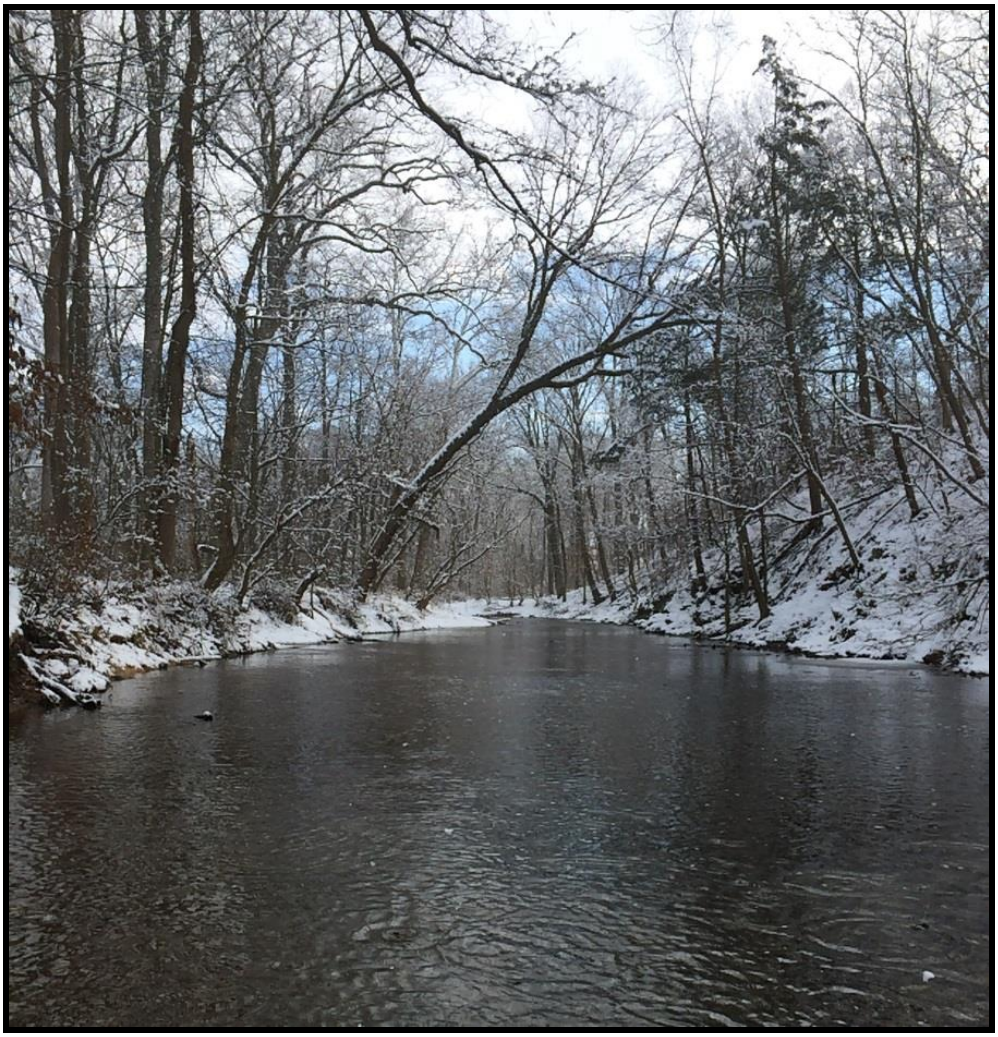
Lower Monocacy River Watershed Characterization Plan

Spring 2016



Prepared by

Carroll County Bureau of Resource Management

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List of Acronyms

BMPs	best management practices
COMAR	Code of Maryland Regulations
DNR	Maryland Department of Natural Resources
EPA	United States Environmental Protection Agency
FEMA	Federal Emergency Management Agency
GIS	geographic information system
HSG	hydrological soil group
IBI	Index of Biotic Integrity
MBSS	Maryland biological stream survey
MDE	Maryland Department of the Environment
NLCD	National Land Cover Database
NPDES	national pollution discharge elimination system
PFA	priority funding area
RTE	rare, threatened or endangered
SW	stormwater
TMDL	total maximum daily load
TSS	total suspended sediments
USDA	United States Department of Agriculture
WLA	wasteload allocation

I. Characterization Introduction

A. Purpose of the Characterization

The Lower Monocacy River Watershed Characterization Plan is intended to provide a background on the hydrological, biological and other natural characteristics of the watershed as well as discuss human related characteristics that may have an impact within the watershed. The information provided in this report will be used as a tool to direct future watershed restoration and protection efforts.

B. Location and Scale of Analysis

The Monocacy River is a free-flowing stream that originates in Pennsylvania and flows 58 miles within Maryland where it finally empties into the Potomac River. The Lower Monocacy River Watershed is located in the Potomac River Sub-basin, which lies within the Piedmont physiographic province. The Piedmont Plateau province is characterized by gentle to steep rolling topography, low hills, and ridges (MGS 2009). The Lower Monocacy River Watershed is primarily within Frederick County, and small portions of Carroll and Montgomery Counties covering a total of approximately 194,790 acres. The watershed area within Carroll County covers 5,463 acres within two sub-watersheds. Figure 1-1 depicts the location of the Lower Monocacy River Watershed and the subwatersheds within Carroll County. Table 1-1 displays the distribution of acreage between the subwatersheds within Lower Monocacy River Watershed.

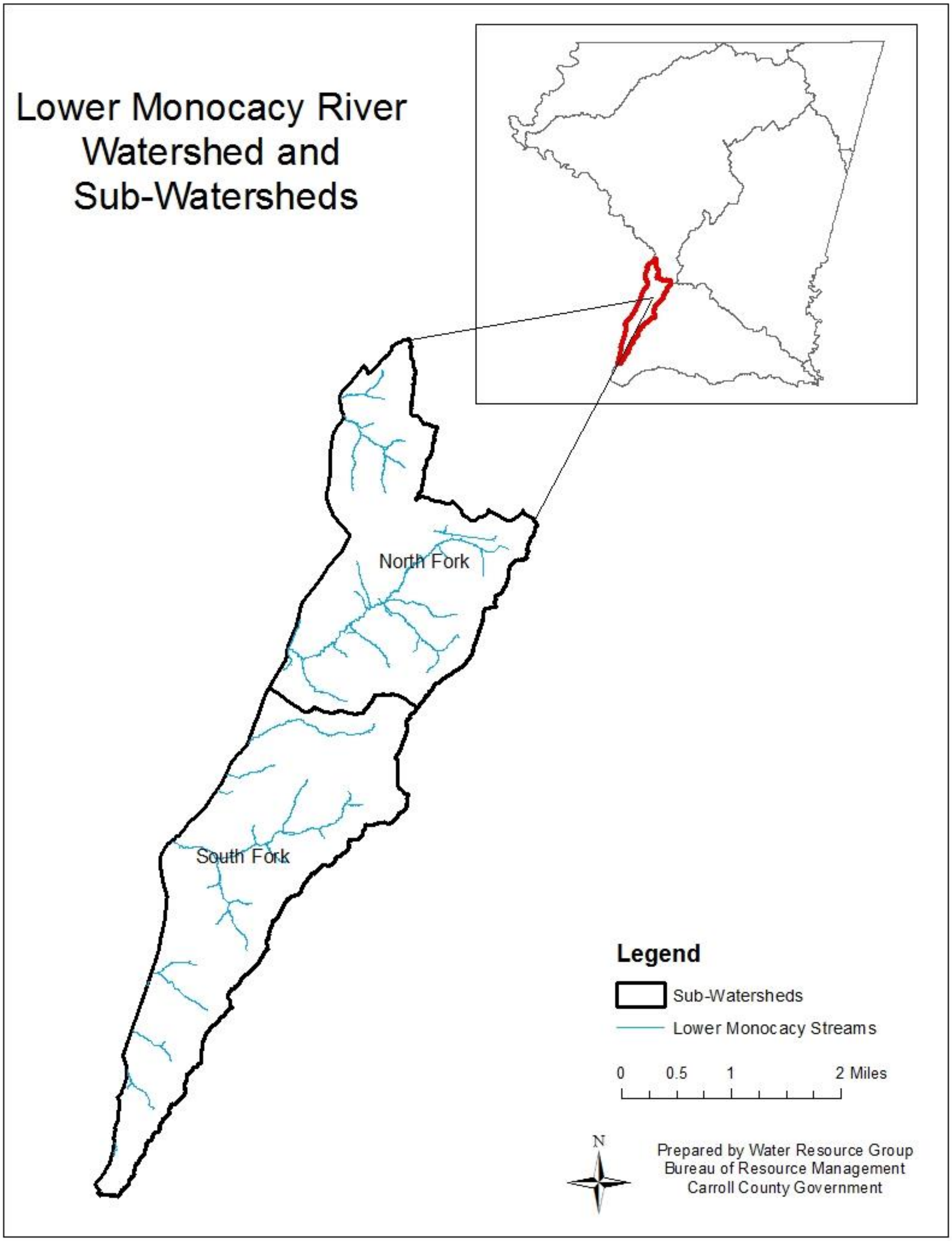

Figure 1-1: Lower Monocacy River Watershed Location Map

Table 1-1: Lower Monocacy River Watershed's Subwatershed Acreages

DNR 12-digit Scale	Subwatershed	Acres
021403020238	North Fork	2,569.28
021403020235	South Fork	2,893.40
Lower Monocacy River Watershed Total		**5,462.68**

C. Report Organization

This report is organized into six different chapters:

Chapter 1 presents the purpose of the characterization plan, shows a general location of the watershed within the County and lists the acreage distribution among the subwatersheds.

Chapter 2 presents background information on the natural characteristics of the watershed. Natural characteristics discussed in this chapter include climate, topography, soils, geology, wetlands and forest cover.

Chapter 3 focuses on anthropogenic influence within the watershed. The human component focuses on land use/land cover, impervious surface area, storm drain systems, drinking water and wastewater systems, and other point source locations. Chapter 3 will also discuss best management practices (BMPs) that have been installed in the watershed as well as any lands that have been protected through various programs.

Chapter 4 focuses on water quality. This chapter will discuss the stream designations, water quality data collected within Lower Monocacy River Watershed, and the total maximum daily loads (TMDLs) associated with the Lower Monocacy River Watershed.

Chapter 5 summarizes the living resources within the Lower Monocacy River Watershed including aquatic and terrestrial, as well as any rare, threatened or endangered (RTE) species.

Chapter 6 summarizes the purpose and use of the Characterization Plan and related work completed within the watershed. This plan will be used in developing the restoration plan for the watershed. This Chapter also lays out approximate cost in completion of this work.

II. Natural Characteristics

A. Introduction

The natural characteristics of a watershed provide the background for the biological and hydrological processes within the system. In this chapter we look at these characteristics in detail, which provides a foundation for the later chapters on human characteristics, water quality, and living resources. The natural characteristics to be covered in this chapter include: climate; physical location characteristics such as topography, soils and geology; and surface water resource characteristics such as wetlands, flood plains and forest cover. This chapter will also take a look at ecologically important areas and groundwater resources. Potential sources of degradation and the actions needed to address impacted areas can be evaluated by an inventory of these features within the watershed. Each watershed is unique, and the process of gathering information about the watershed may reveal key issues that will influence the watershed restoration plan. The Lower Monocacy River Watershed and its subwatersheds are shown in Figure 2-1.

B. Climate

The climate of the region is characterized as a humid continental climate, with four distinct seasons modified by the proximity of the Chesapeake Bay and Atlantic Ocean (DEPRM, 2000). The average temperature during the warm summer months is approximately 79 degrees Fahrenheit; while the average temperature during the cooler winter months is 28 degrees Fahrenheit. Rainfall is evenly distributed through all months of the year, with most months averaging between 3.0 and 3.5 inches per month. Storms in the fall, winter, and early spring tend to be of longer duration and lesser intensity than summer storms, which are often convective in nature with scattered high-intensity storm cells. The average annual rainfall is approximately 42 inches per year. The average annual snowfall is approximately 30 inches per year, with the majority of accumulation in December, January, and February.

The climate of a region affects the rate of soil formation and erosion patterns, and by interacting with the underlying geology, influences the stream drainage network pattern and the resulting topography.

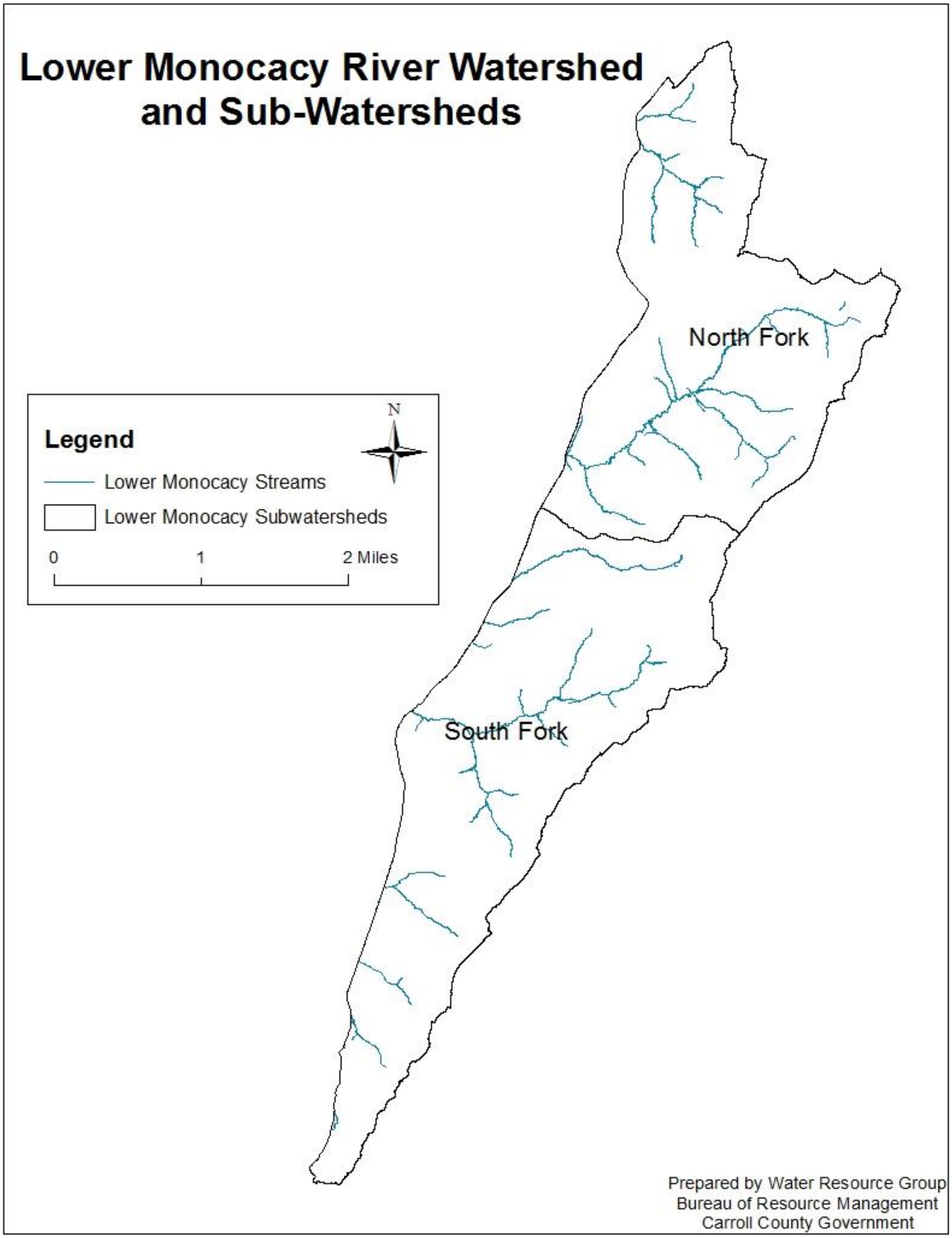

Figure 2-1: Lower Monocacy River Subwatershed Locations

C. Physical Location

The Lower Monocacy River Watershed lies entirely within the Piedmont Plateau Province, predominantly within the Upland Region of this physiographic province. The Piedmont Plateau Province is characterized by low rolling hills with clay-like moderately fertile soils, and complex geology of numerous rock formations consisting of different materials and ages intermingled with one another.

1. Topography

Topography of the land and nearby surrounding areas, including steepness and concavity affect surface water flows, potential for soil erosion, and development suitability. Lands with steep slopes are more prone to soil erosion and may contribute to the amount of pollutants released into a water system. For this watershed characterization we categorized slopes into three categories using soil data from the Carroll County Soil Survey: low slopes (0-8 %), medium slopes (8-15 %), and high slopes (>15 %). The Web Soil Survey produced by the National Cooperative Soil Survey and operated by the United States Department of Agriculture (USDA): Natural Resources Conservation Service provides soil data and slope information. Table 2-1 presents the slope categories and the percentages of each slope category within the Lower Monocacy River Watershed. Figure 2-2 displays the slope categories and their distribution throughout the Lower Monocacy River Watershed.

Table 2-1 Lower Monocacy River Watershed Soil Slope Categories

DNR 12-Digit Scale	Subwatershed	Slope Category (%)		
	Percent of overall total	**Low**	**Medium**	**High**
021403020238	North Fork	36.31	41.85	21.82
	Percent of overall total	17.08	19.69	10.26
021403020235	South Fork	41.67	42.44	15.77
	Percent of overall total	22.07	22.48	8.35
Lower Monocacy River Watershed Total		**39.15**	**42.16**	**18.62**

Note: The top row of each subwatershed is the percent of each slope category within that subwatershed. The second grey row below is the percent of that subwatershed's slopes as part of the overall Upper Monocacy River Watershed.

There is a small percentage of the Lower Monocacy River Watershed that has high soil slopes, approximately 18% of the total watershed residing in Carroll County. Most of the high slopes are in the vicinity of streams. Most of Lower Monocacy River Watershed consists of low to medium soil slopes. Low slopes make up approximately 2,135 acres, or about 39%, of the Watershed. Most of the Lower Monocacy River Watershed consists of medium slopes; though medium soil slopes and low soil slopes occur in relatively equal percentages throughout the Watershed. Medium slopes encompass approximately 2,303 acres, or about 42%, of the Watershed.

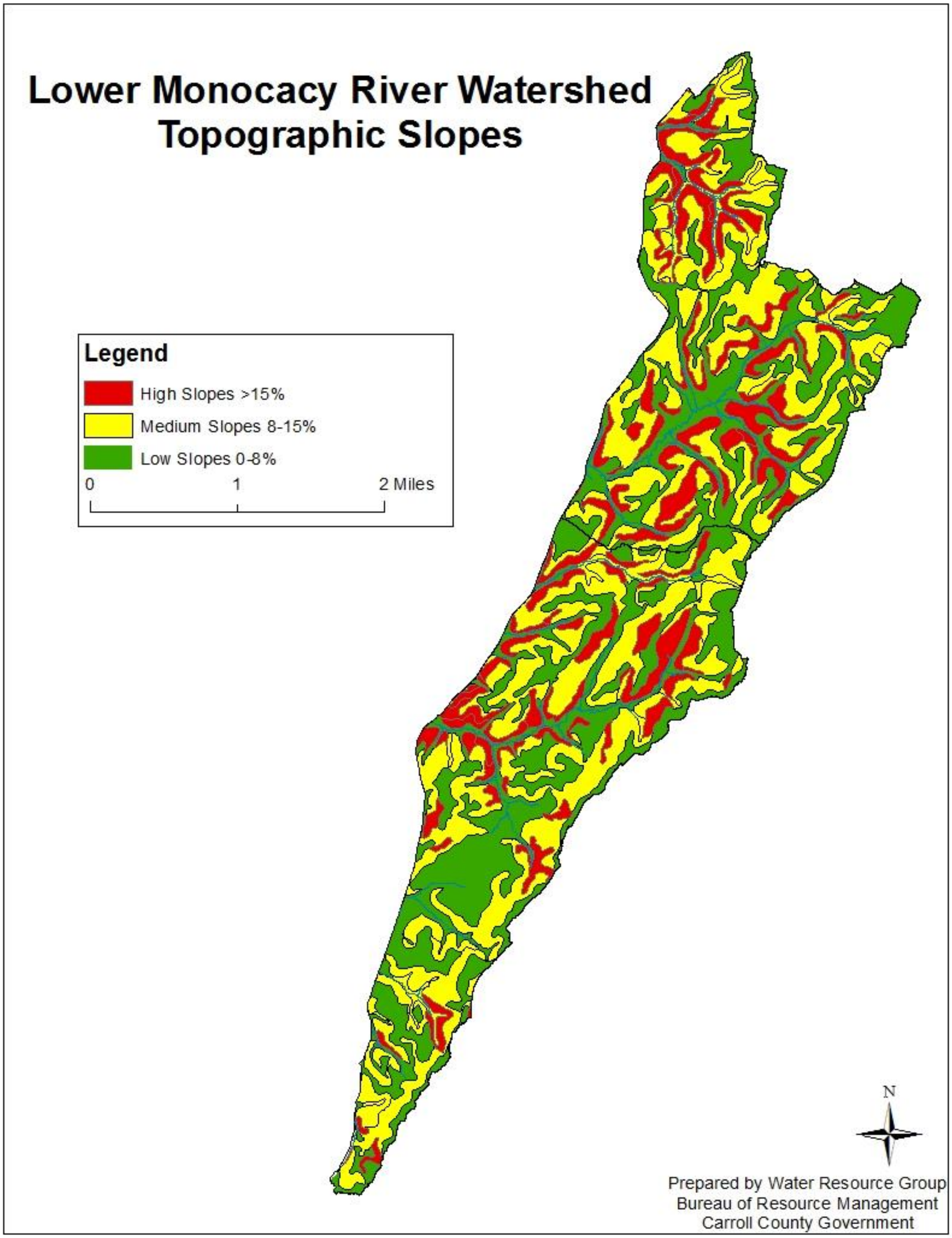

Figure 2-2: Lower Monocacy River Watershed Topography and Slope Categories

2. Soils

Independent of topographic slope, terrestrial systems within a watershed are greatly influenced by the type and condition of underlying soil. Soil factors such as drainage and permeability also greatly influence the amount of water present in a stream as well as water quality.

Soil composition is determined by factors including climate, organic matter, and type of parent material present. Within the Piedmont Plateau Province, highly metamorphosed schist, gneiss, and phyllite make up the vast majority of the parent material. Local soil conditions can vary greatly depending on organic matter and the localized climate. Chester and Manor soils are common in the Piedmont Plateau Province from Pennsylvania to North Carolina, including the Lower Monocacy River Watershed (Costa, 1975).

a. Hydrologic Soil Groups

The Natural Resource Conservation Service classifies soils into four Hydrological Soil Groups (HSG) based on runoff potential. Runoff potential is the opposite of infiltration capacity; soils with high infiltration capacity will have low runoff potential, and vice versa. The four HSG are A, B, C, and D; where group A generally has the smallest runoff potential and Group D has the greatest. Soils with low runoff potential will be less prone to erosion, and their higher infiltration rates result in faster flow-through of precipitation to groundwater (DEPRM, 2008).

The HSG classification was obtained from USDA technical release-55 ‘Urban Hydrology for Small Watersheds’.

> **Group A** is composed of sand, loamy sand or sandy loam types of soil. It has low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, excessively drained sands or gravels and have a high rate of water transmission.
>
> **Group B** is composed of loam or silt loam. This group has a moderate infiltration rate when thoroughly wetted and consist mostly of deep to moderately deep, moderately well to well drained soils with moderately fine to moderately coarse textures.
>
> **Group C** is composed primarily of sandy clay loam. These soils have low infiltration rates when thoroughly wetted and consist mostly of soils with a layer that impedes downward movement of water. These soils also have a moderately fine to fine structure.
>
> **Group D** is composed of clay loam, silty clay loam, sandy clay, silty clay, or clay. This group has the highest runoff potential. They have very low infiltration rates when thoroughly wetted and consist mostly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils lying over an impervious material.

The hydrologic soil data from the Carroll County Soil Survey is summarized in Table 2-2 and shown in Figure 2-3.

Table 2-2: Lower Monocacy River Watershed Hydrologic Soil Group Categories

DNR 12-digit scale	Subwatershed	Hydrologic Soil Group %			
	Percent of overall total	**A**	**B**	**C**	**D**
021403020238	North Fork	0	80.22	14.57	5.19
	Percent of overall total	0	37.73	6.85	2.44
021403020235	South Fork	0	84.59	11.25	4.07
	Percent of overall total	0	44.80	5.96	2.16
Lower Monocacy River Watershed Total		**0**	**82.57**	**12.82**	**4.60**

Note: The top row of each subwatershed is the percent of each soil category within that subwatershed. The second grey row below is the percent of that subwatershed's soils as part of the overall Upper Monocacy River Watershed.

Group A soils are not found within Lower Monocacy River watershed. The majority of the Lower Monocacy River Watershed is group B soils, making up over 82% of the Watershed. Nearly all areas that are group B soils are areas not in the immediate vicinity of streams or ponds. While the overall percentage of groups C and D soils are fairly low, these areas should be targeted when considering where the greatest potential for addressing soil conservation exists. Most of the group C and D soils are surrounding streams and pond areas of the watershed. Overall group D soils are not common in Lower Monocacy River Watershed, making up around 4% of the Watershed.

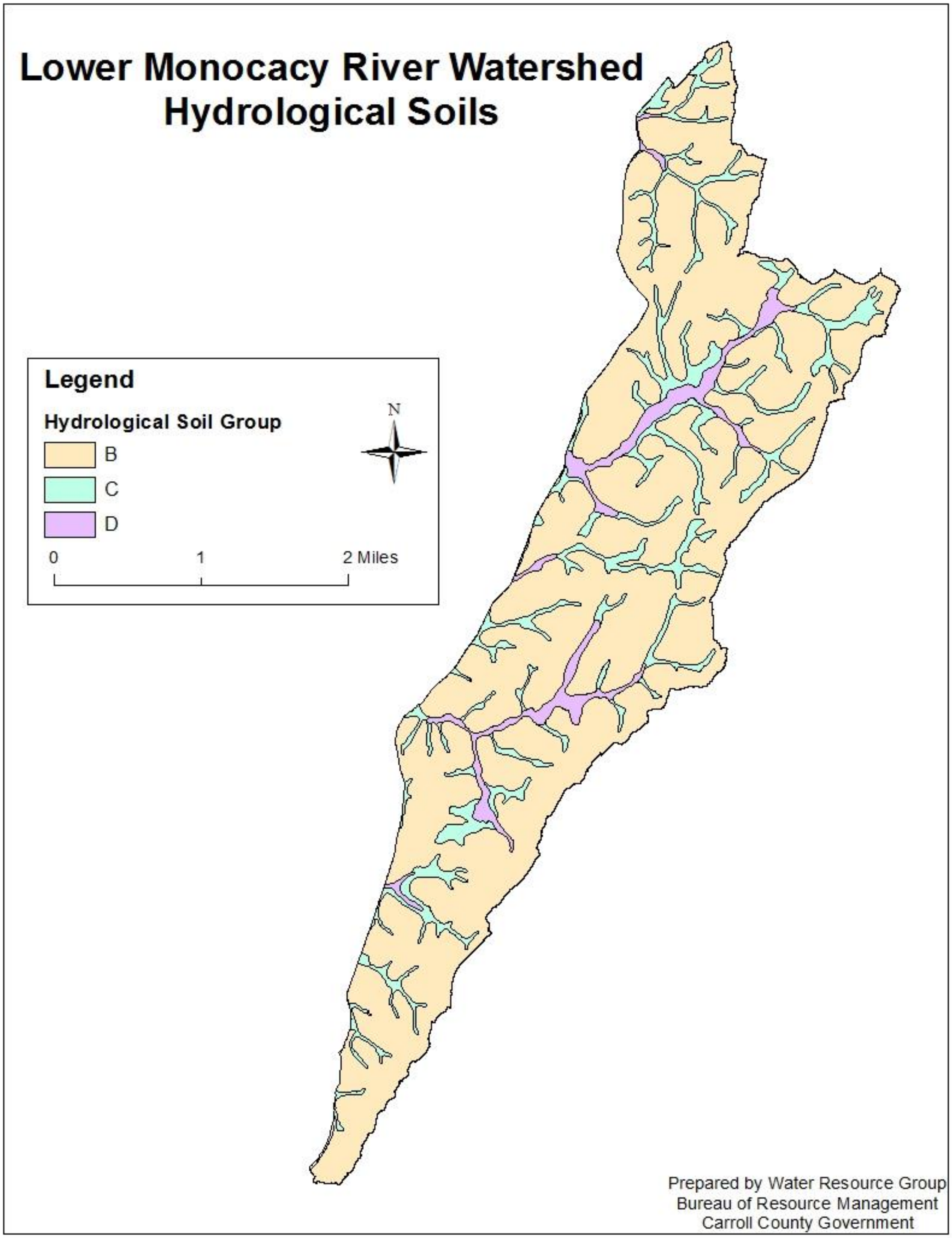

Figure 2-3: Lower Monocacy River Watershed Hydrological Soil Groups

3. Geology

The geological formations within the Lower Monocacy River Watershed are shown in Figure 2-4. Types of geological formations within a watershed can impact and alter the chemical composition of surface and groundwater, as well as the rate of recharge to groundwater. The underlying geology also determines soil formation. Intrinsically, the underlying geology can be closely correlated to the water quality within that system by affecting the buffering capacity.

The Lower Monocacy River Watershed, like most of the Piedmont Plateau Province, consists of metamorphic rock, mainly marburg formation, quartzite and phyllite. Marburg formation contains primarily phyllite, metasilstone, and quartzite. These formations have moderate infiltration rates with average recharge to groundwater.

In 1988, Carroll County initiated a water resource study. Part of this study focused on groundwater resource development in Carroll County. Aquifer type is the ultimate governing factor for groundwater development; however, natural factors like precipitation and topography play an important role in recharge. Carroll County has three distinct aquifer types: saprolite, carbonate rock, and triassic rock aquifers—all with varying rates of groundwater recharge. The carbonate rock aquifer has the highest recharge rate of the three types with an estimated drought recharge of 550,000 gallons per day per square mile (GPD/MI2). The triassic aquifer groundwater recharge under drought conditions is estimated at 220,000 GPD/MI2. The groundwater recharge rate for the saprolite aquifer varies widely depending on the hydrologic group (Carroll County Water Resource Study, 1998).

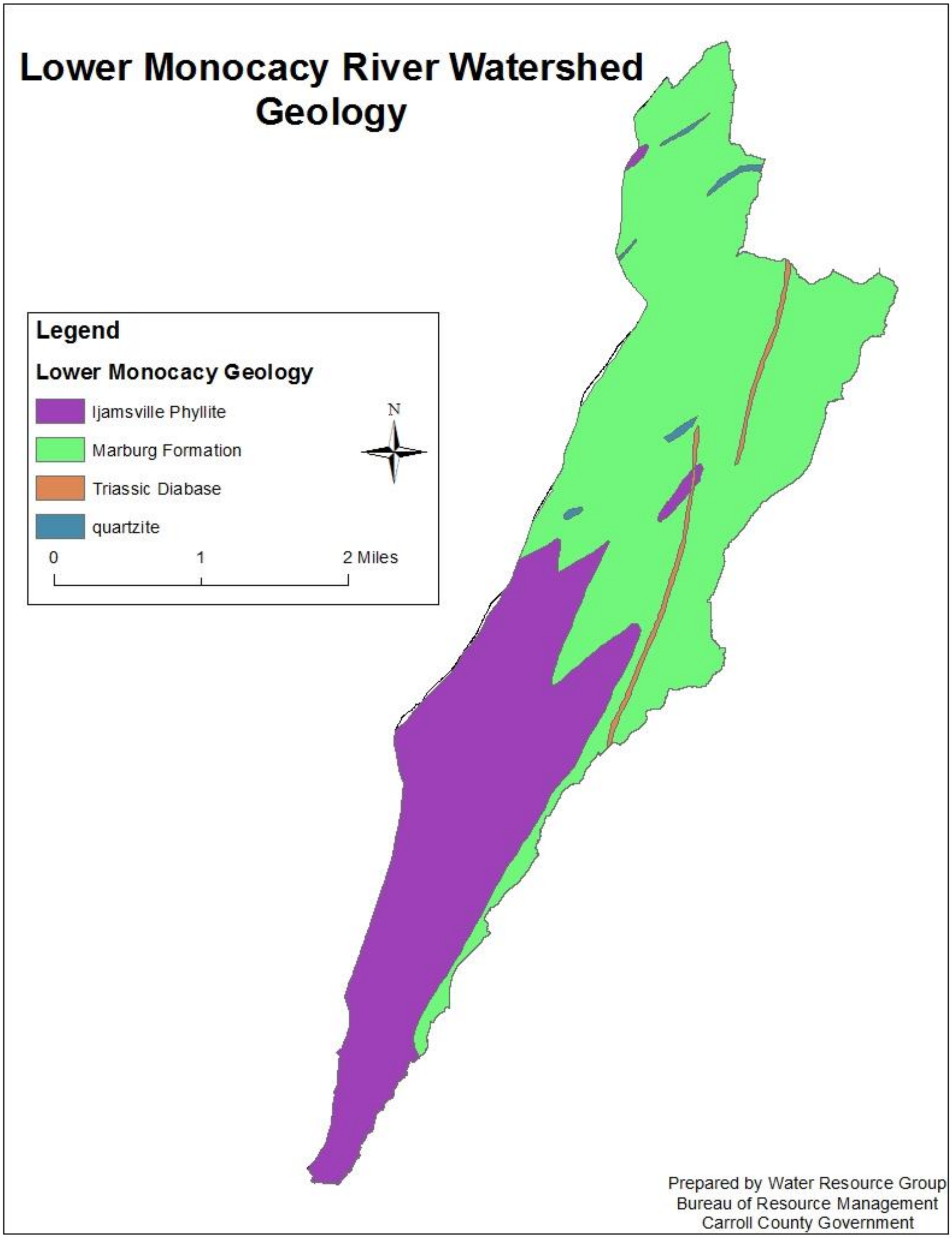

Figure 2-4: Lower Monocacy River Watershed Geology

D. Surface Water Resources

Physical resources within a watershed can greatly alter the hydrological process and can affect water quality. The following section will examine those resources that contribute in stabilizing stream flow as well as help with natural filtration.

1. Wetlands

Wetlands are a beneficial surface water resource. Wetlands provide downstream flood protection by absorbing and slowly releasing storm flows. Wetlands also naturally improve water quality with their filtering capability, nutrient uptake, and transformation.

Wetlands are defined by the US Army Corps of Engineers and the US Environmental Protection Agency (EPA) as: "areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas." Wetlands in the Lower Monocacy River Watershed, as seen in Figure 2-5, can generally be found in low lying areas around streams. This is common of the Piedmont Plateau Province due to the relief in topography, geology, and depth to groundwater.

There are three main sources of wetland information available in Maryland. The first is the National Wetlands Inventory which covers the entire country. The second is the Maryland Department of Natural Resources (DNR) which has mapped wetlands for the State, and the third is the National Land Cover Database (NLCD). The statistical data in this report was based off of the delineations from the NLCD. Actual acreage may be greater when field verified. The estimated acreage of wetlands for the Lower Monocacy River Watershed can be found in Table 2-3.

Table 2-3: Lower Monocacy River Watershed Wetland Acreage

DNR 12-Digit Scale	Subwatershed	Wetland Estimates	
		Acres	%
021403020238	North Fork	51.09	1.99
021403020235	South Fork	23.55	0.81
Lower Monocacy River Watershed Total:		**74.64**	**1.37**

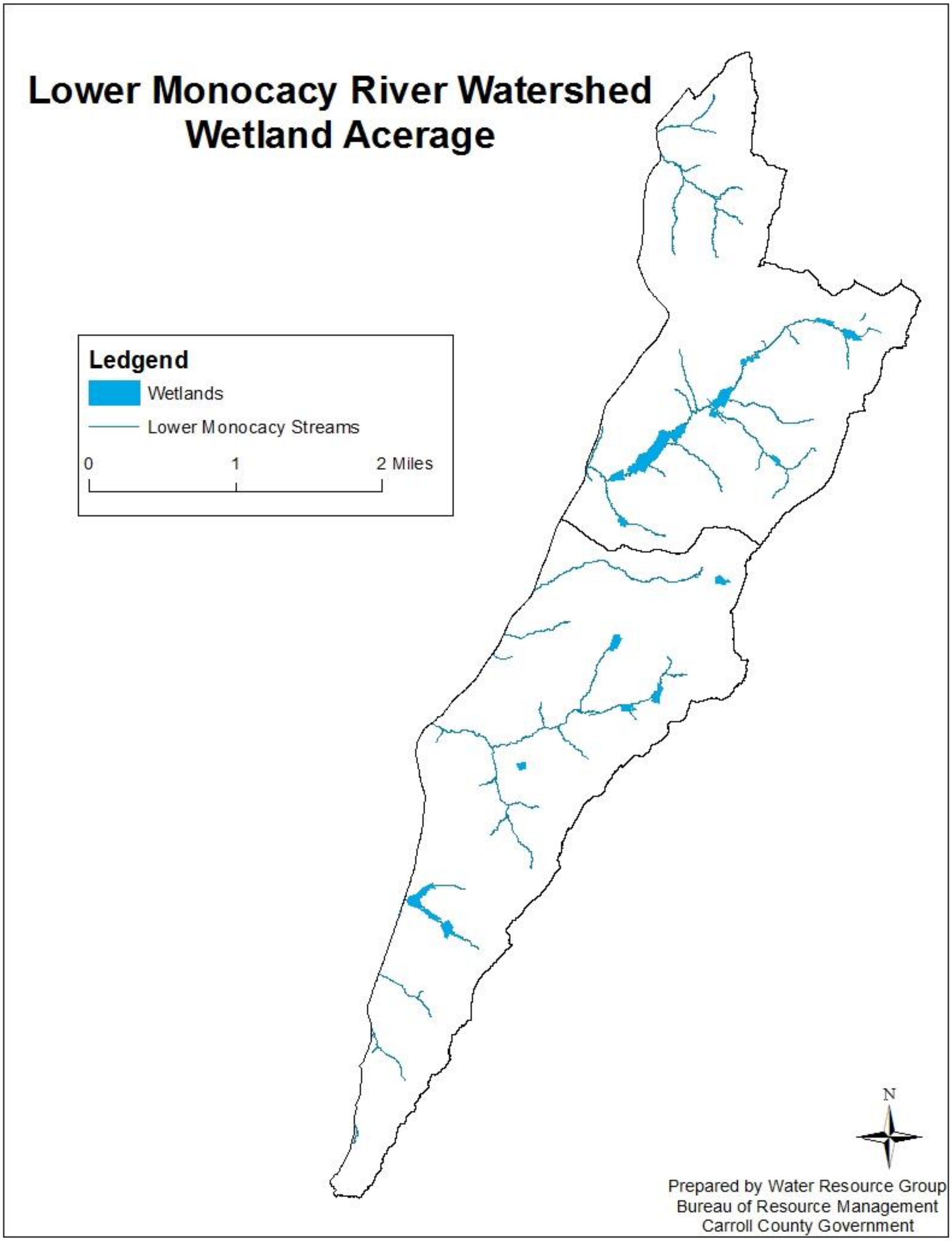

Figure 2-5: Lower Monocacy River Watershed Wetland Acreage

2. Floodplains

Floodplains in their natural state provide benefits to both human and natural systems. Benefits range from reducing the number and severity of floods to handling storm water runoff and minimizing non-point source pollutants. A natural floodplain will slow the velocity of water moving through a system, allowing sediment to settle out and nutrients to be taken up by the surrounding vegetation. Natural floodplains also contribute to groundwater recharge by allowing infiltration, which in turn will reduce the frequency of low surface flows, allowing for a healthier ecosystem.

Many floodplains are ideal locations for hike and bike paths, open spaces and wildlife conservation which in turn will make the community more ascetically appealing. By allowing a floodplain to remain in its natural state, people benefit from outdoor education and the scientific knowledge that comes from the undisturbed ecosystem.

The total floodplain area within the Lower Monocacy River Watershed is shown in Figure 2-6. The Lower Monocacy River Watershed contains about 73 acres of floodplain, which accounts for 1.5% of the total land area within the Watershed. The Federal Emergency Management Agency (FEMA) has updated flood risk identification using newer technology to establish flood risk zones and base flood elevations. Floodplain information obtained from FEMA 2015 effective mapped data.

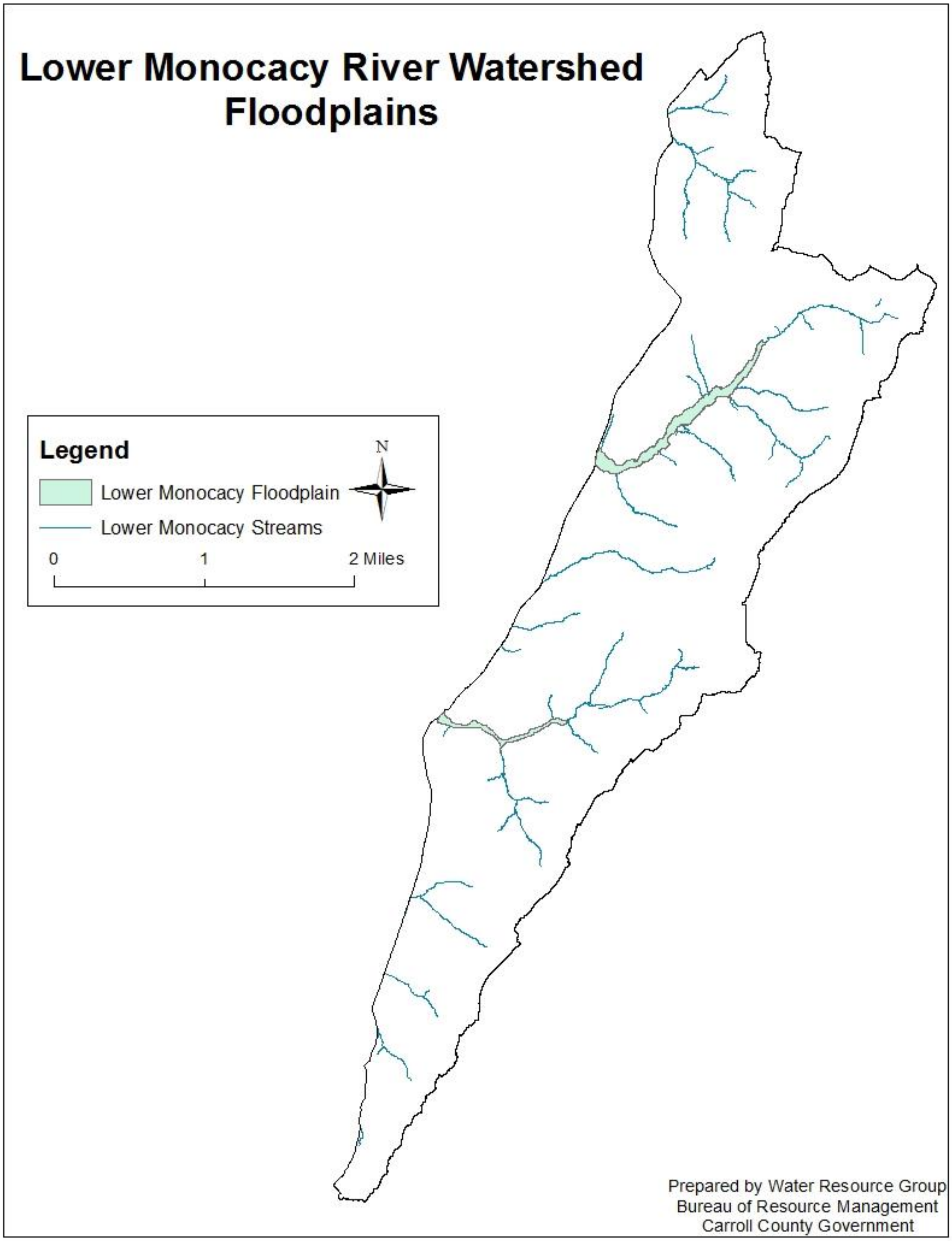

Figure 2-6: Lower Monocacy River Watershed Floodplains

3. Forest

Forests are home to many forms of life, and play an essential role environmentally including but not limited to climatic regulation, carbon cycling, biodiversity preservation, and soil and water conservation. Among land cover types, forest provides the greatest protection for soil and water quality. A healthy forest will hold soil in place which assists in reducing runoff, conserving nutrients and protecting streams from erosion. The riparian forest or corridor directly adjacent to a stream helps to moderate stream temperatures, which in many cases can support cold-water fisheries. In addition to supplying much needed shade for streams, the riparian forest is responsible for supplying detritus matter to the stream, which is natural food and energy input for streams in the Piedmont Plateau Province region.

a. Forest Cover

A healthy forest not only plays an important role environmentally, but can have great aesthetic and recreational benefits as well. Forest areas within the Lower Monocacy River Watershed today consist of secondary succession forest that have regrown and matured. Large forest blocks will provide greater ecological benefits than smaller blocks, because less fragmented landscapes benefit interior dwelling species.

Lower Monocacy Watershed contains 1,971 acres of forest over multiple land uses, and covers about 36 percent of the land within the watershed. The forest cover within the Lower Monocacy Watershed can be found in Figure 2-7 and is shown in Table 2-4.

Table 2-4: Lower Monocacy Watershed Forest Cover

DNR 12-Digit Scale	Subwatershed	Total Acres	Forested Acres	% Forested
021403020238	North Fork	2,569.3	1,079	42%
021403020235	South Fork	2,893.4	892	31%
Lower Monocacy Watershed Total		**5,462.7**	**1,971**	**36%**

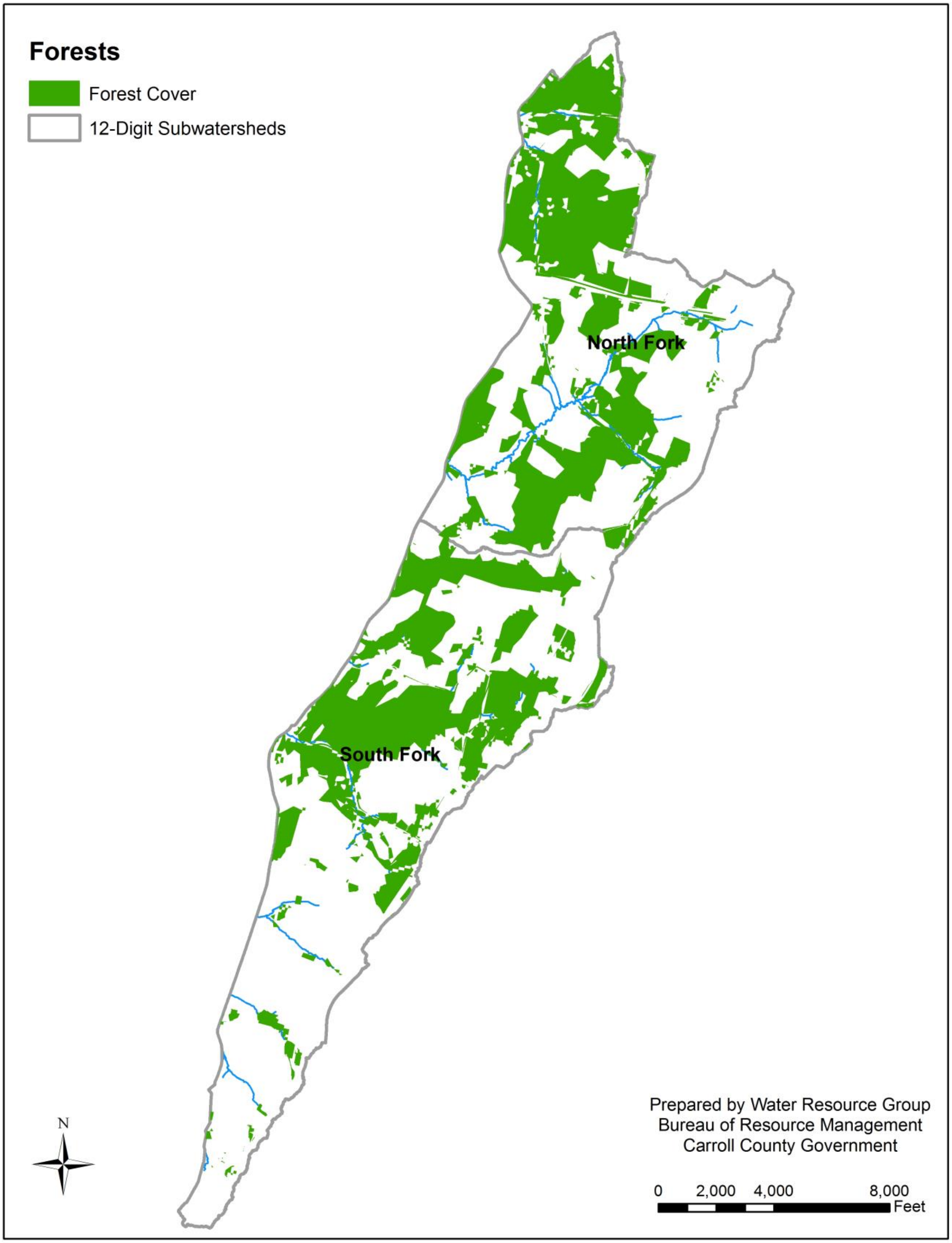

Figure 2-7: Lower Monocacy River Watershed Forest Cover

E. Ecologically Important Areas

The DNR has mapped a statewide network of ecologically important areas across the State called "Green Infrastructure". These areas are known as hubs and corridors. Hubs consist of large blocks of important natural resource land, and corridors connect one hub to the next. The large blocks of land that make up this green infrastructure consist primarily of contiguous forest land, but also may include wetlands and other naturally vegetated lands.

The DNR has mapped this network of ecologically important land by using several geographic information system (GIS) data layers to develop the areas that met specific parameters for green infrastructure. Hubs will contain one or more of the following:

- Areas containing sensitive plant or animal species;
- Large blocks of contiguous interior forest (at least 250 contiguous acres);
- Wetland complexes with at least 250 acres of unmodified wetlands;
- Streams or rivers with aquatic species of concern, rare cold-water or black-water ecosystems, or important to anadromous fish, and their associated riparian forest and wetlands; and
- Conservation areas already protected by public and private organizations (i.e. the DNR, The Nature Conservancy).

These "Green Infrastructure" areas comprise the bulk of the State's natural support system. As stated previously, forest systems are important resources that attribute to filtering and cooling water, storing and cycling nutrients, conserving soils, protecting areas from storm and flood damage, and maintaining the hydrologic function of the watershed. For more information on the Green Infrastructure identification project through the DNR, see: http://dnr.maryland.gov/land/green_infra.asp

Lands identified through the "Green Infrastructure" project where protection is needed may be addressed through various programs, including rural legacy, program open space, or conservation easements.

Figure 2-8 shows the hubs and corridors within the Lower Monocacy River Watershed as identified through the DNR "Green Infrastructure" project.

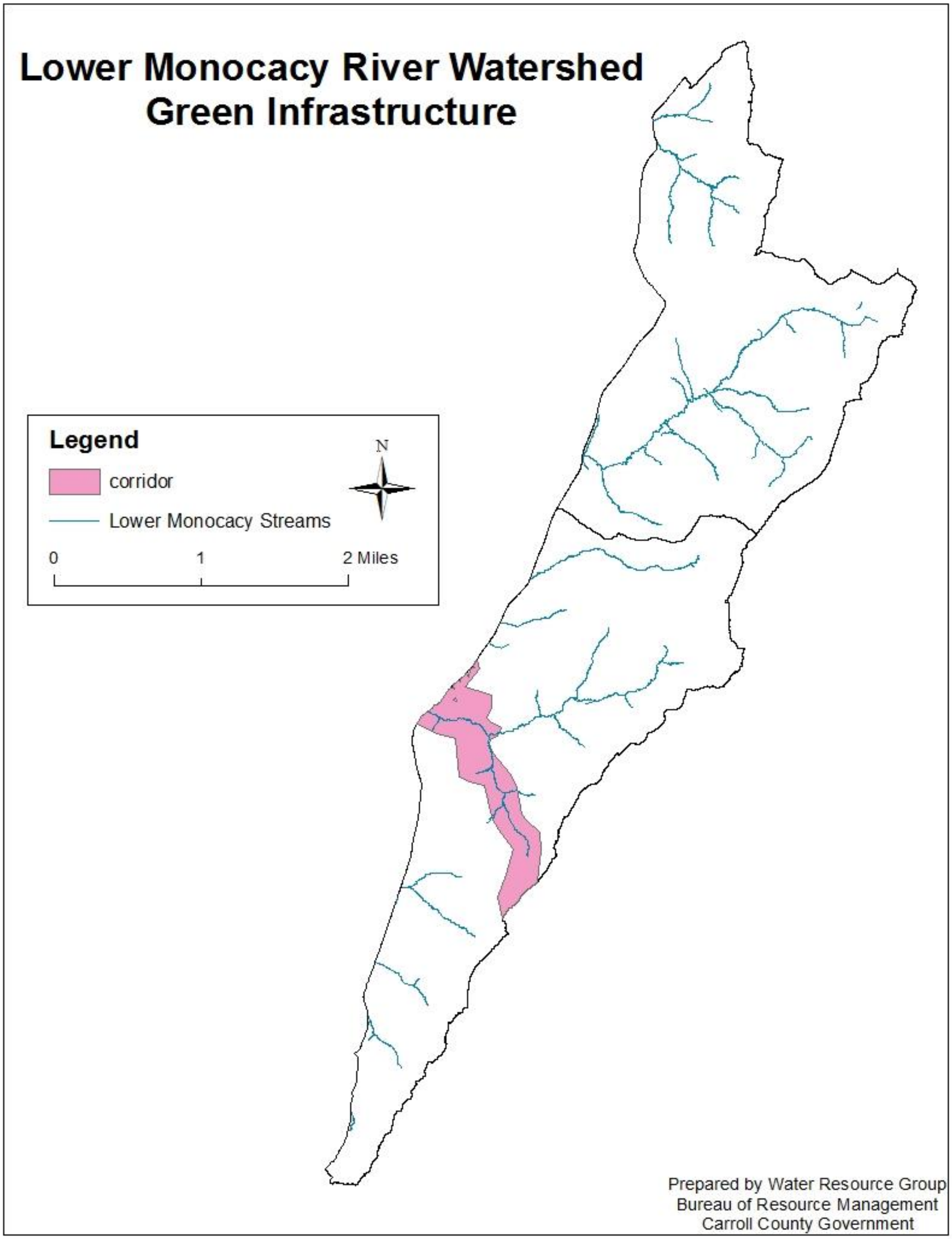

Figure 2-8: Lower Monocacy River Watershed Green Infrastructure

F. Groundwater Resources

Groundwater development potential in Carroll County is limited to the type of aquifer in the area. Of the aquifer types within Carroll County, each has unique water-bearing and yielding properties. The underlying bedrock units have minimal primary porosity and permeability. As such, groundwater occurs principally in interconnected joints, fractures, and faults within the rock mass, as well as in the relatively shallow weathered zone overlying the bedrock and beneath the soil horizon (Carroll County Water Resources Study, 1998).

Transmissivity indicates the ease at which groundwater moves through an aquifer in response to the water table gradient within the aquifer. Transmissivity is a governing factor in determining the amount of water which may be withdrawn in a given area. A highly transmissive aquifer will allow a greater volume of water to be withdrawn than an aquifer with low transmissivity, with a given water table drawdown. Low transmissivity will cause significantly less flow in the groundwater, and restricts withdrawal rates.

To obtain satisfactory well yield, well location is critical and must intersect a permeable fracture. Fracture trace zones are evident on aerial photographs as alignments of valleys and swales, contrasting soil tones, differences in vegetation type and growth along with the occurrence of springs and seeps.

Groundwater withdrawal, if ungoverned will ultimately lower the water table, affecting stream-flow. It is important to maintain a balance between biological needs of a stream and water withdrawal needs. Aquifers are replenished by the seepage of precipitation, but the amount that is absorbed is dependent on geologic, topographic, and human factors, which determine the extent and rate that aquifers are replenished.

The ground works as an excellent mechanism for filtering particulate matter, but natural occurring contaminants such as iron and manganese, as well as human induced contaminants such as chemicals and oil are easily dissolved and could be found in high concentrations within the water. Since underlying rocks have varying porosity and permeability characteristics, water quality will also vary greatly. Rock types with a higher rate of recharge generally have lower associated water quality.

III. Human Characteristics

A. Population

The natural landscape of the Lower Monocacy River Watershed has been modified for human use over time. Anthropogenic modifications have potential to degrade both the terrestrial and aquatic ecosystems. The Lower Monocacy River Watershed currently has an estimated population of approximately 7,626 persons, with greatest population densities in the vicinity of Mount Airy. If you spread the population evenly across the entire Watershed it would equal about one person per 0.716 acre. The following chapter will look at human characteristics of the watershed, and how anthropogenic modifications could impact the natural ecosystem. Specifically, this chapter will examine the general land use and land cover of the watershed, as well as specific human modifications such as impervious surface cover, storm water systems, drinking water, and waste water systems.

B. Baseline and Current Land Cover

The land use information was obtained from the National Land Cover Database (GIS) land use data. Land use data summary for the Lower Monocacy Watershed can be found in Table 3-1. Figure 3-1 shows the land use cover within the Lower Monocacy Watershed.

Table 3-1: Lower Monocacy River Watershed Baseline and Current Land Cover

Land Cover	Acres 2001	Percent 2001	Acres 2006	Percent 2006	Acres 2011	Percent 2011	Current Acres	Percent
Open Water	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Low-Density Residential	896	16%	908	17%	906	17%	1,375	25%
Low-Density Mixed Urban	180	3%	192	4%	191	4%	125	2%
Medium-Density Mixed Urban	24	<1%	37	<1%	38	<1%	30	<1%
High-Density Mixed Urban	3	<1%	4.30	<1%	5	<1%	4	<1%
Barren Land	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Forest	2,004	37%	1,997	37%	1,999	37%	1,971	36%
Shrub/Scrub	51	<1%	50	<1%	49	<1%	27	<1%
Grassland	18	<1%	22	<1%	22	<1%	15	<1%
Pasture/Hay	820	15.0%	815	15%	815	15%	751	14%
Cropland	1,374	25%	1,346	25%	1,346	25%	1,087	20%
Wetland	79	1%	79	1%	75	1%	75	1%

Source: National Land Cover Database

Forest is the dominant land use within the Lower Monocacy Watershed, followed by agriculture and residential. Mixed urban uses account for less than 3 percent of the total land use, which represents the relatively rural nature of the Lower Monocacy Watershed.

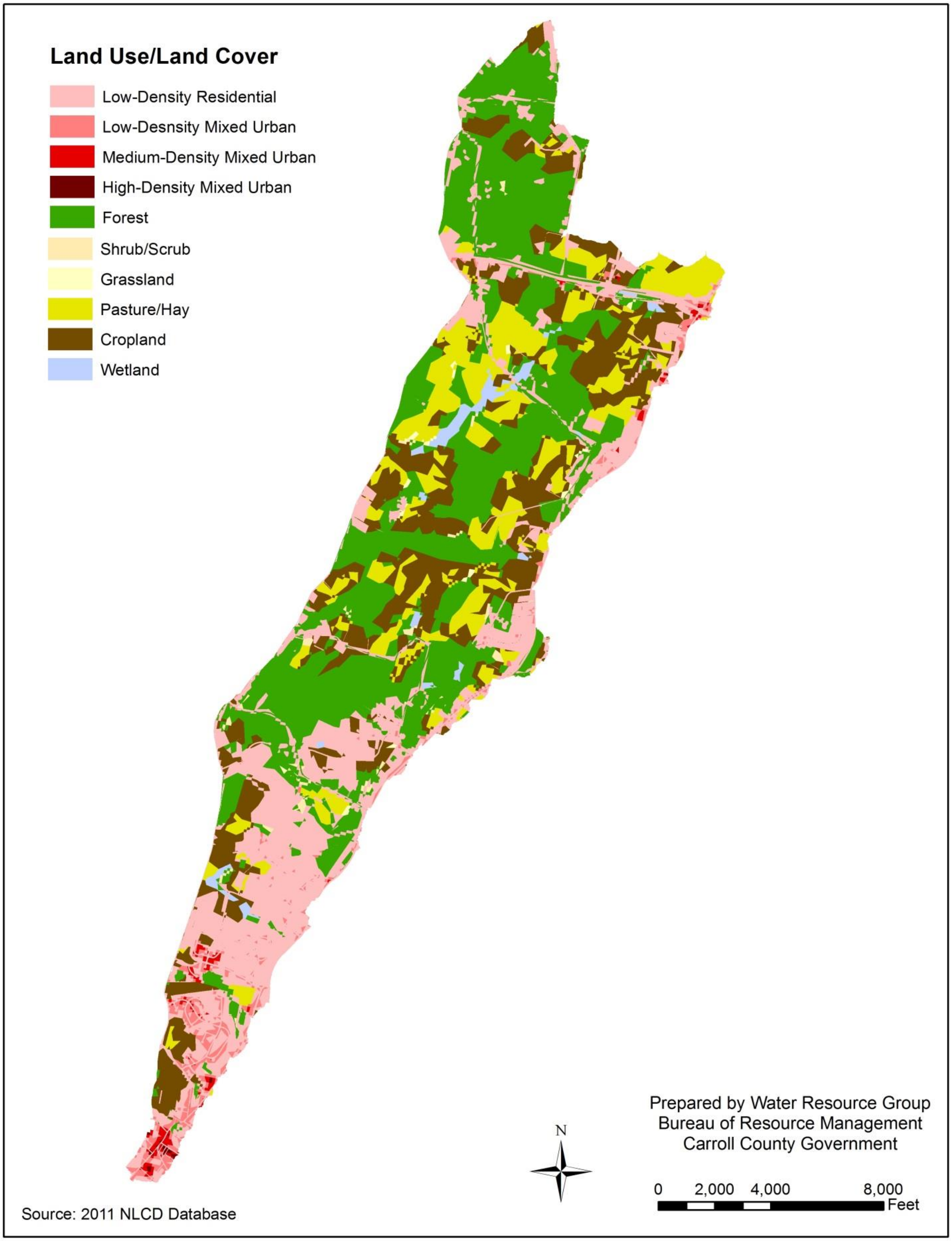

Figure 3-1: Lower Monocacy River Watershed Land Use and Land Cover

C. Priority Funding Areas, Zoning and Build Out

1. Priority Funding Areas

The Maryland Smart Growth Areas Act of 1997 introduced the concept of Priority Funding Areas (PFAs). The Maryland Planning Act and Smart Growth initiatives require that the local jurisdictions map specific growth areas to target infrastructure dollars from the State. Priority Funding Areas are existing communities and locations where State funding for future growth will be designated. These designated areas have specific boundaries and are the focal area for employment, social, and commercial growth within the watershed. The designated PFAs, shown in Figure 3-2, incorporates the Town of Mount Airy in the Lower Monocacy River Watershed.

2. Zoning and Build-Out

Zoning refers to the regulation of land for the purpose of promoting compatible land uses. Typically zoning specifies the areas in which residential, industrial, recreational or commercial activities may take place. The current zoning for the Lower Monocacy River Watershed can be found in Figure 3-3. Carroll County does not regulate zoning within the municipalities. The majority of the Lower Monocacy River Watershed (80.87%) is zoned agricultural.

Build-out analyzes the number of residential units in a given area that could be built based on the current zoning. Build out looks at existing development and, based on a yield calculation, determines how many more residential units can be built in the future. Within the Lower Monocacy River watershed there are 244 parcels remaining with potential development on 2,078 acres for an estimated lot yield of 420 (build out data was provided by Carroll County Department of Land and Resource Management). This data is based on a medium range buildable land inventory estimate by land use designations. The medium range estimates have been determined to be the most accurate for build out. The full buildable land inventory report can be found at: http://ccgovernment.carr.org/ccg/compplanning/BLI/.

Figure 3-4 shows the remaining parcels in Lower Monocacy River Watershed where residential units could be built.

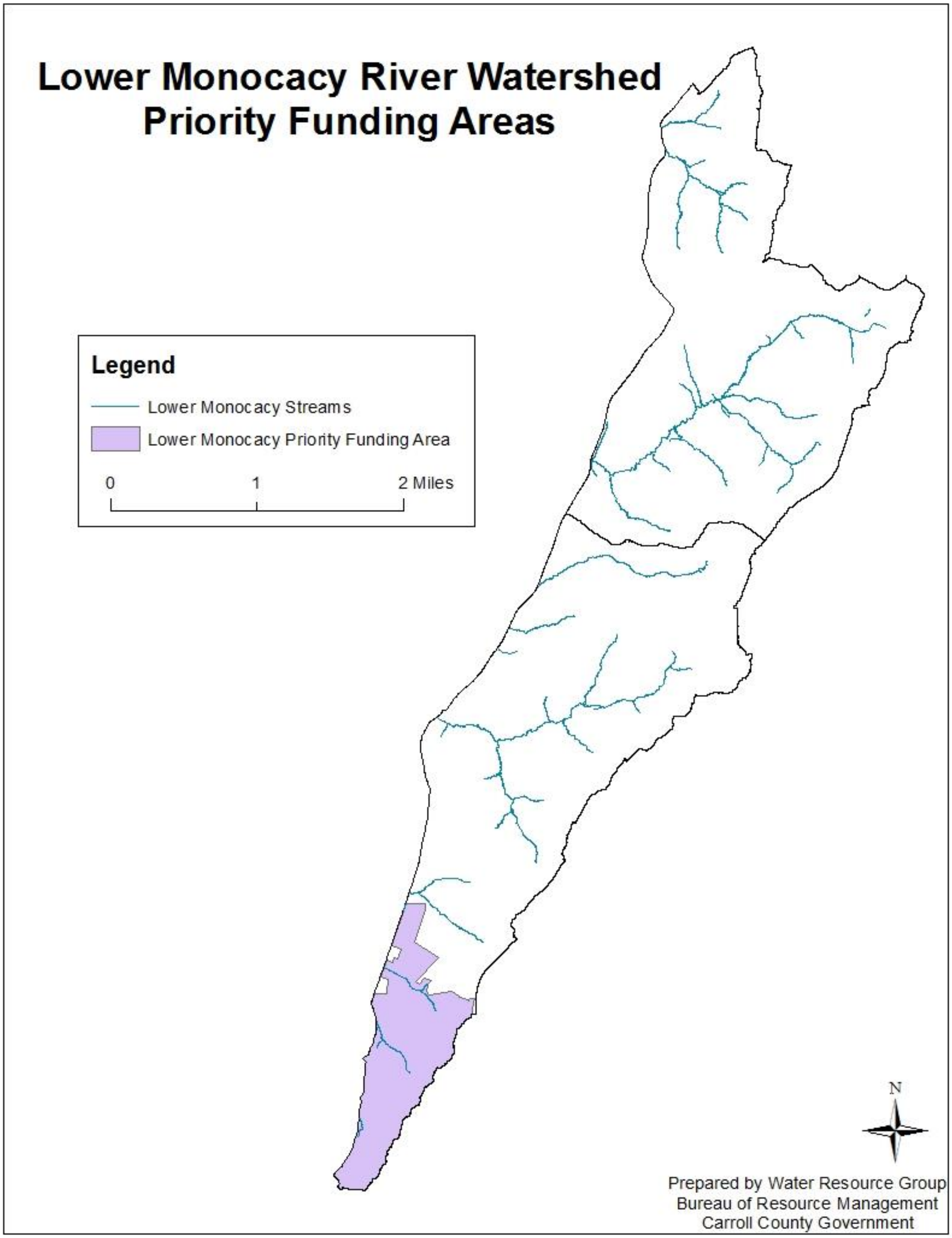

Figure 3-2: Lower Monocacy River Watershed Priority Funding Area

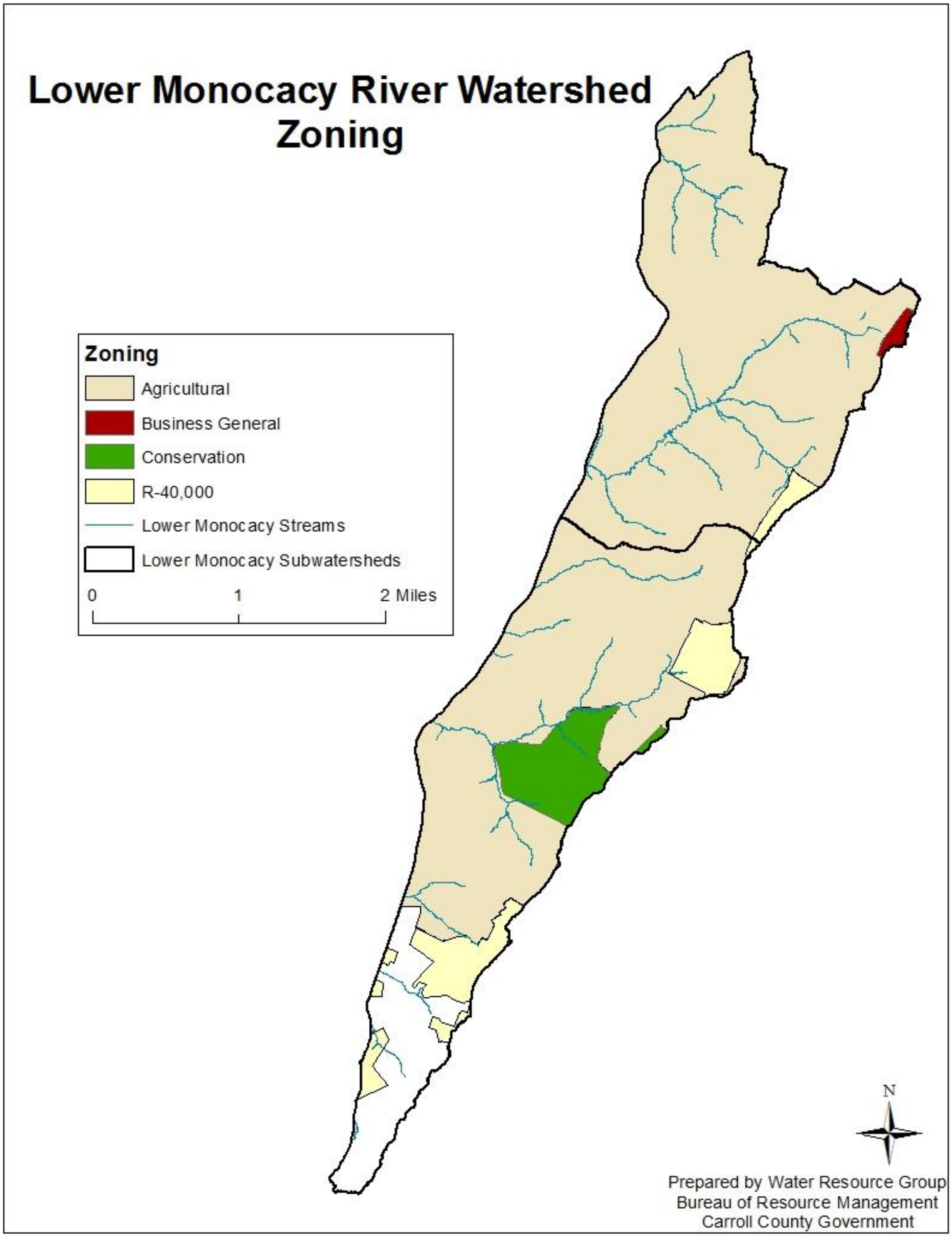

Figure 3-3: Lower Monocacy River Watershed Zoning

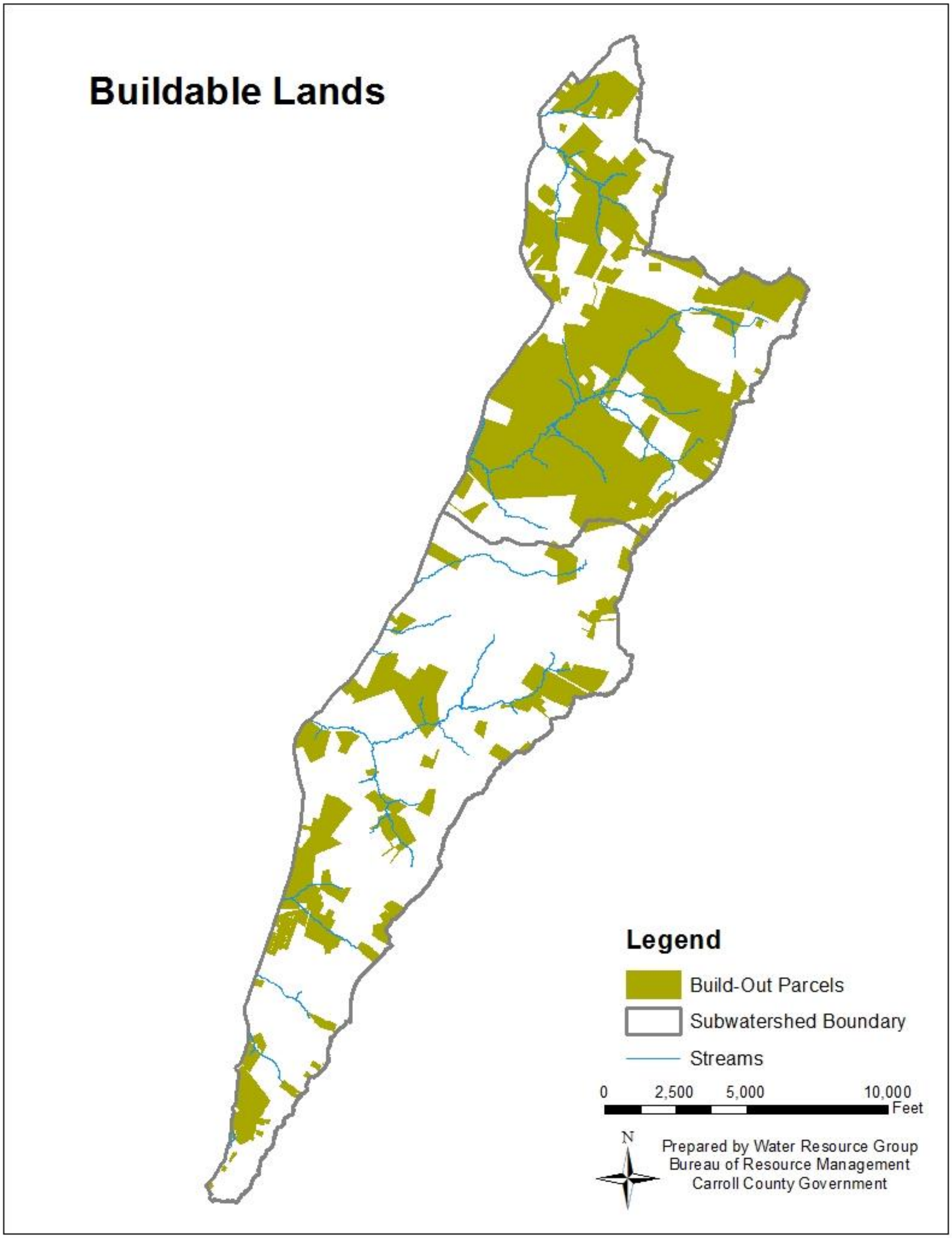

Figure 3-4: Lower Monocacy River Watershed Build-Out Parcels

D. Impervious Surfaces

Watershed and stream health have been tied, via various studies to the amount of impervious surface that lies within the system. Impervious surfaces such as roads, parking areas, and rooftops block the natural seepage of rainwater into the ground, resulting in concentrated stormwater runoff with an accelerated flow rate.

There are two general ways to quantify impervious cover: total impervious and effective impervious. Total impervious accounts for all impervious surfaces within a catchment, and effective impervious is the impervious area within the watershed that is directly connected to stream channels. The impervious surface area within Lower Monocacy River watershed, by subwatershed can be found in Table 3-2 and is shown in Figure 3-5.

Table 3-2 Lower Monocacy River Watershed Estimated Impervious Surface Area

DNR 12-digit Scale	Subwatershed	Acres	Impervious Acres	Percent Impervious
021403020238	North Fork	2,569.3	117.6	4.6
021403020235	South Fork	2,893.4	229.5	7.9
Lower Monocacy River Watershed		**5,462.7**	**347.1**	**6.3**

The Lower Monocacy River watershed is estimated to have 347 acres of total impervious within the catchment and accounts for approximately 6.3 percent of the total land area. Effective impervious was not calculated for this exercise because it is difficult to accurately determine without proper field verification, but it is a much lesser percent.

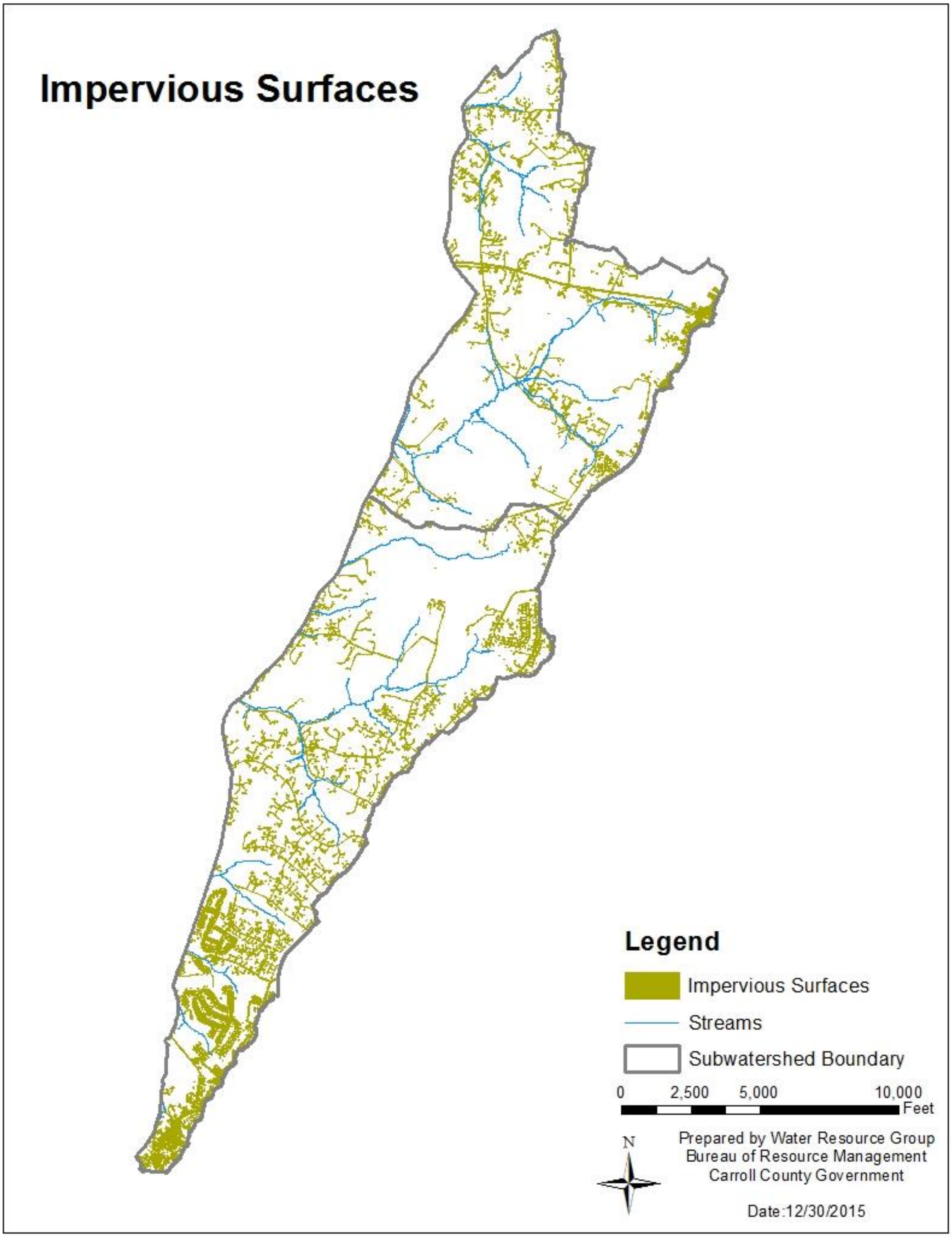

Figure 3-5: Lower Monocacy River Watershed Impervious Surface Area

E. Stormwater

Stormwater consists of runoff from precipitation and snowmelt that flows over the land or an impervious surface that is unable to infiltrate into the ground. As the runoff flows across a surface it can accumulate debris, chemicals, sediment and other pollutants that could adversely affect the water quality of a stream. An increased amount of unmanaged impervious surface within a watershed is likely to increase the amount of polluted stormwater reaching stream channels.

1. Stormwater Management Facilities

The State of Maryland began requiring stormwater management in the mid 1980's for new development to manage the quantity of runoff. These requirements were initially established for any subdivision with lots of less than 2 acres in size. For lots greater than 2 acres, stormwater management was only required to address road runoff. In 2000, MDE released a new design manual for stormwater (MDE, 2000). The new manual required greater water quality and quantity controls and included stormwater management for subdivisions with lots greater than 2 acres. The manual was then revised in 2009 to reflect the use of environmental site design practices.

There are different types of management facilities with varying degrees of pollutant removal capability. Facilities that infiltrate stormwater runoff have among the highest pollutant removal capability; while dry pond designs have the lowest pollutant removal efficiency, and were initially designed to control water quantity. In total there are 19 existing stormwater management facilities within the Lower Monocacy River Watershed. Table 3-3 lists the facility type, number of structures and associated drainage acreage of the structures. Appendix A lists stormwater management facilities by subwatershed location, facility type, drainage area, and facility name. Appendix A also lists a definition of each facility and the pollutant removal capability. Figure 3-6 shows the location of the stormwater management facilities in the Lower Monocacy River Watershed.

Table 3-3: Lower Monocacy River Watershed Stormwater Facility Types

Facility Type	Number of Structures	Drainage Acreage
Detention Facility	3	36.5
Infiltration Facility	13	163.76
Retention Facility	1	0.24
Shallow Marsh	1	26.1
Grass Channel	1	10

Stormwater management facilities proposed for implementation to assist in addressing the stormwater wasteload allocation TMDLs are listed within the Lower Monocacy Watershed TMDL restoration plan.

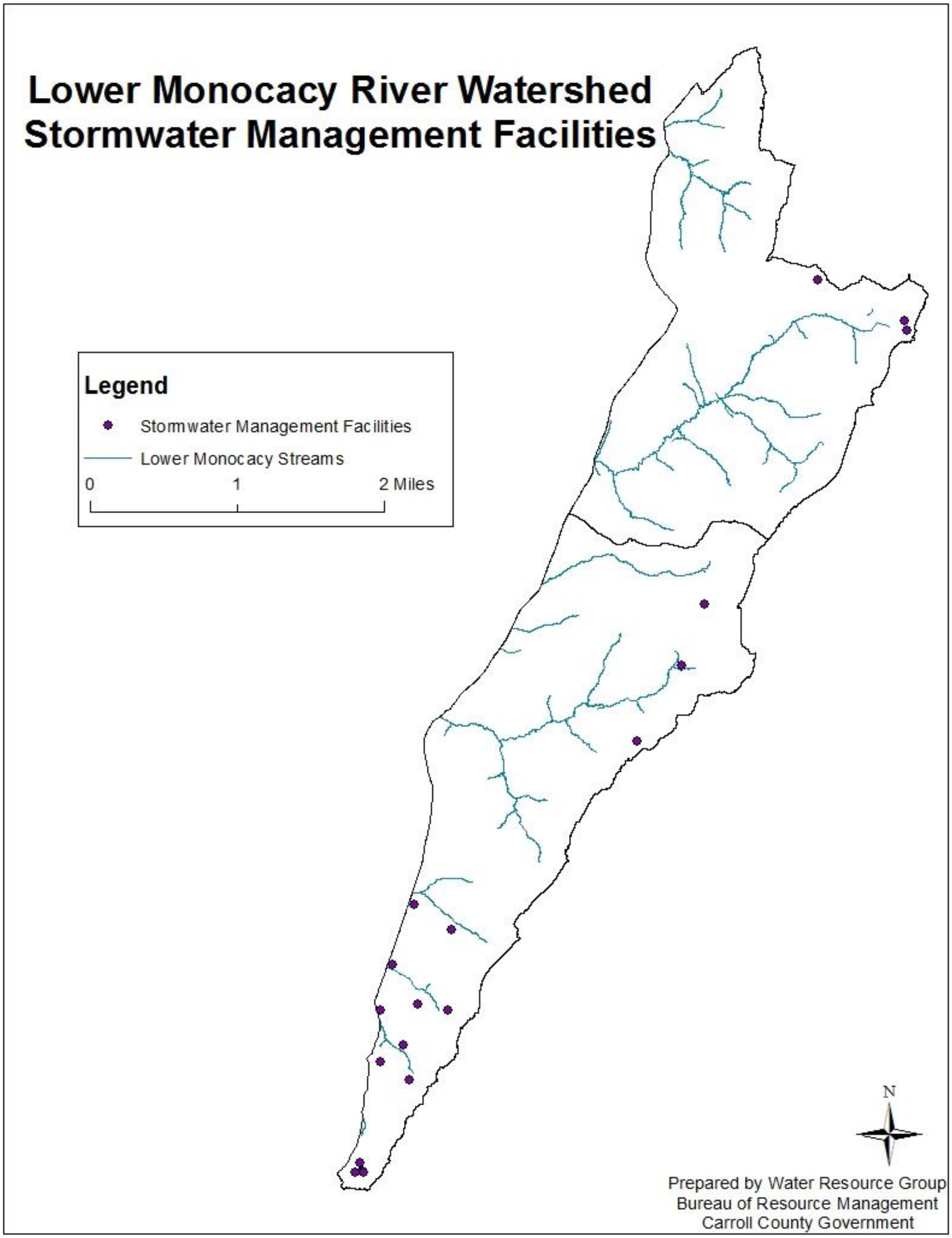

Figure 3-6: Lower Monocacy River Watershed Stormwater Management Facilities

2. Storm Drain Systems

Storm drainage systems consist of either contoured drainage swales or a curb and gutter system with inlets and associated piping. Both systems function to efficiently remove water from impervious areas in order to prevent flooding, but have varying effects on water quality. The curb and gutter system can be directly connected to a stream through its piping network and deliver increased volumes of water, as well as untreated pollutants from the connected impervious surface to the stream. Contoured drainage swales do not allow water to move as efficiently as the curb and gutter system. Swales allow some water to infiltrate, which provides some filtering of pollutants, and reduces the amount of water delivered to a stream.

F. Drinking Water

Having safe drinking water is fundamentally important to support human and livestock populations within a watershed. Within the Lower Monocacy River Watershed, drinking water comes from two main sources; public water systems and private wells.

1. Wellhead Protection Areas

Wellhead protection areas established under the Safe Drinking Water Act are surface and subsurface regulated land areas around public drinking water wells and/or well fields. Wellhead protection areas are regulated to prevent contamination of water supply. Ideally a wellhead protection area will encompass the entire recharge area for a well. Wellhead protection areas within the Lower Monocacy River Watershed can be seen in Figure 3-7.

2. Public Water Service Area

Within the Lower Monocacy River Watershed, the town of Mount Airy and surrounding areas provide residents with public water. Within the Lower Monocacy River watershed the Mount Airy area has 1 existing storage tank, 1 existing well and 1 future well.

A water use appropriation permit is required for any entity withdrawing more than 10,000 gallons of water a day from a single source. Appropriations are determined by the MDE water supply program, and are necessary to conserve and protect wells as a vital resource for the residents in the State of Maryland. At any given time these wells could either be online or offline depending on maintenance and demand. The community well locations and associated public service areas are shown in Figure 3-7.

3. Water Supply

The majority of residents within the Lower Monocacy River Watershed obtain their water from private wells located on their property; within Lower Monocacy River Watershed there are about 1,480 private water wells. Since the underlying geology within the Lower Monocacy River Watershed consists mainly of crystalline metamorphosed rock, the associated water withdrawals from these wells come from an unconfined aquifer. The fractured rock of the Piedmont Plateau Province allows surface water to pass through soil and into the underlying rock fractures; therefore, the source of the water is locally derived.

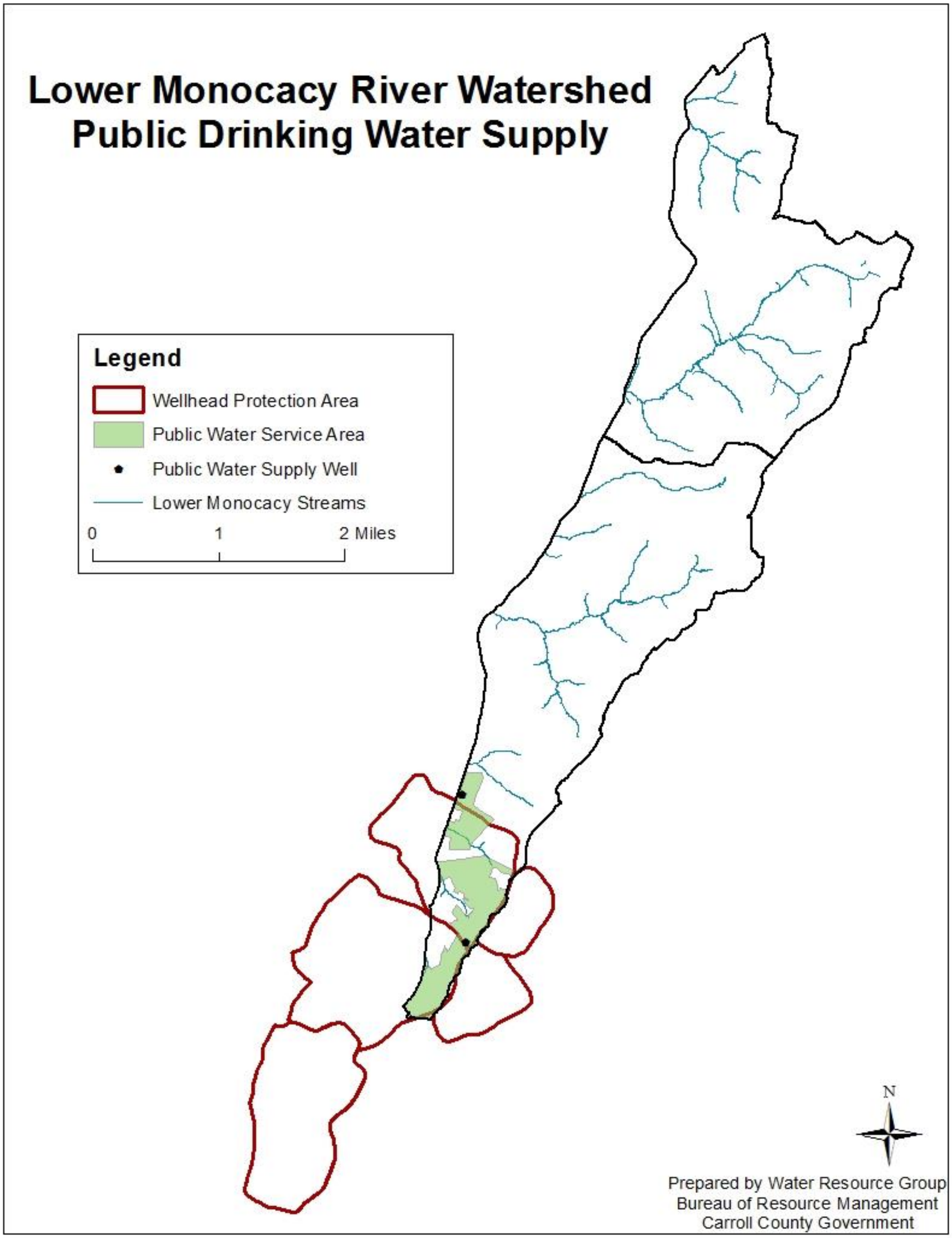

Figure 3-7: Lower Monocacy River Watershed Public Drinking Water Supply

G. Wastewater

Wastewater is any water consumed through human use that adversely affects water quality by anthropogenic influence, and must be properly contained and treated. Treatment and containment of wastewater can be accomplished by either on-site septic systems or through public conveyance to a community or private wastewater treatment plant. Treatment of wastewater is essential because any untreated wastewater, either from a residential or industrial operation, has the potential for carrying harmful contaminants to the natural environment.

1. Public Wastewater Service Area

Public service areas convey wastewater through a piping system from residences and businesses to a treatment facility prior to discharge. Each hookup to the sewer line has a clean-out in which the private landowner is responsible for maintaining. The main part of the system consists of gravity flow lines with manholes for access, pumping stations, and force mains. The public utility is responsible for maintenance on the main lines of the wastewater system. Within the Lower Monocacy River Watershed there are approximately 613 homes utilizing public service, and approximately 20 homes slated for future service. Figure 3-8 shows the public wastewater service area for the Lower Monocacy River Watershed.

2. Wastewater Discharge Locations

Within the Lower Monocacy River Watershed, areas around Mount Airy are served through a public wastewater system. The Mount Airy sewer system includes eleven pumping stations, interceptors and collection lines, and a wastewater treatment plant. The wastewater treatment plant is located one mile east of MD 27 and south of Watersville Road. The plant discharges treated wastewater into the South Branch of the Patapsco River, and has a design capacity of 1.2 Mgd. There are a total of 2 wastewater pumping stations in the Lower Monocacy River Watershed. Each pumping station is in the vicinity of an unknown tributary that flows into the Lower Monocacy River.

3. On-Site Septic Systems

On-site septic systems are the main source of waste disposal in rural and low density areas like Lower Monocacy River Watershed. When maintained and functioning properly, on-site septic systems are effective at treating nitrogen, but are not as effective at treating phosphorus. Improved treatment of nitrogen can be remedied by making sure the leach field is properly located to prevent wastewater effluent from directly entering a body of water. However when these systems fail or are inadequately maintained, excessive nutrients and bacteria can be released causing degradation of groundwater quality and nearby aquatic systems. There are currently approximately 1,480 septic systems within the Lower Monocacy River Watershed.

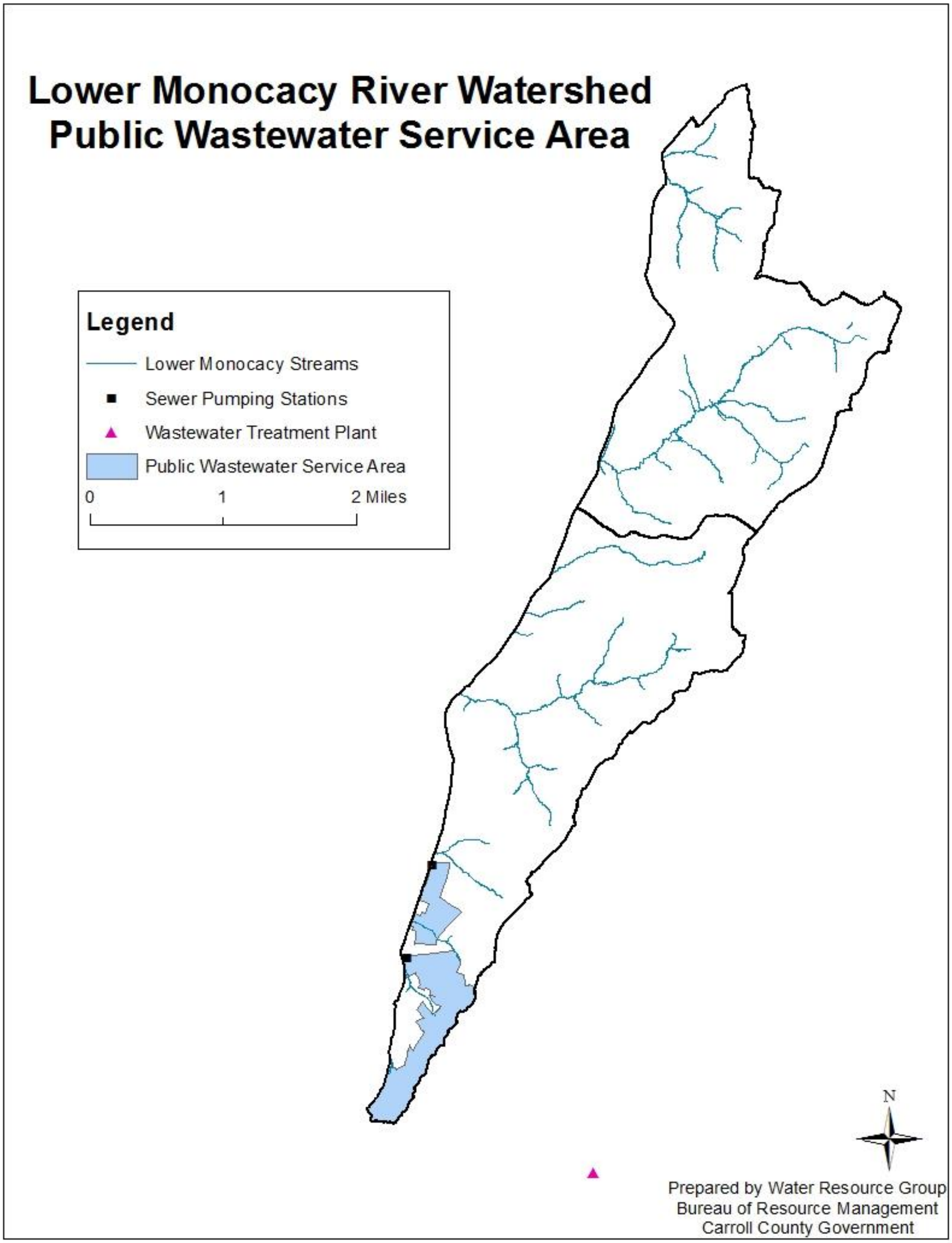

Figure 3-8: Lower Monocacy River Watershed Wastewater Service Area

H. NPDES Point Sources

Any facility that discharges wastewater, whether it is industrial or municipal, or any facility that performs activities that could have a negative impact on a waterway by introducing pollutants into the watershed must obtain a National Pollutant Discharge Elimination System (NPDES) permit. NPDES permits implement restrictions on pollutant loads to be discharged from the source, as well as documenting potential pollutant spills, treatment to wastewaters and regulating pollutants before reaching a water body. Table 3-4 shows a list of NPDES permits within the Lower Monocacy River Watershed (information obtained from EPA.GOV Envirofacts).

Table 3-4: Lower Monocacy River Watershed NPDES Permits

Permit Holder	Permit Number	Subwatershed	Original Issue Date	Status
A&D Auto Parts, Inc.	MDR001142	North Fork	23-MAY-2003	Expired
Ridge Swimming Club	MDG766885	South Fork	23-JUN-2004	Expired
Liberty Crossing	MD3533H06	North Fork	19-FEB-2010	Expired
Liberty Road Crossing Bus. Cntr	MD09I0025	North Fork	18-MAY-2009	Terminated
7-Eleven 28924	MDG916039	North Fork	14-JUL-1997	Admin Continued

I. Protected Lands

Protecting land ensures that non-urban land uses will remain intact over time on the specific parcel being protected. These lands are preserved through various programs, and the extent of protection can vary greatly from one property to the next. Preservation and protection include areas such as parks or watershed protection zones, as well as areas that are being intensively managed for agriculture. Protected lands may be preserved through direct public ownership or via public and private easement acquisition.

Table 3-5 lists the type of protected lands within the Lower Monocacy River Watershed along with the representative acreage. About 685 acres, or about 12.5%, of the total land area within Lower Monocacy River Watershed has some sort of land protection. Agricultural easements have the highest percentage of protection within the watershed at 10% with nearly 549 acres preserved. Figure 3-9 shows where the protected areas are located within the Watershed.

Table 3-5: Lower Monocacy River Watershed Protected Lands

Type of Protection	Acres	Percentage
Agricultural Easement	549.30	10.05
Open Space and Parks	39.3	0.72

Forest Conservation Easement	72	1.32
Water Resource Easement	24.18	0.44
Floodplain Easement	0.31	0.01
Total	**685.09**	**12.54**

1. Rural Legacy Program

Maryland's Rural Legacy Program was created in 1997 to protect large, continuous tracts of land from sprawl development and to enhance natural resource, agricultural, forestry and environmental protection through cooperative efforts among state and local governments and land trusts. http://www.dnr.state.md.us/land/rurallegacy/index.asp

The goals of the rural legacy program are to:

- Establish greenbelts of forests and farms around rural communities in order to preserve their cultural heritage and sense of place;
- Preserve critical habitat for native plant and wildlife species;
- Support natural resource economies such as farming, forestry, tourism, and outdoor recreation, and;
- Protect riparian forests, wetlands, and greenways to buffer the Chesapeake Bay and its tributaries from pollution run-off.

The Lower Monocacy River Watershed lies just south of the Little Pipe Creek Rural Legacy area. The Lower Monocacy River Watershed does not contain any Rural Legacy Areas. The location of Lower Monocacy River Watershed in relation to the Little Pipe Creek Rural Legacy area, and extent of growth area boundaries are shown in Figure 3-10.

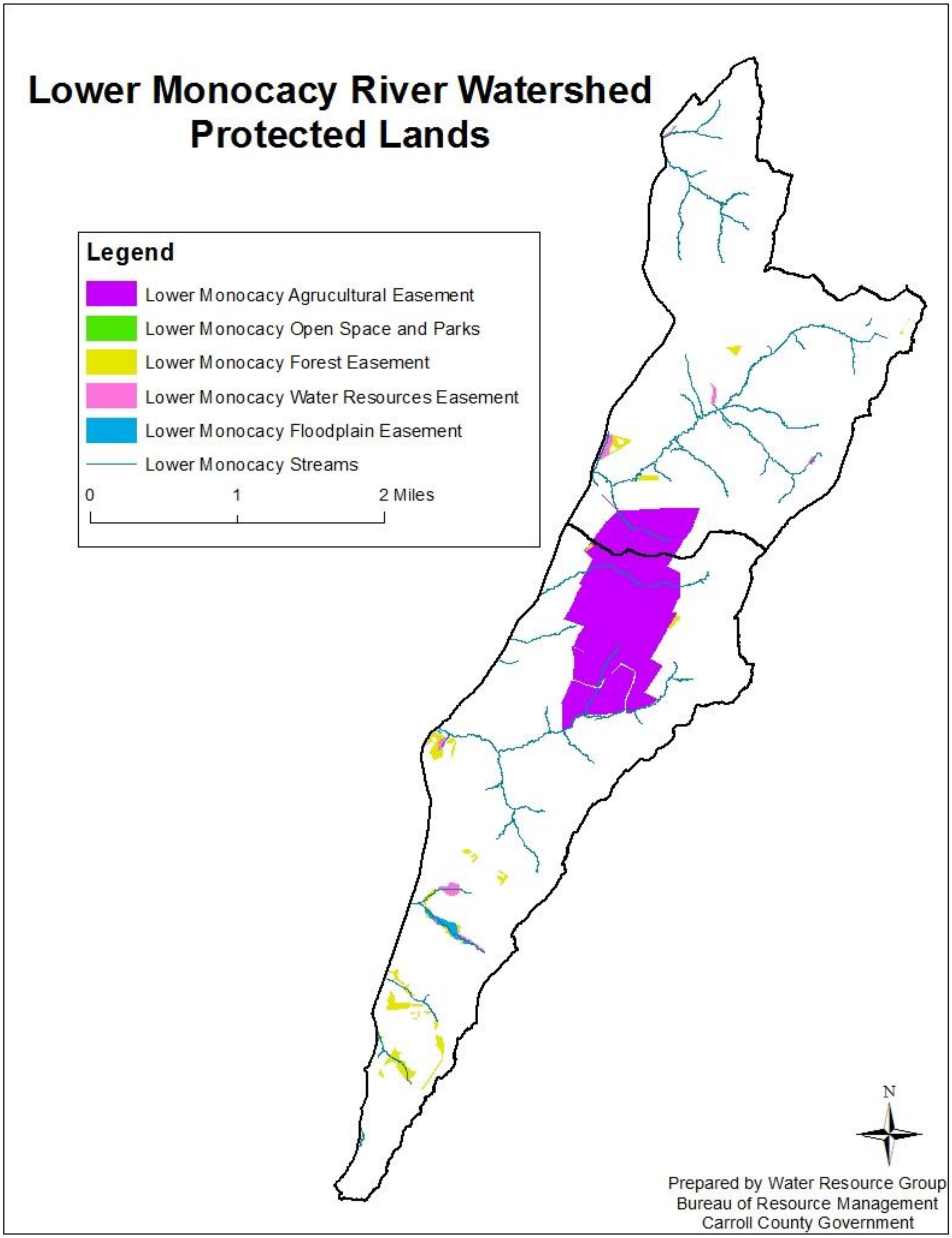

Figure 3-9: Lower Monocacy River Watershed Protected Lands

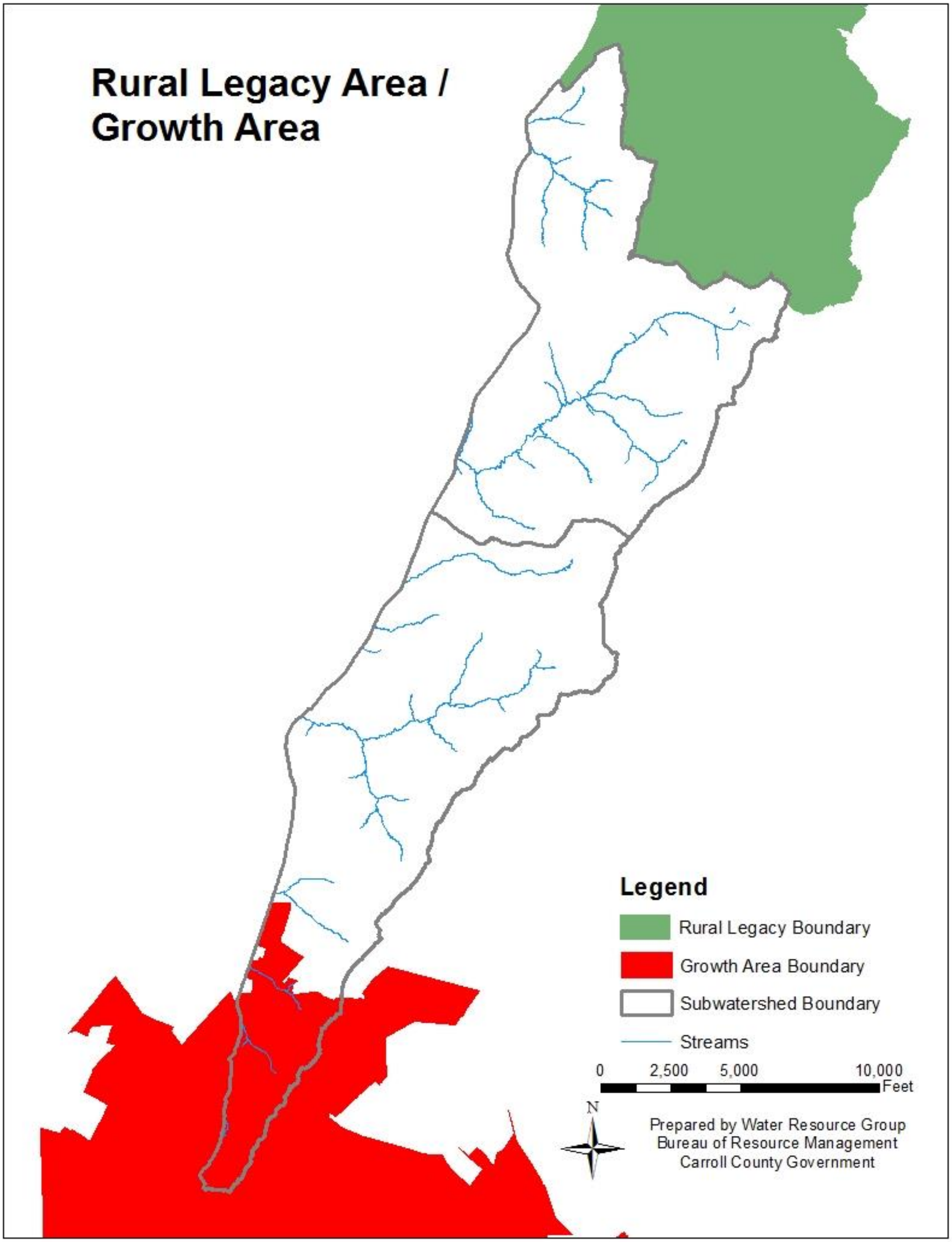

Figure 3-10: Little Pipe Creek Rural Legacy Area

J. Agricultural Best Management Practices

Agricultural BMPs are ground management practices that help minimize runoff and movement of pollutants into waterways. Agricultural BMPs can be categorized as soft BMP's such as streambank fencing and cover cropping, or hard BMP's like heavy use areas and waste storage structures. Appendix B lists the agricultural BMPs located in the Lower Monocacy River Watershed, and provides a detailed explanation of the types of practices used throughout Carroll County. Figure 3-11 shows the locations of agricultural BMPs within the Lower Monocacy River Watershed; each location may have several agricultural BMPs in place.

1. Farm Plan Acres

Farm conservation and nutrient management plans consist of a combination of agronomic, engineered, and management practices that protect and properly utilize the natural resources found on the operation in order to prevent deterioration of the surrounding soil and water. A conservation plan is written for each individual operation and dictates what management practices are necessary to protect and improve soil and water quality. A nutrient management plan is a plan written for the operator to manage the amount, timing, and placement of nutrients in order to minimize nutrient loss to the surrounding waterbodies while maintaining optimum fertilization for crop yield. The Lower Monocacy River Watershed has approximately 247 acres of agricultural land in a comprehensive farm plan.

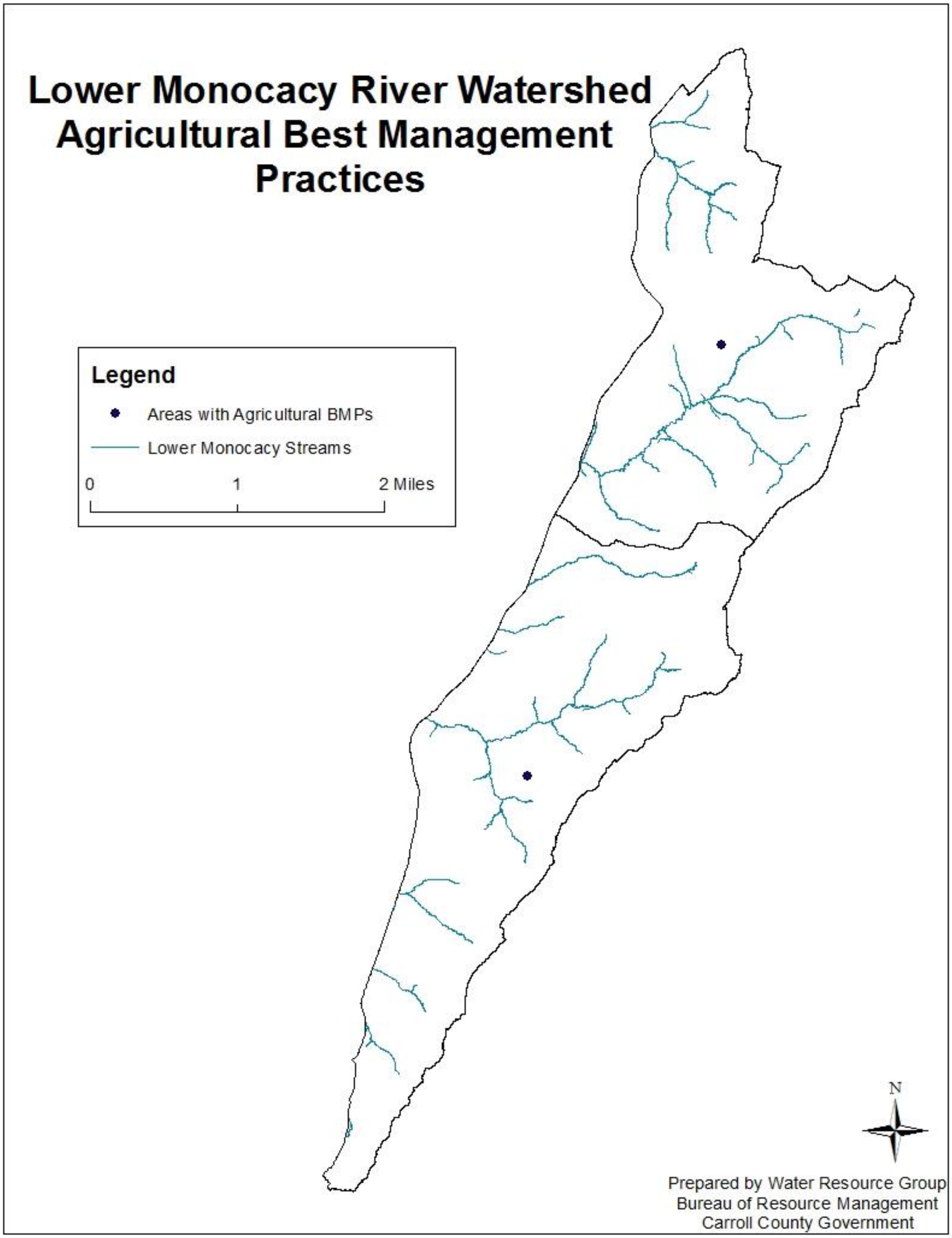

Figure 3-11: Lower Monocacy River Watershed Agricultural BMP Locations

IV. Water Quality

A. Introduction

Maryland water quality standards have been adopted from the Federal Clean Water Act, Section 101, "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters". Individual standards are established to support beneficial use of waterbodies such as fishing, aquatic life, drinking water supply, boating, water contact recreation and protection for terrestrial wildlife. Local monitoring allows for documenting the status of local waterbodies and where restoration or mitigation may be needed. This chapter will look at the designated uses within Lower Monocacy River Watershed, current water quality impairments that have been assigned and existing water quality data within the watershed. Water quality data is utilized along with identified impairments from the stream corridor assessment (Chapter 5) to prioritize preservation and restoration.

B. Designated Uses

All bodies of water, including streams within Maryland and all other states, are each assigned a designated use. Maryland's designated water uses are identified in the Code of Maryland Regulations (COMAR) 26.08.02.08. The designated use of a water body refers to its anticipated use and any protections necessary to sustain aquatic life. Water quality standards refer to the criteria required to meet the designated use of a water body. A listing of Maryland's designated water uses are as follows:

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

If the letter "P" follows the use class listing, that particular stream has been designated as a public water supply.

The entire portion of the Lower Monocacy River watershed within Carroll County is designated as use IV-P, Water Contact Recreation, Protection of Aquatic Life, Recreational Trout Waters and Public Water Supply. The use IV-P waters are not capable of growing and propagating trout, but is capable of supporting adult trout for a put-and-take fishery.

C. Tier II Waters

States are required by the federal Clean Water Act to develop policies, guidance, and implementation procedures to protect and maintain existing high quality waters and prevent them from degrading to the minimum allowable water quality. Tier II waters have chemical or biological characteristics that are significantly better than the minimum water quality requirements. All Tier II designations in Maryland are based on having healthy biological communities of fish and aquatic insects. Within the Lower Monocacy River watershed, there are no listed Tier II waters, though portions of the watershed are part of Tier II catchment basins.

D. Total Maximum Daily Loads

Streams and other waterbodies that are unable to meet their designated use as defined by the COMAR are known as impaired waters. Impaired waters are placed on the 303(d) list, which is a section of the Clean Water Act that tracks impaired and threatened waterbodies.

The MDE uses the 303(d) list of impaired waters to establish TMDL's. A TMDL establishes the maximum amount of a pollutant or stressor that a waterbody can assimilate and still meet water quality standards for its designated use. Each TMDL addresses a single pollutant, whereas one waterbody may have multiple TMDL's. TMDL's are calculated by adding the sum of the allowed pollutant loads for point sources, non-point sources, projected growth, with a margin of safety built in. Load allocations are calculated through the use of watershed modeling using existing and historical data collected in the field.

More information on TMDL's and the 303(d) list can be found at: http://www.mde.maryland.gov/programs/Water/TMDL/Pages/Programs/WaterPrograms/tmdl/index.aspx

1. Current Impairments

The current impairments within the Lower Monocacy River Watershed that have been assigned a TMDL include; Bacteria and Phosphorus.

a. Bacteria

The current estimated stormwater baseline load for bacteria within the Carroll County portion of Lower Monocacy Watershed was determined by (MDE, 2009) to be 116,000 billion MPN/year (MPN, or most probable number is a technique used to estimate microbial populations). The TMDL to meet the watersheds designated use was determined by MDE to be 1,856 billion MPN/year, which is a reduction of 114,144 billion MPN/year (98.4%) from the current estimated loading.

These maximum practicable reduction targets are based on the available literature and best professional judgment. There is much uncertainty with estimated reductions from BMPs. In certain watersheds, the goal of meeting water quality standards may require very high reductions that are not achievable with current technologies and management practices (MDE, 2009). Table 4-1 outlines the bacteria baseline and TMDL for the Carroll County portion of the Loch Raven Watershed.

Table 4-1: Lower Monocacy River 8-digit Watershed Bacteria TMDL

Lower Monocacy Watershed			Percent Reduction
Jurisdiction	Baseline	TMDL	
Carroll County	116,000	1,856	98.4%
Total	**116,000**	**1,856**	**98.4%**

b. Phosphorus

The current estimated stormwater baseline load for Carroll County as determined by the Maryland Department of the Environment (MDE) TMDL Data Center is 1,155 lbs. /yr., the TMDL for the stormwater WLA was determined to be 806 lbs. /yr., which is a reduction of 349 lbs. /yr. (30%) from the current loading (MDE 2012) (Table 4-2). This stormwater WLA includes all Carroll County Phase I jurisdictional MS4s.

Table 4-2: Lower Monocacy River 8-digit Watershed Phosphorus TMDL

Jurisdiction	Baseline	TMDL	Percent Reduction
Carroll County	1,155	806	30
Total	**1,155**	**806**	**30%**

The TMDLs are based on average annual total phosphorus loads for the simulation period 1991-2000, which includes both wet and dry years, and thus takes into account a variety of hydrological conditions. Phosphorus remains as the only nutrient TMDL within the watershed and has been determined by MDE to be the limiting nutrient. If phosphorus is used up or removed, excess algal growth within the system will cease.

E. Water Quality Data

Water quality data within the Lower Monocacy River Watershed has been collected and monitored throughout the years by varying agencies with different program goals. . This section will focus on the current monitoring being performed by Carroll County, as well as monitoring results from DNR’s MBSS program.

1. Current Monitoring

The County’s current monitoring strategy is focused primarily around retrofit locations where reductions in loadings can be documented from the before and after study approach.

The Bureau of Resource Management currently monitors one location within the Lower Monocacy River watershed. The Candice Estates site, shown in Figure 4-1 is located within the South Fork (0235) subwatershed.

Currently there are no stormwater controls to this location; the Bureau of Resource Management is in the planning phase for a project at this site that will consist of a surface sand filter. The Candice Estates location is primarily low-density residential, which encompasses 79% of the land cover. The drainage area to the monitoring site is approximately 39 acres, of which, 13 acres or 33% is impervious.

Bi-weekly monitoring at the Candice Estates site will start at the beginning of FY17, and will consist of chemical grab samples with corresponding discharge measurements in order to calculate loadings. The chemical monitoring parameters, methods, and detection limits for the Candice Estates site can be found in Table 4-3. Additional monitoring at this location includes spring macro-invertebrate collection, which are based upon protocols set by Maryland’s MBSS program (Stranko et al, 2014).

Table 4-3: Water Quality Parameters and Methods

Parameter	Reporting Limit	Method
Total Suspended Solids	1 mg/l	SM 2540 D-97
Total Phosphorus	0.01 mg/l	SM 4500-P E-99
Ortho Phosphorus	0.01 mg/l	SM 4500-P E-99
Nitrate-Nitrite	0.05 mg/l	SM 4500-NO3 H00
Bacteria[1]		

[1] Due to the relative short holding time and complexity of the Bureau’s retrofit monitoring program, bacteria is not included as part of the bi-weekly data collection.

Once construction of this existing facility is underway, monitoring at this location will temporarily be suspended. Following the as-built approval for this new facility, chemical and biological data collection will continue in order to document changes in stream health.

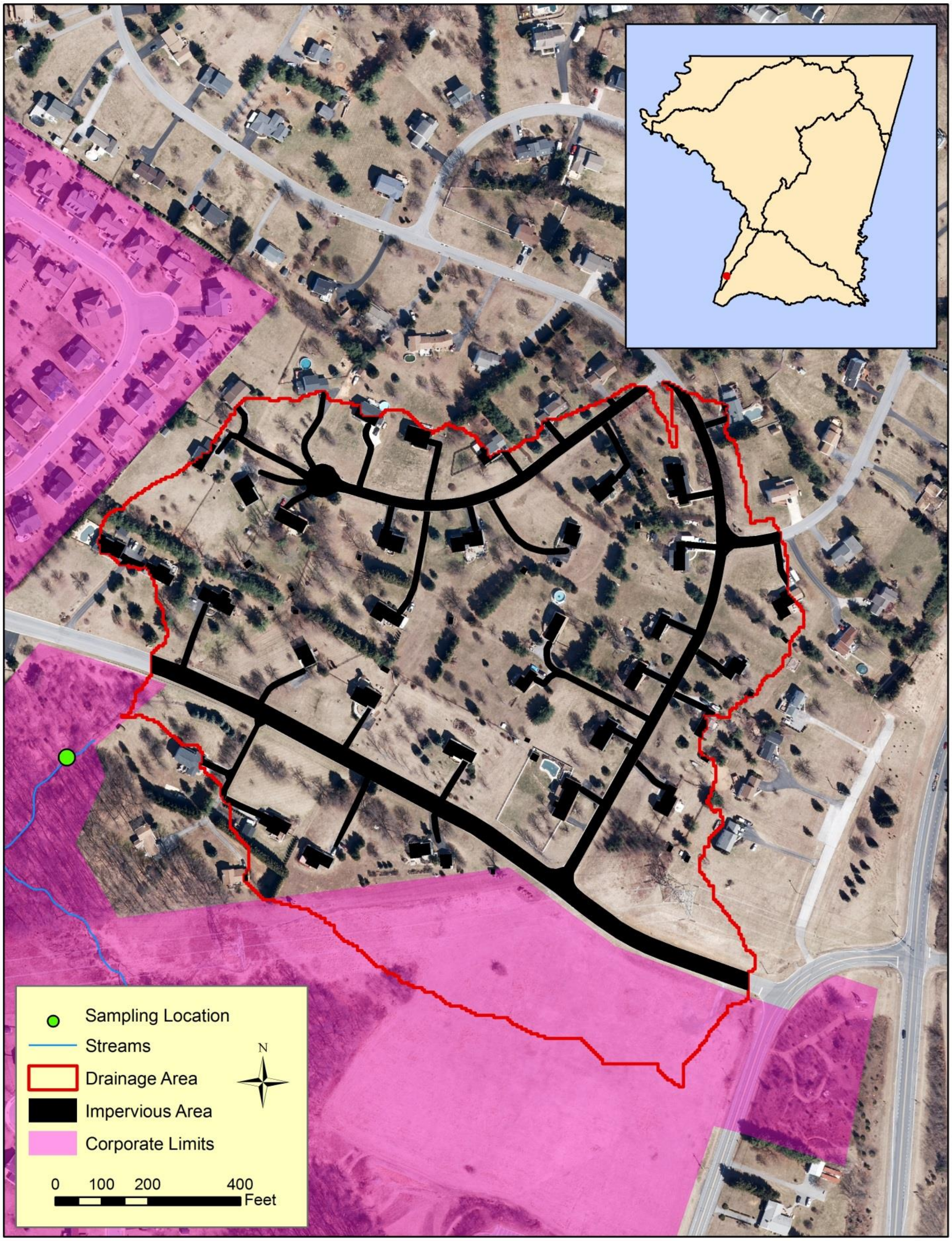

Figure 4-1: Candice Estates Monitoring Location

2. Maryland Biological Stream Survey

The Maryland biological stream survey (MBSS) was started by the DNR in 1993 and expanded statewide in 1994 to characterize the health of Maryland's 10,000+ miles of freshwater streams. The MBSS was Maryland's first stream sampling program intended to provide unbiased estimates of stream conditions. Data is collected at each site on the physical, chemical, and biological characteristics, and then combined into an overall assessment. In this chapter we will discuss the chemical data of the MBSS, and in Chapter 5 we will focus on the biological data of the MBSS. The MBSS goal is to provide the best possible information for the protection and restoration of Maryland's stream ecological resources. The MBSS's objectives to help meet this goal include:

- Assess the current condition of ecological resources in Maryland's streams and rivers;
- Identify the impacts of acidic deposition, climate change, and other stressors on ecological resources in Maryland's streams and rivers;
- Provide an inventory of biodiversity in Maryland's streams;
- Assess the efficacy of stream restoration and conservation efforts to stream ecological resources;
- Continue to build a long-term database and document changes over time in Maryland's stream ecological condition and biodiversity status; and
- Communicate results to the scientific community, the public, and policy makers.

a. Maryland's DNR Results

The DNR has conducted four rounds of MBSS: Round 1 in 1995-1997, Round 2 in 2000-2004 and Round 3 in 2005-2009, a targeted sampling in 2011 and Round 4 began in 2014. Each Round surveyed random and targeted stream reaches from first through fourth order streams. As the MBSS program has progressed, it has shifted to include more targeted sampling focused on a wide range of other program objectives such as TMDL and watershed delineation needs. Information on MBSS site surveys throughout the State can be seen here: http://www.streamhealth.maryland.gov/map.asp.

Site locations for the DNR MBSS are shown in Figure 4-2.

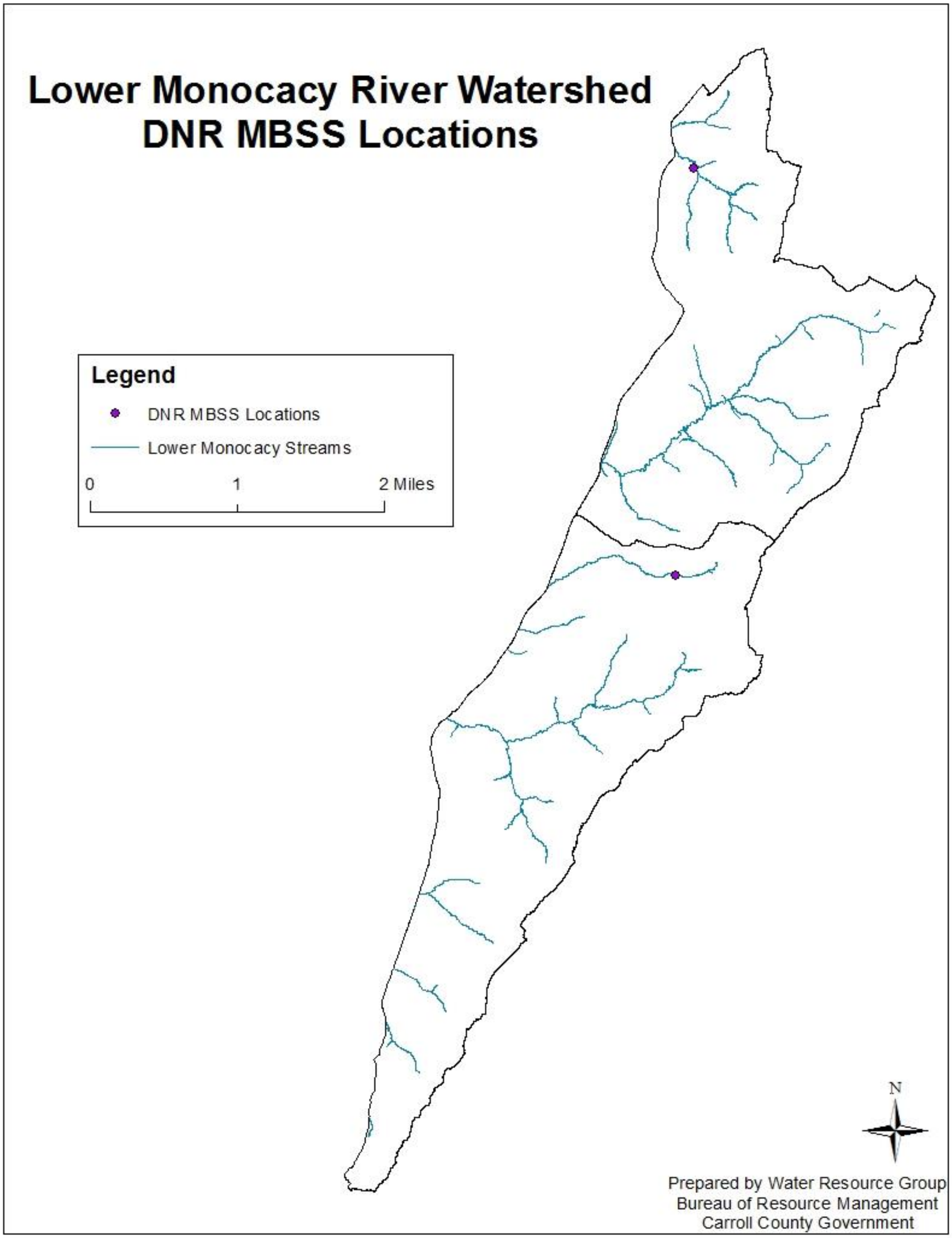

Figure 4-2: Lower Monocacy River Watershed DNR MBSS Locations

The chemical characteristics of a water body influence stream health impacting the habitat and biota. Stream acidification is known to have detrimental effects on aquatic animals. High acidity environments can affect animals' physiological functions, and influences the availability and toxicity of metals to aquatic animals. All streams contain a background level of nitrogen that is essential to the survival of the plants and animals in that stream; however the amount of nitrogen in many streams has increased as a result of anthropogenic influences. Agricultural runoff, wastewater discharge, and nonpoint sources are common culprits leading to an increased nitrogen load. Elevated levels of phosphorus in Maryland waters are usually associated with agricultural impacts. Elevated nitrogen and phosphorus concentrations can cause nutrient enrichment in aquatic systems which lead to decreased amounts of dissolved oxygen. Continued exposure to low dissolved oxygen environments can suffocate biota or lead to reduced spawning success. The COMAR states that dissolved oxygen concentrations greater than 5 mg/l are the standard and a level generally considered healthy for aquatic life. Increased nutrient loads are also linked toxic algal blooms. Conductivity is a measure of the ability of water to pass an electrical current, as affected by inorganic dissolved solids. Organic compounds like oil and phenol do not conduct electrical current very well and therefore have a low conductivity when in water. Discharges to streams can change the conductivity depending on the pollutant. A failing sewage system would raise the conductivity because of the presence of chloride, phosphate, and nitrate while an oil spill would lower the conductivity.

The chemical results obtained during DNR's MBSS sampling are listed in Table 4-4.

Table 4-4: Lower Monocacy River Watershed DNR's MBSS Chemical Results

Site Identification	Stream Segment	Field pH	Temperature (°C)	Dissolved Oxygen	Conductivity
LMON-113-R-2003	South Fork Linganore Creek Unnamed Tributary 1	6.51	13.6	8.8	0.121
LMON-108-R-2003	Weldon Creek	6.86	13.1	8.8	0.099

The Lower Monocacy River Watershed DNR MBSS data demonstrates there is sufficient dissolved oxygen to adequately support aquatic life. The dissolved oxygen level measured during the DNR MBSS sampling event was 8.8 mg/l, which is greater than the COMAR standard of 5.0 mg/l, a level generally considered healthy for aquatic life. The water temperature was below 20°C, at 13.3°C in the watershed. Stream waters below 20°C are generally considered optimal for fish and most other aquatic benthos. The pH of the water was relatively neutral but slightly acidic, at 6.69.

V. Living Resources

A. Introduction

Living resources is the basic knowledge about how living things function and interact with one another and their environment. Water is an integral component of the habitat of all species. Living resources require water to survive, and will respond to changes not only in water availability but water quality as well. These responses allow us to gain a better understanding of how watershed conditions can have an effect on living habitats, and determine whether or not current water management practices are adequately providing for the needs of the natural communities. This Chapter will focus on the aquatic biology within the Lower Monocacy River Watershed, including any RTE species that may be present within the watershed.

B. Aquatic Biology

A number of programs and agencies regularly collect biological data from streams, including the DNR fisheries program in conjunction with MBSS, as well as individual efforts within the County. Biological indicators such as fish and benthic invertebrates are used to study watershed health. Metrics such as species diversity, percent abundance of pollution-sensitive or pollution-indicative organisms, and total organism abundance are used to determine if the benthic community shows signs of stress. Signs of stress in the watershed include poor species diversity, large abundances of a few organisms, and presence of pollution-tolerant organisms.

Signs of biological impairment are indicative of an environmental stressor within the watershed. Such stressors can be natural or anthropogenic in nature; and further analyses need to be conducted to determine the potential cause of environmental stress. Additional analyses to habitat, water quality and land use can help in finding indications of specific biological stressors or pollutants.

Biological data has become a critical component in assessing water quality, and has been incorporated into the Maryland water quality standards. The Biological Water Quality Standard states:

26.08.02.03-4 Biological Water Quality Criteria
A. Quantitative assessments of Biological communities in streams (biological criteria) may be used separately or in conjunction with the chemical and physical criteria promulgated in this chapter to assess whether water quality is consistent with purposes and uses in Regulations .01 and .02 of this chapter.
B. The results of the quantitative assessments of biological communities shall be used for purposes of water quality assessment, including, but not limited to, those assessments required by §§ 303(d) and 305 (b) of the federal Clean Water Act (33 U.S.C. §§ 1313 (d) and 1315(b)).
C. These assessments shall use documented methods that have been subject to technical review, produce consistent and repeatable results, and are objectively interpretable.

D. In using biological criteria to determine whether aquatic life uses are being met, the Department shall allow for the uncertainty and natural variability in environmental monitoring results by using established quantitative and statistical methodologies to establish the appropriate level of uncertainty for these determinations.
E. The Department shall determine whether the application and interpretation of the assessment method are appropriate. In those instances where the Department determines the assessment method is not appropriate, it will provide its justification for that determination.

1. Index of Biotic Integrity

The biological aspects of the MBSS include fish index of biotic integrity (IBI) and benthic IBI. The fish IBI is a quantitative rating of the health of the fish assemblage found at each site. Scores range from 1 (very poor) to 5 (good). No fish IBI were calculated for sites with a catchment area less than 300 acres. The benthic IBI scores are similar, but focus on benthic macroinvertebrates collected in the stream segment. The scores rate how the stream segments compare to reference streams that are considered minimally impacted. Low scores indicate significant deviation from reference conditions, indicating severe degradation; while high scores indicate the segment is comparable to reference streams and are minimally impacted.

a. Maryland's DNR Results

Locations of the specific sites sampled can be seen in Figure 4-2. Specific IBI information for fish and benthic macroinvertebrates from the sites surveyed within the Lower Monocacy River Watershed are listed in Table 5-1.

Table 5-1: Lower Monocacy River Watershed DNR's MBSS Index of Biotic Integrity

Site Identification	Stream Segment	Fish IBI			Benthic IBI		
		Good	Fair	Poor	Good	Fair	Poor
LMON-113-R-2003	South Fork Linganore Creek Unnamed Tributary 1		3.67				2.25
LMON-108-R-2003	Weldon Creek		3.33			3.25	

There was only two locations that were sampled for the MBSS data set from 2003. Both locations has similar fish IBI values around 3.5 which is a fair rating. The benthic IBI rating for the North Fork location was fair at 3.25, while the South Fork location was 2.25, a poor rating that is 1 whole value less than the North Fork location.

C. Sensitive Species

Sensitive species are those plants and animals that are among the rarest in Maryland and most in need of conservation efforts. These species are at the greatest risk of local extinction, and are generally the most sensitive to environmental degradation.

1. Rare, Threatened and Endangered Species

Rare, threatened and endangered species are those plants and animals that are the most at risk to maintain healthy populations. For watershed restoration purposes, it is important to know and account for the habitats of such sensitive species. Protecting and expanding these habitats help to preserve biodiversity and is a critical component in successfully restoring a watershed. The DNR's Wildlife and Heritage Program identifies important areas for sensitive species conservation known as stronghold watersheds. Stronghold watersheds are the places where RTE species have the highest abundance of natural communities. Within the Lower Monocacy River Watershed there are no identified areas as having sensitive state-listed species. There are approximately 24.5 acres of targeted ecological areas within the Lower Monocacy River watershed. Targeted ecological areas are a limited number of areas that rank exceptionally high for ecological criteria and that have a practical potential for preservation. A complete list of all rare, threatened, and endangered plants and animals within Carroll County and throughout the state of Maryland can be found at:

http://www.dnr.state.md.us/wildlife/espaa.asp.

Figure 5-1 shows targeted ecological areas for sensitive species within the Lower Monocacy River Watershed. Sensitive species areas where designated by the DNR.

D. Stream Corridor Assessment

A Stream Corridor Assessment (SCA) of the Lower Monocacy River Watershed was conducted during the winter of 2014 by Carroll County Bureau of Resource Management staff. The Lower Monocacy River SCA was based on protocols developed by the Maryland Department of Natural Resources watershed restoration division (Yetman, 2001). The goal of this assessment was to identify and rank current impairments within the watershed to assist in prioritizing locations for restoration implementation.

This assessment reached out to 170 landowners within the Lower Monocacy River Watershed whose property is intersected by a stream corridor. Landowner permission was obtained through a mailing that detailed the assessment, permission results can be found in Figure 5-2. A response card was also included for the landowner to send back with their permission response. Only properties with owner permission were assessed. Access was granted for approximately 8 of the 24 stream miles within the Lower Monocacy River Watershed.

The most common impairments identified during the assessment are shown in Figure 5-3, and consisted primarily erosion and fish barriers followed by inadequate stream side buffers. Table 5-2 presents a summary of the number of impacts identified in each subwatershed.

Table 5-2: Stream Corridor Assessment – Identified Impacts

DNR 12-Digit	In-Stream Construction	Erosion	Unusual Condition	Fish Barrier	Inadequate Buffer	Trash Dump	Channel Alteration	Pipe Outfall	Exposed Pipe	Total
021403020238	0	4	0	6	3	0	0	0	0	**13**
021403020235	0	16	2	17	6	1	0	2	0	**44**
Total	**0**	**20**	**2**	**23**	**9**	**1**	**0**	**2**	**0**	**57**

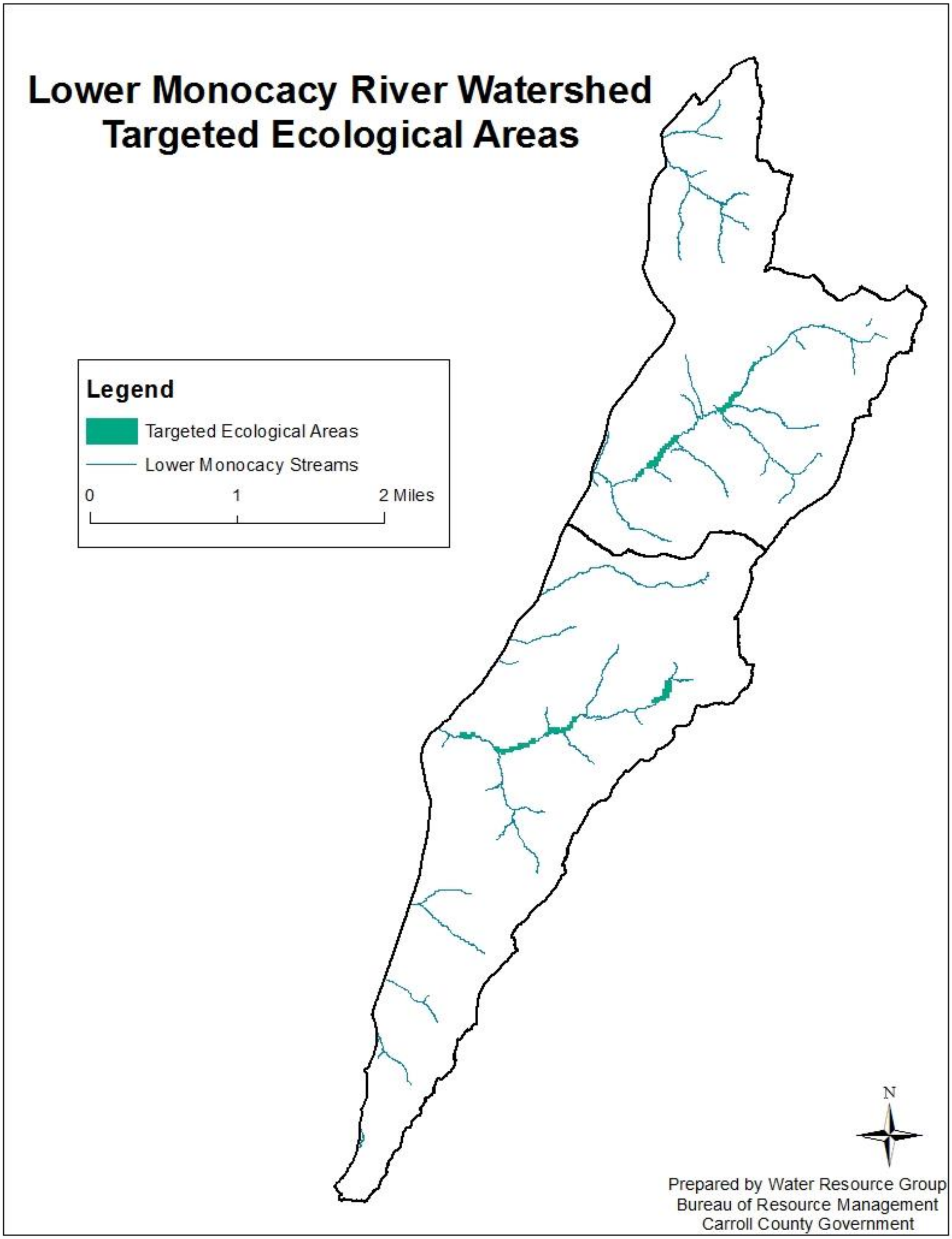

Figure 5-1: Lower Monocacy River Watershed Targeted Ecological Areas

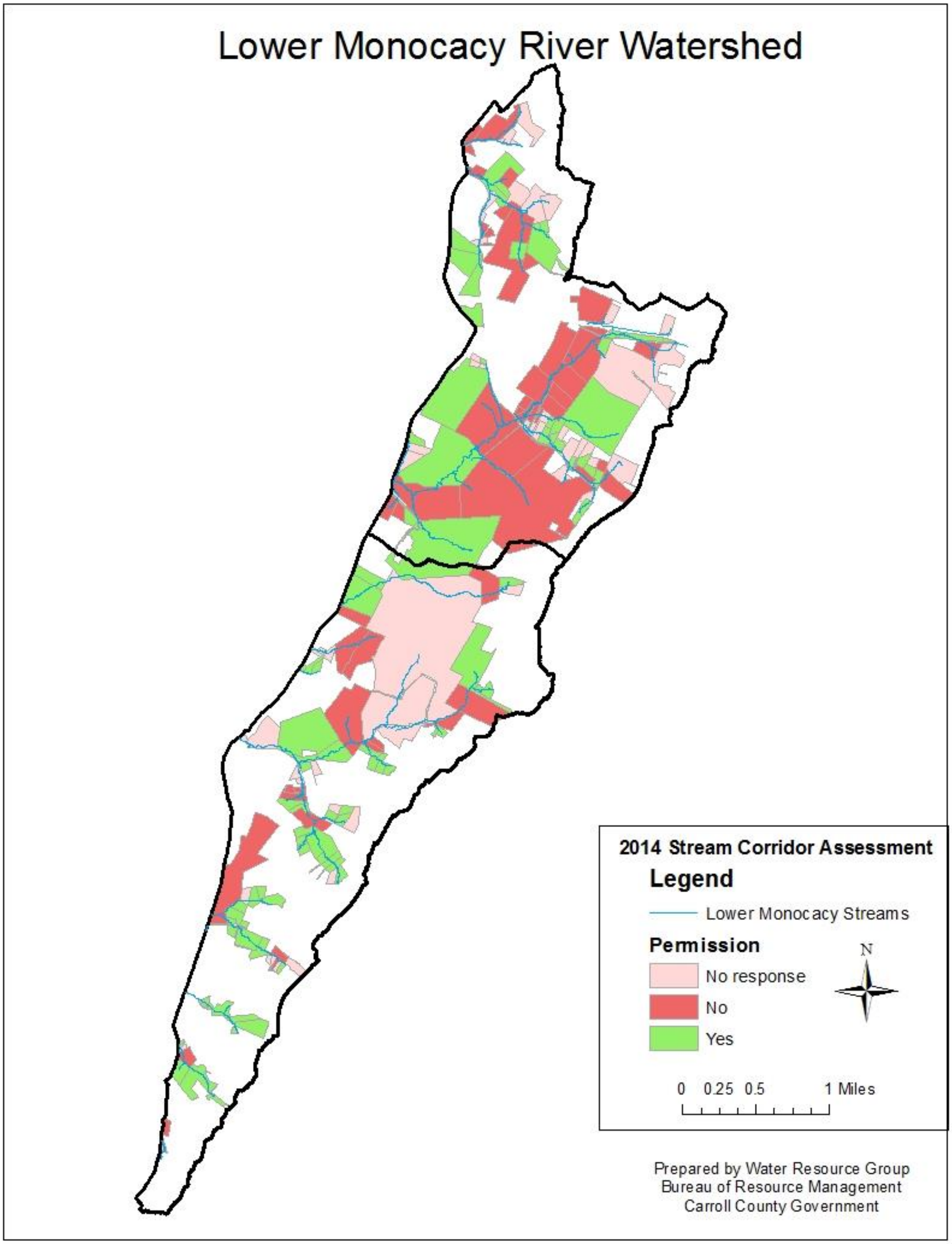

Figure 5-2: SCA Landowner Participation

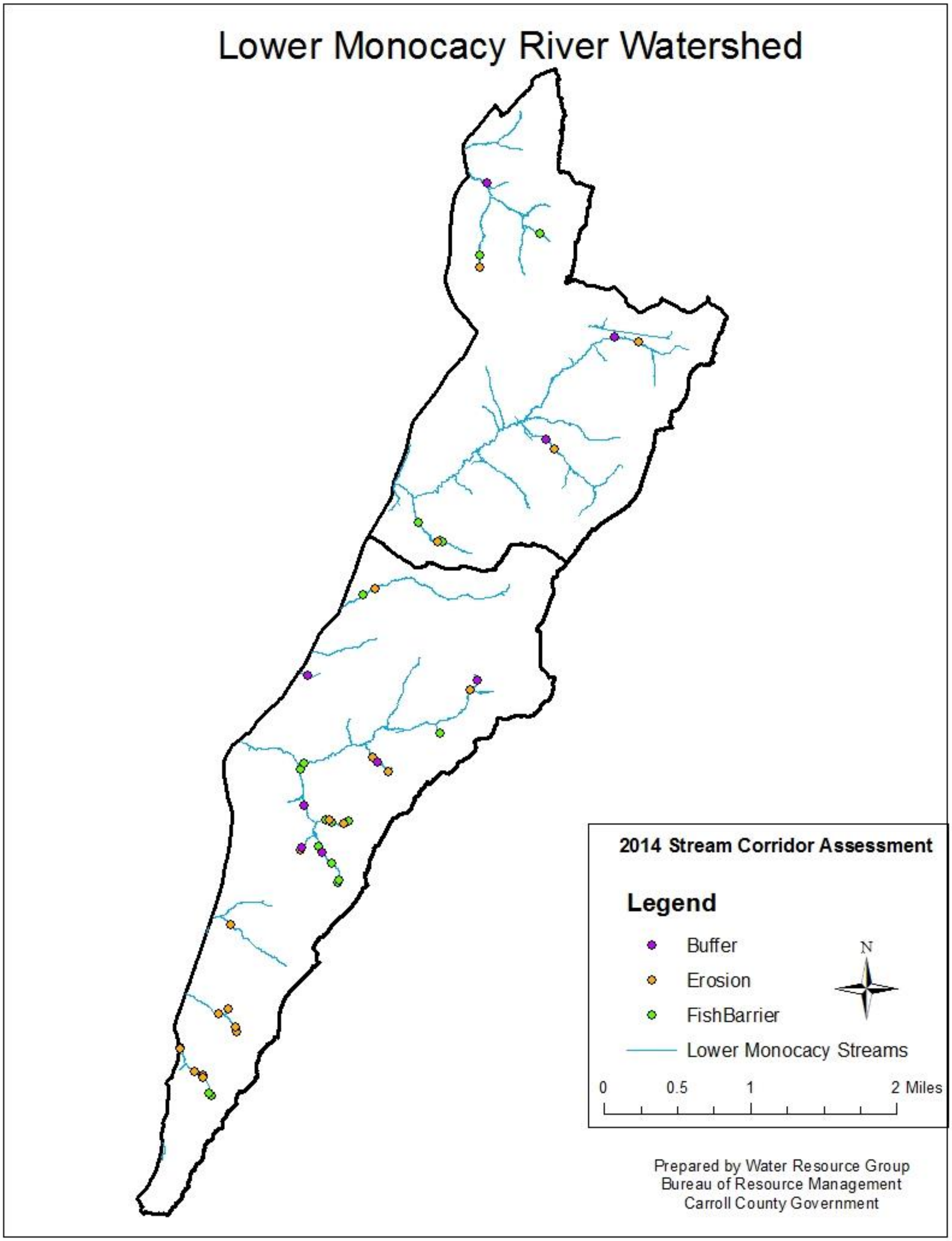

Figure 5-3: Most Commonly Identified Impacts

Approximately 0.71 mile, or 3 percent, of the 24 miles assessed were found to have an erosion problem, primarily low to moderate impacted. Streamside buffers were identified as inadequate along 3.6% of the streams assessed, most of the sites identified the stream as unshaded and on lawns. Table 5-3 shows the linear feet of streambank erosion and inadequate streamside buffers by subwatershed.

Table 5-3: Linear feet of Inadequate Buffer and Stream Erosion

Stream Segment (DNR 12-Digit)	Inadequate Buffer*	Erosion
021403020238	2,700	470
021403020235	6,080	3,297
Total	**8,780 (1.66 miles)**	**3,767 (0.71 mile)**

*Includes both left and right banks of stream

1. **Summary**

Fish Barrier: The most common problem identified through the stream corridor assessment was presence of fish barriers. A total of 23 locations were noted as having a fish barrier. 83% of the fish barriers were noted as total blockages with too high of a drop, averaging approximately 26 inches. The most common causes of fish barriers were debris dams, followed by natural falls and crossings.

Erosion: Approximately 0.71 mile of streams was noted to have an erosion problem, primarily low to moderate impacted downcuts and headcuts.

Inadequate Buffer: Buffer areas were identified as inadequate for 0.86 mile of streams assessed. Most of the sites identified the stream as unshaded and on lawns. Horses were noted on 2 of the sites. Of the 9 sites identified, none had been recently planted.

Pipe Outfalls: Pipe outfalls were noted in 2 locations within the watershed. The purpose of both outfalls was unknown. Both had clear continuous discharge; one was rated as a severe impact.

Channel Alteration: No channel alterations were identified during the assessment.

Trash Dumps: One location was noted with minor trash impacts on private property, consisting of approximately 2 truckloads worth of waste.

In or Near Stream Construction: No in or near stream construction sites were identified during the assessment.

Exposed Pipes: No exposed pipes were identified during the assessment.

Unusual Conditions/Comments: Unusual conditions were identified at 2 locations during the assessment. One condition was a naturally caused, moderate impact leaf litter dam. The other unusual condition was suds in the stream, which was minor impact and potentially related to a nearby pond.

VI. Characterization Summary

A. Summary

This Characterization Plan was developed to describe the unique background of the Lower Monocacy River Watershed. The contents and data presented in this plan will be used by the Carroll County Bureau of Resource Management to develop a Watershed Restoration Plan that will lay out the Bureau's goals for addressing environmental impacts within the watershed. The purpose of the Watershed Restoration Plan will be to focus on identified impacts discovered during stream corridor assessments and to prioritize projects at a subwatershed scale based on the water quality data collected by the MDE as well as County staff initiatives. The Watershed Restoration Plan will also be used by the Bureau as a document to track project implementation in each subwatershed in order to track progress towards meeting applicable goals within the watershed.

B. Cost Summary

The following breakdown shows an approximate cost summary for the completion of the Lower Monocacy River Watershed stream corridor assessment, as well as the development of this Lower Monocacy River Watershed Characterization Plan.

Field Time: Assessment was completed over a span of 2 weeks; field crew averaged 3 days per week for a total of 6 field days.

Field Hours: Field crew averaged 4 hours/day over the 6 days for a total of 24 hours. Field crew varied from 2-3 people performing the assessment for a cumulative total of 60 field hours. Total cost of staff time in field was roughly $1,800 (60 hours at an average of $30/hour).

Plan Development: Watershed plan development took approximately 1 month ($3,350 staff time) and consisted of a full analysis of the stream corridor assessment as well as a complete characterization of the watershed.

Cost: Total estimated cost to complete the Lower Monocacy stream corridor assessment and the Watershed Characterization Plan was approximately $5,150.

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Appendix A:
Lower Monocacy River Watershed
Stormwater Management Facilities

Lower Monocacy River Watershed Stormwater Management Facilities

Subwatershed	Facility Type	Drainage Area (acres)	Impervious Acres (acres)	Project Name	Site Number
South Fork (021403020235)	INFILTRATION BASIN	5.57	2.5	MT. AIRY VOL. FIRE DEPT	SWM-002
South Fork (021403020235)	SHALLOW MARSH	26.1		SUMMITT RIDGE SECT. V	SWM-315
South Fork (021403020235)	RETENTION /UNDER DRAIN	0.24		SUMMIT RIDGE 1 BUFFALO RD	SWM-322
South Fork (021403020235)	INFILTRATION TRENCH	0.47		308 SOUTH MAIN STREET	SWM-059
South Fork (021403020235)	DRY POND	20.6	2.05	CARROLL WOODS NORTH	SWM-060
South Fork (021403020235)	EXTENDED DETENTION	15.2	2.84	CARROLL WOODS EST.SEC 7	SWM-112
North Fork (021403020238)	DRY-INFILTRATION BASIN	0.46		DR. N.J. SUREJA PROPERTY	SWM-414
North Fork (021403020238)	DRY-DETENTION TANK	0.7		HIGH'S ST.,TAYLORSVILLE	SWM-434
South Fork (021403020235)	INFITRATION / DETENTION	3.66	2	MT. AIRY BAPTIST CHURCH	SWM-476
South Fork (021403020235)	DRY-INFILTRATION TRENCH	4.85		CALVERY UNITED METHODIST	SWM-676
South Fork (021403020235)	INFILTRATION DETENTION	38.4		SUMMIT RIDGE SEC. 4	SWM-188
South Fork (021403020235)	INFILTRATION TRENCH	0.48	1.48	CALVARY UNITED METHODIST	SWM-261
South Fork (021403020235)	INFILTRATION/DETENTION POND	23.1		SUMMITT RIDGE SECT. 3	SWM-276
South Fork (021403020235)	IFILTRATION/DETENTION BASIN	41.5		STERLING GLEN	SWM-423
South Fork (021403020235)	WQ GRASS SWALE	10		FAIR WINDS ESTATES SEC. 5	SWM-761
South Fork (021403020235)	INFILTRATION TRENCH	0.23	0.02	HIGHPOINT TOWER RAY PROPERTY	SWM-925
South Fork (021403020235)	DRY-INFILTRATION TRENCH	4.85		CALVERY UNITED METHODIST	SWM-676
South Fork (021403020235)	INFILTRATION BASIN	34.7	8.7	STERLING GLEN PHASE 2	SWM-800

Subwatershed	Facility Type	Drainage Area (acres)	Impervious Acres (acres)	Project Name	Site Number
North Fork (021403020238)	INFILTRATION TRENCH	5.49	1.07	SOUTH HILLS	SWM-980

Urban Best Management Practices (BMPs): are structural, vegetative, or managerial approaches designed to reduce stormwater runoff volume, maximize natural groundwater recharge, and treat, prevent, or reduce degradation of water quality due to stormwater runoff.

Dry Detention Ponds: These are stormwater design features that provide a gradual release of water in order to increase the settling of pollutants and protect downstream channels from frequent storm events. This type of facility will remain dry between storm events.

Dry Extended Detention Ponds: Stormwater management structures that provide a gradual release of a specific volume of water in order to increase the settling of pollutants in the pond and to protect downstream channels from frequent storm events. They are often designed with small pools at the inlet and outlet of the pond. These BMPs can also be used to provide flood control by including additional detention storage above the extended-detention level.

ESD and Microscale Treatment Practices: A diverse group of on-site techniques that capture, store and partially treat rooftop runoff in residential areas and highly urban landscapes. These practices include drywells, rain barrels, rain gardens, green rooftops, and permeable pavers.

Filtering Practices: BMPs which capture and temporarily store the water quality volume and pass it through a filter of sand, organic matter and vegetation, promoting pollutant treatment and groundwater recharge.

Infiltration Practices: These facilities are used to capture and temporarily store the water quality volume before allowing it to infiltrate into the soil, promoting pollutant treatment and groundwater recharge.

Impervious Surface Reduction: A practice which reduces the total area of impervious cover as well as features that capture stormwater and divert it to a previous area, subsequently encouraging stormwater infiltration.

Riparian Forest Buffer: Riparian forest buffers are area of trees usually accompanied by other vegetation, that are adjacent to a body of water and which: maintain the integrity of stream channels; reduce the impact of upland pollution sources by trapping, filtering, and converting sediments, nutrients, and other chemicals; and supply food, cover, and thermal protection to fish and other wildlife. The recommended width of riparian forest buffers is 100 feet with a 35-foot minimum.

Stream Restoration: This BMP is used to restore the stream ecosystem by restoring the natural hydrology and landscape of a stream. Stream restoration is used to help improve habitat and water quality conditions in degraded streams. The objectives of using this practice include, but are not limited to, reducing stream channel erosion, promoting physical channel stability, reducing the transport of pollutants downstream, and working towards a stable habitat with a self-sustaining, diverse aquatic community.

Urban Nutrient Management: A BMP that reduces fertilizer applied to grass lawns and other urban areas. This practice is based on public education and awareness, targeting suburban residences and businesses, with emphasis on reducing excessive fertilizer use.

Wetponds and Wetland Practices: Facilities which collect and increase the settling of pollutants in the structure and protect downstream channels from frequent storm events. Wetponds retain a permanent pool of water.

Appendix B:
Agricultural Best Management Practices

Lower Monocacy River Watershed Agricultural Best Management Practices

Best Management Practice	Extent	Unit
327 - Conservation Cover	131.9	AC
328 - Conservation Crop Rotation	204.7	AC
192 / 1923 – Farm Plan	246.7	AC
412 - Grassed Waterway	0.9	AC
590 - Nutrient Management	165.9	AC
345 - Residue and Tillage Mgmt, Mulch Till	38.8	AC
391 - Riparian Forest Buffer	4.3	AC
574 - Spring Development	2	NO
382 – Fencing	992	FT
614 - Watering Facility	1	NO

Practices which are used by farmers to minimize soil loss, trap nutrients, and minimize the amounts of nutrients and pesticides used on the land. The following definitions related to best management practices used throughout Carroll County:

Access Control: The temporary or permanent exclusion of animals, people, vehicles, and/or equipment from an area.

Conservation Cover: Establishing and maintaining permanent vegetative cover to protect soil and water resources.

Conservation Cropping: Growing crops in a planned sequence on the same field.

Contour Farming: Tillage, planting, and other farming operations performed on or near the contour of the field slope.

Critical Area Planting: Planting vegetation, such as trees, shrubs, vines, grasses, or legumes on highly erodible or critically eroding areas.

Diversion: A diversion is an earthen embankment similar to a terrace that directs runoff water from a specific area.

Fencing: A constructed barrier to livestock, wildlife or people.

Filter Strip: A strip or area of herbaceous vegetation that removes contaminants from overland flow.

Forage and Biomass Planting: is the establishment of adapted and/or compatible species, varieties, or cultivars of herbaceous species suitable for pasture, hay, or biomass production

Forage Harvest Management: The cutting and removal of forages from the field as hay, greenchop, or ensilage.

Grassed Waterway: A natural or constructed channel that is shaped or graded to required dimensions and established with suitable vegetation.

Heavy Use Area: The stabilization of areas frequently and intensively used by people, animals or vehicles by establishing vegetative cover, surfacing with suitable materials, and/or installing needed structures.

Lined Waterway or Outlet: an erosion resistant lining of concrete, stone, or other permanent material. Vegetative or rock cover protects the drainageway from erosion.

Livestock Pipeline: A pipeline and appurtenances installed to convey water for livestock or wildlife. Provides a safe, reliable method of conveying water to a watering facility.

Mulch Till: Managing the amount, orientation, and distribution of crop and other plant residue on the soil surface year-round, while limiting the soil-disturbing activities used to grow crops in systems where the entire field surface is tilled prior to planting.

No-Till: Managing the amount, orientation, and distribution of crop and other plant residues on the soil surface year-round, while limiting soil disturbing activities to only those necessary to place nutrients, condition residue and plant crops.

Nutrient Management Plan: Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments for each field or management unit.

Pond: A water impoundment made by constructing a dam or an embankment or by excavating a pit or dugout.

Prescribed Grazing: Involves managing the harvest of vegetation with grazing and/or browsing animals to improves or maintain quantity and quality of forage for grazing and browsing animals' health and productivity.

Riparian Forest Buffer: An area of predominately trees and/or shrubs located adjacent to and up-gradient from water bodies.

Riparian Herbaceous Cover: Establishment and maintenance of grasses, grass-like plants and forbs that are tolerant of intermittent flooding or saturated soils and that are established or managed in the transitional zone between terrestrial and aquatic habitats.

Roof Runoff Management: Structures that collect, control, and transport precipitation from roofs.

Spring Development: Collection of water from springs or seeps to provide water for a conservation need.

Stream Crossing: A stabilized area or structure constructed across a stream to provide a travel way for people, livestock, equipment, or vehicles.

Subsurface Drain: A conduit, such as corrugated plastic tubing, tile, or pipe, installed beneath the ground surface to collect and/or convey drainage water.

Underground Outlet: A conduit or system of conduits installed beneath the surface of the ground to convey surface water to a suitable outlet.

Upland Wildlife Habitat Management: Creating, maintaining, or enhancing areas to provide food, cover and habitat connectivity for upland wildlife.

Waste Facility Closure: The closure of waste facilities (treatment lagoons and liquid storage facilities), that are no longer used for their intended purpose, in an environmentally safe manner.

Waste Storage Structure: A waste storage impoundment made by constructing an embankment and/or excavating a pit or dugout, or by fabricating a structure.

Wastewater Treatment Strip: An area of vegetation designed to remove sediment, organic matter, and other pollutants from wastewater.

Watering Facility: A watering trough or tank that provides livestock with drinking water at planned locations to protect vegetative cover.