Prettyboy Reservoir Watershed Characterization Plan

Summer 2015

Prepared by
Carroll County Bureau of Resource Management

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I. Characterization Introduction

A. Purpose of the Characterization

The Prettyboy Reservoir Watershed Characterization Plan is intended to provide a background on the hydrological, biological and other natural characteristics of the watershed as well as discuss human characteristics that may have an impact within the watershed. The information provided in this report as well as information gathered during the Prettyboy watershed stream corridor assessment (SCA) will be used as a tool to help direct the watershed implementation plan for the Prettyboy reservoir watershed. The implementation plan will be used to identify opportunities for water quality improvements within the watershed as required by the County's National Pollutant Discharge Elimination System (NPDES) permit, and is designed to meet approved Total Maximum Daily Loads (TMDLs) for the Prettyboy watershed.

B. Location and Scale of Analysis

The Prettyboy watershed is located in the northeast corner of Carroll County. The watershed is within the Gunpowder River Basin in the Piedmont physiographic province of Maryland and consists of five major subwatersheds. Figure 1-1 depicts the location of Prettyboy and its watersheds within Carroll County. The Prettyboy watershed drains into the Prettyboy reservoir, which is a major drinking water source for the City of Baltimore. Table 1-1 displays the distribution of acreage between the subwatersheds within Prettyboy. 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.

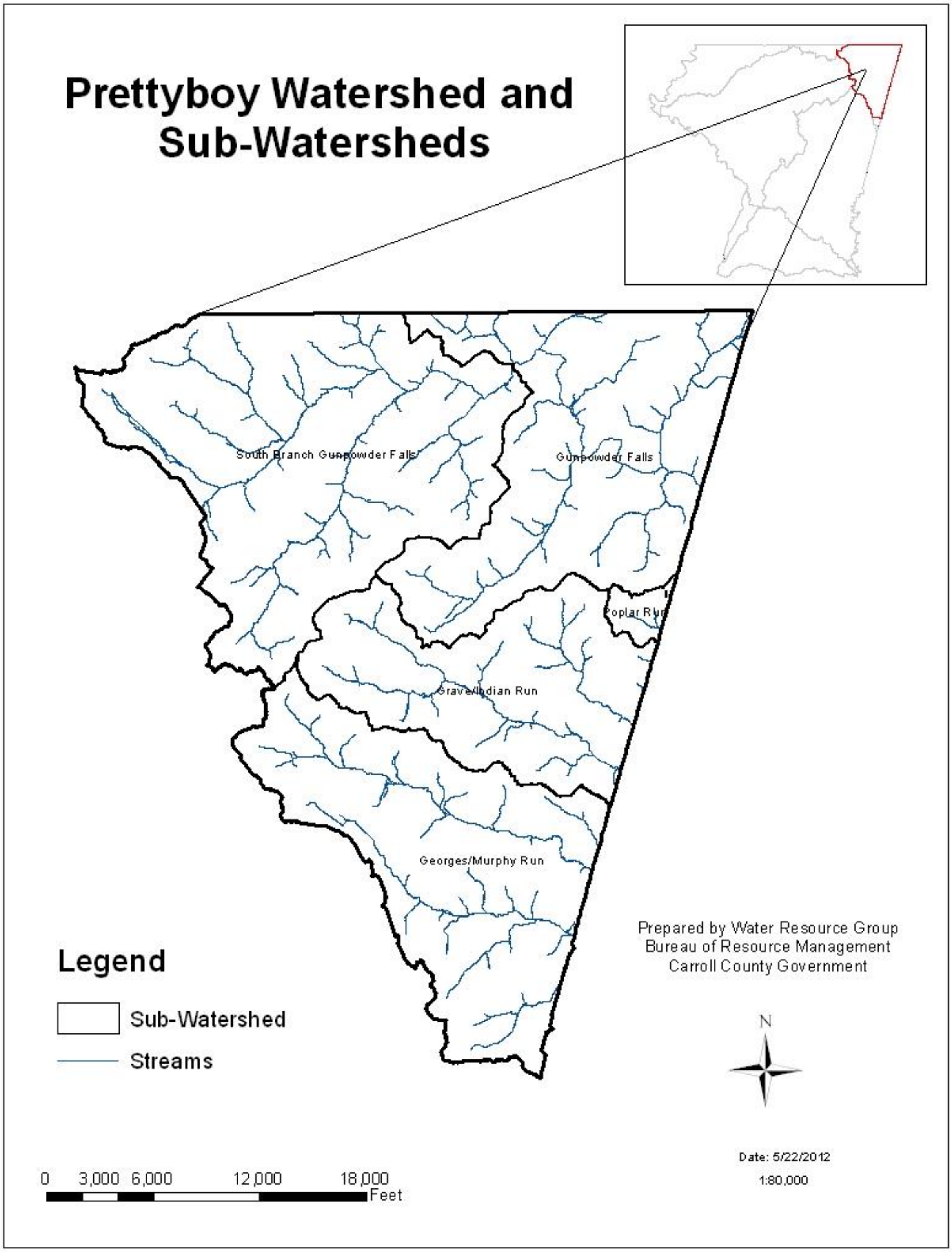

Figure 1-1: Prettyboy Watershed Location Map

Table 1-1: Prettyboy Watershed Subwatershed Acreage - Carroll County

DNR 12-digit Scale	Subwatershed	Acres
0313	Poplar Run	209
0314	Georges/Murphy Run	5,043
0315	Grave/Indian Run	3,558
0316	Gunpowder Falls	5,225
0317	South Branch Gunpowder Falls	6,990
	Prettyboy Watershed Total	**21,025**

C. Report Organization

This report is organized into six different chapters:

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

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

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

Chapter 4 focuses on water quality. This chapter will discuss the stream designations, the water quality data collected within Prettyboy, and the total maximum daily loads associated with the Prettyboy watershed.

Chapter 5 summarizes the living resources within the Prettyboy watershed including aquatic and terrestrial as well as any rare, threatened, or endangered species.

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

II. Natural Characteristics

A. Introduction

The natural characteristics of a watershed provide the background for the biological and hydrological processes within the system. In this chapter, these characteristics are examined in detail, which will provide a foundation for the later chapters on human characteristics, water quality, and the living resources. The natural characteristics to be covered in this chapter include climate; hydrologic factors such as stream flow, floodplains, and wetlands as well as precipitation; physical landscape features such as topography, geology, soils, and forest cover. This chapter will also establish groundwater resources and ecologically important areas. Potential sources of degradation and the actions needed to address impacted areas can be evaluated by an inventory of these features within the watershed. Each watershed is unique, and the process of gathering information about the watershed may reveal key issues that will influence the watershed restoration plan. The Prettyboy 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.

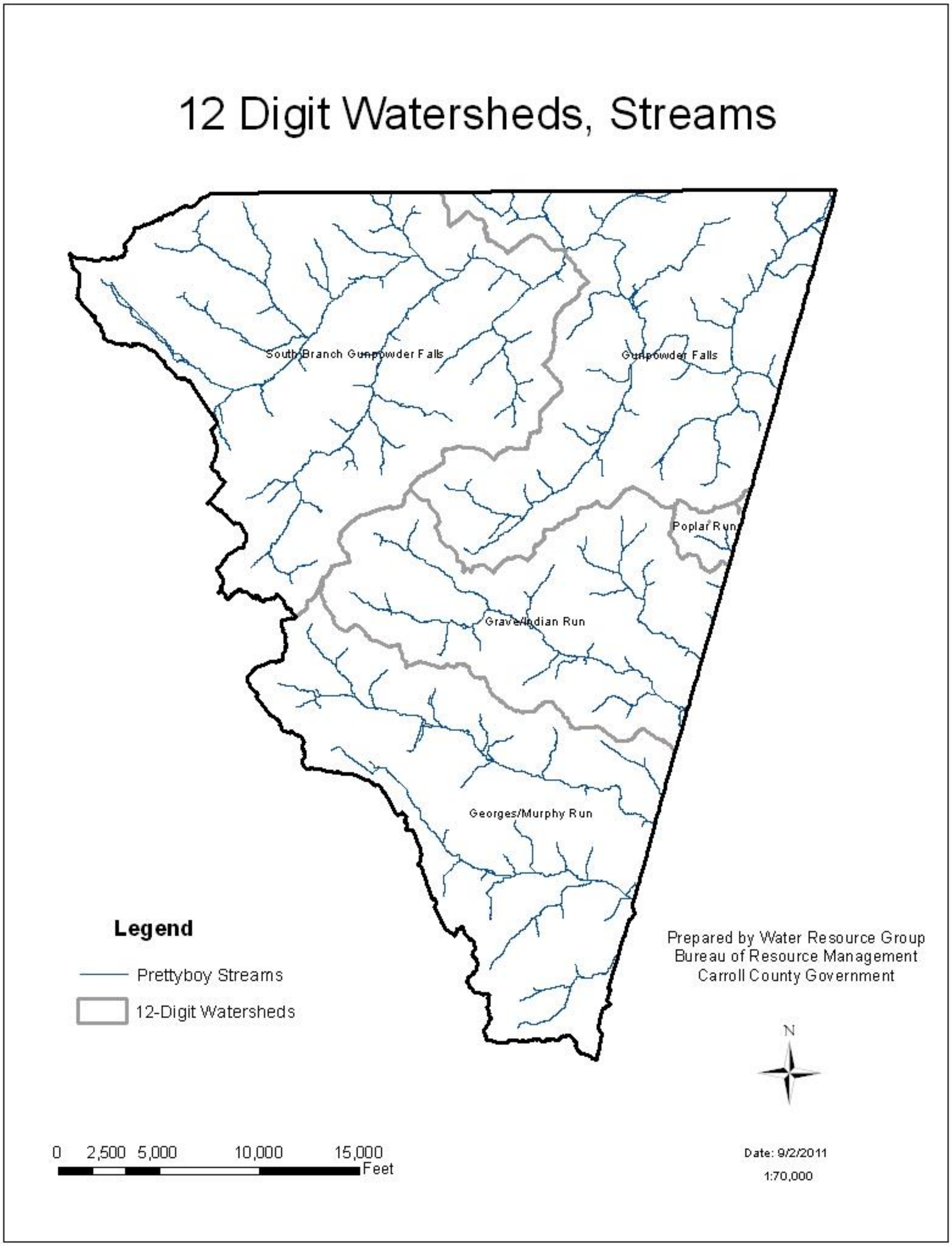

Figure 2-1: Prettyboy Subwatershed Locations

C. Physical Location

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

1. Topography

Topography of the surrounding land, including its steepness and concavity, will affect surface water flows, soil erosion, and development suitability. Steeper slopes are more prone to soil erosion and may have a greater influence on the amount of pollutants generated. For this characterization the slopes were arranged into three categories using soil data from the Carroll County Soil Survey: low slopes (0-8%), medium slopes (8-15%), and high slopes (>15%). Table 2-1 presents the subwatershed slopes as percentages of the 12-digit watershed area.

Table 2-1: Prettyboy Watershed Slope Categories

DNR 12-Digit Scale	Subwatershed	Slope Category (%)		
		Low	Medium	High
0313	Poplar Run	68	22	10
	% of overall total	1	<1	<1
0314	Georges/Murphy Run	55	33	12
	% of overall total	12	7	3
0315	Grave/Indian Run	50	36	14
	% of overall total	9	6	2
0316	Gunpowder Falls	40	32	28
	% of overall total	10	8	7
0317	South Branch Gunpowder Falls	42	37	21
	% of overall total	15	13	7
Prettyboy Watershed Total		**47**	**34**	**19**

The Gunpowder Falls watershed contains the highest proportion of high slopes (>15%) within the Prettyboy watershed at 28 percent of the total area, with South Branch coming in just behind (21 percent of the total area). The broken topography of these two subwatersheds makes them more prone to erosion, depending on the land cover and underlying soil type. Poplar Run had the smallest proportion of steep slopes (10%) within the Prettyboy watershed.

Figure 2-2 displays the slope categories and their distribution throughout the Prettyboy watershed.

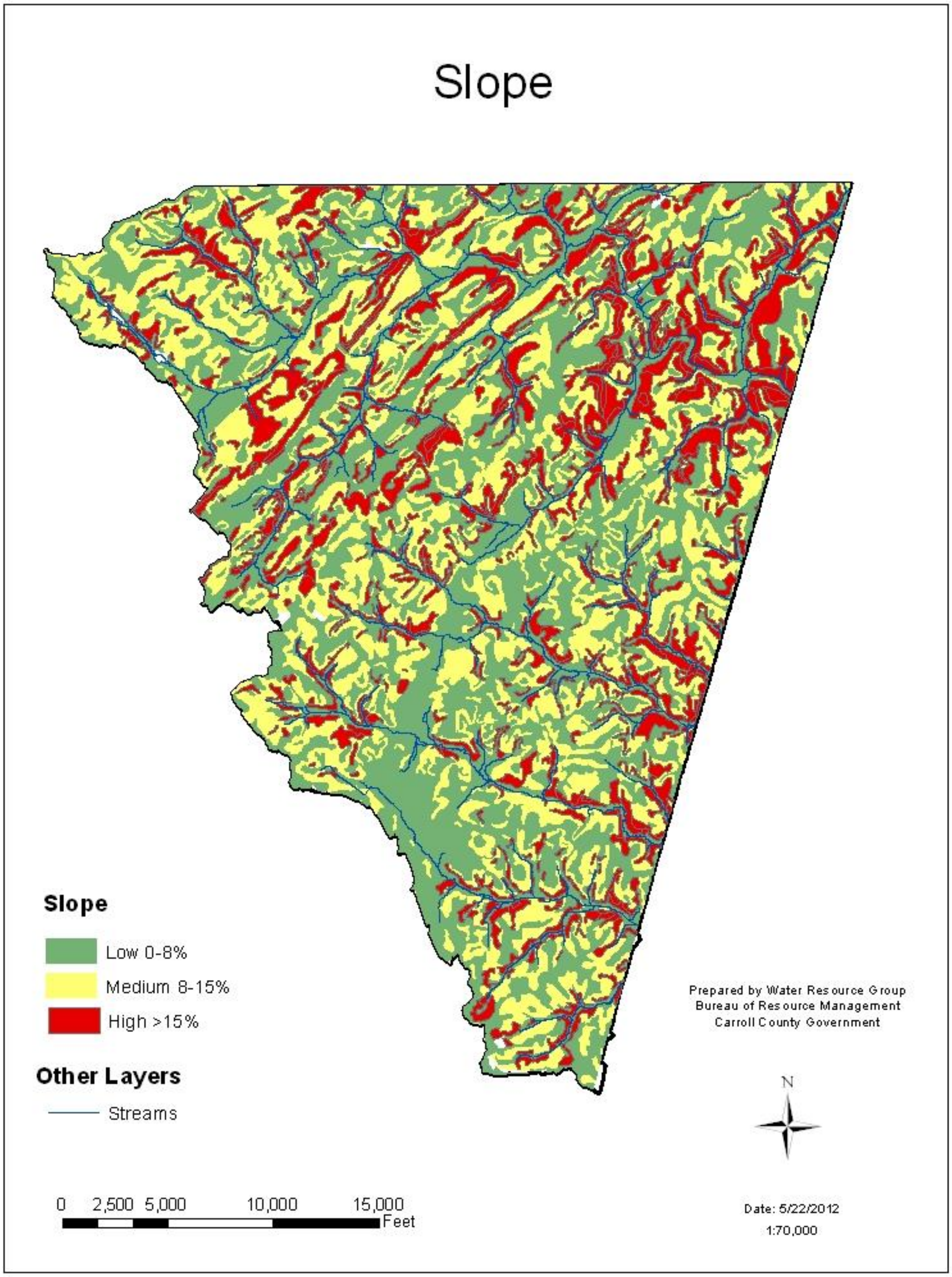

Figure 2-2: Prettyboy Watershed Topography

2. Soils

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

Soil composition is determined by factors like climate, organic matter, and the type of parent material present. Within the Piedmont, highly metamorphosed schist, gneiss, and phyllite make up the vast majority of the parent material. Local soil conditions can vary greatly depending on the organic matter and localized climate. Chester and Manor soils are common in the Piedmont from Pennsylvania to North Carolina, including the Prettyboy 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 consists mostly of deep to moderately deep and moderately well to well drained soils with moderately fine to moderately coarse textures.

Group C is composed primarily of sandy clay loam. These soils have low infiltration rates when thoroughly wetted and consist mostly of soils with a layer that impedes downward movement of water. These soils also have a moderately fine to fine structure.

Group D is composed of clay loam, silty clay loam, sandy clay, silty clay, or clay. This group has the highest runoff potential. They have very low infiltration rates when thoroughly wetted and consist mostly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a clay pan or clay layer at or near the surface, and shallow soils lying over an impervious material.

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

Table 2-2: Prettyboy Subwatershed Hydrologic Soil Group Categories

DNR 12-digit scale	Subwatershed	Hydrologic Soil Group %			
		A	B	C	D
0313	Poplar Run	25	72	1	2
	% of overall total	<1	1	<1	<1
0314	Georges/Murphy Run	19	69	8	4
	% of overall total	4	15	2	<1
0315	Grave/Indian Run	24	64	8	4
	% of overall total	4	11	1	<1
0316	Gunpowder Falls	37	52	9	2
	% of overall total	9	13	2	<1
0317	South Branch	41	46	9	4
	% of overall total	14	16	3	1
Prettyboy Watershed Total		**32**	**56**	**9**	**3**

The majority of the subwatersheds have a similar percentage of C and D soils. While the overall percentage is fairly low, these areas should be targeted when considering where the greatest potential for addressing soil conservation exists. The South Branch watershed contains the highest proportion of C and D soils with 9 percent of the watershed classified as a C soil and 4 percent of the watershed classified as a D soil.

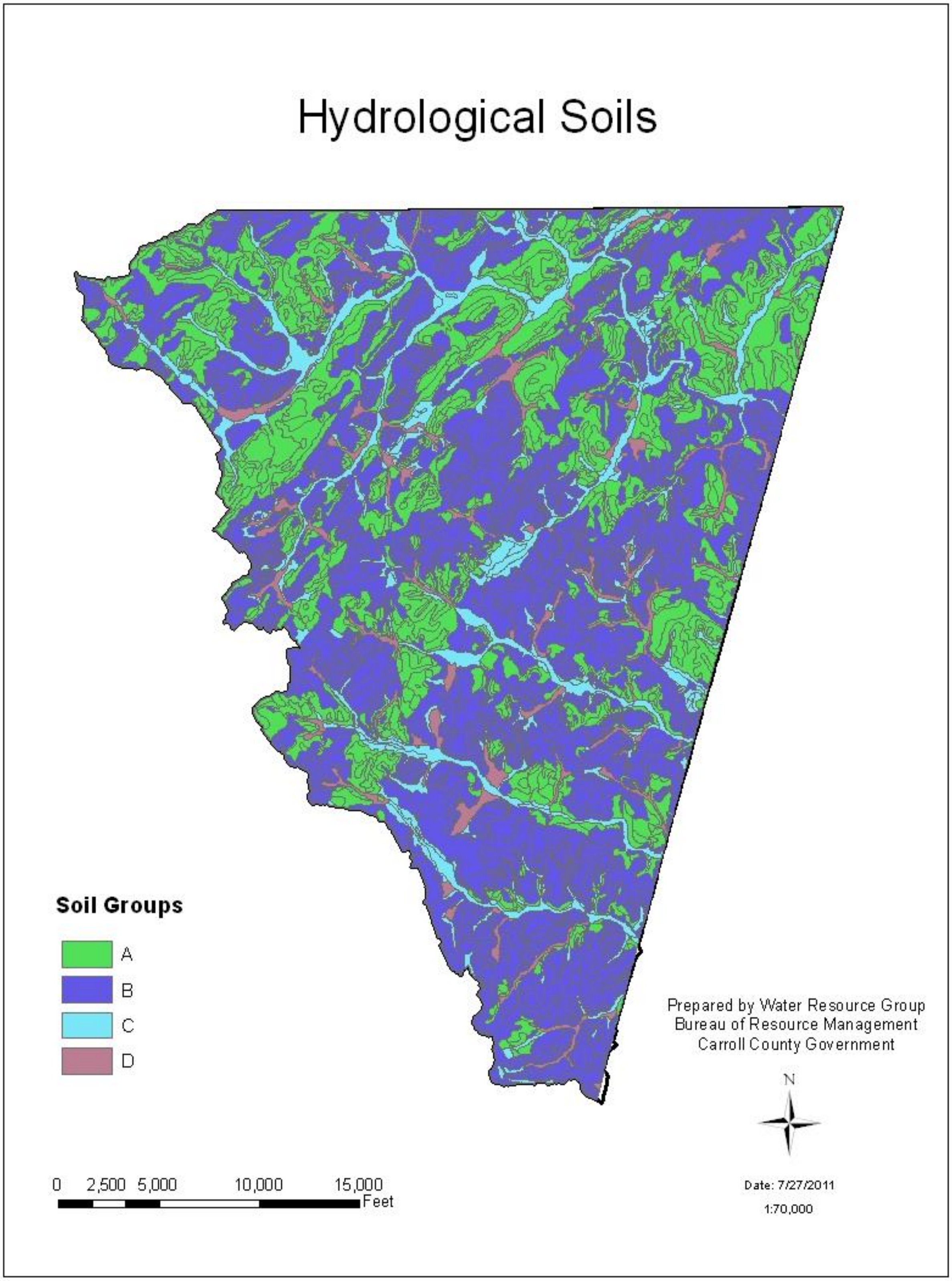

Figure 2-3: Prettyboy Watershed Hydrological Soil Groups

3. Geology

A simplified map of the geologic units within the Prettyboy 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 Prettyboy watershed, like most of the Piedmont, consists of metamorphic rock—mainly crystalline schists. These formations have moderate infiltration rates with average recharge to groundwater.

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

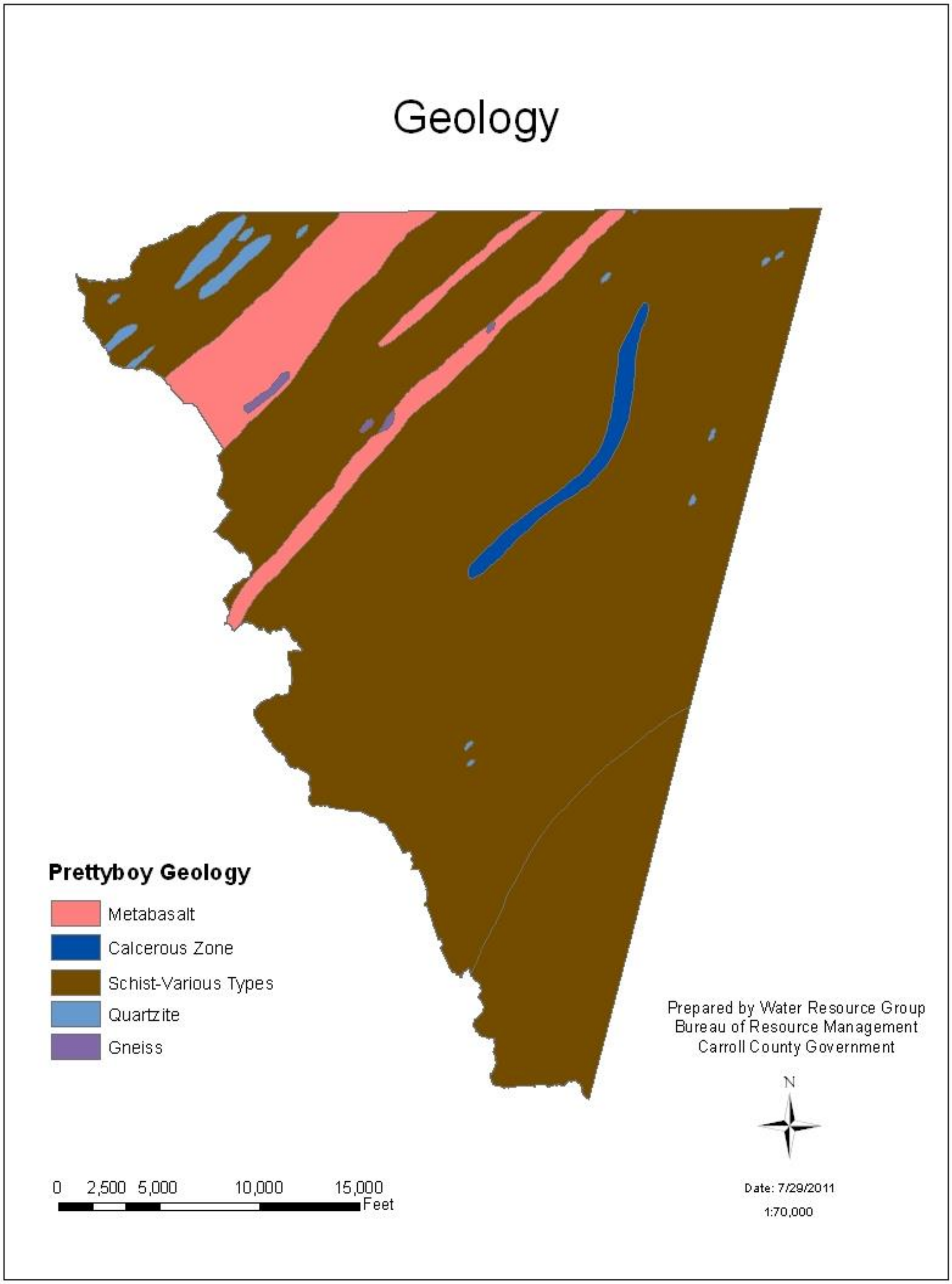

Figure 2-4: Prettyboy Watershed Geology

D. Surface Water Resources

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

1. Wetlands

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

Wetlands are defined by the US Army Corps of Engineers and the US Environmental Protection Agency (EPA) as "areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas." Wetlands in the Prettyboy 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, and the third is the National Land Cover Database (NLCD). The statistical data in this report was based off of the delineations from the NLCD. Actual acreage may be greater when field verified. The estimated acreage of wetlands for the Prettyboy Watershed can be found in Table 2-3.

Table 2-3: Prettyboy Watershed Wetland Acreage

DNR 12-Digit Scale	Subwatershed	NLCD Wetland Estimates	
		Acres	%
0313	Poplar Run	0	0%
0314	Georges/Murphy Run	42.85	<1%
0315	Grave/Indian Run	41.98	1.2%
0316	Gunpowder Falls	38.82	<1%
0317	South Branch Gunpowder Falls	63.70	<1%
	Prettyboy Watershed Total:	**187.34**	**<1%**

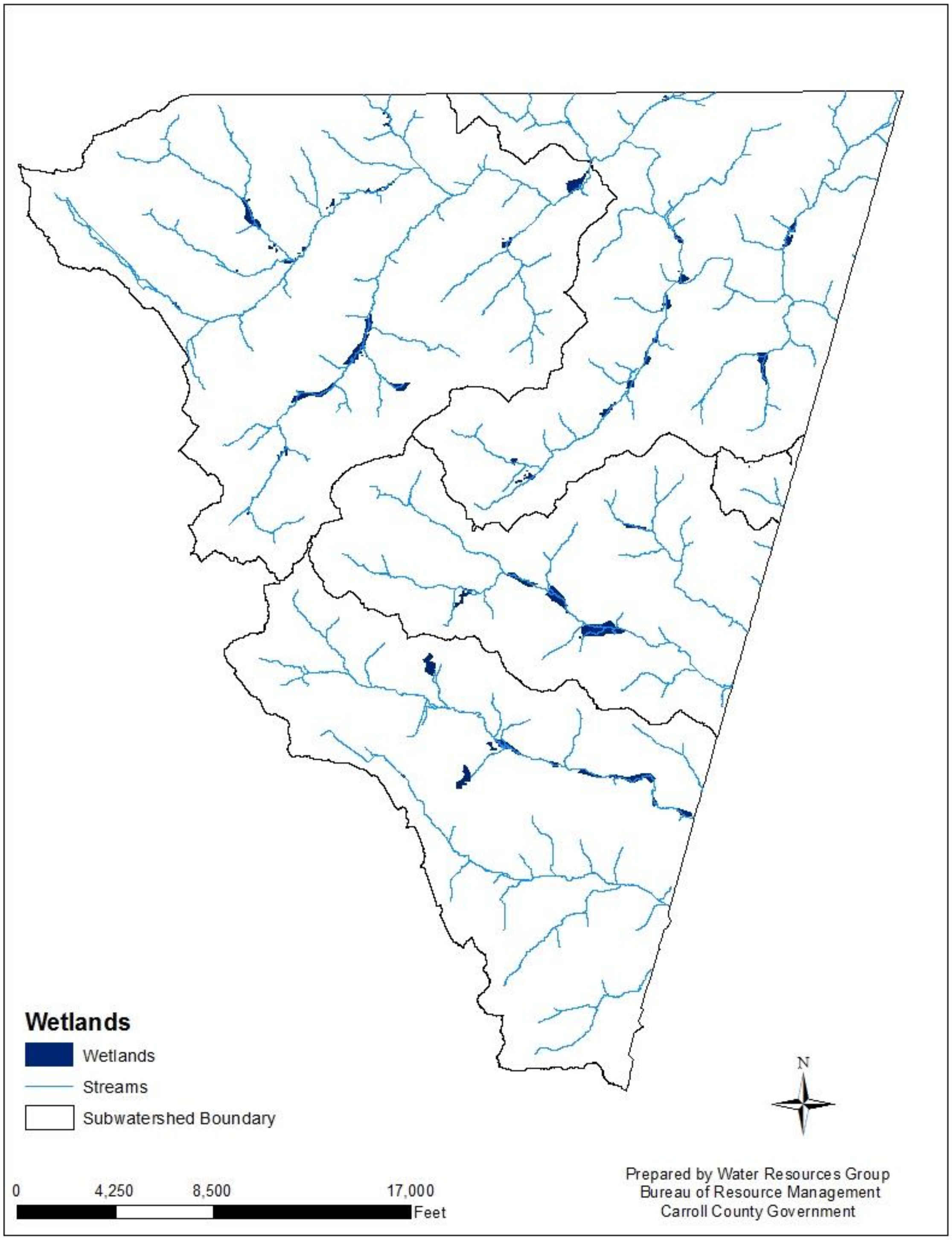

Figure 2-5: Prettyboy Watershed Wetland Acreage

2. Floodplains

A floodplain is an area of low, flat land along a stream or river that is subject to flooding. Floodplains in their natural state provide benefits to both human and natural systems. Benefits range from reducing the number and severity of floods to handling stormwater runoff and minimizing non-point source pollutants. A natural floodplain will slow the velocity of water moving through a system, which allows sediment to settle and nutrients to be absorbed by the surrounding vegetation. Natural floodplains also contribute to groundwater recharge by allowing infiltration. Infiltration will reduce the frequency of low surface flows and allow for a healthier ecosystem.

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

The Prettyboy watershed contains about 879 acres (4%) 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 total regulated floodplain area within the Prettyboy watershed is shown in Figure 2-6.

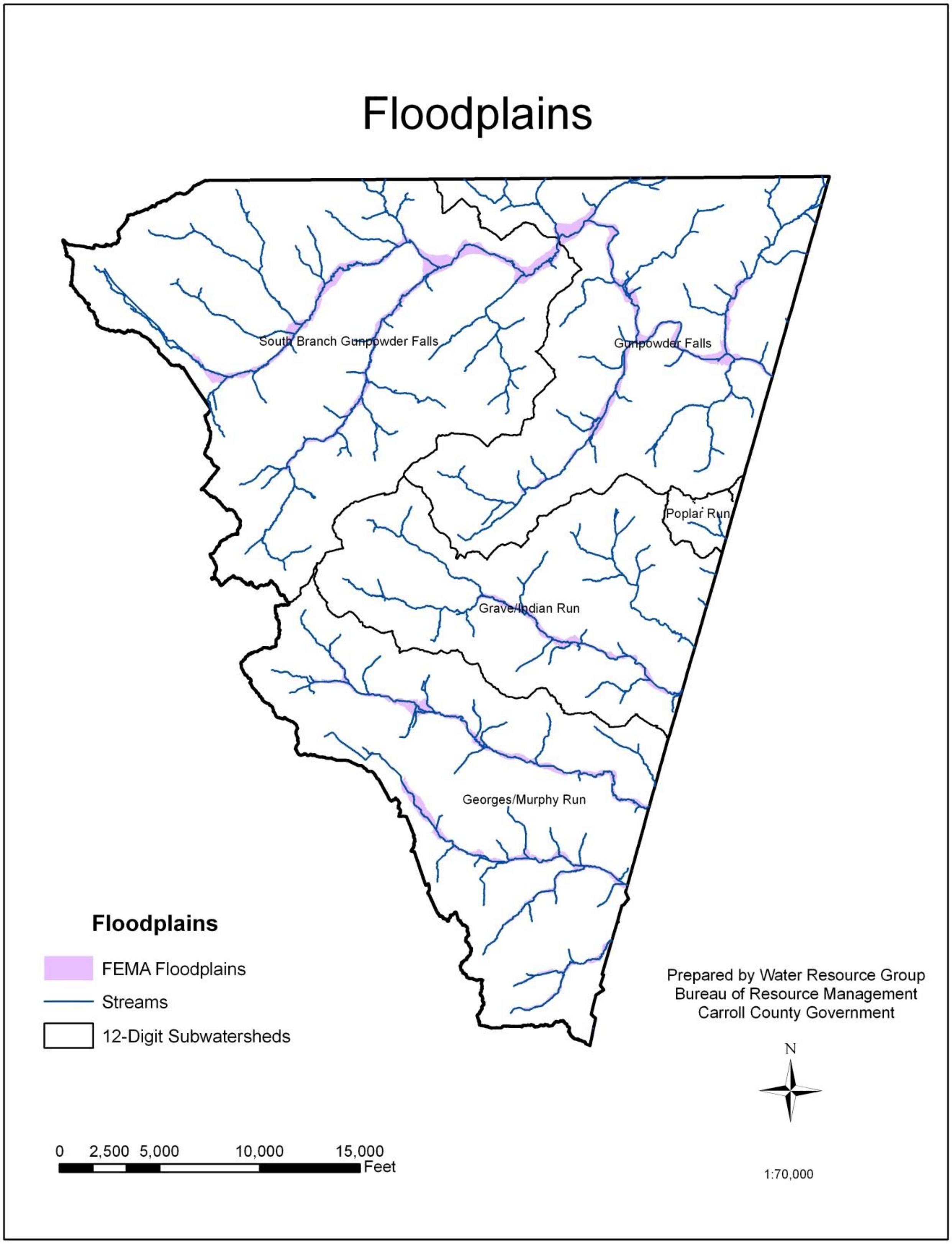

Figure 2-6: Prettyboy Watershed Floodplains

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 Prettyboy 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.

Prettyboy Watershed contains 6,853 acres of forest over multiple land uses, and covers about 33 percent of the land within the watershed. The forest cover within the Prettyboy Watershed can be found in Figure 2-7 and is shown in Table 2-4.

Table 2-4: Prettyboy Watershed Forest Cover

DNR 12-Digit Scale	Subwatershed	Total Acres	Forested Acres	% Forested
0313	Poplar Run	209	56	27%
0314	Georges/Murphy Run	5,043	1,163	23%
0315	Grave/Indian Run	3,558	1,274	36%
0316	Gunpowder Falls	5,225	2,143	41%
0317	South Branch Gunpowder Falls	6,990	2,216	32%
	Prettyboy Watershed Total	**21,025**	**6,853**	**33%**

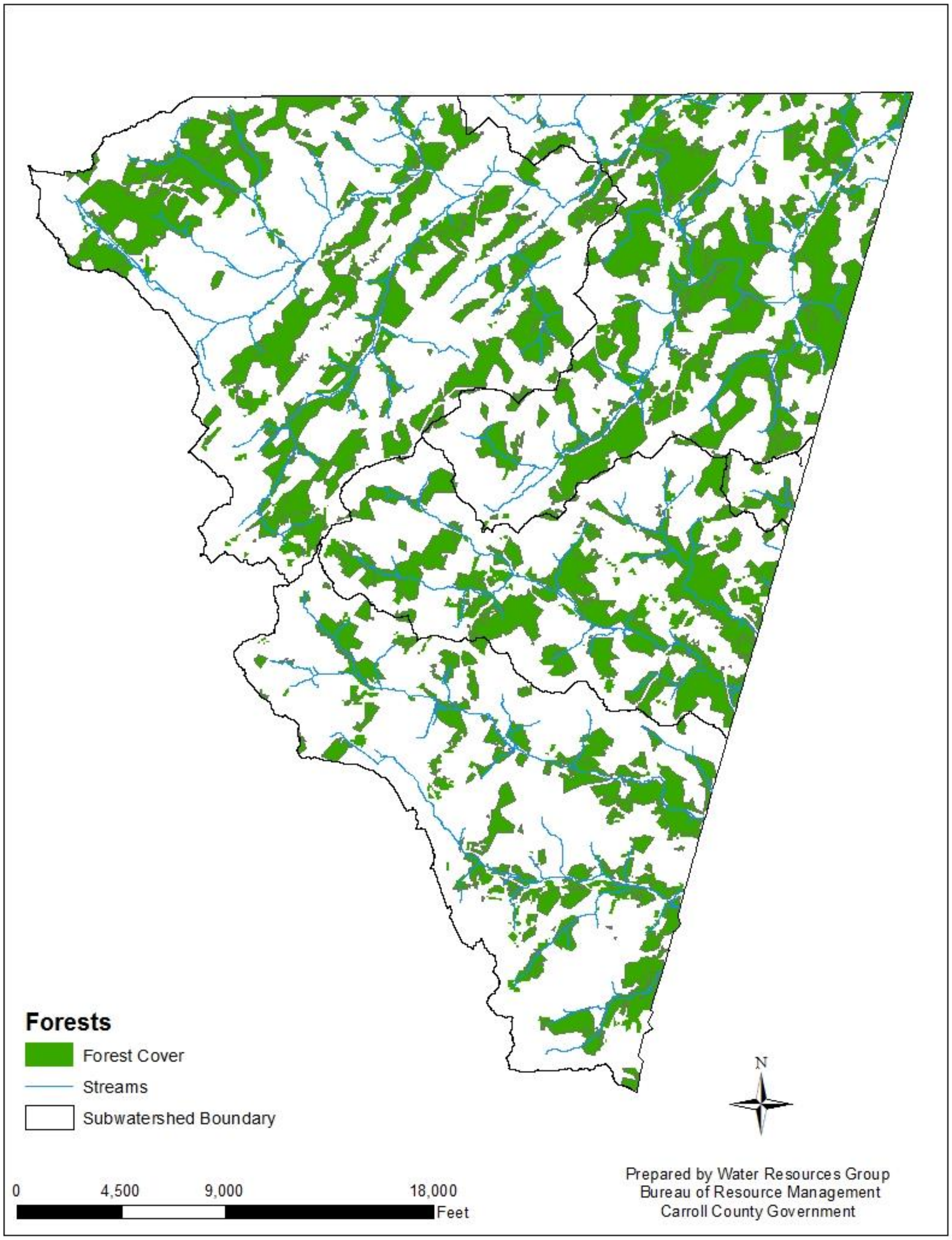

Figure 2-7: Prettyboy Watershed Forest Cover

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 Prettyboy watershed as identified through the DNR Green Infrastructure project.

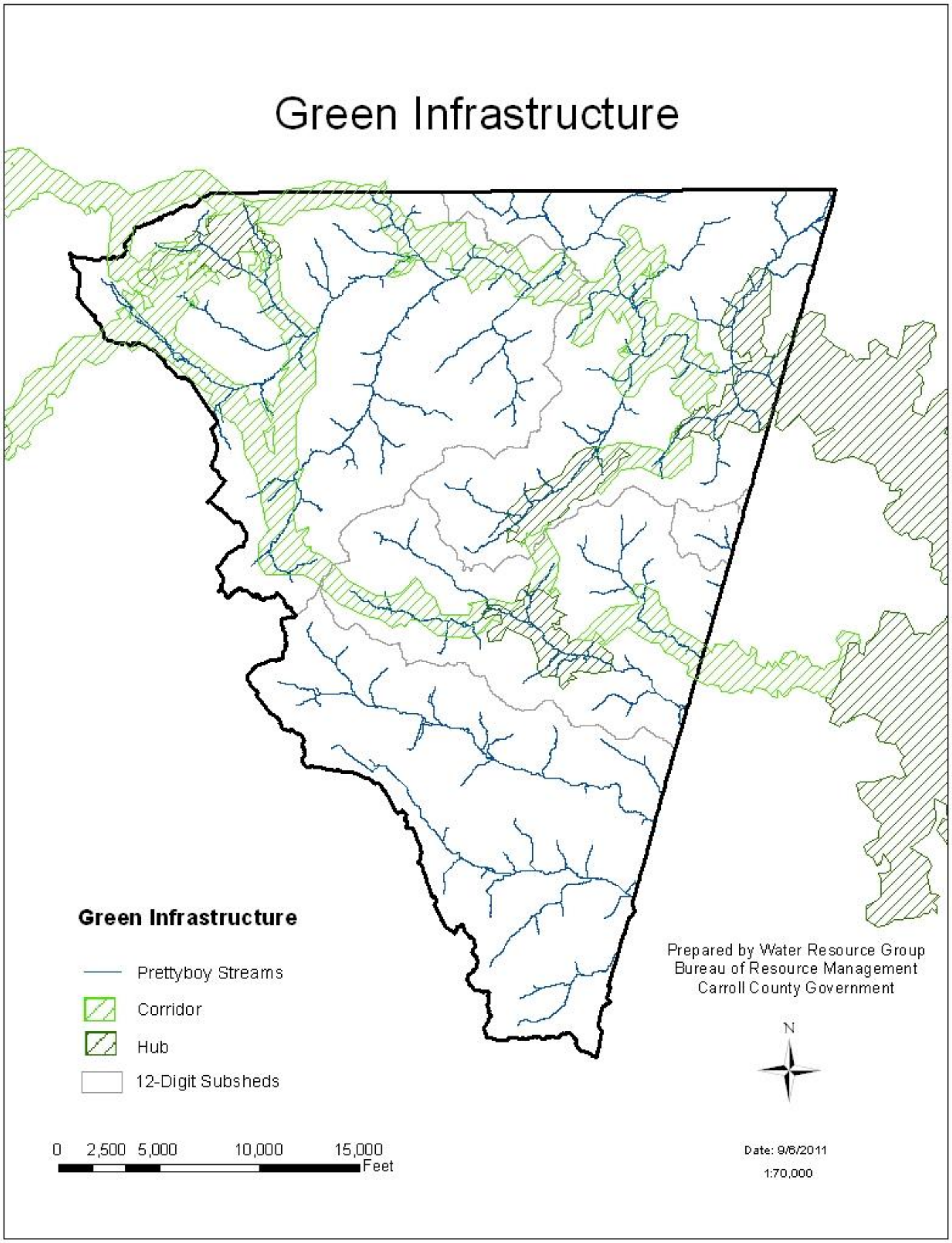

Figure 2-8: Prettyboy Watershed Green Infrastructure

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 Prettyboy watershed has been modified for human use over time. This modification has the potential to degrade both the terrestrial and aquatic ecosystems. The Prettyboy watershed currently has an estimated population of 10,200 persons with approximately 7,600 residing within the town limits of Hampstead and Manchester. The population density outside of the municipalities equates to about one person for every 7.5 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 Prettyboy watershed can be found in Table 3-1. Figure 3-1 shows the land use cover within the Prettyboy watershed.

Table 3-1: Prettyboy Watershed Land Cover

Land Use	Acres 2001	Percent 2001	Acres 2006	Percent 2006	Acres 2011	Percent 2011	Acres 2016	Percent 2016
Open Water	5	<1%	5	<1%	5	<1%	11	<1%
Low-Density Residential	2,071	9.8%	2,065	9.8%	2,165	10%	2,122	10.1%
Low-Density Mixed Urban	313	1.5%	315	1.5%	359	1.7%	424	2%
Medium-Density Mixed Urban	77	<1%	85	<1%	110	<1%	117	<1%
High-Density Mixed Urban	16	<1%	17	<1%	22	<1%	23	<1%
Forest	6,363	30%	6,336	30%	6,325	30%	6,853	32.6%
Shrub/Scrub	473	2.2%	468	2.2%	466	2.2%	125	<1%
Grassland	29	<1%	50	<1%	48	<1%	15	<1%
Pasture/Hay	3,998	19%	3,800	18%	3,766	17.9%	5,555	26.4%
Cropland	7,500	36%	7,704	36.6%	7,580	36%	5,591	26.6%
Wetland	164	<1%	164	<1%	163	<1%	187	<1%

Agriculture is the dominant land use within the Prettyboy watershed, followed by forest and residential. Mixed urban uses account for less than 3 percent of the total land use, which represents the relatively rural nature of the Prettyboy watershed.

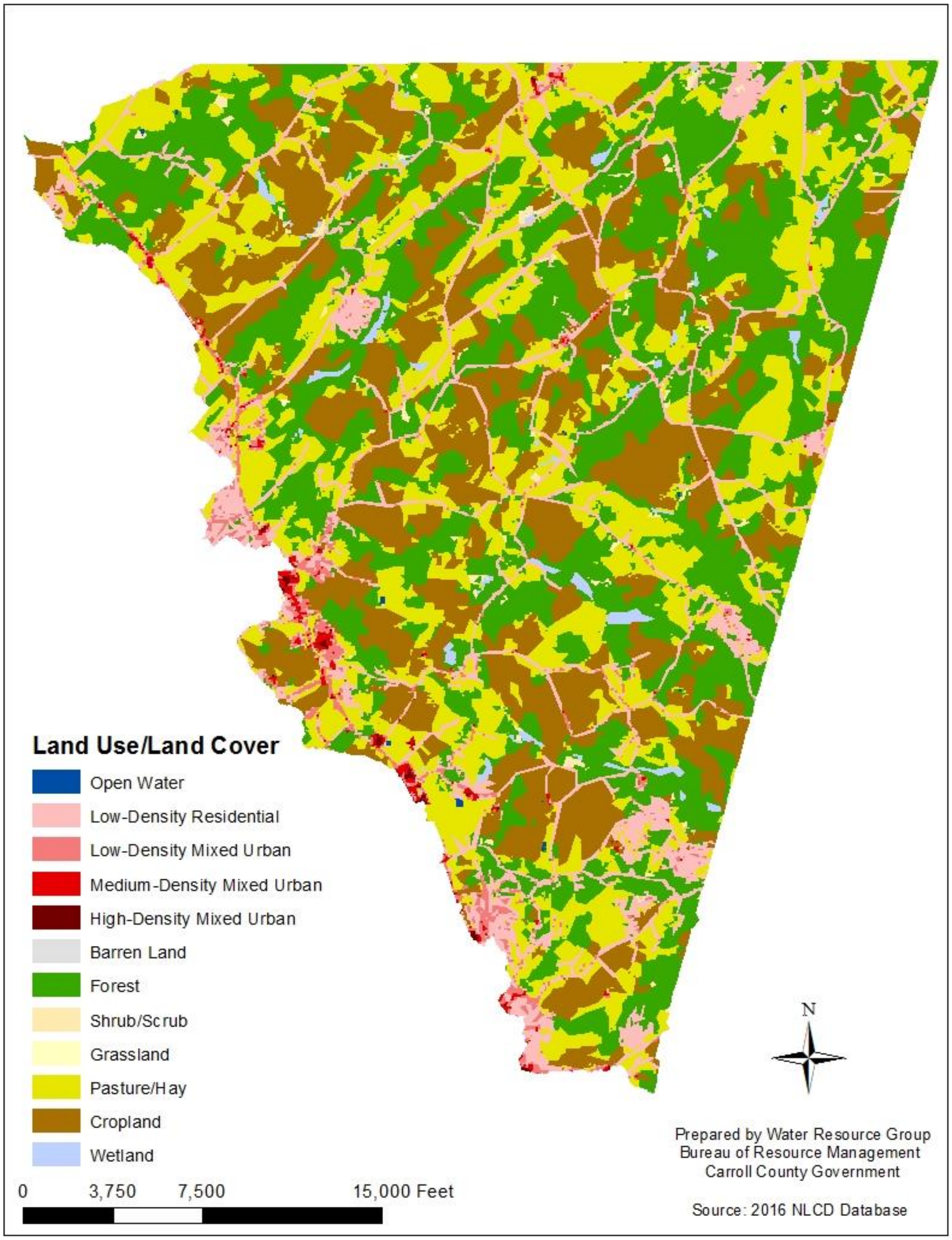

Figure 3-1: Prettyboy Watershed Land Use/Land Cover

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 (PFAs). The Maryland Planning Act and Smart Growth initiatives require that the local jurisdictions map specific growth areas to target infrastructure dollars from the State. PFAs are existing communities and locations where state funding for future growth will be designated. Within the Prettyboy watershed the towns of Manchester and Hampstead are designated PFAs. In addition to these two towns, there are also five rural villages that are designated PFAs. These rural villages include Lineboro, Alesia, Millers, Maple Grove, and Melrose. These designated areas have specific boundaries and are the focal point for employment, social, and commercial activity within the watershed. Figure 3-2 shows the designated PFAs within the Prettyboy watershed.

2. Zoning and Build Out

Zoning refers to the regulation of land for the purpose of promoting compatible land uses. Typically zoning specifies the areas in which residential, industrial, recreational or commercial activities may take place. The current zoning for the Prettyboy watershed can be found in Figure 3-3. Carroll County does not regulate zoning within the municipalities. The majority of the Prettyboy reservoir watershed (72%) is zoned agricultural.

Build-out analyzes the number of residential units in a given area that could be built based on the current zoning. Build out looks at existing development and, based on a yield calculation, determines how many more residential units can be built in the future. Within the Prettyboy watershed there are 945 parcels remaining for potential development on 9,901 acres for a potential lot yield (PLY) of 2,815 (build out data was provided by Carroll County Department of Land Use, Planning and Development). This data is based on a medium range buildable land inventory estimate by land use designations. The medium range estimates have been determined to be the most accurate for build out. The full buildable land inventory report can be found at: http://ccgovernment.carr.org/ccg/compplan/bli/. Figure 3-4 shows the remaining parcels in Prettyboy watershed where residential units could be built.

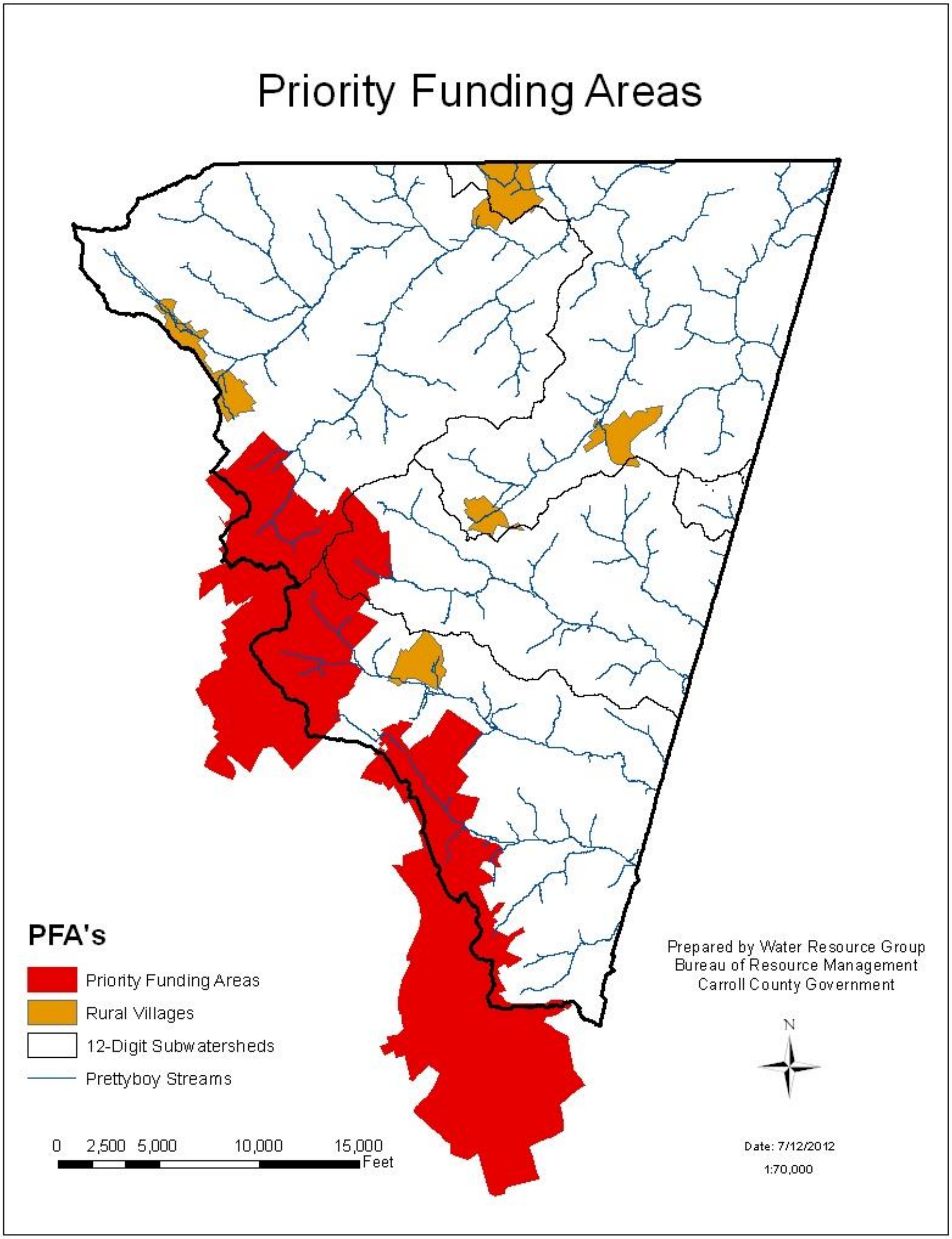

Figure 3-2: Prettyboy Watershed Priority Funding Areas

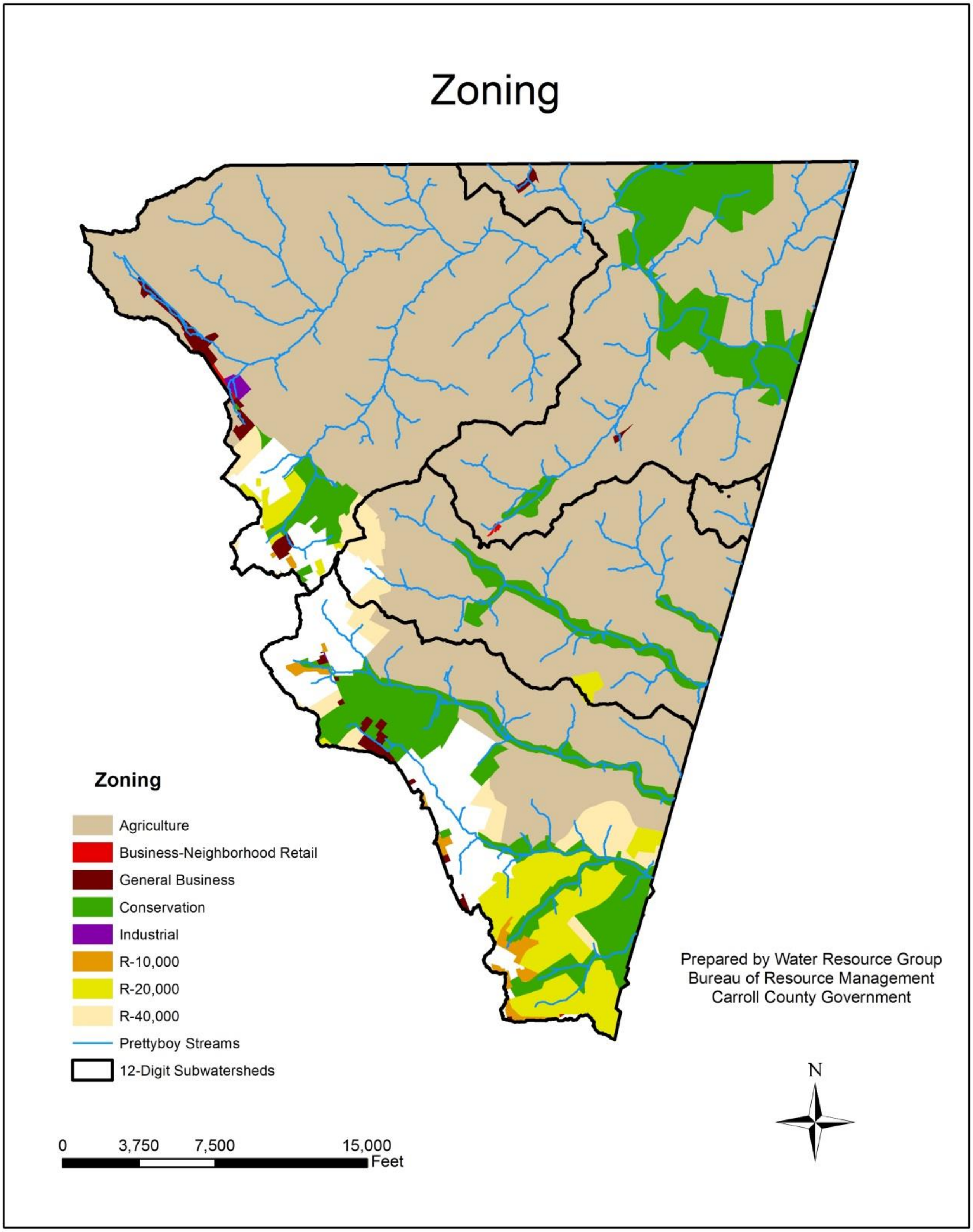

Figure 3-3: Prettyboy Watershed Zoning

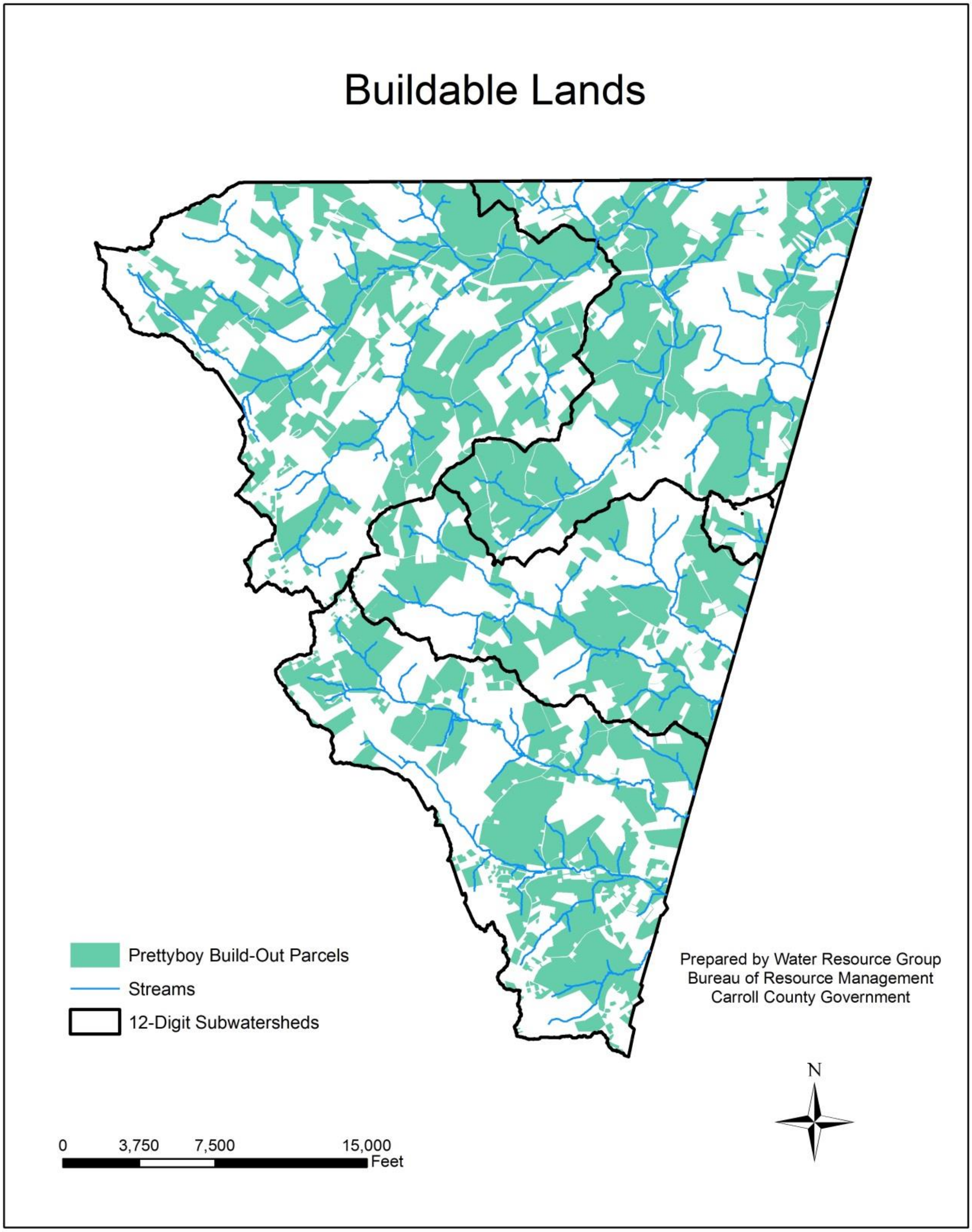

Figure 3-4: Prettyboy Watershed Build Out Parcels

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 Prettyboy watershed.

Table 3-2: Prettyboy Watershed Estimated Impervious Surface Area

DNR 12-digit Scale	Subwatershed	Acres	Impervious Acres	Percent Impervious
0313	Poplar Run	209	10.9	5.2
0314	Georges/Murphy Run	5,043	372.8	7.4
0315	Grave/Indian Run	3,558	107.1	3.0
0316	Gunpowder Falls	5,225	177.6	3.4
0317	South Branch Gunpowder Falls	6,990	324.6	4.6
Prettyboy Watershed		**21,025**	**993.0**	**4.7**

The Prettyboy watershed is estimated to have 993 acres of total impervious within the catchment and accounts for approximately 4.7 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 subwatersheds of Georges and Murphy Run originate within the town boundaries of Hampstead and Manchester and have the highest percentage of total impervious for the entire watershed (7.4%). Some aquatic species begin to disappear once the impervious area of a watershed reaches a certain threshold. This threshold was established at 10 percent back 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 Prettyboy watershed.

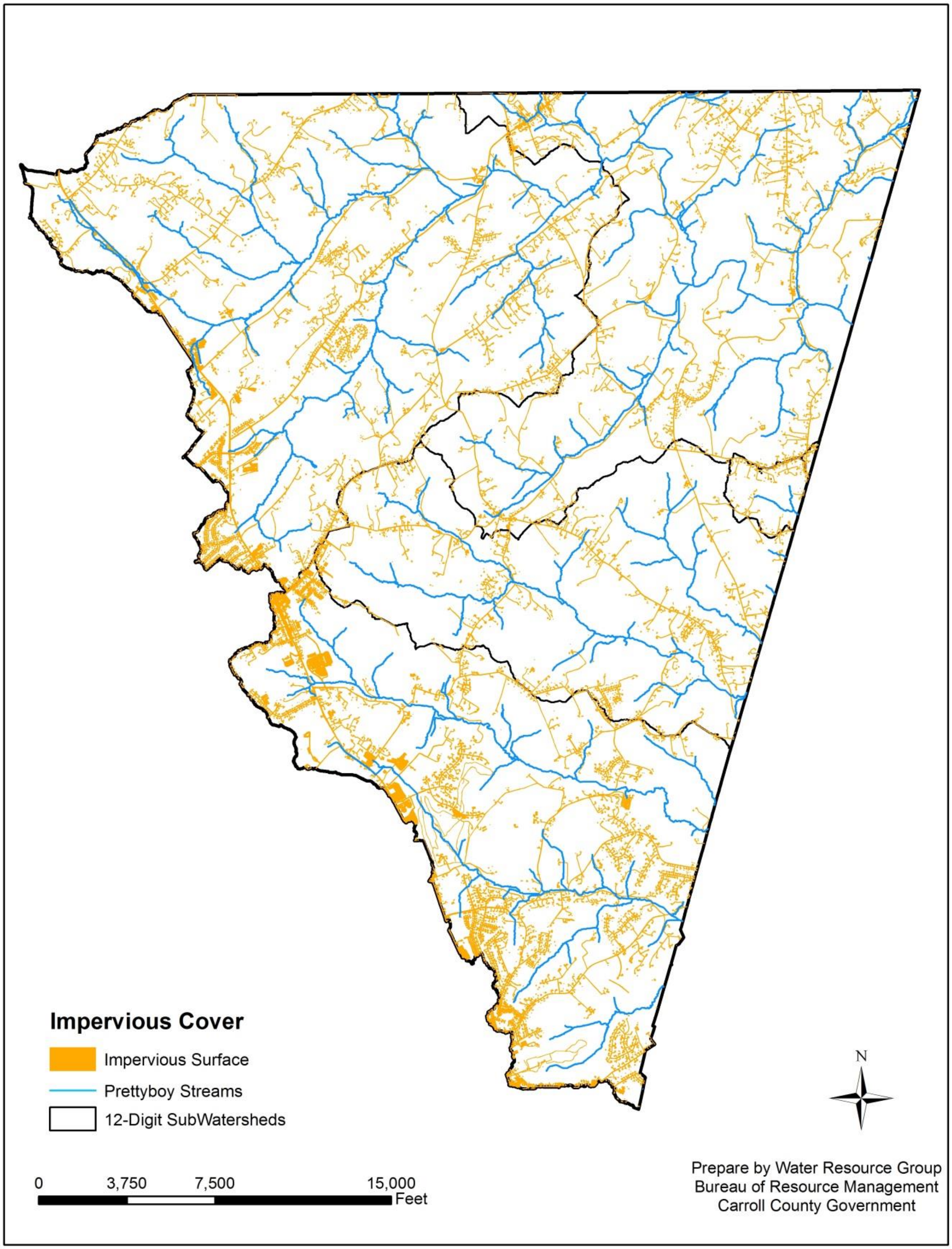

Figure 3-5: Prettyboy Watershed Impervious Surface Area

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 which required greater water quality and quantity controls and included stormwater management for subdivisions with lots greater than 2 acres.

There are different types of management facilities with varying degrees of pollutant removal capability. Facilities that infiltrate stormwater runoff have among the highest pollutant removal capability, while the initial dry pond design has the lowest pollutant removal efficiency and was designed to control water quantity. In total there are 48 existing stormwater management facilities within the Prettyboy watershed, with the majority being located within the town boundaries of Hampstead and Manchester. 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 Prettyboy watershed.

2. Storm Drain Systems

A storm drainage system will consist of either contoured drainage swales or a curb and gutter system with inlets and associated piping. Both systems function to quickly remove water from impervious areas in order to prevent flooding, but they have varying effects on water quality. The curb and gutter system directly connects to the stream through its piping network and delivers increased volumes of water as well as untreated pollutants from the connected impervious surface. Contoured drainage swales do not move water as efficiently as the curb and gutter system which allows for filtration of some pollutants, and infiltration, reducing the amount of water delivered to the stream. The majority of the storm drainage systems in the Prettyboy watershed are contoured drainage swales.

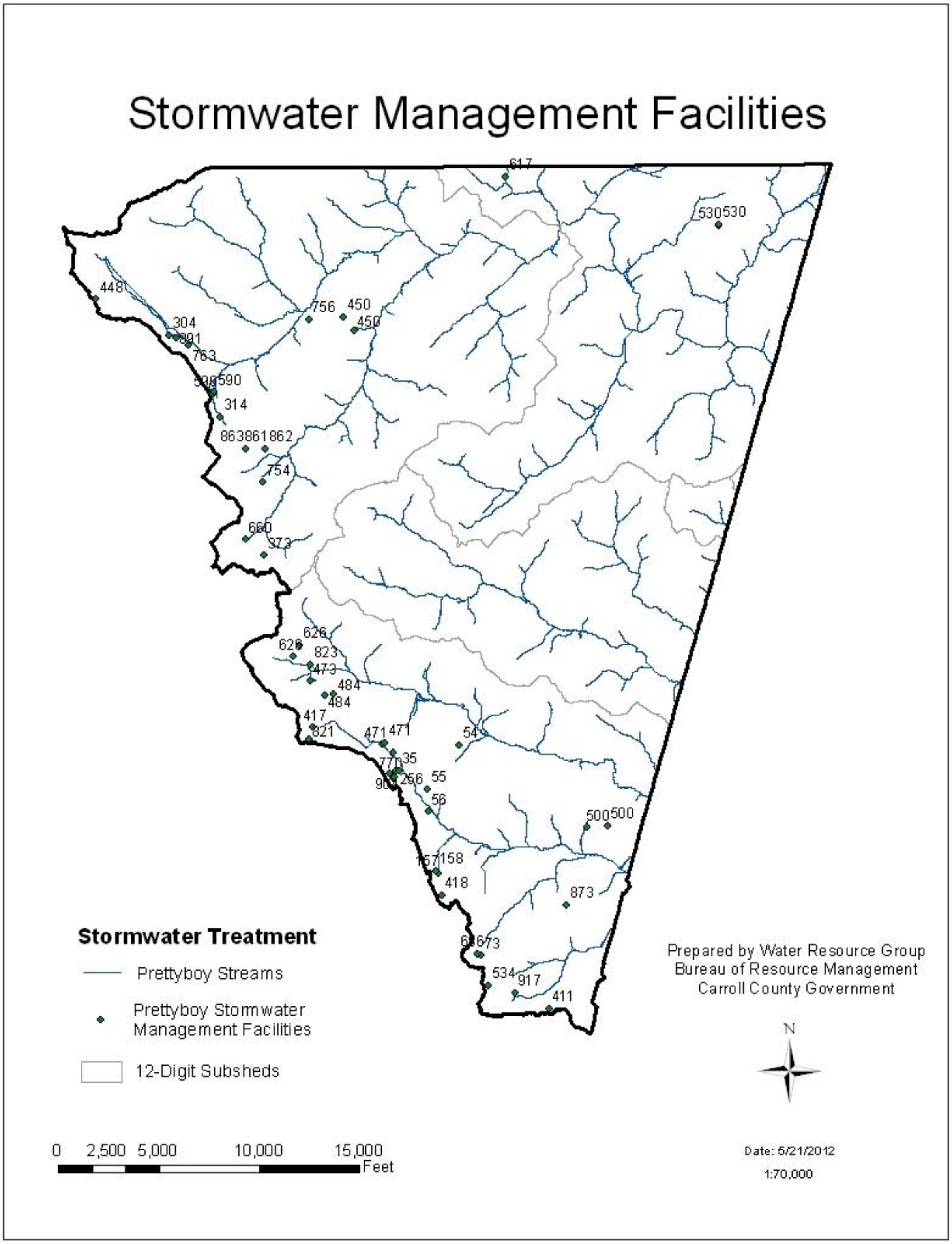

Figure 3-6: Stormwater Management Facilities

Table 3-3: Prettyboy Watershed Stormwater Facility Types

Facility Type	Number of Structures	Drainage Area
Dry Detention	4	52.19
Infiltration Facility	21	140.99
Filtration Facility	7	7.55
Sand Filters	7	150.77
Retention Facility	4	90.18
Shallow Marsh	2	69.6
Underground Stone	3	4.8
Grass Channel	1	1.88

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

F. Drinking Water

Safe drinking water is fundamentally important to support human and livestock populations within a watershed. Within the Prettyboy 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 Prettyboy watershed are shown in Figure 3-7.

2. Water Supply

The majority of the residents within the Prettyboy watershed obtain their water from private wells located on their property. (There are about 2,600 private water wells within the watershed.) Since the underlying geology within the Prettyboy 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 Prettyboy watershed the towns of Hampstead and Manchester provide residents with public water. Hampstead currently has 18 production wells appropriated, while Manchester has 17 wells and 2 springs. A water use appropriation is required for any entity withdrawing more than 10,000 gallons a day from a single source. Appropriations are determined by MDE's Water Supply Program and are necessary to conserve and protect this vital resource for the residents of the State of Maryland. At any given time these wells could be either online or offline depending on maintenance and demand. Both towns sit along the topographical watershed divide and obtain their water from community wells located in the Prettyboy watershed as well as the Liberty Reservoir and Double Pipe Creek watersheds. The community well locations and associated public service area is shown in Figure 3-7.

4. Baltimore Water Supply Drainage Area

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

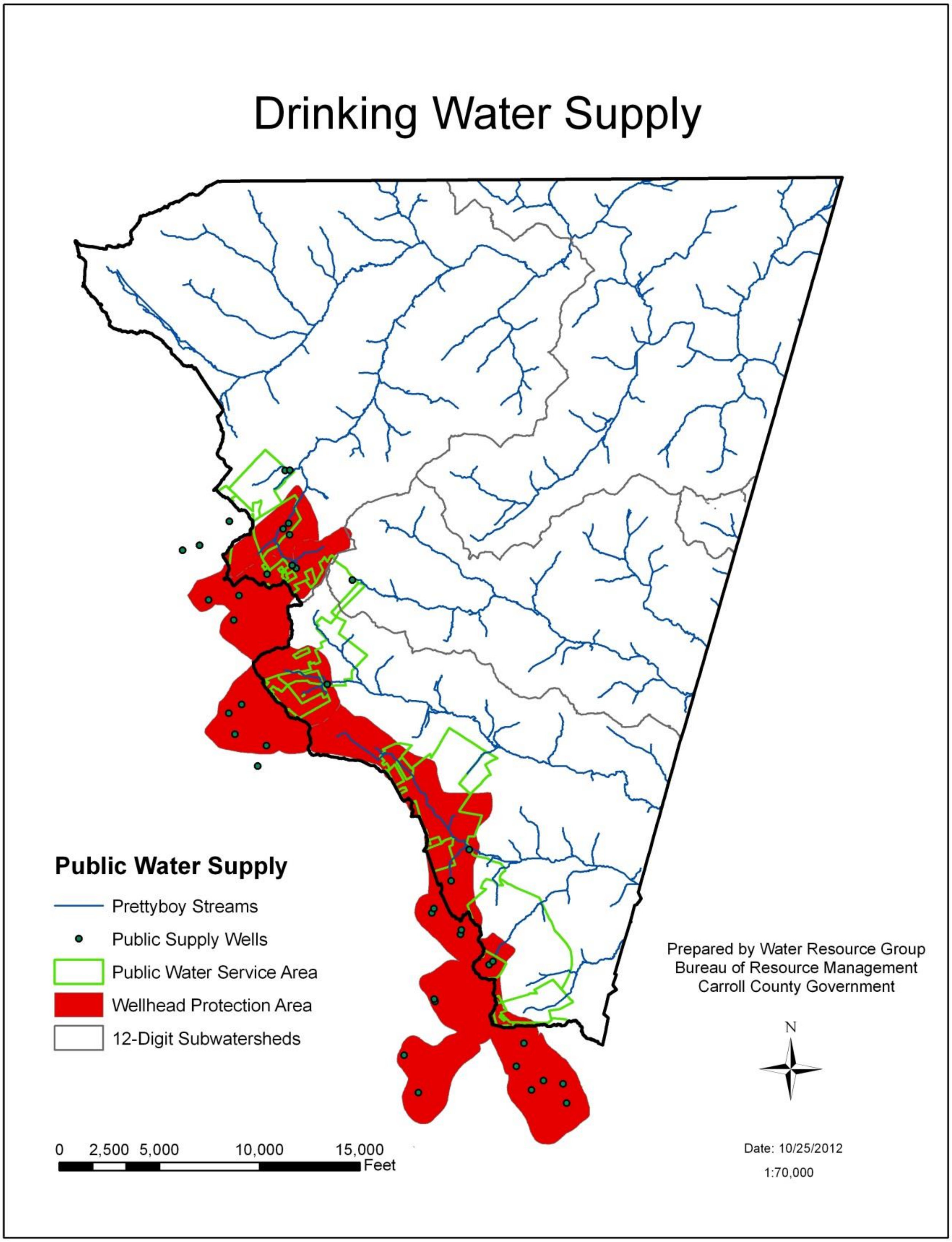

Figure 3-7: Prettyboy Public Water Supply

G. Wastewater

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

1. Public Wastewater Service Area

The public service area conveys wastewater through a piping system from residences and businesses to a treatment facility prior to discharge. Each hookup to the sewer line has a clean-out in which the private landowner is responsible for maintaining. The main part of the system consists of gravity flow lines with manholes for access, pumping stations, and force mains. The public utility is responsible for maintenance on the main part of the wastewater system. Within the Prettyboy watershed there are approximately 1,100 homes utilizing public service and about 200 homes that are within the area slated for future service. Figure 3-8 shows the public wastewater service area for the Prettyboy watershed.

2. Wastewater Discharge Locations

Within the Prettyboy watershed the towns of Manchester and Hampstead are serviced through a public wastewater system. Only the town of Manchester discharges treated wastewater effluent into the Prettyboy watershed. This wastewater treatment facility uses spray irrigation on the land in the headwaters of Georges Run from April 1 to November 30, and is designed for a 0.5 million gallon per day flow. Spray irrigation relies on vegetation for nutrient uptake and the natural filtering ability of soil results in the attenuation of many of the constituents found in sanitary sewer affluent. During the remainder of the year when vegetation is dormant, the treatment plant is permitted to discharge into Georges Run. The Hampstead wastewater treatment plant discharges into Piney Run stream, which is part of the Loch Raven reservoir watershed.

3. On-Site Septic Systems

On-site septic systems are the main source of waste disposal in rural areas like the Prettyboy watershed. 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 2,600 septic systems within the Prettyboy watershed.

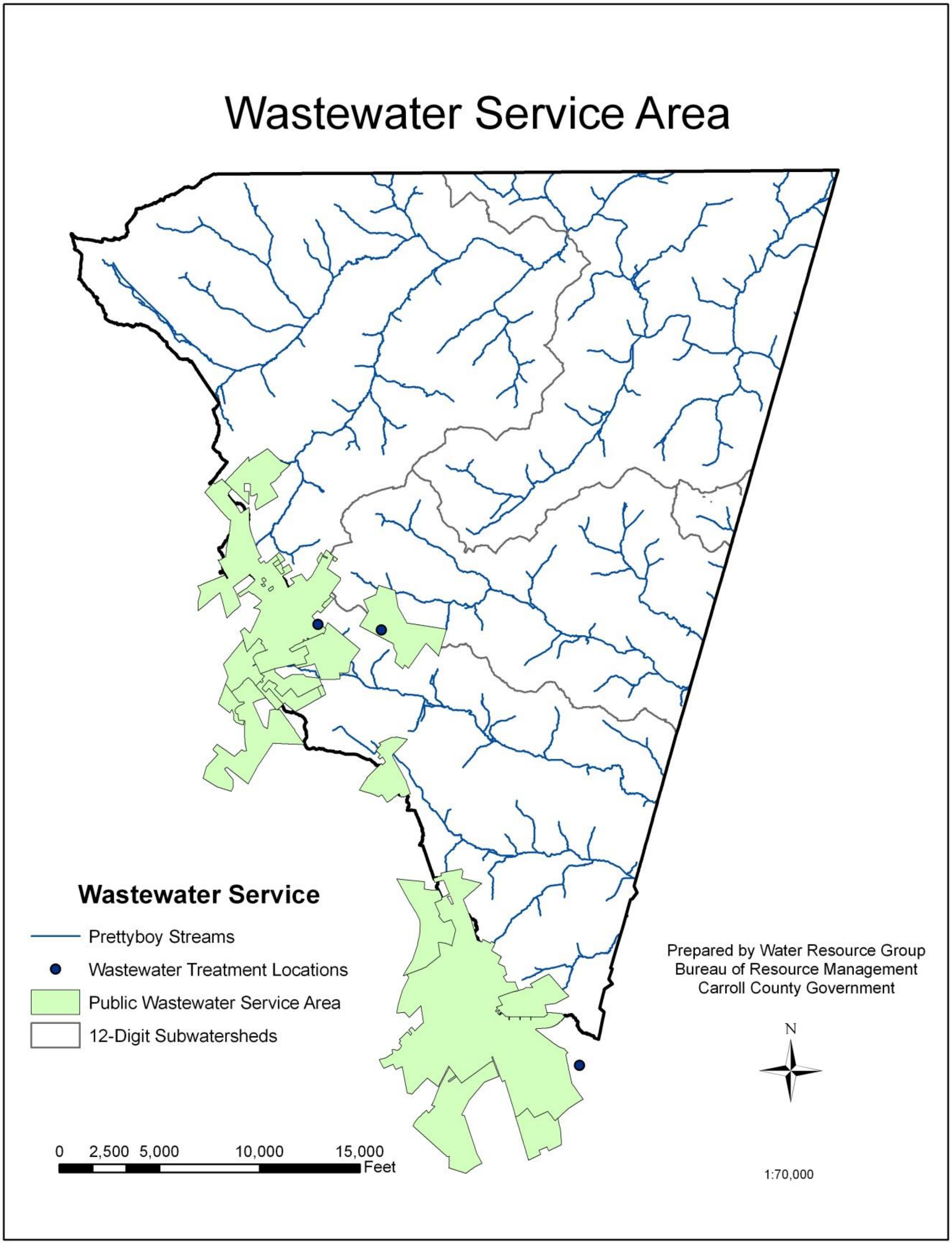

Figure 3-8: Prettyboy Wastewater Service Area

H. NPDES Point Sources

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

Table 3-4: NPDES Permits in Prettyboy Watershed

Permit Holder	Permit Number	Permit Type	Subwatershed	Original Issue Date	Status
Lions Club Pool	MDG766686	WMA5	Grave Run	5/6/03	Effective
Manchester Water Distribution System	MDR002201	WMA5	Georges Run	12/4/00	Effective
Manchester WWTP	MD0022578	WMA2G	Georges Run	2/27/75	Expired
Masonry Contractors, INC.	MD3312G99	WMA3	South Branch	8/1/06	Effective
J.C. Wilhelm, INC.	MDR003011	WMA5	Georges Run		Effective
River Valley Ranch	MD3513G05	WMA4	Gunpowder	12/9/03	Effective

I. Protected Lands

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

Table 3-5 lists the type of protected lands within the Prettyboy watershed along with the representative acreage. Nearly 3,800 acres (18%) of the total land area within Prettyboy has some sort of protection associated with the land. Agricultural easements have the highest percentage of protection within the watershed at 11 percent with nearly 2,400 acres preserved. Figure 3-9 shows where the protected areas are located within the watershed.

Table 3-5: Protected Lands in Prettyboy Watershed

Type of Protection	Acres	Percentage
Agricultural Easement	2,340	11
Open Space and Parks	1,057	5
Forest Conservation Easement	253	1
Water Resource Easement	69	<1
Floodplain Easement	5	<1
Total	**3,724**	**18**

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 Prettyboy watershed lies within the Upper Patapsco Rural Legacy Area. The Rural Legacy Area encompasses 18,412 acres (88%) of the Prettyboy watershed depicted in Figure 3-10.

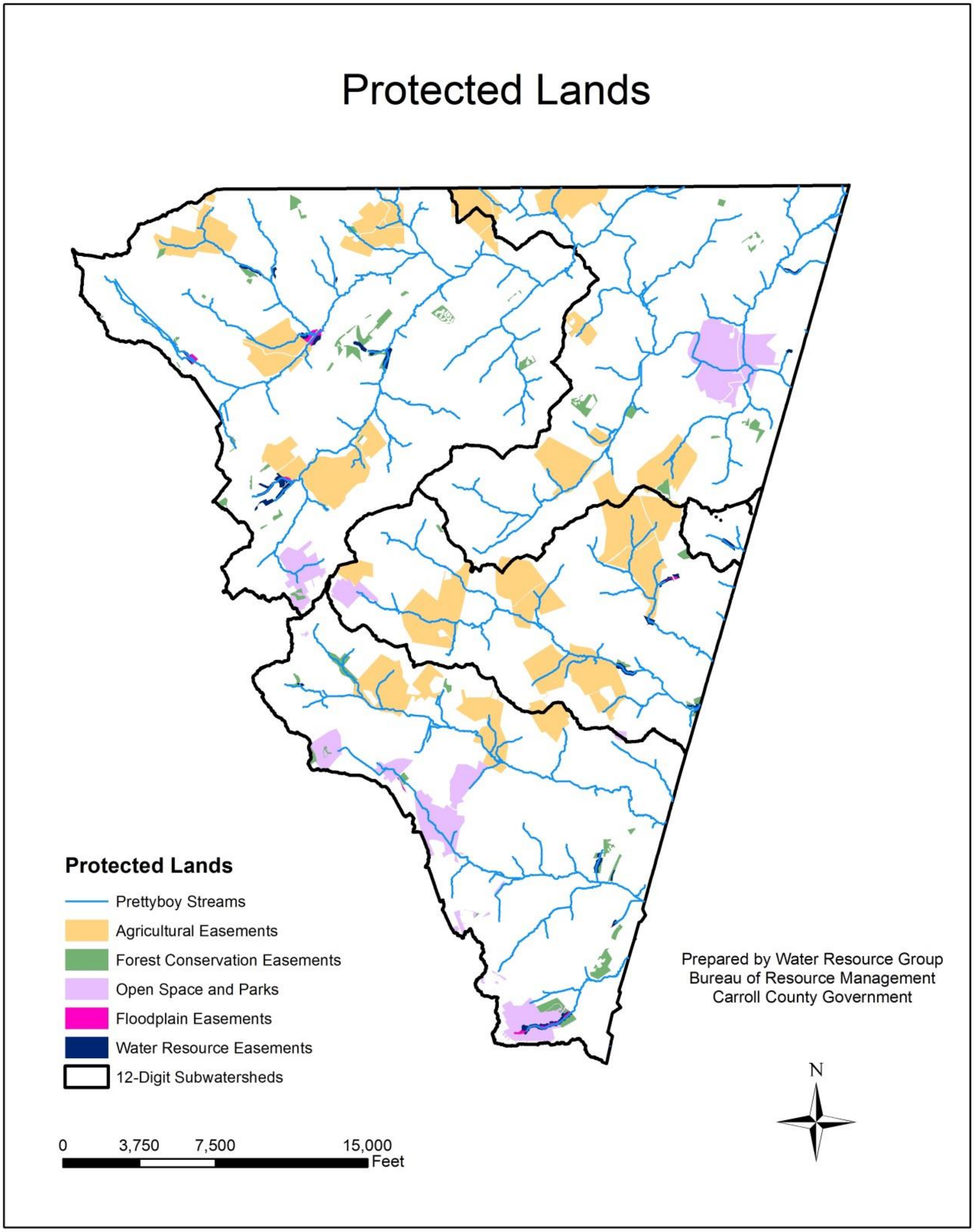

Figure 3-9: Prettyboy Protected Lands

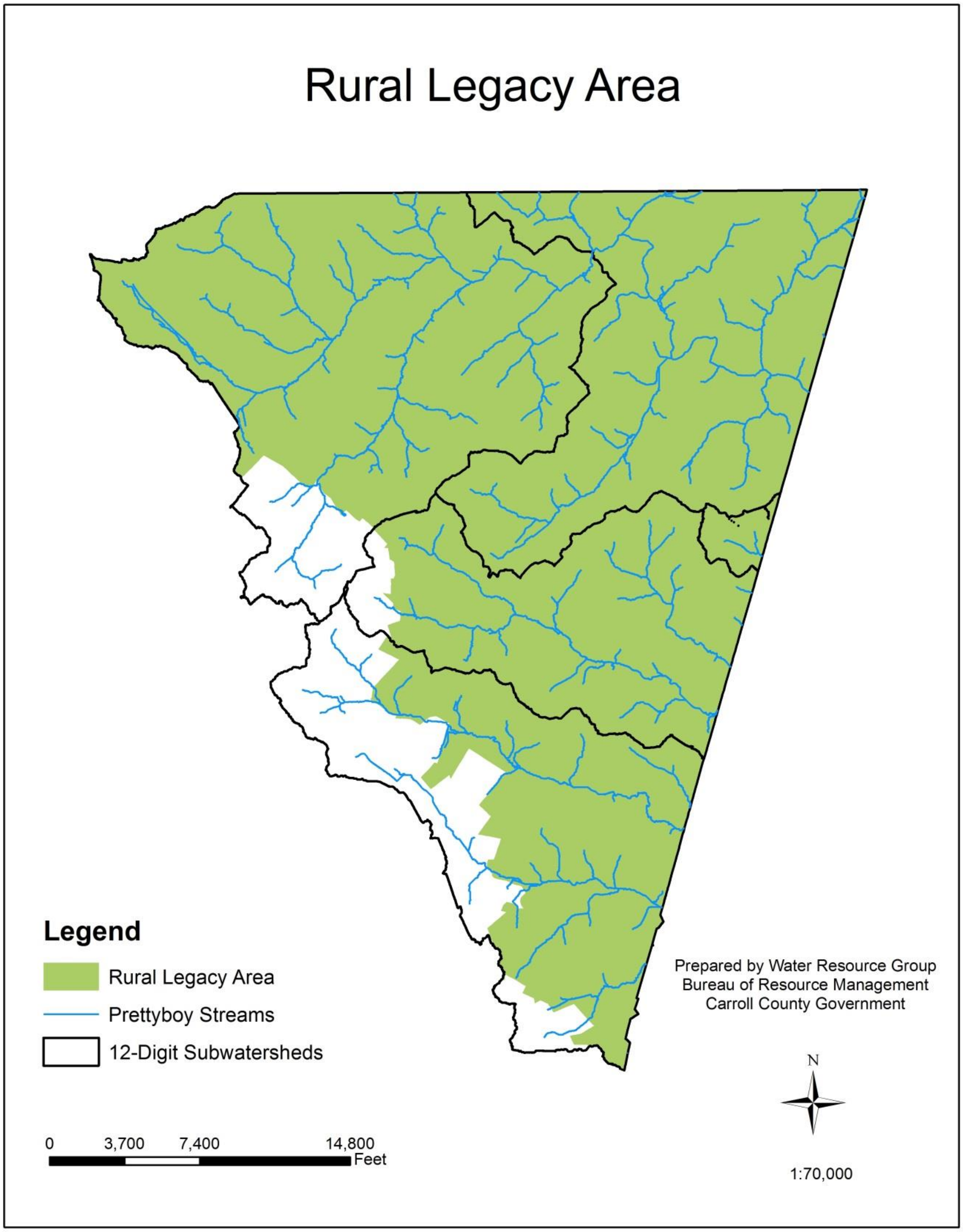

Figure 3-10: Upper Patapsco Rural Legacy Area

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. Long term waste storage structures allows for manure to be applied during appropriate weather conditions to reduce runoff and allows some bacteria to die off during the storage practice (Walker, et al. 1990).

Appendix B lists the agricultural BMPs located in the Prettyboy watershed as of summer 2014 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 Prettyboy 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 summer 2014, the Prettyboy watershed had approximately 11,567 acres (55%) of the total land area in a farm plan.

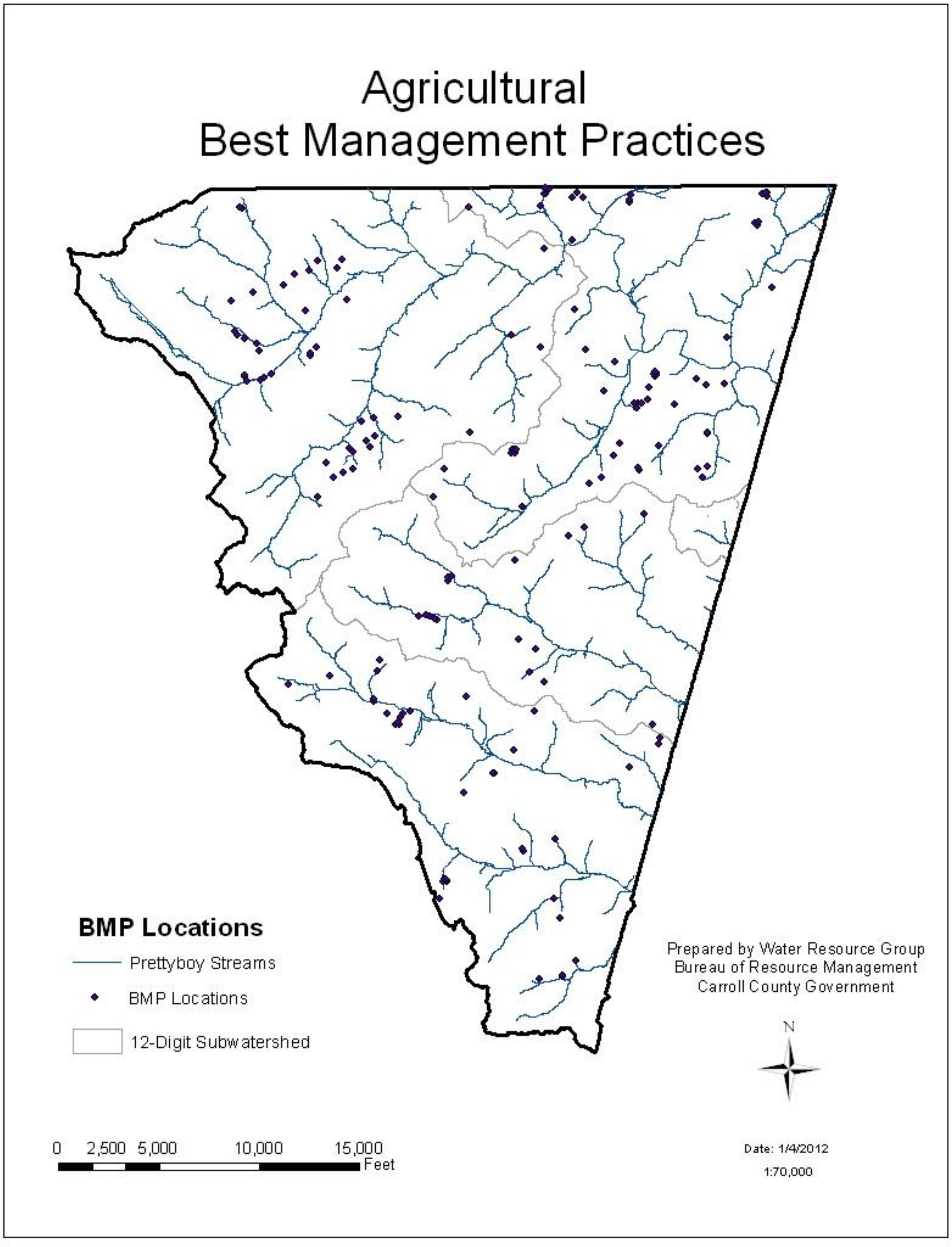

Figure 3-11: Prettyboy Agricultural BMP Locations

IV. Water Quality

A. Introduction

Maryland water quality standards have been adopted per the Federal Clean Water Act Section 101 to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters". Individual standards are established to support the beneficial uses of water bodies such as fishing, aquatic life, drinking water supply, boating, water contact recreation as well as terrestrial wildlife that depend on water. Local monitoring allows documentation of the status of local water bodies and indicates where restoration or mitigation may be needed. This chapter will discuss the designated uses within Prettyboy, current water quality impairments that have been assigned, and existing water quality data within the watershed. Water quality data is utilized along with identified impairments from the stream corridor assessment to prioritize preservation and restoration.

B. Designated Uses

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

The entire portion of the Prettyboy watershed within Carroll County is designated as use III-P, Non-tidal Cold Water and Public Water Supply. The use III-P is capable of growing and propagating trout, but may not be capable of supporting adult trout for a put-and-take fishery.

C. Tier II Waters

States are required by the federal Clean Water Act to develop policies, guidance, and implementation procedures to protect and maintain existing high quality waters and prevent them from degrading to the minimum allowable water quality. Tier II waters have chemical or biological characteristics that are significantly better than the minimum water quality requirements. All Tier II designations in Maryland are based on having healthy biological communities of fish and aquatic insects. Tier II designated stream segments for the Prettyboy watershed can be found in Figure 4-1.

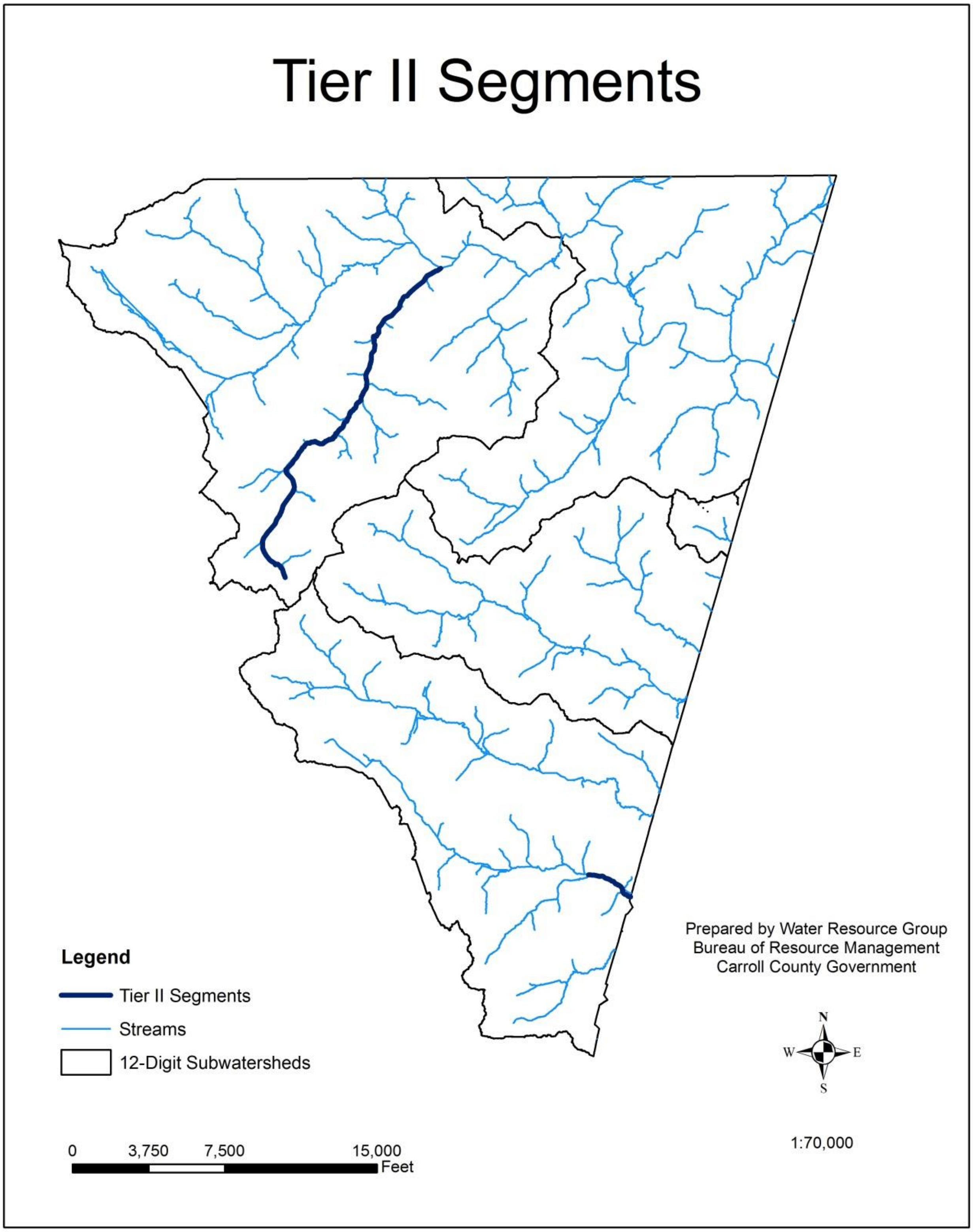

Figure 4-1: Prettyboy Watershed Tier II Stream Segments

D. Total Maximum Daily Loads (TMDLs)

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

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

TMDLs for the Prettyboy watershed are summarized below. More information on TMDLs and the 303(d) list can be found at http://www.mde.maryland.gov/programs/Water/TMDL/Pages/Programs/WaterPrograms/tmdl/index.aspx.

1. Current Impairments

The current impairments within the Prettyboy watershed that have been assigned a TMDL: Bacteria and Nutrients.

a. Bacteria

The current estimated baseline load for bacteria within the entire Prettyboy watershed was determined by (MDE, 2008) to be 625,714 billion MPN/year (MPN, or most probable number is a technique used to estimate microbial populations). The TMDL to meet the watershed designated use was determined by MDE to be 199,917 billion MPN/year, which is a reduction of 425,797 billion MPN/year (32%) from the current estimated loading. The baseline load for Carroll County was determined by MDE to be 292,956 billion MPN/year. With the TMDL to meet the designated use for the Carroll County portion of the watershed to be 77,029 billion MPN/year, a reduction of 215,927 billion MPN/year (74%) from the current estimated loading. Table 4-1 outlines the bacteria baseline and TMDL for the entire watershed as well as the Carroll County baseline load and TMDL allocation.

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 4-2 lists the bacteria stormwater WLA for the phase II jurisdictions within the Prettyboy Watershed.

Table 4-1: Prettyboy 8-digit Watershed Bacteria TMDL

Subwatershed	Baseline Load (Billion MPN/Year)		TMDL Allocation (Billion MPN/Year)	
	Sub-Watershed Load	Carroll County Load	Sub-Watershed Allocation	Carroll County Load
GUN0476	203,147	191,919	31,918	27,833
GRG0013	31,597	22,662	28,663	20,560
GOB0042	142,514	73,376	63,458	27,950
SUB	248,456	5,000	75,878	687
Total	**625,714**	**292,956**	**199,917**	**77,029**

Table 4-2: Stormwater WLA for Bacteria by Jurisdiction (Source: MDE TMDL Data Center)

Carroll County (Phase 1)[1]	Hampstead (Phase II) Stormwater WLA (Billion MPN/Year)	% Reduction	Manchester (Phase II) Stormwater WLA (Billion MPN/Year)	% Reduction
N/A	2,311	79.7%	3,339	88.9%

[1] No stormwater WLA for the County's Phase I because the Prettyboy Reservoir watershed is essentially outside the reach of each County's stormwater system management plan. The predominate zoning and land use in the watershed is agriculture and as such, is not served by an organized storm sewer system. There is one area of urban development in the Prettyboy Watershed, represented by the Incorporated Towns of Manchester and Hampstead (MDE, 2008).

b. Phosphorus

The current estimated stormwater baseline load for Carroll County as determined by MDE TMDL Data Center is 1,843 lbs. /yr., the TMDL for the stormwater WLA was determined to be 1,572 lbs. /yr., which is a reduction of 271 lbs. /yr. (15%) from the current loading (Table 4-3). This stormwater WLA is an aggregate of the municipal and industrial stormwater, including the loads from construction activity. Estimating a load contribution from the stormwater Phase I and II sources is imprecise, given the variability in sources, runoff volumes, and pollutant loads over time (MDE, 2006).

Table 4-3: Prettyboy 8-digit Watershed Phosphorus TMDL

Subwatershed	WGP0050		Percent Reduction
Jurisdiction	Baseline	TMDL	
Carroll County	1,843	1,572	15%
Total	**1,843**	**1,572**	**15%**

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

E. Water Quality Data

Water quality data within the Prettyboy Reservoir has been collected throughout the years by varying agencies with different program goals. This section will focus on water quality data that has been collected in support of the Prettyboy Watershed Restoration Action Strategy (WRAS, 2007). The first section will discuss the synoptic survey results performed by MDE in support of the Prettyboy WRAS. An examination of the discharge and chemical data collected by Carroll County staff, which focused on the major subwatersheds within Prettyboy watershed, will also be discussed.

1. Synoptic Survey Results

In the spring of 2005, MDE performed, in support of the Prettyboy WRAS, a synoptic survey at 68 tributary sites within the Prettyboy watershed. A synoptic survey is a one-time water quality survey designed to provide a snapshot of the nutrient levels and the quality of the biological community at a specific site within a watershed. The survey typically collects surface water grab samples during spring baseflow. The synoptic information is used to identify subwatersheds or reaches within a watershed that might benefit from the implementation of best management practices, stream restoration, or protection. The synoptic survey is used as a relative comparison between sites and to prioritize watersheds that could benefit from additional nutrient concentration sampling.

Of the 68 synoptic sampling sites 23 had nitrate/nitrite levels that were considered excessive (>5mg/L), 37 were found to have a high concentration (3-5mg/L), 7 were found to be moderately elevated (1-3mg/L), and only one subwatershed had a baseline concentration (<1mg/L). With regards to orthophosphate, only 2 of the 68 sites were found to have excessive concentrations (>.015 mg/L), 3 sites were rated highly concentrated (.01-.015 mg/L), 32 sites had moderate concentrations (.005-.01 mg/L), and the remaining 31 sites were found to have an orthophosphate concentration below baseline (<.005 mg/L). Nutrient concentrations and ranges can be found in Table 4-4. Nitrate concentrations and yields can be found in Figure 4-2 and 4-3. Orthophosphate concentrations and yields can be found in Figure 4-4 and 4-5.

Figure 4-2: 2005 Synoptic Survey Nitrate/Nitrite Concentrations (Figure 2, MDE 2006)

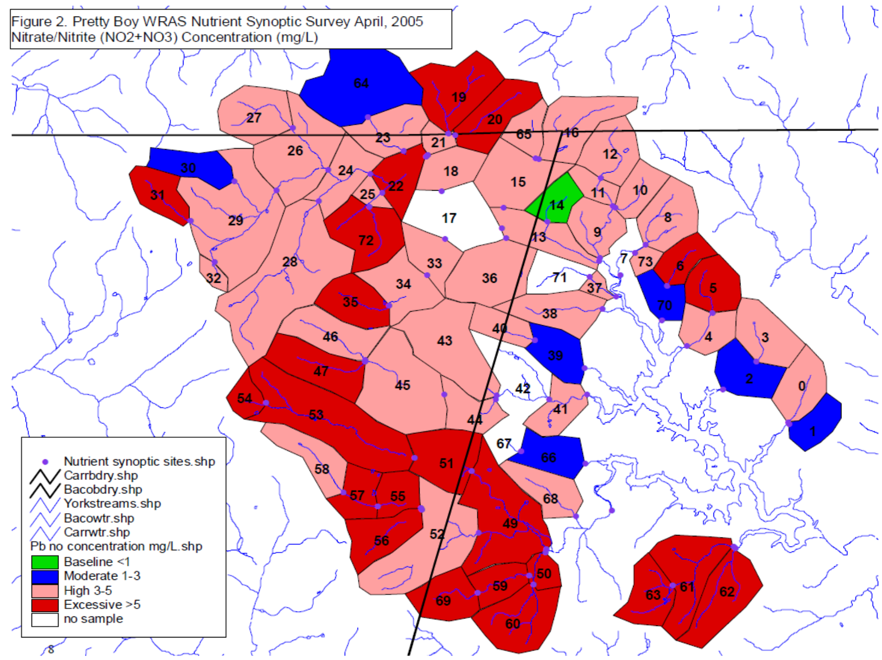

Figure 4-3: 2005 Synoptic Survey Nitrate/Nitrite Yields (Figure 3, MDE 2006)

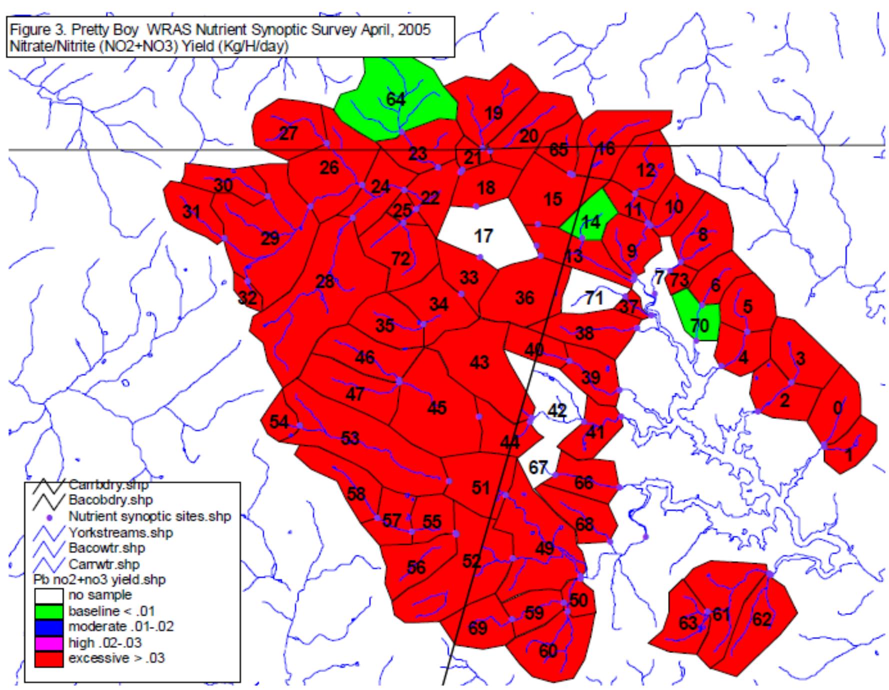

Figure 4-4: 2005 Synoptic Survey Orthophosphate Concentrations (Figure 4, MDE 2006)

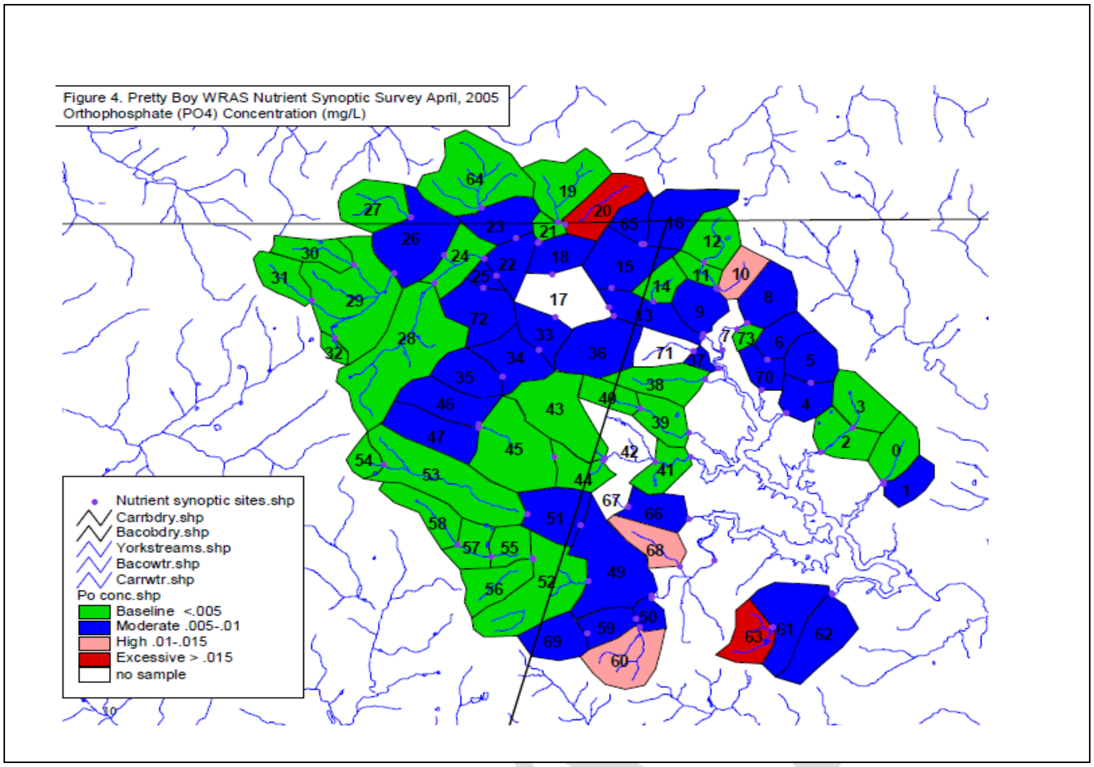

Figure 4-5: 2005 Synoptic Survey Orthophosphate Yields (Figure 5, MDE 2006)

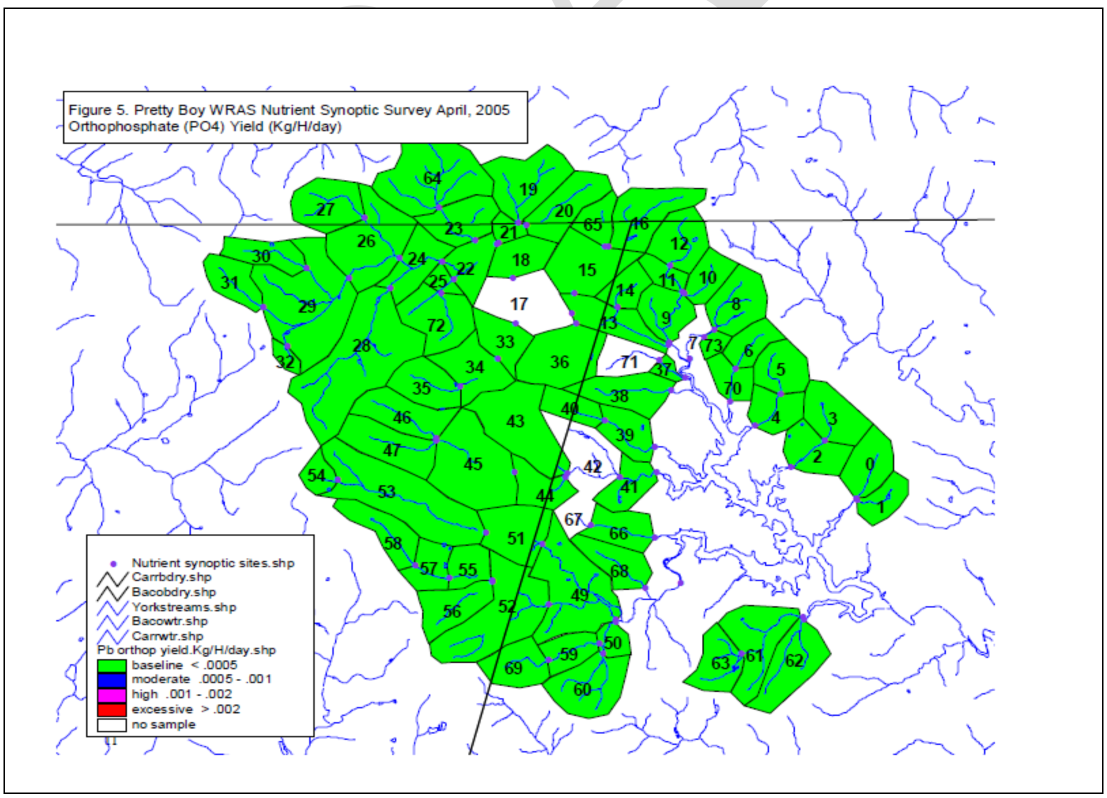

Table 4-4: Nutrient Rating and Ranges

Rating1	Nitrate/Nitrite Concentration Mg/L	Nitrate/Nitrite Yield lbs./Ac/Day	Orthophosphate Concentration Mg/L	Orthophosphate Yield lbs./Ac/Day
Baseline	<1	<.009	<.005	<.00045
Moderate	1-3	.009-.018	.005-.01	.00045-.00089
High	3-5	.018-.027	.01-.015	.00089-.0018
Excessive	>5	>.027	>.015	>.0018

1. Frink, Charles R. 1991. Estimating Nutrient Exports to Estuaries. Journal of Environmental Quality. 20:717-724.

The full report on this survey can be found at http://dnrweb.dnr.state.md.us/download/bays/pbres_synoptic.pdf.

2. Synoptic Survey Summary

Estimates of annual dissolved nitrogen loads/yields from samples taken during spring of the year will result in inflated load estimates. More accurate nitrate/nitrite load/yield estimates need to include sampling during the growing season to account for potential lower concentrations and discharges.

The tendency of orthophosphate to be transported-bound to sediments makes any estimates of annual orthophosphate loads/yields derived from base flow conditions very conservative. More accurate estimates of orthophosphate loads/yields in a watershed must include samples from storm flows that carry the vast majority of the sediment load of a watershed.

3. Carroll County Data

Carroll County Bureau of Resource Management conducted a three year sampling program from June of 2007 to November of 2009 of the five main subwatersheds within the Prettyboy watershed, as shown in Figure 4-6. Each site was strategically located at the bottom of the drainage area along the Carroll/Baltimore County line. The selected monitoring sites covered 93 percent of the Prettyboy watershed surface water flow within Carroll County. At each sampling location water samples were taken in order to analyze concentrations for nitrate/nitrite, total phosphorus, orthophosphorus, and total suspended solids. Each site was sampled on a weekly basis to ensure that a variety of hydrological conditions would be encountered for both dry and wet weather conditions. Discharge measurements were taken in accordance with USGS protocol (Harrison, Rawlins, and Potyondy, 1994). A summary of the nutrient concentrations for each subwatershed can be found in Appendix C.

Discharge (flow) measurements were taken in conjunction with the nutrient samples at each site to determine yield and to calculate a daily nutrient loading. The calculated loadings in the following sub-sections were based on actual monitoring and show a discrepancy between real data and modeled data which calculates loadings based on land use. Detailed phosphorus loadings for each sampling event within each subwatershed can be found in Appendix D.

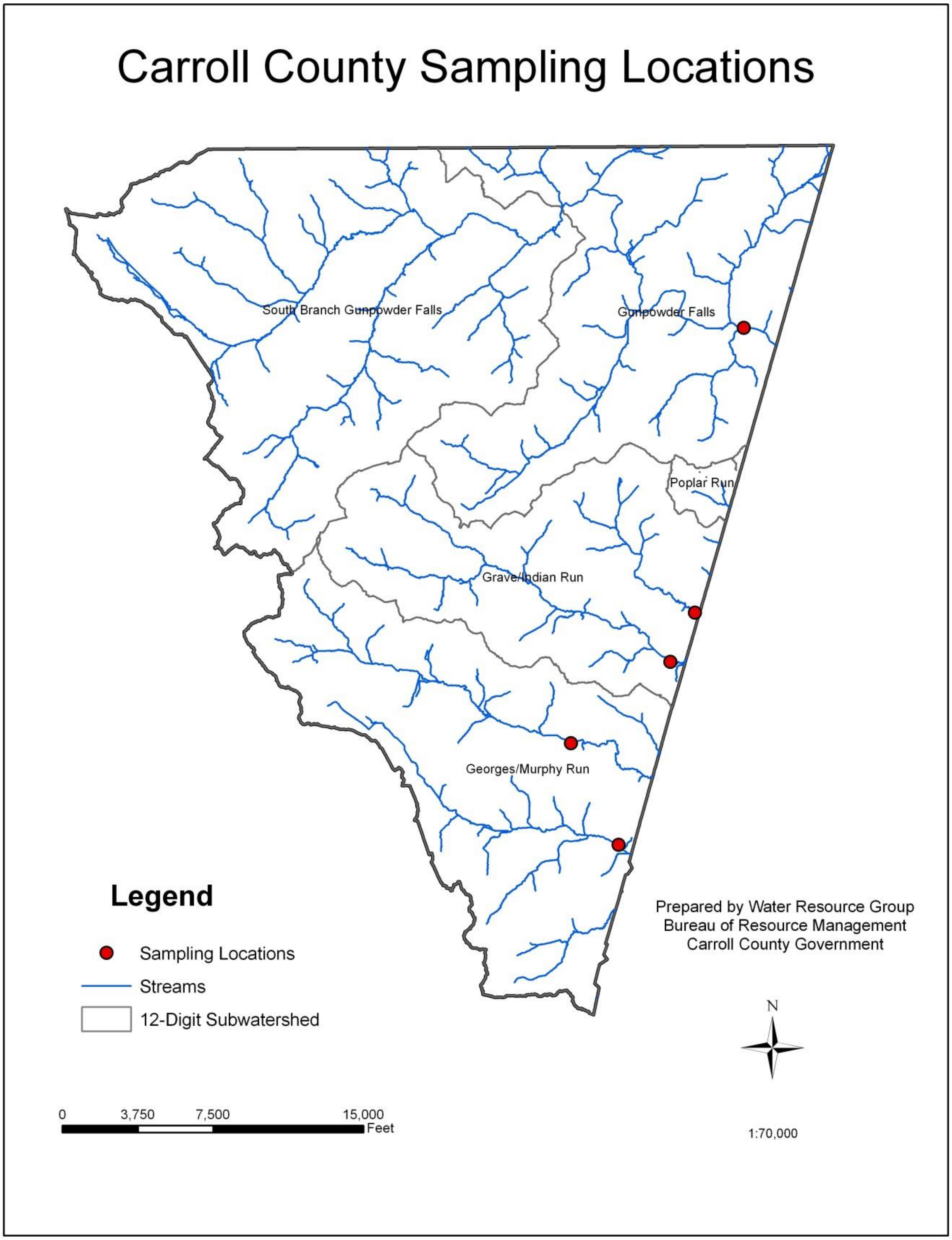

Figure 4-6: Carroll County Surface Water Sampling Stations

a. Murphy Run

Murphy Run sampling was performed about 150 feet upstream from the bridge crossing located along Upper Beckleysville Road. Table 4-5 displays the average phosphorus loadings by year for Murphy Run with a three year average of all sampling events.

Table 4-5: Murphy Run Average Yearly Phosphorus Loadings

Year	Discharge (CFS)	Total Phosphorus Mg/L	Total Phosphorus Lbs/day	Total Phosphorus Lbs/year
2007	1.82	0.058	0.61	222.65
2008	3.16	0.050	1.01	368.65
2009	2.85	0.031	0.73	266.45
3 year Average	**2.61**	**0.046**	**0.78**	**285.9**

b. Georges Run

Georges Run sampling was performed about 100 feet upstream from the bridge crossing located along Fairmount Road. This location was about a mile upstream from the Baltimore County line but was the best location with regards to access. Table 4-6 displays the average phosphorus loadings by year for Georges Run with a three year average of all sampling events.

Table 4-6: Georges Run Average Yearly Phosphorus Loadings

Year	Discharge (CFS)	Total Phosphorus Mg/L	Total Phosphorus Lbs/day	Total Phosphorus Lbs/year
2007	2.29	0.089	1.34	489.1
2008	4.17	0.073	1.79	653.4
2009	4.08	0.057	1.92	700.8
3 year Average	**3.51**	**0.073**	**1.68**	**614.4**

c. Grave Run

Grave Run sampling was performed about 175 feet upstream from the bridge crossing located along Millers Station Road. Table 4-7 displays the average phosphorus loadings by year for Grave Run with a three year average of all sampling events.

Table 4-7: Grave Run Average Yearly Phosphorus Loadings

Year	Discharge (CFS)	Total Phosphorus Mg/L	Total Phosphorus Lbs/day	Total Phosphorus Lbs/year
2007	2.57	0.069	1.13	412.5
2008	5.20	0.059	1.96	715.4
2009	4.89	0.035	1.32	481.8
3 year Average	**4.22**	**0.054**	**1.47**	**536.6**

d. Indian Run

Indian Run sampling was performed about 100 feet upstream from the bridge crossing located along Falls Road. Table 4-8 displays the average phosphorus loadings by year for Indian Run with a three year average of all sampling events.

Table 4-8: Indian Run Average Yearly Phosphorus Loadings

Year	Discharge (CFS)	Total Phosphorus Mg/L	Total Phosphorus Lbs/day	Total Phosphorus Lbs/year
2007	0.93	0.058	0.28	102.2
2008	1.98	0.046	0.53	193.5
2009	1.78	0.034	0.40	146.0
3 year Average	**1.56**	**0.046**	**0.403**	**147.2**

e. Gunpowder Falls

The sampling for Gunpowder Falls was performed on River Valley Ranch property about 300 feet below where Muddy Creek empties into Gunpowder. Table 4-9 displays the average phosphorus loadings by year for Gunpowder Falls with a three year average of all sampling events.

Table 4-9: Gunpowder Falls Average Yearly Phosphorus Loadings

Year	Discharge (CFS)	Total Phosphorus Mg/L	Total Phosphorus Lbs/day	Total Phosphorus Lbs/year
2007	18.01	0.091	10.53	3,843.5
2008	32.64	0.069	14.15	5,164.8
2009	29.03	0.049	9.37	3,420.1
3 year Average	**26.56**	**0.069**	**11.35**	**4,142.8**

4. Prettyboy Phosphorus Loadings

Tables 4-10 through 4-12 display the average yearly phosphorus loadings from each of the five subwatersheds within Prettyboy with a cumulative loadings summary and average nutrient concentrations for the entire sampling year. Table 4-13 displays a summary of phosphorus loadings for the whole Prettyboy watershed by year over the entire sampling program.

Table 4-10: 2007 Subwatershed Phosphorus Loadings

Subwatershed	Discharge (CFS)	Total Phosphorus Mg/L	Total Phosphorus Lbs/Day	Total Phosphorus Lbs/Year
Murphy Run	1.82	0.058	0.61	222.65
Georges Run	2.29	0.089	1.34	489.10
Grave Run	2.57	0.069	1.13	412.50
Indian Run	0.93	0.058	0.28	102.20
Gunpowder Falls	18.01	0.091	10.53	3843.50
2007 Loadings	**25.62[2]**	**0.073[1]**	**13.89[2]**	**5069.95[2]**

Table 4-11: 2008 Subwatershed Phosphorus Loadings

Subwatershed	Discharge (CFS)	Total Phosphorus Mg/L	Total Phosphorus Lbs/Day	Total Phosphorus Lbs/Year
Murphy Run	3.16	0.050	1.01	368.65
Georges Run	4.17	0.073	1.79	653.40
Grave Run	5.20	0.059	1.96	715.40
Indian Run	1.98	0.046	0.53	193.50
Gunpowder Falls	32.64	0.069	14.15	5164.80
2008 Loadings	**47.15[2]**	**0.059[1]**	**19.44[2]**	**7095.75[2]**

Table 4-12: 2009 Subwatershed Phosphorus Loadings

Subwatershed	Discharge (CFS)	Total Phosphorus Mg/L	Total Phosphorus Lbs/Day	Total Phosphorus Lbs/Year
Murphy Run	2.85	0.031	0.73	266.45
Georges Run	4.08	0.057	1.92	700.80
Grave Run	4.89	0.035	1.32	481.80
Indian Run	1.78	0.034	0.40	146.00
Gunpowder Falls	29.03	0.049	9.37	3420.10
2009 Loadings	**42.63[2]**	**0.041[1]**	**13.74[2]**	**5015.15[2]**

Table 4-13: Summary of Prettyboy Phosphorus Loadings

Year	Discharge (CFS)	Total Phosphorus Mg/L	Total Phosphorus Lbs/Day	Total Phosphorus Lbs/Year
2007	25.622	0.0731	13.892	5069.952
2008	47.152	0.0591	19.442	7095.752
2009	42.632	0.0411	13.742	5015.152
Program Average	**38.47[3]**	**0.058[1]**	**15.69[3]**	**5726.95[3]**

1Average Nutrient Concentrations
2 Yearly Cumulative Loadings
3 Average Loadings-Entire Program

5. Current Monitoring

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

The Bureau of Resource Management currently monitors one location within the Prettyboy reservoir watershed. The Whispering Valley site, shown in Figure 4-7, is located within the South Branch Gunpowder Falls subwatershed, and is almost entirely within the corporate limits of the Town of Manchester.

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

Bi-weekly monitoring at the Whispering Valley site began in January of 2015 and consists of chemical grab samples with corresponding discharge measurements in order to calculate loadings. The chemical monitoring parameters, methods, and detection limits for the Whispering Valley site can be found in Table 4-14. Additional monitoring at this location includes geomorphic channel surveys as well as spring macro-invertebrate collection, which are based upon protocols set by Maryland's MBSS program (Stranko et al, 2014).

Table 4-14: Water Quality Parameters and Methods

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

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

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

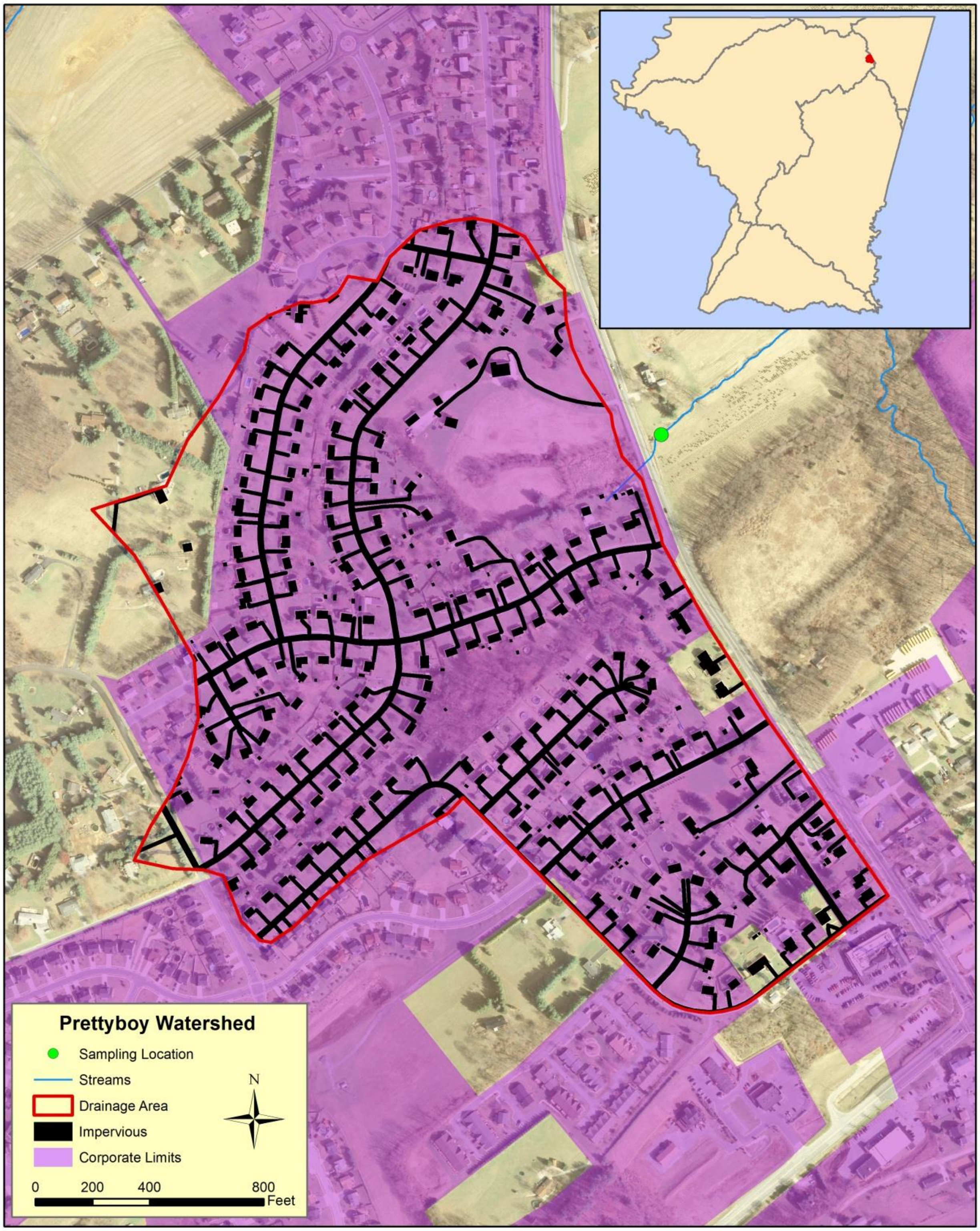

Figure 4-7: Whispering Valley Monitoring Location

V. Living Resources

A. Introduction

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

B. Aquatic Biology

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

Biological data has become a critical component in assessing water quality and has been incorporated into the Maryland water quality standards. The biological water quality standard states:

26.08.02.03-4 Biological Water Quality Criteria

A. Quantitative assessments of Biological communities in streams (biological criteria) may be used separately or in conjunction with the chemical and physical criteria promulgated in this chapter to assess whether water quality is consistent with purposes and uses in Regulations .01 and .02 of this chapter.

B. The results of the quantitative assessments of biological communities shall be used for purposes of water quality assessment, including, but not limited to, those assessments required by §§ 303(d) and 305 (b) of the federal Clean Water Act (33 U.S.C. §§ 1313 (d) and 1315(b)).

C. These assessments shall use documented methods that have been subject to technical review, produce consistent and repeatable results, and are objectively interpretable.

D. In using biological criteria to determine whether aquatic life uses are being met, the Department shall allow for the uncertainty and natural variability in environmental monitoring results by using established quantitative and statistical methodologies to establish the appropriate level of uncertainty for these determinations.

E. The Department shall determine whether the application and interpretation of the assessment method are appropriate. In those instances where the Department determines the assessment method is not appropriate, it will provide its justification for that determination.

1. Maryland Biological Stream Survey (MBSS)

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

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

Table 5-1: MBSS Results by Subwatershed

12-Digit Scale	Subwatershed	BIBI			FIBI		
		Good	Fair	Poor	Good	Fair	Poor
0313	Poplar Run	1					
0313 Total		1					
0314	Georges Run			3	1		
	Murphy Run			1		1	
0314 Total				4	1	1	
0315	Grave Run	3			1	1	
	Indian Run	2	1				
0315 Total		5	1		1	1	
0316	Gunpowder Falls	1	3				1
0316 Total		1	3				1
0317	South Branch	3	1	1	1		1
0317 Total		3	1	1	1		1
Prettyboy Watershed Total		10	5	5	3	2	2

A total of 20 sites were sampled for benthic macro-invertebrates, and 7 sites were sampled for fish assemblage. Within the Prettyboy watershed 50 percent of the sites were rated good based on the benthic macro-invertebrates, and 43 percent were rated good based on the fish community. Georges Run, Murphy Run and South Branch Gunpowder Falls have poor biological integrity. These three subwatersheds also had the highest concentration of outfalls and exposed pipes identified through the stream corridor assessment. The headwaters from these three watersheds also originate within the towns of Hampstead and Manchester. The correlation between the MBSS data and the impacts identified through the stream corridor assessment indicate where restoration of the biological community should be targeted. There are currently no MBSS locations within Carroll County along Indian Run. Indian Run information was taken from an MBSS location just across the County border in Baltimore. Figure 5-1 shows the MBSS sampling locations within the Prettyboy watershed in Carroll County.

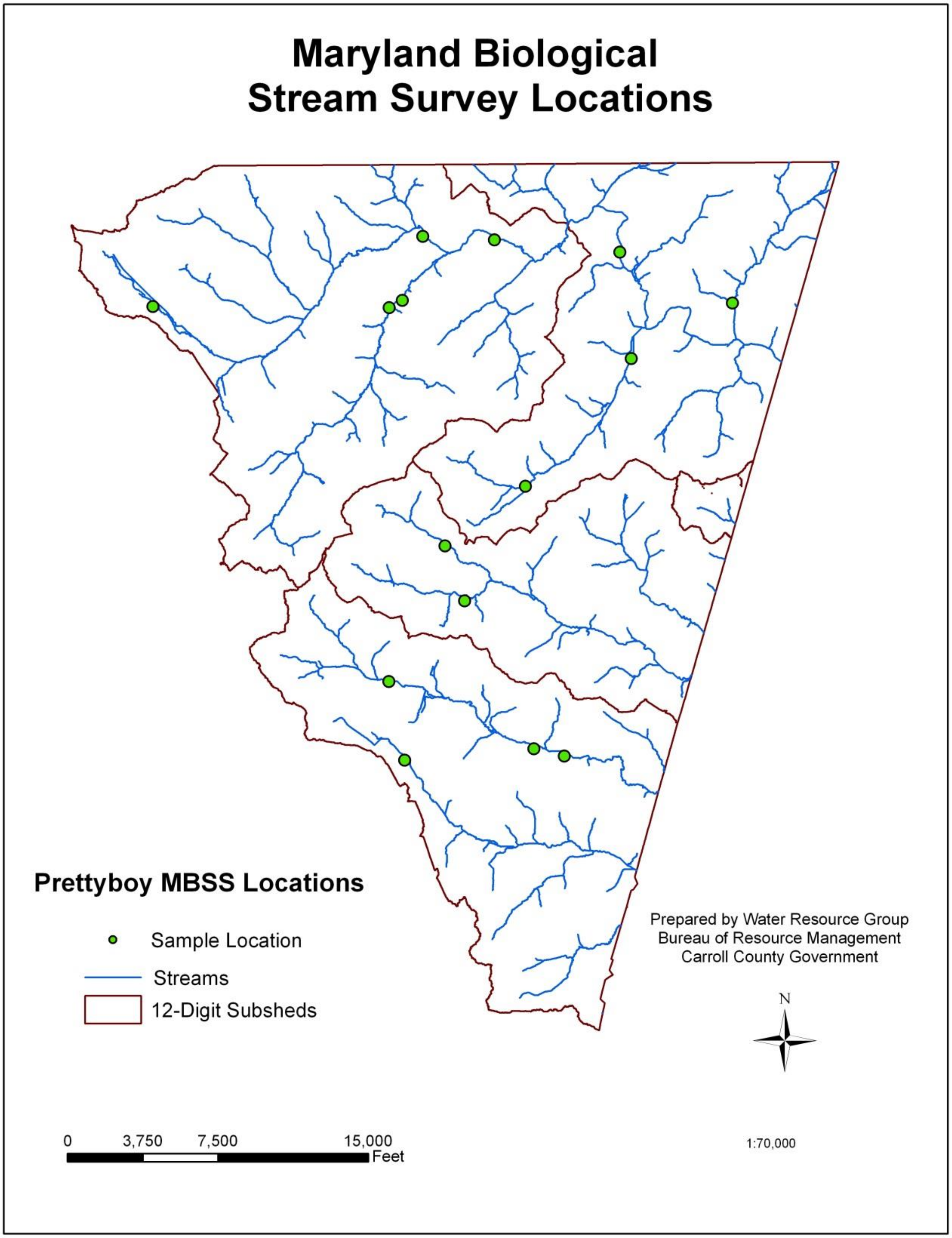

Figure 5-1: Prettyboy MBSS Locations

2. Carroll County Brook Trout Study

Carroll County initiated a temperature and Brook Trout study in 2009. The purpose of this study was to understand temperature regimes within the watershed and identify population ranges and possible communities. Stream temperature plays an important role in trout communities as populations will begin to disappear once a threshold of 68 degrees Fahrenheit is reached within the stream (Creaser 1930; MacCrimmon and Campbell 1969). Temperature probes were installed at different subwatershed locations within the Prettyboy watershed to continually monitor seasonal stream temperature variations. Through the help of the DNR fisheries program, fish sampling was performed during summer months at the temperature locations to establish population ranges. Table 5-2 displays the temperature and Brook Trout results by subwatershed. Figure 5-2 shows the data collection locations for the temperature and Brook Trout study, as well as the priority watersheds associated with trout communities.

Table 5-2: Brook Trout and Temperature Results

		2009					2010				
Subwatershed	Station	% Time over 68F	Longest Duration (hrs) >68F	Brook Trout	Brown Trout	Physical Habitat Index	% Time over 68F	Longest Duration (hrs) >68F	Brook Trout	Brown Trout	Physical Habitat Index
South Branch	SBG01	32.5	401.33	1	0	101	33.8	258	0	0	92
	SBG02	n/a	n/a	1	0	70	n/a	n/a	n/a	n/a	n/a
	SBG03	2.9	15.67	0	0	84	n/a	n/a	n/a	n/a	n/a
	SBG04	n/a	n/a	n/a	n/a	n/a	26.8	87	0	0	78
	SBG05	n/a	n/a	n/a	n/a	n/a	15.7	66	9	0	110
	SBG06	n/a	n/a	n/a	n/a	n/a	n/a	n/a	14	0	74
	SBG07	n/a	n/a	n/a	n/a	n/a	n/a	n/a	3	0	102
Gunpowder Falls	GPF01	23.8	187.33	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	GPF02	5.3	16.67	8	0	110	20	66	13	0	95
	GPF03	4.5	17	3	0	118	24.7	210	15	0	94
	GPF04	4.5	18	n/a	n/a	n/a	16.14	66.33	25	0	92
	GPF05	n/a	n/a	n/a	n/a	n/a	34.5	237	0	0	89
	GPF06	n/a	n/a	n/a	n/a	n/a	39.5	282	n/a	n/a	n/a
Georges/ Murphy Run	GMR01	13.6	46	0	0	104	n/a	n/a	n/a	n/a	n/a
Grave/ Indian Run	GIR01	10.5	68	0	1	98	n/a	n/a	n/a	n/a	n/a
	GIR02	5.3	39.67	0	7	96	n/a	n/a	n/a	n/a	n/a
	GIR03	n/a	n/a	0	1	105	21.2	81	0	3	106
	GIR04	<1	7.33	6	0	96	14.2	18.67	15	0	106

The Gunpowder Falls watershed had the highest concentration of Brook Trout population. The only other watersheds that showed a potential for recurring populations were the headwaters of South Branch and Grave Run. Trout populations can be closely tied to stream temperature, but there are many other factors such as available habitat, water chemistry, and substrate conditions that can dictate actual communities. (Creaser 1930, Raleigh 1982).

C. Aquatic Sensitive Species

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

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

Rare, threatened, and endangered species are those plants and animals that are the most at risk in their ability to maintain healthy population levels. Within the Prettyboy watershed the most widely known are the bald eagle and bog turtle, which are listed on both the state and federal endangered species list. For watershed restoration purposes, it is important to know and account for the habitats of sensitive species. Protecting and expanding these habitats help to preserve biodiversity and is a critical component in successfully restoring a watershed. DNR's Wildlife and Heritage Service identifies important areas for sensitive species conservation known as "stronghold watersheds". Stronghold watersheds are the places where rare, threatened, and endangered species have the highest abundance of natural communities. Within the Prettyboy watershed the Gunpowder Falls subwatershed has been identified as a stronghold watershed, and special protection is necessary to ensure the persistence of these communities. A complete list of all rare, threatened, and endangered plants and animals within Carroll County and throughout the state of Maryland can be found at

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

Figure 5-3 shows the targeted ecological areas for sensitive species within the Prettyboy watershed. Sensitive species areas were designated by the DNR.

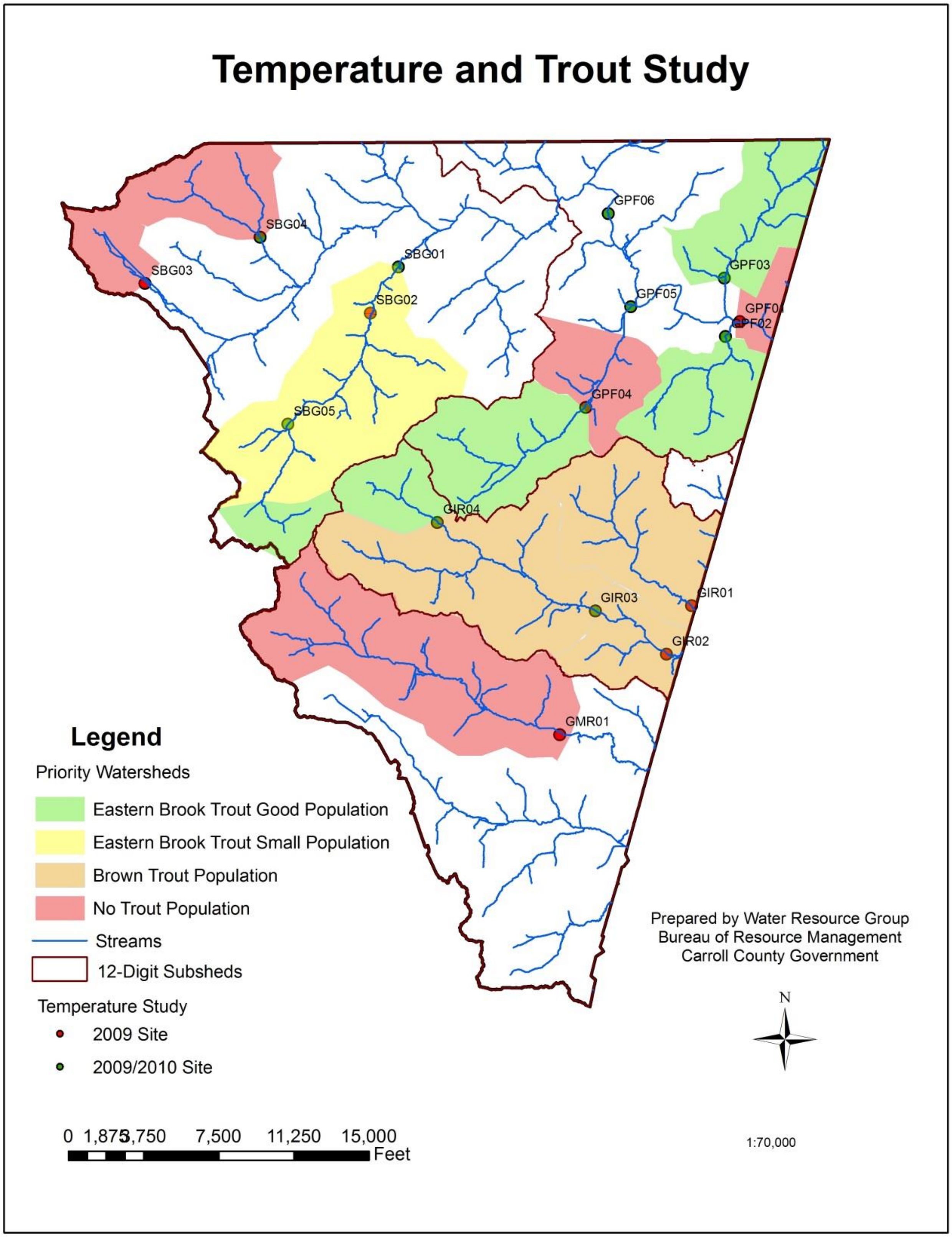

Figure 5-2: Prettyboy Data Collection Locations

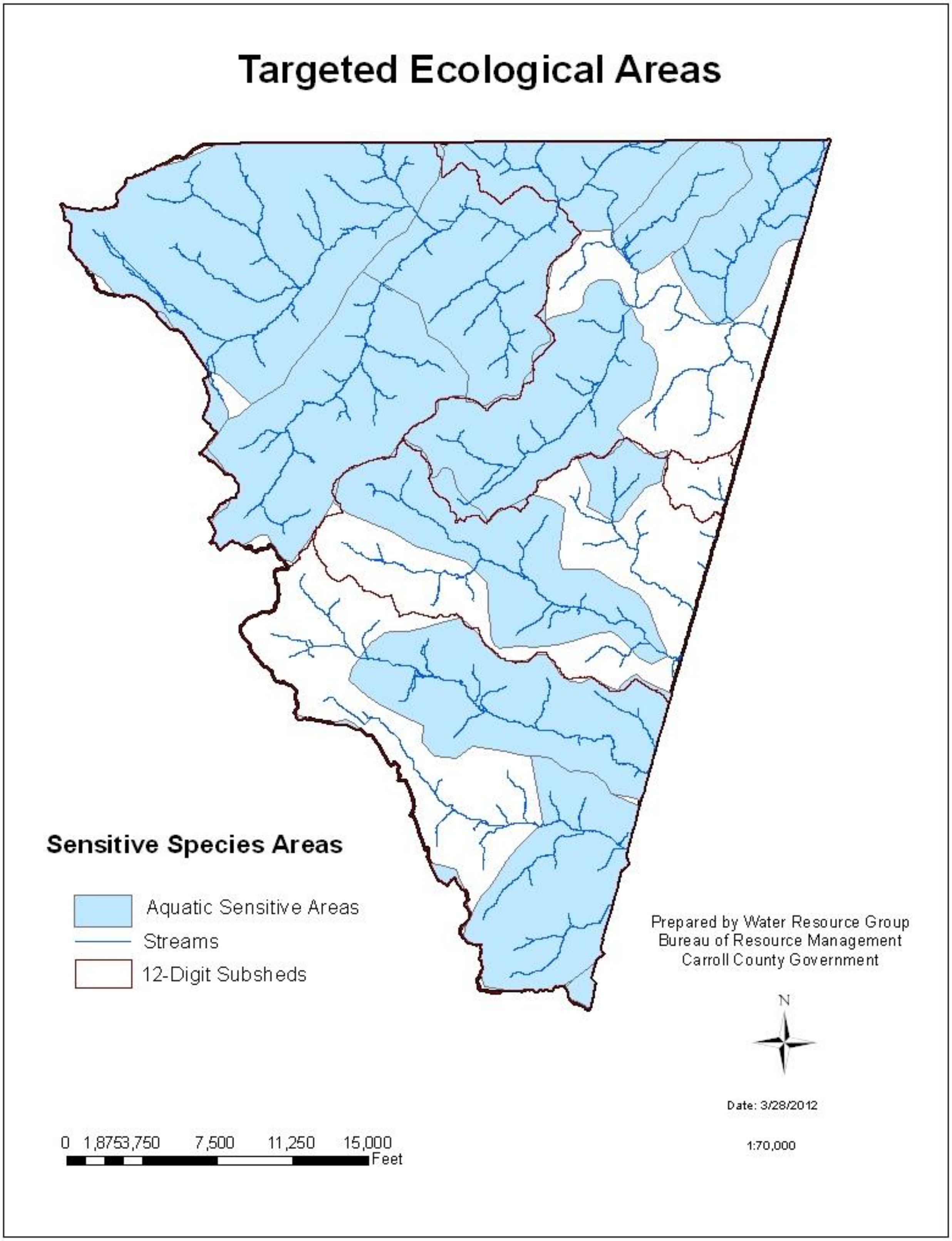

Figure 5-3: Prettyboy Targeted Ecological Areas

D. Stream Corridor Assessment

A Stream Corridor Assessment (SCA) of the Prettyboy watershed was conducted during the winter of 2011 by Carroll County Bureau of Resource Management staff. The Prettyboy 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 590 landowners within the Prettyboy 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 5-4. 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 80 of the 97 stream miles within the Prettyboy watershed.

The most common impairments identified during the assessment are shown in Figure 5-5, and consisted primarily of erosion sites and inadequate streamside buffers followed by rural pipe outfalls. Table 5-3 presents a summary of the number of impacts identified in each subwatershed.

Table 5-3: Stream Corridor Assessment – Identified Impacts

Stream Segment	Erosion	Fish Barrier	Inadequate Buffer	Trash Dump	Channel Alteration	Pipe Outfalls	Unusual Condition	Total
Poplar Run	0	0	0	0	0	0	0	0
Georges/Murphy Run	31	15	29	1	7	47	13	143
Grave/Indian Run	36	26	21	3	4	28	8	126
Gunpowder Falls	41	6	32	2	2	8	2	93
South Branch Gunpowder Falls	85	5	55	0	1	50	10	206
Total	**193**	**52**	**137**	**6**	**14**	**133**	**33**	**568**

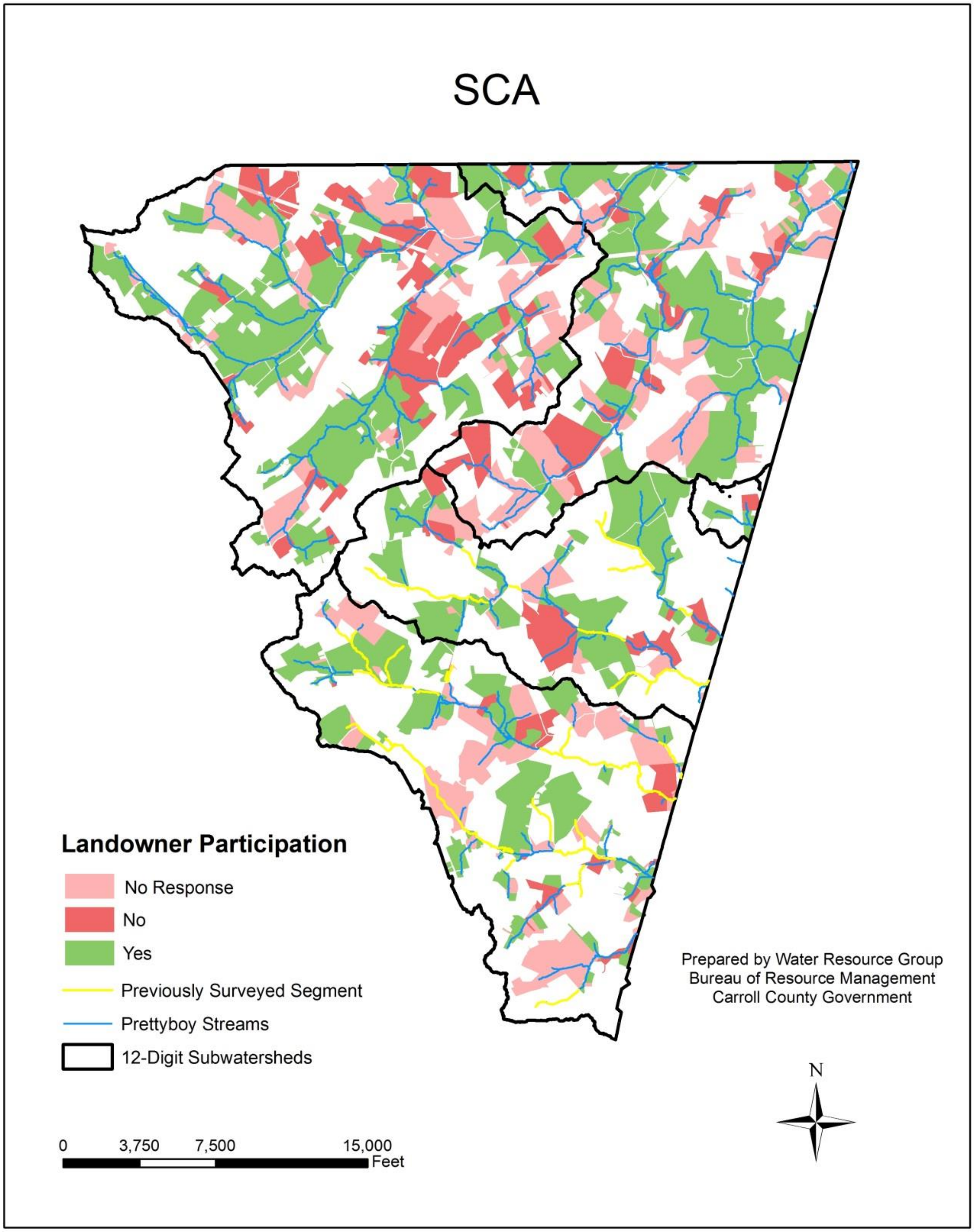

Figure 5-4: SCA Landowner Participation

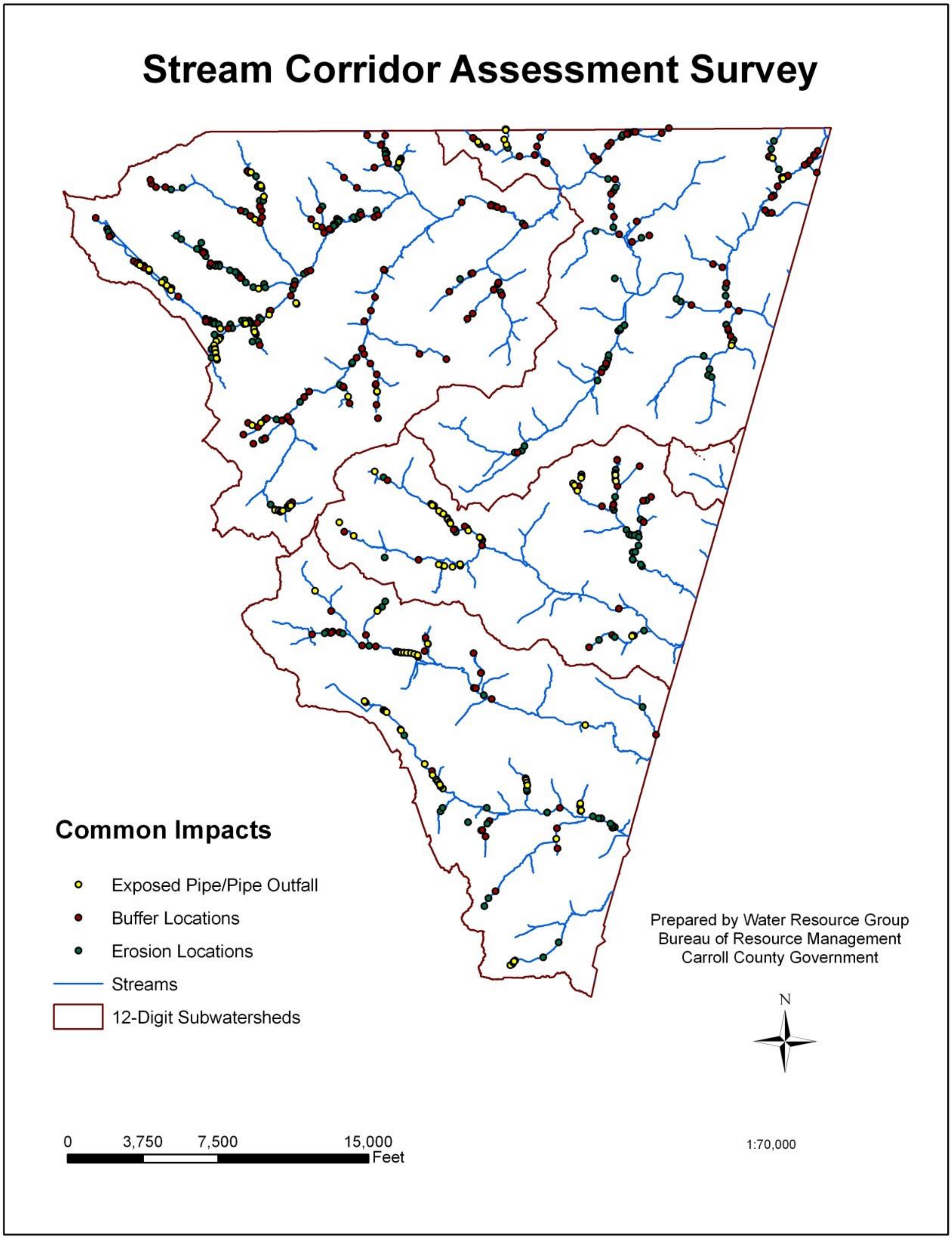

Figure 5-5: Most Commonly Identified Impacts

Erosion problems were identified along 11.67 (14.5%) of the 80 miles assessed, with approximately 2.5% of the watershed categorized as having a severe erosion problem. Streamside buffers were found to be inadequate along 24 (30%) of the miles assessed, with nearly 12% of the watershed classified as severely un-buffered. Table 5-4 shows the linear feet of streambank erosion and inadequate streamside buffers by subwatershed.

Table 5-4: Linear feet of Inadequate Buffer and Stream Erosion

Stream Segment	Erosion	Inadequate Buffer
Poplar Run	N/A	N/A
Georges Run	3,352	13,857
Grave Run	5,934	9,122
Indian Run	4,130	8,047
Murphy Run	9,919	23,347
South Branch Gunpowder Falls	30,019	52,805
Gunpowder Falls	8,265	19,825
Total	**61,619**	**127,003**

1. Subwatershed Summary

Murphy Run: Murphy Run had the highest percentage of severe erosion and the highest percentage of inadequate buffer identified as severe. Erosion problems were identified along 9,919 linear feet (16%) of the stream channel, with 5,113 feet (8%) classified as severely eroded. Inadequate buffer was identified along 23,347 linear feet (38%) of the streambank, with 16,227 feet (26.6%) classified as severe.

Indian Run: Indian Run had the next highest percentage of severe erosion, with the second highest percentage of inadequate buffer identified as severe. Erosion problems were identified along 4,130 linear feet (18%) of Indian Run, with 1,700 feet (7%) classified as severely eroded. Inadequate buffer was identified along 8,047 linear feet (34%) of the streambank, with 6,194 linear feet (26.5%) classified as severe.

South Branch: Erosion problems in South Branch were identified along 30,019 linear feet (17%) of the stream channel, with 4,775 feet (3%) classified as severely eroded. Inadequate buffer was identified along 52,805 linear feet (30%) of the streambank with 20,425 linear feet (11.8%) classified as severe.

Georges Run: Erosion problems in Georges Run were identified along 3,352 linear feet (6%) of the stream channel, with 1,100 feet (2%) classified as severely eroded. Inadequate buffer was identified along 13,857 linear feet (23.5%) of the streambank, with 6,833 linear feet (11.6%) classified as severe.

Grave Run: Erosion problems in Grave Run were identified along 5,934 linear feet (10.6%) of the stream channel, with none being classified as severely eroded. Inadequate buffer was identified along 9,122 linear feet (16.4%) of the streambank, with 5,153 linear feet (9.2%) classified as severe.

Gunpowder Falls: Erosion problems in Gunpowder Falls were identified along 8,265 linear feet (6%) of the stream channel, with none being classified as severely eroded. Inadequate buffer was identified along 19,825 linear feet (14%) of the streambank, with 5,250 linear feet (3.8%) classified as severe.

Outfalls and exposed pipes were found throughout the entire watershed but the highest concentrations were located on South Branch Gunpowder Falls, George's Run, and Murphy Run. This higher concentration can be attributed to the towns of Hampstead and Manchester, which make up the headwaters of these three sub-watersheds.

Due to the relative rural nature of the Prettyboy watershed, problems associated with channel alterations, trash dumps, and in-stream construction were either limited or not identified.

VI. Characterization Summary

A. Summary

This Characterization Plan was developed to describe the unique background of the Prettyboy 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 Prettyboy stream corridor assessment, as well as the development of the Prettyboy Characterization Plan.

Field Time: Assessment was completed over a span of 4 weeks. Field crew averaged 3 days per week for a total of 12 field days.

Field Hours: Field crew averaged 4 hours/day over the 12 days for a total of 48 hours. Field crew varied from 2-3 people performing the assessment for a cumulative total of 120 field hours. Total cost of staff time in field was roughly $3,600 (120 hours at an average of $30/hour).

Plan Development: Watershed plan development took approximately 2 months ($6,700 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 Prettyboy Stream Corridor Assessment and the Watershed Characterization Plan was approximately $10,300.

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Appendix A:

Prettyboy Watershed Stormwater Management Facilities/Definitions

Prettyboy Watershed Stormwater Management Facilities

Subwatershed	Facility Type	Drainage Area (Acres)	Impervious Area (Acres)	Project Name	Site #
Georges Run	Pond and Sand Filter (2 Facilities)	15.00	0.4	St. Bartholomew Catholic	626
Georges Run	WQ Grass Channel	1.88	0	MD 30 & Maple Grove	823
Georges Run	WQ Infiltration Trench	0.10	0.1	Eckhardt Funeral Home	473
Georges Run	Dry-Infiltration Basins (2 Facilities)	4.88	0.88	N.C. Assembly of God	484
Georges Run	Retention #1	27.76	3	Oakmont Green #1	54
Gunpowder Falls	Sand Filter	0.27	0.27	Lineboro Fire Dept.	617
Gunpowder Falls	Infiltration Trench (2 Facilities)	1.46	0.24	Walkerwood Estates	530
Murphy Run	Shallow Marsh	20.50	0	Stoffle Park	417
Murphy Run	Infiltration Trench	3.08	0	St. Georges Episcopal	821
Murphy Run	WQ. RV. UD Stone and Bioretention	2.54	1.82	North Carroll Middle	471
Murphy Run	RV Infiltration Trench	10.31	7.14	Hampstead Marketplace	770
Murphy Run	Infiltration/Detention	12.20	8.63	Oakmont Green	35
Murphy Run	Infiltration Trench	0.62	0.52	North Carroll Library	256
Murphy Run	Under Ground Stone Reservoir	1.01	0.78	NW State Bank Hampstead	904
Murphy Run	Wet Infiltration Basin	1.42	0.6	Hampstead North Bus. Ctr.	432
Murphy Run	Dry Detention	1.44	0.83	North Carroll Library	255
Murphy Run	Retention #2	29.68	6.51	Oakmont Green #2	55
Murphy Run	Retention #3	30.20	1.11	Oakmont Green #3	56
Murphy Run	Infiltration Detention Basin	23.03	15	North Carroll Farm Sec. 4	158
Murphy Run	Infiltration Detention Basin	41.62	0	North Carroll Farm Sec. 4	157
Murphy Run	Dry-Infiltration Trench Basin	2.71	0	Hampstead Square	418
Murphy Run	Filtration Basin (2 Facilities)	0.50	1.0	Bluebird Hills	500
Murphy Run	Infiltration Trench	3.27	0	Crestview Meadows Sect. 6	873
Murphy Run	Infiltration Basin	5.18	1.23	Savannah Estates	73
Murphy Run	Dry Detention	29.70	0	Small Crossings	686
Murphy Run	Infiltration Trench	0.45	0	Hampstead Senior Housing	534
Murphy Run	Infiltration Trench	9.49	0	Leister Park	917
Murphy Run	Dry-Detention Pond	5.33	3.88	Ridgely House	411
South Branch	Filtration/Detention	1.40	0	Rohrbaugh's Bus Co.	373
South Branch	Dry Detention Pond	15.72	0	Whispering Valley	660
South Branch	Infiltration Trench	4.68	4.35	EBB Valley Elem. School	754
South Branch	Surface Sand Filter	9.81	4.6	Hallie Hill Farm Sect. 2	861
South Branch	Surface Sand Filter	34.12	0	Hallie Hill Farm Sect. 2	862
South Branch	Surface Sand Filter	73.00	8.93	Hallie Hill Farm Sect. 2	863
South Branch	Shallow Marsh	49.10	0	Ron's Automotive	314
South Branch	Dry Infiltration Trench	1.62	1.38	Melrose Station	590
South Branch	Dry Infiltration Trench	2.53	1.63	Melrose Station	590
South Branch	WQ Sand Filter	3.57	0	Driven America	763
South Branch	Underground Stone Cavity	1.25	0	Melrose Crossing	891
South Branch	Water Quality Filtration	0.82	0.82	High's Melrose	304
South Branch	Infiltration Trench	6.00	0	Bachman Overlook	756
South Branch	Filtration Basin UD	1.31	0	Stone Valley	448
South Branch	Filtration Basin (2 Facilities)	1.51	0	The Farms Spencers Choice	450

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

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

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

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

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

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

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

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

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

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

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

Appendix B:

Agricultural Best Management Practices/Definitions

Agricultural Best Management Practices as of summer 2014-Prettyboy Watershed

Best Management Practice	Practice Code	Extent	Unit
Stream Crossing	728	17	Number
Waste Storage Structure	313	4	Number
Conservation Cover	327	130.9	Acres
Contour Farming	330	173.3	Acres
Diversion	362	360	Feet
Critical Area Planting	342	1.25	Acres
Livestock Pipeline	516	1,370	Feet
Grade Stabilization Structure	410	1	Number
Fencing	382	49,303	Feet
Riparian Forest Buffer	391	107.1	Acres
Riparian Herbaceous Cover	390	5.8	Acres
Filter Strip	393	33.7	Acres
Grassed Waterway	412	9.83	Acres
Roof Runoff Management	558	13	Number
Heavy Use Area Protection	561	0.62	Acres
Spring Development	574	20	Number
Farm Plans	192&193	11,567	Acres
Prescribed Grazing	528	11.9	Acres
Water Control Structure	587	1	Number
Drain Tile	606	5,188	Feet
Underground Outlet	620	490	Feet
Upland Habitat Management	645	10.2	Acres
Waste Transfer	634	1	Number
Watering Facility	614	30	Number
Wastewater Treatment Strip	635	0.15	Acres

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Appendix C:

Prettyboy Watershed Nutrient Concentrations

Average Nutrient Concentrations

Sub-Watershed	Year	Discharge CFS	NO2/NO3 Mg/L	Total Suspended Solids Mg/L	Orthophosphate Mg/L	Total Phosphorus Mg/L
Murphy Run	2007	1.82	4.9	2.7	.029	.058
	2008	3.16	5.1	3.6	.021	.050
	2009	2.85	4.87	6.1	.016	.031
3 Year Average		2.61	4.96	4.1	.022	.046
Grave Run	2007	2.57	3.45	4.93	.019	.069
	2008	5.20	4.19	5.78	.019	.059
	2009	4.89	3.91	9.75	.018	.035
3 Year Average		4.22	3.85	6.82	.0187	.054
Georges Run	2007	2.29	5.78	6.36	.034	.089
	2008	4.17	6.29	4.86	.031	.073
	2009	4.08	6.13	8.29	.025	.057
3 year Average		3.51	6.07	6.50	.030	.073
Indian Run	2007	.093	3.56	5.71	.016	.058
	2008	1.98	4.02	2.71	.017	.046
	2009	1.78	3.81	7.91	.013	.034
3 year Average		1.28	3.80	5.44	.015	.046
Gunpowder Falls	2007	18.01	2.55	9.50	.028	.091
	2008	32.64	3.48	6.95	.026	.069
	2009	29.03	3.22	10.58	.020	.049
3 Year Average		26.56	3.08	9.01	.025	.070

Summary of Nutrient Concentrations by Subwatershed

Sub-Watershed	Discharge CFS	NO2/NO3 Mg/L	Total Suspended Solids Mg/L	Orthophosphate Mg/L	Total Phosphorus Mg/L
Murphy Run	2.61	4.96	4.1	.022	.046
Grave Run	4.22	3.85	6.82	.0187	.054
Georges Run	3.51	6.07	6.50	.030	.073
Indian Run	1.28	3.80	5.44	.015	.046
Gunpowder Falls	26.56	3.08	9.01	.025	.070
Watershed Average	38.18*	4.35	6.37	.022	.058

***Cumulative Discharge**

Appendix D:

Prettyboy Subwatershed Phosphorus TMDL Loadings/ Sampling Event

Murphy Run Phosphorus Loadings

Date	Discharge CFS	Total Phosphorus Mg/L	Total Phosphorus Lbs/Day	Total Phosphorus Lbs/year
		2007		
6/14/2007	3.18	.04	.686	250.39
6/28/2007	2.14	.06	.693	252.95
7/13/2007	1.61	.04	.347	126.66
7/30/2007	1.06	.06	.343	125.20
8/13/2007	1.41	.05	.380	138.70
8/27/2007	1.46	.07	.551	201.12
9/10/2007	0.98	.05	.264	96.36
9/24/2007	1.31	.07	.495	180.68
10/9/2007	0.77	.04	.166	60.59
10/22/2007	0.97	.05	.262	95.63
11/5/2007	0.92	.04	.199	72.64
11/19/2007	2.29	.09	1.112	405.88
12/3/2007	4.12	.10	2.222	811.03
12/17/2007	3.28	.05	.885	323.03
2007 Average	1.82	.058	0.615	224.48
		2008		
1/2/2008	1.86	.04	.401	146.37
1/14/2008	1.44	.02	.155	56.58
1/28/2008	0.80	.02	.086	31.39
2/25/2008	2.51	.03	.406	148.19
3/11/2008	3.69	.05	.995	363.18
3/24/2008	2.74	.02	.296	108.04
4/7/2008	2.61	.02	.282	102.93
4/21/2008	15.71	0.1	8.47	3,091.55
5/5/2008	3.2	.02	.345	125.93
5/19/2008	6.55	.02	.707	258.06
6/2/2008	4.32	.03	.699	255.14
6/16/2008	2.79	.02	.301	109.87
6/30/2008	1.99	.04	.429	156.59
7/14/2008	5.68	.09	2.76	1,007.40
7/30/2008	1.63	.03	.264	96.36
8/11/2008	1.62	.03	.262	95.63
8/25/2008	1.24	0.1	.669	244.19
9/22/2008	1.22	.07	.461	168.27
10/6/2008	1.44	.04	.311	113.52
10/20/2008	1.17	.06	.379	138.34
11/4/2008	1.23	.03	.199	72.64
11/17/2008	1.95	.17	1.79	653.35
12/1/2008	5.99	.08	2.58	941.70
12/15/2008	2.94	.09	1.43	521.95
12/29/2008	2.74	.04	.591	215.72
2008 Average	3.29	.05	1.01	368.65
		2009		
1/12/2009	2.74	.02	.296	108.04
2/9/2009	2.14	<.01	0	0
2/23/2009	1.97	.02	.213	77.75
3/9/2009	2.47	.01	.133	48.55
3/23/2009	1.51	.02	.163	59.50
4/6/2009	2.77	.01	.149	54.39
4/20/2009	3.87	.04	.835	304.78
5/4/2009	10.9	.12	7.06	2,576.90
5/18/2009	2.79	.03	.452	164.98
6/1/2009	1.94	.02	.209	79.29
7/13/2009	1.19	.02	.128	46.72
8/10/2009	0.96	.02	.104	37.96
9/21/2009	1.77	.03	.286	104.39
10/19/2009	3.46	.02	.373	136.15
11/16/2009	2.29	.05	.618	225.57
2009 Average	2.85	.031	0.73	266.45

Grave Run Phosphorus Loadings

Date	Discharge CFS	Total Phosphorus Mg/L	Total Phosphorus Lbs/Day	Total Phosphorus Lbs/year
2007				
6/14/2007	4.52	0.03	0.731	266.82
6/28/2007	2.93	0.09	1.422	519.03
7/13/2007	2.35	0.06	0.761	277.77
7/30/2007	1.93	0.08	0.833	304.05
8/13/2007	1.92	0.05	0.518	189.07
8/27/2007	1.39	0.07	0.525	191.63
9/10/2007	1.81	0.04	0.391	142.72
9/24/2007	1.37	0.05	0.370	135.05
10/9/2007	0.89	0.06	0.288	105.12
10/22/2007	0.74	0.05	0.200	73.00
11/5/2007	1.36	0.03	0.220	80.30
11/19/2007	3.08	0.12	1.994	727.81
12/3/2007	6.65	0.15	5.381	1964.07
12/17/2007	5.0	0.08	2.158	787.67
2007 Average	2.57	0.069	1.13	412.45
2008				
1/2/2008	3.57	0.06	1.155	421.58
1/14/2008	2.08	0.02	0.224	81.76
1/28/2008	2.13	0.03	0.345	125.93
2/25/2008	4.53	0.07	1.711	624.52
3/11/2008	6.07	0.05	1.637	597.51
3/24/2008	4.12	0.02	0.444	162.06
4/7/2008	4.49	0.02	0.484	176.66
4/21/2008	23.68	0.13	16.606	6061.19
5/5/2008	6.29	0.02	0.679	247.84
5/19/2008	11.71	0.05	3.158	1152.67
6/2/2008	8.46	0.05	2.282	832.93
6/16/2008	6.09	0.05	1.643	599.70
6/30/2008	4.30	0.03	0.696	254.04
7/14/2008	6.54	0.1	3.528	1287.72
7/30/2008	3.07	0.04	0.662	241.63
8/11/2008	1.76	0.05	0.475	173.38
8/25/2008	1.53	0.06	0.495	180.68
9/22/2008	1.90	0.07	0.717	261.71
10/6/2008	2.48	0.08	1.070	390.55
10/20/2008	1.88	0.05	0.507	185.06
11/4/2008	2.36	0.03	0.382	139.43
11/17/2008	3.26	0.18	3.165	1155.23
12/1/2008	7.05	0.1	3.803	1388.10
12/15/2008	5.62	0.05	1.516	553.34
12/29/2008	5.10	0.06	1.651	602.62
2008 Average	5.20	0.059	1.96	715.40
2009				
1/12/2009	5.09	0.04	1.098	400.77
2/9/2009	4.41	0.04	0.952	347.48
2/23/2009	3.03	0.01	0.163	59.50
3/9/2009	3.59	0.04	0.775	282.88
3/23/2009	2.66	0.02	0.287	104.76
4/6/2009	4.65	0.02	0.502	183.23
4/20/2009	8.04	0.05	2.169	791.69
5/4/2009	13.09	0.14	9.886	3608.39
5/18/2009	6.36	0.02	0.686	250.39
6/1/2009	4.07	0.02	0.439	160.24
7/13/2009	2.19	0.02	0.236	86.14
8/10/2009	1.9	0.03	0.307	112.06
9/21/2009	3.57	0.01	0.193	70.45
10/19/2009	5.98	0.03	0.968	353.32
11/16/2009	4.72	0.04	1.018	371.57
2009 Average	4.89	0.035	1.31	478.15

Georges Run Phosphorus Loadings

Date	Discharge CFS	Total Phosphorus Mg/L	Total Phosphorus Lbs/Day	Total Phosphorus Lbs/year
2007				
6/14/2007	3.37	0.07	1.273	464.65
6/28/2007	3.38	0.1	1.823	665.40
7/13/2007	1.57	0.08	0.678	247.47
7/30/2007	1.56	0.09	0.757	276.31
8/13/2007	1.57	0.07	0.593	216.45
8/27/2007	1.85	0.08	0.798	291.27
9/10/2007	1.12	0.07	0.423	154.40
9/24/2007	0.8	0.07	0.302	110.23
10/9/2007	0.78	0.05	0.210	76.65
10/22/2007	1.02	0.07	0.385	140.53
11/5/2007	1.56	0.06	0.505	184.33
11/19/2007	2.85	0.11	1.691	617.22
12/3/2007	5.62	0.22	6.670	2434.55
12/17/2007	4.94	0.1	2.665	972.73
2007 Average	2.29	0.089	1.34	489.10
2008				
1/2/2008	3.31	0.05	0.893	325.95
1/14/2008	2.68	0.04	0.578	210.97
1/28/2008	2.43	0.1	1.311	478.52
2/25/2008	4.21	0.09	2.044	746.06
3/11/2008	5.61	0.05	1.513	552.25
3/24/2008	5.12	0.03	0.829	302.59
4/7/2008	3.42	0.01	0.184	67.16
4/21/2008	13.81	0.1	7.450	2719.25
5/5/2008	5.3	0.06	1.715	625.98
5/19/2008	8.66	0.04	1.869	682.19
6/2/2008	5.45	0.04	1.176	429.24
6/16/2008	2.8	0.04	0.604	220.46
6/30/2008	3.6	0.05	0.971	354.42
7/14/2008	6.26	0.18	6.078	2218.47
7/30/2008	2.13	0.04	0.460	167.90
8/11/2008	1.74	0.05	0.469	171.19
8/25/2008	1.48	0.1	0.798	291.27
9/22/2008	1.62	0.07	0.612	223.38
10/6/2008	2.45	0.05	0.661	241.27
10/20/2008	1.42	0.05	0.383	139.80
11/4/2008	2.13	0.02	0.230	83.95
11/17/2008	2.54	0.2	2.740	1000.10
12/1/2008	6.23	0.19	6.385	2330.53
12/15/2008	5.43	0.09	2.636	962.14
12/29/2008	4.35	0.09	2.112	770.88
2008 Average	4.17	0.073	1.79	653.35
2009				
1/12/2009	4.31	0.1	2.325	848.63
2/9/2009	3.64	0.04	0.785	286.53
2/23/2009	2.5	0.03	0.405	147.83
3/9/2009	2.39	0.04	0.516	188.34
3/23/2009	1.89	0.02	0.204	74.46
4/6/2009	3.8	0.03	0.615	224.48
4/20/2009	5.96	0.05	1.608	586.92
5/4/2009	12.87	0.23	15.968	5828.32
5/18/2009	4.89	0.06	1.583	577.80
6/1/2009	3.1	0.04	0.669	244.19
7/13/2009	1.91	0.04	0.412	150.38
8/10/2009	1.44	0.03	0.233	85.05
9/21/2009	2.6	0.02	0.281	102.57
10/19/2009	5.4	0.06	1.748	638.02
11/16/2009	4.49	0.06	1.453	530.35
2009 Average	4.08	0.057	1.92	700.80

Indian Run Phosphorus Loadings

Date	Discharge CFS	Total Phosphorus Mg/L	Total Phosphorus Lbs/Day	Total Phosphorus Lbs/year
2007				
6/14/2007	1.71	0.02	0.184	67.16
6/28/2007	1.21	0.06	0.392	143.08
7/13/2007	0.92	0.05	0.248	90.52
7/30/2007	0.69	0.08	0.298	108.77
8/13/2007	0.77	0.08	0.332	121.18
8/27/2007	0.84	0.07	0.317	115.71
9/10/2007	0.55	0.06	0.178	64.97
9/24/2007	0.58	0.05	0.156	56.94
10/9/2007	0.27	0.04	0.058	21.17
10/22/2007	0.29	0.05	0.078	28.47
11/5/2007	0.72	0.04	0.155	56.58
11/19/2007	1.24	0.12	0.803	293.10
12/3/2007	1.51	0.05	0.407	148.56
12/17/2007	1.67	0.04	0.360	131.40
2007 Average	0.93	0.058	0.283	103.30
2008				
1/2/2008	1.23	0.01	0.066	24.09
1/14/2008	0.87	0.03	0.141	51.47
1/28/2008	0.87	0.03	0.141	51.47
2/25/2008	2.07	0.03	0.335	122.28
3/11/2008	2.37	0.01	0.128	46.72
3/24/2008	1.98	0.02	0.214	78.11
4/7/2008	1.52	0.04	0.328	119.72
4/21/2008	10.35	0.08	4.467	1630.46
5/5/2008	2.7	0.04	0.583	212.80
5/19/2008	3.93	0.03	0.636	232.14
6/2/2008	2.08	0.05	0.561	204.77
6/16/2008	2.13	0.03	0.345	125.93
6/30/2008	1.71	0.03	0.277	101.11
7/14/2008	2.67	0.05	0.720	262.80
7/30/2008	0.9	0.04	0.194	70.81
8/11/2008	0.81	0.07	0.306	111.69
8/25/2008	0.69	0.07	0.261	95.27
9/22/2008	0.81	0.08	0.350	127.75
10/6/2008	0.86	0.07	0.325	118.63
10/20/2008	1.34	0.03	0.217	79.21
11/4/2008	0.8	0.03	0.129	47.09
11/17/2008	1.09	0.12	0.706	257.69
12/1/2008	2.13	0.05	0.575	209.88
12/15/2008	2.04	0.08	0.880	321.20
12/29/2008	1.44	0.04	0.311	113.52
2008 Average	1.98	0.046	0.528	192.72
2009				
1/12/2009	1.51	0.03	0.244	89.06
2/9/2009	1.58	0.04	0.341	124.47
2/23/2009	1.2	0.02	0.129	47.09
3/9/2009	1.24	0.03	0.201	73.37
3/23/2009	1	0.01	0.054	19.71
4/6/2009	1.79	0.02	0.193	70.45
4/20/2009	4.2	0.07	1.586	578.89
5/4/2009	4.56	0.06	1.476	538.74
5/18/2009	1.79	0.04	0.386	140.89
6/1/2009	1.21	0.04	0.261	95.27
7/13/2009	0.67	0.02	0.072	26.28
8/10/2009	0.59	0.04	0.127	46.36
9/21/2009	0.97	0.03	0.157	57.31
10/19/2009	2.79	0.03	0.452	164.98
11/16/2009	1.55	0.03	0.251	91.62
2009 Average	1.78	0.034	0.395	144.18

Gunpowder Falls Phosphorus Loadings

Date	Discharge CFS	Total Phosphorus Mg/L	Total Phosphorus Lbs/Day	Total Phosphorus Lbs/year
		2007		
6/14/2007	30.19	0.03	4.886	1783.39
6/28/2007	15.97	0.09	7.753	2829.85
7/13/2007	12.58	0.07	4.750	1733.75
7/30/2007	14.73	0.13	10.330	3770.45
8/13/2007	13.94	0.07	5.264	1921.36
8/27/2007	13.95	0.07	5.268	1922.82
9/10/2007	8.69	0.06	2.813	1026.75
9/24/2007	7.32	0.09	3.554	1297.21
10/9/2007	6.35	0.09	3.083	1125.30
10/22/2007	6.66	0.06	2.156	786.94
11/5/2007	10.26	0.04	2.214	808.11
11/19/2007	21.25	0.14	16.048	5857.52
12/3/2007	44	0.25	59.338	21658.37
12/17/2007	46.28	0.08	19.972	7289.78
2007 Average	18.01	.091	10.531	3843.82
		2008		
1/2/2008	22.63	0.04	4.883	1782.30
1/14/2008	15.06	0.03	2.437	889.51
1/28/2008	14.98	0.04	3.232	1179.68
2/25/2008	29.88	0.02	3.224	1176.76
3/11/2008	45.48	0.07	17.174	6268.51
3/24/2008	38.92	0.03	6.298	2298.77
4/7/2008	28.86	0.06	9.341	3409.47
4/21/2008	148	0.17	135.723	49538.90
5/5/2008	51.75	0.07	19.541	7132.47
5/19/2008	61	0.03	9.872	3603.28
6/2/2008	46.52	0.05	12.547	4579.66
6/16/2008	36.29	0.03	5.873	2143.65
6/30/2008	28.9	0.03	4.677	1707.11
7/14/2008	39	0.21	44.180	16125.70
7/30/2008	16.9	0.05	4.558	1663.67
8/11/2008	15.79	0.03	2.555	932.58
8/25/2008	11	0.1	5.934	2165.91
9/22/2008	15.32	0.07	5.785	2111.53
10/6/2008	20.76	0.07	7.839	2861.24
10/20/2008	14.31	0.09	6.947	2535.66
11/4/2008	16.77	0.03	2.714	990.61
11/17/2008	24.25	0.11	14.389	5251.99
12/1/2008	0	0.18	0.000	0.00
12/15/2008	39	0.07	14.727	5375.36
12/29/2008	34.54	0.05	9.316	3400.34
2008 Average	32.64	.069	14.151	5165.12
		2009		
1/12/2009	32.75	0.04	7.067	2579.46
2/9/2009	28	0.02	3.021	1102.67
2/23/2009	20	0.01	1.079	393.84
3/9/2009	20.76	0.03	3.360	1226.40
3/23/2009	17.48	0.07	6.601	2409.37
4/6/2009	29.49	0.03	4.772	1741.78
4/20/2009	44	0.07	16.615	6064.48
5/4/2009	66	0.16	56.965	20792.23
5/18/2009	34.74	0.04	7.496	2736.04
6/1/2009	21.94	0.05	5.918	2160.07
7/13/2009	12.18	0.03	1.971	719.42
8/10/2009	12.69	0.03	2.054	749.71
9/21/2009	23.25	0.08	10.034	3662.41
10/19/2009	37.8	0.03	6.117	2232.71
11/16/2009	34.42	0.04	7.427	2710.86
2009 Average	29.03	.049	9.366	3418.59