

ANTIETAM CREEK WATERSHED RESTORATION PLAN



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Canaan Valley Institute

September 17, 2012

Creation of this watershed plan was a cooperative effort by:

The Washington County Soil Conservation District
The Board of County Commissioners of Washington County
The Antietam Creek Watershed Alliance
The Canaan Valley Institute
and

Maryland Department of the Environment
Science Services Administration
TMDL Implementation Division

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LIST OF ABBREVIATIONS:

ACWA	Antietam Creek Watershed Alliance
Ag	Agriculture
BEHI	Bank Erodibility Hazard Index
BIBI	Benthic Index of Biotic Integrity
BMP	Best Management Practice
BRF	Bay Restoration Fund, State of Maryland Chesapeake Bay
BST	Bacteria Source Tracking
CBOD	Carbonaceous Biological Oxygen Demand
COMAR	Code of Maryland Regulations
CVI	Canaan Valley Institute
CWA	Clean Water Act
DNRF	MD Department of Natural Resources Inland Fisheries
DOC	Dissolved Organic Carbon
DPW	Washington County Division of Public Works
EOF	Edge of Field
EOS	Edge of Stream
FIBI	Fish Index of Biotic Integrity
GIS	Geographic Information System
gpm	gallons per minute
LA	Load Allocations
MACS	Maryland Agricultural Water Quality Cost-Share Program
MAST	Maryland Assessment Scenario Tool
MBSS	Maryland Biological Stream Survey
MDA	Maryland Department of Agriculture
MDE	Maryland Department of the Environment
mg/L	milligrams per liter
MPN	Most Probably Number
MS4	Municipal Separate Storm Sewer System
NBOD	Nitrogenous Biological Oxygen Demand
NPDES	National Pollutant Discharge Elimination System
NPS	Non-Point Source
NRCS	Natural Resources Conservation Service
TMDLs	Total Maximum Daily Loads
TN	Total Nitrogen
TP	Total Phosphorus
tpy	tons per year
TSS	Total Suspended Solids
USEPA	United States Environmental Protection Agency
VADCR	Virginia Department of Conservation and Recreation
VADEQ	Virginia Department of Environmental Quality
WCSCD	Washington County Soil Conservation District
WLA	Waste Load Allocations
WIP	Chesapeake Bay Watershed Implementation Plan
WRP	Watershed Restoration Plan

ACKNOWLEDGEMENTS

The Antietam Creek Watershed Restoration Plan was developed with cooperation and input from state, local and private agencies that represent the interests of the Antietam Creek Watershed.

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This project was funded in part by the US Environmental Protection Agency (EPA), Region III – Water Quality Assistance Grant CP-973423. Although this project is funded in part by the EPA, it does not necessarily reflect the opinion or position of the EPA.

1. Introduction

In 1996, the Antietam Creek (MD Segment 02140502) was placed on Maryland's 303(d) list for sediment, then fecal coliform (2002), and impacts to biological communities (2002). A Total Maximum Daily Load (TMDL) for sediment was developed and approved for the Antietam watershed in 2008 with a subsequent TMDL for Bacteria developed in 2009.

The headwaters of the Antietam Creek originate in Pennsylvania's Michaux State Forest. The East Branch descends from South Mountain near Waynesboro flowing over a five-foot weir at the Waynesboro Country Club. The West Branch originates near Mont Alto. The branches join just north of the Mason-Dixon Line to form the main stem of the Antietam. Approximately 5% of the total watershed is covered by water (i.e. streams, ponds, lakes, etc.) and drains into the Potomac River in Maryland. **(Figure1)**

Purpose

This plan will incorporate phased mitigation strategies to eliminate sediment and bacterial impairments associated with non-point sources and to monitor the effects of mitigation efforts on biological communities. This document provides a comprehensive Watershed Restoration Plan (WRP) for Antietam Creek with respect to Non-Point Sources (NPS) of sediment and fecal coliform. The watershed receives loads from both urban and agricultural land, but the focus of this plan will be on agricultural and rural areas. The intent of this effort is to establish a comprehensive, holistic approach toward assessment and eventual pollution abatement and mitigation of the existing water quality problems. The WRP will provide a framework for future efforts by the stakeholders of the Antietam Creek watershed for prioritizing and coordinating restoration/planning activities with citizens as well as federal and local agencies.

With the recent approval of the Chesapeake Bay TMDL and the accompanying Watershed Implementation Plan (WIP) being developed by the state of Maryland, this plan intends to follow the timeline laid out by EPA and MDE for meeting 2017 and 2025 allocations for Total Suspended Solids (TSS) within the Antietam. By pairing up the goals of meeting both TMDLs, additional funding may be available to mitigate or address local TMDL requirements as well as Bay TMDL requirements. Approaching restoration and mitigation in this phased manner would eliminate some impediments to funding as well as allow more time to develop access or relationships with the associated stakeholders in order to place effective mitigation projects in impaired segments.

This WRP will serve as a working template/framework to guide future mitigation/planning and monitoring efforts and will assist in setting mitigation priorities. Phased priority identification of sources and solutions will assist stakeholders with planning and performing more efficiently when restoring and identifying NPS outfalls and related impacts providing the means for more efficient use of already limited funding.

This plan is will demonstrate that the strategy employed will restore the Antietam and its tributaries within the state of Maryland to support their designated uses and to remove the watershed from the Maryland 303(d) list of impaired waters for bacteria and sediment.

Plan Objectives

The first objective of this plan is to identify major NPS discharges associated with established TMDLs in the Antietam watershed, obtaining existing analytical/physical data associated with the discharges, and to develop a working Geographic Information System (GIS) database of the data collected. A comprehensive GIS database of known, and newly discovered, sediment and bacterial impairments will be created in this and all sub-watersheds of Antietam

Creek within Maryland.

The second objective is to implement a prioritization schema that would allow private, local and state partners to select a priority list of impaired stream segments for which general mitigation strategies would be developed. Due to the fluctuating availability of resources, this WRP will be implemented in two Phases based on goals which coincide with the recent Chesapeake Bay TMDL:

- Phase I (2012-2017) will include several goals, one being the implementation of sediment management measures in five priority stream segments identified during an initial investigation. Pre and post implementation water quality and biological community sampling will be conducted to evaluate the effectiveness of management measures used. Additional projects not included in this assessment will also be evaluated for implementation and subject to available resources.

Bacterial reduction strategies will be given priority in subwatersheds ANT0277 (Figure 2) and MRS0000 due to their ranking as the highest contributors of all four bacteria source sectors (Human, Domestic, Agriculture and Wildlife) within the Maryland portion of the Antietam Creek watershed. Additional opportunities in other subwatersheds will be addressed as opportunities arise in this phase.

Subwatershed BEC0001 (Figure 2) will be the focus of anti-degradation and enhancement of an important trout fishery.

Sediment reduction strategies will be given priority in, ANT0277, MRS0000 and BEC0001 to match resource allocation and focus for bacteria reduction efforts due to the overlapping nature of many conservation planning and implementation efforts that reduce both bacteria and sediments.

An outreach campaign will be conducted to contact private stakeholders in order to secure access to properties and participation for implementation of phase I and phase II practices. It is anticipated that phase I will require approximately five years to complete.

- Phase II (2017-2025) will be a continuation of Phase I where known impairments will continue to be mitigated for sediment, and any additional impairments identified during Phase I will be prioritized according to severity, access and resources available.

Bacterial reduction strategies will continue in the priority watersheds, with additional focus on the remaining sub-watersheds to meet both local and Bay focused TMDLs.

Limitations of the WRP

This plan is based on data generated as a result of a number of previous studies within the watershed. In addition, this assessment will focus on the non-point sources of fecal coliform and sediment within the streams of the watershed including both urban and agricultural areas. Additional impairments and TMDLs may be introduced during the operating phases of this plan, when a new TMDL affecting the Antietam Creek watershed is approved, the plan will be updated/ revised.

Although portions of the Antietam flow through Pennsylvania, this document addresses only the portion that flows through Maryland. **(Figure 1)** WRP partners are aware that a dialogue with Pennsylvania Department of Environmental Protection, the Franklin County Conservation District and Adams County Conservation District is needed to address sediment and bacteria loads coming from Pennsylvania’s portion of the watershed. This will be part of the contingency plan since WRP partners have no authority to address these loads across state borders.

After developing and implementing, to the maximum extent possible, a reduction goal based on the anthropogenic sources identified in the TMDL, Maryland anticipates that implementation to reduce the controllable non-point sources may also reduce some wildlife inputs to the waters. **(Table 1)**

The bacteria source analysis indicates that after controls are in place for all anthropogenic sources, the waterbody will not meet water quality standards. However, while neither Maryland nor EPA is proposing the elimination of wildlife to allow for the attainment of water quality standards, managing the overpopulation of wildlife remains an option for state and local stakeholders and a wildlife management plan will be part of the goals of Phase I.

Table 1 – Maximum Practicable Reduction Scenario (2009 Bacteria TMDL)

Subwatershed	Applied Reductions				% Total Reduction	% Target Reduction
	Domestic %	Human %	Livestock %	Wildlife %		
ANT0366 ¹	75	95	75	0	61.1	94.9
ANT0277sub ¹	75	95	75	0	64.3	94
MRS0000 ¹	75	95	75	0	56.8	94.2
ANT0223sub	75	95	75	0	57.7	93.6
ANT0132sub	75	95	75	0	54.9	91.1
BEC0001	75	95	75	0	53	90.6
LAS0004	75	95	75	0	58.2	92.3
ANT0044sub	75	95	75	0	60	90
ANT0002sub	75	95	75	0	58.4	90.1

¹Subwatersheds partially located in Pennsylvania

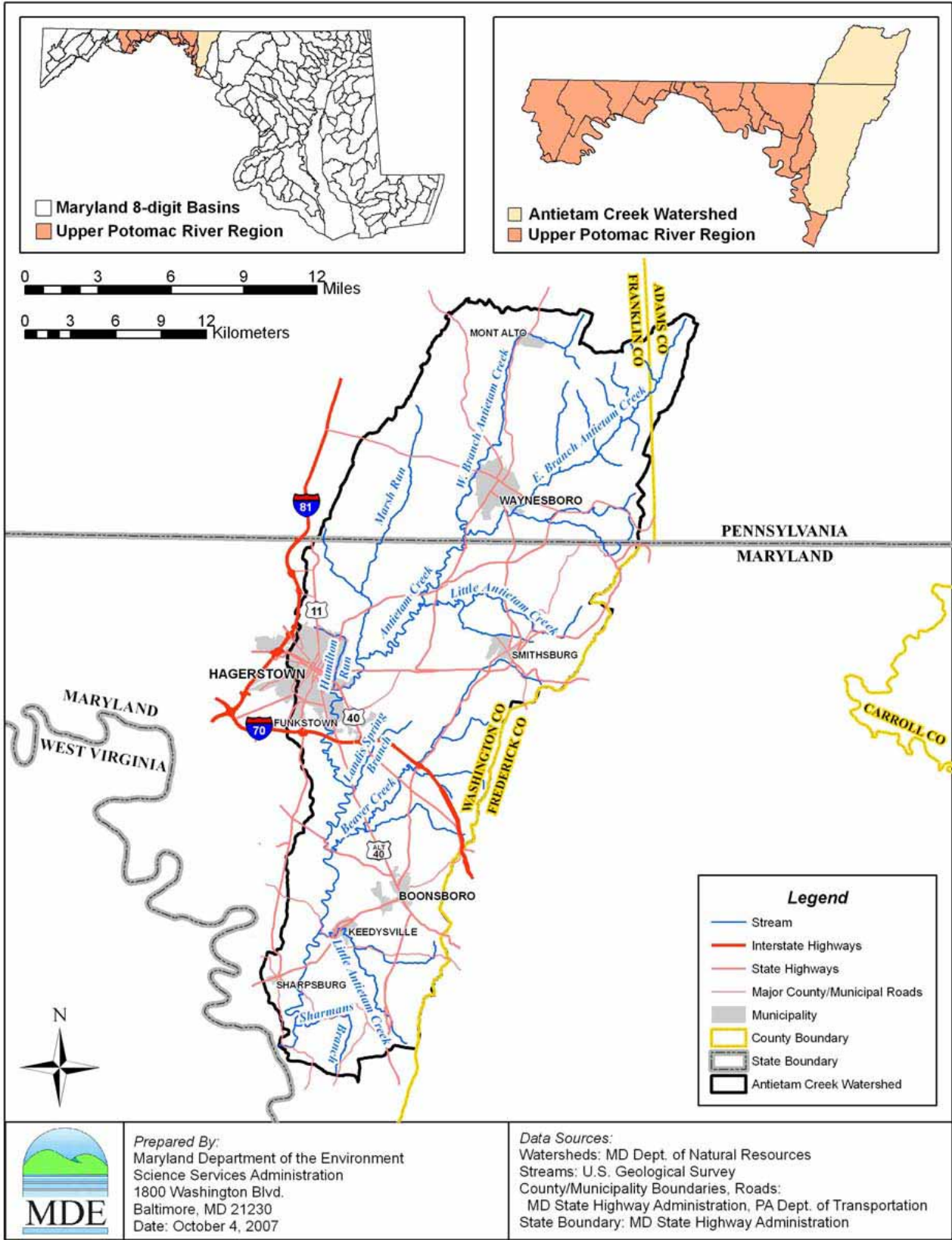


Figure 1 - Antietam Creek Watershed location

2. Watershed Characterization

The Antietam Creek is located in the Ridge and Valley Province physiographic region of Western Maryland. It is approximately 54 miles in length; 42 miles reside in Washington County, Maryland with the remainder in Franklin and Adams County, Pennsylvania. The total watershed area covers 290 square miles, with approximately 185 square miles in Maryland and 105 square miles in Pennsylvania.

The main metropolitan area, Hagerstown, is centrally located along the western edge of the watershed. Antietam Creek and its tributaries flow through several small towns including Mont Alto and Waynesboro in Pennsylvania and Smithsburg, Boonsboro and Sharpsburg in Maryland. The headwaters of Antietam Creek originate south of Waynesboro, PA with the confluence of East and West Branch Antietam Creek. It continues flowing southwest past Hagerstown, MD then through Antietam National Battlefield in Sharpsburg, and empties into the Potomac River near the town of Antietam. **(Bacteria TMDL)**

There are approximately 118,400 acres of the watershed located in Washington County Maryland. **(Figure 1)** For the purposes of this plan, the Antietam Creek watershed has been divided into nine subwatersheds to mirror those subwatersheds established in the TMDL for Fecal Coliform. Subwatersheds were referenced by their corresponding bacteria monitoring station's name and location. The nine subwatersheds **(Figure 2)** are ANT0366 (Antietam Creek in Rocky Forge), ANT0277 (Antietam Creek at Marsh Run), MRS0000 (Marsh Run), ANT0223 (Antietam Creek in Funkstown), ANT0132 (Antietam Creek in Devil's Backbone Park), BEC0001 (Beaver Creek), LAS0004 (Little Antietam Creek in Keedysville), ANT0044 (Antietam Creek at Burnside Bridge) and ANT0002 (Antietam Creek in Antietam).

The majority of the watershed is located in the Great Valley (Hagerstown Valley) The Great Valley is a wide, flat, and open valley formed on Cambrian and Ordovician limestone dolomite, and alluvial fan deposits alongside the bordering mountains. The Hagerstown Valley presents unique challenges to addressing water quality issues with its numerous limestone outcroppings and sinkholes as well as the karst geology which makes pollutant sequestration and treatment within the subsurface a challenge. **Table 2** contains a list of pollutants with approved TMDLs in the Antietam Creek watershed.

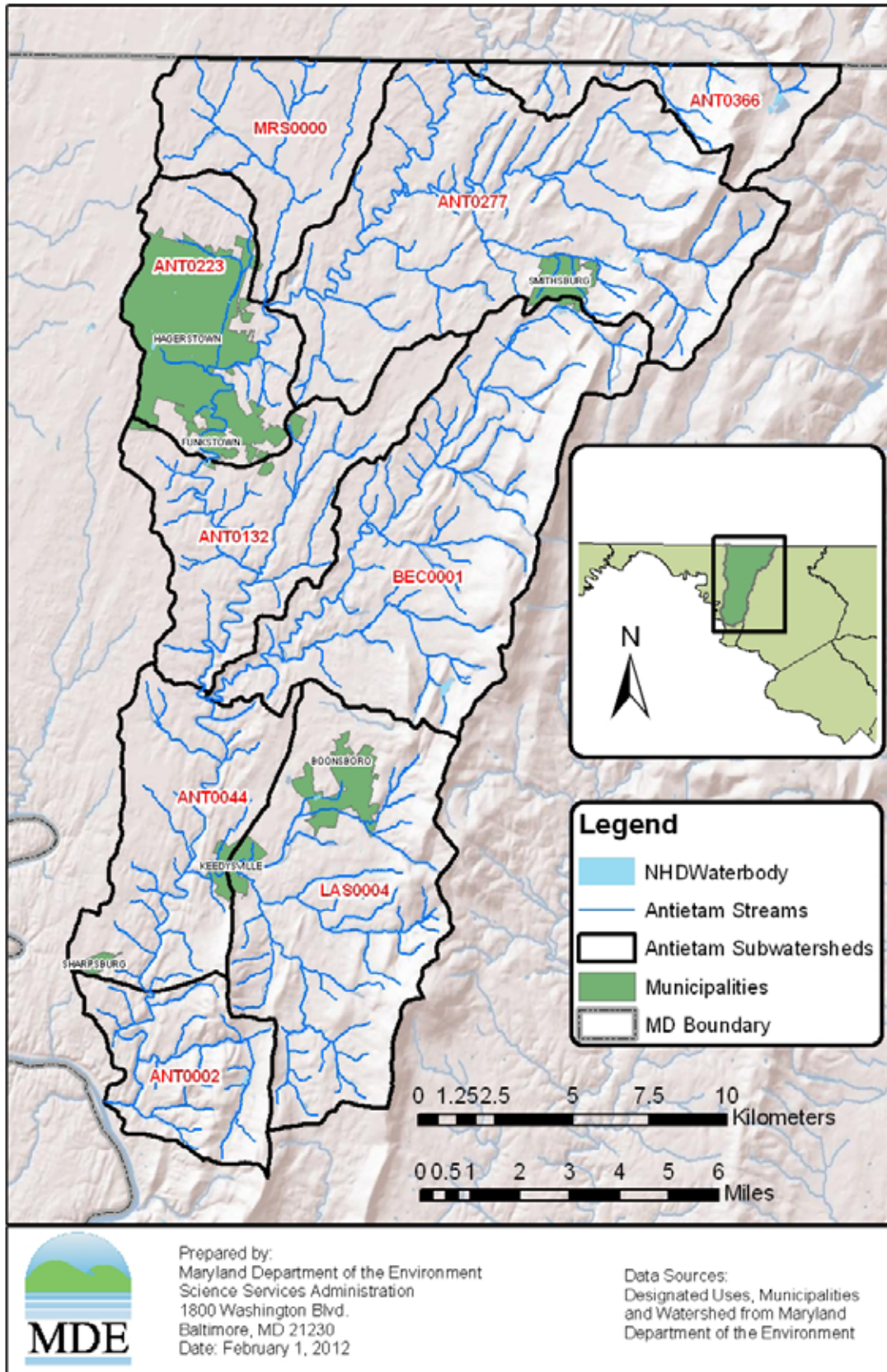


Figure 2 - Antietam Creek Sub-watersheds

Table 2 – Pollutants identified in TMDL

Pollutant or Concern	Data Source	Potential Sources of Contamination	Watershed Effects
Sediments (TSS - total suspended solids)	2009 Sediment TMDL	<ul style="list-style-type: none">· Urban runoff- Agricultural runoff- In-stream erosion/channelization- Atmospheric Deposition	<ul style="list-style-type: none">- Loss of habitat for Aquatic Species- Contribution to Chesapeake Bay pollution
Bacteria	2009 Bacteria TMDL	<ul style="list-style-type: none">· Urban runoff- Agricultural runoff- Failing Septic Systems- Pet waste- Wildlife	<ul style="list-style-type: none">- Swimming and water contact related illnesses- Fish Consumption
Biological Impairment (addressed primarily through sediment TMDL)	MD 303d list	<ul style="list-style-type: none">- Impervious surface- Hydrologic alteration- Lack of adequate stream buffers- Sedimentation	<ul style="list-style-type: none">· Thermal impacts- Loss of sensitive species- Loss of trout fishery

2.1 Land Use

The total population in the MD 8-digit Antietam Creek watershed is estimated to be approximately 82,000. The TMDL documentation includes acreage of various land uses in the watershed. Approximately 31% of the watershed is forest, 42% is agriculture consisting of cropland, pasture, animal feeding operations, hay, high till and low till farming, and nurseries. Urban areas account for 27% with the majority of the urban areas being “urban pervious,” which is urban or suburban areas that are not covered with rooftops, roads, or other surfaces that make the land impervious to water. **(Figure 3)**

The primary animal based agricultural enterprise is dairy with 86 active dairies currently in operation **(Figure 17)**. Urban land use is centered in the municipalities of Hagerstown, Smithsburg, Sharpsburg, Keedysville, Boonsboro, Leitersburg, and Cascade. Numerous smaller towns and villages as well as rural housing developments round out the urban landscape.

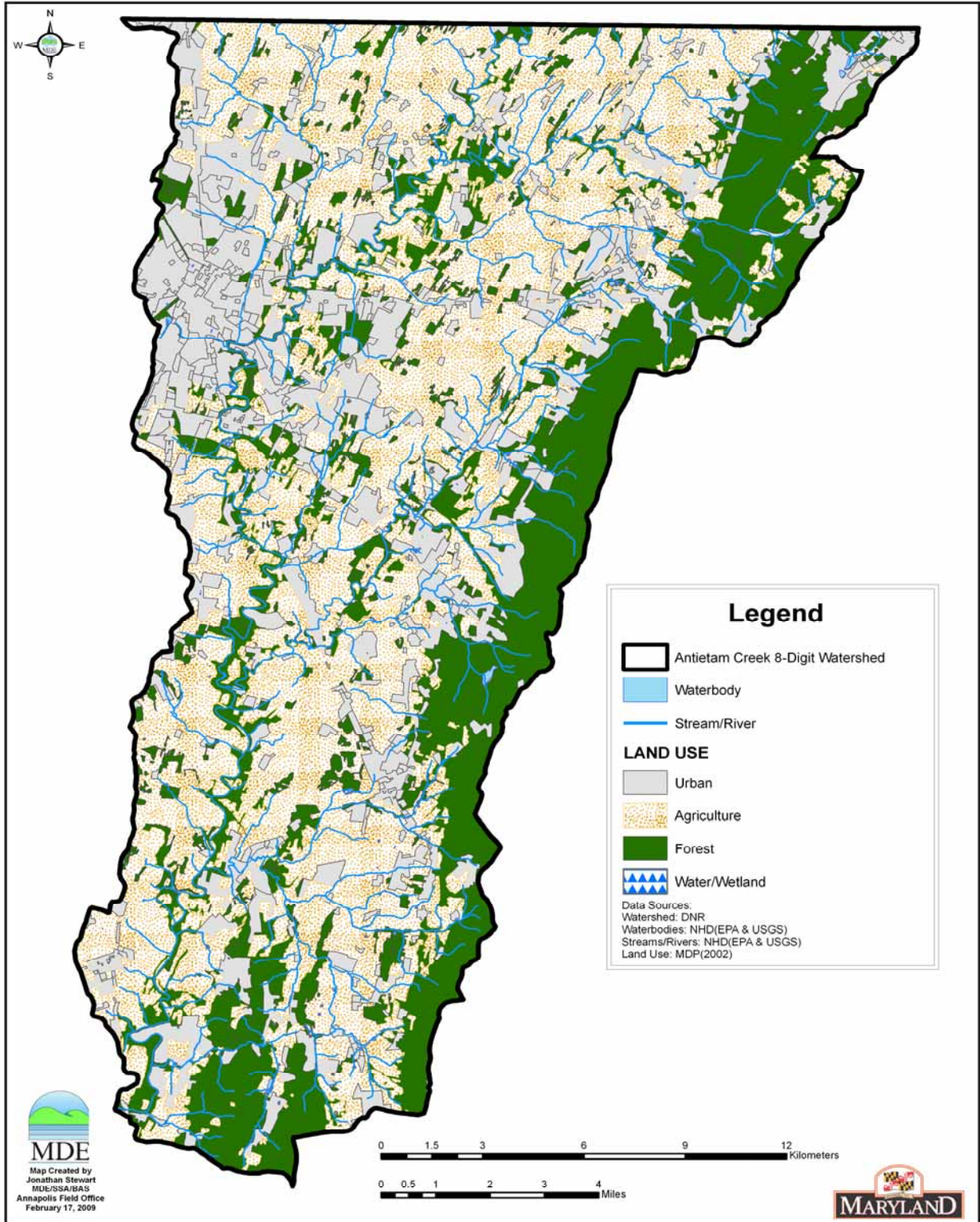


Figure 3- Land Use Map of Antietam

2.2 Geology

Characterization

The Antietam Creek Watershed lies in the Great Valley sub-province of the Valley and Ridge physiographic province and is locally known as the Hagerstown Valley of Washington County, Maryland (Duigon, 1997). The terrain of the Hagerstown Valley has developed on thick folded beds of sedimentary rocks which were deposited during the Paleozoic Era. These different types of rocks caused valleys to form when more resistant sandstone bordered carbonate formations. The more resistant sandstone (caprocks) protect the underlying softer (less resistant) bedrock from weathering and erosion while the carbonate bedrocks of the valley, which are more susceptible to weathering than the surrounding sandstone ridges, were more easily eroded, leaving valleys. Like other regions that are dominated by carbonate bedrock, the Antietam Creek Watershed exhibits karst topography which is commonly characterized by underground streams, sinkholes, caves, and caverns that are formed by the dissolution of carbonate rocks by surface and groundwater (NPS Geologic Resource Evaluation Report, 2005). The Hagerstown Valley is underlain by about 89% carbonate rocks (limestones and dolomites) that have more than 50 caves, 190 springs, many sinkholes, and about 200 wells intersecting cavernous zones that demonstrate the development of solution cavities in the bedrock of the valley (Duigon, 2001; Duigon, 2002; nps.gov, 2005).

Problems associated with Karst Terrain

Because of the unique inter-relationship between surface and subsurface hydrology on the karst landscape of the Antietam Creek Watershed, there are special challenges associated with water quality that are posed by karst features. Much of the groundwater in the area comes from streams that flow from the surrounding mountains into sinkholes in the valley. Sinkholes on a karst terrain allow water and the contaminants it carries to be directly injected to the groundwater. These contaminants can range from farm runoff containing animal waste, effluent from septic systems containing bacteria and nutrients, and petroleum based contaminants that runoff from a parking lot or industrial sites. Sinkholes are found throughout the watershed, but are mainly found in the Rockdale Run Formation, Stonehenge Limestone, Elbrook limestone, and the Conococheague Formation (NPS Geologic Resource Evaluation Report, 2005).

There are several sinking and losing streams within the watershed. In fact, the National Park Service reports that many of the local streams lose most of their flow within a mile of reaching the carbonate rocks of the valley (NPS Geologic Resource Evaluation Report, 2005). These are also places where possibly contaminated surface runoff has direct access to the aquifer. A sinking stream is where a stream disappears underground completely into a sinkhole. A losing stream leaks flow slowly through its bed into the aquifer, causing the stream to dry up at times of low flow (Field, M.F., 2006). The portion of Beaver Creek above the State Trout Hatchery would be an example of a losing stream.

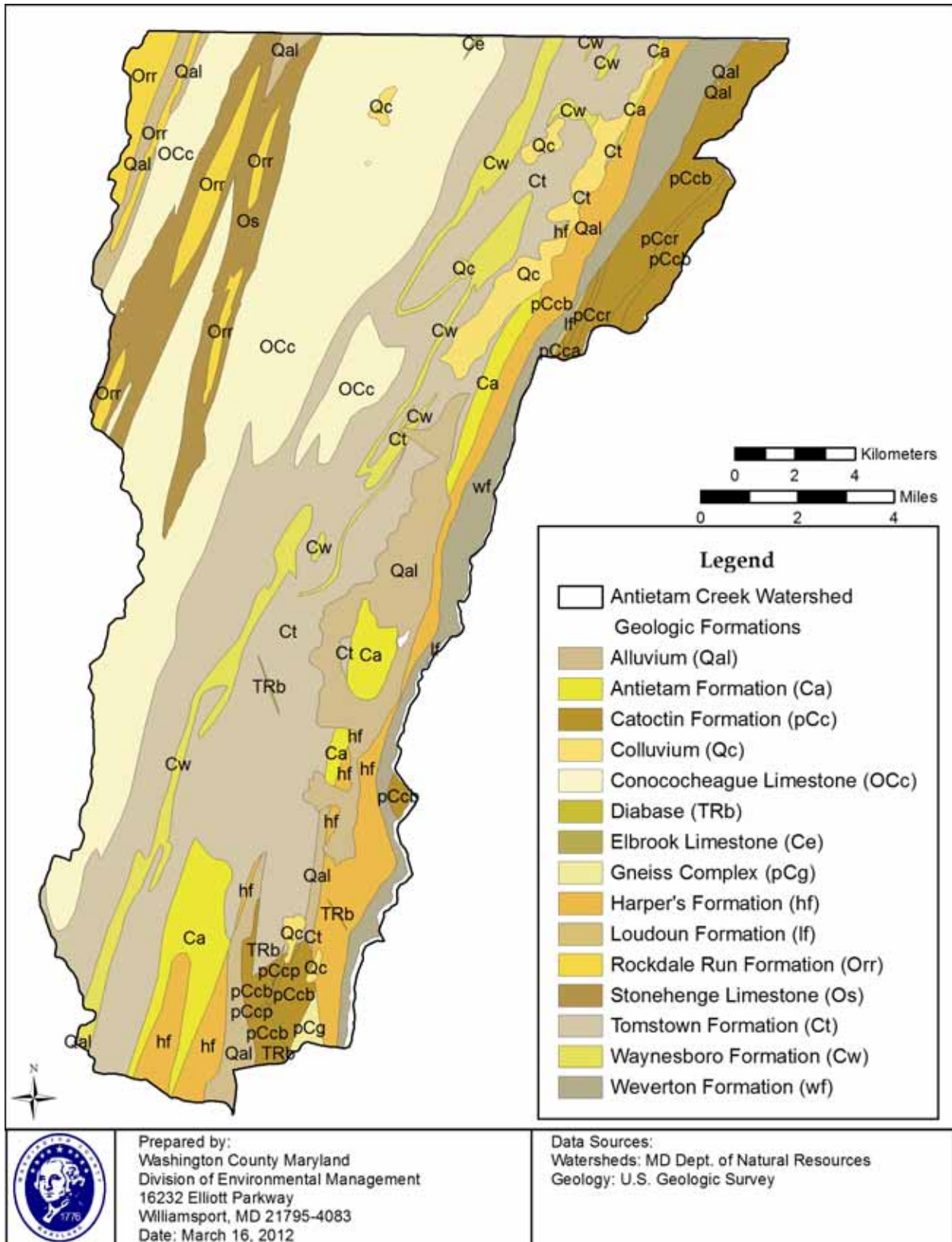


Figure 4 - Distribution of Antietam Creek Geologic Formations

Soils

The soils in the watershed are primarily in the Hagerstown-Duffield-Ryder Association and are derived from the underlying limestone, impure limestone and calcareous shale limestone respectively. They range from moderately deep to very deep; all are considered well drained with moderate permeability.

These soils are some of the most productive in Washington County. However, limestone outcrops impede some agricultural operations, and sinkholes pose a great threat to water quality. Agricultural conservation operations such as injection of animal manures and contour strip cropping to improve agricultural production and water quality are not practical on most farms in this watershed.

The soils of South Mountain are in the Thurmont-Braddock-Trego Association, on the footslopes, and in the Bagtown-Dekalb-Weverton Association on the steeper side slopes and ridge tops. They are all derived from quartzite and phyllite. The Thurmont-Braddock-Trego Association soils are well drained to moderately well drained. They all are very deep and range from moderate to slow permeability. They are well suited to crop production on their gently sloping areas. The Bagtown-Dekalb-Weverton Association soils are also well drained to moderately well drained. They range from very deep to moderately deep with permeabilities ranging from slow to rapid. This association is well suited to tree production and unsuitable for most agricultural and urban uses because of the steep slopes and surface stones (USDA 2003) (**Figure 3**). Underlying the soils in Antietam Creek is a Karst geology shaped by the dissolution of a layer or layers of soluble bedrock, which is limestone.

Hydrologic Soils (Figure 5)

Group A Soils

Group A soil has low runoff potential and a high infiltration rate even when wet. The group consists of soil that is deep and well-to-excessively draining. The soil ranges from sandy loam to high gravel content. The water transmission rate is greater than 0.30 inch per hour.

Group B Soils

Group B hydrologic soil classification indicates silt loam or loam soil. It has moderately fine-to-moderately coarse texture created by its mineral particle content relative to its organic matter content. It has small amounts of sand and clay in silt-size particles. Group B soils have moderate water infiltration rates 0.15 to 0.30 inch per hour. They are moderately well-to-well-draining soils.

Group C Soils

Group C soils have slow infiltration rates even when thoroughly wetted. They have a layer that impedes the movement of water downward. Group C hydrologic soils are moderately fine-to-fine in texture. It forms a more cohesive ball than Group B soils when squeezed in the hand. The rate of water filtration is 0.05 to 0.15 inch per hour.

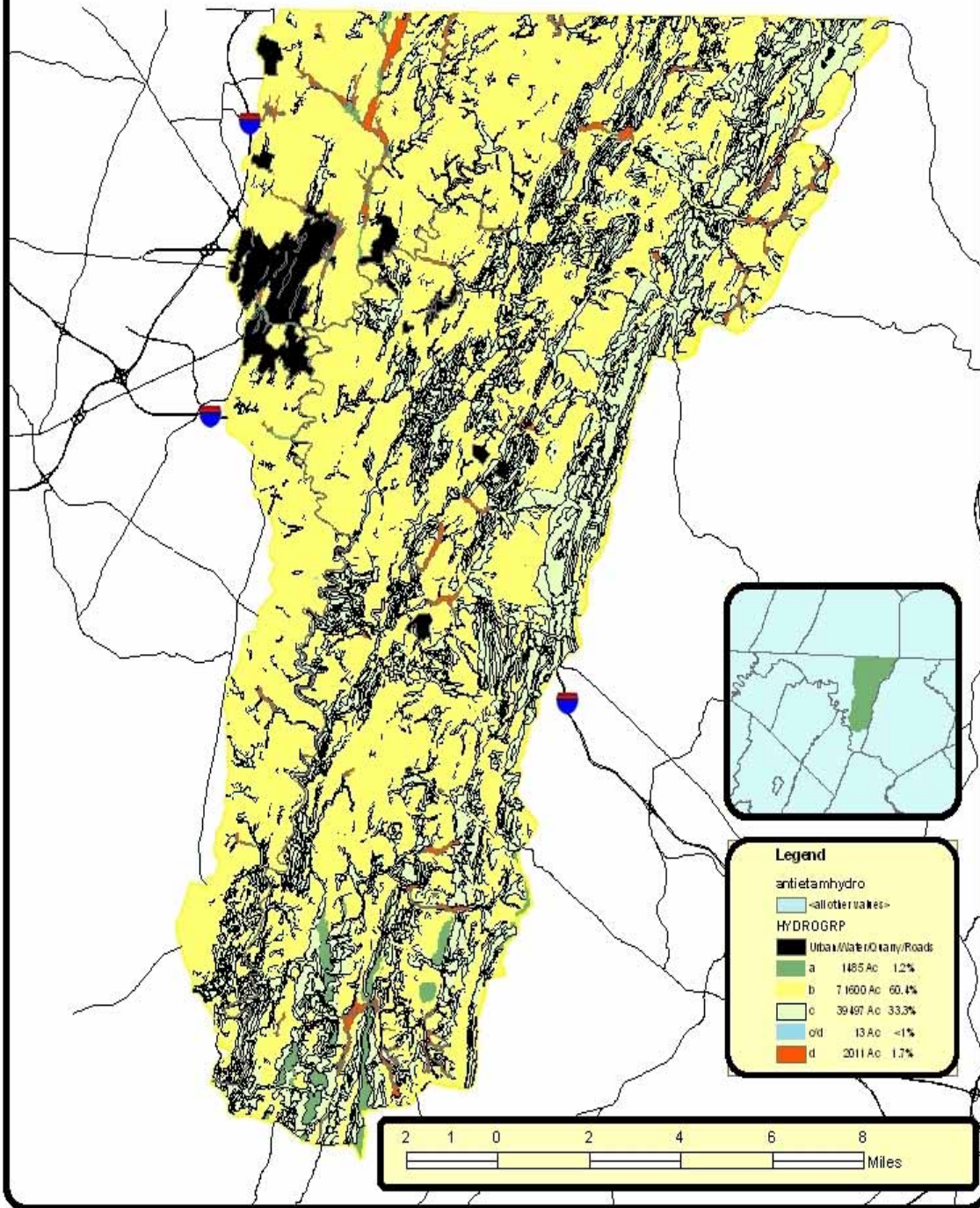
Group D Soils

Hydrologic soil classification Group D consists of soils with high clay content and very low rate of water transmission. Clay is the finest textured soil of all classifications. It forms hard clods or clumps when dry or squeezed in the hand. It is sticky and plastic when wet. Group D soils have a permanently high water table and high swelling potential. Its rate of water filtration and transmission is 0 to 0.05 inch per hour.

The distribution of hydrologic soil types includes approximately:

- Hydrologic Group A 1,485 acres-1.2%
- Hydrologic Group B 71,600 acres-60.4%
- Hydrologic Group C 39,497 acres-33.3%
- Hydrologic Group D 2,011 acres-1.7%
- Hydrologic Group C/D 13 acres->1%

ANTIETAM WATERSHED HYDROLOGIC SOIL GROUPS



Prepared by:
 Washington County Soil Conservation District
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 Date: February 29, 2012

Data Sources:
 Washington County Soil Survey
 Issued 2003



Figure 5 - Distribution of Antietam Creek Hydrologic soils

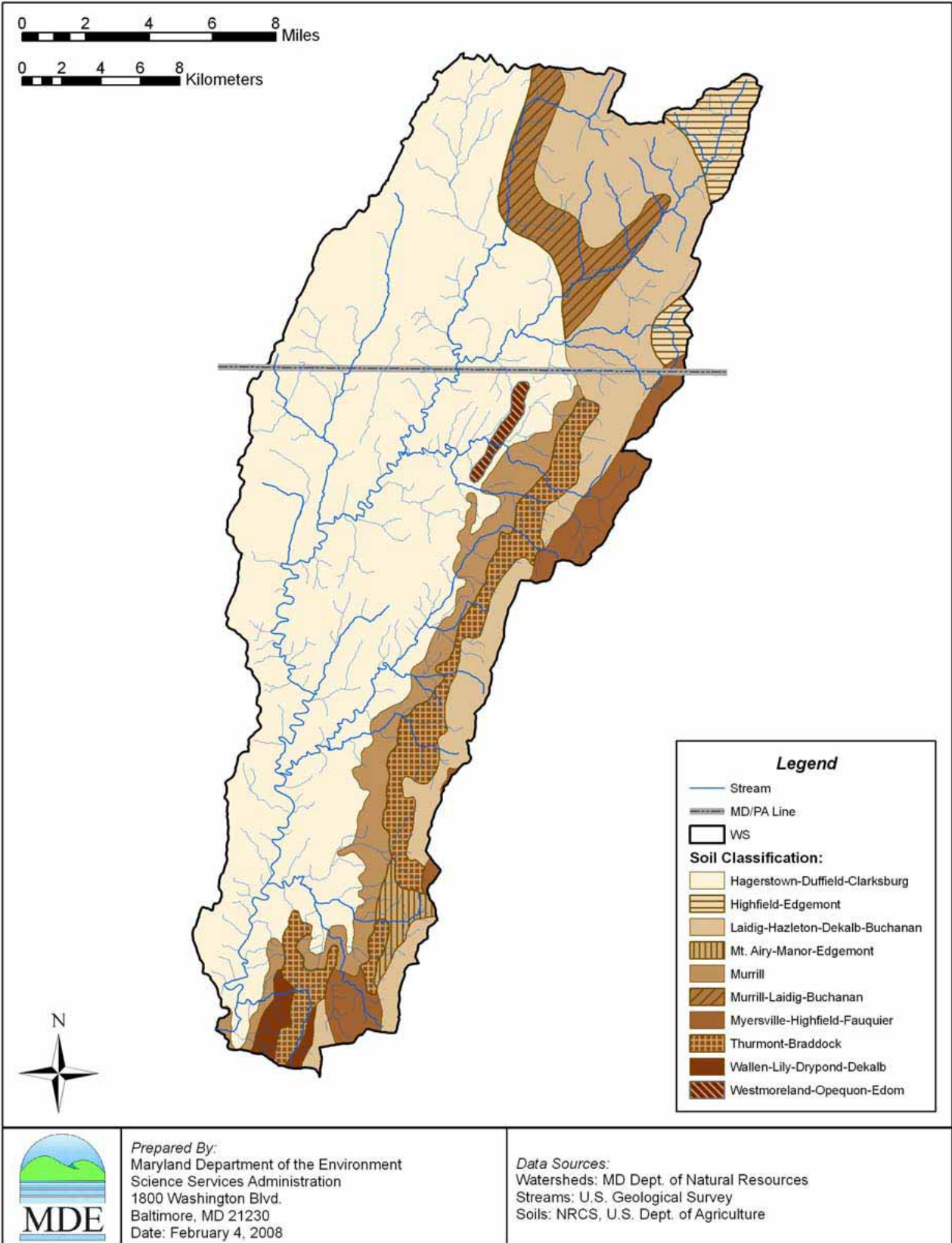


Figure 6 - Distribution of Antietam Creek soils

2.3 Historical and Recreational Significance

Early history in the Antietam watershed begins with its first known inhabitants, the native Algonquin Indians. While almost no trace of their habitation remains today, they are credited with giving us the word “Antietam,” believed to be derived from a word or phrase for “swift water.”

In 1910, about 150 years after European settlement, Helen Ashe Hays described the Antietam as “placid.”

“There is a stream running through Washington County, Maryland, from the Pennsylvania line to the Potomac River, whose name will be famous as long as America endures, the placid Antietam.”

Milling Industry

The Antietam’s waters were harnessed by many dams to power a variety of milling industries including many grist mills, many sawmills, forges, furnaces, a paper mill, a powder mill, a woolen factory, and hemp mills

- There were 19 mill dams on the main stem of the Antietam in 1818 (on average, a dam every 2-3 miles) when the Potomac Company attempted to make it navigable ([ref: Dan Guzy and Harbaugh](#))
- There were 45 historical water-powered mills identified in the Antietam watershed in Maryland in research conducted in 1988, however ([ref: by Susan Frey Winter](#)) almost all of the dams were gone by 1988.

The Antietam and its tributaries were literally reshaped by the construction of the many mills, millraces, dams, weirs, locks, and other structures. Today some of the “swift water” has returned to the Antietam as only two of the historical mill dams remain and two modern dams still stand. To the casual observer there is little other evidence of the water-powered milling era save the place names and some of the historical structures around the mills themselves. Yet if one travels the Antietam in a small boat, they will see the tell-tale signs of human efforts along virtually every mile.

Iron Industry

The developing iron industry in the Antietam watershed, beginning about 1750, had a tremendous appetite for charcoal. The Mont Alto iron furnace in the Antietam’s headwaters owned 22,000 acres of land and timber was cut at the rate of approximately one acre per day to produce charcoal. There were other iron furnaces in the Antietam watershed – principally Antietam Iron Works and Mt Aetna Furnace – that also required a steady supply of charcoal.

Although most of the dams are gone and much of the forest has returned, the legacy of those earlier days seems to be with us still. The following description of the Antietam was written over 100 years ago and yet it is surprisingly similar to what is observed today:

“Its waters are not sparkling; they often carry a large amount of muddy matter which gives the stream a thick and turgid appearance, and after heavy rains it will carry this earthy charge for days. But it is peacefully beautiful, and flows through one of the richest farming lands in America.” (Helen Ashe Hays in 1910).

Boating

Jacob Stoner wrote a newspaper column in the 1930-40s about the history and nature he observed in his wanderings along the Antietam’s branches and tributaries. He lamented the lack of public access that would allow more people to explore the Creek and enjoy nature there. He also suggested local boys construct flat-bottomed skiffs to play in

the Antietam as a worthwhile activity even though there were only short stretches of free-flowing water due to the many mill dams.

Today, most of the mill dams are gone and canoes and kayaks are seen traveling the length of the Antietam to the Potomac. However public access to the Creek is still very limited. To address that, several partners –Washington County Parks & Recreation, the Maryland Department of Natural Resources, and Antietam Creek Watershed Alliance - are working to develop the concept of a “water trail” that would identify new and existing public access areas and propose new ones. A water trail map is also planned that would serve as a guide to recreation on the Antietam.

The lower 14 miles of the Antietam are more accessible with three existing public areas to launch a boat and there is a take-out on the Potomac River provided by the National Park Service on C & O Canal property. There are three private companies offering canoe, kayak, and tube trips along with rentals, lessons and shuttle service; Antietam Creek Canoe is located adjacent to Devils Backbone County Park, Outdoor Excursions operates near Keedysville, and River & Trail Outfitters is based in Knoxville, MD. These outfitters bring bus-loads of adventurers from the Baltimore – Washington, DC, area and surrounding States to enjoy the cool shade and to “float through history” especially around Burnside Bridge in Antietam National Battlefield.

Fishing

For those who like to fish, the Maryland Department of Natural Resources Fisheries Service manages most of Antietam Creek as a put-and-grow fishery. This means that although stocked trout may survive and even grow to trophy size, there is insufficient suitable habitat to enable them to naturally reproduce. Approximately one mile of Antietam Creek, from Devil's Backbone County Park downstream to the mouth of Beaver Creek, is managed as a put-and-take trout-fishing area and receives more than 5,000 adult rainbow trout annually.

Several tributaries of the Antietam do have the needed water quality to support populations of naturally reproducing trout. Most notably is Beaver Creek, Maryland's only major limestone-influenced trout stream, where a 1½-mile stretch south of the Albert Powell Fish Hatchery has been designated for catch-and-release fly-fishing.

Protected Lands

Mont Alto State Park and the surrounding Michaux State Forest help to protect the headwaters of the East and West Branches of the Antietam in Franklin County Pennsylvania. These lands were once owned by several large iron companies who cut the old growth forests to make charcoal to fire their iron furnaces. Remnants of the charcoal days can still be seen in the state forest as the land where the kilns burned for so many years has yet to fully recover.

http://en.wikipedia.org/wiki/Michaux_State_Forest

Devils Backbone County Park is significant because it is the only park on the Antietam in Maryland and one of the few public access areas. Throngs of people seek out the cool shade of Devils Backbone Park to picnic, launch canoes and kayaks, and to fish the pool above the dam and also downstream about for one mile to the mouth of Beaver Creek.

http://www.marylandmemories.org/maps/Washington_County_Map_2006.pdf

Antietam National Battlefield was the site of the Bloodiest One Day Battle in American History after twelve hours of savage combat on September 17, 1862. The Battle of Antietam ended the Confederate Army of Northern Virginia's first invasion into the North and led to Abraham Lincoln's issuance of the preliminary Emancipation Proclamation.

<http://www.nps.gov/ancm/index.htm>

In addition to the historic significance, the Battlefield site and the surrounding Park Service lands have protected a 3 ½ -mile section along the Antietam from development. The Park Service has also planted many trees to restore the Battlefield to the way it looked in September 1862 as well as trees along the stream. Today the Battlefield stretch of the Antietam is a favorite of fishermen who float in to fish or walk in along the Snavelys Ford Trail to bank-fish. South Mountain State Park includes 13,000-acres of forest and provides significant headwater protection for the many Antietam tributaries that originate on the western flank of South Mountain. South Mountain is a state park that encompasses nearly the entire length of South Mountain through Maryland and is contiguous with several other national, state and local parks on the mountain, including the Chesapeake and Ohio Canal National Historical Park, Gathland State Park, Washington Monument State Park, Greenbrier State Park and Pen Mar County Park (Washington County). Forty-one miles of the Maryland section of the Appalachian Trail traverses the length of the park. The park also contains part of the South Mountain Battlefield.

http://en.wikipedia.org/wiki/South_Mountain_State_Park

3. Water Quality

3.1 Water Quality Standards

Maryland’s water quality standards require by law that water quality in the Antietam Creek support its designated uses. The Code of Maryland Regulations (COMAR) has two primary criteria to meet water quality standards within the state. These numeric and qualitative goals are illustrated in the form of stream designated uses (**Figure 8**) and narrative or numeric water quality criteria necessary to support those uses. Furthermore, water quality standards serve the purpose of protecting public health, enhancing the quality of water, and protecting aquatic resources.

Turbidity (COMAR 26.08.02.03-3)

A. Criteria for Use I Waters (Criteria for use IV-P is the same as Use I)—Water Contact Recreation and Protection of Nontidal Warmwater Aquatic Life.

(5) Turbidity.

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

(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.

Fecal Coliform

The State water quality standard for bacteria (*E. coli*) is as follows:

Table 3 - Applicable Water Quality Standards for Bacteria

Indicator	Steady State Geometric Mean Indicatory Density
Freshwater	
Enterococci	33 MPN/100 ml
E. Coli	126 MPN/100 ml

*Source COMAR(26.08.02.03-3) Table 1 (Criteria for Use IV-P is the same as Use I)

3.2 TMDL Summaries

Antietam Creek's identified water quality problems are: elevated fecal bacteria indicator, elevated sediment load and turbidity. Potential ground water quality problems identified in the area are: elevated fecal bacteria indicator and elevated nutrient load. The sources of these problems are both point and nonpoint in origin and both related to rural and urban land uses. Portions of the Antietam Creek watershed have been designated as both a Priority I and Priority III waters under the Clean Water Action Plan. (References: 208 water quality Management Plan for the Upper Potomac River Basin, September, 1976,; Maryland's 319 Nonpoint Source Assessment Report, April, 1989, Final 1998 Report on Unified Watershed Assessment, Prioritization and Plans for Restoration Action Strategies)

Total Maximum Daily Loads (TMDL's) have been approved for Carbonaceous Biochemical Oxygen Demand (CBOD) and Nitrogenous Biochemical Oxygen Demand (NBOD), August 2002, Sediment, December 2008 and Fecal Bacteria, September 2009. A Water Quality Analysis (WQA) for CBOD and NBOD indicate that Antietam Creek currently meets water quality standards for those parameters and those goals will not be included in this plan. Therefore the focus will be on sediment and fecal bacteria as measured by *E. coli*.

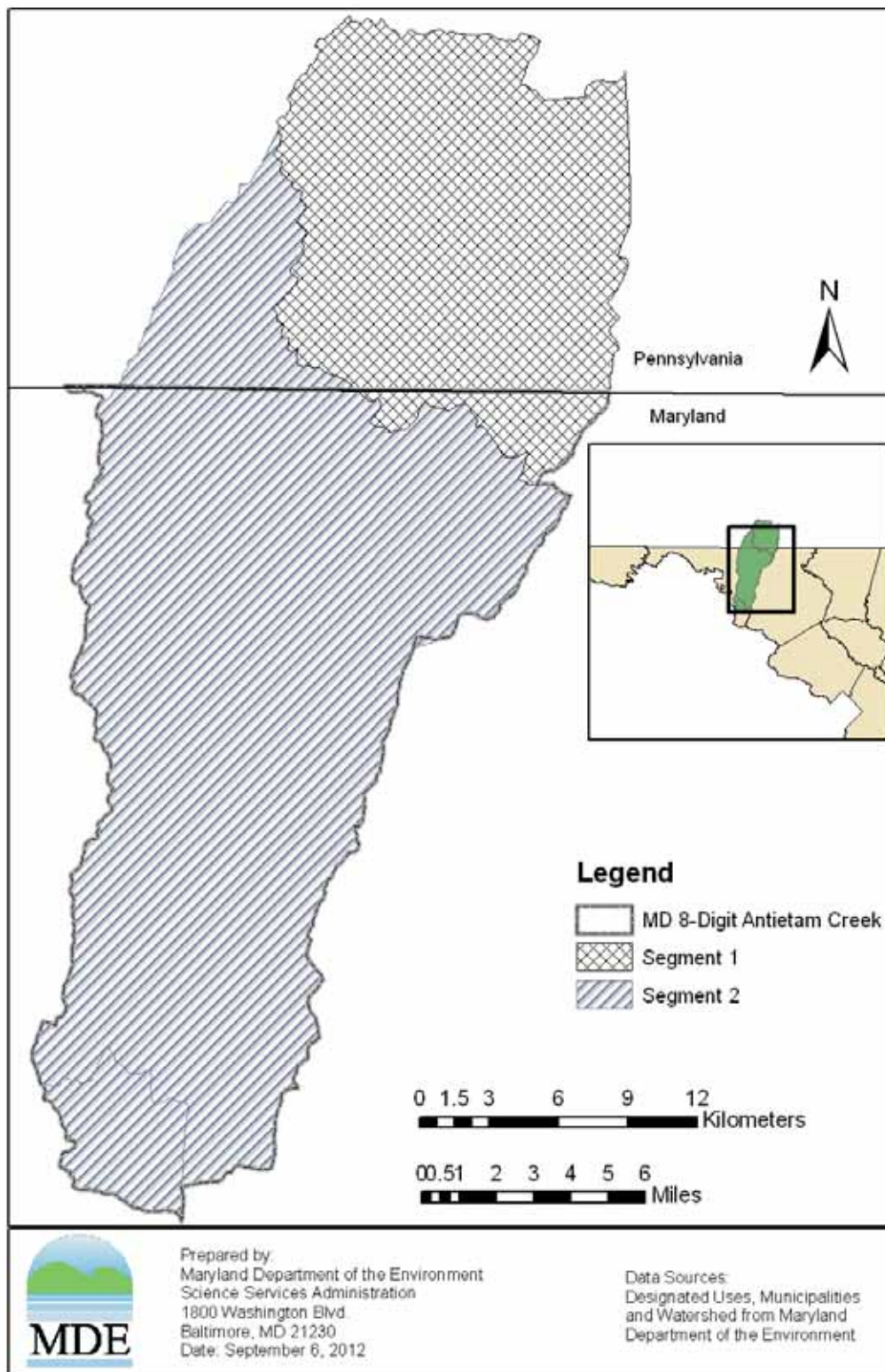


Figure 7- Sediment TMDL Segmentation

3.2.1 Sediment

The TMDL for sediment developed by the state of Maryland was for the portion of the Antietam watershed labeled as “Segment 2” (**Figure 8**) in the TMDL. This includes portions of PA and MD, however the Antietam WRP is dedicated to achieving sediment reductions in the Maryland portion of the Segment 2 watershed.

Loads and Turbidity

The computational framework chosen for the MD 8-digit Antietam Creek watershed TMDL was the Chesapeake Bay Program Phase 5 (CBP P5) watershed model target *edge-of-field* (EOF) land use sediment loading rate calculations combined with a *sediment delivery ratio*. The *edge-of-stream* (EOS) sediment load is calculated per land use as a product of the land use area, land use target loading rate, and loss from the EOF to the main channel. The spatial domain of the CBP P5 watershed model segmentation aggregates to the Maryland 8-digit watersheds, which is consistent with the impairment listing. (MDE 2008)

Table 4 - Current estimated Baseline Loads and TMDLs for sediment for each load source category in the Maryland portion of Antietam Creek Watershed. (MDE 2008)

Load Source Categories	Baseline Load (ton/year)	TMDL (ton/year)	Load Reduction Needed (ton/year)	Percent reduction necessary
Crop	18,610.80	8,035.80	10,575.00	56.8
Extractive	172.4	172.4	0	0
Forest	1,629.60	1,629.60	0.00	0
Pasture	3,972.90	2,081.60	1,891.30	47.6
Urban	8,490.40	3,556.80	4,933.60	58.1
Permits	703.2	703.2	0	0
MD Totals	33,579.20	16,179.40	17,399.90	51.8

Load reduction achieved from the period of TMDL acceptance (2008) and development of the plan (2012) was calculated to create a new baseline from which to develop the Antietam Creek WRP. The analysis to create the new baseline is reflected in **Table 16**, located in section 5.1 of the plan. It was calculated that Best Management Practices (BMPs) implemented from 2008-2011 resulted in a reduction of 4,477.04 tons/yr of sediment making the goal of this plan a sediment load reduction of 12,923 tons/yr.

Biological Response to Sediment Loading (Sediment TMDL 2009)

EPA’s regulations require TMDLs to take into account seasonality and critical conditions for stream flow, loading, and water quality parameters (CFR 2007b). The intent of this requirement is to ensure that the water quality of the waterbody is protected during times when it is most vulnerable. The biological monitoring data used to determine the reference watersheds integrates the stress effects over the course of time and thus inherently addresses critical conditions. Seasonality is captured in two components. First, it is implicitly included in biological sampling. Second, the Maryland Biological Stream Survey (MBSS) dataset included benthic sampling in the spring and fish sampling in the summer. (MDE 2008)

The MBSS program monitored 14 locations in the MD 8-digit Antietam Creek watershed in 2003 (**see Figure 8 and Table 5**). The MBSS parameters recommended from the stressor identification model for determining a sediment stressor were: percent embeddedness, epifaunal substrate score, instream habitat score, bank stability, and

number of benthic tolerant species. These specific parameters were chosen based on their ecological and statistical significance (Southerland et. al. 2007) as well as their linkage to increased terrestrial and/or instream erosion. High percent embeddedness indicates that fine particulates are filling the spaces between cobbles, thus covering habitat and limiting food supply. Low epifaunal substrate is an indication of either stream erosion or excess deposition limiting the quality of the streambed to support a benthic community. Decreased instream habitat is an indication of potential erosion removing woody debris and is primarily linked with the Fish Index of Biotic Integrity (FIBI). The bank stability index is a composite score that indicates the lack of channel erosion, based on the presence or absence of riparian vegetation and other stabilizing bank materials. The number of benthic tolerant species is an indicator of frequent stream scouring, which prevents more sensitive species from colonizing the streambed.

Biological results from both the DNR Core/Trend and MBSS stations along the mainstem of the MD 8-digit Antietam Creek indicate that mainstem water quality can be classified as good. Statistical analysis of the long-term Core/Trend data indicates that since 1976, all stations have shown improvement and are ranked as having good water quality based on percent EPT, taxa number, biotic index, and diversity index (DNR 2007a). In addition, the MBSS mainstem station (ANTI-414-R-2003) has been assigned a BIBI score indicative of acceptable water quality.

Since all biological monitoring results on the Antietam Creek mainstem indicate good conditions, it is concluded that sediment loads from Pennsylvania and the Northeast portion of Maryland, located upstream of station ANT0336, are not impacting water quality in the MD 8-digit Antietam Creek mainstem. Furthermore, the MBSS station ANTI-107-R-2003, located upstream of station ANT0336, does not indicate a sediment impact to biological conditions. Thus, MDE had concluded that the sediment impairment is within the lower order (smaller) streams in the Maryland portion of the watershed, extending up to station ANT0336, and is subsequently dividing the watershed into two TMDL segments for sediment with only TMDL segment 2 exhibiting sediment impairments.

Table 5 - TMDL IBI and SSDI Scores (MDE 2008)

Site	Benthic IBI	Benthic SSDI	Fish IBI	Fish SSDI
ANTI-105-R-2003	2.75	3.00	3.33	3.00
ANTI-106-R-2003	2.50	1.00	2.67	1.67
ANTI-107-R-2003	1.50	3.50	2.00	4.33
ANTI-111-R-2003	1.50	1.50	2.00	1.67
ANTI-113-R-2003	3.50	4.00	4.00	3.00
ANTI-116-R-2003	2.25	3.00	3.33	3.00
ANTI-120-R-2003	2.00	4.00	1.00	2.33
ANTI-201-R-2003	2.00	3.00	3.67	3.00
ANTI-208-R-2003	4.00	2.50	3.67	1.67
ANTI-215-R-2003	3.25	4.00	2.00	3.67
ANTI-226-R-2003	2.50	2.00	2.67	3.00
ANTI-304-R-2003	1.75	1.00	NS	N/A
ANTI-310-R-2003	3.00	2.50	4.00	2.33
ANTI-414-R-2003	3.00	1.00	NS	N/A
Average	2.54 ± 0.33	2.57 ± 0.49	2.86 ± 0.45	2.72 ± 0.39

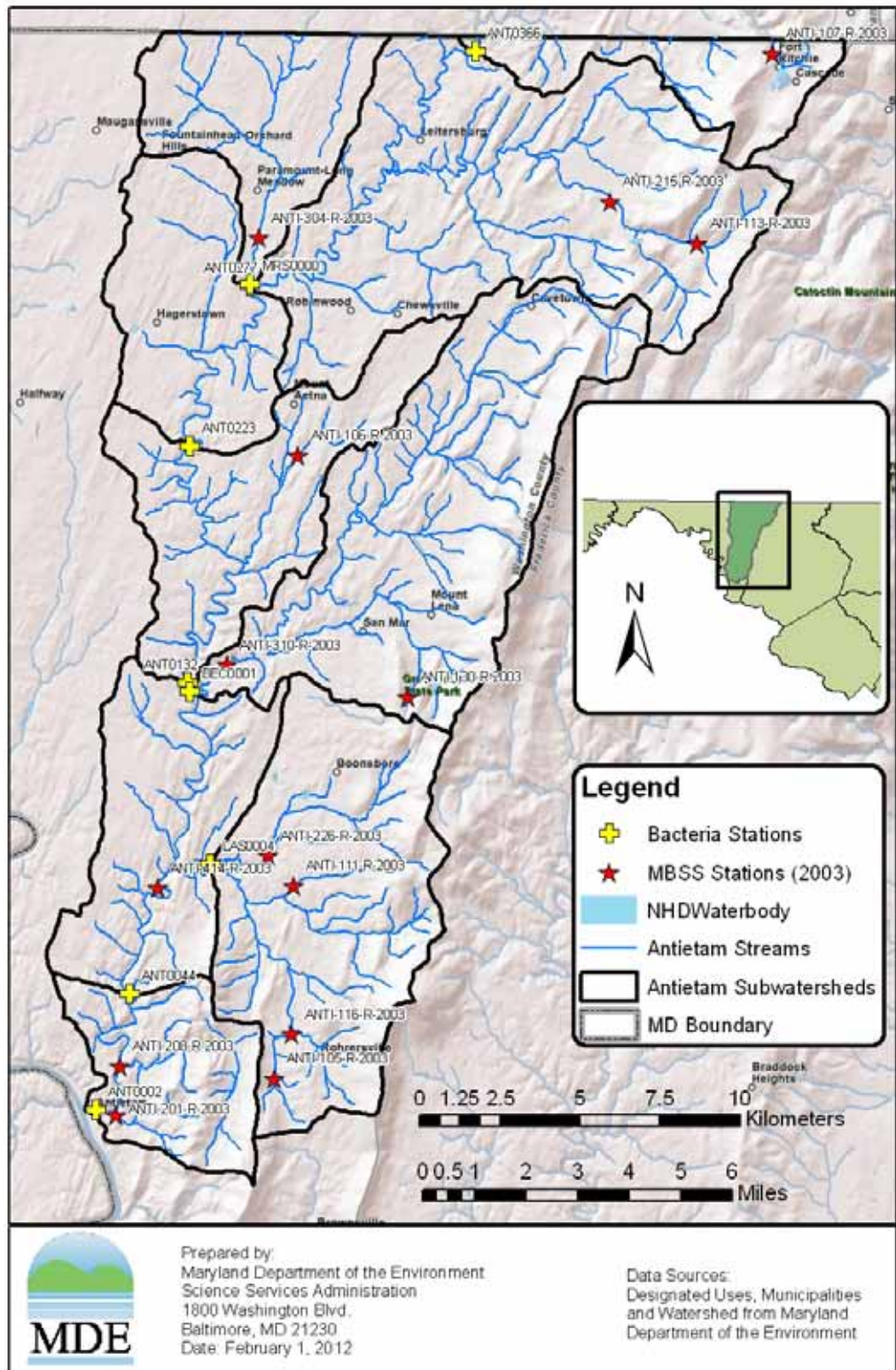


Figure 8- MBSS and Bacteria Sampling stations

3.2.2 Bacteria

Bacteria source tracking (BST) was used to identify the relative contributions of different sources of bacteria to in-stream water samples. BST monitoring was conducted at nine stations in the Antietam Creek watershed, where samples were collected once per month for one-year duration. Sources are defined as domestic (pets and human associated animals), human (human waste), livestock (agricultural animals), and wildlife (mammals and waterfowl). To identify sources, samples are collected within the watershed from known fecal sources, and the patterns of antibiotic resistance of these known sources are compared to isolates of unknown bacteria from ambient water samples.

An accurate representation of the expected contribution of each source at each station is estimated by using a stratified weighted mean of the identified sample results. The weighting factors are based on the log10 of the bacteria concentration and the percent of time that represents the high stream flow or low stream flow (see Appendix B). The procedure for calculating the stratified weighted mean of the sources per monitoring station is as follows:

1. Calculate the percentage of isolates per source per each sample date (S).
2. Calculate an initial weighted percentage (MS) of each source per flow strata (high/low). The weighting is based on the log10 bacteria concentration for the water sample.
3. Adjust the weighted percentage based on the classification of known sources.
4. The final weighted mean source percentage, for each source category, is based on the proportion of time in each flow duration zone.

This methodology produced the following baseline loads for the TMDL:

Table 6 - Current estimated Baseline Loads and TMDLs for fecal coliform in 9 subwatersheds in the Maryland Portion of Antietam Creek. (Bacteria TMDL 2009)

Subwatershed	Domestic Load		Human Load		Livestock Load		Wildlife Load		Total Load
	%	(Billion <i>E. coli</i> MPN/year)	%	(Billion <i>E. coli</i> MPN/year)	%	(Billion <i>E. coli</i> MPN/year)	%	(Billion <i>E. coli</i> MPN/year)	
ANT0366 ¹	24.5	484,049	20.5	404,455	31.0	610,915	24.0	472,648	1,972,068
ANT0277sub ¹	21.5	194,701	27.9	252,210	28.9	261,021	21.7	196,178	904,110
MRS0000 ¹	24.5	210,279	13.3	114,298	34.4	295,804	27.8	239,350	859,730
ANT0223sub	20.4	62,662	22.1	68,018	33.2	102,017	24.3	74,861	307,558
ANT0132sub	14.3	58,492	18.5	75,817	35.6	145,989	31.7	129,947	410,245
BEC0001	14.5	53,361	15.5	56,947	36.5	134,094	33.5	123,044	367,446
LAS0004	27.9	118,612	16.4	69,479	29.0	122,947	26.7	113,511	424,550
ANT0044sub	22.5	69,295	23.0	70,840	28.4	87,501	26.2	80,762	308,398
ANT0002sub	21.2	50,817	20.5	49,034	30.7	73,421	27.6	66,205	239,477

¹Subwatersheds partially located in Pennsylvania

Table 7 - Annual Average TMDL Loading Caps

Subwatershed	<i>E. coli</i> Baseline Load (Billion MPN/year)	Long-Term Average <i>E. coli</i> TMDL Load (Billion MPN/year)	% Target Reduction
ANT0366 ¹	1,972,068	100,268	94.9
ANT0277sub ¹	904,110	54,285	94.0
MRS0000 ¹	859,730	49,530	94.2
ANT0223sub	307,558	19,793	93.6
ANT0132sub	410,245	36,472	91.1
BEC0001	367,446	34,572	90.6
LAS0004	424,550	32,632	92.3
ANT0044sub	308,398	30,837	90.0
ANT0002sub	239,477	23,720	90.1
<i>Total</i>	5,793,581	382,109	93.4

¹Subwatersheds partially located in Pennsylvania

3.2.3 Chesapeake Bay TMDL

The waters of Antietam Creek eventually reach the Potomac River and continue on to empty into the Chesapeake Bay. With the adoption of a new Chesapeake Bay TMDL, Antietam Creek has to reduce contributions of total nitrogen (TN) total phosphorus (TP) and total suspended solids (TSS). The amount of exactly how much the Bay watershed needs to reduce these pollutants is based on the Chesapeake Bay Model version 5.3.2.

Based upon the fact that the Antietam Creek sediment TMDL is specific to this watershed and likely represents a greater amount of stressor decrease, the numbers from this TMDL will be used as a basis for measuring progress towards meeting the Chesapeake Bay TMDL goals for this watershed. Actions taken as part of this WRP are in line with Bay TMDL reduction strategies as well and will serve to meet the TMDLs of both waterbodies.

3.3 Water Quality Objectives and Goals

This watershed is on the 303(d) list as impaired by sediment and bacteria, however since biological community health is pivotal to the evaluation of successful sediment pollution mitigation, this WRP will focus on meeting water quality standards established in the Code of Maryland Regulations (COMAR) as well as the improvement of biological communities in the Antietam Creek Watershed. The end goal is to reduce sediment and bacteria loads, but also to improve stream community health to “good” standards established in the Index of Biotic Integrity (IBI) used by the Maryland Biological Stream Survey (MBSS). By fully implementing this plan it is expected that all waters of the Antietam Creek watershed comply with COMAR and meet their designated uses as identified below.

Designated Uses

All stream segments in the Antietam watershed should, at a minimum, be fishable and swimmable, and should be clean enough to contain healthy communities of indigenous aquatic species. The federal Clean Water Act (CWA) and state regulations have determined a set of interlinked water quality goals. COMAR designated uses for the streams in the Antietam watershed include: **(Figure 9)**

Use III-P Waters: Nontidal Cold Water and Public Water Supply

Use IV-P Waters: Recreational Trout Water and Public Water Supply

The mainstem of the Antietam Creek and many of its tributaries are designated as use IV-P — Recreational Trout Water and Public Water Supply (COMAR 26.08.02.08Q(6)(g)). Beaver Creek (COMAR 26.08.02.08Q(4)(b)), Little Antietam (COMAR 26.08.02.08Q(4)(d)), Marsh Run (COMAR 26.08.02.08Q(4)(c)) and their tributaries are designated as Use III-P—Water Nontidal Cold Water and Public Water Supply.

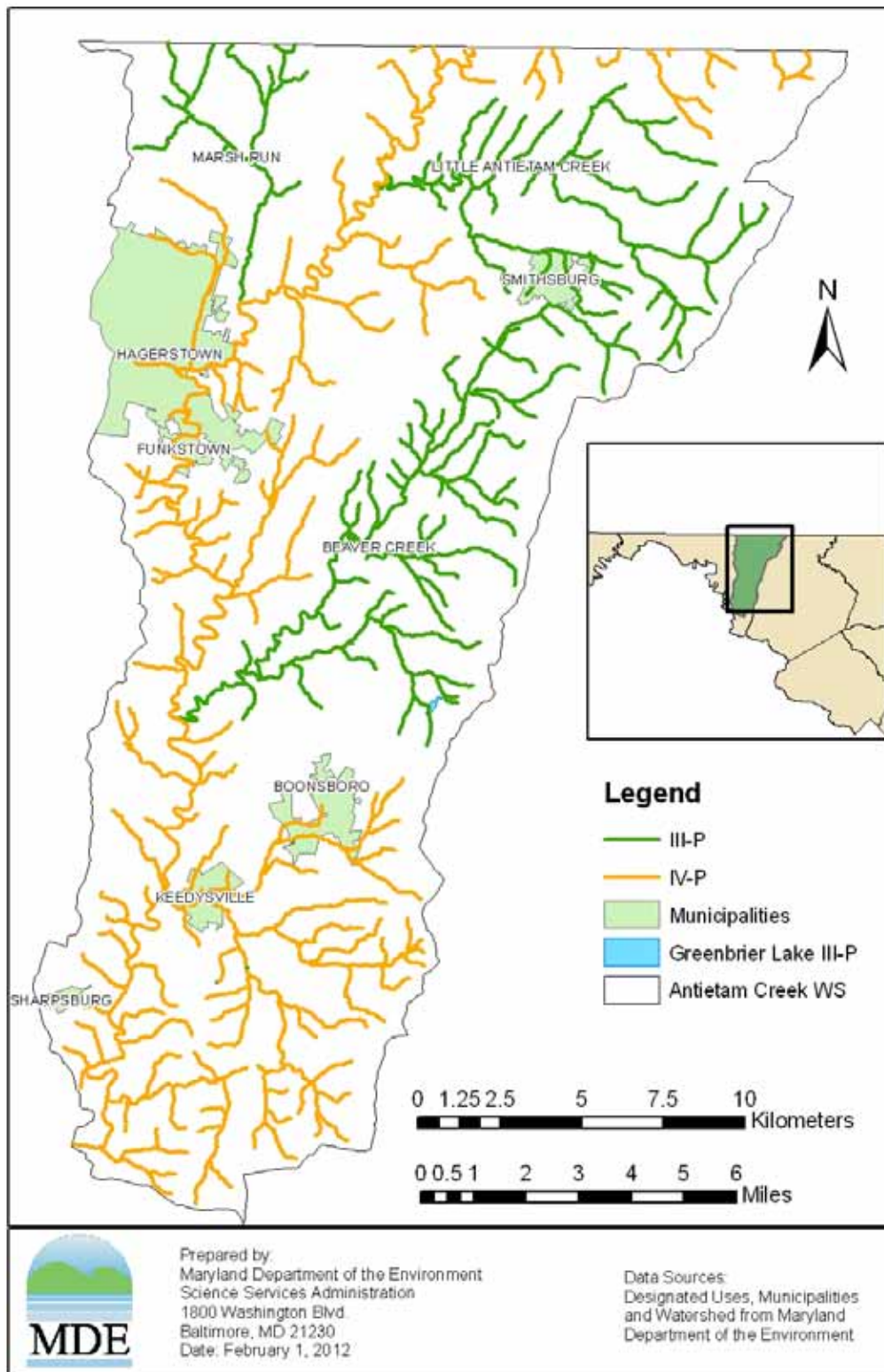


Figure 9- Antietam Creek Watershed Stream Designations

4. Non-point Source Inventory (Criterion A)

4.1 Sediment

The TMDL for sediment developed by the state of Maryland was for the portion of the Antietam watershed labeled as (http://www.mde.state.md.us/programs/Water/TMDL/ApprovedFinalTMDLs/Pages/Programs/WaterPrograms/TMDL/ApprovedFinalTMDL/tmdl_final_antietam_creek_sediment.aspx) "Segment 2" (Figure 7) in the TMDL. This includes portions of PA and MD, however the TMDL loads committed to in the section of Assurance of Implementation in the TMDL refer to the Maryland portion of Segment 2 only.

Excess sediment is a significant biological stressor of the benthic communities in Antietam Creek. The TMDL identifies sources of sediment present in Antietam Creek watershed to include permitted Process Water sources with specific TSS limits. There are 21 process water sources in the watershed which include 3 industrial sources, 15 municipal facilities and 3 mineral mines. There are two Municipal Separate Storm Sewer Systems (MS4s) permits for Hagerstown and Washington County which cover the regulated urban load

Other sources of sediment include crop, extractive, forest, and pasture lands. No load reductions were prescribed for extractive or forest sources, so this document will address primarily the sediment from crop, and pasture sources (Table 8).

Stream channel erosion versus surficial erosion was not differentiated in the TMDL, however are significant sources of overall TSS. Areas with significant amounts of streambank and channelization have been identified and will be addressed as separate sources. As the implementation phase of the WRP continues it is expected that further study will identify additional stream channel erosion sites in need of mitigation.

Table 8 – Estimation of MD non-point source sediment contributions from TMDL

Load Source Categories	Baseline Load (ton/year)	TMDL (ton/year)	Amount of load to be reduced as part of this plan (ton/year)
Crop	18,610.8	8035.8	10,575
Extractive	172.4	172.4	0
Forest	1,629.6	1,629.6	0
Pasture	3972.9	2,082.5	1,891.3
Urban	8,490.4	3,556.8	*4932.6
Permits	703.2	703.2	0
Baseline Reduction needed for TMDL in 2008			17399.9
Baseline Reduction needed for WRP in 2012			12923

*Part of the WLA, but is addressed in this plan to meet TMDL goals

Pasture and Cropland

Agricultural runoff can contribute excess sediment loads when farming practices allow soils to be washed into the stream. The erosion potential of cropland and overgrazed pasture is particularly high because of the lack of year round vegetative cover. Livestock traffic, especially along streambanks, disturbs the riparian buffer and reduces vegetative cover, causing an increase in erosion from these areas. The 2008 baseline load from crop and pasture sources is 3972.9 tons/year.

Stream Bank Erosion



Figure 10 - Little Antietam Creek Site # 1

There is very rapid stream bank erosion at various locations along the main stem of Antietam Creek and its tributaries. The erosion contributes sediment into the stream and adds to that being washed in from runoff and storm drainage. The field analyses performed in preparation of this Watershed Based Plan included two types: a general assessment of Antietam Creek mainstem by Antietam Creek Watershed Alliance (ACWA) volunteers, and site visits by Canaan Valley Institute's Circuit Rider and Aquatic Restoration specialist and WCSCD Staff in summer 2011 to estimate Bank Erodibility Hazard Index (BEHI) values. ACWA is a watershed organization that consists of Washington County residents and local, state, and federal agency personnel who are dedicated to improving the quality of water in Antietam Creek watershed. In spring 2011, ACWA volunteers, WCSCD staff and CVI staff kayaked the mainstem of Antietam Creek and noted areas of erosion and sedimentation.



Figure 11 - Main Stem Antietam Creek, Site # 2

Although there is minor erosion along much of the Antietam Creek mainstem located in Washington County, MD the assessment identified 5 erosion sites, with a total length of 3281 feet as having greater amounts of erosion than is typical for Antietam Creek. Five sites with a total length of 6186 feet were identified on Little Antietam Creek, a tributary of Antietam Creek where highly eroding banks are very typical. Three erosion sites totaling 1652 feet in length were identified as highly eroding along Beaver Creek. In addition, 2260 feet of Hamilton Run that runs through the Hagerstown Greens at Hamilton Run golf course and 680 feet of Little Grove Creek at the Smithsburg Wastewater Treatment Plant have eroding banks (**Figure 12**)

Bank Erodibility Hazard Index (BEHI) estimates were made in summer 2011 for each of the 15 highly eroding sites identified from the field assessment. These provided estimates of sediment loads associated with these lengths. With this method, observations are made on bank height, depth of root zone, density of root material, bank angle, bank surface cover, bank material and soil stratification. These observations are combined to assign a rating for the erosion potential of Very Low (VL), Low, Moderate (MOD), High, Very High (VH), and Extreme for a streambank at a site. Near bank stress (NBS), a measure of the potential disproportionate energy distribution of the near bank region of the channel, is also determined. A regional curve of the measured streambank erosion in relation to near-bank stress and BEHI score was used to estimate the potential sediment contribution from eroding banks and sites were prioritized and mapped based on the amount of erosion (in tons/yr) being contributed by each site. (**Table 9 & Figure 14**) (USGS 2005). Further descriptions and example worksheets can be found in **Appendix C**.



Figure 12 - Smithsburg Wastewater Treatment Plant site, (Urban Stream Restoration)

The 15 sites evaluated are representative of a wide range of opportunities and challenges in the watershed. Settings include agricultural pasture and cropland to more urban settings such as adjacent to the Smithsburg Wastewater Treatment Plant and the golf course on Hamilton Run. Erosion from the sites also varies from 0.4 tons/year/foot to 0.008 tons/year/foot. The total amount of erosion being contributed by these 15 sites is 2385 tons/year or 15% of the total prescribed to be reduced by the TMDL in Maryland.

Sites were ranked by their BEHI scores, site accessibility, and landowner willingness for restoration to take place, public infrastructure threat and potential availability of funds for implementation. Prioritized sites are presented in **Table 9** and **Figure 14**.

The site of highest priority is located along 1910 feet of Little Antietam Creek. The site was formerly pastured but it has since been fenced with a constructed stream crossing for cows. High steep banks along this section continue to undercut and slump into the creek in large masses. This site contributes an annual sediment load of roughly 790 tons/year to Antietam Creek, whereas the site of lowest priority contributes less than 3 tons/year.

Table 9 – Estimated stream erosion contributions from 15 sites on Antietam Creek.

Map Key	Stream	BEHI*	NBS*	Bank Length (ft)	tons/yr/ft	tons/yr
1	Little Antietam	EXT	HIGH	1910	0.4	790.2
2	Antietam	VH	VH	2100	0.38	788.7
3	Little Grove Creek	VH	VH	680	0.43	290.5
4	Beaver Creek	EXT	MOD	450	0.37	166.5
5	L. Ant/Dog Creek	HIGH	HIGH	3200	0.05	148
6	Little Antietam	VH	MOD	730	0.118	87
7	Hamilton Run	MOD	HIGH	2260	0.03	58
8	Antietam	HIGH	HIGH	500	0.038	19.2
9	Antietam	MOD	HIGH	290	0.03	7.7
10	Beaver Creek	MOD	MOD	902	0.008	7.4
11	Antietam	HIGH	EXT	70	0.09	6.15
12	Little Antietam	HIGH	MOD	191	0.03	4.8
13	Beaver Creek	LOW	HIGH	300	0.02	4.6
14	Little Antietam	HIGH	LOW	155	0.02	3.6
15	Antietam	MOD	MOD	321	0.009	2.85
			Total	14059		2385.2
			Percent of prescribed reduction			19%

*Sites were evaluated using Bank Erodibility Hazard Index (BEHI) and Near Bank Stress (NBS) methods.

The 15 sites listed above were chosen as representative of the types of eroding banks found along Antietam Creek and its tributaries.

An additional ten sites (Identified as letters a through j on **Figure 13**) represent locations where eroding banks are in need of stabilization but have not yet been evaluated using the BEHI or NPS methodology. During phase I of the implementation plan these sites will be evaluated using the BEHI methodology and prioritized for implementation accordingly. These sites include a section of Hamilton Run that runs through Pangborn Park, a section of Beaver Creek immediately downstream of the bridge on Crystal Falls Drive (bridge scheduled for replacement in 2015

The Washington County Department of Public Works has selected 600 foot a section of Little Antietam Creek adjacent to Greensburg Road as their first priority for stream restoration (indicated on **Figure 13** as letter e). The County has allocated significant resources as part of their annual Capital Improvement program budget for this stream restoration. The eroding stream banks threaten public infrastructure and contribute a significant amount of sediment in the watershed. A reduction of 2,140 lbs/yr is expected from completion of this project. The County has made application through the MDE for \$240,000 in FFY 2012 Federal Clean Water Act Section 319 (h) to supplement county funds for project completion.



Figure 13 – Little Antietam Creek at Greensburg Road (Letter e, in Figure 17)

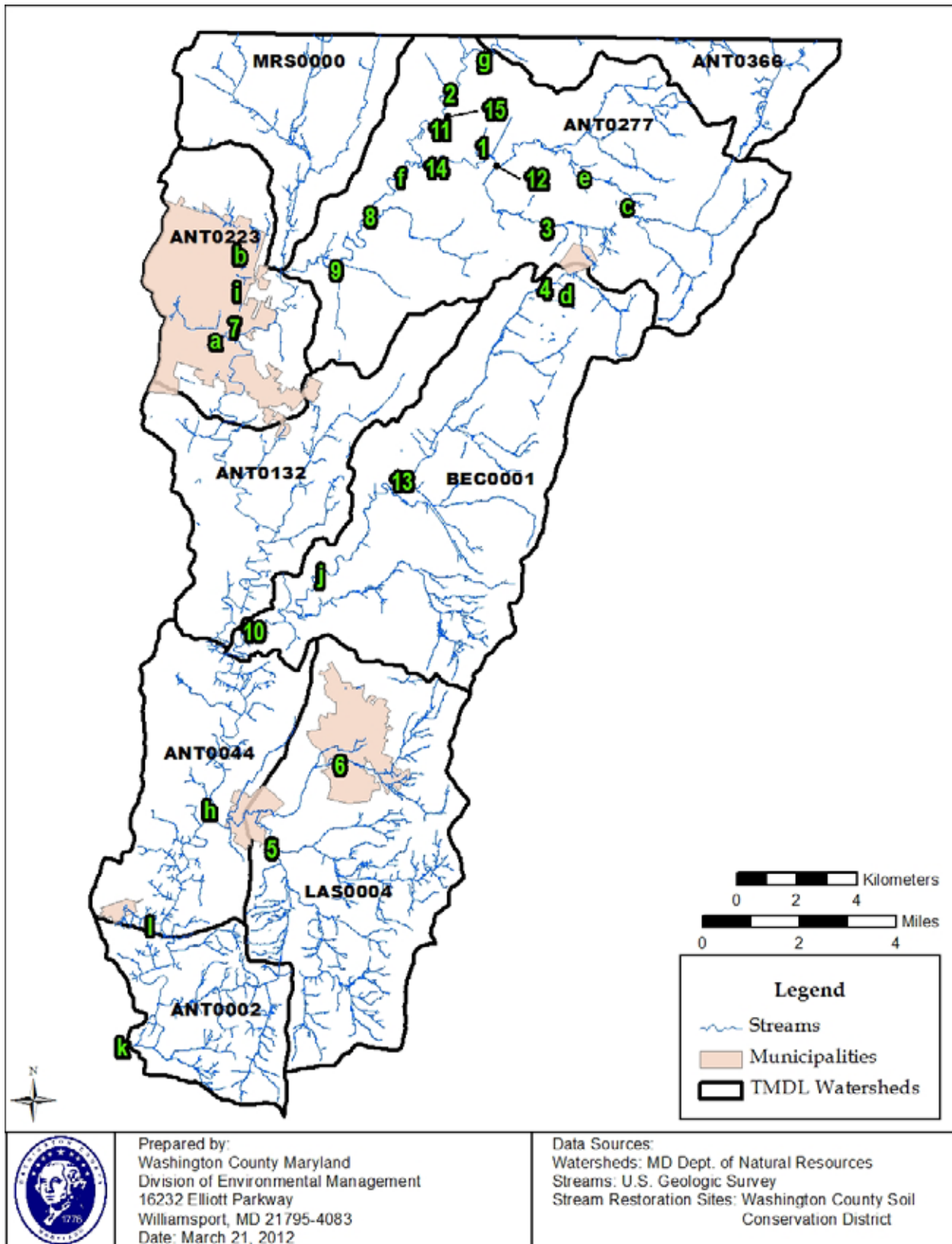


Figure 14 – Map of Priority Sites Identified for Stream Restoration*

*Numbered sites represent priority ranking for which BEH's have been performed. Letters indicated stream erosion sites of interest to landowners, but have not evaluated fully to date.

4.2 Bacteria

(http://www.mde.state.md.us/programs/Water/TMDL/ApprovedFinalTMDLs/Pages/Programs/WaterPrograms/TMDL/approvedfinaltmdl/tmdl_final_antietam_bacteria.aspx)

The Bacteria TMDL for the Antietam Creek Watershed lists the sources of fecal coliform impairment in the watershed as those from Human, Domestic, Livestock and Wildlife. Human sources present in Antietam Creek watershed include sewage treatment facilities (12 active municipal and 2 industrial NPDES permitted point source facilities), discharges from Municipal Separate Storm Sewer Systems (MS4s), failing or nonexistent on-site sewage disposal systems (also called “septic systems” in this plan), and storm water runoff from pasture and cropland.

The sewage treatment facilities are regulated as point sources. Maryland’s portion of Antietam Creek watershed is located entirely within Washington County. Parts of the Antietam Creek watershed in Maryland are covered by a general Phase II NPDES Municipal Separate Storm Sewer System (MS4) permit for the State Highway Administration, Washington County, Hagerstown, and Smithburg. Therefore, some of the fecal coliform bacteria loading associated with precipitation and runoff from residential and urbanized areas is considered regulated as a point source. **Table 10** summarizes the fecal coliform load reductions estimated to be needed from nonpoint sources. Those sources are discussed below. Since the purpose of this document is to address the non-point sources of fecal bacteria, the loads from livestock and domestic animals will be addressed primarily, as well as the portion of the human load associated with failing septic systems.

Table 10 - TMDL Baseline loads and reductions for all sectors

Source	Baseline Load (Billion <i>E. coli</i> MPN/year)	Allocated Load (Billion <i>E. coli</i> MPN/year)	Reduction Needed (Billion <i>E. coli</i> MPN/year)	Percent reduction necessary
Domestic Load ¹	1,302,268	26,045	1,276,223	98%
Human Load ¹	1,161,098	43,389	1,117,709	96%
Livestock Load	1,833,709	36,673	1,797,036	98%
Wildlife Load	1,496,506	276,002	1,220,504	82%

Numbers are taken from fecal bacteria TMDL Tables 4.6.1 and 4.7.2.

¹Loads assigned to the Waste Load Allocation (WLA) are covered by NPDES MS4 permits

4.2a Domestic Load

Runoff from residential and urbanized areas during storm events can be significant fecal coliform sources, delivering bacteria from the waste of pets and wildlife to the water body. In the Antietam Creek watershed, approximately 94% of impervious urban acres and 80% pervious urban acres are covered under Phase II NPDES permits. The magnitude of the load reduction prescribed by the TMDL for this source is 1,276,223 billion *E. coli* MPN/year. It will be beneficial to implement residential/urban BMPs that reduce bacteria deposition or the volume of stormwater runoff into streams. These may include proper pet waste disposal, forest and grass buffers along streams, bioretention (rain gardens), wetlands, downspout disconnections, dry swales, and impervious surface reduction. Residential/urban BMPs are included in this Watershed Based Plan, and should be eligible for federal Section 319 funding.

4.2b Human Load

Roughly 60% of Washington County consists of Karst topography, areas shaped by the dissolution of soluble limestone bedrock. Karst formations are cavernous and therefore have high rates of permeability, resulting in reduced opportunity for contaminants to be filtered out. Overloaded or malfunctioning septic tanks in Washington County may dump raw sewage directly into underground channels. Many of these channels find their opening at the banks of Antietam Creek. The TMDL considers the entire human load generated through county stormwater systems and sanitary sewer overflows as a regulated point source under Washington County's National Pollutant Discharge Elimination System (NPDES) MS4 permit.

Although the TMDL considers all of the human load from stormwater to be regulated as a point source under Washington County's NPDES MS4 permit it is likely that bacteria from failing septic systems is reaching the creek untreated. There are an estimated 31,865 households in the Antietam Creek Watershed. Of these, 8,730 are served by onsite disposal (septic) systems (**Figure 15**). According to the Washington County Health Department, it is estimated that approximately 43 of these fail or underperform each year and are in need of some type of correction (**Figure 16**). The Minnesota Pollution Control Agency found that effluent from septic systems had bacteria concentrations of up to 240,000 MPN/100ml (**Appendix E**). During the development of the West Virginia Potomac Direct Drains TMDL, Tetra Tech observed average bacteria concentrations of 527,179 counts/100ml from failing septic systems which were modeled to be contributing 50 gal (190,000ml) of untreated sewage per day (WVDWWM 2007). Therefore if the more conservative estimate of 240,000 MPN/100ml is used, it can be expected that effluent from a failing septic system passing through the karst geology contributes up to 166 Billion MPN *E. coli* per year. Each year the 43 septic systems estimated to be failing, potentially contribute 7138 Billion MPN *E. coli* to Antietam Creek.

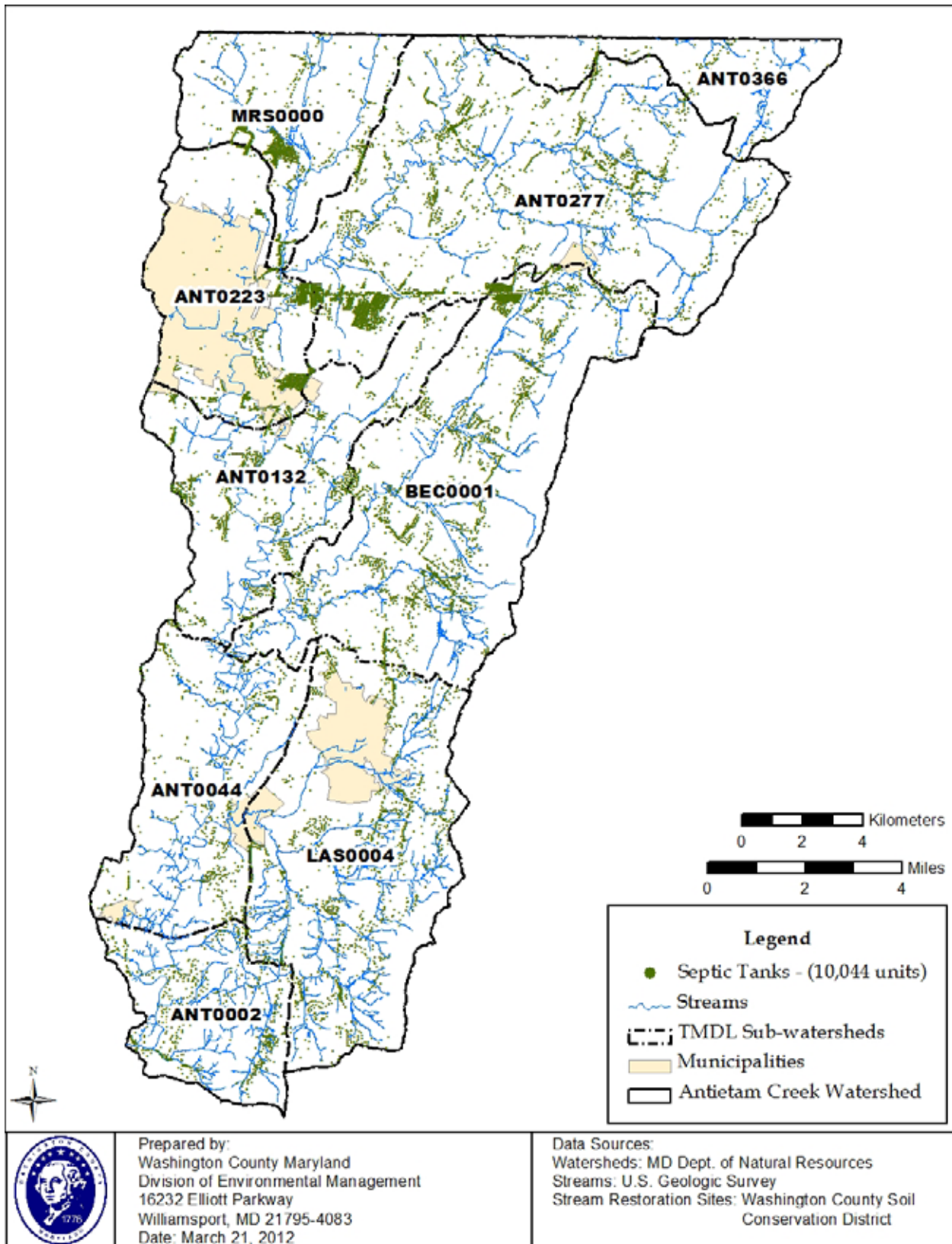


Figure 15 - Location of Septic Systems

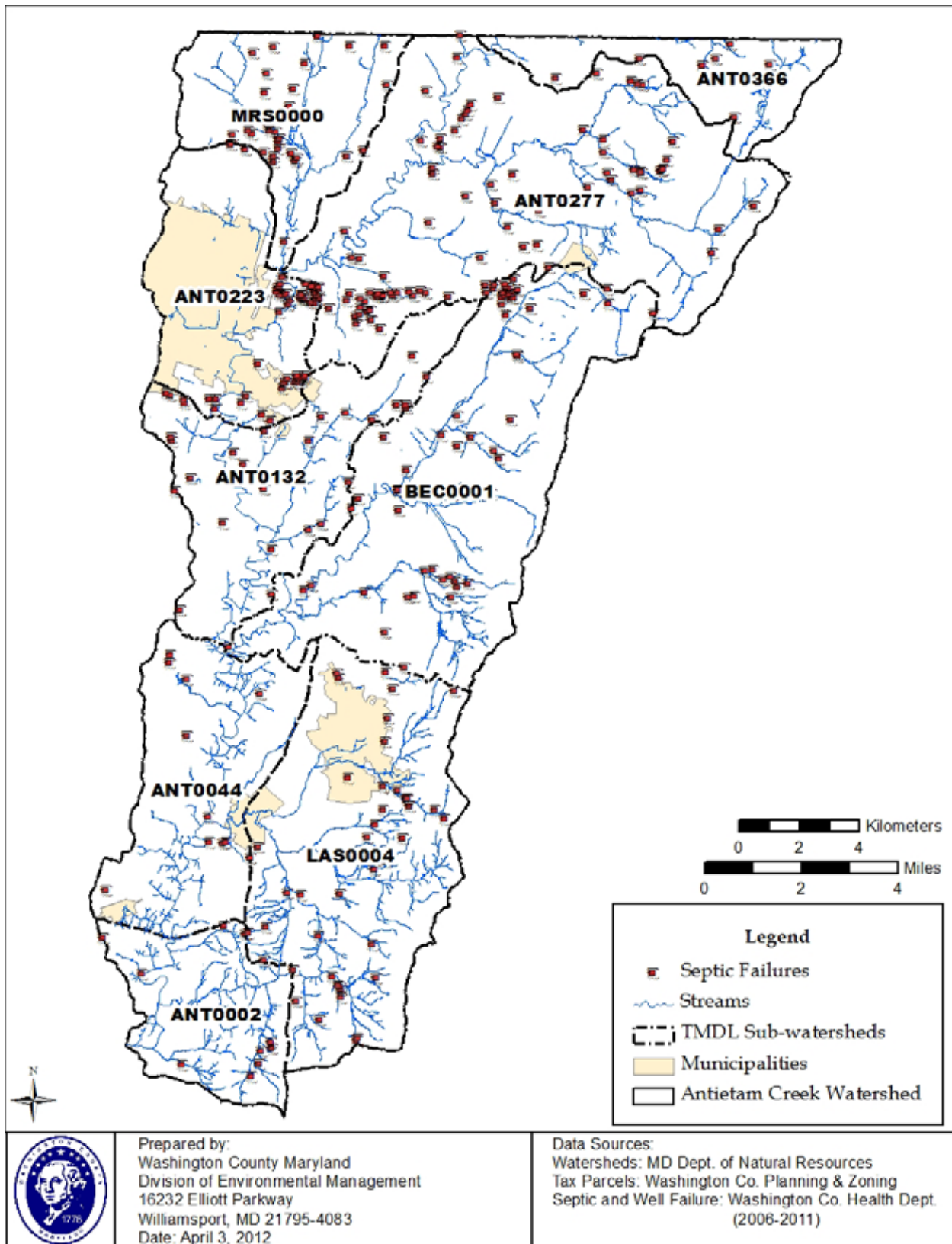


Figure 16 - Location of replaced septic systems

4.2c Livestock Load

Grazing livestock and land application of manure (cattle and poultry) result in the deposition and accumulation of bacteria on land surfaces in the Antietam Creek watershed and are the main sources of the livestock load in Antietam Creek Watershed. In addition, limestone soils in the watershed with their numerous limestone rock outcrops and sinkholes present pathways for bacteria to enter groundwater resources. Additional loadings come from barnyard areas that have uncontrolled storm water runoff flowing over areas with animal wastes present.

Unrestricted access to streams by livestock can be a significant source of bacteria due to deposition of animal waste immediately adjacent to or directly into streams. While significant strides have been made by the agricultural producers in the watershed to exclude livestock from streams this remains a significant source of bacteria.

The dairy industry is the predominant agricultural enterprise in the watershed with 86 operations licensed to ship milk. Of the operating dairies 51 (59%) have constructed animal waste storage facilities to better manage animal waste. Animal waste storage facilities allow for better timing of land application to optimize crop benefits and detrimental impacts to water resources. **Table 11** details livestock numbers by type in the watershed. **Figure 17** shows the location of dairies within MD's portion of Antietam Creek. It is estimated that agriculture contributes 1,833.708 billion *E. coli* MPN/year in the Antietam watershed.

Table 11 – Antietam Creek Livestock Census

Animal Type	Number of Animals*
DAIRY COWS	13,440
BEEF COWS	1,042
CHICKENS (Layers)	150,000
HOGS	900
SHEEP	873
DUCKS	18,800

* Animal numbers based on 2010 National Agricultural Statistics Service (NASS), 2010 Washington County Profile. Animal numbers confirmed by local knowledge of average and specific herd and flock sizes. Basic calculations based on proportionate land area in the watershed compared to NASS animal numbers for the entire County.

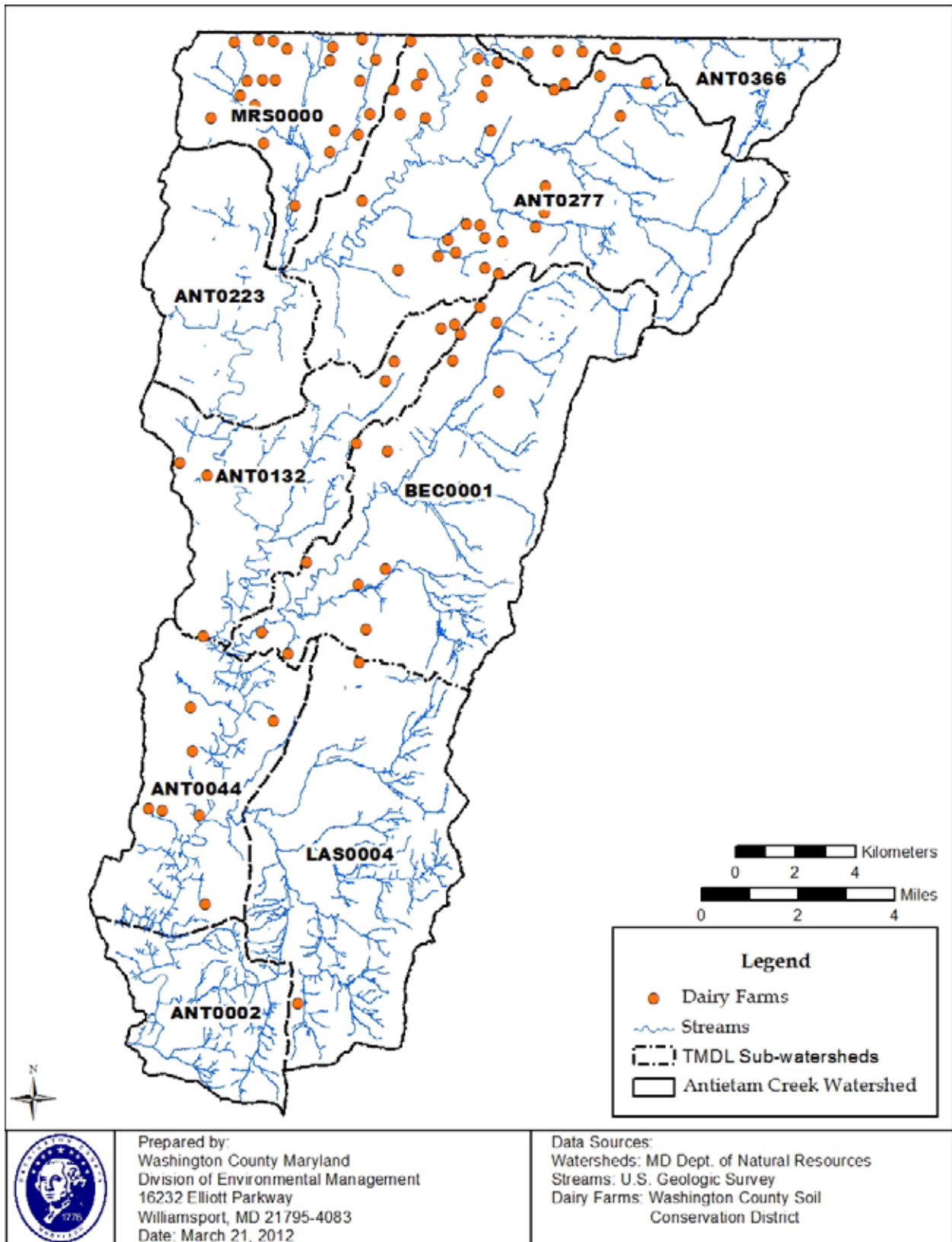


Figure 17 - Location of Dairy Operations

4.2d Wildlife Load

Wildlife are a significant source of bacteria in the watershed contributing a load of 1,496,506 billion *E. coli* MPN/year. It is anticipated that non-point source BMP's implemented for agriculture and urban lands will effect some reductions of the wildlife load, but will not achieve the required reduction of 1,220,504 billion *E. coli* MPN/year. Current methods of wildlife control center on hunting to reduce wildlife populations to achieve balance with habitats and the community. Liberal deer, small game and resident goose seasons are in place to manage wildlife populations and revision of the wildlife management plan for this area may be needed to meet TMDL goals. The wildlife load alone exceeds the TMDL for bacteria will need to be addressed once the other managed non-point source sectors have been fully implemented.

5. Non-point Source Management (Criterion B)

5.1 Sediment

Implementation for sediment load reduction is limited to "Segment 2" (**Figure 7**) as indicated in the Sediment TMDL. This includes portions of PA and MD, however the Antietam WRP is dedicated to achieving reductions in the Maryland portion of the watershed.

Load reductions for sediment were estimated using a simple accounting spreadsheet and the Maryland Assessment Scenario Tool (MAST) (www.mastonline.org). Pollution reduction efficiencies are based on those in the Chesapeake Bay Tributary Strategy (where applicable). A detailed description of the load reduction calculations can be found in Appendix B. Using this spreadsheet, the work group estimated that the sediment reductions found in the following tables would be achieved through the installations of various Best Management Practices.

Table 12 - Sediment Reductions from Non-Point Sources during period of TMDL development to 2012

2009-11					
Acres	BMP	Reduction Efficiency	Reference	Landuse	Tons (EOS)
26.25	Grass Buffer	45%	2	Hi-Till	9.35
10.9	Forest Buffer	60%	2	Hi-Till	6.66
280	Stream Protection without Fencing	40%	1	Pasture	25.21
403	Stream Protection with Fencing	75%	1	Pasture	68.03
12410	SCWQP	40%	1	Low-Till	3114.69
16	Runoff Control	75%	1	AFO	25.35
2384	Conservation Tillage	LU	3	Hi-Till	1047.1
	Retire Highly Erodible Land	LU			
4.35		Change	3	Tramp. Past.	8.98
1230	Stream Rest.	MAST	4	Mix Pas, lowtill	0.27
543.6	Harvested Forest*	50%	1	Harvested Forest	171.4
Total Reduction					4477.04

*Assumes 81% compliance with ESC practices.

1 -Chesapeake Bay Model version 4.3 BMP efficiencies

2 -Chesapeake Bay Model version 5.3 BMP efficiencies (no 4.3 values)

3 - LU Change using TMDL reduction spreadsheet from MDE

4 - Calculated using MAST w/5.3 model BMP efficiencies (no 4.3 reference)

Table 13 – Non-Point Source Strategy for 2017

2017 Milestone					
Acres	BMP	Reduction Efficiency	Reference	Landuse	Tons (EOS)
4000	Cover Crops	65%	2	low-till	1595.3
	Conservation Tillage	LU			
4000		Change	3	Hi-Till	1562.7
6000	SCWQP	40%	1	low-till	527.1
500	Stream Protection without Fencing	40%	1	Pasture	11.25
300	Stream Protection with Fencing	75%	1	Pasture	40.5
113	Grass and Forest Buffers	53%	1	low-till	69.0
50	Retire Highly Erodible Land	MAST*	3	70 T.Past/Low-Till	173.5
0.15	Stream Rest	MAST	4	Pasture & Low-Till	1.6
543	Forest Harvesting Practices	50%	1	Forest	171
	Total Reduction				4152

1 -Chesapeake Bay Model version 4.3 BMP efficiencies

2 - Calculated by WCSCD using RUSLE2

3 - LU Change using TMDL reduction spreadsheet from MDE

4 - Calculated using MAST w/5.3 model BMP efficiencies (no 4.3 reference)

Table 14 – Non-Point Source Strategy to meet TMDL in 2025

2025 Strategy Includes building upon 2017					
Acres	BMP	Reduction Efficiency	Reference	Landuse	Tons (EOS)
4000	Cover Crops	65%	2	low-till	1380.4
	Conservation Tillage	LU			
6200		Change	3	Hi-Till	2454.17
3050**	SCWQP	40%	1	low-till	795
1300	Stream Protection without Fencing	40%	1	Pasture	117.04
780	Stream Protection with Fencing	75%	1	Pasture	131.67
295	Grass and Forest Buffers	53%	1	low-till	98.10
130	Retire Highly Erodible Land	MAST*	3	70 T.Past/Low-Till	148.27
4800	No-Till	70%	1	low-till	2108.25
0.25	Stream Rest	MAST	4	Pasture & Low-Till	3.68
250	Forest Harvesting Practices	50%	1	Forest	78.8
	Total Reduction				7408

* Local Acreage greater than TMDL

**Additional Acres as compared with Table 13

1 -Chesapeake Bay Model version 4.3 BMP efficiencies

2 - Calculated by WCSCD using RUSLE2

3 - LU Change using TMDL reduction spreadsheet from MDE

4 - Calculated using MAST w/5.3 model BMP efficiencies (no 4.3 reference)

Table 15 – Urban Strategy to meet TMDL in 2025

BMP Type	*Sediment Reduction per Impervious Acre Treated (lbs)	% Area Of Watershed That BMP Was Applied To In MAST Scenario
Bioretention / Rain Garden	774.9	7.17
Bio-swale	774.9	7.17
Dry Detention Ponds and Hydrodynamic Structures	97.1	7.17
Dry Extended Detention Ponds	581.2	7.17
Forest Conservation (pervious only)	168.6	2
Impervious Urban Surface Reduction (impervious only)	767.7	2
MS4 Permit 20% Retrofit	629.7	7.17
Permeable Pavement (no sand or veg. with under drain AB soils)	678.3	2
Stormwater Management by era 1985 - 2002	387.5	2
Stormwater Management by era 2002 - 2010	774.9	7.17
SWM to the MEP	872.1	7.17
Urban Filtering Practices	774.9	7.17
Urban Forest Buffers	311.6	2
Urban Infiltration Practices (no sand/vegetation, no under drain)	920.6	2
Urban Nutrient Management (pervious only)	-	2
Street Sweeping 25 Times a Year	87.0	7.17
Urban Stream Restoration (per 100' of stream)	16,604.3	7.17
Vegetated Open Channel	678.3	7.17
Wet Ponds & Wetlands	581.2	7.17
	*Total tons/yr of sediment reduced from urban strategy	5930.49

*Urban Reduction calculated in MAST

Table 16 - Evaluation of reductions to meet TMDL

REDUCTION Summary	EOS Load reduced (tons/yr)
2017 Milestone NPS Reduction goal	7618
2017 Urban Sector*	3558
2017 Non-Point Source	4152
2017 Milestone NPS Reduction	7710
WRP TMDL Reduction goal	12923
2025 Urban Reduction*	5931
2025 Non-Point Source	7408
NPS Post-Implementation Reduction	13339

*Urban Reduction calculated in new model

5.2 Bacteria

Non-point source bacteria loads for the Antietam Creek were derived by measuring in-stream concentrations at various subwatershed outfalls within the Antietam Creek watershed. The NPS pollutant concentrations coming off Agricultural land and via failing Septic systems are the focus of this plan. In particular, dairy and beef operations will be the primary target of developing animal waste management systems, livestock exclusion from streams and loafing lot management to control livestock loads from animal operations. Filter Strips and new nutrient management laws will be incorporated to remove bacteria from manure applications to cropland. The reduction efficiencies associated with the individual practices and combinations of those practices should yield the necessary bacteria load reduction to meet the water quality criteria for the TMDL.

The calculation of Bacteria reductions in a strict quantitative manner was more difficult to display based on the way the TMDL was set up. The TMDL was based on in-stream concentrations that were not necessarily attributable to individual land use values and therefore an Edge of Stream or delivered load for specific land uses was not able to be calculated as was the sediment reductions. However, the bacterial reduction efficiencies (**Table 17**) will show that the implementation of the practices identified will likely meet the reductions required by the Bacteria TMDL due to their treatment of animal production facilities and manure spreading on croplands.

Table 17 – Bacteria BMPs Reduction Efficiencies

BMP Type	Description	Reduction Efficiency	Reference
Res*	Septic tank pumpout	50%	2
Res	Septic system repair	100%	1
Res	Septic system replacement	100%	1
Res*	Alternative waste treatment	100%	1
Res*	Pet waste digester	100%	4
Res*	Rain garden	40%	2,6
Res*	Pet waste education program	50%	3
Ag	Improved pasture management	50%	5,8
Ag	Riparian buffer	50%	2
Ag	Woodland buffer filter strip	60%	2
Ag	Grassed buffer filter strip	50%	2
Ag	Livestock exclusion	100%	1
Ag	Poultry litter storage	99%	7
Ag	Manure storage	80%	7
Ag	Loafing lot management system	75%	6,7
Ag	Sod waterway	50%	9
Ag	2012 MD Nutrient Management Laws	100%	10

1. Removal is defined by the practice
2. VADCR and VADEQ TMDL Implementation Plan Development Guidance Manual
3. Modified from Swann, C. 1999. A survey of residential nutrient behaviors in the Chesapeake Bay. Widener Burrows, Inc. Chesapeake Bay Research Consortium. Center for Watershed Protection. Ellicott City, MD. 112pp.
4. Virginia Mill and Hawksbill TMDL IP, MapTech, September 13, 2007
5. Commonwealth of Virginia. 2005. Chesapeake Bay Nutrient and Sediment Reduction Tributary Strategy. www.naturalresources.virginia.gov/Initiatives/TributaryStrategies/
6. Chesapeake Bay Model version 4.3 BMP efficiencies
7. Virginia North River TMDL IP, MapTech, July 5, 2001
8. Bacteria efficiency estimated based on sediment and nutrient efficiency
9. Fiener, P., Auerswald, K. Effectiveness of grassed waterways in reducing runoff and sediment delivery from agricultural watersheds. J. Environ. Qual. 32:927-936 (2003).
10. Code of Maryland Regulations 15.20 (2012).

Though the Bacteria TMDL presents many challenges, the goal of Phase I is to reduce fecal coliform loads by approximately 60% in the non-point Ag sector and 25% reduction in wildlife load. This would be a reduction 1,078,221.6 billion *E. coli* MPN/year for Agriculture and a 305,126 billion *E. coli* MPN/year for wildlife in 2017. The BMPs outlined in **Table 18**, along with the new MD nutrient management laws which regulate the application of manure on croplands, will be sufficient to achieve the phase I target.

Table 18 – BMP Schedule for Bacterial Mitigation

Practice	Units	Goal 2017	Goal 2025
Pet Waste Runoff Campaign	N/A	Ongoing sustained campaign	Ongoing sustained campaign
Septic System Upgrades	Systems	248	645
Grass Buffers	Acres	13	35
Riparian Forest Buffers	Acres	100	260
Stream Protection with Fencing (livestock exclusion)	Acres	300	780
Stream Protection without Fencing (livestock exclusion)	Acres	500	1300
Livestock Stream Crossing	Each	7	17
Soil Conservation and Water Quality Planning	Acres	6,000	15,460
Runoff Control Systems (loafing lot management)	Acres	4	12
Animal Waste Management Systems (Manure Storage)	Each	10	26
Education and Outreach	Employee and outreach costs	Secure funding and hire by 2013	Maintain funding through 2025

Table 19 – Failing Septics Strategy to meet TMDL in 2025

2012-25						
Units	Annual Amount	BMP	Estimated reduction per unit	# years Phase1&2	Landuse	Total Reduction
Systems	43	Replace Failing Septics	166 B. MPN/yr	13	Residential	92794 B. MPN/yr
Total Reduction for septic strategy and work achieved						92794 B.MPN/yr

The bacteria load from wildlife will be addressed by many of the cropland and pasture BMPs implemented. However, in order to truly reduce all wildlife loads, it will require treatment through point source (MS4) areas as well. Part of the adaptive management strategy being employed is to take care of the sources which can be affected by direct mitigation and then work with Maryland Department of Natural Resources to come up with a wildlife management plan if bacteria levels from that source are still significant.

If by the end of 2017, reductions have not been met in Ag and wildlife sectors, then new technologies such as manure digesters will be explored in order to treat bacteria at the source for livestock, and a wildlife management plan will be put into effect to limit the amount of bacteria from that sector.

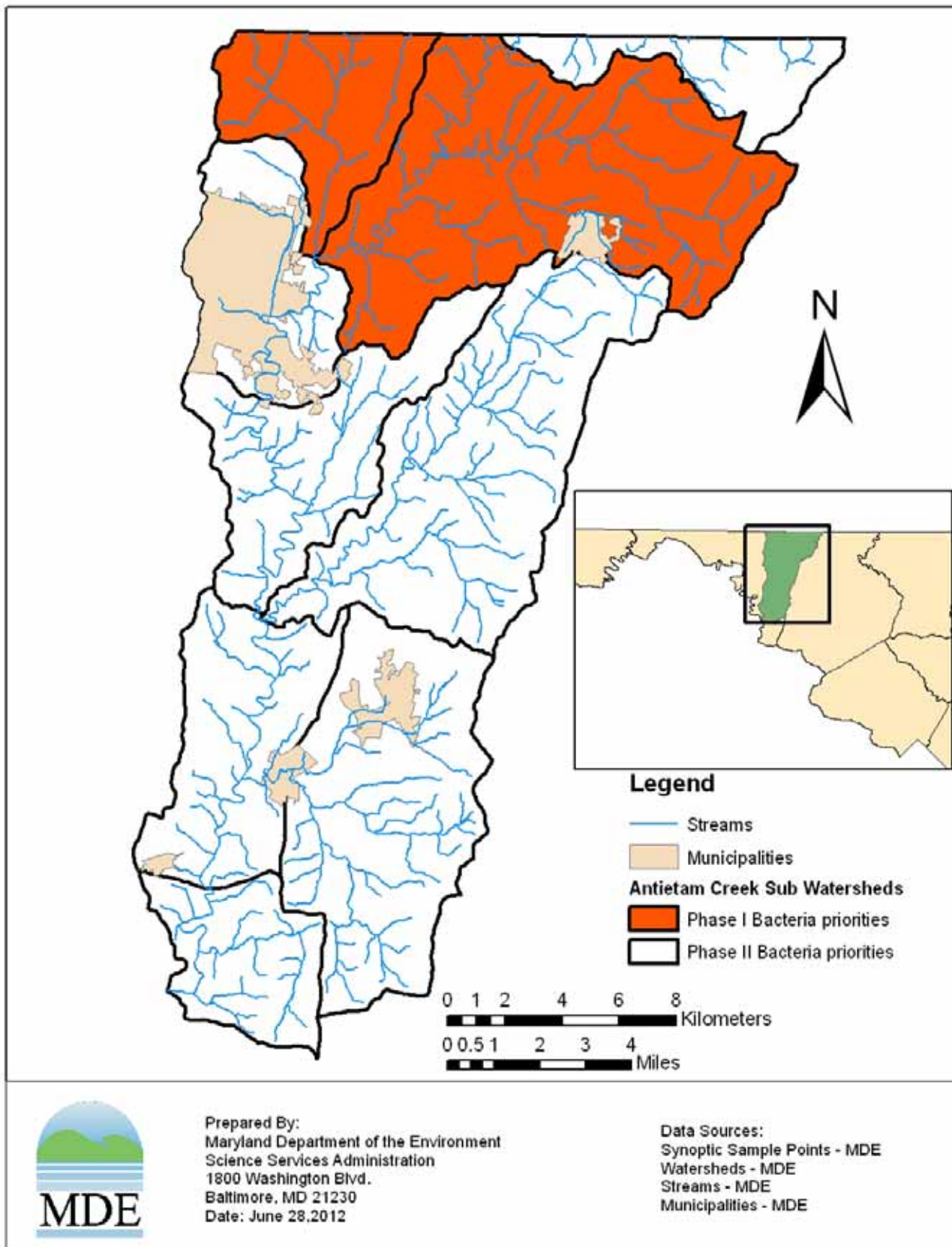


Figure 18 – Map of priority subwatersheds for bacteria BMP implementation

5.3 Potential Treatment Technologies (Criterion C)

The following list describes in depth the various best management practices that may be used to reduce sediment and fecal coliform impairments within the Antietam Creek watershed. The addition of the following indicators identifies whether or not the BMPs address sediment, fecal coliform or both: B = Both, F = Fecal Coliform specific and S = Sediment specific.

Filtering practices (B)

Filtering BMPs are designed for reduction of urban runoff impacts, water quality control, stream channel protection, and peak discharge control for both small and large storms. They capture and temporarily store the water quality volume and pass it through a filter of sand, organic matter and vegetation, promoting pollutant treatment and recharge. Examples of practices include vegetated open channels and raingardens.

Infiltration practices (B)

Infiltration BMPs are designed for reduction of urban runoff impacts, groundwater recharge, water quality control, stream channel protection, and peak discharge control for both small and large storms. Performance information for all of these practices was derived from their use in urbanized/high impervious land use areas. Effectiveness estimates vary by soil type and other factors, and are described in Simpson and Weammert 2009, pp. 342-362. The following are examples of infiltration BMPs:

- *Bioretention*: An excavated pit backfilled with engineered media, topsoil, mulch, and vegetation. These are planting areas installed in shallow basins in which the storm water runoff is temporarily ponded and then treated by filtering through the bed components, and through biological and biochemical reactions within the soil matrix and around the root zones of the plants.
- *Permeable Pavement and Pavers*: Pavement or pavers that reduce runoff volume and treat water quality through both infiltration and filtration mechanisms. Water filters through open voids in the pavement surface to a washed gravel subsurface storage reservoir, where it is then slowly infiltrated into the underlying soils or exits via an under drain.
- *Infiltration Trenches and Basins*: A depression to form an infiltration basin where sediment is trapped and water infiltrates the soil. No under drains are associated with infiltration basins and trenches, because by definition these systems provide complete infiltration.

Urban Wet Ponds (S)

Depressions or basins created by excavation or berm construction that receive sufficient water via runoff, precipitation, and groundwater to contain standing water year-round at depths too deep to support rooted emergent or floating-leaved vegetation (in contrast with dry ponds, which dry out between precipitation events). Nutrients and suspended particles are removed via settling. Nitrogen is further removed primarily via plant and microbial uptake and nitrification-denitrification reactions, while phosphorus is further removed by soil sorption.

Urban Wetlands (S)

Wetlands have soils that are saturated with water or flooded with shallow water that support rooted floating or emergent aquatic vegetation (e.g. cattails). Nutrients and suspended particles are removed via settling. Nitrogen is further removed primarily via plant and microbial uptake and nitrification-denitrification reactions, while phosphorus is further removed by soil sorption. Effectiveness estimates: (Simpson and Weammert 2009, p. 541).

Impervious Surface Reduction (B)

Practices that reduce the total area of impervious cover and practices that capture storm water and divert it to pervious areas, subsequently encouraging storm water infiltration; e.g. natural area conservation, disconnection of rooftop runoff, and rain barrels.

Pet Waste Runoff Campaign (F)

Practices to increase awareness regarding the importance of proper disposal of pet waste will include: maintaining vegetative buffer areas between streams and areas where pets or wildlife defecate, distributing and promoting pet waste digesters, installing pet waste bag stations in common areas of subdivisions, and conducting outreach about pet waste disposal, especially showcasing the above practices

Septic Upgrade (F)

Washington County is currently participating in MDE's Bay Restoration Fund (BRF) septic system upgrade program. As of July 2011 55 failing septic systems in the Antietam Creek watershed were replaced with MDE approved Best Available Technology for nitrogen removal. These systems are also efficient at addressing bacterial loads in effluent.

Grass Buffers (B)

A linear strip of grass or other non-woody vegetation maintained along stream banks helps filter bacteria, nutrients, sediment and other pollution from runoff. During highwater and flooding events, vegetation holds soil in place and can trap some excess nutrients from upstream waters flowing over it. .

Riparian Forest Buffer (B)

A tree and shrub buffer of at least 35 feet will be established and maintained along the stream corridor and/or water body to reduce excess amounts of sediment, organic material, nutrients and pesticides in surface runoff and reduce excess nutrients and other chemicals in shallow ground water flow. The location, layout, width, and density of the riparian forest buffer will be selected to accomplish the intended purpose and function

Stream Protection with Fencing (B)

A fence will be constructed adjacent to the stream bank to eliminate livestock access to streams. Pasture fencing keeps farm animals out of streams and prevents streambank erosion.

Stream Protection without Fencing (B)

Watering troughs provide a safe, reliable source of water for livestock that is away from streams. The troughs help protect stream banks from erosion that may be caused by farm animals. Water for the trough will be supplied from a well or other collection system linked to sub-surface water or a spring.

Livestock Stream Crossing (S)

A stream crossing will be constructed to improve water quality by reducing sediment, nutrient, organic, and inorganic loading of the stream and reduce stream bank and streambed erosion. The stream crossing will be constructed according to an engineering design based on NRCS standards. This practice is not given its own pollutant reduction efficiencies, but is used in conjunction with Livestock Fencing and Alternative Watering.

Runoff Control Systems (B)

Runoff control systems use a variety of techniques to direct rainwater to places where it won't cause nutrient runoff or soil erosion. Gutters and downspouts on barns and grading of the land are examples of ways to direct runoff from rainfall.

Nutrient Management Planning (F)

Farm operators develop a comprehensive plan that describes the optimum use of nutrients (sometimes consisting of animal manures) to minimize nutrient loss while maintaining yield.

Soil Conservation and Water Quality Planning (S)

Farm operators develop a plan to address soil erosion and water quality issues on their owned and rented lands.

Conservation Tillage (S)

Conservation Tillage involves planting and growing crops with minimal disturbance of the surface soil. No-till farming, a form of conservation tillage, is used to seed the crop directly into vegetative cover or crop residue with no disturbance of the soil surface. Minimum tillage farming involves some disturbance of the soil, but uses tillage equipment that leaves much of the vegetative cover or crop residue on the surface

Cover Crops (S)

Plant commodity and traditional cover crops (small grains such as wheat or rye that are planted in the fall after the harvest of corn, soybeans and other summer crops to absorb unused fertilizers that may remain in the soil and provide a ground cover to prevent soil erosion in the winter.

Continuous No-till (S)

Continuous no-till farming, a form of conservation tillage in which seed is applied into the vegetative cover or crop residue with no disturbance of the surface soil.

Retire Highly Erodible Land (S)

Retire highly erodible land on Private Lands. Land that is especially vulnerable to erosion is removed from crop or hay production and is planted in either grass or forest. This land usually is not disturbed for at least 10 years.

Natural Stream Design (NSD) (S)

Natural Stream Design will take place on properties with significant stream bank loss and which score moderate to extreme in the BEHI assessment.

Armored Stream Bank Stabilization (S)

In some cases where streambank erosion is a problem but NSD is not possible due to site constraints (e.g. a road or building very close to streambank, making a bankfull bench out of the question), rip-rap or other methods of streambank armoring may be necessary. Innovative options which allow for greater vegetative growth may also be used, such as articulated concrete block.

Manure Digesters (F)

This technology is a component of a waste management system that provides biological treatment in the absence of oxygen. These systems offer multiple benefits for the treatment of manure and other byproducts of animal agricultural operations including, pathogen reduction, odor management, capture of biogas for energy, and reduction the net effect of greenhouse gas emissions. This technology is feasible and efficient at reducing bacteria in manure. However it is also prohibitively expensive in many areas and will be used as contingency BMP if reductions are not met through other management measures.

6. Technical and Financial Assistance/Benefits (Criterion D)

To meet TMDL standards, it will take a combination of federal, state, private and public partnerships to work jointly to provide the desired outcome; restoration of the watershed.

6.1 Technical Assistance Needs and Partners

Domestic and human BMPs costs

Canaan Valley Institute's "Watershed Wastewater Protection Plan" addresses the cost of the septic system implementation. There are estimated to be 43 systems in need of repair or upgrade annually in the Antietam Creek watershed. Estimating \$5,000 of project money to fix each failure would yield a project budget of roughly \$215,000/year. This estimate assumes the homeowner makes up the rest of the cost not provided through Section 319 project funds. In a similar report for the Sleepy Creek watershed in Morgan County, WV (Winant, 2007), the estimated average total cost of upgrading each septic system is \$7500, for a total cost of about \$322,500 annually. This is likely an overestimate of what will actually be incorporated into Section 319 project proposals, because Washington County receives funds to upgrade roughly 20 failing septic systems thru MDE's Bay Restoration Fund. However the BRF program does not include the cost to upgrade or replace the disposal system (i.e. drainfield, sand mound, etc.) This cost, averaging roughly \$5000 comes at the homeowners' expense making participation into the program difficult for many. Since a septic upgrade program already exists in Washington County, 319 funds will be used to assist homeowners already participating in the BRF program with the cost of the disposal unit.

Partners anticipated to contribute to meeting technical assistance needs include:

- Washington County Soil Conservation District (WCSCD)
- Canaan Valley Institute (CVI)
- Washington County Health Department (WCHD)
- Washington County Department of Environmental Management (WCDEM)
- Washington County Division of Public Works (WCDPW)
- Washington County Department of Planning (WCDP)
- Antietam Creek Watershed Association
- Maryland Department of the Environment

6.2 Financial Assistance Needs

The following table summarizes the costs associated with practices identified in the two phases of the Watershed Restoration Plan.

Table 20- Agriculture Best Management Practices and Costs

Practice	Units	Goal 2017	Goal 2025	Cost/unit	Total Cost
Pet Waste Runoff Campaign	N/A	Ongoing sustained campaign	Ongoing sustained campaign	\$5,000 annually	\$65,000
Septic System Upgrades	Systems	248	645	\$5000	\$3,225,000
Grass Buffers	Acres	13	35	\$350	\$12,250
Riparian Forest Buffers	Acres	100	260	\$3,300	\$858,000
Stream Protection with Fencing	Acres	300	780	\$283	\$220,740
Stream Protection without Fencing	Acres	500	1300	\$150	\$195,000
Livestock Stream Crossing	Each	7	17	\$15,000	\$255,000
Nutrient Management Planning	Acres	49,728	49,728	\$7.00	\$348,096
Soil Conservation and Water Quality Planning	Acres	6,000	15,460	\$45.00	\$695,700
Runoff Control Systems	Acres	4	12	\$5,700	68,400
Cover Crops* (Annual Practice)	Acres	4,000	4,000	\$50	\$200,000* Annual Cost
Animal Waste Management Systems	Each	10	26	\$90,000	\$2,340,000
Conservation Tillage	Acres	4,000	10,000	\$17	\$170,000
Retire Highly Erodible Land	Acres	50	130	\$1,304	\$169,520
Natural Stream Design Implementation	Linear Feet	5,000	7,800	\$150	\$1,170,000
Armored Stream Bank Stabilization	Linear Feet	1300	3,250	\$450	\$1,462,500
Education and Outreach	Employee and outreach costs	Secure funding and hire by 2013	Maintain funding through 2025	\$75,000 employee \$10,000 activities	\$85,000 annual cost
Stream Restoration Design Services	Survey, stream assessment and project design and permitting	Secure funding by 2013	Maintain funding through 2025	N/A	\$50,000 annual cost

Table 21: Urban BMPs that can be implemented to achieve the urban sediment reductions.

BMP Type	Estimated Cost Per Acre With Cost Index Adjustment (King, 2011)	Sediment Reduction per Impervious Acre Treated (lbs)	% Area Of Watershed That BMP Was Applied To In MAST Scenario
Bioretention / Rain Garden	\$44,967.30	774.9	7.17
Bio-swale	\$39,670.40	774.9	7.17
Dry Detention Ponds and Hydrodynamic Structures	\$39,670.40	97.1	7.17
Dry Extended Detention Ponds	\$39,670.40	581.2	7.17
Forest Conservation (pervious only)	\$39,273.70	168.6	2.00
Impervious Urban Surface Reduction (impervious only)	\$131,859.00	767.7	2.00
MS4 Permit 20% Retrofit	\$45,080.00	629.7	7.17
Permeable Pavement (no sand or veg. with under drain AB soils)	\$216,005.33	678.3	2.00
Stormwater Management by era 1985 - 2002	\$67,620.00	387.5	2.00
Stormwater Management by era 2002 - 2010	\$45,080.00	774.9	7.17
SWM to the MEP	\$36,064.00	872.1	7.17
Urban Filtering Practices	\$50,489.60	774.9	7.17
Urban Forest Buffers	\$29,752.80	311.6	2.00
Urban Infiltration Practices (no sand/vegetation, no under drain)	\$57,206.52	920.6	2.00
Urban Nutrient Management (pervious only)	\$54,997.60	-	2.00
Street Sweeping 25 Times a Year	\$5,453.78	87.0	7.17
Urban Stream Restoration (per 100' of stream)	\$58,153.20	16,604.3	7.17
Vegetated Open Channel	\$23,441.60	678.3	7.17
Wet Ponds & Wetlands	\$23,545.28	581.2	7.17

The Antietam Creek Sediment TMDL calls for a 58.1% reduction of the Baseline Load (8,490.4 ton/year) for the urban sector which equates to 4,932.9 ton/year. Utilizing the Maryland Assessment Scenario Tool (MAST) website, the amount of BMP implementation necessary to meet the sediment TMDL was calculated using BMP implementation parameters that were established by the County in development of the County’s Urban WIP Report. The Washington County Division of Public Works developed a MAST scenario to demonstrate how many acres would have to be treated with the MDE approved suite of BMPs in the MAST in order for the County to reach its nitrogen and phosphorus WIP targets. As part of their analysis for the WIP Urban Sector Report, DPW determined which BMPs provided in the MAST could likely be implemented throughout the county to treat stormwater.

In their report, DPW presented the total area to be treated by a BMP as a “percentage” of the county since that was the only unit that the allowed at the time. The percentages that were used for each BMP application in the WIP report were used in the MAST again to determine the sediment reductions within the Antietam Creek Watershed (HUC 02140502). It should be noted that in the development of the MAST scenarios, the BMPs were applied to percentages of “County Phase I/II MS4 Impervious,” “County Phase I/II MS4 pervious,” “nonregulated impervious developed,” “nonregulated pervious developed,” “Municipal Phase II MS4 Impervious,” and “Municipal Phase II MS4 pervious” land uses.

Some BMPs could be implemented more often than others and there were a few BMPs that DPW considered unlikely or infeasible to implement in the county due to the karst geology, dominant soil class, or implementation and maintenance costs. Engineers from the City of Hagerstown also developed a similar MAST scenario using the same methods, but for the “Municipal Phase II MS4 Impervious” land use. The “percent area” for BMP treatment that was applied to the municipal areas within the County was applied to the “Municipal Phase II MS4 Impervious” land use in the Antietam Creek Watershed.

A scenario was built in the MAST for just the urban land uses in the Antietam Creek Watershed. The Antietam Creek TMDL calls for a sediment reduction of 4,933.6 tons/year (9,867,200.0 lbs) from the urban sector and once the MAST scenario was completed, a reduction of 5,930.49 ton/year (11,860,983.0 lbs) was achieved. This is an excess reduction of 996.89 tons/year (1,993,783.0 lbs) of sediment that is most likely due to the fact that the “percent area” numbers were developed for nitrogen and phosphorus reduction scenarios. If the County meets the TN and TP WIP targets, then the urban sector of the ACWS will have met its 2025 sediment TMDL goals and vice versa.

The MAST was used to calculate the pound-per-acre reduction for each BMP. There are different loading reductions associated with a BMP in the MAST depending on whether or not the surface area being treated is a pervious or impervious. Since the majority of urban surface that may be treated with one of the BMPs are impervious, the “County Phase I/II MS4 Impervious” land use was used to calculate the BMP reductions, except where the BMP could only be applied to a pervious surface (i.e. Forest Conservation, Nutrient Management, etc).

The “percent area” of BMP treatment area was used in the development of the County’s WIP Urban Sector Report and the same numbers were used here for consistency and for planning purposes only. These numbers in no way constitute a commitment by the Washington County BOCC or municipalities of Washington County to the reduction scenario discussed here.

6.2.1 Funding

Pasture, cropland and livestock BMPs costs

Unit cost estimates for pasture BMPs were provided by Washington County Soil Conservation District. Pasture, cropland and livestock BMPs will be pursued through Conservation Reserve Enhancement Program (CREP), Maryland Agricultural Water Quality Cost Share Program (MACS), Environmental Quality Incentives Program (EQIP), and Wildlife Habitat Incentives Program (WHIP) enrollments. However, there may be a need in Antietam Creek for cost share funding for fencing close to, or at the top of, streambanks. The MACS implements the cover crop program with funding from the Chesapeake Bay Restoration Fund, 2010 Trust Fund and targeted Federal grants.

The various cost-share programs pay only a portion of the BMP implementation costs the range of cost share percentage varies from 50% to 87.5% depending on landowner program eligibility. The remaining costs are born by the individual landowners.

Many of the landowners in the watershed are of the Mennonite faith and do not accept cost share funds from any source. These individuals would bear the entire cost of BMP implementation. Innovative methods of accomplishing BMP implementation will need to be developed to accelerate BMP adoption in this community.

Natural Stream Design costs

Costs are divided into two categories, implementation and design services. Often funding is only available from grant funders for implementation costs. This presents a challenge to local partners who do not have the staff capacity to provide the level of sophistication needed to survey, design and obtain construction permits for the projects. Federal, State and Local requirements require that professional surveyors and professional engineers provide be involved in the design process and ultimately approve the designs for implementation. Funding will be sought to hire such professionals to work collaboratively with the WRP partners to accomplish this design phase of stream restoration. Funding will be pursued from Federal, State, Local and private organizations

Education/outreach costs

In order to accelerate implementation of BMPs in the watershed it will be necessary to employ an outreach and education specialist. This position will focus on adult education in the agricultural community and coordinate urban landowner/landuser education and outreach efforts. This position will partner with existing organizations such as the University of Maryland Cooperative Extension Service, Canaan Valley Institute, the Chesapeake Bay Foundation and other federal and state agencies to accomplish the needed education and outreach.

Monitoring costs

Monitoring of pre and post implementation will need to occur in a strategic manner according to the amount of implementation being conducted throughout the watershed. TMDL monitoring stations have been established and will need to be monitored on a bi-annual basis for bacteria, and sediment monitoring will need to be modified to follow implementation of BMPs. Long-term monitoring within the watershed may be addressed through a network of auto-loggers that will record data at continuous set intervals.

6.2.2 Funding Sources

This section contains a list of know possible funding sources that contribute to implementation of the management practices identified in section

Table 22- Funding Sources (Existing/Potential)

Type	Source Name	Strategic Use
Federal	319(h) Grant, Federal Clean Water Act	BMP implementation consistent with an EPA-accepted watershed plan. Also before/after monitoring of BMP implementation. Education and Outreach and Stream Restoration design funding.
Federal	USDA, NRCS, Farm Bill Conservation Programs (EQIP,WHIP, CREP and Cooperative agreements with SCD.	BMP implementation funding and Conservation Technical Assistance funding for preparation of Soil Conservation and Water Quality Plans and Stream Restoration design funding.
Federal	Chesapeake Bay Implementation Grant (CBIG) Federal Clean Water Act	Currently funds 1 Conservation Planner, 1 Conservation Technician and a Nutrient Management Specialist focused in the Antietam Creek watershed. For preparation of SCWQP's NMP's and BMP Implementation.
Federal	Innovative Nutrient and Sediment Reduction Grant, administered by National Fish & Wildlife Federation	The creation of innovative and cost-effective projects that reduce N, P and sediment to the Bay. Funding can be used to support construction, analysis, monitoring, and policy implementation, preferably in concert. http://www.nfwf.org/chesapeake
Federal	Small Watershed Grants Program, administered by National Fish & Wildlife Federation	The development of projects that improve water quality, restore habitat, and/or build citizen-based resource stewardship. Funding can be used to support design and/or construction with project analysis and monitoring if required. http://www.nfwf.org/chesapeake
State	Maryland Department of Agriculture Office of Resource Conservation annual support to WCSCD	Preparation of Soil Conservation and Water Quality Plans. Survey, Design, Construction oversight and certification of BMPs

State	Maryland Agricultural Water Quality Cost Share Program	BMP implementation funding
State	Chesapeake and Atlantic Coastal Bays Trust Fund, administered by Maryland Dept of Natural Resources	Supports implementation of projects the reduce N, P and sediment transported to the Bay. Funding preference is given to construction, some design is supported. http://www.dnr.state.md.us/ccp/funding/trust_fund.asp
State	Chesapeake Bay Trust	Watershed planning, implementation of water quality projects, new/innovative techniques for treating nutrient and sediment, green streets/infrastructure concepts & designs, community greening (urban tree canopy). www.cbtrust.org
Local	Annual Budget for SCD	Soil Conservation District management and oversight of Watershed Plan Implementation
Local	Annual CIP Budget for Washington County	Funding for stream restoration design and implementation and tree planting projects
Private	Chesapeake Bay Foundation	Funding for pasture consultant to facilitate Management Intensive Grazing and conversion of croplands to pasture acres

7. Information, Education and Public Participation (Criteria E)

This section of the plan includes the stakeholder outreach strategy including planning for public meetings, listing of stakeholders identified to date, and education and outreach materials.

Table 23- Stakeholder Outreach Strategy for the Antietam Creek Watershed Plan

Preliminary Outreach and Education 2013-2017	Initiate outreach with key stakeholders focusing on: 1) Landowners potentially affected by watershed plan, 2) Groups and individuals potentially interested in plan goals, 3) Partner agencies concerned with NPS pollution management.
Public Participation 2013-2017	Upon release of the approved watershed plan, input from stakeholders and the public will be gathered and, as appropriate, incorporated as a watershed plan update. A public meeting will be held early 2013 in cooperation with interested groups such as the Canaan Valley Institute, Antietam Creek Watershed Alliance and the Beaver Creek Watershed Association.
Implementation Outreach 2013-2025	For stream segments where BMP implementation is anticipated, “pre-implementation outreach” with landowners and other stakeholders who have a direct stake in BMP implementation will be conducted. Input gathered during pre-implementation outreach will be used to help assess the feasibility of BMP implementation. Individual contacts with farm owners and operators will be conducted as part of the farm conservation planning process. For key landowners and stakeholders identified during pre-implementation outreach, communication will be continued during BMP implementation as needed to maintain stakeholder support. Post-implementation outreach will be addressed through Annual Progress Reporting and End Phase Assessment.
Annual Progress Reporting	Each year progress will be reported in MDE’s NPS Program Annual Report, which is made available to the public via the Internet. Other special reports the may be generated will also be made publicly available. Because the majority of agricultural BMPs that will be installed also support the Watershed Implementation Plan for Washington County and the entire Chesapeake Bay annual reporting will be provided to the County and Maryland Department of Agriculture to ensure any progress is recognized as part of the larger scale efforts.
End Phase Assessments 2015, 2020, 2025	Progress toward meeting milestones will be assessed and findings in the form of watershed plan updates will be made available to the public. Input from stakeholders and the public will be gathered and, as appropriate, may be incorporated into the watershed plan as a plan update. If the assessment findings indicate that the plan should be modified, a plan addendum will be released to the public. Changes in water quality impairment (delisting) will be made public (MDE Internet). Interest in a public meeting will be solicited and, if the solicitation generates interest, a public meeting will be held in cooperation with the Washington County SCD.

Table 24- Stakeholders Identified in the Antietam Creek Watershed, February 2012

<p>Citizen Groups</p>	<p>Antietam Creek Watershed Association (ACWA) The ACWA has a vested interest in projects proposed for the Antietam Creek Watershed. ACWA has been a key partner in development of the watershed plan. They are active in the watershed hosting an annual trash clean up, promoting recreational activities and act as advocates for the Creeks health.</p> <p>Beaver Creek Watershed Association (BCWA) has a vested interest in the sub watershed of Beaver Creek. BCWA has completed three important stream restoration projects in cooperation with the SCD and other partners such as Trout Unlimited to reduce stream bank erosion and improve trout habitat.</p> <p>Antietam Fly Anglers (AFA) The AFA have participated in various restoration activities by providing funding and volunteers for tree plantings.</p>
<p>Land Owners</p>	<p>Private land owners, Washington County State of Maryland, Department of Natural Resources (DNR):</p> <ul style="list-style-type: none"> - Forest Service - Park Service -Wildlife and Heritage <p>National Park Service (Antietam National Battlefield) National Park Service (Chesapeake and Ohio Canal National Historical Park)</p>
<p>Government</p>	<p>Washington County Soil Conservation District</p> <p>Washington County (various agencies, elected officials) Md Dept. of Natural Resources: Fisheries Service, Wildlife and Heritage, and Forestry Service Md Dept of the Environment: NPS management, permitting Pennsylvania (state/local): coordination for upstream watershed US EPA: NPS management US Dept of Agriculture, Natural Resource Conservation Service (NRCS)</p>
<p>Private Business</p>	<p>Washington County Chamber of Commerce Others</p>

Education and Outreach Materials

WCSCD will seek funding to hire an outreach and education specialist to implement the education and outreach portion of the plan. This individual will develop the materials listed below, coordinate the activities of all partners in outreach and education to both the farm and urban communities of landowners and land users.

Ongoing programs of outreach will continue through community events such as the Washington County Home Builders show, Washington County Ag Expo, Boonsboro Green Fest and Sharpsburg Heritage Days.

Informational Kiosks will be placed at ten locations in the watershed on public lands to provide educational materials to watershed residents and encourage voluntary implementation of individual actions to reduce sediments and bacteria.

A pet waste campaign will be initiated to educate pet owners on the need to collect and properly dispose of pet waste. This effort will build on the current efforts of the City of Hagerstown to provide pet waste disposal bags in public places frequented by pet owners.

Develop a watershed specific publication that will identify each sub-watershed and specific actions citizens can take to reduce bacteria and sediment loads from land they own or operate.

WCSCD maintains a web site at www.conservationplace.com with a variety of information and education materials related to no-point source pollution.

MDA maintains farming and homeowner related education and outreach materials on the Internet at:

http://www.mda.state.md.us/resource_conservation/technical_assistance/index.php

Citizen Participation in Education and Outreach

The Antietam Creek Watershed Alliance (ACWA), the local nonprofit watershed group, is committed to participating in implementing this plan. ACWA is actively engaged in projects that will lead to a reduction in pollutants such as nutrients, sediment, fecal coliform bacteria, and trash entering Antietam Creek and its tributaries. Through these projects they have gained visibility in the community for the issue of water quality in its streams and creeks. They communicate both through conversation and direct mailings with residential and agricultural landowners to learn about their concerns regarding the Antietam Creek watershed and in turn to share information about the need for BMPs such as proper septic system maintenance, stormwater runoff, riparian forest buffers and livestock fencing. ACWA through its activities and community network is well positioned to assist in the education and information component of this plan which will be the coordinated responsibility of all WRP partners.

Wastewater outreach

Canaan Valley Institute focuses on improvements to wastewater treatment systems to reduce pollution to the region's rivers and streams caused by inadequate wastewater treatment and have considerable experience in the development of regional comprehensive wastewater plans. These plans typically focus on four components: community engagement; assessment; identifying options; and assisting and coordinating design and implementation.

Other forums will also be used to reach out to homeowners. CVI has extensive experience in hosting public workshops on wastewater issues. Such workshops are developed to inform local citizens on: the effects of wastewater pollution on a watershed, proper maintenance and care of an onsite wastewater (septic) system, alternative options to traditional wastewater systems, and available financial assistance programs. The project team will also meet with reporters to develop articles for local newspapers about onsite maintenance.

CVI will also continue the well established relationship between CVI and ACWA for disseminating project goals to the public by developing displays and information booths at local fairs and festivals across the project area.

CVI has already developed courses on alternative onsite and subsurface disposal systems. These training courses will be made available to installers and sanitarians in the project area. Another critical component of improving wastewater treatment in the project areas will be working to educate developers about alternative treatment systems. Information

packets will be designed specifically for this group and we will work with sanitarians and other local leaders to identify key stakeholders.

Another avenue for education will be through a more technical approach. Working with consultants and technical providers, Canaan Valley Institute will provide education and technical assistance for the public and the administrators in Washington County. CVI focuses on improvements to wastewater treatment systems and natural stream design (NSD) to reduce pollution to the region's rivers and streams. CVI has considerable experience in the development of regional comprehensive wastewater plans and in designing and overseeing construction of NSD projects. Planning efforts typically focus on four components: community engagement; assessment; identifying options; and assisting and coordinating design and implementation. CVI also has extensive experience in hosting public workshops on water quality issues. Such workshops are developed to inform local citizens on:

- The effects of wastewater pollution on a watershed
- Proper maintenance and care of an onsite wastewater (septic) systems
- Alternative options to traditional wastewater systems
- Available financial assistance programs
- The benefits of stream stabilization and Natural Stream Design

8. Implementation Schedule and Milestones (Criteria F/G)

Due to the broad scope of bacteria and sediment impairment mitigation distributed through the Antietam watershed, a phased implementation schedule with milestones and measurable goals is detailed in this section. Because of the recent addition of the Chesapeake Bay TMDL being introduced by EPA, this plan will follow the implementation schedule outlined in its strategy.

These sections will be revisited in future iterations of this WRP.

8.1 Phase I (2012-2017)

Phase I seeks to address the highest priority sub-watersheds (ANT0277), MRS0000, and BEC0001 for bacteria, sediment and identified stream restoration opportunities. During this period, suitable stakeholders will continued to be identified as partners in phase I and phase II project implementation.

An outreach campaign will be conducted to contact private stakeholders in order to secure access to properties and participation for implementation of phase I and phase II practices.

WCSCD will continue with implementation of BMP's on agricultural lands utilizing current staff and available cost share programs from Federal and State sources. WCSCD will seek to maintain and increase funding for staff from the Maryland Department of Agriculture, Chesapeake Bay Trust Fund, Chesapeake Bay Implementation Grant, Chesapeake Bay Foundation and the Natural Resource Conservation Service while seeking additional staff and resources from the 319 program and other sources.

8.1.1 Secure Implementation Funding

- *Secure funds for implementation projects.* Each year of project implementation, WRP partners will secure funds to pay capital costs from the 319 program, and alternative sources.

Agricultural BMP's will be funded on an ongoing basis dependant on available funding from state and federal agricultural BMP cost share programs.

8.1.2 Coordinate Project Design and Materials

- *Begin Pre-Implementation Monitoring.* The WRP partners have coordinated with the MDE 319 monitoring group to begin pre-implementation monitoring of water quality and biological conditions of specific phase I restoration sites in accordance with the proposed monitoring strategy. Additional monitoring by local partners will be included as well to cover the long-term change in sites.
- *Develop specs and site design.* The WRP partners will plan and begin to implement projects in the selected phase I project sites to improve existing water quality in the watershed. Preliminary designs for each mitigation measure or agricultural BMP will be developed based upon observed water quality problems and measured , erosivity and BEHI site inspections.
- *Permits.* Identify and acquire all the necessary permits to place the proposed measures in non-tidal freshwater streams prior to implementation of each BMP or stream restoration project.
- *Select Contractor/s.* Bid out scope to make sure that the contractors necessary to build stream restoration projects are in place.

8.1.3 Conservation Planning on Agricultural Lands

- WCSCD staff will identify farms in the priority watersheds that are in need of a SCWQP, those in need of an updated SCWQP and complete plans where needed to document opportunities for BMP installation
- WCSCD staff will visit all dairy operations in the priority sub-watersheds to offer conservation planning and technical and financial assistance for BMP implementation.
- WCSCD staff will document farmer installed and non-cost shared BMP's already existing on agricultural lands utilizing the Non-Cost shared Best Management Practice Verification Procedures Manual developed by the Maryland Department of Agriculture as part of the conservation planning process (Appendix A).

5-year goals

- *Reassess the big picture.* At the end of a five year period, the WRP partners will reassess the strategic priorities for sediment, bacteria and any additional stressors identified in the watershed. This assessment will be used to track improvements over time and to help plan additional mitigation projects in other sections of the watershed as well as determining priorities for additional Phase I and II management measures.
- *Phase II preliminary analysis.* Site selection and initial design of phase II projects will be place in order to prepare for the next phase of implementation. Identify all potential stakeholders for site selection and begin outreach with private land owners for participation in the process.

8.1.4 Install management measures

March 2013 – December 2017

- *Build new projects.* As funds are secured, new projects will be built. In the short term, the sites selected will be based on available funding, priority assigned by this plan.

5-year goals

- *Begin monitoring project effectiveness.* Once baseline standards are taken, allow time for the project to begin working and sample at regular intervals to reflect the changes in Low and High flow impairments in accordance with the proposed monitoring strategy.
- *Demonstrate Success/Change the plan.* Identify success stories of mitigation projects throughout the watershed. Analyze what works and what does not work to modify the plan as appropriate. Incorporate any new or improved strategies to meet the TMDL in an appended timeline as appropriate.

8.1.5 Measurable goals for Phase I

By the end of Phase I in December 2017, the following measurable goals will be achieved:

- WCSCD will complete Soil Conservation and Water Quality Plans on 80% of the farms located in the sub-watersheds identified as first priority during phase I. These plans will identify opportunity for BMP implementation and document current levels of BMP adoption by farmers.
- *Project implementation.* Stream restoration projects and agricultural BMP's will have been installed on Phase I project areas of this watershed plan. These projects will function well enough to demonstrate that a reduction in bacteria and/or sediment has been accomplished. An estimated 215 septic systems will be fixed to Best Available Technology.
- *Water Quality Monitoring.* Instream water chemistry measurements will show that these treated reaches of the Antietam or its tributaries are meeting water quality standards for TSS and are showing a 25% reduction in bacteria.
- *Biological Monitoring.* Biological communities at the end of the five year period will show improvement in diversity of species and size of communities.
- *Document Results.* Success stories will be generated for projects where applicable. Agricultural BMP's will be tracked by the WCSCD in the Conservation Tracker program in cooperation with MDA to ensure all installed BMP's meet established NRCS standards and specifications. Sediment and bacteria reductions will be assessed for all documented BMP's and stream restoration projects.
- *Outreach for Phase II.* WRP partners will have created an additional inventory of implementation projects with private land owner permissions, preliminary monitoring plan created, and in some cases designs in place. The Antietam

Creek Watershed Restoration Plan will need to be evaluated at this time to determine if modifications are warranted in order to continue with the next implementation phase.

8.2 Phase II (2018-2025)

8.2.1 Secure additional funding

- *Secure funds for reclamation projects.* Funding sources will depend on the successful implementation of phase I projects as well as the types of projects being funded.
- *Investigate other funding sources.* NRCS, State Revolving Loan Fund, US Fish & Wildlife and US Army Corp of Engineers funds will also be investigated.

8.2.2 Coordinate Project Design and Materials

- *Select next sub-watersheds to concentrate BMP implementation.* Project partners will evaluate progress water quality data and implementation opportunities to re-focus implementation in additional sub-watersheds
- *Select Mitigation Technologies.* Based on the results of phase I projects assessment, WRP partners will decide whether or not to continue with the technologies evaluated in phase I or to use different technologies to address sediment and bacteria in the phase II areas.
- *Develop specs and site design.* Secure the personnel and resources needed to accomplish this task.
- *Select Contractor/s.* Bid out scope to make sure that the contractors necessary to construct stream restoration projects and bank armaments as well as any filtering or infiltration practices are in place.

Annual goals

- *Reassess the big picture.* At the end of each year, WRP partners will reassess the strategic priorities in the phase II operating area. This assessment will be used to track progress over time and to help evaluate the potential for additional mitigation, operations and maintenance priorities for Phase I and II management measures.

8.2.3 Install management measures

- *Install projects.* Secure landowner permissions, permits and establish agreements to operate and maintain mitigation projects.
- *Operate and maintain existing sites.* Continue to maintain and assess phase I sites as well as incorporating the needs of projects in the phase II operating area.
- *Continue monitoring project effectiveness.* Continue to assess phase I and phase II implementation in accordance with the proposed monitoring strategy.

8.2.4 Measurable goals for Phase II

By the end of Phase II in December 2025, the following measurable goals will be achieved:

- All projects identified in **Table 15** of this plan should be completed.
- *Water Quality Monitoring.* Instream water chemistry measurements will show that all treated tributaries of the Antietam Creek are meeting water quality standards for sediments and bacteria. Measurements in the Antietam Creek mainstem below these projects will also show that it is meeting standards.
- *Biological Monitoring.* Biological communities at the end of the five year period will show improvement in diversity of species and size of communities. Pollution intolerant species should begin to recolonize areas that were previously too acidic for their survival.
- *Document Results.* A summation of the mitigation strategies and observed reductions will show that the Maryland portion of the Antietam Creek is meeting water quality goals for the local TMDL and the Chesapeake Bay TMDL.

9. Load Reduction Evaluation (Criterion H)

Overall, success of this watershed plan will be determined by the extent that the Maryland water quality standards for sediment and bacteria are met in previously impaired stream segments of the Antietam Creek watershed identified in the Antietam Creek TMDLs created in 2008 and 2009 (respectively). In order to effectively document success for the impaired segments, all Best Management Practices implemented during Phase I and Phase II of the WRP will be tracked according to the 9 Antietam Creek subwatersheds identified in **Figures 8 and 14-17**.

In addition, there are other important measures of success to be considered by meeting sediment standards across the watershed in supporting more healthy populations of benthic macroinvertebrates and fish. This section presents quantitative and qualitative criteria for gauging progress and success. This section also presents approaches to adaptive management based on both criteria. Results of adaptive management, such as watershed plan updates and addenda, will be made available to the public. When a watershed plan addendum is available for public consideration, an opportunity for a public meeting will be offered (see Section E).

2017 milestone adaptive management threshold criteria that will trigger update or modification to this watershed plan:

- If sediment loads in the water column where BMP implementation has occurred do not reflect the 60% reduction estimated in the plan within the first milestone in 2017, then a re-examination of the methodology for sediment reductions and practices will trigger a plan update.
- If bacteria loads, particularly from livestock, do not show 25% reduction within the first phase of the plan, then the plan will be rewritten to incorporate newer technologies such as manure digesters which have been proven to remove up to 90% of bacteria in manure.
- If the Phase I goal for Soil Conservation and Water Quality Plans on 80% of the farms located in the first priority sub-watersheds is not achieved by a large margin indicating that insufficient stakeholder buy-in is a significant local issue, then the WCSCD and its partners will hold a local agricultural community summit focused on the priority watersheds area to actively involve farm owners/operators in sharing ideas on local successes and inhibiting factors and in building a local consensus on how to promote and accelerate buy-in during Phase II. Results of the summit will be used to update/revise the watershed plan if appropriate.
- If new TMDLs are approved in the Antietam Creek watershed, then the plan will be updated to address the impairment identified.

2025 milestone adaptive management threshold criteria that will trigger update or modification to this watershed plan include the failure to meet any of the TMDLs established for the Antietam Creek watershed.

TMDLs are not met

A summation of the mitigation strategies and observed reductions will show that the Maryland portion of the Antietam Creek is either meeting or not meeting the local or Chesapeake Bay TMDL. If adaptive management strategies determine the remainder of the impacting load is being generated within the state of Maryland, the focus will be on continued effort on mitigating those inputs within MD's borders. A plan update will be conducted in 2026 to address the load reductions to meet whichever TMDL is not being met and to provide a timeline that will achieve that goal.

TMDLs are met

If the loads being generated are being received from Pennsylvania, Maryland will appeal to Pennsylvania Department of Environmental Protection to focus mitigation in upstream areas of the Antietam Creek watershed. If Maryland is meeting its obligations established under the TMDL, it will then remove Antietam Creek from Maryland's 303(d) list of impaired waters.

9.1 Stream Segment Criterion for Biology

For each stream segment that is 1) receiving BMP implementation proscribed in this watershed plan, and 2) has a biological impairment that both appears on Maryland's 303(d) list of impaired watershed and the source assessment indicates that the impairment is caused by sedimentation, the Stream Segment Criteria for Biology is to attain a "fair" or "good" Index of Biotic Integrity for benthic macroinvertebrates and fish. After the stream segment has received some mitigation measures, stream segment monitoring for biology as described in Section 10 will be conducted to measure progress and to document success in meeting this criterion.

Adaptive management threshold criteria for biology for stream segments that will trigger update or modification to this watershed plan:

If stream biological health does not improve within several years of successful sediment mitigation monitoring, additional analysis will be conducted to ascertain if other impairments appear to be limiting improvement. After the analysis is completed, a watershed plan update or an addendum will be made available that presents the findings of the analysis and any changes to the watershed plan that are appropriate as a result.

10. Monitoring (Criterion I)

Baseline historic conditions of water quality in the Antietam Creek watershed have been documented through the TMDL studies as well as synoptic surveys conducted by MDE. In order to measure project success, it will require a comprehensive stream monitoring strategy to determine if TSS and bacteria TMDLs are being met according to individual designated use of each stream and over the entire watershed. In accordance with the proposed implementation schedule, a detailed monitoring schedule will be conducted in a phased approach with emphasis on evaluation of project effectiveness. Biological Integrity will be used in a qualitative manner to determine the effect of the mitigation/restoration projects on biological communities in impaired streams.

10.1 Phase I Monitoring Plan

10.1.1 Water Quality Monitoring

Water quality samples will be collected bi-annually from the water quality stations identified in the 2009 fecal coliform TMDL (**Figure 8**) to establish long-term trends and determine the cumulative effect of BMP implementation throughout the Antietam Creek watershed. Analyses will include nitrogen, phosphorus, TSS, fecal coliform and chlorides. All laboratories selected will perform the specified analysis in accordance with standard protocols (USEPA 1987, 1999).

In-situ water quality parameters including pH, dissolved oxygen, conductivity, and water temperature will be measured using a handheld water quality meter and stream flow measurements will also be taken at each sample site so that constituent loads can be calculated in the future.

Location and frequency of additional monitoring for individual practices will be based on the number of BMPs within proximity and implemented practices. However, it is anticipated that additional Phase I sampling sites will be based within subwatersheds ANT0277, MRS0000, and BEC0001. This is consistent with the targeted approach to implementation.

10.1.2 - Benthic Assemblage Monitoring

MDE/SSA FED biologists are responsible for performing field biological sampling, as well as, the laboratory processing and taxonomic identification for all benthic organisms collected at each site. Benthic sample stations will be established in relation to mitigation sites to document biological response over time. All sample stations will coincide with the water quality sampling sites as feasible. One benthic station will be established as close to the remediation site as possible, making sure that it is outside any negative influence from the treatment operation. A second site will be established further down stream, preferably below the confluence with the next downstream tributary, in order to document sustained biological effect. Samples will be extracted during the March/April Maryland Biological Stream Survey (MBSS) Spring Index period. Staff biologists will coordinate as appropriate with the Chemical and Biological Monitoring Division and share personnel and resources as necessary. MBSS techniques and protocols will be followed. The exact site locations for each mitigation site have yet to be determined therefore biological monitoring stations location will be determined during Phase I.

10.1.2a – Biological Field Sampling

All field sampling will be performed under guidance established by the MBSS. The Maryland Biological Stream Survey Sampling Manual, February 2000, will serve as the authority. MBSS methods include qualitative sampling of best available habitats incorporating approximately 20 square feet of substrate within each 75 meter designated station. All samples will be collected from riffle areas, as practical, because this is typically the most productive habitat in stream

ecosystems. A 600-micron mesh D-net will be used to trap organisms dislodged from the sample area. The composited sample is condensed in the field with a standard 0.5-micron sieve bucket, placed in a sample jar with appropriate field label, and preserved with alcohol. Each sample is then sub-sampled to approximately 100 individual macroinvertebrates in the laboratory using a random-grid picking/sorting process. Most organisms are identified to genus, if possible, using stereoscopes. Chironomidae are slide-mounted and identified using compound microscopes. Habitat conditions will be assessed using standard MBSS methodology. In-situ water quality parameters will be recorded at each station with a multi-parameter field instrument.

10.1.2b - Laboratory Methods

All benthic macroinvertebrates will be processed and identified through guidance established in the MBSS protocol. The laboratory manual "Laboratory Methods for Benthic Macroinvertebrate Processing and Taxonomy" Maryland Department of Natural Resources, November 2000, will serve as the basis for analysis of all field samples collected.

10.1.2c - Data Analysis and Report

Each station will be ranked qualitatively according to the protocols established for calculating the Benthic Index of Biological Integrity (BIBI) score (Stribling et al. 1998.), where "good" equals 4.0-5.0, "Fair" equals 3.0-3.9, "Poor" equals 2.0-2.9 and "Very Poor" equals 1.0-1.9. Each BIBI score will be compared against percentage of the best attainable in stream physical habitat in order to assess relationships between habitat and biology. The benthic IBI will be calculated using Non-Coastal Plain metrics. (Mercurio et al. 1999)

10.1.2d - Habit Assessment

Habitat conditions will be assessed using standard MBSS methodology targeting riffle/run prevalent streams. This methodology involves the field observations of eight parameters, including: instream habitat, epifaunal substrate, velocity/depth diversity, pool/glide/eddy quality, riffle/run quality, embeddedness, shading, and Trash Rating. Each category contains a maximum value of twenty and overall habitat will be rated as a percentage of the best possible score. There are four categories, Excellent 76-100, Good 51-75, Fair 26-50, and poor 0-25. (Stranko et al. 2010)

10.1.3 –Synoptic Surveys

The synoptic survey is a monitoring design which attempts to canvas an entire watershed taking grab samples within a short period of time to glimpse several snapshots of water quality that can be compared with other sampling in that area. In Maryland's case, most sampling is limited to TN and TP, but may involve some TSS. For the Antietam, it will incorporate TSS and periodic bacteria count sampling. An additional synoptic survey is scheduled for completion in 2012 (**Figure 18**), this will add to the general knowledge of baseline water quality conditions within the Antietam Creek watershed.

Continuing to include synoptic surveys during the Phase I project may serve an additional purpose to allow WRP partners to establish a methodology for using nutrient concentrations as an indicator for bacteria concentrations in agricultural areas. Another added benefit will be the overall characterization of the watershed outside of the established long-term stations. A cost benefit analysis of continued synoptic surveys should be conducted near the end of Phase I implementation period to see if continuing this monitoring is warranted in Phase II.

10.2 Phase II Monitoring Plan

The second phase of monitoring will be a modified continuation of the Phase I plan to continue to evaluate long-term effects and an adjustment to the number of monitoring sites selected during Phase I in order to compliment Phase II of implementation. The monitoring plan will need to be revised and adjusted according to any trends observed from the Phase I mitigation projects yet maintain the integrity of the data collected during Phase I and Phase II.

This phase of the monitoring plan should start to be revised in the fifth year of Phase I to create a seamless transition between the two phases and include baseline monitoring in new project areas, as well as continued monitoring of Phase I project areas. Frequency and number of sites depend upon the success of projects implemented.

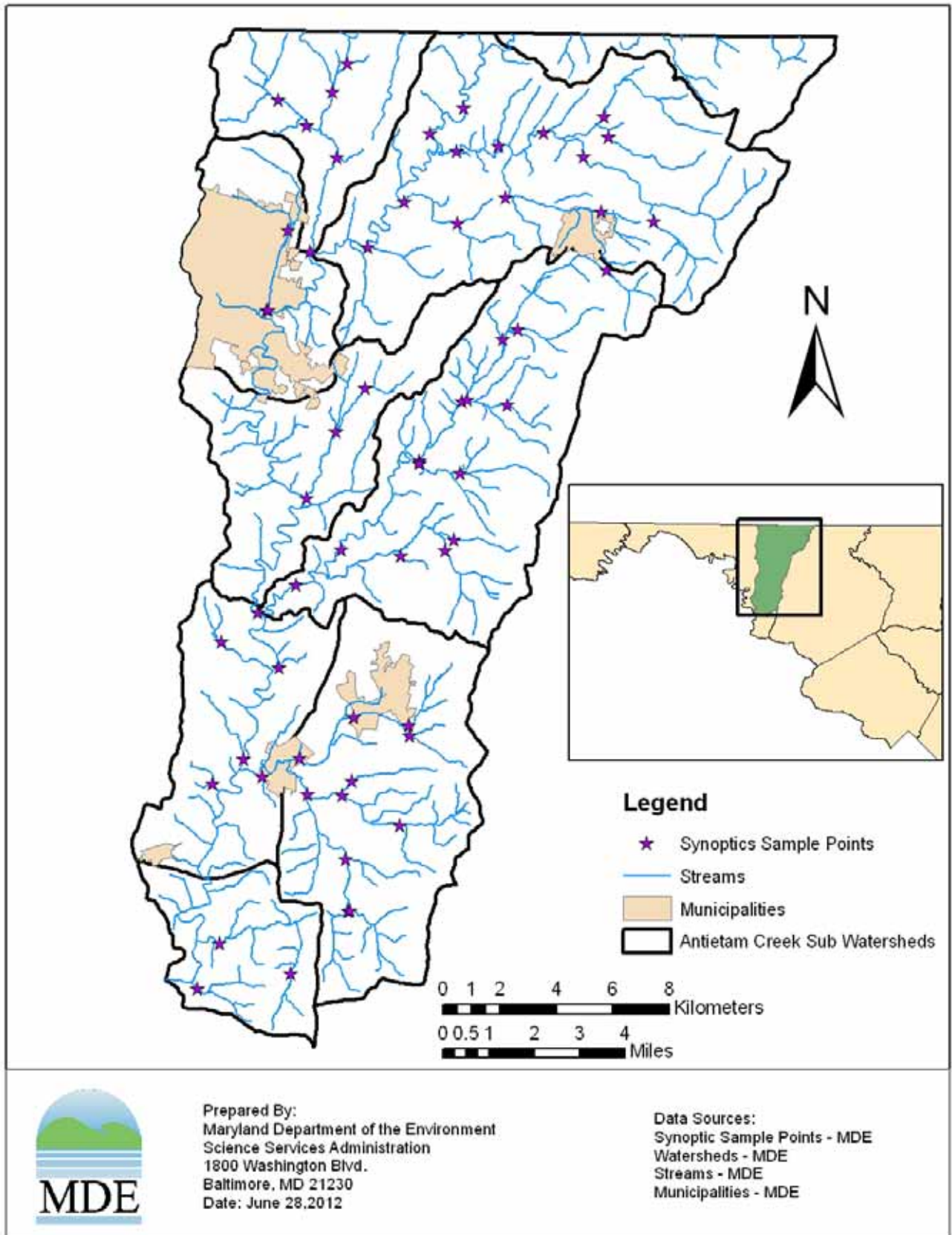


Figure 19 – Synoptic Survey Sites

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