Double Pipe Creek Watershed Characterization Plan

Fall 2019

Prepared by
Carroll County Bureau of Resource Management

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I. Characterization Introduction

A. Purpose of the Characterization

The Double Pipe Creek 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 Double Pipe Creek Watershed stream corridor assessment (SCA) will be used as a tool to help direct the watershed implementation plan for the Double Pipe Creek 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 Double Pipe Creek Watershed.

B. Location and Scale of Analysis

The Double Pipe Creek Watershed is located in the northwestern portion of Carroll County. The watershed is within the Piedmont physiographic province of Maryland and consists of 21 major subwatersheds. The Double Pipe Creek Watershed drains into the Monocacy River which drains to the Potomac River. Table 1-1 displays the distribution of acreage between the subwatersheds within Double Pipe Creek, while Figure 1-1 depicts the location of Double Pipe Creek and its subwatersheds within Carroll County. The analysis presented in this report was done at the subwatershed scale. This allows for restoration and preservation efforts to be focused on the smaller drainage areas where efforts can be prioritized and more easily monitored.

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, wastewater 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 and quantity. This chapter will discuss the stream designations, the water quality data collected within Double Pipe Creek and the total maximum daily loads associated with the Double Pipe Creek Watershed.

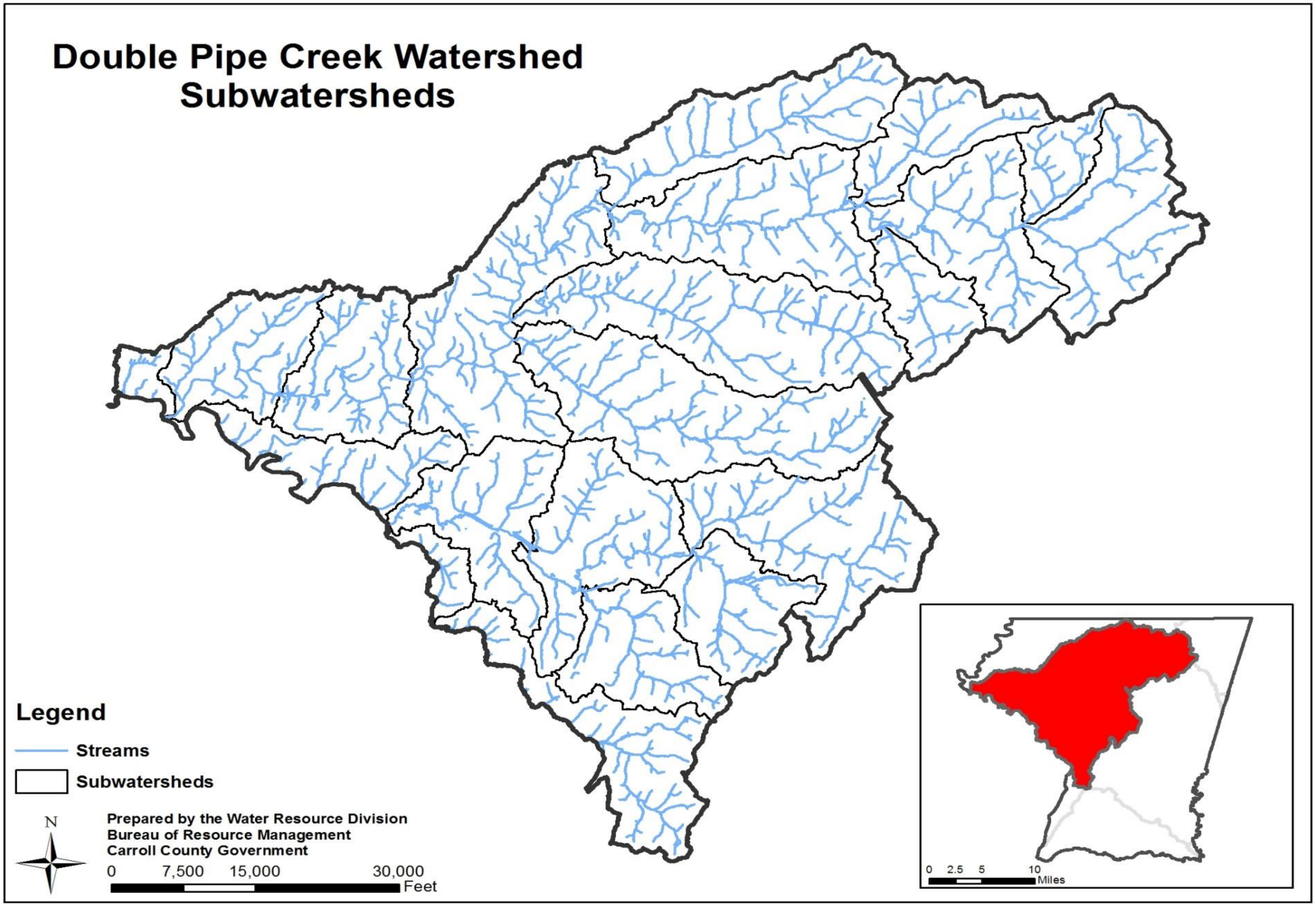

Figure 1-1: Double Pipe Creek Watershed Location Map

Table 1-1: Double Pipe Creek Watershed Subwatershed Acreage

DNR 12-digit Scale	Subwatershed	Acres
0281	Bear Branch	9,158
0282	Bear Branch	2,643
0278	Big Pipe Creek	8,799
0279	Big Pipe Creek	4,582
0280	Big Pipe Creek	3,937
0283	Big Pipe Creek	7,183
0284	Big Pipe Creek	5,568
0286	Big Pipe Creek	6,074
0287	Big Pipe Creek	1,796
0274	Cherry Branch/Ltl Pipe Creek	3,452
0288	Deep Run	3,456
0271	Dickenson Run	4,049
0248	Double Pipe Creek	759
0272	Little Pipe Creek	5,880
0276	Little Pipe Creek	7,442
0277	Meadow Branch	9,490
0273	Priestland/Wolf Pit Branch	4,760
0268	Sams Creek	5,393
0269	Sams Creek	991
0285	Silver Run	6,212
0275	Turkeyfoot Run	3,833
Double Pipe Creek Watershed Total		**105,457**

Chapter 5 summarizes the living resources within the Double Pipe Creek Watershed, including both aquatic and terrestrial and any rare, threatened, or endangered species within the Double Pipe Creek Watershed.

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. The Double Pipe Creek Watershed and its subwatersheds can be found in Figure 2-1.

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.

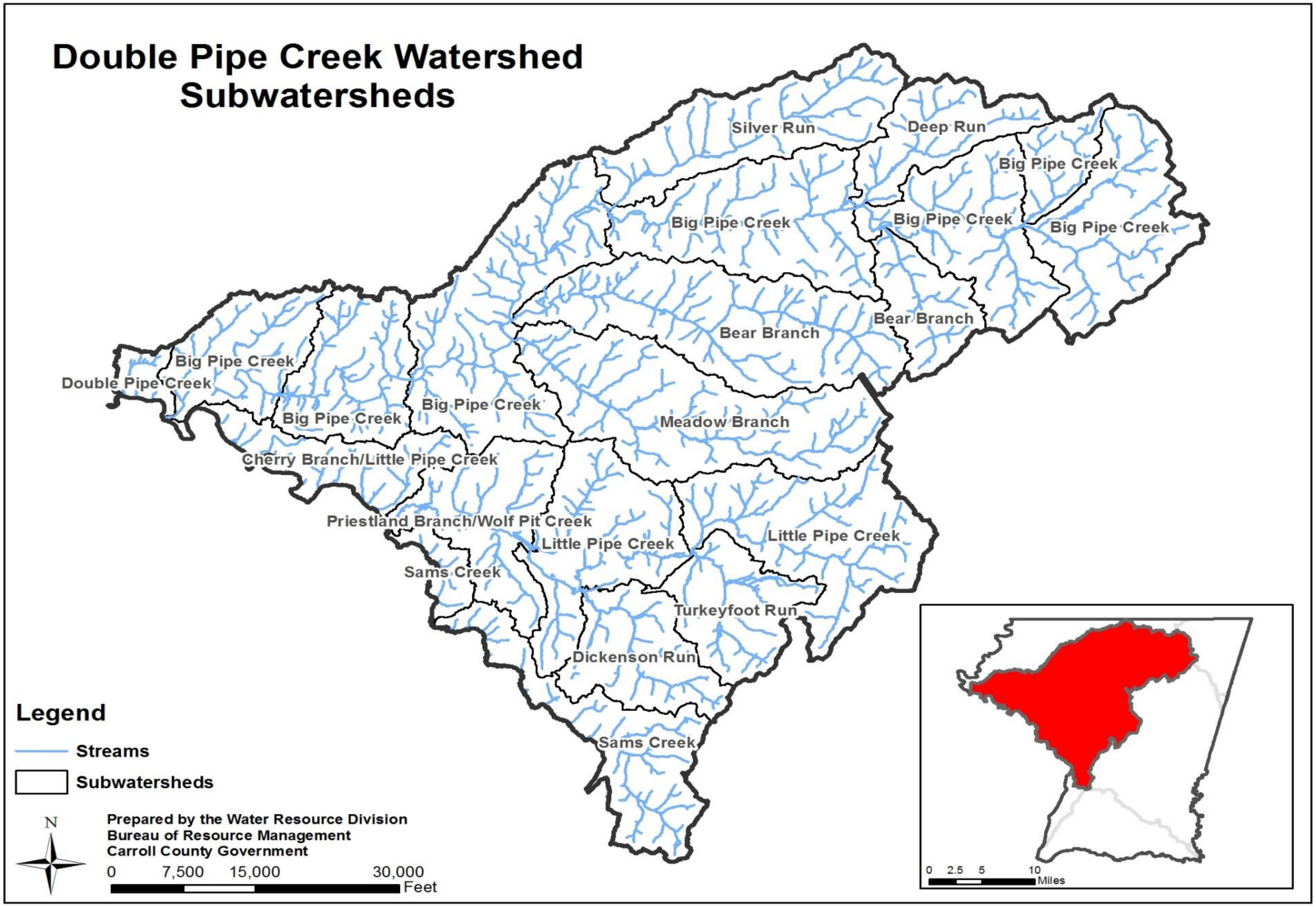

Figure 2-1: Double Pipe Creek Subwatershed Location

C. Physical Location

The Double Pipe Creek 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 the same three categories as the Carroll County Soil Survey: low slopes (0-8%), medium slopes (8-15%), and high slopes (>15%). Slopes are derived from 2015 LiDAR data. Table 2-1 presents the subwatershed slopes as percentages of the 12-digit watershed area.

Table 2-1: Double Pipe Creek Watershed Slope Categories

DNR 12-Digit Scale	Subwatershed	Slope Category (%)		
		Low	Medium	High
0281	Bear Branch	41	34	24
0282	Bear Branch	36	31	33
0278	Big Pipe Creek	69	22	9
0279	Big Pipe Creek	68	21	11
0280	Big Pipe Creek	65	23	12
0283	Big Pipe Creek	35	34	31
0284	Big Pipe Creek	30	34	36
0286	Big Pipe Creek	33	34	33
0287	Big Pipe Creek	32	37	31
0274	Cherry Branch/Ltl Pipe Creek	64	22	14
0288	Deep Run	20	36	43
0271	Dickenson Run	43	32	26
0248	Double Pipe Creek	67	21	12
0272	Little Pipe Creek	46	33	21
0276	Little Pipe Creek	38	31	31
0277	Meadow Branch	46	32	22
0273	Priestland/Wolf Pit Branch	50	32	18
0268	Sams Creek	36	35	29
0269	Sams Creek	48	30	21
0285	Silver Run	38	35	28
0275	Turkeyfoot Run	46	28	25
Double Pipe Creek Watershed Total		**45**	**31**	**24**

The Deep Run subwatershed contains the highest proportion of slopes greater than 15% within the Double Pipe Creek Watershed at 43% of the total area; while the middle portion of Big Pipe Creek (0278) contains the lowest proportion of slopes greater than 15% within the Double Pipe Creek Watershed at 9% of the total area. Figure 2-2 displays the slope categories and their distribution throughout the Double Pipe Creek Watershed.

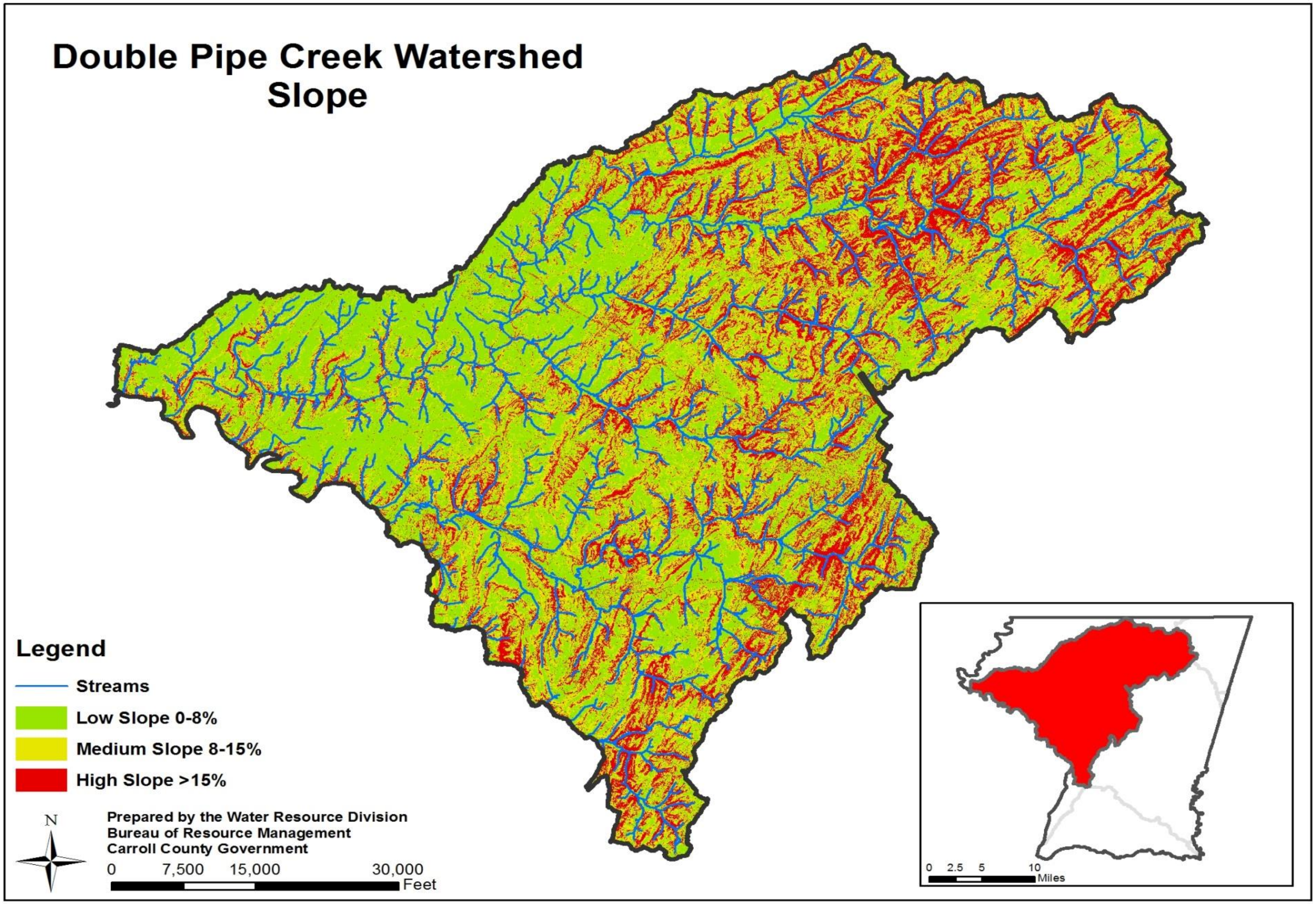

Figure 2-2: Double Pipe Creek Watershed Topography

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 granite 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, including the Double Pipe Creek Watershed (Costa, 1975).

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 (DEPRM, 2008).

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 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 are summarized in Table 2-2 and in Figure 2-3.

The majority of the subwatersheds have a similar percentage of C and D soils. While the overall percentage is relatively low, these areas should be targeted when considering where the greatest potential for addressing soil conservation exists. The Double Pipe Creek (0248) and Big Pipe

Creek (0280) subwatersheds located at the terminus of the watershed contain the highest proportion of C and D soils, with 92% of the Watershed classified as a C or D soils. Three adjacent subwatersheds, Big Pipe Creek (0278 and 0279) and Cherry Branch / Little Pipe Creek (0274) also had notably high proportions of C and D soils with 70%, 90%, and 87%, respectively. These subwatersheds were predominately C soils. Sams Creek (0269) has the highest percentage of D soils at 16% of the total watershed; as stated before D soils have the highest risk of runoff potential.

Table 2-2: Double Pipe Creek Subwatershed Hydrologic Soil Group Categories

DNR 12-digit scale	Subwatershed	Hydrologic Soil Group %			
		A	B	C	D
0281	Bear Branch	< 1	68	23	9
0282	Bear Branch	< 1	78	14	8
0278	Big Pipe Creek	1	29	65	5
0279	Big Pipe Creek	1	9	88	2
0280	Big Pipe Creek	1	7	91	1
0283	Big Pipe Creek	1	72	17	10
0284	Big Pipe Creek	0	81	11	8
0286	Big Pipe Creek	0	80	11	9
0287	Big Pipe Creek	0	80	9	11
0274	Cherry Branch/Ltl Pipe Creek	1	12	86	1
0288	Deep Run	0	87	8	5
0271	Dickenson Run	2	61	33	4
0248	Double Pipe Creek	2	6	92	0
0272	Little Pipe Creek	< 1	70	25	5
0276	Little Pipe Creek	< 1	66	29	5
0277	Meadow Branch	< 1	71	23	6
0273	Priestland/Wolf Pit Branch	< 1	69	29	2
0268	Sams Creek	0	72	23	5
0269	Sams Creek	11	55	18	16
0285	Silver Run	< 1	75	20	5
0275	Turkeyfoot Run	9	42	46	3
Double Pipe Creek Watershed Total		**1**	**60**	**33**	**6**

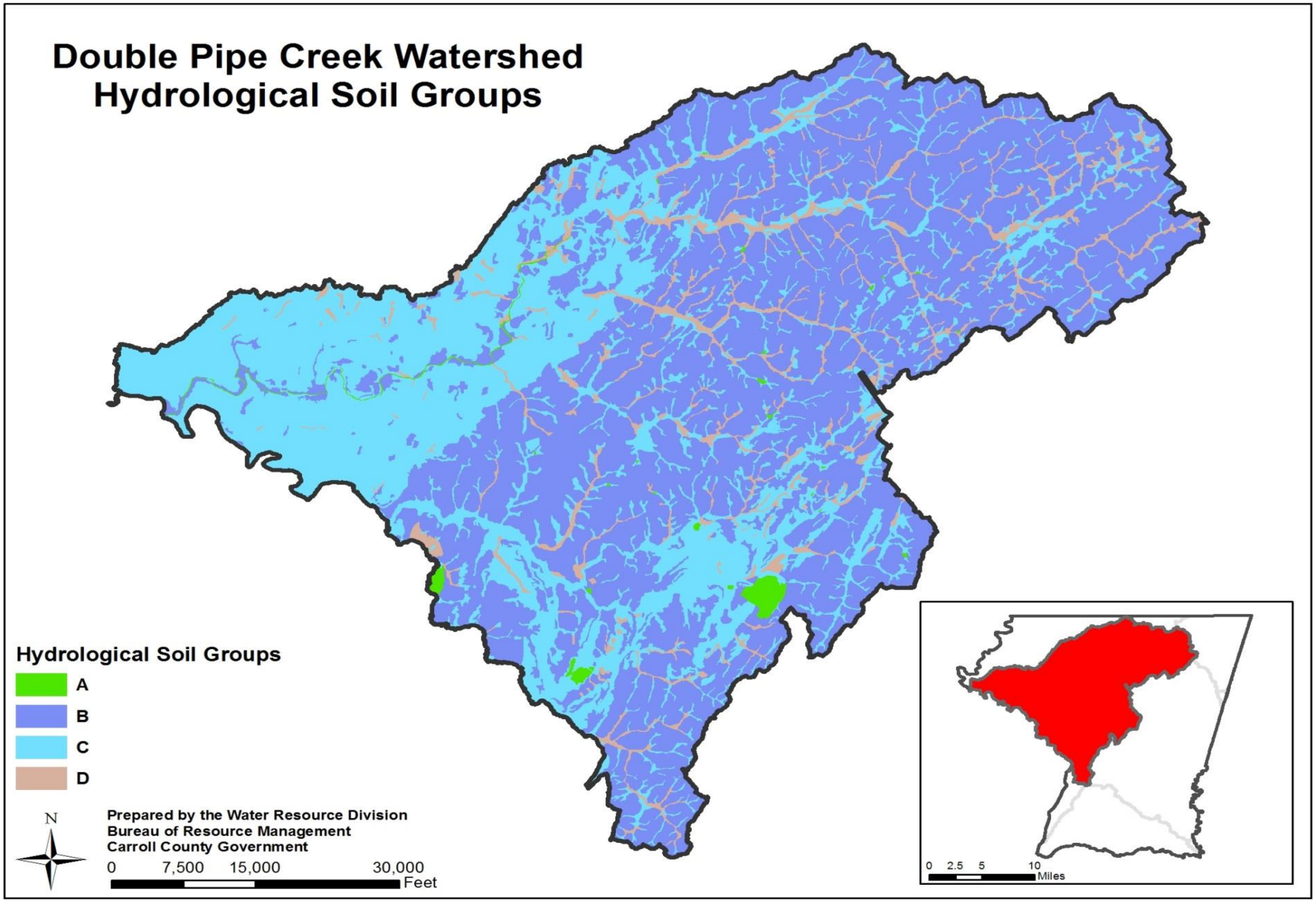

Figure 2-3: Double Pipe Creek Watershed Hydrological Soil Groups

3. Geology

A simplified map of the geologic units within the Double Pipe Creek Watershed is shown in Figure 2-4. 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 Double Pipe Creek Watershed, like most of the Piedmont, consists of predominately 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/MI^2). The triassic aquifer groundwater recharge under drought conditions is estimated at 220,000 GPD/MI^2. The groundwater recharge rate for the saprolite aquifer varies widely depending on the hydrologic group (Carroll County Water Resource Study, 1998).

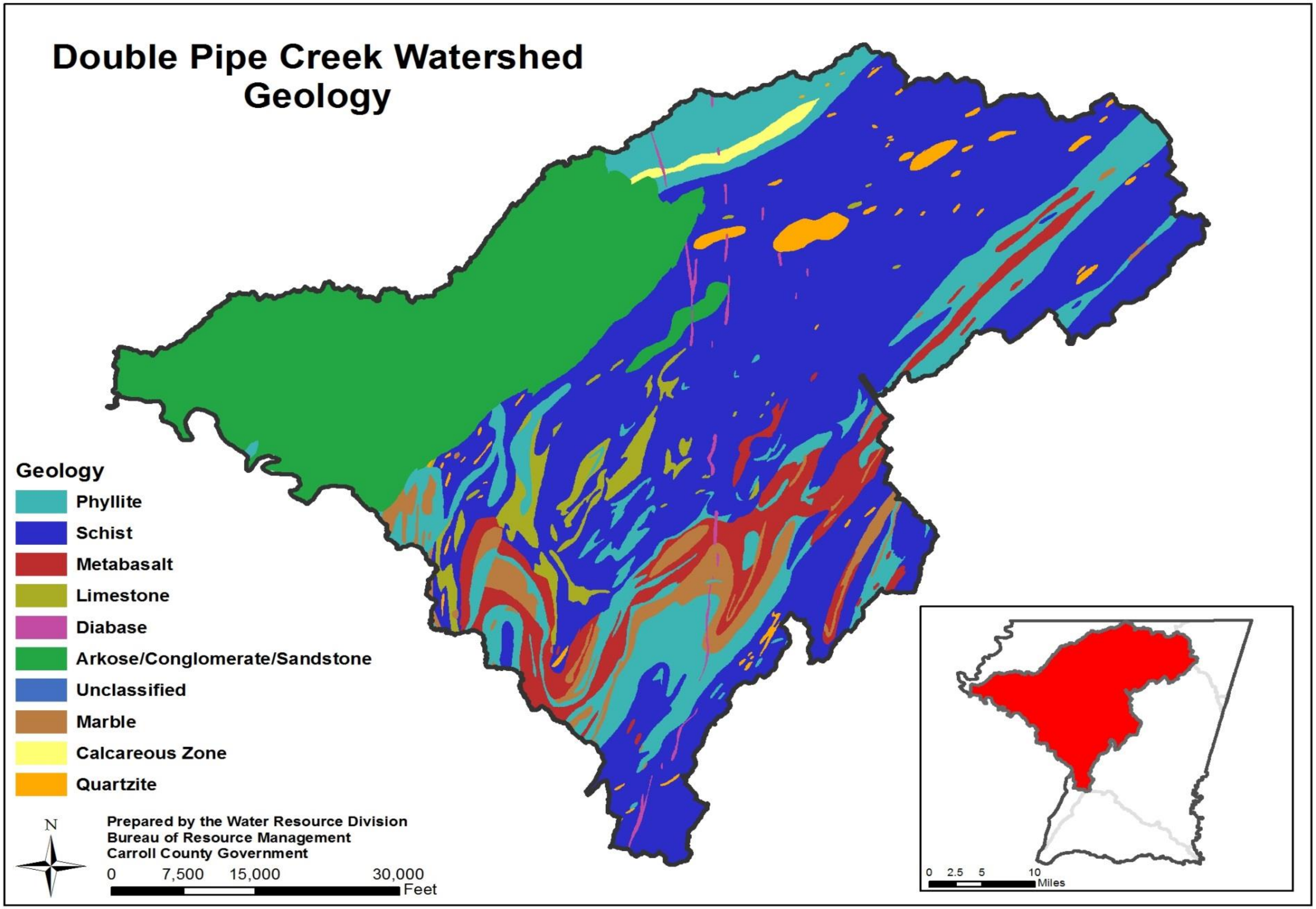

Figure 2-4: Double Pipe Creek Watershed Geology

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 take a look at 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 flow after an event. 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 Double Pipe Creek Watershed, as seen in Figure 2-5, 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. 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 Double Pipe Creek Watershed can be found in Table 2-3.

Table 2-3: Double Pipe Creek Watershed Wetland Estimates

DNR 12-Digit Scale	Subwatershed	NLCD Wetland Estimates	
		Acres	%
0281	Bear Branch	274	3.0
0282	Bear Branch	34	1.3
0278	Big Pipe Creek	51	0.6
0279	Big Pipe Creek	5	0.1
0280	Big Pipe Creek	11	0.3
0283	Big Pipe Creek	312	4.3
0284	Big Pipe Creek	87	1.6
0286	Big Pipe Creek	27	0.4
0287	Big Pipe Creek	9	0.5
0274	Cherry Branch/Ltl Pipe Creek	14	0.4
0288	Deep Run	33	1.0
0271	Dickenson Run	10	0.2
0248	Double Pipe Creek	27	3.5
0272	Little Pipe Creek	44	0.7
0276	Little Pipe Creek	14	0.2
0277	Meadow Branch	132	3.5
0273	Priestland/Wolf Pit Branch	1	0.0
0268	Sams Creek	30	0.5
0269	Sams Creek	3	0.3
0285	Silver Run	158	2.5
0275	Turkeyfoot Run	7	0.2
Double Pipe Creek Watershed Total:		**1,282**	**1.2**

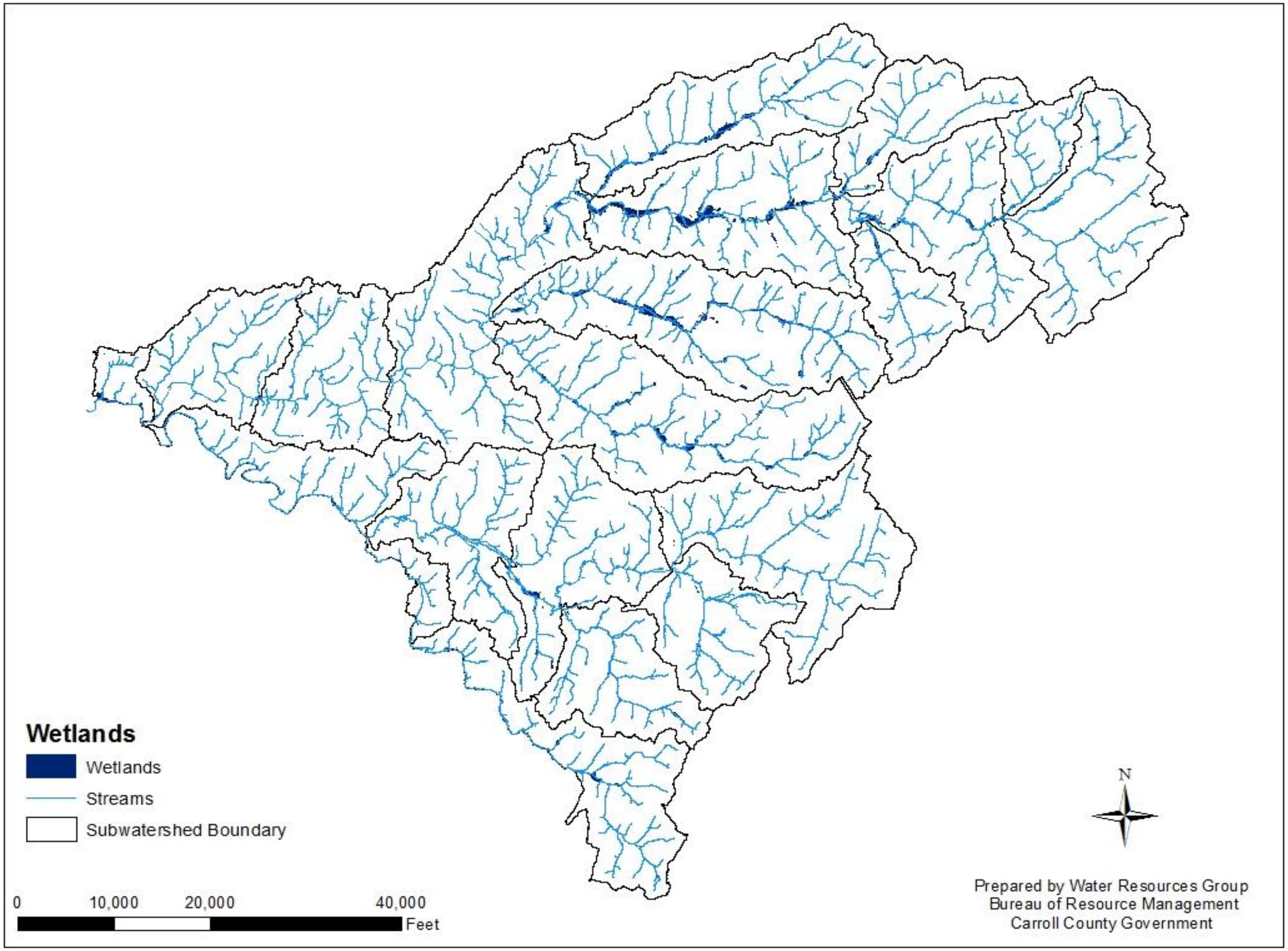

Figure 2-5: Double Pipe Creek Watershed Wetland Estimates

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 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 Double Pipe Creek Watershed contains about 5,835 acres (6%) of floodplain 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 FEMA 2015 effective mapped data. The floodplain acreage for each subwatershed can be found in Table 2-4. The total regulated floodplain area within the Double Pipe Creek Watershed is shown in Figure 2-6.

Table 2-4: Double Pipe Creek Watershed Floodplain Estimates

DNR 12-Digit Scale	Subwatershed	FEMA Floodplain Estimates	
		Acres	%
0281	Bear Branch	442	4.8
0282	Bear Branch	4	0.2
0278	Big Pipe Creek	581	6.6
0279	Big Pipe Creek	278	6.1
0280	Big Pipe Creek	235	6.0
0283	Big Pipe Creek	564	7.9
0284	Big Pipe Creek	275	4.9
0286	Big Pipe Creek	207	3.4
0287	Big Pipe Creek	69	3.9
0274	Cherry Branch/Ltl Pipe Creek	266	7.7
0288	Deep Run	12	0.3
0271	Dickenson Run	94	2.3
0248	Double Pipe Creek	76	10.0
0272	Little Pipe Creek	514	8.7
0276	Little Pipe Creek	476	6.4
0277	Meadow Branch	488	5.1
0273	Priestland/Wolf Pit Branch	508	10.7
0268	Sams Creek	156	2.9
0269	Sams Creek	108	10.9
0285	Silver Run	313	5.0
0275	Turkeyfoot Run	167	4.4
Double Pipe Creek Watershed Total:		**5,835**	**5.5**

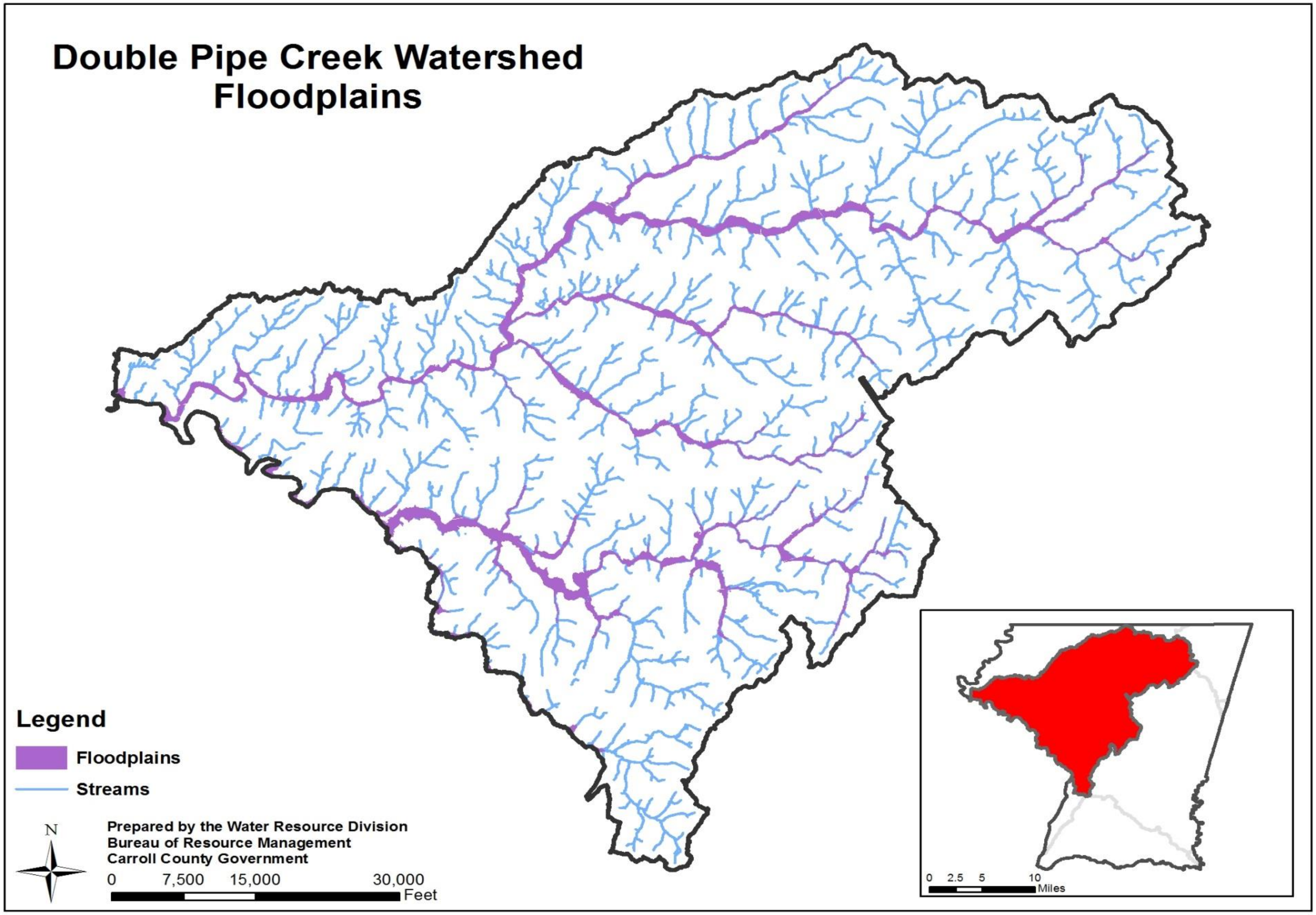

Figure 2-6: Double Pipe Creek Watershed Floodplain

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. The forest areas within the Double Pipe Creek Watershed today consist of succession forests that have regrown and matured. 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.

Double Pipe Creek Watershed contains 25,705 acres of forest over multiple land uses and covers about 24 percent of the land within the Watershed. The forest cover within the Double Pipe Creek Watershed can be found in Figure 2-7 and is shown in Table 2-5.

Table 2-5: Double Pipe Creek Watershed Forest Cover

DNR 12-Digit Scale	Subwatershed	Total Acres	Forested Acres	% Forested
0281	Bear Branch	9,158	2,120	23.2%
0282	Bear Branch	2,643	837	31.7%
0278	Big Pipe Creek	8,799	1,387	15.8%
0279	Big Pipe Creek	4,582	910	19.9%
0280	Big Pipe Creek	3,937	597	15.2%
0283	Big Pipe Creek	7,183	2,359	32.8%
0284	Big Pipe Creek	5,568	2,317	41.6%
0286	Big Pipe Creek	6,074	2,170	35.7%
0287	Big Pipe Creek	1,796	699	38.9%
0274	Cherry Branch/Ltl Pipe Creek	3,452	708	20.5%
0288	Deep Run	3,456	1,671	48.3%
0271	Dickenson Run	4,049	752	18.6%
0248	Double Pipe Creek	759	101	13.4%
0272	Little Pipe Creek	5,880	849	14.4%
0276	Little Pipe Creek	7,442	1,576	21.2%
0277	Meadow Branch	9,490	1,670	17.6%
0273	Priestland/Wolf Pit Branch	4,760	597	12.5%
0268	Sams Creek	5,393	1,305	24.2%
0269	Sams Creek	991	115	11.6%
0285	Silver Run	6,212	2,117	34.1%
0275	Turkeyfoot Run	3,833	846	22.1%
Double Pipe Creek Watershed Total		**105,457**	**25,705**	**24%**

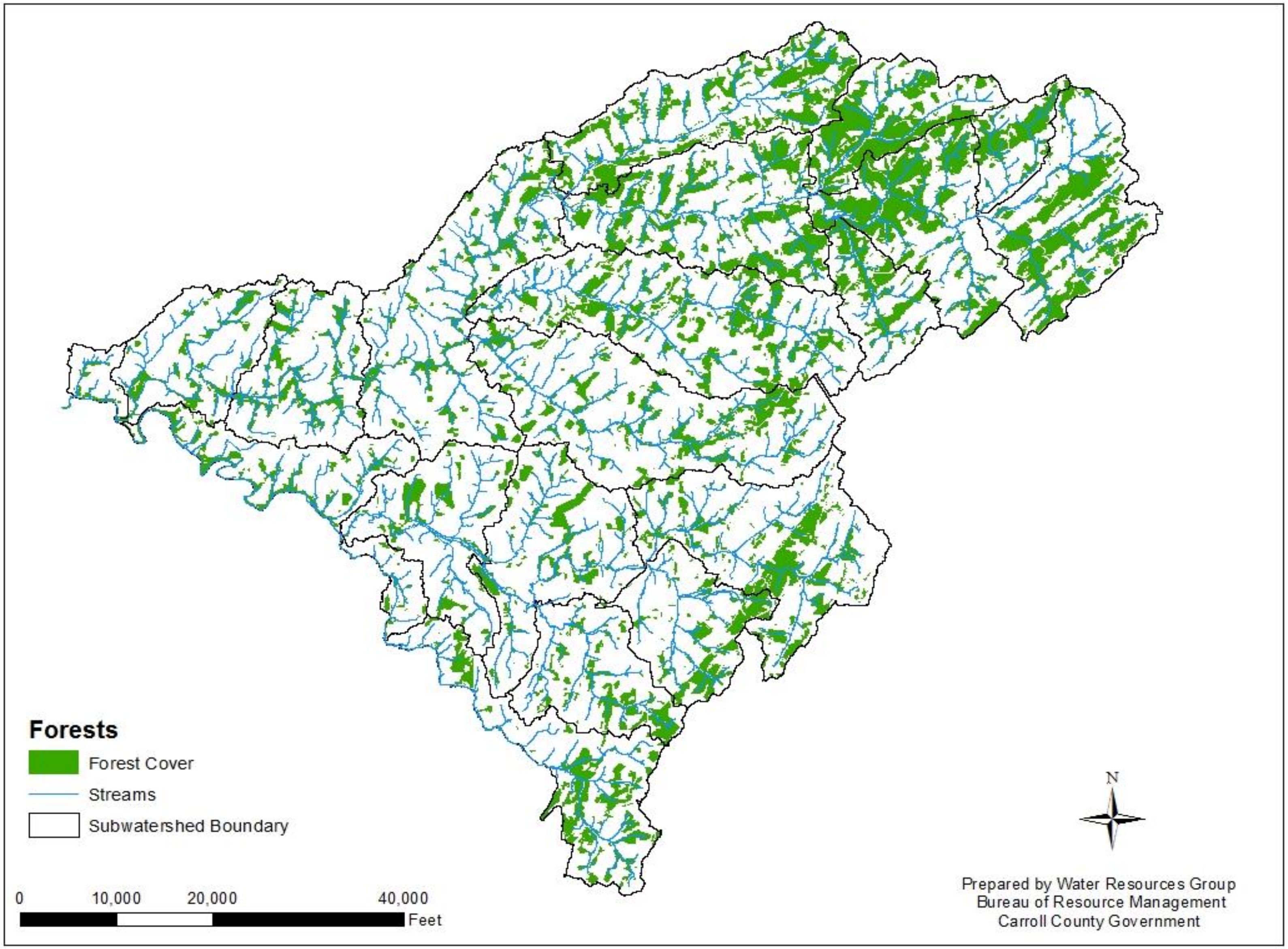

Figure 2-7: Double Pipe Creek Watershed Forest Cover

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.

Figure 2-8 shows the hubs and corridors within the Double Pipe Creek Watershed as identified through the DNR Green Infrastructure project.

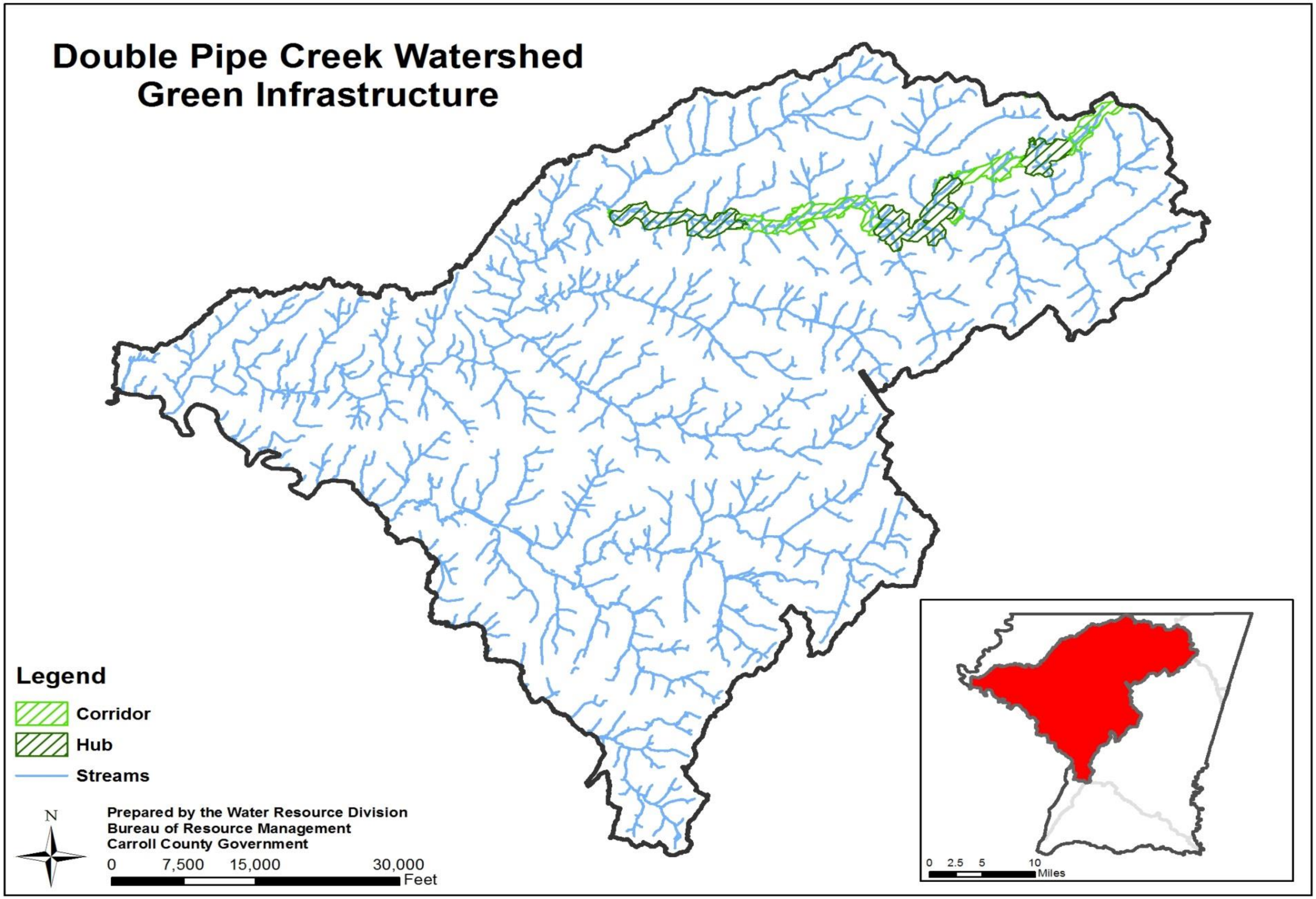

Figure 2-8: Double Pipe Creek Watershed Green Infrastructure

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

A. Population

The natural landscape of the Double Pipe Creek Watershed has been modified for human use over time. This modification has the potential to degrade both the terrestrial and aquatic ecosystems. The Double Pipe Creek Watershed currently has an estimated population of 41,794 persons with most of that being within the Westminster area. The population density for the entire watershed is about one person for every 2.5 acres with urban densities increasing to one person for every one quarter of an acre. The population density outside of the municipalities equates to about one person for every 4.3 acres. 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.

B. Land Use and Land Cover

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

Table 3-1: Double Pipe Creek 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	28	<1%	33	<1%	48	<1%	93	<1%
Low-Density Residential	7,375	7%	7,566	7%	7,636	7%	7,305	6.9%
Low-Density Mixed Urban	2,234	2%	2,344	2%	2,405	2%	2,613	2.5%
Medium-Density Mixed	385	<1%	508	<1%	591	<1%	636	<1%
High-Density Mixed Urban	64	<1%	110	<1%	129	<1%	131	<1%
Barren Land	241	<1%	276	<1%	263	<1%	256	<1%
Forest	23,894	23%	23,808	23%	23,742	23%	25,706	24.4%
Shrub/Scrub	1,057	1%	1,051	1%	1,091	1%	250	<1%
Grassland	127	<1%	193	<1%	203	<1%	89	<1%
Pasture/Hay	24,083	23%	23,630	22%	23,596	22%	33,108	31.4%
Cropland	44,409	42%	44,384	42%	44,192	42%	33,988	32.2%
Wetland	1,532	1.5%	1,526	1.5%	1,533	1.5%	1,282	1.2%

Agriculture is the dominant land use within the Double Pipe Creek Watershed, followed by forest and residential. Mixed urban uses account for about 3 percent of the total land use, which represents the relatively rural nature of the Double Pipe Creek Watershed.

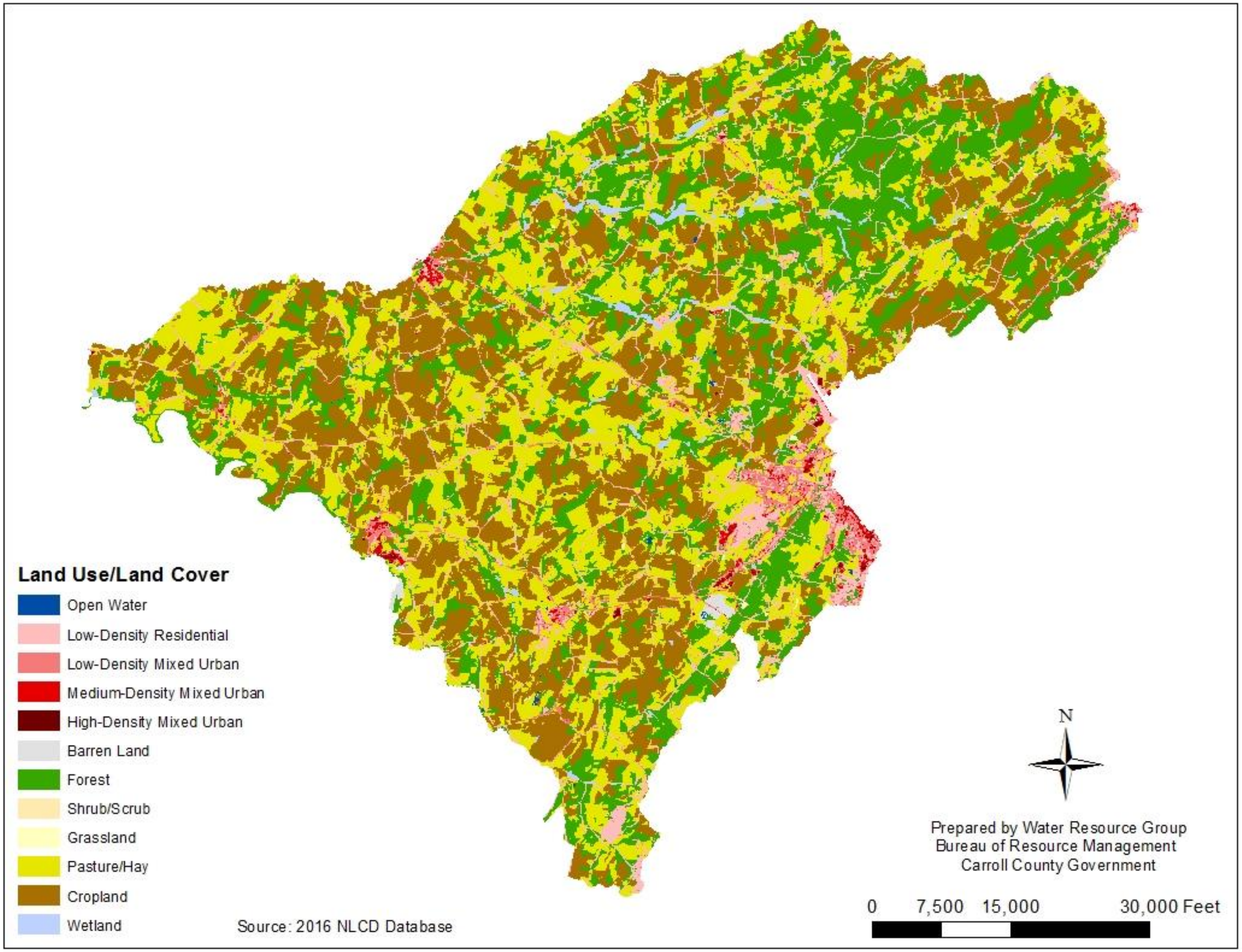

Figure 3-1: Double Pipe Creek Watershed Land Use/Land Cover

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 (PFA's). The Maryland Planning Act and Smart Growth initiatives require that the local jurisdictions map specific growth areas to target infrastructure dollars from the state. PFA's are existing communities and locations where state funding for future growth will be designated. Within the Double Pipe Creek Watershed, the towns of Manchester, New Windsor, Taneytown, Union Bridge, and Westminster are designated PFA's. These designated areas have specific boundaries and are the focal area for employment, social, and commercial activity within the watershed. Figure 3-2 shows the designated PFA's within the Double Pipe Creek Watershed.

2. Zoning and Build Out

Zoning refers to the regulation of land use 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 unincorporated areas of Double Pipe Creek Watershed can be found in Figure 3-3. Carroll County does not regulate zoning within the municipalities. The majority of the Double Pipe Creek Watershed (84%) is zoned agricultural.

Build-out analyzes the number of residential units in a given area that could be built, based on the current zoning of that area. Build-out looks at the existing development and based on the density, determines how many more residential units can be built in the future. Within the Double Pipe Creek Watershed there are 2,695 parcels remaining on 39,244 acres for a potential lot yield (PLY) of 8,343 (build out data was provided by Carroll County Department of Land and Resource Management). This data is based on medium range buildable land inventory estimates 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 3-4 shows the remaining parcels in Double Pipe Creek Watershed where residential units could be built.

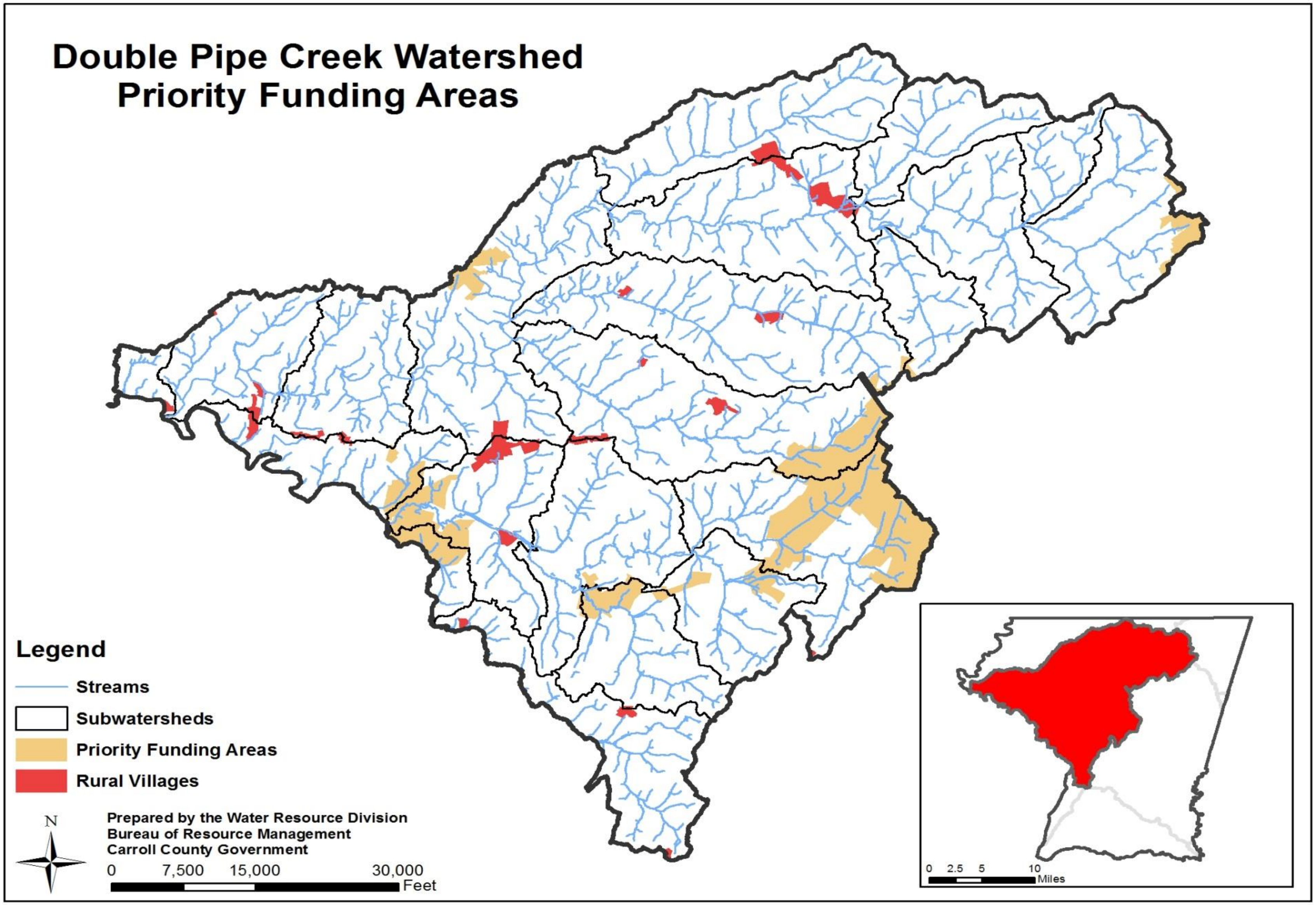

Figure 3-2: Double Pipe Creek Watershed Priority Funding Areas

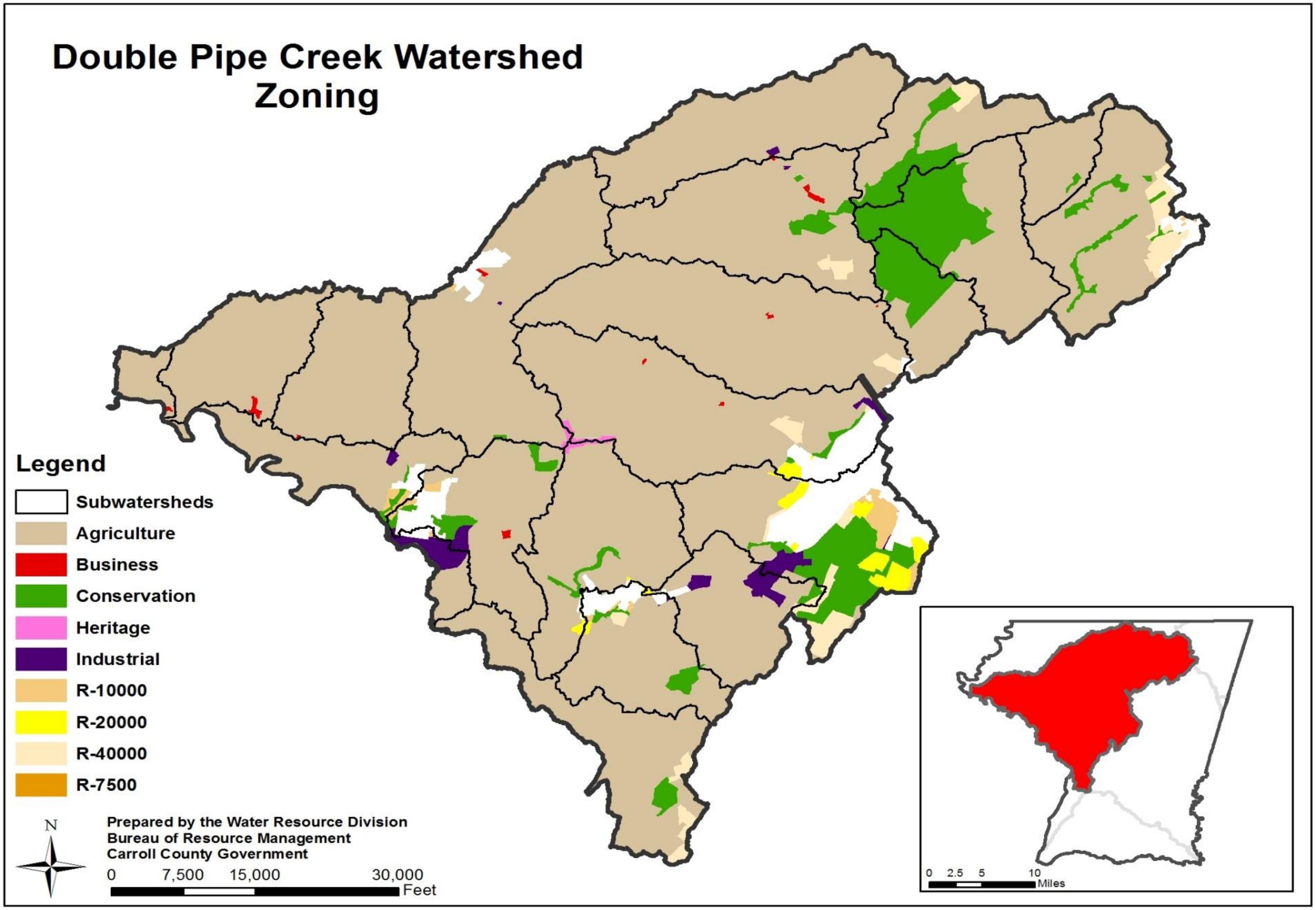

Figure 3-3: Double Pipe Creek Watershed Zoning

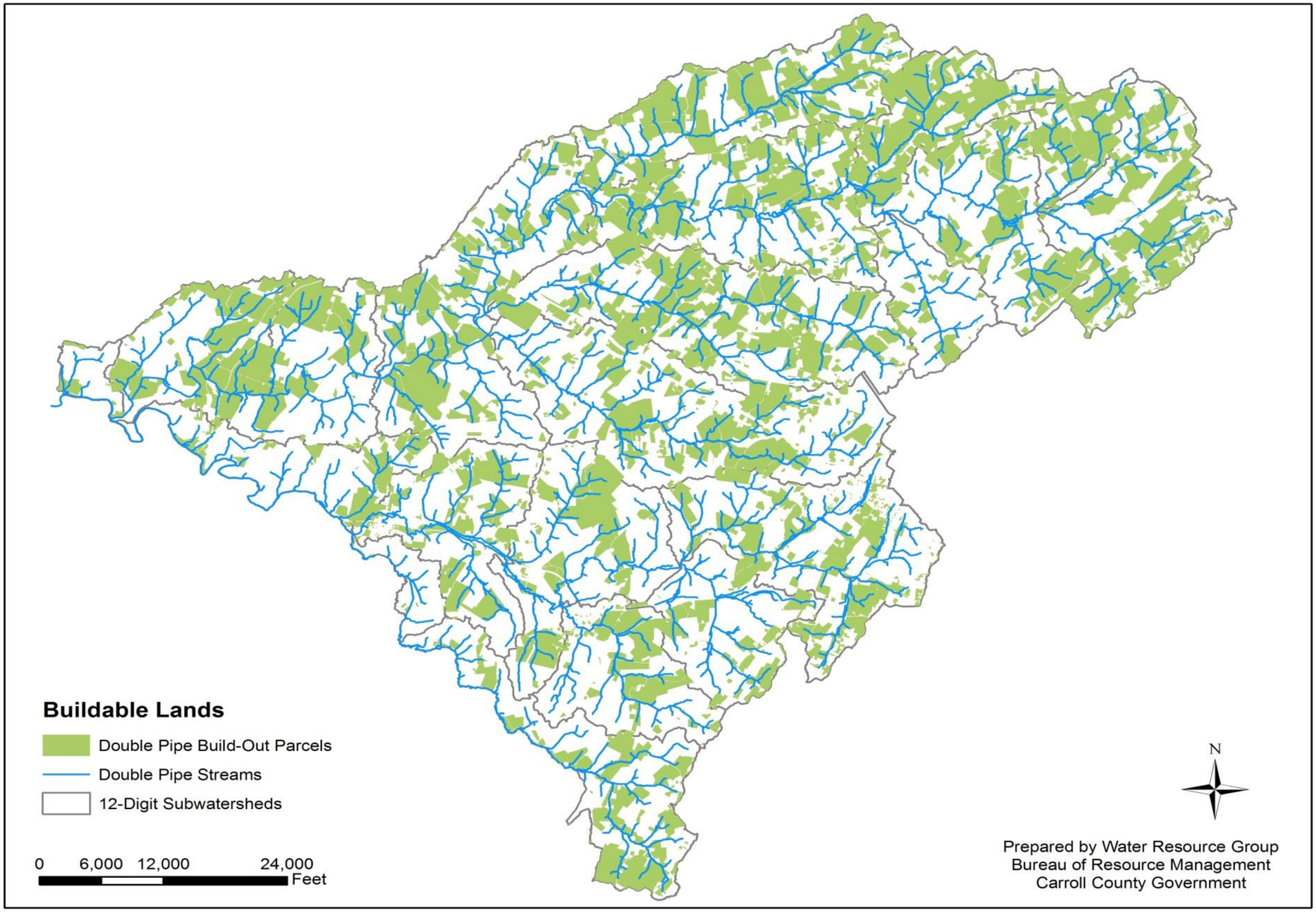

Figure 3-4: Double Pipe Creek Watershed Build-Out Parcels

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 Double Pipe Creek Watershed.

Table 3-2: Double Pipe Creek Watershed Estimated Impervious Surface Area

DNR 12-digit Scale	Subwatershed	Acres	Impervious Acres	Percent Impervious
0281	Bear Branch	9,158	309	3.4
0282	Bear Branch	2,643	62	2.4
0278	Big Pipe Creek	8,799	261	3.0
0279	Big Pipe Creek	4,582	77	1.7
0280	Big Pipe Creek	3,937	77	2.0
0283	Big Pipe Creek	7,183	218	3.0
0284	Big Pipe Creek	5,568	111	2.0
0286	Big Pipe Creek	6,074	267	4.4
0287	Big Pipe Creek	1,796	36	2.0
0274	Cherry Branch/Ltl Pipe Creek	3,452	78	2.3
0288	Deep Run	3,456	98	2.8
0271	Dickenson Run	4,049	168	4.1
0248	Double Pipe Creek	759	21	2.7
0272	Little Pipe Creek	5,880	141	2.4
0276	Little Pipe Creek	7,442	790	10.6
0277	Meadow Branch	9,490	482	5.1
0273	Priestland/Wolf Pit Branch	4,760	193	4.1
0268	Sams Creek	5,393	178	3.3
0269	Sams Creek	991	42	4.3
0285	Silver Run	6,212	156	2.5
0275	Turkeyfoot Run	3,833	131	3.4
Double Pipe Creek Watershed		**105,457**	**3,897**	**3.7**

The Double Pipe Creek Watershed is estimated to have 3,897 acres of total impervious within the catchment and accounts for approximately 3.7 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 Little Pipe Creek (0276) subwatershed, which contains a large portion of the City of Westminster, has the highest percentage of total impervious for the entire Watershed (10.6%). Some aquatic species begin to disappear once the impervious area of a Watershed reaches a certain threshold. This threshold was established at 10 percent in the 1970's, but a change in this number has been considered by DNR after drastic declines in Brook Trout populations became evident in watersheds where the impervious surface is at or above the 4 percent range (Southerland, 2005). Figure 3-5 shows the estimated total impervious surface area within the Double Pipe Creek Watershed.

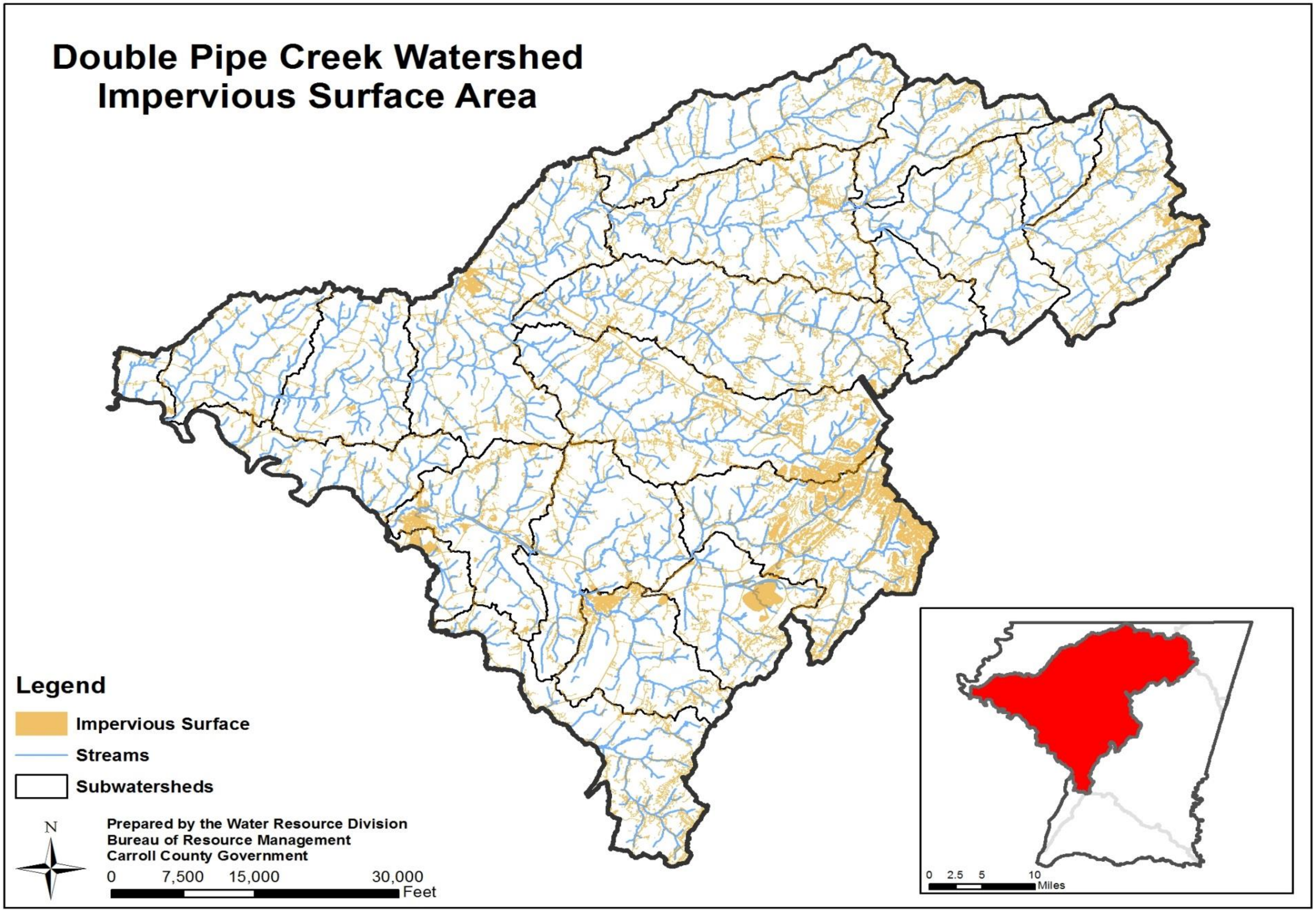

Figure 3-5: Double Pipe Creek Watershed Impervious Surface Area

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 (MDE, 2000). The new manual 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 172 stormwater management facilities within the Double Pipe Creek Watershed, with the majority being located within the Westminster urban area. 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 Double Pipe Creek Watershed.

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

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 connect 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.

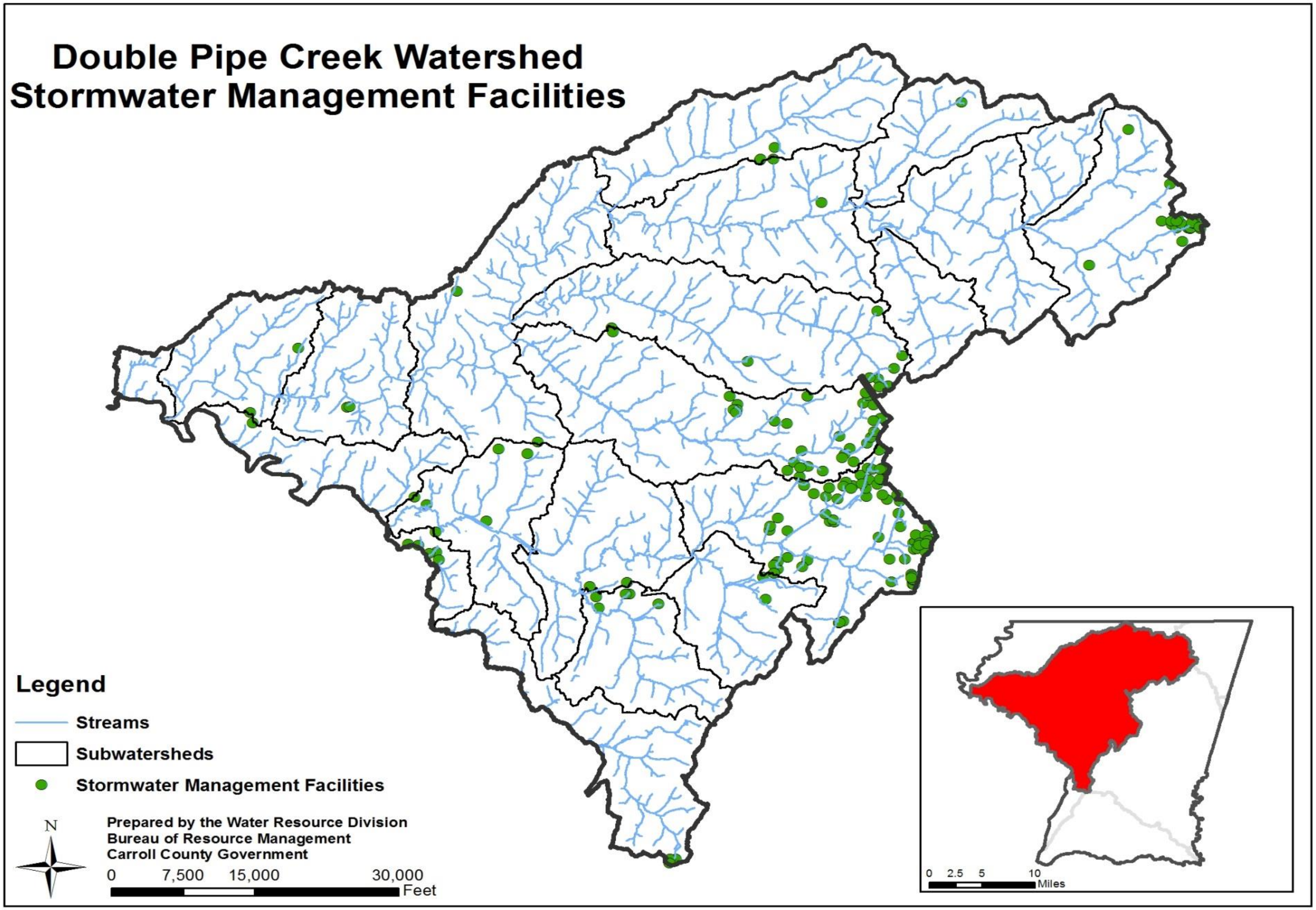

Figure 3-6 Stormwater Management Facilities

Table 3-3: Double Pipe Creek Watershed Stormwater Facility Types

Above Ground		
Facility Type	**Number of Structures**	**Drainage Area**
Dry Detention Pond	20	454.33
Extended Detention Pond	20	446.27
Filtration Basin (sand filter & underdrain)	25	398.89
Infiltration Basin	22	309.60
Open Grass Channel	1	0.19
Porous Pavement	3	17.84
Retention Pond	18	372.13
Water Quality Basin	2	3.88
Shallow Marsh	4	75.42
Swale	3	22.65
Swale w. Check Dams	1	2.48
Subtotal	**119**	**2,103.68**
Underground		
Facility Type	**Number of Structures**	**Drainage Area**
Detention Tank	2	3.23
Infiltration Dry Well	3	11.95
Infiltration Trench	30	97.3
Infiltration Trench w. Sand Filter	8	69.03
Infiltration Trench w. Storage Tank	2	3.84
Oil Grit Separator	1	0.5
Underground Storage Tank	7	27.44
Subtotal	53	213.29
Total	**172**	**2,316.29**

F. Drinking Water

Having safe drinking water is fundamentally important to support human and livestock populations within a watershed. Within the Double Pipe Creek 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 Double Pipe Creek Watershed are shown in Figure 3-7.

2. Water Supply

Slightly more than half of the residents within the Double Pipe Creek Watershed obtain their water from private wells located on their property. (There are about 8,134 private water wells within the watershed.) Since the underlying geology within the Double Pipe Creek 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 Double Pipe Creek Watershed, the towns of Manchester, New Windsor, Taneytown, and Westminster provide residents with public treated water. Additional public water service areas include Bark Hill and Pleasant Valley. Bark Hill currently has 2 production wells appropriated, Manchester has 16 wells and 2 springs, New Windsor has 4 wells and 3 springs, Pleasant Valley has 1 well, Taneytown has 8 wells, Union Bridge has 3 wells, and Westminster has 13 wells. At any given time, these wells could be either online or offline depending on maintenance and demand. Each well has its own appropriation, which is determined by MDE's water supply program. The New Windsor, Bark Hill, and Pleasant Valley service areas are all contained within the Double Pipe Creek Watershed. All other service areas sit along the topographical Watershed divide and obtain their water from community wells located in the Double Pipe Creek Watershed as well as the Prettyboy, Liberty, and Upper Monocacy Watersheds. The community well locations and associated public service area is shown in Figure 3-7.

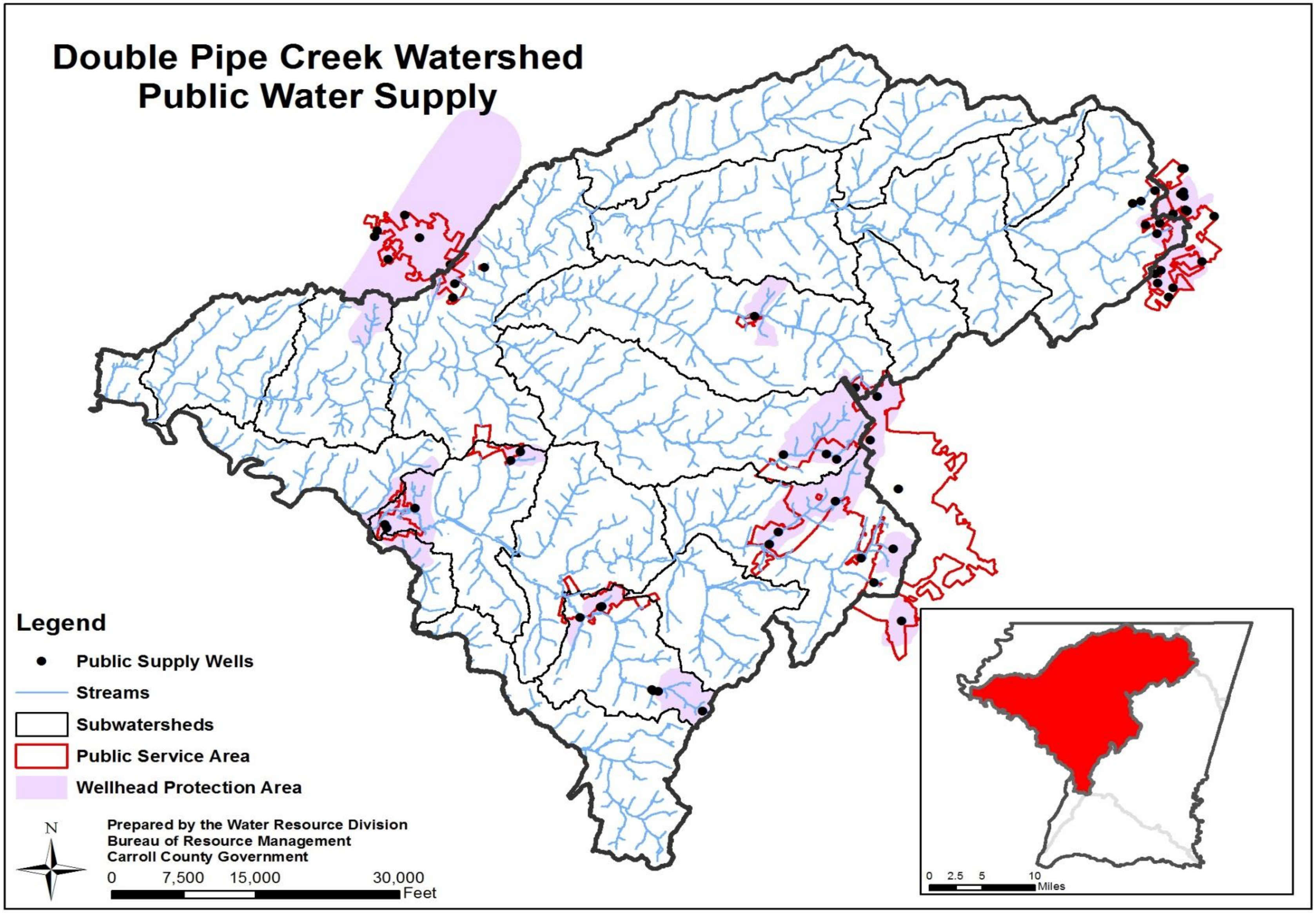

Figure 3-7 Double Pipe Creek Public Water Supply

G. Wastewater

Wastewater is any water created through human use that has been adversely affected in quality by anthropogenic influence and 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 wastewater treatment plant. The treatment of wastewater is essential because any untreated waste either 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 Double Pipe Creek Watershed there are approximately 8,070 homes utilizing public service and about 82 homes that are within the area slated for future service. Figure 3-8 shows the public wastewater service area for the Double Pipe Creek Watershed.

2. Wastewater Discharge Locations

Within the Double Pipe Creek Watershed, the towns of Manchester, New Windsor, Taneytown, Union Bridge, and Westminster are serviced through a public wastewater system. Additional wastewater service includes the area of Pleasant Valley. New Windsor, Union Bridge, Westminster, and Pleasant Valley all discharge treated wastewater effluent into Double Pipe Creek Watershed (Table 3-4). The Manchester wastewater treatment plant discharges into Georges Run, which is part of the Prettyboy Watershed. Taneytown's effluent is discharged into Piney Creek, which is a part of the Upper Monocacy Watershed.

Table 3-4: Double Pipe Creek Watershed Wastewater Treatment Plants

WWTP Location	Current Treatment Type	Capacity (mgd)	Avg Flows (mgd)	Current and Future Upgrades
New Windsor	Continuous Sequencing Batch Reactor Process	0.115	N/A	▪ ENR Improvements (10 years) ▪ Add 0.115 MGD capacity (10 years)
Union Bridge	Activated Sludge	0.200	0.196	▪ Add 0.046 MGD capacity (5 years) ▪ Add 0.115 MGD capacity (10 years)
Westminster	Activated Sludge / Biological Nutrient Removal	5.000	4.823	▪ Pre-treatment upgrade (Current) ▪ ENR Improvements (Current) ▪ Add 1.5 MGD capacity (5 years)
Pleasant Valley	Sequencing Batch Reactor / Biological Digestion	0.019	0.003	▪ No planned projects

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 8,142 septic systems within the Double Pipe Creek Watershed.

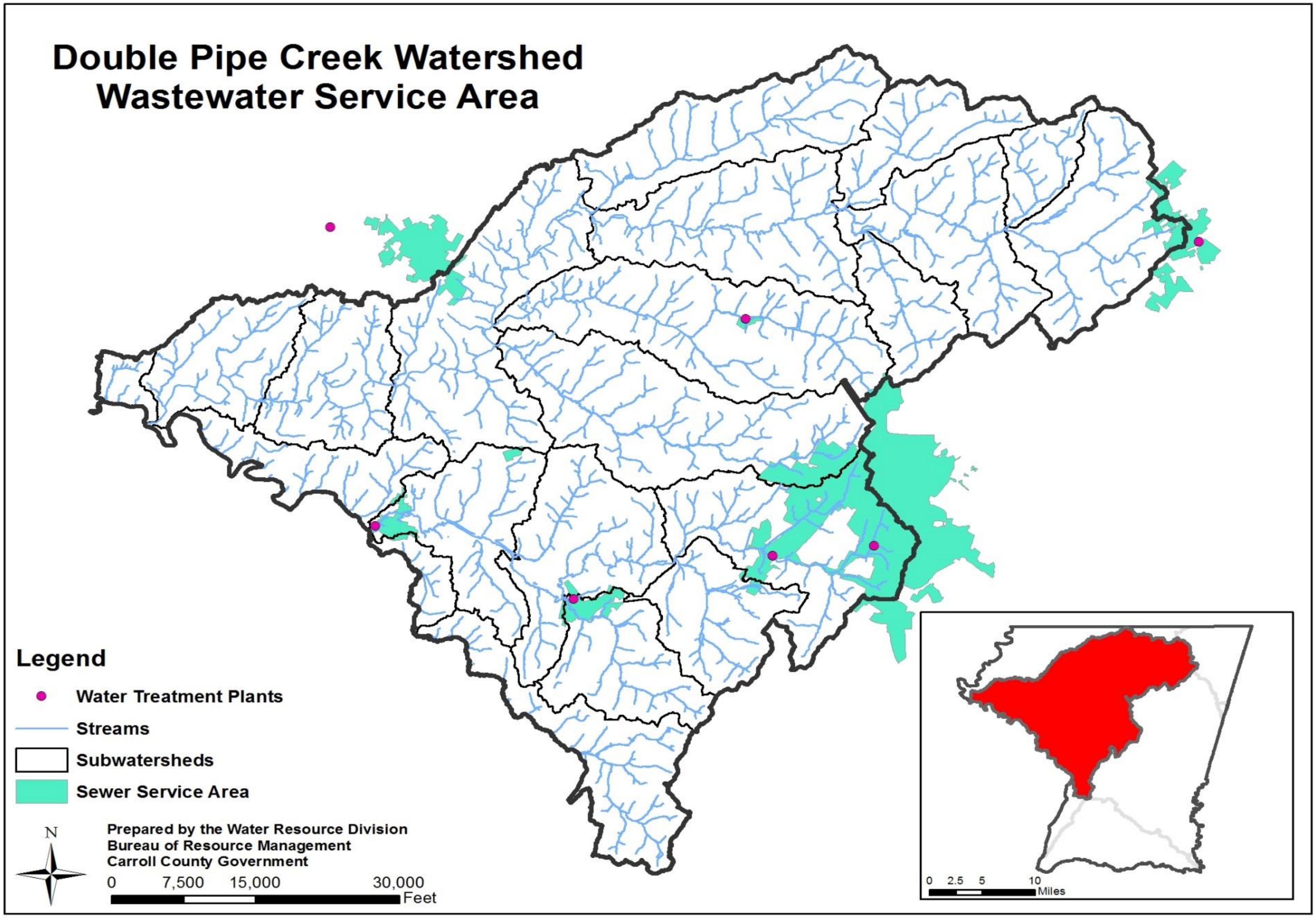

Figure 3-8 Double Pipe Creek Wastewater Service Area

H. NPDES Point Sources

Any facility that discharges wastewater whether it is industrial or municipal; or any facility that performs activities in which those activities could have a negative impact on a waterway by introducing pollutants into the watershed must obtain a National Pollutant Discharge Elimination System (NPDES) permit. Table 3-5 shows a list of NPDES permits within the Double Pipe Creek Watershed (information obtained from EPA.GOV).

Table 3-5: NPDES Permits in Double Pipe Creek Watershed

Permit Holder	Permit Number	Subwatershed	Permit Type
New Windsor WWTP	MD0022586	Dickenson Run	WMA2
Town Of New Windsor Sewer Pumping Station	MDG675027	Dickenson Run	WMA5
Universal Forest Products Eastern Division	MDR000920	Dickenson Run	WMA5
Stambaugh's. Inc	MDG499720	Priestland/Wolf Pit Br.	WMA5
Union Bridge Water Distribution System	MDG675056	Priestland/Wolf Pit Br.	WMA5
Union Bridge WWTP	MD0022454	Priestland/Wolf Pit Br.	WMA2
Babylon Vault Company, Inc	MDR001456	Turkeyfoot Run	WMA5
Lafarge Mid-Atlantic, LLC - Medford Quarry	MDG490226	Turkeyfoot Run	WMA5
Lehigh Cement Company LLC - New Windsor	MDG492448	Turkeyfoot Run	WMA5
Best Western - Westminster	MDG766195	Little Pipe Creek	WMA5
Introl Company, Inc	MDR003014	Little Pipe Creek	WMA5
McDaniel College	MDG7660	Little Pipe Creek	WMA5
Ridgeview at Wakefield	MDG766777	Little Pipe Creek	WMA5
Westminster Concrete Plant	MDG490433	Little Pipe Creek	WMA5
Westminster WWTP	MD0021831	Little Pipe Creek	WMA2M
Westminster WWTP	MDR002252	Little Pipe Creek	WMA5
C.J. Miller	MDG499852	Meadow Branch	WMA5
Bark Hill Landfill	MDR000662	Big Pipe Creek	WMA5
Bark Hill Water Supply System / Carroll	MDG498017	Big Pipe Creek	WMA5
Silver Oak Academy	MD0067571	Big Pipe Creek	WMA2
Silver Oak Academy	MDG675017	Big Pipe Creek	WMA5
Imrm Weatern Carroll Site	MDR001821	Big Pipe Creek	WMA5
Carroll County Maintenance Facility	MDR001861	Bear Branch	WMA5
Pleasant Valley Water Supply System / Carroll	MDG498017	Bear Branch	WMA5
Runnymede WWTP	MD0065927	Bear Branch	WMA2
John Owings Landfill	MDR000665	Bear Branch	WMA5
Almega Manufacturing Corp	MDR003013	Big Pipe Creek	WMA5
Bachman Valley Tire Facility	MDR000663	Big Pipe Creek	WMA5
Mountain View Bible Camp for Children	MDG766272	Big Pipe Creek	WMA5

I. Protected Lands

The protection of land ensures that non-urban land uses will remain intact over time on the specific parcel that is being protected. These lands are preserved through various programs and the extent of "protection" can vary greatly from one easement to the next. Preservation and protection include areas such as parks or watershed protection zones where non extractive uses predominate, as well as areas that are being intensively managed for agriculture.

Table 3-6 lists the type of protected lands within the Double Pipe Creek Watershed along with the representative acreage. 40,724* acres (39%) of the total land area within Double Pipe Creek has some sort of protection associated with the land. Agricultural easement areas have the highest percentage of protection within the Watershed at 36.4 percent with about 38,429 acres preserved. Figure 3-9 shows where the protected areas are located within the watershed.

Table 3-6: Protected Lands in Double Pipe Creek Watershed

Type of Protection	Acres	Percentage
Agricultural Easement	38,429	36.4
Open Space and Parks	1,343	1.3
Forest Conservation Easement	1,053	1
Water Resource Easement	287	0.3
Floodplain Easement	163	0.2
Total	**40,724***	**38.6**

* Total protected area is not equivalent to sum area of easement types due to overlap

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 Double Pipe Creek Watershed lies within the Little Pipe Creek Rural Legacy Area. The Rural Legacy Area encompasses 34,237 acres (33%) of the Double Pipe Creek Watershed depicted in Figure 3-10.

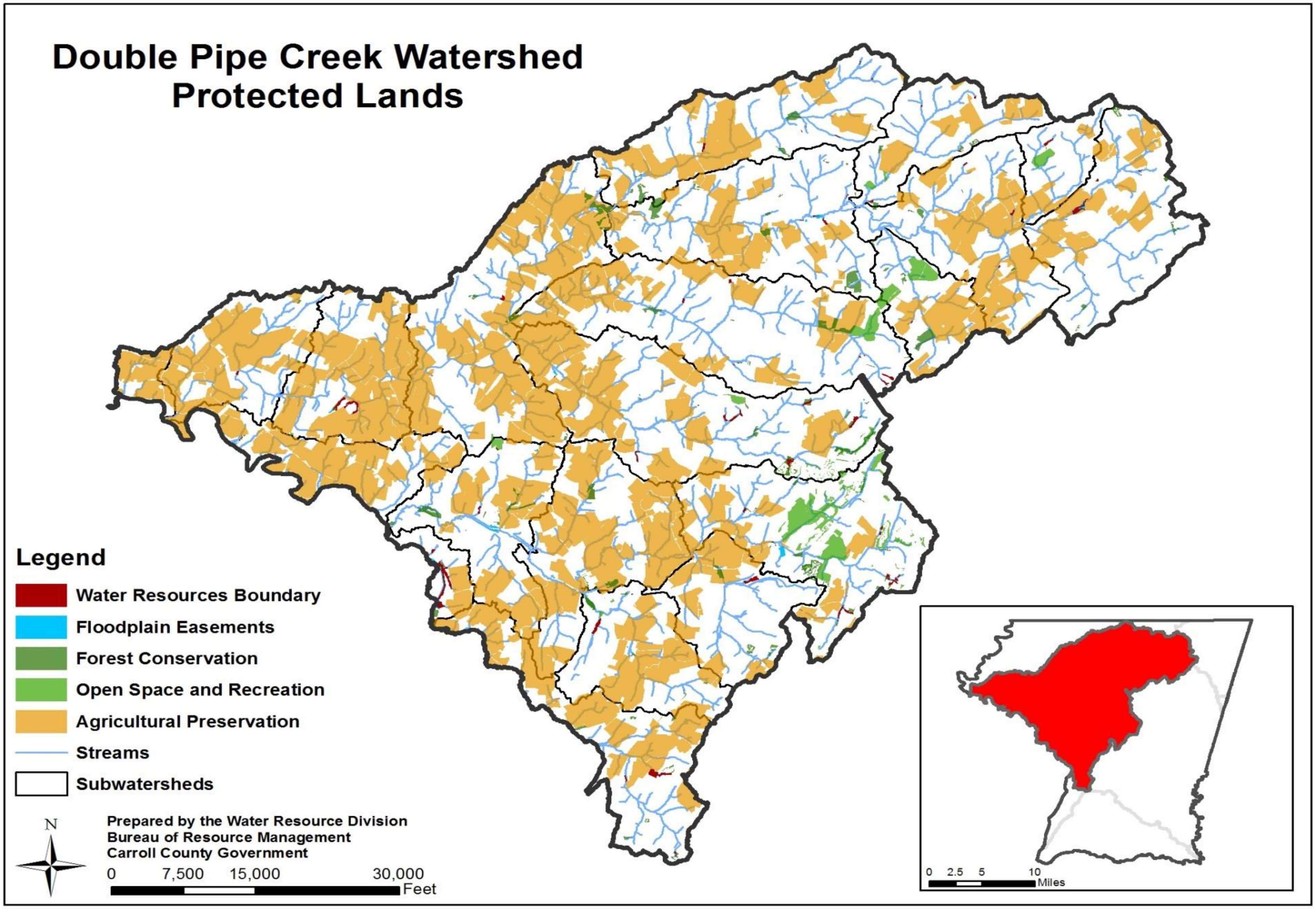

Figure 3-9: Double Pipe Creek Protected Lands

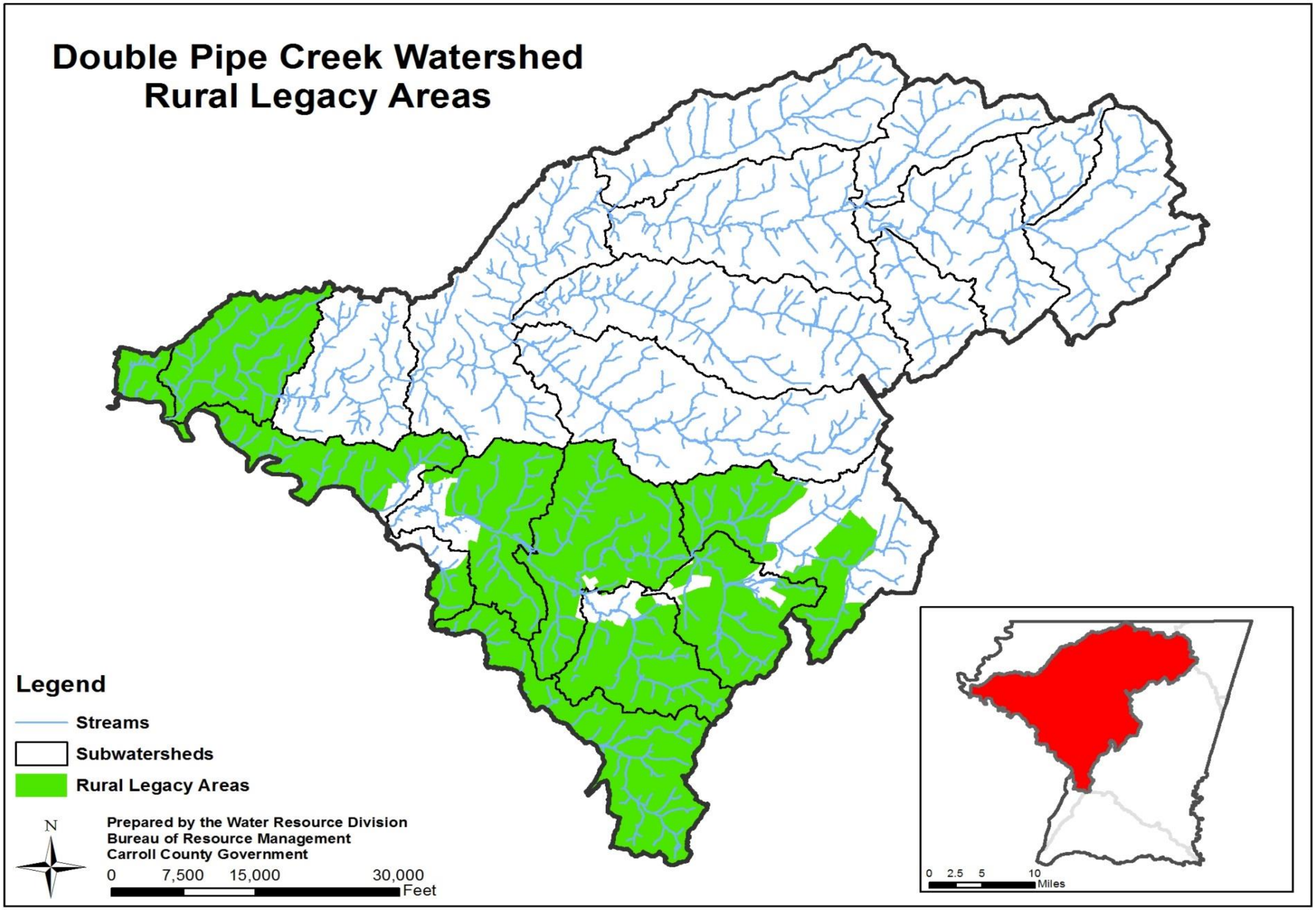

Figure 3-10: Little Pipe Creek Rural Legacy Area

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 Double Pipe Creek Watershed as of spring 2016 and provides a detailed explanation of the types of practices used throughout Carroll County. Figure 3-11 shows the locations of the agricultural BMPs within the Double Pipe Creek Watershed.

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. As of spring 2016, the Double Pipe Creek Watershed had approximately 63,347 acres (60%) of the total land area in a farm plan. Additionally, the Double Pipe Creek Watershed has approximately 1,995 acres of agricultural land in a comprehensive nutrient management plan.

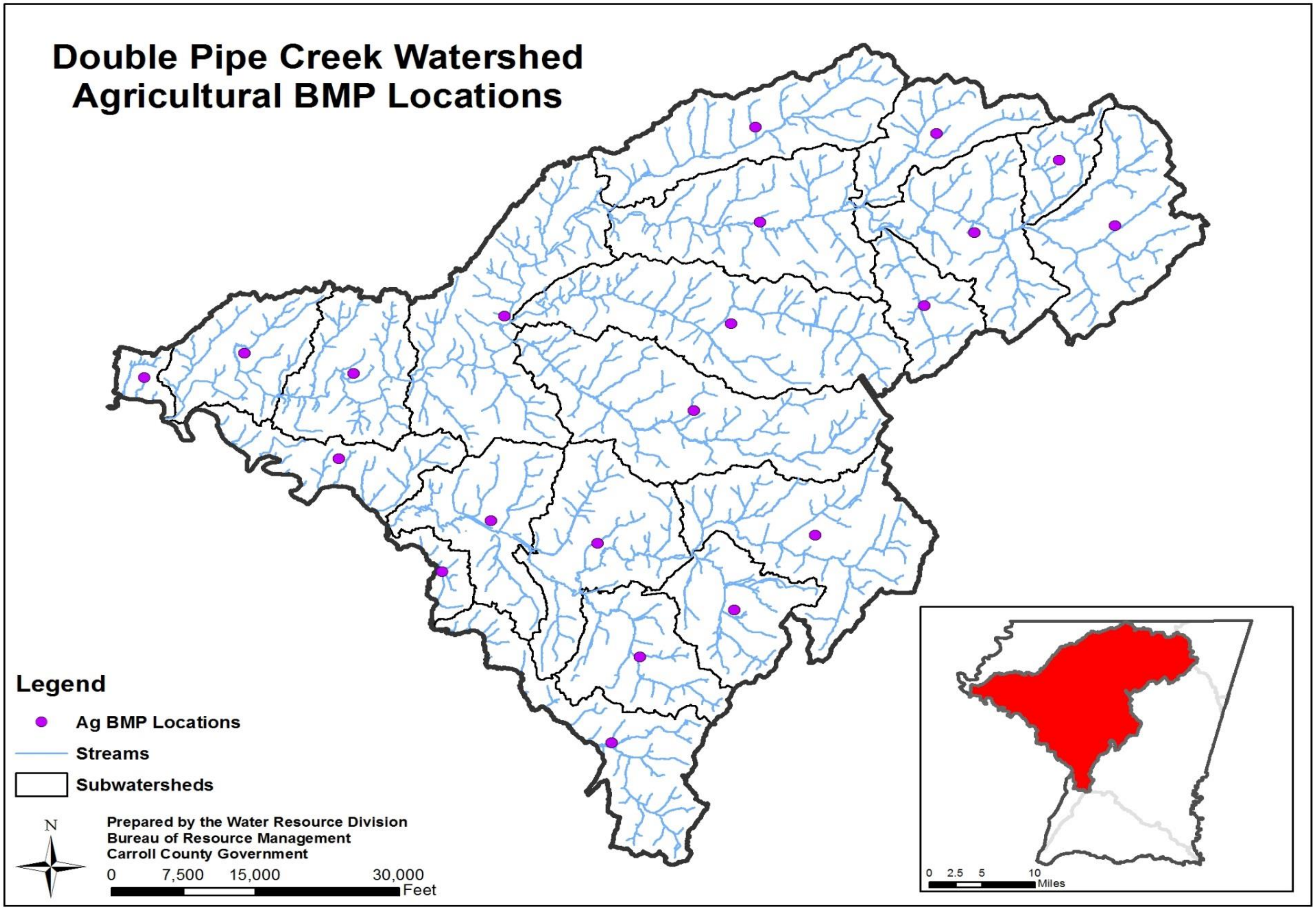

Figure 3-11: Double Pipe Creek Agricultural BMP Locations

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 Double Pipe Creek 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, are assigned a designated use specified by each state’s regulations. 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 waterbody.

The State of Maryland has defined the following general uses:

Use I: Water contact recreation, and protection of nontidal warmwater aquatic life
Use I-P: Water contact recreation, protection of aquatic life, and public water supply
Use II: Support of estuarine and marine aquatic life and shellfish harvesting
Use II-P: Tidal freshwater estuary – includes applicable Use II and public water supply
Use III: Nontidal cold water
Use III-P: Nontidal cold water and public water supply
Use IV: Recreational trout waters
Use IV-P: Recreational trout waters and public water supply

The Double Pipe Creek Watershed contains Use III-P and Use IV-P waters. The majority of waters in this Watershed are Use IV-P. Figure 4-1 shows the designated water uses within the Double Pipe Creek Watershed. Use I, Use III, Use I-P, Use III-P, and Use IV-P waters within the state of Maryland allow for contact water sports and leisure activities that allow direct contact with water; fishing; growth and propagation of non-trout fish and other aquatic and wildlife; and agricultural and industrial water supplies. Use III and Use III-P waters also allow for growth and propagation of trout. Use I-P, Use III-P and Use IV-P waters allow for use in public water supply. Use IV-P waters are also capable of supporting adult trout for a ‘put and take fishery’.

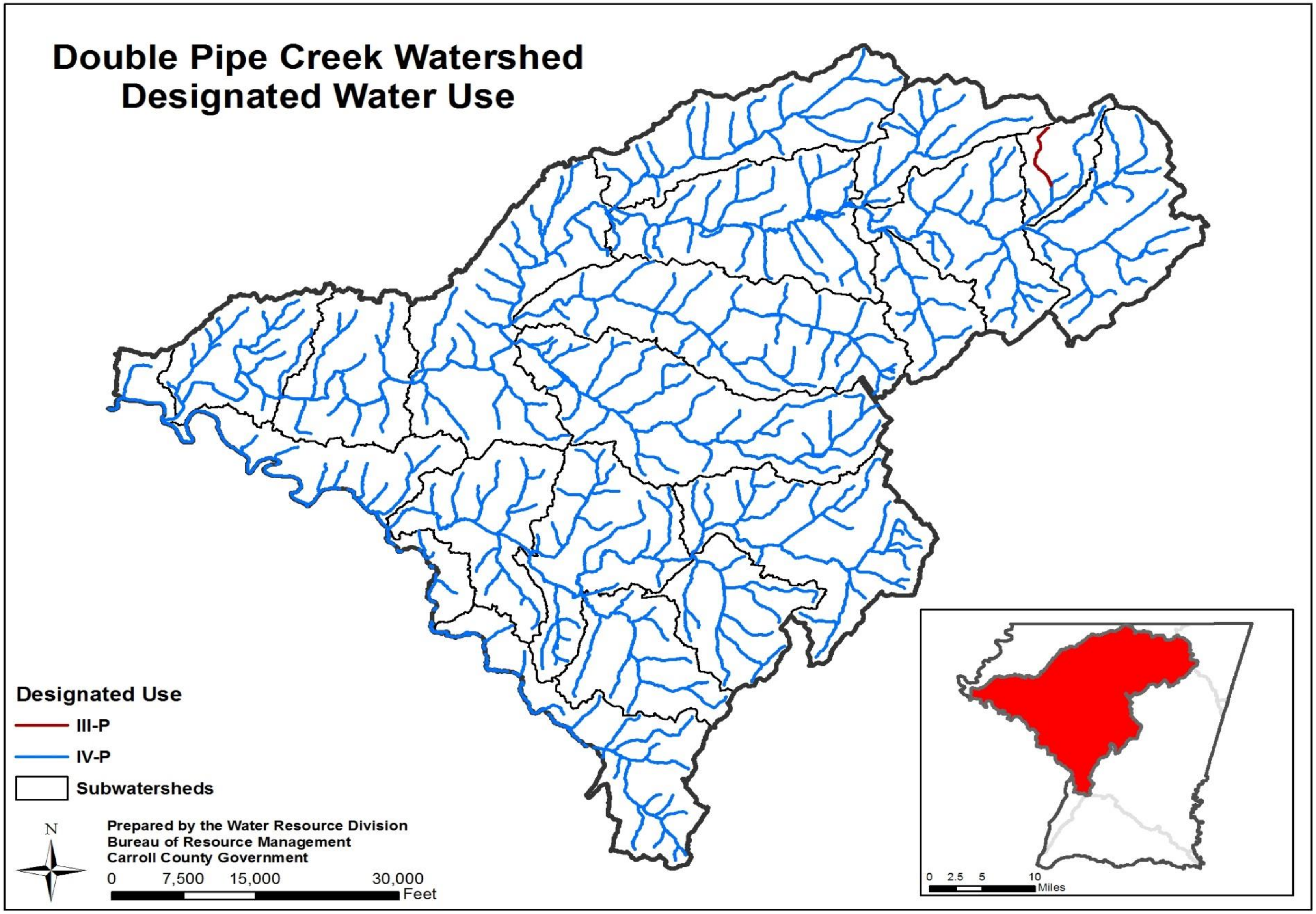

Figure 4-1: Double Pipe Creek Designated Water Use

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. There are currently no Tier II designated stream segments for the Double Pipe Creek Watershed.

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 Double Pipe Creek Watershed that have been assigned a TMDL include; Bacteria, Phosphorus, and Sediment.

a. Bacteria

The current estimated stormwater baseline load for bacteria within the Carroll County portion of Double Pipe Creek Watershed was determined by (MDE, 2009) to be 4,423,635 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 67,365 billion MPN/year, which is a reduction of 4,356,270 billion MPN/year (98.5%) 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 Double Pipe Creek Watershed.

Table 4-1: Double Pipe Creek 8-digit Watershed Bacteria TMDL

Double Pipe Creek Watershed			Percent Reduction
Jurisdiction	Baseline (Billion MPN/yr)	TMDL (Billion MPN/yr)	
Carroll County	4,423,635	67,365	98.5%
Total		**67,365**	**98.5%**

a. Phosphorus

The current estimated stormwater baseline load for Carroll County was determined by (MDE, 2012) to be 16,129 lbs. /yr., the TMDL for the stormwater WLA was determined to be 4,441 lbs. /yr., which is a reduction of 11,688 lbs. /yr. (72%) from the current loading (Table 4-2). The baseline loads for the County and Towns were derived from the TMDL Data Center. These baseline loads were combined and compared to the combined allocations for the County and Towns to derive the total percent reduction required. 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, 2012).

Table 4-2: Double Pipe Creek 8-digit Watershed Phosphorus TMDL

Jurisdiction	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Carroll County	9,316	2,329	75%
Municipalities	6,813	2,112	69%
Total	**16,129**	**4,441**	**72%**

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.

c. Sediment

The current estimated stormwater baseline load for Carroll County as determined by (MDE, 2008) is 4,759 tons/yr., the TMDL for the stormwater WLA was determined to be 3,149 tons/yr., which is a reduction of 1,610 tons/yr. (34%) from the current loading (Table 4-3).

Table 4-3: Double Pipe Creek 8-digit Watershed Sediment TMDL

Jurisdiction	Baseline	TMDL	Percent Reduction
Carroll County	4,759	3,149	34%
Total	**4,759**	**3,149**	**34%**

E. Water Quality Data

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 BRM currently monitors two locations within the Double Pipe Creek Watershed. The Farm Museum site, shown in Figure 4-2 is located within the Little Pipe Creek (0276) subwatershed just outside the corporate limits of Westminster. The Skatepark site, shown in Figure 4-3 is located within the Big Pipe Creek (0286) subwatershed and is almost entirely within the corporate limits of the Town of Manchester.

Both locations currently have no stormwater management control measures. The Farm Museum location is a public educational facility owned by the Carroll County Commissioners, with a drainage area of 23 acres, of which 4 or 17% is impervious. The Skatepark location is primarily low-density residential, which encompasses 37% of the land cover. The drainage area to the monitoring site is approximately 99 acres, of which, 27 acres or 27% is impervious.

Bi-weekly monitoring at the Farm Museum site began in February of 2015, while monitoring at the Skatepark location started in April of 2013. Both sites involve the collection of chemical grab samples with corresponding discharge measurements in order to calculate loadings. The chemical monitoring parameters, methods, and detection limits for both sites can be found in Table 4-4. Additional monitoring at these locations include 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
Bacteria[1]		

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

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

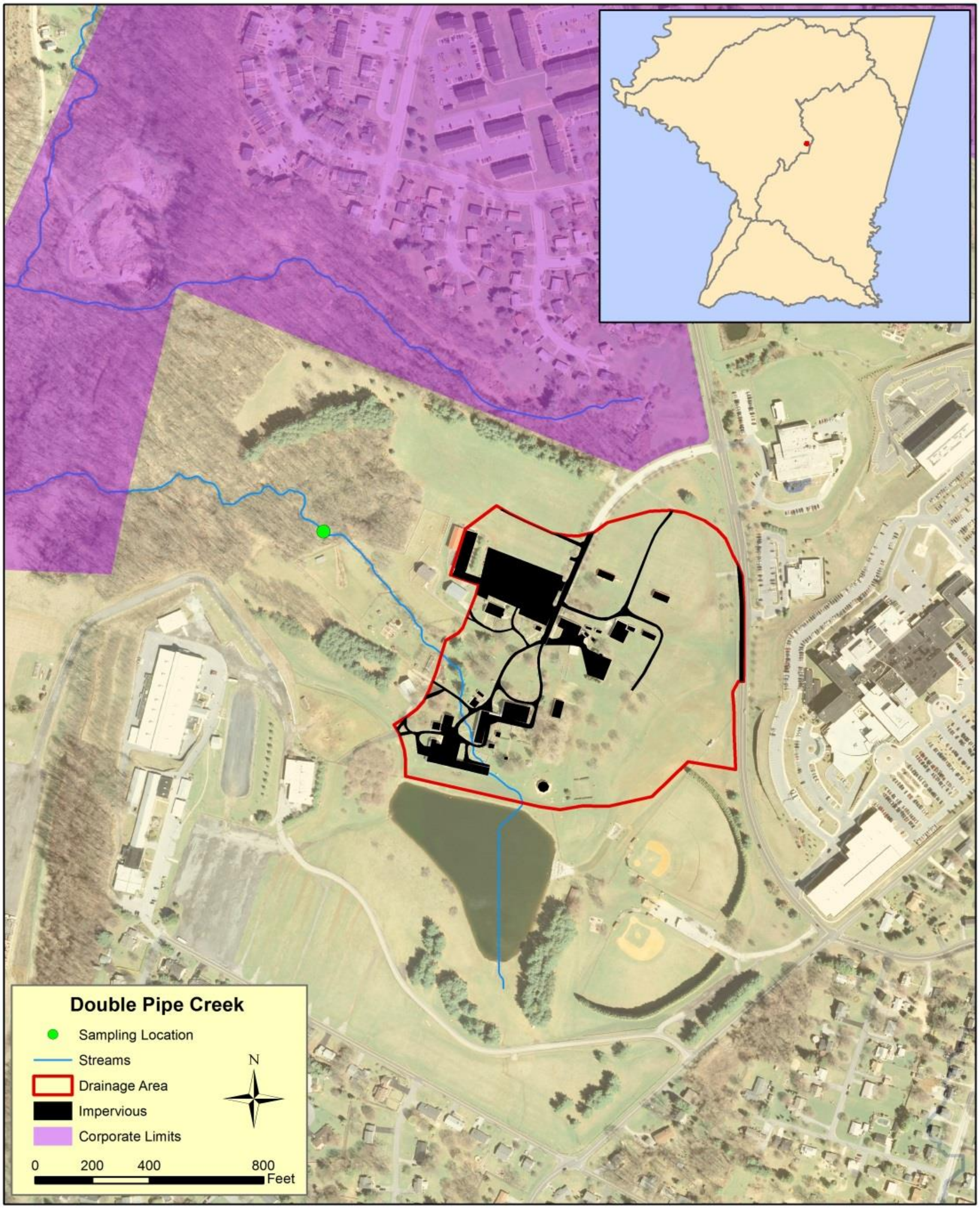

Figure 4-2: Farm Museum Monitoring Location

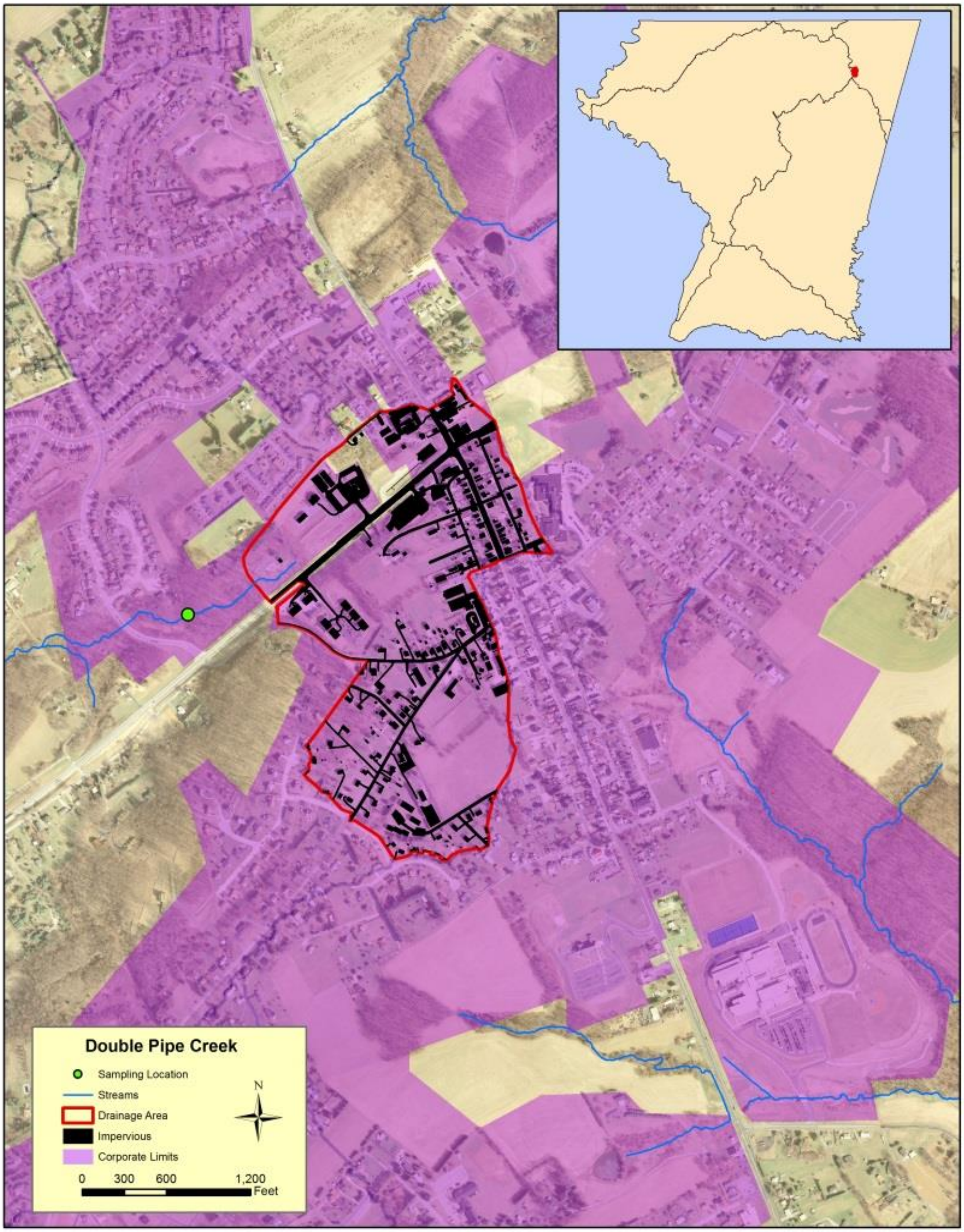

Figure 4-3: Skatepark Monitoring Location

2. Maryland Biological Stream Survey

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

The DNR has conducted three 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 sites within Double Pipe Creek Watershed are shown in Figure 4-4.

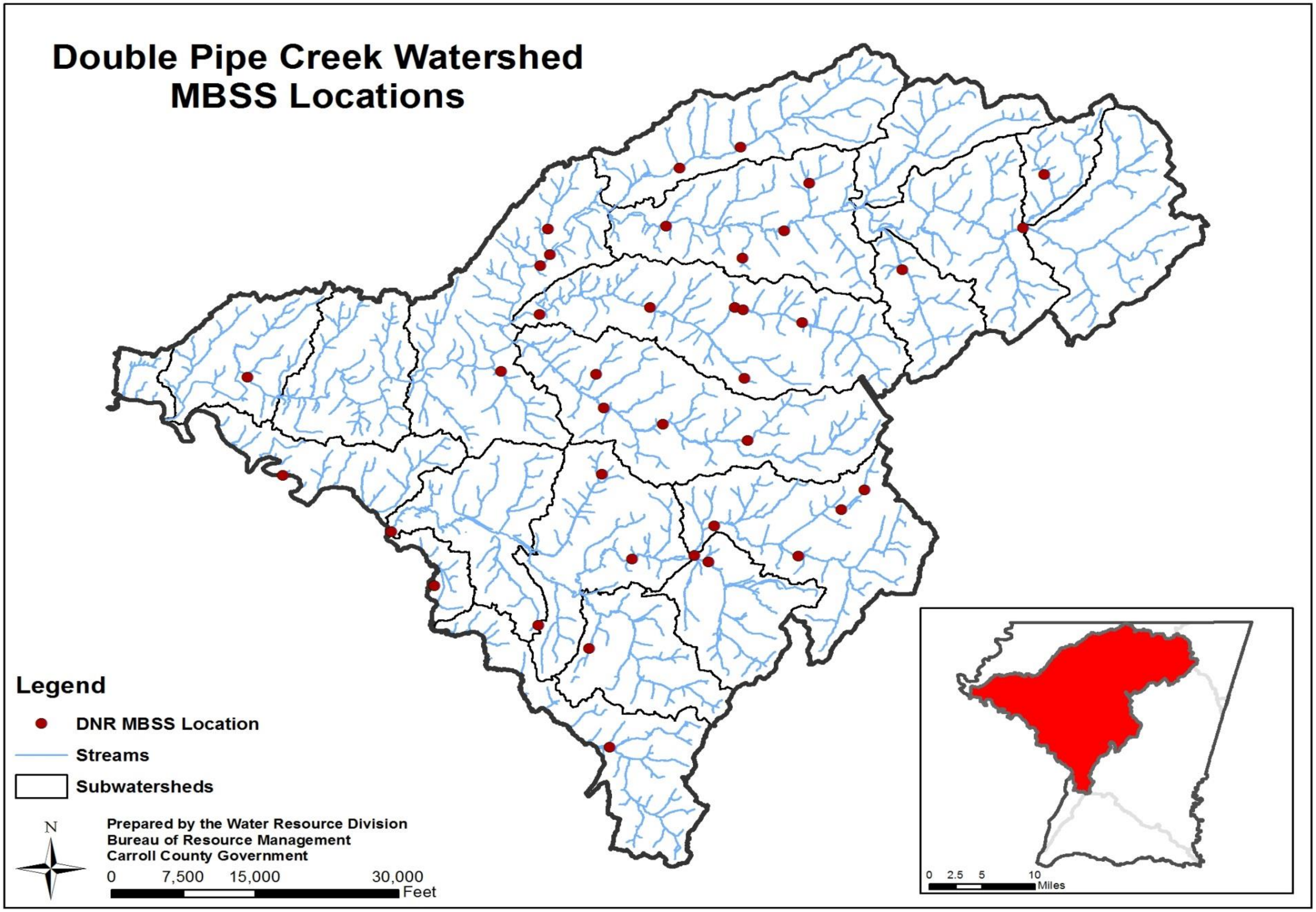

Figure 4-4: Double Pipe Creek Watershed DNR MBSS Locations

a. Chemical Results

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 standard, and a level generally considered healthy for aquatic life. Increased nutrient loads are also linked to 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 DNR MBSS chemical results for the Double Pipe Creek Watershed for the several rounds of sampling are displayed in Table 4-6. Table 4-5 displays all sampling sites as divided by subwatershed. When a location was sampled but chemical results were not obtained a "- -" is shown in lieu of data.

Table 4-5: Double Pipe Creek Watershed DNR's MBSS Chemical Results

12-Digit Scale	**Subwatershed**	**Field pH**	**Temperature (°C)**	**Dissolved Oxygen**	**Conductivity**
Site Identification	Stream Segment				
21403040281	**Bear Branch**				
CR-P-318-338-96	Bear Branch	7.62	18.4	7.9	212
CR-P-374-343-96	Bear Branch	7.49	18	9.9	196
CR-P-019-248-96	Bear Branch	6.95	13.1	8.7	204
DOUB-221-R-2002	Bear Branch	7.48	17.2	7.5	280
CR-P-019-201-96	Bear Branch	7.07	19.4	8.5	209
DOUB-120-R-2002	Bear Branch UT1	7.45	21.7	8.9	150
21403040282	**Bear Branch**				
DOUB-122-R-2002	Bear Branch	7.42	22.1	7.5	290

12-Digit Scale	Subwatershed	Field pH	Temperature (°C)	Dissolved Oxygen	Conductivity
Site Identification	Stream Segment				
21403040278	**Big Pipe Creek**				
CR-P-323-326-96	Big Pipe Creek	8.55	22.2	10.7	188
CR-P-180-124-96	Big Pipe Creek UT4	7.17	18.4	8	199
CR-P-205-319-96	Big Pipe Creek	8.1	20.9	10.4	188
CR-P-162-207-96	Big Pipe Creek UT1	7.58	19.6	9.1	346
21403040280	**Big Pipe Creek**				
DOUB-407-R-2002	Big Pipe Creek	7.69	22.8	4.9	270
21403040283	**Big Pipe Creek**				
DOUB-119-R-2002	Big Pipe Creek UT6	7.27	21.4	5.1	130
CR-P-284-328-96	Big Pipe Creek	7.85	13.7	7.5	180
CR-P-280-340-96	Big Pipe Creek	7.33	18	8.5	182
DOUB-103-R-2002	Big Pipe Creek UT8	7.26	18.8	6.9	190
21403040286	**Big Pipe Creek**				
DOUB-214-R-2002	Big Pipe Creek	7.35	16.2	8	220
21403040287	**Big Pipe Creek**				
DOUB-116-R-2002	Big Pipe Creek UT7	7.05	18.4	7.5	120
21403040274	**Cherry Branch/Ltl Pipe Creek**				
DOUB-404-R-2002	Little Pipe Creek	7.78	22.1	6.2	530
21403040271	**Dickenson Run**				
DOUB-105-R-2007	Dickenson Run UT1 (Five Daughters Run)	8.01	20.5	7.7	501
21403040272	**Little Pipe Creek**				
CR-P-274-104-96	Roop Branch	7.28	12.5	8.95	370
DOUB-314-H-2010	Little Pipe Creek	8.05	--	--	515
21403040276	**Little Pipe Creek**				
CR-P-263-332-96	Little Pipe Creek	8.11	21.5	12.4	441
CR-P-295-128-96	Copps Branch	7.72	24.3	5.9	538

12-Digit Scale	**Subwatershed**	**Field pH**	**Temperature (°C)**	**Dissolved Oxygen**	**Conductivity**
Site Identification	Stream Segment				
DOUB-197-B-2012	Copps Branch	8.06	--	--	781
DOUB-296-B-2010	Little Pipe Creek	8	--	--	402
21403040277	**Meadow Branch**				
DOUB-101-R-2002	Meadow Branch UT1	7.24	21.8	3.5	530
DOUB-217-R-2002	Meadow Branch	8.3	25.1	9.1	320
CR-P-365-219-96	Meadow Branch	7.76	24.3	8.5	271
DOUB-113-R-2002	Meadow Branch UT2	7.57	18.9	7.8	270
21403040273	**Priestland/Wolf Pit Branch**				
CR-P-158-123-96	Priestland Branch	7.63	16	8.1	680
21403040268	**Sams Creek**				
CR-P-434-138-96	Sams Creek	7.4	22.5	7.7	214
21403040269	**Sams Creek**				
FR-P-474-302-96	Sams Creek	7.51	19	9	372
CR-P-021-329-96	Sams Creek	7.9	20.5	9.6	308
21403040285	**Silver Run**				
DOUB-218-R-2002	Big Silver Run	7.67	19.8	6.4	340
CR-P-035-216-96	Big Silver Run	8.14	18.2	9.4	196
21403040275	**Turkeyfoot Run**				
CR-P-094-349-96	Turkeyfoot Run	7.47	17	9.4	398
DOUB-212-R-2002	Turkeyfoot Run	8.28	23.9	10.6	460

Table 4-6: Double Pipe Creek Watershed DNR's MBSS Chemical Results Summary

	Field pH	**Temperature (°C)**	**Dissolved Oxygen**	**Conductivity**
Maximum	8.55	25.1	12.4	781
Minimum	6.95	12.5	3.5	120
Average	7.65	19.7	8.2	321

The Double Pipe Creek Watershed DNR MBSS data demonstrates there is sufficient dissolved oxygen in most locations to adequately support life. Only two locations sampled, Meadow Branch UT1 and a section of Big Pipe Creek, had observed dissolved oxygen levels less than the COMAR standard of 5.0 mg/l, a level generally considered healthy for aquatic life. During the majority of sampling events, the water temperature was below 20°C, averaging around 19.7°C in the watershed. Stream waters below 20°C are generally considered optimal for fish and most other aquatic benthos. The pH of the water was relatively neutral, albeit slightly alkaline. pH values at sample locations averaged 7.65, ranging as acidic as 6.95 to a more alkaline pH of 8.55. The relatively low pH range suggests overall pH stability in the Double Pipe Creek Watershed. The range of observed conductivities at the sampled locations is typical of most freshwater streams. Locations sampled from 2007 – 2012 all had higher conductivities than the overall average of 321 μS/cm.

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 Double Pipe Creek 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 4-4. Specific IBI information for fish and benthic macroinvertebrates from the sites surveyed within the Double Pipe Creek Watershed are listed in Table 5-1.

Table 5-1: Double Pipe Creek 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
21403040281	**Bear Branch**						
CR-P-318-338-96	Bear Branch	4.67				3.00	
CR-P-374-343-96	Bear Branch	5					2.5
CR-P-019-248-96	Bear Branch		3.67			3.75	
DOUB-221-R-2002	Bear Branch		3.67			3.75	
CR-P-019-201-96	Bear Branch		3.67			3.75	
DOUB-120-R-2002	Bear Branch UT1			1.67			1.5
21403040282	**Bear Branch**						
DOUB-122-R-2002	Bear Branch		3.67				2.75
21403040278	**Big Pipe Creek**						
CR-P-323-326-96	Big Pipe Creek	4.67				3.00	
CR-P-180-124-96	Big Pipe Creek UT4	4.33					2.75
CR-P-205-319-96	Big Pipe Creek	4.33				3.00	
CR-P-162-207-96	Big Pipe Creek UT1		3.33				1.75
21403040280	**Big Pipe Creek**						
DOUB-407-R-2002	Big Pipe Creek		3.67			3.25	
21403040283	**Big Pipe Creek**						
DOUB-119-R-2002	Big Pipe Creek UT6		3.67		4.25		
CR-P-284-328-96	Big Pipe Creek	5				3.25	
CR-P-280-340-96	Big Pipe Creek	5				3.75	
DOUB-103-R-2002	Big Pipe Creek UT8			1			1.75
21403040286	**Big Pipe Creek**						
DOUB-214-R-2002	Big Pipe Creek		3.67				2.75
21403040287	**Big Pipe Creek**						
DOUB-116-R-2002	Big Pipe Creek UT7	4				3.5	

12-Digit Scale	**Subwatershed**	**Fish IBI**			**Benthic IBI**		
Site Identification	Stream Segment	Good	Fair	Poor	Good	Fair	Poor
21403040274	**Cherry Branch/Ltl Pipe Creek**						
DOUB-404-R-2002	Little Pipe Creek		3.33				2.25
21403040271	**Dickenson Run**						
DOUB-105-R-2007	Dickenson Run UT1 (Five Daughters Run)			2			2
21403040272	**Little Pipe Creek**						
CR-P-274-104-96	Roop Branch			1.67			1.25
DOUB-314-H-2010	Little Pipe Creek	--	--	--			2
21403040276	**Little Pipe Creek**						
CR-P-263-332-96	Little Pipe Creek		3.33				1.75
CR-P-295-128-96	Copps Branch			1.33			1.5
DOUB-197-B-2012	Copps Branch		3.33				2.25
DOUB-296-B-2010	Little Pipe Creek		3.67				2.25
21403040277	**Meadow Branch**						
DOUB-101-R-2002	Meadow Branch UT1			2			2.25
DOUB-217-R-2002	Meadow Branch		3.67				2.75
CR-P-365-219-96	Meadow Branch	5					2.25
DOUB-113-R-2002	Meadow Branch UT2		3.67				2.75
21403040273	**Priestland/Wolf Pit Branch**						
CR-P-158-123-96	Priestland Branch			1			1.5
21403040268	**Sams Creek**						
CR-P-434-138-96	Sams Creek			1			1.75
21403040269	**Sams Creek**						
FR-P-474-302-96	Sams Creek		3				1.75
CR-P-021-329-96	Sams Creek		3				1
21403040285	**Silver Run**						
DOUB-218-R-2002	Big Silver Run	4					2.75

12-Digit Scale	**Subwatershed**	**Fish IBI**			**Benthic IBI**		
Site Identification	Stream Segment	Good	Fair	Poor	Good	Fair	Poor
CR-P-035-216-96	Big Silver Run	5					1.5
21403040275	**Turkeyfoot Run**						
CR-P-094-349-96	Turkeyfoot Run	5					1.75
DOUB-212-R-2002	Turkeyfoot Run	4					2

In total there are 38 samples contributing to the MBSS IBI data set from 1995 to 2012. Within the Double Pipe Creek Watershed, 43% of the fish samples were in 'fair' condition, with an overall average rating of 3.45. Of the benthic samples, 71% were in 'poor' condition with an overall average rating of 2.45. The IBI for fish throughout the years and locations sampled were mostly within the 'fair' range, suggesting some adverse impacts to the fish population. The benthic IBI for the Double Pipe Creek Watershed is predominately within the 'poor' range, suggesting some more serious adverse impacts to the benthic community within the watershed. The Sams Creek (21403040268) and Priestland/Wolf Pit Branch (21403040273) subwatersheds are noted as having the lowest overall IBI ratings. The Big Pipe Creek (21403040287) subwatershed is noted as having the highest overall IBI rating.

b. Carroll County Results

Carroll County's Bureau of Resource Management conducted MBSSs in Double Pipe Creek Watershed from 2004 – 2015. Site locations for the Carroll County MBSS sites specific for Benthic IBI are shown in Figure 5-1. Specific IBI information for benthic macroinvertebrates from the sites surveyed within the Double Pipe Creek Watershed are listed in Table 5-2.

Table 5-2: Double Pipe Creek Watershed Carroll County's MBSS Benthic IBI

12-Digit Scale	**Subwatershed**	**Benthic IBI**		
Sample Year	Site Identification	Good	Fair	Poor
21403040282	**Bear Branch**			
2004	BBA01		3.66	
2008	BBA01		3.22	
2010	BBA01			2
2011	BBA01		3.33	
2012	BBA01			2.67
2013	BBA01			2.67
2014	BBA01			2.67
2015	BBA01			1.67
2004	BBA02		3.44	

12-Digit Scale	Subwatershed	Benthic IBI		
Sample Year	Site Identification	Good	Fair	Poor
2008	BBA02		3	
2010	BBA02		3.67	
2011	BBA02		3.33	
2012	BBA02		3.33	
2013	BBA02			2.67
2014	BBA02		3.33	
2015	BBA02		3	
2012	BPC08		3	
21403040284	**Big Pipe Creek**			
2004	BPC01	4.11		
2008	BPC01		3.67	
2010	BPC01			2.33
2012	BPC01		3.67	
2013	BPC01		3.67	
2015	BPC01		3	
2004	BPC02		3.22	
2008	BPC02		3.44	
2010	BPC02	4.33		
2004	BPC03		3.44	
2008	BPC03		3.22	
2010	BPC03		3.33	
2004	BPC04		3.44	
2008	BPC04		3.22	
2004	BPC05			2.78
2008	BPC05		3.22	
2010	BPC05		3	
2004	BPC06	4.11		
2008	BPC06		3.44	
2010	BPC06		3.33	
21403040286	**Big Pipe Creek**			
2004	BPA01		3.66	

12-Digit Scale	**Subwatershed**	**Benthic IBI**		
Sample Year	Site Identification	Good	Fair	Poor
2008	BPA01			2.78
2004	BPA02		3.66	
2008	BPA02		3.22	
2010	BPA02		3.67	
2008	BPA03		3.67	
2013	BPC07			2.67
2014	BPC07			2.67
2015	BPC07			2.67
21403040276	**Little Pipe Creek**			
2012	LPC01			1.00
2013	LPC01			1.67
2014	LPC01			2.00
2015	LPC02			2.33
21403040277	**Meadow Branch**			
2013	MDB01			2.00
Double Pipe Creek Watershed Total Counts:		**3**	**31**	**17**
Double Pipe Creek Watershed Average:		**4.18**	**3.37**	**2.31**

In total there are 51 samples contributing to the County's MBSS data set from 2004 to 2015. Within the Double Pipe Creek Watershed, the overall benthic IBI rating was 3.07, putting the watershed in 'fair' condition. The benthic IBI for the Double Pipe Creek Watershed is for the most part within the 'fair' to 'poor' range, suggesting some adverse impacts to the benthic community within the watershed.

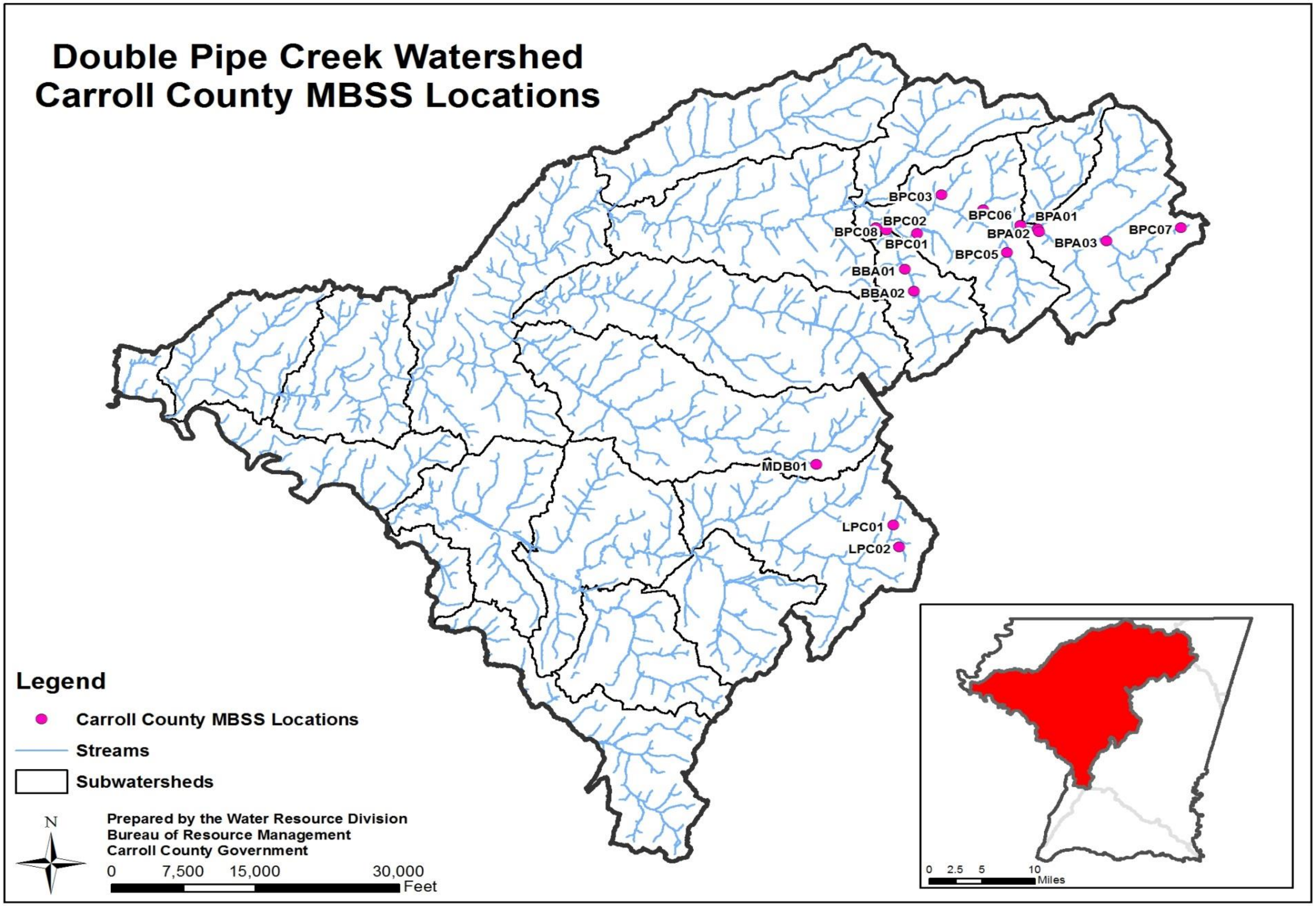

Figure 5-1: Double Pipe Creek Watershed Carroll County MBSS Locations

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

RTE 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 Double Pipe Creek Watershed the Bear Branch (0281, 0282), Big Pipe Creek (0278, 0279, 0283, 0284, 0286, 0287), Deep Run (0288), Double Pipe Creek (0248), Little Pipe Creek (0276), and Meadow Branch (0277) subwatersheds are identified as having sensitive state-listed species, and special protection is necessary to ensure the persistence of these communities. A complete list of all RTE plants and animals within Carroll County and throughout the state of Maryland can be found at: http://dnr.maryland.gov/wildlife/Plants_Wildlife/espaa.asp

Figure 5-2 shows targeted ecological areas for sensitive species within the Double Pipe Creek Watershed. Sensitive species areas were designated by the DNR.

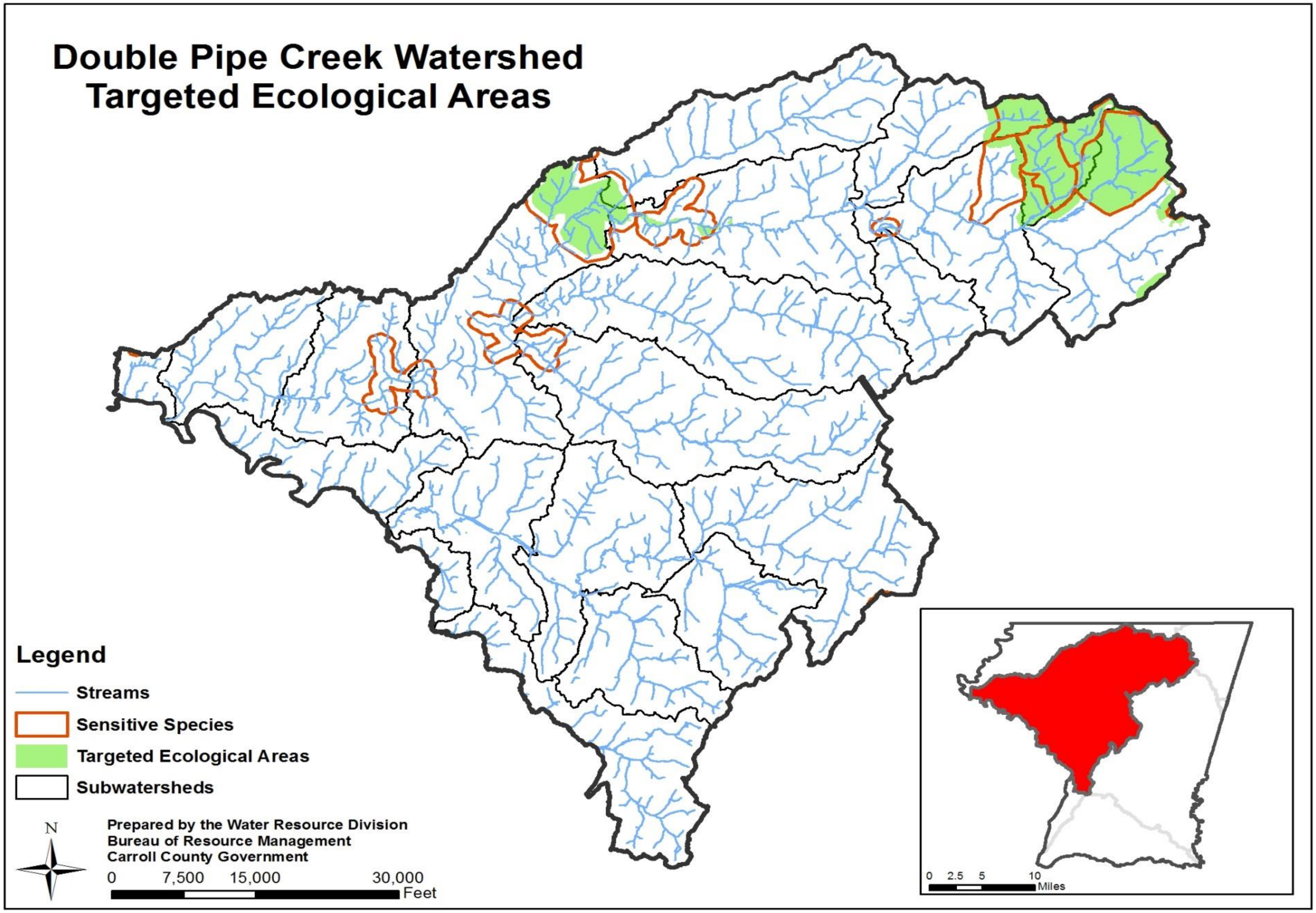

Figure 5-2: Double Pipe Creek Watershed Targeted Ecological Areas

D. Stream Corridor Assessment

A Stream Corridor Assessment (SCA) of the Double Pipe Creek Watershed was conducted during the winter of 2016 by Carroll County Bureau of Resource Management staff. The Double Pipe Creek 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 1,781 landowners within the Double Pipe Creek 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 5-3. 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 266 of the 514 stream miles within the Double Pipe Creek Watershed. Due to unforeseen circumstances, only 170 miles of the Double Pipe Creek Watershed were actually assessed.

The most common impairments identified during the assessment are shown in Figure 5-4 and consisted primarily of erosion sites and inadequate streamside buffers followed by fish barriers. Table 5-3 lists the data points by severity across the entire watershed, and Table 5-4 presents a summary of the number of impacts identified in each subwatershed.

Table 5-3: Data Points by Severity

Identified Impacts	Total	Very Severe	Severe	Moderate	Low	Minor
Erosion	**234**	51	27	73	38	45
Inadequate Buffer	**194**	61	31	65	22	15
Pipe Outfall	**54**	4	3	6	4	37
Fish Barrier	**73**	2	7	25	25	14
Trash Dump	**27**	2	3	7	2	13
Channel Alteration	**21**	0	1	3	9	8
Construction	**0**	0	0	0	0	0
Exposed Pipe	**20**	1	1	1	7	6
Unusual Condition	**31**	2	0	10	5	11
Total	**654**	**123**	**73**	**190**	**113**	**149**

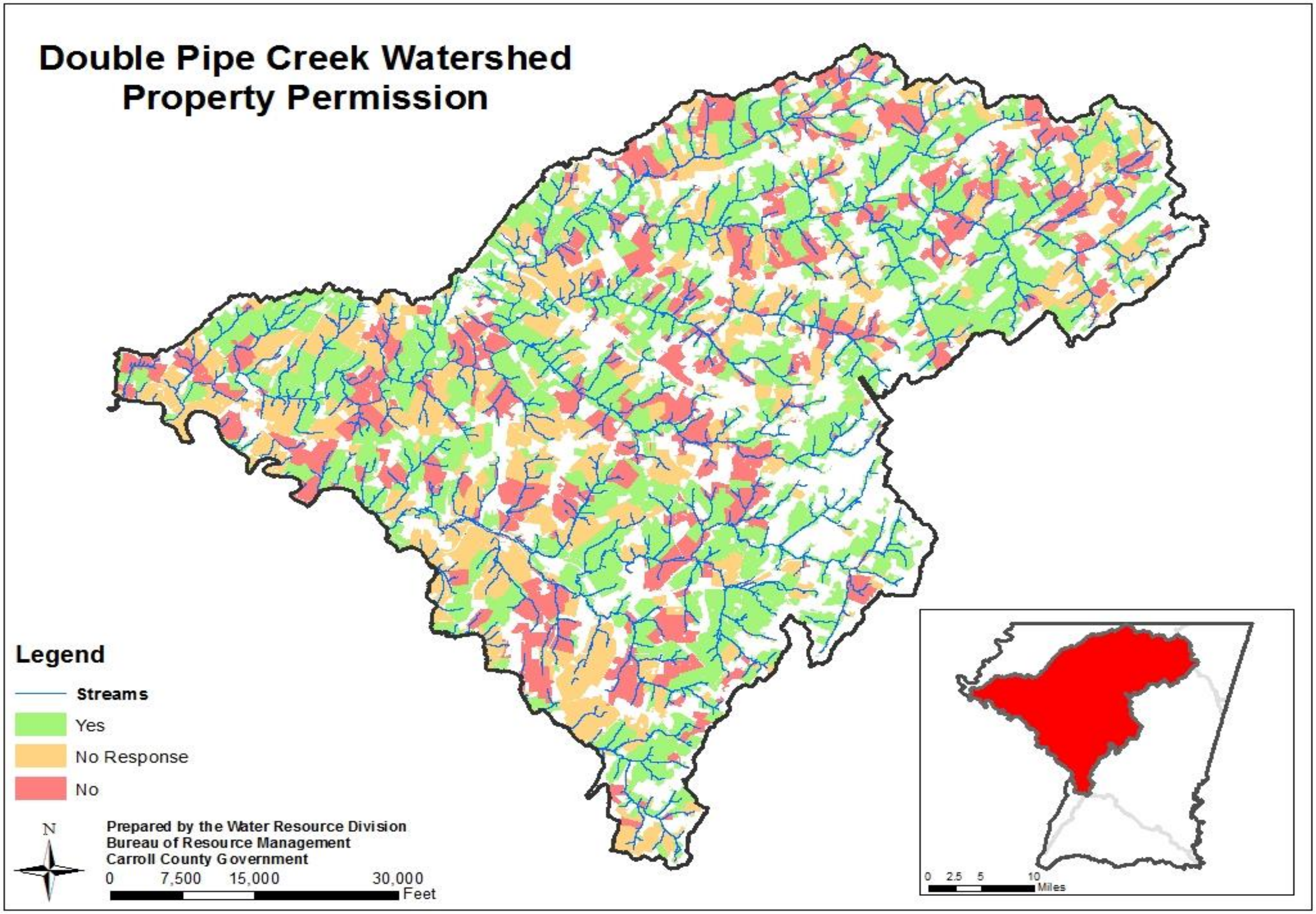

Figure 5-3: Landowner Participation

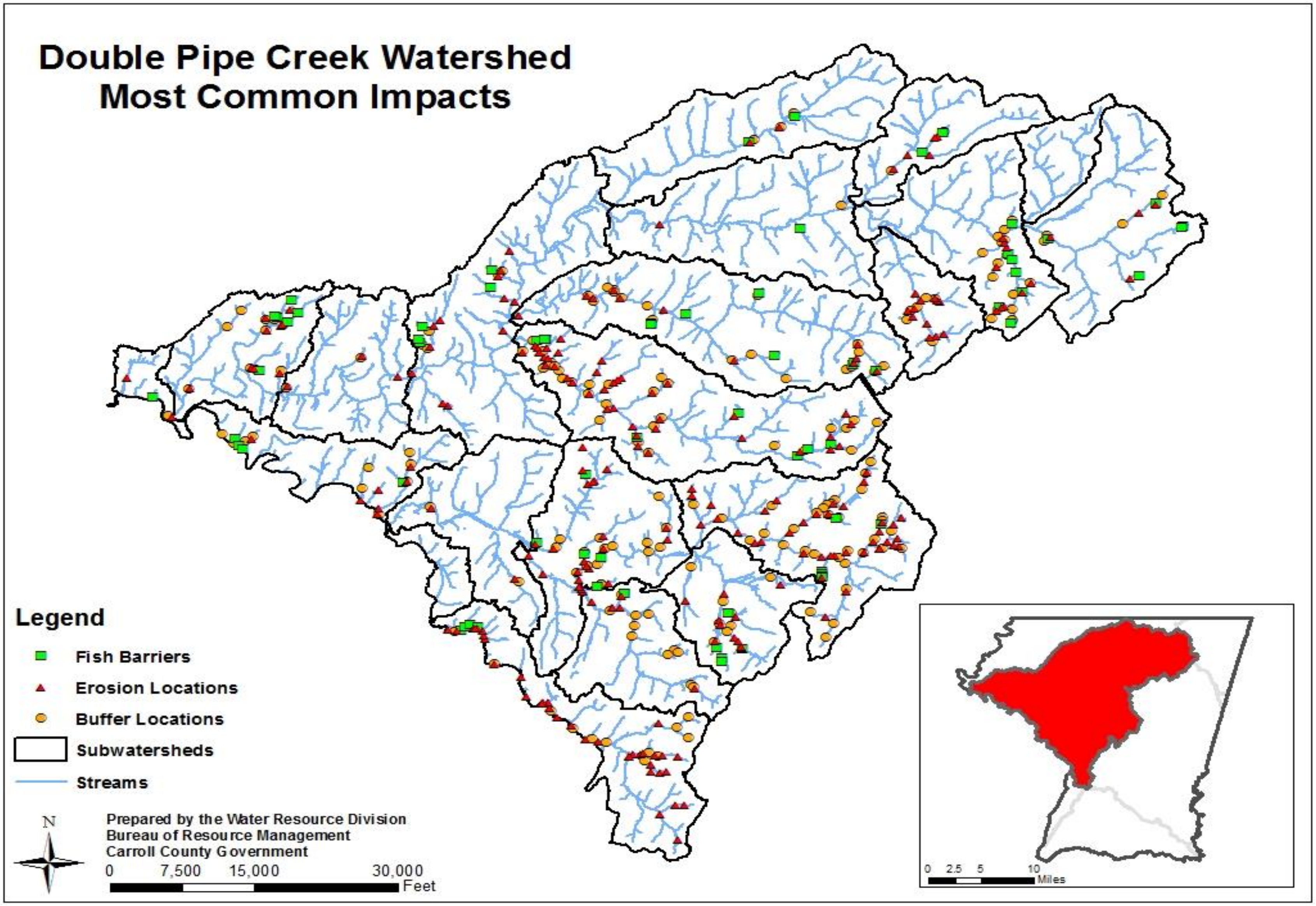

Figure 5-4: Most Commonly Identified Impacts

Table 5-4: Stream Corridor Assessment – Identified Impacts

DNR 12-Digit	In-Stream Construction	Erosion	Fish Barrier	Inadequate Buffer	Trash Dump	Channel Alteration	Pipe Outfall	Exposed Pipe	Total
0281	0	11	8	18	0	4	3	2	**46**
0282	0	12	0	6	0	0	1	2	**21**
0278	0	12	5	5	3	0	3	0	**28**
0279	0	3	0	2	2	0	0	0	**7**
0280	0	10	6	11	4	0	8	0	**39**
0283	0	1	1	1	0	0	0	0	**3**
0284	0	9	7	16	0	0	2	0	**34**
0286	0	4	5	4	0	0	0	0	**13**
0287	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
0274	0	7	4	10	0	1	1	2	**25**
0288	0	5	3	2	0	0	0	0	**10**
0271	0	9	3	12	2	1	1	7	**35**
0248	0	1	1	0	0	0	3	0	**5**
0272	0	21	4	17	2	1	4	0	**49**
0276	0	39	6	33	8	10	15	4	**115**
0277	0	38	9	29	2	2	6	2	**88**
0273	0	2	0	2	0	1	2	0	**7**
0268	0	37	4	14	2	0	2	0	**56**
0269	0	0	0	0	0	0	0	0	**0**
0285	0	2	2	4	0	1	2	0	**11**
0275	0	11	5	8	2	0	1	1	**28**
Total	**0**	**234**	**73**	**194**	**27**	**21**	**54**	**20**	**623**

VI. Characterization Summary

A. Summary

This Characterization Plan was developed to describe the unique background of the Double Pipe Creek 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 Double Pipe Creek Watershed stream corridor assessment, as well as the development of this Double Pipe Creek Watershed Characterization Plan.

Field Time: Assessment was completed over a span of 3 months; field crew averaged 3 days per week for a total of 36 field days.

Field Hours: Field crew averaged 4 hours/day over the 36 days for a total of 144 hours. Field crew consisted of 2 – 3 two person teams performing the assessment for a cumulative total of 432 field hours. Total cost of staff time in field was roughly $13,000 (432 hours at an average of $30/hour).

Plan Development: Watershed plan development took approximately 1 month ($3,400 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 Double Pipe Creek stream corridor assessment and the Watershed Characterization Plan was approximately $16,400.

VII. References:

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Appendix A:

Double Pipe Creek Watershed Stormwater Management Facilities/Definitions

Double Pipe Creek Watershed Stormwater Management Facilities

Facility Type	Drainage Area (Acres)	Impervious Area (Acres)	Project Name	Site #
Water Quality Basin	1.67	0	WESTCHESTER SQ.PHASE 2	272
Water Quality Basin	2.21	0	WESTCHESTER SQ.PHASE 2	273
Dry Detention Pond	41.4	4	C.C.REGIONAL AIRPORT	433
Dry Detention Pond	55.2	18.3	C.C.REGIONAL AIRPORT	435
Dry Detention Pond	4.1	0	C.C.REGIONAL AIRPORT	437
Dry Detention Pond	5.3	0	C.C.REGIONAL AIRPORT	439
Dry Detention Pond	38.4	7.4	C.C.REGIONAL AIRPORT	440
Dry Detention Pond	13.75	0.27	CARROLL CO. FOODS,ADD.	639
Dry Detention Pond	40.5	23.8	CARROLL LUTHERAN VILLAGE2	218
Swale	5.01	0.34	KALTEN ACRES SECTION 1	182
Detention Tank	1.83	0	WEST CHESTER SQUARE	562
Detention Tank	1.4	1.4	PARK AVENUE ESTATES	141
Dry Detention Pond	35	14.25	PARR'S RIDGE	670
Swale	0.64	0.107	ROOP-RINEHART HOUSE	589
Infiltration Dry Well	4.05	1.8	MCDANIEL LIBRARY ADDITION	0
Dry Detention Pond	82.57	0	GRAND VALLEY FARMS,SEC.2	98
Dry Detention Pond	0	0	C.C. MAINTENANCE FACILITY	102
Dry Detention Pond	14.1	0	RYLAND HOMES	356
Dry Detention Pond	0	0	HUGHES BROTHERS, INC.	362
Dry Detention Pond	0	0	CRAFT WORLD	363
Dry Detention Pond	62.4	17	MCGREGOR PRINTING	374
Dry Detention Pond	0	0	MCGREGOR PRINTING	711
Dry Detention Pond	41	15.6	GREENS OF WEST. SEC.VI #2	650
Infiltration Basin	0.78	0.22	MEDFORD QUARRY MAIN. SHOP	427
Swale	17	2.18	BEAR CREEK GOLF COURSE	621
Infiltration Trench	3.86	0	301-305 E. MAIN ST.	490
Infiltration Trench	0.69	0.25	BRADCLIFF	569
Infiltration Trench	3.8	0	HUNTER PROFESSIONAL CTR.	467
Infiltration Trench	3.8	0	HUNTER PROFESSIONAL CTR.	467
Infiltration Trench	3.8	0	HUNTER PROFESSIONAL CTR.	467
Infiltration Trench	3.8	2.2	HUNTER PROFESSIONAL CTR.	467
Porous Pavement	0.46	0.45	BREWER'S MARKET	540
Infiltration Dry Well	3.95	0.61	MCDANIEL COLLEGE BAIR STADIUM	960
Infiltration Dry Well	3.95	0.61	MCDANIEL COLLEGE BAIR STADIUM	961
Extended Detention Pond	22.1	5.73	MEADOW RIDGE	171
Extended Detention Pond	18.2	5.35	MEADOW RIDGE	172
Extended Detention Pond	4.6	1.75	MEADOW RIDGE	173
Extended Detention Pond	52.95	17.64	EAGLEVIEW PHASE ONE	20
Extended Detention Pond	53.44	11.42	EAGLEVIEW PHASE TWO	21
Extended Detention Pond	5.2	0	UNION BRIDGE SUPER THRIFT	44

Facility Type	Drainage Area (Acres)	Impervious Area (Acres)	Project Name	Site #
Extended Detention Pond	45.67	13.09	FURNACE HILLS SECTION TWO	48
Extended Detention Pond	4.18	2.26	WINDSOR VIEW EST. SEC. 2	601
Extended Detention Pond	8.03	5.62	NEW WINDSOR MIDDLE SCHOOL	76
Extended Detention Pond	9.76	4.56	ELMER WOLF ELEMENTARY	209
Extended Detention Pond	22.2	8.44	CROSSROADS OVERLOOK POND 1	228
Extended Detention Pond	0	73	GREENS OF WESTMINSTER, SEC. 5	0
Extended Detention Pond	10.4	0	RUNYMEADE ELEMENTARY	38
Extended Detention Pond	4.8	0	RUNYMEADE ELEMENTARY	39
Extended Detention Pond	21.27	17	SNAVELY FOREST PRODUCTS	758
Extended Detention Pond	66.8	13.59	LEHIGH CEMENT CO. FAC 1A	641
Extended Detention Pond	24.4	22.21	LEHIGH CEMENT CO. FAC 2A	643
Extended Detention Pond	21	5.26	LEHIGH CEMENT CO. FAC 3	644
Extended Detention Pond	20.4	14.27	LEHIGH CEMENT CO. FAC 4	645
Extended Detention Pond	30.87	19.17	LEHIGH CEMENT CO. FAC 5	646
Filtration Basin	5.19	7.18	COVENTRY	343
Filtration Basin	63.19	0	SUN VALLEY SECT. 2	323
Filtration Basin	19.52	0	WAKEFIELD OVERLOOK	574
Filtration Basin	54.48	30.88	WAKEFIELD OVERLOOK	583
Filtration Basin	7.9	0	MILLER ASPHALT WESTMINSTE	410
Swale w Check Dams	2.48	0	GIBBS PROPERTY	461
Infiltration Trench w UGS	1.83	1.338	BELLA VITA	447
Infiltration Basin	4.71	0	JEHOVAH WITNESS	618
Infiltration Basin	1.7	1.07	FIRST UNITED PRESBYTERIAN	14
Infiltration Basin	2.72	1.24	LONGVIEW NURSING HOME	672
Infiltration Basin	21.6	7.57	FAIRWAYS AT WAKEFIELD:	682
Infiltration Basin	5.07	0.59	BARK HILL PARK	825
Infiltration Basin	2.43	1.51	CARROLL COUNTY PUBLIC TRANSPORATION	927
Infiltration Basin	7.57	0.53	ALBERT RILL RD.	934
Infiltration Basin	6.75	2.04	CLIVEDEN #2	18
Infiltration Basin	58	7.31	CLIVEDEN #1	22
Infiltration Basin	7.5	0	DAVID GREEN PROFESSIONAL CENTER	844
Infiltration Basin	52.8	0	DOVES CREST	442
Infiltration Basin	7.45	0	SPRINGDALE VILLAGE	80
Infiltration Trench	0.33	0.22	B. B. & T.	57
Infiltration Trench	11.09	1.3	CARROLLYN MANOR SEC. 6	616
Infiltration Trench	1.88	1.05	C.C. CHILDREN'S CENTER	695
Infiltration Trench	3.26	0.3	MCDANIEL COLLEGE HARRISON HOUSE PAR	538
Infiltration Trench	3.2	2.64	NEW WINDSOR FIRE CO.	577
Infiltration Trench	0.38	0.26	COLONEL ROSSER LANE PARK.	598
Infiltration Trench	0.84	0.429	MONTESSORI SCHOOL OF WEST	605
Infiltration Trench	0.45	0.33	MAIDEN LANE PROF. CENTER	737

Facility Type	Drainage Area (Acres)	Impervious Area (Acres)	Project Name	Site #
Infiltration Trench	19.5	0	CARROLL HOSPITAL CTR-EAST	740
Infiltration Trench	0.85	0.296	CARROLL HOS. CENT. THRIFT	609
Infiltration Trench	3.26	0.3	MCDANIEL COLLEGE HARRISON HOUSE PAR	538
Infiltration Trench	3.62	0	SUN VALLEY ASSIST. LIVING	732
Infiltration Trench	9.81	0	THE OVERLOOK @ KINGS PARK	768
Infiltration Trench	3.26	0.3	MCDANIEL COLLEGE HARRISON HOUSE PAR	538
Infiltration Trench	1.7	0	FIRST UNITED PRESBYTERIAN	14
Infiltration Trench	1.42	0	DAVID GREEN PROFESSIONAL CENTER	841
Infiltration Trench	0.52	0	DAVID GREEN PROFESSIONAL CENTER	842
Infiltration Trench	0.64	0	DAVID GREEN PROFESSIONAL CENTER	843
Infiltration Trench	4.47	1.03	SUN VALLEY ASSISTED LIVING	898
Infiltration Trench	1.88	<Null>	VILLAGE OF MEADOW CREEK 2	614
Infiltration Trench	1.41	0	ST MARY'S U.C.C	36
Infiltration Trench	1.41	0	ST MARY'S U.C.C	36
Infiltration Trench	2.2	1.17	MILLERS MARKET	293
Infiltration Trench w UGS	2.01	1.72	C.C. HEALTH DEPT	241
Infiltration Basin	7.5	2.85	CROSSROADS OVERLOOK POND 2	229
Infiltration Basin	17.6	6.68	CROSSROADS OVERLOOK POND 3	230
Infiltration Basin	49.66	11.35	HALLIE HILL FARM	415
Infiltration Basin	28.88	0	WESTMINSTER HIGHLANDS I	140
Infiltration Basin	13.83	1.44	CROSSROADS OVERLOOK POND 4	129
Infiltration Basin	6.97	3.03	MANCHESTER MANOR	194
Infiltration Basin	1	0.3	KEYMAR POST OFFICE	153
Porous Pavement	17.1	17.1	SHELTER SYSTEMS	575
Porous Pavement	0.28	0.2	PRITTS FUNERAL HOME	951
Retention Pond	47.56	11.26	MCDANIEL COLLEGE	513
Retention Pond	30.79	7.69	BLUE RIDGE MANOR	45
Retention Pond	0.8	0.8	JOHANNA'S JOY 2	341
Retention Pond	2.62	0.58	CROSSROADS OVERLOOK POND 5	130
Retention Pond	8.67	2.24	CROSSROADS OVERLOOK POND 6	131
Retention Pond	82.01	18.11	FRIENDSHIP OVERLOOK	220
Retention Pond	14.7	6.2	FRANCIS SCOTT KEY H.S.	238
Infiltration Trench	0.17	0.17	SAFE HAVEN	478
Sand Filter	0.44	0	WESTMINSTER SQUARE	357
Sand Filter	0.55	0.55	CARROLL CO. ONCOLOGY CTR	282
Sand Filter	0.55	0.55	WEST GREEN ST IMP	731
Infiltration Trench w SF	4.06	0	CARROLL CO. AG. CENTER	655
Infiltration Trench w SF	2.143	0	BOWLING BROOK	729
Infiltration Trench w SF	2.143	0	BOWLING BROOK	729
Sand Filter	2	2	SNAVELY FOREST PRODUCTS	757
Infiltration Trench w SF	4.062	1.06	FURNACE HILLS SECT.4	416

Facility Type	Drainage Area (Acres)	Impervious Area (Acres)	Project Name	Site #
Infiltration Trench w SF	5.54	0.63	CARROLL LUTHERAN SCHOOL	661
Infiltration Trench w SF	5.54	0.81	CARROLL LUTHERAN SCHOOL	661
Infiltration Trench w SF	5.54	0.67	CARROLL LUTHERAN SCHOOL	661
Filtration Basin	1.14	0.25	BARK HILL RD. IMP.	267
Sand Filter	4.37	0	VILLAGE OF MEADOW CREEK	551
Sand Filter	77.97	<Null>	VILLAGE OF MEADOW CREEK	548
Shallow Marsh	32	15.93	STONERIDGE OVERLOOK	265
Shallow Marsh	35.9	30.51	COLLEGE SQUARE	266
Shallow Marsh	5.62	1.3	GRACE FELLOWSHIP CHAPEL	150
Shallow Marsh	1.9	0	SUMMERVILLE AT WESTMINSTE	245
Sand Filter	2.44	1.5	VILLAGE OF MEADOW CREEK SEC 1 FAC 2	973
Sand Filter	1.06	1.06	SOUTH PLEASANT VALLEY RD	831
Sand Filter	0.34	0	CARROLL COUNTY FOODS	819
Sand Filter	0.2	0.2	CARROLL VISTA TREVANION RD. IMP.	921
Sand Filter	13.25	2.145	BOLTON HILL PH. 4	1026
Sand Filter	20.22	4.76	BOLTON HILL PH. 4	1025
Sand Filter	6.085	1.264	BOLTON HILL PH. 4	1024
Underground Storage	0.38	0.313	KIRBY PROPERTY	37
Underground Storage	2.83	1.63	RIDGE RESIDENCES	702
Underground Storage	1.75	1.08	CHANGE, INC.	119
Underground Storage	11.16	1.8	CARROLLYN MANOR SEC. 7	579
Underground Storage	5.35	4.25	WASHINGTON RD MEDICAL CLI	634
Underground Storage	4.42	3.184	MEDICAL OFF. BLDG STONER	776
Underground Storage	1.55	0	SHRINER CT. ELDERLY HOUS	360
Filtration Basin	9.58	2.4	RIDGE TERRACE	111
Filtration Basin	0.277	0.277	BLUE RIDGE MANOR SECT 2	379
Oil Grit Separator	0.5	0.5	POTOMAC EDISON SITE	133
Filtration Basin	52.8	0	DOVES CREST	442
Filtration Basin	52.8	0	DOVES CREST	442
Dry Detention Pond	5.71	2.17	REMVIEW/FURNACEHILLS 3-Facility 4	248
Dry Detention Pond	4.62	3	REMVIEW/FURNACEHILLS 3-Facility 3	248
Dry Detention Pond	7.73	2.94	REMVIEW/FURNACEHILLS 3-Facility 1	248
Dry Detention Pond	2.55	1.66	REMVIEW/FURNACEHILLS 3-Facility 2	248
Retention Pond	0.75	3.77	AVONDALE ACRES SECTION 2	291
Retention Pond	1	3	KEYMAR FERTILIZER	299
Retention Pond	155	39	FARM MUSEUM POND	283
Retention Pond	17.7	0	WESTMIN. AIR BUS. CTR-NO	603
Retention Pond	0	0	EXCEPTIONAL CENTER	84
Retention Pond	2.11	1.65	ALLSTATE COMPONENTS	399
Retention Pond	1.65	1.65	AVONDALE RUN PHASE2	232
Retention Pond	2.02	2.02	AVONDALE RUN PHASE2	232

Facility Type	Drainage Area (Acres)	Impervious Area (Acres)	Project Name	Site #
Retention Pond	0.55	0.55	AVONDALE RUN PHASE2	232
Retention Pond	2.24	2.24	AVONDALE RUN PHASE2	232
Infiltration trench w SF	40	9.06	UNIONTOWN BIBLE CHURCH	765
Open Grass Channel	0.19	0.19	MCDANIEL COLLEGE ACDEMIC	520
Infiltration Basin	2.72	0.239	RAPID ROOTER	493
Infiltration Basin	2.36	1.325	MANCHESTER PROF. CTR.	518
Sand Filter	0.7	0.189	STULLER CONSTRUCTION	468
Sand Filter	1.84	1.84	COUNTRYSIDE DRIVING RANGE	585
Retention Pond	1.96	0	WESTMINSTER CHURCH OF CHR	514
Water Quality Basin	1.67	0	WESTCHESTER SQ.PHASE 2	272
Water Quality Basin	2.21	0	WESTCHESTER SQ.PHASE 2	273
Dry Detention Pond	41.4	4	C.C.REGIONAL AIRPORT	433
Dry Detention Pond	55.2	18.3	C.C.REGIONAL AIRPORT	435
Dry Detention Pond	4.1	0	C.C.REGIONAL AIRPORT	437
Dry Detention Pond	5.3	0	C.C.REGIONAL AIRPORT	439
Dry Detention Pond	38.4	7.4	C.C.REGIONAL AIRPORT	440
Dry Detention Pond	13.75	0.27	CARROLL CO. FOODS,ADD.	639
Dry Detention Pond	40.5	23.8	CARROLL LUTHERAN VILLAGE2	218
Swale	5.01	0.34	KALTEN ACRES SECTION 1	182
Detention Tank	1.83	0	WEST CHESTER SQUARE	562
Detention Tank	1.4	1.4	PARK AVENUE ESTATES	141
Dry Detention Pond	35	14.25	PARR'S RIDGE	670
Swale	0.64	0.107	ROOP-RINEHART HOUSE	589
Infiltration Dry Well	4.05	1.8	MCDANIEL LIBRARY ADDITION	0
Dry Detention Pond	82.57	0	GRAND VALLEY FARMS,SEC.2	98
Dry Detention Pond	0	0	C.C. MAINTENANCE FACILITY	102
Dry Detention Pond	14.1	0	RYLAND HOMES	356
Dry Detention Pond	0	0	HUGHES BROTHERS, INC.	362
Dry Detention Pond	0	0	CRAFT WORLD	363
Dry Detention Pond	62.4	17	MCGREGOR PRINTING	374
Dry Detention Pond	0	0	MCGREGOR PRINTING	711
Dry Detention Pond	41	15.6	GREENS OF WEST. SEC.VI #2	650
Infiltration Basin	0.78	0.22	MEDFORD QUARRY MAIN. SHOP	427
Swale	17	2.18	BEAR CREEK GOLF COURSE	621
Infiltration Trench	3.86	0	301-305 E. MAIN ST.	490
Infiltration Trench	0.69	0.25	BRADCLIFF	569
Infiltration Trench	3.8	0	HUNTER PROFESSIONAL CTR.	467
Infiltration Trench	3.8	0	HUNTER PROFESSIONAL CTR.	467
Infiltration Trench	3.8	0	HUNTER PROFESSIONAL CTR.	467
Infiltration Trench	3.8	2.2	HUNTER PROFESSIONAL CTR.	467
Porous Pavement	0.46	0.45	BREWER'S MARKET	540

Facility Type	Drainage Area (Acres)	Impervious Area (Acres)	Project Name	Site #
Infiltration Dry Well	3.95	0.61	MCDANIEL COLLEGE BAIR STADIUM	960
Infiltration Dry Well	3.95	0.61	MCDANIEL COLLEGE BAIR STADIUM	961
Extended Detention Pond	22.1	5.73	MEADOW RIDGE	171
Extended Detention Pond	18.2	5.35	MEADOW RIDGE	172
Extended Detention Pond	4.6	1.75	MEADOW RIDGE	173
Extended Detention Pond	52.95	17.64	EAGLEVIEW PHASE ONE	20
Extended Detention Pond	53.44	11.42	EAGLEVIEW PHASE TWO	21
Extended Detention Pond	5.2	0	UNION BRIDGE SUPER THRIFT	44
Extended Detention Pond	45.67	13.09	FURNACE HILLS SECTION TWO	48
Extended Detention Pond	4.18	2.26	WINDSOR VIEW EST. SEC. 2	601
Extended Detention Pond	8.03	5.62	NEW WINDSOR MIDDLE SCHOOL	76
Extended Detention Pond	9.76	4.56	ELMER WOLF ELEMENTARY	209
Extended Detention Pond	22.2	8.44	CROSSROADS OVERLOOK POND 1	228
Extended Detention Pond	0	73	GREENS OF WESTMINSTER, SEC. 5	0
Extended Detention Pond	10.4	0	RUNYMEADE ELEMENTARY	38
Extended Detention Pond	4.8	0	RUNYMEADE ELEMENTARY	39
Extended Detention Pond	21.27	17	SNAVELY FOREST PRODUCTS	758
Extended Detention Pond	66.8	13.59	LEHIGH CEMENT CO. FAC 1A	641
Extended Detention Pond	24.4	22.21	LEHIGH CEMENT CO. FAC 2A	643
Extended Detention Pond	21	5.26	LEHIGH CEMENT CO. FAC 3	644
Extended Detention Pond	20.4	14.27	LEHIGH CEMENT CO. FAC 4	645
Extended Detention Pond	30.87	19.17	LEHIGH CEMENT CO. FAC 5	646
Filtration Basin	5.19	7.18	COVENTRY	343
Filtration Basin	63.19	0	SUN VALLEY SECT. 2	323
Filtration Basin	19.52	0	WAKEFIELD OVERLOOK	574
Filtration Basin	54.48	30.88	WAKEFIELD OVERLOOK	583
Filtration Basin	7.9	0	MILLER ASPHALT WESTMINSTE	410
Swale w Check Dams	2.48	0	GIBBS PROPERTY	461
Infiltration Trench w UGS	1.83	1.338	BELLA VITA	447
Infiltration Basin	4.71	0	JEHOVAH WITNESS	618
Infiltration Basin	1.7	1.07	FIRST UNITED PRESBYTERIAN	14
Infiltration Basin	2.72	1.24	LONGVIEW NURSING HOME	672
Infiltration Basin	21.6	7.57	FAIRWAYS AT WAKEFIELD:	682
Infiltration Basin	5.07	0.59	BARK HILL PARK	825
Infiltration Basin	2.43	1.51	CARROLL COUNTY PUBLIC TRANSPORATION	927
Infiltration Basin	7.57	0.53	ALBERT RILL RD.	934
Infiltration Basin	6.75	2.04	CLIVEDEN #2	18
Infiltration Basin	58	7.31	CLIVEDEN #1	22
Infiltration Basin	7.5	0	DAVID GREEN PROFESSIONAL CENTER	844
Infiltration Basin	52.8	0	DOVES CREST	442
Infiltration Basin	7.45	0	SPRINGDALE VILLAGE	80

Facility Type	Drainage Area (Acres)	Impervious Area (Acres)	Project Name	Site #
Infiltration Trench	0.33	0.22	B. B. & T.	57
Infiltration Trench	11.09	1.3	CARROLLYN MANOR SEC. 6	616
Infiltration Trench	1.88	1.05	C.C. CHILDREN'S CENTER	695
Infiltration Trench	3.26	0.3	MCDANIEL COLLEGE HARRISON HOUSE PAR	538
Infiltration Trench	3.2	2.64	NEW WINDSOR FIRE CO.	577
Infiltration Trench	0.38	0.26	COLONEL ROSSER LANE PARK.	598
Infiltration Trench	0.84	0.429	MONTESSORI SCHOOL OF WEST	605
Infiltration Trench	0.45	0.33	MAIDEN LANE PROF. CENTER	737
Infiltration Trench	19.5	0	CARROLL HOSPITAL CTR-EAST	740
Infiltration Trench	0.85	0.296	CARROLL HOS. CENT. THRIFT	609
Infiltration Trench	3.26	0.3	MCDANIEL COLLEGE HARRISON HOUSE PAR	538
Infiltration Trench	3.62	0	SUN VALLEY ASSIST. LIVING	732
Infiltration Trench	9.81	0	THE OVERLOOK @ KINGS PARK	768
Infiltration Trench	3.26	0.3	MCDANIEL COLLEGE HARRISON HOUSE PAR	538
Infiltration Trench	1.7	0	FIRST UNITED PRESBYTERIAN	14
Infiltration Trench	1.42	0	DAVID GREEN PROFESSIONAL CENTER	841
Infiltration Trench	0.52	0	DAVID GREEN PROFESSIONAL CENTER	842
Infiltration Trench	0.64	0	DAVID GREEN PROFESSIONAL CENTER	843
Infiltration Trench	4.47	1.03	SUN VALLEY ASSISTED LIVING	898
Infiltration Trench	1.88	<Null>	VILLAGE OF MEADOW CREEK 2	614
Infiltration Trench	1.41	0	ST MARY'S U.C.C	36
Infiltration Trench	1.41	0	ST MARY'S U.C.C	36
Infiltration Trench	2.2	1.17	MILLERS MARKET	293
Infiltration Trench w UGS	2.01	1.72	C.C. HEALTH DEPT	241
Infiltration Basin	7.5	2.85	CROSSROADS OVERLOOK POND 2	229
Infiltration Basin	17.6	6.68	CROSSROADS OVERLOOK POND 3	230
Infiltration Basin	49.66	11.35	HALLIE HILL FARM	415
Infiltration Basin	28.88	0	WESTMINSTER HIGHLANDS I	140
Infiltration Basin	13.83	1.44	CROSSROADS OVERLOOK POND 4	129
Infiltration Basin	6.97	3.03	MANCHESTER MANOR	194
Infiltration Basin	1	0.3	KEYMAR POST OFFICE	153
Porous Pavement	17.1	17.1	SHELTER SYSTEMS	575
Porous Pavement	0.28	0.2	PRITTS FUNERAL HOME	951
Retention Pond	47.56	11.26	MCDANIEL COLLEGE	513
Retention Pond	30.79	7.69	BLUE RIDGE MANOR	45
Retention Pond	0.8	0.8	JOHANNA'S JOY 2	341
Retention Pond	2.62	0.58	CROSSROADS OVERLOOK POND 5	130
Retention Pond	8.67	2.24	CROSSROADS OVERLOOK POND 6	131
Retention Pond	82.01	18.11	FRIENDSHIP OVERLOOK	220
Retention Pond	14.7	6.2	FRANCIS SCOTT KEY H.S.	238
Infiltration Trench	0.17	0.17	SAFE HAVEN	478

Facility Type	Drainage Area (Acres)	Impervious Area (Acres)	Project Name	Site #
Sand Filter	0.44	0	WESTMINSTER SQUARE	357
Sand Filter	0.55	0.55	CARROLL CO. ONCOLOGY CTR	282
Sand Filter	0.55	0.55	WEST GREEN ST IMP	731
Infiltration Trench w SF	4.06	0	CARROLL CO. AG. CENTER	655
Infiltration Trench w SF	2.143	0	BOWLING BROOK	729
Infiltration Trench w SF	2.143	0	BOWLING BROOK	729
Sand Filter	2	2	SNAVELY FOREST PRODUCTS	757
Infiltration Trench w SF	4.062	1.06	FURNACE HILLS SECT.4	416
Infiltration Trench w SF	5.54	0.63	CARROLL LUTHERAN SCHOOL	661
Infiltration Trench w SF	5.54	0.81	CARROLL LUTHERAN SCHOOL	661
Infiltration Trench w SF	5.54	0.67	CARROLL LUTHERAN SCHOOL	661
Filtration Basin	1.14	0.25	BARK HILL RD. IMP.	267
Sand Filter	4.37	0	VILLAGE OF MEADOW CREEK	551
Sand Filter	77.97	<Null>	VILLAGE OF MEADOW CREEK	548
Shallow Marsh	32	15.93	STONERIDGE OVERLOOK	265
Shallow Marsh	35.9	30.51	COLLEGE SQUARE	266
Shallow Marsh	5.62	1.3	GRACE FELLOWSHIP CHAPEL	150
Shallow Marsh	1.9	0	SUMMERVILLE AT WESTMINSTE	245
Sand Filter	2.44	1.5	VILLAGE OF MEADOW CREEK SEC 1 FAC 2	973
Sand Filter	1.06	1.06	SOUTH PLEASANT VALLEY RD	831
Sand Filter	0.34	0	CARROLL COUNTY FOODS	819
Sand Filter	0.2	0.2	CARROLL VISTA TREVANION RD. IMP.	921
Sand Filter	13.25	2.145	BOLTON HILL PH. 4	1026
Sand Filter	20.22	4.76	BOLTON HILL PH. 4	1025
Sand Filter	6.085	1.264	BOLTON HILL PH. 4	1024
Underground Storage	0.38	0.313	KIRBY PROPERTY	37
Underground Storage	2.83	1.63	RIDGE RESIDENCES	702
Underground Storage	1.75	1.08	CHANGE, INC.	119
Underground Storage	11.16	1.8	CARROLLYN MANOR SEC. 7	579
Underground Storage	5.35	4.25	WASHINGTON RD MEDICAL CLI	634
Underground Storage	4.42	3.184	MEDICAL OFF. BLDG STONER	776
Underground Storage	1.55	0	SHRINER CT. ELDERLY HOUS	360
Filtration Basin	9.58	2.4	RIDGE TERRACE	111
Filtration Basin	0.277	0.277	BLUE RIDGE MANOR SECT 2	379
Oil Grit Separator	0.5	0.5	POTOMAC EDISON SITE	133
Filtration Basin	52.8	0	DOVES CREST	442
Filtration Basin	52.8	0	DOVES CREST	442
Dry Detention Pond	5.71	2.17	REMVIEW/FURNACEHILLS 3-Facility 4	248
Dry Detention Pond	4.62	3	REMVIEW/FURNACEHILLS 3-Facility 3	248
Dry Detention Pond	7.73	2.94	REMVIEW/FURNACEHILLS 3-Facility 1	248
Dry Detention Pond	2.55	1.66	REMVIEW/FURNACEHILLS 3-Facility 2	248

Facility Type	Drainage Area (Acres)	Impervious Area (Acres)	Project Name	Site #
Retention Pond	0.75	3.77	AVONDALE ACRES SECTION 2	291
Retention Pond	1	3	KEYMAR FERTILIZER	299
Retention Pond	155	39	FARM MUSEUM POND	283
Retention Pond	17.7	0	WESTMIN. AIR BUS. CTR-NO	603
Retention Pond	0	0	EXCEPTIONAL CENTER	84
Retention Pond	2.11	1.65	ALLSTATE COMPONENTS	399
Retention Pond	1.65	1.65	AVONDALE RUN PHASE2	232
Retention Pond	2.02	2.02	AVONDALE RUN PHASE2	232
Retention Pond	0.55	0.55	AVONDALE RUN PHASE2	232
Retention Pond	2.24	2.24	AVONDALE RUN PHASE2	232
Infiltration trench w SF	40	9.06	UNIONTOWN BIBLE CHURCH	765
Open Grass Channel	0.19	0.19	MCDANIEL COLLEGE ACDEMIC	520

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:

Double Pipe Creek Watershed Agricultural Best Management Practices/Definitions

Agricultural Best Management Practices as of Spring 2016-Double Pipe Creek Watershed

Best Management Practice	Practice Code	Extent	Unit
Access Control	472	42.1	Acres
Agrichemical Handling Facility	309	2	Number
Conservation Cover	327	2,273.6	Acres
Conservation Crop Rotation	328	2,702.6	Acres
Contour Farming	330	1,485.2	Acres
Critical Area Planting	342	59.4	Acres
Diversion	362	3,704	Feet
Farm Plans	192 & 193	63,347.3	Acres
Fencing	382	287,484	Feet
Filter Strip	393	440.9	Acres
Forage and Biomass Planting	512	113.7	Acres
Grade Stabilization Structure	410	3	Number
Grassed Waterway	412	176.1	Acres
Heavy Use Area Protection	561	2.5	Acres
Integrated Pest Management	595	4.2	Acres
Irrigation System, Microirrigation	441	8	Acres
Irrigation Water Management	449	8	Acres
Lined Waterway or Outlet	468	198	Feet
Livestock Pipeline	516	4,270	Feet
Nutrient Management Plan	590	1,995	Acres
Prescribed Grazing	528	120.2	Acres
Residue & Tillage Management	329 & 345	2,479.2	Acres
Riparian Forest Buffer	391	1,042.0	Acres
Riparian Herbaceous Cover	390	33.6	Acres
Roof Runoff Management	558	130	Number
Roofs and Covers	367	3	Number
Seasonal High Crop Tunnel System	798	9,897	Sq. Feet
Sediment Basin	350	1	Number
Spring Development	574	47	Number
Stream Crossing	728	42	Number
Streambank Protection	580A	120	Feet
Tree/Shrub Establishment	612	4.2	Acres

Best Management Practice	Practice Code	Extent	Unit
Underground Outlet	620	3,271	Feet
Upland Habitat Management	645	47.9	Acres
Waste Recycling	633	184.4	Acres
Waste Storage Structure	313	55	Number
Waste Transfer	634	1	Number
Wastewater Treatment Strip	635	6.6	Acres
Water Well	642	4	Number
Watering Facility	614	108	Number

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:

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

Agrichemical Handling Facility: A facility with an impervious surface to provide an environmentally safe area for the handling of on-farm agrichemicals.

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

Grade Stabilization Structure: A structure used to control the channel grade in natural or constructed watercourses.

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.

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

Irrigation System, Microirrigation: An irrigation system for frequent application of small quantities of water on or below the soil surface: as drops, tiny streams or miniature spray through emitters or applicators placed along a water delivery line.

Irrigation Water Management: The process of determining and controlling the volume, frequency, and application rate of irrigation water in a planned, efficient manner.

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.

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.

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.

Residue and Tillage Management, No Till: Limiting soil disturbance to manage the amount, orientation and distribution of crop and plant residue on the soil surface year round.

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 Structure/Management: Structures that collect, control, and transport precipitation from roofs.

Roofs and Covers: A rigid, semi-rigid, or flexible manufactured membrane, composite material, or roof structure placed over a waste management facility.

Seasonal High Tunnel System For Crops: A seasonal polyethylene covered structure that is used to cover crops to extend the growing season in an environmentally safe manner.

Sediment Basin: A basin constructed with an engineered outlet, formed by an embankment or excavation or a combination of the two.

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.

Streambank Protection: Treatment(s) used to stabilize and protect banks of streams or constructed channels, and shorelines of lakes, s, or estuaries.

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

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

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 Recycling: The use of the by-products of agricultural production or the agricultural use of non-agricultural by-products.

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

Waste Transfer: A system of using structures, conduits or equipment to convey byproducts (wastes) from agricultural operations to points of usage.

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

Water Well: A hole drilled, dug, driven, bored, jetted or otherwise constructed into an aquifer for water supply.

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

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