LOWER GUNPOWDER FALLS (URBAN) SMALL WATERSHED ACTION PLAN

Volumes II

December 2015

Baltimore County Executive Kevin Kamenetz
and the County Council

Prepared for

Baltimore County Department of
Environmental Protection and Sustainability

Prepared by

VERSAR

with

Coastal Resources, Inc.

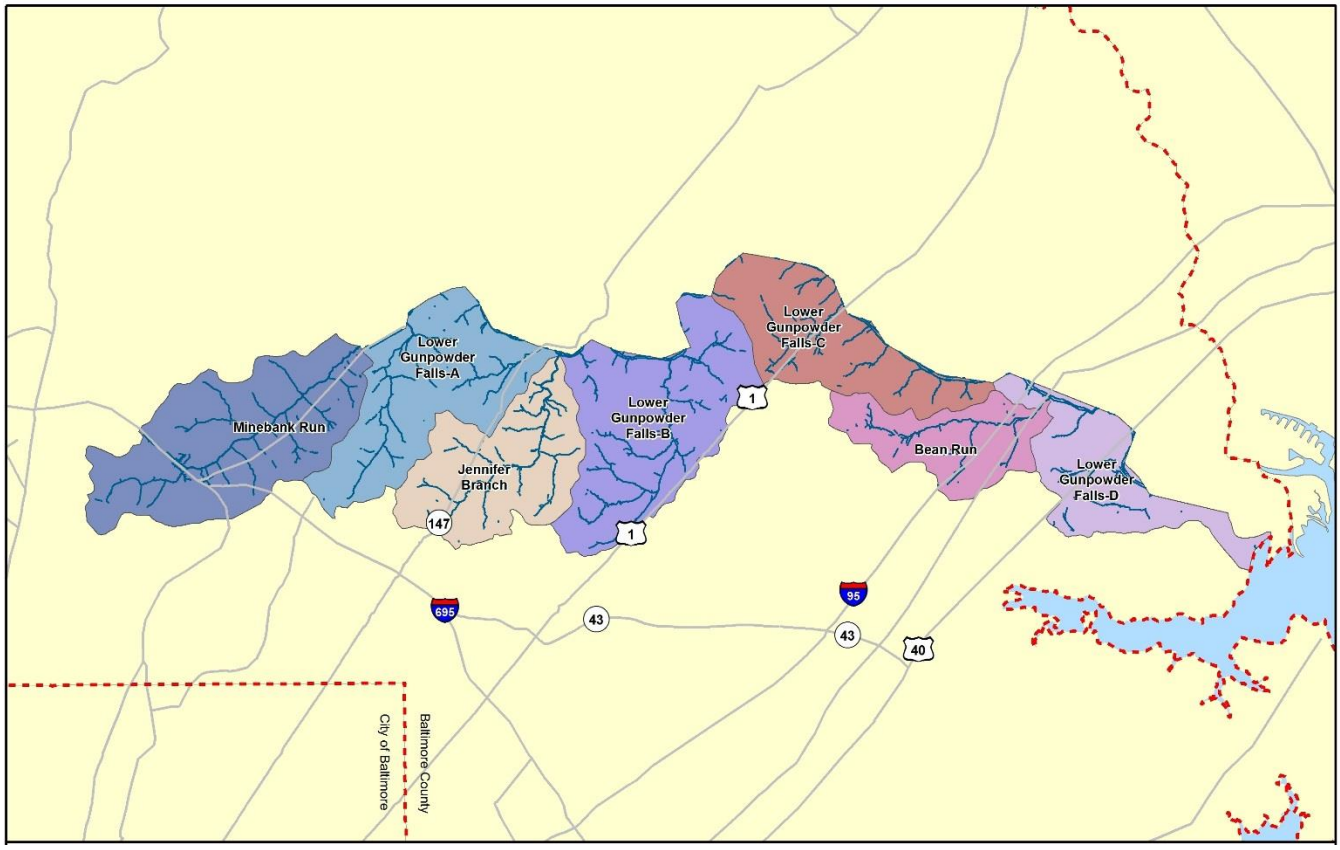
McCormick Taylor

CLEAN GREEN COUNTY

APPENDIX E:

LOWER GUNPOWDER FALLS (URBAN) WATERSHED CHARACTERIZATION REPORT

LOWER GUNPOWDER FALLS (URBAN) WATERSHED CHARACTERIZATION



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CHAPTER 1: INTRODUCTION

1.1 PURPOSE

The purpose of the Lower Gunpowder Falls (Urban) Watershed Characterization Report is to:

1. Summarize the factors that may affect the water quality of the Lower Gunpowder Falls, such as landscape, geomorphology, hydrology, and biological characteristics; and
2. Explain the current conditions of the watershed and its natural resources.

This report also describes human-induced effects on the watershed and identifies restoration and preservation strategies appropriate for accomplishing watershed goals. A Small Watershed Action Plan (SWAP) for the Lower Gunpowder Falls (Urban) watershed will be developed based on the information provided in this watershed characterization report.

1.2 WATERSHED LOCATION AND SCALE

The Lower Gunpowder Falls (Urban) watershed is within the Eastern Piedmont and Coastal Plain regions of Maryland, located northeast of the City of Baltimore (Figure 1-1). It drains to the tidal Gunpowder River just north of where the Gunpowder enters the Chesapeake Bay. The Lower Gunpowder Falls (Urban) SWAP area includes several towns (Loch Raven, Carney, Parkville, Perry Hall, and White Marsh) and is approximately 10,533 acres 16.5 square miles) or 3.7 percent of the overall Gunpowder River watershed.

The Lower Gunpowder Falls (Urban) watershed contains seven smaller drainage areas called subwatersheds (Figure 1-2). In addition to characterizing the entire watershed, analyses were conducted on a subwatershed scale to provide detailed information for smaller areas and to focus restoration and preservation efforts. Also, success of restoration efforts can be more easily monitored and measured on this smaller scale. Subwatersheds and corresponding acreages are listed in (Table 1-1). Watershed and subwatershed delineation is explained further in Chapter 2.

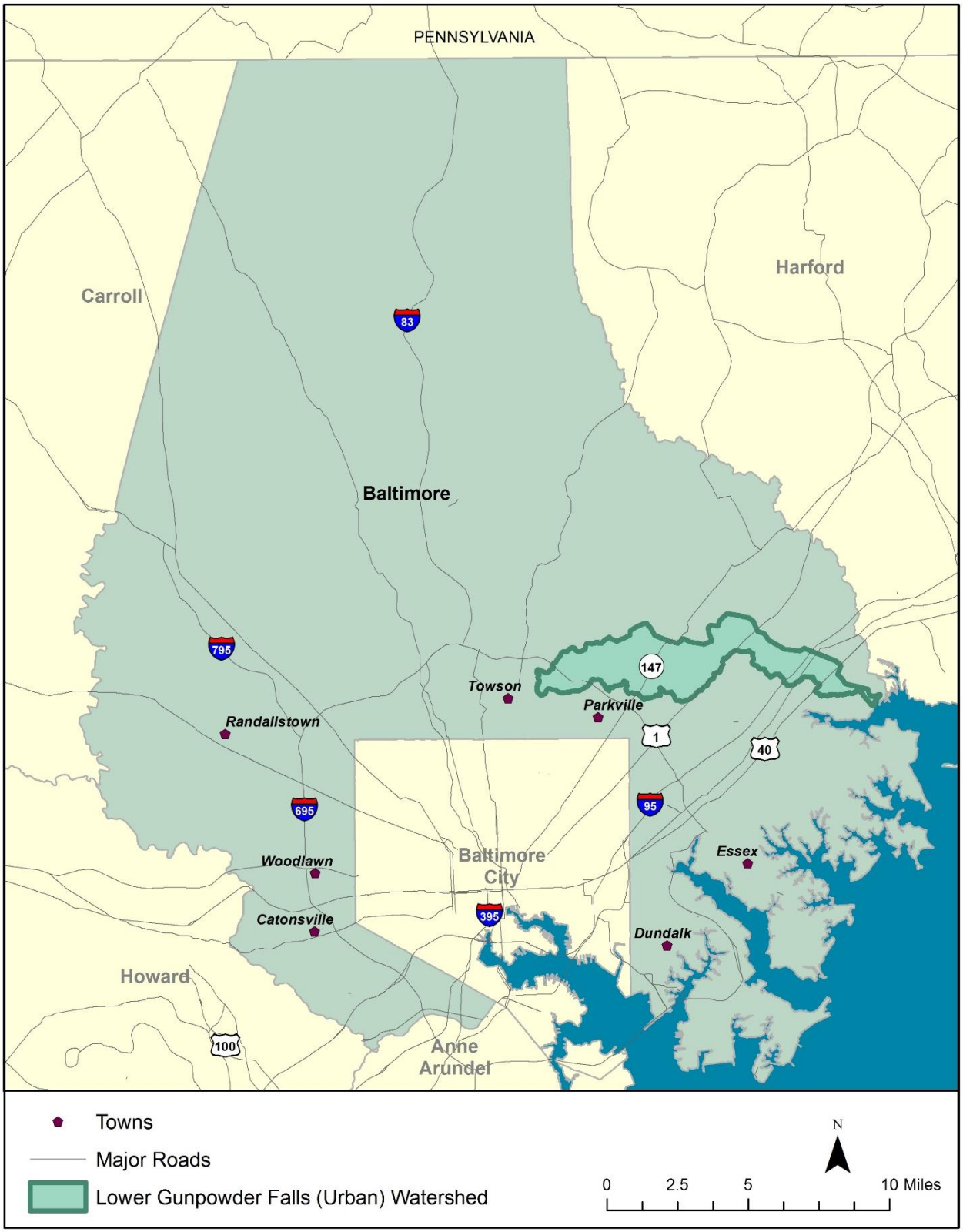


Figure 1-1: Lower Gunpowder Falls (Urban) Watershed Location

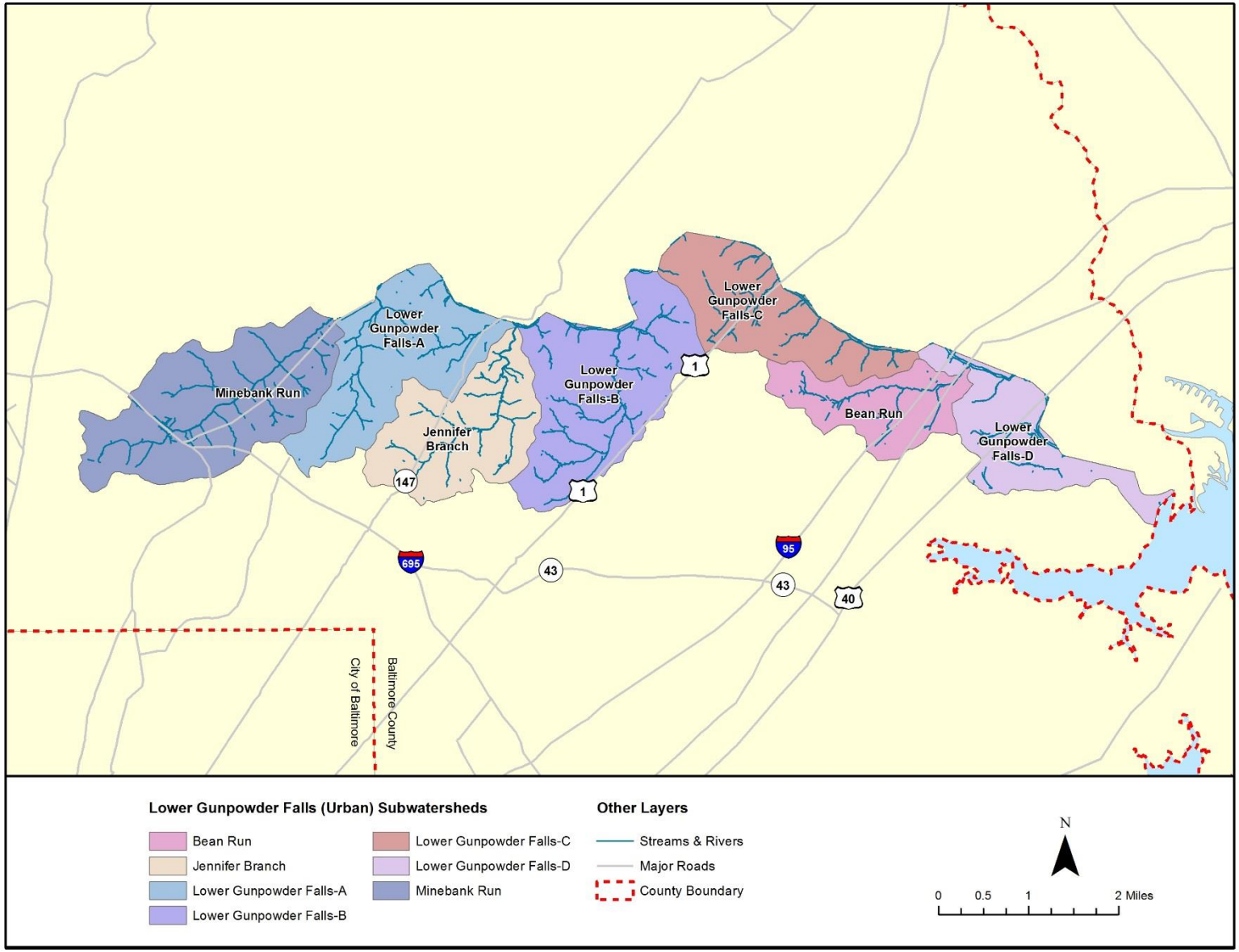


Figure 1-2: Lower Gunpowder Falls (Urban) Subwatersheds

Table 1-1: Lower Gunpowder Falls (Urban) Subwatershed Areas

Subwatershed	Area (Acres)	Area (Sq. Miles)
Bean Run	916.21	1.43
Jennifer Branch	1,412.39	2.21
Lower Gunpowder Falls-A	1,636.46	2.56
Lower Gunpowder Falls-B	1,989.70	3.11
Lower Gunpowder Falls-C	1,360.44	2.13
Lower Gunpowder Falls-D	1,081.71	1.69
Minebank Run	2,136.01	3.34
Total	10,532.92	16.47

1.3 REPORT ORGANIZATION

This report is organized into the following six major chapters:

Chapter 1 explains the purpose of this report, the watershed location, and the scope of the watershed characterization.

Chapter 2 summarizes watershed characteristics related to landscape and land use that may affect natural resources and water quality. This chapter contains landscape information related to natural features such as geology, soils, forest cover, and streams, as well as information pertaining to human influence such as land use, population, impervious cover, water distribution, and stormwater infrastructure.

Chapter 3 includes an analysis of pollutant loads, as calculated through modeling efforts, and discusses water quality and quantity conditions based on available monitoring and stream assessment data. This chapter also includes results of stormwater management facility evaluations and ranks facilities by conversion potential. Additional details are presented for top-rated facilities.

Chapter 4 describes the uplands assessment conducted to identify pollutant sources and restoration opportunities for neighborhoods, institutions, pervious areas, and hotspots.

Chapter 5 presents an overview of the key best management practice (BMP) recommendations appropriate for accomplishing watershed goals developed by the community and the Lower Gunpowder Falls (Urban) Steering Committee.

Chapter 6 contains a list of references consulted during the development of this report.

CHAPTER 2: LANDSCAPE AND LAND USE

2.1 INTRODUCTION

This chapter describes land cover and land use in the Lower Gunpowder Falls (Urban) watershed, including natural land surface characteristics and development activities. Characteristics such as soil type and impervious cover strongly influence the quantity and quality of stormwater runoff in the watershed. For example, the amount and rate at which precipitation will be absorbed by the ground surface depends on the infiltration capacity of a soil for pervious areas; impervious (e.g., paved) surfaces impede rainfall infiltration which can result in flooding, erosion, and a decrease in groundwater supply. In addition, the type and extent of pollutants carried by stormwater is affected by land use characteristics. For example, residential or agricultural areas may contribute fertilizers and pesticides to stormwater runoff. Developed areas may transmit various types of pollutants directly to receiving water bodies such as trash, bacteria (livestock and pet waste), and chemicals, depending on specific land use activities, since there is often inadequate buffer or vegetation to filter pollutants. The information presented in this chapter provides the physical setting and background necessary to evaluate other watershed components including water quality, natural resources, restoration, and management.

2.2 NATURAL LANDSCAPE

Natural climate and land surface characteristics relevant to watershed properties and processes are described in the following sections.

2.2.1 Climate

Climate is an important consideration since it can influence soil and erosion processes, stream flow patterns, and topography. In addition, climate affects vegetative growth and determines the species composition of the terrestrial and aquatic life of a region.

This region can be described as a humid continental climate with four distinct seasons (DEPRM 2008). It has a relatively temperate climate due to the combined effects of the Appalachian Mountains to the west and the Chesapeake Bay and the Atlantic Ocean to the east. According to the National Climatic Data Center (NCDC), it is also in the path of the low pressure systems that move across the country, which results in frequent changes in wind direction and weather (NCDC 2013). Average annual rainfall in Baltimore, Maryland is 41.94 inches based on 30 years of data (1971-2000) collected by the Northeast Regional Climate Center (NRCC 2013). Monthly average rainfall is 3.5 inches based on the same data set. Rainfall is uniformly distributed through the year, with monthly averages ranging from 3.00 inches in April to 3.98 inches in September. Most snowfall occurs in December, January, February, and March; an average annual snowfall of 21.4 inches is based on 58 years of data (1950-2008).

2.2.2 Watershed Delineation

A watershed-based approach for evaluating water quality conditions and improvement potential involves determining the drainage area that contributes runoff and groundwater to a specific water body. Drainage areas vary greatly depending on the scale of the stream system of interest. Drainage areas for large river, estuary and lake systems are typically on the order of several

thousand square miles, and usually referred to as basins. For example, the Chesapeake Bay basin covers over 64,000 square miles, including over 100,000 tributaries (i.e., rivers and streams) and includes portions of six different states (CBP 2011). Basins consist of sub-basins, which are on the order of several hundred square miles and may consist of one or more major stream networks. Maryland has 13 sub-basins, including the Upper Western Shore sub-basin, of which the Lower Gunpowder Falls is a part (CWP 2005). These units are then further subdivided into watersheds and subwatersheds, which are a practical size for watershed assessment, management, and restoration planning.

The Lower Gunpowder Falls (Urban) watershed covers 16.5 square miles in southeastern Baltimore County. For the purposes of the Lower Gunpowder Falls (Urban) Small Watershed Action Plan, Baltimore County used stream maps and topography to divide the watershed into seven subwatersheds, ranging in size from 916 acres to 2,136 acres (Figure 1-2; Table 1-1).

2.2.3 Topography

The topography of a region describes the relative elevations of surface features, such as ridges and valleys. Land surface shape, including degree of slope and concavity, is important as it affects the flow of surface water, soil erosion patterns, and suitability for development. For example, steep slopes are more prone to overland flow and soil erosion than flatter slopes, and thus have a greater potential for generating pollutants. Slopes were determined based on Baltimore County's Geographic Information System (GIS) soils data and divided into the following six categories, derived from slope class definitions provided in the U.S. Department of Agriculture (USDA) *Soil Survey Manual* (USDA 1993):

- Nearly level (0-3% slope);
- Gently sloping, undulating (1-8% slopes);
- Strongly sloping, rolling (4-16% slopes);
- Moderately steep, hilly (10-30% slopes);
- Steep (20-60% slopes); and
- Very steep (> 45% slope).

Table 2-1 summarizes the percent breakdown of each soil slope category by subwatershed. The distribution of these slope categories within the Lower Gunpowder Falls (Urban) watershed is depicted in Figure 2-1. Most of the watershed is categorized as "Nearly level" to "Strongly sloping." Only a few small blocks of land are categorized as "Steep" or "Very steep" and would be more prone to erosion, depending on development and land use.

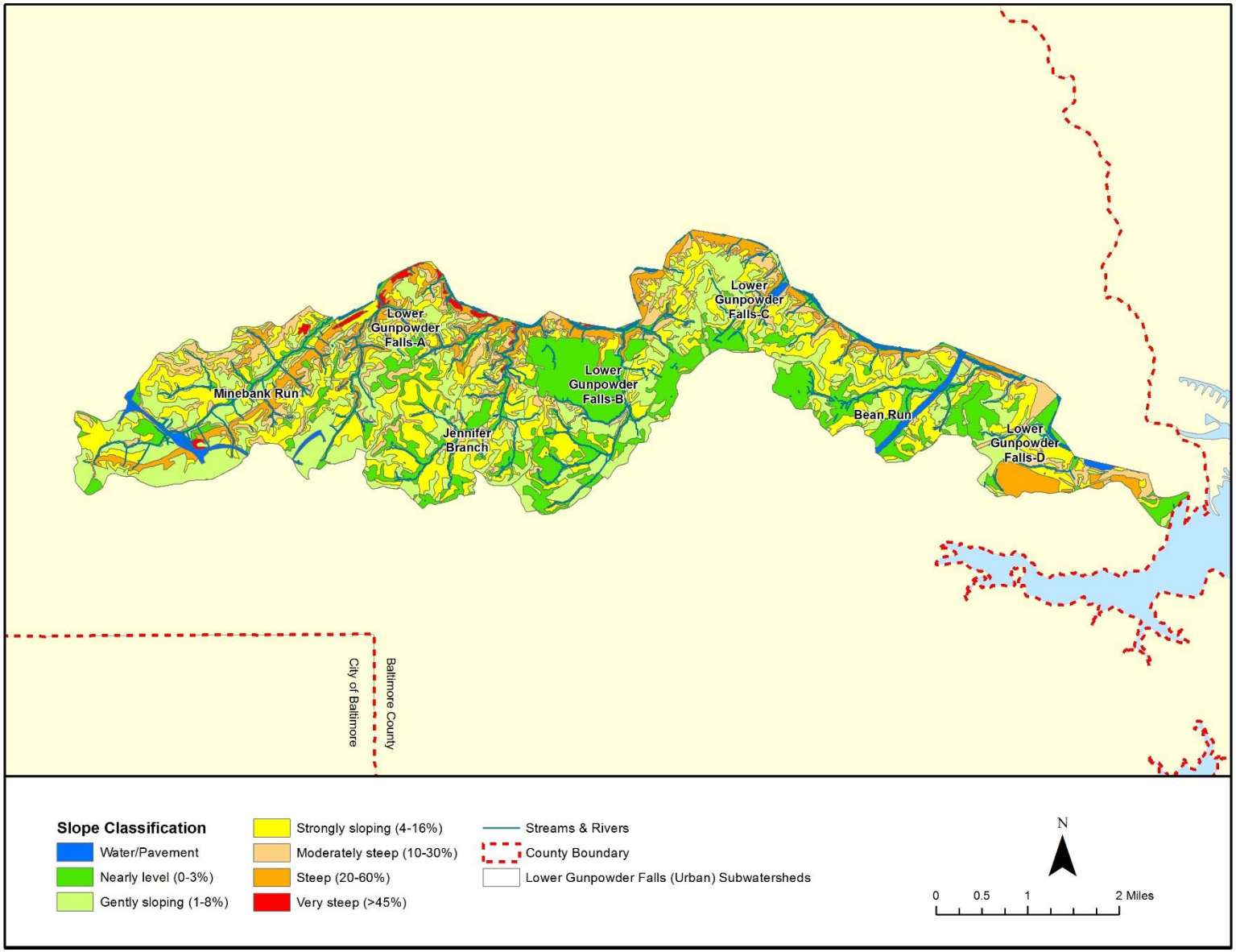


Figure 2-1: Lower Gunpowder Falls (Urban) Watershed Topography Based on Soil Slopes

Table 2-1: Lower Gunpowder Falls (Urban) Subwatershed Slope Categorization

Subwatershed	Slope Category (% of Subwatershed)						
	Water/ Pavement	Nearly Level (0-3%)	Gently Sloping (1-8%)	Strongly Sloping (4-16%)	Moderately-Steep (10-30%)	Steep (20-60%)	Very Steep (>45%)
Bean Run	5.0	43.5	21.7	28.7	1.1	0.0	0.0
Jennifer Branch	0.0	21.8	24.6	43.1	7.6	2.6	0.3
Lower Gunpowder Falls-A	1.3	13.8	32.4	27.7	10.7	11.2	3.0
Lower Gunpowder Falls-B	0.8	45.5	23.4	17.8	6.7	5.8	0.1
Lower Gunpowder Falls-C	2.3	9.9	30.5	34.2	11.1	11.9	0.0
Lower Gunpowder Falls-D	3.7	18.6	19.6	22.3	19.3	16.5	0.0
Minebank Run	3.1	9.0	33.9	29.7	13.6	10.0	0.7
Total	2.1	22.5	27.5	28.7	10.2	8.4	0.7

2.2.4 Geology

Geology affects the chemical composition of surface and groundwater, as well as the recharge rate to groundwater and wells. It is also key in soil formation and influences the buffering of pollution to water bodies in developed areas. Consequently, geology is closely related to water quality. The Lower Gunpowder Falls (Urban) watershed lies almost entirely within the Piedmont region. Only a small portion at the eastern tip of the watershed lies within the Coastal Plain region (Figure 2-2). Table 2-2 displays the geology of the subwatersheds, showing both the percent distribution and the geological type. This area of the Piedmont is characterized by hard igneous and metamorphic rocks, with areas of gneiss, quartzite, marble and schist (MGS 2009). These varying rock types have different erosion potentials, and are a big factor in the unusual topography in this part of the Piedmont. The Coastal Plain of this area is underlain with unconsolidated rocks, including gravel, sand, silt, and clay.

The geological formations of the Lower Gunpowder Falls watershed are shown in Figure 2-3.

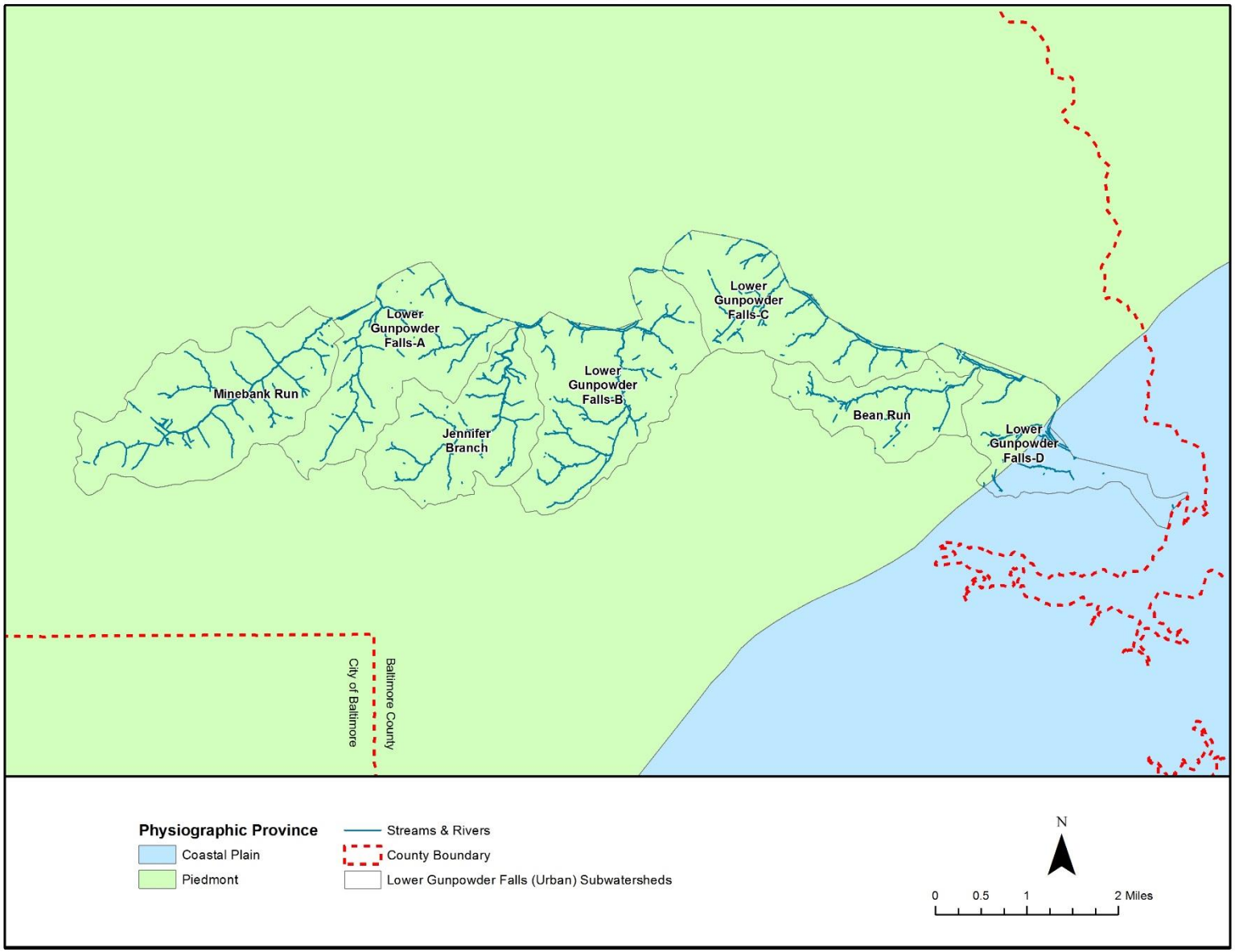


Figure 2-2: Lower Gunpowder Falls (Urban) Watershed Physiographic Provinces

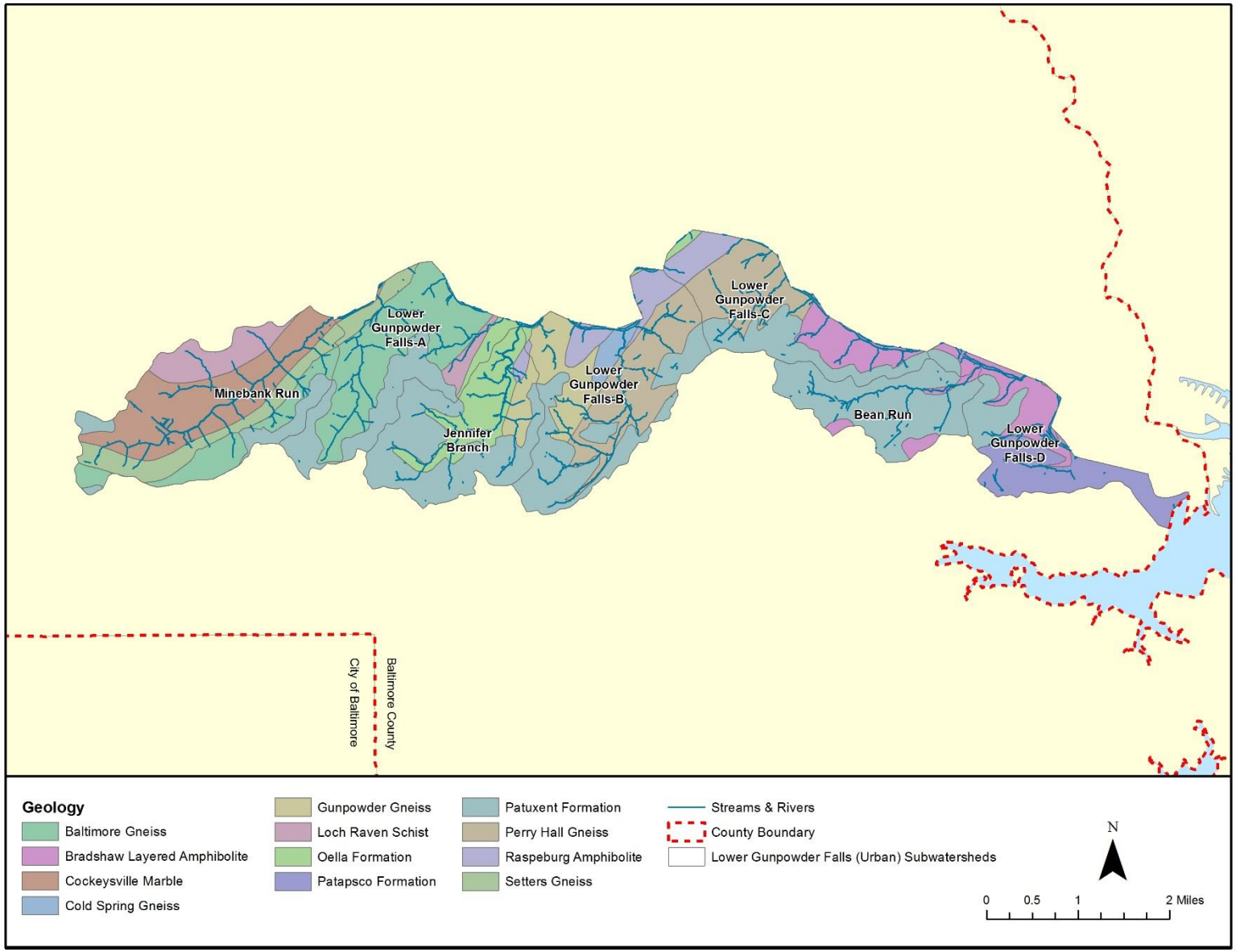


Figure 2-3: Lower Gunpowder Falls (Urban) Watershed Geology

Table 2-2: Geological Composition by Subwatershed (%)

Geology	Type	Bean Run	Jennifer Branch	Lower Gunpowder Falls-A	Lower Gunpowder Falls-B	Lower Gunpowder Falls-C	Lower Gunpowder Falls-D	Minebank Run
Baltimore Gneiss	Metamorphic	0.0	0.0	56.3	0.0	0.0	0.0	15.9
Bradshaw Layered Amphibolite	Metamorphic	9.1	0.0	0.0	0.0	20.7	29.6	0.0
Cockeysville Marble	Metamorphic	0.0	0.0	0.6	0.0	0.0	0.0	44.4
Cold Spring Gneiss	Metamorphic	0.0	0.0	0.0	5.1	0.0	0.0	0.0
Gunpowder Gneiss	Metamorphic	0.0	8.1	0.0	17.4	0.0	0.0	0.0
Loch Raven Schist	Sedimentary	0.0	0.0	5.0	0.0	0.0	0.0	13.9
Oella Formation	Metasedimentary	0.0	32.0	4.7	0.8	1.8	0.0	0.0
Patapsco Formation	Unconsolidated	0.0	0.0	0.0	0.0	0.0	49.6	0.0
Patuxent Formation	Unconsolidated	90.9	58.0	26.8	32.2	28.0	20.8	8.7
Perry Hall Gneiss	Metamorphic	0.0	0.0	0.0	33.3	38.4	0.0	0.0
Raspeburg Amphibolite	Metamorphic	0.0	1.9	0.0	11.1	11.1	0.0	0.0
Setters Gneiss	Metamorphic	0.0	0.0	6.6	0.0	0.0	0.0	17.1

2.2.5 Soils

Soil conditions are important when evaluating water quantity and quality in streams and rivers. Soil type and moisture conditions, for example, affect how land may be used and its potential for vegetation and habitat. Soils are an important consideration for projects aimed at improving water quality and/or habitat. Baltimore County's GIS soils layer was used for the soils data analysis and is a representation of the Baltimore County Soil Survey, published by USDA/ Natural Resources Conservation Service (NRCS) in 1976.

Urbanization has an impact on soil conditions within a watershed (Konrad 2003). In addition to increasing the amount of impervious surfaces, which prevent infiltration, construction and development result in soil compaction and the thinning of soil surface layers. These thinner soil layers are quickly saturated and result in increased overland flow, when compared to the natural, vegetated landscape that existed before urbanization.

2.2.5.1 Hydrologic Soil Groups

The Natural Resource Conservation Service (NRCS) classifies soils into four hydrologic soil groups (HSG) based on runoff potential. Runoff potential is the opposite of infiltration capacity (ability for the soil to absorb precipitation). Soils with high infiltration capacity will have low runoff potential, and vice versa. Infiltration rates are highly variable among soil types and are also influenced by disturbances to the soil profile (e.g., land development activities). For example, urbanization in watersheds with high infiltration rates (e.g., sands and gravels) will have a greater impact than urbanization in watersheds consisting mostly of silts and clays, which have low

infiltration rates. The four hydrologic soil groups are A, B, C, and D, where group A soils generally have the lowest runoff potential and Group D soils have the greatest.

Brief descriptions of each hydrologic soil group are provided below. Further explanation of each can be found in the USDA/NRCS publication, *Urban Hydrology for Small Watersheds*, also called Technical Release 55 (USDA 1986).

- Group A soils include sand, loamy sand, or sandy loam types. These soils have a high infiltration rate and low runoff potential even when thoroughly wet. These consist mainly of deep, well to excessively drained sands or gravel. These soils have a high rate of water transmission.
- Group B soils include silt loam or loam types. They have a moderate infiltration rate when thoroughly wet. These soils mainly consist of somewhat deep to deep, moderately well to well drained soils with moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.
- Group C soils are sandy clay loam. These soils have a low infiltration rate when thoroughly wet. These types of soils typically have a layer that hinders downward movement of water and soils with moderately fine or fine texture. These soils have a low rate of water transmission.
- Group D soils include clay loam, silty clay loam, sandy clay, silty clay, or clay types. These soils have a very low infiltration rate and high runoff potential when thoroughly wet. These consist mainly of clays with high swell potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very low rate of water transmission.

Table 2-3 and Figure 2-4, the soils in the Lower Gunpowder Falls (Urban) watershed are mostly divided between soil groups B and C (those with moderate and low infiltration rates, respectively). The distribution of hydrologic soil groups is patchy, with a few solid blocks of soils in groups A and D, the very well drained soils and very low infiltration rate soils. The large blocks of Group D correspond to areas of dense urbanization and large areas of impervious surface.

Table 2-3: Lower Gunpowder Falls (Urban) Subwatershed Hydrologic Soil Group Categorization

Subwatershed	Hydrologic Soil Group (% of Subwatershed)			
	A	B	C	D
Bean Run	10.54	40.31	32.27	16.89
Jennifer Branch	4.07	68.90	22.10	4.93
Lower Gunpowder Falls-A	0.00	75.09	15.80	9.11
Lower Gunpowder Falls-B	27.97	46.40	17.94	7.70
Lower Gunpowder Falls-C	1.10	82.32	13.19	3.39
Lower Gunpowder Falls-D	1.00	51.70	28.02	19.28
Minebank Run	2.50	70.87	12.46	14.17
Total	7.50	63.49	18.72	10.29

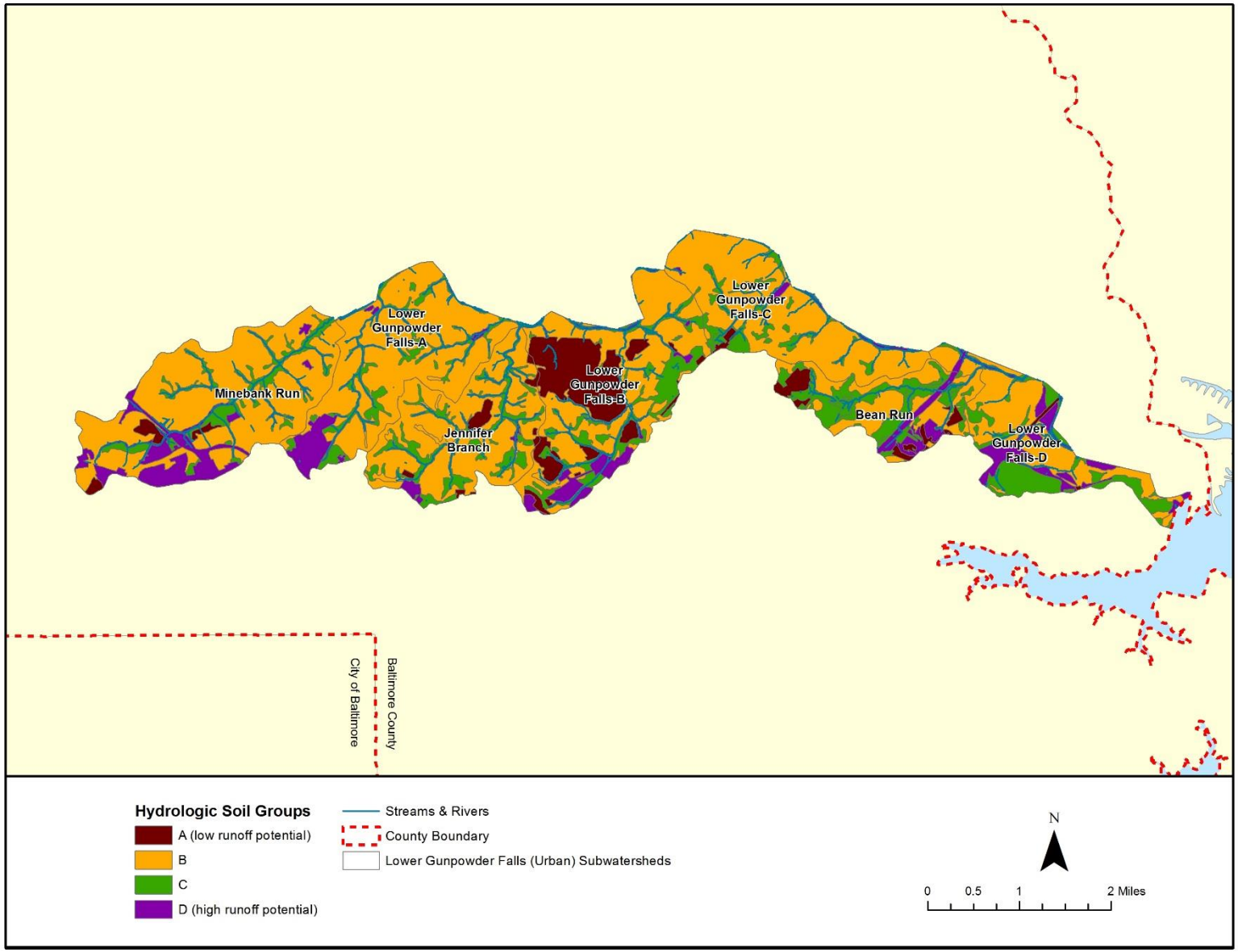


Figure 2-4: Lower Gunpowder Falls (Urban) Watershed Hydrologic Soil Groups

2.2.5.2 Erodibility

Erodibility is the susceptibility of soil to erosion. It is quantified by the K factor, which is part of the Universal Soil Loss Equation (USLE) developed by USDA's Agricultural Research Service to estimate rate of erosion and soil loss for a particular site. Low K factor values indicate low erodibility or high resistance to detachment and high K factors represent high erodibility potential. Erodibility is based on the physical and chemical properties of the soil, which determine how strongly soil particles cohere with one another. For example, clay soils are cohesive or resistant to detachment and have low K values on the order of 0.05 to 0.15 (Ouyang 2002).

Soil erodibility was divided into the following three categories, based on the soils data obtained from Baltimore County's Office of Information Technology (OIT) for the Lower Gunpowder Falls (Urban) watershed:

- Low Erodibility (K factor < 0.24);
- Medium Erodibility (0.24 ≤ K factor ≤ 0.32); and
- High Erodibility (K factor > 0.32).

Figure 2-5 shows the distribution of soil erodibility in the Lower Gunpowder Falls (Urban) watershed based on these categories and a summary by subwatershed is shown in Table 2-4. Subwatersheds with the largest fractions of highly erodible soils present the greatest potential for addressing soil conservation issues via best management practices (BMPs) such as minimizing bare soil and keeping topsoil in place. Soil erodibility data are also useful in combination with other information such as location of cropland, slope steepness, and distance to streams to determine where retirement of highly erodible land, another BMP, is appropriate. High K factor values can also serve as a warning for urban activities planned near streams such as road construction or utility placements.

As shown in Table 2-4 and Figure 2-5, medium and high erodibility categories represent over 66 percent of the soil erodibility distribution in this watershed. This indicates that most of the watershed's soils are prone to moderate or high erosion. Significant portions (> 35%) of the Lower Gunpowder Falls-C subwatershed consist of highly erodible soils. This subwatershed should rank as a priority for maintaining protective land cover such as forested area.

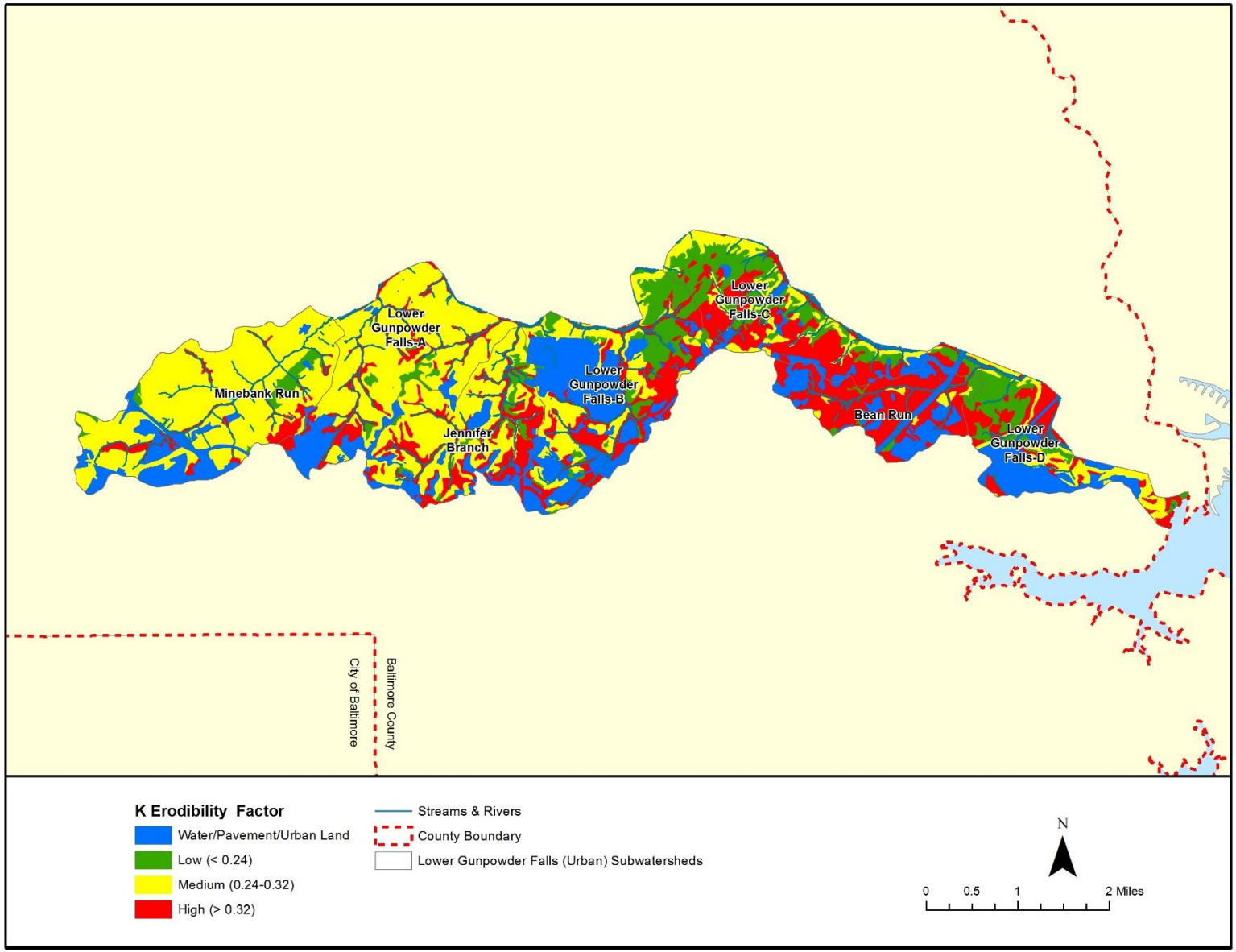


Figure 2-5: Lower Gunpowder Falls (Urban) Watershed Soil Erodibility (based on the soil K factor)

Table 2-4: Lower Gunpowder Falls (Urban) Subwatershed Soil Erodibility Categorization

Subwatershed	Water/ Pavement/ Urban Land	Soil Erodibility Category (K Factor) (% of Subwatershed)		
		Low (< 0.24)	Medium (0.24-0.32)	High (> 0.32)
Bean Run	31.14	4.25	3.17	61.44
Jennifer Branch	13.58	5.84	51.10	29.48
Lower Gunpowder Falls-A	12.63	3.74	67.33	16.30
Lower Gunpowder Falls-B	38.46	16.49	20.49	24.56
Lower Gunpowder Falls-C	9.93	30.49	21.38	38.20
Lower Gunpowder Falls-D	30.29	23.15	20.58	25.99
Minebank Run	14.97	4.59	72.65	7.78
Total	21.19	12.10	41.07	25.65

2.2.6 Forest Cover

Forest provides the greatest protection among land cover types for water and soil quality. In pristine systems, forest and soils co-evolve, shaping the hydrologic cycle; these systems operate within a natural range of variability, assuring healthy habitat and water quality. The entire Chesapeake Bay basin, including the Lower Gunpowder Falls (Urban) watershed, consisted overwhelmingly of old-growth forest at the time of European settlement. In human-impacted systems, forest cover can still provide many benefits and protect water quality if judiciously planned and conserved.

While the forested area has been greatly reduced in this watershed since European settlement, some subwatersheds have maintained a relatively high percentage of forest cover (e.g., Jennifer Branch, Lower Gunpowder Falls-A, Lower Gunpowder Falls-C and Minebank Run) compared to the other more densely urbanized watersheds in this area. This is partly due to the fact that the northern section of much of this watershed along the Lower Gunpowder Falls is part of the Gunpowder Falls State Park. Table 2-5 summarizes forested acres and percent forested area by subwatershed and Figure 2-6 shows the distribution of forest cover within the Lower Gunpowder Falls (Urban) watershed based on Baltimore County's wooded GIS layer. Data used to calculate and display forest cover were developed by the University of Vermont (UVM) Spatial Analysis Laboratory in 2008. LiDAR images from 2005 and National Agricultural Imagery Program (NAIP) data from 2007 were used to create this high resolution land cover dataset.

Table 2-5 shows that the Lower Gunpowder Falls (Urban) watershed has approximately 5,125 acres of forested area, which is 49% of the total watershed area. This is higher than the Maryland Department of Planning's (MDP) 2010 land use/land cover classification scheme, which estimates that just under 26% of forest cover remains in this watershed. (Slight variations between the UVM land cover/canopy cover dataset and MDP land use/land cover scheme result from different scales and photo sources used.)

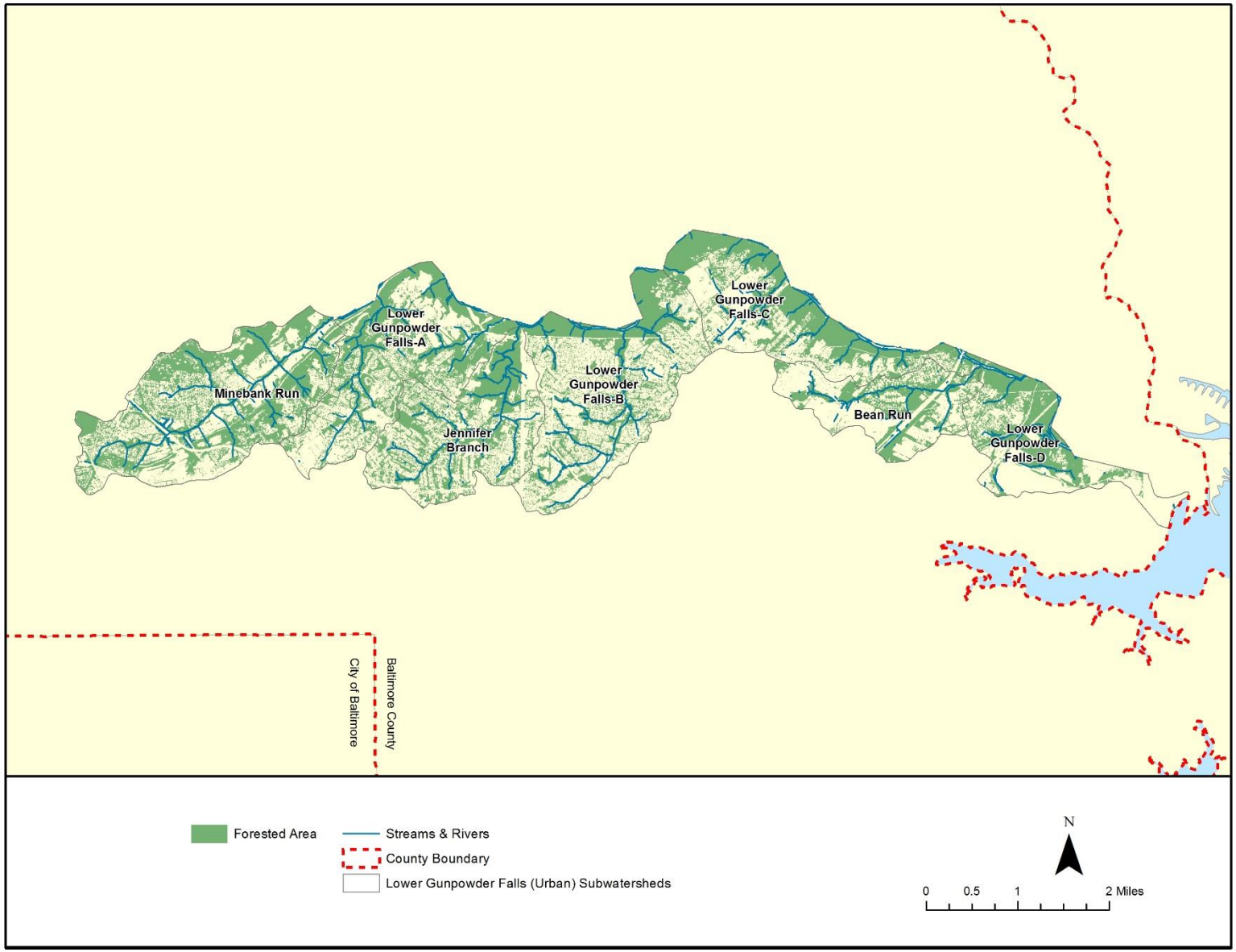


Figure 2-6: Lower Gunpowder Falls (Urban) Watershed Forest Cover

Table 2-5: Lower Gunpowder Falls (Urban) Subwatershed Forest Cover

Subwatershed	Total Acres	Forested Acres	% Forested
Bean Run	916	361	39
Jennifer Branch	1,412	700	50
Lower Gunpowder Falls-A	1,636	824	50
Lower Gunpowder Falls-B	1,990	832	42
Lower Gunpowder Falls-C	1,360	756	56
Lower Gunpowder Falls-D	1,082	532	49
Minebank Run	2,136	1,120	52
Total	10,533	5,125	49

2.2.7 Stream Systems

Stream systems are a watershed's circulatory system, and the most visible part of the hydrologic cycle. Streams are the flowing surface waters, and while they are distinct from groundwater and standing surface water such as lakes, they are closely connected to both. The stream system is an intrinsic part of the landscape and closely reflects conditions on the land. Streams are a fundamental natural resource with numerous benefits for plants, animals, and humans. Maintaining a healthy stream system is a priority for many individuals and organizations, and requires ensuring that stream flows and water quality closely mimic the conditions found in un-impacted watersheds.

2.2.7.1 Stream System Characteristics

The Lower Gunpowder Falls (Urban) watershed is part of a state-defined, 8-digit watershed (Lower Gunpowder Falls) and, as discussed in Section 2.2.2, is part of the Chesapeake Bay basin. The other part of this 8-digit watershed will be covered under its own SWAP. This watershed is subdivided into seven subwatersheds and contains approximately 67 miles of stream (Figure 2-7). These streams all drain to the Gunpowder Falls, which drains to the Gunpowder River and then ultimately to the Chesapeake Bay. A summary of stream mileage and density by subwatershed is included in Table 2-6. The Lower Gunpowder Falls-B and Minebank Run subwatersheds have the largest number of stream miles, with more than double the stream miles of the smallest subwatersheds, Bean Run and Lower Gunpowder Falls-D.

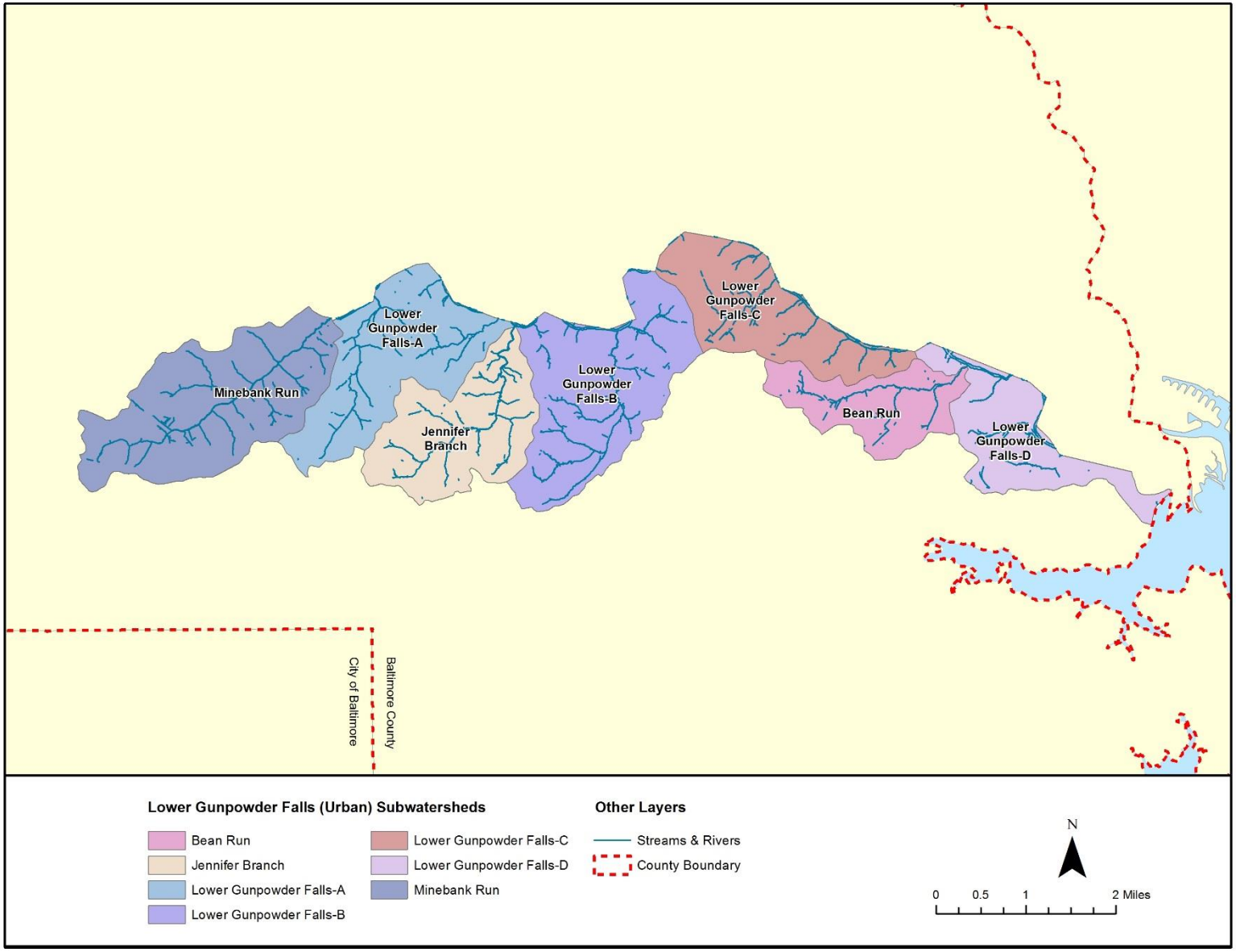


Figure 2-7: Lower Gunpowder Falls (Urban) Watershed Stream System and Subwatersheds

Table 2-6: Lower Gunpowder Falls (Urban) Watershed Stream Mileage and Density

Subwatershed	Area (square miles)	Stream Miles	Stream Density (miles/square mile)
Bean Run	1.43	5.70	3.98
Jennifer Branch	2.21	9.65	4.37
Lower Gunpowder Falls-A	2.56	10.43	4.08
Lower Gunpowder Falls-B	3.11	13.40	4.31
Lower Gunpowder Falls-C	2.13	8.93	4.20
Lower Gunpowder Falls-D	1.69	5.53	3.27
Minebank Run	3.34	12.71	3.81
Total	16.46	66.35	4.03

2.2.7.2 Stream Riparian Buffers

Riparian buffers are the vegetated areas adjacent to streams that protect water bodies from toxins and excessive nutrients, while also providing bank stabilization and habitat. Forested buffer areas along streams play a crucial role in improving water quality and flood mitigation since they can reduce surface runoff, stabilize stream banks, trap sediment, and provide habitat for various types of terrestrial and aquatic life including fish. Tree roots, for example, capture and remove pollutants including excess nutrients (e.g., nitrogen) from shallow flowing water; the tree root structure also impedes erosion and water flow, which in turn reduces sediment load and the risk of flooding. Tree canopy provides shading and results in cooler water temperatures required by a variety of stream biota, particularly cold-water species like trout. In smaller streams such as the ones surveyed, terrestrial plant material falling into the stream is the primary source of food for stream fauna. Trees provide seasonal food in the form of leaves and plant parts for stream life at the base of the food chain, while fallen tree branches and trunks provide a more consistent, slow-release food source throughout the year. Tree roots and snags offer habitat for fish and other aquatic species. Maintaining healthy, forested buffers is important for reducing nutrient and sediment loadings to the Gunpowder River and to the Chesapeake Bay. When stream riparian buffers are converted from forest to agriculture or urban land uses (e.g., residential), many of these benefits are lost and stream health declines. Riparian buffer zones can be re-established or preserved as a BMP to reduce land use impacts by intercepting and controlling the pollutants entering a water body.

The vegetative condition of the riparian buffer was analyzed based on a 100-ft buffer on either side of the stream system. Three conditions were used to classify stream buffer conditions: impervious, open pervious, or forested. Impervious areas were determined by overlaying the roads and buildings data layers over the 100-ft stream buffer layer. Similarly, the forested areas were determined using the UVM land cover layer and removing any impervious area footprint. Remaining areas were classified as open pervious areas. Stream buffer conditions are summarized by subwatershed in terms of acres and percentages in Table 2-7. The distribution of land cover classes within the 100-ft stream buffer is shown in Figure 2-8. As expected, streams in the highly urbanized subwatersheds, such as Bean Run and Minebank Run, have the highest percentage of impervious surface within the 100-ft buffer corridor. The Jennifer Branch and Lower Gunpowder Falls-A subwatersheds have the highest proportion of forested stream buffer.

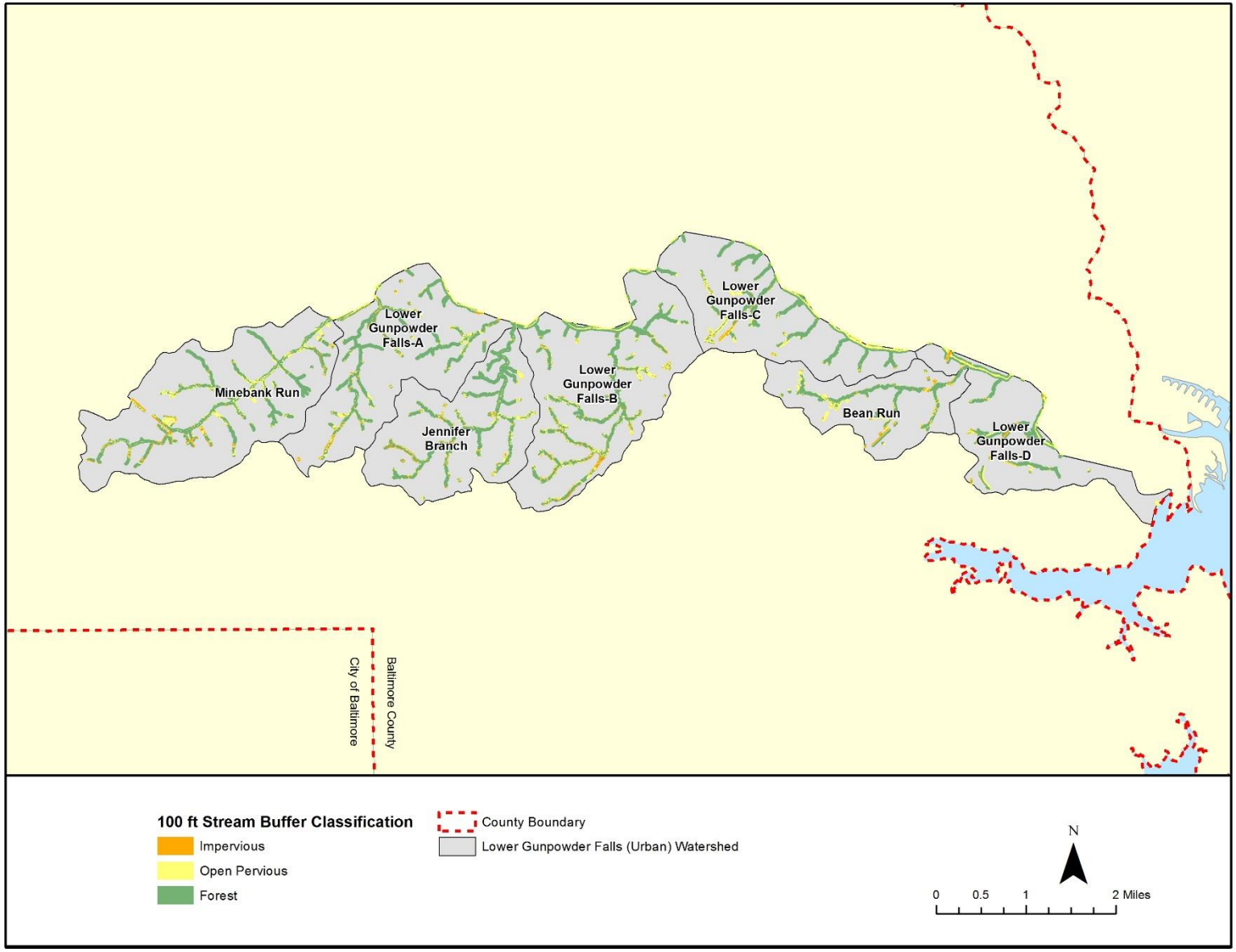


Figure 2-8: Lower Gunpowder Falls (Urban) Watershed 100-ft Stream Buffer Land Use

Table 2-7: Lower Gunpowder Falls (Urban) Subwatershed Land Use in the 100-ft Stream Buffer

Subwatershed	Forest		Open Pervious		Impervious	
	Acres	%	Acres	%	Acres	%
Bean Run	86.4	65.3	34.8	26.3	11.2	8.5
Jennifer Branch	177.7	77.2	38.8	16.8	13.8	6.0
Lower Gunpowder Falls-A	189.9	72.6	56.2	21.5	15.6	6.0
Lower Gunpowder Falls-B	219.3	66.8	86.1	26.2	23.0	7.0
Lower Gunpowder Falls-C	157.7	66.4	69.0	29.1	10.8	4.6
Lower Gunpowder Falls-D	105.3	67.0	41.4	26.3	10.5	6.7
Minebank Run	205.3	66.6	79.5	25.8	23.3	7.6
Total	1,141.5	69.0	405.7	24.5	108.2	6.5

2.3 THE HUMAN MODIFIED LANDSCAPE

The natural landscape has been modified for human use over time. The intensity of development activities has increased, starting with the colonization of Maryland in the 1600s. This modification has resulted in environmental impacts to both terrestrial and aquatic ecosystems. This section describes the characteristics of the human modified landscape and how it is associated with impacts to the natural ecosystem. This includes a general description of land use and land cover and more specific issues such as population, impervious cover, drinking water and wastewater, stormwater systems, discharge permits, zoning, and build-out analysis.

This section also demonstrates how pollutants may enter waterways from both point and non-point sources. Point sources of pollution are those that may be easily traced to a single, easily-defined origin, for example a wastewater treatment plant or a leaking barrel. Non-point sources (NPS) are those that originate from a diffuse area and are typically carried by precipitation or snowmelt into storm drain systems and/or waterways. NPS pollutants may include chemicals that wash off of roadways, including oils, salt and other de-icing agents that are used to treat roadways during winter storms. Other common NPS pollutants are the fertilizers and pesticides used on residential lawns, commercial landscaping, and cropfields; improper or excessive application of these chemicals often results in increased NPS pollution.

2.3.1 Land Use and Land Cover

Land use has pronounced impacts on water quality and habitat. Different land uses generate different types and amounts of pollutants. As discussed in the previous section, a forested watershed has the capacity to absorb pollutants such as sediment and nutrients and reduce the flow rate of water into streams. Developed areas with impervious surfaces, such as roads, parking lots, and roofs, block the natural seepage of precipitation into the ground. Unlike most natural surfaces, impervious surfaces tend to concentrate stormwater runoff, accelerate flow rates, and direct stormwater to the nearest stream. This can cause bank erosion and destruction of in-stream and riparian habitat. Undeveloped watersheds and those with small amounts of impervious surfaces tend to have better water quality in local streams than developed watersheds with larger amounts of impervious surfaces. In addition, agricultural land uses can contribute to increases in nutrients and coliform bacteria in streams, if not properly managed.

MDP develops a statewide land use/land cover GIS layer every five years to provide a general overview of predominant land cover/usage (interpreted from aerial photography and satellite imagery) and to monitor development activities throughout the state. The most recent update available and used for this characterization report is the 2010 MDP land use/land cover scheme. This was a revision of the 2002 land use/land cover GIS layer, updated using a combination of aerial imagery and parcel information. These data are for use by government agencies and other stakeholders to assess trends in land development and consumption of undeveloped/natural resources over time. Two new land use/land cover categories were introduced in the draft 2007 GIS layer and are were also included in the 2010 dataset: very low density residential (large lot subdivision, 5 to 20 acres) and transportation (major highways and miscellaneous transportation features not classified elsewhere). A summary of land use/land cover percentages by subwatershed is included in Table 2-8. A map and pie chart of land use/land cover according to MDP's 2010 scheme is shown in Figure 2-9.

The Lower Gunpowder Falls (Urban) watershed encompasses approximately 10,532 acres (16.5 square miles) of land. The primary land uses in the watershed are Medium Density Residential (30%), Deciduous Forest (26%), and Low Density Residential (13%), which occur in large patches that are spread throughout the watershed. Forest land use is concentrated near the northern border of the watershed, along the Falls and within the Gunpowder Falls State Park. Commercial development is concentrated primarily along the southern border of the watershed in the vicinity of Carney and Towson.

Table 2-8 shows that the MDP dataset estimates the Lower Gunpowder Falls (Urban) watershed is 29% forested. This is lower than the 49% forest cover presented in Section 2.2.6, Table 2-5, which was calculated using the UVM land cover dataset. Variations between the UVM land cover dataset and MDP land use/land cover scheme result from different scales and photo sources used during their development.

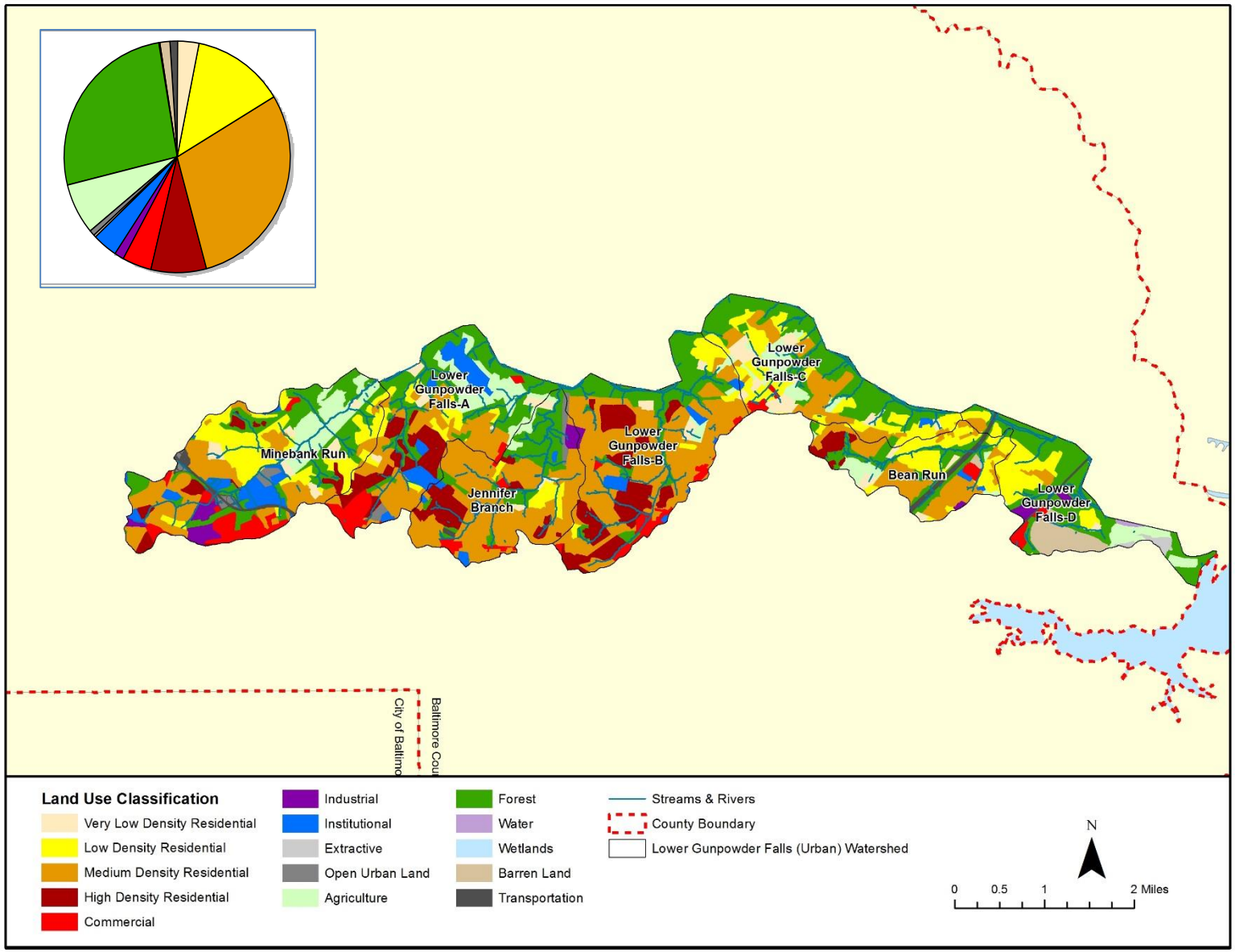


Figure 2-9: Map and Pie Chart of Lower Gunpowder Falls (Urban) Watershed Land Use/Land Cover

Table 2-8: Lower Gunpowder Falls (Urban) Land Use/Land Cover Classification (%)

Land Use	Subwatershed							
	Bean Run	Jennifer Branch	Lower Gunpowder Falls-A	Lower Gunpowder Falls-B	Lower Gunpowder Falls-C	Lower Gunpowder Falls-D	Minebank Run	Total
Very Low Density Residential	3.6	1.6	2.3	1.6	8.2	0.5	3.2	3.0
Low Density Residential	23.9	4.5	6.5	3.7	23.0	19.8	18.9	13.2
Medium Density Residential	30.9	54.3	22.9	48.6	17.7	3.6	21.2	29.7
High Density Residential	5.9	9.8	12.6	18.0	0.0	0.0	4.1	8.0
Commercial	1.9	2.7	5.9	4.2	1.5	2.8	6.9	4.1
Industrial	0.5	1.6	0.0	0.4	0.0	2.9	3.4	1.3
Institutional	1.0	2.3	9.1	2.5	0.8	0.0	6.2	3.7
Extractive	0.0	0.0	0.0	0.0	0.0	2.7	0.0	0.3
Open Urban Land	0.0	1.7	0.8	0.2	0.0	0.0	1.9	0.8
Cropland	6.1	0.0	3.4	1.5	8.6	5.8	5.6	4.2
Orchards/Vineyards/Horticulture	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.2
Pasture	0.0	1.9	8.7	0.0	0.0	0.1	5.6	2.7
Feeding Operations	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Agricultural Buildings	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Deciduous Forest	16.9	19.0	27.6	19.2	39.8	43.5	20.0	25.6
Evergreen Forest	4.0	0.3	0.0	0.0	0.3	0.0	0.0	0.4
Mixed Forest	0.0	0.0	0.2	0.0	0.0	0.0	0.7	0.2
Brush	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bare Ground	0.9	0.0	0.0	0.0	0.0	13.4	0.0	1.5
Water	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.1
Wetlands	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Transportation	4.4	0.4	0.0	0.0	0.0	1.9	2.3	1.1

A total of 1,772 acres of this watershed are contained within state and County parks (Figure 2-10), primarily Gunpowder Falls State Park. Parks account for 17% of the total watershed area; most of this parkland is adjacent to mainstem Gunpowder Falls.

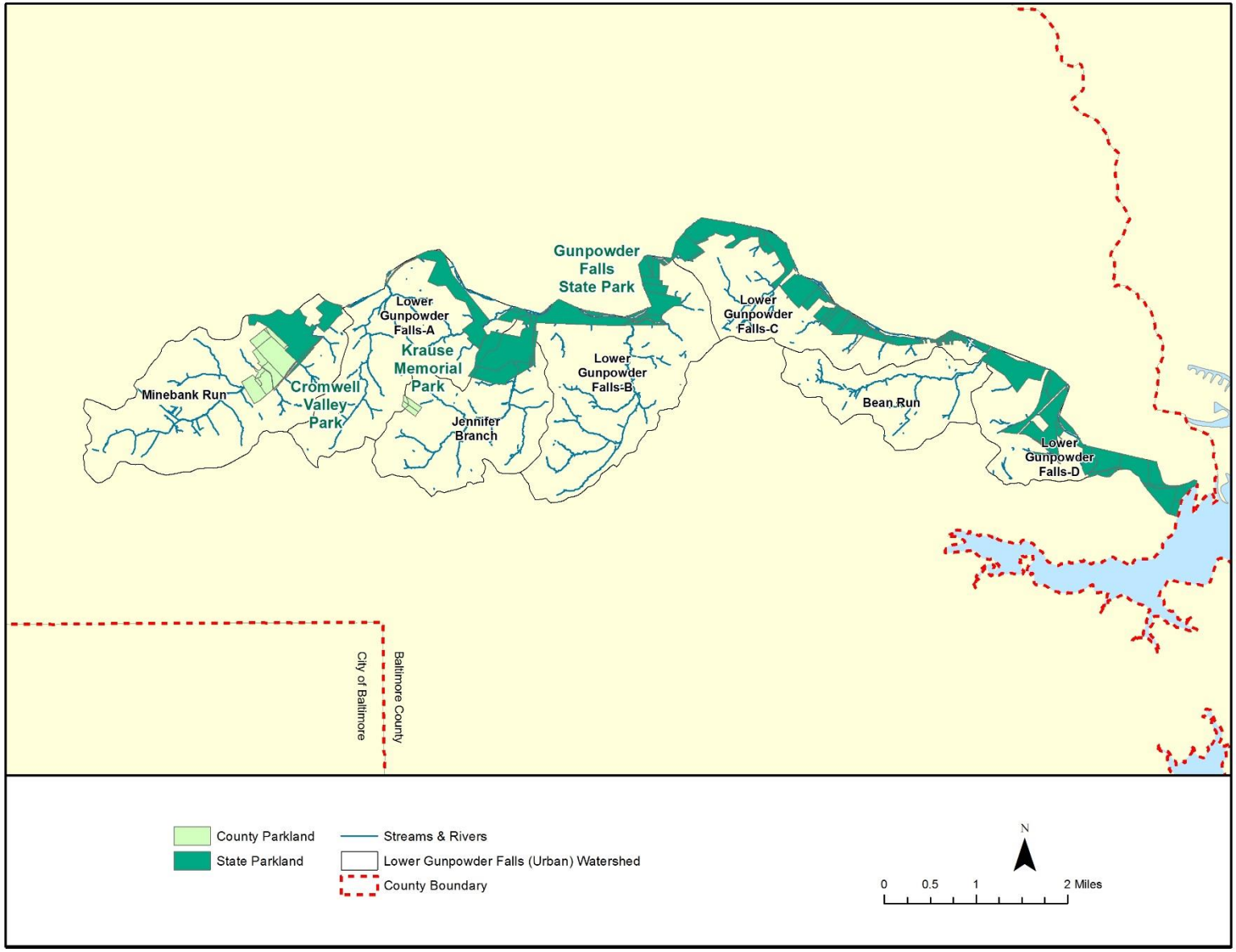


Figure 2-10: Lower Gunpowder Falls (Urban) Watershed Parklands

2.3.2 Population

Population data provides another way to evaluate the intensity of land use. As previously mentioned, much of the degradation from urban/suburban land uses (where population is mainly concentrated) is related to the extent of impervious cover and also conversion of land uses that protect water resources such as forest. A higher population density (persons per acre) represents a more intense use of the land and potential for environmental degradation. On the other hand, urban planning and smart growth initiatives, which concentrate development and maximize land use in some areas, are ways of preserving open spaces and protecting areas outside of the growth zone, leaving them undisturbed and undeveloped. Much of the development in the watershed pre-dates the recent push for smart growth, but the principles may still be of use. Smart growth principles are aimed at directing future growth to areas of existing services and where development has already occurred. This will result in less land conversion to residential and supporting urban development such as commercial areas and therefore, conservation of land uses with less environmental impacts such as forest and agriculture. Population density in the Lower Gunpowder Falls (Urban) watershed was estimated based on the 2010 U.S. Census. Table 2-9 summarizes population density by subwatershed with respect to total area and impervious area. Population density distribution for the watershed is shown in Figure 2-11. In general, higher population densities correspond to the areas designated as high density residential land use discussed in the last section. Population density is greatest in Jennifer Branch and Lower Gunpowder Falls-B, where residential land use is most common.

Table 2-9: Lower Gunpowder Falls (Urban) Watershed Population Data

Subwatershed	Total Population (2010 census)	Total Area (acres)	Population Density (per acre)	Impervious Area (acres)	Population Density (per impervious acre)
Bean Run	4,204.6	916.2	4.6	163.7	25.7
Jennifer Branch	7,846.3	1,412.4	5.6	254.8	30.8
Lower Gunpowder Falls-A	4,142.5	1,636.5	2.5	277.8	14.9
Lower Gunpowder Falls-B	10,797.6	1,989.7	5.4	419.5	25.7
Lower Gunpowder Falls-C	2,092.0	1,360.4	1.5	113.6	18.4
Lower Gunpowder Falls-D	1,356.1	1,081.7	1.3	112.0	12.1
Minebank Run	8,394.9	2,136.0	3.9	412.0	20.4
Total	38,834.0	10,532.9	3.7	1,753.4	22.1

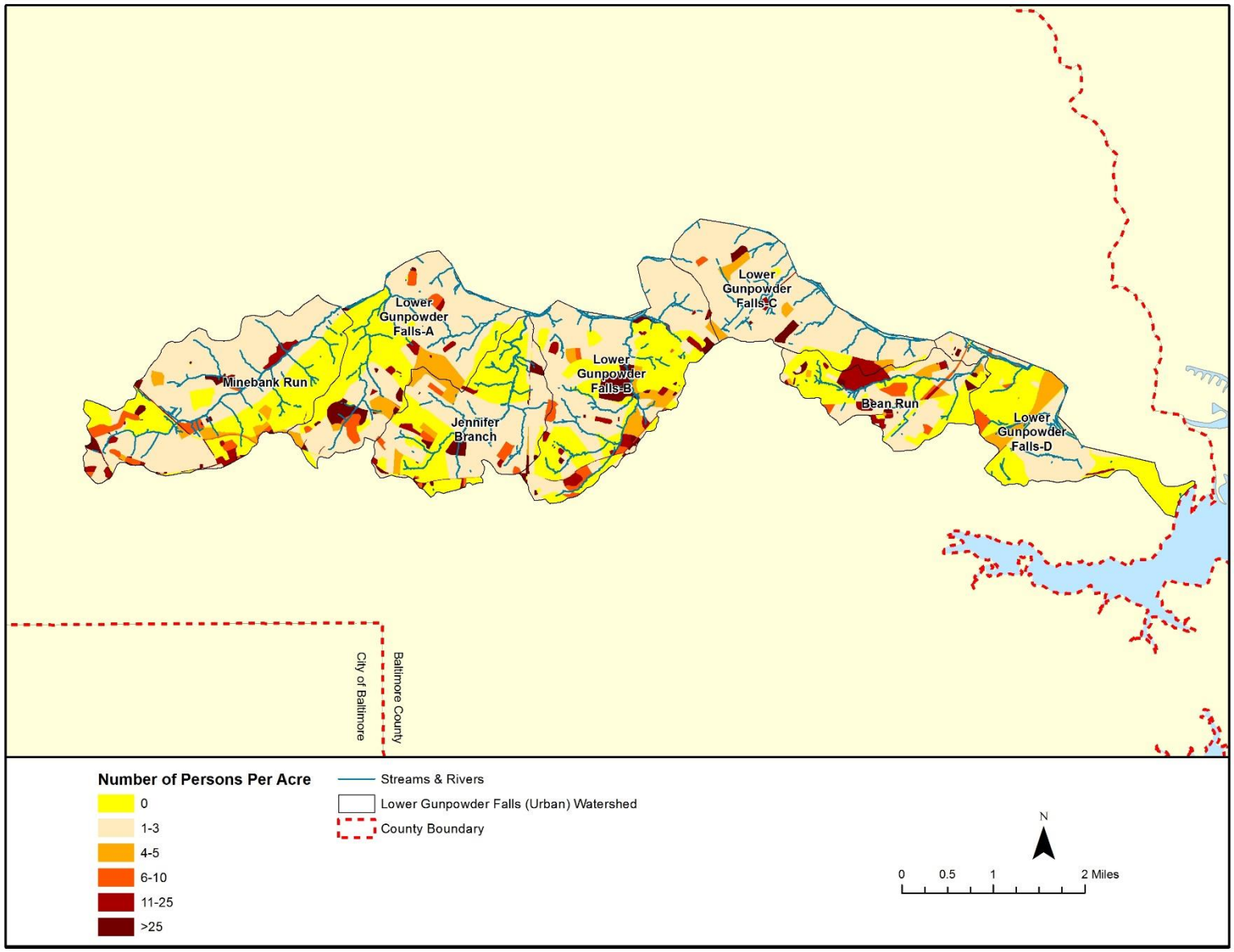


Figure 2-11: Lower Gunpowder Falls (Urban) Watershed Population Distribution

2.3.3 Impervious Surfaces

Impervious surfaces prevent precipitation from naturally infiltrating into the ground; these types of surfaces include roads, parking areas, roofs, and other paved surfaces. When precipitation cannot infiltrate, it is typically concentrated, accelerated and conveyed directly to the nearest stream. Consequently, stormwater and snowmelt runoff from impervious surfaces can cause stream erosion and habitat destruction from the high energy flow and is likely more polluted than runoff generated from pervious areas. Undeveloped watersheds with small amounts of impervious cover are likely to have better water quality in local streams than urbanized watersheds with greater amounts of impervious cover. Impervious cover is a primary factor when determining pollutant characteristics and amounts in stormwater runoff. Research has been conducted to link the degree of urbanization (typically measured by amount of impervious cover) with various watershed-based indicators of water quality such as the diversity and abundance of aquatic and terrestrial life. The Center for Watershed Protection (CWP) compiled stream research conducted in various parts of the country and developed a simple model that relates stream quality to percentage of impervious cover in a watershed. Studies used to develop the impervious cover model measured stream quality based on a variety of indicators such as number of aquatic insect species, stream temperature, channel stability, aquatic habitat, wetland plant density, and fish communities. CWP's impervious cover model is illustrated in Figure 2-12.

Based on the research compiled, CWP determined three general categories to classify and predict stream quality in terms of impervious cover. Watersheds with less than 10 percent impervious cover are referred to as sensitive and typically have high quality streams with stable channels, good habitat conditions, and good to high water quality; sensitive watersheds are susceptible to environmental degradation with urbanization and increases in impervious cover. The model predicts that between 10 and 25 percent impervious cover, watersheds become impacted and would show clear signs of degradation such as erosion, channel widening, and a decline in stream habitat. There is a possibility to restore streams to a somewhat natural functioning system within this category. When a watershed has more than 25 percent impervious cover, streams are classified as damaged which are characterized by fair to poor water quality, unstable channels, severe erosion, and inability to support aquatic life and provide habitat; many streams in this category are typically piped or channelized.

Figure 2-12 shows that when impervious cover exceeds 60 percent, a watershed is classified as severely damaged and means that most of the natural stream system is gone. Management of damaged and severely damaged streams may focus on decreasing pollutant loads to downstream receiving waters (e.g., installing BMPs) but the ability to restore natural functions, such as habitat, is unlikely. Restoration efforts may also focus on making the remaining stream systems stable, aesthetically pleasing and an amenity to the community. It should be noted that the impervious cover model is a simplified approach for classifying the quality of urban streams. Although it is based on research, there are inherent model assumptions and limitations that should be considered such as regional variations and scale effects. In addition, while impervious cover is a relevant and significant indicator for watershed health, it is only one of many different factors affecting stream health and contributing to the cumulative impacts of development on water quality. For example, agricultural land uses contribute sediment and nutrient loads to receiving waters depending on management practices. Also, the ability of BMPs to offset adverse impacts from urbanized areas is not specifically accounted for in this model.

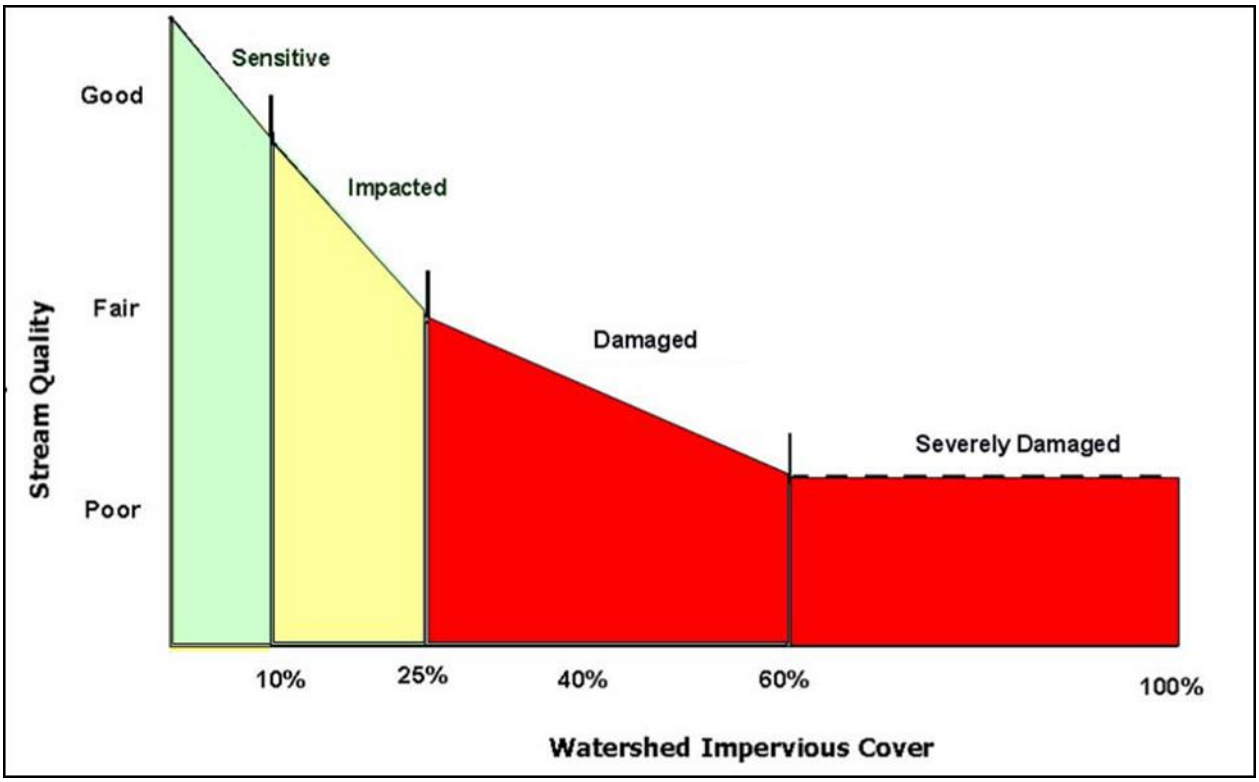


Figure 2-12: Impervious Cover Model (adapted from CWP 2003)

The roads and buildings (including parking lots) GIS data layers from Baltimore County were used to derive impervious surface areas within the Lower Gunpowder Falls (Urban) watershed (Figure 2-13). Data for sidewalks was unavailable so they are not accounted for in this analysis. The area for each layer was determined and then combined to obtain estimates of impervious cover areas on a subwatershed scale. Table 2-10 summarizes the area of roads and buildings, total impervious area, and percent impervious area for each subwatershed. Impervious cover represents about 16.6 percent of the watershed or 1,753 acres. Subwatershed ratings according to the CWP impervious cover model and these impervious area estimates are shown in Figure 2-14.

Table 2-10: Lower Gunpowder Falls (Urban) Subwatershed Impervious Area Estimates

Subwatershed	Total Area (acres)	Buildings (acres)	Parking Lots (acres)	Roads (acres)	Impervious Area (acres)	% Impervious
Bean Run	916.2	68.1	9.9	85.6	163.7	17.9
Jennifer Branch	1,412.4	128.6	23.8	102.4	254.8	18.0
Lower Gunpowder Falls-A	1,636.5	118.9	49.2	109.7	277.8	17.0
Lower Gunpowder Falls-B	1,989.7	196.6	41.0	181.9	419.5	21.1
Lower Gunpowder Falls-C	1,360.4	59.9	9.6	44.1	113.6	8.3
Lower Gunpowder Falls-D	1,081.7	30.1	38.0	43.9	112.0	10.4
Minebank Run	2,136.0	154.8	98.2	159.0	412.0	19.3
Total	10,532.9	757.1	269.7	726.6	1,753.4	16.6

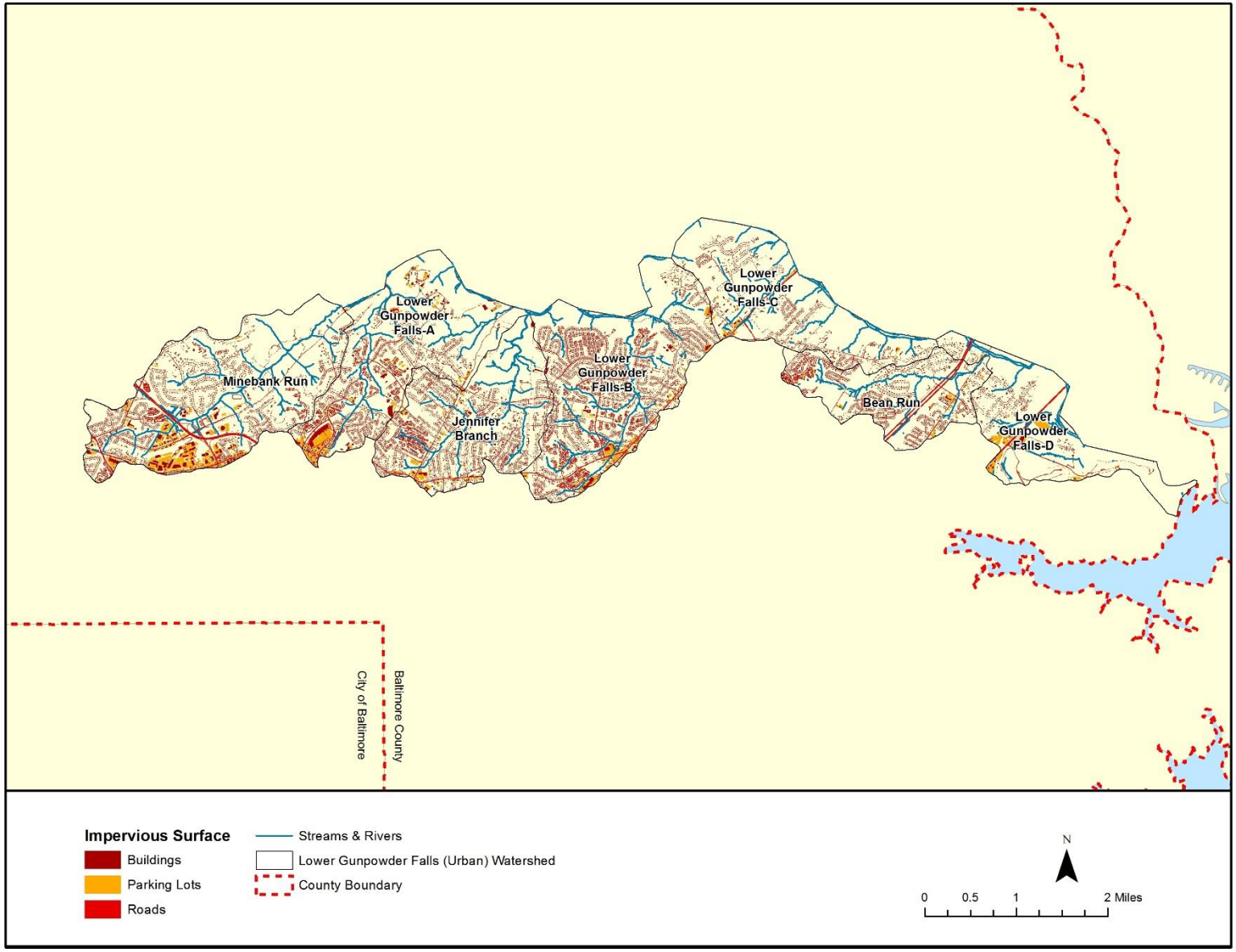


Figure 2-13: Lower Gunpowder Falls (Urban) Watershed Impervious Surface

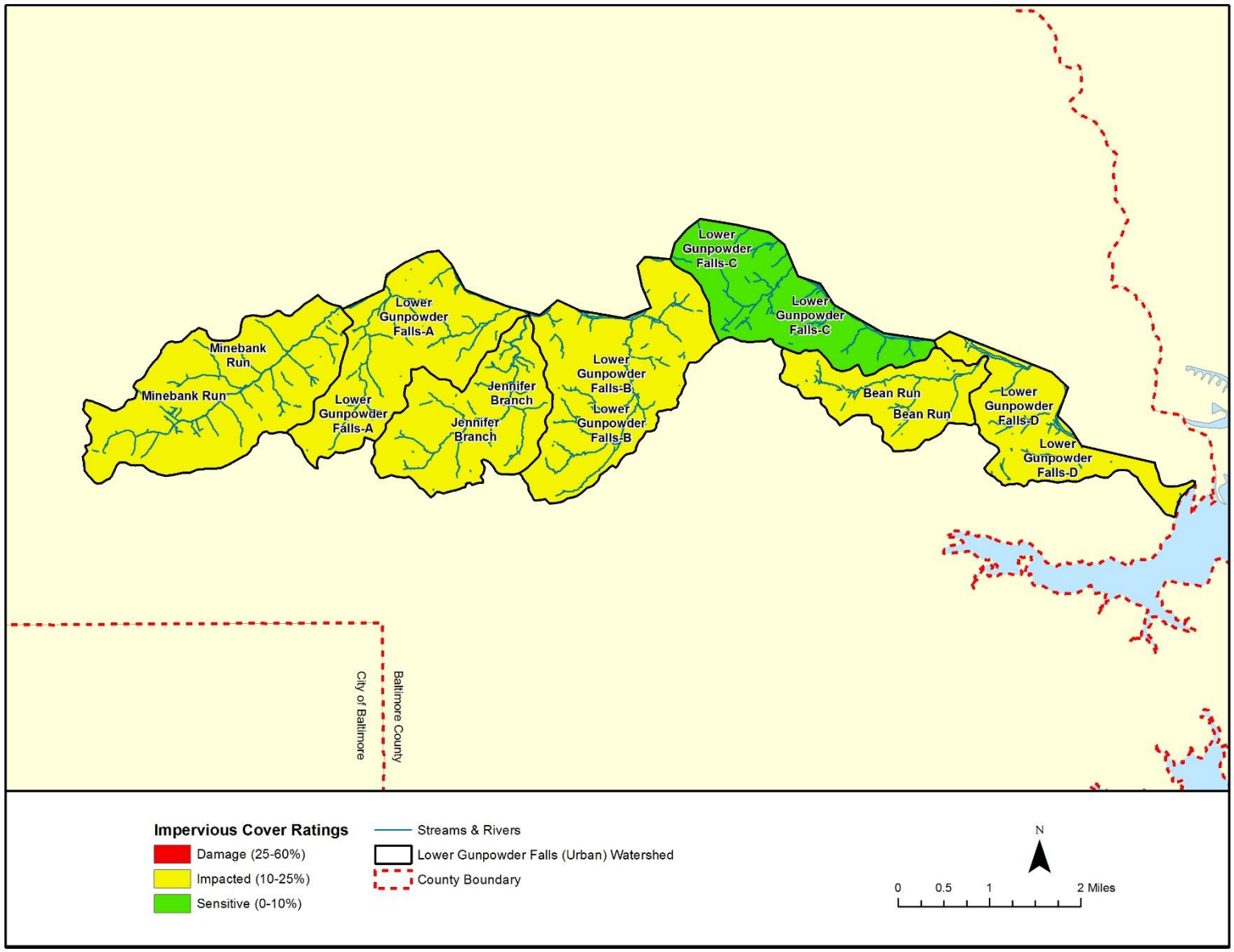


Figure 2-14: Lower Gunpowder Falls (Urban) Watershed Impervious Cover Ratings

2.3.4 Stormwater

Stormwater is water generated during and immediately after storm events. Stormwater that does not seep into the ground becomes stormwater runoff and goes directly to receiving water bodies. The amount and characteristics of stormwater runoff is affected by rainfall amount and intensity, soil properties, slope, and land use/land cover. Concerns associated with stormwater include rate and volume of runoff and water pollution. For example, more runoff is generated from impervious cover and agricultural land than from forested land. As previously mentioned, impervious surfaces do not allow any water to infiltrate into the ground and runoff is conveyed more rapidly into the stream system. The increase in runoff rate and volume can cause flooding and stream erosion which in turn, results in the destruction of habitat and natural stream functions such as nutrient reduction. In addition, there is less potential for groundwater recharge when there is little or no infiltration of stormwater.

Stormwater runoff can also carry various contaminants depending on land use characteristics and human activities. Pollutants deposited on impervious surfaces and other developed lands from daily human activities are often carried by stormwater to stream systems. For example, common constituents in impervious surface runoff (e.g., highways, parking lots) include sediment, metals, bacteria, nutrients, and petroleum; pollutants such as these build up over time from various sources such as maintenance activities (de-icing, roadside fertilizer use), vehicles (exhaust, leaks), and accidents/spills and are washed off during storm events. While the runoff from other developed areas, agriculture operations and residential areas for example, may be moderate compared to highly impervious areas, it can still carry pollutants such as nutrients, bacteria, and chemicals to receiving water bodies.

2.3.4.1 Storm Drainage System

The storm drainage system consists of either drainage swales (roadside ditches) or a curb and gutter system including inlets, piping, and outfalls. Both methods are intended to prevent flooding and potentially hazardous situations by removing water quickly from roadways. However, the efficiency and environmental impacts associated with each method are different. The curb and gutter system removes stormwater from impervious surfaces quickly and typically conveys water directly to the stream system. While the curb and gutter system removes stormwater quickly from roadways, it delivers increased runoff volumes and untreated pollutants to receiving water bodies. Drainage swales do not convey water as quickly as the curb and gutter system and the stormwater flow is somewhat reduced before entering the stream system. Drainage swales also allow some infiltration into the ground unlike the curb and gutter system; this reduces the amount of water delivered and provides some filtering of pollutants.

Curb and gutter system components in the Lower Gunpowder Falls (Urban) watershed are summarized in Table 2-11 by subwatershed. This includes an estimate of the number of major (> 3 feet in diameter) and minor (< 3 feet in diameter) storm drain outfalls and corresponding number of inlets and length of storm drain pipe. Storm drain system databases used to compile this table were created in 1992 with periodic updates according to county storm drain plans. This data provides a reasonable approximation of storm drain pipe data for this analysis and the numbers presented in Table 2-11 where pipe lengths were rounded to the nearest tens of feet. Table 2-12 provides a summary of the proportion of subwatershed area covered by the storm drain system (stormwater drainage area within subwatershed divided by total subwatershed area) and the

number of inlets per square mile for each subwatershed. Figure 2-15 shows the location of major (> 3 feet) and minor (< 3 feet) outfalls within the watershed. The subwatershed with the most storm drain system coverage is Lower Gunpowder Falls-B. This coincides with the high concentration of residential and commercial development that is present in this area. Jennifer Branch, Lower Gunpowder Falls-A, Lower Gunpowder Falls-B, and Minebank Run have the highest number of outfalls (>50 in each).

Table 2-11: Lower Gunpowder Falls (Urban) Subwatershed Storm Drain System Components

	Major Outfalls (> 3 ft diameter)			Minor Outfalls (< 3 ft diameter)			All Outfalls		
Subwatershed	Outfalls (#)	Inlets (#)	Pipes (ft)	Outfalls (#)	Inlets (#)	Pipes (ft)	Total Outfalls (#)	Total Inlets (#)	Total Pipes (ft)
Bean Run	0	0	0	9	32	2,687	9	32	2,687
Jennifer Branch	13	105	14,250	40	155	20,615	53	260	34,865
Lower Gunpowder Falls-A	11	45	8,380	43	138	16,420	54	183	24,800
Lower Gunpowder Falls-B	10	46	8,800	77	401	54,368	87	447	63,168
Lower Gunpowder Falls-C	1	4	1,065	16	44	6,065	17	48	7,130
Lower Gunpowder Falls-D	2	9	1,375	1	5	640	3	14	2,015
Minebank Run	9	38	7,675	48	219	30,294	57	257	37,969
Total	46	247	41,545	234	994	131,089	280	1,241	172,634

Note: Baltimore County is currently updating their storm drain data and although this current dataset is incomplete and in draft form, it is more accurate and complete than the County's historic storm drain data.

Table 2-12: Lower Gunpowder Falls (Urban) Subwatershed Stormwater System Coverage

Subwatershed	Stormwater System Drainage Area (acres)	% of Watershed Covered by Stormwater System	Total Inlets (#)	Inlet Density (#/sq. mi.)
Bean Run	56.1	6.1	32	22.4
Jennifer Branch	670.8	47.5	260	117.8
Lower Gunpowder Falls-A	710.6	43.4	183	71.6
Lower Gunpowder Falls-B	1,330.2	66.9	447	143.8
Lower Gunpowder Falls-C	175.8	12.9	48	22.6
Lower Gunpowder Falls-D	33.2	3.1	14	8.3
Minebank Run	723.2	33.9	257	77.0
Total	3,699.8	35.1	1,241	75.4

Note: Baltimore County is currently updating their storm drain data and although this current dataset is incomplete and in draft form, it is more accurate and complete than the County's historic storm drain data.

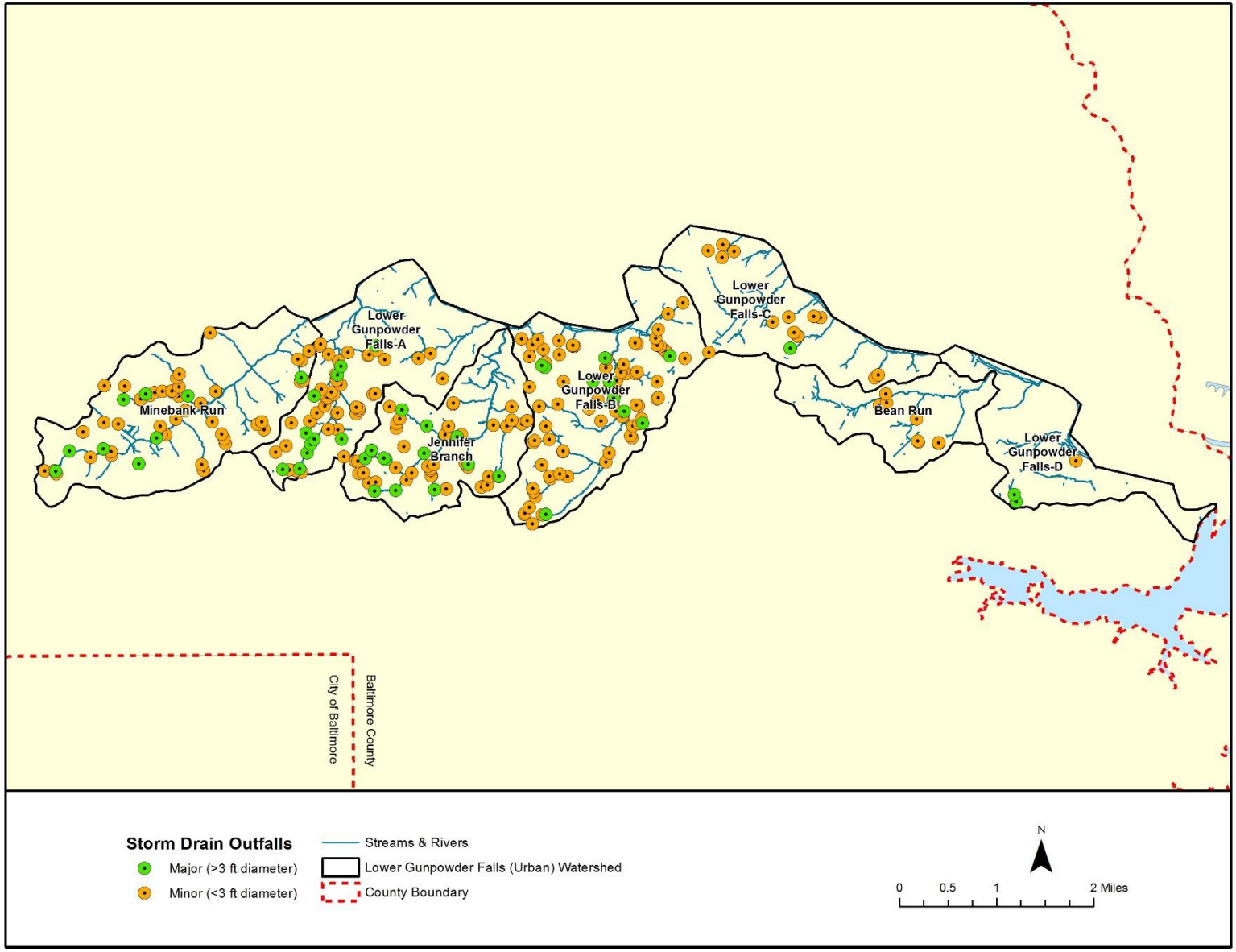


Figure 2-15: Lower Gunpowder Falls (Urban) Watershed Storm Drain Outfalls

2.3.4.2 Stormwater Management Facilities

Maryland was the first state to adopt stormwater quality regulations more than 20 years ago. Stormwater management (SWM) practices evolve as technology and research advance. It continues to be a significant consideration for new construction and re-development within the state. Management of stormwater runoff is required to reduce erosion, sedimentation, pollution, and flooding per Title 4, Subtitle 2 of the Environment Article of The Annotated Code of Maryland. Increased importance of water quality and water resource protection led to the development of the Maryland Stormwater Design Manual to provide BMP design standards and environmental incentives (MDE 2000) and a general shift toward adopting practices that mimic natural hydrologic processes, are low impact, and achieve pre-development conditions. The latter is evident in the Maryland "Stormwater Management Act of 2007," which requires that environmental site design (ESD) be implemented to the maximum extent practicable via nonstructural BMPs and/or other better site design techniques. Maryland Department of the Environment is responsible for implementing this regulation and issued an update to the Design Manual in May 2009.

There are many types of BMPs available for managing stormwater runoff and providing stormwater quality treatment. SWM can target specific objectives depending on the BMP type such as stormwater quality, soil stabilization, stormwater flow control, and stream restoration. In addition, different SWM facilities have different pollutant removal capabilities. For example, initial dry pond designs for SWM typically have low pollutant removal efficiency compared to practices that filter the stormwater or allow it to infiltrate into the ground or through plant roots. Several considerations are taken into account when selecting appropriate stormwater treatment measures such as space requirements, maintenance, cost, and community acceptance. Table 2-13 provides a summary of the different SWM facilities located within the Lower Gunpowder Falls (Urban) watershed by subwatershed including dry and wet ponds, wetlands, infiltration/filtration practices, extended detention, and proprietary BMPs. The distribution of SWM facilities throughout the watershed is illustrated in Figure 2-16.

Dry ponds, extended detention facilities, and filtration/infiltration practices are common types of SWM within the SWAP area. More acreage drains to dry ponds than any other type of SWM facility. The dry pond facilities represent the best opportunity for conversion to BMPs with higher pollutant removal capabilities. Every subwatershed has some form of SWM, though the Lower Gunpowder Falls-D subwatershed contains only three facilities. This is likely due to the fact that this subwatersheds land use/land cover is mostly forest. The proprietary BMPs in the watershed are Stormceptor devices, which remove sediment, oil and grease through hydrodynamic separation. Sediment particles and oil and grease settle out as flow circulates in a swirling path; floatable and settled debris collected in the treatment chamber are typically removed by a vacuum truck at regular intervals.

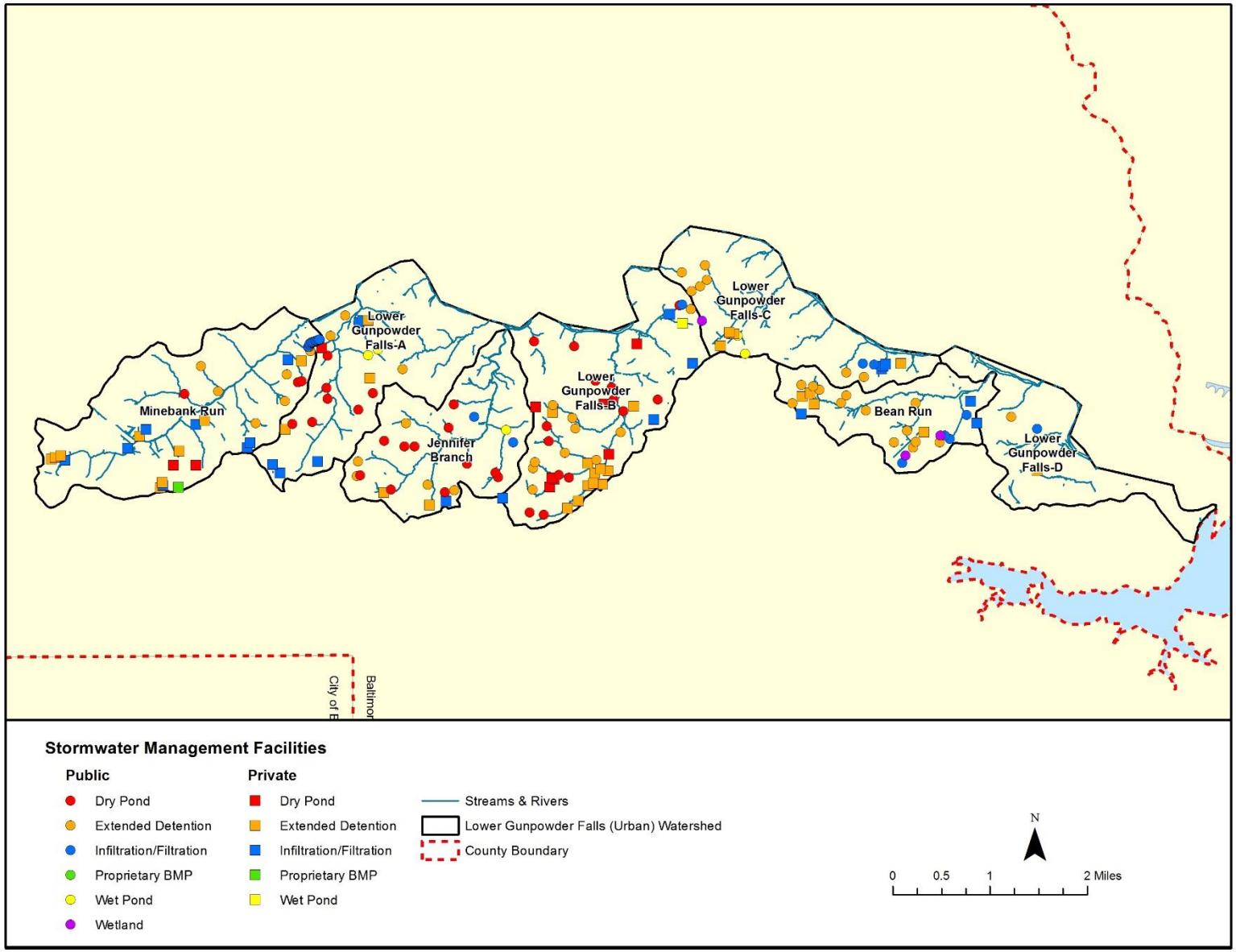


Figure 2-16: Stormwater Management Facilities in Lower Gunpowder Falls (Urban) Watershed

Table 2-13: Lower Gunpowder Falls (Urban) Stormwater Management Facilities by Subwatershed

SWM Facility Type	Subwatersheds							
	Bean Run	Jennifer Branch	Lower Gunpowder Falls-A	Lower Gunpowder Falls-B	Lower Gunpowder Falls-C	Lower Gunpowder Falls-D	Minebank Run	Total
Dry Pond (#)	0	11	8	21	0	0	5	45
Extended Detention (#)	17	7	6	21	12	2	15	80
Infiltration/Filtration (#)	7	3	7	5	5	1	26	54
Proprietary BMP (#)	0	0	0	0	0	0	1	1
Wet Pond (#)	0	1	2	1	2	0	0	6
Wetland (#)	2	0	0	0	1	0	0	3
Total (#)	26	22	23	48	20	3	47	189
Dry Pond Drainage Area (acres)	0.00	155.06	135.55	533.86	0.00	0.00	354.07	1,178.54
Extended Detention Drainage Area (acres)	294.02	29.90	28.72	159.57	72.45	26.24	151.72	762.62
Infiltration/Filtration Drainage Area (acres)	51.56	19.21	6.44	24.78	14.55	11.05	19.73	147.32
Proprietary BMP Drainage Area (acres)	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.29
Wet Pond Drainage Area (acres)	0.00	43.67	43.75	43.77	27.71	0.00	0.00	158.90
Wetland Drainage Area (acres)	18.71	0.00	0.00	0.00	2.03	0.00	0.00	20.74
Total Drainage Area (acres)	364.29	247.84	214.46	761.98	116.74	37.29	525.81	2,268.41

The total area treated by SWM and the proportion of urban area treated by SWM is summarized in Table 2-14 by subwatershed. Note that for this analysis urban land use includes the following MDP land use categories: low, medium and high residential, commercial, industrial, institutional, open urban, and transportation. Table 2-14 shows that urban land use encompasses about 63 percent of the Lower Gunpowder Falls (Urban) watershed and only 34% of that is treated by SWM practices. This indicates an opportunity to implement SWM (BMPs or treatment devices) in existing developed areas where no practices are currently in place or to retrofit facilities that are not providing adequate treatment before stormwater reaches the stream system. Refer to Section 3.7 for more details on assessed SWM facilities within the watershed.

Table 2-14: Lower Gunpowder Falls (Urban) Stormwater Management by Subwatershed

Subwatershed	Area (acres)	Urban Land Use (acres)	Area Treated by SWM (acres)	Urban Land Use Treated by SWM (%)
Bean Run	916	632	364	58
Jennifer Branch	1,412	1,091	248	23
Lower Gunpowder Falls-A	1,636	952	214	23
Lower Gunpowder Falls-B	1,990	1,551	762	49
Lower Gunpowder Falls-C	1,360	601	117	19
Lower Gunpowder Falls-D	1,082	365	37	10
Minebank Run	2,136	1,395	526	38
Total	10,533	6,587	2,268	34

2.3.5 NPDES Discharge Permits

Facilities that discharge municipal or industrial wastewater or conduct activities that can contribute pollutants to a waterway are required to obtain a National Pollutant Discharge Elimination System (NPDES) permit. The number and type of NPDES-permitted facilities within each subwatershed is summarized in Table 2-15.

As of 2014, there are currently 17 active NPDES-permitted facilities within the Lower Gunpowder Falls (Urban) watershed (Figure 2-17). These permitted facilities include the Notch Cliff Generating Stations, Richlyn Manor Wastewater Treatment Plant (WWTP), Days Cove Rubble Landfill, a bus facility, apartment complexes, several swimming pool facilities, and more. Industrial surface water discharge permits are issued for industrial facilities that discharge process water to State surface waters which must meet applicable federal effluent guidelines and/or State water quality standards.

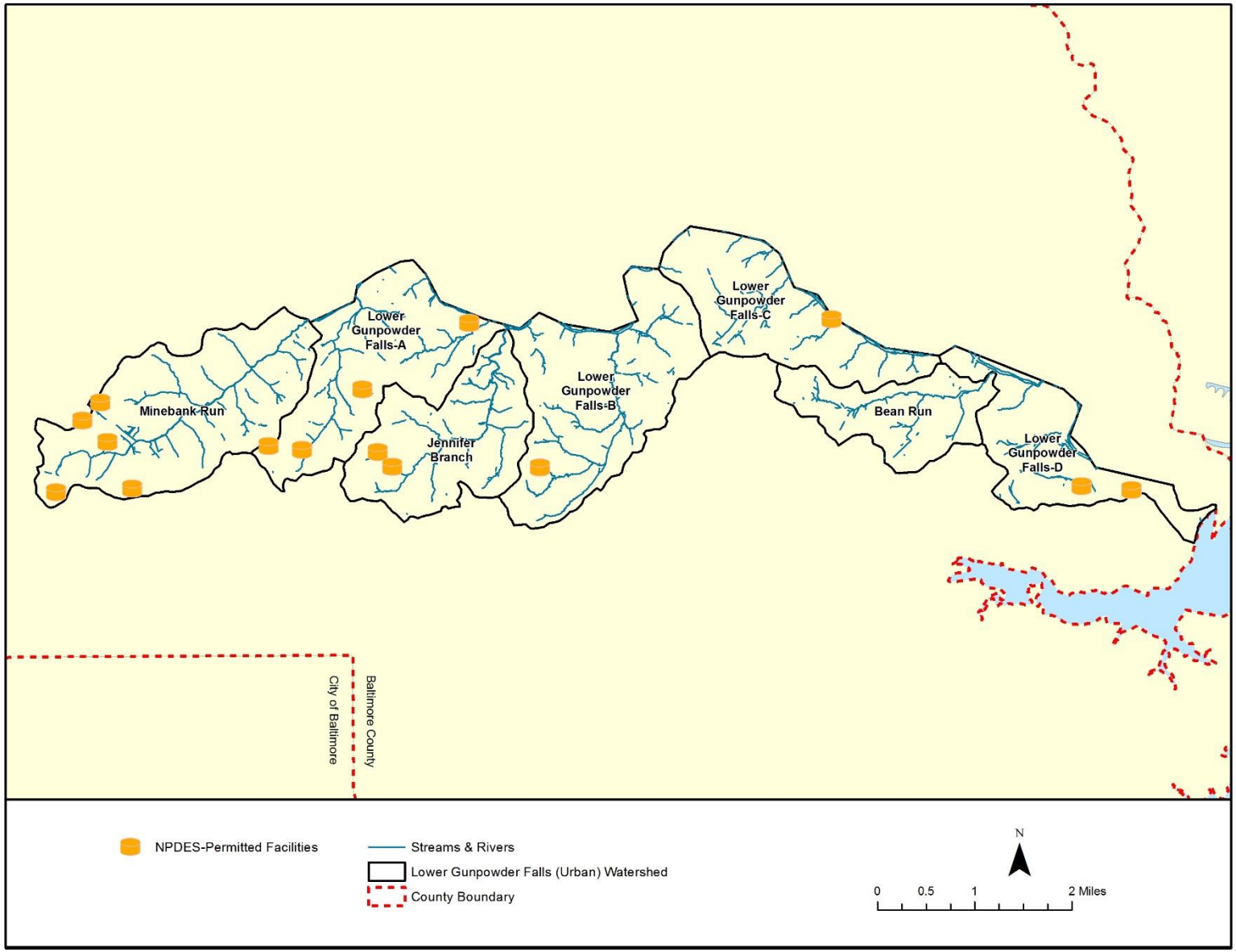


Figure 2-17: Locations of NPDES-Permitted Facilities in Lower Gunpowder Falls (Urban) Watershed

Table 2-15: NPDES-Permitted Facilities in Lower Gunpowder Falls (Urban) Subwatersheds

Subwatershed	# General Permits	# Individual Industrial Permits	# Municipal Surface Discharge Permits	# Groundwater Discharge Permits	Total # of Permits
Bean Run	0	0	0	0	0
Jennifer Branch	2	0	0	0	2
Lower Gunpowder Falls-A	4	0	0	1	5
Lower Gunpowder Falls-B	1	0	0	0	1
Lower Gunpowder Falls-C	0	0	1	0	1
Lower Gunpowder Falls-D	2	1	0	0	3
Minebank Run	5	0	0	0	5
Total	14	1	1	1	17

2.3.6 Wastewater

Wastewater created through human use must be treated and disposed. This is accomplished either through public conveyance to a treatment facility or through individual wastewater treatment systems (septic systems). Residential wastewater consists of all water typically used by residents including wash water, bathing water, human waste disposal water, and any other rinse water (paint brush, floor washing, etc.). Industrial wastewater depends on the operation and could contain various contaminants such as metals, organic compounds, detergents, or synthetic compounds. All of these types of wastewater have the potential to adversely impact the natural environment.

2.3.7 Septic Systems

Properly functioning septic systems provide treatment for nearly all of the phosphorus present in wastewater, but can leak nitrogen in the form of nitrate. Depending on the location of the system, nitrate may be reduced or eliminated through de-nitrification as the treated water passes through riparian buffers, particularly forested riparian buffers (i.e., septic systems in closer proximity to streams will generally contribute more nitrogen to local waterways). Failing systems can release nitrogen, phosphorus, and other chemicals and in turn, contaminate the aquatic environment. They can also result in increased bacterial contamination of nearby streams and therefore, potential for human health concerns. Table 2-16 summarizes the approximate number of septic systems by subwatershed; only one of the septic systems noted below lies within the Chesapeake Bay Critical Area.

Maryland requires all new construction and failing systems to have a Best Available Technology (BAT) system installed rather than a traditional septic system. BAT systems are required to remove at least 50% of total nitrogen (TN). The Bay Restoration Fund (BRF) offers grants for qualifying applicants that need a BAT systems. See the MDE Website for more information: http://www.mde.state.md.us/programs/Water/BayRestorationFund/OnsiteDisposalSystems/Pages/water/cbwrf/osds/brf_bat.aspx

Table 2-16: Lower Gunpowder Falls (Urban) Septic Systems by Subwatershed

Subwatershed	No. of Septic Systems	No. of Septic Systems within 100 ft. of a Stream
Bean Run	24	1
Jennifer Branch	69	7
Lower Gunpowder Falls-A	27	1
Lower Gunpowder Falls-B	47	0
Lower Gunpowder Falls-C	252	12
Lower Gunpowder Falls-D	10	0
Minebank Run	228	4
Total	657	25

2.3.7.1 Public Sewer

A public sewer system conveys wastewater from individual households or businesses to a facility that treats the wastewater prior to discharge. It consists of the piping system within the public right-of-way and cleanouts on individual properties. Property owners are responsible for the maintenance of the latter part of the system, their individual cleanouts. The portion of the system within the public right-of-way is owned and maintained by the local government. This includes gravity piping system, access manholes, pumping stations, and force mains. Table 2-17 summarizes the types and lengths of public sewer piping by subwatershed in the Lower Gunpowder Falls (Urban) watershed. This includes force (pressure) and gravity main lines and portions of the gravity main that have been abandoned or removed. Table 2-18 includes sewer piping density, or length per square mile, for each subwatershed.

Table 2-17: Public Sewer Piping in Lower Gunpowder Falls (Urban) Subwatersheds

Subwatershed	Pressurized Main (ft)	Pressurized Main Abandoned (ft)	Gravity Main (ft)	Gravity Main Abandoned (ft)	Total (ft)
Bean Run	3,299	5,509	88,857	66	97,731
Jennifer Branch	259	556	139,343	591	140,749
Lower Gunpowder Falls-A	0	3,037	109,381	235	112,652
Lower Gunpowder Falls-B	7,134	1,014	212,149	100	220,397
Lower Gunpowder Falls-C	9,387	0	34,329	0	43,716
Lower Gunpowder Falls-D	22,967	0	16,308	37	39,312
Minebank Run	1,625	8,357	136,164	1,866	148,012
Total	44,671	18,473	736,531	2,894	802,569

Table 2-18: Public Sewer Piping Density in Lower Gunpowder Falls (Urban) Subwatersheds

Subwatershed	Area (sq. miles)	Gravity Main (ft/sq. mi.)	Pressurized Main (ft/sq. mi.)
Bean Run	1.43	62,184	6,159
Jennifer Branch	2.21	63,319	369
Lower Gunpowder Falls-A	2.56	42,819	1,186
Lower Gunpowder Falls-B	3.11	68,247	2,620
Lower Gunpowder Falls-C	2.13	16,117	4,407
Lower Gunpowder Falls-D	1.69	9,671	13,590
Minebank Run	3.34	41,326	2,988
Total	16.46	44,923	3,836

Environmental impacts associated with public sewer are usually the result of sewage overflows. Overflows typically result from blockages within the sewage system, pumping station failure, or rainwater inflows exceeding pipe capacity. Dry weather flows can also have potential impacts due to leaks in the sewer system. Environmental concerns related to sewer overflows and leaks include high bacteria concentrations, release of nutrients, elevated turbidity (cloudiness), and low dissolved oxygen.

2.3.8 Drinking Water

Drinking water is a fundamental need for human development. It can be supplied either by public distribution systems or by wells associated with individual developed properties. Having an adequate supply of drinking water is essential to maintaining the human population in a region.

2.3.8.1 Public Water Supply

Environmental impacts associated with public supply of water include the potential for increased residential development with the associated impervious cover effects discussed in the previous section and the potential for leaks from the system. Leaks from public water supply systems introduce chlorine into the aquatic system which can result in the death of aquatic organisms. In addition, major leaks can cause erosion which contributes to the sediment load in stream channels; this can bury aquatic benthic communities and degrade habitat.

2.3.9 Zoning

According to the Baltimore County Office of Planning (2011), zoning is defined as “a system of land use regulation that controls the physical development of land and a legal mechanism by which local government is able to regulate an owner’s right to use privately owned land for the sake of protecting the public health, safety, and/or general welfare.” In other words, zoning manages development patterns over time throughout the county. The current zoning for the Lower Gunpowder Falls (Urban) watershed is shown in **Figure 2-18**. A summary of zoning category acreages and proportions within the Lower Gunpowder Falls (Urban) watershed is included in Table 2-19. As shown in the table, a variety of zoning categories are represented in the watershed however, the dominant category is residential (‘DR’ codes).

The land adjacent to the Gunpowder Falls in the Lower Gunpowder Falls-D subwatershed are zoned Resource Conservation - Critical Area. Cromwell Valley Park, and the areas of the Gunpowder Falls State Park in the western section of the watershed, are zoned Resource Conservation – Resource Preservation (Figure 2-18). Commercial and industrial zoning are mostly restricted to the southern border of the watershed.

Table 2-19: County Zoning in Lower Gunpowder Falls (Urban) Watershed

Zoning Description	Zoning Codes	Acres	% of Watershed
Business Local	BL,BLR	237.56	2.3
Business Major	BM	103.71	1.0
Business Roadside	BR	65.09	0.6
Community Business	CB	3.19	0.0
Low Density Residential	DR 1, DR 2	3,212.14	30.5
Medium Density Residential	DR 3.5, DR 5.5	3,920.71	37.2
High Density Residential	DR 10.5	35.63	0.3
Very High Density Residential	DR 16	224.58	2.1
Residential Apartment - Mid-rise	RAE 1	0.00	0.0
Manufacturing Heavy	MH	12.93	0.1
Manufacturing Light	ML	314.56	3.0
Manufacturing Light Restricted	MLR	17.80	0.2
Manufacturing Restricted	MR	5.55	0.1
Office Park	O 3	6.89	0.1
Office/Residential - High Density	OR 1	4.76	0.0
Office/Residential - Medium Density	OR 2	0.00	0.0
Office and Technology	OT	0.00	0.0
Resource Conservation - Agricultural	RC 2	830.35	7.9
Resource Conservation - Deferral of Pl. and Devel.	RC 3	0.00	0.0
Resource Conservation - Rural Residential	RC 5	87.35	0.8
Resource Conservation - Rural Cons. & Reside.	RC 6	0.00	0.0
Resource Conservation – Resource Preservation	RC 7	1,124.72	10.7
Resource Conservation - Critical Area	RC 20, RC 50	286.27	2.7
Residential Office	RO, ROA	38.63	0.4
Service Employment	SE	0.34	0.0
Total		10,532.72	100.0

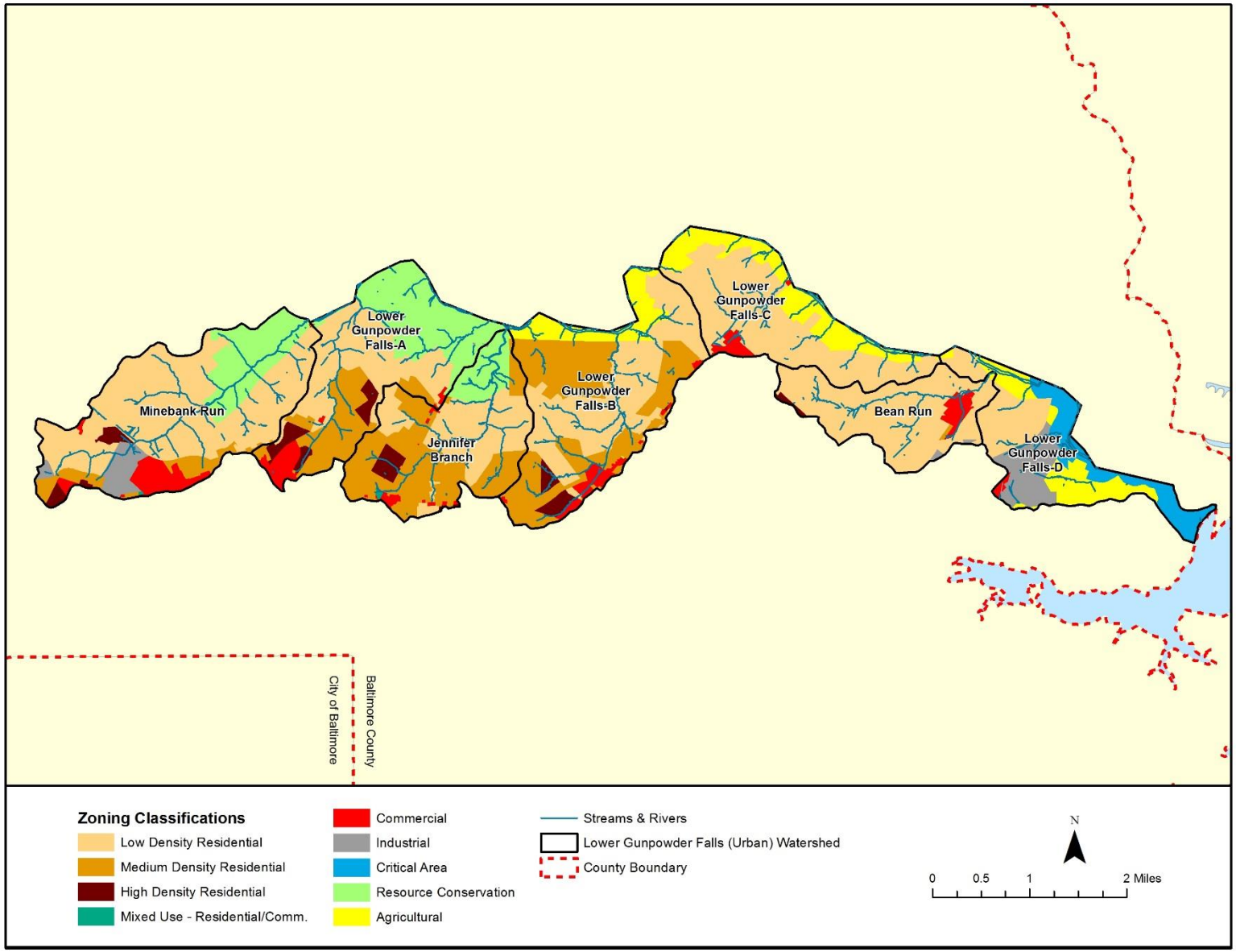


Figure 2-18: Lower Gunpowder Falls (Urban) Watershed Zoning

2.3.9.1 Coastal Rural Legacy

Baltimore County, in partnership with the Gunpowder Valley Conservancy (GVC), a watershed and local land trust organization, participates in the State's Rural Legacy Program. This program was developed in 1997 to protect large, continuous tracts of valuable cultural and natural resource lands through state grants made to local land trusts. The Coastal Rural Legacy (CRL) area, one of five state-approved rural legacy areas in Baltimore County, is among the richest in resources within the County and is the most threatened by development. The area encompasses 14,103 acres of vital wetlands, forests, marshes, farmland, and habitat along the shoreline of the Upper Western Shore of the Chesapeake Bay. 578 acres of CRL lie in the Lower Gunpowder Falls (Urban) SWAP area, all of which are within the Lower Gunpowder Falls-B subwatershed (Figure 2-19). There are currently no acres in this watershed preserved under the Rural Legacy program.

The preservation of large blocks of forest and wetland areas creates a system of environmental reserves, which is important in the protection and restoration of the Chesapeake Bay watershed. Significant progress has been made in protecting these coastal areas and if support continues, the long-term goal of protecting 11,700 acres county-wide can be achieved.

For more information, or to apply for this program, visit Baltimore County's Coastal Rural Legacy website,
http://www.baltimorecountymd.gov/Agencies/environment/landpreservation/coastalrurallegacy.html
or contact the land preservation office at 410-887-3854.

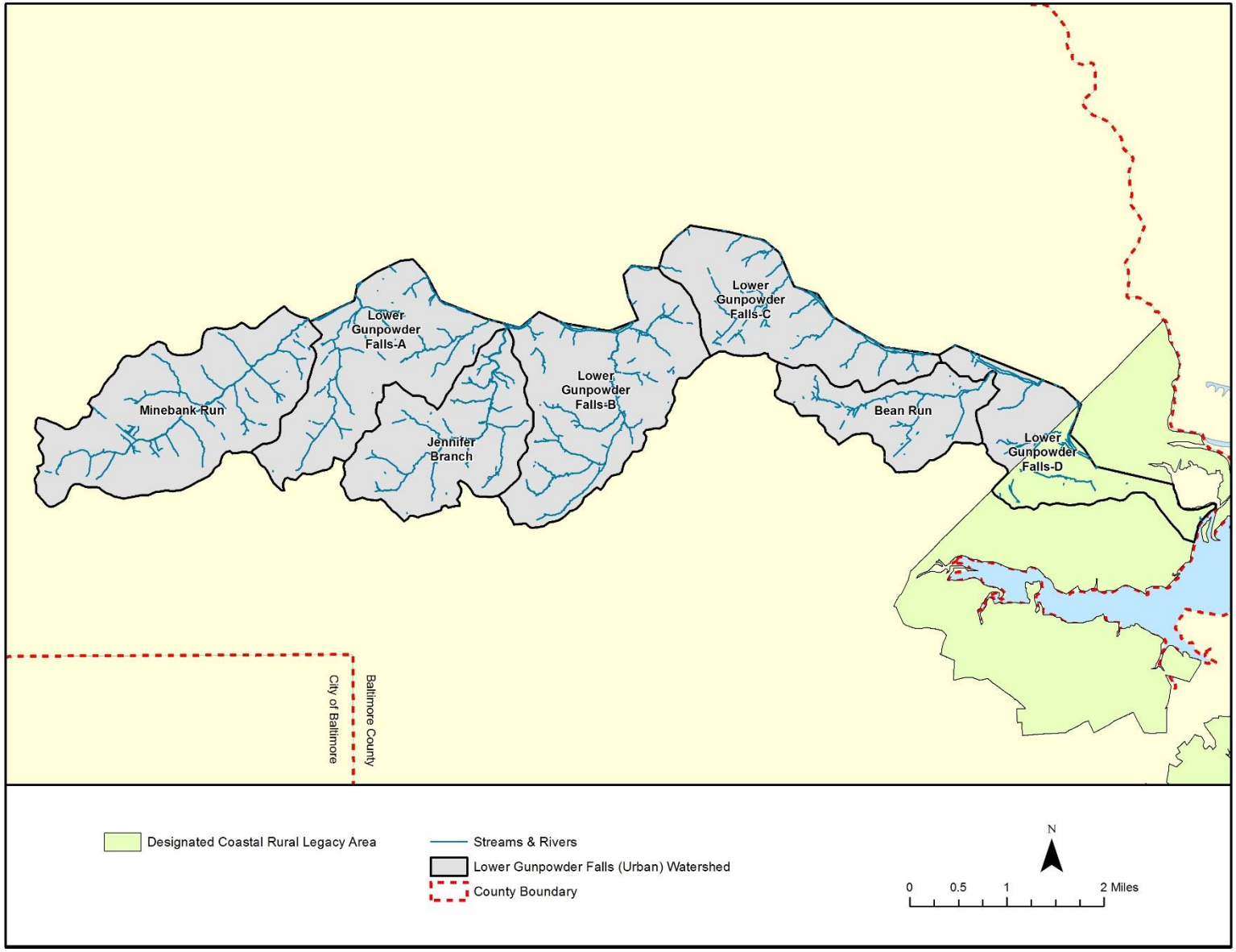


Figure 2-19: Lower Gunpowder Falls (Urban) Watershed Coastal Rural Legacy Area

CHAPTER 3: WATER QUALITY AND LIVING RESOURCES

3.1 INTRODUCTION

This chapter describes the water quality, living resources, and habitat for the Lower Gunpowder Falls (Urban) watershed based on existing conditions. In addition to water quality maintenance and improvement, the SWAP aims to provide for plants, animals, and their habitat. Natural communities require many habitat characteristics for survival. This includes land, water, and biological conditions that provide their needs for food, water, shelter, and reproduction. Water is an integral part of the habitat of all species. Living resources, including all animals and plants, require water to survive. Living resources and their habitat are intimately connected to water quality and availability. They respond to changes in water quality and habitat conditions in ways that indicate the status of water bodies and the effects of watershed characteristics and activities. In some cases, water quality is measured in terms of its ability to support living resources such as trout or shellfish. Information on living resources is presented in this chapter to indicate water quality status and to evaluate habitat conditions in the watershed. This information can help to determine if current watershed management practices are adequately providing for the needs of natural communities.

The following sections include descriptions of the following with respect to the Lower Gunpowder Falls watershed: impairments per Maryland's 303(d) listing, water quality monitoring data available to date, pollutant loadings analysis for total nitrogen and total phosphorus, sewer overflow occurrences and impacts, stream corridor assessments, and stormwater management facility assessments.

3.2 303(D) LISTINGS AND TOTAL MAXIMUM DAILY LOADS (TMDLS)

Section 303(d) of the 1972 Clean Water Act requires states to develop (and periodically update) a list of impaired waters that fail to meet applicable state water quality standards which are defined by their designated uses. States must also establish priority rankings and develop Total Maximum Daily Loads (TMDLs) for waters on the 303(d) list. According to the U.S. Environmental Protection Agency (EPA), a TMDL is a calculation of the maximum amount of a pollutant that a water body can receive and still safely meet state water quality standards. TMDLs can be developed for a single pollutant or group of pollutants of concern which generally include sediment, metals, bacteria, nutrients, and pesticides.

The Lower Gunpowder Falls has been listed as impaired in the Maryland 303(d) list of impaired waters for the following pollutants of concern: sediment, sulfates, and chloride, as well as for nutrients and sediment as part of the Chesapeake Bay TMDL.

The mainstem Lower Gunpowder Falls is designated as *Use IV: Recreational Trout Waters;* the tributary non-tidal streams (including Minebank Run, Jennifer Branch, Bean Run and several unnamed streams) in the watershed are designated as *Use I: Water Contact Recreation, and Protection of Nontidal Warmwater Aquatic Life.* The tidal portion of Lower Gunpowder River is designated as *Use II: Support of Estuarine and Marine Aquatic Life,* according to Maryland water quality standards.

Impairment listings reflect the potential inability to meet water quality standards for these designated uses. Impairment in the tidal receiving waters is related to pollutants coming from the

entire watershed; therefore, TMDLs developed for this segment will require watershed pollutant load reductions. Water Quality Assessments (WQAs) are performed to determine if the pollutant of concern is actually impairing the waters. If it is determined that the pollutant of concern is not contributing to water impairment, a report documenting the findings is submitted to EPA for concurrence. Table 3-1 summarizes the status of the various impairment listings for the Lower Gunpowder Falls.

Table 3-1: Lower Gunpowder Falls Water Quality Impairment Listings and Status

Impairment	Applicable Segment	Status	Approval Date
Nutrients, TSS	Gunpowder River, including Lower Gunpowder Falls	Impaired; the Chesapeake Bay TMDL, addressing this impairment, was finalized on 12/29/2010.	December 2010
TSS, Sulfates, Chlorides	Lower Gunpowder Falls 1st thru 4th order streams	The Biostressor analysis indicates that sediment, sulfates, and chlorides are major stressors affecting biological integrity in this watershed	2012 Listing
Channelization	Lower Gunpowder Falls 1st thru 4th order streams	The Biostressor analysis indicates that stream channelization due to urban development is a major stressor affecting biological integrity in this watershed.	2012 Listing
Heavy Metals	Lower Gunpowder Falls	WQA – water quality standard is being met	2003
Phosphorus	Lower Gunpowder Falls	WQA – water quality standard is being met	2012

As shown in the table above, the Lower Gunpowder Falls watershed has three impairment listings and two WQAs have been completed. TMDLs or WQAs will be developed at some point in the future for the TSS, Sulfate, and Chloride impairment listings. The two WQA reports that has been completed are included in Appendix H.

The Lower Gunpowder Falls was first identified on the 1996 303(d) list submitted to EPA by the Maryland Department of the Environment (MDE) as impaired by heavy metals and nutrients. All impairments are listed for the non-tidal streams. The initial listing for heavy metals was questionable because: 1) no specific pollutants were defined; 2) the original listing was based on total recoverable metals (current standard is based on dissolved metals); 3) inappropriate sampling techniques were applied (lack of filtration); 4) supporting data needed to interpret criteria was not available (hardness); and 5) a default hardness of 100 mg/L was used to convert and relate the total recoverable metals to the dissolved criteria, which superseded the total recoverable metals criteria. A WQA of heavy metals for Lower Gunpowder Falls was performed using recent water column data. Results show no impairment for heavy metals.

The Lower Gunpowder Falls Watershed was identified on the 2010 Integrated Report as impaired by nutrients (1996 listings); and impacts to biological communities—1st through 4th order streams

(2006 listing). The WQA provides an analysis of recent monitoring data to address whether or not the watershed is still impaired by nutrients. The study demonstrated that both applicable criteria for nutrients and the designated uses supported by this criteria are being met in the Lower Gunpowder Falls 8-digit basin; therefore, a nutrient TMDL is not required.

While there are no local TMDLs for Lower Gunpowder Falls, the entire watershed is subject to the Chesapeake Bay TMDL for nutrients and sediment. EPA established the Chesapeake Bay TMDL in 2010, a historic and comprehensive "pollution diet" with rigorous accountability measures to initiate sweeping actions to restore clean water in the Chesapeake Bay and the region's streams, creeks, and rivers. Concurrent with the development of the Bay TMDL, EPA charged the Bay watershed states and the District of Columbia with developing watershed implementation plans (WIPs) to provide adequate "reasonable assurance" that the jurisdictions can and will achieve the nutrient and sediment reductions necessary to implement the TMDL within their respective boundaries. Maryland's Phase II WIP provided a series of proposed strategies that will collectively meet the 2020 target (70% of the total nutrient and sediment reductions needed to meet final 2025 goals). Baltimore County's Phase I plan required reductions equivalent to retrofit of 30% of pre-1985 developed land. Phase II WIP reduction targets for the Baltimore County watershed urban areas are: 28.88% for nitrogen and 45.08% for phosphorus, both as annual average delivered loads as a reduction from 2009 progress, as reported by MDE for Stormwater Wasteload Allocations.

3.3 POLLUTANT LOADING ANALYSIS

Pollutant loading analyses are underway for each of the Maryland-designated 8-digit watersheds located entirely or in part within Baltimore County. Analyses are intended to assess the impacts of current and future development on water quality. To support these analyses, watershed-specific pollutant loading rates were derived for nitrogen, phosphorus, and sediment based on the Chesapeake Bay Program (CBP; USEPA 2010) – Watershed Model Phase 5.3.2, July 2011 model run, using specific rates from Lower Gunpowder Falls HUC8 number 02130803. The Maryland Assessment Scenario Tool (MAST) based on the CBP's model was used to develop loadings rates for all land uses except for wetlands, the rate for which was set the same as forest land cover. Pollutant loading rates for different land cover types in the Lower Gunpowder Falls and used to estimate pollutant loadings from the Lower Gunpowder Falls watershed are summarized in the Table 3-2 below.

Table 3-2: Annual Pollutant Loadings Rates for the Lower Gunpowder Falls (Urban) Watershed (lbs/acre/year)

Land Use	Nitrogen	Phosphorus	Sediment
Urban Impervious	17.40	1.51	1,947
Urban Pervious	11.50	0.24	266
Crop	9.30	0.68	683
Pasture	8.50	0.72	238
AFO/CAFO	171.60	25.09	3,874
Forest	2.80	0.04	77
Water	10.30	0.61	0
Wetlands	10.30	0.61	0
Bare Ground	32.30	5.15	10,292

As discussed in Chapter 2.3.1, land use information for the Lower Gunpowder Falls (Urban) watershed was obtained from MDP's 2010 Land Use/Land Cover (LU/LC) GIS layer. For the purposes of watershed-scale pollutant loading analyses, Baltimore County uses a consolidated version of MDP's 2010 land use classifications since loading rates do not differ significantly among certain land use classes (e.g., various forest types). The MDP LU/LC categories present in the Lower Gunpowder Falls and the corresponding Bay Model/MAST land cover classes used for the pollutant loading analyses are summarized in Table 3-3.

Consolidated land uses were used to determine the total acreage for each MAST land cover category. These were multiplied by the corresponding loading rates presented in Table 3-2. Resulting annual pollutant loads for total nitrogen, total phosphorus, and sediment from the Lower Gunpowder Falls (Urban) SWAP N watershed are summarized by land use in Table 3-4 and Table 3-5, and for the entire watershed in **Table 3-6**.

Table 3-3: Reclassification of MDP 2010 LU/LC to MAST Land Cover for Lower Gunpowder Falls (Urban) Watershed

MDP LU/LC Classification	MAST Land Cover Type
191 Very Low Density Residential (agriculture)	Urban*
192 Very Low Density Residential (forest)	Urban*
11 Low Density Residential	Urban*
12 Medium Density Residential	Urban*
13 High Density Residential	Urban*
14 Commercial	Urban*
15 Industrial	Urban*
16 Institutional	Urban*
17 Extractive	Urban*
18 Open Urban Land	Urban*
21 Cropland	Cropland
22 Pasture	Pasture
41 Deciduous Forest	Forest and Wetlands
43 Mixed Forest	Forest and Wetlands
44 Brush	Forest and Wetlands
50 Water	Water
60 Wetlands	Forest and Wetlands
73 Bare Ground	Bare Ground
80 Transportation	Urban*

* These categories were split into pervious urban and impervious urban areas using Baltimore County's roads and buildings GIS layers.

Table 3-4: Total Annual Nutrient and Sediment (Edge-of-stream) Loads by Land Use from the Lower Gunpowder Falls (Urban) Watershed (SWAP N)

		Nitrogen		Phosphorus		Sediment	
Land Use	Area (acres)	Rate (lbs/ac/yr)	Load (lbs/yr)	Rate (lbs/ac/yr)	Load (lbs/yr)	Rate (lbs/ac/yr)	Load (lbs/yr)
Urban Pervious	4,950	11.50	56,924	0.24	1,188	266	1,316,681
Urban Impervious	1,640	17.40	28,538	1.51	2,477	1947	3,193,301
Crop	477	9.30	4,439	0.68	325	683	325,976
Pasture/Orchards/Ag. Bldgs.	410	8.50	3,489	0.72	295	238	97,682
Livestock	0	171.60	0	25.09	0	3874	0
Forest	2,891	2.80	8,096	0.04	113	77	222,645
Water	10	10.30	103	0.61	6	0	0
Wetlands	0	10.30	0	0.61	0	0	0
Bare Ground	154	32.30	4,964	5.15	791	10,292	1,581,747
Totals	10,533		106,553		5,195		6,738,032

Table 3-5: Total Annual Nutrient and Sediment Loads (Edge-of-stream and Delivered) and Delivery Ratios for Urban, Agricultural and Undeveloped Land Uses

	Total Nitrogen			Total Phosphorus			Total Sediment		
Land Use	EOS Load (lbs/yr)	Delivered Load (lbs/yr)	Delivery Ratio	EOS Load (lbs/yr)	Delivered Load (lbs/yr)	Delivery Ratio	EOS Load (lbs/yr)	Delivered Load (lbs/yr)	Delivery Ratio
Urban	90,426	80,653	0.89	4,456	3,522	0.79	6,091,729	4,023,037	0.66
Agricultural	7,927	7,040	0.89	620	492	0.79	423,658	279,686	0.66
Forest/Wet-lands/Water	8,199	7,320	0.89	119	94	0.79	222,645	147,466	0.66
Totals	106,553	95,012	0.89	5,195	4,109	0.79	6,738,032	4,450,189	0.66

Table 3-6: Estimated Nutrient and Sediment Loads (sum of all land uses) from the Lower Gunpowder Falls (Urban) Watershed (SWAP N)

	Total Nitrogen	Total Phosphorus	Total Sediment
Edge-of-stream Load (lbs/yr)	106,450	5,189	6,738,032
Edge-of-stream Load (lbs/acre/yr)	10.11	0.49	640
Delivered Loads (lbs/yr)	94,921	4,104	4,450,189
Delivered Loads (lbs/acre/yr)	9.01	0.39	423

Note: Load from “Water” category is not included in edge of stream or delivered load totals.

For Lower Gunpowder Falls (Urban), loads delivered to the Chesapeake Bay from urban land uses for average annual flow totaled 94,921 lbs/year for total nitrogen, 4,104 lbs/year for total phosphorus, and 4,450,189 lbs/year for total sediment. These loads represent 89.2% percent of urban nitrogen edge-of-stream (EOS) loads, 79.1% percent of urban phosphorus EOS loads, and 66.0% percent of urban sediment EOS loads. Nutrient loadings were also calculated on a subwatershed basis using the same loading rates and land cover designations. These estimates will provide baseline nutrient loads before implementation of restoration projects and will allow a better assessment of both progress made to date and further progress needed to meet TMDL goals for urban nonpoint source reduction. Table 3-7 summarizes acreages of land cover categories by subwatershed.

The resulting annual nutrient loads (lbs/yr) for the seven subwatersheds in the Lower Gunpowder Falls area are summarized in the tables below. These tables also include nitrogen, phosphorus, and sediment loading rates (lbs/ac/yr) for each subwatershed.

Table 3-8 through **Table 3-10** show the nutrient and sediment loads generated by the subwatersheds. Subwatersheds with the greatest delivered nitrogen load per unit area are Jennifer Branch and Lower Gunpowder Falls-B, while Lower Gunpowder Falls-D generates the highest amounts of phosphorus and sediment per acre. Subwatershed pollutant loadings and rates will be used to prioritize restoration efforts. The total planning level pollutant load estimate will be used to determine necessary reductions to meet the Chesapeake Bay TMDL reductions.

Table 3-7: Lower Gunpowder Falls (Urban) SWAP Area N Land Use (acres) by Subwatershed

Land Use	Bean Run	Jennifer Branch	Lower Gunpowder Falls-A	Lower Gunpowder Falls-B	Lower Gunpowder Falls-C	Lower Gunpowder Falls-D	Minebank Run	Total
Urban Pervious	474	846	697	1,143	504	278	1,008	4,950
Urban Impervious	158	248	255	408	97	87	387	1,640
Crop	60	3	58	34	132	63	127	477
Pasture/Orchards/Ag Build.	9	35	148	14	41	23	141	410
Livestock	0	0	0	0	0	0	0	0
Forest	207	282	478	390	586	476	472	2,891
Water	0	0	0	0	0	9	1	10
Wetlands	0	0	0	0	0	0	0	0
Bare Ground	8	0	0	0	0	145	0	154
Totals	916	1,412	1,636	1,990	1,360	1,082	2,136	10,533

Table 3-8: Lower Gunpowder Falls (Urban) SWAP Area N Annual Nitrogen Loads by Subwatershed

Subwatershed	Total Area (acres)	Annual Nitrogen Loads by Land Cover (lbs/yr)									Edge-of-stream		Delivered	
		Imper-vious Urban	Per-vious Urban	Crop-land	Pasture/ Orchards/ Ag Buildings	Live-stock	Forest	Water*	Wet-lands	Bare Ground	Total (lbs/yr)	Total (lbs/acre /yr)	Total (lbs/yr)	Total (lbs/acre /yr)
Bean Run	916	2,751	5,449	555	79	0	579	0	0	272	9,685	10.57	8,639	9.43
Jennifer Branch	1,412	4,311	9,724	27	293	0	789	0	0	0	15,144	10.72	13,512	9.57
Lower Gunpowder Falls-A	1,636	4,431	8,013	542	1,259	0	1,340	1	0	0	15,585	9.52	13,890	8.49
Lower Gunpowder Falls-B	1,990	7,100	13,147	320	116	0	1,093	0	0	0	21,776	10.94	19,423	9.76
Lower Gunpowder Falls-C	1,360	1,690	5,801	1,227	345	0	1,642	0	0	0	10,705	7.87	9,557	7.02
Lower Gunpowder Falls-D	1,082	1,513	3,198	590	197	0	1,332	95	0	4,692	11,522	10.65	10,262	9.49
Minebank Run	2,136	6,741	11,592	1,178	1,199	0	1,322	7	0	0	22,032	10.31	19,638	9.19
Total	10,533	28,538	56,924	4,439	3,489	0	8,096	103	0	4,964	106,450	10.11	94,921	9.01

* Load from “Water” category is not included in edge of stream or delivered load totals.

Table 3-9: Lower Gunpowder Falls (Urban) SWAP Area N Annual Phosphorus Loads by Subwatershed

Subwatershed	Total Area (acres)	Annual Phosphorus Loads by Land Cover (lbs/yr)									Edge-of-stream		Delivered	
		Imper-vious Urban	Per-vious Urban	Crop-land	Pasture/ Orchards/ Ag Buildings	Live-stock	Forest	Water*	Wet-lands	Bare Ground	Total (lbs/yr)	Total (lbs/acre /yr)	Total (lbs/yr)	Total (lbs/acre /yr)
Bean Run	916	239	114	41	7	0	8	0	0	43	451	0.49	357	0.39
Jennifer Branch	1,412	374	203	2	25	0	11	0	0	0	615	0.44	485	0.34
Lower Gunpowder Falls-A	1,636	385	167	40	106	0	19	0	0	0	716	0.44	567	0.35
Lower Gunpowder Falls-B	1,990	616	274	23	10	0	15	0	0	0	939	0.47	742	0.37
Lower Gunpowder Falls-C	1,360	147	121	90	29	0	23	0	0	0	410	0.30	323	0.24
Lower Gunpowder Falls-D	1,082	131	67	43	17	0	19	6	0	748	1,025	0.95	813	0.75
Minebank Run	2,136	585	242	86	101	0	18	0	0	0	1,033	0.48	817	0.38
Total	10,533	2,477	1,188	325	295	0	113	6	0	791	5,189	0.49	4,104	0.39

* Load from “Water” category is not included in edge of stream or delivered load totals.

Table 3-10: Lower Gunpowder Falls (Urban) SWAP Area N Annual Sediment Loads by Subwatershed

Subwatershed	Total Area (acres)	Annual Sediment Loads by Land Cover (lbs/yr)									Edge-of-stream		Delivered	
		Imper-vious Urban	Pervious Urban	Crop-land	Pasture/ Orchards/ Ag Buildings	Live-stock	Forest	Water*	Wetlands	Bare Ground	Total (lbs/yr)	Total (lbs/ acre/ yr)	Total (lbs/yr)	Total (lbs/acre/ yr)
Bean Run	916	307,780	126,046	40,788	2,204	0	15,930	86,609	579,357	632	382,649	418	916	307,780
Jennifer Branch	1,412	482,425	224,911	1,949	8,212	0	21,693	0	739,189	523	488,281	346	1,412	482,425
Lower Gunpowder Falls-A	1,636	495,847	185,352	39,811	35,245	0	36,844	0	793,099	485	523,834	320	1,636	495,847
Lower Gunpowder Falls-B	1,990	794,480	304,100	23,500	3,253	0	30,056	0	1,155,389	581	763,128	384	1,990	794,480
Lower Gunpowder Falls-C	1,360	189,146	134,179	90,099	9,667	0	45,147	0	468,239	344	309,389	227	1,360	189,146
Lower Gunpowder Falls-D	1,082	169,343	73,967	43,319	5,521	0	36,617	1,495,138	1,823,905	1,686	1,204,327	1,113	1,082	169,343
Minebank Run	2,136	754,281	268,125	86,510	33,579	0	36,358	0	1,178,854	552	778,581	365	2,136	754,281
Total	10,533	3,193,301	1,316,681	325,976	97,682	0	222,645	1,581,747	6,738,032	640	4,450,189	423	10,533	3,193,301

* Load from “Water” category is not included in edge of stream or delivered load totals.

3.4 WATER QUALITY MONITORING DATA

Baltimore County conducts chemical, biological, and illicit connection monitoring within the Lower Gunpowder Falls (Urban) watershed. Section 3.4.1 summarizes the chemical data available for Lower Gunpowder Falls and Section 3.4.2 summarizes the biological monitoring program. Section 3.4.3 discusses the illicit connection program.

3.4.1 Chemical Data

Various chemical monitoring data are available for the Lower Gunpowder Falls, including a program administered by Baltimore County. Chemical water quality data available to date in the watershed are summarized in the following sections.

3.4.1.1 County Trend Chemical Monitoring Program

From 1999-2010 Baltimore County maintained a baseflow monitoring program that evolved several times over the years (EPS 2013). In 1999, sampling targeted the Lower Gunpowder, Little Gunpowder, Middle River, and Baltimore Harbor watersheds, as these areas had Water Quality Management plans under development at that time. In the fall of 2000, baseflow monitoring shifted to the Back River, Jones Falls, and Gwynns Falls watersheds. The program was re-designed in 2003, and through 2010, baseflows were monitored in the Patapsco/Back River Basin in odd-numbered years and in the Gunpowder/Deer Creek Basin in even-numbered years.

In January 2011, Baltimore County's baseflow monitoring program was replaced with a water quality trend monitoring program. The trend monitoring program observes ambient chemical conditions and determines trends in chemical concentrations and pollutant loads over time. This data is used to determine areas to target restoration, assess the impact of implemented restoration activities, and determine the amount of progress made towards meeting TMDLs and other restoration goals. Forty monitoring sites are visited on the same day, once per month. One of those trend sites, GU08, is within the Lower Gunpowder Falls (Urban) watershed, and is located on Minebank Run near Cromwell Bridge Road (Figure 3-1). Trend chemical monitoring results collected for these sites are summarized in Table 3-11.

Water quality parameters measured as part of the County's trend monitoring program include total suspended solids (TSS), nutrients, metals, and chloride. The importance of each of these parameters is briefly described below.

- Suspended Solids: Excessive suspended solids in water bodies can adversely impact aquatic life as it affects the light available for photosynthesis by plants and visual capacity of aquatic life. Decreased light can lead to an increase in algae communities and resulting decrease in abundance and diversity of invertebrate and fish communities. Excessive sediment can also negatively affect habitat structure, by filling in the niche spaces used by organisms for feeding and protection from predators.

- Nutrients: As discussed previously, over-enrichment of water bodies by excessive nutrient input can cause excessive algal growth and bacterial consumption of dissolved oxygen when the algae decompose. This can lead to significant reductions in water quality, as well as abundance and diversity of aquatic life communities.

- Metals: Metals are a concern because they may dissolve in water and are easily absorbed by aquatic organisms such as fish. Even low concentrations of metals in water bodies can be toxic to aquatic life and human health. While metals may not directly kill organisms, they may adversely affect an organism's health and interfere with growth and reproduction.

- Chloride: Chlorides come from various sources such as agricultural runoff, waste water, and road salting. High levels of chlorides can be toxic to aquatic communities including fish.

Table 3-11: Lower Gunpowder Falls Trend Monitoring Results at Site GU08 (mg/l)

Date	TKN	TSS	NO_2	NO_3	NO_2+ NO_3	TP	CD	CU	PB	ZN	CL
1/14/2014	0.54	73	0.05	1.48	1.53	0.180	0.0005	0.0040	0.0020	0.023	298.12
2/11/2014	0.29	5	0.05	2.00	2.05	0.025	0.0005	0.0005	0.0005	0.008	439.90
3/18/2014	0.32	17	3.57	1.91	5.48	0.025	0.0005	0.0005	0.0005	0.002	1217.62
4/8/2014	0.32	0.5	0.05	2.12	2.17	0.025	0.0005	0.0005	0.0005	0.004	257.72
5/13/2014	0.28	7	0.05	1.76	1.81	0.025	0.0005	0.0005	0.0005	0.001	201.87
6/10/2014	0.10	3	0.74	1.61	2.35	0.025	0.0005	0.0010	0.0005	0.004	210.64
7/8/2014	0.26	1	0.05	1.27	1.32	0.025	0.0005	0.0040	0.0005	0.016	203.69
8/12/2014	0.45	90	0.05	0.28	0.33	0.100	N/A	N/A	N/A	N/A	16.38
9/9/2014	0.30	3	0.05	0.97	1.02	0.025	0.0005	0.0010	0.0005	0.007	174.05
10/14/2014	0.27	7	0.05	0.95	1.00	0.025	N/A	N/A	N/A	N/A	140.47
11/12/2014	0.32	8	0.05	0.95	1.00	0.025	N/A	N/A	N/A	N/A	181.65
12/16/2014	0.28	10	0.05	1.30	1.35	0.025	0.0005	0.0005	0.0005	0.001	158.93
Min	0.10	1	0.05	0.28	0.33	0.025	0.0005	0.0005	0.0005	0.001	16.38
Max	0.54	90	3.57	2.12	5.69	0.180	0.0005	0.0040	0.0020	0.023	1217.62
Median	0.30	7	0.05	1.39	1.44	0.025	0.0005	0.0005	0.0005	0.004	202.78

Most of the streams within the Lower Gunpowder Falls (Urban) watershed have a Class I Use designation, defined as water contact recreation, fishing, and protection of aquatic life and wildlife. Per COMAR, it is subject to toxic substance criteria established for ambient surface waters, pertaining to aquatic life in fresh water. The mainstem Gunpowder Falls is designated Class IV Use Recreational Trout Waters. EPA National Recommended Water Quality Criteria (USEPA 2014) and reporting limits for measured water quality parameters in Lower Gunpowder Falls are summarized in Table 3-12

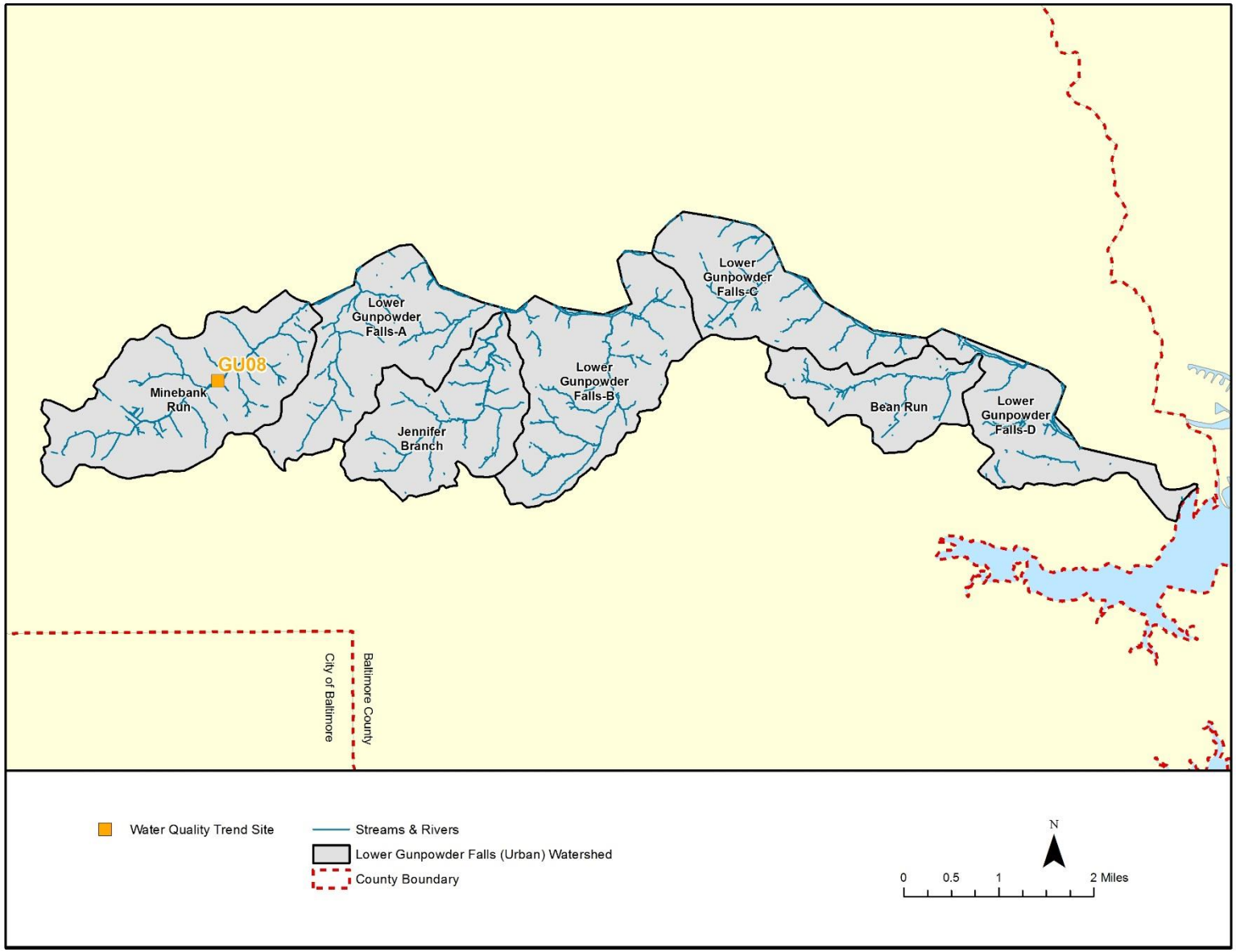


Figure 3-1: Baltimore County Trend Monitoring Locations in Lower Gunpowder Falls (Urban) Watershed

Table 3-12: Numeric Water Quality Criteria and Report Limits (mg/l)

Parameter	CMC (acute)	CCC (chronic)	Reporting Limit
Suspended Solids	N/A	N/A	1
Total Phosphorus	N/A	N/A	0.02
Total Nitrogen	N/A	N/A	0.2
Cadmium	0.002	0.0025	0.0001
Copper	0.013	0.009	0.001
Lead	0.065	0.0025	0.001
Zinc	0.12	0.12	0.001
Chloride	860	230	-

CMC: Criteria Maximum Concentration is an estimate of the highest concentration to which an aquatic community can be exposed briefly without resulting in an unacceptable effect.
CCC: Criterion Continuous Concentration is an estimate of the highest concentration to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect.

3.4.1.2 Upper Western Shore Tributary Strategy Data

To help achieve Maryland's portion of the reductions in nitrogen, phosphorus and sediment to the Chesapeake Bay, a Tributary Strategy Team was created in 1995 for each of the 10 basins that make up the Chesapeake Bay, including the Upper Western Shore Basin, of which the Lower Gunpowder Falls (Urban) watershed is a part. Each Team consists of local citizens, farmers, business leaders, and state and local government officials appointed by the Governor. The Teams help implement pollution prevention measures and to support local water quality programs including water quality monitoring. To assist the Tributary Team, Maryland DNR documented Upper Western Shore basin characteristics including available water quality monitoring results in their report, Maryland Tributary Strategy Upper Western Shore Basin Summary Report for 1985-2005 Data (DNR 2007).

Water quality parameters including nitrogen, phosphorus, chlorophyll-a (algal abundance), total suspended solids, water clarity and dissolved oxygen are measured at three long-term tidal monitoring stations in the Upper Western Shore Basin, one of which (Station WT2.1) is located on the Gunpowder River, near the mouth of the Gunpowder Falls mainstem (Figure 3-2). Results are assigned a current status of good, fair or poor relative to baseline data or scientifically based benchmarks (e.g., applicable state thresholds) depending on the parameter. For example, concentrations of dissolved oxygen (DO) are compared to ecologically meaningful thresholds available: good (DO > 5 mg/L); fair (DO = 2-5 mg/L); and poor (DO < 2 mg/L). Since scientific benchmarks are not available for the remaining parameters, a Chesapeake Bay-wide scale was developed for each parameter based on salinity zone. All data available for the Chesapeake Bay between 1985 and 1990 were used to establish a baseline for rating water quality at each station. Three cutoff points were derived to define good, fair, and poor ratings from a cumulative logistic function for the monthly medians of the baseline data. Monthly medians from the most recent data set (2003-2005) at a given station are compared to these cutoff points to establish water quality status ratings. Water quality ratings are indicators relative to similar stations in the Chesapeake Bay during the baseline time period (1985-1990); therefore, a good rating does not necessarily reflect levels needed to sustain healthy living resource populations. Refer to the following link for more details regarding water quality analysis:
http://www.dnr.state.md.us/Bay/tribstrat/status_trends_methods.html

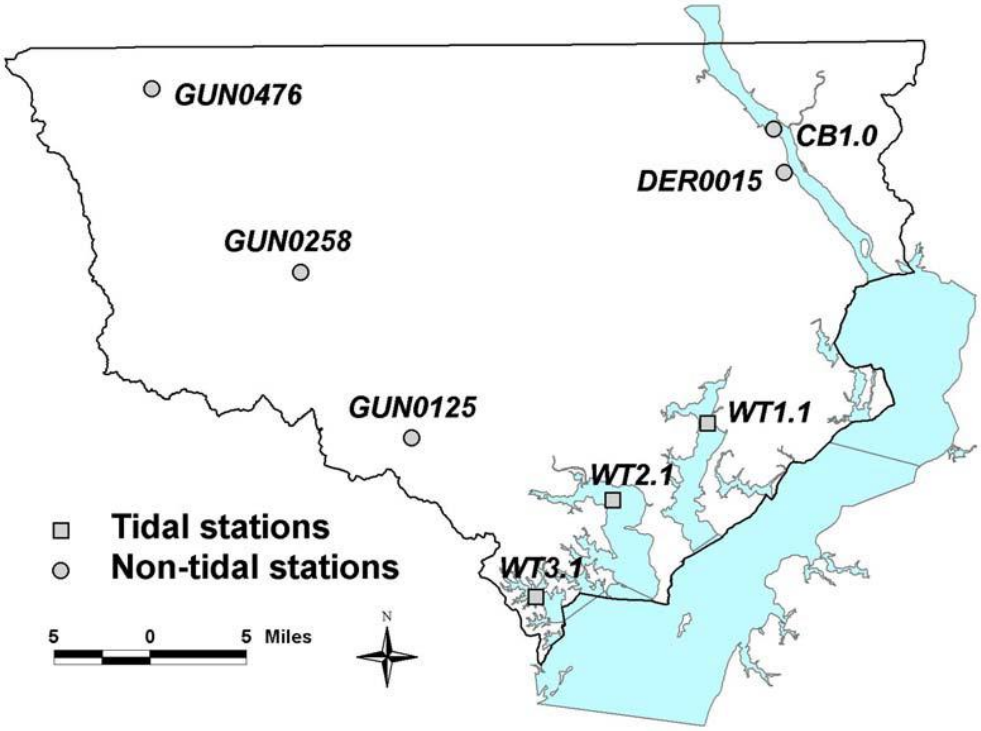
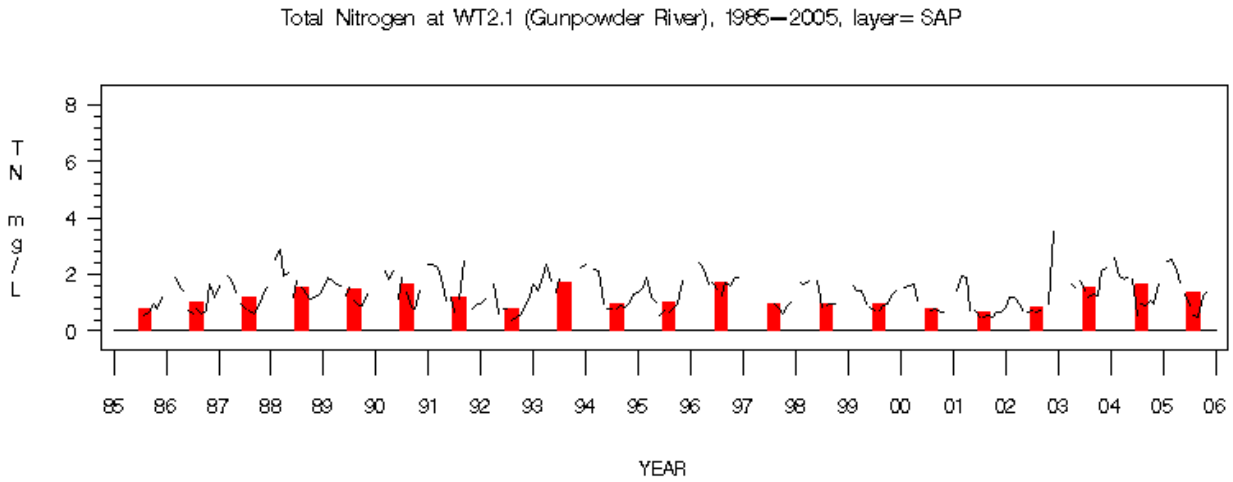


Figure 3-2: Location of Maryland DNR's Long-Term Fixed Monitoring Stations (figure from DNR 2007)

Figure 3-3, Figure 3-4, and Figure 3-5 show the water quality monitoring results reported by Maryland DNR for Gunpowder River (Station WT2.1 in Figure 3-2) during the period 1985-2005. Note that the black lines on each graph denote concentrations for each sampling date; annual medians of these values are shown as red bars. Total nitrogen concentrations ranged from as high as 4 mg/l in 2003 to as low as 0.5 mg/l in 1992. Total phosphorus concentrations ranged from approximately 0.01 mg/l to 0.28 mg/l with a general decreasing trend in more recent years, and fewer high spikes. Chlorophyll concentrations were as high as 125 µg/l in 1990, and continued to spike periodically through the years, though concentrations overall are decreasing and have been less extreme since the mid-1990's. Total suspended solids concentrations have frequently spiked to above 50 mg/l at this location. While spikes in TSS continued to be a pattern at this location, their frequency has decreased since 1995. Water clarity was measured in terms of Secchi depth or the depth of water transparency. Water clarity was generally consistent from 1985 to 2005, while the Secchi depth varied from 0.5-1.0 meters, seasonally. Dissolved oxygen was not generally a problem at this location with values rarely sinking below 5 mg/l, the concentration known to be necessary for many aquatic organisms. For more information, please refer to the Maryland Tributary Strategy Upper Western Shore Basin Summary Report for 1985-2005 Data (DNR 2007).



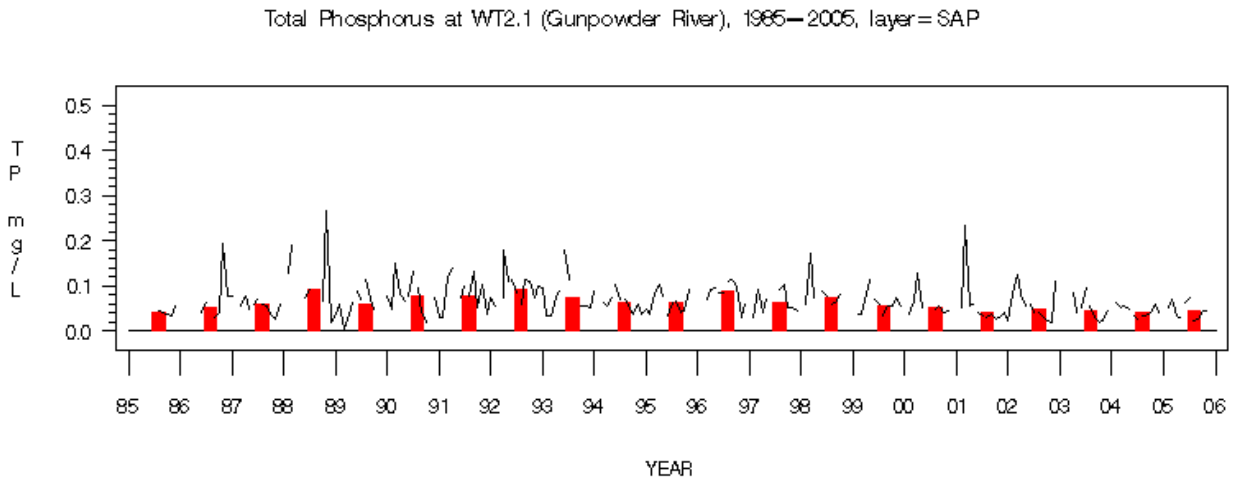


Figure 3-3: Total Nitrogen and Phosphorus Tidal Monitoring Results in Gunpowder River

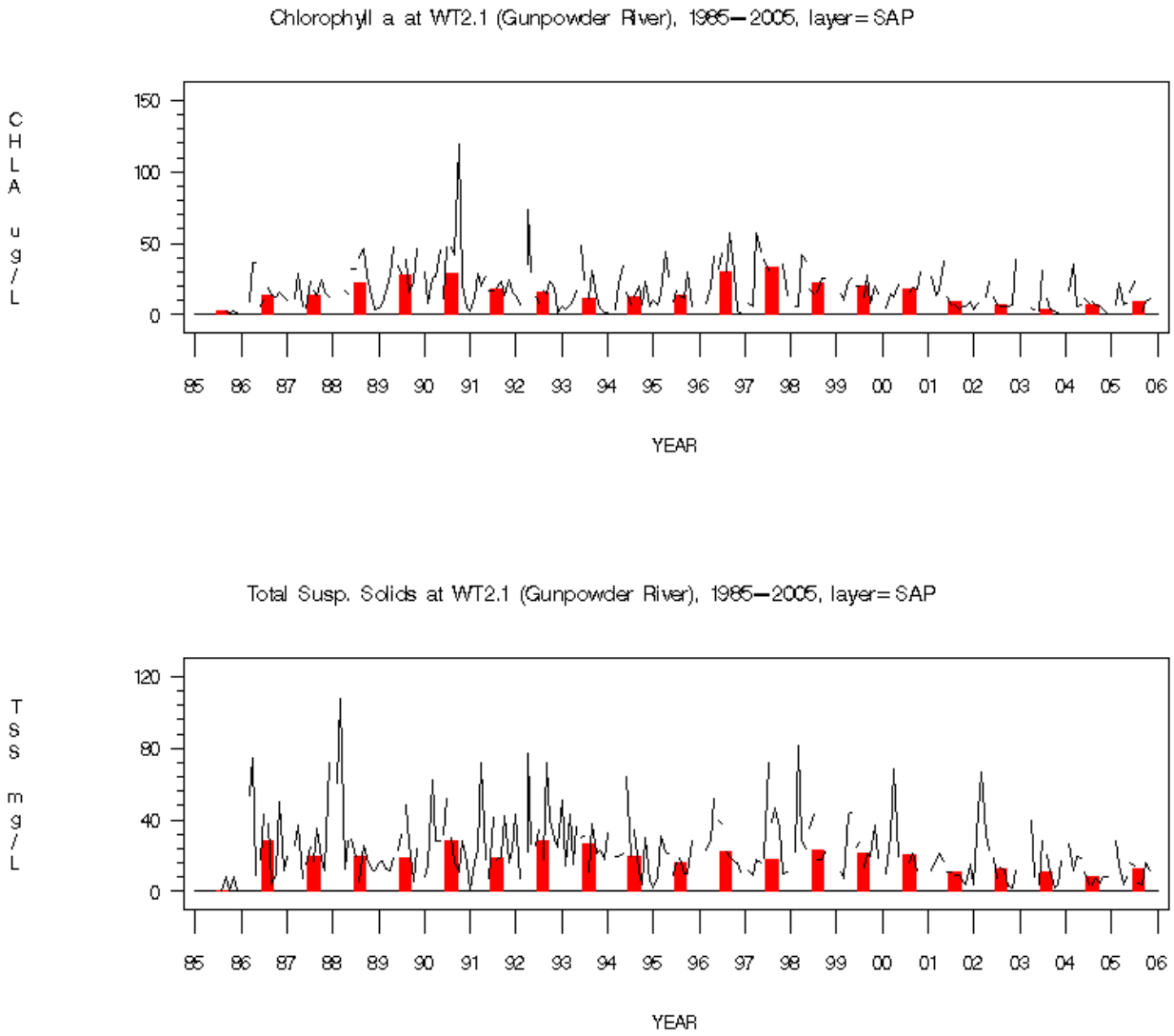


Figure 3-4: Chlorophyll-a and Total Suspended Solids Tidal Monitoring Results in Gunpowder River

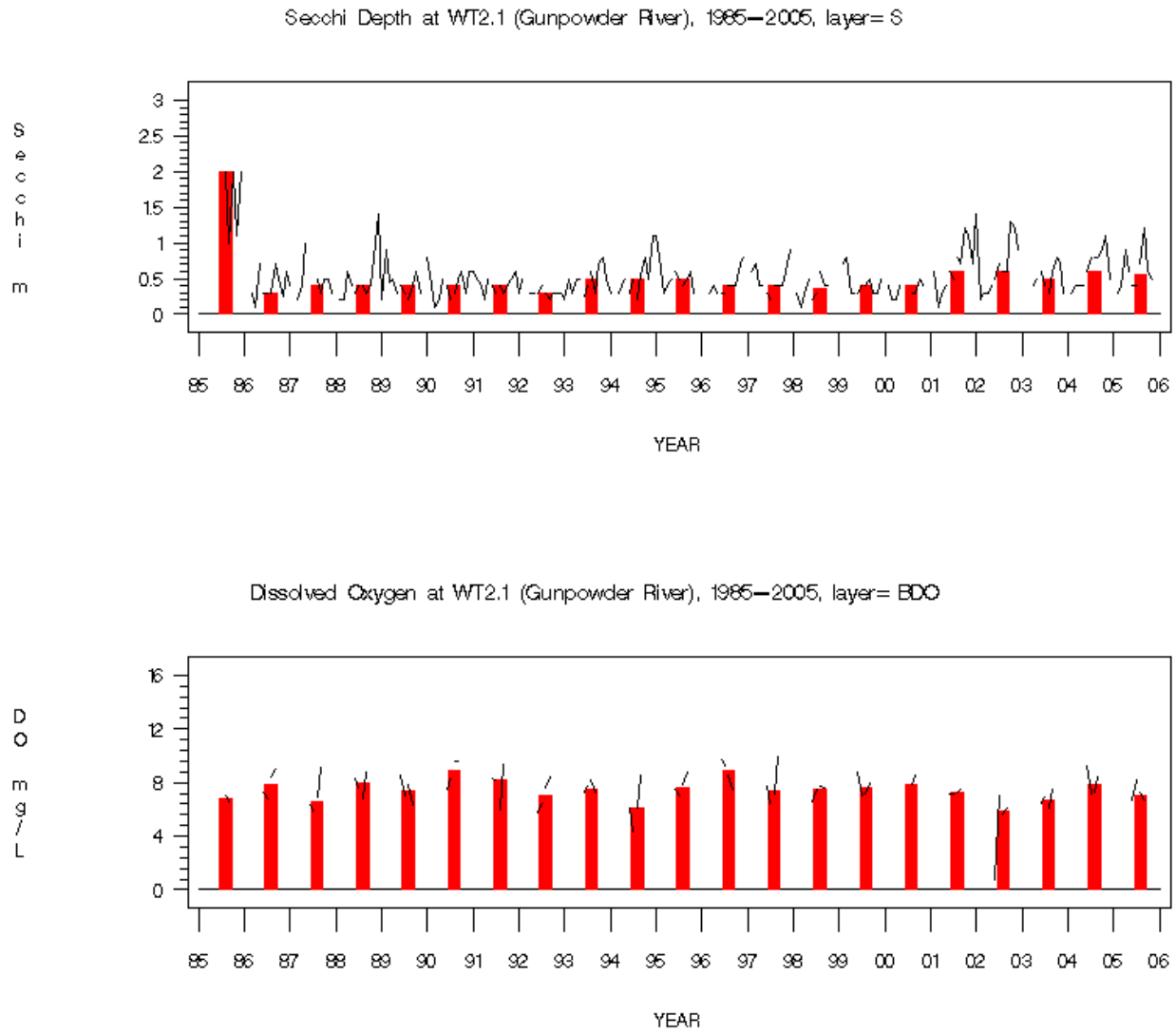


Figure 3-5: Water Clarity and Dissolved Oxygen Tidal Monitoring Results in Gunpowder River

3.4.2 Biological Data

Baltimore County conducts biological monitoring of benthic macroinvertebrates on an annual basis using the Maryland Biological Stream Survey (MBSS) protocols (Stranko 2007). The MBSS is a random-site design stream sampling program that was initiated by the Maryland DNR in 1993. It is intended to provide unbiased, statewide and watershed estimates of the biological resources in streams and rivers.

Benthic macroinvertebrates are organisms without a backbone that live on the bottom of streams and can be seen with the naked eye. They are an important part of stream ecosystems as they are a source of food for other aquatic life, including fish. The presence, numbers, and types of benthic macroinvertebrates also convey information about a water body's quality. Results of the MBSS protocol include a benthic Index of Biological Integrity (BIBI) score based on the benthic community at a sampling site. Qualitative ratings of stream biological integrity are based on IBI scores and range from good (4.0 – 5.0), denoting minimally impacted conditions, to very poor (1.0 – 1.9), indicating severe degradation.

Sites for the Baltimore County biological sampling program are randomly selected, focusing on the Patapsco/Back River Basin in odd years and the Gunpowder/Deer Creek Basin in even years. Between 2004 and 2014, 23 sites were sampled in the Lower Gunpowder Falls (Urban) watershed by Baltimore County. Figure 3-6 shows the distribution of sites, as well as their BIBI narrative ratings. The majority of sites received ratings of Poor or Very Poor. In addition to data collected by the County, Maryland DNR sampled six random sites in the watershed through the MBSS program (Figure 3-7). The DNR data were in agreement with the County data, and no sites were rated above the Poor category, using the BIBI.

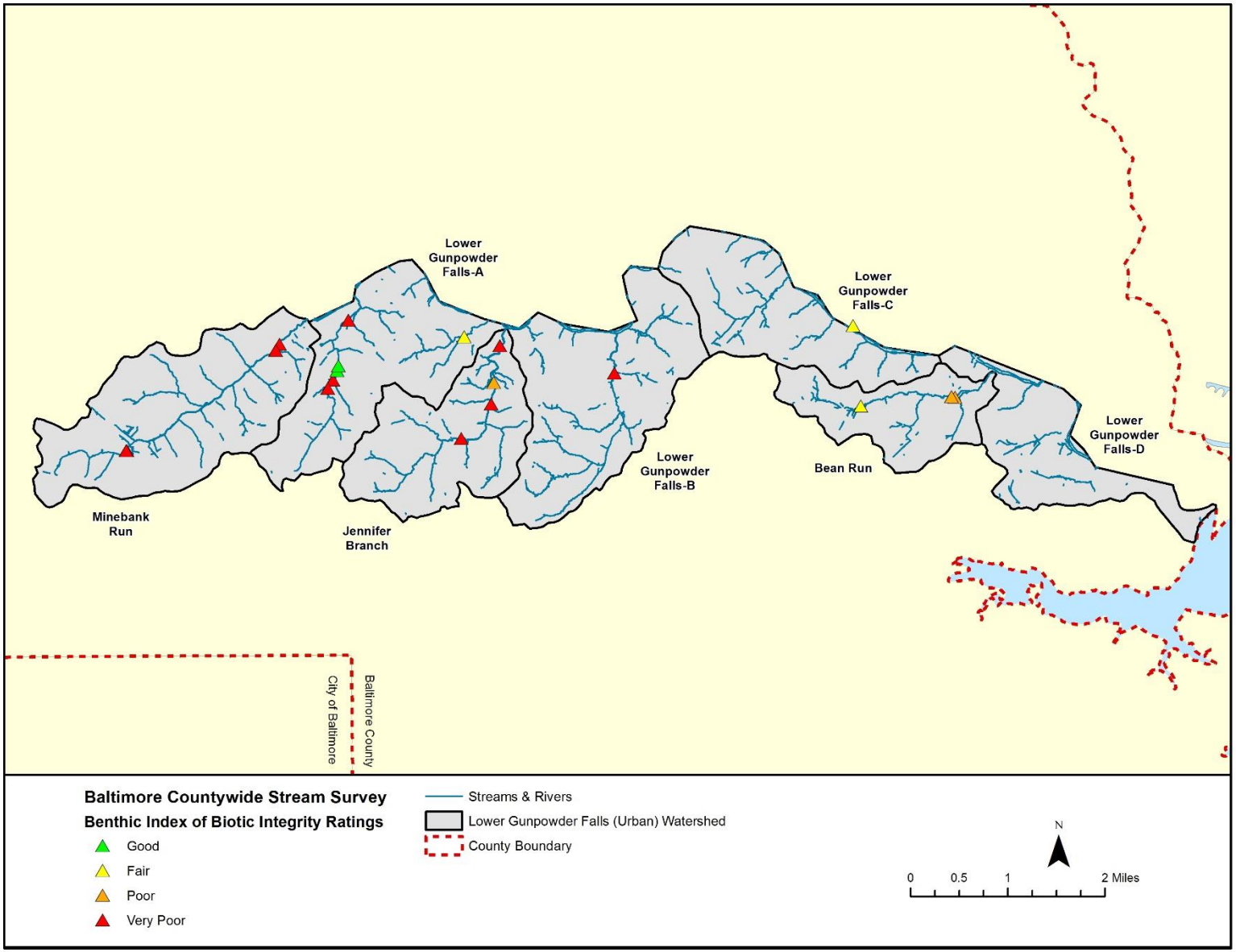


Figure 3-6: Results at Locations Sampled by Baltimore County in Lower Gunpowder Falls (Urban) Watershed (2004-2014)

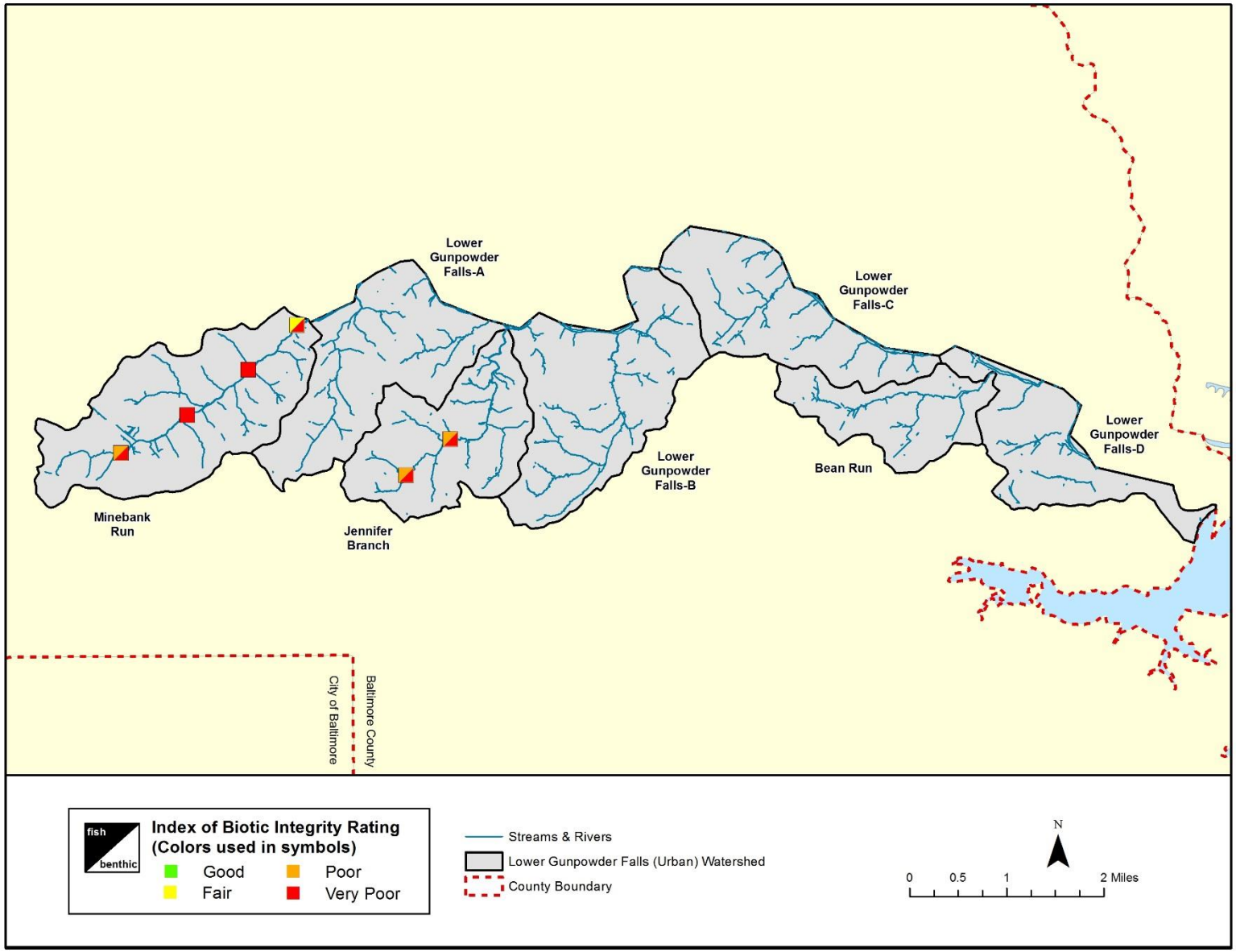


Figure 3-7: Results at Monitoring Locations Sampled by the Maryland Biological Stream Survey (1995-2014)

3.4.3 Illicit Discharge and Elimination Data

Baltimore County tracks illicit discharges through a program of routine outfall screening. The program consists of three parts:

1. A quantitative analysis of the effluent that includes measuring the effluent flow rate, temperature and pH, and field testing for parts per million (ppm) of chlorine, phenols, ammonia, boron, fluorides, and copper using a specially configured LaMotte NPDES test kit;
2. A qualitative assessment of the effluent, outfall structure, and receiving channel, noting conditions such as water color, odor, vegetative condition, sedimentation, erosion, damage, etc.; and
3. A visual inspection of each outfall that identifies any structural damage.

The County has an outfall prioritization system based on data from the outfall screening. There are approximately 280 outfalls in Lower Gunpowder Falls (Urban) watershed. About 84 percent (234) of these are minor outfalls (less than 3 feet in diameter). The remaining 46 outfalls are classified as major (greater than 3 feet in diameter); 37 of these have a prioritization rating (Table 3-13; Figure 3-8). The prioritization system allows for a more streamlined approach in selecting outfalls to screen and provides a more efficient use of manpower.

Under that outfall prioritization system, major outfalls that have not been screened at least three times are not prioritized. Outfalls that are inaccessible are removed from the database. Prioritized major outfalls, those screened three or more times, are assigned one of the following priority ratings:

- Priority 0 (Not Prioritized): Outfalls with insufficient data to determine a priority rating. This may be due to the outfall only having been screened once.

- Priority 1 (Critical): Outfalls with major problems that require immediate correction and/or close monitoring, or outfalls with recurring problems. These outfalls are sampled four times each year.

- Priority 2 (High): Outfalls with moderate to minor problems that have the potential to become severe. These outfalls are sampled once a year.

- Priority 3 (Low): Outfalls with minor or no problems that do not require close monitoring. These outfalls are sampled on a 10-year cycle.

A second screening is conducted if nearly a decade has passed since the previous screening.
If no pollution problems were indicated, then the outfall is considered a low priority. This allows more focus on outfalls with greater potential of an illicit connection. A second screening is also performed at an outfall when prior screening indicates that one or more of the water quality criteria were exceeded. The second screening helps determine whether the pollutant is a persistent constituent of the effluent or simply an anomaly. No remedial action is taken if the second screening indicates that the pollutant is within acceptable levels; however, the outfall is considered to have a potential illicit connection and is automatically queued for re-screening within one year. If the problem is severe enough to warrant immediate correction, an investigation begins

immediately. Some sites are determined to have problems severe enough to warrant immediate investigation and/or corrective action after only one screening.

Table 3-13: Major Outfalls by Priority Level in Lower Gunpowder Falls (Urban) Subwatersheds

Outfall Priority Rating	Bean Run	Jennifer Branch	Lower Gunpowder Falls-A	Lower Gunpowder Falls-B	Lower Gunpowder Falls-C	Lower Gunpowder Falls-D	Minebank Run	Total
Priority 0	0	1	1	5	0	2	0	9
Priority 1	0	3	1	0	0	0	3	7
Priority 2	0	2	7	5	1	0	6	21
Priority 3	0	7	2	0	0	0	0	9
Total	0	13	11	10	1	2	9	46

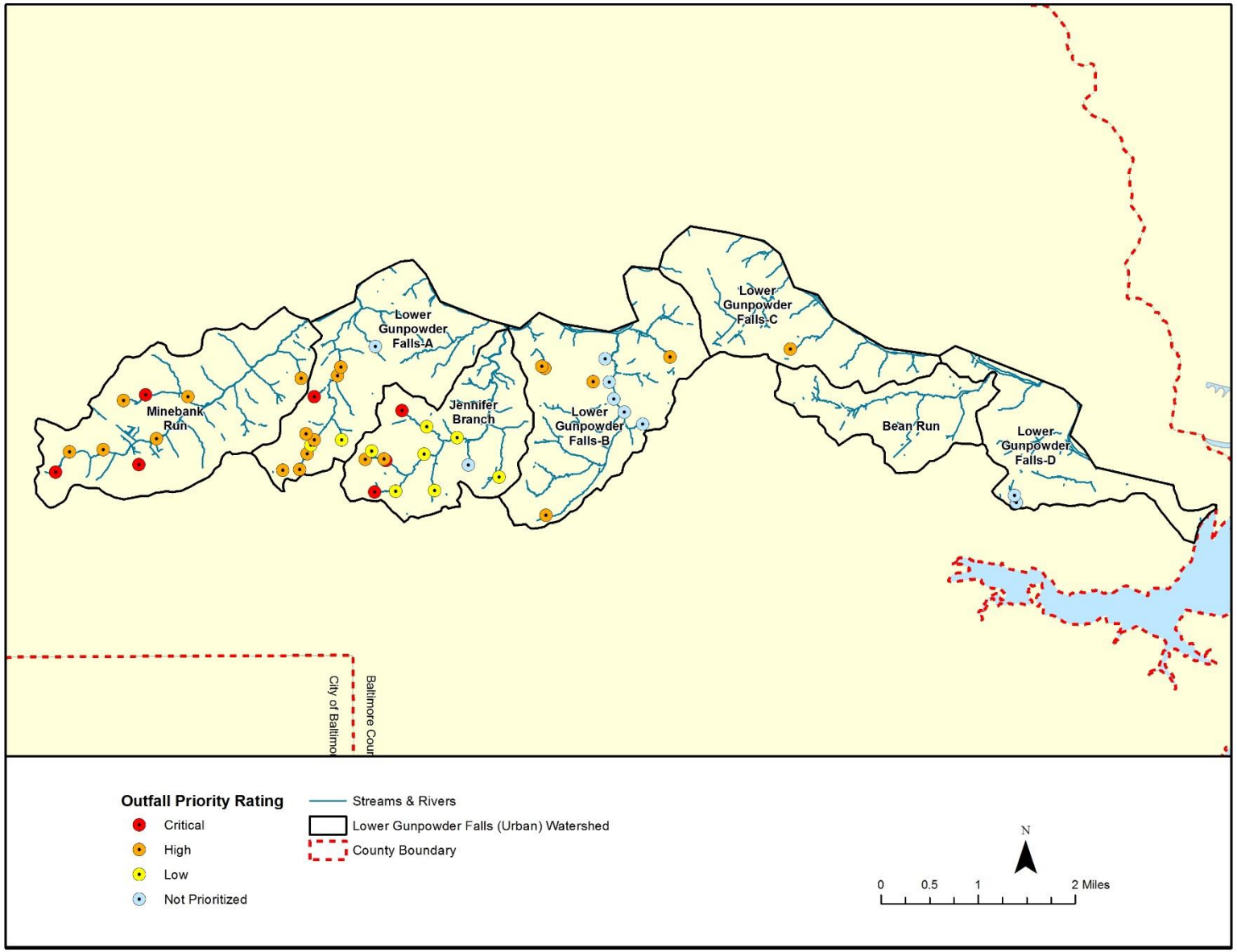


Figure 3-8: Major Outfalls by Priority Level in Lower Gunpowder Falls (Urban) Watershed

3.5 SEWER OVERFLOW IMPACTS

At present, sanitary sewer overflows (SSOs) and combined sewer overflows (CSOs) are inevitable byproducts of the area's expanding population and aging sewer systems. Sewer overflows can be caused by various factors such as severe weather, insufficient maintenance, pumping station equipment malfunction, electrical outage, sewer line breaks, improper disposal of fats and grease, and vandalism. Raw sewage can enter nearby streams when a sanitary sewer system is overwhelmed by volume or if the infrastructure fails. EPA reports that there are at least 40,000 of these incidents per year nationwide. Environmental and human health consequences of these overflows can be serious. *E. coli* bacteria and other pathogens are typically present in raw sewage and can pose health risks to individuals who come into contact with contaminated water. Sewer overflows can also contain high levels of nutrients (nitrogen and phosphorus), which are toxic to aquatic life and feed organisms that deplete oxygen in waterways. High levels of sediment are also present in sewer overflows and may clog streams and block sunlight from reaching essential aquatic plants.

In September 2005, EPA and MDE issued a consent decree to Baltimore County with deadlines to reduce and eliminate sanitary sewer overflows. Implementation of work (capital, equipment, operations improvements) in compliance with the consent decree will result in a reduction of nutrients and bacteria entering streams in the Lower Gunpowder Falls (Urban) watershed. However, this may not address all impacts associated with the sanitary sewer system, as the consent decree is targeted at overflows. For example, the sanitary sewer system may leak without resulting in an overflow. Depending on the locations of the leaks, which are typically at joints, there may still be adverse impacts to the stream system from the sanitary sewer system.

Figure 3-9 shows the locations of sanitary sewer pump stations and the location of the Richlyn Wastewater Treatment Plant (WWTP) within the Lower Gunpowder Falls (Urban) watershed. The number of SSO events documented and approximate volume discharged between 2000 and 2013 is summarized in Table 3-14 based on Baltimore County's SSO GIS layer. Table 3-15 summarizes the estimated volume and pollutant loads associated during this 14-year period by subwatershed.

While there are occasionally spikes in the volume of sewage overflows due to unusual damage or malfunction within the sanitary sewer system, the frequency of overflows is decreasing, since a high of 10 events in 2002. Since 2002, sewage spills for a given year have generally not exceeded 50,000 gallons. However, there was a spike in volume in 2013 after a sewer manhole was vandalized, where a 220,000 gallon spill occurred, accounting for 99% of that year's overflow volume. Otherwise, 2013 would have been similar in volume to previous years, with less than 2,500 gallons being spilled during two other minor events.

Table 3-14: Sanitary Sewer Overflow Events and Volumes in Lower Gunpowder Falls (Urban) Watershed, 2000-2013

Year	# of SSO Events	Volume (gallons)
2000	1	5,000
2001	4	7,290
2002	10	4,978,723
2003	7	7,750
2004	3	1,450
2005	7	2,985
2006	6	12,025
2007	0	0
2008	4	8,875
2009	3	1,040
2010	5	1,975
2011	2	2,100
2012	0	0
2013	3	222,950
Total	55	5,252,163

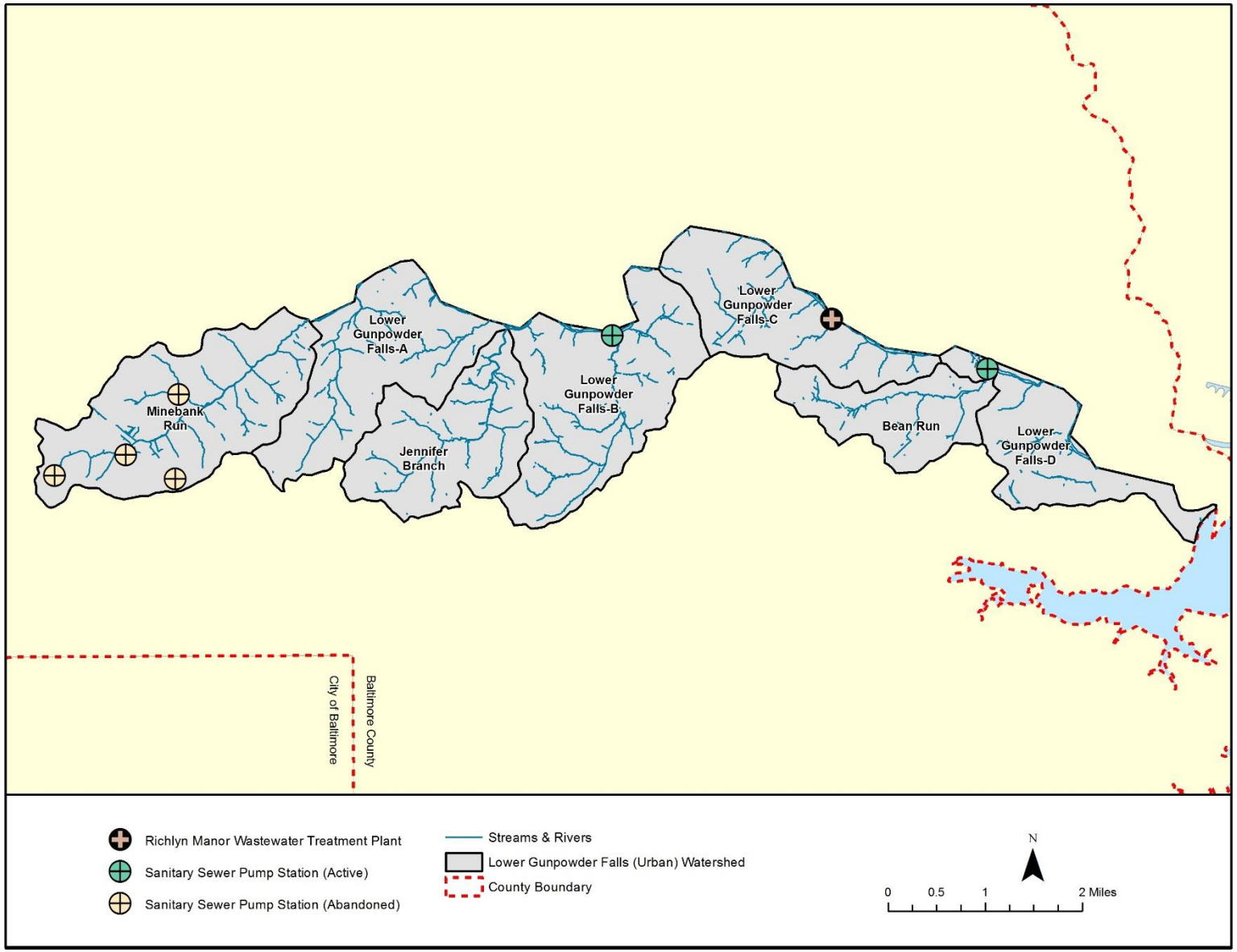


Figure 3-9: Sanitary Sewer Pump Stations and Wastewater Treatment Plant in Lower Gunpowder Falls (Urban) Watershed

Table 3-15: Sanitary Sewer Overflow Volumes and Pollutant Loads by Subwatershed, 2000-2013

Subwatershed	# of SSO Events	Volume (gallons)	TN (lbs)	TP (lbs)	Fecal Coliform (MPN)
Bean Run	1	2,000	0.5	0.2	4.80×10^{11}
Jennifer Branch	13	224,860	56.2	18.7	5.40×10^{13}
Lower Gunpowder Falls-A	9	9,565	2.4	0.8	2.30×10^{12}
Lower Gunpowder Falls-B	17	4,999,908	1,250.0	415.0	1.20×10^{15}
Lower Gunpowder Falls-C	0	0	0.0	0.0	0
Lower Gunpowder Falls-D	0	0	0.0	0.0	0
Minebank Run	15	15,830	4.0	1.3	3.80×10^{12}
Total	55	5,252,163	1,313.0	435.9	1.26×10^{15}

Pollutant load estimates were calculated based on the following assumptions:

- Total Nitrogen (TN): A conversion factor of 2.5×10^{-4} was used to convert gallons of overflow to pounds of pollutant. This is based on a 30 mg/l TN concentration for raw sewage and a multiplier of 8.3×10^{-6} lb•L/mg•gal.

- Total Phosphorus (TP): A conversion factor of 8.3×10^{-5} was used to convert gallons of overflow to pounds of pollutant. This is based on a 10 mg/l TP concentration for raw sewage and a multiplier of 8.3×10^{-6} lb•L/mg•gal.

- Fecal Coliform (FC): A conversion factor of 2.4×10^{8} was used to convert gallons of overflow to MPN fecal coliform. This is based on a multiplier of 6.4×10^{6} MPN/100 ml.

Figure 3-10 shows the location of SSOs in in Lower Gunpowder Falls (Urban) watershed. Lower Gunpowder Falls-C and Lower Gunpowder Falls-D subwatersheds had no reported sanitary sewer overflows between 2000 and 2011. Lower Gunpowder Falls-B had the highest number of SSOs (17) and had by far the largest volume of leaked sewage (close to five million gallons). This was primarily due to a single large event in 2002 when a foreign object caused a massive overflow at a pumping station.

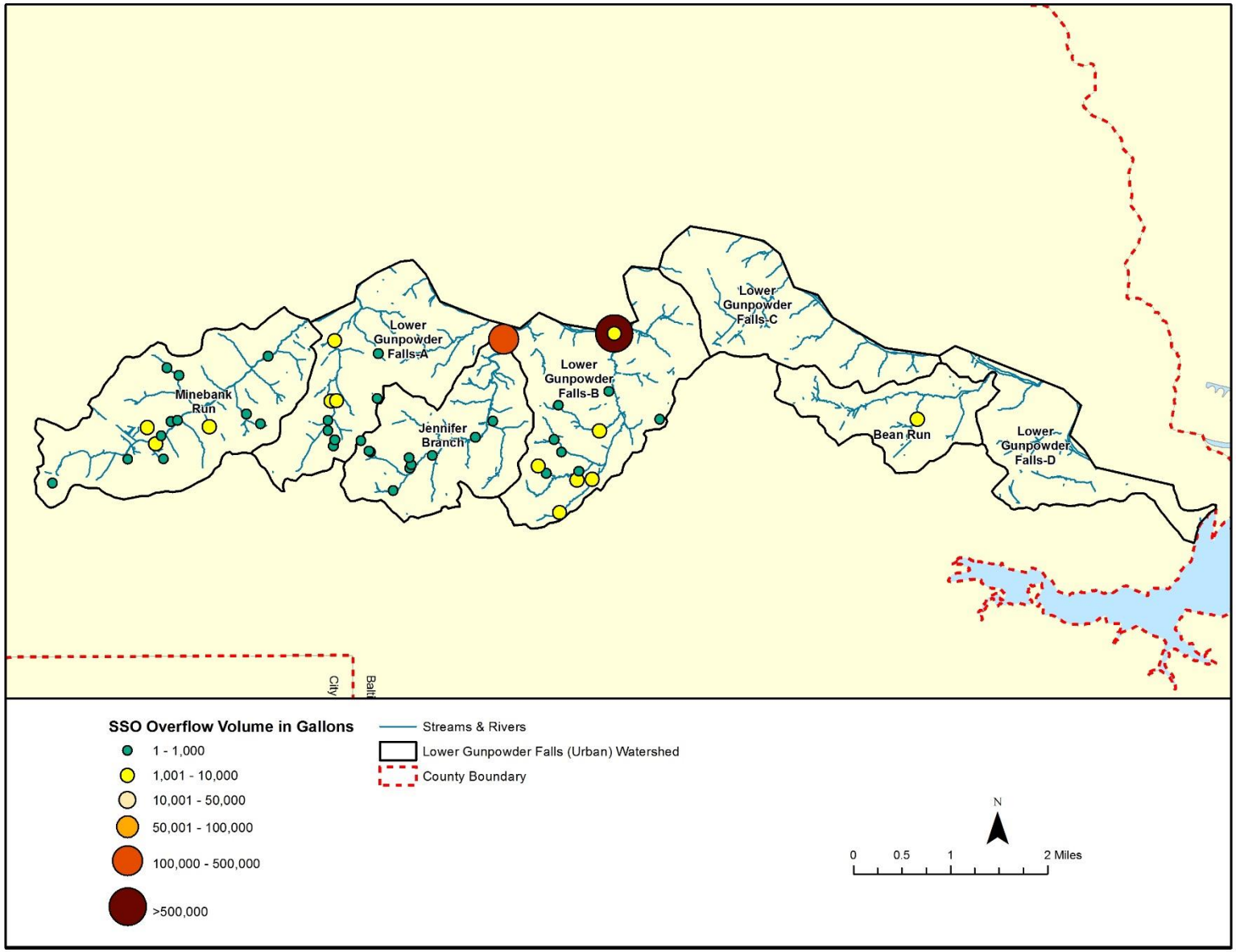


Figure 3-10: Sanitary Sewer Overflow Locations in Lower Gunpowder Falls (Urban) Watershed, 2000-2013

3.6 STREAM ASSESSMENTS AND STREAM RESTORATION RECOMMENDATIONS

Two reports have evaluated the streams in Area N in detail. The Lower Gunpowder Falls Water Quality Management Study (WQMS) by Parsons Brinkerhoff (1999) looked at all of the drainage to the Lower Gunpowder River below the Loch Raven Reservoir, while the Lower Gunpowder Falls Watershed Assessment (WA) by McCormick Taylor (2011) focused on the Perry Hall Tributary subwatershed. The 2015 evaluation of Area N focused on streams that enter the Gunpowder River from the south only, because stream reaches were re-delineated by the new subwatershed boundaries drawn by EPS for the 2015 SWAP. The previous studies used different desktop and field evaluation methods to characterize the streams and classify their impairments. Both reports presented a ranking of potential projects in categories such as bank stabilization, channel restoration, riparian buffer improvement, drainage channel retrofit, outfall enhancement, and pond retrofit. The methods and results of these studies are described below.

In 2015, recommended stream restoration projects from these two reports were revisited to evaluate if the need and potential for restoration still existed. Results from site visits in 2015 and recommendations for stream restoration projects are presented below; however, more detailed evaluations would need to be conducted before any restoration work could take place.

3.6.1 Overview of Previous Reports

The 1999 WQMS defined some subwatersheds differently than the 2015 SWAP. The Bean Run, Jennifer Branch, and Minebank Run subwatersheds are nearly identical in the 1999 and 2015 mapping. Other streams are now grouped into the Lower Gunpowder Falls-A through Lower Gunpowder Falls-D subwatersheds. The Pine Ridge subwatershed is contained within LGUN-A, and the Perry Hall subwatershed, which the 2011 WA focused on, is contained with the LGUN-B subwatershed. See Figure 1 for general locations of subwatersheds.

Approximately 31.2 miles of stream were classified to Rosgen Level I by either field verification or extrapolation from mapping. Fifteen stream restoration projects were recommended in the WQMS (Table 3-16). The 2011 WA focused on the Perry Hall Tributary (located in LGUN-B), where more than ten miles of stream were assessed using the Stream Corridor Assessment (SCA; Yetman, 2001). This field work resulted in 22 recommended stream restoration projects totaling 15,465 linear feet (Table 3-16). Methods and results of the previous studies are described in more detail below.

Table 3-16: Summary of Previous Stream Assessments

Subwatershed Name (2015)	Stream Length Assessed (ft)		Proposed Stream Restorations			
			1999 WQMS		2011 WA	
	1999 WQMS	2011 WA	Number of Projects	Length (ft)	Number of Projects	Length (ft)
Bean Run	20,064		2	2,550		
Jennifer Branch			1	NA		
Lower Gunpowder Falls-A	47,202		4	1,750*		
Lower Gunpowder Falls-B	52,109	54,000	2	2,850	22	15,465
Lower Gunpowder Falls-C	29,289		3	2,825*		
Lower Gunpowder Falls-D	17,087					
Minebank Run			3	NA		
Total	165,751	54,000	15	9,975	22	15,465

*This number is a minimum as length was not listed for one project in each of these subwatersheds.
NA = no length provided for recommended projects.

3.6.1.1 Lower Gunpowder Falls Water Quality Management Study (1999)

The 1999 WQMS first used existing data and mapping to characterize the watershed. Geomorphic and hydraulic controls were identified to streamline field assessments. Geology in the southwest portion of the watershed is composed of metamorphic rocks highly resistant to erosion (including Baltimore Gneiss, Setters Quartzite, and Baltimore Gabbro Complex). Cockeysville Marble, which is less resistant to erosion, is found in Minebank Run. During the preliminary field review, topographic and aerial maps were used to identify what were presumed to be typical stream reaches and major watershed features. Reach breaks were identified based on visual assessment of Rosgen stream type and changes in topography and land use, and were generally less than 1,000 linear feet.

The watershed was delineated into 62 catchments for hydrologic and non-point source pollution modeling. Smaller modeling units were used in order to increase the resolution of the results. Modeling used Version 4.4 of the EPA's stormwater management model (SWMM) for existing and proposed conditions. Results included discharge frequency relationships for each catchment and the pollutant loading characteristics for ten non-point source pollutants for each subwatershed. Baseflow water quality samples were taken at 8 sites and the results used to show existing pollutant loadings and to calculate proposed levels.

The stream stability assessment used geomorphic assessment methods based on the Rosgen classification system (Rosgen 1996). All streams were assessed for a Rosgen Level I channel type assigned from either field visits or aerial photos. Reaches were classified using mapping by analyzing valley type and certain morphologic parameters, such as valley slope, channel slope, and sinuosity. In total 1,073 reaches totaling 947,509 linear feet were classified using Rosgen Level I practices.

At least one reach from each major Rosgen stream type was then studied with more detailed field work. These were called Representative Reaches, and field work included cross-sectional and longitudinal survey to determine the Rosgen Level II classification, a Wolman pebble count, and measurements of valley length and channel length in order to calculate sinuosity. In order to confirm the accuracy of Extrapolated Reach classifications, all streams in Haystack Branch were

classified and confirmed. Additional stream reaches were classified to Level II while using more rapid field techniques and knowledge gained from observations during the more detailed studies. In total, 37% of stream reaches in the study area were classified to Level II. A modified Level III assessment included factors such as riparian vegetation, stream size and order, flow regime, bank erodibility hazard index (BEHI), and sediment supply and streambed vertical stability. Remote sensing was used to classify all reaches that were not verified in the field (63% total). Figure 3-11 shows the stream reaches in Area N that were either field reviewed or desktop assessed for the 1999 WQMS.

Potential projects were identified from the stream stability analysis and further field visits to locate storm drain outfalls and identify causes of non-point source pollution. Sites were ranked for factors that assessed water quality enhancement benefits, feasibility, and public acceptance of projects. Cost estimate unit costs were developed and compared to project benefits. All identified water quality enhancement projects are located in Table V-2 of the WQMS (included with Appendix I). Projects were then ranked within each subwatershed based on the project score and water quality enhancement benefits.

The stream stability assessment found that geology was a major factor in channel types. Resistant bedrock ridges in the watershed provide grade control, while the valleys are comprised of easily eroded alluvial fill. The most stable streams were those that had sufficient floodplain access. Agricultural land practices and riparian buffer condition also play an important role in maintaining stream stability. Stream instabilities were found to generally have local causes and thus need local remedies. Examples include poor riparian buffers, debris jams, and unprotected cattle crossings. However, there are also systematic causes of stream instability. The Bean Run subwatershed has streams more typical of the Coastal Plain, which may be destabilized by land use changes due to the Honeygo Development. Stream stability assessments were not completed in Jennifer Branch or Minebank Run because these subwatersheds were predominantly urban and would be the focus of future studies.

The report concluded with generalized subwatershed findings as well as recommended projects including channel restoration, stream buffer improvement, bank stabilization, drainage channel retrofits, outfall retrofits, grade control, bioretention, and new stormwater management ponds. Characterizations of each subwatershed and the general problems that plague each are described below.

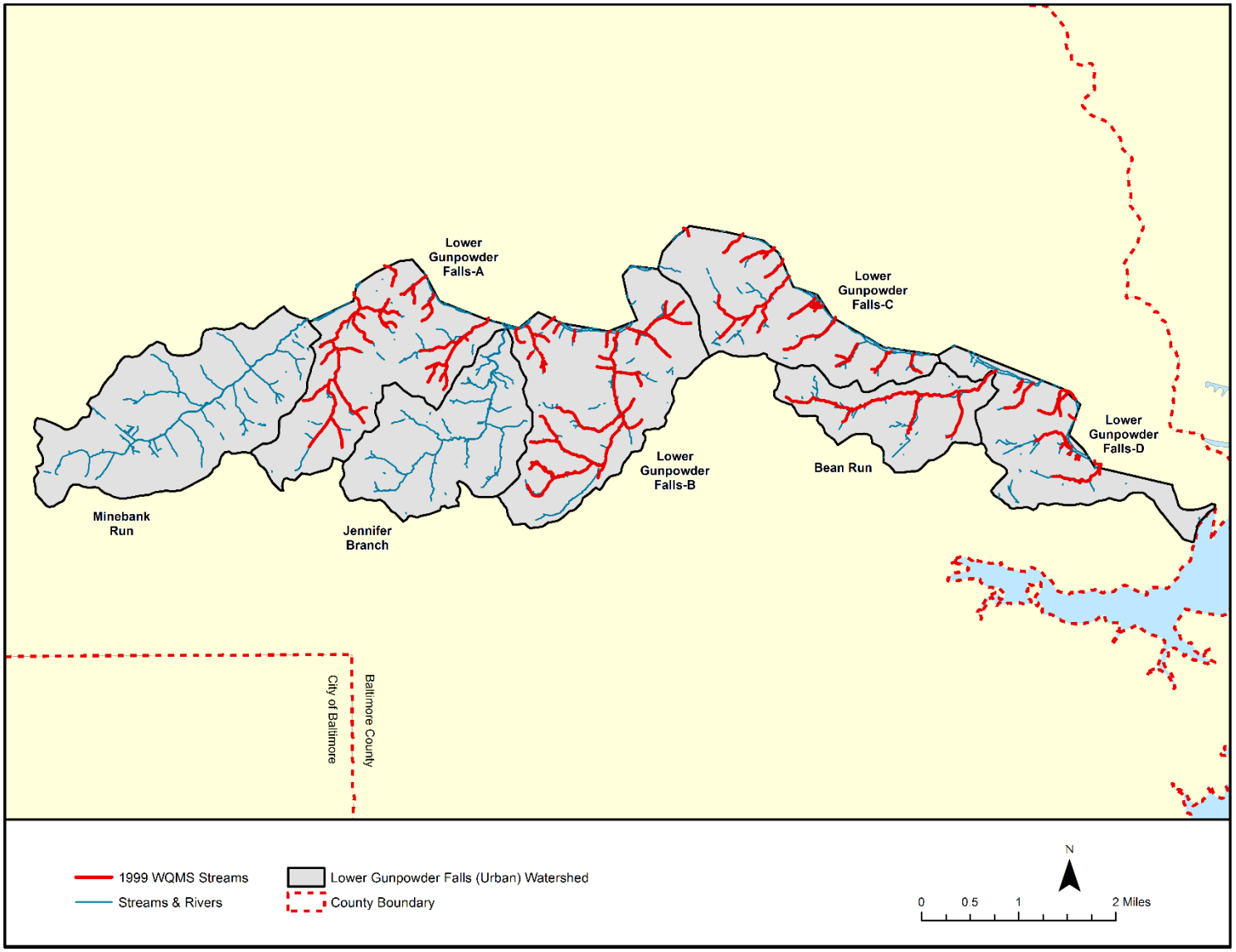


Figure 3-11: Streams Assessed for 1999 WQMS

3-33

Bean Run

Stream channel stability in the Bean Run subwatershed was degrading due to rapid land use change, including the Honeygo Development. This subwatershed is unique because the soil and slopes are more typical of coastal plain than piedmont, with highly erodible soils and few grade controls. Streams in this subwatershed likely will not downcut due to their gentle slope, but they may widen and convert from C to F type channels. Eventually, E type channels may form, but infrastructure could be impacted. In order to prevent additional stormwater runoff from impervious services, the WQMS recommends restrictions for the Honeygo Development in terms of riparian buffers; on-site stormwater management; no encroachment on 10-yr floodplain for road crossings, pre- and post-construction monitoring; and incorporating low impact development.

Two stream restoration projects, BN-1 and BN-2, were recommended in this subwatershed.

Jennifer Branch

Detailed stream classifications were not performed in Jennifer Branch, as future detailed studies were expected. Initial field visits for the 1999 WQMS did not reveal any systematic problems in this subwatershed. The lower section is bedrock where streams flow off a ridge top into a valley. The upper section is older medium-density residential with constricted sections in backyards and no natural grade controls on the ridgetop, so culverts are the only grade control. General observations included little stream buffer, cut banks, debris jams, and some downcutting downstream of culverts and sewer crossings. The WQMS recommended mandatory stormwater management as large lots are subdivided. There is no space for new stormwater management so retrofits were recommended.

One stream restoration project was recommended in this subwatershed (JB-6). This area was restored as part of the restoration of Jennifer Branch completed in 2013 (Jennifer Branch-Harford Rd).

Lower Gunpowder Falls Mainstem (Lower Gunpowder Falls-A through –D)

This subwatershed encompassed all of the smaller tributaries to the mainstem of Gunpowder Falls on both the north and south sides. Only the tributaries entering the mainstem from the south were revisited for 2015 evaluations. These reaches are located in subwatersheds Lower Gunpowder Falls-A through Lower Gunpowder Falls-D by the 2015 SWAP delineations (see Figure 3-11 for subwatershed locations).

A rocky gorge borders the mainstem, made up mostly of Gunpowder Falls State Park. As a park, the mainstem is buffered by forested open space on the south side. No systematic problems were found in the tributaries to the mainstem. North of the mainstem is rural with agriculture land use, while Area N is dense urban. There are two named tributaries to the mainstem in Area N: the Pine Ridge Tributary, and the Perry Hall Tributary. The Pine Ridge tributary has similar characteristics to Jennifer Branch, while the Perry Hall tributary was eroding to shallow bedrock due to new residential development. Despite the heavy development in the area of the Perry Hall Tributary, the 1999 studies did not find problems caused by development as were expected, as bedrock controls have limited damage since the depth to bedrock is shallow. The WQMS recommended frequent inspection of SWM ponds in new development to reduce water quality impacts from non-point source pollution.

Nine stream restoration projects were recommended in the Lower Gunpowder Falls-A, -B, and -C subwatersheds. Two projects are planned in the Perry Hall Tributary portion of Lower Gunpowder Falls-B, Lower Gunpowder Falls at Proctor and Lower Gunpowder Falls at Seven Courts. The Lower Gunpowder Falls at Seven Courts project will address recommended project GF-39, while another recommended site, GF-31, was not accessible due to private property. This left seven sites recommended for restoration in the Lower Gunpowder Falls-A, -B, and -C subwatersheds to revisit in 2015. No projects were recommended in Lower Gunpowder Falls-D.

Minebank Run

Detailed stream classifications were not performed in Minebank Run, as future studies were expected to study it in detail. The development in this watershed is older with no stormwater management. Small areas of new infill development are too small to require stormwater management. The subwatershed was generalized into three areas: 1) west of I-695: steep and ditched with little buffer and heavy residential and commercial development; 2) northeast of I-695: better buffer, but receives flashy stormflow drainage from steep slopes, resulting in F streams that will continue to widen and become unstable; and 3) Cromwell Valley Farm Park: better buffer, land use is light residential, has C/F type streams except near the confluence with Gunpowder Falls, which has been excavated for flood storage. The WQMS recommendations include retrofitting and stabilizing drainage channels from developed areas entering streams, adding new SWM where space allows, and stabilizing banks along mainstem.

Two bank stabilization projects (MB-11 and MB-12) and one drainage channel retrofit that was causing erosion downstream (MB-17) were recommended in this subwatershed. Most of the mainstem of Minebank Run has been restored. Upstream (west) of I-695 was restored in 1996 (Minebank I). The mainstem through Cromwell Valley Farm Park was restored in 2007 (Minebank II) and the lowest portion of the mainstem in 2014 (Lower Minebank). A short reach of stream on a tributary to Minebank Run was restored in 2008 (Minebank Run at Waller Court). The extensive amount of work in this subwatershed has addressed of the stream reaches most in need of help. This left one recommended stream restoration site to from the 1999 WQMS to revisit in 2015.

3.6.1.2 Lower Gunpowder Falls Watershed Assessment (2011)

The Lower Gunpowder Falls Watershed Assessment (WA; McCormick Taylor 2011) identified Capital Improvement Projects (CIPs) in the Mainstem-Perry Hall Tributary subwatershed, which is part of the Lower Gunpowder Falls-B subwatershed. Teams completed desktop and field evaluations of existing watershed conditions and subsequently assessed the need for restoration activities, with a focus on improving stream stability, aquatic habitat, water quality, and ecological connectivity. The resulting implementation strategy included stormwater management, water quality BMPs, and stream restoration projects in the drainage areas with greatest need.

Approximately 54,000 linear feet (10.2 miles) of stream were assessed using the Maryland Stream Corridor Assessment (SCA) survey protocols (Yetman 2001). SCAs document the location, severity, correctability, and accessibility of environmental problems such as channel alterations, erosion sites, and fish barriers. Channel and floodplain connectivity in the subwatershed had been reduced by interruptions such as on-line SWM ponds, culverts, headcuts, and utility right-of-ways. Figure 2 shows the streams assessed by the 2011 WA.
Twenty drainage areas within the subwatershed were delineated for assessment and ranking. Geomorphic assessments were completed in 15 stream segments that represented the breadth

of channel types in the subwatershed. Each geomorphic assessment included a longitudinal profile up to 300 feet long, three cross sections, and a 150 particle pebble count. Results were used in hydrologic modeling and used with calculated discharges to create hydrologic variables that could be compared between the drainage areas.

GIS was used to analyze historic and current land use and the stormwater management (SWM) facilities. Forty one SWM facilities were identified and evaluated for overall condition and function, with the goal of determining if a facility would be a suitable retrofit candidate. Sixty one outfalls were also evaluated for stability and potential for BMP implementation. In addition, three areas were identified as possible locations for new stormwater management facilities. Hydrologic models compared the existing conditions to an ideal state of 10% impervious surfaces.

Geomorphic, ecologic, and hydrologic variables or metrics were chosen to compare and rank the drainage areas. Metrics included those that provided insight into the longitudinal, lateral, and temporal connectivity as well as stability of the streams. Metrics were eliminated if they were found to not vary greatly between drainage areas. Two sets of metrics were compared to assign a priority ranking to each drainage area: existing conditions and restoration opportunities. Drainage areas with the closest to ideal conditions received high scores, while those that were the most impaired and had the greatest capacity for improvement scored low.

The cumulative ranking system results showed that subdrainage areas 4, 19, 16, 11, and 12 were the top five for most optimal opportunities for restoration. Drainage area 2 was least optimal for restoration. In total, the report identified 23,675 linear feet of impaired channel, 24 outfall improvements, 15 pond retrofit opportunities, and 3 areas with potential and need for stormwater management. See Section V of the WA report for a description and mapping of the conditions of each subdrainage area, including soil, land use, and areas treated by SWM. The locations of headcuts, longitudinal interruptions, impaired riparian areas, and encroachments are also shown. Specific locations of restoration opportunities are presented, including: outfall enhancement, longitudinal interruption removal, riparian buffer enhancement, bank stabilization, floodplain reconnection, and pond retrofit.

Two stream restoration projects have been planned as a result of this report: Lower Gunpowder Falls at Proctor and Lower Gunpowder Falls at Seven Courts. These projects encompass the highest-ranked stream reaches for restoration from the report. The remaining stream reaches recommended by the report as part of Capital Improvement Projects were revisited in 2015.

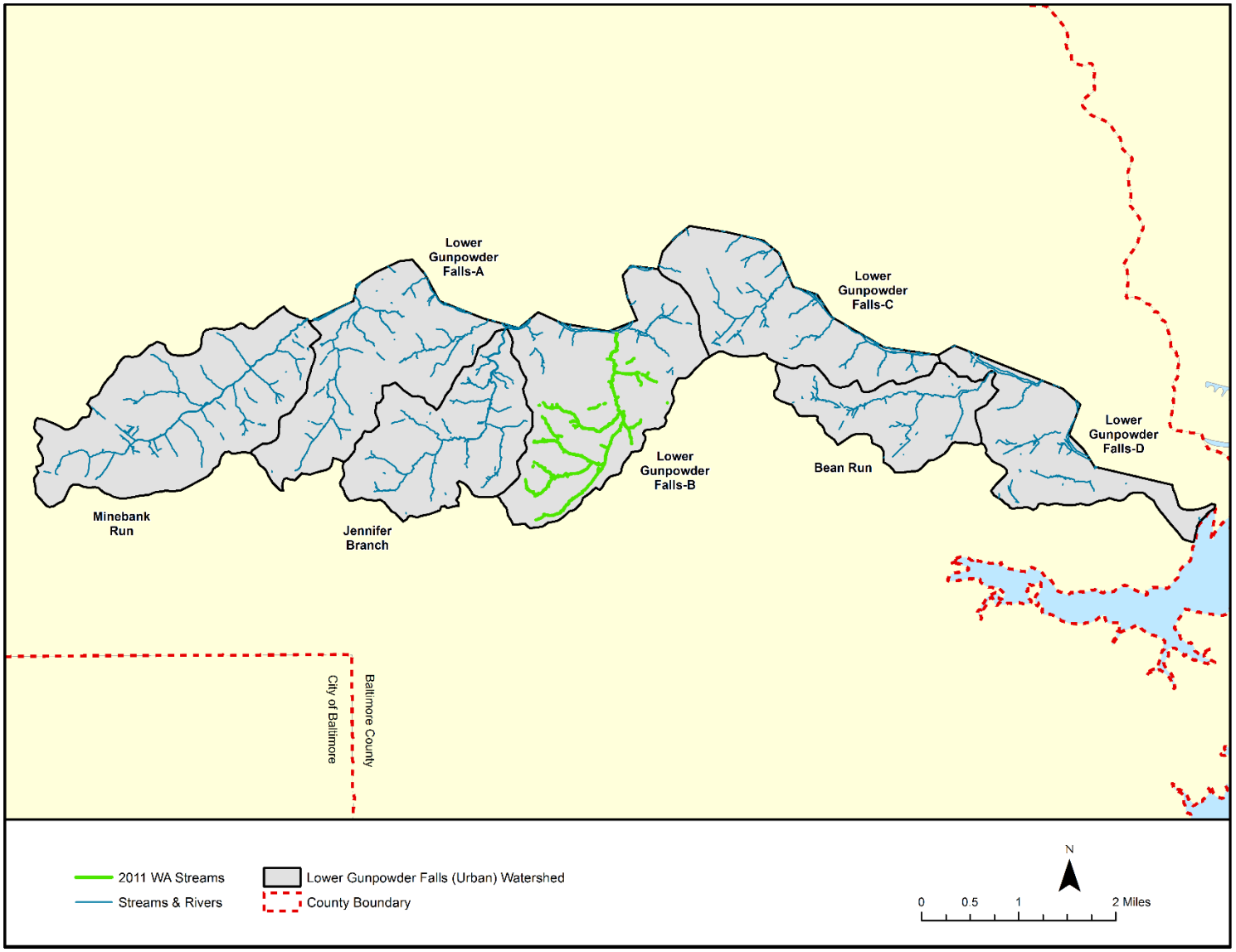


Figure 3-12: Streams Assessed for 2011 WA

3.6.2 Stream Review Process (2015)

Twenty one recommended stream restoration projects from the two previous reports were checked against completed stream restoration projects. All recommended stream restoration project reaches from the 2011 WA and 1999 WQMS that are not part of a previous or planned restoration were revisited to determine if the need for restoration still exists. Reevaluation focused on streams accessible from road crossings, public right of way, and County owned stream corridors. Streams were cruised when possible due to property ownership and access, otherwise reaches were evaluated from road crossings or spot-checked at discrete locations along the reach. This method allowed for efficient field visits to verify the stream conditions described in the previous reports, as land use has continued to change in the intervening years since their studies.

The 1999 WQMS identified a variety of water quality enhancement projects (see Table V-2 in the 1999 WQMS, included in Appendix I). In 2015, projects with the type "Channel Restoration" or "Bank Stabilization" that were located within the Area N subwatersheds were revisited. Additional projects with the type "Grade-Control" or "Drainage Channel Retrofit" were also visited when the project descriptions indicated that stream channel degradation was occurring.

Table 46 in the 2011 WA presented a ranking of CIPs in the Perry Hall Tributary subwatershed (included in Appendix I). The projects ranked first and second are currently planned for restoration; therefore they were not revisited for the 2015 evaluations. The remaining stream reaches recommended for restoration (in Table 46 and Figure 89 of the 2011 WA included in Appendix I) were visited in 2015.

In addition to specific restoration opportunities listed in the previous reports, particular attention was paid to the Bean Run subwatershed. The 1999 WQMS emphasized the potential of stream degradation in Bean Run due to the construction of the Honeygo Development, a large multi-type residential development located in both Bean Run and adjacent areas that drain to the Bird River. Due to the potential for degradation, six additional stream reaches or crossings were evaluated in Bean Run were access was possible. Streams that were not recommended for restoration and that could be viewed from road crossings, easements, or County properties were also evaluated in other subwatersheds as time allowed. For example, no projects were recommended in the Lower Gunpowder Falls-D subwatershed, but two streams were observed where it was possible from road crossings.

For each stream reach, a stream evaluation worksheet was filled out and photos were taken to document the current conditions (Appendix I). The evaluation worksheet focused on assessing stream stability by ranking features such as bank stability, floodplain access, utility conflicts, potential for habitat improvement, and riparian buffer condition. A higher score on the stream evaluation worksheet indicated greater potential for restoration. However, any specific opportunities or problems were also identified for each reach. See Appendix I for a summary of the evaluation worksheets with individual rankings. Figure 3-13 shows the distribution of all sites that were evaluated in 2015.

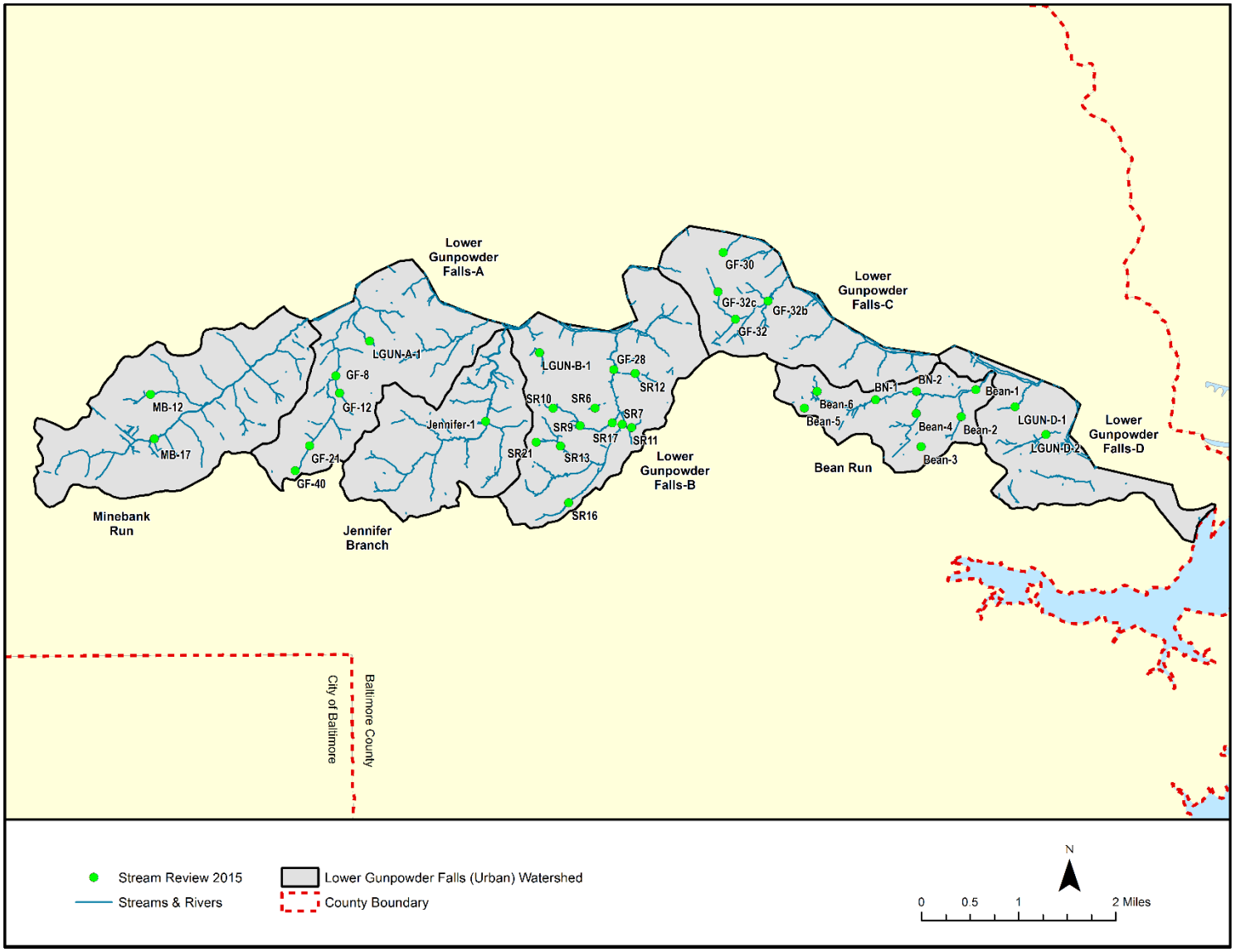


Figure 3-13: Locations of 2015 Stream Evaluations

Completed Restorations

Based on recommendations from the watershed studies described above, as well as other evaluation efforts, several of the highest need stream reaches have already been restored. See Figure 3-14 for the locations of completed and pending stream restoration projects.

The mainstem of Minebank Run was restored in three phases. The most upstream section, located to the west of I-695, was completed in 1996 and restored approximately 7,000 feet of stream. From Cowpens Ave downstream through Cromwell Valley Farm park was restored in 2007 and approximately 10,000 feet in length. Lower Minebank Run, just above the confluence with Gunpowder Falls, was restored in 2014 for approximately 3,000 feet. A tributary to Minebank Run had 482 feet restored in 2008 (Minebank Run at Waller Court). This project was recommended in the 1999 WQMS.

Approximately 4,500 linear feet of Jennifer Branch was restored in 2013. This addressed the issues at the recommended stream restoration project in that subwatershed from the 1999 WQMS.

Two stream restoration projects are planned in the Perry Hall Tributary (Lower Gunpowder Falls-B) subwatershed as a result of recommendations from the 2011 WA. These projects represent the two top ranked projects from that report. The Lower Gunpowder at Proctor project will be approximately 2,000 feet in length while the Lower Gunpowder at Seven Courts project will restore approximately 4,500 feet.

3.6.3 Restoration Recommendations

Several recommended projects from the previous reports still warrant restoration. Others have since been stabilized with spot fixes (such as SR17) or have begun to heal themselves and are not high priorities for restoration at this time (such as BN-1). The Lower Gunpowder Falls (Urban) watershed is in general highly developed, and thus most stream reaches reevaluated in 2015 showed the effects of high peak flows and excessive sediment. Water quality and quantity BMPs would help some streams recover without restoration, particularly in cases where concentrated flow from an outfall is causing erosion.

Ten stream reaches totaling approximately 7,400 linear feet are recommended for restoration in Area N as a result of 2015 field reviews. Reach lengths were measured from 2005 County stream lines in GIS and thus are approximate. Table 3-17 lists recommended stream restoration projects in no particular order. Figure 3-14 shows the locations of recommended projects as well as completed or planned stream restorations.

Opportunities for stream buffer enhancement, outfall stabilization, and fish blockage removal in locations where a full-scale stream restoration is not recommended are listed with the rankings for each site in Appendix I.

It is recommended that upstream projects are completed before downstream projects, because reducing bank erosion and peak flows from upstream sources may allow downstream reaches to heal themselves.

Table 3-17: Recommended Stream Restoration Projects

Reach ID	Source	Subwatershed	Location/ Ownership	Description of Problems	Recommended Actions	Observed Limitations
Bean-1	1999 WQMS	Bean Run	Philadelphia Rd near Bush St (private property outside of ROW)	WQMS emphasized vulnerability of Bean Run. US of Philadelphia Rd: slightly incised, mowed to top of bank, but banks are stable. ~2-3 ft vertical drop upstream of culvert, then concrete lined with vertical walls for ~ 100 ft downstream of Philadelphia Rd. ~2-3 ft drop off concrete at downstream end with scour pool.	Grade left bank back to increase floodplain access upstream of Philadelphia Rd, and vegetate (~250 LF). Remove fish blockages (2 vertical drops, ~3 ft each, and ~120 LF of shallow flow over concrete). Could create cascades over concrete drops to reconnect fish passage, and use baffles to increase depth through shallow concrete section. Banks around scour pool may need stabilization.	Private property, close to houses, sanitary sewer line (encasement visible in bed)
GF-12	1999 WQMS	LGUN-A (Pine Ridge Trib)	NE of Pearwood Rd at Teakwood Rd (County owned - Pine Grove ES)	Scour pool and bank erosion below concrete channel. Concrete is broken in several places, eroding underneath. Approximately 4 ft drop and scour pool at downstream end. Trees had been planted around concrete but most appear dead.	Remove ~400 LF of concrete channel and replace with step pools. Stabilize banks around scour pool downstream of concrete section. Establish stream buffer.	Steep slope from behind ball field down to concrete channel, possible forest impacts
GF-32	1999 WQMS	LGUN-C	Upstream from crossing at Perry Hall Rd (private property - residential)	Upstream of Perry Hall Rd, both tribs are fairly straight and slightly incised with minor bank erosion and mowed close to top of bank. A large cascade at the downstream side of the culvert is a fish blockage. The stream enters forest downstream - no erosion or problems were visible. Stream may be more stable upstream of culvert, but did not investigate due to private property.	Improve floodplain access (and possibly geometry) of both tribs upstream of road (~1,540 LF total). Fix fish blockage at downstream end of culvert under Perry Hall Rd. Educate homeowners about mowing to top of bank (tribs surrounded mowed lawn, could be used for hay but did not appear to be).	Private property, multiple property owners, overhead utilities along Perry Hall Rd

Reach ID	Source	Subwatershed	Location/ Ownership	Description of Problems	Recommended Actions	Observed Limitations
GF-40	1999 WQMS	LGUN-A (Pine Ridge Trib)	East of Waltham Woods Rd at Townhill Rd (apartment complex)	~300' of concrete channel. No buffer, mowed to edge of water including inner channel benches. Confined by apartment complex. Potential for BMPs at SW outfalls. Mostly stable banks, one area of tall vertical banks along school property.	Educate apartment complex about mowing in stream buffer. Remove ~250 LF of concrete channel. Stabilize eroding banks in upstream end (~150 ft). Remove or relocate cable line that is exposed across channel and catching trash and debris. Add SWM below outfalls.	Close to apartment buildings, sanitary sewer line, cable line
SR10	2011 WA	LGUN-B (Perry Hall Trib)	End of Cody Ave upstream to ROW	Small headwater stream, mostly entrenched. Erodible soils. Headcut from SW outfall, previous stabilization has failed. Limited habitat due to low baseflow. Stream shows evidence of damage by peak flows, but surrounding neighborhoods do have SWM facilities.	Reconnect floodplain by grading banks back at the expense of tree impacts. Other options include creating benches within the narrow channel or raising the bed to reconnect the existing floodplain. Stabilize ~6' headcut from outfall.	Private property, forest impacts
SR12	2011 WA	LGUN-B (Perry Hall Trib)	Upstream of Gunview Rd (County-owned stream corridor)	Small headwater stream with agricultural fields upstream. Narrow, low quality stream buffer with many invasives and vines. SW outfall apron collapsed. Stream entrenched to bedrock, upper bank erosion causing property loss (water line in back yard exposed in bank).	Stabilize banks, improve floodplain where corridor is wide enough, and improve buffer quality and width. Reach is ~750 LF but the upstream end is more stable. Stabilize outfall apron. Educate homeowners about mowing in stream and dumping yard waste. Educate farmer upstream about stream buffer.	Sanitary sewer line, water line (likely sprinkler system), close to houses, steep slopes
SR13	2011 WA	LGUN-B (Perry Hall Trib)	Crossing at Simms Rd near Hines Rd downstream to SWM pond (County owned stream corridor)	Entrenched, but has some inner benches and bed stability due to bedrock. Narrow forested buffer, mowed close to top of bank in places. ~1 ft drop off concrete apron at downstream side of Simms Rd (fish blockage).	Raise stream to reconnect floodplain or grade banks back throughout reach (~1,100 LF). Educate homeowners about mowing to top of bank, including at Seven Oaks Elementary (though some trees have been planted in stream buffer). Multiple property owners would be an issue,	Narrow County-owned corridor

Reach ID	Source	Subwatershed	Location/ Ownership	Description of Problems	Recommended Actions	Observed Limitations
SR21	2011 WA	LGUN-B (Perry Hall Trib)	Bretton Reef Ct near Horn Point Ct (County-owned stream corridor)	Headcut advancing up through large riprap to outfall. Mass wasting of banks, stream entrenched ~10 ft. Several short but deep gullies enter right bank. Bank material is highly erodible. Banks are lower once stream enters utility ROW).	Stabilize headcut and banks to arrest erosion. ~425 LF for main channel and short tributary.	Overhead and buried utilities in ROW, steep slopes
SR6	2011 WA	LGUN-B (Perry Hall Trib)	North of Cedarbrooke Pl near Innsbrook Way (HOA-owned stream corridor)	Severe bank erosion posing a safety issue. Erosion around manhole. Huge sediment source, but is likely all trapped in wetland/SWM area downstream.	Stabilize bed and banks throughout reach to reduce property loss, protect infrastructure, improve safety, and reduce sediment inputs to watershed. ~700 LF.	Sanitary sewer line, close to houses
SR9	2011 WA	LGUN-B (Perry Hall Trib)	Upstream of Seven Courts Dr near Pinedale Dr (County owned)	Approximately 6 ft headcut at downstream edge of ROW. Stream is entrenched below headcut until Seven Courts Drive with areas of vertical raw banks (not entrenched downstream of road). Culvert through ROW is partially buried and no functioning.	Stabilize headcut and reconnect stream to floodplain (~825 LF). Raise bed, or create step pools down to channel invert and grade banks back.	Forest impacts, possible buried utilities in ROW

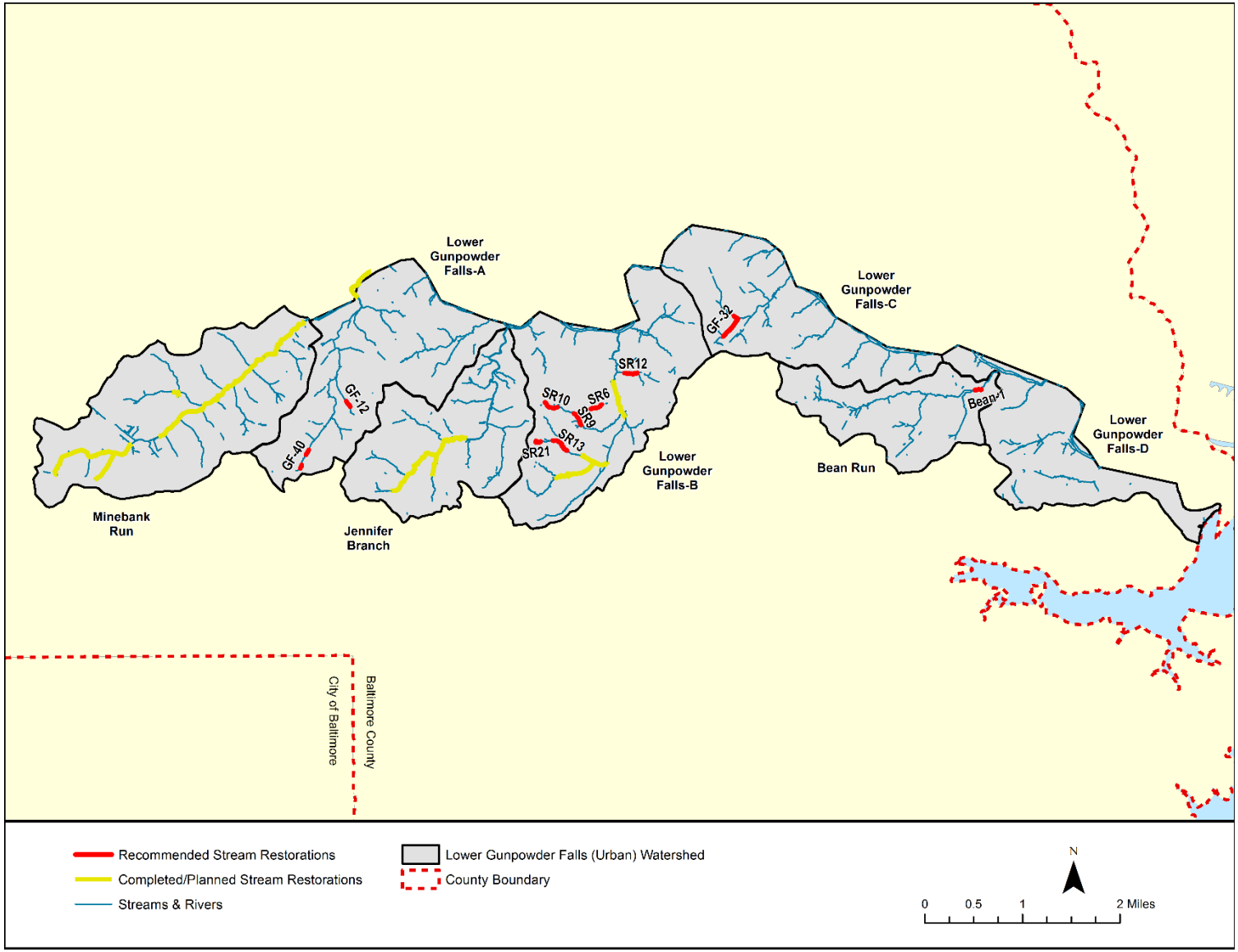


Figure 3-14: Area N Completed Stream Restorations and Recommended Projects

3.7 STORMWATER MANAGEMENT FACILITIES

As part of a larger on-going effort by the County, and in conjunction with the characterization of Lower Gunpowder Fall (Urban) watershed and development of the SWAP, existing stormwater management facilities were investigated for potential conversion to improve water quality treatment within the study area.

Some of the factors that may contribute to a facility being a good candidate for conversion are:

- Percent impervious cover within the contributing drainage area
  - Impervious surfaces prevent runoff from infiltrating back into the ground.
  - Runoff from impervious surfaces carries pollutants such as oils, fertilizers, sediment and trash into downstream ponds.
- Site accessibility for construction and maintenance
- Site topography/slope for potential facility expansion or grading
- Length of flow path through the facility
  - Possibility to increase the length to provide additional retention and filtering of runoff
- Tree/vegetation impacts during construction
- Potential permit requirements (specifically for in-line ponds)
- Cost vs. environmental benefit of conversion

Ponds that are considerably overgrown, or holding a significant amount of water, or located within a stream channel (in-line) are not considered to have conversion potential due to the amount of effort that would be required to provide additional benefits at that location. Even though some ponds are no longer functioning as originally designed (detention pond), they may already be providing additional water quality benefits naturally (e.g., clogged outfall pipes may result in a flooded wetland type facility). There is a relatively small benefit to be gained from conversion of these ponds and it is possible some benefit is already being achieved through “self-conversion”.

Baltimore County EPS has identified 15 existing stormwater management facilities as good candidates for conversion; 11 of these facilities have already been converted, and four more are planned as future conversion projects (Table 3-18). These existing facilities, had originally been designed for water quantity management and were assessed to determine if additional water quality benefits could be achieved through a conversion.

Table 3-18: SWM Detention Pond Conversions in Lower Gunpowder Falls (Urban) Watershed by Subwatershed

Subwatershed	Number of Converted SWM Ponds	Drainage Area to Converted SWM Ponds (acres)	Number of Planned SWM Pond Conversions	Drainage Area to Planned SWM Pond Conversions (acres)
Jennifer Branch	4	32.4	1	10.2
Lower Gunpowder Falls-A	4	37.5	0	0.0
Lower Gunpowder Falls-B	3	33.4	3	31.7
Totals	11	103.3	4	41.29

CHAPTER 4: UPLANDS ASSESSMENT

4.1 INTRODUCTION

Upland areas were assessed according to the Unified Subwatershed and Site Reconnaissance (USSR) Manual developed by CWP (CWP 2004) to identify potential pollution sources influencing water quality and to identify restoration project opportunities. The USSR manual is the last manual in a series of 11 regarding techniques for restoring urban watersheds. It provides detailed guidance for field survey techniques and was developed to help watershed groups, municipal staff, and consultants to quickly identify major stormwater pollution sources and to assess subwatershed restoration potential for source controls, pervious area management, and improved municipal maintenance such as education, retrofits, street sweeping, and open space management.

The field survey of upland areas in the Lower Gunpowder Falls (Urban) watershed included four major components:

- Neighborhood Source Assessments (NSAs),
- Hotspot Site Investigations (HSIs),
- Institutional Site Investigations (ISIs), and
- Pervious Area Assessments (PAAs).

Each of these components is described in detail in the following sections.

Subwatersheds were assigned the following unique numbers for the purposes of assigning site identification numbers for HSIs, ISIs, and PAAs: Minebank Run (100); Lower Gunpowder Falls-A (200); Jennifer Branch (300); Lower Gunpowder Falls-B (400); Lower Gunpowder Falls-C (500); Bean Run (600); and Lower Gunpowder Falls-D (700).

4.2 NEIGHBORHOOD SOURCE ASSESSMENTS (NSA)

NSAs describe pollution source areas, stewardship behaviors, and restoration opportunities within individual neighborhoods. Each neighborhood has unique characteristics that are to be considered in deciding if it is possible and/or necessary to implement restoration projects, source controls, and stewardship practices. The sections below describe the methods used to delineate and assess individual neighborhoods in the Lower Gunpowder Falls (Urban) watershed.

4.2.1 Assessment Protocol

Prior to conducting NSAs in the field, neighborhoods were delineated using GIS data such as tax parcels, roads, historical development information and aerial photographs. A neighborhood was delineated based on a group of homes with similar characteristics including lot sizes, road widths, set-backs, year built, and type (apartment complex, rowhomes, single family detached, etc.). NSAs were identified using the classification scheme “NSA_N_45”, where ‘N’ denotes the Lower Gunpowder Falls (Urban) watershed and neighborhoods were then numbered sequentially as delineated. The accuracy of these defined neighborhoods was verified in the field. Adjustments were made as necessary to group similar neighborhoods or ungroup dissimilar neighborhoods.

Field investigations were conducted from June and July 2015, using the NSA protocol documented in the USSR (CWP 2004). The field team drove through every street in a defined neighborhood to identify potential pollution sources and restoration opportunities. To standardize the NSA process, and be able to prioritize potential restoration efforts, data were collected in each neighborhood for four main source areas: yards and lawns; driveways, sidewalks, and curbs; rooftop runoff; and common areas. These are each described briefly below. Opportunities for planting street and shade trees were also noted.

Yards and Lawns

Yards and lawns typically represent a significant portion of the pervious cover in an urban subwatershed and therefore can be a major source of nutrients, pesticides, sediment, and runoff. Maintenance behaviors tend to be similar within individual neighborhoods and certain activities can impact subwatershed quality such as fertilization, pesticide use, watering, landscaping, and waste. Potential pollution sources evaluated under this source category include grass cover and management status (fertilization and irrigation methods), bare soil, outdoor swimming pools, and uncontained junk or trash. The amount of existing shade tree cover and landscaping in neighborhoods were also evaluated, and locations for possible new plantings were noted. These plantings would provide water quality benefits through interception and filtration of stormwater runoff.

Driveways, Sidewalks, and Curbs

Driveways, sidewalks, and curbs are common in many urban subwatersheds and link neighborhood runoff to the storm drain system. Activities such as car washing, deicing, and improper chemical storage can contribute pollutants such as nutrients, oil, sediment, and chlorides into the storm drain system. Data were collected for potential pollution sources including stained/dirty driveways, sidewalks covered with lawn clippings/leaves or receiving non-target irrigation (source of nutrients and sediment), pet waste (bacteria), long-term car parking (unused old cars with potential to leak chemicals, oil, and/or grease) and the amount of sediment, organic matter, and/or trash present along curbs. Potential for street tree planting and street sweeping was also evaluated based on some of these factors.

Rooftops

Rooftop runoff is another contributor to stormwater runoff and pollutants in neighborhoods. Downspout retrofits can help reduce runoff and pollutants introduced to local streams. The field crews identified whether downspouts discharged rooftop runoff to pervious areas, rain barrel, impervious surfaces (driveways, street), and/or directly to the storm drain system, and the proportion of each within a neighborhood. The potential for disconnecting and redirecting downspouts from impervious surfaces or the storm drain system was also evaluated.

Common Areas

Common areas such as community parks, parking lots and alleys are good opportunities to observe community behaviors such as pet waste disposal, stormwater management, storm drain marking, and how natural areas or buffers are managed. Good upkeep of these areas indicates that residents or a homeowner's association (HOA) are active and may represent opportunities for restoration projects. Data was collected on the condition of storm drain inlets (whether they were clean or filled with debris) and presence of pet waste or dumping in common areas to identify potential pollution sources in a neighborhood. The potential for storm drain marking, stormwater management practices, and stream buffer planting was also evaluated. In addition to these four

source areas, potential pollution sources were identified in individual neighborhoods by collecting basic information regarding the presence of sewer service and amount of remodeling or redevelopment activities.

Basic neighborhood information collected to help rate restoration potential included lot size, house types, fraction of houses with basements and garages, and whether a homeowner's association exists for the community. After driving around the entire neighborhood and completing the basic information and four major source area sections, any major pollutants that were potentially being generated by the neighborhood were indicated on the field form including nutrients, oil and grease, trash/litter, bacteria, and sediment. For example, if a neighborhood had several stained driveways and/or several long-term parked vehicles/ boats, oil and grease would be flagged as a potential major pollutant being generated in that neighborhood. The presence of trash in several yards or dumping in common areas would be a significant indicator for trash/litter generated in a neighborhood. Sediment was flagged as a major pollutant source if several areas of erosion or bare soil were observed, significant amount of remodeling/redevelopment was occurring, and/or a considerable portion of the curb and gutters were covered with sediment.

After driving through and evaluating an entire neighborhood, specific actions were recommended for neighborhoods in the Lower Gunpowder Falls (Urban) watershed included:

- Downspout disconnection, rain barrels, and rain gardens;
- Fertilizer reduction/education;
- BayScaping;
- Storm drain marking;
- Street tree planting;
- Trash management; and
- Multi-family parking lot or alley retrofit.

The last step of the NSA involved rating the overall neighborhood pollution severity and restoration potential. The severity of pollution generated by a neighborhood is denoted by the Pollution Severity Index (PSI) based on benchmarks and scoring system in the USSR manual (CWP 2004). An NSA PSI is rated as severe, high, moderate, or low. A neighborhood's potential for residential restoration projects is rated as high, moderate, or low according to the Restoration Opportunity Index (ROI). The USSR also provides benchmarks and guidelines to establish NSA ROI ratings.

4.2.2 Summary of Sites Investigated

A total of 89 neighborhoods were assessed throughout the Lower Gunpowder Falls (Urban) watershed (Figure 4-1). The number of neighborhoods within each subwatershed is summarized in Table 4-1. Note that a neighborhood may exist in more than one subwatershed; in this case the neighborhood was assigned to the subwatershed containing the largest portion of the watershed. Seventeen of the neighborhoods were rated as having a high PSI. Of these 17, 11 neighborhoods are considered as having a high ROI and six have a moderate ROI. The 11 neighborhoods with high PSI and high ROI ratings represent the best areas to target for restoration initially. The distribution of PSI and ROI ratings among the NSAs are shown in Figure 4-2.

Table 4-1: Neighborhoods Surveyed in Lower Gunpowder Falls (Urban) by Subwatershed

Subwatershed	# of NSAs
Bean Run	11
Jennifer Branch	20
Lower Gunpowder Falls-A	11
Lower Gunpowder Falls-B	28
Lower Gunpowder Falls-C	7
Lower Gunpowder Falls-D	2
Minebank Run	10
Total	89

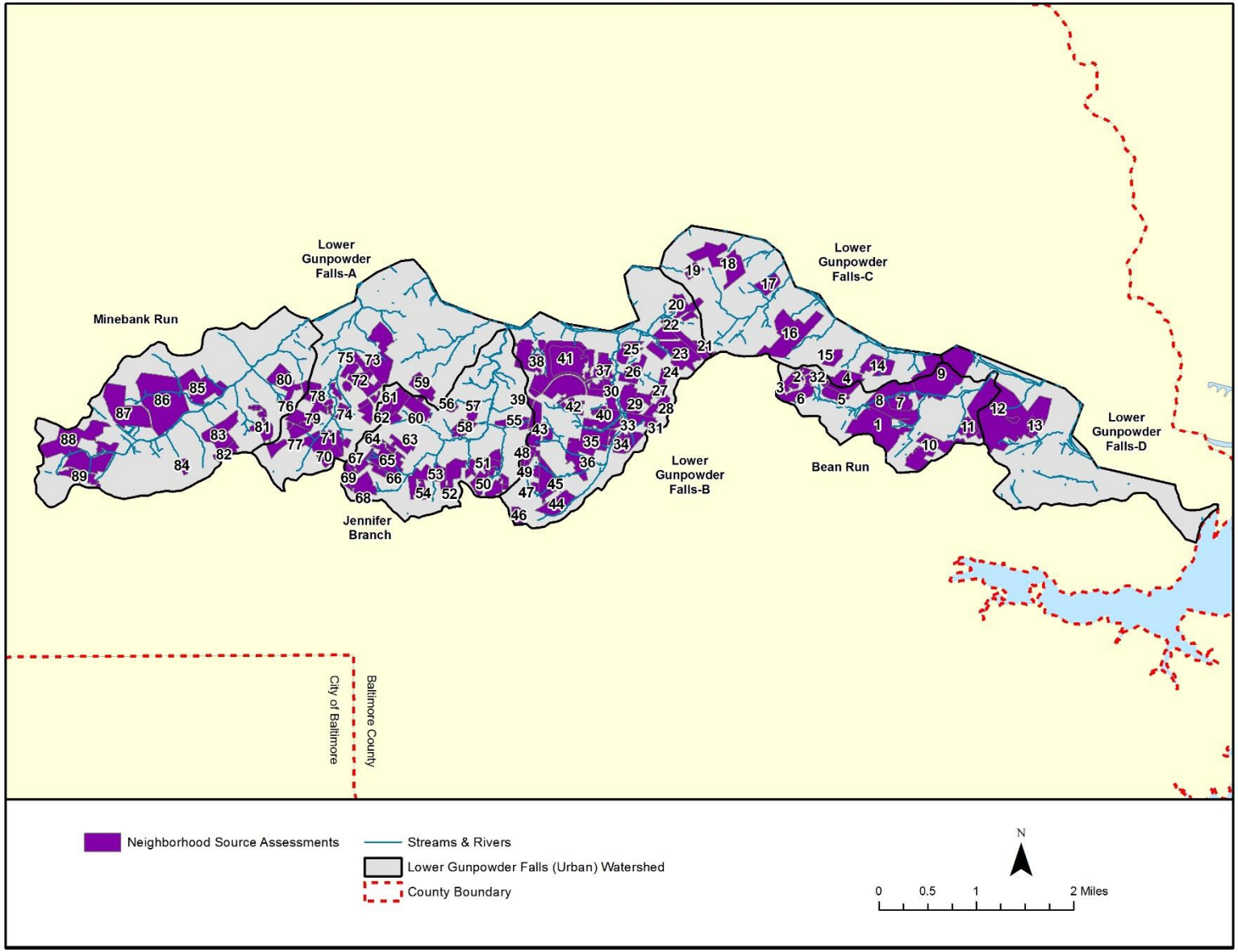


Figure 4-1: Location of NSAs in Lower Gunpowder Falls (Urban) Watershed

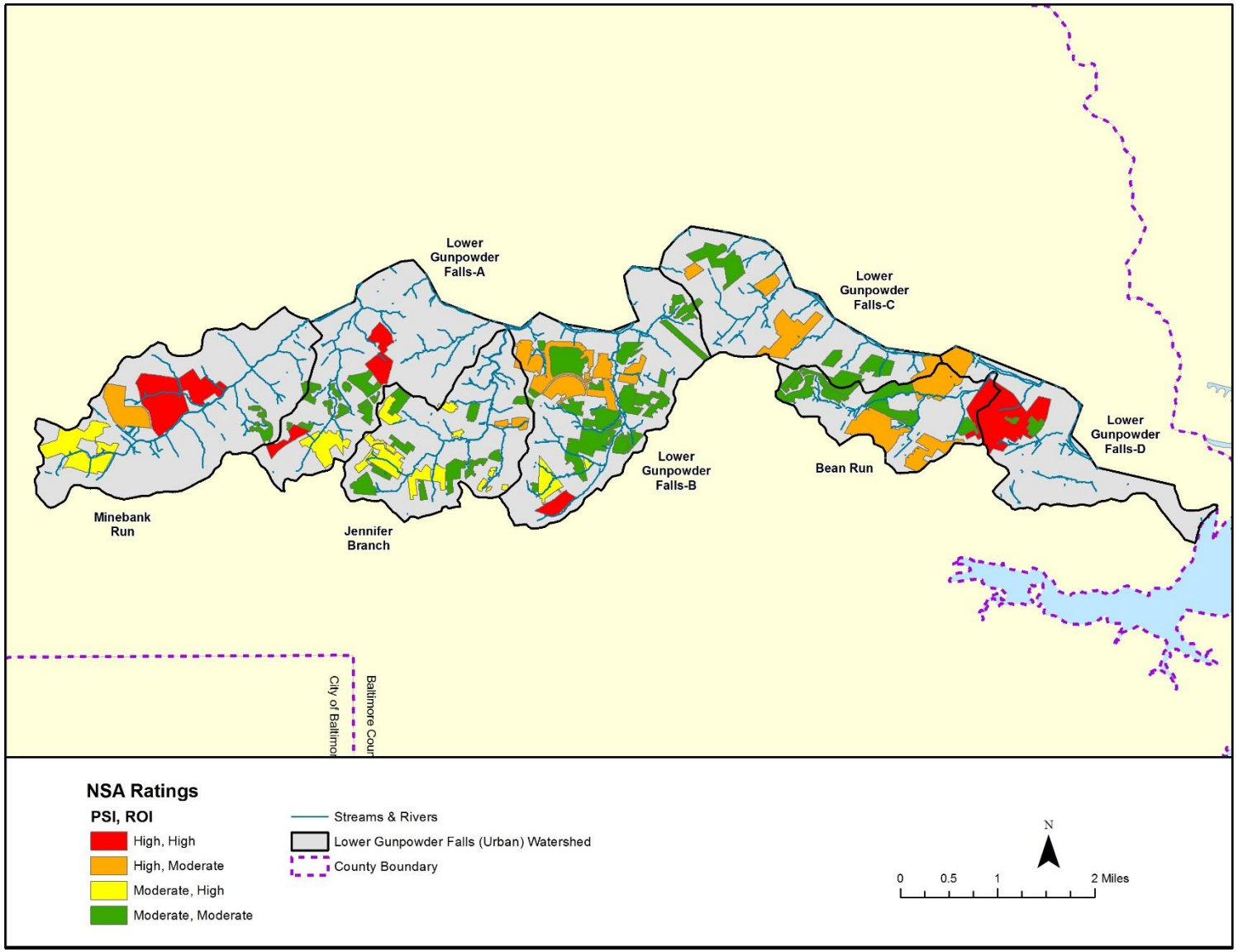


Figure 4-2: Top Target Areas for Restoration Based on NSA Pollution Severity and Restoration Opportunity Indices in Lower Gunpowder Falls (Urban) Watershed

4.2.3 General Findings

The following subsections describe the actions recommended based on the NSAs. This includes an explanation of the methodologies and criteria used to evaluate the potential for recommended actions and results expected if these actions were applied. Figures showing general locations of NSAs recommended for certain actions are included in each subsection. Appendix F includes a summary of NSA data collected and recommended actions by individual neighborhoods. Calculations supporting estimates of results for recommended actions are included in Appendix G.

4.2.3.1 Downspout Retrofits: Downspout Redirection, Rain Barrels, and Rain Gardens

Rooftop runoff is managed via downspouts which are considered as either connected or disconnected. Directly connected downspouts extend underground, discharging runoff directly to the storm drain system without treatment. Indirectly connected downspouts drain to impervious surfaces such as paved driveways, sidewalk, or curb and gutter system with little or no treatment. Disconnected downspouts allow rooftop runoff to infiltrate into the ground and enter streams through the groundwater system in a slower more natural fashion. Downspout retrofitting is desirable because it decreases flow to local streams during storm events; this helps prevent erosion and reduces pollutant loads to streams. Retrofitting may involve redirecting connected downspouts from impervious areas or the storm drain system onto pervious areas such as yards and lawns. Infiltration of rooftop runoff requires at least 15 linear feet of pervious area down gradient from the downspout. Under certain conditions, rain barrels and rain gardens are also retrofit options and may be recommended in lieu of redirection. Rain barrels, for example, may be used to store rooftop runoff for irrigation if there is limited pervious area available for downspout redirection. Rain gardens are the most desirable option in terms of water quality because they consist of amended soils and native plants that capture and treat runoff; this is a potential option for disconnection if the typical neighborhood has several hundred square feet of lawn area available down gradient from the downspout. Rain gardens are also an option in areas where downspouts are already disconnected, and are useful for capturing other types of impervious runoff. They also provide an opportunity for education and outreach, and can be a hands-on activity that opens the door for discussion of other best management practices with homeowners.

Downspout redirection is recommended for neighborhoods where at least 25 percent of the downspouts are connected to impervious area or directly to the storm drain system and where the average lot has at least 15 feet of pervious area available down gradient from the connected downspout for redirection. Table 4-2 includes a summary of the number of neighborhoods recommended for downspout redirection and the acres of rooftop that would be addressed if downspout disconnection was implemented. Figure 4-3 shows an example of downspouts draining directly to an impervious driveway. A neighborhood identified for downspout disconnection may also be recommended for rain gardens and/or rain barrels, which are also noted in the table.

Figure 4-4, Figure 4-5, and Figure 4-6 show the location of neighborhoods recommended for downspout redirection, rain barrels, and rain gardens. Out of the 89 neighborhoods assessed, 24 have the potential for downspout disconnection through redirection, 88 are recommended for rain barrels (Figure 4-7), and 29 are recommended for rain gardens (Figure 4-8).

Table 4-2: Downspout Retrofit Recommendations

Subwatershed	# of NSAs Recom-mended for Downspout Redirection	Rooftop Acres Addressed by Downspout Redirection	# of NSAs Recommended for Rain Barrels	# of NSAs Recommended for Rain Gardens
Bean Run	1	4.4	11	4
Jennifer Branch	5	7.4	20	4
Lower Gunpowder Falls-A	3	14.1	11	3
Lower Gunpowder Falls-B	13	28.8	28	8
Lower Gunpowder Falls-C	1	5.2	7	4
Lower Gunpowder Falls-D	0	0.0	2	1
Minebank Run	1	2.9	9	5
Total	24	62.6	88	29

Figure 4-3: Example of a House Where Downspout Drains Directly to Impervious Driveway in NSA_N_7

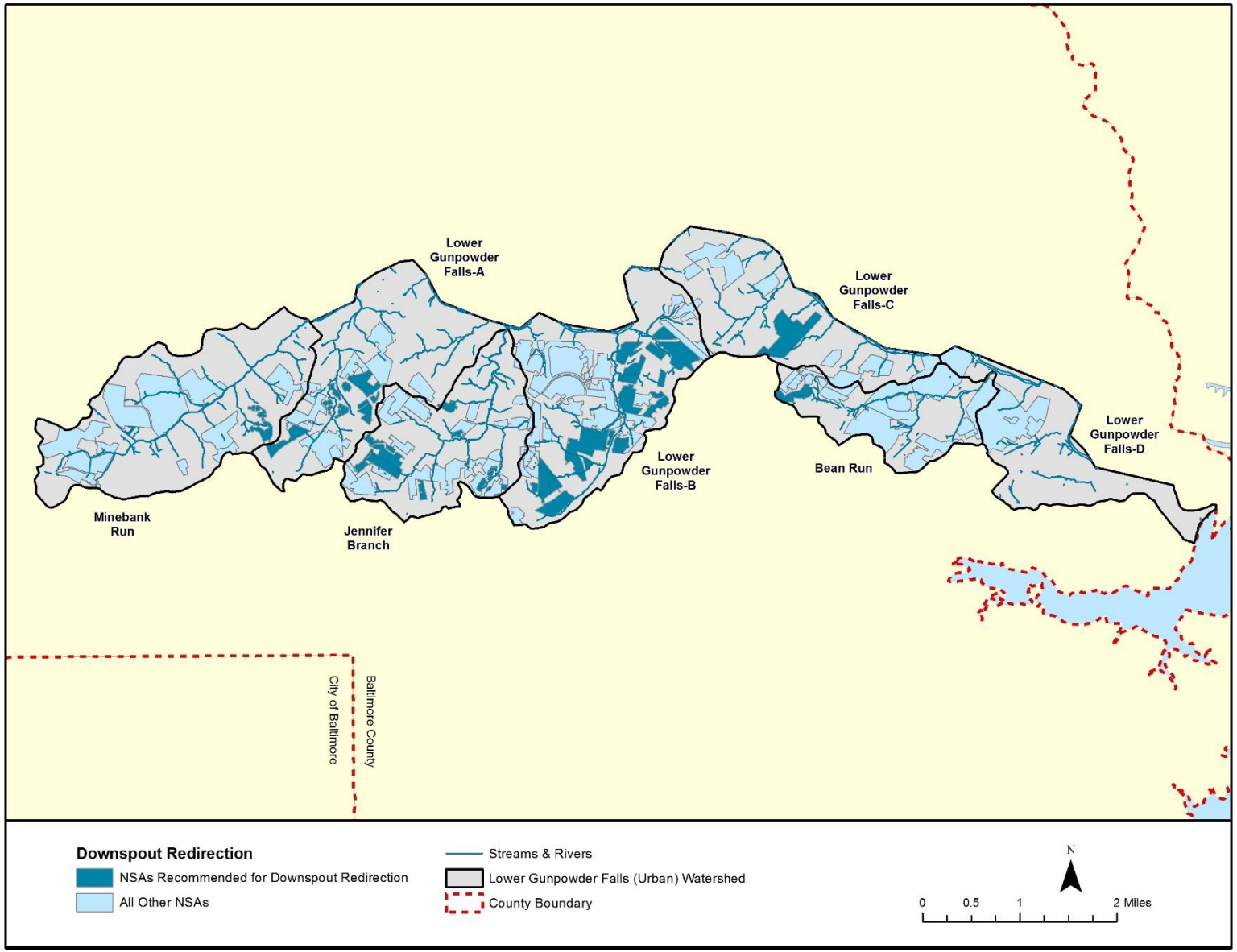


Figure 4-4: Neighborhoods Recommended for Downspout Redirection

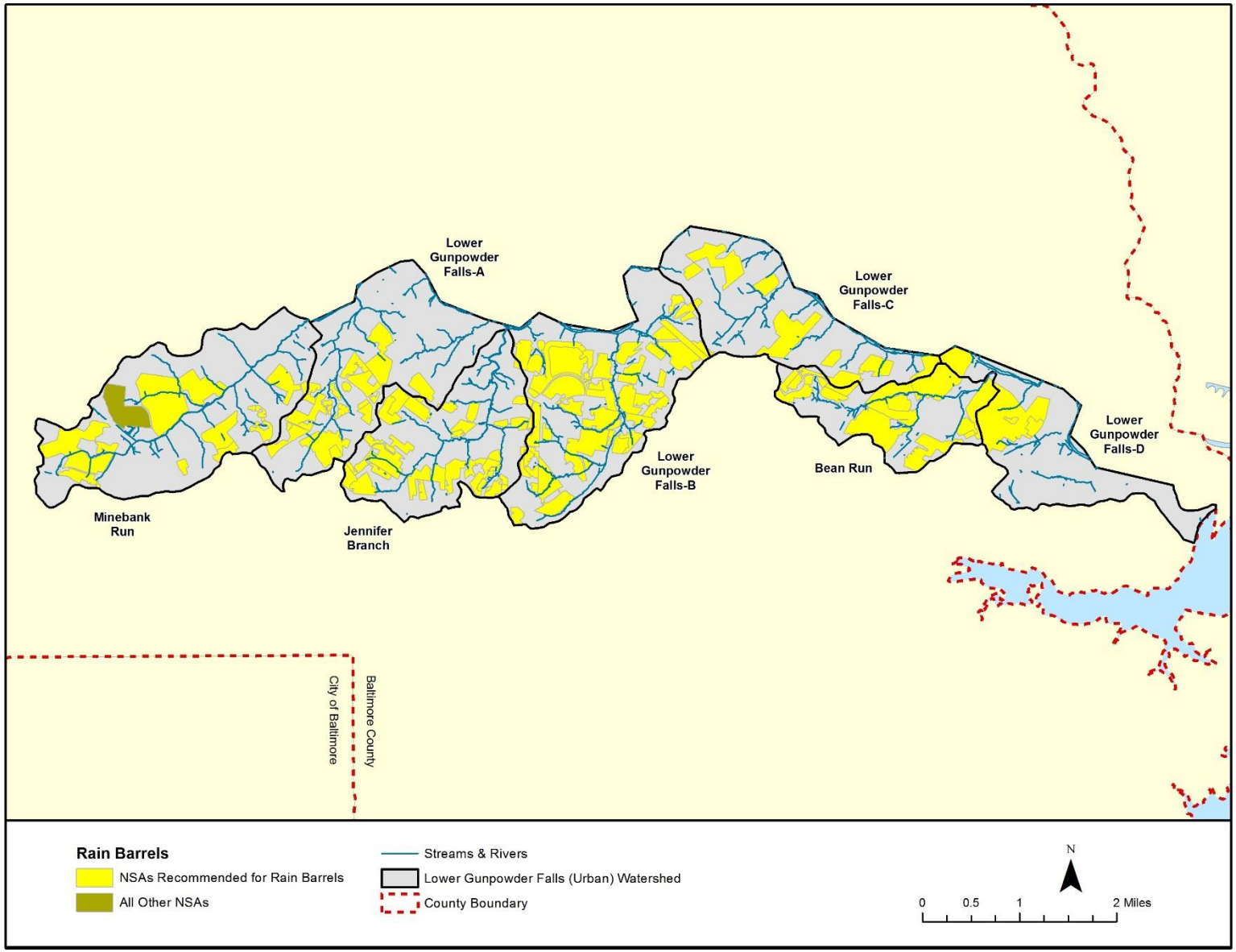


Figure 4-5: Neighborhoods Recommended for Rain Barrels

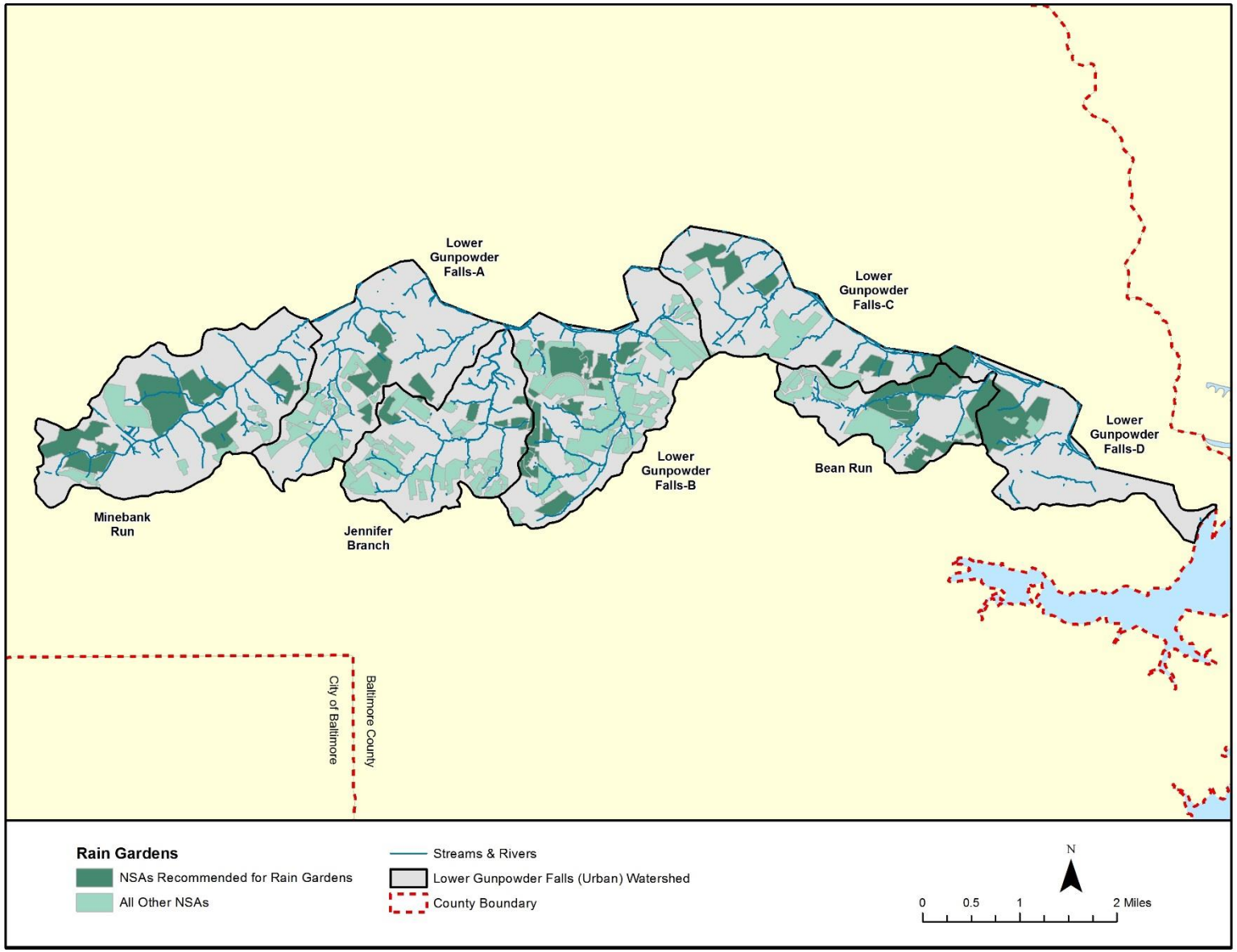


Figure 4-6: Neighborhoods Recommended for Rain Gardens

Figure 4-7: Example of a Rain Barrel Installation. Photo Credit: Gunpowder Valley Conservancy (GVC)

Figure 4-8: Example of a Rain Garden. Photo Credit: Gunpowder Valley Conservancy (GVC)

4.2.3.2 Fertilizer Reduction/Education

A well-maintained lawn can be beneficial to the watershed. However, lawn maintenance activities often involve over-fertilization, poor pest-management, and over-watering resulting in polluted stormwater runoff to local streams. Lawns with a dense, uniform grass cover or signs designating poisonous lawn care chemicals indicate high lawn maintenance activities. Neighborhoods where 20 percent or more of the homes appeared to employ high lawn maintenance practices were recommended for fertilizer reduction/education. Table 4-3 includes a summary of the number of neighborhoods recommended for fertilizer reduction/education and the acres of lawn addressed if implemented. Figure 4-9 shows the location of neighborhoods recommended for fertilizer reduction/education (any neighborhood with 20 – 100% high maintenance lawns). Forty-two neighborhoods were recommended for fertilizer reduction/education.

Table 4-3: Fertilizer Reduction Recommended in Subwatersheds

Subwatershed	# of NSAs Recommended for Fertilizer Reduction	Acres of Lawn Addressed
Bean Run	7	61.4
Jennifer Branch	6	14.6
Lower Gunpowder Falls-A	2	5.7
Lower Gunpowder Falls-B	14	60.9
Lower Gunpowder Falls-C	6	31.0
Lower Gunpowder Falls-D	2	44.9
Minebank Run	5	88.1
Total	42	306.6

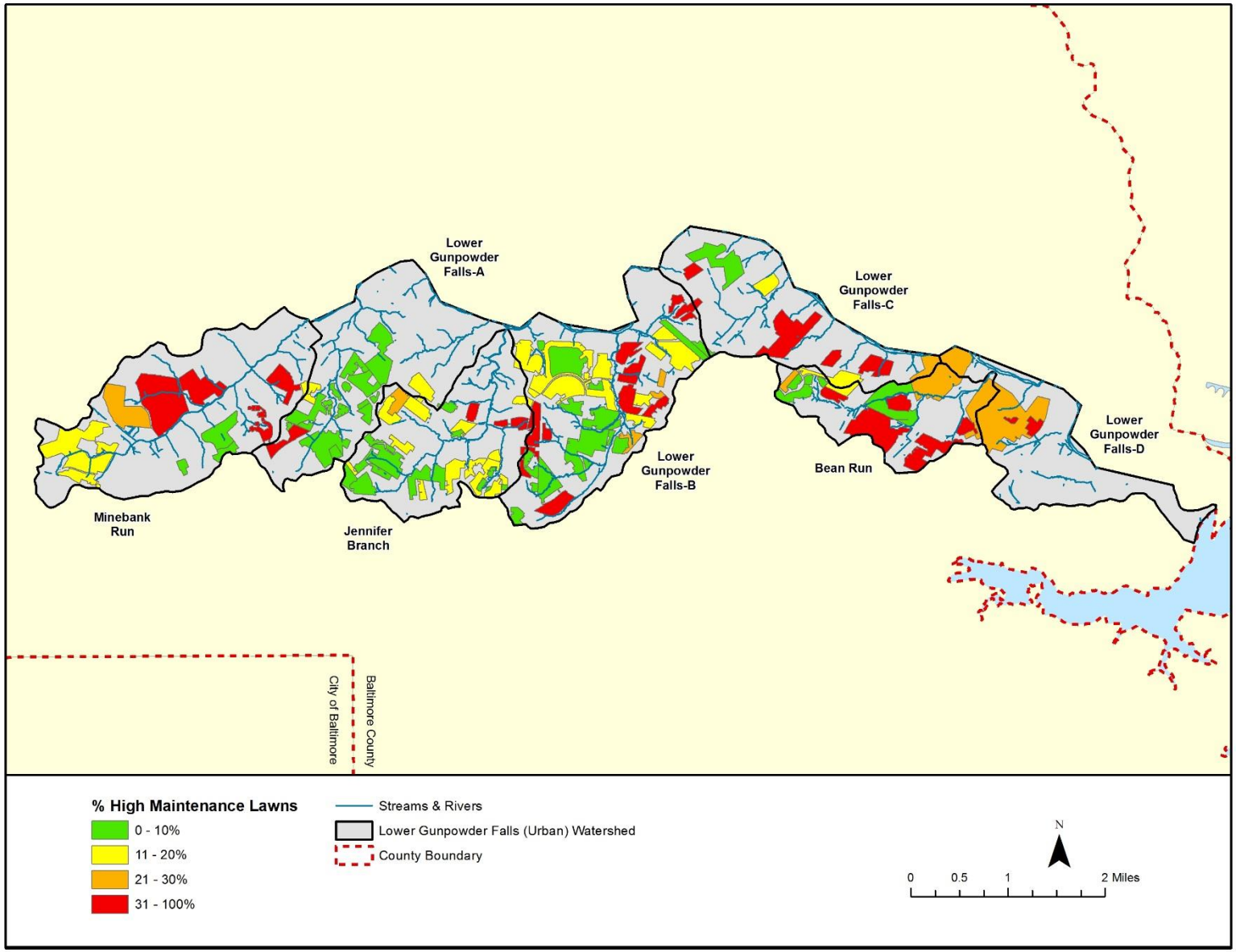


Figure 4-9: Neighborhoods by Percentage of High Maintenance Lawns

4.2.3.3 BayScaping

BayScaping refers to the use of plants native to the Chesapeake Bay watershed for landscaping (Figure 4-10). Because they are native to the region, these plants require less irrigation, fertilizers, and pesticides to maintain as compared to non-native or exotic plants. This means less stormwater pollution and lawn maintenance requirements. BayScaping is also beneficial to wildlife.

All neighborhoods could use more BayScaping; however, the benefits and feasibility of this action are limited by several factors. BayScaping was recommended in neighborhoods where the typical lot was at least ¼ acre in size, was less than 25 percent landscaped, and where there was sufficient grass area available (i.e., where impervious cover on the lot would not inhibit improvement of this percentage). Table 4-4 includes a summary of the number of neighborhoods recommended for BayScaping and the acres of land addressed if implemented. Figure 4-11 shows the location of neighborhoods recommended for BayScaping. Out of the 89 neighborhoods assessed, 55 met the criteria and were recommended for BayScaping.

Table 4-4: BayScaping Recommendations

Subwatershed	# of NSAs Recommended for BayScaping	Acres of Land Addressed
Bean Run	3	85.1
Jennifer Branch	11	83.5
Lower Gunpowder Falls-A	10	101.2
Lower Gunpowder Falls-B	19	179.6
Lower Gunpowder Falls-C	5	88.5
Lower Gunpowder Falls-D	2	134.8
Minebank Run	5	169.5
Total	55	842.1

Figure 4-10: Example of BayScaping. Photo Credit: US Fish and Wildlife Service BayScape at Maryland State Treasury Building.

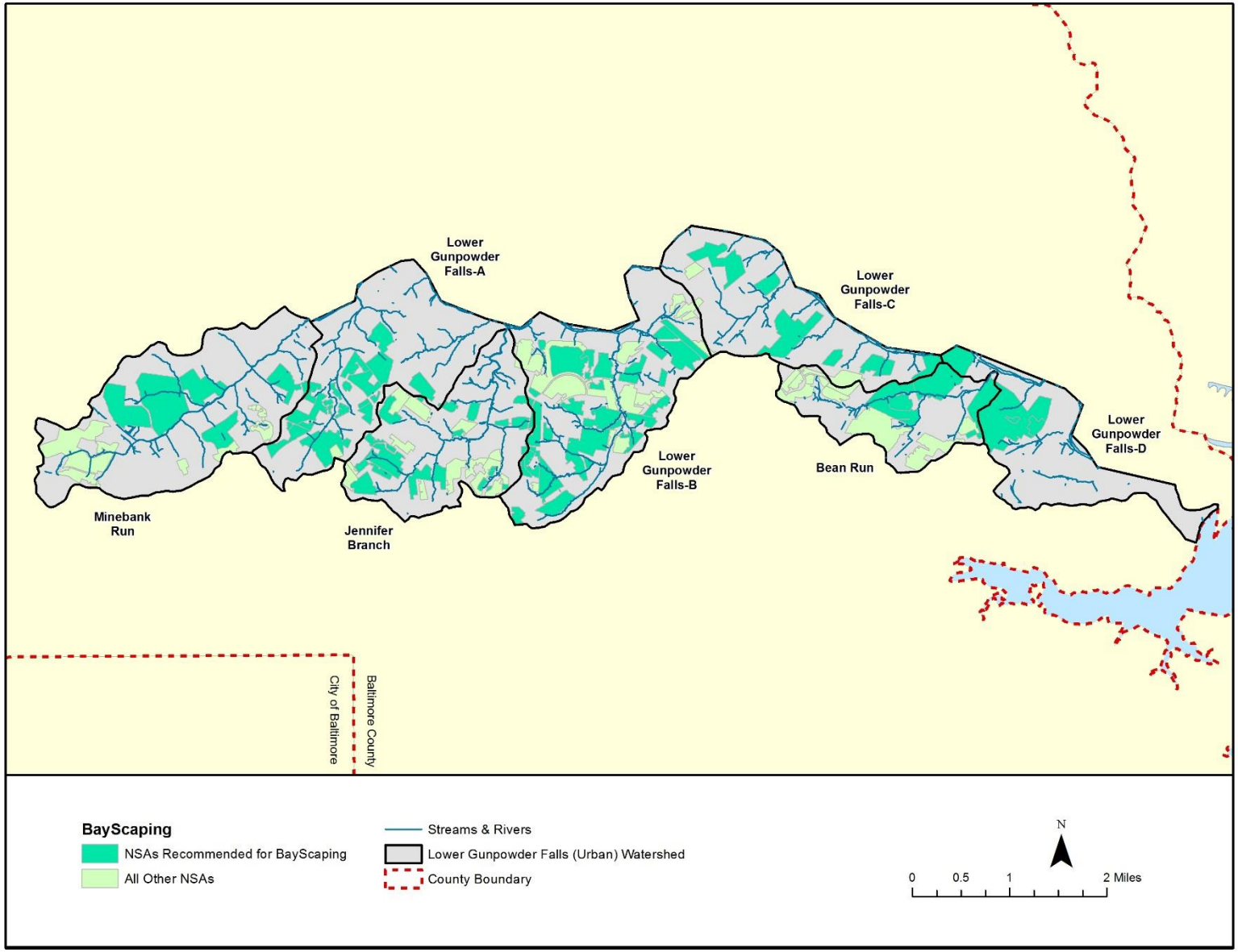


Figure 4-11: Neighborhoods Recommended for BayScaping

4.2.3.4 Storm Drain Marking

Most of the neighborhoods in the Lower Gunpowder Falls (Urban) watershed consist of curb and gutter systems. These include storm drain inlets that convey stormwater runoff quickly and directly to the stream system and ultimately into the river and Chesapeake Bay. Marking these inlets is an excellent way to educate the public about the connection between their storm drain inlets and the Bay. Knowing this helps them to understand that anything building up along the curbs and gutters, such as trash and lawn clippings (potential for nutrient pollution), will be washed away after a storm event and end up in the Gunpowder River and/or the Bay. Many neighborhoods had inlets with faded storm drain markings, or no markings at all. Particularly in areas with little or no infiltration of stormwater, there is more potential for pollutants to be carried to the stream system.

Neighborhoods recommended for storm drain marking had curb and gutter systems with inlets appropriate for marking and where less than 10 percent of the existing inlets were already marked (and legible). Table 4-5 includes a summary of the number of neighborhoods recommended for storm drain marking and the inlets addressed if implemented. Figure 4-12 shows the location of neighborhoods recommended for storm drain marking. Out of the 89 neighborhoods assessed, 78 met the criteria and were recommended for storm drain marking.

Table 4-5: Storm Drain Marking Recommendations

Subwatershed	# of NSAs Recommended for Storm Drain Marking	Approximate No. of Inlets Addressed	% of Subwatershed Inlets Addressed
Bean Run	11	311	80
Jennifer Branch	19	233	40
Lower Gunpowder Falls-A	11	168	48
Lower Gunpowder Falls-B	24	524	54
Lower Gunpowder Falls-C	6	123	64
Lower Gunpowder Falls-D	1	12	22
Minebank Run	6	145	26
Total	78	1,516	49

Note: Baltimore County is currently updating their storm drain data and although this current dataset is incomplete and in draft form, it is more accurate and complete than the County's historic storm drain data.

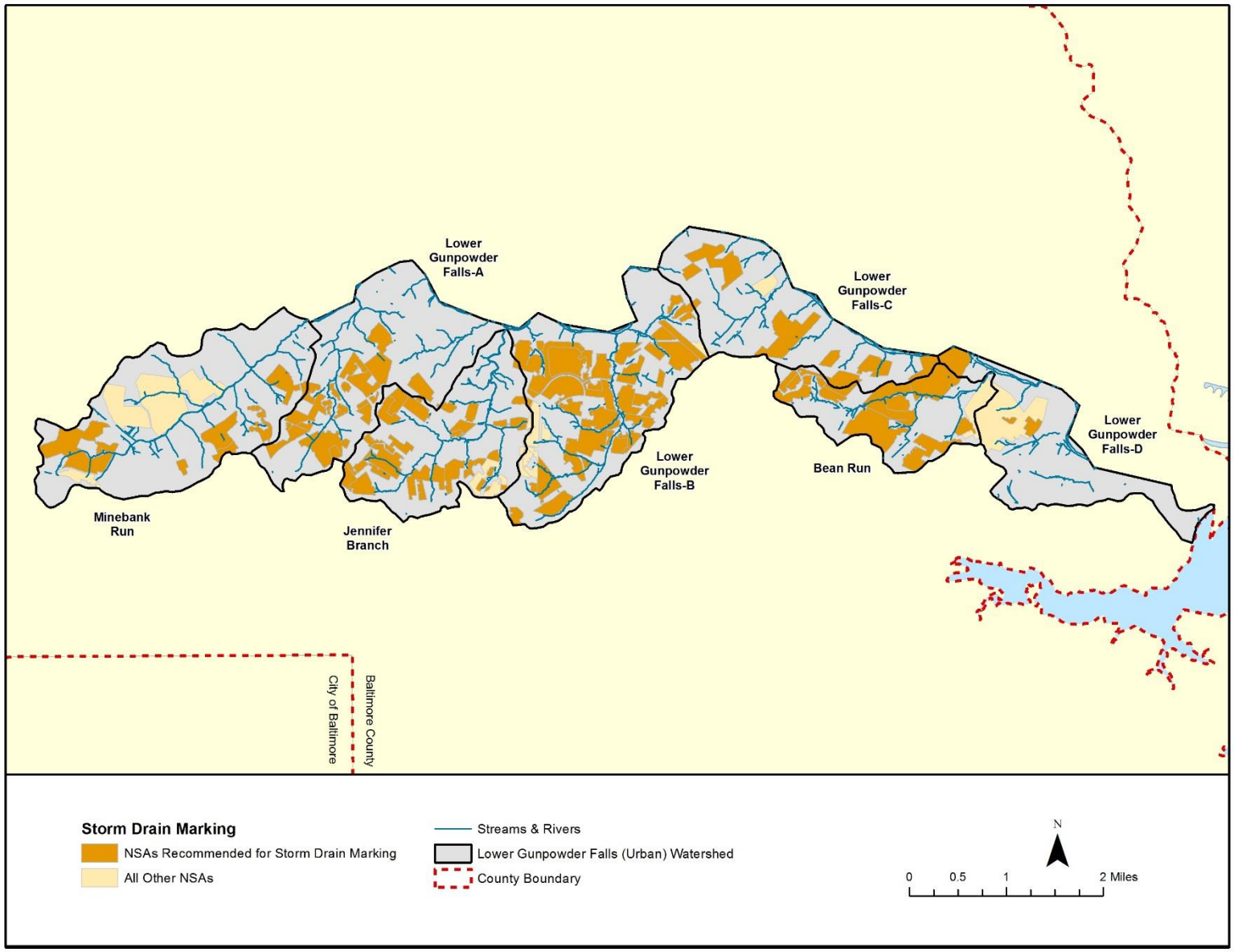


Figure 4-12: NSAs Recommended for Storm Drain Marking

4.2.3.5 Tree Planting Opportunities

Trees are an asset to a neighborhood aesthetically, and they also improve air and water quality as they intercept precipitation with their leaves and can absorb precipitation and nutrients through their root systems. Interception of precipitation with the leaves or infiltration through the root systems slows stormwater runoff and provides some treatment before it reaches the stream system. Street trees were recommended for neighborhoods where at least 25 percent of the streets had a minimum of 6 feet of greenspace between the sidewalk and curb and less than 75 percent of the suitable areas had trees planted. The number of trees was estimated based on a spacing of one tree per 15 to 20 feet. Street tree estimates would be capped at a maximum of 100 per neighborhood and the potential for more than 100 street trees would be noted in these cases; however, no neighborhoods reached this number. Open space trees were recommended for neighborhoods where there were open pervious areas that were not being used by the community for other purposes (Figure 4-13). The recommended planting density on open space land is 200 trees per acre, or a spacing of approximately 15 to 25 feet between trees.

Table 4-6 includes a summary of the number of neighborhoods recommended for tree planting and the number of street and open space trees proposed per subwatershed. Figure 4-14 illustrates the location of neighborhoods where street or open space trees could be planted. Out of the 89 neighborhoods assessed, 35 met the criteria and were recommended for tree planting. Neighborhoods not recommended for street trees did not have sidewalks and a curb and gutter system, had insufficient greenspace between the sidewalk and curb, or lawn trees already provided shade for the street. In several areas, most of the appropriate areas had been planted. There is potential for planting 32 street trees and 6,321 open space trees throughout the watershed. Table 4-7 lists tree species appropriate for tree plantings within the Lower Gunpowder Falls (Urban) watershed.

Table 4-6: Tree Planting Potential by Subwatershed

Subwatershed	# of NSAs Recommended for Tree Planting	# of Potential Street Trees	# of Potential Open Space Trees
Bean Run	4	0	990
Jennifer Branch	5	0	580
Lower Gunpowder Falls-A	7	7	980
Lower Gunpowder Falls-B	13	25	2,735
Lower Gunpowder Falls-C	2	0	270
Lower Gunpowder Falls-D	2	0	66
Minebank Run	2	0	700
Total	35	32	6,321

Figure 4-13: Examples of Excellent Tree Planting Opportunities in NSA_N_1 (top) and NSA_N_28 (bottom)

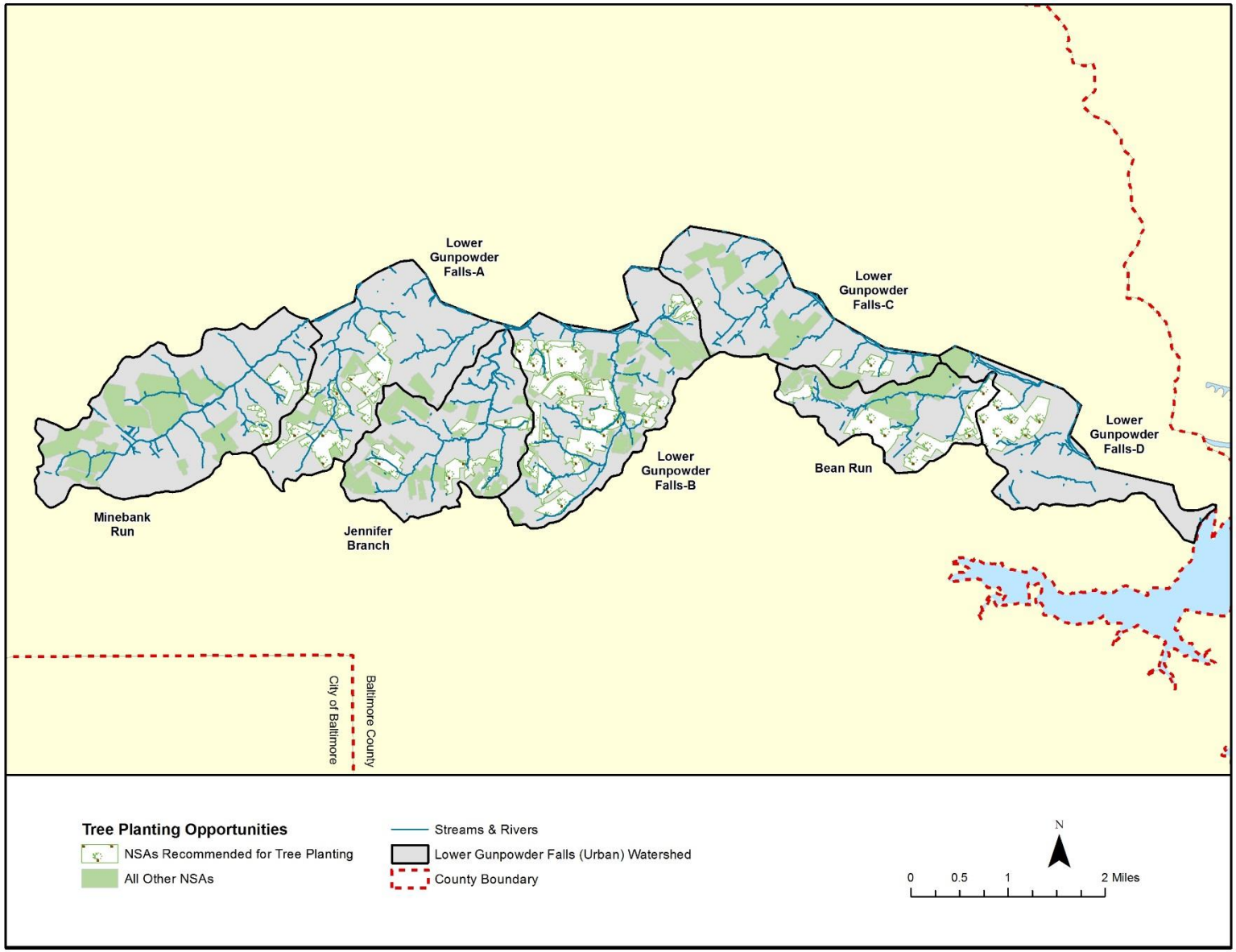


Figure 4-14: Neighborhoods Recommended for Tree Planting

Table 4-7: Native Tree Species Recommended for Street Tree Plantings within the Lower Gunpowder Falls (Urban) Watershed

Common Name	Scientific Name	Positive Attributes
Black gum	*Nyssa sylvatica*	Strong trunks; summer fruits; fall color
Downy juneberry	*Amelanchier arborea*	Small tree; edible fruits; earlier flowerer
Hackberry	*Celtis occidentalis*	Strong trunks; interesting bark pattern
Musclewood	*Carpinus caroliniana*	Strong trunk; slow grower; interesting trunk shapes
Pin oak	*Quercus palustris*	Strong trunks; slow grower; small acorns
Red maple	*Acer rubrum*	Fast grower; good shade tree; fall color
Redbud	*Cercis canadensis*	Small; shade tree
Sassafras	*Sassafras albidum*	Small; shade tree; fall color
Scarlet oak	*Quercus coccinea*	Fast growing tough oak, resists drought
Serviceberry	*Amelanchier canadensis*	Small tree; edible fruits; earlier flowerer
Slippery elm	*Ulmus rubra*	Strong trunks; fast grower; good wildlife species
Sourwood	*Oxydendron arboreum*	Moderate size; fall color
Sugar maple	*Acer saccharum*	Strong trunks; fall color
Swamp white oak	*Quercus bicolor*	Tolerates variety of habitats
Yellowwood	*Cladrastis kentukea*	Small tree; interesting showy, fragrant flowers

4.2.3.6 Street Sweeping

Street sweeping helps remove trash, sediment and other organic matter, such as leaves and grass clippings, from the curb and gutter system and prevents them from entering the storm drain system and nearby streams. Street sweeping also reduces other materials, like oil and metals, from being washed into the stream by stormwater runoff. Excessive organic matter, sediment, and trash can clog streams and the storm drain system and result in costly maintenance and stream health impairment. As the excess organic matter in the stream begins to decay, oxygen in the water is depleted, which in turn harms fish and other organisms living in the stream. An aggressive street sweeping initiative can ease the effects of a curb and gutter storm drain system on receiving streams.

Neighborhoods where 20 percent or more of the curbs and gutters were covered with excessive trash, sediment, and/or organic matter were recommended for street sweeping. Out of the 89 neighborhoods assessed, none met the criteria for street sweeping. Gutters in all neighborhoods were found have little or no debris and sediment in them.

4.2.3.7 Neighborhood Trash Management

Trash is one of the many types of pollution that may affect a watershed. Neighborhoods where junk or trash was observed in at least 25 percent of yards would be recommended for trash management initiatives. The upland NSA survey revealed that there were no neighborhoods where trash management was an issue. Any ongoing efforts such as community cleanups, trash management education, and working with the Department of Public Works (DPW) to manage any

bulk trash pick-up programs should be continued in order to prevent the occurrence of trash pollution in the future.

4.2.3.8 Parking Lot Retrofits

There are many apartment, townhouse, and condo complexes in the Lower Gunpowder Falls (Urban) watershed. Multi-family parking lots in these types of neighborhoods can be an opportunity for stormwater retrofits to address runoff from impervious surfaces. This type of retrofit can address a large area of impervious cover within a single design plan. As discussed previously in Chapter 2, infiltration/filtration practices such as bioretention areas with native plantings could be used to capture and treat stormwater runoff from impervious parking lots and alleys while requiring minimal maintenance.

Neighborhoods where sufficient greenspace was available down gradient of a multi-family parking lot were recommended for stormwater retrofits. There are seven neighborhoods with appropriate areas for parking lot retrofits: two locations each in the Jennifer Branch, Lower Gunpowder Falls-B, and Minebank Run subwatersheds, and one location in the Lower Gunpowder Falls-A subwatershed.

4.3 HOTSPOT SITE INVESTIGATIONS (HSI)

Hotspots are areas that have the potential to generate higher concentrations of stormwater pollutants than typically found in urban runoff because they run higher risk of spills, leaks, or illicit discharges due to the nature of their operations (CWP 2007). These generally include commercial, industrial, municipal, or transport-related operations. The purpose of hotspot investigations is to evaluate pollution potential from hotspot operations and identify potential restoration practices that may be necessary.

Hotspots can be either unregulated or regulated by a permit for discharge under the National Pollutant Discharge Elimination System (NPDES). These permits allow for certain amounts of effluent discharge to the storm drain system which would be regulated by the State (or in some cases to a sanitary sewer connection which would be regulated locally). Stormwater pollutants generated as a result of hotspot operations depend on the specific activities but typically include nutrients, hydrocarbons, metals, chloride, pesticides, bacteria, and trash.

Some types of operations, such as retail and wholesale establishments, lawns, employee/customer parking, or roofs of administrative buildings are not regulated, but the nature of their operations makes them likely to be potential pollutant sources, and so they may be monitored locally to ensure compliance with applicable laws.

Regulated hotspots are known sources of pollution that are subject to applicable federal or state laws. In 1990, the USEPA issued regulations requiring that all stormwater associated with industrial activity be regulated by discharge permits, either by individual permits or general permits. General permits are also known as a Multi-Sector General Permit (MSGP). Maryland's new MSGP is permit No. 12-SW. A permit is required if there is an opportunity for pollutants from the industrial facility to be carried away by stormwater runoff ("exposure"). Generally, if all operations, movement of materials, and storage of materials are under a roof, then a permit is not needed. However, as long as there is any potential for exposure, a permit is required.

The EPA has identified six types of activities at industrial facilities that have the potential to be major sources of pollutants in stormwater (EPA 2009):

Loading and Unloading Operations

Loading and unloading operations can include pumping of liquids or gases from tankers to storage facilities, pneumatic transfer of dry chemicals, transfer by mechanical conveyor systems, or transfer of bags, boxes, drums or other containers by forklift or other material handling equipment. Material spills or losses in these areas can accumulate and be washed away during a storm.

Outdoor Storage

Outdoor storage activities include storage of fuels, raw materials, by-products, intermediate products, final products, and process residuals. Materials may be stored in containers, on platforms or pads, in bins, boxes or silos, or as piles. Storage areas that are exposed to rainfall and/or runoff can contribute pollutants to stormwater when solid materials wash off or materials dissolve into solution.

Outdoor Process Activities

Although many manufacturing activities are performed indoors, some activities, such as timber processing, rock crushing, and concrete mixing, occur outdoors. Outdoor processing activities can result in liquid spillage and losses of material solids, which makes associated pollutants available for discharge in runoff.

Dust or Particulate Generating Processes

Dust or particulate generating processes include industrial activities with stack emissions or process dusts that settle on surfaces. Some industries, such as mines, cement manufacturing, and refractories, also generate significant levels of dust that can be mobilized in stormwater runoff.

Illicit Connections and Non-Stormwater Discharges

Illicit connections of process wastes or other pollutants to stormwater collection systems, instead of to sanitary sewers, can be a significant source of stormwater pollution. Non-stormwater discharges include any discharge from the facility that is not generated by rainfall runoff (for example, wash water from industrial processes). With few exceptions, these non-stormwater discharges are prohibited. Permits include a list of authorized non-stormwater discharges.

Waste Management

Waste management practices include everything from landfills to waste piles to trash containment. All industrial facilities conduct some type of waste management at their site, much of it outdoors, which must be controlled to prevent pollutant discharges in stormwater.

While these HSIs are not focused on permitted industrial facilities, which already have rigorous self- inspection requirements, we can look for the same opportunities for illicit discharges

throughout the watershed at commercial, institutional, municipal and transportation-related sites that engage in the activities listed above. Additionally, oil spill prevention laws in Maryland require that facilities with 1,320 gallons of oily liquids stored above ground receive permits and develop Spill Prevention Control and Countermeasures plans (SPCCs). Hotspot investigations are also an opportunity to note any obvious violations of SPCC requirements or bad housekeeping practices for those facilities where storage of oily liquids exceeds 1,320 gallons. Moreover, some private facilities may be storing more than the 1,320 gallon threshold and may not know that they are required to apply for a permit and develop an SPCC. The HSI field work is a good opportunity to bring these situations to the County's attention as these sites have potential for significant non-stormwater discharges.

4.3.1 Field Investigation Protocol

A field crew was tasked with investigating potential hotspots throughout the Lower Gunpowder Falls (Urban) watershed. The 2014 field visits employed a hotspot investigation form modified by the County for previous SWAPs. The following subsections describe the methods used to identify and assess hotspots.

The types of parcels or land use categories that are typically associated with pollution activity include the following:

Commercial hotspots include a range of businesses and activities but are often grouped together in subwatersheds. Operations characteristic of commercial hotspots include waste or wash water generation, outdoor material storage, fuel handling, and auto/boat repair. Common commercial hotspots include auto repair shops, car dealers, car washes, parking facilities, gas stations, marinas, garden centers, construction equipment and building material lots, swimming pools, and restaurants.

Industrial operations utilize, generate, handle, and/or store pollutants that can be washed off with stormwater, spilled, or mistakenly discharged into the storm drain. Many industrial hotspots are regulated under NPDES industrial discharge permits and include various manufacturing operations such as metal production, chemical manufacturing, and food processing.

Municipal hotspots typically refer to local government operations such as solid waste, wastewater, road and vehicle maintenance, and yard waste. Like industrial operations, many municipal hotspots are subject to NPDES stormwater permits.

Transport-related hotspots normally include areas of significant impervious cover and extensive private storm drain systems. Many are regulated and include uses such as airports, ports, highway construction, and trucking centers.

Following the Baltimore County HSI protocol, which is largely based on the CWP USSR Manual, each hotspot investigation involved an evaluation of six common operations at each potential hotspot: vehicle operations, outdoor materials, waste management, physical plant, turf/landscaping, and stormwater infrastructure. The field team conducted windshield surveys and walked as much of the property of each potential hotspot as was accessible to look for potential or confirmed pollution sources and document them with photographs. Parameters evaluated within each operation category are described briefly below.

1. *Vehicle Operations*

For each site, any vehicle operations done outdoors (e.g., maintenance, repair, recycling, fueling, washing or long-term parking) were noted since they can be a major source of hydrocarbons and nutrients. Connections between outdoor vehicle operations exposed to precipitation and the storm drain system without any site-specific or regional stormwater water quality management facilities are the main focus of this category.

2. Outdoor Materials

Water quality issues can result from improper handling or storage of outdoor materials at hotspots. Locations where materials were loaded or unloaded were examined to see if liquid or transportable materials could be exposed to rain and drain to a storm drain. The field team also looked for improperly labeled storage containers, lack of secondary containment for liquids, and whether the storage area was directly or indirectly connected to the storm drain system.

3. Waste Management

Businesses typically generate waste as a result of daily operations, which can be potentially hazardous sources of stormwater pollution depending on the type of waste and how it is stored. The field team noted the type of waste generated (e.g., consumer packaging, food products, used cooking oils, construction materials etc.) and the condition of dumpsters. Dumpsters exposed to precipitation with no runoff diversion methods and with no cover or open lids, with leaks, damaged/in poor condition, and/or overflowing were noted as potential pollution sources.

4. Physical Plant

Common physical plant practices include cleaning, maintaining, or repairing the building, outdoor work areas, and parking lots. These activities can be a source of sediment, nutrients, paints, and solvents in stormwater runoff. For each hotspot, the condition of the building itself was evaluated. Stained, dirty, or damaged buildings were noted as evidence of potential pollution sources, as well as staining or discoloration around a building, which is evidence that maintenance activities (e.g., painting, power-washing, resealing, etc.) may discharge to storm drains. Similarly, parking lots that were stained, dirty, and/or breaking up, were recorded as potential pollution sources. Downspouts connected to impervious surfaces or connected directly to the storm drain system were also recorded.

5. Turf/Landscaping

Maintenance of turf/landscaped areas was also evaluated. High maintenance turf and improper irrigation practices were noted since they are potential pollution sources of nutrients, fertilizer, and pesticides. The field team also determined whether landscaped areas drained directly to storm drains or if organics (leaves, grass) accumulated on impervious surfaces. Areas of more than 20 percent of bare soil in turf/landscaped areas were flagged as a sediment pollution source.

6. Stormwater Infrastructure

If stormwater management practices were not present, the location was flagged as a potential pollution source. Private storm drains with considerable amounts of sediment, organics, and/or trash were identified as potential pollution sources.

For each operation listed on the HSI field form, there are observed pollution source indices and potential pollution source indices which can be checked off and summed to calculate a “Hotspot status” for the site. Finally, one or more of the follow-up actions listed below could be recommended based on initial field observations:

- Refer for immediate enforcement,
- Follow-up on-site inspection,
- Test for illicit discharge,
- Future education effort, and
- On-site non-residential retrofit.

4.3.2 Summary of Sites Investigated

Field investigations were conducted in October and November 2014. Table 4-8 shows the list of the 23 sites visited, which included sites selected during a GIS desktop analysis and sites that the field teams discovered while in the field. The table also details the type of facility; its “Hotspot Status” and number of potential pollution sources (i.e., number of circles filled-in on the HSI forms); any observed pollution sources; and follow-up actions and notes. Figure 4-15 shows the location of each candidate hotspot investigated within the watershed.

Unique ID numbers were assigned to HSI sites using the classification scheme “HSI_N_101”, where ‘N’ denotes the Lower Gunpowder Falls (Urban) watershed and the first digit of the site number corresponds to a specific subwatershed. The seven subwatersheds were assigned unique numbers (100 to 700) for the purposes of the upland assessments, as described in Section 4.1. For example, HSI locations in Minebank Run (subwatershed 100) would be identified as 101, 102, 103, etc.

Table 4-8: Summary of Hotspot Investigations, October-November 2014, Lower Gunpowder Falls (Urban) Watershed

Site ID	Date of Investigation	Type - Description	Hotspot Status (# filled circles)	Observed Pollution Source?	Recommended Follow-up Actions / Notes
HSI_N_101	11/25/2014	Commercial – Strip Mall	Confirmed (12)	Yes	Salt needs better containment so it does not spill past roof. Businesses throughout the strip mall need to clean up dumpster areas and pick up windblown trash.
HSI_N_102	10/22/2014	Commercial – Shopping Center	Severe (16)	No	Very filthy site. Storage, washing, and maintenance of school buses in back. Lots of outdoor storage of materials. Deicing material spilling out of trailer into back parking lot
HSI_N_103	10/22/2014	Commercial – Seafood Restaurant	Confirmed (4)	Yes	Improve waste oil storage.
HSI_N_128	11/25/2014	Commercial – Equipment Rental	Severe (17)	No	Several uncommon fueling tanks present. Lots of uncommon equipment stored outdoors. Entire site drains to one catch basin in back. Portable generator/construction lighting was leaking coolant. Make sure spill control plan is up to date. Fueling hoses lying in asphalt driveway.
HSI_N_129	11/24/2014	Commercial – Car Rental	Not a Hotspot(4)	No	Did not observe any active car washing only car vacuuming and window washing. Site has a sand filter device in rear.
HSI_N_131	11/25/2014	Commercial – Casual Dining Restaurant	Potential (7)	No	Nasty stain leading from dumpster to storm drain, but otherwise clean. Excessive impervious behind adjacent facility, but might be planned for new mixed use development.
HSI_N_132	11/25/2014	Commercial - Diner	Potential (7)	No	Nasty stain from dumpster area to catch basin in front. Spoke with cook, seemed aware of proper practices for handling grease and other waste.
HSI_N_223	11/25/2014	Commercial – Large Shopping Center	Potential (9)	No	The dumpster situation is not great. Grease dumpsters close to inlets is also an issue.
HSI_N_224	11/24/2014	Commercial – Fast Food Restaurant	Not a Hotspot (4)	No	Open dumpster, signs of leakage. Parking lot needs to be repaved.
HSI_N_225	11/25/2014	Commercial – Fast Food Restaurant	Potential (6)	No	Clean site. 55-gallon grease drums under roof. Dumpster has some leakage but is not connected to MS4 directly.
HSI_N_226	11/25/2014	Commercial – Italian Restaurant	Potential (6)	No	Some grease making its way into storm drain. Back parking lot needs to be repaved.
HSI_N_233	11/25/2014	Commercial – Casual Dining Restaurant	Potential (8)	No	Very poor practices documented by heavy 100-foot long grease stain from grease dumpster into catch basin. Mop buckets obviously being dumped outside of two back doors as evidenced by stains. Back of facility has significant garbage in bush line.
HSI_N_306	11/24/2014	Commercial – Strip Mall	Confirmed (12)	No	Biggest issues are five uncovered dumpsters and large lidless dumpster. Additionally there is trash scattered throughout facility. Unmarked 2-gallon container of fats in rear.

Site ID	Date of Investigation	Type - Description	Hotspot Status (# filled circles)	Observed Pollution Source?	Recommended Follow-up Actions / Notes
HSI_N_319	11/24/2014	Commercial – Small Machinery Repair and Landscaping Services	Confirmed (10)	Yes	This location is "hotter" than the HSI implies. The lot has lots of bare soil and erosion from heavy equipment. Used oil drums and outdoor fueling present. One drum was leaking. Repair and storage of small equipment is under a roof. A large front loader was being power washed during site visit.
HSI_N_320	11/24/2014	Commercial – Shopping Center	Not a Hotspot (5)	No	Clean site. Open dumpster only issue
HSI_N_405	11/24/2014	Commercial – Shopping Center	Confirmed (14)	No	Significant garbage in bushes at border of property. One mystery 55-gallon drum present. One leaking mystery pail (5 gallon), two unsealed 55-gallon grease drums behind Grocery store. One mystery 55-gallon blue drum with no lid. Garbage is particularly bad around Sushi Bar.
HSI_N_411	11/24/2014	Commercial – Strip Mall	Potential (6)	No	Relatively clean site. No staining, but possibly due to new pavement. Opportunity to direct stormwater into grassy area rather than directing it straight into stream. Noticed some suds behind the Vietnamese restaurant, which may be a sign of wash water dumping.
HSI_N_412	11/24/2014	Commercial – Diner	Not a Hotspot (4)	No	Even though it scores a "not a hotspot" status it should be reported for its waste management issues. Grease leakage is a big problem at this site.
HSI_N_415	11/24/2014	Commercial – Fast Food Restaurant	Confirmed (11)	No	Only concern is unsealed 55-gallon drums of fats inside dumpster enclosure.
HSI_N_416	11/24/2014	Commercial – Fast Food Restaurant	Not a Hotspot (5)	No	Grassed area outside of parking lot which could accommodate a large tree.
HSI_N_417	11/24/2014	Commercial – Small Auto Repair Shop	Confirmed (14)	No	Despite all of the filled circles this site is orderly. Biggest issue is uncovered dumpster w/ car parts in it. No easy retrofits.
HSI_N_418	11/24/2014	Commercial – Restaurant and Strip Mall	Not a Hotspot (4)	No	Dumpster area is a little messy, but not too bad. Some trash blowing around in back. Stains leading out of kitchen door, likely from dumping wastewater.
HSI_N_434	11/24/2014	Commercial – Pizza Restaurant and Granite Store	Not a Hotspot (5)	No	Sheet flow towards bank. Dumpsters and grease bin look good.

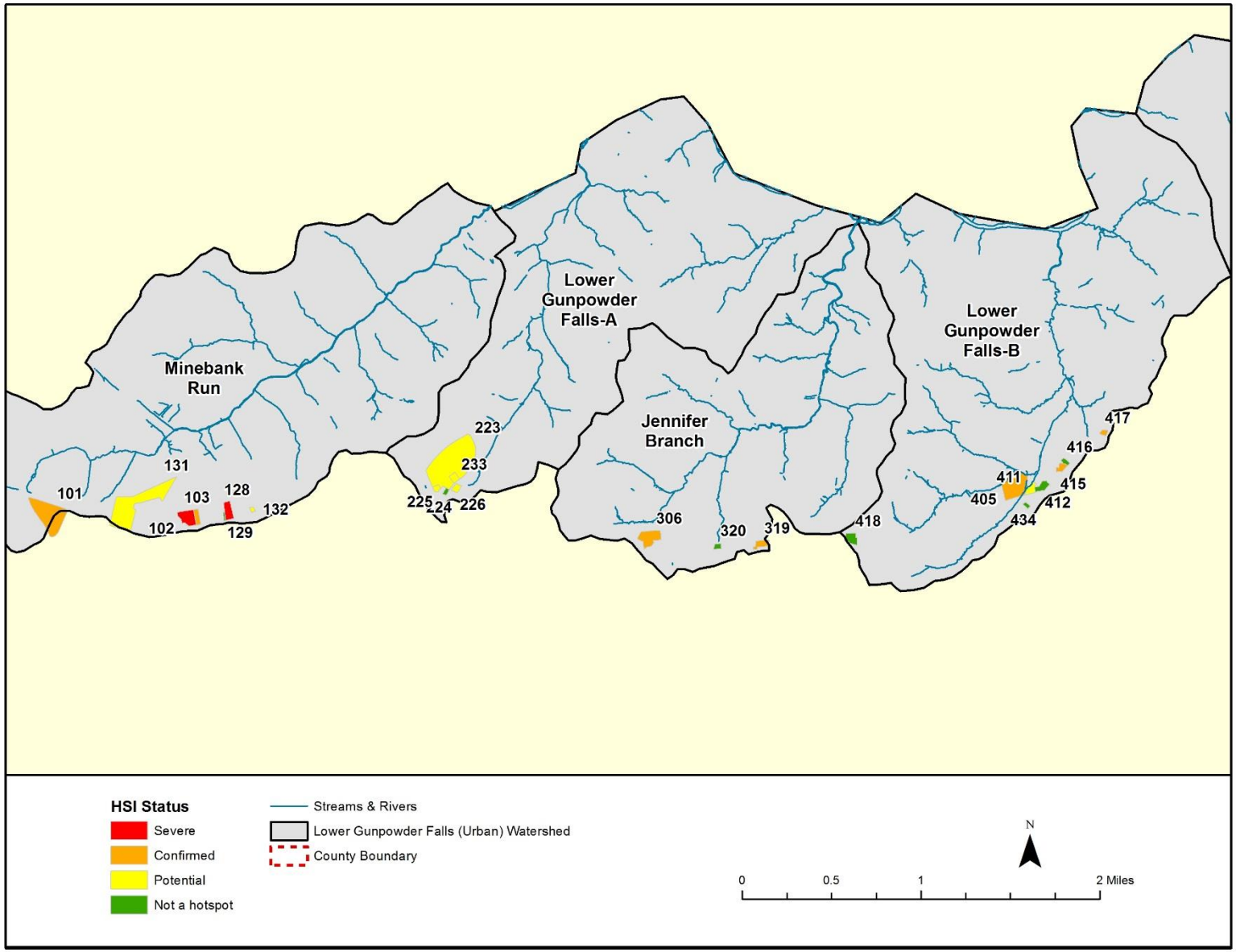


Figure 4-15: Location of Hotspots Investigated in Lower Gunpowder Falls (Urban) Watershed

4.3.3 General Findings

An initial GIS desktop analysis identified 31 potential hotspots to be selected from for field investigations. Of the 31 sites identified through the desktop analysis, 20 were investigated in the field. Field crews also identified 3 new areas that were suspected to be likely pollutant sources. In the end a total of 23 hotspot investigation were performed. Additionally, investigations were performed at two sites located just outside of the Lower Gunpowder Falls (Urban) watershed boundary due to field crews observing instances of active pollution. Field forms and photos for these two locations were submitted to the County, but they are not included as part of this report.

All of the investigated sites were commercial-type land uses, and most sites were located along either Route 1 or Joppa Road. In terms of severity, two of the locations were designated as a “Severe Hotspot.” Seven locations were categorized as “Confirmed Hotspots.” Seven sites were labeled as “Potential Hotpots” and seven sites visited were not considered to be a hotspot. Crews noted certain conditions during the field investigations that they felt merited immediate notification of Baltimore County for further investigation and/or follow-up action. A summary of the HSI data may be found in Appendix F. All of the completed HSI forms can be found in Appendix I.

Three sites had observed pollution sources. A restaurant had waste oil splattered on asphalt near the dumpster area. One shopping center was allowing the outdoor maintenance and washing of school buses in the back lot. One landscaping services business was actively washing equipment outdoors and had an uncovered fueling station with leaky oil drums located on site.

Selected photographs of the commercial HSIs are included below (Figure 4-16 through Figure 4-22).

Figure 4-16: Typical Open and Overflowing Dumpsters With Trash and Food Products Laying on Asphalt Observed in Lower Gunpowder Falls (Urban) Watershed, November 2014

Figure 4-17: Typical Messy Dumpster Areas Observed in Lower Gunpowder Falls (Urban) Watershed, October and November 2014

Figure 4-18: Typical Dumpster Staining on Asphalt Observed in Lower Gunpowder Falls (Urban) Watershed, November 2014

Figure 4-19: Typical Grease Dumpster with Staining on Ground Observed in Lower Gunpowder Falls (Urban) Watershed, November 2014

Figure 4-20: Uncovered Fueling Station without Collision Protection and Leaky Oil Drums Observed in Lower Gunpowder Falls (Urban) Watershed, November 2014

Figure 4-21: Stained Asphalt from Improper Disposal of Wash Water, November 2014

Figure 4-22: Example of Poor Housekeeping Practices - Trash and Debris Collecting near a Storm Drain Inlet, November 2014

4.4 INSTITUTIONAL SITE INVESTIGATIONS (ISI)

The USSR manual does not treat institutional sites as a separate component of the uplands survey; instead, institutions can be assessed using protocols adapted from the HSI protocols. Consistent with all previous Baltimore County SWAPs, a modified version of the HSI field form was used to assess institutional sites since HSI protocols do not exactly match conditions encountered on institutional properties and because institutional areas make up nearly 3.7% percent of the watershed area. The ISI method was first developed and implemented for the Lower Jones Falls and Upper Back River studies and was also used for this Lower Gunpowder Falls (Urban) study. Institutions surveyed as part of this study include the following types of community-based facilities: faith-based facilities, public schools, and community facilities (e.g., swimming pool, historical mansion). The following subsections describe the methods used to identify and evaluate pollution sources and restoration potential at institutional facilities.

4.4.1 Assessment Protocol

Twenty-two examples of institutional properties were identified and selected in the office prior to conducting the field assessment using GIS tax parcel information, land use data, aerial photographs, and an ADC map. These were shown and labeled on aerial field maps created for each site and on larger base maps showing the entire watershed. Unique ID numbers were assigned to ISIs using the classification scheme “ISI_N_101”, where ‘N’ denotes the Lower Gunpowder Falls (Urban) watershed and the first digit of the number corresponds to a specific subwatershed. Institutional sites were numbered sequentially in the order they were identified within the watershed. For example, ISIs located in Jennifer Branch subwatershed (subwatershed code 300) would be identified as 317, 318, etc.

In most cases and when practical, the entire property of an institutional site was walked by the field team to collect necessary data and take photographs. Basic information was filled out first including type of institution, address, and ownership (public or private). Ownership is important because different approaches may be used to contact and work with private versus public institutions. For example, a message may be received differently when the source is from the government or from a non-profit group. Strategies for individual institutions will incorporate these different approaches. The ISI field form includes many of the pollution source categories used on the HSI form. Some of the restoration opportunities and recommended actions from the NSAs and PAAs are also incorporated into the ISI. The focus of ISIs is to identify potential restoration opportunities, educate the community, and provide water quality benefits. The information collected for each of the pollution source and restoration categories are briefly described below.

Tree Planting

Potential tree planting locations at an ISI site were marked on aerial photographs while walking the property. After walking the entire site, the total number of trees that could be planted at the site was estimated based on a 40-foot spacing between trees. Note that previous SWAPs, including Lower Patapsco, estimated potential trees per site based on 15-foot spacing. More accurate numbers of trees can be determined during the post-fieldwork desktop analysis after restoration opportunities have been selected and prioritized. Note that tree planting opportunities were not identified on public school sites in this watershed since a separate County program is implementing a tree planting program at public schools. Through close cooperation with Baltimore County Public Schools, EPS will work to identify tree planting opportunities on school properties where appropriate. The plantings will primarily be completed by the Forest Management section of EPS.

Exterior

The exterior category is similar to the physical plant category in the HSI, except that it also includes restoration opportunities. The condition of the building(s) and parking lot(s) were noted. Stained, dirty, and damaged/breaking up surfaces were noted as potential pollution sources for both of these components. If no stormwater management was provided for impervious parking areas, this was also considered as a potential pollution source. Exterior storm drain inlets were inspected for evidence of maintenance or wash water dumping and poor erosion/sediment control, cleaning, or material storage practices for construction activities. Any observations of staining, discoloration, or mop threads around a storm drain inlet indicated a potential pollution source as a result of these activities. Building downspouts that were directly connected to the storm drain system or indirectly connected to impervious surfaces were also recorded as potential pollution sources.

Potential restoration opportunities that were evaluated in the exterior category included impervious cover removal and downspout disconnection. Locations where excess impervious cover could be removed were marked on aerial field maps. Examples include unused or underutilized parking areas and abandoned foot paths.

Waste Management

Every institution generates waste as a result of daily operations, but unlike hotspots, it is typically just garbage. The field team noted the type of waste generated (e.g., hazardous, garbage, etc.) and the condition of the dumpsters. Dumpsters with no cover or open lids, with leaks, damaged/in poor condition, and/or overflowing were noted as potential pollution sources. The field team also observed whether trash was present that could leave the site with wind or rain. Dumpsters located near storm drain inlets or lacking runoff diversion methods were also recorded as potential pollution sources.

Vehicle Operations

Vehicle operations include maintenance, repair, recycling, fueling, washing, or long-term parking. The presence of any of these activities was noted for each site since they can be a source of metals, oil and grease, and hydrocarbons. Only two institutional sites had vehicle operations, and the extent of the vehicle operations was very small. One faith-based organization had a fleet of two vans and another had a storage trailer parked on-site.

Outdoor Materials

Materials such as mulch piles, storage drums, and de-icing salt are sometimes stored on institution grounds. Locations where materials were loaded or unloaded were examined to determine if areas were uncovered and draining toward a storm drain inlet. Storage areas were evaluated for types of materials stored outdoors and their potential for entering the storm drain system. Uncovered materials and stained storage areas were used as indicators of poor outdoor storage practices and potential pollution sources.

Turf/Landscaping

The percentage of forest canopy, turf grass, landscaping, and bare soil covering the pervious area of a site was recorded on the field form. Sites with more than 20% of bare soil were noted as potential sources of sediment pollution. No institutional facilities exceeded this criterion, but extensive bare ground areas were found at Gunpowder Elementary School and Pine Grove Middle School. Ground maintenance activities for turf/landscaped areas were also evaluated.

High turf management and improper irrigation practices (non-target/over-watering) were noted since they are potential sources of nutrient, fertilizer, and pesticide pollution. The field team also determined whether landscaped areas drained directly to storm drains or if organics (leaves, grass) accumulated on impervious surfaces. Evidence of stream buffer encroachment and whether a buffer was adequately planted was also recorded for evaluating restoration potential.

Stormwater Infrastructure

The field team checked whether storm drains were marked and whether stormwater treatment practices were present. These were evaluated for restoration potential. Stormwater treatment was present at few sites in the watershed; several sites had no stormwater infrastructure at all. Loch Raven High School was found to be undergoing stormwater upgrades at the time of the site visit. Other treatments found at faith-based institutions consisted of grassy swales; one church appeared to have been recently redeveloped and modern stormwater management was employed. Maryland Presbyterian Church utilized rain barrels in their stormwater management.

After walking an entire property, and evaluating the categories discussed above, one or more of the follow-up actions listed below were recommended based on initial field observations:

- Tree planting
- Storm drain marking
- Downspout disconnection
- Stormwater retrofit
- Education
- Impervious cover removal
- Stream buffer improvement
- Develop a Pollution Prevention Plan
- Trash management

4.4.2 Summary of Sites Investigated

A total of 17 institutions were assessed throughout the Lower Gunpowder Falls (Urban) watershed. The number and type of institutions assessed within each subwatershed is summarized in Table 4-9. No institutions were assessed in the Bean Run or Lower Gunpowder Falls-D subwatersheds due to the lack of institutional land use in those areas.

Figure 4-23 shows the distribution of the various types of institutions assessed throughout the watershed.

Table 4-9: Types of Institutions Assessed by Subwatershed

Subwatershed	Faith-based	Hospital/ Care Center	Public School	College/ Research Facility	Municipal Facility	Other	Total
Jennifer Branch	6	0	0	0	0	0	6
Lower Gunpowder Falls-A	0	0	2	0	1	0	3
Lower Gunpowder Falls-B	3	0	1	0	0	0	4
Lower Gunpowder Falls-C	0	0	0	0	1	0	1
Minebank Run	1	0	2	0	0	0	3
Total	10	0	5	0	2	0	17

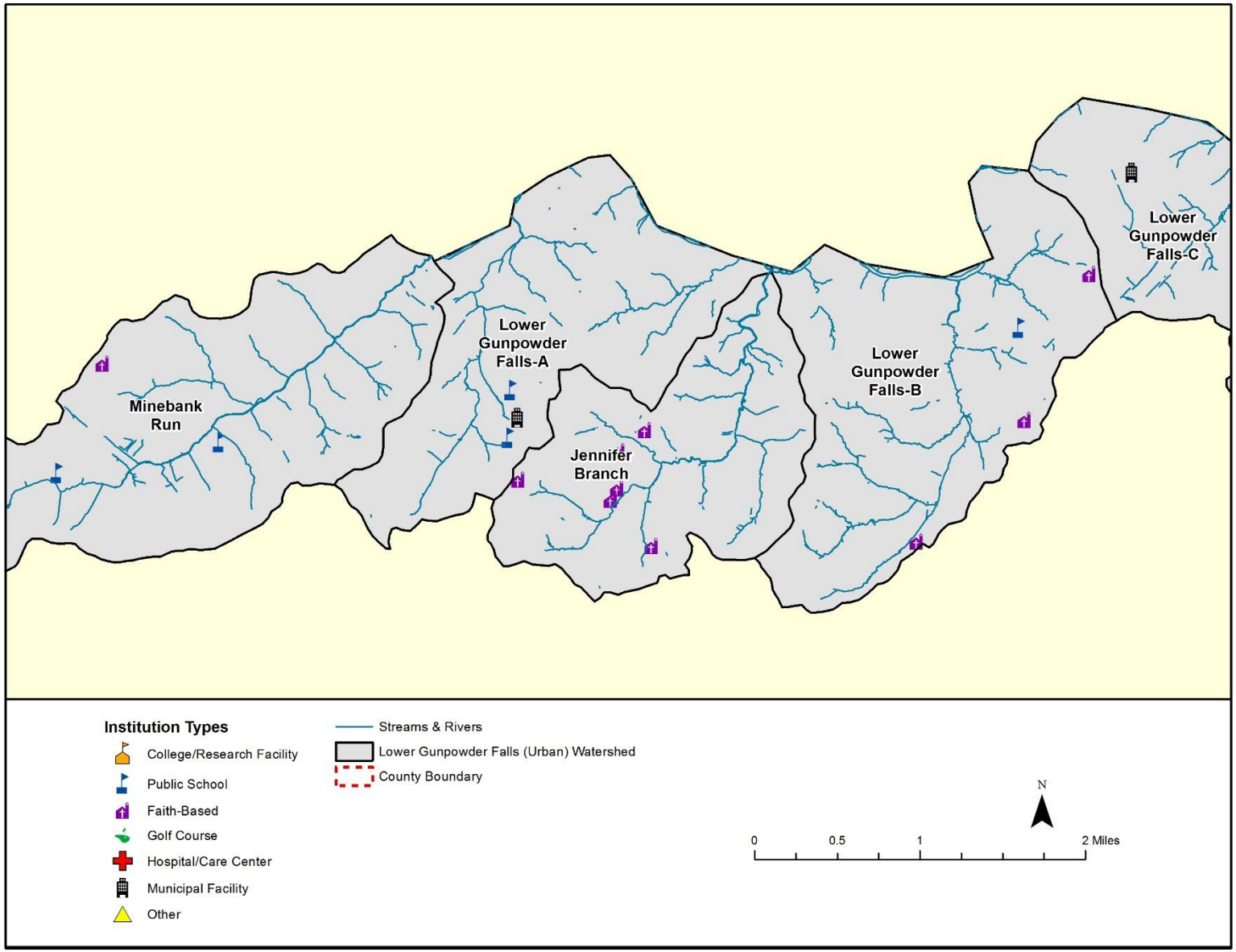


Figure 4-23: ISI Locations in Lower Gunpowder Falls (Urban) Watershed

4.4.3 General Findings

The number of the different types of recommended actions for ISIs is summarized in Table 4-10 by subwatershed.

Table 4-10: ISI Recommended Actions by Subwatershed

Subwatershed	# of Trees	Storm Drain Marking	Down-spout Discon-nect	SW Retrofit	Future Educa-tion	Imper-vious Cover Removal	Buffer Improve-ment	Pollution Preven-tion Plan	Trash Manage-ment
Jennifer Branch	32	1	2	5	0	1	1	0	2
Lower Gunpowder Falls-A	0	3	0	3	2	2	2	0	1
Lower Gunpowder Falls-B	90	1	1	4	2	2	2	0	1
Lower Gunpowder Falls-C	56	0	0	0	0	0	0	0	0
Minebank Run	3	1	0	3	3	1	1	0	2
Total	181	6	3	15	7	6	6	0	6

4.4.3.1 Tree Planting

An estimated 181 trees can be planted at institutions within the Lower Gunpowder Falls (Urban) watershed. Trees were recommended for 11 out of the 17 institutions assessed. Tree planting sites were identified in the field and noted on field maps. Small quantities (i.e., less than 10) of trees were generally recommended for smaller-acreage institutions such as most churches; greater numbers of trees were recommended for congregations with large properties, such as Perry Hall Baptist Church. Perry Hall Mansion, a County-owned facility, also had a large turf area that could accommodate a large number of trees. Two examples of potential tree planting areas are shown in Figure 4-24. The number of trees was estimated based on 40-foot spacing between trees. Table 4-10 presents planning-level estimates that would be refined through follow-up site investigations if a site is selected for a restoration/improvement project(s). Like street trees, open space shade trees are not only an asset aesthetically but they also provide air and water quality improvement since they intercept precipitation with their leaves and can absorb precipitation and nutrients through their root systems. This infiltration of precipitation through leaves or the root systems slows flow rates and provides some treatment before stormwater runoff reaches the stream network.

Figure 4-24: Potential Tree Planting Areas at ISI-N-414 (left) and at ISI-N-511 (right)

4.4.3.2 Stormwater Retrofits

As presented in Table 4-10, the action that was recommended the most after tree planting was stormwater retrofits (15 sites). Stormwater retrofits were recommended at 10 public institutions and five private facilities (15 sites in all). Downspout disconnection was recommended for three sites where sufficient pervious area was available to redirect rooftop runoff into rain gardens. Storm drain inlet stenciling was recommended at six sites.

Bioretention incorporates vegetation and filter media through which stormwater infiltrates for pollutant removal prior to groundwater recharge or entering the stream system. Examples of bioretention retrofit opportunities are presented in Figure 4-25. At Loch Raven High School, stormwater runoff from the access driveway to the western student lot can be diverted to a bioretention facility, the footprint of which at present is a grass turf area. The new bioretention facility would reduce polluted runoff to a first order stream that is currently piped underneath the parking lot and access road. At Pine Grove Elementary School, runoff from the bus parking loop currently enters a single storm drain inlet. The runoff could be diverted instead to a grassy area just to the north of this impervious surface. These actions present an opportunity to educate the community about the connection between the storm drain system and Lower Gunpowder Falls and how their individual actions can improve its water quality.

Figure 4-25: Opportunities for Bioretention Stormwater Retrofits at ISI-N-104 (left) and at ISI-N-209 (right)

4.4.3.3 Impervious Cover Removal

As discussed previously, impervious surfaces prevent precipitation from naturally infiltrating into the ground. Because runoff from impervious surfaces is often accelerated and concentrated when it reaches the storm drain and stream systems, it can contribute to stream erosion, habitat destruction, and water pollution. Removing unused or underutilized impervious surfaces will help increase pervious area and the watershed's capacity for infiltrating and treating stormwater runoff.

Impervious cover removal was a recommended action at six of the 17 institutions investigated. Field investigators recommended impervious area removal in locations where impervious surfaces appeared to be abandoned, superfluous, or underutilized, such as parking lots and walking paths. Of the six sites recommended for impervious cover removal, four were public schools and the remaining two were faith-based facilities. Impervious cover removal opportunities

were found at Gunpowder Elementary School and Pine Grove Middle School (Figure 4-26). The type of asphalt apron found attached to the facility building at Gunpowder Elementary School was noted at two other public schools. The alcove at Pine Grove Middle School pictured in Figure 4-31 is one of four such along the west edge of the building that have three sidewalks leading to one entry.

Figure 4-26: Potential Impervious Cover Removal at ISI-N-413 (left) and at ISI-N-208 (right)

4.4.3.4 Buffer Improvement

Forested buffer areas along streams are important for improving water quality and flood mitigation since they can reduce surface runoff, stabilize stream banks with dense rooting systems, provide shade, remove pollutants including nutrients and sediment from runoff, and provide habitat for various types of terrestrial and aquatic life. Six institutions had streams running through their property which would be potential opportunities for improving inadequate stream buffers by introducing native vegetation and trees.

The headwaters of a first order stream is located on the grounds of Pine Grove Middle School and presents a great opportunity to restore an impacted reach and provide an educational opportunity to students. Presently there is a forested area in the buffer zone of the stream, however it is being maintained as a Frisbee golf course and is kept mowed (Figure 4-27). A portion of the stream was also found to be enclosed within a concrete channel. The stream has eroded away portions of the channel and the eroded sediment has deposited around and obstructed a yard inlet. The yard inlet forms the upstream end of a short stormwater network that ends in an outfall to a tributary of Lower Gunpowder Falls, but the outfall has been undermined and is perched. Since the yard inlet is blocked, overland flow is cutting a new channel overland to bypass the network, which in turn is causing more erosion.

At neighboring Pine Grove Elementary School, a first order stream that crosses the southwest corner of the school grounds flows within a concrete channel, which is breaking up. The buffer zone consists of turf and forms the downslope edge of an athletic field. The buffer zone could be easily planted and, in conjunction with a channel restoration, would promote infiltration and volume reduction.

Figure 4-27: Potential Stream Buffer Restoration at ISI-N-208 (left) and ISI-N-209 (right)

4.4.3.5 Pollution Prevention Planning

A Stormwater Pollution Prevention Plan (SWPPP) establishes procedures for minimizing the potential for pollutants to be carried away in stormwater discharges. These procedures emphasize the use of BMPs to provide the flexibility to address varying sources of pollutants at different categories of industrial facilities. There were no institutional sites recommended for the development of SWPPPs in this watershed.

4.4.3.6 Trash and Other Waste Management

Trash/waste management is an area in need of improvement throughout various areas of the watershed, including institutions. A total of six institutional sites were recommended for trash management action. Waste management education is recommended to address leaking dumpsters, open or uncovered dumpsters where trash can leave the site, and dumpster placement near storm drain inlets or streams. When field investigators noted dumpsters that were open and overflowing with trash or were leaking, those institutions were identified as locations where trash management was necessary (Figure 4-28). Signs of past leakage, such as stains or rust on impervious surfaces like that found at Pine Grove Elementary School were found at a small number of locations. Open dumpsters were found at multiple locations, including Loch Raven High School, pictured below. Most problems with open dumpsters, residual staining on impervious surfaces, and situation of dumpsters near storm drain inlets, were found at public school sites. These trash management problems may be addressed through various measures such as trash campaigns, waste management education, improving bulk trash pick-up options, and community clean-ups.

Figure 4-28: Trash Management Opportunities at ISI-N-104 (left) and ISI-K-539 (right)

4.5 PERVIOUS AREA ASSESSMENTS (PAA)

PAAs were conducted to identify and evaluate sites within the Lower Gunpowder Falls (Urban) watershed with potential for land reclamation, reforestation, or re-vegetation. Field investigations took place on November 24 and November 25, 2014. The following subsections describe the methods used to identify and evaluate restoration potential of pervious areas.

4.5.1 Assessment Protocol

Large parcels of open land throughout the watershed were identified in the office prior to conducting the field assessment using GIS tax parcel information, land use data, aerial photographs, and an ADC map. These were shown and labeled on maps created for NSAs and on larger base maps showing the entire watershed. Upon visiting pervious areas identified in the office, a PAA was conducted if the field team verified the site as having sufficient space and potential for restoration. In some cases, additional sites were identified for PAAs while surveying other upland areas such as underutilized areas on institutional property and highway medians. The USSR manual recommends assessing publicly-owned pervious areas greater than two acres and privately-owned areas greater than five acres. Because some of the subwatersheds in Lower Gunpowder Falls (Urban) watershed are highly urbanized, all sites greater than approximately 1 acre were considered.

Unique ID numbers were assigned to PAAs using the classification scheme “PAA_N_100”, where ‘N’ denotes the Lower Gunpowder Falls (Urban) watershed and the first number corresponds to a specific subwatershed. As described in Section 4.1, subwatersheds were assigned numbers of 100-700 for the purposes of labeling PAA sites. Pervious areas were numbered sequentially in the order they were surveyed within a particular subwatershed. For example, PAAs in Minebank Run would be identified as 101, 102, etc.

The entire property of a PAA site was walked by the field team to collect necessary data and take photographs. Basic information was filled out first including site accessibility, ownership, current management, and whether the site was connected to other pervious area. The area of the site was determined in the office using GIS tax parcel information and aerial photographs.

Access to a site is important when considering its real restoration potential. The field team determined in the field whether the site could be accessed by foot, vehicle, and/or heavy equipment. A site that can only be accessed by foot may have less potential for restoration if it requires greater disturbance or costs to restore (e.g., constructing an access road). Ownership is also important because different approaches may be used to coordinate with private versus public institutions. Current management describes the current use of the land including the following: school, park, right-of-way, or vacant land. The presence and type of connected pervious area is also relevant to the restoration potential of a pervious area. For example, if a site connects forested areas, reforesting the site would help to continue the forested corridor for wildlife habitat or stream buffer purposes. If a site is connected to an existing wetland area, it could be reforested to protect the wetland or re-vegetated to extend the wetland area. The other data categories assessed are briefly described below.

Current Vegetative Cover

The current vegetative cover was assessed including the proportion of the site covered by turf, herbaceous, bare soil, trees, or shrubs. Turf management status was also recorded including turf height, mowing frequency, and condition (e.g., thick, sparse, continuous, etc.). The presence of invasive species was noted including percent of site with invasive species and type.

Impacts

Impacts were assessed to indicate the amount of site preparation required to restore the pervious area. Possible impacts noted include soil compaction, erosion, trash and dumping, and poor vegetative health. Significant impacts from any of these factors will influence site preparation required, types of plants that can survive and success of an implemented project.

Reforestation Constraints

Similar to impacts, information regarding factors that may impede reforestation efforts was collected. The type of sun exposure was recorded as full sun, partial sun, or shade. The field team noted whether there was a nearby water source for supplemental water if necessary.

Other constraints related to reforestation that were noted include overhead wires, underground utilities, pavement, and buildings. Private ownership was noted as a potential constraint. Recommendations for pervious area restoration based on initial field observations included one or more of the following:

- Good candidate for natural regeneration
- May be reforested with minimal site preparation
- May be reforested with moderate site preparation
- May be reforested with extensive site preparation
- Poor reforestation or regeneration site

4.5.2 Summary of Sites Investigated

A total of 17 pervious areas were assessed within the Lower Gunpowder Falls (Urban) watershed, totaling 432.26 acres (Table 4-11). Parcel sizes ranged from 1.00 acre to 192.87 acres. Twelve of the sites assessed were less than 10 acres in size. All sites surveyed were considered as open pervious cover type, but in reality were a mixture of treed, shrubby, and open areas. Figure 4-29 shows the location and size of PAAs within the watershed.

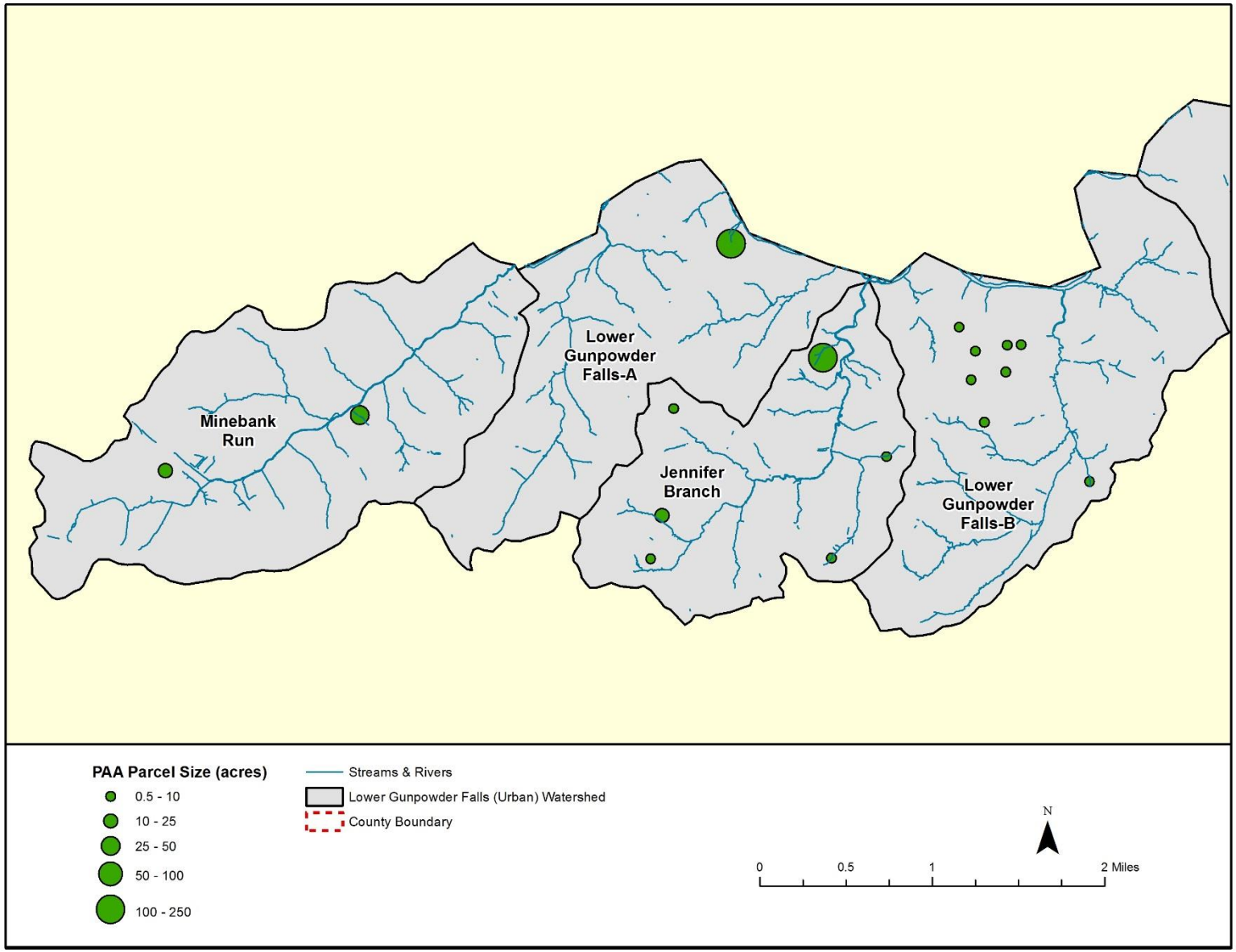


Figure 4-29: PAA Locations in Lower Gunpowder Falls (Urban) Watershed

4.5.3 General Findings

A summary of PAA results including parcel size, ownership, management, percent turf cover, and site preparation required for the sites assessed is provided in Table 4-11.

Table 4-11: Summary of Lower Gunpowder Falls (Urban) Watershed PAA Results

Site ID	Site Name	Total Parcel Size (acres)	Plantable Area (acres)	Ownership	Management	Turf (%)	Site Prep.
PAA_N_101	Cromwell Valley Park	49.9	13.79	Public	Park	20	Minimal
PAA_N_302	County Open Space - A	4.67	0.84	Public	Vacant Land	75	Minimal
PAA_N_103	Airway Circle Apts. Open Space	16.01	0.00	Public	HOA Open Space	90	Poor Site
PAA_N_304	Proctor Lane Apartment Open Space	11.20	0.44	Private	Vacant Land	95	Minimal
PAA_N_305	County Open Space - B	5.89	1.84	Public	Park and Ride	85	Minimal
PAA_N_406	County Open Space - C	1.28	0.50	Public	Vacant Land	95	Minimal
PAA_N_407	County Open Space – D	2.22	1.69	Public	County Open Space	98	Minimal
PAA_N_408	County Open Space - E	6.50	4.77	Public	County Open Space	90	Minimal
PAA_N_409	County Open Space - F	2.47	1.65	Public	County Open Space	85	Minimal
PAA_N_210	Gunpowder State Park	125.98	0.00	Public	Park	0	Minimal (nat.regen.)
PAA_N_311	Baltimore City Property	192.87	6.18	Public	Equestrian Center	80	Minimal
PAA_N_412	County Open Space – G	2.30	0.00	Public	County Open Space	100	Poor Site
PAA_N_413	County Open Space – H	1.03	0.67	Public	County Open Space	98	Minimal
PAA_N_314	County Open Space – I	2.49	2.02	Public	County Open Space	80	Minimal
PAA_N_315	County Open Space – J	1.00	0.62	Public	County Open Space	80	Minimal
PAA_N_416	County Open Space - K	1.91	0.33	Public	County Open Space	90	Minimal
PAA_N_417	Georgetown Square HOA	4.54	2.33	Private	HOA Open Space	80	Minimal
Totals		432.26	37.69				

Based on the history of previous SWAP assessments in the County, the most likely candidates for successful pervious area restoration efforts are those on public lands with minimal site preparation required. Public sites are eligible for tree planting through Maryland DNR's "Tree-mendous Maryland" program and are good opportunities for volunteer or community projects. Of

the 17 sites surveyed, 15 are under public ownership and most were considered to require minimal site preparation. These 15 were considered the best opportunities for plantings. All 17 pervious area sites assessed are briefly described below.

Cromwell Valley Park

The Cromwell Valley Park site is located immediately north of Cromwell Bridge Road, and is maintained by Baltimore County (Figure 4-30). It is a fairly large park, and is currently covered by a diverse mixture of semi-fallow fields, planted woodlands (primarily conifers), riparian deciduous woodlands, and turf. This site receives full sun exposure and is easily accessible by foot, vehicle, and heavy equipment. There are narrow areas of forested wetlands along the Lower Gunpowder Falls in the northern parts of the site. Reforestation at the site would require verification that it would not interfere with the current use of the site and tree planting could be a potential community project.

Figure 4-30: Photos of PAA_N_101, Cromwell Valley Park

County Open Space - A

The County Open Space - A site is located off Goldenrod Lane, near its intersection with Red Clover Court, (Figure 4-31). It is owned and maintained by Baltimore County, and is easily accessible by foot, vehicle, or heavy equipment. It is primarily covered by turf (75%), and receives full sun exposure. A small perennial stream flows through part of the site. Reforestation of the site would require verification that it would not interfere with the current use of the site and tree planting could be a potential community project. Invasive plant species management should be implemented prior to tree planting, particularly in the parcel immediately north of Goldenrod Lane.

Figure 4-31: Photos of PAA_N_302, County Open Space – A

Airway Circle Apt. Open Space

The Airway Circle Apt. Open Space site is located off of Airway Circle and Treeway Court, adjacent to I-695 (Figure 4-32). It is owned and maintained by Cromwell Realty Company; parts of it are accessible by foot, and small vehicles, but steep slopes would prevent access by larger equipment. It was deemed a generally poor site for tree planting because of the steep slopes, as well as the proximity of existing buildings, roads, and other development features.

Figure 4-32: Photos of PAA_N_103, Airway Circle Apt. Open Space

Proctor Lane Apartments Open Space

The Proctor Lane Apartments Open Space site is located to the immediate south of Proctor Lane, near the intersection with Cold Stream Way (Figure 4-33). It is privately owned by the community HOA, but is easily accessible by foot, vehicle, or heavy equipment. It is almost entirely covered by turf (95%), and receives full sun exposure. A small perennial stream flows through the southern-most part of the site. The mature deciduous forest in the riparian area of the stream forms part of the southern boundary of the site. Tree planting in this corridor would likely be most beneficial. Reforestation of the site would require verification that it would not interfere with the current use of the site and tree planting could be a potential community project.

Figure 4-33: Photos of PAA_N_304, Proctor Lane Apartments Open Space

County Open Space - B

The County Open Space – B site is located to the immediate south of Jomat Avenue, near its intersection with Harford Road (Figure 4-34). It is a Park and Ride facility owned and maintained by Baltimore County, and is easily accessible by foot, vehicle, or heavy equipment. It is largely covered by turf (85%), and receives full sun exposure. Jennifer Branch flows near the southeastern corner of the site, adjacent to a stormwater BMP. Reforestation of this site would require verification that it would not interfere with the current uses of the site and tree planting could be a potential community project.

Figure 4-34: Photos of PAA_N_305, County Open Space – B

County Open Space – C

The County Open Space – C site is located to the west of Cedarside Drive, near its intersection with Belair Road (Figure 4-35). It is a stormwater facility owned and maintained by Baltimore County, and is accessible by foot, vehicle, or heavy equipment. It is primarily covered by turf (95%), although parts of the site possess a dense stand of common reed (this area likely contains nontidal wetlands). The site receives full sun exposure. A small perennial stream flows through the length of the site. Reforestation of this site would require verification that it would not interfere with the current uses of the site and tree planting could be a potential community project.

Figure 4-35: Photos of PAA_N_406, County Open Space – C

County Open Space - D

The County Open Space – D site is located immediately south of Oak Park Drive, between Bellfalls Way and Sylvan Park Court (Figure 4-36). It functions as a small neighborhood green space; it is accessible by foot, vehicle, or heavy equipment. It is almost entirely covered by turf (98%), with a few small trees around its peripheries. The site receives full sun exposure. Reforestation of this site would require verification that it would not interfere with the current uses of the site and tree planting could be a potential community project.

Figure 4-36: Photos of PAA_N_407, County Open Space – D

County Open Space - E

The County Open Space – E site is located immediately west of Hickoryhurst Drive, near its intersection with Oak Park Drive (Figure 4-37). It functions as a medium-sized neighborhood green space; it is accessible by foot, vehicle, or heavy equipment. It is largely covered by turf (90%), with a few small landscaping trees around its peripheries. The site presents a reasonably good opportunity for tree planting, as it is almost completely turf, has relatively easy access, and receives full sun exposure. It also connects to an existing forested plot off site to the north. Reforestation of this site, however, would require verification that it would not interfere with the current uses of the site and tree planting could be a potential community project.

Figure 4-37: Photos of PAA_N_408, County Open Space – E

County Open Space – F

The County Open Space – F site is located south of Stone Way Place, and north of Stone Falls Court and Sylvan Oak Way (Figure 4-38). It functions as a small neighborhood green space; it is accessible by foot, vehicle, or heavy equipment. It is largely covered by turf (85%), with a few coniferous landscaping trees around its peripheries. The site presents a reasonable opportunity for tree planting, as it is almost completely turf, has relatively easy access, and receives full sun exposure. Reforestation of this site, however, would require verification that it would not interfere with the current uses of the site and tree planting could be a potential community project. There is precious little usable existing open green space in the vicinity.

Figure 4-38: Photos of PAA_N_409, County Open Space – F

Gunpowder Falls State Park

The Gunpowder Falls State Park site is located near the eastern terminus of Old Harford Road, adjacent to the Hickey School (Figure 4-39). This parcel of the State Park was previously managed by mowing, but has been left fallow for 10 to 15 years; there is no turf cover here. It possesses a generally shrubby, later-stage old field vegetative cover, consisting of both native and invasive species (especially multiflora rose). The site presents a very good opportunity for

natural regeneration (i.e., no tree planting is necessary), in conjunction with a program of an aggressive program of invasive plant species management. Reforestation of this site, however, would require verification that it would not interfere with its current uses and future planning.

Figure 4-39: Photos of PAA_N_210, Gunpowder Falls State Park

Graham Equestrian Center (Gunpowder Falls State Park)

The Graham Equestrian Center is a non-profit organization located within Gunpowder Falls State Park, to the east of Harford Road, near its intersection with Knoll Acres Drive (Figure 4-40). This parcel is currently managed as an equestrian center (i.e., for horses). Fields are separated by numerous large, sturdy horse fences. Turf in the horse pastures is generally very thin and sparse from the constant grazing and trampling by the horses. The site presents some valuable opportunity for tree planting, particularly in the eastern part, in the riparian area of several headwater streams. These open areas, however, currently consist of well-used horse pastures. Reforestation of this site, however, would require verification that it would not interfere with its current uses and future planning.

Figure 4-40: Photos of PAA_N_311, Graham Equestrian Center

County Open Space - G

The County Open Space – G site is located immediately north of Parkhurst Way, and south of Bellhall Drive (Figure 4-41). It functions as a small neighborhood green space; it is partly only accessible by foot. It is completely covered by turf (100%), with a few small landscaping trees around its peripheries. There are currently no potential tree planting areas on this site, owing to steep slopes, access issues, and likely problems with land use issues by adjacent residents. There is precious little usable existing open green space in the vicinity, and this site appears to be frequently used by local residents and their children.

Figure 4-41: Photos of PAA_N_412, County Open Space – G

County Open Space – H

The County Open Space – H site is located west of Hickoryhurst Drive, and immediately south of Hurst Court (Figure 4-42). It functions as a small neighborhood green space; it is accessible by foot, vehicle, or heavy equipment. It is almost completely covered by turf (98%), with a few coniferous landscaping trees around its peripheries. There is also a small tract of urban upland woods offsite to the immediate south. The site presents a reasonable opportunity for tree planting, as it is almost completely turf, has relatively easy access, and receives full sun exposure. Reforestation of this site, however, would require verification that it would not interfere with the current uses of the site and tree planting could be a potential community project. There is precious little usable existing open green space in the vicinity.

Figure 4-42: Photos of PAA_N_413, County Open Space – H

County Open Space – I

The County Open Space – I site is located south of Northwind Road, off of North Trail Way (Figure 4-43). It is directly adjacent to an approximately 250-foot-wide Baltimore Gas & Electric electric transmission line right-of-way, and possesses a small perennial stream that flows along its northern boundary. Most of the area along the stream was formerly wooded, but was recently cleared (most likely when BGE cleared along their ROW). The site is easily accessible by foot, vehicle, or heavy equipment. It has a large component of turf (80%), as well as some herbaceous nontidal wetlands (formerly treed), and a few scattered small trees and shrubs. The site presents an excellent opportunity for tree planting, as it is almost completely turf, possesses riparian wetlands (formerly treed), and receives full sun exposure. Some focused invasive plant species management should be implemented prior to tree planting at the site (Japanese honeysuckle, mile-a-minute, and porcelainberry were all observed here). Reforestation of this site would also require verification that it would not interfere with the current uses of the site and tree planting could be a potential community project.

Figure 4-43: Photos of PAA_N_314, County Open Space – I

County Open Space – J

The County Open Space – J site is located south of Erie Avenue, between Superior Avenue and Montego Avenue (Figure 4-44). It functions as a small neighborhood green space. Because of its layout, access to the parcel is somewhat limited, but it is accessible by foot, or potentially a small vehicle (not heavy equipment). It is largely covered by turf (80%), with a scattering of large and small landscaping trees (primarily around its peripheries). The site presents a reasonable opportunity for tree planting, as it is almost completely turf, has relatively easy access (on foot, and with small equipment), and receives full sun exposure. Reforestation of this site, however, would require verification that it would not interfere with the current uses of the site and tree planting could be a potential community project.

Figure 4-44: Photos of PAA_N_315, County Open Space – J

County Open Space – K

The County Open Space – K site is located west of Hickoryhurst Drive, adjacent to Stone Park Place (Figure 4-45). It functions as a small neighborhood green space; it is accessible by foot, vehicle, or heavy equipment. It is almost completely covered by turf (90%), with a few small landscaping trees around its peripheries. There is also a small tract of urban upland woods offsite to the north and east. The site presents a reasonable opportunity for tree planting, as it is almost completely turf, has relatively easy access, and receives full sun exposure. Reforestation of this site, however, would require verification that it would not interfere with the current uses of the site and tree planting could be a potential community project. There is precious little usable existing open green space in the vicinity.

Figure 4-45: Photos of PAA_N_416, County Open Space – K

Georgetown Square HOA

The Georgetown Square HOA site is located south of Proctor Lane, and west of west of Seven Courts Drive (Figure 4-46). The site consists of three small parcels of neighborhood green space; they are accessible by foot, vehicle, or occasionally, heavy equipment. It is privately owned by the community HOA, The entire site is dominated by turf cover (80%), with a few small to medium-sized landscaping trees around the adjacent houses. There is also a small perennial stream with a narrow forested buffer bordering the site to the south. The site presents a good opportunity for tree planting, especially in the southern part, closest to the stream corridor. The three planting parcels selected are almost completely covered by turf, have relatively easy access, and receive full sun exposure. Reforestation of this site, however, would require verification that it would not interfere with the current uses of the site and tree planting could be a potential community project.

Figure 4-46: Photos of PAA_N_417, Georgetown Square HOA

CHAPTER 5: RESTORATION AND PRESERVATION OPTIONS

5.1 INTRODUCTION

This chapter presents an overview of the best management practices (BMPs) potentially suitable for the Lower Gunpowder Falls (Urban) watershed. There is a significant difference in land cover and runoff characteristics between residential and agricultural areas, and the difference extends to stormwater BMPs as well. For that reason, potential treatment approaches for the Lower Gunpowder Falls (Urban) watershed are discussed based on those that apply to developed areas and those applicable to agricultural lands. In addition, citizen awareness activities, volunteer restoration programs, and land preservation options are discussed.

5.2 BEST MANAGEMENT PRACTICES FOR DEVELOPED AREAS

5.2.1 County Restoration Programs

5.2.1.1 Stormwater Management Upgrades

Stormwater Management Conversion

Older stormwater management facilities were typically designed only for flood control and have little to no pollutant removal capacity. However, these facilities can generally be altered to capture and retain stormwater runoff to provide water quality benefits. Consideration must be given to the pond's storage capacity and overflow outlets to ensure the structure is capable of handling large storm events. Conversion to an extended detention facility typically requires adjustments to the facility's outlet structure. This will result in water quality benefits by allowing sediments and pollutants to settle out, in addition to controlling the amount of runoff entering receiving waters. Wetland vegetation can be planted in and around an extended detention pond for additional environmental benefits. Dry detention ponds have the greatest potential for conversion to extended detention BMPs.

Stormwater Retrofits

Retrofitting involves the implementation of stormwater management controls in developed areas where previous practices did not exist. Stormwater retrofits improve water quality by capturing, slowing and treating runoff before it reaches receiving water bodies. Retrofits are targeted towards specific objectives, depending on BMP type; objectives may include water quality, soil stabilization, and runoff flow control. Several considerations must be taken into account to select appropriate stormwater treatment measures such as ecological benefit, available land area, cost, and community acceptance. There are factors which limit the effectiveness of stormwater retrofitting, such as insufficient land area in an appropriate portion of the subwatershed (i.e., no available area large enough to intercept a significant amount of runoff). Small-scale BMPs such as bioretention for parking lot/alley retrofits can be effective if space is limited. See Section 5.5 for more information about these and other citizen-led BMPs.

5.2.1.2 Stream Corridor Restoration

Stream corridor restoration practices are used to enhance the ecological function, stability, and riparian habitat of degraded stream corridors. These types of practices typically involve a

comprehensive approach using earth-moving equipment to address wide-spread channel degradation. Stream corridor restoration practices are often combined with stormwater management upgrades and riparian enhancement practices to meet watershed restoration objectives. Primary practices considered for Lower Gunpowder Falls (Urban) watershed stream corridors include stream restoration, buffer restoration, and wetland restoration.

Stream Restoration

Stream restoration projects are implemented to restore physical, biological, and/or ecological function to a natural watercourse which has become degraded. Degradation of a stream often occurs due to changes in the watershed, such as an increase in impervious surface and/or vegetation removal, and alterations made to the channel itself, such as straightening, lining with concrete or gabions, and/or culvert installation for road crossings.

The goal of stream restoration is to return a degraded channel to a stable state, one in which it does not significantly erode or fill with sediment, can convey runoff for a range of storm events, and has improved ecological function.

A sound restoration project should utilize native materials such as rock, wood, and vegetation to imitate a natural, self-sustaining and ecologically functional stream system. The design approach of a stream restoration project requires an extensive quantity of field collected data and scientifically defensible calculations to determine the appropriate size, shape, and planform of the degraded channel. The design should take into account existing and possible future land use within the watershed. Hydrology and stormwater management practices upstream of a restoration site will dictate the velocity and volume of runoff that will reach a site. In addition, the sediment supply of the upstream channel is also an important consideration during the design of a stream restoration.

Implementation of a stream restoration project usually involves grading of the earth to reconfigure the shape and planform of the degraded channel and/or using structural controls where required for optimal hydrological and ecological function. Stream restoration utilizes a number of techniques to stabilize eroded stream banks, prevent stream bed degradation, recreate habitat, and protect adjacent infrastructure such as utilities, roads and structures. Bank stabilization improves water quality by attenuating the erosion of soils and adhered pollutants, in addition to reducing the likelihood of sewer line breaks. Appropriate placement of bed features and the use of grading and/or structures dissipates energy, creates a variety of aquatic habitats, and oxygenates the water.

Buffer Restoration

Riparian buffers are vegetated areas along rivers, streams, and shorelines that help stabilize banks and prevent erosion; filter pollutants such as sediment and nutrients; provide wildlife habitat; and aid in regulating stream water temperatures. Several portions of the Lower Gunpowder Falls (Urban) watershed stream system have inadequate riparian buffers as a result of human activities.

This restoration strategy enhances or reforests areas adjacent to streams with a variety native trees, shrubs, and herbaceous plantings. Plants are selected based on the growing conditions at each site and the plant’s requirements. Implementation of targeted educational programs can teach private and institutional property owners that having vegetation along the stream can help preserve their property, as well as about what plants are appropriate for their site and the water

quality benefits of riparian buffers. The inclusion of stream buffer signs is one way to remind residents of the importance of this essential vegetation.

Wetland Creation

Wetlands are highly valuable lands in terms of their ability to both improve water quality by filtering and slowing runoff, and as critical habitat for many species. A wetland is an area of land that has a specific soil type that remains wet or covered with water, and native vegetation that is adapted to these conditions. Swamps, marshes, and bogs are all types of wetland. Unfortunately, many wetlands were drained and converted to land useable for agriculture or development before their importance was realized. One strategy entails the reintroduction of wetlands in settings where they have been lost in the past but favorable conditions still exist. Unfortunately, due to the very specific parameters required, it can be difficult to create and sustain new wetlands. Preservation of the few remaining wetlands and limiting changes to hydrology in the landscape adjacent to existing wetlands are key strategies for watershed protection.

5.2.1.3 Reforestation

The Community Reforestation Program (CRP) was established by Baltimore County*s Department of Environmental Protection and Sustainability (EPS) to provide a dedicated workforce for planting, monitoring, and maintaining forest mitigation projects. The program is funded through fees-in-lieu of mitigation for forests removed as a result of public and private land development, as required by the implementation of the County's Forest Conservation Act and Chesapeake Bay Critical Area Regulations. The CRP is the only full-time county-wide reforestation mitigation program among Maryland's counties.

The CRP includes a four-person reforestation crew that carries out year-round reforestation operations. The crew is based at a one-acre site in eastern Baltimore County that is provided by the Department of Recreation and Parks. This home base houses a growing out nursery for 13,000 tree seedlings; equipment and machinery needed for planting, monitoring, and maintaining the reforestation projects; and office space for the reforestation team. Occasionally, the CRP will undertake special grant-funded projects to improve water quality and groundwater recharge, as well as wildlife habitat. The most recent example is the expansion of forest buffers and the reforestation of fields on private rural properties.

In addition to mitigatory reforestation, the Sustainability and Forest Management section of EPS is working to increase tree canopy in support of the County's Tree Canopy Goals announced in spring 2013, and to increase total tree cover by about 1,500 acres by 2025 as part of the County's Chesapeake Bay Watershed Implementation Plan (WIP). County revenues from the State-mandated stormwater remediation fees will be used mostly for contractor-installed reforestation projects. Planting in urban areas will include street trees; County facilities; and managed urban lands such as apartments, condominiums, businesses, and private institutions. Trees will also be planted by homeowners who purchase potted saplings through the County's Big Trees sales. EPS will also track citizen planting projects on County lands under the Policy & Guidelines for Community Tree Planting Projects. The Gunpowder Valley Conservancy (GVC) organizes citizens' tree planting projects. Contractor-installed planting in rural areas will include large-lot rural residential subdivisions, properties with conservation easements, and other properties where landowners want to increase tree cover.

5.2.2 County Management Programs

Municipal management programs can directly support watershed restoration efforts through services, monitoring, and development review. Street sweeping, inlet cleaning, and trash and recycling collection are services that help protect water quality. The Illicit Discharge Detection and Elimination (IDDE) Program monitors stormwater outfalls to identify any potential contamination. The land development review process imposes a rigorous review of impacts to natural resources. This section describes these municipal programs.

5.2.2.1 Street Sweeping

Baltimore County has an active street sweeping program to remove debris, dirt, and pollutants from the roads before they enter the storm drain system. Effective street sweeping usually involves using a vacuum assisted sweeper, and a schedule that takes into account factors such as trash pickup days and seasonal changes, such as leaf litter in the fall and more frequent lawn care activities by residents in spring and summer.

5.2.2.2 Inlet Cleaning

The Baltimore County storm drain system consists of approximately 1,760 miles of storm drain pipe, 72,096 inlets, and 8,640 outfalls. To keep the entire system clean of trash, debris, and sediment, the Department of Public Works maintains three storm drain cleaning vehicles. Each vehicle has a two man crew and operates each day, cleaning the storm drains and pipes. Removing the material from the storm drain system reduces street flooding, a potential safety hazard, and aids in the detection of illicit connections.

5.2.2.3 Illicit Discharge Detection and Elimination Program

The county's illicit connection program ensures that all discharges to and from the municipal separate storm sewer system that are not stormwater are either permitted by the Maryland Department of the Environment (MDE) or eliminated. The County is required to screen a minimum of 150 storm drain outfalls annually for the purposes of detecting and removing these unpermitted discharges. The illicit connection program is responsible for performing outfall screenings, reporting screening data, and coordinating remedial actions. The illicit connection program also investigates illicit connection complaints from other agencies, citizens, or volunteers in the Stream Watch Program. Stream Watch allows citizens to adopt a stream, which includes tracking the health of that stream and reporting problems or potential problems they observe.

Routine outfall screenings for detection of illicit connections complements screenings and follow-up triggered by citizen reports of problems they observe. The routine outfall screenings catch the chronic problems that may be missed by the public, such as chlorine leaks from the municipal water supply. Citizens provide additional surveillance at a level beyond that of the monitoring staff. A majority of the time citizens call while they are actually observing a problem and often can provide immediate local information that increases the chance of eliminating illicit connections. The illicit connections program also recently began taking data on potential retrofit opportunities at the outfalls that are investigated.

5.2.2.4 Land Development Review

New development and redevelopment projects undergo a rigorous review for impacts to natural resources. Regulations are in place for the protection of stream buffers, forests, tidal shorelines, groundwater, and stormwater runoff. In addition, on-site inspections take place during the construction process for erosion and sediment control. Tidal shoreline protection must be inspected before a development project is released for occupancy. Stormwater facilities must be confirmed to be functional one year after construction before “close-out” can occur and security bonds are returned to the developer. After construction is complete, stream buffers and forest conservation areas are inspected on a random basis for compliance. The following are the current regulatory programs applicable to the development and redevelopment plan review process and follow-up inspections.

Riparian Forest Buffers

Baltimore County enacted the Regulations for the Protection of Water Quality, Streams, Wetlands and Floodplains in 1991. These regulations require development designs to include a 75- or 100-foot stream buffer and include provisions for expansion of the riparian buffer for steep slopes, wetlands, and floodplains. Development plans must minimize stream and buffer road crossings, have stormwater management facilities and outfalls outside of the riparian buffer, and place utilities outside the buffer to the extent possible. In cases where fish passage is an issue, stream crossings should be either open bottom bridges or provide for low flow fish passage. These regulations are intended to maintain the integrity of the riparian buffer.

Forest Conservation

The main purpose of the Maryland Forest Conservation Act, enacted in 1991, is to minimize the loss of Maryland's forest resources during land development by making the identification and protection of forests and other sensitive areas an integral part of the site planning process. EPS oversees local implementation of these regulations during the development review process and conducts inspections during the construction and post-construction closeout process. Of primary interest are areas adjacent to streams or wetlands; those on steep or erodible soils; or those within or adjacent to large contiguous blocks of forest or wildlife corridors. Identification of priority areas is completed prior to design of the development plan. Any construction activity or development proposal for an area that is 40,000 square feet (approximately one acre) or greater is subject to the Forest Conservation Act and requires a Forest Conservation Plan prepared by a licensed forester, licensed landscape architect, or other qualified professional.

Chesapeake Bay Critical Area

The Chesapeake Bay Critical Area law and criteria were designed to foster more sensitive land use and development activity along the tidal shorelines and to ensure the implementation of appropriate long-term conservation measures to protect important habitats. The law identified the "Critical Area" as all land within 1,000 feet of the mean high water line of tidal waters or the landward edge of tidal wetlands. The Critical Area Act, passed in 1984, was significant and far-reaching, and marked the first time that the state and local governments jointly addressed the impacts of land development on habitat and aquatic resources. There are 321 acres (all within the Lower Gunpowder Falls-D subwatershed) that are located within the Critical Area. Maryland Department of Natural Resources has developed an interactive map to show the critical area: http://webmaps.esrgc.org/cbca/desktop/Map.

Groundwater Management

The Groundwater Management section of EPS is charged with the responsibility of managing and protecting the groundwater resources of Baltimore County. It handles issues related to drinking water wells, septic systems, and removal of residential underground storage tanks. These systems are regulated during the development review process and property title transfers to protect residents and groundwater resources.

Stormwater Management

Stormwater management in the State of Maryland has evolved over time, with the initial emphasis on quantity control in the mid to late 1980s, to quantity and quality control in the 1990s, to the more recent emphasis on channel protection (one-year storm management) and diffusing stormwater over the site (Low Impact Development [LID]). The control of erosive flows through stormwater management augments the riparian forest buffer in the protection of natural resources. The latest state regulations, revised and updated by MDE in 2009, require Environmental Site Design (ESD) to the Maximum Extent Practicable (MEP). ESD is using a combination of planning practices, alternate ground cover, and small-scale practices, which in combination, are intended to retain, infiltrate, and treat as much runoff as possible on-site (MDE 2000). Development or redevelopment projects that were already in the process of seeking approval for stormwater management plans at the time the new regulations were enacted were "grandfathered" in under the older regulations – in other words, they were granted a waiver so that they could complete their projects without needing to seek additional funding or investment for regulations that did not exist at the time the projects were designed. These projects were required to attain final project approval by May 4, 2013, when all waivers were set to expire. Jurisdictions were permitted to grant extensions in special cases; no waivers were permitted to extend beyond May 4, 2017.

Erosion and Sediment Control

Baltimore County has authority delegated from the Maryland Department of the Environment to enforce the State Erosion and Sediment Control Program. The main function of this program is to monitor best management practices (BMPs) for sediment from new development and redevelopment during the construction phase. These practices prevent sediment and other pollutant inputs into the storm drain system and stream network. The sediment control BMPs are specified in the sediment and erosion control plan for each development site. Sediment control plans are required for any construction activity disturbing an area greater than 5,000 square feet. Standard Plans are used in lieu of Sediment and Erosion Control Plans approved by the Baltimore County Soil Conservation District for residential construction activities that disturb less than 30,000 square feet and for all other construction activities that disturb less than 20,000 square feet.

5.2.2.5 Trash and Recycling

Single Stream Recycling

Single stream recycling allows for the County to collect a mix of recyclable materials (e.g., plastics, glass, metals, paper, and cardboard) without the need for citizens to sort their recyclables prior to collection. Single-family homeowners set out one bin with all recyclables curbside or in the alley for single stream recycling collection each week. The majority of multifamily complexes (apartments, condominiums) also have single stream recycling collection each week. Information on what materials are accepted and how to set them out for recycling are provided at

http://www.baltimorecountymd.gov/Agencies/publicworks/recycling/collectioninformation.html. Creating new products from recycled materials often requires less energy than manufacturing that uses virgin materials. Recycling saves energy, helps protect natural resources, reduces air and water pollution, extends the life of the Eastern Sanitary Landfill, and saves the County money, as landfill disposal is more expensive for the County than recycling.

Household Hazardous Waste Collection

In response to numerous requests from citizens and elected officials concerned with disposal of hazardous wastes from their own homes, Baltimore County citizens can drop off household hazardous waste materials for recycling or proper disposal at a permanent processing facility located at the Eastern Sanitary Landfill Solid Waste Management Facility. Materials dropped off for processing include unwanted household chemicals, such as paints, flammable cleaning solvents, automotive fluids, pesticides, pool chemicals, acids, mercury thermometers, gasoline, corrosive material, etc. In addition, EPS holds two one-day collection events annually, in the spring and fall, at different locations around Baltimore County.

Waterway Trash Boom

Trash can collect in storm drains and then enter waterways, where it poses additional hazards: fish, birds, and mammals may ingest plastic materials or become tangled in debris; garbage may smother or damage aquatic habitat; and waste materials may harbor pathogens or leach toxic substances into the aquatic environment. Refuse also detracts from the aesthetic and recreational value of streams and rivers. Floating trash booms may be installed on targeted waterways to intercept and corral trash and debris, preventing it from spreading throughout a river system. Designs vary, but a typical boom consists of a series of floats, a curtain that hangs below the water surface, and a bottom anchor to keep the boom in place. These booms require maintenance and frequent cleaning, particularly after rain events.

Baltimore County has installed and manages one trash boom located in the tidal Back River area. This boom was installed in 2010 and is maintained by a local citizen-based watershed group using grant funds supplied by Baltimore County.

5.3 BEST MANGEMENT PRACTICES FOR AGRICULTURAL AREA

There are a large number of agricultural practices that are used by farmers to reduce soil loss, trap nutrients, and minimize the amounts of nutrients and pesticides used on the land. For many of these agricultural best management practices (BMPs), the Chesapeake Bay Program has assigned specific reduction efficiencies for nitrogen, phosphorus, and sediment to each practice. The following descriptions of agricultural BMPs are derived from the Natural Resource Conservation Service (NRCS) and further information is available at: http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/fotg/

5.3.1 Farm Conservation Plans

A Soil Conservation and Water Quality Plan (SCWQP) is a comprehensive plan that addresses natural resource management on agricultural lands and describes BMPs that will be used to control erosion and sediment loss, and manage runoff. SCWQPs include management practices (*e.g.* crop rotations) and structural practices (*e.g.* grassed waterways and diversions). By request, a farmer will receive assistance from a Soil Conservation District (SCD), Maryland Department of Agriculture (MDA), or U.S. Department of Agriculture (USDA) NRCS professional to determine

the group of practices needed to address environmental concerns specific to the farm. The practices are designed to reduce erosion to an acceptable level and to be compatible with management and cropping systems. A SCWQP can be used for up to ten years without revision, if substantial changes in the farm's operation or management do not occur. SCWQPs are required on agricultural land in the critical area by The Code of Maryland Regulations (COMAR 27.01.06.03 C). Also included in a SCWQP are recommendations concerning forestry management; wildlife habitat and plantings; and the management of other natural resources. These plans must be approved by the SCD and updated every five years; enforcement authority lies with MDE. Plans are also required on agricultural land under preservation easement, such as Coastal Rural Legacy, and enforcement of these plans are by the holder of the easement. BMPs commonly included in SCWQPs are detailed below.

Cover Crops

Use of cover crop entails growing a crop of grass, small grain or legumes and is primarily for seasonal protection and soil improvement. Cover crops act as a filter and reduce the movement of sediment and pathogens, as well as dissolved and sediment-attached pollutants.

Nutrient Management

Nutrient management involves managing the amount, placement, and timing of plant nutrients (e.g., fertilizers) in order to obtain optimum yields and minimize the risk of surface and groundwater pollution.

Integrated Pest Management (IPM)

IPM includes appropriate cultural, biological, and chemical controls, and combinations thereof. The pest management programs developed are designed to address both crop production goals and environmental concerns.

Residue and Tillage Management – Mulch Till

Mulch tilling is a technique used to manage crop residue on a year-round basis in order to limit erosion to an acceptable rate, conserve soil moisture, and maintain or improve soil tilth. This practice is generally applied to cropland but may also be used on other areas where field crops are grown, such as wildlife or recreation lands.

Residue and Tillage Management – No-Till

No till is a technique used to manage the amount, orientation, and distribution of crop and other plant residue on the soil surface year-round. Crops are planted and grown in narrow slots or tilled strips, established in the untilled seedbed of the previous crop. The objective of this practice is to maintain most of the crop residue on the soil surface throughout the year. The practice may be referred to as no-till, zero-till, slot plant, row-till, strip-till, or simply generic term conservation tillage.

Conservation Crop Rotation

Conservation crop rotation entails growing various crops on the same piece of land in a planned sequence. Perennial plants used for forage are very effective in crop rotations due to increases in organic matter and reduced soil erosion. In addition, crop rotations help break insect, disease and weed cycles. Additionally, practices such as residue management, contouring, stripcropping,

diversions, terraces and grassed waterways may not function properly without a planned crop rotation.

Stripcropping

Stripcropping is growing crops in a systematic arrangement of strips across the field to reduce soil erosion by water and/or wind. This practice is used on cropland, as well as certain recreation and wildlife lands where field crops are grown. On sloping land where sheet and rill erosion are a concern, the strips are laid out on the contour or across the general slope. Where wind erosion is a concern, the strips are laid out as close to perpendicular as possible to the prevailing erosive wind direction.

5.3.2 Nutrient Management Plans

Nutrient management plans (NMPs) are comprehensive plans required by MDA that describe the optimum use of nutrient inputs for crop yield to minimize loss of excess nutrients to the environment. Plans are prepared either by University of Maryland Extension or by certified private consultants.

5.4 CITIZEN AWARENESS ACTIVITIES

Residents and businesses can engage in behaviors and activities that can negatively influence water quality, including over-fertilizing lawns, using excessive amounts of pesticides, poor housekeeping practices (such as inappropriate disposal of paints, household cleaners or automotive fluids), and dumping into storm drains. Alternatively, positive behaviors such as tree planting, disconnecting downspouts, and picking up pet waste can help improve water quality. Whether a pollution prevention program is designed to discourage negative behaviors or encourage positive ones, targeted education is needed to deliver messages that promote changes in behavior. Local watershed organizations, such as the GVC, and other civic groups, such as the Master Gardeners, are in a position to influence these changes using pollution prevention education and outreach to teach citizens how to properly care for the watershed.

5.4.1 Stormwater Runoff

A survey regarding people's knowledge about stormwater was conducted in 2007 by the Herring Run Watershed Association and the Jones Falls Watershed Association (both organizations are now part of Blue Water Baltimore) in conjunction with OpinionWorks. It concluded that even citizens who want to reduce the negative impacts of stormwater runoff do not realize their role in controlling runoff. By slowing and reducing the amount of stormwater runoff, more water can infiltrate into the ground and lessen damaging stormwater surges into streams. Annually, Baltimore County holds a one-day truckload sale of rain barrels for citizens to purchase. There is more detail on this and other ways that homeowners can help reduce stormwater runoff in section 5.5.

5.4.2 Pet Waste/Bacteria Awareness

Pet waste is one of the contributors of bacteria to streams and can cause health problems in humans. A pet waste station is a sign reminding pet owners of the importance of proper disposal of pet waste and it usually includes a supply of bags for pet waste cleanup. Often it is located next to an existing trashcan or it includes one. Pet waste stations can help neighborhoods to reduce

bacteria flowing into their local streams and help to keep their neighborhood park or school site clean. Citizens can participate by monitoring the supply of bags to make sure they are continually available. In collaboration with other county agencies, EPS is developing an awareness campaign for better pet waste management.

5.4.3 Fertilizer Reduction

A well-manicured and responsibly maintained lawn can be an asset to the watershed. Too often, however, over fertilization and irresponsible pest management result in pollutant-charged runoff to local streams. Significant reductions of total nitrogen to stormwater can be achieved through careful fertilizer management. Homeowners should be reminded to follow the fertilizer application instructions so that it is applied in the correct amount, during the right season, and under the right conditions so that the fertilizer does not wash away in a rainstorm. Citizens can be more cognizant about fertilizer placement so that it doesn't land on driveways and sidewalks where it may wash directly into the street and storm drain system. The County also promotes eco-friendly lawn care, including the use of mulching lawn mowers that reduce the need for fertilizer and decrease the amount of material handled by the yard material collection program.

5.4.4 Trash and Recycling

Compost Bins

Baltimore County holds a one-day compost bin sale for residents to purchase bins for composting yard waste in their backyards. By composting leaves and weeds in backyard bins, the amount of material handled by the municipal yard material collection is reduced. Use of compost is an environmentally friendly way of improving soil and avoids the application of manufactured chemical fertilizer. This event is held in conjunction with the annual rain barrel sale.

Stewardship Projects

EPS provides assistance in planning and advertising local stewardship projects such as Project Clean Stream, an annual stream cleanup hosted by the Alliance for the Chesapeake Bay.

Reuse Directory

The Reuse Directory is a listing of reuse organizations for Baltimore County residents and businesses that is available online and in print. In it are all of the places that you can take unwanted items for reuse, including construction materials, appliances, office supplies, clothing, household items, automobiles, food, medical equipment, and more. By donating reusable items, you will: help other people and organizations, reduce disposal costs, reduce air and water pollution, and conserve space in the landfill. The directory is kept updated and published by the Baltimore County Bureau of Solid Waste Management; it is linked to from this webpage: http://www.baltimorecountymd.gov/Agencies/publicworks/recycling/pubsanddownloads.html

The Re-Source Newsletter

The Re-Source Newsletter is an online resource that is published quarterly and provides information and updates about Baltimore County's solid waste reduction, reuse, recycling, and refuse disposal programs.
http://www.baltimorecountymd.gov/Agencies/publicworks/recycling/newsletter/index.html

5.4.5 Environmental Awareness and Education

Outreach and education programs are intended to communicate to the public how to reduce the potential for pollutants to reach waterways. These programs are designed to change pollutant-causing behaviors by providing information on how certain habits and actions affect water quality and to recommend new behaviors that can reduce impacts. There are also a number of activities that can reduce runoff or improve water quality that don't involve pollution prevention, such as landscaping improvements, which could be the target of an outreach program.

A pollution prevention program can be designed to discourage negative behaviors and/or encourage positive behaviors. Either way, the goal is to deliver a tailored message through targeted education to promote behavior changes. Local watershed organizations such as the Gunpowder Valley Conservancy can help influence these changes using pollution prevention education and outreach to teach citizens how to properly care for the watershed. The upland assessments described in Chapter 4 identified pollution prevention or source control education programs which could be effective in the Lower Gunpowder Falls (Urban) watershed.

Community-based facilities present good opportunities for educating the public about water quality issues and opportunities for improving the health of the watershed. This can be accomplished by implementing water quality BMPs such as rain gardens and bioretention areas at these sites. In addition to environmental education, these BMPs have water quality and aesthetic benefits for property users. Tree plantings present great opportunities for community involvement and education, as do water quality sampling and monitoring of stormwater management.

5.5 VOLUNTEER RESTORATION PROGRAMS

There are several restoration activities that citizens in the watershed can engage in to help restore and protect the watershed. These activities are described in the following sections and include downspout disconnection, BayScaping, tree canopy improvement, fertilizer reduction/education, planting open space trees, and participating in a citizen stream watch program. The GVC, as well as the Master Gardeners, can provide education and workshops on these activities.

5.5.1 Downspout Disconnection

In addition to road runoff, rooftops can sometimes contribute stormwater directly into streams. Many downspouts are connected directly to the storm drain system through underground pipes, while others are funneled toward driveways and sidewalks, which then are connected to the street. By redirecting downspouts to a pervious area, this runoff is allowed to infiltrate the ground in areas such as gardens and lawns.

Downspout disconnection refers to several practices that capture or treat rooftop runoff from individual downspouts through either a simple disconnection that allows the runoff to spread across the lawn or yard where it filters or infiltrates into the ground, a rain barrel that captures the runoff for re-use in watering gardens, or a rain garden that infiltrates the runoff. Several of the neighborhoods assessed in the Lower Gunpowder Falls (Urban) watershed were recommended for downspout disconnection because they are draining to impervious surfaces such as driveways, sidewalks, or the curb and gutter system.

Simple downspout disconnection can be achieved, where appropriate, if the downspouts are relocated to drain onto pervious areas (i.e., lawn). This will allow rooftop runoff to be filtered by vegetation, and soak into the ground. This decreases flow to local streams during storm events, reducing erosion and pollutant loads to streams.

The use of rain barrels for the collection and reuse of the runoff is a highly sustainable practice, and is effective when there is limited space on the property and other disconnection practices are not possible. Downspouts are directed into rain barrels, where rooftop water is captured and stored for later use to water the yard or garden, or simply to be released onto a pervious area on a dry day.

Finally, some of the residential lots in the watershed have sufficient room for rain gardens, which are the most desirable option in terms of water quality. Rain gardens capture runoff from impervious surfaces such as roofs, roads, patios and driveways. They are planted with native perennials and shrubs that are compatible with wet soils. A downhill area that naturally collects rain water is an ideal location for a rain garden. The garden temporarily holds runoff, allowing it to gradually percolate into the ground, thus replenishing groundwater and reducing floods. Garden plants naturally filter pollutants and improve the water quality.

5.5.2 BayScaping

Numerous water quality benefits are achieved from converting turf into landscaping and through increasing the area of urban tree canopy. A BayScape is a designed feature that uses plants native to the Chesapeake Bay watershed to provide habitat for local and migratory animals, improve water quality, and reduce the need for chemical pesticides and herbicides. BayScaping plants, such as trees, shrubs and perennials, are able to make better use of rain water than typical lawn grasses, and so require less watering once established. They are also better at trapping and removing nitrogen and pollutants from rain water so that it is not released into nearby waterbodies. A BayScape is also valuable for the gardener or landowner because it offers greater visual interest than lawn; reduces the time and expense of mowing, watering, fertilizing, and treating lawn and garden areas; and can address areas with problems such as erosion, poor soils, steep slopes, or poor drainage. The removal of exotic, invasive plant species also benefits native plant and animal communities.

5.6 PUBLIC LANDS/OPEN SPACE

Lands in the SWAP area, owned by Baltimore County, Baltimore City, and the State of Maryland, meet various public needs as described.

<u>Baltimore County Department of Recreation and Parks</u>

Krause Memorial Park

Krause Memorial Park is a 14.6-acre park located in the Parkville community. Amenities include trails, a pavilion, and a picnic area. The Parkville Recreation Office manages daily operations and reservations for this park.

Cromwell Valley Park

Cromwell Valley Park is a 426-acre park located in the Greater Loch Raven area. Amenities include the Willow Grove Nature Center, Willow Grove Farm, Sherwood Farm, picnic areas, nature trails, and historic sites. Facilities at this park are managed by the Cromwell Valley Parks Council. http://www.cromwellvalleypark.org/index.html

Maryland Department of Natural Resources

Gunpowder Falls State Park

Gunpowder Falls State Park is the largest of Maryland's state parks, encompassing over 18,000 acres. The Central Area section of the park includes 173 acres located within the Lower Gunpowder Falls (Urban) watershed. This section of the park offers miles of nature trails and opportunities for fishing and river recreation.

5.6.1 Tree Canopy Improvement

Programs to promote tree planting in residential yards and commercial open space can increase the tree canopy, increase evapotranspiration and interception, slow runoff, and allow greater infiltration of stormwater into the ground due to tree roots reducing soil compaction. Trees also reduce erosion by holding soil and by reducing the impact of rain to bare ground. These types of programs also provide an opportunity to involve volunteers from neighborhoods, businesses, and schools to help plant trees throughout the watershed while also educating the community about the importance of trees for air and water quality.

Baltimore County holds the Big Tree Sale; the County has its own native tree nursery for county reforestation projects. Twice a year, in the spring and fall, trees from the nursery are made available to the public to encourage planting of native trees, especially oaks, which have exceptional water quality, air quality, and wildlife benefits. Trees are sold at one-day sale events.

The State of Maryland's TREE-MENDOUS program provides high-quality, native trees and shrubs, available at reasonable prices, for plantings on public lands. The trees may be planted in places such as community open spaces, schools, government facilities, and rights-of-way. They may not be planted at private residences.

5.6.2 Fertilizer Reduction/Education

Proper lawn and turf care practices can reduce excess nitrogen, phosphorus, insecticides, and herbicides from getting into local streams. Education on soil testing, fertilizer application, and pesticide use is intended to reduce the amount of these materials applied to the land.

5.6.3 Stream Watch Program

The Stream Watch Program is intended to develop citizen stewardship through participation of citizen volunteers who actively assume the responsibility of caring for segments of the stream network by observing changes in the system, providing stream clean-ups, and participating in planting activities. The Stream Watch Program also includes identification of potential restoration projects for possible inclusion in the Waterway Capital Improvement Program and provides a

valuable addition to the county's Illicit Connection Program through reports of potential illicit discharges by Stream Watch participants. The GVC organizes the Stream Watch Program within the Lower Gunpowder Falls (Urban) subwatersheds and works with Baltimore County EPS in reporting the outcomes of these activities.

5.6.4 Open Space Trees

Open pervious areas (i.e., areas covered with turf grass, rather than pavement or forest) and natural area remnants provide important natural groundwater recharge functions within a subwatershed, and should be optimized to promote natural infiltration. These areas also present an opportunity for reforestation in the watershed. Reforestation is the best way to improve the infiltration, recharge function, and pollutant reduction capability of a site. Other techniques, such as soil aeration, amendments, and establishing native plantings or meadows may be used when reforestation is not an option, as all of these alternatives still provide greater benefit(s) than turf grass. Ideal sites for planting have little evidence of soil compaction, invasive plants, or trash/dumping, and can be reforested with minimal site preparation.

5.7 INSTITUTIONAL INITIATIVES

There are several restoration activities that institutions in the watershed such as churches and schools can engage in to help restore and protect the watershed. These activities are described in the following sections.

5.7.1 Parking Lot Retrofits

Often large parking surfaces are included in commercial and institutional development projects for events that occur very infrequently. If reducing the impervious cover is not an option, then filtering practices can provide a substantial benefit when applied over large areas. Onsite commercial and institutional retrofit practices often include the use of sand filters, bioretention, and grass swales adjacent to parking lots. Larger redevelopment projects often include underground storage or filtering systems. Several research groups are exploring innovative parking surfaces to develop a surface that is both durable and porous. These surfaces are another option for providing better filtration of runoff, while still allowing for the same number of parking spaces.

5.7.2 Open Space Planting

An increasing number of faith-based institutions are showing interest in adopting conservation landscaping practices. This often begins with removal of unused turf areas at these institutions. These areas are then replaced by an assortment of more sustainable and environmentally-friendly practices. Options include: planting trees, restoring wildlife habitat, introducing no-mow zones, and creating meadows, all of which also improve the quality and quantity of stormwater runoff. Trees planted near buildings provide wind protection and shade, which can reduce energy use, leading to lower heating and cooling costs. When lawn area is eliminated there is less mowing required, reducing fossil fuel consumption and the associated air pollution.

5.8 LAND PRESERVATION

Land preservation complements the implementation of BMPs by insuring that land use is stabilized over time. Unlike park land, land preservation maintains certain restrictions on the land's use in perpetuity. The restrictions range from limits on development to specific resource protection, such as forest, stream buffer or prime land protection.

These preservation areas may be large, multi-parcel blocks or small, individual parcels. Land preservation in Baltimore County complements the long-term multifaceted efforts to limit sprawl and protect rural resources, water supplies, and rural economies. The limitations on the property vary depending on the principle of the easement program, and as specifically limited by the Deed of Conservation Easement. For example, the Maryland Environmental Trust easements provide for a broad array of environmental protection restrictions. The Agricultural Protection programs focus on protection of prime and productive soils, while still permitting resource extraction. Rural Legacy blends these two objectives.

For purposes of watershed management, an understanding of existing protected lands can provide a starting point in prioritizing potential protection and restoration activities. In many cases, protected lands may provide a better opportunity for restoration projects simply because the risk of the land being converted to development is removed, thus the investment involved in the implementation of the practice is secure. A summary of current conservation easements is provided in Chapter 2.

Descriptions of the land preservation programs in effect in the Lower Gunpowder Falls (Urban) watershed follow.

5.8.1 Maryland and County Rural Legacy Programs

Baltimore County, in partnership with the GVC, participates in the State's Rural Legacy Program. The program was developed in 1997 to protect large, continuous tracts of valuable cultural and natural resource lands through state grants made to local land trusts. A large section of the Lower Gunpowder Falls-D subwatershed falls within the Coastal Rural Legacy area, which aims to protect large blocks of farmland, forest, wetlands, and other environmental resources that affect Chesapeake Bay both directly and indirectly. Protection is afforded through the purchase of development rights and the placement of a perpetual Conservation Easement on the property. The easements are held by the GVC, state or county, or a combination. In all cases, the land trust and the governmental co-holder of the easement are responsible for monitoring the property to assure compliance with the easement. Currently, there is no land within the watershed that is actively enrolled in this program.

5.8.2 Maryland Environmental Trust and Local Land Trusts

Created by the Maryland General Assembly in 1967 to protect Maryland's natural environment, the Maryland Environmental Trust (MET) seeks donated easements on farms and forestlands, wildlife habitats, waterfront acreages, natural areas, historic sites, and other valuable and scenic features. In 1974, a landowner in Baltimore County was one of the first to protect their property through this program. Today, Baltimore County remains a leader in the state, with county landowners preserving over 18,500 acres through donations, 163 acres of which are in the Lower Gunpowder Falls (Urban) watershed. Although both MET and local land trusts prefer to accept

donations on lands greater than 25 acres, local land trusts are often willing to work with smaller property owners. Donations are accepted throughout the year. Landowners may qualify for a significant tax deduction and/or credit. MET also provides loans to qualified groups for the purchase of land for preservation.

5.8.3 Maryland Agricultural Land Preservation Foundation

Created in 1979, this program has been dedicated to preserving farmland and fostering commercial agriculture. With joint funding by the county and the state, over 22,000 acres of farmland have been preserved in Baltimore County. To qualify for this program, a farm must be a minimum of 50 acres or located adjacent to a preserved property. Applications to sell development rights may be made annually by July 1st following enrollment in an Agricultural District. Landowners receive cash payments for participating in the easement program.

5.8.4 Baltimore County Agricultural Land Preservation Program

Created in 1994 to preserve working family farms, this Baltimore County program has used innovative and collaborative funding mechanisms for land preservation. Landowners have protected over 5,600 acres through this program, though no farms within the Lower Gunpowder Falls (Urban) watershed are currently enrolled in this program. To participate, a farm must be 50 acres in size or located adjacent to a preserved property.

CHAPTER 6: REFERENCES

Baltimore County Office of Planning. 2011. Baltimore County Zoning (revised June 24). Baltimore County, MD. http://www.baltimorecountymd.gov/Agencies/permits/pdm_zoning/zonemaps.html

CBP (Chesapeake Bay Program). 2011. *The Bay Watershed: A Watershed Partnership* (modified August 1). Annapolis, MD. http://www.chesapeakebay.net

CWP (Center for Watershed Protection). 2003. *Impervious Cover Model.* Ellicott City, MD.

CWP (Center for Watershed Protection). 2004. *Unified Subwatershed and Site Reconnaissance: A User's Manual - Manual 11*. Ellicott City, MD.

CWP (Center for Watershed Protection). 2005. *A User's Guide to Watershed Planning in Maryland.* Prepared for the Maryland Department of Natural Resources, Watershed Services Division. Ellicott City, MD.

CWP (Center for Watershed Protection). 2007. *Urban Stormwater Retrofit Practices: Urban Subwatershed Restoration Manual Series - Manual 3.* Prepared for U.S. Environmental Protection Agency, Office of Watershed Management. Ellicott City, MD.

DEPRM (Baltimore County Department of Environmental Protection and Management). 2008. *Upper Back River Watershed Action Plan. Volumes 1 and 2.* Prepared in Consultation with Upper Back River SWAP Steering Committee. Towson, MD.

DNR (Maryland Department of Natural Resources). 2007. *Maryland Tributary Strategy Upper Western Shore Basin Summary Report for 1985-2005 Data.* Annapolis, MD.

EPS (Baltimore County Department of Environmental Protection and Sustainability). 2013. *NPDES Municipal Stormwater Discharge Permit - 2013 Annual Report.* Baltimore County, MD.

Konrad, C.P. 2003. USGS Factsheet 076-03: Effects of Urban Development on Floods. Washington, D.C.

McCormick Taylor. 2011. Lower Gunpowder Falls Watershed Assessment (WA). Prepared for Baltimore County Department of Environmental Protection and Sustainability (EPS). Towson, MD.

MDE (Maryland Department of the Environment). 2000. *2000 Maryland Stormwater Design Manual, Volumes I & II.* Prepared by the Center for Watershed Protection. Ellicott City, MD. Revised May 2009.

MGS (Maryland Geological Survey). 2009. MGS Online – Guide to Maryland Geology (updated January 22). Baltimore, MD. http://www.mgs.md.gov/indexgeo.html

NCDC (National Climatic Data Center). 2013. Weather Data for Station Locator: Baltimore Washington *International Airport.* National Oceanic and Atmospheric Administration (NOAA). Asheville, NC.

NRCC (Northeast Regional Climate Center). 2013. US Comparative Climate Data. Partners with National Climate Data Center, Cornell University. Ithaca, NY. http://www.nrcc.cornell.edu/page_ccd.html

Ouyang, D. 2002. *RUSLE: On-Line Soil Erosion Assessment Tool.* Institute of Water Research, Michigan State University. East Lansing, MI. http://www.iwr.msu.edu/rusle/

Parsons Brinckerhoff Quade & Douglas, Inc. 1999. Lower Gunpowder Falls Water Quality Management Study (WQMS). Prepared for Baltimore County Department of Environmental Protection and Resource Management (EPS). Baltimore, MD.

Rosgen, D. 1996. *Applied River Morphology.* Woldland Hydology, Pagosa Springs, CO.

Stranko, S., D. Boward, J. Kilian, A. Becker, M. Ashton, A. Schenck, R. Gauza, A. Roseberry-Lincoln, and P. Kazyak. 2007. *Maryland Biological Stream Survey, Round Three Field Sampling Manual* (revised January). Maryland Department of Natural Resources. Annapolis, MD.

USDA (U.S. Department of Agriculture). 1976. *Soil Survey Manual.* Soil Survey Division, Natural Resource Conservation Service (NRCS).

USDA (U.S. Department of Agriculture). 1986. *Technical Release 55: Urban Hydrology for Small Watersheds.* Conservation Engineering Division, Washington, DC. Natural Resource Conservation Service (NRCS).

USEPA (U.S. Environmental Protection Agency). 2009. *Developing Your Own Stormwater Pollution Prevention Plan: A Guide for Industrial Operators.* Washington, DC. EPA 833-B-09-002.

USEPA (U.S. Environmental Protection Agency). 2010. Chesapeake Bay Phase 5.3 Community Watershed Model. EPA 903S10002 - CBP/TRS-303-10. U.S. Environmental Protection Agency, Chesapeake Bay Program Office, Annapolis MD. December 2010. http://www.chesapeakebay.net/about/programs/modeling/53/

USEPA (U.S. Environmental Protection Agency). 2014. *National Recommended Water Quality Criteria*. http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm Last updated: February 28, 2014.

Yetman, K.T. 2001. *Stream Corridor Assessment Survey - SCA - Survey Protocols*. Maryland Department of Natural Resources, Watershed Restoration Division. Annapolis. MD. September 2001.

APPENDIX F: UPLAND ASSESSMENT DATA SUMMARY

Lower Gunpowder Falls (Urban) Upland Assessments
Hotspot Investigations (HSIs)

Site ID	Subshed	Hotspot Status	Cat.	Business Type	Vehicle Oper.	Outdoor Materials	Waste Mgmt.	Physical Plant	Turf Land-scaping	Stormwtr. Infrastruc.	Refer for Enforce-ment
HSI_N_101	Minebank Run	Confirmed hotspot	Commercial	Strip Mall	N/A	X					
HSI_N_102	Minebank Run	Severe hotspot	Commercial	Shopping Center	X						X
HSI_N_103	Minebank Run	Confirmed hotspot	Commercial	Seafood Restaurant	N/A		X				
HSI_N_128	Minebank Run	Severe hotspot	Commercial	Equipment Rental							
HSI_N_129	Minebank Run	Not a hotspot	Commercial	Car Rental							
HSI_N_131	Minebank Run	Potential hotspot	Commercial	Restaurant	N/A	N/A					
HSI_N_132	Minebank Run	Potential hotspot	Commercial	Diner	N/A	N/A					
HSI_N_223	Lower Gunpowder Falls-A	Potential hotspot	Commercial	Shopping Center	N/A						
HSI_N_224	Lower Gunpowder Falls-A	Not a hotspot	Commercial	Fast Food Restaurant	N/A	N/A					
HSI_N_225	Lower Gunpowder Falls-A	Potential hotspot	Commercial	Fast Food Restaurant	N/A	N/A					
HSI_N_226	Lower Gunpowder Falls-A	Potential hotspot	Commercial	Restaurant	N/A	N/A					
HSI_N_233	Lower Gunpowder Falls-A	Potential hotspot	Commercial	Restaurant	N/A	N/A					X
HSI_N_306	Jennifer Branch	Confirmed hotspot	Commercial	Strip Mall w/ Supermarket	N/A						
HSI_N_319	Jennifer Branch	Confirmed hotspot	Commercial	Small Machinery Repair, Landscaping Services		X	N/A				X

Lower Gunpowder Falls (Urban) Upland Assessments
Hotspot Investigations (HSIs)

Site ID	Subshed	Hotspot Status	Cat.	Business Type	Vehicle Oper.	Outdoor Materials	Waste Mgmt.	Physical Plant	Turf Land-scaping	Stormwtr. Infrastruc.	Refer for Enforce-ment
HSI_N_320	Jennifer Branch	Not a hotspot	Commercial	Shopping Center	N/A	N/A					
HSI_N_405	Lower Gunpowder Falls-B	Confirmed hotspot	Commercial	Shopping Center	N/A						
HSI_N_411	Lower Gunpowder Falls-B	Potential hotspot	Commercial	Strip Mall w/ Restaurant	N/A	N/A					
HSI_N_412	Lower Gunpowder Falls-B	Not a hotspot	Commercial	Restaurant	N/A						X
HSI_N_415	Lower Gunpowder Falls-B	Confirmed hotspot	Commercial	Fast Food Restaurant	N/A						
HSI_N_416	Lower Gunpowder Falls-B	Not a hotspot	Commercial	Fast Food Restaurant	N/A						
HSI_N_417	Lower Gunpowder Falls-B	Confirmed hotspot	Commercial	Auto Repair							
HSI_N_418	Lower Gunpowder Falls-B	Not a hotspot	Commercial	Restaurant and Strip Mall	N/A	N/A					
HSI_N_434	Lower Gunpowder Falls-B	Not a hotspot	Commercial	Restaurant, Granite Sales	N/A						

Lower Gunpowder Falls (Urban) Upland Assessments
Institutional Site Investigations (ISIs)

Site ID	Subshed	Name	Own-ership	Waste Mngmt.	Vehicle Ops.	Outdoor Mater-ials	Turf Land-scaping	Storm Drain Marking	Tree Planting	Down-spout Dis-connect	SW Retrofit	Imp. Cover Removal
ISI_N_101	Minebank Run	Cromwell Valley Elementary	Public								X	X
ISI_N_104	Minebank Run	Loch Raven High School	Public					X			X	
ISI_N_105	Minebank Run	Maryland Presbyterian Church	Public		N/A				X		X	
ISI_N_207	Lower Gunpowder Falls-A	Pine Ridge Swim Club	Private		N/A			X			X	
ISI_N_208	Lower Gunpowder Falls-A	Pine Grove Middle School	Public					X			X	X
ISI_N_209	Lower Gunpowder Falls-A	Pine Grove Elementary	Public					X			X	X
ISI_N_306	Jennifer Branch	Linthicum Heights Methodist	Private		N/A				X	X		
ISI_N_317	Jennifer Branch	Carney Assembly of God	Private	N/A					X		X	X
ISI_N_318	Jennifer Branch	Kindom Hall Jehovah's Witness	Private						X		X	
ISI_N_319	Jennifer Branch	Christus Victor Lutheran	Private		N/A				X	X	X	
ISI_N_320	Jennifer Branch	Zion Presbyterian	Private		N/A				X		X	
ISI_N_321	Jennifer Branch	Atonement Evangelical Lutheran	Private	N/A	N/A			X	X		X	
ISI_N_412	Lower Gunpowder Falls-B	Perry Hall Baptist Church	Private						X		X	
ISI_N_413	Lower Gunpowder Falls-B	Gunpowder Elementary School	Public					X			X	X

Lower Gunpowder Falls (Urban) Upland Assessments

Institutional Site Investigations (ISIs)

Site ID	Subshed	Name	Own-ership	Waste Mngmt.	Vehicle Ops.	Outdoor Mater-ials	Turf Land-scaping	Storm Drain Marking	Tree Planting	Down-spout Dis-connect	SW Retrofit	Imp. Cover Removal
ISI_N_414	Lower Gunpowder Falls-B	Church of Christ in East Baltimore	Private		N/A	N/A			X		X	
ISI_N_416	Lower Gunpowder Falls-B	Perry Hall Presbyterian	Private		N/A				X	X	X	X
ISI_N_511	Lower Gunpowder Falls-C	Perry Hall Mansion	Public	N/A	N/A				X			

Lower Gunpowder Falls (Urban) Upland Assessments
Pervious Area Assessments (PAAs)

Site ID	Subshed	Site Name	Ownership	% Turf	Prep.	Notes
PAA_N_101	Minebank Run	Cromwell Valley Park	Public	20	Minimal site prep	This site presents an excellent opportunity for tree planting directly in riparian area of the river (and directly adjacent to it). This may be the best opportunity we have seen in the watershed.
PAA_N_302	Jennifer Branch	County Open Space - A	Public	75	Minimal site prep	Good small site for planting along existing forest and stream. Invasive plants should be removed prior to tree planting.
PAA_N_304	Jennifer Branch	Proctor Lane Apartment Open Space	Private	95	Minimal site prep	There may be room to plant a narrow margin of trees along the edges of the existing "forest" adjacent to the stream. Would have to balance planting w/apartment owner needs/wishes (very close proximity). No other places for planting here.
PAA_N_305	Jennifer Branch	County Open Space - B	Public	85	Minimal site prep	Open lawn area in the western part of property would be best for tree planting. Not much space for planting elsewhere.
PAA_N_311	Jennifer Branch	Baltimore City Property	Public	80	Minimal site prep	In theory, some opportunity for tree planting exists here. In reality, these fields are currently all horse pastures - all currently in use. Would need to negotiate with Baltimore City for planting. Areas adjacent to stream may be best.
PAA_N_314	Jennifer Branch	County Open Space - I	Public	80	Minimal site prep	This would be a good opportunity to re-establish the stream buffer along the northern parts of the site.
PAA_N_315	Jennifer Branch	County Open Space - J	Public	80	Minimal site prep	Small potential tree planting site. Note several residences have swingsets, sheds and other items within site. Tree planting may not be popular.
PAA_N_406	Lower Gunpowder Falls-B	County Open Space - C	Public	95	Minimal site prep	Much of this site is covered in common reed (dense). Part of the wetlands possess a cover of cattails; some of this part of the wetland could be planted in trees. There are also two small areas of maintained lawn that could be planted in trees.
PAA_N_407	Lower Gunpowder Falls-B	County Open Space - D	Public	98	Minimal site prep	Used by local residents as a play area. Little green space in the area - it may be hard convincing homeowners and park users to plant trees here.
PAA_N_408	Lower Gunpowder Falls-B	County Open Space - E	Public	90	Minimal site prep	Parts of this site may provide a good planting area, if landowners are amenable to it.
PAA_N_409	Lower Gunpowder Falls-B	County Open Space - F	Public	85	Minimal site prep	This could be a good area for tree planting, but there is precious little existing green space here. Would have to come to agreement with condo owners.
PAA_N_413	Lower Gunpowder Falls-B	County Open Space - H	Public	98	Minimal site prep	Not a very large site for tree planting. May conflict with current use as green space by residents.

Lower Gunpowder Falls (Urban) Upland Assessments
Pervious Area Assessments (PAAs)

Site ID	Subshed	Site Name	Ownership	% Turf	Prep.	Notes
PAA_N_416	Lower Gunpowder Falls-B	County Open Space - K	Public	90	Minimal site prep	Very small, urban site for tree planting. Note small, recently roto-tilled area within site.
PAA_N_417	Lower Gunpowder Falls-B	Georgetown Square HOA	Private	80	Minimal site prep	The best area for tree planting is in the southern part of the site, along the stream.

Lower Gunpowder Falls (Urban) Upland Assessments
Neighborhood Source Assessments (NSAs)

Site ID	Subshed	Name	Acres	PSI	ROI	Downspt. Disco-nnect	Rain Barrel	Rain Garden	Storm Drain Marking	Bay-Scape	Fertilizer Reduc.	Pet Waste	Trash Mgmt.	Trees to Plant
NSA_N_1	Bean Run	Glenside Farms, Forge Landing	90.4	High	Mod.		X		X		X			300
NSA_N_2	Bean Run	The Townes at Perry Hall Farms	8.0	Mod.	Mod.		X		X					0
NSA_N_3	Bean Run	Perry Hall Farms	10.7	Mod.	Mod.		X		X		X			0
NSA_N_5	Bean Run	Glenside Farms	15.1	Mod.	Mod.		X		X		X			0
NSA_N_6	Bean Run	Perry Hall Farms	23.8	Mod.	Mod.	X	X		X					15
NSA_N_7	Bean Run	Forge Heights	21.6	Mod.	Low		X	X	X	X	X			0
NSA_N_8	Bean Run	Forge Heights	69.8	Mod.	Mod.		X	X	X	X				0
NSA_N_9	Bean Run	Forge Acres	140.6	High	Mod.		X	X	X	X	X			0
NSA_N_10	Bean Run	Equestrian Acres, Honeygo Ridge	57.6	High	Mod.		X	X	X		X	X		500
NSA_N_11	Bean Run	New Forge Rd, Aubree Ln, Lipscomb Way	15.2	Mod.	Mod.		X		X		X			175
NSA_N_32	Bean Run	Perry Hall Farms	9.2	Mod.	Mod.		X		X					0
NSA_N_39	Jennifer Branch	North Wind Village	13.9	Mod.	Mod.		X	X	X	X	X	X		0
NSA_N_50	Jennifer Branch	Scott's Haven, Village of Vanderway, Cloverfield Manor	11.3	Mod.	High	X	X		X	X				150
NSA_N_51	Jennifer Branch	Scott's Haven, Village of Vanderway, Cloverfield Manor	38.3	Low	Mod.		X							0
NSA_N_52	Jennifer Branch	Brittany, Brittany Hill, Brittany III, Brittary IV	45.2	Mod.	Mod.		X		X		X			80
NSA_N_53	Jennifer Branch	White Oaks, Summit HIlls, Shady Grove	39.5	Mod.	High		X		X	X				0

Lower Gunpowder Falls (Urban) Upland Assessments
Neighborhood Source Assessments (NSAs)

Site ID	Subshed	Name	Acres	PSI	ROI	Downspt. Disco-nnect	Rain Barrel	Rain Garden	Storm Drain Marking	Bay-Scape	Fertilizer Reduc.	Pet Waste	Trash Mgmt.	Trees to Plant
NSA_N_54	Jennifer Branch	Oak Summit	8.1	Mod.	Mod.	X	X		X					0
NSA_N_55	Jennifer Branch	Northwind Farms	16.5	High	Mod.		X	X	X	X	X			100
NSA_N_56	Jennifer Branch	North Winds, Village of Nearbrook	13.1	Mod.	High	X	X		X	X				0
NSA_N_57	Jennifer Branch	Eagerton Farm Ct	11.8	Mod.	Mod.		X	X	X	X	X			0
NSA_N_58	Jennifer Branch	Village of Nearbrook	13.6	Low	Mod.		X		X					150
NSA_N_60	Jennifer Branch	Harford Farms	23.0	Low	Mod.		X		X					0
NSA_N_61	Jennifer Branch	Mis-Jan Estates	21.2	Mod.	Mod.		X		X		X			0
NSA_N_62	Jennifer Branch	Sunrise Hills	22.3	Mod.	High		X	X	X	X				0
NSA_N_63	Jennifer Branch	Erdmanor, Harford Acres	13.2	Mod.	Mod.		X		X		X			0
NSA_N_64	Jennifer Branch	Robin Ridge, Town & County-Carney	19.0	Mod.	High	X	X		X	X				0
NSA_N_65	Jennifer Branch	Harford Village Apts, Cub Hill Apts, Skylark Pointe Apts	45.0	Mod.	High	X	X		X	X				100
NSA_N_66	Jennifer Branch	Forestview	9.3	Mod.	Mod.		X		X	X				0
NSA_N_67	Jennifer Branch	Pine Grove	4.2	Low	Mod.		X		X					0
NSA_N_68	Jennifer Branch	Carney View	24.9	Mod.	Mod.		X		X	X				0
NSA_N_69	Jennifer Branch	Harford Hills, Hillside Park	14.1	Low	Mod.		X		X					0
NSA_N_59	Lower Gunpowder Falls-A	Debaugh Farms	27.6	Low	Mod.		X	X	X	X				0
NSA_N_70	Lower Gunpowder Falls-A	Parkway Manor	8.0	Low	Mod.		X		X					0
NSA_N_71	Lower Gunpowder Falls-A	Perring Park	60.0	Mod.	High		X		X	X				50
NSA_N_72	Lower Gunpowder Falls-A	Doncaster Village	40.2	Mod.	Mod.	X	X	X	X	X				207

Lower Gunpowder Falls (Urban) Upland Assessments
Neighborhood Source Assessments (NSAs)

Site ID	Subshed	Name	Acres	PSI	ROI	Downspt. Disco-nnect	Rain Barrel	Rain Garden	Storm Drain Marking	Bay-Scape	Fertilizer Reduc.	Pet Waste	Trash Mgmt.	Trees to Plant
NSA_N_73	Lower Gunpowder Falls-A	Hunting Lodge, Pine Ridge	63.8	High	High		X	X	X	X				80
NSA_N_74	Lower Gunpowder Falls-A	Doncaster Village, Chippendale	31.0	Mod.	Mod.	X	X		X	X				150
NSA_N_75	Lower Gunpowder Falls-A	Doncaster Village	21.0	Low	Mod.		X		X	X				0
NSA_N_76	Lower Gunpowder Falls-A	Satyr Woods, Chippendale	31.4	Low	Mod.		X		X	X				0
NSA_N_77	Lower Gunpowder Falls-A	Kenilworth at Perring Park Apts	25.6	High	High	X	X		X	X	X			100
NSA_N_78	Lower Gunpowder Falls-A	Slywood	18.1	Mod.	Mod.		X		X	X	X			300
NSA_N_79	Lower Gunpowder Falls-A	Satyr Woods, Carriage Walk	7.9	Mod.	Mod.		X		X	X				100
NSA_N_20	Lower Gunpowder Falls-B	Gunview Farms, Gunview II, Broad Run	29.3	Mod.	Mod.		X		X		X			50
NSA_N_21	Lower Gunpowder Falls-B	Cliffvale	10.0	Low	Low		X							0
NSA_N_22	Lower Gunpowder Falls-B	Khaland	23.9	Mod.	Mod.		X		X	X				0
NSA_N_23	Lower Gunpowder Falls-B	Perry Hall Estates, Silvergate Village	73.0	Low	Mod.	X	X		X	X				0
NSA_N_24	Lower Gunpowder Falls-B	Holiday Manor	7.1	Mod.	Mod.	X	X		X	X	X			0
NSA_N_25	Lower Gunpowder Falls-B	Red Fox Farm Condos	23.3	Mod.	Mod.	X	X	X	X		X			0
NSA_N_26	Lower Gunpowder Falls-B	Perry Hall Gardens	26.1	High	Mod.	X	X		X	X	X			0
NSA_N_27	Lower Gunpowder Falls-B	Dawnvale West	5.0	Mod.	Mod.	X	X		X		X			0

Lower Gunpowder Falls (Urban) Upland Assessments
Neighborhood Source Assessments (NSAs)

Site ID	Subshed	Name	Acres	PSI	ROI	Downspt. Disco-nnect	Rain Barrel	Rain Garden	Storm Drain Marking	Bay-Scape	Fertilizer Reduc.	Pet Waste	Trash Mgmt.	Trees to Plant
NSA_N_28	Lower Gunpowder Falls-B	Dawnvale	14.6	Mod.	Mod.	X	X		X	X	X			300
NSA_N_29	Lower Gunpowder Falls-B	Steve Way, Linwen Way, Lona Ct	12.2	Mod.	Mod.		X		X		X	X		20
NSA_N_30	Lower Gunpowder Falls-B	Perry Hall Gardens, Village of White Oak	29.8	Mod.	Mod.	X	X		X		X			0
NSA_N_31	Lower Gunpowder Falls-B	Pinedale	16.9	Low	Mod.		X		X	X				60
NSA_N_33	Lower Gunpowder Falls-B	Cedarside Farm	14.8	Mod.	Mod.		X		X	X	X			0
NSA_N_34	Lower Gunpowder Falls-B	Cedarside Farm	18.7	Mod.	Mod.	X	X		X					0
NSA_N_35	Lower Gunpowder Falls-B	Seven Courts	73.9	Mod.	Mod.	X	X		X	X				700
NSA_N_36	Lower Gunpowder Falls-B	Perry Hall Courts Condos	4.9	Mod.	High	X	X		X	X				0
NSA_N_37	Lower Gunpowder Falls-B	Oakhurst	37.5	High	Mod.		X	X	X	X	X			0
NSA_N_38	Lower Gunpowder Falls-B	Oakhurst, Village of White Oak, Harmony Hills	167.6	High	Mod.		X		X		X			30
NSA_N_40	Lower Gunpowder Falls-B	Pinedale Woods	39.1	Mod.	Mod.		X		X	X				300
NSA_N_41	Lower Gunpowder Falls-B	Oakhurst	71.5	Mod.	Mod.		X	X	X	X				720
NSA_N_42	Lower Gunpowder Falls-B	Pinedale Woods	16.3	Mod.	Mod.		X	X	X	X				200
NSA_N_43	Lower Gunpowder Falls-B	Ferguson Meadows, Northwind Farms II	40.5	Mod.	Low		X	X		X	X	X		150
NSA_N_44	Lower Gunpowder Falls-B	Perry Hall Apartments	30.9	High	High	X	X	X	X	X	X			105

Lower Gunpowder Falls (Urban) Upland Assessments
Neighborhood Source Assessments (NSAs)

Site ID	Subshed	Name	Acres	PSI	ROI	Downspt. Disco-nnect	Rain Barrel	Rain Garden	Storm Drain Marking	Bay-Scape	Fertilizer Reduc.	Pet Waste	Trash Mgmt.	Trees to Plant
NSA_N_45	Lower Gunpowder Falls-B	Spring Hill, Spring Mill	39.8	Mod.	High	X	X		X	X				25
NSA_N_46	Lower Gunpowder Falls-B	Ridgely's Choice	12.7	Low	Mod.		X		X	X				0
NSA_N_47	Lower Gunpowder Falls-B	Turnbrook	3.8	Mod.	Mod.	X	X		X					0
NSA_N_48	Lower Gunpowder Falls-B	Hines Estates	14.3	Mod.	Low		X	X		X	X			0
NSA_N_49	Lower Gunpowder Falls-B	Hines Estates	14.9	Low	Low		X	X		X				100
NSA_N_4	Lower Gunpowder Falls-C	Perry Hall Farms	46.7	Mod.	Mod.		X		X		X			0
NSA_N_14	Lower Gunpowder Falls-C	Lauren Woods, Enclave at Perry Hall	33.2	Mod.	Mod.		X	X	X	X	X			70
NSA_N_15	Lower Gunpowder Falls-C	Forge Meadows	13.6	Mod.	Mod.		X	X	X	X	X			200
NSA_N_16	Lower Gunpowder Falls-C	Richlyn Manor, Gunpowder Estates	87.2	High	Mod.	X	X		X	X	X			0
NSA_N_17	Lower Gunpowder Falls-C	Gunpowder Valley Estates	21.4	High	Mod.		X	X		X	X			0
NSA_N_18	Lower Gunpowder Falls-C	Perry Hall Manor	69.6	Mod.	Mod.		X	X	X	X				0
NSA_N_19	Lower Gunpowder Falls-C	Highlands at Perry Hall	12.6	High	Mod.		X		X		X			0
NSA_N_12	Lower Gunpowder Falls-D	Darryl Gardens	221.8	High	High		X	X		X	X			20
NSA_N_13	Lower Gunpowder Falls-D	Carrington Ridge	18.5	Mod.	Mod.		X		X	X	X			46
NSA_N_80	Minebank Run	Satyr Hill Estates	38.3	Low	Mod.		X	X	X	X	X			300
NSA_N_81	Minebank Run	Cromwell Station	24.5	Mod.	Mod.	X	X		X		X			400
NSA_N_82	Minebank Run	Cromwood	13.9	Low	Low		X		X					0

Lower Gunpowder Falls (Urban) Upland Assessments
Neighborhood Source Assessments (NSAs)

Site ID	Subshed	Name	Acres	PSI	ROI	Downspt. Disco-nnect	Rain Barrel	Rain Garden	Storm Drain Marking	Bay-Scape	Fertilizer Reduc.	Pet Waste	Trash Mgmt.	Trees to Plant
NSA_N_83	Minebank Run	Coventry, Haver Hill	45.4	Low	Low		X	X	X	X				0
NSA_N_84	Minebank Run	Green Meadows	8.0	Low	Mod.		X		X					0
NSA_N_85	Minebank Run	Brookview Farms	59.8	High	High		X	X		X	X			0
NSA_N_86	Minebank Run	Hunt Club Farms, Brook Meadows, Hunt Crest Estates	141.2	High	High		X	X		X	X			0
NSA_N_87	Minebank Run	Mine Bank	80.7	High	Mod.					X	X			0
NSA_N_88	Minebank Run	Campus Hills, Cromwell Valley	133.7	Mod.	High		X	X	X					0
NSA_N_89	Minebank Run	Towson Estates	22.3	Low	Low		X							0

APPENDIX G: SUPPORTING CALCULATIONS FOR NSA ANALYSES

Supporting Calculations for NSA Analyses

Downspout Disconnection

Table 4-2 in the Lower Gunpowder Falls (Urban) watershed characterization report summarizes rooftop acres addressed by downspout redirection for the recommended neighborhoods. The method by which this column was calculated is described below.

Rooftop Acres Addressed

NSAs not recommended for downspout disconnection contribute 0 acres to this analysis. Rooftop acres addressed by disconnecting downspouts in a recommended neighborhood were calculated as follows:

Acres of Buildings x %Connected Downspouts

For example, NSA_N_6 was recommended for downspout redirect and has a total of 5.82 acres of buildings (i.e., rooftop) based on Baltimore County's GIS buildings layer. During the uplands survey, it was estimated that 75% of the downspouts in NSA_N_6 were connected. Therefore, the total rooftop acres addressed by disconnecting downspouts in NSA_N_6 would be 5.82 acres x 0.75 = 4.37 acres.

% of Subwatershed NSA Rooftop Area Addressed

For a given subwatershed, the % of subwatershed rooftop area addressed was calculated as:

Σ Individual NSA Rooftop Acres Addressed / Total NSA Rooftop Acres

The total acres of rooftop within a subwatershed were determined using Baltimore County's GIS buildings layer.

Fertilizer Reduction/Education

Table 4-3 in the Lower Gunpowder Falls (Urban) watershed characterization report summarizes the acres of lawn addressed by fertilizer reduction for the recommended neighborhoods. The method by which this column was calculated is described below.

Acres of Lawn Addressed

NSAs not recommended for fertilizer reduction (i.e., have less than 20% high maintenance lawns) contribute 0 acres to this analysis. Acres of lawn addressed by fertilizer reduction/education in a recommended neighborhood were calculated as follows:

(NSA Total Acres - NSA Road Acres) x %Lot Grass Cover x %High Maintenance Lawns

The first expression in parentheses in the equation above represents the total acres of individual lots in an NSA. Multiplying this by the % of grass cover estimated for a typical lot in the NSA yields the total acres of lawn in an NSA. Finally, multiplying this result by the % of lawns using high management lawn practices yields the acres of lawn that would be addressed via fertilizer reduction.

For example, NSA_N_1 was recommended for fertilizer reduction and has a total area of 90.4 acres. Based on Baltimore County's GIS roads layer, there are approximately 12.6 acres of roads in this NSA. This means NSA_N_1 consists of approximately 90.4 – 12.6 = 77.8 acres for individual lots. During the uplands survey, it was estimated that the average lot in NSA_N_1 consists of 30% grass cover which equates to 77.8 acres x 0.30 = 23.3 total acres of lawn. It was also noted that about 75% of the lawns in NSA_N_1 were employing high maintenance practices. So there are approximately 23.3 acres x 0.30 = 7.0 acres of high maintenance lawn that could be addressed by fertilizer reduction in NSA_N_1

<u>% of Subwatershed NSA Lawn Area Addressed</u>

For a given subwatershed, the % of the total NSA lawn area addressed was calculated as:

Σ Individual NSA Lawn Acres Addressed / Total NSA Lawn Acres

BayScaping

Table 4-4 in the Lower Gunpowder Falls (Urban) watershed characterization report summarizes the acres of land addressed by BayScaping for the recommended neighborhoods. The method in which this column was calculated is described below.

<u>Acres of Land Addressed</u>

NSAs not recommended for BayScaping contribute 0 acres to this analysis. According to CWP, the minimum recommended proportion of BayScaping is 25% of an individual lot. To determine the percent of the lots available, the current landscaping percentage was subtracted from the current percentage of the lot covered in grass:

%Lot Available for BayScaping = %Lot Grass Cover - %Lot Landscaping

Acres of land addressed by BayScaping in a recommended neighborhood were calculated as follows:

(NSA Total Acres - NSA Road Acres) x %Lot Available for BayScaping

The first expression in parentheses in the equation above represents the total acres of individual lots in an NSA.

Multiplying these two factors yields the total acres of land in an NSA recommended/available for BayScaping. NSA_N_22 was 23.9 acres and was recommended for BayScaping. It has approximately 1.5 acres of roads. This means NSA_N_22 consists of approximately 23.9 – 1.5 = 22.4 acres for individual lots. During the uplands survey, it was estimated that the average lot in

NSA_N_22consists of 65% grass cover and 3% landscaping, which means 62% would be recommended for BayScaping. This equates to 22.4 acres x 0.62 = 13.9 acres of land that could be addressed by BayScaping in this NSA.

For a given subwatershed, the % of the total NSA area addressed was calculated as:

Σ Individual NSA Land Acres Addressed / Total NSA Acres

Storm Drain Marking

Table 4-5 in the Lower Gunpowder Falls (Urban) watershed characterization report summarizes the number of inlets and % of subwatershed inlets addressed by storm drain marking for the recommended neighborhoods. The method in which these two columns were calculated is described below.

Approximate Number of Inlets Addressed

NSAs not recommended for storm drain marking contribute 0 inlets to this analysis. The approximate number of inlets addressed in a neighborhood recommended for storm drain marking was calculated as follows:

NSA # of Inlets x NSA % of Inlets Not Marked

For example, NSA_N_38 was recommended for storm drain marking and has a total of 96 inlets. 95% of the inlets in NSA_N_38 were determined to have no storm drain markings. Therefore, 96 inlets x 0.95 = 91 storm drain inlets need to be addressed in this NSA.

% of Subwatershed Inlets Addressed

For a given subwatershed, the % of the total subwatershed inlets addressed was calculated as:

Σ Individual NSA Inlets Addressed / Total Subwatershed Inlets

APPENDIX H: WATER QUALITY ANALYSES (WQA) FOR THE LOWER GUNPOWDER FALLS AND THE CHESAPEAKE BAY TOTAL MAXIMUM DAILY LOAD (TMDL)

(Available on CD)

APPENDIX I: ACCESS DATABASES AND OTHER ELECTRONIC DOCUMENTS

(Available on CD)