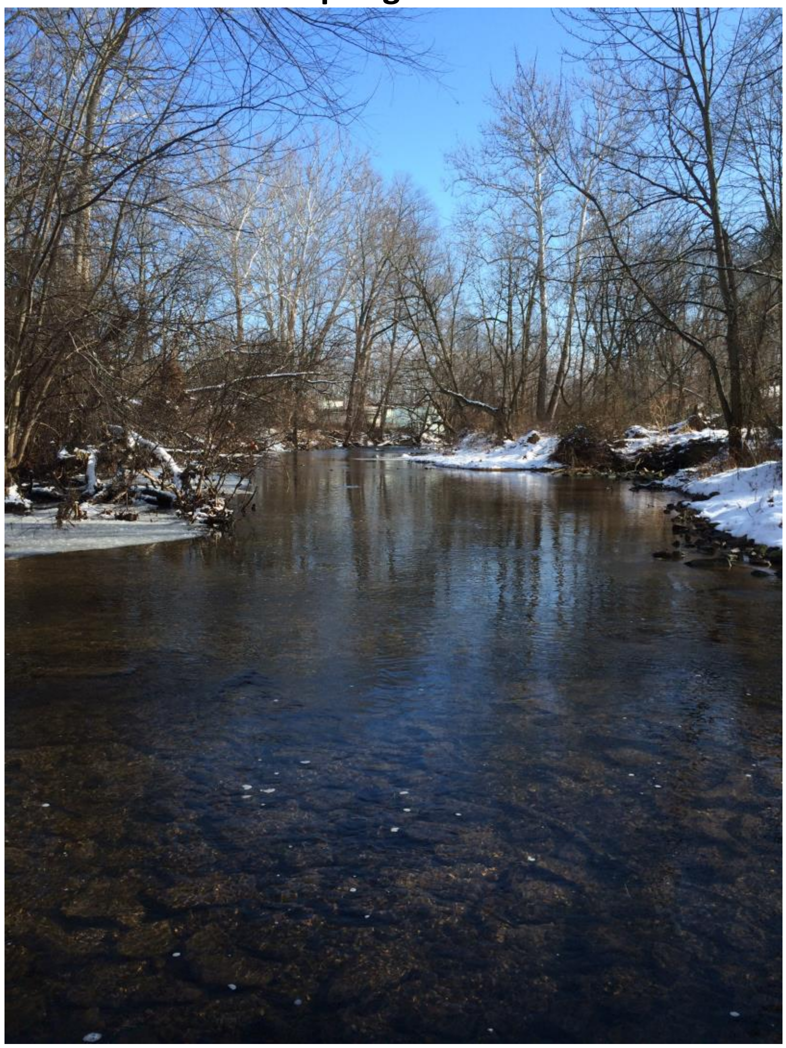
Upper Monocacy River Watershed Characterization Plan

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 Upper Monocacy 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 characteristics that may have an impact within the watershed. The information provided in this report as well as information gathered during the Upper Monocacy Watershed stream corridor assessment (SCA) will be used as a tool to help direct the watershed implementation plan for the Upper Monocacy Watershed. The implementation plan will be used to identify opportunities for water quality improvements within the watershed as required by the County's National Pollutant Discharge Elimination System (NPDES) permit, and is designed to meet approved Total Maximum Daily Loads (TMDLs) for the Upper Monocacy Watershed.

B. Location and Scale of Analysis

The Upper Monocacy River watershed is located in the Potomac River Sub-basin in Frederick and Carroll Counties, Maryland, which lies within the Piedmont Plateau physiographic province. The Piedmont Plateau province is characterized by gentle to steep rolling topography, low hills, and ridges (MGS 2009). The watershed area within Carroll County covers 27,123 acres within eight sub-watersheds. Figure 1-1 depicts the location of the Upper Monocacy River Watershed and the several subwatersheds within Carroll County. The Upper 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, which is a tributary to the Chesapeake Bay. Table 1-1 displays the distribution of acreage between the subwatersheds within Upper Monocacy River Watershed. The analyses presented in this report are done at the subwatershed scale. This allows for restoration and preservation efforts to be focused on smaller drainage areas where efforts can be prioritized and more easily monitored.

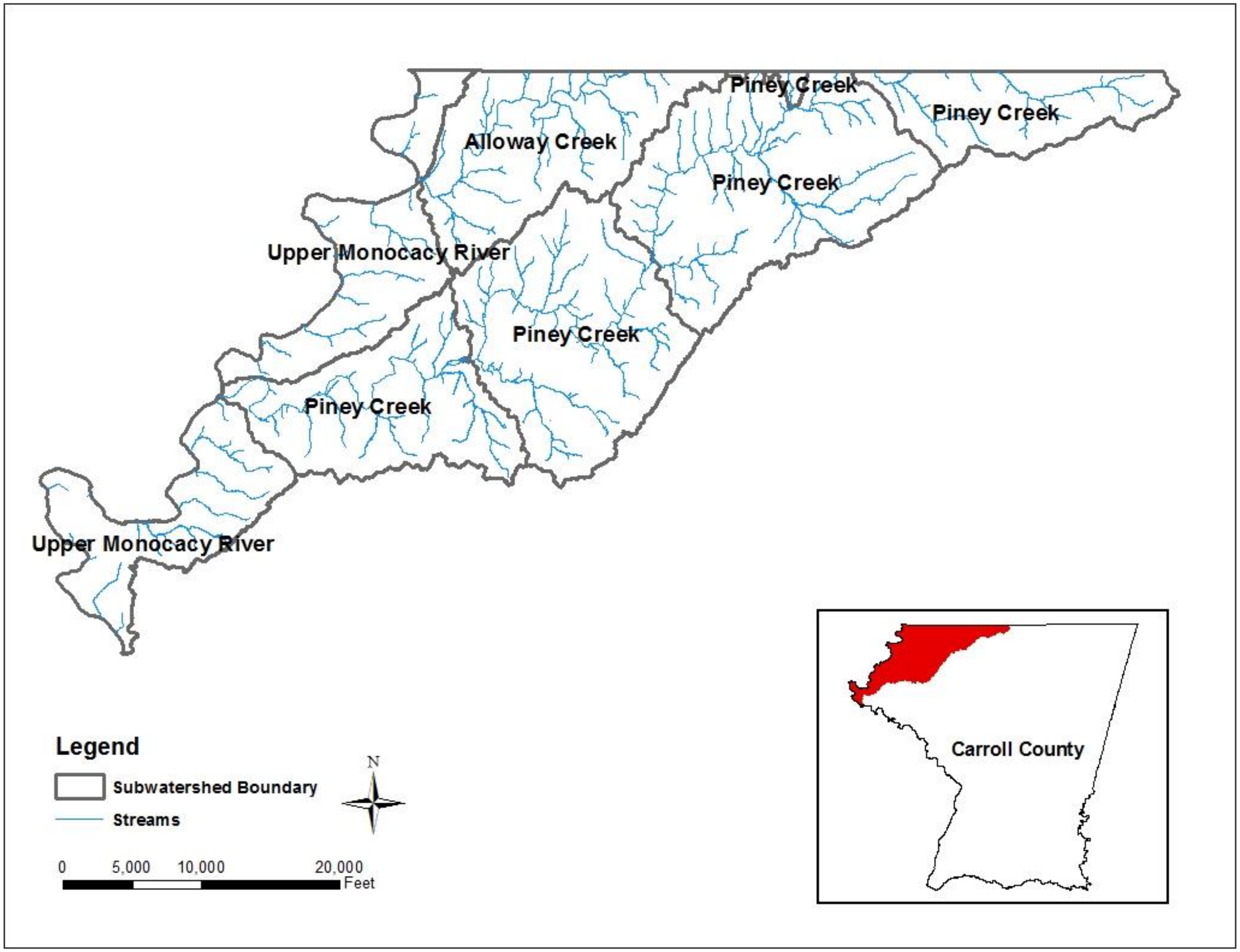

Figure 1-1: Upper Monocacy River Watershed Location Map

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

DNR 12-digit Scale	Subwatershed	Acres
021403030264	Alloway Creek	3,952.90
021403030267	Piney Creek Upper A	2,371.26
021403030266	Piney Creek Upper B	95.13
021403030257	Piney Creek C	5,988.55
021403030255	Piney Creek D	5,293.55
021403030254	Piney Creek Lower	3,762.76
021403030256	Upper Monocacy River North	2,914.95
021403030247	Upper Monocacy River South	2,744.47
Upper Monocacy River Watershed Total		**27,123.57**

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 Upper Monocacy River Watershed, and the total maximum daily loads (TMDLs) associated with the Upper Monocacy River Watershed.

Chapter 5 summarizes the living resources within the Upper 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, floodplains 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 Upper 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 74 degrees Fahrenheit; while the average temperature during the cooler winter months is 38 degrees Fahrenheit. Rainfall is evenly distributed through all months of the year, with most months averaging between 3.2 and 3.7 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 41 inches per year. The average annual snowfall is approximately 25 inches per year, with the majority of accumulation in January, February and March.

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.

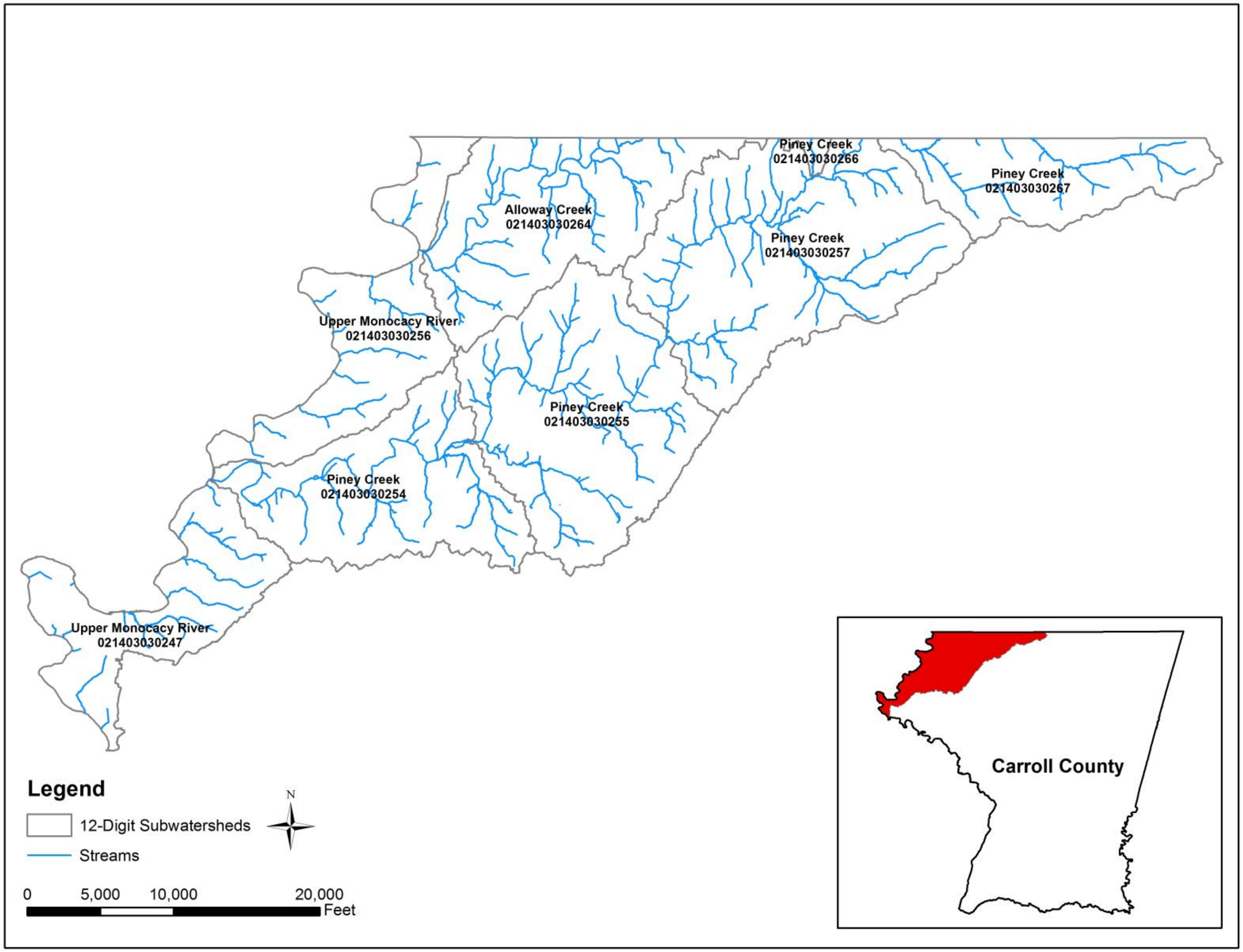

Figure 2-1: Upper Monocacy River Subwatershed Locations

C. Physical Location

The Upper Monocacy River Watershed lies entirely within the Piedmont Plateau Province, predominantly within the Lowland 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 subwatersheds' slopes and the percentages of each subwatersheds' slopes as part of the overall Upper Monocacy River Watershed. Figure 2-2 displays the slope categories and their distribution throughout the Upper Monocacy River Watershed.

In general, high slopes are not prevalent in the Upper Monocacy River Watershed, making up only 2.79% of all topography. Piney Creek C (0257) is the largest subwatershed, and has the greatest percentage of all low and high slope types contributing to the total topographic area. Piney Creek C (0257) and Upper Monocacy River North (0256) have the greatest cluster of high slopes contributing to 0.56% of the Upper Monocacy River Watershed topography each. Piney Creek Upper A (0267) and Piney Creek C (0257) contain the greatest percentages of medium slopes in the Upper Monocacy River Watershed and are located adjacent to each other in the north-eastern part of the Watershed.

There is a small percentage of Upper Monocacy River Watershed that is classified as Urban Land (66.04 acres or 0.24% of the total watershed). Urban Land classification is part of the Udorthents Complex with variable low slopes. There are also areas of water within the Upper Monocacy River Watershed totaling 36.47 acres or 0.13% of the watershed.

Table 2-1: Upper Monocacy River Watershed Slope Categories

DNR 12-Digit Scale	Subwatershed	Slope Category (%)		
	Percent of overall total	Low	Medium	High
021403030264	Alloway Creek[1]	88.42	8.16	3.37
	Percent of overall total	12.89	1.19	0.49
021403030267	Piney Creek Upper A	62.73	32.88	4.38
	Percent of overall total	5.48	2.87	0.38
021403030266	Piney Creek Upper B	100	0	0
	Percent of overall total	0.35	0	0
021403030257	Piney Creek C[1]	85.01	12.25	2.54
	Percent of overall total	18.77	2.70	0.56
021403030255	Piney Creek D[1,2]	93.72	4.48	0.45
	Percent of overall total	18.29	0.87	0.09
021403030254	Piney Creek Lower	87.47	9.98	2.55
	Percent of overall total	12.13	1.38	0.35
021403030256	Upper Monocacy River North[1]	87.19	7.20	5.23
	Percent of overall total	9.37	0.77	0.56
021403030247	Upper Monocacy River South[1]	88.93	7.18	3.48
	Percent of overall total	9.00	0.73	0.35
Upper Monocacy River Watershed Total		86.29	10.53	2.79

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.

[1]Subwatershed contains several acres of water not included in table percentages
[2]Subwatershed contains several acres of Urban Land not included in table percentages

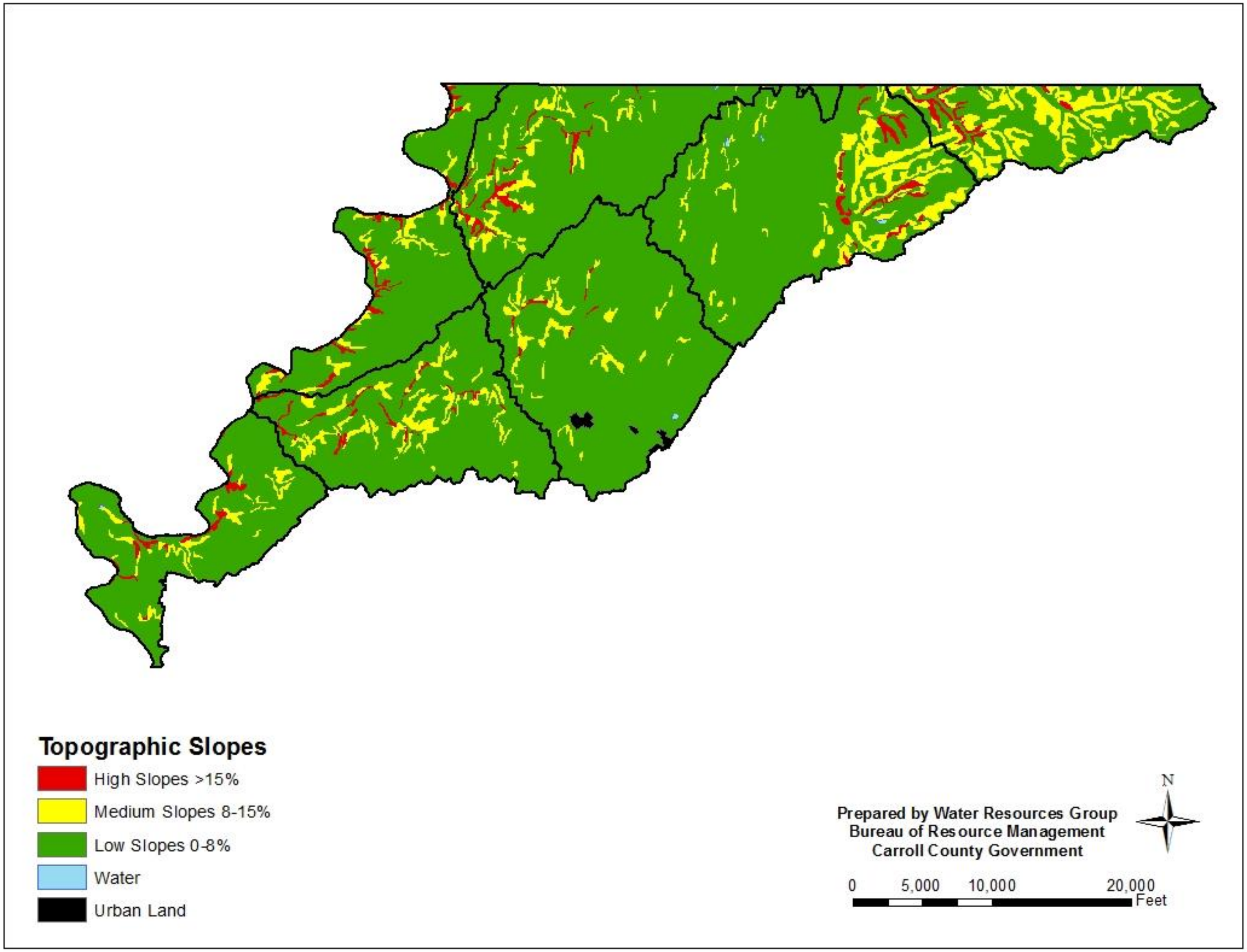

Figure 2-2: Upper Monocacy River Watershed Topography and Slope Categories

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 Upper 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: Upper Monocacy River Subwatershed Hydrologic Soil Group Categories

DNR 12-digit scale	Subwatershed	Hydrologic Soil Group %			
	Percent of overall total	A	B	C	D
021403030264	Alloway Creek	0.03	24.17	73.17	2.63
	Percent of overall total	0	3.52	10.66	0.38
021403030267	Piney Creek Upper A	N/A	86.40	10.92	2.68
	Percent of overall total	N/A	7.56	0.95	0.23
021403030266	Piney Creek Upper B	N/A	N/A	97.97	2.03
	Percent of overall total	N/A	N/A	0.34	0.01
021403030257	Piney Creek C	0.19	29.57	63.67	6.57
	Percent of overall total	0.04	6.53	14.06	1.45
021403030255	Piney Creek D	0.08	18.89	74.88	6.15
	Percent of overall total	0.01	3.69	14.61	1.20
021403030254	Piney Creek Lower	0	8.16	91.46	0.38
	Percent of overall total	0	1.13	12.69	0.05
021403030256	Upper Monocacy River North	0.29	11.70	86.59	1.33
	Percent of overall total	0.03	1.26	9.31	0.14
021403030247	Upper Monocacy River South	0.39	15.98	83.01	0.59
	Percent of overall total	0.04	1.62	8.40	0.06
Upper Monocacy River Watershed Total		**0.13**	**25.30**	**71.03**	**3.53**

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.

The majority of the subwatersheds have a similar, relatively high percentage of group C soils, which predominates this watershed. Group B soils are the second most prevalent, with a large concentration found in Piney Creek Upper A (0267). The majority of group A soils are along the boundary of the watershed with Frederick County. While the overall percentage of group D soils is fairly low, over 71 percent of the watershed contains group C soils; these areas should be targeted when considering where the greatest potential for addressing soil conservation exists.

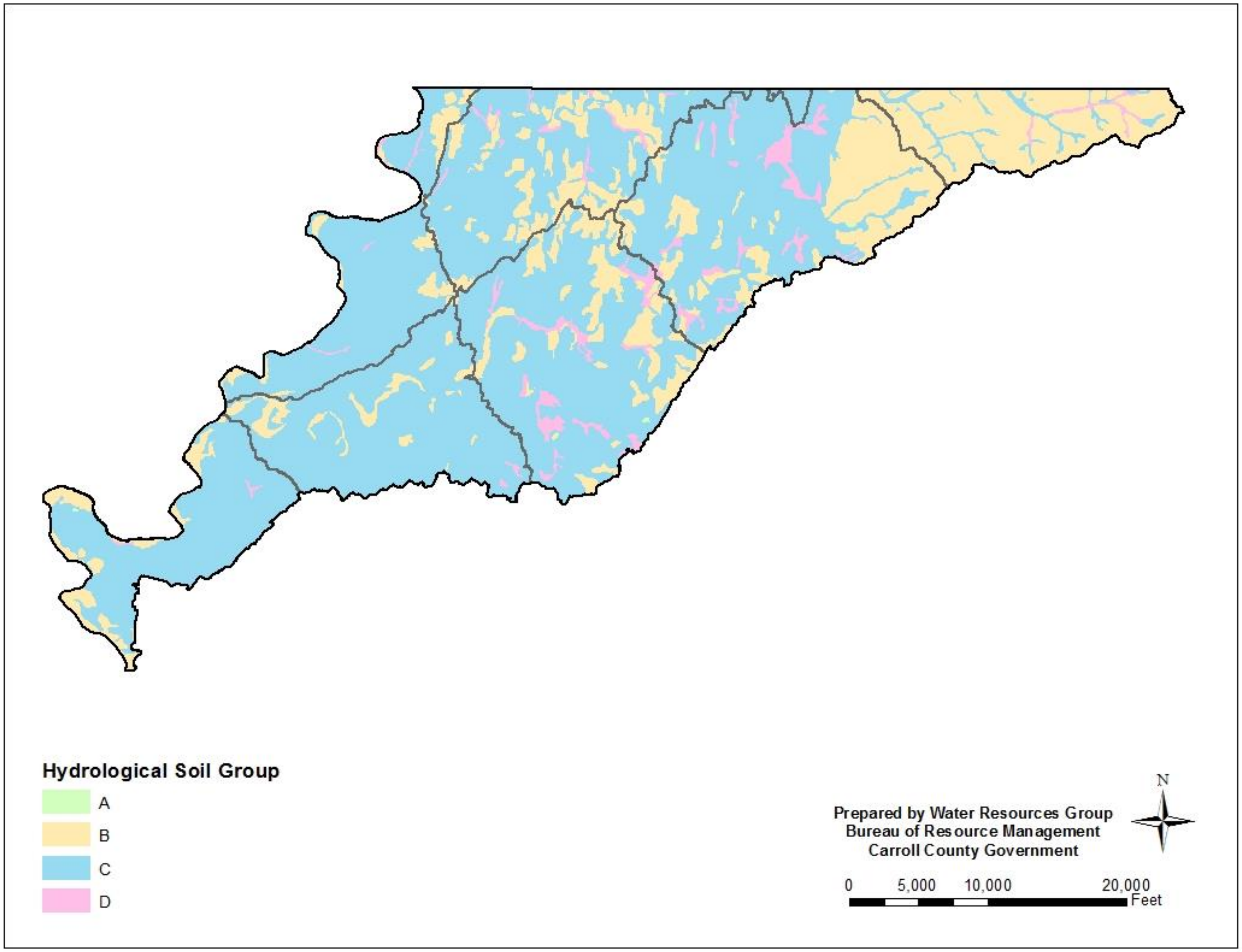

Figure 2-3: Upper Monocacy River Watershed Hydrological Soil Groups

3. Geology

The geological formations within the Upper 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 Upper Monocacy River Watershed, lies within the Lowland section of the Piedmont Plateau Province, and consists mainly of Triassic New Oxford Formation, Babylon Phylite and Blacks Corner Phylite, and quartzite and conglomerate formations. The New Oxford Formation, over 85 percent of the Upper Monocacy River Watershed, consists of arkosic sandstone interbedded with red shale, mudstone, and fine-grained sandstone and conglomerates.

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).

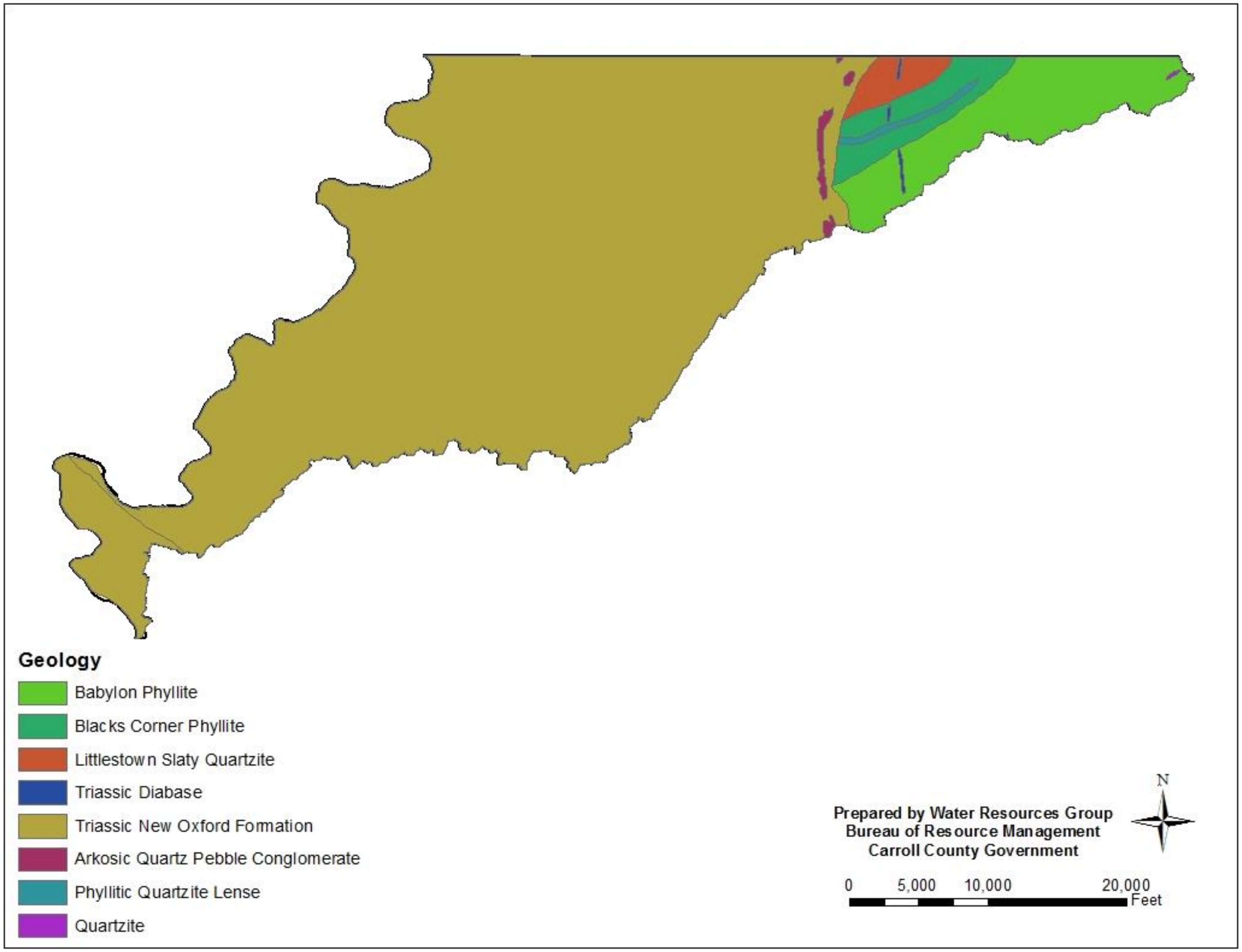

Figure 2-4: Upper Monocacy River Watershed Geology

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 Upper 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 by subwatershed for the Upper Monocacy River Watershed can be found in Table 2-3.

Table 2-3: Upper Monocacy River Watershed Wetland Acreage

DNR 12-Digit Scale	Subwatershed	Wetland Estimates	
		Acres	%
021403030264	Alloway Creek	6.94	0.18
021403030267	Piney Creek Upper A	24.95	1.05
021403030266	Piney Creek Upper B	12.77	13.42
021403030257	Piney Creek C	163.77	2.73
021403030255	Piney Creek D	93.35	1.76
021403030254	Piney Creek Lower	41.48	1.10
021403030256	Upper Monocacy River North	10.61	0.36
021403030247	Upper Monocacy River South	13.12	0.48
Upper Monocacy River Watershed Total:		**366.99**	**1.35**

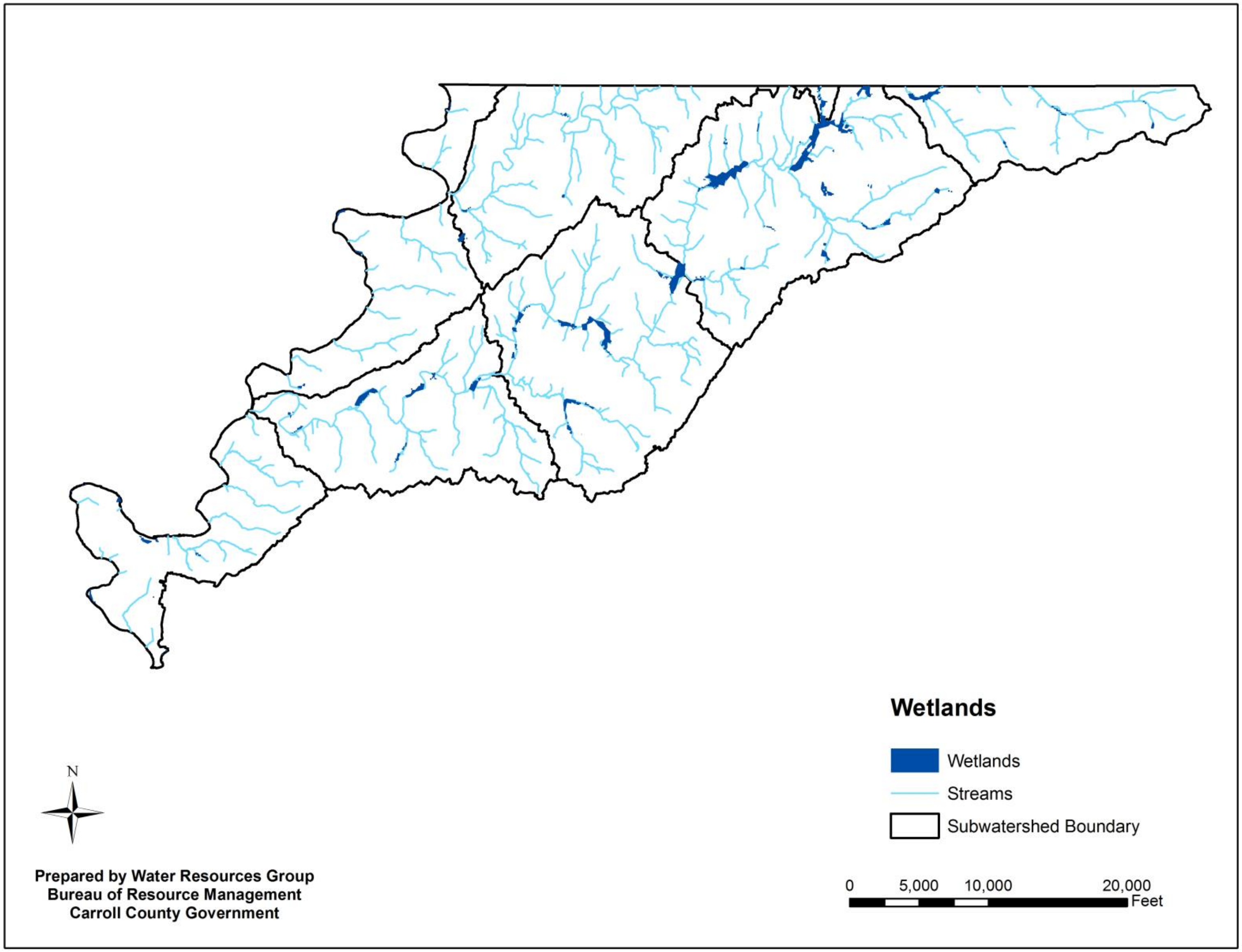

Figure 2-5: Upper Monocacy River Watershed Wetland Acreage

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 Upper Monocacy River Watershed is shown in Figure 2-6. The Upper Monocacy River Watershed contains about 2,173.02 acres of floodplain, which accounts for 8.01% 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.

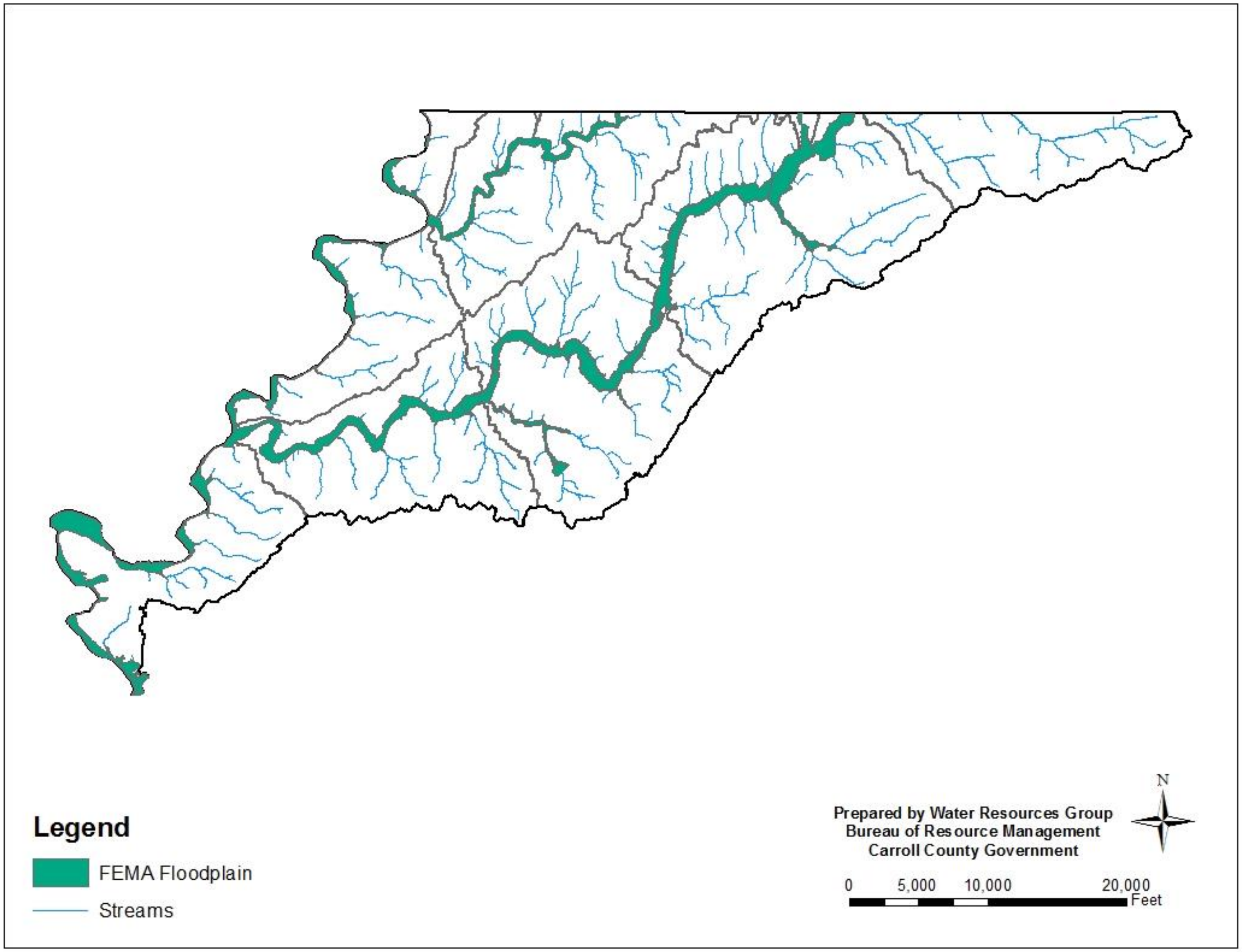

Figure 2-6: Upper Monocacy River Watershed Floodplains

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 Upper 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.

Upper Monocacy Watershed contains 4,808 acres of forest over multiple land uses, and covers about 18 percent of the land within the watershed. The forest cover within the Upper Monocacy Watershed can be found in Figure 2-7 and is shown in Table 2-4.

Table 2-4: Upper Monocacy River Watershed Forest Cover

DNR 12-Digit Scale	Subwatershed	Total Acres	Forested Acres	% Forested
021403030264	Alloway Creek	3,952.90	802	20.3%
021403030267	Piney Creek Upper A	2,371.26	431	18.2%
021403030266	Piney Creek Upper B	95.13	20	20.5%
021403030257	Piney Creek C	5,988.55	1,111	18.6%
021403030255	Piney Creek D	5,293.55	648	12.2%
021403030254	Piney Creek Lower	3,762.76	712	18.9%
021403030256	Upper Monocacy River North	2,914.95	628	21.6%
021403030247	Upper Monocacy River South	2,744.47	457	16.6%
Upper Monocacy River Watershed Total		**27,123.57**	**4,808**	**17.7%**

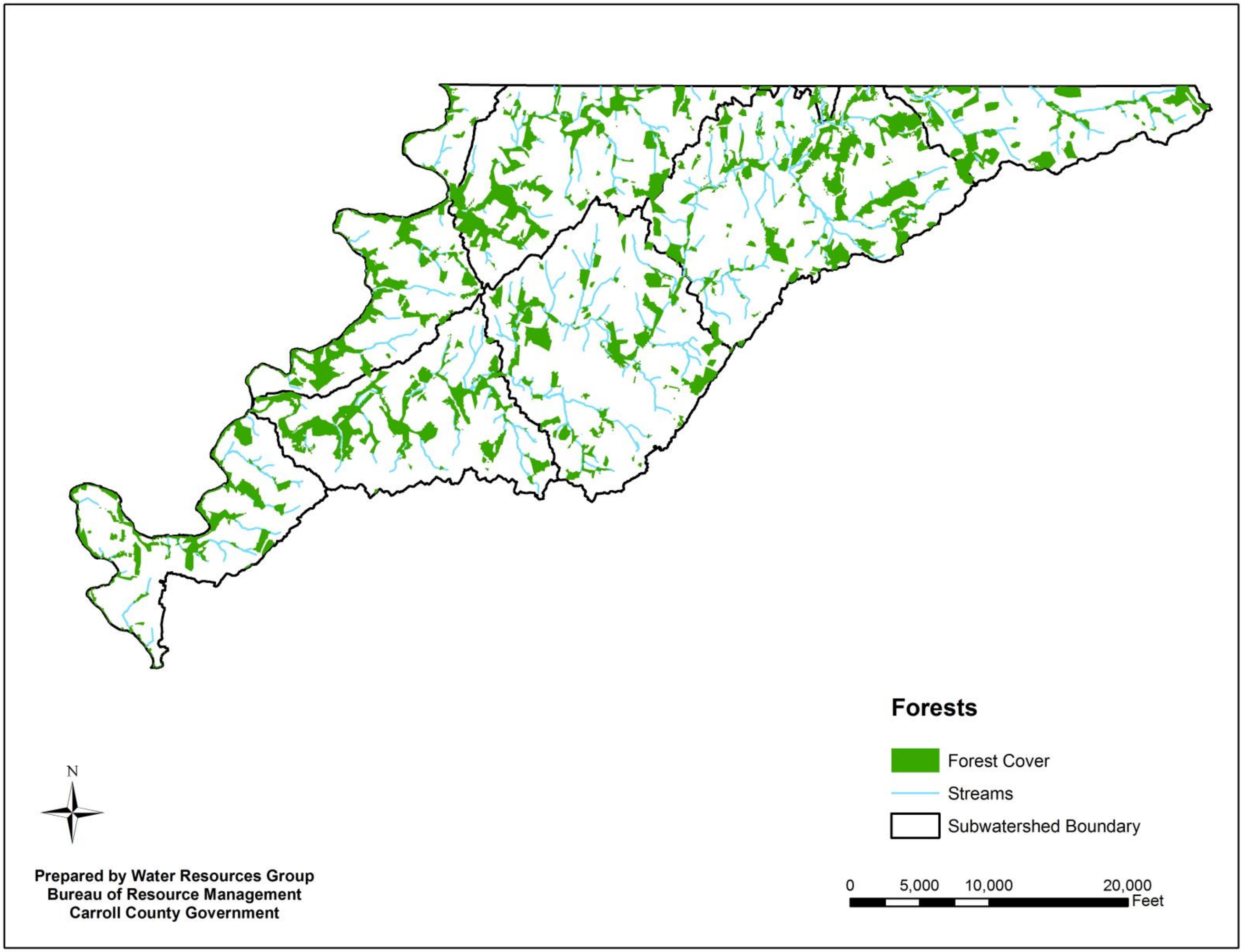

Figure 2-7: Upper Monocacy River Watershed Forest Cover

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 Upper Monocacy River Watershed as identified through the DNR "Green Infrastructure" project.

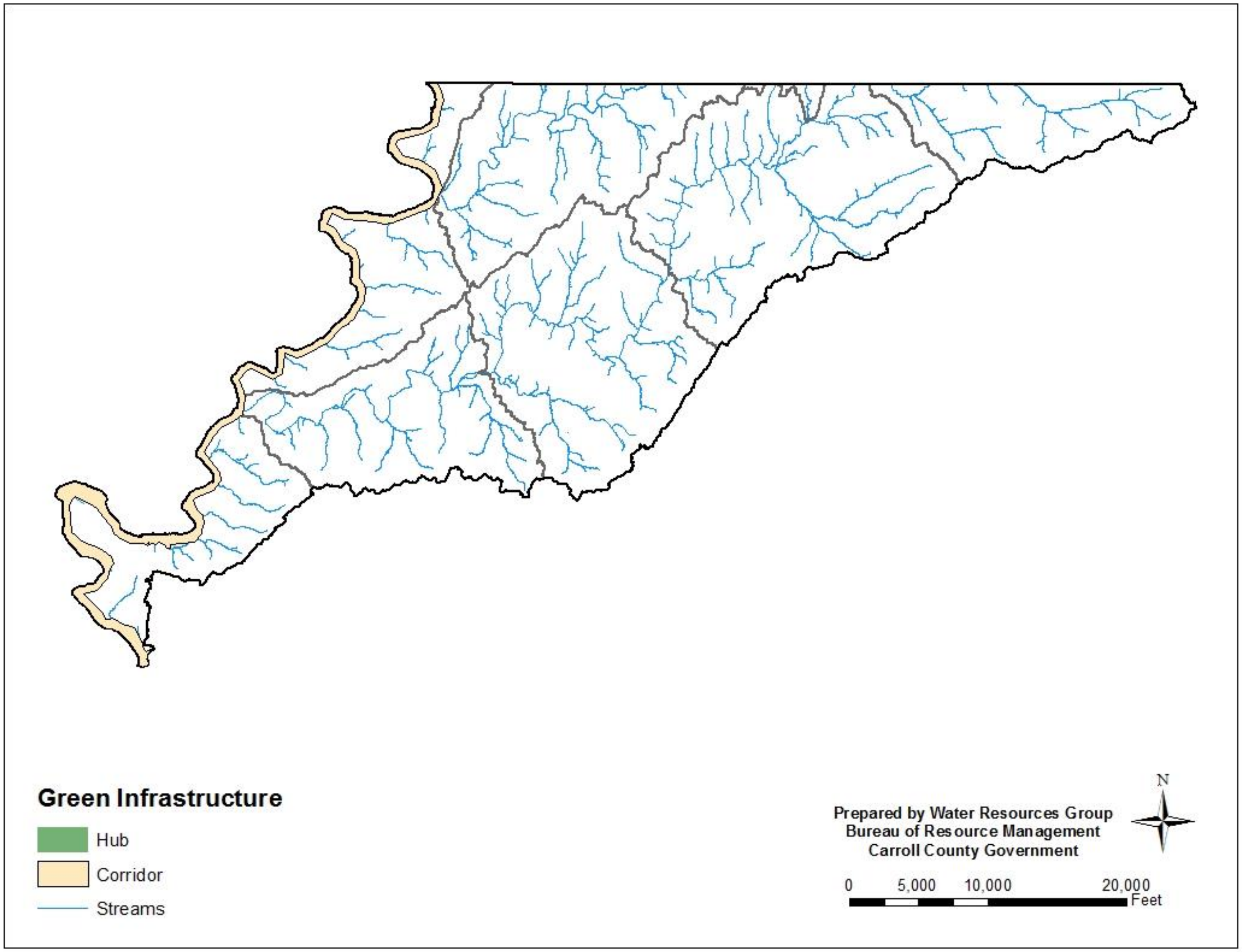

Figure 2-8: Upper Monocacy River Watershed Green Infrastructure

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 Upper Monocacy River Watershed has been modified for human use over time. Anthropogenic modifications have potential to degrade both the terrestrial and aquatic ecosystems. The Upper Monocacy River Watershed currently has an estimated population of approximately 167,134 persons, with greatest population densities within and in the vicinity of the town of Taneytown. If you spread the population evenly across the entire Watershed it would equal about one person per 6.16 acres. 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 Upper Monocacy Watershed can be found in Table 3-1. Figure 3-1 shows the land use cover within the Upper Monocacy Watershed.

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

Land Cover	Acres 2001	Percent 2001	Acres 2006	Percent 2006	Acres 2011	Percent 2011	Acres 2016	Percent 2016
Open Water	164	<1%	162	<1%	162	<1%	70	<1%
Low-Density Residential	1,492	5.5%	1,471	5.4%	1,474	5.4%	1,440	5.3%
Low-Density Mixed Urban	671	2.5%	663	2.4%	661	2.4%	665	2.5%
Medium-Density Mixed Urban	105	<1%	139	<1%	151	<1%	161	<1%
High-Density Mixed Urban	14	<1%	23	<1%	28	<1%	30	<1%
Barren Land	8	<1%	8	<1%	8	<1%	2	<1%
Forest	4,559	17%	4,548	17%	4,533	16.7%	4,808	17.7%
Shrub/Scrub	39	<1%	39	<1%	39	<1%	48	<1%
Grassland	22	<1%	26	<1%	22	<1%	38	<1%
Pasture/Hay	6,620	24%	6,816	25%	6,838	25%	10,179	37.5%
Cropland	12,953	48%	12,749	47%	12,732	47%	9,314	34.3%
Wetland	442	1.6%	443	1.6%	442	1.6%	367	1.4%

Source: National Land Cover Database

Within the Upper Monocacy River watershed, agriculture is the dominant land cover at about 71 percent of the total land, followed by forest which accounts for about 17 percent, and residential, which accounts for about 5 percent of the total land cover. Mixed urban uses account for about 3 percent of the total land cover which represents the relatively rural nature of the Upper Monocacy River Watershed.

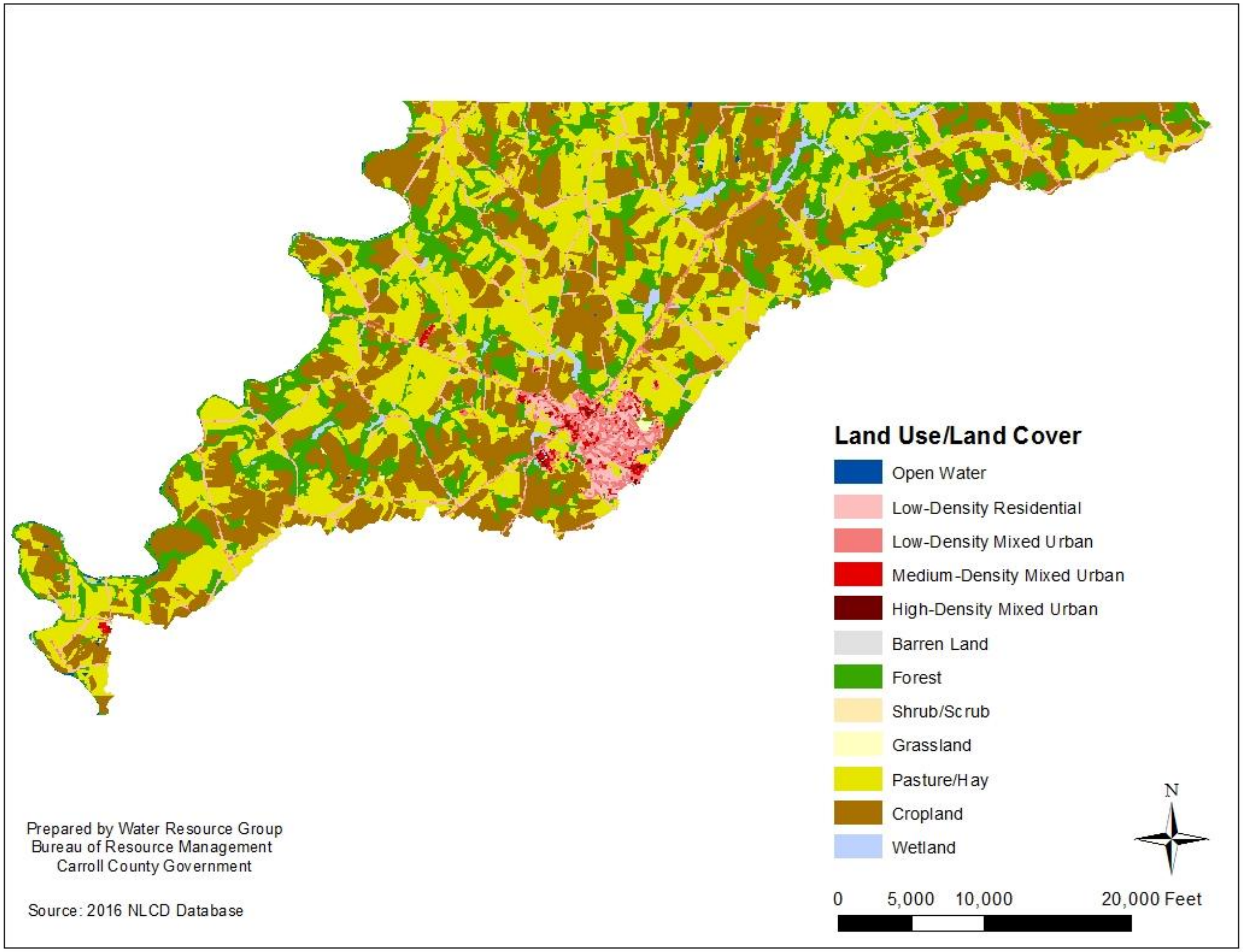

Figure 3-1: Upper Monocacy River Watershed Land Use and Land Cover

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. Within the Upper Monocacy River Watershed, the town of Taneytown is a designated PFA. In addition to this PFA, there are also two rural villages that are designated PFAs; these rural villages are Harney and Keysville. These designated areas have specific boundaries and are the focal area for employment, social, and commercial growth within the watershed. Figure 3-2 shows the designated PFAs within the Upper 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 Upper Monocacy River Watershed can be found in Figure 3-3. Carroll County does not regulate zoning within the municipalities. The majority of the Upper Monocacy River Watershed (86%) 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 Upper Monocacy River Watershed there are 630 parcels remaining with potential development on 10,846 acres for an estimated lot yield of 3,143 (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 Upper Monocacy River Watershed where residential units could be built.

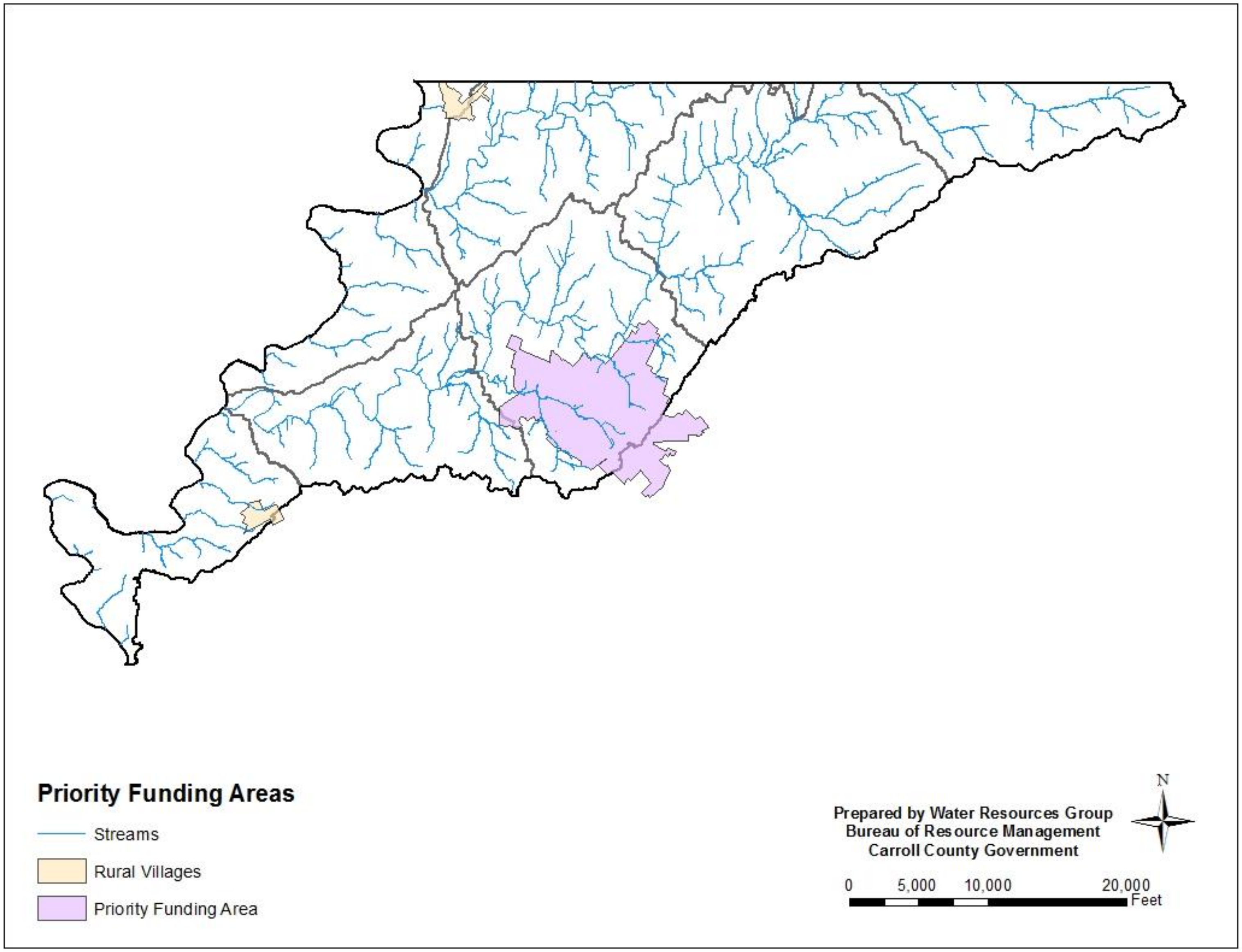

Figure 3-2: Upper Monocacy River Watershed Priority Funding Areas

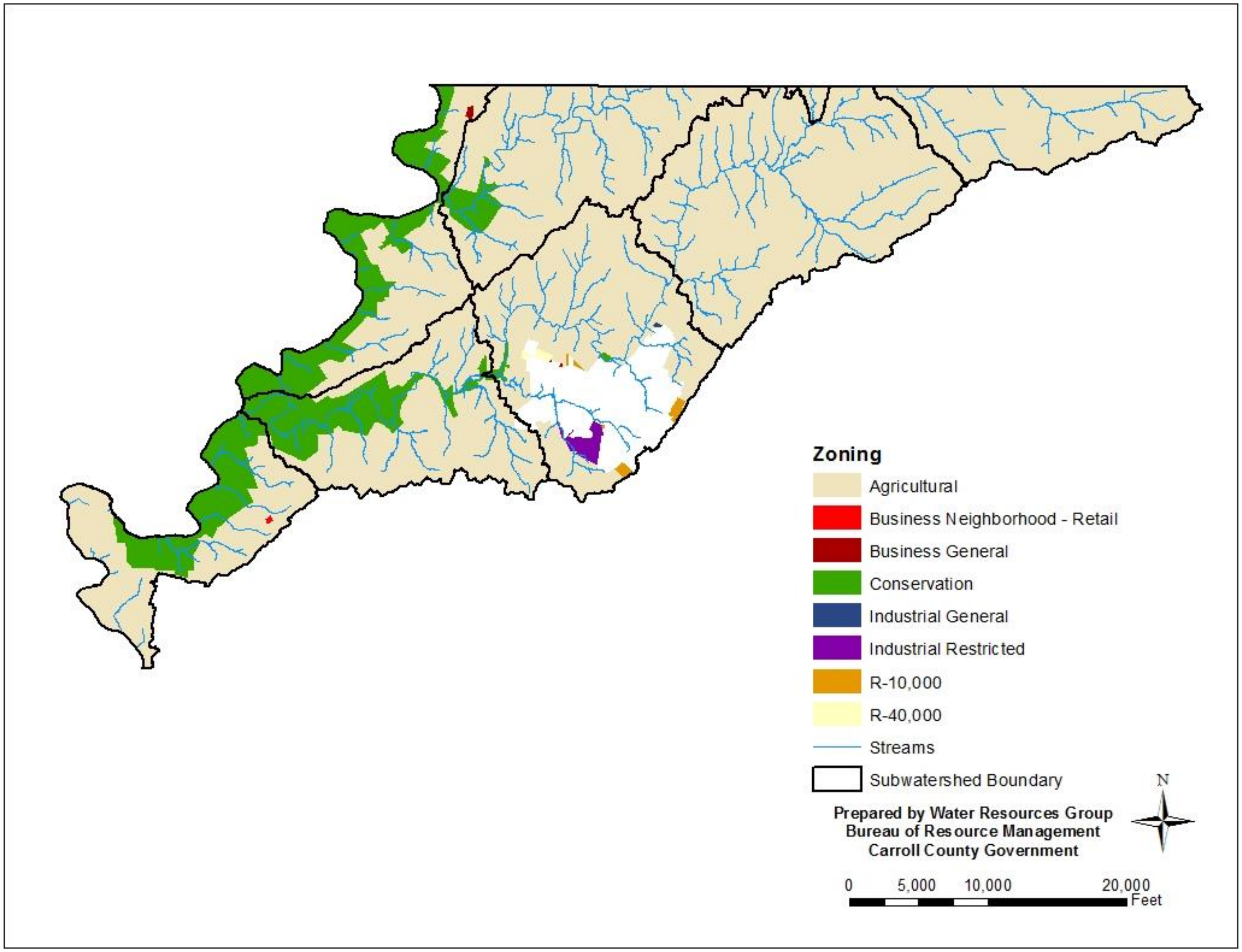

Figure 3-3: Upper Monocacy River Watershed Zoning

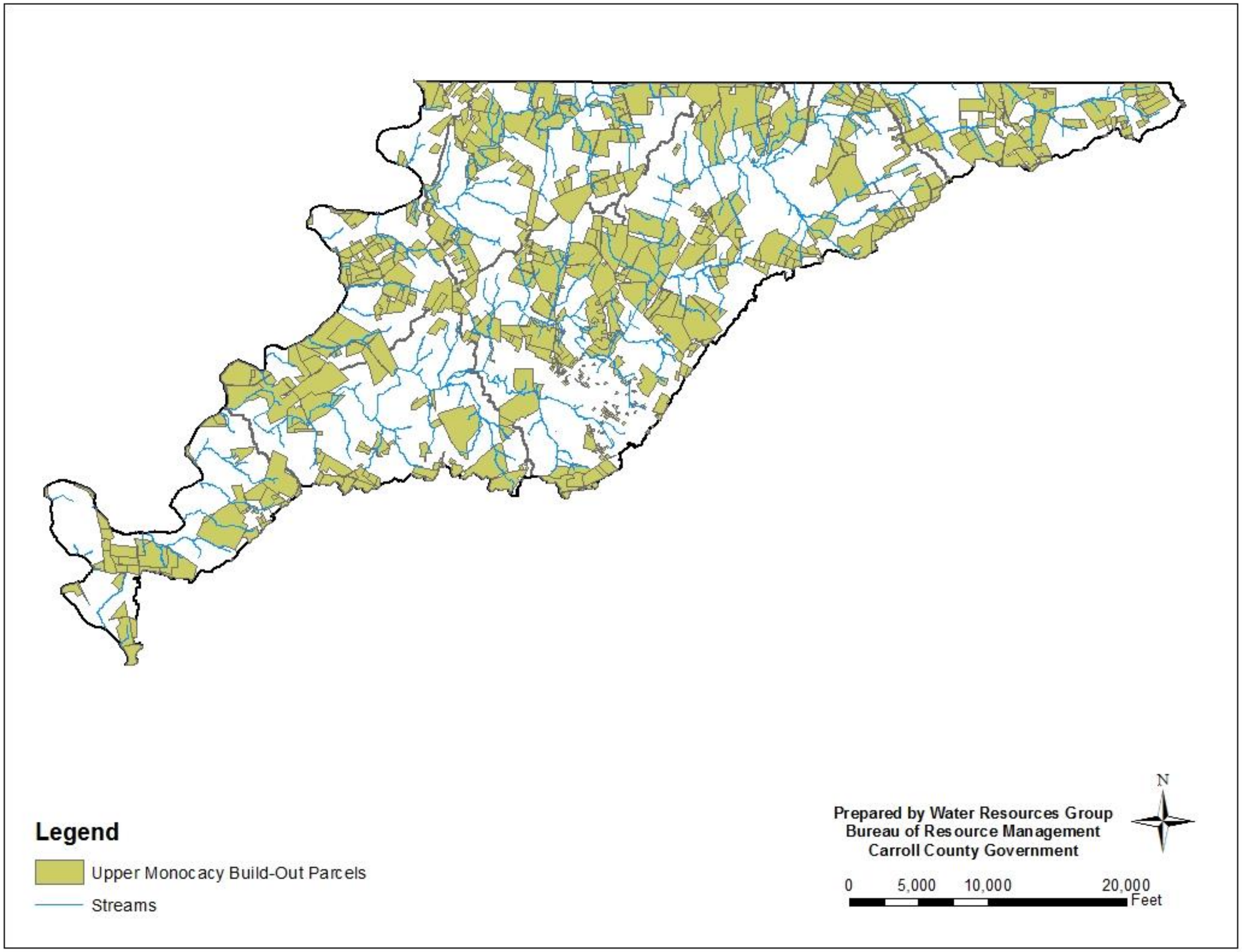

Figure 3-4: Upper Monocacy River Watershed Build-Out Parcels

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. Table 3-2 shows the estimated total impervious area by subwatershed for the Upper Monocacy Watershed.

Table 3-2: Upper Monocacy River Watershed Estimated Impervious Surface Area

DNR 12-digit Scale	Subwatershed	Acres	Impervious Acres	Percent Impervious
021403030264	Alloway Creek	3,953	74.3	1.88
021403030254	Piney Creek	3,763	64.2	1.71
021403030255	Piney Creek	5,294	399.7	7.55
021403030257	Piney Creek	5,989	122.2	2.04
021403030266	Piney Creek	95.1	0.81	0.85
021403030267	Piney Creek	2,371	59.1	2.49
021403030247	Upper Monocacy River	2,744	54.0	1.97
021403030256	Upper Monocacy River	2,915	80.9	2.78
Upper Monocacy River Watershed		**27,124**	**855.2**	**3.15**

The Upper Monocacy Watershed is estimated to have 855 acres of total impervious within the catchment and accounts for approximately 3.2 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. The subwatershed of Piney Creek (0255) drains a large portion of the city of Taneytown and had the highest percentage of total impervious for the entire watershed at (7.55%).

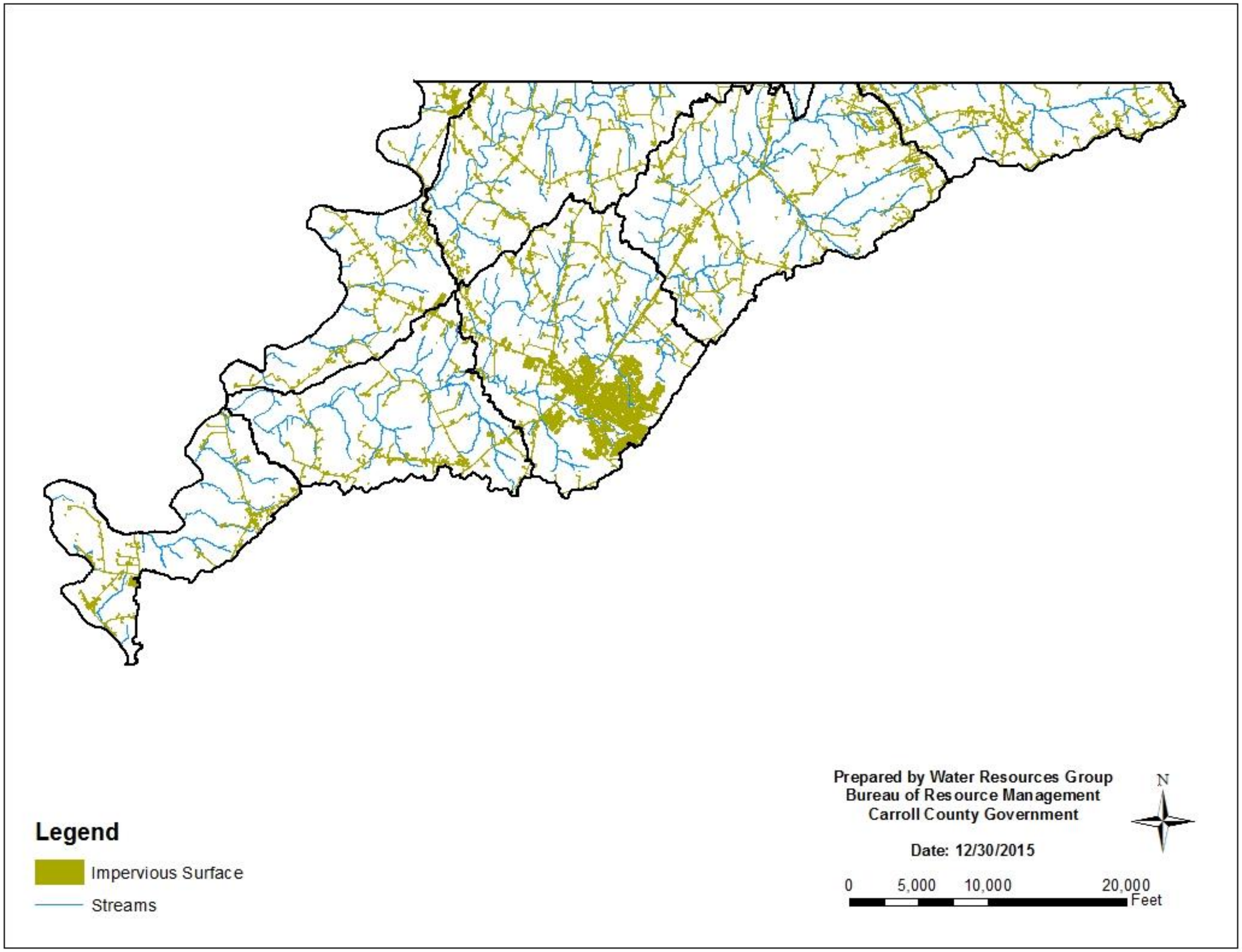

Figure 3-5: Upper Monocacy River Watershed Impervious Surface Area

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 3 existing stormwater management facilities within the County limits and 25 stormwater management facilities within the corporate limits of Taneytown within the Upper 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. There are several stormwater management facilities within the corporate limits of Taneytown where the impervious acres and site number information was not reported to the County. 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 Upper Monocacy River Watershed.

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

Facility Type	Number of Structures	Drainage Acreage
Detention Facility	11	577.689
Infiltration Facility	3	7.6
Dry-Infiltration Facility	3	4.58
Shallow Marsh	1	19.1
Flush Pond & Control	1	30.15
Swale	1	53.24

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

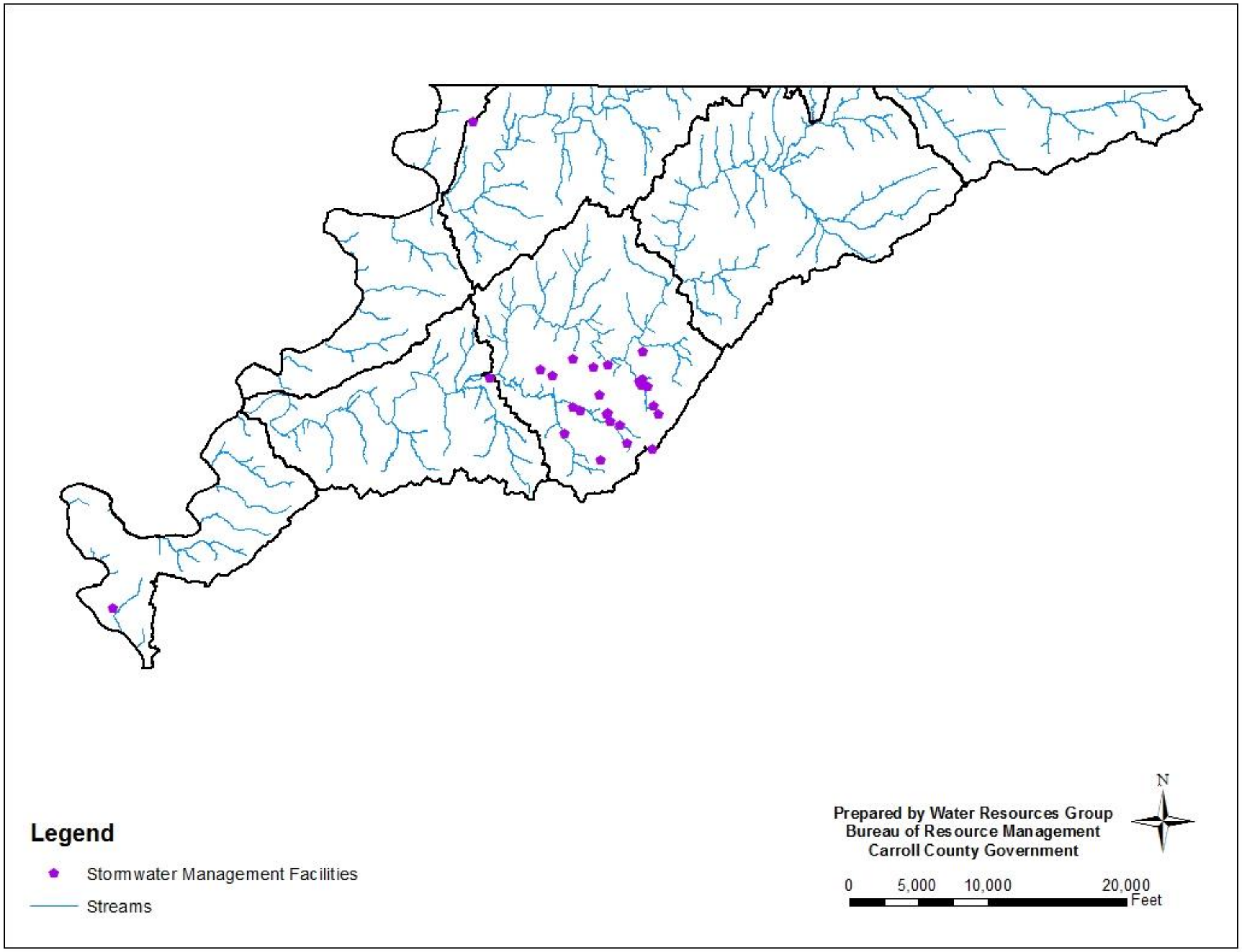

Figure 3-6: Upper Monocacy River Watershed Stormwater Management Facilities

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 Upper 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 Upper Monocacy River Watershed are shown in Figure 3-6.

2. Public Water Service Area

Within the Upper Monocacy River Watershed, the town of Taneytown and surrounding areas provide residents with public water. Within the Upper Monocacy River Watershed, the Taneytown area has 1 existing pumping station, 6 existing public wells and 1 priority wells, 16 future well locations as well as 1 existing storage tank.

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

Residents outside of the public water service area within the Upper Monocacy River Watershed obtain their water from private wells located on their property; within Upper Monocacy River Watershed there are about 1,346 private water wells. Since the underlying geology within the Upper Monocacy River Watershed consists mainly of New Oxford Formation and quartzite, 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.

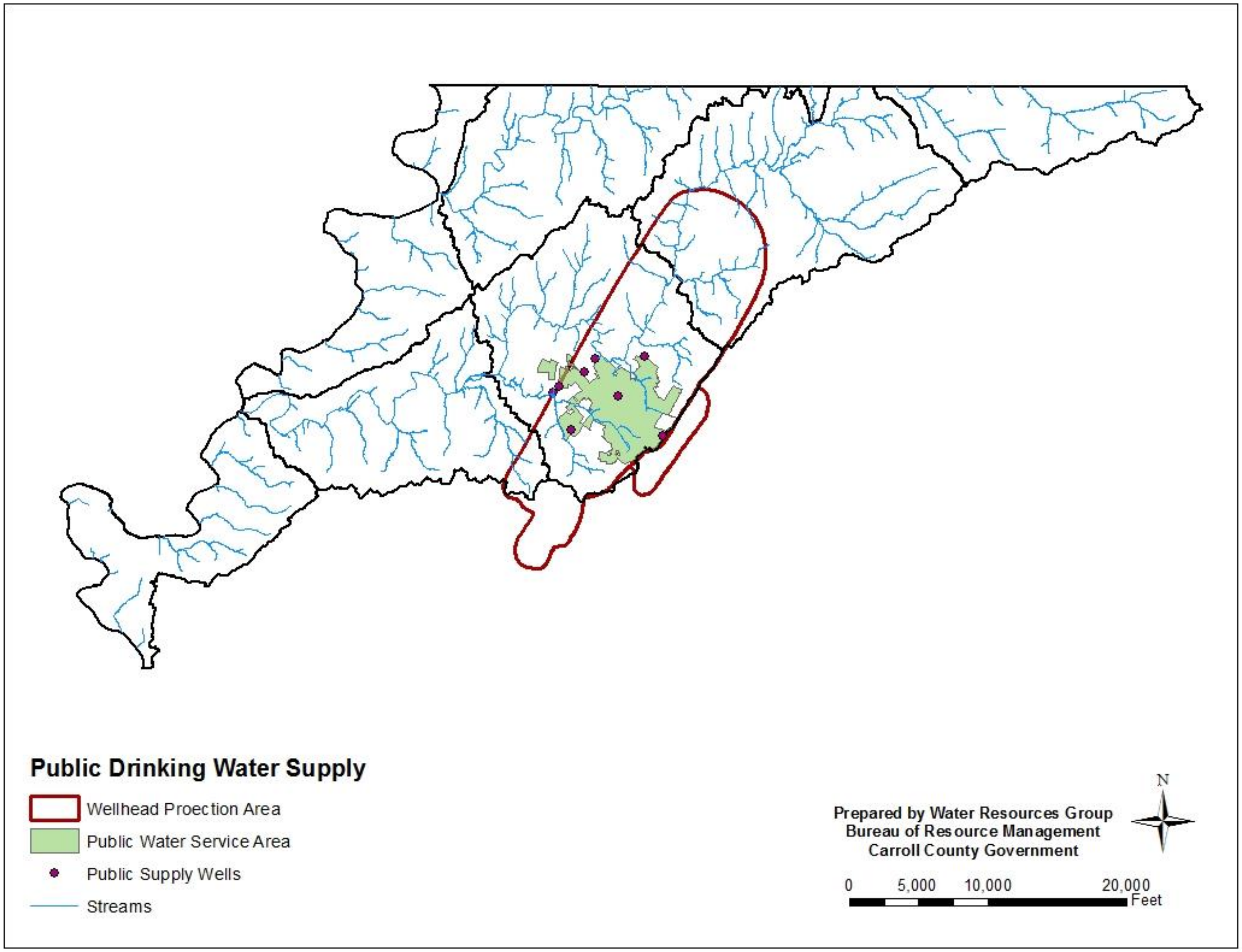

Figure 3-7: Upper Monocacy River Watershed Public Drinking Water Supply

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 cleanout 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 Upper Monocacy River Watershed there are approximately 2,140 homes utilizing public service, and approximately 146 homes slated for future service. Figure 3-8 shows the public wastewater service area for the Upper Monocacy River Watershed.

2. Wastewater Discharge Locations

Within the Upper Monocacy River Watershed, the town of Taneytown and surrounding areas are served through a public wastewater system. There are a total of 1 wastewater treatment facility in the Taneytown area, and 4 pumping stations in the vicinity. Each treatment facility is in the vicinity of an unnamed tributary that flows into Piney Creek, and treated effluent from the treatment plant is discharged into Piney Creek. The current wastewater treatment facility is an activated sludge/biological nutrient removal treatment plant with a flow design capacity of 1.1 million gallons per day. To meet NPDES permit limits, the treatment plant is being upgraded to meet enhanced nutrient removal discharge limits. The upgrade design was completed in 2013 and construction is ongoing. The community wastewater treatment facilities locations and associated public service areas are shown in Figure 3-8.

3. On-Site Septic Systems

On-site septic systems are the main source of waste disposal in rural and low density areas within Upper 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 1,346 septic systems within the Upper Monocacy River Watershed.

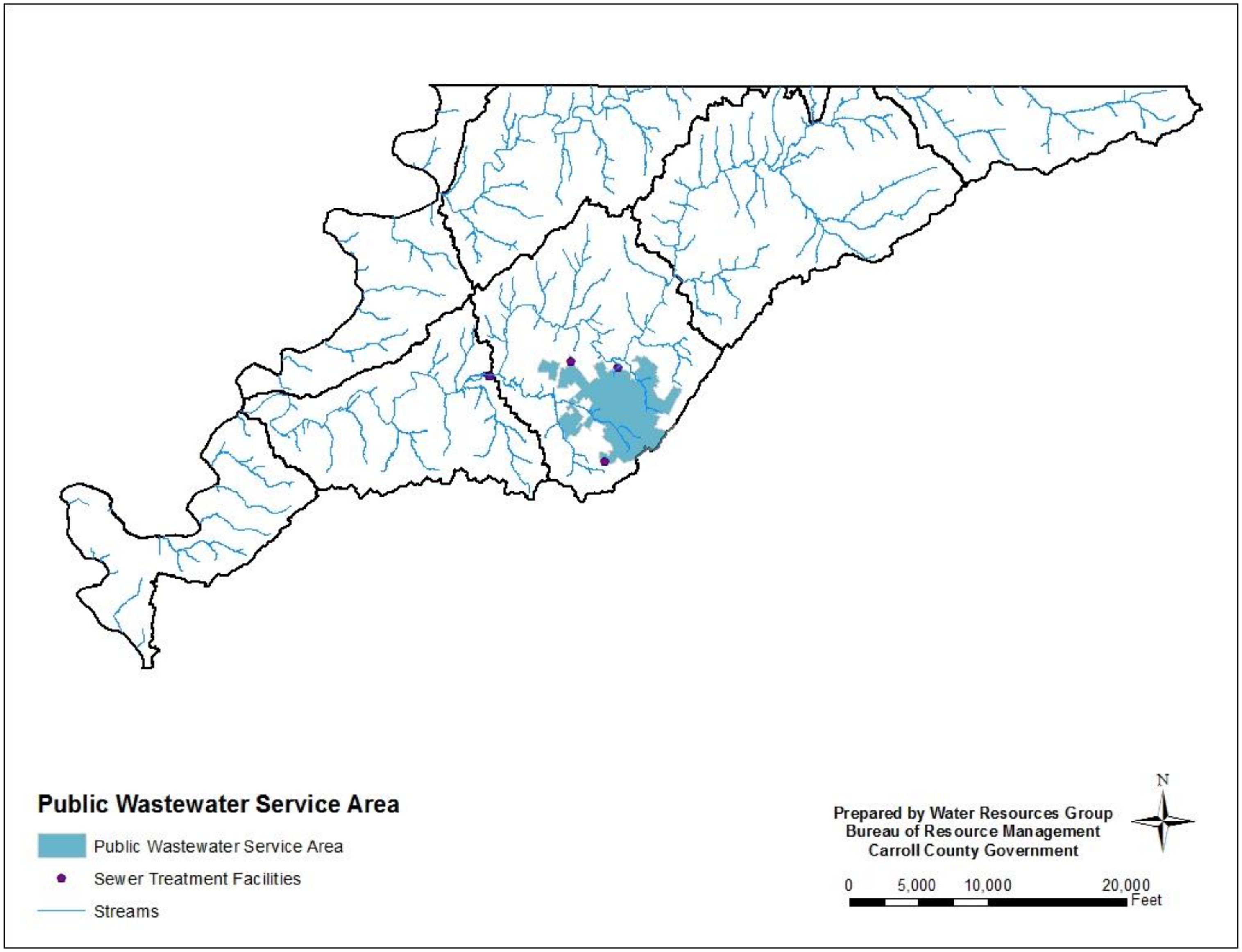

Figure 3-8: Upper Monocacy River Watershed Wastewater Service Area

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. National Pollutant Discharge Elimination System 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 Upper Monocacy River Watershed (information obtained from EPA.GOV Envirofacts).

Table 3-4: Upper Monocacy River Watershed NPDES Permits

Permit Holder	Permit Number	Subwatershed	Original Issue Date	Status
Chaz's Used Auto Parts & Towing, Inc.	MDR001812	Piney Creek (0254)	14-JAN-2004	Expired
Flow Serve Pump Division	MDR000062	Piney Creek (0255)	27-JAN-2003	Expired
Taneytown Public Works Maintenance Facility	MDR002263	Piney Creek (0255)	17-JUL-2014	Effective
Taneytown Wastewater Treatment Plant	MDR001743	Piney Creek (0255)	16-MAY-2003	Effective
ESAB	MD3492G04	Piney Creek (0255)	01-JUL-2007	Effective
Evapco, Inc.	MDR000458	Piney Creek (0255)	10-FEB-2003	Expired
Sheetz Store #132	MDG912397	Piney Creek (0255)	12-MAY-2006	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 Upper Monocacy River Watershed along with the representative acreage. Over 12,283 acres or about 45% of the total land area within Upper Monocacy River Watershed has some sort of land protection. Agricultural easements have the highest percentage of protection within the watershed at 44% with approximately 12,029 acres preserved. Figure 3-9 shows where the protected areas are located within the watershed.

Table 3-5: Upper Monocacy River Watershed Protected Lands

Type of Protection	Acres	Percentage
Agricultural Easement	12,029.32	44.35
Open Space and Parks	113.92	0.42
Forest Conservation Easement	86.82	0.32
Water Resource Easement	41.77	0.15
Floodplain Easement	11.83	0.04
Total	**12,283.66**	**45.29**

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 Upper Monocacy River watershed lies within the Little Pipe Creek Rural Legacy area and encompasses 2,4338 acres (90%) of the Upper Monocacy River watershed. The extent of the Rural Legacy Area within Upper Monocacy River can be found in Figure3-10.

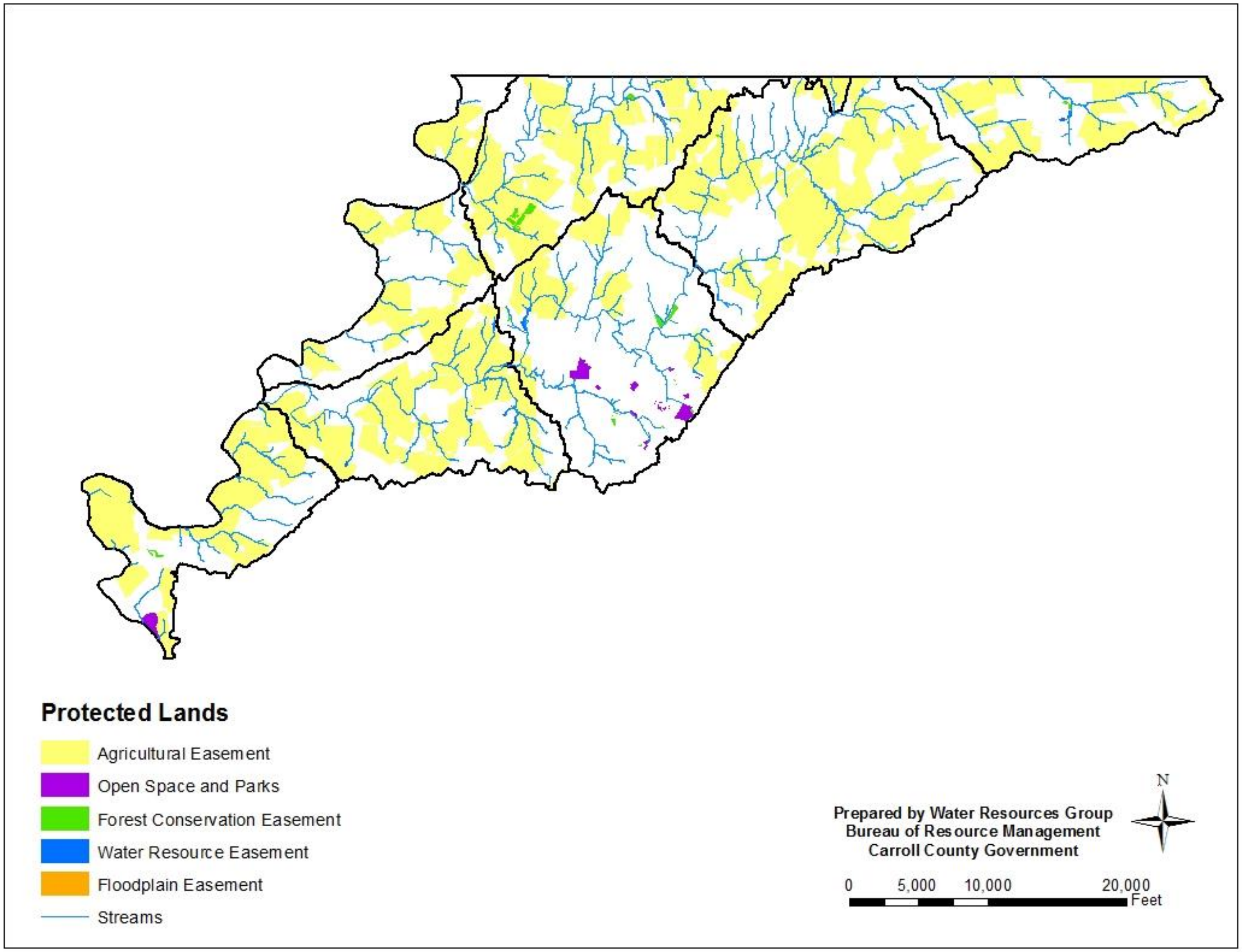

Figure 3-9: Upper Monocacy River Watershed Protected Lands

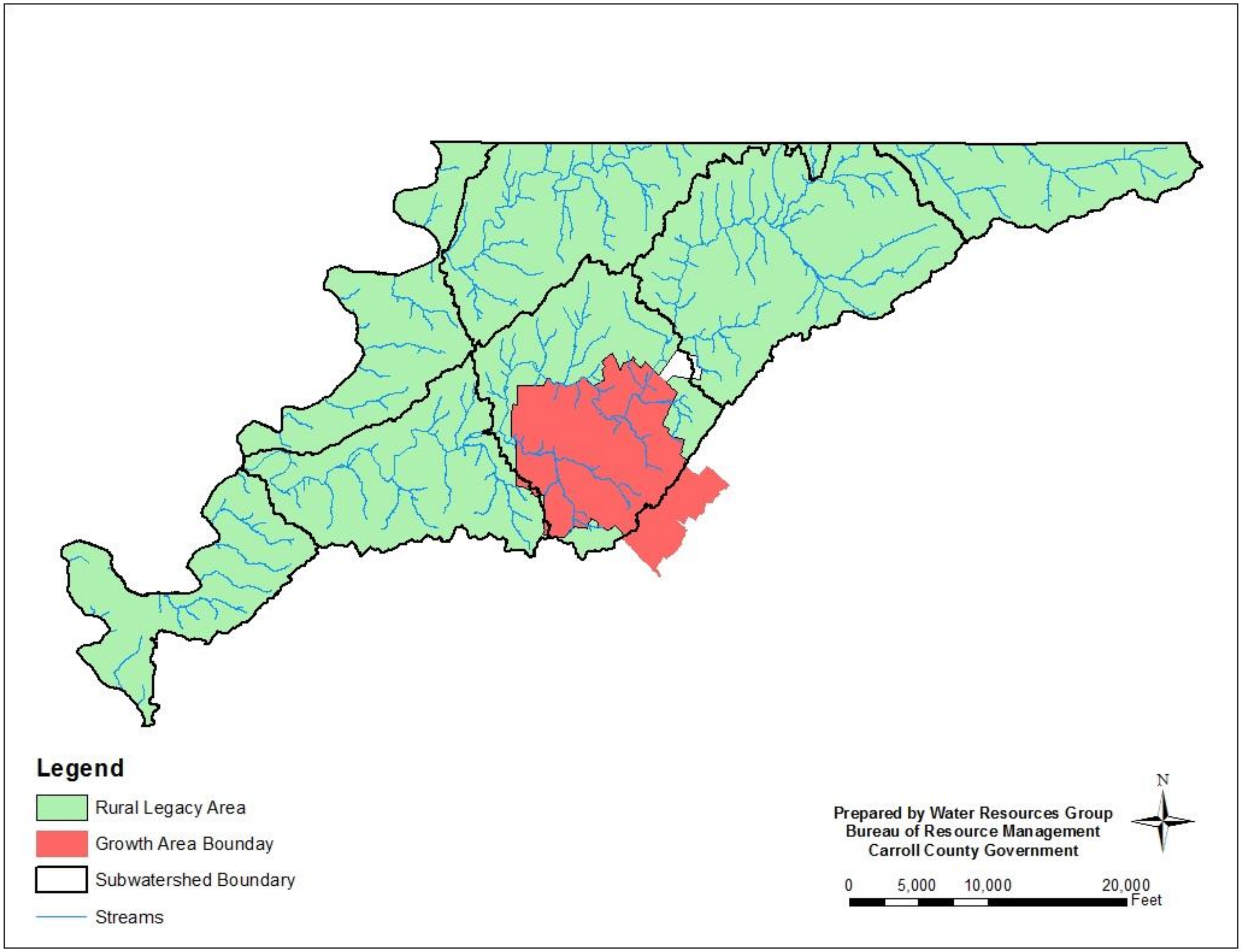

Figure 3-10: Upper Monocacy River Watershed Rural Legacy Area

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 Upper 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 Upper 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 Upper Monocacy River Watershed has approximately 17,561 acres of agricultural land in farm management plans and 450 acres of agricultural land in comprehensive nutrient management plans.

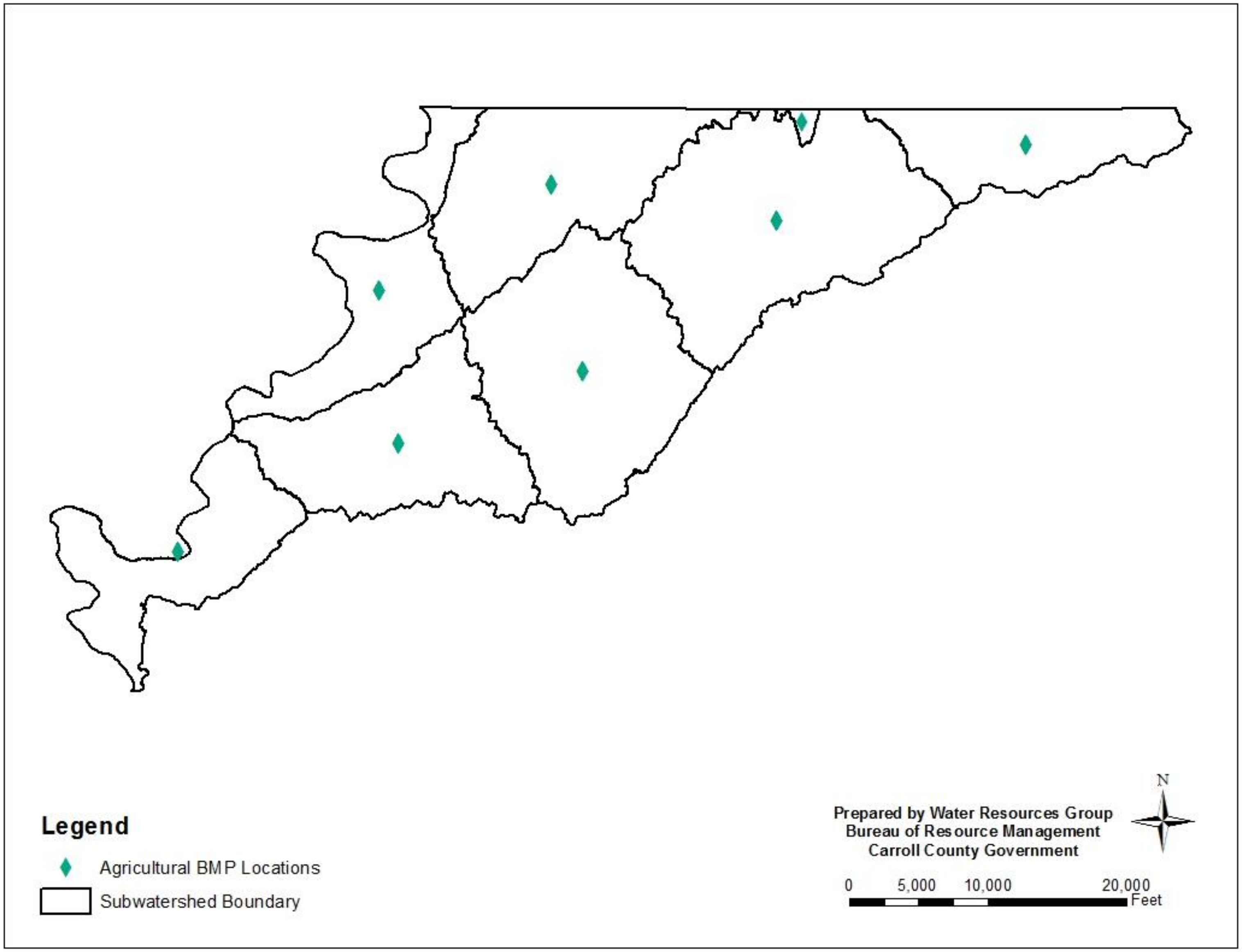

Figure 3-11: Upper Monocacy River Watershed Agricultural BMP Locations

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 Upper 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 Upper 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 Upper Monocacy River watershed, there are no listed Tier II waters.

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 Upper Monocacy River Watershed that have been assigned a TMDL include; Bacteria, Phosphorus, and Total Suspended Sediments (TSS).

a. Bacteria

The current estimated stormwater baseline load for bacteria within the Carroll County portion of Upper Monocacy Watershed was determined by (MDE, 2009) to be 432,969 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 13,855 billion MPN/year, which is a reduction of 419,114 billion MPN/year (96.8%) 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 Upper Monocacy Watershed.

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

Lower Monocacy Watershed			Percent Reduction
Jurisdiction	Baseline (Billion MPN/yr)	TMDL (Billion MPN/yr)	
Carroll County	432,969	13,855	96.8%
Total	**432,969**	**13,855**	**96.8%**

b. Phosphorus

The current estimated stormwater baseline load for Carroll County as determined by the MDE TMDL Data Center is 1,427 lbs. /yr., the TMDL for the stormwater WLA was determined to be 1,353 lbs. /yr., which is a reduction of 74 lbs. /yr. (5%) from the current loading (MDE 2012) (Table 4-2). This stormwater WLA includes all Carroll County Phase I jurisdictional MS4s.

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

Jurisdiction	Baseline (lbs./yr)	TMDL (lbs./yr)	Percent Reduction
Carroll County	1,427	1,353	5%
Total	**1,427**	**1,353**	**5%**

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 (MDE, 2012).

c. Total Suspended Sediments

The current estimated stormwater baseline load for the Carroll County segments of the Upper Monocacy River watershed as determined by the MDE TMDL Data Center is 657.9 ton /yr., the TMDL for the stormwater WLA was determined to be 371.5 ton /yr., which is a reduction of 286.4 ton /yr. (44%) from the current loading (MDE 2009) (Table 4-3).

Table 4-3: Upper Monocacy River 8-digit Watershed TSS TMDL

Jurisdiction	Baseline	TMDL	Percent Reduction
Carroll County	657.9	371.5	44%
Total	**657.9**	**371.5**	**56%**

In Maryland there are no specific numeric criteria that quantify the impact of sediment on the aquatic health of non-tidal stream systems. The threshold used to determine watershed specific sediment TMDL is the sediment loading threshold from a reference waters based on Maryland's biocriteria (MDE, 2009).

E. Water Quality Data

Water quality data within the Upper 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 Upper Monocacy River watershed. The Robert's Mill site, shown in Figure 4-1 is located within the Piney Creek (0255) subwatershed, and is almost entirely within the corporate limits of the Town of Taneytown.

The current facility is a dry detention pond that was built the late 1980's. The Robert's Mill location is primarily low-density mixed urban, which encompasses 41% of the land cover, followed by low-density residential at 32% of the land cover. The drainage area to the monitoring site is approximately 274 acres, of which, 83 acres or 30% is impervious.

Bi-weekly monitoring at the Robert's Mill site began in January of 2016 and consists of chemical grab samples with corresponding discharge measurements in order to calculate loadings. The chemical monitoring parameters, methods, and detection limits for the Robert's Mill site can be found in Table 4-4. 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 4-4: 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

2. Bacteria Trend Monitoring

Carroll County's trend monitoring program is focused around showing long term trends of bacteria concentrations within the urbanized areas of Carroll County associated with the SW WLA. Monitoring within the Upper Monocacy Watershed began in February of 2018, and is currently performed at two locations, shown in Figure 4-2. Samples are currently collected on the 3rd Thursday of each month by the County's Bureau of Resource Management.

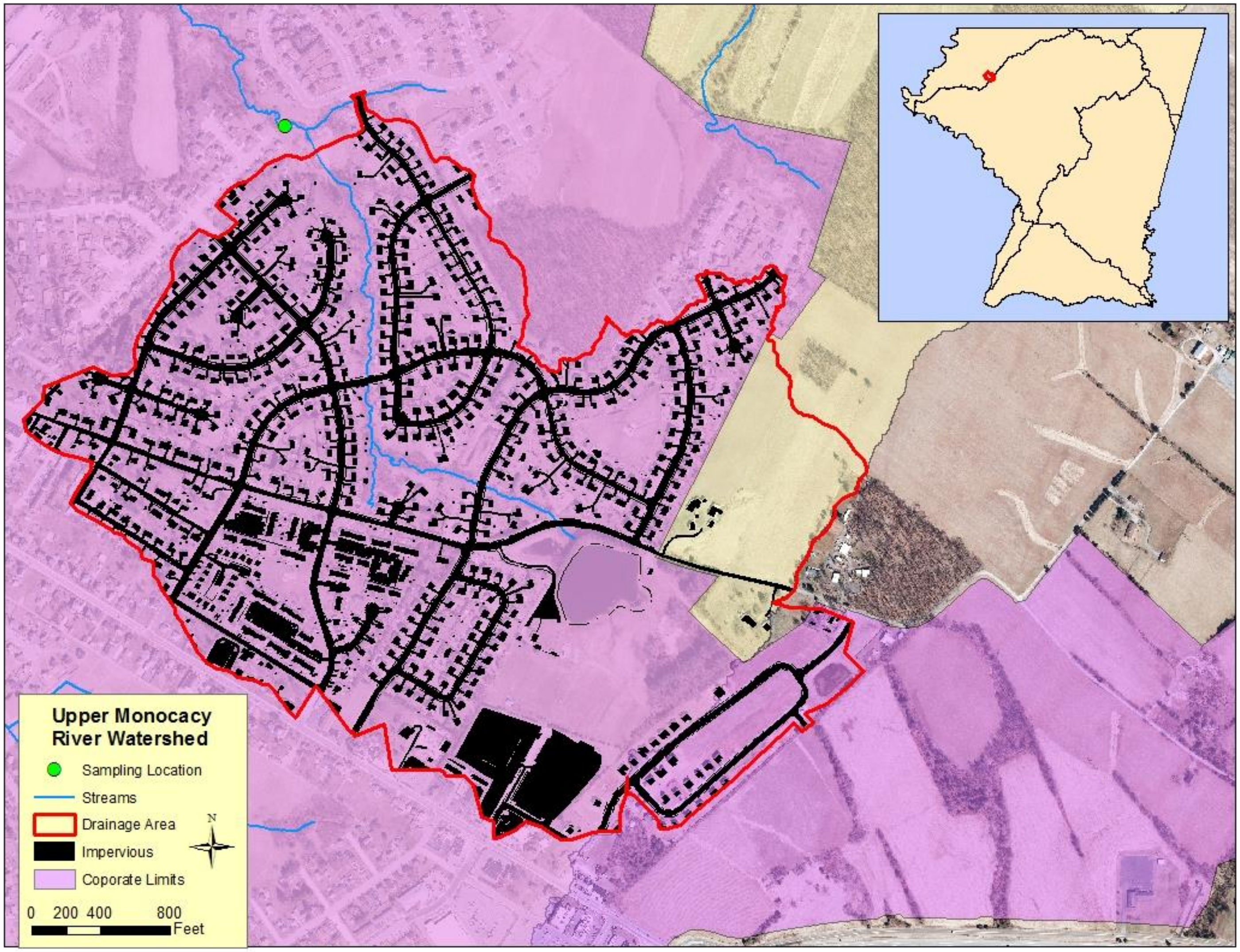

Figure 4-1: Robert's Mill Monitoring Location

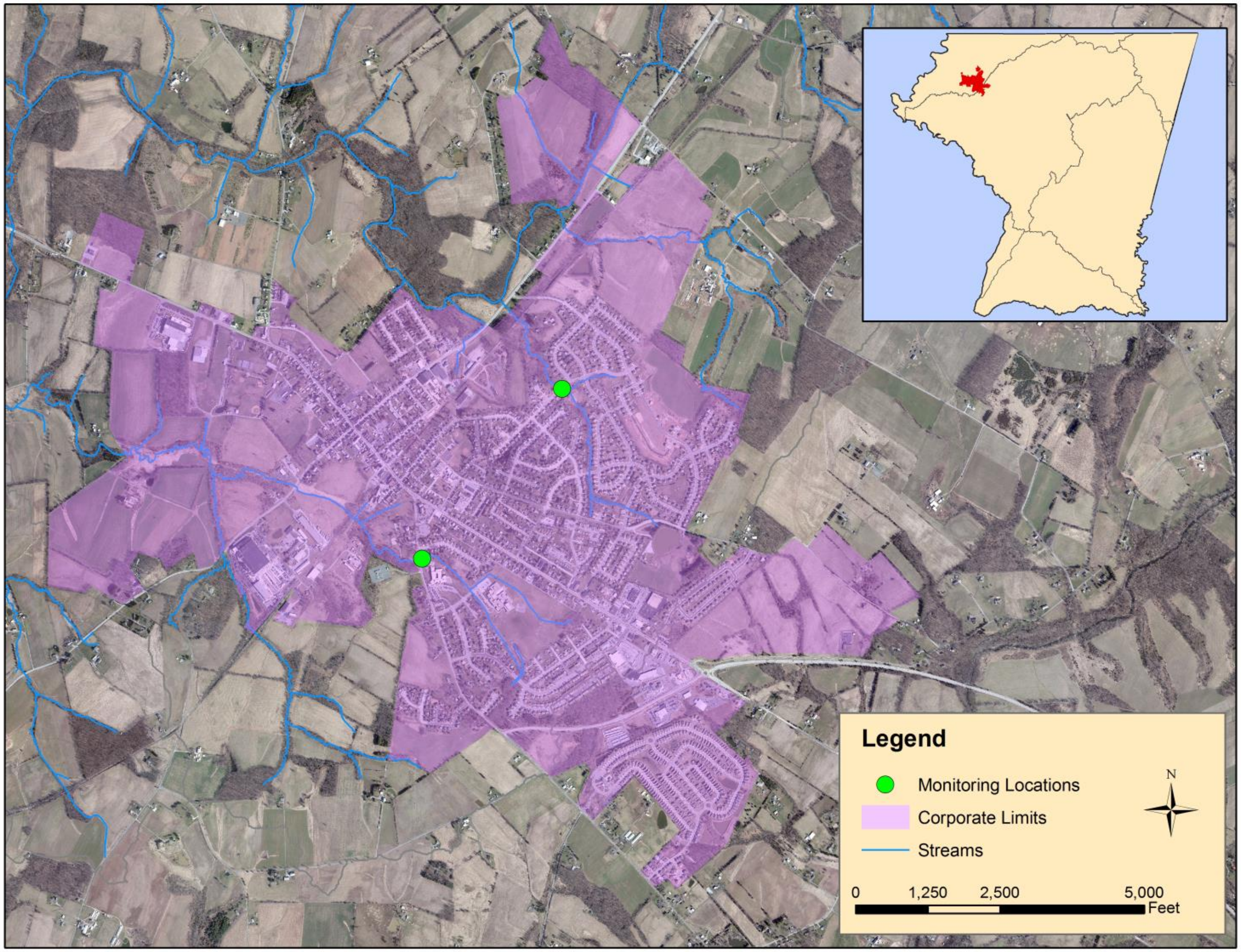

Figure 4-2: Upper Monocacy Bacteria Monitoring Locations

3. 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 4-3.

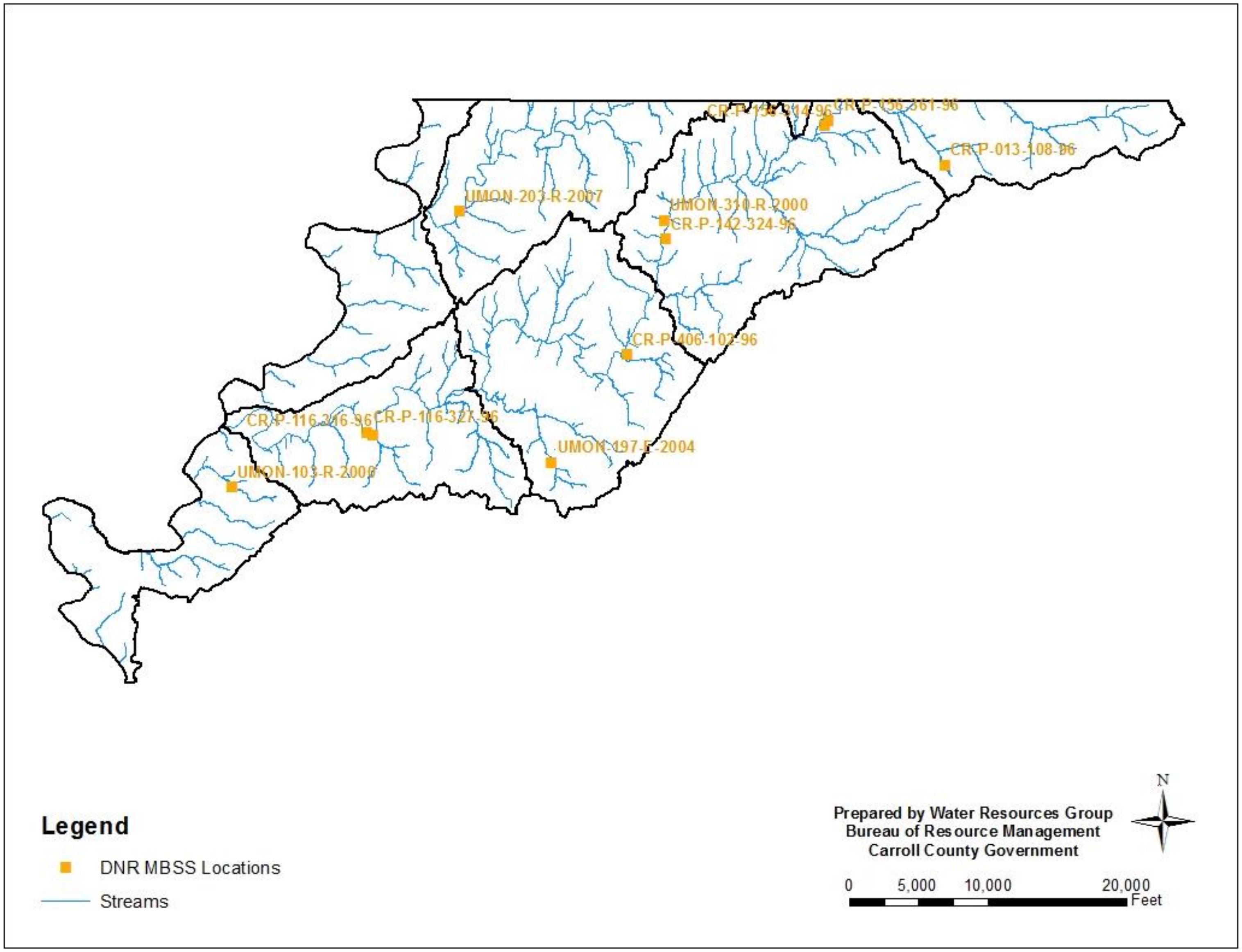

Figure 4-3: Upper Monocacy River Watershed DNR MBSS Locations

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 4-5 and summarized in Table 4-6. Data included in this document were provided by the Maryland Department of Natural Resources Monitoring and Non-tidal Assessment Division.

Table 4-5: Upper Monocacy River Watershed DNR's MBSS Chemical Results

12-Digit Scale Site Identification	**Subwatershed** Stream Segment	**Field pH**	**Temperature (°C)**	**Dissolved Oxygen**	**Conductivity**
021403030264	**Alloway Creek**				
UMON-203-R-2007	Alloway Creek	8.12	24.9	6.9	531
02140303067	**Piney Creek Upper A**				
CR-P-013-108-96	Piney Creek UT1 UT1	7.1	15.8	12.2	72
02140303257	**Piney Creek C**				
CR-P-156-361-96	Piney Creek	7.43	18.9	9.3	188
CR-P-156-314-96	Piney Creek	7.23	18.6	9.3	189
UMON-310-R-2000	Piney Creek	8.4	21.8	9.2	650
CR-P-142-324-96	Piney Creek	8.61	23.7	10.7	214
021403030255	**Piney Creek D**				
CR-P-406-102-96	Piney Creek UT2	7.23	24.4	7.1	312
UMON-197-E-2004	Piney Creek UT3	7.16	17.8	6.9	3
021403030254	**Piney Creek Lower**				
CR-P-116-327-96	Piney Creek	7.25	21.3	7.5	262

12-Digit Scale	**Subwatershed**	**Field pH**	**Temperature (°C)**	**Dissolved Oxygen**	**Conductivity**
Site Identification	Stream Segment				
CR-P-116-316-96	Piney Creek	7.78	22.2	9.6	256
021403030247	**Upper Monocacy River South**				
UMON-103-R-2000	Monocacy River UT3	7.14	20.9	6	210

Table 4-6: Upper Monocacy River Watershed DNR's MBSS Chemical Results Summary

	Field pH	**Temperature (°C)**	**Dissolved Oxygen**	**Conductivity**
Maximum	8.61	24.9	12.2	650
Minimum	7.1	15.8	6	3
Average	7.59	20.94	8.61	262.45

The Upper Monocacy River Watershed DNR MBSS data demonstrates there is sufficient dissolved oxygen to adequately support aquatic life. The lowest dissolved oxygen level measured during the DNR MBSS sampling events was 6 mg/l, which is greater than the COMAR standard of 5.0 mg/l, a level generally considered healthy for aquatic life. During most of the sampling events the water temperature was around 20°C, averaging around 21°C in the watershed. The pH of the water was relatively neutral, averaging 7.59, and ranging as acidic as 7.1 to a more alkaline pH of 8.61. The relatively low range of pH suggests overall pH stability.

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 Upper 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 Upper Monocacy River Watershed are listed in Table 5-1. Data included in this document were provided by the Maryland Department of Natural Resources Monitoring and Non-tidal Assessment Division.

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

12-Digit Scale	**Subwatershed**	**Fish IBI**			**Benthic IBI**		
Site Identification	Stream Segment	Good	Fair	Poor	Good	Fair	Poor
021403030264	**Alloway Creek**						
UMON-203-R-2007	Alloway Creek			1.67		3.75	
02140303067	**Piney Creek Upper A**						
CR-P-013-108-96	Piney Creek UT1 UT1		3.33			3.75	
02140303257	**Piney Creek C**						
CR-P-156-361-96	Piney Creek	5					2
CR-P-156-314-96	Piney Creek	5					2
UMON-310-R-2000	Piney Creek	4					1.75
CR-P-142-324-96	Piney Creek	4					1.75
021403030255	**Piney Creek D**						
CR-P-406-102-96	Piney Creek UT2		3.33				1.50
UMON-197-E-2004	Piney Creek UT3			2			2.5
021403030254	**Piney Creek Lower**						
CR-P-116-327-96	Piney Creek	4					1.5
CR-P-116-316-96	Piney Creek	4					1.5

12-Digit Scale	**Subwatershed**	**Fish IBI**			**Benthic IBI**		
Site Identification	Stream Segment	Good	Fair	Poor	Good	Fair	Poor
021403030247	**Upper Monocacy River South**						
UMON-103-R-2000	Monocacy River UT3			1.33			1.75
Upper Monocacy River Watershed Total Counts:		**6**	**2**	**3**	**0**	**2**	**9**
Upper Monocacy River Watershed Average:		**4.33**	**3.33**	**1.66**	**--**	**3.75**	**1.81**

In total there are 11 samples contributing to the MBSS data set from 1995 to 2009. Within the Upper Monocacy River Watershed, 54% of the fish samples were in 'good' condition, with an average rating of 4.33. Of the benthic samples, 82% were in 'poor' condition with an average rating of 1.81. The IBI for fish throughout the years and locations sampled were mostly within the 'good' range, suggesting fish populations are, for the most part, similar to reference streams that are unaffected by pollutants. The benthic IBI for the Upper Monocacy River Watershed is for the most part within the 'poor' range, suggesting adverse impacts to the benthic community within the watershed.

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 Upper Monocacy River Watershed the Alloway Creek (0264), Upper Monocacy River (0256), Upper Monocacy River (0247), Piney Creek (0257), and Piney Creek (0254) subwatersheds are identified as having sensitive state-listed species; and special protection is necessary to ensure the persistence of these communities. There is also approximately 4,348 acres of targeted ecological areas within the Upper 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 Upper Monocacy River Watershed. Sensitive species areas where designated by the DNR.

D. Stream Corridor Assessment

A Stream Corridor Assessment (SCA) of the Upper Monocacy River Watershed was conducted during the winter of 2014-2015 by Carroll County Bureau of Resource Management staff. The Upper 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 569 landowners within the Upper 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 67 of the 133 stream miles within the Upper Monocacy River Watershed.

The most common impairments identified during the assessment are shown in Figure 5-3, and consisted primarily of inadequate streamside buffers and erosion followed by fish barriers. 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
021403030264	0	8	5	4	14	7	2	4	1	**45**
021403030267	0	7	4	1	3	0	0	3	0	**18**
021403030266	0	0	0	0	0	0	0	0	0	**0**
021403030257	0	18	3	10	24	9	0	2	1	**67**
021403030255	0	13	7	16	25	6	6	11	3	**87**
021403030254	0	8	3	5	5	0	0	2	0	**23**
021403030256	0	3	0	3	11	1	0	0	0	**18**
021403030247	0	2	0	6	2	3	0	0	0	**13**
Total	**0**	**59**	**22**	**45**	**84**	**26**	**8**	**22**	**5**	**271**

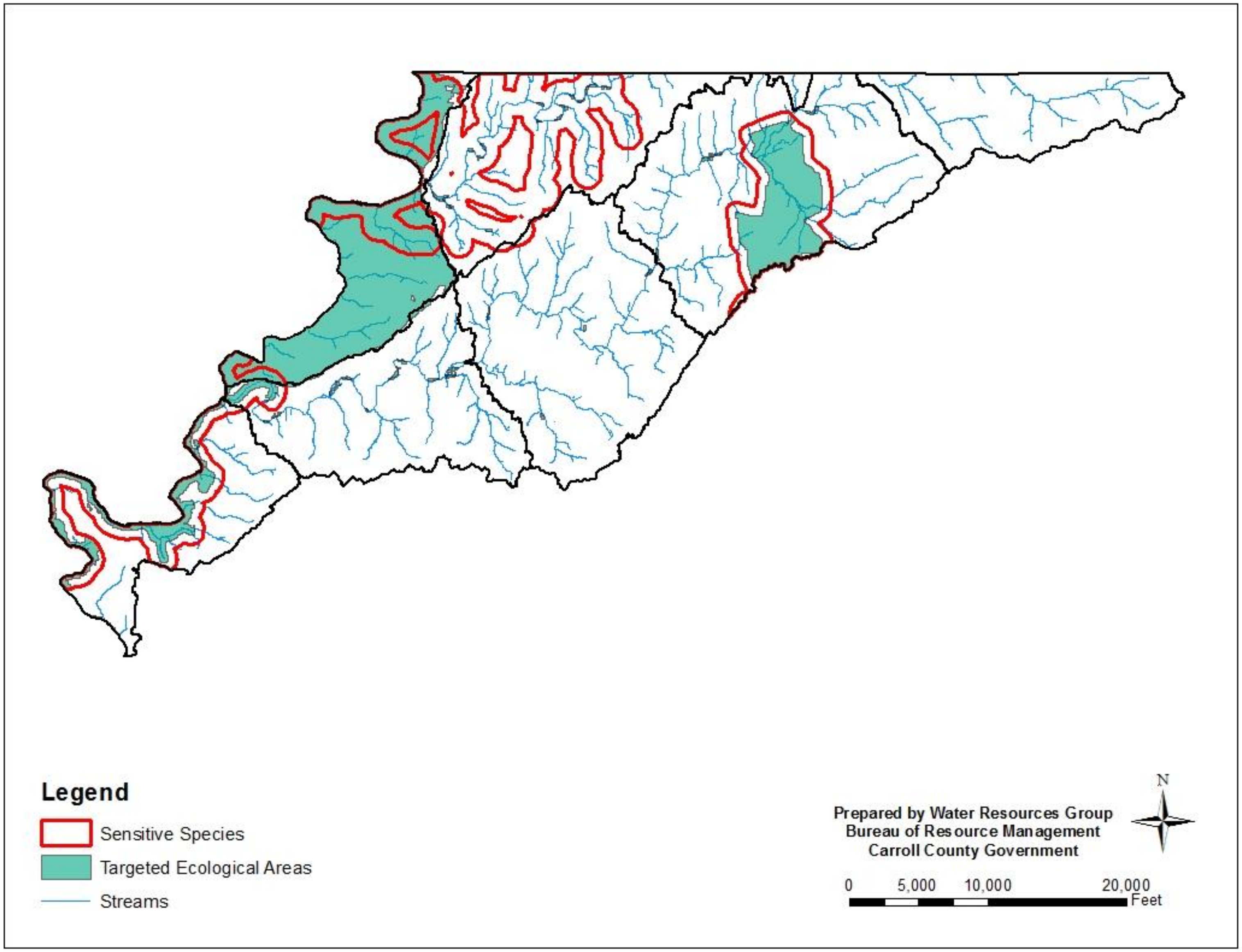

Figure 5-1: Upper Monocacy River Watershed Targeted Ecological Areas

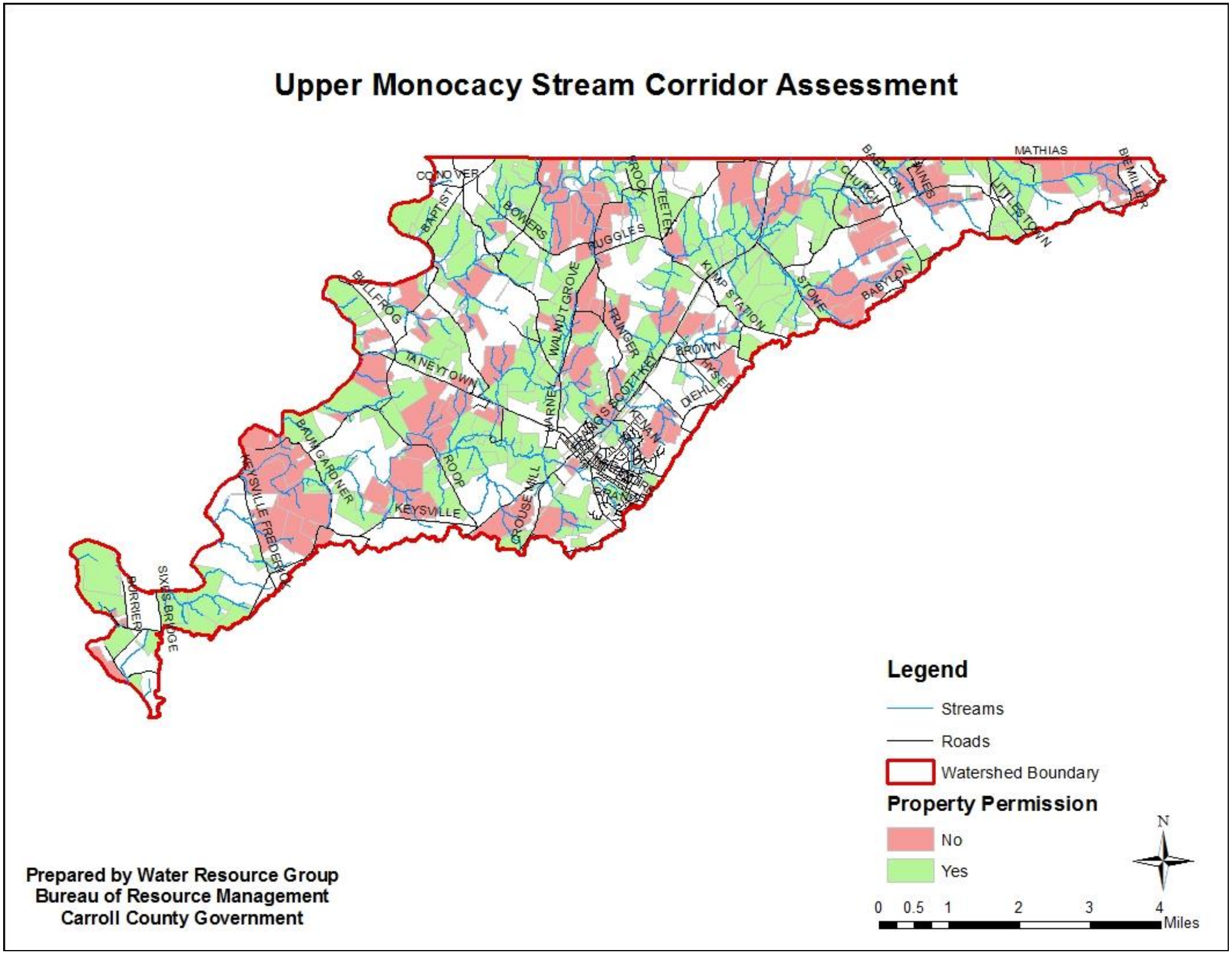

Figure 5-2: SCA Landowner Participation

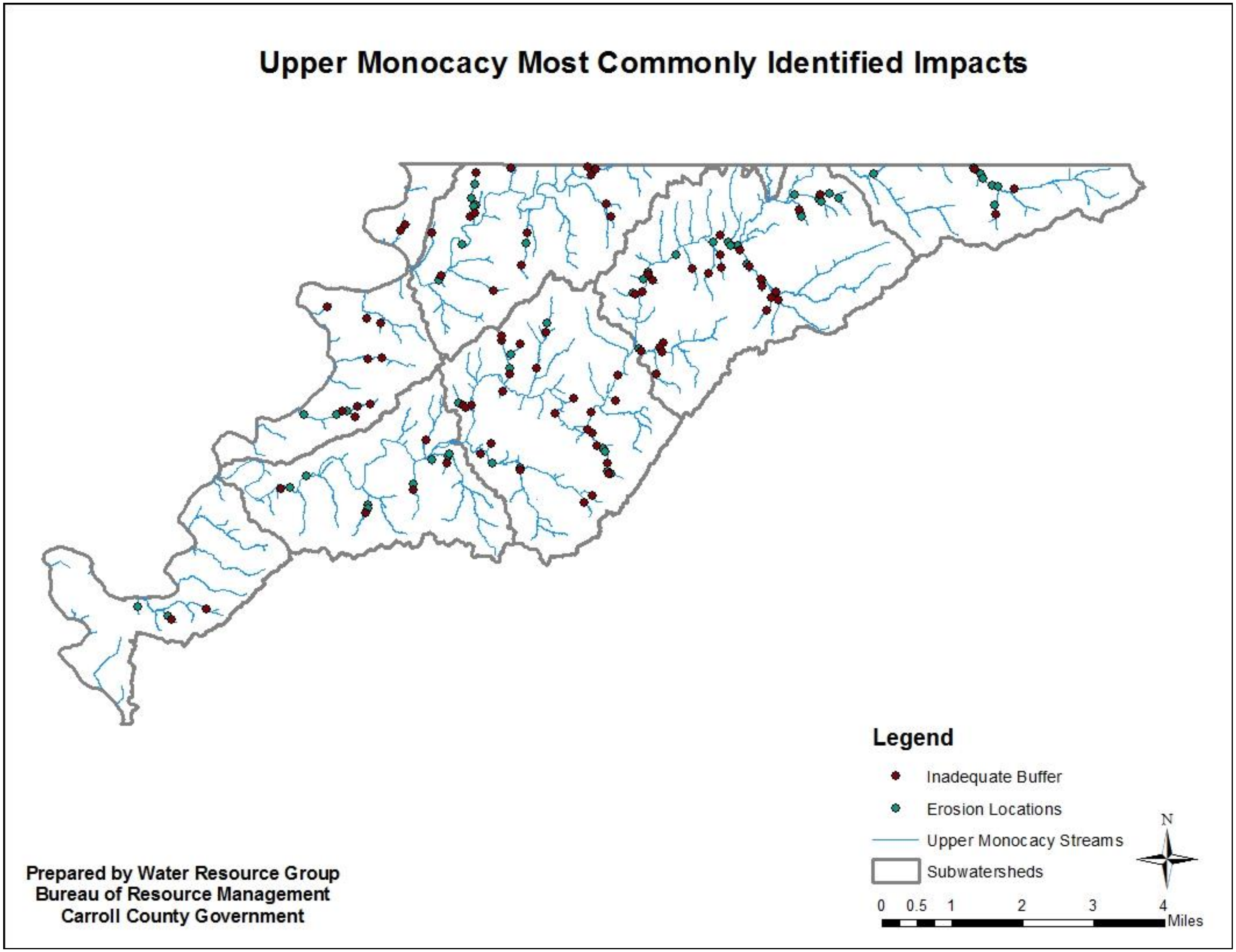

Figure 5-3: Most Commonly Identified Impacts

A total of 4.8 miles, or 7 percent, of the 67 miles assessed were found to have an erosion problem, with approximately 1 percent of the watershed categorized as having a severe erosion problem. Streamside buffers were identified as inadequate along 44% of the streams assessed, with 7 percent of the entire watershed classified as severely un-buffered. 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
021403030264	37,685	3,320
021403030267	6,800	800
021403030266	0	0
021403030257	33,335	4,470
021403030255	45,240	7,650
021403030254	9,575	6,185
021403030256	19,400	210
021403030247	4,200	2,900
Total	**156,235 (29.59 miles)**	**25,535 (4.84 miles)**

1. **Subwatershed Summary**

Alloway Creek (0264): Erosion problems were identified along 3,320 linear feet of the stream channel (3% of subwatershed streams), with 400 feet classified as severely eroded (12% of marked erosion within the subwatershed). Inadequate buffers were identified along 37,685 linear feet of the streambank (33% of subwatershed streams), with 8,000 feet classified as severe (21% of marked inadequate buffer within the subwatershed).

Piney Creek Upper A (0267): Erosion problems were identified along 800 linear feet of the stream channel (1% of subwatershed streams), with none classified as severely eroded. Inadequate buffers were identified along 6,800 linear feet of the streambank (12% of subwatershed streams), with 3,000 feet classified as severe (44% of marked inadequate buffer within the subwatershed).

Piney Creek Upper B (0266): Erosion problems and inadequate buffers were not noted in this subwatershed.

Piney Creek C (0257): Erosion problems were identified along 4,470 linear feet of the stream channel (2.5% of subwatershed streams), with 1000 feet classified as severely eroded (22% of marked erosion within the subwatershed). Inadequate buffers were identified along 33,335 linear feet of the streambank (19% of subwatershed streams), with 19,160 feet classified as severe (57% of marked inadequate buffer within the subwatershed).

Piney Creek D (0255): Erosion problems were identified along 7,650 linear feet of the stream channel (5% of subwatershed streams), with none classified as severely eroded. Inadequate buffers were identified along 45,240 linear feet of the streambank (31% of subwatershed streams), with 19,550 feet classified as severe (43% of marked inadequate buffer within the subwatershed).

Piney Creek Lower (0254): Erosion problems were identified along 6,185 linear feet of the stream channel (6% of subwatershed streams), with 5,200 feet classified as severely eroded (84% of marked erosion within the subwatershed). Inadequate buffers were identified along 9,575 linear feet of the streambank (9% of subwatershed streams), with 8,025 feet classified as severe (84% of marked inadequate buffer within the subwatershed).

Upper Monocacy River North (0256): Erosion problems were identified along 210 linear feet of the stream channel (less than 1% of subwatershed streams), with none classified as severely eroded. Inadequate buffers were identified along 19,400 linear feet of the streambank (41% of subwatershed streams), with 11,000 feet classified as severe (57% of marked inadequate buffer within the subwatershed).

Upper Monocacy River South (0247): Erosion problems were identified along 2,900 linear feet of the stream channel (5% of subwatershed streams), with none classified as severely eroded. Inadequate buffers were identified along 4,200 linear feet of the streambank (8% of subwatershed streams), with none classified as severe.

VI. Characterization Summary

A. Summary

This Characterization Plan was developed to describe the unique background of the Upper 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 Upper Monocacy River Watershed stream corridor assessment, as well as the development of this Upper Monocacy River Watershed Characterization Plan.

Field Time: Assessment was completed over a span of 6 weeks; field crew averaged 3 days per week for a total of 18 field days.

Field Hours: Field crew averaged 4 hours/day over the 18 days for a total of 72 hours. Field crew varied from 2-3 people performing the assessment for a cumulative total of 180 field hours. Total cost of staff time in field was roughly $5,400 (180 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 Upper Monocacy stream corridor assessment and the Watershed Characterization Plan was approximately $8,750.

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Appendix A: Upper Monocacy River Watershed Stormwater Management Facilities

Upper Monocacy River Watershed Stormwater Management Facilities

Subwatershed	Facility Type	Drainage Area (acres)	Impervious Acres (acres)	Project Name	Site Number
Upper Monocacy River South (0247)	INFILTRATION BASIN	7.6	0.5	GRAND MEADOWS	SWM-43
Alloway Creek (0264)	DRY-INFILTRATION BASIN	3.02	0.53	HARNEY WOODWRKING STORAGE	SWM-595
Piney Creek (0254)	SHALLOW MARSH	19.1	0.72	TANEYTOWN W.T.T.P.	SWM-263
Piney Creek (0255)	DETENTION BASIN	17.133		WINDY HILLS	
Piney Creek (0255)	DETENTION BASIN	8.133		TREVANION TERRACE	
Piney Creek (0255)	DETENTION BASIN	25.018		FAIRTOWN	
Piney Creek (0255)	DETENTION BASIN	3.116		TANEYTOWN SHOPPING CENTEER	
Piney Creek (0255)	DETENTION BASIN	1.312		ANTRIM PARKING LOT	
Piney Creek (0255)	DETENTION BASIN	39.273		ROBERTS MILL PARK	
Piney Creek (0255)	DETENTION BASIN	44.155		COPPERFIELD	
Piney Creek (0255)	DETENTION BASIN	63.62		MEADOWBROOK	
Piney Creek (0255)	DETENTION BASIN	8.432		FREESTATE HEIGHTS NO.2	
Piney Creek (0255)	DETENTION POND IN STREAM	280.684		ROBERTS MILL RUN	
Piney Creek (0255)	DRY-DETENTION POND	7.35		EVAPCO	SWM-397
Piney Creek (0255)	DRY-INFILTRATION BASIN	1		SHEETZ POND	SWM-654
Piney Creek (0255)	DRY-INFILTRATION BASIN	0.56		MASON/DIXON AUTO PARTS	SWM-688
Piney Creek (0255)	FLUSH POND & CTRL STRUCT	30.146		ROBERTS MILL FIRST FLUSH POND	

Subwatershed	Facility Type	Drainage Area (acres)	Impervious Acres (acres)	Project Name	Site Number
Piney Creek (0255)	SWALE	53.244		MIDDLE SCHOOL SWALE	
Piney Creek (0255)	SWM BASIN	16.819		SARAH'S CHOICE BASIN NO.1	
Piney Creek (0255)	SWM BASIN	7.316		SARAH'S CHOICE BASIN NO.2	
Piney Creek (0255)	SWM BASIN	13.033		FREESTATE HEIGHTS NO.1	
Piney Creek (0255)	SWM BASIN	8.855		TANEY SUPPLY/ERIC GLASS PROPERTY	
Piney Creek (0255)	SWM DETENTION BASIN	0.951		HERRING APARTMENTS	
Piney Creek (0255)	SWM DETENTION BASIN	12.009		FLOWSERVE	
Piney Creek (0255)	SWM DETENTION BASIN	3.714		IKEX	
Piney Creek (0255)	SWM DETENTION POND	5.91		F.P. DUFFY	
Piney Creek (0255)	WQ BASIN	8.088		ROBERTS MILL RUN WQ POND 1	
Piney Creek (0255)	WQ BASIN	2.768		SARAH'S CHOICE WQ POND NO.1	

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

Upper Monocacy River Watershed Agricultural Best Management Practices

Best Management Practice	Extent	Unit
472 – Access Control	20.7	AC
313 - Waste Storage Structure	10	ST
327 - Conservation Cover	1,455.7	AC
328 - Conservation Crop Rotation	554.5	AC
330 - Contour Farming	307.8	AC
342 - Critical Area Planting	2.2	AC
362 – Diversion	315	FT
192 / 1923 – Farm Plan	17,561	AC
393 - Filter Strip	896.7	AC
512 - Forage and Biomass Planting	54.5	AC
511 - Forage Harvest Management	84.3	AC
412 - Grassed Waterway	20.81	AC
561 - Heavy Use Area Protection	1.14	AC
468 - Lined Waterway or Outlet	10	FT
516 - Livestock Pipeline	865	FT
590 - Nutrient Management	449.3	AC
528 - Prescribed Grazing	48.9	AC
329 - Residue and Tillage Mgmt, No Till	307.3	AC
345 - Residue and Tillage Mgmt, Mulch Till	1,359.4	AC
391 - Riparian Forest Buffer	132.3	AC
390 - Riparian Herbaceous Cover	6.8	AC
558 - Roof Runoff Structure	33	NO
378 - Sediment Control Pond	1	ST
574 - Spring Development	8	NO
728 - Stream Crossing	6	ST
382 – Fencing	61,530	FT
606 - Subsurface Drain	24,336	FT
620 - Underground Outlet	690	FT
645 - Upland Wildlife Habitat Management	4.1	AC

360 - Waste Facility Closure	1	NO
635 - Wastewater Treatment Strip	2.45	AC
614 - Watering Facility	17	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.