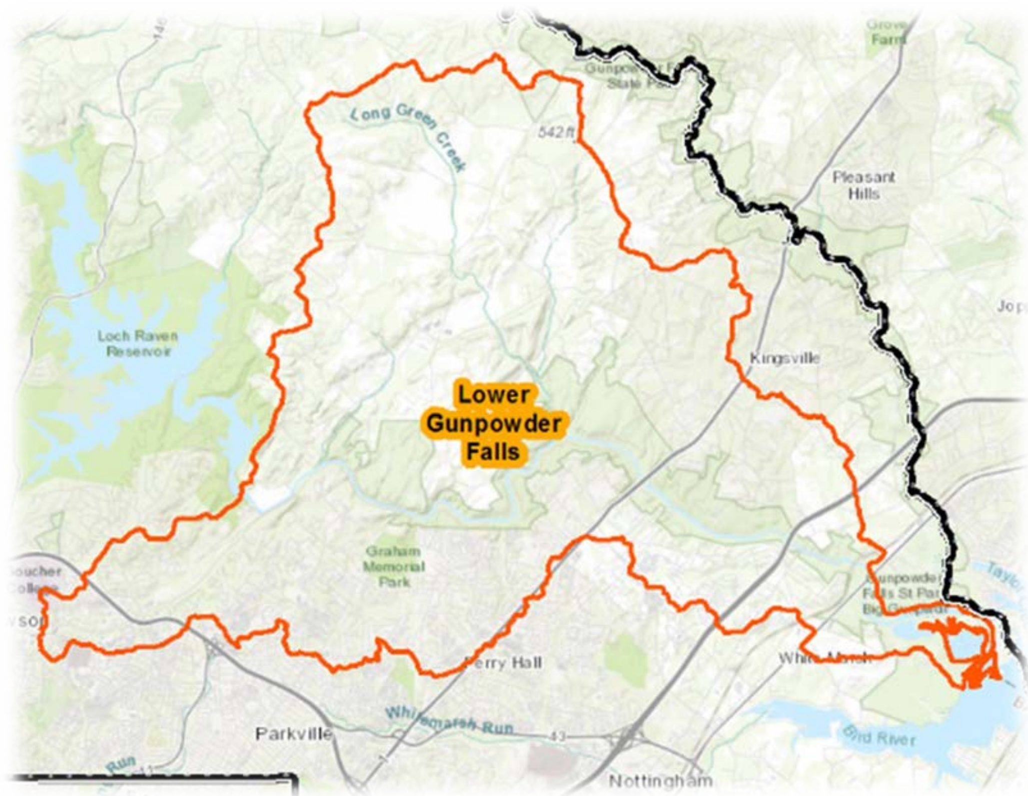
BALTIMORE COUNTY
TMDL IMPLEMENTATION PLAN

Sediment in
Lower Gunpowder Falls



Baltimore County Executive Kevin Kamenetz and the County Council

Vincent J. Gardina, Director

Department of Environmental Protection and Sustainability

Submitted to MDE: May 4, 2018

Approved by MDE: October 8, 2019

Table of Contents

List of Tables

List of Figures

List of Abbreviations

ARA	**Antibiotic Resistance Analysis**
BMP	**Best Management Practice**
BOD	**Biological Oxygen Demand**
BSID	**Biological Stressor Identification**
BST	**Bacteria Source Tracking**
CBP	**Chesapeake Bay Program**
CFR	**Code of Federal Regulations**
Chl *a*	**Chlorophyll *a***
COMAR	**Code of Maryland Regulations**
CWA	**Clean Water Act**
DO	**Dissolved Oxygen**
DPW	**Department of Public Works**
ED	**Extended Detention**
EOF	**Edge of Field**
EOS	**Edge of Stream**
EPA	**U.S. Environmental Protection Agency**
EPS	**Environmental Protection & Sustainability**
FSA	**Farm Service Administration**
HSG	**Hydrologic Soil Groups**
HUC	**Hydrologic Unit Code**
IP	**Implementation Plan**
LA	**Load Allocation**
lbs/yr	**Pounds per Year**
MAST	**Maryland Assessment Scenario Tool**
MD	**Maryland**
MDA	**Maryland Department of Agriculture**
MDE	**Maryland Department of Environment**
MDP	**Maryland Department of Planning**
µg/l	**Micrograms per Liter**
mg/l	**Milligrams per Liter**
MGD	**Million Gallons per Day**

MGS	**Maryland Geological Survey**
MOS	**Margin of Safety**
MPN	**Most Probable Number**
MPR	**Maximum Practicable Reduction**
MS4	**Municipal Separate Storm Sewer System**
NLCD	**National Land Cover Dataset**
NMP	**Nutrient Management Plan**
NOAA	**National Oceanic and Atmospheric Administration**
NPDES	**National Pollutant Discharge Elimination System**
NPS	**Nonpoint Source**
NSA	**Neighborhood Source Assessment**
OIT	**Office of Information Technology**
PAA	**Pervious Area Assessment**
PAI	**Office of Permits Approvals & Inspections**
POM	**Particulate Organic Matter**
PS	**Point Source**
RTG	**Reservoir Technical Group**
SCWQP	**Soil Conservation and Water Quality Plan**
SSA	**Science Services Administration**
SSO	**Sanitary Sewer Overflow**
SWAP	**Small Watershed Action Plan**
SWM	**Stormwater Management**
TMDL	**Total Maximum Daily Load**
TN	**Total Nitrogen**
TP	**Total Phosphorus**
TSI	**Trophic State Index**
TSS	**Total Suspended Solids**
URDL	**Urban Rural Demarcation Line**
USGS	**United States Geological Survey**
USLE	**Urban Soil Loss Equation**
WAG	**Watershed Advisory Group**
WIP	**Watershed Implementation Plan**
WLA	**Waste Load Allocation**

WQBEL	**Water Quality Based Effluent Limitations**
WQIA	**Water Quality Improvement Act**
WQLS	**Water Quality Limited Segment**
WQMP	**Water Quality Management Plan**
WRAS	**Watershed Restoration Action Strategy**
WWTP	**Waste Water Treatment Plant**

This Implementation Plan (IP) has been prepared to address the presence of excess sediment in the Lower Gunpowder Falls watershed that has been found to be negatively affecting the aquatic community. The required amount of reduction in sediment inputs has been determined by a Total Maximum Daily Load (TMDL) developed by the Maryland Department of the Environment (MDE) in the document titled *Total Maximum Daily Load of Sediment in the Lower Gunpowder Falls Watershed, Baltimore County, Maryland*, and after a public comment period, submitted to the US Environmental Protection Agency (EPA) Region 3 for review and approval. EPA approved the TMDL May 4, 2017.

1.1 What is a TMDL?

A TMDL has two different meanings. It is the document that is produced by MDE when any Maryland water body is listed on the state's 303(d) list of impaired and threatened waters. MDE must then submit the TMDL to EPA for approval. Any time a TMDL document is developed, extensive scientific study is done on the pollutant of concern in the listed water body. This study is done with the goal of finding the maximum load of the pollutant that the water body can receive and still meet Maryland's water quality standards. It is often thought of as a "pollution diet" for the watershed. All of the studying and monitoring that is done in preparing the TMDL document boils down to a single maximum load number that will be the target for pollution reduction in the water body. This number is also called a TMDL. In other words, the goal of the TMDL document is to justify the TMDL number, which can be found within the TMDL document.

The TMDL number is expressed as a sum of all the different sources of the pollutant plus a margin of safety (MOS). The MOS value helps to account for any lack of knowledge or understanding concerning the relationship between loads and water quality and also for any rounding errors in the TMDL calculation (calculation format shown below). Expressing the TMDL in terms of this simple equation makes it easier to see where pollution reduction efforts need to be focused. In other words, which sources can be reduced to reach the final TMDL number, by how much they need to be reduced, and which pollution sources are not practical for reduction. The sources that make up the final TMDL number are categorized as either Load Allocation (LA) or Waste Load Allocation (WLA). LAs are all non-point source loads, meaning that they do not come from a single source or pipe. LAs include agricultural runoff, forest runoff, and upstream loads. WLAs are all point source loads, meaning that they do come from a single traceable source. WLAs are further categorized as process water or stormwater. Process water WLA comes from sources that have permits allowing them to release a specific amount of a pollutant into the water. They include individual industrial facilities, individual municipal facilities, and mineral mining facilities. Stormwater WLA is any stormwater that is regulated by a municipal separate storm sewer systems (MS4) permit, water from industrial facilities permitted to release stormwater, and all runoff from construction sites.

All Baltimore County urban stormwater is regulated under Baltimore County's MS4 permit. That means that stormwater WLA includes all of the water that runs to any storm drain within the watershed area. The MOS is the final part of the equation. The MOS can be implicit, meaning that the final TMDL was calculated in such a way that it accounted for any errors without needing to tack an explicit MOS to the end of the sum of load sources equation. When an explicit MOS is necessary, it is assumed that a 5% reduction of the final TMDL number will be sufficient.

TMDL Sum of Load Sources Equation:

TMDL	**=**	**LA**	**+**	**WLA Stormwater**	**+**	**WLA Process Water**	**+**	**MOS**

1.1.1 How is the Final TMDL Determined?

The process of determining the TMDL number can be very complex. Pollution data are regularly collected throughout Maryland by many different federal, state, and local government agencies as well as universities and watershed organizations. The agency or organization may send individuals out to the stream to collect and measure information about the watershed as part of a study or regular monitoring program. Data are also collected from the many different monitoring stations that are located throughout Maryland's watersheds. Some of these monitoring stations have been collecting water data for decades. The U.S. Geological Survey and the Maryland Department of Natural Resources monitoring stations are often used as the data source for Maryland TMDLs. To find out who is keeping an eye on your watershed see MDE's Water Quality Monitoring Web Page.

Complex scientific models are often used to help find a practical number for the total reduction. Models often use existing monitoring data and observations about the watershed area in a calculation that determines the TMDL number. The type of model used and the complexity of the model vary by pollutant, water body type, and complexity of flow conditions. The specific model used for this TMDL is explained in Section 3.

In all cases, scientists first find a baseline load for the pollutant. The baseline load is how much of the pollutant is in the water body at the time of the study, before restoration actions specifically developed to reach the TMDL number are implemented. The calculated target number, that is the TMDL, is the final goal. It could be thought of as the finish line in the TMDL process. That is not to say that other restoration efforts will not continue once that target is reached, but that the water body will be able to meet state water quality standards and can be removed from the list of impaired and threatened waters for that particular pollutant.

When calculating the TMDL number, a percent reduction and load reduction are usually calculated as well. The load reduction is the difference between the baseline load and the TMDL target. Think of it as the amount that needs to be removed from the system in order to reach the target. The percent reduction is the percentage of the baseline load that needs to be removed in order to reach the TMDL target.

1.2 Geographic Area

Pollution reduction goals are determined by watershed. A watershed is all the land area where all of the water that runs off that land and all the water running under that land drain into the same place. Everything within a watershed is linked by a common water destination. Watersheds exist at many levels: some very large, and some quite small. Identifying your watershed is similar to identifying your current location on a map. You could say you are in the United States, or that you are in Maryland, or that you are in your kitchen at your specific street address. Similarly, you could say that you are in the Mid-Atlantic Region Watershed, which drains to the Atlantic Ocean, Long Island Sound and Riviere Richelieu, a tributary of the St. Lawrence River. You could also say that you are in the Upper Chesapeake Bay Watershed, which includes the area of drainage to the Chesapeake Bay that is north of the Maryland-Virginia line. Both would describe a watershed that you are located in. However, watersheds can become much more specific.

A system was established by the U.S. Geological Survey for dividing the U.S. into successively smaller hydrologic units. Each hydrologic unit is identified by a hydrologic unit code (HUC), which range from two to twelve digits. The smaller the scale of the watershed, the more digits it has in its code. For example, the Mid-Atlantic Region is a 2-digit watershed and the Upper Chesapeake Bay is a 4-digit watershed. The 6-digit unit, also known as the "basins" unit, is to serve as the common scale for watershed assessments at the national level, but the condition of these basins can be determined based on an aggregation of assessments of even smaller watershed units. Maryland has chosen to go the route of assessing smaller watershed units. As a result, TMDLs are determined at the 8-digit watershed scale. For a further explanation of HUCs or to see maps of watersheds at different HUC levels, go to: USGS Hydrologic Unit Maps. If you would like to know which Maryland 8-digit watershed you are located in, go to MDE's Find My Watershed Map.

It is important to note that 8-digit watersheds can overlap multiple counties and may, therefore, have several regulating authorities.

1.2.1 Lower Gunpowder Falls Geographic Area

The Lower Gunpowder Falls is a watershed that covers a total land area of approximately 29,470 acres, all within Baltimore County. The Lower Gunpowder Falls watershed begins in the East-central portion of Baltimore County, immediately downstream of the Loch Raven Reservoir dam. The Lower Gunpowder continues flowing eastward before discharging into the tidal Gunpowder River and Chesapeake Bay along the Baltimore County and Harford County boundary. This TMDL Implementation Plan will specifically address the sediment impairment in non-tidal streams within the Lower Gunpowder Falls watershed.

The further disposition of the watershed will be addressed during Section 5 of this IP which presents the watershed characterization. Below, Figure 1-1 provides a map of the location of the Lower Gunpowder Falls watershed within Baltimore County.

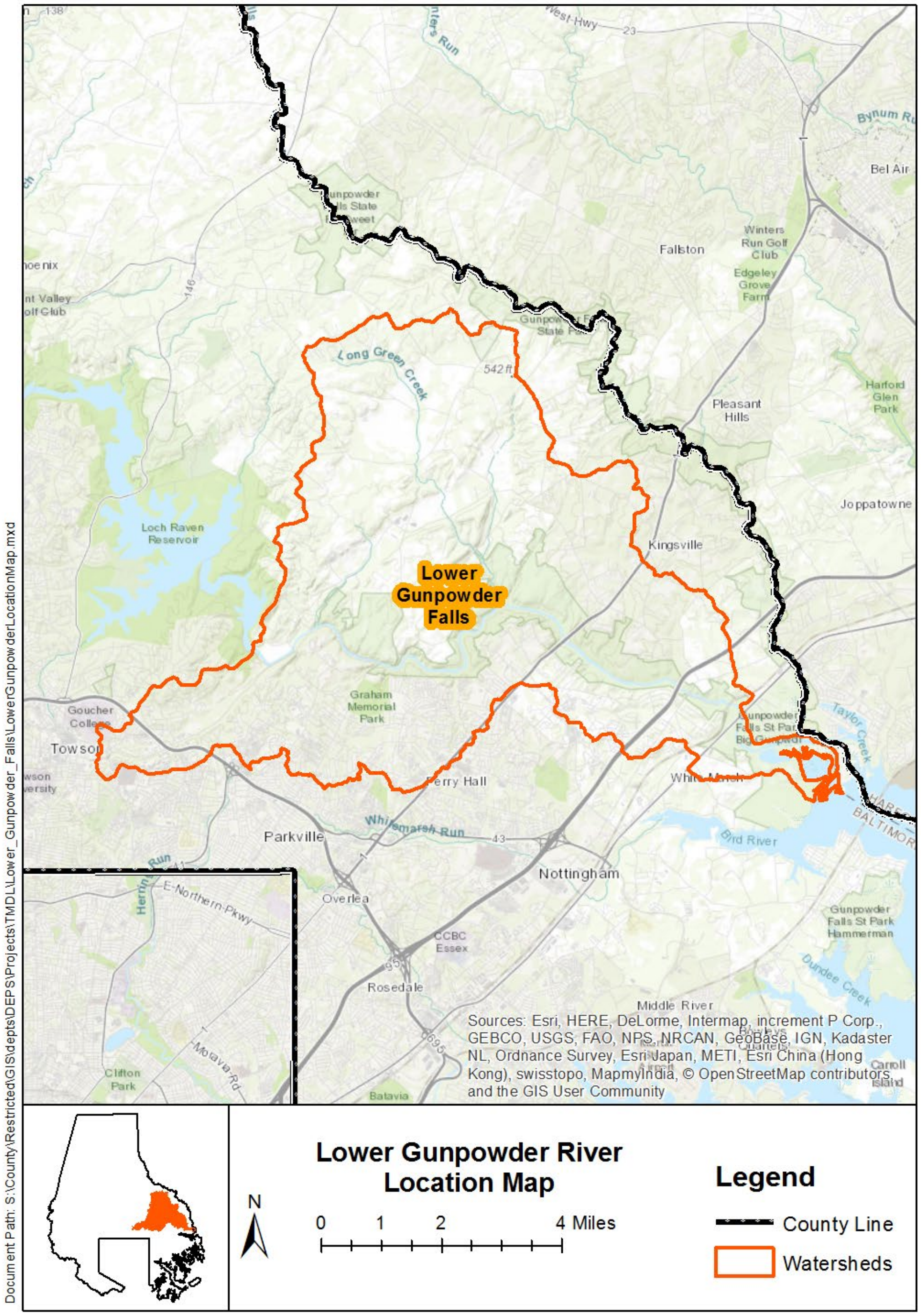


Figure 1-1: Lower Gunpowder Falls Watershed within Baltimore County

1.3 Goal of the TMDL Implementation Actions

TMDL Implementation Plan Objective:

Through a cooperative effort of Baltimore County Department of Environmental Protection and Sustainability, other county agencies, local watershed associations, and the general public, to provide a comprehensive plan of action for achieving TMDL targets and ultimately restoring the health of Baltimore County waters to acceptable water quality standards.

Baltimore County is required to reduce pollution in its waterways; the plans to meet these reductions need to be in place within one year of TMDL issuance by MDE. More on the legal requirements for these implementation plans will be discussed in depth during Section 2 of this document. The goal of this IP is to set the “road map” for the county to reach the goal of reducing pollutant loads in the water to meet water quality standards.

1.4 Document Organization

The Baltimore County TMDL implementation plans provide the following information to explain the necessity of the TMDL Implementation Plan and to develop a management strategy that will be followed in order to meet county TMDL reduction targets. The County will take an adaptive management approach that will include periodic assessments to determine progress and identify changes needed in the management strategy to meet the reduction targets in a timely, cost effective manner.

Section 1: Introduction

This Introduction states the pollutant that is being addressed by the TMDL IP, and the watershed for which the IP was developed. It provides a background on what a TMDL is and how the TMDL is determined. A general description of the geographic area for the specific IP is provided. The Introduction also states the overall goal of the TMDL IP and summarizes the actions that have been identified to bring Baltimore County to that goal. It also includes a brief summary of the contents of the thirteen sections of the TMDL Implementation Plan.

Section 2: Regulatory Policy and Planning

This part of the document describes the administration and legal authority that mandates the development of Baltimore County’s TMDL implementation plan and oversees its fulfillment. It will provide a background of how various regulating authorities and policies are related to the requirement to develop a TMDL Implementation Plan. It will also summarize the various planning guidance documents that have been produced to assist in the development of TMDL Implementation Plans and how TMDL Implementation Plans fit in the overall Baltimore County planning context.

Section 3: TMDL Summary

The section summarizes the original TMDL document that was submitted by MDE and approved by the EPA. The summary includes: when the TMDL was developed, what is impaired, why the TMDL was developed, a description of the analysis process that was used to determine the total maximum daily load targets, the baseline year of data collection and analysis, the results from that analysis, and a further break down of the target loads by source sector.

Section 4: Literature Summary

Each TMDL IP will address a specific pollutant. This part of the document provides an overview of the pollutant that is summarized from published literature. The literature summary includes known sources of the pollutant, the impacts associated with the pollutant, the pathways and transformations of the pollutant, and other relevant ecological processes that affect how the pollutant can be controlled and regulated.

Section 5: Watershed Characterization

Characterization of the watershed will include geographical and technical information for the portion of the watershed that is specific to each TMDL IP. Each characterization will describe the watershed acreage, population size, geology and soils, topography, land use, streams, infrastructure related to watershed pollution sources, implemented restoration projects since the baseline year, and changes in pollutant load since the baseline year.

Section 6: Existing Data Summary

This section will include a summary of Baltimore County's existing monitoring data that will be pertinent to the pollutant in question. It may also include some data received from sources other than Baltimore County, such as data from the Maryland Department of the Environment, or other relevant sources.

Section 7: Summary of Existing Restoration Plans

Previous planning efforts will be summarized in this section. Water Quality Management Plans (WQMP) and Small Watershed Action Plans (SWAP) applicable to the IP area are identified. The process and goals for SWAP development are explained.

Section 8: Best Management Practice Efficiencies

This section is an explanation of the best management practices that will be used for removing the particular pollutant and the known efficiency of those best management practices. A table will be found in this section of BMPs and the known reduction efficiency for the pollutants that can be reduced by each BMP. BMP efficiencies will also include a discussion of the uncertainty and research needs for BMPs.

Section 9: Implementation

The implementation section will provide a description of programmatic, management, and restoration actions; and pollutant load reduction calculations to meet the pollutant reduction target for the specific pollutant. For each of the programmatic, management, and restoration actions there will be a list of responsible parties, actions, timeframe of actions, and performance standards.

Section 10: Assessment of Implementation Progress

Assessment of implementation progress will give Baltimore County a formal method of reporting on the development of implementation and of describing the progressive success of implementation actions. The section will include a description of tracking and reporting mechanisms, and a monitoring plan that includes progress monitoring as well as BMP effectiveness monitoring.

Section 11: Continuing Public Outreach Plan

This part of the document will be a continuing public outreach plan. It will encourage public involvement in the implementation process, extending beyond the finalization of this document.

Section 12: References

A list of references used in the creation of this document.

The Legal Authority, Policy, and Planning Framework section will present, in brief, the background on the legal requirements that pertain to the development of Total Maximum Daily Loads (TMDLs), and the preparation of TMDL Implementation Plans. This section will also cover the planning framework for the development of the TMDL Implementation Plans (IP). Furthermore, this section is intended to provide the context for the development of this TMDL Implementation Plan and understanding of the linkage between water quality and the TMDL. Whether at the federal or state level there are a number of processes at work that result in the regulations that must be followed to remain within the law. First, legislation is passed by an elected governing body (e.g. Congress, state legislature), and once passed and signed by the executive branch, they become Acts (laws), such as the Clean Water Act. In order to provide guidelines in maintaining compliance with these laws, it is often necessary that regulations be issued to specify the law's requirements. A regulation is a rule issued by a government agency that provides details on how legislation will be implemented, and may set specific minimum requirements for the public to meet if they are to be considered in compliance with the law. These regulations may come in various forms, such as the Code of Federal Regulations (CFR), or Code of Maryland Regulations (COMAR). The information that follows is generally taken from CFR and COMAR.

Under the Code of Federal Regulations (CFR), Title 40 encompasses the regulations enforced by the U.S. Environmental Protection Agency (EPA). These regulations include not only those related to water quality, but also air quality, noise, and a variety of land based regulations (oil operations, etc.)

2.1 Regulatory and Policy Framework

The ultimate regulatory authority for protecting and restoring water quality rests with the federal government through legislative passage of the Clean Water Act in 1972 and subsequent amendments. Prior to the Clean Water Act (1972), the Federal Water Pollution Control Act (1948) served as the basis for controlling water pollution. The Clean Water Act significantly amended the Federal Water Pollution Control Act and established the basic structure for regulating discharges of pollutants into the waters of the United States. Major amendments were enacted in 1977 and 1987 that further strengthened and expanded the Clean Water Act of 1972. The 1987 amendments incorporated the requirement that stormwater discharges from urban (municipal) areas be required to obtain a permit for discharge and that stormwater discharges from industrial sources also be permitted. There have been a number of minor amendments and reauthorizations over the years that have resulted in the law as it now stands.

There are several significant provisions of the Clean Water Act that pertain to TMDLs. These provisions include the requirement that states adopt Water Quality Standards by designating water body uses and set criteria that protect those uses. The Clean Water Act also requires states to assess their waters and provide a list (known as the 303(d) list) of waters that are impaired. The list specifies the impairing substance and requires that a TMDL be developed to address the impairment.

Through policy (memos dated November 22, 2002 and November 12, 2010) the US EPA has indicated that the pollutant loads attributable to regulated stormwater discharges are to be included in the Waste Load Allocation as a point source discharge and not as part of the non-point load. The initial memo also affirmed that the Water Quality-Based Effluent Limitations

(WQBELs) in Municipal Separate Storm Sewer System (MS4) permits may be expressed in the form of Best Management Practices (BMPs) and not as numeric limits for stormwater discharges. The second memo clarified that when the MS4 permits are expressed in the form of BMPs, the permit should contain objectives and measurable elements (e.g., schedule for BMP installation or level of BMP performance). By providing both an expected level of BMP performance and a schedule of implementation of the various practices, Baltimore County will have addressed this requirement. This plan once approved by Maryland Department of the Environment (MDE) will be enforceable under the terms of the permit.

2.2 Maryland Use Designations and Water Quality Standards

In conformance with the Clean Water Act, the State of Maryland has developed use designations for all of the waters in the state of Maryland, along with water quality standards to maintain the use designations.

Designated uses define an intended human and aquatic life goal for a water body. It takes into account what is considered the attainable use for the water body, for protection of aquatic communities and wildlife, use as a public water supply, and human uses, such as recreation, agriculture, industry, and navigation. Water quality standards include both the Use Designation and Water Quality Criteria (numeric standards). Water Quality Criteria are developed to protect the uses of a water body.

2.2.1 Use Class Designations

Every stream, lake, reservoir, and tidal water body in Maryland has been assigned a Use Designation. The Use Designation is linked to specific water quality standards that will enable the Designated Use of the water body to be met. A listing of the Use Designations follows:

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

The letter "P" may follow any of the Use Designations, if the surface waters are used for public water supply. There may be a mix of Use Classes within a single 8-digit watershed; for example, Lower Gunpowder Falls has Use I, Use III, and Use IV Designations depending on the subwatershed. Towards the mouth of the mainstem channel the Lower Gunpowder Falls has a Use II designation, however this TMDL and IP are specific to the non-tidal streams which would not include this designation.

Table 2-1: Designated Uses and Applicable Use Classes

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

2.2.2 Water Quality Criteria

Water quality criteria are developed to protect the uses designated for each water body. Certain standards apply over all uses, while some standards are specific to a particular use. The criteria are based on scientific data that indicate threats to aquatic life or human health. For the protection of aquatic communities the criteria have been developed for fresh water, estuarine water, and salt water. The criteria have been further based on acute levels (have an immediate negative effect) and chronic levels (have longer term effects). The human health criteria are based on drinking water levels, organism consumption levels, or a combination of drinking water and organism consumption levels, or recreational contact bacteria levels.

Dissolved oxygen criteria for all Use Designations is 5 mg/L, except for Use II Designations and special criteria for drinking water reservoir hypolimnion waters (bottom waters of the reservoir).

Bacteria criteria are based on human health concerns, and apply to all Uses, with additional bacteria criteria applicable in shellfish waters. Since none of the local TMDLs are related to the shellfish criteria, they are not discussed here. The human health criteria are based on either the geometric mean of 5 samples or single sample criteria based on the frequency of full body contact, these criteria are displayed in Table 2-2. For the freshwater bacteria TMDLs the indicator bacteria E. coli has been used in the development of the TMDL, therefore it serves as the water quality end point. The human health recreational contact bacteria criteria are displayed in Table 2-2. The table displays both the geometric mean for bacteria and single sample maximum allowable bacteria concentrations based on the frequency of full body contact.

Table 2-2: Bacteria Criteria for Human Health (MPN/100 ml)

Indicator	Steady State Geometric Mean Density	Single Sample Maximum Allowable Density			
		Frequent Full Body Contact Recreation	Moderately Frequent Full Body Contact Recreation	Occasional Full Body Contact Recreation	Infrequent Full Body Contact Recreation
Enterococci	33	61	78	107	151
E. coli	126	235	298	410	576
Enterococci	35	104	158	275	500

2.3 Planning Guidance

In March of 2008 the EPA released a guidance document on the development of watershed plans titled Handbook for Developing Watershed Plans to Restore and Protect Our Waters. The handbook laid out nine minimum elements to be included in watershed plans, commonly called the "a through i" criteria. The criteria include:

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 Non-point Source (NPS) management measures.
c. A description of the NPS management measures that will need to be implemented.
d. An estimate of the amounts of technical and financial assistance 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 efforts over time.

EPA now evaluates watershed plans on the basis of the above criteria in consideration of its grant funding. The State of Maryland is also increasingly using the above criteria for funding consideration. Baltimore County has used these criteria since the publication of the handbook in the development of its Small Watershed Action Plans; and will use the criteria in the development of this TMDL Implementation Plan.

Maryland Department of the Environment (MDE) developed a guidance document in conjunction with local government representatives entitled *Maryland's 2006 TMDL Implementation Guidance for Local Governments*, which provides a framework for the development of TMDL Implementation Plans. MDE has also provided guidance on the development of TMDL Implementation Plans related to specific pollutants. Guidance for specific pollutants includes:

- PCBs
- Bacteria

- Mercury
- Trash

These guidance documents have been taken into consideration in the development of the Baltimore County TMDL Implementation Plans.

2.4 Water Quality Standards Related to This Implementation Plan

The Lower Gunpowder Falls watershed (02-13-08-02) has been designated a combination of Use III, Use IV, and Use I. All of these designations include the growth and propagation of fish and other aquatic life and wildlife as a part of the designated use. The water quality criteria applicable to the sediment TMDL include biological community criteria and sediment related criteria.

There are no specific sediment criteria, but there are criteria related to turbidity, which is a function of suspended solids. The criteria specify:

(5)(a) Turbidity may not exceed levels detrimental to aquatic life.

(5)(b) Turbidity in the surface water resulting from any discharge may not exceed 150 units at any time or 50 units as a monthly average. Units shall be measured in Nephelometer Turbidity Units (NTU).

The biological water quality criteria are found in COMAR 26.08.02.03-4 and specify:

A. *Quantitative assessments of biological communities in streams (biological criteria) may be used separately or in conjunction with the chemical and physical criteria promulgated in this chapter to assess whether water quality is consistent with the purposes and uses in Regulations .01 and .02 of this chapter.*

B. *The results of the quantitative assessments of biological communities shall be used for purposes of water quality assessment, including, but not limited to, those assessments required by §§303(d) and 305(b) of the federal Clean Water Act (33 U.S.C. §§1313(d) and 1315(b)).*

C. *These assessments shall use documented methods that have been subject to technical review, produce consistent and repeatable results, and are objectively interpretable.*

D. *In using biological criteria to determine whether aquatic life uses are being met, the Department shall allow for the uncertainty and natural variability in environmental monitoring results by using established quantitative and statistical methodologies to establish the appropriate level of uncertainty for these determinations.*

E. *The Department shall determine whether the application and interpretation of the assessment method are appropriate. In those instances where the Department determines the assessment method is not appropriate, it will provide its justification for that determination.*

To determine impairment listings due to aquatic biological community condition, the biological data are analyzed on an 8-digit watershed scale. If the biological scores for benthic macroinvertebrates and fish indicating degraded stream conditions are significantly different than reference condition watersheds (i.e. healthy stream, <10% degraded), then the watershed is determined as not meeting biological water quality criteria. Index scores below 3.0 for the benthic community and fish are considered degraded. Based on the MBSS round one (1995-

1997) and two (2000-2004) data presented in the *Watershed Report for Biological Impairment of the Non-Tidal Lower Gunpowder Falls Watershed, Baltimore County, Maryland: Biological Stressor Identification Analysis Results and Interpretation* (MDE 2012) nine of thirteen monitoring sites had fish and benthic scores of 'poor' to 'very poor' (less than 3.0). The data further suggests that 61% of the stream miles in 'poor' to 'very poor' condition are impacted by sediment. This report also determined that the aquatic community was impacted by chlorides and at two sites impacts due to ammonia were identified.

The water quality end point to be achieved is biological scores greater than 3.0. Baltimore County will assess this end point on a subwatershed basis and use existing data for targeting impaired subwatersheds.

3.0 Introduction

The TMDL summary provides context for the TMDL implementation plan. It is necessary to understand some basic information from the original TMDL document that preceded this particular implementation plan. The TMDL document describes the condition of the watershed at the time that the baseline load of the pollutant was calculated. The baseline load is simply a measurement of the amount of the pollutant that was in the waterbody during a specific time. The baseline load provides a starting pollutant measurement for the county to reduce from, in order to meet the TMDL target. The term TMDL is also used to describe the specific numeric load target, which is explained in detail within the TMDL document. The original TMDL document provides a detailed justification for choosing the TMDL target number. This justification is a description of the entire technical process including monitoring methods and calculations. The following section is a simplification of that section of the TMDL document and a brief explanation of why the TMDL was developed for the specific pollutant in this watershed.

3.1 TMDL Background

- **The Problem:** The TMDL was developed because sedimentation was found to be degrading the health of aquatic organisms in the non-tidal streams of the Lower Gunpowder Falls.

The non-tidal streams of the Lower Gunpowder Falls were listed as being impaired for impacts to biological communities in 2002 and specifically by sediment in 2012. Maryland Department of the Environment (MDE) developed the TMDL and submitted it to EPA in September of 2016. It was approved by EPA in May of 2017.

An Index of Biotic Integrity (IBI) was used to determine biological impairment and a Biological Stressor Identification Analysis (BSID) was used to determine that sediment was the primary cause of that biological impairment.

IBI is the preferred tool for measuring the health of the aquatic community in a particular waterbody. An IBI score is a numerical measure of the completeness (Integrity) of the biological community. The Lower Gunpowder Falls TMDL involves two different types of IBI measurement: a Fish IBI (F-IBI) and a benthic macroinvertebrate IBI (B-IBI). An IBI score is determined by taking a series of samples of the community from different areas of the stream. A number of metrics are evaluated for the samples and are then used to calculate the IBI score. The Biological Assessment of Water Quality for Non-tidal Wadeable Streams is a document that is produced by MDE that explains the accepted methodology for assessing biological impairment in non-tidal streams (it may be found in part C.2.3 of Maryland's 2014 Integrated Report of Surface Water Quality). It describes how both F-IBI and B-IBI are used in Maryland to evaluate biological data for Clean Water Act requirements.

Notice that IBIs are affected by a wide range of stressors. Even if the TMDL target for sediment is reached and water quality standards for sediment are restored, it is possible that other factors could keep the IBI from reaching a healthy score. There is currently no standard test that can exclusively measure sediment's effect on the health of aquatic life. There is also no sediment concentration standard in Maryland.

Although it is not possible to exclusively measure the effect of sediment on the health of aquatic life, the BSID analysis is designed to systematically and objectively determine the predominate cause of the reduced biological conditions. The IBI identified that a biological impairment exists, but the BSID verified that sediment was the primary impairing substance. For more information on the BSID analysis, see the Biological Stressor Identification Lower Gunpowder Falls Watershed Report on the MDE website.

The sediment load in the Lower Gunpowder Falls watershed was studied over an extensive time period. The data used to determine this particular TMDL was gathered from round 2 and round 3 data of the Maryland Biological Stream Survey (MBSS) (see: Maryland Biological Stream Survey at DNR web-page) and supplemented by CORE/TREND Data (see: Benthic Macroinvertebrates and Maryland's Core Trend Monitoring Stations). Both are water quality monitoring programs of the Maryland Department of Natural Resources (DNR) and both involve collecting and analyzing samples of benthic macroinvertebrates for species diversity. Benthic macroinvertebrates are organisms without backbones that are visible without a microscope. They live on, under or around rocks and debris on the bottom of lakes, rivers, and streams. They act much like "the canary in a coal mine", but for watersheds. Some species are more tolerant to pollutants than others. The absence of less pollutant tolerant macroinvertebrate species usually indicates that a pollutant has been present long enough and in high enough concentrations to kill off those organisms in that area. This is often seen as an early indication that the pollutant could cause harm to other species. The death of organisms from sedimentation can occur from accumulation over timer, such as in the case of habitat modification, or can be an immediate death, such as in the case of smothering. MBSS sampling also involves the collection of fish for analysis of species diversity, so fish data from the MBSS was used as well. The data provided the information necessary to calculate a final IBI score for both fish and macroinvertebrates for the stream.

The CORE/TREND data was collected from 1976 to 2006 while round 2 and 3 MBSS data was collected from 2000 to 2009. It was determined that 2009 will be used as the baseline year of the data collection for this TMDL implementation plan. This 2009 baseline is called out in Section 2.2.4 of the MDE TMDL document (based on the CBP 5.3.2 2009 progress scenario).

3.2 TMDL Development

A critical step in the TMDL process is establishing the method by which the TMDL targets will be determined. This particular TMDL was developed using a reference site approach. Reference sites are determined based on Maryland's biocriteria methodology, which utilizes both B-IBI and F-IBI. Reference watersheds are determined based on calculated IBI scores at MBSS stations Reference watersheds are those with average IBI scores indicating good biological health for the watershed overall. Watershed impairment is evaluated by the percentage of MBSS stations within the watershed that are below an IBI minimum allowable limit in comparison to reference conditions. Based on MBSS data, MDE estimates that 54% of the stream miles in the watershed have B-IBI and/or F-IBI significantly lower than 3.0 on a scale of 1-5.

Sediment loads for the Lower Gunpowder Falls were compared to reference sites with similar physical and hydrological characteristics. Eleven reference watersheds were selected from the Highland/Piedmont region. Sediment loads were then normalized with background conditions that would be present in a watershed surrounded by all forest cover. This condition is known as the forest normalized sediment load. The forest normalized sediment load represents how many times greater the current sediment load is compared to the all forested sediment load. The median and 75th percentile of reference watershed forest normalized sediment loads were found to be 3.6 and 7.2 respectively. The median value of 3.6 was used as the sediment loading threshold. In short, this threshold is established based on an analysis of sediment loads observed in watersheds that are meeting their water quality standards. After the analysis, the amount of sediment loading a watershed may receive without causing considerable detriment to aquatic biota is used to determine the goal for sediment loads in similar watersheds that are not meeting water quality standards.

3.3 TMDL Results

Using the sediment loading threshold analysis in conjunction with current (baseline) sediment loading conditions, a goal for sediment reductions in the watershed may be developed. The sediment loading threshold determined that the TMDL for sediment in the Lower Gunpowder Falls would be 3,696 tons/year. The baseline load was determined using the 2009 Progress Scenario of the Chesapeake Bay Program model version 5.3.2. Table 3-1 below displays land uses within the Lower Gunpowder Falls and the modeled sediment load from each land use in the watershed.

Table 3-1: Lower Gunpowder Falls 2009 Baseline Sediment Loads by Land Use

General Land Use			
Forest	Forest	426	6.2
	Harvested Forest	29	0.4
AFOs	Animal Feeding Operations	10	0.1
Pasture	Pasture	115	1.7
Crop	Crop	1,959	28.4
Nursery	Nursery	50	0.7
Regulated Urban	Construction	812	11.8
	Developed	3,477	50.3
	Extractive	29	0.4
Point Sources	Industrial Point Sources	0	0.0
	Municipal Point Sources	8	0.1
Total		**6,916**	**100.0**

*adapted from (MDE, 2016); totals may not add to 100% due to rounding

Using the current baseline loading from the model, determined to be 6,916 tons/year, and the target load determined from the sediment loading threshold as 3,696 tons/year, the Lower Gunpowder Falls is required to reduce its sediment loading by 3,220 or 46.6 percent. Table 3-2 below summarizes the required reductions of sediment for the whole Lower Gunpowder Falls.

Table 3-2: Summary of TMDL Required Sediment Reduction for Lower Gunpowder Falls (all sources)

Baseline Load (tons/year)			
6,916	3,220	3,696	46.6

Using the landuse data, and knowledge of baseline loading by source sector, it is able to be determined that the baseline load is split up in the following way:

Total Baseline Load	=	Nonpoint Sources	+	NPDES Stormwater	+	Wastewater
6,916	**=**	**2,589**	**+**	**4,319**	**+**	**8**

3.4 TMDL Reduction Targets by Source Sector

TMDLs must be presented as a sum of waste load allocations (WLA) for point sources and load allocations (LA) for nonpoint source loads and a margin of safety (MOS).

- LA: Nonpoint sources were not targeted for reduction in this TMDL
- WLA: The WLA consists of two permitted sources: process water WLA and stormwater WLA.
  - Process water permits with specific TSS include municipal facilities, and mineral mining facilities. There was no reduction applied to these sources because they are not a significant portion of the total load.
  - Stormwater WLA can include regulated stormwater flowing from Municipal Separate Storm Sewer Systems (MS4s – the county's storm drain system), industrial facilities permitted to discharge stormwater, and construction sites.
- MOS: The margin of safety is implicit because the forest normalized sediment load and chosen sediment loading threshold was considered to be an environmentally conservative estimate.

Recalling the TMDL equation presented in Section 1 of this TMDL Implementation Plan:

TMDL	=	LA	+	WLA Stormwater	+	WLA Process Water	+	MOS
3,696	**=**	**1,832**	**+**	**1,856**	**+**	**8**	**+**	**Implicit**

To reach the endpoint goals of this TMDL, different sources of sediment pollution will need to be reduced. Baltimore County's requirement for reducing sediment loading is specific to the reductions required to meet the WLA Stormwater load presented in the equation above. Table 3-3 below summarizes reductions required for each category of source sector.

Table 3-3: Summary of Sediment Load Reductions Required by TMDL

LA/non-point source	2,589	1,856	733	28.3
WLA/point source Stormwater	4,319	1,856	2,463	57.0
WLA/point source Process Water	8	8	0	0.0
Margin of Safety	Implicit			
Totals	6,916	3,696	3,220	46.6

Table 3-4 below breaks out the WLA/point source Stormwater category into more specific categories. This information is taken from the Point Source Technical Memorandum, a supplement to the main TMDL document from MDE.

Table 3-4 Detailed Sediment Load Reductions Required for WLA Stormwater Sources in Lower Gunpowder Falls

WLA/point source Stormwater				
Baltimore County MS4	3,095	1,009	2,086	67.4
State Highways Administration MS4	163	53	110	67.5
"Other NPDES Regulated Stormwater"	1,061	794	267	25.2
Totals	4,319	1,856	2,463	57.0

The load reductions associated with Baltimore County's MS4 (storm drain system) represent the County's responsibility for implementation.

This review pertains to direct and indirect effects of sediment on fresh water rivers and streams, specifically those effects that are relevant to the Lower Gunpowder Falls non-tidal streams. This is not intended to be an exhaustive review of primary literature, but rather a summary of the sources, pathways and biological effects of sediment in non-tidal watersheds from literature available to Baltimore County Department of Environmental Protection and Sustainability.

Sediment is solid soil or rock material (e.g. pebbles, sand, dirt, and mud) that is transported by wind, water or ice, or is secreted or carried by organisms, or precipitated from a solution, i.e., chemical sedimentary rocks (U.S. Geological Survey and U.S Department of the Interior 2003). The effects of sediment on a water ecosystem are multi-dimensional (Berry, Rubinstien and Melzian 2003). Stream channels are inherently dynamic systems that change in their width, slope, shape, depth, meander pattern and bed material over time (Berry, Rubinstien and Melzian 2003) (Davis 2009) . Fluctuations in the sediment load occur naturally and are a vital part of the aquatic system. Sediment stress results when significant changes to the normal sediment load occur, compromising the ecological integrity of the water ecosystem (Berry, Rubinstien and Melzian 2003).

Sediment has different impacts on the system depending on the particle size. Classifications include bottom deposition sediment and suspended sediment. Course sediment is typically transported along the bottom of the river or stream, while silt and clay sediments become suspended in the water column. Turbidity is a measure of the water's cloudiness as a result of suspended sediment. Suspended sediment can include material that is large enough to eventually settle as bottom deposition. It can also include particles that fluctuate, through natural processes, between suspensions and deposition. Suspended sediment particles that are small enough to settle very slowly, or not at all, are those that contribute to the problem of turbid water (Berry, Rubinstien and Melzian 2003). Deposited sediment can create unique problems for aquatic life as well. The rate of flow of the river or stream determines what size particles become suspended or deposited (Davis 2009). Faster moving water has the power to move larger particles. Because the rate of water flow changes with water volume, the maximum size of particles in suspension is also subject to change. See USGS Summary Report on Sediment Processes: Chapter 3Watershed Sediment Transport and Chapter 4 Watershed Sediment Deposition and Storage. By the processes of re-suspension and deposition sediment can be re-introduced into the water column or deposited to the river or stream bed (Colorado Department of Public Health and the Environment Water Quality Control Commission Water Quality Control Division 2005).

Sediments enter the waterbody through a wide variety of transport mechanisms, including surface water (e.g. stormwater runoff), bank sloughing, and atmospheric deposition. See the USGS Summary Report on Sediment Processes: Chapter 2 Watershed Sediment Sources. Upland and bank erosion contribute to nonpoint sources of the sediment load. Anthropologic activities enhance the erosion process (Booth and Henshaw 2000). Those activities include construction, mining, farming, urban development, and dredging (Berry, Rubinstien and Melzian 2003).

Erosion rates differ by land use. Estimates of average annual erosion rates help to determine the amount of sediment delivered to the waterbody, but not all eroded sediment enters the river. The average annual erosion rate from the land is known as the edge-of-field (EOF) erosion, but the edge-of-stream (EOS) is what actually enters the river reaches. The EOS is calculated using the

EOF, but also takes into account the deposition of sediment on hillsides, and sediment transport through smaller streams and rivers (Maryland Department of the Environment 2011).

Stream bank erosion is aggravated by high water flows during storm events. Impervious surfaces, such as parking lots, roads, and rooftops are directly connected to the stream channel via the storm sewer system. This causes water to flow more rapidly into the stream during a storm event without the natural filtration that occurs when rain water runs through vegetation and soil. The outcome is higher water flows in the stream channel during storms and higher sediment content in the streams and rivers. The stress of these high flows through the stream and river channels wears away at the banks, causing higher than normal bank erosion (Booth and Henshaw 2000) (Maryland Department of the Environment 2011).

A study produced by U.S. Geological Survey on sediment processes in the Chesapeake Bay watershed found that river basins with the highest percentage of agricultural land use have the highest annual sediment yields (U.S. Geological Survey and U.S Department of the Interior 2003). Basins with the highest percentage of forest cover were found to have the lowest annual sediment yields. The study also found that urbanization can more than double the background sediment yield (U.S. Geological Survey and U.S Department of the Interior 2003). This urban sediment is highest during construction phases and then declines after the initial development is complete. In some instances, when construction alters stream hydrology, the sedimentation rate remains high because the erosion of stream banks continues long after development (U.S. Geological Survey and U.S Department of the Interior 2003). For more information on urbanization and sedimentation, see: U.S. EPA Urbanization and Streams: Studies of Hydrologic Impacts.

Sediment can affect humans by reducing water clarity, which is not aesthetically pleasing. It can also reduce cleanliness of water for swimming or recreational activities, as well as drinking.

An overabundance of sediment in the water column, resulting in cloudy water, inhibits light penetration. This can be a problem for predators, as both big and small fish hunt primarily by sight (Berry, Rubinstien and Melzian 2003) (Lester 2013). When fish and other aquatic animals cannot see their prey, their ability to capture food is limited. Murky water is a problem for both large and small fish, but smaller fish that feed on zooplankton can have an advantage, to a degree, of not being seen as easily by predators while scavenging for food. However, too much cloudiness, negates this advantage and both large and small fish will find it difficult to get enough food for their survival (Lester 2013).

Excessive sediments can also destroy valuable aquatic habitats for fish, aquatic invertebrates, and algae (Berry, Rubinstien and Melzian 2003) (Lisle, 1989). Fish habitats are affected when fine sediment settles into spawning gravels, reducing oxygen levels in the spaces between gravel particles. Spawning gravels are stream bed materials that females excavate to form nests for egg laying. During excavation, females minimize fine sediment particles to enhance gravel permeability and oxygenate the eggs. Decreased oxygenation due to sedimentation can lead to a reduction in survival and growth rates (Colorado Department of Public Health and the Environment 2005; Lisle 1989). Sedimentation can also negatively affect fish through loss of food sources and loss of habitat variety that normally result from natural variations in steam morphology (Colorado Department of Public Health and the Environment Water Quality Control Commission Water Quality Control Division 2005).

Aquatic invertebrates can suffer habitat loss due to sedimentation in addition to being smothered by fine sediments that settle into rocks and gravel. Chapman and Mcleod, 1987, as cited in Colorado Department of Public Health and the Environment, 2005, found a relationship between bed material size and macroinvertebrate habitat availability, and also found that excessive sediment decreases the diversity and density of macroinvertebrates. If sediments are carried downstream into brackish and salt waters, it can degrade the health of oyster beds, which are critical for water filtration and cleaning in the Chesapeake Bay (U.S. Geological Survey and U.S Department of the Interior 2003; Cerco & Noel 2005).

Another way that sediments can damage the health of aquatic communities is by transporting pollutants into the watershed. Nutrients and metals can form complexes with minerals found in fine sediment, consequently, water runoff not only carries excessive sediments, but often includes pollutants as it washes into waterways. Excess of certain nutrients and minerals can be toxic to many aquatic organisms (Nelson and Booth 2002). For example, excess phosphorus in the water increases the growth of surface level algae. The algae can block out sunlight and prevent it from getting to the submerged aquatic vegetation (SAV), which is an essential part of the aquatic food chain. Excessive algae growth also uses up oxygen in the water and can create hypoxic conditions, meaning that the dissolved oxygen level is too low to support many aquatic organisms. See USGS Summary Report on Sediment Processes: Executive Summary.

Section 5 - Watershed Characterization

This section will describe the watershed characteristics of the Lower Gunpowder Falls watershed. Section 5.1 has general characterization information and Section 5.2 discusses land use, sediment loads and reductions and the total reduction the Baltimore County MS4 is required to meet the TMDL. Characterizing the watershed can aid planning and restoration targeting efforts and improve understanding of sediment sources.

The TMDL document produced by Maryland Department of the Environment (MDE) used 2009 as the baseline year for data in determining the sediment load reduction required (MDE, 2016). Figure 5-1 shows the Lower Gunpowder Falls watershed.

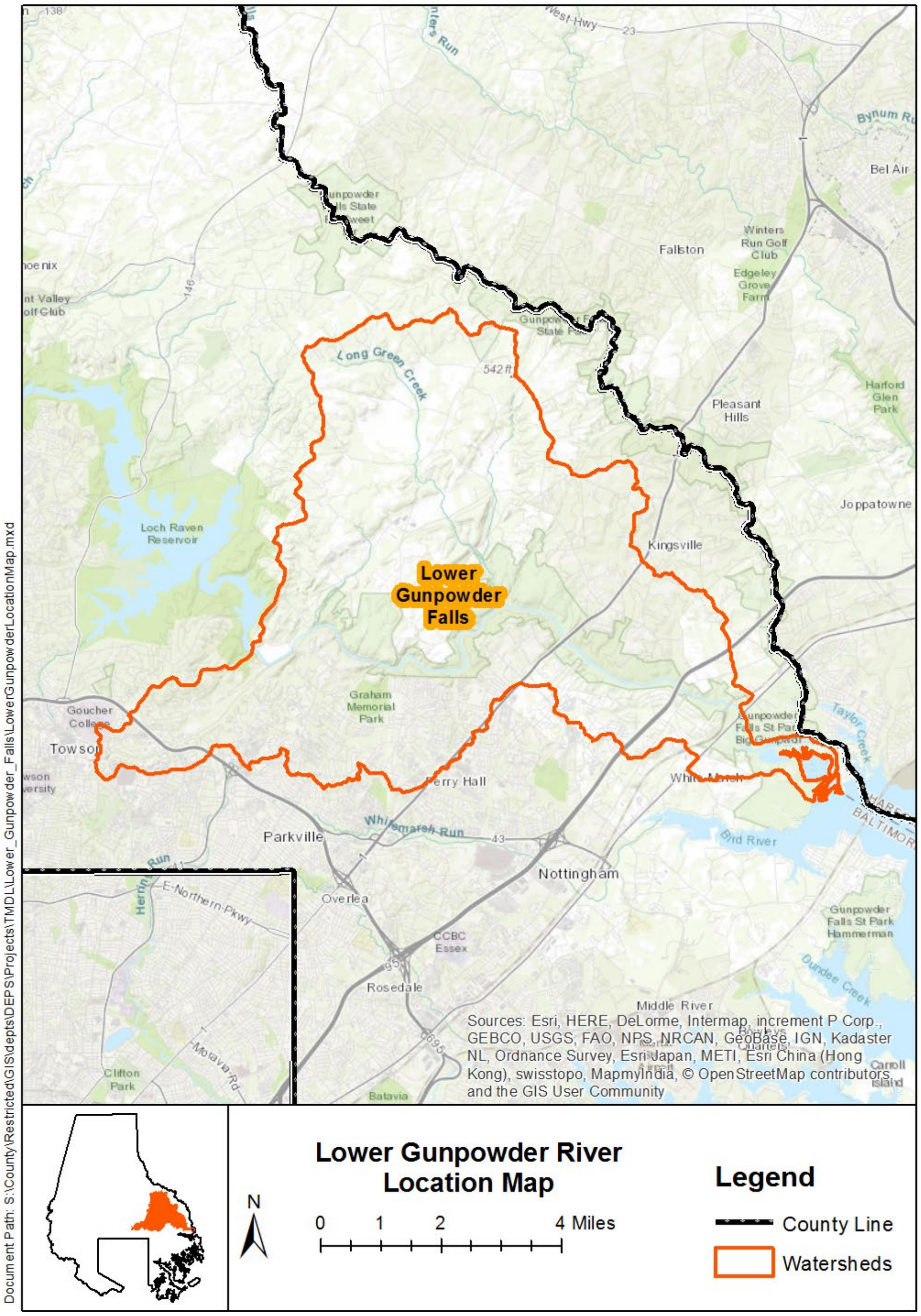


Figure 5-1: Lower Gunpowder Falls Watershed within Baltimore County

5.1 General Information

5.1.1 Acreage

The Lower Gunpowder Falls watershed contains approximately 29,470 acres with varying land uses and pollution potential. All of the watershed is contained within Baltimore County.

5.1.2 Population

Population data provides another way to evaluate the intensity of land use. Much of the degradation from urban/suburban land uses (where population is mainly concentrated) is related to the extent of impervious cover and also conversion of land uses that protect water resources such as forest. A higher population density (persons per acre) represents a more intense use of the land and potential for environmental degradation.

Census block data from the 2000 US Census and 2010 US Census was used to determine the population in the watershed. Data from the 2000 US Census was interpolated in order to estimate the population for 2009, which is the baseline year for the TMDL and therefore important to understand the conditions at the time the TMDL was developed and how they may have changed since then. Population for 2009, 2010, and the percent change over time in the Lower Gunpowder Falls watershed is shown in Table 5-1.

Table 5-1: Population Data for Lower Gunpowder Falls Watershed

Watershed			
Lower Gunpowder Falls	50,759	51,093	+0.70%

5.1.3 Streams

Streams were analyzed using Geographic Information Systems. 2005 Hydrology data was queried on “SINGLE LINE STREAM” and “DOUBLE LINE STREAMS/RIVERS”. Double line streams data was divided by 2 and added to the single line stream data to calculate total stream miles. Table 5-2 shows length of streams in Lower Gunpowder Falls.

Table 5-2: Streams Data for the Lower Gunpowder Falls Watershed

Linear Feet of Stream	Miles of Stream
882,158.6	20.3

5.2 Land use, Sediment Loads, and Reductions

As mentioned above, 2009 is the baseline year for the sediment TMDL for the Lower Gunpowder Falls watershed. This section updates the sediment loads and BMP reductions to the beginning of the County's current NPDES MS4 permit term, approximately fiscal year 2014. This helps the County plan for and track TMDL implementation in the context of other MS4 permit requirements, including the Bay TMDL and other local TMDLs.

Due to the need to reconcile this plan with the Chesapeake Bay TMDL, a land use dataset was needed that had recent data, and was also appropriate for analyzing change over time. The National Land Cover Dataset (NLCD) (Jin 2013) met these needs and was therefore used for this analysis. The NLCD dataset and the pollutant loading rates used for the analysis in this plan differ from the data used in the TMDL document, and therefore produced different results. Pollutant loading rates from the most recent Bay Model (Version 5.3.2) were used to calculate the loads for this plan based on land use.

Table 5.3 shows the Lower Gunpowder Falls sediment loads for the baseline and 2014 broken out by all land uses. Loading rates used and shown in Table 5-3 are from the Chesapeake Bay Program's Watershed Model Version 5.3.2.

Table 5-3: Change In Lower Gunpowder Falls Sediment Total Loads Based on Land Use (Baltimore County)

Land Use	SED Loading Rate (lbs/ac/yr)	Acres Baseline (2009)	SED Load Baseline (lbs/yr)	Acres (2011)	SED Load 2014 (lbs/yr)	∆ in acres (acres)	∆SED Load 2014 (lbs/yr)
Water	0	99.1	0.0	114.3	0.0	15.2	0.0
Urban Pervious	265.88	7,494.4	1,992,615.8	7,506.5	1,995,833.8	12.1	3,218.0
Urban Impervious	1946.89	2,560.2	4,984,426.9	2,603.1	5,067,929.3	42.9	83,502.4
Extractive	3118.41	125.3	390,848.9	116.6	363,556.1	-8.8	-27,292.8
Forest	76.58	11,902.6	911,499.7	11,853.4	907,733.4	-49.2	-3,766.4
Pasture	236.46	4,426.2	1,046,612.2	4,412.7	1,043,418.2	-13.5	-3,194.0
Crop	1049.91	2,869.0	3,012,233.5	2,861.7	3,004,530.5	-7.3	-7,703.0
Total		29,476.8	12,338,237.0	29,468.2	12,383,001.4	-8.6	44,764.4

Note that Table 5-3 demonstrates that there was a significant increase in urban impervious and urban pervious coupled with a decrease in forest, pasture, extractive, and crops. This resulted in an overall increase in the sediment load.

Some restoration has already taken place, both before and after the TMDL baseline year. Pre and post baseline restoration is shown in Table 5-4 and Table 5-5 respectively.

Table 5-4: Lower Gunpowder Falls Restoration Sediment Reductions Before Baseline (2009)

Restoration Type	
Stormwater Management	**549,327.5**
Ba Co Restoration Projects	896,816.3
Watershed Group Plantings	16,475.5
Ba Co Tree Planting	1,966.8
Total Restoration	**915,258.6**
Total (lbs/yr)	**1,464.586.1**

Table 5-5: Lower Gunpowder Falls Restoration Total Sediment Reductions

Restoration Type	
Stormwater Management	**674,898.8**
Ba Co Restoration Projects	1,306,768.2
Watershed Group Plantings	21,712.3
Ba Co Tree Planting	4,337.8
Total Restoration	**1,332,818.3**
Total (lbs/yr)	**2,007,717.1**

Baltimore County is responsible for addressing sediment from its MS4. The point source stormwater load is the urban pervious and urban impervious loads (see Table 5-6). Table 3-4 of the Point Source Technical Memorandum (MDE, 2017b) shows that Baltimore County MS4 is responsible for 71.7% of the stormwater WLA (3,095 ton/yr of 4,319 ton/yr), therefore the Baltimore County MS4 load is calculated as the urban load multiplied by 71.7%. Also shown in Table 5-6 are the restoration reductions prior to the baseline year and up to 2014 from Table 5-4 and Table 5-5. The total sediment load after these reductions are applied is shown in Table 5-6.

Table 5-6: Change In Lower Gunpowder Falls Sediment Urban Loads Based on Land Use

Land Use	SED Loading Rate (lbs/ac/yr)	Acres Baseline (2009)	SED Load Baseline (lbs/yr)	Acres (2011)	SED Load 2014 (lbs/yr)	ΔSED Load 2014 (lbs/yr)
Urban Pervious	265.88	7,494.4	1,992,616	7,506.5	1,995,834	3,218
Urban Impervious	1,946.89	2,560.2	4,984,427	2,603.1	5,067,929	83,502
Total		10,054.6	6,977,043	10,109.6	7,063,763	86,721
Total Balto. Co. MS4		7,205.1	4,999,749	7,244.5	5,061,893	62,144
Development Stormwater Management			549,328		674,899	125,571
Restoration Reductions			915,259		1,332,818	417,560
Total Load (lbs/yr)			3,535,162		3,054,176	-480,986
Total Load (tons/yr)			1,767.58		1,527.09	-149.50

Section 8 of this Implementation Plan has more specific details on the restoration BMPs and how their reductions shown in Table 5-4 through Table 5-6 are calculated.

The baseline year in the Lower Gunpowder Falls Sediment TMDL document has a load of 6,916 tons of sediment per year and Baltimore County MS4 regulated stormwater load of 3,095 tons per year. Table 5-6 indicates a baseline Baltimore County MS4 regulated stormwater load of 1,767.58 tons of sediment per year after accounting for BMPs and restoration.

In order to determine the Baltimore County MS4 TMDL target load, the change in the Baltimore County MS4 load from the baseline year (2009) (1,767.58 tons/yr) to the end of fiscal year 2014 was calculated and is shown in Table 5-6 (-149.5 tons/yr).

The percent reduction required to meet the TMDL for Baltimore County MS4 is 67.4% from the baseline load (MDE, 2017a). However, since the baseline year, the total sediment load from the Baltimore County MS4 has decreased due to changes in land use and BMPs installed. This decrease in load (-480,986 pounds/yr) was deducted from the reduction required from the baseline load (2,382,699 pounds/yr) to obtain the total sediment reduction required (1,901,713 pounds/yr). Table 5-7 shows this load decrease along with other data from the calculations used to determine the total reduction required to meet the TMDL.

Table 5-7: Sediment Reduction Required to meet TMDL (Baltimore County Urban Land)

Baseline SED Load (lbs)	2014 SED Load (lbs/yr)	% Reduction Required From Baseline	SED Reduction Required From Baseline (lbs/yr)	Δ in SED Load From Baseline (lbs/yr)	Total SED Reduction Required (lbs/yr)
3,535,162	3,054,176	67.4	2,382,699	-480,986	1,901,713

In order to meet the requirements of the TMDL, BMPs must be installed to reduce 950.86 tons of sediment per year. Section 9 of this TMDL Implementation Plan details how Baltimore County can meet this urban allocation of the Lower Gunpowder Falls sediment TMDL. Most BMPs have a cumulative effect, meaning a one-time installation results in pollutant reduction year after year for the life of the BMP.

Two ambient water quality monitoring programs provide sediment data for the Lower Gunpowder Falls including monitoring done by Baltimore County and the Maryland Department of Natural Resources (DNR). DNR core/trend data is presented in Section 6.1 and Baltimore County trend data is presented in Section 6.2. Section 6.0 examines the current condition of sediment in Lower Gunpowder Falls using both sets of data. Baltimore County had a baseflow program but that data is not applicable to the TMDL. The baseflow program sampled dry weather flows only and this is representative of only a small part of the total suspended sediment load. Sites can be seen in Figure 6-1.

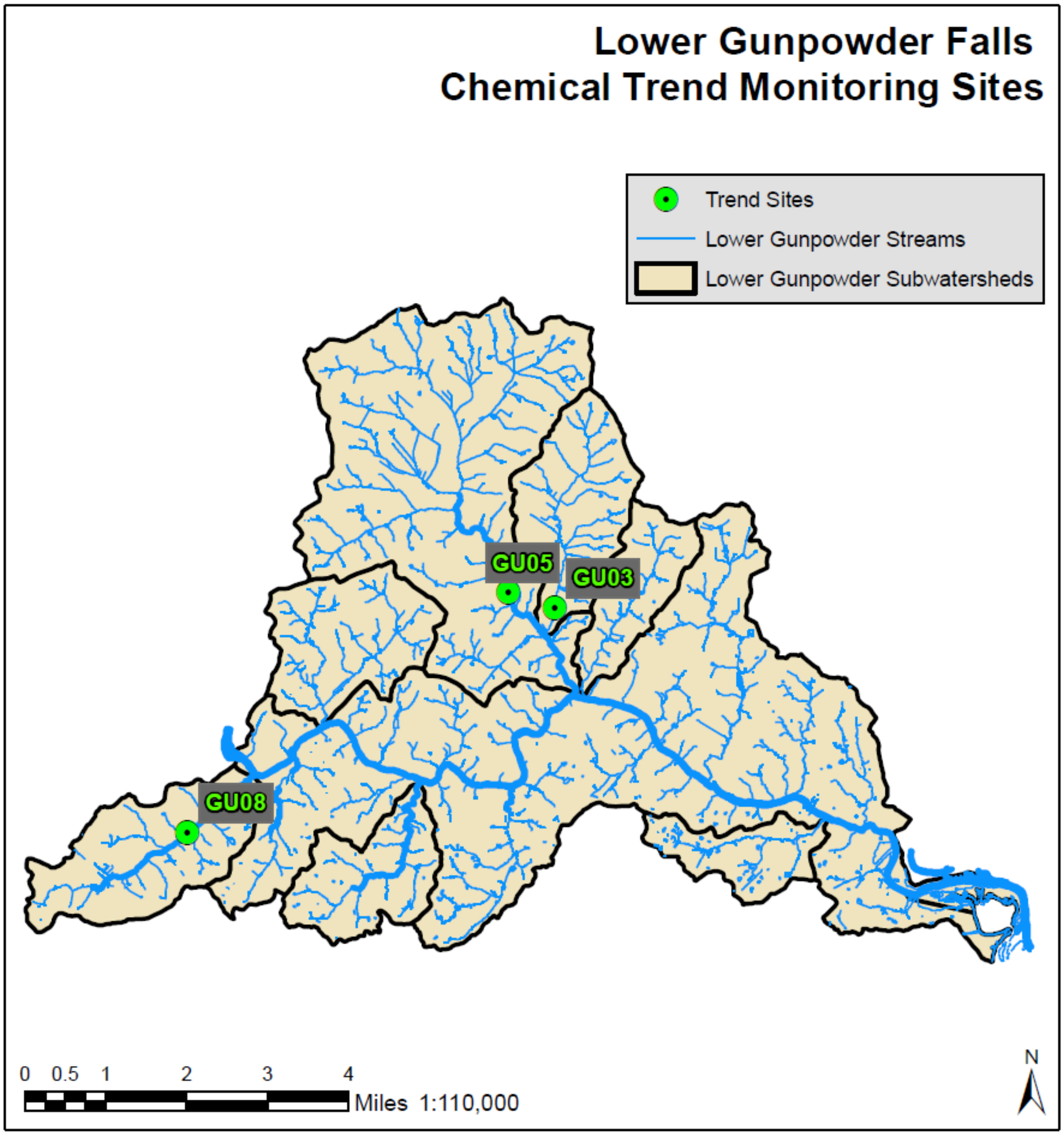


Figure 6-1: Chemical Monitoring Locations in Lower Gunpowder Falls Watershed

6.1 Core/Trend Program

DNR conducts an ambient fixed station water quality monitoring program (Core/Trend) to assess statewide water quality status and trends. The 54 sampling locations are distributed throughout the state, with particular attention to the Potomac River. Two of the sites are located in the Lower Gunpowder Falls watershed. Station GUN0125 is located in the mainstem at the Glen Arm Rd/Cub Hill Rd/Cromwell Bridge Rd intersection and bridge crossing. Station GUN0036 is located in the mainstem at the Philadelphia Rd (MD Route 7) crossing. However, these two sites are not gaged and discharge measurements could not be obtained for the data, therefore comparison could be made between Core/trend and Baltimore county trend loading rates.

$$\mathbf{P_L = (P_C x 0.000008345) x (CFS x 448.8 x 1440)} \qquad \mathbf{(6.1)}$$

Where:

P_L = Pollutant Load,

P_C = Pollutant Concentration,

0.000008345 = Conversion factor to convert mg/L to pounds per gallon,

CFS = Cubic feet per second,

448.8 = Conversion factor to convert cubic feet per second to gallons per minute

1440 = number of minutes in one day

The result of the above equation is in lbs/day of pollutant, which can then be divided by the number of acres in the drainage area to derive the lbs/acre/day load. The flow is the average for the year of cfs at time of sampling.

6.2 Baltimore County Data

In January 2011, Baltimore County's baseflow monitoring program was replaced with a water quality trend monitoring program. The trend monitoring program observes ambient chemical conditions and determines trends in chemical concentrations and pollutant loads over time at forty-one sites. This data is used to determine areas to target for restoration, assess the impact of implemented restoration activities, and determine the amount of progress made towards meeting TMDLs and other restoration goals. The sites are broken into four sampling days which remain the same each month regardless of weather. Three of those trend sites were within the Lower Gunpowder Falls watershed (Figure 6-1):

1. GU03 (1,814.6 acres) which is located on Haystack Branch off of Harford Road;
2. GU05 (6,002.6 acres) which is located on Long Green Creek off of Hartley Mill Road;
3. GU08 (1,649.4 acres) which is located on Minebank Run in Cromwell Valley Park off of Cromwell Valley Road.

6.2.1 Summary of Data Results

Water quality parameters measured as part of the County's trend monitoring program include Total Suspended Sediment (TSS). Trend chemical monitoring results collected for these sites are summarized in Table 6-1.

Table 6-1: Average Baltimore County Trend Sampling Results

Site					
GU03	2011	12	4.60	11,198	0.017
GU03	2012	12	3.59	22,906	0.034
GU03	2013	12	3.79	26,561	0.040
GU03	2014	12	4.16	62,044	0.093
GU03	2015	12	4.45	45,596	0.068
GU03	2016	12	3.63	36,341	0.054
GU05	2011	13	16.24	1,728	0.001
GU05	2012	12	10.47	188,819	0.086
GU05	2013	12	10.62	101,845	0.046
GU05	2014	12	16.13	532,074	0.243
GU05	2015	12	15.44	545,903	0.249
GU05	2016	12	10.77	204,220	0.093
GU08	2011	12	3.86	21,605	0.041
GU08	2012	12	2.47	8,766	0.016
GU08	2013	12	2.57	22,437	0.042
GU08	2014	12	3.39	61,214	0.115
GU08	2015	11	3.67	98,668	0.186
GU08	2016	12	1.89	66,509	0.125

Figure 6-2 graphically shows TSS lbs/acre/day at the eleven trend monitoring program sites over the years.

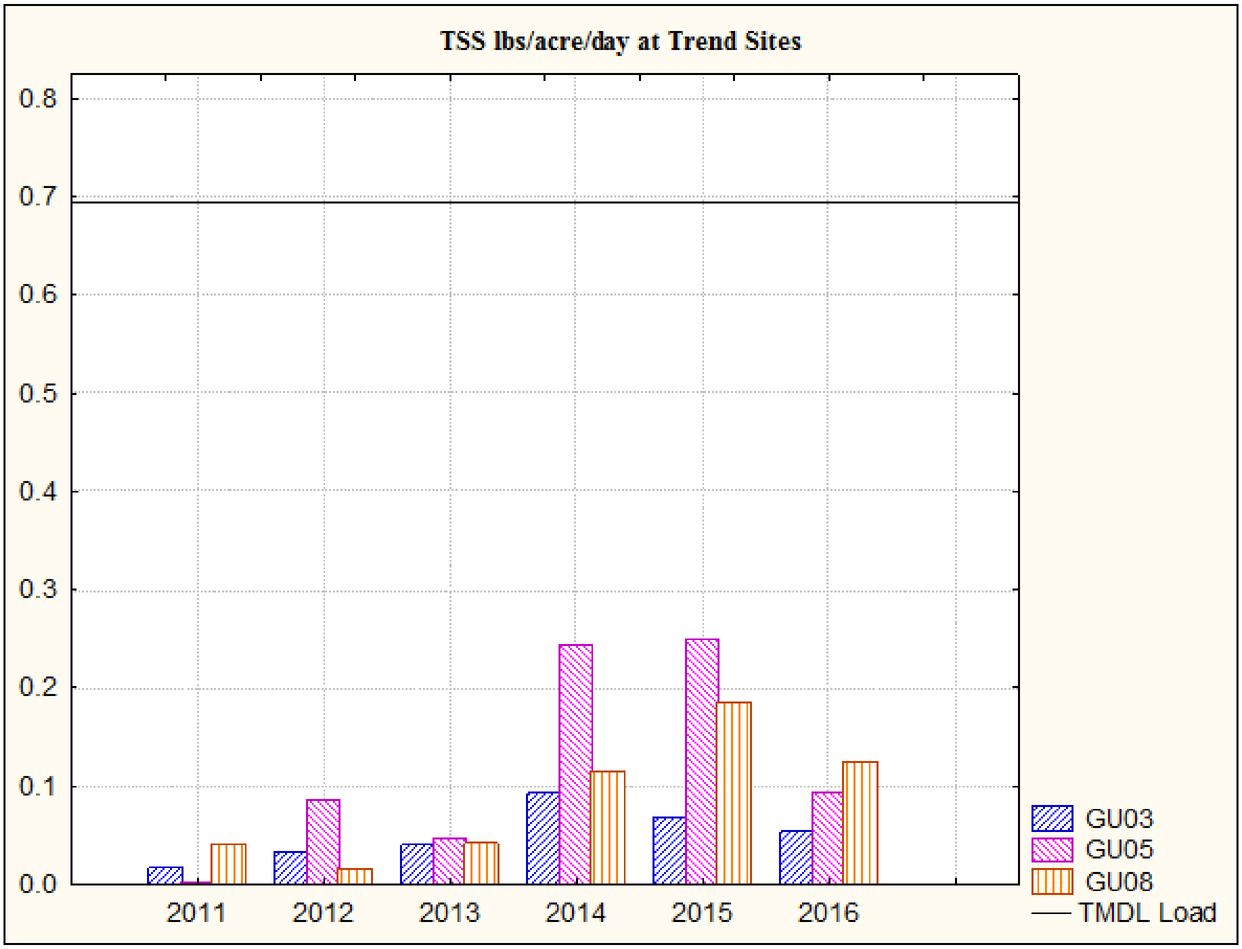


Figure 6-2: TSS lbs/acre/day at Baltimore County Trend Monitoring Sites

6.3 Comparison of Data to TMDL Water Quality Standard: Benthic Index of Biological Integrity (BIBI)

Baltimore County conducts biological monitoring of benthic macroinvertebrates on an annual basis using the Maryland Biological Stream Survey (MBSS) protocols (Kazyak 2001, Stranko 2010). The MBSS is a random design stream sampling program that was initiated by the Maryland DNR in 1993. It is intended to provide unbiased, statewide estimates of the biological resources in streams and rivers.

Benthic macroinvertebrates are organisms without a backbone that live on the bottom of streams and can be seen with the naked eye. They are an important part of stream ecosystems as they are a source of food for other aquatic life, including fish. The presence, numbers, and types of benthic macroinvertebrates also convey information about a water body's quality. Results of the MBSS protocol include a benthic Index of Biological Integrity (BIBI) score based on the benthic community at a sampling site. Qualitative ratings of stream Biological Integrity are based on IBI scores and range from good (4.0 – 5.0), denoting minimally impacted conditions, to very poor (1.0 – 1.9), indicating severe degradation.

6.3.1 Biological Data from Baltimore County

Sites for the Baltimore County biological sampling program are randomly selected, focusing on the Patapsco/Back River Basin in odd years and the Gunpowder/Deer Creek Basin in even years. Between 2004 and 2015, 78 samples were randomly sampled in the Lower Gunpowder Falls watershed by Baltimore County. Figure 6-3 provides a map of biological monitoring stations sampled by Baltimore County, as well as their BIBI narrative ratings. The overall average BIBI score was 2.64 (Poor) with 29 sites (37%) having scores above a rating of 3.00 and 49 sites having scores of Poor and Very Poor (63%).

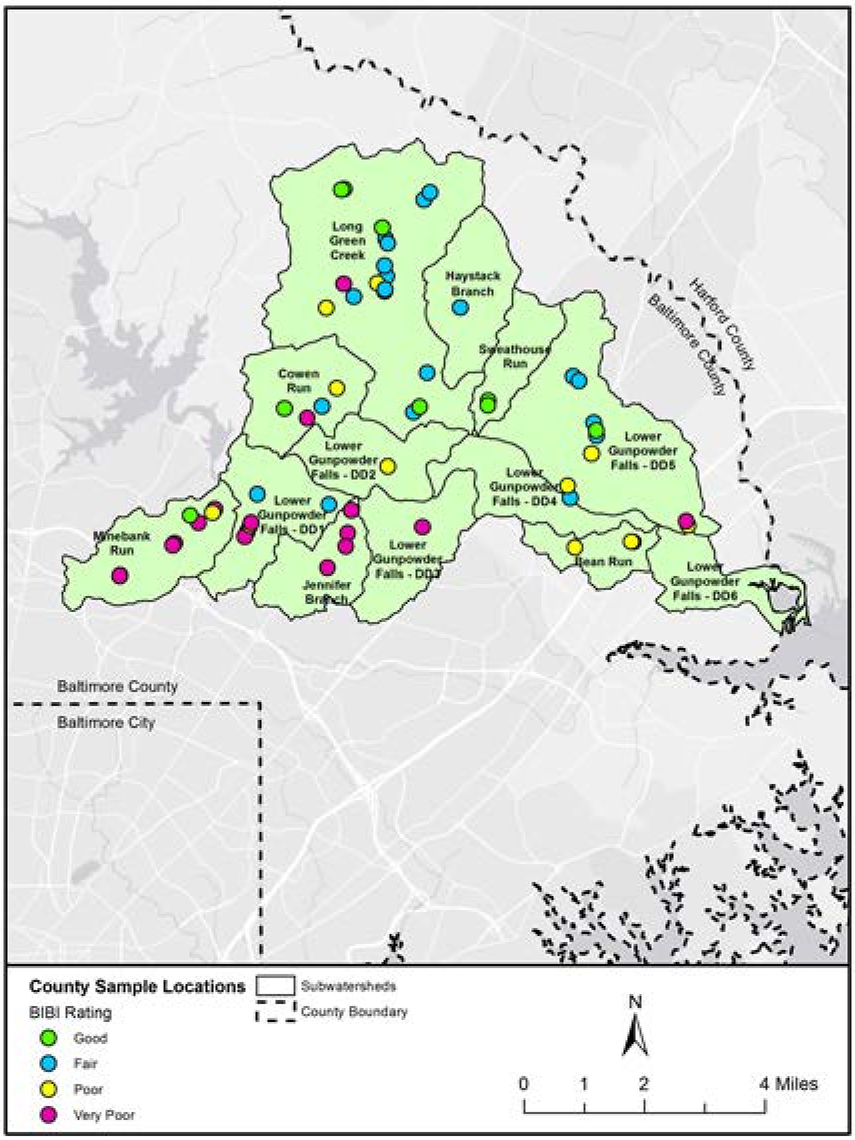


Figure 6-3: Locations of Biological Monitoring Sampled by Baltimore County in the Lower Gunpowder Falls Watershed and Results of Benthic Macroinvertebrate Monitoring, 2004-2015.

6.3.2 Maryland Department of Natural Resources Data

The Maryland Biological Stream Survey (MBSS) was started by the Maryland Department of Natural Resources in 1993 as a small pilot study and expanded statewide by 1994. Round 1 of the sampling started in 1995 with the completion of Round 3 in 2009. The MBSS was Maryland's first probability-based or random design stream sampling program intended to provide unbiased estimates of stream conditions with known precision at various spatial scales ranging from large 6-digit river basins and medium-sized 8-digit watersheds to the entire state. In addition to data collected by the County, Maryland DNR sampled twenty two random sites in the Lower Gunpowder Falls watershed through the MBSS program (

Figure 6-4). The DNR data were in agreement with the County data, with an average BIBI score of 2.48 (Poor). Of the twenty two sites only 11 had a rating of Fair or above (50%) with 11 sites having a rating of Poor and Very Poor (50%).

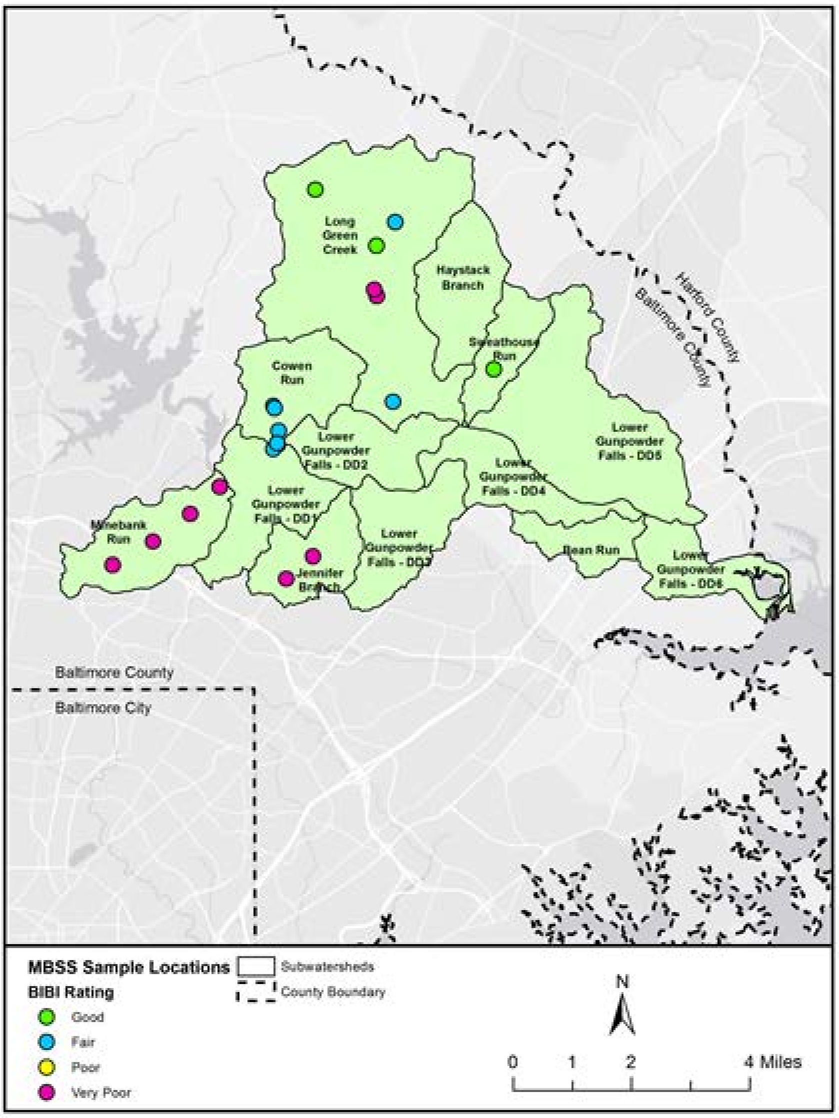


Figure 6-4: Locations of Maryland Biological Stream Survey Locations in the Lower Gunpowder Falls Watershed and Results of Benthic Macroinvertebrate Monitoring, 1996-2016.

6.3.3 Summary of Data by Subwatershed

The Lower Gunpowder Falls watershed is comprised of 13 subwatersheds. Combining the BIBI data collected by Baltimore County and the MBSS Program provides sixteen years of data, which offers a better understanding of the impairment by subwatershed. It also shows the need of additional monitoring in those watersheds that data is lacking. Table 6-2 summarizes the BIBI data by subwatershed, and segments.

Table 6-2: Summary of Subwatershed BIBI Data for the Lower Gunpowder Falls Watershed

Subwatershed	1996 MBSS	2002 MBSS	2003 MBSS	2004 B.C.	2005 B.C.	2006 B.C.	2007 MBSS	2008 B.C.	2009 B.C.	2010 B.C.	2011 MBSS	2012 B.C.	2013 B.C.	2014 B.C.	2015 B.C.	2016 MBSS	Mean
Bean Run				2.56		1.67				2.67							2.30
DD4																	na
Long Green Creek	3.00	1.67		3.15		2.87	4.33	1.83		3.38		3.73				2.00	2.88
Cowen Run	2.67	3.50				2.11					3.33	4.67					3.26
Minebank Run			1.00	1.36	2.33	1.24	1.00	1.06	1.42	1.00	1.17	1.57	1.00	1.44	1.67	1.00	1.30
Jennifier Branch		1.33		1.94	1.33	1.67	1.00	1.22	2.83	1.67	1.00	1.42	1.00	1.17		1.00	1.43
Haystack Branch												3.33					3.33
Sweathouse Branch		4.33						4.33									4.33
DD5						2.47		2.67		3.50							2.88
DD1				3.67				1.00				2.17					2.28
DD2										2.67							2.67
DD3								1.00									1.00
DD6																	na
																Average	**2.51**

7.0 Introduction

Baltimore County has already developed plans that aim to manage certain pollutants in parts of the Lower Gunpowder Falls watershed. Section 7.1 includes a description of the 1999 Lower Gunpowder Falls Water Quality Management Study. Section 7.2 is a brief summary of the 2011 Lower Gunpowder Falls Watershed Assessment, and section 7.3 is a brief overview of the two Lower Gunpowder Falls Small Watershed Action Plans (SWAPs). SWAPs include many suggested actions for improvement of water quality, including citizen-based goals and objectives that may sometimes go beyond the scope of the TMDL IP. All completed SWAP documents and their appendices are available online. Past studies, including these SWAPs and the Watershed Management Plan, were used to inform the Implementation Plan. While all of these studies had aims to help maintain compliance with the National Pollutant Discharge Elimination System (NPDES), there were different focuses of each report. The following subsections provide more specific information for each plan within the Lower Gunpowder Falls watershed.

7.1 Water Quality Management Study

This 1999 study developed a water quality management plan for the Lower Gunpowder Falls. The methodology focused on non-point stormwater pollution sources, determinations on management strategies for those sources, and developing a range of capital restoration options for water quality improvement. More specifically this report fulfilled the tasks of providing a watershed characterization, hydrologic modeling, stream stability analysis, identification of water quality restoration measures, and recommendations for prioritization.

7.2 Watershed Assessment

In 2011, Baltimore County contracted with consultants to re-visit a specific subwatershed within the urban parts of the Lower Gunpowder Falls. This assessment was more detailed than the 1999 Water Quality Management Study, but focused on similar objectives for evaluation of potential capital improvement projects.

7.3 SWAPs

Baltimore County's SWAP program focuses on assessments which conform to EPA guidance on developing watershed plans. This guidance, known as the "a through i" criteria lays out nine elements which may help a jurisdiction conduct a successful and meaningful watershed plan. SWAP development is guided by an active steering committee which meets many times throughout the process, helping to define the vision, goals, and specific objectives of each SWAP as they may be most relevant to the area in question. To see EPA's nine elements to be included in watershed plans, visit: https://www3.epa.gov/region9/water/nonpoint/9elements-WtrshdPlan-EpaHndbk.pdf

7.3.1 Lower Gunpowder Falls (urban) SWAP

This SWAP, completed in March 2016, assessed the southern drainages to the Lower Gunpowder Falls mainstem, and consisted of mostly urbanized areas including East Towson, Parkville, Carney, and Perry Hall.

The Lower Gunpowder Falls (urban) steering committee adopted the following vision statement and goals that served as a guide in the development of the SWAP:

> *Our vision for the Urban Lower Gunpowder Falls Watershed is an environmentally-sensitive community with valuable connections made to surrounding natural and recreational areas, in which healthy networks of streams deliver high-quality water to the Gunpowder Falls and Chesapeake Bay.*

- Goal 1: Improve and Maintain Water Quality
- Goal 2: Maintain and Improve Aquatic Biodiversity
- Goal 3: Increase Tree Cover and Support Healthy Sustainable Forests
- Goal 4: Improve Community Connection to the Gunpowder Falls and Awareness of Recreational Opportunities along the River
- Goal 5: Support Terrestrial Species in the Watershed

7.3.2 Lower Gunpowder Falls (rural) SWAP

This SWAP, completed in July 2017, assessed the northern drainages to the Lower Gunpowder Falls mainstem, and consisted of mostly rural areas including Long Green, Glen Arm, Baldwin, and Kingsville.

The Lower Gunpowder Falls (rural) steering committee adopted the following vision statement and goals that served 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.*

- 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)
- 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
- Goal 5: Support conservation of contiguous forested areas
- Goal 6: Protect and restore riparian forest buffers to the maximum extent practicable
- Goal 7: Preserve the agricultural heritage of the watershed
- Goal 8: Promote implementation of conservation practices on agricultural lands
- Goal 9: Engage the public in actions to support a healthy watershed
- Goal 10: Improve community connection to parkland and public access to streams

This section provides an overview of pollutant reduction measures and their predicted effectiveness as approved by the Chesapeake Bay Program (CBP). This overview is meant to serve as a guide to aid in selecting the most efficient possible BMPs that may be implemented to meet the pollutant reduction goals required by the TMDL. This review utilizes conservative estimates of BMP efficiency for planning purposes, as exact types of BMPs (e.g. structural BMPs) will not be chosen until appropriate on-site analysis is complete. It is possible that only some of the listed actions in this section will be selected for inclusion in Section 9 of this Implementation Plan.

8.1 BMP Descriptions

Listed and briefly described below are the approved BMPs for reducing sediment that are applicable to the Lower Gunpowder Falls. Most definitions were obtained from the Excel sheet *BmpDefinitions 5_15_2014.xlsx* from the MAST website: http://www.mastonline.org/Documentation.aspx (MDE; Devereux Environmental Consulting, 2014). Many of these practices are representative of one of many types of Stormwater Management (SWM) retrofits or conversions. A retrofit is a SWM feature that is installed in an area that has already been developed, but has minimal or no SWM treatment practices currently in place. A conversion uses an existing, older practice that may only provide water *quantity* treatment, and alters it so that water *quality* may be improved as well.

8.1.1 Dry Detention Ponds

Dry Detention Ponds are depressions or basins created by excavation or berm construction that temporarily store runoff and release it slowly via surface flow or groundwater infiltration following storms.

8.1.2 Hydrodynamic Structures

Hydrodynamic Structures are devices designed to improve quality of stormwater using features such as swirl concentrators, grit chambers, oil barriers, baffles, micropools, and absorbent pads that are designed to remove sediments, nutrients, metals, organic chemicals, or oil and grease from urban runoff.

8.1.3 Dry Extended Detention Ponds

Dry Extended Detention (ED) basins are depressions created by excavation or berm construction that temporarily store runoff and release it slowly via surface flow or groundwater infiltration following storms. Dry ED basins are designed to dry out between storm events, in contrast with wet ponds, which contain standing water permanently. As such, they are similar in construction and function to dry detention basins, except that the duration of detention of stormwater is designed to be longer, theoretically improving treatment effectiveness.

8.1.4 Wet Ponds and Wetlands

A water impoundment structure that intercepts stormwater runoff then releases it to an open water system at a specified flow rate. These structures retain a permanent pool and usually have retention times sufficient to allow settlement of some portion of the intercepted sediments and attached nutrients/toxics. Until recently, these practices were designed specifically to meet water quantity, not water quality objectives. There is little or no vegetation living within the pooled area nor are outfalls directed through vegetated areas prior to open water release. Nitrogen reduction is minimal.

8.1.5 Infiltration Practices

A depression to form an infiltration basin where sediment is trapped and water infiltrates the soil. No underdrains are associated with infiltration practices, because by definition these systems provide complete infiltration. Design specifications require infiltration basins and trenches to be build in good soil, they are not constructed on poor soils, such as C and D soil types. Engineers are required to test the soil before approved to build is issued. To receive credit over the longer term, jurisdictions must conduct yearly inspections to determine if the basin or trench is still infiltrating runoff.

8.1.6 Filtering Practices

Practices that capture and temporarily store runoff and pass it through a filter bed of either sand or an organic media. There are various sand filter designs, such as above ground, below ground, perimeter, etc. An organic media filter uses another medium besides sand to enhance pollutant removal for many compounds due to the increased cation exchange capacity achieved by increasing the organic matter. These systems require inspection and maintenance to receive pollutant reduction credit (Collins, et al. 2009).

8.1.7 Environmental Site Design

Small-scale stormwater management practices, nonstructural techniques, and better site planning to mimic natural hydrologic runoff characteristics and minimize the impact of land development on water resources (MDE, 2000 Maryland Stormwater Design Manual 2000).

8.1.8 Street Sweeping and Inlet Cleaning

Street sweeping measured by the weight of street residue collected. Street sweeping and storm drain cleanout practices rank among the oldest practices used by communities for a variety of purposes to provide a clean and healthy environment, and more recently to comply with their National Pollutant Discharge Elimination System stormwater permits.

8.1.9 Tree Planting

Tree planting includes any tree planting, except those used to establish riparian forest buffers.

8.1.10 Urban Forest Buffers

An area of trees at least 35 feet wide on one side of a stream, usually accompanied by trees, shrubs and other vegetation that is adjacent to a body of water. The riparian area is managed to maintain the integrity of stream channels and shorelines, to reduce the impacts of upland sources of pollution by trapping, filtering, and converting sediments, nutrients, and other chemicals.

8.1.11 Impervious Surface Removal

Reducing impervious surfaces to promote infiltration and percolation of runoff storm water.

8.1.12 Stream Restoration

Stream restoration in urban areas is used to restore the urban stream ecosystem by restoring the natural hydrology and landscape of a stream, help improve habitat and water quality conditions in degraded streams.

8.1.13 Redevelopment

Redevelopment consists of applying new uses to previously occupied urban space. This can sometimes involve a change in zoning or land use all together, or simply finding new uses for existing structures. In many cases this can allow for a site that previously had no water quality treatment practices to incorporate them into the new development.

Table 8-1: Pollutant Reductions of BMPs

Practice	Nitrogen	Phosphorus	Sediment	Bacteria
Dry Detention Ponds and Hydrodynamic Structures	✓	✓	✓	✓
Dry Extended Detention Ponds	✓	✓	✓	✓
Wet Ponds & Wetlands	✓	✓	✓	✓
Infiltration Practices	✓	✓	✓	✓
Filtering Practices	✓	✓	✓	✓
Environmental Site Design	✓	✓	✓	
Street Sweeping and Inlet Cleaning	✓	✓	✓	✓
Tree Planting	✓	✓	✓	
Urban Forest Buffers	✓	✓	✓	✓
Impervious Surface Removal	✓	✓	✓	
Stream Restoration	✓	✓	✓	✓
Redevelopment	✓	✓	✓	✓

Table 8-2 shows how the BMP practices listed above are credited.

Table 8-2: Sediment Reduction Efficiencies of BMPs

Practice		
Dry Detention Ponds and Hydrodynamic Structures	Reduction Efficiency	10%
Dry Extended Detention Ponds	Reduction Efficiency	60%
Wet Ponds & Wetlands	Structural Treatment Curve	Varies
Infiltration Practices	Runoff Reduction Curve	Varies
Filtering Practices	Structural Treatment or Runoff Reduction Curve	Varies
Environmental Site Design	Runoff Reduction Curve	Varies
Street Sweeping and Inlet Cleaning	Load reduction (lbs) / ton of wet material	382.62
Tree Planting	Land use change	71.2%
Urban Forest Buffers	Efficiency + Land use change	50%
Impervious Surface Removal	Land use change	86.3%
Stream Restoration	Load reduction (lbs)/length (linear ft)	43.4
Redevelopment	Varies	Varies

8.2 BMP Calculations

Below is a description of the different types of reduction calculations used to estimate the amount of sediment removed by a BMP.

8.2.1 Reduction Efficiency Calculations

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

Equation 8-1

$$Sediment\ Load = [LR * DA] * RE$$

Where LR is the loading rate (lbs/acre/year), DA is the drainage area (acres), and RE is the pollutant reduction efficiency of the BMP in question in decimal format. The pollutant load received from the drainage area contributing to the SWM facility or other BMP is denoted by the first expression in brackets in the above Equation 8-1. The load must be calculated for each type of land use draining to the facility using the appropriate loading rate. The percent pollutant removal efficiency depends on the type of facility and is based on the values shown in Table 8-2. The pollutant removal efficiency of stormwater management facilities (other than dry detention, extended detention, and hydrodynamic facilities) vary based on the area of impervious surfaces contributing stormwater to the facility, the volume of water treated for water quality by the facility (calculated following the Maryland Stormwater Design Manual (MDE and Center for Watershed Protection, 2009)), and the appropriate BMP removal rate adjustor curve (stormwater treatment or runoff reduction) as per the Chesapeake Bay Program expert panel report (Comstock, et al., 2012).

8.2.2 Land Use Change Calculations

Pollutant reductions for practices like tree planting and impervious surface removal use a land use change calculation to estimate pollutant reductions. The equation used to estimate sediment load reductions for the land use conversion portion of stream buffer reforestation is expressed as:

Equation 8-2

$$Land\ Use\ Conversion = (LR1 - LR2) * Area$$

Where LR1 is the loading rate of the previous land use, and LR2 is the loading rate of the new or projected land use. Pervious area reforestation for example would involve converting open pervious area to forest. Therefore, the loading rate would be reduced by a factor equal to the difference between pervious urban (LR1) and forest (LR2) loading rates used in the watershed pollutant analysis as shown in the first expression in brackets in the equations above. The approximate reduction in pollutant load would then be the reduced loading rate multiplied by the open pervious area available for reforestation.

8.3 Uncertainty and Research Needs

The sediment TMDL for Lower Gunpowder Falls is based on impairment of the aquatic community identified through the Maryland Biological Stream Survey monitoring. The current listings for biological impairments represent degraded biological conditions for which the stressors, or causes, are unknown. The MDE Science Services Administration (SSA; now the Water and Science Administration) has developed a Biological Stressor Identification (BSID) analysis that uses a case-control, risk-based approach to systematically and objectively determine the predominant cause of reduced biological conditions, thus enabling the Department to most effectively direct corrective management action(s).

Data suggest that the degradation of biological communities in the Lower Gunpowder Falls is strongly associated with urban land use and its concomitant effects: altered hydrology and elevated levels of sulfate, chlorides, and conductivity (a measure of the presence of dissolved substances).

The results of the BSID analysis, and the probable causes and sources of the biological impairments in the Lower Gunpowder Falls, can be summarized as follows:

- The BSID process has determined that the biological communities in the Lower Gunpowder Falls are likely degraded due to inorganic pollutants (i.e., chlorides and sulfates). Chloride and sulfate levels are significantly associated with degraded biological conditions and found in approximately 45% and 46% of the stream miles with poor to very poor biological conditions in the watershed. Impervious surfaces and urban runoff cause an increase in contaminant loads from point and nonpoint sources by delivering an array of inorganic pollutants to surface waters. Discharges of inorganic compounds are very intermittent; concentrations vary widely depending on the time of year as well as a variety of other factors may influence their impact on aquatic life. Future monitoring of these parameters will help in determining the spatial and temporal extent of these impairments in the watershed. The BSID results thus support Category 5 listings of chloride and sulfates as an appropriate management action to begin addressing these stressor's impacts on the biological communities in the Lower Gunpowder Falls watershed.

- The BSID process has determined that biological communities in Lower Gunpowder Falls are also likely degraded due to sediment and in-stream habitat related stressors. Specifically, altered hydrology and increased runoff from urban and impervious surfaces have resulted in channel alteration, channel erosion, scouring, and transport of suspended sediments in the watershed, which are in turn probable causes of impacts to biological communities. The BSID results confirm the tidal 2010 Category 5 listing for total suspended solids (TSS) as an appropriate management action in the watershed, and links this pollutant to biological conditions in these waters and extend the impairment to the watershed's non-tidal waters. Therefore, the establishment of total suspended solids TMDL in 2010 through the Chesapeake Bay TMDL was an appropriate management action to begin addressing this stressor to the biological communities in the Lower Gunpowder Falls watershed. In addition, the BSID results support the identification of the non-tidal portion of this watershed in Category 5 of the Integrated Report as impaired by TSS to begin addressing the impacts of this stressor on the biological communities in the Lower Gunpowder Falls.

- The BSID process has also determined that biological communities in the Lower Gunpowder River watershed are likely degraded due to anthropogenic channelization of stream segments. MDE considers channelization as pollution not a pollutant; therefore, a Category 5 listing for this stressor is inappropriate. However, Category 4c is for waterbody segments where the State can demonstrate that the failure to meet applicable water quality standards is a result of pollution. Category 4c listings include segments impaired due to stream channelization or the lack of adequate flow. MDE recommends a Category 4c listing for the Lower Gunpowder Falls watershed based on channelization being present in approximately 39% of degraded stream miles.

- The BSID analysis did not identify any nutrient stressors present and/or nutrient stressors showing a significant association with degraded biological conditions, except acute ammonia. After analysis of MDE water quality data, it was determined that ammonia toxicity is not a significant stressor in the Lower Gunpowder Falls watershed.
  (from the non-tidal Lower Gunpowder Falls BSID analysis)

The sediment TMDL was developed to address the degradation of the aquatic community. With the above stressors in mind, meeting the sediment TMDL reduction requirements may not result in improvement of the aquatic community to fair or good conditions due to the existence of additional impairing factors for which TMDLs have yet to be developed. However, improvement of aquatic habitat and reduction of sediment are necessary components to any aquatic community improvement.

In this section you will find a list of actions that together become one scenario as to how the county could reach the pollutant load target. While EPS has developed this scenario, progress will be assessed on an annual basis through results of implementation actions and monitoring data. It is intended that the IP will be reviewed on a five-year cycle for potential revisions. The county takes an adaptive management approach to all watershed planning efforts.

Adaptive management is a decision process that promotes flexible decision making that be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood (U.S Department of the Interior 2009). The tools that Baltimore County will use in adaptive management are the tracking of implementation progress through the various actions proposed in the strategy in this section, identification of barriers that prevent targeted actions from occurring, and an enhanced monitoring program to measure progress in both reductions and meeting water quality standards. While this will be an on-going process, there will be a formal review of the strategy at five year intervals to determine if changes are needed or if the strategies are on track.

The list of actions provides all of the numeric load reductions necessary to prove that the actions will bring the county to its TMDL target. Finally, you can find a discussion of the reductions, which states the year by which the reduction load will be met and describes other factors that play into meeting the water quality criteria.

9.1 Implementation Actions

For this IP we will categorize the actions to be taken with respect to addressing source reduction. Implementation actions have been pulled directly from the SWAPs within the watershed area. These actions have been carefully analyzed for their projected participation rates and feasibility during the SWAP development process. Please refer to the associated SWAPs for further explanation of the scientific development process: Baltimore County SWAPS.

There are many actions that may be taken that would have an explicitly indirect impact on sediment, however with no ability to prove the cause/effect relationship of these actions, they will be omitted from this plan (e.g. storm drain marking).

The actions are broken out into three separate sections. Programmatic actions are actions that do not have a measureable load reduction, but create the condition necessary to reduce the pollutant. Some of these actions require a plan for program development because they are new programs that have not yet been developed by the county. Management actions are actions that require regular actions on county property. Restoration actions are new control measures aimed to reduce pollutant loads.

9.1.1 Programmatic Actions

Programmatic actions are those that do not directly result in load reductions, but create the necessary conditions for load reduction. Actions within this category might include public education and outreach activities, monitoring, or supporting specific legislation. These actions will move Baltimore County closer to achieving TMDL targets; however, there is currently no way to attribute a predictable pollutant load reduction to programmatic actions. Some programmatic actions, such as investigation and monitoring, are necessary to implement management and restoration actions or make those actions more efficient. Other programmatic actions, such as education and outreach actions, are predicted to increase the load reduction over time through BMP implementation by individual citizens. The exact load reduction is not predictable because the participation rate for individual home owners installing BMPs, as a result of public education, is not yet known. Educated citizens may support load reductions in other ways such as educating other citizens about watershed management actions, supporting legislation that improves watershed management, and other actions that do not have associated load reductions but support the necessary condition for pollutant reduction. Programmatic actions can be found in Table 9-1.

9.1.2 Management Actions

Management actions are those where there is regular management of county property, such as, street sweeping. It does not include the development of new control measures, such as, retrofitting highway yards. Management actions have predictable load reductions, which can be used to calculate the contribution of each action toward meeting the overall load reduction required by the TMDL. Management actions can be found in Table 9-2.

9.1.3 Restoration Actions

Restoration actions include the development of new control measures aimed to reduce pollutant loads as well as retrofits of existing stormwater management facilities. It may include reforestation actions as well as any stormwater control measures that do not require regular management on county property. Restoration actions will have predictable load reductions, which will be used to calculate the contribution of each action toward meeting the overall load reduction required by the TMDL. These actions are also found in Table 9-2.

9.1.4 Implementation Actions Tables

The following Table 9-1 and Table 9-2 collectively describe the actions that will be taken to reach the TMDL reduction goal as stated in the TMDL document issued by MDE.

Table 9-1: Programmatic TMDL Implementation Actions for Sediment in the Lower Gunpowder Falls

Programmatic Action	Time Frame	Performance Standard	Responsible Party
Programmatic Actions			
Coordinate restoration activities between and among Baltimore County and Gunpowder Valley Conservancy	On-going	Documented in NPDES Report	Baltimore County EPS, Gunpowder Valley Conservancy
Implement a unified restoration tracking system to track progress toward meeting TMDL reduction requirements	2 years	None	Lower Gunpowder Falls SWAP Implementation Committee
Monitoring Actions			
Continue Random Point Biological Monitoring Program	On-going	Benthic macro-invertebrate samples collected in odd calendar years	EPS
Institute Subwatershed Biological Condition Program	Start 2020 – continue until BIBI standards are met	Benthic macro-invertebrate samples collected every third year (see Section 10)	EPS
Continue Chemical Trend Monitoring Program	On-going	Samples collected monthly	EPS
Explore feasibility of installing turbidity meters	2 years	Feasibility report generated, if feasible, monitoring plan developed	EPS
Reporting Actions			
Lower Gunpowder Falls SWAP Implementation Committee to meet on a semi-annual basis to discuss implementation progress and assess any changes needed to meet the goals.	20 years	2 meeting per year	EPS and Implementation Committee partners
Continue to update status of restoration projects and BMPs in the Annual MS4 Report.	Annually	MS4 Report submitted to MDE and posted on county website	EPS
Implement the Continuing Public Outreach Plan	On-going	Number of actions per year	EPS
Adaptive Management assessment of the Implementation Plan	5 year interval	Assessment complete	EPS

The following pollutant load reductions were calculated using accepted loading rates for land uses in this watershed, coupled with expected percentages of reduction as discussed in Section 8 of this Implementation Plan.

Table 9-2: TMDL Implementation Actions with Measurable Load Reductions for Lower Gunpowder Falls Sediment

Action	Area Addressed[1]	Time Frame	Performance Standard	Responsible Party	Projected 2038 Load Reductions (lbs/year)
Management Actions					
Street Sweeping Existing[1]	N/A[2]	Ongoing	Pounds Removed	Baltimore County	N/A[2]
Storm Drain Cleaning	N/A	Ongoing	Pounds Removed	Baltimore County	23,800
Restoration Actions					
Stream Restoration	24,716 linear feet	20 years	Stream restoration projects completed	Baltimore County EPS	1,109,254
Stormwater BMP Conversions	118.7 acres	20 years	Acres Converted	Baltimore County EPS	55,751
Reduce Impervious Cover	38.8 acres	20 years	Acres Removed	Baltimore County EPS, DPW	65,223
Downspout Disconnection	80 acres	20 years	Acres of rooftop disconnected	Gunpowder Valley Conservancy, SWAP Implementation Committee	140,176
Stormwater Retrofits	302.5 acres	20 years	Acres Retrofit	Baltimore County EPS, DPW	167,910
Stream Buffer Reforestation	414.8 acres	20 years	Acres Reforested	Baltimore County EPS	220,852
Upland Reforestation	111 acres	20 years	Acres Reforested	Baltimore County EPS	29,510
Redevelopment	225 acres	20 years	Acres Redeveloped	Baltimore County	92,768
Total Projected Sediment Reductions by 2038					**1,905,243**

1. Extent of projected implementation sourced from estimated participation in Small Watershed Action Plan initiatives for urban and rural Lower Gunpowder Falls. Does not include 15,638 linear feet of stream restoration currently in progress in this area. 275 acres of retrofits were added to SWAP projections in order to meet the TMDL goal.
2. While Baltimore County plans to continue with street sweeping operations, the method of allocating pollutant reduction credits is currently under review. Until this review is completed, we will not be considering street sweeping credits as providing progress toward meeting the TMDL and may for now be considered as an additional margin of safety.

9.2 Sediment Baseline Load and TMDL Required Reductions

Total TSS Baseline Load (lbs/year)	3,353,162
Adjusted Baseline Load (2014 Baltimore County Data; lbs/year)	3,054,176
TMDL Target Load	1,093,131
Remaining TSS Load Reduction Goal to Meet TMDL Target Load (lbs/year)	1,901,713
Projected Load Reduction from this TMDL IP (lbs/year)	**1,905,243**

*Details on how the TMDL target and pollutant loads and reductions were calculated can be found in Section 5.2.

9.3 Interim Milestones

The reductions for sediment in the Lower Gunpowder Falls will have measurable milestones until the 2038 implementation goal is reached. Due to the need to meet other TMDL reduction requirements, such as, the Chesapeake Bay TMDL nitrogen, phosphorus, and sediment reductions, it is anticipated that all of the actions will be completed to meet those requirements. The following table describes the interim milestones to meeting the TMDL goal by 2038.

Table 9-3: Interim Milestones

Year						
			50%			100%
	2.64	2.75	2.82	2.89	2.94	3.0

1. See discussion in Section 9.4 on lag times

9.4 Reductions Discussed

The reductions in the given scenario meet the reductions necessary for satisfying the TMDL target. The timeline to implement all of the future actions with measurable reduction extends over the next 20 years. That means that all actions will be implemented by 2038. However, it is important to understand the role of lag times in watershed management and planning. Lag time is the delay from when a pollution control action is taken to when it actually results in water quality improvements. It is the sum of time required for practices to take desired effect, time required for effect to be delivered to the water source, and time required for the waterbody to respond to the effect (Meals, Dressing and Davenport 2010). Lag times will vary depending on the watershed, the management action and the pollutant type. According to the Chesapeake Bay STAC Program Report from 2012, the lag time for sediment from source to stream in the Chesapeake Bay region is less than 1-5 years, but he lag time for sediment transport from stream to Bay is 5-100 years (Chesapeake Bay Program 2012). The report also states approximate lag times for various sediment reduction actions. The lag time for an urban sediment pond was reported to be approximately 1-3 years, while the lag time for a riparian forest was approximated at 2-10 years (Chesapeake Bay Program 2012). Given this data, it is reasonable to assume that in-stream reduction will not necessarily be measurable by 2038 when all actions will be implemented. What this means is that Baltimore County may implement all of the necessary measures to meet the TMDL reductions by 2038, as a TMDL is actually a limit on the amount of pollutant that is allowed to enter the stream from upland sources, but measureable in-stream effects on water quality may take a decade or more to fully reflect the load reductions. Expectations for water quality improvement should be reasonably based on the effects of lag time.

Another factor that must be considered when forming expectations about water quality improvements is the vulnerability of the end goal to other disturbances. The water quality criterion for sediment is not a measureable load, but it is to reach a fair or good IBI score. The IBI score is a measure of the diversity of the macro-invertebrate community. Sediment is not the only threat to that community. They can also be affected by excessive nutrients, low dissolved oxygen, and other disturbances in the water. The aquatic community in Lower Gunpowder Falls is also listed by MDE as being impaired by chlorides and sulfates, as well as, channelization. It is highly possible that the sediment load target will be reached, but that IBI scores could remain below fair or good condition due to other environmental factors.

The assessment of implementation progress is based on two aspects; progress in meeting programmatic, management, and restoration actions; and progress in meeting water quality standards and any interim water quality benchmarks. The assessment of progress in meeting the restoration actions; includes setting up methods of data tracking, validation of projects, and pollutant load reductions associated with the actions (10.1) and will be consistent across all TMDL Implementation Plans. The assessment of progress in meeting water quality standards and interim milestones (10.2) is the data analysis associated with the monitoring plan specific to each TMDL Implementation Plan.

10.1 Implementation Progress: Data Tracking, Validation, Load Reduction Calculation, and Reporting

The Baltimore County Department of Environmental Protection and Sustainability – Watershed Management and Monitoring Section is currently preparing a document entitled *Baltimore County Method for Pollutant Load Calculations, Pollutant Load Reduction Calculations, and Impervious Area Treated*. This document will detail the data sources, data analysis (including pollutant load calculations, and pollutant load reductions calculations), validation of the practices, and reporting of progress made. It was determined that a document was needed to document how Baltimore County calculated pollutant loads and pollutant load reductions from the implementation of various best management practices, as guidance from the state and Chesapeake Bay Program continue to evolve. The document will be updated annually to account for any changes that may have occurred during the previous year. Due to the fact that implementation is being achieved through the actions of many county agencies, it was also determined that the means of data acquisition, any data manipulation, and the means of data analysis needs to be documented on an annual basis to provide consistency in the data acquisition and analysis and to document any changes in the process over time. The overall result is intended to provide transparency for the general public and users of reports on progress generated as a result of the analysis.

The Maryland Department of the Environment (MDE) has provided a guidance document for NPDES – MS4 permits entitled: *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated*. The draft document was released in June 2011, followed by a final release in August 2014. The document is intended to provide consistency among the MS4 jurisdictions in calculating baselines and reporting implementation progress. The August 2014 edition includes the Chesapeake Bay Program (CBP) recent recommendations for nutrient and sediment reductions for various practices. It is anticipated that the document will be updated on a periodic basis to reflect new information on restoration practice efficiencies in pollutant load reductions. MDE also provides guidance through its web site, with a webpage entitled *Maryland TMDL Data Center*. This site provides guidance on the development of the TMDL Implementation Plans and is updated on a regular basis.

The CBP has developed a process whereby through the formation of Expert Panels, the scientific literature is reviewed to determine pollutant load reductions for various types of restoration practices. The Expert Panels provide reports on the load reduction calculations for the various practices, along with supporting documentation; these reports are then reviewed by a series of CBP workgroups and when approved, become the basis for pollutant load reduction credits. The completed documents are posted on the web along with a description of the process, see:

http://stat.chesapeakebay.net/?q=node/130&quicktabs_10=3 Completed reviews of restoration practices applicable to the urban sector include:

- New State Stormwater Performance Standards,
- Urban Stormwater Retrofits,
- Urban Nutrient Management,
- Urban Stream Restoration,
- Enhanced Erosion and Sediment Controls, and
- Urban Filter Strip/Stream Buffer Upgrades.
- Expert Panel reports essentially complete and awaiting approval include:
- Urban Shoreline Management, and
- Illicit Discharge Elimination (Nutrient Discharges from Grey Infrastructure).
- Expert Panel reports developing recommendations include:
- Street Sweeping (including catch-basin clean outs and bulk sediment removal),
- Floating wetlands,
- Urban Tree Planting/Expanded Tree Canopy, and
- Riparian Forest Buffers.

In addition, to the changes in the pollutant removal efficiencies, the CBP is in the process of developing the next phase of the Watershed Model (Phase 6) to be used in the mid-point assessment to determine progress being made for the Chesapeake Bay TMDL. There will likely be changes in the land use categories designed to improve the model with respect to the pollutant loads associated with land use types. When the model is calibrated and run in 2017 there will likely be changes in the loads with respect to land use. This will necessitate a recalculation of the nutrient and sediment loads and the reductions associated with practices that treat the various land uses.

The document *Baltimore County Method for Pollutant Load Calculations, Pollutant Load Reduction Calculations, and Impervious Area Treated* will be posted for review and comment in the spring of 2015. It will be modified on an annual basis to take into account any future Expert Panel documents, modifications to any guidance documents and future calculations will reference the edition on which the calculations were based.

10.1.1 Reporting

Baltimore County will prepare two-year milestones for each local TMDL in conformance with the Chesapeake Bay TMDL two-year milestone process. Programmatic actions and monitoring data analysis will be based on the calendar year, while restoration actions will be based on the fiscal year (July 1 – June 30). The current two-year milestone period was developed in January 2014; for Programmatic actions covers January 2014 through December 2015, and for restoration actions cover July 1, 2013 through June 30, 2015. When the next two-year milestones are developed in 2016, they will be presented by watershed and will include each of the local TMDLs.

Reporting will be done through the annual NPDES – MS4 Permit Report. This is technically due on the anniversary date of the permit renewal, but will be completed for submittal to MDE in October each year. The report will detail progress made in meeting each of the local TMDLs and the Chesapeake Bay TMDL. The analysis will include progress in meeting the two-year milestone programmatic and restoration actions, along with the calculated load reduction. It will also present the results of the monitoring conducted the previous year. See below for TMDL specific monitoring.

In January of each year, a progress report (mostly extracted from the MS4 report) will be prepared and posted on the web.

10.2 Implementation Progress: Water Quality Monitoring

The rationale for the development of the Lower Gunpowder Falls Sediment TMDL was an impairment of the aquatic biological community with sediment identified as a stressor of that community. This was determined through the biostressor analysis conducted on the biological data, and associated data, collected as part of the Maryland Biological Stream Survey (MBSS). The biostressor analysis indicated that ammonia, low dissolved oxygen, high conductivity, chlorides, sulfates, and channelization are also impacting the aquatic biological community. These additional stressors will have to be taken into account when determining whether actions taken to address the sediment TMDL alone have met the aquatic biological community water quality end point. The full Biological Stressor Identification may be reviewed here: http://mde.maryland.gov/programs/Water/TMDL/Documents/BSID_Reports/Lower_Gunpowder_BSID_Report_012512_revisedfinal.pdf

10.2.1 Biological Monitoring

The Random Point Biological Monitoring Program will continue with monitoring in the Lower Gunpowder Falls conducted in even calendar years. While this will provide a continuity of data that has been collected since 2003, it will not provide sufficient data to determine progress in meeting the biological community standards on a subwatershed basis. To make this determination, Baltimore County will develop a new biological monitoring program entitled, Subwatershed Biological Condition Monitoring Program. This program will target one watershed per year that has a TMDL associated with aquatic biological community impairment. The monitoring schedule is meant to focus on a single watershed in each year.

This Subwatershed Biological Condition Monitoring Program will monitor every subwatershed within the impaired watershed or a subset depending on the results of the TMDL analysis. The analysis of the biological data for the Lower Gunpowder Falls watershed (Section 6) found that only 3 of the 13 subwatersheds met the aquatic biological community water quality standard with a BIBI score of 3.0 or greater. Baltimore County will continue to monitor all 13 subwatersheds to determine the biological condition status.

A stratified random design will be used, where one random site will be sampled for each 1,000 acres within the subwatershed, rounded to the nearest 500 acres; with at least one sample per subwatershed. Table 10-1 presents the subwatersheds, their associated acreages, the number of samples and the current condition of the subwatershed determined by past monitoring. Using MBSS methods benthic macroinvertebrate community will be sampled during the spring index period fitting into the multiannual schedule discussed above. The results will be compared to the current condition to assess changes in the subwatershed condition.

Table 10-1: **Lower Gunpowder Falls Subwatershed Biological Monitoring – Acres, # of Random Samples and Current Condition**

Subwatershed	Acres	# of Random Samples	Current Condition		
			N	BIBI	Status
Bean Run	920	1	3	2.30	Poor
DD4	2,851	3	0	na	na
Long Green Creek	7,231	7	31	2.88	Poor
Cowen Run	1,857	2	10	3.26	Fair
Minebank Run	2,154	2	61	1.30	Very Poor
Jennifer Branch	1,418	1	24	1.43	Very Poor
Haystack Branch	1,895	2	1	3.33	Fair
Sweathouse Branch	1,089	1	3	4.33	Good
DD5	4,469	4	10	2.88	Poor
DD1	1,993	2	6	2.28	Poor
DD2	1,684	2	1	2.67	Poor
DD3	1,904	2	1	1.00	Very Poor
DD6	1,309	1	0	na	na

10.2.2 Chemical Monitoring

Full chemical monitoring will continue through the Chemical Trend Monitoring Program at the three sites located within the Lower Gunpowder Falls watershed (see Section 6, 6.2 for description). This program monitors TSS, chlorides, and sulfates, but does not give full coverage of all of the subwatersheds in the Lower Gunpowder Falls watershed.

10.2.3 Continuously Recording Turbidity Meters

Baltimore County EPS will explore the utility of deploying continuously recording turbidity meters as a surrogate means of determining TSS concentrations without having to acquire samples for analysis. Sampling all subwatersheds for TSS, other than by grab samples; is not possible. Continuously recording turbidity meters offers an alternative that may provide the needed information in a more consistent fashion. This option and any technical difficulties will be explored within two years of the acceptance of this TMDL Implementation Plan.

10.2.4 Other MS4 Related Monitoring

Baltimore County will continue to provide its street sweeping, storm drain cleaning, and stormwater management pond cleanout operations in relation to sediment reduction.

In order to engage the public in the TMDL implementation process this continuing public outreach plan will be implemented upon approval of this TMDL Implementation Plan. The continuing public outreach plan is applicable to all TMDL Implementation Plans that are currently being developed and those developed in the future, as well as the Trash and Litter Reduction Strategy. This continuing public outreach plan is meant to engage county agencies, environmental groups, the business community, and the general public.

11.1 County Agencies

County agencies will be engaged through two regularly scheduled NPDES Management Committee meetings per year and other agencies meetings as necessary to move implementation forward.

11.1.1 NPDES Management Committee

The NPDES Management Committee is composed of representative agencies that are involved in meeting the NPDES – MS4 Permit requirements. This committee has met irregularly in the past, generally to review information on permit requirements and other upcoming regulatory requirements, such as, the General Industrial Stormwater Discharge Permit. In the future this committee will meet twice per year and will discuss not only the NPDES – MS4 Permit requirements, but also the TMDL Implementation Plans and progress being made in meeting the implementation strategy. In order to address all components of the TMDL Implementation Plans the committee membership will be expanded to include any county agency that has some responsibility for TMDL implementation. Examples being, the County Police Department and the Department of Environmental Protection and Sustainability – Groundwater Management Section. Prior to the development of the TMDL Implementation Plans and the Trash and Litter Reduction Strategy, these agencies were not specifically engaged in NPDES – MS4 Permit activities.

The first yearly meeting will be held in January of each year. The focus of this meeting will be to review the implementation plan 2-year milestones for each plan; provide a forum for discussion of the ability to meet the implementation actions; and determine any revisions necessary to meet the interim implementation milestones set in the plan. This meeting is also the forum for discussion of data tracking and reporting to ensure that the implementation actions are properly credited.

The second yearly meeting will be held in July of each year and will provide the forum for determining data submittal for the yearly progress report on the implementation actions and the resulting load reductions. The monitoring data from the previous calendar year will be presented and contrasted with the interim water quality milestones that are detailed in each implementation plan.

11.1.2 Other Agency Meetings

In order to move forward with implementation, agency meetings regarding specific implementation actions are anticipated. These will be scheduled as needed, and tracked by meeting date, attendance, TMDL Implementation Plans discussed, and topic. Meeting minutes will be reported in the Annual NPDES – MS4 Report submitted to Maryland Department of the Environment. This report is also posted on the County website for public access.

11.2 Environmental Groups

Baltimore County is currently engaged with local watershed associations through its funding of *Watershed Association Restoration Planning and Implementation Grants*, and through inclusion of watershed association members on the Steering Committees of the Small Watershed Action Plans. Formerly, this engagement and support was coordinated through the *Baltimore Watershed Agreement*. As part of that engagement, periodic Watershed Advisory Group (WAG) meetings were held. As part of this continuing public outreach plan, WAG participation will be formalized with two meetings per year.

The first meeting will be held in March of each year and focus on the local and Chesapeake Bay TMDL implementation actions and implementation progress, including an analysis of the pollutant load reduction calculations from the previous fiscal year. The watershed associations are currently engaged in citizen-based restoration activities and report their implementation progress to the county for inclusion in the Annual NPDES – MS4 Report. This meeting will provide a forum for discussion of the progress being made, coordination between the watershed associations, and any changes to the *Watershed Association Restoration Planning and Implementation Grant* being considered for the next grant period.

The second meeting will be held in November of each year and will focus on the water quality monitoring results from the previous calendar year. The results presented will compare trends and measures against the TMDL Implementation Plans water quality benchmarks and water quality standards.

11.3 Business Community

The business community will be engaged through various business forums, targeted outreach and education efforts on specific topics, and hosting workshops on specific topics as necessary.

11.3.1 Business Forums

Business forums, such as the Hunt Valley Business Forum with greater than 200 business members, provide opportunities to present the TMDL Implementation Plans and the Trash and Litter Reduction Strategy, and discuss the role of business in helping improve water quality. These forums will be convened as the opportunities arise. Summaries of these meetings will be reported in the annual NPDES – MS4 Report and will include the name of the forum (or other business organization), approximate number in attendance, the topic presented, and audience responses.

11.3.2 Targeted Business Outreach and Education

The Small Watershed Action Plan (SWAP) process includes an upland assessment of potential pollution hotspots. Often, these potential hotspots are commercial or industrial sites. The information derived from this assessment will be used to target outreach and education to businesses specific to the issue(s) at the location identified in each SWAP. These actions will be tracked and reported in the annual NPDES – MS4 Report.

11.3.3 Business Workshops

There are certain issues that may be pervasive through a segment of the business community that can most effectively be addressed through hosting workshop education on the specific topic. These issues will be identified as SWAP implementation moves forward, but one potential topic for a business workshop is related to the recently renewed *General Discharge Permit for Stormwater Associated with Industrial Activities.* A workshop designed in conjunction with

Maryland Department of the Environment would not only result in improved water quality, but it would also benefit the business community through increased understanding of the requirements of the permit.

11.4 General Public

The general public will be engaged through a number of mechanisms, including:

- WIP Team meetings
- Targeted outreach and education efforts on specific topics
- Steering Committee meetings and stakeholder meetings in the development of Small Watershed Action Plans
- Meetings of the Implementation Committee for completed Small Watershed Action Plans
- Displays at various events
- Annual progress reports posted on the county website and placed in our libraries
- A biennial State of Our Watersheds conference

11.4.1 Watershed Implementation Plan (WIP) Team Meetings

Baltimore County has assembled a Watershed Implementation Plan (WIP) team to serve as a sounding board for the development of the WIP to address the Chesapeake Bay TMDL. Members of the team include representatives from various county agencies, business community representatives (particularly the environmental engineering community), watershed associations, representatives from the agricultural community, and Baltimore County citizens.

The county will schedule at least one meeting annually to present implementation progress and to address specific topics related to the TMDL Implementation Plans and the Trash and Litter Reduction Strategy. Meetings will be scheduled as issues arise. It is anticipated that the WIP team will provide initial review of newly developed outreach and education materials, in order to provide feedback from a variety of perspectives.

11.4.2 Targeted Outreach and Education

The Small Watershed Action Plan development process includes upland assessments of neighborhoods to identify pollution sources and restoration opportunities. This information will be used to prioritize and target outreach and education efforts specific to the issue(s) in neighborhoods with the intent to affect behavioral change and/or increase citizen based restoration actions. These actions will be tracked and reported in the annual NPDES – MS4 Report.

11.4.3 Small Watershed Action Plans (SWAPs)

Baltimore County has been developing Small Watershed Action Plans since 2008. There are 22 planning areas in the county, with 13 completed plans, 5 plans in development, and 4 areas pending. These planning areas cover the entire county. The planning process includes the development of a steering committee, the composition of which is determined by the issues, and land ownership within the planning area. At a minimum membership consists of agency representatives, watershed associations, and citizen representatives. The process also includes a number of stakeholder meetings, open to all planning area residents and businesses, which provide information on the plan and solicit input. Once the SWAP is complete, the steering committee becomes the implementation committee. As designed the implementation committee is to meet twice per year, however, most implementation committees have not met this goal.

The plans have addressed to varying degrees the TMDLs that are applicable within the planning area. Some of the TMDLs have been developed subsequent to the specific SWAP development or did not address the full range of TMDLs that were applicable to the planning area. The TMDL Implementation Plans are built on incorporation of the actions from each SWAP within the applicable TMDL area. In some cases, additional actions have been identified in order to meet water quality standards.

11.4.3.1 Small Watershed Action Plans in Development and Future Plans

For SWAPs currently under development, and for plans developed in the future, the steering committee and stakeholder meetings will be used for outreach regarding the TMDL Implementation Plans and the progress being made in achieving water quality standards. The meeting participants will be informed on where they can access the TMDL Implementation Plans, the Trash and Litter Reduction Strategy and any Progress Reports that have been developed.

Applicable TMDL Implementation Plan actions will be incorporated into the SWAP based on the assessment of applicable restoration actions within the SWAP planning area. Since the SWAPs incorporate field assessments of streams and uplands, they provide more detailed information on applicable restoration actions, both on quantity and location. The accelerated schedule for developing TMDL Implementation Plans precluded conducting field work to build the plans.

11.4.3.2 Small Watershed Action Plans Already Developed

For those SWAPs already developed, the implementation committee meetings will be scheduled twice per year. The first meeting will be held in winter and will present the implementation progress not only of the SWAP, but also any applicable TMDL Implementation Plan progress. The progress analysis will be based on fiscal year. This meeting will also provide the opportunity to discuss any changes in the SWAP or the TMDL Implementation Plan based on an analysis of what actions have been successful and what actions have been more difficult to implement.

The second implementation committee meeting will be held in fall of each year and will present the monitoring data in relation to progress being made in relation to interim milestones and water quality standards.

11.4.4 Educational Displays at Events

Educational displays and handouts will continue to be used at applicable events as they occur. The particular display and handout materials will be determined by the location and focus of the event. The location and focus of the event, number of citizens engaging staff at the display, and the number of handouts taken by citizens will be tracked for annual reporting in the NPDES – MS4 Report.

11.4.5 TMDL Implementation Plan, Trash and Litter Reduction Strategy, and Progress Report Availability

The TMDL Implementation Plans and the Trash and Litter Reduction Strategy will be posted on the Baltimore County website with hard copies placed in county libraries. The hard copies in the libraries will be specific to the watershed in which the library is located. Progress reports will be posted on the County website and placed in libraries. A set of hard copy plans will be kept at the Baltimore County Department of Environmental Protection and Sustainability

11.4.6 Biennial State of Our Watersheds Conference

Baltimore County, in conjunction with Baltimore City, has held *State of Our Watershed* conferences in the past to present information to county and city citizens on water quality issues applicable to the watersheds in these jurisdictions. Future conferences will be held in early March of even numbered years. Information on implementation progress for local TMDLs and the Bay TMDL will be presented, along with other topics of interest. These conferences will be organized with the assistance of the Watershed Advisory Group (WAG), and the surrounding local jurisdictions (Baltimore City, Howard County, Carroll County, Harford County, and York County, PA) will be invited to participate in the organization and presentation of the conference.

The timing of even years is related to the 2-year milestone process set up by the Maryland Chesapeake Bay TMDL Watershed Implementation Plan (WIP) whereby in January of even calendar years, progress in meeting the previous 2-year milestone programmatic and restoration implementation is reported and the next 2-year programmatic and restoration implementation milestones are proposed by the local jurisdictions. The timing of the conference not only permits reporting on the progress made in meeting the previous 2-year milestones but also what is planned for the next two years.

11.5 Adaptive Management

As Baltimore County moves forward to meet its pollutant reduction goals, there will be consideration of the elements of public outreach as they pertain to this Implementation Plan. During implementation, a more specific, and tailor-made outreach plan will be developed to address the various pollutants and watersheds impacted by them. A sampling of the types of outreach elements Baltimore County currently intends to employ is presented in Table 11-1.

Table 11-1: Continuing Public Outreach Plan Summary

Plan Component	
Agencies	NPDES Management Committee
	Other Agency meetings
Environmental Groups	Watershed Advisory Group (WAG) meetings
Business Community	Business Forums
	Targeted Business Outreach and Education
	Topical Workshop
General Public	WIP Team meetings
	Targeted Outreach and Education
	SWAP – Steering Committee meetings
	SWAP – Stakeholder meetings
	SWAP – Implementation Committee meetings
	Educational Displays at Events
	Document availability (various)
	Biennial Conference

Berry, W., Rubinstien, N., & Melzian, B. (2003). *The Biological Effects of Suspended and Bedded Sediment (SABS) in Aquatic Systems:A Re.* Narragansett: US Environmental Protection Agency Office of Research and Development .

Booth, D. B., & Henshaw, P. C. (2000). Rates of Channel Erosion in Small Urban Streams. *Stream Channels in Disturbed Environments: AGU Monograph Series*.

Chesapeake Bay Program. (2012). *Incorporating Lag Times in the Chesaeake Bay Program.* Annapolis : Chesapeake Bay Program .

Collins, K., Davis, A., Kloss, C., Simpson, T., & Weammert, S. (2009). *Infiltration and Filtration Practices.*

Colorado Department of Public Health and the Environment Water Quality Control Commission Water Quality Control Division. (2005). *Implementation Guidance for Determining Sediment Deposition Impacts to Aquatic Life in Streams and Rivers.* Denver, CO: Colorado Department of Public Health and the Environment.

Comstock, S., Crafton, S., Greer, R., Hill, P., Hirschman, D., Karimpour, S., . . . Wilkins, S. (2012). *Recommendations of the Expert Panel to Define Removal Rates for New State Stormwater Performance Standards.* Annapolis, MD: Chesapeake Bay Program.

Davis, L. (2009). Sediment Entrainment Potential in Modified Alluvialstreams: Implications for Re-Mobilization of Storedin-Channel Sediment. *Physical Geography*, 30, 3, pp. 249–268.

Jin, S. Y. (2013). . *A comprehensive change detection method for updating the National Land Cover Database to circa 2011. Remote Sensing of Environment.*

Lester, L. (2013, January 11). *A Yellow Perch in Murky Water.* Retrieved March 1, 2014, from Ecological Society of America: http://www.esa.org/esablog/research/a-yellow-perch-in-murky-water/

Lisle, T. E. (1989). *Sediment Transportation and Resulting Deposition in Spawning Gravels, North Costal California* . Arcata, CA: Pacific Southwest Experiment Station, Forest Service, U.S. Department of Agriculture.

Maryland Department of the Environment. (2011). *Total Maximum Daily Load of Sediment in the Patapsco River Lower North Branch Watershed, Baltimore City and Baltimore, Howard, Carroll and Anne Arundel Counties, Maryland.* Baltimore, MD: Maryland Department of the Environment.

Maryland Geological Survey. (2008, September). Physiographic Map of Maryland. Retrieved from http://www.mgs.md.gov/geology/physiographic_map.html

MDE. (2000). *2000 Maryland Stormwater Design Manual.*

MDE. (2009). *Watershed Report for Biological Impairment of the Patapsco Lower North Branch Watershed in Anne Arundel, Baltimore, Carroll, and Howard Counties and Baltimore City, Maryland Biological Stressor Identification Analysis Results and Interpretation.*

MDE. (2014). *MDE TMDL Data Center WLA Search*. Retrieved from MDE: http://wlat.mde.state.md.us/WLASearch.aspx

MDE. (2016). *Total Maximum Daily Load of Sediment in the Lower Gunpowder Falls Watershed, Baltimore County, Maryland.* MDE. Retrieved from http://mde.maryland.gov/programs/Water/TMDL/ApprovedFinalTMDLs/Documents/Lower_Gunpowder_Sediment/LowerGun_SedTMDL_022317_final.pdf

MDE. (2017a). *Total Maximum Daily Loads of Sediment in the Lower Gunpowder Falls Watershed, Baltimore County, Maryland.* Baltimore, MD: MDE.

MDE. (2017b). *Technical Memorandum: Significant Sediment Point Sources in the Non-Tidal Lower Gunpowder Falls Watershed.* Baltimore, MD: MDE.

MDE and Center for Watershed Protection. (2009). *2000 Maryland Stormwater Design Manual, 2009 Revision.* Baltimore, MD: MDE.

MDE; Devereux Environmental Consulting. (2014). *MAST Documentation*. Retrieved from MAST: http://www.mastonline.org/Documentation.aspx

Meals, D. W., Dressing, S. A., & Davenport, T. E. (2010). Lag Time in Water Quality Response to Best Management Practices: A Review. *J. Environ. Qual.*, 39:85–96.

Nelson, E. J., & Booth, D. B. (2002). Sediment sources in an urbanizing, mixed land-use watershed. *Journal of Hydrology,* 51-68.

U.S. Geological Survey and U.S Department of the Interior. (2003). *A Summary Report of Sediment Processes in the Chesapeake Bay Watershed.* New Cumberland, PA: U.S. Geological Survey

This plan was posted on the County website (https://www.baltimorecountymd.gov/departments/environment/index.html and https://www.baltimorecountymd.gov/departments/environment/watersheds/tmdl) from 3 April 2018 through 4 May 2018.

A legal notice was published in the Baltimore Sun on 4 April 2018.

Baltimore County Department Of

Baltimore County Department of Environmental Protection and Sustainability (EPS) Implementation Plan to address the Total Maximum Daily Load (TMDL) for sediment in Lower Gunpowder Falls available for public comment. A TMDL Implementation Plan is the County's statement of how it will reach the pollution reduction requirements issued by Maryland Department of the Environment (MDE) for various pollutants and watersheds in Baltimore County. Written comments will be accepted until 4:30 p.m. on May 4, 2018 by email (preferred) to watersheds@baltimorecountymd.gov, or received by US mail (received by May 4, 2018) or in person at: Baltimore County EPS 111 W. Chesapeake Ave., Room 319 Towson, MD 21204 Attn: Watershed Management To view the Implementation Plan, or for more information on watershed planning, in Baltimore County go to: www.baltimorecountymd.gov/eps or call 410-887-5683.

On 5 April 2018 Baltimore County EPS posted a link on its Clean Green Baltimore County Facebook page describing the plan and requesting the public to submit comments.

Clean Green Baltimore County
April 5 at 1:15pm ·

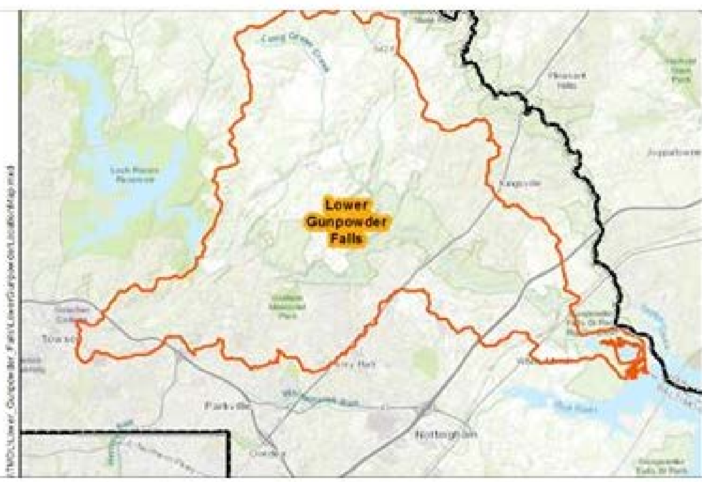
Want to help improve the quality of your local waterways? After a thorough study, the Maryland Department of the Environment (MDE) issued a Total Maximum Daily Load (TMDL) for excess sediment in the local streams within the Lower Gunpowder Falls watershed.

Okay…so what does that mean?

A TMDL (or Total Maximum Daily Load) describes the amount of a pollutant a body of water can receive while still meeting water quality standards. TMDLs can be issued for different pollutants, such as litter, bacteria from pet waste and excessive sediment (the result of erosion). It's up to Baltimore County EPS to make sure those TMDLs are met by developing 'implementation plans' to outline practices that may be used to reduce those pollutants.

So, how can you help?

EPS has assembled an implementation plan to address sediment in the Lower Gunpowder Falls and wants to hear from you! Follow the link to where you can read more about the plans to restore impaired waters and submit your thoughts, observations, questions and concerns.



Document Available for Public Comment - Baltimore County

Review the Total Maximum Daily Load and send your public comments.

BALTIMORECOUNTYMD.GOV

Like Comment Share

The plan did not receive public comments.

Comments received after final publication of this document may be considered during future revisions. MDE provided approval of this plan on 8 October 2019.