree planting and extraneous impervious cover was recommended for removal as seen in Figure 4-26.

Figure 4-25: Stormwater Retrofit Potential at ISI_F_502

Figure 4-26: Impervious Cover Removal at ISI_F_502

At ISI_F_505, installation of permeable pavement is recommended to infiltrate rainfall that falls on the parking lot area. In addition, tree planting in open space areas and downspout disconnection was recommended here. See Figure 4-27 for photographs of ISI_F_505.

Figure 4-27: Parking Lot (left) and Downspout Disconnection (right) at ISI_F_505

Two (2) of the three (3) private facilities in Hopkins Creek were recommended for stormwater retrofits, ISI_F_501 and ISI_F_504. At ISI_F_501, standing water and sediment at three existing stormwater facilities indicated that there is potential for improvement through retrofitting. At ISI_F_504, a member of the institution noted standing water in the adjacent park due to sheet flow from the parking lot. This area could be converted to a bioswale or bioretention are for water quality treatment. As a faith-based school with an environmental group, this institution has the ability to provide willing participants for any water quality enhancement measures.

*Pervious Areas*

One (1) pervious area was assessed for restoration potential in Hopkins Creek: Fields at Renaissance. A summary is provided in Table 4-49.

Table 4-49: PAA Descriptions – Hopkins Creek

| Site ID | Location | Description | Site Size (acres) | Ownership |
|---|---|---|---|---|
| PAA_F_501 | Old Eastern Avenue at ISI_F_504 | Fields at Renaissance | 30.38 | Public |

Publicly owned, PAA_F_501 consists of 30.38 acres of park area with 50% turf coverage. Existing buffer planting has been performed at the site which also contains numerous athletic fields. Although the athletic fields prevent reforestation of the entire site, there are almost 2 acres that are not used for athletic recreation that could be planted. In addition, an existing wet pond on the site provides treatment for runoff from ISI_F_504, and educational signs are present on the site, informing users of the site of its benefit. Figure 4-28 shows an area for tree planting potential and an educational sign at PAA_F_501.

Figure 4-28: Planting Site (left) and Educational Sign (right) at PAA_F_501

*Marinas*

One (1) marina was assessed in Hopkins Creek and is summarized in Table 4-50.

Table 4-50: Marina Recommendations – Hopkins Creek

| Site ID | Type | Clean Marina | Maintenance/ Repair | Petroleum | Sewage | Waste Management | Marina Management | Stormwater Management | Turf | TotalScore | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MAR_F_501 | Boatyard | N | 50 | 0 | 0 | 67 | 0 | 50 | 100 | 58 | Many abandoned boats on site; No designated work areas; Educate about outdoor materials storage; Erosion on site, sediment and washwater drains to Hopkins Creek |

MAR_F_501 is a boatyard which maintains and repairs boats and offers long-term dry storage. No slips are for rent at the site and the boatyard does not offer sales or handle sewage and petroleum. Maintenance on the site is done without cover and stormwater runoff from the site flows over the bulkhead and directly into Hopkins Creek. The owner also noted that customers who no longer wish to keep and maintain their boats often leave them at the site for the owner to deal with. Education on pollution reduction measures associated with maintenance, repairs, and outdoor storage is recommended at the site.

*Industrial Landowners*

None of the large industrial landowners reside in Hopkins Creek.

*Stream Corridor Assessments*

Stream corridor assessments (SCAs) were not conducted in Hopkins Creek. Streams within this subwatershed are mostly tidal, marshy areas and not appropriate for a walking field survey utilizing Maryland DNR's SCA Survey Protocols. Therefore, no stream restoration opportunities have been identified in Hopkins Creek.

*Illicit Discharges*

Hopkins Creek contains one outfall rated as priority 2, which indicates moderate to minor problems with the potential to become more severe. 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*

Hopkins Creek contains three (3) detention ponds assessed during the study. Information on the ponds can be found in Table 4-51.

Table 4-51: Detention Pond Conversion - Hopkins Creek

| Site ID | Riser | Embankment | Vege-tation | Gate | Water Quality Potential | Access | Flow Path | Expansion Potential |
|---|---|---|---|---|---|---|---|---|
| SWM_F_591 | Minor Maintenance | Trees | Trees | Locked | Y | Moderate | Long | No |
| SWM_F_711 | Good | Trees | Wetland Veg. | No Gate | Y | Easy | Long | Yes |
| SWM_F_914 | Good | Good | Turf | Locked | N | Easy | Long | No |

Detention Pond, SWM_F_591, is a publicly-owned facility, located off of Horney Court. The existing pond is constrained horizontally on all sides, so there is no potential for horizontal expansion. There are small trees and dense vegetation surrounding control structure (18-inch end section) and the pond bottom contains invasive vegetation. Also, there is minor gully erosion along the pond side slope adjacent to homeowners' backyards. This pond is recommended for vertical expansion through excavation and installation of a pretreatment forebay. In addition, routine maintenance is recommended including removing vegetation surrounding the outlet structure, removing invasive vegetation, and repairing the eroded side slope.

Detention Pond, SWM_F_711, is a public-owned facility, located at the intersection of Hilltop Avenue and Back River Neck Road. There is room northeast of the pond for horizontal expansion. The area is currently meadow with some brush. Most of the pond bottom is turf. This pond is recommended for horizontal and vertical expansion and installation of pretreatment forebays. In addition, routine maintenance is recommended including removing trees from the pond embankment.

Detention Pond, SWM_F_914, is a privately-owned facility, located off of Stemmers Run Road. The pond bottom consists of turf grass and the pond handles a very small drainage area. Due to the lack of expansion opportunities, the good condition of the pond currently, and the small drainage area, no recommendations were made for either retrofitting or maintenance at SWM_F_914.

*Shoreline Restoration*

Hopkins Creek has 4.49 miles of shoreline of which 68% (35.7 acres) of the 100-foot shoreline buffer is classified as open, pervious area. No shoreline enhancement projects were identified in EPS's Shoreline Enhancement Feasibility Study (EPS 1998). Planting of the open pervious shoreline buffer in Hopkins Creek is recommended.

*Subwatershed Management Strategy*

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

1. Conduct appropriate downspout disconnection measures in neighborhoods according to Table 4-46 and educate citizens on the benefits of rain barrels and rain gardens.
2. Engage citizens in a storm drain marking program and conduct marking activities in the neighborhoods indicated in Table 4-46.
3. Increase tree canopies on private lots by educating citizens on the benefits of trees and about programs such as The Growing Home Campaign in the neighborhoods indicated in Table 4-46.
4. Educate citizens about the benefits and importance of proper lawn care, bayscaping, waste management and pet waste management in the neighborhoods indicated in Table 4-46.

5. Educate residents of NSA_F_13A, NSA_F_14, NSA_F_15, and NSA_F_18 about the importance of stream buffers and encourage more environmentally friendly stream treatments.
6. Educate ISI_F_903 on implementing proper waste management practices.

Municipal Actions

1. Investigate the potential for installation of stormwater retrofits at NSA_F_15 and NSA_F_16.
2. Conduct street sweeping operations at the 6 neighborhoods indicated in Table 4-46.
3. Work with HSI_F_701 and similar businesses to implement appropriate practices for vehicle operations, outdoor materials storage, waste management, and parking lot maintenance.
4. Investigate facilities similar to HSI_F_701 to ensure that appropriate NPDES permits are held and followed.
5. Conduct tree plantings at the institutional sites list in Table 4-48.
6. Investigate the potential for installation of stormwater retrofits and conduct programs with members of faith-based institutions to provide education and install retrofits at the facilities in Table 4-48.
7. Remove extraneous impervious cover at ISI_F_502.
8. Investigate the potential for tree planting at PAA_F_501.
9. Encourage MAR_F_501 to obtain a Clean Marina certification.
10. Investigate potential bootleg marinas along Hopkins Creek and ensure marinas have proper NPDES general stormwater permits.
11. Identify open pervious shoreline areas in Hopkins Creek for the potential for reforestation and preservation.
12. Perform recommended retrofits and maintenance on detention ponds in Table 4-51.

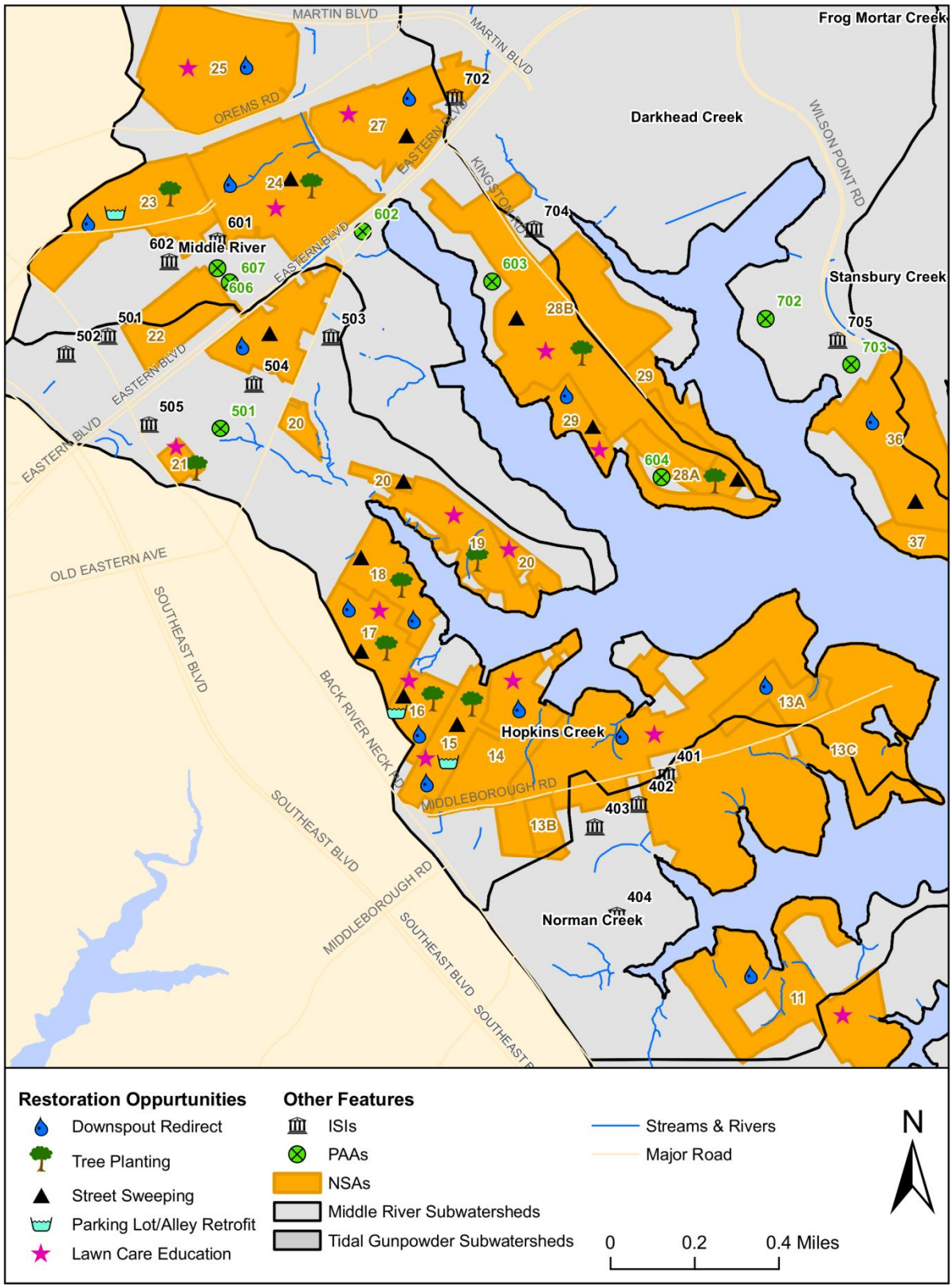


Figure 4-29: Restoration Opportunities in Hopkins Creek

### 4.3.7 Middle River

Middle River is the seventh smallest subwatershed in the Middle River and Tidal Gunpowder watersheds. Over 70% of Middle River is occupied by residential area with the remaining area comprised of mostly commercial, institutional and forest uses. With a population of 5,706, Hopkins Creek has second highest population density of the subwatersheds in the study. Table 4-52 summarizes key subwatershed characteristics of Middle River.

Table 4-52: Key Subwatershed Characteristics - Middle River

| | | |
|---|---|---|
| Drainage Area | 674.0 acres (1.05 sq. mi.) | |
| Stream Length | 1.02 miles | |
| Coastline Length | 3.08 miles | |
| Population | 6,899 (2000 Census)<br>10.24 people/acre | |
| Land Use/Land Cover | Very Low Density Residential:<br>Low Density Residential:<br>Medium Density Residential:<br>High Density Residential:<br>Commercial:<br>Industrial:<br>Institutional:<br>Extractive:<br>Open Urban:<br>Forest:<br>Agriculture:<br>Water/Wetlands:<br>Transportation | 0.6%<br>0.0%<br>23.3%<br>46.4%<br>16.0%<br>0.0%<br>3.8%<br>0.0%<br>0.0%<br>9.0%<br>0.0%<br>0.9%<br>0.0% |
| Impervious Cover | 36% of subwatershed | |
| Soils | A Soils (low runoff potential):<br>B Soils:<br>C Soils:<br>D Soils (high runoff potential): | 1.5%<br>27.6%<br>17.0%<br>53.7% |
| SWM Facilities | 34% of urban land use treated | |
| Priority Rating | Very High | |

*Neighborhoods*

A total of ten (10) distinct neighborhoods were identified and assessed within Middle River during the uplands assessment of Middle River and Tidal Gunpowder. Recommendations for addressing stormwater volume and pollutants within this subwatershed include downspout disconnection, storm drain marking, buffer improvement, parking lot/alley retrofits, tree planting and public education (i.e., bayscaping, increasing lot tree canopy, lawn care, pet waste management, trash management, car maintenance, boat maintenance, and pool maintenance). A summary of neighborhood recommended actions is presented in Table 4-46.

Table 4-53: NSA Recommendations – Middle River

| | | | RECOMMENDED ACTIONS | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NSA_ID | Lot Size (acres) | % Opportunity for Downspout Disconnection | Rain Barrels | Rain Gardens | Storm Drain Stencils | Bayscape | Increase Lot Canopy | Fertilizer Reduction | Pet Waste | Trash Management | Buffer Improvement | Parking Lot Retrofit | Alley Retrofit | Miles of Street Sweeping | # of Street Trees | # of Common Area Shade Trees | Notes |
| NSA_F_23 | <1/8 | 90% | X | | X | | X | | | X | | | X | | 172 | | Boat and car maintenance education; Stabilized parking surface/ driveways; Public education about dumping; Retrofit off-street parking |
| NSA_F_24 | <1/4 | 40% | X | | X | | X | X | X | | | | | X | | 500 | Dog waste bag and trash can stations; Sump pump sediment trap/filter |
| NSA_F_25 | <1/4 | 20% | X | | X | X | X | | | | | | | | | | Stabilize off-street parking |
| NSA_F_26 | >1 | 25% | | X | X | X | X | | | | | X | | X | | 240 | |
| NSA_F_27 | 1/4 | 40% | X | X | X | X | X | | | X | | | | X | | | Pool maintenance education |
| NSA_F_28A | <1/8 | 0% | | | X | | X | | | | | | | X | 70 | | |
| NSA_F_28B | <1/8 | 80% | X | | X | | X | | X | X | | | | X | 415 | | Public education about dumping; Auto repair in backyards |
| NSA_F_29 | <1/4 | 30% | X | | X | | X | X | | X | X | | | X | | | Stabilize private driveways; Boat education |
| NSA_F_30 | >1 | 100% | X | | X | X | X | | | X | | | | X | | | Establish healthy grass & stabilize bare area;, Litter control; Resurface parking lot and street; Replace broken curb |
| NSA_F_31 | <1/8 | 45% | X | | X | | X | | | X | | | | X | | | Litter control; Resurface parking lots |

Seven (7) of the neighborhoods assessed in Hopkins Creek are recommended for downspout disconnections. In neighborhoods with larger lots such as NSA_F_25 and NSA_F_227, there is sufficient space for construction of rain gardens to accept drainage from downspouts. All the neighborhoods are recommended for storm drain stenciling and increasing their lot canopy. Several neighborhoods were recommended for public education on lawn care, pet waste, trash management, buffer improvement, car maintenance, boat maintenance, and pool maintenance. In addition, NSA_F_23, NSA_F_25, and NSA_F_29 were recommended for stabilization of driveways or off-street parking areas.

Two neighborhoods were recommended for stormwater retrofits: NSA_F_23 and NSA_F_26. At NSA_F_23, permeable, interlocking pavers are recommended for the off-street parking area along the

alley adjacent to the railroad tracks. At NSA_F_26, approximately 0.2 acres of parking lot area could be treated the installation of an infiltrative BMP such as a bioretention area. See Figure 4-30 for potential neighborhood stormwater retrofit sites in Middle River.

Figure 4-30: Stormwater Retrofit Potential at NSA_F_23 (left) and NSA_F_26 (right)

*Hotspots*

Four (4) hotspot investigations were performed within Middle River. This included a bus lot and maintenance facility, a shopping center, an auto service facility, and a construction office. Table 4-54 summarizes the potential pollution sources found at each of the sites.

Table 4-54: HSI Results Summary – Middle River

| | | | POTENTIAL POLLUTION SOURCES | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| HSI_ID | HSI Status* | Description | Vehicle Operations | Outdoor Materials | Waste Management | Physical Plant | Stormwater Infrastructure | | Notes |
| HSI_F_601 | Potential | Bus Lot/ Fueling/ Maintenance | X | | | X | | | |
| HSI_F_602 | Severe | Shopping Center | | X | X | | X | | Staining and grease flowing to storm sewer |
| HSI_F_603 | Confirmed | Auto Repair-Transmission | X | X | X | X | | | Old transmissions being stored unprotected in the parking lot |
| HSI_F_604 | Confirmed | Home Remodeling Contractor | X | X | X | | | | |

*Notes:
Potential – pollution not observed, potential pollutant sources
Confirmed – pollution observed, many potential sources
Severe – multiple polluting activities observed

At HSI_F_601, County-owned school buses are maintained, fueled, and stored. Staining of the parking lot was evident here. In addition, garbage dumpsters were open to rainfall and the vegetated portions of the site were completely turf grass. At HSI_F_602, cook oil was seen stored outside and staining on

pavement revealed grease flowing to the storm sewer. Vehicles at HSI_F_603 are repaired outdoors and unused car parts were stored outdoors. In addition vehicles and construction materials were stored outdoors at HSI_F_604. It is recommended that the County provide educational information to these hotspots and similar facilities in Middle River to prevent pollution from the sources listed in Table 4-54. Figure 4-31 contains photos of the hotspots assessed in Middle River.

Figure 4-31: HSI_F_601 (top left), HSI_F_602 (top right), HSI_F_603 (bottom left), and HSI_F_604 (bottom right)

*Institutions*

Three (3) institutional sites were assessed for retrofit opportunities in Middle River during the uplands assessment of Middle River and Tidal Gunpowder. Table 4-55 summarizes recommendations for the institutional sites assessed in Middle River.

Table 4-55: ISI Recommendations – Middle River

| | | | RECOMMENDATIONS | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Site ID | Name | Public/ Private | Nutrient Management | # of Trees Recommended for Planting | Stormwater Retrofit | Impervious Cover Removal | Trash Management | Storm Drain Marking | Buffer Improvement | Notes |
| ISI_F_601 | Christian Community Church | Private | | 30 | | | | | | Leaf and gutter mgmt education |
| ISI_F_602 | Middlesex Elementary School | Public | X | 180 | X | X | X | X | | Ex oil/grit seperator; Bare ground; Retrofit at front driveway |
| ISI_F_603 | Ivy Hall Geriatric And Rehab Center | Private | | 25 | X | | | | X | 2 parking lot retrofit sites; Erosion at entrance and outfall |

All three (3) facilities had open space areas where tree planting is feasible. ISI_F_601 is a private, faith-based facility. At this location, roof downspouts discharge directly to an impervious gutter around the perimeter of the building and eventually to the storm drain areas. This site was recommended for education on downspout disconnection and rain gardens. A photo of the current downspout configuration can be seen in Figure 4-32. ISI_F_602 is a public, elementary school with potential for stormwater retrofitting, impervious cover removal, storm drain marking and education on lawn care, trash management, and buffer improvements. Trash was observed on the ground around the dumpsters and bare earth was present on the site. There is potential for an underground stormwater quality facility in the south parking lot at the site. 3,100 $ft^2$ of impervious area at the rear of the site was suggested for removal as seen in Figure 4-32. At ISI_F_603, a private senior living complex, two parking lot retrofit sites were identified. A drainage channel carries runoff from the adjacent parking lot and possibly other developed areas through a culvert to a detention pond. The beginning of the channel near the outfall is incised and eroding. The area may be limited for trees; however, incorporating native vegetation would help stabilize the channel, while also providing pre-treatment of the runoff before it reaches the detention pond.

Figure 4-32: Downspout Disconnection at ISI_F_601 (left), Tree Planting at ISI_F_602 (center), and Planting at ISI_F_603 (right)

*Pervious Areas*

Seven (7) pervious areas were assessed for restoration potential in Middle River including an EPS-owned open space near the Village of Pawnee, two (2) unnamed parks, Hawthorne Park, Kingston Park, and two (2) privately owned open spaces. Five (5) of the sites are maintained by Baltimore County while PAA_F_605 and PAA_F_607 are privately owned. The sites range from a turf coverage of approximately 27% to 100%. All seven (7) sites are classified as open pervious with minimal site preparation needed to conduct tree planting. In addition, trash dumping was noted at PAA_F_601. This presents an opportunity to conduct a neighborhood cleanup and to post signs educating users of the facility to dispose of trash in a proper manner. At PAA_F_602 and PAA_F_603, there was potential for educational signs to be placed to inform the public on the importance and tidal waters and existing stormwater management facilities, respectively. Table 4-25 provides a description of the PAAs located in Darkhead Creek.

Table 4-56: PAA Descriptions – Middle River

| Site ID | Location | Description | Site Size (acres) | Ownership |
|---|---|---|---|---|
| PAA_F_601 | Village Of Pawnee | EPA-owned open space | 1.63 | Public |
| PAA_F_602 | 280 SW Eastern Avenue | Unnamed Park | 1.34 | Public |
| PAA_F_603 | 70 S Midthorne Road | Hawthorne Park | 7.81 | Public |
| PAA_F_604 | E Cockspur Road | Kingston Park | 2.87 | Public |
| PAA_F_605 | 216 Schilling Circle | Windsor House Apartments | 1.03 | Private |
| PAA_F_606 | SW Orville Rd | Unnamed Park | 1.62 | Public |
| PAA_F_607 | SW Orville Rd | Mars Riversale LLC | 1.07 | Private |

*Marinas*

No marinas were assessed in Middle River. In addition, the subwatershed does not contain any marinas with an NPDES stormwater discharge permit. A review of aerial photography along the shoreline of the watershed revealed several areas where a high density of boats were being stored on land along with several docks with numerous slips. It is recommended that a review of potential "bootleg" marinas be undertaken in Middle River to ensure that proper zoning laws are followed and stormwater discharge requirements are being met.

*Industrial Landowners*

None of the large industrial landowners reside in Middle River.

*Stream Corridor Assessments*

Stream corridor assessments (SCAs) were not conducted in Middle River. Streams within this subwatershed are mostly tidal, marshy areas and not appropriate for a walking field survey utilizing Maryland DNR's SCA Survey Protocols. Therefore, no stream restoration opportunities have been identified in Middle River.

*Illicit Discharges*

Middle River contains three (3) outfalls rated as priority 1 which indicates major or reoccurring problems that require either immediate action or close monitoring. This subwatershed also contains one outfall

rated as priority 2, which indicates moderate to minor problems with the potential to become more severe. 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*

One dry detention pond was assessed in the Middle River subwatershed, SWM_F_586. Details summarizing the assessment can be found in Table 4-57.

Table 4-57: Detention Pond Conversion - Middle River

| Site ID | Riser | Embankment | Vege-tation | Gate | Water Quality Potential | Access | Flow Path | Expansion Potential |
|---|---|---|---|---|---|---|---|---|
| SWM_F_586 | Minor Maintenance | Trees | Wetland Veg. | Locked | Y | Easy | Long | No |

Detention Pond, SWM_F_586, is a privately-owned facility, located off of Windlass Drive. The existing pond is constrained horizontally on all sides, so there is no potential for horizontal expansion. Trees were seen growing on the embankment and dense vegetation is surrounding the low-flow outlet pipe. This pond is recommended for vertical expansion and installation of pretreatment forebays. In addition, routine maintenance is recommended including removing trees from the pond embankment, removing vegetation surrounding the low-flow pipe and repairing broken sections of the perimeter fencing.

*Shoreline Restoration*

Middle River has 3.08 miles of shoreline of which 69% (24.6 acres) of the 100-foot shoreline buffer is classified as open, pervious area. One (1) shoreline enhancement projects was identified in EPS's Shoreline Enhancement Feasibility Study (EPS 1998). This project at Hawthorne Park consisted of 350 linear feet of shoreline improvements and was completed by EPS in 1995. Planting of the open pervious shoreline buffer in Middle River is recommended.

*Subwatershed Management Strategy*

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

1. Conduct appropriate downspout disconnection measures in neighborhoods according to Table 4-53 and educate citizens on the benefits of rain barrels and rain gardens.
2. Engage citizens in a storm drain marking program and conduct marking activities in the neighborhoods indicated in Table 4-53.
3. Increase tree canopies on private lots by educating citizens on the benefits of trees and about programs such as The Growing Home Campaign in the neighborhoods indicated in Table 4-53.
4. Educate citizens about the benefits and importance of proper lawn care, pet waste management, trash management, car maintenance, boat maintenance, and pool maintenance in the neighborhoods indicated in Table 4-53.
5. Educate residents of NSA_F_29 about the importance of stream buffers and encourage more environmentally friendly stream treatments.

6. Educate ISI_F_602 on implementing proper lawn care and waste management practices.
7. Work with teachers and students at ISI_F_602 to conduct storm drain markings at the school.

Municipal Actions

1. Investigate the potential for installation of stormwater retrofits at NSA_F_23 and NSA_F_26.
2. Conduct street sweeping operations at the 8 neighborhoods indicated in Table 4-53.
3. Work with the hotspots in Table 4-54 and similar businesses to implement appropriate practices for vehicle operations, outdoor materials storage, waste management, and physical plant maintenance.
4. Perform a follow-up inspection at HSI_F_602 to inspect grease management practices.
5. Conduct tree plantings at the institutional sites list in Table 4-48.
6. Investigate the potential for installation of stormwater retrofits and conduct programs with institutions to provide education and install retrofits at the facilities in Table 4-55.
7. Remove extraneous impervious cover at ISI_F_602.
8. Investigate the potential for tree planting at PAAs listed in Table 4-56.
9. Post trash-dumping signs at PAA_F_601.
10. Create and post environmental education signs at PAA_F_602 and PAA_F_603.
11. Investigate potential bootleg marinas along Middle River and ensure marinas have proper NPDES general stormwater permits.
12. Identify open pervious shoreline areas in Middle River for the potential for reforestation and preservation.
13. Perform recommended retrofits and maintenance on SWM_F_586.

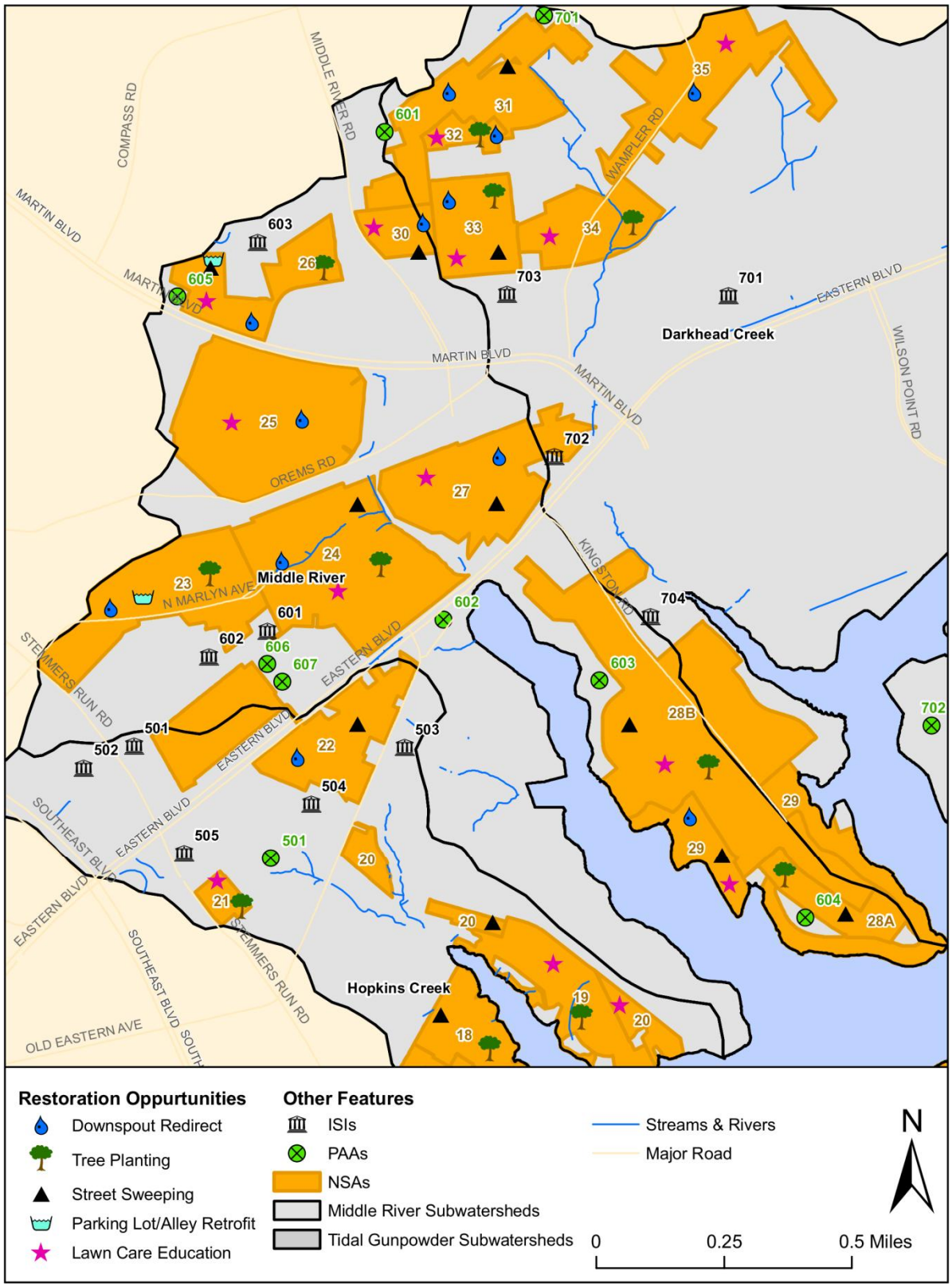


Figure 4-33: Restoration Opportunities in Middle River

### 4.3.8 Norman Creek

Norman Creek is the second smallest subwatershed in the Middle River and Tidal Gunpowder watersheds. Over 62% of Norman Creek is occupied by residential area with the remaining area comprised of commercial, institutional, open urban forest and wetland/water uses. Table 4-52 summarizes key subwatershed characteristics of Norman Creek.

Table 4-58: Key Subwatershed Characteristics - Norman Creek

| | | |
|---|---|---|
| Drainage Area | 311.4 acres (0.49 sq. mi.) | |
| Stream Length | 1.49 miles | |
| Coastline Length | 3.51 miles | |
| Population | 903 (2000 Census)<br>2.90 people/acre | |
| Land Use/Land Cover | Very Low Density Residential:<br>Low Density Residential:<br>Medium Density Residential:<br>High Density Residential:<br>Commercial:<br>Industrial:<br>Institutional:<br>Extractive:<br>Open Urban:<br>Forest:<br>Agriculture:<br>Water/Wetlands:<br>Transportation | 7.4%<br>3.6%<br>51.7%<br>0.0%<br>2.7%<br>0.0%<br>1.8%<br>0.0%<br>1.7%<br>29.0%<br>0.0%<br>2.2%<br>0.0% |
| Impervious Cover | 17% of subwatershed | |
| Soils | A Soils (low runoff potential):<br>B Soils:<br>C Soils:<br>D Soils (high runoff potential): | 0.3%<br>10.3%<br>87.7%<br>1.6% |
| SWM Facilities | 0% of urban land use treated | |
| Priority Rating | Medium | |

*Neighborhoods*

One (1) distinct neighborhood was identified and assessed within Norman Creek during the uplands assessment of Middle River and Tidal Gunpowder. Recommendations for addressing stormwater volume and pollutants within this subwatershed include downspout disconnection, storm drain marking, buffer improvement, and public education (i.e., bayscaping, increasing lot tree canopy, trash management, car maintenance, and boat maintenance). A summary of neighborhood recommended actions is presented in Table 4-59 below.

Table 4-59: NSA Recommendations – Norman Creek

| RECOMMENDED ACTIONS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| NSA_ID | Lot Size (acres) | % Opportunity for Downspout Disconnection | Rain Barrels | Storm Drain Stencils | Bayscape | Increase Lot Canopy | Trash Management | Buffer Improvement | Notes |
| NSA_F_13C | 1/4 | 50% | X | X | X | X | X | X | Stabilize eroded ditches present north of Middle Borough Road; Car and boat maintenance education |

NSA_F_13C is comprised of single-family detached homes. Eroded ditches were present in the neighborhood to the north of Middleborough Road that should be stabilized with rip rap.

*Hotspots*

No hotspots were assessed and no NPDES-permitted facilities reside in Norman Creek.

*Institutions*

A total of four (4) institutions were assessed for retrofit opportunities in Norman Creek during the uplands assessments. This includes one (1) public school, one (1) fire station, and two (2) private faith-based institutions. Table 4-60 summarizes recommendations for these institutional sites.

Table 4-60: ISI Recommendations – Norman Creek

| RECOMMENDATIONS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Site ID | Name | Public/ Private | Nutrient Management | # of Trees Recommended for Planting | Stormwater Retrofit | Downspout Disconnection | Trash Management | Storm Drain Marking | Buffer Improvement | Notes |
| ISI_F_401 | Middleborough Vo Fire Co 23 | Public | | 40 | | | X | | | Waste management/ outdoor material storage education |
| ISI_F_402 | Hope Lutheran | Private | | 20 | | X | | | | Dumping in stream at rear of property; permeable pavement |
| ISI_F_403 | Middleborough Elementary School | Public | X | 80 | X | | X | X | X | Litter; Erosion; Dumping in stream; Parking lot retrofit |
| ISI_F_404 | New Testament | Private | | 20 | | | X | | | Dumping; Outdoor material/turf management education |

ISI_F_401 was recommended for tree planting and education on waste management and material storage. At the private facilities, ISI_F_402 and ISI_F_404, open areas were present that could provide an opportunity for tree planting. ISI_F_402 was recommended for downspout disconnection. Dumping was also seen in a stream at the rear of the property. At ISI_F_404, education on proper trash management, storage of outdoor materials, and turf management is needed.

Public schools represent unique opportunities to combine water quality improvement measures with student education/outreach. At ISI_F_403, education was recommended for trash management and buffer improvement. In addition, there are opportunities for education of teachers and students and participation in restoration efforts including stormwater retrofitting, storm drain marking and tree planting. A bioretention area or other infiltrative BMP is proposed to provide treatment for the parking lot at the southwest corner of the property. In addition, erosion and dumping into a stream was seen at the west side of the property. This provides an opportunity for education and a possible project for students. Providing trash cans on the site could also help reduce trash present at the site. Figure 4-34 shows some of the restoration potential at ISI_F_403.

Figure 4-34: Bioretention (left) and Tree Planting (right) Potential at ISI_F_403

*Pervious Areas*

No pervious areas were assessed in Norman Creek.

*Marinas*

No marinas were assessed in Norman Creek. In addition, the subwatershed does not contain any marinas with an NPDES stormwater discharge permit. A review of aerial photography along the shoreline of the watershed revealed several areas where a high density of boats were being stored on land along with several docks with numerous slips. It is recommended that a review of potential "bootleg" marinas be undertaken in Norman Creek to ensure that proper zoning laws are followed and stormwater discharge requirements are being met.

*Industrial Landowners*

None of the large industrial landowners reside in Norman Creek.

*Stream Corridor Assessments*

Stream corridor assessments (SCAs) were not conducted in Norman Creek. Streams within this subwatershed are mostly tidal, marshy areas and not appropriate for a walking field survey utilizing Maryland DNR's SCA Survey Protocols. Therefore, no stream restoration opportunities have been identified in Norman Creek.

*Illicit Discharges*

Norman Creek does not contain any rated outfalls. 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 dry detention pond assessments were conducted in Norman Creek.

*Shoreline Restoration*

Norman Creek has 3.51 miles of shoreline of which 69% (28.9 acres) of the 100-foot shoreline buffer is classified as open, pervious area. No shoreline enhancement projects were identified in EPS's Shoreline Enhancement Feasibility Study (EPS 1998). Planting of the open pervious shoreline buffer in Norman Creek is recommended.

*Subwatershed Management Strategy*

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

1. Conduct appropriate downspout disconnection measures in NSA_F_13C and educate citizens on the benefits of rain barrels and rain gardens.
2. Engage citizens in a storm drain marking program and conduct marking activities in the neighborhoods indicated in NSA_F_13C.
3. Increase tree canopies on private lots by educating citizens on the benefits of trees and about programs such as The Growing Home Campaign in NSA_F_13C.
4. Educate citizens about the benefits and importance of proper bayscaping, trash management, car maintenance, and boat maintenance in NSA_F_13C.
5. Educate residents of NSA_F_13C about the importance of stream buffers and encourage more environmentally friendly stream treatments.
6. Educate institutions on implementing proper waste management, materials storage, and stream buffers at the facilities listed in Table 4-60.
7. Work with teachers and students at ISI_F_602 to conduct storm drain markings at the school.
8. Engage students and teachers to participate in storm drain marking and tree planting at ISI_F_403.

Municipal Actions

1. Investigate the potential for stabilization of eroded ditches in NSA_F_13C.
2. Conduct tree plantings at the institutional sites list in Table 4-60.
3. Investigate the potential for installation of stormwater retrofits and conduct programs with institutions to provide education and install retrofits at the facilities in Table 4-60.
4. Investigate potential bootleg marinas along Norman Creek and ensure marinas have proper NPDES general stormwater permits.
5. Identify open pervious shoreline areas in Norman Creek for the potential for reforestation and preservation.

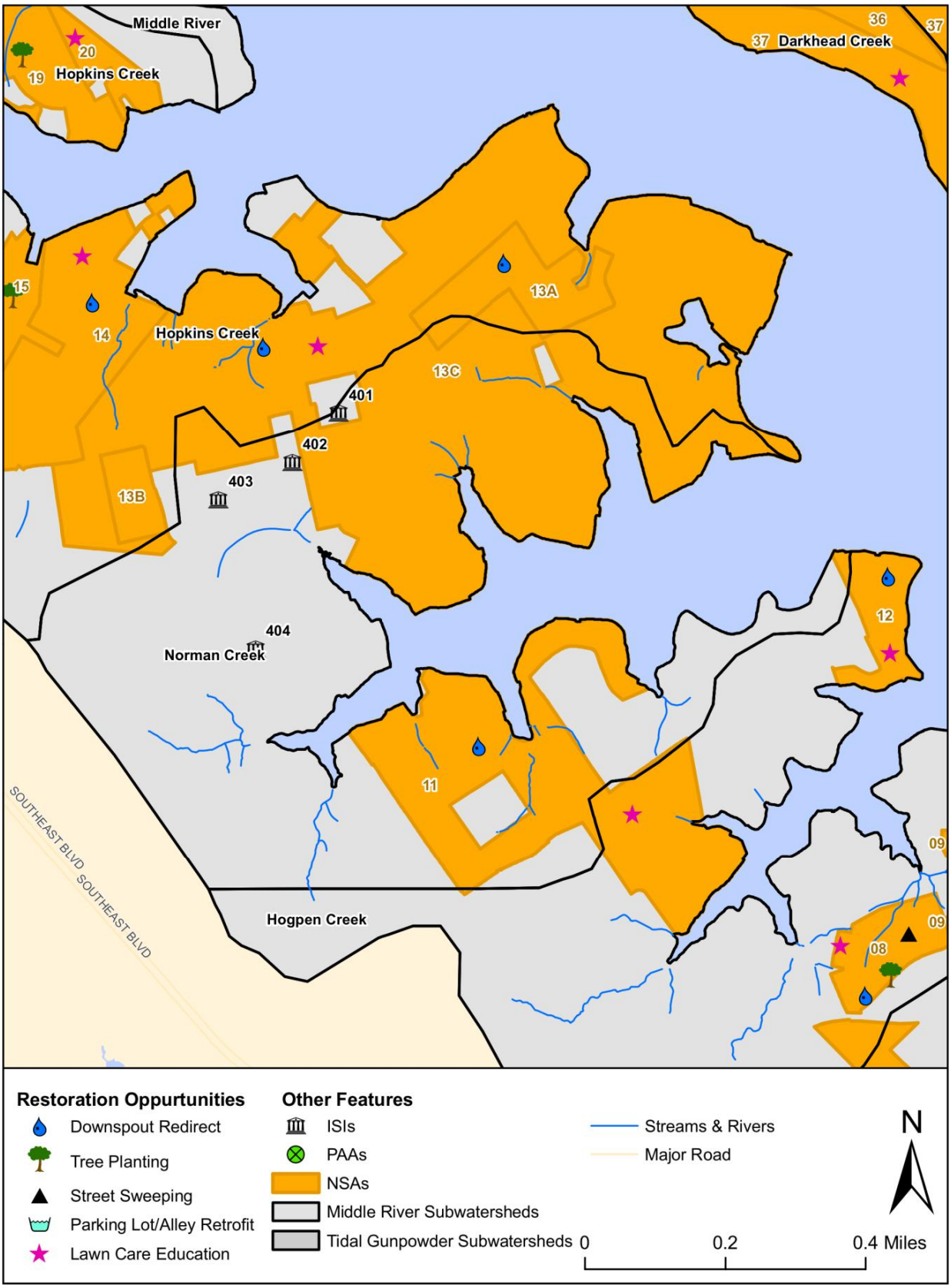


Figure 4-35: Restoration Opportunities in Norman Creek

### 4.3.9 Stansbury Creek

Stansbury Creek is the third smallest subwatershed in the Middle River and Tidal Gunpowder watersheds. 69% of Stansbury Creek is occupied by commercial development while 12% is residential. Forested areas and water/wetlands comprise the remaining subwatershed area. Table 4-61 summarizes key subwatershed characteristics of Stansbury Creek.

Table 4-61: Key Subwatershed Characteristics - Stansbury Creek

| | | |
|---|---|---|
| Drainage Area | 345.8 acres (0.54 sq. mi.) | |
| Stream Length | 0.40 miles | |
| Coastline Length | 2.47 miles | |
| Population | 270 (2000 Census)<br>0.78 people/acre | |
| Land Use/Land Cover | Very Low Density Residential:<br>Low Density Residential:<br>Medium Density Residential:<br>High Density Residential:<br>Commercial:<br>Industrial:<br>Institutional:<br>Extractive:<br>Open Urban:<br>Forest:<br>Agriculture:<br>Water/Wetlands:<br>Transportation | 0.0%<br>0.0%<br>12.3%<br>0.5%<br>69.2%<br>0.0%<br>0.0%<br>0.0%<br>0.0%<br>8.7%<br>0.0%<br>9.4%<br>0.0% |
| Impervious Cover | 24% of subwatershed | |
| Soils | A Soils (low runoff potential):<br>B Soils:<br>C Soils:<br>D Soils (high runoff potential): | 0.0%<br>17.6%<br>37.6%<br>44.7% |
| SWM Facilities | 0% of urban land use treated | |
| Priority Rating | Medium-Low | |

*Neighborhoods*

A portion of NSA_F_36 and NSA_F_37 overlap a portion of the Stansbury Creek watershed along with Darkhead Creek. These neighborhoods are summarized in Section 4.3.1.

*Hotspots*

No hotspots were assessed in Stansbury Creek. Two large industrial landowners have a portion of their property in Stansbury Creek along with Darkhead Creek and Frog Mortar Creek. They are summarized in Section 4.3.1.

*Institutions*

No institutions were assessed in Stansbury Creek.

*Pervious Areas*

No pervious areas were assessed in Stansbury Creek.

*Marinas*

No marinas were assessed in Stansbury Creek. A review of aerial photography along the shoreline of the watershed revealed an area with docks with numerous slips. It is recommended that a review of potential "bootleg" marinas be undertaken in Darkhead Creek to ensure that proper zoning laws are followed and stormwater discharge requirements are being met.

*Industrial Landowners*

Two (2) large industrial landowners properties bisect a portion of Stansbury Creek: MSA and MANG. Information on recommendations and potential restoration opportunities at these sites can be found in Section 4.3.1 under Industrial landowners.

Table 4-62: Industrial Landowners – Stansbury Creek

| Site ID | Name | Acres |
|---|---|---|
| IND_F_801 | Martin State Airport | 585 |
| IND_F_901 | Maryland Air National Guard | 156 |

*Stream Corridor Assessments*

Stream corridor assessments (SCAs) were not conducted in Stansbury Creek. Streams within this subwatershed are mostly tidal, marshy areas and not appropriate for a walking field survey utilizing Maryland DNR's SCA Survey Protocols. Therefore, no stream restoration opportunities have been identified in Stansbury Creek.

*Illicit Discharges*

Stansbury Creek does not contain any rated outfalls. 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 dry detention pond assessments were conducted in Stansbury Creek.

*Shoreline Restoration*

Stansbury Creek has 2.47 miles of shoreline of which 52% (14.8 acres) of the 100-foot shoreline buffer is classified as open, pervious area. No shoreline enhancement projects were identified in EPS's Shoreline Enhancement Feasibility Study (EPS 1998). Planting of the open pervious shoreline buffer in Stansbury Creek is recommended.

*Subwatershed Management Strategy*

The assessments performed in Stansbury Creek and their corresponding recommendations are summarized in other sections of the report.

Municipal Actions

1. Investigate potential bootleg marinas along Stansbury Creek and ensure marinas have proper NSPDES general stormwater permits.

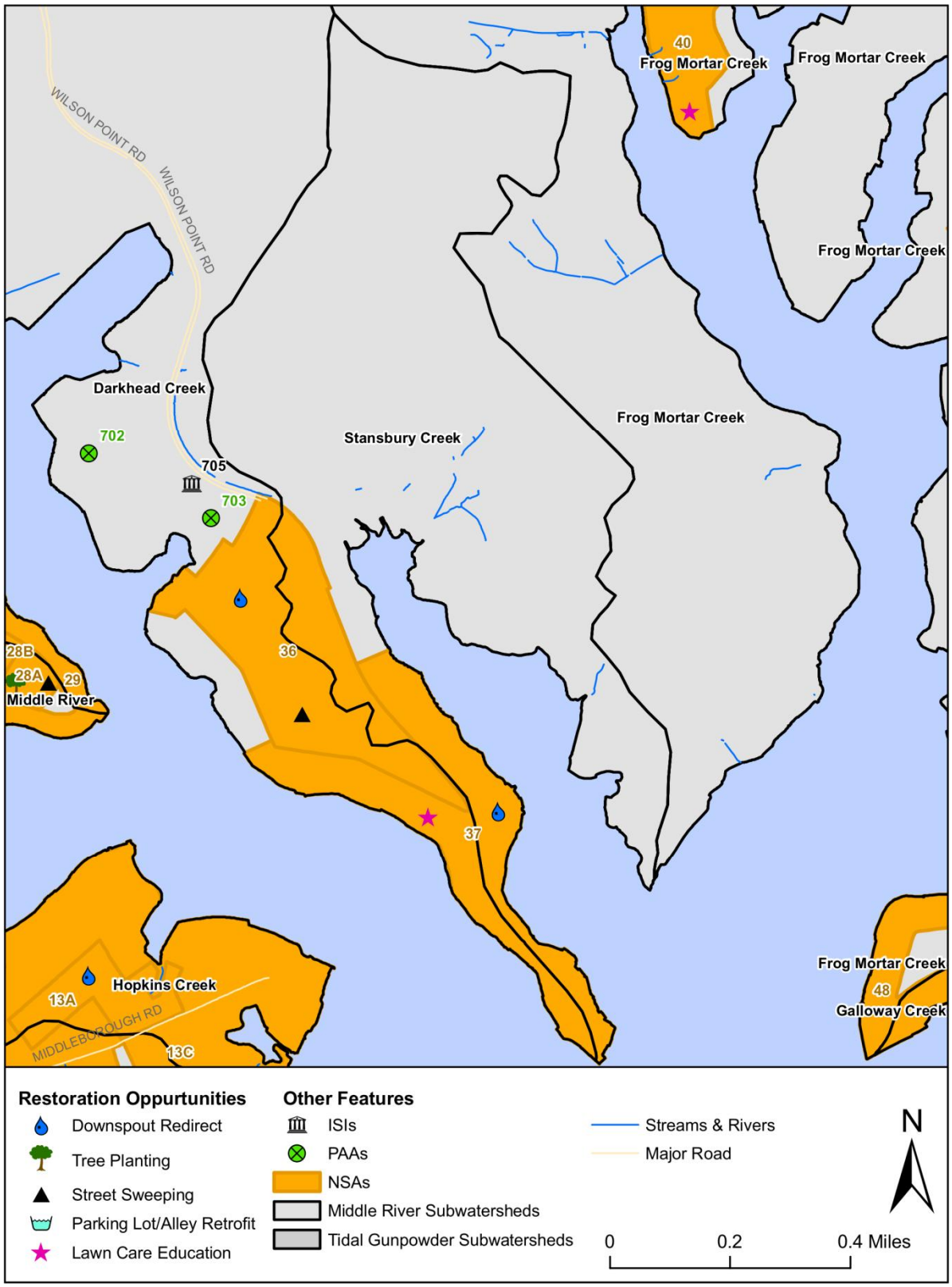


Figure 4-36: Restoration Opportunities in Stansbury Creek

### 4.3.10 Sue Creek

Sue Creek is the sixth largest subwatershed in the Middle River and Tidal Gunpowder watersheds. 47% of the subwatershed area is comprised of residential uses while forested areas and wetland/water uses comprise 42%. Because of the land use in Sue Creek and population of 1,816, the population density is relatively low. Table 4-63 summarizes key subwatershed characteristics of Sue Creek.

Table 4-63: Key Subwatershed Characteristics - Sue Creek

| | | |
|---|---|---|
| Drainage Area | 955.0 acres (1.49 sq. mi.) | |
| Stream Length | 2.78 miles | |
| Coastline Length | 13.00 miles | |
| Population | 1,816 (2000 Census)<br>1.90 people/acre | |
| Land Use/Land Cover | Very Low Density Residential:<br>Low Density Residential:<br>Medium Density Residential:<br>High Density Residential:<br>Commercial:<br>Industrial:<br>Institutional:<br>Extractive:<br>Open Urban:<br>Forest:<br>Agriculture:<br>Water/Wetlands:<br>Transportation | 5.6%<br>7.8%<br>31.8%<br>2.0%<br>3.2%<br>0.0%<br>3.5%<br>0.0%<br>0.5%<br>39.2%<br>2.5%<br>3.8%<br>0.0% |
| Impervious Cover | 13% of subwatershed | |
| Soils | A Soils (low runoff potential):<br>B Soils:<br>C Soils:<br>D Soils (high runoff potential): | 2.1%<br>5.7%<br>87.1%<br>5.0% |
| SWM Facilities | 2% of urban land use treated | |
| Priority Rating | High | |

*Neighborhoods*

A total of six (6) distinct neighborhoods were identified and assessed within Sue Creek during the uplands assessment of Middle River and Tidal Gunpowder. Recommendations for addressing stormwater volume and pollutants within this subwatershed include downspout disconnection, storm drain marking, buffer improvement, street sweeping, tree planting and public education (i.e., bayscaping, increasing lot tree canopy, lawn care, trash management, car maintenance, and boat maintenance). A summary of neighborhood recommended actions is presented in Table 4-64.

Table 4-64: NSA Recommendations – Sue Creek

| | | | RECOMMENDED ACTIONS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NSA_ID | Lot Size (acres) | % Opportunity for Downspout Disconnection | Rain Barrels | Rain Gardens | Storm Drain Stencils | Bayscape | Increase Lot Canopy | Fertilizer Reduction | Trash Management | Buffer Improvement | Miles of Street Sweeping | # of Common Area Shade Trees | Notes |
| NSA_F_04 | <1/4 | 40% | X | | X | | X | X | X | X | 2.9 | | Boat education |
| NSA_F_05 | <1/4 | 95% | X | | | X | X | X | | X | | 100 | Boat education; Sue Avenue is used as alley |
| NSA_F_06 | >1 | 67% | X | | X | | | | | | | 100 | Dumpster uncovered |
| NSA_F_07 | 1/4 | 40% | X | X | X | X | X | X | X | X | | | Construction equipment and snow plows present; Car parking on grass causing bare areas; Boat education; old lawn equipment stored in open spaces. |
| NSA_F_09 | <1/8 | 50% | X | | X | | X | X | | | 0.58 | | Pond maintenance (remove phragmites and other overgrown vegetation) |
| NSA_F_10 | <1/4 | 35% | X | | X | | X | | X | X | | | Outdoor storage of old vehicles, chemicals, old lawn equipment; 2 lots with dirt stockpiles with no sediment control at waterfront |

All of the neighborhoods assessed in Sue Creek were recommended for downspout disconnection and installation of rain barrels. Lots in NSA_F_07 were equipped with enough space to construct rain gardens to treat rooftop runoff.

In NSA_F_09, an existing pond overgrown with invasive vegetation was observed. It is recommended that this pond be maintained to ensure maximum pollutant removal. In NSA_F_10 outdoor storage of vehicles, chemicals, and equipment was observed providing an opportunity for education on proper storage of vehicles and materials. Two of the neighborhoods, NSA_F_07 and NSA_F_10, contained evidence of construction activities; therefore education on proper construction techniques to prevent pollution may be appropriate.

*Hotspots*

No hotspots were assessed in Sue Creek.

*Institutions*

Two (2) institutional sites were assessed for retrofit opportunities in Sue Creek during the uplands assessment of Middle River and Tidal Gunpowder. Table 4-65 summarizes recommendations for the institutional sites assessed in Sue Creek.

Table 4-65: ISI Recommendations – Sue Creek

| | | | RECOMMENDATIONS | | | | | |
|---|---|---|---|---|---|---|---|---|
| Site ID | Name | Public/ Private | Nutrient Management | # of Trees Recommended for Planting | Stormwater Retrofit | Trash Management | Storm Drain Marking | Notes |
| ISI_F_201 | Chesapeake High School | Public | X | 200 | X | | X | Bare ground; New trees along creek; 4 parking lot retrofit sites |
| ISI_F_202 | Rockaway Beach Vo Fire Co 24 | Public | | 60 | | X | | Waste management/outdoor material storage education |

Both institutions assessed in Sue Creek are public and open areas are present for tree planting. At ISI_F_201, a high school, 80% of the vegetative cover on the site is turf grass with evidence of plant material accumulating on impervious surfaces. In addition, approximately 5% of the site consisted of bare soil, providing an opportunity to teach students, teachers, and facility personnel on proper lawn management and the benefits of native vegetation. Storm drain marking is another activity recommended for the site that could engage and educate students and staff. 4 potential stormwater retrofit sites were identified around the school to treat parking lot areas with bioretention areas. Figure 4-37 shows potential retrofit opportunities at ISI_F_201.

Figure 4-37: Storm Drain Marking (left) and Tree Planting (right) Opportunities at ISI_F_201

ISI_F_202 is a publicly-owned fire station. Along with potential tree planting, education on trash management and materials storage is recommended here.

*Pervious Areas*

Two (2) pervious areas were assessed for restoration potential in Sue Creek including Bauernschmidt Manor Park and privately-owned vacant land. Bauernschmidt Manor Park is maintained by Baltimore The sites range from a turf coverage of approximately 30% at PAA_F_201 to 60% at PAA_F_202. Both sites would require minimal site preparation to conduct tree planting. Table 4-66 provides a description of the PAAs located in Sue Creek.

Table 4-66: PAA Descriptions – Sue Creek

| Site ID | Location | Description | Site Size (acres) | Ownership |
|---|---|---|---|---|
| PAA_F_201 | 350 E Bauernschmidt Drive | Bauernschmidt Manor Park | 18.47 | Public |
| PAA_F_202 | Beneca Road & Turkey Point Road | Vacant Bobby B's Palace | 1.11 | Private |

At PAA_F_202, extraneous impervious cover was observed with the potential for conversion to pervious area or permeable pavement. In addition, because of its location adjacent to ISI_F_202, there might be an opportunity to conduct a community planting event at this location. Photographs taken at ISI_F_202 can be seen in Figure 4-38.

Figure 4-38: Extraneous Impervious Cover and Planting Opportunities at PAA_F_202

*Marinas*

One (1) marina was assessed in Sue Creek and is summarized in Table 4-50.

Table 4-67: Marina Recommendations – Sue Creek

| Site ID | Type | Clean Marina | Maintenance/ Repair | Petroleum | Sewage | Waste Management | Marina Management | Stormwater Management | Turf | TotalScore | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MAR_F_201 | Marina/ Boatyard | N | 100 | 0 | 67 | 60 | 67 | 80 | 100 | 64 | Clean marina pledge; In certification process; recycle spare parts stored outdoors; Clean burn for oil; Recommended approved County product list; Sells hydrocoat paint; Abandoned boat issues |

MAR_F_201 is a marina and a boatyard with 60 wet slips, over 100 dry slips, and public boat ramp. Though not currently a Clean Marina, the owner signed the Clean Marina pledge in 2008 and is working towards certification. All maintenance activities are performed indoors and environmental impacts are

minimized. There is a sewage pump-out at the site that is well maintained and the facility uses a clean burn process to dispose of used oil. Additional education could be provided to the site regarding keeping dumpsters closed, storing spare parts under cover, and implementing spill prevention measures.

*Industrial Landowners*

None of the large industrial landowners reside in Sue Creek.

*Stream Corridor Assessments*

Stream corridor assessments (SCAs) were not conducted in Sue Creek. Streams within this subwatershed are mostly tidal, marshy areas and not appropriate for a walking field survey utilizing Maryland DNR's SCA Survey Protocols. Therefore, no stream restoration opportunities have been identified in Sue Creek.

*Illicit Discharges*

Sue Creek does not contain any rated outfalls. 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 dry detention pond assessments were conducted in Sue Creek.

*Shoreline Restoration*

Sue Creek has 13.0 miles of shoreline of which 61% (90.6 acres) of the 100-foot shoreline buffer is classified as open, pervious area. Four (4) shoreline enhancement projects were identified in EPS's Shoreline Enhancement Feasibility Study (EPS 1998). Two projects at Turkey Point (1,000 linear feet) and Pottery Farm Park (1,700 linear feet) were completed in 1997 and 1995, respectively. Sue Creek Waterfront Park was deemed to have a low restoration potential. One (1) project on the Vandermast Peninsula was rated as high for both erosion control and habitat enhancement potential. The Vandermast Peninsula is private and shoreline enhancement would require the cooperation of the property owner. It is recommended that the County investigate if a shoreline enhancement project could be undertaken here. In addition, planting of the open pervious shoreline buffer in Sue Creek is recommended.

*Subwatershed Management Strategy*

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

1. Conduct appropriate downspout disconnection measures in neighborhoods according to Table 4-64 and educate citizens on the benefits of rain barrels and rain gardens.
2. Engage citizens in a storm drain marking program and conduct marking activities in the neighborhoods indicated in Table 4-64.
3. Increase tree canopies on private lots by educating citizens on the benefits of trees and about programs such as The Growing Home Campaign in the neighborhoods indicated in Table 4-64.

4. Educate citizens about the benefits and importance of proper lawn care, bayscaping, waste management, materials storage, and construction activities in the neighborhoods indicated in Table 4-46.
5. Educate residents of NSA_F_04, NSA_F_05, NSA_F_07, and NSA_F_10 about the importance of stream buffers and encourage more environmentally friendly stream treatments.
6. Educate ISI_F_201 on implementing proper lawn care practices.
7. Educate ISI_F_202 on implementing proper waste management practices.
8. Engage students and teachers to participate in storm drain marking and tree planting at ISI_F_201.

Municipal Actions

1. Conduct street sweeping operations at the 2 neighborhoods indicated in Table 4-64.
2. Perform maintenance on the existing stormwater pond in NSA_F_09.
3. Conduct tree plantings at the institutional sites list in Table 4-65.
4. Investigate the potential for installation of stormwater retrofits and conduct programs with student and teachers to provide education and install retrofits at the facilities in Table 4-65.
5. Investigate the potential for tree planting at PAA_F_201 and PAA_F_202.
6. Investigate the potential to conduct impervious cover removal at PAA_F_202.
7. Encourage MAR_F_201 to obtain a Clean Marina certification and provide education on waste management, materials storage, and spill prevention techniques.
8. Investigate potential bootleg marinas along Sue Creek and ensure marinas have proper NPDES general stormwater permits.
9. Work with the property owner at the Vandermast Peninsula to conduct a shoreline enhancement project on 4,300 linear feet of shoreline.
10. Identify open pervious shoreline areas in Sue Creek for the potential for reforestation and preservation.

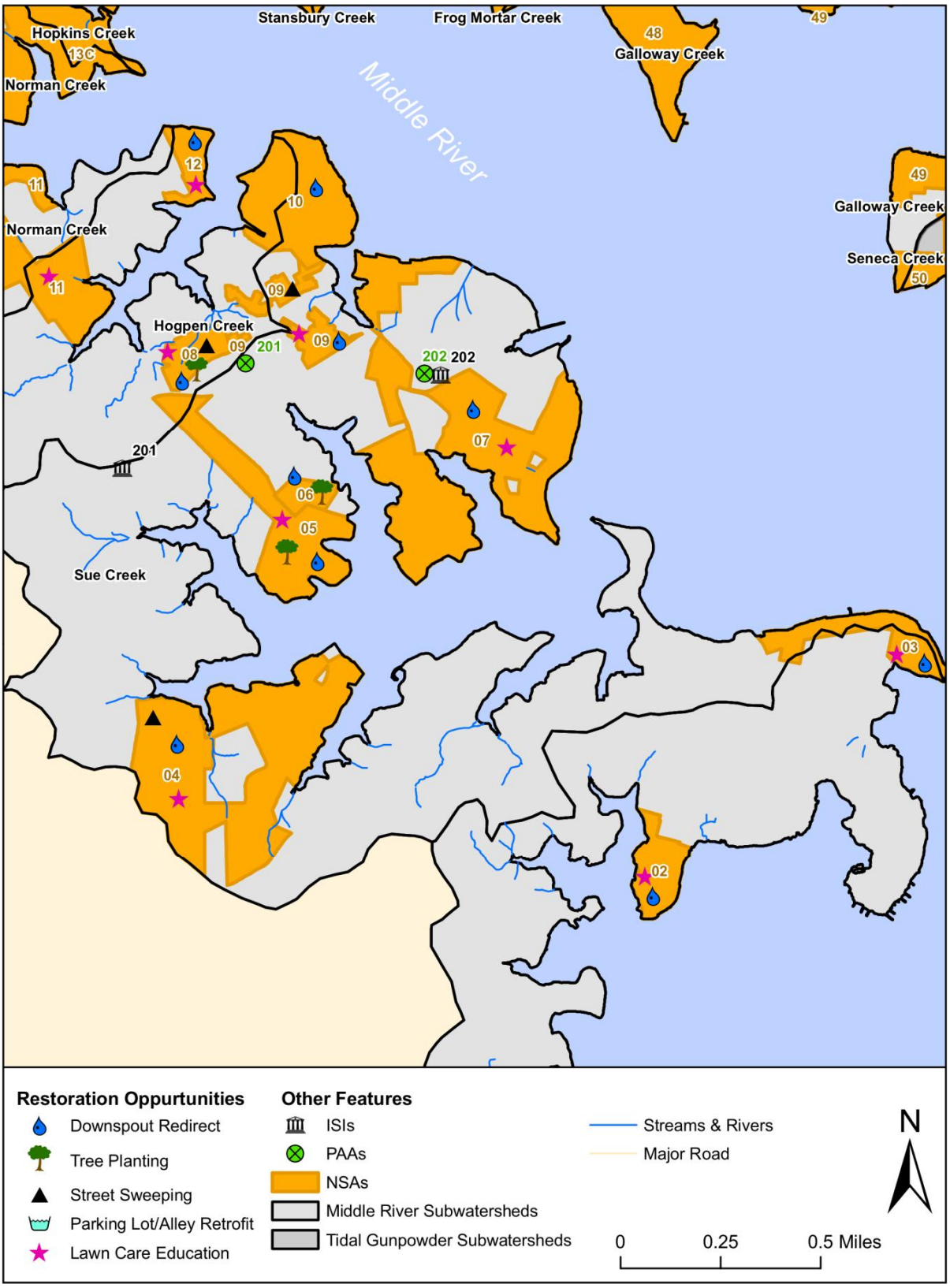


Figure 4-39: Restoration Opportunities in Sue Creek

### 4.3.11 Aberdeen Proving Ground (APG)

Aberdeen Proving Ground (APG) is the second largest subwatershed in Middle River and Tidal Gunpowder. Encompassed entirely by the US Army's Aberdeen Proving Ground, there are no permanent residents that live here. The property consists mainly (93%) of forest, wetlands, and water with the remaining 7% of the subwatershed listed as institutional in the land use code. Table 4-68 summarizes the key subwatershed characteristics of APG.

Table 4-68: Key Subwatershed Characteristics - Aberdeen Proving Ground

| | | |
|---|---|---|
| Drainage Area | 1,280.9 acres (2.00 sq. mi.) | |
| Stream Length | 1.32 miles | |
| Coastline Length | 17.99 miles | |
| Population | 0 (2000 Census)<br>0.00 people/acre | |
| Land Use/Land Cover | Very Low Density Residential:<br>Low Density Residential:<br>Medium Density Residential:<br>High Density Residential:<br>Commercial:<br>Industrial:<br>Institutional:<br>Extractive:<br>Open Urban:<br>Forest:<br>Agriculture:<br>Water/Wetlands:<br>Transportation | 0.0%<br>0.0%<br>0.0%<br>0.0%<br>0.0%<br>0.0%<br>7.4%<br>0.0%<br>0.0%<br>48.5%<br>0.0%<br>44.1%<br>0.0% |
| Impervious Cover | 2% of subwatershed | |
| Soils | A Soils (low runoff potential):<br>B Soils:<br>C Soils:<br>D Soils (high runoff potential): | 0.0%<br>7.2%<br>45.7%<br>47.1% |
| SWM Facilities | 0% of urban land use treated | |
| Priority Rating | Low | |

*Neighborhoods*

With the entirety of the subwatershed being encompassed by a US army facility, no neighborhoods are present in APG.

*Hotspots*

No hotspots were assessed and no NPDES-permitted facilities are present within APG.

*Institutions*

No institutions were assessed in APG.

*Pervious Areas*

No pervious areas were assessed in APG.

*Marinas*

No marinas were assessed in APG.

*Industrial Landowners*

The Aberdeen Proving Ground (APG), a U.S. Army facility, occupies approximately 1,274 acres within Tidal Gunpowder. The portion of APG within the planning area is not attached to the main installation near Aberdeen, Maryland and includes Carroll Island and Graces Quarters. This portion of APG was formerly used for chemical testing and firing programs as early as World War II, which stopped in the late 1960s at this site. APG completed a cleanup program on Carroll Island, where the island has been deemed safe for natural resource management and military training; however, it is not open to the public for safety reasons as there remains the potential for unknown explosives throughout the area.

The majority of the site consists of forest and wetlands which is an important property to maintain and preserve given its proximity to tidal waters including the Chesapeake Bay. APG has conducted various environmental studies and restoration projects on both Carroll Island and Graces Quarters including: approximately 26,700 linear feet of shoreline restoration; SAV planting; wetland mitigation; forest management; and invasive species control. Shoreline restoration projects include a combination of natural shoreline techniques and riprap/breakwaters (due to wind conditions). APG also conducts monitoring of shoreline restoration and SAV planting projects. TSS and nutrient monitoring is conducted in Gunpowder River.

Similar to many of the large, industrial sites visited, APG is proactively incorporating environmental conservation and restoration practices into their operations. The main recommendation is for the County to continue dialogue with the natural resource specialists at APG to track the pollutant removal efficiency of existing and future restoration practices as well as explore partnership options for future projects including forest and wetland preservation, wetland creation, reforestation, SAV planting, and shoreline restoration.

Table 4-69: Industrial Landowners – Aberdeen Proving Ground

| Site ID | Name | Acres |
|---|---|---|
| IND_F_1501 | Aberdeen Proving Ground | 1,274 |

*Stream Corridor Assessments*

Stream corridor assessments (SCAs) were not conducted in APG. Streams within this subwatershed are mostly tidal, marshy areas and not appropriate for a walking field survey utilizing Maryland DNR's SCA Survey Protocols. Therefore, no stream restoration opportunities have been identified in APG.

*Illicit Discharges*

APG does not contain any rated outfalls. 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 dry detention pond assessments were conducted in APG.

*Shoreline Restoration*

APG has 17.99 miles of shoreline of which 28.8% (58.8 acres) of the 100-foot shoreline buffer is classified as open, pervious area. No shoreline enhancement projects were identified in EPS's Shoreline Enhancement Feasibility Study (EPS 1998). Over 26,000 linear feet of shoreline restoration has been conducted at APG by the US Army to date. It is recommended that the County continue to work with the landowner in APG to conduct additional shoreline enhancement projects where feasible.

*Subwatershed Management Strategy*

Engaging Citizens & Watershed Groups

1. Encourage forest and wetland preservation
2. Encourage wetland creation, reforestation, SAV planting, shoreline restoration opportunities
3. Encourage reforestation opportunities on Graces Quarters

Municipal Actions

1. Investigate potential for beneficial reuse of County dredge material (eroded area off of Carroll Island)
2. Track pollutant load reductions from existing and future restoration projects
3. Exchange TSS and nutrient monitoring data to assist with establishing baseline conditions and tracking progress of SWAP restoration actions

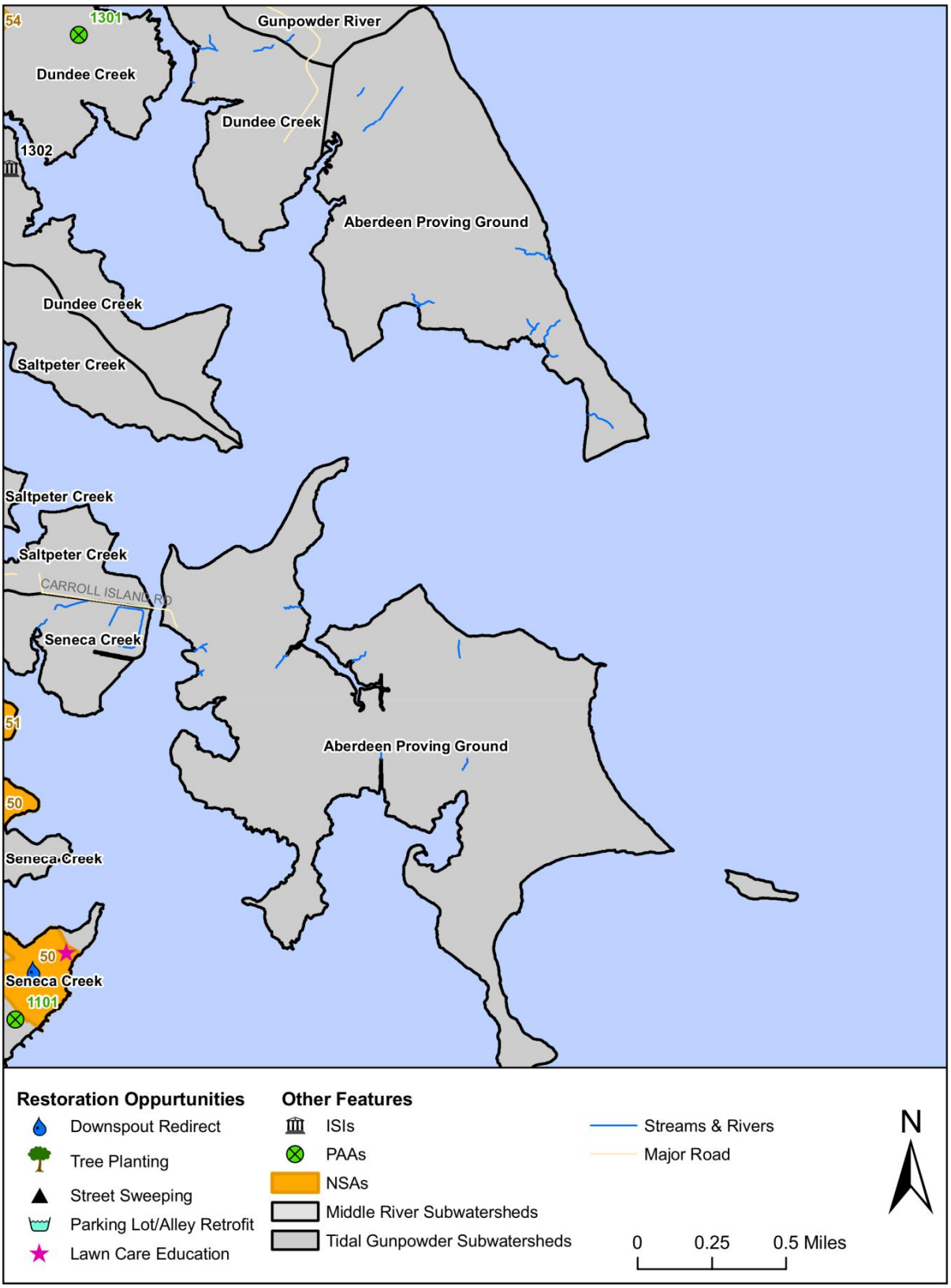


Figure 4-40: Restoration Opportunities in Aberdeen Proving Ground

### 4.3.12 Dundee Creek

Dundee Creek is the seventh largest subwatershed in the Middle River and Tidal Gunpowder watersheds. 16% of the subwatershed area is comprised of residential uses while forested areas and wetland/water uses comprise 65%. 7% of Dundee Creek is covered by extractive uses. Because of the land use in Sue Creek and population of 858, the population density is relatively low. Table 4-63 summarizes key subwatershed characteristics of Dundee Creek.

Table 4-70: Key Subwatershed Characteristics - Dundee Creek

| | | |
|---|---|---|
| Drainage Area | 920.4 acres (1.44 sq. mi.) | |
| Stream Length | 3.20 miles | |
| Coastline Length | 7.57 miles | |
| Population | 858 (2000 Census)<br>0.70 people/acre | |
| Land Use/Land Cover | Very Low Density Residential:<br>Low Density Residential:<br>Medium Density Residential:<br>High Density Residential:<br>Commercial:<br>Industrial:<br>Institutional:<br>Extractive:<br>Open Urban:<br>Forest:<br>Agriculture:<br>Water/Wetlands:<br>Transportation | 0.2%<br>0.0%<br>14.2%<br>1.4%<br>1.8%<br>0.0%<br>1.0%<br>6.6%<br>0.0%<br>50.7%<br>13.9%<br>10.2%<br>0.0% |
| Impervious Cover | 5% of subwatershed | |
| Soils | A Soils (low runoff potential):<br>B Soils:<br>C Soils:<br>D Soils (high runoff potential): | 9.0%<br>30.2%<br>29.5%<br>30.0% |
| SWM Facilities | 36% of urban land use treated | |
| Priority Rating | Medium-Low | |

*Neighborhoods*

A total of two (2) distinct neighborhoods were identified and assessed within Dundee Creek during the uplands assessment of Middle River and Tidal Gunpowder. Recommendations for addressing stormwater volume and pollutants within this subwatershed include storm drain marking and public education (i.e., bayscaping, increasing lot tree canopy, lawn care, and trash management). A summary of neighborhood recommended actions is presented in Table 4-71.

Table 4-71: NSA Recommendations – Dundee Creek

| | | RECOMMENDED ACTIONS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NSA_ID | Lot Size (acres) | % Opportunity for Downspout Disconnection | Rain Barrels | Rain Gardens | Storm Drain Stencils | Bayscape | Increase Lot Canopy | Fertilizer Reduction | Trash Management | Notes |
| NSA_F_54 | 1/2 | 10% | X | X | | X | X | | X | Stabilize bare earth/ deteriorated driveways, public education about outdoor storage and old cars |
| NSA_F_55 | <1/4 | 5% | X | | X | | X | X | | |

All of the neighborhoods in Dundee Creek are recommended for public education related to increasing lot tree canopy. NSA_F_54 consists of single-family attached lots in which 75% of the pervious areas are turf grass. Education on bayscaping is recommended in this neighborhood to increase the amount of native vegetation and decrease the amount of turf grass. In addition trash and old cars were seen in the neighborhood, providing an opportunity for education on trash management and car storage and maintenance. Numerous bare earth or deteriorated driveways were also seen in the area. Educating residents of the neighborhood on potential driveway stabilization techniques would decrease the amount of sediment in runoff at NSA_F_54.

At NSA_F_55, education on proper lawn care techniques is recommended due to the fact that 25% of lawns were rated as high maintenance. Storm drain stenciling is also recommended at this neighborhood.

*Hotspots*

One (1) hotspot site was assessed in Dundee Creek on a nursery and garden center. Table 4-72 summarizes the potential pollution sources found at HSI_F_1301.

Table 4-72: HSI Results Summary – Dundee Creek

| | | | POTENTIAL POLLUTION SOURCES | | |
|---|---|---|---|---|---|
| HSI_ID | HSI Status* | Description | Vehicle Operations | Outdoor Materials | Notes |
| HSI_F_1301 | Potential | Nursery | X | X | Cover material stockpiles |

*Notes:
Potential – pollution not observed, potential pollutant sources

Vehicle operations and storage of outdoor materials were noted at the hotspot assessed in Dundee Creek. Vehicles are stored indoors at the site, and no spills or leakage were evident from vehicle fueling. Uncovered stockpiles of garden and nursery materials were observed on the site as seen in Figure 4-41.

It is recommended that education be provided to HSI_F_1301 and similar businesses on proper storage of outdoor materials.

Figure 4-41: Outdoor Stockpiles at HSI_F_1301

*Institutions*

No institutions were assessed in Dundee Creek.

*Pervious Areas*

One (1) pervious area, an EPA-owned open space, was assessed for restoration potential in Dundee Creek. A summary is provided in Table 4-73.

Table 4-73: PAA Descriptions – Dundee Creek

| Site ID | Location | Description | Site Size (acres) | Ownership |
|---|---|---|---|---|
| PAA_F_1301 | Brinkmans Road | EPA Owned Open Space | 106.00 | Public |

Publicly owned, PAA_F_1301 consists of 106 acres of park area with 50% turf coverage. There is a reforestation nursery owned by Baltimore County EPS on-site. The field team also observed newly planted trees in the southeast portion of the site. This site is recommended for reforestation with minimal site preparation to continue to expand and connect the surrounding forested areas and could be a potential community tree planting project.

Figure 4-42: Reforestation Opportunities at PAA_F_1301

*Marinas*

No marinas were assessed in Dundee Creek.

*Industrial Landowners*

A portion of one (1) industrial landowner's property is within the boundaries of Dundee Creek: Lafarge Quarry. Section 4.3.14 contains information on recommendations for this site. Table 4-74 provides information on this facility.

Table 4-74: Industrial Landowners – Dundee Creek

| Site ID | Name | Acres |
|---|---|---|
| IND_F_1201 | Lafarge Quarry | 324 |

*Stream Corridor Assessments*

Field crews walked 0.8 miles of stream (25% of total stream miles) within Dundee Creek to identify water quality problems and restoration opportunities. This included a survey of all wadeable and accessible portions of Dundee Creek. A total of 12 potential environmental problems were identified in Dundee Creek. The most predominant water quality issues included inadequate buffer, trash dumping, and channel alteration. Several unusual conditions were noted which mostly include fallen trees in the stream and construction of structured stormwater controls within the streambed. Table 4-75 summarizes the results of the SCA survey and restoration opportunities.

Table 4-75: Summary of Stream Conditions – Dundee Creek

| OPPORTUNITIES (# of ENVIRONMENTAL PROBLEM SITES) | | | | |
|---|---|---|---|---|
| Inadequate Buffer | Trash Dumping | Channel Alteration | Unusual Conditions | Totals |
| 3 | 1 | 3 | 5 | *12* |

| Length of Inadequate Buffer (ft) | Length of Channel Alteration (ft) | # of Truckloads for Trash Dumping Sites |
|---|---|---|
| 848 | 132 | 10 |

*Illicit Discharges*

Dundee Creek does not contain any outfalls rated as priority 1 or priority 2. 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*

Dundee Creek contains one (1) detention pond assessed during the study. Information on the pond can be found in Table 4-76.

Table 4-76: Detention Pond Conversion - Dundee Creek

| Site ID | Riser | Embankment | Vege-tation | Gate | Water Quality Potential | Access | Flow Path | Expansion Potential |
|---|---|---|---|---|---|---|---|---|
| SWM_F_435 | Damaged | Trees | Wetland Veg. | No Gate | Y | Easy | Long | No |

Detention Pond, SWM_F_435, is a publicly-owned facility, located near the intersection of Ebenezer Road and Cunninghill Cove Road. The existing pond is constrained horizontally on all sides, so there is no potential for horizontal expansion. The entrance of the low flow pipe was completely blocked with sediment, causing low flows to travel into the bottom of the corrugated metal pipe (CMP) riser, causing localized gully erosion in front of riser. The invert of the 36-inch CMP principal spillway was corroded and the bottom of the metal end sections for the 36-inch CMP principal spillway and 18-inch CMP culvert beneath Ebenezer Road were completely rusted out and no longer present. The pond is recommended for vertical excavation and installation of pretreatment forebays. In addition, routine maintenance is recommended including replacement of the low-flow pipe, upgrading the principal spillway, and replacing metal end sections of the 36-inch and 18-inch culverts in the pond

*Shoreline Restoration*

Dundee Creek has 7.57 miles of shoreline of which 23% (19.1 acres) of the 100-foot shoreline buffer is classified as open, pervious area. Two (2) shoreline enhancement projects were identified in EPS's

Shoreline Enhancement Feasibility Study (EPS 1998). Segment II of the Dundee Saltpeter Park shoreline restoration had been completed prior to the study and was found to be stable. Segment I of Gunpowder Falls State Park was found to have moderate potential for habitat enhancement. It is recommended that the County work with DNR, who manages the park, to determine if shoreline enhancement is feasible at this site. In addition, planting of the open pervious shoreline buffer in Dundee Creek is recommended.

*Subwatershed Management Strategy*

Engaging Citizens & Watershed Groups

1. Engage citizens in a storm drain marking program and conduct marking activities in the neighborhoods indicated in Table 4-71.
2. Increase tree canopies on private lots by educating citizens on the benefits of trees and about programs such as The Growing Home Campaign in the neighborhoods indicated in Table 4-71.
3. Educate citizens about the benefits and importance of proper lawn care, bayscaping, and waste management in the neighborhoods indicated in Table 4-71.
4. Educate residents of NSA_F_54 about proper storage of cars and outdoor materials along with driveway stabilization techniques.

Municipal Actions

1. Work with HSI_F_701 and similar businesses to implement appropriate practices for vehicle operations and outdoor materials storage.
2. Investigate the potential for tree planting at PAA_F_1301.
3. Work with DNR to investigate the potential for a shoreline enhancement project of 13,100 linear feet of shoreline in Gunpowder Falls State Park.
4. Identify open pervious shoreline areas in Dundee Creek for the potential for reforestation and preservation.
5. Investigate the opportunity for stream restoration projects in Dundee Creek.

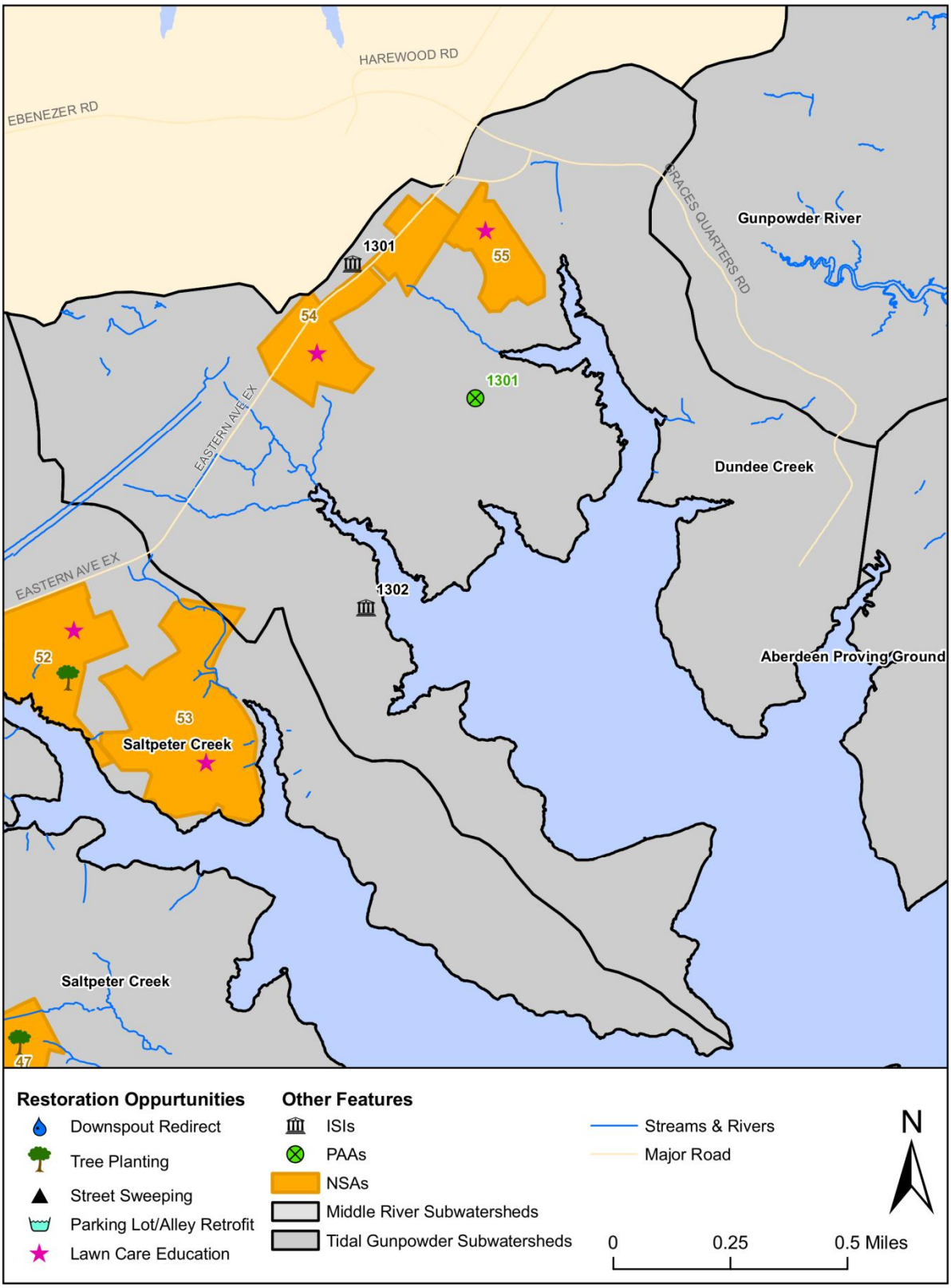


Figure 4-43: Restoration Opportunities in Dundee Creek

### 4.3.13 Gunpowder River

Gunpowder River is the median subwatershed in the study with regards to size with 7 larger and 7 smaller subwatersheds in Middle River and Tidal Gunpowder. With a population of 1,634, Gunpowder River is has a relatively low population density since the majority of the watershed consists of forest, water/wetlands, or open urban. The open urban area of this watershed is made up entirely of the Gunpowder Falls State Park. A summary of the key watershed characteristics is presented in Table 4-76.

Table 4-77: Key Subwatershed Characteristics - Gunpowder River

| | | |
|---|---|---|
| Drainage Area | 745.4 acres (1.16 sq. mi.) | |
| Stream Length | 5.16 miles | |
| Coastline Length | 2.84 miles | |
| Population | 1,634 (2000 Census)<br>1.82 people/acre | |
| Land Use/Land Cover | Very Low Density Residential:<br>Low Density Residential:<br>Medium Density Residential:<br>High Density Residential:<br>Commercial:<br>Industrial:<br>Institutional:<br>Extractive:<br>Open Urban:<br>Forest:<br>Agriculture:<br>Water/Wetlands:<br>Transportation | 1.2%<br>0.0%<br>27.0%<br>0.0%<br>0.0%<br>0.0%<br>1.7%<br>0.0%<br>18.2%<br>33.9%<br>0.3%<br>17.6%<br>0.0% |
| Impervious Cover | 8% of subwatershed | |
| Soils | A Soils (low runoff potential):<br>B Soils:<br>C Soils:<br>D Soils (high runoff potential): | 0.2%<br>42.8%<br>35.4%<br>21.5% |
| SWM Facilities | 6% of urban land use treated | |
| Priority Rating | Medium-Low | |

*Neighborhoods*

One (1) distinct neighborhood was identified and assessed within Gunpowder River during the uplands assessment. Recommendations for addressing stormwater volume and pollutants within this subwatershed include downspout disconnection, storm drain stenciling, buffer improvement, and public education (bayscaping, increasing lot canopy, boat and outdoor storage). A summary of the recommended actions in presented in Table 4-78.

Table 4-78: NSA Recommendations – Gunpowder River

| | | RECOMMENDED ACTIONS | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| NSA_ID | Lot Size (acres) | % Opportunity for Downspout Disconnection | Rain Barrels | Rain Gardens | Storm Drain Stencils | Bayscape | Increase Lot Canopy | Buffer Improvement | Notes |
| NSA_F_56 | 1/4 | 20% | X | X | X | X | X | X | Boat education; Outdoor storage education; Pave/regravel portion of Oliver Beach Road. |

Because of the size of lots, NSA_F_56 presents good opportunities for disconnection of downspouts into rain barrels or rain gardens. Currently, connected downspouts are piped directly to ditches in the front yards of properties. In addition, the lot sizes offer an opportunity to encourage bayscaping and increasing lot tree canopy through public education/outreach efforts. Trash, old cars, boats, and other materials were seen stored outdoors in this neighborhood which provides another opportunity for public education. Finally, Oliver Beach Road is a graveled road on the site that has the potential to cause sediment to be displaced by runoff into neighboring waters. This road is recommended to have new gravel or pavement placed to prevent erosion of sediments. Figure 4-44 shows photographs of pollution sources and restoration opportunities in Gunpowder River.

Figure 4-44: Outdoor Storage (left) and Unpaved Drive at NSA_F_56

*Hotspots*

No hotspots were assessed and no NPDES-permitted facilities are present within Gunpowder River.

*Institutions*

One (1) institution was assessed for retrofit opportunities in Gunpowder River during the uplands assessment of Middle River and Tidal Gunpowder. ISI_F_1401 is a public elementary school which is summarized in Table 4-79.

Table 4-79: ISI Recommendations – Gunpowder River

| | | | RECOMMENDATIONS | | | |
|---|---|---|---|---|---|---|
| Site ID | Name | Public/ Private | Nutrient Management | # of Trees Recommended for Planting | Storm Drain Marking | Notes |
| ISI_F_1401 | Oliver Beach Elementary School | Public | X | 400 | X | Trees cut down along west side of property |

There is an opportunity for tree planting along the northern and eastern boundary of the site with room for a potential total of 400 trees. Another recommendation for this site is to address nutrient management, in particular the large amount of turf on the grounds along with bare soil that has the potential to contribute sediment to runoff.

Figure 4-45: Tree Planting Potential at ISI_F_1401

*Pervious Areas*

One (1) pervious area was assessed for restoration potential in Gunpowder River: Gunpowder Falls Stake Park. Located on Graces Quarter road, PAA_F_1401 is the largest pervious area assessment performed during the uplands assessment of Middle River and Tidal Gunpowder. Table 4-80 summarizes the characteristics of this park.

Table 4-80: PAA Descriptions – Gunpowder River

| Site ID | Location | Description | Site Size (acres) | Ownership |
|---|---|---|---|---|
| PAA_F_1401 | Graces Quarters Road | Gunpowder Falls State Park | 767.39 | Public |

Gunpowder Falls State Park is owned and managed by DNR. Although much of the park consists of forests and wetlands, a tour of the site and review of aerial photographs found the potential for over 15 acres of reforestation that could occur here. In addition, two potential stormwater retrofit

opportunities were identified to treat existing parking lots. Figure 4-46 shows potential tree planting and stormwater retrofits sites at PAA_F_1401.

Figure 4-46: Tree Planting (left) and Retrofit (right) Potential at PAA_F_1401

*Marinas*

No marinas were assessed in Gunpowder River. A review of the aerial photos did not reveal any potential bootleg marinas.

*Industrial Landowners*

None of the large industrial landowners reside in Gunpowder River.

*Stream Corridor Assessments*

SCAs were not conducted in Gunpowder River. Stream mileage is very limited within this subwatershed and streams are mostly tidal, marshy areas. These are not appropriate for the walking field survey based on Maryland DNR's SCA Survey Protocols. Therefore, no stream restoration opportunities have been identified in Gunpowder River.

*Illicit Discharges*

Gunpowder River does not contain any rated outfalls. 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*

Gunpowder River contains one detention pond, located near Oliver Beach Road and Cunninghill Cove Road. Detention Pond, SWM_F_449, is a publicly-owned facility is designed to handle runoff from a 10-year storm event from a 17.86-acre development of single family homes. Key characteristics of SWM_F_449 can be found in Table 4-81.

Table 4-81: Detention Pond Conversion - Gunpowder River

| Site ID | Riser | Embankment | Vege-tation | Gate | Water Quality Potential | Access | Flow Path | Expansion Potential |
|---|---|---|---|---|---|---|---|---|
| SWM_F_449 | Damaged | Erosion | Wetland Veg. | No Gate | Y | Moderate | Long | Yes |

SWM_F_449 is a good candidate for conversion to an extended detention facility. There is open space between existing pond footprint and adjacent private property for horizontal expansion. In addition, there is potential for excavation of the pond bottom to provide more storage depth. Due to deterioration of the existing pond outlet pipe and gabion outlet protection, the receiving stream is entrenched approximately 3 feet.

The key recommendations for this pond include restoring the downstream receiving stream along with replacement of the outlet structure. Because of the ability to expand, another recommendation is the installation of pretreatment forebays. The pond is also in need of routine maintenance including removing trees from the embankment and landscaping updates. Figure 4-47 illustrates the condition of the outfall and receiving stream at SWM_F_449.

Figure 4-47: Deteriorated Outfall (left) and Potential Stream Restoration (right) at SWM_F_449

*Shoreline Restoration*

Gunpowder River has 2.84 miles of shoreline of which almost 74% (24.0 acres) of the 100-foot shoreline buffer is classified as open, pervious area. Gunpowder Falls State Park's shoreline is classified as stable, and any enhancements or repairs needed would fall under the purview of DNR. No other shoreline enhancement projects were identified in EPS's Shoreline Enhancement Feasibility Study (EPS 1998).

*Subwatershed Management Strategy*

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

1. Conduct appropriate downspout disconnection measures in neighborhoods according to Table 4-77 and educate citizens on the benefits of rain barrels and rain gardens.
2. Engage citizens in a storm drain marking program and conduct marking activities in the neighborhoods indicated in Table 4-77.

3. Increase tree canopies on private lots by educating citizens on the benefits of trees and about programs such as The Growing Home Campaign.
4. Educate citizens about the benefits and importance of bayscaping.
5. Educate residents about the importance of stream buffers and encourage more environmentally friendly buffer treatments.
6. Educate residents on proper techniques for vehicle, boat, and materials storage and maintenance.

Municipal Actions

1. Conduct tree plantings at the institutional site, ISI_F_1401.
2. Investigate the potential for installation of stormwater retrofits at PAA_F_1401.
3. Identify open pervious shoreline areas in Gunpowder River for the potential for reforestation and preservation.
4. Convert SWM_F_449 into a extended dry detention facility, replace the existing outlet structure, and stabilize the receiving stream located downstream of the pond.
5. Perform maintenance on SWM_F_449 to replace invasive vegetation and remove trees from the pond embankment.

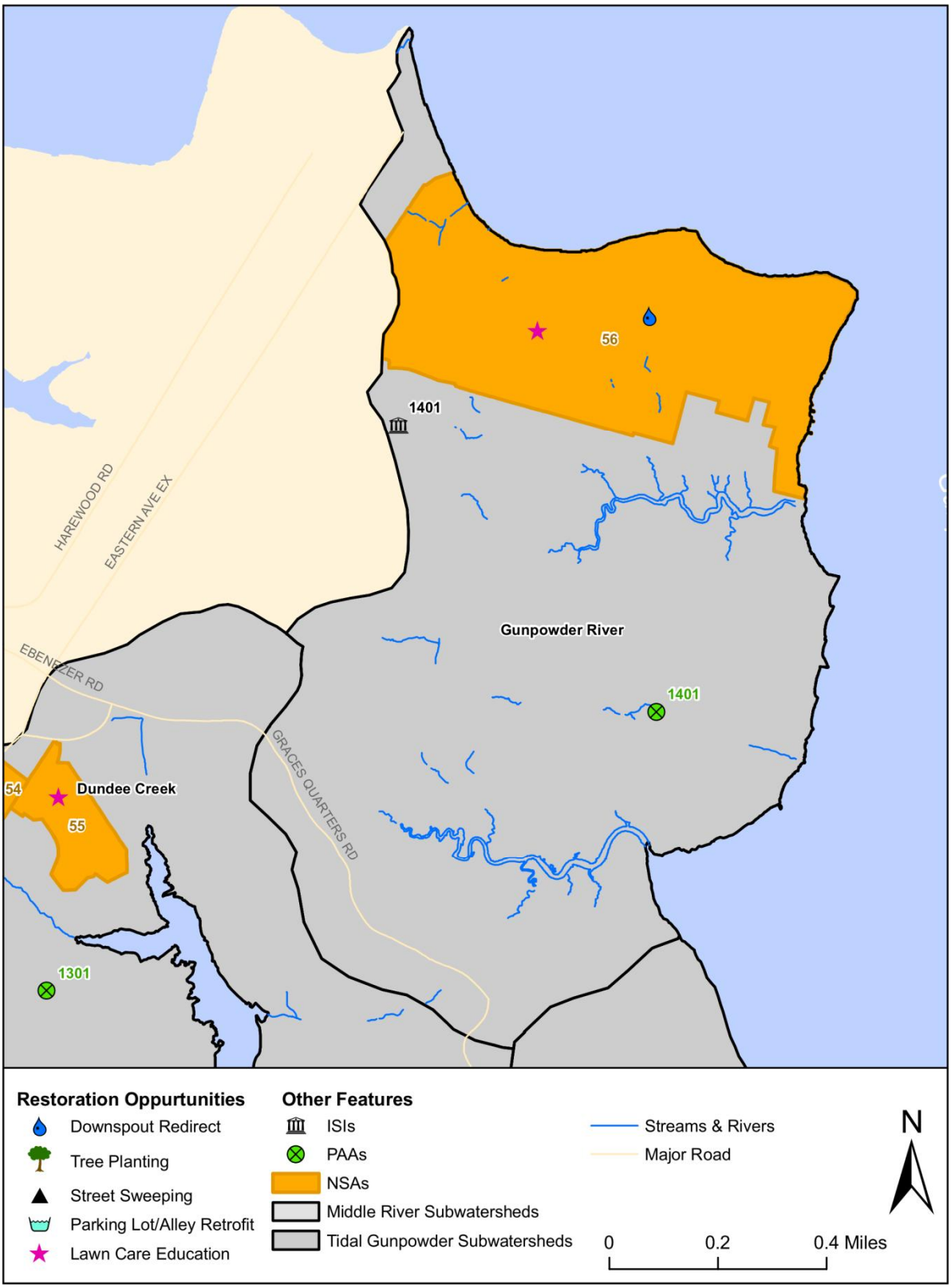


Figure 4-48: Restoration Opportunities in Gunpowder River

### 4.3.14 Saltpeter Creek

Saltpeter Creek is the largest subwatershed in the Middle River and Tidal Gunpowder watersheds. Over 55% of the watershed is comprised of forested land use. Other uses in the subwatershed include residential, commercial, industrial, institutional, extractive, agriculture, and water/wetlands. Table 4-82 summarizes key subwatershed characteristics of Saltpeter Creek.

Table 4-82: Key Subwatershed Characteristics - Saltpeter Creek

| | | |
|---|---|---|
| Drainage Area | 1,902.2 acres (2.97 sq. mi.) | |
| Stream Length | 10.54 miles | |
| Coastline Length | 10.68 miles | |
| Population | 3,039 (2000 Census)<br>1.60 people/acre | |
| Land Use/Land Cover | Very Low Density Residential:<br>Low Density Residential:<br>Medium Density Residential:<br>High Density Residential:<br>Commercial:<br>Industrial:<br>Institutional:<br>Extractive:<br>Open Urban:<br>Forest:<br>Agriculture:<br>Water/Wetlands:<br>Transportation | 2.4%<br>0.5%<br>0.8%<br>7.8%<br>0.7%<br>5.2%<br>1.1%<br>11.2%<br>4.1%<br>55.6%<br>4.6%<br>6.0%<br>0.0% |
| Impervious Cover | 10% of subwatershed | |
| Soils | A Soils (low runoff potential):<br>B Soils:<br>C Soils:<br>D Soils (high runoff potential): | 19.2%<br>24.2%<br>37.7%<br>16.1% |
| SWM Facilities | 21% of urban land use treated | |
| Priority Rating | Medium-Low | |

*Neighborhoods*

A total of three (3) distinct neighborhoods were identified and assessed within Saltpeter Creek during the uplands assessment of Middle River and Tidal Gunpowder. Recommendations for addressing stormwater volume and pollutants within this subwatershed include downspout disconnection, storm drain marking, buffer improvement, tree planting, and public education (i.e., bayscaping, increasing lot tree canopy, lawn care, and pet waste management). A summary of neighborhood recommended actions is presented in Table 4-83.

Table 4-83: NSA Recommendations – Saltpeter Creek

| | | RECOMMENDED ACTIONS | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NSA_ID | Lot Size (acres) | % Opportunity for Downspout Disconnection | Rain Barrels | Rain Gardens | Storm Drain Stencils | Bayscape | Increase Lot Canopy | Fertilizer Reduction | Pet Waste | Buffer Improvement | # of Street Trees | # of Common Area Shade Trees | Notes |
| NSA_F_47 | <1/8 | 50% | X | | X | X | | X | X | | 25 | 660 | |
| NSA_F_52 | >1 | 50% | | X | X | X | X | | | X | 260 | 115 | One great spot for rain garden in back of complex |
| NSA_F_53 | >1 | 75% | X | | X | X | X | X | X | | | | Pond maintenance including removal of trees and invasives on embankment, removal of large CMP (120in) just outside Bayou Court stormwater pond. |

All of the neighborhoods in Saltpeter Creek are recommended for downspout disconnection, storm drain stenciling and public education related to bayscaping. At NSA_F_47 and NSA_F_52, there was potential for the planting of over 1,000 trees combined. NSA_F_47 consists of multi-family attached dwellings. Education on lawn care and pet waste management is recommended here due to evidence of high maintenance lawns with pet waste in some areas. NSA_F_52 also consists of multifamily attached dwellings. As seen in Figure 4-49, mowing activities are encroaching on the buffer area. In addition, there is potential for construction of a rain garden in the rear of the complex to treat rooftop runoff.

Figure 4-49: Rain Garden Potential at NSA_F_52

NSA_F_53 is a mobile home park surrounded by a forested buffer along Saltpeter Creek. Education on the benefits of individual lot canopies along with education on proper lawn care due to high maintenance lawns is recommended. In addition, evidence of pet waste was seen in the neighborhood. As seen in Figure 4-50, the neighborhood does have a stormwater management pond which is recommended for routine maintenance. In addition, large corrugated metal pipe was observed in a pile which should be removed.

Figure 4-50: Existing Stormwater Pond at NSA_F_53

*Hotspots*

Five (5) hotspot investigations were performed within Saltpeter Creek. This included a multipurpose industrial facility, an auto junkyard, construction stockpile sale center, a plant nursery, and a construction office. Table 4-84 summarizes the potential pollution sources found at each of the sites.

Table 4-84: HSI Results Summary – Saltpeter Creek

| | | | POTENTIAL POLLUTION SOURCES | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| HSI_ID | HSI Status* | Description | Vehicle Operations | Outdoor Materials | Waste Management | Physical Plant | Turf/Landscape Management | Stormwater Infrastructure | Notes |
| HSI_F_1201 | Potential | Steel Fabrication, Dirt Track, Boat Repair/ Storage | X | X | X | X | | X | No sediment controls for dirt track and large lot of bare earth; Include in future education for dumping and sediment control |
| HSI_F_1202 | Potential | Auto Junk Yard | X | X | X | X | | | |
| HSI_F_1203 | Confirmed | Material Stockpiles And Sales For Construction | X | X | | X | | | No sediment controls in place to prevent sediment from leaving the site. Requires sediment controls. |
| HSI_F_1204 | Potential | Nursery | X | X | | | X | | |
| HSI_F_1205 | Confirmed | Construction Company | X | X | | X | | X | |

*Notes:
Potential – pollution not observed, potential pollutant sources
Confirmed – pollution observed, many potential sources

Vehicle operations and storage of outdoor materials was a potential pollution source at all of the hotspots in Saltpeter Creek. HSI_F_1201 is a multipurpose facility with steel fabrication operations, a dirt track, and boat storage and repair. Large stockpiles of dirt along with tires were seen at the site,

adjacent to wetlands without any runoff diversions. In addition, no sediment controls are in place for the dirt motor-track and other bare earth on the site.

HSI_F_1202 is an auto junkyard with over 200 vehicles stored outside on the site. In addition, waste management seemed to be an issue at the site with open and overflowing dumpsters. Figure 4-51 contains photographs of HSI_F_1201 and HSI_F_1202.

Figure 4-51: Dirt Track at HSI_F_1201 (left) and Outdoor Storage at HSI_F_1202 (right)

HSI_F_1203 is a site with construction materials stockpiled and for sale. Vehicles at this site are fueled and stored outside at the site. In addition, displaced sediment was observed from soil and gravel stockpiles on the site. At HSI_F_1204, turf/landscape management was an additional pollutant source. 40% of the site's pervious area is covered by high maintenance lawn. In addition, a large portion of the site is covered in bare soil. At HSI_F_1205, vehicles are maintained, repaired, fueled and stored outside. Sand, gravel, and unknown liquids were stored on the site and evidence of runoff to storm drains was observed. The site did contain a stormwater wet pond that treats a building and the parking lot on the site. Figure 4-52 shows photographs of HSI_F_1203, HSI_F_1204, and HSI_F_1205.

Figure 4-52: Stockpile at HSI_F_1203 (left), High Maintenance Lawn at HSI_F_1204 (center), and Vehicles at HSI_F_1205 (right)

*Institutions*

Six (6) institutional sites were assessed for retrofit opportunities in Saltpeter Creek during the uplands assessment of Middle River and Tidal Gunpowder. They include (1) public school, two (2) public community centers, and three (3) private faith-based institutions. Table 4-85 summarizes recommendations for the institutional sites assessed in Saltpeter Creek.

Table 4-85: ISI Recommendations – Saltpeter Creek

| | | | RECOMMENDATIONS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Site ID | Name | Public/ Private | Nutrient Management | # of Trees Recommended for Planting | Stormwater Retrofit | Downspout Disconnection | Impervious Cover Removal | Trash Management | Storm Drain Marking | Buffer Improvement | Notes |
| ISI_F_1201 | Shining Star Baptist | Private | | 40 | | | | | | | May be rebuilding new church on site |
| ISI_F_1202 | Sharp Street United Methodist | Private | | 25 | | | | X | | | Possibly abandoned; Dumping; Permeable pavement/ impervious cover removal |
| ISI_F_1203 | Eastern Regional Community Center | Public | X | 150 | X | X | | | X | | Retrofit to treat front turn-around; Existing pond retrofit in rear |
| ISI_F_1204 | Chase Elementary School | Public | X | 150 | X | | X | X | X | | 2 retrofit sites; Bare ground draining to inlets; Dumpster stains |
| ISI_F_1205 | Bengies Community Building | Public | | | X | | | | | | Retrofit rear parking lot; Erosion along entrance |
| ISI_F_1206 | Maranatha Chapel | Private | | 40 | X | | | X | X | X | Outdoor material near stream; Permeable pavement; Parking lot retrofit |

ISI_F_1201, ISI_F_1202, and ISI_F_1206 are all faith-based institutions in the Saltpeter Creek subwatershed. At ISI_F_1201, tree planting opportunities were noted. In addition, there appeared to be preparations being made for the reconstruction of the church building. At ISI_F_1202, tree planting opportunities were noted along with excessive dumping in the rear of the property. The site was noted as potentially abandoned, as the building was dilapidated and the site was cordoned off by a fence. The site could potentially be an opportunity for impervious cover removal if truly abandoned. ISI_F_1206 is recommended for education on trash management due to evidence of waste on the site along with storage of outdoor materials near stream buffers. Tree planting opportunities were noted on the site as well as the need for storm drain marking. A community activity could be planned for this institution to achieve this. In addition, the parking lot could potentially be treated by a bioretention area or other infiltrative BMP through a retrofit. Figure 4-53 contains photographs of the three (3) faith-based institutions assessed in Saltpeter Creek.

Figure 4-53: Parking Lot at ISI_F_1201 (left), Dumping at ISI_F_1202 (center), and Tree Planting at ISI_F_1206 (right)

ISI_F_1203 and ISI_F_1205 are both publicly-owned community centers. At ISI_F_1203, tree planting opportunities were noted for open spaces on the site. In addition, with the large amount of turf on the site, education on lawn management is proposed at the site. Downspouts at the site are directly connected to the storm drain system, providing an opportunity to disconnect rooftop runoff and direct towards the existing stormwater management pond on the site. One stormwater retrofit opportunities was noted at ISI_F_1203. The front looped driveway at the site currently drains to a grassed channel that can be enhanced to address standing water and provide water quality treatment. At ISI_F_1205, the rear parking lot could be directed to a bioretention area or another infiltrative BMP. Figure 4-54 shows photographs of potential stormwater retrofit potential at these sites. Soil erosion at the southern entrance was also noted at ISI_F_1205 and should be addressed.

Figure 4-54: Stormwater Retrofit Opportunities at ISI_F_1203 (left) and ISI_F_1205 (right)

ISI_F_1205 is a public elementary school in Saltpeter Creek and provides an excellent opportunity to engage on educate students and teachers on watershed restoration. Recommended education at this site includes nutrient management and trash management. In addition, tree planting and storm drain marking are potential activities at the site where students and teachers could be engaged. Two potential retrofit opportunities were identified where rooftop or parking lot runoff could be treated with bioretention areas. Excessive impervious area was noted on the northeast side of the school for possible removal.

Figure 4-55: Storm Drain Marking (left) and Impervious Cover Removal (right) at ISI_F_1205

*Pervious Areas*

One (1) pervious area, Eastern Regional Park, was assessed for restoration potential in Saltpeter Creek. A summary is provided in Table 4-86.

Table 4-86: PAA Descriptions – Saltpeter Creek

| Site ID | Location | Description | Site Size (acres) | Ownership |
|---|---|---|---|---|
| PAA_F_1201 | 750 NE Bowleys Qtr Rd | Eastern Regional Park | 82.94 | Public |

Publicly owned, PAA_F_1201 consists of 83 acres of park area with 50% turf coverage. The site is recommended for reforestation with minimal site preparation. The open space areas at the northern portion of the site along Eastern Avenue appear to be good candidates for tree planting; this could be a community project.

Figure 4-56: Tree Planting Opportunities at PAA_F_1201

*Marinas*

No marinas were assessed in Saltpeter Creek.

*Industrial Landowners*

A portion of two (2) industrial landowners' properties are within the boundaries of Saltpeter Creek: Constellation Energy and Lafarge Quarry. Information on recommendations at ISI_F_1101 is contained in Section 4.3.15. Table 4-74 provides information on these facilities.

Table 4-87: Industrial Landowners – Saltpeter Creek

| Site ID | Name | Acres |
|---|---|---|
| IND_F_1101 | Constellation Energy | 111 |
| IND_F_1201 | Lafarge Quarry | 324 |

Lafarge occupies approximately 324 acres off of Earls Road in the Saltpeter Creek and Dundee Creek subwatersheds for sand mining operations. Lafarge has a general NPDES permit and therefore, discharges must abide by applicable state laws. However, the manager noted that there have been no discharges from site related to mining in the last three years because of the high permeability of the sand. There are several pond areas on-site which are used for washing and settling operations. All water is reused for these processes. Leftover fines are sold to cement plants as fill. The site does include fueling operations and spill kits are available in these locations. Double-walled liquid storage tanks are on-site and inspected monthly. The recommendation at this site is for the County to continue dialog with the landowner to implement restoration activities such as forest and wetland preservation, wetland creation, reforestation, and invasive species removal. In addition, the County will continue to track pollutant load reductions from existing and future restoration projects at the site.

*Stream Corridor Assessments*

Field crews walked 1.9 miles of stream (18% of total stream miles) within Saltpeter Creek to identify water quality problems and restoration opportunities. This included a survey of all wadeable and accessible portions of Saltpeter Creek. A total of 15 potential environmental problems were identified in Saltpeter Creek. The most predominant water quality issues included inadequate buffer, trash dumping, fish barriers, and pipe outfalls. Several unusual conditions were noted which mostly include inlet outfalls to the stream. Table 4-88 summarizes the results of the SCA survey and restoration opportunities.

Table 4-88: Summary of Stream Conditions – Saltpeter Creek

| OPPORTUNITIES (# of ENVIRONMENTAL PROBLEM SITES) | | | | | |
|---|---|---|---|---|---|
| Inadequate Buffer | Trash Dumping | Fish Barriers | Pipe Outfalls | Unusual Conditions | Totals |
| 4 | 1 | 3 | 3 | 4 | *15* |

| Length of Inadequate Buffer (ft) | # of Truckloads for Trash Dumping Sites |
|---|---|
| 1,612 | 3 |

*Illicit Discharges*

Saltpeter Creek does not contain any rated outfalls. 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 dry detention pond assessments were conducted in Saltpeter Creek.

*Shoreline Restoration*

Saltpeter Creek has 10.68 miles of shoreline of which 30% (35.0 acres) of the 100-foot shoreline buffer is classified as open, pervious area. One (1) shoreline enhancement project was identified in EPS's Shoreline Enhancement Feasibility Study (EPS 1998). ). Segment I of the Dundee Saltpeter Park shoreline restoration was found to have only low potential for habitat enhancement as was dropped from further consideration. Planting of the open pervious shoreline buffer in Saltpeter Creek is recommended.

*Subwatershed Management Strategy*

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

1. Conduct appropriate downspout disconnection measures in neighborhoods according to Table 4-83 and educate citizens on the benefits of rain barrels and rain gardens.
2. Engage citizens in a storm drain marking program and conduct marking activities in the neighborhoods indicated in Table 4-83.
3. Increase tree canopies on private lots by educating citizens on the benefits of trees and about programs such as The Growing Home Campaign in the neighborhoods indicated in Table 4-83.
4. Educate citizens about the benefits and importance of proper lawn care, bayscaping, and pet waste management in the neighborhoods indicated in Table 4-83.

5. Educate residents of NSA_F_52 about the importance of stream buffers and encourage more environmentally friendly stream treatments.
6. Engage residents in NSA_F_47 and NSA_F_52 for participation in possible tree planting events.
7. Engage institutions in tree plantings at the institutional sites list in Table 4-85.
8. Educate institutions indicated in Table 4-85 on nutrient management, trash management, and improvement of buffer areas.
9. Engage institutions to participate in storm drain marking at ISI_F_1203, ISI_F_1204, and ISI_F_1206.

Municipal Actions

1. Perform maintenance on the existing stormwater pond in NSA_F_53.
2. Provide education to hotspots indicated in Table 4-84 and similar facilities on proper methods for vehicle operations, storage of outdoor materials, waste management, physical plant maintenance, turf/landscape maintenance, and storm system maintenance.
3. Investigate the potential for installation of stormwater retrofits and conduct programs with institutions to provide education and install retrofits at the facilities in Table 4-85.
4. Investigate the potential for impervious cover removal at ISI_F_1204
5. Investigate the potential for tree planting at PAA_F_1201.
6. Investigate the opportunity for stream restoration projects in Saltpeter Creek.
7. Identify open pervious shoreline areas in Saltpeter Creek for the potential for reforestation and preservation.

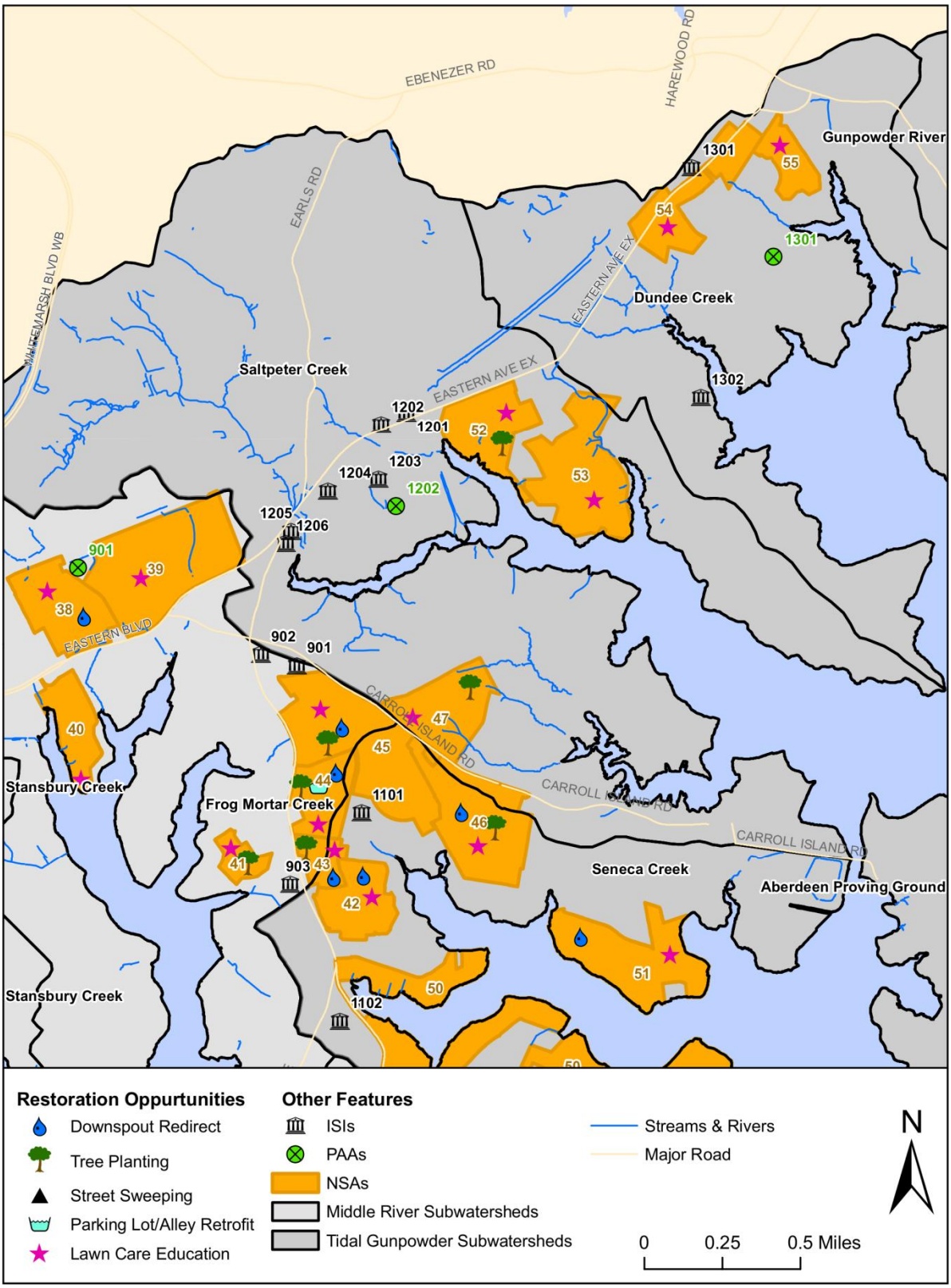


Figure 4-57: Restoration Opportunities in Saltpeter Creek

### 4.3.15 Seneca Creek

Seneca Creek is the fifth largest subwatershed in the Middle River and Tidal Gunpowder watersheds. 46% of the subwatershed is used for residential purposes while another 40% is classified as forest or wetland/water uses. In addition, there are commercial, industrial, institutional, and agricultural uses in Seneca Creek. Table 4-89 summarizes key subwatershed characteristics of Seneca Creek.

Table 4-89: Key Subwatershed Characteristics - Seneca Creek

| | | |
|---|---|---|
| Drainage Area | 1,007.2 acres (1.57 sq. mi.) | |
| Stream Length | 1.06 miles | |
| Coastline Length | 11.32 miles | |
| Population | 3,278 (2000 Census)<br>3.25 people/acre | |
| Land Use/Land Cover | Very Low Density Residential:<br>Low Density Residential:<br>Medium Density Residential:<br>High Density Residential:<br>Commercial:<br>Industrial:<br>Institutional:<br>Extractive:<br>Open Urban:<br>Forest:<br>Agriculture:<br>Water/Wetlands:<br>Transportation | 1.0%<br>6.4%<br>32.4%<br>6.0%<br>3.3%<br>4.5%<br>2.4%<br>0.0%<br>0.0%<br>33.7%<br>3.7%<br>6.5%<br>0.0% |
| Impervious Cover | 16% of subwatershed | |
| Soils | A Soils (low runoff potential):<br>B Soils:<br>C Soils:<br>D Soils (high runoff potential): | 19.1%<br>19.9%<br>45.5%<br>15.2% |
| SWM Facilities | 7% of urban land use treated | |
| Priority Rating | Medium | |

*Neighborhoods*

A total of four (4) distinct neighborhoods were identified and assessed within Seneca Creek during the uplands assessment of Middle River and Tidal Gunpowder. Recommendations for addressing stormwater volume and pollutants within this subwatershed include downspout disconnection, storm drain marking, buffer improvement, tree planting, and public education (i.e., bayscaping, increasing lot tree canopy, lawn care, trash management, and pet waste management). A summary of neighborhood recommended actions is presented in Table 4-90.

Table 4-90: NSA Recommendations – Seneca Creek

| | | | RECOMMENDED ACTIONS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NSA_ID | Lot Size (acres) | % Opportunity for Downspout Disconnection | Rain Barrels | Rain Gardens | Storm Drain Stencils | Bayscape | Increase Lot Canopy | Fertilizer Reduction | Pet Waste | Trash Management | Buffer Improvement | # of Street Trees | Notes |
| NSA_F_42 | <1/4 | 20% | X | | X | | X | X | | | | | Pond maintenance: Remove invasives and pick up trash |
| NSA_F_46 | <1/8 | 30% | X | | X | | X | X | | | | 32 | Pond maintenance |
| NSA_F_50 | 1/4 | 25% | X | X | X | X | X | | X | X | X | | Improve unstabilized driveways; Education on outdoor storage, old cars, and boats; Livestock pasture with manure |
| NSA_F_51 | 1/4 | 20% | X | X | X | X | X | X | | X | X | | Stabilize dirt and gravel driveways; Boat and car maintenance education |

All of the neighborhoods assessed in Seneca Creek are recommended for storm drain stenciling and increasing lot canopy on the site. At NSA_F_42, education of residents on proper lawn care management is recommended due to the presence of high maintenance lawns on 80% of the neighborhood's turf grass. In addition, the existing pond is recommended for maintenance because of the high presence of invasive species. Pond maintenance, and lawn care education is also recommended at NSA_F_46, in addition to street tree planting and downspout disconnection opportunities.

Figure 4-58: High Maintenance Lawns at HSI_F_42 (left) and HSI_F_46 (right)

At NSA_F_50 and 51, education on bayscaping, trash management, outdoor storage, and increasing buffers is proposed. In addition, a number of unstable driveways that could be improved were seen on the site. At NSA_F_50, a livestock pasture with manure is contained within the neighborhood. NSA_F_51 was also recommended for education on boat and car maintenance.

*Hotspots*

No hotspots were assessed in Seneca Creek.

*Institutions*

Two (2) institutional sites were assessed for retrofit opportunities in Seneca Creek during the uplands assessment of Middle River and Tidal Gunpowder. They include (1) public school and one (1) public fire station. Table 4-91 summarizes recommendations for the institutional sites assessed in Seneca Creek.

Table 4-91: ISI Recommendations – Seneca Creek

| | | | RECOMMENDATIONS | | | | | |
|---|---|---|---|---|---|---|---|---|
| Site ID | Name | Public/ Private | Nutrient Management | # of Trees Recommended for Planting | Stormwater Retrofit | Trash Management | Storm Drain Marking | Notes |
| ISI_F_1101 | Seneca Elementary School | Public | X | 60 | X | X | X | Bare ground; Remove gutter; Trash along woods |
| ISI_F_1102 | Bowleys Quarters Volunteer Fire & Rescue Station 210 | Public | | 5 | | | | Permeable pavement; Adjacent to Chesapeake Bay Protection Area |

At ISI_F_1101, a public elementary school, education on nutrient and trash management on the site is recommended. In addition, there are opportunities for teachers and students to participate in tree planting and storm drain marking. One stormwater retrofit site was identified where a concrete channel surrounding a tennis and basketball court is currently collecting runoff. This concrete channel could be converted to a vegetated channel to provide water quality treatment. A large area of bare soil was seen on the site that should be planted as seen in Figure 4-59.

Figure 4-59: Bare Soil at ISI_F_1101

ISI_F_1102 is a 4.5 acre site located adjacent to the Chesapeake Bay Protection Area. Mostly forested, limit shade tree planting opportunities were noted at the site. The site does contain a large parking lot that could be replaced with permeable pavement to reduce runoff volumes from the site.

*Pervious Areas*

One (1) pervious area, Miami Beach Park, was assessed for restoration potential in Seneca Creek. A summary is provided in Table 4-92.

Table 4-92: PAA Descriptions – Seneca Creek

| Site ID | Location | Description | Site Size (acres) | Ownership |
|---|---|---|---|---|
| PAA_F_1101 | Miami Beach Road | Miami Beach Park | 59.56 | Public |

Publicly owned, PAA_F_1201 consists of 83 acres of park area predominately covered in forest and wetland vegetation with 15% turf coverage. It is a potential candidate for reforestation with minimal site preparation and a community tree planting project; however, reforestation should consider existing uses of the site. A stormwater retrofit to treat runoff from the small impervious parking area was also noted.

Figure 4-60: Reforestation (left) and Stormwater Retrofit (right) Opportunities at PAA_F_1101

*Marinas*

Two (2) marina facilities were assessed during the uplands assessment of Seneca Creek. Characteristics for these can be found in Table 4-93.

Table 4-93: Marina Recommendations – Seneca Creek

| Site ID | Type | Clean Marina | Maintenance/ Repair | Petroleum | Sewage | Waste Management | Marina Management | Stormwater Management | Turf | TotalScore | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MAR_F_1101 | Marina/ Boatyard | Y | 80 | 100 | 100 | 60 | 100 | 75 | 0 | 80 | Improve wash area - deeper pit or better contained area; Recycles shrink-wrap, not solid waste; No sandblasting, only baking soda blasting |
| MAR_F_1102 | Marina | N | 100 | 25 | 67 | 50 | 33 | 20 | 67 | 44 | Planted 9 trees in 2010 and rocked shoreline. Future development possible. No power washing or painting allowed. Fuel pump on dock, not covered. Septic pump-out out-of-order. |

MAR_F_1101 is a certified Clean Marina since 2010. Recommendations for this marina are to improve the existing wash pit to prevent polluted water from entering Seneca Creek.

MAR_F_1102 is a marina facility that has recently conducted tree planting and shoreline stabilization through placement of rip rap. The marina has plans for development adjacent to the existing building. It is recommended that the County work with this marina to ensure that water quality is not degraded through further development in Seneca Creek.

*Industrial Landowners*

One (1) large industrial landowner's property bisects a portion of Senca Creek: Constellation Energy. Information on this site can be found in Table 4-94.

Table 4-94: Industrial Landowners – Seneca Creek

| Site ID | Name | Acres |
|---|---|---|
| IND_F_1101 | Constellation Energy | 111 |

Constellation Energy occupies approximately 111 acres adjacent to Carroll Island Road in Bowleys Quarters. The coal-fired electric generating station overlaps portions of Seneca Creek and Saltpeter Creek subwatersheds and includes: two generating units which began operating in the early 1960s; coal storage yard; wastewater treatment plant (WWTP); power generation building and offices; a rail spur for coal delivery; and discharge canal with steel sheet pile. Discharges from the Constellation Energy facility must abide by regulations set forth in their individual NPDES permit. The plant has also installed a fish passage system for fish to be safely released if they enter the intake system. Inner and outer dikes have been installed around the coal pile to help control runoff from the storage yard. Runoff from the coal storage yard is also sent to the WWTP for solids removal and pH adjustment. Constellation Energy staff noted that they maintain a stormwater pollution prevention plan as well as a spill prevention and control plan for the site.

Constellation Energy also developed a stormwater management master plan in 2008 in anticipation of continual needs for construction activities within the Chesapeake Bay Critical Area. This plan includes impervious cover removal and buffer mitigation areas to offset impacts from proposed development. Nearly 6 acres of impervious cover removal has been proposed, which would be replaced by topsoil, trees, and vegetative plantings. Reforestation of a portion of this former oil tank storage site has already occurred. Tidal wetlands in the southwest portion of the site are within the Chesapeake Bay Critical Area and must be preserved.

The County will continue to work with Constellation Energy to track the amount of sediment removed from filter bags installed in on-site storm drains. In addition, impervious cover removal and buffer mitigation area should be included in pollutant load reductions as appropriate for the SWAP planning area. It is also important to ensure that tidal wetlands and areas within the critical area remain undisturbed.

*Stream Corridor Assessments*

Stream corridor assessments (SCAs) were not conducted in Seneca Creek. Streams within this subwatershed are mostly tidal, marshy areas and not appropriate for a walking field survey utilizing Maryland DNR's SCA Survey Protocols. Therefore, no stream restoration opportunities have been identified in Seneca Creek.

*Illicit Discharges*

Seneca Creek does not contain any outfalls rated as priority 1 or priority 2. 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 dry detention pond assessments were conducted in Seneca Creek.

*Shoreline Restoration*

Seneca Creek has 11.32 miles of shoreline of which 69% (88.5 acres) of the 100-foot shoreline buffer is classified as open, pervious area. No shoreline enhancement projects were identified in EPS's Shoreline Enhancement Feasibility Study (EPS 1998). Planting of the open pervious shoreline buffer in Seneca Creek is recommended.

*Subwatershed Management Strategy*

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

1. Conduct appropriate downspout disconnection measures in neighborhoods according to Table 4-89 and educate citizens on the benefits of rain barrels and rain gardens.
2. Engage citizens in a storm drain marking program and conduct marking activities in the neighborhoods indicated in Table 4-90.
3. Increase tree canopies on private lots by educating citizens on the benefits of trees and about programs such as The Growing Home Campaign in the neighborhoods indicated in Table 4-90.

4. Educate citizens about the benefits and importance of proper lawn care, bayscaping, trash management and pet waste management in the neighborhoods indicated in Table 4-90.
5. Educate residents of NSA_F_50 and NSA_F_51 about the importance of stream buffers and encourage more environmentally friendly stream treatments.
6. Engage residents in NSA_F_46 for participation in possible tree planting events.
7. Engage institutions in tree plantings at the institutional sites list in Table 4-91.
8. Educate institutions indicated in Table 4-91 on nutrient management, trash management, and improvement of buffer areas.
9. Engage students and teachers to participate in tree planting and storm drain marking at ISI_F_1101.

Municipal Actions

1. Perform maintenance on the existing stormwater pond in NSA_F_42 and NSA_F_46.
2. Investigate the potential for installation of stormwater retrofits and conduct programs with teachers and students to provide education and install retrofits at ISI_F_1101.
3. Investigate the potential for permeable pavement installation at ISI_F_1102.
4. Investigate the potential for tree planting and stormwater retrofit at PAA_F_1101.
5. Encourage MAR_F_1102 to obtain a Clean Marina certification.
6. Identify open pervious shoreline areas in Seneca Creek for the potential for reforestation and preservation.

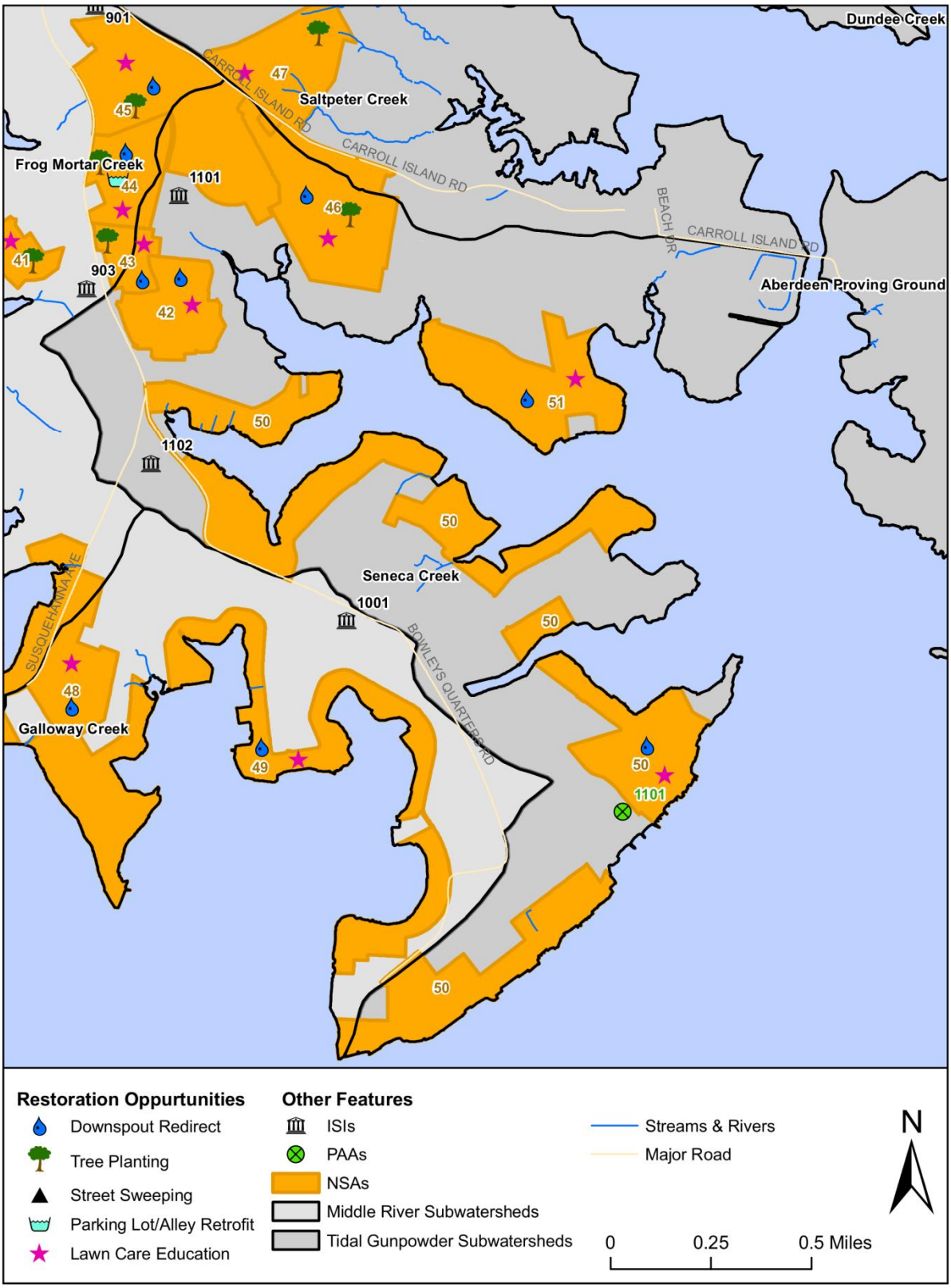


Figure 4-61: Restoration Opportunities in Seneca Creek

## 4.4 Stormwater Retrofit Opportunities

Because multiple stormwater retrofit opportunities were identified through the SWAP study area, Table 4-95 provides a summary of the subwatershed location and assessment category of each.

Table 4-95: Stormwater Retrofit Subwatersheds and Assessment Category

| SUBWATERSHED | NSAs | PAAs | ISIs |
|---|---|---|---|
| Darkhead Creek | | | ISI_F_704 |
| Frog Mortar Creek | NSA_F_44 | | ISI_F_902, ISI_F_903 |
| Galloway Creek | | | |
| Browns Cove | | | |
| Hogpen Creek | | | ISI_F_201 |
| Hopkins Creek | NSA_F_15, NSA_F_16 | | ISI_F_403, ISI_F_501, ISI_F_502, ISI_F_504, ISI_F_505 |
| Middle River | NSA_F_23, NSA_F_26 | | ISI_F_602, ISI_F_603, ISI_F_703 |
| Norman Creek | | | ISI_F_403 |
| Stansbury Creek | | | |
| Sue Creek | | | ISI_F_201 |
| Aberdeen Proving Ground | | | |
| Dundee Creek | | | ISI_F_1301 |
| Gunpowder River | | PAA_F_1401 | |
| Saltpeter Creek | | | ISI_F_1203, ISI_F_1204, ISI_F_1205, ISI_F_1206 |
| Seneca Creek | NSA_F_44 | PAA_F_1101 | ISI_F_1101 |

## 4.5 Preservation

In addition to the various opportunities laid out in the subwatershed strategies, the preservation of non-urban land uses is vital to protecting buffers and maintaining the high water quality in the Middle River and Tidal Gunpowder watershed. Table 4-96 provides a summary of each subwatershed's potential for land preservation by displaying the percent of forested land in each subwatershed, the percentage of forested stream and shore buffer, and the percentage of each subwatershed that is classified as agricultural.

Table 4-96: Land Preservation Opportunities in Middle River and Tidal Gunpowder

| Subwatershed | % Forested | % of Stream Buffer Forested | % of Shore Buffer Forested | % Agricultural Land |
|---|---|---|---|---|
| Darkhead Creek | 23.9% | 38.8% | 14.0% | 0.4% |
| Frog Mortar Creek | 19.8% | 29.8% | 18.0% | 0.8% |
| Galloway Creek | 27.1% | 55.9% | 9.0% | 17.0% |
| Browns Cove | 41.1% | 77.5% | 23.2% | 24.8% |
| Hogpen Creek | 42.7% | 72.6% | 32.0% | 0.0% |
| Hopkins Creek | 13.5% | 35.3% | 14.8% | 0.0% |
| Middle River | 10.2% | 36.1% | 13.3% | 0.0% |
| Norman Creek | 34.0% | 63.6% | 18.4% | 0.0% |
| Stansbury Creek | 15.6% | 30.0% | 25.8% | 0.0% |
| Sue Creek | 43.9% | 72.9% | 23.0% | 2.5% |
| *Middle River Subtotal* | *26.3%* | *47.3%* | *19.5%* | *3.9%* |
| | | | | |
| Aberdeen Proving Ground | 55.4% | 3.5% | 9.4% | 0.0% |
| Dundee Creek | 31.9% | 49.2% | 22.1% | 13.9% |
| Gunpowder River | 29.1% | 21.9% | 5.3% | 0.3% |
| Saltpeter Creek | 45.0% | 67.4% | 30.3% | 4.6% |
| Seneca Creek | 33.7% | 20.4% | 14.0% | 3.7% |
| *Tidal Gunpowder Subtotal* | *39.3%* | *48.6%* | *16.4%* | *4.3%* |
| | | | | |
| *Total* | *32.5%* | *48.0%* | *18.0%* | *4.1%* |

In the Middle River watershed, Browns Cove, Hogpen Creek, and Sue Creek have the highest percentage of forested land. In addition, these three subwatersheds contain the highest percentage of forested stream buffer. As a whole, the Tidal Gunpowder has a higher percentage of forested land than Middle River, with Aberdeen Proving Ground possessing the highest percentage. Saltpeter Creek has the 2nd highest percentage of forested land within the Tidal Gunpowder watershed along with the highest percentages of forested stream and shoreline buffer. Galloway Creek, Browns Cove, and Dundee Creek have the highest percentage of agricultural lands. Preservation efforts should be focused on maintaining the maximum amount of quality forested areas within both watersheds and to preserving and increasing the amount of forested stream and shoreline buffers.

## 4.6 Tidal Basin Strategies

Some of the action strategies described in Chapter 3 and Appendix A apply to tidal areas of the watershed and were not be included under specific subwatershed management strategies. Tidal basin strategies are intended to benefit the watershed as a whole in order to be effective and help achieve restoration goals and objectives. One tidal basin strategy includes marking and maintaining navigation channels in Middle River and Tidal Gunpowder to help keep a balance between encouraging recreational boat use and submerged aquatic vegetation (SAV) growth.

## 4.7 Watershed-Wide Strategies

Some of the action strategies described in Chapter 3 and Appendix A apply to the entire watershed and were not included under 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.

*Municipal Strategies:* One example of a municipal action is developing and implementing trash and recycling campaigns for the watershed. Trash-related water quality concerns were observed throughout the watershed and therefore, this action is recommended for all subwatersheds. This may also involve the development of a trash treaty to engage institutions, neighborhoods, and patrons of public properties throughout the watershed by raising awareness and seeking support to address the trash problem. Examples of other municipal, watershed-based actions include the promotion of advertisements of the Clean Marina Initiative and Clean Boater program. Because all of the subwatersheds in the study have tidal shoreline, most with residential boat docks if not commercial marinas, clean boating practices is a study-wide issue.

*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 Middle River and Tidal Gunpowder and be effective at meeting water quality goals and objectives. Examples of watershed-wide citizen actions include conducting tours of completed water quality BMP and shoreline enhancement projects and encouraging safe and recreational public access through water trail tours and/or brochures.

# CHAPTER 5: PLAN EVALUATION

## 5.1 Introduction

The Middle River and Tidal Gunpowder SWAP is based on an implementation schedule with an anticipated endpoint of 2020 and an intermediate milestone of 2017. This timeframe is necessary to implement restoration measures and meet the Chesapeake Bay TMDL. The ability to implement this plan within the specified timeframe is dependent upon the availability of staff and sufficient funding. The Middle River and Tidal Gunpowder 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, completed projects will be recorded in the County's annual NPDES report. An adaptive management approach will be used to meet watershed goals and objectives based on SWAP evaluation data. The Middle River and Tidal Gunpowder SWAP Implementation Committee will initiate a revision of the plan within six months if additional TMDLs are developed and approved or when a water quality issue arises.

Progress and success of the Middle River and Tidal Gunpowder 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. The progress and success of actions in Appendix A will be evaluated every year. 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 a semiannual 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 approved by the Chesapeake Bay Program (CBP) for various nonpoint source BMPs. For actions not covered in CBP, reduction rates from the Maryland *Accounting for Stormwater Wasteload Allocations and Impervious Areas* draft document were used. These pollutant removal efficiencies will continue to be used to measure progress in meeting the nutrient TMDL reduction goal (See Table 1-1). CBP-approved BMP removal efficiencies are summarized in the tables included in Appendix C. Actions and associated pollutant load reductions will be reevaluated if CBP revises or updates pollutant removal efficiencies within the 10-year timeframe to ensure that the nutrient TMDL reductions are met.

## 5.4 Implementation Tracking

Implementation of restoration actions for the Middle River/Tidal Gunpowder SWAP will be overseen by the Implementation Committee (an outgrowth of the Steering Committee). The committee will assess progress with individual actions related to the amount complete and the ease of implementation. Overall progress with meeting pollutant reductions will also be assessed. 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. If additional water quality issues arise, the Area F SWAP implementation committee will initiate revisions of the plan.

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

## 5.5 Monitoring

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

*Existing Monitoring*

Baltimore County conducts chemical, biological, and illicit connection monitoring within the Middle River and Tidal Gunpowder watershed. These are described in detail in Chapter 3.4 of the *Watershed Characterization Report* (Appendix D) and listed below:

- County Recreational Water Sampling Program - 4 sampling locations in Middle River and Tidal Gunpowder to measure levels of bacteria, suspended solids, nutrients, metals, toxics, and chloride

- Upper Western Shore Basin Tributary Strategy Data – 2 long-term water monitoring stations and four continuous monitoring stations in the tidal waters of Middle River and Gunpowder River to measure levels of nutrients, algal abundance, suspended solids, water clarity, dissolved oxygen, turbidity, fluorescence, water temperature, salinity, and pH.

- SAV Monitoring – Baltimore County conducts annual SAV surveys measuring SAV distribution, density, and species to calculate overall SAV coverage in Middle River and Tidal Gunpowder.

- Illicit Discharge Detection and Elimination Program – Routine outfall screening and prioritization system to track and reduce illicit connections and discharges

*SWAP Implementation Monitoring*

SWAP implementation monitoring activities will focus on project specific monitoring and targeted subwatershed monitoring. Project specific monitoring will be indentified 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 bayscaping 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. There is potential to coordinate a citizen-based stream watch program since existing water quality monitoring stations are limited in non-tidal portions of the Middle River and Tidal Gunpowder watershed. Monitoring activities will be coordinated among SWAP participants through participation in the Middle River and Tidal Gunpowder SWAP Implementation Committee.

# CHAPTER 6: REFERENCES

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# APPENDIX A:

## Middle River and Tidal Gunpowder Action Strategies

# Middle River and Tidal Gunpowder Action Strategies

This appendix presents the actions related to the goals and objectives presented in Chapter 2 of the Middle River and Tidal Gunpowder 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. Table A-2 indicates the goals and objectives targeted for each action. Some of the key columns included in Table A-1 are briefly described below.

*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
  - Tidal Waters
  - 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*

As part of the Chesapeake Bay TMDL, jurisdictions are required to track progress on 2 year intervals. To help facilitate this process, the proposed action items for this SWAP have been divided into columns representing the 2 year intervals. These columns denote 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).

*Responsible Party*

Those responsible for ensuring the success/completion of a given action are denoted by a numeric code in this column. Responsible parties are indicated by numerals as follows:

1. Baltimore County
2. Gunpowder Valley Conservancy
3. Essex-Middle River Civic Council
4. Bowley's Quarter Improvement Association
5. Baltimore County Marine Trade Assocation
6. Lockheed Martin
7. Martin State Airport
8. Maryland Air National Guard
9. Constellation
10. LaFarge
11. Aberdeen Proving Ground
12. SWAP Implementation Committee

# Table A-2: Middle River and Tidal Gunpowder Action Strategies – Goal Objective Matrix

| | Action | Basis for Performance Measure | Performance Measure | Total Number Units | Period 1 7/11-6/13 | Period 2 7/13-6/15 | Period 3 7/15-6/17 | Period 4 7/17-6/19 | Period 5 7/19-6/20 | Unit Cost | Respons. Party* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **RESTORATION ACTIONS** | | | | | | | | | | | |
| | ***Nutrient Reduction*** | | | | | | | | | | |
| 1 | Reduce lawns and plant bayscapes in the 32 neighborhoods identified. | Conduct 8 bayscaping education events targeting 4 neighborhoods per event (223.8 acres of lawn identified for bayscaping x 5% participation rate = 11 acres) | 5% participation x 223.8 acres | 8 events | 2 events | 3 events | 3 events | | | $500 / event | 1, 2, 3, 4 |
| 2 | Continue municipal road maintenance street sweeping activities. Investigate the 10 neighborhoods recommended for street sweeping to implement activities and/or adjust frequency as needed. | 31.5 miles of road within neighborhoods identified for street sweeping | 100% participation x 31.5 miles | 11.2 miles | 11.2 miles | 11.2 miles | 11.2 miles | 11.2 miles | 11.2 miles | Existing Staff | 1 |
| | ***Stormwater Management*** | | | | | | | | | | |
| 3 | Investigate the potential of the 3 existing dry detention ponds for enhanced water quality treatment. | 3 out of 9 existing detention ponds identified as having physical expansion capability x assume 100% projected participation = 3 conversions | 9 conversions x 33% participation | 3 conversion | | 1 conversion | 1 conversion | 1 conversion | | $3,200 / acre | 1 |
| 4 | Investigate the feasibility of implementing stormwater retrofits to treat runoff from impervious surfaces (parking lots, alleys) in the 5 neighborhoods identified. | 5 potential neighborhood sites identified | 4 neighborhoods investigated | 2 investigations | 2 investigations | 3 investigations | | | | Existing Staff | 1 |
| 5 | Investigate the feasibility of implementing stormwater retrofits for parking lots and/or inlets at the 18 institutional sites identified (12 public, 6 private). | 18 potential institution sites identified | 18 institutions investigated | 6 investigations | 6 investigations | 12 investigations | | | | Existing Staff | 1 |
| 6 | Design and implement stormwater retrofits at feasible sites identified in Actions 5 and 6. | 5 neighborhoods + 18 institutions = 22 sites identified x 50% participation rate = 11 stormwater retrofits | 50% participation x 22 retrofit sites | 11 sites | | 3 sites | 3 sites | 3 sites | 2 sites | $50,000 / retrofit | 1 |
| 7 | Work with institutional partners to reduce impervious cover at the 5 institutional sites identified (4 public schools, 1 other public). | Maximum potential of 0.4 acres of impervious cover removal identified x 50% participation rate; Work with institutions to remove impervious cover and meet 0.2 acres reduction goal | 50% participation x 0.4 acres | 0.2 acres | | 0.1 acres | 0.1 acres | | | $25,000 / acre | 1, 2, 3, 4, 12 |
| 8 | Work with industrial partners to reduce impervious cover at the 6 industrial sites identified. | Conduct annual meetings with industrial site owners to discuss feasibility of impervious cover removal | 1 industrial facility meeting per year | | 1 meetings | 2 meetings | 2 meetings | 2 meetings | 1 meetings | Existing Staff | 1, 6, 7, 8, 9, 10, 11 |
| 9 | Develop and implement a downspout disconnection program. Use rainbarrels, rain gardens, and/or redirection for downspout disconnection in the 44 recommended neighborhoods. | 106 acres of impervious rooftop identified x 55% participation rate = 60 acres | 55% participation x 106 acres | 58.5 acres | 7.3 acres | 14.6 acres | 14.6 acres | 14.6 acres | 7.3 acres | $150 / house | 1, 2, 3, 4, 12 |
| 10 | Inspect and maintain stormwater conversions and retrofits. | 3 conversions + 11 retrofits = 14 projects | 3 site inspections per year after installation | | | | 3 inspections | 3 inspections | 3 inspections | Existing Staff | 1, 2, 3, 4, 12 |
| | ***Urban Tree Canopy*** | | | | | | | | | | |
| 11 | Investigate the feasibility of planting riparian stream buffers on open pervious land. | 317 acres of open pervious land identified within the 100-foot stream buffer through GIS analysis. | Feasible buffer planting sites identified | | 155 acres investigated | 162 acres investigated | | | | Existing Staff | 1 |
| 12 | Investigate the feasibility of planting riparian shoreline buffers on open pervious land. | 641 acres of open pervious land identified within the 100-foot shoreline buffer through GIS analysis. | Feasible buffer planting sites identified | | 320 acres investigated | 321 acres investigated | | | | Existing Staff | 1 |
| 13 | Reforest stream buffer at feasbile sites with a minimum width of 35 feet. | 317 acres of open pervious stream buffer identified in the GIS analysis x 35% participation rate =111 acres | 35% participation x 317 acres | 111.0 acres | | 31.7 acres | 31.7 acres | 31.7 acres | 15.9 acres | $15,000 / acre | 1, 2, 3, 4, 12 |
| 14 | Reforest shoreline buffer at feasbile sites with a minimum width of 35 feet. | 641 acres of open pervious shoreline buffer identified in the GIS analysis x 35% participation rate = 224 acres | 35% participation x 641 acres | 224.2 acres | | 64.1 acres | 64.1 acres | 64.1 acres | 32.0 acres | $15,000 / acre | 1, 2, 3, 4, 12 |
| 15 | Plant trees on PAA sites, focusing efforts on sites identified as mostly open pervious cover type and requiring minimal site preparation. (This includes working with MD SHA to plant trees in suitable medians and rights-of-way.) | 72 acres of PAA sites with open pervious cover & minimal site prep required x 50% participation rate = 36 acres | 50% participation x 72 acres | 34.7 acres | | 9.9 acres | 9.9 acres | 9.9 acres | 5.0 acres | $6,000 / acre | 2 |
| 16 | Encourage street and shade tree planting in the 24 recommended neighborhoods. | Maximum potential of 4,931 trees x (1 acre/400 trees) = 12.3 acres x 40% participation rate = 4.92 acres (or 1,972 trees) | 40% participation x 4,931 trees | 1972 trees | | 563 trees | 563 trees | 563 trees | 283 trees | $175 / tree | 2 |
| 17 | Encourage institutions to plant trees on available open space at the 31 sites identified. | Maximum potential of 2,365 trees x (1 acre/400 trees) = 5.9 acres x 40% participation rate = 2.37 acres (or 946 trees) | 40% participation x 2,365 trees | 946 trees | | 270 trees | 270 trees | 270 trees | 136 trees | $175 / tree | 1, 2, 3, 4, 12 |
| 18 | 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 | Acres preserved | | | On-going | On-going | On-going | On-going | Existing Staff | 1 |
| 19 | 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/planted: 206+385+36+5.4+4.7 = 637 acres (max 1,048 acres) | Maintain 637 acres | | | Maintain | Maintain | Maintain | Maintain | $1,300 / acre | 1, 2, 3, 4, 12 |
| 20 | Improve forest health by removing exotic invasive species. | Remove 1 acres of exotic species per year | Remove 8 acres of exotic species | 8 | 1.0 acres | 2.0 acres | 2.0 acres | 2.0 acres | 1.0 acres | | 2 |
| 21 | Continue revitalization and redevelopment of Baltimore County Communities incorporating an increase of parkland. Develop a track system and track associated load reductions | 829 acres of redevelopment opportunity identified | Redevelop 50% of 829 acres of urban area | 415.0 acres | 0.0 acres | 118.0 acres | 118.0 acres | 118.0 acres | 61.0 acres | | |
| | ***Trash Management*** | | | | | | | | | | |
| 22 | Post no dumping signs in problem areas identified and enforce no dumping. | Signs posted; Upland sites identified with trash management/dumping issues: 22 neighborhoods + 11 hotspots + 15 institutions = 48 sites | Post 20% of signs per year | 48 signs | 10 signs | 19 signs | 19 signs | | | $40 / sign | 1 |
| 23 | Identify areas where additional trash cans, covered receptacles, and/or better maintenance measures are needed. | Assess bus stops and community parks in the watershed. | Problem areas identified and addressed | | Identify | Identify | | | | Existing Staff | 1 |
| 24 | Implement recycling and add separate receptacles for recycling on public properties such as parks. | Implement recycling in County parks | Address community parks | | | Implement | Implement | | | Existing Staff | 1 |
| | ***Tidal Waters*** | | | | | | | | | | |
| 25 | Install and maintain navigation channel markers to prevent encroachment from boats into SAV and habitat areas. | Continue to support marked channels | Channel markers maintained | | On-going | On-going | On-going | On-going | On-going | Existing Staff | 1 |
| 26 | Evaluate potential locations for wetland creation and enhancement throughout the watershed. | Identify feasible tidal areas and plant species (at LaFarge and APG) | Feasible planting sites identified | | Identify | Identify | | | | Existing Staff | 1 |

Responsible Parties:

1. Baltimore County
2. GVC
3. EMRCC
4. BQIA
5. BCMTA
6. Lockheed Martin
7. MSA
8. MANG
9. Constellation
10. LaFarge
11. APG
12. SWAP Implementation Committee

Table A-2: Middle River and Tidal Gunpowder Action Strategies – Goal Objective Matrix

| | Action | Basis for Performance Measure | Performance Measure | Total Number Units | Period 1 7/11-6/13 | Period 2 7/13-6/15 | Period 3 7/15-6/17 | Period 4 7/17-6/19 | Period 5 7/19-6/20 | Unit Cost | Respons. Party* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 27 | Implement wetland plantings at feasible sites. | Work with LaFarge and APG to conduct wetland plantings at feasible sites. | Planting at feasible sites | | | | | | | | 1, 6, 7, 8, 9, 10, 11 |
| 28 | Evaluate shoreline enhancement project potential of the 1 site identified in Middle River as part of DEPRM's Shoreline Feasibility Study. | 1 potential shoreline enhancement site identified in the Shoreline Feasibility Study | Feasible shoreline sites identified | Assess site | | | | | | Existing Staff | 1 |
| 29 | Implement shoreline enhancement projects at feasible sites. | Maximum potential of 2,500 feet of shoreline restoration at Darkhead Creek Park; Complete 1 shoreline enhancement projects | 100% participation x 2,500 LF | 2500 LF | | | 833 LF | 833 LF | 833 LF | $1,000,000 / project | 1 |
| 30 | Reevaluate recreational water quality monitoring sites. | Water quality monitoring by Baltimore County was reduced in 2010. Community is requesting that it be started again | | | Monitor | Monitor | Monitor | Monitor | Monitor | Existing Staff | 1 |
| | ***Stream Corridor Restoration*** | | | | | | | | | | |
| 31 | Evaluate the restoration potential and feasibility of restoring eroded stream banks and channel alterations identified in the stream corridor assessments. | 132 LF (1% of 2.7 mile surveyed channel length) identified in SCA. | Feasible restoration sites identified | | | Assess | | | | Existing Staff | 1 |
| 32 | Complete stream restoration projects at feasible sites. | 1,125 LF of stream restoration potential x 75% participation rate = 843 LF of stream restoration to be completed | 75% particpation x 1,125 LF of stream | 843 LF | 0 LF | 0 LF | 169 LF | 337 LF | 337 LF | Existing Staff | 1 |
| 33 | Remove fish blockages, restore and protect portions of the stream network and riparian habitats such that natural biological conditions can support diverse aquatic communities, as can be monitored and assessed by fish and invertebrate community structure and function. | Remove 1 of the 3 fish barriers found | 1 fish barrier removed | 3 barriers | | | | 1 barrier | | | 2 |
| | ***Land Preservation*** | | | | | | | | | | |
| 34 | Identify lands available for permanent conservation and preservation. | Develop a catalog of lands within the 100-foot stream and shoreline buffers available to permanent conservation and preservation. | Available land identified | Ongoing | Ongoing | Ongoing | Ongoing | Ongoing | Ongoing | Existing Staff | 1 |
| 35 | Work with private property owners to undertake perpetual land conservation easements on currently undeveloped properties. | Identify and assist privately-owned properties within the 100-foot stream and shorline buffers move to permanent conservation and preservation | 10% of available land parcels conserved | Ongoing | Ongoing | Ongoing | Ongoing | Ongoing | Ongoing | | 1 |
| 36 | Acquire undeveloped parcels for permanent conservation and preservation | Identify forested parcels within the 100-foot stream and shorline buffers and facilitate perservation and conservation through agencies. | 10% of available land parcels conserved | Ongoing | Ongoing | Ongoing | Ongoing | Ongoing | Ongoing | | 1 |
| **OUTREACH & AWARENESS** | | | | | | | | | | | |
| 37 | Distribute pollution prevention information to facilities falling within hotspot categories and marinas 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. | 10 hotspot sites assessed; Categories identified: shopping centers, auto-related facilities, construction facilities, garden centers, and marinas; Conduct 2 workshops and distribute outreach material | 1 workshop every 3 years | 2 workshops | | 1 workshop | | 1 workshop | | $500 / workshop | 1, 2, 3, 4, 5, 12 |
| 38 | Distribute information to the public and to facilities near waterways on the benefits of living shorelines and SAVs. | Conduct SAV tour and distribute educational information. | Conduct tour | 1 tour | 1 tour | | | | | Existing Staff | 1, 5 |
| 39 | Locally recognize the 10 marinas that are certified Maryland Clean Marinas and encourage the remaining marinas to participate in the Clean Marina Initiative. | Advertise Clean Marina Initiative and participating marinas in local newspapers | 1 advertisement per year | 8 advertisement | 1 ad | 2 ads | 2 ads | 2 ads | 1 ad | $40/ad | 1, 5 |
| 40 | Increase citizen awareness of Clean Boater Pledge Program | Advertise Clean Boater Program in local newspapers | 1 advertisement per year | 8 advertisement | 1 ad | 2 ads | 2 ads | 2 ads | 1 ad | $40/ad | 1, 5 |
| 41 | Form partnerships with community groups and discuss the BMP recommendations from the neighborhood assessments and implementation options. | 59 neighborhoods assessed - target at least 3 neighborhoods per informational meeting | 2 neighborhood meetings per year | 16 meetings | 2 meetings | 4 meetings | 4 meetings | 4 meetings | 2 meetings | $500 / meeting | 1, 2, 3, 4, 12 |
| 42 | Form partnerships with institutions and discuss the BMP recommendations from the institutional assessments and implementation options. Include implementing/enhancing recycling programs on their properties. | 34 institutions assessed | 3-4 institution meetings per year | 24-32 meetings | 6-8 meetings | 9-12 meetings | 9-12 meetings | 9-12 meetings | 6-8 meetings | Existing Staff | 1, 2, 3, 4, 12 |
| 43 | Work with community groups to install storm drain markers in the 52 recommended neighborhoods. | Install markers in 52 neighborhoods identified | 5-6 neighborhoods per year | 52 sites | 5 sites | 14 sites | 14 sites | 14 sites | 5 sites | $11 / event (site) | 1, 2, 3, 4, 12 |
| 44 | Work with institutional sites to install storm drain markers at the 14 recommended sites. | Install markers at 14 institutions identified | 1-2 institutions per year | 14 sites | | 4 sites | 4 sites | 4 sites | 2 sites | $11 / event (site) | 1, 2, 3, 4, 12 |
| 45 | Develop and implement signs and educational material for the trash campaign in the watershed. | Develop signs and post throughout watershed; | Develop material, post signs | | Ongong | Ongong | Ongong | Ongong | Ongong | $9,000 / year | 1, 2, 3, 4, 12 |
| 46 | Develop a trash treaty for institutions, public properties and neighorhoods. | Develop signs and post throughout watershed | Develop material, post signs | | Ongong | Ongong | Ongong | Ongong | Ongong | Existing Staff | 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 |
| 47 | Encourage institional partners, community groups, and patrons of public properties to sign and support a trash treaty. | Have sign-up events | 1 sign-up event per year | 8 events | 1 event | 2 events | 2 events | 2 events | 1 event | Existing Staff | 1, 2, 3, 4, 12 |
| 48 | Encourage and support community cleanups in neighborhoods. | 22 neighborhoods identified as having trash management issues | 2-3 community cleanups per year | 18-27 cleanups | 2-3 cleanups | 4-6 cleanups | 4-6 cleanups | 4-6 cleanups | 4-6 cleanups | Existing Staff | 1, 2, 3, 4, 12 |
| 49 | Encourage and support waterway cleanups in streams and tidal areas. | Conduct an annual stream and tidal area cleanups. | 1 cleanup per year | 8 cleanups | 1 cleanups | 2 cleanups | 2 cleanups | 2 cleanups | 1 cleanups | | 1, 2, 3, 4, 12 |
| 50 | 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, shoreline enhancement project) | 1 tour per 5 years | 2 tours | | 1 tour | | 1 tour | | Existing Staff | 1 |

Responsible Parties:

1. Baltimore County
2. GVC
3. EMRCC
4. BQIA
5. BCMTA
6. Lockheed Martin
7. MSA
8. MANG
9. Constellation
10. LaFarge
11. APG
12. SWAP Implementation Committee

Table A-2: Middle River and Tidal Gunpowder Action Strategies – Goal Objective Matrix

| | Action | Basis for Performance Measure | Performance Measure | Total Number Units | Period 1 7/11-6/13 | Period 2 7/13-6/15 | Period 3 7/15-6/17 | Period 4 7/17-6/19 | Period 5 7/19-6/20 | Unit Cost | Respons. Party* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 51 | Develop and distribute a brochure advertising and encouraging public access points to Middle River and Tidal Gunpowder River. | Develop and distribute material; consider working with marinas to produce brochures & include marina locations/advertisements | Develop and distribute | | Ongong | Ongong | Ongong | Ongong | Ongong | Existing Staff | 1 |
| 52 | Develop and distribute public awareness materials that promote the use of public access to the Middle River and Tidal Gunpowder. | Develop and distribute material; work with marinas to produce materials and include marina locations. | 2 signs per year | 16 signs | 2 signs | 4 signs | 4 signs | 4 signs | 2 signs | Existing Staff | 1 |
| 53 | Support the completion of the Eastern Regional Trail to create access for pedestrians and cyclists. | Provide support to connections to the waterfront along the Eastern Regional Trail | Ongoing | Ongoing | Ongoing | Ongoing | Ongoing | Ongoing | Ongoing | Existing Staff | 1 |
| 54 | Address bootleg marinas | Identify sites and require proper zoning, removal of slips, and fines | Ongoing | Ongoing | Ongoing | Ongoing | Ongoing | Ongoing | Ongoing | Existing Staff | 1, 5 |
| 55 | Increase agency collaboration through in-house meetings | Conduct 4 meetings with Economic Development | 2 meetings per year | | 2 meetings | 2 meetings | | | | Existing Staff | 1 |
| 56 | Conduct water trail tours for community groups including description of public access points, navigation channel markings, shoreline/wetland enhancement project(s), etc. | Conduct annual educational tours | 1 tour per year | | 1 tour | 2 tours | 2 tours | 2 tours | 2 tours | Existing Staff | 1 |
| 57 | Increase signage to teach resident not to feed wild deer or geese. | Post signage in public parks | 2 signs per year | 18 signs | 2 signs | 4 signs | 4 signs | 4 signs | 4 signs | $40 / sign | 1 |
| 58 | Reduce geese population within the watershed | Perform exclusion and harassement techniques | | 10 years | | | | | | | 1 |
| **MONITORING** | | | | | | | | | | | |
| 59 | Continue to monitor and remove illicit connections through the Illicit Connections Program | Inspect all ninety-eight of the non-prioritized outfalls within four years and the eleven priority 1 or 2 outfalls according to their designated inspection schedule | routine inspections per year | Ongoing | Ongoing | Ongoing | Ongoing | Ongoing | Ongoing | Existing Staff | 1 |
| 60 | Implement a Stream Watch program, a citizen-based program to increase the ability to monitor/identify sources of water quality and habitat degradation. | Implement a program based on number of stream miles adopted by citizen groups | 39.2 miles of stream adopted | 39.2 miles of stream | 4.2 miles adopted | 9 miles adopted | 9 miles adopted | 9 miles adopted | 9 miles adopted | Existing Staff | 1, 2, 3, 4, 12 |
| 61 | Continue stormwater facility maintenance and inspection program | Assure continued function of Stormwater Facilities as required as part of the NPDES MS4 permit. | Continue routine inspections | Ongoing | Ongoing | Ongoing | Ongoing | Ongoing | Ongoing | Existing Staff | 1 |
| 62 | Continue to work with teachers to develop water quality monitoring activities for students at Baltimore County public schools. | Identify schools with potential opportunities for program implementation | Monitoring activities implemented | Ongoing | Ongoing | Ongoing | Ongoing | Ongoing | Ongoing | Existing Staff | 1, 2, 3, 4, 12 |
| 63 | Monitor SAV coverage in the watershed annually. | SAV coverage is monitored yearly and reports are produced quantifying % coverage in tidal waters | Yearly reports | Yearly | 1 report | 2 reports | 2 reports | 2 reports | 2 reports | Existing Staff | 1 |
| 64 | Monitor deer population in the watershed | White-tailed deer populations monitored yearly and biannual reports are produced by Maryland Department of Natural Resources | Biannual reports | 2 years | 1 report | 2 reports | 2 reports | 2 reports | 2 reports | Existing Staff | 1 |
| **FUNDING** | | | | | | | | | | | |
| 65 | Coordinate grant funding requests to secure funding and implement restoration projects to meet TMDL nutrient reductions requirements. | Seek a minimum of 1 grant per year to meet nutrient reduction goals within 10 years | 1 grant proposal per year | 8 proposals | 1 proposal | 2 proposals | 2 proposals | 2 proposals | 1 proposal | Existing Staff | 1, 2, 3, 4, 12 |
| 66 | Increase funding for the Baltimore County - Green Building Tax Credit Program as a model. | | | | | | | | | Existing Staff | 1, 2, 3, 4, 12 |
| 67 | Increase applications for the Maryland Department of Natural Resources Land Conservation Programs including Program Open Space, Rural Legacy, and Maryland Environmental Trust | Submit a minimum of 1 application per year | 1 application per year | 8 applications | 1 application | 2 applications | 2 applications | 2 applications | 1 application | Existing Staff | 1, 2, 3, 4, 12 |
| **REPORTING** | | | | | | | | | | | |
| 68 | Middle River and Tidal Gunpowder River SWAP Implementation Committee will meet to discuss implementation progress and assess any changes needed to meet the goals. | Conduct meetings in a semi-annual basis | 2 meetings per year | 16 meetings | 2 meetings | 4 meetings | 4 meetings | 4 meetings | 2 meetings | Existing Staff | 12 |
| 69 | Develop a unified restoration tracking system to track progress toward meeting TMDL reduction requirements. | Tracking system currently being developed for similar SWAPs (e.g., Back River, Jones Falls) | Tracking system developed | On-going | On-going | On-going | On-going | On-going | On-going | Existing Staff | 1, 12 |
| 70 | Update the status of citizen-based restoration projects and BMPs on an annual basis | Provide progress update in annual NPDES Report. | NPDES annual report | Annual Reports | 1 Annual Report | 2 Annual Reports | 2 Annual Reports | 2 Annual Reports | 1 Annual Report | Existing Staff | 1 |
| 71 | Continue to update status of County capital budget restoration projects and BMPs | Provide progress update in annual NPDES Report. | NPDES annual report | Annual Reports | 1 Annual Report | 2 Annual Reports | 2 Annual Reports | 2 Annual Reports | 1 Annual Report | Existing Staff | 1 |

Responsible Parties:

1. Baltimore County
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8. MANG
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10. LaFarge
11. APG
12. SWAP Implementation Committee

Table A-2: Middle River and Tidal Gunpowder Action Strategies – Goal Objective Matrix

| | Action | Goal 1 | | | | | Goal 2 | | | Goal 3 | | | | | | Goal 4 | | | | Goal 5 | | | | | Goal 6 | | | Goal 7 | | | | Goal 8 | | | Goal 9 | | | Goal 10 | | Goal 11 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 1 | 2 | 3 | 4 |
| | **RESTORATION ACTIONS** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | ***Nutrient Reduction*** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | Reduce lawns and plant bayscapes in the 32 neighborhoods identified. | X | X | X | X | | | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | Continue municipal road maintenance street sweeping activities. Investigate the 10 neighborhoods recommended for street sweeping to implement activities and/or adjust frequency as needed. | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | ***Stormwater Management*** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | Investigate the potential of the 3 existing dry detention ponds for enhanced water quality treatment. | X | X | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | Investigate the feasibility of implementing stormwater retrofits to treat runoff from impervious surfaces (parking lots, alleys) in the 5 neighborhoods identified. | X | X | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | Investigate the feasibility of implementing stormwater retrofits for parking lots and/or inlets at the 18 institutional sites identified (12 public, 6 private). | X | X | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | Design and implement stormwater retrofits at feasible sites identified in Actions 5 and 6. | X | X | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | Work with institutional partners to reduce impervious cover at the 5 institutional sites identified (4 public schools, 1 other public). | X | X | X | X | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | Work with industrial partners to reduce impervious cover at the 6 industrial sites identified. | X | X | X | X | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 | Develop and implement a downspout disconnection program. Use rainbarrels, rain gardens, and/or redirection for downspout disconnection in the 44 recommended neighborhoods. | X | X | X | X | | X | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | Inspect and maintain stormwater conversions and retrofits. | X | X | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | ***Urban Tree Canopy*** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | Investigate the feasibility of planting riparian stream buffers on open pervious land. | X | X | | | X | | | | | | | | | | | | | | X | | | | | | | | X | | X | X | X | X | | X | | | | | | | | |
| 12 | Investigate the feasibility of planting riparian shoreline buffers on open pervious land. | X | X | | | X | | | | | | | | | | | | | | X | | X | X | | | | | X | | X | X | X | X | | X | | | | | | | | |
| 13 | Reforest stream buffer at feasbile sites with a minimum width of 35 feet. | X | X | | | X | | | | | | | | | | | | | | X | | | | | | | | X | | X | X | X | X | | X | | | | | | | | |
| 14 | Reforest shoreline buffer at feasbile sites with a minimum width of 35 feet. | X | X | | | X | | | | | | | | | | | | | | X | | X | X | | | | | X | | X | X | X | X | | X | | | | | | | | |
| 15 | Plant trees on PAA sites, focusing efforts on sites identified as mostly open pervious cover type and requiring minimal site preparation. (This includes working with MD SHA to plant trees in suitable medians and rights-of-way.) | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | X | | | | | | | | | | |
| 16 | Encourage street and shade tree planting in the 24 recommended neighborhoods. | X | X | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | X | X | | | | | | | | | | |
| 17 | Encourage institutions to plant trees on available open space at the 31 sites identified. | X | X | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | X | X | | | | | | | | | | |
| 18 | Baltimore County shall continue to require riparian buffers and forest conservation for all new and re-development. | X | X | | | X | | | | | | | | | | | | | | X | | | | | | | | X | | X | X | X | X | | | | | | | | | | |
| 19 | Maintain trees planted at reforestation/tree planting sites. | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | X | | | | | | | | | | |
| 20 | Improve forest health by removing exotic invasive species. | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | X | | | | | | | | | | |
| 21 | Continue revitalization and redevelopment of Baltimore County Communities incorporating an increase of parkland. Develop a track system and track associated load reductions | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | ***Trash Management*** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 22 | Post no dumping signs in problem areas identified and enforce no dumping. | | | X | X | | | | | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 23 | Identify areas where additional trash cans, covered receptacles, and/or better maintenance measures are needed. | | | | | | | | | X | X | | X | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 24 | Implement recycling and add separate receptacles for recycling on public properties such as parks. | | | | | | | | | X | X | | X | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | ***Tidal Waters*** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 25 | Install and maintain navigation channel markers to prevent encroachment from boats into SAV and habitat areas. | X | X | | | | | | | | | | | | | | | | | | | | | X | X | X | X | | | | | | | | | | | | X | X | | | |
| 26 | Evaluate potential locations for wetland creation and enhancement throughout the watershed. | X | X | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | X | | | | | | | | |

Responsible Parties:

1. Baltimore County
2. GVC
3. EMRCC
4. BQIA
5. BCMTA
6. Lockheed Martin
7. MSA
8. MANG
9. Constellation
10. LaFarge
11. APG
12. SWAP Implementation Committee

Table A-2: Middle River and Tidal Gunpowder Action Strategies – Goal Objective Matrix

| | Action | Goal 1 | | | | | Goal 2 | | | Goal 3 | | | | | | Goal 4 | | | | Goal 5 | | | | | Goal 6 | | | Goal 7 | | | | Goal 8 | | | Goal 9 | | | Goal 10 | | Goal 11 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 1 | 2 | 3 | 4 |
| 27 | Implement wetland plantings at feasible sites. | X | X | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | X | | | | | | | | |
| 28 | Evaluate shoreline enhancement project potential of the 1 site identified in Middle River as part of DEPRM's Shoreline Feasibility Study. | X | X | | | X | | | | | | | | | | X | | | | X | | X | X | | | | | X | | X | X | | | | X | | | | | | | | |
| 29 | Implement shoreline enhancement projects at feasible sites. | X | X | | | X | | | | | | | | | | | X | | | X | | X | X | | | | | X | | X | X | | | | X | | | | | | | | |
| 30 | Reevaluate recreational water quality monitoring sites. | | | | | | | | | | | | | | | | | | | X | X | | | | | | | | | | | | | | | | | | | | | | |
| | ***Stream Corridor Restoration*** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 31 | Evaluate the restoration potential and feasibility of restoring eroded stream banks and channel alterations identified in the stream corridor assessments. | X | X | | | X | | | | | | | | | | | | | | X | | | | | | | | X | | X | X | | | | | | | | | | | | |
| 32 | Complete stream restoration projects at feasible sites. | X | X | | | X | | | | | | | | | | | | | | X | | | | | | | | X | | X | X | | | | | | | | | | | | |
| 33 | Remove fish blockages, restore and protect portions of the stream network and riparian habitats such that natural biological conditions can support diverse aquatic communities, as can be monitored and assessed by fish and invertebrate community structure and function. | | | | | X | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | |
| | ***Land Preservation*** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 34 | Identify lands available for permanent conservation and preservation. | | | | | | | | | | | | | | | | | | | | | | | | | | | X | X | X | X | | | | X | X | | | | | | | |
| 35 | Work with private property owners to undertake perpetual land conservation easements on currently undeveloped properties. | | | | | | | | | | | | | | | | | | | | | | | | | | | X | X | X | X | | | | X | X | X | | | | | | |
| 36 | Acquire undeveloped parcels for permanent conservation and preservation | | | | | | | | | | | | | | | | | | | | | | | | | | | X | X | X | X | | | | X | X | X | | | | | | |
| | **OUTREACH & AWARENESS** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 37 | Distribute pollution prevention information to facilities falling within hotspot categories and marinas 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. | X | X | X | X | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 38 | Distribute information to the public and to facilities near waterways on the benefits of living shorelines and SAVs. | X | X | X | X | X | | | | | | | | | | | | | | | | | | X | X | X | X | | | | | | | | | | | | | X | | | |
| 39 | Locally recognize the 10 marinas that are certified Maryland Clean Marinas and encourage the remaining marinas to participate in the Clean Marina Initiative. | | | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | X | X |
| 40 | Increase citizen awareness of Clean Boater Pledge Program | | | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | X | X |
| 41 | Form partnerships with community groups and discuss the BMP recommendations from the neighborhood assessments and implementation options. | | | X | X | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 42 | Form partnerships with institutions and discuss the BMP recommendations from the institutional assessments and implementation options. Include implementing/enhancing recycling programs on their properties. | X | X | X | X | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 43 | Work with community groups to install storm drain markers in the 52 recommended neighborhoods. | X | X | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 44 | Work with institutional sites to install storm drain markers at the 14 recommended sites. | X | X | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 45 | Develop and implement signs and educational material for the trash campaign in the watershed. | | | X | X | | | | | X | X | | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 46 | Develop a trash treaty for institutions, public properties and neighorhoods. | | | X | X | | | | | X | X | | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 47 | Encourage institional partners, community groups, and patrons of public properties to sign and support a trash treaty. | | | X | X | | | | | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 48 | Encourage and support community cleanups in neighborhoods. | | | X | X | | | | | X | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 49 | Encourage and support waterway cleanups in streams and tidal areas. | | | X | X | | | | | X | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 50 | Conduct a tour of a completed water quality project/BMP on public property. | | | X | X | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Responsible Parties:

1. Baltimore County
2. GVC
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7. MSA
8. MANG
9. Constellation
10. LaFarge
11. APG
12. SWAP Implementation Committee

Table A-2: Middle River and Tidal Gunpowder Action Strategies – Goal Objective Matrix

| | Action | Goal 1 | | | | | Goal 2 | | | Goal 3 | | | | | | Goal 4 | | | | Goal 5 | | | | | Goal 6 | | | Goal 7 | | | | Goal 8 | | | Goal 9 | | | Goal 10 | | Goal 11 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 1 | 2 | 3 | 4 |
| 51 | Develop and distribute a brochure advertising and encouraging public access points to Middle River and Tidal Gunpowder River. | | | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | X | X | X | | X |
| 52 | Develop and distribute public awareness materials that promote the use of public access to the Middle River and Tidal Gunpowder. | | | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | X | X | X | | |
| 53 | Support the completion of the Eastern Regional Trail to create access for pedestrians and cyclists. | | | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | X | | |
| 54 | Address bootleg marinas | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 55 | Increase agency collaboration through in-house meetings | | | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 56 | Conduct water trail tours for community groups including description of public access points, navigation channel markings, shoreline/wetland enhancement project(s), etc. | | | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 57 | Increase signage to teach resident not to feed wild deer or geese. | | | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | |
| 58 | Reduce geese population within the watershed | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | **MONITORING** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 59 | Continue to monitor and remove illicit connections through the Illicit Connections Program | X | X | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | |
| 60 | Implement a Stream Watch program, a citizen-based program to increase the ability to monitor/identify sources of water quality and habitat degradation. | | | | | | | | | | | | | | | | | X | X | | X | | | | | | | | | | | | | | | | | | | | | | |
| 61 | Continue stormwater facility maintenance and inspection program | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 62 | Continue to work with teachers to develop water quality monitoring activities for students at Baltimore County public schools. | X | X | X | X | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | |
| 63 | Monitor SAV coverage in the watershed annually. | | | | | | | | | | | | | | | | | X | | | X | | | | | | | | | | | | | | | | | | | | | | |
| 64 | Monitor deer population in the watershed | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | X | | | | | | | | | |
| | **FUNDING** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 65 | Coordinate grant funding requests to secure funding and implement restoration projects to meet TMDL nutrient reductions requirements. | X | X | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 66 | Increase funding for the Baltimore County - Green Building Tax Credit Program as a model. | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 67 | Increase applications for the Maryland Department of Natural Resources Land Conservation Programs including Program Open Space, Rural Legacy, and Maryland Environmental Trust | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | **REPORTING** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 68 | Middle River and Tidal Gunpowder River SWAP Implementation Committee will meet to discuss implementation progress and assess any changes needed to meet the goals. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 69 | Develop a unified restoration tracking system to track progress toward meeting TMDL reduction requirements. | | | | | | | | | | | | | | | | | | X | | X | | | | | | | | | | | | | | | | | | | | | | |
| 70 | Update the status of citizen-based restoration projects and BMPs on an annual basis | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 71 | Continue to update status of County capital budget restoration projects and BMPs | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Responsible Parties:

1. Baltimore County
2. GVC
3. EMRCC
4. BQIA
5. BCMTA
6. Lockheed Martin
7. MSA
8. MANG
9. Constellation
10. LaFarge
11. APG
12. SWAP Implementation Committee

# APPENDIX B:

## Cost Analysis and Potential Funding Sources

# Cost Analysis and Potential Funding Sources

This appendix presents cost estimates and potential funding sources for the implementation of proposed restoration BMPs in the Middle River and Tidal Gunpowder SWAP. Each is described below.

## Cost Analysis

The cost analysis is based on the actions detailed in Appendix A. Cost estimates are summarized in Tables B-1 and B-2. Table B-1 presents cost estimates based on the maximum implementation scenario described in Chapter 3. Table B-2 presents costs estimates based on the projected participation rates needed to achieve the 2017 reduction goals in nutrient loads from urban runoff, also described in Chapter 3. Table B-3 presents costs estimates based on the projected participation rates needed to achieve the 2020 reduction goals in nutrient loads from urban runoff. For each scenario, estimates are provided in 2011 dollars and represent total cost estimates for the anticipated implementation timeframe. Unit costs are based on a combination of local information and previous SWAPs completed for other local watersheds. BMP costs are not annualized over the implementation timeframe and do not include costs of existing staff. Costs are also presented in dollars per pound of nitrogen and phosphorus 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 $19,496,172 for maximum implementation and $18,265,236 based on projected participation rates meeting the 2020 pollution reduction goals.

Table B-1: Maximum Estimated Costs for Middle River and Tidal Gunpowder SWAP Implementation

| Action | Unit Cost | Max Quantity | Max Total Cost | Max TN Load Reduction (lbs / yr) | Max TP Load Reduction (lbs / yr) | Max Cost / lb of TN Removal per year | Max Cost / lb of TP Removal |
|---|---|---|---|---|---|---|---|
| Bayscaping Education | $ 500 / event | 8 events | $ 4,000 | 214 | 11 | $ 19 | $ 348 |
| SWM Conversions | $ 75,000 / pond | 3 ponds | $ 225,000 | 28 | 2 | $ 7,994 | $ 147,856 |
| SW Retrofits | $ 50,000 / retrofit | 11 retrofits | $ 550,000 | 102 | 21 | $ 5,401 | $ 26,077 |
| Impervious Cover Removal | $ 25,000 / acre | 0.4 acre | $ 10,300 | 1 | 0 | $ 7,778 | $ 23,273 |
| Downspout Disconnection Program | $ 150 / house | 6,908 houses | $ 1,036,200 | 471 | 84 | $ 2,201 | $ 12,399 |
| Reforest Stream Buffer | $ 15,000 / acre | 317 acres | $ 4,758,000 | 1,669 | 127 | $ 2,850 | $ 37,481 |
| Reforest Shoreline Buffer | $ 15,000 / acre | 641 acres | $ 9,610,500 | 2,634 | 127 | $ 3,649 | $ 75,786 |
| Pervious Area Reforestation | $ 6,000 / acre | 69 acres | $ 416,972 | 283 | 14 | $ 1,475 | $ 30,559 |
| Neighborhood Tree Planting | $ 175 / tree | 1,972 trees | $ 345,100 | 51 | 2 | $ 6,799 | $ 141,249 |
| Institutional Tree Planting | $ 175 / tree | 1,868 trees | $ 326,961 | 24 | 1 | $ 13,474 | $ 279,734 |
| Tree Maintenance | $ 1,300 / acre | 637 acres | $ 828,100 | N/A | N/A | NA | NA |
| Navigation Channel Markers | $ 5,000 / year | 8 years | $ 40,000 | N/A | N/A | NA | NA |
| Shoreline Enhancement Projects | $ 350 / ln ft | 2,500 ln ft | $ 875,000 | 400 | 275 | $ 2,188 | $ 3,182 |
| Stream Restoration | $ 350 / ln ft | 1,125 ln ft | $ 393,624 | 104 | 18 | $ 3,781 | $ 21,647 |
| Pollution Prevention Workshops | $ 300 / workshop | 2 workshops | $ 600 | N/A | N/A | NA | NA |
| Clean Marina and Boater ads | $ 50 / ad | 8 ads | $ 400 | N/A | N/A | NA | NA |
| SAV Tour | $ 225 / tour | 1 tour | $ 225 | N/A | N/A | NA | NA |
| Neighborhood BMP Meetings | $ 500 / meeting | 16 meetings | $ 8,000 | N/A | N/A | NA | NA |
| Storm Drain Markers | $ 11 / site | 52 sites | $ 572 | N/A | N/A | NA | NA |
| Trash Campaign Materials | $ 200 / year | 8 years | $ 1,600 | N/A | N/A | NA | NA |
| Waterway Cleanups | $ 1,000 / cleanup | 27 cleanups | $ 27,000 | N/A | N/A | NA | NA |
| Water Quality Monitoring Report | $ 34,000 / report | 8 reports | $ 272,000 | N/A | N/A | NA | NA |
| | | ***Total:*** | ***$ 19,730,154*** | ***5,981*** | ***682*** | | |

Note: 'NA" denotes not assessed in the pollutant removal analysis.

Table B-2: 2017 Projected Estimated Costs for Middle River and Tidal Gunpowder SWAP Implementation

| Action | Unit Cost | Proj. 2017 Quantity | Proj. 2017 Total Cost | Proj. 2017 TN Load Reduction (lbs / yr) | Proj. 2017 TP Load Reduction (lbs / yr) | Proj. 2017 Cost / lb of TN Removal per year | Proj. 2017 Cost / lb of TP Removal per year |
|---|---|---|---|---|---|---|---|
| Bayscaping Education | $ 500 / event | 8 events | $ 4,000 | 11 | 1 | $ 374 | $ 6,960 |
| SWM Conversions | $ 75,000 / pond | 2 ponds | $ 150,000 | 19 | 1 | $ 7,994 | $ 147,856 |
| SW Retrofits | $ 50,000 / retrofit | 6 retrofits | $ 300,000 | 28 | 6 | $ 10,802 | $ 52,154 |
| Impervious Cover Removal | $ 25,000 / acre | 0.2 acre | $ 5,150 | 1 | 0 | $ 7,778 | $ 23,273 |
| Downspout Disconnection Program | $ 150 / house | 2,375 houses | $ 356,321 | 162 | 29 | $ 2,202 | $ 12,403 |
| Reforest Stream Buffer | $ 15,000 / acre | 118 acres | $ 1,767,257 | 620 | 47 | $ 2,850 | $ 37,481 |
| Reforest Shoreline Buffer | $ 15,000 / acre | 220 acres | $ 3,295,029 | 903 | 43 | $ 3,649 | $ 75,786 |
| Pervious Area Reforestation | $ 6,000 / acre | 408 acres | $ 2,448,814 | 81 | 4 | $ 30,318 | $ 628,142 |
| Neighborhood Tree Planting | $ 175 / tree | 1,126 trees | $ 197,050 | 12 | 1 | $ 16,984 | $ 352,870 |
| Institutional Tree Planting | $ 175 / tree | 1,068 trees | $ 186,900 | 11 | 1 | $ 17,048 | $ 353,929 |
| Tree Maintenance | $ 1,300 / acre | 751 acres | $ 976,438 | N/A | N/A | NA | NA |
| Navigation Channel Markers | $ 5,000 / year | 5 years | $ 25,000 | N/A | N/A | NA | NA |
| Shoreline Enhancement Projects | $ 350 / ln ft | 1,667 ln ft | $ 583,333 | 267 | 183 | NA | NA |
| Stream Restoration | $ 350 / ln ft | 450 ln ft | $ 157,450 | 42 | 7 | $ 3,781 | $ 21,647 |
| Pollution Prevention Workshops | $ 300 / workshop | 1 workshops | $ 300 | N/A | N/A | NA | NA |
| Clean Marina and Boater ads | $ 50 / ad | 5 ads | $ 250 | N/A | N/A | NA | NA |
| SAV Tour | $ 225 / tour | 1 tour | $ 225 | N/A | N/A | NA | NA |
| Neighborhood BMP Meetings | $ 500 / meeting | 5 meetings | $ 2,500 | N/A | N/A | NA | NA |
| Storm Drain Markers | $ 11 / site | 33 sites | $ 363 | N/A | N/A | NA | NA |
| Trash Campaign Materials | $ 200 / year | 5 years | $ 1,000 | N/A | N/A | NA | NA |
| Waterway Cleanups | $ 1,000 / cleanup | 5 cleanups | $ 5,000 | N/A | N/A | NA | NA |
| Water Quality Monitoring Report | $ 34,000 / report | 5 reports | $ 170,000 | N/A | N/A | NA | NA |
| | | ***Total:*** | ***$ 10,632,379*** | ***2,154*** | ***323*** | | |

Note: 'NA" denotes not assessed in the pollutant removal analysis.

Table B-2: 2020 Projected Estimated Costs for Middle River and Tidal Gunpowder SWAP Implementation

| Action | Unit Cost | Proj. 2020 Quantity | Proj. 2020 Total Cost | Proj. 2020 TN Load Reduction (lbs / yr) | Proj. 2020 TP Load Reduction (lbs / yr) | Proj. 2020 Cost / lb of TN Removal per year | Proj. 2020 Cost / lb of TP Removal per year |
|---|---|---|---|---|---|---|---|
| Bayscaping Education | $ 500 / event | 8 events | $ 4,000 | 11 | 1 | $ 374 | $ 6,960 |
| SWM Conversions | $ 75,000 / pond | 3 ponds | $ 225,000 | 28 | 2 | $ 5,329 | $ 98,570 |
| SW Retrofits | $ 50,000 / retrofit | 11 retrofits | $ 550,000 | 51 | 11 | $ 5,892 | $ 28,447 |
| Impervious Cover Removal | $ 25,000 / acre | 0.2 acre | $ 5,150 | 1 | 0 | $ 7,778 | $ 23,273 |
| Downspout Disconnection Program | $ 150 / house | 3,801 houses | $ 570,114 | 259 | 46 | $ 1,376 | $ 7,752 |
| Reforest Stream Buffer | $ 15,000 / acre | 206 acres | $ 3,092,700 | 1,085 | 83 | $ 1,629 | $ 21,418 |
| Reforest Shoreline Buffer | $ 15,000 / acre | 384 acres | $ 5,766,300 | 1,580 | 76 | $ 2,085 | $ 43,306 |
| Pervious Area Reforestation | $ 6,000 / acre | 712 acres | $ 4,272,568 | 141 | 7 | $ 17,325 | $ 358,938 |
| Neighborhood Tree Planting | $ 175 / tree | 1,972 trees | $ 345,100 | 20 | 1 | $ 9,705 | $ 201,631 |
| Institutional Tree Planting | $ 175 / tree | 1,868 trees | $ 326,961 | 19 | 1 | $ 9,750 | $ 202,409 |
| Tree Maintenance | $ 1,300 / acre | 1,312 acres | $ 1,705,984 | N/A | N/A | NA | NA |
| Navigation Channel Markers | $ 5,000 / year | 8 years | $ 40,000 | N/A | N/A | NA | NA |
| Shoreline Enhancement Projects | $ 350 / ln ft | 2,500 ln ft | $ 875,000 | 400 | 275 | NA | NA |
| Stream Restoration | $ 350 / ln ft | 1,125 ln ft | $ 393,624 | 104 | 18 | $ 1,512 | $ 8,659 |
| Pollution Prevention Workshops | $ 300 / workshop | 2 workshops | $ 600 | N/A | N/A | NA | NA |
| Clean Marina and Boater ads | $ 50 / ad | 8 ads | $ 400 | N/A | N/A | NA | NA |
| SAV Tour | $ 225 / tour | 1 tour | $ 225 | N/A | N/A | NA | NA |
| Neighborhood BMP Meetings | $ 500 / meeting | 8 meetings | $ 4,000 | N/A | N/A | NA | NA |
| Storm Drain Markers | $ 11 / site | 52 sites | $ 572 | N/A | N/A | NA | NA |
| Trash Campaign Materials | $ 200 / year | 8 years | $ 1,600 | N/A | N/A | NA | NA |
| Waterway Cleanups | $ 1,000 / cleanup | 8 cleanups | $ 8,000 | N/A | N/A | NA | NA |
| Water Quality Monitoring Report | $ 34,000 / report | 8 reports | $ 272,000 | N/A | N/A | NA | NA |
| | | ***Total:*** | ***$ 18,459,898*** | ***3,699*** | ***519*** | | |

Note: 'NA" denotes not assessed in the pollutant removal analysis.

## Potential Funding Sources

Funding sources for the implementation of the Middle River and Tidal Gunpowder SWAP includes local government funding for Baltimore County, monetary and time contributions to the Gunpowder Valley Conservancy, 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 Middle River and Tidal Gunpowder watershed as a whole currently has $0.50 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 B-2, additional funding from grants will be required. Table B-2 presents potential funding sources to support the implementation of the Middle River and Tidal Gunpowder 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:* The Trust Fund was established 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, 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:* Federal money for restoration implementation is available annually through MDE.
- *Bay Restoration Fund (MDE):* This is a dedicated fund, financed by wastewater treatment plant users, to upgrade Maryland's wastewater treatment plants with enhanced nutrient removal technology. In addition, a similar fee paid by septic system users is utilized to upgrade onsite systems and to pay for cover crops to reduce nitrogen loading to the Bay. Proposed modifications to the fund will allow the fund to be used for implementation of stormwater restoration projects.
- *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 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), the U.S. Department of Agriculture Forest Service (USFS), and the National Oceanic and Atmospheric 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 B-3: Middle River and Tidal Gunpowder 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<br>Local Government<br>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<br><br>YES | 6 months (?) |
| Chesapeake Bay Trust | Targeted Watershed Initiative Grant Program | Non-profits 501(c)<br>Institutions<br>Soil/Water Conservation Districts<br>Local Government | Involve local organizations; Address non-point source pollution; Projects related to water quality and habitat restoration | $50 to $200,000 | 0%<br><br>YES | 1-2 years |
| Chesapeake Bay Trust | Capacity Building Initiative Grant Program | Non-profits 501(c) with a board on which half the members participate meaningfully and at least one paid staff (or a part-time paid staff and volunteer) | Strengthen an organization through management operations, technology, governance, fundraising, and communications | $15,000 per year | 0%<br><br>YES | 3 years |
| Chesapeake Bay Trust | Stewardship Grant Program | Non-profits 501(c)<br>Schools/Universities<br>Soil/Water Conservation Districts<br>Local Government<br>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%<br><br>YES | 1 Year |
| DNR | Clean Water Action Plan Nonpoint Source Program 319 Grant | Non-profits 501(c)<br>Universities<br>Soil/Water Conservation Districts<br>Local Government<br>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 Governments | Green Restoration Project | None specified | 50%<br><br>YES | None specified |

Table B-3 (con't): Middle River and Tidal Gunpowder SWAP Potential Funding Sources

| Managing Agency | Funding Source | Application Eligibility | Eligible Projects | Funding Amount | Cost Share/ In - Kind | Project Period |
|---|---|---|---|---|---|---|
| NFWF | Chesapeake Bay Small Watersheds Grant Program | Non-profits 501(c)<br>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)<br>Universities<br>Local Government<br>State Government | Innovative demonstration type restoration projects | $400,000 to $1,000,000 | 25%<br>YES | 2-3 years |
| NRCS | Watershed Operations Program | Local Government<br>State Government<br>Tribes | Address watershed protection, flood mitigation, water quality, soil erosion, sediment control, habitat enhancement, and wetland creation and restoration | None specified | ? | None specified |
| USEPA | Targeted Watersheds Grant Program - Capacity Building Grant Program | Non-profits 501(c)<br>Institutions<br>Local Government<br>State Government | Promote organizational development of local watershed partnerships; Provide training and assistance to local watershed groups | $400,000 to $800,000 | 25%<br>YES | 2 years |
| USEPA | Targeted Watersheds Grant Program - Implementation Grant Program | Non-profits 501(c)<br>Universities<br>Local Government<br>State Government | Watershed Restoration and/or Protection Projects (must include a monitoring component) | $600,000 to $900,000 | 25%<br>YES | 3-5 years |

# APPENDIX C:

## Chesapeake Bay Program Pollutant Load Reduction Efficiencies and Maryland *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated.*

## *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 |

| | | | | |
|---|---|---|---|---|
| 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 |

| | | | | | |
|---|---|---|---|---|---|
| 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**<br><br>**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% |

| | | | | |
|---|---|---|---|---|
| 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% |

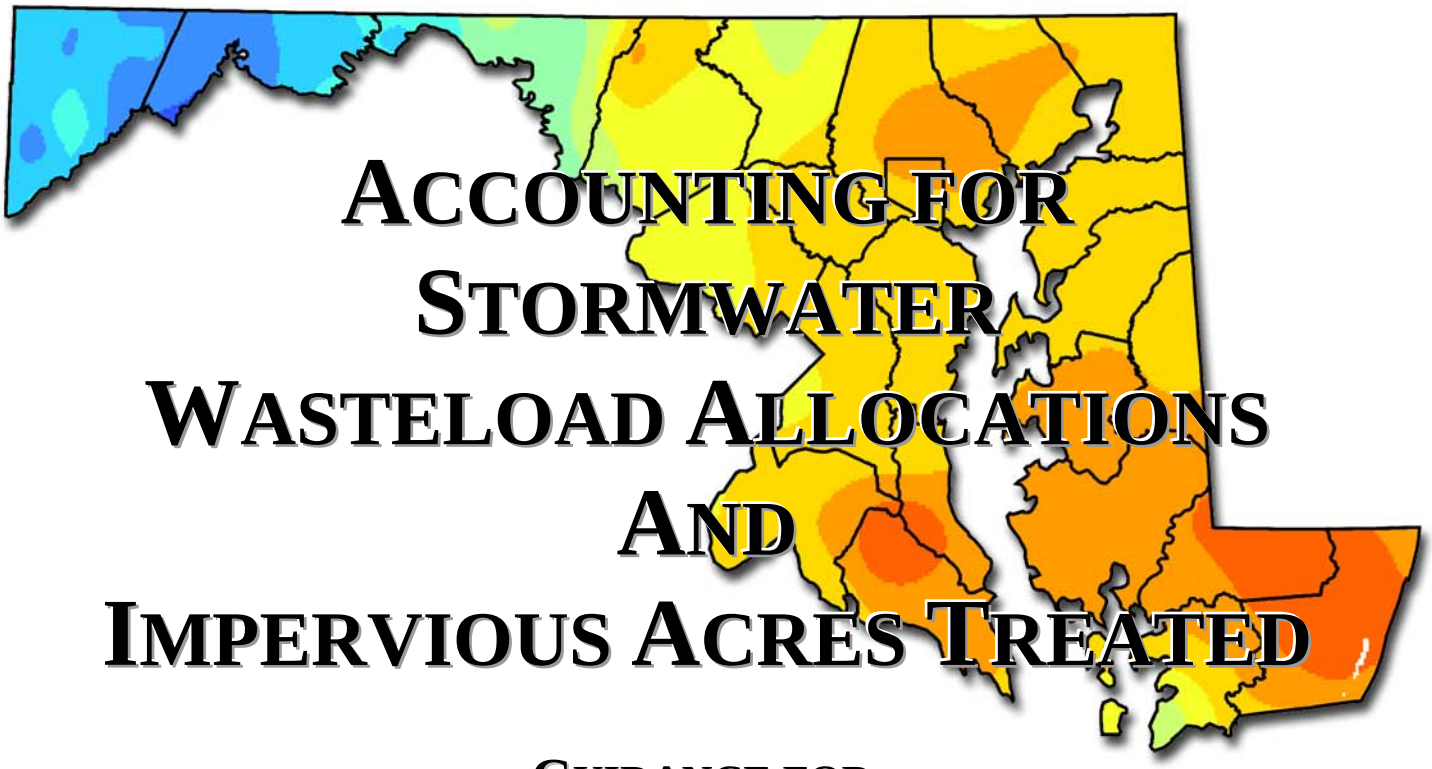
| | | | | |
|---|---|---|---|---|
| efficiency) | | | | |
| Cover Crop Standard Other Wheat (Low-till gets only TN efficiency) | Coastal Plain/Piedmont Crystalline/Karst Settings* | 24% | 7% | 10% |
| | Mesozoic Lowlands/Valley and Ridge Siliciclastic** | 18% | 7% | 10% |
| Cover Crop Late Drilled Wheat (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% |

| | | | | |
|---|---|---|---|---|
| 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) |

| | | | | |
|---|---|---|---|---|
| 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



# ACCOUNTING FOR STORMWATER WASTELOAD ALLOCATIONS AND IMPERVIOUS ACRES TREATED

## GUIDANCE FOR NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM STORMWATER PERMITS

## JUNE (DRAFT) 2011

MARYLAND
DEPARTMENT OF THE ENVIRONMENT

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## I. Introduction

National Pollutant Discharge Elimination System (NPDES) municipal separate storm sewer system permits in Maryland require the restoration of a certain percent of a jurisdiction's impervious surface area, e.g., 20%, that has little or no stormwater management. How to calculate impervious surface requirements and treatment credits has generated numerous questions. This document standardizes procedures for the reporting of traditional, new, and alternative best management practices (BMPs) and the impervious area they control.

With the inclusion of total maximum daily loads (TMDLs) and specifically the Chesapeake Bay TMDL in municipal stormwater permits, the answer to "what constitutes restoration?" becomes fairly easy to answer. This means meeting TMDL requirements and water quality criteria. This document provides information on how to calculate stormwater baseline loads and BMP pollutant removal efficiencies for showing progress toward meeting stormwater waste load allocations (WLA) for NPDES accounting purposes. Implementing water quality improvement projects on a certain percent of a locality's impervious surface area each permit term sets the schedule for meeting the Chesapeake Bay TMDL.

A primary goal of this guidance is to expand the list of traditional urban BMPs with a suite of alternative water quality practices. By developing a comprehensive matrix of practices and consistent accounting measures, the Maryland Department of the Environment (MDE) brings greater certainty to the local planning and budgeting processes. Local governments can weigh the cost associated with implementing different practices and choose the most efficient option for meeting pollutant load reductions. Also included in this document is a method for translating the pollutant load reductions associated with alternative stormwater practices into equivalent impervious acres treated. This will tie the implementation of these BMPs and meeting stormwater WLAs and impervious area restoration requirements together under one permit.

This guidance will continue to evolve as stormwater science, program implementation, and Chesapeake Bay modeling improve. Maryland counties, municipalities, and agencies are encouraged to participate fully in this endeavor by exploring and monitoring alternative approaches to stormwater management. The data gathered may be used to update and improve Maryland's stormwater management matrix of options for achieving water quality. Finally, while the principles and methods presented here are primarily geared toward meeting NPDES permit impervious surface requirements and Chesapeake Bay stormwater WLAs, they are relevant and applicable for use for any EPA approved TMDL.

## II. Modeling Methods

**1. Model Selection**: Computer models can aid local jurisdictions in establishing stormwater baseline pollutant loads, planning restoration work, and showing progress toward meeting WLAs. Maryland's Assessment and Scenario Tool (MAST) developed for the Chesapeake Bay Program (CBP) and the Hydrological Simulation Program -- Fortran (HSPF), the Stormwater Management Model (SWMM), and spreadsheet versions like the Watershed Treatment Model (WTM) are acceptable for use by Maryland's NPDES localities. MAST is the only model that relates directly to the CBP model and where pollutant removal credits may be assured under the Bay's TMDL.

Other models and results can be compared to the Bay model on a proportional basis for NPDES accounting purposes. For example, while different models will likely generate different baseline pollutant loads in pounds, the reductions from implementing water quality improvement projects will be comparable on a percent reduction basis. In order to develop greater consistency among the models, local governments will need to use the same pollutant loading rates that were used to develop the Bay TMDL. Also, consistent BMP pollutant removal efficiencies need to be used to ensure equitable accounting among jurisdictions. Websites with documentation on the use of various models may be found in Appendix A.

**2. CBP Loading Rates**: Jurisdictions shall use the pollutant loading rates derived from the CBP Model, Version 5.3.0, for total nitrogen (TN), total phosphorus (TP), and total suspended sediment (TSS) along with land use data to calculate the stormwater loads discharged from municipal storm drain systems. These rates, found in Table 1, were used for developing stormwater WLAs in the Chesapeake Bay TMDL, and local use of these data will ensure consistency. For ease in modeling, Maryland used a weighted pollutant load average for all CBP urban land covers (impervious high density, impervious low density, pervious high density, and pervious low density) in its Watershed Implementation Plan (WIP).

**Table 1.** CBP Annual Urban Runoff Loads Per Acre

| Parameter | Urban Impervious | | | Urban Pervious | | | All Urban |
|---|---|---|---|---|---|---|---|
| | high density | low density | average | high density | low density | average | weighted average |
| TN (lbs) | 10.48 | 11.22 | 10.85 | 9.10 | 9.76 | 9.43 | 9.96 |
| TP (lbs) | 2.01 | 2.06 | 2.04 | 0.55 | 0.58 | 0.57 | 0.97 |
| TSS (tons) | 0.44 | 0.47 | 0.46 | 0.07 | 0.07 | 0.07 | 0.18 |

(Adapted from CBP Model, Version 5.3.0, 2011)

These pollutant loads are specific to the Chesapeake Bay TMDL. Other water bodies are likely to have different pollutant loads than those used for Chesapeake Bay. A jurisdiction's analysis needs to be consistent with the loads found in each particular TMDL.

**3. BMP Efficiency Matrices**: This guidance provides two BMP efficiency matrices for computer model input values. One contains traditional stormwater retrofits, i.e., wet ponds, bioretention, and filtering practices, and efficiencies provided in the CBP Model. A second matrix contains alternate urban practices, i.e., stream restoration, street sweeping, and septic

system upgrades, that can be used to meet stormwater WLAs. Together these matrices provide local governments with numerous options for meeting NPDES stormwater WLAs and impervious cover restoration requirements.

## III. Establishing Baselines

**1. Municipal Separate Storm Sewer System**: Local jurisdictions need to account for and map the storm drain system that they own or operate. Title 40 of the Code of Federal Regulations (CFR), 122.26 (b) (8) defines a municipal separate storm sewer system as "a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains) *owned or operated* by a State, city, town, borough, county, parish, district, association, or other public body." Emphasis added.

The storm drain system within a jurisdiction's boundary is typically a mix of ownership, which includes parts of local, State, and federal systems. How a locality accounts for these various entities when defining what it "owns or operates" is important. Because stormwater management for private property in Maryland is locally administered for plan approval, inspection, and enforcement, these facilities are inherently a part of a locality's storm drain system. Some State and federal property, certain small municipalities, and industrial facilities are regulated under other NPDES stormwater permits and the storm drain systems in these entities may be excluded from a locality's responsibility. Any stormwater discharge, however, that passes through a county or municipal storm drain system or appurtenance becomes, at the very least, the shared responsibility of that locality.

**2. Land Use Data** are integral for estimating stormwater WLAs and assessing impervious surfaces for restoration. Local governments should use the best land use data that are available to them and can be generated from the same source from year to year. This will ensure consistent annual analysis regarding imperviousness, acres treated, retrofit goals, and permit compliance. An exception to this may be when technology allows for the current land use data to be further refined or improved. For example, some jurisdictions use local land use maps along with impervious surface coefficients to estimate impervious cover. If in the future, more accurate data can be derived from aerial views and geographic information system (GIS) application, then the more accurate data should be used. Because this may cause slight increases or decreases in reported impervious acres, local governments will need to document any changes to baseline data. When it comes to the Chesapeake Bay TMDL, there will be scale issues that may cause urban land cover to be over or under-estimated. These differences can be reconciled through the use of the stormwater management by era approach described later in this document.

**3. Stormwater WLA**: Urban land use data shall be used in conjunction with the approved TMDL pollutant loading rates to calculate local baseline stormwater pollutant loads. Typically, the year in which the monitoring data were gathered to support the TMDL should be used as the baseline year. Local stormwater program and restoration efforts implemented after the baseline year, and the associated pollutant load reductions, can then be measured against the stormwater WLAs to determine if benchmarks and water quality criteria are being met. EPA approved TMDLs may be found at http://www.mde. State.md.us/programs/Water/TMDL/Pages/Programs/WaterPrograms/tmdl/index.aspx.

**4. Impervious Cover**: Jurisdictions will need to determine the total impervious surface area that they are legally responsible for and delineate the portions that are either treated to the maximum extent practicable (MEP), partially treated, or untreated and available for retrofit. This assessment will provide the baseline from which the 20% restoration requirement may be calculated. A good place to start is 2002 because this is when Maryland regulations and local ordinances began requiring BMPs to address a specific suite of volumes [recharge ($Re_v$), water quality ($WQ_v$), and channel protection ($Cp_v$)] and it can therefore be justified that water quality treatment has been provided to the MEP.

Development after 2002 should not be counted toward impervious surfaces that need to be restored. BMPs from this stormwater program era are deemed state-of-the-art and need to be maintained, but will provide limited opportunity for water quality improvement. Hence, the regular implementation of stormwater management since 2002 may not be used for fulfilling restoration requirements. When local data for 2002 do not exist, jurisdictions should use the most appropriate land use year and document how it reflects the implementation of state-of-the-art BMPs according to the *2000 Maryland Stormwater Design Manual* (the *Manual*).

**5. Water Quality Facilities**: Stormwater BMPs implemented before 2002 that provide water quality treatment will need to be considered. For example, commonly used BMPs during this time included infiltration trenches and basins, wetlands facilities, and extended-detention structures, which all provide some water quality benefits. On the other hand, detentions facilities (dry ponds) that were designed primarily for flood control provide very little water quality.

Structural BMPs implemented prior to 2002 can be credited for treatment of impervious area based on the volume treated in relation to the *Manual's* $WQ_v$, or one inch of rainfall. If BMPs were designed to a criterion less than the $WQ_v$, impervious area credits should be pro-rated based on the proportion of the volume treated. These areas may provide significant retrofit opportunities, where meeting the full $WQ_v$ will increase the jurisdiction's impervious area treatment credit.

In order to claim credit, local jurisdictions will need to document how BMPs implemented before 2002 provide water quality. Documentation may include State or local policies and ordinances established to implement water quality BMPs in conjunction with Maryland's Urban BMP database (Appendix B), which may be used to verify BMP type and maintenance status. An example of how a locality may use State policy in this regard would be to reference, *Design Procedures for Stormwater Management Extended Detention Structures* (MDE, 1987).

By delaying one inch of rainfall over 24 hours, extended detention facilities improve the settling of pollutants and provide channel protection. If a local jurisdiction can document the use of this approach before 2002 for individual BMPs and each has been properly maintained, then the full $WQ_v$ may be claimed for these facilities. Each jurisdiction should provide MDE with specific information on the policies or local ordinances used to account for water quality BMPs implemented before 2002 and the impervious acres treated.

**6. Stormwater Management by Era**: Maryland's Urban BMP Database has records for over 33,000 facilities statewide, yet only 22,000 have complete information on drainage area and year built. The under-counting of BMPs has contributed to a flawed analysis regarding Maryland's

stormwater management programs that have been implemented since the early 1980's. To better reflect actual program implementation, BMPs may be recorded in four stormwater management eras when facility data are incomplete.

Based on distinct regulatory eras in Maryland with known BMP performance criteria, pollutant removal efficiencies have been developed that directly correlate to these eras (MDE, 2009). By combining these era efficiencies with the CBP's annual estimate for urban land cover, a better representation of program implementation can be achieved. The stormwater management by era approach was used in the development of Maryland's WIP for meeting Chesapeake Bay TMDLs and will be valuable for local planning and analysis as well. The major stormwater management eras and associated pollutant load reduction efficiencies are depicted in Figure 1.

**a. Local Data Gaps**: Local governments should use the information reported on Maryland's Urban BMP Database (Appendix B) for TMDL assessments. This database has been in use since the inception of stormwater management in Maryland and contains valuable empirical data on BMPs implemented across the State. Jurisdictions should further concentrate efforts to gather specific drainage area and other pertinent data during routine program updates and BMP maintenance inspections. Because individual BMP efficiencies tend to be greater than the conservatively estimated efficiencies for Maryland's early regulatory eras, there is a strong incentive for local governments to compile more accurate BMP data. Where these data are lacking however, counties and municipalities may use the CBP's annual estimate for urban land cover along with the stormwater management by era efficiencies to reflect the local implementation of BMPs.

**b. Reconciling Local and CBP Scale Data**: CBP methods for estimating urban land cover are based on a larger scale analysis than local data. While the CBP data are continually being improved to better reflect local land cover data, they tend to over or under-estimate actual urban land and impervious cover. When an over-estimation occurs, local jurisdictions can use the CBP annual data for land developed and the stormwater management by era efficiencies to reconcile these differences. Table 2 shows hypothetical CBP data for 1995 and 1996. In each year, urban land cover grew by 1,000 acres. The local urban BMP database for those same years however, shows 900 and 950 acres of BMP implementation, respectively. In this case, the stormwater management by era BMP category may be used to reconcile the difference between the CBP urban land cover and local land use. For 1995, 100 acres were added to this category and for 1996, 50 acres were added.

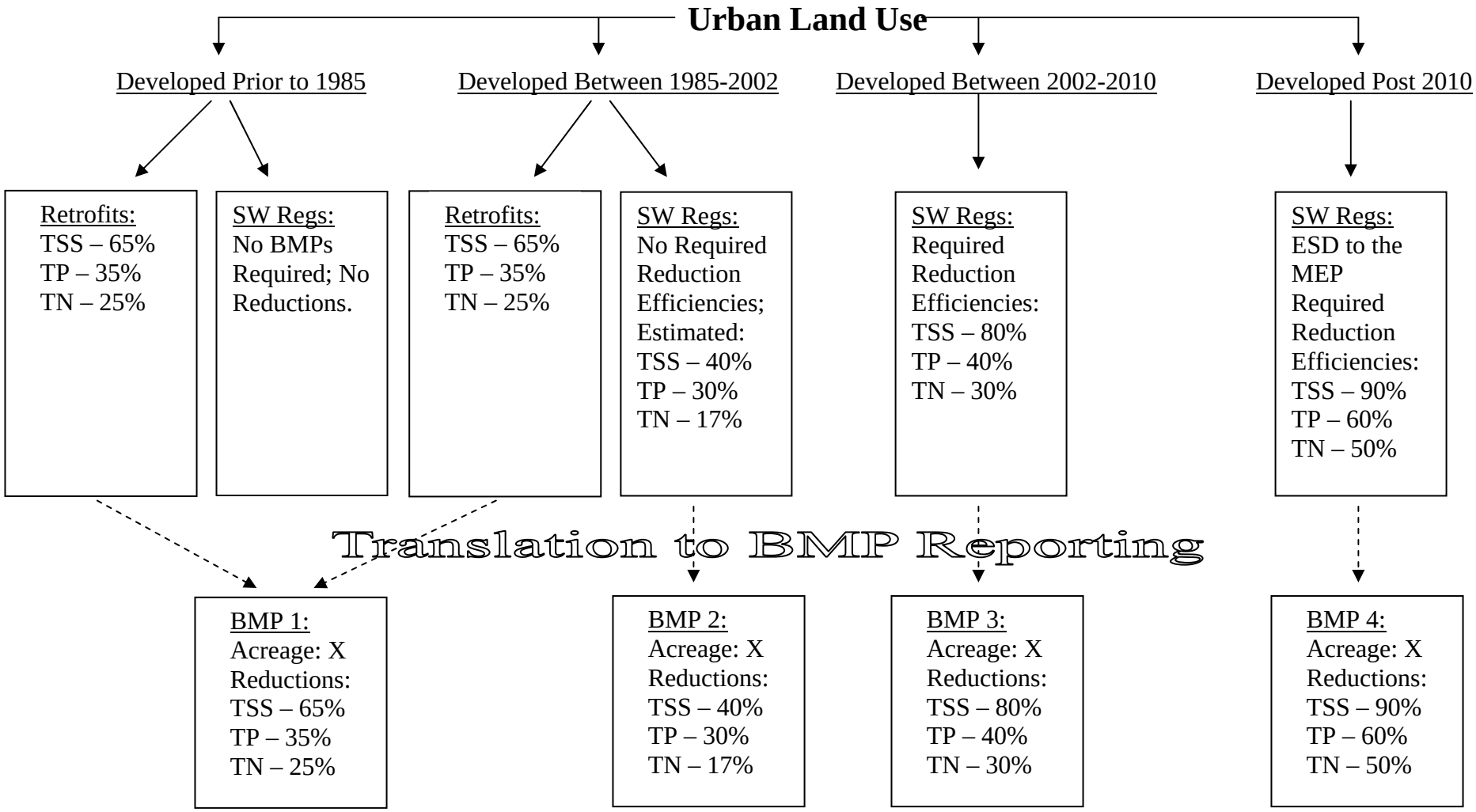
**Table 2.** Stormwater Management by Era Accounting Approach

| Year | CBP Urban Acres | Local Urban BMP Database Acres | | | | | SWM by Era Acres | Total Local Acres |
|---|---|---|---|---|---|---|---|---|
| | | Extended Detention | Wet Ponds | Filtering | Infiltration | Local Total | | |
| 1995 | 1,000 | 300 | 400 | 100 | 100 | 900 | 100 | 1,000 |
| 1996 | 1,000 | 300 | 400 | 100 | 150 | 950 | 50 | 1,000 |

(Adapted from MDE Stormwater Management by Era, 2009)

To obtain the latest available CBP Model land cover data for each jurisdiction by year, local governments may contact MDE or the Bay Program.

# Figure 1. Stormwater Management by Era



**7. New Development**: As stated above, impervious area caused by development after 2002 will not be required to be restored provided that current State regulations are met. This is because the design criteria in the *Manual* results in more than sufficient stormwater management and there will be limited opportunity for improving water quality through retrofitting. Moreover, Maryland's Stormwater Management Act of 2007 requires implementation of environmental site design (ESD) to the MEP. ESD is a performance-based approach mandating the control of the one-year frequency storm event, about 2.6" per 24 hours. The goal of the MEP standard is to replicate the runoff characteristics of "woods in good conditions" and stormwater systems meeting current requirements are considered sufficient to off-set pollutant load increases caused by land use changes.

From a data management perspective, ESD to the MEP should be viewed as a systems-approach for meeting volume requirements. Where the MEP standard is met using ESD, each development site should be recorded as a single entry in MDE's Urban BMP database. There will however, be some instances where a combination of ESD techniques and conventional stormwater management practices are used to control new development runoff. In those cases, localities should take care to avoid double accounting for each new development by keeping track of the drainage area and impervious acreage unique to ESD and structural BMPs.

## IV. Structural Restoration Credits

### 1. ESD and BMP Retrofits

The water quality objective for stormwater retrofit design is to manage the largest volume of runoff possible. Numerous constraints inherent to the urban environment, though, make full ESD implementation impractical. Meeting the design standards for structural BMPs specified in the *Manual* can be difficult as well. Subsequent to discussion within the State's NPDES stormwater community, structural BMP retrofits shall be designed to meet the *Manual's* $WQ_v$ criteria.

The $WQ_v$ criteria has been a fundamental regulatory requirement for stormwater management in Maryland since 2000. Additionally, many of the CBP approved BMP efficiencies are based upon designs that treat the volume from one inch of rainfall. Retrofit opportunities that achieve less than the $WQ_v$ should be pursued where they make sense. These retrofits, however, will need to be pro-rated based on the $WQ_v$ treated. Structural stormwater retrofit credits can be applied individually or across an entire watershed.

**a. Individual Project Credit**: Retrofits shall be credited according to the following criteria:

- An acre for acre impervious credit will be given when a structural BMP is specifically designed to provide treatment for the full $WQ_v$ (one inch), or
- A proportional acreage of credit will be given when less than the $WQ_v$ is provided: (percent of the $WQ_v$ achieved) x (drainage area impervious acres)

**Table 3.** Retrofit of a Dry Pond Constructed Circa 1985

| | | |
|---|---|---|
| original design | = | 2 and 10 year peak management |
| impervious acre drainage area | = | 15 acres |
| retrofit design | = | 1 inch, or $WQ_v$ |
| impervious acre credit | = | 15 acres |
| retrofit design | = | 0.5 inch |
| impervious acre credit | = | 7.5 acres, (50% of $WQ_v$ * 15 acres) |

(Adapted from the 2000 Maryland Stormwater Design Manual)

**b. Watershed Implementation Credit**: There will be instances where BMP retrofits provide greater than one inch of volume control. These BMPs should receive additional credit. One way to do this is to calculate the one inch rainfall volume over an entire watershed. Using a larger watershed perspective, structural BMPs above and below one inch of rainfall management can be equitably credited toward the overall goal of treating the watershed to the MEP.

**2. Redevelopment** can play a significant role in reducing stormwater pollutants. First, redevelopment limits the expansion of Maryland's urban footprint, preserving undeveloped resource lands. Second, redevelopment usually occurs in older urban environments, replacing unmanaged impervious surfaces with the controls mandated in the *Manual*. Stormwater

management requirements for redevelopment are outlined in the Code of Maryland Regulations (COMAR 26.17.02.05D), and discussed in the *Manual* (Supplement 1, pages 5.117 – 5.120). These specify that some combination of impervious area reduction and water quality treatment needs to be provided.

When water quality treatment practices are provided for redevelopment, the existing impervious area treated may be credited toward restoration requirements. In most cases the credit will be equivalent to 50% of the existing impervious area for the project (per COMAR). However, when additional volume above the regulatory requirements is provided, additional credit will be accepted on a proportional basis as described in Section IV.1. above. Also, if new development results in the management of existing impervious area, i.e. < 40% according to the *Manual*, then these formerly unmanaged areas may be credited toward the impervious acre restoration requirement.

**3. Existing Roads and Subdivisions**: Many roads and subdivisions, including those built before 1985, have vegetated swale systems or sheetflow conditions that filter and treat stormwater runoff. Many of these existing features approximate the ESD designs found in Maryland's *Manual*. Each jurisdiction should conduct a systematic review of existing roads and subdivisions to determine the extent of water quality treatment already provided and to identify opportunities for retrofitting.

Land use designation may play a significant role in selecting areas that may already be adequately managed. For example, public roads and subdivisions in predominantly rural areas with low population densities, e.g., 1 dwelling unit per 5 acres or greater, will be more likely to have water quality design features equivalent to those defined in the *Manual*. If these areas can be shown to provide adequate water quality and sufficient documentation is provided to MDE, then the impervious acres can be excluded from the jurisdiction's total impervious area requiring management.

**4. Step Pool Storm Conveyance**: There are several stormwater management practices, such as the Step Pool Storm Conveyance system (SPSC), used for retrofitting that are not listed in the *Manual*. According to Anne Arundel County's Design Guidelines for SPSC (2010), these are "open-channel conveyance structures that convert, through attenuation ponds and a sand seepage filter, surface storm flow to shallow groundwater flow." When these practices are used as retrofits to capture the runoff from one inch of rainfall, the pollutant removal efficiencies from the most similar BMP type may be used. In this case, the SPSC performs very similar to a filtration practice, and therefore, the pollutant removal efficiencies for micro-bioretention can be applied to the drainage area treated. Other innovative practices that capture one inch of rainfall may also be considered for MDE approval pending further study and results of field implementation.

**5. Recording Structural BMP Retrofits**: NPDES stormwater permits require that all stormwater retrofit data be recorded on a stormwater restoration database (Appendix C). A comprehensive list of structural BMPs can be found in Table 4. All BMP efficiencies are derived from the CBP unless otherwise noted. BMP definitions and design criteria can be found in Maryland's *Manual*, materials that support the CBP's approved BMP efficiencies, and within the body of this guidance document. Impervious acres treated shall be calculated from the approved plans for each retrofit. BMP drainage areas need to be GIS-mapped as polygon shape files and linked to the restoration database. The GIS mapping of these retrofits shall be used by

localities to demonstrate how the 20% impervious cover restoration requirement is being met and also to prevent the double reporting of structural BMPs. Additionally, local governments shall use the previously calculated baseline pollutant loads, BMP implementation rates, and the efficiencies provided in Table 4 to show progress toward meeting NPDES stormwater WLAs.

**Table 4.** Structural BMP Retrofit Matrix

| BMP Practice | TN | TP | TSS |
|---|---|---|---|
| **CBP Structural BMPs** | | | |
| Dry Detention Ponds | 5% | 10% | 10% |
| Hydrodynamic Structures | 5% | 10% | 10% |
| Dry Extended Detention Ponds | 20% | 20% | 60% |
| Wet Ponds and Wetlands | 20% | 45% | 60% |
| Infiltration Practices | 80% | 85% | 95% |
| Filtering Practices | 40% | 60% | 80% |
| Vegetated Open Channels | 45% | 45% | 70% |
| Erosion and Sediment Control | 25% | 40% | 40% |
| **Stormwater Management by Era** | | | |
| Development Between 1985 - 2002 | 17% | 30% | 40% |
| Urban BMP Retrofit | 25% | 35% | 65% |
| Development Between 2002 and 2010 | 30% | 40% | 80% |
| Development After 2010 | 50% | 60% | 90% |
| **ESD to the MEP from the *Manual*** | | | |
| Green Roofs | 50% | 60% | 90% |
| Permeable Pavements | 50% | 60% | 90% |
| Reinforced Turf | 50% | 60% | 90% |
| Disconnection of Rooftop Runoff | 50% | 60% | 90% |
| Disconnection of Non-Rooftop Runoff | 50% | 60% | 90% |
| Sheetflow to Conservation Areas | 50% | 60% | 90% |
| Rainwater Harvesting | 50% | 60% | 90% |
| Submerged Gravel Wetlands | 50% | 60% | 90% |
| Landscape Infiltration | 50% | 60% | 90% |
| Infiltration Berms | 50% | 60% | 90% |
| Dry Wells | 50% | 60% | 90% |
| Micro-Bioretention | 50% | 60% | 90% |
| Rain Gardens | 50% | 60% | 90% |
| Grass, Wet, or Bio-Swale | 50% | 60% | 90% |
| Enhanced Filters | 50% | 60% | 90% |
| **Additional Structural BMP Guidance** | | | |
| Redevelopment (MDE) | 50% | 60% | 90% |
| Existing Roadway Disconnect (MDE) | 50% | 60% | 90% |
| Step Pool Storm Conveyance (MDE) | 50% | 60% | 90% |

(Adapted from CBP Urban BMP Efficiencies, and Stormwater Management by Era, MDE 2009)

## V. Alternative Restoration Credits

This section presents alternative BMPs that will give jurisdictions greater flexibility toward meeting stormwater permit requirements. These BMPs can be grouped into four main categories. First are stormwater practices that have been recently approved by the CBP, e.g., street sweeping, stream restoration, and nutrient management. Second are practices that can be derived easily from documenting changes in land use and CBP loading rates, e.g., impervious surface reduction, tree planting, and reforestation. Third are practices not traditionally used for stormwater management, but will be allowed as an option for mitigating the effects from uncontrolled development, e.g., septic system upgrades and shoreline erosion control.

The fourth category includes alternative BMPs that have been proposed by Maryland's NPDES municipalities for further examination like education, sub-soiling, trash removal, pet waste management, outfall stabilization, floodplain restoration, river bank stabilization, disconnection of illicit discharges, and bio-reactor carbon filter. These options may be used for fulfilling NPDES stormwater restoration requirements when clear performance criteria are set and monitoring data documenting pollutant removal capability are submitted to MDE for approval.

**1. Street Sweeping** removes the buildup of pollutants that have been deposited along the street or curb, using mechanical or vacuum-assisted sweeper trucks. Localities can use one of two methods to compute the projected nutrient and sediment reductions associated with street sweeping.

**a. Mass Loading Approach**: For the mass loading approach, the street dirt collected is measured in tons at the landfill or ultimate point of disposal and converted to pounds. The TSS load is then estimated by multiplying the total particulate dry mass collected by 30%, or the fraction of material reflecting the particle size that dominates TSS (Law et al., 2008). The pounds of TN and TP can be calculated by multiplying the TSS load by 0.0025 and 0.001, respectively.

**b. Street Lane Approach**: For the street lane approach, a jurisdiction reports the number of lane miles they have swept during the course of the year. The following formula is used to convert lane miles swept into acres:

$$\frac{\text{(miles swept) x (5,280 ft/mile) x (lane width ft)}}{\text{43,560 ft/acre.}}$$

The total acres swept is multiplied by the annual nutrient and sediment load for impervious surfaces, or 10.85 lbs/acre for TN, 2.04 lbs/acre for TP, and 0.46 tons/acre for TSS to arrive at a baseline load. The baseline load can be multiplied by the pollutant removal efficiencies shown in Table 5 to determine the load reduction associated with street sweeping.

The sediment and nutrient reductions are based on the sweeping technology in use, with lower reductions for mechanical sweeping and higher reductions for vacuum-assisted or regenerative air sweeping technologies. The reductions only apply to an enhanced street sweeping program

**Table 5.** Street Sweeping Pollutant Removal Efficiencies

| Technology | TN | TP | TSS |
|---|---|---|---|
| Mechanical | 4% | 4% | 10% |
| Regenerative/Vacuum | 5% | 6% | 25% |

(CBP Street Sweeping Efficiencies, 2011)

where the streets are located in commercial, industrial, central business district, or high density residential neighborhoods and they are swept on a regular basis, e.g., twice per month.

**2. Catch Basin Cleaning and Storm Drain Vacuuming** are systematic water quality based storm drain programs where routine cleanouts are performed on targeted infrastructure that have high accumulation rates. Municipal inspections of the storm drain system can be used to identify priority areas. The projected nutrient reduction associated with enhanced storm drain cleanout programs are calculated using the mass loading approach described above for street sweeping.

**3. Impervious Surface Elimination**: Eliminating impervious surfaces and replacing them with vegetation will greatly improve urban hydrology and water quality. A credit for this practice is based on the pollutant load reduction expected when land cover is converted from impervious to pervious or forest. Two scenarios are shown in Table 6. One is the conversion of urban impervious to pervious, and the other is the conversion of urban impervious to forest. The difference in pollutant loads between land covers can be used to calculate pollutant load reduction efficiencies that may be used for NPDES stormwater permit accounting.

**Table 6.** Pollutant Reduction Efficiencies Associated with Impervious Surface Elimination

| Conversion from | TN (lbs/acre/yr) | TP (lbs/acre/yr) | TSS (tons/acre/yr) |
|---|---|---|---|
| Urban Impervious | 10.85 | 2.04 | 0.44 |
| Pervious | 9.43 | 0.57 | 0.07 |
| Efficiency | 13% | 72% | 84% |
| **Conversion from** | **TN (lbs/acre/yr)** | **TP (lbs/acre/yr)** | **TSS (tons/acre/yr)** |
| Urban Impervious | 10.85 | 2.04 | 0.44 |
| Forest | 3.16 | 0.13 | 0.03 |
| Efficiency | 71% | 94% | 93% |

(Adapted from CBP Model, Version 5.3.0, 2011)

**4. Tree Planting and Reforestation**: When localities convert urban land to forest, significant hydrologic and water quality benefits accrue. Tree planting typically occurs piecemeal across the urban landscape whereas reforestation usually occurs on a much larger scale. In either case, to claim these credits a survival rate of 100 trees per acre or greater is necessary with at least 50% of the trees being 2 inches or greater in diameter at 4 ½ feet above ground level. (Maryland Department of Natural Resources, 2009). Because contiguous parcels of one acre or greater may be difficult to locate for an urban tree planting program, an aggregate of smaller sites may be used.

The same method described above for impervious surface elimination can be used for tree planting and reforestation. For example, a credit is based on the pollutant load reduction expected when land cover is converted from urban to forest. Examples of converting urban pervious and impervious land cover to forest are shown in Table 7 along with the expected pollutant reduction efficiencies. These efficiencies will be accepted for NPDES stormwater permit accounting.

**Table 7.** Tree Planting and Reforestation Pollutant Load Reduction Efficiencies

| **Conversion from** | **TN (lbs/acre/yr)** | **TP (lbs/acre/yr)** | **TSS (tons/acre/yr)** |
|---|---|---|---|
| Urban Pervious | 9.43 | 0.57 | 0.07 |
| Forest | 3.16 | 0.13 | 0.03 |
| Efficiency | 66% | 77% | 57% |
| **Conversion from** | **TN (lbs/acre/yr)** | **TP (lbs/acre/yr)** | **TSS (tons/acre/yr)** |
| Urban Impervious | 10.85 | 2.04 | 0.44 |
| Forest | 3.16 | 0.13 | 0.03 |
| Efficiency | 71% | 94% | 93% |

(Adapted from CBP Model, Version 5.3.0, 2011)

**5. Stream Restoration** has been used throughout Maryland to address a wide range of problems observed in urban streams. As a watershed is developed, changes in the natural flow regime contribute to stream instability, erosion and sediment pollution, and degraded water quality. Stream restoration techniques are used to address these impacts and re-establish a healthy aquatic ecosystem.

Stream restoration includes a number of different approaches that recognize complex interactions within the stream ecosystem in order to contribute to a wide array of watershed benefits. An individual project will utilize the most appropriate practices to address site conditions and local constraints. These practices may include: physical grading to re-establish a stable channel pattern and reconnect the stream with the floodplain; introducing habitat features such as step-pools, woody debris, or riparian vegetation; and integrating structural approaches such as rock walls or riprap. Stream restoration projects that enhance ecosystem functions and environmental benefits will qualify for pollutant removal and impervious area treatment credit.

**a. Local Monitoring Studies**: Some of Maryland's local jurisdictions have monitored to quantify pollutant removal benefits from stream restoration projects. The most notable of these is the Spring Branch Stream Study by Baltimore County. In addition, Baltimore City and Maryland State Highway Administration (SHA) have used empirical methods for estimating pollutant load reductions for site specific situations. The method used for the Baltimore City and SHA monitoring included bank pin data and sediment samples for pre-restoration conditions to predict bank erosion and nutrient loading rates.

The Spring Branch Study however, is the only project known to quantify both sediment and nutrient reductions based on pre and post-restoration monitoring. These efficiencies were used as the basis for the CBP approved stream restoration credits. The erosion problems observed in the Spring Branch were significant and are typical of many of Maryland's urban streams.

Therefore, MDE will allow the efficiencies approved by the CBP to be used for other stream restoration projects in Maryland.

**b. Literature Review**: The literature review and the CBP guidance on stream restoration (Appendix E) emphasize that restoration projects should be planned within broader watershed goals. Walsh and Kunapo, 2009, and Booth, 2005 describe the importance of dispersing stormwater controls within a watershed to mimic natural flow attenuation to improve the success of stream restoration. Further, Palmer, 2008, emphasized the importance of focusing on replacing hydrology and other watershed processes when planning restoration projects.

The credit system established by MDE includes the consideration of the research on this topic and recognizes the importance of planning stream restoration with other activities to replace natural hydrology. The information provided in the stream restoration design criteria will support these goals and provide the basis for any credit given.

**c. Stream Restoration Design Criteria**: CBP accounting principles from Appendix E have been incorporated in the criteria below. It is recognized that there are numerous methods and design strategies that may be utilized for a given stream restoration project. In addition, each project is subject to a regulatory process that requires detailed evaluation and reporting. Therefore, it will be important to consider the level of analysis and the basis for the proposed management strategy when jurisdictions use stream restoration for credit. At a minimum, each jurisdiction should report a summary of the following information as part of NPDES required watershed assessments:

- A stream stability evaluation for restoration projects
- An evaluation of upstream impacts and a description of how these may be addressed
- A description of the watershed and stream restoration strategy
- A description of maintenance and inspection activities or planned monitoring to determine the effectiveness of the project

**d. Accounting Recommendation**: The three methods described below provide options for applying credit to stream restoration projects. These methods are based on approved CBP efficiencies. As further research is developed, these numbers may be modified.

**Method I**: Baseline Stream Restoration Credit

TN = 0.02 lb/linear foot/year
TP = 0.0035 lb/linear foot/year
TSS = 2.55 lb/linear foot/year

In recognizing that stream restoration projects provide some benefit, a baseline credit may be applied toward pollutant removal rates and impervious area restored. MDE will not require intensive physical, chemical, and biological monitoring for these projects. However, inspection and maintenance is recommended to ensure that the goals of the project are met.

Impervious acreage treated = 1 acre / 100 linear feet stream restored

The impervious area credit of 1 acre restored for every 100 linear feet of stream restoration is based on the pollutant removal efficiencies for TN, TP, and TSS. MDE has developed a method for determining an equivalent impervious area credit based on the approved CBP numbers. Section VI. of this document will describe how this credit is derived for all practices.

**Method II**: Stream Restoration using ESD and Structural BMPs

The credit granted in Method I above assumes that BMPs or ESD practices have not been implemented in the uplands. Additional credit will be available when structural BMPs and ESD practices are provided in combination with a stream restoration project. Each BMP will receive credit for pollutant removal (according to that BMP type) and impervious acreage treated for its corresponding drainage area. All BMPs must meet the criteria outlined under Section IV.1. of this document.

ESD disconnection practices provide additional opportunity to receive credit on untreated impervious areas. In order to maximize the area that may be used for disconnections, field surveys may be necessary to confirm runoff drainage patterns. Local jurisdictions should use outreach efforts with private property owners to explore opportunities for using landscaped areas to establish disconnections and small scale ESD practices.

The example below illustrates how these credits are applied in conjunction with stream restoration. The data are based on a stream restoration project on 1,000 linear feet of channel. The total drainage area to the downstream point of the restored stream is 90 acres and the total impervious area is 30 acres.

**Table 8.** Stream Restoration Credits

| **BMP Credit** | **Contributing Drainage Area (Acres)** | **Impervious Area to BMP (Acres)** |
|---|---|---|
| Wet Pond | 5.8 | 3.6 |
| Infiltration | 2.2 | 1.6 |
| Wet Extended Detention | 7.4 | 3.4 |
| Filtration | 2.4 | 1.0 |
| Existing Impervious Surface Disconnections | 2.0 | 2.0 |
| Private Property Disconnects | 2.0 | 2.0 |
| | Upland BMP Sub Total: | 13.6 |
| **Stream Restoration Credit** | | |
| 1000 linear feet | 90 | 10.0 |
| | Stream Restoration Sub Total: | 10.0 |
| | Grand Total: | 23.6 |

In this example, a certain level of management is provided using upland BMPs (13.6 acres of impervious area treatment). This includes 2 acres of disconnection credit where field observations confirm that runoff from impervious surfaces will sheetflow onto vegetated areas and provide water quality treatment. Another 2 acres of disconnection practices are implemented

by working with residential property owners. Because the baseline credit is available, the upland BMPs combined with stream restoration result in a credit for a significant portion of the watershed impervious area. Incorporating these strategies together in small watersheds provides an advantage toward achieving impervious area restoration credit. As a general rule, whether Methods I or II is used, the impervious area credit for stream restoration shall not be greater than the total impervious area within the drainage for that project.

**Method III**: Local Monitoring for Stream Restoration Credits

A local jurisdiction may choose to provide more detailed monitoring for pre and post-restoration conditions in order to justify greater credit. In these situations, the jurisdiction should work closely with MDE to ensure that the monitoring program will be acceptable. Application of stream restoration credits will be based on individual review and approval and will be determined on a case by case basis. Further application to other projects within a jurisdiction may be considered. However, until more research is done toward stream restoration efficiencies and credits across Maryland, MDE does not recommend applying monitoring data across jurisdictions until the CBP accepts those data.

**6. Shoreline Stabilization**: These practices apply to the shoreline of the Chesapeake and Atlantic Coastal Bays and tidal rivers. Proper stabilization techniques can reduce shoreline erosion and improve water quality. MDE and Maryland's Chesapeake and Coastal Bays Critical Area Protection Program encourage the use of nonstructural practices or living shorelines. These include tidal marsh creation and beach nourishment. Structural practices include stone revetments, breakwaters, or groins. Further information on the design and construction of these practices can be found in MDE's *Shoreline Erosion Control Guidelines for Waterfront Property Owners* (MDE, 2008).

The Maryland Department of Natural Resources (DNR) provides a website tool, Maryland Shorelines Online (MSO), to determine shoreline erosion rates. Using this computer-driven tool and some field measurements, the cubic feet of soil lost can be estimated for an unprotected shoreline. The nutrient composition of eroding banks along the Bay shoreline is documented in the study, *Eroding Bank Nutrient Verification Study for the Lower Chesapeake Bay* (Ibison et al, 1992).

**Table 9.** Annual Shoreline Stabilization Credit

| Practice Type | TN (lbs/linear ft) | TP (lbs/linear ft) | TSS (lbs/linear ft) |
|---|---|---|---|
| Structural | 0.16 | 0.11 | 451 |
| Nonstructural | 0.16 | 0.11 | 451 |

Baltimore County used the MSO tool and the results from Ibison to estimate the pounds retained for 23 shoreline restoration projects, structural and nonstructural. MDE analyzed these data to establish nutrient and sediment removal rates that would be applicable for use in other jurisdictions, see Table 9. Because there are many factors that effect shoreline erosion and pollutant reduction can vary, a median analysis was used to prevent the influence of data

extremes. The pollutant load reduction rates provided by MDE for shoreline stabilization may be used for NPDES stormwater permit accounting.

**7. Nutrient Management** plans specify the rate, timing, and application of fertilizers to urban turf grass. Soil disturbed during the development process is required to be stabilized with grass seed and mulch according to approved erosion and sediment control plans. Soil tests are required for determining the appropriate amount of fertilizer to be applied to ensure a healthy stand of grass that will prevent further soil erosion. Once a site is stabilized, i.e. > 95%, soil tests can be used as part of a comprehensive nutrient management plan for reducing and or eliminating fertilizer use. On government-owned land, localities may claim this credit when nutrient management policies have been recently established and receipts from the jurisdiction can be used to show a commensurate reduction in the pounds of fertilizer bought.

**8. Septic Systems** are accounted for in the CBP model as a nonpoint source load allocation (LA). When describing pollutant sectors the CBP often refers to an urban load, which is actually a combination of stormwater WLAs and septic system LAs. Because these two sources are often intertwined, localities can investigate opportunities to improve septic system discharges in urban areas, which may be used for achieving reductions under NPDES stormwater permits.

The CBP estimates that septic systems, per unit, deliver 12 pounds of TN annually to the Bay. Also, the Bay Program estimates that the pollutant removal efficiency for septic system pumping is 5%, or 0.6 pounds of TN annually, and enhanced denitrification units reduce nitrogen by 50%, or 6 pounds annually. MDE estimates that when septic systems are connected to WWTP with enhanced nitrogen removal capability, then the net unit reduction is 9 pounds of TN annually. Load reductions associated with septic system maintenance, enhancements, and conversions can be used by local governments as alternative practices for meeting NPDES stormwater permit requirements.

**9. Alternative BMPs for Consideration**: The following alternative BMPs have been recommended by Maryland's NPDES municipalities for further examination: education, sub-soiling, trash removal, pet waste management, outfall stabilization, floodplain restoration, river bank stabilization, disconnection of illicit discharges, and bio-reactor carbon filter. These options may be used for fulfilling NPDES stormwater restoration requirements when clear performance criteria are set and monitoring data documenting pollutant removal capability are submitted to MDE for approval. Additionally, routine inspection and maintenance procedures for these practices shall be established to ensure longevity and performance. MDE will work collaboratively with Maryland's NPDES stormwater community and the CBP in order to determine the proper recording of any alternative BMP that appears to work well.

**10. New Technology/Innovative Practices**: MDE recognizes that new and innovative approaches to stormwater management are being developed on a continuous basis. These practices are currently allowed for redevelopment, infill development, pretreatment, and retrofit projects provided that they are accepted locally. In order to foster further innovative approaches for achieving watershed restoration goals and meeting stormwater requirements for new development projects, MDE offers the following guidelines:

- The use of any BMP must be documented in the jurisdiction's TMDL implementation plan. Documentation must include all relevant data related to the expected pollutant reduction efficiencies of the practice and describe life-cycle maintenance requirements and costs.
- Jurisdictions shall provide independently verified assessment data or propose a monitoring plan to evaluate the effectiveness of the practice.
- MDE will evaluate all monitoring data and approve any credit toward meeting pollutant reduction targets under established TMDL's.
- Jurisdictions shall submit the practice to the Bay Program's Urban Stormwater Workgroup for consideration as an EPA recognized stormwater BMP.

## VI. An Equivalent Impervious Acre

While structural BMPs have a clearly defined drainage area and imperviousness, the task of relating an impervious area controlled by alternative stormwater management practices such as street sweeping, reforestation, and stream restoration becomes more difficult. Alternative stormwater management practices however, do provide significant pollutant load reductions and should receive a credit toward NPDES restoration requirements. MDE has developed a method for relating the reduction in pollutant loads from alternative practices into an equivalent impervious acre.

**Table 10.** Pollutant Loads for Impervious and Forest Cover

| Parameter | Impervious (lbs/acre/yr) | Forest (lbs/acre/yr) | Delta (lbs/acre/yr) |
|---|---|---|---|
| TN | 10.85 | 3.16 | 7.69 |
| TP | 2.04 | 0.13 | 1.91 |
| TSS (tons) | 0.46 | 0.03 | 0.43 |

(MDE derived from CBP Model, Version 5.3.0, 2011)

Fundamental to this approach is knowing the pollutant loads associated with runoff from an acre of impervious land cover and an acre of forest. The CBP estimates that the TN load in runoff from an impervious acre is 10.85 lbs annually while the load from an acre of forest is 3.16 lbs annually. The difference between the two land covers is 7.69 lbs of TN per year. The Delta for TP and TSS loads are shown in Table 10. These differences can be used to set a level of implementation that alternative practices would need to meet to mimic forest conditions.

**Table 11.** Estimated Pollutant Load Reductions from Mechanical Street Sweeping

| Parameter | Implementation Units | Urban Impervious (lbs/acre/yr) | Reduction Efficiency | Pollutant Load Reduction (lbs/acre/yr) |
|---|---|---|---|---|
| TN | 1 acre | 10.85 | 4% | 0.43 |
| TP | 1 acre | 2.04 | 4% | 0.08 |
| TSS (tons) | 1 acre | 0.46 | 10% | 0.05 |

(MDE derived from CBP Model, Version 5.3.0, 2011)

Next, using the BMP efficiencies for street sweeping and a unit rate of implementation, a pollutant load reduction in pounds can be determined as shown in Table 11. These are based on enhanced, bi-monthly sweeping. If the Delta between impervious and forest land cover is divided into the pounds reduced as a result of street sweeping, then an equivalent impervious acre factor can be derived. Because Chesapeake Bay's TMDLs are based on TN, TP, and TSS, the equivalent impervious acre analyses for all three pollutants are averaged together to determine a single weighted equivalent impervious acre conversion factor as shown in Table 12.

**Table 12.** Equivalent Impervious Acre Analyses for Street Sweeping

| Parameter | Implementation Units | Treatment Delta (lbs) | BMP Load Reduction (lbs) | Impervious Acre Conversion Factor |
|---|---|---|---|---|
| TN | 1 acre | 7.69 | 0.43 | 0.06 |
| TP | 1 acre | 1.91 | 0.08 | 0.04 |
| TSS (tons) | 1 acre | 0.43 | 0.05 | 0.12 |
| | | | Average for Nutrients and Sediment: | 0.07 |

Examples are presented in Table 13 using the equivalent impervious acre conversion factor for street sweeping, or 0.07, along with various drainage areas, e.g., 2, 50, and 100 acres, to calculate an equivalent impervious acre. An equivalent impervious acre analysis has been conducted by MDE for each alternative stormwater management practice presented in this document and listed in Table 14, Matrix of Alternative Urban BMPs.

**Table 13.** An Equivalent Impervious Acre

| Implementation Units | Conversion Factor for Street Sweeping | Impervious Acre Equivalent |
|---|---|---|
| 2 acres | 0.07 | 0.14 |
| 50 acres | 0.07 | 3.5 |
| 100 acre | 0.07 | 7.0 |

## VII. Alternative Urban BMP Matrix

NPDES stormwater permits require that alternative urban BMPs be recorded on a stormwater restoration database (Appendix C). MDE has expanded the list of acceptable alternative BMPs for reporting and the appropriate abbreviations for coding (Appendix D). All BMPs need to be GIS-mapped as point or polygon shape files and linked to the restoration database.

BMP efficiencies and impervious acre equivalencies in Table 14 are calculated per acre of practice implementation, except where noted otherwise. For example, the pounds reduced and impervious acre equivalency for stream restoration need to be multiplied by the linear feet of the project. Catch basin cleaning needs to be multiplied by the tons of dry material removed. And, septic system pumping or treatment system changes need to be multiplied by the number of units improved.

BMP definitions and design criteria can be found in Maryland's *Manual*, materials that support the CBP's approved BMP efficiencies, and within the body of this guidance document. All BMP efficiencies are derived from the CBP unless otherwise noted, e.g., MDE. Local governments shall use the BMP efficiencies and impervious acre equivalencies in this guidance to show progress toward meeting the NPDES 20% impervious cover restoration requirement, water quality benchmarks, and stormwater WLAs.

Some of the alternative stormwater management practices, including reforestation, shoreline stabilization, and septic system upgrades may be claimed by other agencies in pursuit of the Chesapeake Bay TMDL. To prevent the double counting of BMPs, any practice used for meeting stormwater WLAs and NPDES stormwater permit conditions cannot be claimed by another program or government agency. Because local governments maintain the responsibility for various environmental regulatory programs and are the organizational structure for implementing the Chesapeake Bay Phase II WIP, it will be incumbent upon localities to prevent the double reporting of BMPs.

**Table 14.** Matrix of Alternative Urban BMPs

| BMP Practice | Efficiency Per Acre | | | Impervious Acre Equivalent |
|---|---|---|---|---|
| | TN | TP | TSS | |
| Mechanical Street Sweeping | 4% | 4% | 10% | 0.07 |
| Regenerative/Vacuum Street Sweeping | 5% | 6% | 25% | 0.13 |
| Nutrient Management | 17% | 22% | 0% | 0.09 |
| Grass/Meadow Buffers | 30% | 40% | 55% | 0.27 |
| Forest Buffers | 45% | 40% | 55% | 0.34 |
| Impervious Urban to Pervious (MDE) | 13% | 72% | 84% | 0.62 |
| Impervious Urban to Forest (MDE) | 71% | 94% | 93% | 1.00 |
| Planting Trees on Pervious Urban (MDE) | 66% | 77% | 57% | 0.38 |
| Planting Trees on Impervious Urban (MDE) | 71% | 94% | 93% | 1.00 |
| Reforestation on Pervious Urban (MDE) | 66% | 77% | 57% | 0.38 |
| Reforestation on Impervious Urban (MDE) | 71% | 94% | 93% | 1.00 |
| **BMP Practice** | **Pounds Reduced per Ton of Collected Dry Material** | | | **Impervious Acre Equivalent** |
| | **TN** | **TP** | **TSS** | |
| Catch Basin Cleaning | 1.5 | 0.6 | 600 | 0.40 |
| Storm Drain Vacuuming | 1.5 | 0.6 | 600 | 0.40 |
| Mechanical Street Sweeping | 1.5 | 0.6 | 600 | 0.40 |
| Regenerative/Vacuum Street Sweeping | 1.5 | 0.6 | 600 | 0.40 |
| **BMP Practice** | **Pounds Reduced per Linear Foot** | | | **Impervious Acre Equivalent** |
| | **TN** | **TP** | **TSS** | |
| Stream Restoration | 0.02 | 0.035 | 2.55 | 0.01 |
| Shoreline Stabilization (MDE) | 0.16 | 0.11 | 451 | 0.04* |
| **BMP Practice** | **Pounds Reduced per Unit** | | | **Impervious Acre Equivalent** |
| | **TN** | **TP** | **TSS** | |
| Septic Pumping | 0.6 | 0 | 0 | 0.03 |
| Septic Denitrification | 6.0 | 0 | 0 | 0.26 |
| Septic Connections to WWTP (MDE) | 9.0 | 0 | 0 | 0.39 |
| **Alternative BMPs for Consideration** | | | | |
| Education | | | | |
| Sub-Soiling | | | | |
| Trash Removal | | | | |
| Pet Waste Management | | | | |
| Outfall Stabilization | | | | |
| Floodplain Restoration | | | | |
| River Bank Stabilization | | | | |
| Bio-Reactor Carbon Filter | | | | |
| Disconnection of Illicit Discharges | | | | |

* Only nutrient values were used to derive impervious acre equivalent

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## Appendix A -- Stormwater Model Weblinks

Stormwater management computer models can aid local jurisdictions in establishing baseline pollutant loads, planning restoration work, and showing progress toward meeting waste load allocations (WLAs). Maryland's Assessment and Scenario Tool (MAST) developed for the Chesapeake Bay Program (CBP) and the Hydrological Simulation Program -- Fortran (HSPF), the Stormwater Management Model (SWMM), and spreadsheet versions like the Watershed Treatment Model (WTM) are acceptable for use by Maryland's NPDES localities. MAST is the only model that relates directly to the CBP model and where pollutant removal credits may be assured under the Bay's TMDL. Other models and results can be compared to the Bay model on a proportional basis for NPDES accounting purposes.

1. Maryland Assessment and Scenario Tool

http://www.mde.state.md.us/programs/Water/TMDL/TMDLImplementation/Documents/Webinars/April/WIP_Webinar_2011-04-13_MAST.pdf

2. Hydrological Simulation Program -- Fortran:

http://water.usgs.gov/software/HSPF/

3. Stormwater Management Model

http://www.epa.gov/ednnrmrl/models/swmm/index.htm

4. Watershed Treatment Model

http://www.stormwatercenter.net/monitoring%20and%20assessment/WTM_Users_Notes.htm

## Appendix B -- Maryland's Urban BMP Database

| Column Name | Data Type | Length | Description |
|---|---|---|---|
| YEAR | NUMBER | 4 | Annual report year |
| STRU_ID | TEXT | 4 | Unique structure ID |
| PERMIT_NO | TEXT | 10 | Unique permit number |
| STRU_NAME | TEXT | 60 | Structure name |
| ADDRESS | TEXT | 50 | Structure address |
| CITY | TEXT | 15 | Structure address |
| STATE | TEXT | 2 | Structure address |
| ZIP | NUMBER | 10 | Structure address |
| MD_NORTH | NUMBER | 8 | Maryland grid coordinate (NAD 83 meters) Northing |
| MD_EAST | NUMBER | 8 | Maryland grid coordinate (NAD 83 meters) Easting |
| ADC_MAP | TEXT | 5 | ADC map book coordinate (optional if BMP has MD Northing\Easting) |
| WATERSHED_CODE | NUMBER | 20 | Maryland 12-digit hydrologic unit code |
| STRU_TYPE | TEXT | 10 | Identify structure or BMP type[3] |
| RESTORATION | TEXT | 3 | Is this a stormwater restoration practice? Answer Yes or No |
| LAND_USE | NUMBER | 3 | Predominant land use[2] |
| DRAIN_AREA | NUMBER | 8 | Structure drainage area (acres)[1] |
| IMP_DRAIN | NUMBER | 8 | Structure impervious drainage area (acres) |
| TOT_DRAIN | NUMBER | 8 | Total site area (acres) |
| RCN | NUMBER | 5 | Runoff curve number (weighted) |
| ON_OFF_SITE | TEXT | 3 | On or offsite structure |
| APPR_DATE | DATE/TIME | 8 | Permit approval date |
| BUILT_DATE | DATE/TIME | 8 | Construction completion date |
| INSP_DATE | DATE/TIME | 8 | Record most recent inspection date |
| GEN_COMNT | TEXT | 60 | General comments (e.g., redundant controls) |
| LAST_CHANGE | DATE/TIME | 8 | Date last change made to this record |

[1] GIS shapefile required
[2] Use Maryland Office of Planning land use codes
[3] Use urban BMP type code

## Appendix C -- Maryland's NPDES Stormwater Restoration Database

| Column Name | Data Type | Length | Description |
|---|---|---|---|
| YEAR | TEXT | 4 | Annual report year |
| STRU_ID | TEXT | 10 | Unique structure ID |
| STRU_NAME | TEXT | 60 | Structure name |
| STRU_TYPE | TEXT | 10 | Identify structure or BMP type[3] |
| DESCRIPTION | TEXT | 60 | Brief description of the project |
| LAND_USE | TEXT | 3 | Predominant land use[2] |
| DRAIN_AREA | NUMBER | 8 | Structure drainage area (acres)[1] |
| IMP_AREA | NUMBER | 8 | Imperviousness in drainage area (acres)[1] |
| MD_NORTH | NUMBER | 9 | Maryland grid coordinate (NAD 83 meters) Northing |
| MD_EAST | NUMBER | 9 | Maryland grid coordinate (NAD 83 meters) Easting |
| WATERSHED_CODE | TEXT | 20 | Maryland 12-digit hydrologic unit code |
| PROJ_STAT | TEXT | 2 | Enter P for Proposed, UC for Under Construction, and C for Complete |
| APPR_DATE | DATE/TIME | 8 | Permit approval date |
| BUILT_DATE | DATE/TIME | 8 | Construction completion date |
| INSP_DATE | DATE/TIME | 8 | Maintenance inspection date |
| GEN_COMNT | TEXT | 60 | General comments (e.g., experimental BMP) |
| LAST_CHANGE | DATE/TIME | 8 | Date last change made to this record |

[1] GIS shapefile required
[2] Use Maryland Office of Planning land use codes.
[3] Use urban BMP type code.

## Appendix D -- Maryland's NPDES Urban BMP Index of Practices

| BMP Practice | Code |
|---|---|
| **CBP Structural BMPs** | |
| Dry Detention Ponds | DP |
| Hydrodynamic Structures | OGS |
| Dry Extended Detention Ponds | ED |
| Wet Ponds and Wetlands | WP |
| Infiltration Practices | IP |
| Filtering Practices | FP |
| Vegetated Open Channels | VOC |
| Erosion and Sediment Control | E&S |
| **Stormwater Management by Era** | |
| Development Between 1985 - 2002 | ERA1 |
| Urban BMP Retrofit | ERA2 |
| Development Between 2002 and 2010 | ERA3 |
| Development After 2010 | ERA4 |
| **ESD to the MEP from the *Manual*** | |
| Green Roofs | ESD |
| Permeable Pavements | ESD |
| Reinforced Turf | ESD |
| Disconnection of Rooftop Runoff | ESD |
| Disconnection of Non-Rooftop Runoff | ESD |
| Sheetflow to Conservation Areas | ESD |
| Rainwater Harvesting | ESD |
| Submerged Gravel Wetlands | ESD |
| Landscape Infiltration | ESD |
| Infiltration Berms | ESD |
| Dry Wells | ESD |
| Micro-Bioretention | ESD |
| Rain Gardens | ESD |
| Grass, Wet, or Bio-Swale | ESD |
| Enhanced Filters | ESD |
| **Additional Structural BMP Guidance** | |
| Redevelopment | RED |
| Existing Roadway Disconnect | ERD |
| Regenerative Stormwater Conveyance | RSC |

**Appendix D -- Maryland's NPDES Urban BMP Index of Practices**

| **Alternative Practice Type** | **Code** |
|---|---|
| Mechanical Street Sweeping | MSS |
| Regenerative/Vacuum Street Sweeping | VSS |
| Nutrient Management | NM |
| Grass/Meadow Buffers | GMB |
| Forest Buffers | FB |
| Impervious Urban to Pervious | IMPP |
| Impervious Urban to Forest | IMPF |
| Planting Trees on Pervious Urban | PTPU |
| Planting Trees on Impervious Urban | PTIU |
| Reforestation on Pervious Urban | RPU |
| Reforestation on Impervious Urban | RIU |
| Catch Basin Cleaning | CBC |
| Storm Drain Vacuuming | SDV |
| Stream Restoration | STRE |
| Shoreline Stabilization | SHST |
| Septic Pumping | SEPP |
| Septic Denitrification | SEPD |
| Septic Connections to WWTP | SEPC |
| **Alternative BMPs for Consideration** | |
| Education | EDU |
| Sub-Soiling | SUB |
| Trash Removal | TRA |
| Pet Waste Management | PET |
| Outfall Stabilization | OUTS |
| Floodplain Restoration | FPRES |
| River Bank Stabilization | RBS |
| Bio-Reactor Carbon Filter | BRCF |
| **Disconnection of Illicit Discharges** | DID |
| | |
| | |

## Appendix E -- CBP Stream Restoration Guidance

### Stream Restoration in Urban Areas
### Crediting Jurisdictions for Pollutant Load Reductions

The Chesapeake Bay Program will credit jurisdictions for reducing pollutant loads to the Bay and its tidal rivers, resulting from stream restoration in urban areas (including suburban areas). This document provides guidance to the jurisdictions regarding the stream restoration actions in urban areas that will be credited in the watershed model.

**Stream Restoration in Urban Areas**

Land cover changes in the contributing watersheds disrupt the existing natural balance between the water flow regime and sediment flux, destabilize stream channels, and increase the loadings of pollutants to downstream areas. The objectives, opportunities, and measures for stream restoration may differ in urban and rural areas. The objectives for stream restoration in urban areas include, but are not limited to, reducing stream channel erosion, promoting physical channel stability, reducing the transport of pollutants downstream, and working towards a stable habitat with a self-sustaining, diverse aquatic community. Stream restoration activities should result in a stable stream channel that experiences no net aggradation or degradation over time.

In addition to these in-stream restoration activities, addressing upland sources of stream impacts (for example, reducing watershed runoff and associated pollutant loads, or encouraging groundwater recharge) is critical to ensuring the success of stream restoration projects in urban areas. Projects should be planned in the context of a comprehensive watershed assessment or inventory, where upland sources of the problem are considered in the project design. Smaller stream restoration projects on isolated stretches of a stream can be counted as long as upland sources of impacts are considered in some way. To ensure the success of a stream restoration project in an urban area, the project must have adequate watershed controls of upstream sources of urban runoff or be designed to accommodate the current and future urban runoff volume and velocity from upstream sources.

Just like with other best management practices in the Chesapeake Bay watershed, it is important to track and monitor the effectiveness of stream restoration projects in urban areas. All projects should either have a monitoring component or regular inspection and maintenance program to ensure ongoing stability of the urban stream.

**What Types of Projects are Credited as Stream Restoration in Urban Areas?**

Pollutant load reductions associated with stream restoration projects in urban areas can be credited in the Chesapeake Bay Watershed model if they meet the following criteria:

- Projects must meet multiple objectives of stream restoration in urban areas.
- Project must be set within the context of a watershed assessment that considers the effect of upland sources to the viability of the stream restoration project.
- Project must have a monitoring component and/or regular inspections to demonstrate ongoing stability of the urban stream.

The Chesapeake Bay watershed jurisdictions will annually report the number of urban stream miles restored in each Chesapeake Bay Watershed Model county segment to the Chesapeake Bay Program Office.

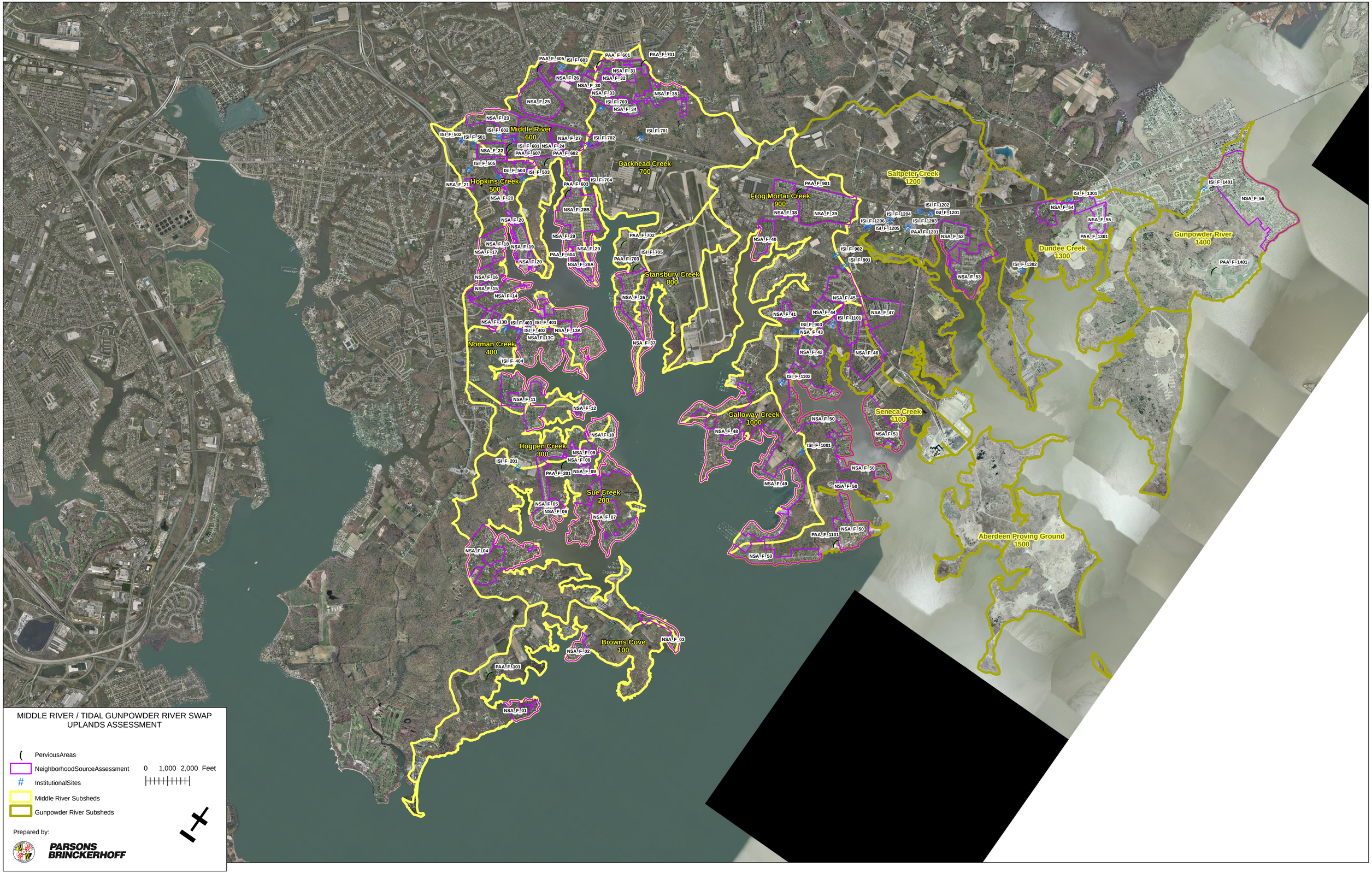
**Pollutant Load Reductions Associated with Stream Restoration in Urban Areas**

In addition to localized benefits, stream restoration in urban areas can result in reductions of pollutant loads entering the Bay and its tidal rivers. There is only one known study that quantifies the pollutant load reductions associated with stream restoration in an urban area. Although data are lacking, the Chesapeake Bay Program decided it was important to account for load reductions resulting from stream restoration. The Chesapeake Bay Program will refine these efficiencies as additional data become available. Reductions in pollutant loads entering the Bay and its tidal rivers from stream restoration in urban areas will be calculated based on the following pollutant removal efficiencies (Baltimore County, Maryland, Spring Branch Stream Study, 2002):

- TN = 0.02 lb/linear foot/year
- TP = 0.0035 lb/linear foot/year
- TSS = 2.55 lb/linear foot/year

# APPENDIX D:

## Middle River and Tidal Gunpowder SWAP Uplands Assessment Map


Middle River 600
Hopkins Creek 500
Darkhead Creek 700
Frog Mortar Creek 900
Saltpeter Creek 1200
Dundee Creek 1300
Gunpowder River 1400
Stansbury Creek 800
Norman Creek 400
Hogpen Creek 300
Sue Creek 200
Galloway Creek 1000
Seneca Creek 1100
Aberdeen Proving Ground 1500
Browns Cove 100
MIDDLE RIVER / TIDAL GUNPOWDER RIVER SWAP
UPLANDS ASSESSMENT
PerviousAreas
NeighborhoodSourceAssessment
InstitutionalSites
Middle River Subsheds
Gunpowder River Subsheds
0 1,000 2,000 Feet
Prepared by:
PARSONS BRINCKERHOFF