LOWER GUNPOWDER FALLS (RURAL)

Small Watershed Action Plan: Final Report

Prepared for
Department of Environmental
Protection and Sustainability

VOLUME 1

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Baltimore County Executive Kevin Kamenetz and the Baltimore County Council

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CHAPTER 1.0
Introduction

1.1 Purpose

This Small Watershed Action Plan (SWAP) is a strategy for the restoration and protection of the rural Lower Gunpowder Falls watershed, referred to as Area Q in this report. The report presents the plan for watershed restoration, describes management strategies for each of the six subwatersheds comprising Area Q and identifies priority projects for implementation. A schedule for implementation through 2025 that aligns with the timeframe for the Maryland pollutant reduction targets for the Chesapeake Bay TMDL 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 Baltimore County Department of Environmental Protection and Sustainability (EPS) and partners to keep moving forward with the restoration and protection of Area Q.

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 protection and restoration strategies requires the coordination of all watershed partners and the participation of many stakeholders.

Over the past year, Area Q partners have worked together, conducting field assessments, identifying restoration and protection opportunities, and engaging the community, in order to build a successful plan. A Steering Committee, consisting of watershed partners, was formed to develop the Area Q SWAP. This includes Baltimore County personnel, Gunpowder Valley Conservancy, Soil Conservation District and other organizations and leaders from the local community. The Steering Committee met six times to provide input and guidance on the development of the SWAP document. Area Q Steering Committee members are listed in Table 1-1.

Table 1-1: Area Q Steering Committee Members

Name	Organization
Dan Callihan	Baltimore County Resident
Charlie Conklin	Gunpowder Valley Conservancy
Jim Ensor	Baltimore County Soil Conservation District
Dorothy Foos	Greater Kingsville Civic Association
Melinda Fowl	Baltimore County Resident
Lisa Fraley-McNeal	Center for Watershed Protection
Dan Golliday	Glen Meadows Retirement Community
Darcy Herman	Gunpowder Valley Conservancy
Erin Kelly	Baltimore County, Dept. of Public Works
Wesley Schmidt	Baltimore County, Dept. of Environmental Protection & Sustainability
Bill Stack	Center for Watershed Protection

In addition, two community meetings were held during the SWAP development to inform and receive input from the broader public. Community meetings are intended to raise citizen awareness and solicit feedback from residents in neighborhoods, leaders from the local community, institutions and business associations regarding watershed restoration strategies. A description of each meeting including date, approximate number of attendees and topics presented is provided below.

- **Community Meeting #1** (March 7, 2017; 19 attendees including committee members): This meeting included an introduction to the SWAP process and the Area Q Steering Committee members. A description of watersheds, county goals, environmental requirements (see Section 1.3), and a SWAP framework was presented. The current conditions of Area Q were presented based on a desktop analysis and the field assessments conducted.

- **Community Meeting #2** (June 20, 2017; 9 attendees including committee members): An overview of the SWAP developed for the Area Q watershed was presented. This presentation included an overview of the SWAP process, watershed vision and goals, major watershed characterization, municipal and citizen strategies, pollutant removal analysis, subwatershed prioritization, and SWAP implementation.

1.3 Environmental Requirements

This 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 and regulations were considered during the development of this SWAP and are briefly described in the sections below.

- National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit assessment and planning requirements
- Maryland's 2016 Integrated Report of Surface Water Quality Category 5 water bodies requiring a TMDL
- Chesapeake Bay TMDL reductions for nutrients (total nitrogen, total phosphorus) and sediment to meet water quality standards
- Maryland Fertilizer Use Act of 2011
- Maryland Department of Agriculture's Revised Nutrient Management Regulations

1.3.1 NPDES MS4 Permit

Many requirements of Baltimore County's NPDES permit (11-DP-3317(MD0068314)) will be addressed by this plan. One of these requirements is to systematically assess the water quality and develop restoration plans for all watersheds within the County. These assessments must include the following:

- Provide for public participation in the development and implementation of watershed restoration activities
- Determine current water quality conditions
- Include the results of a visual watershed inspection
- Identify and rank water quality problems
- Prioritize all structural and non-structural water quality improvement projects
- Specify pollutant load reduction benchmarks and deadlines that demonstrate progress toward meeting all applicable wasteload allocations.

The County's existing NPDES permit also requires the County to address runoff from 20 percent of existing impervious cover not already treated. Continued efforts are required by the County to implement Environmental Site Design (ESD) technologies for new and redevelopment projects to the Maximum Extent Practicable (MEP) along with inspection and enforcement of the Illicit Discharge and Elimination Program. The County is also required to develop and implement plans to address stormwater waste load allocations (WLAs) established under EPA-approved total maximum daily load (TMDL) estimates. There are no local TMDLs in the Lower Gunpowder Falls watershed. In terms of meeting the Chesapeake Bay TMDL nutrient and sediment reduction targets, the County developed a Phase II Watershed Implementation Plan (WIP) in 2012

(http://www.mde.state.md.us/programs/Water/TMDL/TMDLImplementation/Documents/FINAL_PhaseII_Report_Docs/Final_County_WIP_Narratives/Baltimore_County_WIPII_2012.pdf).

1.3.2 Maryland 2016 Integrated Report of Surface Water Quality Category 5 Water Bodies

Category 5 listings in the Integrated Report (IR) indicate a water body is impaired, does not attain the water quality standards for the designated uses, and a TMDL or other acceptable pollution abatement initiative is required. This is the part of the IR historically known as the 303(d) List. The Maryland Department of the Environment designated a majority of Lower Gunpowder Falls and its tributaries as Use Class III and Use Class I (COMAR 26.08.02.08). Use Class III is Nontidal Cold Water and the designated uses include growth and propagation of trout, other fish, and other aquatic life and wildlife; water contact sports; leisure activities involving direct contact with surface water; fishing; and agricultural and industrial water supply. Use Class I is Water Contact Recreation and Protection of Nontidal Warmwater Aquatic Life. The designated uses are the same as Use III, except Use I does not include growth and propagation of trout (COMAR 26.08.02.02).

There are Category 5 listings in the 2016 Integrated Report for sulfates, total suspended solids (TSS), and chlorides in 1st through 4th order streams of the Lower Gunpowder Falls (MDE, 2016). These listings are low priority, and therefore will not be addressed by a TMDL for at least two years. The impairments were first listed in the 2012 Integrated Report. For all other water quality criteria and pollutants, the streams in the Lower Gunpowder Falls watershed meet the standards. Table 1-2 provides a summary of the impairment listing and TMDL status.

Table 1-2: Water Quality Impairment Listing and Status (MDE, 2016)

Basin Name	Designated Use	Impairment	Priority	TMDL in 2 Years
MD-02130802–Lower Gunpowder Falls	Aquatic Life and Wildlife	Sulfates	Low	No
MD-02130802–Lower Gunpowder Falls	Aquatic Life and Wildlife	Total Suspended Solids	Low	No
MD-02130802–Lower Gunpowder Falls	Aquatic Life and Wildlife	Chlorides	Low	No

1.3.3 Chesapeake Bay TMDL

The Chesapeake Bay TMDL was finalized in 2010 by the EPA to restore the Chesapeake Bay by 2025. This TMDL allocates nutrient and sediment reductions for each bay state and for Maryland that includes a 25 percent reduction in nitrogen, 24 percent reduction in phosphorus and 20 percent reduction in sediment. The load reductions are based on estimates of existing nitrogen, phosphorus and sediment from a 2009 scenario of the Bay Watershed Model

(http://www.epa.gov/reg3wapd/tmdl/ChesapeakeBay/tmdlexec.html). These reductions were further broken down by county and major river basin.

At the state level, Phase 1 Watershed Implementation Plans (WIPs) were developed to determine how each state will help meet pollutant reductions. EPA charged the Bay watershed states and the District of Columbia with developing WIPs to provide adequate "reasonable assurance" that the jurisdictions can and will achieve the nutrient and sediment reductions necessary to implement the TMDL within their respective boundaries. Maryland's Phase I WIP provided a series of proposed strategies that will collectively meet the 2017 target (70% of the total nutrient and sediment reductions needed to meet final 2025 goals). After more than a year of cooperative work, the Maryland Department of the Environment (MDE) and the Departments of Natural Resources, Agriculture, and Planning, submitted Maryland's Final Phase I WIP to EPA in December 2010. Baltimore County's Phase I plan required reductions equivalent to retrofit of 30% of pre-1985 developed land.

MDE worked with the other Maryland Bay agencies and many partners in local jurisdictions to develop Phase II WIPs with more detailed reduction targets and specific strategies to further ensure that the water quality goals of the Bay TMDL will be met (EPS, 2012). Baltimore County completed its Phase II WIP in July 2012, which was incorporated into the Maryland Phase II WIP that was finalized in October 2013. Phase II WIP reduction targets for the Baltimore County watershed urban areas are: 32.2% for nitrogen and 47.0% for phosphorus.

Table 1-3: Chesapeake Bay TMDL Nutrient Load Reduction Requirements

	Required Nitrogen Reduction	Required Phosphorus Reduction
Urban Load	32.2%	47.0%
Agricultural Load	32.0%	21.4%

Baltimore County must reduce what is referred to as the "urban sector" to meet Chesapeake Bay mandates. The Urban Load reductions in Table 1-3 above are for urban regulated stormwater. The agricultural allocation is shown in the table above because the agricultural community is also working to reduce pollution from the "agricultural sector." These pollution reduction efforts for agricultural properties are coordinated between the Maryland Department of Agriculture, Baltimore County Soil Conservation District (SCD), and local farmers. Agricultural load reductions are not part of the County's urban stormwater reduction responsibilities. Baltimore County is only responsible for the Urban Load.

1.3.4 Maryland Fertilizer Use Act of 2011

The Fertilizer Use Act of 2011 is an environmental law that limits the amount and use of phosphorus and nitrogen in lawn fertilizer products. The major components of the law include

content and labeling restrictions, use restrictions by commercial applicators and 'do-it yourself' applicators, certification requirements and a homeowner education program about best management practices. The law became fully effective on October 1, 2013.

1.3.5 Maryland Department of Agriculture's Revised Nutrient Management Regulations

The Maryland Department of Agriculture revised nutrient management regulations took effect on October 15, 2012 and will be phased in through March 1, 2020. The revised regulations call for updated nutrient management plans to address the new regulatory requirements, restrictions on organic nutrient use, and best management practices to restrict nitrogen applications.

1.4 USEPA Watershed Planning A-I Criteria

The Clean Water Act (CWA) was amended in 1987 and established the Section 319 Nonpoint Source Management Program, after recognizing the need for federal assistance with 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 human activities, wildlife and atmospheric deposition, and is deposited on the ground to eventually be carried to receiving waters by stormwater runoff. Common NPS pollutants and sources include:

- Excess fertilizers, herbicides, and insecticides from agricultural and residential lands
- Oil, grease, and toxic chemicals from urban runoff
- Sediment from improperly managed construction sites, agricultural and forest lands, and eroding stream banks
- Bacteria and nutrients from livestock, wildlife, pet waste, and failing septic systems

CWA Section 319 grant funds can be requested to support nonpoint source related 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 plans to restore impaired water bodies and address nonpoint source pollution using Section 319 funds must meet USEPA's nine minimum elements, known as the "A through I criteria" for watershed planning. The "A through I criteria" are summarized below:

A. Identification of the causes and sources that will need to be controlled to achieve the load reductions estimated in the watershed plan

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

C. A description of the NPS management measures that will need to be implemented

D. An estimate of the amount of technical and financial assistance needed to implement the plan

E. An information/education component that will be used to enhance public understanding and encourage participation

F. A schedule for implementing the NPS management measures

G. A description of interim, measurable milestones

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

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

This Area Q SWAP meets the A through I criteria. Table 1-4 shows where these criteria are addressed throughout this document.

Table 1-4: U.S. EPA Watershed Planning "A-I" Criteria

Chapter of the Report	USEPA A-I Criteria								
	A	B	C	D	E	F	G	H	I
Chapter 1. Introduction					X				
Chapter 2. Vision, Goals and Objectives					X				
Chapter 3. Restoration Strategies		X	X		X				
Chapter 4. Subwatershed Management Strategies	X		X		X				
Chapter 5. Plan Evaluation				X		X	X	X	X
Appendix A. Area Q Action Strategies			X	X	X	X	X		X
Appendix B. U.S. Environmental Protection Agency A Through I Criteria for Watershed Planning									
Appendix C. Cost Analysis and Potential Funding Sources				X					
Appendix D. Chesapeake Bay Program Pollutant Load Reduction Efficiencies		X							
Appendix E. Area Q Watershed Characterization Report	X		X		X				

Chapter of the Report	USEPA A-I Criteria								
	A	B	C	D	E	F	G	H	I
Appendix F. Potential Stream Restoration Sites	X								
Appendix G. Uplands Survey Data	X								
Appendix H. Electronic Databases and Documents related to the SWAP	X								

1.5 Partner Capabilities

In order to achieve effective watershed restoration, the capabilities of many organizations must be brought together and coordinated. Within Area Q, key partner organizations include Baltimore County EPS, Baltimore County Public Schools, Baltimore County Soil Conservation District, Gunpowder Valley Conservancy, and the Area Q SWAP Implementation Committee. Other organizations and local partners may assist with implementation on a project specific basis.

1.5.1 Baltimore County Environmental Protection and Sustainability (EPS)

Baltimore County EPS has a waterway restoration program to implement restoration projects, including stream restoration, stormwater conversions and retrofits, and reforestation projects. Baltimore County has an extensive monitoring program that assesses the current ambient water quality, efficiency of various restoration projects in relation to pollutant removal and biological community improvement, and tracks trends over time. The County also has an illicit discharge and elimination program that monitors storm drain outfalls, tracks pollutant sources, and coordinates remediation.

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

1.5.2 Baltimore County Public Schools

The Baltimore County Public Schools (BCPS) office of science uses the SWAPs to reinforce educational programming regarding environmental literacy. BCPS uses information in the SWAPs to help guide teaching of environmental planning principles. They have the ability to guide curriculum development and promote education/outreach awareness through the school system. BCPS is a valuable partner in activating schools and their local communities for involvement in environmental projects.

1.5.3 Baltimore County Soil Conservation District

The Baltimore County Soil Conservation District works with federal, state, local agencies and the private sectors/residents to address the County's soil and water conservation needs. They are not a regulatory agency, rather they promote practical and effective soil, water and related natural resource programs to all citizens on a voluntary basis through leadership, education and cooperation. Staff provides technical assistance and help to identify funding sources to install best management practices that protect water quality such as the development of Nutrient Management Plans, Soil Conservation and Water Quality Plans.

1.5.4 Gunpowder Valley Conservancy

The Gunpowder Valley Conservancy (GVC) is a non-profit land trust and waterway restoration volunteer organization. The GVC seeks to connect people from the community to the natural resources of the watershed by increasing use, appreciation and understanding of the environment, agriculture, and history through the protection and preservation of valuable open space land forever. In addition, the GVC provides people from the community a choice of hands-on preservation practices through programs, such as waterway clean-ups and adoptions, forest stewardship, rain barrels, conservation gardens, and educational outreach.

1.6 Area Q Overview

The rural Lower Gunpowder Falls watershed encompasses 18,849 acres (29.5 square miles) and lies in the Piedmont region of Maryland located along the border of the Little Gunpowder Falls watershed (Planning Area P). The Area Q planning area represents approximately 64% of the Lower Gunpowder Falls watershed drainage area. The urban portion of the Lower Gunpowder Falls (Planning Area N) makes up the remainder of the drainage area and is located to the south of Area Q. In this study, Area Q is subdivided into six subwatersheds: Cowen Run, Haystack Branch, Long Green Creek, Lower Gunpowder Falls East, Lower Gunpowder Fall West, and Sweathouse Run. (Figure 1-1). Streams in the Lower Gunpowder Falls subwatersheds drain to mainstem Gunpowder Falls which joins the Little Gunpowder Falls near the head of tide.

The Area Q watershed is completely outside of the Urban Rural Demarcation Line (URDL) that ensures limited development in the watershed through restrictions on water and sewage infrastructure extensions. Land use in the watershed is dominated by deciduous forest (27.5%), cropland (28.5%), and low-density residential (20.0%). The watershed has a low impervious cover of 9.0%. The soils in the watershed consist of mostly hydrologic soil groups B (65.7%) and C (27.6%) with moderate to low infiltration rates. The total population for the watershed is 7,429 people based on the 2010 census, which translates into a low average population density of less than 1.0 person/acre. The watershed contains 132 stream miles. Streams were evaluated in the 1999 Lower Gunpowder Falls Water Quality Management Study (WQMS; Parsons Brinckerhoff, 1999) and found that geology was a major factor in channel instability. Resistant bedrock ridges in the watershed provide grade control, while the valleys are

comprised of easily eroded alluvial fill. Further, this WQMS reinforces management approaches that include channel restoration, stream buffer improvement, bank stabilization, drainage channel retrofits, outfall retrofits, grade control, bioretention, and new stormwater management facilities.

The six subwatersheds that comprise the Area Q watershed are intended to help target restoration, preservation and monitoring efforts. The Area Q Watershed Characterization Report includes detailed analyses and descriptions of the current watershed conditions and potential water quality issues. This report is included as Appendix E of this plan. A summary of the key watershed characteristics for Area Q based on the characterization report is provided in Table 1-5.

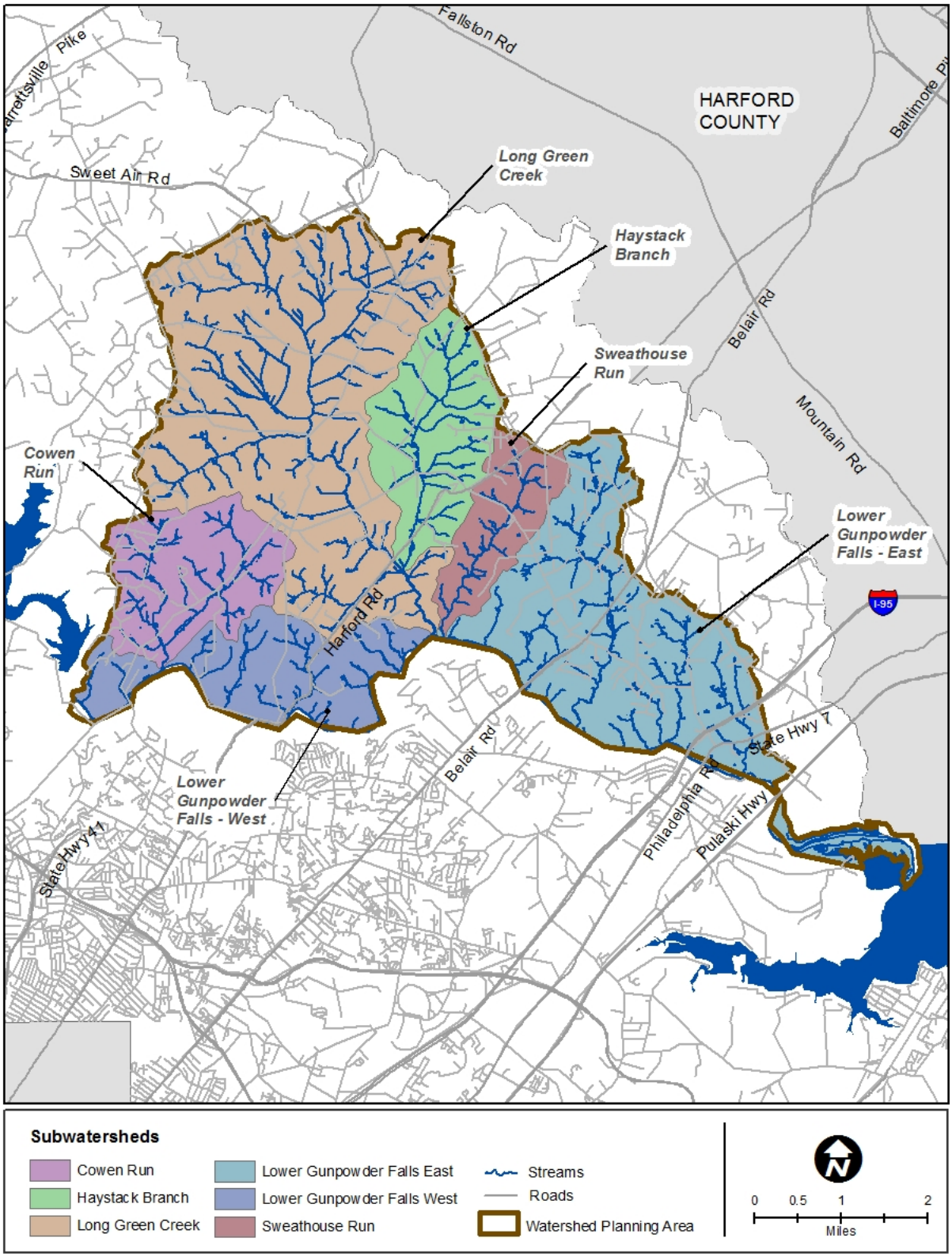

Figure 1-1: Area Q SWAP Planning Area

Table 1-5: Area Q Key Watershed Characteristics

Key Watershed Characteristics	Subwatershed						Lower Gunpowder Falls Total
	Cowen Run	Haystack Branch	Long Green Creek	Lower Gunpowder Falls East	Lower Gunpowder Falls West	Sweathouse Run	
Drainage Area (acres)	1,857.3 (2.9 mi^2)	1,895.1 (3.0 mi^2)	7,229.6 (11.3 mi^2)	4,757.6 (7.4 mi^2)	2,020.1 (3.2 mi^2)	1,089.2 (1.7 mi^2)	18,848.8 (29.5 mi^2)
Stream Miles	15.3	13.1	46.8	33.4	16.0	7.3	132.0
Total Population (2010 Census)	1,005	626	2,489	2,280	508.5	521	7,429
Land Use/Land Cover (%)							
Very Low Density Residential (Agricultural)	0.7	9.3	5.3	4.5	3.2	5.5	4.8
Very Low Density Residential (Forested)	6.4	8.3	4.8	10.0	2.9	13.2	6.9
Low Density Residential	35.5	18.7	16.5	21.4	14.8	22.3	20.0
Medium Density Residential	0.1	0.2	0.1	1.2	0.0	2.7	0.5
Commercial	1.3	0.0	0.3	0.6	1.5	0.4	0.9
Industrial	0.0	0.0	0.7	0.7	0.0	0.0	0.5
Transportation	0.0	0.0	0.0	0.7	0.0	0.0	0.2
Institutional	0.9	0.0	0.4	0.1	0.0	0.0	0.3
Open Urban Land	0.0	0.0	0.0	1.7	0.0	0.0	0.4
Agriculture	25.3	41.1	54.4	15.8	30.6	21.2	36.0
Forest	29.7	22.4	17.4	38.5	46.7	34.8	28.6
Brush	0.0	0.0	0.0	0.3	0.0	0.0	0.1
Water and Wetlands	0.0	0.0	0.0	4.3	0.7	0.0	1.2
Impervious Cover (%)	11.6	8.1	8.3	10.3	6.5	9.8	9.0
Hydrologic Soil Group (%)							
A (low runoff potential)	0.0	0.0	0.2	0.1	0.8	0.0	0.1
B	72.2	73.2	67.7	51.5	79.4	63.7	65.7
C	25.0	26.0	26.7	34.3	16.7	32.6	27.6
D (high runoff potential)	2.7	0.8	5.6	12.3	1.4	3.7	5.9

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 Area Q watershed.

Chapter 3 describes the types of watershed restoration practices planned for Area Q and estimated pollutant load reductions.

Chapter 4 discusses prioritization of restoration of the three subwatersheds in the Area Q watershed and summarizes subwatershed specific restoration and protection strategies.

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

This volume (Volume 1) also includes the following appendices with additional, detailed information used to develop and support this SWAP:

- Appendix A: Area Q Action Strategies
- Appendix B: U.S. Environmental Protection Agency A Through I Criteria for Watershed Planning
- Appendix C: Cost Analysis and Potential Funding Sources
- Appendix D: Chesapeake Bay Program Pollutant Load Reduction Efficiencies

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

- Appendix E: Area Q Watershed Characterization Report
- Appendix F: Potential Stream Restoration Sites
- Appendix G: Uplands Survey Data
- Appendix H: Electronic Databases and Documents Related to the SWAP

CHAPTER 2.0
Vision, Goals and Objectives

2.1 Vision Statement

The Area Q Steering Committee adopted the following vision statement that acted as a guide in the development of the SWAP:

We envision maintaining the pristine stream conditions and high quality watershed of the Lower Gunpowder Falls to serve as a model for other watersheds within the County that feed into the Chesapeake Bay.

2.2 Area Q SWAP Goals and Objectives

The Steering Committee created a vision statement for Area Q and identified ten goals to define the desired restoration and protection objectives. The goals were based on input from watershed residents at the first community meeting and revised with input from the Steering Committee. To achieve watershed goals and objectives, stakeholders then identified the type of restoration activities that are of interest. The action strategies developed to achieve these goals and objectives are summarized in Appendix A. The watershed goals, organized by category, are provided below:

GOALS:

Clean Water

- Goal 1: Improve and maintain clean water
- Goal 2: Reduce nitrogen, phosphorus, and sediment inputs to the Lower Gunpowder Falls watershed to meet the Baltimore County allocated load reduction for the Chesapeake Bay total maximum daily load (TMDL)

Stream Protection

- Goal 3: Reduce and control stormwater runoff to support Maryland Use Class I, III and IV designations (Water Contact Recreation and Protection of Nontidal Warmwater Aquatic Life, NonTidal Cold Water, and Recreational Trout Waters)
- Goal 4: Protect high quality streams to support cold water fisheries

Forest and Habitat

- Goal 5: Support conservation of contiguous forested areas
- Goal 6: Protect and restore riparian forest buffers to the maximum extent practicable

Agricultural Practices

- Goal 7: Preserve the agricultural heritage of the watershed
- Goal 8: Promote implementation of conservation practices on agricultural lands

Stewardship

- Goal 9: Engage the public in actions to support a healthy watershed
- Goal 10: Improve community connection to parkland and public access to streams

The following sections present a discussion of each of the ten goals for restoring and protecting the Area Q watershed that are organized by category. For each goal, a series of objectives was developed to ensure that the plan will meet each goal. Measurable action items for each objective are included in Appendix A.

Clean Water

2.2.1 Goal 1: Improve and Maintain Clean Water

The majority of Lower Gunpowder Falls and its tributaries are designated as Use Class I (Water Contact Recreation, and Protection of Nontidal Warm Water Aquatic Life), and Use Class III (Nontidal Cold Water). The designated uses include growth and propagation of trout, other fish, and other aquatic life and wildlife; water contact sports; leisure activities involving direct contact with surface water; fishing; and agricultural and industrial water supply (*COMAR* 26.08.02.02). Through community awareness, capital projects, and citizen action, the existing high quality waters in Area Q can be maintained or improved.

Objectives:

1. Increase oversight of septic system performance and promote proper maintenance of septic systems.
2. Identify and target areas to retrofit with stormwater management projects.
3. Reduce fertilizer/pesticide/herbicide use from lawns.

2.2.2 Goal 2: Reduce Nitrogen, Phosphorus and Sediment Inputs to the Lower Gunpowder Falls Watershed to meet the Baltimore County Allocated Load Reduction for the Chesapeake Bay Total Maximum Daily Load (TMDL)

In 2010, the US EPA developed a TMDL, or “pollution diet” that sets nitrogen, phosphorus and sediment load reductions to restore the Chesapeake Bay by 2025. The TMDL allocates load reductions to each of the six Bay States and District of Columbia with a goal to have practices in place by 2017 to meet 60% of the reductions. The implementation of BMPs are needed throughout the Lower Gunpowder Falls watershed on existing development as only 2.8% of the urban land in the watershed is treated with stormwater BMPs.

Objectives:

1. Meet the Chesapeake Bay TMDL goal to reduce urban loads of nitrogen by 32.2% by 2025.
2. Meet the Chesapeake Bay TMDL goal to reduce urban loads of phosphorus by 47% by 2025.
3. Reduce sediment input to the Lower Gunpowder Falls to support healthy living resources in the stream (i.e., biological communities).
4. Support ambient water quality sampling efforts throughout the Lower Gunpowder Falls watershed. Identify and target areas to retrofit with stormwater management practices and stream protection.

Stream Protection

2.2.3 Goal 3: Reduce and Control Stormwater Runoff to Support Maryland Use Class I, III and IV Designations (Water Contact Recreation and Protection of Nontidal Warmwater Aquatic Life, NonTidal Cold Water, and Recreational Trout Waters)

The streams in Area Q have an average rating as fair for both benthic macroinvertebrates and fish populations. Area Q currently has a relatively low impervious cover of 9 percent, which is an indicator of good stream health (Schueler et al. 2009). Activities should be taken to protect these high quality streams, to include the continuing use of Environmental Site Design that conserves and protects natural resources during site development.

Objectives:

1. Identify and target areas to retrofit with stormwater management projects and stream restoration.
2. Meet the County's MS4 permit goal to treat 20% of untreated impervious cover.
3. Limit impervious cover in new development in compliance with Environmental Site Design.
4. Work with Bureau of Highways to review road de-icing practices to minimize use of road salt impact on local waterways.

2.2.4 Goal 4: Protect High Quality Streams to Support Cold Water Fisheries

The strategy for this goal is to ensure that conditions to support trout streams are maintained. Landscape and stream conditions once supported a thriving native trout population. Remediation efforts, including forested buffer plantings, reductions in impervious cover, and stormwater management practices are needed to restore habitat and stream conditions for cold water fisheries.

Objectives:

1. Identify high quality trout streams and document trout populations in the waters.
2. Maintain and enhance current trout populations in the watershed.
3. Identify high quality streams.
4. Restore or sustain water temperatures in trout streams at 68° F.
5. Maintain or improve baseflow in trout streams.

Forest and Habitat

2.2.5 Goal 5: Support Conservation of Contiguous Forested Areas

The conservation of trees and forests is a key prevention measure to protect and maintain waters quality and provide many other benefits to air quality and habitat for wildlife. The Lower Gunpowder Falls watershed is 34.5% forested with the effects of development shown by the patchiness of forest cover. While 49% of the streams have a forested 100-ft buffer, continued efforts are needed to conserve remaining contiguous areas of forest. Trees and forests reduce stormwater runoff through evapotranspiration into the air and infiltration of rainwater into the soil. The presence of trees also helps to slow down and temporarily store runoff, which further promotes infiltration, and decreases flooding and erosion downstream. In addition, trees and forests reduce pollutants by transforming them into less harmful substances.

Objectives:

1. Identify and protect groundwater 'recharge' areas for forest conservation.
2. Support collaboration with watershed organizations and homeowners for projects to plant native species.
3. Work with local, state and other organizations to manage forests to limit damage from invasive species, insects and deer.
4. Improve and sustain native species and age diversity in forests.

2.2.6 Goal 6: Protect and Restore Riparian Forest Buffers to the Maximum Extent Practicable

Forested areas along stream channels benefit the physical, chemical, and biological conditions of streams by providing channel stability through root structures, processing of nutrients, shading of streams and food supplies. The buffer width required by the Baltimore County regulation can effectively protect streams. The majority of the 100-ft buffer in the Lower Gunpowder Falls watershed is forested or grass/open space. Less than 5 percent of the land cover within the buffer is impervious.

Objectives:

1. Target restoration efforts in headwater areas.
2. Continue to apply Baltimore County's forest buffer regulation to enhance and protect streams.

Agricultural Practices

2.2.7 Goal 7: Preserve the Agricultural Heritage of the Watershed

Agriculture (cropland, orchards, and pasture including horse farms) makes up the largest land use (36 percent) in Area Q. The current zoning of predominantly agriculture and rural residential combined with the lack of service for water and sewer for the Lower Gunpowder Falls watershed has allowed this area to maintain its rural character. In addition to the economic and cultural benefits of preserving agricultural land, watershed benefits of properly managed agricultural lands can include soil conservation, water quality protection, flood prevention, groundwater recharge, and wildlife habitat.

Objectives:

1. Limit upzoning through monitoring of zoning change requests.
2. Promote initiatives to increase funding for agricultural conservation easements.

2.2.8 Goal 8: Promote the Implementation of Conservation Practices on Agricultural Lands

This goal attempts to integrate the use of established, as well as new or innovative, conservation practices on all agricultural lands. There are a large number of proven agricultural practices that can be used by farmers to reduce pollutant runoff by reducing soil loss, trapping nutrients, and minimizing the amounts of nutrients and pesticides used on the land. The use of these practices will also help meet other watershed goals to maintain and restore stream conditions and aquatic biodiversity, and reduce pollution from stormwater runoff.

Objectives:

1. Work with Conservation Districts and University of Maryland Extension to inform agricultural land owners of the benefit of conservation practices/ BMPs in the restoration and protection of the Lower Gunpowder Falls Watershed.
2. Implement an urban/agricultural TMDL workgroup to promote coordination between the County and the agricultural community to reach TMDL goals.

Stewardship and Education

2.2.9 Goal 9: Engage the Public in Actions to Support a Healthy Watershed

Actions taken by private citizens and residents are an essential element to the success of the SWAP implementation. The mixed residential and rural character of the Lower Gunpowder Falls watershed provide a wide-range of type of practices that homeowners and other citizens may voluntarily adopt. Resources need to be available to connect people with available technical, educational and funding opportunities that increase awareness of actions, which people can take in their neighborhoods and on their individual properties to enhance water quality and monitor stream conditions.

Objectives:

1. Develop partnerships with a variety of stakeholders at diverse geographic locations to adopt practices that reduce pollutant loads to streams and improve stream biology.
2. Continue to develop partnerships with the Baltimore County Public Schools Office of Science to help provide meaningful environmental education experiences and opportunities for student involvement in implementing restoration activities.
3. Promote community education and increase involvement in stream clean-up activities.
4. Increase community awareness of water conservation strategies to improve stream baseflow.
5. Utilize the Lower Gunpowder Falls as a safe training location for public monitoring due to its high quality streams and marshland.

2.2.10 Goal 10: Improve Community Connection to Parkland and Public Access to Streams

The Lower Gunpowder's narrow corridors host a varied topography ranging from tidal wetlands to steep and rugged slopes. Area Q includes the Gunpowder Falls State Park, which is one of Maryland's largest state parks and includes trails, protected State Wildlands, historic sites, fishing and canoeing/kayaking streams. There are numerous outdoor recreation opportunities for the community that currently are underutilized due to the lack of awareness of existing trails and public access points. Increasing public awareness will help draw public attention to the pristine stream conditions and high quality waters within Area Q and provide education and outreach opportunities.

Objectives:

1. Increase awareness of safe and eco-friendly use of recreation opportunities.

2. Increase awareness of existing trails and public access points to the Lower Gunpowder Falls for recreational use.
3. Advocate for the responsible use of recreational areas to enhance the community's sense of propriety.

CHAPTER 3.0
Restoration Strategies

3.1 Introduction

This chapter presents an overview of the key urban restoration strategies and associated pollutant load reductions proposed for restoring the Lower Gunpowder Falls watershed. A complete list of actions proposed for the watershed including goals and objectives targeted, timelines, performance measures, cost estimates, and responsible parties is included in Appendix A.

The key urban restoration strategies are the focus of this chapter ranging from capital projects such as stormwater retrofits and stream restoration, to green infrastructure such as buffer restoration and tree planting to source control through public education and outreach. It is important that a combination and variety of restoration practices are implemented to engage citizens and meet watershed-based goals and objectives.

Watershed restoration and preservation for Lower Gunpowder Falls will occur as a partnership between the local government, watershed groups, citizens, and the agricultural community. All partners are critical to the success of the overall watershed restoration strategy. Local governments can implement large capital projects such as stormwater retrofits, stream restoration, changes in municipal operations, and large-scale public awareness. Watershed groups and citizens can implement locally based programs such as tree planting and downspout disconnection that require citizen participation, and increase awareness.

Therefore, key restoration strategies are divided into three categories: Urban Municipal Strategies (Section 3.2), Urban Citizen-Based Strategies (Section 3.3), and Agricultural Best Management Practices (Section 3.4). A summary of the existing agricultural BMPs is provided for the watershed, however, associated pollutant load reductions and additional proposed practices are not included. While the County does not receive pollution reduction credit for implemented agricultural BMPs, it will continue to work with the agricultural community to help achieve overall pollution reduction goals. It is important that all groups are active in restoration activities and that a variety of projects are implemented.

Appendix E describes the watershed pollutant loading analysis performed to estimate current nutrient and sediment loads associated with land uses and other sources (e.g. septic systems). Sections 3.2 and 3.3 present a description of Best Management Practices (BMPs) that may be implemented by the County, citizens or watershed groups to help the County comply with total maximum daily load (TMDL) requirements in the Gunpowder Falls and Chesapeake Bay watersheds. Section 3.5 discusses the Pollutant Load Reduction Analysis to Meet the TMDLs for the existing and proposed (BMP) strategies presented.

3.2 Urban Municipal Strategies

The Baltimore County government 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 Lower Gunpowder Falls are discussed in the following sections.

3.2.1 Stormwater Management

Increased importance of water quality and water resource protection led to the development of the Maryland Stormwater Design Manual which provided BMP design standards for water quality and environmental incentives (MDE, 2000). The Maryland Stormwater Act of 2007 required that all new development adopt environmental site design (ESD) to the maximum extent practicable via nonstructural BMPs and/or other improved site design techniques. The intent of ESD BMPs is to distribute and reduce flow through multiple small BMPs throughout a development site to reduce stormwater runoff leaving that site. This will also reduce loads associated with high flows and stream erosion downstream.

3.2.1.1 Existing Stormwater Management

There are 46 public and private stormwater management facilities for all land uses in Lower Gunpowder Falls, which treat 180.3 acres (2.8%) of the urban land in the watershed. Filtration practices are the most numerous. With the exception of detention ponds, designed for controlling the quantity and not the quality of runoff, these stormwater management facilities provide water quality treatment.

3.2.1.2 Stormwater Management Conversion

Older stormwater management facilities were typically designed only for water quantity management and have little to no pollutant removal benefit. However, these facilities can generally be altered to capture and retain stormwater runoff to provide water quality benefits. This is referred to as a stormwater pond conversion. These facilities were assessed and six ponds were identified as potential candidates for conversion projects, treating 77 acres.

3.2.1.3 Stormwater Retrofits

Stormwater retrofits involve implementing BMPs in existing developed areas where stormwater management practices do not exist to help improve water quality. Stormwater retrofits improve water quality by capturing and treating runoff before it reaches the receiving water body. Potential sites for upland stormwater retrofits include the installation of one Regenerative Storm Conveyance, two Grass Swales, and two Bioretention facilities. In total, these retrofits will treat 2.45 impervious acres.

Impervious surfaces including roads, parking lots, rooftops, and other paved surfaces prevent precipitation from naturally infiltrating into the ground. As a result, impervious surface runoff can result in erosion, flooding, habitat degradation, and increased pollutant loads and temperature impacts in receiving water bodies. Subwatersheds with high amounts of impervious cover are more likely to have degraded stream systems and are larger contributors to water quality problems in a watershed than those that are less developed as discussed in Appendix E, Chapter 2.3.3. Removing impervious cover and converting to pervious or forested land will help promote infiltration of runoff and reduce pollutant loads from overland runoff.

Two institutional site treating 0.80 impervious acres were identified for impervious cover removal in Lower Gunpowder Falls. Additional opportunities for impervious cover removal could be identified through awareness and outreach tools to inform residents of the water quality impacts associated with large impervious parking lots, driveways or patios and the options available for conversion to, or incorporating more, permeable surfaces.

3.2.2 Stream Corridor Restoration

Stream restoration practices are used to enhance the appearance, stability, and aquatic function of urban stream corridors. Stream restoration practices range from routine stream cleanups and simple stream repairs such as vegetative bank stabilization and localized grade control to comprehensive repairs such as full channel redesign and realignment. Stabilizing the stream channel improves water quality by preventing soils, and the pollutants contained in them, from eroding from the bank and entering the waterway. Sediment from stream bank and channel erosion was also found to be one of the leading stressors contributing to biological impairment in the watershed which prompted the development of the sediment TMDL.

No comprehensive stream corridor assessments (SCAs) were performed in the Lower Gunpowder Falls watershed as part of this SWAP. Instead, the 1999 Lower Gunpowder Falls Watershed Water Quality Management Study (WQMS; Parsons Brinckerhoff, 1999) was reviewed for potential stream restoration opportunities. These projects were revisited to evaluate if the need and potential for restoration still existed. In another previous study of Cowen Run, Baltimore County Environmental Protection and Sustainability (EPS) Watershed Restoration Section staff walked and assessed nearly the entire subwatershed for stream restoration potential during 2015 and 2016. Overall, 30,400 feet of streams were determined to be suitable for restoration projects.

3.2.3 Reforestation/Tree Planting

Trees provide aesthetic value, and air and water quality benefits. They can provide shade and absorb nutrients through their root systems while also providing habitat for wildlife. Tree planting incentive programs can also help increase the success of planting efforts. Converting grassed and open areas in the upland portion of the watershed to forested areas through tree plantings can also reduce runoff and nutrient inputs to nearby water bodies and their erosion. A total of 179 individual properties were identified through a desktop GIS analysis within the Lower Gunpowder Falls watershed, totaling approximately 444 acres of potential tree plantings.

It should be noted that pollutant load reductions attributed to these sites have not yet been calculated because further field evaluation is required to verify their tree planting potential. In addition to the areas discussed above, the Institutional Site Investigation (ISI) identified ten institutional sites with a potential for 18.11 acres of tree planting. Load reductions have been calculated for these ISI sites.

3.3 Urban 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 water bodies within the watershed that would otherwise not be possible. Citizen participation is critical to the implementation and long-term maintenance of restoration activities. Key citizen-based strategies proposed for restoring the Lower Gunpowder Falls watershed are discussed in the following sections.

3.3.1 Tree Planting

Trees strategically planted around a house can form windbreaks to reduce heating costs in the winter and can provide shade which reduces cooling costs in the summer. Incentive programs, such as Tree-Mendous Maryland (http://www.dnr.state.md.us/forests/treemendous), the State Highway Administration's Partnership Program for public property, and the Baltimore County Big Tree Sales for private residential properties (http://www.baltimorecountymd.gov/Agencies/environment/forestsandtrees/bigtrees.html), help increase successful planting efforts. Twelve of the 30 assessed neighborhoods were identified for lot canopy improvements and included 87 acres of land that could potentially be replanted.

3.3.2 Riparian Buffer

Stream riparian buffers are critical to maintaining healthy streams and rivers. Forested buffer areas along streams can improve water quality and prevent flooding since they filter pollutants, reduce surface runoff, stabilize stream banks, trap sediment, and provide habitat for various types of terrestrial and aquatic life including fish. Buffer encroachment from development was noted during neighborhood surveys conducted throughout the watershed. Fourteen out of the 30 neighborhoods were recommended for better stream buffer management due to encroachment. These areas can be targeted for buffer awareness initiatives to encourage landowners to plant trees and/or create a no-mow area adjacent to streams.

Approximately 359.6 acres of urban open pervious areas identified within the 100-foot stream buffer were identified through a GIS analysis discussed in Appendix E. This area is a good candidate for tree planting and is recommended for initial buffer reforestation efforts.

3.3.3 Urban Nutrient Management

Many common activities around homes can have a negative effect on water quality. Yards and lawns typically represent a significant portion of the pervious cover in an urban subwatershed and therefore, can be a major source of nutrients, pesticides, sediment, and runoff. Maintenance behaviors tend to be similar within individual neighborhoods and certain activities can impact subwatershed quality such as fertilizer, herbicide and pesticide use, lawn watering, landscaping, and trash/yard waste disposal. Urban nutrient management efforts related to lawn maintenance and Bayscaping can help reduce nutrient loads to nearby streams. Citizen awareness and behavior change is key to improved urban nutrient management.

3.3.3.1 Lawn Maintenance Education

Lawn maintenance activities that involve over-fertilization, improper use of herbicides and pesticides, and over-watering may result in polluted 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 issues are targeted for awareness programs emphasizing responsible fertilizing techniques such as proper application rates and time of year for fertilization, soil testing for nutrient requirements and keeping fertilizers off impervious surfaces. Lawn maintenance education can be achieved through door-to-door canvassing, informational brochures/mailing, 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. During the Neighborhood Source Assessment, ten neighborhoods were identified for a fertilizer reduction/education program.

3.3.3.2 Bayscaping

Reducing the amount of mowed lawn and increasing landscaping features with native vegetation 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, fertilizer, herbicides and pesticides to maintain as compared to non-native or exotic plants. This means that there will be 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. Many of the neighborhoods are already fairly wooded and/or landscaped; twelve of 30 neighborhoods were identified as potential candidates during the Neighborhood Source Assessment.

3.3.3.3 Maryland Fertilizer Use Act of 2011

This act, which bans phosphorus in most fertilizer products and provides a greater percentage of slow release nitrogen in fertilizer, took effect in October 2013. Fertilizer bags sold in hardware stores and nurseries now have better labeling, and large applicators will have to be

certified in proper fertilizer application. There are 2,903.4 acres of urban pervious areas in the watershed where this Act applies.

3.4 Agricultural Best Management Practices

Approximately 36% of the Lower Gunpowder Falls watershed is agricultural land use that includes cropland, pasture, orchards, or agricultural buildings. There are many agricultural practices used by farmers to reduce soil loss, trap nutrients, and minimize nutrient and pesticide use on the land. As of October 2016, there were 22 agricultural BMPs in the watershed reported by the Baltimore County Soil Conservation District (SCD).

The Maryland Department of Agriculture in conjunction with the SCD works with farms to implement BMPs in an effort to improve water quality. While the County does not receive pollution reduction credit for implemented agricultural BMPs, it will continue to work with the agricultural community to help achieve overall pollution reduction goals for the watershed. The existing agricultural BMPs in the watershed are explained below. Baltimore County EPS is in the process of forming an agricultural TMDL workgroup to promote coordination between the County and agricultural community to identify practices for future implementation and reach TMDL goals. Pollution load reduction targets from the 'agricultural sector' based on future implementation of agricultural BMPs will be coordinated between the Maryland Department of Agriculture, Baltimore County SCD and local farmers.

3.4.1 Soil Conservation and Water Quality Plans

A Soil Conservation and Water Quality Plan (SCWQP) is a comprehensive plan that addresses natural resource management on agricultural lands. It describes BMPs which will be used to control erosion and sediment loss, and manage runoff. These plans are required on farmland enrolled in the Maryland Agricultural Land Preservation Foundation Program and by the Federal Food Security Act on all highly erodible lands. Some of the BMPs currently implemented in Lower Gunpowder Falls are discussed below.

3.4.1.1 Diversion

A diversion is a channel generally constructed across the slope with a supporting ridge on the lower side. It can be used for a number of purposes, including breaking up concentrated flow on long slopes, or on land that is generally considered too flat or irregular for terracing; reducing damage from upland runoff; or diverting water away from active gullies or critically eroding areas. There are 1,280 feet of diversion structures installed in the watershed.

3.4.1.2 Forage and Biomass Planting

This BMP consists of establishing adapted and/or compatible herbaceous species suitable for pasture, hay, or biomass production. It can be used to provide or increase forage supply during periods of low forage production to improve livestock health or as a feedstock for biofuel or energy production. As a water quality BMP, it helps reduce soil erosion and improve soil water

quality similarly to vegetation establishment for urban erosion and sediment control. A total of 4.1 acres of forage/biomass planting have been implemented.

3.4.1.3 Livestock Pipeline

A livestock pipeline is installed to convey water through a closed conduit for livestock or wildlife. It provides an alternative to streams for watering livestock and helps to prevent streambank failure and erosion. Farms have installed 1,135 feet of pipelines for this purpose.

3.4.1.4 Roof Runoff Structures

Roof runoff structures are implemented to collect, control and convey runoff from roofs of agricultural structures. They can protect surface water quality by excluding roof runoff from contaminated areas and reduce washoff of contamination to streams. They can also increase infiltration of runoff if soils are appropriate. At present, one site in the watershed has installed this type of BMP.

3.4.1.5 Heavy Use Area Protection

This practice involves the stabilization of areas frequently and intensively used by people, animals or vehicles by establishing vegetative cover, surfacing with suitable materials, and/or installing needed structures. There are currently 0.3 heavy use protection acres in the watershed.

3.4.1.6 Stream Crossings

Stream crossings are stabilized areas or structures constructed across a stream to provide a travel way for people, livestock, equipment, or vehicles. They help improve water quality by reducing streambank and streambed erosion, in turn reducing sediment, nutrient, organic, and inorganic loading of the stream. There is currently one stream crossing BMP in the watershed.

3.4.1.7 Nutrient Management Plans

Nutrient management plan (NMP) implementation refers to a comprehensive plan that describes the optimal use of nutrient inputs for crop yield to minimize loss of excess nutrients to the environment. It is a requirement through the Maryland Water Quality Improvement Act of 1998 for farmers to incorporate specific management practices in their operations. A NMP details the type, rate, timing, and placement of nutrients for each crop. Soil, plant tissue, manure and/or sludge tests are used to assure optimal application rates. Plans are prepared by either University of Maryland Extension or certified private consultants, and are typically revised every year but may be written for up to three years to incorporate management, fertility and technology changes. There are currently 295.3 acres covered by nutrient management plans in the watershed.

3.4.1.8 Watering Facilities

A watering facility without stream fencing is used to provide livestock and/or wildlife with drinking water to meet daily needs. It is sometimes installed to keep livestock out of streams and other surface water areas where water quality is a concern. A tank can be installed to

store water to supply the trough. A watering ramp can be used to provide a controlled access to a pond or stream. There are currently three watering facilities in the watershed.

3.4.1.9 Critical Area Planting

This BMP consists of establishing permanent vegetation on sites that have, or are expected to have, high erosion rates, and on sites that have physical, chemical, or biological conditions that prevent the establishment of vegetation with normal seeding/planting methods. It is used to stabilize areas with existing or expected high rates of soil erosion by wind or water stabilize stream and channel banks, pond and other shorelines, earthen features of structural conservation practices, or to stabilize riparian areas. Planting has been completed for 0.3 acres.

3.4.1.10 Streamside Fence (10' - 34')

Streamside fencing is the installation of fencing along streams to exclude livestock. The fenced areas may be planted with trees or grass, but are typically not wide enough to provide the benefits of buffers. Stream fencing should be implemented so as to substantially limit livestock access to streams; however, it can allow for the use of limited hardened crossing areas if other options aren't possible to accommodate access to additional pastures or for livestock watering. By preventing or limiting access of livestock to streams, erosion from hooves and bacteria / nutrient contamination from cows in the stream is reduced. A total of 4,595 feet of fencing are currently in place.

3.4.1.11 Non-Streamside Fence

This BMP consists of fencing to control animal movement. It includes fencing for purposes other than keeping livestock out of streams, such as dividing pastures to allow rotational grazing. The use of fencing can decrease erosion, improve water quality, and evenly distribute nutrients in pastures. 1,300 feet of this type of fencing have been constructed in the watershed.

3.5 Pollutant Load Reduction Analysis to Meet the TMDLs

This section presents results of the watershed pollutant loading analysis performed to estimate current nutrient and sediment loads generated by the various non-point sources within the Lower Gunpowder Falls watershed.

3.5.1 TMDL Pollutant Load Reduction Requirements

The runoff pollutant loading analysis for the watershed was based on land use area from the following source:

- Baltimore County's Land Cover Dataset (BCLCD) created by overlaying the 2011 National Land Cover Dataset (NLCD) with Baltimore County's 2014 impervious surface data, and reclassifying the result to match the loading rate land use categories.

Pollutant loading rates were based on the following source:

- Pollutant loading rates were estimated by means of watershed-specific pollutant loading rates for nitrogen, phosphorus, and sediment based on the Chesapeake Bay Program (CBP) July 2011 Watershed Model. The model derived segment-specific loading rates for urban and non-urban land uses.

Urban pervious and impervious edge-of-stream nutrient loading rates were provided by Baltimore County and derived as watershed-specific pollutant loading rates based on the Maryland Assessment and Scenario Tool in July 2011. The pollutant loading analysis is described in detail in Chapter 3.3 of the Watershed Characterization Report (Appendix E). Table 3-1 presents the per-acre loadings for nitrogen, phosphorus and sediment used in this analysis. The urban loading rates are used for the reduction analysis discussed below.

Table 3-1: Land Cover per Acre Nitrogen and Phosphorus Edge-of-Stream Loadings (pounds/acre/year)

Land Cover	Nitrogen Load per Acre	Phosphorus Load per Acre	Area (acres)
Urban Pervious*	11.55	0.30	2,903.4
Urban Impervious	17.36	1.51	858.9
Cropland	23.08	1.32	2,737.9
Pasture	7.76	0.72	3,952.9
Forest	2.78	0.04	8,344.0
Water	10.26	0.61	50.1
Extractive	16.30	2.59	1.7

The results of this reduction analysis are presented in Table 3-2 showing the average annual urban loads of nitrogen and phosphorus. The Chesapeake Bay TMDL requires 32.2% and 47.0% reductions in nitrogen and phosphorus respectively from the County MS4 (urban) loads. Table 3-2 also presents the pollutant removals needed to achieve these reduction goals.

Table 3-2: Land Cover Nitrogen, and Phosphorus Edge-of-Stream Loads (pounds/year)

Land Cover	Nitrogen (lbs)	Phosphorus (lbs)	Nitrogen Reduction	Phosphorus Reduction
		Urban Percent	32.2%	47.0%
Urban	48,445	2,168	15,599	1,019
Agriculture	93,865	6,460		
Forest/Wetlands	23,196	334		
Water	514	31		
Extractive	28	4		
Septics	22,294	0		
Total	188,342	8,997		

For purposes of this SWAP, the reductions are applied to the urban load. Nutrient loads associated with all other land uses were not incorporated into these reduction estimates.

3.5.2 Pollutant Load Reduction Calculations

This section presents a quantitative analysis of pollutant removal capabilities of existing and proposed BMPs. Many of the calculations and estimates presented in the following subsections represent maximum potential pollutant removal capabilities. A summary of overall pollutant load reduction estimates is presented at the end of this section.

Most pollutant removal calculations are based on Chesapeake Bay Program models that credit nutrient reductions specific to individual scenarios as efficiencies or land use conversions. Table 3-3 shows the Chesapeake Bay Program removal efficiencies of some stormwater management practices and Appendix D presents the full suite of best management practices and the associated efficiencies.

Table 3-3: Pollutant Removal Rates

SWM Facility Type	TN Removal Efficiency (%)	TP Removal Efficiency (%)	TSS Removal Efficiency (%)
Detention	5%	10%	10%
Extended Detention	20%	20%	60%
Filtration	40%	60%	80%
Infiltration	80%	85%	95%
Proprietary	40%	60%	80%
Wet Ponds and Wetlands	20%	45%	60%
Bioretention	70%	75%	80%
Grass Swale (Bioswale)	70%	75%	80%
Sand Filter	40%	60%	80%
Porous Pavement (no underdrain)	80%	80%	85%
Rainwater Harvesting	100%	100%	100%
Regenerative Stormwater Conveyance (Dry)	50%	50%	50%
Urban Stream Buffers	25%	50%	60%
Conversion Dry Pond to Wet Pond	15%	35%	50%
Stream Restoration*	0.075	0.068	44.88

**Stream restoration removal rates are lbs/linear foot*

Listed below are descriptions of how the reduction numbers displayed in Table 3-6, Table 3-7, and Table 3-8 are derived for specific BMPs.

3.5.2.1 Existing Urban SWM Practices

As described in detail in Section 2.3.6 of the *Watershed Characterization Report* (Appendix E), there are 46 existing SWM facilities in Lower Gunpowder Falls including detention and extended detention dry ponds, infiltration/filtration practices and wet ponds. The pollutant loading analysis included in Appendix E did not account for the existing SWM practices in the watershed. The pollutant load reduction from existing SWM practices are taken into account as part of this analysis. All of the Lower Gunpowder Falls facilities have had their drainage areas digitized, and therefore actual pollutant loads from the drainage areas can be modeled. Removal efficiencies used for all facilities are those in Table 3-3.

3.5.2.2 Stormwater Management Conversion

Six detention ponds have the potential for conversion to water quality treatment. Pollutant reductions are calculated based on the pollutant load received from the drainage area (DA). This has been calculated with a weighted average of the load per acre and area of pervious and impervious area for the watershed. Removal rates are based on increased removal efficiency from dry to wet ponds, shown in Table 3-3.

3.5.2.3 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., streets, parking lots) which are currently untreated. Sites noted for retrofit potential during the upland surveys included the number of sites and impervious acreage treated shown in Table 3-4 below.

Table 3-4: Stormwater Retrofit Treated Area

Stormwater Retrofit	Number of sites	Area in acres
Regenerative Stormwater Conveyance	1	0.99
Grass Swales	2	0.47
Bioretention	2	0.99
Impervious Cover Removal	2	0.80

Pollutant reductions for the regenerative stormwater conveyance, grass swales, and bioretention retrofits are calculated based on the pollutant load generated from the impervious area and removal efficiency shown in Table 3-3.

Impervious cover removal involves converting impervious surfaces to pervious surfaces such as turf. 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 (Table 3-1), as follows (in lb/ac/yr):

TN: 17.36 – 11.55 = 5.81
TP: 1.51 – 0.30 = 1.21

The total reduction is the reduced loading rate multiplied by the area proposed for the projects.

3.5.2.4 Stream Corridor Restoration

Pollutant reductions for stream corridor restoration are calculated based on the load reduction factors provided by CBP (Appendix D) multiplied by the linear feet of the proposed restoration site.

Table 3-5: Proposed Stream Restoration Length

	Number of sites	Length in feet
Cowen Run	1	4,500
Haystack Branch	2	3,640
Long Green Creek	7	18,140
Lower Gunpowder Falls East	4	3,710
Lower Gunpowder Falls West	1	410
Total	15	30,400

3.5.2.5 Urban Stream Buffer Reforestation

Pollutant reductions for stream buffer reforestation are calculated based on a land use conversion from pervious urban to forest plus an additional reduction efficiency based on BMP performance guidance from CBP (Appendix D). A total of 1,594.4 acres of open pervious land were assessed for reforestation within the 100-foot stream buffer through a GIS analysis described in Appendix E. Approximately 359.6 of these acres are in urban areas, with the remainder located in agricultural areas. The pollutant load for forested land is subtracted from the current urban pervious load to obtain the land use change reduction. A reduction efficiency of 25% for nitrogen and 50% for phosphorus yields the reduction efficiency estimates. The reduction efficiency and land use change numbers are then summed to achieve the total nutrient reduction estimate.

3.5.2.6 Institutional Tree Plantings

Tree planting opportunities were identified at many institutional sites. Pollutant reductions for pervious area reforestation are calculated based on a land use conversion from pervious urban to forest. An estimated 18.11 acres were identified based on the land available and a planting density of 200 trees/acre.

3.5.2.7 Urban Nutrient Management – Maryland Fertilizer Use Act of 2011

The State of Maryland passed the Maryland Fertilizer Use Act of 2011 (the Act) that took effect in October 2013. Load reductions were modeled with The Chesapeake Bay Program Urban Nutrient Management Expert Panel Report recommendations:

- TN reductions of 9.0 percent for commercial applicators of fertilizer
- TN reductions of 4.5 percent for "do-it yourself" fertilizer applicators
- 25% reduction for TP for urban nutrient management.

In Lower Gunpowder Falls, this reduction will apply to an estimated 2,903.4 acres of urban pervious land, assumed as a 50/50 split between commercial and DIY applications. Pollutant reductions are calculated based on the urban pervious pollutant load multiplied by the acres of urban pervious land, then the pollutant reduction efficiency.

3.5.3 Overall Pollutant Load Reductions

For nitrogen and phosphorus, respectively, Table 3-6, Table 3-7, and Table 3-8 present summaries of the maximum potential pollutant load reductions, the methods used to credit each BMP, pollutant removal efficiencies, number of BMPs available for restoration, and projected load reductions. The projected implementation of BMP restoration projects shown is as follows:

Table 3-6: Urban Edge-of-Stream Load Reduction per Pollutant

Pollutant	Total Urban Load (lb.yr)	Load Reduction (lb/yr)	Percent Reduction	Chesapeake Bay TMDL Required Reduction (%)	Chesapeake Bay TMDL Required Reduction (lb/yr)	Additional Reduction Needed (lb/yr)
TN	48,445	6,415	13.3%	32.2%	15,599	9,184
TP	2,168	1,446	66.7%	47.0%	1,019	0

Additional reductions in the Lower Gunpowder Falls watershed may be achieved as new BMPs are identified by the CBP or the CBP identifies ways to enhance the efficiency of existing BMPs.

The Chesapeake Bay Program is continuously reviewing the types and removal efficiencies for BMPs that may result in new BMPs or changes in pollutant load reductions that may be achieved with existing BMPs. The restoration practices identified in the SWAP should be revisited and adapted based on this information.

Table 3-7: Current and Projected Edge-of-Stream Nitrogen Reductions due to Urban BMPs

	BMP	How Credited	TN Efficiency	Units available	Projected Participation	Max. Potential TN Load Reduction (lbs/yr)	Projected TN Load Reduction (lbs/yr)
	Restoration Options						
Existing Urban	Urban Nitrogen to be removed to meet the Bay TMDL 32.2% Reduction						15,599
	Detention	Efficiency	5.0%	27.0 ac	100%	17.4	17.4
	Extended Detention	Efficiency	20.0%	160.6 ac	100%	413.6	413.6
	Filtration	Efficiency	40.0%	135.0 ac	100%	695.3	695.3
	Infiltration	Efficiency	80.0%	0.6 ac	100%	6.2	6.2
	Wet Ponds and Wetlands	Efficiency	20.0%	254.9 ac	100%	656.4	656.4
	Maryland Fertilizer Use Act of 2011	Efficiency	DIY: 4.50% Commercial: 9.00%	1,451.7 ac 1,451.7 ac	100%	2.263.5	2,263.5
	Nitrogen removed from existing urban practices						4,052.4
Proposed Urban	Regenerative Stormwater Conveyance (Dry)	Efficiency	50%	1.0 ac	100%	8.6	8.6
	Grass Swale (Bioswale)	Efficiency	70%	0.5 ac	100%	5.7	5.7
	Bioretention	Efficiency	70%	1.0 ac	100%	12.0	12.0
	Impervious Cover Removal	LU Change	Land Use Reduction	0.8 ac	100%	4.6	4.6
	Institutional Tree Planting	LU Change	Land Use Reduction	18.1 ac	25%	158.8	39.7
	Conversion Dry-to-Wet	Efficiency	15%	76.7 ac	50%	148.0	74.0
	Stream Restoration	Load Reduction	0.075 lb/ft/yr	30,400 ft	50%	2,280.0	1,140.0
	Urban Stream Buffers	LU Change + Efficiency	25.0% and Land Use Reduction	359.6 ac	25%	4,311.3	1,077.8
	Nitrogen removed from proposed urban practices						2,362.4
	Total Load Reduction (lbs/yr):						6,414.8
	Total Existing Annual Urban Load (lbs/yr):						48,444.8
	Reduction Achieved:						13.2%
	Percent of TMDL Goal Achieved:						41.1%

Table 3-8: Current and Projected Edge-of-Stream Phosphorus Reductions due to Urban BMPs

	BMP	How Credited	TP Efficiency	Units available	Projected Participation	Max. Potential TP Load Reduction (lbs/yr)	Projected TP Load Reduction (lbs/yr)
	Restoration Options						
Existing Urban	Urban Phosphorus to be removed to meet the Bay TMDL 47.0% Reduction						1,019
	Detention	Efficiency	10.0%	27.0 ac	100%	1.6	1.6
	Extended Detention	Efficiency	20.0%	160.6 ac	100%	18.5	18.5
	Filtration	Efficiency	60.0%	135.0 ac	100%	46.7	46.7
	Infiltration	Efficiency	85.0%	0.6 ac	100%	0.3	0.3
	Wet Ponds and Wetlands	Efficiency	45.0%	254.9 ac	100%	66.1	66.1
	Maryland Fertilizer Use Act of 2011	Efficiency	25%	2,903.4 ac	100%	217.8	217.8
	Phosphorus removed from existing urban practices						351.0
Proposed Urban	Regenerative Stormwater Conveyance (Dry)	Efficiency	50%	1.0 ac	100%	0.8	0.8
	Grass Swale (Bioswale)	Efficiency	75%	0.5 ac	100%	0.5	0.5
	Bioretention	Efficiency	75%	1.0 ac	100%	1.1	1.1
	Impervious Cover Removal	LU Change	Land Use Reduction	0.8 ac	100%	1.0	1.0
	Institutional Tree Planting	LU Change	Land Use Reduction	18.1 ac	25%	4.7	1.2
	Conversion Dry-to-Wet	Efficiency	35%	76.7 ac	50%	15.5	7.7
	Stream Restoration	Load Reduction	0.068	30,400 ft	50%	2,067.2	1,033.6
	Urban Stream Buffers	LU Change + Efficiency	50.0% and Land Use Reduction	359.6 ac	25%	197.1	49.3
	Phosphorus removed from proposed urban practices						1,095.2
	Total Load Reduction (lbs/yr):						1,446.2
	Total Existing Annual Urban Load (lbs/yr):						2,167.9
	Reduction Achieved:						66.7%
	Percent of TMDL Goal Achieved:						141.9%

As shown by the tables above, the actions recommended by this SWAP will be sufficient to meet the reductions required by the Bay TMDL for phosphorus, but not for nitrogen. The proposed urban measures will only meet 41.1% of the nitrogen TMDL reduction goal. The phosphorus treatment, at 142%, more than meets the requirement.

To address this deficiency, additional stormwater retrofit opportunities will need to be identified. Table 3-6 shows that an additional 9,184 lbs of nitrogen will need to be reduced to meet the urban sector Bay TMDL requirements. Using loading rates from Table 3-1 and bioretention efficiencies from Table 3-3, the following equation was used to determine that 756 acres of impervious area, or the equivalent thereof, would need to be retrofitted to meet the goal.

Load reduced = Acres Treated x Loading Rate x Efficiency or
Acres Treated = Load Reduced / (Loading Rate x Efficiency)

TN: Ac = 9,184 lb/yr / (17.36 lb/ac/yr x 70%) = 756 ac

Alternatively, stream restoration may be a preferable approach to meet the Bay TMDL requirements. Using the recommendations of the stream restoration expert panel from Appendix D, the following equation was used to determine that 122,453 linear feet (approximately 23.2 miles) of stream restoration would be needed to meet the goal. The most likely approach would be a combination of both upland stormwater retrofits and stream restoration.

Load reduced = Linear Feet Treated x Removal Rate per Linear Foot or
Linear Feet Treated = Load Reduced / (Loading Rate per Linear Foot)

TN: Linear Feet = 9,184 lb/yr / 0.075 lb/ft = 122,453 ft (23.2 miles)

CHAPTER 4.0
Subwatershed Management Strategies

4.1 Introduction

This chapter describes the criteria and methodology used to rank the six subwatersheds within the Area Q watershed based on restoration and protection potential. Although restoration and protection actions will likely have to occur throughout the entire Area Q in order to meet environmental goals and requirements, the subwatershed priority ranking provides a tool for targeting restoration and protection actions identified in Chapter 3 by subwatershed. This chapter also provides individual subwatershed summaries that include key subwatershed characteristics, recommended management strategies and implementation priorities. The recommended management strategies were based on field verification of stream restoration projects in the 1999 Lower Gunpowder Falls Water Quality Management Study, upland assessment data, available water quality and biological monitoring data, and agricultural data in the watershed. These subwatershed-specific management strategies are for practices where a specific location is identified, for example, stormwater retrofits and tree planting. Other restoration practices that are dispersed throughout the watershed are included in Appendix A as general restoration actions (e.g., education and outreach to homeowners on proper lawn management, and reduced road salt application).

4.2 Subwatershed Prioritization

A ranking methodology was developed to prioritize subwatersheds in terms of restoration and protection need and potential. In general, a subwatershed is prioritized for restoration and protection based on the data and analysis that characterize its environmental quality. As such, restoration and protection opportunities may target specific factors within the subwatershed. The following restoration and protection ranking criteria are:

Restoration Ranking Criteria

- Total Nitrogen and Total Phosphorus Loads
- Biological Indicators
- Impervious Surfaces
- Institutional Site Investigation
- Hotspot Site Investigation

Protection Ranking Criteria

- Total Nitrogen and Total Phosphorus Loads
- Biological Indicators
- Impervious Surfaces
- Stream Buffer Improvement

Restoration Ranking Criteria

- Neighborhood Restoration Opportunity/Pollution Severity Indices
- Neighborhood Lawn Fertilization Reduction/Awareness
- Stream Buffer Improvement
- Stream Restoration Potential
- Septic Systems
- Pervious Area Assessment

Protection Ranking Criteria

- Agricultural Land in Easement

An ordinal ranking scale of 1 to 6 was used to prioritize the subwatersheds based on the lowest to highest score for each criterion, except for the Neighborhood Source Area (NSA) restoration score which is further explained in Section 4.2.4. This approach to ranking was taken given the narrow range, or small numerical differences amongst the subwatersheds for many of the criteria. If there was no data available for a subwatershed, a 'no data' qualifier was added in the table and taken into consideration for the prioritization score and ranking. For instances where more than one subwatershed had the same value for a specific criterion, the same ordinal score was assigned. Ordinal scores were assigned in descending order.

4.2.1 Total Nitrogen and Total Phosphorus Loads

Annual total nitrogen and total phosphorus loads (lbs/year) were estimated for each subwatershed using land use-based loading rates defined by the Baltimore County Land Cover Dataset (BCLCD) and the Chesapeake Bay Program (CBP). The pollutant loading analysis for the Area Q watershed is explained in further detail in Appendix E, Chapter 3. A subwatershed loading rate (lb/acre/yr) for each nutrient was calculated from the total subwatershed load (lb/yr) divided by the subwatershed area. The subwatershed with the highest pollutant loading rate was assigned the lowest protection score (1) and the highest restoration score (6). Conversely, the subwatershed with the lowest pollutant loading rate was assigned the lowest restoration score (1) and the highest protection score (6). The results are shown in Table 4-1 with total nitrogen loading rates ranging from 8.6 to 11.3 lbs/acre/year and 0.3 to 0.6 lbs/acre/year for total phosphorus.

Table 4-1: Total Nitrogen and Total Phosphorus Loading Rate Scores

Subwatershed	Total Nitrogen Loading Rate (lbs/acre/year)	Total Nitrogen Restoration Load Score	Total Nitrogen Protection Load Score	Total Phosphorus Loading Rate (lbs/acre/year)	Total Phosphorus Restoration Load Score	Total Phosphorus Protection Load Score
Cowen Run	9.6	4	3	0.4	4	5
Haystack Branch	10.2	5	2	0.5	5	4
Long Green Creek	11.3	6	1	0.6	6	3
Lower Gunpowder Falls East	8.6	1	6	0.3	3	6
Lower Gunpowder Falls West	8.9	2	5	0.4	4	5
Sweathouse Run	9.4	3	4	0.3	3	6

4.2.2 Biological Indicators

The Fish Index of Biotic Integrity (FIBI) and Benthic Index of Biotic Integrity (BIBI) were used to rank the subwatersheds for priority restoration and protection. The scores for each of these indicators were determined using sampling data collected from Baltimore County Department of Environmental Protection and Sustainability (EPS) and Maryland Department of Natural Resources (MD DNR) Maryland Biological Stream Survey (MBSS). Chapter 3 in Appendix E provides a detailed discussion of the data.

For each subwatershed, average FIBI and BIBI scores were calculated using the data provided by EPS and MD DNR MBSS. FIBI and BIBI scores range from good (4.0 – 5.0) denoting minimally impacted conditions to very poor (1.0 – 1.9) indicating severe degradation. For restoration prioritization, lower biological indicator scores are assigned higher restoration scores (6) to denote greater restoration need. In contrast, lower scores were given to a subwatershed with a high biological indicator score (3). For protection prioritization, higher scores are provided for subwatersheds with a high biological indicator score and lower scores are provided for subwatersheds with a low biological indicator score. The results are shown in Table 4-2.

Table 4-2: Fish and Benthic Indices Restoration and Protection Scores

Subwatershed	FIBI Average Score	FIBI Restoration Score	FIBI Protection Score	BIBI Average Score	BIBI Restoration Score	BIBI Protection Score
Cowen Run	3.27	5	5	3.46	4	5
Haystack Branch	--	--	--	3.33	5	4
Long Green Creek	3.17	6	4	2.86	6	3
Lower Gunpowder Falls East	--	--	--	3.34	5	4
Lower Gunpowder Falls West	--	--	--	--	--	--
Sweathouse Run	3.33	4	6	4.33	3	6

4.2.3 Impervious Surfaces

The level of impervious cover of 9.0% in the Area Q subwatershed suggests the watershed may be characterized as a 'sensitive' watershed, but just below the 'impacted' threshold. Sensitive watersheds have typically high quality streams with stable channels, good habitat conditions and good water quality, according to the Impervious Cover Model described by Schueler et al. (2009). The estimate of impervious cover for each subwatershed was based on data provided by Baltimore County that identifies roads, buildings, tennis courts, and other impervious areas. Overall, these subwatersheds have somewhat low impervious cover ranging from 6.5 to 11.6% (Table 4-3). However, research has found that brook trout populations cannot survive in watersheds with impervious surfaces exceeding 4% (MD DNR, 2006). Further, while the impervious cover is relatively low at the subwatershed scale, there may be pockets of concentrated development (e.g., commercial areas) with much higher impervious cover that can negatively affect localized stream reaches.

Table 4-3: Percent Impervious Surface Restoration and Protection Scores

Subwatershed	Total Area (acres)	Roads (acres)	Buildings (acres)	Other Impervious Area (acres)	Total Impervious Area (acres)	% Impervious	% Impervious Restoration Score	% Impervious Protection Score
Cowen Run	1,857.3	139.7	74.7	1.2	215.6	11.6	6	1
Haystack Branch	1,895.1	104.2	49.4	0.2	153.8	8.1	2	5
Long Green Creek	7,229.6	407.7	191.5	1.3	600.5	8.3	3	4

Subwatershed	Total Area (acres)	Roads (acres)	Buildings (acres)	Other Impervious Area (acres)	Total Impervious Area (acres)	% Impervious	% Impervious Restoration Score	% Impervious Protection Score
Lower Gunpowder Falls East	4,757.6	338.8	138.9	10.5	488.1	10.3	5	2
Lower Gunpowder Falls West	2,020.1	93.9	37.3	0.2	131.4	6.5	1	6
Sweathouse Run	1,089.2	67.3	38.7	0.4	106.4	9.8	4	3

4.2.4 Neighborhood Restoration Opportunity/Pollution Severity Indices

A total of 30 neighborhoods were ranked in Area Q and identified with the subwatershed in which the majority of its area was located. Chapter 4 in Appendix E rated each neighborhood with a Pollution Severity Index (PSI) of high, moderate, or low and a Restoration Opportunity Index (ROI) of high, moderate or low.

Restoration prioritization was rated based on the subwatersheds that had the most number of neighborhoods with high PSI and highest ROI. The highest score (6 points) was given to the subwatershed that had the most neighborhoods with a high or moderate PSI and ROI score. The second highest score (5 points) was given to the subwatershed with the largest *proportion* of its neighborhoods scoring a high or moderate PSI/ROI relative to its total number of neighborhoods, and so on. The results of the NSA restoration ranking scores are shown in Table 4-4.

Table 4-4: NSA PSI/ROI Restoration Scores

Subwatershed	Number of Neighborhoods for PSI/ROI Ratings								NSA PSI/ROI Restoration Score
	High/ High	High/ Moderate	High/ Low	Moderate/ High	Moderate/ Moderate	Moderate/ Low	Low/ Moderate	Low/ Low	
Cowen Run					1	3		1	2
Haystack Branch					1				3
Long Green Creek		1				4	1	2	4
Lower Gunpowder Falls East		2		1	1	5	1	1	6
Lower Gunpowder Falls West						2			1
Sweathouse Run		1			1		1		5

4.2.5 Neighborhood Lawn Fertilizer Reduction/Awareness

Residential lawns were assessed as part of the SWAP using visual survey methods described in Chapter 4 in Appendix E. A lawn was designated as high maintenance if it had dense, uniform grass cover or signs designating pesticide/fertilizer lawn care applications. These high maintenance lawns were indicators of nutrient pollution originating from lawn fertilizer. Neighborhoods where 20 percent or more of the homes appeared to employ high lawn maintenance practices were recommended for fertilizer reduction/education. This criterion was used for subwatershed restoration prioritization because a reduction in nutrient loading may be achieved through urban nutrient management practices as credited by the Chesapeake Bay Program and the TMDL. In addition, this criterion is the major restoration practice that was identified during the neighborhood source assessments. Protection prioritization was not rated for this criterion because neighborhood lawn fertilizer reduction/awareness activities do not provide protection potential.

The ranking for this criterion is based on the acres of high maintenance lawns within the subwatershed. The acreage of lawns is expressed as a percentage of the total subwatershed area in Table 4-5. Subwatersheds with the greatest percentage of high maintenance lawns received the greatest restoration potential score (e.g. 6).

Table 4-5: Neighborhood Lawn Fertilizer Reduction/Awareness Restoration Scores

Subwatershed	% of Subwatershed Addressed	NSA Lawn Fertilizer Reduction Restoration Score
Cowen Run	0.07%	2
Haystack Branch	1.65%	6
Long Green Creek	0.16%	3
Lower Gunpowder Falls East	1.19%	5
Lower Gunpowder Falls West	0.00%	1
Sweathouse Run	0.40%	4

4.2.6 Institutional Site Investigation

A total of 18 institutional sites were assessed in Area Q; 8 faith-based institutions, two schools, two fire companies, two parks/recreation sites, and one residential facility have identified actions. Typically, institutional properties offer restoration opportunities to engage citizens in watershed stewardship and have large parcels of undeveloped land that may be considered for stormwater retrofits or tree planting, for example. The ranking of institutional sites was based on the total land area of sites with identified actions within a subwatershed. A higher restoration score was assigned with the more institutional land with identified actions

within a subwatershed. The highest score was given to the Lower Gunpowder Falls East as this subwatershed has 170 acres of institutional land area, whereas the Haystack Branch and Lower Gunpowder Falls West subwatersheds received no score because they have no institutional land. Protection prioritization was not rated for this criterion because the institutional site investigation doesn't provide protection potential. The results are summarized in Table 4-6.

Table 4-6: Institutional Site Restoration Scores

Subwatershed	ISI Acres	ISI Restoration Score
Cowen Run	65.5	3
Haystack Branch	--	-
Long Green Creek	85.7	5
Lower Gunpowder Falls East	170.0	6
Lower Gunpowder Falls West	--	--
Sweathouse Run	83.4	4

4.2.7 Hotspot Site Investigation

Stormwater hotspots are areas that have potential to generate higher concentrations of stormwater pollutants than typically found in runoff from developed areas or have a higher risk of spill, leaks, or illicit discharges due to the nature of the facility (CWP, 2004). Stormwater pollutants generated at hotspots vary depending on the activities at each location, but they can include nutrients, hydrocarbons, metals, chloride, pesticides, bacteria, and trash. The purpose of the HSIs is to evaluate pollution potential from hotspot operations and identify potential restoration practices that may be necessary.

A total of 25 hotspots were assessed in the Lower Gunpowder Falls watershed and include commercial, industrial, and transport-related facilities. These were investigated primarily for opportunities to improve waste management, storage of outdoor materials, vehicle operations areas, and stormwater management. The hotspots were ranked as a confirmed hotspot, potential hotspot, or not a hotspot. These rankings were used to determine the hotspot index score to prioritize subwatersheds. The Long Green Creek subwatershed had the most hotspots, including four potential hotspots and was assigned the highest restoration score of 6. One confirmed and one potential hotspots were identified in the Lower Gunpowder Falls East subwatershed, which was assigned the second highest restoration score of 5. Haystack Branch and Sweathouse Run did not have any hotspots to assess, therefore did not receive a score. The results are summarized in Table 4-7.

Table 4-7: Hotspot Restoration Scores

Subwatershed	Number of Hotspots			HSI Restoration Score
	Not a Hotspot	Potential Hotspot	Confirmed Hotspot	
Cowen Run	2			4
Haystack Branch	--	--	--	--
Long Green Creek	14	4		6
Lower Gunpowder Falls East	2	1	1	5
Lower Gunpowder Falls West	1			3
Sweathouse Run	--	--	--	--

4.2.8 Pervious Area Assessment

Sections of public and private contiguous lawn area were identified from the pervious area assessment, as they are usually the most probable for implementation of large-scale tree plantings. A total of 179 individual parcels were assessed within the Lower Gunpowder Falls watershed, totaling approximately 444 acres of potential tree plantings.

The restoration score for each subwatershed was assigned based on the total acres of potential tree planting within the subwatershed. Long Green Creek has the greatest area of potential tree planting acres, so was assigned the highest restoration score of 6. On the other hand, Lower Gunpowder Falls West had very few acres of potential tree planting opportunity, so was assigned the lowest restoration score of 1.

Table 4-8: Pervious Area Scores

Subwatershed	Acres of Planting Opportunity	Pervious Area Restoration Score
Cowen Run	27.8	2
Haystack Branch	50.2	4
Long Green Creek	170.1	6
Lower Gunpowder Falls East	145.4	5
Lower Gunpowder Falls West	14.6	1
Sweathouse Run	35.6	3

4.2.9 Stream Buffer Improvements

A stream buffer is defined as the 100 feet adjacent to either side of a stream channel. The condition of the stream buffer was classified into three categories based on its type of vegetative cover to include: forests, impervious and open pervious. Using Geographic Information Systems (GIS), impervious areas were determined by calculating the area of roads and buildings within the 100-foot stream buffer. The area of forest land cover within the stream buffer was determined using the forested GIS layer and removing any impervious area footprint. The remaining areas within the 100-foot stream buffer were classified as open pervious area. 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 for restoration prioritization. Subwatersheds with lower percentages of open pervious buffer areas have a higher percentage of forested buffer that are key areas for protection and are scored highest for protection prioritization. Long Green Creek received the highest buffer restoration score, whereas Sweathouse Run had the highest protection score. The absolute area available for reforestation in each subwatershed ranges from 49.5 to 774.6 acres as shown in Table 4-9.

Table 4-9: Stream Buffer Improvement Score

Subwatershed	Forested		Impervious		Open Pervious		Stream Buffer Improvement Restoration Score	Stream Buffer Improvement Protection Score
	Acres	%	Acres	%	Acres	%		
Cowen Run	217.7	60.9	18.1	5.1	121.1	34.0	2	4
Haystack Branch	148.1	42.7	58.4	4.5	181.6	52.3	5	2
Long Green Creek	467.5	36.0	58.4	4.5	774.6	59.6	6	1
Lower Gunpowder Falls East	512.8	61.6	22.3	2.7	297.9	35.8	3	5
Lower Gunpowder Falls West	220.9	54.0	18.3	4.5	169.8	41.5	4	3
Sweathouse Run	120.5	68.9	5.0	2.8	49.5	28.3	1	6

4.2.10 Stream Restoration Potential

As described in Section 3.5 of the Watershed Characterization Report (Appendix E), the Lower Gunpowder Falls Watershed Water Quality Management Study (WQMS; Parsons Brinckerhoff, 1999) was reviewed for potential stream restoration opportunities. Various types of

water quality enhancement projects, including stream restoration, were recommended in all six subwatersheds: Cowen Run, Haystack Branch, Long Green Creek, Lower Gunpowder Falls East and West, and Sweathouse Run. The reaches recommended for stream restoration were field reviewed in early 2017 where property access allowed, and project extents were revised based on current conditions. No projects were reviewed in Cowen Run because of recent stream assessments by Baltimore County in 2015 and 2016, the results of which are incorporated in the ranking strategy described below.

The total length of possible stream restoration was used to assign a Stream Restoration Potential score to each subwatershed, from 1 to 6 (Table 4-10). Long Green Creek had the greatest length of potential stream restoration, with approximately 18,140 feet spread across seven reaches, and therefore was given the highest Stream Restoration Potential Score of 6. Baltimore County estimated that approximately 4,500 feet of stream restoration was possible in Cowen Run, giving it the second highest score of 5. Lower Gunpowder Falls East had approximately 3,710 feet of potential restoration from four reaches, and was given a score of 4. Haystack Branch had two potential stream restoration projects totaling 3,640 feet, giving it a score of 3. A single project identified in Lower Gunpowder Falls West had a length of just 410 feet, so it received the second lowest score of 2. Two potential projects were assessed in Sweathouse Run, but neither was recommended for restoration. Therefore, no projects were recommended in Sweathouse Run and it was given the lowest score.

Only the discrete reaches that were identified in the 1999 WQMS and sites that were given permission by landowners were reevaluated for current restoration potential. Therefore, they may not represent the most degraded conditions that exist in each subwatershed. Of the streams reviewed, the best opportunities in each subwatershed are described in more detail in Section 4.3, with full details in Appendix E.

Table 4-10: Stream Restoration Potential Score

Subwatershed	Proposed Restoration Length (ft)	Stream Restoration Potential Score
Cowen Run	4,500	5
Haystack Branch	3,640	3
Long Green Creek	18,140	6
Lower Gunpowder Falls East	3,710	4
Lower Gunpowder Falls West	410	2
Sweathouse Run	0	1

4.2.11 Septic Systems

According to Baltimore County Bay Restoration Fund tracking, there are approximately 2,684 septic systems in Area Q. Nutrient and pathogens can be a source of pollutants if septic systems are not functioning properly. Subwatersheds with a greater number of septic systems have the greatest potential to be a nutrient and pathogenic pollutant source and were assigned a high restoration score. The number of septic systems in each subwatershed and septic system restoration score are provided in Table 4-11.

Table 4-11: Septic System Restoration Scores

Subwatershed	Number of Septic Systems	Septic System Restoration Score
Cowen Run	372	4
Haystack Branch	240	3
Long Green Creek	860	6
Lower Gunpowder Falls East	827	5
Lower Gunpowder Falls West	183	1
Sweathouse Run	202	2

4.2.12 Agricultural Land

Agricultural land uses including cropland, orchards, feeding operations, and pasture, occupy 36% of the land area in Area Q. The ranking criterion for agricultural land is based on the amount of land in conservation easements. Conservation easements relevant to Area Q agricultural land include properties under the following programs: Maryland Environmental Trust, Long Green Land Trust, and Maryland Agricultural Land Preservation Foundation. Conservation easements protect significant natural resources on a property from development. A property owner maintains ownership of the land and may receive income, or estate and property tax benefits for the land area in a conservation easement. The acres of agricultural land without an easement and the protection score for each subwatershed is provided in Table 4-12.

Table 4-12: Agricultural Land Protection Scores

Subwatershed	Acres of Agriculture	Percent of Agriculture in easement	Percent of Agriculture not in easement	Agricultural Land Protection Score
Cowen Run	469.9	67.9%	32.1%	3
Haystack Branch	778.9	54.2%	45.8%	4
Long Green Creek	3932.9	90.6%	9.4%	1
Lower Gunpowder Falls East	751.7	8.2%	91.8%	6
Lower Gunpowder Falls West	618.2	68.9%	31.1%	2
Sweathouse Run	230.9	15.6%	84.4%	5

4.2.13 Subwatershed Restoration and Protection Prioritization Summary

The six subwatersheds within Area Q are ranked per the total restoration and protection prioritization score (i.e., the sum of prioritization criterion scores). Subwatershed ranking results for restoration and protection are summarized in Table 4-13 and Table 4-14 respectively, including criterion scores, total scores and rankings. Table 4-15 provides a summary of the restoration and protection prioritization for each subwatershed, which are also illustrated in Figure 4-1.

4.2.13.1 Restoration Prioritization

The six subwatersheds within Area Q are ranked according to the total restoration prioritization scores. The total scores were adjusted to account for criteria not ranked for the subwatershed due to data availability. In Sweathouse Run, for example, there were no hotspots to assess, so that subwatershed was not given a score for that criterion. If all the thirteen criteria for restoration were ranked for a subwatershed, the total possible score was 78 points. The ranking is based on the total possible score for each subwatershed. Table 4-13 provides the scores for each criterion, total scores and ranking for restoration. Long Green Creek scored the highest for restoration, while Lower Gunpowder Falls West scored lowest.

Table 4-13: Subwatershed Restoration Ranking Results

Subwatershed	Total Nitrogen Load	Total Phosphorus Load	Fish IBI	Biological IBI	Impervious Surfaces	NSA PSI/ROI	NSA Lawn Fertilizer Reduction	ISI Investigation	HSI Investigation	Pervious Area Tree Planting	Stream Buffer Improvement	Stream Restoration Potential	Septic Systems	TOTAL SCORE	NORMALIZED SCORE	SUBWATERSHED RANK
Cowen Run	4	4	5	4	6	2	2	3	4	2	2	5	4	47	60	Moderate
Haystack Branch	5	5	--	5	2	3	6	--	--	4	5	3	3	41	68	Moderate
Long Green Creek	6	6	6	6	3	4	3	5	6	6	6	6	6	69	88	High
Lower Gunpowder Falls East	1	3	--	5	5	6	5	6	5	5	3	4	5	53	74	High
Lower Gunpowder Falls West	2	4	--	--	1	1	1	--	3	1	4	2	1	20	33	Low
Sweathouse Run	3	3	4	3	4	5	4	4	--	3	1	1	2	37	51	Moderate

4.2.13.2 Protection Prioritization

The six subwatersheds within Area Q are ranked according to the total protection prioritization scores. Again, the ranking is based on the total possible score for each subwatershed. If all seven criteria for protection were ranked for a subwatershed, the total possible score was 42 points. Table 4-14 provides the scores for each criterion, total scores and ranking for protection. Sweathouse Run scored the highest and is the best target for protecting water quality in the watershed.

Table 4-14: Subwatershed Protection Ranking Results

Subwatershed	Total Nitrogen Load	Total Phosphorus Load	Fish IBI	Biological IBI	Impervious Surfaces	Stream Buffer Improvement	Agricultural Land	TOTAL SCORE	NORMALIZED SCORE	SUBWATERSHED RANK
Cowen Run	3	5	5	5	1	4	3	26	62	Moderate
Haystack Branch	2	4	--	4	5	2	4	21	58	Moderate
Long Green Creek	1	3	4	3	4	1	1	17	40	Low
Lower Gunpowder Falls East	6	6	--	4	2	5	6	29	81	High
Lower Gunpowder Falls West	5	5	--	--	6	3	2	21	70	High
Sweathouse Run	4	6	6	6	3	6	5	36	86	High

Table 4-15: Subwatershed Restoration and Protection Prioritization

Subwatershed	Total Normalized Restoration Score	Restoration Prioritization Category	Total Normalized Protection Score	Protection Prioritization Category
Cowen Run	60	Moderate	62	Moderate
Haystack Branch	68	Moderate	58	Moderate
Long Green Creek	88	High	40	Low
Lower Gunpowder Falls East	74	High	81	High
Lower Gunpowder Falls West	33	Low	70	High
Sweathouse Run	51	Moderate	86	High

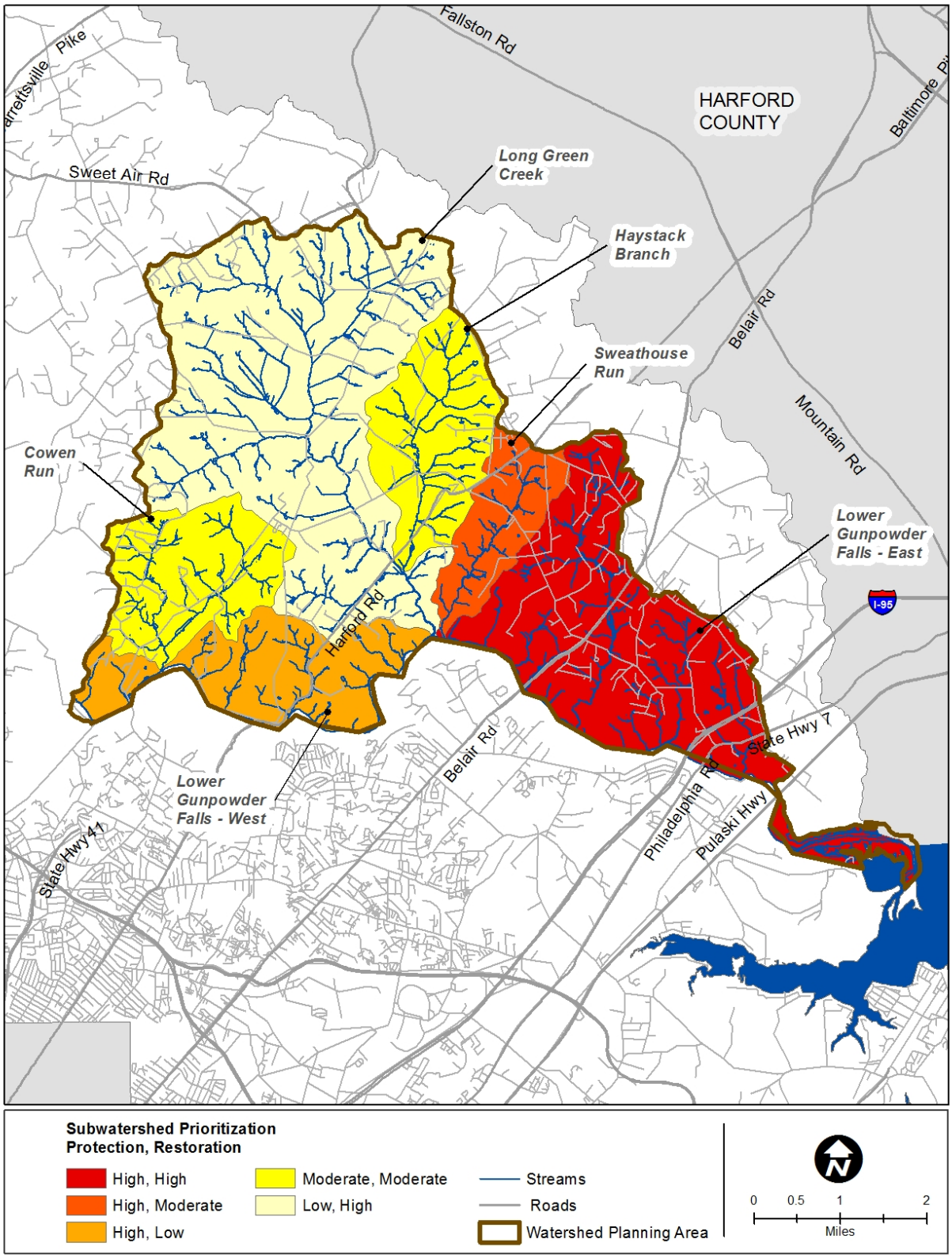

Figure 4-1: Subwatershed Protection and Restoration Priority Ranking

4.3 Subwatershed Restoration and Protection Strategies

Restoration and protection management strategies for each subwatershed are presented in the following subsections. The strategies are based on strategies presented in Chapter 3 and site specific actions. Appendix A presents measurable actions that correspond to each strategy and the goals and objectives described in Chapter 2. This section includes the results of the upland assessments (see Chapter 3 in Appendix E). For each subwatershed, key characteristics are presented that include drainage area, stream length, total population, land use/land cover, land in easement, impervious cover, hydrologic soil group, stormwater management (SWM) facilities and restoration and protection priority ranking. A summary of assessment results for neighborhoods, hotspots, institutions, stream corridors and stormwater conversions are provided for each subwatershed. Finally, a subwatershed management strategy including recommended citizen and municipal actions are presented at the end of each section.

4.3.1 Cowen Run

Existing land use in the Cowen Run subwatershed consists primarily of low density residential land use, agricultural lands, and forest. Most of the development occurred from the 1950s through the 1990s, with a major boom in the 1950s. Nearly half of the subwatershed is categorized as residential (42.7%). Approximately one third of the land area is protected by conservation easements, including well over half of all farmland in the subwatershed (67.9%). Impervious cover occupies 11.6% of the subwatershed. Table 4-16 summarizes the key subwatershed characteristics of Cowen Run.

Table 4-16: Cowen Run Subwatershed Key Characteristics

Drainage Area	1,857.3 acres (2.9 mi^2)	
Stream Length	15.3 miles	
Total Population	1,005 (2010 Census) 0.54 people/acre	
Land Use/Land Cover	Very Low Density Residential (Agriculture):	0.7%
	Very Low Density Residential (Forested):	6.4%
	Low Density Residential:	35.5%
	Medium Density Residential:	0.1%
	High Density Residential:	0.0%
	Commercial:	1.3%

	Institutional:	0.9%
	Open Urban Land:	0.0%
	Agriculture (Cropland, Orchards, Pasture):	25.3%
	Forest:	29.7%
	Wetlands:	0.0%
Land in Easement	Total: 561 acres (30.2% of Subwatershed) Agriculture: 318.9 acres (67.9% of Agricultural Area)	
Impervious Cover	11.6% of Subwatershed	
Hydrologic Soil Group	A soils (low runoff potential): B soils: C soils: D soils (high runoff potential):	0.0% 72.2% 25.0% 2.7%
SWM Facilities	4 Facilities 0.8% of urban land use treated	
Restoration/Protection Priority Rating	Moderate/Moderate	

Neighborhood Source Assessment

A total of 5 distinct neighborhoods were identified and assessed within the Cowen Run subwatershed during the uplands assessment of Area Q. Characteristics such as lot size, age, and type of development were used to delineate neighborhoods rather than subwatershed boundaries. Recommendations for addressing stormwater pollutants within this subwatershed include storm drain marking and fertilizer reduction. The results of the Neighborhood Source Assessment (NSA) are presented in Table 4-17.

Table 4-17: Actions Identified for Neighborhoods in Cowen Run

Site ID	Lot Size (acres)	Rain Garden/Rain Barrels/Downspout Disconnection	Storm Drain Marking	BayScape	Fertilizer Reduction	Lot Canopy
NSA_Q_203	>1		X			
NSA_Q_204	>1		X			
NSA_Q_205	>1		X			
NSA_Q_206	>1		X			
NSA_Q_207	>1		X		X	

All the neighborhoods were identified for storm drain marking and one was also identified for fertilizer reduction. The amount of heavy lawn management and fertilizer application appears to be relatively low in most of these neighborhoods. Figure 4-2 shows a typical lot in neighborhood NSA_Q_204.

Figure 4-2: Typical lot in neighborhood NSA_Q_204.

Hotspot Site Investigation

Only two sites (HSI_Q_202 & 203) were assessed in the Cowen Run subwatershed and neither was found to be an active hotspot problem.

Institutional Site Investigation

An Institutional Site Investigation (ISI) was conducted at one site in the Cowen Run subwatershed, the Glen Meadows Retirement Community. This residential community has the

potential for tree planting, better trash management, and a stormwater retrofit (RRI_Q_207) to convert an existing dry pond to a wet pond or wetland to enhance water quality treatment. The actions recommended for this site are summarized in Table 4-18.

Table 4-18: Identified Actions for the Institutional Site in Cowen Run

Site ID	Type	Identified Actions					
		Tree Planting	Stormwater Retrofit	Downspout Disconnection	Trash Mgmt.	Storm Drain Marking	Stream Buffer Improv.
ISI_Q_201	Residential Facility	X	X		X		

Figure 4-3: Existing dry pond at ISI_Q_201 with the potential for conversion to a wet pond or wetland.

Pervious Area Assessment

A total of 10 parcels (27.8 acres) were found in Cowen Run to have large pervious areas that could potentially serve for tree planting.

Stream Corridor Assessment

Baltimore County's Department of Environmental Protection and Sustainability conducted stream walks in Cowen Run in 2015 and 2016. Nearly all the streams in the subwatershed were walked and assessed for stream restoration potential. Based on the stream walks, the County estimated that approximately 4,500 feet of stream had restoration potential. Mapping of the impaired sections of streams in Cowen Run can be found in the Watershed Characterization Report (Appendix E).

In addition, the stream buffer land use evaluation described in Section 4.2.9 found that approximately a third (34.0%) of the 100-foot stream buffer in Cowen Run contains open pervious land, indicating a high potential for stream buffer reforestation.

Subwatershed Management Strategy

Restoration and protection strategies for Cowen Run subwatershed are outlined below.

Engaging Citizens & Watershed Groups

1. Engage citizens in a storm drain marking program and conduct marking activities in all Cowen Run neighborhoods.
2. Promote awareness of the benefits of proper lawn care in NSA_Q_207 and encourage residents to reduce fertilizer use to maintain healthy turfgrass.

Municipal Actions

3. Work with property owners at ISI_Q_201 (Glen Meadows Retirement Community) to identify options for tree planting.
4. Evaluate the potential to convert the existing dry detention pond at ISI_Q_201 to a wet pond or wetland that provides greater water quality benefits.
5. Continue assessment of the 4,500-ft proposed stream restoration project and develop plan for implementation.
6. Evaluate the 27.8 acres of potential tree planting on the 10 identified parcels from the pervious area assessment to determine implementation feasibility.
7. Promote new tree planting in the 34% of the 100-ft stream buffer that is currently open pervious land and maintain existing forests.

4.3.2 Haystack Branch

Haystack Branch is comparable in size (1,895 acres) to Cowen Run subwatershed, but is more heavily agricultural (41.1%). The agricultural land uses in this subwatershed include feeding operations, cropland, orchard, and pasture. Approximately half of all farmland in this subwatershed (54.2%) is protected by conservation easements. One third of the subwatershed is used for residential purposes and approximately one quarter is forest. There is no commercial, industrial, or institutional land use in Haystack Branch, however there are eight stormwater management facilities that treat almost 6% of the residential land use. Impervious land cover occupies 8.1% of the subwatershed. Table 4-19 summarizes the key subwatershed characteristics of Haystack Branch.

Table 4-19: Haystack Branch Subwatershed Key Characteristics

Drainage Area	1,895.1 acres (3.0 mi^2)	
Stream Length	13.1 miles	
Total Population	626 (2010 Census) 0.33 people/acre	
Land Use/Land Cover	Very Low Density Residential (Agriculture):	9.3%
	Very Low Density Residential (Forested):	8.3%
	Low Density Residential:	18.7%
	Medium Density Residential:	0.2%
	Commercial:	0.0%
	Institutional:	0.0%
	Open Urban Land:	0.0%
	Agriculture (Feeding Operations, Cropland, Orchard, Pasture):	41.1%
	Forest:	22.4%
	Wetlands:	0.0%
Land in Easement	Total: 777.7 acres (41.0% of Subwatershed) Agricultural: 422.1 acres (54.2% of Agricultural Area)	
Impervious Cover	8.1% of Subwatershed	
Hydrologic Soil Group	A soils (low runoff potential): B soils: C soils: D soils (high runoff potential):	0.0% 73.2% 26.0% 0.8%
SWM Facilities	8 Facilities 5.7% of urban land use treated	
Restoration/Protection Priority Rating	Moderate/Moderate	

Neighborhood Source Assessment

Only one neighborhood was assessed within Haystack Branch (NSA_Q_416), but it has several identified restoration opportunities. The lots in the approximately100-acre neighborhood have a large proportion of their land area covered in turf grass, 60% of which is estimated to be highly maintained with fertilizer (see Figure 4-4). As summarized in Table 4-20, the recommendations for this neighborhood include rain gardens/rain barrels/downspout disconnection, storm drain marking and fertilizer reduction.

Table 4-20: Actions Identified for the Neighborhood in Haystack Branch

Site ID	Lot Size (acres)	Rain Garden	Storm Drain Marking	BayScape	Fertilizer Reduction	Lot Canopy
NSA_Q_416	>1	X	X		X	

Figure 4-4: A lot with highly maintained lawn in neighborhood NSA_Q_416 in Haystack Branch.

Hotspot Site Investigation

No hotspots were investigated in Haystack Branch subwatershed.

Institutional Site Investigation

No institutional sites were investigated in Haystack Branch subwatershed.

Stormwater Conversions

One detention pond within the Haystack Branch subwatershed was identified for potential conversion to a facility that provides water quality benefits in addition to quantity control. This pond at Brintonwood neighborhood (SWM-1987) has a drainage area of 14.1 acres.

Pervious Area Assessment

A total of 22 parcels (50.2 acres) were found in Haystack Branch to have large pervious areas that could potentially serve for tree planting.

Stream Corridor Assessment

The Lower Gunpowder Falls Watershed Water Quality Management Study (WQMS; Parsons Brinckerhoff, 1999) identified potential water quality enhancement projects in this subwatershed. These recommendations included projects such as channel restoration, bank stabilization, riparian buffer improvement, and wetland creation/SWM pond. Three channel restoration or bank stabilization projects were identified in Haystack Branch.

Two of the recommended stream restoration projects were revisited in early 2017. One was not able to be visited due to lack of permission. Reach HS-6a consisted of approximately 2,630 linear feet of stream through farm fields. The reach was incised with bank erosion and lacked a riparian buffer. Reach HS-1 consisted of approximately 1,010 linear feet of stream that had moderate bank erosion in some meander bends, but ranked low due to difficult construction access and vertical and lateral constraints. A total of 3,640 feet of potential stream restoration is recommended in Haystack Branch. Additional information can be found in Section 3.5.2 of the Watershed Characterization Report (Appendix E).

In addition, the stream buffer land use evaluation described in Section 4.2.9 found that over half (52.3%) of the 100-foot stream buffer in Haystack Branch contains open pervious land, indicating a high potential for stream buffer reforestation.

Subwatershed Management Strategy

Restoration and protection strategies for Haystack Branch subwatershed are outlined below.

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

1. Engage property owners and homeowner's association in neighborhood NSA_Q_416 to disconnect downspouts onto adjacent pervious surfaces or into retrofitted rain barrels or rain gardens.
2. Engage citizens in a storm drain marking program and conduct marking activities in NSA_Q_416.

3. Promote awareness of the benefits of proper lawn care in NSA_Q_416 and encourage residents to reduce fertilizer use to maintain healthy turfgrass.

Municipal Actions

4. Continue assessment of the 3,640 feet of proposed stream restoration and develop a plan for implementation, focusing on Reach HS-6a to remediate bank erosion and an impacted riparian buffer.
5. Evaluate the ability to convert the identified dry detention stormwater management facility (SWM-1987) in this subwatershed to another practice that provides greater water quality benefits.
6. Evaluate the 50.2 acres of potential tree planting on the 22 identified parcels from the pervious area assessment to determine implementation feasibility.
7. Promote new tree planting in the 52% of the 100-ft stream buffer that is currently open pervious land and maintain existing forests.

4.3.3 Long Green Creek

Long Green Creek is the largest subwatershed within Area Q, having an area of 11.3 square miles. The existing land use consists primarily of agriculture, forest, and low density residential. The majority (54.4%) of the land area serves agricultural uses such as feeding operations, crops, orchards, and pasture. Nearly all the agricultural land in this subwatershed (90.6%) is protected by conservation easements. Table 4-21 summarizes the key subwatershed characteristics of Long Green Creek.

Table 4-21: Long Green Creek Subwatershed Key Characteristics

Drainage Area	7,229.6 acres (11.3 mi^2)	
Stream Length	46.8 miles	
Total Population	2,489 (Census 2010) 0.34 people/acre	
Land Use/Land Cover	Very Low Density Residential (Agriculture):	5.3%
	Very Low Density Residential (Forested):	4.8%
	Low Density Residential:	16.5%
	Medium Density Residential:	0.1%

	Industrial:	0.7%
	Commercial:	0.3%
	Institutional:	0.4%
	Open Urban Land:	0.0%
	Agriculture (Feeding Operations, Cropland, Orchard, Pasture):	54.4%
	Forest:	17.4%
	Wetlands:	0.0%
Land in Easement	Total: 4,175.8 acres (57.76% of Subwatershed) Agricultural: 3,561.1 (90.6% of Agricultural Area)	
Impervious Cover	8.3% of Subwatershed	
Hydrologic Soil Group	A soils (low runoff potential): B soils: C soils: D soils (high runoff potential):	0.2% 67.7% 26.7% 5.6%
SWM Facilities	11 Facilities 4.0% urban land treated	
Restoration/Protection Priority Rating	High/Low	

Neighborhood Source Assessment

A total of 8 neighborhoods were assessed in the Long Green Creek subwatershed during the Neighborhood Source Assessment of Area Q. Recommendations for addressing stormwater volume and pollutants within this subwatershed include rain gardens/rain barrels/downspout disconnection, storm drain marking, BayScaping, fertilizer reduction and lot canopy improvements. The results of the Neighborhood Source Assessment (NSA) are presented in Table 4-22.

Table 4-22: Actions Identified for Neighborhoods in Long Green Creek

Site ID	Lot Size (acres)	Rain Garden/Rain Barrels/Downspout Disconnection	Storm Drain Marking	BayScaping	Fertilizer Reduction	Lot Canopy
NSA_Q_308	1			X	X	X
NSA_Q_309	1		X			
NSA_Q_310	>1	X		X	X	X
NSA_Q_311	1		X			
NSA_Q_312	>1					
NSA_Q_313	>1		X			
NSA_Q_314	>1		X	X		X
NSA_Q_315	>1		X			

The most common action recommended is storm drain marking, recommended for 5 of the 8 neighborhoods. This is followed by BayScaping and lot canopy improvement, which are both suggested for 3 neighborhoods that had large lawn areas and minimal tree canopy cover. Half of the neighborhoods were found to have stream buffer encroachment due to homeowner mowing (NSA_Q_309, 310, 311, 315). Two neighborhoods are recommended for fertilizer reduction due to high maintenance lawns and one was recommended for downspout disconnection to rain gardens or rain barrels. Figure 4-5 provides an example of neighborhood restoration opportunities and stream buffer encroachment.

Figure 4-5: A lot in neighborhood NSA_Q_314 where BayScaping and tree planting are recommended (left); stream buffer encroachment due to mowing in NSA_Q_311 (right).

Hotspot Site Investigation

The Long Green Creek subwatershed had the largest number of hotspots to investigate in Area Q. The HSI was conducted at a total of 18 sites – 16 commercial and two municipal in the Long Green Creek subwatershed. None of the sites were found to be confirmed hotspots, but four are potential hotspots with recommended actions summarized in Table 4-23. The three commercial sites could be included in educational activities to encourage better stormwater management practices (e.g., proper containment of materials stored outside). A review of the stormwater pollution prevention plan is recommended for the municipal site to determine whether drainage from the property is going a stormwater wet pond on an adjacent lot. If drainage is going to the pond, it could be evaluated for opportunities to provide additional storage and/or water quality benefits. Figure 4-6 shows examples of pollution sources at two of the hotspot sites in the Long Green Creek subwatershed.

Table 4-23: Recommended Actions for Hotspots Identified in Long Green Creek

Site ID	Type	Status	Recommended Actions					
			Refer for Enforcement	Follow-Up Inspection	Test for Illicit Discharge	Education	On-site Retrofit	Review Pollution Plan
HSI_Q_304	Commercial	Not a Hotspot						
HSI_Q_305	Commercial	Not a Hotspot						
HSI_Q_306	Commercial	Potential				X		
HSI_Q_307	Commercial	Not a Hotspot						
HSI_Q_308	Commercial	Not a Hotspot						
HSI_Q_309	Municipal	Potential						X
HSI_Q_310	Commercial	Not a Hotspot						
HSI_Q_311	Commercial	Not a Hotspot						
HSI_Q_312	Commercial	Not a Hotspot						
HSI_Q_313	Commercial	Potential				X		
HSI_Q_314	Commercial	Not a Hotspot						
HSI_Q_315	Municipal	Not a Hotspot						
HSI_Q_316	Commercial	Not a Hotspot						
HSI_Q_317	Commercial	Not a Hotspot						
HSI_Q_318	Commercial	Not a Hotspot						
HSI_Q_319	Commercial	Potential				X		
HSI_Q_320	Commercial	Not a Hotspot						
HSI_Q_321	Commercial	Not a Hotspot						

Figure 4-6: Uncovered mulch pile at HSI_Q_306 (left) and broken up asphalt surface at HSI_Q_309 (right) in Long Green Creek subwatershed.

Institutional Site Investigation

Eight institutional sites in the Long Green Creek subwatershed were preselected for the field teams to conduct an Institutional Site Investigation (ISI). Table 4-24 shows the list of all the sites assessed and their respective recommended actions. Of the six sites with identified actions, three of them are faith-based institutions, while the remaining three are a fire company, a school, and park & recreational facility. All but one have tree planting opportunities and three of them were identified for potential stormwater retrofits. Examples of those potential retrofit locations are shown in Figure 4-7.

Table 4-24: Identified Actions for Institutional Sites in Long Green Creek

Site ID	Type	Identified Actions				
		Tree Planting	Stormwater Retrofit	Downspout Disconnection	Trash Management	Stormdrain Marking
ISI_Q_302	Faith-Based	X				
ISI_Q_303	Faith-Based					
ISI_Q_304	Fire Company	X	X			
ISI_Q_305	Faith-Based	X				
ISI_Q_306	School	X	X			
ISI_Q_307	Faith-Based					
ISI_Q_308	Faith-Based	X				
ISI_Q_309	Park & Recreational		X			

Figure 4-7: Potential bioswale retrofit at Carroll Manor Elementary School, RRI_Q_309 (left photo); rock channel in Hyde's Road Park that could be converted to a bioswale, RRI_Q_310 (right photo).

Stormwater Conversions

One detention pond within the Long Green Creek subwatershed was identified for potential conversion to a facility that provides water quality benefits in addition to quantity control. This pond at Beaverbrook Farms Phase II (SWM-2179) has a drainage area of 10.1 acres.

Pervious Area Assessment

A total of 63 parcels (170.1 acres) were found in Long Green Creek subwatershed to have large pervious areas that could potentially serve for tree planting.

Stream Corridor Assessment

The Lower Gunpowder Falls Watershed Water Quality Management Study (WQMS; Parsons Brinckerhoff, 1999) identified potential water quality enhancement projects in this subwatershed. These recommendations included projects such as channel restoration, bank stabilization, riparian buffer improvement, and SWM ponds. Seven channel restoration or bank stabilization projects were identified in Long Green Creek.

Six of the recommended stream restoration projects were revisited in early 2017. One site (LG-2) was not able to be visited due to lack of permission. Some of these projects encompassed several thousand feet of stream. Project extents were revised based on current conditions, resulting in seven reaches recommended for restoration that make up smaller portions of the original seven projects. Two projects ranked high based on the field reviews: LG-4 and LG-3b. LG-3b is on the mainstem of Long Green Creek. Typical to this subwatershed, both streams flow through agricultural fields with little to no riparian buffer. Downcutting has decreased floodplain access and the banks are vertical and eroding. In total, 18,140 feet of stream is recommended for restoration after the field reviews of projects identified in the 1999 WQMS. Additional information can be found in Section 3.5.2 of the Watershed Characterization Report (Appendix E).

In addition, the stream buffer land use evaluation described in Section 4.2.9 found that over half (59.6%) of the 100-foot stream buffer in Long Green Creek contains open pervious land, indicating a high potential for stream buffer reforestation.

Subwatershed Management Strategy

Restoration and protection strategies for Long Green Creek subwatershed are outlined below.

Engaging Citizens & Watershed Groups

1. Engage citizens in a storm drain marking program and conduct marking activities in the neighborhoods indicated in Table 4-22.
2. Engage property owners in opportunities to plant trees to increase lot canopy for the neighborhoods indicated in Table 4-22.
3. Engage property owners in riparian buffer reforestation efforts in NSA_Q_309, 310, 311, and 315.
4. Encourage citizens to adopt landscape practices to increase native vegetation and habitat, and decrease turfgrass to include BayScapes in neighborhoods identified in Table 4-22.
5. Promote awareness of the benefits of proper lawn care in neighborhoods noted for fertilizer reduction in Table 4-22 and encourage citizens to reduce fertilizer use to maintain healthy turfgrass.
6. Engage property owners in NSA_Q_310 in downspout disconnection onto adjacent pervious surfaces or into retrofitted rain barrels or rain gardens.

Municipal Actions

7. Review the stormwater pollution plan for the Glen Arm Property Management and Maintenance Facility (HSI_Q_309) to determine whether runoff from the site is being treated by the wet pond located on an adjacent lot, and if so, evaluate the pond for retrofit opportunities.
8. Follow up with the commercial property owners of potential hotspots noted in Table 4-23 with future education efforts.
9. Follow up with property owners to evaluate the potential to implement stormwater retrofit opportunities at the three institutional sites listed in Table 4-24.
10. Evaluate the 170 acres of potential tree planting on the 63 identified parcels from the pervious area assessment to determine implementation feasibility.

11. Work with property owners of institutional sites listed in Table 4-24 to identify options for tree planting.
12. Evaluate the ability to convert the dry detention stormwater management facility (SWM-2179) in Beaverbrook Farm Phase II neighborhood to another practice that provides greater water quality benefits.
13. Continue assessment of the 18,140 feet of proposed stream restoration in the Long Green Creek subwatershed to develop plan for implementation.
14. Promote new tree planting in the 60% of the 100-ft stream buffer that is currently open pervious land and maintain existing forests.

4.3.4 Lower Gunpowder Falls East

Lower Gunpowder Falls East is the second largest subwatershed within Area Q, with an area of 7.4 square miles. The existing land use consists primarily of forest and low density residential. Only 16% of the land area serves agricultural uses, such as crops and pasture, and very little of that land is under some form of conservation easement (8%). Only 3.3% of the subwatershed is protected by any form of conservation easement – the smallest percentage of any of the Area Q subwatersheds. Table 4-25 summarizes the key subwatershed characteristics of Lower Gunpowder Falls East.

Table 4-25: Lower Gunpowder Falls East Subwatershed Key Characteristics

Drainage Area	4,757.6 acres (7.4 mi^2)	
Stream Length	33.4 miles	
Total Population	2,280 (Census 2010) 0.48 people/acre	
Land Use/Land Cover	Very Low Density Residential (Agriculture):	4.5%
	Very Low Density Residential (Forested):	10.0%
	Low Density Residential:	21.4%
	Medium Density Residential	1.2%
	Commercial:	0.6%
	Institutional:	0.1%
	Industrial:	0.7%

	Transportation:	0.7%
	Open Urban Land:	1.7%
	Agriculture (Cropland, Pasture):	15.8%
	Forest:	38.5%
	Brush:	0.3%
	Water and Wetlands:	4.3%
Land in Easement	Total: 157.6 acres (3.3% of Subwatershed) Agricultural: 61.8 acres (8.2% of Agricultural Area)	
Impervious Cover	10.3% of Subwatershed	
Hydrologic Soil Group	A soils (low runoff potential): B soils: C soils: D soils (high runoff potential):	0.1% 51.5% 34.3% 12.3%
SWM Facilities	17 Facilities 2.0% of urban land use treated	
Restoration/Protection Priority Rating	High/High	

Neighborhood Source Assessment

A total of 11 distinct neighborhoods were identified and assessed within the Lower Gunpowder Falls East subwatershed. Recommendations for addressing stormwater volume and pollutants within this subwatershed include storm drain marking, downspout disconnection to rain barrels or rain gardens, lot canopy improvements, BayScaping, and fertilizer reduction. The results of the Neighborhood Source Assessment (NSA) are presented in Table 4-26.

Table 4-26: Actions Identified for Neighborhoods in Lower Gunpowder Falls East

Site ID	Lot Size (acres)	Rain Garden/Rain Barrels/Downspout Disconnection	Storm Drain Marking	BayScape	Fertilizer Reduction	Lot Canopy
NSA_Q_620	>1		X			
NSA_Q_621	>1		X	X	X	X
NSA_Q_622	>1				X	
NSA_Q_623	>1		X	X	X	X
NSA_Q_624	>1	X	X	X		X
NSA_Q_625	>1		X	X	X	X
NSA_Q_626	1	X	X	X		X
NSA_Q_627	>1			X		X
NSA_Q_628	>1		X			
NSA_Q_629	1/2 - 1		X	X		X
NSA_Q_630	>1	X			X	

Most of the neighborhoods in Lower Gunpowder Falls East are recommended for storm drain marking. Seven of the neighborhoods could benefit from a combination of BayScaping and tree canopy improvements to reduce runoff and improve habitat. Stream buffer encroachment was found in three neighborhoods (NSA_Q_623, 624, 625). There are opportunities for downspout disconnection to rain gardens or rain barrels in three neighborhoods to better manage roof runoff. High maintenance lawns were identified in approximately half of neighborhoods, which are recommended for fertilizer reduction. Figure 4-8 illustrates some of the identified actions in the Lower Gunpowder Falls East subwatershed.

Figure 4-8: Opportunities for fertilizer reduction, lot canopy improvement, and BayScaping for a lot in NSA_Q_625 (left photo); Storm drain marking opportunity in NSA_Q_626 (right photo).

Hotspot Site Investigation

The HSI was conducted at four sites in Lower Gunpowder Falls East – two commercial properties, one transport-related facility, and one industrial site. The transport-related facility (HSI_Q_622) was considered a potential hotspot and the industrial site, Maryland Scrap Metal Recyclers (HSI_Q_625), was confirmed to be a hotspot and recommended for immediate enforcement. The two commercial sites were not found to be of concern. However, HSI_Q_624 is recommended for additional follow-up inspection due to degrading material and equipment storage on the site. Specific remediation actions identified for the confirmed and potential hotspots are summarized in Table 4-27. Sources of pollution at these sites primarily involve outdoor storage of material and inadequate containment of waste. Two of the sites are suggested for follow-up inspections to further gauge the severity of the pollution problem. Figure 4-9 shows examples of pollution sources at the potential and confirmed hotspot sites in the Lower Gunpowder Falls East subwatershed.

Table 4-27: Recommended Actions for Hotspots Identified in Lower Gunpowder Falls East

Site ID	Type	Status	Recommended Actions					
			Refer for Enforcement	Follow-Up Inspection	Test for Illicit Discharge	Education	On-site Retrofit	Review Pollution Plan
HSI_Q_622	Transport-Related	Potential				X		
HSI_Q_623	Commercial	Not a Hotspot						
HSI_Q_624	Commercial	Not a Hotspot		X				
HSI_Q_625	Industrial	Confirmed	X	X	X	X		X

Figure 4-9: Outdoor material storage at HSI_Q_622 (left photo); Abandoned gardening center suggested for further on-site inspection due to degrading outdoor material and equipment storage at HSI_Q_624 (right photo).

Institutional Site Investigation

Six sites were assessed during the ISI in the Lower Gunpowder Falls East subwatershed, including four churches, one fire station, and one golf course. Stormwater retrofits are recommended for three of the sites. The actions identified for these institutional sites are shown in Table 4-28. Grace Community Church (ISI_Q_613) has the most number of recommendations: storm drain marking, stormwater retrofit, and trash management. Tree planting and downspout disconnection were also suggested at the other sites. Examples of institutional site opportunities are shown in Figure 4-10.

Table 4-28: Identified Actions for Institutional Sites in Lower Gunpowder Falls East

Site ID	Type	Identified Actions					
		Tree Planting	Stormwater Retrofit	Downspout Disconnection	Trash Mgmt.	Storm Drain Marking	Stream Buffer Improv.
ISI_Q_612	Faith-Based	X					
ISI_Q_613	Faith-Based		X		X	X	
ISI_Q_614	Fire Company		X				
ISI_Q_615	Faith-Based						
ISI_Q_616	Faith-Based			X			
ISI_Q_617	Golf Course		X				

Figure 4-10: Rain garden opportunity at Grace Community Church, RRI_Q_601 (left photo); Tree planting location suggested for First Baptist Church of Kingsville, ISI_Q_612 (right photo).

Stormwater Conversions

Four detention ponds within the Lower Gunpowder Falls East subwatershed were identified for potential conversion to facilities that provide water quality benefits in addition to quantity control. The collective drainage area to these four ponds is 52.5 acres.

Pervious Area Assessment

A total of 60 parcels (145.4 acres) were found in the Lower Gunpowder Falls East subwatershed to have large pervious areas that could potentially serve for tree planting.

Stream Corridor Assessment

The Lower Gunpowder Falls Watershed Water Quality Management Study (WQMS; Parsons Brinckerhoff, 1999) identified potential water quality enhancement projects in this subwatershed. These recommendations included projects such as channel restoration, bank stabilization, riparian buffer improvement, outfall retrofit, and wetland creation. Five channel restoration or bank stabilization projects were identified in Lower Gunpowder Falls East.

Field reviews of the potential stream restoration projects were conducted in early 2017. Four of the reaches were located entirely or partially within Gunpowder Falls State Park and, in general, were stable. The exception was GF-34a, a reach with tall, eroding banks that was situated between stable reaches upstream and downstream. Field observations suggested that fill material was previously piled up on the banks, which disconnected the stream from its floodplain. Three other reaches (GF-36a, GF-37a, and GF-37c) are also recommended for restoration based on the field reviews, bringing the total length recommended for restoration in this subwatershed to 3,710 feet. Additional information can be found in Section 3.5.2 of the Watershed Characterization Report (Appendix E).

In addition, the stream buffer land use evaluation described in Section 4.2.9 found that about a third (35.8%) of the 100-foot stream buffer in Lower Gunpowder Falls East contains open pervious land, indicating a high potential for stream buffer reforestation.

Subwatershed Management Strategy

Restoration and protection strategies for Lower Gunpowder Falls East are outlined below.

Engaging Citizens & Watershed Groups

1. Engage citizens in a storm drain marking program and conduct marking activities in the neighborhoods indicated in Table 4-26.
2. Engage property owners in opportunities to plant trees to increase lot canopy for the neighborhoods indicated in Table 4-26,
3. Engage property owners in riparian buffer reforestation efforts in NSA_Q_623, 624, and 625.
4. Encourage citizens to adopt landscape practices to increase native vegetation and habitat, and decrease turfgrass to include BayScapes in neighborhoods identified in Table 4-26.
5. Promote awareness of the benefits of proper lawn care in neighborhoods noted for fertilizer reduction in Table 4-26 and encourage citizens to reduce fertilizer use to maintain healthy turfgrass.
6. Engage property owners in downspout disconnection onto adjacent pervious surfaces or into retrofitted rain barrels or rain gardens for the neighborhoods indicated in Table 4-26.

Municipal Actions

7. Review the stormwater pollution plan and conduct follow-up inspection of the Maryland Scrap Metal Recyclers site (HSI_Q_625) to resolve problem of waste dumping near stream.
8. Follow up with the property owners of hotspots noted in Table 4-27 with future education efforts.
9. Work with property owners to evaluate the potential to implement stormwater retrofit opportunities at the three institutional sites listed in Table 4-28.
10. Evaluate the ability to convert the four dry detention stormwater management facilities in this subwatershed to another practice that provides greater water quality benefits.
11. Evaluate the 145 acres of potential tree planting on the 6 identified parcels from the pervious area assessment to determine implementation feasibility.

12. Promote new tree planting in the 36% of the 100-ft stream buffer that is currently open pervious land and maintain existing forests.
13. Continue assessment of the 3,710 feet of proposed stream restoration in this subwatershed to develop plan for implementation.

4.3.5 Lower Gunpowder Falls West

Lower Gunpowder Falls West has an area of 3.2 square miles. Nearly half of the land area is in forest (46.7%) and agriculture makes up the next-largest land use (30.6%). Over two thirds of the agricultural land is projected by conservation easements. This subwatershed is the least densely populated and least developed subwatershed in Area Q. Table 4-29 summarizes the key subwatershed characteristics of Lower Gunpowder Falls West.

Table 4-29: Lower Gunpowder Falls West Subwatershed Key Characteristics

Drainage Area	2,020.1 acres (3.2 mi^2)	
Stream Length	16.0 miles	
Total Population	508.5 (Census 2010) 0.25 people/acre	
Land Use/Land Cover	Very Low Density Residential (Agriculture):	3.2%
	Very Low Density Residential (Forested):	2.9%
	Low Density Residential:	14.8%
	Medium Density Residential	0.0%
	Commercial:	1.5%
	Institutional:	0.0%
	Industrial:	0.0%
	Transportation:	0.0%
	Open Urban Land:	0.0%
	Agriculture (Cropland, Pasture):	30.6%
	Forest:	46.7%
	Water and Wetlands:	0.7%

Land in Easement	Total: 433.0 acres (21.4% of Subwatershed) Agricultural: 426.1 acres (68.9% of Agricultural Area)	
Impervious Cover	6.5% of Subwatershed	
Hydrologic Soil Group	A soils (low runoff potential): B soils: C soils: D soils (high runoff potential):	0.8% 79.4% 16.7% 1.4%
SWM Facilities	1 Facility 0.0% of urban land use treated	
Restoration/Protection Priority Rating	Low/High	

Neighborhood Source Assessment

Two neighborhoods were assessed within the Lower Gunpowder Falls West subwatershed. Storm drain marking in one of the neighborhoods was the only action identified during the Neighborhood Source Assessment (NSA), as shown in Table 4-30. However, there is also some stream buffer encroachment due to homeowner mowing that should be addressed in both neighborhoods. Figure 4-11 shows an example residential lot in Lower Gunpowder Falls West.

Table 4-30: Actions Identified for Neighborhoods in Lower Gunpowder Falls West

Site ID	Lot Size (acres)	Rain Garden/Rain Barrels/Downspout Disconnection	Storm Drain Marking	BayScape	Fertilizer Reduction	Lot Canopy
NSA_Q_101	>1					
NSA_Q_102	>1		X			

Figure 4-11: A typical residential lot in NSA_Q_102.

Hotspot Site Investigation

Only one site – a restaurant that appears to no longer be in operation – was assessed during the HSI in the Lower Gunpowder Falls West. It was determined not to be a hotspot; therefore, no recommendations exist for this site.

Institutional Site Investigation

No institutional sites were investigated in the Lower Gunpowder Falls West subwatershed.

Stormwater Conversions

No detention ponds were identified for conversion in the Lower Gunpowder Falls West subwatershed.

Pervious Area Assessment

A total of 8 parcels (14.6 acres) were found in the Lower Gunpowder Falls West subwatershed to have large pervious areas that could potentially serve for tree planting.

Stream Corridor Assessment

The Lower Gunpowder Falls Watershed Water Quality Management Study (WQMS; Parsons Brinckerhoff, 1999) identified potential water quality enhancement projects in this subwatershed. These recommendations included projects such as channel restoration, bank stabilization, riparian buffer improvement, outfall retrofit, and wetland creation. One channel restoration or bank stabilization project was identified in Lower Gunpowder Falls West.

Reach GF-25 was the only recommended stream restoration project in this subwatershed. The unstable nature of the reach was confirmed during field reviews in early 2017 and

approximately 410 feet of stream are recommended for restoration. A deep gully has formed downstream of the outfall from a manmade pond, which itself is undercut. A small tributary to this reach has also downcut as a result. The downcutting and erosion end where the stream encounters bedrock as it descends toward the Gunpowder Falls mainstem. Additional information can be found in Section 3.5.2 of the Watershed Characterization Report (Appendix E).

In addition, the stream buffer land use evaluation described in Section 4.2.9 found that over a third (41.5%) of the 100-foot stream buffer in Lower Gunpowder Falls West contains open pervious land, indicating a high potential for stream buffer reforestation.

Subwatershed Management Strategy

Restoration and protection strategies for Lower Gunpowder Falls West are outlined below.

Engaging Citizens & Watershed Groups

1. Engage citizens in a storm drain marking program and conduct marking activities in neighborhood NSA_Q_102.
2. Engage property owners in riparian buffer reforestation efforts in NSA_Q_101 and NSA_Q_102.

Municipal Actions

3. Evaluate the 15 acres of potential tree planting on the 8 identified parcels from the pervious area assessment to determine implementation feasibility.
4. Promote new tree planting in the 42% of the 100-ft stream buffer that is currently open pervious land and maintain existing forests.
5. Continue assessment of the 410 feet of proposed stream restoration in this subwatershed to develop a plan for implementation.

4.3.6 Sweathouse Run

Sweathouse Run is the smallest subwatershed in Area Q, having an area of only 1.7 square miles. Its land cover is relatively evenly split between low and very low density residential (35.5%), forest (34.8%), and agriculture (21.2%). Over half of the subwatershed area is in conservation easements (57.8%). Table 4-31 summarizes the key subwatershed characteristics of Sweathouse Run.

Table 4-31: Sweathouse Run Subwatershed Key Characteristics

Drainage Area	1,089.2 acres (1.7 mi^2)	
Stream Length	7.3 miles	
Total Population	521 (Census 2010) 0.48 people/acre	
Land Use/Land Cover	Very Low Density Residential (Agriculture):	5.5%
	Very Low Density Residential (Forested):	13.2%
	Low Density Residential:	22.3%
	Medium Density Residential	2.7%
	Commercial:	0.4%
	Institutional:	0.0%
	Industrial:	0.0%
	Open Urban Land:	0.0%
	Agriculture (Cropland, Pasture):	21.2%
	Forest:	34.8%
	Water and Wetlands:	0.0%
Land in Easement	Total: 40.2 acres (57.8%) Agricultural: 35.9 acres (15.6%)	
Impervious Cover	9.8% of Subwatershed	
Hydrologic Soil Group	A soils (low runoff potential): B soils: C soils: D soils (high runoff potential):	0.0% 63.7% 32.6% 3.7%
SWM Facilities	4 Facilities 1.9% of urban land use treated	
Restoration/Protection Priority Rating	Moderate/High	

Neighborhood Source Assessment

Three distinct neighborhoods were identified and assessed within the Sweathouse Run subwatershed. Recommendations for addressing stormwater volume and pollutants within this subwatershed include downspout disconnection to rain barrels and rain gardens (two neighborhoods), storm drain marking (two neighborhoods), BayScaping (two neighborhoods), lot canopy improvements (two neighborhoods), and fertilizer reduction (one neighborhood). The results of the Neighborhood Source Assessment (NSA) are presented in Table 4-32. In addition, two neighborhoods (NSA_Q_518 & 519) had encroachment into the stream buffer due to mowing. Figure 4-12 illustrates some of the identified actions in the Sweathouse Run neighborhoods.

Table 4-32: Actions Identified for Neighborhoods in Sweathouse Run

Site ID	Lot Size (acres)	Rain Garden/Rain Barrels/Downspout Disconnection	Storm Drain Marking	BayScape	Fertilizer Reduction	Lot Canopy
NSA_Q_517	1/2	X	X			
NSA_Q_518	>1	X		X	X	X
NSA_Q_519	>1		X	X		X

Figure 4-12: Stream buffer encroachment in NSA_Q_519 (left photo); Opportunities for fertilizer reduction, lot canopy improvement, and bayscaping in NSA_Q_518 (right photo).

Hotspot Site Investigation

No hotspots were investigated in the Sweathouse Run subwatershed.

Institutional Site Investigation

Three sites were assessed during the ISI in the Sweathouse Run subwatershed – two churches and one school. The actions identified for these ISIs are shown in Table 4-33. Tree planting opportunities were the primary recommendation for these sites. Additional recommendations include trash management at one of the church sites. Examples of potential tree planting areas are shown in Figure 4-13.

Table 4-33: Identified Actions for Institutional Sites in Sweathouse Run

Site ID	Type	Identified Actions					
		Tree Planting	Stormwater Retrofit	Downspout Disconnection	Trash Mgmt.	Storm Drain Marking	Stream Buffer Improv.
ISI_Q_510a	Faith-Based	X			X		
ISI_Q_510b	Faith-Based	X					
ISI_Q_511	School	X					

Figure 4-13: Tree Planting Opportunities at Swingtime Ballroom, ISI_Q_511 (left photo) and Beachmont Ministries, ISI_Q_510b (right photo).

Stormwater Conversions

No detention ponds were identified for conversion in Sweathouse Run subwatershed.

Pervious Area Assessment

No parcels were identified in Sweathouse Run subwatershed to have large enough pervious area to serve for tree planting.

Stream Corridor Assessment

The Lower Gunpowder Falls Watershed Water Quality Management Study (WQMS; Parsons Brinckerhoff, 1999) identified potential water quality enhancement projects in this subwatershed. These recommendations included projects such as channel restoration, bank stabilization, and riparian buffer improvement. Two channel restoration or bank stabilization projects were identified in Sweathouse Run.

Both recommended stream restoration projects were revisited in early 2017, however only a small portion of SH-1 could be assessed due to property access. No instability was noted in this small portion and therefore it was not recommended for restoration. Reach SH-3 was a steep channel with step-pools and bedrock. Most of the reach was stable, with bank erosion present in some outer meander bends in the upstream end. Due to the short extent of the erosion, and the stability provided by bedrock, this reach was also not recommended for restoration. Additional information can be found in Section 3.5.2 of the Watershed Characterization Report (Appendix E).

In addition, the stream buffer land use evaluation described in Section 4.2.9 found that over a quarter (28.3%) of the 100-foot stream buffer in Sweathouse Run contains open pervious land, indicating a high potential for stream buffer reforestation.

Subwatershed Management Strategy

Restoration and protection strategies for Sweathouse Run subwatershed are outlined below.

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

1. Engage property owners in downspout disconnection onto adjacent pervious surfaces or into retrofitted rain barrels or rain gardens in NSA_Q_517 and NSA_Q_518.
2. Engage citizens in a storm drain marking program and conduct marking activities in the neighborhoods indicated in NSA_Q_517 and NSA_Q_519.
3. Engage property owners in opportunities to plant trees to increase lot canopy in NSA_Q_518 and NSA_Q_519.
4. Engage property owners in riparian buffer reforestation efforts in NSA_Q_518 and NSA_Q_519.
5. Encourage citizens to adopt landscape practices to increase native vegetation and habitat, and decrease turfgrass to include BayScapes in neighborhoods identified in NSA_Q_518 and NSA_Q_519.

6. Promote awareness of the benefits of proper lawn care in NSA_Q_518 and encourage residents to reduce fertilizer use to maintain healthy turfgrass.

Municipal Actions

7. Promote new tree planting in the 28% of the 100-ft stream buffer that is currently open pervious land and maintain existing forests.
8. Work with institutional property owners listed in Table 4-33 to identify options for tree planting.
9. Follow up with the property owner of ISI_Q_510a with future trash management education efforts.

CHAPTER 5.0
Plan Evaluation

5.1 Introduction

The Lower Gunpowder Falls Watershed Action Plan (SWAP) is based on an implementation schedule with an anticipated endpoint of 2025. This time frame is necessary to implement restoration measures and meet the Chesapeake Bay Total Maximum Daily Loads (TMDL). The ability to implement this plan within the specified timeframe is dependent upon the availability of staff and sufficient funding. The Lower Gunpowder Falls SWAP Implementation Committee (an outgrowth of the Steering Committee) will meet twice per year to assess progress in meeting watershed goals and objectives to discuss funding options. In addition, any completed projects will be recorded in the County's annual National Pollutant Discharge Elimination System (NPDES) report. An adaptive management approach will be used to meet watershed goals and objectives based on SWAP evaluation data. The Lower Gunpowder Falls 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 Lower Gunpowder Falls SWAP will be evaluated during implementation based on the following: interim measureable milestones, pollutant load reduction criteria, implementation tracking, and monitoring. These evaluation components are described in the following sections.

5.2 Interim Measurable Milestones

Overall 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. Actions 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. The effectiveness estimates for best management practices (BMPs) that are implemented and reported by the Chesapeake Bay partners, as well as those planned for future implementation, were obtained from the Documentation for Scenario Builder Version 2.4, which was revised January 2013 (U.S. EPA, 2013). These estimates are the most recent at the time of SWAP development. The BMP effectiveness estimates are extracted from Tables 8-4 and 8-5 from this documentation. In addition, recommendations from the Chesapeake Bay Program

BMP Expert Panels which provide updated efficiencies for Urban Nutrient Management and urban stream restoration were used in this SWAP. The revised BMP effectiveness estimates from two other Expert Panel reports, Urban Stormwater Retrofit Expert Panel and New State Stormwater Performance Standards, were not applied given the detailed information on individual BMPs needed to estimate the value, and therefore values in Tables 8-4 and 8-5 were used. These references are available in Appendix D.

5.4 Implementation Tracking

Implementation of restoration actions for the Lower Gunpowder Falls SWAP will be overseen by the Implementation 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 Lower Gunpowder Falls SWAP Implementation Committee will initiate revisions of the plan.

5.5 Monitoring

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

5.5.1 Existing Monitoring

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

Trend Monitoring – 41 monitoring sites throughout the county, two of which are located within the Lower Gunpowder Falls watershed, provide information on ambient chemical conditions and assess trends in chemical concentrations and loads (Baltimore County, 2015).

Biological Monitoring – Conducted since 2003 following the Maryland Biological Stream Survey (MBSS) probabilistic monitoring methods to assess ecological health in local streams, assess the effectiveness of stream restoration projects, and provide data on the best streams in the county to serve as bench marks for other stream assessments (Baltimore County, 2015).

Illicit Discharge Detection and Elimination Program – Routine outfalls screening and prioritization system to track and reduce illicit connections and discharges.

5.5.2 SWAP Implementation Monitoring

SWAP implementation monitoring activities will focus on project specific monitoring and targeted subwatershed monitoring. Project specific monitoring will be identified as restoration progresses. It will not be possible to monitor all restoration projects due to the number of actions proposed. Project specific monitoring will target activities with limited data regarding removal efficiencies such as 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. Monitoring activities will be coordinated among SWAP participants through participation in the Lower Gunpowder Falls SWAP Implementation Committee.

CHAPTER 6.0
References

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APPENDIX A

Area Q Action Strategies

This appendix presents the actions related to the goals and objectives presented in Chapter 2 of the Area Q SWAP. The Goals and Objectives are summarized in Table A-1. A complete list of actions proposed for the watershed including timelines, performance measures, unit cost estimates, and responsible parties is included in Table A-2. In many cases, actions relate to multiple goals and objectives. Some of the key columns included in Table A-2 are briefly described below. Note that some of the programmatic actions in Table A-2 are included in existing EPS programs and are not necessarily discussed in the SWAP report.

Goals and Objectives

Table A-1 indicates the goals and objectives targeted for each action. Each is further explained in Chapter 2 of the Area Q SWAP.

Table A-1: Area Q Goals and Objectives

Goal	Objectives
CLEAN WATER	
1. Improve and maintain clean water	1. Increase oversight of septic system performance and promote proper maintenance of septic systems. 2. Identify and target areas to retrofit with stormwater management projects. 3. Reduce fertilizer/pesticide/herbicide use from lawns.
2 Reduce nitrogen, phosphorus, and sediment inputs to the Lower Gunpowder Falls watershed to meet the Baltimore County allocated load reduction for the Chesapeake Bay total maximum daily load (TMDL)	1. Meet the Chesapeake Bay TMDL goal to reduce urban loads of nitrogen by 32.2% by 2025. 2. Meet the Chesapeake Bay TMDL goal to reduce urban loads of phosphorus by 47% by 2025. 3. Reduce sediment input to the Lower Gunpowder Falls to support healthy living resources in the stream (i.e., biological communities). 4. Support ambient water quality sampling efforts throughout the Lower Gunpowder Falls watershed. Identify and target areas to retrofit with stormwater management practices and stream protection.
STREAM PROTECTION	
3. Reduce and control stormwater runoff to support Use Class I, III, and IV Designations (Water Contact Recreation and Protection of Nontidal Warmwater Aquatic Life, NonTidal Cold Water, and Recreational Trout Waters)	1. Identify and target areas to retrofit with stormwater management projects and stream restoration. 2. Meet the County's MS4 permit goal to treat 20% of untreated impervious cover. 3. Limit impervious cover in new development in compliance with Environmental Site Design.

Goal	Objectives
	4. Work with Bureau of Highways to review road de-icing practices to minimize use of road salt impact on local waterways.
4. Protect high quality streams to support cold water fisheries	1. Identify high quality trout streams and document trout populations in the waters. 2. Maintain and enhance current trout populations in the watershed. 3. Identify high quality streams. 4. Restore or sustain water temperatures in trout streams at 68° F. 5. Maintain or improve baseflow in trout streams.
FOREST AND HABITAT	
5. Support conservation of contiguous forested areas	1. Identify and protect areas in groundwater 'recharge' areas for forest conservation. 2. Support collaboration with watershed organizations and homeowners for projects to plant native species. 3. Work with local, state and other organizations to manage forests to limit damage from invasive species, insects and deer. 4. Improve and sustain native species and age diversity in forests.
6. Protect and Restore Riparian Forest Buffers to the Maximum Extent Practicable	1. Target restoration efforts in headwater areas. 2. Continue to apply Baltimore County's forest buffer regulation to enhance and protect streams.
AGRICULTURAL PRACTICES	
7. Preserve the Agricultural Heritage of the Watershed	1. Limit upzoning through monitoring of zoning change requests. 2. Promote initiatives to increase funding for agricultural conservation easements.
8. Promote the Implementation of Conservation Practices on Agricultural Lands	1. Work with Conservation Districts and University of Maryland Extension to inform agricultural land owners of the benefit of conservation practices/ BMPs in the restoration and protection of the Lower Gunpowder Falls Watershed. 2. Implement an urban/agricultural TMDL workgroup to promote coordination between the County and the agricultural community to reach TMDL goals.
STEWARDSHIP AND EDUCATION	
9. Engage the public in actions to support a healthy watershed	1. Develop partnerships with a variety of stakeholders at diverse geographic locations to adopt practices that reduce pollutant loads to streams and improve stream biology. 2. Continue to develop partnerships with the Baltimore County Public Schools Office of Science to help provide meaningful environmental

Goal	Objectives
	education experiences and opportunities for student involvement in implementing restoration activities. 3. Promote community education and increase involvement in stream clean-up activities. 4. Increase community awareness of water conservation strategies to improve stream baseflow. 5. Utilize the Lower Gunpowder Falls as a safe training location for public monitoring due to its high quality streams and marshland.
10. Improve Community Connection to Parkland and Public Access to Streams	1. Increase awareness of safe and eco-friendly use of recreation opportunities. 2. Increase awareness of existing trails and public access points to the Lower Gunpowder Falls for recreational use. 3. Advocate for the responsible use of recreational areas to enhance the community's sense of propriety.

Actions

Actions developed to achieve watershed goals and objectives are grouped in Table A-2 according to the type of activity. Actions are grouped according to the following categories and subcategories:

- Restoration and Preservation
    - Clean Water
    - Stream Protection
    - Forest and Habitat
    - Agricultural Practices
    - Stewardship
- Monitoring
- Funding
- Reporting

Basis for Performance Measure

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

Timeline

This column denotes the timeline over which an action will be performed as part of the Chesapeake Bay Program TMDL. By the 2025, 100% of pollution reduction measures are required to be in place to meet the requirements of the TMDL. Table A-2

lists the recommended actions to achieve the 2025 milestone. Stream restoration and stormwater retrofits will not be implemented within the first couple of years due to the involved planning that needs to occur for these types of projects. Actions to be completed first include assessment-type of activity and development of outreach materials. The implementation committee will set goals in the context of Baltimore County's Watershed Implementation Plan in the future.

Performance Measure

This column describes how the success/completion of a given action will be measured. In many cases, it is the numeric 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 C).

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, Dept. of Environmental Protection & Sustainability (EPS)
2. Baltimore County Soil Conservation District (SCD)
3. Gunpowder Valley Conservancy (GVC)
4. Baltimore County Public Schools (BCPS)
5. Area Q SWAP Implementation Committee

Table A-2: Area Q Action Strategies

Goal	Objective	Type[1]	Action	Basis for Performance Measure	Timeline 2025	Performance Measure	Unit Cost	Responsible Party
RESTORATION AND PRESERVATION								
Clean Water								
1 2 3 4	2 1,2,3 1,2 4	P	Conduct stormwater retrofit assessments at institutional sites and neighborhoods and work with property owners to identify options for implementation of the recommended actions.	Assessment of stormwater retrofit opportunities.	1 year	Assessments completed	Existing Staff	1
1 2 3 4	2 1,2,3 1,2 4	I	Design and implement stormwater retrofits at all feasible sites.	Field assessments identified 5 retrofits at institutional sites to treat a maximum impervious area of 2.5 acres x 100% participation rate = 2.5 acres.	5 years	1 retrofit per year	$7,600/acre	1
1 2 3 4	2 1,2,3 1,2 4	I	Remove impervious cover at all feasible sites.	Field assessments recommended impervious cover removal at 1 institutional and 1 neighborhood site to treat a maximum impervious area of 0.8 acres x 100% participation = 0.8 acres	2 years	1 site per year	$25,000/acre	1
1 2 3 4	2 1,2,3 1,2 4	P	Conduct field assessments of 6 stormwater dry ponds identified as having conversion potential.	Assessment of stormwater dry pond conversion potential.	1 year	Assessments completed	Existing Staff	1
1 2 3 4	2 1,2,3 1,2 4	I	Design and implement stormwater dry pond conversions.	Desktop assessments identified 6 dry pond conversions to treat a maximum of 76.7 acres x 50% participation rate = 38.4 acres.	3 years	1 conversion per year	$7,500/acre	1
2 3 4	1,2,3 2,3 4	P	Baltimore County shall continue to implement stormwater management regulations that use ESD.	On-going.	On-going	# of ESD practices installed	Existing staff	1
Stream Protection								
2 3	1,2,3 1	P	Design and implement stream restoration projects at all feasible sites.	Field assessments verified potential stream restoration projects from the 1999 Water Quality Management Study. Restore 30,400 ft of stream to provide water quality improvement x 50% participation = 15,200 ft.	7 years	Approximately 2,200 linear feet per year	$400/linear foot	1
3	4	P	Consult with Bureau of Highways on best practices for road deicing.	Provide update on best practices or post information on website.	On-going	Review every 5 years	Existing staff	1
Forest and Habitat								
2 4 5 6 9	1,2,3 4 2,4 1,2 1	I	Reforest existing impacted stream buffers with native plants to include woody vegetation.[2]	Reforest 360 acres of urban riparian open pervious land x 25% participation = 90 acres.	7 years	Reforest 13 acres per year	$15,000/acre	1,3
2 3 4 6	1,2,3 3 4 2	P	Baltimore County shall continue to require riparian buffers and forest conservation for all new and redevelopment. The County shall also continue to inspect and enforce existing forested buffers on residential easements.	On-going, keep track of existing riparian buffer and forest preserved.	On-going	Inspection every 2-5 years	Existing staff	1

Goal	Objective	Type[1]	Action	Basis for Performance Measure	Timeline	Performance Measure	Unit Cost	Responsible Party
					2025			
2 5 9	1,2,3 2,4 1	I	Coordinate with the Gunpowder Valley Conservancy to plant trees at institutional sites.	Plant 18.1 acres with 200 trees/acre x 25% participation = 4.5 acres	3 years	Plant 1.5 acres per year	$175/tree	1,3
4 5 6	4 3,4 2	I	Maintain trees planted at stream buffer sites.[2]	Tree maintenance (watering, mowing, weeding, etc.) is required for the first 5 years to ensure successful growth; projected number of acres to be reforested: 360 x 25% participation = 90 acres.	On-going	Maintain 90 acres per year	$1,300/acre for 5 years	1
5	3,4	I	Maintain trees planted at institutional sites.	Tree maintenance (watering, mowing, weeding, etc.) is required for the first 5 years to ensure successful growth; projected number of acres to be planted: 18.1 x 25% participation = 4.5 acres.	On-going	Maintain 4.5 acres per year	$1,300/acre for 5 years	1
2 4 5	1,2,3 4 2,4	I	Conduct field assessments of pervious areas identified from the desktop assessment and work with property owners to identify options for tree planting.	Assessment of 179 individual properties consisting of 444 acres of potential tree planting.	1 year	Assessment completed	Existing staff	1
5	1,3,4	P	Support expansion of existing deer population management programs for protection of natural resources.	More effective deer herd management.	On-going	Reduced impact of deer on natural resources	Existing staff	1
1 2 9	3 1,2,3 1,2	P	Investigate opportunities to create "no-mow" areas or reduce mowing on public lands.	"No-mow" areas help reduce stormwater runoff, increase habitat, and reduce maintenance costs associated with mowing.	On-going	Reduced area of public lands that are mowed	Existing staff	1,4
3 7	3 1	P	Continue support of downzoning for protection of natural resources.	Comment on zoning issues in support of natural resources.	On-going	Downzoning supported	Existing staff	1
Agricultural Practices								
7 8	1,2 1,2	P	Convene an Agricultural – TMDL workgroup	Promote coordination between the County and the agricultural community to reach TMDL goals.	Within one year, then On-going	Establish a workgroup and meet	Existing staff	1,2
Stewardship								
9 10	2 1,2,3	P	Encourage citizens to utilize recreational opportunities within the Area Q planning area.	Develop awareness materials for recreational opportunities, including existing trails, public access points to the Lower Gunpowder Falls, and responsible use of recreation areas.	On-going	Materials available for distribution (handout and online)	Existing staff	1,3,4
1 2 9	3 1,2,3 1	P	Utilize expert panel on urban nutrient management to assess the extent of high risk lawns within the Area Q planning area and develop education and outreach for those land owners.	Conduct lawn maintenance education events targeting 10 neighborhoods with high risk lawns, totaling 104.9 acres.	On-going	1 event every 3 years	$500/event	1
1 4 9	3 5 1,2,4	P	Encourage citizens to adopt landscape practices to increase native vegetation and habitat, and decrease turf grass to include Bayscapes.	Conduct Bayscaping awareness events targeting 12 neighborhoods identified as potential candidates.	On-going	1 event every 3 years	$500/event	1,3,4
1 4 9	3 5 1,4	P	Encourage community associations to obtain BayWise certification through the Master Gardener's program.	Work with the County's Master Gardeners Committee to publicize materials on the Bay-Wise Program.	On-going	1 announcement per year	Existing staff	1,3
4 5 6	4 1,2,3,4 1	P	Coordinate with the Gunpowder Valley Conservancy to increase homeowner awareness of proper buffer management in regulated areas	Maintain existing buffers and remove invasive vegetation.	On-going	1 event every 3 years	$5,000/event	1,3,4

Goal	Objective	Type[1]	Action	Basis for Performance Measure	Timeline	Performance Measure	Unit Cost	Responsible Party
					2025			
9	1,2,3		(easements), remove invasive vegetation and plant native plants.					
5 9	3,4 1,2	P	Increase homeowner awareness of deer management programs and deer resistant landscaping.	Provide brochures to homeowners and publicize the County's website on deer herd management.	On-going	1 announcement per year	Existing staff	1,4
5 9	1,2,4 1,2	P	Engage citizenss to encourage tree canopy improvements on residential lots.	Work with the 12 neighborhoods identified for lot tree canopy improvement.	On-going	1 event every 3 years	$500/event	1,3,4
2 9	1,2 1,2	P	Promote awareness of the benefits of proper disposal of yard waste.	Publicize several actions in E-News Stream and MD extension service's "Branching Out" and other media	On-going	1 announcement per year	Existing staff	1,4
1 2 9	1 1 1,2	P	Inform citizens on the importance of septic system maintenance.	Conduct septic system maintenance awareness events	On-going	1 event every 3 years	$500/event	1,4
2 9	1,2,3 1,2	I	Coordinate with Gunpowder Valley Conservancy to engage citizens and institutions in a storm drain marking program.	Work with community groups and institutions to conduct storm drain stenciling for 22 neighborhoods and 1 institution identified.	7 years	3 neighborhoods per year	$400/neighborhood	1,3,4
1 2 3 4 9	2 1,2,3 1 5 1,2	P	Coordinate with Gunpowder Valley Conservancy and identify opportunities to partner with other local organizations with existing programs to engage property owners in downspout disconnection onto adjacent pervious surfaces or into retrofitted rain barrels or rain gardens.	Conduct rain garden/rain barrel events	On-going	1 event every 3 years	$500/event	1,3,4
9	1,2	P	Develop awareness materials for commercial businesses on proper waste management and disposal.	Awareness materials developed	1 year to develop materials, then on-going	Materials available for distribution (handout and online)	$500 for materials	1,4
MONITORING								
2	1,2	P	Conduct inspection of BMPs and provide on-going maintenance for all public facilities.	Assure that each facility is inspected every 3 years.	On-going	Inspections completed	Existing staff	1
2 4 9	4 1,3 1,2,3,4,5	P	Promote awareness of the stream watch Adopt-a-Stream program and MD DNR Stream Waders program, with specific focus on filling in the gaps for biological monitoring.	Adopt a section of stream within Area Q and solicit students and other volunteers to sample sites through the Stream Waders program.	On-going	Host 2 events per year	$500/event	1,4
2 4 9	4 3 1,2,3,5	P	Engage students in water quality monitoring.	Establish an Izaak Walton League Creek Freaks Program within Area Q to engage students in monitoring local streams and learning about improving water quality.	On-going	Program established	Existing staff	1,4
4	1,3	P	Continue County biological monitoring program.	Biological monitoring stations in Area Q are monitored in even numbered years and summarized in the County's annual report.	Even numbered years	Stations monitored, summary in annual report	Existing staff	1
4	1,2,3	P	Continue to monitor the fish populations in coordination with DNR.	Annual monitoring.	On-going	Annual Monitoring	Existing staff	1, DNR
FUNDING								
7 8	2 1,2	P	Continue to make agricultural community aware of cost share opportunities	Publicize cost share opportunities.	On-going	Agricultural land owner applications for funding.	Existing staff	1,2

Goal	Objective	Type[1]	Action	Basis for Performance Measure	Timeline	Performance Measure	Unit Cost	Responsible Party
					2025			
7 8 9	2 1,2 1	P	Promote awareness of reforestation funding opportunities for land owners.	Publicize funding sources for reforestation on private property in E-News Stream and MD extension service's "Branching Out" and other media.	On-going	Landowners apply for funding	Existing staff	1
REPORTING								
All	All	P	Area Q SWAP Implementation Committee will meet to discuss implementation progress and assess any changes needed to meet the goals.	Meet on a semi-annual basis.	On-going	2 meetings per year	Existing staff	5
All	All	P	Report restoration progress.	NPDES annual report.	On-going	NPDES annual report	Existing staff	1
All	All	P	Develop a SWAP progress report template.	Template created.	2 years	SWAP Progress Report	Existing staff	1
All	All	P	Update SWAP progress report.	Update annually.	On-going	SWAP Progress Report	Existing staff	1

[1]Project type denotes programmatic (P) or implementation (I) projects. The programmatic elements are tracked on a calendar year (January 1st through December 31st). The implementation projects are tracked on a fiscal year (July 1st through June 30th).

[2]Stream buffer acreage to reforest includes upland urban open pervious area riparian tree planting.

APPENDIX B

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

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:

This appendix will provide information on how the development of the Area Q Small Watershed Action Plan addresses the USEPA A through I criteria for watershed planning. It will serve as a guide to the location within the document, including appendices, where each criterion is addressed. Table B-1 provides the location information for each of the A through I Criteria and describes how the document meets the Criteria.

The list below provides a description of each element of the EPA Watershed Planning Criteria.

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 amount of technical and financial assistance needed to implement the plan

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

f) A schedule for implementing the NPS management measures

g) A description of interim, measurable milestones 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 B-1 is a guide to the location within the document, including appendices, where each criterion is addressed.

Table B-1: Where to Locate Information for Each USEPA's A-I Criteria Element

Chapter of the Report	USEPA A-I Criteria								
	A	B	C	D	E	F	G	H	I
Chapter 1. Introduction					X				
Chapter 2. Vision, Goals and Objectives					X				
Chapter 3. Restoration Strategies		X	X		X				
Chapter 4. Subwatershed Management Strategies	X		X		X				
Chapter 5. Plan Evaluation				X		X	X	X	X
Appendix A. Area Q Action Strategies			X	X	X	X	X		X
Appendix B. U.S. Environmental Protection Agency A Through I Criteria for Watershed Planning									

Chapter of the Report	USEPA A-I Criteria								
	A	B	C	D	E	F	G	H	I
Appendix C. Cost Analysis and Potential Funding Sources				X					
Appendix D. Chesapeake Bay Program Pollutant Load Reduction Efficiencies		X							
Appendix E. Area Q Watershed Characterization Report	X		X		X				
Appendix F. Potential Stream Restoration Sites	X								
Appendix G. Uplands Survey Data	X								
Appendix H. Electronic Databases and Documents related to the SWAP	X								

The following provides a discussion on how the development of the Area Q Small Watershed Action Plan addresses the US Environmental Protection Agency (USEPA) A through I criteria for watershed planning. It serves as a guide to the location within the document, including the appendices, where each criterion is addressed.

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 this watershed-based plan (and to achieve any other watershed goals identified in the watershed-based plan), as discussed in item (b) below.

There are currently no TMDLs for the Lower Gunpowder Falls watershed. There are Category 5 listings for sulfates, total suspended solids (TSS), and chlorides in 1st through 4th order streams of the Lower Gunpowder Falls (MDE, 2016). Category 5 indicates an impairment requiring a TMDL. These listings in the Lower Gunpowder Falls are low priority, and therefore will not be addressed by a TMDL for at least two years. The impairments were first listed in the 2012 Integrated Report and are described further in Appendix E, Chapter 3. For all other water quality criteria and pollutants, the streams in the Lower Gunpowder Falls watershed meet the standards.

In addition, to further refine the sources of pollutants, upland source assessments were performed. The upland assessment results are presented in Chapter 4, as well as Appendix E, Chapter 4. Stream restoration projects from the 1999 Lower Gunpowder Falls Water Quality Management Study were revisited to evaluate if the need and potential for restoration still existed (Parsons Brinckerhoff, 1999). Baltimore County also conducted an assessment of stream restoration potential in Cowen Run. The stream channel assessment results are presented in Appendix E, Chapter 3, as well as Appendix F.

Further analysis of pollution sources are provided by a GIS analysis of potential landscape indicators of pollution presented in Appendix E, Chapter 2. Further pollutant load analysis is provided in Appendix E, Chapter 3.3.

b. An estimate of the load reductions expected for the management measures described under paragraph (c) below (recognizing the natural variability and the difficulty in precisely predicting the performance of management measures over time). Estimates should be provided at the same level as in item (a) above (e.g., the total load reduction expected for dairy cattle feedlots; row crops; or eroded streambanks).

Expected nitrogen and phosphorus load reductions were based on the EPA - Chesapeake Bay Program load reduction criteria used in their Phase 5.3 model for the water quality impairments of the non-tidal Chesapeake Bay. These load reductions are presented in Appendix D. Using the information in Appendix D, the nitrogen and phosphorus load reductions for the various actions were calculated and summarized in Chapter 3 (Table 3-6 through 3-8).

c. A description of the NPS management measures that will need to be implemented to achieve the load reductions estimated under paragraph (b) above (as well as to achieve other watershed goals identified in this watershed-based plan), and an identification (using a map or a description) of the critical areas in which those measures will be needed to implement this plan.

The management measures that will need to be implemented to achieve the goals are detailed in Appendix A. Information on the achievement of the phosphorus and nitrogen reduction goals is provided in Chapter 3, Section 5. Chapter 4 details the management measures for each subwatershed in the SWAP study area.

d. An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and the authorities that will be relied upon, to implement this plan. As sources of funding, States should consider the use of their 319 programs, State Revolving Funds, USDA's Environmental Quality Incentives Program and Conservation Reserve Program, and other relevant Federal, State, local and private funds that may be available to assist in implementing this plan.

Appendix C provides the cost analysis and the anticipated funding sources to implement the actions. Appendix A details the anticipated cost for each action on an annual or unit basis and details the organizations that will be responsible for implementation of the each action.

e. An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the NPS management measures that will be implemented.

The educational activities to enhance public understanding and encourage participation in restoration implementation planning and the installation of best management practices are

detailed in Appendix A. Chapter 3, Section 3 details specific education/awareness focus areas, and Chapter 4 details specific education/awareness activities for each subwatershed.

f. A schedule for implementing the NPS management measures identified in this plan that is reasonably expeditious.

A schedule for each activity is provided in Appendix A. It is anticipated that the restoration will occur over the course of 7 years, through to 2025. Some actions have a shorter time frame based on sequencing of actions, or on the urgency of the actions. However, most management measures have annual performance measures that will determine if the restoration is on pace to be completed within the time frame. The limitations on the pace of the implementation include staffing, and funding. Increases in staffing and funding will be used to accelerate the restoration timeline. Chapter 5 presents an adaptive management approach to implementation.

g. A description of interim, measurable milestones for determining whether NPS management measures or other control actions are being implemented.

Appendix A provides the annual interim measurable milestones for determining the implementation status of the NPS management measures. In addition, semi-annual meetings with the implementation committee will update the status on implementation progress.

h. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards, and, if not, the criteria for determining whether this watershed based plan needs to be revised or, if a NPDES TMDL has been established, whether the NPS TMDL needs to be revised.

The load reductions due to the restoration activities will be calculated via a spreadsheet using the EPA Chesapeake Bay Program – Best Management Practice Pollutant Reduction Efficiencies (Appendix D). These efficiencies will be used in conjunction with the implementation tracking to calculate the load reductions being achieved. The efficiencies used will be modified based on any modifications of the EPA Chesapeake Bay Program efficiencies.

i. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item (h) immediately above.

Chapter 5 details the monitoring that will occur to evaluate the effectiveness of implementation. The monitoring results will be compared to the predicted load reductions determined under item (*h*) above.

APPENDIX C

Cost Analysis and Potential Funding Sources

Cost estimates and potential funding sources for the implementation of proposed restoration BMPs for the Area Q SWAP are described below.

Cost Analysis

The cost analysis is based on the actions detailed in Appendix A. Table C-1 presents cost estimates based on the implementation scenario described in Chapter 3 with the goal of achieving the 32.2 percent reduction in total nitrogen and 47.0 percent reduction in total phosphorus loads from urban runoff, also described in Chapter 3. For this scenario, estimates represent total cost estimates for the anticipated implementation timeframe for the Chesapeake Bay total maximum daily load (TMDL) of 2025, assuming 100% participation. Unit costs are based on a combination of local information and previous SWAPs completed for other local watersheds (e.g., Upper Gwynns Falls). 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 are possible (refer to Chapter 3). This provides an additional tool for the assessment and selection of BMPs. The total cost of maximum implementation (i.e., 100% participation) exclusive of staffing costs is estimated at $19,338,480.00. The estimated cost for implementation given the projected participation level for each BMP through 2025 is $8,077,050.00 and is provided in Table C-2.

Potential Funding Sources

Funding sources for the implementation of the Area Q SWAP include local government funding for Baltimore County, monetary and time contributions from the Area Q SWAP Implementation Committee, and various grants as described below.

Baltimore County uses general funds to support staff, whose responsibility is to monitor and improve water quality through implementation of various programs including capital restoration projects. Baltimore County has a Watershed Restoration Capital Program that is funded by a combination of general funds, bonds, stormwater remediation fee, metropolitan funds, and grants. Per Baltimore County Council Bill 85-15 the stormwater management fee will be eliminated as of July 1, 2017. After the funding from the stormwater management fee has been used, funding for projects will continue from the other various sources listed above.

Approximately $16 million per year is allocated for environmental restoration projects throughout the county. Additional general funds are used by the Baltimore County Department of Public Works to support stormwater infrastructure remediation, street sweeping, stormdrain system cleaning, and retrofitting county property subject to the general industrial stormwater discharge permit. 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. Baltimore County also aggressively seeks grant funding from federal and state funding sources to supplement restoration efforts.

In order to implement all of the actions listed in Appendix A and to meet the anticipated funding needs summarized in Table C-1, additional funding from grants will be required. Table C-3 presents potential funding sources to support the implementation of the Area Q 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). http://dnr2.maryland.gov/ccs/Pages/funding/trust-fund.aspx

- **319 Non-point Pollution Grants:** Federal money for restoration implementation is available annually through MDE. http://www.mde.state.md.us/programs/water/319NonPointSource/Pages/factsheet.aspx

- **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. http://www.mde.state.md.us/programs/Water/BayRestorationFund/Pages/index.aspx

- **Water Quality Revolving Loan Fund (MDE):**
  Provides low interest loans to local governments to finance waste water treatment plant upgrades, non-point source projects, and other water quality and public health improvement projects. http://mde.maryland.gov/programs/water/WQFA/Pages/water_quality_fund.aspx

- **Linked Deposit (MDE):** The Linked Deposit mechanism was designed to provide a source of low interest financing to encourage private landowners to implement capital improvements that will reduce delivery of nutrients to the Chesapeake Bay and its

tributaries.
http://www.mde.state.md.us/programs/water/WQFA/Pages/linked_deposit.aspx

- **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, awards 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.
http://www.nfwf.org/chesapeake/Pages/applying-for-grants.aspx

- **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).
http://www.nfwf.org/chesapeake/Pages/home.aspx

- **MD State Highway Administration (SHA) Transportation Alternatives Program (TAP): As part of the Federal Highway Administration Surface Transportation Program, the TAP** is a reimbursable, federal-aid funding program for transportation-related community projects designed to strengthen the intermodal transportation system. The program assists in funding projects that create bicycle and pedestrian facilities, restore historic transportation buildings, convert abandoned railway corridors to pedestrian trails, mitigate highway runoff, and other transportation related enhancements. The program requires a sponsor to fund 20% of the project cost. TAP funding can be requested for up to half of a project's total estimated cost.
http://roads.maryland.gov/index.aspx?pageid=144

- **Chesapeake Bay Trust:** Provides grants through a variety of grant programs that are shaped by three core objectives; environmental education, demonstration-based restoration, and community engagement. Specifically, the Watershed Assistance Grant Program provides funding for design assistance, watershed planning and programmatic development associated with protection and restoration programs and projects that lead to improved water quality in the Maryland portion of the Chesapeake Bay watershed.
https://cbtrust.org/grants/

- **Natural Resources Conservation Service:** The US Department of Agriculture Natural Resources Conservation Service (NRCS) provides financial assistance to landowners to

protect and conserve natural resources. The programs are voluntary to eligible landowners and agricultural producers**.** NRCS delivers conservation technical assistance through its voluntary Conservation Technical Assistance Program (CTA). CTA is available to any group or individual interested in conserving our natural resources and sustaining agricultural production in this country.
http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/

Table C-1: Maximum Estimated Costs for Area Q SWAP Implementation

BMP or Action	Cost	Unit	Quantity	Project Total Cost	Project TN Load Reduction (lbs)	Project Cost/lb of TN Removal	Project TP Load Reduction (lbs)	Project Cost/lb of TP Removal
Urban BMP								
Promote Bayscaping	$500	/event	3	$1,500.00	n/a	n/a	n/a	n/a
Stream Restoration	$400	/linear foot	30,400	$12,160,000.00	2,280.00	$5,333.33	2,067.20	$5,882.35
Adopt-a-Stream Program Events	$500	/event	14	$7,000.00	n/a	n/a	n/a	n/a
SWM Retrofits	$7,600	/acre	2.5	$19,000.00	26.3	$722.43	2.4	$7,916.67
Impervious Cover Removal	$25,000	/acre	0.8	$20,000.00	4.6	$4,347.83	1	$20,000.00
Stormwater Dry Pond Conversions	$7,500	/acre	76.7	$575,250.00	148	$3,886.82	15.5	$37,112.90
Urban Stream Buffer Reforestation	$15,000	/acre	360	$5,400,000.00	4,311.30	$1,252.52	197.1	$27,397.26
Institutional Tree Planting	$175	/tree	3,620	$633,500.00	158.8	$3,989.29	4.7	$134,787.23
Stream Buffer Maintenance	$1,300	/acre	360	$468,000.00	n/a	n/a	n/a	n/a
Institutional Tree Maintenance	$1,300	/acre	18.1	$23,530.00	n/a	n/a	n/a	n/a
Septic System Maintenance Events	$500	/event	3	$1,500.00	n/a	n/a	n/a	n/a
Exotic Species Removal Event	$5,000	/event	3	$15,000.00	n/a	n/a	n/a	n/a
Citizen Storm Drain Marking	$400	/neighborhood	23	$9,200.00	n/a	n/a	n/a	n/a
Promote Residential Downspout Disconnection	$500	/event	3	$1,500.00	n/a	n/a	n/a	n/a
Promote tree canopy improvement on residential lots	$500	/event	3	$1,500.00	n/a	n/a	n/a	n/a
Lawn Maintenance Education Events	$500	/event	3	$1,500.00	n/a	n/a	n/a	n/a
Develop Awareness Materials for Commercial Properties on Proper Waste Disposal	$500	/materials	1	$500.00	n/a	n/a	n/a	n/a
			TOTAL	$19,338,480.00				

Table C-2: Projected Estimated Costs for Area Q SWAP Implementation for 2025 Accounting for Projected Participation

BMP or Action	Cost	Unit	Projected Par-ticipation	Cumulative Projected Quantity 2025	2025 Project Total Cost	Project TN Load Reduction (lbs)	Project Cost/lb of TN Removal	Project TP Load Reduction (lbs)	Project Cost/lb of TP Removal
Urban BMP					*Projected 2025 Milestone Implementation*				
Promote Bayscaping	$500	/event	100%	3	$1,500.00	n/a	n/a	n/a	n/a
Stream Restoration	$400	/linear foot	50%	15,200	$6,080,000.00	1,140.00	$5,333.33	1,033.60	$5,882.35
Adopt-a-Stream Program Events	$500	/event	100%	14	$7,000.00	n/a	n/a	n/a	n/a
SWM Retrofits	$7,600	/acre	100%	2.5	$19,000.00	26.3	$722.43	2.4	$7,916.67
Impervious Cover Removal	$25,000	/acre	100%	0.8	$20,000.00	4.6	$4,347.83	1	$20,000.00
Stormwater Dry Pond Conversions	$7,500	/acre	50%	38.4	$287,625.00	74	$3,886.82	7.8	$37,112.90
Urban Stream Buffer Reforestation	$15,000	/acre	25%	90	$1,350,000.00	1,077.8	$1,252.52	49.3	$27,397.26
Institutional Tree Planting	$175	/tree	25%	905	$158,375.00	39.7	$3,989.29	1.2	$134,787.23
Stream Buffer Maintenance	$1,300	/acre	25%	90	$117,000.00	n/a	n/a	n/a	n/a
Institutional Tree Maintenance	$1,300	/acre	25%	4.5	$5,850.00	n/a	n/a	n/a	n/a
Septic System Maintenance Events	$500	/event	100%	3	$1,500.00	n/a	n/a	n/a	n/a
Exotic Species Removal Event	$5,000	/event	100%	3	$15,000.00	n/a	n/a	n/a	n/a
Citizen Storm Drain Marking	$400	/neighborhood	100%	23	$9,200.00	n/a	n/a	n/a	n/a
Promote Residential Downspout Disconnection	$500	/event	100%	3	$1,500.00	n/a	n/a	n/a	n/a
Promote tree canopy improvement on residential lots	$500	/event	100%	3	$1,500.00	n/a	n/a	n/a	n/a
Lawn Maintenance Education Events	$500	/event	100%	3	$1,500.00	n/a	n/a	n/a	n/a
Develop Awareness Materials for Commercial Properties on Proper Waste Disposal	$500	/materials	100%	1	$500.00	n/a	n/a	n/a	n/a
				TOTAL	$8,077,050.00				

Table C-3: Area Q SWAP Potential Funding Sources

Managing Agency	Funding Source	Applicability Eligibility	Eligible Projects Funding Amount	Funding Amount	Match	Project Period
Chesapeake Bay Trust	Outreach and restoration	Non-profits Community associations Faith-based organizations Service, youth and civic groups Universities Soil/water conservation districts Local government State government	Outreach and community engagement activities that increase stewardship ethic of natural resources and on-the-ground restoration activities that demonstrate restoration techniques and engage Maryland citizens in the restoration and protection of the Chesapeake Bay and its rivers	$5001 to $75,000	Encouraged but not required	2 years
Chesapeake Bay Trust	Watershed Assistance	Local Governments Non-profits	Design assistance, watershed planning or program development in counties for which 2016-2017 2-year milestone commitments have been submitted to MDE	$5001 - 75,000	Encouraged but not required	1 year
Chesapeake Bay Trust	Green Streets, Green Jobs, Green Towns	Non-profits 501(c) Local government Neighborhood/ community associations	Design projects, financing strategies, and/or implementation of green street projects that enhance livability in cities and communities that can be replicated elsewhere	<= $30,000 for design projects <= $75,000 for implementation projects <= $20,000 for white papers	Encouraged but not required	1 year planning 2 year construction
Chesapeake Bay Trust	Pioneer Grants	Non-profits Local governments Universities Conservation districts	New techniques, information or programs that increase the rate at which nutrient and sediment load reductions can occur in Maryland	Cash and in-kind match strongly encouraged	$5,001-$75,000	2 years
Maryland Department of the Environment	319 (h) Grant Program	State government Universities Soil/water conservation districts Local government	Implementation of water quality improvement projects identified in an EPA-approved watershed plan	Negotiable (typical range is $30,000 to $400,000)	40% non-federal	Negotiable
Maryland Department of Natural Resources	Chesapeake and Atlantic Coastal Bays Trust Fund	Local governments Non-profits Conservation districts Universities	Implementation of the most cost-effective, efficient nutrient and sediment reduction projects in geographically targeted areas of Maryland	$500,000 minimum (no maximum)	Strongly encouraged	3 years
National Fish and Wildlife Foundation	Chesapeake Bay Stewardship Fund	Non-profits Local government	Small Watershed Grants are for projects that promote	$20,000 to $200,000 for	One-third of request for	2 years for SWGs 3 years for INSR

Managing Agency	Funding Source	Applicability Eligibility	Eligible Projects Funding Amount	Funding Amount	Match	Project Period
		Universities K-12 schools	community-based efforts to protect and restore the Chesapeake Bay. Innovative Nutrient and Sediment Reduction Grants are for projects that dramatically accelerate nutrient and sediment reduction through sustainable, innovative and cost-effective approaches	SGWs $200,000-$500,000 for INSR	SWGs 1:1 non-federal match for INSR	
National Fish and Wildlife Foundation	Chesapeake Bay Technical Capacity Grants	Approved NFWF Technical Assistance Providers	Technical services on behalf of local governments, nonprofit organizations, and conservation districts for projects that enhance local capacity to more efficiently and effectively restore the habitats and water quality of the Chesapeake Bay and its tributaries	Up to $50,000	Non-federal in-kind match encouraged	1 year
National Fish and Wildlife Foundation	5-Star Urban Waters Program	Non-profits Local government State government	Projects that improve water quality, restore habitat, restore urban forests and increase public access, specifically targeted to Urban Waters Federal Partnership Designated Areas (includes Patapsco)	$20,000-$50,000	1:1 non-federal	2 years

APPENDIX D

Chesapeake Bay Program Pollutant Load Reduction Efficiencies

The effectiveness estimates for urban best management practices (BMPs) that are implemented and reported by the Chesapeake Bay partners, as well as those planned for future implementation, were obtained from the Documentation for Scenario Builder Version 2.4, which was revised January 2013 (U.S. EPA, 2013). These estimates are the most recent at the time of SWAP development. The BMP effectiveness estimates are extracted from Tables 8-4 and 8-5 from this documentation. In addition, recommendations from the Chesapeake Bay Program BMP Expert Panels which provide updated efficiencies for Urban Nutrient Management and urban stream restoration were used in this SWAP. The revised BMP effectiveness estimates from two other Expert Panel reports, Urban Stormwater Retrofit Expert Panel and New State Stormwater Performance Standards, were not applied given the detailed information on individual BMPs needed to estimate the value, and therefore values in Tables 8-4 and 8-5 were used. The values in these tables are considered "default" effectiveness estimates and are still applicable to estimate nutrient and sediment pollutant load reductions.

Recommendations of the Urban Stormwater Retrofit Expert Panel (approved October 2012)

The Panel developed a protocol whereby the removal rate for each individual retrofit project is determined based on the amount of runoff it treats and the degree of runoff reduction it provides. The Panel conducted an extensive review of recent BMP performance research and developed a series of retrofit removal adjustor curves to define sediment, nitrogen and phosphorus removal rates. The Panel then developed specific calculation methods tailored for different retrofit categories.

Runoff reduction is defined as the total post development runoff volume that is reduced through canopy interception, soil amendments, evaporation, rainfall harvesting, engineered infiltration, extended filtration or evapo-transpiration. Retrofit projects that achieve at least a 25% reduction of the annual runoff volume are classified as providing Runoff Reduction (RR), and therefore earn a higher net removal rate. Retrofit projects that employ a permanent pool, constructed wetlands or sand filters have less runoff reduction capability, and their removal rate is determined using the Stormwater Treatment (ST) curve.

In order to determine the runoff volume treated by a retrofit practice, the designer must first estimate the Runoff Storage volume (RS) in acre-feet. This, along with the Impervious Area (IA) in acres, is used to determine the amount of runoff volume in inches treated at the site. Once the amount of runoff captured by the practice is determined, the retrofit removal adjustor curves make it easy to determine pollutant removal rates for individual stormwater retrofits. The designer first defines the runoff depth treated by the project (on the x-axis), and then determines whether the project is classified as having runoff reduction (RR) or stormwater treatment (ST)

capability. The designer then goes upward to intersect with the appropriate curve, and moves to the left to find the corresponding removal rate on the y-axis.

For more information, the report is available at:
http://www.chesapeakebay.net/documents/Final_CBP_Approved_Expert_Panel_Report_on_Stormwater_Retrofits--_short.pdf

Recommendations of the New State Stormwater Performance Standards Expert Panel (approved October 2012, updated January 2015)

The Panel developed a protocol whereby the removal rate for each individual BMP is determined based on the type of BMP, a runoff reduction (RR) or stormwater treatment (ST) practice, and the amount of runoff it treats and the degree of runoff reduction it provides. The Panel conducted an extensive review of recent BMP performance research and developed a series of BMP performance removal adjustor curves to define sediment, nitrogen and phosphorus removal rates. The Panel then developed specific calculation methods tailored for different retrofit categories.

Runoff reduction is defined as the total post-development runoff volume that is reduced through canopy interception, soil amendments, evaporation, rainfall harvesting, engineered infiltration, extended filtration or evapo-transpiration. Stormwater practices that achieve at least a 25% reduction of the annual runoff volume are classified as providing RR, and therefore earn a higher net removal rate. Stormwater practices that employ a permanent pool, constructed wetlands or sand filters have less runoff reduction capability, and their removal rate is determined using the stormwater treatment ST curve. The removal rates determined from the new BMP removal rate adjustor curves are applied to the entire site area, and not just the impervious acres.

The protocol is used to account for nutrient reduction associated with the implementation of more BMPs for redevelopment projects. The general approach to estimate the pollutant load reduction is similar to new development with some modifications. For example, the area treated is limited to impervious acres, rather than the total site. Overall, the stormwater standards for redevelopment tend to be lower than for new development.

For more information, the report is available at:
http://www.chesapeakebay.net/documents/Final-CBP-Approved-Expert-Panel-Report-on-Stormwater-Performance-Standards-SHORT_0120151.pdf

Recommendations of the Urban Nutrient Management Expert Panel (approved March 2013)

The Panel recommended three types of nutrient reduction credits. The first is an automatic state-wide P reduction credit starting in 2013 that reflects declines in P fertilizer application rates due to recent state phosphorus fertilizer legislation and the gradual industry phase out of P in fertilizer products. The exact reduction varies by state, but is about 25% for states that have adopted legislation and 20% for those that have not.

The automatic credit expires in three years, and will be replaced by a more verifiable and variable credit based on declines in unit area P application rates derived from improved non-farm fertilizer sales statistics. States may also be eligible for a state-wide N reduction credit in 2014 if they can document declines in unit N fertilizer applications relative to the current application rate benchmark employed in the CBWM. States that implement N fertilizer regulations that satisfy certain verification requirements may also qualify for an automatic N credit.

The second credit is a removal rate for the acreage of pervious land covered by qualifying Urban Nutrient Management (UNM) practices, based on the site risk for N and P export. For low risk lawns, the UNM load reductions for TN and TP are 3 and 6% respectively. The load reductions increase when UNM practices are applied to high risk lawns (20% TN, 10% TP). These reductions may be applied by local jurisdictions in Maryland for unfertilized lawns.

A third credit is applicable only to Maryland and is based on the Fertilizer Use Act 2011. Maryland is the only Bay state that is currently eligible for an automatic N reduction credit based on the provisions of its law. A credit for acres of turfgrass fertilized by commercial applicators are eligible for a 9% TN reduction and a 4.5% TN reduction is eligible for "do-it-yourself" fertilizer applicators.

A summary of the urban nutrient management credits is provided in the table below. For more information, the report is available at: http://www.chesapeakebay.net/documents/Final_CBP_Approved_Expert_Panel_Report_on_Urban_Nutrient_Management--short.pdf

Summary of Urban Fertilizer Management Credits for Phosphorus and Nitrogen

Nutrient	*Statewide with P fertilizer legislation*	*Statewide without P fertilizer legislation*	*Urban Nutrient Management UNM[2]*
Phosphorus	25%	20%	Low risk: 3% High risk: 10% Blended: 4.5%
Notes & Conditions of Credit	Effective 2013 for 3 years. In 2016 , need to show reduction in P using two years of fertilizer sales data		Need to survey high-risk every 5 years; Renew UNM every 3 years
Nitrogen	For States with N fertilizer legislation: 9% reduction for qualifying acres by commercial applicators, 4.5% reduction for do-it-yourselfer acres For all other States: 3% load reduction for every 10% decrease in N urban fertilizer input from CBWM benchmark		Low risk: 6% High risk: 20% Blended: 9%
Notes & Conditions of Credit	Effective 2014, need to show N reduction using two consecutive years sales data		Need to survey high-risk every 5 years; Renew UNM every 3 years

Recommendations of the Stream Restoration Expert Panel (approved May 2013, updated September 2014)

The Panel crafted four general protocols that can be used to define the pollutant load reductions associated with individual stream restoration projects. The following protocols apply for smaller

0 – 3rd order stream reaches not simulated in the Chesapeake Bay Watershed Model (CBWM). These protocols do not apply to sections of streams that are tidally influenced, which will be included in either the Shoreline Erosion Control Expert Panel or a pending future Expert Panel for tidal wetlands:

- Protocol 1: Credit for Prevented Sediment during Storm Flow -- This protocol provides an annual mass nutrient and sediment reduction credit for qualifying stream restoration practices that prevent channel or bank erosion that would otherwise be delivered downstream from an actively enlarging or incising urban stream.

- Protocol 2: Credit for Instream and Riparian Nutrient Processing during Base Flow -- This protocol provides an annual mass nitrogen reduction credit for qualifying projects that include design features to promote denitrification during base flow within the stream channel through hyporheic exchange within the riparian corridor.

- Protocol 3: Credit for Floodplain Reconnection Volume-- This protocol provides an annual mass sediment and nutrient reduction credit for qualifying projects that reconnect stream channels to their floodplain over a wide range of storm events.

- Protocol 4: Credit for Dry Channel RSC as an Upland Stormwater Retrofit-- This protocol provides an annual nutrient and sediment reduction rate for the contributing drainage area to a qualifying dry channel RSC project. The rate is determined by the degree of stormwater treatment provided in the upland area using the retrofit rate adjustor curves developed by the Stormwater Retrofit Expert Panel.

An individual stream restoration project may qualify for credit under one or more of the protocols, depending on its design and overall restoration approach. The results of stream restoration BMPs are reported to the CBP as TN, TP, and TSS total load reduction. A new approved default rate replaces the interim rate in Table 8-5 and applies to historic projects and new projects that cannot conform to recommended reporting requirements. In addition, the new default rate will continue to be used for planning purposes and is the efficiency used in the Maryland Assessment Scenario Tool. For more information on the protocols, the report is available at:
http://www.chesapeakebay.net/documents/Stream_Panel_Report_Final_08282014_Appendices_A_G.pdf

Edge-of-Stream Default Removal Rates per Linear Foot of Qualifying Stream Restoration (lb/ft/yr)		
TN	TP	TSS*
0.075	0.068	44.88 non-coastal plain 15.13 coastal plain
*To convert edge of field values to edge of stream values a sediment delivery ratio (SDR) was applied to TSS. The SDR was revised to distinguish between coastal plain and non-coastal plain streams. The SDR is 0.181 for non-coastal plain streams and 0.061 for coastal plain streams. Additional information about the sediment delivery ratio is provided in Section 2.5 and Appendix B.		

Recommendations of the Urban Filter Strip/Stream Buffer Upgrade Expert Panel (approved June 2014)

The Expert Panel determined that a modification to the methods presented in the State Stormwater Performance Standards report was needed to quantify the nutrient and sediment load reduction from urban filter strips. Pollutant removal efficiencies are given to urban filter strips as a runoff reduction (RR) and a stormwater treatment (ST) practice.

The Panel reviewed the Chesapeake Bay Watershed Model assumptions to simulate the impact of grass and forested filter strips and buffers and make recommendations to quantify and qualify these BMPs as well as information to verify their performance after implementation. The expert panel did not address or provide recommendations for the existing urban forest buffer BMP.

For more information, the report is available at:
http://www.chesapeakebay.net/documents/UFS_SBU_Expert_Panel_Draft_Report_Decision_Draft_FINAL_WQ_GIT_APPROVED_JUNE_9_2014.pdf

BMP Efficiencies from the Documentation for Scenario Builder 2.4

Table 8-4: Maximum and minimum BMP efficiencies

Sector	BMP	Nitrogen Effectiveness Minimum	Nitrogen Effectiveness Maximum	Phosphorus Effectiveness Minimum	Phosphorus Effectiveness Maximum	Sediment Effectiveness Minimum	Sediment Effectiveness Maximum	Interim
Urban	Bioretention/raingardens - A/B soils, no underdrain	80	80	85	85	90	90	N
Urban	Bioretention/raingardens - A/B soils, underdrain	70	70	75	75	80	80	N
Urban	Bioretention/raingardens - C/D soils, underdrain	25	25	45	45	55	55	N
Urban	Bioswale	70	70	75	75	80	80	N
Urban	Dry Detention Ponds and Hydrodynamic Structures	5	5	10	10	10	10	N
Urban	Dry Extended Detention Ponds	20	20	20	20	60	60	N
Urban	Erosion and Sediment Control	25	25	40	40	40	40	N
Urban	Erosion and Sediment Control on Extractive, excess applied to all other pervious urban	25	25	40	40	40	40	Y
Urban	MS4 Permit-Required Stormwater Retrofit	25	25	35	35	65	65	N
Urban	Permeable Pavement w/ Sand, Veg. - A/B soils, no underdrain	80	80	80	80	85	85	N
Urban	Permeable Pavement w/ Sand, Veg. - A/B soils, underdrain	50	50	50	50	70	70	N
Urban	Permeable Pavement w/ Sand, Veg. - C/D soils, underdrain	20	20	20	20	55	55	N
Urban	Permeable Pavement w/o Sand, Veg. - A/B soils, no underdrain	75	75	80	80	85	85	N
Urban	Permeable Pavement w/o Sand, Veg. - A/B soils, underdrain	45	45	50	50	70	70	N
Urban	Permeable Pavement w/o Sand, Veg. - C/D soils, underdrain	10	10	20	20	55	55	N
Urban	Stormwater Management by Era 1985 to 2002 MD	17	17	30	30	40	40	N
Urban	Stormwater Management by Era 2002 to 2010 MD	30	30	40	40	80	80	N
Urban	Stormwater to the Maximum Extent Practicable (SW to the MEP)	50	50	60	60	90	90	N
Urban	Street Sweeping 25 times a year-acres (formerly called Street Sweeping Mechanical Monthly)	3	3	3	3	9	9	N
Urban	Urban Filtering Practices	40	40	60	60	80	80	N
Urban	Urban Forest Buffers	25	25	50	50	50	50	N
Urban	Urban Infiltration Practices w/ Sand, Veg. - A/B soils, no underdrain	85	85	85	85	95	95	N
Urban	Urban Infiltration Practices w/o Sand, Veg. - A/B soils, no underdrain	80	80	85	85	95	95	N
Urban	Urban Nutrient Management	17	17	22	22	0	0	N
Urban	Vegetated Open Channels - A/B soils, no underdrain	45	45	45	45	70	70	N
Urban	Vegetated Open Channels - C/D soils, no underdrain	10	10	10	10	50	50	N
Urban	Wet Ponds and Wetlands	20	20	45	45	60	60	N

Table 8-5: Unit load reduction BMPs

Sector	BMP	Unit	Nitrogen Reduction Factor	Phosphorus Reduction Factor	Sediment Reduction Factor	Interim
Urban	Dirt & Gravel Road Erosion & Sediment Control - Driving Surface Aggregate + Raising the Roadbed	feet	NULL	NULL	2.96	N
Urban	Dirt & Gravel Road Erosion & Sediment Control - Outlets only	feet	NULL	NULL	1.76	N
Urban	Dirt & Gravel Road Erosion & Sediment Control - with Outlets	feet	NULL	NULL	3.6	N
Urban	Regenerative Stormwater Conveyance	feet	0.02	0.0025	2	N
Urban	Shoreline Erosion Control	feet	0.02	0.0025	2	N
Urban	Street Sweeping 25 times a year-lbs	lbs	0.00175	0.0007	1	N
Urban	Street Sweeping Pounds	lbs	NULL	NULL	1	N
Urban	Urban Stream Restoration	feet	0.02	0.0025	2	N
Urban	Urban Stream Restoration (interim)	feet	0.2	0.068	310	Y

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