Loch Raven Reservoir Watershed Characterization Plan

Spring 2016

Prepared by
Carroll County Bureau of Resource Management

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I. Characterization Introduction

A. Purpose of the Characterization

The Loch Raven Reservoir 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 Loch Raven watershed stream corridor assessment (SCA) will be used as a tool to help direct the watershed implementation plan for the Loch Raven Reservoir 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 Loch Raven Watershed.

B. Location and Scale of Analysis

The Loch Raven Watershed is located in the northeast corner of Carroll County. The watershed is within the Gunpowder River Basin in the Piedmont physiographic province of Maryland and consists of one major subwatersheds. Figure 1-1 depicts the location of Loch Raven within Carroll County.

The Loch Raven Watershed drains into the Loch Raven reservoir, which is a major drinking water source for the City of Baltimore. Table 1-1 displays the distribution of acreage between the subwatersheds within Loch Raven.

The analysis presented in this report was done at the subwatershed scale, which allows for restoration and preservation efforts to be focused on the smaller drainage areas where efforts can be prioritized and more easily monitored.

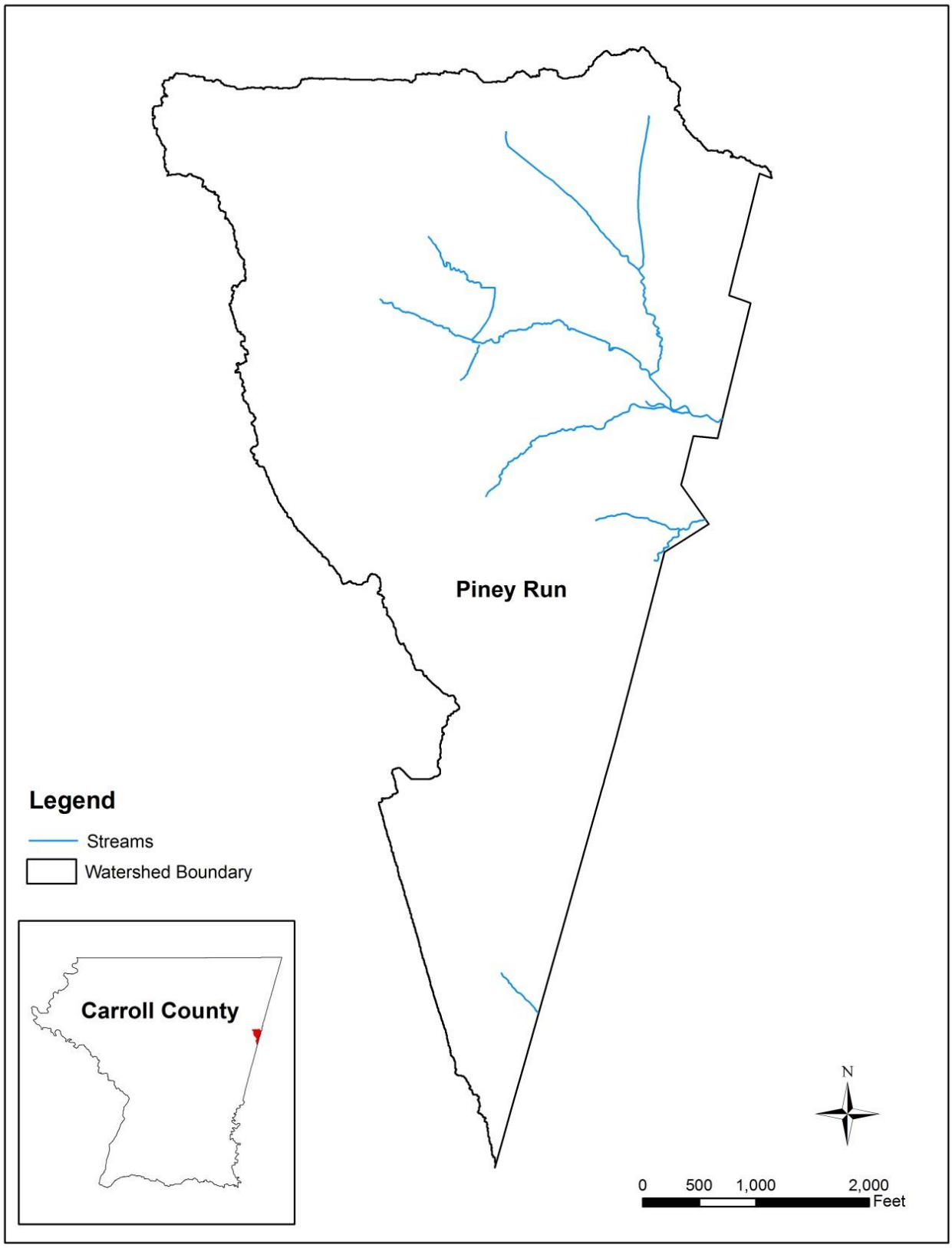

Figure 1-1: Loch Raven Watershed Location Map

Table 1-1: Loch Raven Watershed Subwatershed Acreage - Carroll County

DNR 12-digit Scale	Subwatershed	Acres
0308	Piney Run	592
	Loch Raven Watershed Total	**592**

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 the human characteristics 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 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, the water quality data collected within Loch Raven, and the total maximum daily loads associated with the Loch Raven Watershed.

Chapter 5 summarizes the living resources within the Loch Raven Watershed including aquatic and terrestrial as well as any rare, threatened, or endangered 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, these characteristics are examined in detail, which will provide a foundation for the later chapters on human characteristics, water quality, and the living resources. The natural characteristics to be covered in this chapter include climate; hydrologic factors such as stream flow, floodplains, and wetlands as well as precipitation; physical landscape features such as topography, geology, soils, and forest cover. This chapter will also establish groundwater resources and ecologically important areas. 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.

B. Climate

The climate of the region can be characterized as a humid continental climate with four distinct seasons modified by the proximity of the Chesapeake Bay and Atlantic Ocean (DEPRM, 2000). Rainfall is evenly distributed through all months of the year with most months averaging between 3.0 and 3.5 inches per month. Storms in the fall, winter, and early spring tend to be of longer duration and lesser intensity than summer storms, which are often convective in nature with scattered high-intensity storm cells. The average annual rainfall, measured at the Westminster State Police Barracks, is approximately 44 inches per year. The average annual snowfall is approximately 21 inches with the majority of accumulation in December, January, and February.

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

C. Physical Location

The Loch Raven Watershed lies entirely within the Piedmont physiographic province. The Piedmont is classified as low rolling hills with loamy moderately fertile soils and complex geology with numerous rock formations of different materials and ages intermingled with one another.

1. Topography

Topography of the surrounding land, including its steepness and concavity, will affect surface water flows, soil erosion, and development suitability. Steeper slopes are more prone to soil erosion and may have a greater influence on the amount of pollutants generated. For this characterization the slopes were arranged into three categories using soil data from the Carroll County Soil Survey: low slopes (0-8%), medium slopes (8-15%), and high slopes (>15%). Table 2-1 presents the subwatershed slopes as percentages within the Loch Raven Watershed.

Table 2-1: Loch Raven Watershed Slope Categories

DNR 12-Digit Scale	Subwatershed	Slope Category (%)		
		Low	Medium	High
0308	Piney Run	77%	20%	3%
Loch Raven Watershed Total		**77%**	**20%**	**3%**

Figure 2-1 displays the slope categories and their distribution throughout the Loch Raven Watershed.

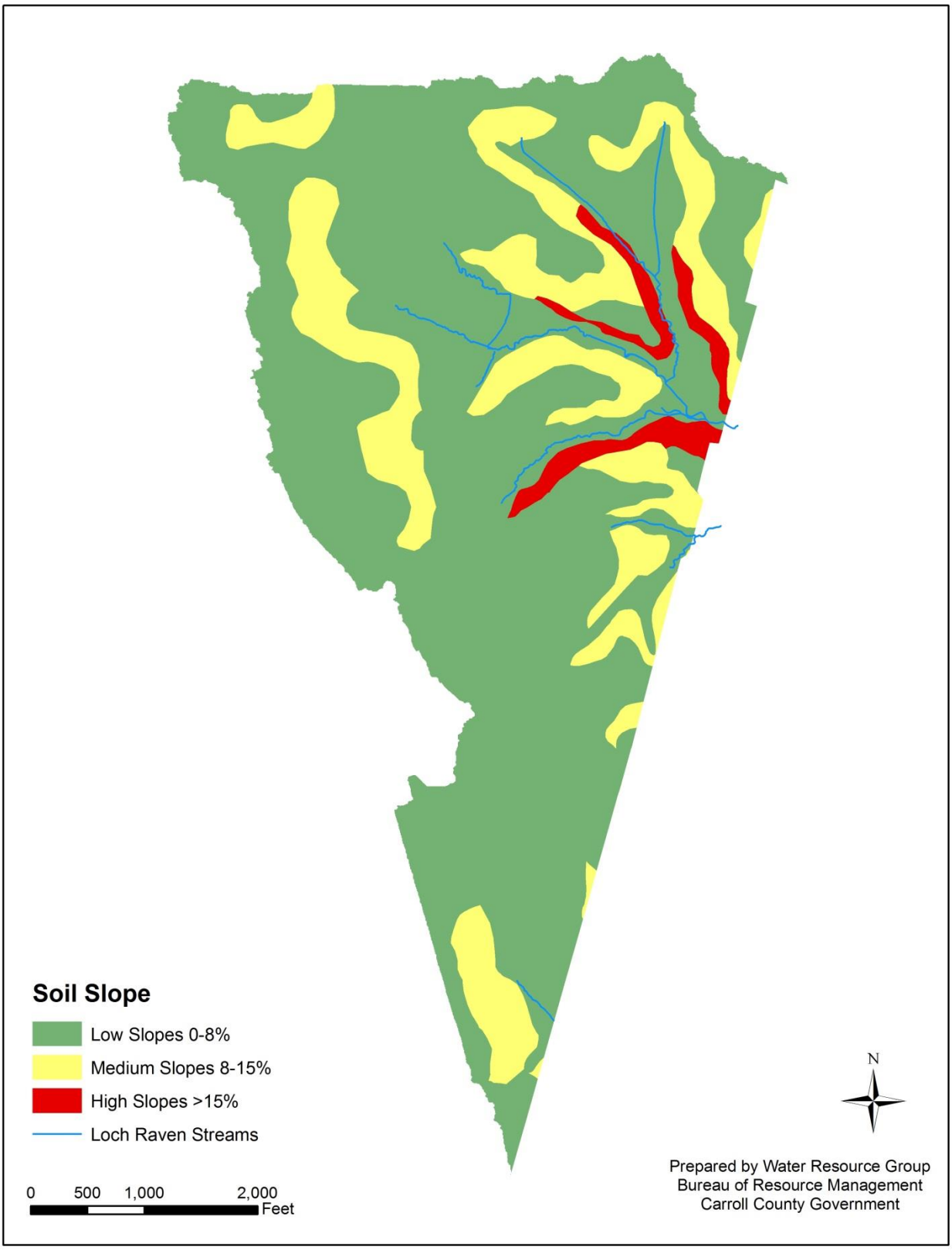

Figure 2-1: Loch Raven Watershed Topography

2. Soils

The terrestrial system within a watershed is greatly influenced by the type and condition of the underlying soil. Soil factors such as drainage and permeability also greatly reflect the amount of water present in a stream as well as its quality.

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

a. Hydrologic Soil Groups

The Natural Resource Conservation Service (NRCS) classifies soils into four Hydrological Soil Groups (HSG) based on the soil's 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 Hydrological Soil Groups 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.

Hydrological Soil Group 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, well to 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 consists mostly of deep to moderately deep and 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 clay pan 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 2-2.

Table 2-2: Loch Raven Subwatershed Hydrologic Soil Group Categories

DNR 12-digit scale	Subwatershed	Hydrologic Soil Group %			
		A	B	C	D
0308	Piney Run	<1%	80%	10.3%	9%
Loch Raven Watershed Total		**<1%**	**80%**	**10.3%**	**9%**

3. Geology

A simplified map of the geologic units within the Loch Raven Watershed is shown in Figure 2-3. The 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 Loch Raven Watershed, like most of the Piedmont, consists of metamorphic rock—mainly crystalline schists. These formations have moderate infiltration rates with average recharge to groundwater.

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

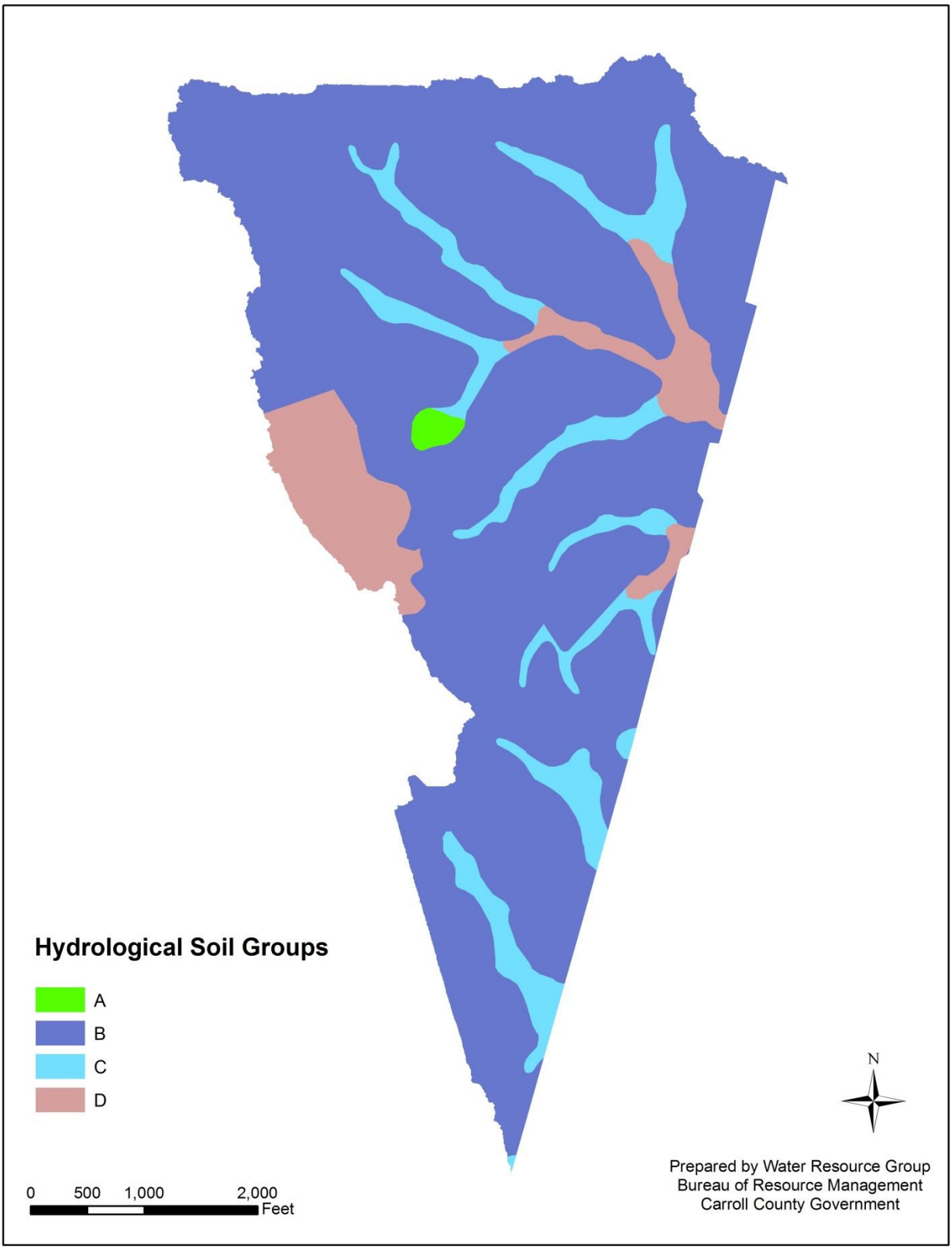

Figure 2-2: Loch Raven Watershed Hydrological Soil Groups

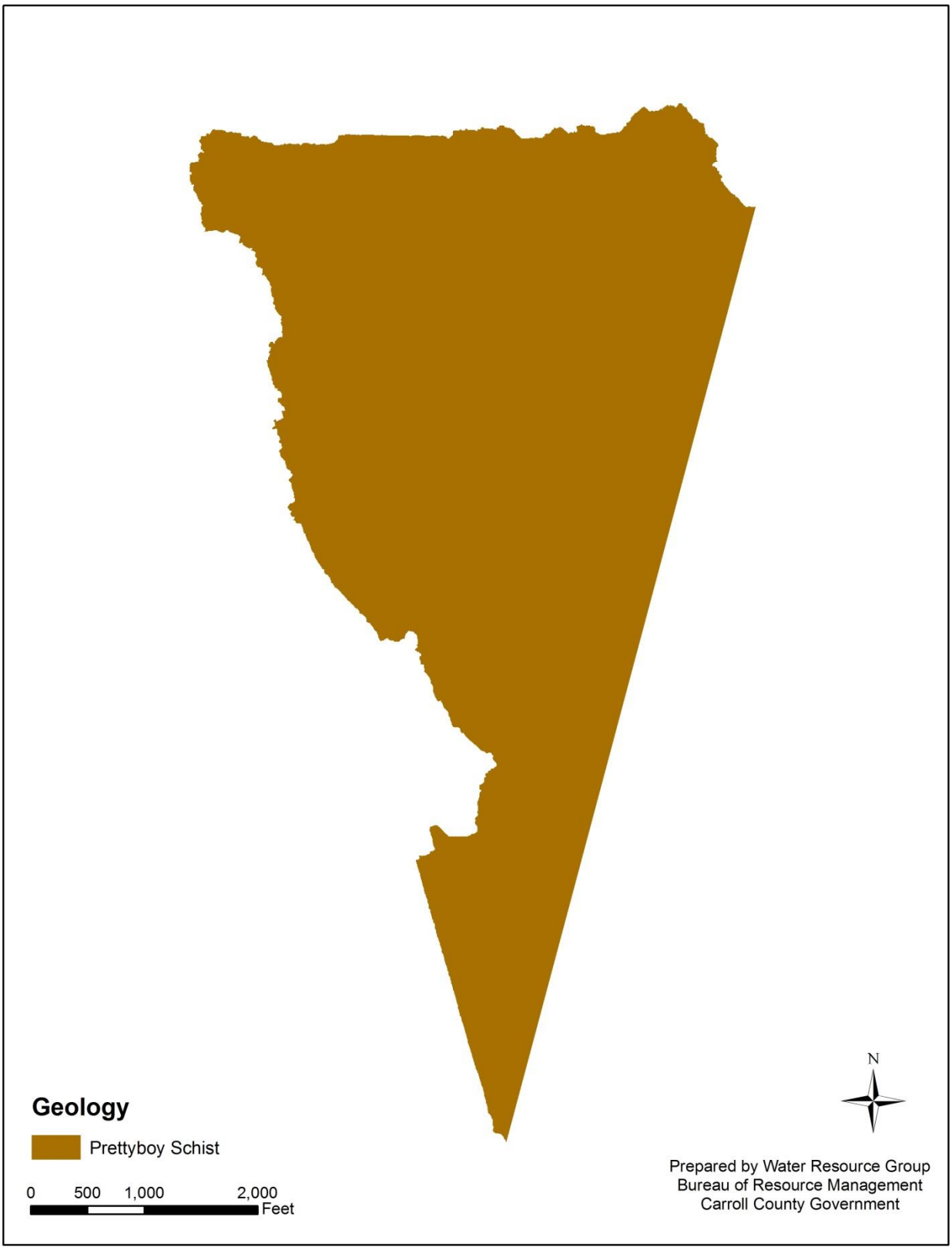

Figure 2-3: Loch Raven Watershed Geology

D. Surface Water Resources

The 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 Loch Raven Watershed, as seen in Figure 2-4, can generally be found in low-lying areas around streams. This is common of the Piedmont 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 (NWI), which covers the entire country. The second is the Maryland Department of Natural Resources (DNR) which has mapped wetlands for the State, and the third is the National Land Cover Database (NLCD). The statistical data in this report was based off of the delineations from the NLCD. Actual acreage may be greater when field verified. The estimated acreage of wetlands for the Loch Raven Watershed can be found in Table 2-3.

Table 2-3: Loch Raven Watershed Wetland Acreage

DNR 12-Digit Scale	Subwatershed	NLCD Wetland Estimates	
		Acres	%
0308	Piney Run	2	<1%
Loch Raven Watershed Total:		**2**	**<1%**

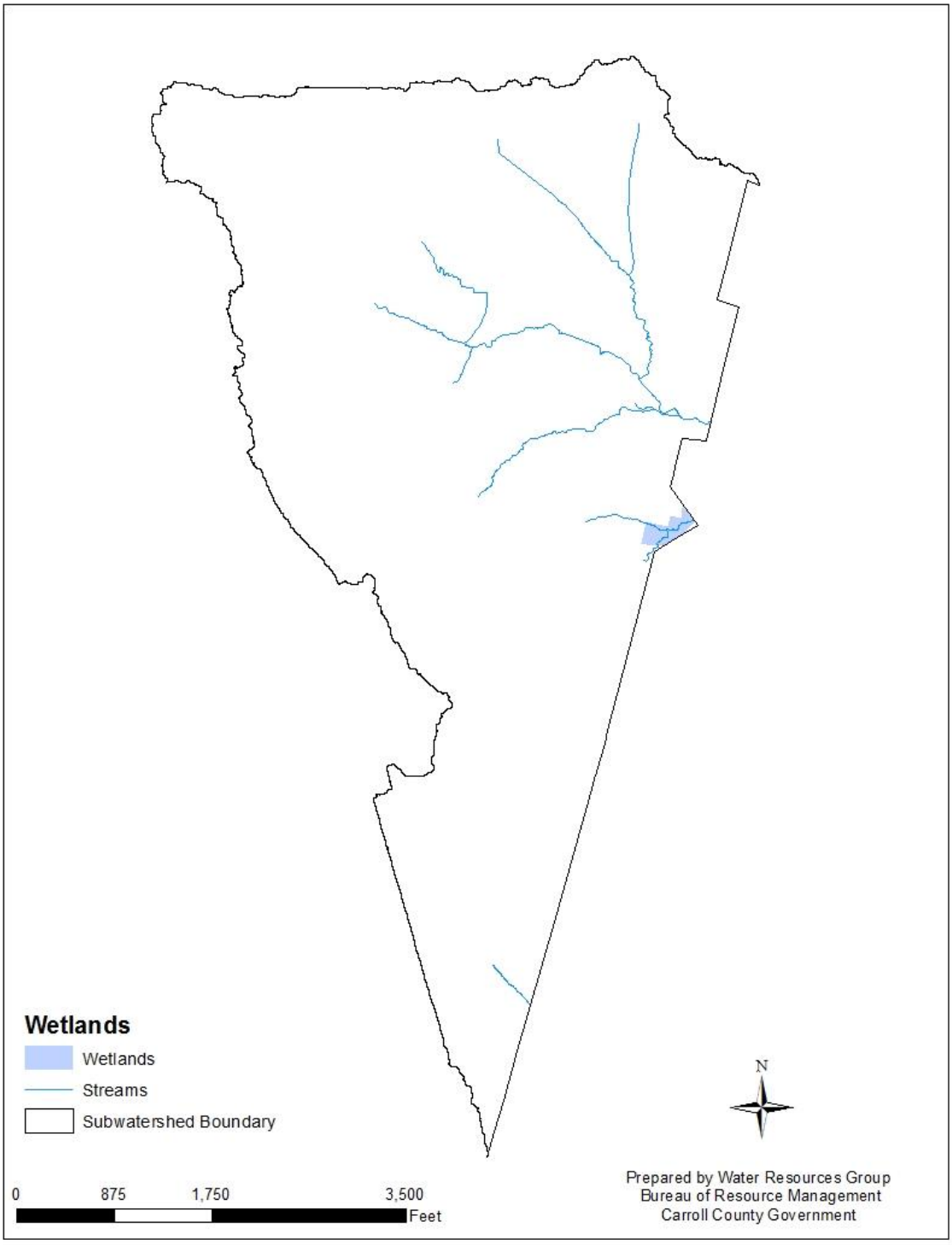

Figure 2-4: Loch Raven Watershed Wetland Acreage

2. Floodplains

A floodplain is an area of low, flat land along a stream or river that is subject to flooding. 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 stormwater runoff and minimizing non-point source pollutants. A natural floodplain will slow the velocity of water moving through a system, which allows sediment to settle and nutrients to be absorbed by the surrounding vegetation. Natural floodplains also contribute to groundwater recharge by allowing infiltration. Infiltration will reduce the frequency of low surface flows and allow for a healthier ecosystem.

Many floodplains are ideal locations for bike paths, open spaces, and wildlife conservation which will create a more appealing community. A floodplain in its natural state will provide outdoor education and scientific study.

The Loch Raven Watershed contains no floodplains that are regulated under the National Flood Insurance Program (NFIP). 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 Federal Emergency Management Agency (FEMA) 2015 effective mapped data.

3. Forest

Forests are home to many forms of life and play many essential roles environmentally including climatic regulation, carbon cycling, biodiversity preservation, and soil and water conservation. Among land cover types, the forest provides the greatest protection for soil and water quality. A healthy forest will hold soil in place which reduces runoff, conserves nutrients, and protects streams from erosion. The riparian forest or corridor directly adjacent to the stream helps to moderate stream temperatures, which in many cases can support coldwater fisheries. In addition to supplying much-needed shade for streams, the riparian forest is responsible for supplying the detritus matter to the stream, which is the natural food and energy input for streams in the Piedmont region.

a. Forest Cover

A healthy forest not only plays an important role environmentally, but it can have great aesthetic and recreational benefits as well. Larger forest blocks will provide greater benefits ecologically than smaller blocks. Typically there is less fragmentation of the landscape in a larger forest block which benefits interior dwelling species.

Loch Raven Watershed contains 38 acres of forest over multiple land uses, and covers about 6 percent of the land within the watershed. The forest cover within the Loch Raven Watershed can be found in Figure 2-5.

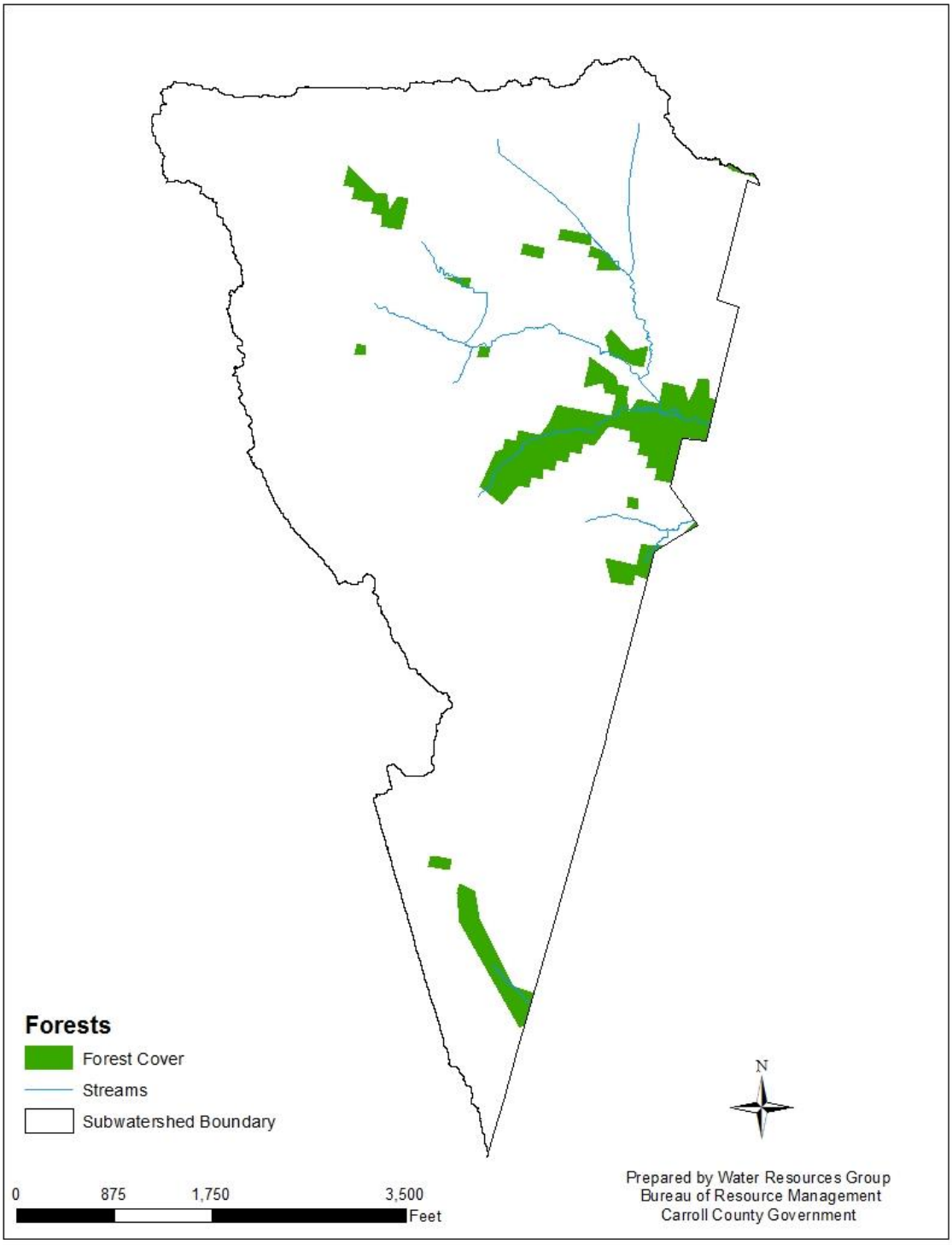

Figure 2-5: Loch Raven Watershed Forest Cover

E. Ecologically Important Areas

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 form this green infrastructure consist primarily of contiguous forest land but also may include wetlands and other naturally vegetated lands.

DNR 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 coldwater or blackwater ecosystems, or important to anadromous fish and their associated riparian forest and wetlands
- Conservation areas already protected by public and private organizations (i.e. DNR, The Nature Conservancy)

This "Green Infrastructure" provides 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 DNR, see www.dnr.maryland.gov/greenways.

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.

Within the Loch Raven Watershed there are no areas identified through the DNR Green Infrastructure project.

F. Groundwater Resources

Groundwater development potential in Carroll County is limited to the aquifer type of that 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).

The ease at which groundwater moves through an aquifer in response to a water table gradient is indicated by aquifer transmissivity. 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 restrict withdrawal rates.

To obtain satisfactory 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. 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 out particulate matter, but natural occurring contaminants such as iron and manganese, as well as human induced contaminants like chemicals and oil, are easily dissolved and can be transmitted via groundwater to surface water bodies. Since the underlying rocks have varying porosity and permeability characteristics, water quality will also vary greatly.

III. Human Characteristics

The following chapter will discuss the human characteristics of the watershed and how these modifications could possibly impact the natural ecosystem. This chapter will examine the general land use and land cover of the watershed as well as the specific human modifications like impervious surface cover, stormwater systems, drinking water, and wastewater systems.

A. Population

The natural landscape of the Loch Raven Watershed has been modified for human use over time. This modification has the potential to degrade both the terrestrial and aquatic ecosystems. The Loch Raven Watershed currently has an estimated population of 2,955 persons; one person for every 0.20 acres, with approximately 2,779 residing within the town limits of Hampstead. The population density outside of the municipalities equates to about one person for every 1.48 acres.

B. Land Use and Land Cover

As the land use of a watershed is modified over time it will ultimately influence the water quality within that watershed. Natural landscapes, like forests and grasslands allow for infiltration of stormwater while absorbing excess nutrients. Unmanaged impervious surfaces don't allow for infiltration, causing stormwater to concentrate. The increased runoff velocity will de-stabilize stream banks, causing potential sedimentation problems downstream. Within the Loch Raven watershed, agriculture is the dominant land cover at about 43 percent of the total land, followed by low-density mixed urban which accounts for 21 percent, and low-density residential, which accounts for about 20 percent of the total land cover.

The following table, Table 3-1 shows the land cover data for the Loch Raven watershed as of 2016, as well as the changes in land cover over time since 2001.

Table 3-1: Loch Raven Watershed Baseline and Current Land Cover

Land Use	Acres 2001	Percent 2001	Acres 2006	Percent 2006	Acres 2011	Percent 2011	Acres 2016	Percent 2016
Open Water	0	0%	0	0%	0	0%	1	<1%
Low-Density Residential	135	23%	137	23%	147	25%	121	20%
Low-Density Mixed Urban	95	16%	98	17%	119	20%	127	21%
Medium-Density Mixed Urban	36	6%	39	7%	39	7%	42	7%
High-Density Mixed Urban	9	2%	9	2%	9	2%	10	2%
Forest	26	4%	25	4%	23	4%	38	6%
Shrub/Scrub	6	1%	6	1%	6	1%	2	0%
Grassland	0	0%	0	0%	0	0%	0	0%
Pasture/Hay	52	9%	52	9%	51	9%	76	13%
Cropland	229	39%	222	37%	195	32%	175	30%
Wetland	4	<1%	4	<1%	3	<1%	2	<1%

C. Impervious Surfaces

An increase in impervious surface cover within a watershed alters the hydrology and geomorphology of streams, resulting in increased loadings of nutrients, sediment, and other contaminants to the stream (Paul and Meyer, 2001).

The Loch Raven Watershed is estimated to have 109.25 acres of total impervious within the catchment and accounts for approximately 18.5 percent of the total land area. The impervious surface area and percentage within Loch Raven can be found in Table 3-2 and is shown in Figure 3-2.

Table 3-2: Loch Raven Watershed Estimated Impervious Surface Area

DNR 12-digit Scale	Subwatershed	Acres	Impervious Acres	Percent Impervious
0308	Piney Run	592	109.25	18.5%
Loch Raven Watershed		**592**	**109.25**	**18.5%**

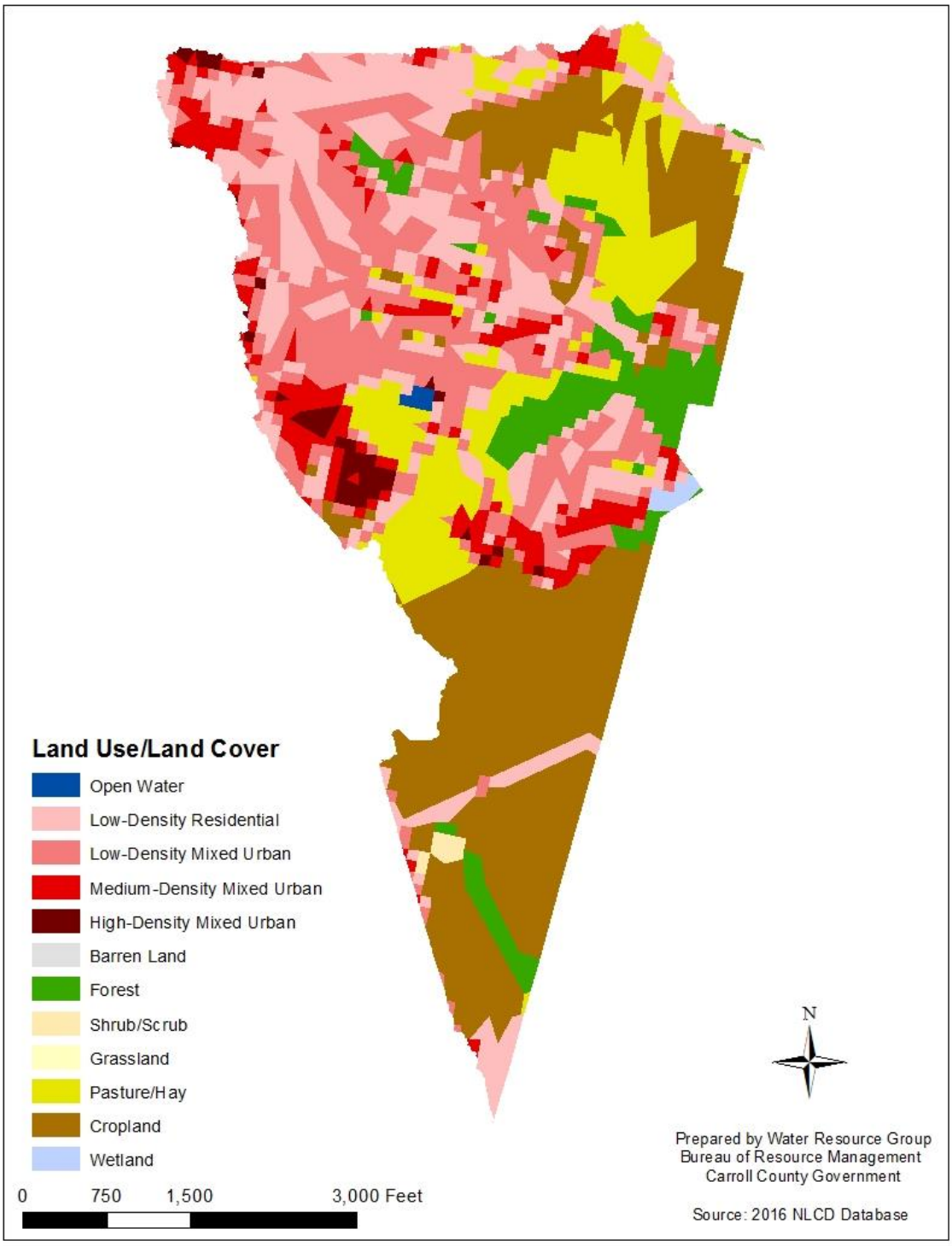

Figure 3-1: Loch Raven Watershed Land Use/Land Cover

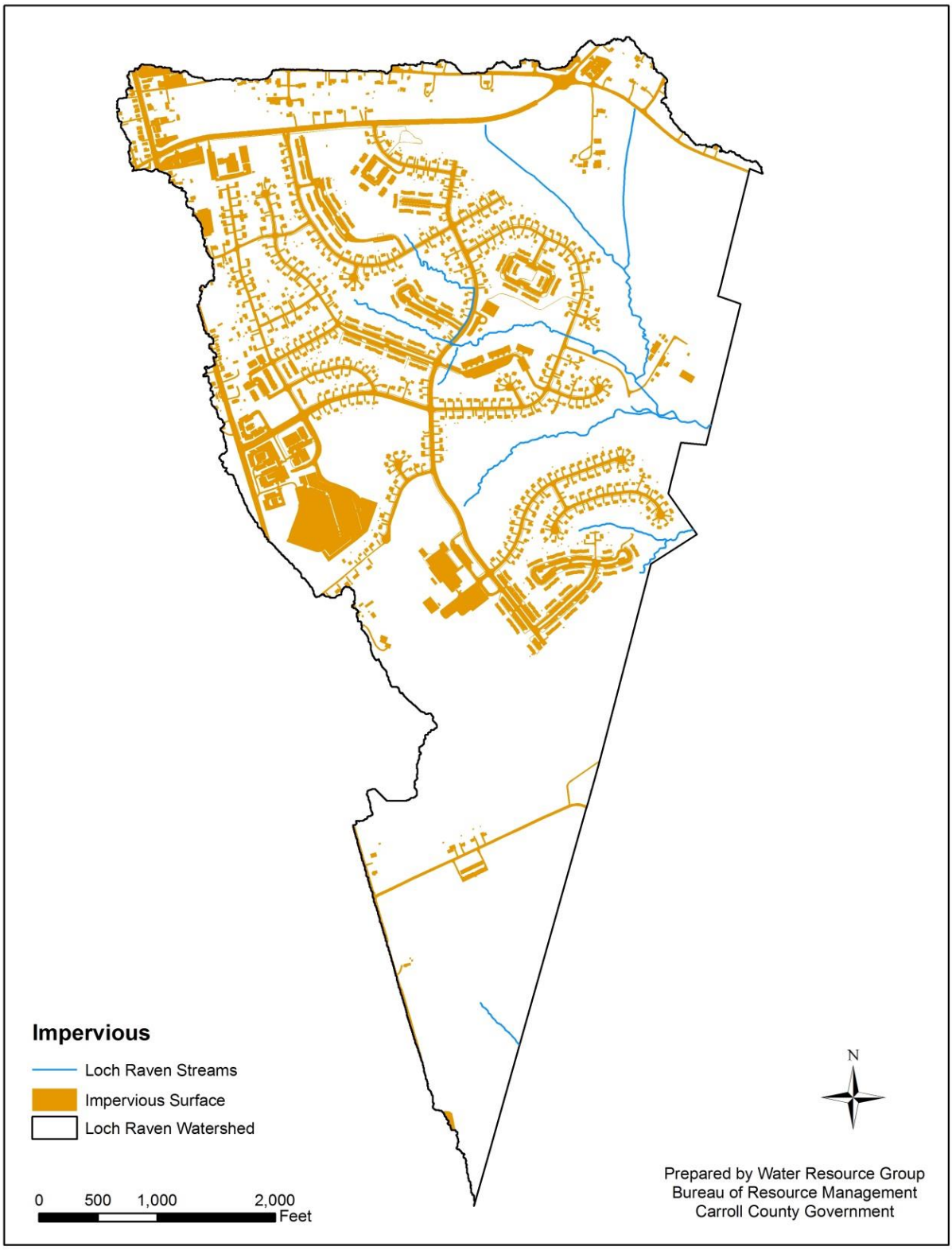

Figure 3-2: Loch Raven Watershed Impervious Surface Area

D. 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. PFAs are existing communities and locations where state funding for future growth will be designated. Within the Loch Raven Watershed the town of Hampstead is a designated PFA. These designated areas have specific boundaries and are the focal point for employment, social, and commercial activity within the watershed. Figure 3-3 shows the designated PFAs within the Loch Raven 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 Loch Raven Watershed can be found in Figure 3-4. Carroll County does not regulate zoning within the municipalities; the majority of the Loch Raven Watershed outside of the corporate boundary of Hampstead is zoned residential (71%).

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 Loch Raven Watershed there are 34 parcels remaining with potential development on 146 acres for an estimated lot yield of 281 (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/compplan/bli/. Figure 3-5 shows the remaining parcels in Loch Raven Watershed where residential units could be built.

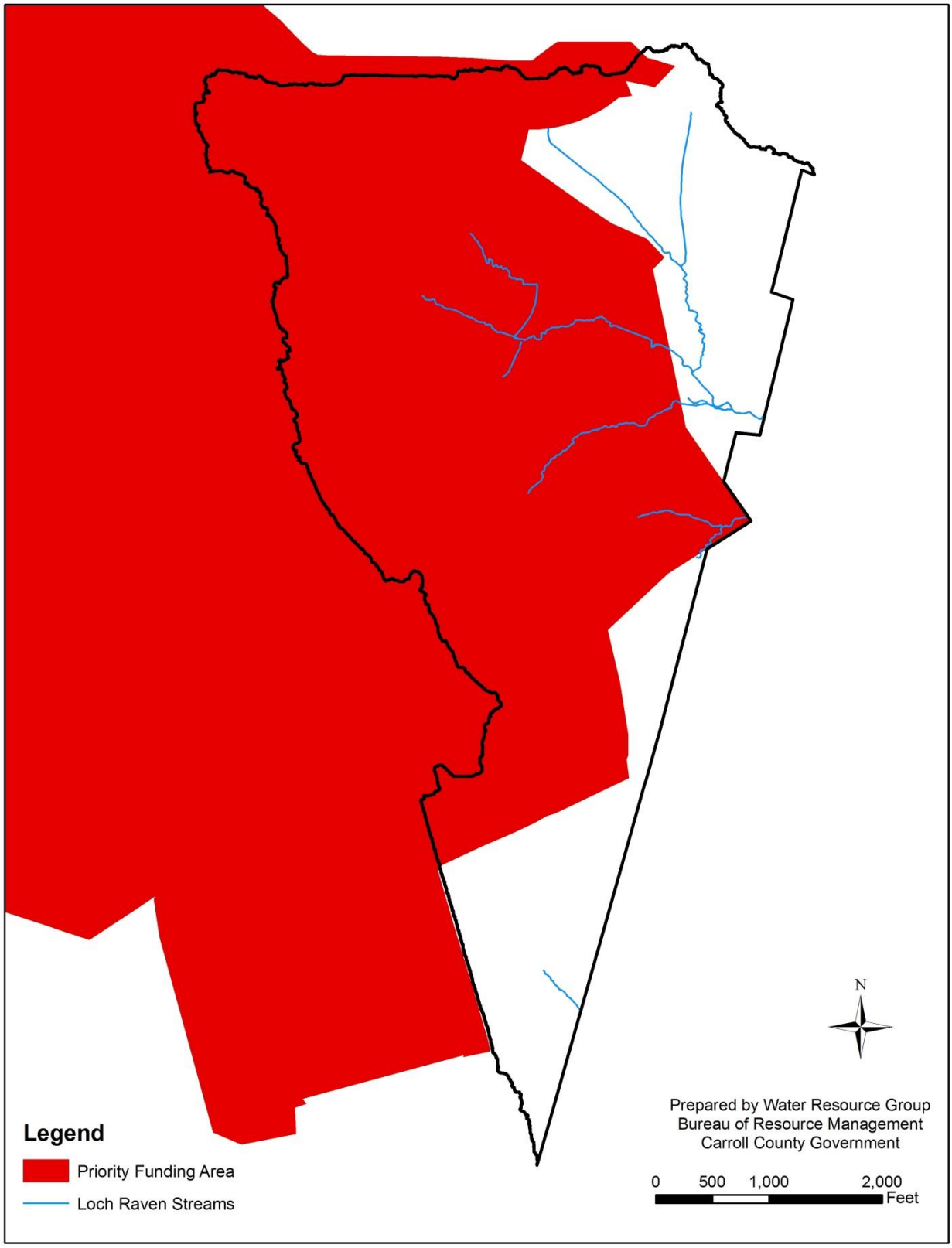

Figure 3-3: Loch Raven Watershed Priority Funding Areas

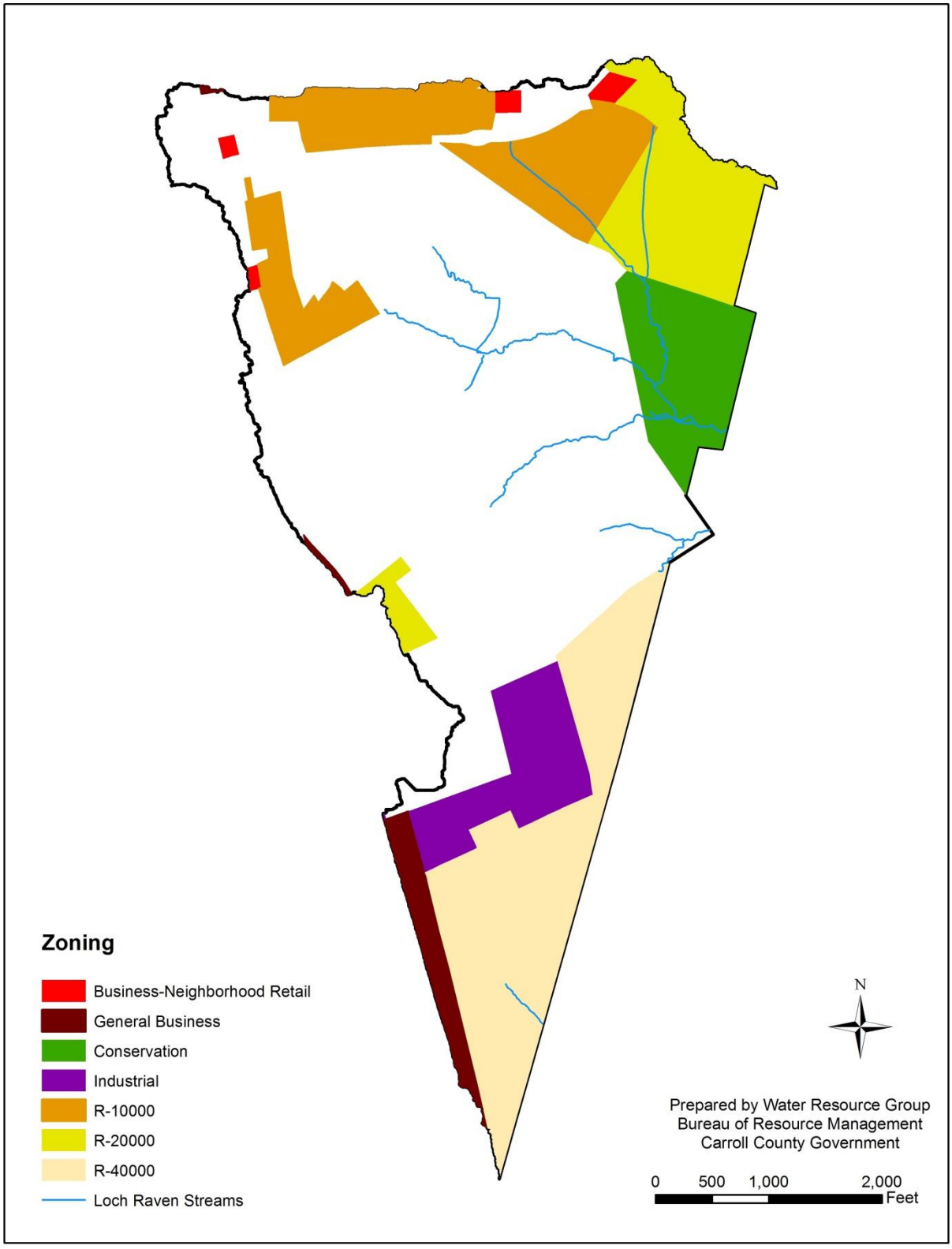

Figure 3-4: Loch Raven Watershed Zoning

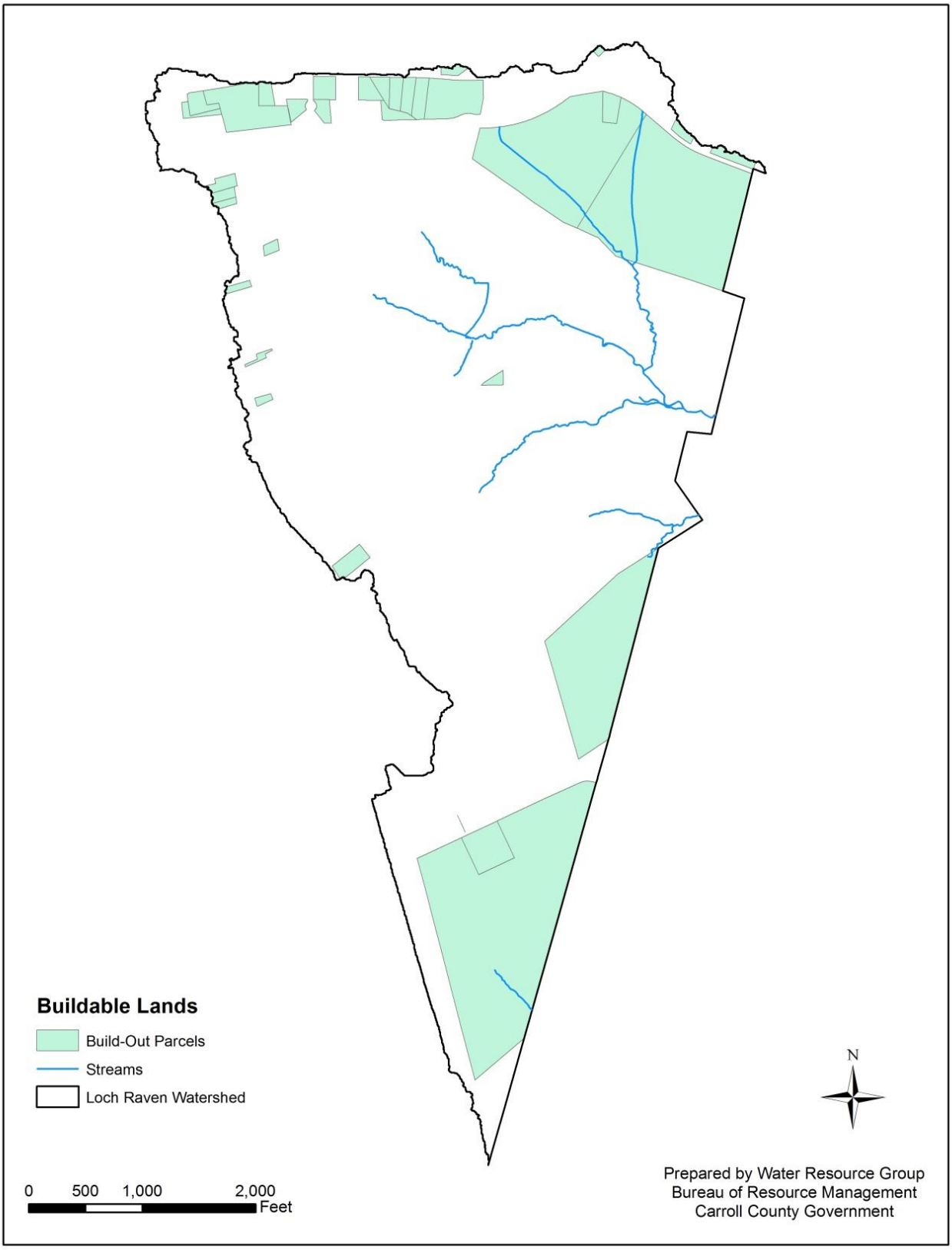

Figure 3-5: Loch Raven Watershed Build Out Parcels

E. Stormwater

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

1. Stormwater Management Facilities

In the 1980's, the State of Maryland required stormwater management for new development to manage the quantity of runoff. These requirements were initially put in place to treat subdivisions with less than 2 acre lots. For lots greater than 2 acres, stormwater management was only required to address road runoff. In 2000 Maryland Department of Environment (MDE) released a new design manual for stormwater which required greater water quality and quantity controls and included stormwater management for subdivisions with lots greater than 2 acres.

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 the initial dry pond design has the lowest pollutant removal efficiency and was designed to control water quantity. In total there are 17 existing stormwater management facilities within the Loch Raven Watershed, with the majority being located within the town boundaries of Hampstead. Table 3-3 lists the facility type, number of structures, and associated drainage acreage of the structures. Appendix A lists the subwatershed location, facility type, drainage area, and facility name along with a definition of each facility and the pollutant removal capability. Figure 3-6 shows the location of the stormwater management facilities in the Loch Raven watershed.

2. Storm Drain Systems

A storm drainage system will consist of either contoured drainage swales or a curb and gutter system with inlets and associated piping. Both systems function to quickly remove water from impervious areas in order to prevent flooding, but they have varying effects on water quality. The curb and gutter system directly connects to the stream through its piping network and delivers increased volumes of water as well as untreated pollutants from the connected impervious surface. Contoured drainage swales do not move water as efficiently as the curb and gutter system which allows for filtration of some pollutants, and infiltration, reducing the amount of water delivered to the stream. The storm drain network in the County has been mapped as part of requirements of the MS4 NPDES permit (Figure 3-7).

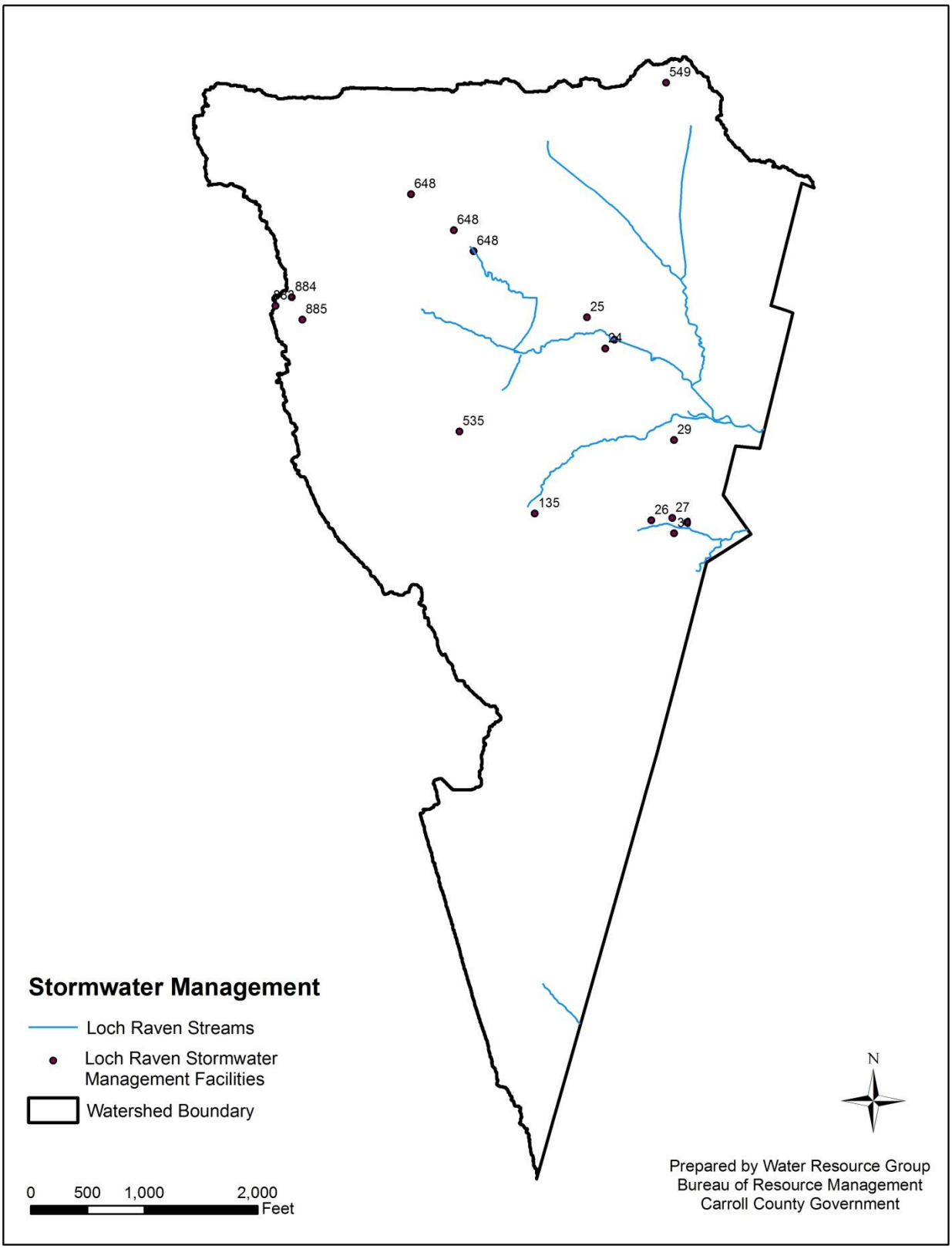

Figure 3-6: Stormwater Management Facilities

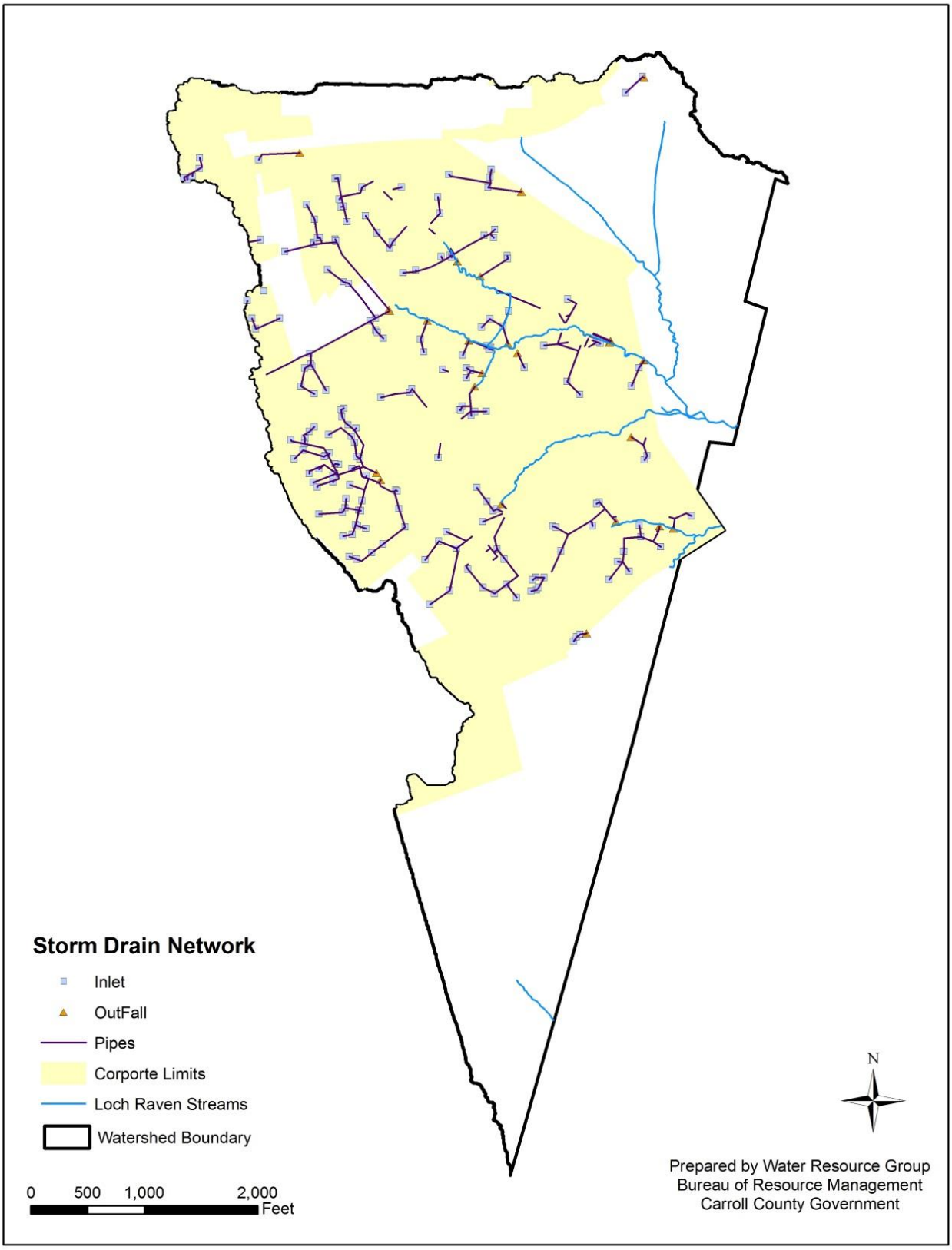

Figure 3-7: Loch Raven Storm Drain Network

Table 3-3: Loch Raven Watershed Stormwater Facility Types

Facility Type	Number of Structures	Drainage Area
Dry Detention	3	31.2
Infiltration Facility	8	26.12
Extended Detention	2	14.8
Retention Facility	1	47.2
Detention	3	36.0

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

F. Drinking Water

Safe drinking water is fundamentally important to support human and livestock populations within a watershed. Within the Loch Raven Watershed drinking water comes from two main sources: public water systems and private wells.

1. Wellhead Protection Areas

Wellhead protection areas defined under the Safe Drinking Water Act are surface and subsurface regulated land areas around public drinking water wells or well fields that prevent contamination of that water supply. Ideally, a wellhead protection area will encompass the entire potential recharge area for that well. Wellhead protection areas within the Loch Raven Watershed are shown in Figure 3-8.

2. Water Supply

The majority of the residents within the Loch Raven Watershed obtain their water from the town of Hampstead's public works department. (There are only about 37 private water wells within the watershed.) Since the underlying geology within the Loch Raven Watershed consists mainly of crystalline metamorphosed rock, the associated water withdrawals from these wells come from an unconfined aquifer. The fractured rock of the Piedmont physiographic region allows surface water to pass through the soil and into the underlying rock fractures; therefore, the source of the water is locally derived.

3. Public Water Service Area

Within the Loch Raven Watershed the town of Hampstead provides residents with public water; Hampstead currently has 18 production wells appropriated. A water use appropriation is required for any entity withdrawing more than 10,000 gallons a day from a single source. Appropriations are determined by MDE's Water Supply Program and are necessary to conserve and protect this vital resource for the residents of the State of Maryland. At any given time these wells could be either online or offline depending on maintenance and demand. Hampstead sits along the topographical watershed divide and obtains their water from community wells located in the Loch Raven Watershed as well as the Liberty Reservoir and Prettyboy Reservoir Watersheds. The community well locations and associated public service area is shown in Figure 3-8.

4. Baltimore Water Supply Drainage Area

The surface water resources within the Loch Raven Watershed drain entirely to the Loch Raven Reservoir, which is part of the drinking water supply for the greater Baltimore metropolitan area. Carroll County is a member of the Reservoir Technical Group (RTG); the RTG includes technical staff from many jurisdictions within the greater Baltimore metropolitan area, and is charged with coordinating the implementation of the Baltimore Reservoir Watershed Management Agreement, signed in 1984. The ultimate goal of the Baltimore Reservoir Watershed Management Program is to ensure the quality of untreated "raw" water in each of the three reservoirs, minimizing the cost of treating raw water in order to meet drinking water standards.

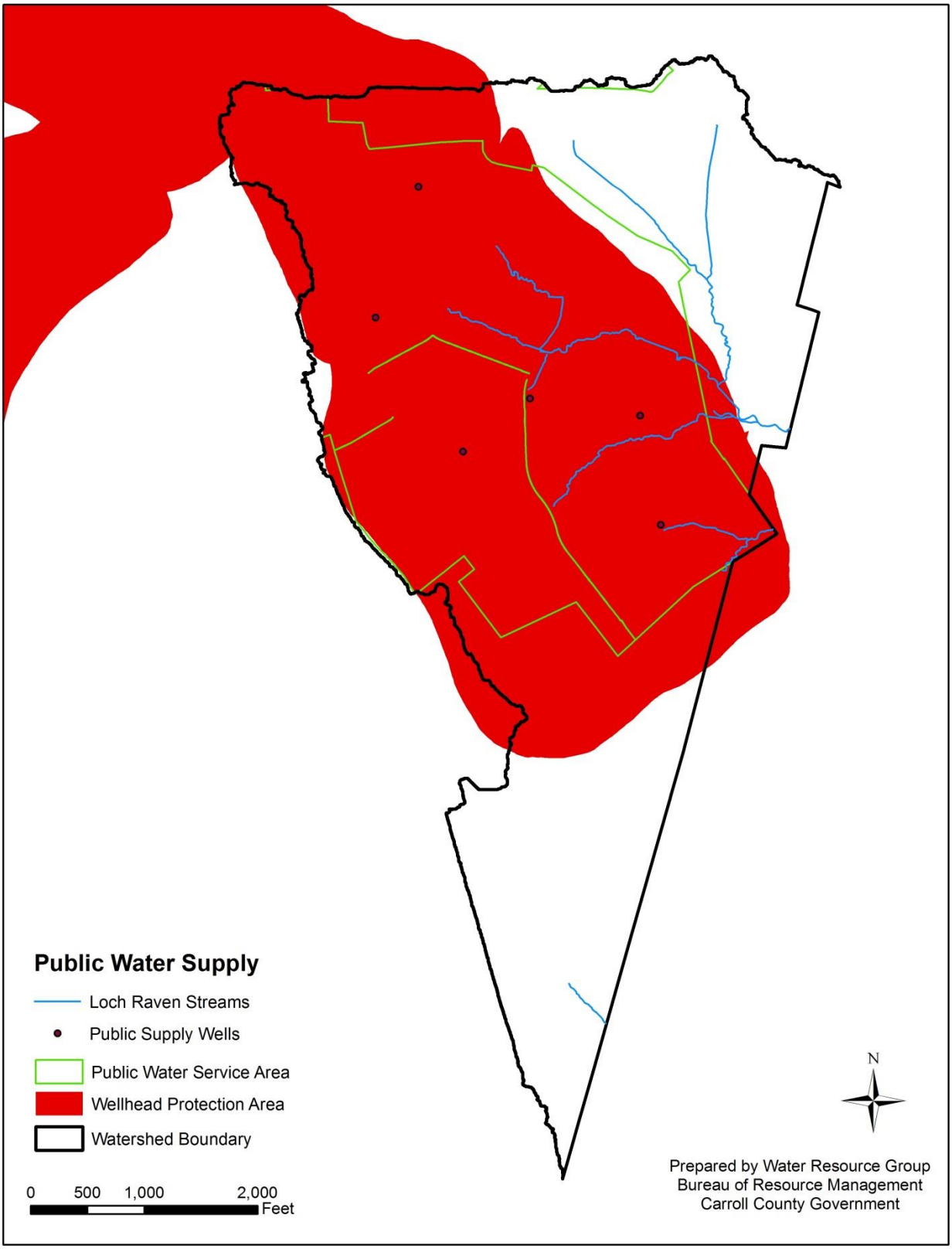

Figure 3-8: Loch Raven Public Water Supply

G. Wastewater

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

1. Public Wastewater Service Area

The public service area conveys wastewater through a piping system from residences and businesses to a treatment facility prior to discharge. Each hookup to the sewer line has a clean-out in which the private landowner is responsible for maintaining. The main part of the system consists of gravity flow lines with manholes for access, pumping stations, and force mains. The public utility is responsible for maintenance on the main part of the wastewater system. Within the Loch Raven Watershed there are approximately 1,200 homes utilizing public service and about 5 homes that are within the area slated for future service. Figure 3-9 shows the public wastewater service area for the Loch Raven Watershed.

2. Wastewater Discharge Locations

Within the Loch Raven Watershed the town of Hampstead is serviced through a public wastewater system. Hampstead's wastewater treatment plant is also located within the Loch Raven Watershed, where it discharges effluent into Western Run. The Hampstead WWTP provides advanced secondary treatment of domestic wastes using an activated sludge treatment process; planning is currently underway to upgrade the plant to enhanced nutrient removal (ENR). Hampstead's wastewater treatment plant also collects wastewater from the town's service area located within Liberty and Prettyboy Watersheds.

3. On-Site Septic Systems

On-site septic systems are the main source of waste disposal in rural areas. When maintained and functioning properly, on-site septics are effective at treating nitrogen. (Phosphorus binds with soil particles and is not considered an issue.) Improved treatment of nitrogen can be achieved by making sure the leach field is properly located to prevent effluent from directly entering a body of water; however, when these systems fail or are inadequately maintained, excessive nutrients and bacteria can be released, which causes degradation of the groundwater and nearby aquatic systems. There are currently about 36 septic systems within the Loch Raven Watershed.

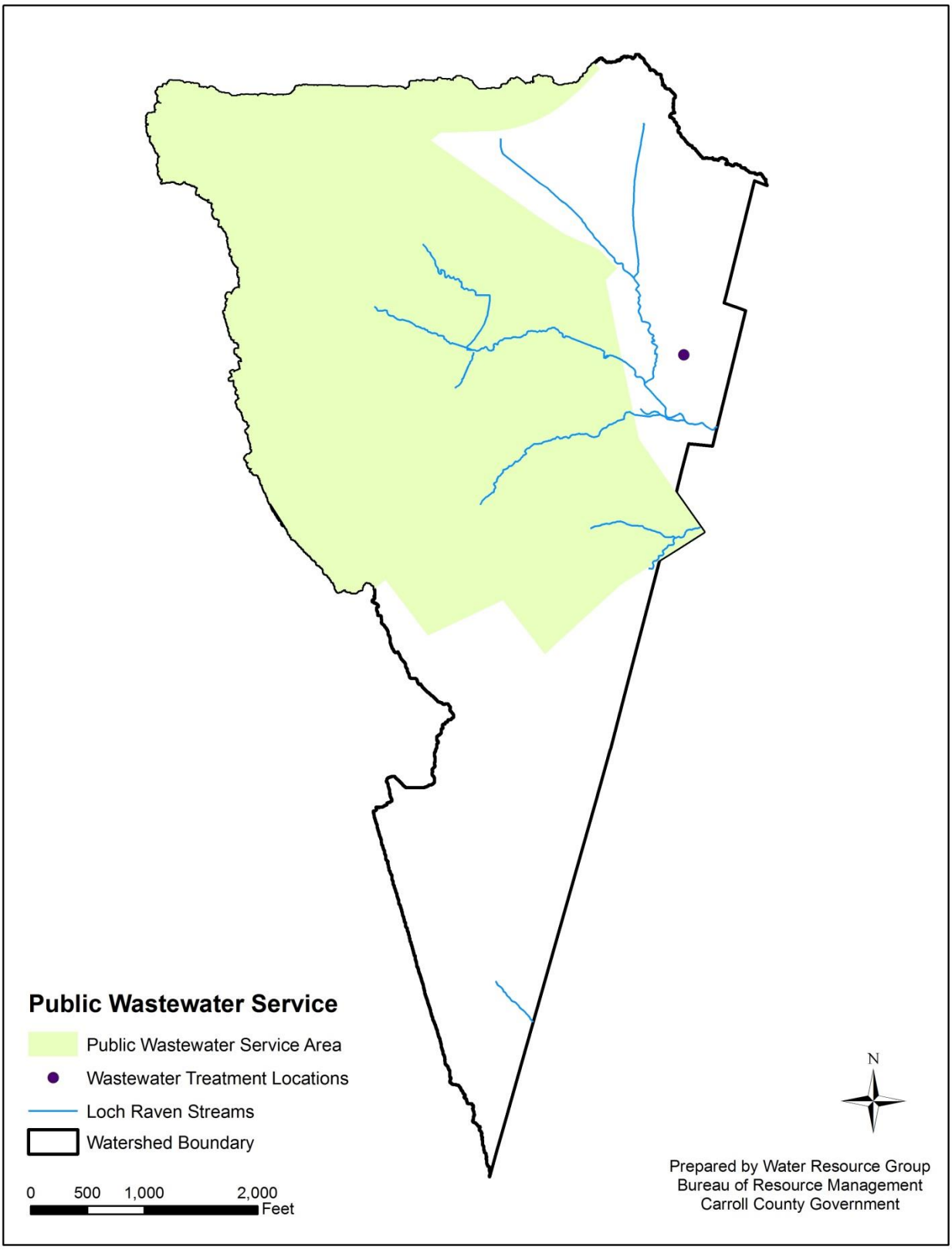

Figure 3-10: Loch Raven Wastewater Service Area

H. NPDES Point Sources

Any facility that discharges wastewater or introduces pollutants into the watershed, whether it is industrial or municipal, must obtain a National Pollutant Discharge Elimination System (NPDES) permit. Table 3-4 shows a list of NPDES permits within the Loch Raven Watershed (information obtained from epa.gov).

Table 3-4: NPDES Permits in Loch Raven Watershed

Permit Holder	Permit Number	Permit Type	Subwatershed	Status
Hampstead WWTP	MD0022446	WMA2	Western Run	Effective
Hampstead WWTP	MDR000666	WMA5	Western Run	Expired

I. Protected Lands

The protection of land ensures that non-urban land uses remain protected over time. These lands are preserved through various programs and the extent of "protection" can vary greatly from one property to the next. Preserved and protected lands include areas such as open space or parks as well as areas that are preserved for agriculture. Protected lands may be preserved through direct public ownership or public or private easement acquisition.

Table 3-5 lists the type of protected lands within the Loch Raven Watershed along with the representative acreage. Just over 100 acres (17%) of the total land area within Loch Raven has some sort of protection associated with the land. Agricultural easements have the highest percentage of protection within the watershed at 11 percent, with about 58 acres preserved. Figure 3-10 shows where the protected areas are located within the Loch Raven Watershed.

Table 3-5: Protected Lands in Loch Raven Watershed

Type of Protection	Acres	Percentage
Agricultural Easement	58.34	11.0%
Open Space and Parks	40.1	6.8%
Forest Conservation Easement	4.32	<1%
Water Resource Easement	0	0
Floodplain Easement	0	0
Total	**102.76**	**17.4%**

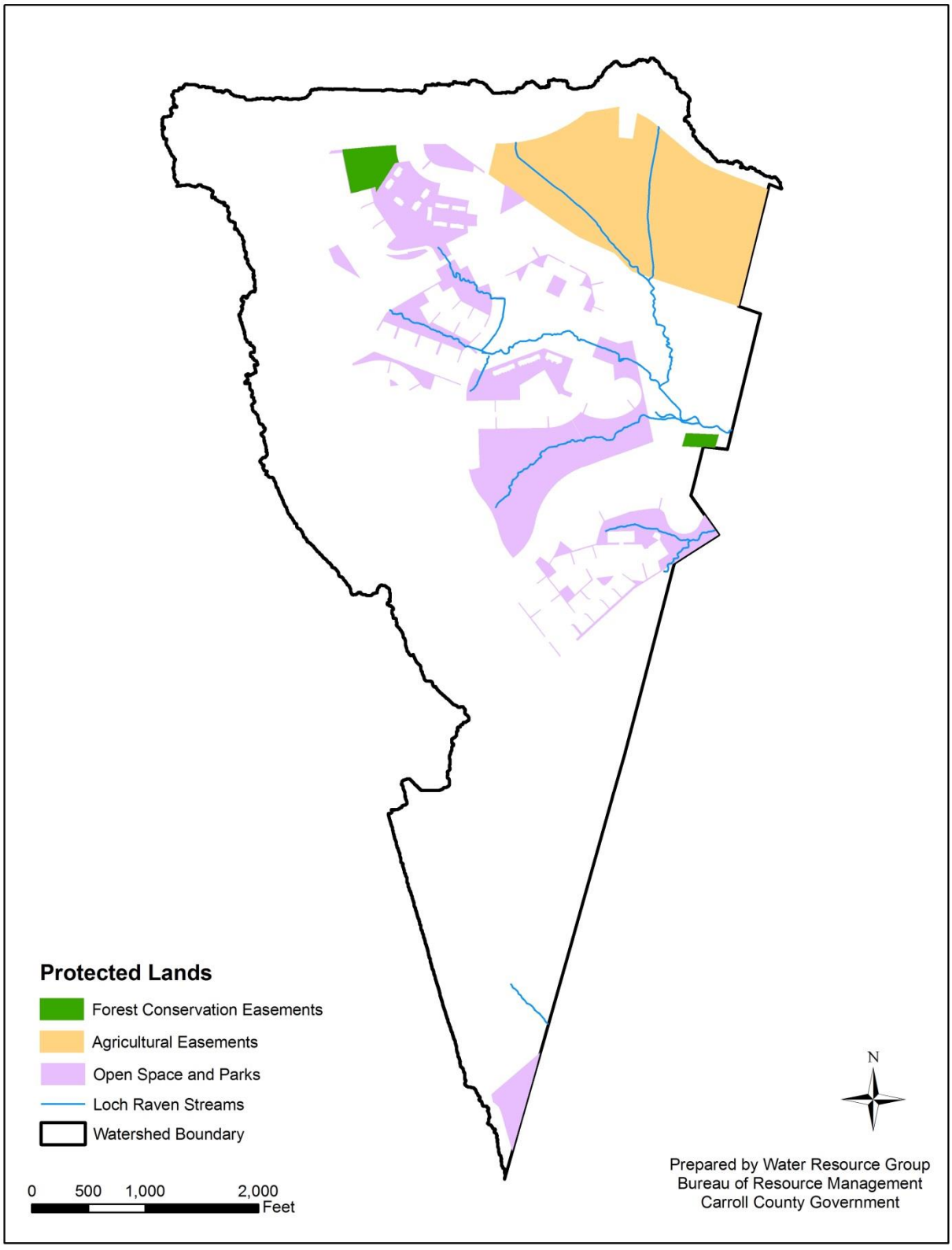

Figure 3-10: Loch Raven Protected Lands

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 Loch Raven watershed lies within the Upper Patapsco Rural Legacy area and encompasses 218 acres (37%) of the Loch Raven watershed. The extent of the Rural Legacy Area within Loch Raven can be found in 3-11.

J. Agricultural Best Management Practices

Agricultural best management practices (BMPs) are on-the-ground practices that help minimize runoff and the delivery of pollutants into our waterways. Practices can be categorized as soft BMPs such as streambank fencing and cover cropping or hard BMPs like heavy use areas and waste storage structures. Appendix B lists the agricultural BMPs located in the Loch Raven Watershed as of summer 2014 and provides a detailed explanation of the types of practices used throughout Carroll County.

1. Farm Plan Acres

Farm plans consist of a combination of agronomic and engineered management practices that protect and properly utilize natural resources in order to prevent deterioration of the surrounding soil and water. A farm plan is written for each individual operation and dictates the management practices that are necessary to protect and improve soil and water quality. Nutrient management is prescribed as part of the farm plan and assists the operator with managing the amount, timing, and placement of nutrients in order to minimize nutrient loss to the surrounding bodies of water while maintaining optimum crop yield. There are currently no farm plans within the Loch Raven Watershed.

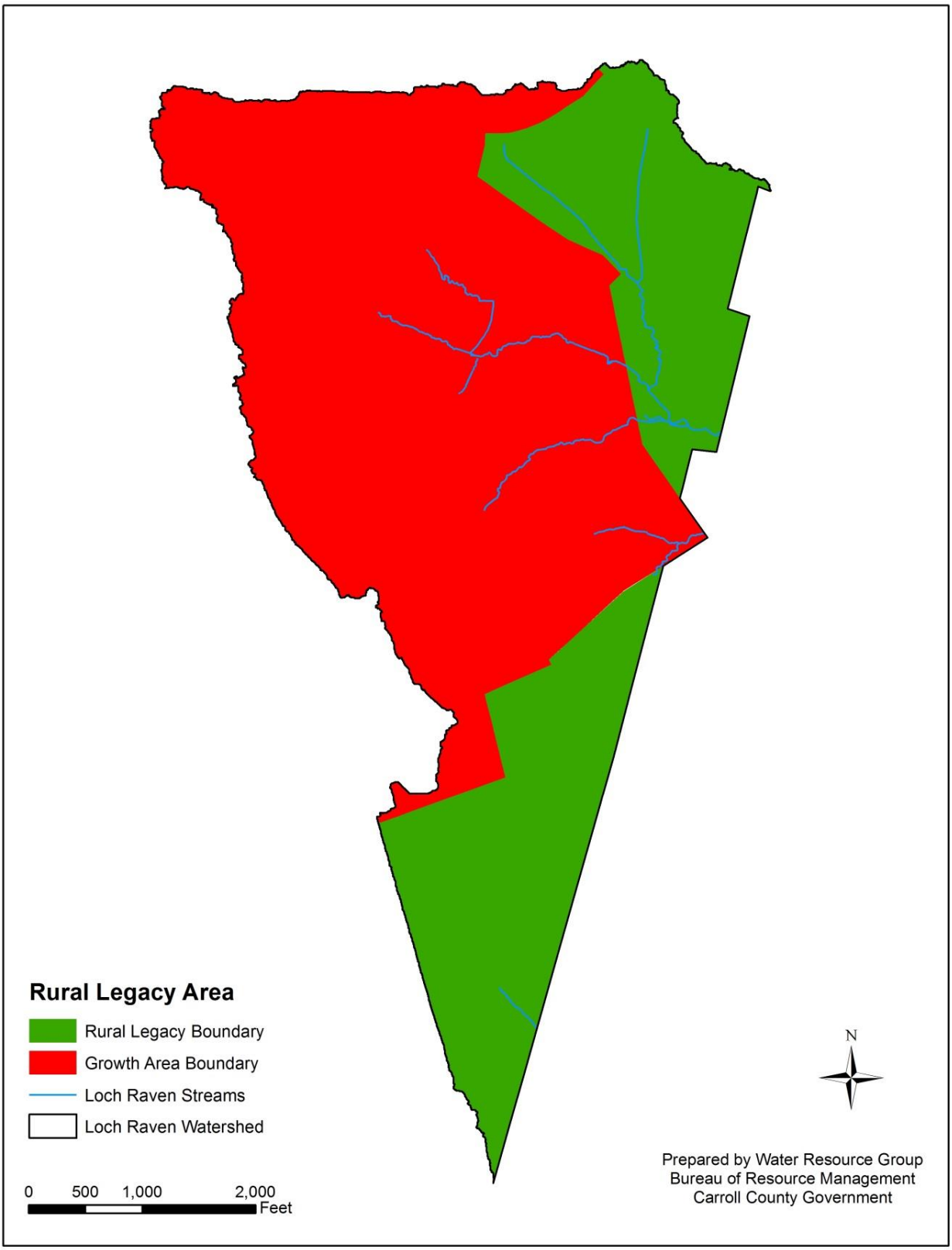

Figure 3-11: Upper Patapsco Rural Legacy Area

IV. Water Quality

A. Introduction

Maryland water quality standards have been adopted per 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 the beneficial uses of water bodies such as fishing, aquatic life, drinking water supply, boating, water contact recreation as well as terrestrial wildlife that depend on water. Local monitoring allows documentation of the status of local water bodies and indicates where restoration or mitigation may be needed. This chapter will discuss the designated uses within Loch Raven, 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 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.

The entire portion of the Loch Raven Watershed within Carroll County is designated as use III-P, Non-tidal Cold Water and Public Water Supply. The use III-P is capable of growing and propagating trout, but may not be 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 Loch Raven Watershed there are no Tier II designations.

D. Total Maximum Daily Loads (TMDLs)

Impaired waters are streams and other water bodies that are unable to meet their designated use as defined by the Code of Maryland Regulations. Impaired waters are placed on the State's 303(d) list, which is a section of the Clean Water Act that tracks impaired and threatened water bodies.

MDE uses the 303(d) list of impaired waters to establish Total Maximum Daily Loads (TMDLs). 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 water body may have multiple TMDLs. TMDLs are calculated by adding the sum of the allowed pollutant loads for point sources, non-point sources, and 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.

TMDLs for the Loch Raven Watershed are summarized below. More information on TMDLs 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 Loch Raven Watershed that have been assigned a TMDL: bacteria and phosphorus.

a. Bacteria

The current estimated stormwater baseline load for bacteria within the Carroll County portion of Loch Raven watershed was determined by (MDE, 2008) to be 5,140 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 125 billion MPN/year, which is a reduction of 5,015 billion MPN/year (98%) 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, 2008). Table 4-1 outlines the bacteria baseline and TMDL for the Carroll County portion of the Loch Raven Watershed.

Table 4-1: Loch Raven 8-digit Watershed Bacteria TMDL

Subwatershed	WGP0050		Percent Reduction
Jurisdiction	Baseline (Billion MPN/yr)	TMDL (Billion MPN/yr)	
Carroll County	426	21	95%
Hampsted	4,714	104	98%
Total	**5,140**	**125**	**98%**

b. Phosphorus

The current estimated stormwater baseline load for Carroll County as determined by MDE TMDL Data Center is 472 lbs. /yr., the TMDL for the stormwater WLA was determined to be 401 lbs. /yr., which is a reduction of 71 lbs. /yr. (15%) from the current loading (Table 4-2). This stormwater WLA is an aggregate of the municipal and industrial stormwater, including the loads from construction activity. Estimating a load contribution from the stormwater Phase I and II sources is imprecise, given the variability in sources, runoff volumes, and pollutant loads over time (MDE, 2006).

Table 4-2: Loch Raven 8-digit Watershed Phosphorus TMDL

Subwatershed	WGP0050		Percent Reduction
Jurisdiction	Baseline (lbs./yr)	TMDL (lbs./yr)	
Carroll County	472	401	15%
Total	**472**	**401**	**15%**

The purpose of phosphorus reductions is to reduce high chlorophyll a (Chla) concentrations that reflect excessive algal blooms and to maintain dissolved oxygen (DO) at a level supportive of the designated uses for Loch Raven Reservoir. The TMDLs are based on average annual total phosphorus loads for the simulation period 1992-1997, which includes both wet and dry years, and thus takes into account a variety of hydrological conditions. Phosphorus remains as the only nutrient TMDL within the watershed and has been determined by MDE to be the limiting nutrient. If phosphorus is used up or removed, excess algal growth within the system will cease.

E. Water Quality 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 does not currently have a monitoring location in the Loch Raven watershed. The Bureau monitors one location within the Gunpowder river segment and is located within the Prettyboy reservoir watershed. The Whispering Valley site, shown in Figure 4-1, is located within the South Branch Gunpowder Falls

subwatershed, and is almost entirely within the corporate limits of the Town of Manchester.

The current facility is a dry detention pond that was built in 1983 for the Whispering Valley subdivision, and is scheduled to be retrofitted to a sand filter in FY17. The Whispering Valley location is primarily residential, which encompasses 84% of the land use. The drainage area to the monitoring site is approximately 95 acres, of which, 19 acres or 20% is impervious.

Bi-weekly monitoring at the Whispering Valley site began in January of 2015 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 Whispering Valley site can be found in Table 4-3. Additional monitoring at this location includes geomorphic channel surveys as well as spring macro-invertebrate collection, which are based upon protocols set by Maryland's MBSS program (Stranko et al, 2014).

Table 4-3: Water Quality Parameters and Methods

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

[1] Due to the relative short holding time and complexity of the Bureau's retrofit monitoring program, bacteria is not included as part of the bi-weekly data collection. The Bureau has been performing monthly bacteria trend monitoring in conjunction with Baltimore County in the Liberty reservoir watershed since 2012. The program was recently expanded to the Prettyboy Watershed in August of 2015.

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

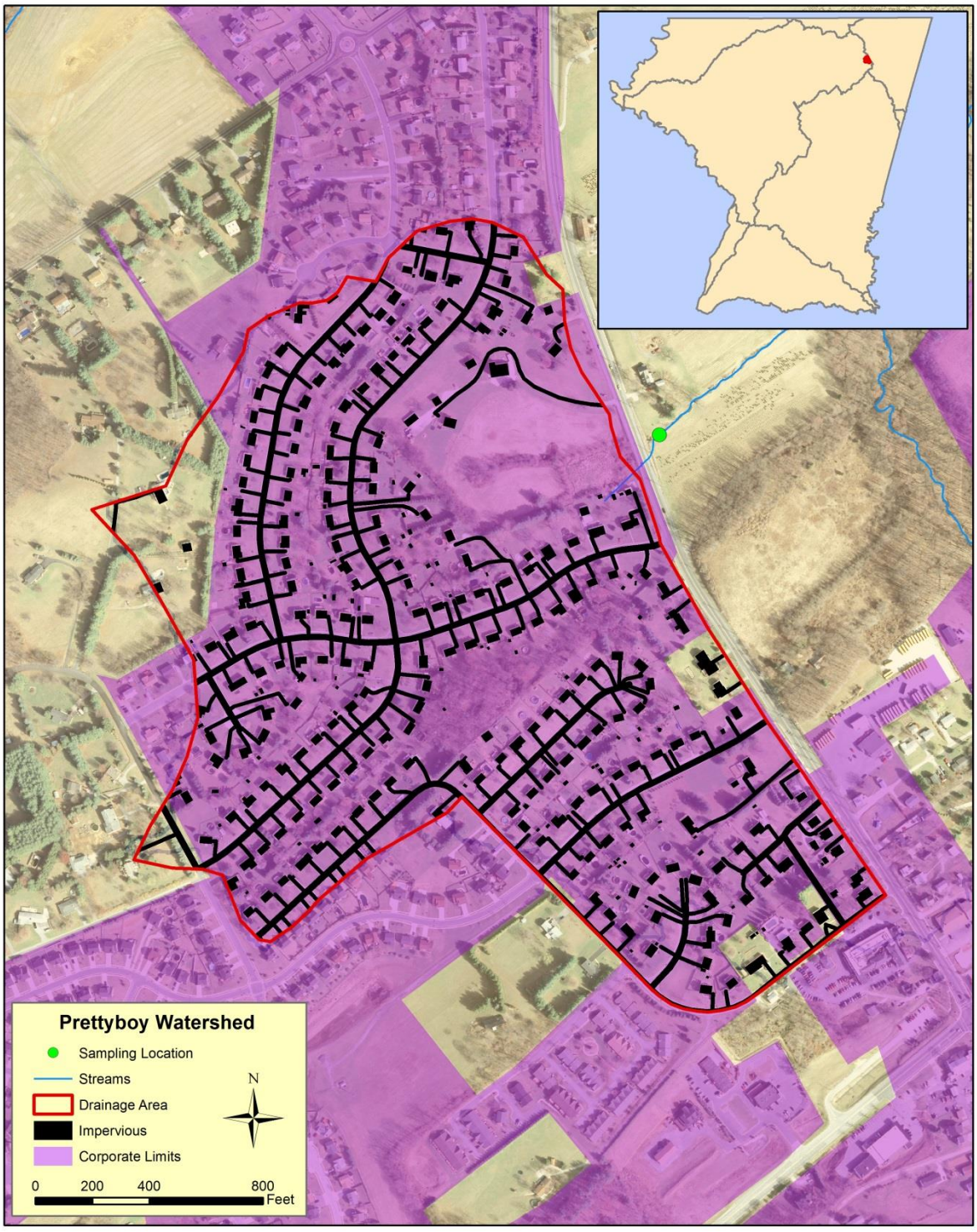

Figure 4-1: Whispering Valley Monitoring Location

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 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 Loch Raven watershed as well as any rare, threatened, or endangered species that may be present within the watershed.

B. Aquatic Biology

Benthic macro-invertebrates and fish communities serve as indicators of water quality and the overall ecological health of the aquatic system. A number of programs and agencies regularly collect biological data from streams, including the DNR Fisheries Program in conjunction with the Maryland Biological Stream Survey (MBSS), as well as individual efforts within the County.

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. Maryland Biological Stream Survey (MBSS)

The Maryland Biological Stream Survey (MBSS) is conducted by biologists and based on 8-digit watersheds. Each year sites are randomly chosen within selected watersheds and surveyed for benthic macro-invertebrates and fish communities. Using randomly selected sites provides the statistical requirements necessary to develop valid biological inferences at both the 8-digit and 12-digit scale. Separate metrics of biological integrity have been developed by the MBSS program, for both the benthic macro-invertebrates and the fish communities. These metrics are based on measures of the respective communities and are a measure of community health. The Benthic Index of Biological Integrity (BIBI) is based on the benthic invertebrates living in the stream, while the Fish Index of Biological Integrity (FIBI) is based on the fish community. Table 5-1 presents the MBSS results for both the benthic macro-invertebrate and fish communities. Additional information regarding the MBSS program, including methods and the year site selection occurred can be found on the web at:

http://www.dnr.state.md.us/streams/mbss/.

There are currently no MBSS locations within Carroll County along Piney Run. Piney Run information was obtained from an MBSS location across the County border in Baltimore (Figure 5-1).

Table 5-1: MBSS Results by Subwatershed

12-Digit Scale	Subwatershed	BIBI			FIBI		
		Good	Fair	Poor	Good	Fair	Poor
0308	Piney Run			1	1		
Total							
Loch Raven Watershed Total				1	1		

The correlation between the MBSS data and the impacts identified through the stream corridor assessment indicate where restoration of the biological community could be targeted.

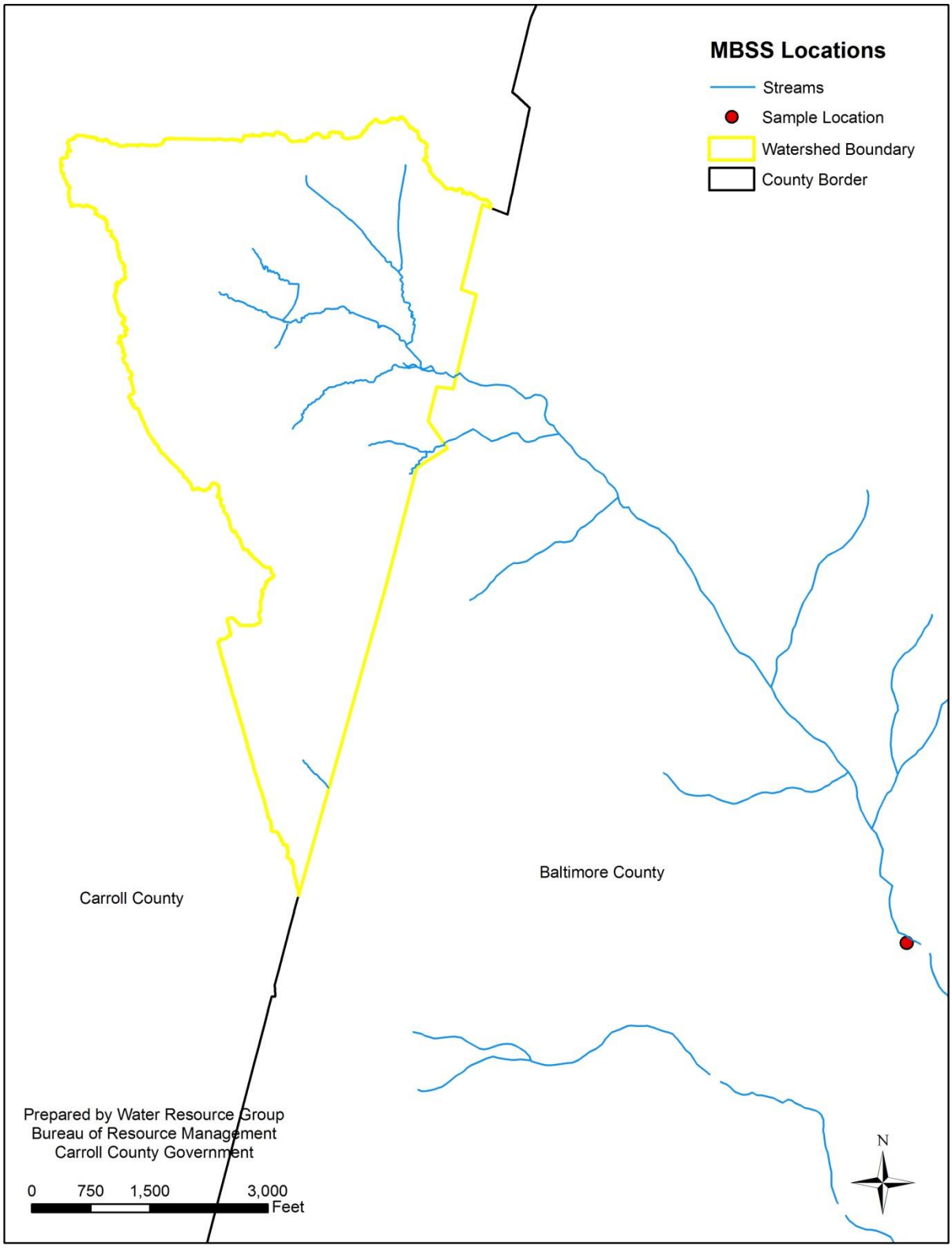

Figure 5-1: Loch Raven MBSS Locations

C. Aquatic Sensitive Species

Aquatic 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 generally the most sensitive to environmental degradation.

1. Rare, Threatened, and Endangered Species (R.T.E.)

Rare, threatened, and endangered species are those plants and animals that are the most at risk in their ability to maintain healthy population levels. Within the Loch Raven Watershed the most widely known are the bald eagle and bog turtle, which are listed on both the state and federal endangered species list. For watershed restoration purposes, it is important to know and account for the habitats of sensitive species. Protecting and expanding these habitats help to preserve biodiversity and is a critical component in successfully restoring a watershed. DNR's Wildlife and Heritage Service identifies important areas for sensitive species conservation known as "stronghold watersheds". Stronghold watersheds are the places where rare, threatened, and endangered species have the highest abundance of natural communities. No areas within the Loch Raven Watershed have been identified as a stronghold watershed. 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.

D. Stream Corridor Assessment

A Stream Corridor Assessment (SCA) of the Loch Raven Watershed was conducted during the winter of 2016 by Carroll County Bureau of Resource Management staff. The Loch Raven 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 evaluated only stream segments on public, Carroll County, and City of Hampstead properties, therefore no mailing was required to request permission for access. Figure 5-2 shows the locations that were assessed. 2.11 of the 2.81 stream miles were assessed within the Loch Raven watershed.

The most common impairments identified during the assessment consisted primarily of pipe outfalls and erosion sites. Table 5-2 presents a summary of the number of data points by severity.

Table 5-2: Data Points by Severity

Identified Impacts	Total	Very Severe	Severe	Moderate	Low	Minor
Erosion	**3**	0	1	1	1	0
Inadequate Buffer	**2**	0	0	1	0	1
Pipe Outfall	**9**	1	1	2	1	4
Fish Barrier	**1**	0	0	0	1	0
Trash Dump	**1**	0	0	0	0	1
Channel Alteration	**2**	0	0	0	1	1
Construction	**0**	0	0	0	0	0
Exposed Pipe	**0**	0	0	0	0	0
Unusual Condition	**0**	0	0	0	0	0
Total	**18**	**1**	**2**	**4**	**4**	**7**

Erosion problems were identified along 0.38 miles (18%) of the 2.11 miles assessed, with approximately 4% of the watershed categorized as having a severe erosion problem.

Streamside buffers were found to be inadequate along 0.04 (2%) of the miles assessed, with none of the watershed classified as severely un-buffered. Table 5-3 shows the linear feet of streambank erosion and inadequate streamside buffers for the Western Run Subwatershed.

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

Stream Segment	Erosion	Inadequate Buffer
Western Run	1,990	200
Total	**1,190**	**200**

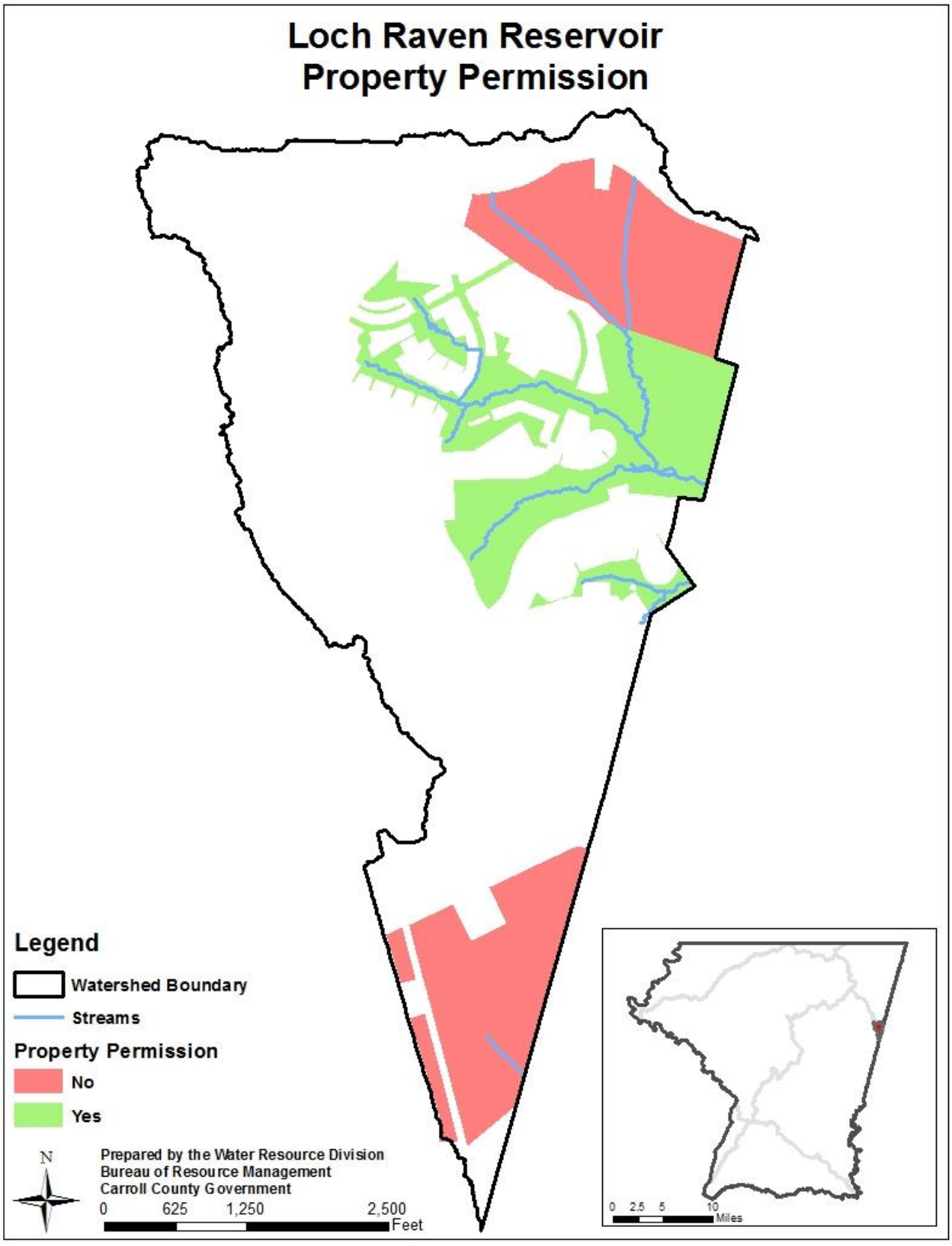

Figure 5-2: SCA Landowner Participation

VI. Characterization Summary

A. Summary

This Characterization Plan was developed to describe the unique background of the Loch Raven Watershed. The contents and data presented in this plan along with information gathered during the SCA will be used by the Bureau of Resource Management to develop a Watershed Restoration Plan that will define 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 the Stream Corridor Assessment and prioritize projects at a subwatershed scale based on the water quality data collected by 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 and monitor progress toward meeting applicable goals within the watershed.

B. Cost Summary

The following breakdown shows an approximate cost summary for the completion of the Loch Raven stream corridor assessment, as well as the development of the Loch Raven Characterization Plan.

Field Time: Assessment was completed over a span of 1 day.

Field Hours: Field crew averaged 6 hours/day over the 1 day for a total of 6 hours. Field crew varied from 2-3 people performing the assessment for a cumulative total of 12 field hours. Total cost of staff time in field was roughly $360 (12 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 Loch Raven Stream Corridor Assessment and the Watershed Characterization Plan was approximately $3,710.

VII. References:

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Appendix A:

Loch Raven Watershed Stormwater Management Facilities/Definitions

Loch Raven Watershed Stormwater Management Facilities

Subwatershed	Facility Type	Drainage Area (Acres)*	Project Name	Site #
Western Run	Wet Retention Pond	47.2	Robert's Field Section 1	535
Western Run	Detention	236.8	Robert's Field Section 1	23
Western Run	Detention	21.64	Robert's Field Section 2	28
Western Run	Detention	5.7	Spring Garden Elementary	135
Western Run	Infiltration	1.17	Cedarbrook Center	549
Western Run	Extended Detention #1B	21.97	Robert's Field Section 2	238
Western Run	Extended Detention #1C	26.19	Robert's Field Section 2	238
Western Run	Infiltration	2.54	Robert's Field Section 2	238
Western Run	Infiltration	6.21	Robert's Field Section 1	216
Western Run	Infiltration	7.56	Robert's Field Section 1	216
Western Run	Infiltration	8.54	Robert's Field Section 2	238
Western Run	Infiltration	0.43	Hampstead Crossing	798
Western Run	Infiltration	0.71	Hampstead Crossing	798
Western Run	Infiltration	0.78	Hampstead Crossing	798
Western Run	Dry Detention	9.33	Hampstead Valley #2	49
Western Run	Dry Detention	56.33	Hampstead Valley #1	49
Western Run	Dry Detention	13.54	Hampstead Valley	49

*** Some Facilities are within the same catchment and exact drainage areas may not match Table 3-3**

Urban Best Management Practices: BMPs that are structural, vegetative, or managerial 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: 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 remains 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 that capture and temporarily store water quality volume and pass it through a filter of sand, organic matter, and vegetation, which promotes pollutant treatment and groundwater recharge.

Impervious Surface Reduction: A practice that reduces the total area of impervious cover and captures stormwater to divert it to a previous area, subsequently enhancing stormwater infiltration.

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

Riparian Forest Buffer: Riparian forest buffers are area of trees usually accompanied by other vegetation that are adjacent to a body of water. Riparian forests 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 toward a stable habitat with a self-sustaining, diverse aquatic community.

Urban Nutrient Management: A BMP that reduces fertilizer when 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 that 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/Definitions

Agricultural Best Management Practices as of summer 2014-Loch Raven Watershed

Best Management Practice	Practice Code	Extent	Unit
Critical Area Planting	342	5	Acres

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

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.

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.

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

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

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

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

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

Cover Crop: Crops including grasses, legumes, and forbs for seasonal cover and other conservation purposes.

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.

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.

Pest Management: A site-specific combination of pest prevention, pest avoidance, pest monitoring, and pest suppression strategies.

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

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 that provide a travel way for people, livestock, equipment, or vehicles.

Tree Planting: Establishing woody plants by planting seedlings or cuttings, direct seeding, or natural regeneration.

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.