Middle River and Tidal Gunpowder Small Watershed Action Plan

Volume II

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Final Report

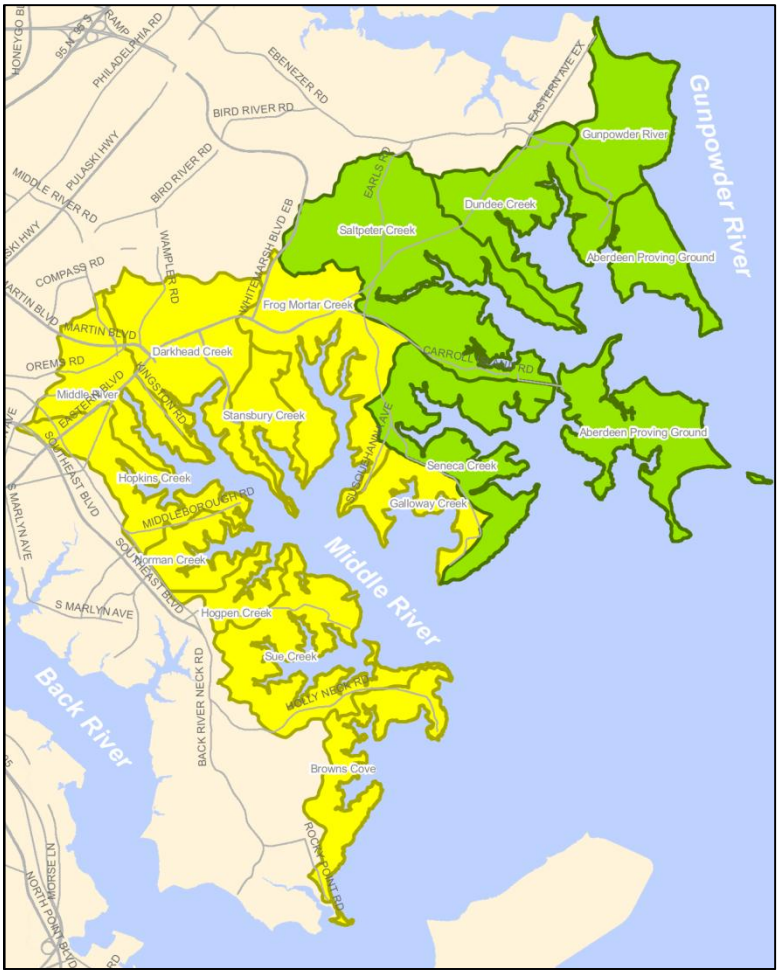
Baltimore County Executive Kevin Kamenetz and the Baltimore County Council

APPENDIX E:

Middle River and Tidal Gunpowder Watershed Characterization Report

(PB 2011)

Middle River & Tidal Gunpowder River Watershed Characterization



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CHAPTER 1: INTRODUCTION

1.1 Purpose

The Middle River/Tidal Gunpowder River Watershed Characterization Report aims to:

1. Summarize the factors that may affect the water quality of Middle River and Tidal Gunpowder River such as landscape, geomorphology, hydrology, and biological characteristics;
2. Explain the current conditions of the Middle River and Tidal Gunpowder River watersheds and their natural resources; and
3. Describe human impacts on the watersheds and identify restoration and preservation strategies appropriate for accomplishing watershed goals.

The information presented in this watershed characterization report will be used to develop a Small Watershed Action Plan (SWAP) for the Middle River/Tidal Gunpowder River planning area.

1.2 Watershed Location and Scale

The Middle River and Tidal Gunpowder River watersheds are located in the Western Coastal Plain of Maryland, in southeast Baltimore County (see Figure 1-1). The two watersheds are grouped together into one planning area for the SWAP and are both addressed in this watershed characterization report. The Middle River/Tidal Gunpowder River planning area has an extent of approximately 12,324 acres (19 square miles). The Middle River watershed is approximately 6,468 acres (10 square miles) and 52% of the planning area; the Tidal Gunpowder River watershed is approximately 5,856 acres (9 square miles) and 48% of the planning area. The watersheds are bounded by the Tidal Back River watershed to the West and the Bird River watershed to the North.

The Middle River and Tidal Gunpowder River watersheds were subdivided into smaller drainage areas or subwatersheds, which are listed in Table 1-1 along with respective acreages. In addition to characterizing the entire planning area, analyses were conducted on a subwatershed scale to provide detailed information for smaller areas and to focus restoration and preservation efforts. Also, success of restoration efforts can be more easily monitored and measured on this smaller scale. Figure 1-2 shows the 10 subwatersheds comprising the Middle River watershed and the 5 subwatersheds forming the Tidal Gunpowder River watershed. Methods for the delineation of the watersheds and subwatersheds are described in further detail in Chapter 2.

Table 1-1: Middle River and Tidal Gunpowder River Subwatershed Areas

Subwatershed	Area (Acres)	Area (Sq Miles)
Darkhead Creek	1,139.6	1.78
Frog Mortar Creek	1,191.8	1.86
Galloway Creek	371.5	0.58
Browns Cove	611.8	0.96
Hogpen Creek	262.3	0.41
Hopkins Creek	604.6	0.94
Middle River	674.0	1.05
Norman Creek	311.4	0.49
Stansbury Creek	345.8	0.54
Sue Creek	955.0	1.49
Middle River Subtotal	*6,467.9*	*10.1*
Aberdeen Proving Ground	1,280.9	2.00
Dundee Creek	920.4	1.44
Gunpowder River	745.4	1.16
Saltpeter Creek	1,902.2	2.97
Seneca Creek	1,007.2	1.57
Tidal Gunpowder Subtotal	*5,856.1*	*9.2*
Total	*12,323.9*	*19.3*

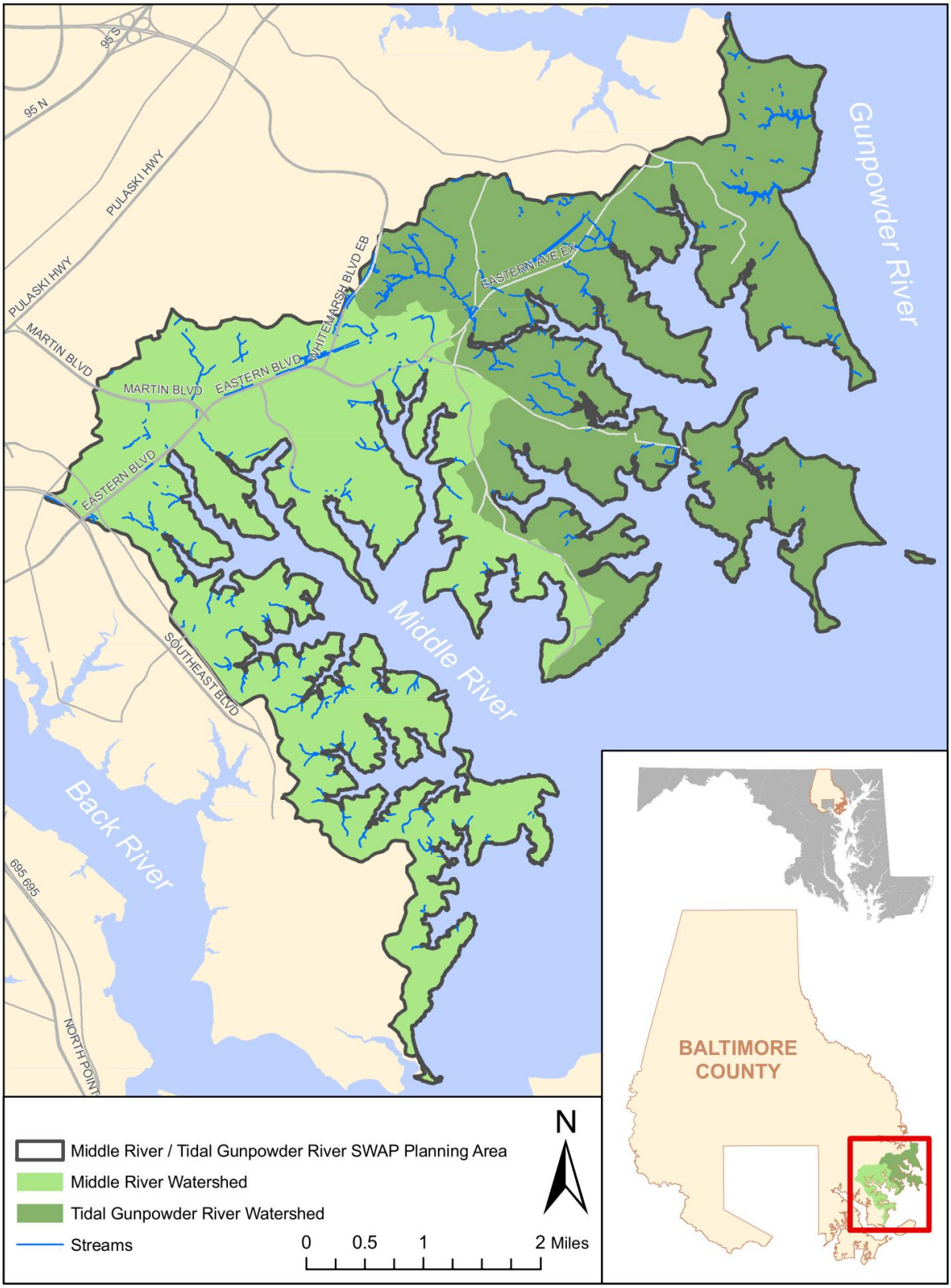

Figure 1-1: Location of Middle River and Tidal Gunpowder River Watersheds

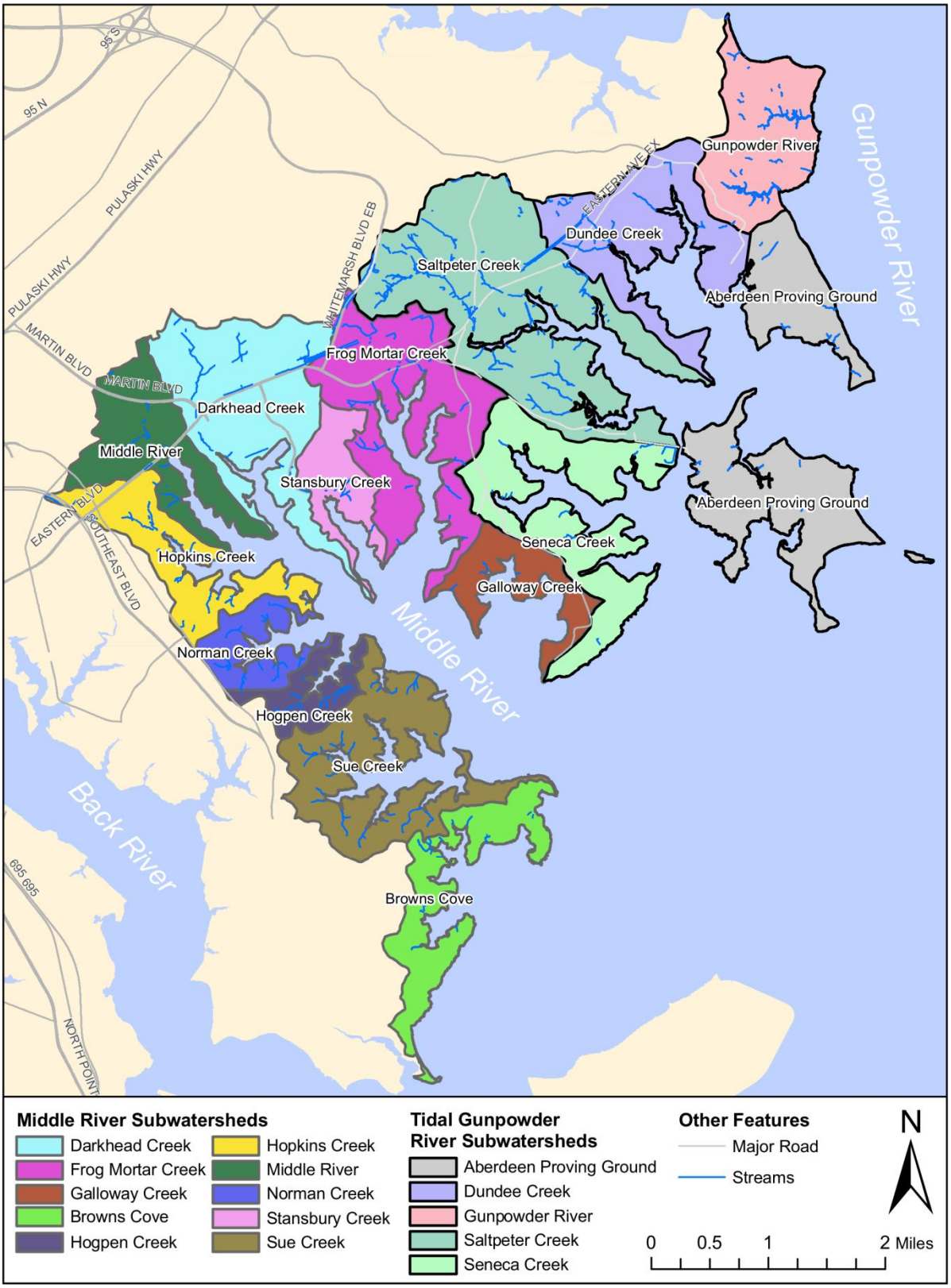

Figure 1-2: Middle River and Tidal Gunpowder River Subwatersheds

1.3 Report Organization

This report is organized into the following six chapters:

Chapter 1 – Explains the purpose of the report and the location and scope of the watershed characterization.

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

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

Chapter 4 – Describes the upland assessments conducted to identify pollutant sources and restoration opportunities for six assessment categories: neighborhoods, institutions, pervious areas, hotspots, marinas, and large industrial sites.

Chapter 5 – Presents restoration and preservation strategies appropriate for accomplishing watershed goals developed by the community and the Middle River/Tidal Gunpowder River Steering Committee.

Chapter 6 – Lists the references consulted during the development of this report.

CHAPTER 2: LANDSCAPE AND LAND USE

2.1 Introduction

This chapter discusses land cover and land use in the Middle River and Tidal Gunpowder River watersheds, describing characteristics of both the natural land surface as well as development activities taking place within the watersheds. 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 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.

2.2 Natural Landscape

Natural land surface characteristics relevant to watershed properties and processes are described in the following sections. These topics include climate, watershed delineation, topography, geology, soil properties, forest cover, streams, and tidal water features.

2.2.1 Climate

Climate is an important consideration because it can influence soil and erosion processes, stream flow patterns, and topography. Climate also affects vegetative growth and determines the species composition of terrestrial and aquatic life of a region. In addition, rainfall patterns are an important component of the hydrology of a watershed and can affect watershed management strategies.

The Middle River/Tidal Gunpowder River region can be described as a humid continental climate with four distinct seasons (DEPRM 2008). It has a relatively temperate climate due to the combined effects of the Appalachian Mountains to the West and the Chesapeake Bay and Atlantic Ocean to the East. According to the National Climatic Data Center (NCDC), the region is also in the path of low pressure systems that move across the country resulting in frequent changes in wind direction and weather (NCDC 2009). Average annual rainfall in Baltimore, Maryland is 41.94 inches based on 30 years of data (1971-2000) (NRCC 2009). Rainfall is uniformly distributed throughout the year, with monthly averages ranging from 3.00 inches for April to 3.98 inches for September. Most snowfall occurs in December, January, February and March, with an average annual snowfall of 21.4 inches based on 58 years of data (1961-2008).

2.2.2 Watershed Delineation

A watershed-based approach for evaluating water quality conditions and improvement potential involves determining the drainage areas that contribute runoff and groundwater to a specific water body. Drainage areas vary greatly in size depending on the scale of the stream system of interest. Drainage areas for large river, estuary, and lake systems are typically on the order of several thousand square miles and are often referred to as basins. For example, the Chesapeake Bay basin covers over 64,000 square miles, including over 100,000 rivers and streams and portions of six different states (CBP 2009). Basins consist of sub-basins which refer to drainage areas on the order of several hundred square miles and may consist of one or more major stream networks. Maryland has 13 sub-basins including the Upper Western Shore sub-basin. Sub-basins are further subdivided into watersheds and then subwatersheds which are the most commonly used and practical hydrologic units for management and restoration purposes. There are 138 state-defined watersheds (called 8-digit watersheds) in Maryland, ranging in size from 20 to 100 square miles, and these are comprised of over 1,100 subwatersheds (called 12-digit watersheds) identified by Maryland Department of Natural Resources (DNR); a subwatershed refers to the drainage area of a specific stream and typically covers 10 square miles or less (DNR 2005).

There are 14 state-defined, 8-digit watersheds in Baltimore County. The 8-digit Middle River watershed (02-13-08-07) is approximately 10 square miles. The 8-digit Gunpowder River watershed (02-13-08-01) is approximately 13 square miles. The Middle River watershed is approximately 10 square miles (6,468 acres), and the Tidal Gunpowder River watershed is approximately 9 square miles (5,856 acres). For planning and management purposes, the Middle River and Tidal Gunpowder River watersheds have been further subdivided into 15 subwatersheds by Baltimore County – ten in Middle River and five in Tidal Gunpowder River, as illustrated in Figure 1-2. Watershed delineations were provided by the Baltimore County Office of Information Technology (OIT) via spatial data based on 1998 Maryland state-defined 8-digit and 12-digit watershed information.

2.2.3 Slope

The topography of a region describes the shape of the land including locations and elevations of surface features such as ridges and valleys. Land shape characteristics such as steepness affect the direction and magnitude of surface water flows, degree of soil erosion, and suitability for development. Land surface topography has importance in water quality because steeper slopes are more prone to overland flow and soil erosion, which means that these areas have a greater potential to generate pollutants in runoff. Soil slope data for the Middle River and Tidal Gunpowder River watersheds were obtained from the Natural Resources Conservation Service (NRCS) Soil Survey Geographic (SSURGO) database (USDA 2010) and divided into the following five slope ranges which were derived from slope classification definitions provided in the U.S. Department of Agriculture (USDA) *Soil Survey Manual* (USDA 1993):

- Nearly level (0 to 5% slopes)
- Gently sloping, undulating (2 to 10% slopes)
- Strongly sloping, rolling (4 to 16% slopes)
- Moderately steep, hilly (10 to 30% slopes)
- Steep (15 to 65% slopes)

Table 2-1 provides a summary of the percent breakdown of soil slopes by subwatershed. Figure 2-1 illustrates the distribution of the slope ranges within the Middle River and Gunpowder River watersheds.

Table 2-1: Middle River and Tidal Gunpowder River Slope Classification by Subwatershed

	SLOPE CATEGORY %				
Subwatershed	Nearly Level* (0-3%)	Gently sloping, undulating (2-10%)	Strongly sloping, rolling (4-16%)	Moderately steep, hilly (10-30%)	Steep (15-65%)
Darkhead Creek	68.7	29.3	2.1	0.0	0.0
Frog Mortar Creek	57.6	41.0	1.4	0.0	0.0
Galloway Creek	60.7	39.3	0.0	0.0	0.0
Browns Cove	23.0	52.7	24.3	0.0	0.0
Hogpen Creek	23.0	56.2	20.8	0.0	0.0
Hopkins Creek	29.0	62.1	7.4	1.5	0.0
Middle River	59.2	35.0	5.3	0.5	0.0
Norman Creek	18.6	60.1	21.3	0.0	0.0
Stansbury Creek	51.0	49.0	0.0	0.0	0.0
Sue Creek	18.4	58.5	23.1	0.0	0.0
Middle River Subtotal	*44.5*	*45.8*	*9.4*	*0.2*	*0.0*
Aberdeen Proving Ground	84.5	13.0	2.5	0.0	0.0
Dundee Creek	57.3	35.2	1.2	0.0	6.2
Gunpowder River	27.3	53.8	9.8	9.0	0.0
Saltpeter Creek	44.9	39.3	5.7	1.4	8.7
Seneca Creek	65.5	34.5	0.0	0.0	0.0
Tidal Gunpowder Subtotal	*56.8*	*33.9*	*3.9*	*1.6*	*3.8*
Total	*50.4*	*40.2*	*6.8*	*0.9*	*1.8*

* Includes Water features shown in Figure 2-1.

The majority of the Middle River and Tidal Gunpowder River watersheds is relatively flat, with over 50% being nearly level and 40% gently sloping. Less than 3% of the entire area has moderately steep or steep slopes. Based on soil slope alone, the Middle River/Tidal Gunpowder River planning area is not very prone to erosion by overland flow; however, degree of erosion is also dependent on soil type and land use/land cover. The subwatershed with the flattest topography is the Aberdeen Proving Ground, with 97.5% nearly level to gently sloping land. Steeper slopes are found in the Saltpeter Creek, Dundee Creek, and Gunpowder River subwatersheds, which have 10.1%, 6.2%, and 9% moderately steep to steep slopes, respectively. The majority of steep slopes in the Saltpeter and Dundee Creek subwatersheds is within a quarry area, where human-induced disturbance has altered the ground to

facilitate mining activities. Areas west of the Middle River subwatershed have more intermediate slopes (i.e., gently sloping to strongly sloping) than the rest of the planning area. These subwatersheds include Hopkins Creek, Hogpen Creek, Norman Creek, Sue Creek and Browns Cove.

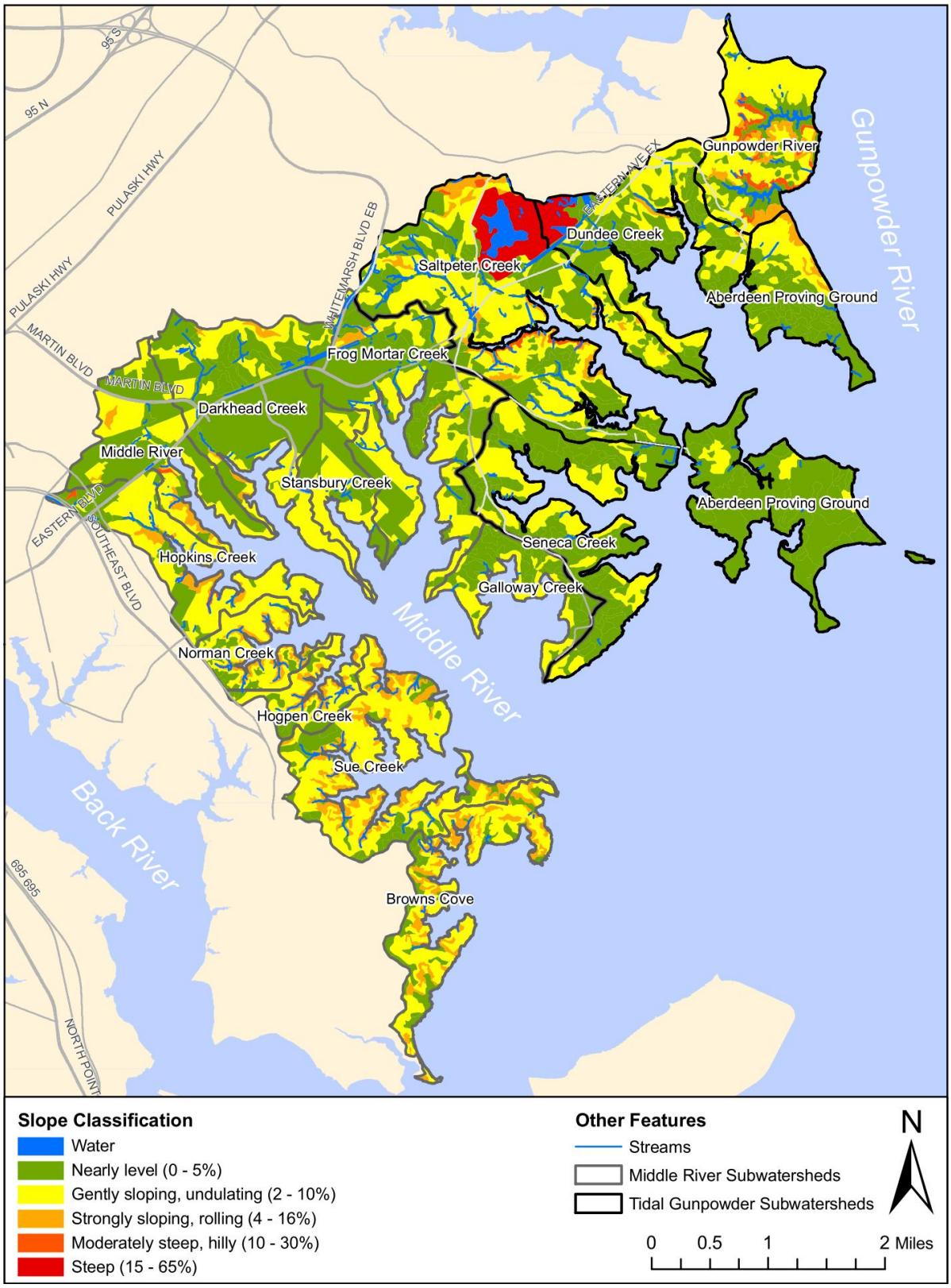

Figure 2-1: Middle River and Tidal Gunpowder River Topography based on Soil Slopes

2.2.4 Geology

The Middle River and Tidal Gunpowder River watersheds are located in the Western Shore Lowlands Region of the Coastal Plain Province of Maryland. Soils in this region consist of unconsolidated sediments including gravel, sand, silt, and clay (MGS 2009). The dominant geologic formation in the planning area is Patapsco Formation (99.6%). Approximately 0.4% of the planning area is underlain by Arundel Formation. The Patapsco formation mainly consists of well sorted, medium to fine grained quartz sand with local deposits of quartz gravel and clays, which are typically red-yellow and brown mottled kaolinitic clays (DEPRM 2001).

The geology of an area affects the chemical composition of surface water and groundwater, as well as groundwater and well recharge rates. It is also relevant to soil formation and influences the buffering of pollutants to water bodies in developed areas. Consequently, geology often has a close correlation to water quality.

2.2.5 Soils

Soil characteristics are an important consideration when evaluating water quantity and quality in streams and rivers. Soil type and moisture content, for example, impact how land may be used and its potential for vegetation and habitat. Soil conditions are also evaluated for projects aimed at improving water quality and/or habitat.

Soils data including hydrologic soil groups and soil erodibility for the Middle River and Tidal Gunpowder River watersheds were obtained from spatial data provided by the NRCS SSURGO database (USDA 2010).

2.2.5.1 Hydrologic Soil Groups

The NRCS classifies soils into four hydrologic soil groups (HSG) based on their runoff potential and infiltration rates. Infiltration rate can be described as the ability of a soil to absorb precipitation, and runoff potential as just the opposite. Soils with high runoff potential have low infiltration capacity and tend to cause overland flow instead of allowing runoff to infiltrate. Infiltration rates are highly variable among soil types and are also influenced by disturbances to the soil profile such as land development activities. For example, urbanization on land composed of high infiltration soils (such as sands and gravels) will greatly increase runoff; whereas development on land composed of low infiltration soils such as silts and clays will have less of an impact on runoff.

The four hydrologic soil groups range from A to D, from lowest runoff potential to highest, respectively. Brief descriptions of each hydrologic soil group are provided below. Further explanation can be found in the USDA/NRCS publication, *Urban Hydrology for Small Watersheds, Technical Release 55* (USDA 1986).

- Group A soils include sand, loamy sand, or sandy loam types. These soils have a high infiltration rate and low runoff potential even when thoroughly wet. These consist mainly of deep, well to excessively drained sands or gravel. These soils have a high rate of water transmission.
- Group B soils include silt loam or loam types. They have a moderate infiltration rate when thoroughly wet. These soils mainly consist of somewhat deep to deep, moderately well to well

drained soils with moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

- Group C soils are sandy clay loam. These soils have a low infiltration rate when thoroughly wet. These types of soils typically have a layer that hinders downward movement of water. These are soils with moderately fine texture or fine texture, and have a low rate of water transmission.
- Group D soils include clay loam, silty clay loam, sandy clay, silty clay, or clay types. These soils have a very low infiltration rate and high runoff potential when thoroughly wet. These consist mainly of clays with high swell potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very low rate of water transmission.

As shown in Table 2-2 and Figure 2-2, over 73% of soils in the Middle River/Tidal Gunpowder River planning area fall into hydrologic soil groups C and D, which have low to very low infiltration rates and therefore, relatively high runoff potential. The Tidal Gunpowder River watershed has more soil in hydrologic soil groups A and B than in the Middle River watershed (34.1% versus 18.3% for Middle River), which have higher infiltration rates and lower runoff potential. This excludes, however, the Aberdeen Proving Ground which has over 90% of soils in groups C and D. One reason for this difference between Middle River and Tidal Gunpowder River is the greater degree of urbanization in the Middle River watershed, particularly in the Middle River, Darkhead Creek, and Frog Mortar Creek subwatersheds.

Table 2-2: Middle River and Tidal Gunpowder River Hydrologic Soil Groups

Subwatershed	Hydrologic Soil Group (%) A	B	C	D	Water (%)
Darkhead Creek	5.5	10.1	21.5	62.4	0.5
Frog Mortar Creek	3.2	11.0	42.5	43.3	0.0
Galloway Creek	0.0	13.6	66.9	19.3	0.1
Browns Cove	0.2	20.2	70.6	8.9	0.1
Hogpen Creek	5.0	10.7	81.0	3.2	0.1
Hopkins Creek	10.4	31.8	43.1	14.7	0.0
Middle River	1.5	27.6	17.0	53.7	0.1
Norman Creek	0.3	10.3	87.7	1.6	0.1
Stansbury Creek	0.0	17.6	37.6	44.7	0.1
Sue Creek	2.1	5.7	87.1	5.0	0.1
Middle River Subtotal	*3.2*	*15.1*	*50.3*	*31.2*	*0.1*
Aberdeen Proving Ground	0.0	7.2	45.7	47.1	0.0
Dundee Creek	9.0	30.2	29.5	30.0	1.3
Gunpowder River	0.2	42.8	35.4	21.5	0.0
Saltpeter Creek	19.2	24.2	37.7	16.1	2.8
Seneca Creek	19.1	19.9	45.5	15.2	0.2
Tidal Gunpowder Subtotal	*11.0*	*23.1*	*39.2*	*25.6*	*1.1*
Total	*6.9*	*18.9*	*45.1*	*28.6*	*0.6*

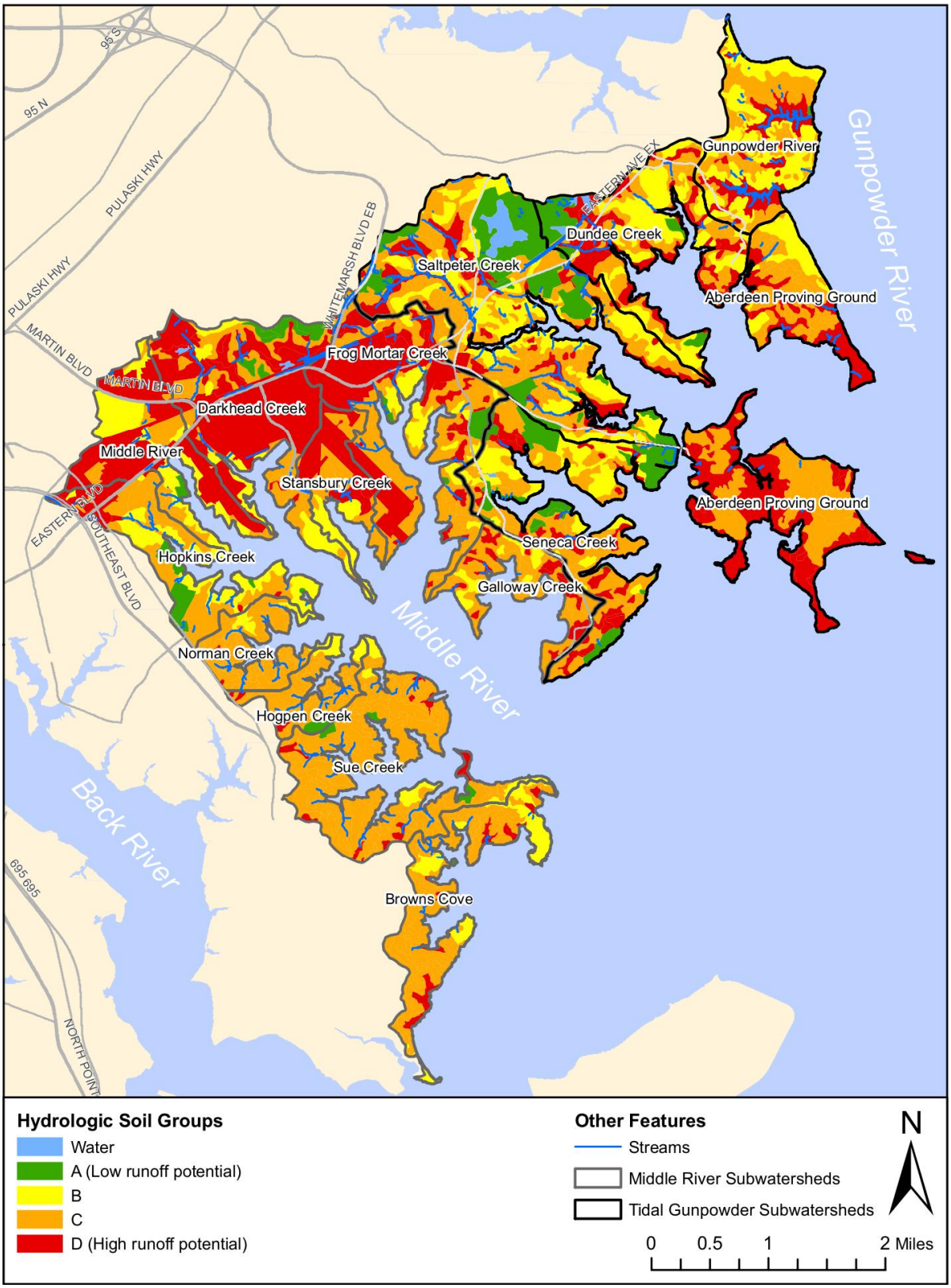

Figure 2-2: Middle River and Tidal Gunpowder River Hydrologic Soil Groups

2.2.5.2 Erodibility

Erodibility is the susceptibility of soil to erosion. It is quantified by the K factor, which is used in the Universal Soil Loss Equation (USLE) developed by USDA's Agricultural Research Service to estimate rate of erosion and soil loss for a particular site. Soil erodibility is determined based on the physical and chemical properties of the soil, which represent how strongly soil particles cohere with one another. Soils with low K factors indicate low erodibility or high resistance to detachment, and soils with high K factors indicate high erodibility potential. For example, soils high in clay content are least erodible with K values of about 0.05 to 0.15, and soils with high silt content are most erodible with K values often greater than 0.4 (Ouyang 2002).

Table 2-3 summarizes soil erodibility values in the Middle River and Tidal Gunpowder River watersheds by subwatershed. Erodibility K factors range from 0 to 0.49 and were grouped into three categories as follows:

- Low Erodibility ($0 \leq$ K factor ≤ 0.2);
- Medium Erodibility ($0.24 \leq$ K factor ≤ 0.32); and
- High Erodibility ($0.37 \leq$ K factor ≤ 0.49)

Table 2-3: Middle River and Tidal Gunpowder River Soil Erodibility Categorization Based on K factor

	Soil Erodibility Category (%)		
Subwatershed	Low*	Medium	High
Darkhead Creek	56.1	29.4	14.5
Frog Mortar Creek	35.5	37.9	26.7
Galloway Creek	0.1	85.3	14.6
Browns Cove	9.2	2.2	88.6
Hogpen Creek	5.1	9.4	85.5
Hopkins Creek	23.3	42.5	34.2
Middle River	55.3	29.8	14.9
Norman Creek	0.9	5.6	93.5
Stansbury Creek	34.8	23.8	41.4
Sue Creek	5.3	6.4	88.3
Middle River Subtotal	*28.1*	*27.2*	*44.7*
Aberdeen Proving Ground	38.5	38.3	23.2
Dundee Creek	15.0	58.3	26.8
Gunpowder River	17.9	36.6	45.6
Saltpeter Creek	20.4	58.6	21.0
Seneca Creek	21.1	71.9	7.1
Tidal Gunpowder Subtotal	*23.3*	*53.6*	*23.1*
Total	*25.8*	*39.7*	*34.4*

* Includes Water features shown in Figure 2-3

As shown in Table 2-3 and Figure 2-3, there is significant presence of all three soil erodibility categories in the Middle River/Tidal Gunpowder River planning area. Highly erodible soils are more evident in the Middle River watershed, especially in Norman Creek, Hogpen Creek, Sue Creek and Browns Cove subwatersheds, which all have over 85% highly erodible soils. These soils also correspond to soils classified as having low infiltration rates (pertaining to hydrologic soil group C), which means high erodibility and relatively high runoff potential in these areas. In contrast, soils within the Tidal Gunpowder River watershed mostly fall within the moderately erodible category, with the exception of the Gunpowder River subwatershed which contains more highly erodible soils. Low erodibility soils occur mostly in Middle River, Darkhead Creek, Frog Mortar Creek, and Stansbury Creek subwatersheds in Middle River. These soils, however, correspond to soils with very low infiltrations rates (pertaining to hydrologic soil group D). This is because most of these soils are classified as Urban Land, which over time have been graded and compacted for urban development. Areas that are relatively undeveloped, on the other hand, are suitable for preservation of forested area especially in locations with high soil erodibility but low slopes. This would apply to much of the Tidal Gunpowder River watershed.

Subwatersheds with the largest percentages of highly erodible soils present the greatest potential for addressing soil conservation issues via best management practices (BMPs), such as minimizing bare soil and keeping topsoil in place. Soil erodibility data are also useful in combination with other information such as location of cropland, slope steepness, and distance from streams to determine where other BMPs, such as retirement of highly erodible land, are appropriate. High K factor values also serve as a warning for planning of urban activities near streams such as road construction or utility placements.

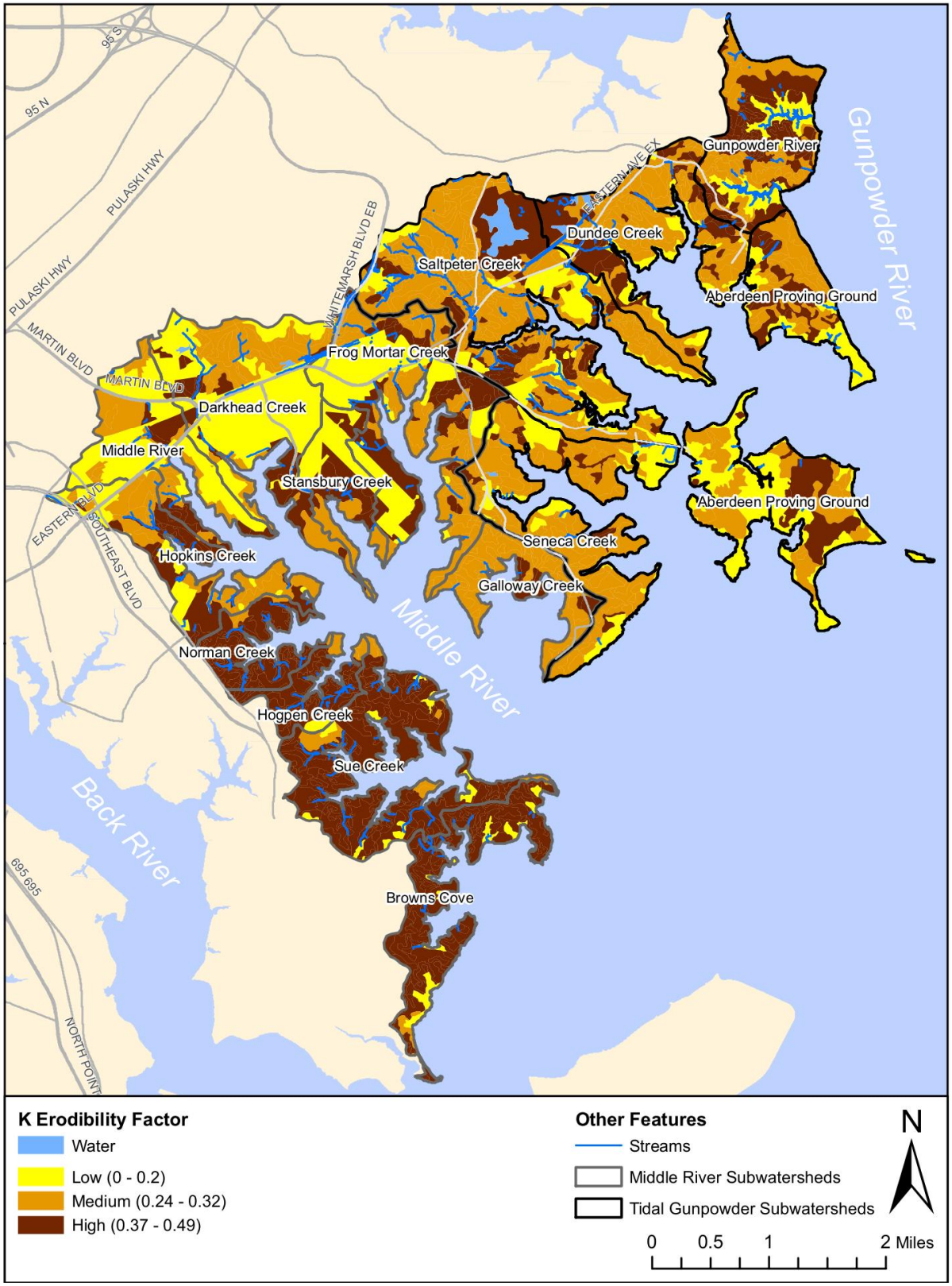

Figure 2-3: Middle River and Tidal Gunpowder River Soil Erodibility Based on K factor

2.2.6 Forest Cover

Forests provide the greatest protection among land cover types for water and soil quality. In pristine systems, forest and soils co-evolve, shaping the hydrologic cycle; these systems operate within a natural range of variability, assuring healthy habitat and water quality. The Middle River and Tidal Gunpowder River watersheds consisted mainly of old-growth forest prior to colonial settlement, as is true for the entire Chesapeake Bay basin. Much deforestation has occurred since then; however, even in developed systems, forest cover can still provide many benefits such as reducing erosion potential and protecting water quality if carefully planned and conserved.

Forest cover data for the Middle River and Tidal Gunpowder River watersheds were obtained from various sources. Spatial data from Baltimore County OIT showing wooded areas delineated before 1998 were used as a base. As some of the planning area has undergone further deforestation over the years, this data was then edited based on aerial imagery provided by Baltimore County OIT as well as 2007 Urban Tree Canopy Land Cover spatial data for Baltimore County. The latter was created based on 2007 infrared aerial imagery and 2005 LiDAR data by the University of Vermont Spatial Analysis Laboratory.

Table 2-4 lists the number of acres of forest cover for each subwatershed in the Middle River/Tidal Gunpowder River planning area, along with percent of the subwatershed that is forested. Figure 2-4 shows the distribution of forest cover within the planning area. The Middle River and Tidal Gunpowder River watersheds contain approximately 4,000 acres of forest cover, or slightly less than one-third of the planning area. This is generally consistent with Maryland Department of Planning's (MDP) 2007 land use/land cover classification scheme, which estimates that 33.6% of forest cover remains in the planning area. (Slight variations result from different scale and data sources used, as well as possible additional forest depletion since 2005.) The Tidal Gunpowder River watershed is less developed and has approximately 39% forest cover, whereas the Middle River watershed has approximately 26%. Much of the forested areas in the Tidal Gunpowder River watershed are owed to the Aberdeen Proving Ground and County- and State-owned parks such as Marshy Point and Gunpowder Falls State Park. Although the parks in the Middle River watershed are much smaller, forest cover has been retained in many residential areas. These areas present a potential priority for forest preservation. The lowest forest cover percentages are found in the Middle River, Hopkins Creek, and Stansbury Creek subwatersheds, ranging from approximately 10% to 16%. These areas offer a potential opportunity for reforestation.

Table 2-4: Middle River and Tidal Gunpowder River Forested Area by Subwatershed

Subwatershed	Total Acres	Forested Acres	% Forested
Darkhead Creek	1,139.6	272.0	23.9%
Frog Mortar Creek	1,191.8	235.7	19.8%
Galloway Creek	371.5	100.6	27.1%
Browns Cove	611.8	251.6	41.1%
Hogpen Creek	262.3	112.0	42.7%
Hopkins Creek	604.6	81.4	13.5%
Middle River	674.0	69.0	10.2%
Norman Creek	311.4	105.8	34.0%
Stansbury Creek	345.8	53.9	15.6%
Sue Creek	955.0	419.0	43.9%
Middle River Subtotal	*6,467.9*	*1,701.0*	*26.3%*
Aberdeen Proving Ground	819.7	454.1	55.4%
Dundee Creek	1,227.1	391.0	31.9%
Gunpowder River	899.9	261.8	29.1%
Saltpeter Creek	1,902.2	855.6	45.0%
Seneca Creek	1,007.2	339.4	33.7%
Tidal Gunpowder Subtotal	*5,856.1*	*2,301.8*	*39.3%*
Total	*12,323.9*	*4,002.8*	*32.5%*

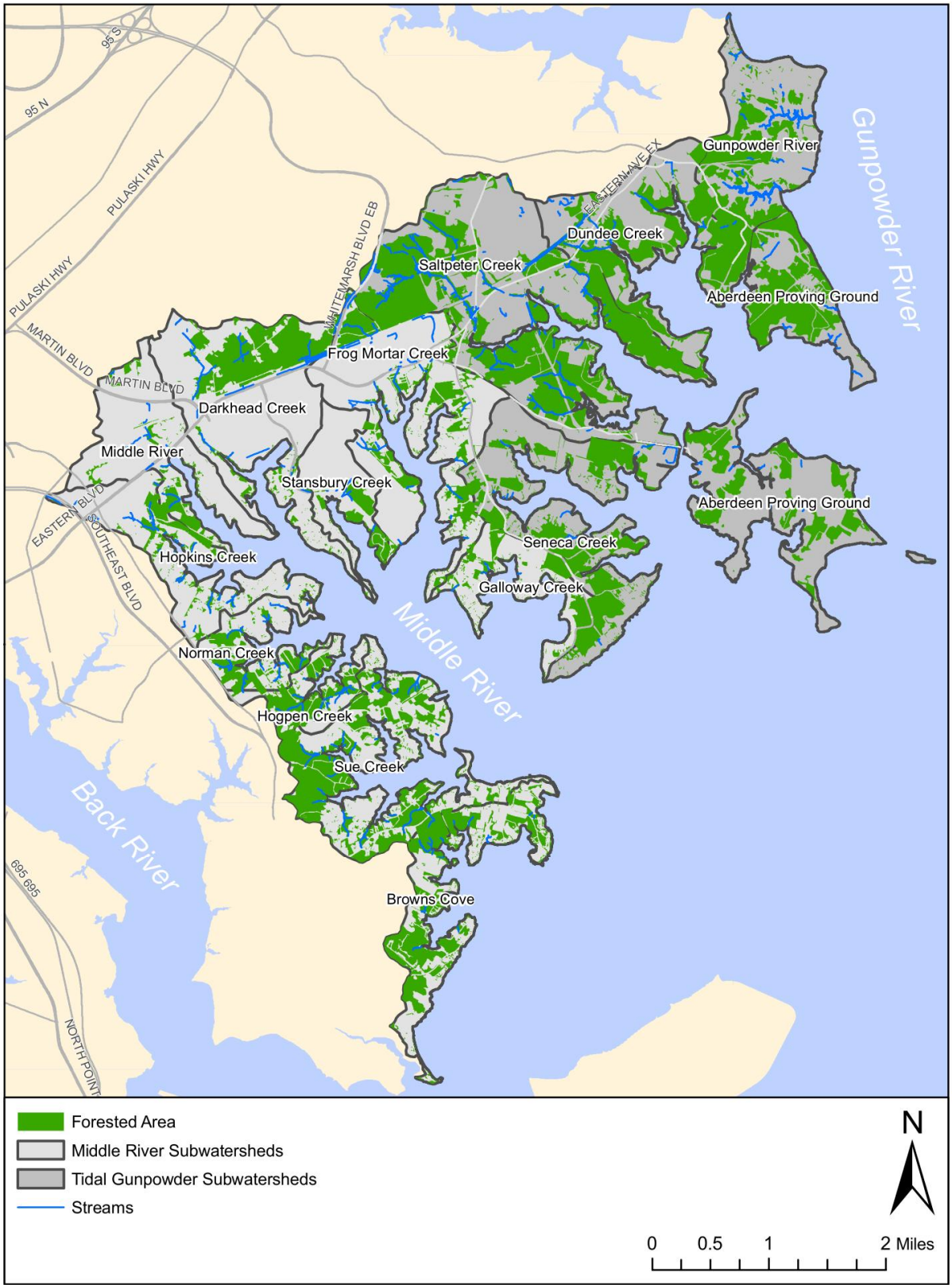

Figure 2-4: Middle River and Tidal Gunpowder River Forest Cover

2.2.7 Stream Systems

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

2.2.7.1 Stream System Characteristics

The subwatersheds with the most stream miles include Darkhead Creek and Frog Mortar Creek in the Middle River watershed, and Saltpeter Creek and Gunpowder River in the Tidal Gunpowder River watershed. These four watersheds comprise nearly 60% of all stream miles in the planning area. Saltpeter Creek alone contains over 10 miles of stream, constituting over a quarter of all stream miles in the planning area, which may be explained by the abundance of wetland-like braided channels in this subwatershed. The above four subwatersheds may represent a priority for stream preservation, whereas streams in more urbanized areas may present a priority for stream restoration opportunities.

The Middle River and Tidal Gunpowder River watersheds were divided into a series of subwatersheds based on the drainage areas contributing to major creeks and rivers as well as geographic/property considerations within the watershed. Baltimore County delineated ten subwatersheds for Middle River, and five for Tidal Gunpowder River. Figure 2-5 shows the system of streams and subwatersheds comprising the Middle River and Tidal Gunpowder River watersheds. Table 2-5 summarizes number of stream miles in each subwatershed along with stream density, defined as miles of stream per square mile of subwatershed area. There are approximately 39 miles of stream in the planning area, with approximately 18 miles draining to Middle River and 21 miles to Tidal Gunpowder River, all of which eventually drains to the Chesapeake Bay. Stream data for the planning area was provided by Baltimore County Office OIT based on hydrology lines captured from 3D compilation processes using imagery captured in 2008.

Table 2-5: Middle River and Tidal Gunpowder River Stream Mileage and Density

Subwatershed	Area (Sq Miles)	Stream Miles	Stream Density (mi./sq. mi.)
Darkhead Creek	1.78	3.61	2.03
Frog Mortar Creek	1.86	4.02	2.16
Galloway Creek	0.58	0.23	0.40
Browns Cove	0.96	0.94	0.98
Hogpen Creek	0.41	1.27	3.10
Hopkins Creek	0.94	2.11	2.24
Middle River	1.05	1.02	0.97
Norman Creek	0.49	1.49	3.06
Stansbury Creek	0.54	0.40	0.74
Sue Creek	1.49	2.78	1.87
Middle River Subtotal	*10.1*	*17.9*	*1.8*
Aberdeen Proving Ground	1.28	1.32	1.03
Dundee Creek	1.92	3.20	1.67
Gunpowder River	1.41	5.16	3.67
Saltpeter Creek	2.97	10.54	3.55
Seneca Creek	1.57	1.06	0.67
Tidal Gunpowder Subtotal	*9.2*	*21.3*	*2.3*
Total	*19.3*	*39.2*	*2.0*

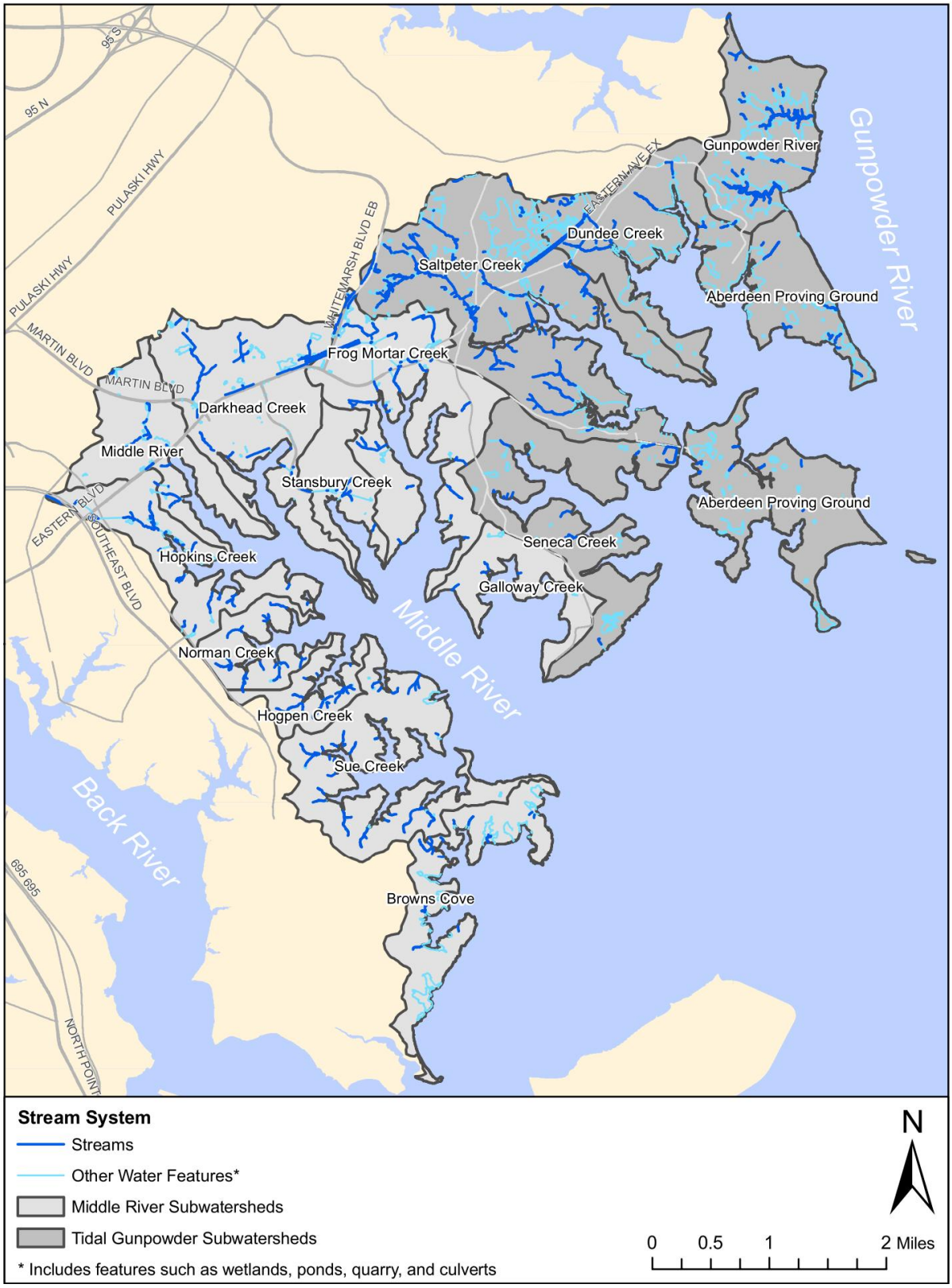

Figure 2-5: Middle River and Tidal Gunpowder River Stream System

2.2.7.2 Stream Riparian Buffers

Riparian buffers refer to the vegetated areas adjacent to streams and other water bodies that protect them from pollutant loads while also providing bank stabilization and habitat. Forested buffer areas along streams play a crucial role in improving water quality and flood mitigation since they can intercept and reduce surface runoff, stabilize stream banks, trap sediment, and provide habitat for various types of terrestrial and aquatic life. For example, tree roots capture and remove pollutants including excess nutrients such as nitrogen from shallow flowing water; the tree root structure also holds soil together to reduce erosion potential, and slows water flow which reduces sediment load and risk of flooding. Tree canopies provide shading that helps to keep cool water temperatures preferred by many aquatic organisms, particularly cold-water species like trout. In smaller streams, terrestrial plant material falling into the stream is the primary source of food for stream life. While leaves provide seasonal food for stream life at the base of the food chain, fallen tree branches and trunks provide a more consistent, slow-release food source throughout the year. Tree roots and snags also offer habitat and spawning areas for fish and other aquatic species.

Maintaining healthy streams and forest buffers are important for reducing nutrient and sediment loadings to the Middle River and Tidal Gunpowder River watersheds, and thus to the Chesapeake Bay. When stream riparian buffers are converted from forest to agriculture or urban development, many of these benefits are lost and stream health declines. Riparian buffer zones can be re-established or preserved as a BMP to reduce land use impacts by intercepting and controlling pollutants entering a water body.

The condition of the stream riparian buffers in the Middle River and Tidal Gunpowder River watersheds was analyzed based on a 100-foot buffer on both sides of all streams. The condition of the riparian buffer was classified using four categories: impervious, open pervious, forest, or wetland. Wetland areas were included as a separate category because they are a common feature within the planning area and also provide significant ecological and water quality benefits. The stream data described in the previous section were used as a base to create the 100-foot buffer. First, road and building data were overlaid on the 100-foot buffer area to obtain the impervious areas lying within the buffer zone. Similarly, forested areas were obtained by overlaying the urban tree canopy data over the buffer area and removing portions that overlapped with impervious areas. Wetland areas extracted from 2007 land use data provided by Baltimore County OIT were also overlaid with the buffer area; portions that overlapped with impervious and forest cover were removed from the layer. Remaining areas that were not impervious, forested, or wetland were classified as open pervious. Table 2-6 summarizes stream riparian buffer conditions by subwatershed, and the distribution is shown in Figure 2-6.

Table 2-6: Middle River and Tidal Gunpowder River Land Cover in the 100-ft Stream Buffer

Subwatershed	IMPERVIOUS Acres	IMPERVIOUS %	OPEN PERVIOUS Acres	OPEN PERVIOUS %	FOREST Acres	FOREST %	WETLAND Acres	WETLAND %	Total Acres	Total % of Watershed
Darkhead Creek	14.8	16.6%	39.5	44.2%	34.7	38.8%	0.4	0.4%	89.3	19.6%
Frog Mortar Creek	18.1	17.2%	55.9	53.0%	31.4	29.8%	0.0	0.0%	105.4	23.2%
Galloway Creek	0.4	6.7%	2.0	37.3%	3.0	55.9%	0.0	0.0%	5.4	1.2%
Browns Cove	0.4	1.9%	2.5	10.7%	18.0	77.5%	2.3	10.0%	23.2	5.1%
Hogpen Creek	1.6	5.2%	6.9	22.1%	22.5	72.6%	0.0	0.0%	31.0	6.8%
Hopkins Creek	8.2	14.8%	27.7	50.0%	19.5	35.3%	0.0	0.0%	55.4	12.2%
Middle River	5.0	16.6%	13.5	45.0%	10.8	36.1%	0.7	2.3%	30.0	6.6%
Norman Creek	2.2	6.1%	10.8	30.2%	22.8	63.6%	0.0	0.0%	35.9	7.9%
Stansbury Creek	0.9	7.2%	7.6	61.6%	3.7	30.0%	0.2	1.2%	12.3	2.7%
Sue Creek	2.8	4.2%	13.5	20.2%	48.6	72.9%	1.8	2.7%	66.7	14.7%
Middle River Subtotal	*54.4*	*12.0%*	*179.8*	*39.6%*	*215.1*	*47.3%*	*5.3*	*1.2%*	*454.6*	*100.0%*
Aberdeen Proving Ground	0.3	1.0%	8.5	26.2%	1.1	3.5%	22.4	69.3%	32.3	7.1%
Dundee Creek	3.2	4.4%	32.6	44.7%	35.8	49.2%	1.2	1.7%	72.8	15.9%
Gunpowder River	2.5	2.9%	16.7	19.3%	19.0	21.9%	48.5	55.9%	86.7	19.0%
Saltpeter Creek	14.1	5.9%	62.0	26.0%	160.9	67.4%	1.7	0.7%	238.7	52.2%
Seneca Creek	2.0	7.4%	17.6	66.3%	5.4	20.4%	1.6	5.9%	26.5	5.8%
Tidal Gunpowder Subtotal	*22.1*	*4.8%*	*137.4*	*30.1%*	*222.2*	*48.6%*	*75.3*	*16.5%*	*457.1*	*100.0%*
Total	*76.6*	*8.4%*	*317.2*	*34.8%*	*437.3*	*48.0%*	*80.7*	*8.8%*	*911.7*	*100.0%*

Total impervious areas within the stream riparian buffers zone are relatively low at approximately 8% for the planning area. As mentioned before, the Middle River watershed is more developed, so there is a higher percentage of impervious area in the buffer zone (approximately 12% compared to approximately 5% for Tidal Gunpowder River). The largest percentage of the riparian buffer falls under forest and wetlands (approximately 57% total), which are important areas to protect and maintain. Hopkins Creek, Darkhead Creek, Middle River and Frog Mortar Creek subwatersheds have the highest percentages of impervious area in the buffer zone, ranging from approximately 15% to 17%. These subwatersheds, along with Saltpeter Creek, also have the highest acreages of impervious area in the buffer zone, with Frog Mortar Creek having the highest amount of approximately 18 acres. These areas may present potential opportunities for impervious cover removal or buffer reestablishment. Subwatersheds with high open pervious acreages in the buffer zone, such as Frog Mortar Creek and Saltpeter Creek, may also have potential for reforestation.

Subwatersheds with the highest acreages of forested buffer include Frog Mortar Creek, Darkhead Creek, Dundee Creek, Sue Creek and Saltpeter Creek, ranging from approximately 31 to 161 acres. These areas

may present potential preservation opportunities. It is also noteworthy that several subwatersheds within Middle River that have significant residential development also have high percentages of forested buffer, including Norman Creek, Hogpen Creek, Sue Creek and Browns Cove, ranging from approximately 64% to 78%. It appears that stream riparian buffers are relatively well maintained in these areas despite the urbanization, which also offers preservation and public education opportunities. Subwatersheds with the greatest amount of wetland areas within the riparian buffer include Gunpowder River and Aberdeen Proving Ground, potentially also providing preservation opportunities.

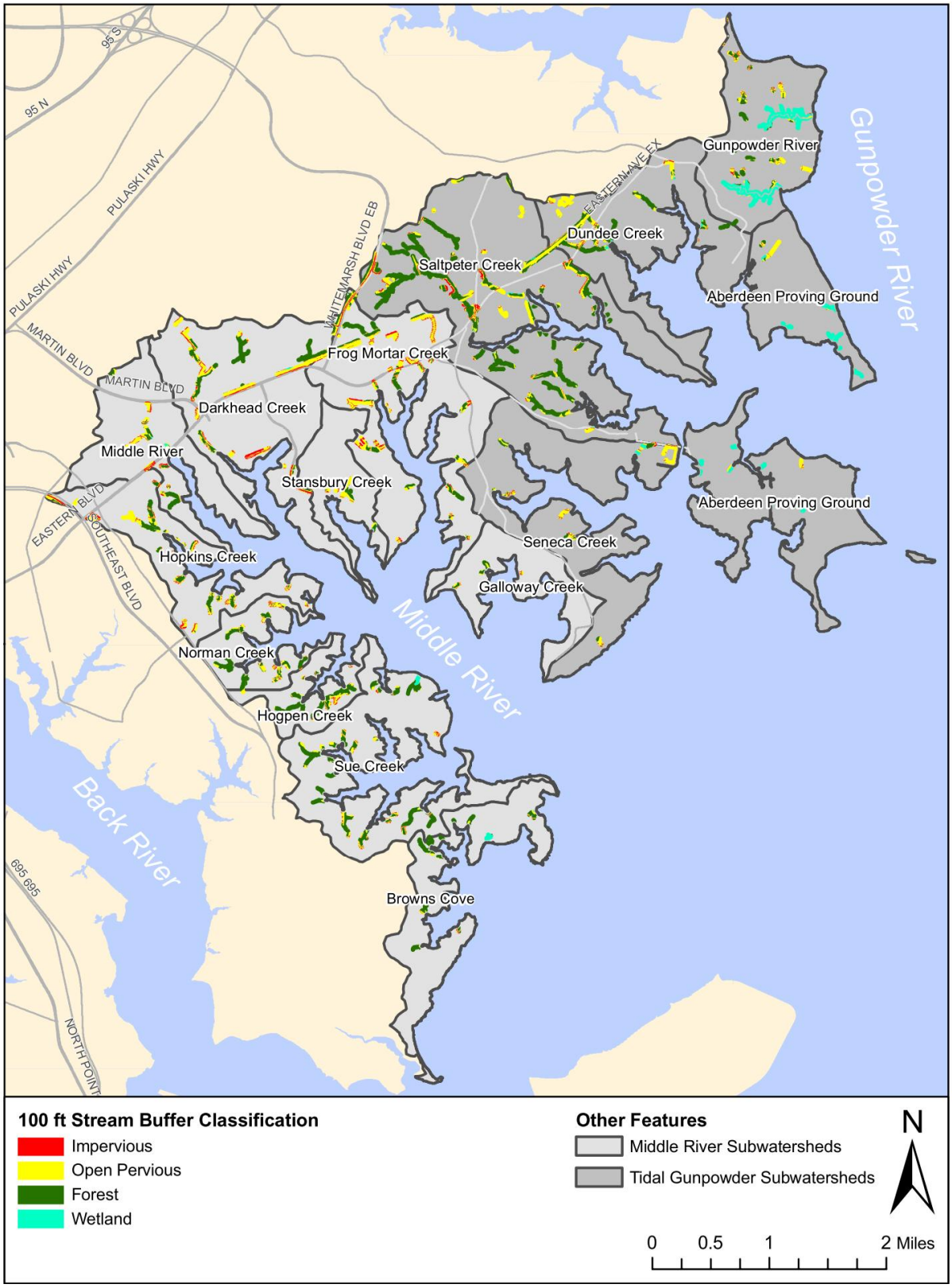

Figure 2-6: Middle River and Tidal Gunpowder River 100-ft Stream Buffer Condition

2.2.8 Tidal Waters

The tidal waters of Middle River encompass approximately 3,977 acres. Gunpowder River covers approximately 10,374 acres, which also includes Bird River. Figure 2-7 shows the state-defined tidal water segments surrounding the Middle River/Gunpowder River planning area.

The tidal waters of Middle River and Gunpowder River are oligohaline, characterized by low salinity/brackish waters of 0.5 to 5 parts per thousand (ppt). Water quality impairments related to nutrients and polychlorinated biphenyls (PCBs) in fish tissue have been identified for the tidal waters of both Middle River and Gunpowder River according to MDE's 2008 Integrated Report of Surface Water Quality in Maryland (MDE 2008). This is the most recent final report approved by USEPA regarding the status of water quality within the state of Maryland, required pursuant to Section 303(d) of the Clean Water Act. The 2008 Integrated Report also identifies impairments related to sediment for the tidal waters of Middle River. The impairment listings reflect the inability to meet water quality standards for the designated uses of the tidal segments of Middle River and Gunpowder River, which is Use II – support of estuarine and marine aquatic life and shell fish harvesting according to the Maryland Water Quality Standards Surface Water Use Designation [Code of Maryland Regulations (COMAR) 26.08.02.07]. Pollutant load limits for these tidal waters have not yet been established but may be required for the various pollutants of concern. Targets have been established for submerged aquatic vegetation (SAV) and water quality as these are both indicators of good water quality and habitat.

Note that there are currently no impairment listings for streams corresponding to the 8-digit Middle River and Tidal Gunpowder River watersheds. However, a Chesapeake Bay TMDL has been developed and is being used to assign nutrient (nitrogen and phosphorus) and sediment loads and load reductions to Bay segments and individual local jurisdictions. Impairments in tidal receiving waters are related to pollutants coming from the entire watershed; therefore, any impairment listings or TMDLs developed for the Middle River and Gunpowder River tidal segments will require watershed pollutant load reductions. A detailed discussion of water quality status and targets for the planning area is included in Chapter 3.

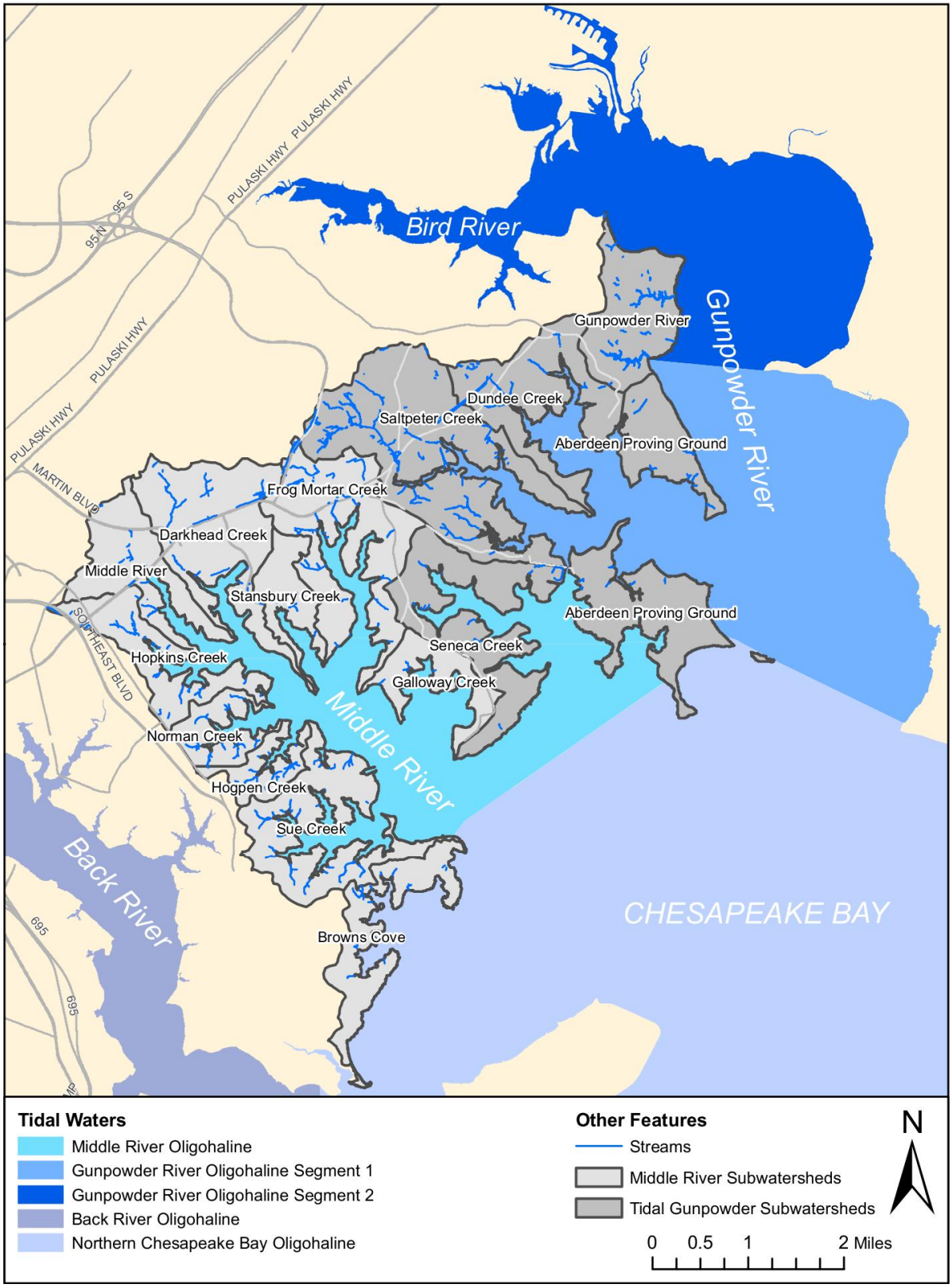

Figure 2-7: Tidal Waters of Middle River and Tidal Gunpowder River

The Middle River watershed contains approximately 55 miles of coastline, and the Tidal Gunpowder River watershed contains approximately 50 miles, for a total of over 105 miles of coastline for the planning area. Coastline data was derived from water feature and County boundary spatial data obtained from Baltimore County OIT. Table 2-8 presents the number of coastline miles for each subwatershed and coastline density, defined as miles of coastline per square mile of subwatershed area. Saltpeter Creek, Seneca Creek, Sue Creek and Aberdeen Proving Ground have the greatest lengths of coastline, ranging from approximately 11 miles to 18 miles. These four subwatersheds comprise approximately 50% of all coastline miles in the planning area.

Table 2-7: Middle River and Tidal Gunpowder River Shoreline Mileage and Density

Subwatershed	Area (Sq Miles)	Coastline Miles	Coastline Density (mi./sq. mi.)
Darkhead Creek	1.78	4.52	2.54
Frog Mortar Creek	1.86	7.76	4.17
Galloway Creek	0.58	4.70	8.09
Browns Cove	0.96	8.89	9.30
Hogpen Creek	0.41	2.75	6.70
Hopkins Creek	0.94	4.49	4.75
Middle River	1.05	3.08	2.93
Norman Creek	0.49	3.51	7.22
Stansbury Creek	0.54	2.47	4.57
Sue Creek	1.49	13.00	8.71
Middle River Subtotal	*10.1*	*55.2*	*5.5*
Aberdeen Proving Ground	1.28	17.99	14.05
Dundee Creek	1.92	7.57	3.95
Gunpowder River	1.41	2.84	2.02
Saltpeter Creek	2.97	10.68	3.59
Seneca Creek	1.57	11.32	7.19
Tidal Gunpowder Subtotal	*9.2*	*50.4*	*5.5*
Total	*19.3*	*105.6*	*11.0*

A riparian buffer analysis similar to the stream riparian buffer study was conducted to characterize the vegetative condition of coastline buffers in the Middle River/Tidal Gunpowder River planning area. Coastline buffer condition was analyzed based on a 100-foot buffer along tidal waters and classified as one of four categories: impervious, open pervious, forest, or wetland. The coastline data described above were used as a base to create the 100-foot buffer. Road and building data were overlaid on the 100-foot buffer area to obtain the impervious areas. Similarly, forested areas were obtained by overlaying the urban tree canopy data over the buffer area and removing any overlapping impervious

area. Wetland areas extracted from 2007 land use data provided by Baltimore County OIT were also overlaid with the buffer area, and portions that overlapped with impervious and forest cover were removed from the layer. Remaining areas that were not impervious, forested, or wetland were classified as open pervious. Table 2-8 summarizes coastline riparian buffer conditions by subwatershed, and the distribution is shown in Figure 2-8.

Table 2-8: Middle River and Tidal Gunpowder River Land Cover in the 100-ft Shoreline Buffer

	IMPERVIOUS		OPEN PERVIOUS		FOREST		WETLAND		Total	Total % of
Subwatershed	Acres	%	Acres	%	Acres	%	Acres	%	Acres	Watershed
Darkhead Creek	6.9	13.1%	38.4	72.8%	7.4	14.0%	0.0	0.0%	52.7	8.3%
Frog Mortar Creek	13.0	14.0%	61.1	66.1%	16.7	18.0%	1.7	1.8%	92.5	14.5%
Galloway Creek	8.0	14.9%	41.0	76.1%	4.9	9.0%	0.0	0.0%	53.9	8.5%
Browns Cove	5.2	5.2%	61.2	61.1%	23.3	23.2%	10.5	10.5%	100.2	15.7%
Hogpen Creek	3.4	10.4%	18.9	57.6%	10.5	32.0%	0.0	0.0%	32.9	5.2%
Hopkins Creek	8.7	16.7%	35.7	68.5%	7.7	14.8%	0.0	0.0%	52.1	8.2%
Middle River	6.4	17.8%	24.6	68.9%	4.7	13.3%	0.0	0.0%	35.7	5.6%
Norman Creek	5.2	12.4%	28.9	69.1%	7.7	18.4%	0.0	0.0%	41.9	6.6%
Stansbury Creek	2.6	9.0%	14.8	51.9%	7.4	25.8%	3.8	13.3%	28.5	4.5%
Sue Creek	17.7	12.0%	90.6	61.3%	34.1	23.0%	5.5	3.7%	147.8	23.2%
Middle River Subtotal	*77.0*	*12.1%*	*415.3*	*65.1%*	*124.4*	*19.5%*	*21.5*	*3.4%*	*638.2*	*100.0%*
Aberdeen Proving Ground	4.1	2.0%	58.8	28.8%	19.1	9.4%	122.1	59.8%	204.0	36.2%
Dundee Creek	1.0	1.2%	19.1	23.3%	18.2	22.1%	43.9	53.4%	82.1	14.6%
Gunpowder River	2.3	7.1%	24.0	73.7%	1.7	5.3%	4.5	13.9%	32.6	5.8%
Saltpeter Creek	1.9	1.6%	35.0	30.0%	35.4	30.3%	44.5	38.1%	116.7	20.7%
Seneca Creek	13.8	10.7%	88.5	69.0%	18.0	14.0%	8.0	6.3%	128.4	22.8%
Tidal Gunpowder Subtotal	*23.0*	*4.1%*	*225.4*	*40.0%*	*92.4*	*16.4%*	*223.0*	*39.5%*	*563.8*	*100.0%*
Total	*100.0*	*8.3%*	*640.8*	*53.3%*	*216.8*	*18.0%*	*244.5*	*20.3%*	*1202.1*	*100.0%*

Over half of the coastline in the planning area, approximately 53%, is designated as open pervious. Almost two-thirds of the Middle River watershed coastline is open pervious, totaling approximately 415 acres. Open pervious areas may present potential buffer re-establishment opportunities. The amount of coastline buffer that is forested is approximately 18% of the total planning area; wetland areas make up slightly more, approximately 20% of the coastline buffer. Subwatersheds with the highest acreages of forested coastline buffer are Browns Cove, Sue Creek, and Saltpeter Creek. These subwatersheds also have high percentages of forested stream buffer as described in the previous section. Subwatersheds with the largest amounts of wetlands in the coastline buffer are Saltpeter Creek, Dundee Creek, and Aberdeen Proving Ground. These forested and wetland areas may present potential opportunities for

preservation. There is a relatively low percentage of impervious area in the coastline buffer zone at approximately 8%. The subwatersheds with the most acres of impervious area in the coastline buffer zone include Frog Mortar Creek, Seneca Creek, and Sue Creek (though they also have greater coastline miles), which all contain large amounts of private shoreline properties. Impervious coastline areas in these subwatersheds range from approximately 13 to 18 acres. These areas may present opportunities for shoreline restoration; however, restoration potential is likely influenced by property ownership.

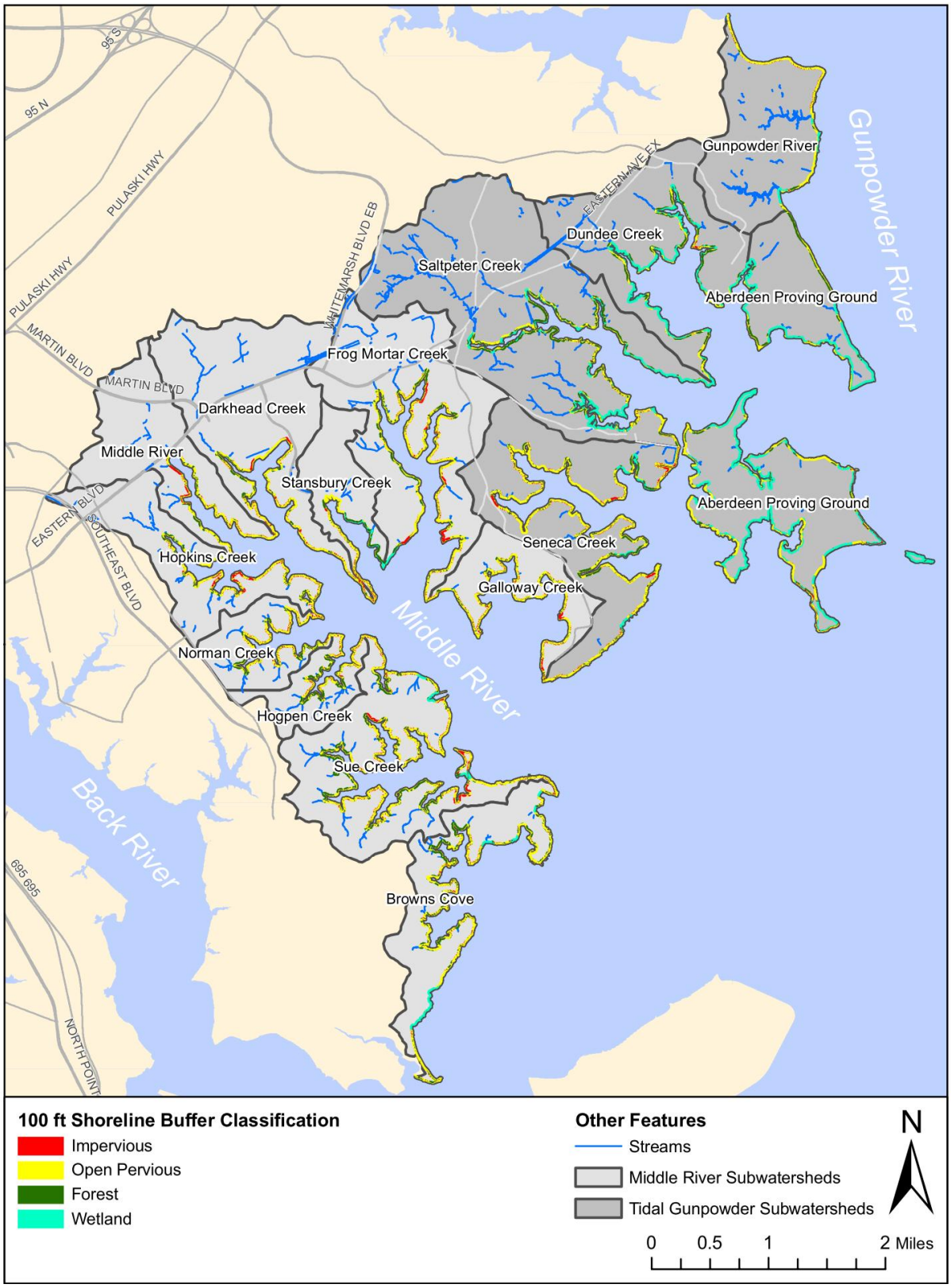

Figure 2-8: Middle River and Tidal Gunpowder River 100-ft Shoreline Buffer Condition

Baltimore County encompasses approximately 219 miles of tidal shoreline on several tributaries to the Chesapeake Bay. The County monitors and manages the conditions of its shorelines for the overall benefit of the public. Baltimore County Department of Environmental Protection & Sustainability (EPS), formerly known as the Department of Environmental Protection & Resource Management (DEPRM), has a well established program for waterway improvement and coastal management to protect these resources and meet public demands for access and recreation. Approximately three miles of shoreline in the Middle River watershed and seven miles of shoreline in the Tidal Gunpowder River watershed were identified as having enhancement potential in EPS's Shoreline Enhancement Feasibility Study (DEPRM 1998). This includes areas adjacent to previously improved shorelines, state lands, and large tracts of private lands where the County could cooperate with the property owner. The purpose of the feasibility study was to establish baseline shoreline conditions and identify shoreline enhancement potential. A summary of existing conditions results for the shoreline reaches surveyed in the Middle River and Tidal Gunpowder River watersheds are presented in Table 2-9 by subwatershed. This table includes property ownership, reach lengths, adjacent land cover and land use, shoreline change rates, and presence of SAV.

As shown in Table 2-9, a total of 13 reaches within 11 different shoreline properties were investigated in the Middle River and Tidal Gunpowder River watersheds, including 10 publicly-owned properties and one private property that the County could approach. The locations of these 13 shoreline reaches are approximately shown in Figure 2-9. Nearly half of the subwatersheds had at least one potential shoreline enhancement property. Four of these properties were located in the Sue Creek subwatershed, which has the longest length of coastline aside from the Aberdeen Proving Ground. The shoreline areas investigated are either forested or open pervious, with more forested reaches in the Middle River watershed and more open pervious reaches in the Tidal Gunpowder River watershed. Forested areas present good opportunities for preservation, and open pervious areas such as grassland and open fields may offer opportunities for reforestation. All areas represent an opportunity for resource conservation because there are no impervious surfaces along these shoreline reaches. SAV was present in most study areas, excluding Turkey Point Park, Miami Beach, Carrollwood Park, and Chase Middle School Site, where SAV was unobserved at the time of the study. Manmade structures including those for coastal protection and public access were identified at most shoreline reaches investigated. These include bulkheads, revetments, groins, rubble, breakwaters, and marsh creation.

Shorelines change and erode naturally over time. Erosion patterns and rates vary depending on the degree of wave action and boat wakes to which a shoreline is subjected. The rates of erosion or accretion presented in feet per year in Table 2-9 were based on scaled measurements and comparisons of Maryland Geological Survey's oldest and more recent shoreline maps. The table shows the greatest rates of changes for shoreline reaches surveyed in Sue Creek, Dundee Creek, and Gunpowder River subwatersheds.

Table 2-9: Shoreline Study Results for Middle River and Tidal Gunpowder River Watersheds

	Subwatershed	Reach Name	Ownership	Reach Length (ft)	LAND COVER (%) Open Pervious	Forest	Impervious	Land Use	Erosion/Accretion Rate (ft/yr)	SAV
Middle River Watershed										
1	Sue Creek	Vandermast Peninsula	Private	4,300	10%	90%	0%	Residential	-2.0	Present
2	Sue Creek	Pottery Farm Park	County	5,400		100%	0%	Park	-3.8	Present
3	Sue Creek	Sue Creek Waterfront Park	County	1,200		100%	0%	Park	+7.7	Present
4	Sue Creek	Turkey Point Park	County	800	10%	90%	0%	Park	-3.3	Absent
5	Middle River	Hawthorne Park	County	900	70%	30%	0%	Park	Null	Present
6	Darkhead Creek	Darkhead Creek Park	County	2,500	50%	50%	0%	Park	Null	Present
Tidal Gunpowder River Watershed										
7	Seneca Creek	Miami Beach	County	1,000	100%		0%	Park	-1.0	Absent
8	Seneca Creek	Carrollwood Park	County	201	100%		0%	Park	Null	Absent
9	Saltpeter Creek	Chase Middle School Site	County	2,200	95%	5%	0%	Park	Null	Unobserved
10	Saltpeter Creek	Dundee Saltpeter Park (Segment I)	County	9,900		100%	0%	Park	+0.5 to -1.0	Present
11	Dundee Creek	Dundee Saltpeter Park (Segment II)	County	7,200	5%	95%	0%	Park	+0.8 to -3.1	Present
12	Dundee Creek	Gunpowder Falls State Park (Segment I)	State	13,100	90%	10%	0%	Park	+1.5	Present
13	Gunpowder River	Gunpowder Falls State Park (Segment II)	State	5,400	80%	20%	0%	Park	+2.3 to -0.4	Present

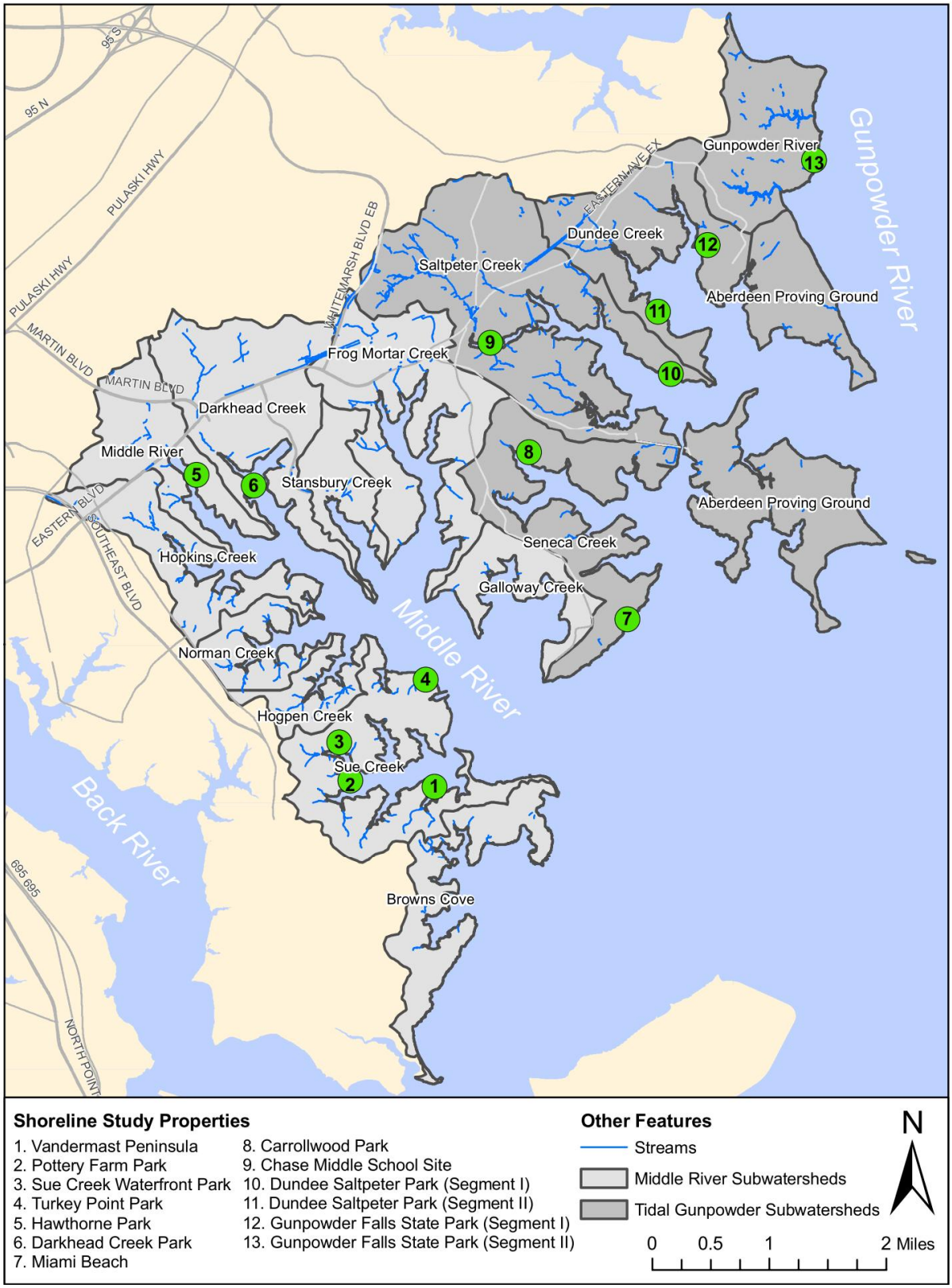

Figure 2-9: Potential Shoreline Enhancement Properties in Middle River and Tidal Gunpowder River Watersheds

After baseline conditions were established and reviewed, Baltimore County EPS rated enhancement potential for the reaches studied. For each reach, a rating was assigned to describe the feasibility of implementing the following five categories of enhancement projects:

- Erosion Control
- Habitat Enhancement
- Existing Project – Expansion/Protection/Enhancement
- Existing Project – Enhancement/Retrofit
- Beneficial Use

Enhancement potential/feasibility for each category was rated as high (H), medium (M) or low (L) based on accepted practice and professional judgment/experience of the study team. In general, reaches with serious erosion or degraded habitat were designated as high enhancement potential. A low enhancement potential rating was assigned where a low probability of success was anticipated such as reaches that were relatively stable with a balanced habitat or where development would have measurable impacts. Reaches where the shorelines were stable or where previous enhancement projects were successful were classified as complete/stable and not prioritized for shoreline enhancement. Feasibility ratings for potential shoreline enhancement projects are summarized in Table 2-10.

Table 2-10: Shoreline Enhancement Feasibility Ratings

	Subwatershed	Reach Name	Erosion Control	Habitat Enhance-ment	Expand Existing Project	Retrofit Existing Project	Beneficial Use
Middle River Watershed							
1	Sue Creek	Vandermast Peninsula	H	H			
2	Sue Creek	Pottery Farm Park				M	
3	Sue Creek	Sue Creek Waterfront Park				L	
4	Sue Creek	Turkey Point Park	Complete/Stable				
5	Middle River	Hawthorne Park				L	
6	Darkhead Creek	Darkhead Creek Park				M	
Tidal Gunpowder River Watershed							
7	Seneca Creek	Miami Beach	Complete/Stable				
8	Seneca Creek	Carrollwood Park	Complete/Stable				
9	Saltpeter Creek	Chase Middle School Site		L			
10	Saltpeter Creek	Dundee Saltpeter Park (Segment I)		L			
11	Dundee Creek	Dundee Saltpeter Park (Segment II)	Complete/Stable				
12	Dundee Creek	Gunpowder Falls State Park (Segment I)		M			
13	Gunpowder River	Gunpowder Falls State Park (Segment II)	Complete/Stable				

Potential shoreline enhancement sites were narrowed down based on the feasibility ratings. During the screening process, sites that were labeled as complete/stable or had only one low priority rating were dropped from further consideration. In addition to these, three other properties were not carried forward: the Vandermast Peninsula is private and shoreline enhancement would require the cooperation of the property owner; Pottery Farm Park had received significant County investment during previous projects; and the majority of Gunpowder Falls State Park shoreline was stable and any enhancement projects could be pursued by the State. After the screening process, only one shoreline property in the Middle River/Tidal Gunpowder River planning area, Darkhead Creek Park, remained. This 2,500-foot reach was a former County park shoreline protection project, and it was determined that the area could be retrofitted to improve accessibility while reducing erosion and degradation. The proposed shoreline enhancement elements included a wetland planting terrace with a low sill.

In addition to the Complete/Stable projects shown in Table 2-11, Baltimore County has completed shoreline enhancement projects at Pottery Farm Park, Hawthorne Park, and Darkhead Creek Park subsequent to the 1998 feasibility study. Federal shoreline enhancement projects have also been completed within the Aberdeen Proving Ground subwatershed including Carroll Island and Graces Quarters. Remaining reaches with medium to high shoreline enhancement potential according to the 1998 feasibility study include Vandermast Peninsula in Sue Creek and Gunpowder Falls State Park (Segment I) in Dundee Creek.

2.2.9 Waterway Dredging

Dredging of tidal waterways to restore or enhance use and navigability for both recreational and commercial boat traffic is an integral component in the management of Baltimore County's 219 miles of shoreline. Recreational and commercial boating and the industries it supports have become a significant component of the County's economy.

Baltimore County EPS initiated a comprehensive dredging program in 1987 to address the demand for dredging and to identify and control the sources of sedimentation. The funding for the dredging program is typically cost shared between Maryland DNR and Baltimore County Funds. The State DNR funding is from the State Vessel Excise Tax, which is generated from the tax on the sale of boats; thus, the state funds are used to benefit boaters. In order to systematically address issues and establish a County-wide program, a study was completed in 1988 to develop priorities for all the tidal waterways in the County. The report prioritized 63 segments of 26 creeks. The study evaluated the volume of material to be dredged and the number of boaters benefiting from each dredging project. This report has been used as a tool for implementation of the County's program.

Baltimore County EPS administers the dredging program which includes: collecting the necessary data to determine the need for dredging; identifying environmental constraints; evaluating dredged material placement opportunities; applying for State and Federal Permits; assisting spur applicants with permit applications; and carrying out the design and construction management for the project. Baltimore County also identifies problems and implements necessary corrections to improve water quality for each creek through water quality improvement projects.

Baltimore County EPS has planned, designed, permitted, and overseen the construction of dredging projects in several locations within the Middle River and Tidal Gunpowder River planning area. Figure 2-10 shows the waterways dredging projects that have been completed within the Middle River and Tidal Gunpowder watersheds. Baltimore County EPS also maintains aids to navigation on these waterways and, as a key indicator of waterway health, collects SAV data and conducts annual monitoring for all creeks that are dredged (see Chapter 3.4.3). Bathymetry surveys in the next several years will help to determine the need and frequency of future maintenance dredging.

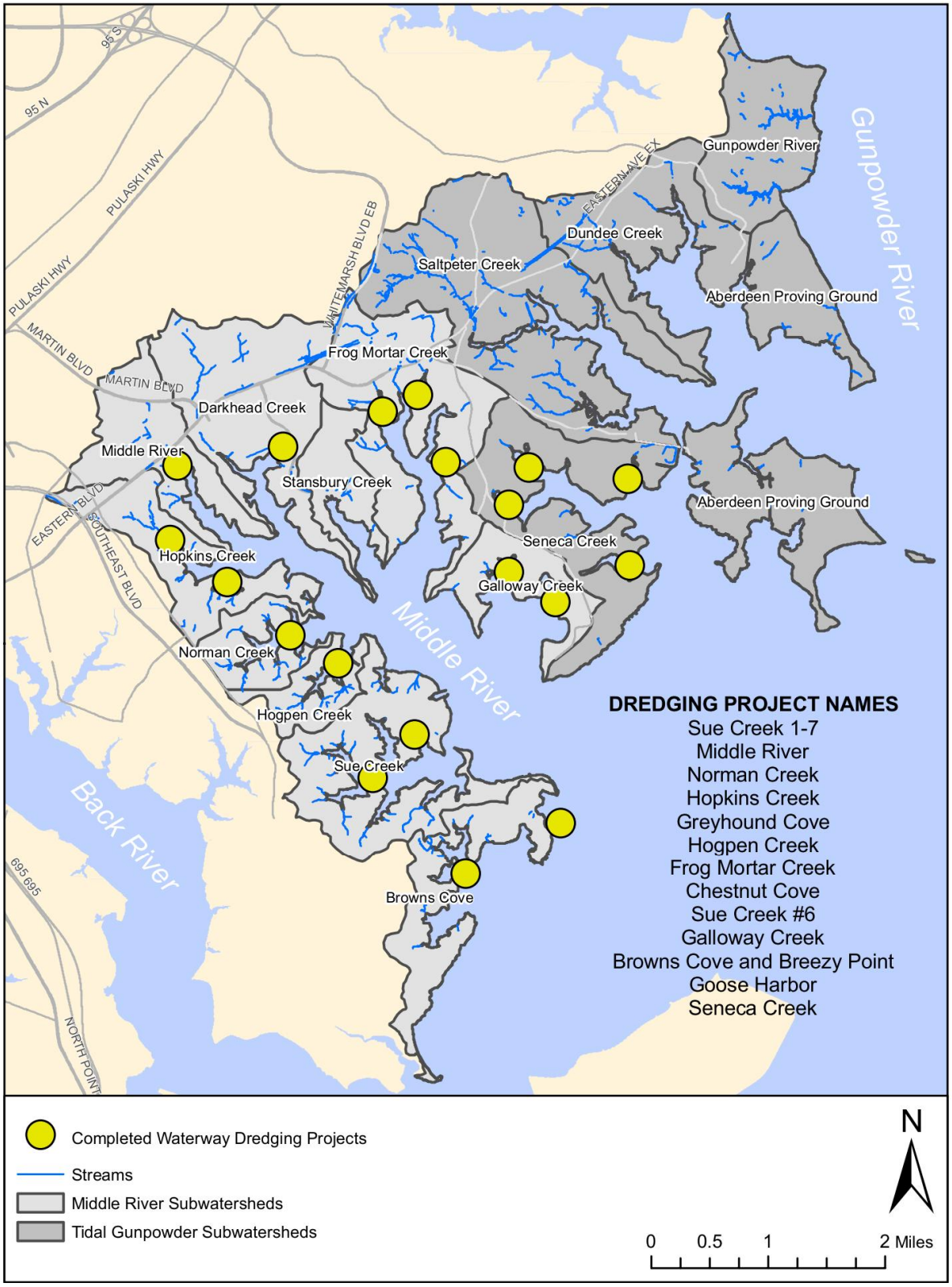

Figure 2-10: Middle River and Tidal Gunpowder River Completed Waterway Dredging Projects

2.3 The Human Modified Landscape

Human activities have altered the natural landscape over time through the use of land and water resources. The intensity of development activities has increased since the colonization of Maryland in the 1600s, which has resulted in environmental impacts to both terrestrial and aquatic ecosystems. This section describes the characteristics of the human modified landscape and how it is associated with impacts to the natural ecosystem of the Middle River and Tidal Gunpowder River watersheds. This includes a description of land use and land cover, population, impervious cover, drinking water and wastewater, stormwater systems, discharge permits, and zoning.

2.3.1 Land Use and Land Cover

Land use represents the types of human activities taking place within a watershed and has pronounced impacts on water quality and habitat. The extent of these impacts, including types and amounts of pollutants generated, varies depending on the types of land uses that are present in the watershed. As discussed previously, a forested watershed has the ability to absorb pollutants such as sediment and nutrients and reduce the flow rate of water into streams. Developed areas have impervious surfaces that block the natural seepage of precipitation into the ground. These impervious surfaces include roads, parking lots, roofs and other human constructions. Unlike most natural surfaces, impervious surfaces tend to concentrate stormwater runoff, accelerate flow rates, and direct stormwater to the nearest stream. This behavior can cause bank erosion and destruction of in-stream and riparian habitat of the receiving water body. Undeveloped watersheds and those with smaller amounts of impervious surfaces tend to have better water quality in local streams than developed watersheds with larger amounts of impervious surfaces. In addition, agricultural land can contribute to increases in nutrients and coliform bacteria in streams if not properly managed.

MDP develops statewide land use/land cover spatial data to provide a general overview of predominant land cover and usage, and to monitor development activities throughout the state. The land use/land cover delineations are based on high altitude aerial photography and satellite imagery. In this report, land use analyses were performed using 2007 MDP land use spatial data provided by Baltimore County OIT. This data was originally based on the 2002 MDP-developed land use/land cover data which were later refined using 2005 aerial imagery and 2006 tax parcel data. Table 2-11 summarizes land use categories in the Middle River and Tidal Gunpowder River watersheds and their percent composition in each subwatershed. Figure 2-11 illustrates the land use/land cover distribution in the planning area.

Predominant land use types present within the Middle River/Tidal Gunpowder River planning area are forests and wetlands (approximately 5230 acres or 42% of total area) and residential areas (approximately 4030 acres or 33% of total area). In addition, there is more forested area in Tidal Gunpowder River (47% of watershed) than in Middle River (23% of watershed) because it is less developed. Wetlands are also much more abundant in the Tidal Gunpowder River watershed, particularly in the subwatersheds of Gunpowder River and Aberdeen Proving Ground. As mentioned in section 2.2.6, forest and wetland areas provide a good opportunity for preservation. Residential areas were subdivided into four subcategories based on density: very low density (5 to 20-acre lots); low density (1/2 to 5-acre lots); medium density (1/8 to 1/2-acre lots); and high density (less than 1/8-acre lots). Medium and high density residential subcategories make up the majority of residential areas

within the planning area (approximately 86%). Subwatersheds with the highest percentages of residential areas include Middle River, Hopkins Creek, and Norman Creek. Residential areas present an opportunity for community involvement in restoration efforts, neighborhood pollutant source control, and environmental stewardship.

Other urban land uses including commercial, institutional, industrial, open urban land, and transportation also make up a significant portion of the planning area (approximately 2,140 acres or 17% of total area). The majority of commercial land use is in the Middle River watershed (15.6% of the watershed versus 1.1% in the Tidal Gunpowder River watershed), with the highest percentages occurring in the Stansbury Creek and Frog Mortar Creek subwatersheds. Institutional areas such as community centers, schools, churches, medical facilities, and government offices comprise about 3% of the total area and may present opportunities to initiate environmentally sensitive management of the property and to promote environmental awareness education. Other land uses include agriculture, extractive, and water, and make up the remaining 8%. Agriculture lands, which comprise approximately 4% of the planning area, may indicate likely sources of nutrient loading into the river.

Table 2-11: Middle River and Tidal Gunpowder River Land Use/Land Cover Classification (%)

Land Use Type	Darkhead Creek	Frog Mortar Creek	Galloway Creek	Browns Cove	Hogpen Creek	Hopkins Creek	Middle River	Norman Creek	Stansbury Creek	Sue Creek	*Total % of Middle River*		APG	Dundee Creek	Gunpowder River	Saltpeter Creek	Seneca Creek	*Total % of Tidal Gunpowder*		*Total % of SWAP Area*
Very Low Density Residential	1.7	0.0	1.8	0.6	26.8	0.0	0.6	7.4	0.0	5.6	*2.8*		0.0	0.2	1.2	2.4	1.0	*1.1*		*2.0*
Low Density Residential	0.0	6.0	0.0	10.8	4.8	3.3	0.0	3.6	0.0	7.8	*4.0*		0.0	0.0	0.0	0.5	6.4	*1.3*		*2.7*
Medium Density Residential	18.0	22.2	55.9	8.8	26.7	34.1	23.3	51.7	12.3	31.8	*25.8*		0.0	14.2	27.0	0.8	32.4	*11.5*		*19.0*
High Density Residential	15.6	13.7	0.0	0.0	7.1	30.5	46.4	0.0	0.5	2.0	*13.6*		0.0	1.4	0.0	7.8	6.0	*3.8*		*8.9*
Commercial	16.1	33.0	1.9	0.0	0.0	6.1	16.0	2.7	69.2	3.2	*15.6*		0.0	1.8	0.0	0.7	3.3	*1.1*		*8.7*
Industrial	18.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	*3.3*		0.0	0.0	0.0	5.2	4.5	*2.5*		*2.9*
Institutional	1.7	7.2	0.0	1.6	7.2	5.8	3.8	1.8	0.0	3.5	*3.6*		7.4	1.0	1.7	1.1	2.4	*2.8*		*3.2*
Extractive (Quarry)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	*0.0*		0.0	6.6	0.0	11.2	0.0	*4.7*		*2.2*
Open Urban Land	2.7	0.4	0.0	0.0	2.4	7.9	0.0	1.7	0.0	0.5	*1.5*		0.0	0.0	18.2	4.1	0.0	*3.6*		*2.5*
Agriculture - Cropland	0.0	0.0	17.0	24.8	0.0	0.0	0.0	0.0	0.0	2.5	*3.7*		0.0	13.9	0.3	4.6	3.7	*4.3*		*4.0*
Agriculture - Pasture	0.4	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	*0.2*		0.0	0.0	0.0	0.0	0.0	*0.0*		*0.1*
Deciduous Forest	22.6	13.8	21.5	39.9	15.4	8.7	9.0	22.8	8.7	39.2	*21.3*		21.3	33.6	24.3	49.8	33.7	*35.0*		*27.8*
Evergreen Forest	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	*0.0*		0.0	2.6	0.0	0.0	0.0	*0.4*		*0.2*
Mixed Forest	0.3	0.1	0.0	0.0	7.4	0.3	0.0	6.2	0.0	0.0	*0.7*		27.1	14.5	9.6	4.6	0.0	*10.9*		*5.6*
Brush	0.0	1.3	0.0	5.1	0.0	0.0	0.0	0.0	0.0	0.0	*0.7*		0.0	0.0	0.0	1.3	0.0	*0.4*		*0.6*
Water	0.4	0.6	1.8	1.4	2.1	1.4	0.3	2.2	0.6	2.4	*1.2*		3.3	0.5	0.4	0.5	2.2	*1.4*		*1.3*
Wetland	1.8	0.8	0.0	7.1	0.0	0.0	0.6	0.0	8.8	1.4	*1.9*		40.8	9.7	17.2	5.4	4.4	*15.2*		*8.2*
Transportation	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	*0.2*		0.0	0.0	0.0	0.0	0.0	*0.0*		*0.1*

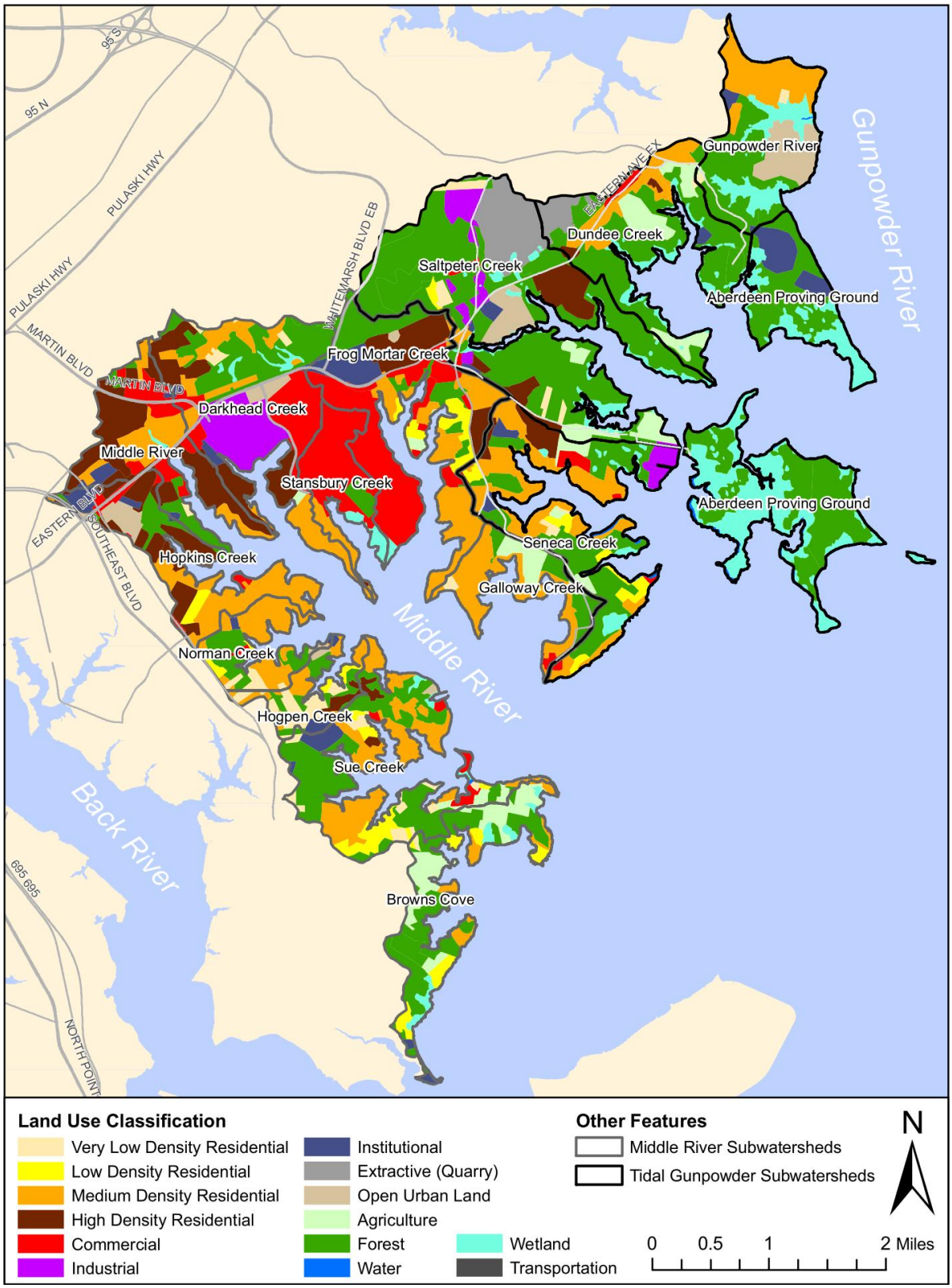

Figure 2-11: Middle River and Tidal Gunpowder River Land Use/Land Cover

2.3.2 Population

Population data provides another method of evaluating the intensity of land use. Areas of concentrated population normally represent more intense use of the land and potential for environmental degradation. Much of the degradation from these locations (likely found in urban and suburban areas) is related to the extent of impervious cover and depletion of land covers such as forests that help to protect water resources. Smart growth principles are aimed at directing future growth to areas of existing services and locations where development has already begun. This strategy will result in less conversion into residential and commercial land uses, and therefore promote conservation of land uses with less environmental impact such as forest and agriculture.

Population data presented in this section are based on 2000 Census blocks and population data from the U.S. Census Bureau. Table 2-12 summarizes population and population densities with respect to total area and total impervious area for each subwatershed. Figure 2-12 shows the distribution of population density throughout the Middle River/Tidal Gunpowder River planning area. Not surprisingly, population is generally most dense in areas occupied by medium to high density residential land uses. The subwatersheds with the highest population densities are Middle River and Hopkins Creek in the Middle River watershed. These subwatersheds also have the highest percentages of residential areas as discussed in the previous section. Darkhead Creek, Hogpen Creek, and Seneca Creek subwatersheds also have relatively high population densities. The Middle River watershed is generally much more populated than the Tidal Gunpowder River watershed, totaling approximately 25,900 residents and 4 persons per acre compared to approximately 8,800 residents and 1.5 persons per acre, respectively. Because population is closely related to urban development, subwatersheds with higher population densities also tend to have higher amounts of impervious cover.

Table 2-12: Middle River and Tidal Gunpowder River Population Data

Subwatershed	Total Population (2000 census)	Total Area (Acres)	Population Density (per acre)	Impervious Area (Acres)	Impervious Acres per person	Population Density (per impervious acre)
Darkhead Creek	5,289	1,139.6	4.64	380.8	0.07	13.89
Frog Mortar Creek	3,249	1,191.8	2.73	368.3	0.11	8.82
Galloway Creek	637	371.5	1.71	54.3	0.09	11.72
Browns Cove	299	611.8	0.49	39.6	0.13	7.55
Hogpen Creek	826	262.3	3.15	38.2	0.05	21.63
Hopkins Creek	5,706	604.6	9.44	173.7	0.03	32.84
Middle River	6,899	674.0	10.24	244.7	0.04	28.20
Norman Creek	903	311.4	2.90	52.7	0.06	17.14
Stansbury Creek	270	345.8	0.78	84.3	0.31	3.20
Sue Creek	1,816	955.0	1.90	124.4	0.07	14.60
Middle River Subtotal	*25,894*	*6,467.9*	*4.0*	*1560.9*	*0.06*	*16.6*
Aberdeen Proving Ground	0	819.7	0.00	13.5	-	0.00
Dundee Creek	858	1,227.1	0.70	61.1	0.07	14.05
Gunpowder River	1,634	899.9	1.82	75.0	0.05	21.80
Saltpeter Creek	3,039	1,902.2	1.60	185.1	0.06	16.42
Seneca Creek	3,278	1,007.2	3.25	161.6	0.05	20.28
Gunpowder River Subtotal	*8,809*	*5,856.1*	*1.5*	*496.2*	*0.06*	*17.8*
Total	*34,703*	*12,324*	*2.8*	*2,057*	*0.06*	*16.9*

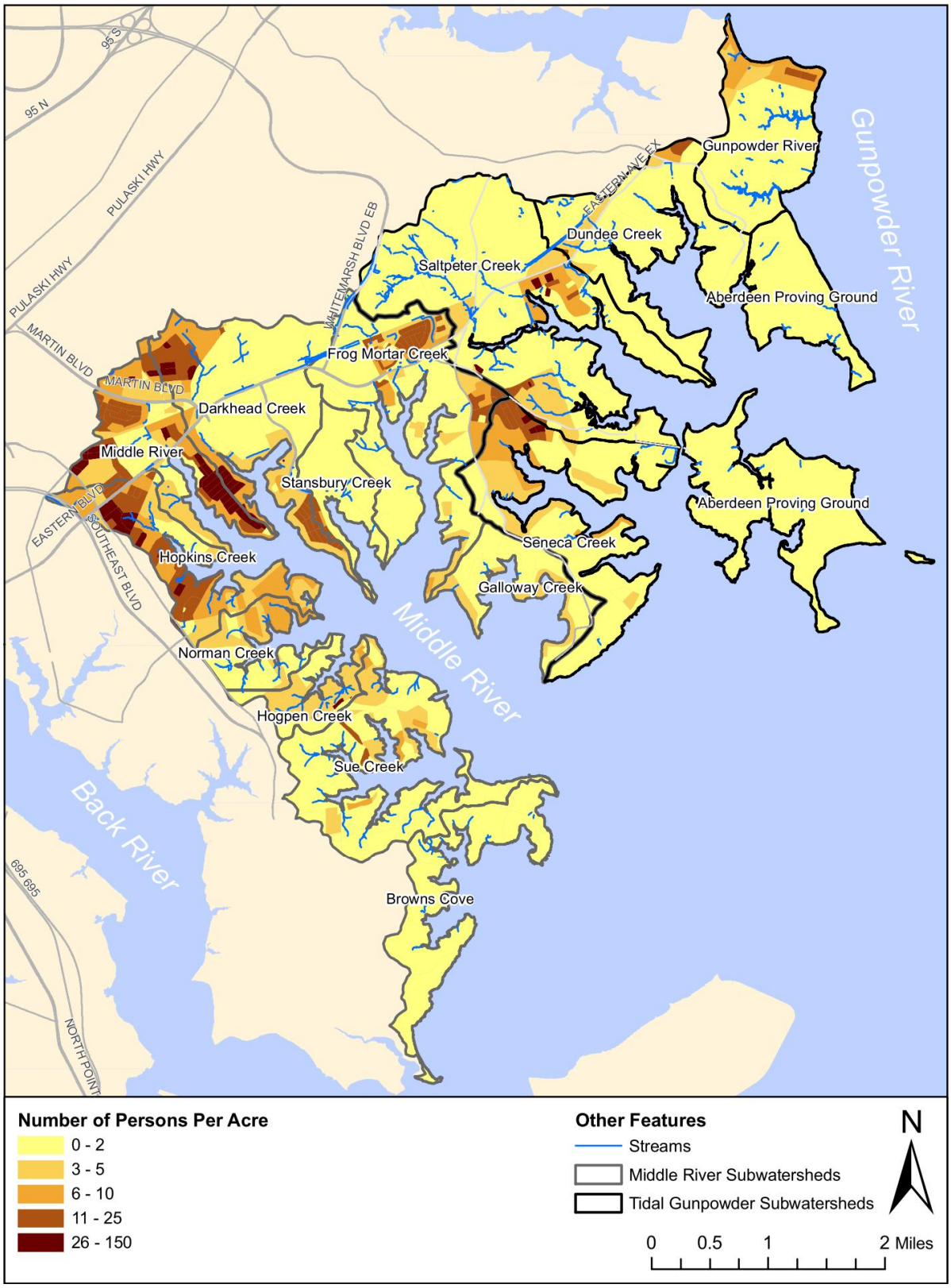

Figure 2-12: Middle River and Tidal Gunpowder River Population Distribution

2.3.3 Impervious Surfaces

Impervious surfaces such as roads, parking lots, roofs, and other paved areas prevent precipitation from naturally infiltrating into the ground. Stormwater runoff from these areas becomes overland flow and is typically concentrated, accelerated, and conveyed directly to the nearest stream. Consequently, the high energy flows of stormwater runoff from impervious surfaces can cause stream erosion and habitat destruction. This runoff is also likely to be more polluted than runoff 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 quantities in stormwater runoff. Research has been conducted to link the degree of urbanization (typically measured by amount of impervious cover) with various watershed-based indicators of water quality such as diversity and abundance of aquatic and terrestrial life. The Center for Watershed Protection (CWP) compiled stream research conducted in various parts of the country and developed a simple model that relates stream quality to percentage of impervious cover in a watershed. Studies used to develop the impervious cover model measured stream quality based on a variety of indicators such as number of aquatic insect species, stream temperature, channel stability, aquatic habitat, wetland plant density, and fish communities present. CWP's impervious cover model is shown in Figure 2-13.

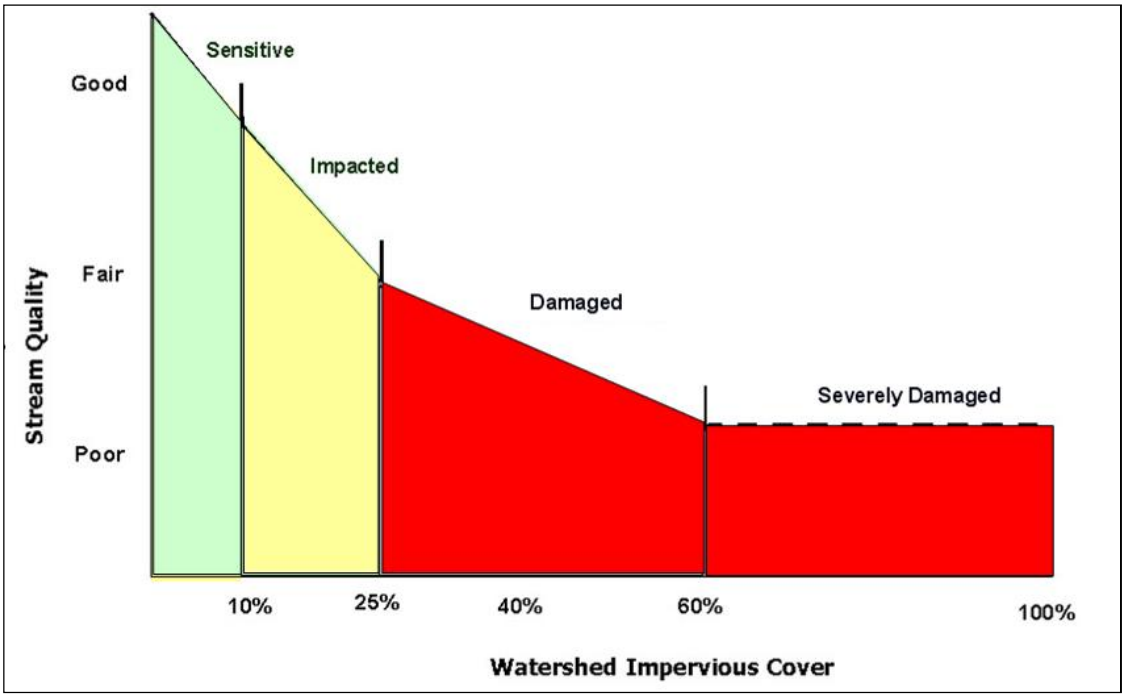

Figure 2-13: Impervious Cover Model (adapted from CWP 2003)

Based on the compiled research, CWP determined four classifications to predict stream quality based on watershed imperviousness: sensitive; impacted; damaged; or severely damaged. Watersheds with less than 10% 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. These watersheds are called

sensitive because they are susceptible to environmental degradation with increased urbanization and impervious cover. The model predicts that between 10 and 25 percent impervious cover, watersheds become impacted and would show clear signs of degradation such as erosion, channel widening, and a decline in stream habitat. There is a possibility to restore streams to a somewhat natural functioning system within this category. When a watershed has more than 25 percent impervious cover, streams are classified as damaged and characterized by fair to poor water quality, unstable channels, severe erosion, and inability to support aquatic life and provide habitat; many streams in this category are typically piped or channelized. Figure 2-10 shows that when impervious cover exceeds 60 percent, a watershed is classified as severely damaged and means that most of the natural stream system is gone. Management of damaged and severely damaged streams may focus on decreasing pollutant loads to downstream receiving waters (e.g., installing BMPs) but the ability to restore natural functions, such as habitat, is unlikely. Restoration efforts may also focus on making the remaining stream systems stable, aesthetically pleasing and an amenity to the community. It should be noted that the impervious cover model is a simplified approach for classifying the quality of urban streams. Although it is based on research, there are inherent model assumptions and limitations that should be considered such as regional variations and scale effects. In addition, while impervious cover is a relevant and significant indicator for watershed health, it is only one of many different factors affecting stream health and contributing to the cumulative impacts of development on water quality. For example, agricultural land uses may also contribute sediment and nutrient loads to receiving waters. Furthermore, the ability of BMPs to offset adverse impacts from urbanized areas is not specifically accounted for in the model.

Impervious cover data were obtained from 2008 roads and buildings spatial data provided by Baltimore County OIT. Impervious area quantities shown in Table 2-13 are the sum of road and building areas. The table also shows the percentage of impervious cover within each subwatershed. Figure 2-14 illustrates the location of impervious surfaces within the Middle River and Tidal Gunpowder River watersheds. The total impervious area calculated is approximately 2,057 acres, nearly 17% of the planning area. The Middle River watershed has approximately 1,561 acres of impervious cover, making up 24% of the watershed. The Tidal Gunpowder River watershed is distinctly different with only 496 acres of impervious cover, constituting 8.5% of the watershed. Subwatersheds with the highest percentages of impervious cover include Middle River, Darkhead Creek, and Frog Mortar Creek.

Table 2-13: Middle River and Tidal Gunpowder River Impervious Area Estimates

Subwatershed	Total Area (Acres)	Roads (Acres)	Buildings (Acres)	Impervious Area (Acres)	% Impervious
Darkhead Creek	1,139.6	277.67	103.17	380.84	33.4%
Frog Mortar Creek	1,191.8	257.57	110.72	368.29	30.9%
Galloway Creek	371.5	35.52	18.82	54.34	14.6%
Browns Cove	611.8	26.69	12.90	39.59	6.5%
Hogpen Creek	262.3	23.23	14.96	38.19	14.6%
Hopkins Creek	604.6	114.25	59.48	173.73	28.7%
Middle River	674.0	156.11	88.56	244.67	36.3%
Norman Creek	311.4	32.75	19.93	52.68	16.9%
Stansbury Creek	345.8	71.24	13.02	84.26	24.4%
Sue Creek	955.0	82.62	41.76	124.38	13.0%
Total	*6,467.9*	*1,077.6*	*483.3*	*1,560.9*	*24.1%*
Aberdeen Proving Ground	819.7	18.47	0.12	18.59	2.3%
Dundee Creek	1,227.1	37.91	20.37	58.28	4.7%
Gunpowder River	899.9	46.78	25.87	72.66	8.1%
Saltpeter Creek	1,902.2	143.40	41.69	185.10	9.7%
Seneca Creek	1,007.2	102.63	58.99	161.62	16.0%
Total	*5,856.1*	*349.2*	*147.0*	*496.2*	*8.5%*
Total	*12,323.9*	*1,426.8*	*630.4*	*2,057.2*	*16.7%*

Figure 2-15 shows impervious cover ratings for the subwatersheds in the Middle River/Tidal Gunpowder River planning area based on the CWP model. As expected from the extent of urbanization and impervious cover percentages, the Middle River watershed contains damaged and impacted subwatersheds, whereas all Tidal Gunpowder River subwatersheds are sensitive, except for Seneca Creek, according to the CWP model. "Impacted" subwatersheds mainly correspond to those with high amounts of residential development; "damaged" subwatersheds have more commercial development, which is associated with more impervious cover density. There are no subwatersheds in the Middle River/Tidal Gunpowder River planning area classified as "severely damaged" under the CWP impervious cover model.

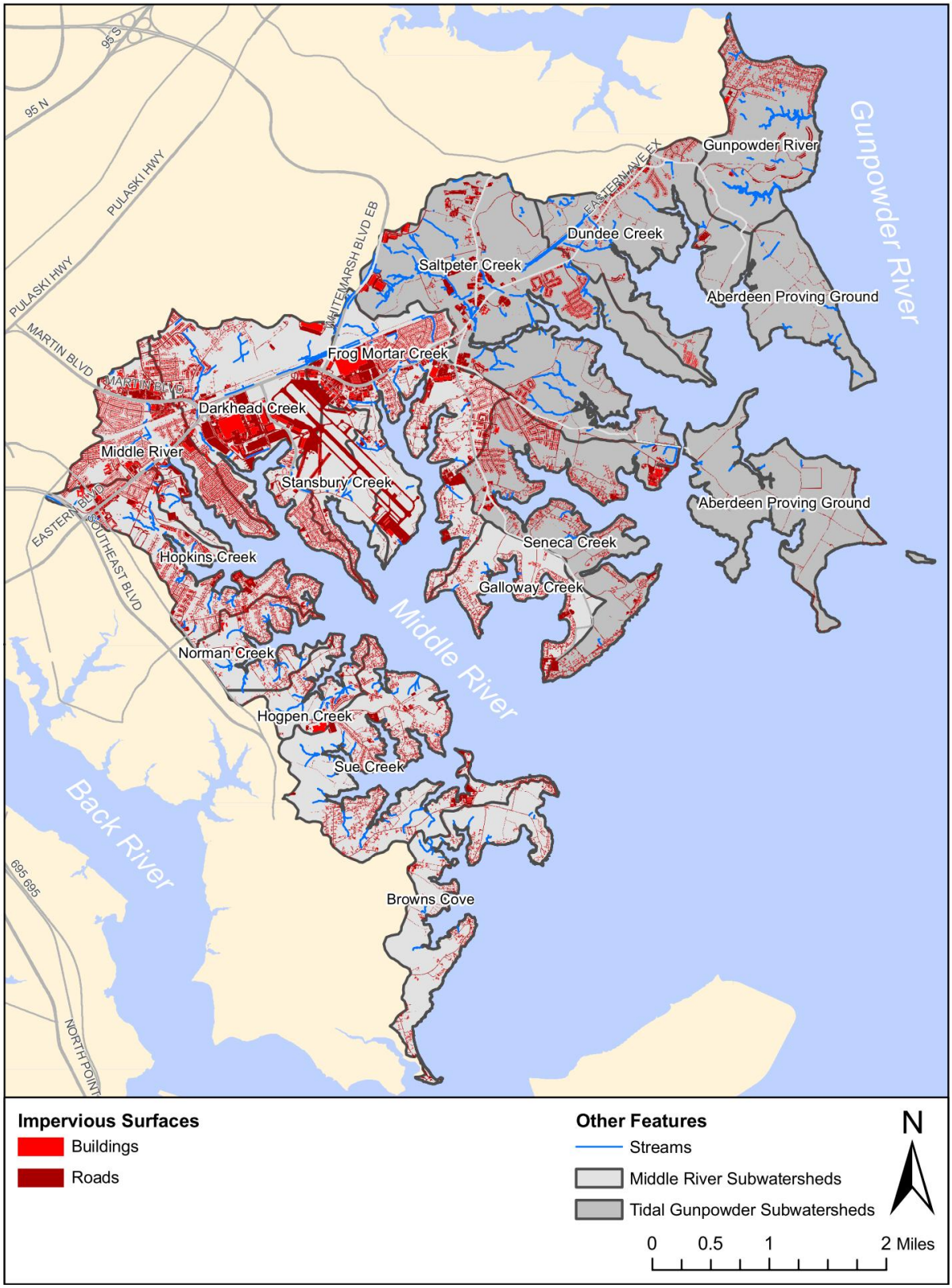

Figure 2-14: Middle River and Tidal Gunpowder River Impervious Surfaces

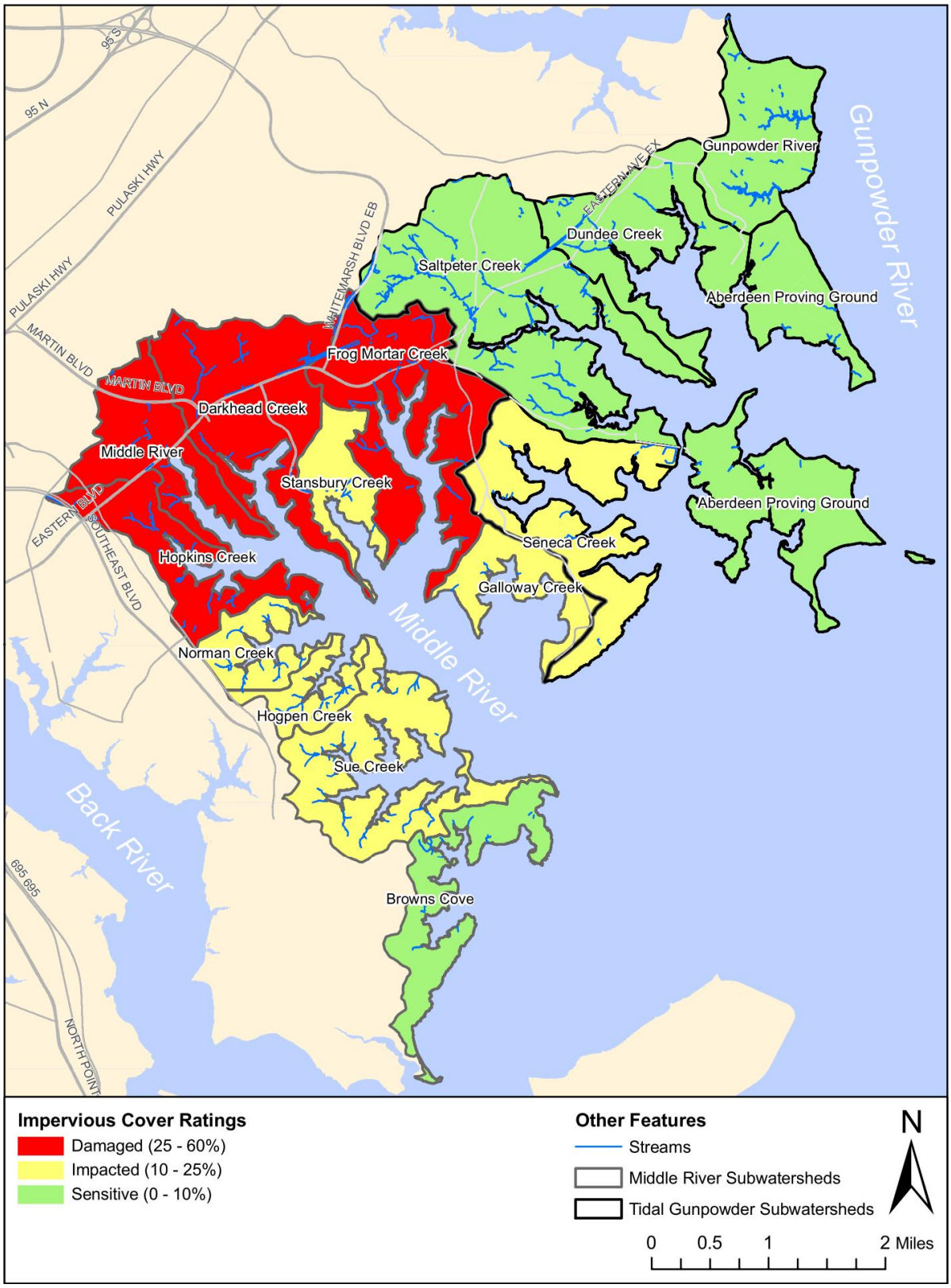

Figure 2-15: Middle River and Tidal Gunpowder River Impervious Cover Ratings

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 developed properties. Having an adequate supply of drinking water and a method for its conveyance is essential to the human population.

2.3.4.1 Public Water Supply

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

2.3.5 Wastewater

Wastewater produced by human processes must be treated and disposed properly. This is accomplished either through public conveyance to a 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, bathroom water, and any other rinse water such as paint brush, floor washing, etc. Industrial wastewater could contain various contaminants such as metals, organic compounds, detergents, or synthetic compounds depending on the operation. All of these types of wastewater have the potential to adversely impact the natural environment.

2.3.5.1 Septic Systems

Properly functioning septic systems provide treatment for nearly all the phosphorus present in wastewater, but can leak nitrogen in the form of nitrates. Depending on the location of the system, nitrates may be reduced or eliminated through de-nitrification as the treated water passes through riparian buffers, particularly forested buffers. Failing systems can release nitrogen, phosphorous, and other chemicals, and in turn, contaminate the aquatic environment. They can also result in increased bacterial contamination of nearby streams and therefore increased potential for human health concerns. Table 2-14 summarizes the approximate number of septic systems present in the Middle River/Tidal Gunpowder River planning area by subwatershed. Septic systems data are based on 2009 septic and public sewer spatial data from Baltimore County EPS. Based on this data, the Saltpeter Creek subwatershed contains the most septic systems of all subwatersheds in the planning area, almost half of which are non-residential (mostly privately owned business and institutions). Figure 2-16 shows the distribution of residential and non-residential septic systems in the Middle River and Tidal Gunpowder River watersheds.

Table 2-14: Middle River and Tidal Gunpowder River Septic Systems by Subwatershed

Subwatershed	# of Septic Systems
Darkhead Creek	51
Frog Mortar Creek	16
Galloway Creek	10
Browns Cove	50
Hogpen Creek	11
Hopkins Creek	15
Middle River	26
Norman Creek	25
Stansbury Creek	0
Sue Creek	31
Middle River Subtotal	*235*
Aberdeen Proving Ground	0
Dundee Creek	20
Gunpowder River	5
Saltpeter Creek	119
Seneca Creek	37
Tidal Gunpowder Subtotal	*181*
Total	*416*

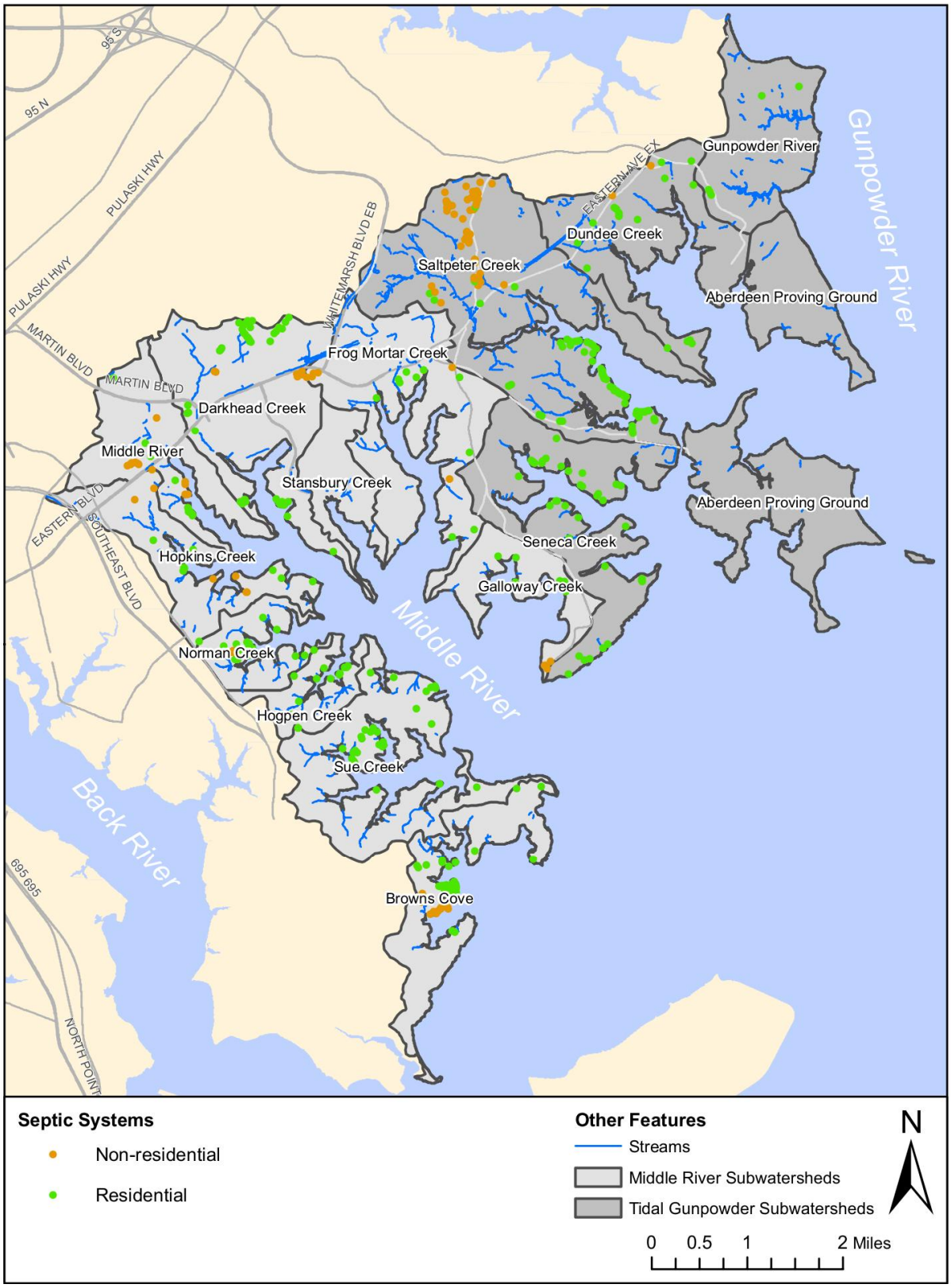

Figure 2-16: Location of Septic Systems in Middle River and Tidal Gunpowder River Watersheds

2.3.5.2 Public Sewer

The public sewer system conveys wastewater from individual households or businesses to a facility that treats the wastewater prior to discharge. It consists of the piping system within the public right-of-way and cleanouts on individual properties. Property owners are responsible for the maintenance of their individual cleanouts. The portion of the system within the public right-of-way is owned and maintained by the local government, including the gravity piping system, access manholes, pumping stations, and force mains. Table 2-15 below summarizes the lengths of public sewer piping in the Middle River/Tidal Gunpowder River planning by type (gravity main or pressurized main) and by subwatershed. This data was compiled from gravity main, manhole, and force main spatial data provided by Baltimore County OIT. Table 2-16 summarizes public sewer piping density (length of sewer main per square mile of subwatershed area) for each subwatershed. Seneca Creek subwatershed contains the most sanitary sewer piping including both gravity mains and pressurized mains; Hopkins Creek and Middle River subwatersheds have the most sanitary sewer piping, gravity and pressurized combined, per subwatershed area.

Table 2-15: Public Sewer Piping Length in Middle River and Tidal Gunpowder River Watersheds

Subwatershed	Pressurized Main (ft)	Gravity Main (ft)	Gravity Main Abandoned (ft)	Total (ft)
Darkhead Creek	23,388	70,647	474	94,510
Frog Mortar Creek	33,092	45,049	700	78,841
Galloway Creek	38,990	1,419	0	40,409
Browns Cove	39,706	0	0	39,706
Hogpen Creek	4,901	16,608	0	21,509
Hopkins Creek	12,591	59,376	3,440	75,407
Middle River	5,252	80,772	3,135	89,159
Norman Creek	4,178	19,459	0	23,636
Stansbury Creek	2,575	7,805	0	10,379
Sue Creek	56,602	30,957	0	87,559
Middle River Subtotal	*221,274*	*332,092*	*7,750*	*561,116*
Aberdeen Proving Ground	0	0	0	0
Dundee Creek	5,467	17,160	0	22,628
Gunpowder River	3,780	26,191	0	29,971
Saltpeter Creek	5,792	18,863	0	24,655
Seneca Creek	66,124	38,364	108	104,596
Tidal Gunpowder Subtotal	*81,164*	*100,578*	*108*	*181,850*
Total	*302,438*	*432,670*	*7,858*	*742,966*

Table 2-16: Public Sewer Piping Density in Middle River and Tidal Gunpowder River Watersheds

Subwatershed	Area (Sq Miles)	Pressurized Main (ft/sq mi)	Gravity Main (ft/sq mi)
Darkhead Creek	1.78	13,135	39,675
Frog Mortar Creek	1.86	17,771	24,192
Galloway Creek	0.58	67,179	2,445
Browns Cove	0.96	41,534	0
Hogpen Creek	0.41	11,956	40,518
Hopkins Creek	0.94	13,327	62,849
Middle River	1.05	4,987	76,696
Norman Creek	0.49	8,586	39,991
Stansbury Creek	0.54	4,765	14,444
Sue Creek	1.49	37,934	20,747
Middle River Subtotal	*10.1*	*21,895*	*32,861*
Aberdeen Proving Ground	2.00	0	0
Dundee Creek	1.44	3,802	11,933
Gunpowder River	1.16	3,246	22,488
Saltpeter Creek	2.97	1,949	6,346
Seneca Creek	1.57	42,018	24,378
Tidal Gunpowder Subtotal	*9.2*	*8,870*	*10,992*
Total	*19.3*	*15,706*	*22,469*

Environmental impacts associated with public sewers are usually the result of sewage overflows. Sanitary sewer overflows (SSOs) typically result from blockages in the sewage system, pumping station failure, or rainwater inflows exceeding pipe capacity. Contamination can also occur during dry weather due to leaks in the sewer system. Water quality concerns related to sewer overflows and leaks include high bacteria concentrations, release of nutrients, increased turbidity (cloudiness), and low dissolved oxygen concentrations.

2.3.5.3 Wastewater Treatment Facilities

There are no wastewater treatment facilities in the Middle River/Tidal Gunpowder River planning area. Wastewater from the Middle River and Tidal Gunpowder River watersheds is conveyed to the Back River Wastewater Treatment Plant located in the Tidal Back River watershed.

2.3.6 Stormwater

Stormwater is generated during and immediately after storm events. Precipitation that does not seep into the ground becomes stormwater runoff and flows directly to receiving water bodies. The quantity and characteristics of stormwater runoff is affected by rainfall amount and intensity, soil properties,

land slope, and land use/land cover type. Concerns associated with stormwater include 1) volume and rate of runoff and 2) water pollution.

As previously discussed, larger volumes of stormwater runoff are generated from areas with impervious cover than from undeveloped land; impervious surfaces prevent infiltration of runoff into the ground, conveying it to the stream system more swiftly and in larger quantities. The increase in runoff rate and volume can cause flooding and stream erosion, which results in destruction of habitat and natural stream functions such as nutrient reduction. In addition, there is less potential for groundwater recharge when there is little or no infiltration of stormwater.

Stormwater runoff also contains various contaminants depending on land use characteristics and human activities that take place within a watershed. The contaminants that are carried by stormwater to the stream systems include pollutants deposited on impervious surfaces and other developed lands from daily human activity. Common pollutants found in impervious surface runoff (such as from highways and parking lots) are sediment, metals, bacteria, nutrients, and petroleum; pollutants such as these accumulate over time from sources such as road maintenance activities (de-icing and roadside fertilizer use), vehicles (exhaust and leaks), and accidents or spills and are washed off during storm events. While the runoff from other developed lands, for example agriculture and residential areas, may be moderate compared to highly impervious areas, it can still carry pollutants such as nutrients, bacteria, and chemicals to receiving water bodies.

2.3.6.1 Storm Drainage System

The storm drainage system consists of either drainage swales (roadside ditches) or a curb and gutter system including inlets, piping, and outfalls. Both methods are intended to prevent flooding and potentially hazardous situations by removing water quickly from roadways. However, the efficiency and watershed impacts associated with each method differ significantly. The curb and gutter system drains stormwater more quickly from impervious surfaces and typically conveys water directly into the stream system. In doing so, however, it delivers increased runoff volumes and more untreated pollutants to receiving water bodies. Drainage swales typically convey stormwater at a slower rate than the curb and gutter system, but the stormwater flow is somewhat reduced before entering the stream system. Drainage swales also allow some infiltration into the ground unlike the curb and gutter system, thereby reducing the amount of water delivered to the streams and providing some filtering of pollutants.

Table 2-17 summarizes the curb and gutter system components in the Middle River/Tidal Gunpowder River planning area by subwatershed. The summary includes estimates of major outfalls (greater than 3 feet in diameter) and minor outfalls (less than 3 feet in diameter), along with corresponding number of inlets and pipe length draining to those outfalls. Storm drain system data used to compile this information were created by Baltimore County EPS based on storm drain plans and topographic data. This data provides a reasonable approximation of storm drain pipe lengths which were rounded to the nearest tens of feet. Table 2-18 provides a summary of the percentage of each subwatershed that is covered by the storm drain system, or in other words, the drainage areas of the storm drain system in a subwatershed divided by the total subwatershed area. It also shows the inlet density (number of inlets

per square mile) of each subwatershed. Figure 2-17 shows the location of major and minor outfalls within the Middle River and Tidal Gunpowder River watersheds.

Table 2-17: Stormwater System Components in Middle River and Tidal Gunpowder River Watersheds

	MAJOR (> 3ft)			MINOR (> 3ft)			ALL OUTFALLS		
Subwatershed	Oufalls (#)	Inlets (#)	Pipe (ft)	Oufalls (#)	Inlets (#)	Pipe (ft)	Total Oufalls (#)	Total Inlets (#)	Total Piping (ft)
Darkhead Creek	4	30	3,980	12	67	7,850	16	97	11,830
Frog Mortar Creek	5	25	3,550	2	3	300	7	28	3,850
Galloway Creek	0	0	0	0	0	0	0	0	0
Browns Cove	0	0	0	1	1	270	1	1	270
Hogpen Creek	0	0	0	6	17	1,640	6	17	1,640
Hopkins Creek	2	11	2,450	17	58	7,740	19	69	10,190
Middle River	4	21	3,100	13	62	7,820	17	83	10,920
Norman Creek	0	0	0	3	21	2,330	3	21	2,330
Stansbury Creek	0	0	0	0	0	0	0	0	0
Sue Creek	0	0	0	13	90	8,230	13	90	8,230
Middle River Subtotal	*15*	*87*	*13,080*	*67*	*319*	*36,180*	*82*	*406*	*49,260*
Aberdeen Proving Ground	0	0	0	0	0	0	0	0	0
Dundee Creek	1	2	470	6	32	4,760	7	34	5,230
Gunpowder River	0	0	0	8	27	3,490	8	27	3,490
Saltpeter Creek	0	0	0	1	2	210	1	2	210
Seneca Creek	2	22	3,440	10	38	5,220	12	60	8,660
Tidal Gunpowder Subtotal	*3*	*24*	*3,910*	*25*	*99*	*13,680*	*28*	*123*	*17,590*
Total	*18*	*111*	*16,990*	*92*	*418*	*49,860*	*110*	*529*	*66,850*

Table 2-18: Stormwater System Coverage in Middle River and Tidal Gunpowder River Watersheds

Subwatershed	Subwatershed Area (Acres)	Stormwater System Drainage Area (Acres)	Area Covered by Stormwater System (%)	No. of Inlets (#)	Inlet Density (#/sq mi)
Darkhead Creek	1,140	234	21%	97	54.5
Frog Mortar Creek	1,192	187	16%	28	15.0
Galloway Creek	371	0	0%	0	0.0
Browns Cove	612	2	0%	1	1.0
Hogpen Creek	262	18	7%	17	41.5
Hopkins Creek	605	233	39%	69	73.0
Middle River	674	283	42%	83	78.8
Norman Creek	311	24	8%	21	43.2
Stansbury Creek	346	0	0%	0	0.0
Sue Creek	955	39	4%	90	60.3
Middle River Subtotal	*6,468*	*1,021*	*16%*	*406*	*40.2*
Aberdeen Proving Ground	1,281	0	0%	0	0.0
Dundee Creek	920	68	7%	34	23.6
Gunpowder River	745	45	6%	27	23.2
Saltpeter Creek	1,902	1	0%	2	0.7
Seneca Creek	1,007	78	8%	60	38.1
Tidal Gunpowder Subtotal	*5,856*	*192*	*3%*	*123*	*13.4*
Total	*12,324*	*1,213*	*10%*	*529*	*27.5*

Subwatersheds with the highest number of total outfalls and the largest percentages of storm drain coverage are Middle River, Hopkins Creek, and Darkhead Creek. These subwatersheds, including Sue Creek, also have the highest inlet densities and belong to the Middle River watershed, which has far greater residential and commercial development than the Tidal Gunpowder River watershed. Approximately 16% of the Middle River watershed is covered by the storm drainage system with an inlet density of approximately 40 inlets per square mile, whereas the storm drainage system covers only 3% of the Tidal Gunpowder River watershed with an inlet density of approximately 13 inlets per square mile. Locations with higher inlet densities represent potential locations for management of pollution sources and community education measures such as storm drain marking.

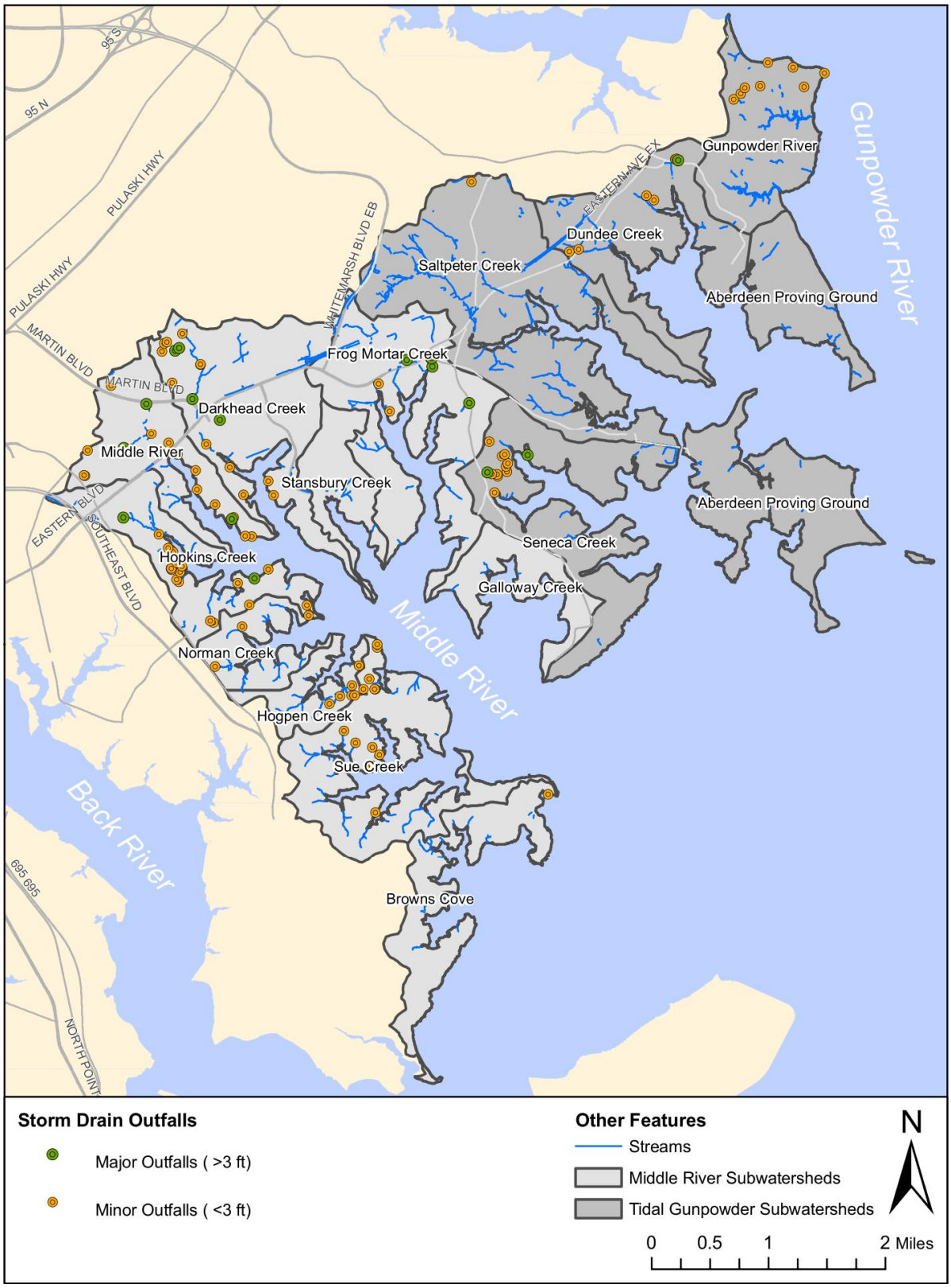

Figure 2-17: Middle River and Tidal Gunpowder River Storm Drain Outfalls

2.3.6.2 Stormwater Management Facilities

The Maryland Department of the Environment (MDE) developed stormwater management (SWM) regulations over 25 years ago to control the quantity of runoff. SWM practices have evolved since then, and will continue to grow as new technology and research are developed. SWM is a significant consideration for new and redevelopment within the state. Per Title 4, Subtitle 3, of the Environment Article of Annotated Code of Maryland, management of stormwater runoff is required to reduce erosion, sedimentation, pollution, and flooding (MDE 2000). Increased importance of water quality and water resource protection has led to the development of the Maryland Stormwater Design Manual to provide Best Management Practice (BMP) design standards and environmental incentives (MDE 2000), and promoting a general shift toward low-impact SWM practices that mimic natural hydrologic processes and achieve pre-development conditions. The latter is evident by the Maryland Stormwater Management Act of 2007 which requires that Environmental Site Design (ESD) be implemented to the maximum extent practicable via nonstructural BMPs and/or other innovative design techniques.

There are many types of BMP options for managing stormwater runoff and providing stormwater quality treatment. SWM facilities can target specific objectives depending on the BMP type such as stormwater quality, soil stabilization, stormwater flow control, and stream restoration. In addition, different SWM facilities have different pollutant removal capabilities. For example, initial pond designs for SWM have low pollutant removal efficiency compared to practices that filter stormwater or allow it to infiltrate into the ground or through plant roots. Considerations such as space requirement, maintenance needs, cost, and community acceptance are taken into account when selecting the appropriate stormwater treatment measures.

Table 2-19 summarizes the number of various types of SWM facilities in the Middle River/Tidal Gunpowder River planning area including the sum of their drainage areas per subwatershed. The SWM facilities are categorized into detention ponds, wet ponds, wetlands, infiltration/filtration practices, extended detention, proprietary BMPs, grassed swales and channels, and others. Figure 2-18 shows the distribution of these SWM facilities within the planning area. Data for SWM facilities and their drainage areas were obtained from Baltimore County EPS.

Table 2-19: Stormwater Management Facilities in Middle River and Tidal Gunpowder River Watersheds

SWM Facility Type	Darkhead Creek	Frog Mortar Creek	Galloway Creek	Browns Cove	Hogpen Creek	Hopkins Creek	Middle River	Norman Creek	Stansbury Creek	Sue Creek	*Middle River Subtotals*		APG	Dundee Creek	Gunpowder River	Saltpeter Creek	Seneca Creek	*Tidal Gunpowder Subtotals*		*Totals*
Detention Pond (#)	2	11	0	0	0	3	2	0	0	0	*18*		0	1	1	0	0	*2*		*20*
Drainage Area (acres)	125.9	92.1	0.0	0.0	0.0	16.4	6.4	0.0	0.0	0.0	*240.7*		0.0	38.1	17.9	0.0	0.0	*56.0*		*296.6*
Wet Pond (#)	1	0	0	0	0	2	7	0	0	0	*10*		0	0	0	3	3	*6*		*16*
Drainage Area (acres)	2.8	0.0	0.0	0.0	0.0	130.1	150.8	0.0	0.0	0.0	*283.8*		0.0	0.0	0.0	29.5	39.6	*69.1*		*352.8*
Wetland (#)	1	1	0	0	0	9	0	0	0	0	*11*		0	1	0	4	0	*5*		*16*
Drainage Area (acres)	6.3	1.6	0.0	0.0	0.0	57.9	0.0	0.0	0.0	0.0	*65.8*		0.0	15.2	0.0	17.2	0.0	*32.4*		*98.2*
Infiltration/Filtration (#)	9	8	0	0	1	0	3	0	0	6	*27*		0	1	3	8	0	*12*		*39*
Drainage Area (acres)	49.3	29.7	0.0	0.0	1.4	0.0	7.1	0.0	0.0	8.1	*95.6*		0.0	3.4	2.2	37.9	0.0	*43.5*		*139.1*
Extended Detention (#)	2	0	0	0	0	1	1	0	0	1	*5*		0	1	0	2	1	*4*		*9*
Drainage Area (acres)	18.6	0.0	0.0	0.0	0.0	1.5	3.0	0.0	0.0	3.5	*26.6*		0.0	4.7	0.0	4.3	1.7	*10.7*		*37.3*
Proprietary BMP (#)	0	1	0	0	0	1	1	0	0	0	*3*		0	0	0	0	0	*0*		*3*
Drainage Area (acres)	0.0	0.6	0.0	0.0	0.0	0.8	1.1	0.0	0.0	0.0	*2.5*		0.0	0.0	0.0	0.0	0.0	*0.0*		*2.5*
Grassed Swale/Channel (#)	0	0	0	0	0	0	2	0	0	0	*2*		0	0	0	2	0	*2*		*4*
Drainage Area (acres)	0.0	0.0	0.0	0.0	0.0	0.0	32.0	0.0	0.0	0.0	*32.0*		0.0	0.0	0.0	2.8	0.0	*2.8*		*34.8*
Other (#)	0	0	0	0	0	1	3	0	0	0	*4*		0	0	0	0	0	*0*		*4*
Drainage Area (acres)	0.0	0.0	0.0	0.0	0.0	1.8	6.6	0.0	0.0	0.0	*8.4*		0.0	0.0	0.0	0.0	0.0	*0.0*		*8.4*
Total SWM Facilities (#)	*15*	*21*	*0*	*0*	*1*	*17*	*19*	*0*	*0*	*7*	*80*		*0*	*4*	*4*	*19*	*4*	*31*		*111*
Total Drainage Area Acres to SWM	*202.9*	*124.0*	*0.0*	*0.0*	*1.4*	*208.5*	*206.9*	*0.0*	*0.0*	*11.6*	*755.4*		*0.0*	*61.4*	*20.0*	*91.6*	*41.3*	*214.4*		*969.7*

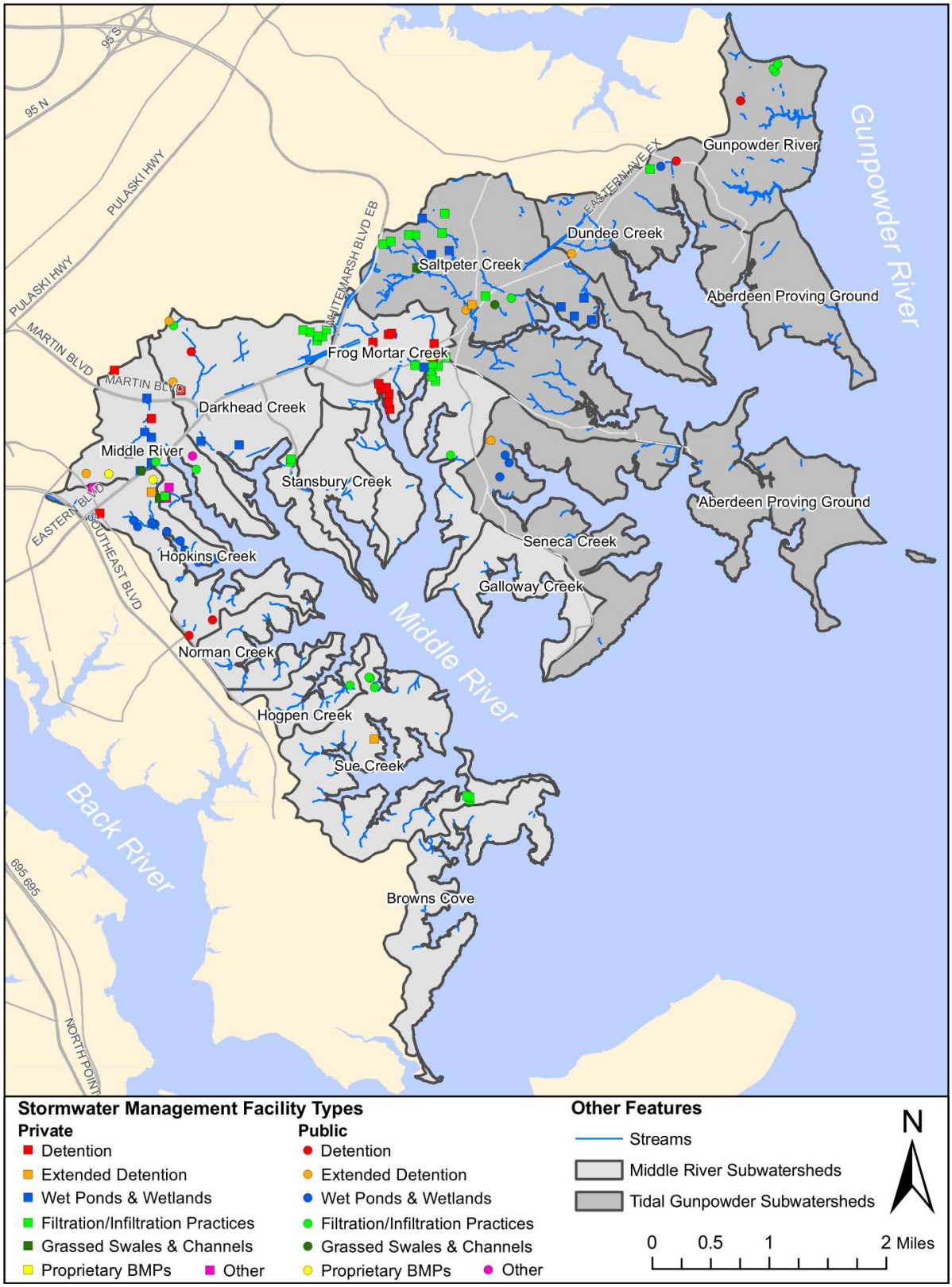

Figure 2-18: Distribution of Stormwater Management Facilities in Middle River and Tidal Gunpowder River Watersheds

SWM facilities are present in most subwatersheds of the Middle River/Tidal Gunpowder River planning area with the exception of Galloway Creek, Browns Cove, Norman Creek, Stansbury Creek, and Aberdeen Proving Ground. The most common SWM facility type in both watersheds is infiltration/filtration. This category of SWM includes infiltration basins and trenches, bioretention facilities, recharge trenches, and surface and underground sand filters. Subwatersheds with the most SWM facilities tend to be those with more commercial and industrial activity. In addition to infiltration/filtration devices, the Middle River watershed also has a high number of detention ponds, wet ponds, and man-made wetlands. Detention pond facilities represent the best opportunity for conversion to BMPs with higher pollutant removal capabilities, such as extended detention ponds. The proprietary BMPs that are listed include oil & grit separators and Stormceptor devices which remove sediment, oil and grease; these are removed through a hydrodynamic separation process where they settle out as the stormwater flows in a circular path. Floatables and debris that are collected in the treatment chamber are typically removed by a vacuum truck at regular intervals. SWM facilities that are classified under "other" include stilling basins and porous pavement.

Table 2-20 shows the total drainage area and the percentage of urban land treated by SWM facilities in each subwatershed. Urban land in this case refers to low, medium and high density residential, commercial, industrial, institutional, open urban, and transportation land uses. This is important to evaluate because subwatersheds with high amounts of urban land but low SWM coverage percentages present opportunities to implement BMPs. BMPs can be implemented in existing developed areas with no current SWM practices or for retrofitting facilities that are not providing adequate stormwater treatment. Approximately 50% of the planning area is classified as urban land, and 16% of this area is treated by SWM facilities. Chapter 3 provides more details on assessed SWM facilities within the Middle River/Tidal Gunpowder River planning area.

Table 2-20: Area Treated by Stormwater Management Facilities in Middle River and Tidal Gunpowder River Watersheds

Subwatershed	Area (Acres)	Urban Land Use (Acres)	Area Treated by SWM (Acres)	Urban Land Use Treated by SWM (%)
Darkhead Creek	1,140	847	203	24%
Frog Mortar Creek	1,192	984	124	13%
Galloway Creek	371	222	0	0%
Browns Cove	612	133	0	0%
Hogpen Creek	262	197	1	1%
Hopkins Creek	605	542	209	38%
Middle River	674	607	207	34%
Norman Creek	311	214	0	0%
Stansbury Creek	346	283	0	0%
Sue Creek	955	520	12	2%
Middle River Subtotal	*6,468*	*4,549*	*755*	*17%*
Aberdeen Proving Ground	1,281	95	0	0%
Dundee Creek	920	172	61	36%
Gunpowder River	745	358	20	6%
Saltpeter Creek	1,902	432	92	21%
Seneca Creek	1,007	564	41	7%
Tidal Gunpowder Subtotal	*5,856*	*1,622*	*214*	*13%*
Total	*12,324*	*6,171*	*970*	*16%*

2.3.7 NPDES Discharge Permits

Businesses and other 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 type of NPDES permit required depends on the nature of the activities conducted by the facility. Table 2-21 summarizes the number of facilities holding NPDES permits in the Middle River and Tidal Gunpowder River watersheds, by subwatershed and permit type. While some facilities hold multiple permits, only one per facility is reflected in the table.

Table 2-21: NPDES-Permitted Facilities in Middle River and Tidal Gunpowder River Watersheds

Subwatershed	# General Industrial Stormwater Permits	# Surface Industrial Discharge Permits	# Surface Municipal Discharge Permits	# General Permits	Total # of Permits in Subwatershed
Darkhead Creek	1	1			2
Frog Mortar Creek	5			4	9
Galloway Creek				2	2
Browns Cove					0
Hogpen Creek					0
Hopkins Creek				1	1
Middle River				2	2
Norman Creek				1	1
Stansbury Creek					0
Sue Creek			1		1
Middle River Subtotal	*6*	*1*	*1*	*10*	*18*
Aberdeen Proving Ground					0
Dundee Creek				1	1
Gunpowder River					0
Saltpeter Creek	4			1	5
Seneca Creek		1		4	5
Tidal Gunpowder Subtotal	*4*	*1*	*0*	*6*	*11*
Total	*10*	*2*	*1*	*16*	*29*

The federal NPDES permits listed above also function as MDE water management permits. Descriptions of each type of NPDES permit are provided as follows by MDE:

- 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.
- General Industrial Stormwater Permits are required for industrial facilities discharging stormwater to storm drains or surface waters.
- Surface Industrial Discharge Permits are required for any industrial facility or landfill discharging wastewater to any place other than a sanitary sewer.
- Surface Municipal Discharge Permits are required for facilities discharging wastewater to any place other than a sanitary sewer, or for facilities operating a sewage or water treatment plant.

NPDES permit data for the Middle River and Tidal Gunpowder River watersheds were estimated from spatial data provided by Baltimore County EPS, based on 2008 MDE records; this data was cross-referenced with more recent data obtained from MDE in 2011. As of 2008, there are a total of 29 facilities holding NPDES permits in the Middle River/Tidal Gunpowder River planning area. Most of these facilities hold General Permits or General Industrial Stormwater permits. Almost all General Permit holders are marinas, mainly pertaining to the Middle River watershed and the Seneca Creek subwatershed in Tidal Gunpowder River. General Industrial Stormwater permits have been issued to a variety of industrial facilities including chemical and machine manufacturers, automobile recycling centers, and transportation facilities such as Martin State Airport. Surface Industrial Discharge Permits are held by Lockheed Martin and Constellation Power. Baltimore Yacht Club holds the only Surface Municipal Discharge Permit for discharge of treated wastewater. As described above, facilities holding Surface Industrial or Surface Municipal Discharge Permits discharge process water to state surface waters; the discharge must meet applicable federal effluent guidelines and/or state water quality standards. Subwatersheds with the most NPDES permitted facilities include Frog Mortar Creek, Saltpeter Creek, and Seneca Creek. Frog Mortar Creek and Saltpeter Creek contain the most NPDES-permitted industrial facilities; Seneca Creek has the greatest number of permitted marinas. Figure 2-19 shows the locations of NPDES-permitted facilities in the Middle River and Tidal Gunpowder River watersheds.

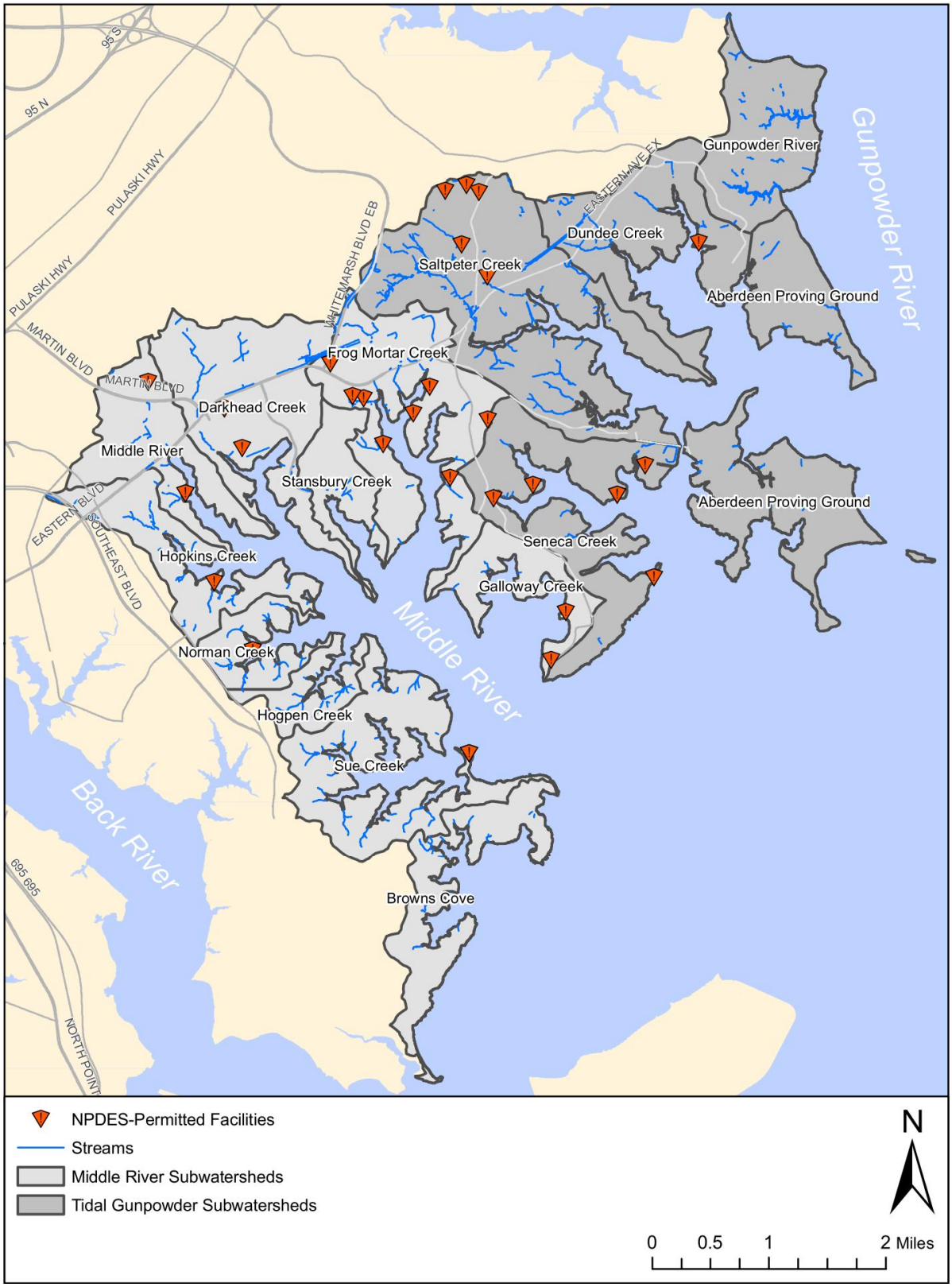

Figure 2-19: Location of NPDES-Permitted Facilities in Middle River and Tidal Gunpowder River Watersheds

2.3.8 Zoning

According to the Baltimore County Office of Planning (2009), zoning is defined "a system of land use regulation that controls the physical development of land and a legal mechanism by which local government is able to regulate an owner's right to use privately owned land for the sake of protecting the public health, safety, and/or general welfare." In other words, zoning manages development patterns over time throughout the county. Table 2-22 shows the various zoning categories present in the Middle River and Tidal Gunpowder River watersheds.

As shown in Figure 2-20, significant portions of the Middle River, Hopkins Creek, Frog Mortar Creek, and Seneca Creek subwatersheds permit dense residential development or commercial development. Residential and commercial areas are located in the same general locations because they are considered compatible land uses as population is typically concentrated in these areas. A very large section of Darkhead Creek, Stansbury Creek, Frog Mortar Creek, and Saltpeter Creek is zoned for industrial use, but it is mostly contained in one large area rather than distributed throughout the watershed. The largest remaining zoning categories in the Middle River/Tidal Gunpowder planning area include rural residential and resource conservation critical area. These areas cover the majority of the Tidal Gunpowder River watershed and the southernmost subwatersheds of Middle River; these areas may represent potential for forest preservation or restoration.

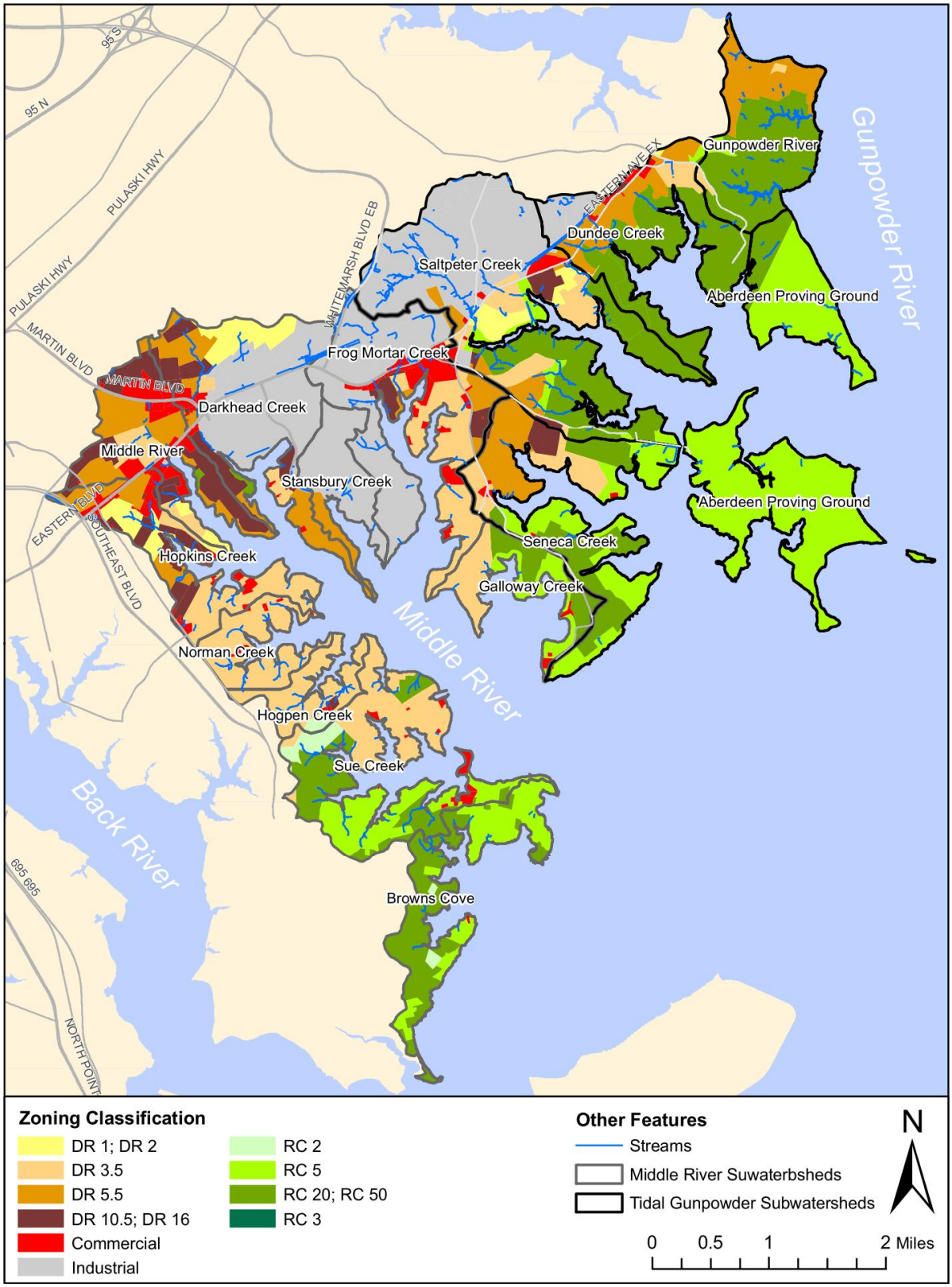

Figure 2-20: Middle River and Tidal Gunpowder River Zoning

Table 2-22: Baltimore County Zoning in Middle River and Tidal Gunpowder River Watersheds

Zoning Code	Zoning Description	Total Acres	% of Watershed Area
DR 1	Density Residential - 1 unit/acre	44	0.7%
DR 2	Density Residential - 2 units/acre	175	2.7%
DR 3.5	Density Residential - 3.5 units/acre	1,660	25.7%
DR 5.5	Density Residential - 5.5 units/acre	627	9.7%
DR 10.5	Density Residential - 10.5 units/acre	274	4.2%
DR 16	Density Residential - 16 units/acre	266	4.1%
Commercial	Office/Business	441	6.8%
Industrial	Manufacturing	1,526	23.6%
RC 2	Agricultural	80	1.2%
RC 5	Rural Residential	616	9.5%
RC 20, 50	Resource Conservation Critical Area	757	11.7%
Middle River Subtotal		*6,465*	*100.0%*
DR 1	Density Residential - 1 unit/acre	83	1.4%
DR 2	Density Residential - 2 units/acre	3	0.0%
DR 3.5	Density Residential - 3.5 units/acre	372	6.4%
DR 5.5	Density Residential - 5.5 units/acre	668	11.4%
DR 16	Density Residential - 16 units/acre	96	1.6%
Commercial	Office/Business	69	1.2%
Industrial	Manufacturing	932	15.9%
RC 5	Rural Residential	1,648	28.1%
RC 20, 50	Resource Conservation Critical Area	1,984	33.9%
RC 3	Deferral of Planning and Development	0	0.0%
Tidal Gunpowder Subtotal		*5,855*	*100.0%*
Total		*12,321*	-

As presented in Table 2-22, approximately 47% of the Middle River watershed and 21% of the Tidal Gunpowder River watershed are zoned for residential land use, the most common being categories DR 3.5 and DR 5.5 which generally correspond to the MDP-classified medium density residential land use category. Industrial use is permitted in approximately 24% and 16% of the Middle River and Tidal Gunpowder River watersheds, respectively, which are considerable fractions of both watersheds. Rural residential and Resource conservation critical area zoning categories make up 21% of the Middle River watershed and 62% of the Tidal Gunpowder River watershed.

CHAPTER 3: WATER QUALITY AND LIVING RESOURCES

3.1 Introduction

This chapter describes the water quality, living resources, and habitat for the Middle River and Tidal Gunpowder River watersheds based on existing conditions. The SWAP goals for maintaining and improving water quality also aim to provide for plants, animals, and their habitat. Because habitat conditions affect the ability of natural communities to find food and shelter and carry on natural processes, it is necessary to evaluate the state of existing land, water, and biological elements that provide for their needs.

Water is an integral part of the habitat of all species. Living resources, including all animals and plants, require water to survive. Living resources and their habitats are intimately connected to and respond sensitively to water quality and habitat conditions. Their dependence on water quality provides a gauge with which to measure and evaluate the status of water bodies and the effects that watershed characteristics and activities have on these water bodies. For example, in some cases water quality is measured in terms of its ability to support living resources such as trout or shellfish. Information on living resources is presented in this chapter to indicate water quality status and to evaluate habitat conditions in the Middle River and Tidal Gunpowder River watersheds. This information can help to determine if current watershed management practices are adequately providing for the needs of natural communities.

The following sections include descriptions of the following with respect to the Middle River and Tidal Gunpowder River watersheds: impairments per Maryland state water quality standards, pollutant loading analysis for total nitrogen and total phosphorus, water quality monitoring data available to date, sewer overflow occurrences and impacts, stream corridor assessments, and stormwater management facility assessments.

3.2 303(d) Listings and Total Maximum Daily Loads (TMDLs)

The Clean Water Act (CWA) requires states, territories and authorized tribes to: develop water quality standards for all jurisdictional surface waters; monitor these surface waters; and identify and list impaired waters. More specifically, Section 305(b) of the CWA requires annual water quality assessments to determine the status of jurisdictional waters. Section 303(d) requires states to identify and periodically update a list of impaired waters that fail to meet applicable state water quality standards. States must also establish priority rankings and develop Total Maximum Daily Loads (TMDLs) for waters on the 303(d) list. According to 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 which generally include sediment, metals, bacteria, nutrients, and pesticides.

Water quality standards are a combination of a designated use for a given water body and the water quality criteria designed to protect that use. Surface waters (e.g., streams) within the Middle River and

Tidal Gunpowder River watersheds are designated as Use I - water contact recreation, fishing, and protection of aquatic life and wildlife. The receiving tidal waters of these watersheds, Middle River and Gunpowder River, are designated as Use II - support of estuarine and marine aquatic life and shell fish harvesting - Subcategories 1, 2, and 3 according to the Maryland water quality standards:

1. Migratory Fish Spawning and Nursery	Migratory fish including striped bass, perch, shad, herring and sturgeon during the late winter/spring spawning and nursery season.	In tidal freshwater to low-salinity habitats. This habitat zone is primarily found in the upper reaches of many Bay tidal rivers and creeks and the upper mainstem Chesapeake Bay.
2. Shallow Water – Submerged Aquatic Vegetation	Underwater bay grasses and the many fish and crab species that depend on this shallow-water habitat.	Shallow waters provided by grass beds near the shoreline.
3.Open-Water Fish and Shellfish	Water quality in the surface water habitats to protect diverse populations of sportfish, including striped bass, bluefish, mackerel and seatrout, bait fish such as menhaden and silversides, as well as the shortnose sturgeon, and endangered species.	Species within tidal creeks, rivers, embayments and the mainstem Chesapeake Bay year-round.

Impairment listings reflect the inability to meet water quality standards for these designated uses. Action can be taken by developing and/or adhering to a TMDL or by submitting a Water Quality Analysis (WQA) to remove a specific pollutant from an impairment listing. WQAs are performed to determine if the pollutant of concern is actually impairing the waters. If it is determined that the pollutant of concern is not contributing to water impairment, a report documenting the findings is submitted to USEPA for concurrence. Maryland's 2008 Integrated Report (IR) of Surface Water Quality represents the first edition of a fully combined 303(d) and 305(b) report and is the most recent final report approved by USEPA (MDE 2008). The 2010 Draft IR is currently undergoing comprehensive USEPA review; however, the final version with full USEPA approval has not yet been posted. Table 3-1 summarizes the current impairment listings for the watersheds and tidal waters of Middle River and Gunpowder River based on MDE's 2008 IR. Figure 2-7 in Chapter 2 shows the location of the watersheds and tidal segments included in Table 3-1.

Table 3-1: Middle River and Gunpowder River Water Quality Impairment Listings and Status

Watershed/ Tidal Segment	WATER QUALITY INDICATOR				
	Nutrients	Bacteria	Sediment	Biological Community	Toxics*
Watersheds					
Middle River	Not Impaired	Not Impaired	Not Impaired	Insufficient Information	Not Impaired
Tidal Gunpowder River	Not Impaired	Not Impaired	Not Impaired	Insufficient Information	Not Impaired
Tidal Segments					
MIDOH (Middle River)	Impaired	Not Impaired	Impaired	Not Impaired	Impaired
GUNOH (Gunpowder River)	Impaired	Not Impaired	Not Impaired	Not Impaired	Impaired

*Impairments related to PCBs – Polychlorinated Biphenyls (toxic organic compounds that were widely used for applications such as transformers, capacitors, and coolants)

As shown in Table 3-1, the non-tidal water bodies of the Middle River and Tidal Gunpowder River watersheds are not impaired by nutrients, bacteria, sediment or toxics; there is insufficient information to determine whether the biological community in the streams is impaired. There are five impairment listings for the corresponding tidal waters – three for Middle River and two for Gunpowder River. Impairments related to nutrients (nitrogen and phosphorus) and PCBs have been identified for both Middle River and Gunpowder River. Sediment has also been identified as an impairment within Middle River. Note that in 2003, a WQA was submitted for Middle River in response to impairment listings for copper and nickel in 1998, and cadmium and lead in 2002 (MDE 2003). The WQA justified the removal of copper and nickel from the list because Middle River is defined as a fresh water body in COMAR, and these pollutants did not exceed impairment levels under freshwater water quality criteria. The document also provided analyses showing that aquatic life criteria and designated uses associated with cadmium and lead were being met in Middle River and that TMDLs were not necessary to achieve water quality standards. However, the state reserves the right to impose pollution control requirements if these pollutants contribute to downstream water quality problems in the future.

TMDLs have not yet been developed for any of the impairments shown in Table 3-1. However, a Chesapeake Bay TMDL has been developed and is being used to assign nutrient (nitrogen and phosphorus) and sediment loads and load reductions to Bay segments and individual local jurisdictions. Impairments in tidal receiving waters are related to pollutants coming from the entire watershed; therefore, any impairment listings or TMDLs developed for the Middle River and Gunpowder River tidal segments will require watershed pollutant load reductions.

Nitrogen and phosphorus impairments are determined by evaluating levels of chlorophyll *a*, dissolved oxygen, and water clarity. Table 3-2 shows dissolved oxygen criteria for tidal waters with designated

Use II, Subcategories 1, 2, and 3, based on COMAR 26.08.02.03-3. In addition, Table 3-3 provides water quality criteria for PCBs, applicable to all Uses based on COMAR 26.08.02.03-2.

Table 3-2: Tidal Water Dissolved Oxygen Criteria

Use II Subcategory	Dissolved Oxygen Criteria	Applicable Time Period
1. Migratory Fish Spawning and Nursery	7 day mean >= 6 mg/liter Instantaneous minimum >= 5 mg/liter	February 1 - May 31
2. Shallow Water – Submerged Aquatic Vegetation	30 day mean of >=5.5 mg/l in low salinity; 5 mg/l in high salinity 7 day mean of >= 4 mg/l Instantaneous minimum of >= 3.2 mg/l	Year-round
3. Open-Water Fish and Shellfish	30 day mean of >=5.5 mg/l in low salinity; 5 mg/l in high salinity 7 day mean of >= 4 mg/l Instantaneous minimum of >= 3.2 mg/l	Year-round

Table 3-3: Water Quality Criteria - Polychlorinated Biphenyls (PCBs)

Substance	Aquatic Life (µg/L)				Human Health for Consumption of:		
	Fresh Water		Salt Water		Drinking Water + Organism (µg/L)	Organism Only (µg/L)	Drinking Water MCL (mg/L)
	Acute	Chronic	Acute	Chronic			
Polychlorinated Biphenyls -PCBs	-	0.014	-	0.03	0.00064	0.00064	0.0005

Drinking water maximum contaminant levels (MCLs) apply to Public Water Supply designated waters only.

While TMDLs have not yet been established for the water quality impairments summarized in Table 3-1, MDE has developed target SAV acreage goals and water clarity depths, based on the analysis of the Chesapeake Bay Program of historic SAV distribution. These SAV and water clarity targets have become water quality standards, where amounts below the criteria would result in the tidal water segment being considered impaired. The SAV and water quality criteria for the Middle River and Gunpowder River tidal segments are presented in Table 3-4. Note that water clarity criteria are only applicable to the SAV growing season of April 1 to October 1.

Table 3-4: Tidal Segment SAV Acreage and Water Clarity Targets

Tidal Segment Designation	SAV Acres	Water Clarity Depth (meters)
MIDOH	879	1.4
GUNOH1	1,860	0.4
GUNOH2	572	1.4

3.3 Pollutant Loading Analysis

Pollutant loading analyses are intended to assess the impacts of current and future development on water quality. For the Middle River and Tidal Gunpowder watersheds, a pollutant loading analysis was completed based on land-uses in the watershed along with the presence of septic systems and point sources within the watershed.

3.3.1 Land-Use Pollutant Loading

Land use analyses have been performed for each of the Maryland designated 8-digit watersheds located entirely or in part within Baltimore County. As part of these analyses, Baltimore County derived watershed-specific pollutant loading rates for nitrogen and phosphorus based on two sources: technical guidance provided by MDE's *User's Guide for Nutrient Load Analysis Spreadsheet in Support of the Water Resources Element (WRE)* and the Chesapeake Bay Program (CBP) – Watershed Model Phase 5.3.

The final model used to develop nutrient loading rates was a hybrid between MDE's guidance document with loading rates for non-urban land uses and the segment specific loading rates for urban land uses from the CBP model. Pollutant loading rates corresponding to different land cover types in the Middle River and Tidal Gunpowder River watersheds are summarized in Table 3-5. More details regarding pollutant loading rates and analysis methods are presented in Baltimore County's *Water Resources Element (WRE) Technical Memo-B: Pollutant Loading Analysis*.

Table 3-5: Annual Pollutant Loading Rates for WRE Land Use Classifications (lbs/acre/year)

	Middle River		Tidal Gunpowder	
WRE Land Use	Nitrogen per acre	Phosphorus per acre	Nitrogen per acre	Phosphorus per acre
Impervious Urban	8.82	1.30	8.85	1.31
Pervious Urban	5.59	0.23	5.64	0.23
Cropland	12.05	1.25	11.90	1.24
Pasture	3.28	0.59	3.24	0.58
Livestock	34.52	6.08	34.37	6.07
Forest and Wetlands	1.56	0.04	1.49	0.03
Water*	10.26	0.61	10.26	0.61
Extractive	8.92	2.59	0.00	0.00

*Nutrient loading rates from water represent atmospheric deposition; this was not included in the watershed pollutant loading analysis.

As discussed in Chapter 2, land use information for the Middle River and Tidal Gunpowder River watersheds was obtained from Baltimore County and is based on MDP's 2007 land use/land cover (LU/LC) GIS spatial data. For purposes of the watershed pollutant loading analyses, Baltimore County uses a consolidated version of MDP's LU/LC classifications since loading rates do not differ significantly between certain land use classes (e.g., various forest types). The MDP LU/LC categories present in the Middle River and Tidal Gunpowder River planning area and the corresponding WRE land cover classes used for the pollutant loading analyses are summarized in Table 3-6.

Table 3-6: Reclassification of MDP LU/LC to WRE Land Cover for Middle River and Tidal Gunpowder River

MDP LU/LC Classification	WRE Land Cover
191 Large Lot Agriculture	Urban*
192 Large Lot Forest	Urban*
11 Low Density Residential	Urban*
12 Medium Density Residential	Urban*
13 High Density Residential	Urban*
14 Commercial	Urban*
15 Industrial	Urban*
16 Institutional	Urban*
17 Extractive	Extractive*
18 Open Urban	Urban*
21 Cropland	Cropland
22 Pasture	Pasture
41 Deciduous Forest	Forest and Wetlands
42 Evergreen Forest	Forest and Wetlands
43 Mixed Forest	Forest and Wetlands
44 Brush	Forest and Wetlands
50 Water	Water
60 Wetlands	Forest and Wetlands
80 Transportation	Urban*

* These categories were split into pervious urban and impervious urban areas using Baltimore County roads and buildings spatial data.

Total acreages of each WRE land cover category were calculated for the Middle River and Tidal Gunpowder River watersheds. These were multiplied by the corresponding loading rates presented in Table 3-5, yielding annual pollutant loads for total nitrogen and total phosphorus from the planning area. The total annual nutrient loadings calculated for the Middle River and Tidal Gunpowder River watersheds are summarized in Table 3-7 and Table 3-8, respectively.

Table 3-7: Total Annual Nutrient Loads for Middle River Watershed

		NITROGEN		PHOSPHORUS	
WRE Land Use	Area (acres)	Loading Rate (lbs/ac)	Load (lbs)	Loading Rate (lbs/ac)	Load (lbs)
Impervious Urban	1,467.3	8.85	12,985	1.31	1,921
Pervious Urban	2,919.5	5.64	16,465	0.23	685
Cropland	249.9	11.90	2,974	1.24	310
Pasture	31.8	3.24	103	0.58	18
Livestock	0.0	34.37	0	6.07	0
Forest	1,602.1	1.49	2,380	0.03	56
Wetlands	120.9	1.49	180	0.03	4
Water*	76.4	10.26	-	-	-
Extractive	0.0	0.00	0	0.00	0
Total	*6,467.9*		*35,086*		*2,995*

*Nutrient loadings from Water were not included in the analysis

Table 3-8: Total Annual Nutrient Loads for Tidal Gunpowder River Watershed

		NITROGEN		PHOSPHORUS	
WRE Land Use	Area (acres)	Loading Rate (lbs/ac)	Load (lbs)	Loading Rate (lbs/ac)	Load (lbs)
Impervious Urban	368.3	8.82	3,248	1.30	480
Pervious Urban	1,467.3	5.59	6,682	0.23	277
Cropland	260.5	12.05	3,139	1.25	325
Pasture	13.7	3.28	45	0.59	8
Livestock	0.0	34.52	0	6.08	0
Forest	2,777.1	1.56	4,339	0.04	103
Wetlands	887.8	1.56	1,387	0.04	33
Water*	81.3	-	-	-	-
Extractive	0.0	8.92	2,432	2.59	705
Total	*5,856.0*		*21,271*		*1,931*

*Nutrient loadings from Water were not included in the analysis

Note that the pollutant loading rates developed for the Water land use category represent atmospheric deposition of nitrogen and phosphorus to water. Because this nutrient delivery system is not addressed in SWAPs, it was not included in the analysis. Also note that MDP land use categories 191-Large lot subdivision (agriculture) and 192-Large lot subdivision (forest), were subdivided into cropland, urban, forest and pasture land uses based on the percentage breakdown shown in Table 3-9 below and developed by Baltimore County EPS based on a GIS and statistical analysis of various large lot subdivision land use polygons:

Table 3-9: Recommended Loading Group Breakdown by Large Lot Subdivision Type

	Proportion of Area By Loading Rate Groups			
LU Code	Cropland	Urban	Forest	Pasture
191	14.2%	16.1%	27.6%	42.1%
192	5.4%	9.6%	78.4%	6.6%

Total annual nitrogen and phosphorus loads estimated for the Middle River and Tidal Gunpowder River planning area are 56,357 lbs TN/year and 4,926 lbs TP/year. The loads calculated for Middle River watershed represent approximately 62% of the annual nitrogen load and 61% of the annual phosphorus load from the entire Middle River/Tidal Gunpowder River planning area. The loads calculated for Tidal Gunpowder River watershed represent approximately 38% of the annual nitrogen load and 39% of the annual phosphorus load from the entire planning area. This difference can be attributed to significantly higher amounts of urban areas and fewer forests and wetlands in the Middle River watershed as compared to the Tidal Gunpowder River watershed.

Nutrient loadings were also calculated on a subwatershed basis using the same loading rates and land cover designations. These estimates will provide baseline nutrient loads before implementation of restoration projects and will allow a better assessment of both progress made to date and further progress needed to meet watershed goals or anticipated TMDLs for urban nonpoint source reduction. Tables 3-10 and 3-11 summarize acreages of WRE land cover categories by subwatershed in the Middle River and Tidal Gunpowder River watersheds, respectively. The resulting nutrient loads for the 15 subwatersheds in Middle River and Tidal Gunpowder River are summarized in Tables 3-12 to 3-15. These tables also include annual nitrogen and phosphorus loading rates per acre (lbs/ac/yr) for each subwatershed. The tables show that the subwatersheds generating the greatest annual total nitrogen and total phosphorus loads are Frog Mortar Creek and Darkhead Creek in the Middle River watershed, and Saltpeter Creek and Seneca Creek in the Tidal Gunpowder River watershed. Note, however, that these subwatersheds also have larger surface areas in comparison to the remaining subwatersheds. Subwatersheds generating the highest amount of annual nutrient loading per acre are Middle River, Hopkins Creek, and Frog Mortar Creek. Darkhead Creek, Stansbury Creek, and Galloway Creek also have high nutrient loading rates. Subwatershed pollutant loadings and rates will be used to prioritize restoration efforts. Total planning level pollutant load estimates will be used to determine necessary reductions to meet watershed goals and any future TMDL reductions.

Table 3-10: Middle River WRE Land Cover Acreages by Subwatershed

	WRE LAND COVER (acres)							
SUBWATERSHED	Impervious Urban	Pervious Urban	Cropland	Pasture	Livestock	Forest	Wetlands	Bare Ground
Darkhead Creek	362	468	1	6	0	277	21	0
Frog Mortar Creek	356	628	0	10	0	181	9	0
Galloway Creek	45	170	63	0	0	85	0	0
Browns Cove	21	109	152	0	0	278	43	0
Hogpen Creek	35	99	4	7	0	112	0	0
Hopkins Creek	169	373	0	0	0	54	0	0
Middle River	239	365	0	0	0	64	4	0
Norman Creek	48	146	2	3	0	106	0	0
Stansbury Creek	83	200	0	0	0	30	30	0
Sue Creek	110	362	27	5	0	415	13	0
Total	*1,467*	*2,919*	*250*	*32*	*0*	*1,602*	*121*	*0*

Table 3-11: Tidal Gunpowder River WRE Land Cover Acreages by Subwatershed

	WRE LAND COVER (acres)							
SUBWATERSHED	Impervious Urban	Pervious Urban	Cropland	Pasture	Livestock	Forest	Wetlands	Bare Ground
Aberdeen Proving Ground	2	93	0	0	0	621	523	0
Dundee Creek	41	190	128	1	0	468	89	0
Gunpowder River	64	286	3	2	0	258	128	0
Saltpeter Creek	120	484	91	10	0	1,085	103	0
Seneca Creek	141	414	38	1	0	346	44	0
Total	*368*	*1,467*	*260*	*14*	*0*	*2,777*	*888*	*0*

Table 3-12: Middle River Annual Nitrogen Loads by Subwatershed Based on WRE Land Cover (lbs/year)

		WRE LAND COVER									
SUBWATERSHED	Total Area (acres)	Impervious Urban	Pervious Urban	Cropland	Pasture	Livestock	Forest	Wetlands	Extractive	Total Nitrogen Load (lbs/yr)	Nitrogen Loading Rate (lbs/acre/yr)
Darkhead Creek	1,139.6	3,193	2,615	13	21	0	432	33	0	6,307	5.5
Frog Mortar Creek	1,191.8	3,140	3,510	0	32	0	283	14	0	6,981	5.9
Galloway Creek	371.5	397	953	765	1	0	133	0	0	2,250	6.1
Browns Cove	611.8	184	609	1,832	1	0	435	68	0	3,127	5.1
Hogpen Creek	262.3	308	553	53	23	0	174	0	0	1,110	4.2
Hopkins Creek	604.6	1,486	2,086	0	0	0	85	0	0	3,658	6.0
Middle River	674.0	2,104	2,041	3	1	0	100	7	0	4,255	6.3
Norman Creek	311.4	422	816	19	10	0	166	0	0	1,433	4.6
Stansbury Creek	345.8	731	1,121	0	0	0	47	47	0	1,947	5.6
Sue Creek	955.0	973	2,024	328	15	0	648	20	0	4,008	4.2
Total	*6,467.9*	*12,940*	*16,328*	*3,012*	*104*	*0*	*2,503*	*189*	*0*	*35,076*	*5.4*

Table 3-13: Tidal Gunpowder River Annual Nitrogen Loads by Subwatershed Based on WRE Land Cover (lbs/year)

		WRE LAND COVER									
SUBWATERSHED	Total Area (acres)	Impervious Urban	Pervious Urban	Cropland	Pasture	Livestock	Forest	Wetlands	Extractive	Total Nitrogen Load (lbs/yr)	Nitrogen Loading Rate (lbs/acre/yr)
Aberdeen Proving Ground	1,280.9	22	519	0	0	0	970	817	0	2,327	1.8
Dundee Creek	920.4	357	724	1,541	3	0	730	139	539	4,035	4.4
Gunpowder River	745.4	566	1,602	41	6	0	403	201	0	2,819	3.8
Saltpeter Creek	1,902.2	1,056	1,521	1,094	31	0	1,694	162	1,892	7,451	3.9
Seneca Creek	1,007.2	1,246	2,316	463	5	0	541	69	0	4,639	4.6
Total	5,856.1	3,248	6,682	3,139	45	0	4,339	1,387	2,432	21,271	3.6

Table 3-14: Middle River Annual Phosphorus Loads by Subwatershed Based on WRE Land Cover (lbs/year)

		WRE LAND COVER									
SUBWATERSHED	Total Area (acres)	Impervious Urban	Pervious Urban	Cropland	Pasture	Livestock	Forest	Wetlands	Extractive	Total Phosphorus Load (lbs/yr)	Phosphorus Loading Rate (lbs/acre/yr)
Darkhead Creek	1,139.6	474	110	1	4	0	10	1	0	599	0.5
Frog Mortar Creek	1,191.8	466	147	0	6	0	6	0	0	626	0.5
Galloway Creek	371.5	59	40	79	0	0	3	0	0	181	0.5
Browns Cove	611.8	27	26	189	0	0	10	2	0	253	0.4
Hogpen Creek	262.3	46	23	5	4	0	4	0	0	82	0.3
Hopkins Creek	604.6	221	87	0	0	0	2	0	0	310	0.5
Middle River	674.0	312	86	0	0	0	2	0	0	401	0.6
Norman Creek	311.4	63	34	2	2	0	4	0	0	104	0.3
Stansbury Creek	345.8	109	47	0	0	0	1	1	0	158	0.5
Sue Creek	955.0	145	85	34	3	0	15	0	0	281	0.3
Total	*6,467.9*	*1,921*	*685*	*310*	*18*	*0*	*56*	*4*	*0*	*2,995*	*0.5*

Table 3-15: Tidal Gunpowder River Annual Phosphorus Loads by Subwatershed Based on WRE Land Cover (lbs/year)

		WRE LAND COVER									
SUBWATERSHED	Total Area (acres)	Impervious Urban	Pervious Urban	Cropland	Pasture	Livestock	Forest	Wetlands	Extractive	Total Phosphorus Load (lbs/yr)	Phosphorus Loading Rate (lbs/acre/yr)
Aberdeen Proving Ground	1,280.9	3	22	0	0	0	23	19	0	67	0.1
Dundee Creek	920.4	53	30	160	1	0	17	3	156	420	0.5
Gunpowder River	745.4	84	66	4	1	0	10	5	0	170	0.2
Saltpeter Creek	1,902.2	156	63	113	6	0	40	4	549	931	0.5
Seneca Creek	1,007.2	184	96	48	1	0	13	2	0	343	0.3
Total	*5,856.1*	*480*	*277*	*325*	*8*	*0*	*103*	*33*	*705*	*1,931*	*0.3*

3.3.2 Septic and Point Source Pollutant Loading

An analysis was completed by Baltimore County based on the presence of septic systems and point source pollution contributions within the Middle River and Tidal Gunpowder watersheds. Septic systems are classified based on their location in the watershed are 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 10.27 lbs Nitrogen /year if the system is located with 1,000 feet of a stream and 6.16 lbs Nitrogen/year if the system is located further than 1,000 feet of a stream are used. Septic systems do not provide phosphorus to the nutrient loading of the watersheds. Table 3-16 presents the yearly load for septic systems in the Middle River and Tidal Gunpowder watersheds.

Point sources are made up of pollutant loads accounted for by NPDES permit holders within the watershed. In the Middle River and Tidal Gunpowder watersheds, these consist of major industrial facilities and marinas. Table 3-16 presents that annual nutrient loads attributable to point sources within the study area.

Table 3-16: Annual Nitrogen and Phosphorus Loads from Septic and Point Sources (lbs/year)

Other Pollution Sources	Middle River		Tidal Gunpowder	
	Nitrogen (lbs/year)	Phosphorus (lbs/year)	Nitrogen (lbs/year)	Phosphorus (lbs/year)
Septic Systems	14,492	0	11,112	0
Point Sources	128,467	2,537	89,772	3,013

3.3.3 Total Pollutant Loading

Table 3-17 shows the total pollutant loading for the Middle River and Tidal Gunpowder watersheds attributable to land-use sources and septic systems. Because Baltimore County does not govern NPDES permits for facilities contributing pollution as point sources, they are not included as part of the total pollutant contribution in the County. To achieve the pollution reduction criteria established by the Chesapeake Bay-wide TMDL, it will be important for point sources and the issuer of their NPDES permits to have a strategy to reduce the amount of pollutants from their site.

Table 3-17: Middle River and Tidal Gunpowder Annual Nitrogen and Phosphorus Loads (lbs/year)

Other Pollution Sources	Middle River		Tidal Gunpowder		Total	
	Nitrogen (lbs/year)	Phosphorus (lbs/year)	Nitrogen (lbs/year)	Phosphorus (lbs/year)	Nitrogen (lbs/year)	Phosphorus (lbs/year)
Land-Use	35,086	2,995	21,271	1,931	56,357	4,926
Septic Systems	3,286	0	2,427	0	5,712	0
Total	38,372	2,995	23,697	1,931	62,069	4,926

3.4 Water Quality Monitoring Data

Various water quality monitoring data is available for the Middle River and Tidal Gunpowder River watersheds. Chemical monitoring data are available through the County's tidal recreational water

sampling program as well as through Maryland DNR's tributary strategy for the Upper Western Shore Basin. These data are presented in sections 3.4.1 and 3.4.2, respectively. No biological monitoring data is available through Baltimore County for these watersheds because the non-tidal streams are relatively few, small in drainage area, and short in length. Section 3.4.3 presents results from the SAV monitoring program conducted by Baltimore County, and Section 3.4.4 discusses the County's illicit connection program.

3.4.1 County Recreational Water Sampling Program

Baltimore County has approximately 217 miles of tidal coastline including public and privately owned tidal and fresh water recreational beaches. These resources support various recreational uses such as fishing, camping, and boating. Baltimore County regularly conducts bacteriological sampling of many of these areas to provide water quality information to the public and encourage safe use of these resources. The sampling program uses the indicator organism, enterococci, which are found in the intestines of all warm-blooded animals; if enterococci are found in high concentrations in association with a known or suspected source of sewage contamination, it indicates the probable presence of pathogenic (disease causing) organisms in the water samples. Sampling for tidal waters is generally performed April through November as weather permits. Additional sampling may be conducted in response to unusual conditions that could adversely impact water quality.

As shown in Figure 3-1, there are four water sampling areas in the tidal waters of Middle River and Tidal Gunpowder River: Middle River, Miami/Seneca Creek, Dundee Creek, and Gunpowder River. Within these sampling areas, there are currently a total of 28 individual sampling locations. The most recent sampling data results for these sampling locations (from 2009) are summarized in Table 3-18 through Table 3-21. The USEPA/MDE bacteriological standard for consideration of beach closure at tidal beaches is a geometric mean of 35 MPN enterococci. MPN stands for most probable number. Measurements are typically denoted as MPN/100 mL which stands for the most probable number of bacteria colonies expected to be found in a 100-mL sample of water. (DEPRM 2011, see also Code of Maryland Regulations (COMAR) 26.08.02.03)

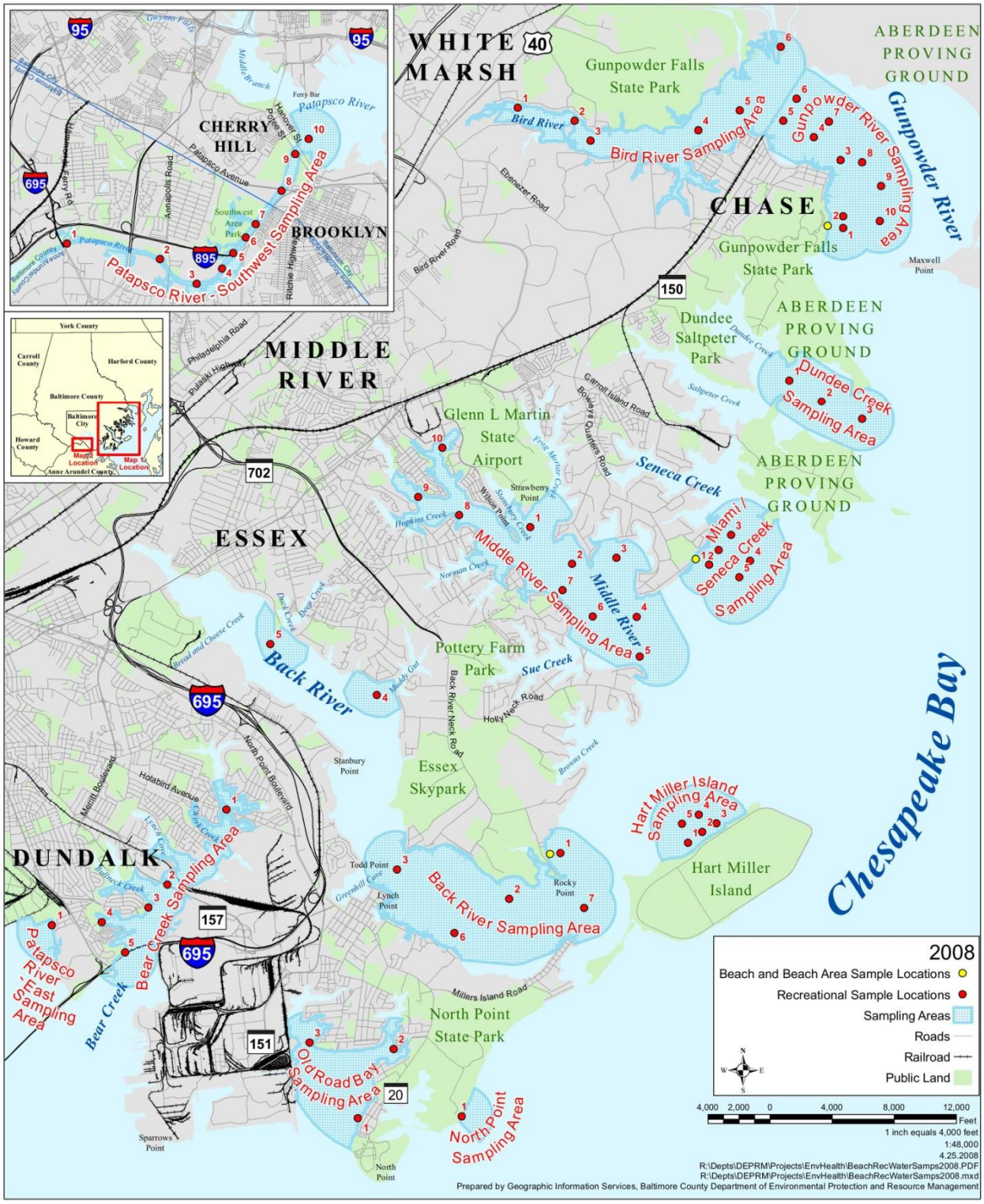

Figure 3-1: Baltimore County Recreational Water Sampling Locations (Excerpt from DEPRM 2011)

Table 3-18: Recreational Waters Sampling Results for Middle River Sampling Area (MPN Enterococci)

Sample Date	Sampling Location ID 1	2	3	4	5	6	7	8	9	10	Geometric Mean
11/23/09	10	<10	<10	<10	<10	10	20	10	10	<10	3.38
11/09/09	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	1.00
10/26/09	10	40	<10	<10	<10	<10	10	40	50	10	6.17
10/13/09	<10	<10	10	<10	<10	<10	<10	<10	10	<10	1.58
09/28/09	50	30	20	<10	<10	10	10	10	50	<10	8.27
09/14/09	<10	10	10	<10	<10	<10	<10	10	10	10	3.16
09/01/09	<10	<10	<10	20	<10	<10	<10	<10	10	20	2.29
08/17/09	10	10	<10	<10	<10	<10	<10	<10	10	10	2.51
08/03/09	30	<10	<10	<10	<10	<10	<10	10	10	<10	2.22
07/20/09	<10	10	<10	10	10	10	<10	<10	<10	<10	2.51
07/13/09	<10	<10	<10	<10	<10	<10	<10	<10	10	<10	1.25
06/24/09	<10	<10	<10	<10	<10	<10	<10	<10	10	10	1.58
06/08/09	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	1.00
05/11/09	<10	<10	10	10	<10	<10	<10	30	20	30	4.22
05/11/09	<10	<10	10	10	<10	<10	<10	20	10	30	3.78
04/27/09	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	1.25
04/13/09	10	10	<10	<10	<10	<10	<10	<10	10	10	2.51
04/01/09	10	10	30	20	<10	<10	<10	20	30	20	7.68

Table 3-19: Recreational Waters Sampling Results for Miami/Seneca Creek Sampling Area (MPN Enterococci)

Sample Date	Sampling Location ID 1	2	3	4	5	Geometric Mean
11/09/09	<10	<10	<10	<10	<10	1.00
10/26/09	20	20	<10	<10	<10	3.31
10/13/09	<10	<10	<10	<10	<10	1.00
10/01/09	<10	<10	<10	<10	<10	1.00
09/14/09	20	<10	<10	<10	<10	1.82
09/01/09	10	<10	10	<10	<10	2.51
08/17/09	30	<10	<10	<10	<10	1.97
08/03/09	<10	<10	<10	<10	<10	1.00
07/20/09	<10	<10	<10	<10	<10	1.00
07/13/09	<10	<10	<10	<10	<10	1.00
06/24/09	<10	<10	10	<10	<10	1.58
06/08/09	<10	<10	<10	<10	<10	1.00
05/11/09	<10	<10	<10	<10	<10	1.00
05/11/09	<10	10	<10	<10	<10	1.58
04/27/09	<10	<10	<10	<10	<10	1.00
04/13/09	<10	<10	<10	<10	<10	1.00
04/01/09	<10	<10	<10	<10	<10	1.00

Table 3-20: Recreational Waters Sampling Results for Dundee Creek Sampling Area (MPN Enterococci)

Sample Date	Sampling Location ID 1	2	3	Geometric Mean
11/09/09	<10	<10	<10	1.00
10/26/09	<10	30	<10	3.10
10/13/09	<10	<10	<10	1.00
09/28/09	90	20	10	26.20
09/14/09	30	30	30	30.00
09/01/09	<10	10	<10	2.15
08/17/09	<10	20	<10	2.71
08/03/09	<10	<10	<10	1.00
07/20/09	<10	10	<10	2.15
07/13/09	<10	<10	<10	1.00
06/24/09	<10	<10	<10	1.00
06/08/09	<10	<10	<10	1.00
05/28/09	10	<10	<10	2.15
05/11/09	<10	<10	<10	1.00
04/27/09	<10	<10	<10	1.00
04/13/09	<10	<10	<10	1.00
04/01/09	10	<10	<10	2.15

Table 3-21: Recreational Waters Sampling Results for Gunpowder River Sampling Area (MPN Enterococci)

Sample Date	Sampling Location ID 1	2	3	4	5	6	7	8	9	10	Geometric Mean
11/09/09	20	10	<10	<10	<10	20	10	40	10	10	6.61
11/02/09	60	10	20	50	10	30	30	20	30	20	24.05
10/26/09	60	160	270	210	100	240	220	450	120	210	178.36
10/13/09	<10	<10	<10	<10	10	10	<10	<10	<10	10	1.99
10/01/09	<10	<10	<10	10	<10	<10	<10	<10	10	<10	1.58
09/28/09	40	20	40	620	1010	80	210	40	10	20	69.66
09/21/09	<10	10	20	<10	<10	10	<10	20	<10	<10	2.88
09/14/09	250	210	150	410	360	110	150	140	240	110	192.77
09/01/09	10	<10	20	10	20	10	<10	< 10	20	10	6.17
08/17/09	<10	50	<10	<10	10	<10	<10	< 10	<10	<10	1.86
08/03/09	<10	<10	10	<10	<10	10	<10	< 10	10	<10	1.99
07/20/09	<10	<10	<10	<10	<10	<10	<10	< 10	<10	<10	1.00
07/13/09	<10	<10	10	<10	<10	<10	<10	< 10	<10	<10	1.25
06/24/09	<10	10	<10	<10	<10	<10	<10	< 10	10	<10	1.58
06/08/09	<10	<10	20	<10	<10	<10	<10	10	<10	<10	1.69
05/28/09	<10	<10	30	10	<10	<10	10	10	<10	<10	2.80
05/11/09	<10	20	<10	<10	<10	<10	<10	<10	10	20	2.29
04/27/09	<10	<10	<10	10	10	<10	40	<10	<10	<10	2.29
04/13/09	<10	20	10	<10	<10	<10	<10	<10	10	<10	2.13
04/01/09	<10	<10	<10	20	<10	30	10	<10	<10	<10	2.38

Tables 3-18 to 3-21 also show the geometric mean of the sampling results for each sampling date. Results for the Middle River and Miami/Seneca Creek sampling areas are well below the USEPA/MDE limit of concern of 35 MPN enterococci. Geometric means near the 35 MPN enterococci were observed during the month of September. The Gunpowder River sampling area shows multiple geometric means exceeding 35 MPN enterococci limit in October and September of 2009.

Sampling results are also available for years 2002 to 2008 in the same sampling areas. Baltimore County maintains an archive for water sampling results here:
http://www.baltimorecountymd.gov/Agencies/environment/watersampling/results.html

Approximate locations of the historical sampling sites corresponding to the data archived in the website above are shown in Figure 3-2. Table 3-22 provides a comparison of the ranges of geometric means of MPN enterococci measured from 2002 to 2007 and from 2008 to 2009, for each of the four sampling areas. Geometric means of bacteria measured in 2008-2009 compared to those measured in 2002-2007 indicate a decrease in bacteria population in the Middle River and Tidal Gunpowder River watersheds.

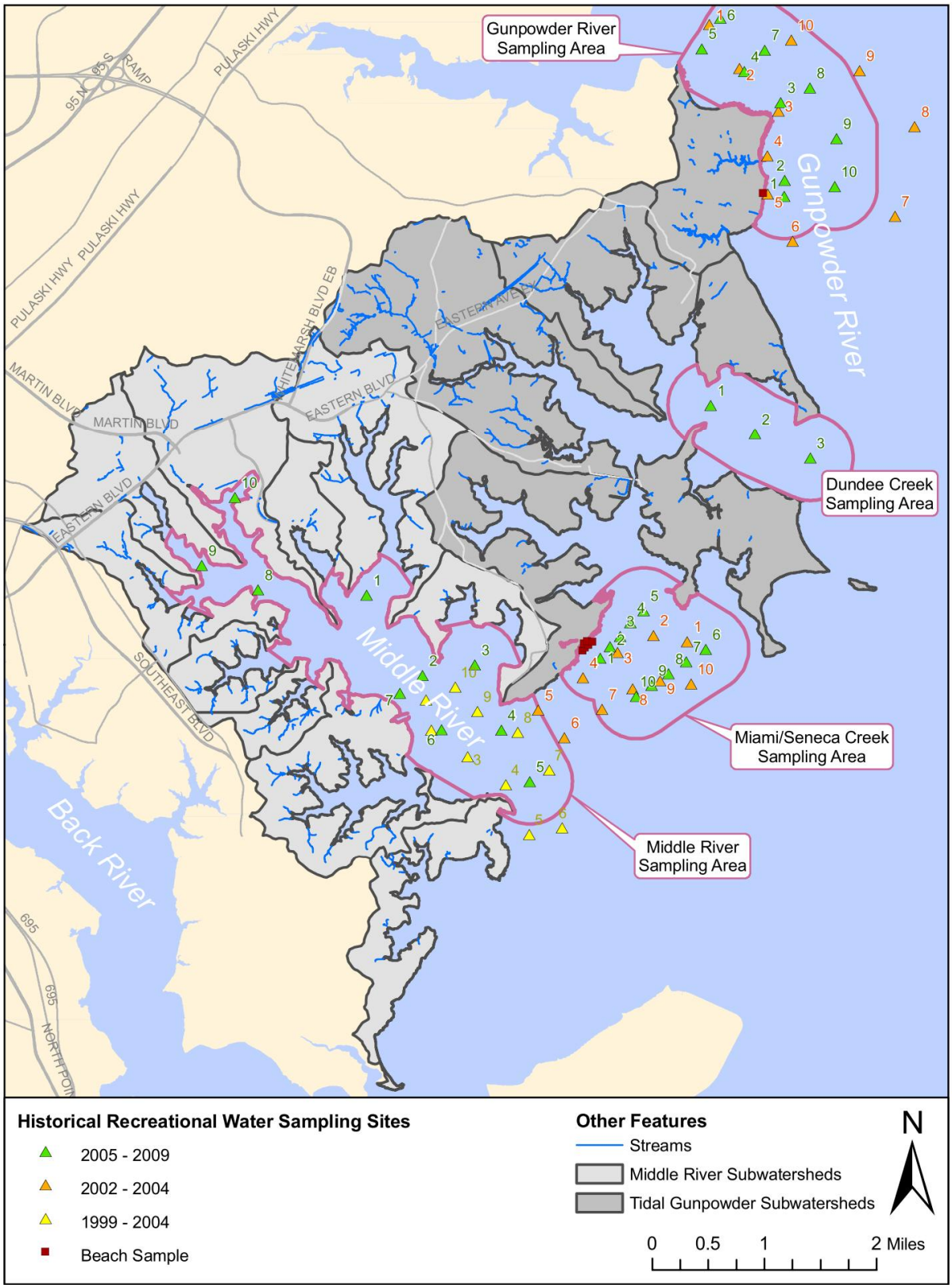

Figure 3-2: County Historical Recreational Sampling Locations in Middle River/Tidal Gunpowder River Planning Area

Table 3-22: Recreational Waters Sampling Results – Range of Geometric Means (MPN Enterococci)

	SAMPLING PERIOD			
	2002-2007		2008-2009	
SAMPLING AREA	min	max	min	max
Middle River	8.9	55.7	0.0	8.3
Miami/Seneca Creek	9.9	15.3	0.0	3.3
Dundee Creek	9.9	139.9	1.0	30.0
Gunpowder River	8.9	1,395.0	0.0	192.8

Other water quality parameters are also measured as part of the tidal recreational waters monitoring program including total suspended solids (TSS), nutrients, metals, and chloride. The importance of each of these parameters is briefly described below.

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

- Nutrients: As discussed previously, 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.

- Metals: Metals are a concern because they dissolve in water and are easily absorbed by aquatic organisms such as fish. Small concentrations of metals in water bodies can be toxic to aquatic life and human health. While metals may not directly kill organisms, many adverse health effects are associated with metals such as growth and reproductive impacts.

- Chloride: Chlorides come from various sources such as agricultural runoff, waste water, and road salting. High levels of chlorides can be toxic to aquatic communities including fish. Note, however, that the chlorides in tidal waters are more reflective of the salinity of the water body rather than watershed input. The pattern of chloride concentrations is also different for tidal waters, with highest levels in late summer to early fall as compared to late winter to early spring for watershed streams.

Since the Middle River and Tidal Gunpowder River are defined as fresh water bodies per COMAR, they are subject to toxic substance criteria established for ambient surface waters, pertaining to aquatic life in fresh water. USEPA National Recommended Water Quality Criteria (USEPA 2011) and reporting limits for measured water quality parameters in Middle River and Tidal Gunpowder River are summarized in Table 3-23. Water quality criteria for suspended solids and nutrients are currently not available. As discussed previously, the effect of nutrients in Middle River and Tidal Gunpowder River is measured by chlorophyll *a* and dissolved oxygen. For tidal waters, suspended solids are expressed as a water clarity

requirement, which is 1.4 meters for Middle River (MIDOH) and Gunpowder River Segment 2 (GUNOH2) and 0.4 meters for Gunpowder River Segment 1 (GUNOH1).

Table 3-23: Numeric Water Quality Criteria and Reporting Limits (mg/L)

Parameter	CMC (acute)	CCC (chronic)	Reporting Limit
Total Suspended Solids (TSS)	N/A	N/A	1
Total Nitrogen (TN)	N/A	N/A	0.2
Total Phosphorus (TP)	N/A	N/A	0.02
Cadmium (Cd)	0.002	0.00025	0.001
Copper (Cu)	0.00467	0.00145	0.001
Lead (Pb)	0.065	0.0025	0.001
Zinc (Zn)	0.12	0.12	0.001
Chloride (Cl)	860	230	N/A

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

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

The geometric means of the above water quality parameters measured in the Middle River and Tidal Gunpowder River sampling areas for the years 2002 to 2009 are presented in Table 3-24.

Table 3-24: Recreational Waters Sampling Results (Annual Geometric Means, mg/L)

YEAR	TSS	TN	TP	Cd	Cu	Pb	Zn	Cl
MIDDLE RIVER								
1999	65.7	1.55	0.21	0.0006	0.0341	0.0042	0.0943	596
2002	19.1	0.59	0.05	0.0005	0.0173	0.0010	0.0119	1,204
2003	6.9	0.52	0.05	0.0005	0.0050	0.0010	0.0020	822
2004	2.4	0.54	0.05	0.0005	0.0095	0.0009	0.0023	668
2005	15.4	0.54	0.04	0.0005	0.0063	0.0010	0.0082	2,071
2006	17.6	0.45	0.05	0.0005	0.0111	0.0008	0.0045	1,774
2007	10.4	0.34	0.05	0.0005	0.0040	0.0008	0.0036	1,358
2008	14.5	0.34	0.07	0.0005	0.0026	0.0007	0.0070	702
2009	3.3	0.50	0.03	0.0005	0.0016	0.0006	0.0035	1,774
MIAMI/SENECA CREEK								
2002	24.4	0.63	0.06	0.0005	0.0194	0.0011	0.0126	1,150
2003	8.7	0.56	0.05	0.0005	0.0042	0.0008	0.0018	678
2004	2.0	0.47	0.05	0.0005	0.0060	0.0008	0.0020	427
2005	19.0	0.48	0.04	0.0005	0.0022	0.0007	0.0021	1,918
2006	17.9	0.36	0.05	0.0005	0.0078	0.0009	0.0060	1,753
2007	12.2	0.29	0.05	0.0005	0.0038	0.0008	0.0041	1,512
2008	24.5	0.34	0.05	0.0005	0.0023	0.0007	0.0093	1,453
2009	12.4	0.48	0.03	0.0005	0.0018	0.0006	0.0040	1,742
DUNDEE CREEK								
2008	23.7	0.38	0.06	0.0005	0.0023	0.0008	0.0098	1,132
2009	11.1	0.54	0.03	0.0005	0.0013	0.0005	0.0026	1,638
GUNPOWDER RIVER								
2002	7.8	0.76	0.05	0.0006	0.0186	0.0012	0.0101	776
2003	4.1	0.61	0.06	0.0005	0.0029	0.0008	0.0025	172
2004	1.6	0.53	0.04	0.0005	0.0023	0.0007	0.0015	132
2005	16.6	0.57	0.04	0.0005	0.0015	0.0007	0.0017	804
2006	19.4	0.38	0.06	0.0005	0.0081	0.0007	0.0035	736
2007	12.2	0.32	0.06	0.0005	0.0033	0.0006	0.0034	856
2008	18.1	0.33	0.08	0.0005	0.0051	0.0007	0.0084	866
2009	15.3	0.49	0.04	0.0005	0.0028	0.0006	0.0055	1,097

TSS = Total Suspended Solids; TN = Total Nitrogen; TP = Total Phosphorus; CD = Total Cadmium; CU = Total Copper; PB = Total Lead; ZN = Total Zinc; CL = Chloride

The table above shows that heavy metal and nutrient concentrations have remained fairly consistent during the time period from 2002 to 2009. For all sampling areas, lead and zinc levels are well below applicable water quality criteria; cadmium levels are well below the detection limit of 0.001 and meets the County's reporting limit of 0.0005. There is a decreasing trend in copper levels among all sampling areas; since about 2007, copper levels are generally below acute criteria but slightly exceed the chronic threshold. Chloride concentrations consistently exceed water quality criteria, and levels were well above

chronic and acute criteria at all sampling areas in 2009. This is a reflection of an estuarine system with salt water input from the Chesapeake Bay.

3.4.2 Upper Western Shore Basin Tributary Strategy Data

To help achieve Maryland's portion of the reductions in nitrogen, phosphorus and sediment to the Chesapeake Bay, a Tributary Strategy Team has been selected for each of the 10 basins comprising the Chesapeake Bay including the Upper Western Shore Basin. Maryland's Tributary Teams consist of local citizens, farmers, business leaders, and state and local government officials appointed by the Governor to help implement pollution prevention measures and to address local water quality programs including water quality monitoring. To assist the Tributary Team, Maryland DNR documented the Upper Western Shore basin characteristics including available water quality monitoring results in their report, *Maryland Tributary Strategy Upper Western Shore Basin Summary Report for 1985-2005 Data* (DNR 2007).

As shown in Figure 3-3, there are a total of 25 tidal water monitoring stations for the Upper Western Shore Basin. Among these are two long-term fixed monitoring stations (stations 9 and 10 in Figure 3-3) and four continuous monitoring stations (stations 1, 6, 15, and 19 in Figure 3-3) in the tidal waters of Middle River and Gunpowder River. Measurements and results from these long-term fixed and continuous monitoring stations are described in the following sections.

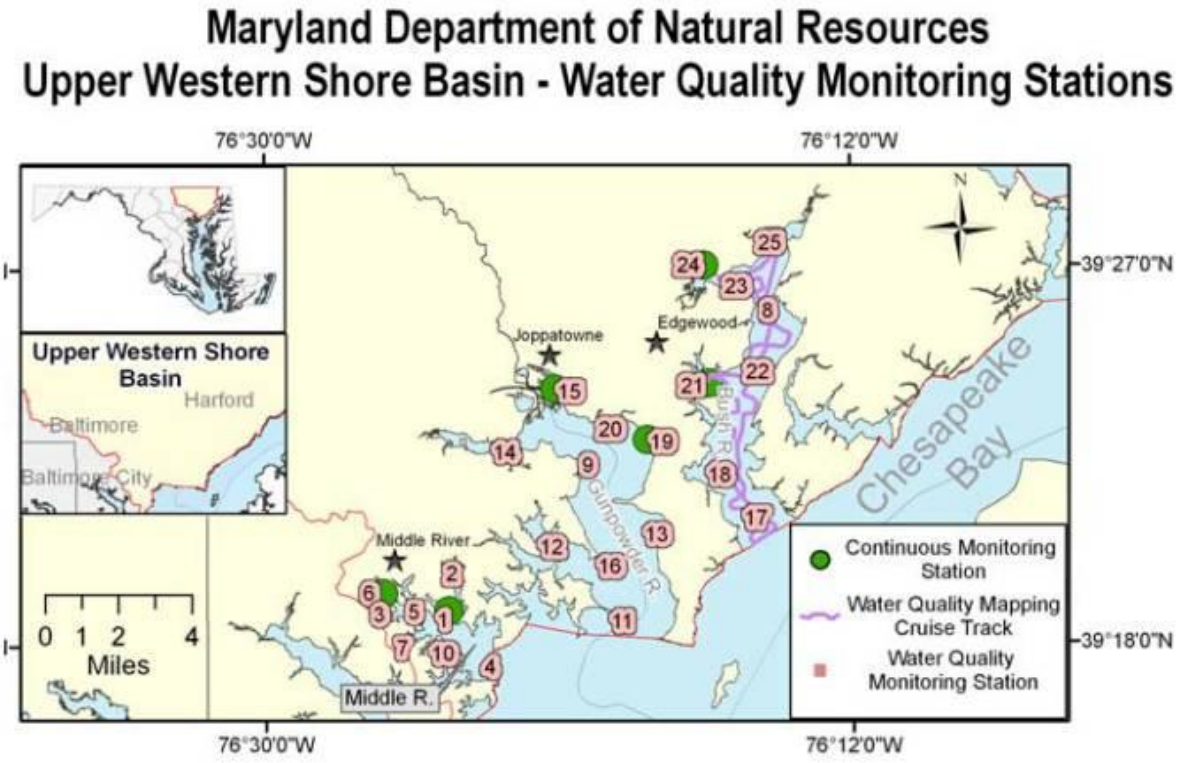

Figure 3-3: Location of Maryland DNR's Tidal Monitoring Stations

3.4.2.1 Long-term Fixed Monitoring Locations

Six water quality parameters including nitrogen, phosphorus, chlorophyll-a (algal abundance), total suspended solids, water clarity and dissolved oxygen are measured at the long-term fixed tidal

monitoring stations. Results from the long-term fixed monitoring stations are assigned a current status of good, fair or poor relative to baseline data or scientifically based benchmarks (e.g., applicable state thresholds) depending on the parameter. For example, concentrations of dissolved oxygen (DO) are compared to ecologically meaningful thresholds available: good (DO > 5 mg/L); fair (DO = 2-5 mg/L); and poor (DO ≤ 2 mg/L). Since scientific benchmarks are not available for the remaining parameters, a Chesapeake Bay-wide scale was developed for each parameter based on salinity zone (tidal fresh, oligohaline, and mesohaline). All data available for the Chesapeake Bay between 1985 and 1990 were used to establish a baseline for rating water quality at each station. Three cutoff points were derived to define good, fair, and poor ratings from a cumulative logistic function for the monthly medians of the baseline data. Monthly medians from the most recent data set (2003-2005) at a given station are compared to these cutoff points to establish water quality status ratings. Water quality ratings are indicators relative to similar stations in the Chesapeake Bay during the baseline time period (1985-1990); therefore, a good rating does not necessarily reflect levels needed to sustain healthy living resource populations. Refer to the following link for more details regarding water quality analysis methods:
http://www.dnr.state.md.us/Bay/tribstrat/status_trends_methods.html

Figures 3-4 to 3-6 show the water quality monitoring results reported by DNR for Middle River (Station WT3.1) during the period 1985-2005; Figures 3-7 to 3-9 show the results for Gunpowder River (Station WT2.1) for the same period. Note that Station WT3.1 corresponds to water quality monitoring station 10 and Station WT2.1 corresponds to water quality monitoring station 9 in Figure 3-3 above. Also note that the black lines in Figures 3-4 to 3-9 denote concentrations for each sampling date and annual medians of these values are shown as red bars.

Figures 3-4 and 3-7 show that total nitrogen concentrations range from less than 1 to 4 mg/L in both Middle River and Gunpowder River; slightly higher levels of total phosphorus were measured in Gunpowder River, approximately 0 to 0.3 mg/L compared to approximately 0 to 0.2 mg/L in Middle River. Figures 3-5 and 3-8 show that Chlorophyll *a* levels have reached as high as 120 μg/L in both Middle River and Gunpowder River but have decreased in recent years. However, chlorophyll levels in Middle River still fluctuated between 0 and 70 μg/L from 2000-2005; levels in Gunpowder River have remained below 40 μg/L from 2000-2005, which is less than the level associated with excess eutrophication or 50 μg/L. TSS concentrations in Middle River have generally been less than 30 to 40 mg/L during the 1985-2005 data range. Higher TSS concentrations, often exceeding 60 mg/L, were reported in Gunpowder River in the beginning of the 20-year data period, but levels have generally decreased in more recent years (2000-2005). Water clarity is measured in terms of Secchi depth or the depth of water transparency. Figures 3-6 and 3-9 show Secchi depths of as high as 3 meters in Middle River but mostly ranging from 0.5 to 1.5 meters. Secchi depths in Gunpowder River are lower, ranging from 0 to 1.5 meters. Dissolved oxygen levels in both locations appear to be within the desired range (> 5 mg/L), ranging from approximately 4 to 10 mg/L, with the exception of one low record of 1 mg/L in Gunpowder River in 2002.

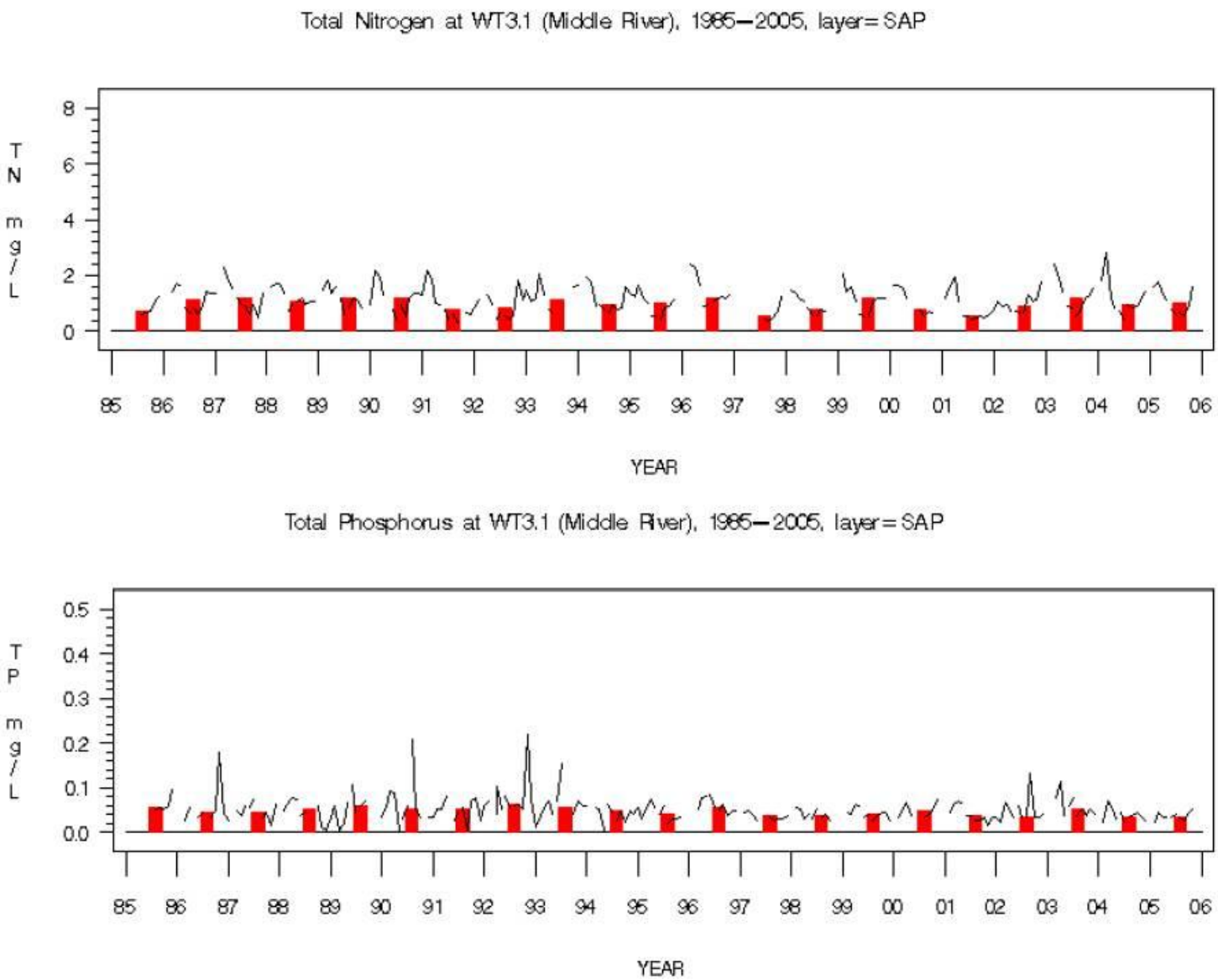

Figure 3-4: Total Nitrogen and Total Phosphorus in Middle River - Tidal Waters Monitoring Results for 1985-2005 (DNR 2007)

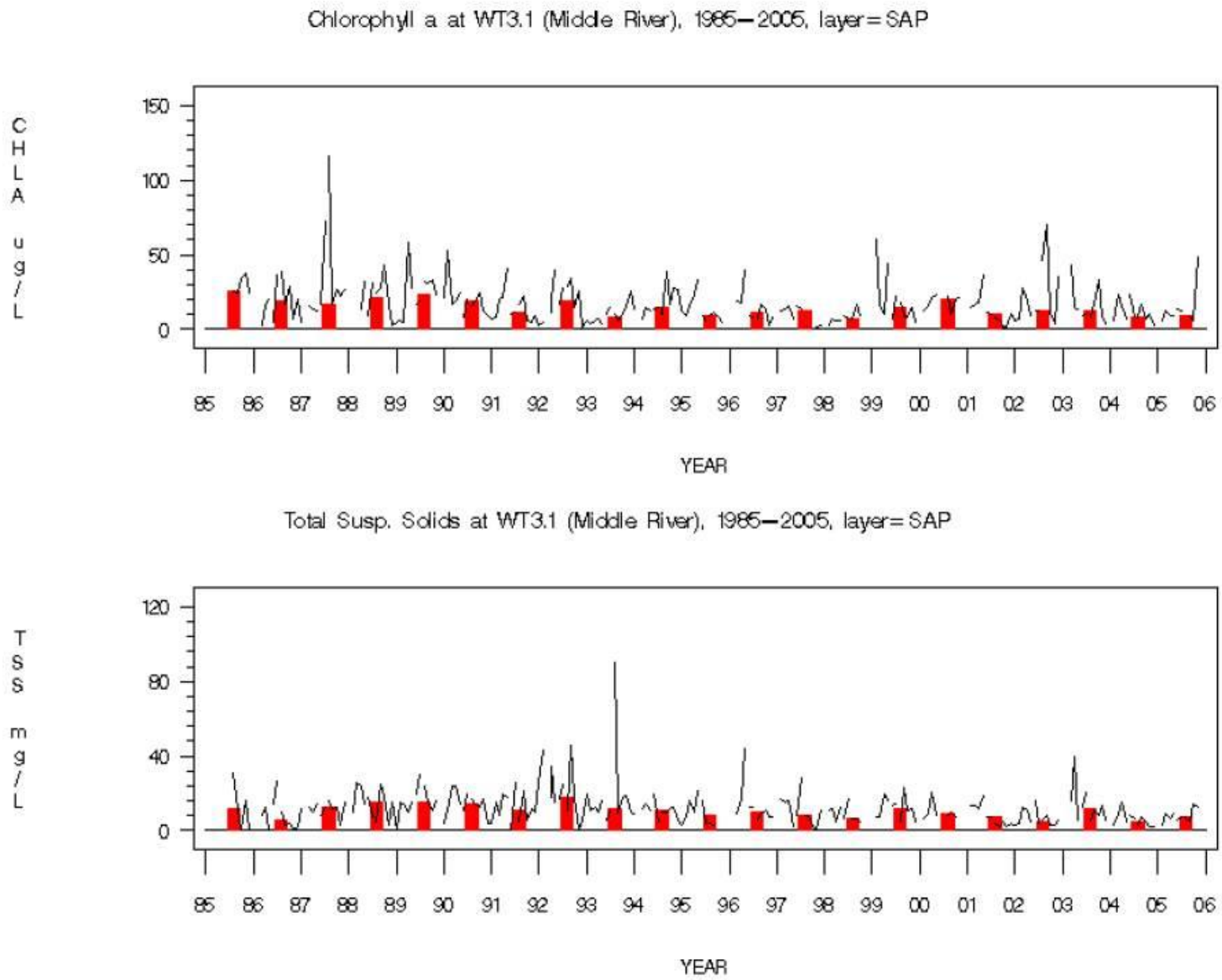

Figure 3-5: Chlorophyll *a* and Total Suspended Solids in Middle River - Tidal Waters Monitoring Results for 1985-2005 (DNR 2007)

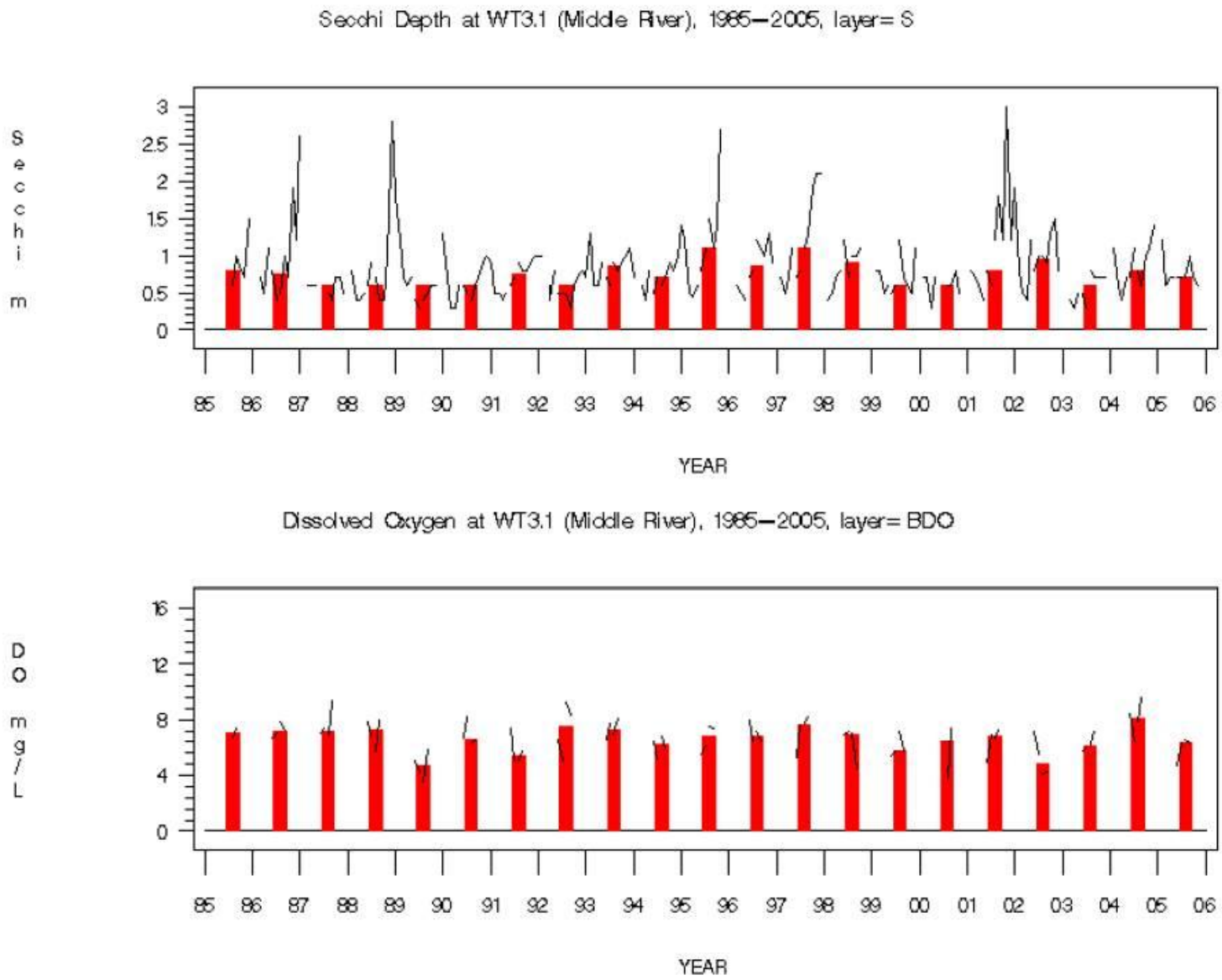

Figure 3-6: Water Clarity and Dissolved Oxygen in Middle River - Tidal Waters Monitoring Results for 1985-2005 (DNR 2007)

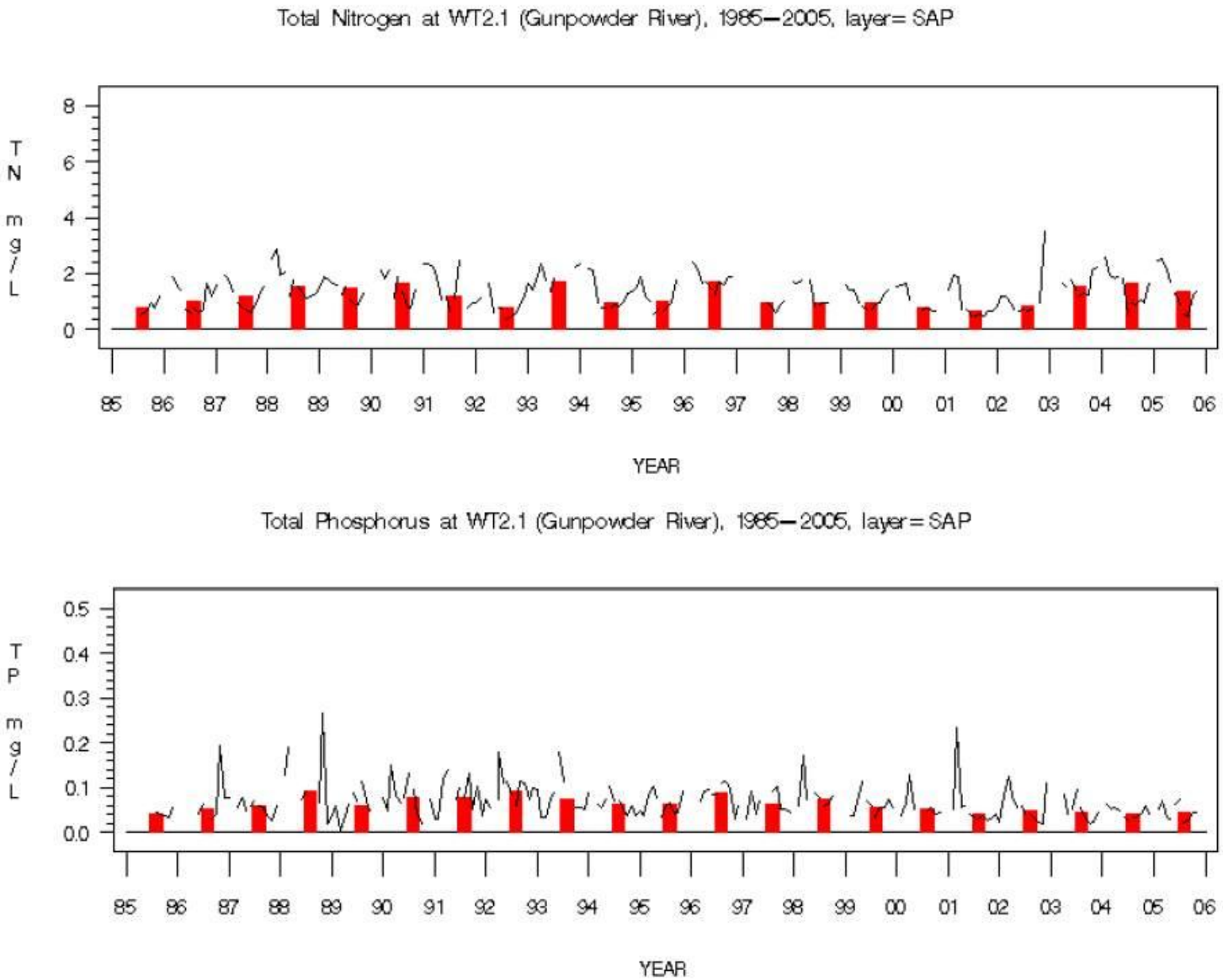

Figure 3-7: Total Nitrogen and Total Phosphorus in Gunpowder River - Tidal Waters Monitoring Results for 1985-2005 (DNR 2007)

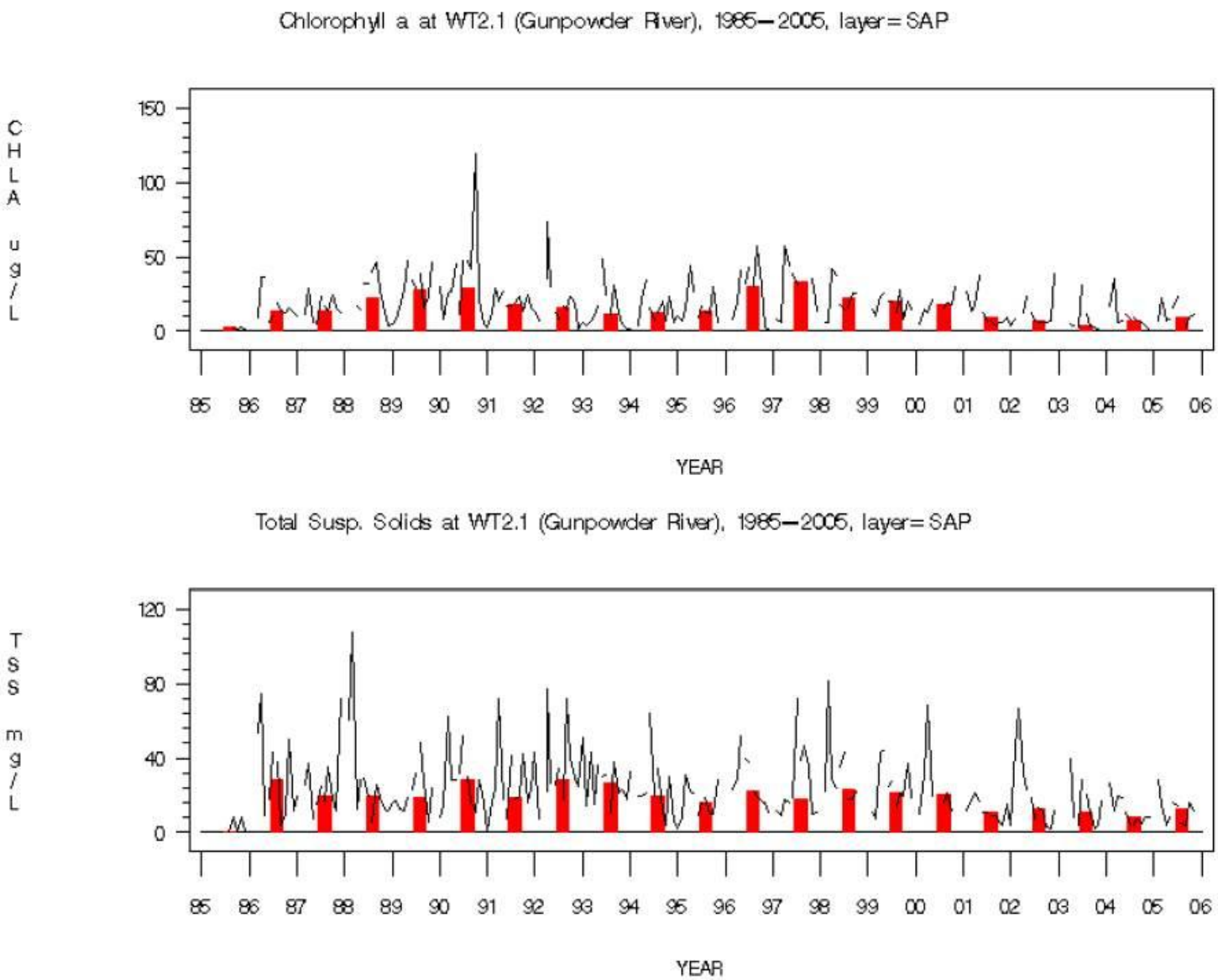

Figure 3-8: Chlorophyll *a* and Total Suspended Solids in Gunpowder River - Tidal Waters Monitoring Results for 1985-2005 (DNR 2007)

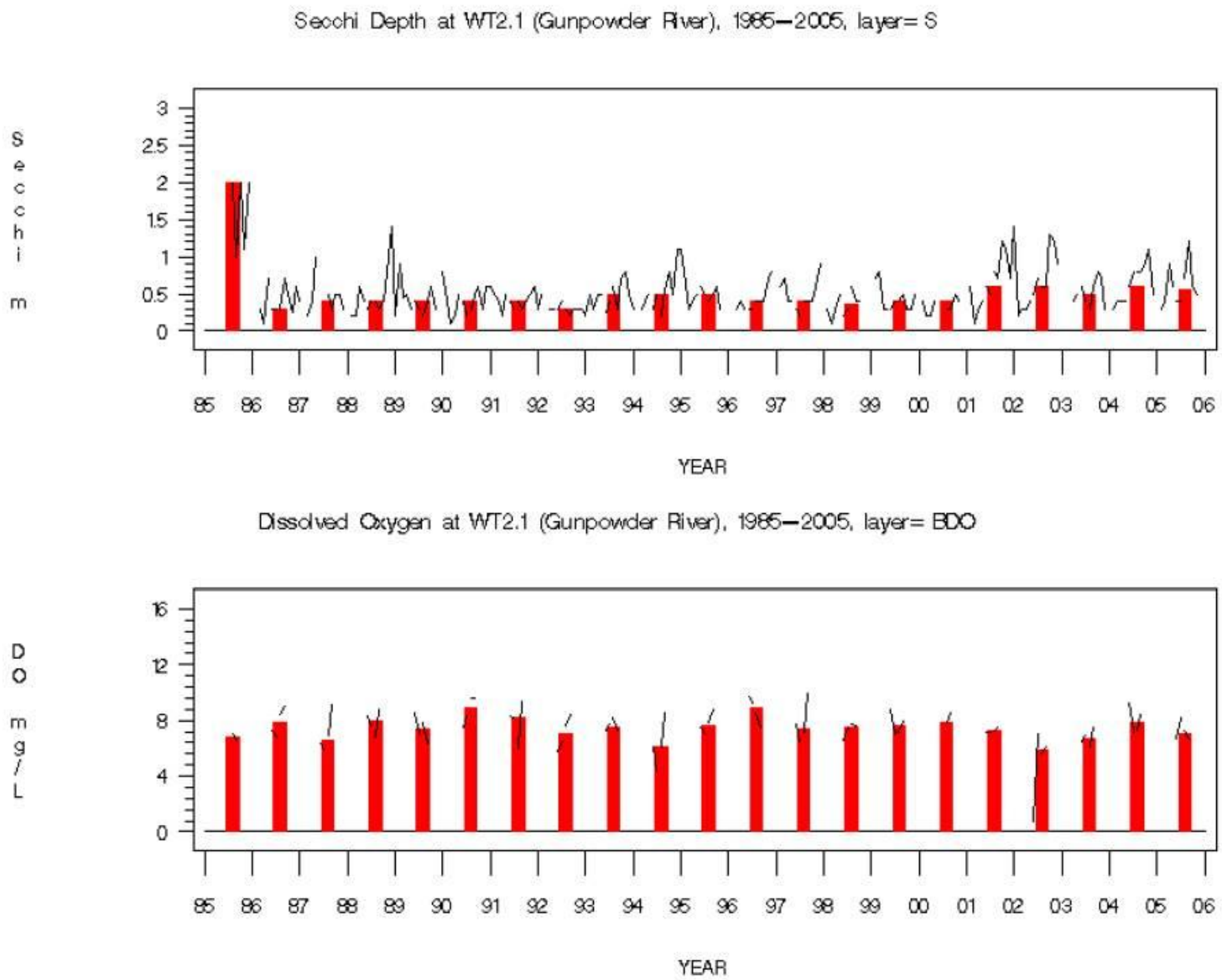

Figure 3-9: Water Clarity and Dissolved Oxygen in Gunpowder River - Tidal Waters Monitoring Results for 1985-2005 (DNR 2007)

Based on these monitoring results, the tidal waters of Middle River are considered as having good water and habitat quality for all six parameters except for algal abundance which was rated as fair. Trends in total phosphorus, total suspended solids, and algal abundance are all improving based on the 1985-2005 data range, but water clarity is degrading. No trends were detected in total nitrogen and dissolved oxygen. Gunpowder River is considered as having good water and habitat quality for all parameters except for total nitrogen which was considered fair. Improving trends were detected for total phosphorus, total suspended solids, algal abundance, and water clarity; no trend was detected for dissolved oxygen. For more information, please refer to the *Maryland Tributary Strategy Patapsco/Back Rivers Basin Summary Report for 1985-2005 Data* (DNR 2007).

3.4.2.2 Continuous Monitoring Locations

DNR's continuous monitoring component is designed to measure temporally intensive water quality data from fixed shallow water locations throughout the Chesapeake Bay. Continuous monitoring stations record water quality parameters at 15-minute intervals using electronic equipment during April through October (SAV growing season); parameters include dissolved oxygen, turbidity, fluorescence, water temperature, salinity, and pH. There are two continuous monitoring stations in Gunpowder River and two in Middle River (as shown in Figure 3-3). For all continuous monitoring stations, DNR calculates the percent failure of the instantaneous and 30-day mean threshold criteria for dissolved oxygen, fluorescence, and turbidity. Percent failure values calculated for the four continuous monitoring stations in Middle River and Gunpowder River for the 2003-2005 sampling period are shown in Table 3-25. Thresholds for dissolved oxygen were based on criteria for open-water fish and shellfish use in the Chesapeake Bay. Thresholds for fluorescence were measured by chlorophyll *a* levels, based on state criteria for excess algae. The turbidity threshold represents the boundary between acceptable and marginal water clarity for SAV growth in the Upper Western Shore Basin.

Table 3-25: Upper Western Shore Basin - Continuous Monitoring Percent Failure (2003-2005). (DNR 2007).

Year	Tributary	Station	ID [1]	Dissolved Oxygen Thresholds <3.2 mg/L[2]	Dissolved Oxygen Thresholds <5 mg/L[3]	Fluorescence Thresholds >15 µg/L[2]	Fluorescence Thresholds >50 µg/L[3]	Turbidity Threshold >8 NTU[4]
2003	Middle	FRG0002	1	0.00	1.45	29.08	0.72	68.46
	Middle	MDR0038	6	0.00	0.09	53.80	0.88	87.77
	Gunpowder	XJF4289	15	0.00	0.00	1.80	0.00	90.24
	Gunpowder	XJG2718	19	0.02	0.39	6.17	0.00	78.08
2004	Middle	FRG0002	1	0.58	2.23	14.87	2.39	45.63
	Middle	MDR0038	6	0.00	0.47	40.87	0.02	56.89
	Gunpowder	XJF4289	15	0.00	0.07	14.49	0.58	62.44
	Gunpowder	XJG2718	19	0.00	0.00	11.93	0.14	45.26
2005	Middle	FRG0002	1	0.08	0.73	27.11	0.35	38.63
	Middle	MDR0038	6	0.41	4.66	52.79	0.17	59.60
	Gunpowder	XJF4289	15	0.00	0.76	17.47	0.08	68.27
	Gunpowder	XJG2718	19	0.00	0.37	15.62	0.71	34.90

1. Corresponds to station numbers shown in Figure 3-3.
2. Instantaneous threshold
3. 30-day mean threshold
4. Boundary between acceptable and marginal water clarity for SAV growth in the Upper Western Shore Basin

Table 3-25 shows high rates of failure for meeting the turbidity threshold between 2003-2005 in Middle River and Gunpowder River. Rates of failure for meeting the instantaneous fluorescence threshold are also relatively high. Conversely, rates of failure for meeting the dissolved oxygen thresholds are low for both rivers between 2003 and 2005. Rates of failure for meeting dissolved oxygen and fluorescence thresholds are higher for the Middle River stations as compared to those reported in Gunpowder River.

Continuous water quality monitoring stations also provided other interesting water quality results and patterns. For example, it was observed in many locations that dissolved oxygen and pH have correlated diurnal changes. This is because algae produce oxygen and high levels of pH due to photosynthesis during the day, and respire at night consuming oxygen and producing carbon dioxide which lowers pH. Continuous monitoring data also show a repeated seasonal decline in pH from April through October in 2003 and 2004 at Strawberry Point in Middle River, the causes of which to date are unknown.

3.4.2.3 Other Monitoring Data

SAV is also monitored because it is a good indicator of water quality and habitat. SAV conditions are determined through aerial photography by the Virginia Institute of Marine Science (VIMS). Middle River has had variable SAV coverage from 1985 to 2005, with an increasing trend since 1995. The highest amount of 740 acres was observed by aerial survey in 2000, which is 84% of MDE's 879-acre target for Middle River. Most of the SAV in Middle River has been observed at the mouth of the river, particularly near Galloway Creek, where 7 species have been found. In order of frequency of occurrence, these

species include milfoil, horned pondweed, coontail, elodea, wild celery, redhead grass, and curly pondweed. Water quality data from the monitoring station near Wilson Point indicate suspended solids and algae meet habitat requirements but percent light at leaf and light attenuation fail. SAV presence has increased significantly in Gunpowder River since 1996, with 2,424 acres observed in 2000 and 2,391 acres in 2004. These values were very close to the SAV target of 2,432 acres. Most of the SAV is found in Dundee Creek and Saltpeter Creek; out of the 14 different species found in Gunpowder River, the three most common are milfoil, wild celery, and coontail.

The benthic community is an essential component of estuarine ecosystems, and its health can be a good indicator of habitat quality. For example, small worms and crustaceans are a key food source for larger aquatic species such as crabs and bottom-feeding fish, and clams can remove excess algae from the water column. Random site sampling in Middle River and Gunpowder River has led to the determination of a benthic index of biotic integrity (B-IBI) for each sampling site, which is a single-number indicator of benthic community health. The B-IBI is rated between four categories: meets goal, marginal, degraded, and severely degraded. Only one site was sampled in Middle River for benthic community health; results from this site met goals. Four of six sites met goals in Gunpowder River, one was marginal, and one was degraded.

3.4.3 County SAV Monitoring

As discussed previously, presence of SAV is a key indicator of the health of a water body and MDE has developed SAV acreage goals for all tidal water segments in the state including Middle River and Gunpowder River (see Table 3-4). Baltimore County has conducted SAV monitoring since 1989, and currently 30 waterways are monitored in the County. SAV distributions are measured in the spring and summer of each year during peak growth periods in accordance with U.S. Fish and Wildlife methodologies. SAV location, density, and species types are all recorded. Total SAV coverage is calculated by the following formula to account for overlap between the seasons:

$$\text{Total SAV}_{acres} = (\text{Spring SAV}_{acres} - \text{Overlap}_{acres}) + (\text{Summer SAV}_{acres} - \text{Overlap}_{acres}) + \text{Overlap}_{acres}$$

The Chesapeake Bay Program has also recognized SAV acreage and water clarity as standards for meeting designated Use II, Subcategory 2 - Shallow-water SAV. The recommended procedure for reporting SAV condition is to use the single best year SAV acreage based on the most recent three-year period of data. Table 3-26 shows the acres of SAV observed in the Middle River and Gunpowder River tidal segments for the latest three-year monitoring period from 2006 to 2008.

Table 3-26: Baltimore County SAV Monitoring Results (2006-2008)

Tidal Segment Designation	2006		2007		2008	
	Acres	% of Goal	Acres	% of Goal	Acres	% of Goal
MIDOH	234	27%	241	27%	518	59%
GUNOH1*	-	-	-	-	-	-
GUNOH2	84	15%	194	34%	188	33%

*SAV monitoring not conducted by Baltimore County in this segment

The Middle River tidal segment generally shows higher acreages of SAV. In fact, Middle River consistently exhibits the highest amounts of SAV compared to all other tidal segments in Baltimore County (WRE 2010). SAV coverage in Middle River and the monitored segment of Gunpowder River has increased during the three-year period, with a total of over 700 acres documented in 2008. Because segment GUNOH1 is not monitored, this is a conservative estimate of progress in meeting SAV goals. The increasing trend also reflects the overall SAV condition in Baltimore County. Figure 3-10 is an excerpt from Baltimore County's 2010 *WRE Technical Memo*-A and shows SAV coverage in the County over 20 years of monitoring. It is important to clarify that the percentages reflect SAV acreage in multiple monitoring segments throughout Baltimore County; Middle River and Gunpowder percentages are generally at the higher end of the spectrum.

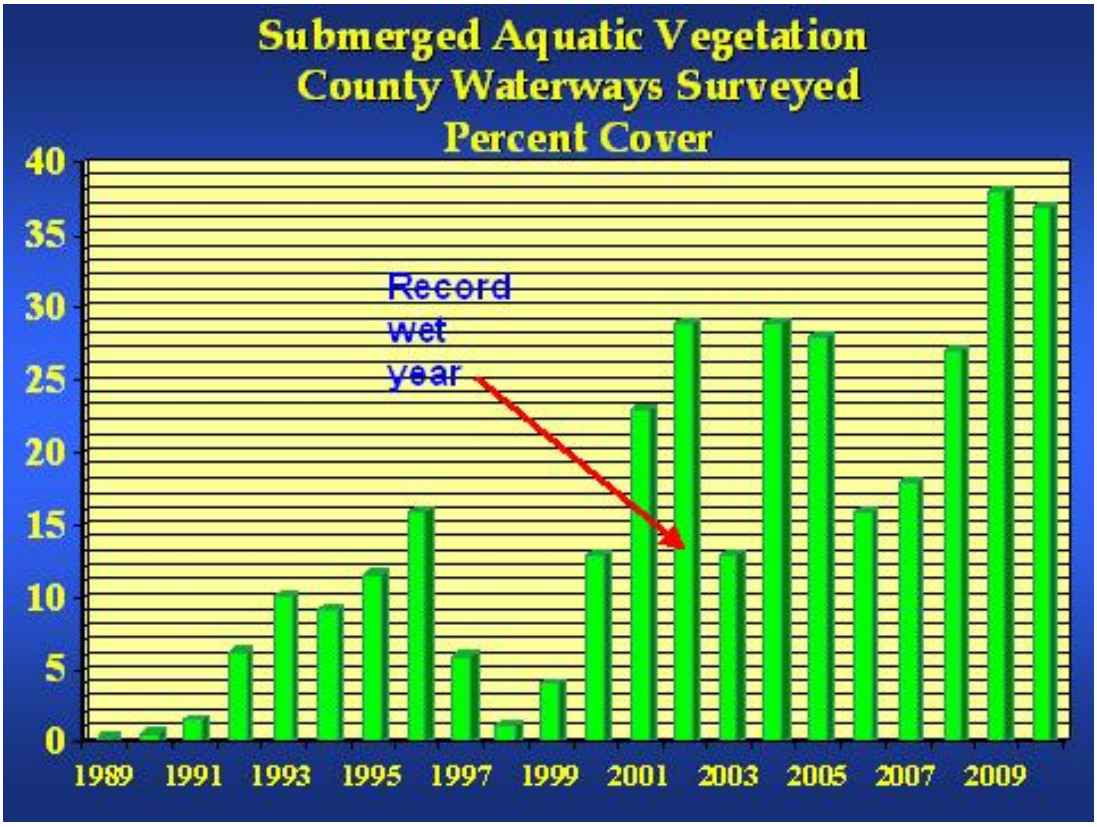

Figure 3-10: Baltimore County SAV Monitoring Program – Trends in % Coverage (excerpt from WRE 2010)

3.4.4 Illicit Discharge and Elimination Data

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

1. A quantitative analysis of the effluent that includes measuring the effluent flow rate, temperature and pH, and field testing for parts per million (ppm) of chlorine, phenols, and copper using a specially configured LaMotte NPDES test kit;

2. A qualitative assessment of the effluent, outfall structure, and receiving channel noting conditions such as water color, odor, vegetative condition, sedimentation, erosion, damage, etc.; and
3. A visual inspection of each outfall that identifies any structural damage.

The County has an outfall prioritization system based on data from the outfall screening. There are approximately 3,628 outfalls based on storm drain spatial data provided by Baltimore County EPS. About 80 percent of these (2,912) are minor outfalls (less than 3 feet in diameter) which are not prioritized. Of the remaining 716 major outfalls (greater than 3 feet in diameter), 593 of them have a prioritization rating. The prioritization system allows for a more streamlined approach in selecting outfalls to screen and provides a more efficient use of manpower. Also under this system, outfalls screened only once or not at all can be screened sufficiently and properly prioritized. The list of outfalls to be screened is generated by a Microsoft Access query based on the prioritization.

Under the outfall prioritization system, outfalls that have not been screened at least twice are not prioritized. Prioritized outfalls, those screened two or more times, are assigned one of the following priority ratings:

- *Priority 1 (Critical):* Outfalls with major problems that require immediate correction and/or close monitoring, or outfalls with recurring problems. These outfalls are sampled four times each year.
- *Priority 2 (High):* Outfalls with moderate to minor problems that have the potential to become severe. These outfalls are sampled once a year.
- *Priority 3 (Low):* Outfalls with minor or no problems that do not require close monitoring. These outfalls are sampled on a 10-year cycle.
- *Priority 0 (Not prioritized)*: Outfalls with insufficient data to determine a priority rating. This may be due to inaccessibility or if there has been only a single screening.

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

There are 18 major outfalls in the Middle River and Tidal Gunpowder River watersheds (see Figure 2-17). Table 3-27 summarizes the priority ratings for these outfalls by subwatershed.

Table 3-27: Baltimore County Storm Drain Outfall Prioritization Results

	OUTFALL PRIORITY RATING				
Subwatershed	Priority 1	Priority 2	Priority 3	Priority 0	Total
Darkhead Creek	0	1	3	0	4
Frog Mortar Creek	0	4	1	0	5
Hopkins Creek	0	1	1	0	2
Middle River	3	1	0	0	4
Middle River Subtotal	*3*	*7*	*5*	*0*	*15*
Dundee Creek	0	0	0	1	1
Seneca Creek	0	0	0	2	2
Tidal Gunpowder Subtotal	*0*	*0*	*0*	*3*	*3*
Total	*3*	*7*	*5*	*3*	*18*

As shown, all major outfalls in the Tidal Gunpowder River watershed are not prioritized. All 15 prioritized outfalls in the planning area are located in four subwatersheds of Middle River. The most critical outfalls are in the Middle River subwatershed which contains all three Priority 1 outfalls and one Priority 2 outfall. Frog Mortar Creek also contains four high priority (Priority 2) outfalls.

3.5 Sewer Overflow Impacts

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

In September 2005, USEPA and MDE issued a consent decree to Baltimore County with deadlines to reduce and eliminate sanitary sewer overflows. Implementation of work in compliance with the consent decree, such as capital projects, equipment upgrades, and operations improvements, will reduce nutrients and bacteria entering streams in the Middle River and Tidal Gunpowder River watersheds. However, this may not address all impacts associated with the sanitary sewer system since the consent decree only targets overflows. For example, leaks that are not associated with an overflow may occur in the sanitary sewer system. Depending on the location of the leaks, which are typically at joints, there may still be adverse impacts to the stream system from the sanitary sewer system.

The number of SSO events documented and approximate volume discharged between 2000 and 2009 are summarized in Table 3-28 based on Baltimore County's SSO spatial data. Table 3-29 summarizes the estimated volume and pollutant loads associated during this 10-year period by subwatershed.

Table 3-28: Sanitary Sewer Overflow Volumes in Middle River and Tidal Gunpowder River (2000-2009)

Year	# of SSO Events	Volume of Overflow (gal)
2000	1	*(not reported)*
2001	3	870
2002	3	510
2003	2	2,000
2004	1	100
2005	2	700
2006	2	400
2007	0	0
2008	4	1,539
2009	2	850
Total	*20*	*6,969*

Table 3-29: Sanitary Sewer Overflow Volumes and Pollutant Loads by Subwatershed

Subwatershed	# of SSO Events	Volume of Overflow (gal)	TN (lbs)	TP (lbs)	FC (MPN)
Darkhead Creek	7	2,544	0.21	0.64	6.1E+11
Frog Mortar Creek	1	600	0.05	0.15	1.4E+11
Galloway Creek	0	0	0	0	0
Browns Cove	0	0	0	0	0
Hogpen Creek	0	0	0	0	0
Hopkins Creek	4	455	0.04	0.11	1.1E+11
Middle River	2	1,050	0.09	0.26	2.5E+11
Norman Creek	0	0	0	0	0
Stansbury Creek	0	0	0	0	0
Sue Creek	1	60	0.005	0.02	1.4E+10
Middle River Subtotal	*15*	*4,709*	*0.4*	*1.2*	*1.1E+12*
Aberdeen Proving Ground	0	0	0	0	0
Dundee Creek	1	10	0.001	0.003	2.4E+09
Gunpowder River	2	2,050	0.17	0.51	4.9E+11
Saltpeter Creek	2	200	0.02	0.05	4.8E+10
Seneca Creek	0	0	0	0	0
Tidal Gunpowder Subtotal	*5*	*2,260*	*0.2*	*0.6*	*5.4E+11*
Total	*20*	*6,969*	*0.6*	*1.7*	*1.7E+12*

Pollutant load estimates were calculated based on the following assumptions:

- Total Phosphorus (TP): A conversion factor of 8.3×10^{-5} was used to convert gallons of overflow to pounds of pollutant. This is based on a 10 mg/L TP concentration for raw sewage and a multiplier of 8.3×10^{-6} lb·L/mg·gal.
- Total Nitrogen (TN): A conversion factor of 2.5×10^{-4} was used to convert gallons of overflow to pounds of pollutant. This is based on a 30 mg/L TN concentration for raw sewage and a multiplier of 8.3×10^{-6} lb·L/mg·gal.
- Fecal Coliform (FC): A conversion factor of 2.4×10^{8} was used to convert gallons of overflow to MPN fecal coliform. This is based on a multiplier of 6.4×10^{6} MPN/100 mL.

Figure 3-11 shows the location of SSO events reported during 2000 to 2009 in the Middle River/Tidal Gunpowder River planning area. The greatest numbers of SSO incidents have been documented in the Darkhead Creek and Hopkins Creek subwatersheds. The largest cumulative overflow volumes over the 10-year period were observed in the Darkhead Creek, Middle River, and Gunpowder River

subwatersheds. The two largest SSO events of 1,400 gal and 1,750 gal occurred in the Darkhead Creek and Gunpowder River subwatersheds, respectively. All of these areas have the potential for follow-up inspection and addressing SSO problems.

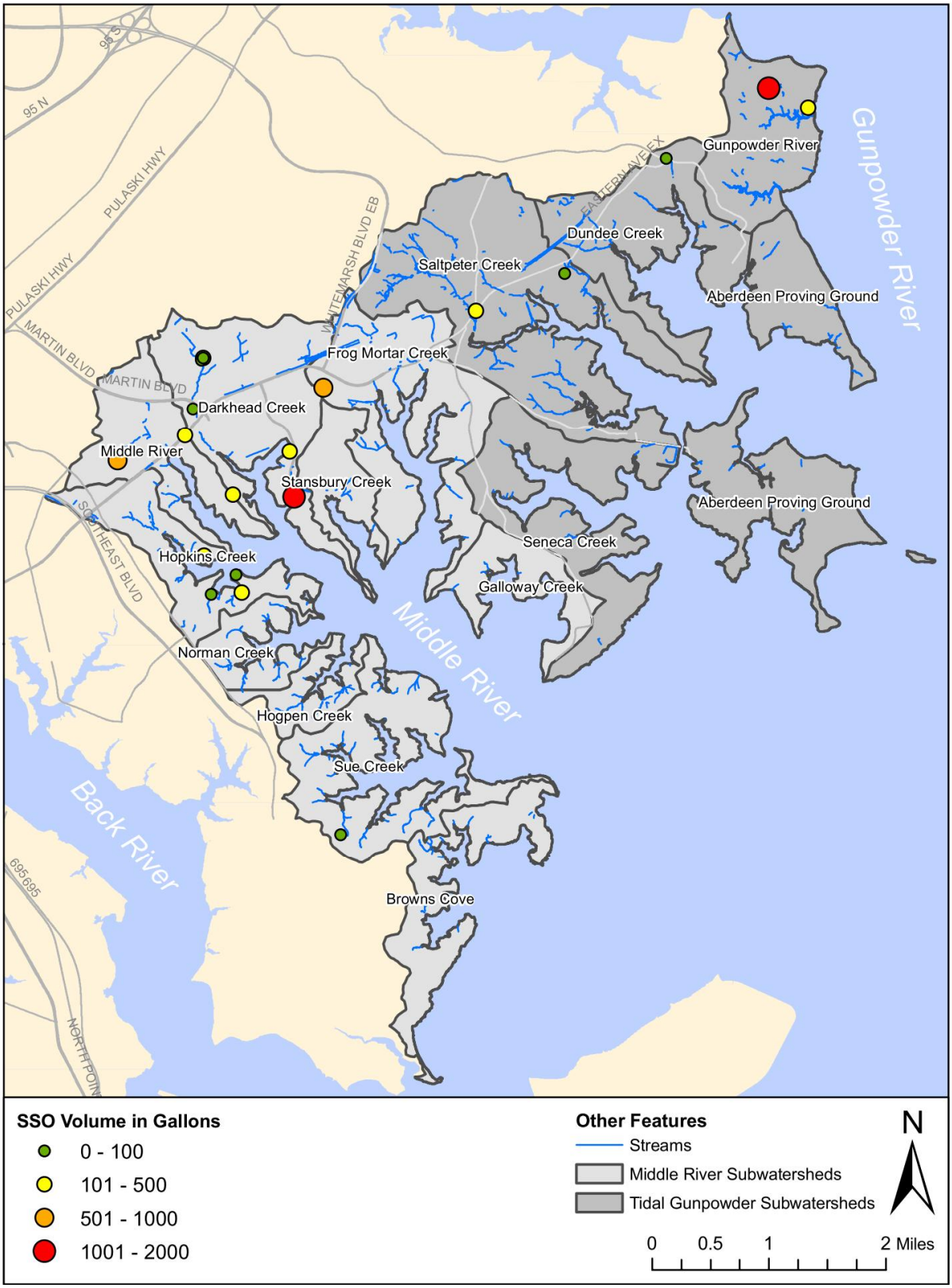

Figure 3-11: Sanitary Sewer Overflow Locations in Middle River and Tidal Gunpowder River (2000-2009)

3.6 Stream Corridor Assessments

Stream Corridor Assessments (SCAs) were conducted for selected streams in the Tidal Gunpowder River watershed. The subwatersheds selected for SCAs include Saltpeter Creek and Dundee Creek. The Middle River watershed was not included in the assessment because the County has already performed detailed stream studies in this watershed. These were conducted based on Maryland DNR's SCA Survey Protocols which were developed as a tool for environmental managers to quickly identify environmental problems within a watershed's stream network (Yetman 2001). This methodology represents a rapid field survey, rather than a detailed scientific assessment, to better target monitoring, management, and conservation efforts on the watershed and subwatershed scale. The following sections present a description of the SCA protocol employed, an overview of the streams that were assessed, and general results for the Tidal Gunpowder River watershed.

3.6.1 Assessment Protocol

The SCA method is used to quickly assess physical conditions and identify common environmental problems in a stream corridor. A two person field crew walked the subset of streams in the Tidal Gunpowder River watershed that were selected by Baltimore County EPS based on accessibility and owner permission. Following the SCA method, the field crew looked for the following environmental problems during the assessment:

- Channel Alteration Sites (CA)
- Erosion Sites (ES)
- Exposed Pipes (EP)
- Pipe Outfalls (PO)
- Fish Migration Barriers (FB)
- Inadequate Stream Buffers (IB)
- In or Near Stream Construction (IC)
- Trash Dumping (TD)
- Unusual Conditions or Comments (UC)

The field team walked along the selected stream corridors while noting the location of the problem sites and filling out appropriate data forms for each site, using a GPS handheld unit. Electronic field forms were based on guidance provided in DNR's SCA manual, with slight modifications made by Baltimore County EPS for more efficient data collection and management. Each site was assigned a unique identification number according to the map grid ID number, followed by a two-digit sequential site number, and two letters representing the type of problem as shown in the list above. The map grid is based on a grid system used by Baltimore County for generating tabloid size field maps and assigning unique IDs to field data items. At least one photograph was taken at each problem site to document observed conditions. The photo number and problem site identification number were also entered into the GPS unit.

SCA problem sites were rated on a scale of one to five indicating the severity of the problem. Severity is a measure of how serious a problem site is compared to other problems in the same category. The most severe problems are those with a direct and wide impact on stream resources. Severity ratings are intended to help prioritize potential restoration opportunities, ranging from a score of 5 which represents a minor problem or one that is easy to fix, to a score of 1 denoting the worst or most severe observed.

In addition to identifying the problem sites, a stream Stability Assessment (SA) site was also assigned and evaluated for each stream reach surveyed. Stream reaches were determined in the field based on segments of stream exhibiting similar physical characteristics and condition. SA sites were characterized according to three parameters: 1) Channel condition based on the stages of the Channel Evolution Model (CEM); 2) Bed condition; and 3) Planform type. The SA evaluation is designed to help identify restoration potential during the stream assessments. The SA forms were also filled out in the field using the handheld GPS unit. A photo looking upstream and one looking downstream were taken at each SA site to document current conditions of the reach. Each SA site was assigned a unique identification number starting with the map grid ID number, followed by a letter representing the stream branch and then a number representing the corresponding stream reach..

3.6.2 Summary of Sites Investigated

SCAs were conducted in the Saltpeter Creek and Dundee Creek subwatersheds of the Tidal Gunpowder River watershed, targeting wadeable, non-tidal/non-marsh areas, and accessible portions of streams of 2nd order or greater. Landowner permission was requested by mail for all private properties located along the proposed stream corridors. Stream corridors that were located on properties whose landowner denied permission for access were not included in the SCAs. In addition, during the field assessments, it was determined that several segments of the proposed stream corridors no longer exist because they were either ephemeral (intermittent) or had been modified due to development. Initially, a total of approximately 7 miles of stream were proposed for SCAs; however, based on these criteria, a total of 2.7 miles of stream were assessed, herein referred to as surveyed streams. Table 3-30 summarizes the total miles of surveyed streams in each subwatershed.

Table 3-30: Surveyed Streams in Tidal Gunpowder River Watershed

Subwatershed	Stream Miles Proposed for SCA	Surveyed Stream Miles
Saltpeter Creek	5.3	1.9
Dundee Creek	1.4	0.8
Total	*6.7*	*2.7*

Figure 3-12 shows the location of the SCA area and surveyed streams with respect to the overall Middle River and Tidal Gunpowder River planning area. Figure 3-13 shows the stream network within the SCA area, the streams initially proposed for the SCA in red, and the actual surveyed streams in yellow

highlighting. These figures also show landowner permission responses and help explain why certain segments of stream were not assessed.

As described previously, SCA problem sites were assigned unique identification numbers according to map grid ID number and then numbered sequentially. The map grid used for the Tidal Gunpowder River SCAs is also shown in Figure 3-13. The field team walked stream segments by map number. For example, the first SCA problem site located in Saltpeter Creek within map number "083B3" was an inadequate buffer site, and was numbered as 083B3-01_IB; the remaining sites were numbered consecutively (regardless of type) along the rest of the streams within the map (e.g., 083B3-02_TD, 083B3-03_FB, etc.). The same site naming scheme was applied to the remaining maps and stream segments within the survey area. As mentioned above, the stream stability assessment sites had a slightly different naming convention. All stream branches located on the same map were given a letter (A, B, C, etc.) for organization purposes; then each branch was divided into one or more reaches based on stream characteristics and given a single digit number. An SA site on map "083B3," for example, corresponding to the third reach of stream branch "A" would be named 083B3-A3. The SA sites corresponding to the reaches of the next stream branch "B" in same the map would be named 083B3-B1, 083B3-B2, etc.

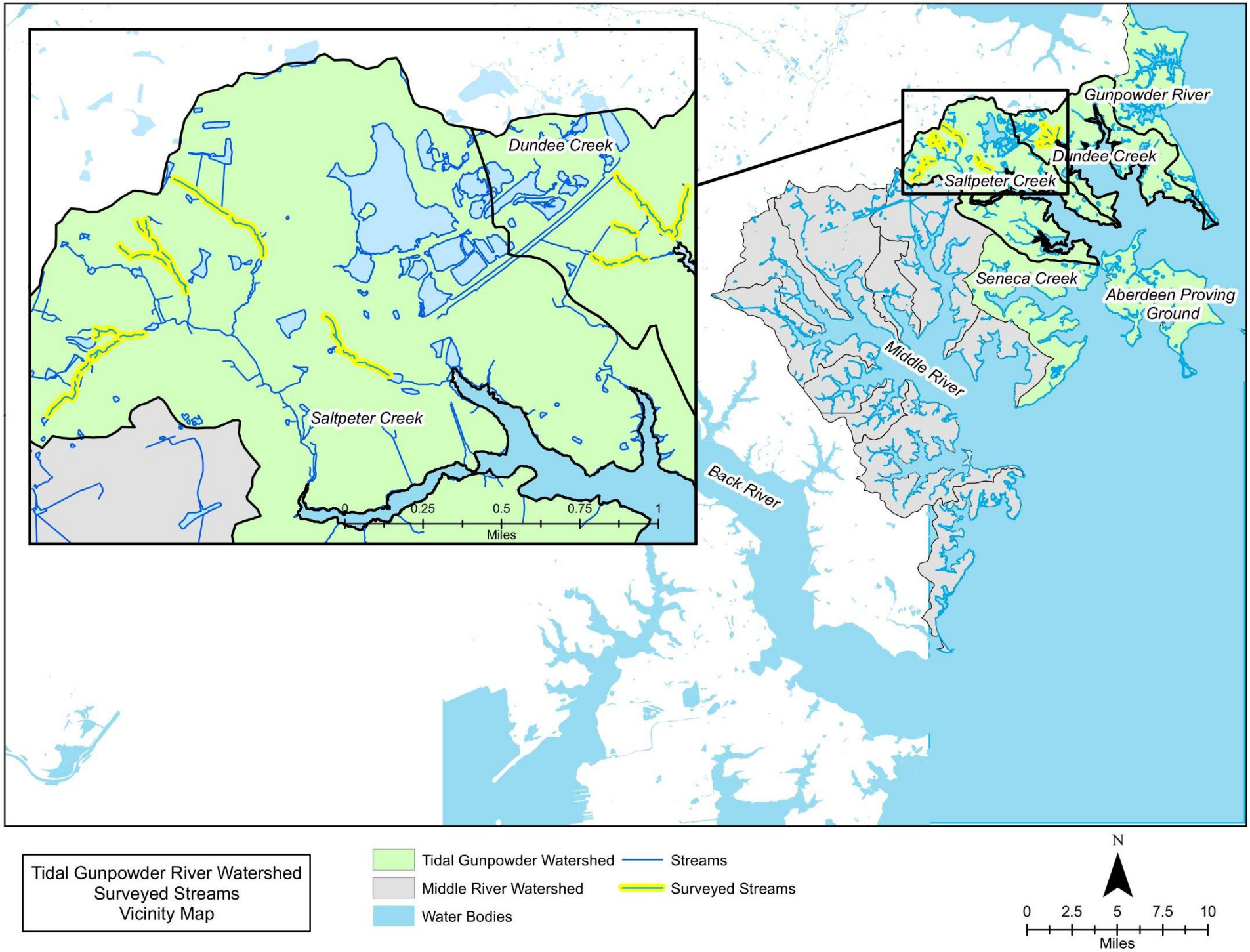

Figure 3-12: Location of Surveyed Streams in Tidal Gunpowder River SCA

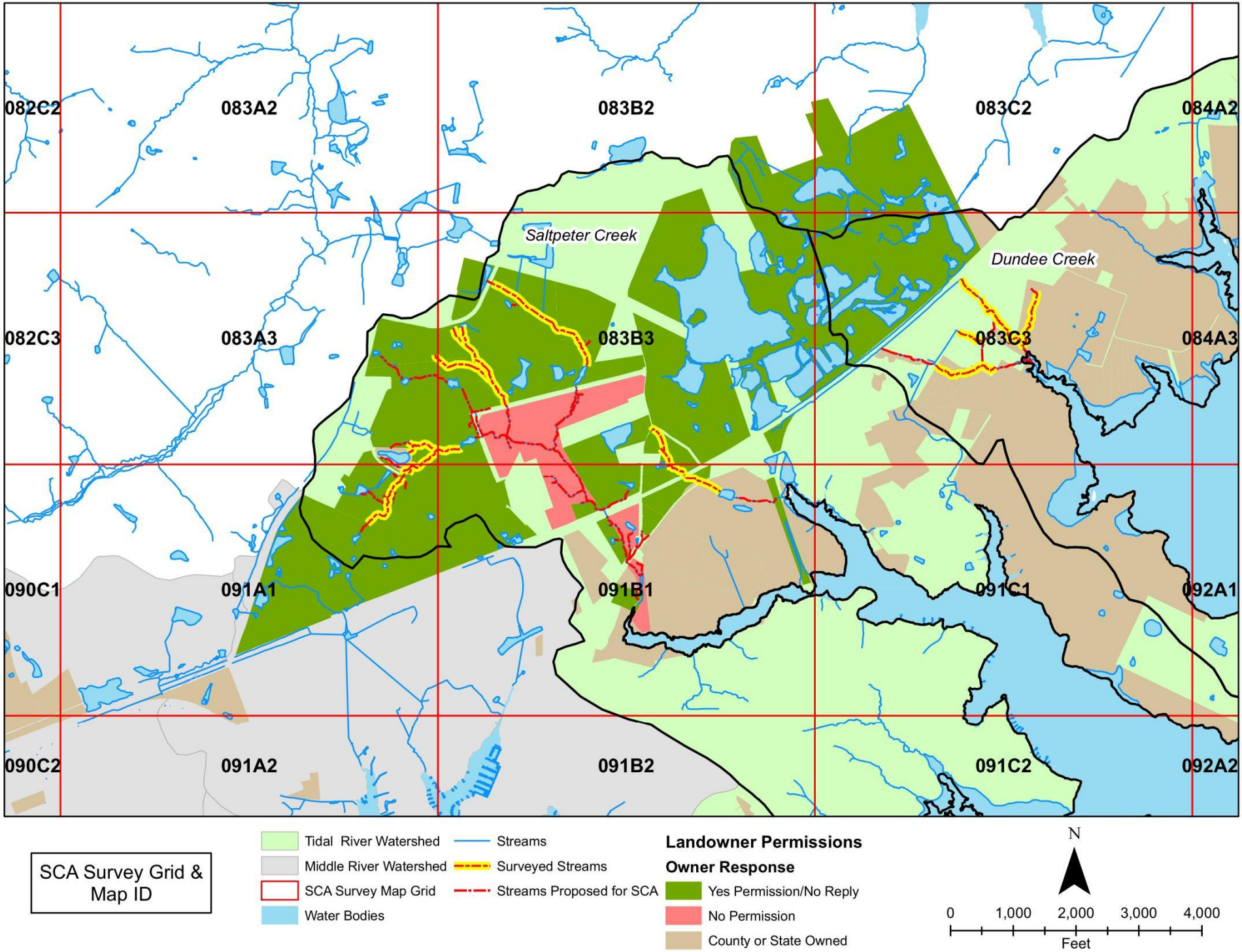

Figure 3-13: Tidal Gunpowder River SCA Survey Grid and Map Numbers

3.6.3 General Findings

Along the 2.7 miles of stream walked within the Tidal Gunpowder River watershed, 27 potential environmental problem sites were observed. The number of problem sites observed in each subwatershed are summarized in Table 3-31.

Table 3-31: SCA Survey Results - Number of Environmental Problem Sites

Subwatershed	Inadequate Buffer	Trash Dumping	Fish Barriers	Pipe Outfalls	Channel Alteration	Unusual Conditions or Comments	Total
Saltpeter Creek	4	1	3	3	0	4	15
Dundee Creek	3	1	0	0	3	5	12
Total	*7*	*2*	*3*	*3*	*3*	*9*	*27*

Sites assessed as unusual conditions or comments include field observations and may not necessarily reflect environmental problems. These will be discussed in further detail in subsequent sections. Aside from the unusual conditions and comments, the most frequently observed potential problems were inadequate stream buffers. No occurrences of erosion sites, exposed pipes, or in/near stream construction were observed.

In addition to the environmental problem sites, the field team also performed stream stability assessments for 26 stream reaches. As described previously, stream reaches were determined in the field based on segments of stream exhibiting similar physical characteristics and condition. Stability assessment sites and environmental problems found in the Tidal Gunpowder River watershed are described in the following sections. Data collected in the field for environmental problem sites and stability assessment sites are compiled in tables included in Appendix A.

3.6.3.1 Inadequate Stream Buffers

Forested buffer areas along streams are important for improving water quality and for flood mitigation since they can reduce surface runoff, stabilize stream banks with root systems, shade streams, remove pollutants such as nutrients and sediment from runoff, and provide habitat for various types of terrestrial and aquatic life including fish. For the SCA, a stream buffer was considered inadequate if it was less than 50 feet wide from the edge of the stream. Inadequate stream buffers were the most commonly observed environmental problem within the Tidal Gunpowder River SCA survey area. The field team identified 7 inadequate buffer sites in the study area with a total length of 2,460 feet. This means that approximately 17% of the total stream miles surveyed was considered as having inadequate stream buffers.

The severity of inadequate stream buffers was rated according to length and width. The most severe rating of 1 would be given to inadequate buffer lengths of greater than 1,000 feet with limited or no trees on either bank. The present land use was also taken into consideration, such as pavement, lawn, agriculture, or shrubs and trees. There were no inadequate buffer sites with the most severe rating of 1 in the Tidal Gunpowder River SCA survey area. Most sites were rated as low (4) or minor (5). However, a rating of 2, which is second most severe, was given to a site with a 500-foot section with 5 feet or less buffer width on both banks. A moderate rating of 3 was also assigned to a site with approximately 300 feet of inadequate buffer on both banks. Figure 3-14 shows photos of these two sites. Stream buffer restoration potential depends on various factors such as accessibility, property ownership, and current land use. Restoration at a site that is currently an industrial property such as the one shown on the left may not be as feasible as one that is open lawn such as the one shown on the right, even though it is in more severe condition.

Figure 3-14: Examples of Inadequate Buffer Sites with Severe Rating-2 (left) and Moderate Rating-3 (right)

Table 3-32 below summarizes the number of inadequate buffer sites associated with each severity rating. The total length of inadequate buffer in each subwatershed and the percentage of surveyed streams having inadequate buffer are also shown.

Table 3-32: Tidal Gunpowder River SCA Survey Results - Inadequate Stream Buffers

	SEVERITY RATING						LENGTH		
Subwatershed	Severe 1	2	3	4	Minor 5	All	ft	mi	% of Surveyed Length
Saltpeter Creek	0	1	1	1	1	4	1,612	0.3	16%
Dundee Creek	0	0	0	2	1	3	848	0.2	21%
Total	*0*	*1*	*1*	*3*	*2*	*7*	*2,460*	*0.5*	*17%*

Four inadequate buffer sites were encountered in the Saltpeter Creek subwatershed and three sites in Dundee Creek. The most severe sites were found in Saltpeter Creek, near several industrial sites off of

Eastern Avenue. Three of the seven inadequate buffer sites encountered in the Tidal Gunpowder River SCA survey are located directly adjacent to this road. The locations of the stream segments with inadequate buffers and their severity ratings are shown in Figure 3-15. Tables summarizing data collected for inadequate buffer sites are included in Appendix B.

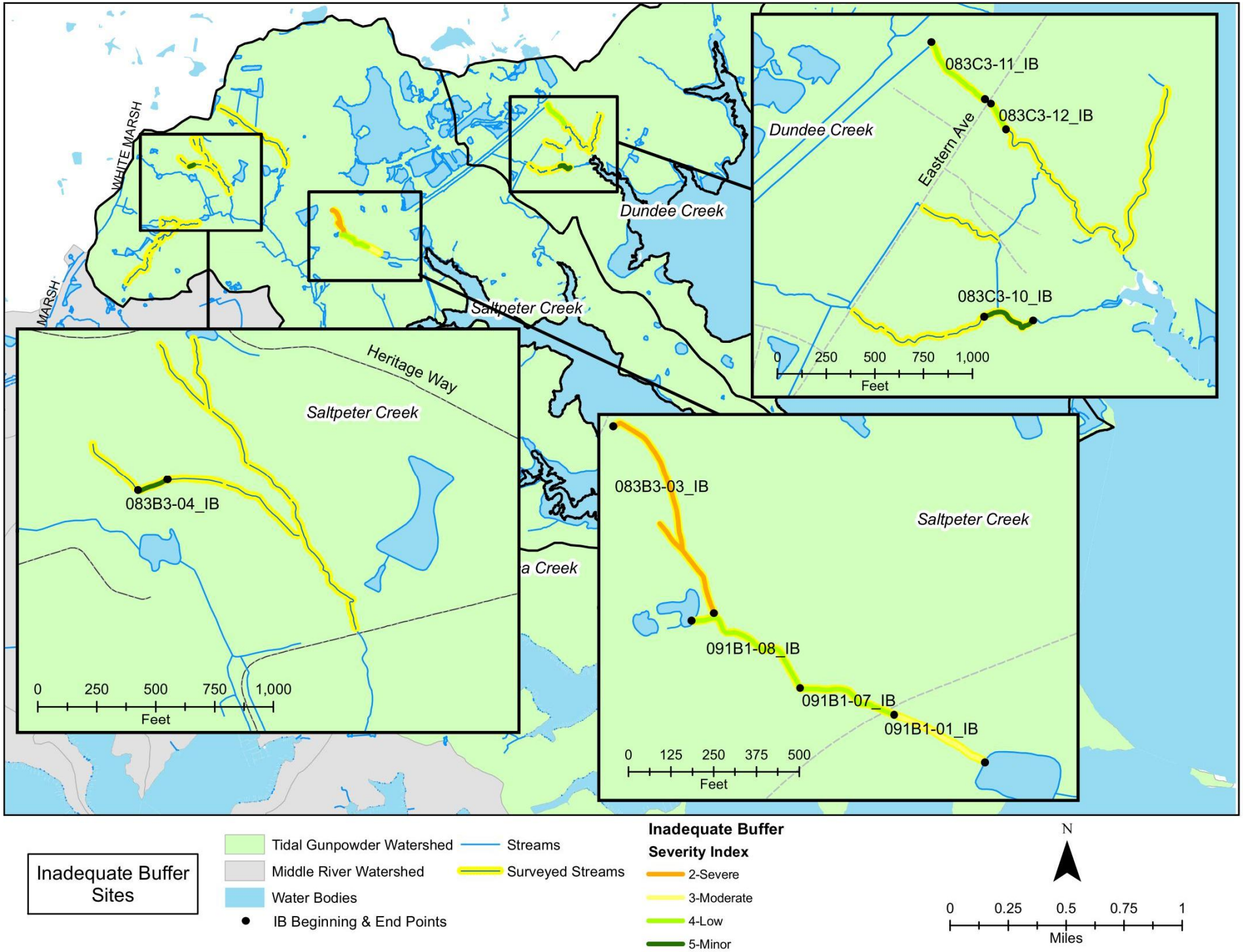

Figure 3-15: Inadequate Stream Buffer Locations in Tidal Gunpowder River SCA

3.6.3.2 Other SCA Environmental Problems

Other environmental problems encountered during the Tidal Gunpowder River SCA include trash dumping, fish barriers, pipe outfalls, and channel alterations. Because of the relatively low number of occurrences of these sites, they are shown on the same set of maps in Figures 3-24 through 3-28, at the end of this section. Locations of unusual conditions/comments are also shown on these figures. Brief descriptions of these environmental problems and unusual conditions/comments follow in this section. As previously mentioned, there were no occurrences of erosion sites, exposed pipes, or in/near stream construction in the survey area.

Trash Dumping

Trash dumping sites are places where large amounts of trash have been dumped or have accumulated inside the stream corridor. Identifying trash dumping sites serves two main purposes. One is to limit access to the areas of the stream corridor, as feasible, where trash dumping and accumulation is a problem. The second is to identify locations suitable for and to encourage volunteer stream clean-ups. Stream clean-up events are a chance to raise awareness among the community of the condition of their local streams and encourage them to take action toward its improvement. The trash dumping sites found during the Tidal Gunpowder River SCA survey were located near industrial sites and consisted of heavy materials that were determined not suitable for volunteer clean-up. However, this presents an opportunity to educate the adjacent businesses about proper outdoor materials storage and waste management practices.

The severity of trash dumping sites was rated according to the amount and type of trash present (estimated in terms of number of pick-up truck loads), whether it is located in a large area or confined to a single site, and whether cleaning up the trash would present access or safety problems. Type of trash was classified under the following: residential, industrial, yard waste, floatables, tires, construction, or other. A very severe rating of 1 would be assigned to sites with large amounts of trash scattered over a large area where access is difficult, and to sites with any indications of hazardous materials. Moderately severe trash dumping sites with a rating of 3 would be those with a fairly large amount of trash in a small area with easy access that could be cleaned up in a few days. Low severity and minor trash dumping sites with ratings of 4 or 5 would be those with easy access and potential for volunteer clean-up. Two trash dumping sites were encountered during the Tidal Gunpowder River SCA survey, and both sites were determined to be of moderate severity (rating = 3). There was a large amount of trash at both sites but access was not difficult. Both sites are located on industrial properties near Eastern Avenue. As shown in the Figure 3-16, site 083C3-09_TD, on the left, had a mix of commercial and industrial trash; site 083B3-02_TD, shown on the right, consisted of mostly tires and heavy industrial equipment. Table 3-33 shows the severity ratings and estimated number of pick-up truck loads for the two trash dumping sites.

Figure 3-16: Trash Dumping Sites in the Tidal Gunpowder River SCA Survey Area

Table 3-33: Tidal Gunpowder River SCA Survey Results - Trash Dumping Sites

	SEVERITY RATING						
	Severe				Minor		
Subwatershed	1	2	3	4	5	All	# Truck Loads
Saltpeter Creek	0	0	1	0	0	1	3
Dundee Creek	0	0	1	0	0	1	10
Total	*0*	*0*	*2*	*0*	*0*	*2*	*13*

Fish Migration Barriers

A fish barrier refers to anything in the stream that significantly interferes with the upstream movement of fish. Unobstructed upstream movement is important for various species that move up and downstream during their life cycle such as for spawning. Fish barriers can reduce the fish population and diversity in stream sections. Fish barriers include manmade structures such as dams or road culverts and natural features such as waterfalls. Three main problems of fish barriers were evaluated when identifying blockages: 1) vertical drop is too high (>6 inches) for fish to swim over; 2) water depth is too shallow such as when water is spread over a large area at channelized sections or road crossings; and 3) water is moving too fast such as when a steep culvert pipe is discharging high velocity flow. The type of barrier was also noted, including man-made dam, debris dam, road or pipe crossing, natural falls, beaver dam, pond, or other causes.

Severity was rated based on location of the barrier in the stream network and whether the blockage was total, partial, or temporary. A total of three fish barriers were identified during the Tidal Gunpowder River SCA survey, all located in the Saltpeter Creek subwatershed. One was assigned a severity of 1-very severe, and two a severity of 3-moderate. The very severe fish barrier, site 091B1-06_FB shown in Figure 3-17 on the left, was encountered at the railroad crossing near the intersection of Eastern Avenue and Earls Road. There seemed to be a buried outlet causing complete blockage with little opportunity

for correction. Another fish barrier, site 019B1-02_FB, was located at a culvert road crossing upstream of the one just mentioned. This barrier was assigned a moderate severity rating of 3 because it was a partial blockage where the water in the culvert was shallow (3 inches). A moderate severity rating was also assigned to a debris dam located on a stream segment off Crossroads Circle, site 083B3-09_FB shown in Figure 3-17 on the right, which created a total blockage with a vertical drop measured at 18 inches. Barriers such as this one do not necessarily warrant corrective action because they are not man-made and may change form over time or during a large storm event. Table 3-34 summarizes the fish barriers by severity rating.

Figure 3-17: Fish migration barriers in the Tidal Gunpowder River SCA Survey Area

Table 3-34: Tidal Gunpowder River SCA Survey Results - Fish Migration Barriers

	SEVERITY RATING					
	Severe				Minor	
Subwatershed	1	2	3	4	5	All
Saltpeter Creek	1	0	2	0	0	3
Dundee Creek	0	0	0	0	0	0
Total	*1*	*0*	*2*	*0*	*0*	*3*

Pipe Outfalls

Pipe outfalls include pipes or small manmade channels that discharge into the stream. These are considered a potential environmental problem since they can carry untreated runoff and pollutants such as oil, heavy metals, and nutrients to a stream system. There are few storm drain systems in the Tidal Gunpowder River watershed, and most are located outside the SCA survey area. For this reason, only three pipe outfalls were encountered during the Tidal Gunpowder River SCA survey. Pipe outfalls were evaluated based on type and size, and evidence of discharge was noted along with any signs of

pollutants in the runoff. All three outfalls are located in the Saltpeter Creek subwatershed and received a minor severity rating of 5.

The severity rating for a pipe outfall was primarily based on the discharge including whether discharge was present, color, odor, amount, and downstream impacts. The largest of the three outfalls, site 083A3-01_PO, is located at a development on White Marsh Boulevard and Pocomoke Court. It consists of two 24-inch concrete pipes, as shown in Figure 3-18. This outfall had evidence of iron flocculent in the discharge but was assigned a minor severity rating of 5 because it is located at the outlet of a stormwater management pond and there was no evidence of sediment in the discharge.

Figure 3-18: Pipe outfall at outlet of pond

The two other outfalls showed presence of discharge but it was clear in color and did not have odor, and no signs of downstream erosion were visible. Thus, they were given the least severe rating of 5. One is an 8-inch polyvinyl chloride (PVC) pipe located off Bengies Road (site 083B3-05_PO); the other seemed to be a buried outfall located at the head of a stream segment at a development on Crossroads Circle (site 083B3-06_PO). These are shown in Figure 3-19 on the left and right, respectively. Table 3-35 summarizes the pipe outfalls by severity rating.

Figure 3-19: Pipe outfalls with minor severity ratings in the Tidal Gunpowder River SCA Survey Area

Table 3-35: Tidal Gunpowder River SCA Survey Results - Pipe Outfalls

	SEVERITY RATING					
	Severe				Minor	
Subwatershed	1	2	3	4	5	All
Saltpeter Creek	0	0	0	0	3	3
Dundee Creek	0	0	0	0	0	0
Total	*0*	*0*	*0*	*0*	*3*	*3*

Channel Alteration

Channel alteration refers to stream sections where the banks or channel have been modified from their naturally occurring form or condition. This includes channelized stream sections where a stream channel has been dredged, widened, straightened, and/or covered with concrete or other material. Channelized streams are typically intended to convey more water and to prevent flooding but often create adverse environmental impacts such as increasing flow velocities, impairing habitat, or increasing water temperature.

Three channel alteration sites, all within Dundee Creek, were documented during the Tidal Gunpowder River SCA survey with a total length of 132 feet. Less than 1% of the total stream miles surveyed was considered to have channel alterations. Severity rating was mainly based on channel alteration length, channel type, and stream functions. For example, more severe ratings would be given to concrete-lined segments of over 1,000 feet with no shade; moderate ratings would be given to reaches of about 500 feet showing signs of stabilization and vegetation; and minor ratings would be assigned to segments 100 feet or less in length with good water depth and natural sediment bottom. The stream segments with channel alterations found in the Tidal Gunpowder River SCA are relatively short and minor. All three sites are located within a 400-foot reach of stream located off of Eastern Avenue near its intersection with Minnow Branch Road. Site 083C3-08_CA exhibited stream bank alteration with concrete rubble, shown in Figure 3-20 on the left. This site was the longest of the three sites, approximately 65 feet, and was given a low severity rating of 4. Site 083C3-06_CA shown in the center of Figure 3-20 was channelized with a concrete pipe, approximately 25 feet in length, and it was assigned a minor rating of 5 due to its short length. Site 083C3-07_CA, shown in the right of Figure 3-20, consisted of tires placed along the stream bank and was also assigned a minor rating of 5 due to its short length (40 feet) and its minor impact to the streambed and natural channel shape. Table 3-36 summarizes the channel alteration sites by severity rating, length of observed channelization, and percent of channelization out of total stream miles surveyed.

Figure 3-20: Channel alterations in the Tidal Gunpowder River SCA Survey Area

Table 3-36: Tidal Gunpowder River SCA Survey Results - Channel Alteration Sites

	SEVERITY RATING						LENGTH		
	Severe				Minor				% of Surveyed
Subwatershed	1	2	3	4	5	All	ft	mi	Length
Saltpeter Creek	0	0	0	0	0	0	0	0.00	0%
Dundee Creek	0	0	0	1	2	3	132	0.03	3%
Total	*0*	*0*	*0*	*1*	*2*	*3*	*132*	*0.03*	*1%*

Unusual Conditions/Comments

Unusual conditions and comments were used to document the location of anything out of the ordinary or to identify and describe a specific problem observed in the field. An unusual condition was ranked as very severe if the potential problem was considered to have a possible direct and wide-reaching impact on the stream's aquatic resources. A site was rated as minor if the site was considered to have no significant impact on aquatic resources.

Six unusual conditions and three comments were documented during the Tidal Gunpowder River SCA. The comments were used more for descriptive purposes rather than to indicate a potential problem; for example, they were used to describe segments of stream that exhibited wetland characteristics such as shallow channels with hummock and phragmites. Therefore, comments were not given severity ratings. Of the remaining six unusual conditions observed, two were assigned a severe rating of 2. Sites 091B1-03_UC and 091B1-04_UC, shown in Figure 3-21 on the left and right, respectively, were described as locations where the curb inlet discharged directly into the stream. These sites present potential environmental concerns because pollutants and debris from road runoff can be conveyed directly and swiftly into the stream. The two sites are located approximately 30 feet apart on Eastern Avenue near the Earls Road intersection (Saltpeter Creek subwatershed).

Figure 3-21: Unusual Condition Sites 091B1-03_UC (left) and 091B1-04_UC (right)

Two other unusual condition sites were located in the Dundee Creek subwatershed near the intersection of Eastern Avenue and Minnow Branch Road. At site 083C3-01_UC, shown in Figure 3-22 on the left, a fallen tree is causing sediment accumulation and cutting off the flow which backwaters upstream. Site 083C3-04_UC, shown in Figure 3-22 on the right, consists of a deep pool (estimated depth of 4 feet) below a tree root-controlled head cut. Both sites received minor ratings of 5 because they seemed to be naturally occurring and were determined to have minimal impact on the stream channel and aquatic habit.

Figure 3-22: Unusual Condition Sites 083C3-01_UC (left) and 083C3-04_UC (right) with Minor Severity Ratings.

The two remaining sites that were documented as unusual conditions are located approximately 650 feet apart off of Eastern Avenue between Myersview Drive and Minnow Branch Road, also in the Dundee Creek subwatershed. Site 083C3-02_UC, shown in Figure 3-23 on the left, is an excavated pool at the outlet of a culvert crossing beneath Eastern Avenue. Site 083C3-03_UC, shown in Figure 3-23 on the right, is a similar pool lined with riprap, also at the outlet of a culvert crossing beneath the same road. These structures seemed to have been installed as energy dissipation devices for stormwater management and were not assigned severity ratings.

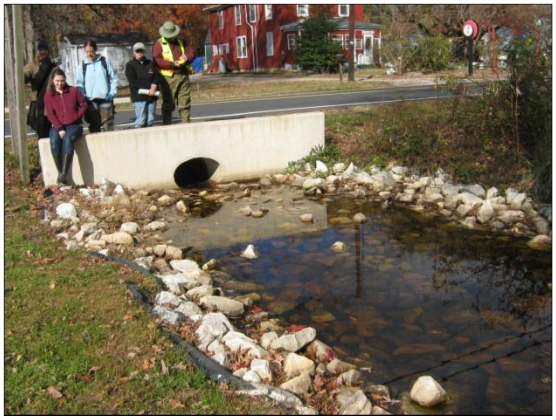

Figure 3-23: Sites 083C3-02_UC (left) and 083C3-03_UC (right) in the Dundee Creek subwatershed

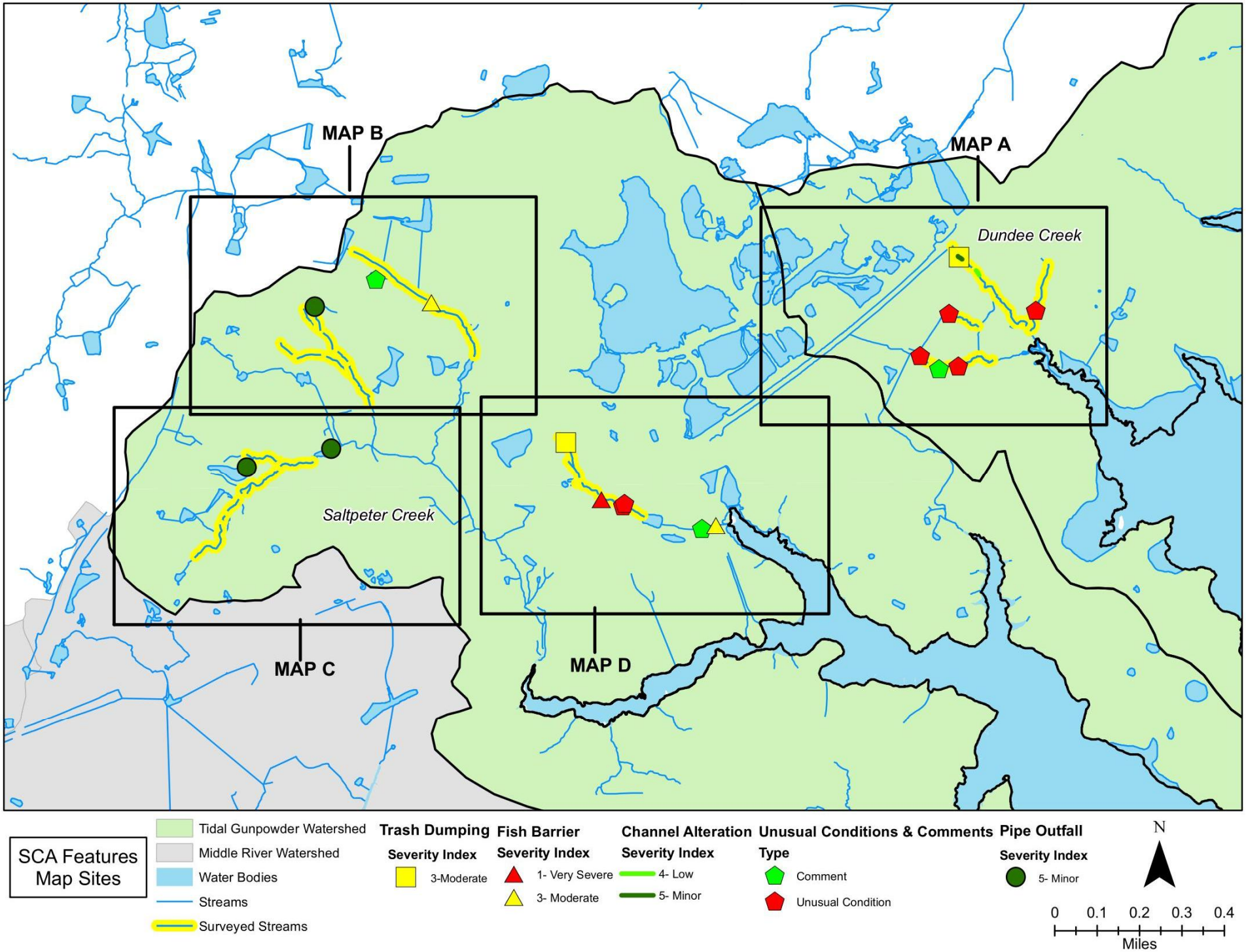

Figure 3-24: Location of Other SCA Problem Sites in Tidal Gunpowder River: Key Map

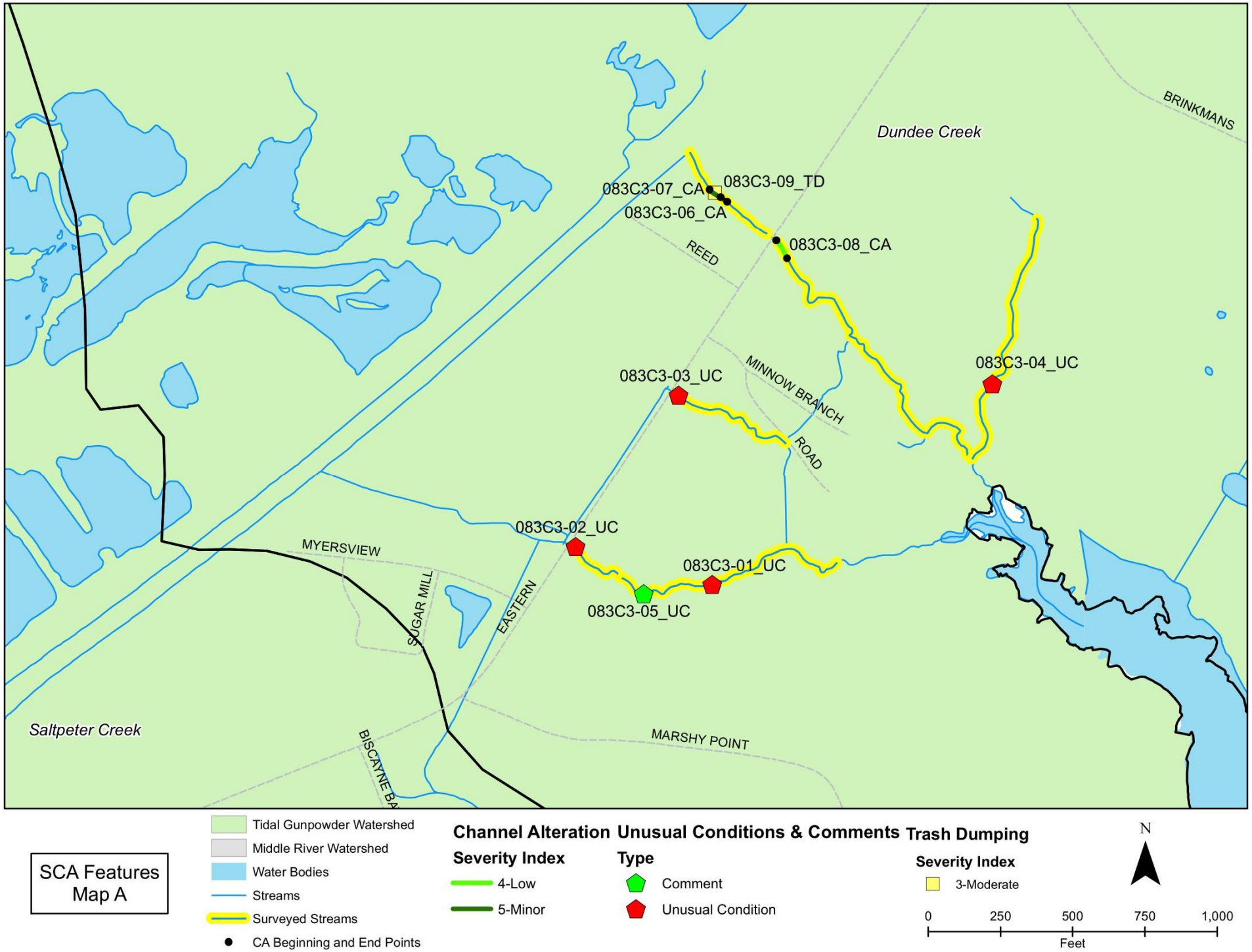

Figure 3-25: Location of Other SCA Problem Sites in Tidal Gunpowder River: Map A

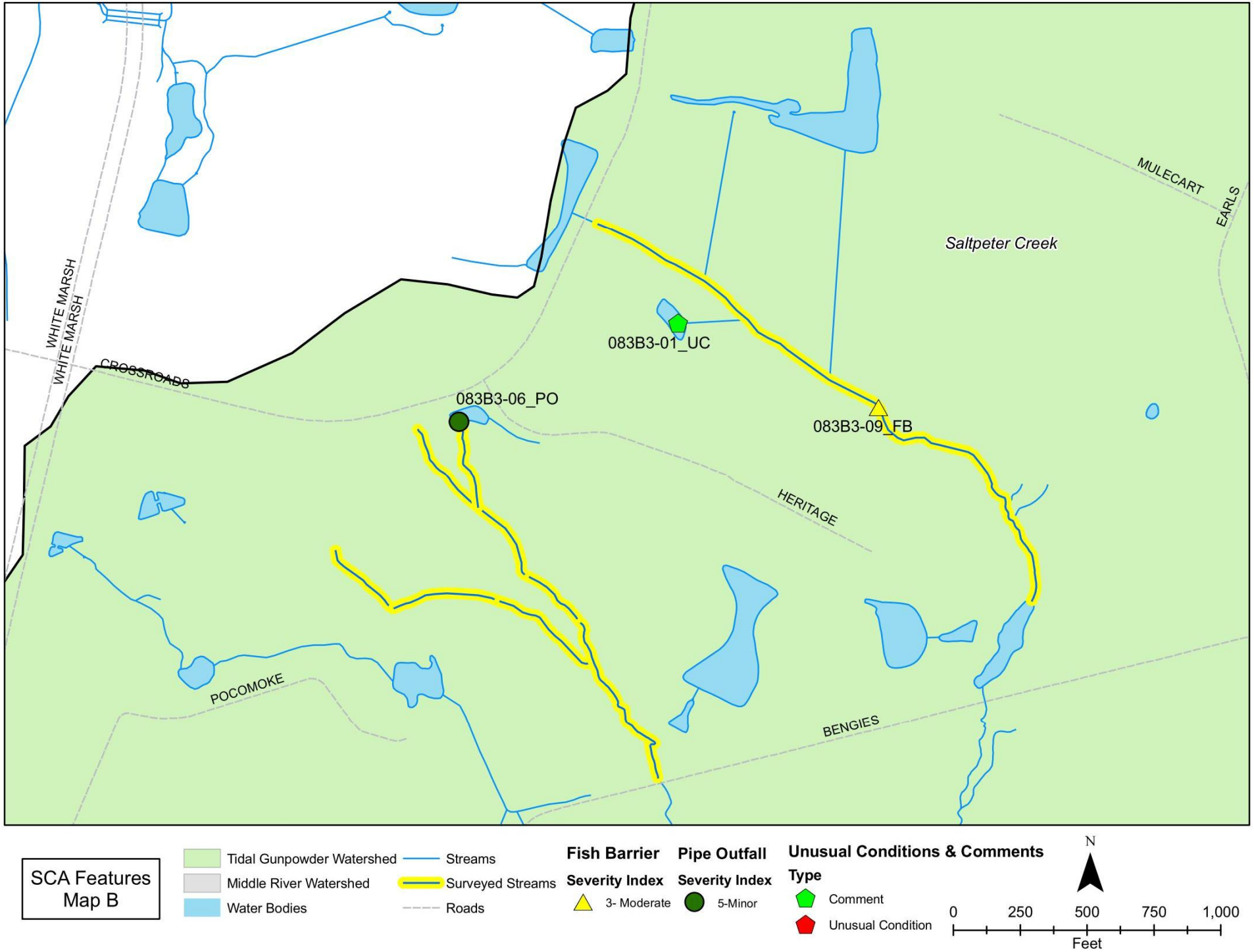

Figure 3-26: Location of Other SCA Problem Sites in Tidal Gunpowder River: Map B

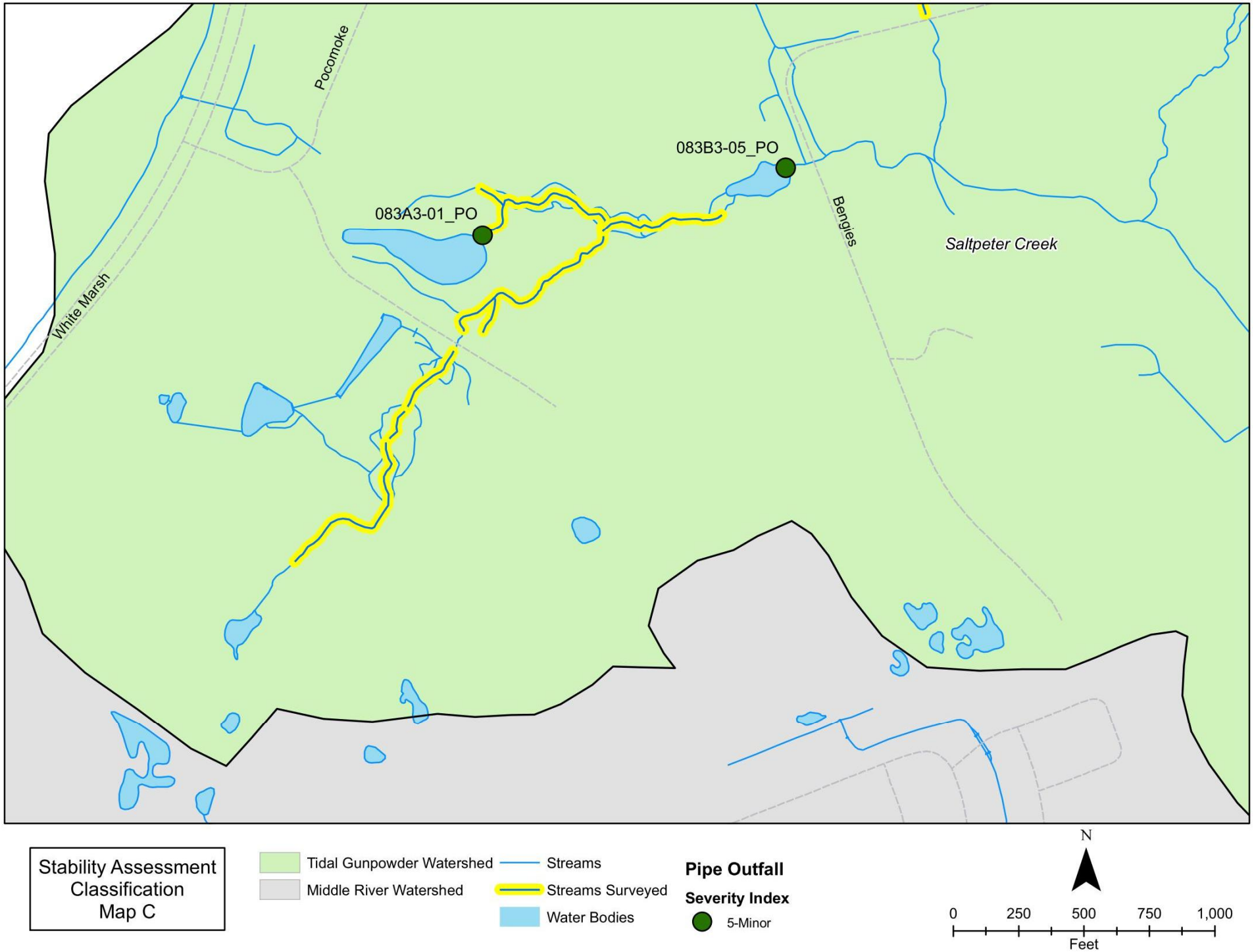

Figure 3-27: Location of Other SCA Problem Sites in Tidal Gunpowder River: Map C

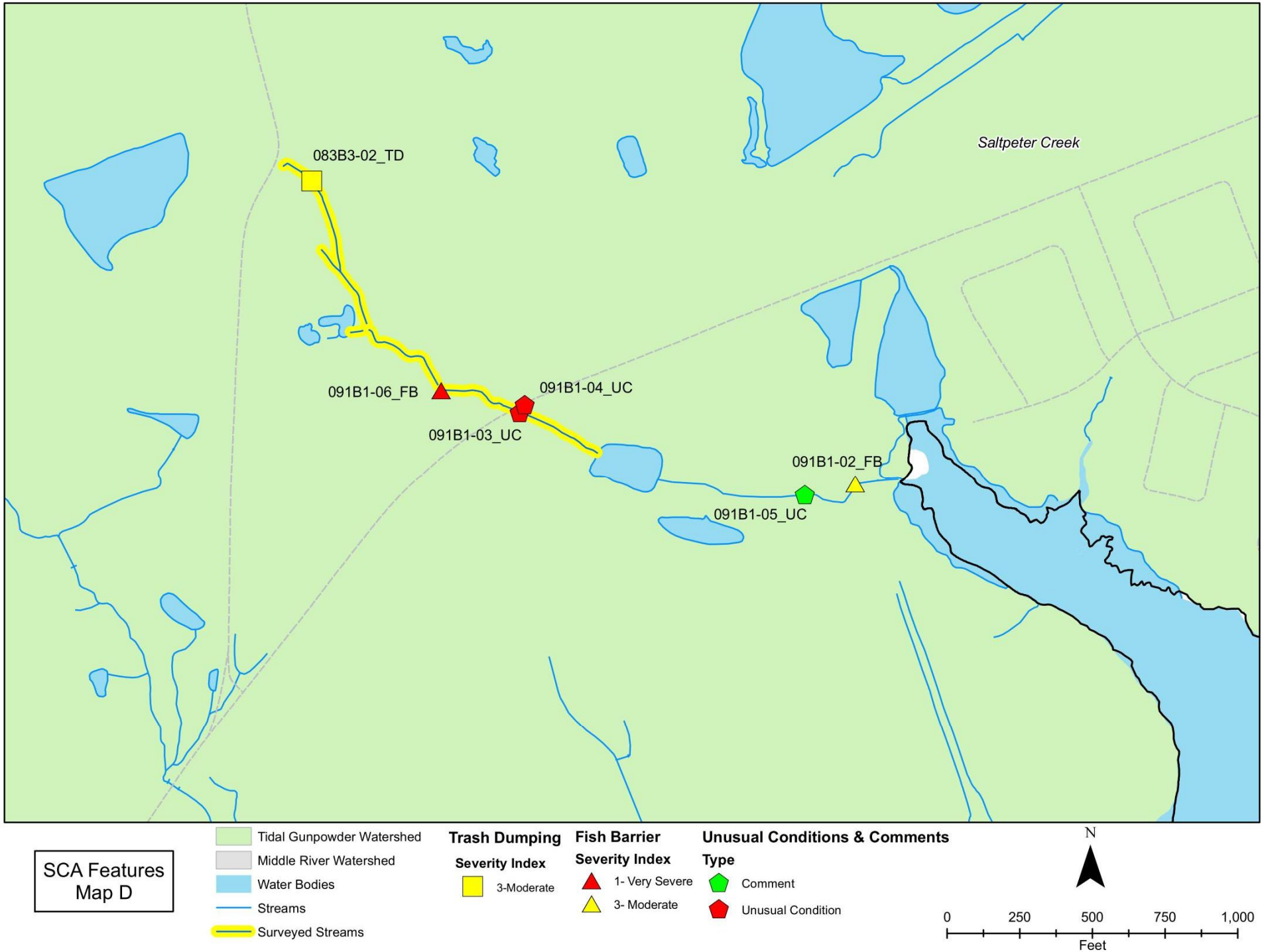

Figure 3-28: Location of Other SCA Problem Sites in Tidal Gunpowder River: Map D

3.6.3.3 Stream Stability Assessments

As described previously, stream stability assessments are aimed to help identify restoration potential of individual stream reaches during the SCA process. For each stream reach surveyed in the field, an SA site was assigned and characterized according to three parameters:

1. Channel condition
2. Streambed condition
3. Stream planform type

During the Tidal Gunpowder River stream assessments, the channel condition of SA sites were classified as one of four stages, based on a condensed version of the Channel Evolution Model (CEM): Stage I-Incision; Stage II-Widening; Stage III-Deposition; and Stage IV-Recovery and Reconstruction. To summarize, the CEM classifies streams that have been disturbed by urbanization into varying stages of disequilibrium based on the concepts of channel evolution, starting from the beginning stages of incision and channelization to the latter stages of widening, deposition, and recovery. This model is helpful during the SCA process because it provides a method to identify the direction of current trends in a stream channel and match restoration solutions to its current behavior, as different stabilization approaches are more suitable for different types of problems (USDA 2001). The CEM also helps prioritize restoration activities based on the predicted future behavior of the channel. Streambed condition was classified based on dominant and secondary substrate material composition including bedrock, boulder, cobble, gravel, sand, and silt/clay. Streambed material can be a good indication of stream health. Planform types were classified as straight, meandering, or braided. A straight channel may signify evidence of where previous channelization has occurred in contrast to a more natural meandering stream. Braided channels are typical of low-gradient streams suitable for wetland habitats.

A total of 26 SA sites were identified in the Tidal Gunpowder River SCA survey area. Figures 3-31 through 3-35, included at the end of this section, show the locations of the surveyed streams. The stream reaches and corresponding SA sites are shown with their identification number, planform type, and channel condition classification. Table 3-37 summarizes the length and percentage of streams surveyed classified under each channel condition category and planform category. Table 3-38 shows the length and percentage of streams surveyed classified under each dominant/secondary bed material combination.

Table 3-37: Tidal Gunpowder River SCA Survey Results - Stability Assessment (SA) Channel Condition and Planform

	Channel Condition (ft) Total Surveyed Streams = 14,408 ft					Planform (ft) Total Surveyed Streams = 14,408 ft			
Subwatershed	I - Incision	II - Widening	IV - Recovery	Total		Straight	Meandering	Braided	Total
Saltpeter Creek	0	600	9,680	10,280		1,164	5,362	3,754	10,280
Dundee Creek	402	0	3,726	4,128		402	2,907	819	4,128
Total	*402*	*600*	*13,406*	*14,408*		*1,566*	*8,269*	*4,573*	*14,408*

	Channel Condition (% by length)					Planform (% by length)			
Subwatershed	I - Incision	II - Widening	IV - Recovery	Total		Straight	Meandering	Braided	Total
Saltpeter Creek	0%	6%	94%	100%		11%	52%	37%	100%
Dundee Creek	10%	0%	90%	100%		10%	70%	20%	100%
Total (%)	*3%*	*4%*	*93%*	*100%*		*11%*	*57%*	*32%*	*100%*

Table 3-38: Tidal Gunpowder River SCA Survey Results - Stability Assessment (SA) Streambed Condition

	Streambed Condition (ft) D = Dominant material S = Secondary material					
Subwatershed	D - Gravel S - Sand	D - Sand S - Gravel	D - Sand S - Silt/Clay	D - Silt/Clay S - Sand	D - Silt/Clay S - Silt/Clay	Total
Saltpeter Creek	0	0	9,067	896	317	10,280
Dundee Creek	402	1,444	2,282	0	0	4,128
Total	*402*	*1,444*	*11,349*	*896*	*317*	*14,408*

	Streambed Condition (% by length) D = Dominant material S = Secondary material					
Subwatershed	D - Gravel S - Sand	D - Sand S - Gravel	D - Sand S - Silt/Clay	D - Silt/Clay S - Sand	D - Silt/Clay S - Silt/Clay	Total
Saltpeter Creek	0%	0%	88%	9%	3%	100%
Dundee Creek	10%	35%	55%	0%	0%	100%
Total (%)	*3%*	*10%*	*79%*	*6%*	*2%*	*100%*

With respect to channel condition, most stream reaches surveyed were considered stable (24 out of 26 reaches). These were classified under CEM Stage IV-Recovery and Reconstruction, though many of them are located in wooded areas and are most probably pre-disturbance streams. No stream reaches were observed to be in Stage III of deposition. Almost 90% of the total stream length surveyed was also observed to be meandering (57%) or braided (32%). This indicates that most streams in the survey area exhibit natural planform behavior. Two of the three straight channel reaches are located on industrial properties near Eastern Avenue; these are also reaches with over 400 feet of inadequate buffer.

Streambed materials observed ranged from silt/clay to gravel, with the most common substrate being sand as the dominant bed material and silt/clay as the secondary material (79% of total stream length surveyed). Two reaches with silt/clay as the dominant bed material are located in the Saltpeter Creek subwatershed near relatively new developments; however, it is unknown if the developments are the cause of the fine grained substrate. Stream reaches with more coarse grained bed material, such as gravel, were observed in the Dundee Creek subwatershed. It should be noted, however, that these are located off of Eastern Avenue in areas where there is a high chance that the channels have been altered at some point. This is evidenced by the fact that Reach 083C3-C1 with gravel as the dominant bed material and sand as the secondary material also has a straight planform and is the only reach in the

survey area observed to be slightly incised. This reach also contains two channel alteration sites described in the previous section. Figure 3-29 shows a photo of this stream reach. The images in Figure 3-30 show typical examples of a meandering stream reach (left) and a braided stream (right) observed during the field assessments. The abundance of stable channels exhibiting natural stream characteristics in the Tidal Gunpowder River SCA survey area confirms that there are many potential opportunities for preservation.

Figure 3-29: Stream Reach 083C3-C1, Looking Upstream

Figure 3-30: Meandering Stream Reach 083B3-B2, Looking Upstream (left); and Braided Stream Reach 083B3-G1 (right), Looking Upstream

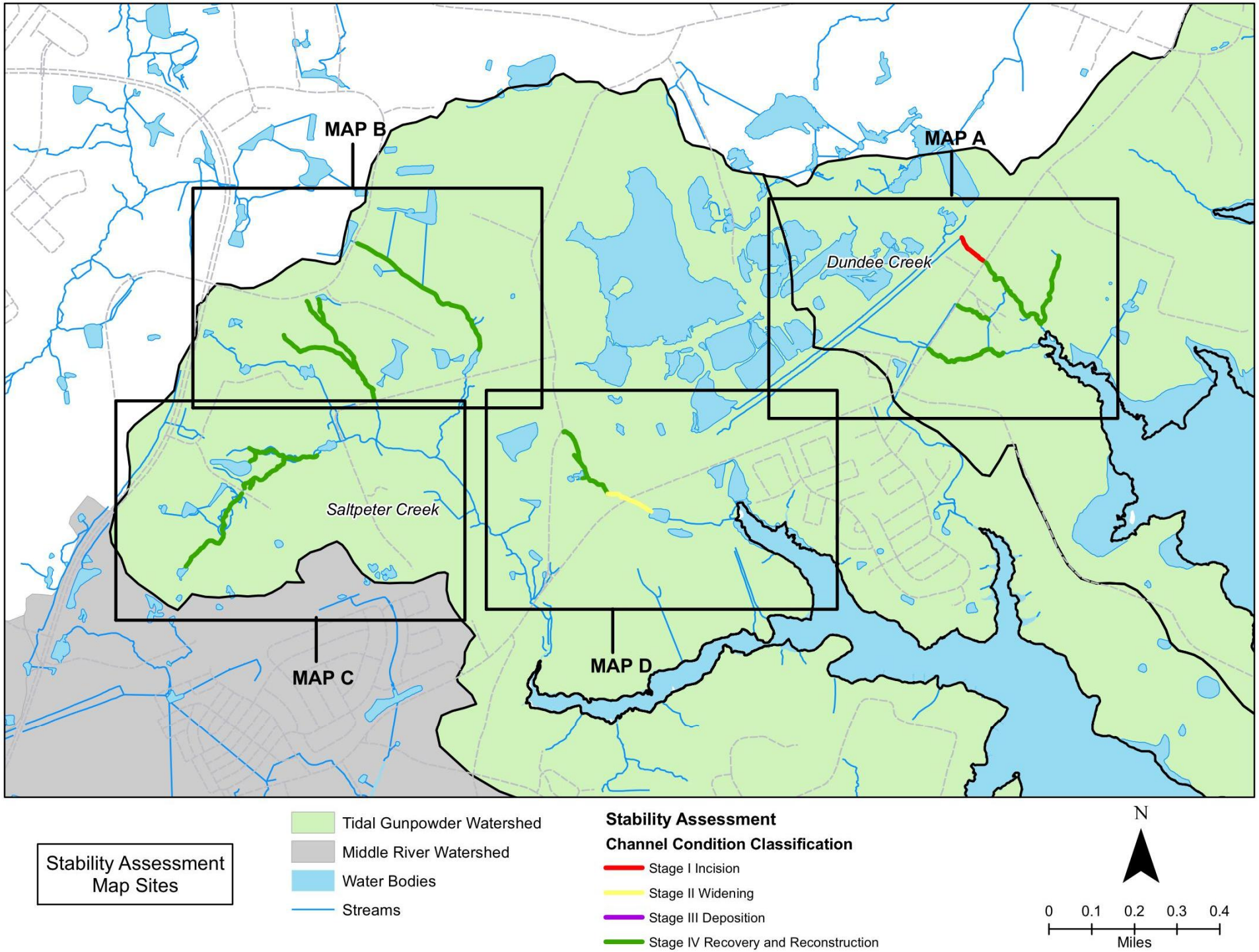

Figure 3-31: Location of Stability Assessment Reaches in Tidal Gunpowder River: Key Map

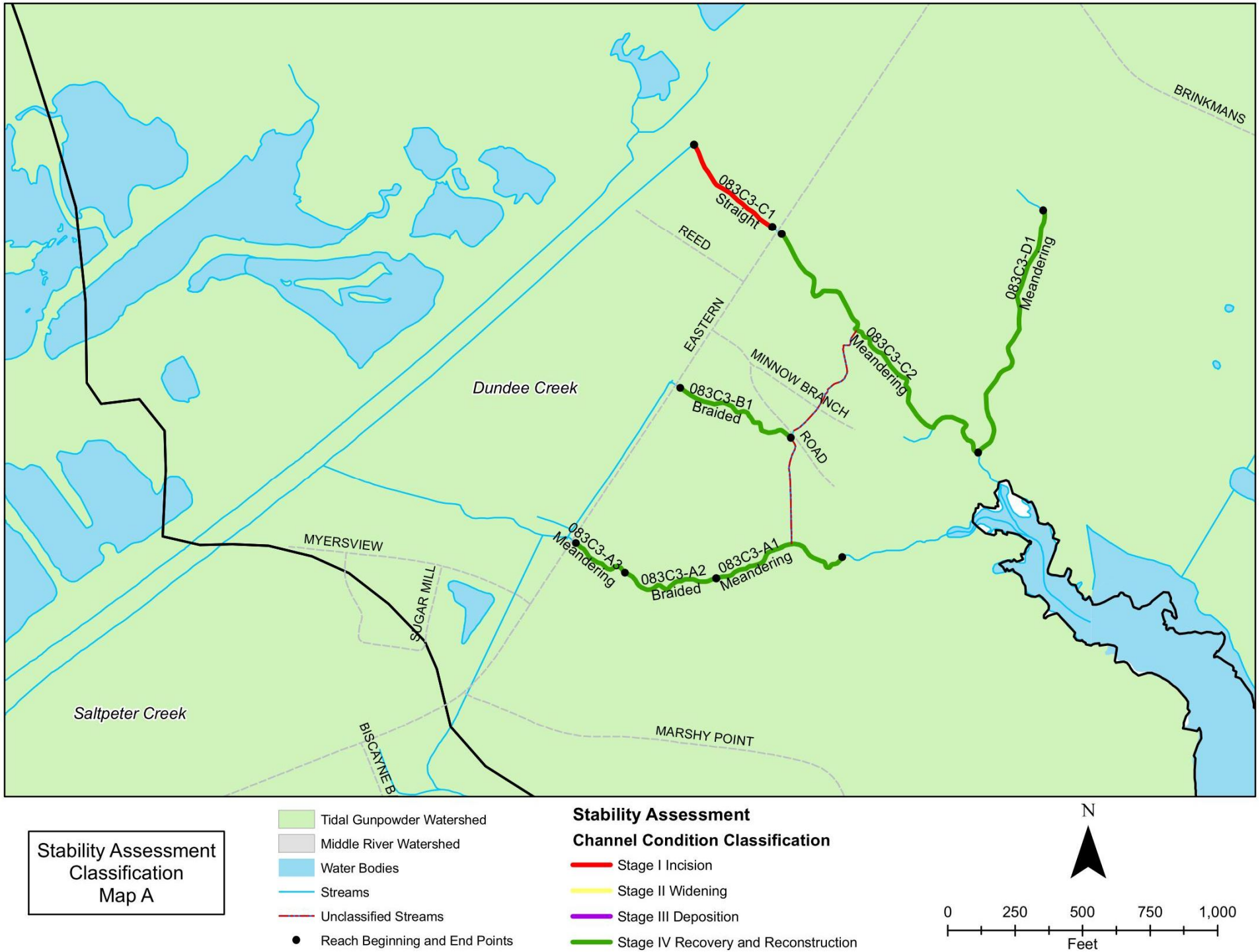

Figure 3-32: Location of Stability Assessment Reaches in Tidal Gunpowder River: Map A

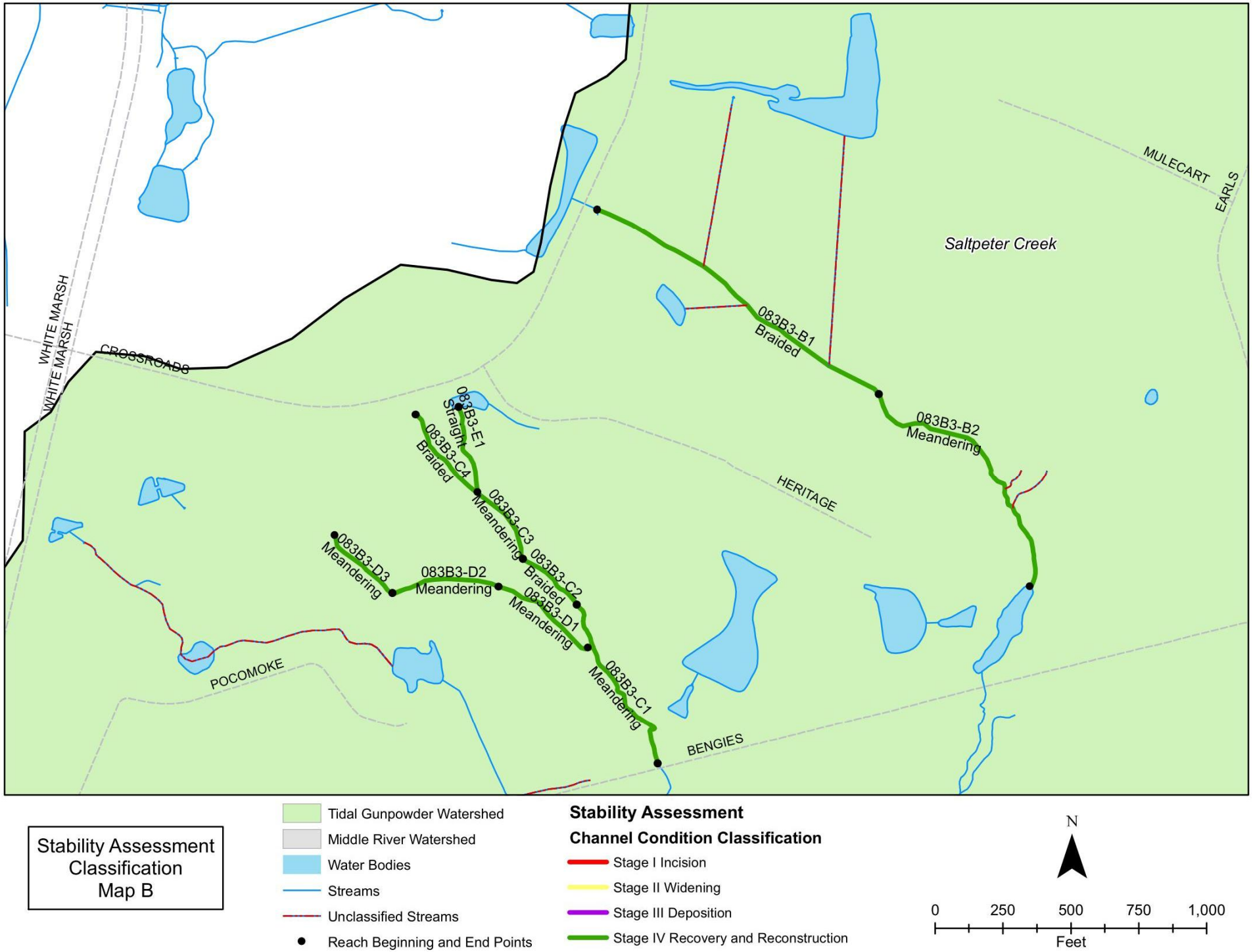

Figure 3-33: Location of Stability Assessment Reaches in Tidal Gunpowder River: Map B

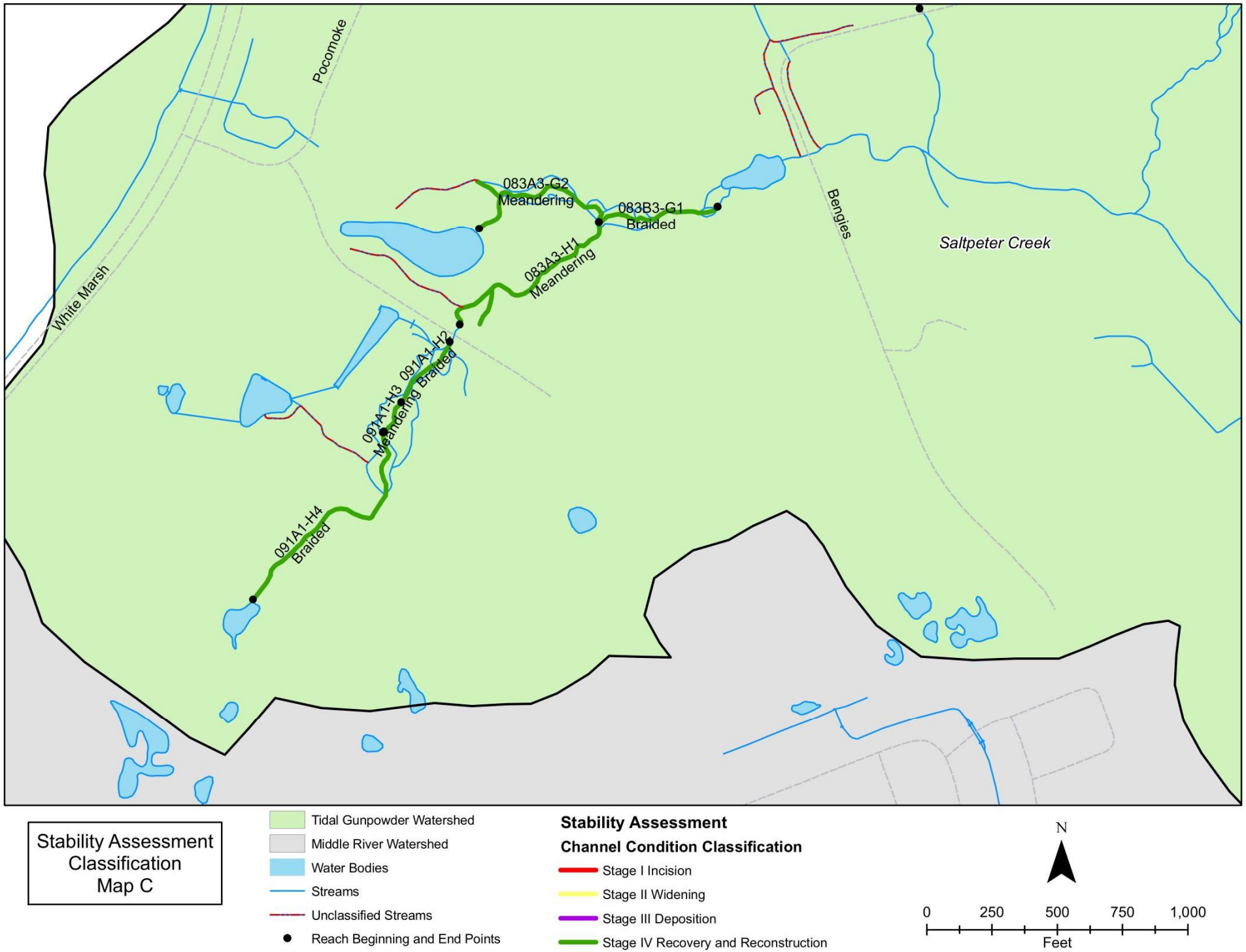

Figure 3-34: Location of Stability Assessment Reaches in Tidal Gunpowder River: Map C

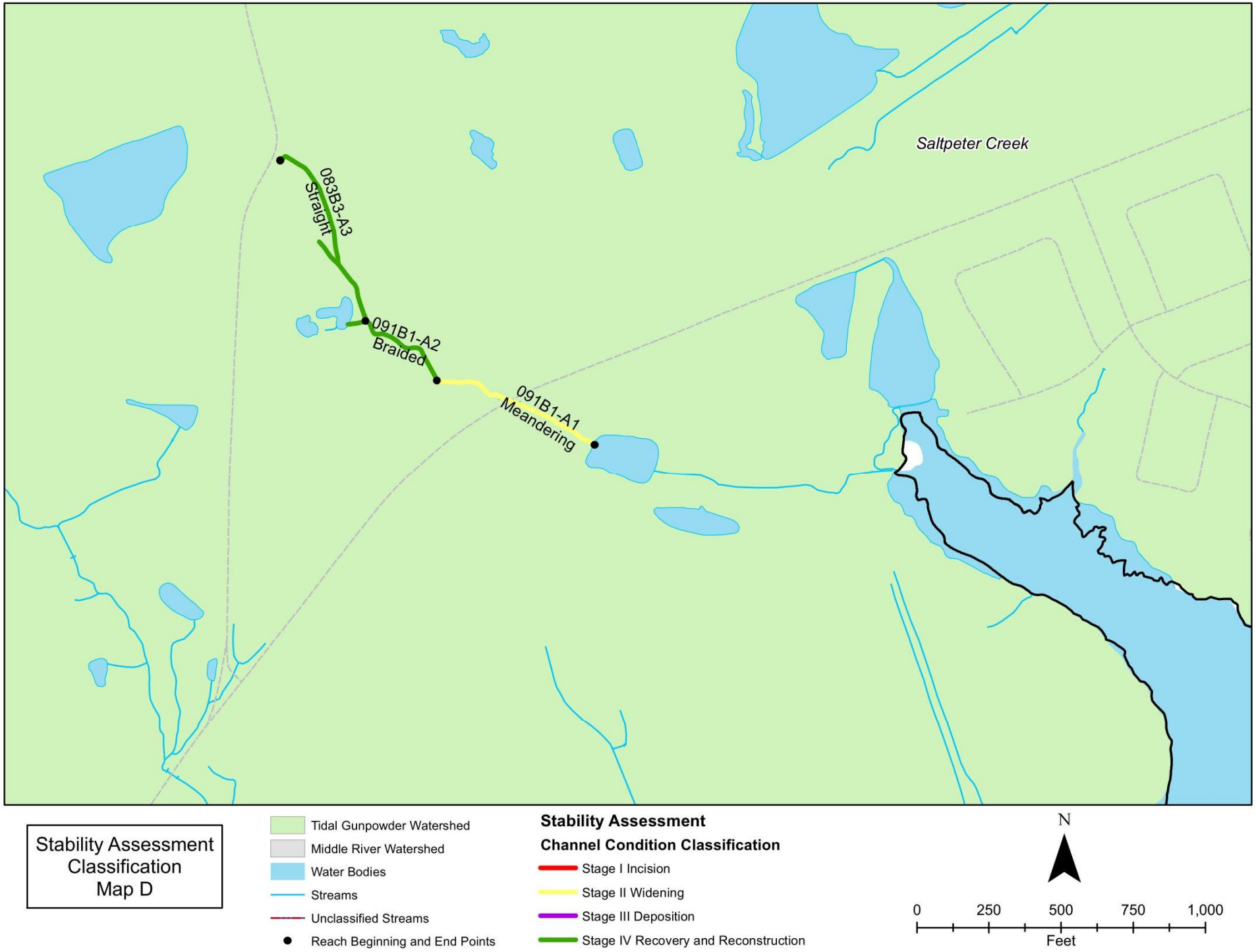

Figure 3-35: Location of Stability Assessment Reaches in Tidal Gunpowder River: Map D

3.7 Stormwater Management Facilities

Existing SWM facilities within the Middle River and Tidal Gunpowder River watersheds were investigated for potential conversion to water quality management facilities. As discussed in Chapter 2.3.6, there are a total of 111 SWM facilities that have been built within the planning area according to Baltimore County EPS's database. These include dry and wet ponds, wetlands, infiltration/filtration practices, extended detention, proprietary BMPs, and grassed swales and channels. Approximately 43% of these SWM facilities are filtration/infiltration practices or extended detention 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 111 existing SWM facilities, there are 20 dry detention ponds which are typically designed to address water quantity only (flood control) and therefore, provide almost no pollutant removal. Dry ponds have the greatest potential for conversion to a type of facility that provides water quality benefits in addition to quantity control. Therefore, 10 of the facilities were selected assessed for their potential to be converted to an extended detention facility. Dry extended detention ponds are designed to capture and retain stormwater runoff from a storm for a minimum duration (e.g., 24 hours) to allow sediment and pollutants to settle out while also being able to provide flood control if additional storage is incorporated into the design. The locations of the 10 detention ponds in the Middle River and Tidal Gunpowder River watersheds are shown in Figure 3-36. Table 3-39 summarizes the available information obtained from Baltimore County EPS's database including structure location, ownership, design capacity (drainage area, storm event), and as-built date (if available). Note that Site ID numbers correspond to structure numbers in the County database.

Information was collected in the field to assess the existing conditions and conversion potential of each dry detention pond in the Middle River and Tidal Gunpowder River watersheds. SWM assessment criteria is listed in Table 3-40. Field data findings are summarized in Table 3-41.

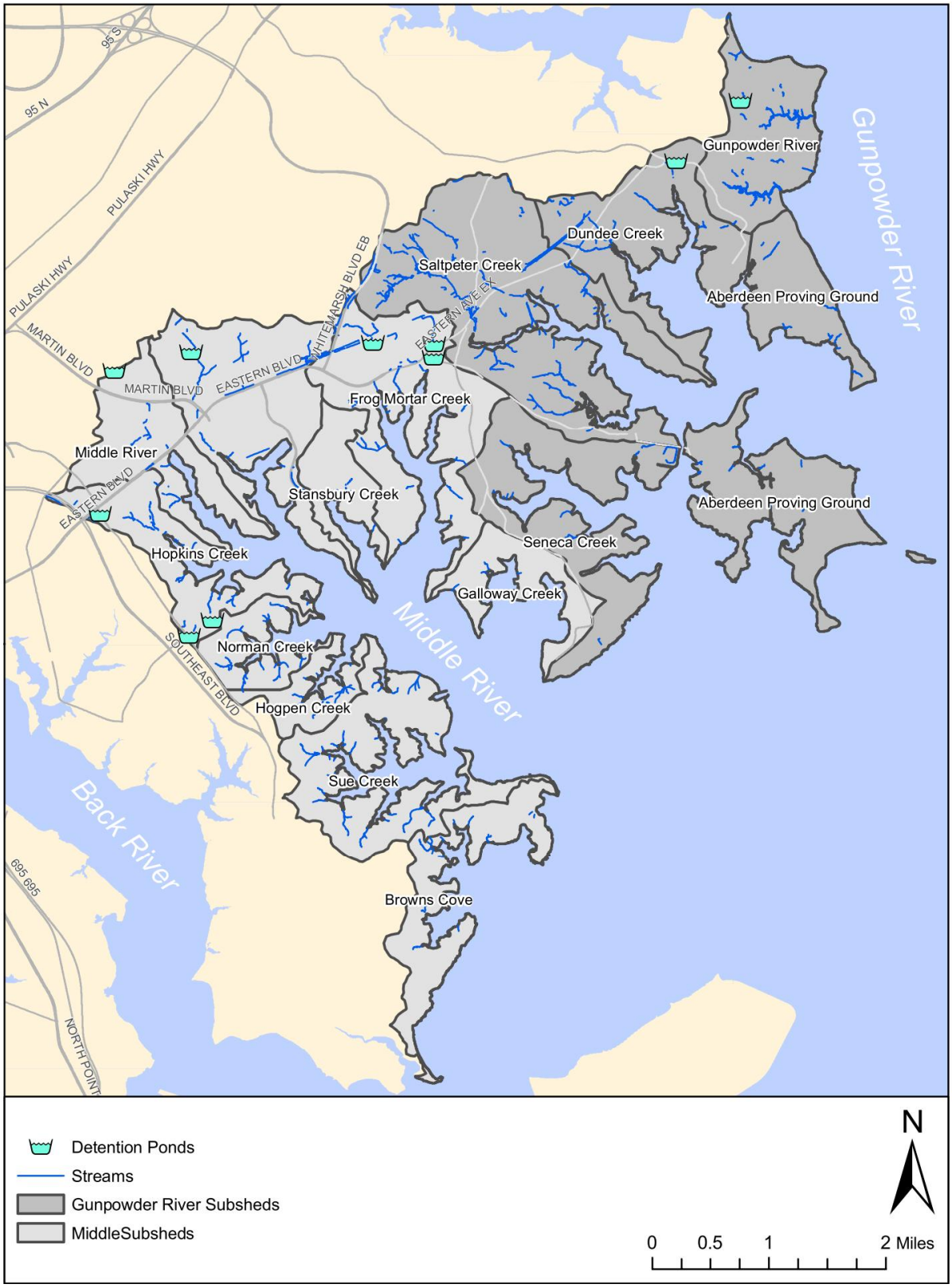

Figure 3-36: Detention Ponds Assessed for Conversion Potential in Middle River/Tidal Gunpowder River

Table 3-39: Detention Pond Information from Baltimore County Database

Site ID	Subwatershed	Structure Name	Nearest Road	Ownership	Drainage Area (acres)	Pond Design	Pond As-Built
SWM_F_435	Dundee Creek	Cunninghill Cove Pond 2	Grace Quarters Rd/ Cunningham Hill Cove Rd	Public	38.10	2,10,50,100	3/11/1192
SWM_F_449	Gunpowder River	Cunninghill Cove Addition	Oliver Beach Rd/ Cunningham Hill Cove Rd	Public	17.86	10	
SWM_F_586	Middle River	Ivy Hall Nursing Home	Windlass Dr	Private	5.38	2,10	7/13/1990
SWM_F_591	Hopkins Creek	Harry Horney Property	Horney Ct	Public	5.80	2,10,100	2/23/1998
SWM_F_711	Hopkins Creek	Middleborough Rd Link	Hilltop Ave/ Back River Neck Rd	Public	9.97	2,10,100	
SWM_F_731	Frog Mortar Creek	Oakdale Addition	Tearose Dr/ Rasberry Ct	Private	4.63	2,10,100	10/1/1990
SWM_F_914	Hopkins Creek	Super 8 Motel	Stemmers Run Rd	Private	0.60	WQ	
SWM_F_950	Darkhead Creek	Village of Pawnee	Pawnee Rd/ Choctaw Ct	Public	122.00	2,10,100	
SWM_F_988	Frog Mortar Creek	Williams Estate, Eastern Pond	Eastern Blvd	Private	66.40	2,10,100	
SWM_F_1358	Frog Mortar Creek	Amoco Oil	Carroll Island Rd	Private	1.08	2,10	7/23/1992

Table 3-40: SWM Facility Assessment Criteria

Pond No._____ Staff:_____ Date:_____

ADC Map:_____ Nearest Road:_____

Database Pond Type:_____ Field Pond Type:_____

Pond Drainage Area:_____

Pond Ownership: (circle one) Public Private Unknown

Pond Condition: Check all that apply

Riser: ☐ Good Condition ☐ Damaged

Describe Damage:_____

Embankment ☐ No problems ☐ Trees on Embankment ☐ Erosion

☐ Holes in the embankment

Vegetation Pond bottom ☐ Wetland vegetation ☐ Trees ☐ Bare soil erosion

Fence/gate ☐ Fence in good condition ☐ Fence need repair ☐ No Fence

☐ Gate locked ☐ Gate unlocked ☐ No Gate

Conversion Potential: Check all that apply

Pond field type conducive to conversion: ☐ Yes ☐ No

Pond is on line: ☐ Yes ☐ No

Ease of access: ☐ Easy ☐ Moderate ☐ Difficult

Flow routing: ☐ Short flow path ☐ Long flow path

Comments On Conversion Potential:

_____

_____

Table 3-41: Detention Pond Field Assessment Summary

Site ID	Riser	Embankment	Bottom	Fence	Gate	Water Quality Potential	Connection	Access	Flow Path
SWM_F_435	Damaged	Trees	Wetland Veg.	No Fence	No Gate	Y	Online	Easy	Long
SWM_F_449	Damaged	Erosion	Wetland Veg.	No Fence	No Gate	Y	Online	Moderate	Long
SWM_F_586	Minor Maint.	Trees	Wetland Veg.	Repair Needed	Locked	Y	Offline	Easy	Long
SWM_F_591	Minor Maint.	Trees	Trees	Good	Locked	Y	Offline	Moderate	Long
SWM_F_711	Good	Trees	Wetland Veg.	No Fence	No Gate	Y	Offline	Easy	Long
SWM_F_731	Good	Trees	Turf Grass	No Fence	No Gate	Y	Offline	Easy	Short
SWM_F_914	Good	No Problems	Turf Grass	Good	Locked	N	Offline	Easy	Long
SWM_F_950	Good	Trees	Wetland Veg.	Repair Needed	Unlocked	Y	Offline	Easy	Long
SWM_F_988	Good	No Problems	Turf Grass	Good	Unlocked	Y	Online	Easy	Short
SWM_F_1358	Good	No Problems	Wetland Veg.	Good	Locked	Y	Offline	Easy	Short

Nine out of the 10 detention ponds have water quality improvement potential such as conversion to an extended detention facility or possible incorporation of filtration/infiltration practices. Each of the detention ponds are described briefly below including key findings, pond maintenance and retrofit recommendations, and site photos. Field evaluation forms and conceptual design sketches are included in Appendix B.

SWM_F_435

Detention Pond, SWM_F_435, is a publicly-owned facility, located near the intersection of Ebenezer Road and Cunninghill Cove Road. This pond is designed to handle runoff from 2-, 10-, 50-, and 100-year events from a 38.1-acre development of single family homes. Key findings, pond maintenance and retrofit recommendations are listed below.

Key Findings

- The entrance of the low flow pipe was completely blocked with sediment. Low flows have found a new pathway into bottom of the corrugated metal pipe (CMP) riser, causing localized gully erosion in front of riser.
- There are many trees on the upstream side of pond embankment.
- There was trash and oil sheen floating within puddles at the existing pipe outfalls into the pond.
- The invert of the 36-inch CMP principal spillway was corroded.
- The bottom of the metal end sections for the 36-inch CMP principal spillway and 18-inch CMP culvert beneath Ebenezer Road was completely rusted out and no longer present.
- Access to the pond is easy along Ebenezer Road and Cunninghill Cove Road.
- The existing pond is constrained horizontally on all sides, so there is no potential for horizontal expansion.

Pond Maintenance Recommendations

- Replace low flow pipe.
- Remove trees on the upstream side of pond embankment.
- Slipline the 36-inch CMP principal spillway. If pipe is not structurally sound enough for sliplining, then replace. Note that sliplining will reduce the Manning's n value (resistance) and thus, increase flow velocity exiting the pipe. Adequate riprap outlet protection (or other suitable velocity dissipater) will likely need to be installed if pipe is sliplined.
- Replace the metal end sections for the 36-inch CMP principal spillway and 18-inch CMP culvert beneath Ebenezer Road.

Pond Retrofit Recommendations

- Install pretreatment forebays at existing pipe outfalls into the pond.
- Construct maintenance access roads to the forebays and riser.
- Excavate below the existing pond bottom in order to provide water quality volume. The pond bottom area is large enough for some flexibility. One possibility would be to direct flow from

forebays into a shallow wetland in center of pond and then have a deep micropool in front of riser with submerged reverse-slope low flow pipe.

- Re-landscape entire pond.

Figure 3-37: Detention Pond SWM_F_435

SWM_F_449

Detention Pond, SWM_F_449, is a publicly-owned facility, located near Oliver Beach Road and Cunninghill Cove Road. This pond is designed to handle runoff from a 10-year storm event from a 17.86-acre development of single family homes. Key findings, pond maintenance and retrofit recommendations are listed below.

Key Findings

- There are many trees on the pond embankment.
- There is gully erosion behind the pond control structure (concrete headwall), likely due to surface flow.
- The 30-inch CMP principal spillway is structurally failing. The pipe invert is completely rusted out and no longer present on both upstream and downstream ends. The circular cross-section of the pipe is visibly distorted with bulges along the top.
- Baseflow passing through the principal spillway is flowing beneath the pipe through the embankment. The rusted out pipe invert at the upstream end is allowing flow to get under the pipe. The baseflow exits the principal spillway approximately 6 feet upstream of the original pipe end where the pipe invert is rusted out. The baseflow has caused a head cut (+/- 4 feet high) to form on the downstream side of the embankment at the pipe outfall.
- There is gabion outlet protection at the 30-inch CMP principal spillway outfall. The gabion mattress is leaking stone; about half of the stone is remaining in the mattress. The stone that has leaked out is visible within the receiving stream.
- The receiving stream is entrenched (+/- 3 feet deep), starting at the downstream end of the gabion outlet protection.

- The pond embankment is 10-15 feet high.
- Access to the pond is physically easy via a private driveway; access may require an easement/ agreement with homeowner.
- There is room between existing pond footprint and adjacent private property for horizontal expansion. This area is currently open space.

Pond Maintenance Recommendations

- Remove trees from pond embankment.
- Replace the principal spillway and outlet protection. The 36-inch CMP cannot be sliplined. Install filter diaphragm around new principal spillway to control seepage.

Pond Retrofit Recommendations

- Restoration of receiving stream downstream of principal spillway outfall.
- Install pretreatment forebays at existing pipe outfalls into the pond.
- Install new concrete riser.
- Construct maintenance access roads to the forebays and riser. The access road could begin at the end of the private driveway and travel along the 10-foot wide top of embankment.
- Excavate below the existing pond bottom in order to provide water quality volume. The pond bottom area is large enough for some flexibility. One possibility would be to direct flow from forebays into a shallow wetland in center of pond and then have a deep micropool in front of riser with submerged reverse-slope low flow pipe.
- Re-landscape entire pond.

Figure 3-38: Detention Pond SWM_F_449

SWM_F_586

Detention Pond, SWM_F_586, is a privately-owned facility, located off of Windlass Drive. This pond is designed to handle runoff from 2- and 10-year storm events from Ivy Hall Senior Living Center, a 5.38-acre development. Key findings, pond maintenance and retrofit recommendations are listed below.

Key Findings

- There are many trees on the pond embankment.
- There is dense vegetation surrounding the low flow pipe (perforated horizontal pipe with stone jacket).
- Several sections of fence surrounding the pond are collapsed.
- Maintenance personnel stated that the low flow pipe was replaced 2-3 years ago. Prior to replacement, the pond was holding water due to the clogged low flow pipe.
- Access to the pond is easy from several points along parking lot.
- The existing pond is constrained horizontally on all sides, so there is no potential for horizontal expansion.

Pond Maintenance Recommendations

- Remove trees from pond embankment.
- Remove dense vegetation surrounding low flow pipe.
- Repair broken sections of fence.

Pond Retrofit Recommendations

- Install pretreatment forebays at existing pipe outfalls into the pond.
- Excavate below the existing pond bottom in order to provide water quality volume. The pond bottom area is large enough for some flexibility. One possibility would be to direct flow from forebays into a shallow wetland in center of pond and then have a deep micropool in front of riser with submerged reverse-slope low flow pipe.
- Re-landscape entire pond.

Figure 3-39: Detention Pond SWM_F_586

SWM_F_591

Detention Pond, SWM_F_591, is a publicly-owned facility, located off of Horney Court. This pond is designed to handle runoff from 2-, 10-, and 100-year storm events from a 5.8-acre development of single family homes. Key findings, pond maintenance and retrofit recommendations are listed below.

Key Findings

- There are small trees and dense vegetation surrounding control structure (18-inch end section).
- Pond bottom has invasive vegetation (phragmites).
- There is minor gully erosion along the pond side slope adjacent to homeowners' backyards.
- The only part of the pond that has easy access is at the pipe outfall into the pond. The remainder of the pond is difficult to access because of the surrounding pond fence; adjacent property is only +/- 6 feet from the pond top of cut (narrow for heavy equipment).
- The existing pond is constrained horizontally on all sides, so there is no potential for horizontal expansion.

Pond Maintenance Recommendations

- Remove small trees and dense vegetation surrounding the control structure.
- Remove invasive vegetation from pond bottom.
- Repair minor gully erosion on pond side slope.

Pond Retrofit Recommendations

- Install pretreatment forebay at existing pipe outfall into the pond.
- Construct maintenance access road directly to the forebay.
- Excavate below the existing pond bottom in order to provide water quality volume. The pond bottom area is large enough for some flexibility. One possibility would be to direct flow from forebays into a shallow wetland in center of pond and then have a deep micropool in front of riser with submerged reverse-slope low flow pipe.
- Re-landscape entire pond.

Figure 3-40: Detention Pond SWM_F_591

SWM_F_711

Detention Pond, SWM_F_711, is a public-owned facility, located at the intersection of Hilltop Avenue and Back River Neck Road. This pond is designed to handle runoff from 2-, 10-, and 100-year storm events from a 9.97-acre development of single family homes. Key findings, pond maintenance and retrofit recommendations are listed below.

Key Findings

- There are trees on the downstream side of pond embankment.
- There was trash and oil sheen floating within puddles at the existing pipe outfalls into the pond.
- Access is easy from Hilltop Avenue.
- Most of pond bottom is turf grass.
- There is room northeast of the pond for horizontal expansion. This area is currently meadow with some brush.

Pond Maintenance Recommendations

- Remove trees from downstream side of pond embankment.

Pond Retrofit Recommendations

- Install pretreatment forebays at existing pipe outfalls into the pond.
- Construct maintenance access roads directly to the forebays.
- Excavate below the existing pond bottom in order to provide water quality volume. The pond bottom area is large enough for some flexibility. One possibility would be to direct flow from forebays into a shallow wetland in center of pond and then have a deep micropool in front of riser with submerged reverse-slope low flow pipe.
- Re-landscape entire pond.

Figure 3-41: Detention Pond SWM_F_711

SWM_F_731

Detention Pond, SWM_F_731, is a privately-owned facility, located at the intersection of Tearose Drive and Raspberry Court. This pond is designed to handle runoff from 2-, 10-, and 100-year storm events from a 4.63-acre mobile home development. Key findings, pond maintenance and retrofit recommendations are listed below.

Key Findings

- There are trees on the pond embankment.
- Entire pond footprint is high maintenance turf grass. It appears that this area may receive chemical lawn treatment (fertilizer and herbicide).
- Pet waste was found on the ground within the pond. This indicates that residents use the pond as a pet walking area.
- Access is easy from Raspberry Court and Tearose Drive.
- There is a concrete lined pilot channel from inflow pipe directly to riser.
- The existing pond is constrained horizontally on all sides, so there is no potential for horizontal expansion.

Pond Maintenance Recommendations

- Remove trees from pond embankment.
- Install signage reminding pet owners to pick up pet waste.
- Reduce/eliminate chemical lawn treatment.

Pond Retrofit Recommendations

- Install pretreatment forebays at existing pipe outfall and curb opening inflow into the pond.
- Construct maintenance access roads directly to the forebays.
- Excavate below the existing pond bottom in order to provide water quality volume. The pond bottom area is large enough for some flexibility. One possibility would be to direct flow from forebays into a shallow wetland in center of pond and then have a deep micropool in front of riser with submerged reverse-slope low flow pipe. Note, however, that the pond is located in the middle of a residential community, and there is currently no fencing surrounding pond. A deep micropool may not be possible (due to public safety concerns) without the installation of fencing.
- Re-landscape entire pond.
- Remove concrete pilot channel as part of excavation of pond bottom

Figure 3-42: Detention Pond SWM_F_731

SWM_F_914

Detention Pond, SWM_F_914, is a privately-owned facility, located off of Stemmers Run Road. This pond is designed to handle runoff from 0.6 acres of a single hotel development. Key findings, pond maintenance and retrofit recommendations are listed below.

Key Findings

- Pond bottom is turf grass.
- Small area draining to pond.
- Pond footprint is very small.
- Access is easy from apartment parking lot.
- The existing pond is constrained horizontally on all sides, so there is no potential for horizontal expansion.

Pond Maintenance Recommendations

- None required.

Pond Retrofit Recommendations

- No recommendations due to small drainage area and limited expansion capability.

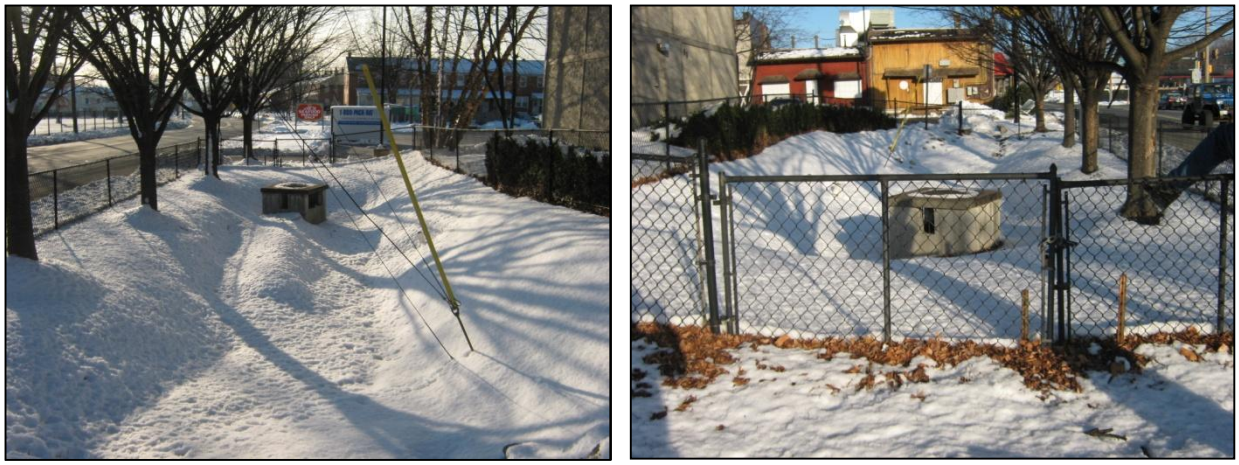

Figure 3-43: Detention Pond SWM_F_914

SWM_F_950

Detention Pond, SWM_F_950, is a publicly-owned facility at the intersection of Pawnee Road and Choctaw Court. This pond is designed to handle runoff from 2-, 10-, and 100-year storm events from a 122-acre development of single family homes. Key findings, pond maintenance and retrofit recommendations are listed below.

Key Findings

- There are trees on the pond embankment.
- Several sections of the existing fence were damaged.
- Pond bottom was overrun with invasive vegetation (phragmites).
- Access is easy from Choctaw Court.
- The existing pond is constrained horizontally on all sides, so there is no potential for horizontal expansion. However, the pond has a very large surface area, conducive to providing water quality treatment; therefore, horizontal expansion may not be needed.

Pond Maintenance Recommendations

- Remove trees from pond embankment.
- Remove invasive vegetation from pond bottom.
- Repair damaged sections of existing fence.

Pond Retrofit Recommendations

- Install pretreatment forebays at existing pipe outfalls into the pond.
- Construct maintenance access roads to the forebays and riser. The access road to the riser should be located on the top of existing pond embankment. However, the embankment width may need to be widened from its current width of 6 feet to 10-12 feet.
- Excavate below the existing pond bottom in order to provide water quality volume. The pond bottom area is large enough for some flexibility. One possibility would be to direct flow from

forebays into a shallow wetland in center of pond and then have a deep micropool in front of riser with submerged reverse-slope low flow pipe.

- Re-landscape entire pond.

Figure 3-44: Detention Pond SWM_F_950

SWM_F_988

Detention Pond, SWM_F_988, is a privately-owned dry detention pond off of Eastern Boulevard. This pond is designed to handle runoff from 2-, 10-, and 100-year storm events from a 66.40-acre mobile home development. Key findings, pond maintenance and retrofit recommendations are listed below.

Key Findings

- Entire pond footprint is high maintenance turf grass. It appears that this area may receive chemical lawn treatment (fertilizer and herbicide).
- Inflow into pond is via triple culverts beneath Lariat Road. There is a gabion-lined channel at the culvert outfall that directs flow into the pond, which is stable and shows no signs of erosion. However, the flow path through the pond is very short.
- Access is easy from Eastern Boulevard.
- The existing pond is constrained horizontally on all sides, so there is no potential for horizontal expansion. There also does not appear to be adequate space or access for a pretreatment forebay. However, the pond has a very large surface area, conducive to providing water quality treatment; therefore, horizontal expansion may not be needed.

Pond Maintenance Recommendations

- Reduce/eliminate chemical lawn treatment.

Pond Retrofit Recommendations

- Construct maintenance access roads to the riser.
- Excavate below the existing pond bottom in order to provide water quality volume. The pond bottom area is large enough for some flexibility. One possibility would be to direct flow from the

existing inflow channel to wet pools on each side of the pond (this is where the available space is for excavation). Construct a diversion channel/berm inside the pond in order to direct incoming flow into the wet pools and maximize the flow path through the pond.

- Re-landscape entire pond.

Figure 3-45: Detention Pond SWM_F_988

SWM_F_1358

Detention Pond, SWM_F_1358, is a privately-owned detention pond off of Carroll Island Road. This pond is designed to handle runoff from 2- and 10-year storm events from a 1.08-acre business development. Key findings, pond maintenance and retrofit recommendations are listed below.

Key Findings

- Gas station parking lot drained into an inlet that appeared to be some sort of water quality device (e.g., oil/grit separator). This inlet then drained into the pond.
- Access is easy from gas station parking lot.
- There is room north of the pond for horizontal expansion. This area is currently open space. However, this area may have underground storage tanks for gasoline which would preclude this area for pond expansion.

Pond Maintenance Recommendations

- Inspect water quality inlet and clean as needed.

Pond Retrofit Recommendations

- Excavate below the existing pond bottom in order to provide water quality volume. Note that the pond bottom area is fairly small, potentially limiting room for grading flexibility.
- Re-landscape entire pond.

Figure 3-46: Detention Pond SWM_F_1358

CHAPTER 4: UPLANDS ASSESSMENT

4.1 Introduction

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

The field survey of upland areas in the Middle River and Tidal Gunpowder River watersheds included six major components:

- Neighborhood Source Assessment (NSA)
- Hotspot Site Investigation (HSI)
- Institutional Site Investigation (ISI)
- Pervious Area Assessment (PAA)
- Marina Site Visits (MAR)
- Industrial Site Visits (IND)

The last two components, Marina and Industrial Site Visits, have been added to the typical list of upland categories as they are unique to the Middle River/Tidal Gunpowder River planning area. Each of the above components is described in detail in the following sections.

4.2 Neighborhood Source Assessment (NSA)

NSAs describe pollution source areas, stewardship behaviors, and restoration opportunities within individual neighborhoods. Each neighborhood has unique characteristics which determine the ability to implement restoration projects, source controls, and stewardship practices. The sections below describe the methods used to delineate and assess individual neighborhoods in the Middle River and Tidal Gunpowder River watersheds.

4.2.1 Assessment Protocol

Prior to conducting NSAs in the field, neighborhoods were delineated in the office using ADC street maps and GIS data such as tax parcels, historical development information and aerial photography provided by Baltimore County OIT. A neighborhood was delineated based on a group of homes with similar characteristics including lot sizes, road widths, setbacks, year houses were built, and house types (apartment complex, row homes, single family detached, etc.) NSAs were identified using the classification scheme “NSA_F_01”, where ‘F’ denotes the Middle River/Tidal Gunpowder River planning area, and neighborhoods were then numbered sequentially as delineated. Neighborhoods defined in

the office using available information were verified in the field. Adjustments were made as necessary in the field to group similar neighborhoods or separate dissimilar neighborhoods. If NSA boundaries were modified in the field, additional letters were used to distinguish NSA IDs. For example, if a neighborhood was originally designated as NSA_F_28 but was divided into two separate NSAs because of characteristics observed in the field, they would be denoted as NSA_F_28a and NSA_F_28b.

The field team conducted the initial assessments together in order to calibrate many of the assessment criteria. To complete an assessment, the field team drove through a defined neighborhood to identify potential pollution sources and restoration opportunities. To standardize the NSA process and be able to prioritize potential restoration efforts, data was collected in each neighborhood for four main source areas: yards and lawns; driveways, parking lots, sidewalks, and curbs; rooftop runoff; and common areas. These are each described briefly below.

Yards and Lawns

Yards and lawns typically represent a significant portion of the pervious cover in an urban subwatershed and therefore can be a major source of nutrients, pesticides, sediment, and runoff. Maintenance behaviors tend to be similar within individual neighborhoods and certain activities can impact subwatershed quality such as fertilization, pesticide use, watering, landscaping, and waste management. Potential pollution sources evaluated under the yards and lawns category include grass cover and management status (fertilization and irrigation methods), bare soil, outdoor swimming pools, and junk or trash. The field team also identified the proportions of impervious cover, grass cover, landscaping, and bare soil within each neighborhood. The amount of existing tree cover and landscaping was then compared to the other cover types to evaluate potential for increasing these features and providing water quality benefits through interception and filtration of stormwater runoff.

Driveways, Parking Lots, Sidewalks, and Curbs

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

Rooftops

Rooftop runoff is another contributor to stormwater runoff and pollutants in neighborhoods. Downspout retrofits can help reduce runoff and pollutants introduced to local streams. The field team identified whether downspouts discharged rooftop runoff to pervious areas, rain barrel, impervious

surfaces (driveways, street), and/or directly to the storm drain system and the proportion of each within a neighborhood. The potential for disconnecting and redirecting downspouts from impervious surface or storm drain system was also evaluated.

Common Areas

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

Other NSA Information

In addition to these four source areas, basic information was collected in individual neighborhoods to help rate restoration potential. This information included lot size, house types, fraction of houses with basements and garages, and whether a homeowners' association exists for the community. Presence of sewer service and amount of remodeling or redevelopment activities were also identified for additional potential pollution sources. After driving around the entire neighborhood and completing the basic information and four major source area sections, any major pollutants that are potentially being generated by the neighborhood are indicated on the field form in the following categories: nutrients; oil and grease; trash/litter; bacteria; and sediment. For example, if a neighborhood had several stained driveways and/or several long-term parked vehicles or boats, oil and grease would be flagged as a potential major pollutant being generated in that neighborhood. The presence of trash in yards, dumping in common areas, or overflowing/uncovered dumpsters would be a significant indicator for trash/litter generated in a neighborhood. Sediment was flagged as a major pollutant source if erosion or bare soil was observed, significant amount of remodeling or redevelopment was occurring, and/or a considerable portion of the curb and gutters were covered with sediment.

Recommended Actions

After driving through and evaluating an entire neighborhood, specific actions were recommended for neighborhood restoration or retrofits based on initial field observations. Recommended actions included in the Middle River and Tidal Gunpowder River watershed NSAs included:

- Downspout disconnection
- Fertilizer reduction/education
- Bayscaping
- Storm drain marking
- Street tree and shade tree planting

- Street sweeping
- Trash management
- Multi-family parking lot or alley retrofit

The last step of the NSA involved rating the overall neighborhood pollution severity and restoration potential. The severity of pollution generated by a neighborhood is denoted by the Pollution Severity Index (PSI) based on benchmarks and scoring system in the USSR manual. An NSA PSI is rated as severe, high, moderate, or none. A neighborhood's potential for residential restoration projects is rated as high, moderate, or low according to the Restoration Opportunity Index (ROI). The USSR also provides benchmarks and guidelines to establish NSA ROI ratings.

4.2.2 Summary of Sites Investigated

A total of 59 neighborhoods were assessed throughout the Middle River and Tidal Gunpowder River watersheds (see Figure 4-1). The number of neighborhoods within each subwatershed is summarized in Table 4-1. Note that a neighborhood may overlap multiple subwatersheds; in this case, the neighborhood is counted once for each subwatershed in which it falls. Analyses of acres of land or miles of road addressed by recommended actions, however, are based on the actual proportion of the neighborhood that falls within each subwatershed. This is explained further in subsequent sections.

Table 4-1: Neighborhoods Surveyed per Subwatershed

Subwatershed	# of NSAs
Middle River	
Darkhead Creek	12
Frog Mortar Creek	9
Galloway Creek	3
Browns Cove	3
Hogpen Creek	6
Hopkins Creek	12
Middle River	11
Norman Creek	5
Stansbury Creek	2
Sue Creek	7
Tidal Gunpowder River	
APG	0
Dundee Creek	3
Gunpowder River	1
Saltpeter Creek	6
Seneca Creek	8

Over one-third of the assessed neighborhoods, 23 out of 59, were rated as having both high PSI and high ROI. 19 neighborhoods were considered to have high PSI and moderate ROI; and 5 neighborhoods had high ROI and moderate PSI. The remaining 12 neighborhoods assessed were considered as having moderate PSI and moderate ROI. The 23 neighborhoods with high PSI and high ROI ratings represent the best areas to target for restoration initially. The distribution of PSI and ROI ratings among the NSAs are shown in Figure 4-2.

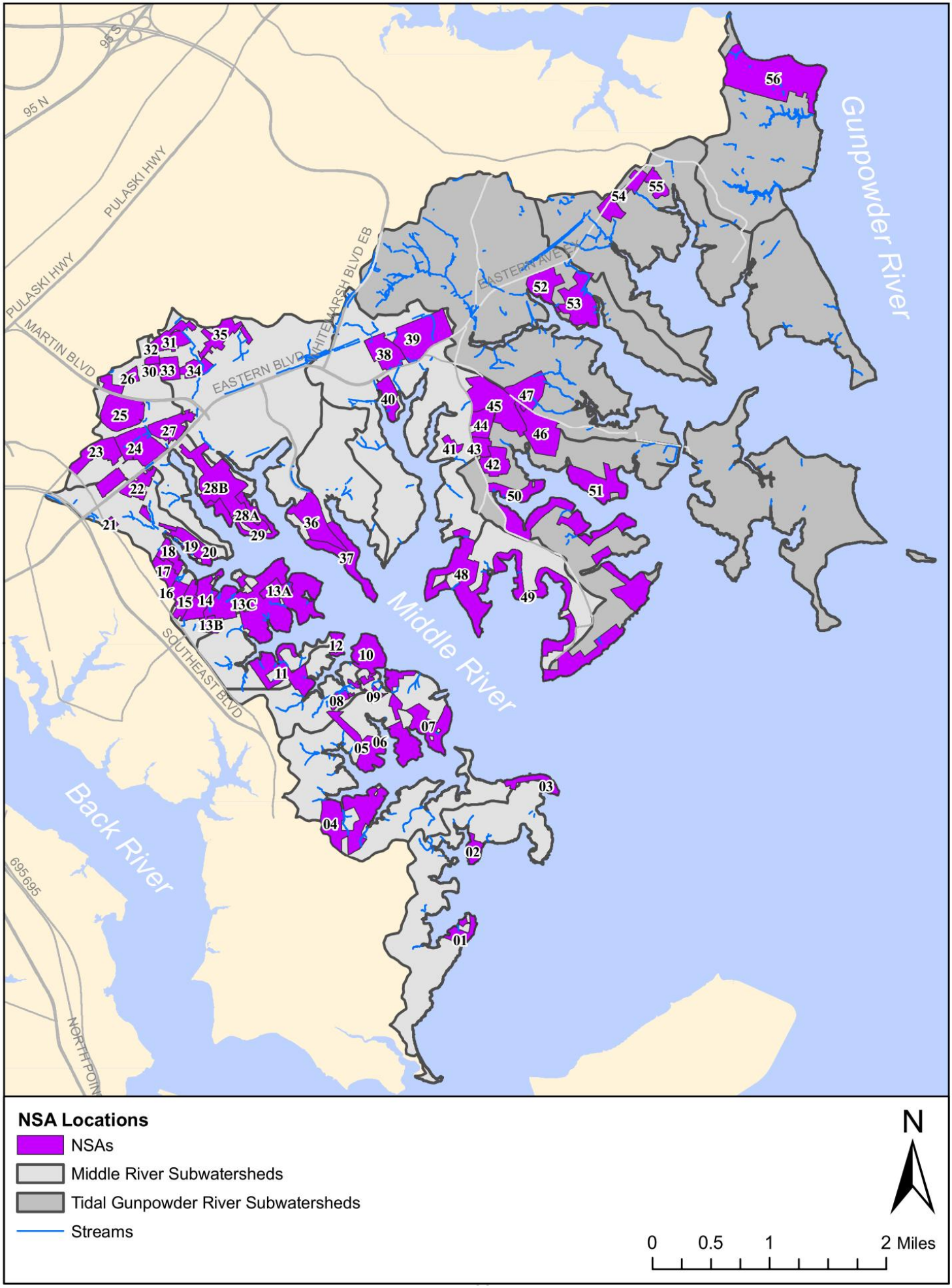

Figure 4-1: Location of NSAs in Middle River and Tidal Gunpowder River Watersheds

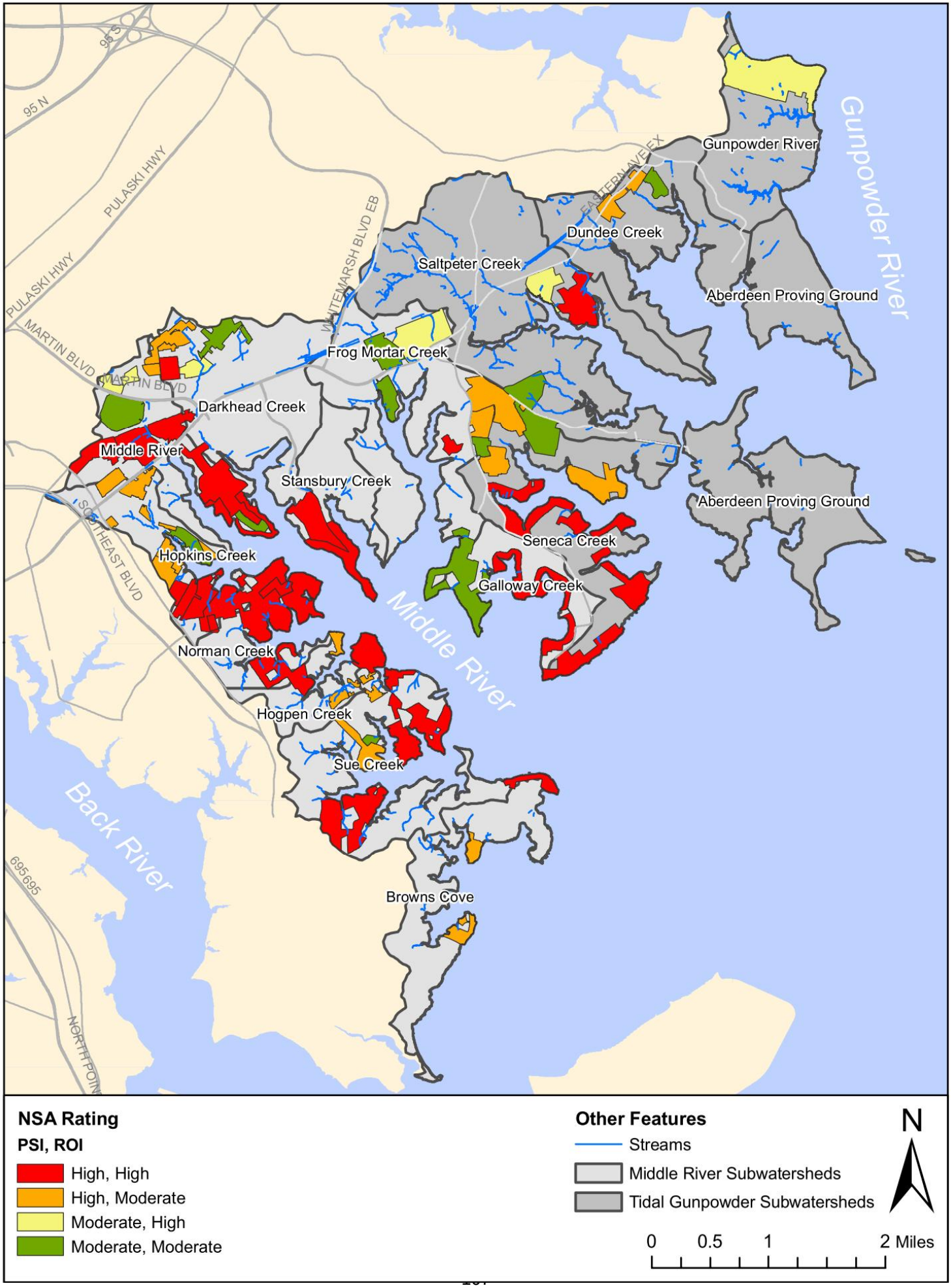

Figure 4-2: NSA Pollution Severity and Restoration Opportunity Indices in Middle River and Tidal Gunpowder River Watersheds

4.2.3 General Findings

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

4.2.3.1 Downspout Disconnection

Rooftop runoff is managed via downspouts which are classified as either connected or disconnected. Directly connected downspouts extend underground, discharging runoff directly to the storm drain system without treatment. Indirectly connected downspouts drain to impervious surfaces such as paved driveways, sidewalk, or to the curb and gutter system with little or no treatment. Disconnected downspouts allow rooftop runoff to infiltrate into the ground and enter streams through the groundwater system in a slower more natural fashion. Downspout disconnection is desirable because it decreases flow to local streams during storm events; this helps prevent erosion and reduces pollutant loads to streams. Disconnection may involve redirecting connected downspouts from impervious areas or the storm drain system onto pervious areas such as yards and lawns. This requires at least 15 feet of pervious area down gradient from the downspout for infiltration to occur. Rain barrels and rain gardens are other disconnection options that can be recommended in lieu of redirection if certain conditions exist. Rain barrels, for example, may be used to store rooftop runoff for irrigation if there is limited pervious area available for downspout redirection. Rain gardens are the most desirable option in terms of water quality because they consist of native plants that capture and treat runoff; this is a potential option for disconnection if the typical neighborhood has over one-hundred square feet of lawn area available down gradient from the downspout.

Downspout redirection is recommended for neighborhoods where at least 25% of the downspouts are connected to impervious area or directly to the storm drain system and where the average lot has at least 15 feet of pervious area available down gradient from the connected downspout for redirection. Table 4-2 includes a summary of the number of neighborhoods recommended for downspout redirection and the acres of rooftop addressed if downspout redirection were implemented by subwatershed. Table 4-2 also lists the percent of total impervious rooftop area in each subwatershed that would be addressed if downspout redirection were implemented; total impervious rooftop area per subwatershed was calculated using 2008 buildings spatial data provided by Baltimore County OIT.

Table 4-2: Rooftop Acres Addressed by Downspout Redirection

Subwatershed	# of NSAs Recommended for Downspout Redirection*	Rooftop Acres Addressed	% of Subwatershed Rooftop Area Addressed
Darkhead Creek	9	11.0	10.6%
Frog Mortar Creek	5	9.0	8.1%
Galloway Creek	3	2.3	12.3%
Browns Cove	3	2.3	17.7%
Hogpen Creek	6	3.0	20.0%
Hopkins Creek	8	19.7	33.1%
Middle River	10	18.7	21.1%
Norman Creek	4	6.8	33.9%
Stansbury Creek	2	2.2	16.7%
Sue Creek	7	15.9	38.0%
Middle River Subtotal		*90.7*	*18.8%*
Aberdeen Proving Ground	0	0.0	0.0%
Dundee Creek	0	0.0	0.0%
Gunpowder River	1	3.9	15.0%
Saltpeter Creek	2	0.4	1.0%
Seneca Creek	7	11.4	19.3%
Tidal Gunpowder Subtotal		*15.7*	*10.7%*
Total		*106.4*	*16.9%*

* If a neighborhood overlaps multiple subwatersheds, it is counted in "# of NSAs" for each subwatershed it encompasses. Rooftop acres are counted only for the subshed where they are present.

Figure 4-3 illustrates the location of neighborhoods recommended for downspout redirection. Out of the 59 neighborhoods assessed, 44 have the potential for downspout disconnection through redirection. If implemented, this could address approximately 17% of the total impervious rooftop area in the Middle River and Tidal Gunpowder River watersheds.

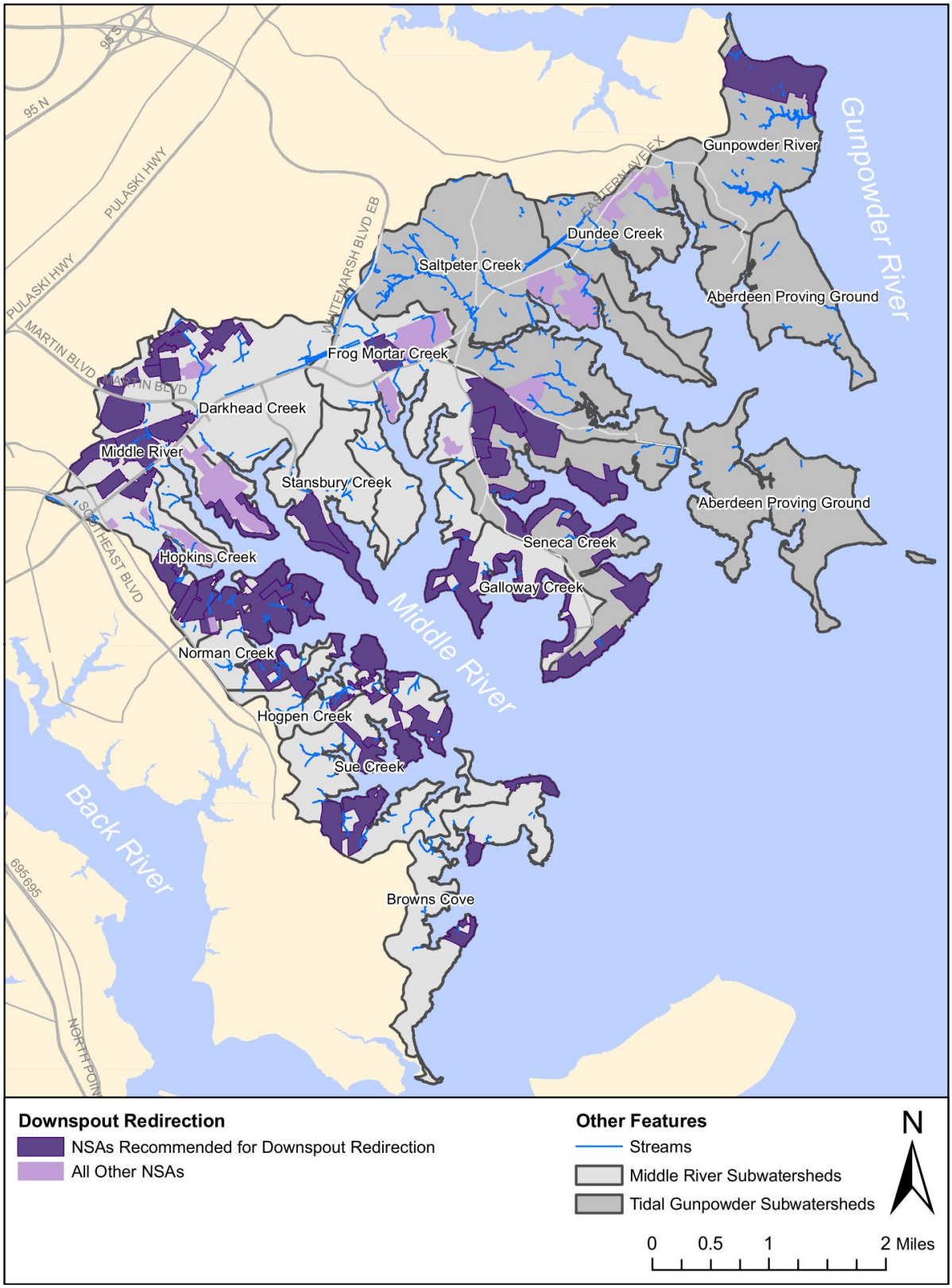

Figure 4-3: Neighborhoods Recommended for Downspout Disconnection

4.2.3.2 Fertilizer Reduction/Education

A well-maintained lawn can be beneficial to the watershed. However, lawn maintenance activities often involve over-fertilization, poor pest-management, and over-watering resulting in polluted stormwater runoff to local streams. Lawns with a dense, uniform grass cover or signs designating poisonous lawn care indicate high lawn maintenance activities.

Neighborhoods where 20% or more of the homes appeared to employ high lawn maintenance practices were recommended for fertilizer reduction/education. Table 4-3 includes a summary by subwatershed of the number of neighborhoods recommended for fertilizer reduction/education and the acres of lawn addressed if this action were initiated. Note that the acres of lawn addressed were calculated based on the percentage of high maintenance lawns within each neighborhood recommended for this action (see Appendix D for supporting calculations). Table 4-3 also lists the percent of the total subwatershed area that would be addressed by implementing fertilizer reduction/education in the recommended neighborhoods.

Table 4-3: Acres of Lawn Addressed by Fertilizer Reduction

Subwatershed	# of NSAs Recommended for Fertilizer Reduction*	Acres of Lawn Addressed	% of Subwatershed Area Addressed
Darkhead Creek	3	4.2	0.4%
Frog Mortar Creek	8	40.3	3.4%
Galloway Creek	1	8.6	2.3%
Browns Cove	3	7.4	1.2%
Hogpen Creek	5	5.0	1.9%
Hopkins Creek	3	11.8	2.0%
Middle River	2	13.3	2.0%
Norman Creek	2	3.9	1.2%
Stansbury Creek	1	2.6	0.7%
Sue Creek	5	39.3	4.1%
Middle River Subtotal		*136.4*	*2.1%*
Aberdeen Proving Ground	0	0.0	0.0%
Dundee Creek	2	1.7	0.2%
Gunpowder River	0	0.0	0.0%
Saltpeter Creek	5	5.9	0.3%
Seneca Creek	7	28.4	2.8%
Tidal Gunpowder Subtotal		*36.0*	*0.6%*
Total		*172.4*	*1.4%*

* If a neighborhood overlaps multiple subwatersheds, it is counted in "# of NSAs" for each subwatershed it encompasses. Acres of lawn are counted only for the subshed where they are present.

Figure 4-4 illustrates the location of neighborhoods recommended for fertilizer reduction/education (neighborhoods with 20 – 100% high maintenance lawns). Out of the 59 neighborhoods assessed, 31 (over half) were recommended for fertilizer reduction/education. Table 4-3 shows that only approximately 1.4 percent of the Middle River/Tidal Gunpowder River planning area would be addressed by this action; this is because the proportion of lawns in the total watershed area is relatively small.

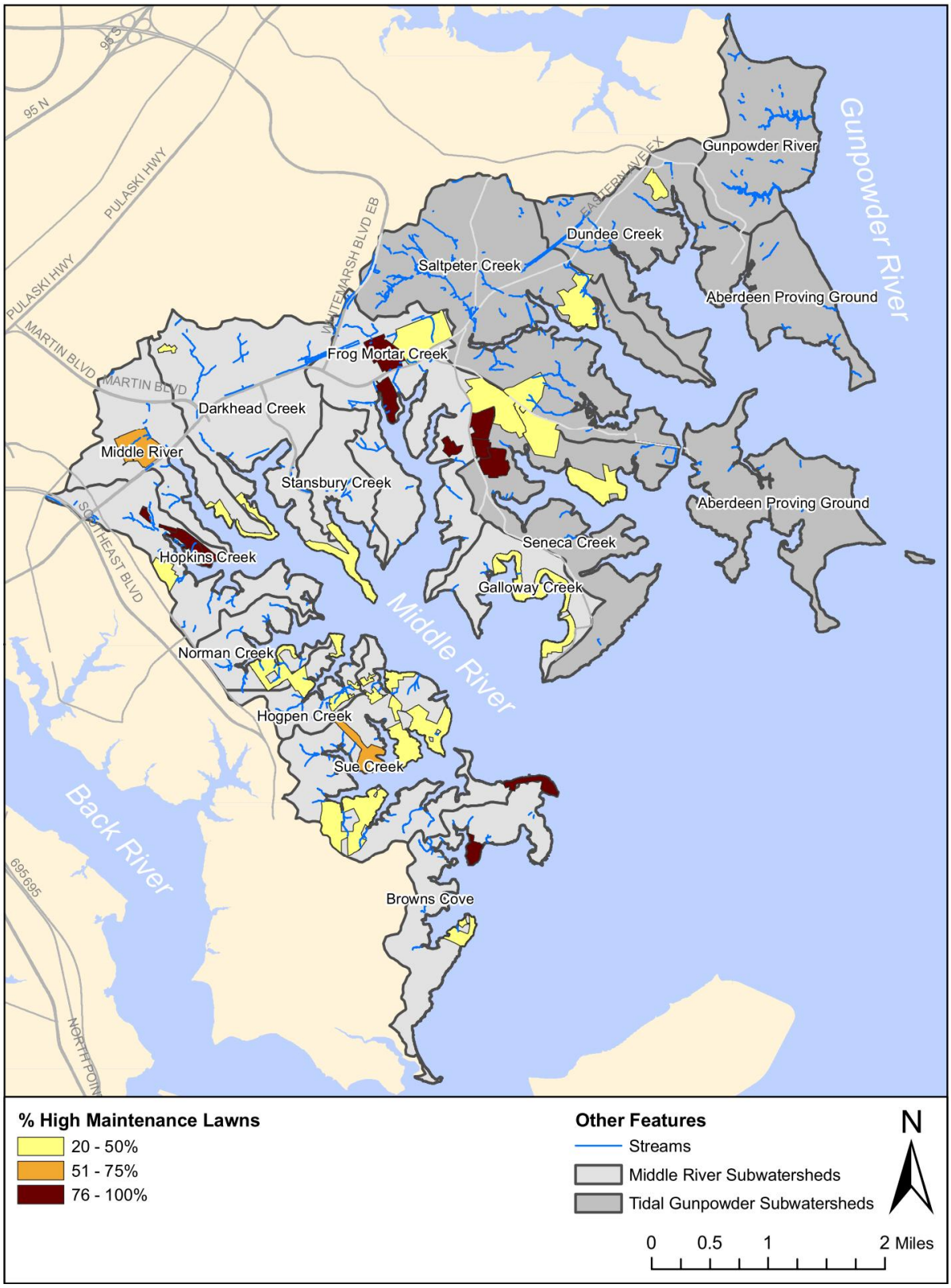

Figure 4-4: Neighborhoods with 20-100% High Maintenance Lawns

4.2.3.3 Bayscaping

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

All neighborhoods could use more bayscaping; however, the benefits and feasibility of this action are limited by the space available for landscaping. Several neighborhoods are characterized by smaller lot sizes and/or significant impervious cover, where bayscaping might be difficult. In addition, neighborhoods with a significant amount of landscaping already were not considered a priority. Therefore, bayscaping was recommended in neighborhoods where the typical lot was at least ¼ acre in size, was less than 25% landscaped, and where there was sufficient grass area available. Table 4-4 includes a summary of the number of neighborhoods recommended for bayscaping based on these criteria and the acres of land addressed if this action were initiated by subwatershed. Table 4-4 also lists the percent of the total subwatershed area that would be addressed by implementing bayscaping in the recommended neighborhoods.

Table 4-4: Acres of Land Addressed by Bayscaping

Subwatershed	# of NSAs Recommended for Bayscaping*	Acres of Land Addressed	% of Subwatershed Area Addressed
Darkhead Creek	3	6.8	0.6%
Frog Mortar Creek	4	22.7	1.9%
Galloway Creek	3	23.9	6.4%
Browns Cove	3	4.6	0.8%
Hogpen Creek	2	3.9	1.5%
Hopkins Creek	5	28.6	4.7%
Middle River	2	6.3	0.9%
Norman Creek	3	17.6	5.7%
Stansbury Creek	0	0.0	0.0%
Sue Creek	3	16.4	1.7%
Middle River Subtotal		*130.9*	*2.0%*
Aberdeen Proving Ground	0	0.0	0.0%
Dundee Creek	2	6.7	0.7%
Gunpowder River	1	21.5	2.9%
Saltpeter Creek	3	18.4	1.0%
Seneca Creek	3	46.4	4.6%
Tidal Gunpowder Subtotal		*93.0*	*1.6%*
Total		*223.8*	*1.8%*

* If a neighborhood overlaps multiple subwatersheds, it is counted in "# of NSAs" for each subwatershed it encompasses. Acres of land are counted only for the subshed where they are present.

Figure 4-5 illustrates the location of neighborhoods recommended for bayscaping. Out of the 59 neighborhoods assessed, 27 (46%) met the criteria and were recommended for bayscaping. Table 4-4 shows that only approximately 2 percent of the Middle River/Tidal Gunpowder River planning area would be addressed by this action; this is because many of the neighborhoods have limited amount of area available for bayscaping due to small lot sizes and/or significant impervious cover.

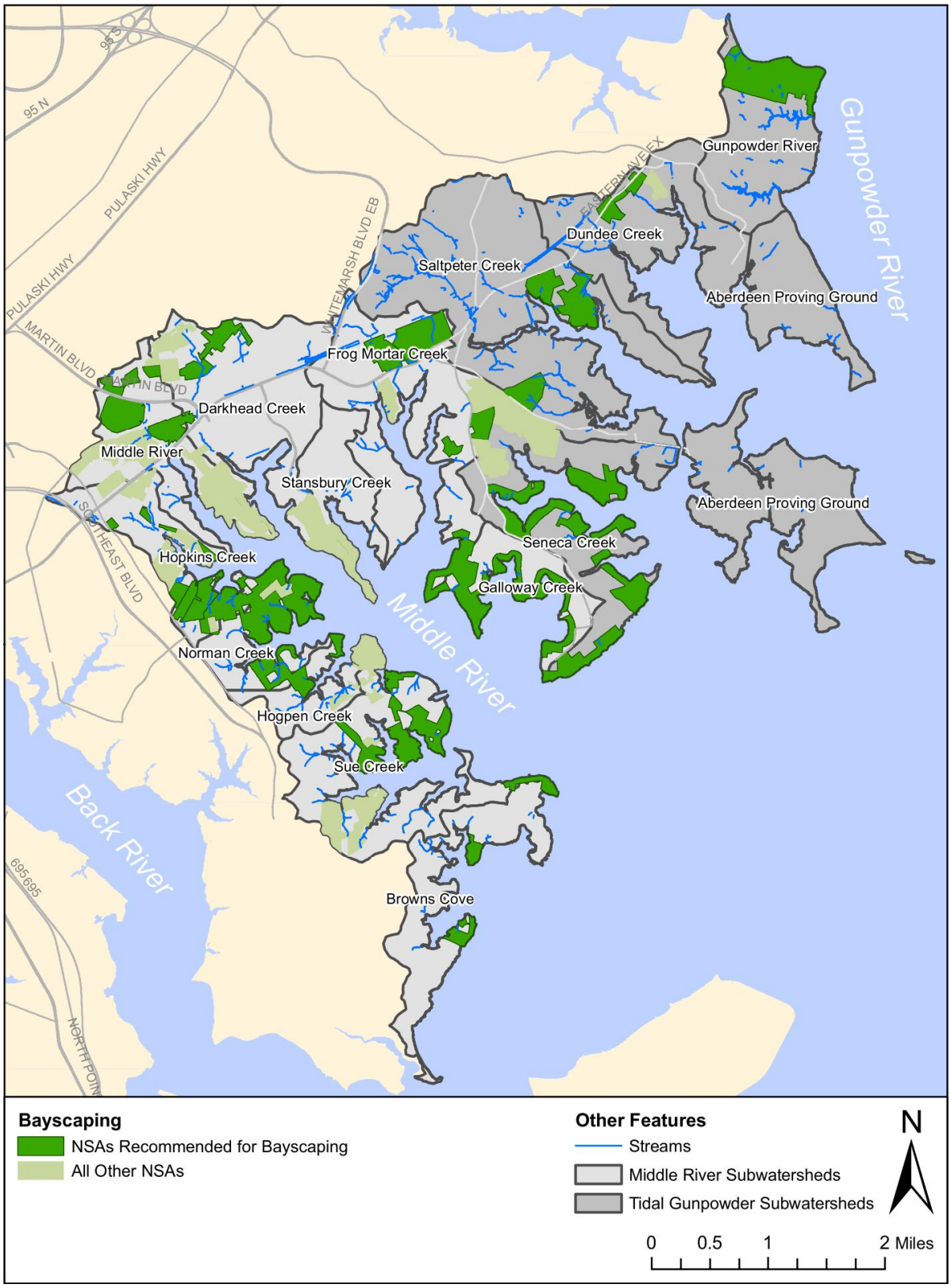

Figure 4-5: Neighborhoods Recommended for Bayscaping

4.2.3.4 Storm Drain Marking

Most of the neighborhoods in the Middle River and Tidal Gunpowder River watersheds consist of curb and gutter systems with storm drain inlets that convey stormwater runoff quickly and directly to the stream system and ultimately to the Chesapeake Bay. Most neighborhoods did not have any storm drain markings or indicators that the inlets eventually drain to the Chesapeake Bay. Since there is little or no infiltration of stormwater in a curb and gutter system, there is more potential for pollutants to be carried to the stream system. Storm drain markings indicate that the inlets drain to the Chesapeake Bay; this is a way to educate residents that any trash or lawn clippings (potential for nutrient pollution), or other debris accumulating along the curbs and gutters will be washed away after a storm event and end up in the Middle River, Gunpowder River, or the Bay.

Neighborhoods recommended for storm drain marking had curb and gutter systems with inlets appropriate for marking and where less than 10% of the existing inlets were already marked and legible. Table 4-5 includes a summary of the number of neighborhoods recommended for storm drain marking and the number of inlets addressed if this action were initiated by subwatershed. The number of inlets addressed was estimated based on the inlet densities calculated by subwatershed in Chapter 2.3.6. Table 4-5 also lists the percent of the total inlets in each subwatershed that would be addressed if storm drain marking was implemented in the recommended neighborhoods.

Table 4-5: Number of Inlets Addressed by Storm Drain Marking

Subwatershed	# of NSAs Recommended for Storm Drain Marking*	Approximate # of Inlets Addressed	% of Inlets in Subwatershed Addressed
Darkhead Creek	11	17	30.4%
Frog Mortar Creek	9	6	41.5%
Galloway Creek	0	0	0.0%
Browns Cove	1	0	1.2%
Hogpen Creek	3	3	6.2%
Hopkins Creek	12	38	51.4%
Middle River	12	40	50.9%
Norman Creek	4	9	21.5%
Stansbury Creek	0	0	0.0%
Sue Creek	6	25	41.4%
Middle River Subtotal		*138*	*37.6%*
Aberdeen Proving Ground	0	0	0.0%
Dundee Creek	2	1	2.9%
Gunpowder River	1	6	25.9%
Saltpeter Creek	6	0	23.4%
Seneca Creek	8	24	64.2%
Tidal Gunpowder Subtotal		*31*	*36.2%*
Total		*169*	*37.2%*

* If a neighborhood overlaps multiple subwatersheds, it is counted in "# of NSAs" for each subwatershed it encompasses. # of inlets addressed are counted only for the subshed where they are present.

Figure 4-6 illustrates the location of neighborhoods recommended for storm drain marking. Out of the 59 neighborhoods assessed, 52 (88%) met the criteria and were recommended for storm drain marking. Table 4-5 also shows that about 37% of the inlets in the watershed could be addressed by this action just in the neighborhoods alone.

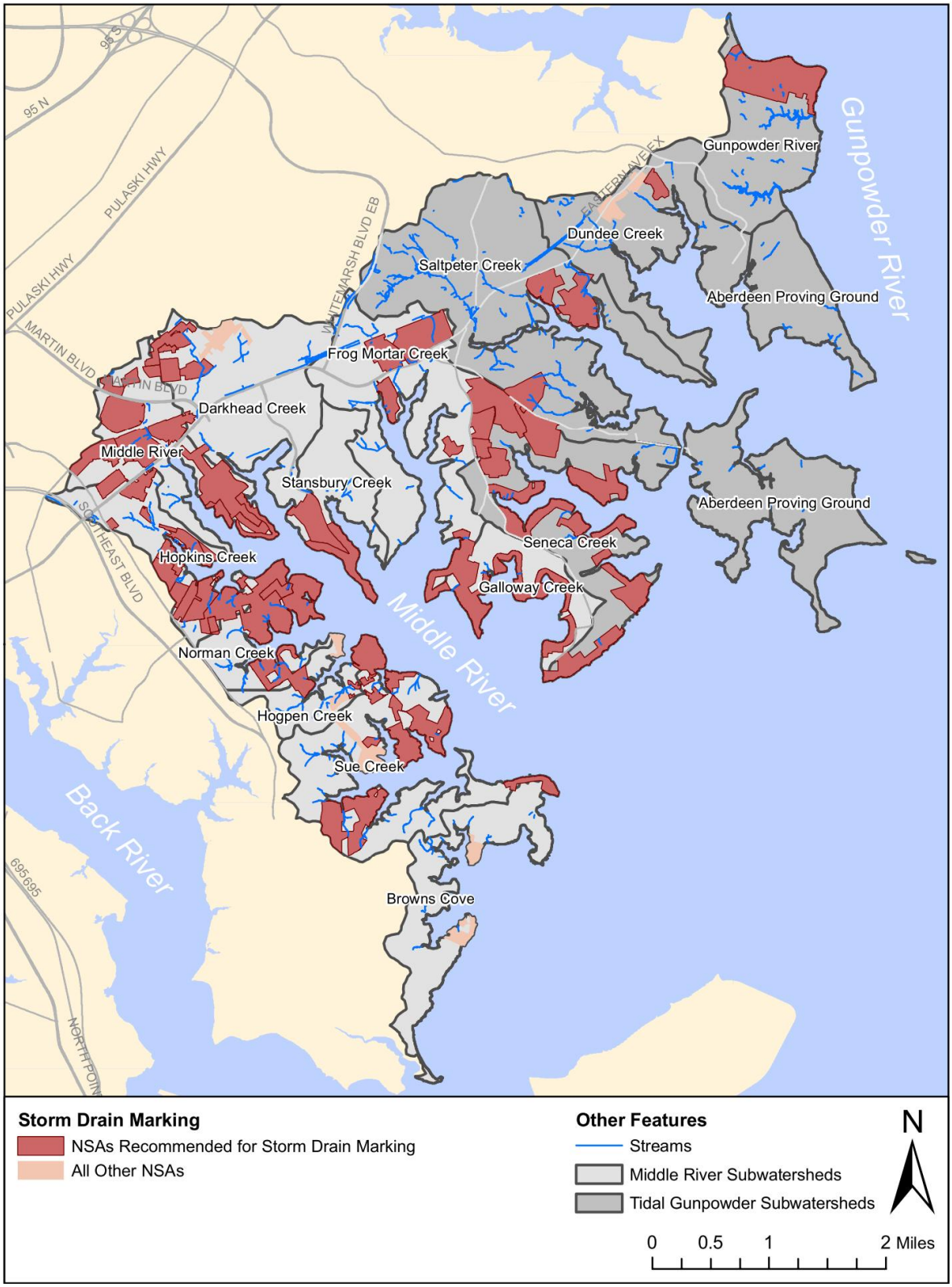

Figure 4-6: Neighborhoods Recommended for Storm Drain Marking

4.2.3.5 Street Trees and Shade Trees

Street trees and shade trees are not only an asset to a neighborhood aesthetically but also provide air and water quality improvement since they intercept precipitation with their leaves and absorb precipitation and nutrients through their root systems. This infiltration of precipitation through leaves or the root systems slows flow input and provides some treatment before stormwater runoff reaches the stream system.

Street trees were recommended for neighborhoods where at least 25% of the streets had a minimum of 4 feet of greenspace between the sidewalk and curb and less than 75% of these areas had trees planted. The number of trees was estimated based on a spacing of one tree per 15 to 20 feet. Open space shade trees were recommended for open pervious areas in neighborhoods where the space had no apparent current use. The number of shade trees was estimated based on a spacing of 15 to 20 feet for narrow areas or approximately 200 trees per acre for larger areas. Table 4-6 includes a summary of the number of neighborhoods recommended for street tree planting and the number of street trees proposed per subwatershed. Table 4-7 shows a summary of the number of neighborhoods recommended for shade tree planting and the number of shade trees proposed per subwatershed.

Table 4-6: Street Tree Potential by Subwatershed

Subwatershed	# of NSAs Recommended for Street Trees*	# of Street Trees that Could be Planted
Darkhead Creek	4	450
Frog Mortar Creek	4	334
Galloway Creek	0	0
Browns Cove	0	0
Hogpen Creek	0	0
Hopkins Creek	2	235
Middle River	4	527
Norman Creek	0	0
Stansbury Creek	0	0
Sue Creek	0	0
Middle River Subtotal		*1,546*
Aberdeen Proving Ground	0	0
Dundee Creek	0	0
Gunpowder River	0	0
Saltpeter Creek	4	293
Seneca Creek	4	298
Tidal Gunpowder Subtotal		*591*
Total		*2,137*

* If a neighborhood overlaps multiple subwatersheds, it is counted in "# of NSAs" for each subwatershed it encompasses. Street trees are counted only for the subshed where they are proposed.

Table 4-7: Shade Tree Potential by Subwatershed

Subwatershed	# of NSAs Recommended for Shade Trees*	# of Shade Trees that Could be Planted
Darkhead Creek	1	235
Frog Mortar Creek	2	416
Galloway Creek	0	0
Browns Cove	0	0
Hogpen Creek	2	31
Hopkins Creek	5	319
Middle River	2	740
Norman Creek	0	0
Stansbury Creek	0	0
Sue Creek	2	194
Middle River Subtotal		*1,935*
Aberdeen Proving Ground	0	0
Dundee Creek	0	0
Gunpowder River	0	0
Saltpeter Creek	2	768
Seneca Creek	2	91
Tidal Gunpowder Subtotal		*859*
Total		*2,794*

* If a neighborhood overlaps multiple subwatersheds, it is counted in "# of NSAs" for each subwatershed it encompasses. Shade trees are counted only for the subshed where they are proposed.

Figure 4-7 illustrates the location of neighborhoods where street trees could be planted. Out of the 59 neighborhoods assessed, 13 (22%) met the criteria and were recommended for street trees. For the most part, neighborhoods not recommended for street trees either did not have sidewalks and a curb and gutter system or there was insufficient greenspace between the sidewalk and curb. There is potential for planting over 2,130 street trees throughout the watershed. Figure 4-8 shows the location of neighborhoods where shade trees are recommended. Out of the 59 neighborhoods assessed, 14 (24%) met the criteria for potential shade tree planting. Over 2,790 shade trees are estimated for the Middle River and Tidal Gunpowder River watersheds.

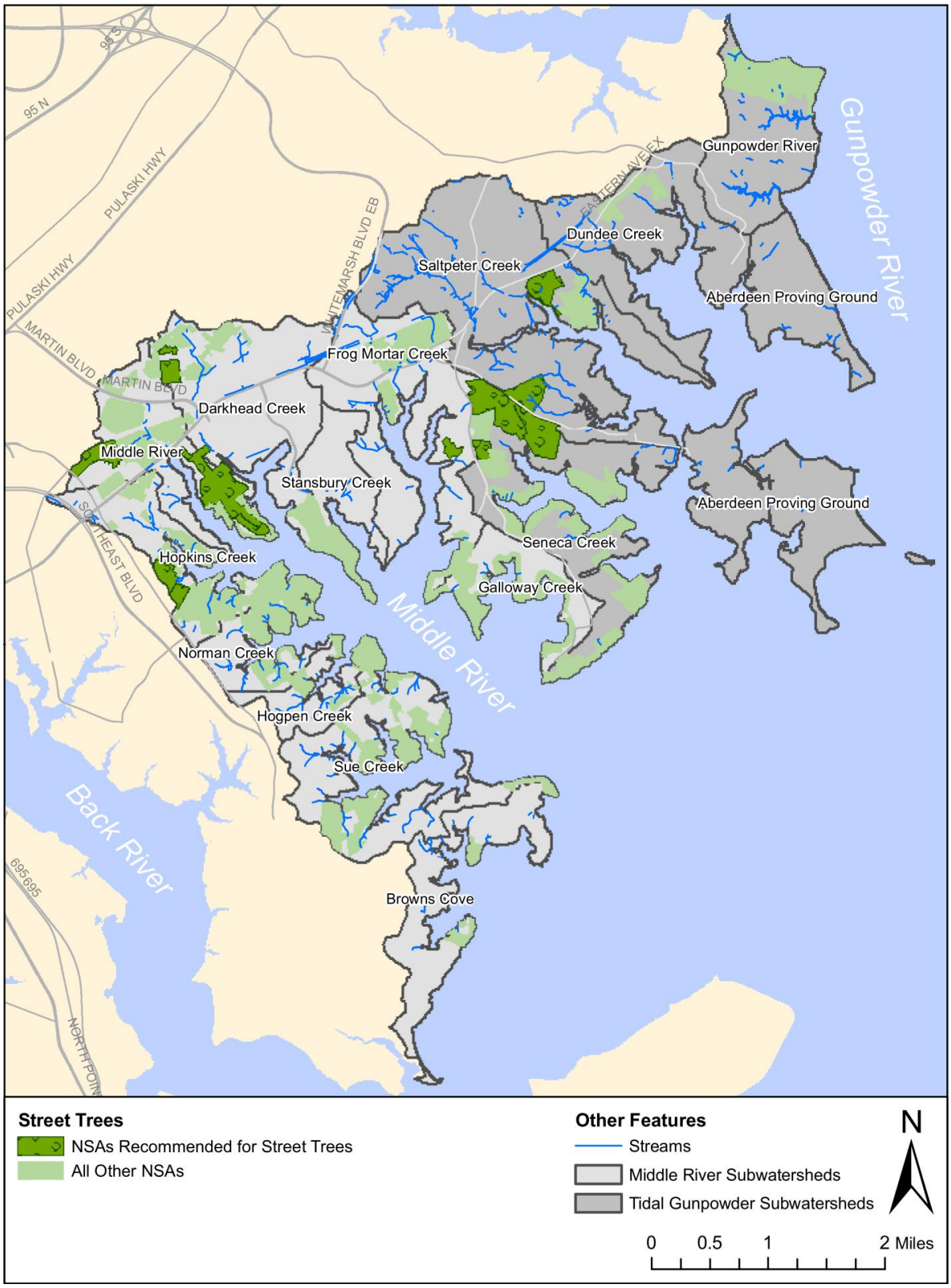

Figure 4-7: Neighborhoods Recommended for Street Tree Planting

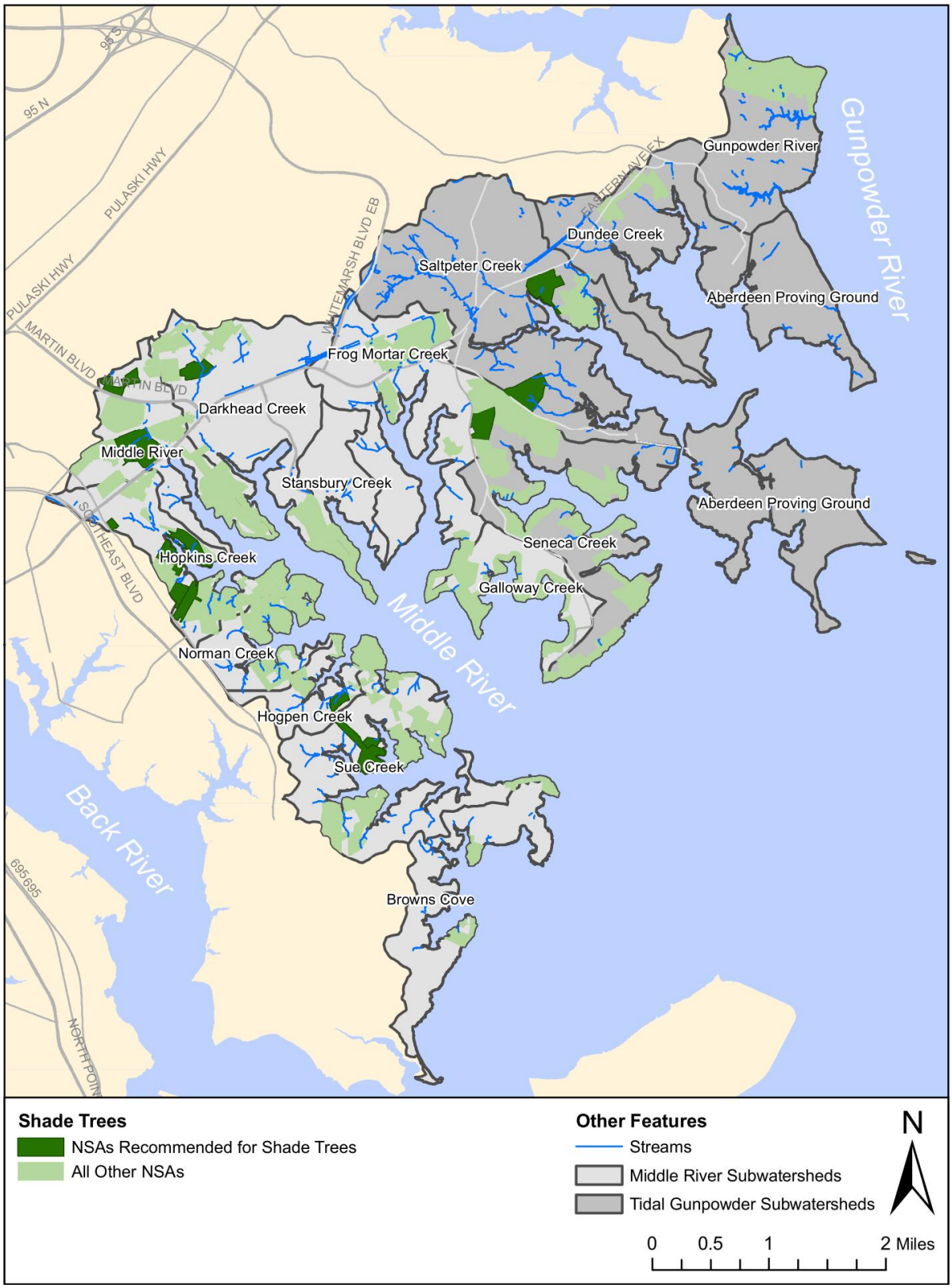

Figure 4-8: Neighborhoods Recommended for Shade Tree Planting

4.2.3.6 Street Sweeping

Street sweeping helps remove trash, sediment and other organic matter such as leaves and grass clippings from the curb and gutter system and prevents them from entering the storm drains and nearby streams. Street sweeping also reduces sediment and other pollutant loads such as oil and metals to the stream system. Excessive organic matter, sediment, and trash can clog streams and the storm drain system resulting in costly maintenance and stream health impairment. Also, the decay of an unbalanced amount of organic matter in a stream depletes the supply of dissolved oxygen, depriving other aquatic life including fish of their oxygen demand. An aggressive street sweeping initiative can ease the effects of a curb and gutter storm drain system on receiving streams.

Neighborhoods where 20% or more of the curbs and gutters were covered with excessive trash, sediment, and/or organic matter were recommended for street sweeping. Table 4-8 includes a summary of the number of neighborhoods recommended for street sweeping and the miles of street addressed if it was implemented by subwatershed. Miles addressed by street sweeping were estimated by determining the miles of roads within each neighborhood recommended for street sweeping using Baltimore County's 2008 roads spatial data. For neighborhoods intersecting two or more subsheds, the miles addressed are only displayed for the subsheds where they are present.

Table 4-8: Miles Addressed by Street Sweeping

Subwatershed	# of NSAs Recommended for Street Sweeping*	Miles Addressed by Street Sweeping
Darkhead Creek	8	8.7
Frog Mortar Creek	0	0.0
Galloway Creek	0	0.0
Browns Cove	0	0.0
Hogpen Creek	2	0.6
Hopkins Creek	6	5.2
Middle River	10	12.7
Norman Creek	0	0.0
Stansbury Creek	1	1.0
Sue Creek	2	3.3
Middle River Subtotal		*31.5*
Aberdeen Proving Ground	0	0.0
Dundee Creek	0	0.0
Gunpowder River	0	0.0
Saltpeter Creek	0	0.0
Seneca Creek	0	0.0
Tidal Gunpowder Subtotal		*0.0*
Total		*31.5*

* If a neighborhood overlaps multiple subwatersheds, it is counted in "# of NSAs" for each subwatershed it encompasses. Miles of sweeping are counted only for the subshed where they are proposed.

Figure 4-9 illustrates the location of neighborhoods recommended for street sweeping. Out of the 59 neighborhoods assessed, 19 (32%) met the criteria for street sweeping. If initiated, this could address approximately one-third of the total miles of road within all neighborhoods surveyed in the watershed.

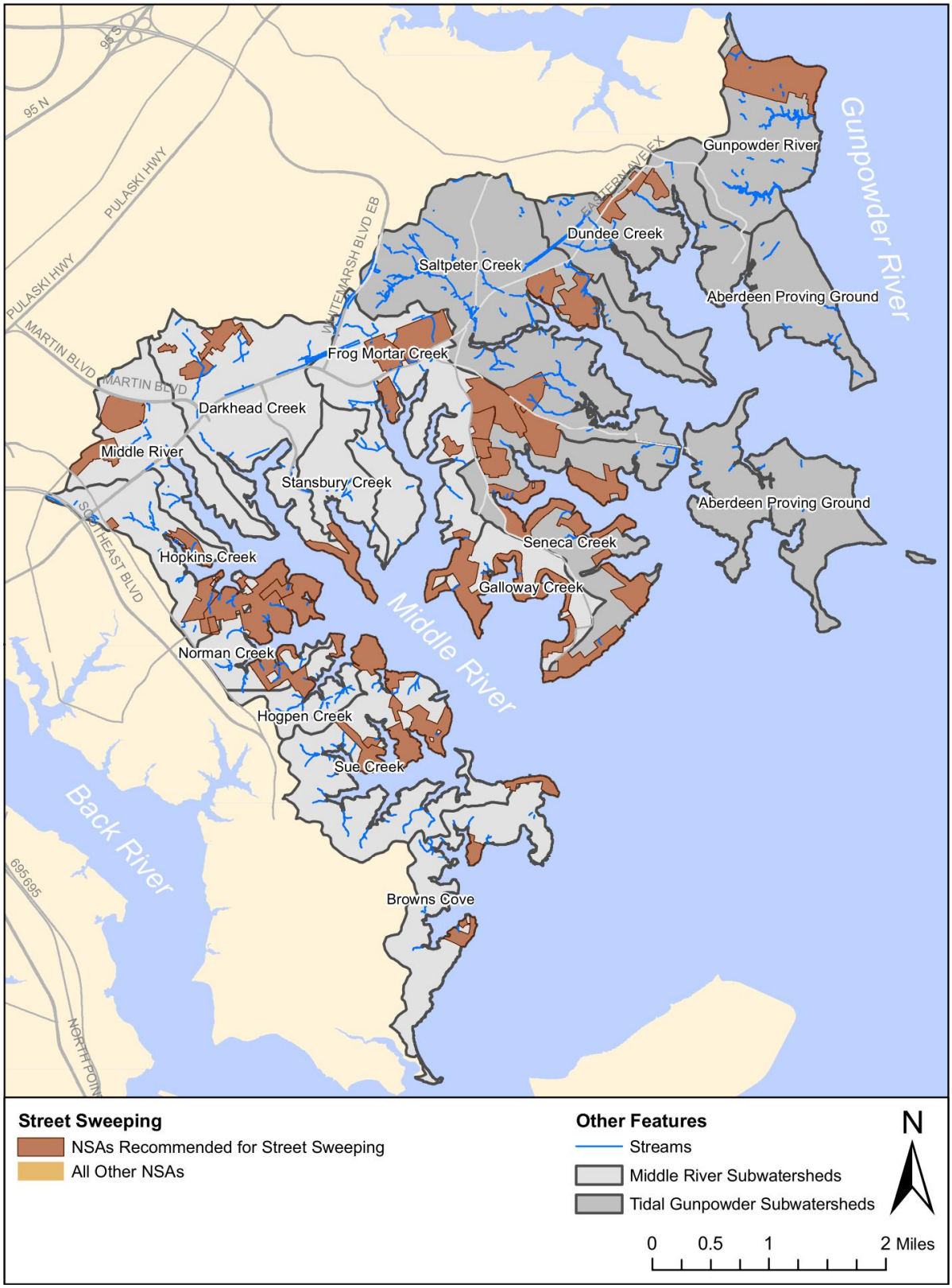

Figure 4-9: Neighborhoods Recommended for Street Sweeping

4.2.3.7 Neighborhood Trash Management

Trash can be a major pollutant of concern in neighborhoods. The uplands survey revealed that the Middle River and Tidal Gunpowder River may benefit from trash management initiatives such as community cleanups, trash management education, and working with the Department of Public Works (DPW) to implement a bulk trash pick-up program.

Neighborhoods where junk or trash was observed in 25% or more of yards were recommended for trash management initiatives. Neighborhoods with less than 25% of yards with junk/trash but had other warning signs such as overflowing dumpsters or dumping in alleys or other common areas were also included. Table 4-9 includes a summary of the number of neighborhoods recommended for trash management initiatives and the acres of land addressed if it was implemented by subwatershed. Table 4-9 also includes a summary of the percent of the total subwatershed area addressed by initiating trash management.

Table 4-9: Acres of Land Addressed by Trash Management

Subwatershed	# of NSAs Recommended for Trash Management*	Acres of Land Addressed	% of Subwatershed Area Addressed
Darkhead Creek	7	159.6	14.0%
Frog Mortar Creek	0	0.0	0.0%
Galloway Creek	1	3.1	0.8%
Browns Cove	1	20.1	0.0%
Hogpen Creek	3	45.4	0.0%
Hopkins Creek	5	227.7	37.7%
Middle River	7	180.1	26.7%
Norman Creek	3	136.9	44.0%
Stansbury Creek	1	16.1	4.7%
Sue Creek	3	235.4	24.6%
Middle River Subtotal		*1024.4*	*15.8%*
Aberdeen Proving Ground	0	0.0	0.0%
Dundee Creek	1	36.3	3.9%
Gunpowder River	0	0.0	0.0%
Saltpeter Creek	0	0.0	0.0%
Seneca Creek	2	278.4	27.6%
Tidal Gunpowder Subtotal		*314.7*	*5.4%*
Total		*1339.1*	*10.9%*

* If a neighborhood overlaps multiple subwatersheds, it is counted in "# of NSAs" for each subwatershed it encompasses. Acres of land are counted only for the subshed where they are proposed.

Figure 4-10 illustrates the location of neighborhoods recommended for trash management initiatives. Out of the 59 neighborhoods assessed, 22 (37%) were recommended for trash management. If initiated, this could address approximately 11% of the total Middle River and Tidal Gunpowder River planning area. Trash management has the potential to address more developed and potential problem areas on the subwatershed scale; for example, targeting neighborhoods in the Norman Creek subwatershed could potentially address 44 percent of the subwatershed area.

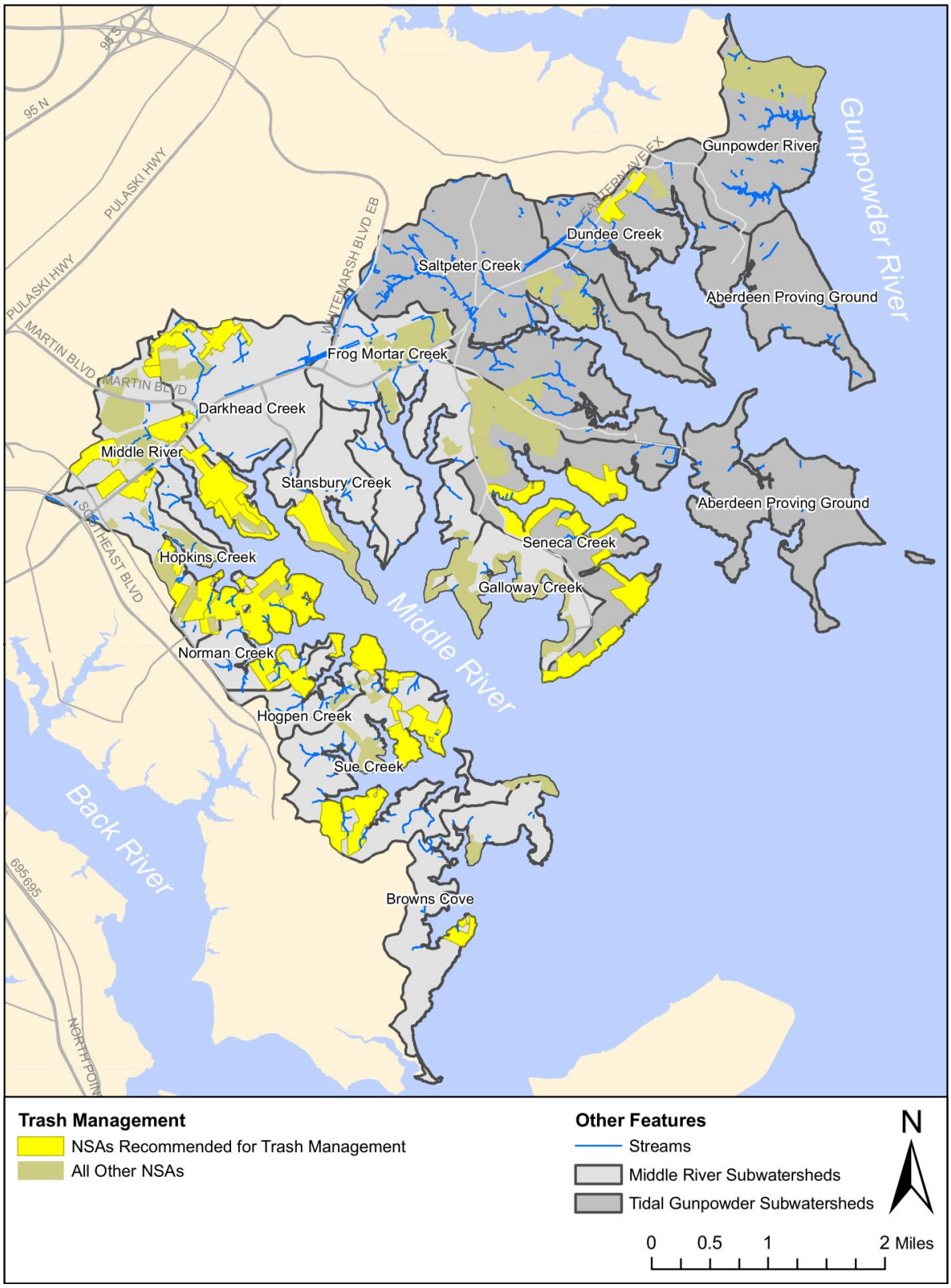

Figure 4-10: Neighborhoods Recommended for Trash Management

4.2.3.8 Parking Lot or Alley Retrofit

There are several apartment, townhouse, and condo complexes in the Middle River and Tidal Gunpowder River watersheds. Multi-family parking lots in these types of neighborhoods can be an opportunity for a stormwater retrofit to address stormwater runoff from impervious surfaces. In addition, neighborhoods with paved alleys could also be an opportunity for stormwater retrofit if sufficient pervious area is available. As discussed previously in Chapter 2, infiltration/filtration practices such as bioretention areas with native plantings could be used to capture and treat stormwater runoff from impervious parking lots and alleys while requiring minimal maintenance.

Neighborhoods where sufficient greenspace was available down gradient of a multi-family parking lot or alley were recommended for stormwater retrofit practice. Table 4-10 includes a summary by subwatershed of the number of neighborhoods recommended for stormwater retrofits and the approximate acres of impervious cover addressed if implemented.

Table 4-10: Acres of Impervious Cover Addressed by Stormwater Retrofit

Subwatershed	# of NSAs Recommended for Stormwater Retrofit*	Acres of Impervious Cover Addressed
Darkhead Creek	0	0.0
Frog Mortar Creek	1	0.7
Galloway Creek	0	0.0
Browns Cove	0	0.0
Hogpen Creek	0	0.0
Hopkins Creek	2	4.9
Middle River	2	1.2
Norman Creek	0	0.0
Stansbury Creek	0	0.0
Sue Creek	0	0.0
Middle River Subtotal		*6.8*
Aberdeen Proving Ground	0	0.0
Dundee Creek	0	0.0
Gunpowder River	0	0.0
Saltpeter Creek	0	0.0
Seneca Creek	1	0.1
Tidal Gunpowder Subtotal		*0.1*
Total		*6.9*

* If a neighborhood overlaps multiple subwatersheds, it is counted in "# of NSAs" for each subwatershed it encompasses. Acres of impervious cover are counted only for the subshed where they are proposed.

Figure 4-11 illustrates the location of neighborhoods recommended for multi-family parking lot or alley stormwater retrofits. Out of the 59 neighborhoods assessed, 5 (8%) have sufficient greenspace available for multi-family parking lot or alley stormwater retrofits. Note that the 6.9 acres of impervious cover addressed is an approximation based on potential sites identified in the field and area calculations using GIS and visual inspection of aerial images. Actual area addressed will depend on a closer inspection of site conditions conducive to a stormwater retrofit application (e.g., grading requirements, cost, etc.)

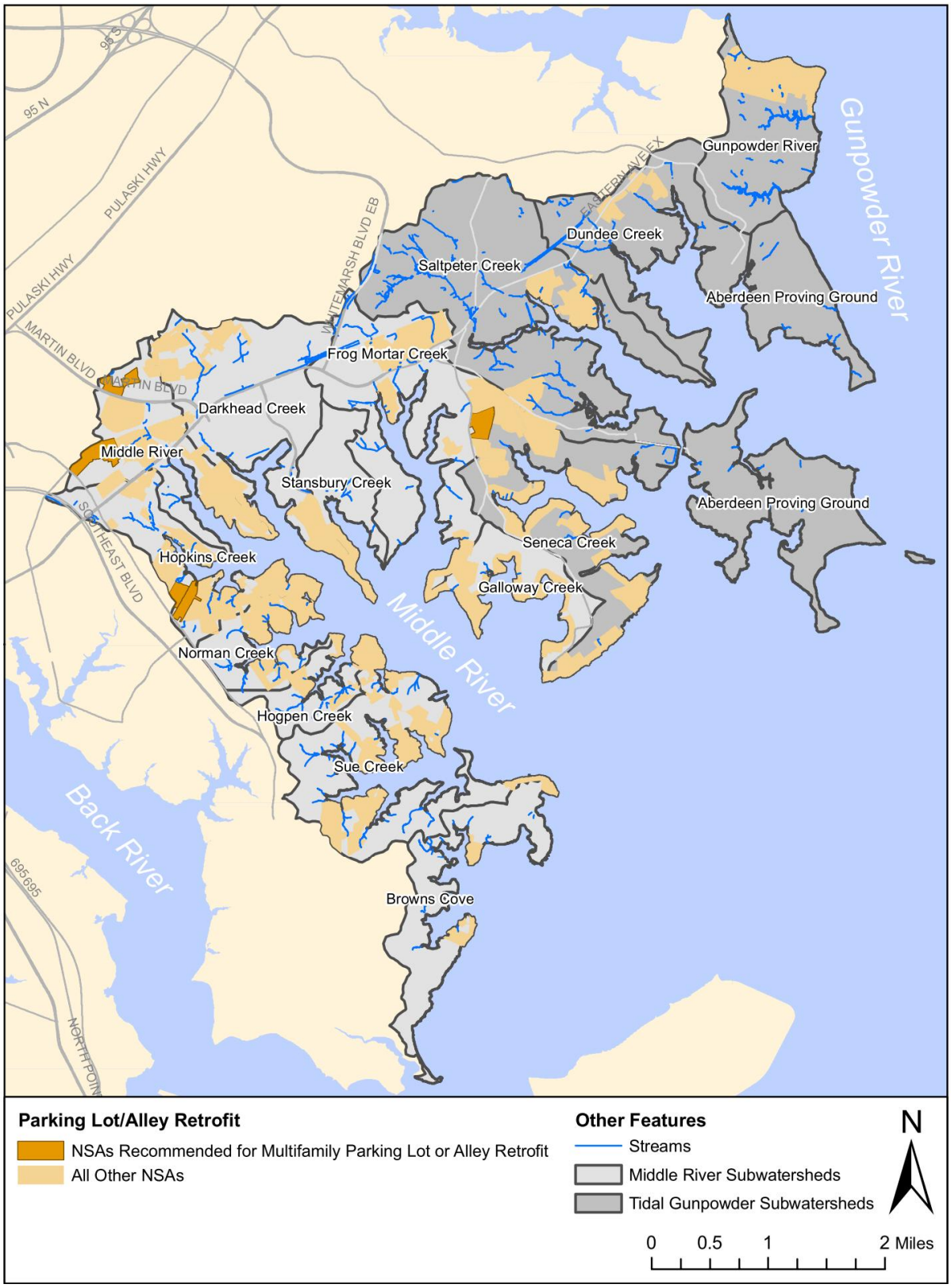

Figure 4-11: Neighborhoods Recommended for Parking Lot or Alley Stormwater Retrofit

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 2007). These generally include commercial, industrial, municipal, or transport-related operations. Hotspots are either regulated or unregulated. Regulated hotspots are known sources of pollution that abide by applicable federal or state laws (e.g., NPDES permits). Unregulated hotspots are not regulated but the nature of their operations makes them likely to be potential pollutant sources. Stormwater pollutants generated as a result of hotspot operations depend on the specific activities but typically include nutrients, hydrocarbons, metals, chloride, pesticides, bacteria, and trash.

Commercial hotspots include a range of businesses and activities but are normally grouped together in subwatersheds. Operations characteristic of commercial hotspots include waste or wash water generation, outdoor material storage, fuel handling, or auto/boat repair. Common commercial hotspots include auto repair shops, car dealers, car washes, parking facilities, gas stations, marinas, garden centers, construction equipment and building material lots, swimming pools, and restaurants. Industrial operations utilize, generate, handle, and/or store pollutants that can be washed off with stormwater, spilled, or mistakenly discharged into the storm drain. Many industrial hotspots are regulated under NPDES industrial discharge permits and include various manufacturing operations such as metal production, chemical manufacturing, and food processing. Municipal hotspots typically refer to local government operations such as solid waste, wastewater, road and vehicle maintenance, and yard waste. Like industrial operations, many municipal hotspots are subject to NPDES stormwater permits. Transport-related hotspots normally include areas of significant impervious cover and extensive private storm drain systems. Many are regulated and include uses such as airports, ports, highway construction, and trucking centers.

The purpose of HSIs 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 a sample of hotspots in the Middle River and Tidal Gunpowder River watersheds. Note that marinas and NPDES-permitted industrial sites are addressed separately in Chapters 4.6 and 4.7, respectively.

4.3.1 Assessment Protocol

Because there are numerous operations in the Middle River and Tidal Gunpowder River watersheds that qualify as stormwater hotspots, individual sites were not preselected in the office. Instead, commercial/industrial areas within the watershed were identified using GIS tax parcel information, land use data, NPDES locations and aerial photographs in the office. Commercial/industrial areas were depicted on base maps for field use and included clustered urban areas and distinct or larger hotspot type operations. During the uplands survey, these commercial/industrial areas were briefly explored for hotspot potential. Sites were selected for formal investigation based on several factors. One objective of the HSIs was to examine a variety of hotspot operations and select sites to represent common types of hotspots found in the planning area. HSIs were also focused on unregulated hotspots since access to regulated hotspots is often limited and because regulated hotspots are previously documented/known

pollutant sources. Regulated hotspots are already subject to NPDES permit regulations which normally require strict effluent concentration limits and periodic monitoring. Note, however, that since considerable portions of upland areas are occupied by specific industrial sites, these were addressed as a separate upland category (see Chapter 4.6). Marinas also typically hold NPDES permits and have a significant presence within the planning area. Consequently, these are also addressed as a separate upland category (see Chapter 4.7). Obvious sources of pollution observed during the upland assessment were revisited for hotspot potential. Problem areas identified by community members during the upland assessment were also scouted for hotspot potential.

Unique ID numbers were assigned to HSIs using the classification scheme "HSI_F_100", where 'F' denotes the Middle River and Tidal Gunpowder River planning area and the first number corresponds to a specific subwatershed. Subwatersheds were assigned unique numbers summarized in Table 4-11 for the purposes of HSIs, ISIs, and PAAs.

Table 4-11: Subwatershed ID Numbers

ID	Subwatershed
Middle River	
1	Browns Cove
2	Sue Creek
3	Hogpen Creek
4	Norman Creek
5	Hopkins Creek
6	Middle River
7	Darkhead Creek
8	Stansbury Creek
9	Frog Mortar Creek
10	Galloway Creek
Tidal Gunpowder	
11	Seneca Creek
12	Saltpeter Creek
13	Dundee Creek
14	Gunpowder River
15	Aberdeen Proving Ground

Hotspot sites were numbered sequentially in the order they were surveyed within a particular subwatershed. For example, HSIs in Darkhead Creek would be identified as 700, 701, 702, etc.

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. Per the USSR manual, the HSI involved an evaluation of six common operations at each potential hotspot: vehicle operations, outdoor materials, waste management, physical plant, turf/landscaping, and stormwater infrastructure. The field team surveyed the entire property of each potential hotspot selected for an HSI 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. Parameters evaluated within each operation category 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. Connections between vehicle operations and the storm drain system are the main focus of this category. The following were noted during the HSI as potential pollution sources: vehicle spills/leakage, lack of runoff diversion methods from storage/repair areas, directly connected fueling areas, and direct discharges to the storm drain from vehicle washing.

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 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. The field team also looked for improperly labeled storage containers, lack of secondary containment for liquids, and whether the storage area was directly or indirectly connected to the storm drain system. 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 which 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. These activities can be a source of sediment, nutrients, paints, and solvents in stormwater runoff. For each hotspot, the condition of the building itself was evaluated. Stained, dirty, or damaged buildings were noted as potential pollution sources as well as staining or discoloration around the building which is evidence that maintenance activities (e.g., painting, power-washing, resealing, etc.) discharge to storm drains. Similarly, parking lots that were stained, dirty, breaking up, and/or impervious were recorded as potential pollution sources. Downspouts connected to impervious surfaces or directly to the storm drain system were also recorded as pollution sources at a hotspot site. A stain leading to storm drains denoted poor cleaning practices (e.g., for construction activities).

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 sources of nutrient, fertilizer, and pesticide pollution. The field team also determined whether landscaped areas drained directly to storm drains or if organics (leaves, grass) accumulated on impervious surfaces. More than 20% of bare soil in turf/landscaped areas was flagged as a sediment pollution source.

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 and illicit connection potential. Storm drains with considerable amounts of sediment, organics, and/or trash were identified as potential pollution sources.

Recommended Actions

For each operation on the HSI field form, there is an observed pollution source box which was checked when there was clear evidence of pollution problems at the time of the investigation. After surveying the entire property and evaluating hotspot operations, one or more of the follow-up actions listed below may be recommended based on initial field observations:

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

4.3.2 Summary of Sites Investigated

A total of 16 hotspot candidates were investigated in the Middle River and Tidal Gunpowder River watersheds. Most of the sites (14 out of 16) were commercial establishments with two transport-related sites. The hotspot candidates included as part of the uplands survey are listed in Table 4-12 including site ID, facility name, type, and subwatershed. Locations and initial hotspot status designations are shown in Figure 4-12. As shown in Table 4-12, 1 hotspot was investigated in Hopkins Creek, 4 in Middle River, 1 in Darkhead Creek, 4 in Frog Mortar Creek, 5 in Saltpeter Creek, and 1 in Dundee Creek. As mentioned previously, hotspot candidates represent areas where urban development/commercial uses are concentrated and are intended to represent common types of hotspot operations located throughout the watershed. While based on this sample assessment, the overall watershed strategy should also encompass all hotspot operations occurring in the watershed.

Table 4-12: Summary of Hotspot Sites Investigated in Middle River and Tidal Gunpowder River

Site ID	Subwatershed	Type
HSI_F_501	Hopkins Creek	Commercial (auto-related)
HSI_F_601	Middle River	Transport-related
HSI_F_602	Middle River	Commercial (shopping center)
HSI_F_603	Middle River	Commercial (auto-related)
HSI_F_604	Middle River	Commercial (construction)
HSI_F_701	Darkhead Creek	Transport-related
HSI_F_901	Frog Mortar Creek	Commercial (auto-related)
HSI_F_902	Frog Mortar Creek	Commercial (auto-related)
HSI_F_903	Frog Mortar Creek	Commercial (storage)
HSI_F_904	Frog Mortar Creek	Commercial (shopping center)
HSI_F_1201	Saltpeter Creek	Commercial (storage)
HSI_F_1202	Saltpeter Creek	Commercial (auto-related)
HSI_F_1203	Saltpeter Creek	Commercial (construction)
HSI_F_1204	Saltpeter Creek	Commercial (nursery)
HSI_F_1205	Saltpeter Creek	Commercial (construction)
HSI_F_1301	Dundee Creek	Commercial (nursery)

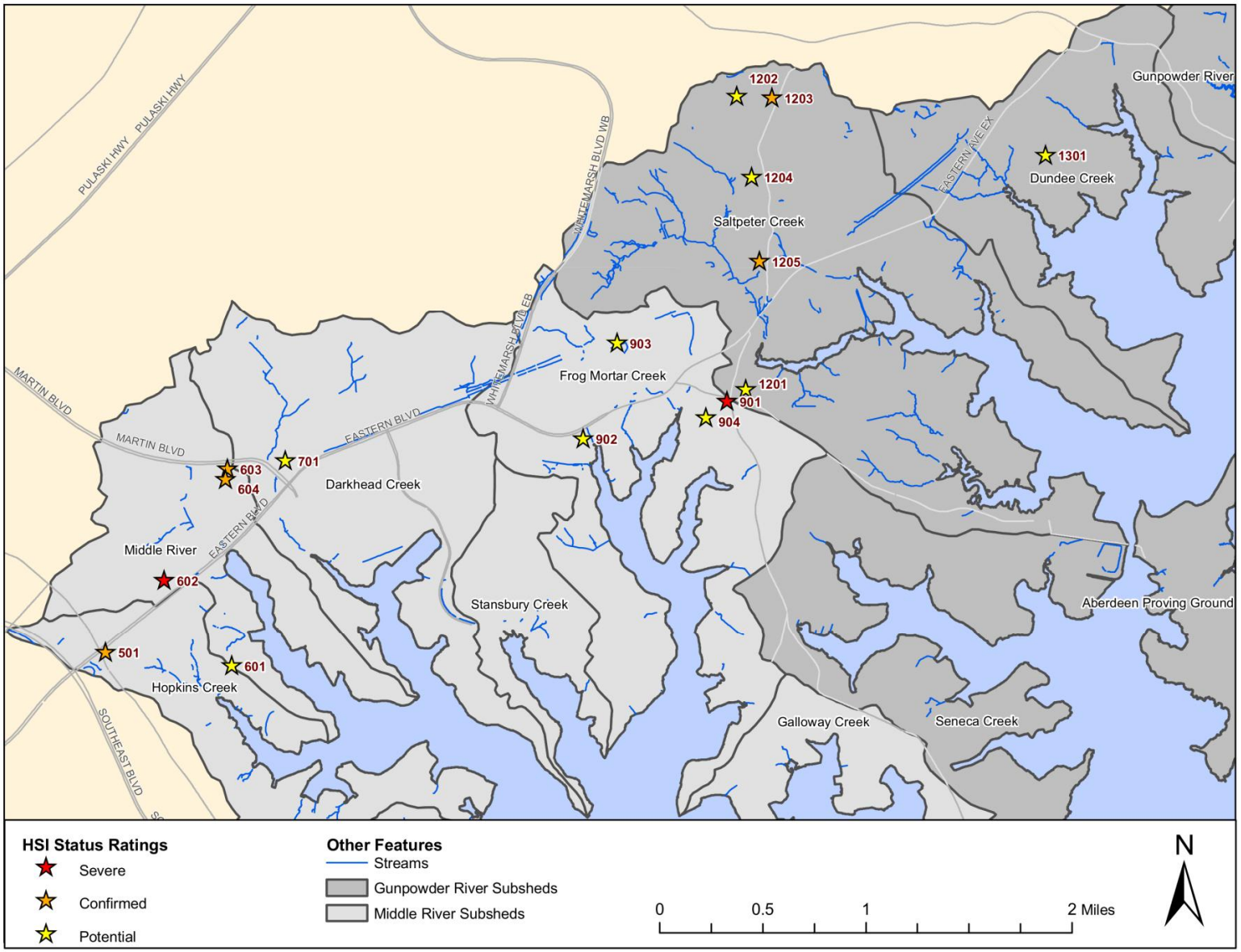

Figure 4-12: HSI Locations in Middle River and Tidal Gunpowder River

4.3.3 General Findings

A summary of HSI results is presented in Appendix C including hotspot status, category, pollution sources, and comments regarding hotspot observations. Vehicle operations and outdoor materials storage were the most common operations contributing to hotspot stormwater pollution among this sample of hotspot candidates. Waste management and physical plant conditions (e.g., stained/breaking up parking lot, evidence of stains leading to storm drain) were also common pollutant sources at investigated hotspots. Stormwater infrastructure (i.e., lack of stormwater management and/or condition of storm drains) were identified as potential pollution sources for four sites and turf/landscaping operations were cited for two sites. A brief description of the various hotspot categories assessed and general findings are provided below. This includes a description of how the pollution potential for specific sites can be ranked within a specific category.

Commercial

There are several commercial areas within the watershed, each with unique operations and pollution sources. Commercial hotspots were divided into five subcategories based on characteristic operations and pollution sources: auto-related; shopping centers; nurseries; construction; and storage. Each of these is described below.

<u>Auto-related</u>

There are several auto-related commercial establishments throughout the Middle River/Tidal Gunpowder planning area including auto repair shops, sales (e.g., car parts, accessories), tire service centers, gas stations, and car washes. The typical sources of stormwater pollution from this category of hotspots include vehicle, outdoor materials, physical plant, and waste management operations. Vehicle operations generally include repair, fueling, washing, and storing. Any of these activities can contribute potentially hazardous pollution to the storm drain system if proper housekeeping is not performed or if impervious surfaces lack diversions or treatment for stormwater runoff. In some cases, materials such as tires or engine parts were being stored outdoors. If materials are uncovered or lack secondary containment for liquids and stored on an impervious surface, there is potential for any vehicle-related pollutants attached to the materials to be washed off during a storm event into the stream or storm drain system (see Figure 4-13). It is also common for impervious surfaces (parking lots) at these types of hotspots to be stained as a result of vehicle operations or outdoor material storage which can also result in pollutants being transported by stormwater runoff (see Figure 4-14). The main recommended action for these types of operations is to include in future education efforts explaining proper storage of outdoor materials (covered, store on pallets not directly on pavement), ensure adequate buffer or diversion methods for stream/storm drain system, and incorporate treatment of stormwater runoff where possible.

Figure 4-13: Examples of Potential Pollution Sources from Outdoor Material Storage at Auto-related Hotspots

Figure 4-14: Example of Potential Pollution Sources from Outdoor Vehicle Operations at Auto-related Hotspots

All commercial operations generate waste and auto-related enterprises have the potential to generate hazardous pollutants that can enter the stream or storm drain system. For example, trash from a dumpster was observed around one site and along the edge of the buffer separating the adjacent wetland from the property (see Figure 4-15). This included an assortment of trash such as paper and tires. Again, future education could help address waste management related efforts. This may include proper waste management operations such as closing dumpster lids, creating runoff diversion between dumpsters and stream/storm drains, proper disposal of hazardous materials, and providing more trash receptacles in the parking area for clients. It may also involve educating clients about the hotspot and harmful effects of trash getting into the stream or storm drain system.

Figure 4-15: Example of Potential Pollution Sources from Waste Management Operations at Auto-related Hotspots

Shopping Centers

There are multiple commercial shopping center areas within the planning area, each with unique operations and pollution sources. Common sources of pollutants from the commercial shopping centers assessed include those from waste management operations. Dumpsters are often located on impervious surfaces at shopping centers and if in poor condition, staining or leaks can contribute pollutants directly into the storm drain system or nearby stream. There is also potential for wind or rain to carry trash from uncovered or overflowing dumpsters to the storm drain or stream system (see Figure 4-16).

Figure 4-16: Example of Potential Pollution Sources from Waste Management Operations at Commercial Hotspots

Commercial areas sometimes have outdoor shopping or stockpile areas where materials are stored outside. Similar to the discussion above, if materials are uncovered and on impervious surfaces, runoff from these areas can go directly into the storm drain system along with certain pollutants depending on the type of materials. For example, Figure 4-17 shows an outdoor stockpile of salt that is stored on a

shopping center parking lot. There is potential for the road salt to be washed away during a rainfall or snow event and enter into the storm drain system as the stockpile is only partially covered. De-icing salt can contain constituents such as sodium chloride which can end up in storm drains or streams, lead to water quality and habitat degradation, and be harmful to aquatic life. There is also potential for the salt to spill over onto the adjacent landscaped areas, which can disrupt uptake of nutrients through plant and tree roots and inhibit long-term growth.

Figure 4-17: Example of Potential Pollution Source from Outdoor Material Storage at Commercial Hotspots

Diversions to prevent stormwater runoff and potential pollutants including trash from discharging directly into the stream or storm drains are one recommended follow-up action for commercial hotpots. Another is to educate store owners about proper waste management and outdoor material storage techniques and conduct follow-up site inspections to enforce these measures. This may also involve reviewing or encouraging stormwater pollution prevention plans. Stormwater management practices should be implemented where possible to treat runoff from the large impervious surfaces often found at commercial shopping centers.

Nurseries

There are some nurseries and garden centers located within the Middle River/Tidal Gunpowder River planning area. Proper storage of outdoor materials such as plants, topsoil, and fertilizers is important to prevent nutrients and other pollutants from entering the storm drain system. Non-target irrigation, watering of paved surfaces, and draining of landscaped areas to storm drains may also be a potential pollution source at these hotspots. These sites are recommended for follow-up site inspections, review of stormwater pollution prevention plans, and future education efforts related to outdoor material storage and maintenance of landscaped areas.

Construction

Several construction-related sites were also observed in the Middle River/Tidal Gunpowder River planning area. At all assessed, fleet vehicles were observed on-site as well as operations related to vehicle maintenance, repair, fueling, and/or storage. All had uncovered fueling areas and for two out of

the three sites, these were directly connected to storm drains. There is potential to educate these types of property owners about the importance of runoff diversion methods to prevent pollutants from spills or leaks related to vehicle operations from getting into the storm drain system. Construction-related sites often have outdoor stockpiles of various construction materials such as sand and gravel. As mentioned above, if materials are uncovered and on impervious surfaces, runoff from these areas can go directly into the storm drain system along with certain pollutants depending on the type of materials if proper controls are not in place. In one case, stockpiles of sand and gravel were stored on a grassed area rather than an impervious surface. However, since no sediment and erosion controls were in place, sediment from the stockpile materials were observed in the adjacent roadside ditch which led to a nearby stream. Figure 4-18 shows examples of potential sources of pollution from outdoor material storage on impervious and pervious surfaces. For both scenarios, proper sediment and erosion controls, such as silt fence or other diversion methods, are necessary to prevent the stockpile materials from leaving a site and causing adverse water quality impacts after reaching a storm drain or stream system.

Figure 4-18: Examples of Potential Pollution Sources from Construction-related Hotspots

These sites are recommended for follow-up site inspections, review of stormwater pollution prevention plans, and future education efforts, particularly related to vehicle operations and outdoor materials storage.

Storage

Several outdoor storage sites were observed within the planning area and two were assessed to represent this commercial hotspot subcategory. Each had operations related to boats and vehicles, outdoor materials, and waste management. Vehicle operations included storage and maintenance of boats and vehicles. At both sites, vehicle operations were observed outdoors (uncovered) and lacking runoff diversion methods. Also at both sites, outdoor storage areas lacked coverage. In one case, an assortment of materials was being stored such as vehicles, boats, tires, old lawn mowers and sediment. These materials were being stored immediately adjacent to a wetland area with no diversion methods in place to prevent potential pollutants from being carried off-site via stormwater runoff.

Figure 4-19: Examples of Potential Pollution Sources from Storage-related Hotspots

These sites are recommended for future education efforts related to proper vehicle operations and outdoor materials storage.

Commercial Hotspot Summary

Pollution potential from commercial hotspots including auto-related facilities, shopping centers, nurseries, construction-related sites, and storage facilities can be ranked as high, medium or low based on the following example criteria:

- *High pollution potential*: Staining of impervious surfaces leading to storm drain inlets or stream; dumpsters in poor condition (leaking, overflowing, uncovered, next to storm drain or stream without diversion); improper disposal of hazardous materials or wash water; uncovered or lack of runoff diversion methods for repair/fueling areas or outdoor materials storage
- *Low pollution potential:* Proper disposal methods; good housekeeping (well maintained parking lot, waste management); stormwater management practices

Transport-related

Transport-related hotpots generally include large impervious areas and significant amount of vehicle operations. They can also include waste management operations. These areas can be sources of potentially hazardous pollutants such as oil and grease from leaking vehicles and stained parking lot surfaces. Some can also be potential sources of trash/dumping and stormwater pollution from outdoor materials storage. These types of sites may be good candidates for future education efforts related to vehicle operations, outdoor materials storage, and waste management.

Pollution potential from transport-related hotspots can be ranked as high, medium or low based on the following example criteria:

- High pollution potential: Staining of impervious surfaces leading to storm drain inlets or stream; dumpsters in poor condition (leaking, overflowing, uncovered, next to storm drain or stream without diversion); uncovered or lack of runoff diversion methods for repair/fueling areas or outdoor materials storage

- Low pollution potential: Proper disposal methods; good housekeeping (well maintained parking lot, waste management); stormwater management practices

4.4 Institutional Site Investigation (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 recently completed County watershed studies, a modified version of the HSI field form was used to assess institutional sites since HSI protocols do not exactly match conditions encountered on institutional properties and because institutional areas make up 3 percent of the watershed area. The ISI method was first developed and implemented for the Upper Back River watershed study and was also used for the Tidal Back River watershed study. Institutions surveyed as part of this study include the following types of community-based facilities: schools, faith-based facilities, community centers, fire and rescue stations, and care facilities (e.g., senior living). 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, aerial photographs, and an ADC map. These were shown and labeled on field maps created for the upland assessments and on larger base maps showing the entire watershed. Institutions were surveyed as encountered in the field using these maps and a list of institutions as guidance. Unique ID numbers were assigned to ISIs using the classification scheme "ISI_F_100", where 'F' denotes the Middle River/Tidal Gunpowder River planning area watershed and the first number corresponds to a specific subwatershed. As previously described, subwatersheds were assigned the unique numbers summarized in Table 4-11 for the purposes of HSIs, ISIs, and PAAs. Institutional sites were numbered sequentially in the order they were surveyed within a particular subwatershed. For example, ISIs in Saltpeter Creek would be identified as 1201, 1202, 1203, etc.

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

Tree Planting

Potential tree planting locations at an ISI site were marked on aerial photographs while walking the property. After walking the entire site, the total number of trees that could be planted at the site was estimated based on a 15- to 20-foot spacing between trees for narrow sites or based on an estimate of 200 trees per acre for larger open areas. More accurate numbers can be determined during the post-fieldwork desktop analysis after restoration opportunities have been selected and prioritized.

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.

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

Waste Management

Every institution generates waste as a result of daily operations, but unlike hotspots, it is typically just garbage. The field team noted the type of waste generated (e.g., hazardous, garbage, etc.) and the condition of 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 did not have vehicle operations but a few (including faith-based, care facilities and fire & rescue stations) did have fleet vehicles such as buses and trucks 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. For the most part, it appeared that institutions likely only stored and washed vehicles on-site. Outdoor

activities including vehicle storage, repair, fueling, and washing were also noted as potential pollution sources.

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 (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 (leaves, grass) accumulated on impervious surfaces. Evidence of buffer encroachment and whether 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.

Recommended Actions

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

- Tree planting
- Stormwater retrofit
- Downspout disconnection
- Impervious cover removal
- Trash management
- Storm drain marking
- Stream buffer improvement
- Education (e.g., lawn care, outdoor materials storage)

4.4.2 Summary of Sites Investigated

A total of 34 institutions were assessed throughout the Middle River and Tidal Gunpowder River watersheds. The number and type of institutions assessed within each subwatershed is summarized in Table 4-13. Note that several institutions overlapped two subwatersheds. For this analysis, it is counted toward the subwatershed in which the majority of the area falls within. For example, Chesapeake High School encompasses portions of Sue Creek and Hogpen Creek. Since the majority of the area falls within Sue Creek, it was counted toward this subwatershed for analysis purposes.

Table 4-13: Types of Institutions Assessed

Subwatershed	Community Centers	Public Schools	Private Schools	Fire & Rescue	Care Facilities	Faith-Based
Darkhead Creek	-	2	-	2	-	1
Frog Mortar Creek	-	-	-	-	-	3
Galloway Creek	1	-	-	-	-	-
Browns Cove	-	-	-	-	-	-
Hogpen Creek	-	-	-	-	-	-
Hopkins Creek	1	2	1	-	1	1
Middle River	-	1	-	-	1	1
Norman Creek	-	1	-	1	-	2
Stansbury Creek	-	-	-	-	-	-
Sue Creek	-	1	-	1	-	-
Middle River Subtotal	*2*	*7*	*1*	*4*	*2*	*8*
Aberdeen Proving Ground	-	-	-	-	-	-
Dundee Creek	1	-	-	-	-	-
Gunpowder River	-	-	-	1	-	-
Saltpeter Creek	2	1	-	-	-	3
Seneca Creek	-	1	-	1	-	-
Tidal Gunpowder Subtotal	*3*	*2*	*1*	*2*	*-*	*3*
Total	*5*	*9*	*1*	*6*	*2*	*11*

Figure 4-20 shows the distribution of the various types of institutions assessed throughout the planning area.

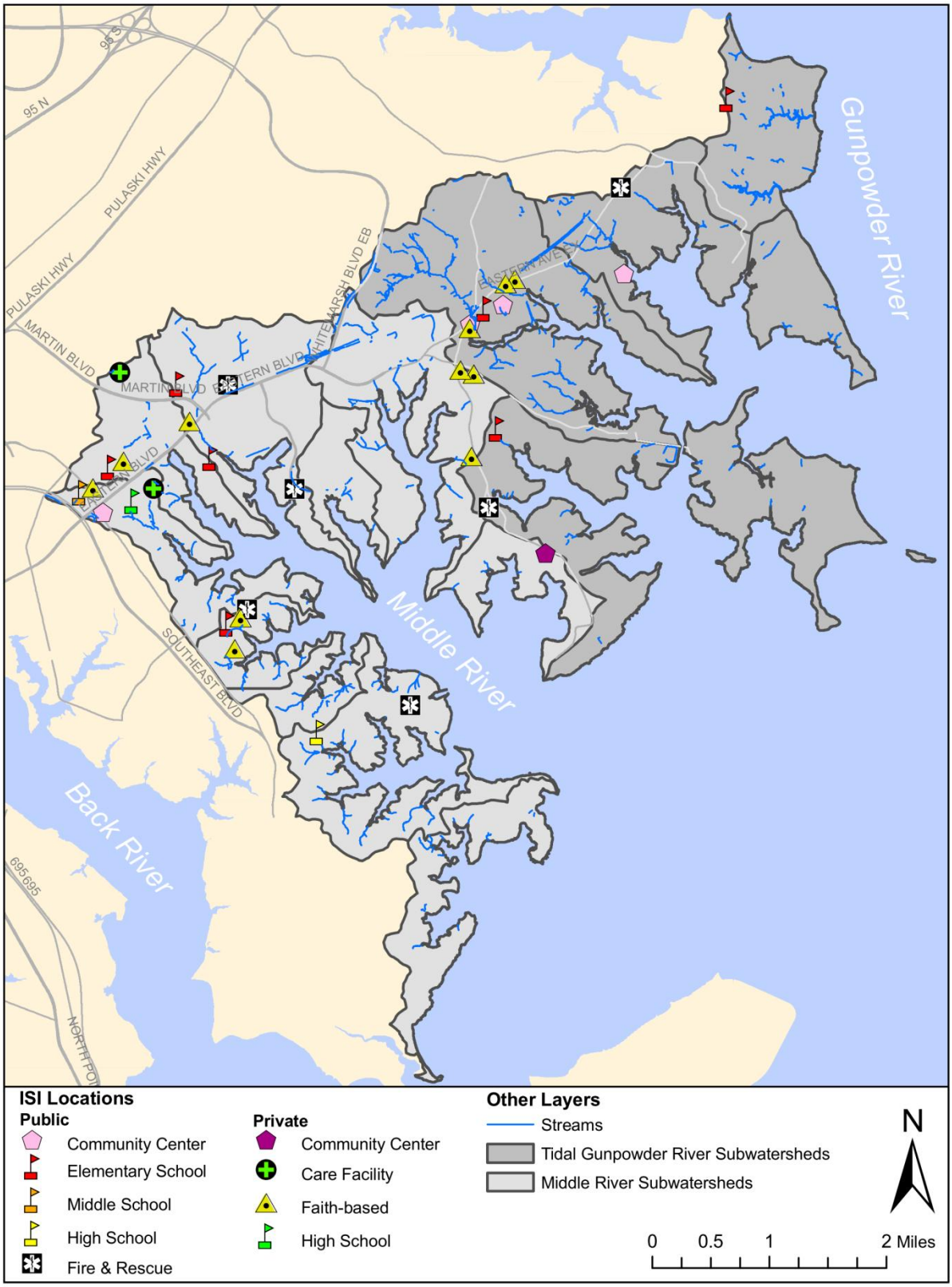

Figure 4-20: ISI Locations in Middle River and Tidal Gunpowder River

4.4.3 General Findings

The number of the different types of recommended actions for ISIs is summarized in Table 4-14 by subwatershed.

Table 4-14: ISI Recommended Actions by Subwatershed

Subwatershed	# of Trees	SW Retrofit	Dwnspt Disconn	IC Removal	Trash Mgmt	SD Mark	Buffer Imprvmt	Educate
Darkhead Creek	215	2	-	2	2	2	-	1
Frog Mortar Creek	160	2	-	-	1	-	-	1
Galloway Creek	40	-	-	-	1	-	-	
Browns Cove	-	-	-	-	-	-	-	-
Hogpen Creek	-	-	-	-	-	-	-	-
Hopkins Creek	340	4	2	1	2	4	-	-
Middle River	235	2	-	1	1	1	1	1
Norman Creek	160	1	1	-	3	1	1	2
Stansbury Creek	-	-	-	-	-	-	-	-
Sue Creek	260	1	-	-	1	1	-	1
Middle River Subtotal	*1,410*	*12*	*3*	*4*	*11*	*9*	*2*	*6*
Aberdeen Proving Ground	-	-	-	-	-	-	-	-
Dundee Creek	85	1	-	-	-	1	-	-
Gunpowder River	400	-	-	-	-	1	-	-
Saltpeter Creek	405	4	1	1	3	3	1	1
Seneca Creek	65	1	-	-	1	1	-	-
Tidal Gunpowder Subtotal	*955*	*6*	*1*	*2*	*4*	*6*	*1*	*1*
Total	*2,365*	*18*	*4*	*6*	*15*	*15*	*3*	*7*

4.4.3.1 Tree Planting

It was estimated that a total of 2,365 trees could be planted at institutions located within 11 of the 15 subwatersheds comprising the Middle River/Tidal Gunpowder River planning area. Trees were recommended for 31 out of the 34 institutions assessed. Tree planting sites were identified in the field and noted on field maps. The number of trees was estimated based on 15- to 20-foot spacing between trees for narrow sites or based on an estimate of 200 trees per acre for larger open areas. The table above represents planning level estimates which would be refined through follow-up site investigations if a site is selected for a restoration/improvement project(s). Like street trees, open space shade trees are not only an asset aesthetically but they also provide air and water quality improvement since they intercept precipitation with their leaves and can absorb precipitation and nutrients through their root

systems. This infiltration of precipitation through leaves or the root systems slows flow input and provides some treatment before stormwater runoff reaches the stream system.

4.4.3.2 Stormwater Retrofits

As shown in the table above, the action that was recommended the most were stormwater retrofits (18 sites). Storm drain marking was also a common recommendation (15 sites). Downspout disconnection was recommended for 2 public community centers and 2 private institution sites (church, high school) where sufficient pervious area was available to redirect rooftop runoff. All of these actions present an opportunity to educate the community about the connection between the storm drain system and the Middle and Gunpowder Rivers and how their actions can impact or improve water quality.

Stormwater retrofits were recommended at 12 public institutions (8 schools, 3 community centers, 1 fire & rescue) and 6 private facilities (4 faith-based, 1 school, 1 care facility). Stormwater retrofit opportunities included treating runoff from parking lots, inlet retrofits, and conversion/inspection of existing SWM facilities. Sites where sufficient pervious area was available to treat a portion of the runoff from an impervious parking lot could implement infiltration/filtration practices such as trenches, basins, or bio-retention that incorporate vegetation and filter media through which stormwater infiltrates for pollutant removal prior to groundwater recharge or entering the stream system. Three examples of stormwater retrofit recommendations for parking lots are shown in Figure 4-21. The photos show sites which have large pervious areas available adjacent to impervious parking lot. This is a good opportunity to address runoff from the parking lots and potential ponding or sediment build-up issues, and also treat runoff before it enters any on-site inlets or streams. The photos on the bottom are at ISI_F_1206 in Saltpeter Creek. There is an open space of turf grass between a large impervious parking lot and the stream that runs behind the property. This is a great opportunity to provide additional treatment/infiltration of runoff from the parking lot before it gets into the stream system.

Figure 4-21: Parking Lot Retrofit Opportunities at ISI_F_403 (top left), ISI_F_703 (top right) and ISI_F_1206 (bottom photos)

Inlet retrofits were recommended for sites where considerable ponding of water and/or bare soil was observed around storm drain inlets on the property. Planting native vegetation around these inlets would help stabilize soil, reduce sediment and flow input into the storm drain system, and provide some infiltration/treatment prior to runoff entering the ground and inlet. Figure 4-22 shows examples of two sites recommended for this type of stormwater retrofit: ISI_F_1101 in Seneca Creek (photo on left) and ISI_F_1103 in Darkhead Creek (photo on right).

Figure 4-22: Inlet Retrofit Opportunities at ISI_F_1101 (left) and ISI_F_1103 (right)

At ISI_F_501, there appeared to be multiple existing SWM facilities, including permeable pavement and curb cuts leading runoff to stone diaphragms and a grass berm area. Standing water and sediment build-up issues were observed at the curb cut areas. It is recommended that the existing facilities be investigated to assess existing function and conversion potential for enhanced water quality treatment of runoff from the adjacent parking lots. Because the site has taken initiative to install permeable pavement and educate church patrons via signs, this indicates a potential partnership opportunity for the County.

Figure 4-23: Existing SWM Retrofit Opportunities at ISI_F_501

4.4.3.3 Impervious Cover Removal

As discussed previously, impervious surfaces prevent precipitation from naturally infiltrating into the ground. Because runoff from impervious surfaces is often accelerated and concentrated when it reaches the storm drain and stream systems, it can lead to stream erosion, habitat destruction, and

water pollution. Removing unused or underutilized impervious surfaces will help increase pervious area and the watersheds' capacity for infiltrating and treating stormwater runoff.

Impervious cover removal was a recommended action for 5 out of the 34 institutions investigated. It was a recommended action for sites where a considerable impervious area appeared to be abandoned or underutilized such as parking lots and athletic courts. It also included areas where impervious cover was not absolutely necessary and appeared to be damaged (patched, breaking up) such as areas on the side or behind buildings, areas between building and parking lot, or areas between walkways/sidewalks. The photo on the left in Figure 4-24 shows an impervious area located between two athletic fields that appears to be a remnant of an old athletic court that is no longer used. There is also a paved strip or walkway extending from this area that stops abruptly in the middle of the field. Adjacent to this impervious area at the southwest corner of the tennis court is a concrete-lined channel (right photo in figure below) that could also be a potential opportunity for impervious cover removal and restoring the stream to a more natural system including buffer improvement.

Figure 4-24: Impervious Cover Removal Opportunities at ISI_F_502

4.4.3.3 Buffer Improvement

As discussed in the stream assessment section, forested buffer areas along streams are important for improving water quality and flood mitigation since they can reduce surface runoff, stabilize stream banks (root systems), shade streams, remove pollutants such as nutrients and sediment from runoff and provide habitat for various types of terrestrial and aquatic life including fish. Several institutions have streams that run through the property which is a potential opportunity for improving an inadequate stream buffer by introducing native vegetation and trees. Buffer improvement options, however, must be sensitive to property uses while striking a balance with protecting water resources. For example, a narrow buffer consisting of native vegetation might be an alternative to 50-foot wide wooded buffers on either side.

Buffer improvement was identified as a recommended action for 3 out of the 34 institutions assessed including a public elementary school and two private facilities (1 care facility, 1 faith-based). School

properties typically represent a unique opportunity to combine restoration projects with education. The public school recommended for buffer improvement is ISI_F_403. The stream runs adjacent to the fence line of a baseball field. Between the fence and the stream, there is a grass strip (photo on left in figure below) where bare soil and dumping (photo on right in figure below) were observed. Enhancing the buffer (increase the buffer width) within this area will provide extra protection from trash or sediment loads from the adjacent property or passersby.

Figure 4-25: Buffer Improvement Opportunity at ISI_F_403

Two private facilities, ISI_F_603 (Figure 4-26, left) and ISI_F_1206 (Figure 4-26, right), were identified as having inadequate stream buffers. At ISI_F_603, a drainage channel carries runoff from the adjacent parking lot and possibly other developed areas through a culvert to a detention pond. The beginning of the channel near the outfall is incised and eroding. The area may be limited for trees; however, incorporating native vegetation would help stabilize the channel, while also providing pre-treatment of the runoff before it reaches the detention pond. At ISI_F_1206, there is a narrow buffer between the stream and the adjacent grass area and storage building. The field team observed outdoor materials being stored close to the stream with potential for trash or potentially hazardous liquids to runoff into the stream. This is an opportunity to educate the property owner about proper outdoor materials storage and the importance of maintaining an adequate buffer for water quality purposes.

Figure 4-26: Buffer Improvement Opportunities at ISI_F_603 (left) and ISI_F_1206 (right)

4.4.3.3 Trash Management

Trash management is an area in need of improvement throughout various areas of the watersheds including institutions. A total of 15 institution sites (9 public, 6 private) were recommended for trash management action. Waste management education is recommended to address leaking dumpsters, open or uncovered dumpsters where trash can leave the site, and dumpster placement near storm drain inlets or streams. For example, at ISI_F_703 and ISI_F_1204 there was evidence of leakage by stains on the ground. Dumpsters with evidence of leaking should be repaired or replaced. At both of these sites, staining from the dumpsters led to nearby storm drains. Runoff diversion methods should be used to contain leaks and prevent them potential pollutants from being carried by stormwater runoff into the storm drains. At some sites, dumpsters were noted as overflowing and with potential for trash to be carried off-site by wind and/or rain. In these cases, it should be determined whether additional dumpsters or increased pick-up frequency is necessary. Dumping was also noted at multiple institutional areas including both litter and bulk items. One trash dumping problem was observed at ISI_F_1202, which looked like a potentially condemned building (see Figure 4-27). Other dumping and trash issues were observed along the edge of a property or in a nearby stream. Dumping or trash/litter issues were noted at ISI_F_403, ISI_F_404, ISI_F_504, ISI_F_704 and ISI_F_1101. This may be addressed through various measures such as a trash campaign, waste management education, improving bulk trash pick-up options, increased on-site trash receptacles, and community cleanups.

Figure 4-27: Trash Management Opportunity at ISI_F_1202

4.5 Pervious Area Assessment (PAA)

PAAs were conducted to identify and evaluate sites within the Middle River and Tidal Gunpowder River watersheds with potential for land reclamation, reforestation, or re-vegetation. The following subsections describe the methods used to identify and evaluate restoration potential of pervious areas.

4.5.1 Assessment Protocol

Large parcels of open land throughout the watershed were identified in the office prior to conducting the field assessment using GIS tax parcel information, land use data, aerial photographs, and an ADC map. These were shown and labeled on maps created for upland assessments and on larger base maps showing the entire planning area. Upon visiting pervious areas identified in the office, a PAA was conducted if the field team verified the site as having sufficient space and potential for restoration. In some cases, sites were identified for PAAs while surveying other upland areas such as underutilized areas on institutional property or large open spaces within an NSA. The USSR manual recommends assessing publicly-owned pervious areas greater than two acres and privately-owned areas greater than five acres. Because many of the subwatersheds are highly urbanized, particularly in the Middle River watershed, sites greater than approximately 1 acre were considered. Unique ID numbers were assigned to PAAs using the classification scheme "PAA_F_100", where 'F' denotes the Middle River/Tidal Gunpowder River planning area and the first number corresponds to a specific subwatershed. As previously described, subwatersheds were assigned the unique numbers summarized in Table 4-11 for the purposes of HSIs, ISIs, and PAAs. Pervious areas were numbered sequentially in the order they were surveyed within a particular subwatershed. For example, PAAs in Saltpeter Creek would be identified as 1201, 1202, 1203, etc.

The entire property of a PAA site was walked by the field team to collect necessary data and take photographs. Basic information was filled out first including site accessibility, ownership, current management, and whether the site was connected to another pervious area. The area of the site was determined in the office using GIS tax parcel information and aerial photographs. Access to the site is important when considering its restoration potential. The field team checked whether access included foot, vehicle, and/or heavy equipment. A site that can only be accessed by foot may have less potential for restoration if it requires greater disturbance or costs to restore (e.g., constructing an access road). Similar to institutions, ownership is important because different approaches may be used to contact private versus public institutions. Current management describes the current use of the land including the following: school, park, right-of-way, or vacant land. The presence and type of connected pervious area is also relevant to restoration potential of a pervious area. For example, if a site connects forested areas, reforesting the site would help to continue the forested corridor for wildlife habitat or stream buffer purposes. If a site is connected to an existing wetland area, it could be reforested to protect the wetland or revegetated to extend the wetland area. The other data categories assessed are briefly described below.

Current Vegetative Cover

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

Impacts

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

Reforestation Constraints

Similar to impacts, information regarding factors that may impede reforestation efforts was collected. The type of sun exposure was recorded as full sun, partial sun, or shade. The field team noted whether there was a nearby water source for supplemental water if necessary. Other constraints related to reforestation that were noted include overhead wires, underground utilities, pavement, and buildings. Private ownership was noted as a potential constraint.

Recommended Actions

Recommendations for pervious area restoration based on initial field observations included one or more of the following:

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

4.5.2 Summary of Sites Investigated

A total of 19 pervious areas were assessed within the Middle River/Tidal Gunpowder River planning area totaling approximately 1,154 acres. Parcel sizes ranged from 1 acre to over 700 acres. Most sites assessed (11 out of 19) were less than 10 acres in size. All sites surveyed were considered as open pervious cover type with minimal site preparation required for restoration. Figure 4-28 shows the location and size of PAAs within the planning area.

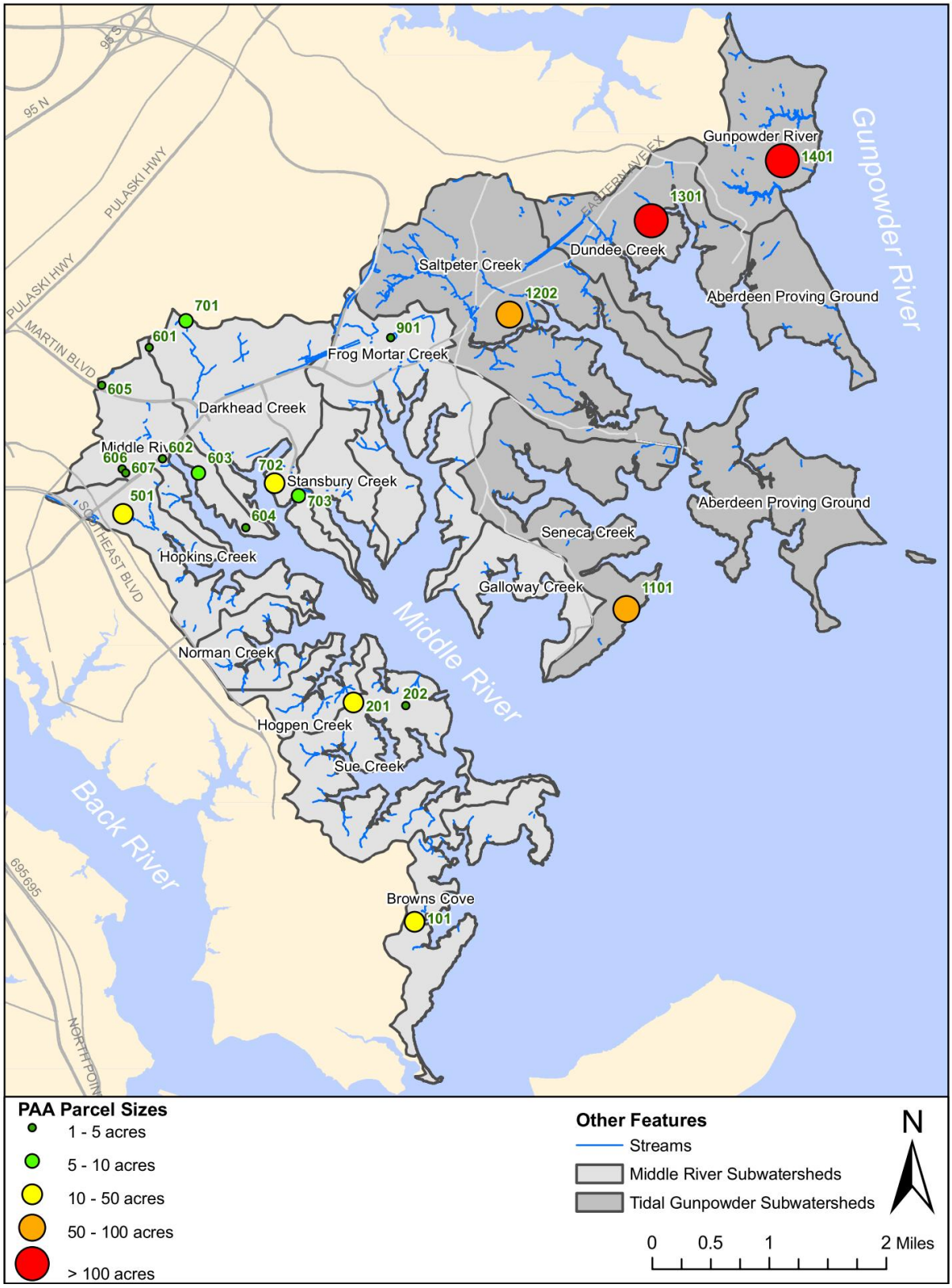

Figure 4-28: PAA Locations

4.5.3 General Findings

A summary of PAA results including parcel size, ownership, management, percent turf cover, and site preparation required for the sites assessed is provided in Table 4-15.

Table 4-15: Summary of PAA Results

Site ID	Acres	Ownership	Management	% Turf	Site Prep
PAA_F_101	32.27	Public	Vacant Land	30	Minimal
PAA_F_201	18.47	Public	Park	30	Minimal
PAA_F_202	1.11	Private	Vacant Land	60	Minimal
PAA_F_501	30.38	Public	Park	50	Minimal
PAA_F_601	1.63	Public	Vacant Land	70	Minimal
PAA_F_602	1.34	Public	Park	75	Minimal
PAA_F_603	7.81	Public	Park	27	Minimal
PAA_F_604	2.87	Public	Park	70	Minimal
PAA_F_605	1.03	Private	Other	100	Minimal
PAA_F_606	1.62	Public	Park	85	Minimal
PAA_F_607	1.07	Private	Vacant Land	90	Minimal
PAA_F_701	7.01	Public	Vacant Land	38	Minimal
PAA_F_702	19.89	Public	Park	70	Minimal
PAA_F_703	7.67	Public	Park	85	Minimal
PAA_F_901	3.62	Private	Park	100	Minimal
PAA_F_1101	59.56	Public	Park	15	Minimal
PAA_F_1201	82.94	Public	Park	50	Minimal
PAA_F_1301	106.00	Public	Vacant Land	50	Minimal
PAA_F_1401	767.39	Public	Park	20	Minimal

The most likely candidates for successful pervious area restoration efforts are those on public lands with minimal site preparation required. Public sites are eligible for tree planting through DNR's "Tree-mendous Maryland" program and are good opportunities for volunteer or community projects. Of the 19 sites surveyed, 15 are under public ownership and all were considered to require minimal site preparation. The 15 public pervious area sites assessed are briefly described below.

PAA_F_101: Schaffers Rd

PAA_F_101 is located off of Schaffers Road in the Browns Cove subwatershed. It is designated as a permanent, County-owned easement, according to spatial tax parcel information provided by the County. The parcel is approximately 32 acres and is within a Coastal Rural Legacy area. The parcel is mostly forested and surrounded by other forested areas. Approximately 30% of the area appears to be cropland. It was not clear during the assessment whether the cropland is still being utilized. This site is

recommended for reforestation with minimal site preparation to connect the existing forested area. This site receives full sun exposure and is easily accessible by foot, vehicle, and heavy equipment. Reforestation of the site would require verification that the property is owned by the County and not dedicated cropland. Tree planting could be a potential community project.

Figure 4-29: Reforestation Opportunities at PAA_F_101

PAA_F_201: Bauernschmidt Manor Park

Bauernschmidt Manor Park is located at the intersection of Bauernschmidt Drive and Turkey Point Road within a residential area, and falls mostly within the Sue Creek subwatershed. It is an 18.5-acre public park and maintained by Baltimore County Department of Recreation and Parks. It is mostly forested (70%) with approximately 30% turf cover, which appears to be maintained as a soccer/athletic field. There is, however, potential for trees to be planted at the intersection of Bauernschmidt Drive and Turkey Point Road and along the perimeter of the athletic fields. This site is recommended for reforestation with minimal site preparation to enhance and preserve the existing forested area. This site receives full sun exposure and is easily accessible by foot, vehicle, and heavy equipment. Reforestation of a portion of the site would require verification that it would not interfere with the current use of the site and overhead wires. Tree planting could be a potential community project.

Figure 4-30: Reforestation Opportunities at PAA_F_201

PAA_F_501: Fields at Renaissance Park

The Fields at Renaissance Park is a community park project funded by Maryland DNR and maintained by Baltimore County Department of Recreation and Parks. It is approximately 30 acres and located near the intersection of Eastern Boulevard and Stemmers Run Road in the Hopkins Creek subwatershed. The site consists of approximately 50% turf cover, 45% forest, and 5% bare soil. The County installed a wet pond on-site which treats runoff from over 134 acres including Middlesex Elementary School and two neighboring communities. The field crew also noted newly planted trees, intended to enhance the existing stream buffer, which runs through the site. Portions of the site have full sun exposure and others have partial sun exposure. Additional tree planting opportunities were noted for this site, particularly along Old Eastern Avenue, north of the wet pond. This site is recommended for reforestation with minimal site preparation as it is easily accessible by foot, vehicle and heavy equipment. It is also noted as a potential stormwater retrofit site to treat runoff from the adjacent, impervious parking lot at ISI_F_504. It appears that runoff from the parking lot has formed a minor, eroded channel which leads to a grassed channel within the park. A stormwater practice, such as bioretention, could address the bare soil and provide enhanced water quality treatment for the parking lot runoff. Tree planting could be a potential community project.

Figure 4-31: Reforestation (left) and Stormwater Retrofit (right) Opportunities at PAA_F_501

PAA_F_601: Village of Pawnee (1)

PAA_F_601 is a County-owned open space, located at the end of Chattuck Court within the Village of Pawnee townhome complex. The parcel is approximately 1.6 acres and mostly turf cover (70%). It has full sun exposure and is easily accessible by foot, vehicle and heavy equipment. The site is recommended for reforestation with minimal site preparation. Trash and dumping was noted at the end of Chattuck Court and along the wooded edge of the parcel. This could be a potential constraint for reforestation purposes but also a potential opportunity to educate the community about proper waste management options. This could be integrated with a community tree planting project.

Figure 4-32: Reforestation Opportunity (left) and Dumping (right) at PAA_F_601

PAA_F_602: Eastern Blvd

PAA_F_602 is a 1.3-acre public park, located between Eastern Boulevard and Old Eastern Avenue in the Middle River subwatershed. The parcel is mostly turf cover (75%) and has full sun exposure. It is also easily accessible by foot, vehicle and heavy equipment. This site is recommended for reforestation with minimal site preparation and could be a potential community, tree planting project. Because of the proximity of the park to the tidal portion of Middle River, there is a good opportunity to integrate watershed and water quality education with tree planting projects or signage in the park.

Figure 4-33: Reforestation Opportunities at PAA_F_602

PAA_F_603: Hawthorn-Midthorn Park

The Hawthorn-Midthorn Park is located along the waterfront in the Middle River subwatershed, parallel to Riverthorn Road. It is a 7.8-acre public park maintained by the Baltimore County Department of Recreation and Parks and is part of the Hawthorne Trail System. The park is currently mostly trees (70%), with approximately 27% turf cover and 3% bare soil. Portions of the site have full sun exposure and others have partial sun exposure. It is easily accessible by foot, vehicle and heavy equipment. There

are two existing detention ponds on-site as well as newly planted trees throughout the park. This site is recommended for reforestation with minimal site preparation to enhance the existing shoreline buffer. It is also recommended that newly planted trees be monitored and maintained for future health and sustainability. This park may also present a good opportunity to raise awareness about the importance of trees, shoreline buffers and the detention ponds to the river's health.

Figure 4-34: Reforestation Opportunities at PAA_F_603

PAA_F_604: Kingston Park

Kingston Park is located along Kingston Park Lane in the Darkhead Creek subwatershed. It is a 2.9-acre public park within a residential area that is maintained by the Baltimore County Department of Recreation and Parks. The park is mostly turf cover (70%) with areas of full and partial sun exposure. This site is recommended for reforestation with minimal site preparation. Reforestation of a portion of the site would require verification that it would not interfere with the current use of the site. The field team also noted some litter scattered in the park, which could be addressed through the use of covered trash cans. Tree planting could be a potential community project.

Figure 4-35: Reforestation (left) and Waste Management Opportunities (right) at PAA_F_604

PAA_F_606: Orville Rd

PAA_F_606 is an unnamed, 1.6-acre public park space located off of Orville Road in the Middle River subwatershed. It is mostly turf cover (85%) with areas of full and partial sun exposure. The site is easily accessible by foot, vehicle and heavy equipment. A line of newly planted trees was observed along the southern edge of the property. There is a playground and large open space recommended for reforestation with minimal site preparation. Reforestation would require verification that it would not interfere with the current use of the site. Tree planting could be a potential community project. The field team also noted bare soil at the entrance to the park area, which drains to the curb and gutter along Orville Road.

Figure 4-36: Reforestation Opportunity (left) and Bare Soil (right) PAA_F_606

PAA_F_701: Village of Pawnee (2)

PAA_F_701 is a County-owned open space, located at the end of Chelmsford Court and TomaBrowns Terrace within the Village of Pawnee townhome complex. The parcel is approximately 7 acres and 38% turf cover with some bare soil (2%) as a result of a walking trail. It has areas of full and partial sun exposure and is easily accessible by foot, vehicle and heavy equipment. The site is recommended for reforestation with minimal site preparation to connect surrounding forested parcels. Similar to PAA_F_601, also located within the Village of Pawnee, trash and dumping was observed along the woods behind the houses including bulk items such as a couch, mattress, computer, and chairs. This could be a potential constraint for reforestation purposes. A community cleanup could be integrated with a tree planting project to raise awareness about proper waste management options and water quality concerns. Reforestation would require verification that it would not interfere with the current use of the site.

Figure 4-37: Reforestation Opportunity (left) and Dumping (right) at PAA_F_701

PAA_F_702: Wilson Point Park

Wilson Point Park is a 20-acre, public park, located off of Beech Drive along the waterfront in the Darkhead Creek subwatershed. The park consists mostly of turf cover (70%) and is easily accessible by foot, vehicle and heavy equipment. There are areas with full and partial sun exposure as well as completely shaded areas. This site is recommended for reforestation with minimal site preparation to enhance the shoreline buffer. Reforestation would require verification that it would not interfere with the current recreational uses of the site. Tree planting could be a potential community project. There is also potential for the existing no-mow/vegetated buffers along the shoreline to be extended. This will need to be balanced with providing access to and view of the waterfront. The field team observed SWM facilities (stone diaphragms) along the edge of the parking lot in the boat ramp area. It is recommended that these be maintained by cleaning out sediment and replacing gravel periodically to ensure proper function and water quality benefits. Erosion and invasive plant species were observed along the shoreline at the southern end of the site. This may be an opportunity for a natural shoreline restoration project to stabilize the shoreline while also providing water quality benefits. Public education can be a component of any of the recommended actions to raise awareness about the water quality benefits of reforestation, stormwater retrofit, and buffer and shoreline enhancement opportunities.

Figure 4-38: Buffer Enhancement (left) and Reforestation (right) Opportunities at PAA_F_702

Figure 4-39: Stormwater Retrofit (left) and Shoreline Restoration (right) Opportunities at PAA_F_702

PAA_F_703: Wilson Point Rd

PAA_F_703 is an unnamed park located adjacent to Wilson Point Park and off of Wilson Point Road in the Darkhead Creek subwatershed. It is a 7.8-acre park owned by the state of Maryland with mostly turf cover (85%) and full sun exposure. The site is easily accessible by foot, vehicle and heavy equipment. It is recommended for reforestation with minimal site preparation. Reforestation would require verification that it would not interfere with the current recreational uses of the site. Similar to Wilson Point Park, there is an existing no-mow/vegetated buffer zone along the waterfront of the property with potential to be expanded. This would also require that it would not compromise existing uses of the site. Tree planting and buffer enhancement could be potential community projects.

Figure 4-40: Buffer Enhancement (left) and Reforestation (right) Opportunities at PAA_F_703

PAA_F_1101: Miami Beach Park

Miami Beach Park is a 60-acre public park and beach maintained by Baltimore County Department of Recreation and Parks. It is located at the end of Miami Beach Road in the Seneca Creek subwatershed. It is predominantly forested (65%) with wetlands (15%) and turf cover (15%). The turf area has full sun exposure and is easily accessible by foot, vehicle and heavy equipment. It is a potential candidate for reforestation with minimal site preparation and a community tree planting project; however, reforestation should consider existing uses of the site. The field team also noted an opportunity for stormwater retrofit to treat runoff from the small impervious parking area. This may involve filtering/filtration practices such as a bioretention area to treat runoff and address standing water issues.

Figure 4-41: Reforestation (left) and Stormwater Retrofit (right) Opportunities at PAA_F_1101

PAA_F_1201: Eastern Regional Park

Eastern Regional Park is an 83-acre public park located off of Eastern Avenue in the Saltpeter Creek subwatershed. It consists of approximately 50% turf, 30% trees, and 20% other herbaceous. Turf areas suitable for reforestation have full sun exposure and are easily accessible by foot, vehicle and heavy equipment. The field team estimated that approximately 70% of the turf area appears to be dedicated to recreational fields. The site is recommended for reforestation with minimal site preparation. The open space areas at the northern portion of the site along Eastern Avenue appear to be good candidates for tree planting; this could be a community project.

Figure 4-42: Reforestation Opportunities at PAA_F_1201

PAA_F_1301: Brinkmans Rd

PAA_F_1301 is a County-owned open space located off of Brinkmans Road in the Dundee Creek subwatershed. It is approximately 106 acres with approximately 50% turf cover and 50% existing tree cover. Turf areas include both full and partial sun exposure and are easily accessible by foot, vehicle, and heavy equipment. There is a reforestation nursery owned by Baltimore County EPS on-site. The field team also observed newly planted trees in the southeast portion of the site. This site is recommended for reforestation with minimal site preparation to continue to expand and connect the surrounding forested areas and could be a potential community tree planting project.

Figure 4-43: Reforestation Opportunities at PAA_F_1301

PAA_F_1401: Gunpowder Falls State Park

Gunpowder Falls State Park is located off of Graces Quarters Road in the Gunpowder River subwatershed. It is over 750 acres and consists of approximately 50% trees, 30% wetland areas, and 20% turf cover. Turf areas include both full and partial sun exposure and are easily accessible by foot, vehicle and heavy equipment. Newly planted trees were observed throughout the park which should be monitored and maintained to ensure forest health and sustainability. There is still considerable opportunity for tree planting and potential community projects; therefore, it is recommended for reforestation with minimal site preparation. There are several existing SWM facilities in place to capture runoff from adjacent parking lots; this may be a good opportunity to incorporate signs describing the facility and its purpose and water quality benefits. The field team noted a potential new stormwater retrofit opportunity for the third parking lot on the right after the park entrance where a practice such as bioretention would address standing water and treat runoff prior to entering Gunpowder River. A potential stormwater retrofit for an existing SWM facility was noted within the parking lot located just past the entrance to the visitor center. There is a curb cut directing runoff from the parking lot to an infiltration type facility; however, an eroded channel was observed at the outfall of the SWM facility. The field team also noted a large, uncontrolled population of geese and as a result, significant animal waste throughout the park. Measures, such as plants that deter geese and fencing, to control geese activities and waste that leads to the beach areas and river may need to be considered.

Figure 4-44: New Stormwater Retrofit Opportunity at PAA_F_1401

Figure 4-45: Existing Stormwater Retrofit Opportunity at PAA_F_1401

4.6 Marina Site Visits (MAR)

There are 31 marinas within the Middle River and Tidal Gunpowder River watersheds, which is a unique feature among SWAP planning areas. Marinas present a unique opportunity to promote environmental stewardship and reinforce the connection between water quality and recreational benefits. Marinas qualify as commercial hotspots since there is 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. In addition, stormwater runoff drains directly to tidal waters because of their location and need for access to waterways. Most marinas have individual NPDES permits, meaning discharges are already regulated and must abide by applicable state laws. A typical hotspot investigation was not conducted for marinas. Rather, site visits were conducted to gather information about typical marina operations and to identify potential restoration and partnership opportunities relevant to meeting watershed goals. The following subsections describe the methods used to evaluate a sample of marinas within the planning area.

4.6.1 Assessment Protocol

The County distributed a letter to all Baltimore County marina owners to solicit participation in a survey involving a tour of the marina property and typical operations. Some members of the Marine Trades Association of Baltimore County (MTABC) offered to give tours and helped identify other marina owners that would be willing to participate in the survey. Based on this information, the County arranged tours with 9 different marinas, representing various types of marinas distributed throughout the planning area. Unique ID numbers were assigned to marinas using the classification scheme "MAR_F_901", where 'F' denotes the Middle River/Tidal Gunpowder River planning area watershed and the first number corresponds to a specific subwatershed. As previously described, subwatersheds were assigned the unique numbers summarized in Table 4-11 for the purposes of upland assessments. Marina sites were numbered sequentially in the ordered they were surveyed within a particular subwatershed. For example, marinas in Frog Mortar Creek would be identified as 901, 902, etc.

A key strategy for including marinas in the SWAP process is to encourage all marinas to become a certified Maryland Clean Marina. The Maryland Clean Marina Initiative was developed by DNR as an alternative to additional regulations on the marina industry. Marinas that meet legal requirements and voluntarily adopt pollution prevention practices are recognized and promoted by Maryland DNR through the Clean Marina Initiative. A condensed and modified version of DNR's Clean Marina Checklist was used to gather key information related to existing pollution prevention practices and areas with improvement potential. More information on this program can be found here: http://www.dnr.state.md.us/boating/cleanmarina/

Marina owners typically gave a walking tour of the site and helped the field team answer a series of yes or no questions comprising the marina review checklist. Basic information was filled out first including type of marina, clean marina status, and contact information. Then, a series of yes/no questions was answered for each of the following operation categories:

- Vessel Maintenance & Repair
- Petroleum Control
- Sewage Handling
- Waste Management
- Marina Management
- Stormwater Management
- Turf/Landscaping Areas

For each of the above operation categories, a score (out of a maximum of 100) was calculated based on the number of yes responses divided by the number of applicable questions. Parameters evaluated within each operation category are described briefly below.

Vessel Maintenance & Repair

Vessels require many activities, such as cleaning, engine lubrication, and winterization, which have the potential for introducing pollutants into the environment. Vessel operations may include maintenance, repair, cleaning, and/or painting. The field team noted whether maintenance and repair activities took place in designated, covered work areas and whether runoff diversion methods were in place for these areas to limit stormwater pollution potential. Marina owners were asked whether and how environmental impacts from bottom coatings and paintings as well as cleaning are minimized. For example, some marinas use water-based paints and vacuum sanding or no sanding to minimized impacts from bottom coatings. Many marinas also use filter cloth and collect debris during boat washing as well as stock non-toxic washing products in their marina store.

Petroleum Control

Petroleum in or on the water can be harmful to aquatic and human health. Petroleum not only contains contaminants but can also reduce light penetration and the exchange of oxygen at the water's surface. For those marinas with fueling operations, it was noted whether fueling areas were covered and environmental controls, such as shut-off and vapor control nozzles and spill cleanup instructions, were in place at fueling pumps. Marina owners were also asked whether fueling areas were staffed by a trained employee and the field team checked whether oil absorbent pads were available.

Sewage Handling

Raw or poorly treated sewage is hazardous to human health. Waterborne diseases can be passed to people who come into contact with contaminated waters or by eating contaminated shellfish. Effluent discharged to waterways also reduces the amount of oxygen available for aquatic life. If applicable, marina owners were asked whether pump-out stations are well maintained. For example, regular inspections and an inspection log are indicators of well maintained pump-out systems. The field team also determined whether the pump-out station was easily accessible and if methods are in place to prevent spills. Marina owners were also asked whether clean, functioning restrooms are available 24 hours a day and if on a septic system, whether it is regularly maintained and functional.

Waste Management

Every business generates waste as a result of daily operations, which 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 whether hazardous wastes were stored, used and disposed of properly. For example, some proper liquid waste management techniques that were observed included using separate containers for storing oil, antifreeze and solvents, employing a certified waste hauler to dispose or recycle, surrounding tanks with impervious, secondary containment, and locking intake to oil and antifreeze recycling containers to prevent contamination. The field team checked whether non-hazardous dumpsters were covered, accessible, and in good condition (no leaking or overflow). Marina owners were also asked

whether solid waste recycling is provided on-site and if trash-pick up is conducted frequently to prevent litter from getting into waterways.

Marina Management

Maintaining and educating marina staff and clients about pollution prevention practices is important to routinely minimize pollution. This involves training staff, informing boaters about how their actions can affect water quality and letting the public know that the marina is doing its part to protect the environment. Marina owners were asked whether a spill prevention, control and countermeasures plan is in place and whether employees are trained for best management practices such as proper disposal techniques, spill prevention and control, and general good housekeeping. The field team also asked whether customers are educated about best management practices (BMPs) such as through signs, their rental slip contracts, or other information. For example, several of the certified Clean Marinas provide brochures with clean boating tips from DNR to their customers and others provide mailings or newsletters with similar information. Another marina provides annual safety training for boat owners.

Stormwater Management

Any marina that conducts boat maintenance activities or that has wastewater discharges must apply for coverage under a general permit for discharges from marinas. This authorizes and regulates the discharge of boat and equipment washing water, stormwater runoff from maintenance areas, treated bilge water, noncontact cooling water, and condensate discharges. Permit compliance requires a stormwater pollution prevention plan and BMPs to make sure that wastewater and stormwater leaving a marina will not impact water quality. Marina owners were asked whether they hold a current marina general permit and whether stormwater treatment practices are in place. The field team also determined whether paved areas were limited (which was often the case) and if runoff from paved areas was treated. If storm drains were on site, it was noted whether these were marked. In most cases storm drains were not present. Marina owners were also asked whether shoreline erosion control measures were in place if needed.

Turf/Landscaping Areas

Ground maintenance activities for turf/landscaped areas were also evaluated at marina sites. High turf management practices are potential pollution sources of nutrients, fertilizer, and pesticides. The field team asked marina owners whether toxic lawn/garden chemicals were minimized and determined whether landscaped areas accumulated on impervious surfaces. It was also noted whether runoff diversion methods were in place for landscaped areas. Most of the marinas had very little or no turf/landscaped areas.

Other Comments

After surveying the entire property and evaluating marina operations, notes were made about possible follow-up actions or partnership opportunities.

4.6.2 Summary of Sites Investigated

Approximately one-third of the marinas (9 out of 31) in the Middle River and Tidal Gunpowder River watersheds were surveyed. The marinas that participated in the uplands survey are listed in Table 4-16 including site ID, marina name, subwatershed and Clean Marina status. Locations of marina site reviews are shown in Figure 4-46. As shown in Table 4-16, nearly half of the marinas surveyed (4 out of 9) are certified Maryland Clean Marinas. This table also shows that 6 marinas were surveyed in the Middle River watershed and 3 were surveyed in the Tidal Gunpowder River watershed. While this is a sample assessment, the overall watershed strategy should also encompass all marina operations occurring in the watershed.

Table 4-16: Summary of Marina Sites Surveyed in Middle River and Tidal Gunpowder River

Site ID	Name	Subwatershed	Clean Marina?
Middle River Watershed			
MAR_F_201	Boating Center of Baltimore	Sue Creek	-
MAR_F_501	Deckleman's Boatyard	Hopkins Creek	-
MAR_F_901	Long Beach Marina	Frog Mortar	-
MAR_F_902	Maryland Marina	Frog Mortar	Yes
MAR_F_903	Tradewinds Marina	Frog Mortar	Yes
MAR_F_1001	Galloway Creek Marina	Galloway Creek	-
Tidal Gunpowder Watershed			
MAR_F_1101	Porters Seneca Marina	Seneca	Yes
MAR_F_1102	Beacon Light Marina	Seneca	-
MAR_F_1301	Dundee Creek Marina	Dundee Creek	Yes

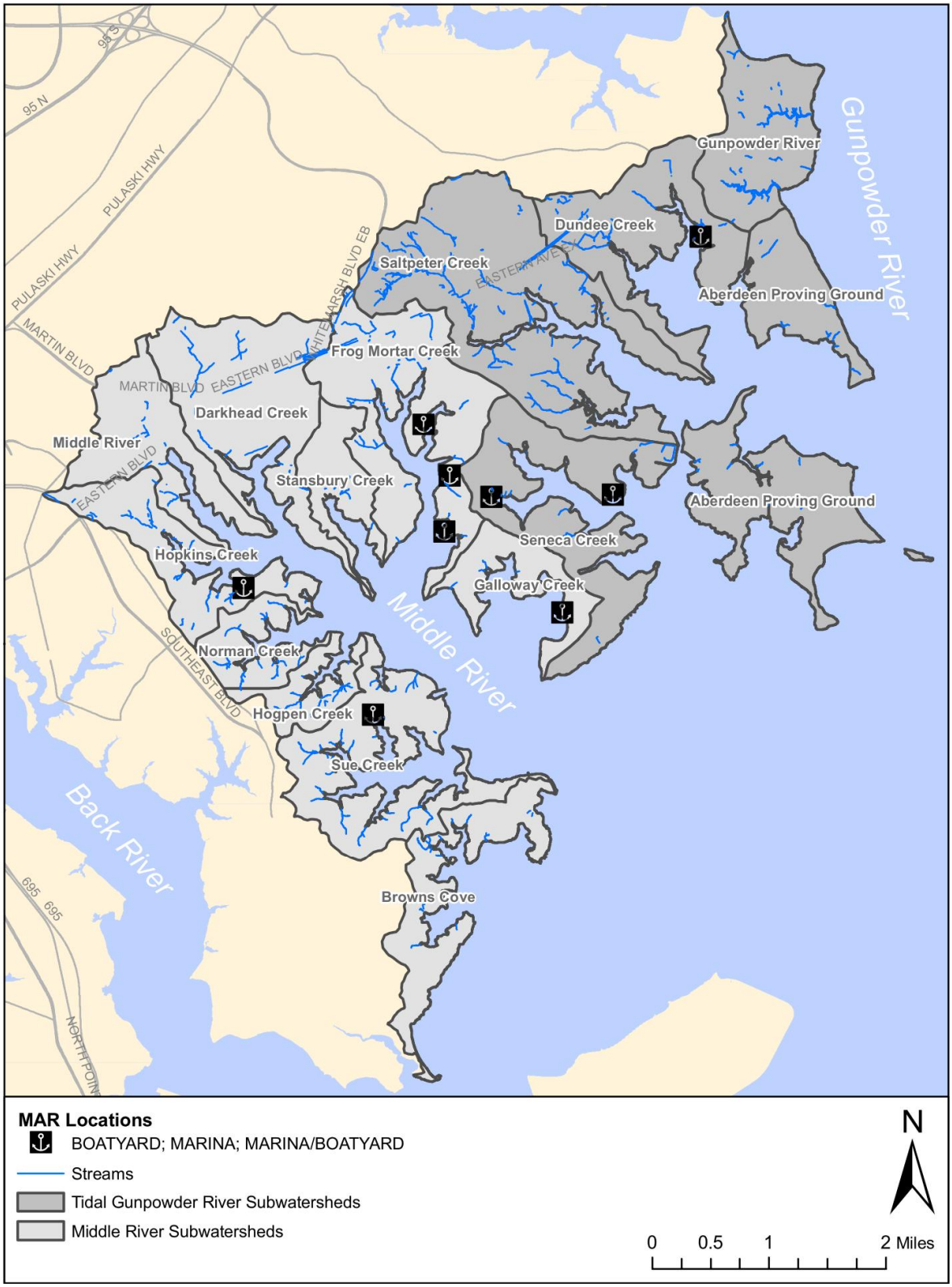

Figure 4-46: Marina Site Visit Locations

4.6.3 General Findings

A summary of marina survey results is presented in Table 4-17 including Clean Marina status, year certified as a Clean Marina if applicable, and operation category scores. As previously described, for operation category assessed, a score (out of a maximum of 100) was calculated based on the number of yes responses divided by the number of applicable questions. If a category was not applicable, for example no fueling operations present at a given marina, a score was not calculated. This is denoted by '-' in the table below. Further information including comments regarding observations is presented in Appendix C.

Table 4-17: Marinas Survey Results

Site ID	Clean Marina?	Year Certified	Maint/ Repair	Petroleum Control	Sewage Handling	Waste Mgmt	Marina Mgmt	SW Mgmt	Turf/ Scape
MAR_F_201	-	-	100	-	67	60	67	80	100
MAR_F_501	-	-	50	-	-	67	-	50	100
MAR_F_901	-	-	60	75	100	80	67	67	100
MAR_F_902	Yes	2009	40	-	100	80	100	75	100
MAR_F_903	Yes	2009	60	-	100	80	67	75	0
MAR_F_1001	-	-	0	100	100	67	67	40	100
MAR_F_1101	Yes	2010	80	100	100	60	100	75	0
MAR_F_1102	-	-	100	25	67	50	33	20	67
MAR_F_1301	Yes	2009	-	75	100	75	67	0	100

In general, sewage handling and petroleum control operations are well managed at the marinas surveyed. Waste management and turf/landscaping operations were also well managed at most of the marinas surveyed. Vessel maintenance/repair, marina management, and stormwater management were the operation categories with the most room for improvement based on the marinas surveyed. A brief description of the operation categories with the most potential for pollution and general findings are provided below.

Vessel Maintenance & Repair

Marinas with higher scores (and lower pollution potential) for vessel maintenance and repair activities generally have designated and covered work areas with runoff diversion methods in place, such as berms, filter cloth or drip pans. Many of these marinas have eliminated sand blasting practices. Some use baking soda for blasting and others use vacuum sanders if sanding is still used to prevent particulate matter and potential chemicals from leaving the site. Many also use roller paint rather than spray painting. In addition, marinas with lower pollution potential in this category minimize environmental impacts from boat cleaning such as providing and encouraging the use of non-toxic cleaners, paints, and antifreeze products. Many also have debris collection systems in place during boat washing operations. Marinas with lower vessel maintenance and repair scores and higher pollution potential had no

designated and/or uncovered work area, where some operations, such as engine repair or boat washing may take place adjacent to the water.

Waste Management

Most of the marinas surveyed exhibited good waste management practices and therefore low pollution potential for this category. There was only one instance where dumpsters were uncovered and located near the waterway with no runoff diversions in place. All marina owners indicated that trash pick-up was conducted frequently along the shoreline and within the marina, which reduces the risk for trash and litter to leave the site and enter nearby waterways. The Dundee Creek marina, for example, has a trash free policy where site users must take any trash they have generated with them after they leave the site. Most marinas also appeared to abide by requirements related to hazardous waste storage, use, and disposal. The Boating Center for Baltimore, for example, has a Clean Burn system which converts used oil into heat; this reduces extra handling and transportation of oils and helps minimize the potential for waste oils to enter nearby waterways. The Maryland Marina recycles waste oil, antifreeze and batteries. At the Tradewinds and Long Beach Marinas, oil is picked up and hauled by a certified hazardous material company.

The main reason for waste management scores of less than 100 is that solid waste recycling is not provided for customers on-site at most of the marinas surveyed. There is potential to encourage both certified and non-certified Clean Marinas to incorporate recycling as part of their waste management operations. Several marinas mentioned issues with shrink wrap recycling. Most indicated a willingness to participate in this program but indicated a need for reinstating the County pick-up/disposal service or location that was available in the past. Some marina owners also noted an issue with abandoned boats, particularly after taking over a marina business and having to deal with boats that have been left behind. These are all opportunities to partner with private landowners to minimize pollution potential from waste management operations. The owner of the Tradewinds Marina also noted an issue with trash entering Frog Mortar Creek from an adjacent outfall that carries stormwater from the upstream Royal Farms gas station and convenience store. This warrants a follow-up investigation to determine actions to address pollution potential from waste management operations at this potential hotspot.

Marina Management

Keeping marina staff and clients informed about pollution prevention practices is important to routinely minimize pollution. Marinas with lower scores for this operation category and higher potential for pollution, tended to have no formal training for staff or education for customers about BMPs such as spill prevention and control practices, trash management, and non-toxic boat maintenance practices and products. Many do have spill prevention, control, and countermeasures plans including spill kits and self report to MDE in case of a potentially hazardous spill. Several also have staff that have many years of experience with the same marina and are well trained about BMPs. The field team also noticed that brochures with clean boating tips from DNR were made available to customers, particularly certified Clean Marinas. Porters Seneca Marina was given a score of 100 for this operation category as they have

a spill prevention plan, conduct routine staff training, and also educate customers about BMPs such as a signs with fueling and spill control instructions and a winter contract which requires the use of non-toxic antifreeze for winterization. Some marinas have newsletters or mailings, which could be a potential opportunity to incorporate safety and clean boating tips to educate customers.

Stormwater Management

Marinas with higher scores for stormwater management operations are those with limited impervious areas and shoreline erosion control measures in place. Marinas with higher pollution potential as a result of stormwater management operations are those with large impervious areas where runoff drains directly to surface water without treatment and/or where shoreline instability issues were observed. The Boating Center of Baltimore noted a failing bulkhead and similarly, erosion issues were noted for the Long Beach Marina. These sites may be opportunities to investigate natural shoreline stabilization alternatives and/or incorporation of stormwater management practices such as grass filter strips along marina bulkheads. Grassed swales were located throughout the Maryland Marina property which provides some infiltration and treatment of stormwater before draining to Frog Mortar Creek. A rain garden was also noted at the Dundee Creek marina and intended to treat some of the runoff from the adjacent parking lot. There may be potential to expand this concept to treat more of the impervious surfaces at this marina.

Recommended Actions

Based on the observations from the sample assessment, the following actions are recommended to minimize pollution potential from marina operations within the Middle River/Tidal Gunpowder River planning area:

- Encourage all marinas to become certified Maryland Clean Marinas and/or maintain Clean Marina status.
- Promote the Clean Boater Program including clean boating practices among marina customers.
- Develop and distribute a County-approved list of non-toxic, marina-related products (e.g., cleaners, antifreeze, etc.).
- Encourage solid waste recycling at area marinas.
- Work with marinas to properly recycle shrink wrap and address abandoned boats.
- Continue to enforce zoning laws related to marina use.

A list of the marinas within the Middle River/Tidal Gunpowder River planning area is included in Table 4-18, including marina name, ADC map number, address, and Clean Marina status. As shown, only about one-third of the marinas are certified Maryland Clean Marinas. A key strategy is to encourage all marinas to enroll in the Clean Marina Initiative. This could involve working with the County, state and/or local community to become certified. In many cases, marinas are already adopting pollution prevention practices voluntarily and/or pursuant to NPDES permit requirements that could count toward the certification. Some of the marinas surveyed seemed willing to participate if educated about the process

and cost efficient options. DNR launched an outgrowth of the Clean Marina Initiative in 2007, called the Clean Boater program, to help boaters join the effort to protect waterways. Many of the certified Maryland Clean Marinas included brochures about this program and also encourage customers. This involves signing a clean boater pledge and learning and adopting clean boating practices such as no littering, picking up litter, following sewage, chemical, and debris discharge laws, supporting Maryland Clean Marinas, and sharing clean, safe boating habits with others. This program and clean boating tips should be advertised at all marinas and encourage among all recreational boaters within the planning area.

In addition to the potential restoration opportunities described in the previous sections, some marina owners referred to the presence of "bootleg" marinas where boats are kept at private residences or properties not zoned for marina use. This was also noted as in issue in the 2009 Lower Back River Neck Community Action Plan. Marina operations present within the planning area should be overlaid with current zoning laws to determine whether marina uses are within the appropriate zoning classifications. Follow-up investigations should be conducted for those marina-related businesses that are not consistent with zoning laws and enforced as necessary.

Table 4-18: Marinas in Middle River/Tidal Gunpowder River

Marina Name	ADC Map No.	Address	Clean Marina?
Middle River Watershed			
Baltimore Yacht Club	46	800 Baltimore Yacht Club Rd, Essex, MD 21221	Yes
Sue Island Yacht Basin	46	850 Baltimore Yacht Club Rd, Essex, MD 21221	
Anderson Brothers Boat Sales	46	2434 Hollyneck Rd, Essex, MD 21221	
Sue Creek Boatyard	46	2216 Poplar Rd, Essex, MD 21221	
Boating Center of Baltimore	38	2015 Turkey Point Rd, Essex, MD 21221	
Norman Creek Marina	38	2229 Corsica Rd, Essex, MD 21221	
Sunset Harbor Marina	37	1651 Browns Rd, Essex, MD 21221	Yes
Markley's Marina	37	233 Nanticoke Rd, Essex, MD 21221	
River Watch Restaurant & Marina	37	207 Nanticoke Rd, Essex, MD 21221	
Driftwood Inn	37	203 Nanticoke Rd, Essex, MD 21221	
Anchor Bay Marina & Ships Store	37	202 Nanticoke Rd, Essex, MD 21221	
Deckelman's Boatyard	37	201 Oak Ave, Essex, MD 21221	
Essex Marina & Boat Sales	37	1755 Hilltop Ave, Essex, MD 21221	
Hilltop Marina	37	1802 Hilltop Ave, Essex, MD 21221	
Cutter Marine Yacht Basin	37	1900 Old Eastern Ave, Essex, MD 21221	Yes
Riley's Marina	37	1901 Old Eastern Ave, Essex, MD 21221	
Stansbury Yacht Basin, Inc.	37	1312 Shore Rd, Middle River, MD 21220	
Wilhelms Restaurant	37	1012 Beech Dr, Middle River, MD 21220	
Chesapeake Yachting Center	38	114 Carroll Island Rd, Middle River, MD 21220	Yes
Edwards Boat Yard, Inc.	38	3420 Edwards Ln, Middle River, MD 21220	
Parkside Marina	38	3300 Edwards Ln, Middle River, MD 21220	Yes
Tradewinds Marina	38	412 Armstrong Rd, Middle River, MD 21220	Yes
Brigadoon Marine Facility	38	3644 Hughes Ln, Middle River, MD 21220	
Maryland Marina	38	3501 Red Rose Farm Rd, Middle River, MD 21220	Yes
Long Beach Marina	38	800 Chester Rd, Middle River, MD 21220	
Galloway Creek Marina	38	1414 Burke Rd, Middle River, MD 21220	
Bowleys Marina	38	1700 Bowleys Quarters Rd, Middle River, MD 21220	Yes
Tidal Gunpowder Watershed			
Goose Harbor Marina	38	4040 Briar Point Rd, Middle River, MD 21220	
Porter's Seneca Marina	38	918 Seneca Park Rd, Middle River, MD 21220	Yes
Beacon Light Marina	38	825 Bowleys Quarters Rd, Middle River, MD 21220	
Dundee Creek Marina	38	Dundee Rd, Chase, MD 21027	Yes

4.7 Industrial Site Visits (IND)

Several large parcels of land are occupied by specific industrial-related sites within the Middle River and Tidal Gunpowder watersheds. Like marinas, this is a unique feature to this planning area that warrants a separate upland assessment category to assess restoration potential and identify possible partnership opportunities. Industrial sites also qualify as hotspots since there is 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. In addition, stormwater runoff from many of these sites drains directly to tidal waters because of their location and need for access to waterways. The large industrial sites included in this assessment hold individual NPDES permits, meaning discharges are already regulated and must abide by applicable state laws. Therefore, a typical hotspot investigation was not conducted for large industrial sites. Rather, site visits were conducted to gather information about operations concerning stormwater and to identify potential restoration and partnership opportunities relevant to meeting watershed goals. The following subsections describe the methods used to evaluate large industrial sites present within the planning area.

4.7.1 Assessment Protocol

The County contacted the major, large industrial sites present within the planning area to solicit participation in the watershed study and arrange a tour of the property and typical operations relevant to stormwater and water quality. Unique ID numbers were assigned to large, industrial sites using the classification scheme "IND_F_701", where 'F' denotes the Middle River/Tidal Gunpowder River planning area watershed and the first number corresponds to a specific subwatershed. As previously described, subwatersheds were assigned the unique numbers summarized in Table 4-11 for the purposes of upland assessments. Marina sites were numbered sequentially in the order they were surveyed within a particular subwatershed. For example, marinas in Darkhead Creek would be identified as 701, 702, etc.

Each of the large industrial sites assessed has unique operations, pollutant-related risks, property features, and restoration potential. Also, as previously mentioned, site discharges must already abide by certain regulations per individual NPDES permit. Therefore, it was decided that a more site-specific evaluation of restoration and partnership opportunities was more appropriate for these sites rather than a common form or checklist. In general, industrial site managers and/or representatives gave a tour of the exterior of the property including outdoor operations, impervious surfaces, waterfront areas, on-site storm drains, undeveloped areas while also explaining stormwater pollution prevention measures and restoration practices currently in place. The field team took detailed notes during site tours and identified potential opportunities or relevant features on aerial maps. The team also asked general questions regarding common hotspot operations described in Chapter 4.3 (vehicle operations, outdoor materials, waste management, physical plant, turf/landscaping, and stormwater infrastructure).

4.7.2 Summary of Sites Investigated

A total of 6 large, industrial sites were evaluated in the Middle River and Tidal Gunpowder River watersheds. The participating sites are listed in Table 4-19 and the locations are shown in Figure 4-47.

Table 4-19: Summary of Industrial Sites Surveyed in Middle River and Tidal Gunpowder River

Site ID	Name	Subwatershed	Acres
Middle River Watershed			
IND_F_701	Lockheed Martin	Darkhead Creek	163
IND_F_801	Martin State Airport	Darkhead Creek/Stansbury Creek/ Frog Mortar Creek	585
IND_F_901	Air National Guard	Darkhead Creek/Stansbury Creek/ Frog Mortar Creek	156
Tidal Gunpowder Watershed			
IND_F_1101	Constellation Energy	Seneca Creek/Saltpeter Creek	111
IND_F_1201	LaFarge Quarry	Saltpeter Creek/Dundee Creek	324
IND_F_1501	Aberdeen Proving Ground	Aberdeen Proving Ground	1,281

As shown in the table above, the six sites comprise a considerable portion of the planning area, approximately 21%. It will be important to involve these landowners in the watershed plan and implementation process to help meet watershed goals. General findings from each site are described in the next section.

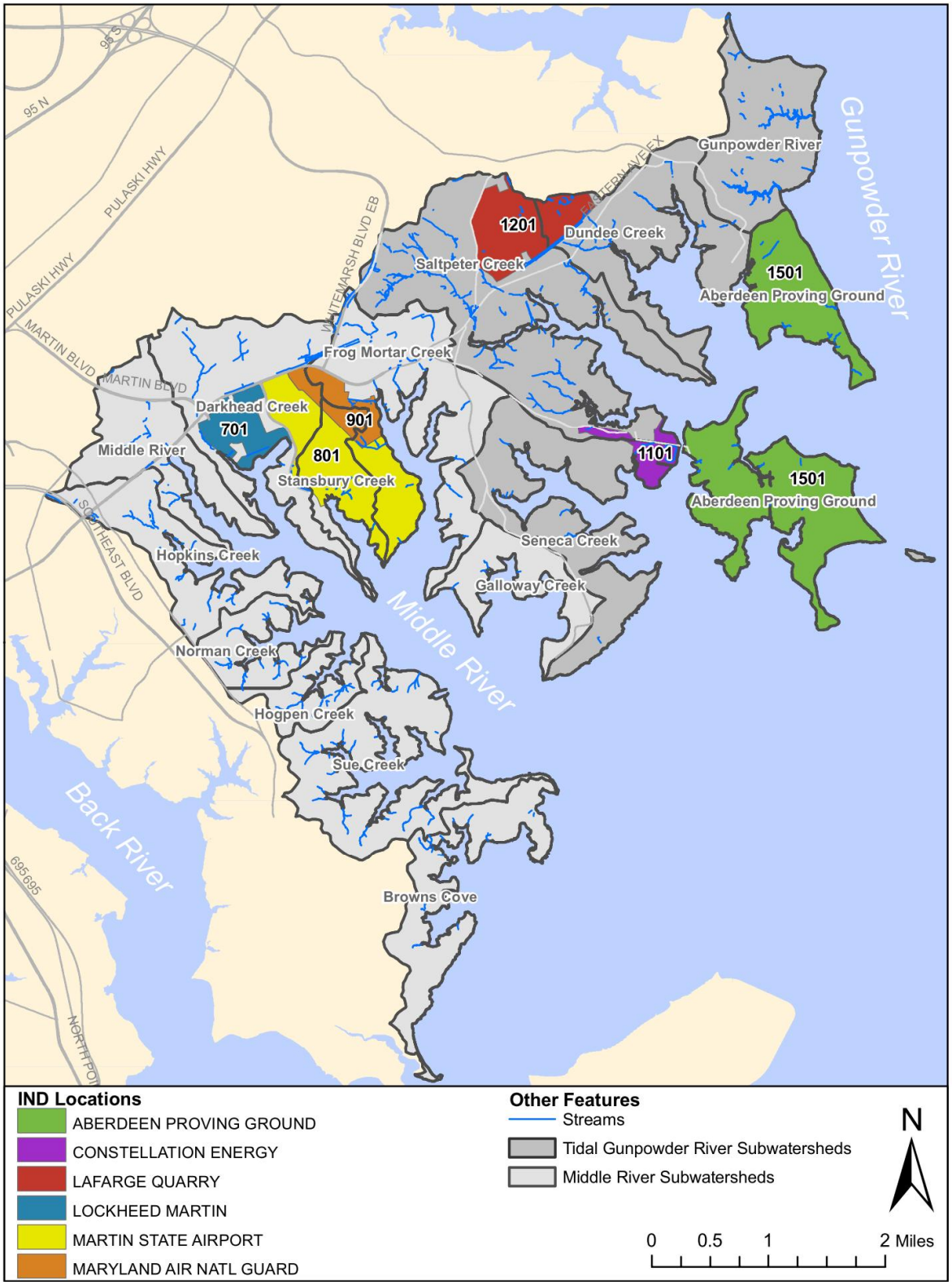

Figure 4-47: Industrial Site Visit Locations

4.7.3 General Findings

In many cases, the large industrial sites were not only meeting NPDES permit requirements but were also proactively going beyond minimum requirements such as on-site environmental restoration projects and additional stormwater pollution prevention measures. The general findings and potential restoration opportunities observed at each of the five sites surveyed are summarized below.

Lockheed Martin

The Lockheed Martin Corporation (LMC) occupies approximately 163 acres of waterfront property, off of Eastern Boulevard in the Middle River/Chesapeake Park Plaza complex, within the Darkhead Creek subwatershed. The Glenn L. Martin Company, a predecessor to LMC, acquired land in Middle River in the late 1920s to build and test military aircraft. In the late 1970s, some of the surrounding land parcels were sold to Maryland Aviation Administration (Martin State Airport), Johnson and Towers, Tilley Chemical, North American Electric, U.S. Postal Service, and Exxon, which continue to operate today. In the mid-1990s, Lockheed Corporation merged with the Martin Marietta Corporation to form LMC. The current footprint of the LMC property is shown in Figures 4-47 and 4-48. The 8 parcels/tax blocks comprising the current property are shown in Figure 4-48. LMC has a facility for assembling military missile launch systems (Block I); leases space to Applied NanoStructured Solutions, LLC (ANS, a subsidiary of LMS; and leases part of the facility to Middle River Aircraft Systems (MRAS), a subsidiary of General Electric, that assembles aircraft parts (Block I). Block B is an overflow parking lot and baseball area. Blocks D-H are currently employee parking (primarily Block H) or are used occasionally for truck or equipment storage.

LMC has voluntarily conducted extensive environmental investigations of both the Martin State Airport (to determine environmental impacts during the time LMC or its predecessor companies owned the airport property) and Middle River complex properties since the late 1990s. This has involved collection of thousands of soil, sediment, and groundwater samples to assess potential environmental and public health risks as a result of historical facility operations and the level of cleanup necessary to mitigate any current or potential future exposures. LMC has also entered the Middle River Complex into MDE's Voluntary Cleanup Program (VCP) and is currently in the process of developing Response Action Plans (RAPs) for soil and groundwater in 7 of the 8 tax blocks comprising the Middle River complex and shown in Figure 4-48 (note that Block C was previously sold). The field team toured the site with facility operations and environmental specialists from LMC as well as site remediation consultants from Armstrong Associates and TetraTech. Observations regarding the status and restoration potential of each tax block is briefly described below. Final environmental reports and other public information regarding environmental studies at the Middle River complex and Martin State Airport sites are available at the Essex Public Library. LMC also posts environmental monitoring and remediation for the public at: http://www.lockheedmartin.com/aboutus/energy-environment/places/remediation/index.html

It should also be noted that LMC has developed a stormwater guidance document (last revised in 2009) which provides detailed guidance for designated employees to conduct a compliant stormwater

management program including sampling and analyses of discharge water and identification of potential pollution sources that may affect quality of stormwater discharges from permitted outfalls.

Block A

Block A is located along the northwest edge of the site along Eastern Boulevard. LMC has an administrative office located on this tax block. No remedial action is required within this parcel based on results from the environmental studies and LMC is currently negotiating site closure with MDE. There are several existing trees within the western portion of this parcel. No opportunities were discussed or identified to treat runoff from the parking lot areas.

Block B

Block B is located in the northeast corner of the complex along Eastern Boulevard and includes a large, overflow parking lot and baseball field. Studies have revealed very limited soil impacts in this area, with elevated levels of petroleum compounds, namely polycyclic aromatic hydrocarbons (PAHs), as well as heavy metals (mercury and lead). Soil removal was first planned within this tax block and was conducted in this area in the fall of 2010. Approximately 2400 tons of soil were removed and taken to a permitted landfill. Most soil was removed from an area under the parking lot and a smaller quantity was removed from the athletic field. Disturbed areas were restored to original conditions with clean material, meaning paved areas were repaved and grassed areas were seeded and replanted. LMC has submitted the construction completion report to MDE and is currently awaiting approval for site closure. An on-site community tour and information exchange was conducted in October 2010 for the Block B soil remediation efforts. The tour was provided at the request of civic leaders to familiarize themselves on behalf of the neighboring community with safety measures and work plans. An ongoing community outreach program routinely provides the community with informational opportunities as all site-wide remediation activities progress.

The parking lot is still used for overflow parking and an annual carnival. There are no stormwater management practices in place to treat runoff from the parking lot before it discharges to Darkhead Creek. There is potential to implement stormwater measures to treat runoff from the parking lot area such as converting existing grass strips at the southern end of the parking lot into bioretention areas or implementing new infiltration/filtration areas throughout the parking lot. Stormwater retrofits would require verification that practices would not interfere with current uses of the site.

Block D

Block D encompasses approximately 13 acres in the southeast portion of the Middle River Complex. Investigations in this area included record reviews, geophysical surveys, and soil and groundwater sampling. Chemicals of concern in subsurface soils include primarily PAHs. LMC is currently in the process of assessing appropriate response actions for soil.

Block D is a paved asphalt parking lot with no known structures to have existed within the area. Between 1938 and 1940, this waterfront area was filled in to current elevations and a steel bulkhead installed to extend LMC's property to the current layout. It is currently characterized by deteriorating asphalt and is only occasionally used for temporary vehicle storage. The entire area is surrounded by a chain-link fence with locked gates. The existing bulkhead appears to be deteriorating; the County mentioned a potential partnership opportunity with LMC for a shoreline stabilization project in this area. LMC expressed interest in a tour of other County shoreline stabilization projects including living/natural shoreline restoration. There is also potential for impervious cover removal in this area; however, LMC expressed concerns with impervious cover conversion as it may limit future use of the property.

Block E

Block E occupies approximately 16 acres in the southern portion of the Middle River complex. Over half of the area is encompassed by a former building foundation and ground floor slab (mostly concrete). There is also an abandoned 1,800-foot, 2-inch diameter pipe that was used to transmit fuel oil from now-removed storage tanks. A 500,000 gallon water storage tank is also located in this Block. Although located here, the tank's purpose is to provide fire water storage for Martin State Airport. The airport is developing a new fire water protection system that will replace this tank, and that project is in process. However the fire marshal has determined that LMC must continue to maintain the tank for water to the Middle River complex even after the Airport changes its fire protection system.

Studies indicate that the abandoned 2-inch fuel oil pipeline coincides with a drainage ditch that runs along the west and south boundary of Block E. Surface water and marsh-type vegetation have been observed in these ditches. Investigations in this area included record reviews, radiological and geophysical surveys, and soil and groundwater sampling. PCBs have been detected in the upland soils and are the primary chemicals of concern. LMC is currently in the process of assessing appropriate response actions for soil. LMC is also assessing potential PCB contamination associated with storm sewer piping located in the vicinity of the former building and discharging to Darkhead Creek. Obstructions, debris, and sediment within the storm sewer piping as well as surrounding soil with contaminant levels above cleanup goals will likely be removed.

Block E remediation will be completed on a separate schedule from the other tax blocks due to the ongoing study of storm drains and because the presence of PCBs are at concentrations that involve USEPA. These issues limit the restoration potential of this parcel; however, it is important that dialogue continues between LMC and the proper environmental agencies (MDE and USEPA) to ensure that there is no on-going pollution source to Darkhead Creek from this parcel.

Block F

Block F occupies approximately 12 acres in the southern portion of the Middle River complex along the Darkhead Creek waterfront. A portion of the area is covered by a series of concrete slabs which was formerly used as alaunch area for sea planes. The field team noted grass growing through many of the slab joints as well as some cracks and potholes. Studies have identified seven former aviation fuel underground storage tanks (USTs) underlying the north central portion of the concrete tarmac. The rest of the parcel is mostly turf cover that is regularly mowed with some trees and shrubs. There are no structures currently on-site; however, degraded remnants of walkways, parking areas, and foundations have been identified. A chain-link fence with locked gates is present along the northern edge of the property. Investigations in this area included record reviews, geophysical surveys, and soil and groundwater sampling. PAHs were detected in shallow soils in the former boat dock area and in subsurface soils in the former boat launch area within this tax block. LMC is currently in the process of assessing appropriate response actions for soil. The abandoned USTs and associated piping and contaminated soil will likely be removed as part of any future response action.

The grassed area in the eastern portion of the site has greater potential for tree planting and shoreline buffer enhancement compared to sites that are currently impervious. There is an existing steel bulkhead along this portion of the site where studies have noted ground subsidence. Concrete rubble was observed along the shoreline in the vicinity of the former boat launch area. Similar to Block D, this is a potential opportunity to partner with LMC and implement a shoreline restoration project involving natural shoreline stabilization techniques. The presence of USTs and soil contamination may limit restoration potential of the boat launch area; however, once a response action is completed, there may be potential to encourage LMC to restore a portion of the site to forest or vegetative cover rather than re-establishing paved surfaces, particularly in the areas with degraded impervious surface remnants. The western portion of the site is a good candidate for preservation as it consists of turf cover with shrubs and trees growing thickly along the shoreline.

Block G

Block G occupies approximately 13 acres in the southwest portion of the Middle River complex. It used to be the site of a former sewage treatment plant that consisted of various buildings and two fuel oil USTs. There are no structures currently present within the parcel; however, foundations (concrete slabs) of former test buildings do remain as well as a storm drain outfall. There is an open, grass area in the vicinity of the former plant and a large, unused, paved parking area. A chain-link fence and locked gates surround the area. Investigations in this area included historical and geophysical surveys, and soil and groundwater sampling. PAHs have been identified as the primary chemical of concern in soil with lesser contributions from arsenic and cobalt, mostly in shallow soils in a former parking lot area. LMC is currently in the process of

assessing appropriate response actions for soil. Previously abandoned USTs and associated piping and contaminated soil will likely be removed as part of any future response action.

There is potential for impervious cover removal in this area, which could involve coordinating with LMC during remedial efforts to reforest the area rather than re-establishing paved surfaces; however similar to Block D, LMC expressed concerns with impervious cover conversion as it may limit future use of the property.

Block H

Block H occupies approximately 8 acres of land in the northwest portion of the Middle River complex and has been primarily used as an employee parking lot. No structures are known to have existed within this area. About half of the parking lot is in good condition. The other half is older, stained, and breaking up. Investigations in this area consisted of a geophysical survey and soil and groundwater sampling. Results showed PAHs as the primary chemical of concern. LMC is currently in the process of assessing appropriate response actions for soil.

The site is still currently being used as a parking lot for employees. During the site visit, only a portion of the site appeared to be used for parking. There may be potential for impervious cover removal for a portion of the site, particularly the older area of the parking lot that is breaking up. The lot is bounded by grass strips of land along the western and eastern edges of the property. This presents a potential stormwater retrofit opportunity where practices such as infiltration/filtration or bioretention could be implemented to treat runoff from the parking lot. Restoration projects should coincide with future remediation efforts.

Block I

Block I contains the active production facilities operated by LMC and Middle River Aircraft Systems, Environmental characterization and monitoring continue both indoors and outdoors within this block to determine the extent of potential soil and groundwater impacts. A report of investigation results is planned to be submitted to MDE sometime during 2011; these and future monitoring results will be used to help plan remedial action as necessary. The field team did not identify any water quality improvement opportunities since the extent of contamination and remedial action is unknown at this time and the majority of the site is occupied by buildings.

Summary of Potential Restoration Opportunities

There are several opportunities to partner with LMC and implement restoration projects. However, it is important to consider soil contamination issues and coordinate projects with on-going remedial efforts. In addition, while LMC currently has several vacant parcels on-site, there is potential for reuse in the future. It is important to approach LMC with potential restoration options that would provide water quality benefits while not compromising the potential use of the property. For example, shoreline restoration projects could involve natural shoreline stabilization methods without significantly reducing

the current footprint of vacant parcels. Note that sediment sampling revealed elevated concentrations of PAHs, PCBs, and heavy metals in sediments along the bulkheads of Block D and F, which may require action to reduce risks associated with long-term direct contact and potential impacts to wildlife. Any shoreline projects should take such risks into account but could coincide with future remedial actions. There is also the potential for LMC, the County, and the state to discuss various redevelopment options that would benefit all stakeholders. For example, offering future redevelopment or tax credit if a portion of a site was redeveloped as forest or donated to the County for preservation. A summary of potential restoration opportunities and tax blocks with greatest potential for each type of action is included below:

- Tree planting: Blocks D, F, G
- Stormwater retrofit: Blocks B, H
- Impervious cover removal: Blocks D, F, G
- Shoreline restoration: Blocks D, F

Figure 4-48: Lockheed Martin Site Map

Martin State Airport

Martin State Airport occupies over 740 acres off of Eastern Boulevard in Middle River. The general aviation facility primarily handles private and corporate aircraft and overlaps portions of Darkhead Creek, Stansbury Creek, and Frog Mortar Creek subwatersheds. The facility includes one runway, taxiways, multiple hangars, a fuel storage facility, and multiple operations and maintenance buildings. Operated by the Maryland Aviation Administration (MAA), the State of Maryland purchased the land for the airport formerly owned by the Martin Marietta Corporation in 1975. In addition to private and corporate aircraft, the airport is also utilized by the Maryland Air National Guard which leases a portion of the property (~20%) from MAA. This portion of the site is described in the next section. The Maryland State Police, Maryland DNR, and Baltimore County also lease smaller facility spaces on the site.

Because the facility is owned by MAA, they are obligated to comply with all applicable state regulations including having a NPDES permit and Stormwater Pollution Prevention Plan (SWPPP) and monitoring discharges from the site. In addition to meeting these required state mandates, MAA has taken the initiative to develop their own Stormwater Management Plan summarizing the existing stormwater facilities on the site to facilitate planning of future development. At this time, no near-term development plans have been developed and future public demand would be needed to initiate long-term development such as construction of additional hangars.

The field team met and toured the site with facility operators and environmental specialists from MAA. Because of the nature of the facility, MAA must comply with the Federal Aviation Administration (FAA) Advisory Circular 150/5200-33B which provides guidance on stormwater management facilities to reduce or eliminate hazardous wildlife attractants on or within a 3 mile radius of the airport. The guidance prevents the use of any stormwater management facilities that detain standing water for greater than 48 hours, specifically wet detention ponds and other “wet” stormwater facilities. The location of the facility and the shallow depth to groundwater in the area prevent the use of underground facilities such as infiltration trenches or detention chambers.

Though MAA is limited in their stormwater management approach, the facility has taken other measures to prevent pollutant discharges from the site. The facility has developed a Spill Prevention Plan along with an Illicit Discharge Detection and Elimination Plan. Outfalls are monitored, and representatives have indicated that illicit discharges have been redirected to the sanitary sewer system when found in the past. Fueling operations consist of storage tanks located at the southwestern end of the runway where tanker trucks are filled for fueling airplanes. This area is protected through secondary containment in case of any spills. Fueling of planes themselves takes place in individual hangars, equipped with floor drains connected to the sanitary sewer system. In addition, the operations and maintenance facilities are covered with floor drains. The outdoor wash area is equipped with a drain connected to a mechanically operated valve. When the wash area is not being utilized, the valve directs storm runoff from the wash area to the storm drain system. When the area is being utilized for wash operations, the valve is activated to direct wash water to the sanitary sewer system. Oil separators have been installed in many of the storm drains to treat runoff potentially impacted from fueling and/or

washing operations. The facility uses storage sheds for hazardous materials such as fuels and batteries and uses a third party contractor for disposal. Solid waste collections areas are also covered, and MAA performs daily monitoring for any loose trash on the grounds. Representatives of the site indicated that around 34% of solid waste is recycled by MAA as a whole.

Landscaping on the site consists strictly of mowing the turf on the site with no fertilizer or pesticide application. Advisory Circular 150/5200-33B prevents the planting of any large or ornamental trees on or near the site as a wildlife attractant source. MAA representatives indicated that they have developed a seed mixture for use during construction to minimize erosion on site. There are two forested areas along the southern end of the property bordering Stansbury Creek that have conservation easements through the state.

Summary of Potential Restoration Opportunities

Martin State Airport has proactively developed a number of pollution prevention measures on the site and maintains an NPDES permit. The main outcome is that the County will continue the dialogue with the environmental manager to track the pollutant removal efficiency of existing and future restoration practices as well as explore partnership options for future offsite improvement measures. A summary of potential restoration opportunities at MTN are included below:

- Work with MAA to track illicit discharge eliminations
- Educate private and corporate users of the airport on proper hazardous and solid waste disposal
- Work with MAA and adjacent property holders to provide treatment of stormwater runoff for current and future developments that meets the water quality goals of the watershed while also adhering to the terms of Advisory Circular 150/5200-33B
- Work with MAA to maintain existing conservation easements

Figure 4-49: Martin State Airport Site Map

Maryland Air National Guard

The Maryland Air National Guard's (MANG) Warfield Air National Guard Base occupies approximately 156 acres off of Eastern Boulevard and adjacent to Martin State Airport in Middle River. The facility is a composite fighter and tactical airlift unit and overlaps portions of Darkhead Creek, Stansbury Creek, and Frog Mortar Creek subwatersheds. The facility includes a large outdoor aircraft storage area, multiple hangars, a fuel storage facility, and multiple operations and maintenance buildings. Leased from the Maryland Aviation Administration (MAA), the State of Maryland purchased the land formerly owned by the Martin Marietta Corporation in 1975. The base houses the 175th Wing comprised of two flying units as well as support staff.

Because the facility is leased from MAA and is adjacent to Martin State Airport, they are obligated to comply with all applicable state regulations including having a NPDES permit and Stormwater Pollution Prevention Plan (SWPPP) and monitoring discharges from the site. In addition, the facility must comply with the Federal Aviation Administration (FAA) Advisory Circular 150/5200-33B which provides guidance on stormwater management facilities to reduce or eliminate hazardous wildlife attractants on or within a 3 mile radius of the airport. The guidance prevents the use of any stormwater management facilities that detain standing water for greater than 48 hours, specifically wet detention ponds and other "wet" stormwater facilities. The location of the facility and the shallow depth to groundwater in the area prevent the use of underground facilities such as infiltration trenches or detention chambers.

The field team met and toured the site with a representative of the operations department. Although stormwater quality treatment on the site is limited due to site constraints, a number of other measures are in place to prevent pollutant discharges from the site. All vehicle operations and maintenance facilities are located indoors with drains that are directed to the sanitary sewer system. Each of the indoor drains is equipped with an oil/water separator to ensure no petroleum enters the sewer system. All used fluids are saved in 55 gallon drums and stored in a covered structure prior to pickup and disposal. Spill cleanup kits were observed throughout the facility wherever maintenance or storage of hazardous materials was occurring. In addition, it was indicated that fueling vehicles stored outside were emptied of any hazardous materials prior to long-term storage. The outdoor vehicle washing area was equipped with a drain that directs wash water to the sanitary sewer system.

Two, 200,000-gallon jet fuel tanks were also observed on the site. The tanks are surrounded by a 4' high concrete wall to contain any leaks. The tanks were connected to two large ponds that provide dual protection in the event of any major spill or malfunction. MANG representatives also indicated that trash on the site was collected and emptied on a daily basis. One weekend per month, a cafeteria facility on the site serves meals during military excercises. Kitchen staff indicated that no food is stored on site and that all leftover food and supplies are disposed of after each event.

Landscaping on the site consists strictly of mowing the turf on the site with no fertilizer or pesticide application. Advisory Circular 150/5200-33B prevents the planting of any large or ornamental trees on or near the site as a wildlife attractant source. The eastern portion of the site bordering Frog Mortar

Creek is mostly forested with approximately 80 recently planted trees observed in one of the open space areas.

Summary of Potential Restoration Opportunities

MANG has proactively developed a number of pollution prevention measures on the site and maintains a NPDES permit. The County will continue the dialogue with the environmental manager to track the pollutant removal efficiency of existing and future restoration practices as well as explore partnership options for future offsite improvement measures. A summary of potential restoration opportunities at MANG are included below:

- Work with MANG to track illicit discharge eliminations
- Work with MANG and adjacent property holders to provide treatment of stormwater runoff for current and future developments that meets the water quality goals of the watershed while also adhering to the terms of Advisory Circular 150/5200-33B
- Work with MANG to ensure that forested areas and tidal wetlands within the critical area remain undisturbed.

Track pollutant load reductions from existing and future reforestation projects.

Figure 4-50: Maryland Air National Guard Site Map

Constellation Energy

Constellation Energy occupies approximately 111 acres adjacent to Carroll Island Road in Bowleys Quarters. The coal-fired electric generating station overlaps portions of Seneca Creek and Saltpeter Creek subwatersheds and includes: two generating units which began operating in the early 1960s; coal storage yard; wastewater treatment plant (WWTP); power generation building and offices; a rail spur for coal delivery; and discharge canal with steel sheet pile. Coal is crushed on-site and transported into the plant via mechanical conveyor, where it is then gravity fed to the generating units (boilers). The units each have a baghouse to capture particulate matter emissions. The two major coal combustion byproducts include fly ash (fine powder, composed mostly of silica) and boiler slag (molten bottom ash, black granular material). Constellation Energy submits an annual report to MDE regarding the annual volume of byproducts generated, chemical characterizations, disposal methods, and beneficial uses. In general, fly ash is collected from the baghouses, conveyed to storage silos and then loaded into trucks for temporary staging on an asphalt pad. It is disposed of in regional, permitted industrial waste landfills. Boiler slag is collected from the boilers and beneficially used for blasting grit and/or roofing granules.

The field team met and toured the site with environmental technicians and specialists from Constellation Energy. The plant intakes cooling water from Seneca Creek and discharges it to Saltpeter Creek. Discharges from the Constellation Energy facility must abide by regulations set forth in their individual NPDES permit. The plant has also installed a fish passage system for fish to be safely released if they enter the intake system. Inner and outer dikes have been installed around the coal pile to help control runoff from the storage yard. Runoff from the coal storage yard is also sent to the WWTP for solids removal and pH adjustment. Constellation Energy staff noted that they maintain a stormwater pollution prevention plan as well as a spill prevention and control plan for the site. The field team observed that equipment loading and satellite storage areas were covered; waste management areas were also covered and secondary containment was provided for storage tanks and liquid wastes. Constellation Energy has also proactively implemented measures above minimum permit requirements. For example, inlet protection (covers) was observed for storm drains in the path of loading/unloading operations to prevent solids and associated contaminants from entering the storm drain system. In addition, filter bags have been installed in most of the on-site storm drains to collect solids and are generally maintained on a 6-month basis or as needed. Constellation Energy staff noted collaboration with Oyster King in installing 16 oyster cages as well as working with University of Maryland to test algae scrubbers suitable for the site. Constellation Energy also developed a stormwater management master plan in 2008 in anticipation of continual needs for construction activities within the Chesapeake Bay Critical Area. This plan includes impervious cover removal and buffer mitigation areas to offset impacts from proposed development. Nearly 6 acres of impervious cover removal has been proposed, which would be replaced by topsoil, trees, and vegetative plantings. Reforestation of a portion of this former oil tank storage site has already occurred. Tidal wetlands in the southwest portion of the site are within the Chesapeake Bay Critical Area and must be preserved.

Summary of Potential Restoration Opportunities

Constellation Energy has already implemented many stormwater pollution prevention related measures proactively. The main outcome is that the County will continue the dialogue with the plant and track the pollutant removal efficiency of existing and future restoration practices. A summary of potential restoration opportunities at the Constellation site are included below:

- Work with Constellation Energy to track the amount of sediment removed from filter bags installed in on-site storm drains.
- Follow-up about various inlet protection methods used and success rates for consideration at other sites (e.g., hotspots) throughout the planning area.
- Follow-up about progress of algae scrubbing testing studies, potential for installation of this technology on-site, and possible pollutant removal tracking methods.
- Include impervious cover removal and buffer mitigation area into pollutant load reductions as appropriate for the SWAP planning area.
- Ensure that tidal wetlands and areas within the critical area remain undisturbed.

Figure 4-51: Constellation Energy Site Map

Lafarge Quarry

Lafarge occupies approximately 324 acres off of Earls Road in the Saltpeter Creek and Dundee Creek subwatersheds for sand mining operations. The total quarry operation encompasses over 400 acres. The field team met and toured the site with Lafarge's environmental manager for the Mid-Atlantic region. According to the manager, mining operations have occurred at this site since the early 1950s. Sand resources are expected to be exhausted within the next couple of years, which means mining operations will cease unless Lafarge is able to obtain adjacent properties. Site reclamation has begun in a portion of the site, where Lafarge currently has a contract with Potts & Callahan to dump fill and will continued to be filled in, in phases as resources are exhausted. The County and manager discussed potential for dredge fill material to be used as part of the site reclamation process. The future use of the site is unknown as Lafarge is considering a range of options from mixed use development to wetland mitigation. Excluding the mining operation areas, the majority of the site consists of forest and wetlands which presents a good opportunity for preservation. The Lafarge manager noted issues with all terrain vehicles (ATV) and residents trespassing on the site after normal business hours, which would need to be addressed for any future wetland creation projects.

Lafarge has a general NPDES permit and therefore, discharges must abide by applicable state laws. However, the manager noted that there have been no discharges from site related to mining in the last three years because of the high permeability of the sand. There are several pond areas on-site which are used for washing and settling operations. All water is reused for these processes. Leftover fines are sold to cement plants as fill. The site does include fueling operations and spill kits are available in these locations. Double-walled liquid storage tanks are on-site and inspected monthly. Lafarge has a corporate sustainability plan which includes the following major priorities and partnerships with the World Wildlife Federation (WWF): climate change (CO2 emission reductions); protecting biodiversity; conserving water; health and safety; sustainable construction; and acting locally. Protecting biodiversity is a key initiative for Lafarge's quarry operations and requires biodiversity programs for sites located in sensitive areas or presenting potential for wildlife. The site manager must demonstrate compliance with biodiversity requirements at the corporate level. As part of this initiative, the Lafarge quarry site in this planning area maintains several blue bird houses and holds annual tree planting events for Earth Day. This quarry site has also been certified since 2010 through the Wildlife Habitat Council's (WHC) Corporate Wildlife Habitat Certification Program. WHC is a non-profit group of corporations, conservation organizations and individuals dedicated to restoring and enhancing wildlife habitat. The certification is a third party evaluation and recognition of commendable wildlife habitat management and environmental education programs. It requires that programs have been active for at least one year with goals, objectives and complete documentation. The quarry certification recognizes the 20 acres of property managed for wildlife on-site including: artificial nest box program for native song birds; planting a pollinator garden with native plants and education to local Boy Scouts about habitat and conservation; land reclamation project at the northwest end of the property involving non-native species removal and establishing a native wildflower meadow. More information can be found at: http://www.wildlifehc.org/registry/lafarge-14/

Summary of Potential Restoration Opportunities

Lafarge maintains an individual NPDES permit and proactively incorporates sustainability and conservation practices into their operations. The main outcome is that the County will continue the dialogue with the environmental manager to track the pollutant removal efficiency of existing and future restoration practices as well as explore partnership options for future land reclamation. A summary of potential restoration opportunities at the Lafarge sand quarry are included below:

- Forest and wetland preservation
- Wetland creation and reforestation opportunities
- Potential for beneficial reuse of County dredge material
- Invasive species removal
- Tracking of pollutant load reductions from existing and future restoration projects (e.g., reforestation, meadow establishment)

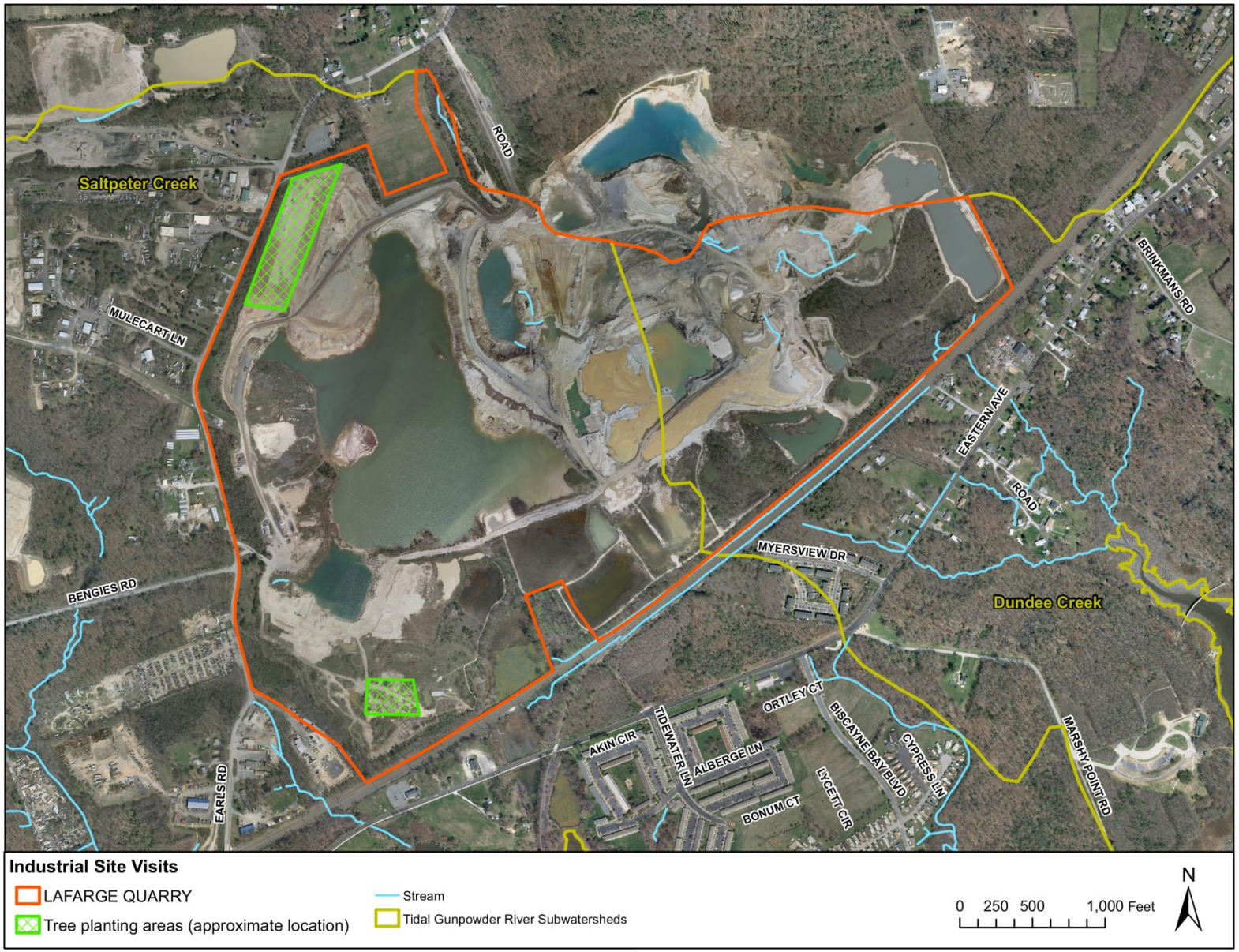

Figure 4-52: Lafarge Quarry Site Map

Aberdeen Proving Ground

The Aberdeen Proving Ground (APG), a U.S. Army facility, occupies approximately 1,274 acres within the Tidal Gunpowder River watershed. The portion of APG within the planning area is not attached to the main installation near Aberdeen, Maryland and includes Carroll Island and Graces Quarters. Due to safety concerns, the field team was unable to tour the site; however, the team did meet with a natural resources specialist regarding current uses and restoration projects on-site. This portion of APG was formerly used for chemical testing and firing programs as early as World War II, which stopped in the late 1960s at this site. APG completed a cleanup program on Carroll Island, where the island has been deemed safe for natural resource management and military training; however, it is not open to the public for safety reasons as there remains the potential for unknown explosives throughout the area. The APG site in Tidal Gunpowder is part of APG's Integrated Natural Resources Management Plan and is predominantly designated for natural resources management and environmental mitigation, particularly Carroll Island; note, however, that the Army reserves the right to use the property for military use (e.g., firing programs) as necessary. Graces Quarters consists of a former communication tower area which is under consideration for various options such as no action, removal, replacement, or use as a biofuel testing and manufacturing site. The majority of the site consists of forest and wetlands which is an important property to maintain and preserve given its proximity to tidal waters including the Chesapeake Bay. APG has conducted various environmental studies and restoration projects on both Carroll Island and Graces Quarters including: approximately 26,700 linear feet of shoreline restoration; SAV planting; wetland mitigation; forest management; and invasive species control. Shoreline restoration projects include a combination of natural shoreline techniques and riprap/breakwaters (due to wind conditions). APG also conducts monitoring of shoreline restoration and SAV planting projects. TSS and nutrient monitoring is conducted in Gunpowder River. In partnership with William & Mary, a study of turtle population was conducted on Carroll Island which revealed the presence of turtles greater than 50 years of age.

Summary of Potential Restoration Opportunities

Similar to many of the large, industrial sites visited, APG is proactively incorporating environmental conservation and restoration practices into their operations. The main outcome is that the County will continue the dialogue with the natural resource specialists at APG to track the pollutant removal efficiency of existing and future restoration practices as well as explore partnership options for future projects. A summary of potential restoration opportunities at the Aberdeen Proving Ground are included below:

- Forest and wetland preservation
- Wetland creation, reforestation, SAV planting, shoreline restoration opportunities
- Reforestation opportunities on Graces Quarters
- Potential for beneficial reuse of County dredge material (eroded area off of Carroll Island)

- Tracking of pollutant load reductions from existing and future restoration projects
- Exchange of TSS and nutrient monitoring data to assist with establishing baseline conditions and tracking progress of SWAP restoration actions

Figure 4-53: Aberdeen Proving Ground Site Map

CHAPTER 5: RESTORATION AND PRESERVATION OPTIONS

5.1 Introduction

This chapter presents an overview of the key management practice recommendations for the Middle River and Tidal Gunpowder River watersheds based on the information collected during both the office/desktop analysis and field assessments. These practices are geared toward restoring degraded resources in urban/suburban watersheds. The chapter is divided into five sections: Municipal Capital Programs; Municipal Management Programs; Volunteer Restoration Programs; Neighborhood, Business and Institutional Initiatives; and Citizen Awareness Activities. The sections were delineated based on the entity controlling and performing the activities along with their funding and schedule requirements.

5.2 Municipal Capital Programs

Municipal capital programs are projects and purchases that the County can undertake in the short term to improve water quality in the Middle River and Tidal Gunpowder watersheds.

5.2.1 Stormwater Management Upgrades

The application of stormwater management practices varies according to the impervious cover and land use makeup of the site or subwatershed. The most efficient method to augment stormwater treatment is to convert existing dry detention ponds to a design with greater pollutant removal capability. This is referred to as a stormwater pond conversion. If enough land is available, the greatest benefit would be to construct a new facility, designed with current state of the art technology, to reduce pollutants to the maximum extent practicable. However, a developed subwatershed seldom has sufficient open space. Instead there are options available to put treatment systems directly in the storm drain system. Many packaged systems are available through the retail market and are explained further below. Additional sites in alleys and adjacent to parking lots can offer treatment of large amounts of impervious surface. Also, new research in porous concrete and asphalt may offer the potential for additional reductions in impervious cover on public and private properties.

Stormwater retrofitting involves implementing stormwater BMPs and/or treatment devices in existing developed areas where previous practices did not exist or were ineffective to help improve water quality. Stormwater retrofits improve water quality by capturing and treating runoff before it reaches receiving water bodies. Retrofits target specific objectives depending on BMP type including stormwater quality, soil stabilization, stormwater flow control, and stream restoration. Several considerations must be taken into account to select appropriate stormwater treatment measures such as space requirement, cost, and community acceptance. Based on initial field and desktop evaluations, the following stormwater retrofit categories are recommended for addressing water quality issues in the Middle River and Tidal Gunpowder River watersheds through municipal capital programs: conversion of existing detention ponds; and storm drain inlet and outfall retrofits. Each of these categories is described briefly in the sections below.

Detention Pond Conversion

Dry detention ponds are typically designed for flood control and have little or no pollutant removal capacity. These facilities have the greatest potential for conversion to an extended detention pond which is designed to capture and retain stormwater runoff to allow sediments and pollutants to settle out while also providing flood control if necessary. Nine out of the ten existing detention ponds assessed during the SWM facility survey were determined to have potential for conversion to a wetland or extended detention facility. The facilities currently are vegetated with wetland vegetation, turf grass, or trees on the bottom with a riser structure acting as an outlet. Four of the facilities had no fence at all, and two needed repairs. While open pervious area provides more filtration of stormwater runoff than impervious surfaces, an extended detention pond or wetland with more dense vegetation such as trees, shrubs, and/or native plants would provide even more water quality benefits and would require less maintenance.

Storm Drain Inlet and Outfall Retrofits

Baltimore County's curb and gutter system consists of numerous inlets, pipes, and outfalls. While the curb and gutter system removes stormwater quickly from roadways, it often delivers increased runoff volumes and untreated pollutants to receiving water bodies. One way to address these potential water quality issues is to install proprietary BMPs at selected storm drain inlets. Various structural BMPs are commercially available and include catch basin inserts, water quality inlets, oil/grit separators, filtering devices and hydrodynamic devices. Proprietary BMPs are designed to address specific pollutants such as floatables and solid waste, nutrients, metals, sediment and oil/grease. Most are helpful for removing a portion of pollutants for pretreatment when used in conjunction with another BMP type such as an infiltration trench or a grassed swale for filtering pollutants upstream of an inlet.

While proprietary devices can be costly, they are water improvement alternatives for areas where there is inadequate space for other stormwater management options. Inlets selected for proprietary devices can be prioritized based on the County's outfall screening program. The three pipe outfalls encountered in Saltpeter Creek during the stream assessment were identified as minor severity and therefore, do not require action at this time.

Where space exists between and an outfall and the stream channel, other BMPs can be considered such as floodplain wetlands and energy dissipation devices. Floodplain wetlands can provide treatment of storm flows prior to entering the stream channel. Energy dissipation devices can reduce stream power and thus erosive forces of storm flows prior to entering the stream channel.

Public Parking Lot Retrofits

The potential for installing new stormwater retrofits for treating runoff from existing developed areas is often limited by space availability. However, BMPs that require less space for treating runoff from portions of impervious surfaces can be an alternative to larger storage facilities such as wetlands and extended detention ponds. In areas where insufficient space is available for basin-scale retrofits, other infiltration/filtration practices such as bio-retention can be incorporated into the parking lot layout. Bioretention incorporates vegetation and/or filter media through which stormwater infiltrates for

pollutant removal prior to groundwater recharge. Bio-retention, for example, involves open space combined with vegetated areas where stormwater is temporarily stored and passed through vegetation and a filter bed of sand, organic matter, soil, or other suitable media. Filtered stormwater is collected and returned to the storm drain system or allowed to partially exfiltrate into soil. Many public facilities were identified as having sufficient open space for bio-retention areas to treat runoff from parking lots or as having potential to incorporate retrofits of inlets on a smaller scale. Another retrofit option for treating runoff from large impervious surfaces with limited open space is underground stormwater retention/infiltration systems. Underground stormwater retrofits help address sediment and nutrient inputs to the stream system as well as standing water observed at several of these locations as a result of a lack of stormwater management measures.

5.2.2 Stream Corridor Restoration

Stream corridor restoration practices are used to enhance the appearance, stability, and aquatic function of urban stream corridors. These types of practices can range from simple stream clean-ups and localized bank stabilization to comprehensive repairs such as channel re-design and re-alignment. Stream restoration practices are often combined with stormwater retrofits and riparian management practices to meet subwatershed restoration objectives. Primary recommended practices for Tidal Gunpowder River stream corridors include buffer restoration, stream clean-ups, and stream repair.

Forest and Buffer Improvement

Forests are the best land use for the protection of water quality. The Middle River and Tidal Gunpowder watersheds are each covered with over 30% forest. Much of the two watersheds are classified as open pervious and may provide opportunities for planting. Forested buffers are linear wooded areas along rivers, streams and shorelines which help stabilize banks, prevent erosion, filter pollutants such as sediment and nutrients, and provide wildlife habitat. Several portions of the Middle River and Tidal Gunpowder River stream system and shoreline have inadequate buffers as a result of human development activities. A significant amount of the watershed has been urbanized and as a result, the original forested stream buffer has been replaced by mowed lawn areas or impervious cover.

The main restoration strategy proposed for the Middle River and Tidal Gunpowder watersheds is to enhance forests and impacted stream and shoreline buffers. This can be accomplished by a variety of methods including:

- Planting on residential and open space properties with native vegetation – Institutions and residential communities should reduce the amount of mowed grass and plant additional native trees.
- Land Preservation – Forest protection is one reason for persuing a property as part of the county's land preservation programs. Benefits to water quality are a part of the evaluation criteria in determining the most important parcels for protection. Smaller sites may be protected through NeighborSpace, a nonprofit organization that preserves small blocks of land within urban communities.

- Targeted education programs - Property owners, including private residences, businesses and institutions, need to learn the water quality benefits of buffers that are forested or planted with native vegetation. Stream buffer signs are one way to remind residents of the importance of stream buffers. Educational programs can teach residents that allowing their streams to have natural buffers can help preserve their property as well as provide water quality benefits. It also may help limit some of the trash dumping and yard waste observed in neighborhoods, along roadways, and in commercial areas.

- Invasive species control – Invasive and non-native plant species such as phragmites were identified in various locations within the watersheds. Invasive species concerns can be addressed through public education, training of County grounds maintenance staff, and developing a volunteer group dedicated to controlling invasive species in the planning area.

- Community Reforestation Program (CRP) – established by DEPS to plant, monitor, and maintain 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 includes a four-person reforestation crew that carries out year-round reforestation operations. By utilizing the existing CRP, the county can achieve targeted reforestation along well-suited river, stream, and shoreline buffers.

Stream Repair

Natural channel design techniques are utilized to stabilize eroded, degraded stream banks and to protect infrastructure such as private property, buildings and utilities. Stabilizing the stream channel improves water quality by preventing eroded soils, and the pollutants contained in them, from entering the stream. In addition, protecting infrastructure such as sewer and storm drain pipes reduces and/or eliminates water quality impacts associated with leaking sewer pipes and manholes. Where conditions allow, reconnecting the stream channel to its floodplain provides additional water quality benefits. When considering stream repair, it is important to take into account what is occurring upstream in the watershed. The hydrology and stormwater management practices upstream of a restoration site will dictate the quantity and speed runoff will reach a site. In addition, the sediment supply of the upstream channel is also an important consideration during the design of stream restoration repairs.

Wetland Restoration

Wetlands are highly valuable lands in terms of their abilities to both improve water quality and as important habitat for many species. Wetlands are defined as areas that are inundated or saturated by surface or groundwater at a frequency sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands are often called swamps, marshes, or bogs. This strategy entails the creation or enhancement of existing wetlands that have been lost or impaired in the past. The County often undertakes wetland restoration

on public lands where wetlands have been destroyed or impaired as well as partnering with businesses and institutions where wetland restoration is a viable option.

5.2.3 Tidal Waters and Shoreline Preservation/Enhancement

The Middle River and Tidal Gunpowder River watersheds consists of tidal waters and shoreline areas that have numerous benefits and uses for recreation, wildlife habitat, aquatic life, and water quality. The main recommended strategies for preserving and enhancing tidal and shoreline resources include the following:

- Navigation channels – Marking and maintaining navigation channels in the Middle River and Tidal Gunpowder River will help keep a balance between encouraging recreational boat use and submerged aquatic vegetation (SAV) growth. As noted previously, SAV is important for and a good indicator of water quality and habitat.
- Shoreline enhancement projects –potential shoreline enhancement projects include the following:
    - Hawthorn-Midthorn Park: reforestation to enhance shoreline buffer
    - Wilson Point Park: reforestation to enhance shoreline buffer, extension of no-mow/vegetated buffers, and natural shoreline restoration through erosion stabilization and invasive species removal

5.2.4 Pervious Area Restoration

Pervious areas offer a good opportunity for restoration in subwatersheds since they can be used to restore natural infiltration properties, enhance stream buffers, and provide wildlife habitat. These areas also present an opportunity for reforestation in the watershed which in the highest priority in terms of improving infiltration and recharge functions. Other techniques can also be used to improve natural functions including soil aeration, amendments, and establishing native plants and meadows. Sites prioritized for pervious area restoration should require minimal preparation for reforestation or regeneration with little evidence of soil compaction, invasive plant species, and trash/dumping. Most of the pervious areas assessed were publicly owned.

5.3 Municipal Management Programs

Municipal management programs are longer-term or continuous actions that the county can take to improve water quality in the Middle River and Tidal Gunpowder watersheds.

5.3.1 Trash Management/Education

Dumping of bulk materials was noted as a problem in the watershed by field teams and residents. Ensuring the Department of Public Works provides a user-friendly and effective bulk trash pickup program would help prevent future dumping problems in the watershed. This may involve extending existing hours for bulk trash drop off at landfills or implementing a monthly bulk trash pick-up service at various locations in the watershed.

Existing trash initiatives include Baltimore County's Clean Shores Program (removing trash and debris from shorelines, mudflats, and waterways) and Project Stream Clean (stream clean-ups throughout the region organized by the Alliance for the Chesapeake Bay). Implementing municipal practices and programs related to trash management/education in the Middle River and Tidal Gunpowder River watersheds would improve water quality and aesthetics of the watersheds.

5.3.2 Street Sweeping

Baltimore County has an active street sweeping program to remove debris, dirt and pollutants from the storm drain system. Effective street sweeping usually involves using a vacuum assisted sweeper and a schedule that coincides with things like trash pick-up days or seasonal changes such as leaf litter in the fall and more frequent lawn care activities in spring and summer. The frequency and locations of this program in the study area should be evaluated and updated to include neighborhoods identified as having significant sediment, organic matter, and/or trash in the curb and gutter system. An evaluation of existing street sweeping programs is included as part of the Baltimore Watershed Agreement. Street sweeping is also related to the trash component of the agreement.

5.3.3 Tree Planting

Several opportunities for reforestation and buffer improvement were identified during the field assessments including street tree and open space shade tree plantings in various neighborhoods, open pervious areas and institutions throughout the watershed. This presents an opportunity to apply for municipal tree planting programs including SHA's "Partnership Program" and DNR's "Tree-mendous Maryland" program to help reforest areas of the watershed

5.3.4 Baltimore Watershed Agreement

The Baltimore Watershed Agreement (BWA) formalizes the commitment of Baltimore City and Baltimore County to work together on the management and monitoring of shared watersheds. Rivers and streams don't fall neatly within city and county boundaries. The headwaters of the Gwynns Falls and Jones Falls, for example, are in Baltimore County but the streams flow to the harbor. Herring Run begins in the County, meanders through the City, and finally empties into the Back River in the County. First signed in 2002 and renewed in 2006, the agreement acknowledges that geographic boundaries of watersheds are more appropriate for managing these important natural resources than political boundaries. The 2006 agreement identifies five focus areas, these include: stormwater, community greening, redevelopment and development, public health and trash. An Action Plan was developed and continues to be implemented by staff and overseen by the BWA wprkgroup.

5.3.5 Inlet Cleaning

Over time, solids in stormwater runoff collect in storm drains and inlets. As solids accumulate in an inlet, they are susceptible to downstream transport during larger storm events, contributing to pollution in the Middle River and Tidal Gunpowder River watersheds. A study conducted by UMBC and the Center for Watershed Protection as part of the U.S. EPA Chesapeake Bay Program concluded that annual or semi-annual cleaning of storm drain inlet can significantly increase solids removal rates (18-35%) while also contributing to nitrogen and phosphorus removal. The Department of Public Works employs three

inlet cleaning trucks. Inlet cleaning at regular intervals can reduce pollutant loads in the watershed, reduce flooding and help locate illicit discharges into the storm sewer system.

5.3.6 Erosion and Sediment Control

Construction activities in or near streams were observed during the stream and uplands assessments of the watershed. In these cases, erosion and sediment controls are vital to prevent soil and other pollutants from entering the storm drain system or nearby stream. Follow-up inspection and improvement of erosion and sediment control practices at construction sites are implemented and enforced by EPS to prevent sediment and other pollutant inputs from entering into the storm drain system and stream network.

5.3.7 Dry Weather Discharge Prevention

Discharge prevention targets dry weather flows that contain significant pollutant loads. Examples include illicit discharges, sewage overflows, or industrial and transportation spills. Dry weather discharges can be continuous, intermittent, or transitory. Resulting water quality problems can be extreme depending on the volume and type of discharge. For example, sewage discharges include bacteria and can directly affect public health while other discharges such as oil, chlorine, pesticides, and trace metals can be toxic to aquatic life. Dry weather discharge prevention focuses on four major sources that can occur in a subwatershed as described briefly below.

- Illicit Sewage Discharges: When septic systems fail or when sewer pipes are mistakenly or illegally connected to the storm drain pipe network, sewage can get into streams. Sometimes sewage is directly discharged to a stream or ditch without treatment or illegally dumped into the storm drain system from boats or RVs.

- Commercial and Industrial Illicit Discharges: Some businesses mistakenly or illegally dispose of liquid wastes that can adversely impact water quality into the storm drain system. Examples include hotspots where materials such as oil, paint, and solvents are improperly disposed, where business drains are directly connected to the storm drain system, or where untreated wash water or process water is dumped into the storm drain system.

- Industrial and Transport Spills: Pollutants can enter the storm drain system as a result of ruptured tanks, pipeline breaks, accidents/spills, or illegal dumping. These events are more likely to occur in urban subwatersheds and may result in potentially hazardous materials reaching streams through the storm drain system.

- Failing Sewage Lines: Sewer lines often follow the stream corridor. If they leak, overflow, or break, sewage will be discharged directly into the stream. The frequency of failure depends on the age, condition, and capacity of the existing sanitary sewer system.

5.3.8 Land Preservation

Land preservation complements the implementation of BMP's by insuring that specific non-urban land uses remain intact over time on specific parcels. Land preservation includes areas such as parks and watershed protection zones where non-extractive uses predominate, as well as areas that are intensively managed for agriculture.

These parcels may be large, such as parks, or small, protecting a single farm. Land preservation reflects societal priorities and decisions to limit urban and residential development, and provides broad benefits. However, by themselves, they do not assure that certain environmental goals, such as good water quality, will be met.

"Protected land" includes any land with some form of long-term limitation on conversion to urban/developed land use. This protection may be in various forms: public ownership for natural resource or low impact recreational intent (i.e. park), private ownership where a third party acquired the development rights or otherwise acquired the right to limit use through the purchase of an easement (i.e. conservation easement), etc. The extent of "protection" varies greatly from one situation to the next. Therefore, for some protected land, it may be necessary to explore the details of land protection parcel-by-parcel through the local land records office to determine the true extent of protection.

For purposes of watershed management, an understanding of existing protected lands can provide a starting point in prioritizing potential protection and restoration activities. In some cases, protected lands may provide opportunities for restoration projects because owners of these lands may value natural resource protection or enhancement goals. A summary of current conservation easements is provided in Chapter 2.

Maryland and County Rural Legacy Program

Baltimore County participates in the State's Rural Legacy Program which was developed in 1997 to protect large, continuous tracts of valuable cultural and natural resource lands through grants made to local applicants (DNR 2007). Baltimore County's Rural Legacy Plan aims to protect large blocks of forest, wetlands, farms, and other open spaces that are of significant ecological value as habitat for rare, threatened and endangered species and to preserve the environmental benefits that these areas provide to the Chesapeake Bay. This planning area includes portions of the county's Coastal Rural Legacy Area. Efforts to increase participation in preservation programs are on going through EPS and the Gunpowder Valley Conservancy.

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 12,000 acres through donations. Although both MET and local land trusts prefer to accept donations on lands greater than 50 acres, local land trusts are often willing to work with smaller property owners. Donations are accepted throughout the year. Landowners may qualify for a significant tax deduction and/or credit. MET also provides loans to qualified groups for the purchase of land for preservation.

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 17,000 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.

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 1,300 acres through this program. To participate, a farm must be 50 acres in size or located adjacent to a preserved property.

5.4 Volunteer Restoration Programs

Volunteer restoration programs include activities are projects supported by the County but conducted by volunteers and volunteer organizations such as a watershed improvement group.

5.4.1 Stream Cleanups

Stream clean-ups are a simple practice used to enhance the appearance of the stream corridor and shoreline by removing unsightly trash, litter, and debris. These are usually performed by volunteers and are one of the most effective methods for generating community awareness and involvement in watershed activities. Public outreach tools should be used to encourage and inform residents about organizing stream clean-ups and support available from the County.

5.4.2 Tree Planting

As noted previously, a number of open space and street tree planting opportunities are present in the Middle River and Tidal Gunpowder River watersheds, offering an opportunity to apply for municipal tree planting programs including SHA's "Partnership Program" and DNR's "Tree-mendous Maryland" program to help reforest areas of the watershed. These types of programs also provide an opportunity to involve volunteers from various 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 benefits. The Growing Home Campaign is another way to increase the tree canopy in the watershed while also educating residents about the value of adding trees. This is a public-private partnership between Baltimore County, Baltimore City, Harford County, local retail nurseries/garden centers and homeowners to encourage planting new trees on private residential land.

5.4.3 Pet Waste Stations

Unmanaged pet waste is a major contributor to bacteria in streams, such as fecal coliform. Pet waste stations usually consist of a sign prompting pet owner's to discard of pet waste properly and a supply of convenient pet waste disposal bags for waste collection and disposal. Pet waste stations that are well-

situated in parks or neighborhoods with high pet activity can help to reduce the bacteria flowing into streams along with maintaining an attractive area. Citizen volunteers can be asked to help install pet waste stations in high pet-traffic areas along with ensuring that stations are well-stocked with bags for collection and disposal.

5.4.4 Storm Drain Marking

Most of the developed areas in the Middle River and Tidal Gunpowder River watersheds consist of curb and gutter systems including storm drain inlets that convey stormwater runoff quickly and directly to the stream system and ultimately to the Chesapeake Bay. Some inlets had faded storm drain marking but for the most part, inlets did not have any indicators that they drain to the Middle River and Tidal Gunpowder River and eventually the Chesapeake Bay. Since there is little or no infiltration of stormwater in a curb and gutter system, there is more potential for pollutants to be carried to the stream system. Storm drain marking is a way to educate residents that anything building up along the curbs and gutters such as trash and lawn clippings will be washed away after a storm event and end up in the Middle River and Tidal Gunpowder River and/or the Bay.

5.5 Business and Institutional Initiatives

Business and institutional initiatives include activities that are available for commercial businesses and institutions to undertake in order to improve water quality in the area. These activities can be supported by the County.

5.5.1 Impervious Cover Removal

Impervious surfaces including roads, parking lots, roofs and other paved surfaces prevent precipitation from naturally seeping into the ground. Stormwater runoff from impervious surfaces is often concentrated, accelerated and discharged directly to the storm drain system or nearest stream. This can result in erosion, flooding, habitat destruction, and increased pollutant loads to receiving water bodies. Subwatersheds with high amounts of impervious cover are more likely to have more degraded stream systems and be significant contributors to water quality problems in a watershed than those that are less developed.

Unused or unmaintained impervious surfaces with the potential for removal were identified at several institutions. At sites where parking lots may be larger than necessary, portions of the impervious cover could be removed and converted to bio-retention areas for treating stormwater runoff from the remaining impervious surfaces. One site that may be considered for this option, for example, is Lockheed Martin. Some institutions may also have parking areas that are not frequently used (e.g., cemeteries) and could be suitable for conversion to permeable pavement which allows some infiltration of stormwater runoff while providing support for less frequent traffic/vehicle use. Several neighborhoods incorporated grass strips, gravel, or permeable pavers in private driveways which allows some infiltration of stormwater runoff. Completely paved driveways, however, were more common in the neighborhoods assessed during this study. Education and outreach tools could be used to inform residents of the water quality impacts associated with large impervious driveways or patios and options available for conversion to or incorporating more permeable surfaces. Channelized sections of stream

corridors were identified during the stream assessment and may be candidates for removal of existing concrete lining to restore streams to more natural systems. This would allow natural infiltration of stormwater and support pollutant removal prior to stormwater discharge into receiving waters.

5.5.2 Pervious Area Restoration

Several institutions assessed had extensive opportunities for reforestation which would also require less ground maintenance and improve energy efficiency. Parcels meeting these criteria are good candidates for follow-up investigations and landowner contact.

5.5.3 Stormwater Retrofits

The following represent stormwater retrofits that can be undertaken by private entities to positively affect water quality.

Parking Lot

Many institutions were identified as having sufficient open space for bio-retention areas to treat runoff from parking lots or as having potential to incorporate retrofits of inlets on a smaller scale. Another retrofit option for treating runoff from large impervious surfaces with limited open space is underground stormwater retention/infiltration systems. Stormwater retrofits would help address sediment and nutrient inputs to the stream system as well as standing water observed at several of these locations as a result of a lack of stormwater management measures.

Downspout Disconnection

Downspouts directly connected to the storm drain system or draining to impervious surfaces such as parking lots, sidewalks, or the curb and gutter system increase the volume and flow rate of pollutant-laden runoff reaching streams. Disconnected downspouts allow rooftop runoff to infiltrate into the ground and enter streams through the groundwater system in a slower more natural fashion. This decreases flow to local streams during storm events and helps prevent erosion and reduce pollutants loads to streams. Disconnecting downspouts in commercial corridors is an inexpensive way to improve water quality in the Middle River and Tidal Gunpowder watershed.

5.5.4 Open Space Planting

Several opportunities for reforestation and buffer improvement were identified during the field assessments including open space shade tree plantings in various open pervious areas and institutions throughout the watershed. This presents an opportunity to apply for municipal tree planting programs including SHA's Partnership Program and DNR's Tree-Mendous Maryland program to help reforest areas of the watershed.

Tree-Mendous Maryland coordinates the free delivery of trees to citizens and community groups, and provides an inexpensive way to obtain trees and shrubs for planting on public lands and within community open spaces. These types of programs also provide an opportunity to involve volunteers

from various 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 benefits.

5.5.5 Tidal Waters and Shoreline Preservation/Enhancement

As discussed in Section 5.2 on Municipal Capital Programs, shoreline enhancement is a very effective means of improving water quality in streams and rivers. Some of the businesses and institutions within this planning area are adjacent to the shoreline. These properties may be candidates for shoreline enhancement either with stabilization or buffer planting projects.

5.5.6 Pollution Source Control

Hotspots are commercial, industrial, municipal, or transport-related operations in the watershed that tend to generate higher concentrations of stormwater pollutants and/or have a higher risk of spills, leaks, or illicit discharges. Pollution prevention practices can significantly reduce hotspot pollution problems. Local government agencies must adopt pollution prevention practices for their operations and lead by example. This should be followed by inspection and incentive-based educational efforts for privately operated sites with enforcement measures as a backstop. The ability to conduct such inspections and enforcement actions should be clearly articulated in local codes and ordinances and through education programs. As previously noted, some industrial/commercial sites are required to have NPDES permits for stormwater and/or wastewater discharges. While the County assists with the identification of these sites, MDE is responsible for regulating industrial/commercial sites that are required to have NPDES permits. Another potential program is to host workshops for local businesses that detail the permit requirements and how to prepare pollution prevention plans.

5.6 Citizen Awareness Activities

Citizen awareness activities are actions that any resident or citizen in the Middle River and Tidal Gunpowder watersheds can take that would provide a benefit to water quality.

5.6.1 Pollution Prevention/Source Control Education

Residents engage in behaviors that can adversely impact water quality. Some of these behaviors observed during the assessment of neighborhoods in the watershed include over-fertilizing lawns, excessive use of pesticides, improper disposal/storage of potentially hazardous materials (e.g., household cleaners, paints, automotive fluid, etc.), and dumping into storm drains (e.g., wash water). Pollution prevention/source control education efforts should also target waste management activities in the watershed to address dumpsters located near storm drain inlets or streams without diversion methods, poor dumpster conditions (leaking, overflowing, and uncovered), and the occurrence of trash dumping in the watershed. Positive behaviors were also observed such as tree planting, disconnected downspouts, and picking up pet waste which can help improve water quality. A pollution prevention program can be designed to discourage negative behaviors and/or encourage positive behaviors. Either way, the goal is to deliver a specific message through targeted education to promote behavior changes. Local watershed organizations can help influence these changes using pollution prevention education and outreach to teach citizens how to properly care for the watershed.

5.6.2 Trash and Recycling

Educating the public about the trash issues and impacts to water quality in the watershed through a trash campaign is one way to address trash and dumping problems. Baltimore City has implemented a Cleaner Greener Baltimore initiative including a trash campaign with a slogan ("*Don't make excuses. Make a difference*") and signs with various messages posted throughout the city to encourage residents to use proper disposal methods and inform them that trash is an issue in the City. A similar campaign could be launched in the Middle River and Tidal Gunpowder River watersheds with a slogan and messages tailored to the residents and issues in the study area. By adopting a slogan and campaign for the watershed, residents will be aware of the issues and encouraged to take responsibility for the health of the Middle River and Tidal Gunpowder River in their communities. Public education and awareness can also be accomplished through community clean-ups in neighborhoods or schools with observed trash management issues.

5.6.3 Environmental Awareness and Education

Community-based facilities present good opportunities for educating the public about water quality issues and improvement methods for 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. There is also potential for involving the community through BMP installation and maintenance. Environmental education can also be accomplished through water quality sampling and monitoring of stormwater management measures such as wetlands and extended detention ponds at schools, for example. Buffer and tree planting activities also present an opportunity for combining community involvement and environmental education.

5.6.4 Bayscaping

A BayScape is a landscape using native plants to provide habitat for local and migratory animals, improve water quality, and reduce the need for chemical pesticides and herbicides. BayScaping plants, such 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 water bodies. 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.

5.6.5 MD Green School Awards Program

Baltimore County uses *The Maryland Green School Awards Program* to provide a framework for integrating environmental learning and community involvement in local schools. DEPS supports workshops and site-based meetings for teachers and provides local and regional resources to enhance staff development opportunities and increase the environmental awareness and interest of local school principals, teachers, and facilities managers. A requirement of each Green School is to demonstrate Best Management Practices at their site. These may include: water conservation, energy conservation, solid waste reduction, and habitat restoration using the school grounds.

5.6.6 MD Clean Marina Program

The Maryland DNR Clean Marina Initiative recognizes marinas, boatyards, and yacht clubs that voluntarily undertake pollution prevention practices on site and meet the legal requirements of the designation. These practices deal with vessel maintenance and repair, petroleum control, emergency planning, sewage handling, waste containment and disposal, marina management, stormwater management, and marina design and maintenance. Facilities meeting the requirements for the Clean Marina Award are allowed to advertise themselves as a MD Clean Marina. In addition, boaters are encouraged by DNR to patronize Clean Marinas. Four of the nine marinas assessed in this study were certified as Clean Marinas. By providing educational assistance for other marinas to obtain a Clean Marina certification, pollutant sources in close proximity to waterways can be eliminated while also providing education to the boating public on clean boating practices.

5.6.7 MD Clean Boater Program

The Maryland Clean Boater Program is an outgrowth of the Maryland Clean Marina Initiative, and seeks to involve boaters in protecting Maryland's waterways. The purpose of the program is to educate boaters on sustainable boating practices including proper waste disposal, fueling methods, cleaning, and maintenance. In addition, MD Clean Boaters are encouraged to utilize Clean Marinas. Providing boaters with education on the MD Clean Boater Program can decrease and prevent pollution to local streams and waterways from improper boating practices.

5.6.8 Downspout Disconnection

Most of the neighborhoods assessed in the Middle River and Tidal Gunpowder River watersheds were recommended for downspout disconnection. This is because most downspouts were directly connected to the storm drain system or indirectly connected, draining to impervious surfaces such as driveways, sidewalks, or the curb and gutter system. Disconnected downspouts allow rooftop runoff to infiltrate into the ground and enter streams through the groundwater system in a slower more natural fashion. This decreases flow to local streams during storm events and helps prevent erosion and reduce pollutants loads to streams. Many of the typical lots do not have sufficient room for rain gardens; however, redirecting downspouts to pervious areas such as yards or lawns or to rain barrels seems to be a viable option for most neighborhoods recommended for downspout disconnection.

Rain gardens are the most desirable option in terms of water quality because they consist of native plants that capture and treat runoff. This may be an option for multifamily neighborhoods like apartment complexes where there is several hundred square feet of open pervious area available down gradient from the downspout. Rain gardens may also be an option for disconnecting downspouts at institutional sites with sufficient space available. Redirecting downspouts to pervious areas or rain barrels is also an option for institutional sites as well as individual homeowners.

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APPENDIX A:

STREAM CORRIDOR ASSESSMENT DATA

MIDDLE RIVER AND TIDAL GUNPOWDER RIVER SCA SURVEY:
INADEQUATE BUFFER

WATERSHED	SUBWATER-SHED	SWAP AREA	DATE	MAP	SITE	BUFFER INADEQUATE ON	STREAM UNSHADED ON	BUFFER WIDTH LEFT (FT)	BUFFER LENGTH LEFT (FT)	BUFFER WIDTH RIGHT (FT)	BUFFER LENGTH RIGHT (FT)	LAND USE LEFT	LAND USE RIGHT	BUFFER RECENTLY ESTABLISHED	LIVESTOCK PRESENT	IF YES, TYPE	SEVERITY
Gunpowder RIver	Dundee	F	11/19/2010	083C3	083C3-10_IB	Left	Right	10	150	5000	0	Lawn	Forest	N	N		Minor
Gunpowder RIver	Dundee	F	11/19/2010	083C3	083C3-11_IB	Both	Neither	10	85	20	200	Forest	Forest	N	N		Low Severity
Gunpowder RIver	Dundee	F	11/19/2010	083C3	083C3-12_IB	Both	Both	5	100	15	100	Lawn	Shrubs Smalll Trees	N	N		Low Severity
Gunpowder RIver	Saltpeter	F	1/20/2011	083B3	083B3-03_IB	Both	Both	5	500	0	500	Other	Other	N	N		Severe
Gunpowder RIver	Saltpeter	F	1/20/2011	083B3	083B3-04_IB	Both	Neither	0		0		Other	Other	Y	N		Minor
Gunpowder RIver	Saltpeter	F	1/20/2011	091B1	091B1-08_IB	Both	Neither	75	200	40	200	Other	Other	N	N		Low Severity
Gunpowder RIver	Saltpeter	F	1/20/2011	091B1	091B1-01_IB	Both	Both	20	300	0	300	Shrubs Smalll Trees	Lawn	N	N		Moderate
Gunpowder RIver	Saltpeter	F	1/20/2011	091B1	091B1-07_IB	Left	Neither	25	150			Other	Other	N	N		Low Severity

MIDDLE RIVER AND TIDAL GUNPOWDER RIVER SCA SURVEY:
TRASH DUMPING

WATERSHED	SUBWATERSHED	SWAP AREA	DATE	MAP	SITE	TYPE OF TRASH	AMOUNT PICKUP TRUCK LOADS	OTHER MEASURE	TRASH CONFINED TO	SITE FOR VOLUNTEERS	LAND OWNERSHIP	NAME IF PUBLIC	SEVERITY
Gunpowder RIver	Dundee	F	11/19/2010	083C3	083C3-09_TD	Mixed	10		Large Area	N	Private		Moderate
Gunpowder RIver	Saltpeter	F	1/20/2011	083B3	083B3-02_TD	Industrial	3		Single Site	N	Private		Moderate

MIDDLE RIVER AND TIDAL GUNPOWDER RIVER SCA SURVEY:
FISH BARRIER

WATERSHED	SUBWATERSHED	SWAP AREA	DATE	MAP	SITE	BLOCKAGE TYPE	BARRIER TYPE	BLOCKAGE BECAUSE	WATER DROP (IN)	WATER DEPTH (IN)	SEVERITY
Gunpowder RIver	Saltpeter	F	1/20/2011	083B3	083B3-09_FB	Total	Debris Dam	Too High	18	0	3- Moderate
Gunpowder RIver	Saltpeter	F	1/20/2011	091B1	091B1-06_FB	Total	Road Crossing	Other	0	0	1- Very Severe
Gunpowder RIver	Saltpeter	F	1/20/2011	091B1	091B1-02_FB	Partial	Road Crossing	Too Shallow	0	3	3- Moderate

MIDDLE RIVER AND TIDAL GUNPOWDER RIVER SCA SURVEY:
PIPE OUTFALL

WATERSHED	SUBWATERSHED	SWAP AREA	DATE	MAP	SITE	TYPE OF OUTFALL	TYPE OF PIPE	LOCATION	PIPE DIAMETER (IN)	CHANNEL WIDTH (FT)	EVIDENCE OF DISCHARGE	COLOR	ODOR	SEVERITY
Gunpowder RIver	Saltpeter	F	1/25/2011	083A3	083A3-01_PO	Stormwater	Concrete Pipe	Head of Stream	24	12	Y	Clear	None	Minor
Gunpowder RIver	Saltpeter	F	1/25/2011	083B3	083B3-05_PO	Stormwater	Other	Head of Stream	8	2	Y	Clear	None	Minor
Gunpowder RIver	Saltpeter	F	1/25/2011	083B3	083B3-06_PO	Stormwater	Other	Head of Stream	0	5	Y	Clear	None	Minor

MIDDLE RIVER AND TIDAL GUNPOWDER RIVER SCA SURVEY:
CHANNEL ALTERATION

WATERSHED	SUBWATERSHED	SWAP AREA	DATE	MAP	SITE	TYPE	BOTTOM WIDTH	PERENNIAL FLOW	SEDIMENT DEPOSITION	VEGETATION	ROAD CROSSING	CHANNELIZED LENGTH ABOVE ROAD CROSSING	CHANNELIZED LENGTH BELOW ROAD CROSSING	SEVERITY
Gunpowder RIver	Dundee	F	11/19/2010	083C3	083C3-08_CA	Other	30	Y	N	Y	No	0	3	Low Severity
Gunpowder RIver	Dundee	F	11/19/2010	083C3	083C3-07_CA	Other	48	Y	N	Y	Above	85	0	Minor
Gunpowder RIver	Dundee	F	11/19/2010	083C3	083C3-06_CA	Other	48	Y	N	Y	Above	70	0	Minor

MIDDLE RIVER AND TIDAL GUNPOWDER RIVER SCA SURVEY:
UNUSUAL CONDITION/COMMENT

WATERSHED	SUBWATERSHED	SWAP AREA	DATE	MAP	SITE	TYPE	DESCRIBE	NOTES	POTENTIAL CAUSE	SEVERITY
Gunpowder RIver	Dundee	F	11/19/2010	083C3	083C3-01_UC	Unusual Condition	Other	Downed tree causing sebiment trap that has cut off flow and backwaters US. Photos 03 and 04		Minor
Gunpowder RIver	Dundee	F	11/19/2010	083C3	083C3-05_UC	Comment	Other	Multiple shallow chanels, hummicy		
Gunpowder RIver	Dundee	F	11/19/2010	083C3	083C3-03_UC	Unusual Condition	Other	Upstream end of culvert - ripraped pool, 37'x 16'		
Gunpowder RIver	Dundee	F	11/19/2010	083C3	083C3-02_UC	Unusual Condition	Other	Downstream end of culvert - excavated pool, 20' wide x 31.2'		
Gunpowder RIver	Dundee	F	11/19/2010	083C3	083C3-04_UC	Unusual Condition	Other	pool below root controled head cut. pool depth - 4'	flow over roots	Minor
Gunpowder RIver	Saltpeter	F	1/20/2011	091B1	091B1-03_UC	Unusual Condition	Other	Curb Inlet discharges directly into stream		Severe
Gunpowder RIver	Saltpeter	F	1/20/2011	091B1	091B1-04_UC	Unusual Condition	Other	Curb Inlet discharges directly into stream		Severe
Gunpowder RIver	Saltpeter	F	1/25/2011	083B3	083B3-01_UC	Comment	Other	Wetlands		
Gunpowder RIver	Saltpeter	F	1/20/2011	091B1	091B1-05_UC	Comment	Other	Tidal Reach Choked with Phragmites		

MIDDLE RIVER AND TIDAL GUNPOWDER RIVER SCA SURVEY:
STABILITY ASSESSMENT

WATERSHED	SUBWATERSHED	SWAP AREA	DATE	REACH ID	CEM STAGE	BANK HEIGHT RATIO	BED CONDITION DOMINANT	BED CONDITION SECONDARY	PLANFORM	SHAPE LENGTH (FT)	PHOTO DESCRIPTION
Gunpowder RIver	Dundee	F	11/19/2010	083C3-A3	Stage VI Recovery and Reconstruction		Sand	Gravel	Meandering	216.90	Photo 10 Upstream
Gunpowder RIver	Dundee	F	11/19/2010	083C3-A2	Stage VI Recovery and Reconstruction		Sand	Silt/Clay	Braided	358.40	Photo 09 Downstream
Gunpowder RIver	Dundee	F	11/19/2010	083C3-A1	Stage VI Recovery and Reconstruction		Sand	Silt/Clay	Meandering	528.93	Photo 07 Downstream
Gunpowder RIver	Dundee	F	11/19/2010	083C3-C1	Stage III Incision		Gravel	Sand	Straight	401.98	Photo 16
Gunpowder RIver	Dundee	F	11/19/2010	083C3-C2	Stage VI Recovery and Reconstruction		Sand	Gravel	Meandering	1,226.59	Photo 17 Left Bank
Gunpowder RIver	Dundee	F	11/19/2010	083C3-D1	Stage VI Recovery and Reconstruction		Sand	Silt/Clay	Meandering	934.65	Photo 29 Upstream
Gunpowder RIver	Saltpeter	F	1/25/2011	083A3-G2	Stage VI Recovery and Reconstruction		Sand	Silt/Clay	Meandering	727.60	Photo 750 Downstream
Gunpowder RIver	Saltpeter	F	1/25/2011	083A3-H1	Stage VI Recovery and Reconstruction		Sand	Silt/Clay	Meandering	826.56	Photo 753 Downstream
Gunpowder RIver	Saltpeter	F	1/25/2011	083B3-D3	Stage VI Recovery and Reconstruction		Sand	Silt/Clay	Meandering	320.93	Photo 16 Downstream
Gunpowder RIver	Saltpeter	F	1/25/2011	083B3-D2	Stage VI Recovery and Reconstruction		Sand	Silt/Clay	Meandering	380.24	Photo 12 Downstream
Gunpowder RIver	Saltpeter	F	1/25/2011	083B3-D1	Stage VI Recovery and Reconstruction		Sand	Silt/Clay	Meandering	408.52	Photo 10 Downstream
Gunpowder RIver	Saltpeter	F	1/25/2011	083B3-C1	Stage VI Recovery and Reconstruction		Sand	Silt/Clay	Meandering	677.38	Photo 08 Downstream
Gunpowder RIver	Saltpeter	F	1/25/2011	083B3-C2	Stage VI Recovery and Reconstruction		Sand	Silt/Clay	Braided	243.78	Photo 06 Downstream
Gunpowder RIver	Saltpeter	F	1/25/2011	083B3-C3	Stage VI Recovery and Reconstruction		Sand	Silt/Clay	Meandering	295.78	Photo 04 Downstream
Gunpowder RIver	Saltpeter	F	1/25/2011	083B3-C4	Stage VI Recovery and Reconstruction		Sand	Silt/Clay	Braided	354.21	Photo 02 Downstream
Gunpowder RIver	Saltpeter	F	1/25/2011	083B3-E1	Stage VI Recovery and Reconstruction		Silt/Clay	Silt/Clay	Straight	316.83	Photo 20 Downstream
Gunpowder RIver	Saltpeter	F	1/20/2011	083B3-B1	Stage VI Recovery and Reconstruction		Sand	Silt/Clay	Braided	1,174.44	Photo 738 Downstream
Gunpowder RIver	Saltpeter	F	1/20/2011	083B3-B2	Stage VI Recovery and Reconstruction		Sand	Silt/Clay	Meandering	987.96	Photo 741 Downstream
Gunpowder RIver	Saltpeter	F	1/20/2011	083B3-A3	Stage VI Recovery and Reconstruction		Sand	Silt/Clay	Straight	847.11	Photo 735 Downstream
Gunpowder RIver	Saltpeter	F	1/20/2011	091B1-A2	Stage VI Recovery and Reconstruction		Sand	Silt/Clay	Braided	360.02	Photo 729 Downstream
Gunpowder RIver	Saltpeter	F	1/20/2011	091B1-A1	Stage IV Widening		Sand	Silt/Clay	Meandering	599.83	Photo 721 Downstream
Gunpowder RIver	Saltpeter	F	1/25/2011	083B3-G1	Stage VI Recovery and Reconstruction		Sand	Silt/Clay	Braided	448.53	Photo 748 Downstream
Gunpowder RIver	Dundee	F	1/25/2011	083C3-B1	Stage VI Recovery and Reconstruction		Sand	Silt/Clay	Braided	460.42	
Gunpowder RIver	Saltpeter	F	2/14/2011	091A1-H2	Stage VI Recovery and Reconstruction		Sand	Silt/Clay	Braided	276.41	Photo 758 Downstream
Gunpowder RIver	Saltpeter	F	2/14/2011	091A1-H3	Stage VI Recovery and Reconstruction		Sand	Silt/Clay	Meandering	137.49	Photo 760 Downstream
Gunpowder RIver	Saltpeter	F	2/14/2011	091A1-H4	Stage VI Recovery and Reconstruction		Silt/Clay	Sand	Braided	895.88	Photo 762 Downstream

APPENDIX B:

SWM FACILITY ASSESSMENT DATA

MIDDLE RIVER AND TIDAL GUNPOWDER RIVER SWM FACILITY ASSESSMENT DATA

SITE ID	SUBWATERSHED	STRUCTURE NAME	NEAR RD	OWNERSHIP	POND TYPE	DRAINAGE AREA ACRES	RISER	EMBANKMENT	BOTTOM	FENCE	GATE	DAMAGE NOTES	WQ POTENTIAL	CONNECTION	ACCESS	FLOW PATH	WQ NOTES
SWM_F_449	GUNPOWDER RIVER	CUNNINGHILL COVE ADDITION	OLIVER BEACH RD AND CUNNINGHAM HILL COVE RD	Public	DRY DETENTION	17.86	DAMAGE	EROSION	WETLAND VEGATATION	NO FENCE	NO GATE	MAINTENANCE PRIORITY; SPILLWAY BOT GONE; EMBANKMENT EROSION; GABION DAMAGE; ENTRENCH OUTLET; ETC	Y	ONLINE	MODERATE	LONG	RETROFIT COULD BE DONE WITH NEEDED REPAIRS; FOREBAYS; SHALLOW WETLAND; WETPOOL; POND EXPANSION INTO OPEN AREA; NEW RISER INCLUDING WQV; STREAM RESTORATION D/S
SWM_F_435	DUNDEE CREEK	CUNNINGHILL COVE POND 2	GRACE QUARTERS RD AND CUNNINGHAM HILL COVE RD	Public	DRY DETENTION	38.10	DAMAGE	TREES ON EMBANKMENT	WETLAND VEGATATION	NO FENCE	NO GATE	LOW FLOW CLOGGED; SPILLWAY ENDSECTION GONE; SIGNS OF PINHOLES IN SPILLWAY; TRASH; EROSION AT RISER	Y	ONLINE	EASY	LONG	RETROFIT COULD BE DONE WITH NEEDED REPAIRS; FOREBAYS; SHALLOW WETLAND; WETPOOL; SLIPLINE SPILLWAY AND REPLACE ENDSECTION; REMOVE TREES; LANDSCAPE
SWM_F_586	MIDDLE RIVER	IVY HALL NURSING HOME	WINDLASS DR	Private	DRY DETENTION	5.38	MINOR MAINTANCE	TREES ON EMBANKMENT	WETLAND VEGATATION	REPAIR NEEDED	LOCKED	REMOVE TREES FROM EMBANKMENT	Y	OFFLINE	EASY	LONG	FOREBAYS;SHALLOW WETLAND;WETPOOL;DEEP MICRO POOL @ OUTLET
SWM_F_591	HOPKINS CREEK	HARRY HORNEY PROPERTY	HORNEY CT	Public	DRY DETENTION	5.80	MINOR MAINTANCE	TREES ON EMBANKMENT	TREES	GOOD CONDITION	LOCKED	MINOR GULLY FORMING;CLEAR TREES AROUND RISER	Y	OFFLINE	MODERATE	LONG	FOREBAY;SHALLOW WETLAND;PILOT CHANNEL;MICRO POOL;REMOVE TREES AND PHRAGMITES;RISER IS DIFFICULT TO REACH
SWM_F_711	HOPKINS CREEK	MIDDLEBOROUGH ROAD LINK **BUILT**	HILLTOP AVE AND BACK RIVERNECK RD	Public	DRY DETENTION	9.97	GOOD CONDITION	TREES ON EMBANKMENT	WETLAND VEGATATION	NO FENCE	NO GATE	TRASH AT INFLOWS; SMALL TREES ON D/S SLOPE OF EMBANKMENT	Y	OFFLINE	EASY	LONG	FOREBAYS;SHALLOW WETLANDS;PILOT CHANNELS;WET POOLS
SWM_F_731	FROG MORTAR CREEK	OAKDALE ADDITION	TEAROSE DR AND RASPBERRY CT	Private	DRY DETENTION	4.63	GOOD CONDITION	TREES ON EMBANKMENT	TURF GRASS	NO FENCE	NO GATE	REMOVE TREES ON EMBANKMENT	Y	OFFLINE	EASY	SHORT	FOREBAYS;SHALLOW WETLANDS;PILOT CHANNELS/EARTHEN BERM;WET POOLS;REMOVE CONCRETE PILOT CHANNEL;LANDSCAPE
SWM_F_914	HOPKINS CREEK	SUPER 8 MOTEL NO ASB	STEMMERS RUN RD	Private	DRY DETENTION	0.60	GOOD CONDITION	NO PROBLEMS	TURF GRASS	GOOD CONDITION	LOCKED		N	OFFLINE	EASY	LONG	POND IS BOUNDED ON ALL SIDES WITH CONSTRAINTS
SWM_F_950	DARKHEAD CREEK	VILLAGE OF PAWNEE	PAWNEE RD AND CHOCTAW CT	Public	DRY DETENTION	122.00	GOOD CONDITION	TREES ON EMBANKMENT	WETLAND VEGATATION	REPAIR NEEDED	UNLOCKED	REMOVE TREES FROM EMBANKMENT	Y	OFFLINE	EASY	LONG	HUGE AREA WITH PLENTY OF ROOM TO ADD MULTIPLES TYPES OF WQ; ADD FOREBAYS @ INFLOWS AND REMOVE PHRAGMITES
SWM_F_988	FROG MORTAR CREEK	WILLIAMS ESTATE, EASTERN POND	EASTERN BLVD	Private	DRY DETENTION	66.40	GOOD CONDITION	NO PROBLEMS	TURF GRASS	GOOD CONDITION	UNLOCKED		Y	ONLINE	EASY	SHORT	ADD BERM AND PILOT CHANNELS TO MAXIMIZE FLOW PATH;WET POOLS;LANDSCAPING;SHALLOW WETLAND
SWM_F_1358	FROG MORTAR CREEK	AMOCO OIL CARROLL ISLAND RD **AS BUILT DE	CARROLL	Private	DRY DETENTION	1.08	GOOD CONDITION	NO PROBLEMS	WETLAND VEGATATION	GOOD CONDITION	LOCKED		Y	OFFLINE	EASY	SHORT	OPEN GRASS AREA NORTH OF POND FOR HORIZONTAL OR VERTICAL EXCAVATION

APPENDIX C:

UPLANDS SURVEY DATA

MIDDLE RIVER AND TIDAL GUNPOWDER RIVER UPLANDS SURVEY:
NSA DATA

NEIGHBORHOOD INFORMATION AND RECOMMENDED ACTIONS																									
SUBWATERSHED	NSA ID	NEIGHBORHOOD NAME	ACRES	PSI	ROI	DOWNSPOUT REDIRECT	RAIN BARREL	RAIN GARDEN	STENCIL	BAY SCAPE	LOT CANOPY IMPROVE-MENT	FERTILIZER REDUCTION	PERCENT LAWNS HIGH	PET WASTE	TRASH MANAGE-MENT	BUFFER IMPACT	STREET TREES	OPEN SPACE SHADE TREES	PARK CREATION	PARKING LOT RETROFIT	ALLEY RETROFIT	STREET SWEEPING	OTHER ACTION	LOT SIZE ACRES	IMPERVIOUS ACRES
HAWK COVE	NSA_F_01	Island View / Barrison Point	20.15	High	Moderate	Y	Y	N	N	Y	Y	Y	30	N	Y	Y	0	0	N	N	N	0.00	BOAT ED	1/4	4.39
HAWK COVE	NSA_F_02	Eagles Nest Point	15.99	High	Moderate	Y	Y	N	N	Y	Y	Y	90	N	N	Y	0	0	N	N	N	0.00		1/4	3.32
HAWK COVE / SUE CREEK	NSA_F_03	Holly Beach / Broring Point	20.19	High	High	Y	Y	N	Y	Y	Y	Y	90	N	N	Y	0	0	N	N	N	0.00	BOAT ED	1/4	5.05
SUE CREEK	NSA_F_04	Cedar Beach	116.83	High	High	Y	Y	N	Y	N	Y	Y	30	N	Y	Y	0	0	N	N	N	2.90	BOAT ED	<1/4	20.27
SUE CREEK / HOGPEN CREEK	NSA_F_05	Sue Creek Landing	41.24	High	Moderate	Y	Y	N	N	Y	Y	Y	60	N	N	Y	0	100	N	N	N	0.00	BOAT ED, SUE AVE IS USED AS ALLEY	<1/4	13.49
SUE CREEK	NSA_F_06	Long Cove Condominiums	5.79	Moderate	Moderate	Y	Y	N	Y	N	N	N	0	N	N	N	0	100	N	N	N	0.00	DUMPSTER UNCOVERED	>1	1.05
SUE CREEK	NSA_F_07	Rockaway Beach / Sue Grove	109.98	High	High	Y	Y	Y	Y	Y	Y	Y	20	N	Y	Y	0	0	N	N	N	0.00	CONSTRUCTION EQUIPMENT AND SNOW PLOWS PARKED, CAR PARKING ON GRASS (POOR GRASS/BARE AREAS), BOAT ED, OLD LAWN EQUIPMENT STORE IN THE OPEN	1/4	24.65
HOGPEN CREEK	NSA_F_08	Brighton by the Bay	10.17	High	Moderate	Y	Y	N	N	N	Y	Y	30	N	N	N	0	25	N	N	N	0.47	RETROFIX DRAINAGE DITCH FOR WQ, PLANT TREES IN COMMON AREA, CAR MAINT ED	<1/8	3.82
SUE CREEK / HOGPEN CREEK	NSA_F_09	New Haven Woods	14.66	High	Moderate	Y	Y	N	Y	N	Y	Y	50	N	N	N	0	0	N	N	N	0.58	POND MAINTENANCE (REMOVE PHRAGMITES AND OTHER OVERGROWN VEG.)	<1/8	5.15
SUE CREEK / HOGPEN CREEK	NSA_F_10	Bauernschmidt Manor	42.80	High	High	Y	Y	N	Y	N	Y	N	5	N	Y	Y	0	0	N	N	N	0.00	OUTDOOR STORAGE OF OLD VEHICLES, CHEMICALS, OLD LAWN EQUIPMENT. 2 LOTS WITH DIRT STOCKPILES WITH NO SEDIMENT CONTROL AT WATERFRONT	<1/4	12.16
HOGPEN CREEK / NORMAN CREEK	NSA_F_11	Cape May Manor / Carville Grove	64.30	High	High	Y	Y	Y	Y	Y	Y	Y	20	N	Y	Y	0	0	N	N	N	0.00	PAVE/CLEAN STONE ON WEIR LN, BOAT AND CAR MAINT ED.	1/4	13.70
HOGPEN CREEK / NORMAN CREEK	NSA_F_12	Cape May Point	9.63	High	Moderate	Y	Y	N	N	Y	Y	Y	30	Y	Y	Y	0	0	N	N	N	0.00	ANIMAL PADDOCK SOURCE OF SEDIMENT AND ANIMAL WASTE, BOAT AND CONST. EQUIPMENT MAINT ED	1/4	2.07
HOPKINS CREEK/ NORMAN CREEK	NSA_F_13A		15.08	High	High	Y	N	N	Y	N	Y	N	15	N	N	Y	0	0	N	N	N	0.00	BOAT ED	<1/4	5.36
HOPKINS CREEK	NSA_F_13B		5.45	High	High	N	Y	N	Y	N	Y	N	0	N	N	N	0	0	N	N	N	0.00	POND MAINTENANCE, AND CAR MAINT ED	<1/4	1.31
NORMAN CREEK / HOPKINS CREEK	NSA_F_13C	Middleborough	217.65	High	High	Y	Y	N	Y	Y	Y	N	15	N	Y	Y	0	0	N	N	N	0.00	STABILIZE ERODED DITCHES PRESENT NORTH OF MIDDLE BOROUGH RD, CAR AND BOAT MAINT ED	1/4	58.08
HOPKINS CREEK	NSA_F_14	Hilltop Park	36.51	High	High	Y	Y	Y	Y	Y	N	N	5	N	Y	Y	0	0	N	N	N	0.00	SOME DRIVEWAYS WERE BARE EARTH/SPOTTY GRAVEL THAT ARE CONTRIBUTING SEDIMENT TO THE WATERFRONT, BOAT ED.	1/2	7.37
HOPKINS CREEK	NSA_F_15	Hopkins Creek Apartments	19.47	High	High	Y	Y	Y	Y	Y	Y	N	0	N	N	Y	0	60	N	Y	N	0.77	IMP COVER REMOVAL, CAR MAINT ED TO ADDRESS OIL/GAS, BARE GRD	>1	6.50
HOPKINS CREEK	NSA_F_16	Riverwood Park	14.19	High	High	Y	Y	N	Y	Y	Y	N	0	N	Y	N	160	50	N	N	Y	1.16	BOAT ED, CAR MAINT ED, DUMPING IN COMMONS AREAS	<1/8	5.47
HOPKINS CREEK	NSA_F_17	French's Park	32.63	High	Moderate	Y	Y	N	Y	N	Y	Y	25	N	N	N	75	0	N	N	N	0.63		<1/4	6.41
HOPKINS CREEK	NSA_F_18	Mariners Cove / Marine Oaks Village	19.96	High	Moderate	Y	Y	N	Y	N	Y	N	0	N	Y	Y	0	37	N	N	N	0.95	TRASH CAN MGN ED, TURF MGN AT PLAYGROUND, CLEANOUT INLETS WITHOUT TRASH COLLECTOR	<1/8	8.04
HOPKINS CREEK	NSA_F_19	Hopewell Pointe	26.40	Moderate	Moderate	N	Y	N	Y	N	Y	Y	100	Y	N	N	0	103	N	N	N	0.00	DOG WASTE BAG AND TRASH CAN STATIONS	<1/4	7.63
HOPKINS CREEK	NSA_F_20	Hopewell Pointe Condominiums	12.85	High	Moderate	N	Y	N	Y	Y	Y	Y	100	Y	N	N	0	0	N	N	N	0.22	DOG WASTE BAG AND TRASH CAN STATIONS	>1	4.81

MIDDLE RIVER AND TIDAL GUNPOWDER RIVER UPLANDS SURVEY:
NSA DATA

NEIGHBORHOOD INFORMATION AND RECOMMENDED ACTIONS																									
SUBWATERSHED	NSA ID	NEIGHBORHOOD NAME	ACRES	PSI	ROI	DOWNSPOUT REDIRECT	RAIN BARREL	RAIN GARDEN	STENCIL	BAY SCAPE	LOT CANOPY IMPROVE-MENT	FERTILIZER REDUCTION	PERCENT LAWNS HIGH	PET WASTE	TRASH MANAGE-MENT	BUFFER IMPACT	STREET TREES	OPEN SPACE SHADE TREES	PARK CREATION	PARKING LOT RETROFIT	ALLEY RETROFIT	STREET SWEEPING	OTHER ACTION	LOT SIZE ACRES	IMPERVIOUS ACRES
HOPKINS CREEK	NSA_F_21	Essextowne Apartments	3.79	High	Moderate	N	Y	Y	Y	Y	Y	N	0	Y	N	N	0	69	N	N	N	0.00	SEDIMENT STABILIZATION BETWEEN SIDEWALK AND PARKING LOT, RAIN GARDEN IN COMMON AREA	>1	1.64
HOPKINS CREEK / MIDDLE RIVER	NSA_F_22	Edgewater	44.01	High	Moderate	Y	Y	N	Y	N	Y	N	0	N	Y	N	0	0	N	N	N	1.86	CAR MAINT ED, BOAT ED, HOUSEHOLD STORAGE ED, DRIVEWAY MAINT IS NEEDED	<1/4	14.29
MIDDLE RIVER	NSA_F_23	Middlesex	70.16	High	High	Y	Y	N	Y	N	Y	N	10	N	Y	N	172	0	N	N	Y	0.00	BOAT AND CAR MAINT ED, STABILIZED PARKING SURFACE/DRIVWAYS, PUBLIC ED ABOUT NOT DUMPING INTO INLETS, RETROFIX OFFSTREET PARKING ALONG ALLEY NEXT TO RR TRACKS	<1/8	17.46
MIDDLE RIVER	NSA_F_24	Waterview	56.39	High	High	Y	Y	N	Y	N	Y	Y	70	Y	N	N	0	500	N	N	N	3.06	DOG WASTE BAG AND TRASH CAN STATIONS, SUMP PUMP SEDIMENT TRAP/FILTER	<1/4	16.03
MIDDLE RIVER	NSA_F_25	Aero Acres	56.76	Moderate	Moderate	Y	Y	N	Y	Y	Y	N	5	N	N	N	0	0	N	N	N	0.00	STABILIZE OFF ST PRKG	<1/4	19.17
MIDDLE RIVER	NSA_F_26	Windsor House Apartments	20.56	Moderate	High	Y	N	Y	Y	Y	Y	N	0	N	N	N	0	240	Y	Y	N	0.92	PAA_F_605	>1	8.30
MIDDLE RIVER / DARKHEAD CREEK	NSA_F_27	Homeland / Old Eastern Avenue	37.63	High	High	Y	Y	Y	Y	Y	Y	N	5	N	Y	N	0	0	N	N	N	0.80	POOL MAINT ED (POOL LEAKING ONTO STREET)	1/4	10.41
MIDDLE RIVER / DARKHEAD CREEK	NSA_F_28A	Hawthorne / Waters Watch	12.40	Moderate	Moderate	N	N	N	Y	N	Y	N	0	N	N	N	70	0	N	N	N	0.84		<1/8	4.71
MIDDLE RIVER / DARKHEAD CREEK	NSA_F_28B	Hawthorne / Waters Watch	97.64	High	High	N	Y	N	Y	N	Y	N	5	Y	Y	N	415	0	N	N	N	7.78	PUBLIC ED ABOUT DUMPING IN THE ALLEY; AUTO REPAIR HAPPENING IN BACKYARDS	<1/8	51.72
MIDDLE RIVER / DARKHEAD CREEK	NSA_F_29	Kingston Park	34.86	High	High	Y	Y	N	Y	N	Y	Y	20	N	Y	Y	0	0	N	N	N	1.26	STABILIZE PRIVATE DRIVEWAYS, BOAT ED	<1/4	10.33
MIDDLE RIVER / DARKHEAD CREEK	NSA_F_30	Middle Crest Townhouses	8.16	High	Moderate	Y	Y	N	Y	Y	Y	N	0	N	Y	N	0	0	N	N	N	0.61	ESTABLISH HEALTY GRASS & STABILIZE BARE AREA, LITTER CONTROL, RESURFACE PARKING LOT AND STREET, REPLACE BROKEN CURB, ANY WORK WILL MAKE A BIG DIFFERENCE	>1	4.27
MIDDLE RIVER / DARKHEAD CREEK	NSA_F_31	Village of Pawnee - Rowhomes	35.18	High	Moderate	Y	Y	N	Y	N	Y	N	10	N	Y	N	0	0	Y	N	N	1.56	PAA_F_701, LITTER CONTROL, RESURFACE PARKING LOTS	<1/8	14.70
DARKHEAD CREEK	NSA_F_32	Village of Pawnee - Detached homes	4.94	High	Moderate	Y	Y	N	Y	N	Y	Y	20	N	N	N	45	0	N	N	N	0.00	<Null>	<1/4	0.88
DARKHEAD CREEK	NSA_F_33	Ballard Gardens	19.51	High	High	Y	Y	N	Y	N	Y	N	5	Y	N	N	275	0	N	N	N	1.66	PET WASTE EDUCATION	<1/8	8.81
DARKHEAD CREEK	NSA_F_34	Wampler Village Apartments	20.08	Moderate	High	N	N	Y	Y	Y	Y	N	0	N	N	Y	0	235	N	N	N	0.00	PLANT A FOREST BUFFER ALONG STREAM	>1	7.21
DARKHEAD CREEK	NSA_F_35	Wampler Road	47.24	Moderate	Moderate	Y	Y	Y	N	Y	Y	N	10	Y	Y	Y	0	0	N	N	N	0.00	IMPROVE OUTDOOR STORAGE, STABILIZE DETERIORATED DRIVEWAY, ANIMAL HOUSING ED, BOAT AND CAR MAINT ED	1/2	6.71
DARKHEAD CREEK/ STANSBURY CREEK	NSA_F_36	Stansbury Manor	58.59	High	High	Y	Y	N	Y	N	Y	N	5	N	Y	N	0	0	N	N	N	3.50	STABILIZE OFF STREET PARKING ALONG INTERIOR ROADS, BOAT MAINT ED	<1/4	23.90
DARKHEAD CREEK/STANSBURY CREEK	NSA_F_37	Bull Neck	52.01	High	High	Y	Y	Y	Y	N	Y	Y	20	N	N	Y	0	0	N	N	N	0.00	STABILIZE BARE EARTH/DETERIORATED GRAVEL DRIVEWAYS	<1/4	15.61
FROG MORTAR CREEK	NSA_F_38	Oakdale	40.78	Moderate	Moderate	Y	Y	N	Y	Y	Y	Y	100	Y	N	N	0	0	N	N	N	0.00	EX POND IS DRY DETENTION THAT IS 100% HIGH MAINT TURF. INVESTIGATE ADDING MICROPOOLS TO PROVIDE WQ	>1	19.05
FROG MORTAR CREEK	NSA_F_39	Bengies Trailer Village	81.82	Moderate	High	N	Y	N	Y	Y	Y	Y	30	N	N	N	0	0	Y	N	N	0.00	PAA_F_901	>1	29.98

MIDDLE RIVER AND TIDAL GUNPOWDER RIVER UPLANDS SURVEY:
NSA DATA

NEIGHBORHOOD INFORMATION AND RECOMMENDED ACTIONS																									
SUBWATERSHED	NSA ID	NEIGHBORHOOD NAME	ACRES	PSI	ROI	DOWNSPOUT REDIRECT	RAIN BARREL	RAIN GARDEN	STENCIL	BAY SCAPE	LOT CANOPY IMPROVE-MENT	FERTILIZER REDUCTION	PERCENT LAWNS HIGH	PET WASTE	TRASH MANAGE-MENT	BUFFER IMPACT	STREET TREES	OPEN SPACE SHADE TREES	PARK CREATION	PARKING LOT RETROFIT	ALLEY RETROFIT	STREET SWEEPING	OTHER ACTION	LOT SIZE ACRES	IMPERVIOUS ACRES
FROG MORTAR CREEK	NSA_F_40	Fairwinds	26.70	Moderate	Moderate	N	Y	N	Y	N	Y	Y	100	N	N	N	0	0	N	N	N	0.00	DEVELOPER HAS DONE GOOD JOB OF PLANTING TREES WHERE FEASIBLE	<1/4	6.64
FROG MORTAR CREEK	NSA_F_41	BIDDISON PROPERTY	10.55	High	High	N	Y	Y	Y	Y	Y	Y	80	N	N	N	34	0	N	N	N	0.00	CLEAR/REMOVE PHRAGMITES FROM POND	1/4	2.50
SENECA CREEK	NSA_F_42	Seneca Harbor	30.52	High	Moderate	Y	Y	N	Y	N	Y	Y	80	N	N	N	0	0	N	N	N	0.00	POND MAINTANCE OF REMOVING INVASIVE AND PICKING UP TRASH	<1/4	10.07
FROG MORTAR CREEK/SENECA CREEK	NSA_F_43	Seneca Pointe / Seneca Harbor	13.34	Moderate	Moderate	Y	Y	N	Y	N	Y	Y	80	N	N	N	32	0	N	N	N	0.00		<1/8	4.80
FROG MORTAR CREEK/SENECA CREEK	NSA_F_44	Carrollwood Apartments	27.53	High	Moderate	Y	N	N	Y	Y	Y	Y	100	N	N	N	0	500	N	Y	N	0.00	SWM PARKING LOT/BUILDING RETROFIT(DISCONNECT DOWNSPOUTS IN REAR OF BUILDINGS TO BIOSWALE, REMOVE CURB AND RUNOFF FLOW TO BIOSWALES, ENLARGE EX WETLAND AND DIRECT PARKING LOT RUNOFF TO WETLAND)	>1	10.48
FROG MORTAR CREEK/SENECA CREEK	NSA_F_45	Carrollwood	81.17	High	Moderate	Y	Y	N	Y	N	Y	Y	35	N	N	N	542	0	N	N	N	0.00	POOL MAINT ED	<1/4	24.23
SENECA CREEK / SALTPETER CREEK	NSA_F_46	Carrollwood Manor	61.31	Moderate	Moderate	Y	Y	N	Y	N	Y	Y	30	N	N	N	32	0	N	N	N	0.00	POND MAINTENANCE	<1/8	21.67
SALTPETER CREEK	NSA_F_47	Carroll Crest	40.79	Moderate	Moderate	N	Y	N	Y	Y	N	Y	20	Y	N	N	25	660	N	N	N	0.00		<1/8	9.28
FROG MORTAR / GALLOWAY CREEK	NSA_F_48	LONG BEACH ESTATES	112.32	Moderate	Moderate	Y	Y	Y	Y	Y	Y	N	15	N	N	Y	0	0	N	N	N	0.00	BOAT ED	1/4	23.64
GALLOWAY CREEK	NSA_F_49	BOWLEYS QUARTERS - GALLOWAY CREEK	78.59	High	High	Y	Y	Y	Y	Y	Y	Y	20	N	N	Y	0	0	N	N	N	0.00	BOAT ED	1/4	21.30
SENECA CREEK	NSA_F_50	BOWLEYS QUARTERS - SENECA CREEK	226.11	High	High	Y	Y	Y	Y	Y	Y	N	15	Y	Y	Y	0	0	N	N	N	0.00	IMPROVE UNSTABILIZED DRIVEWAYS, EDUCATION ON STORING JUNK, OLD CARS, AND BOATS OUTSIDE, LIVESTOCK PASTURE WITH MUCH MANURE	1/4	50.08
SENECA CREEK	NSA_F_51	SENECA PARK BEACH	57.24	High	Moderate	Y	Y	Y	Y	Y	Y	Y	20	N	Y	Y	0	0	N	N	N	0.00	STABILIZE DIRT AND GRAVEL DRIVEWAYS, BOAT AND CAR MAINT ED	1/4	12.78
SALTPETER CREEK	NSA_F_52	DUNDEE VILLAGE APARTMENTS	39.20	Moderate	High	N	N	Y	Y	Y	Y	N	0	N	N	Y	260	115	N	N	N	0.00	ONE GREAT SPOT FOR RAIN GARDEN IN BACK OF COMPLEX	>1	12.50
SALTPETER CREEK	NSA_F_53	BISCAYNE BAY	63.21	High	High	N	Y	N	Y	Y	Y	Y	30	Y	N	N	0	0	N	N	N	0.00	POND MAINTANCE REMOVAL OF SMALL TREES AND PHRAGMITES ALONG EMBANKMENT, REMOVAL OF LARGE CMP (120IN) JUST OUTSIDE BAYOU CT SWM POND	>1	18.46
DUNDEE CREEK	NSA_F_54	EASTERN AVENUE AT BRINKMANS ROAD	36.36	High	Moderate	N	Y	Y	N	Y	Y	N	10	N	Y	N	0	0	N	N	N	0.00	STABILIZE BARE EARTH/ DETERIORATED DRIVEWAYS, PUBLIC ED ABOUT OUTDOOR STORAGE AND OLD CARS	1/2	6.75
DUNDEE CREEK	NSA_F_55	HERITAGE	17.48	Moderate	Moderate	N	Y	N	Y	N	Y	Y	25	N	N	N	0	0	N	N	N	0.00		<1/4	6.08
GUNPOWDER RIVER	NSA_F_56	Oliver Beach	175.27	Moderate	High	Y	Y	Y	Y	Y	Y	N	10	N	N	Y	0	0	N	N	N	0.00	BOAT ED, OUTDOOR STORAGE ED, PAVE/LAY DOWN NEW GRAVEL ON PORTION OF OLIVER BEACH RD	1/4	41.61

APPENDIX D:

SUPPORTING CALCULATIONS FOR NSA ANALYSIS

Supporting Calculations for NSA Analysis

Downspout Disconnection

Table 4-2 in the Middle River & Tidal Gunpowder River watershed characterization report summarizes rooftop acres and % of subwatershed rooftop area addressed by downspout redirection for the recommended neighborhoods. The method in which these two columns were calculated is described below.

<u>Rooftop Acres Addressed</u>

Only NSAs recommended for downspout redirection contribute to this analysis. Rooftop acres addressed by redirecting downspouts in a recommended neighborhood were calculated as follows:

Acres of Buildings x %Connected Downspouts

For example, NSA_F_03 was recommended for downspout redirect and has a total of 2.67 acres of buildings (i.e., rooftop) based on Baltimore County's GIS buildings layer. During the uplands survey, it was estimated that 70% of the downspouts in NSA_F_03 were connected. Therefore, the total rooftop acres addressed by redirecting downspouts in this neighborhood would be 2.67 acres x 0.70 = 1.87 acres.

In some cases, NSAs encompass more than one subwatershed. The rooftop acres addressed for a given subwatershed is calculated as the total rooftop acres in the NSA multiplied by the proportion of the NSA area within that subwatershed. NSA_F_03, for example, overlaps Hawk Cove and Sue Creek where 38.5% of its area is within Hawk Cove and 61.5% is within Sue Creek. The rooftop acres addressed by redirecting downspouts in NSA_F_03 in Hawk Cove were calculated as 1.87 acres x 0.385 = 0.72 acres. The rooftop acres addressed through redirecting downspouts in Sue Creek would be 1.87 acres x 0.615 = 1.15 acres.

<u>% of Subwatershed Rooftop Area Addressed</u>

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

Σ Individual NSA Rooftop Acres Addressed / Total Subwatershed Rooftop Acres

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

Fertilizer Reduction/Education

Table 4-3 in the Middle River & Tidal Gunpowder River watershed characterization report summarizes the acres of lawn and % of subwatershed area addressed by fertilizer reduction for the recommended neighborhoods. The method in which these two columns were calculated is described below.

Acres of Lawn Addressed

NSAs with less than 20% high maintenance lawns were not recommended for fertilizer reduction and thus did not contribute to this analysis. Acres of lawn addressed by fertilizer reduction/education in a recommended neighborhood were calculated as follows:

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

The first expression in parentheses in the equation above represents the total acres of individual lots in an NSA. Multiplying this by the % of grass cover estimated for a typical lot in the NSA yields the total acres of lawn in an NSA. Finally, multiplying this result by the % of lawns using high management lawn practices yields the acres of lawn that would be addressed by fertilizer reduction. For example, NSA_F_03 was recommended for fertilizer reduction and has a total area of 20.07 acres. Based on Baltimore County's GIS roads layer, there are approximately 2.38 acres of roads in this NSA. This means NSA_F_03 consists of approximately 20.07 – 2.38 = 17.69 acres of total lots. During the uplands survey, it was estimated that the average lot in NSA_F_03 consists of 20% grass cover which equates to 17.69 acres x 0.20 = 3.54 total acres of lawn. It was also noted that about 90% of the lawns in NSA_F_03 were employing high maintenance practices. So there are approximately 3.54 acres x 0.90 = 3.18 acres of high maintenance lawn that could be addressed by fertilizer reduction in NSA_F_03.

As mentioned above, some NSAs encompass more than one subwatershed. The acres of lawn addressed for a given subwatershed is calculated as the total high maintenance lawn acres in the NSA multiplied by the proportion of the NSA area within that subwatershed. NSA_F_03, for example, overlaps Hawk Cove and Sue Creek where 38.5% of its area is within Hawk Cove and 61.5% is within Sue Creek. The acres of lawn addressed by fertilizer reduction in NSA_F_03 in Hawk Cove were calculated as 3.18 acres x 0.385 = 1.22 acres. The acres of lawn addressed through fertilizer reduction in Sue Creek would be 3.18 acres x 0.615 = 1.96 acres.

% of Subwatershed Area Addressed

For a given subwatershed, the % of the total subwatershed area addressed by fertilizer reduction/education was calculated as:

Σ Individual NSA Lawn Acres Addressed / Total Subwatershed Acres

Bayscaping

Table 4-4 in the Middle River & Tidal Gunpowder River watershed characterization report summarizes the acres of land and % of subwatershed area addressed by bayscaping for the recommended neighborhoods. The method in which these two columns were calculated is described below.

Acres of Land Addressed

Only NSAs recommended for bayscaping contributed to this analysis. Acres of land addressed by bayscaping in a recommended neighborhood were calculated as follows:

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

The first expression in parentheses in the equation above represents the total acres of individual lots in an NSA. According to CWP, the minimum recommended proportion of bayscaping is 25% of an individual lot. Therefore, the %Lot Available for Bayscaping was calculated as 25%

minus the fraction of existing landscaping of a typical lot in a recommended NSA. Multiplying these two factors yields the total acres of land in an NSA recommended/available for bayscaping. For example, NSA_F_03 was recommended for bayscaping and has a total area of 20.07 acres. Based on Baltimore County's GIS roads layer, there are approximately 2.38 acres of roads in this NSA. This means NSA_F_03 consists of approximately 20.07 – 2.38 = 17.69 acres of total lots. During the uplands survey, it was estimated that the average lot in NSA_F_03 already consisted of 15% landscaping which means 25% – 15% = 10% would be recommended for additional bayscaping. This equates to 17.69 acres x 0.10 = 1.77 acres of land that could be addressed by bayscaping in this NSA.

As mentioned above, some NSAs encompass more than one subwatershed. The acres of land addressed for a given subwatershed is calculated as the total acres of land recommended for bayscaping in the NSA multiplied by the proportion of the NSA area within that subwatershed. NSA_F_03, for example, overlaps Hawk Cove and Sue Creek where 38.5% of its area is within Hawk Cove and 61.5% is within Sue Creek. The acres of land addressed by bayscaping in NSA_F_03 in Hawk Cove were calculated as 1.77 acres x 0.385 = 0.68 acres. The acres of land addressed through bayscaping in Sue Creek would be 1.77 acres x 0.615 = 1.09 acres.

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

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

Σ Individual NSA Land Acres Addressed / Total Subwatershed Acres

Storm Drain Marking

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

<u>Approximate No. of Inlets Addressed</u>

Only NSAs recommended for storm drain marking contributed to this analysis. The approximate number of inlets addressed in a neighborhood recommended for storm drain marking was calculated as follows:

NSA Area [sq miles] x Subwatershed Inlet Density [#inlets/sq mile]

The approximate number of inlets was determined for all 15 subwatersheds in the Middle River and Tidal Gunpowder River watersheds using Baltimore County's storm drain system database. Inlet density for each subwatershed was calculated as the number of inlets divided by the total subwatershed area (see Chapter 2.3.6).

As mentioned previously, some NSAs encompass more than one subwatershed. For these cases, the number of inlets addressed for a given subwatershed was calculated using the results from the equation above multiplied by the proportion of the NSA area within that subwatershed. For example, NSA_F_28B was recommended for storm drain marking and has a total area of 97.53 acres or 0.152 square miles. NSA_F_28B overlaps Darkhead Creek and Middle River where 31.1% of its area is within Darkhead Creek and 68.9% is within Middle River. The number of inlets addressed by storm drain marking for this NSA in Darkhead Creek would be 0.152 sq miles x 54.47 inlets/sq mile in Darkhead Creek x 0.311 = 2.57 inlets (~ 3 inlets). The number of inlets addressed by storm drain marking for this NSA in Middle River

would be 0.152 sq miles x 78.81 inlets/sq mile in Middle River x 0.689 = 8.25 inlets (~8 inlets). The total number of inlets addressed within a subwatershed was rounded to the nearest whole number.

<u>% of Subwatershed Inlets Addressed</u>

For a given subwatershed, the % of the total subwatershed inlets addressed for storm drain marking was calculated as:

Σ Individual NSA Inlets Addressed / Total Subwatershed Inlets

Street Trees and Shade Trees

Table 4-6 in the Middle River & Tidal Gunpowder River watershed characterization report summarizes the number of street trees that could be planted in each subwatershed if this action were addressed for the recommended neighborhoods. Similarly, Table 4-7 of the report summarizes the number of open space shade trees that could be planted if this action were addressed for the recommended neighborhoods. The number of street trees recommended for each neighborhood was estimated during the uplands survey based on available space as described in Chapter 4.2.3.5.

For NSAs encompassing more than one subwatershed, the total number of recommended street trees was multiplied by the proportion of the NSA area within each subwatershed. NSA_F_28B, for example, overlaps Darkhead Creek and Middle River where 31.1% of its area is within Darkhead Creek and 68.9% is within Middle River. The total number of street trees recommended for NSA_F_28B was 415. The number of street trees recommended for NSA_F_28B in Darkhead Creek was calculated as 415 x 0.311 = 129 trees. The number of street trees recommended for NSA_F_28B in Middle River would be 415 x 0.689 = 286 trees. A similar example can be made for the calculation of shade trees in NSA_F_44, which overlaps Frog Mortar Creek by 82.2% and Seneca Creek by 17.8%. A total of 500 shade trees were recommended for this neighborhood during the uplands survey. The number of shade trees recommended for NSA_F_44 in Frog Mortar Creek was calculated as 500 x 0.822 = 411 trees. The number of shade trees recommended for NSA_F_44 in Seneca Creek would be 500 x 0.178 = 89 trees.

Street Sweeping

Table 4-8 in the Middle River & Tidal Gunpowder River watershed characterization report summarizes the miles of road recommended for street sweeping in each subwatershed. If a neighborhood was recommended for street sweeping, all roads in the neighborhood counted toward the total miles that would be addressed by this action. Miles of road in each neighborhood were determined based on Baltimore County's GIS roads layer. For NSAs encompassing more than one subwatershed, the total miles addressed by street sweeping was multiplied by the proportion of the NSA area within each subwatershed. NSA_F_28B, for example, overlaps Darkhead Creek and Middle River where 31.1% of its area is within Darkhead Creek and 68.9% is within Middle River. The total length of road in NSA_F_28B is 7.78 miles. The miles of street sweeping recommended for NSA_F_28B in Darkhead Creek was calculated as 7.78 miles x 0.311 = 2.42 miles. The number of miles of street sweeping recommended for NSA_F_28B in Middle River would be 7.78 miles x 0.689 = 5.36 miles.

Trash Management

Table 4-9 in the Middle River & Tidal Gunpowder River watershed characterization report summarizes the acres of land and % of subwatershed area addressed by trash management for the recommended neighborhoods. The method in which these two columns were calculated is described below.

Acres of Land Addressed

Neighborhoods were recommended for trash management during the uplands survey if 25% or more of homes in the neighborhood contained trash or other indications of trash. Acres of land addressed by trash management in a recommended neighborhood were simply taken as the total area of the NSA. Only NSAs recommended for trash management contributed to the total acres of land addressed by this action in each subwatershed.

As mentioned above, some NSAs encompass more than one subwatershed. The acres of land addressed for a given subwatershed is calculated as the total acres in the NSA multiplied by the proportion of the NSA area within that subwatershed. NSA_F_28B, for example, overlaps Darkhead Creek and Middle River where 31.1% of its area is within Darkhead Creek and 68.9% is within Middle River. The total number of acres addressed by trash management in NSA_F_28B is 97.53 acres. The acres addressed for NSA_F_28B in Darkhead Creek was calculated as 97.53 acres x 0.311 = 30.33 acres. The number of acres addressed for NSA_F_28B in Middle River would be 97.53 acres x 0.689 = 67.20 acres.

% of Subwatershed Area Addressed

For a given subwatershed, the % of the total subwatershed area addressed by trash management was calculated as:

Σ Individual NSA Acres Addressed / Total Subwatershed Acres

Parking Lot or Alley Retrofit

Table 4-10 in the Middle River & Tidal Gunpowder River watershed characterization report summarizes the acres of impervious cover addressed if parking lot or alley retrofits were implemented for the recommended neighborhoods. For NSAs encompassing more than one subwatershed, the acres of impervious cover addressed was multiplied by the proportion of the NSA area within each subwatershed. NSA_F_44, for example, overlaps Frog Mortar Creek and Seneca Creek where 82.2% of its area is within Frog Mortar Creek and 17.8% is within Seneca Creek. As determined during the uplands survey, the total area of impervious cover that would be addressed for parking lot or alley retrofit in NSA_F_44 is 0.83 acres. The acres recommended for NSA_F_44 in Frog Mortar Creek was calculated as 0.83 acres x 0.822 = 0.68 acres. The acres recommended for NSA_F_44 in Seneca Creek would be 0.83 acres x 0.178 = 0.15 acres.

APPENDIX F:

Chesapeake Bay TMDL Executive Summary

CHESAPEAKE BAY TMDL EXECUTIVE SUMMARY

INTRODUCTION

The U.S. Environmental Protection Agency (EPA) has established the Chesapeake Bay Total Maximum Daily Load (TMDL), a historic and comprehensive "pollution diet" with rigorous accountability measures to initiate sweeping actions to restore clean water in the Chesapeake Bay and the region's streams, creeks and rivers.

Despite extensive restoration efforts during the past 25 years, the TMDL was prompted by insufficient progress and continued poor water quality in the Chesapeake Bay and its tidal tributaries. The TMDL is required under the federal Clean Water Act and responds to consent decrees in Virginia and the District of Columbia from the late 1990s. It is also a keystone commitment of a federal strategy to meet President Barack Obama's Executive Order to restore and protect the Bay.

The TMDL – the largest ever developed by EPA – identifies the necessary pollution reductions of nitrogen, phosphorus and sediment across Delaware, Maryland, New York, Pennsylvania, Virginia, West Virginia and the District of Columbia and sets pollution limits necessary to meet applicable water quality standards in the Bay and its tidal rivers and embayments. Specifically, the TMDL sets Bay watershed limits of 185.9 million pounds of nitrogen, 12.5 million pounds of phosphorus and 6.45 billion pounds of sediment per year – a 25 percent reduction in nitrogen, 24 percent reduction in phosphorus and 20 percent reduction in sediment. These pollution limits are further divided by jurisdiction and major river basin based on state-of-the-art modeling tools, extensive monitoring data, peer-reviewed science and close interaction with jurisdiction partners.

The TMDL is designed to ensure that all pollution control measures needed to fully restore the Bay and its tidal rivers are in place by 2025, with at least 60 percent of the actions completed by 2017. The TMDL is supported by rigorous accountability measures to ensure cleanup commitments are met, including short-and long-term benchmarks, a tracking and accountability system for jurisdiction activities, and federal contingency actions that can be employed if necessary to spur progress.

Watershed Implementation Plans (WIPs), which detail how and when the six Bay states and the District of Columbia will meet pollution allocations, played a central role in shaping the TMDL. Most of the draft WIPs submitted by the jurisdictions in September 2010 did not sufficiently identify programs needed to reduce pollution or provide assurance the programs could be implemented. As a result, the draft TMDL issued September 24, 2010 contained moderate- to high-level backstop measures to tighten controls on federally permitted point sources of pollution.

A 45-day public comment period on the draft TMDL was held from September 24 to November 8, 2010. During that time, EPA held 18 public meetings in all seven Bay watershed jurisdictions, which were attended by about 2,500 citizens. EPA received more than 14,000 public comments and, where appropriate, incorporated responses to those comments in developing the final TMDL.

After states submitted the draft WIPs, EPA worked closely with each jurisdiction to revise and strengthen its plan. Because of this cooperative work and state leadership, the final WIPs were significantly improved. Examples of specific improvements include:

- Regulated point sources and non-regulated nonpoint sources of nitrogen, phosphorus, and sediment are fully considered and evaluated separately in terms of their relative contributions to water quality impairment of the Chesapeake Bay's tidal waters.
- Committing to more stringent nitrogen and phosphorus limits at wastewater treatment plants, including on the James River in Virginia. (Virginia, New York, Delaware)
- Pursuing state legislation to fund wastewater treatment plant upgrades, urban stormwater management and agricultural programs. (Maryland, Virginia, West Virginia)
- Implementing a progressive stormwater permit to reduce pollution. (District of Columbia)
- Dramatically increasing enforcement and compliance of state requirements for agriculture. (Pennsylvania)
- Committing state funding to develop and implement state-of-the-art-technologies for converting animal manure to energy for farms. (Pennsylvania)
- Considering implementation of mandatory programs for agriculture by 2013 if pollution reductions fall behind schedule. (Delaware, Maryland, Virginia)

These improvements enabled EPA to reduce and remove most federal backstops, leaving a few targeted backstops and a plan for enhanced oversight and contingency actions to ensure progress. As a result, the final TMDL is shaped in large part by the jurisdictions' plans to reduce pollution, which was a long-standing priority for EPA and why the agency always provided the jurisdictions with flexibility to determine how to reduce pollution in the most efficient, cost-effective and acceptable manner.

Now the focus shifts to the jurisdictions' implementation of the WIP policies and programs that will reduce pollution on-the-ground and in-the-water. EPA will conduct oversight of WIP implementation and jurisdictions' progress toward meeting two-year milestones. If progress is insufficient, EPA is committed to take appropriate contingency actions including targeted compliance and enforcement activities, expansion of requirements to obtain NPDES permit coverage for currently unregulated sources, revision of the TMDL allocations and additional controls on federally permitted sources of pollution, such as wastewater treatment plants, large animal agriculture operations and municipal stormwater systems.

In 2011, while the jurisdictions continue to implement their WIPs, they will begin development of Phase II WIPs, designed to engage local governments, watershed organizations, conservation districts, citizens and other key stakeholders in reducing water pollution.

TMDL BACKGROUND

The Clean Water Act (CWA) sets an overarching environmental goal that all waters of the United States be "fishable" and "swimmable." More specifically it requires states and the District of Columbia to establish appropriate uses for their waters and adopt water quality standards that are protective of those uses. The CWA also requires that every two years jurisdictions develop – with EPA approval – a list of waterways that are impaired by pollutants and do not meet water

quality standards. For those waterways identified on the impaired list, a TMDL must be developed. A TMDL is essentially a "pollution diet" that identifies the maximum amount of a pollutant the waterway can receive and still meet water quality standards.

Most of the Chesapeake Bay and its tidal waters are listed as impaired because of excess nitrogen, phosphorus and sediment. These pollutants cause algae blooms that consume oxygen and create "dead zones" where fish and shellfish cannot survive, block sunlight that is needed for underwater Bay grasses, and smother aquatic life on the bottom. The high levels of nitrogen, phosphorus and sediment enter the water from agricultural operations, urban and suburban stormwater runoff, wastewater facilities, air pollution and other sources, including onsite septic systems. Despite some reductions in pollution during the past 25 years of restoration due to efforts by federal, state and local governments; non-governmental organizations; and stakeholders in the agriculture, urban/suburban stormwater, and wastewater sectors, there has been insufficient progress toward meeting the water quality goals for the Chesapeake Bay and its tidal waters.

More than 40,000 TMDLs have been completed across the United States, but the Chesapeake Bay TMDL will be the largest and most complex thus far – it is designed to achieve significant reductions in nitrogen, phosphorus and sediment pollution throughout a 64,000-square-mile watershed that includes the District of Columbia and large sections of six states. The TMDL is actually a combination of 92 smaller TMDLs for individual Chesapeake Bay tidal segments and includes pollution limits that are sufficient to meet state water quality standards for dissolved oxygen, water clarity, underwater Bay grasses and chlorophyll-*a*, an indicator of algae levels (Figure ES-1). It is important to note that the pollution controls employed to meet the TMDL will also have significant benefits for water quality in tens of thousands of streams, creeks, lakes and rivers throughout the region.

Since 2000, the seven jurisdictions in the Chesapeake Bay watershed (Delaware, District of Columbia, Maryland, New York, Pennsylvania, Virginia, and West Virginia), EPA and the Chesapeake Bay Commission, which are partners in the Chesapeake Bay Program, have been planning for a Chesapeake Bay TMDL.

Since September 2005, the seven jurisdictions have been actively involved in decision-making to develop the TMDL. During the October 2007 meeting of the Chesapeake Bay Program's Principals' Staff Committee, the Bay watershed jurisdictions and EPA agreed that EPA would establish the multi-state TMDL. Since 2008, EPA has sent official letters to the jurisdictions detailing all facets of the TMDL, including: nitrogen, phosphorus and sediment allocations; schedules for developing the TMDL and pollution reduction plans; EPA's expectations and evaluation criteria for jurisdiction plans to meet the TMDL pollution limits; reasonable assurance for controlling nonpoint source pollution; and backstop actions that EPA could take to ensure progress.

The TMDL also resolves commitments made in a number of consent decrees, Memos of Understanding, the Chesapeake Bay Foundation settlement agreement of 2010, and settlement agreements dating back to the late 1990s that address certain tidal waters identified as impaired in the District of Columbia, Delaware, Maryland and Virginia.

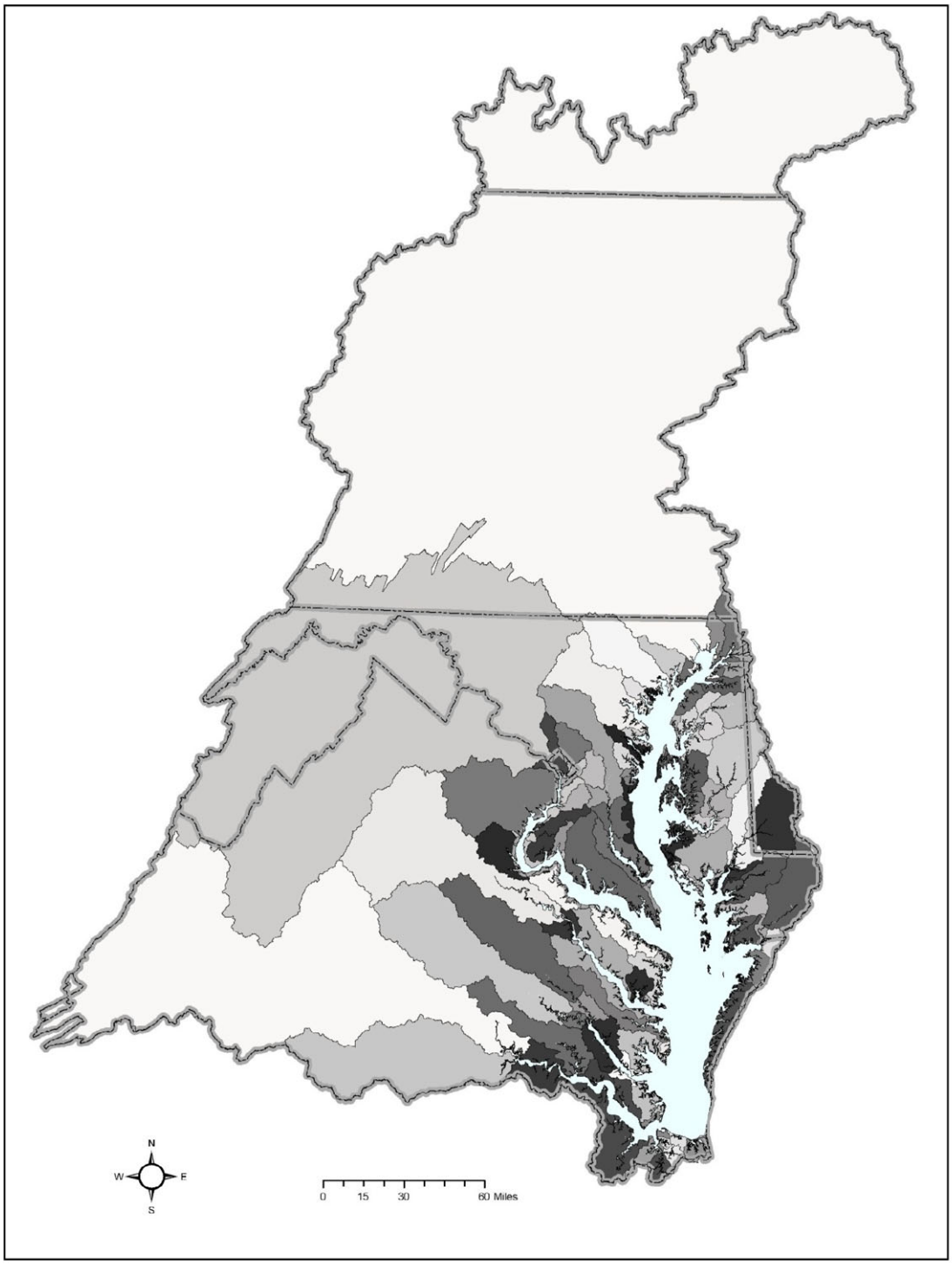

Figure ES-1. A nitrogen, phosphorus and sediment TMDL has been developed for each of the 92 Chesapeake Bay segment watersheds.

Additionally, President Obama issued Executive Order 13508 on May 12, 2009, which directed the federal government to lead a renewed effort to restore and protect the Chesapeake Bay and its watershed. The Chesapeake Bay TMDL is a keystone commitment in the strategy developed by 11 federal agencies to meet the President's Executive Order.

DEVELOPING THE CHESAPEAKE BAY TMDL

Development of the Chesapeake Bay TMDL required extensive knowledge of the stream flow characteristics of the watershed, sources of pollution, distribution and acreage of the various land uses, appropriate best management practices, the transport and fate of pollutants, precipitation data and many other factors. The TMDL is informed by a series of models, calibrated to decades of water quality and other data, and refined based on input from dozens of Chesapeake Bay scientists. Modeling is an approach that uses observed and simulated data to replicate what is occurring in the environment to make future predictions, and was a critical and valuable tool to develop the Chesapeake Bay TMDL.

The development of the TMDL consisted of several steps:

1. EPA provided the jurisdictions with loading allocations for nitrogen, phosphorus and sediment for the major river basins by jurisdiction.
2. Jurisdictions developed draft Phase I WIPs to achieve those basin-jurisdiction allocations. In those draft WIPs, jurisdictions made decisions on how to further sub-allocate the basin-jurisdiction loadings to various individual point sources and a number of point and nonpoint source pollution sectors.
3. EPA evaluated the draft WIPs and, where deficiencies existed, EPA provided backstop allocations in the draft TMDL that consisted of a hybrid of the jurisdiction WIP allocations modified by EPA allocations for some source sectors to fill gaps in the WIPs.
4. The draft TMDL was published for a 45-day public comment period and EPA held 18 public meetings in all six states and the District of Columbia. Public comments were received, reviewed and considered for the final TMDL.
5. Jurisdictions, working closely with EPA, revised and strengthened Phase I WIPs and submitted final versions to EPA.
6. EPA evaluated the final WIPs and used them along with public comments to develop the final TMDL.

Since nitrogen and phosphorus loadings from all parts of the Bay watershed have an impact on the impaired tidal segments of the Bay and its rivers, it was necessary for EPA to allocate the nitrogen and phosphorus loadings in an equitable manner to the states and basins. EPA used three basic guides to divide these loads.

- Allocated loads should protect living resources of the Bay and its tidal tributaries and should result in all segments of the Bay mainstem, tidal tributaries and embayments meeting water quality standards for dissolved oxygen, chlorophyll *a*, water clarity and underwater Bay grasses.
- Tributary basins that contribute the most to the Bay water quality problems must do the most to resolve those problems (on a pound-per-pound basis) (Figure ES-2).
- All tracked and reported reductions in nitrogen, phosphorus and sediment loads are credited toward achieving final assigned loads.

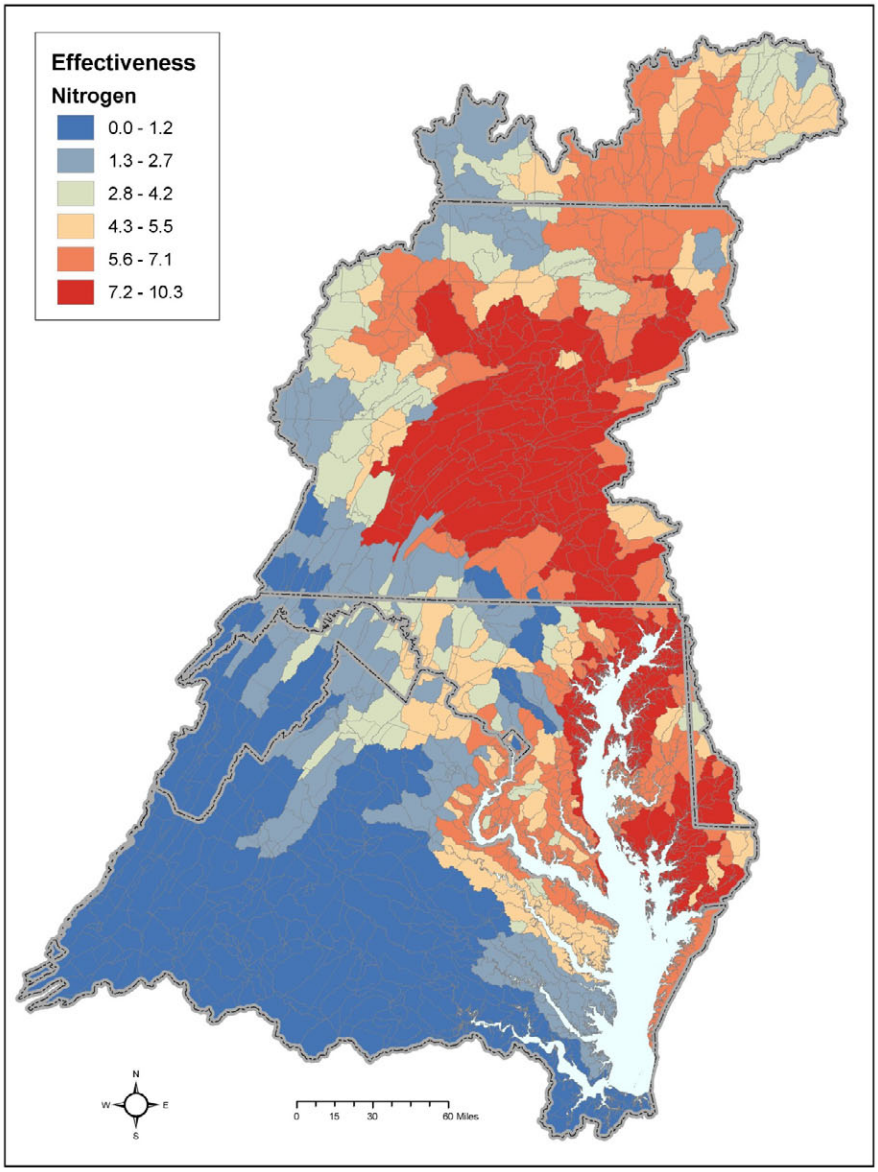

Figure ES-2. Sub-basins across the Chesapeake Bay watershed with the highest (red) to lowest (blue) pound for pound nitrogen pollutant loading effect on Chesapeake Bay water quality.

In addition, EPA has committed to reducing air deposition of nitrogen to the tidal waters of the Chesapeake Bay from 17.9 to 15.7 million pounds per year. The reductions will be achieved through implementation of federal air regulations during the coming years.

To ensure that these pollutant loadings will attain and maintain applicable water quality standards, the TMDL calculations were developed to account for critical environmental conditions a waterway would face and seasonal variation. An implicit margin of safety for nitrogen and phosphorus, and an explicit margin of safety for sediment, also are included in the TMDL.

Ultimately, the TMDL is designed to ensure that by 2025 all practices necessary to fully restore the Bay and its tidal waters are in place, with at least 60 percent of the actions taken by 2017.

The TMDL loadings to the basin-jurisdictions are provided in Table ES-1. These loadings were determined using the best peer-reviewed science and through extensive collaboration with the jurisdictions and are informed by the jurisdictions' Phase I WIPs.

Table ES-1. Chesapeake Bay TMDL watershed nitrogen, phosphorus and sediment final allocations by jurisdiction and by major river basin.

Jurisdiction	Basin	Nitrogen allocations (million lbs/year)	Phosphorus allocations (million lbs/year)	Sediment allocations (million lbs/year)
Pennsylvania	Susquehanna	68.90	2.49	1,741.17
	Potomac	4.72	0.42	221.11
	Eastern Shore	0.28	0.01	21.14
	Western Shore	0.02	0.00	0.37
	PA Total	**73.93**	**2.93**	**1,983.78**
Maryland	Susquehanna	1.09	0.05	62.84
	Eastern Shore	9.71	1.02	168.85
	Western Shore	9.04	0.51	199.82
	Patuxent	2.86	0.24	106.30
	Potomac	16.38	0.90	680.29
	MD Total	**39.09**	**2.72**	**1,218.10**
Virginia	Eastern Shore	1.31	0.14	11.31
	Potomac	17.77	1.41	829.53
	Rappahannock	5.84	0.90	700.04
	York	5.41	0.54	117.80
	James	23.09	2.37	920.23
	VA Total	**53.42**	**5.36**	**2,578.90**
District of Columbia	Potomac	2.32	0.12	11.16
	DC Total	**2.32**	**0.12**	**11.16**
New York	Susquehanna	8.77	0.57	292.96
	NY Total	**8.77**	**0.57**	**292.96**
Delaware	Eastern Shore	2.95	0.26	57.82
	DE Total	**2.95**	**0.26**	**57.82**
West Virginia	Potomac	5.43	0.58	294.24
	James	0.02	0.01	16.65
	WV Total	**5.45**	**0.59**	**310.88**
Total Basin/Jurisdiction Draft Allocation		**185.93**	**12.54**	**6,453.61**
Atmospheric Deposition Draft Allocationa		**15.7**	**N/A**	**N/A**
Total Basinwide Draft Allocation		**201.63**	**12.54**	**6,453.61**

[a] Cap on atmospheric deposition loads direct to Chesapeake Bay and tidal tributary surface waters to be achieved by federal air regulations through 2020.

ACCOUNTABILITY AND GOALS

The Chesapeake Bay TMDL is unique because of the extensive measures EPA and the jurisdictions have adopted to ensure accountability for reducing pollution and meeting deadlines for progress. The TMDL will be implemented using an accountability framework that includes WIPs, two-year milestones, EPA's tracking and assessment of restoration progress and, as necessary, specific federal contingency actions if the jurisdictions do not meet their commitments. This accountability framework is being established in part to provide demonstration of the reasonable assurance provisions of the Chesapeake Bay TMDL pursuant to both the Clean Water Act (CWA) and the Chesapeake Bay Executive Order, but is not part of the TMDL itself.

When EPA establishes or approves a TMDL that allocates pollutant loads to both point and nonpoint sources, it determines whether there is a "reasonable assurance" that the point and nonpoint source loadings will be achieved and applicable water quality standards will be attained. Reasonable assurance for the Chesapeake Bay TMDL is provided by the numerous federal, state and local regulatory and non-regulatory programs identified in the accountability framework that EPA believes will result in the necessary point and nonpoint source controls and pollutant reduction programs. The most prominent program is the CWA's National Pollutant Discharge Elimination System (NPDES) permit program that regulates point sources throughout the nation. Many nonpoint sources are not covered by a similar federal permit program; as a result, financial incentives, other voluntary programs and state-specific regulatory programs are used to achieve nonpoint source reductions. These federal tools are supplemented by a variety of state and local regulatory and voluntary programs and other commitments of the federal government set forth in the Executive Order strategy and identified in the accountability framework.

Beginning in 2012, jurisdictions (including the federal government) are expected to follow two-year milestones to track progress toward reaching the TMDL's goals. In addition, the milestones will demonstrate the effectiveness of the jurisdictions' WIPs by identifying specific near-term pollutant reduction controls and a schedule for implementation (see next section for further description of WIPs). EPA will review these two-year milestones and evaluate whether they are sufficient to achieve necessary pollution reductions and, through the use of a Bay TMDL Tracking and Accountability System, determine if milestones are met.

If a jurisdiction's plans are inadequate or its progress is insufficient, EPA is committed to take the appropriate contingency actions to ensure pollution reductions. These include expanding coverage of NPDES permits to sources that are currently unregulated, increasing oversight of state-issued NPDES permits, requiring additional pollution reductions from point sources such as wastewater treatment plants, increasing federal enforcement and compliance in the watershed, prohibiting new or expanded pollution discharges, redirecting EPA grants, and revising water quality standards to better protect local and downstream waters.

Watershed Implementation Plans

The cornerstone of the accountability framework is the jurisdictions' development of WIPs, which serve as roadmaps for how and when a jurisdiction plans to meet its pollutant allocations under the TMDL. In their Phase I WIPs, the jurisdictions were expected to subdivide the Bay TMDL allocations among pollutant sources; evaluate their current legal, regulatory,

programmatic and financial tools available to implement the allocations; identify and rectify potential shortfalls in attaining the allocations; describe mechanisms to track and report implementation activities; provide alternative approaches; and outline a schedule for implementation.

EPA provided the jurisdictions with detailed expectations for WIPs in November 2009 and evaluation criteria in April 2010. To assist with WIP preparation, EPA provided considerable technical and financial assistance. EPA worked with the jurisdictions to evaluate various "what if" scenarios – combinations of practices and programs that could achieve their pollution allocations.

The two most important criteria for a WIP is that it achieves the basin-jurisdiction pollution allocations and meets EPA's expectations for providing reasonable assurance that reductions will be achieved and maintained, particularly for non-permitted sources like runoff from agricultural lands and currently unregulated stormwater from urban and suburban lands.

After the draft Phase I WIP submittals in September 2010, a team of EPA sector experts conducted an intense evaluation process, comparing the submissions with EPA expectations. The EPA evaluation concluded that the pollution controls identified in two of the seven jurisdictions' draft WIPs could meet nitrogen and phosphorus allocations and five of the seven jurisdictions' draft WIPs could meet sediment allocations. The EPA evaluation also concluded that none of the seven draft Phase I WIPs provided sufficient reasonable assurance that pollution controls identified could actually be implemented to achieve the nitrogen, phosphorus and sediment reduction targets by 2017 or 2025.

In response to its findings, EPA developed a draft TMDL that established allocations based on using the adequate portions of the jurisdictions' draft WIP allocations along with varying degrees of federal backstop allocations in all seven jurisdictions. Backstop allocations focused on areas where EPA has the federal authority to control pollution allocations through NPDES permits, including wastewater treatment plants, stormwater permits, and animal feeding operations.

Public Participation

The draft Chesapeake Bay TMDL was developed through a highly transparent and engaging process during the past two years. The outreach effort included hundreds of meetings with interested groups; two rounds of public meetings, stakeholder sessions and media interviews in all six states and the District of Columbia in fall of 2009 and 2010; a dedicated EPA website; a series of monthly interactive webinars; notices published in the Federal Register; and a close working relationship with Chesapeake Bay Program committees representing citizens, local governments and the scientific community.

The release of the draft Chesapeake Bay TMDL on September 24, 2010 began a 45-day public comment period that concluded on November 8, 2010. During the comment period EPA conducted 18 public meetings in all six states and the District of Columbia. More than 2,500 people participated in the public meetings. Seven of these meetings were also broadcast live online. During the six weeks that EPA officials traveled around the watershed, they also held dozens of meetings with stakeholders, including local governments, agriculture groups, homebuilder and developer associations, wastewater industry representatives and environmental

organizations. EPA received more than 14,000 comments – most of which supported the TMDL – and the Agency's response to those comments is included as an appendix to the TMDL.

Final Watershed Implementation Plans and TMDL

Since submittal of the draft WIPs and release of the draft TMDL in September 2010, EPA worked closely with each jurisdiction to revise and strengthen its plan. Because of this cooperative work and state leadership, the final WIPs were significantly improved. Examples of specific improvements include:

- Committing to more stringent nitrogen and phosphorus limits at wastewater treatment plants, including on the James River in Virginia. (Virginia, New York, Delaware)
- Pursuing state legislation to fund wastewater treatment plant upgrades, urban stormwater management and agricultural programs. (Maryland, Virginia, West Virginia)
- Implementing a progressive stormwater permit to reduce pollution. (District of Columbia)
- Dramatically increasing enforcement and compliance of state requirements for agriculture. (Pennsylvania)
- Committing state funding to develop and implement state-of-the-art-technologies for converting animal manure to energy for farms. (Pennsylvania)
- Considering implementation of mandatory programs for agriculture by 2013 if pollution reductions fall behind schedule. (Delaware, Maryland, Virginia)

These improvements enabled EPA to reduce and remove most federal backstops, leaving a few targeted backstops and a plan for enhanced oversight and contingency actions to ensure progress.

Backstop Allocations, Adjustments, and Actions

Despite the significant improvement in the final WIPs, one of the jurisdictions did not meet all of its target allocations and two of the jurisdictions did not fully meet EPA's expectations for reasonable assurance for specific pollution sectors. To address these few remaining issues, EPA included in the final TMDL several targeted backstop allocations, adjustments and actions. As a result of the jurisdictions' significant improvements combined with EPA's backstops, EPA believes the jurisdictions are in a position to implement their WIPs and achieve the needed pollution reductions. This approach endorses jurisdictions' pollution reduction commitments, gives them the flexibility to do it their way first, and signals EPA's commitment to fully use its authorities as necessary to reduce pollution.

New York Wastewater – Backstop Allocation

- EPA closed the numeric gap between New York's WIP and its modified allocations by establishing a backstop that further reduces New York's wasteload allocation for wastewater. EPA is establishing an aggregate wasteload allocation for wastewater treatment plants.
- EPA calculated this backstop WLA using the nitrogen and phosphorus performance levels that New York committed to, but assumes that significant wastewater treatment plants (WWTPs) are at current flow rather than design flow.

- EPA understands that New York plans to renew and/or modify WWTP permits upon completion of its Phase II WIP, consistent with the applicable TMDL allocations at that time. New York is reviewing engineering reports from WWTPs and, in its Phase II WIP, will provide information to support individual WLAs for these plants.

Pennsylvania Urban Stormwater – Backstop Adjustment

- EPA transferred 50 percent of the stormwater load that is not currently subject to NPDES permits from the load allocation to the wasteload allocation. The TMDL allocation adjustment increases reasonable assurance that pollution allocations from urban stormwater discharges will be achieved and maintained by signaling that EPA is prepared to designate any of these discharges as requiring NPDES permits. Urban areas would only be subject to NPDES permit conditions protective of water quality as issued by Pennsylvania upon designation. EPA will consider this step if Pennsylvania does not demonstrate progress toward reductions in urban loads identified in the WIP. EPA may also pursue designation activities based on considerations other than TMDL and WIP implementation.
- EPA will maintain close oversight of general permits for the Pennsylvania stormwater sector (PAG-13 and PAG-2) and may object if permits are not protective of water quality standards and regulations. Upon review of Pennsylvania's Phase II WIP, EPA will revisit the wasteload allocations for wastewater treatment plants, including more stringent phosphorus limits, in the event that Pennsylvania does not reissue PAG-13 and PAG-2 general permits for Phase II MS4s and construction that are protective of water quality by achieving the load reductions called for in Pennsylvania's Phase I WIP.

West Virginia Agriculture – Backstop Adjustment

- EPA shifted 75 percent of West Virginia's animal feeding operation (AFO) load into the wasteload allocation and assumed full implementation of barnyard runoff control, waste management and mortality composting practices required under a CAFO permit on these AFOs. The shift signals that any of these operations could potentially be subject to state or federal permits as necessary to protect water quality. AFOs would only be subject to NPDES permit conditions as issued by West Virginia upon designation. EPA will consider this step if West Virginia does not achieve reductions in agricultural loads as identified in the WIP. EPA may also pursue designation activities based upon considerations other than TMDL and WIP implementation.
- Based upon West Virginia's ability to demonstrate near-term progress implementing the agricultural section of its WIP, including CAFO Program authorization and permit applications and issuance, EPA will assess in the Phase II WIP whether additional federal actions, such as establishing more stringent wasteload allocations for wastewater treatment plants, are necessary to ensure that TMDL allocations are achieved.

Enhanced Oversight and Contingencies

While final WIPs were significantly improved and the jurisdictions deserve credit for the efforts, EPA also has minor concerns with the assurance that pollution reductions can be achieved in certain pollution sectors in Pennsylvania, Virginia and West Virginia. EPA has informed these jurisdictions that it will consider future backstops if specific near-term progress is not demonstrated in the Phase II WIP.

Pennsylvania Agriculture

- Based on Pennsylvania's ability to demonstrate near-term progress implementing the agricultural section of its WIP, including EPA approval for its CAFO program and enhanced compliance assurance with state regulatory programs, EPA will assess in the Phase II WIP whether additional federal actions, such as shifting AFO loads from the load allocation to the wasteload allocation or establishing more stringent wasteload allocations for WWTPs, are necessary to ensure that TMDL allocations are achieved.

Pennsylvania Wastewater

- EPA established individual wasteload allocations for wastewater treatment plants in the TMDL to ensure that sufficient detail is provided to inform individual permits for sources within the wasteload allocation. Individual allocations do not commit wastewater plants to greater reductions than what the state has proposed in its WIP. Provisions of the TMDL allow, under certain circumstances, for modifications of allocations within a basin to support offsets and trading opportunities.
- EPA will assess Pennsylvania's near-term urban stormwater and agriculture program progress and determine whether EPA should modify TMDL allocations to assume additional reductions from wastewater treatment plants.

Virginia Urban Stormwater

- If the statewide rule and/or the Phase II WIP do not provide additional assurance regarding how stormwater discharges outside of MS4 jurisdictions will achieve nitrogen, phosphorus, and sediment reductions proposed in the final Phase I WIP and assumed within the TMDL allocations, EPA may shift a greater portion of Virginia's urban stormwater load from the load allocation to the wasteload allocation. This shift would signal that substantially more stormwater could potentially be subject to NPDES permits issued by the Commonwealth as necessary to protect water quality.

West Virginia Urban Stormwater

- If stormwater rules and/or the Phase II WIP do not provide additional assurance regarding how urban stormwater discharges outside of MS4 jurisdictions will achieve nitrogen, phosphorus, and sediment allocations proposed in the final Phase I WIP and assumed within the TMDL load allocations, EPA may shift a greater portion of West Virginia's urban stormwater load from the load allocation to the wasteload allocation. The shift would signal that substantially more urban stormwater could potentially be subject to state permit coverage and/or federal Clean Water Act permit coverage as necessary to protect water quality.

West Virginia Wastewater

- EPA established individual wasteload allocations for significant wastewater treatment plants in the TMDL to ensure that sufficient detail is provided to inform individual permits for sources within the wastewater wasteload allocation. Individual allocations do not commit wastewater plants to greater reductions than what the state has proposed in its WIP. Provisions of this TMDL allow, under certain circumstances, for modifications of allocations within a basin to support offsets and trading opportunities.

- EPA will assess West Virginia's near-term agriculture program progress and determine whether additional federal actions consistent with EPA's December 29, 2009 letter, such as modifying TMDL allocations to assume additional reductions from wastewater treatment plants, are necessary to ensure that TMDL allocations are achieved.

Ongoing oversight of Chesapeake Bay jurisdictions

EPA will carefully review programs and permits in all jurisdictions. EPA's goal is for jurisdictions to successfully implement their WIPs, but EPA is prepared to take necessary actions in all jurisdictions for insufficient WIP implementation or pollution reductions. Federal actions can be taken at any time, although EPA will engage particularly during two-year milestones and refining the TMDL in 2012 and 2017. Actions include:

- Expanding coverage of NPDES permits to sources that are currently unregulated
- Increasing oversight of state-issued NPDES permits
- Requiring additional pollution reductions from federally regulated sources
- Increasing federal enforcement and compliance
- Prohibiting new or expanded pollution discharges
- Conditioning or redirecting EPA grants
- Revising water quality standards to better protect local and downstream waters
- Discounting nutrient and sediment reduction progress if jurisdiction cannot verify proper installation and management of controls

FINAL TMDL

As a result of the significantly improved WIPs and the removal and reduction of federal backstops, the final TMDL is shaped in large part by the jurisdictions' plans to reduce pollution. Jurisdiction-based solutions for reducing pollution was a long-standing priority for EPA and why the agency always provided the jurisdictions with flexibility to determine how to reduce pollution in the most efficient, cost-effective and acceptable manner.

Now, the focus shifts to jurisdictions' implementation of the WIP policies and programs designed to reduce pollution on-the-ground and in-the-water. EPA will conduct oversight of WIP implementation and jurisdictions' progress toward meeting two-year milestones. If progress is insufficient, EPA will utilize contingencies to place additional controls on federally permitted sources of pollution, such as wastewater treatment plants, large animal agriculture operations and municipal stormwater systems, as well as target compliance and enforcement activities.

Federal agencies will greatly contribute to restoration of the Chesapeake Bay watershed, particularly through implementation of the new federal strategy created under President Obama's Executive Order. Eleven federal agencies have committed to a comprehensive suite of actions and pursuit of critical environmental goals on the same 2025 timeline as the TMDL. Additionally, federal agencies will be establishing and meeting two-year milestones, with the specific charge of taking actions that directly support the jurisdictions in reducing pollution and restoring water quality.

The jurisdictions are expected to submit Phase II WIPs that provide local area pollution targets for implementation on a smaller scale; the timeframe for these Phase II WIPs will be determined in early 2011. Phase III WIPs in 2017 are expected to be designed to provide additional detail of restoration actions beyond 2017 and ensure that the 2025 goals are met.

APPENDIX G:

Water Quality Analysis of Cadmium and Lead for the Middle River in Baltimore County, Maryland

Water Quality Analysis of Cadmium and Lead for the Middle River in Baltimore County, Maryland

FINAL

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List of Abbreviations

CBL	Chesapeake Biological Laboratory
Cd	Cadmium
cm	Centimeter
COMAR	Code of Maryland Regulations
Cu	Copper
CWA	Clean Water Act
DO	Dissolved Oxygen
DOC	Dissolved Organic Carbon
EPA	Environmental Protection Agency
HAC	Hardness Adjusted Criteria
MDE	Maryland Department of the Environment
mg/l	Milligrams per Liter
Ni	Nickel
NPDES	National Pollution Discharge Elimination System
Pb	Lead
ppt	Parts per Thousand
SCS	Soil Conservation Service
SSURGO	Soil Survey Geographic
TMDL	Total Maximum Daily Load
USGS	United States Geological Survey
WER	Water Effects Ratio
WQA	Water Quality Analysis
WQLS	Water Quality Limited Segment
µg/l	Micrograms per Liter

EXECUTIVE SUMMARY

Section 303(d) of the federal Clean Water Act (CWA) and the U.S. Environmental Protection Agency's (EPA) implementing regulations direct each state to identify and list waters, known as water quality limited segments (WQLSs), in which current required controls of a specified substance are inadequate to achieve water quality standards. For each WQLS, the State is to either establish a Total Maximum Daily Load (TMDL) of the specified substance that the waterbody can receive without violating water quality standards, or demonstrate that water quality standards are being met.

The Middle River (basin code 02-13-08-07), located in Baltimore County, MD, was identified on the State's list of WQLSs as impaired by nutrients (1996 listing), suspended sediments (1996 listing), copper (Cu) (1998 listing), nickel (Ni) (1998 listing), cadmium (Cd) (2002 listing), and lead (Pb) (2002 listing). All impairments were listed for the tidal waters. The listings for Cu and Ni were based on an analysis using salt water criteria. Code of Maryland Regulations (COMAR) defines the Middle River as a fresh waterbody. When applying freshwater criteria, Middle River was found not to be impaired by Cu or Ni, therefore these impairments were removed from the list of WQLSs when it was updated in 2002.

The listings for Cd and Pb were based on an analysis of 1992-1993 water column data using fresh water criteria assuming a hardness of 100 mg/l. This report provides an analysis of recent monitoring data, including hardness data, which shows that the aquatic life criteria for Cd and Pb and the designated uses supported by those criteria are being met in the Middle River. The analyses support the conclusion that TMDLs for Cd and Pb are not necessary to achieve water quality standards in this case. Barring the receipt of any contradictory data, this report will be used to support the removal of the Middle River from Maryland's list of WQLSs for Cd and Pb when the Maryland Department of the Environment (MDE) proposes the revision of Maryland's 303(d) list for public review in the future. The nutrient and suspended sediment impairments will be addressed separately at a future date.

Although the tidal waters of the Middle River do not display signs of toxic impairments due to Cd or Pb, the State reserves the right to require additional pollution controls in the Middle River watershed if evidence suggests that Cd or Pb from the basin are contributing to downstream water quality problems.

1.0 INTRODUCTION

Section 303(d) of the federal Clean Water Act (CWA) and U.S. Environmental Protection Agency (EPA)'s implementing regulations direct each State to identify and list waters, known as water quality limited segments (WQLSs), in which current required controls of a specified substance are inadequate to achieve water quality standards. This list of impaired waters is commonly referred to as the "303(d) list". For each WQLS, the State is to either establish a Total Maximum Daily Load (TMDL) of the specified substance that the waterbody can receive without violating water quality standards, or demonstrate that water quality standards are being met.

A segment identified as a WQLS may not require the development and implementation of a TMDL if current information contradicts the previous finding of an impairment. The most common factual scenarios obviating the need for a TMDL are as follows: 1) more recent data indicating that the impairment no longer exists (i.e., water quality criteria are being met); 2) more recent and updated water quality modeling demonstrates that the segment is now attaining criteria; 3) refinements to water quality criteria, or the interpretation of those standards, which result in standards being met; or 4) correction to errors made in the initial listing.

The Middle River (basin code 02-13-08-07) was identified on the State's 1996 303(d) list as impaired by nutrients and suspended sediment, with copper (Cu) and nickel (Ni) impairments added to the list in 1998, and cadmium (Cd) and lead (Pb) added to the list in 2002. All impairments were listed for the tidal waters. The listings for Cu and Ni were based on an analysis using salt water criteria. Code of Maryland Regulations (COMAR) defines the Middle River as a fresh waterbody. When applying freshwater criteria, Middle River was found not to be impaired by Cu or Ni, therefore these listings were deleted when the 303(d) list was revised in 2002. The listings for Cd and Pb were based on an analysis of 1992-1993 water column data using fresh water criteria at a standard hardness of 100 mg/l. A water quality analysis (WQA) of Cd and Pb for the tidal waters of Middle River was performed using recent water column and sediment toxicity data. Results show no impairment for Cd or Pb. The non-tidal streams are not listed for Cd or Pb, therefore they are not addressed in the WQA. The nutrient and suspended sediment impairments will be addressed separately at a future date.

The remainder of this report lays out the general setting of the waterbody within the Middle River watershed, presents a discussion of the water quality characterization process, and provides conclusions with regard to the characterization. The most recent data establishes that the Middle River is achieving water quality standards for Cd and Pb.

2.0 GENERAL SETTING

Middle River is a wide, shallow tidal estuary that extends southeastward approximately four miles from Eastern Boulevard in Baltimore County before entering the Chesapeake Bay. Adjacent watersheds include the Gunpowder River to the northeast and the Back River to the southwest. The Middle River watershed is located in urban and suburban portions of southeastern Baltimore County, Maryland (see Figure 1). The watershed area covers 5,888 acres.

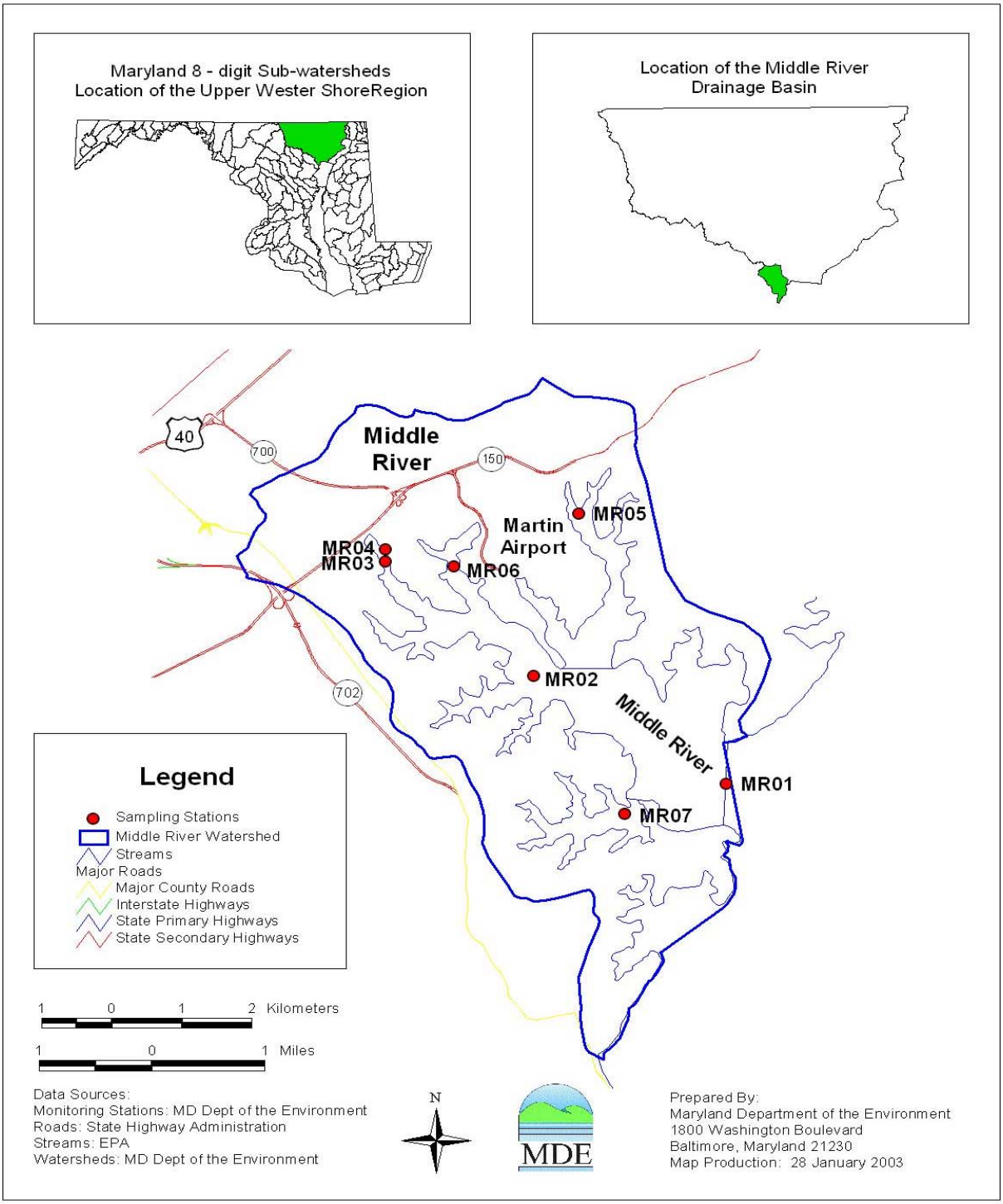

Figure 1: Watershed Map of the Middle River

The Middle River watershed is located entirely within the Atlantic Coastal Plain physiographic province, an area characterized by a relatively flat wedge of unconsolidated sediments, including gravel, sand, silt, and clay, that dip eastward at a low angle. Topography within the watershed is gently rolling to flat. The watershed slopes in a southeastward direction, from just north of Eastern Boulevard down to sea level. Although the maximum elevation within the watershed is approximately 1,000 feet, most elevations are less than 50 feet.

The watershed is almost entirely underlaid by the Patapsco formation, which consists of sand facies that are well sorted, medium to fine grained quartz sand with local deposits of quartz gravel and clays. Clay facies within the Patapsco formation are typically buff, red-yellow and brown mottled kaolinitic clays. A small portion of the watershed, located near the junction of Eastern and Martin Boulevards, is underlaid by the Arundel formation consisting of clay and sand facies. The Arundal formation may include localized deposits of clays, silts, sands, and gravels (Camp, Dresser, McGee, 1997).

The watershed is comprised primarily of B, C and D type soils. Soil type is categorized by four hydrologic soil groups developed by the Soil Conservation Service (SCS). The definitions of the groups are as follows (SCS, 1976):

> Group A: Soils with high infiltration rates, typically deep well-drained to excessively drained sands or gravels.
> Group B: Soils with moderate infiltration rates, generally moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures.
> Group C: Soils with slow infiltration rates, mainly soils with a layer that impedes downward water movement or soils with moderately fine to fine texture.
> Group D: Soils with very slow infiltration rates, mainly clay soils, soils with a permanently high water table, and shallow soils over nearly impervious material.

The soil distribution within the watershed is approximately 1% soil group A, 20% soil group B, 58% soil group C and 21% soil group D. Soil data was obtained from Soil Survey Geographic (SSURGO) coverages created by the National Resources Conservation Service.

The Middle River watershed consists primarily of older residential development intermixed with commercial and industrial areas. Large forested tracts of land remain interspersed throughout the entire watershed and relatively rural lands occupy many locations in the lower portions of the watershed surrounding the mouth of the River (see Figure 2). No major point sources discharge Cd or Pb within the watershed. The land use distribution in the watershed is approximately 67.2 % urban, 25.7 % forest/herbaceous, 4.5% agricultural and 2.5 % water (Maryland Department of Planning, 2000).

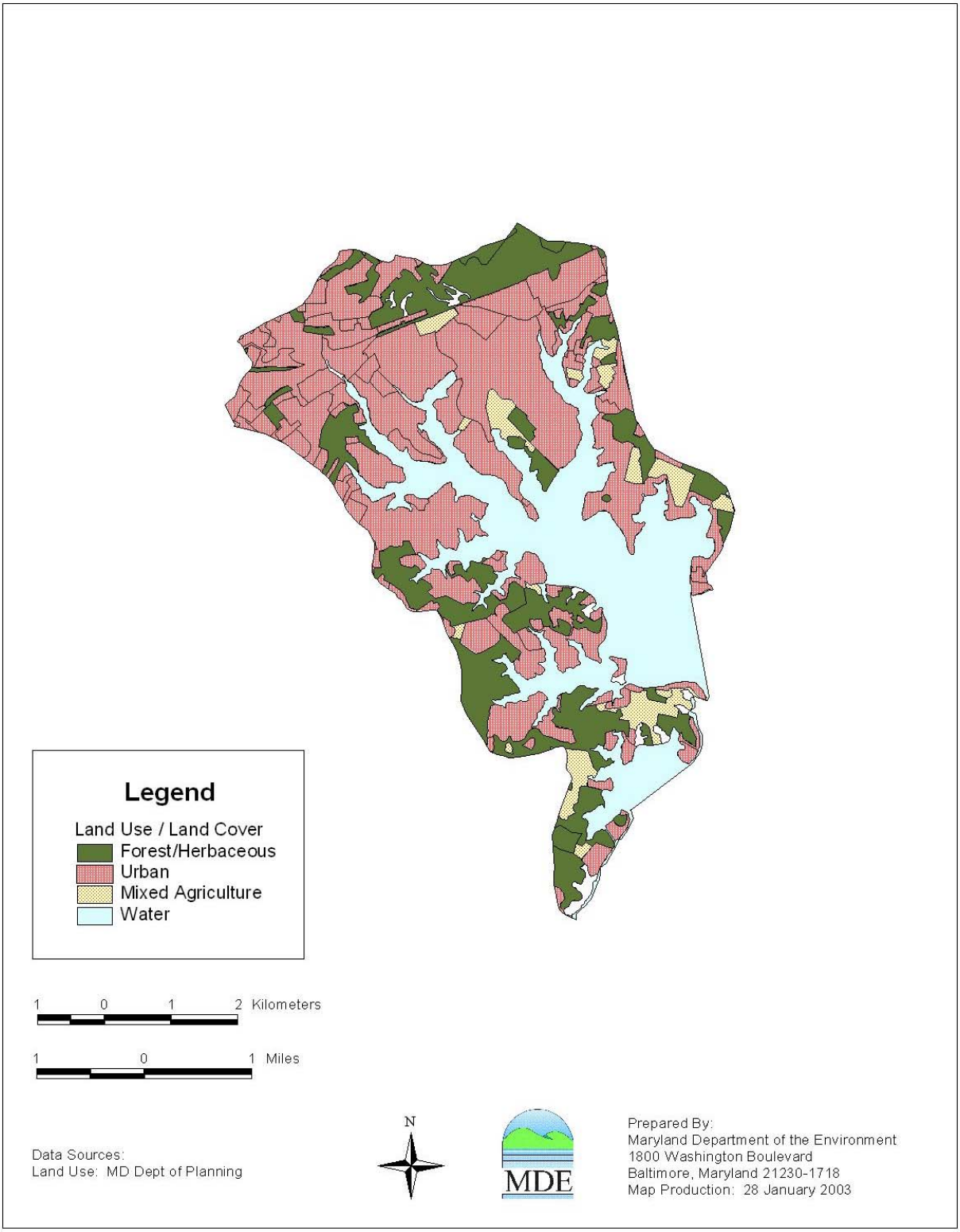

Figure 2: Land Use Map of Middle River Watershed

3.0 WATER QUALITY CHARACTERIZATION

A water quality standard is the combination of a designated use for a particular body of water and the water quality criteria designed to protect that use. Designated uses include support of aquatic life, primary or secondary contact recreation, drinking water supply, and shellfish propagation and harvest. Water quality criteria consist of narrative statements and numeric values designed to protect the designated uses. The criteria developed to protect different designated uses may differ and are dependent on the specific designated use(s) of a waterbody. Maryland's water quality standards presently include numeric criteria for metals and other toxic substances based on the need to protect aquatic life, wildlife and human health. Water quality standards for toxic substances also address sediment quality to ensure the bottom sediment of a waterbody is capable of supporting aquatic life, thus protecting the designated uses.

The Maryland Surface Water Use Designation (COMAR 26.08.02.08I) for the Middle River is Use I inside a line from Log Point to Turkey Point and Use II outside. Use I surface waters are designated for water contact recreation, fishing, and protection of aquatic life while Use II includes an additional designation of shellfish harvesting. COMAR 26.08.02.03-1(B)(3)(i) defines all waters within the Gunpowder River basin (02-13-08), which includes the Middle River, as being freshwater.* The freshwater aquatic life criteria for Cd and Pb are displayed below in Table 1 (COMAR 26.08.02.03-2G). The water column data presented in Section 3.1, Table 5 through Table 9, show that concentrations of Cd and Pb in the water column do not exceed water quality criteria. An ambient sediment bioassay conducted in Middle River establishes that there is no toxicity in the sediment bed (Fisher, 2002). Sediment chemistry analysis was not conducted because toxicity was not observed in the ambient sediment bioassay. The water column and sediment in the Middle River are therefore not impaired by Cd or Pb, thus the designated uses are supported and the water quality standard is being met for these substances.

Table 1: Numeric Water Quality Criteria (Cd and Pb)

Metal	Fresh Water Aquatic Life Acute Criteria (µg/l)	Fresh Water Aquatic Life Chronic Criteria (µg/l)
Cd	4.3	2.2
Pb	65	2.5

Water column surveys conducted at five stations (MR01 thru MR05) in the Middle River estuary from May 2001 to April 2002 were used to support these WQAs. For every sample, dissolved concentrations of Cd and Pb were determined. Sediment samples were also collected at all five stations used in the water column surveys as well as two additional stations (MR06 and MR07) for the sediment bioassay. Table 2 shows the list of stations with their geographical coordinates and descriptive location in the Middle River. Refer back to Figure 1 for the station locations.

* Even though COMAR 26.08.02.03-1(B)(3)(i) defines the Middle River as a freshwater body, significant variability in salinity concentrations were found during the water column survey. A comparison of Cd and Pb concentrations with saltwater aquatic life criteria was also conducted based on new EPA guidance and no exceedances occurred.

Table 2: Water Quality Analysis Stations for Middle River

Station I.D.	GPS Coordinates	Station Description
MR01	39.292 76.384	At river mouth, mid-channel, between Bowley Bar and Boob
MR02	39.307 76.415	At mid-channel, between Wilson Point and Barren Point
MR03	39.323 76.440	At headwaters, mid-channel, off Hawthorne Park Pier
MR04	39.325 76.440	Near MR03
MR05	39.330 76.408	Frog Mortar Creek
MR06	39.322 76.430	Dark Head Creek
MR07	39.288 76.401	Sue Creek

Water column sampling was performed six times at each station from May 2001 to April 2002 to capture seasonal variation. The sampling dates were as follows: 5/21/01 (spring wet weather); 6/14/01 (spring dry weather); 7/26/01 (summer dry weather); 7/30/01 (summer wet weather); 4/5/02 (spring wet weather) and 4/25/02 (spring dry weather).

For the water quality evaluation, a comparison is made between Cd and Pb water column concentrations and fresh water aquatic life chronic criteria, the more stringent of the numericwater quality criteria for Cd and Pb. Hardness concentrations were obtained for each station to adjust the fresh water aquatic life chronic criteria that were established at a hardness of 100 mg/l for Cd and Pb. The State uses hardness adjustment to calculate fresh water aquatic life chronic criteria for Cd and Pb whose toxicity is a function of total hardness. According to EPA's National Recommended Water Quality Criteria (EPA, 2002), allowable hardness values must fall within the range of 25 - 400 mg/L. MDE uses an upper limit of 400 mg/l in calculating the hardness adjusted criteria (HAC) when the measured hardness exceeds this value. Based on technical information, EPA's Office of Research and Development does not recommend a lower limit on hardness for adjusting criteria (EPA, 2002). MDE adopts this recommendation. The HAC equation for Cd and Pb is as follows (EPA, 2002):

$$HAC = e^{(m[\ln (Hardness(mg/l)]+b)} * CF$$

Where,

HAC = Hardness Adjusted Criterion (µg/l)
m = slope
b = y intercept
CF = Conversion Factor (conversion from totals to dissolved numeric criteria)

The HAC parameters for metals are presented in Table 3.

Table 3: HAC Parameters (Fresh Water Aquatic Life Chronic Criteria)

Chemical	Slope (m)	y Intercept (b)	Conversion Factor (CF)
Cd	0.7852	-2.715	1.102 - ln(hardness)*0.0418
Pb	1.2730	-4.705	1.462 - ln(hardness)*0.146

The State performs a scientific review of all data submitted where a water quality criterion exceedance was the result of a hardness adjustment below 50 mg/l. This review is necessary because of the scientific uncertainty existing for hardness-toxicity relationships below 50 mg/l due to:

A. Paucity of toxicity test data below 50 mg/l that was used to develop the relationship between hardness and toxicity.
B. Presence/absence of sensitive species in the waterbody of concern.
C. Existence of other environmental conditions (e.g. high Dissolved Organic Carbon (DOC)), which might mitigate the toxicity of metals due to competitive binding/complexation of metals.

In instances where hardness data is not available, the State will calculate an average of existing hardness concentrations for each station. In applying average hardness, the sampling date for which hardness data is unavailable must not fall during a storm event substantially greater than the sampling dates used to calculate the average. A major rainfall event has the potential to reduce hardness below the average. An analysis of rainfall data from the National Weather Service (NWS) precipitation gauge (0180465) at Baltimore/Washington International Airport (BWI) shows no significant variation in storm events for the sampling dates, thus the average will apply. This is the closest gauge to Middle River and is likely to be representative of the rainfall events that occur within the watershed.

3.1 WATER COLUMN EVALUATION

A data solicitation for metals was conducted by the MDE and all readily available data from the past five years was considered in the WQA. The water column data is presented in Table 5 through Table 9 for each station and is evaluated using the fresh water aquatic life chronic HAC, the more stringent of the numeric water quality criteria for Cd & Pb (Baker, 2002). Each table displays hardness (mg/l), sample concentrations (µg/l) and fresh water chronic HAC (µg/l) by sampling date. For example, in Table 5 for the sampling date of 6/14/01 the hardness is 945 mg/l, the hardness adjusted criterion for Cd is 6.2 µg/l and the Cd sample concentration is 0.06 µg/l. The hardness concentrations reported in bold are for sampling dates in which hardness was not measured and an average value was applied. The detection limits for metals analysis are displayed in Table 4. A hardness limit of 400 mg/l is applied for fresh water HAC as defined by EPA's National Recommended Water Quality Criteria (EPA, 2002).

Table 4: Metals Analysis Detection Limits

Analyte	Detection Limit (µg/L)
Cd	0.001
Pb	0.003

Table 5: Station MR01 Water Column Data

Sampling Date	5/21/01		6/14/01		7/26/01		7/30/01		4/5/02		4/25/02	
Hardness (mg/l)	756		945		1105.5		**951.4**		1098.0		999	
Analyte	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)
Cd	ND	6.2	0.06	6.2	0.18	6.2	0.32	6.2	0.02	6.2	0.03	6.2
Pb	0.03	10.9	0.02	10.9	0.11	10.9	0.36	10.9	0.02	10.9	0.06	10.9

* Fresh Water Aquatic Life Chronic HAC
ND - Not detected

Table 6: Station MR02 Water Column Data

Sampling Date	5/21/01		6/14/01		7/26/01		7/30/01		4/5/02		4/25/02	
Hardness (mg/l)	652.5		852		990		**874.1**		1369.5		1002	
Analyte	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)
Cd	ND	6.2	0.16	6.2	0.85	6.2	0.80	6.2	0.03	6.2	0.04	6.2
Pb	0.03	10.9	0.02	10.9	0.21	10.9	0.18	10.9	0.004	10.9	0.07	10.9

Table 7: Station MR03 Water Column Data

Sampling Date	5/21/01		6/14/01		7/26/01		7/30/01		4/5/02		4/25/02	
Hardness (mg/l)	604.5		694.5		912		**841.5**		1401.0		1155	
Analyte	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)
Cd	ND	6.2	0.07	6.2	0.88	6.2	0.80	6.2	0.13	6.2	0.29	6.2
Pb	0.14	10.9	0.07	10.9	1.02	10.9	0.93	10.9	0.07	10.9	0.26	10.9

Table 8: Station MR04 Water Column Data

Sampling Date	5/21/01		6/14/01		7/26/01		7/30/01		4/5/02		4/25/02	
Hardness (mg/l)	594		690		889.5		**828.8**		1384.5		1141.5	
Analyte	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)
Cd	ND	6.2	0.07	6.2	0.58	6.2	0.76	6.2	0.09	6.2	0.22	6.2
Pb	0.23	10.9	0.08	10.9	0.96	10.9	0.95	10.9	0.07	10.9	0.28	10.9

Table 9: Station MR05 Water Column Data

Sampling Date	5/21/01		6/14/01		7/26/01		7/30/01		4/5/02		4/25/02	
Hardness (mg/l)	595.5		724.5		928.5		**845.3**		1388.3		1132.5	
Analyte	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)
Cd	ND	6.2	0.37	6.2	3.38	6.2	3.35	6.2	0.09	6.2	0.23	6.2
Pb	0.13	10.9	0.05	10.9	0.50	10.9	0.41	10.9	0.03	10.9	0.10	10.9

* Fresh Water Aquatic Life Chronic HAC
ND - Not detected

The range of concentrations for Cd and Pb sampled in the field survey are as follows:

Cd = ND to 3.38 µg/l
Pb = 0.004 to 1.02 µg/l

Hardness ranged from 594 mg/l to 1401 mg/l. The concentration ranges of Cd and Pb are well below their associated fresh water aquatic life chronic HAC. The criteria were not exceeded by any of the Cd or Pb samples.

3.2 SEDIMENT TOXICITY EVALUATION

To complete the WQA, sediment quality in the Middle River was evaluated using 28-day survival, growth and reproduction whole sediment tests with the estuarine amphipod *Leptocheirus plumulosus.* This species was chosen because of its ecological relevance to the waterbody of concern. *L. plumulosus* is an EPA-recommended test species for assessing the toxicity of marine and estuarine sediments (EPA, 2001). Seven surficial sediment samples were collected using a petite ponar dredge (top 2 cm) by Chesapeake Biological Laboratory (CBL) from Middle River. The sediment stations corresponded to the five monitoring stations sampled in the water column surveys as well as two additional stations. Refer back to Figure 1 for the station locations. Sediment toxicity test results are presented in Table 10. Twenty amphipods were exposed to the sediment in each sample test. The table displays amphipod survival (#), amphipod growth rate (mg/day), neonates (#), average amphipod survival (%), average amphipod growth rate (mg/day) and average neonates per survivor.

The test considers three performance criteria, which are survival, growth rate, and reproduction. For the test to be valid the average survival of control sample replicates must be greater than 80%, there must be a measurable growth rate and reproduction of neonates in the control samples. Survival of amphipods in the field sediment samples was not significantly different than the 84% average survival demonstrated in the control samples [$p < 0.05$]. Field sediment sample average survival results were 85, 91, 90, 78, 75, 85, and 85 percent. No sediment samples in the Middle River exhibited toxicity contributing to mortality.

Table 10: Sediment Toxicity Test Results

Sample	Amphipod Survival (#)	Amphipod Growth Rate (mg/day)	Neonates (#)	Average Amphipod Survival (%)	Average Amphipod Growth Rate (mg/day)	Average Neonates/survivor
Control A	18	0.052	61	84	0.046	3.3
Control B	15	0.057	75			
Control C	16	0.05	46			
Control D	20	0.036	80			
Control E	15	0.035	30			
MR-01	17	0.022	5	85	0.035	0.7*
MR-01	17	0.031	0			
MR-01	17	0.049	22			
MR-01	17	0.033	14			
MR-01	17	0.041	21			
MR-02	19	0.055	34	91	0.047	1.5
MR-02	16	0.044	28			
MR-02	20	0.049	33			
MR-02	16	0.053	25			
MR-02	20	0.036	18			
MR-03	18	0.05	66	90	0.049	3.3
MR-03	19	0.055	113			
MR-03	13	0.055	40			
MR-03	20	0.036	20			
MR-03	20	0.048	59			
MR-04	15	0.038	42	78	0.043	3
MR-04	19	0.045	48			
MR-04	15	0.037	12			
MR-04	19	0.04	51			
MR-04	10	0.057	63			
MR-05	17	0.051	32	75	0.047	3.1
MR-05	18	0.044	77			
MR-05	19	0.044	63			
MR-05	10	0.039	24			
MR-05	11	0.059	40			
MR-06	19	0.071	71	85	0.064	3.6
MR-06	15	0.07	49			
MR-06	16	0.056	96			
MR-06	16	0.062	37			
MR-06	18	0.059	46			
MR-07	13	0.056	21	85	0.052	2.7
MR-07	15	0.05	16			
MR-07	19	0.049	107			
MR-07	20	0.048	39			
MR-07	18	0.056	54			

Similarly, measurable amphipod growth rates observed in the field sediment samples, which ranged from 0.035 to 0.049, were not significantly different than the growth rate of 0.046 observed in the control sample [$p < 0.05$] therefore no sediment samples exhibited toxicity contributing to a reduction in growth.

Amphipod reproduction rates were not significantly different than the control samples, with the exception of one station, MR01. The control sample exhibited a reproduction rate of 3.3 neonates per survivor, in contrast to 0.7 neonates per survivor at MR01 [$p< 0.05$]. However, this low reproductive rate is puzzling due to the station's location at the mouth of the Middle River. This station has significant interaction with Chesapeake Bay waters, therefore it is unlikely that this observation is due to potential sources of sediment toxicity originating from the Middle River. The significance of this finding is minimal, because the population dynamics of *L. plumulosus,* as well as most benthic invertebrates, are classified as r strategists. Their population dynamics are characterized by rapid growth in population before falling off rapidly. Due to their opportunistic nature, amphipod species will relocate to regions of reduced population. In addition, sufficient compensatory reproductive capacity exists in the Middle River as demonstrated by amphipod reproduction rates at the remaining six stations.

4.0 CONCLUSION

The WQA shows that water quality standards for Cd or Pb are being achieved. Water column samples collected at five monitoring stations in the Middle River, from May 2001 to April 2002, demonstrate that numeric water quality criteria are being met. Bottom sediment samples collected at seven monitoring stations, and used for bioassay toxicity tests, demonstrate no impacts on survival and growth rates, and reproduction impacts at one of the seven stations. In light of the other information, this one reproduction finding is not considered of significance in regard to a determination of toxicity. Barring the receipt of any contradictory data, this information provides sufficient justification to revise Maryland's 303(d) list to remove Cd and Pb as impairing substances in the Middle River.

5.0 REFERENCES

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