LOWER GUNPOWDER FALLS (RURAL)

Small Watershed Action Plan: Appendices E - G

Prepared for
Department of Environmental
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Baltimore County Executive Kevin Kamenetz and the Baltimore County Council

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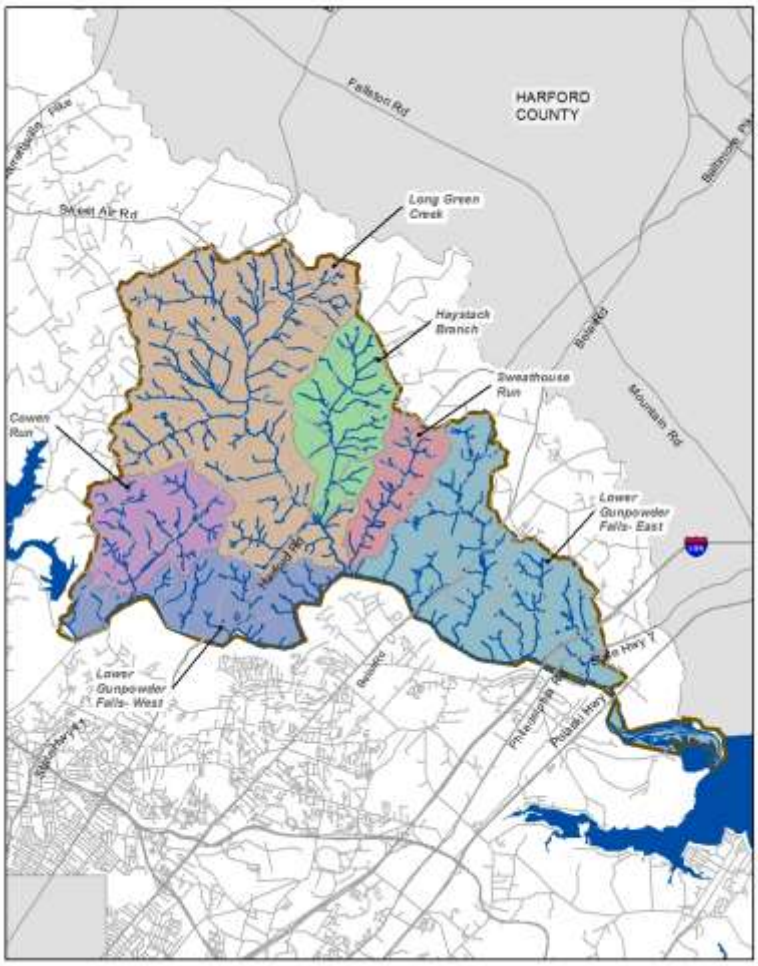
Appendix E
Lower Gunpowder Falls (Rural)
Watershed Characterization Report



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CHAPTER 1.0
Introduction

1.1 Purpose

The Lower Gunpowder Falls (Rural) Watershed Characterization Report has two primary objectives. The first is to summarize the geomorphic, hydrological and biological natural resources in the watershed and to describe the current condition of these resources. The second objective is to describe the various human factors affecting these resources and identify restoration and preservation strategies which will help achieve the goals of the watershed. The information provided here will help to develop a Small Watershed Action Plan (SWAP) for the watershed.

1.2 Watershed Location and Scale

The rural Lower Gunpowder Falls (Planning Area Q) encompasses 18,849 acres (29.5 square miles) and lies in the Piedmont region of Maryland located along the border of the Little Gunpowder Falls watershed (Planning Area P). Streams in the Lower Gunpowder Falls subwatersheds drain to mainstem Gunpowder Falls which joins the Little Gunpowder Falls near the head of tide. The tidal portion is known as the Gunpowder River. The watershed is bisected by several major highways including: MD145, MD147, MD165, US1 and US40. I-95 crosses the watershed near its southern boundary as shown on Figure 1-1. This planning area was divided into six smaller drainage areas known as subwatersheds listed in Table 1-1 and shown on Figure 2-1.

A detailed analysis of the natural and man-made landscapes that could affect water quality was conducted at both the watershed (Lower Gunpowder Falls) and subwatershed level. Analysis at the subwatershed level generally provides the detail required to make decisions about prioritizing restoration and preservation efforts. Restoration efforts are also more easily monitored at the subwatershed scale. This characterization report provides information at both levels, with analyses at the subwatershed level referring only to those portions of the subwatersheds within Lower Gunpowder Falls.

Table 1-1: Subwatershed Acreages

Subwatershed	Acres	Square Miles
Long Green Creek	7,229.6	11.3
Haystack Branch	1,895.1	3.0
Sweathouse Run	1,089.2	1.7
Cowen Run	1,857.3	2.9
Lower Gunpowder Falls East	4,757.6	7.4
Lower Gunpowder Falls West	2,020.1	3.2
Total	**18,848.8**	**29.5**

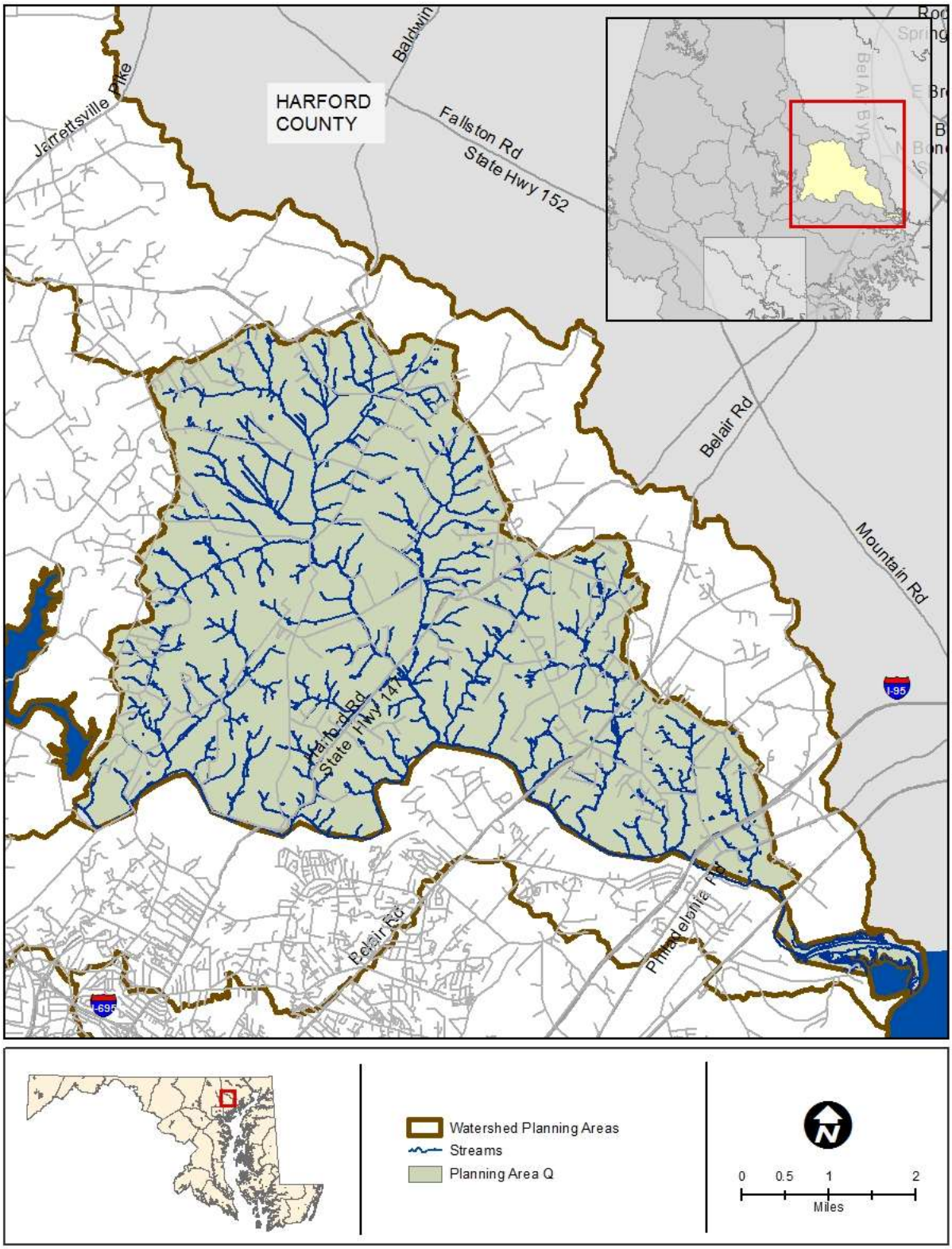


Figure 1-1: Lower Gunpowder Falls Location

1.3 Report Organization

This report is organized into five chapters:

Chapter 1 explains the location of the study area and the purpose and scope of the characterization.

Chapter 2 summarizes watershed and subwatershed characteristics that may have an effect on water quality of streams, downstream receiving waters, groundwater, and other natural resources. This chapter includes information on climate, soils, geology, forest cover and streams within the watershed. It also includes information on human factors influencing these natural resources such as current land use, population, impervious cover, wastewater, and storm water infrastructure.

Chapter 3 discusses water quality and quantity conditions based on available monitoring and stream assessment data.

Chapter 4 includes the upland assessment conducted to identify sources of pollution and potential restoration opportunities for neighborhoods, institutional land uses, pervious areas (open grass areas), and hotspots.

Chapter 5 summarizes potential preservation and restoration strategies appropriate for accomplishing watershed goals developed by the watershed stakeholders.

CHAPTER 2.0
Landscape and Land Use

2.1 Introduction

This chapter discusses land cover and land use in the Lower Gunpowder Falls watershed, describing characteristics of both the natural land surface as well as development activities taking place within the watershed. Natural characteristics, such as soil type, and development related features, such as impervious cover, strongly influence the quantity and quality of watershed runoff. For example, the infiltration capacity of soils on pervious ground affects the amount and rate at which precipitation will be absorbed into the ground surface; impervious surfaces such as buildings and paved areas impede rainfall infiltration, which can lead to flooding, erosion, and eventually a decrease in groundwater supply. In addition, the type and extent of pollutants carried by stormwater is affected by land use characteristics. Residential or agricultural areas may contribute fertilizers and pesticides to stormwater runoff. Depending on the land use activities taking place, developed areas may transmit pollutants such as trash, bacteria from livestock and pet waste, and chemicals directly to receiving water bodies because there is often inadequate vegetative buffer to filter out the pollutants before the runoff reaches the water. The information presented in this chapter provides the physical setting and background necessary to evaluate other watershed elements including water quality, natural resources, restoration and management.

This chapter will be presented in two parts: the first will document the natural characteristics of the watershed landscape, and the second will describe human activities that have altered the natural landscape.

2.2 The Natural Landscape

The natural landscape has characteristics relevant to watershed processes which are discussed in the following sections. These include climate, topography, geology, soils, forest cover, wetlands and the stream system within the watershed.

2.2.1 Climate

Climate influences soil formation and erosion processes, stream flow patterns and a significant part of the geomorphology of a watershed. Precipitation not only provides water to streams and plants, but the intensity, frequency and amount of precipitation can greatly influence watershed characteristics. Climate is a major factor determining the types of terrestrial and aquatic species that are present.

The climate of the region encompassing Lower Gunpowder Falls is best described as humid continental with four well-defined seasons (USDA, 1976). The proximity of the Appalachian Mountains to the west and the Chesapeake Bay to the east provides a temperate climate with precipitation spread evenly throughout the year. Based on data from the National Oceanic and

Atmospheric Administration (NWS, 2015), the average monthly rainfall is 3.5 inches in Baltimore with an average annual rainfall of approximately 42 inches per year. Snowfall generally occurs between January and March, with the heaviest snows occurring in January and February. The long-term average norm is approximately 20 inches of snow per year.

Climate change will have an effect on watershed management in the future and may be included in future revisions of the SWAP.

2.2.2 Watershed Delineation

In order to implement a watershed approach to evaluate aquatic resources and water quality conditions it is necessary to delineate a boundary for the watershed, or drainage area. This is accomplished by selecting a specific water body or point along a stream and drawing a boundary that would encompass all land that would contribute runoff to the selected point. Watersheds vary greatly in size depending on the location of the point of interest. Watersheds can be nested within other drainage areas and can vary from a few acres for a headwater stream to several thousand square miles for large rivers and basins, such as the Chesapeake Bay.

Maryland divides its watersheds into 138 state-defined watersheds (also called 8-digit watersheds) averaging 75 square miles in size. Lower Gunpowder Falls is the 8-digit watershed located along the southwest border of the Little Gunpowder Falls that includes both an urban and rural portion. The rural portion of the watershed is discussed here. Baltimore County has further divided the 8-digit watersheds into 191 subwatersheds. Lower Gunpowder Falls includes the Long Green Creek, Haystack Branch, Sweathouse Run, Cowen Run, and Lower Gunpowder Falls East and West subwatersheds.

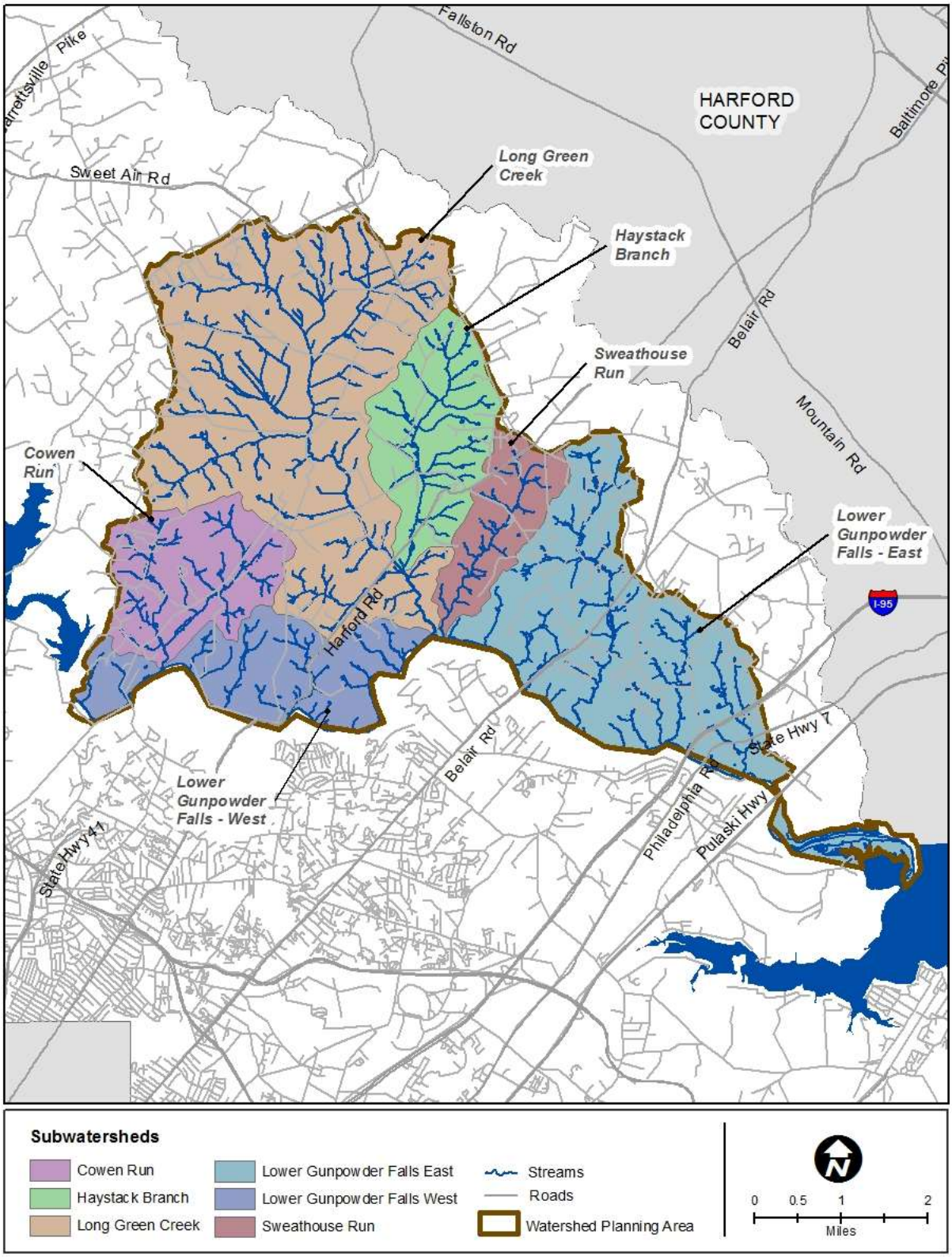


Figure 2-1: SWAP Planning Area

2.2.3 Topography

Topography describes the shape and features of the land surface, such as the elevation, steepness and concavity. Topography affects the flow of surface water, which in turn can have an effect on soil erosion and suitability for development. Steep and strongly sloping areas are generally associated with higher rates of erosion, with soil type and land use/land cover also playing a role. Topography also affects how pollutants are carried in a watershed, with steep slopes and erodible soils generally having a greater potential to carry more pollutants more rapidly to streams than flat slopes.

Slopes were determined using SSURGO soils data for Baltimore County (USDA, 2010) and classified into the following five categories:

- Nearly Level (0 – 3% slopes)
- Gently Sloping (3 – 8% slopes)
- Strongly Sloping (8 – 15% slopes)
- Moderately Steep (15 – 25% slopes)
- Steep (>25% slopes)

Table 2-1 summarizes the percentage of area in each subwatershed for each slope category. Figure 2-2 provides a visual display of the slope categories within the watershed.

Table 2-1: Lower Gunpowder Falls Subwatershed Slope Characterization

Subwatershed	Slope Category (%)				
	Nearly Level (0-3%)	Gently Sloping (3-8%)	Strongly Sloping (8-15%)	Moderately Steep (15-25%)	Steep (>25%)
Long Green Creek	19.7	36.8	25.0	12.7	5.8
Haystack Branch	13.4	31.8	27.4	15.6	11.8
Sweathouse Run	14.7	41.9	26.3	7.8	9.4
Cowen Run	11.9	31.7	26.1	13.5	16.9
Lower Gunpowder Falls East	18.1	47.9	17.9	8.7	7.4
Lower Gunpowder Falls West	9.7	25.2	26.8	16.0	22.4
Total Watershed	**16.4**	**36.8**	**24.3**	**12.4**	**10.0**

As shown on Table 2-1 and Figure 2-2, over half of the watershed is gently or strongly sloping (total of 61.1 percent), with the most common category being gently sloping (36.8 percent). Strongly sloping (24.3 percent) and nearly level (16.4 percent) are the next most prevalent slope categories.

Topography in Lower Gunpowder Falls typically follows what is seen in the Piedmont Physiographic Province, with rolling uplands and steep stream valleys. Gunpowder Falls, which flows the length of the watershed, is the most prominent topographic characteristic. The steepest slopes in the watershed are found in the valleys of both the mainstem and tributaries. The small portion downstream of Pulaski Highway is in the Atlantic Coastal Plain province and is nearly level.

Lower Gunpowder Falls West has the highest percentage of strongly sloping, moderately steep and steep slopes, accounting for approximately 65 percent of the total watershed, while Cowen Run and Haystack have close to even percentages of nearly level and gently sloping land. The highest levels of gently sloping and nearly level land are found in the Lower Gunpowder Falls East subwatershed.

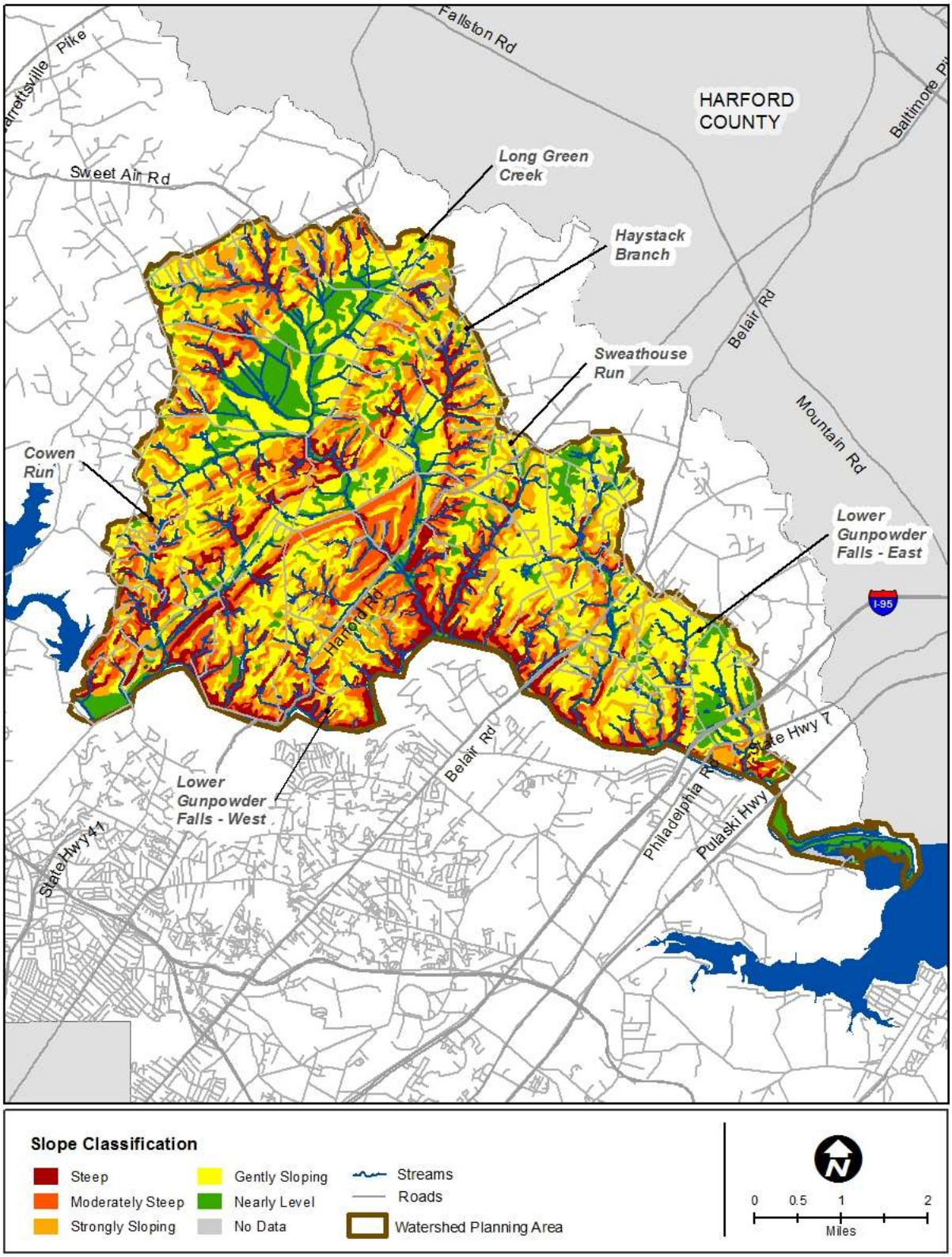


Figure 2-2: Lower Gunpowder Falls Slope Classification

2.2.4 Geology

The geologic formations underlying a watershed have a significant effect on the water resources. Geology is a major determinant of the type of topography and surface features, discussed earlier. The chemical composition and minerals of the parent rock or unconsolidated sediments determines in large part the soil characteristics, including erodibility and infiltration rates. The underlying geology is a major factor in groundwater availability, which will be discussed in further detail in Section 2.3.4.

Lower Gunpowder Falls lies within the both the Piedmont and Coastal Plain Physiographic Provinces. The Piedmont is primarily underlain by metamorphic rock, that is, rock that has been changed over time due to heat and pressure. Fourteen geologic formations are found in Lower Gunpowder Falls, all but two of them of metamorphic origin. The two Coastal Plain formations are the Patapsco and Patuxent Formations, which were formed from Cretaceous sedimentary deposits and overlie the earlier metamorphic rock.

The oldest formation is Baltimore Gneiss, which is among the oldest rock in the eastern United States. This formation is covered by another series of metamorphic rock formations, which in this location is identified as Loch Raven Schist (USDA, 1976). The Loch Raven Schist underlies more than half of the watershed in the Long Green Creek, Haystack Branch, and Cowen Run subwatersheds. The Oella Formation underlies more than half of the Sweathouse Run watershed.

Lower Gunpowder Falls is underlain by metamorphic amphibolite, along with the one sedimentary rock formations.

Table 2-2 shows the geologic composition in the six subwatersheds. This information is also displayed on Figure 2-3.

Table 2-2: Lower Gunpowder Falls Geologic Composition by Subwatershed

Subwatershed	Geology (%)													
	Baltimore Gneiss	Bradshaw Layered Amphibolite	Cockeysville Marble	Franklinville Gneiss	Hydes Marble Member	Loch Raven Schist	Oella Formation	Patapsco Formation	Patuxent Formation	Perry Hall Gneiss	Setters Gneiss	Gunpowder Gneiss	Raspeburg Amphibolite	Cold Spring Gneiss
Long Green Creek	6.3	0.0	6.4	0.0	28.2	52.2	1.8	0.0	0.0	0.0	3.7	1.4	0.0	0.0
Haystack Branch	0.0	0.0	29.4	0.0	0.0	65.2	0.2	0.0	0.0	0.0	5.2	0.0	0.0	0.0
Sweathouse Run	0.0	33.0	0.0	0.0	0.0	7.7	53.5	0.0	0.0	0.0	0.0	0.0	5.8	0.0
Cowen Run	7.3	0.0	24.4	0.0	0.0	57.8	0.0	0.0	0.0	0.0	10.6	0.0	0.0	0.0
Lower Gunpowder Falls East	32.9	0.0	9.5	0.0	0.0	16.4	24.9	0.0	0.0	0.0	2.1	7.4	6.2	0.7
Lower Gunpowder Falls West	0.0	52.0	0.0	0.4	0.0	0.0	0.1	6.7	9.0	29.3	0.0	0.0	2.5	0.0
Total Watershed	**6.6**	**14.9**	**8.9**	**0.1**	**10.8**	**34.6**	**6.5**	**1.7**	**2.3**	**7.3**	**3.2**	**1.3**	**1.6**	**0.1**

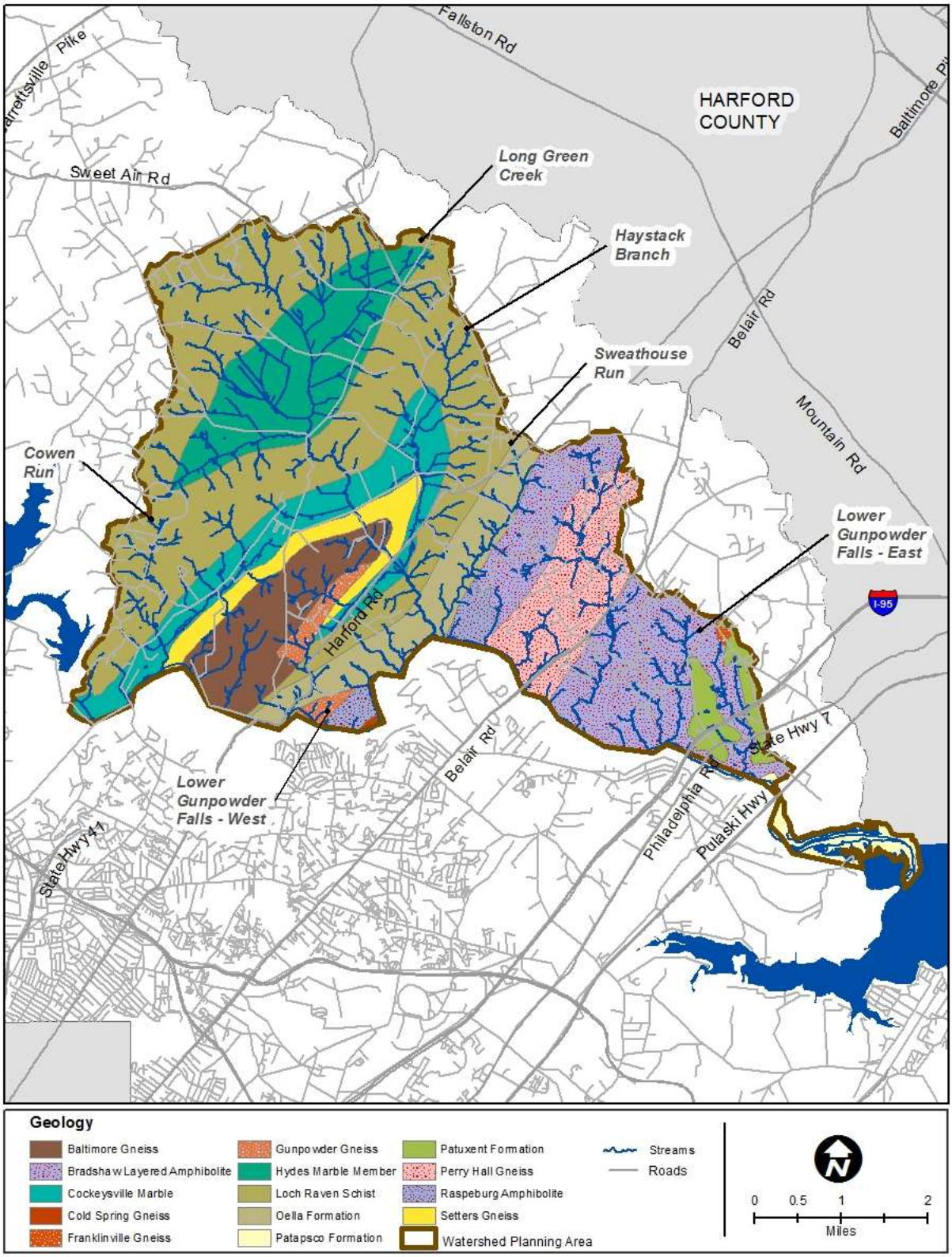


Figure 2-3: Lower Gunpowder Falls Watershed Geology

2.2.5 Soils

Soil conditions are an important factor when evaluating water quantity and quality in streams and rivers. Soil type and moisture conditions greatly impact the amount and quality of runoff. Soils also affect how land may be used and its potential for vegetation and habitat. Soils are an important consideration in targeting projects aimed at improving water quality or habitat. The SSURGO soils data for Baltimore County was used for the soils data analysis (USDA, 2010).

Most of the soils in Lower Gunpowder Falls are derived from the parent metamorphic rock. Piedmont soils in upland areas are typically erodible, with good to moderate infiltration rates. Piedmont alluvial soils, which are eroded soils deposited by flowing water, are found in stream valleys washed down from the upland areas and tend to be silts and clays which are far less permeable. Coastal Plain soils are variable, depending on whether the underlying sedimentary material is sand, silt, or clay.

2.2.5.1 Hydrologic Soil Groups

The Natural Resources Conservation Service (NRCS) classifies soils into four hydrologic soil groups based on the soil's runoff potential which is a measure of how much precipitation will be converted to overland flow that runs off of the landscape downslope. Runoff potential is the opposite of infiltration capacity, which is the ability of 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 such as cuts and fills associated with land development that can reduce infiltration and increase runoff potential. The four hydrologic soil groups are A, B, C, and D where Group A soils generally have the lowest runoff potential (highest infiltration) and Group D soils have the greatest runoff potential (lowest infiltration).

Each hydrologic soil group is described below. Additional information on hydrologic soil groups can be found in the Natural Resource Conservation Service's publication, *Urban Hydrology for Small Watersheds*, often referred to as Technical Release 55, or TR-55 (USDA, 1986):

- **Group A** soils are sand, loamy sand, or sandy loam soil types. These soils have high infiltration rates and low runoff potential even when thoroughly wetted. They consist mainly of deep, well-to excessively-drained sands or gravels with a high rate of water transmission.
- **Group B** soils are silt loam or loam soil types. These soils have moderate infiltration rates when thoroughly wet. They consist mainly of somewhat deep to deep, moderately-well to well-drained soils with moderately fine texture to moderately coarse texture with a moderate rate of water transmission.
- **Group C** soils are sandy clay loam soil types. These soils have a low infiltration rate when thoroughly wet. They typically have a layer that hinders downward movement of water and the soils have a moderately fine to 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 soil types. These soils have a very low infiltration rate and high runoff potential when thoroughly wet. They consist mainly of clays with high swell potential, soils with a

permanent high water table, and 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.

One other classification is included in Table 2-3 . There are small areas of open water or impermeable barren rock which are not included with the other hydrologic soil groups.

As shown on Table 2-3 and Figure 2-4, the majority of soils in Lower Gunpowder Falls are classified as Group B (65.7 percent) and C soils (27.6 percent), with moderate to low infiltration rates and moderate transmission of water through the soil. Lower Gunpowder Falls East and West both contain a small percentage of Group A soils. The small fraction of Group D soils with high runoff potential is associated with stream valleys.

Table 2-3: Lower Gunpowder Falls Hydrologic Soil Categorization

Subwatershed	Hydrologic Soil Group (%)				
	A	B	C	D	Water/ Impermeable
Long Green Creek	0.0	67.7	26.7	5.6	0.0
Haystack Branch	0.0	73.2	26.0	0.8	0.0
Sweathouse Run	0.0	63.7	32.6	3.7	0.0
Cowen Run	0.0	72.2	25.0	2.7	0.0
Lower Gunpowder Falls East	0.1	51.5	34.3	12.3	1.8
Lower Gunpowder Falls West	0.8	79.4	16.7	1.4	1.7
Total Watershed	**0.1**	**65.7**	**27.6**	**5.9**	**0.6**

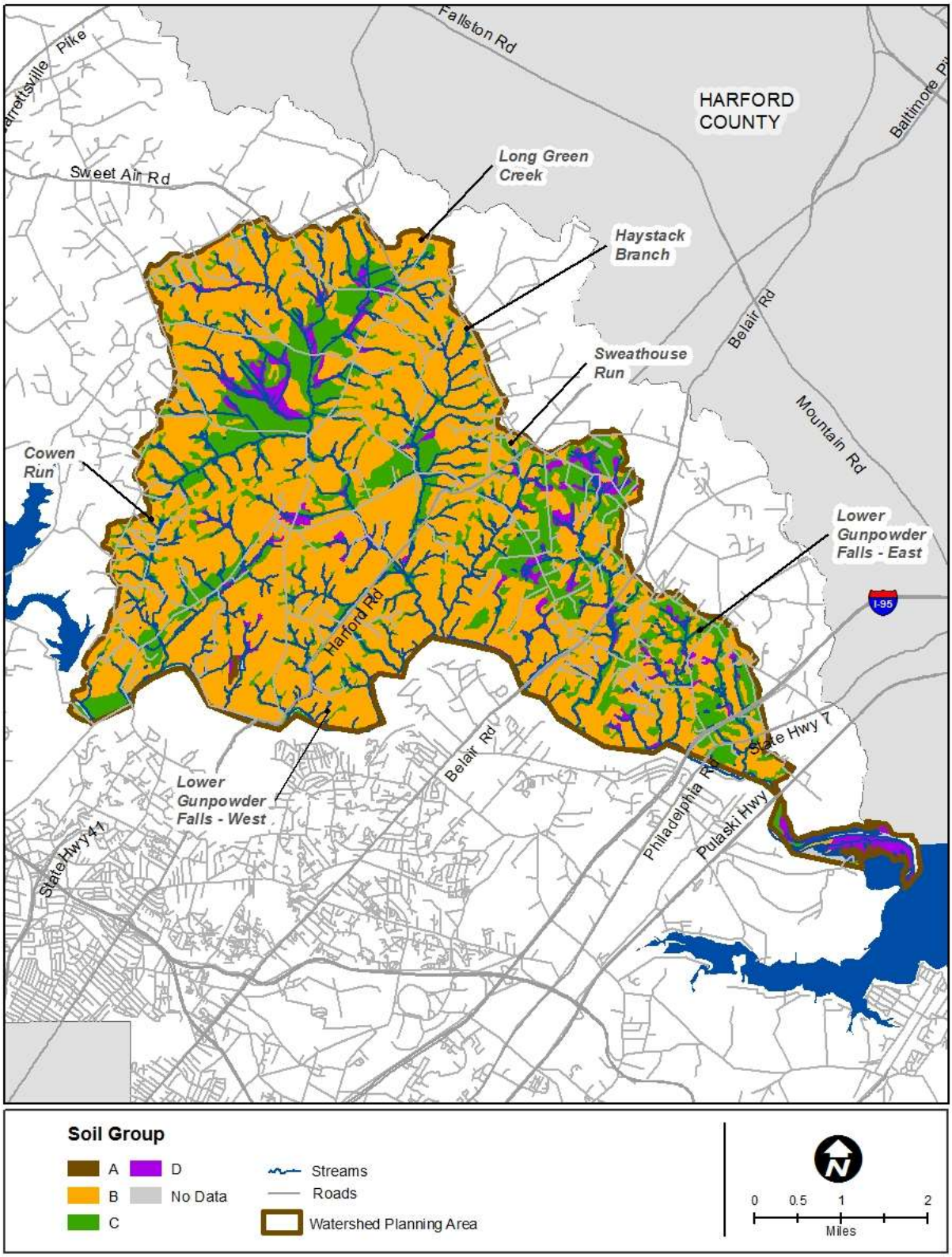


Figure 2-4: Lower Gunpowder Falls Hydrologic Soil Groups

2.2.5.2 Soil Erodibility

Soil erodibility is a measure of the soil's susceptibility to erosion. The Universal Soil Loss Equation (USLE) developed by the United States Department of Agriculture (USDA) Agricultural Research Service is a model used to describe soil erosion processes. In the USLE, erodibility is described quantitatively using the K factor, which represents both the susceptibility of soil to erosion and its contribution to the rate of runoff. For example, clay soils have low K values because they are resistant to detachment. Coarse soils such as sand can also have low K values because even though they are easily detached, they infiltrate well and are therefore less susceptible to runoff. Silts have the highest K values because they detach easily and produce high rates of runoff (Institute of Water Research, 2002).

Subwatersheds with the largest percentage of highly erodible soils offer the greatest potential for addressing soil conservation with best management practices (BMPs) aimed at maintaining topsoil, such as cover crops and riparian buffer forestation. Combining this indicator with other information, such as cropland, slope steepness and distance to streams would help to determine where to retire highly erodible land from farming, a type of BMP. Additionally, a high K value helps to identify areas where urban development near streams, such as road construction or utility placement may have particularly adverse watershed impacts.

Soil erodibility was divided into three categories to match the classes used to classify sensitive areas in the Baltimore County Buffer Protection and Management Ordinance (Baltimore County, 2003).

- Low Erodibility (K factor < 0.24)
- Medium Erodibility (K factor 0.24 – 0.32)
- High Erodibility (K factor > 0.32)

Table 2-4 presents the soil erodibility categories based on K factors for subwatersheds in Lower Gunpowder Falls.

Table 2-4: Lower Gunpowder Falls Subwatershed Soil Erodibility Categories

Subwatershed	Soil Erodibility Category (%)			
	No Data	Low	Medium	High
Long Green Creek	0.0	0.2	62.8	37.0
Haystack Branch	0.0	0.0	71.0	29.0
Sweathouse Run	0.0	15.2	45.1	39.7
Cowen Run	0.0	0.7	74.2	25.0
Lower Gunpowder Falls East	2.7	20.6	3.8	72.8
Lower Gunpowder Falls West	2.7	1.3	67.5	28.5
Total Watershed	**0.8**	**5.2**	**53.0**	**40.9**

As shown on Table 2-4 and Figure 2-5, medium erodibility soils make up 53.0 percent of the watershed, with an additional 40.9 percent of highly erodible soils and 5.2 percent of low erodible soils. Lower Gunpowder Falls East has the highest percentages of highly erodible soils, with approximately 72.8 percent. The highest percentage of low erodible soils is also in Lower Gunpowder Falls East with 20.6 percent.

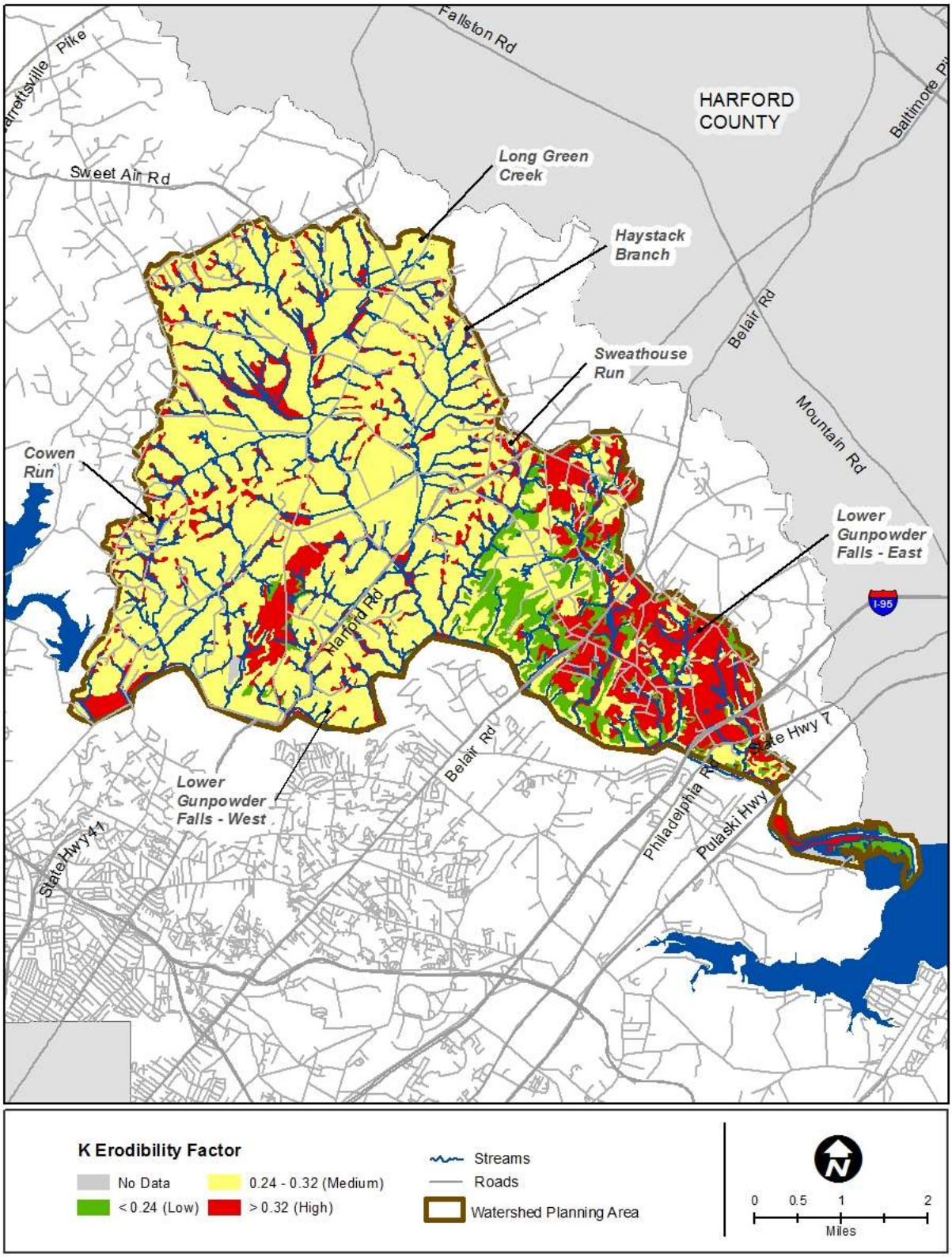


Figure 2-5: Lower Gunpowder Falls Soil Erodibility Based on the K Factor

2.2.6 Forest Cover

Among land cover types, forest cover provides the greatest protection for soil and water quality. The entire Chesapeake watershed at the time of European settlement consisted primarily of old growth forest. In this type of pristine system, forest and soils co-evolve and shape the entire hydrologic cycle; these systems operate within a natural range of variability, assuring healthy habitat and water quality. In human-impacted systems, forest cover can still provide these same benefits and can help to protect water quality if judiciously planned and protected.

Table 2-5 shows the percentage of forested acres for each subwatershed in Lower Gunpowder Falls. Figure 2-6 shows the distribution of forest cover.

Table 2-5: Lower Gunpowder Falls Subwatershed Forest Cover

Subwatershed	Total Acres	Forested Acres	Forested (%)
Long Green Creek	7,229.6	1,721.6	23.8
Haystack Branch	1,895.1	562.4	29.7
Sweathouse Run	1,089.2	443.9	40.8
Cowen Run	1,857.3	765.6	41.2
Lower Gunpowder Falls East	4,757.6	2,094.9	44.0
Lower Gunpowder Falls West	2,020.1	920.2	45.6
Total Watershed	**18,848.8**	**6,508.5**	**34.5**

Since European settlement, forest cover in Lower Gunpowder Falls has been greatly reduced through development for human uses. Over 6,500 acres of forest remain in Lower Gunpowder Falls, or approximately 34.5 percent of the total area. Forest cover ranges from a low of 23.8 percent (Long Green Creek) to a high of 45.6 percent (Lower Gunpowder Falls West). Data represented in the table and figure is derived from Baltimore County's forest GIS layer which differs from the Maryland Department of Planning's (MDP) 2010 land use/land cover data (which also contains forest data) presented in Section 2.3.1 Land Use and Land Cover. This layer was chosen because it was delineated from current higher resolution aerial photography and as a result is a more accurate representation of forest cover.

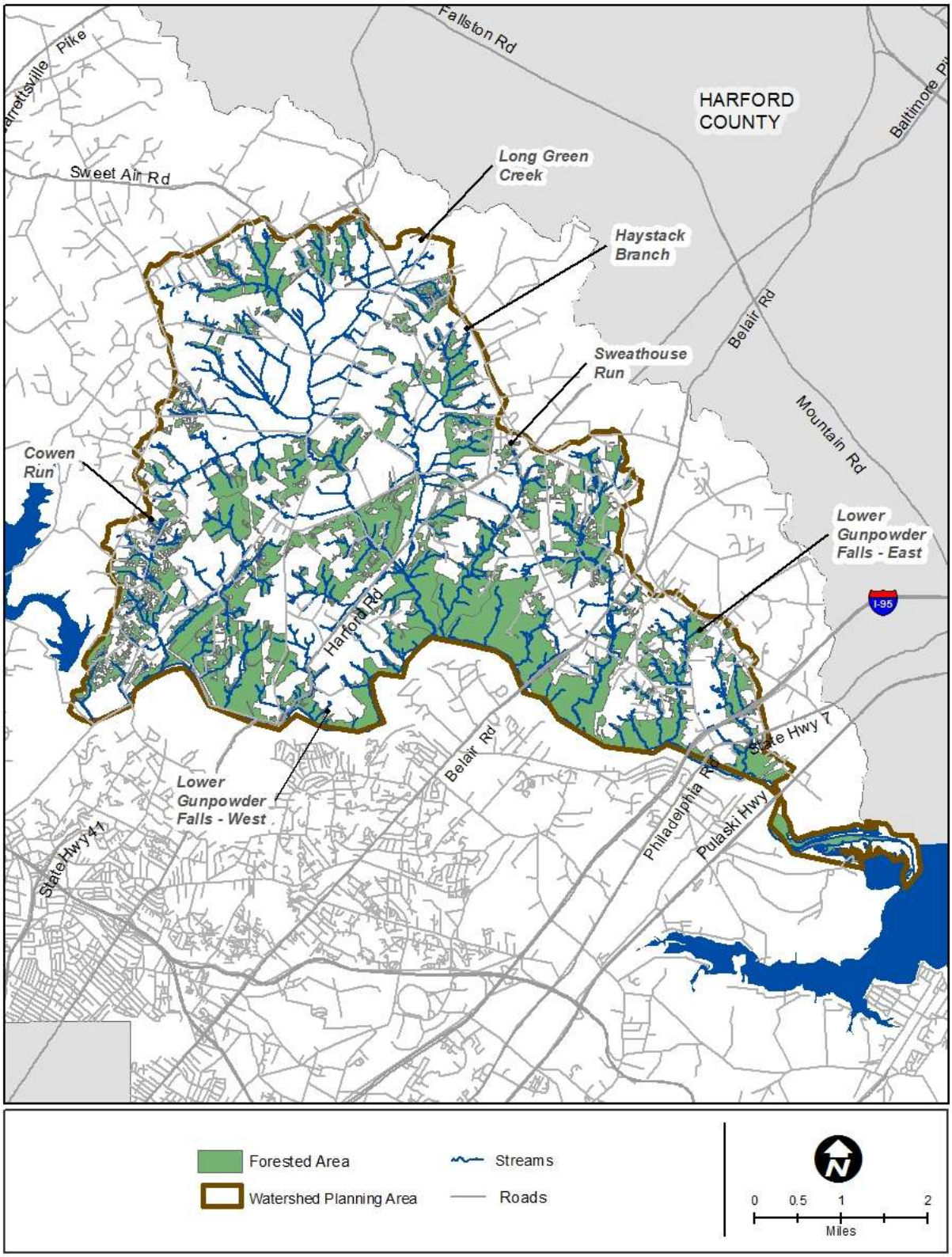


Figure 2-6: Lower Gunpowder Falls Subwatershed Forest Cover

2.2.7 Stream Systems

Streams are the flowing surface waters within a watershed which are connected to groundwater through both baseflow and recharge as well as providing input to other water bodies such as ponds, lakes and wetlands. 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.

2.2.7.1 Stream Characteristics

As mentioned previously, Lower Gunpowder Falls is an 8-digit watershed and part of the Gunpowder River basin. There are approximately 191 miles of streams in this area that join the Little Gunpowder Falls and eventually to Gunpowder River. A summary of stream mileage and density in the subwatersheds is shown in Table 2-6. Figure 2-7 shows the streams and the six subwatersheds comprising Lower Gunpowder Falls. Stream lengths were derived from Baltimore County's Hydrology_Line_2005 layer.

Table 2-6: Lower Gunpowder Falls Stream Mileage and Density

Subwatershed	Area (mi^2)	Stream Miles	Stream Density (mi/mi^2)
Long Green Creek	11.3	46.8	4.1
Haystack Branch	3.0	13.1	4.4
Sweathouse Run	1.7	7.3	4.3
Cowen Run	2.9	15.3	5.3
Lower Gunpowder Falls East	7.4	33.4	4.5
Lower Gunpowder Falls West	3.2	16.0	5.1
Total Watershed	**29.5**	**132.0**	**4.5**

The greatest stream lengths are located in Long Green Creek (46.8 mi). Stream density is highest in Cowen Run with 5.3 miles per square mile of subwatershed (mi/mi^2).

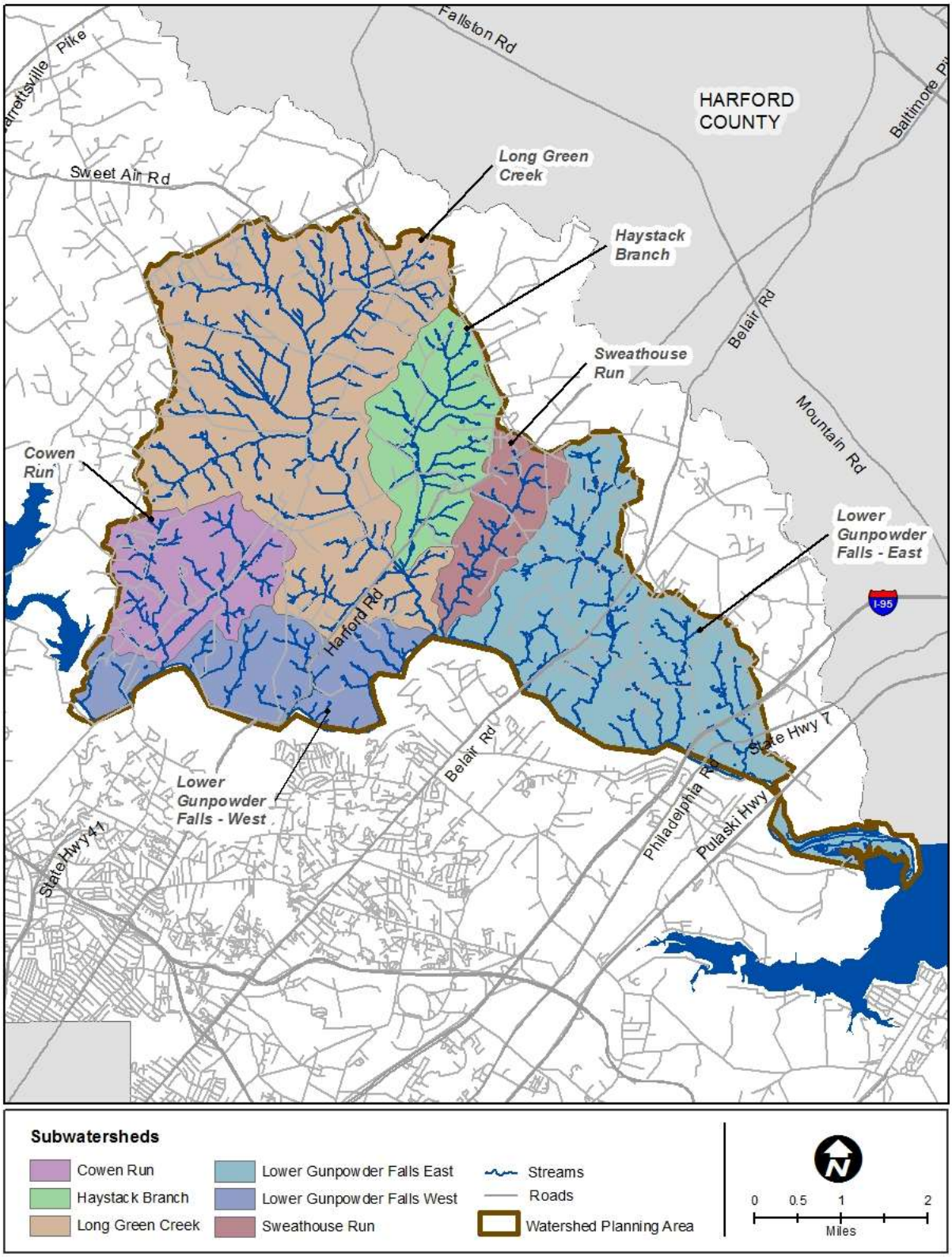


Figure 2-7: Lower Gunpowder Falls Stream System and Subwatersheds

2.2.7.2 Stream Riparian Buffers

Riparian buffers are the vegetated areas adjacent to streams that serve the role of protecting water bodies from pollutant loads and providing bank stabilization and habitat for all types of stream life, including fish. Forested buffers along streams play a crucial role in improving water quality. Leaf litter from trees provide a needed energy source for soil microbes to decompose the organic matter where nutrients are consumed, taken up by plants and released back to the atmosphere, thus reducing the amount of nitrates available for runoff. Buffers mitigate flooding by reducing surface runoff, stabilizing stream banks, and trapping sediment. Tree roots capture and remove pollutants, such as excess nitrogen from shallow flowing water. The tree root structure also slows soil erosion and water flow thus reducing sediment load and flooding. Tree canopy shades streams, providing cooler water temperatures required for stream life, particularly cold-water species such as trout.

In smaller streams, such as those found at the subwatershed level, terrestrial plant material falling into the stream is the primary source of food for stream life. Seasonally, trees provide food in the form of leaves and plant parts for stream life at the base of the food chain (such as insects). Fallen tree branches and trunks provide a more consistent, slow-release food source throughout the year. Tree roots, snags and in-stream woody debris also provide important habitat for fish, insects and other aquatic life. Maintaining healthy streams and forest buffers are important for reducing the nutrient and sediment loads to Lower Gunpowder Falls. When stream riparian buffers are converted from forest to agriculture or other development, many of these benefits are lost and stream health declines. Riparian buffer zones can be replanted or preserved as a type of BMP to reduce impacts of developed land use.

The vegetative condition of the riparian buffer in Lower Gunpowder Falls was analyzed based on a 100-foot buffer on either side of the stream system. Three land cover categories were used to classify stream buffer conditions: forested, open pervious (e.g. lawns, fields, cropland) and impervious (e.g. road and buildings). GIS was used to overlay the 100-foot stream buffer with impervious areas. Forested areas were determined in a similar manner (using Baltimore County's forest GIS layer). Remaining areas were classified as open pervious. Table 2-7 shows the percentages and acreages for stream buffer conditions. Figure 2-8 shows the 100-foot stream buffer classification distribution.

Table 2-7: Lower Gunpowder Falls Land Cover in the 100-foot Stream Buffer

Subwatershed	Forested		Open Pervious		Impervious		Total	
	Acres	%	Acres	%	Acres	%	Acres	%
Long Green Creek	467.5	36.0	774.6	59.6	58.4	4.5	1,300.4	38.0
Haystack Branch	148.1	42.7	181.6	52.3	17.5	5.0	347.2	10.1
Sweathouse Run	120.5	68.9	49.5	28.3	5.0	2.8	175.0	5.1
Cowen Run	217.7	60.9	121.1	34.0	18.1	5.1	356.9	10.4
Lower Gunpowder East	512.8	61.6	297.9	35.8	22.3	2.7	833.0	24.4
Lower Gunpowder West	220.9	54.0	169.8	41.52	18.3	4.5	408.9	12.0
Total Watershed	**1,686.9**	**49.3**	**1,594.4**	**46.6**	**139.6**	**4.1**	**3,420.8**	**100.0**

Overall, stream buffers in Lower Gunpowder Falls are in fair condition with 49.3 percent forested. Sweathouse Run has the largest amount of forested buffers with 68.9 percent. Impervious cover accounts for 4.1 percent of the 100-foot stream buffer, primarily associated with highway and road crossings. Open pervious area makes up the remaining 46.6 percent. It

should be noted that a portion of the open pervious area consists of the stream system itself because the stream is classified as open pervious area. Other areas of open pervious area are candidates for buffer forestation.

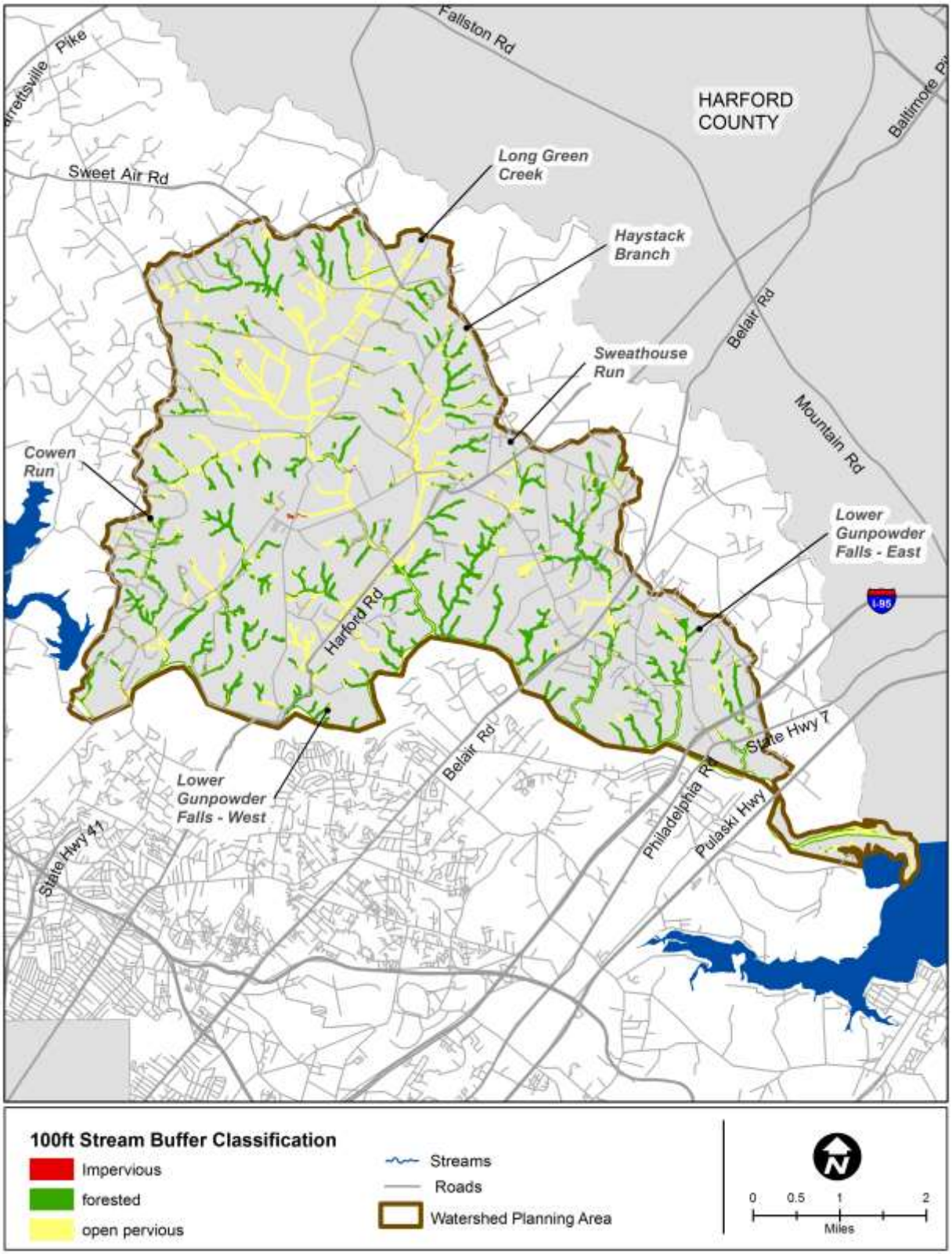


Figure 2-8: Lower Gunpowder Falls 100-foot Stream Buffer Land Cover

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 will provide a characterization of the human modified landscape and how that modification is associated with impacts to the natural ecosystem. This includes a general description of land use and land cover followed by more specific issues such as population, impervious cover, drinking water and wastewater, storm water systems, discharge permits and zoning.

2.3.1 Land Use and Land Cover

Land use has pronounced impacts on water quality and habitat with land uses that generate different types and amounts of pollutants. As discussed previously, a forested watershed has the capacity to absorb pollutants and slow the flow of water into streams. Conversely, impervious surfaces such as roads, parking lots and roofs in developed areas block the natural seepage of runoff. These impervious surfaces tend to concentrate stormwater runoff, accelerate flow rates, and direct stormwater to the nearest stream. In addition, increased impervious cover transmits nutrients, pollutants, and increases water temperature in the stream. This can cause bank erosion and destruction of in-stream and riparian habitat. Watersheds with small amounts of impervious surface tend to have better water quality in local streams than watersheds with greater amounts of impervious surface (Schueler et al., 2009). Additionally, agricultural land, if not properly managed, can cause increases in sediment, nutrients and pathogens in streams.

The Maryland Department of Planning develops land use/land cover data for the entire state every five years. This data is created from aerial photography and satellite imagery. The most recent update available and the source of the data presented in this section is from 2010.

Lower Gunpowder Falls contains 11,865.8 acres (18.5 square miles) of land consisting primarily of deciduous forest, cropland and low-density residential uses (27.5 percent, 28.5 percent and 20.0 percent, respectively). Pasture makes up another 6.1 percent of the watershed area, with the highest amounts in Haystack Branch, and Lower Gunpowder Falls West. Very low density residential uses, both forested and agricultural, collectively account for another 11.7 percent of the watershed. Feeding operations comprise 1.3 percent of the watershed with the remaining land uses each comprising one percent or less of the total area.

Land use/land cover distribution within each subwatershed is dominated either by cropland (Long Green Creek and Haystack Branch), deciduous forest (Lower Gunpowder Falls East and West and Sweathouse Run), or low density residential (Cowen Run). Deciduous forest and low density residential are the second- and third-most dominant land use in Long Green Creek and Haystack Branch. In Sweathouse Run and Lower Gunpowder Falls East low-density residential is the second-most dominant land use category. In Cowen Run deciduous forest is the second-most dominant land use category.

A summary of the land use/land cover percentages by subwatershed is presented in Table 2-8, and shown in Figure 2-9.

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

Subwatershed	Brush	Commercial	Cropland	Deciduous Forest	Evergreen Forest	Feeding Operations	Industrial	Institutional	Low-Density Residential	Medium-Density Residential	Mixed Forest	Open Urban Land	Pasture	Row and Garden Crops	Transportation	Very Low Density Residential (agricultural)	Very Low Density Residential (forest)	Water	Wetlands
Long Green Creek	0.0	0.3	49.6	16.9	0.5	1.9	0.7	0.4	16.5	0.1	0.0	0.0	2.9	0.0	0.0	5.3	4.8	0.0	0.0
Haystack Branch	0.0	0.0	23.1	22.4	0.0	5.9	0.0	0.0	18.7	0.2	0.0	0.0	11.0	1.1	0.0	9.3	8.3	0.0	0.0
Sweathouse Run	0.0	0.4	19.7	30.6	4.2	0.0	0.0	0.0	22.3	2.7	0.0	0.0	1.5	0.0	0.0	5.5	13.2	0.0	0.0
Cowen Run	0.0	1.3	19.9	28.1	1.6	0.0	0.0	0.9	35.5	0.1	0.0	0.0	5.4	0.0	0.0	0.7	6.4	0.0	0.0
Lower Gunpowder Falls East	0.3	0.6	14.2	38.4	0.1	0.0	0.7	0.1	21.4	1.2	0.0	1.7	1.6	0.0	0.7	4.5	10.0	1.3	3.0
Lower Gunpowder Falls West	0.0	1.5	4.2	42.2	0.5	0.0	0.0	0.0	14.8	0.0	4.0	0.0	26.4	0.0	0.0	3.2	2.9	0.7	0.0
Total Watershed	**0.1**	**0.9**	**28.5**	**27.5**	**0.7**	**1.3**	**0.5**	**0.3**	**20.0**	**0.5**	**0.4**	**0.4**	**6.1**	**0.1**	**0.2**	**4.8**	**6.9**	**0.4**	**0.8**

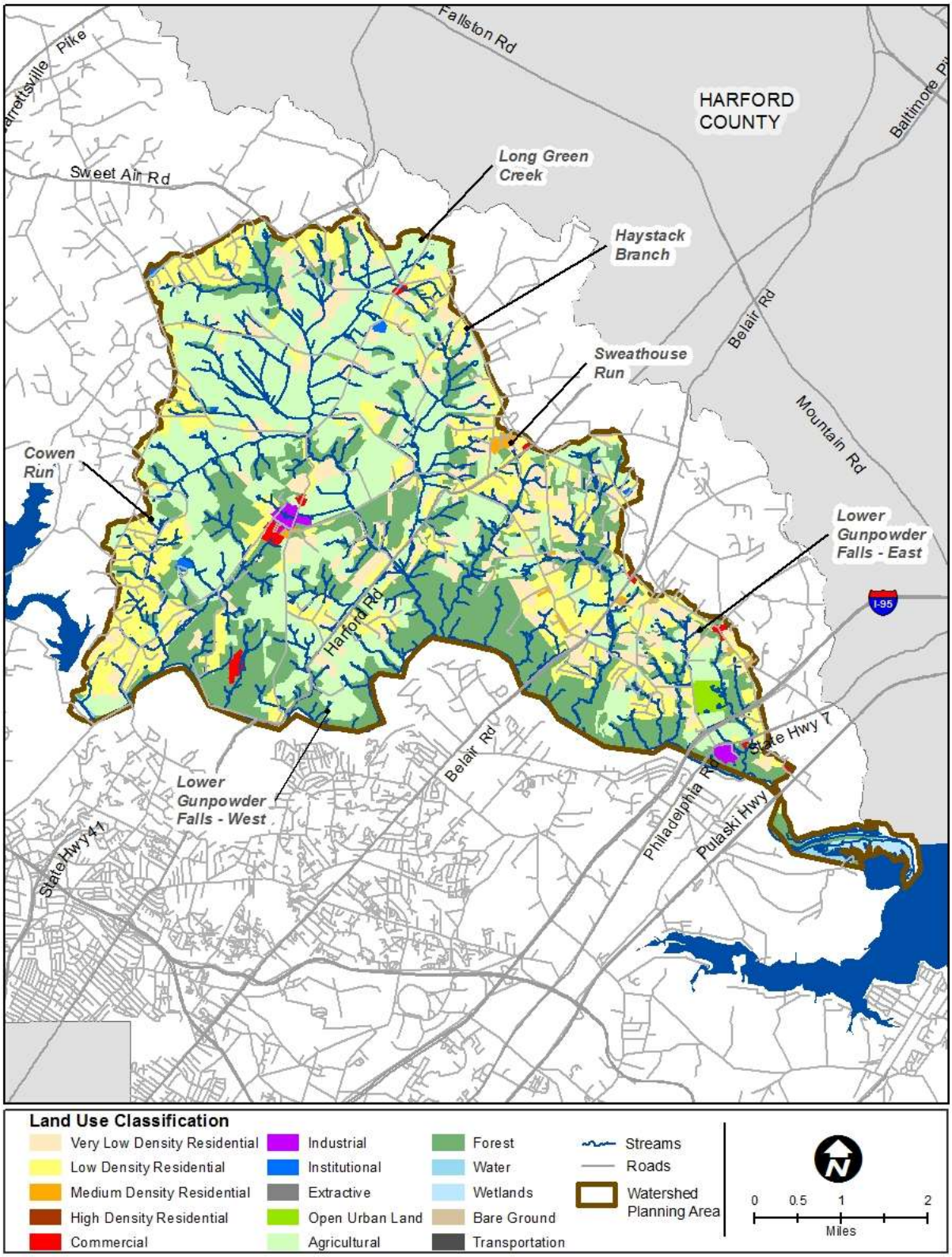


Figure 2-9 : Lower Gunpowder Falls Land Use/Land Cover

2.3.2 Population

Population data provide another way to evaluate the intensity of land use. For example, a higher population density (i.e. persons per acre) represents a more intense use of the land and increases the potential for environmental degradation. Much of the degradation from intensive land uses is related to the extent of impervious cover needed to support higher population densities, which results in the loss of land uses such as forest that protect water resources.

Smart growth principles are aimed at directing future growth to areas of existing services and to where development has already occurred. This will result in less land conversion to residential and supporting commercial areas, resulting in conservation of land uses with lower environmental impact such as forest and agriculture.

Population density in the watershed was estimated based on 2010 US Census data (U.S. Census Bureau, 2010). Table 2-9 summarizes the population data by subwatershed. Total population is provided as well as the calculated population density per acre and per impervious acre. Population density distribution is shown on Figure 2-10.

Table 2-9: Lower Gunpowder Falls Population Data

Subwatershed	Total Population (2010 Census)	Total Area (acres)	Population Density (per acre)	Impervious Area (acres)	Population Density (per impervious acre)
Long Green Creek	2,488.8	7,229.6	0.34	600.5	4.1
Haystack Branch	625.5	1,895.1	0.33	153.8	4.1
Sweathouse Run	520.60	1,089.2	0.48	106.4	4.9
Cowen Run	1,005.2	1,857.3	0.54	215.6	4.7
Lower Gunpowder Falls East	2,279.9	4,757.6	0.48	488.1	4.7
Lower Gunpowder Falls West	508.5	2,020.1	0.25	131.4	3.9
Total Watershed	**7,428.51**	**18,848.8**	**0.39**	**1,695.8**	**4.4**

Population density across the watershed and within each subwatershed is low, with an average of less than 1 person per acre across the watershed. The few parcels shown on the figure with higher population density (yellow and orange parcels) are not actually highly populated acres but show up as high density because of the small size of the census blocks. The most densely populated area in the watershed lies in the central part of the Cowen Run subwatershed. The highest population density per impervious acre is in Sweathouse Run with an estimated 4.9 people per impervious acre. The lowest is in Long Green Creek and Haystack Branch with an estimate of 4.1 people per impervious acre.

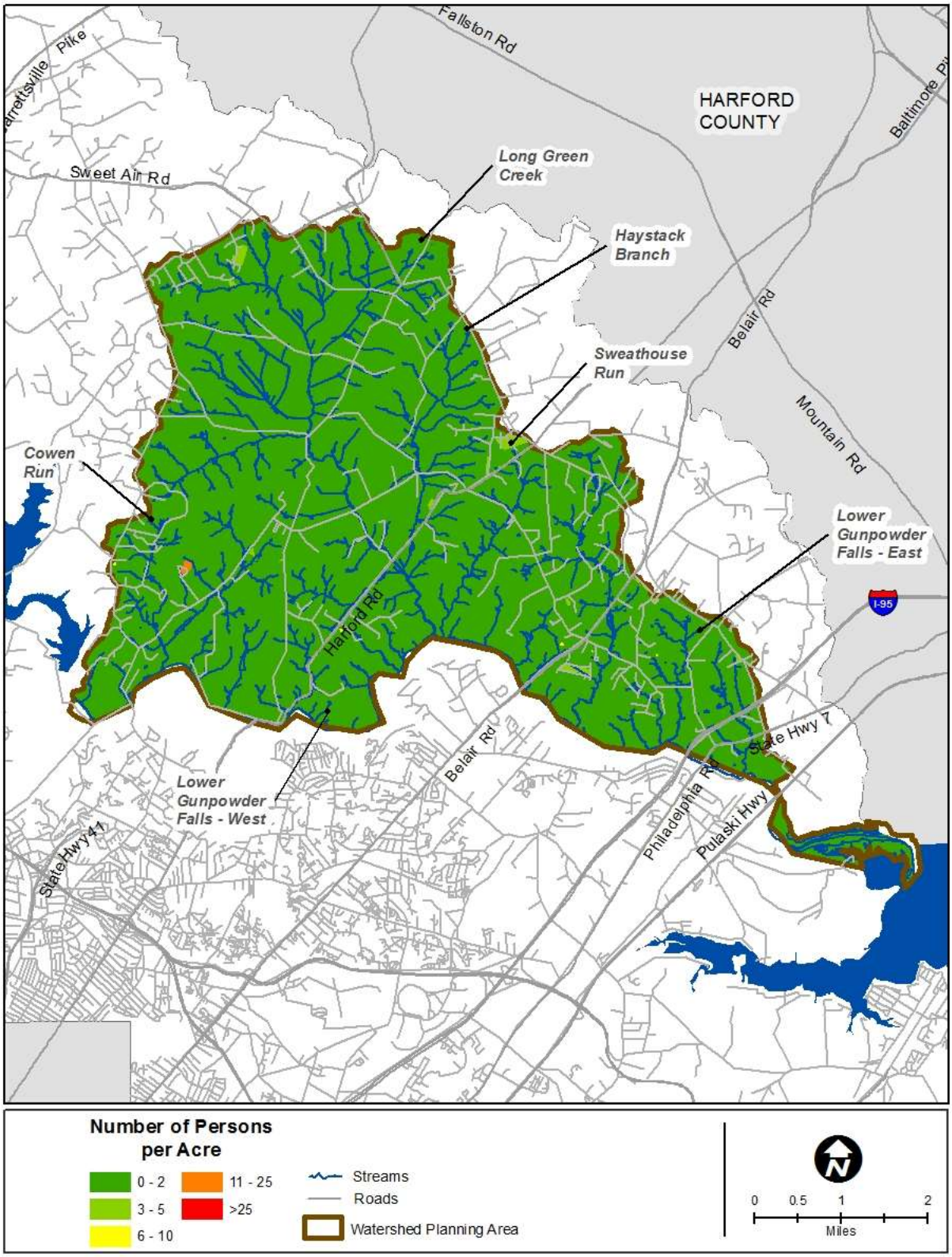


Figure 2-10: Lower Gunpowder Falls Population Distribution (based on 2010 census data)

2.3.3 Impervious Surfaces

Impervious surfaces are materials that impede or prevent infiltration of water into the soil. While there are some naturally occurring impervious surfaces such as rock outcroppings, most impervious surfaces are man-made, and include roofs/ buildings, streets, sidewalks and parking areas.

The accelerated, concentrated runoff created by impervious surfaces can cause stream erosion and habitat destruction. Runoff from impervious surfaces picks up and washes off pollutants and is usually more polluted than runoff generated from pervious areas. In general, undeveloped watersheds with small amounts of impervious cover are more 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 loading in stormwater runoff. Research has been conducted to link the degree of urbanization (as measured by the amount of impervious cover) with various watershed-based indicators of water quality such as the diversity and abundance of aquatic and terrestrial life (Schueler et al., 2009).

The Center for Watershed Protection (CWP) compiled stream research conducted in various parts of the country and developed a simple impervious surface model that relates stream quality to percentage of impervious surfaces in a watershed. This model has been updated and is shown in Figure 2-11. The relationship is represented as a white ‘cone’ that is widest at low levels of impervious cover and decreases as impervious cover increases. This indicates that at low levels of impervious cover, other watershed metrics besides impervious cover such as forest cover, road density, riparian buffer and agricultural practices influence stream health and the resulting quality is more variable. As impervious cover increases, the relationship is stronger and the ‘cone’ is narrower indicating that the resulting stream quality is less variable and is most often degraded. Studies used to develop the impervious cover model measured stream quality based on a variety of indicators such as the number of aquatic insect species, stream temperature, channel stability, aquatic habitat, wetland plant density, and fish communities.

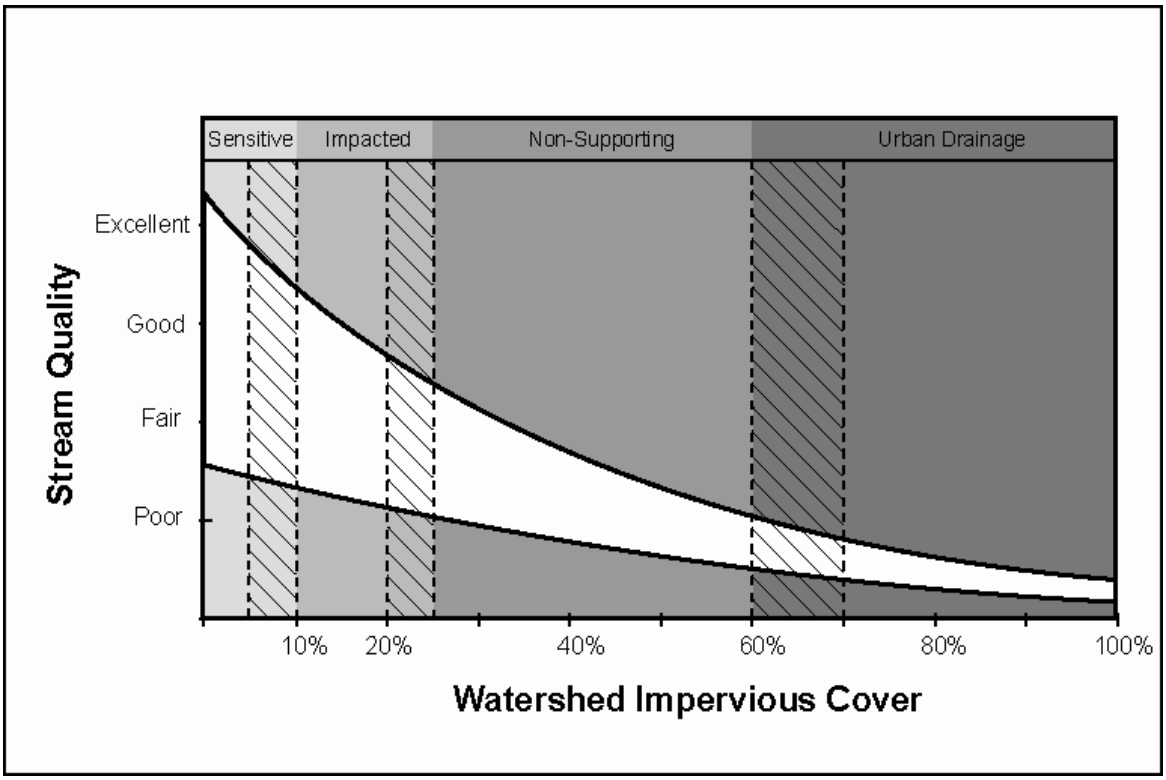


Figure 2-11: Impervious Cover Model (Schueler et al. 2009)

Based on the research compiled, CWP determined the following general categories to classify and predict stream quality in terms of impervious cover represented by bands in Figure 2-11. These 'bands' are colored in a gradation from least (light gray) to most (darker gray) amount of impervious cover.

- **Sensitive** – 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.
- **Impacted** – watersheds with between 10 and 25 percent impervious cover show clear signs of degradation such as erosion, channel widening and decline in stream habitat. Stream restoration to a somewhat natural functioning system is still possible in these watersheds.
- **Non-supporting** – watersheds with between 25 and 60 percent of impervious cover are characterized by fair to poor water quality, unstable channels, severe erosion, and the inability to support aquatic life and provide habitat. Many streams in this category are typically piped or channelized.
- **Urban drainage** – in watersheds where impervious cover exceeds 60 percent, a watershed is classified as severely damaged which means that most of the natural stream system is gone, most often buried to flow in storm drains.

Management of damaged and severely damaged streams may focus on decreasing pollutant loads to downstream receiving waters but the ability to restore natural functions is unlikely. Restoration efforts may also focus on making the remaining stream systems stable, aesthetically pleasing and an amenity to the community.

The impervious GIS data layer from Baltimore County, which includes roads, building, tennis courts and other impervious areas, was used to determine the total impervious area within subwatersheds of Lower Gunpowder Falls. Table 2-10 presents the results of this analysis and Figure 2-12 shows the distribution of impervious area in the study area.

Table 2-10: Lower Gunpowder Falls Estimated Impervious Surfaces

Subwatershed	Total Area (ac)	Roads (ac)	Buildings (ac)	Other	Impervious Area (ac)	% Impervious
Long Green Creek	7,229.6	407.7	191.5	1.3	600.5	8.3
Haystack Branch	1,895.1	104.2	49.4	0.2	153.8	8.1
Sweathouse Run	1,089.2	67.3	38.7	0.4	106.4	9.8
Cowen Run	1,857.3	139.7	74.7	1.2	215.6	11.6
Lower Gunpowder Falls East	4,757.6	338.8	138.9	10.5	488.1	10.3
Lower Gunpowder Falls West	2,020.1	93.9	37.3	0.2	131.4	6.5
Total	**18,848.8**	**1,151.7**	**530.4**	**13.7**	**1,695.8**	**9.0**

Impervious surfaces cover just nine percent of the total land surface in Lower Gunpowder Falls, placing the watershed just below the ten percent of impervious area threshold to qualify as impacted per CWP's impervious cover model. Although the watershed as a whole is below the impacted threshold, there may be smaller order tributaries within the subwatersheds that are impacted. Cowen Run and Lower Gunpowder Falls East are above the ten percent of impervious area threshold and qualify as impacted watersheds. Long Green Creek, Haystack Branch, and Sweathouse Run are at the upper end of the sensitive category, bordering on impacted.

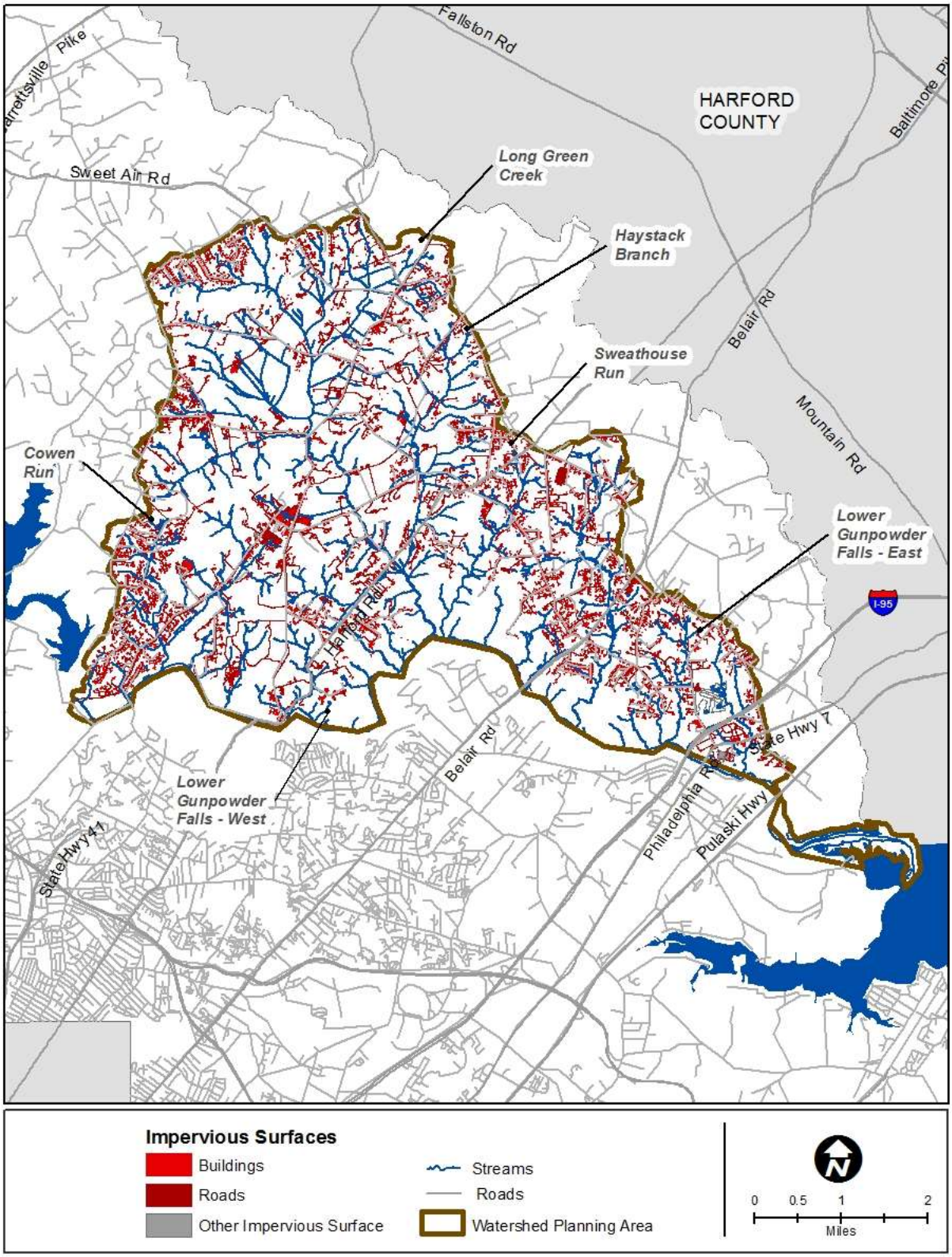


Figure 2-12: Lower Gunpowder Falls Impervious Surfaces

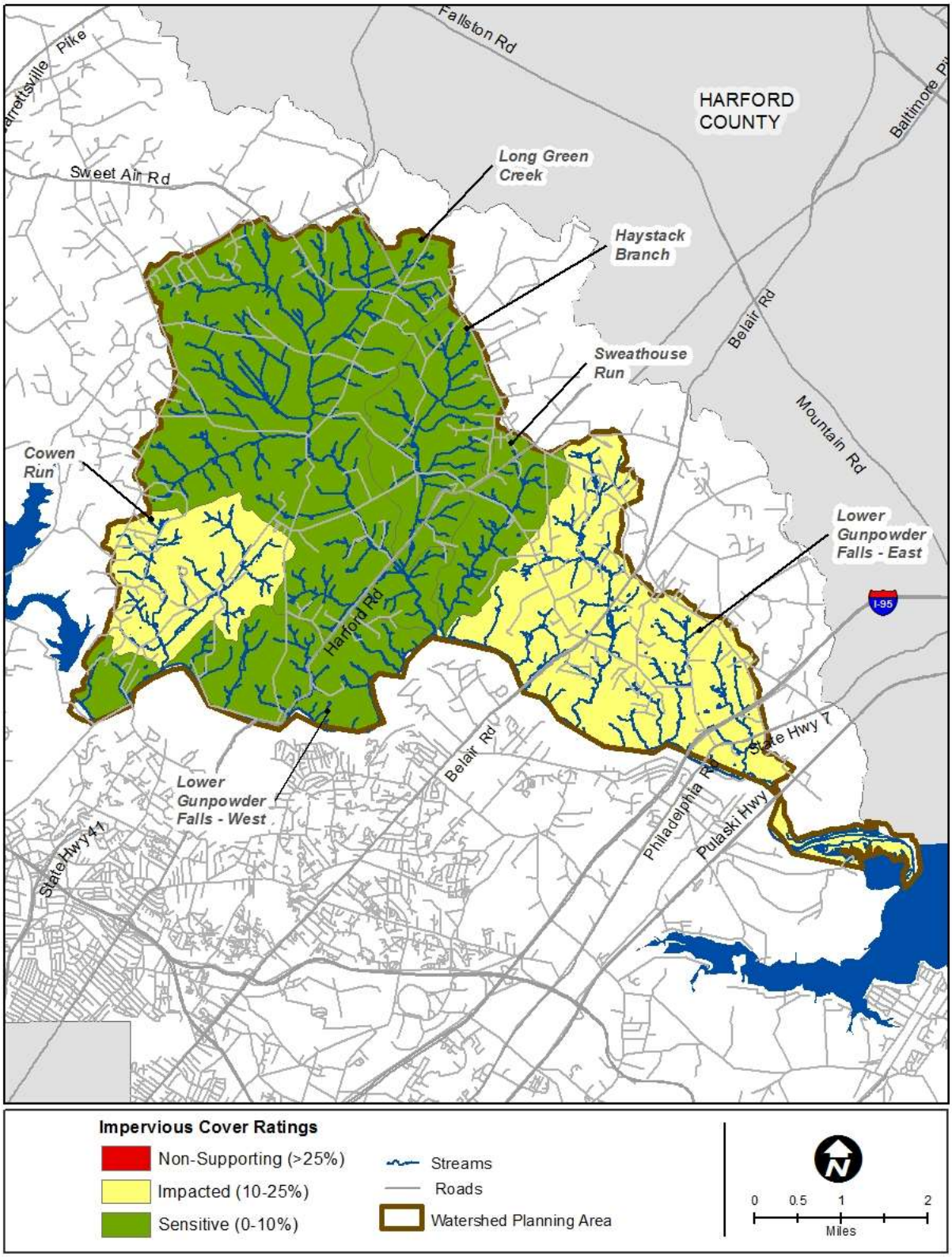


Figure 2-13: Lower Gunpowder Falls Impervious Cover Ratings

2.3.4 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 properties. Having an adequate supply of drinking water is essential to maintaining the human population in a region.

2.3.4.1 Public Water Supply

Environmental impacts associated with public supply of water include the potential for increased residential development, associated impervious cover effects and the potential for leaks from the system. Lower Gunpowder Falls lies outside of the area served by the Baltimore Metropolitan water supply, so the potential for leaks from the system are not an issue in this watershed. However, the effects associated with impervious cover and development in the watershed do have an impact on water quality and habitat in local streams.

2.3.4.2 Groundwater

Water supply in Lower Gunpowder Falls is provided largely by groundwater wells. The underlying geology can cause well yield to be highly variable even in this small area. Wells in areas underlain by Loch Raven schist, approximately 34.6 percent of the watershed primarily in the northern portion of Long Green Creek, and the majority of Cowen Run and Sweathouse Run, have been identified by the county as critical yield areas due to a lower degree of fracturing in the rock and may yield less flow than wells in other geology.

Groundwater quality is also affected by geologic formations. For example, naturally occurring radionuclides have been detected in groundwater at levels above the US EPA Drinking Water Standards in areas underlain by the Baltimore and Setters Gneiss, (http://resources.baltimorecountymd.gov/Documents/Environment/radionuclidehomeownersguiderev011012.pdf) which underlie 10 percent of the watershed. Hardness may be a problem in areas underlain by marble due to higher concentrations of calcium and magnesium. In addition, groundwater may be more acidic when obtained from aquifers in gneiss and schist while in marble formations ground water is usually alkaline (Baltimore County DEPRM, 2011).

2.3.5 Wastewater

Wastewater produced through human use must be treated. This is accomplished either through public conveyance to a wastewater treatment facility or through individual wastewater treatment systems such as 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 (e.g., paint brush, floor washing, etc.). Industrial and commercial facilities must also dispose of any water used as part of their operations. Depending on the operation, the water could contain any number of contaminants, including metals, organic compounds, detergents, or synthetic compounds. All of these wastes have the potential to harm the natural environment and drinking water sources.

2.3.5.1 Septic Systems

Properly functioning septic systems provide treatment for pathogens and phosphorus present in wastewater, but can discharge nitrogen in the form of nitrates. Depending on the

location of the system, the nitrates may either be reduced or eliminated through denitrification as the water passes through riparian buffers, particularly forested riparian buffers. Failing and improperly maintained systems can release nitrogen, phosphorus, and other chemicals, contaminating the aquatic environment. They can also result in increased bacterial contamination of nearby streams and are therefore a human health concern.

There is no public sewer provided in Lower Gunpowder Falls and therefore septic systems are numerous. According to Baltimore County Bay Restoration Fund tracking there are 2,684 septic systems in Lower Gunpowder Falls. Table 2-11 shows the distribution of these septic systems among the subwatersheds.

Table 2-11: Approximate Number of Septic Systems in Lower Gunpowder Falls

Subwatershed	Number of Septic Systems (estimated)
Long Green Creek	860
Haystack Branch	240
Sweathouse Run	202
Cowen Run	372
Lower Gunpowder Falls East	827
Lower Gunpowder Falls West	183
Total	**2,684**

2.3.5.2 Public Sewer

A public sewer system conveys wastewater from individual residences and businesses to a facility that treats the wastewater prior to discharge. The system itself consists of the piping system and cleanouts on the individual properties that are owned by the property owner. The individual landowner is responsible for the maintenance of this part of the system. The part of the system that is in the public right-of-way is owned and maintained by the local government. The public system consists of the gravity piping system, access manholes, pumping stations, and pressurized mains. Environmental impacts associated with the public sewer system are usually the result of sewage overflows. These overflows usually result from blockages within the sewage system, pumping station failure, or rainwater inflows exceeding the capacity of the pipe. Since all of Lower Gunpowder Falls lies outside of the area served by the Baltimore County public sewer system, these issues are not applicable in this watershed.

2.3.6 Stormwater

Stormwater is surface water or snowmelt resulting from precipitation. Stormwater that does not infiltrate into the ground, evaporate, or transpire through plants becomes surface runoff that flows directly to streams, with or without being directed to a storm drainage system. Stormwater runoff is affected by the amount and intensity of rainfall, soil characteristics, surface slope and land use/land cover. Runoff is higher in areas with greater impervious surfaces and on agricultural land than on undeveloped land. Certain types of agricultural uses such as row crops can dramatically increase runoff especially compared to low density development. This can lead

to flooding and stream erosion, resulting in the destruction of habitat and a reduction of a stream's natural ability to remove pollutants.

Stormwater runoff can also carry various contaminants and contribute to thermal impacts on streams. Pollutants deposited on impervious surfaces and other developed lands from daily human activities are washed off into stream systems by stormwater. Runoff from agricultural operations and residential areas can carry pollutants such as nutrients, pathogens, and chemicals to receiving water bodies.

2.3.6.1 Storm Drainage System

Municipalities such as Baltimore County with large storm drainage networks are regulated under the Clean Water Act and issued permits by the Maryland Department of the Environment. The storm drainage system commonly consists of curb and gutter with associated inlets (road drains), and a piping system, or drainage swales (e.g., roadside ditches) which may or may not be connected to storm drain pipes. The purpose of these systems is to remove water quickly from roadways to prevent flooding and potentially hazardous situations. However, the environmental impacts from the two systems are different. The curb and gutter system quickly and efficiently removes water from impervious surfaces and routes that water to low spots in the topography, usually directly to the stream. This type of system delivers not only increased volumes of water, but pollutants associated with impervious surfaces are carried untreated directly to the stream system or other receiving water body (bypassing any existing buffer).

Grass drainage swales do not move the water as quickly as curb and gutter systems and may allow the water to slow somewhat prior to entering the stream system, or in some cases storm drain pipes. Drainage swales also allow some infiltration into the soil thus reducing the amount of water eventually delivered to the receiving water body. The infiltration and slower movement of water also provide some filtering of pollutants.

Table 2-12 shows the components of the storm drain system by subwatershed. There are three major (> 3 feet in diameter) storm drain outfalls in Lower Gunpowder Falls. The minor (< 3 feet in diameter) storm drain outfalls and corresponding pipe lengths are also shown. Table 2-13 shows the percentage of area served by the storm drain system.

Table 2-12: Lower Gunpowder Falls Storm Drain System Components

	Major (>3ft)			Minor (<3ft)			All Outfalls		
Subwatershed	Outfalls (#)	Inlets (#)	Pipe (ft)	Outfalls (#)	Inlets (#)	Pipe (ft)	Total Outfalls (#)	Total Inlets (#)	Total Piping (ft)
Long Green Creek	3	15	600	13	29	2,982	16	44	3,582
Haystack Branch	0	0	0	8	24	14,191	8	24	14,191
Sweathouse Run	0	0	0	7	20	3,195	7	20	3,195
Cowen Run	0	0	0	8	18	3,175	8	18	3,175
Lower Gunpowder Falls East	0	0	0	10	26	2,601	10	26	2,601
Lower Gunpowder Falls West	0	0	0	1	11	975	1	11	975
Total	**3**	**15**	**600**	**47**	**128**	**27,119**	**50**	**143**	**27,719**

Table 2-13: Lower Gunpowder Falls Stormwater System Coverage

Subwatershed	Stormwater System Drainage Area (acres)	Area Covered by Stormwater System (%)	Number of Inlets (#)	Inlet Density (# / mi^2)
Long Green Creek	151.6	2.1	44	3.9
Haystack Branch	18.9	1.0	24	8.1
Sweathouse Run	44.0	4.0	20	11.8
Cowen Run	43.9	2.4	18	6.2
Lower Gunpowder Falls East	60.0	1.3	26	3.5
Lower Gunpowder Falls West	7.7	0.4	11	3.5
Total	**326.2**	**1.7**	**143**	**4.9**

2.3.6.2 Stormwater Management Facilities

Starting in the mid-1980s the Maryland Department of Environment (MDE) began requiring new development to implement stormwater management to control the quantity of stormwater runoff. This continues to be a significant consideration for development across the state. Stormwater management systems, such as stormwater ponds, can reduce erosion, sedimentation, pollution, and flooding. Increased importance of water quality and water resource protection led to the development of the Maryland Stormwater Design Manual in 2000 (MDE, 2009a) which provided BMP design standards that endeavored to mimic natural hydrologic processes to preserve pre-development conditions. The subsequent Maryland Stormwater Management Act of 2007 expanded on the 2000 manual regulations by requiring that environmental site design (ESD) techniques be implemented in new development via nonstructural BMPs and/or other better site design techniques (e.g., green infrastructure). Full implementation of onsite ESD can in some cases eliminate the need for downstream stormwater management (SWM) facilities.

There are many types of BMPs available for managing stormwater runoff and providing stormwater quality treatment, all with differing pollutant removal capabilities. Several considerations are taken into account when selecting appropriate stormwater treatment measures such as space, maintenance, cost, and community acceptance.

Table 2-14 and Figure 2-14 summarize and display the location of the 45 public and private stormwater management facilities for all land uses in Lower Gunpowder Falls. Lower Gunpowder Falls East has the highest number of facilities (17) followed by Long Green Creek with 11 facilities. Cowen Run and Sweathouse Run have 4 facilities and Lower Gunpowder Falls West has the least with 1 facility. Filtration practices are the most numerous in all of the subwatersheds. All of the stormwater management facilities provide water quality treatment with the exception of two detention ponds which were designed only for water quantity control.

Table 2-14: Lower Gunpowder Falls Stormwater Management Facilities

SWM Facility Type	Long Green Creek	Haystack Branch	Cowen Run	Sweathouse Run	Lower Gunpowder Falls East	Lower Gunpowder Falls West	Grand Total
Detention (#)	1	0	1	0	0	0	2
Drainage Area (ac)	3.4	0	23.6	0.0	0.0	0.0	27.0
Extended Detention (#)	1	2	1	0	8	0	12
Drainage Area (ac)	10.1	31.4	0.3	0.0	118.8	0.0	160.6
Filtration (#)	8	6	2	4	9	0	29
Drainage Area (ac)	79.1	13.2	14.0	8.6	20.1	0.0	135.0
Infiltration (#)	0	0	0	0	0	1	1
Drainage Area (ac)	0.0	0	0.0	0.0	0.0	0.6	0.6
Wet Ponds and Wetlands (#)	1	0	1	0	0	0	2
Drainage Area (ac)	253.0	0	1.9	0.0	0.0	0.0	254.9
Total (#)	**11**	**8**	**5**	**4**	**17**	**1**	**46**
Total Area Treated (ac)	**345.6**	**44.6**	**39.8**	**8.6**	**138.9**	**0.6**	**578.1**

Table 2-15 shows the percentage of urban land use area treated by stormwater management. This was calculated by locating SWM facilities in the following MDP land uses: very-low, low-, medium-, and high-density residential, commercial, industrial, institutional, open urban and transportation and calculating the area treated by each of these SWM facilities. Table 2-15 shows that approximately 3 percent of the urban land uses in Lower Gunpowder Falls are treated by SWM, with Long Green Creek receiving the highest area of urban land treated at 82 acres, or 4 percent. Locations of urban land use where there is no current stormwater management are good candidates for implementing BMPs. Locations for implementing BMPs will be further discussed in Chapters 3 and 4.

Table 2-15: Lower Gunpowder Falls Urban Land Uses Treated by Stormwater Management

Subwatershed	Total Area (ac)	Urban Land Use (ac)	Urban Acres Treated by SWM	Urban Land Use Treated by SWM (%)
Long Green Creek	7,229.6	2,038.4	82.0	4.0
Haystack Branch	1,895.1	692.3	39.7	5.7
Sweathouse Run	1,089.2	835.0	16.0	1.9
Cowen Run	1,857.3	479.7	3.7	0.8
Lower Gunpowder Falls East	4,757.6	1,943.7	38.9	2.0
Lower Gunpowder Falls West	2,020.1	452.1	0.0	0.0
Total	**18,848.8**	**6,441.2**	**180.3**	**2.8**

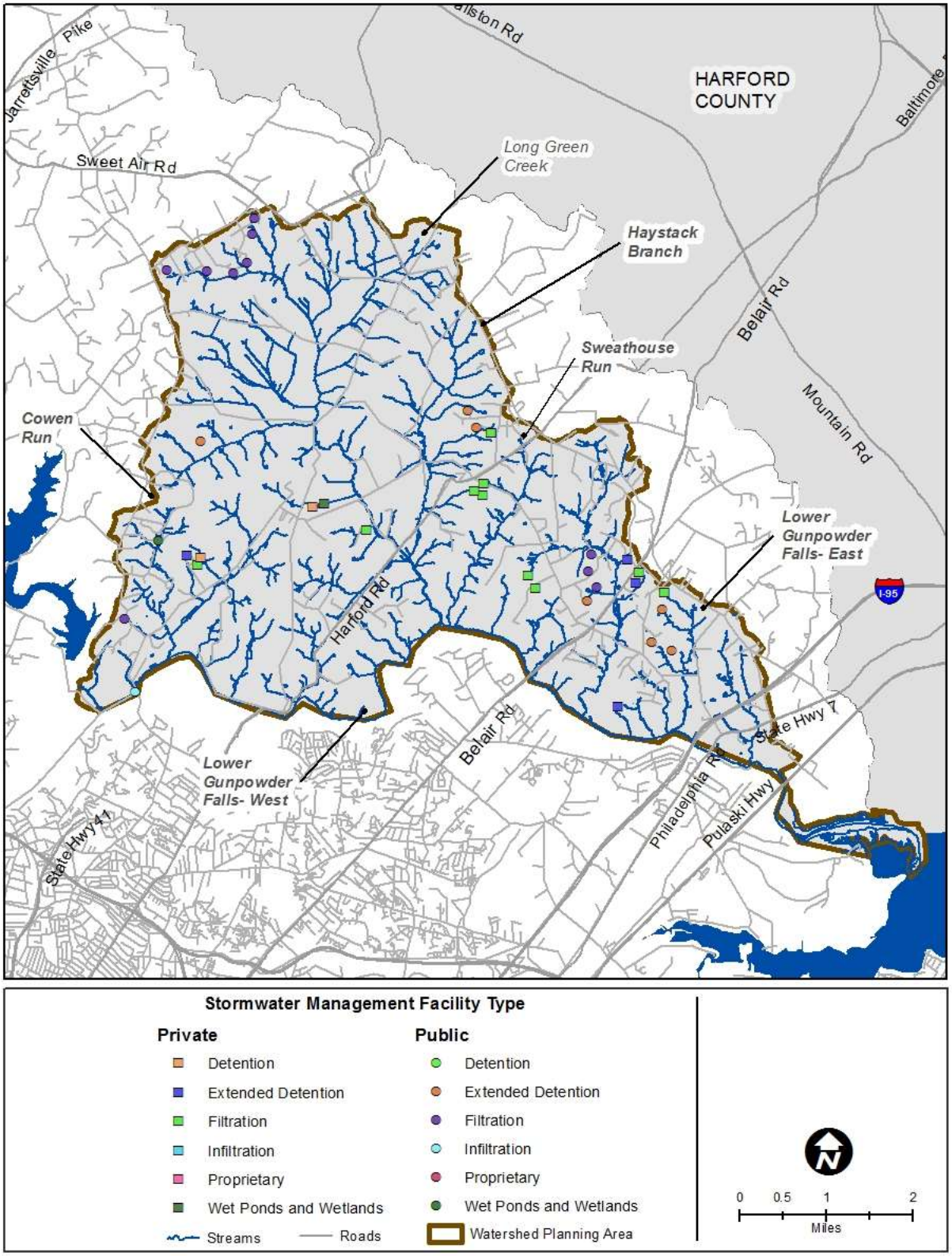


Figure 2-14: Stormwater Management Facility Types

2.3.7 NPDES 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 active NPDES-permitted facilities within the watershed is summarized in Table 2-16.

There are nine permitted facilities, with two of those facilities at the Glen Arm Maintenance Facility and Wastewater Treatment Plant. General Permits are required for facilities discharging wastewater or stormwater to any place other than a sanitary sewer, or for any manufacturing, fleet vehicle, or recycling facility.

Table 2-16: NPDES Permits in Lower Gunpowder Falls

Subwatershed	# Unknown/ General	Hydrostatic Testing	Stormwater Discharge	Wastewater Treatment	No Exposure Certification	# of Permits
Long Green Creek	1	0	2	2	1	6
Haystack Branch	1	0	0	0	0	1
Sweathouse Run	0	0	0	0	0	0
Cowen Run	0	0	0	1	0	1
Lower Gunpowder Falls East	0	0	0	0	0	0
Lower Gunpowder Falls West	0	1	0	0	0	0
Total	**2**	**1**	**2**	**3**	**1**	**9**

2.3.8 Zoning

The Baltimore County Office of Planning defines zoning as “a legal mechanism that limits the use of privately-owned land to protect the health, safety, morals, and/or general welfare of the public.” (Baltimore County Office of Planning, 2015). Zoning controls development patterns throughout the county over time.

The Comprehensive Zoning Map Process (CZMP) takes place every four years as specified in the County Code. The most recent rezoning was completed and took effect September 2012.

In 1967, Baltimore County established the Urban Rural Demarcation Line (URDL) as part of its smart growth management policy. This line identified areas of Baltimore County that had or would receive public water and sewer infrastructure, thus allowing for commercial and residential development. Limits on infrastructure growth effectively ensured limited development in areas outside of the URDL, including all of Lower Gunpowder Falls.

The current zoning for the watershed is summarized in Table 2-17 and shown on Figure 2-15. There are many zoning categories in Baltimore County. Only those most applicable to this watershed are shown on the legend. The majority of zoning categories within the watershed are resource conservation (‘RC’) categories. There are also several properties that are in agricultural or conservation easements. These are discussed later in section 2.3.8.1 Conservation Easements.

The greatest percentage of land in the watershed is zoned ‘RC 2’ or agricultural protection (64.1 percent), which fosters and protects agriculture. Areas zoned ‘RC 5’, or rural

residential (28.0 percent) is the next most common, this category is associated with providing residential development in appropriate rural areas. Of the remaining areas, 4.8 percent is zoned for resource preservation uses, which protect cultural, historical, recreational and environmental resources, and 1.7 percent lies in resource conservation critical areas. The remaining categories each comprise less than one percent of the total area.

Table 2-17: Lower Gunpowder Falls Zoning (Baltimore County Office of Planning, 2013 and 2006b)

Zoning Code	Zoning Description	Total (Acres)	% of Watershed Area
BL	Business Local – Small-scale commercial	24.9	0.1
BM	Business Major – Large-scale commercial	6.1	0.0
BR	Business Roadside – Most permissive commercial classification	2.4	0.0
ML	Manufacturing Light – Permits light industrial uses such as assembly plants, processing, etc.	73.5	0.4
RC 2	Agricultural Protection – Foster and protect agriculture	12,054.1	64.0
RC 20	Resource Conservation Critical Area	73.1	0.4
RC 4	Watershed Protection – Protect the watersheds of the three regional reservoirs	39.2	0.2
RC 5	Rural Residential – Provide for residential development in appropriate rural areas	5,276.9	28.0
RC 50	Resource Conservation Critical Area	322.7	1.7
RC 6	Rural Conservation and Residential – Provide greater protection for resource areas	50.1	0.3
RC 7	Resource Preservation – Protect cultural, historical, recreational and environmental resources	919.5	4.9
RCC	Resource Conservation Commercial - provides commercial development at a scale appropriate to rural areas.	3.3	0.0
RO	Residential Office – Permits house conversions to office buildings.	2.4	0.0
DR 1	Density Residential – Permit low, with one unit per acre	0.4	0.0
DR 2	Density Residential – Permit low with two units per acre	0.1	0.0
	Total	**18,848.7**	**100.0**

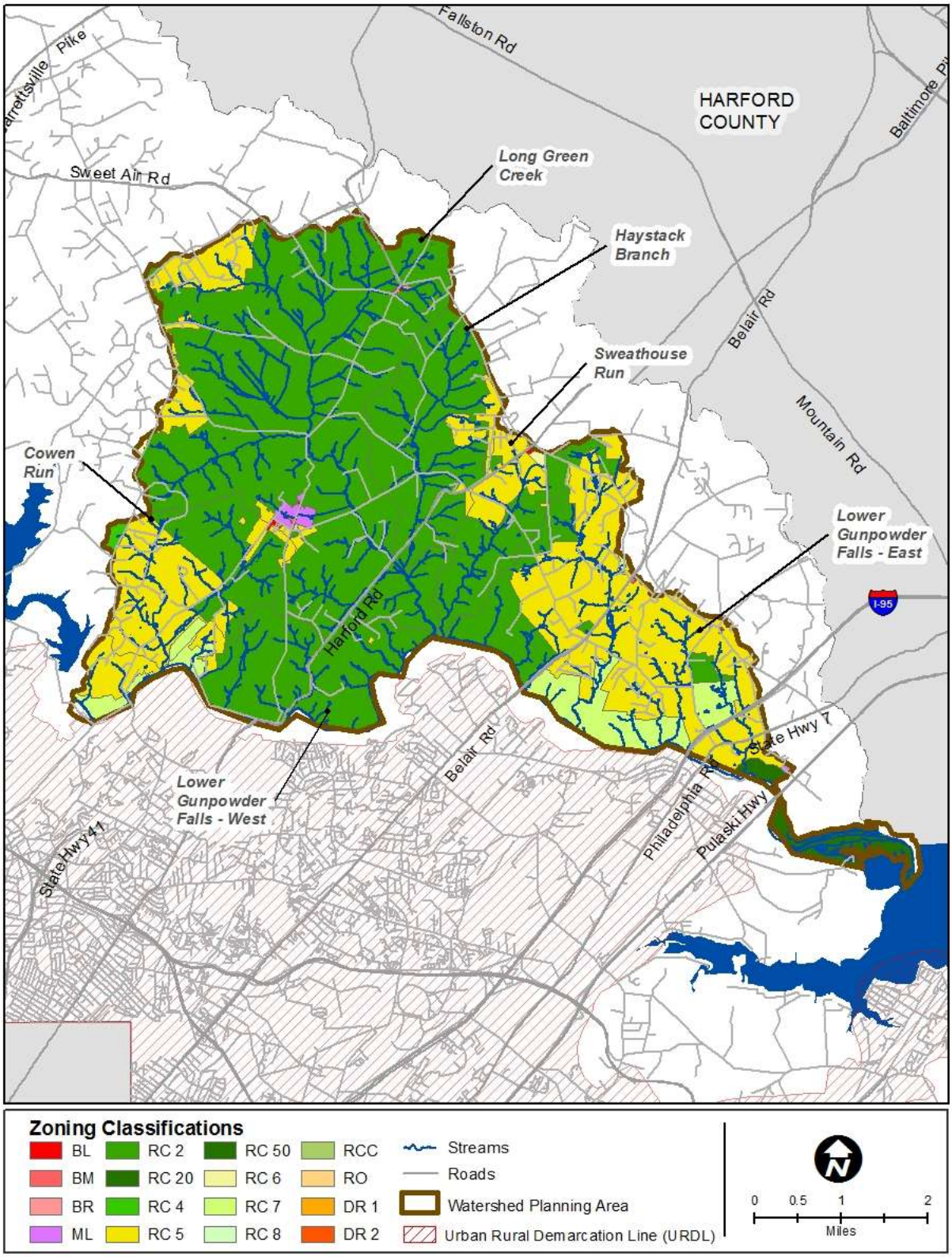


Figure 2-15: Lower Gunpowder Falls Zoning

2.3.8.1 Conservation Easements

A conservation easement ensures the protection of significant natural resources on a property. Placing a property under easement may allow the landowner to receive income, or estate and property tax benefits while still maintaining ownership of the property.

Lower Gunpowder Falls contains several conservation easements held under various preservation programs covering 6,145 acres of land or approximately 33 percent of the total watershed area. These include properties held in forest conservation and those under local land trusts and conservancies, Maryland Agricultural Land Preservation Foundation, and Maryland Environmental Trust properties. These categories are discussed in more detail below. Table 2-18 summarizes the area within each subwatershed held in easement and Figure 2-16 shows the location of these properties.

Table 2-18: Conservation Easements (Acres)

Subwatershed	Baltimore County	Forest Conservation	Long Green Land Trust	MALPF	MET	Land Preservation Trust	Multiple*	Total
Long Green Creek	475.0	139.7	2,097.3	551.3	416.3	0.0	496.2	4,175.8
Haystack Branch	297.3	58.3	254.7	4.2	163.2	0.0	0.0	777.7
Sweathouse Run	0.0	4.3	26.0	9.9	0.0	0.0	0.0	40.2
Cowen Run	36.2	205.9	269.4	1.6	0.0	3.9	44.0	561.0
Lower Gunpowder Falls East	0.0	95.8	0.4	61.4	0.0	0.0	0.0	157.7
Lower Gunpowder Falls West	0.0	6.9	422.2	0.0	0.0	3.9	0.0	433.1
Total	**808.5**	**510.9**	**3,070.0**	**628.4**	**579.5**	**7.8**	**540.1**	**6,145.2**

*Acres of land held under multiple easements. The acres shown for all easement types are for those areas that are not also held in other easement types. The multiple category ensures there is no double-counting of easement acres in the total area of conservation easements.

Forest Conservation easements in Baltimore County provide for the protection of forests as required by the State of Maryland's Natural Resources Article 5-1601-1613, Forest Conservation Act. A forest, as defined by the County Code for this purpose, is an area 1-acre or more in size with at least 50 percent of the trees having a 2-inch or greater diameter at 4.5 feet above the ground. Forested buffers specifically refer to wooded areas that are adjacent to and protect a stream. Buffers can include trees, shrubs or herbaceous vegetation and are not restricted by minimum size requirements (Baltimore County Code Article 33 Title 5). Forest conservation areas in the watershed often overlap other conservation easements. There are some areas of forest that are held in both Forest Conservation and other easements. The 510.9 acres of Forest Conservation easements shown in Table 2-18 are those areas of forest that are not also held in other easements, thus areas are not counted twice.

In conjunction with forest conservation easements, Maryland Department of Natural Resources Forest Stewardship Plans are long-range plans that provide management recommendations incorporating landowner objectives and the capability of the forest resource. They may include wildlife, forestry, recreation, soil, and water management recommendations. The plans provide an assessment of the existing condition of the forest and offer long-term

recommendations on how to best manage the resource to achieve the intended results. Forest Stewardship Plans are required to apply for state and federal fund cost-share programs and for participation in a Forest Conservation and Management Agreement. The practices that are recommended in the plan and have received cost-share assistance must be maintained for a minimum of 10 years. There are a total of 4 active stewardship plans in the Lower Gunpowder Falls watershed, covering a total of 53.8 acres.

There are 3,617.9 acres of property held in local land trusts. These include properties under Long Green Land Trust, Land Preservation Trust and properties in the 'multiple' category which are held by both public agencies and Long Green Land Trust. Local land trusts are preservation programs created in 1967 by the Maryland General Assembly to protect Maryland's natural environment. Larger properties (greater than 50 acres) are preferred for preservation under these programs, but local land trusts are often willing to work with smaller properties (EPS, 2015).

The Maryland Agricultural Land Preservation Foundation (MALPF) properties make up 628.4 acres of the watershed, with 551.3 acres in Long Green Creek. The MALPF program was created in 1979 and jointly funded by Baltimore County and the State of Maryland. The program is dedicated to preserving farmland and promoting commercial agriculture. To qualify for this program, a farm must be a minimum of 50 acres or located adjacent to a preserved property. Landowners receive cash payments for participating in this easement program (EPS, 2015).

There are an additional 579.5 acres held in easement by the Maryland Environmental Trust. The Maryland Environmental Trust (MET) was created by the Maryland General Assembly in 1967 to protect Maryland's natural environment. The MET seeks donated easements on farms and in forests, wildlife habitats, natural areas, historic sites and other valuable and scenic features. MET works with properties of any size but prefers donations of lands greater than 50 acres. Landowners who donate land may qualify for a significant tax deduction or credit.

The Rural Legacy Program is a state program that was adopted in 1997 and additionally funded by Baltimore County to protect Maryland's rural landscapes and natural areas through the purchase of land or conservation easements. The program emphasizes the protection of large blocks of rural agricultural and forested land. Local government and land trusts (sponsors) apply to have places that are significant to the community and the state designated as Rural Legacy Areas. Once a Rural Legacy area is designated, sponsors can then apply for Rural Legacy grants for land or conservation easements within the Rural Legacy boundaries. There are 13,608 rural legacy acres in the Lower Gunpowder Falls including 6,713 acres in Long Green Creek (49% of the subwatershed), 1,895 acres in Haystack Branch (14% of the subwatershed), 1,647 acres in the Lower Gunpowder Falls West (12% of the subwatershed), 1,198 acres in the Lower Gunpowder Falls East (9% of the subwatershed), 1,083 acres in Sweathouse Run (8% of the subwatershed), and 1,071 acres in Cowen Run (8% of the subwatershed).

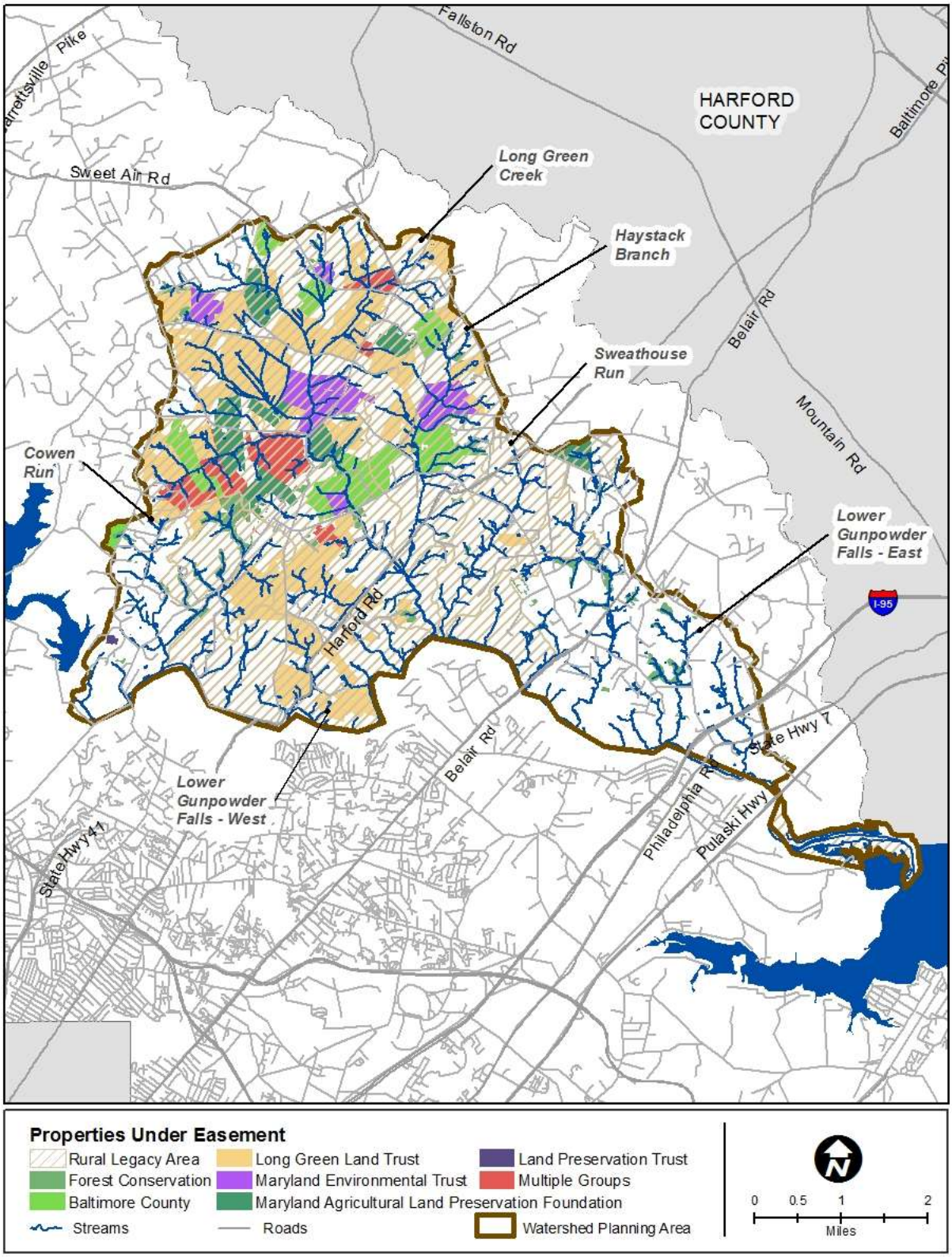


Figure 2-16: Lower Gunpowder Falls Properties Under Easement

2.3.9 Historical Development

Historical development within the watershed began before 1900 with approximately 50 percent of development (of known data) occurring in the 1950s, 60s, and 70s.

Table 2-19 provides a summary of the number of units within each subwatershed and the decade built. Figure 2-17 and Figure 2-18 shows the decade each parcel was developed using the GIS shapefile "HistoricalDevo2005" provided by Baltimore County.

As discussed in section 2.3.6.2, in the mid-1980s the Maryland Department of Environment (MDE) began requiring new development to implement stormwater management to control the quantity of stormwater runoff. In 2007, the Maryland Stormwater Management Act of 2007 expanded on the 2000 manual regulations by requiring that environmental site design (ESD) techniques be implemented in new development via nonstructural BMPs and/or other better site design techniques. As a result of the development patterns, much of the watershed was built prior to the requirement for stormwater management.

Table 2-19: Decade Built and Number of Units

Decade Built	Before 1900	1900 to 1919	1920s	1930s	1940s	1950s	1960s	1970s	1980s	1990s	2000 - 2009	2010 and After	No Data/ Undeveloped
Long Green Creek	74	59	20	13	26	160	183	177	101	93	48	13	364
Haystack Branch	23	12	1	4	5	49	40	41	32	25	48	3	107
Sweathouse Run	9	10	11	16	14	100	42	34	34	10	14	2	197
Cowen Run	19	7	5	7	10	85	69	72	64	54	13	6	145
Lower Gunpowder Falls East	46	25	21	26	56	191	103	65	98	185	58	14	376
Lower Gunpowder Falls West	16	8	3	3	6	40	39	50	17	13	9	0	112
Total	**187**	**121**	**61**	**69**	**117**	**625**	**476**	**439**	**346**	**380**	**190**	**38**	**1,301**

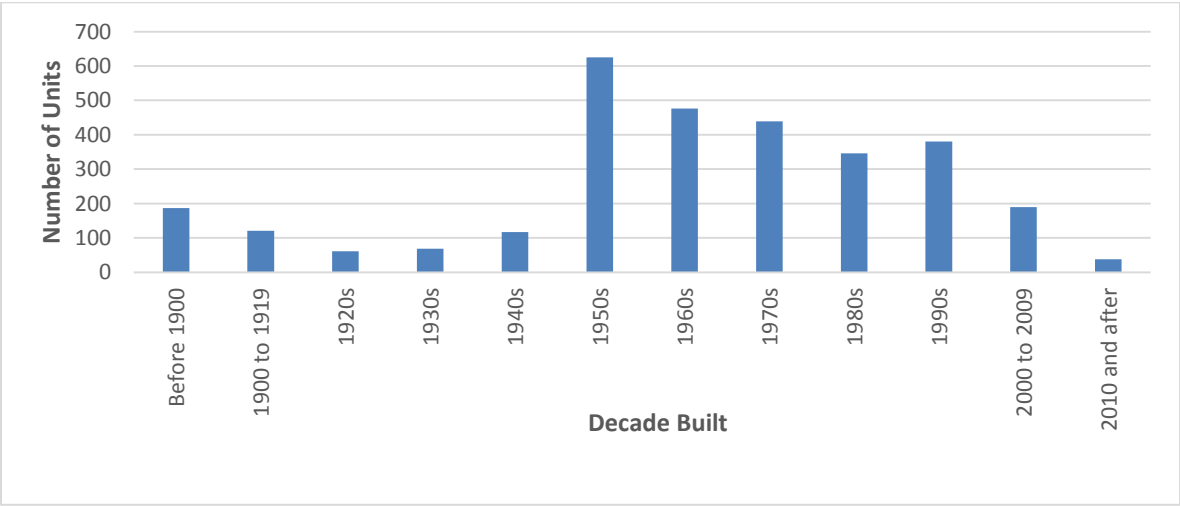


Figure 2-17: Number of Housing Units Built by Decade

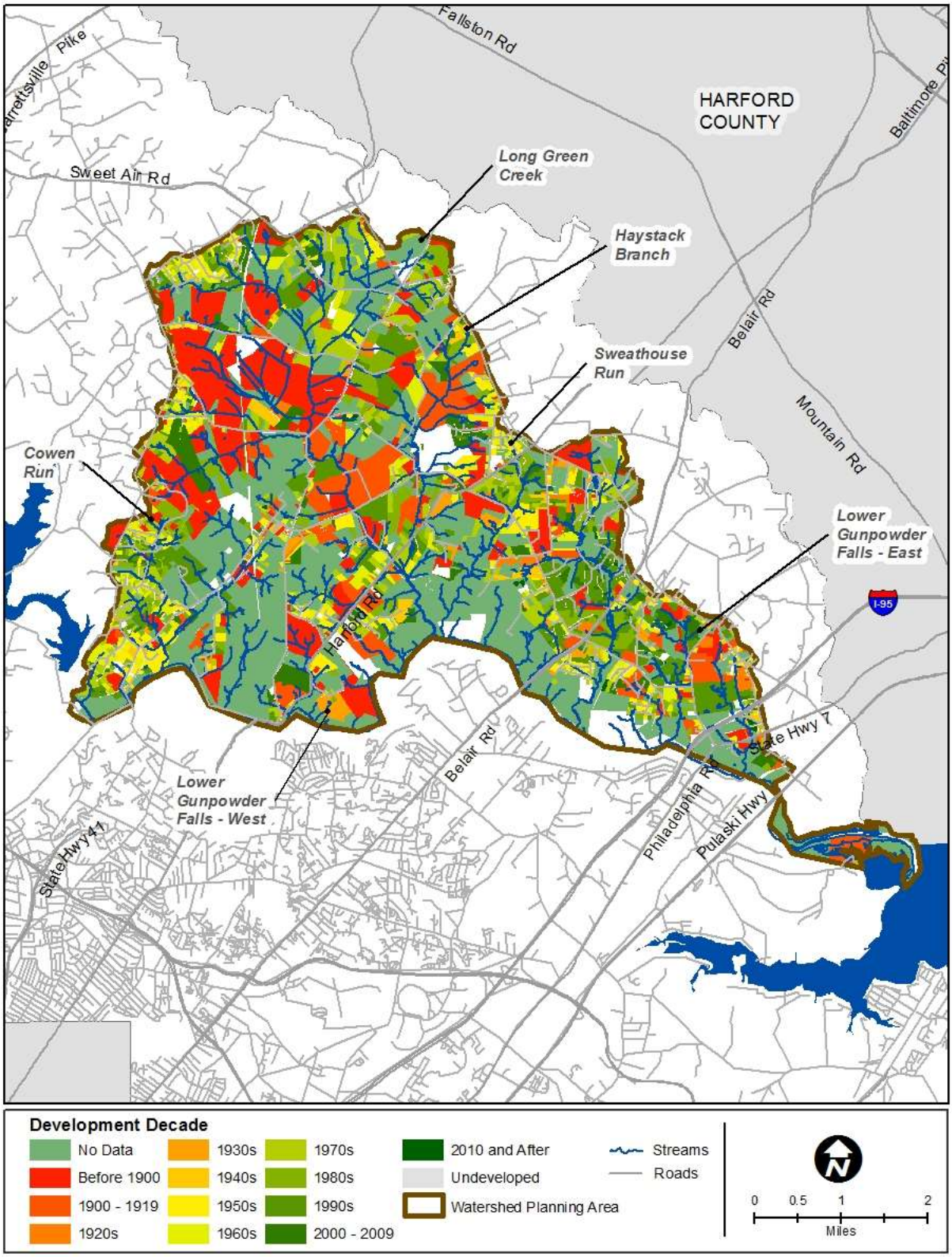


Figure 2-18: Housing Unit Decade Built

CHAPTER 3.0
Water Quality and Living Resources

3.1 Introduction

Area Q is in the rural portion of the Lower Gunpowder Falls 8-digit watershed (02130802) that is located north of the mainstream of Big Gunpowder Falls. This planning area is divided into six smaller drainage areas called subwatersheds: Cowen Run, Haystack Branch, Long Green Creek, Lower Gunpowder Falls East, Lower Gunpowder Fall West, and Sweathouse Run. Haystack Branch is a tributary to Long Green Creek, and Lower Gunpowder Falls East and West contain multiple tributaries that drain directly to the mainstem of Gunpowder Falls. The Area Q subwatersheds represent approximately 64% of the Lower Gunpowder Falls Watershed drainage (Table 3-1).

Chapter 3 describes the water quality, living resources, and habitat for Area Q based on existing watershed conditions. In addition to water quality maintenance and improvement strategies, the SWAP aims to provide a plan for the support of plants, animals, and their habitat. Species living in natural communities require many habitat characteristics for survival including land, water, and biological conditions that provide for their needs of food, water, shelter and reproduction.

Water is an integral part of the habitat of all species. Animals and plants require water to survive; their populations are intimately connected to water's availability and its quality. They respond to changes in water quality and habitat conditions in ways that reflect the health of water bodies, the local geomorphology and activities occurring in the watershed. 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 as an indicator of water quality health and of overall habitat conditions in the watershed. A baseline assessment such as this can help to determine if current and future watershed management practices are adequately providing for the needs of natural communities.

Existing water quality data was reviewed for the SWAP, including: impairments from Maryland's Integrated Report (former 303(d) list), pollutant loadings analysis for total nitrogen and total phosphorus, water quality monitoring data available to date (including chemical, biological, and illicit discharge data), and stream assessments.

Table 3-1: Percent of Area Q Subwatersheds within the Lower Gunpowder Falls Watershed

Subwatershed	Total Area (ac)	% of Lower Gunpowder Falls Watershed
Cowen Run	1,857	6
Haystack Branch	1,895	6
Long Green Creek	7,230	25
Lower Gunpowder Falls East	4,758	16
Lower Gunpowder Falls West	2,020	7
Sweathouse Run	1,089	4
Lower Gunpowder Falls Watershed	29,402	100
Area Q Total	**18,849**	**64**

3.2 Designated Water Uses, 303(d) Listings and Total Maximum Daily Loads (TMDLs)

This section provides a summary of water quality impairments for the Lower Gunpowder Falls watershed as reported by the Maryland Department of the Environment (MDE). Streams in the Cowen Run, Haystack Branch, Long Green Creek, and Sweathouse Run subwatersheds are designated as Use Class III, Nontidal Cold Water (*COMAR* 26.08.02.08). The designated uses of this class include growth and propagation of trout, other fish, and other aquatic life and wildlife; water contact sports; leisure activities involving direct contact with surface water; fishing; and agricultural and industrial water supply (*COMAR* 26.08.02.02). Streams in the Lower Gunpowder Falls East and West subwatersheds are designated as Use Class I, Water Contact Recreation, and Protection of Nontidal Warmwater Aquatic Life. The designated uses are the same as Use III except Use I does not include growth and propagation of trout. The mainstem of Big Gunpowder Falls is Use Class IV, Recreational Trout Waters. The designated uses are the same as Use I with the addition of capable of supporting adult trout for a put and take fishery.

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 this list, known as Category 5 waters in Maryland's Integrated Report of Surface Water Quality and historically called the 303(d) list. According to the USEPA, 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 (e.g. sediment, metals, bacteria, nutrients, and pesticides).

There are currently no approved TMDLs for the Lower Gunpowder Falls. However, development of a TMDL addressing sediment is currently underway for the Lower Gunpowder Falls watershed. It was submitted to the EPA in September, 2016. The Public Review Draft of the TMDL document states that the first stage of implementation of the sediment TMDL will focus on achieving the reductions required by the Chesapeake Bay TMDL which is expected to be completed by 2025. After this, MDE will reassess the impacts of sediment on aquatic life in the Lower Gunpowder Falls watershed (MDE, 2016b).

In the 2016 Integrated Report, Lower Gunpowder Falls (basin code 02130802) had Category 5 listings for sulfates, Total Suspended Solids (TSS), and chlorides in 1st through 4th order streams (MDE, 2016a). These were all initially listed in 2012. Category 5 indicates an impairment requiring a TMDL.

MDE's Biological Stressor Identification (BSID) identified sediment, chlorides, sulfates, and anthropogenic channelization as potential stressors in the Lower Gunpowder Falls watershed (MDE, 2012). It supported the Category 5 listings for sulfates, chlorides, and TSS. It also recommended a Category 4c listing for channelization, which was listed in 2012 and remains the same in the most recent Integrated Report (MDE, 2016a). Category 4c indicates an impairment not caused by a pollutant (e.g. habitat is limiting, dam prevents attainment of use, etc.).

The Gunpowder River (basin code 02130801) has a TMDL for PCBs, completed in October 2015 (MDE, 2015). Discharge from the Gunpowder Falls and Little Gunpowder Falls watersheds was identified as a nonpoint source of PCBs to the Gunpowder River; however, the TMDL does not require a load reduction from these sources.

3.2.1 Chesapeake Bay TMDL

As part of the Chesapeake Bay TMDL, contributing systems from all states draining to the Bay have been assigned nutrient reduction requirements. The nitrogen and phosphorus reductions for the Chesapeake Bay TMDL are to be met by 2025, with 60% of the reductions achieved by 2017. These reductions have been separated out for the urban load and for the agricultural load as shown in Table 3-2.

Table 3-2: TMDL Reduction Requirements for Urban and Agricultural Stormwater

	Required Nitrogen Reduction	Required Phosphorus Reduction
Urban Load	32.2%	47.0%
Agricultural Load	32.0%	21.4%

These reductions are based on land use only and do not account for any reductions in nitrogen and phosphorus from existing BMPs.

3.2.2 Water Quality Analyses

In 2003, the EPA approved MDE's Water Quality Analysis of heavy metals (MDE, 2003) based on historic 303(d) listings for heavy metal and nutrients (1996) and biological impairment (2002). Water column data showed that Maryland's water quality standards for heavy metals were being met for the Lower Gunpowder Falls.

The Lower Gunpowder Falls Watershed was identified in the 2010 Integrated Report as impaired by nutrients (listed in 1996) and impacts to biological communities (1st through 4th order streams) (listed in 2006). In 2011, MDE completed a Water Quality Analysis of eutrophication, which determined that the watershed was not impaired by phosphorus (MDE,

2011). The EPA concurred that based on the results, a TMDL for phosphorus was not necessary at the time (EPA, 2012).

3.3 Pollutant Loading Analysis – Total Nitrogen and Total Phosphorus

Land use analyses have been performed for each of the Maryland designated 8-digit watersheds located entirely or in part within Baltimore County. These analyses used edge-of-stream pollutant loading rates for nitrogen, phosphorus, and sediment. The loading rates were derived by Baltimore County from output produced in July 2011 by the Maryland Assessment Scenario Tool (MAST). The loading rates are specific to each 8-digit watershed, and are for urban and non-urban land use categories that are commonly used in land use GIS data. The land use data used in these analyses is the Baltimore County Land Cover Dataset (BCLCD). Baltimore County created the BCLCD by overlaying the 2011 National Land Cover Dataset (NLCD) with Baltimore County's 2014 impervious surface data, and reclassifying the result to match the loading rate land use categories. Edge-of-stream pollutant loading rates corresponding to different land use types in the Lower Gunpowder Falls watershed are summarized in Table 3-3. This information is used to help prioritize subwatersheds and identify strategies to reduce pollutant loadings presented in the SWAP (see Chapters 3 and 4).

Table 3-3: Annual Edge-of-Stream Pollutant Loading Rates for Lower Gunpowder Falls (lbs/acre/year)

BCLCD Land Cover	Total Nitrogen Per Acre	Total Phosphorus Per Acre
Urban Impervious	17.36	1.51
Urban Pervious	11.55	0.3
Crop	23.08	1.32
Pasture	7.76	0.72
Forest	2.78	0.04
Water	10.26	0.61
Extractive	16.30	2.59

Total nitrogen loads from septic systems were calculated for each subwatershed based on their location in the watershed and their proximity to streams. For septic systems located in the Chesapeake Bay Critical Area, a loading rate of 16.44 lbs nitrogen/year is used. For systems outside the critical area, rates of 10.28 lbs nitrogen/year if the system is within 1,000 feet of a stream and 6.17 lbs nitrogen/year if the system is located further than 1,000 feet of a stream are used. In the Lower Gunpowder Falls watershed, there are two septic systems located within the Chesapeake Bay Critical Area. This method is consistent with the approach taken to define septic system loads in the County Watershed Implementation Plan. Table 3-4 provides a summary of septic systems in each subwatershed. The nitrogen load from septic discharge passes through the soil and reaches the stream through groundwater. A portion of the nitrogen load will be attenuated by the soil. The pass-through rate is defined as the percent of the septic nitrogen load that reaches the stream through groundwater (i.e., is not attenuated). Results are provided in Table 3-5.

Table 3-4: Number of Septic Systems (OSDS) in Each Subwatershed

Subwatershed	# OSDS (<1,000 ft of stream)	# OSDS (>1,000 ft of stream)
Cowen Run	192	180
Haystack Branch	163	77
Long Green Creek	452	408
Lower Gunpowder Falls East (Outside of Critical Area)	389	436
Lower Gunpowder Falls East (Within Critical Area)	2	0
Lower Gunpowder Falls West	62	121
Sweathouse Run	132	70
Total	**1,392**	**1,292**

Total acreages of each BCLCD land use category were calculated for the Lower Gunpowder Falls watershed. These were multiplied by the corresponding loading rates presented in Table 3-3, yielding annual pollutant loads. Total annual edge-of-stream pollutant loads for total nitrogen, total phosphorus from the watershed are summarized in Table 3-5. Pollutant loadings were also calculated on a subwatershed basis using the same loading rates and land use classification. Total acreages of each BCLCD land cover category for the subwatersheds are summarized in Table 3-6. The resulting total nitrogen and total phosphorus for the subwatersheds are presented in Table 3-7 and Table 3-8, respectively.

Table 3-5: Total Annual Edge-of-Stream Nutrient Loads from Area Q

BCLCD Land Cover	Area (Acres)	Nitrogen		Phosphorus	
		Rate (lbs/acre/yr)	Load (lbs/yr)	Rate (lbs/acre/yr)	Load (lbs/yr)
Urban Impervious	859	17.36	14,914	1.51	1,297
Urban Pervious	2903	11.55	33,531	0.3	871
Crop	2738	23.08	63,190	1.32	3,614
Pasture	3953	7.76	30,675	0.72	2,846
Forest	8344	2.78	23,196	0.04	334
Water	50	10.26	514	0.61	31
Extractive	2	16.30	28	2.59	4
Septic Systems	--	--	22,294	--	--
Total	**18,849**		**188,343**		**8,997**

Table 3-6: Lower Gunpowder Falls BCLCD Land Cover Categories (acres)

BCLCD Land Cover	Cowen Run	Haystack Branch	Long Green Creek	Lower Gunpowder Falls East	Lower Gunpowder Falls West	Sweathouse Run
Urban Impervious	112	77	299	250	66	56
Urban Pervious	313	208	830	1,072	197	284
Crop	201	302	1,551	272	339	73
Pasture	239	581	2,296	443	277	117
Forest	992	727	2,252	2,675	1,138	559
Water	-	-	-	46	4	-
Extractive	-	-	2	-	-	-
Totals	**1,857**	**1,895**	**7,230**	**4,758**	**2,020**	**1,089**

Table 3-7: Annual Edge-of-Stream Total Nitrogen Loads by Subwatershed

Subwatershed		Cowen Run	Haystack Branch	Long Green Creek	Lower Gunpowder Falls East	Lower Gunpowder Falls West	Sweathouse Run	Total (watershed)
	Total Area (acres)	1,857.3	1,895.1	7,229.5	4,757.7	2,020.1	1,089.2	18,848.84
Annual Total Nitrogen Loads	**Urban Impervious**	1,944.3	1,332.0	5,186.9	4,338.7	1,141.3	970.5	14,913.8
	Urban Pervious	3,609.8	2,400.3	9,585.0	12,382.0	2,274.0	3,279.8	33,531.0
	Crop	4,644.7	6,965.6	35,793.8	6,276.4	7,813.8	1,696.0	63,190.4
	Pasture	1,857.0	4,511.8	17,820.0	3,433.9	2,147.8	904.7	30,675.2
	Forest	2,758.4	2,021.8	6,260.4	7,436.7	3,164.1	1,554.6	23,196.0
	Water	-	-	-	474.0	40.4	-	514.5
	Extractive	-	-	27.9	-	-	-	27.9
	Septic Systems	3,084.4	2,150.7	7,163.9	6,721.9	1,383.9	1,788.9	22,293.72
	Total Nitrogen (lbs/yr)	17,898.7	19,382.3	81,837.9	41,063.7	17,965.3	10,194.5	188,342.5
	Total Nitrogen Loading Rate (lbs/acre/yr)	9.6	10.2	11.3	8.6	8.9	9.4	10.0

Table 3-8: Annual Edge-of-Stream Total Phosphorus Loads by Subwatershed

Subwatershed		Cowen Run	Haystack Branch	Long Green Creek	Lower Gunpowder Falls East	Lower Gunpowder Falls West	Sweathouse Run	Total (watershed)
	Total Area (acres)	1,857.3	1,895.1	7,229.5	4,757.7	2,020.1	1,089.2	18,848.8
Annual Total Phosphorus Loads	Urban Impervious	169.1	115.9	451.2	377.4	99.3	84.4	1,297.2
	Urban Pervious	93.8	62.3	249.0	321.6	59.1	85.2	870.9
	Crop	265.6	398.4	2,047.1	359.0	446.9	97.0	3,614.0
	Pasture	172.3	418.6	1,653.4	318.6	199.3	83.9	2,846.2
	Forest	39.7	29.1	90.1	107.0	45.5	22.4	333.8
	Water	-	-	-	28.2	2.4	-	30.6
	Extractive	-	-	4.4	-	-	-	4.4
	Septic Systems							
	Total Phosphorus (lbs/yr)	740.5	1,024.3	4,495.2	1,511.8	852.4	372.9	8,997.1
	Total Phosphorus Loading Rate (lbs/acre/yr)	0.4	0.5	0.6	0.3	0.4	0.3	0.5

3.4 Water Quality Monitoring Data

Baltimore County conducts chemical, biological, and illicit discharge monitoring within Area Q. Section 3.4.1 summarizes the chemical data available for Area Q. Section 3.4.2 summarizes the biological monitoring program. Section 3.4.3 discusses the illicit discharge detection and elimination (IDDE) program.

3.4.1 Chemical Data

Chemical data for Area Q was available from the chemical trend monitoring program. Note that no synoptic survey data was available for this watershed. Baltimore County initiated the trend chemical monitoring program in January 2011. Forty-one sites were chosen throughout the County to be monitored once per month on approximately the same day, regardless of weather conditions (Baltimore County EPS, 2016). This type of monitoring program is useful in characterizing long-term trends associated with dry weather although some storm flows are sampled. Although this program is not designed to determine trends associated with sediment and nutrient loadings, it is important in determining ambient conditions that can affect biotic communities in the stream. Sites were generally chosen to correlate with USGS gage locations. The standard set of monitored pollutants includes Total Suspended Solids (TSS), Total Solids (TS), Total Kjeldahl Nitrogen (TKN), Nitrate/Nitrite (NO2-NO3), Total Phosphorus (TP), Ortho-phosphorus, Cadmium, Copper, Lead, Zinc, BOD, COD, Chlorides, Sodium, Hardness, Magnesium and Calcium as well as temperature and pH determined *in situ*. Two trend monitoring sites are located within Area Q: GU-03 is located on Haystack Branch at Harford Road and GU-05 is located on Long Green Creek at Hartley Mill Road (Figure 3-1). The data presented below encompasses monthly samples from January 2011 through June 2016.

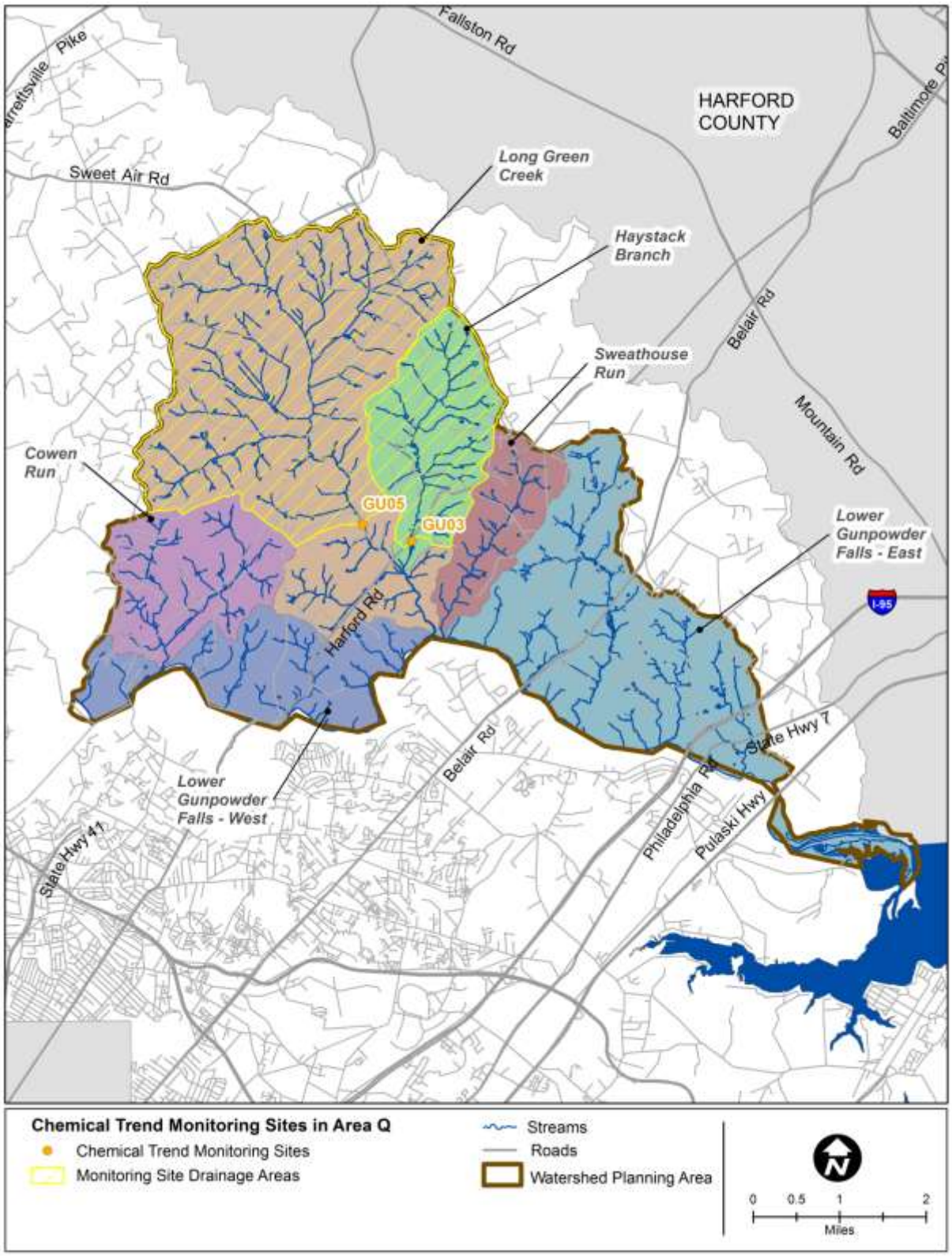


Figure 3-1: Chemical Trend Monitoring Sites in Area Q

Of particular interest were measurements for total suspended solids, chloride, and sulfate due to Category 5 listings in the 2016 Integrated Report (MDE, 2016a). Nitrogen and phosphorus are also reported because they are key Chesapeake Bay Program parameters.

- Suspended Solids: Excessive suspended solids in water can adversely impact aquatic life as it decreases the light available for photosynthesis by plants and visual capacity of aquatic life. Decreased light can lead to an increase in algae communities and that may negatively impact invertebrate and fish communities by limiting food supplies. Excessive sediment can also negatively affect habitat structure by filling in the niche spaces used by organisms for feeding and protection from predators.
- Chloride: Chlorides come from various sources such as industrial discharges, wastewater, metal contamination, and road salting. High levels of chlorides can be toxic to aquatic communities.
- Sulfate: Sulfates can be naturally occurring, such as from the breakdown of leaves or water passing through rock or soil containing gypsum or other common minerals. It can also originate from urban and agricultural runoff, acid mine drainage, atmospheric deposition, and wastewater dischargers. Elevated sulfate levels can lead to changes in pH of surface waters.
- Nutrients: Over-enrichment of water bodies by excessive nutrient input can cause excessive growth of aquatic plants (algal blooms) and bacterial consumption of dissolved oxygen when the plants decompose. This can lead to significant reductions in water quality as well as abundance and diversity of aquatic life communities.

The USEPA National Recommended Water Quality Criteria lists the chronic aquatic life criterion for chloride as 230 mg/L and the acute toxicity limit is 860 mg/L (USEPA, 1988). A level of 50 mg/L was determined by the Maryland Biological Stressor Identification Process (MDE, 2009b) to be detrimental to aquatic life. One sample at GU-03, out of 56 total samples measured for chloride, and two samples at GU-05 out of 56 samples at that site were above 50 mg/L but below 230 mg/L.

The Maryland Biological Stressor Identification Process (MDE, 2009b) determined a threshold for significant biological degradations for sulfate of 21.0 mg/L for the eastern piedmont. No samples at either site have exceeded this threshold.

Nutrient data (i.e. Nitrate/Nitrite, TN and TP) were rated based on the rating system detailed in Table 3-9. Total nitrogen concentration data ratings are adapted from the Maryland DNR (2005) using loading coefficients reported by Frink (1991). The low-end values are based on estimated nutrient exports from forested watersheds, and the high-end values are based on estimated nutrient exports from intensively agricultural watersheds. Total phosphorus ratings were developed by evaluating non-tidal phosphorus data from the Chesapeake Bay Program (USGS, 1999). It should be noted that in some cases, samples below detection limits were scored by default at half of the detection limit. These default scores may impact ratings. For example, the default score for Total Phosphorus prior to 2009 is 0.01, and after 2009 it is 0.025 based on the limitations of sampling equipment. With these limitations, a site will score Moderately

Elevated for Total Phosphorus prior to 2009 if the equipment cannot detect a measurement for Total Phosphorus. After 2009 a site will score Elevated if the Total Phosphorus is not detectable based on the limitations of the sampling equipment.

Table 3-9: Ratings by Mean Nutrient Concentrations

Rating	Total Nitrogen (mg/L)	Nitrate/Nitrite (mg/L)	Total Phosphorus (mg/L)
Low	<1.0	<0.65	<0.01
Moderately Elevated	1.0 – <2.0	0.65 – <1.0	0.01 – <0.02
Elevated	2.0 – <3.0	1.0 – <2.0	0.02 – <0.03
High	3.0 – <4.0	2.0 – <4.0	0.03 – <0.04
Very High	>4.0	>4.0	>0.04

Nutrient concentration ratings based on the average of all samples (January 2011 through June 2016) are shown in Table 3-10. A summary of the trend monitoring data at GU03 and GU05 is presented in Table 3-11, Figure 3-2, and Figure 3-3.

Table 3-10: Chemical Trend Site Nutrient Ratings

Site	Total Nitrogen	Nitrate/Nitrite	Total Phosphorus
GU03	Very High	Very High	Very High
GU05	Very High	Very High	Very High

Table 3-11: Summary of Trend Monitoring Data for Area Q (Jan. 2011 - June 2016)

Parameter (mg/l)		Site		Parameter (mg/l)		Site	
		GU03	GU05			GU03	GU05
Total Nitrogen	No. Samples	50	50	Chloride	No. Samples	56	56
	Min.	0.6	0.75		Min.	3.13	0.39
	Max.	7.99	6.66		Max.	56.15	71.51
	Mean	**4.38**	**4.68**		**Mean**	**28.39**	**29.44**
	St. Dev.	1.35	1.08		St. Dev.	6.97	9.7
	Median	4.3	4.83		Median	28.21	28.82
Nitrate/Nitrite	No. Samples	53	53	Sulfate	No. Samples	55	55
	Min.	0.5	0.1		Min.	1.09	1.08
	Max.	7.7	6.6		Max.	16.38	14.14
	Mean	**4.1**	**4.2**		**Mean**	**10.25**	**9.35**
	St. Dev.	1.4	1.3		St. Dev.	1.97	1.78
	Median	4.1	4.5		Median	10.32	9.33
Total Phosphorus	No. Samples	61	62	Temperature (°C)	No. Samples	65	67
	Min.	0.03	0.03		Min.	1.4	0.3
	Max.	2.17	2.02		Max.	23.4	25.4
	Mean	**0.11**	**0.1**		**Mean**	**13.9**	**14.4**
	St. Dev.	0.38	0.29		St. Dev.	6.2	6.9
	Median	0.03	0.03		Median	14.3	13.8
Total Suspended Solids	No. Samples	66	67	pH	No. Samples	66	67
	Min.	0.5	0.5		Min.	3.80	4.29
	Max.	1275.0	365.0		Max.	15.70	16.60
	Mean	**38.7**	**16.0**		**Mean**	**7.92**	**8.08**
	St. Dev.	193.6	54.7		St. Dev.	1.23	1.26
	Median	1.0	0.5		Median	7.96	8.02

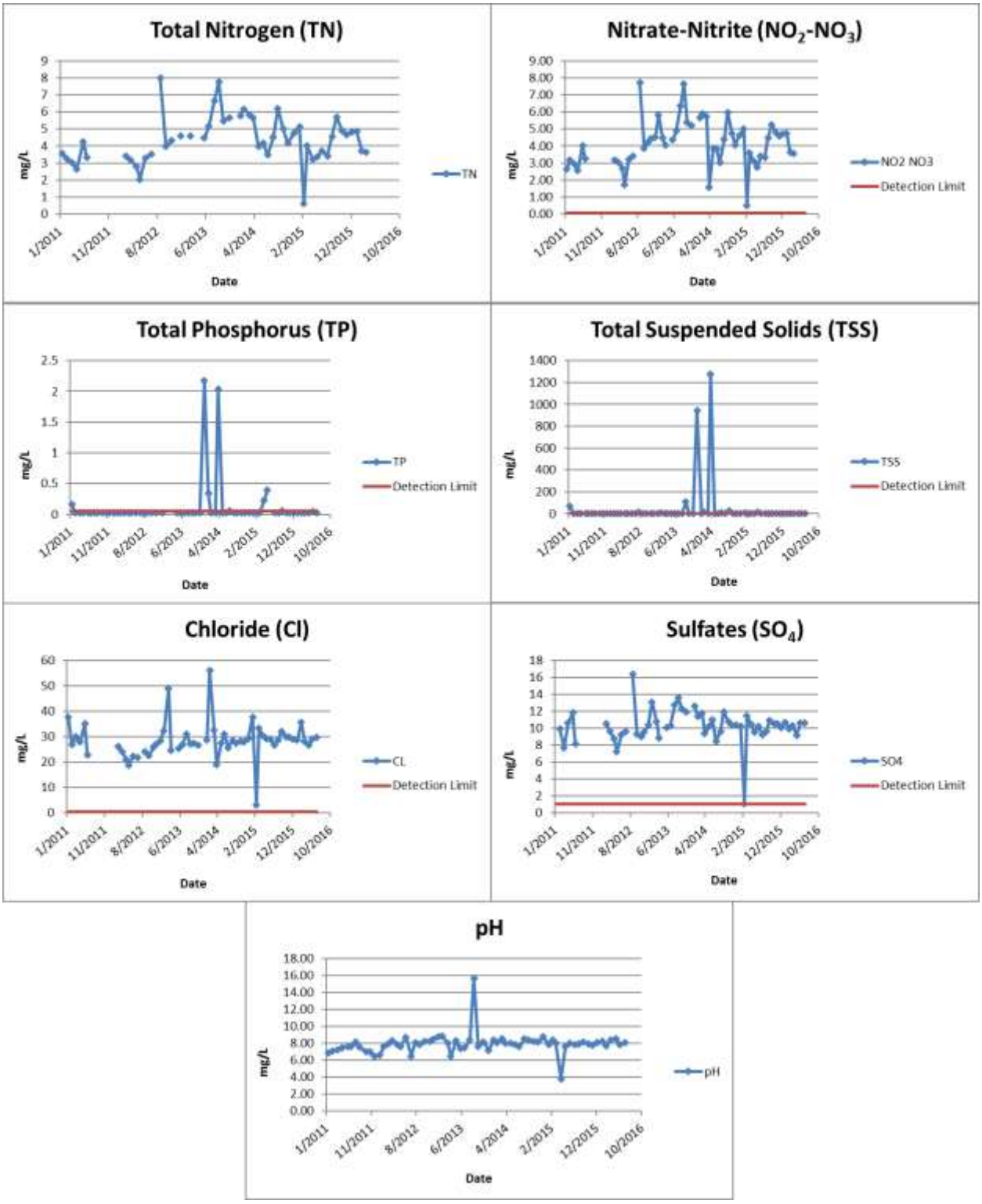


Figure 3-2: Trend Data Plotted over Time for Monitoring Site GU03 in Area Q (Jan. 2011 – June 2016)

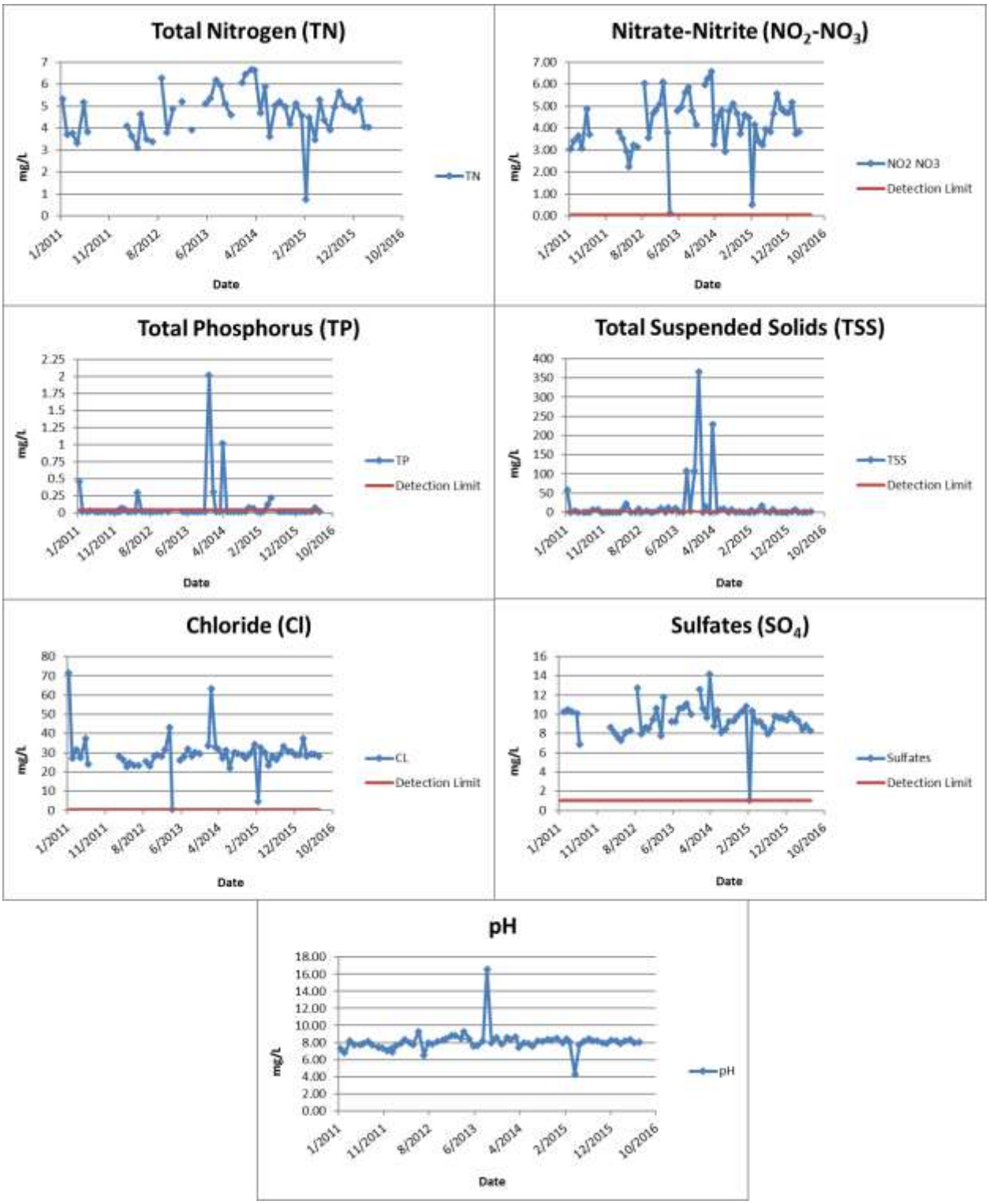


Figure 3-3: Trend Data Plotted over Time for Monitoring Site GU05 in Area Q (Jan. 2011 – June 2016)

A long-term trend analysis was done for five parameters at sites GU03 and GU05: TSS, TN, TKN, NO2-NO3 and TP. Parametric methods, such as fitting a linear regression to the time series over time, are dependent on the assumption that the initial distribution is normally distributed. In addition, the analysis can be hampered by missing values in the data. The data in this dataset are quite skewed. For this reason, the Mann-Kendall test was used, which is a non-parametric option that detects trends based on the rank of the observed values. The specific approach used was based on recommendations by Meals et al. (2011) for hydrologic data. Two outputs from this method are the "tau value," which reflects the trend over time, and the "p-value" which indicates the significance level of the test.

For the first analysis, the trend in concentrations was evaluated, without regard to the concurrent flow measurement. The resulting analysis suggests that there is not sufficient data to detect a significant (at the 10% significance level) trend for any parameters except for TN and NO2-NO3, which show a slight upward trend at site GU03 (Table 3-12).

Table 3-12: Trend Analysis for Concentration Data

Site	Parameter	Tau Value	p-Value	Significant?
GU03	TSS	0.028	0.763	**No**
	TKN	-0.003	0.984	No
	TN	0.171	0.073	Yes
	NO_2-NO_3	0.167	0.088	Yes
	TP	0.079	0.444	No
GU05	TSS	0.013	0.889	No
	TKN	-0.063	0.482	No
	TN	0.136	0.154	No
	NO_2-NO_3	0.089	0.366	No
	TP	-0.008	0.945	No

Some of the data appeared to exhibit a correlation between flow and concentration. Therefore, a locally weighted curve smoothing procedure (LOESS) was used to fit the concentration of each parameter given the observed flow. Next, a time series of the difference (deviance) between the observed and predicted values was developed at each point. This time series was calculated by the following:

$$C_{deviance}(t) = C_{observed}(t) - C_{predicted}(t)$$

Where:

$C_{observed}(t)$ = Observed concentration of a parameter at time t

$C_{predicted}(t)$ = LOESS-predicted concentration at time t, given the observed flow

$C_{deviance}(t)$ = Deviance from the expected concentration given the observed flow

This flow adjustment did not improve trend detection overall. The TN trend was slightly more significant at Site GU03, but the NO_2-NO_3 concentration at this site became less significant (Table 3-13).

Table 3-13: Trend Analysis for Flow-Adjusted Concentration Data

Site	Parameter	Tau Value	p-Value	Significant?
GU03	TSS	0.010	0.915	**No**
	TKN	-0.030	0.742	No
	TN	0.189	0.051	Yes
	NO_2-NO_3	0.151	0.127	No
	TP	0.089	0.320	No
GU05	TSS	0.013	0.881	No
	TKN	-0.027	0.762	No
	TN	-0.026	0.779	No
	NO_2-NO_3	0.129	0.193	No
	TP	0.073	0.415	No

Based on the available data, no trends were detected in concentration for the parameters analyzed. Supplementing the existing monitoring data with more frequent flow-weighted sampling may be useful. Another possible method to capture changes more consistently is to collect "non-storm" or "storm" data separately. In the current dataset, some very high flow events result in high or low concentrations that may hide an underlying trend.

3.4.2 Biological Data

This section combines biological monitoring data from two different sources including the Maryland Department of Natural Resources (DNR) Maryland Biological Stream Survey (MBSS) and Baltimore County Department of Environmental Protection and Sustainability (EPS). The MBSS was initiated by the Maryland DNR in 1993 and is intended to provide unbiased, statewide estimates of the biological resources in streams and rivers (Kazyak, 2001; Stranko, 2014). It uses both a stratified random and targeted sampling approach to evaluate benthic macroinvertebrate and fish communities. Random sites are stratified by basin, ecoregion, and stream order, depending on the sampling round. Targeted sites consist of sentinel sites sampled to assess natural annual variation in stream conditions, as well as other sites dedicated to special studies. The EPS employs a similar approach in their Random Point Monitoring Program to evaluate the benthic macroinvertebrate community using the MBSS protocols.

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. Both benthic macroinvertebrates and fish are useful indicators of stream health, as they integrate stressors at a site over time. The presence, numbers, and types of organisms convey important information about water quality. Data from the MBSS is used to calculate a Benthic Index of Biotic Integrity (BIBI) and a Fish Index of Biotic Integrity, which provide a summary of the biotic conditions at a site (Stribling *et al.*, 1998; Roth *et al.*, 2000; Southerland *et al.*, 2005). Qualitative ratings of stream health are based on Index of Biotic Integrity (IBI) scores and range from good (4.0 – 5.0), denoting minimally impacted conditions, to very poor (1.0 – 1.9), indicating severe degradation (Table 3-14).

The MBSS and EPS have conducted numerous surveys within the Area Q watershed. The results of these surveys, including IBI scores are summarized below.

Table 3-14: MBSS BIBI Scores and Rankings

BIBI Score	Narrative Ranking	Characteristics
4.00 – 5.00	Good	Comparable to reference streams considered to be minimally impacted, biological metrics fall within the upper 50 percent of reference site conditions.
3.00 – 3.90	Fair	Comparable to reference conditions, but some aspects of biological integrity may not resemble the qualities of minimally impacted streams.
2.00 – 2.90	Poor	Significant deviation from reference conditions, indicating some degradation. On average, biological metrics fall below the 10th percentile of reference site values.
1.00 - 1.90	Very Poor	Strong deviation from reference conditions, with most aspects of biological integrity not resembling the qualities of minimally impacted streams, indicating severe degradation. On average, most or all metrics fall below the 10th percentile of reference site values.

Source: Stribling *et al.* 1998

Maryland Biological Stream Survey

Thirteen MBSS sites are located within the Lower Gunpowder Falls study area, and include both fish and benthic macroinvertebrate data. Data were collected by MBSS between 1996 and 2011 (Kazyak, 1996-1997; DNR, 1998-2011). Six MBSS sites are located in the Cowen Run subwatershed, six sites are located in the Long Green Creek subwatershed, and one site is located in the Sweathouse Run subwatershed. No sentinel sites are present in any of the subwatersheds. Figure 3-4 and Table 3-15 summarizes the MBSS results for benthic macroinvertebrates. Figure 3-5 and Table 3-16 summarizes the MBSS results for fish. No subwatersheds within Lower Gunpowder Falls are classified as High Quality (Tier II) Waters Catchments by Maryland Department of the Environment's (MDE) Antidegredation Policy, as required by the federal Clean Water Act. Tier II waters are considered high quality waters in Maryland based on biological monitoring data.

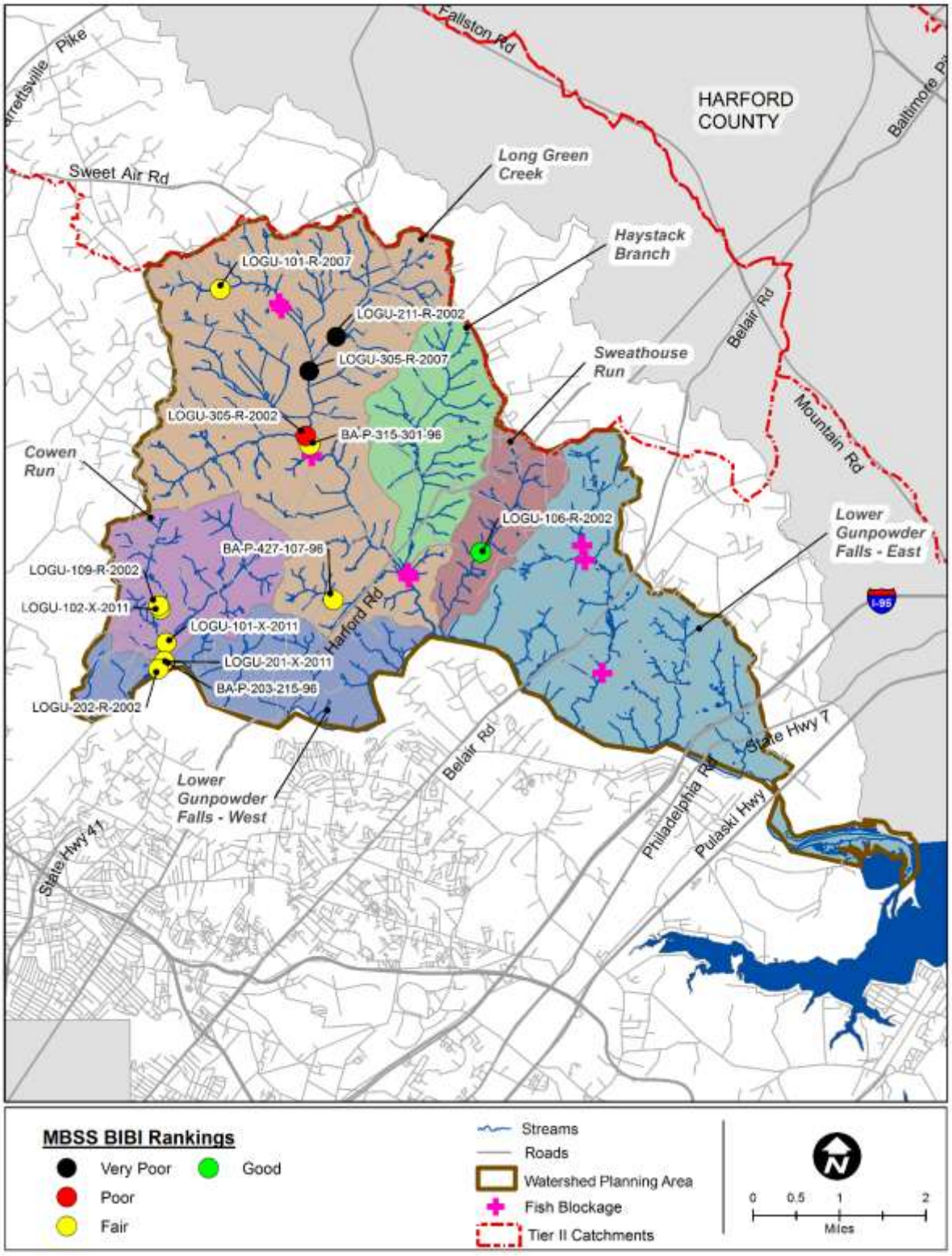


Figure 3-4: MBSS Index of Biological Integrity Site Locations and Rankings

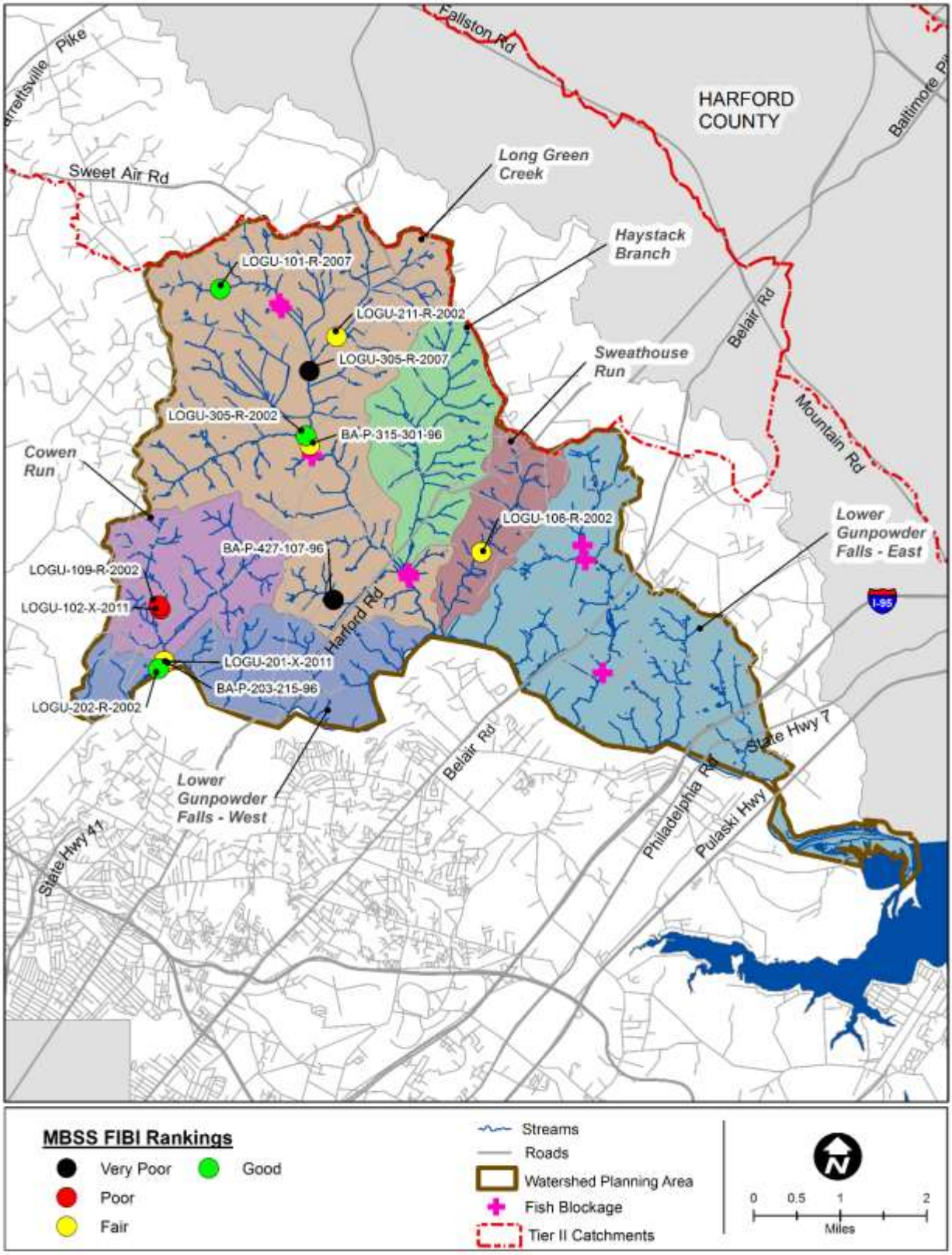


Figure 3-5: MBSS Fish Index of Biological Integrity Site Locations and Rankings

Table 3-15: MBSS Benthic Macroinvertebrate Data Collected in the Watershed Planning Area for SWAP Q

Station ID	Year	BIBI Score	Narrative Ranking	Data Source
Cowen Run Subwatershed				
BA-P-203-215-96	1996	2.67	Poor	MBSS
LOGU-101-X-2011	2011	3.67	Fair	MBSS
LOGU-201-X-2011	2011	3.00	Fair	MBSS
LOGU-202-R-2002	2002	3.33	Fair	MBSS
LOGU-102-X-2011	2011	3.33	Fair	MBSS
LOGU-109-R-2002	2002	3.67	Fair	MBSS
Long Green Creek Subwatershed				
BA-P-315-301-96	1996	3.00	Fair	MBSS
LOGU-101-R-2007	2007	3.00	Fair	MBSS
LOGU-305-R-2002	2002	2.00	Poor	MBSS
LOGU-305-R-2007	2007	1.67	Very Poor	MBSS
BA-P-427-107-96	1996	3.00	Fair	MBSS
LOGU-211-R-2002	2002	1.33	Very Poor	MBSS
Sweathouse Run Subwatershed				
LOGU-106-R-2002	2002	4.33	Good	MBSS

3.4.2.1 Benthic Macroinvertebrate Sampling Results

The BIBI scores for sites in the Cowen Run subwatershed ranged from 2.67 (Poor) to 3.67 (Fair), with an average BIBI of 3.21 (Fair). Five of the six sites were rated as Fair. Stoneflies (Order Plecoptera), which are generally intolerant taxa, dominated at sites in this subwatershed, with non-biting midges (Family Chironomidae), which are generally tolerant taxa, contributing to a lesser degree. The Long Green Creek subwatershed sites ranged from 1.33 (Very Poor) to 3.00 (Fair), with an average BIBI of 2.33 (Poor). Three of the six sites were rated as Fair, with one site rated Poor, and the remaining two Very Poor. Non-biting midges dominated at sites in this subwatershed, with mayflies (Order Ephemeroptera) dominating to a lesser degree. Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa are considered to be sensitive or intolerant to poor water quality conditions. The BIBI score for the only site in the Sweathouse Run subwatershed was 4.33 (Good). Sensitive blackflies (Family Simuliidae) were the dominant taxa at these sites, followed by mayflies.

Table 3-16: MBSS Fish Data Collected in the Watershed Planning Area for SWAP Q

Station ID	Year	FIBI Score	Narrative Ranking	Data Source
Cowen Run Subwatershed				
BA-P-203-215-96	1996	3.33	Fair	MBSS
LOGU-201-X-2011	2011	3.67	Fair	MBSS
LOGU-202-R-2002	2002	4.33	Good	MBSS
LOGU-101-X-2011	2011	-	-	MBSS
LOGU-102-X-2011	2011	2.33	Poor	MBSS
LOGU-109-R-2002	2002	2.67	Poor	MBSS
Long Green Creek Subwatershed				
LOGU-305-R-2007	2007	3.67	Very Poor	MBSS
BA-P-315-301-96	1996	3.00	Fair	MBSS
LOGU-305-R-2002	2002	4.00	Good	MBSS
LOGU-101-R-2007	2007	4.33	Good	MBSS
BA-P-427-107-96	1996	1.00	Very Poor	MBSS
LOGU-211-R-2002	2002	3.00	Fair	MBSS
Sweathouse Run Subwatershed				
LOGU-106-R-2002	2002	3.33	Fair	MBSS

3.4.2.2 Fish Sampling Results

The FIBI scores for sites in the Cowen Run subwatershed ranged from 2.33 (Poor) to 4.33 (Good), with an average FIBI of 3.27 (Fair). The majority of dominant fish species in this subwatershed had no tolerance classification. Of those that did, the majority were tolerant to urban conditions. Four brown trout (*Salmo trutta*) were collected in this subwatershed in 1996. Two rainbow trout (*Oncorhynchus mykiss*) were collected in this subwatershed in 2011. In the Long Green Creek subwatershed, FIBI scores ranged from 1.00 (Very Poor) to 4.00 (Good), with an average FIBI of 2.83 (Poor). Similar to the sites in the Cowen Run subwatershed, the majority of dominant fish species at these sites had no tolerance classification. Of those that did, the majority were intolerant to urban conditions. Fourteen brown trout were found in 2002 and 2007. The fish community at the only site in the Sweathouse Run subwatershed was 3.33 (Fair). The majority of dominant fish species at these sites were tolerant to urban conditions, and no trout were collected.

3.4.2.3 Baltimore County Biological Monitoring Programs

The EPS sampled 11 benthic macroinvertebrate sites in the Lower Gunpowder Falls watershed study area; two sites in the Cowen Run subwatershed; one site in the Haystack Branch subwatershed; six sites in the Long Green Creek subwatershed; and two sites in the Lower Gunpowder Falls East subwatershed. No fish community monitoring was conducted by EPS in the study area. Figure 3-6 and Table 3-17 summarize the EPS benthic macroinvertebrate results.

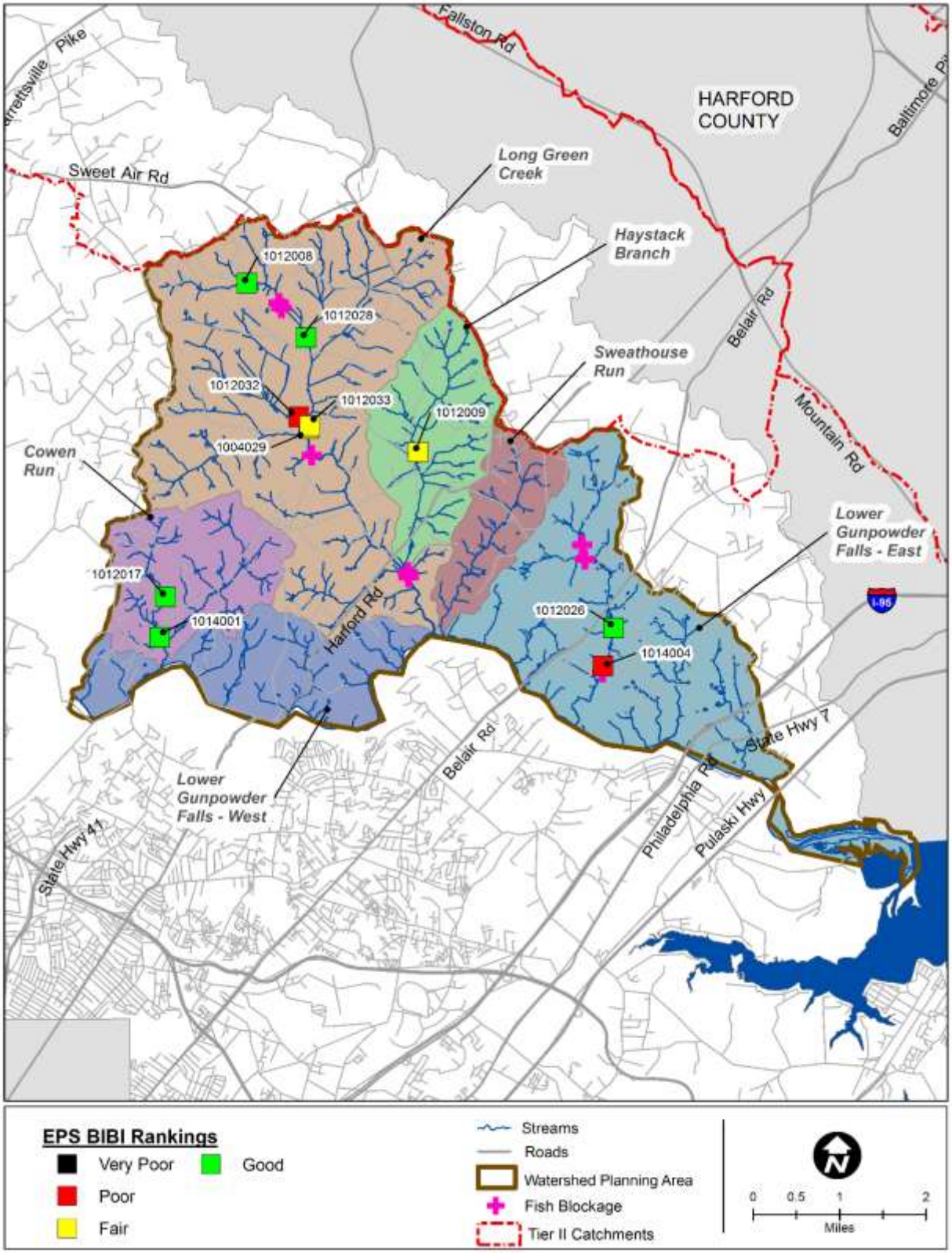


Figure 3-6: EPS Benthic Index of Biological Integrity Site Locations and Rankings

Table 3-17: EPS Benthic Macroinvertebrate Data Collected in the Watershed Planning Area for SWAP Q

Station ID	Year	BIBI Score	Narrative Ranking	Data Source
Cowen Run Subwatershed				
1012017	2012	4.33	Good	EPS
1014001	2014	3.67	Fair	EPS
Haystack Branch Subwatershed				
1012009	2012	3.33	Fair	EPS
Long Green Creek Subwatershed				
1004029	2012	3.33	Fair	EPS
1012008	2012	4.33	Good	EPS
1012028	2012	5.00	Good	EPS
1012032	2012	2.00	Poor	EPS
1012033	2012	3.67	Fair	EPS
1004029	2014	2.00	Poor	EPS
Lower Gunpowder Falls East Subwatershed				
1012026	2012	4.00	Good	EPS
1014004	2014	2.67	Poor	EPS

The BIBI scores for sites in the Cowen Run subwatershed ranged from 3.67 (Fair) to 4.33 (Good), with an average BIBI of 3.78 (Fair). The only Haystack Branch subwatershed site was 3.33 (Fair). The BIBI scores for sites in the Long Green Creek subwatershed ranged from 2.00 (Poor) to 5.00 (Good), with an average BIBI of 3.39 (Fair). The BIBI scores for sites in the Lower Gunpowder Falls East subwatershed ranged from 2.67 (Poor) to 4.00 (Good), with an average BIBI of 3.34 (Fair).

3.4.2.4 Trout and Non-Trout Species

Brown trout were collected at four sites in the Long Green Creek subwatershed area by MBSS. Additionally, two rainbow trout were found by MBSS in the Long Green Creek subwatershed. Largemouth bass (*Micropterus salmoides*) were also found in the Long Green Creek subwatershed. Twenty-two non-trout fish species were collected from the watershed planning area, the largest diversity being found in the Cowen Run subwatershed. Species collected in the subwatersheds are listed in Table 3-18, below.

Table 3-18: List of Fish Species Collected in Lower Gunpowder Falls Watershed Planning Area

Common Name	Scientific Name	Cowen Run	Long Green Creek	Sweathouse Run
American eel	*Anguilla rostrata*	X	X	X
Banded killifish	*Fundulus diaphanus*	X		
Blacknose dace	*Rhinichthys atratulus*	X	X	X
Bluegill	*Lepomis macrochirus*		X	
Brown trout	*Salmo trutta*	X	X	
Common shiner	*Luxilus comutus*	X	X	
Creek chub	*Semotilus atromaculatus*	X	X	X
Cutlip minnow	*Exoglossum maxillingua*	X	X	
Goldfish	*Carassius auratus*		X	
Largemouth bass	*Micropterus salmoides*		X	
Least brook lamprey	*Lampetra aepyptera*	X		
Longnose dace	*Rhinichthys cataractae*	X	X	X
Margined madtom	*Noturus insignis*	X		
Northern hogsucker	*Hypentelium nigricans*	X		
Potomac sculpin	*Cottus girardi*		X	
Rainbow trout	*Oncorhynchus mykiss*	X		
Redbreast sunfish	*Lepomis auritus*	X	X	
River chub	*Nocomis micropogon*	X		
Rosyside dace	*Clinostomus funduloides*	X	X	X
Satinfin shiner	*Cyprinella analostana*	X		
Sea lamprey	*Petromyzon marinus*	X		
Swallowtail shiner	*Notropis procne*	X	X	
Tessellated darter	*Etheostoma olmstedi*	X	X	
White sucker	*Catostomus commersonii*	X	X	X

3.4.2.5 Discussion

The results of the MBSS and EPS monitoring in the watershed planning area for SWAP Q were generally consistent, and show that overall conditions were generally fair. The only obvious difference is a slight improvement in the Long Green Creek subwatershed after 2011. The Cowen Run subwatershed exhibited the healthiest biological communities with a higher average BIBI and FIBI, with the exception of Sweathouse Run, which had a slightly higher FIBI. The Cowen Run subwatershed was typically rated Fair by both the BIBI and FIBI, and the fish community was most dominated by longnose dace (*Rhinichthys cataractae*) and American eel (*Anguilla rostrata*), a fish species with no tolerance type, and blacknose dace *(R. atratulus*), a tolerant fish species. Brown trout were collected in 1996, and rainbow trout were collected in 2011, but it is unknown what their current presence is in this subwatershed as no fish survey data were collected past 2011. This subwatershed also contained more fish species intolerant of urban

conditions, was most species diverse, and contained two trout species. The Haystack Branch subwatershed was rated Fair by the BIBI, based on one sampling event, and had no fish sampling data. The Long Green Creek subwatershed was more temporally variable, with lower BIBI and FIBI scores observed prior to 2012, and BIBI and FIBI scores more similar to the other subwatersheds in 2012 and later. One EPS site (1004029) was sampled in both 2012 and 2014, and declined from a BIBI rating of Fair to Poor. The fish community was most dominated by blacknose dace and white sucker (*Catastomus commersonii*), both tolerant fish species. Six potential limits to fish passage into the Long Green Creek subwatershed exist (DNR, 2016). Three dams are located roughly three quarters of a mile above Hydes Road. A dam is located 0.2 miles below Long Green Road. A pipeline crossing and a dam are located 50 to 60 yards below the mouth of Haystack Branch (Figure 3-6). The Lower Gunpowder Falls East subwatershed was rated Fair overall by the BIBI, based on two sampling events, and had no fish sampling data. The Sweathouse Run subwatershed was rated Good by the BIBI and Fair by the FIBI, based on one sampling event per biological community. The fish community was dominated by blacknose dace, creek chub (*Semotilus atromaculatus*), tolerant fish species, and rosyside dace (*Clinostomus funduloides*), a fish species with no tolerance type. Three potential limits to fish passage into the Lower Gunpowder Falls East subwatershed exist (DNR, 2016). Two dams are located 1 mile and 0.7 miles below Sunshine Avenue. One dam is located 0.3 miles below Mount Vista Road (Figure 3-6).

3.4.3 Illicit Discharge and Elimination Data

An illicit discharge is a discharge into a municipal separate storm sewer, which is not composed entirely of stormwater (e.g. discharge of wastewater or gray water). As outlined in the NPDES 2016 Annual Report, Baltimore County is responsible for continuing to implement and enforce an illicit discharge detection and elimination (IDDE) program to ensure that all discharges to and from the municipal separate storm sewer systems (MS4) are either permitted by MDE or eliminated (Baltimore County EPS, 2016). Baltimore County tracks illicit discharges through a program of routine storm drain outfall screening. A routine outfall screening consists of:

(1) A quantitative analysis of the effluent. This includes measuring the effluent flow rate, temperature and pH, and field-testing with the LaMotte National Pollution Discharge Elimination System (NPDES) test kit (parts per million tests for copper, chlorine, ammonia and phenol).
(2) A visual inspection of the effluent, the outfall structure and the receiving channel, noting such conditions as water color, odor, vegetative condition, sedimentation, erosion, structural damage, etc.

In Baltimore County, there are 3,253 total outfalls (Baltimore County EPS, 2016). There are two types of outfalls: major and minor. Major outfalls are ≥36” in diameter and minor outfalls are <36”. There are 668 major outfalls in the database and 600 have been prioritized. The minor outfalls are still at the beginning of being prioritized, 765 out of 2,585 have been completed so far. Due to the greater number of them, minor outfalls will be dealt with in phases.

The outfall prioritization system works as follows: Outfalls that have not yet been screened three times have not been prioritized. Outfalls that have been screened three times are

assigned one of three priority ratings. Outfalls with major problems that require immediate correction and/or close monitoring, or outfalls with recurrent problems will be assigned a Priority 1 (Critical) rating. Outfalls with moderate to minor problems that have the potential to become severe are assigned a Priority 2 (High) rating. Outfalls with minor or no problems that do not require close monitoring are given a Priority 3 (Low) rating. Outfalls categorized as "Low Priority" are on a ten-year screening cycle for major outfalls and a 20-year cycle for minor outfalls. "High Priority" outfalls are screened once each year, and "Critical" outfalls are screened four times each year. This system allows for a more streamlined approach in selecting outfalls to screen, and provides a more efficient use of manpower. Outfall priority may be changed if it improves or degrades. Minor outfalls will be prioritized after one screening. If a severe problem is found, an investigation begins immediately.

Table 3-19 provides the outfall prioritization results for Area Q. None of the minor outfalls in Area Q have been screened yet, and thus they are listed as Priority 0. Minor outfall screenings in Area Q are expected to be completed in 2021 (Baltimore County EPS, 2016). All three of the major outfalls are in the Long Green Creek subwatershed. Two major outfalls are rated Priority 2 (High) for trash and excessive vegetation. Figure 3-7 shows locations of major and minor outfalls.

Table 3-19: Area Q Storm Drain Outfall Prioritization

	Minor outfalls (<36")	Major outfalls (≥36")
Priority 1 (critical)	0	0
Priority 2 (high)	0	2
Priority 3 (minor)	0	1
Priority 0 (have not been assessed)	47	0

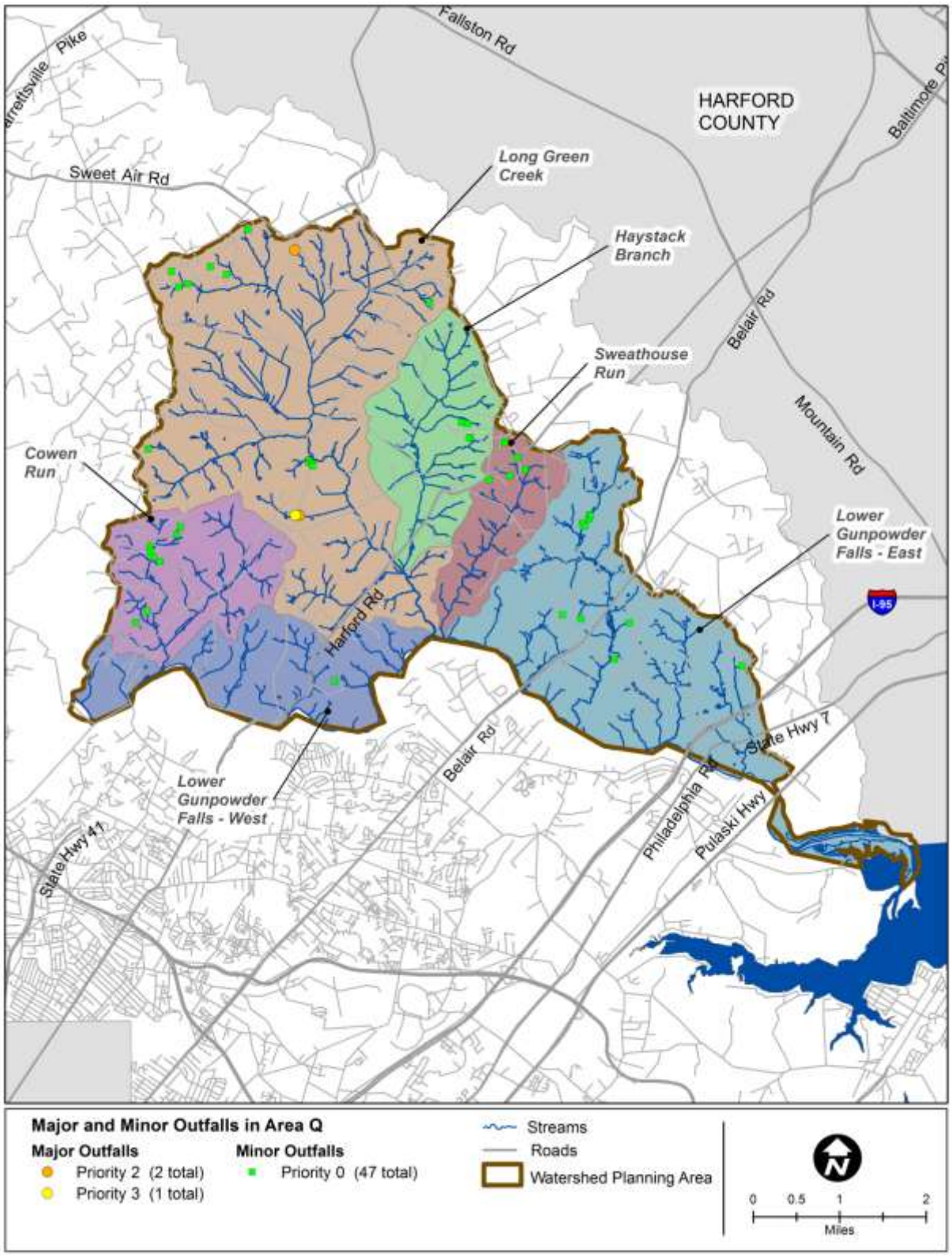


Figure 3-7: Major and Minor Outfalls in Area Q

3.5 Stream Assessments and Stream Restoration Recommendations

The purpose of this section is to summarize the results of previous stream assessments and to integrate their recommendations with those from 2017 field verifications. Two efforts have studied stream stability and restoration potential in Area Q, each with different methods and level of detail. The Lower Gunpowder Falls Watershed Water Quality Management Study (WQMS; Parsons Brinckerhoff, 1999) was a comprehensive study of the drainage to Gunpowder Falls downstream of the Loch Raven Reservoir. The 1999 WQMS report provides a detailed dataset of Rosgen stream types found throughout the watershed, as well as recommended restoration projects. This section focuses on recommended stream restoration projects, though the report also lists project recommendations in categories such as stormwater management, riparian buffer planting, and outfall retrofit. In a second previous study, Baltimore County Environmental Protection and Sustainability (EPS) Watershed Restoration Section staff walked and assessed nearly the entire Cowen Run subwatershed for stream restoration potential during 2015 and 2016 at the request of residents from within the subwatershed. Streams that were considered impaired were mapped in GIS.

Stream restoration projects from the 1999 WQMS report were revisited to evaluate if the need and potential for restoration still existed. No projects in Cowen Run were revisited due to the recent assessments by Baltimore County EPS. The methods and results of the 1999 WQMS report, the 2017 field verifications, and the Cowen Run Stream Assessment are discussed below.

As of early 2017, Baltimore County had not completed any stream restoration projects within the subwatersheds of Area Q. A bank stabilization project was completed in 2009 on approximately 1,200 linear feet of the mainstem of Gunpowder Falls at Cromwell Bridge Road.

3.5.1 Previous Stream Assessments in Area Q

Table 3-20 summarizes the lengths of stream assessed by each of the two previous studies and their respective results. Stream lengths from the Cowen Run study were gleaned from GIS data provided by Baltimore County EPS. The 1999 WQMS report identified a total of 25 water quality enhancement projects within Area Q, which were described as channel restoration and/or bank stabilization. The County stream reach GIS layer that was used in the 1999 WQMS report was based on 1" = 200' topographic maps from the 1950s. Reach locations were updated for the 1999 WQMS report when they were noticed to be incorrect based on field observations. The most recent available stream layer (2005 hydrology lines developed by Baltimore County EPS) has a much finer level of detail than what was used for the 1999 WQMS. Therefore, reach lengths reported in Table 3-20, which are the lengths reported in the 1999 WQMS report, would likely be longer if measured based on the 2005 hydrology line layer. Updated reach lengths based on 2017 field verification used the 2005 hydrology lines. Methods and results of the previous studies are described in more detail below.

Table 3-20: Summary of Previous Stream Assessments in Area Q

Subwatershed	1999 WQMS Report			Cowen Run Field Assessment	
	Stream Length Assessed (ft)	Recommended Stream Restoration Projects		Stream Length Assessed (ft)	Impaired Stream Length (ft)
		Number of Projects	Approximate Length (ft)*		
Cowen Run	75,894	7	9,474	74,233	17,847
Haystack Branch	68,590	3	4,880	-	-
Long Green Creek	272,161	7	17,317	-	-
Lower Gunpowder Falls East	150,405	5	13,020	-	-
Lower Gunpowder Falls West	76,101	1	550	-	-
Sweathouse Run	50,894	2	1,400	-	-
Total	**694,046**	**25**	**46,641**	**74,233**	**17,847**

*In most cases project lengths were reported in Appendix IV-A of the 1999 WQMS Report. Lengths that were not reported were estimated from the length in GIS of the associated reach(es).

3.5.1.1 1999 Lower Gunpowder Falls Watershed Water Quality Management Study

The 1999 WQMS report initially used existing data and mapping to characterize the watershed. Geomorphic and hydraulic controls were identified to streamline field assessments. 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 reaches were generally less than 1,000 linear feet each.

The watershed was delineated into 62 catchments for hydrologic and non-point source pollution modeling. Smaller modeling units were used to increase the resolution of the results. Modeling used Version 4.4 of the EPA's storm water 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 eight 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.

At least one reach from each major Rosgen stream type was 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 sinuosity calculations. Additional stream reaches were classified to Level II while using

more rapid field techniques and knowledge gained from observations during the more detailed studies. These were called Extrapolated Reaches. In order to confirm the accuracy of Extrapolated Reach classifications, all streams in Haystack Branch were classified and confirmed. A modified Level III assessment of Extrapolated Reaches 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. Figure 3-8 shows all stream reaches assessed in Area Q.

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 generally those that had sufficient floodplain access. Agricultural land practices and riparian buffer condition also play an important role in maintaining stream stability. Stream instabilities within Area Q were found to generally have local causes and thus need local remedies. Examples include poor riparian buffers, debris jams, and unprotected cattle crossings.

Potential projects were identified from the stream stability analysis and further field visits were conducted to locate stormdrain outfalls and identify causes of non-point source pollution. Specific recommended projects including channel restoration, stream buffer improvement, bank stabilization, drainage channel retrofits, outfall retrofits, grade control, bioretention, and new stormwater management facilities. 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 listed in Table V-2 and Appendix IV-A of the 1999 WQMS report. Projects were then ranked within each subwatershed based on the project score and water quality enhancement benefits. Figure 3-8 shows the stream restoration projects that were identified within Area Q. Characterizations of each subwatershed and the general problems that were found in each are described below.

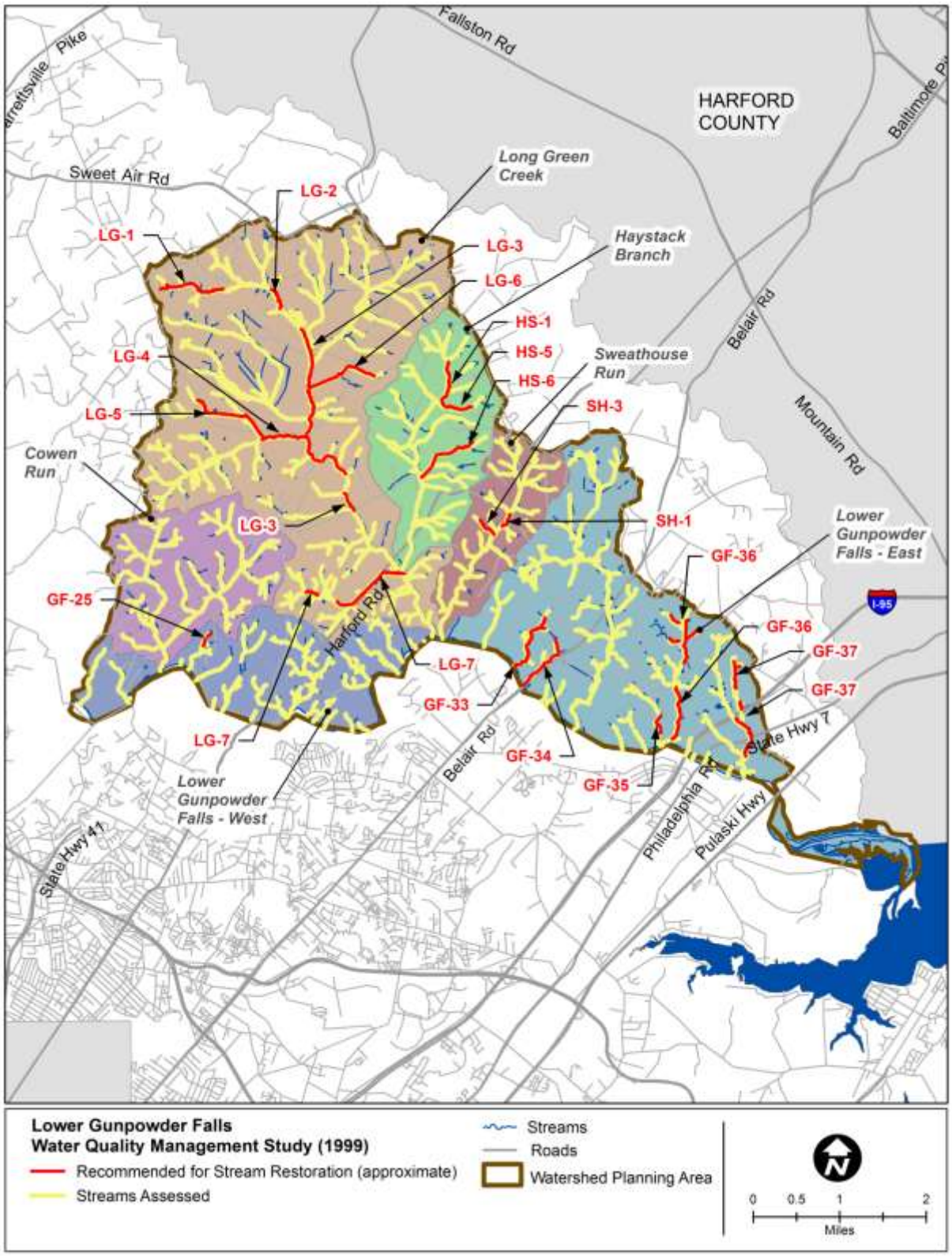


Figure 3-8: Stream Assessments from the Lower Gunpowder Falls Water Quality Management Study (Parsons Brinckerhoff, 1999)

Restoration Recommendations

Cowen Run

No systemic stability problems were identified in Cowen Run (referred to as Cowen Branch in the 1999 WQMS report), though local instabilities were present and projects were recommended for these locations. In general, the subwatershed had rural character, but the loss of forested and agricultural areas was expected to occur as development increased. In addition to some specific projects, the actions recommended for Cowen Branch were protective in nature, such as education for landowners, volunteer-based water quality monitoring, and enforcement of regulations regarding forest conservation, maintenance of stream buffers, and erosion and sediment control. Seven stream restoration projects were recommended in Cowen Branch, totaling approximately 9,500 linear feet.

Long Green Creek

Long Green Creek is the largest tributary within Area Q. The subwatershed is characterized by steep side slopes and a broad valley. Poor agricultural practices were the main cause of impact to streams, mainly in the valleys. Low-density residential development without stormwater management also had the potential to cause problems. Standard agricultural BMPs were recommended, such as restricting livestock access to streams and improving riparian buffers. Other recommendations included education for landowners and volunteer-based water quality monitoring. Seven stream restoration projects were recommended in Long Green Creek, totaling approximately 17,300 linear feet.

Haystack Branch

Haystack Branch is a tributary to Long Green Creek. The land use was mainly agricultural with some large-lot residential, and agricultural land use practices were generally good. Limited development was expected to occur in this subwatershed. The recommended restoration projects were minor channel restoration and riparian buffer improvements. Other recommendations included education for landowners, volunteer-based water quality monitoring, and enforcement of regulations regarding forest conservation, maintenance of stream buffers, and erosion and sediment control. Three stream restoration projects were recommended in Haystack Branch, totaling approximately 4,900 linear feet.

Sweathouse Branch

Sweathouse Branch is a small subwatershed that drains from the community of Fork in the upstream end, and enters Gunpowder Falls State Park downstream. Medium- to low-density residential land use was located along the major roadways, with some agricultural use present as well. Minor stream instabilities were likely caused by poor land management practices, unprotected cattle crossings, and medium-density development, but there were no widespread stability problems. The recommendations for this subwatershed included efforts to protect this high quality stream system: provide a larger riparian buffer, implement stricter development standards through the creation of a County-wide program identifying and protecting high quality areas, education for landowners and citizen volunteer groups, and add additional land to Gunpowder Falls State Park if possible. Two stream restoration projects were recommended in Sweathouse Branch, totaling approximately 1,400 linear feet.

Lower Gunpowder Falls Mainstem

The Lower Gunpowder Falls mainstem subwatershed encompasses smaller tributaries that drain directly to the mainstem of Gunpowder Falls from both the north and south. The SWAP breaks the drainage within Area Q into two subwatersheds, Lower Gunpowder Falls East and West. A rocky gorge borders most of the mainstem through the watershed, with the adjacent land mostly part of Gunpowder Falls State Park and forested. The 1999 WQMS report identified two major tributaries in this subwatershed: Kingsville Branch and the Bradshaw Tributary. No systemic stability problems were identified in this watershed. The stability of individual tributaries varied widely, with degraded reaches generally attributable to poor land use management in the headwater areas. Five potential stream restoration projects were recommended in Lower Gunpowder Falls East, totaling approximately 13,000 linear feet. One potential project of 550 linear feet was recommended in Lower Gunpowder Falls West.

3.5.1.2 Cowen Run Field Assessment

Nearly all the streams in the Cowen Run watershed were walked and assessed for stream restoration potential by Baltimore County EPS Watershed Restoration staff in 2015 and 2016. Notes on mapping and photos were used to informally document stream conditions encountered during the field walks. A shapefile of impaired reaches that EPS produced as a result of these walks was intended to help prioritize reaches and identify projects that are feasible, and does not necessarily mean that those areas were recommended for restoration. Figure 3-9 shows the streams assessed in Cowen Run and those identified as impaired.

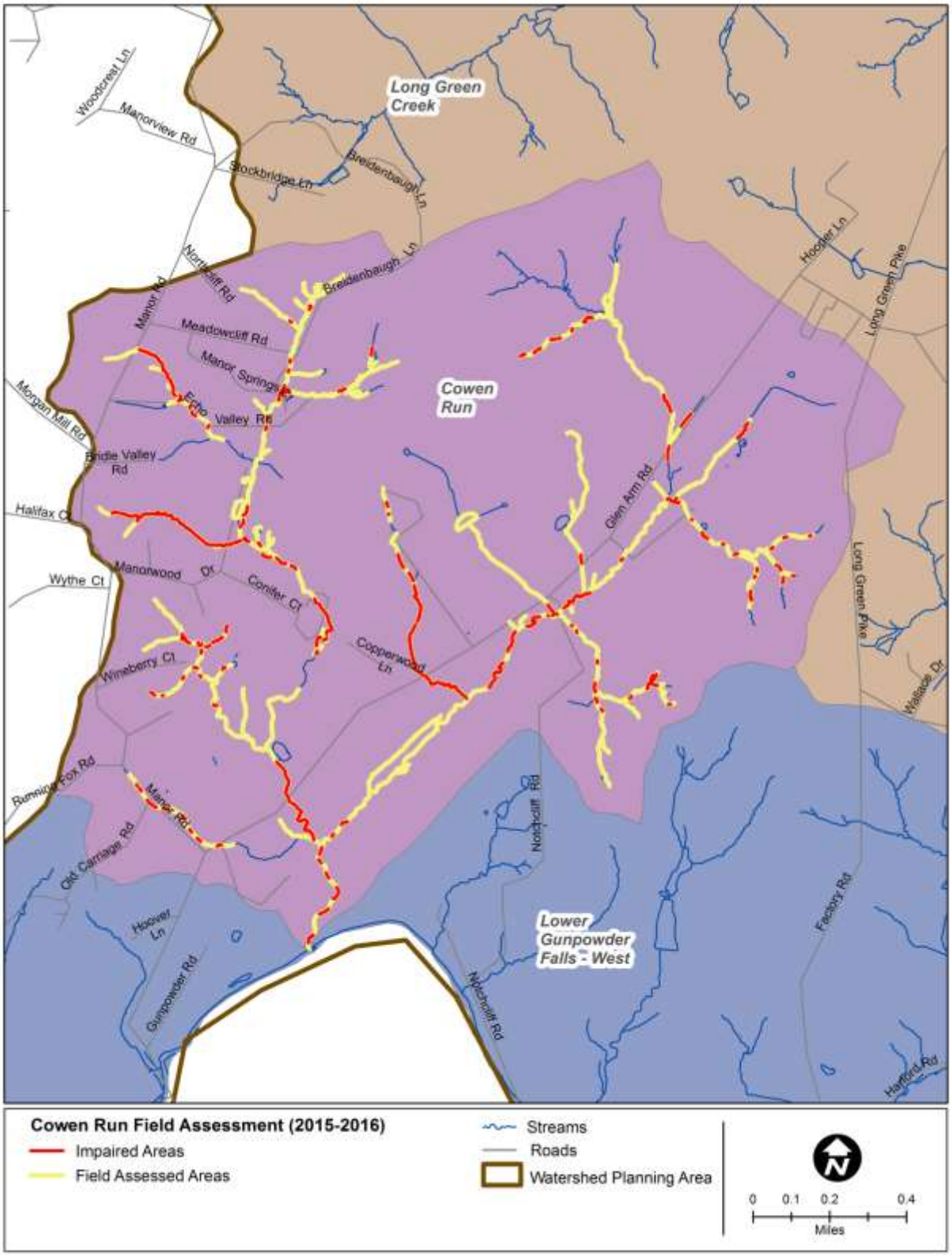


Figure 3-9: Streams Assessments by Baltimore County EPS in Cowen Run

3.5.2 2017 Field Verification of Recommended Restoration Projects from the 1999 WQMS Report

The 1999 WQMS report identified a variety of water quality enhancement projects (see Table V-2 and Appendix IV-A in the report). In 2017, 18 projects with the type "Channel Restoration" and/or "Bank Stabilization" that were located within the Area Q subwatersheds (with the exception of Cowen Run) were revisited.

Many of the recommended restoration projects were located within large parcels and away from road crossings, so visually assessing the streams from the public right-of-way was not possible in many cases. Letters requesting permission to access were sent to property owners for the 18 reaches. No sites were visited in Cowen Run because of the recent assessments by Baltimore County EPS. See Figure 3-8 for the approximate extents of the recommended projects.

Where permission was obtained, reaches were visually assessed for restoration potential. A stream evaluation worksheet was filled out and photos (see Appendix A) were taken to document the current conditions of the impaired reach. 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 need and potential for restoration. Reaches that did not show visual signs of instability were not ranked, but were documented with photos and notes.

Results

Baltimore County EPS sent letters to the owners of 139 parcels that contained the 18 reaches of interest. Approximately half of the letters did not receive a response, while 39% actively granted permission and 10% denied permission. Two projects recommended in the 1999 WQMS report were not visited because access was denied for most or all of the reach length. These were LG-2 and HS-5. Portions of the remaining 16 recommended projects were walked as permission and site conditions allowed. Figure 3-10 shows the distribution of reaches that were evaluated in 2017.

A total of 14 distinct reaches were identified as having potential for stream restoration (Table 3-21). The limits of potential restoration were revised to represent the conditions observed in 2017, and projects from the 1999 WQMS were split into multiple reaches that were assessed individually where it was deemed necessary due to changing conditions (e.g. reach HS-6a has potential for restoration, HS-6b does not have potential for restoration). Recommended reach lengths are approximate, and project feasibility would need to be investigated further before any restoration could take place. See Appendix A for a summary of the stream evaluation worksheet results. Reaches that did not have good potential for stream restoration but that would benefit from other restoration activities, such as riparian buffer enhancement, are also listed in Appendix A. Reach conditions are discussed below by subwatershed.

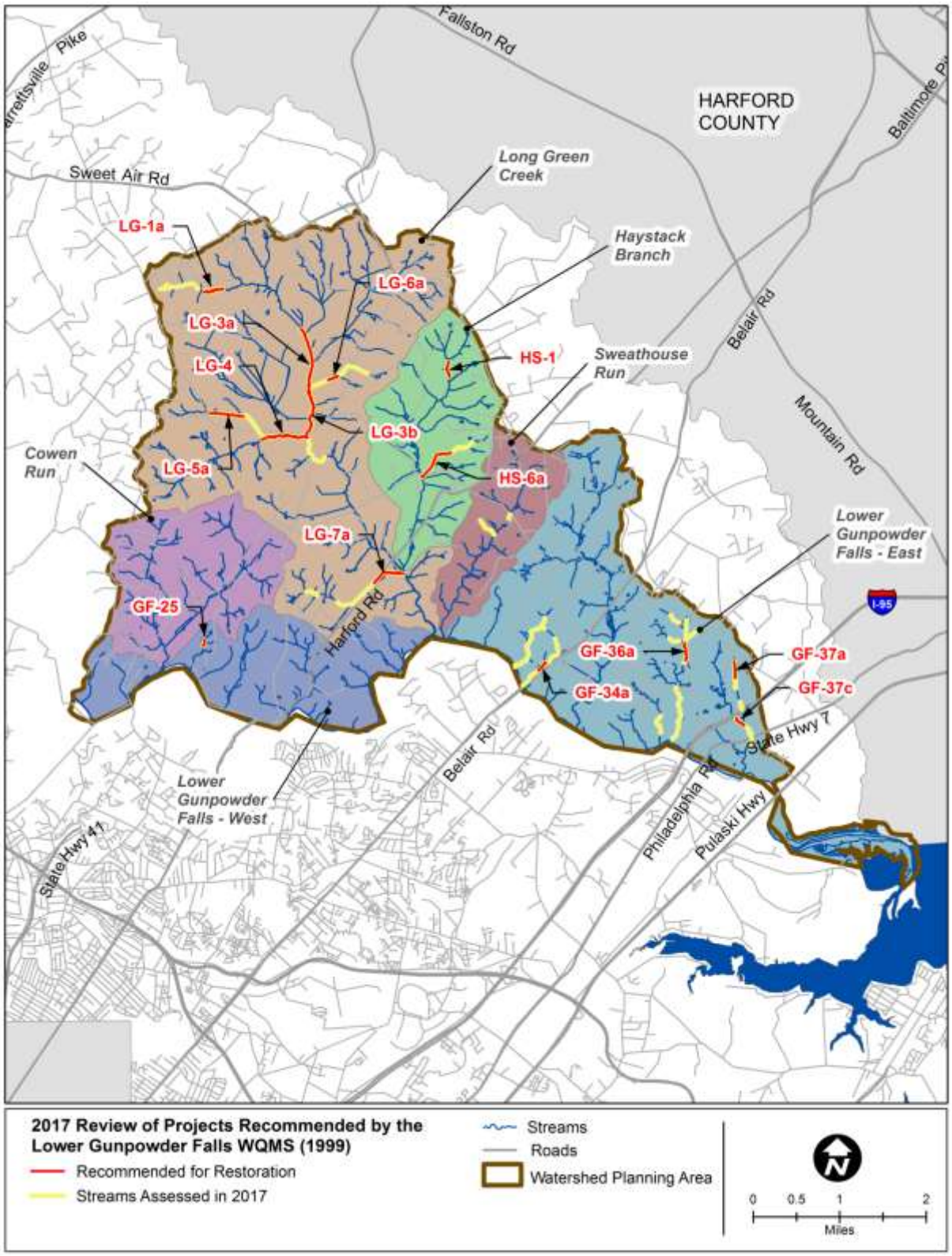


Figure 3-10: Stream Restoration Recommendations Based on Field Verification of the 1999 Lower Gunpowder Falls WQMS

Table 3-21: Recommended Stream Restoration Projects Based on 2017 Reviews of Projects Identified in the 1999 Lower Gunpowder Falls WQMS

Subwatershed	Reach ID	Rank based on Stream Evaluation Worksheet Score	Potential Restoration Length (ft)
Haystack Branch	HS-1	10	1,010
	HS-6a	1	2,630
		Subwatershed Total	3,640
Long Green Creek	LG-1a	12	1,380
	LG-3a	8	4,400
	LG-3b	4	3,810
	LG-4	2	3,390
	LG-5a	5	2,100
	LG-6a	7	680
	LG-7a	7	2,380
		Subwatershed Total	18,140
Lower Gunpowder Falls East	GF-34a	3	730
	GF-36a	9	1,170
	GF-37a	11	1,090
	GF-37c	6	720
		Subwatershed Total	3,710
Lower Gunpowder Falls West	GF-25	7	410
		Subwatershed Total	410
		Area Q Total	25,900

Haystack Branch

Two projects recommended by the 1999 WQMS report were able to be visited in Haystack Branch: HS-6 and a portion of HS-1. Figure 3-11 below shows examples of stream and riparian buffer conditions observed in the subwatershed. As previously stated, HS-5 was not visited due to lack of permission to access. Two distinct reaches were identified as having the best potential for restoration:

Reach HS-6a had the highest overall score from the stream evaluation worksheet. Problems noted at this reach included active erosion, poor water quality (turbid despite no recent rainfall), lack of floodplain access due to incision, and lack of riparian buffer. Agricultural fields surround the stream with scattered trees and shrubs on the banks in the downstream end. Incision increased from minimal at the downstream end to severe at the upstream end. An in-line pond with bare, eroding banks was present in the downstream end. Stream restoration to reduce bank erosion and restore a natural pattern is recommended along with riparian buffer establishment. The upstream portion of HS-6 (HS-6b) was forested and overall stable.

HS-1 was located in a narrow, forested valley with steep slopes on either side. Bedrock in the channel was providing grade control but the reach was actively widening, with bare, eroded banks in most outer meander bends. However, feasibility of this project is low due to difficult

construction access. This project ranked 10th in terms of overall score on the stream evaluation worksheet.

Figure 3-11: Examples of Stream Conditions in Haystack Branch: Bank erosion at HS-1 (top), Bank erosion and inadequate riparian buffer at HS-6a (bottom left), Stable forested channel at HS-6b (bottom right)

Long Green Creek

Six projects recommended by the 1999 WQMS report were able to be visited in Long Green Creek: LG-1, -3, -4, -5, -6, and -7. Figure 3-12 shows examples of stream and riparian buffer conditions encountered in this subwatershed. As previously stated, LG-2 was not visited due to lack of permission to access the majority of the reach. In this subwatershed, seven distinct reaches were identified as having the best potential for restoration:

LG-4 had the 2nd highest score on the stream evaluation worksheet. LG-4 was located in the middle of an agricultural field with no riparian buffer. Vertical eroded banks 3 feet tall or higher were present in most meander bends. The stream was moderately incised and likely did not have floodplain access. Stream restoration with riparian buffer establishment would impact the adjacent agricultural fields in this area.

LG-3b had the 4th highest score on the stream evaluation worksheet. Similar to LG-4, the stream winds through agricultural fields and has bank erosion in most outer meanders. This reach, however, had trees growing on the banks in many places, and the roots were providing

stability to those portions of the banks. Beyond these trees, however, was mowed or in cropland. This reach also may have floodplain connection in some areas. Stream restoration to enhance floodplain connection and establishing a riparian buffer of adequate width are recommended for this reach.

Figure 3-12: Examples of Stream Conditions in Long Green Creek: Bank erosion in LG-1a (top left), Bank erosion and inadequate riaprian buffer in LG-3b (top right), Bank erosion and inadequate riaprian buffer in LG-4 (bottom left), Stable channel through wooded yard (LG-3c)

Reach LG-5a ranked 5th in score on the stream evaluation worksheet. may have been straightened in the past. It is an incised, mostly straight stream with a very narrow riparian buffer composed largely of invasive species. Cattle pasture and cropland line the stream on both sides. Riparian buffer enhancement and stream restoration to reconnect the floodplain and restore a natural pattern would impact the adjacent agricultural land.

LG-6 is a tributary to LG-3b. LG-6a is within agricultural land and may have been straightened in the past. It ranked 7th in score on the stream evaluation worksheet, tied with two other projects receiving the same score. It has a narrow riparian buffer with mowed grass and crops on either side. LG-6a is more deeply incised than the reaches directly upstream and downstream and has some 3-4 ft eroded banks. Expanding the riparian buffer is also

recommended for LG-6a and the reach directly downstream (LG-6b), though it would impact agricultural land.

Reach LG-7a appears to have experienced past incision. That is, the reach appears to be mostly incised from the floodplain but there is little active erosion. LG-7a ranked 7th in score on the stream evaluation worksheet, tied with two other projects receiving the same score. The upstream end of the reach is laterally confined by Harford Road and has a narrow riparian buffer. An old collapsed bridge near the confluence with Long Green Creek may be a fish blockage, and may cause water to back up and flood the adjacent area during storm events. This project has low restoration potential due to the significant constraints and because the reach crosses several properties. Reach LG-7b is located just upstream of 7a through open farmland. While this reach had minor bank erosion, it would benefit most from the establishment of a riparian buffer and livestock exclusion.

Reach LG-3a is located directly upstream of reach LG-3b and ranked 8th highest in score on the stream evaluation worksheet. LG-3a, for the most part, has a riparian buffer, though it is narrow in some places due to pasture and cropland. This reach showed bank erosion of the highly erodible sediments to a lesser degree than downstream in LG-3b, where the riparian buffer is limited to a single line of trees along the banks. Stream restoration potential is low for this reach because it would impact many trees, most of which were somewhat recently planted as evidenced by tree tubes. Additional buffer plantings are recommended for the areas where the buffer is inadequate.

LG-1a was 12th out of 12 in terms of score on the stream evaluation worksheet. Bare, eroded banks were present in most meander bends, but the site would be difficult to access for construction equipment. The extent of the reach that could feasibly be restored may be reduced due to the extensive bedrock influence in the downstream end of the reach.

Lower Gunpowder Falls East

Five projects recommended by the 1999 WQMS report were able to be visited in Lower Gunpowder Falls East: GF-33 through GF-37. The downstream portions of projects GF-33, -34, -35, and -36 were all located within Gunpowder Falls State Park, where the tributaries entered the mainstem of Gunpowder Falls. These portions of the reaches were generally very stable with some exceptions. The stability can likely be attributed to the mature forest of the parkland and bedrock providing grade control. Examples of streams encountered in this subwatershed are shown in Figure 3-13. In this subwatershed, four distinct reaches were identified as having the best potential for restoration:

GF-34a had the 3rd highest score on the Stream evaluation worksheet. This was an unusual reach whose instability may be attributable to anthropogenic landscape alteration. It is located adjacent to a sheer rock wall with a large ponded area at the base that may be a former quarry. The reach is incised from the floodplain and has vertical eroding banks. However, the deep gully and uneven nature of the bank heights and may be due to fill material that historically built up the banks. The reaches upstream and downstream of the quarry are stable and well connected to the floodplain. Restoration in this area would reduce the amount of sediment being introduced to the system by bank erosion and restore a riffle-pool sequence.

Figure 3-13: Examples of Stream Conditions in Lower Gunpowder Falls East: Stable channel located within Gunpowder Falls State Park (GF-33a, top left), Bank erosion at GF-34a (top right), Bank erosion at GF-36b (bottom left), Bank erosion at GF-37c (bottom right)

Reach GF-37c is located directly downstream of a culvert under I-95. It ranked 6th overall on the stream evaluation worksheet. The culvert itself has an approximately one foot drop, which may be a barrier to fish migration. This reach is recommended for restoration because of eroding banks and lack of floodplain access. A gully that enters the right bank of the stream just downstream of the highway embankment is deeply eroded and headcutting. It likely carries roadway runoff to the stream, and may present a BMP opportunity.

Reach GF-36a is located downstream of a driveway culvert where the stream has become incised. GF-36a was ranked 9th based on the stream evaluation worksheet scores. This reach has bank erosion in meander bends and where bedrock is directing flows toward the banks. At the downstream end, there is moderate erosion where the stream runs alongside Raphel Rd. Two pipe outfalls enter the channel here, and the end section of one has fallen off into the channel, indicating the banks have undergone lateral migration toward the road edge. This site presents difficulties in construction access due to steep slopes and forest. Tributaries located upstream of GF-36a, which are designated as GF-36b, do not show widespread instability and therefore are not a high priority for restoration. Riparian buffer planting is recommended where there is mowed grass to the top of bank.

Reach GF-37a begins at the downstream side of a culvert within a utility Right-of-Way. The channel has downcut steeply and becomes a deep gully with eroding banks. Towards the downstream end of the reach, bank heights decrease and the stream is building a new floodplain in the entrenched channel. Past the downstream limit of the proposed restoration, the channel becomes more stable with improved floodplain access. Site access may be difficult to due utilities and dense forest. This site ranked 11th in terms of score on the stream evaluation worksheet.

Lower Gunpowder Falls West

One project identified by the 1999 WQMS report was visited in this subwatershed: GF-25. This reach originates at the outfall from two in-line ponds at the headwaters of the stream. The outfall pipe was severely undercut, and a deep gully continued for several hundred feet downstream. Just downstream of this reach, the channel appears more stable as it drops steeply over bedrock outcrops. Floodplain creation may not be feasible due to the degree to which the channel is incised. Stabilization of the outfall and inspection of the earthen dam are suggested if the channel is to be restored. A similarly incised tributary that enters the left bank of the channel is also a candidate for restoration, and would need to be investigated further. This reach ranked 7th in score on the stream evaluation worksheet, tied with two other projects receiving the same score. Figure 3-14 shows the condition of the stream at GF-25.

Figure 3-14: Examples of stream conditions in Lower Gunpowder Falls West: Eroded gully at GF-25 (left), Stable conditions downstream of GF-25 (right)

Sweathouse Run

Two projects recommended by the 1999 WQMS report were visited in this watershed: SH-1 and SH-3. Neither reach presented a good opportunity for stream restoration. Only a small portion of SH-1 was able to be assessed, directly downstream of a large culvert. No instabilities were noted. Reach SH-3 is a steep channel with step-pools and bedrock influence. The majority of the reach was stable. Bank erosion was present in some outer meanders bends in the upstream end. The stream originates at the outfall from a small pond. Riparian buffer enhancement is recommended for the upstream end to slow down runoff into the channel from open fields. Examples of the conditions observed at these reaches are shown in Figure 3-15.

Figure 3-15: Examples of stream conditions in Sweathouse Run: Stable channels observed at SH-1 (left) and SH-3 (right)

Conclusion

In conjunction with the recommendations of stream restoration and riparian buffer establishment described above and in Appendix A, encouraging the use of agricultural BMPs (such as livestock exclusion fencing, continuous no-till, and cover crops) is recommended in conjunction with projects on farmland. In addition, 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 stabilize naturally.

CHAPTER 4.0
Uplands Assessment

4.1 Introduction

Upland areas in the watershed were assessed to locate potential pollution sources that could influence water quality and to identify opportunities for restoration projects. This assessment was conducted according to the Unified Subwatershed and Site Reconnaissance (USSR) Manual developed by CWP (CWP, 2004). This manual provides detailed guidance for watershed groups, municipal staff and consultants to quickly identify major sources of stormwater pollution and to assess restoration potential for source controls, pervious area management and improved municipal maintenance (e.g., education, retrofits, street sweeping, open space management, etc.).

This chapter outlines the four major components of the USSR:

Neighborhood Source Assessment (NSA)
Hotspot Site Investigation (HSI)
Institutional Site Investigation (ISI)
Pervious Area Assessment (PAA)

Each of these components is described in detail in the following sections. Site locations use the following naming convention: 'XYZ-Q-123' where 'XYZ' is the type of assessment (NSA, HSI, ISI or PAA), 'Q' designates the Study Area Q and '123' is the number assigned to each field site investigated. The first number represents the subwatershed, followed by the site number that was labeled sequentially across all of Area Q. The numbering scheme for the Area Q subwatersheds is as follows:

100 – Lower Gunpowder Falls West
200 – Cowen Run
300 – Long Green Creek
400 – Haystack Branch
500 – Sweathouse Run
600 – Lower Gunpowder Falls East

4.2 Neighborhood Source Assessment

4.2.1 Assessment Protocol

Prior to conducting NSAs in the field, neighborhoods were delineated in the office using GIS data, including tax parcels and aerial photographs. Neighborhoods were delineated based on groups of homes with similar characteristics such as lot size and age of development. These

neighborhoods were then verified in the field. Adjustments to neighborhood boundaries were made as necessary in the field, either through grouping or dividing neighborhoods. For example, a neighborhood may be further divided if there were significant differences in the type of land cover where one part of the neighborhood was heavily forested, and another part of the neighborhood was dominated by turfgrass.

The field team drove through every street in each defined neighborhood to identify potential pollution sources and restoration opportunities. General information was collected in each neighborhood for yards and lawns; driveways, sidewalks, and curbs; rooftop runoff; and common areas. These are each described briefly below.

Yards and Lawns

In suburban residential areas, lawns typically represent a large portion of the pervious cover and can be a major source of pollutants such as pesticides and nutrients. Potential pollution sources evaluated by field teams under this category include grass cover and management status (i.e. fertilization and irrigation methods), bare soils, swimming pools and trash in yards. Existing tree cover and landscaping in each neighborhood was also noted to evaluate the potential to expand these areas to intercept additional stormwater runoff.

Driveways, Parking Lots, Sidewalks and Curbs

The presence of driveways, sidewalks and curbs was noted for each neighborhood assessed. Information was collected for potential or existing pollution sources from these areas such as stained or dirty driveways, lawn clippings or leaves on sidewalks, pet waste, trash and/or debris along curbs and long term car parking (i.e. unused cars can potentially leak oil and other pollutants).

Rooftops

Rooftops that are directly connected to other impervious surfaces through downspouts can contribute pollutants directly to stream systems. Disconnecting rooftops through downspout retrofits can reduce this potential source of pollution. In each neighborhood field teams estimated the percentage of downspouts discharging to impervious surfaces and evaluated the potential for implementing downspout retrofits.

Common Areas

Common areas within neighborhoods and in public parks are a good place to evaluate community behaviors such as pet waste disposal, trash dumping, storm drain marking, and buffer management. Field teams noted the condition of common areas, the activities occurring there that could be a potential source of pollution, and opportunities for tree plantings.

Upon completion of the Neighborhood Source Assessments, specific actions were identified based on the overall assessment. The plan guides homeowners, community associations, watershed associations, and the local government toward specific actions where they are most needed. Potential actions generally include:

Downspout disconnection
Rain gardens

Rain barrels
Fertilizer reduction/education
BayScaping
Storm drain marking
Street tree planting
Trash management
Multi-family parking lot or alley retrofit

Once all of the above neighborhood information was compiled, the final step of the NSA was to rate the overall neighborhood pollution severity and restoration potential. The severity of pollution generated by a neighborhood is denoted by the Pollution Severity Index (PSI). There are up to 14 potential pollution sources rated. Neighborhoods are given PSI ratings of severe (7 or more sources), high (4 to 6), moderate (2 to 3), or low (0 to 1). The neighborhood's potential for restoration projects is also rated with the Restoration Opportunity Index (ROI) in a similar fashion, with nine potential opportunities. These are assigned a rating of high (5 or more), moderate (3 to 4), or low (0 to 2).

4.2.2 Summary of Sites Investigated

A total of 30 neighborhoods were assessed in Area Q, as shown on Figure 4-1. The total number of neighborhoods assessed in each subwatershed is shown on Table 4-1. A neighborhood was assigned to the subwatershed for which the majority of its area was located.

Table 4-1: Neighborhoods Surveyed per Subwatershed

Subwatershed	# of NSAs	Acres
Lower Gunpowder Falls West	2	218.82
Cowen Run	5	395.54
Long Green Creek	8	493.28
Haystack Branch	1	101.45
Sweathouse Run	3	148.13
Lower Gunpowder Falls East	11	700.41
Total	**30**	**2057.63**

Of the 30 neighborhoods in Area Q, none were rated as having a severe Pollution Severity Index. Four were rated high, 19 were rated moderate, and 7 neighborhoods received low PSI ratings. One neighborhood received a high Restoration Opportunity Index rating, 11 were rated moderate, and 18 had low ROI ratings. Neighborhoods should be prioritized to first address areas with both high PSI and high ROI ratings, followed by other neighborhoods. No neighborhoods received both a high PSI and a high ROI rating. Four neighborhoods received a high PSI rating and a moderate ROI rating – NSA_Q_310, NSA_Q_518, NSA_Q_623 and NSA_Q_625. The majority of neighborhoods received low or moderate PSI and low or moderate ROI ratings. The distribution of the NSA ratings is shown on Figure 4-2.

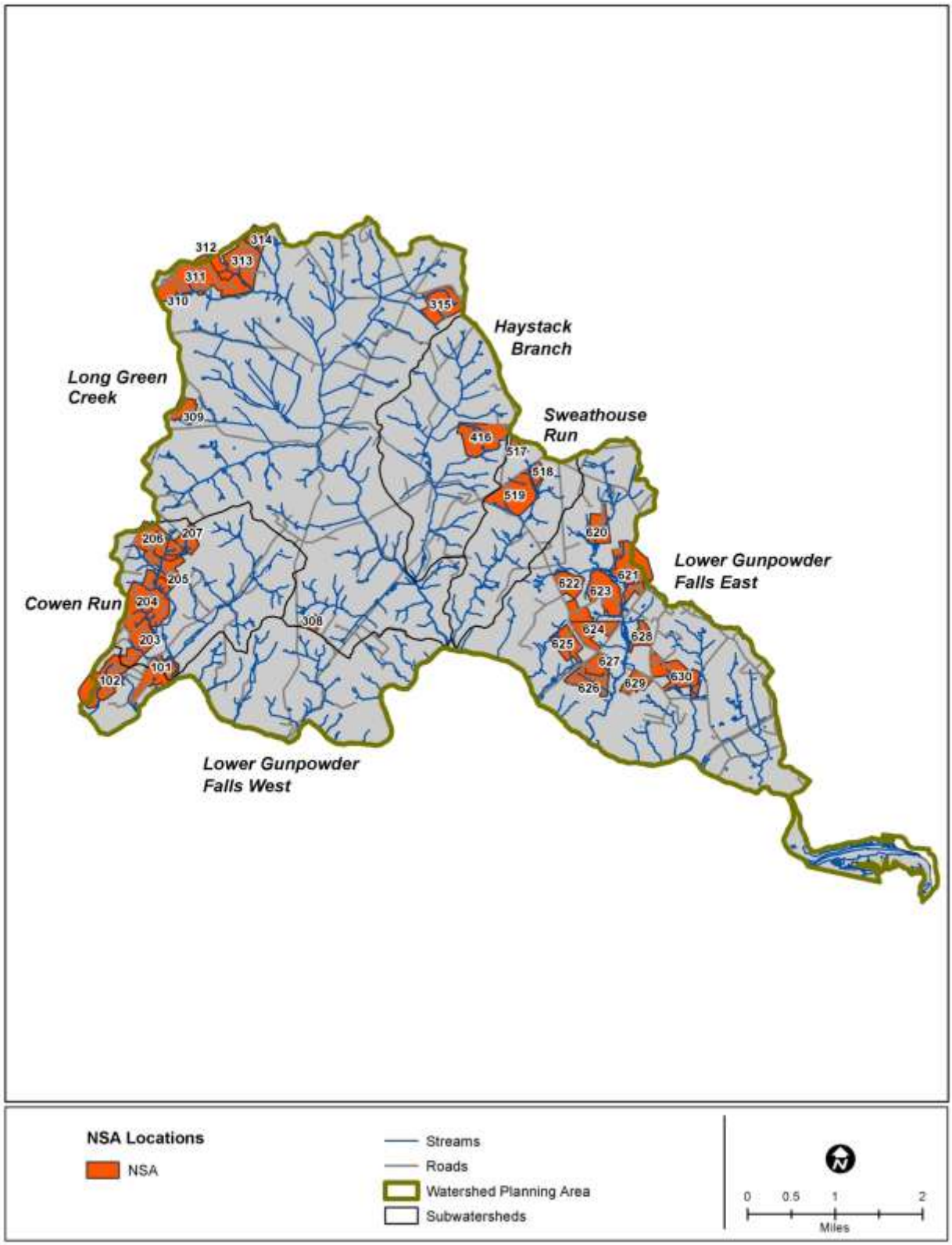


Figure 4-1: Neighborhood Source Assessment (NSA) Locations in Lower Gunpowder Falls Area Q

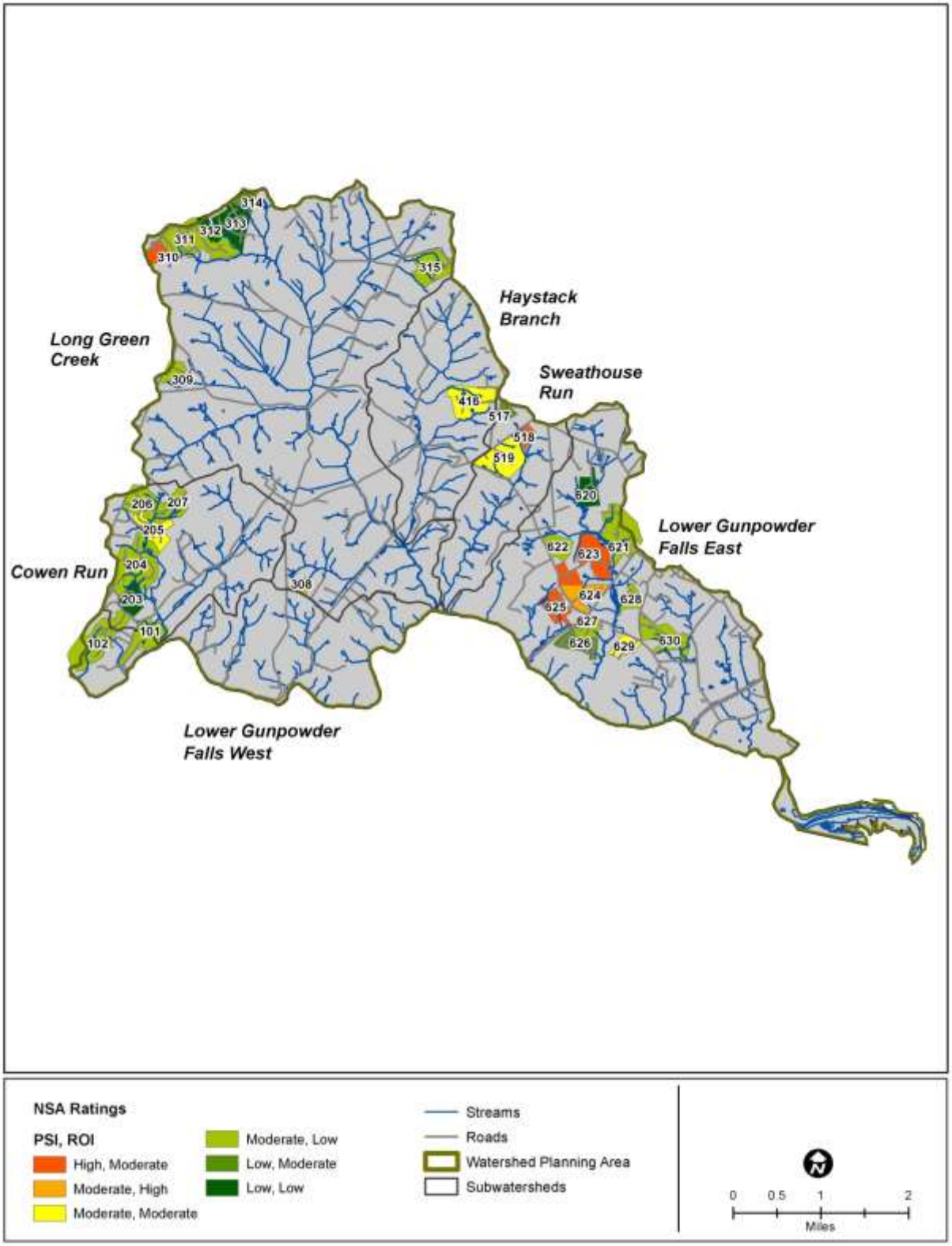


Figure 4-2: Neighborhood Source Assessment (NSA) Ratings in Lower Gunpowder Falls Area Q

4.2.3 General Findings

The following sections describe the actions for Area Q based on the NSA results. A description of the methods and criteria used to evaluate the potential for each action is provided, in addition to figures that show the neighborhoods in which each action is recommended. Due to the low density of development in Area Q, actions such as parking lot and alley retrofits and street tree plantings identified for other Small Watershed Action Plans were not relevant. Street trees were not appropriate for Area Q given the lack of sidewalks and limited right of way beyond the edge of pavement. More effective methods of adding canopy cover such as BayScaping and increasing lot canopy are suggested. Also, none of the neighborhoods had obvious common areas where residents might walk their dogs nor were there signs of pet waste. Therefore, pet waste management was not called out as a recommended action for any of the neighborhoods. Pollutant reduction opportunities identified in the watershed included fertilizer reduction and stormdrain marking. Appendix G includes a summary of NSA data collected and the actions needed for each individual neighborhood. Figure 4-3 illustrates typical neighborhood conditions for Area Q.

Figure 4-3: Example Residential Development in Lower Gunpowder Falls Area Q

Fertilizer Reduction/Education

Lawn maintenance activities often involve fertilization, pest-management, and watering. Lawns with a dense, uniform grass cover and green color are indicative of high lawn maintenance activities. The result is often polluted stormwater runoff that drains to local streams. The lawn care assessment was conducted in the winter. Neighborhoods where 20 percent or more of the homes employ high lawn maintenance practices are generally identified for a fertilizer reduction/education program.

Table 4-2 summarizes the number of neighborhoods identified for fertilizer reduction and the acres of lawn addressed if this were implemented. The acres of lawn addressed are based on the percentage of high maintenance lawns present in each neighborhood for which fertilizer reduction is identified.

Table 4-2 also lists the percentage of total subwatershed area that would be addressed by this practice. The area treated in each neighborhood is based on the amount of lawn area. First, the lot area is found by taking the total acreage in each assessed neighborhood and subtracting out the acres of impervious roadway and buildings. This number is then multiplied by two factors estimated during the NSA assessment: the average percentage of grass cover on each lot and the percentage of high maintenance lawns in the neighborhood area.

Table 4-2: Acres of Lawn Addressed by Fertilizer Reduction

Subwatershed	# of Neighborhoods Identified for Fertilizer Reduction	Acres of Lawn Addressed	% of Subwatershed Area Addressed
Lower Gunpowder Falls West	0	0.00	0.00%
Cowen Run	1	1.26	0.07%
Long Green Creek	2	11.38	0.16%
Haystack Branch	1	31.18	1.65%
Sweathouse Run	1	4.33	0.40%
Lower Gunpowder Falls East	5	56.73	1.19%
Total	**10**	**104.88**	**0.56%***

* Percent of entire Watershed Area Q

Figure 4-4 shows the locations of neighborhoods identified for fertilizer reduction/ education. Of the 30 neighborhoods assessed, 10 were identified for fertilizer reduction/ education. However, implementation of fertilizer reduction/education will only address about 0.6 percent of the total area. There are many neighborhoods that have a high percentage of grass cover classified as medium maintenance lawns. These neighborhoods may also prove to be a valuable target for fertilizer reduction/education.

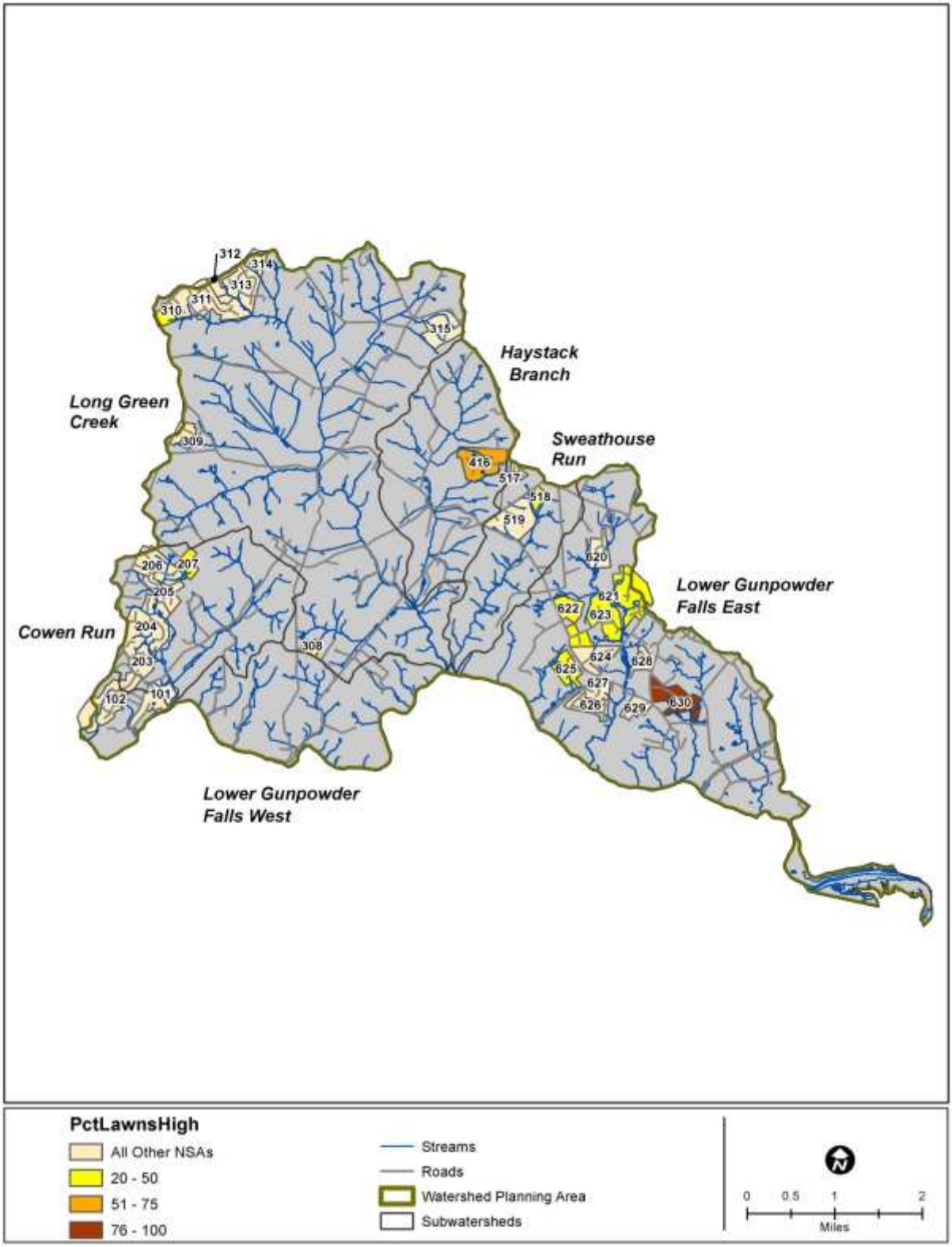


Figure 4-4: Percentage of High Maintenance Lawns in Neighborhoods

BayScaping

BayScaping refers to the use of plants native to the Chesapeake Bay watershed for landscaping. Plants used in BayScaping are native to the region and therefore 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 was identified for implementation in neighborhoods where the lots were at least ¼ acre in size, where 10 percent or less of the lots were already landscaped, and where there was sufficient open grass area available to implement BayScaping. Because many of the neighborhoods in Area Q were on large lots of one acre or greater and had adequate forest canopy, a total of 12 neighborhoods were identified for possible Bayscaping. Table 4-3 includes a summary of neighborhoods identified for BayScaping in each subwatershed and the total acres of land addressed. It also includes the percentage of total subwatershed area addressed. Area to be treated is based on the existing landscaped percentage of the lot, estimated during the NSA assessment. Lot area is found by taking the total acreage in each assessed neighborhood and subtracting out the acres of impervious roadway and buildings. This area is multiplied by the difference, in percent, between the target of 10 percent and the existing landscaped percentage. Figure 4-5 illustrates the location of the neighborhoods identified for BayScaping.

Table 4-3: Acres of Land Addressed by BayScaping

Subwatershed	# of Neighborhoods Identified for BayScaping	Acres of Land Addressed	% of Subwatershed Area Addressed
Lower Gunpowder Falls West	0	0.00	0.00%
Cowen Run	0	0.00	0.00%
Long Green Creek	3	0.79	0.01%
Haystack Branch	0	0.00	0.00%
Sweathouse Run	2	6.21	0.57%
Lower Gunpowder Falls East	7	14.05	0.30%
Total	**12**	**21.05**	**0.11%***

* Percent of entire Watershed Area Q

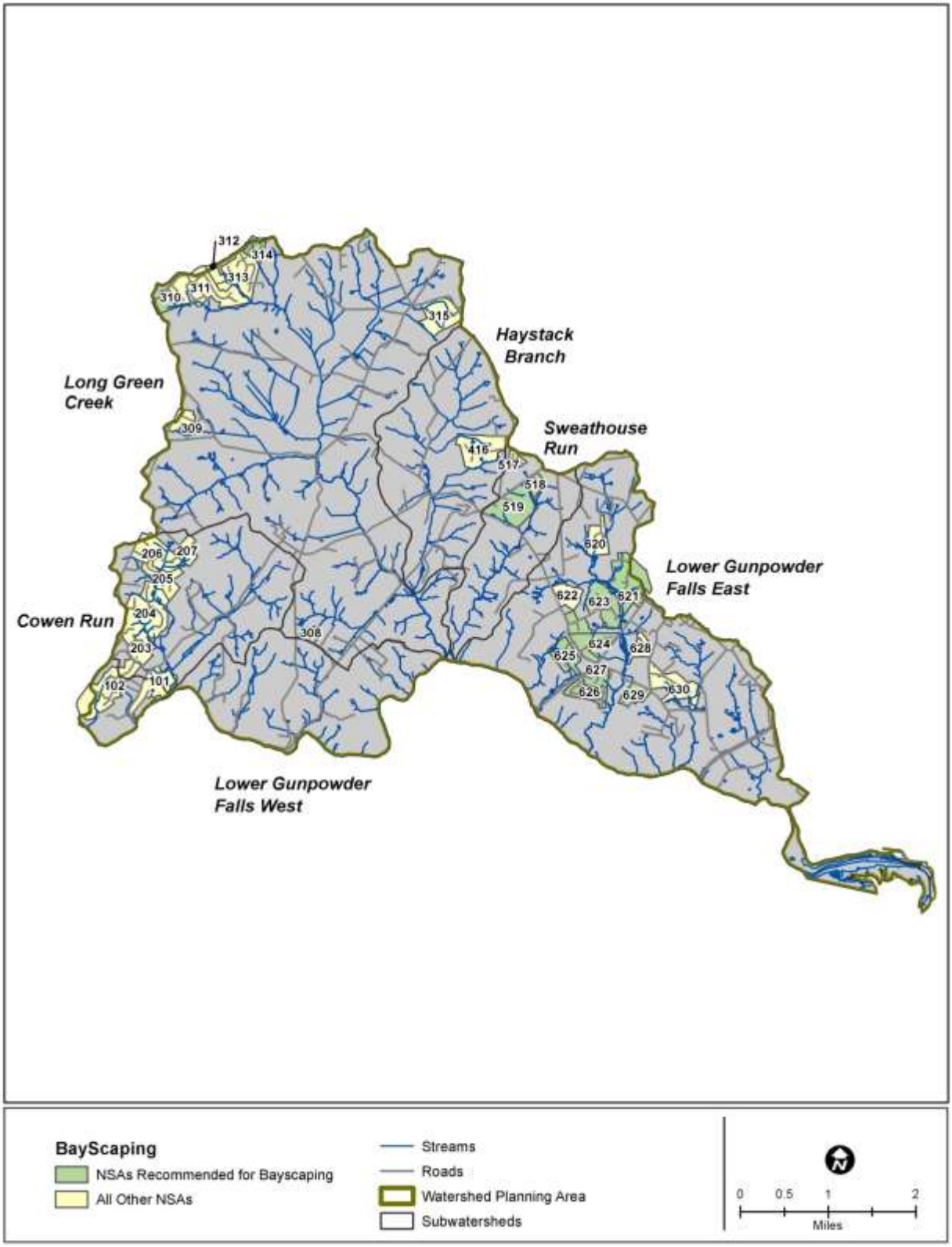


Figure 4-5: Neighborhoods Identified for BayScaping

Storm Drain Marking

Most of the neighborhoods in Area Q have roads with curb and gutter systems that include storm drain inlets that convey stormwater runoff quickly and directly to the stream system and ultimately to the Chesapeake Bay. However, most of the neighborhoods assessed did not have inlets marked as an awareness indicator that the inlets drain untreated stormwater. Storm drain marking indicates that the inlets drain to the local waterways. This is a way to educate residents that anything collecting 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 nearest stream and eventually the Chesapeake Bay.

Neighborhoods recommended for storm drain marking have curb and gutter systems with inlets appropriate for marking. As shown in Table 4-4, a majority of neighborhoods are recommended for storm drain marking. They are shown in Figure 4-6. Area treated was calculated using the total area of each recommended neighborhood: streets, public and privately-owned lots, and common areas. The calculation of inlets to be marked was made by overlaying storm drain mapping with the NSA neighborhoods. All inlets draining to an outfall within a designated neighborhood were assumed to be candidates for marking.

Table 4-4: Acres of Land Addressed by Storm Drain Marking

Subwatershed	# of Neighborhoods Identified for Storm Drain Marking	Acres of Land Addressed	% of Sub-watershed Area Addressed	Approx # of Inlets Addressed	Inlet Drainage Area from Minor and Major Outfall Shapefiles	% of Sub-watershed Inlets Addressed
Lower Gunpowder Falls West	1	136.86	6.77%	0*	0.00	0.00%
Cowen Run	5	395.54	23.05%	18	43.90	100.00%
Long Green Creek	5	392.16	5.42%	17	51.34	54.84%
Haystack Branch	1	101.45	5.35%	24	18.90	100.00%
Sweathouse Run	2	127.15	11.67%	17	32.80	85.00%
Lower Gunpowder Falls East	8	526.11	11.06%	18	47.50	69.23%
Total	**22**	**1711.80**	**9.08%**	**94**	**194.44**	**1.03%****

*Although one neighborhood in Little Gunpowder Falls West was identified for storm drain marking, there were no outfalls or corresponding inlets for this neighborhood within the storm drain mapping data.

** Percent of entire Watershed Area Q.

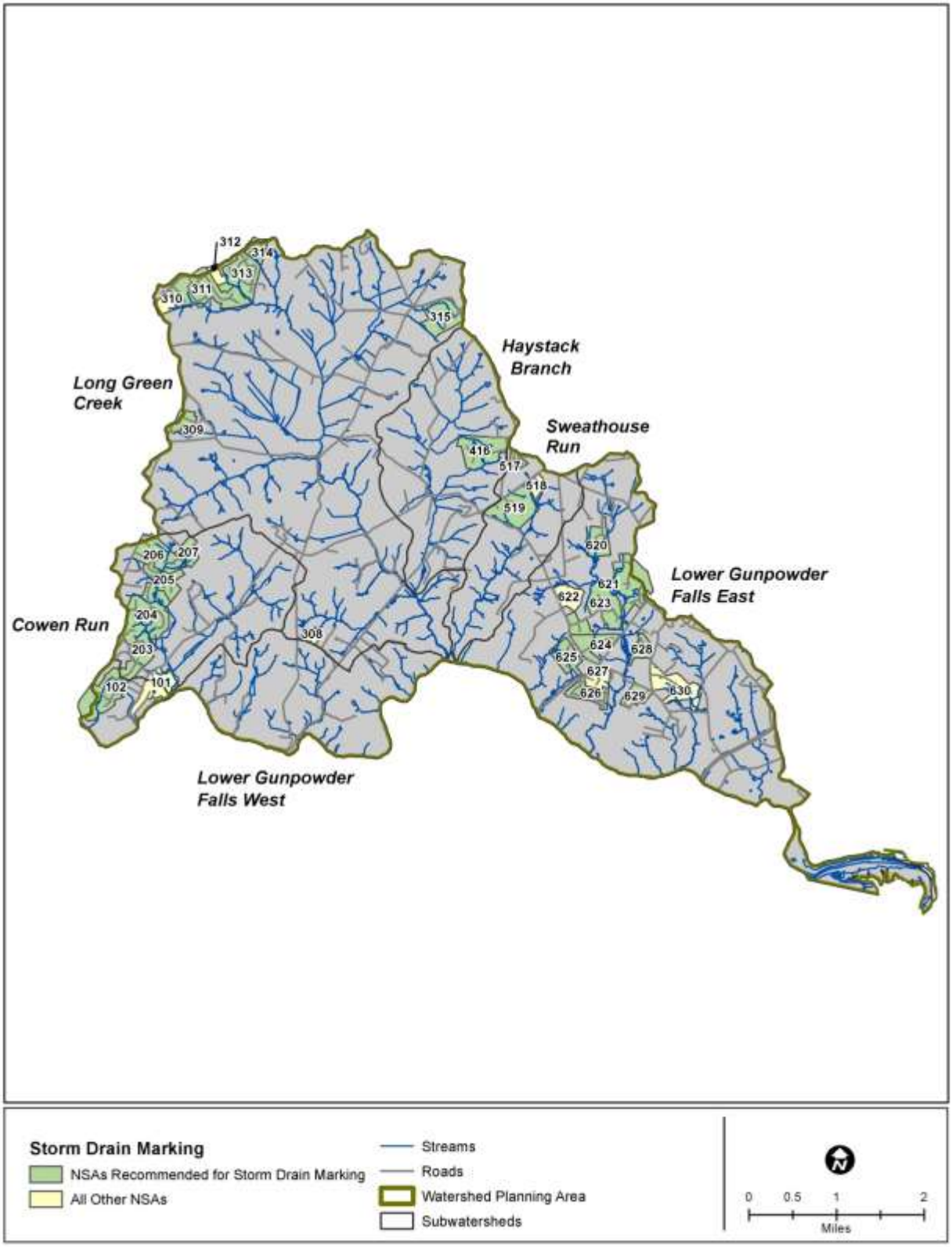


Figure 4-6: Acres of Land Addressed by Storm Drain Marking

Lot Canopy Improvement

Increasing the canopy cover in a watershed is an effective way of reducing runoff and peak flows, promoting infiltration to ground water, providing filtration for water quality, moderating the effect of summer heat spikes on stream temperature, and supplying food in the way of leaf litter for organisms at the base of the stream food web. Reforestation reduces the amount of lawn area and provides more terrestrial habitat in developed areas.

Outreach efforts to encourage canopy improvements were identified in neighborhoods where existing canopy coverage was less than 40 percent of the lot. Twelve of the 30 assessed neighborhoods met these criteria as shown in Figure 4-7. Table 4-5 includes a summary of neighborhoods identified for canopy improvement in each subwatershed and the total acres of land addressed. It also includes the percentage of total subwatershed area addressed through implementation of canopy improvements. The area treated is based on the existing canopy cover of the lot, estimated during the NSA assessment. Lot area is found by taking the total acreage in each assessed neighborhood and subtracting out the acres of impervious roadway and buildings. This area is multiplied by the difference, in percent, between the target of 40 percent and the existing percentage of canopy cover.

Fourteen of the 30 neighborhoods were recommended for better stream buffer management due to encroachment by mowing or by structures. These stream buffers can be enhanced through reforestation, thereby increasing the lot canopy.

Table 4-5: Acres of Land Addressed by Lot Canopy Improvement

Subwatershed	# of Neighborhoods Identified for Canopy Improvement	Acres of Land Addressed	% of Subwatershed Area Addressed
Lower Gunpowder Falls West	0	0.00	0.00%
Cowen Run	0	0.00	0.00%
Long Green Creek	3	11.53	0.16%
Haystack Branch	0	0.00	0.00%
Sweathouse Run	2	8.05	0.74%
Lower Gunpowder Falls East	7	67.77	1.42%
Total	**12**	**87.35**	**0.46%***

* Percent of entire Watershed Area Q

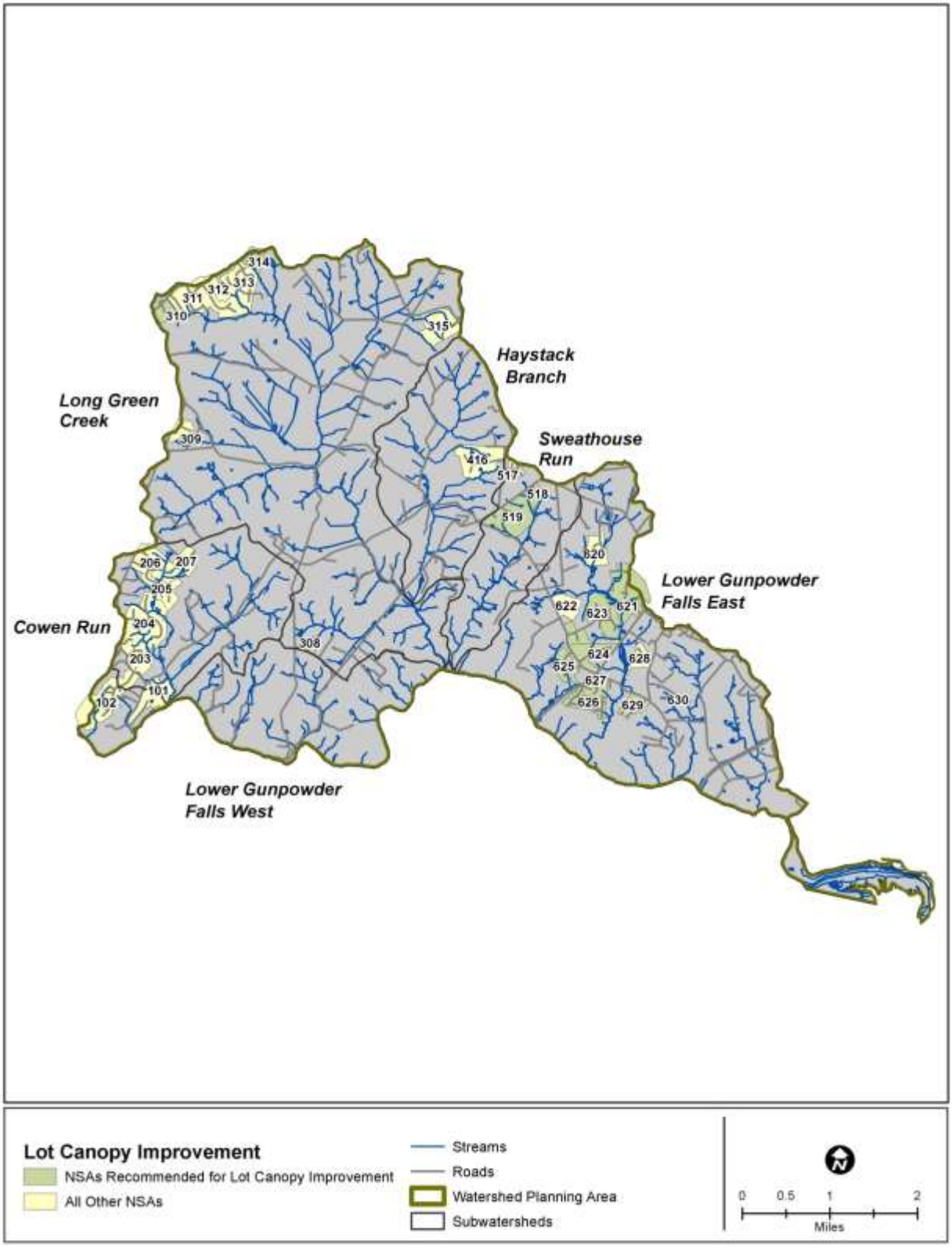


Figure 4-7: Location of the Neighborhoods Identified for Lot Canopy Improvements

4.3 Hotspot Site Investigation (HSI)

Stormwater hotspots are areas that have potential to generate higher concentrations of stormwater pollutants than typically found in urban runoff and/or have a higher risk of spills, leaks, or illicit discharges due to the nature of their operations (CWP 2004). These generally include commercial, industrial, government, or transport-related operations. Stormwater pollutants generated as a result of hotspot operations depend on the specific site activities, but typically include nutrients, hydrocarbons, metals, chloride, pesticides, bacteria, and trash.

Commercial hotspots include a range of businesses and activities. Operations characteristic of commercial hotspots include waste or wash water generation, outdoor material storage, fuel handling, or vehicle 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 National Pollution Discharge Elimination System (NPDES) industrial discharge permits. Like industrial operations, many government hotspots are subject to NPDES stormwater permits. Many are regulated and include uses such as airports, ports, highway construction, and trucking centers.

The purpose of the HSI is to evaluate pollution potential from hotspot operations and identify potential restoration practices that may be necessary. The following subsections describe the methods used to identify and assess the hotspots in Area Q.

4.3.1 Assessment Protocol

A desktop assessment identified the list of potential hotspot sites to investigate in the Lower Gunpowder Falls subwatersheds. The HSIs were focused on unregulated hotspots since regulated hotspots are previously known pollutant sources. Regulated stormwater hotspots are already subject to NPDES permit regulations.

While hotspots have unique operations, drainage systems, and pollutant-related risks, stormwater quality problems can be characterized and evaluated by operations and activities common to most hotspots. The HSI provides 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 visited each potential hotspot to determine water quality impacts and restoration opportunities. These six categories were used to standardize the HSI process and be able to prioritize potential restoration efforts. These categories are described briefly below.

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 major source of metals, oil and grease, and hydrocarbons. Outdoor activities including vehicle storage, repair, fueling, and washing were also noted as potential pollution sources.

Outdoor Materials

Stormwater quality issues result from improper handling or storage of outdoor materials at hotspots. Locations where materials were loaded or unloaded were examined to see if they were uncovered and draining to a storm drain inlet. Storage areas were also evaluated for types of materials stored outdoors and their potential for entering the storm drain system. The field team 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. If any of these were observed, they were marked as potential pollution sources.

Waste Management

Every hotspot generates waste as a result of daily operations that can be potentially hazardous or a source 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., hazardous, garbage, etc.) and the condition of dumpsters. Dumpsters with no cover or open lids, with leaks, damaged/in poor condition, and/or overflowing were noted as potential pollution sources. Dumpsters located near storm drain inlets or lacking runoff diversion methods were also recorded as potential pollution sources.

Physical Plant

Common physical plant practices include cleaning, maintaining, or repairing the building, outdoor work areas, and parking lots. For each hotspot, the condition of the building itself was evaluated. Similarly, parking lots that were stained, dirty, breaking up, and/or impervious were recorded as potential pollution sources.

Turf/Landscaping

Ground maintenance activities for turf/landscaped areas were also evaluated at hotspot sites. High turf management 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 such as leaves and grass accumulated on impervious surfaces.

Stormwater Infrastructure

If stormwater treatment practices were not present, this was flagged as a potential pollution source. Private storm drains were also evaluated for pollution potential. Storm drains with considerable amounts of sediment, organics, and/or trash was identified as potential pollution sources.

For each operation on the HSI field form, there is an observed pollution source box that is checked when there is clear evidence of pollution problems at a site. One example would be washwater from an automotive or vehicle operations business being washed down into a storm drain, or oil and grease stains on the pavement. If applicable, one or more of the potential follow-up actions listed below were identified, based on field observations of a hotspot site.

- Refer for immediate enforcement
- Follow-up on-site inspection

- Test for illicit discharge
- Future education effort
- On-site non-residential retrofit
- Check to see if hotspot is an NPDES non-filer
- Pervious area restoration candidate
- Schedule a review of storm water pollution prevention plan

The overall pollution prevention potential for each hotspot site is assessed based on observed sources of pollution and the potential of the site to generate pollutants that would likely enter the storm drain network. There are up to 26 potential pollution sources rated in the assessment. Sites are classified into four hotspot severity categories:

- Not a Hotspot – no observed pollutant; less than 5 sources noted
- Potential– no observed pollution; five to ten sources noted
- Confirmed– pollution observed; 10 to 15 sources noted
- Severe– multiple polluting activities directly observed, more than 15 sources noted

4.3.2 Summary of Sites Investigated and General Findings

There were 25 hotspot candidates investigated in Area Q, as shown in Table 4-6. A majority of the sites were located in the Long Green Creek subwatershed. All except for three of the sites investigated were commercial and industrial establishments. Those three sites were municipal facilities or transport-related. These were investigated primarily for opportunities to improve waste management, storage of outdoor materials, vehicle operations areas, and stormwater management. One site was confirmed as a hotspot and no sites were found to be severe. Five sites were found to be potential hotspots (where no *active* pollution was found) and nineteen sites were not hotpots. Figure 4-8 provides photos of the confirmed and potential hotspots and Figure 4-9 shows the locations of the sites investigated in Area Q.

Table 4-6: Summary of Hotspot Sites Investigated in Area Q

Site ID	Type	Subwatershed	HSI Status
HSI_Q_101	Commercial	Lower Gunpowder Falls West	Not a Hotspot
HSI_Q_202	Commercial	Cowen Run	Not a Hotspot
HSI_Q_203	Commercial	Cowen Run	Not a Hotspot
HSI_Q_304	Commercial	Long Green Creek	Not a Hotspot
HSI_Q_305	Commercial	Long Green Creek	Not a Hotspot
HSI_Q_306	Commercial	Long Green Creek	Potential
HSI_Q_307	Commercial	Long Green Creek	Not a Hotspot
HSI_Q_308	Commercial	Long Green Creek	Not a Hotspot
HSI_Q_309	Municipal	Long Green Creek	Potential
HSI_Q_310	Commercial	Long Green Creek	Not a Hotspot
HSI_Q_311	Commercial	Long Green Creek	Not a Hotspot

HSI_Q_312	Commercial	Long Green Creek	Not a Hotspot
HSI_Q_313	Commercial	Long Green Creek	Potential
HSI_Q_314	Commercial	Long Green Creek	Not a Hotspot
HSI_Q_315	Municipal	Long Green Creek	Not a Hotspot
HSI_Q_316	Commercial	Long Green Creek	Not a Hotspot
HSI_Q_317	Commercial	Long Green Creek	Not a Hotspot
HSI_Q_318	Commercial	Long Green Creek	Not a Hotspot
HSI_Q_319	Commercial	Long Green Creek	Potential
HSI_Q_320	Commercial	Long Green Creek	Not a Hotspot
HSI_Q_321	Commercial	Long Green Creek	Not a Hotspot
HSI_Q_622	Transport-Related	Lower Gunpowder Falls East	Potential
HSI_Q_623	Commercial	Lower Gunpowder Falls East	Not a Hotspot
HSI_Q_624	Commercial	Lower Gunpowder Falls East	Not a Hotspot
HSI_Q_625	Industrial	Lower Gunpowder Falls East	Confirmed

Figure 4-8: Outdoor Materials Storage at Maryland Scrap Metal Recyclers, HSI_Q_625 (top left) and at Tracker Boats, HSI_Q_622 (top right); Outdoor materials storage (bottom left and right) at HSI_Q_306 the United Container property

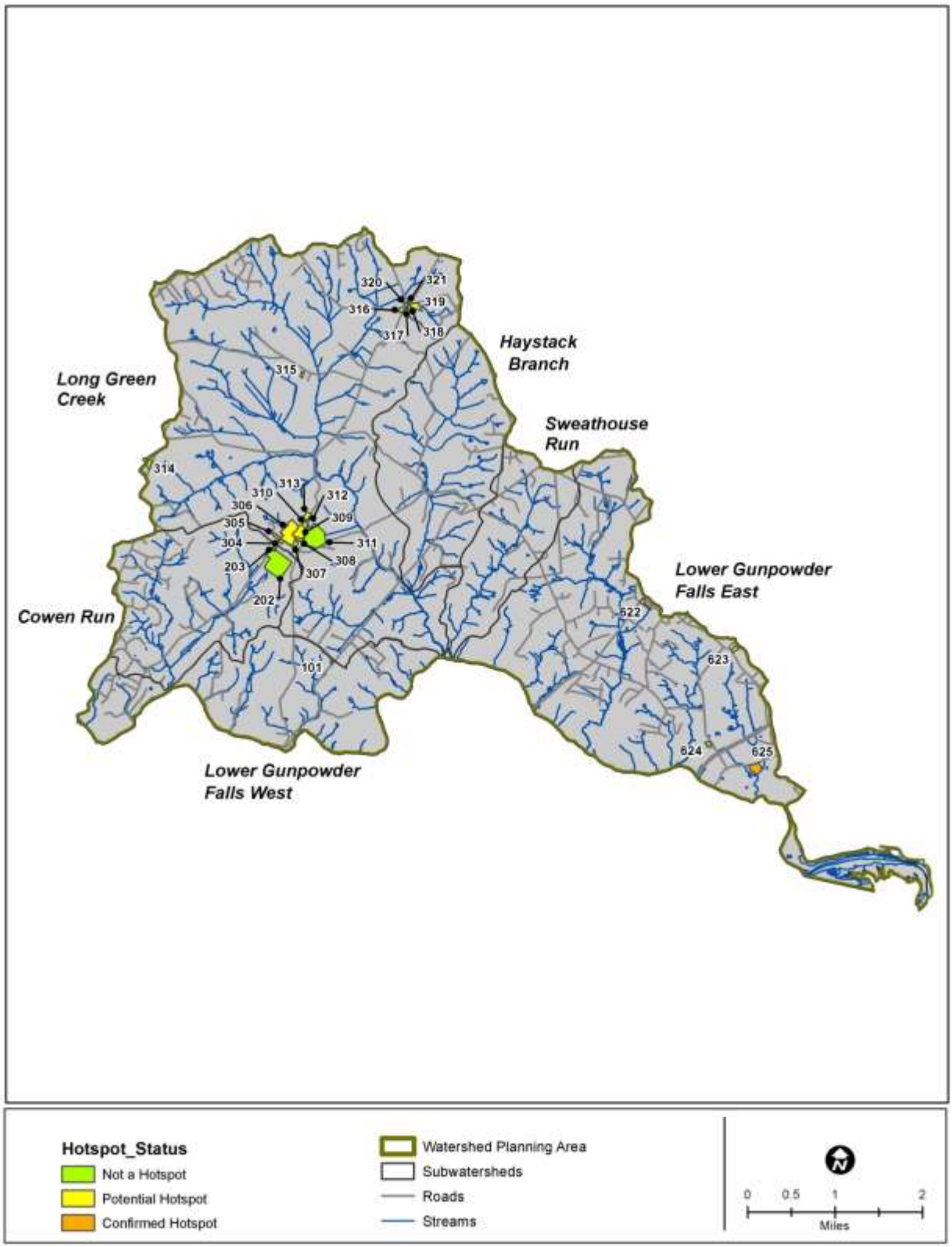


Figure 4-9: Locations of Hotspot Site Investigations (HSIs) in Area Q

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 HSI protocols. Consistent with earlier SWAP projects, 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. The institutional sites surveyed within the Lower Gunpowder Falls subwatersheds as part of this study included faith-based facilities, golf courses, private and public schools, a meeting hall, and a public park. The following subsections describe the methods used to identify and evaluate pollution sources and restoration potential at institutional facilities.

4.4.1 Assessment Protocol

Institutional properties were identified in the office prior to conducting the field assessment using GIS tax parcel information, land use data, and aerial imagery. In the field, sites were visited to collect necessary data and take photographs. The ISI field form includes many of the pollution source categories used on the HSI form that include an assessment of vehicle operations, outdoor materials, waste management, turf/landscaping areas, and stormwater infrastructure. Some of the restoration opportunities and actions from the NSAs 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 sources and restoration categories is briefly described below.

Tree Planting

Potential tree planting locations at an institution were marked on aerial photographs while at the property. The tree planting area was calculated in GIS to estimate the total number of trees that could be planted at the site based on 40-foot spacing between trees or 200 trees/acre.

Exterior

The exterior category is similar to the physical plant category in the HSI, except it also includes restoration opportunities. The condition of the building(s) and parking lot(s) were noted. Stained, dirty, 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.

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 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

Most institutions do not have vehicle operations but a few may have buses on-site. 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.

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 see if materials were uncovered and draining to a storm drain inlet. Storage areas were also 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 percent of bare soil were noted as a potential source of sediment pollution. Ground maintenance activities for turf/landscaped areas were also evaluated. High turf management and improper irrigation practices (i.e. non-target/over-watering) 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 (i.e. leaves, grass) accumulated on impervious surfaces. Evidence of buffer encroachment and whether the 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 potential pollution sources and restoration potential.

After evaluating the categories discussed above, if appropriate one or more of the follow-up actions listed below were identified based on initial field observations:

- Storm drain marking
- Tree planting
- Downspout disconnection
- Stormwater retrofit
- Education

- Impervious cover removal
- Stream buffer improvement
- Trash management
- Invasive species removal
- Follow-up on-site inspection

4.4.2 Summary of Sites Investigated and General Findings

There were 18 institutional sites assessed in Area Q; a total of 12 sites had some identifiable action, mainly potential tree planting opportunities. Information about these sites and identified actions for each one are summarized in Table 4-7. Figure 4-10 shows some areas for potential action at institutional sites in Area Q and Figure 4-11 shows the locations of these sites.

Figure 4-10: Opportunity for Tree Planting at ISI_Q_510a (top left) and ISI_Q_510b (top right); Potential Stormwater Retrofit location at ISI_Q_304 (bottom left), and Trash Management at ISI_Q_201 (bottom right)

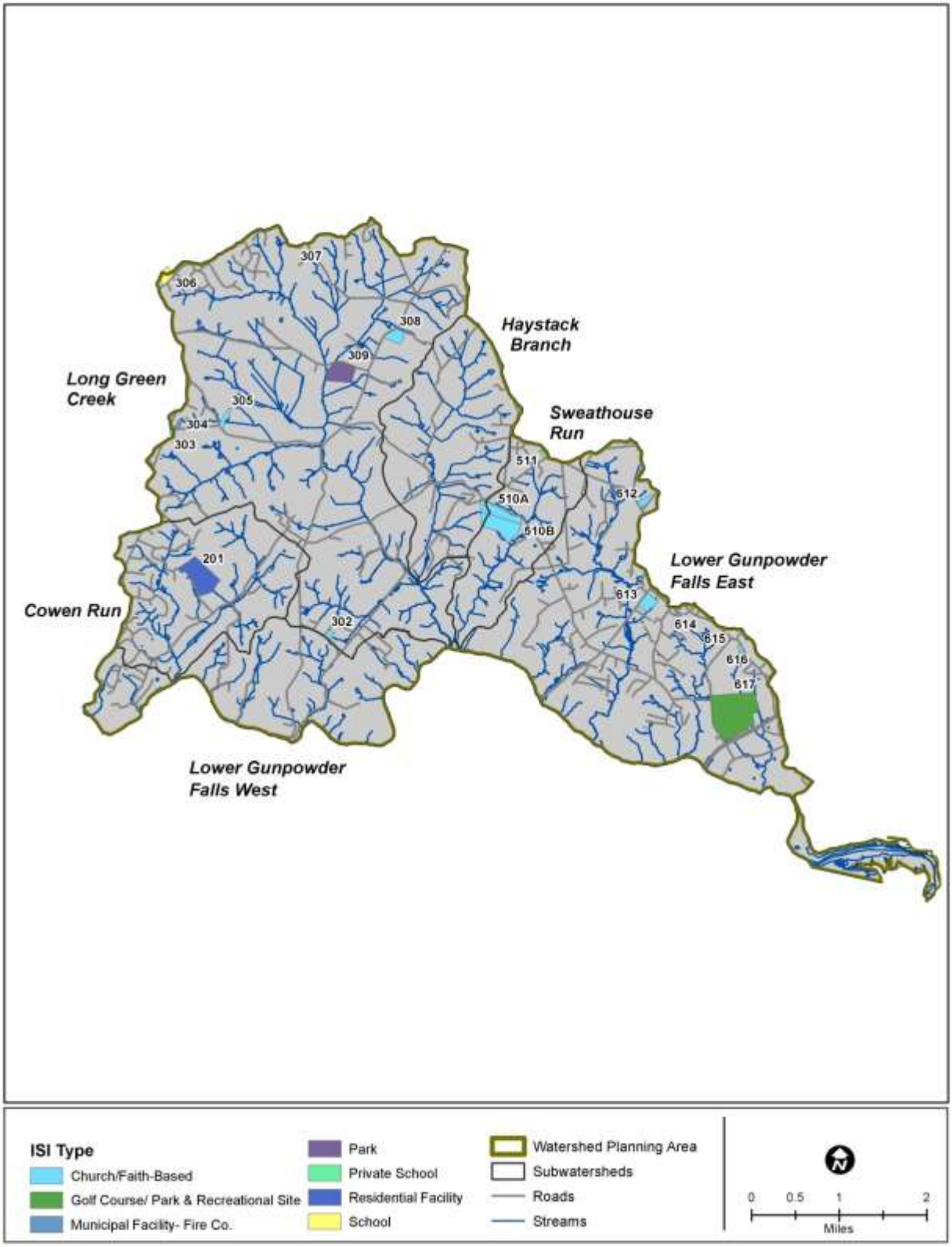


Figure 4-11: Institutional Site Investigation (ISI) Locations in Area Q

Table 4-7: Types of Institutions Assessed by Subwatershed and Identified Actions

Site ID	Type	Sub-watershed	Identified Actions				
			Tree Planting	Stormwater Retrofit	Downspout Disconnection	Trash Management	Stormdrain Marking
ISI_Q_201	Residential Facility	Cowen Run	Y	Y	N	Y	N
ISI_Q_302	Faith-Based	Long Green Creek	Y	N	N	N	N
ISI_Q_303	Faith-Based	Long Green Creek	N	N	N	N	N
ISI_Q_304	Fire Company	Long Green Creek	Y	Y	N	N	N
ISI_Q_305	Faith-Based	Long Green Creek	Y	N	N	N	N
ISI_Q_306	School	Long Green Creek	Y	Y	N	N	N
ISI_Q_307	Faith-Based	Long Green Creek	N	N	N	N	N
ISI_Q_308	Faith-Based	Long Green Creek	Y	N	N	N	N
ISI_Q_309	Park & Recreational	Long Green Creek	N	Y	N	N	N
ISI_Q_510a	Faith-Based	Sweathouse Run	Y	N	N	Y	N
ISI_Q_510b	Faith-Based	Sweathouse Run	Y	N	N	N	N
ISI_Q_511	School	Sweathouse Run	Y	N	N	N	N
ISI_Q_612	Faith-Based	Lower Gunpowder Falls East	Y	N	N	N	N
ISI_Q_613	Faith-Based	Lower Gunpowder Falls East	N	Y	N	Y	Y
ISI_Q_614	Fire Company	Lower Gunpowder Falls East	N	Y	N	N	N
ISI_Q_615	Faith-Based	Lower Gunpowder Falls East	N	N	N	N	N
ISI_Q_616	Faith-Based	Lower Gunpowder Falls East	N	N	Y	N	N
ISI_Q_617	Park & Recreational	Lower Gunpowder Falls East	N	Y	N	N	N

Tree Planting

A total of 18.11 acres were identified to be planted in Area Q at ten different institutional sites. If all of these acres were planted, it is estimated that a total of 3,626 trees would be needed. These numbers are planning level estimates only and would need to be refined through follow-up site investigations and conversations with landowners

Stormwater Retrofit

Stormwater retrofits are recommended for one faith-based institutional site, two volunteer fire department sites, one public park, one retirement community, one closed golf course and one school site. Retrofit forms (RRI) were filled out for all of these sites, describing the location of the potential retrofit and its drainage area. The retrofits are intended to collect and treat runoff that is otherwise not being treated for water quality.

Downspout Disconnection

Downspout disconnection was identified for only one site – Salem United Methodist Church (ISI_Q_616). The downspouts are currently tied into underground stormwater drains, but could be disconnected to allow roof water to flow into pervious areas.

Trash Management

Trash management is recommended for three institutional sites (ISI_Q_201, ISI_Q_510a, and ISI_Q_613) where loose trash has accumulated on the ground around dumpsters. However, the problem is fairly minor. No other sites were identified as needing trash management.

Stormdrain Marking

One faith-based site (ISI_Q_613) was identified for stormdrain marking in Area Q.

4.5 Stormwater Management Retrofits and Conversions

4.5.1 Stormwater Retrofits

Stormwater retrofitting involves implementing stormwater BMPs and/or treatment devices in existing developed areas where previous practices did not exist or were not designed to improve water quality. NSAs, HSIs, and ISIs were evaluated for the potential to implement stormwater retrofits. Through field investigation, a total of ten retrofits were identified at two neighborhoods and eight institutional sites. They included swale, bioretention, step pool conveyance, pavement removal practices, and pond retrofits. Table 4-8 and Figure 4-12 provide a summary of the retrofits and their locations.

Table 4-8: Summary of Stormwater Retrofits Identified in Area Q

Site ID	Land Use Type	Subwatershed	Retrofit Type
RRI_Q_207	Institutional	Cowen Run	Pond Retrofit
RRI_Q_308	Institutional	Lower Gunpowder Falls West	RSC
RRI_Q_309	Institutional	Lower Gunpowder Falls West	Swale
RRI_Q_310	Institutional	Lower Gunpowder Falls West	Swale
RRI_Q_601	Institutional	Lower Gunpowder Falls East	Pond Retrofit and Rain Garden
RRI_Q_602	Institutional	Lower Gunpowder Falls East	Bioretention
RRI_Q_603	Institutional	Lower Gunpowder Falls East	Pavement Removal
RRI_Q_604	Institutional	Lower Gunpowder Falls East	Bioretention
RRI_Q_605	Neighborhood	Lower Gunpowder Falls East	(2) Pond Retrofits
RRI_Q_606	Neighborhood	Lower Gunpowder Falls East	Pavement Removal

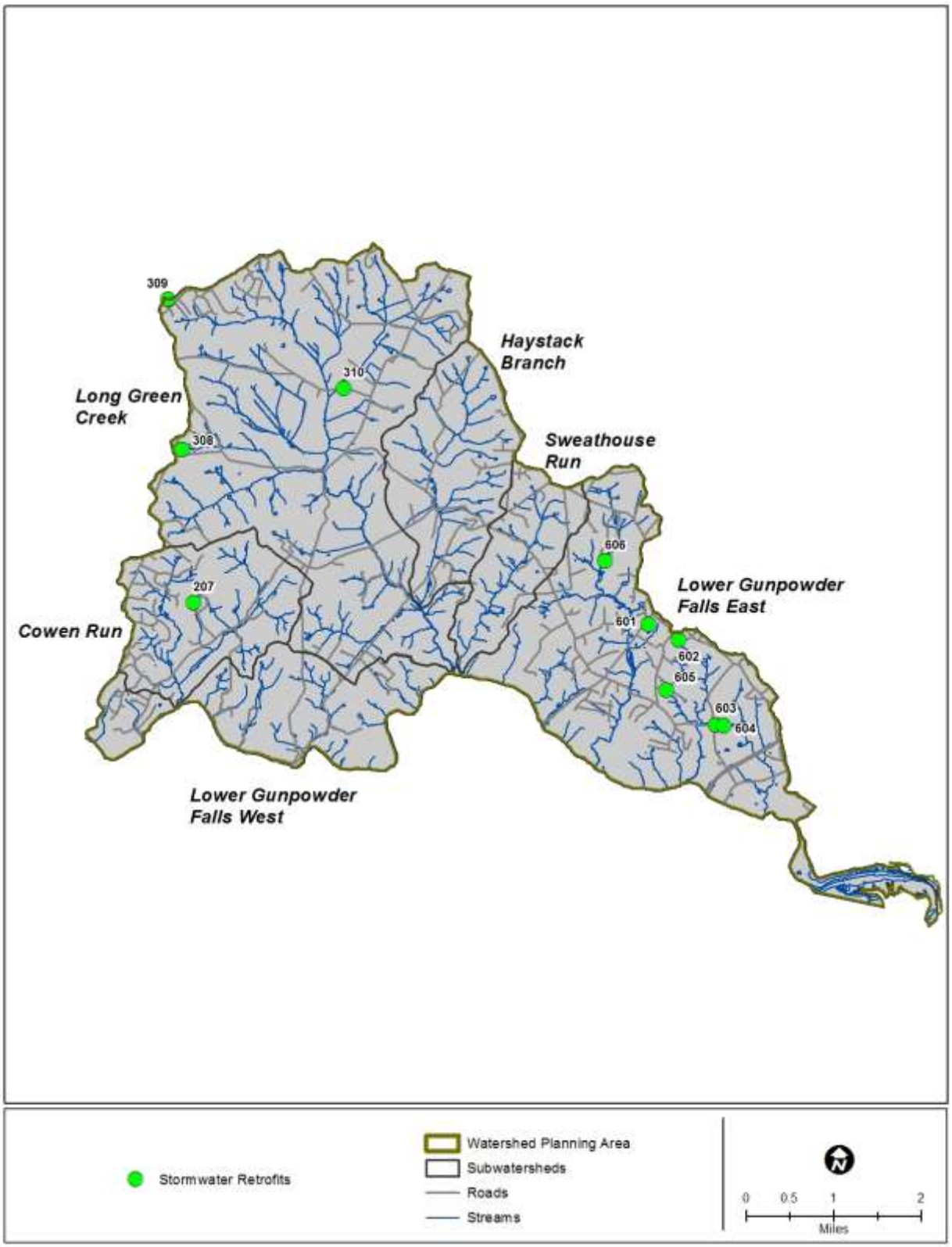


Figure 4-12: Stormwater Retrofit Locations in Area Q

Institutional sites with retrofit opportunities identified are shown in Figure 4-13 below. The sites include Grace Community Church (RRI_Q_601), Mt. Vista Public Golf Course (RRI_Q_603 and RRI_Q_604), Long Green Volunteer Fire Company (RRI_Q_308), Hyde's Road Park (RRI_Q_308), Kingsville Volunteer Fire Company (RRI_Q_602), Glen Meadows Retirement (RRI_Q_207), and Carroll Manor Elementary School (RRI_Q_309).

Grace Community Church has an existing extended detention pond on site (STRU_NO 2210) with potential to retrofit to add a water quality aspect, such as a wetland. The pond receives most of the runoff from the site through the existing closed stormdrain system. Also, there is an open space adjacent to the north side of the church with potential to treat the runoff from the roof. The downspouts are currently directly connected, but they could be disconnected to the low grassy area shown in the figure below. A proposed rain garden in this location would provide a secondary treatment on the site. The landscaped appearance would provide an attractive educational opportunity for outreach to the community regarding watershed management, water quality treatment, and actions to improve the existing watershed conditions.

Mt. Vista Public Golf Course is abandoned and the redevelopment plans are undetermined at this point. Impervious area removal is proposed on this site as a stormwater opportunity. The parking lot is cracking and in poor condition, any redevelopment would most likely replace and revise the parking lot layout. Impervious removal would directly reduce impervious cover and associated runoff. There is also an open space downstream of the east parking lot which receives runoff from a portion of the parking lot through an existing PVC pipe. A proposed bioretention facility here would treat the existing east side of the site, or any future development that would go in its place. There are other opportunities on this site, for example tree planting, but any proposed stormwater and environmental retrofits would dependent on the future development plan.

At Long Green Volunteer Fire Company, the parking area and most of the buildings drain to an open grassy area to the north of the property, and eventually drain to an unnamed branch of Gunpowder Falls. There is an existing head-cut identified at the north boundary of the property near the stream channel. An RSC (Regenerative Stormwater Conveyance) system is proposed from the grass area near the edge of the parking pavement to the stream channel to address the existing instability issue. A grass ditch is also proposed along the edge of the pavement to collect water from the parking lot and convey it to the RSC. The RSC with step pools and filtering media would also provide water quality treatment for the majority of this site.

Hyde's Road Park is a park and recreation area with no existing stormwater quality treatment identified. There is an opportunity for treating the runoff from the smaller parking lot on the west. There is an existing riprap channel on the west side of the parking lot. Part of this riprap channel at the downstream end is proposed to be removed to install a bioswale for water quality treatment, and the portion immediately downstream of the parking lot would remain to slow down the runoff from the parking lot.

Kingsville Volunteer Fire Company has no existing stormwater treatment on site. Almost half of the site drains to a closed stormdrain system, and the rest drains to the grassy open space adjacent to the parking lot. The grass area on the south side of the site is an ideal place for bioretention. The bioretention facility would treat the south parking lot and a portion of the building. There is a planned BMP at this location in the County's database, but no as-built plans were found for this facility and no existing facility was identified during site visit.

Glen Meadows Retirement has an existing dry pond on site with potential to retrofit to a wet pond or wetland to add water quality treatment. The pond receives a large portion of the site through the existing closed stormdrain system. Also, the pond appears to have baseflow from groundwater seeps in the adjacent hillsides and channel. The channel upstream of this pond currently has minor to moderate erosion, which needs to be stabilized. The pond and the upstream channel could be considered for future investigation, as they are on private property.

Carroll Manor Elementary School has no existing stormwater quality treatment on site. There is an opportunity for treating the runoff from the concrete sidewalks and portion of the school building on the north of the building adjacent to the two existing inlets. Two bioswales are proposed along the north of the school building at the grass area for water quality treatment, one for each of the existing inlet on upstream side. The underdrains of bioswales would be connected to the existing inlets.

Figure 4-13: Institutional Site Retrofit Opportunities for Raingarden at Grace Community Church, RRI_Q_601 (top left); Pavement Removal and Bioretention at Mt. Vista Public Golf Course, RRI_Q_603 (top right) and RRI_Q_604 (middle top left); RSC at Long Green Volunteer Fire Company, RRI_Q_308 (middle top right); Swale at Hyde's Road Park, RRI_Q_308 (middle bottom left); Bioretention at Kingsville Volunteer Fire Company, RRI_Q_602 (middle bottom right); Glen Meadows Retirement, RRI_Q_207 (bottom left); Carroll Manor Elementary School, RRI_Q_309 (Bottom right)

Neighborhood sites with retrofits identified are shown in Figure 4-14 below. The sites include Days Woods Manor (RRI_Q_605) and Merrywood Drive (RRI_Q_606). Days Woods Manor has two existing extended detention ponds in the neighborhood. One is on the south side of the road approximately 300 feet down Days Woods Manor (STRU_NO 1574), and the second is at the end of the road adjacent to the cul-de-sac (STRU_NO 1575). Both existing facilities have potential to be retrofit to include water quality treatment, either by retrofitting them into wet ponds, or by creating a wetland. These ponds could be considered for future investigation, as they are not owned by the county.

Merrywood Drive is a closed section road with a cul-de-sac. There is a potential opportunity to remove some of the impervious area in the center of the cul-de-sac to create a grass median area. Future investigations to determine the feasibility of this are required to determine the minimum size turn around for emergency vehicles in a cul-de-sac and any specific county codes and regulations.

Figure 4-14: Neighborhood Site Retrofit Opportunities for Wet Pond or Wetland at Days Woods Manor, RRI_Q_605 (top left and right); Impervious Removal at Merrywood Drive cul-de-sac (bottom)

4.5.2 Stormwater Conversions

Existing SWM facilities within the Area Q watershed were investigated for potential conversion to water quality management facilities. As discussed in Chapter 2.3.6.2, there are a total of 45 SWM facilities that have been built in the Area Q watershed according to Baltimore County EPS database. These include dry and wet ponds, extended detention ponds, filtration and infiltration systems (Table 2-14). Approximately 70 percent of the SWM facilities in the watershed (32 out of 45) are either filtration/infiltration practices or wet pond/wetland facilities. These practices are considered to have higher pollutant removal capabilities, since stormwater has a chance to infiltrate into the ground or through plant roots, compared to conventional SWM techniques which are designed for quantity control without water quality improvement features.

Of the 45 existing SWM facilities, Baltimore County EPS identified six facilities with the potential to be converted to another practice that provides greater water quality benefits. Dry detention ponds are typically designed to address water quantity only (flood control) and therefore, provide almost no pollutant removal. Extended detention ponds provide some pollutant removal benefits due to 12-24 hour detention of stormwater runoff after rain events, but generally have the lowest pollutant removal rate of stormwater practices designed for water quality improvement. These two types of ponds have the greatest potential for conversion to another type of facility that provides greater water quality benefits. The locations of the ponds identified for potential conversion in Area Q are shown in Figure 4-15 and summarized in Table 4-9.

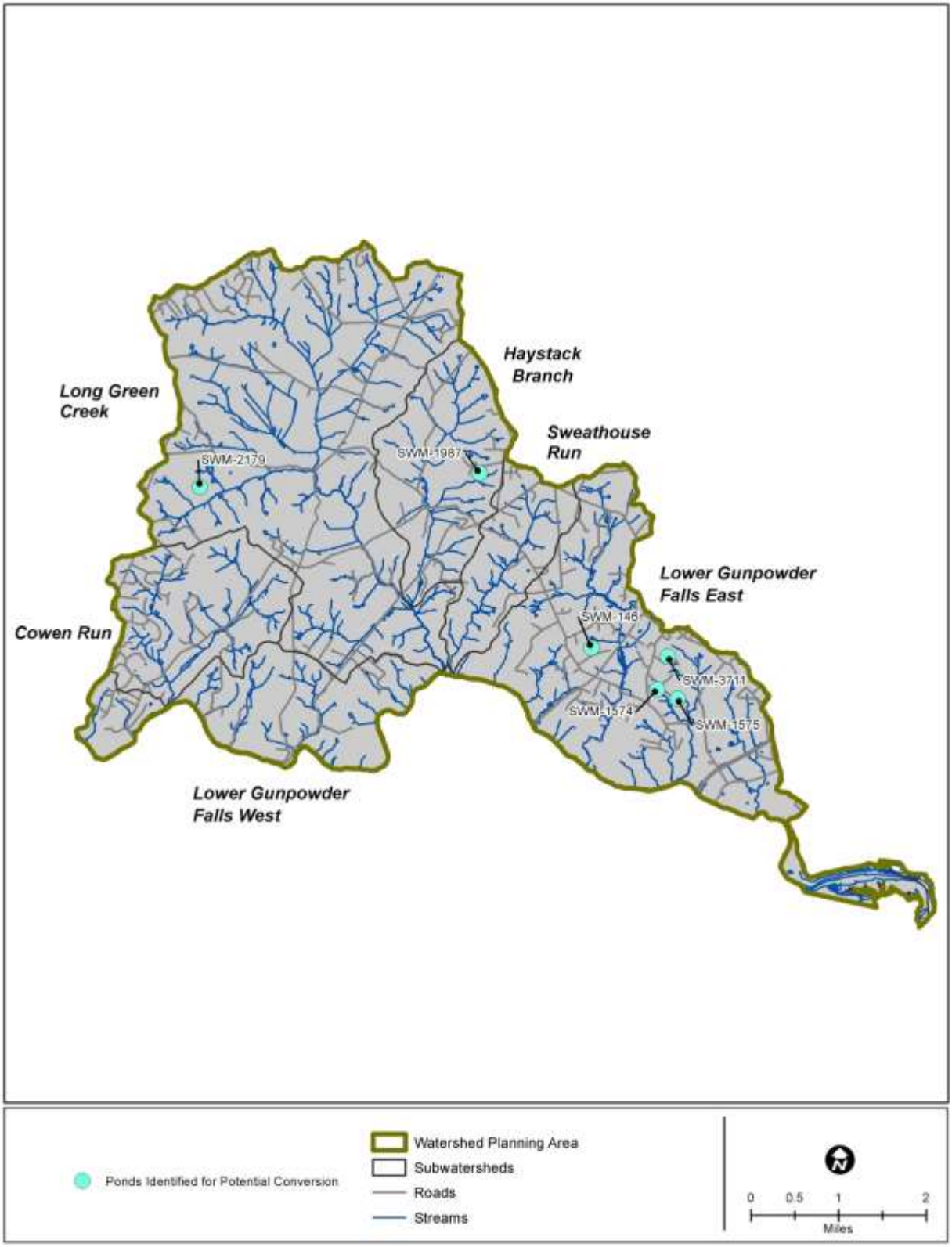


Figure 4-15: Stormwater Ponds Identified for Potential Conversion in Area Q

Table 4-9: Summary of Stormwater Ponds Identified for Potential Conversion in Area Q

County Structure No.	Subwatershed	Structure Name	Drainage Area (acres)
SWM -146	Lower Gunpowder Falls East	El Ray Farm	32.3
SWM- 1574	Lower Gunpowder Falls East	Days Wood Manor Fac 1	1
SWM- 1575	Lower Gunpowder Falls East	Days Wood Manor Fac 2	1.34
SWM- 1987	Haystack Branch	Brintonwood Pond A	14.1
SWM- 2179	Long Green Creek	Beaverbrook Farms Phase II	10.1
SWM- 3711	Lower Gunpowder Falls East	Ruppert Farm	17.81

4.6 Pervious Area Assessment (PAA)

A PAA was conducted to identify and evaluate additional sites within the Lower Gunpowder Falls watershed with potential for reforestation or re-vegetation. The following subsections describe the methods used to identify and evaluate restoration potential of pervious areas.

4.6.1 Assessment Protocol

In conducting PAAs, sections of open land throughout a watershed planning areaare identified using Geographic Information Systems (GIS). In previous SWAPs, the analyses focused mainly on public lands, as they are usually the most probable for locating larger-scale tree planting implementation projects. In this SWAP, a new approach was employed to incorporate more private land into the assessment.

Area Q includes a large amount of public land, however a large proportion of those lands are either already forested or reserved as agricultural land lease areas and used for crop production. SWAPs generally refrain from making suggestions for restoration activity on agricultural land uses as the SWAP, and Baltimore County's requirements for restoration, focus on reductions to non-agricultural sources of pollutant loading. Implementation of restoration activities on agricultural lands will be administered and overseen at the state level by the Maryland Department of Agriculture. To deal with these challenges, this SWAP utilized a GIS analysis of turf cover throughout the watershed.

The purpose of the lawn analysis was to identify rural residential areas that have excess turf areas of 1 acre for possible reforestation/revegetation. The analysis required the use of GIS and overlay geoprocessing techniques. The County's tax parcel, Area Q subwatershed boundaries, and urban tree canopy land cover datasets were used as input for the analysis. Through an overlay analysis, a new layer was created, which contained only the turf areas for each parcel, the subwatershed it belonged to, and the acreage. Turf area in excess of 1 acre on any given parcel was included as part of this analysis. Resources are more efficiently used to plant these larger areas and landowner interest is anticipated to increase with greater lawn areas (e.g. reductions in maintenance cost). As an example, a property with 2.5 acres of turf would be

considered as having 1.5 acres of potential for revegetation. While a property with 1.5 acres of turf would have 0.5 acres of potential for revegetation, but this size would be less than the preferable 1 acre of excess turf and would not be included in this assessment for reasons of cost efficiency.

4.6.2 Summary of Sites Assessed and General Findings

A total of 179 individual properties were identified as having pervious areas with potential for planting within Area Q, totaling approximately 444 acres. Figure 4-16 below displays the possible planting locations.

Table 4-10: Parcels and Acres of Planting Opportunity Identified in Each Subwatershed.

Subwatershed	Number of Parcels	Acres of Opportunity
Cowen Run	10	27.8
Haystack Branch	22	50.2
Long Green Creek	63	170.1
Lower Gunpowder Falls East	60	145.4
Lower Gunpowder Falls West	8	14.6
Sweathouse Run	16	35.6
Total	**179**	**443.7**

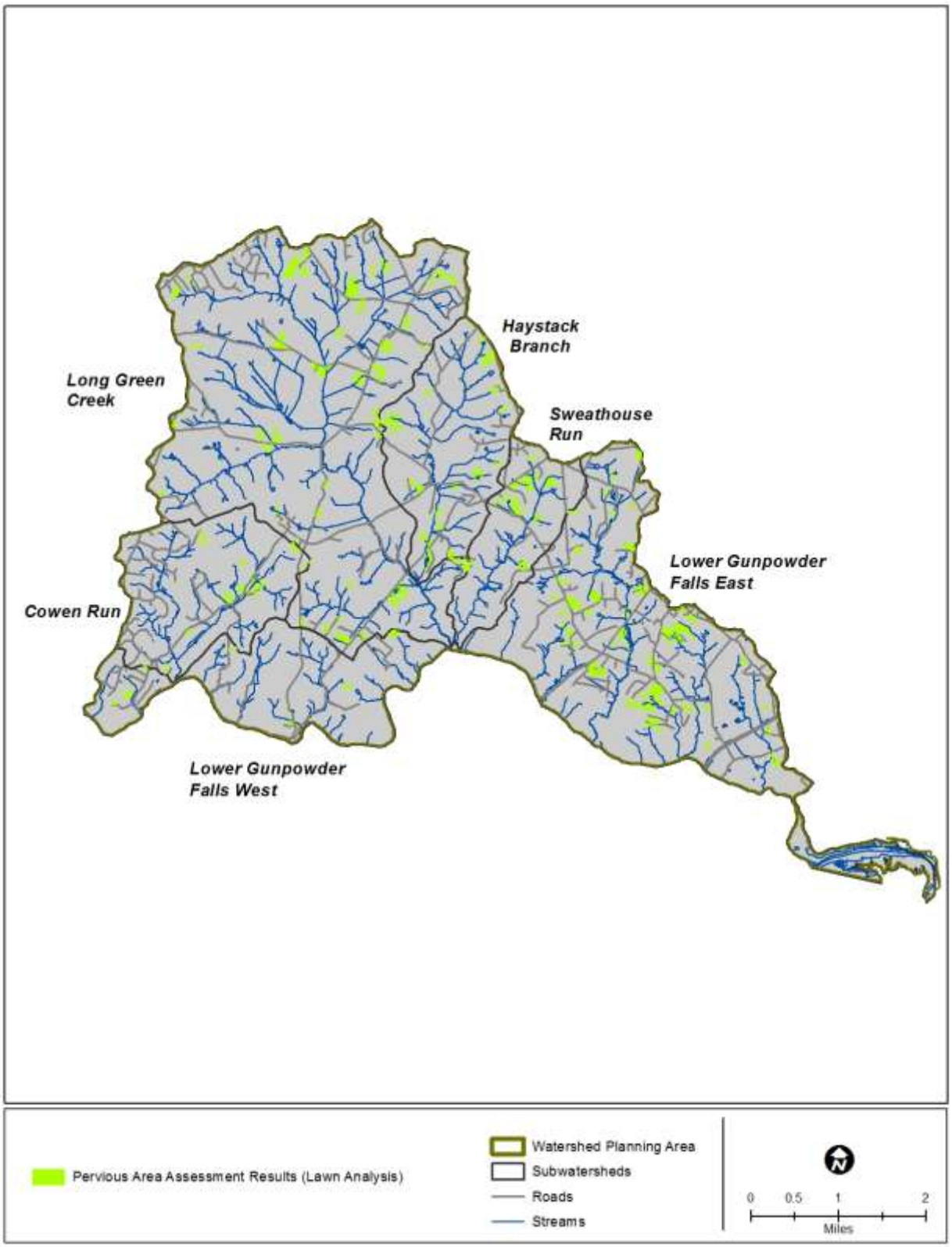


Figure 4-16: Pervious Area Assessment (PAA) Locations in Area Q

4.6.3 Prioritization of Tree Plantings on Pervious Areas

Prioritization of the potential tree planting areas is outside the scope of this SWAP, but may be considered in future analyses when the implementation of restoration practices in Area Q begins. There are many options available for ranking the identified planting opportunities, which will likely take into consideration a number of different metrics, including size. An example ranking of these sites may be accomplished through a combination of methods which prioritize larger tracts of contiguous planting space, and deprioritize tracts with greater irregularity in the shape of the available planting space (irregularity in the shape may indicate multiple small planting opportunities on a property – in many cases to fill in gaps in canopy cover of already mostly wooded areas, as opposed to larger and more accessible reforestation spaces). There are many ways to attempt a mathematical accounting of shape regularity/roundness/wholeness etc. and a combination of them may be employed to sort potential favorable sites. These metrics do not always provide a concrete determination of site worthiness, but may be used to help focus on the generally more favorable parcels.

CHAPTER 5.0
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 watershed based on information collected during both the office/desktop and field assessments. 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 watershed are divided and 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 benefit. However, these facilities can generally be altered to capture and retain stormwater runoff to provide water quality benefits. This is referred to as a stormwater pond conversion. Dry detention ponds have the greatest potential for conversion to extended detention BMPs. 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 of a dry detention pond 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.

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 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 project.

Implementation 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 which are also buried beneath the stream channel. 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 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). 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. Street sweeping is conducted on roads that have a curb and gutter.

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. 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 uses 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” 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

All recyclables (e.g., plastics, glass, metals, paper, and cardboard) are collected co-mingled at the curbside or in the alley for all single-family homes. The majority of multifamily complexes (apartments, condominiums) also have single stream recycling collection each week. Under this program, recycling rates increased as a result of a greater number of accepted materials, convenience of placing everything in the same container, and weekly pickup. 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.

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.

5.3 Best Management Practices for Agricultural Areas

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

Integrated Pest Management (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 the Maryland Department of Agriculture (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

Clean Green County

The Clean Green County is a tag-line and branding which serves as a catch-all for environmentally related projects being conducted by Baltimore County. Among other projects, some initiatives included in this are activities such as the Clean Green 15 litter pick-up challenge (http://www.baltimorecountymd.gov/Agencies/environment/cleangreen/cleangreen15.html), improvements to the county's recycling program, and expansions in public awareness and outreach for enhancement of environmental quality.

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 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 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.

5.5.3 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.

5.5.4 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.

5.5.5 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 subwatersheds and works with Baltimore County EPS in reporting the outcomes of these activities.

5.5.6 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.

5.6 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.

5.6.1 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.

5.6.2 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.

5.7 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 from several years to 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 watershed follow.

5.7.1 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. 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.

5.7.2 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. 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. 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.

5.7.3 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.

5.7.4 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. To participate, a farm must be 50 acres in size or located adjacent to a preserved property.

5.8 Public Lands/Open Space

Parks and open public spaces are critical to healthy communities, as they provide area in which stakeholders may interact with their natural surroundings. Public lands are not as likely to be developed, and in many cases are left as mostly pervious areas. They serve to preserve cultural, ecological, and historical aspects of the land in a more natural state, and to provide continued recreation opportunities for stakeholders. Lands in the SWAP area, owned by Baltimore County and the State of Maryland, meet various public needs as described below.

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. This section of the park offers miles of nature trails and opportunities for fishing and river recreation.

References

Baltimore County. 2003. Baltimore County Code, Title 3. Protection of Water Quality, Streams, Wetlands, and Floodplains, 33-3-111, Design standards for forest buffers and building setbacks. Available online at: https://www.municode.com/library/md/baltimore_county/codes/code_of_ordinances?nodeId=Article%2033%20-%20Environmental%20Protection%20and%20Sustainability

Baltimore County Department of Environmental Protection and Resource Management (DEPRM). 2011 (revised). Ground Water and Wells in Baltimore County, MD. http://resources.baltimorecountymd.gov/Documents/Environment/groundwatermanagement/gwwells050611webversion.pdf

Baltimore County Department of Environmental Protection and Sustainability (EPS). 2016. NPDES - Municipal Stormwater Discharge Permit 2016 Annual Report. http://www.baltimorecountymd.gov/Agencies/environment/npdes/

Baltimore County Department of Environmental Protection and Sustainability (EPS). Updated February 2015. Easement Programs and Applications. http://www.baltimorecountymd.gov/Agencies/planning/landpreservation/easementprograms.html

Baltimore County Office of Planning. 2015. A Citizen's Guide to Zoning (and other Land Use Regulations) http://resources.baltimorecountymd.gov/Documents/Planning/citizensguidetozoning/citizensguide.pdf

Baltimore County Office of Planning. October 18, 2013 (revised). Baltimore County Zoning. http://www.baltimorecountymd.gov/Agencies/planning/zoning/index.html

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

Code of Maryland Regulations (COMAR). 2001 (and periodic updates). §26.08 - MD Dept. Environment. Office of the Secretary of State, Div. of State Documents, Annapolis. http://www.dsd.state.md.us/comar/subtitle_chapters/26_Chapters.aspx#Subtitle08

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

Institute of Water Research. 2002. RUSLE: On-Line Soil Erosion Assessment Tool. Institute of Water Research, Michigan State University. Online tool created by Dr. Da Ouyang and available online at: http://www.iwr.msu.edu/rusle/

Kazyak, P. F. 2001. Maryland Biological Stream Survey Sampling Manual. Maryland Department of Natural Resources, Monitoring and Non-Tidal Assessment Division, Annapolis.

Kazyak, P.F. (1996-1997). Maryland Biological Stream Survey Sampling Manual: Field Protocols. Maryland Department of Natural Resources, Chesapeake Bay Research & Monitoring Division. Annapolis, Maryland.

Maryland Department of the Environment (MDE). 2016a. Maryland's Draft 2016 Integrated Report of Surface Water Quality. Baltimore, Maryland. http://mde.maryland.gov/programs/Water/TMDL/Integrated303dReports/Pages/2016IR.aspx

Maryland Department of the Environment (MDE). 2016b. Total Maximum Daily Load of Sediment in the Lower Gunpowder Falls Watershed, Baltimore County, Maryland - Public Review Draft. Baltimore, Maryland. http://www.mde.state.md.us/programs/Water/TMDL/DraftTMDLforPublicComment/Pages/TMDL_PN_Lower_Gunpowder_Falls_sediment.aspx

Maryland Department of the Environment (MDE). 2015. Total Maximum Daily Load of Polychlorinated Biphenyls in the Gunpowder River and Bird River Subsegments of the Gunpowder River Oligohaline Segment, Baltimore County and Harford County, Maryland. Baltimore, Maryland. http://mde.maryland.gov/programs/Water/TMDL/ApprovedFinalTMDLs/Documents/GunpowderBird_PCB_fa.pdf

Maryland Department of the Environment (MDE). 2014. Maryland's 2014 Integrated Report of Surface Water Quality. http://www.mde.maryland.gov/programs/Water/TMDL/Integrated303dReports/Pages/2014IR.aspx

Maryland Department of the Environment (MDE). 2012. Watershed Report for Biological Impairment of the Non-Tidal Lower Gunpowder Falls Watershed, Baltimore County, Maryland - Biological Stressor Identification Analysis, Results and Interpretation - Revised Final. Baltimore, Maryland. http://www.mde.state.md.us/programs/Water/TMDL/Documents/BSID_Reports/Lower_Gunpowder_BSID_Report_012512_revisedfinal.pdf

Maryland Department of the Environment (MDE). 2011. Water Quality Analysis of Total Phosphorus for the Lower Gunpowder Falls Watershed, Baltimore County, Maryland. http://www.mde.state.md.us/programs/Water/TMDL/ApprovedFinalTMDLs/Documents/Lower_Gunpowder_NutWQA_final_12-15-2011.pdf

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

Maryland Department of the Environment (MDE). 2009b. Maryland Biological Stressor Identification Process. Baltimore, Maryland. http://www.mde.state.md.us/assets/document/BSID_Methodology_Final.pdf

Maryland Department of the Environment (MDE). 2003. Water Quality Analysis of Heavy Metals for the Lower Gunpowder Falls in Baltimore County, Maryland. http://www.mde.state.md.us/programs/Water/TMDL/ApprovedFinalTMDLs/Documents/www.mde.state.md.us/assets/document/Lower%20Gunpowder%20Falls%20WQA_final.pdf

Maryland Department of Natural Resources (DNR). 2016. Maryland Living Resources – Fish Blockage Locations. https://www.arcgis.com/home/item.html?id=5376d5e9ace647a1bd7ec52a1d4d434c

Maryland Department of Natural Resources (DNR). (1998-2011). Maryland Biological Stream Survey Sampling Manual: Field Protocols. Maryland Department of Natural Resources, Monitoring and Non-Tidal Assessment Division. Annapolis, Maryland.

Maryland Department of Natural Resources (DNR). 2005. Report on Nutrient Synoptic Surveys in the Anacostia River Watershed, Prince George's County, Maryland, April 2004, as part of a Watershed Restoration Action Strategy. Watershed Services Division, Annapolis, MD. http://dnr.maryland.gov/waters/Documents/WRAS/ar_synoptic.pdf

Maryland Department of Planning (MDP). 2010. Land Use Land Cover (2010). http://planning.maryland.gov/OurProducts/downloadFiles.shtml

Meals, D., Spooner, J., Dressing, S., and J. Harcum. 2011. Statistical Analysis for Monotonic Trends, Tech Notes 6, November 2011. Developed for U.S. Environmental Protection Agency by Tetra Tech, Inc., Fairfax, Virginia. https://www.epa.gov/sites/production/files/2016-05/documents/tech_notes_6_dec2013_trend.pdf

National Weather Service (NWS), Sterling Forecast Office. 2015. Unique Local Climate Data. http://w2.weather.gov/climate/local_data.php?wfo=lwx

Parsons Brinckerhoff Quade & Douglas, Inc. (PB). 1999. Lower Gunpowder Falls Water Quality Management Study. 1999. Prepared for Baltimore County Department of Environmental Protection and Resources Management. Baltimore, Maryland.

Rosgen, D.L. and H.L. Silvey. 1996. Applied River Morphology. Wildland Hydrology, Pagosa Springs, CO.

Roth, N. E., Southerland, M. T., Chaillou, J. C., Kazyak, P. F., and S. A. Stranko. 2000. Refinement and Validation of a Fish Index of Biotic Integrity for Maryland Streams. Versar, Inc., Columbia, MD, with Maryland Department of Natural Resources, Monitoring and Non-Tidal Assessment Division. CBWP-MANTA-EA-00-2.

Schueler, T., Fraley-McNeal, L., and K. Cappiella. 2009. Is Impervious Cover Still Important? Review of Recent Research. Journal of Hydrologic Engineering 14(4): 309-315.

Stranko, S. A., D. M. Boward, J. V. Kilian, C. J. Millard, A. J. Becker, R. Gauza, A. Schenk, A. Roseberry-Lincoln, and M. O'Connor. 2014. Maryland Biological Stream Survey Sampling Manual. Maryland Department of Natural Resources, Annapolis, Maryland.

Stribling, J. B., B. K. Jessup, J. S. White, D. Boward, and M. Hurd. 1998. Development of a Benthic Index of Biotic Integrity for Maryland Streams. Maryland Department of Natural Resources, Monitoring and Non-Tidal Assessment, Annapolis, MD.

Southerland, M. T., G. M. Rogers, M. J. Kline, R. P. Morgan, D. M. Boward, P. F. Kazyak, R. J. Klauda, S. A. Stranko. 2005. New Biological Indicators to Better Assess the Condition of Maryland Streams. DNR-12-0305-0100. Maryland Department of Natural Resources, Monitoring and Non-Tidal Assessment Division. Annapolis, MD.

U.S. Census Bureau. 2010. http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml

U.S. Department of Agriculture (USDA). March 1976. Soil Survey of Baltimore County, Maryland USDA, Soil Conservation Service, Washington DC. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/md/soils/?cid=nrcs144p2_025719

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

U.S. Department of Agriculture (USDA). 2010. Soil Survey Geographic (SSURGO) database for Baltimore County, Maryland. USDA, Natural Resources Conservation Service (NRCS), Ft. Worth, TX. http://soildatamart.nrcs.usda.gov/Metadata.aspx?Survey=MD005&UseState=MD.aspx?Survey=MD005&UseState=MD

U.S. Environmental Protection Agency (USEPA). 2012. Decision Letter Regarding the Report Entitled Water Quality Analysis of Total Phosphorus for the Lower Gunpowder Falls Watershed, Baltimore County, Maryland. http://www.mde.state.md.us/programs/Water/TMDL/ApprovedFinalTMDLs/Documents/Lower_Gunpowder_NutWQA_Approval_letter.pdf

U.S. Environmental Protection Agency (USEPA). 2003. Decision Letter Regarding the Report Entitled Water Quality Analysis of Heavy Metals for the Lower Gunpowder Falls in Baltimore County, Maryland. http://www.mde.state.md.us/programs/Water/TMDL/ApprovedFinalTMDLs/Documents/www.epa.gov/reg3wapd/tmdl/MD_TMDLs/LowerGunPowderWQA/LowerGunpowderAL.pdf

U.S. Environmental Protection Agency (USEPA). 1988. Ambient Water Criteria for Chloride. Office of Water Regulations and Standards Division Washington, D.C.
United States Geological Survey (USGS). 1999. Monitoring Nutrients in the Major Rivers Draining to the Chesapeake Bay. Water-Resources Investigations Report 99-4238.

Appendix A
Stream Assessment Field Verification Data

APPENDIX F

Stream Restoration Sites

The 1999 Lower Gunpowder Falls Watershed Water Quality Management Study (WQMS; Parsons Brinckerhoff, 1999) was reviewed for potential stream restoration opportunities. The reaches recommended for stream restoration in all Area Q subwatersheds, except for Cowen Run, were field reviewed in early 2017 where property access allowed, and project extents were revised based on current conditions. The table below includes the stream evaluation worksheet results for the reaches field reviewed in 2017. In addition, nearly all the streams in the Cowen Run watershed were walked and assessed for stream restoration potential by Baltimore County EPS Watershed Restoration staff in 2015 and 2016. Baltimore County estimated that approximately 4,500 feet of stream restoration was possible in Cowen Run.

Stream Evaluation Results for Reaches from the 1999 Lower Gunpowder Falls Water Quality Management Study Field Reviewed in 2017

ID	Subwatershed	Recommend for Restoration?	Potential Restoration Length (ft)	Stream Evaluation Worksheet Scores														Rank (1-12)	Comments
				Streambank Erosion	Degree of Incision	Floodplain Condition	Land Use	Riparian Veg. in Flood Area	Habitat Value/ Ecological Lift	Utilities	Construction Access	Potential to Create Floodplain	Utility Conflict Resolution	Fish Passage Restoration	Riparian Buffer Enhancement	Potential for Other BMP Strategies	Total		
HS -1	Haystack Branch	**Yes**	**1,010**	-	3	7	1	1	5	10	3	3	0	2	0	0	**35**	**10**	Avg. bank height: 3-4'. Private, forested, steep, far from roads. Potential fish blockage at driveway culvert. Raw eroded banks in most outer meanders, few roots. Freeze/thaw extensive, bedrock present. Low potential overall due to difficulty of access. Small eroded gully on right bank. Recommend SWM for watershed.
HS -5	Haystack Branch	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	-	-	-	-	Property access denied, was not assessed.
HS -6a	Haystack Branch	**Yes**	**2,630**	7	6	8	5	10	5	5	7	2	0	0	10	10	**75**	**1**	Avg. bank height: 3-8' (higher at upstream end of field). WQ bad due to runoff (turbid despite no rain). Potential water line running parallel to downstream end on right bank. Access might impact agriculture fields. Agriculture fields up to edge of stream, driveway along right bank. Stream straightened through ag. fields, incised with most banks raw and eroding. More incised at upstream end of field. In-line pond has severe bank erosion, bare ground around pond with rilling evident. High priority, but would require lots of coordination with farmer. Recommend agricultural BMPs.

ID	Subwatershed	Recommend for Restoration?	Potential Restoration Length (ft)	Stream Evaluation Worksheet Scores														Rank (1-12)	Comments
				Streambank Erosion	Degree of Incision	Floodplain Condition	Land Use	Riparian Veg. in Flood Area	Habitat Value/ Ecological Lift	Utilities	Construction Access	Potential to Create Floodplain	Utility Conflict Resolution	Fish Passage Restoration	Riparian Buffer Enhancement	Potential for Other BMP Strategies	Total		
HS -6b	Haystack Branch	**No**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	-	N	**-**	-	Forested, steep, narrow valley. Some erosion in bends in upstream end, but overall stable. Pond outfall channel has headcut part way down, about 100' section is incised and eroding.
LG-1a	Long Green Creek	**Yes**	**1,380**	2	3	4	1	1	3	10	3	3	0	0	0	0	**30**	**12**	Avg. bank height: 3'. Several eroded bends (lateral migration). Bedrock present in downstream end.
LG-1b	Long Green Creek	**No**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	-	N	**-**	-	Some bank erosion, but not widespread. Buffer encroachment throughout to different degrees. Old collapsed culvert is causing minor local erosion. Stream is a dry channel in upstream end through yards. Difficult access due to multiple land owners, steep slopes, and mature forest in areas. Recommend riparian buffer plantings and encouraging homeowners not to mow in the buffer.
LG-2	Long Green Creek	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	-	-	-	-	Property access denied for majority of reach, was not assessed.

ID	Subwatershed	Recommend for Restoration?	Potential Restoration Length (ft)	Stream Evaluation Worksheet Scores														Rank (1-12)	Comments
				Streambank Erosion	Degree of Incision	Floodplain Condition	Land Use	Riparian Veg. in Flood Area	Habitat Value/ Ecological Lift	Utilities	Construction Access	Potential to Create Floodplain	Utility Conflict Resolution	Fish Passage Restoration	Riparian Buffer Enhancement	Potential for Other BMP Strategies	Total		
LG-3a	Long Green Creek	**Yes**	**4,400**	2	3	5	3	3	2	10	7	7	0	0	6	0	**48**	**8**	Avg. bank height: 2-3'. Existing tree plantings along both banks, though some areas could use additional buffer. Mostly connected to floodplain. Tree tubes should be removed from tree plantings. Minor erosion along some banks.
LG-3b	Long Green Creek	**Yes**	**3,810**	4	5	6	5	7	4	10	9	5	0	0	10	0	**65**	**4**	Avg. bank height: 3-4'. Mostly grass along banks with scattered trees, surrounded by ag. fields. Erosion on most meander bends, highly erodible bank material. Local bank grading could increase floodplain connectivity. Recommend buffer plantings.
LG-3c	Long Green Creek	**No**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	-	N	**-**	-	Restored by Ecotone. Few buffer plantings, but does not appear mowed.
LG-4	Long Green Creek	**Yes**	**3,390**	3	5	5	5	10	5	10	9	9	0	0	10	0	**71**	**2**	Avg. bank height: 3-4'. Possible pipe across stream in downstream end (may just be a piece of pipe lodged in stream bed). Restoration would impact ag. fields. Little buffer along entire reach. Some bedrock present. Recommend buffer plantings.

ID	Subwatershed	Recommend for Restoration?	Potential Restoration Length (ft)	Stream Evaluation Worksheet Scores														Rank (1-12)	Comments
				Streambank Erosion	Degree of Incision	Floodplain Condition	Land Use	Riparian Veg. in Flood Area	Habitat Value/ Ecological Lift	Utilities	Construction Access	Potential to Create Floodplain	Utility Conflict Resolution	Fish Passage Restoration	Riparian Buffer Enhancement	Potential for Other BMP Strategies	Total		
LG-5a	Long Green Creek	**Yes**	**2,100**	3	5	8	5	7	5	5	6	7	0	0	10	0	**61**	**5**	Avg. bank height: 2'. High transmission OHU crosses stream, signs for pipeline through ROW. Cattle have stream access in a small fenced off area. Restoration/buffer enhancement would impact pasture and cropland. 6" drop at first culvert. Buffer enhancement would require invasive treatment.
LG-5b	Long Green Creek	**No**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	-	N	**-**	-	Low banks, stream appears to have floodplain access. Recommend riparian buffer planting and encouraging homeowners to not mow near the stream.
LG-6a	Long Green Creek	**Yes**	**680**	2	3	3	4	5	1	10	8	3	0	0	10	0	**49**	**7**	Avg. bank height: 1-2' (middle part 3-4'). Pasture with narrow vegetated buffer, dense vines/shrubs. Was likely straightened in the past. This reach is more incised than upstream or downstream, likely never accesses floodplain. Recommend restoring to reconnect floodplain and expanding riparian buffer.
LG-6b	Long Green Creek	**No**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	-	N	**-**	-	Was likely straightened in the past. Narrow riparian buffer in upstream end, buffer has been planted in downstream end (tree tubes need to be removed). Minimal erosion. Likely has floodplain connection in some places. Could restore a more natural pattern if reach LG-6a is restored. Recommend increasing buffer width in upstream end.

ID	Subwatershed	Recommend for Restoration?	Potential Restoration Length (ft)	Stream Evaluation Worksheet Scores														Rank (1-12)	Comments
				Streambank Erosion	Degree of Incision	Floodplain Condition	Land Use	Riparian Veg. in Flood Area	Habitat Value/ Ecological Lift	Utilities	Construction Access	Potential to Create Floodplain	Utility Conflict Resolution	Fish Passage Restoration	Riparian Buffer Enhancement	Potential for Other BMP Strategies	Total		
LG-6c	Long Green Creek	**No**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	-	N	**-**	-	Upstream of Long Green Farm. Minimal erosion. Past incision downstream of Long Green Pike, evidence of old berm along left bank. Stable upstream of Long Green Pike, confined by driveway on left bank.
LG-7a	Long Green Creek	**Yes**	**2,380**	2	5	5	3	3	1	10	3	2	0	0	5	10	**49**	**7**	Avg. bank height: 3-4'. Water likely backs up upstream of collapsed bridge at downstream end of reach. Forested along banks, some mowed yards, horse pasture. Suggest BMPs along Harford Rd. Some erosion, reach confined by road.
LG-7b	Long Green Creek	**No**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	-	N	**-**	-	Minimal erosion. Recommend livestock exclusion and riparian buffer establishment/enhancement. Encourage homeowners not to mow in the buffer.
LG-7c	Long Green Creek	**No**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	-	Y	**-**	-	4-5' tall eroded banks in downstream end. No or minimal erosion for most of reach. One 10'+ tall eroded bank (~50' long) in upstream end. Trib that enters right bank is a ditch originating from roadside swales along Wallace Dr (potential SWM BMP opportunity), minimal erosion but slightly downcut. Recommend buffer for trib and where mowed to top of bank.

ID	Subwatershed	Recommend for Restoration?	Potential Restoration Length (ft)	Stream Evaluation Worksheet Scores														Rank (1-12)	Comments
				Streambank Erosion	Degree of Incision	Floodplain Condition	Land Use	Riparian Veg. in Flood Area	Habitat Value/ Ecological Lift	Utilities	Construction Access	Potential to Create Floodplain	Utility Conflict Resolution	Fish Passage Restoration	Riparian Buffer Enhancement	Potential for Other BMP Strategies	Total		
GF - 33a	LGF - East	**No**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	-	N	**-**	-	Downstream portion is within Gunpowder Falls State Park. Mostly stable with mature forest and connected to floodplain. Upstream of trail crossing near park boundary, channel slightly incised with ~3' bank erosion in a series of tight meander bends. Little erosion downstream of that area.
GF - 33b	LGF - East	**No**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	-	N	**-**	-	Forested, rocky channel originating from a spring. Multiple springs, seeps with potential wetlands around stream. Several eroded bends, not consistent. Recommend SWM in watershed.
GF - 34a	LGF - East	**Yes**	**730**	9	7	10	1	1	5	10	9	9	0	0	0	5	**66**	**3**	Within Gunpowder Falls State Park. Avg. bank height: 5. Possible former quarry is adjacent - appears to be a wetland now with ponded water and small trees growing in it. Uneven and tall banks indicate possible dumped fill material. Evidence of old road crossing. Active bank erosion. Upstream and downstream of this reach is mostly stable and connected to floodplain.

ID	Subwatershed	Recommend for Restoration?	Potential Restoration Length (ft)	Stream Evaluation Worksheet Scores														Rank (1-12)	Comments
				Streambank Erosion	Degree of Incision	Floodplain Condition	Land Use	Riparian Veg. in Flood Area	Habitat Value/ Ecological Lift	Utilities	Construction Access	Potential to Create Floodplain	Utility Conflict Resolution	Fish Passage Restoration	Riparian Buffer Enhancement	Potential for Other BMP Strategies	Total		
GF - 34b	LGF - East	**No**	-	-	-	-	-	-	-	-	-	-	-	-	-	N	-	-	Stream is mostly stable and connected to the floodplain upstream and downstream of the old quarry (?) area. Erosion is present in some meander bends, but neither vertical or lateral instability was widespread. Valley is confined by the steep valley wall on the right bank and Route 1 on the left bank.
GF - 34c	LGF - East	**No**	-	-	-	-	-	-	-	-	-	-	-	-	-	N	-	-	SWM pond at headwaters has an overflow berm or the outflow pipe is buried - overland flow out of pond is causing some headcutting into channel. Steep, rocky channel with bedrock in downstream end, some tall eroded banks present for ~200'. Just downstream it becomes more confined by valley wall and development. Recommend SWM facility maintenance.
GF - 34d	LGF - East	**No**	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	-	-	Stream appears to be piped along the toe of the embankment along Route 1. Embankment is bare soil that appears to be eroding in some places (likely due to overland flow from road runoff). Recommend addressing runoff from Route 1.

ID	Subwatershed	Recommend for Restoration?	Potential Restoration Length (ft)	Stream Evaluation Worksheet Scores														Rank (1-12)	Comments
				Streambank Erosion	Degree of Incision	Floodplain Condition	Land Use	Riparian Veg. in Flood Area	Habitat Value/ Ecological Lift	Utilities	Construction Access	Potential to Create Floodplain	Utility Conflict Resolution	Fish Passage Restoration	Riparian Buffer Enhancement	Potential for Other BMP Strategies	Total		
GF -35	LGF - East	**No**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	-	N	**-**	-	Active erosion at upstream extent, 5' banks where mowed to top of bank. Becomes stable and forested where reach enters Gunpowder Falls State Park. Significant bedrock in downstream end. A tall eroding valley wall is present downstream of a bedrock cascade (~75' long). Downstream of trail crossing had a few eroded banks. Stable confluence with mainstem. Recommend buffer plantings in yards at upstream end.
GF - 36a	LGF - East	**Yes**	**1,170**	3	5	7	1	1	1	10	3	1	0	5	0	0	**37**	**9**	Avg. bank height: 4-5'. Access difficult due to mature forest, steep slopes. Potential for fish passage restoration at driveway culvert. Multiple springs on property, end section of pipe outfall where reach is adjacent to Raphel Rd has broken off due to erosion. Bedrock present. Woodbine Farm was established in the 1700s, may have cultural or historic resources.

ID	Subwatershed	Recommend for Restoration?	Potential Restoration Length (ft)	Stream Evaluation Worksheet Scores														Rank (1-12)	Comments
				Streambank Erosion	Degree of Incision	Floodplain Condition	Land Use	Riparian Veg. in Flood Area	Habitat Value/ Ecological Lift	Utilities	Construction Access	Potential to Create Floodplain	Utility Conflict Resolution	Fish Passage Restoration	Riparian Buffer Enhancement	Potential for Other BMP Strategies	Total		
GF - 36b	LGF - East	**No**	-	-	-	-	-	-	-	-	-	-	-	-	-	N	-	-	Covers several streams at Woodbridge Farm. Several lack riparian buffer, and may have been historically straightened. Western trib has erosion at headwaters near edge of property. Eastern trib has 1-2' banks in upstream end and is confined by horse pasture on right bank and old berm on left bank. Multiple springs on property with associated wetlands. Farm dates back to the 1700s and therefore may have cultural or historic resources.
GF - 36c	LGF - East	**No**	-	-	-	-	-	-	-	-	-	-	-	-	-	N	-	-	Large sediment load ranging from sand to cobble. Bedrock and boulder influence throughout reach. 4-5' erosion in some meanders. Existing stabilization just upstream of Mt Vista Rd. Overall low potential due to forest and bedrock.
GF - 36d	LGF - East	**No**	-	-	-	-	-	-	-	-	-	-	-	-	-	N	-	-	Within Gunpowder Falls State Park. Several large woody debris jams are causing local erosion and deposition upstream. Bank erosion present but not widespread. Overall little to no restoration potential. Restoration would cause significant tree impacts and access would be difficult (mature forest, steep slopes).

ID	Subwatershed	Recommend for Restoration?	Potential Restoration Length (ft)	Stream Evaluation Worksheet Scores														Rank (1-12)	Comments
				Streambank Erosion	Degree of Incision	Floodplain Condition	Land Use	Riparian Veg. in Flood Area	Habitat Value/ Ecological Lift	Utilities	Construction Access	Potential to Create Floodplain	Utility Conflict Resolution	Fish Passage Restoration	Riparian Buffer Enhancement	Potential for Other BMP Strategies	Total		
GF - 37a	LGF - East	**Yes**	**1,090**	4	7	10	1	1	1	3	5	2	0	0	0	0	**34**	**11**	Avg. bank height: 4-5'. High transmission ROW adjacent to site. Construction difficult due to power lines, forest. Stream cuts down ~5' downstream of Dowell Ln, deeply incised for ~500'. Potential tree impacts.
GF - 37b	LGF - East	**No**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	-	N	**-**	-	Forested. 2' erosion in some outer meander bends, low banks with floodplain access, dense roots on banks. Some tortuous bends in downstream end and sediment deposition upstream of I-95 culvert.
GF - 37c	LGF - East	**Yes**	**720**	5	5	8	1	1	5	2	2	5	0	10	0	10	**54**	**6**	Avg. bank height: 4'. Potential wetlands along right floodplain. ROW passes over stream at downstream end. Steep slopes, forest on right bank. 1' drop @ I95 culvert outfall, likely a fish blockage. Eroded gully near I95/upstream end has SWM BMP potential. Iron flocculant throughout channel.
GF - 37d	LGF - East	**No**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	-	N	**-**	-	Green filamentous algae, some iron flocculant present. Riprap on banks just upstream of Philadelphia Rd culvert. Cutoff meander ~350' upstream of Philadelphia Rd. Recent tree plantings on right bank downstream of Philadelphia Rd.

ID	Subwatershed	Recommend for Restoration?	Potential Restoration Length (ft)	Stream Evaluation Worksheet Scores														Rank (1-12)	Comments
				Streambank Erosion	Degree of Incision	Floodplain Condition	Land Use	Riparian Veg. in Flood Area	Habitat Value/ Ecological Lift	Utilities	Construction Access	Potential to Create Floodplain	Utility Conflict Resolution	Fish Passage Restoration	Riparian Buffer Enhancement	Potential for Other BMP Strategies	Total		
GF -25	LGF - West	**Yes**	**410**	8	9	10	1	1	3	10	2	5	0	0	0	0	**49**	**7**	Avg. bank height: 5-6'. Site is far from road, forested, steep slopes. Floodplain reconnection may not be feasible. Undercut outflow pipe should be stabilized. Severely incised trib enters left bank. End of reach is steep but stable bedrock channel.
SH -1	Sweathouse Run	**No**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	-	N	**-**	-	One eroded bank visible from road, ~3', minor severity. Most of reach not assessed because property access was denied.
SH -3	Sweathouse Run	**No**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	-	N	**-**	-	Downstream portion is steep into mainstem. Upstream portion has erosion in some meanders. Forested and steep valley. Begins at outfall from small pond. Camp activity areas/equipment located along both banks. Recommend buffer plantings in upstream end.
		Total	**25,900**																

*LGF – East: Lower Gunpowder Falls East
LGF – West: Lower Gunpowder Falls West

GF-25

Page 1 of 1

Lower Gunpowder Falls West

Stream Reaches Assessed in 2017

- Recommended for Restoration
- Other Reaches Assessed

- Streams
- Roads
- Watershed Planning Area
- Subwatersheds

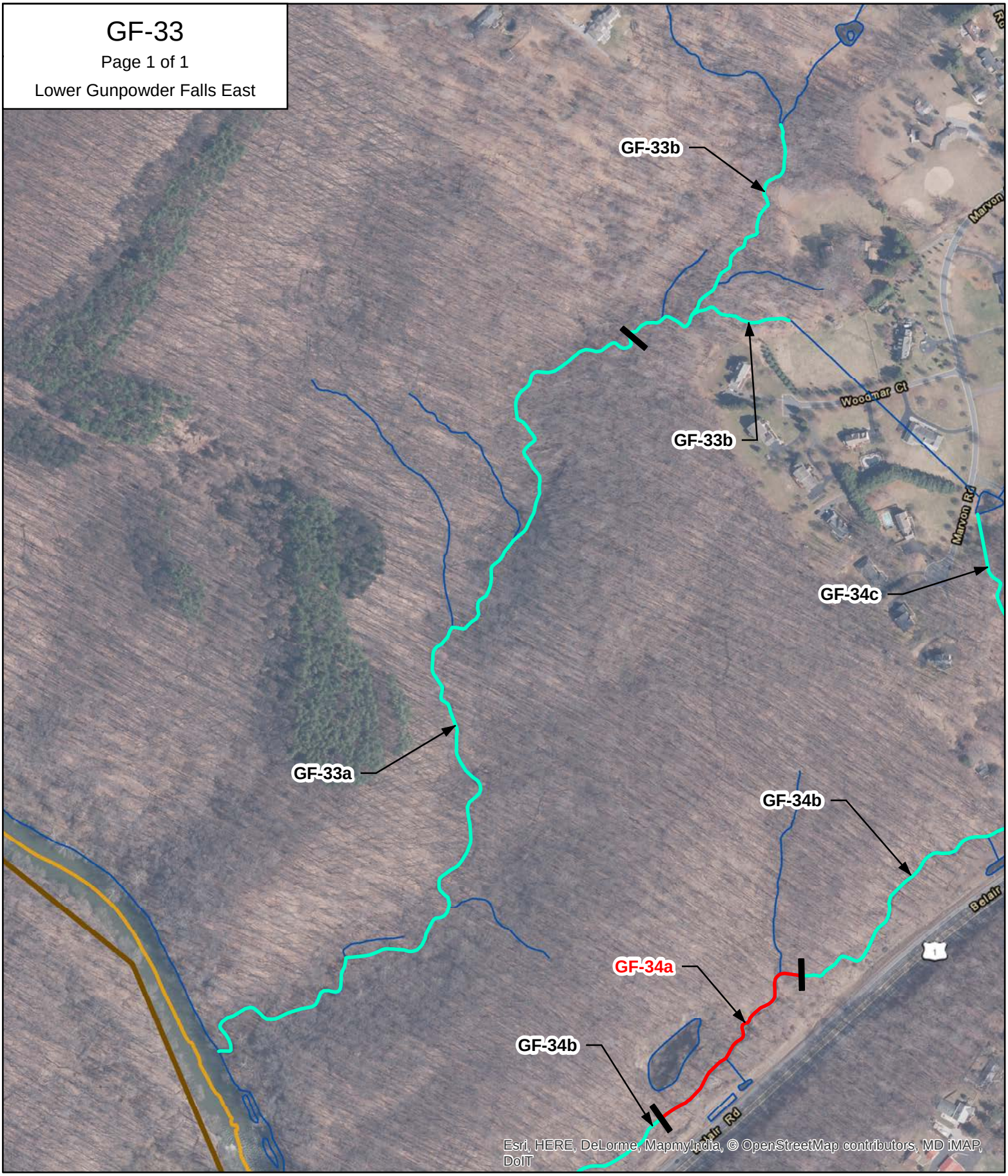
0 35 70 140

Feet

GF-33

Page 1 of 1

Lower Gunpowder Falls East



Stream Reaches Assessed in 2017

- Recommended for Restoration
- Other Reaches Assessed

- Streams
- Roads
- Watershed Planning Area
- Subwatersheds

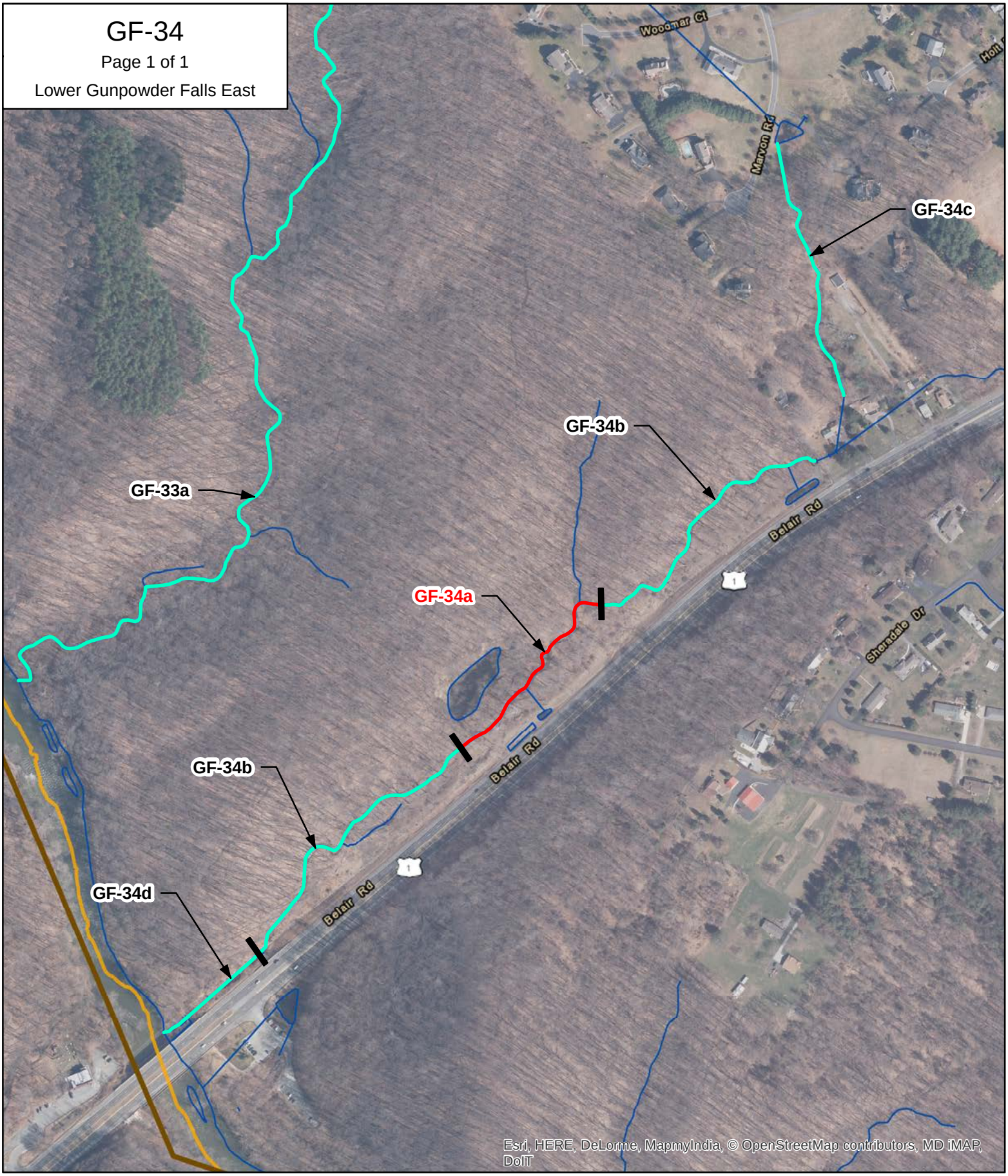
0 145 290 580

Feet

GF-34

Page 1 of 1

Lower Gunpowder Falls East



Stream Reaches Assessed in 2017

- Recommended for Restoration
- Other Reaches Assessed

- Streams
- Roads
- Watershed Planning Area
- Subwatersheds

0 145 290 580

Feet

GF-35

Page 1 of 1

Lower Gunpowder Falls East

Stream Reaches Assessed in 2017

- Recommended for Restoration
- Other Reaches Assessed

- Streams
- Roads
- Watershed Planning Area
- Subwatersheds

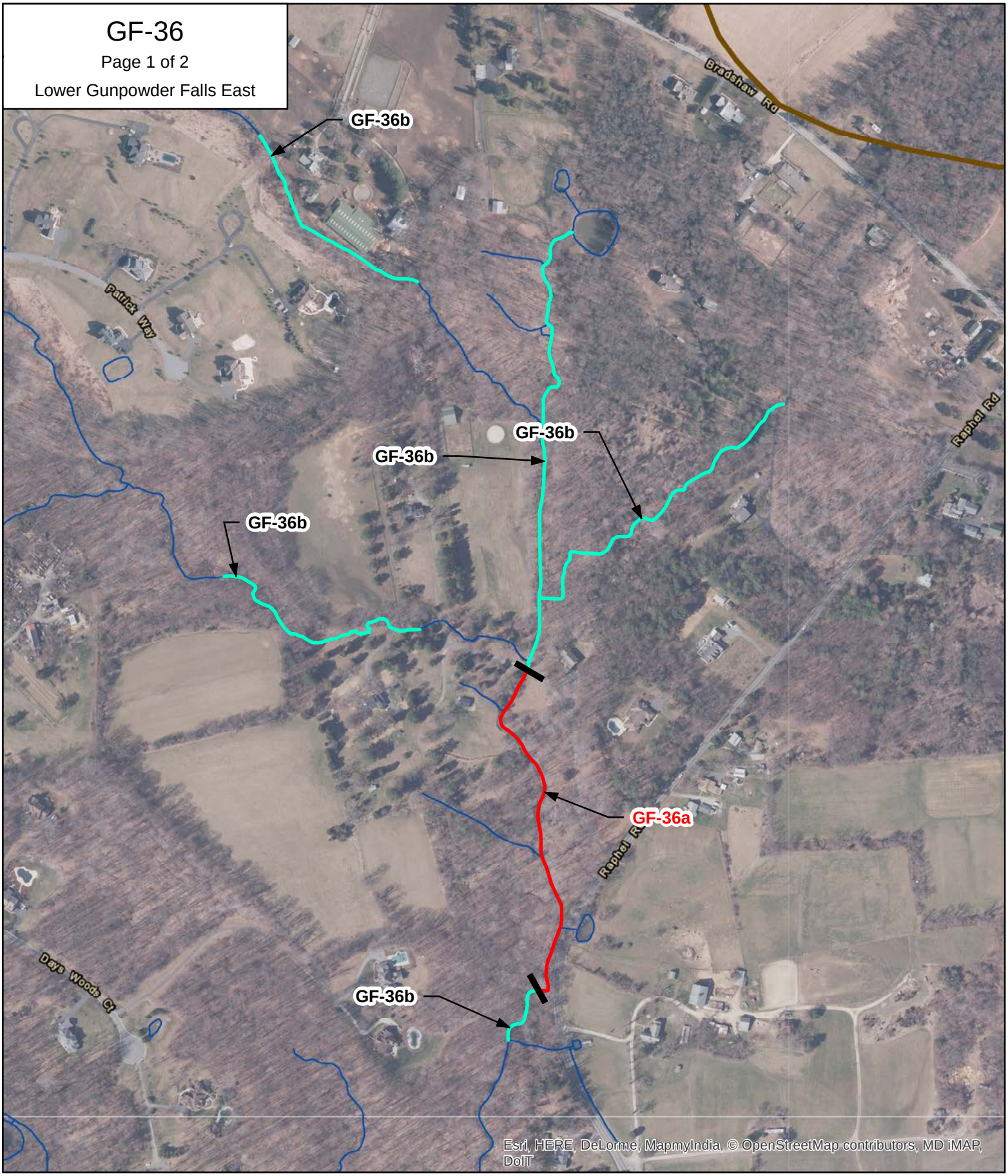
0 70 140 280

Feet

GF-36

Page 1 of 2

Lower Gunpowder Falls East



Stream Reaches Assessed in 2017

- Recommended for Restoration
- Other Reaches Assessed

- Streams
- Roads
- Watershed Planning Area
- Subwatersheds

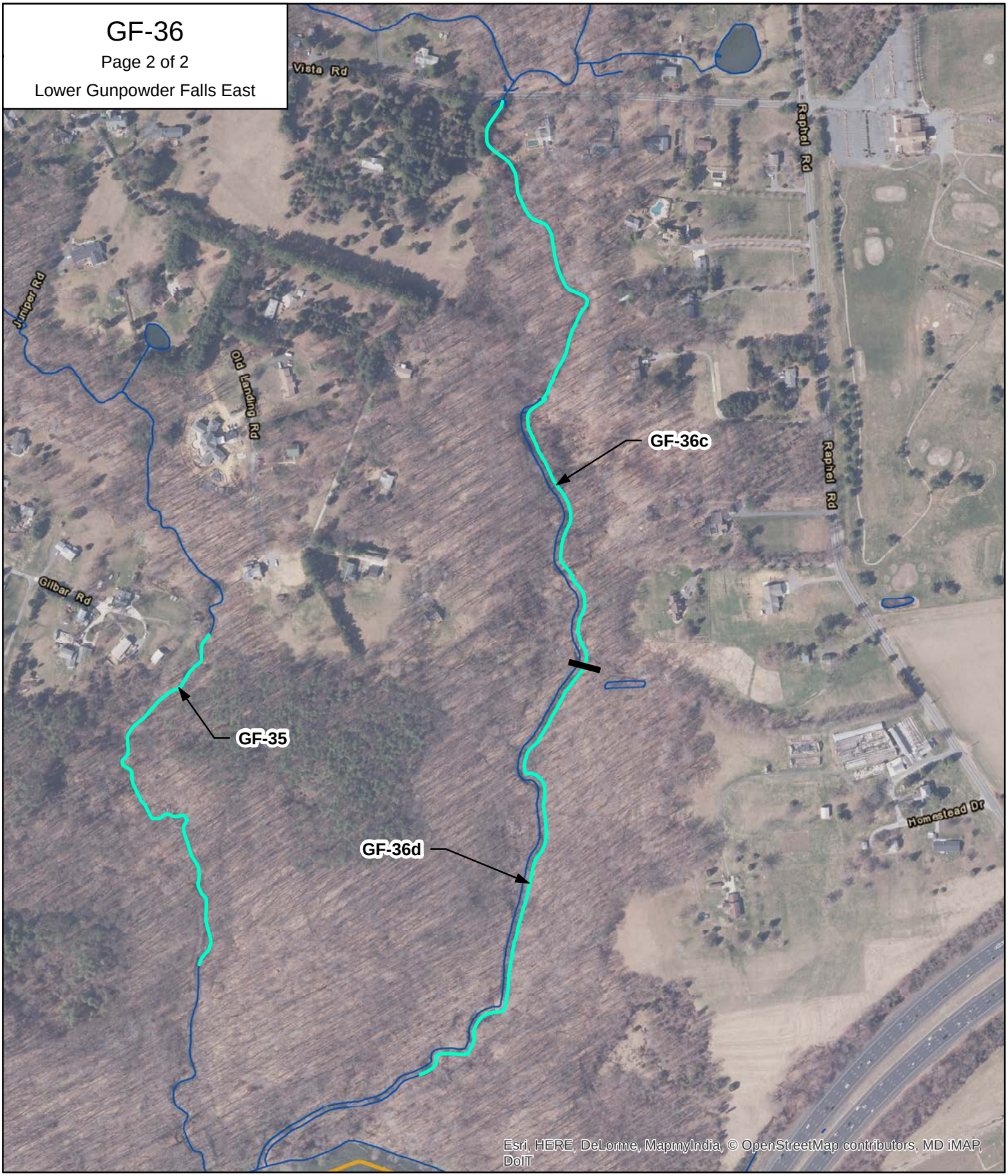
0 145 290 580

Feet

GF-36

Page 2 of 2

Lower Gunpowder Falls East



Stream Reaches Assessed in 2017

- Recommended for Restoration
- Other Reaches Assessed

- Streams
- Roads
- Watershed Planning Area
- Subwatersheds

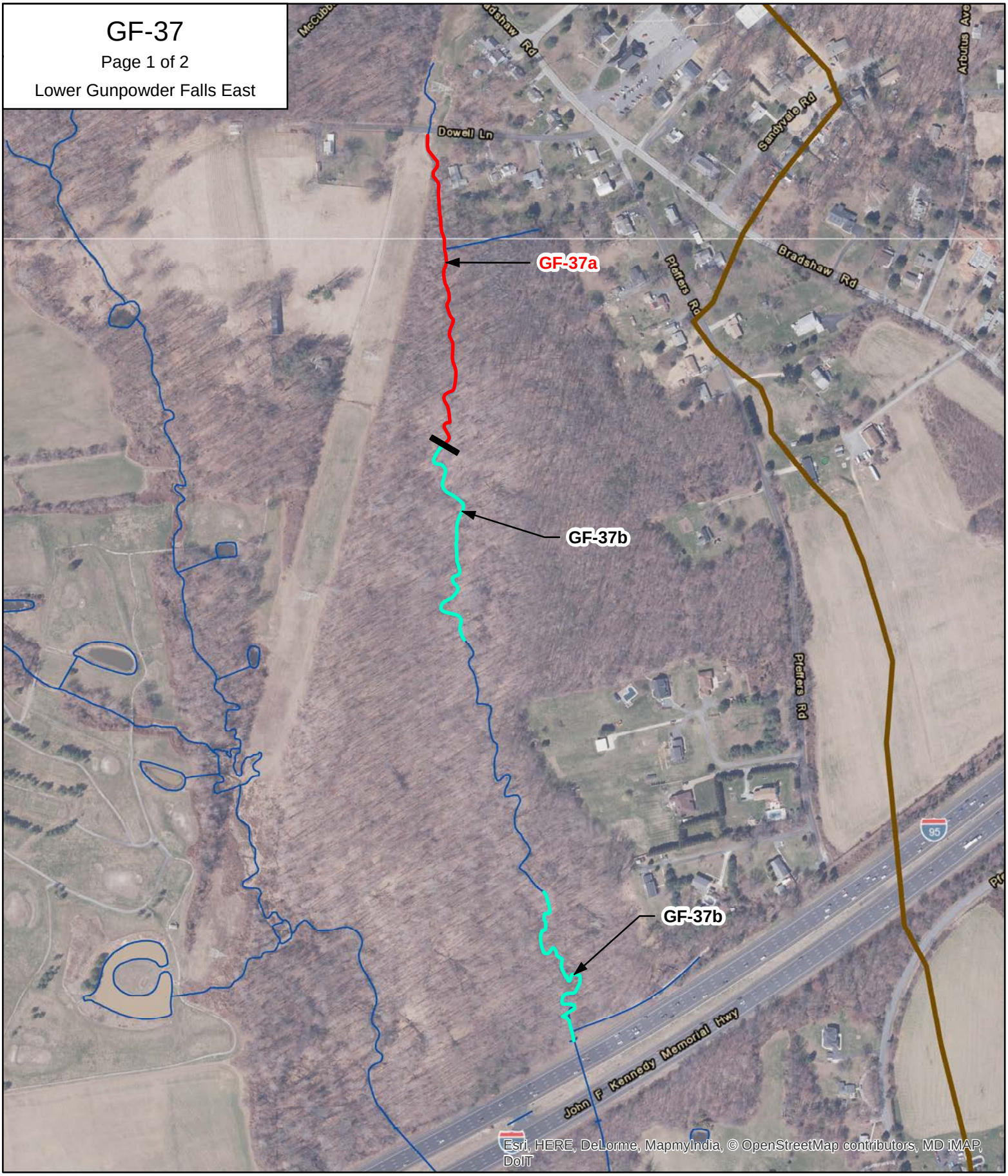
0 145 290 580

Feet

GF-37

Page 1 of 2

Lower Gunpowder Falls East



Stream Reaches Assessed in 2017

- Recommended for Restoration
- Other Reaches Assessed

- Streams
- Roads
- Watershed Planning Area
- Subwatersheds

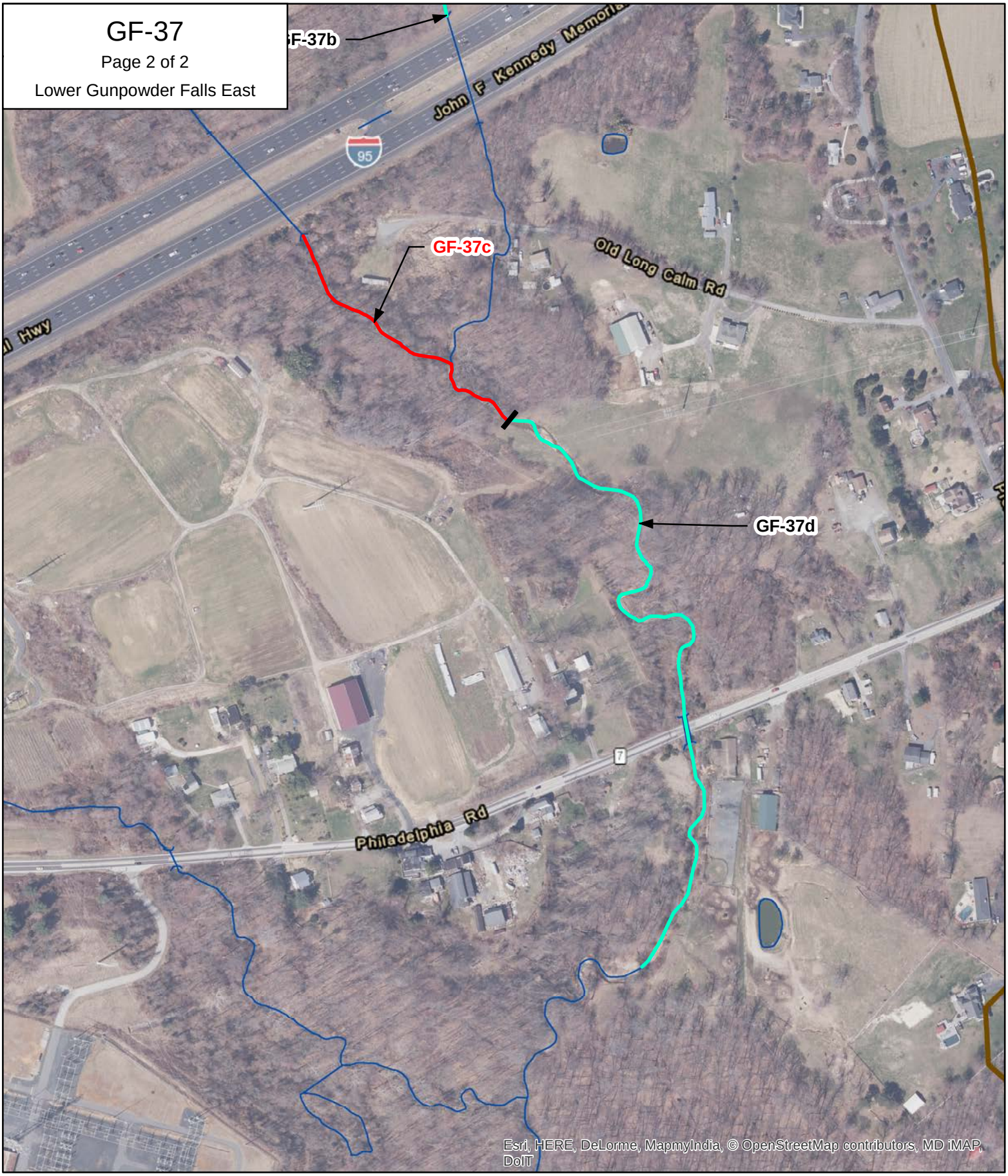
0 145 290 580

Feet

GF-37

Page 2 of 2

Lower Gunpowder Falls East



Stream Reaches Assessed in 2017

- Recommended for Restoration
- Other Reaches Assessed

- Streams
- Roads
- Watershed Planning Area
- Subwatersheds

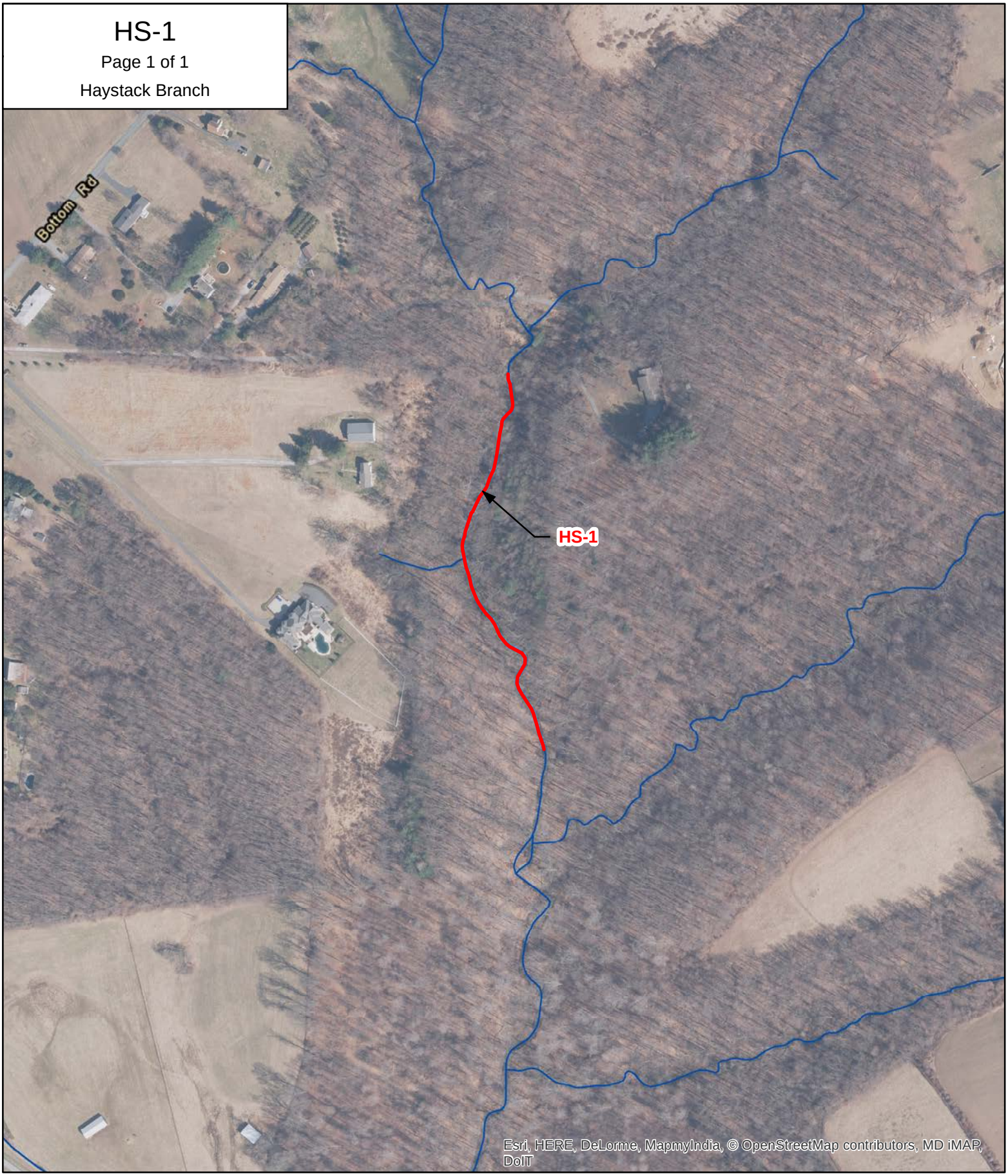
0 110 220 440

Feet

HS-1

Page 1 of 1

Haystack Branch



Stream Reaches Assessed in 2017

- Recommended for Restoration
- Other Reaches Assessed

- Streams
- Roads
- Watershed Planning Area
- Subwatersheds

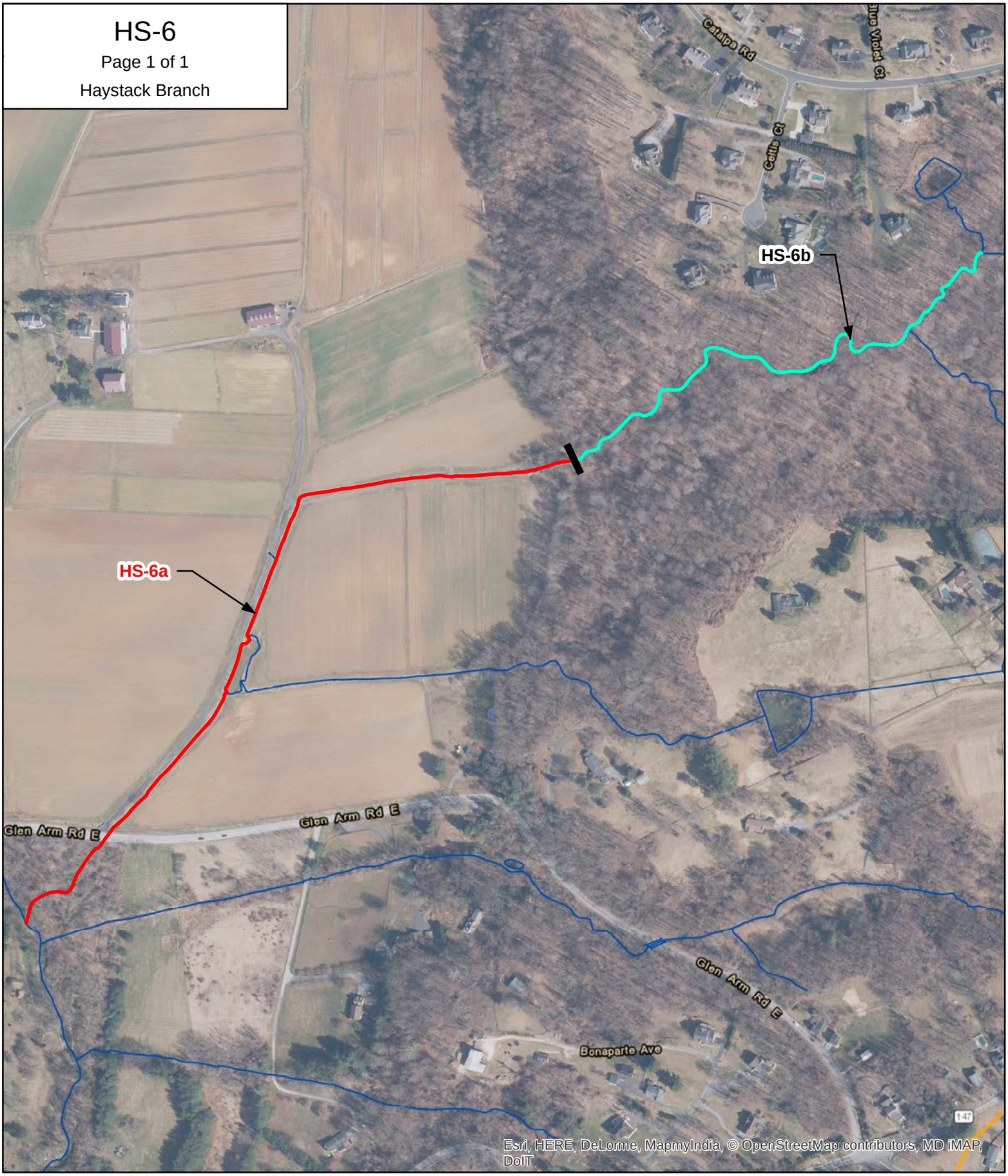
0 110 220 440

Feet

HS-6

Page 1 of 1

Haystack Branch



Stream Reaches Assessed in 2017

- Recommended for Restoration
- Other Reaches Assessed

- Streams
- Roads
- Watershed Planning Area
- Subwatersheds

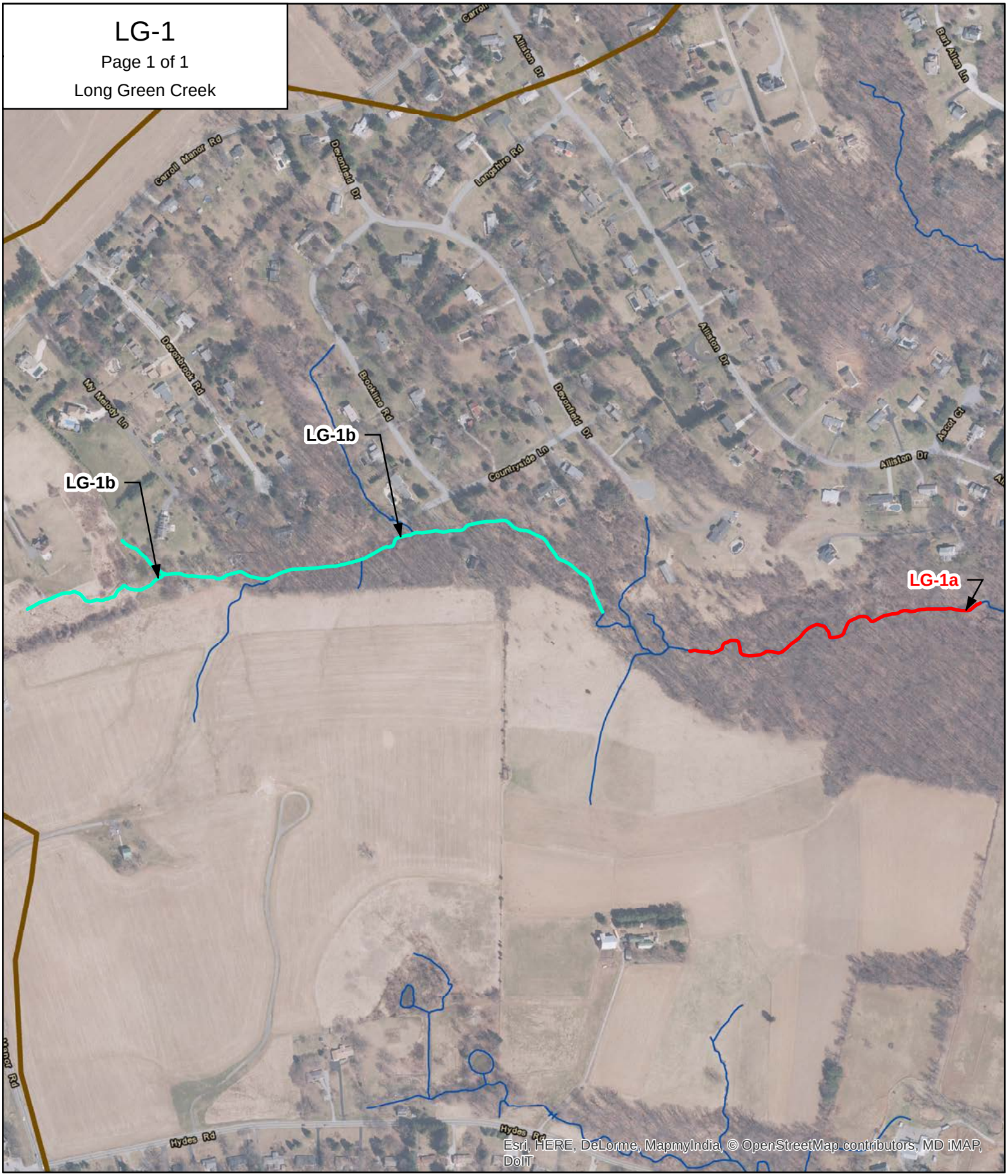
0 145 290 580

Feet

LG-1

Page 1 of 1

Long Green Creek



Stream Reaches Assessed in 2017

- Recommended for Restoration
- Other Reaches Assessed

- Streams
- Roads
- Watershed Planning Area
- Subwatersheds

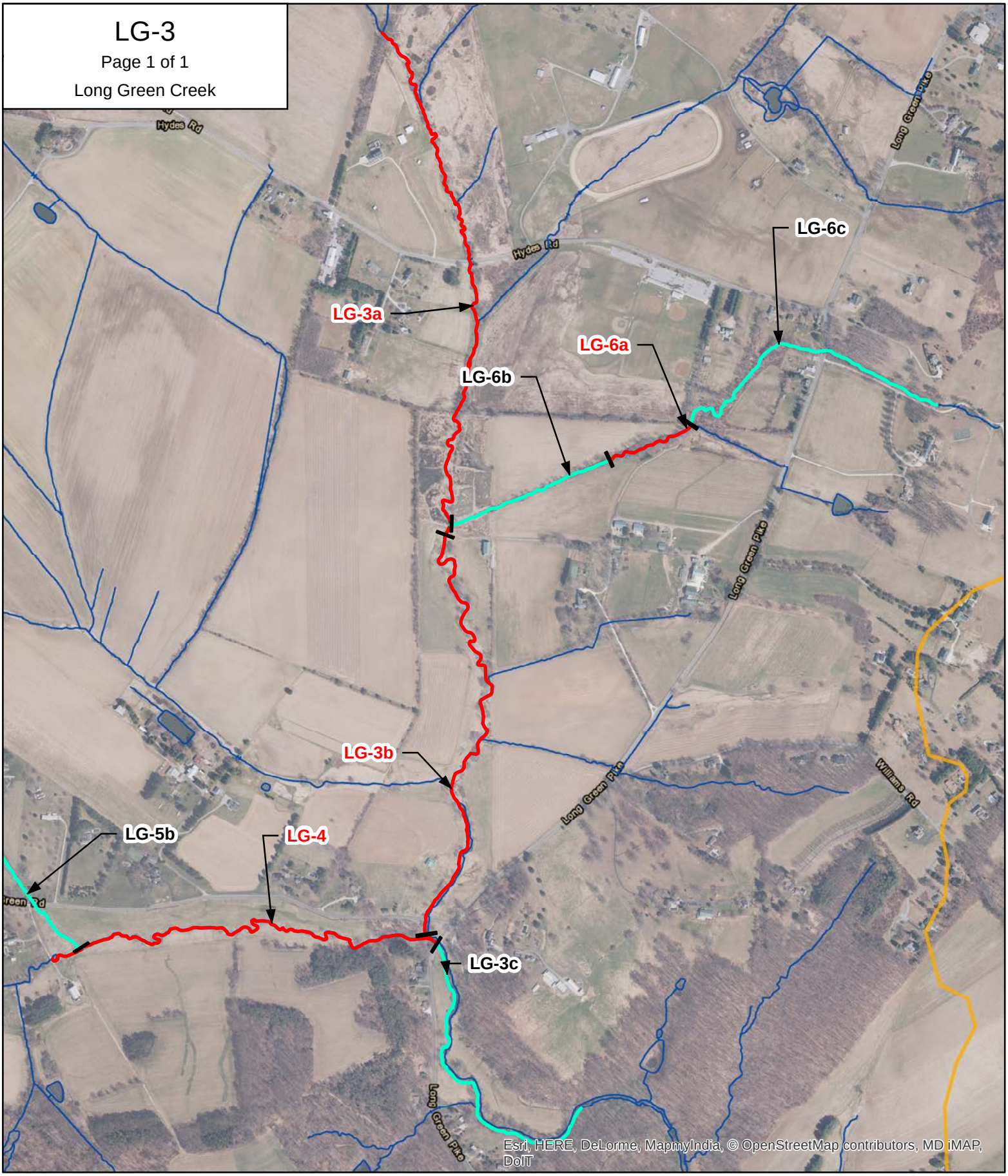
0 180 360 720

Feet

LG-3

Page 1 of 1

Long Green Creek



Stream Reaches Assessed in 2017

- Recommended for Restoration
- Other Reaches Assessed

- Streams
- Roads
- Watershed Planning Area
- Subwatersheds

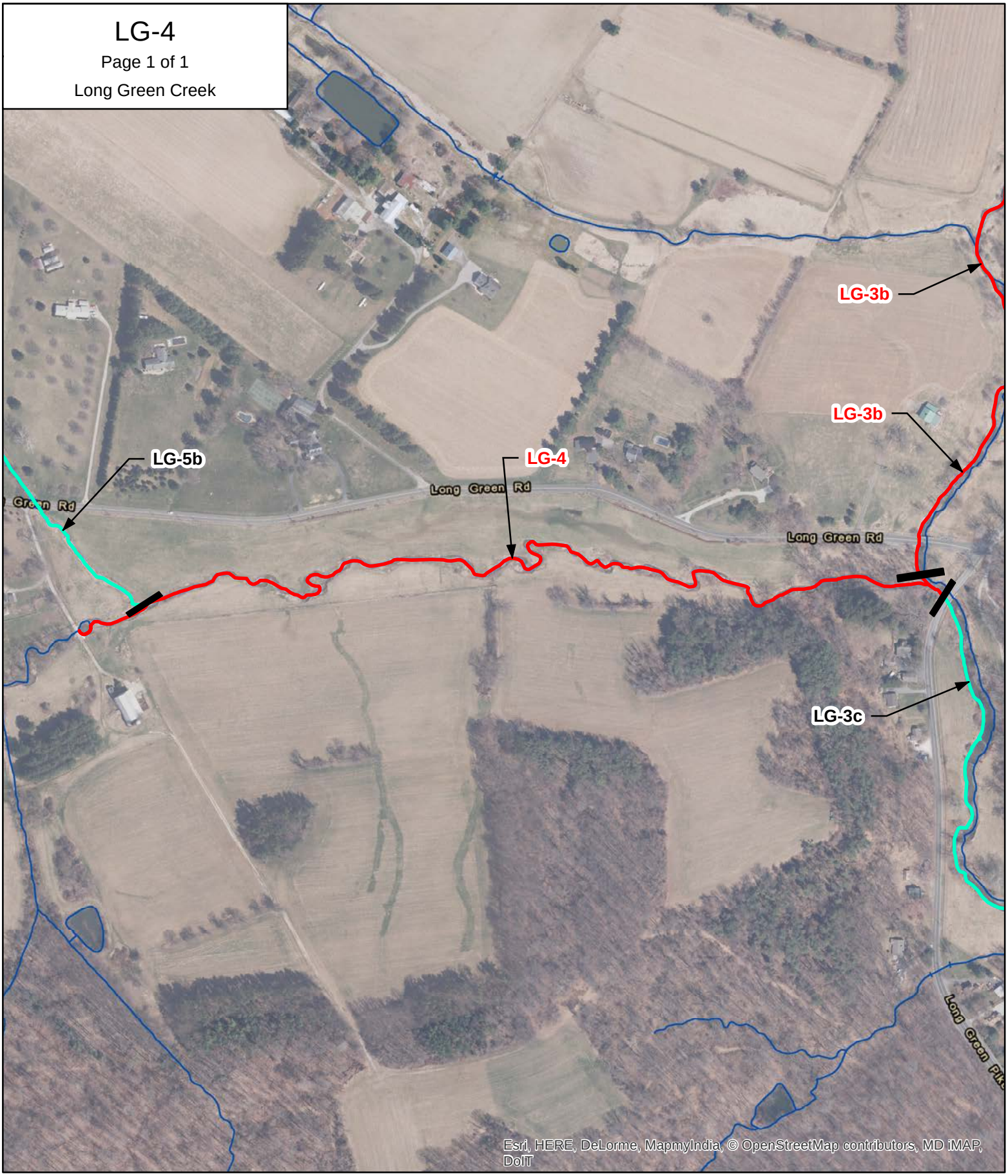
0 320 640 1,280

Feet

LG-4

Page 1 of 1

Long Green Creek



Stream Reaches Assessed in 2017

- Recommended for Restoration
- Other Reaches Assessed

- Streams
- Roads
- Watershed Planning Area
- Subwatersheds

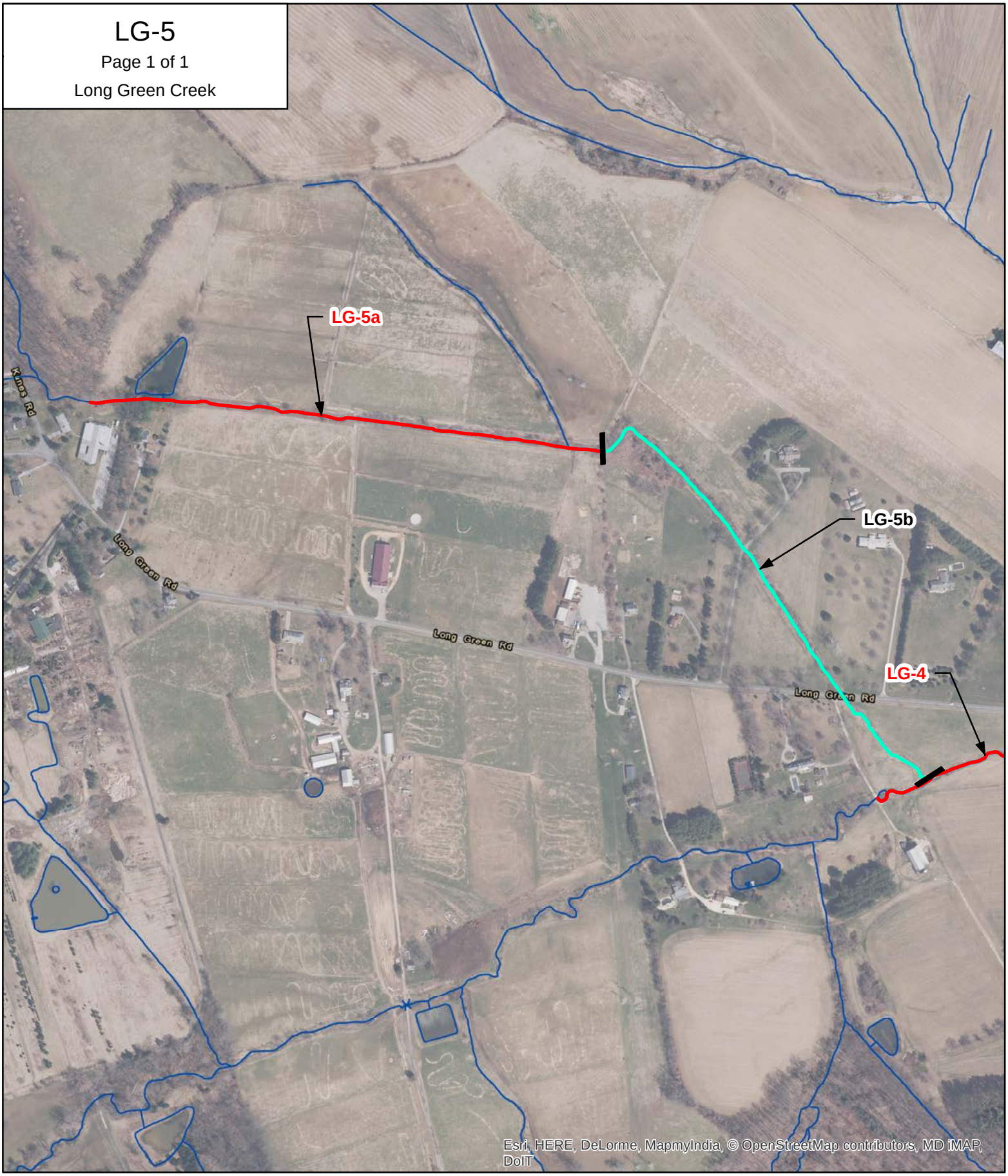
0 145 290 580

Feet

LG-5

Page 1 of 1

Long Green Creek



Stream Reaches Assessed in 2017

- Recommended for Restoration
- Other Reaches Assessed

- Streams
- Roads
- Watershed Planning Area
- Subwatersheds

0 180 360 720

Feet

LG-6

Page 1 of 1

Long Green Creek

Stream Reaches Assessed in 2017

- Recommended for Restoration
- Other Reaches Assessed

- Streams
- Roads
- Watershed Planning Area
- Subwatersheds

0 180 360 720

Feet

LG-7

Page 1 of 1

Long Green Creek

Stream Reaches Assessed in 2017

- Recommended for Restoration
- Other Reaches Assessed

- Streams
- Roads
- Watershed Planning Area
- Subwatersheds

0 285 570 1,140

Feet

SH-1

Page 1 of 1

Sweathouse Run

Stream Reaches Assessed in 2017

- Recommended for Restoration
- Other Reaches Assessed

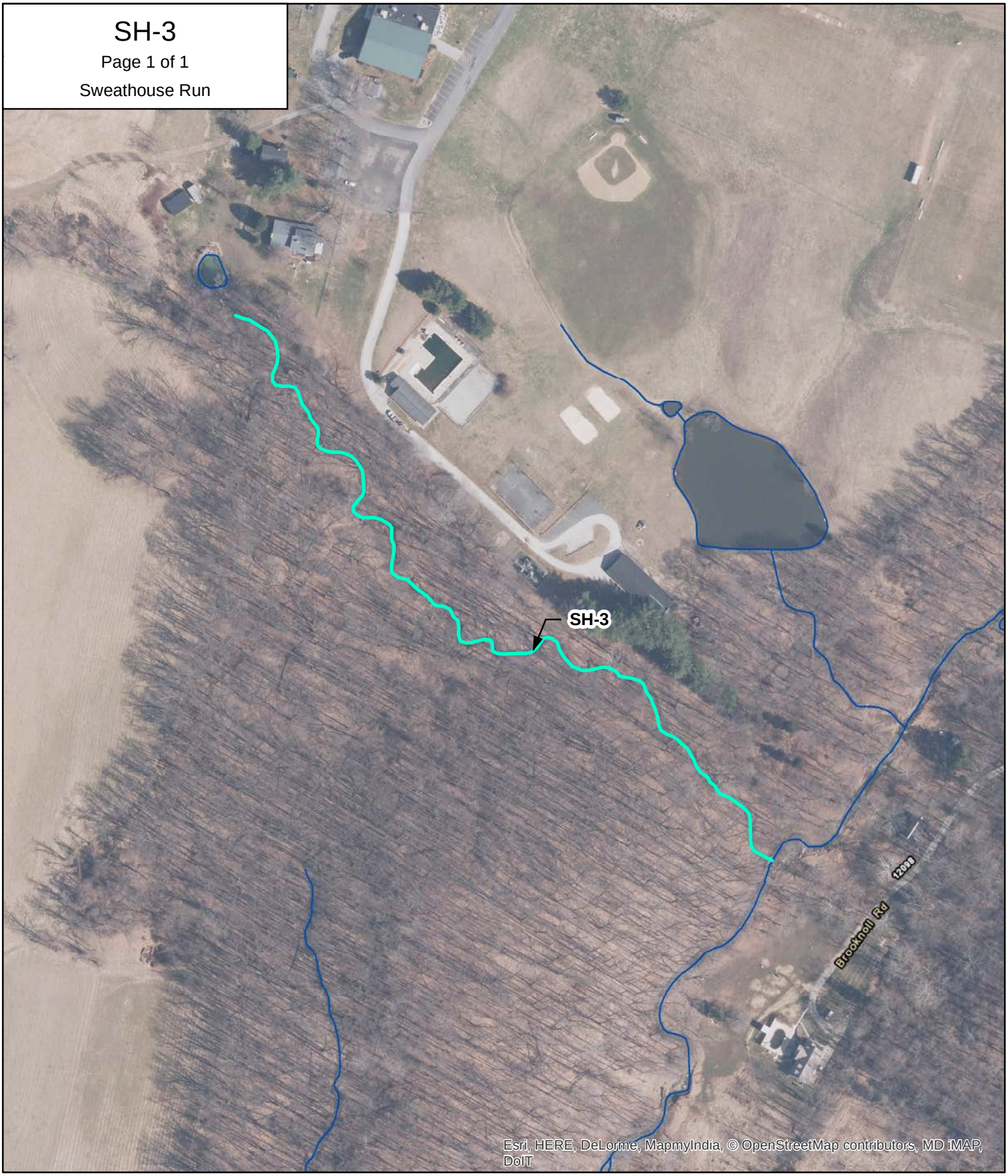
- Streams
- Roads
- Watershed Planning Area
- Subwatersheds

0 35 70 140

Feet

SH-3

Sweathouse Run



Stream Reaches Assessed in 2017

- Recommended for Restoration
- Other Reaches Assessed

- Streams
- Roads
- Watershed Planning Area
- Subwatersheds

0 70 140 280
Feet

Stream Evaluation Worksheet

Field Verification Date: **Ranking Total:**_____

Site Identification:

Personnel:

Technical Criteria		Factor	Score	Additional Information
Streambank Erosion	75-100%	9 - 10		
	50-74%	6 - 8		
	25-49%	3 - 5		
	0-24%	1 - 2		
Degree of Incision	Severe	10		Average bank height:
	Moderate	5		
	Minimal	1		
Floodplain Condition	Disconnected - no evidence of out of bank flow	10		
	Connected - infrequent out of bank flow	5		
	Connected - frequent out of bank flow	1		
Land Use	Open space	10		
	Agriculture or pasture	5		
	Developed or forested	1		
Riparian Vegetation within Floodprone Area	Herbaceous	10		
	Shrub-scrub	5		
	Forested and/or wetland	1		
Habitat Value and Ecological Lift	Multiple aspects of lift could be achieved and maintained	10		
	Lift limited to one or a few aspects	5		
	Would be difficult to achieve lift	1		
Utilities	No utilities visible	10		
	Utilities present but not within restoration area	5		
	Utilities within restoration area; design may need to incorporate relocation	1		
Feasibility Criteria				
Construction Access	Good	10		
	Poor	1		
Potential to Create Floodplain	Good	10		
	Fair	5		
	Poor - little or no space for floodplain development	1		
Multiple Benefits				
Utility Conflict Resolution	Yes	10		
	No	0		
Fish Passage Restoration	Yes	10		
	No	0		
Riparian Buffer Enhancement	Yes	10		
	No	0		
Potential for Other BMP Strategies	Yes	10		
	No	0		
Total Score		**130**		

Stream Geomorphology:
(check which apply)

- ☐ Concrete-lined
- ☐ Channelized with natural substrate
- ☐ Natural stream condition and pattern

Comments:

Project ID	Subwatershed	Recommend for Restoration?	Potential Restoration Length (ft)	Stream Evaluation Worksheet Scores														Rank (1 - 12)	Comments
				Streambank Erosion	Degree of Incision	Floodplain Condition	Land Use	Riparian Vegetation within Floodprone Area	Habitat Value and Ecological Lift	Utilities	Construction Access	Potential to Create Floodplain	Utility Conflict Resolution	Fish Passage Restoration	Riparian Buffer Enhancement	Potential for Other BMP Strategies	Total		
HS-1	Haystack Branch	**Yes**	**1,010**	-	3	7	1	1	5	10	3	3	0	2	0	0	**35**	**10**	Avg. bank height: 3-4'. Private, forested, steep, far from roads. Potential fish blockage at driveway culvert. Raw eroded banks in most outer meanders, few roots. Freeze/thaw extensive, bedrock present. Low potential overall due to difficulty of access. Small eroded gully on right bank. Recommend SWM for watershed.
HS-5	Haystack Branch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Property access denied, was not assessed.
HS-6a	Haystack Branch	**Yes**	**2,630**	7	6	8	5	10	5	5	7	2	0	0	10	10	**75**	**1**	Avg. bank height: 3-8' (higher at upstream end of field). WQ bad due to runoff (turbid despite no rain). Potential water line running parallel to downstream end on right bank. Access might impact agriculture fields. Agriculture fields up to edge of stream, driveway along right bank. Stream straightened through ag. fields, incised with most banks raw and eroding. More incised at upstream end of field. In-line pond has severe bank erosion, bare ground around pond with rilling evident. High priority, but would require lots of coordination with farmer. Recommend agricultural BMPs.
HS-6b	Haystack Branch	**No**	-	-	-	-	-	-	-	-	-	-	-	-	-	N	-	-	Forested, steep, narrow valley. Some erosion in bends in upstream end, but overall stable. Pond outfall channel has headcut part way down, about 100' section is incised and eroding.
LG-1a	Long Green Creek	**Yes**	**1,380**	2	3	4	1	1	3	10	3	3	0	0	0	0	**30**	**12**	Avg. bank height: 3'. Several eroded bends (lateral migration). Bedrock present in downstream end.
LG-1b	Long Green Creek	**No**	-	-	-	-	-	-	-	-	-	-	-	-	-	N	-	-	Some bank erosion, but not widespread. Buffer encroachment throughout to different degrees. Old collapsed culvert is causing minor local erosion. Stream is a dry channel in upstream end through yards. Difficult access due to multiple land owners, steep slopes, and mature forest in areas. Recommend riparian buffer plantings and encouraging homeowners not to mow in the buffer.
LG-2	Long Green Creek	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Property access denied for majority of reach, was not assessed.
LG-3a	Long Green Creek	**Yes**	**4,400**	2	3	5	3	3	2	10	7	7	0	0	6	0	**48**	**8**	Avg. bank height: 2-3'. Existing tree plantings along both banks, though some areas could use additional buffer. Mostly connected to floodplain. Tree tubes should be removed from tree plantings. Minor erosion along some banks.
LG-3b	Long Green Creek	**Yes**	**3,810**	4	5	6	5	7	4	10	9	5	0	0	10	0	**65**	**4**	Avg. bank height: 3-4'. Mostly grass along banks with scattered trees, surrounded by ag. fields. Erosion on most meander bends, highly erodible bank material. Local bank grading could increase floodplain connectivity. Recommend buffer plantings.
LG-3c	Long Green Creek	**No**	-	-	-	-	-	-	-	-	-	-	-	-	-	N	-	-	Restored by Ecotone. Few buffer plantings, but does not appear mowed.
LG-4	Long Green Creek	**Yes**	**3,390**	3	5	5	5	10	5	10	9	9	0	0	10	0	**71**	**2**	Avg. bank height: 3-4'. Possible pipe across stream in downstream end (may just be a piece of pipe lodged in stream bed). Restoration would impact ag. fields. Little buffer along entire reach. Some bedrock present. Recommend buffer plantings.
LG-5a	Long Green Creek	**Yes**	**2,100**	3	5	8	5	7	5	5	6	7	0	0	10	0	**61**	**5**	Avg. bank height: 2'. High transmission OHU crosses stream, signs for pipeline through ROW. Cattle have stream access in a small fenced off area. Restoration/buffer enhancement would impact pasture and cropland. 6" drop at first culvert. Buffer enhancement would require invasive treatment.
LG-5b	Long Green Creek	**No**	-	-	-	-	-	-	-	-	-	-	-	-	-	N	-	-	Low banks, stream appears to have floodplain access. Recommend riparian buffer planting and encouraging homeowners to not mow near the stream.
LG-6a	Long Green Creek	**Yes**	**680**	2	3	3	4	5	1	10	8	3	0	0	10	0	**49**	**7**	Avg. bank height: 1-2' (middle part 3-4'). Pasture with narrow vegetated buffer, dense vines/shrubs. Was likely straightened in the past. This reach is more incised than upstream or downstream, likely never accesses floodplain. Recommend restoring to reconnect floodplain and expanding riparian buffer.
LG-6b	Long Green Creek	**No**	-	-	-	-	-	-	-	-	-	-	-	-	-	N	-	-	Was likely straightened in the past. Narrow riparian buffer in upstream end, buffer has been planted in downstream end (tree tubes need to be removed). Minimal erosion. Likely has floodplain connection in some places. Could restore a more natural pattern if reach LG-6a is restored. Recommend increasing buffer width in upstream end.
LG-6c	Long Green Creek	**No**	-	-	-	-	-	-	-	-	-	-	-	-	-	N	-	-	Upstream of Long Green Farm. Minimal erosion. Past incision downstream of Long Green Pike, evidence of old berm along left bank. Stable upstream of Long Green Pike, confined by driveway on left bank.

Project ID	Subwatershed	Recommend for Restoration?	Potential Restoration Length (ft)	Stream Evaluation Worksheet Scores														Rank (1 - 12)	Comments
				Streambank Erosion	Degree of Incision	Floodplain Condition	Land Use	Riparian Vegetation within Floodprone Area	Habitat Value and Ecological Lift	Utilities	Construction Access	Potential to Create Floodplain	Utility Conflict Resolution	Fish Passage Restoration	Riparian Buffer Enhancement	Potential for Other BMP Strategies	Total		
LG-7a	Long Green Creek	**Yes**	**2,380**	2	5	5	3	3	1	10	3	2	0	0	5	10	**49**	**7**	Avg. bank height: 3-4'. Water likely backs up upstream of collapsed bridge at downstream end of reach. Forested along banks, some mowed yards, horse pasture. Suggest BMPs along Harford Rd. Some erosion, reach confined by road.
LG-7b	Long Green Creek	**No**	-	-	-	-	-	-	-	-	-	-	-	-	-	N	-	-	Minimal erosion. Recommend livestock exclusion and riparian buffer establishment/enhancement. Encourage homeowners not to mow in the buffer.
LG-7c	Long Green Creek	**No**	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	-	-	4-5' tall eroded banks in downstream end. No or minimal erosion for most of reach. One 10'+ tall eroded bank (~50' long) in upstream end. Trib that enters right bank is a ditch originating from roadside swales along Wallace Dr (potential SWM BMP opportunity), minimal erosion but slightly downcut. Recommend buffer for trib and where mowed to top of bank.
GF-33a	Lower Gunpowder Falls East	**No**	-	-	-	-	-	-	-	-	-	-	-	-	-	N	-	-	Downstream portion is within Gunpowder Falls State Park. Mostly stable with mature forest and connected to floodplain. Upstream of trail crossing near park boundary, channel slightly incised with ~3' bank erosion in a series of tight meander bends. Little erosion downstream of that area.
GF-33b	Lower Gunpowder Falls East	**No**	-	-	-	-	-	-	-	-	-	-	-	-	-	N	-	-	Forested, rocky channel originating from a spring. Multiple springs, seeps with potential wetlands around stream. Several eroded bends, not consistent. Recommend SWM in watershed.
GF-34a	Lower Gunpowder Falls East	**Yes**	**730**	9	7	10	1	1	5	10	9	9	0	0	0	5	**66**	**3**	Within Gunpowder Falls State Park. Avg. bank height: 5. Possible former quarry is adjacent - appears to be a wetland now with ponded water and small trees growing in it. Uneven and tall banks indicate possible dumped fill material. Evidence of old road crossing. Active bank erosion. Upstream and downstream of this reach is mostly stable and connected to floodplain.
GF-34b	Lower Gunpowder Falls East	**No**	-	-	-	-	-	-	-	-	-	-	-	-	-	N	-	-	Stream is mostly stable and connected to the floodplain upstream and downstream of the old quarry (?) area. Erosion is present in some meander bends, but neither vertical or lateral instability was widespread. Valley is confined by the steep valley wall on the right bank and Route 1 on the left bank.
GF-34c	Lower Gunpowder Falls East	**No**	-	-	-	-	-	-	-	-	-	-	-	-	-	N	-	-	SWM pond at headwaters has an overflow berm or the outflow pipe is buried - overland flow out of pond is causing some headcutting into channel. Steep, rocky channel with bedrock in downstream end, some tall eroded banks present for ~200'. Just downstream it becomes more confined by valley wall and development. Recommend SWM facility maintenance.
GF-34d	Lower Gunpowder Falls East	**No**	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	-	-	Stream appears to be piped along the toe of the embankment along Route 1. Embankment is bare soil that appears to be eroding in some places (likely due to overland flow from road runoff). Recommend addressing runoff from Route 1.
GF-35	Lower Gunpowder Falls East	**No**	-	-	-	-	-	-	-	-	-	-	-	-	-	N	-	-	Active erosion at upstream extent, 5' banks where mowed to top of bank. Becomes stable and forested where reach enters Gunpowder Falls State Park. Significant bedrock in downstream end. A tall eroding valley wall is present downstream of a bedrock cascade (~75' long). Downstream of trail crossing had a few eroded banks. Stable confluence with mainstem. Recommend buffer plantings in yards at upstream end.
GF-36a	Lower Gunpowder Falls East	**Yes**	**1,170**	3	5	7	1	1	1	10	3	1	0	5	0	0	**37**	**9**	Avg. bank height: 4-5'. Access difficult due to mature forest, steep slopes. Potential for fish passage restoration at driveway culvert. Multiple springs on property, end section of pipe outfall where reach is adjacent to Raphel Rd has broken off due to erosion. Bedrock present. Woodbine Farm was established in the 1700s, may have cultural or historic resources.
GF-36b	Lower Gunpowder Falls East	**No**	-	-	-	-	-	-	-	-	-	-	-	-	-	N	-	-	Covers several streams at Woodbridge Farm. Several lack riparian buffer, and may have been historically straightened. Western trib has erosion at headwaters near edge of property. Eastern trib has 1-2' banks in upstream end and is confined by horse pasture on right bank and old berm on left bank. Multiple springs on property with associated wetlands. Farm dates back to the 1700s and therefore may have cultural or historic resources.
GF-36c	Lower Gunpowder Falls East	**No**	-	-	-	-	-	-	-	-	-	-	-	-	-	N	-	-	Large sediment load ranging from sand to cobble. Bedrock and boulder influence throughout reach. 4-5' erosion in some meanders. Existing stabilization just upstream of Mt Vista Rd. Overall low potential due to forest and bedrock.

Project ID	Subwatershed	Recommend for Restoration?	Potential Restoration Length (ft)	Stream Evaluation Worksheet Scores														Rank (1 - 12)	Comments
				Streambank Erosion	Degree of Incision	Floodplain Condition	Land Use	Riparian Vegetation within Floodprone Area	Habitat Value and Ecological Lift	Utilities	Construction Access	Potential to Create Floodplain	Utility Conflict Resolution	Fish Passage Restoration	Riparian Buffer Enhancement	Potential for Other BMP Strategies	Total		
GF-36d	Lower Gunpowder Falls East	**No**	-	-	-	-	-	-	-	-	-	-	-	-	-	N	-	-	Within Gunpowder Falls State Park. Several large woody debris jams are causing local erosion and deposition upstream. Bank erosion present but not widespread. Overall little to no restoration potential. Restoration would cause significant tree impacts and access would be difficult (mature forest, steep slopes).
GF-37a	Lower Gunpowder Falls East	**Yes**	**1,090**	4	7	10	1	1	1	3	5	2	0	0	0	0	**34**	**11**	Avg. bank height: 4-5'. High transmission ROW adjacent to site. Construction difficult due to power lines, forest. Stream cuts down ~5' downstream of Dowell Ln, deeply incised for ~500'. Potential tree impacts.
GF-37b	Lower Gunpowder Falls East	**No**	-	-	-	-	-	-	-	-	-	-	-	-	-	N	-	-	Forested. 2' erosion in some outer meander bends, low banks with floodplain access, dense roots on banks. Some tortuous bends in downstream end and sediment deposition upstream of I-95 culvert.
GF-37c	Lower Gunpowder Falls East	**Yes**	**720**	5	5	8	1	1	5	2	2	5	0	10	0	10	**54**	**6**	Avg. bank height: 4'. Potential wetlands along right floodplain. ROW passes over stream at downstream end. Steep slopes, forest on right bank. 1' drop @ I95 culvert outfall, likely a fish blockage. Eroded gully near I95/upstream end has SWM BMP potential. Iron flocculant throughout channel.
GF-37d	Lower Gunpowder Falls East	**No**	-	-	-	-	-	-	-	-	-	-	-	-	-	N	-	-	Green filamentous algae, some iron flocculant present. Riprap on banks just upstream of Philadelphia Rd culvert. Cutoff meander ~350' upstream of Philadelphia Rd. Recent tree plantings on right bank downstream of Philadelphia Rd.
GF-25	Lower Gunpowder Falls West	**Yes**	**410**	8	9	10	1	1	3	10	2	5	0	0	0	0	**49**	**7**	Avg. bank height: 5-6'. Site is far from road, forested, steep slopes. Floodplain reconnection may not be feasible. Undercut outflow pipe should be stabilized. Severely incised trib enters left bank. End of reach is steep but stable bedrock channel.
SH-1	Sweathouse Run	**No**	-	-	-	-	-	-	-	-	-	-	-	-	-	N	-	-	One eroded bank visible from road, ~3', minor severity. Most of reach not assessed because property access was denied.
SH-3	Sweathouse Run	**No**	-	-	-	-	-	-	-	-	-	-	-	-	-	N	-	-	Downstream portion is steep into mainstem. Upstream portion has erosion in some meanders. Forested and steep valley. Begins at outfall from small pond. Camp activity areas/equipment located along both banks. Recommend buffer plantings in upstream end.
		Total	**25,900**																

GF-25*:* Erosion at outfall from in-line pond (left), Gully facing downstream from outfall (right)

GF-33a*:* Stable, forested channel with bedrock.

GF-33b*:* Erosion present in some meander bends (left), stream is more stable with low banks in upstream end (right)

GF-34a: Incised channel with eroding banks (left), ponded area adjacent to incised reach, may be former quarry (right)

GF-34b: Low banks with minor erosion and good variety of bed features downstream (left) and upstream (right) of GF-34a

GF-34c: Erosion at head of stream likely due to overland flow from SWM facility (left), downstream channel has significant bedrock with a few eroding banks (right)

<u>GF-34d</u>: Bare soil on the road embankment adjacent to downstream end of reach

<u>GF-35</u>: Incised channel with some bank erosion where it is mowed to the top of bank (top left), channel becomes stable once inside Gunpowder Falls State Park (top right), isolated eroded bank downstream of bedrock cascade (bottom)

GF-36a: 3-4' bank erosion (left), stream runs adjacent to road in downstream end (right)

GF-36b: Northern branch, low banks with minor bank erosion (top left); Western branch had some taller eroded banks in the upstream end (top right); Northwestern branch generally stable (bottom).

GF-36c: Minor to moderate bank erosion present in most meander bends (left, right), typically with floodplain access on the opposite bank

GF-37a: Deep gully with bank erosion in upstream end (left), bank heights decrease downstream (right)

GF-37b: Minor erosion in meander bends, but has dense roots providing stability (left, right)

GF-37c: Potential fish blockage and poor water quality at culvert (top left), bank erosion downstream of culvert (top right), gully in right floodplain (bottom)

GF-37d: Erosion limited to some meander bends (left), reach generally has good floodplain access (right)

HS-1: Erosion evident throughout reach (left), some bedrock present (right)

HS-6a: Stream likely straightened in the past, lacking riparian buffer (top left), in-line pond (top right), incised channel with bank erosion (bottom)

HS-6b: Stable channel through forested valley (left), eroding pond outfall channel enters upstream end of reach (right)

LG-1a: Bank erosion in meander bends (left, right)

LG-1b: Minor bank erosion present in reach (left), upstream end is a dry channel with inadequate riparian buffer (right)

LG-3a: Buffer plantings in upstream (top left) and downstream (top right) ends of reach with minor to moderate erosion in meander bends, middle portion of reach has an inadequate riparian buffer on the right bank (bottom)

LG-3b: Erosion present in most outer meander bends where it is mowed to top of bank (left, right)

LG-3c: Reach has been restored.

LG-4: Reach has an inadequate riparian buffer and erosion in most meander bends (top right, top left, bottom)

LG-5a: Erosion along pond embankment in upstream end (top left), narrow riparian buffer dominated by invasives between cattle pastures (top right), stream is more stable in the downstream end where a narrow buffer of trees is present (bottom)

LG-5b: Low banks with minimal erosion, though lacking an adequate riparian buffer (left, right)

LG-6a: Stream is incised several feet from the surrounding fields with a narrow riparian buffer

LG-6b: Downstream end has low banks and a narrow riparian buffer (left), upstream end has minor erosion in some meander bends (right)

LG-6c: Reach is generally stable with low banks, minor erosion limited to a few areas

LG-7a: Upstream end of reach is confined by Harford Road (left), downstream end has erosion in some meander bends and large depositional bars (right)

LG-7b: Downstream portion is lacking a riparian buffer and has minor erosion (left), upstream end has low banks and a narrow riparian buffer (right)

LG-7c: Erosion present in some meanders (left), small channel entering reach through fields is lacking a riparian buffer (right)

SH-1: Facing downstream from Mt. Vista Rd

SH-3: Downstream end is a steep step-pool system with bedrock at confluence (left), erosion is limited to some meanders in the upstream end (right)

APPENDIX G

Summary of Upland Assessments

Neighborhood Source Area (NSA) Data

NSA ID	Subwatershed	Neighborhood_Name	PSI	ROI	NSA Acres	Imperv Acres	% Imperv
NSA_Q_101	Lower Gunpowder Falls West	Summerfield Farm	Moderate	Low	81.96	5.73	7.0%
NSA_Q_102	Lower Gunpowder Falls West	Honeysuckle Hill	Moderate	Low	136.86	13.52	9.9%
NSA_Q_203	Cowen Run	Deer Woods / Deer Ridge	Low	Low	49.31	4.09	8.3%
NSA_Q_204	Cowen Run	Manor Woods	Moderate	Low	160.14	15.00	9.4%
NSA_Q_205	Cowen Run	Manor Springs	Moderate	Moderate	57.71	5.53	9.6%
NSA_Q_206	Cowen Run	Meadow Cliff	Moderate	Low	94.03	6.87	7.3%
NSA_Q_207	Cowen Run	Sally Love Dugan Property	Moderate	Low	34.35	2.89	8.4%
NSA_Q_308	Long Green Creek	Greenwood Manor	Moderate	Low	17.88	2.16	12.1%
NSA_Q_309	Long Green Creek	Windy Hills	Moderate	Low	30.73	2.68	8.7%
NSA_Q_310	Long Green Creek	Manor Crossing	High	Moderate	32.67	1.87	5.7%
NSA_Q_311	Long Green Creek	Carroll Manor	Moderate	Low	143.83	14.21	9.9%
NSA_Q_312	Long Green Creek	Webster Park	Low	Low	18.03	2.27	12.6%
NSA_Q_313	Long Green Creek	Dulaney Valley Estates	Low	Low	98.77	9.29	9.4%
NSA_Q_314	Long Green Creek	Hurline Farms	Low	Moderate	32.53	2.54	7.8%
NSA_Q_315	Long Green Creek	Long Green Woods	Moderate	Low	118.83	5.95	5.0%
NSA_Q_416	Haystack Branch	Brintonwood	Moderate	Moderate	101.45	6.96	6.9%
NSA_Q_517	Sweathouse Run	Regwood	Low	Moderate	15.86	2.29	14.4%
NSA_Q_518	Sweathouse Run	Country Hill Estates	High	Moderate	20.98	1.74	8.3%
NSA_Q_519	Sweathouse Run	Mount Vista Estates	Moderate	Moderate	111.29	6.30	5.7%
NSA_Q_620	Lower Gunpowder Falls East	Merrywood	Low	Low	49.71	4.86	9.8%
NSA_Q_621	Lower Gunpowder Falls East	Longfield Estates	Moderate	Low	124.02	9.14	7.4%
NSA_Q_622	Lower Gunpowder Falls East	Batterbrook Court	Moderate	Low	43.55	2.56	5.9%
NSA_Q_623	Lower Gunpowder Falls East	Gontrum Road	High	Moderate	118.20	9.91	8.4%
NSA_Q_624	Lower Gunpowder Falls East	El-Ray Farm	Moderate	High	59.34	5.70	9.6%
NSA_Q_625	Lower Gunpowder Falls East	Marvon at Batter Brook Farm	High	Moderate	54.89	4.95	9.0%
NSA_Q_626	Lower Gunpowder Falls East	Kings Country	Low	Moderate	55.43	8.23	14.8%
NSA_Q_627	Lower Gunpowder Falls East	Danville Station	Moderate	Low	36.26	2.45	6.8%
NSA_Q_628	Lower Gunpowder Falls East	Wildon	Moderate	Low	29.06	2.28	7.8%
NSA_Q_629	Lower Gunpowder Falls East	Kingslea	Moderate	Moderate	35.46	3.96	11.2%
NSA_Q_630	Lower Gunpowder Falls East	Days Woods Manor	Moderate	Low	94.49	3.58	3.8%

NSA Recommendations

NSA ID	Downspout Redirect	Rain Barrel	Rain Garden	Stencil	BayScape	Lot Canopy	Fertilizer Reduction	Pct Lawns High	Pet Waste	Buffer Impact
NSA_Q_101								5		X
NSA_Q_102				X				10		X
NSA_Q_203				X				5		
NSA_Q_204				X				10		
NSA_Q_205				X				10		X
NSA_Q_206				X				10		X
NSA_Q_207				X			X	20		X
NSA_Q_308					X	X	X	25		
NSA_Q_309				X				5		X
NSA_Q_310			X		X	X	X	40		X
NSA_Q_311				X				10		X
NSA_Q_312								10		
NSA_Q_313				X				10		
NSA_Q_314				X	X	X		15		
NSA_Q_315				X				5		X
NSA_Q_416			X	X			X	60		
NSA_Q_517			X	X				0		
NSA_Q_518			X		X	X	X	30		X
NSA_Q_519				X	X	X		10		X
NSA_Q_620				X				0		
NSA_Q_621				X	X	X	X	25		
NSA_Q_622							X	25		
NSA_Q_623				X	X	X	X	20		X
NSA_Q_624			X	X	X	X		10		X
NSA_Q_625				X	X	X	X	40		X
NSA_Q_626	X	X		X	X	X		7		
NSA_Q_627					X	X		0		
NSA_Q_628				X				0		
NSA_Q_629				X	X	X		0		
NSA_Q_630	X	X					X	90		

Hotspot Investigation (HSI) Data

			Category			Hotspot Status			
HSI ID	Subwatershed	Description	Commercial or Industrial	Transport Related	Other	Not a Hotspot	Potential	Confirmed	Severe
HSI_Q_101	Lower Gunpowder Falls West	Restaurant	X			X			
HSI_Q_202	Cowen Run	Nursery	X			X			
HSI_Q_203	Cowen Run	Abandoned Retail	X			X			
HSI_Q_304	Long Green Creek	Abandoned Restaurant	X			X			
HSI_Q_305	Long Green Creek	Florist	X			X			
HSI_Q_306	Long Green Creek	Multiple Businesses	X				X		
HSI_Q_307	Long Green Creek	Retail	X			X			
HSI_Q_308	Long Green Creek	Lumber Yard/Tshirt Production	X			X			
HSI_Q_309	Long Green Creek	Municipal Maintenance Facility			X		X		
HSI_Q_310	Long Green Creek	General Contractor	X			X			
HSI_Q_311	Long Green Creek	Warehouse/Offices	X			X			
HSI_Q_312	Long Green Creek	Computer Services	X			X			
HSI_Q_313	Long Green Creek	Commercial & Industrial HVAC	X				X		
HSI_Q_314	Long Green Creek	Commercial Retail/Drilling Services	X			X			
HSI_Q_315	Long Green Creek	Municipal Maintenance Facility			X	X			
HSI_Q_316	Long Green Creek	Restaurant	X			X			
HSI_Q_317	Long Green Creek	Animal Clinic	X			X			
HSI_Q_318	Long Green Creek	Showroom	X			X			
HSI_Q_319	Long Green Creek	Auto Repair	X				X		
HSI_Q_320	Long Green Creek	Retail Food Services/ Gas Station	X			X			
HSI_Q_321	Long Green Creek	Retail Services/ Sales	X			X			
HSI_Q_622	Lower Gunpowder Falls East	Car Storage and Boat Retail		X			X		
HSI_Q_623	Lower Gunpowder Falls East	Paxton Hardware Antiques Ltd.	X			X			
HSI_Q_624	Lower Gunpowder Falls East	Abandoned Gardening Center	X			X			
HSI_Q_625	Lower Gunpowder Falls East	Scrap Metal Recyclers	X					X	

HSI Pollution Sources and Recommendations

	Pollution Sources						Recommendations						
HSI ID	Vehicle Operations	Outdoor Materials	Waste Mgmt	Physical Plant	Turf / Landscaping	Stormwater	Refer for Enforcement	Follow-up Inspection	Test for Illicit Discharge	Future Education	Check NPDES Status	On-site Retrofit	Review Stormwater Pollution Prevention Plan
HSI_Q_101													
HSI_Q_202		X		X		X							
HSI_Q_203				X									
HSI_Q_304				X									
HSI_Q_305				X									
HSI_Q_306	X	X	X	X		X				X			
HSI_Q_307		X	X										
HSI_Q_308		X	X	X									
HSI_Q_309	X	X		X		X							X
HSI_Q_310	X	X		X									
HSI_Q_311		X											
HSI_Q_312													
HSI_Q_313	X	X		X						X			
HSI_Q_314		X		X									
HSI_Q_315	X	X		X									
HSI_Q_316		X											
HSI_Q_317				X									
HSI_Q_318		X	X	X									
HSI_Q_319	X	X		X						X			
HSI_Q_320	X			X									
HSI_Q_321													
HSI_Q_622	X	X	X		X					X			
HSI_Q_623					X	X							
HSI_Q_624		X	X		X			X					
HSI_Q_625		X	X		X		X	X	X	X	X		X

Institutional Site Investigation (ISI) Data

ISI ID	Sub-watershed	Name	Type	Ownership	Nutrient Mgmt Plan Required	Tree Planting	Stormwater Retrofit	Downspout Disconnection	Stormdrain Marking	Stream Buffer Improvement	Comments
ISI_Q_201	Cowen Run	Glen Meadows Retirement	Residential Facility	Private		X	X				Opportunity for stream restoration along roadway. Tree planting site may be designated for future development. May be opportunity for demonstration rain gardens in shared space.
ISI_Q_302	Long Green Creek	Waugh United Methodist Church	Church/Faith-Based	Private		X					
ISI_Q_303	Long Green Creek	Wilson United Methodist Church	Church/Faith-Based	Private							Small church on small parcel.
ISI_Q_304	Long Green Creek	Long Green Volunteer Fire Co Inc	Municipal Facility-Fire Co.	Public		X	X				Most parking lot and roof flow to one corner of lot. Onsite staff person confirmed issues with hill erosion.
ISI_Q_305	Long Green Creek	Long Green Valley Church of the Brethren	Church/Faith-Based	Private		X					
ISI_Q_306	Long Green Creek	Carroll Manor Elementary School	School	Public		X	X				Tree planting in southwest corner and on slope area. Potential bioswale demonstration project.
ISI_Q_307	Long Green Creek	Union Methodist Church	Church/Faith-Based	Private							Small church on small parcel.
ISI_Q_308	Long Green Creek	St John's Catholic Church and School	Church/Faith-Based	Private		X					Tree planting location may be future cemetery.
ISI_Q_309	Long Green Creek	Hydes Road Park	Park	Public			X				
ISI_Q_510a	Sweathouse Run	Redeemer Presbyterian Church and School	Church/Faith-Based	Private		X					Plant trees in sloped area between parking pads.
ISI_Q_510b	Sweathouse Run	Beachmont Christian Ministries	Church/Faith-Based	Private		X					Existing pond needs volume checked and riser structure improved. Swale sideslope needs to be stabilized in swale near parking lot.
ISI_Q_511	Sweathouse Run	Free State Montessori School	Private School	Private		X					Potential to remove pavement in back parking lot.

ISI ID	Sub-watershed	Name	Type	Ownership	Nutrient Mgmt Plan Required	Tree Planting	Stormwater Retrofit	Downspout Disconnection	Stormdrain Marking	Stream Buffer Improvement	Comments
ISI_Q_612	Lower Gunpowder Falls East	First Baptist Church of Kingsville	Church/Faith-Based	Private		X					
ISI_Q_613	Lower Gunpowder Falls East	Grace Community Church	Church/Faith-Based	Private			X		X		Include in future education effort.
ISI_Q_614	Lower Gunpowder Falls East	Kingsville Volunteer Fire Company	Municipal Facility-Fire Co.	Public			X				
ISI_Q_615	Lower Gunpowder Falls East	Independent Order of Odd Fellows	Church/Faith-Based	Private							Unused/abandoned lot. Suggest follow-up on-site inspection.
ISI_Q_616	Lower Gunpowder Falls East	Salem United Methodist Church	Church/Faith-Based	Private				X			Underground "poisonous gas" storage tanks. Include in future education efforts.
ISI_Q_617	Lower Gunpowder Falls East	Mt Vista Public Golf Course	Golf Course/ Park & Recreational Site	Public			X				12 acre reforestation plan has been established.