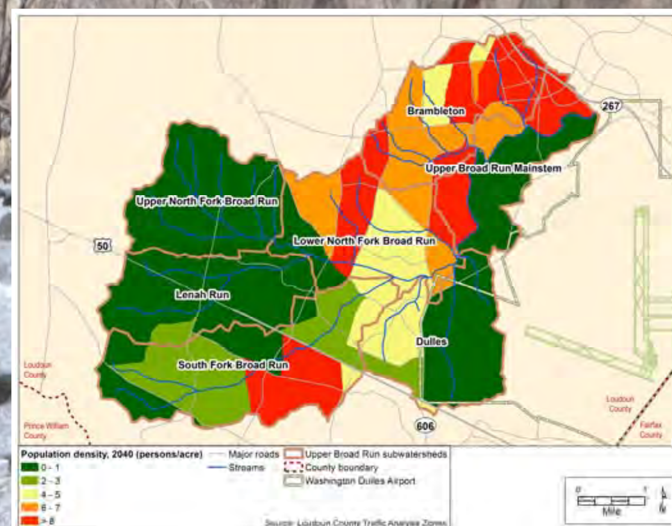
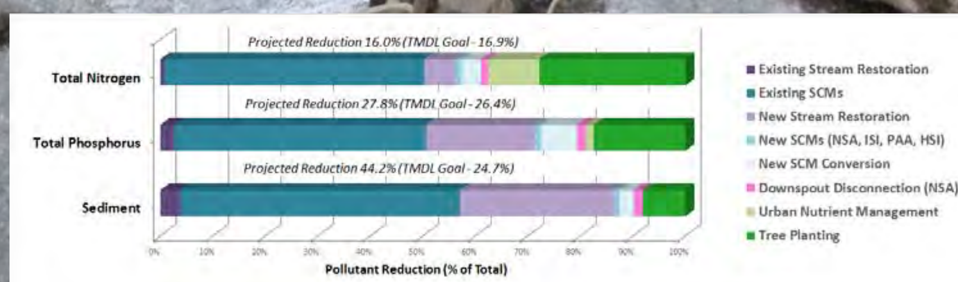
UPPER BROAD RUN WATERSHED MANAGEMENT PLAN





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September 30, 2014

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EXECUTIVE SUMMARY

The Upper Broad Run Watershed Management Plan Pilot Project was undertaken in 2013-2014 to fulfill several purposes, as defined by Loudoun County's Water Resources Technical Advisory Committee (WRTAC) in their original plans for the project:

- Build upon previous, but more general, watershed assessment and planning activities and take the next logical step in the County's on-going watershed management program.
- Provide a basis for cost-effective watershed management plans on a countywide basis.
- Provide a long-term plan to protect and improve watershed conditions in this area, which has many types of planned land use, including the Transition Policy Area, and significant projected future development.
- Provide a list of recommended projects and best management practices (BMPs) to address observed and potential water quality and quantity problems with the watershed.
- Develop pollutant load scenarios based on current and expected future conditions with and without implementing the management plan. These scenarios will provide the County with quantitative pollutant estimates to use in long-term planning and to meet current and future water quality regulatory requirements.
- Include cost estimates for implementing various BMPs and management recommendations that will be useful for forecasting costs to implement watershed management plans elsewhere in the County.

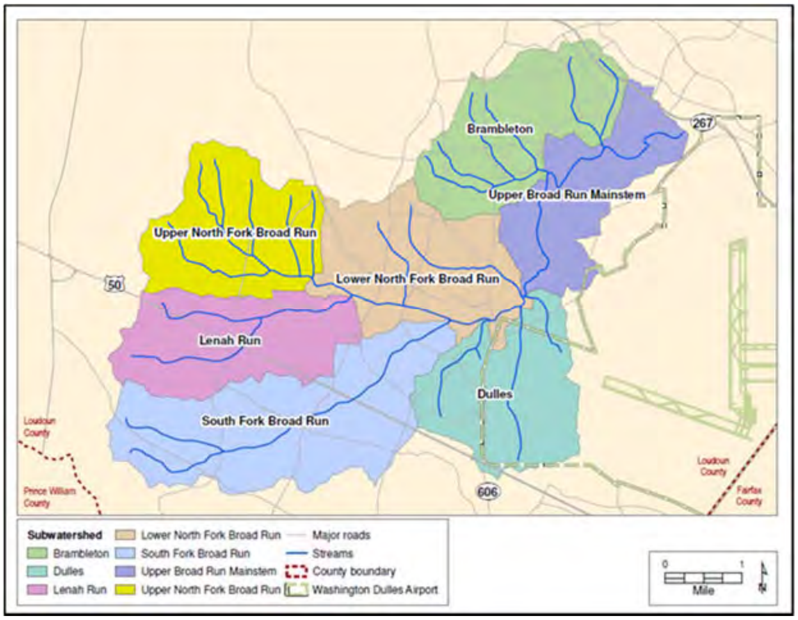
This Upper Broad Run Watershed Management Plan report summarizes the activities conducted to meet these purposes, providing a portrayal of current conditions in Upper Broad Run and proposing specific watershed management recommendations and strategies. The watershed management planning process is intended to address the many mandates that the County must meet in each individual watershed. These include the requirements of the National Pollutant Discharge Elimination System (NPDES), Municipal Separate Storm Sewer System (MS4) permit, watershed-specific Total Maximum Daily Loads (TMDLs), and the Chesapeake Bay TMDL.

Public Involvement

Effective implementation of watershed restoration strategies requires the coordination of diverse watershed partners and the participation of many stakeholders. For the Upper Broad Run Pilot Project this involved conducting local community meetings, participating in a local environmental outreach event, providing updates via the Loudoun County website, and forming a Watershed Partnership Workgroup (WPW). Throughout the project, multiple methods were used to keep the public updated on the project's progress, including postings to the County's webpage (http://www.loudoun.gov/upperbroadrunwatershed), press releases, newsletter items, and announcements via Loudoun County Facebook and Twitter pages.

The Loudoun County WPW included representatives of local homeowner associations, residents, businesses (Loudoun Chamber of Commerce), community organizations (Master Gardeners), Loudoun County Department of Building and Development, Loudoun Water, Loudoun County Public Schools, Loudoun Soil and Water Conservation District, and Virginia Department of Transportation. The Upper Broad Run WPW met four times during the watershed plan development process, providing input on the proposed goals of the watershed plan, issues and specific locations of concern within the watershed, and proposed watershed management strategies.

Upper Broad Run Watershed Overview



The Upper Broad Run watershed is within the Piedmont physiographic region of Virginia, located south of the City of Leesburg and west of Washington Dulles International Airport. It serves as the headwaters to Broad Run, which drains directly into the Potomac River. The 16,863 acres (approximately 26 square miles) of the Upper Broad Run watershed are completely contained within Loudoun County and include parts of several communities including Brambleton, Arcola, and Lenah. For the purposes of watershed management planning, the Upper Broad Run watershed was divided into seven smaller drainage areas called subwatersheds.

Watershed Management Plan Goals

Five goals were identified for restoring the Upper Broad Run watershed, based on input gathered from both the Watershed Partnership Workgroup and the initial community meeting. These goals are:

Goal 1. Improve local watershed/stream conditions to meet Clean Water Act goals such as supporting aquatic life use and contact recreation.

Goal 2. Prevent further degradation of stream habitat, physical integrity, and water quality as watershed lands are developed.

Goal 3. Promote access to streams and streamside areas for recreation.

Goal 4. Educate local businesses and watershed residents about watershed stewardship.

Goal 5. Create a template for developing watershed management plans for other watersheds in Loudoun County.

Watershed Assessment

The initial stages of the investigation centered on assessment of current conditions within the Upper Broad Run Watershed. This assessment was broken into two parts:

1) **Desktop Assessment**

Evaluation of watershed conditions using GIS and other available data including:

a) Climatic conditions

b) Soils information

c) Current land cover based on latest County GIS information

d) Population information using 2010 Traffic Analysis Zone data

e) Existing stormwater infrastructure

f) Zoning and Planned Land Use data

g) Water Quality information from the 2009 Loudoun County Stream Assessment, the 2012 305(b)/303(d) Water Quality Assessment Integrated Report, and Loudoun County illicit discharge information.

2) **Field Assessment**

Current conditions were then assessed by conducting investigations in the field. These assessments were focused on two strategies;

a) **Stream corridor assessments** (SCAs) were conducted for approximately 13 miles of stream reaches within the Upper Broad Run watershed. This method provides a rapid assessment and documentation of environmental problems occurring within stream corridors. Erosion (102 sites) and inadequate buffers (57) were the most common problems observed. Habitat assessments characterizing 49 reaches showed that stream habitat conditions were mostly sub-optimal.

b) **Field survey of upland areas** in the Upper Broad Run watershed included five major components:

- Neighborhood Source Assessments (25 neighborhoods). Assessing each neighborhood for opportunities for specific actions including:
    - downspout disconnection
    - rain barrels, and rain gardens
    - fertilizer reduction/education
    - sustainable landscaping

  - storm drain marking
  - stream buffer improvements
  - open space tree planting
  - open space bioretention and rain garden opportunities

- Hotspot Site Investigations (18 locations). Hotspots are areas (generally commercial, industrial, or transport-related) that have potential to generate higher concentrations of stormwater pollutants than other urban sites because they may have higher risk of spills, leaks, or illicit discharges.
- Institutional Site Investigations (9 school and municipal facilities). Opportunities identified at schools and other institutional sites included:
  - tree plantings
  - stormwater management improvement
  - buffer improvement
  - waste management
- Pervious Area Assessments (8 areas). Open spaces (pervious areas) were assessed for reforestation potential at park and community-owned properties, with potential planting areas totaling about 50 acres.
- Retrofit Reconnaissance Investigations (36 existing stormwater facilities). Stormwater management ponds, both private and public, were evaluated as candidates for conversion to designs with increased pollutant removal efficiencies.

Stormwater Management and Other Watershed Management Practices

Loudoun County has implemented stormwater control measures (SCMs) and other watershed management practices since the 1980s. The earlier focus of stormwater management was detention of large flows to reduce flooding. Subsequent designs addressed water quality treatment and stream channel protection. Most recently, SCMs known as Environmental Site Design (ESD) are being encouraged for new development and to facilitate restoration of watersheds. New Virginia stormwater regulations for new and re-development will require that stormwater management provide for control of water quantity and quality using the latest guidelines. This investigation focused on the effectiveness of existing SCMs, and what categories of practices should be considered as strategies to enhance future watershed management in the Upper Broad Run.

Runoff and Pollutant Load Modeling

A watershed management plan model was developed to estimate current pollutant loads generated by the various non-point sources within the Upper Broad Run watershed. The model was also used to calculate pollutant removal effectiveness for proposed SCMs and other watershed management practices that could be implemented to make progress toward TMDL or other pollutant reduction goals for the Upper Broad Run watershed. A spreadsheet model was developed for the watershed to estimate current pollutant loadings and reductions.

Current Pollutant Load Estimates (based on Edge of Stream Loads)

- Nitrogen: 215,700 lbs/year
- Phosphorus: 14,300 lbs/year
- Sediment: 3,173,000 lbs/year

Pollutant reductions were then estimated for the following suites of watershed management practices:

- Existing SCMs
- SCM Conversion
- New SCMs
- Reforest Stream Buffer
- Pervious Area Reforestation
- Stream Restoration
- Downspout Disconnection
- Tree Plantings (in neighborhoods and at institutions)
- Urban Nutrient Management

If each of these practices were implemented at a designated participation rate, the resulting overall pollutant load reductions would be an estimated 16.5% for total nitrogen, 28.3% for total phosphorus, and 44.5% sediment load reduction. This would make progress toward the 16.9% reduction for nitrogen and would meet the 26.4% reduction for phosphorus and 24.7% reduction for sediment needed to meet water quality standards for the Upper Broad Run watershed, as specified by Chesapeake Bay TMDL for nutrients.

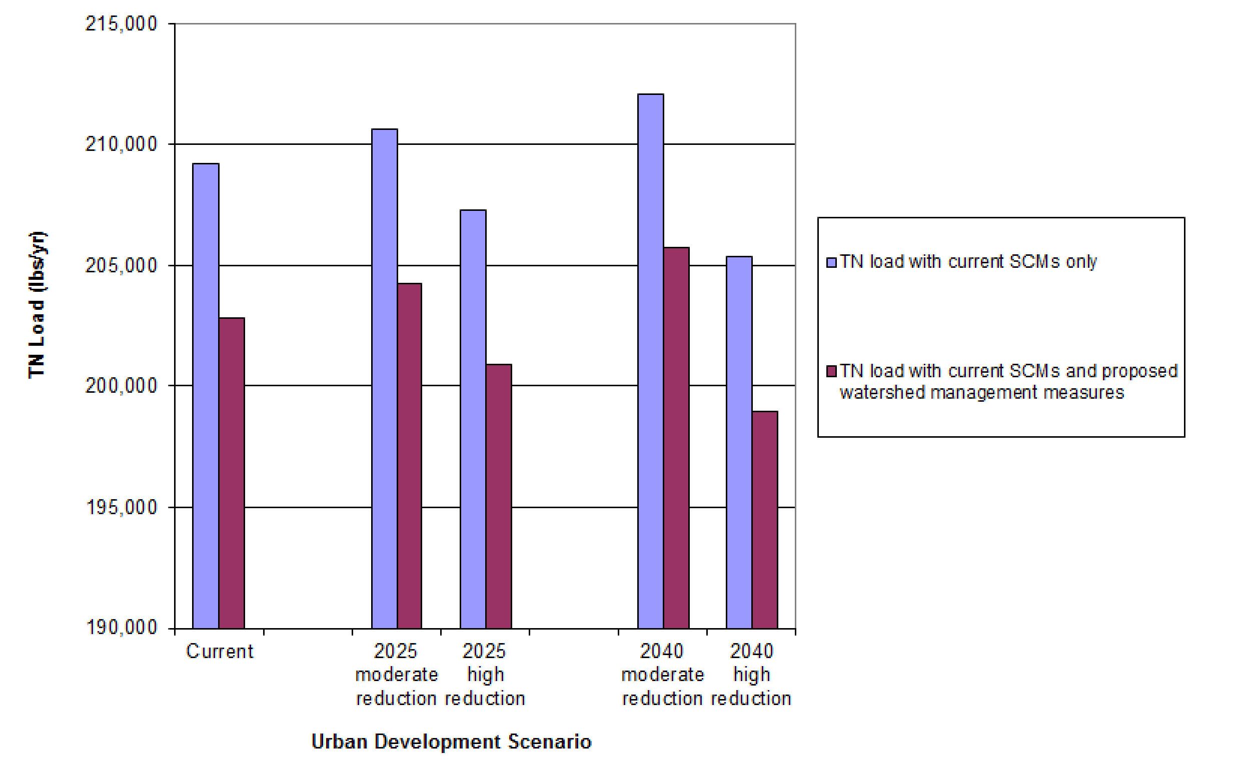
Subwatershed Restoration Strategies

Restoration strategies for each subwatershed are presented in Chapter 7 of this report. A description of key watershed characteristics is presented for each subwatershed, followed by specific recommendations for watershed management measures to be taken, based on assessment results for neighborhoods, hotspots, institutions, pervious areas, stream corridors (including potential stream restoration and preservation sites), and stormwater conversions. Chapter 8 then outlines a restoration priority ranking for each of the subwatersheds based on current conditions and anticipated future conditions.

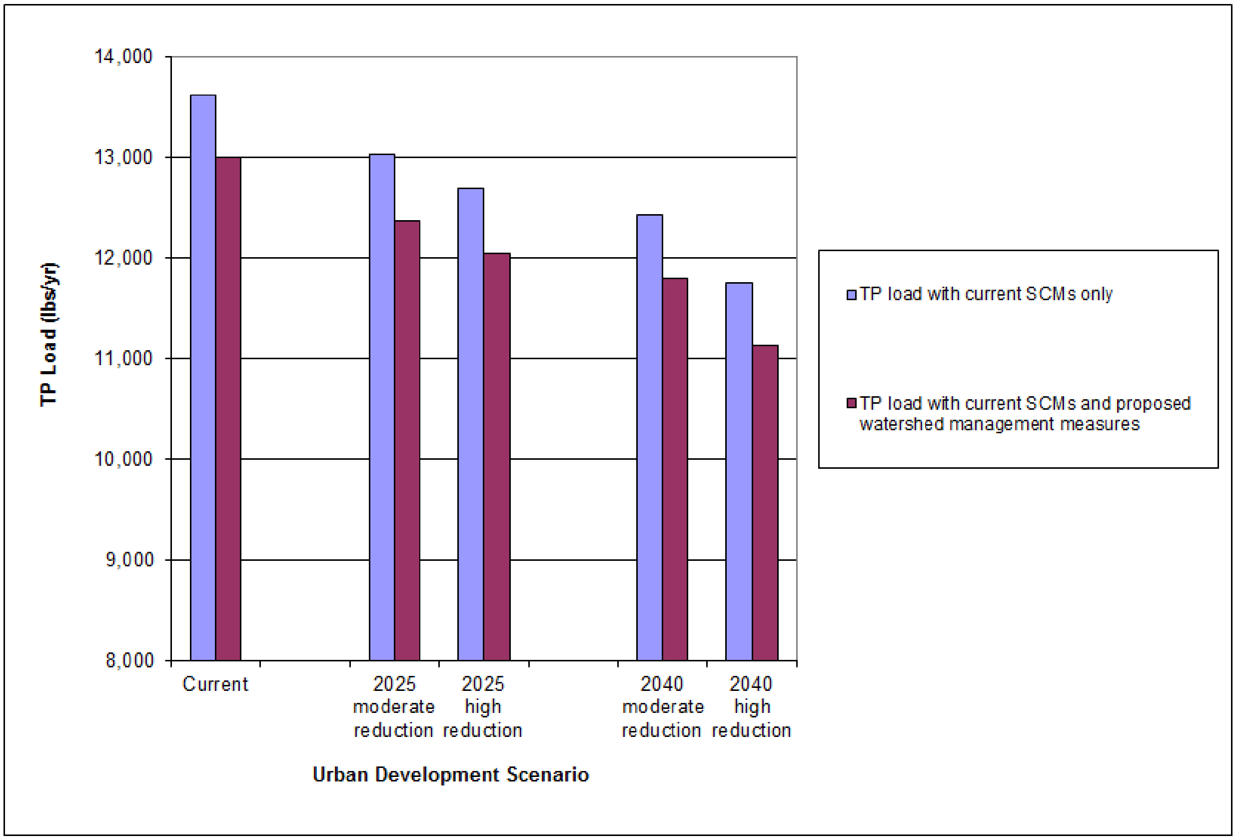
Future Land Use and Pollutant Loads

Projections of future land use were made for the years 2025 (Chesapeake Bay WIP final milestone) and 2040 (timeframe of the County's Traffic Analysis Zone forecast). In addition, pollutant loads and runoff were modeled under four scenarios:

- Current land use/development conditions with proposed practices;
- Current land use/development conditions without proposed practices;
- Future land use/development conditions with proposed practices;
- Future land use/development conditions without proposed practices.



Upper Broad Run total nitrogen (TN) loads estimated for current, 2025, and 2040 land use, without and with implementation of watershed management measures proposed in this plan. Two stormwater management scenarios are presented for each of the future land use scenarios: "moderate reduction" assumes stormwater from new urban areas is treated at rates comparable to current levels, "high reduction" assumes enhanced water quality and quantity treatment, consistent with newer Virginia Stormwater Regulations.

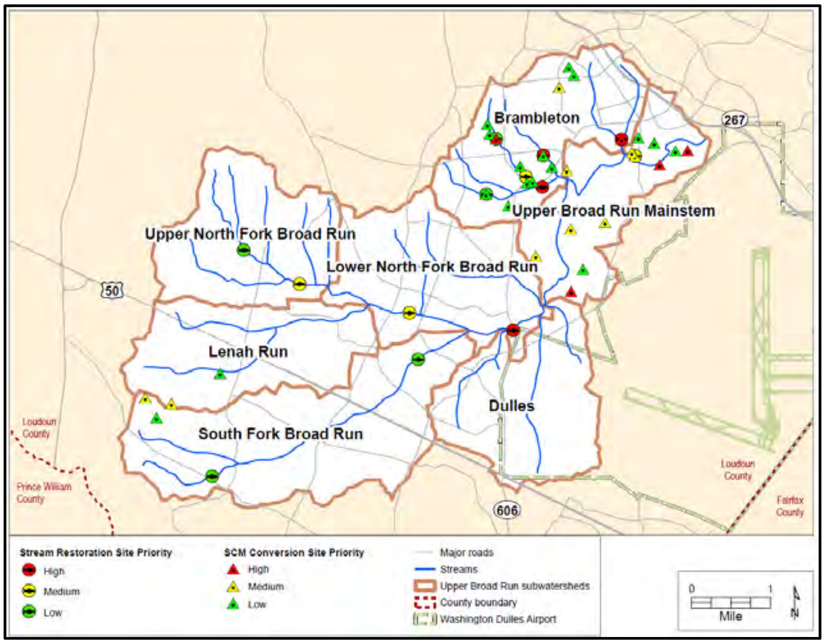


Upper Broad Run total phosphorus (TP) loads estimated for current, 2025, and 2040 land use, without and with implementation of watershed management measures proposed in this plan. Two stormwater management scenarios are presented for each of the future land use scenarios: "moderate reduction" assumes stormwater from new urban areas is treated at rates comparable to current levels, "high reduction" assumes enhanced water quality and quantity treatment, consistent with newer Virginia Stormwater Regulations.

Modeling results indicate that both the implementation of watershed plan recommendations and the type of stormwater treatment employed with future development will likely have a great effect on pollutant loads. For example, if new urban development proceeds with no changes to the suite of SCM practice types commonly used today ("moderate reduction" scenario), annual TN loads would actually increase in 2025 and 2040. However, with improved practices on new urban lands ("high reduction" scenario), TN loads would be expected to decrease. Implementation of the watershed management measures proposed in this plan will further decrease TN loads. According to the model, annual loads of TP would actually be expected to decrease (as a result of converting agricultural lands to urban). Implementing watershed recommendations will further decrease TP loads.

Stream Restoration and SCM Conversion Projects

Chapter 10 of this report provides a detailed list of potential sites for stream restoration and SCM conversion projects. Each project candidate site provides an estimate of pollutant reduction based on currently acknowledged efficiencies, a planning-level cost estimate (based on cost estimates derived from the Loudoun County WIP II Technical Advisory Committee), and an assigned priority ranking for each project. The identified projects include 13 candidate stream restoration sites and 31 candidate SCM conversion sites.



Implementation

Because this watershed is already experiencing rapid changes in land use, reducing the impacts of current and future urbanization will be of key importance to protect and improve water quality in Upper Broad Run. Throughout the plan, numerous opportunities are presented for a variety of watershed management practices that will help achieve watershed goals, including:

- Upgrades and augmentation of existing stormwater controls
- Stream restoration
- Reforestation
- Conservation of existing watershed lands to protect high quality headwaters
- Improved management of business properties
- Best practices for residential lawn and garden maintenance

Chapter 11 of the report offers further information related to implementation of the watershed management plan, including:

- Cost estimates for various plan elements
- Schedule considerations
- A series of programmatic recommendations
- Specific suggestions for involving the community in future watershed planning efforts

Long-term stewardship of the Upper Broad Run watershed will best be accomplished through the combined efforts of residents, the business community, and local agencies and organizations, each of which can play an integral part in watershed management.

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CHAPTER 1: INTRODUCTION

1.1 Purpose

The purpose of the Upper Broad Run Watershed Management Plan Pilot Project was described in a February 2011 memo drafted by Loudoun County's Water Resources Technical Advisory Committee (WRTAC). The memo (WRTAC 2011) stated that the project will:

a) Build upon previous, but more general, watershed assessment and planning activities and take the next logical step in the County's on-going watershed management program.

b) Provide a basis for cost-effective watershed management plans countywide.

c) Provide a long-term plan to protect and improve watershed conditions in this area, which has many types of planned land use, including the Transition Policy Area, and significant projected future development.

d) Have a list of recommended projects and best management practices (BMPs) to address observed and potential water quality and quantity problems with the watershed.

e) Obtain pollutant load scenarios based on current and expected future conditions with and without implementing the management plan. These scenarios will give the County quantitative pollutant estimates to use in long-term planning and to help address current and future water quality regulatory requirements (e.g., the Chesapeake Bay Total Maximum Daily Load, TMDL, or Watershed Implementation Plan, WIP II).

f) Include cost estimates for implementing various BMPs and management recommendations that will be useful for forecasting costs to implement watershed management plans elsewhere in the county.

This Watershed Management Plan Report summarizes the current conditions and proposes watershed management recommendations and strategies for the Upper Broad Run watershed. Current conditions were evaluated through analyses of spatial data provided by Loudoun County and field assessments conducted by the County's consultant, Versar, Inc. Restoration options and recommendations presented within this report, including expected pollutant reductions and estimated costs, will provide a basis for future management of the Upper Broad Run watershed.

1.2 Background

Following the completion of the Loudoun County Comprehensive Watershed Management Plan in 2008, the WRTAC recommended that a watershed management plan pilot project was the next logical step to achieving Loudoun County's goal of effective management of the County's water resources (WRTAC 2011). A watershed management plan identifies strategies to bring a watershed into compliance with water quality standards and to meet other watershed management goals developed by stakeholders. Strategies typically include a combination of government capital projects, actions in partnership with local organizations (such as watershed associations), educational outreach, and volunteer activities.

The watershed management planning process is intended to address the many mandates that the County must meet in each individual watershed. These include the requirements of the National Pollutant Discharge Elimination System (NPDES), Municipal Separate Storm Sewer System (MS4) permit, watershed-specific Total Maximum Daily Loads (TMDLs) and the Bay TMDL. The watershed management plan for the Upper Broad Run watershed will help meet the water quality goals mandated through the Bay TMDL and will prepare for meeting future TMDL goals that are expected to be developed for the watershed's local benthic macroinvertebrate, bacteria, and other impairments.

1.3 Public Involvement

Effective implementation of watershed restoration strategies requires the coordination of diverse watershed partners and the participation of many stakeholders. For the Upper Broad Run Pilot Project this involved conducting local community meetings, participating in a local environmental outreach event, providing updates via the Loudoun County website, and forming a Watershed Partnership Workgroup (WPW).

1.3.1 Community Outreach

Community Meeting # 1

The Upper Broad Run Pilot Project was introduced to the community during a public meeting that was held in the Gum Spring Library on September 16, 2013. Project team staff gave a presentation about the watershed planning process, some of the key existing conditions and characteristics of the Upper Broad Run watershed, proposed goals of the plan, and strategies that may be used to meet those goals. After the presentation the attendees divided into groups to discuss and document their vision for the Upper Broad Run watershed, what major water-related issues they were aware of and would like to see addressed, what locations they would recommend for targeted field visits, and what they believed is needed to implement an effective watershed management plan. Participants were invited to mark specific areas of concern on an electronic map.

Community Meeting # 2

The Upper Broad Run Watershed Management Plan was introduced to the community during a public meeting held at John Champe High School on June 24, 2014. Project team staff gave a presentation about the watershed planning process, reviewed the plan's vision, goals and objectives, and presented findings. Results of the watershed assessment were summarized, along with recommendations for actions to improve water quality.

Family Stream Day

Every fall, Loudoun Watershed Watch and Loudoun Environmental Stewardship Alliance organize an environmental and watershed awareness event known as Family Stream Day. The Family Stream Day event held on October 19, 2013 included multiple stations that contained exhibits and hands-on activities to educate participants about Loudoun County's local watersheds. Versar and Loudoun County Building and Development staff led a station featuring a hands-on family activity, maps, and handouts to promote discussions with local community members about the watershed planning activities occurring as part of the Upper Broad Run Pilot Project.

Ongoing Community Outreach

Multiple methods were used to notify the public of the Upper Broad Run Pilot Project meetings and to keep the public updated on the project's progress. These methods included project updates (including presentations from community and Workgroup meetings) on the County's webpage (http://www.loudoun.gov/upperbroadrunwatershed), press releases, and updates on the Loudoun County Facebook and Twitter pages. A color handout was developed by Loudoun County's Public Affairs and Communications staff to promote and publicize the development of the Upper Broad Run Watershed Management Plan.

1.3.2 Watershed Partnership Workgroup

A knowledgeable and engaged group of stakeholders is an essential part of a successful watershed management plan. The Watershed Partnership Workgroup (WPW) consists of local landowners, residents, businesses, community organizations, government, stormwater management and water supply experts, environmental specialists, and other community members who have collaborated with project staff to address current and future water quality issues that occur within the Upper Broad Run watershed. The Upper Broad Run WPW met four times during the watershed plan development process. The Upper Broad Run WPW members are:

- Loudoun County Department of Building and Development
  - Dennis Cumbie
  - David Ward
  - Glen Rubis

- Virginia Department of Transportation
  - Pawan Sarang

- Loudoun County Public Schools
  - Gary Van Alstyne

- Loudoun Water
  - Micah Vieux

- Loudoun Soil and Water Conservation District
  - Chris Van Vlack

- Loudoun Chamber of Commerce
  - Brian Fauls

- Master Gardeners
  - Alta Jones

- Loudoun Valley Estates Home Owners Association
  - William Stevens

- Brambleton Home Owners Association
  - Rick Stone

- Concerned Citizens
  - Jan Van Camp Lodge
  - Wyatt Latimer
  - Tom Wasaff

A description of each WPW meeting, including date, approximate number of attendees (including project staff), and topics covered is provided below:

WPW Meeting #1 (October 17, 2013; 13 attendees)

Versar staff gave a PowerPoint presentation that included the definition of a watershed, an overview of the watershed planning process, and an overview of conditions in the Upper Broad Run watershed. Versar staff also reviewed the role of the WPW and presented a general project schedule. Discussions that occurred during the meeting included proposed goals of the watershed plan, issues/concerns, existing initiatives/suggested strategies, and specific locations of concern within the watershed.

WPW Meeting #2 (January 15, 2014; 14 attendees)

Versar staff led a discussion with a PowerPoint presentation on several topics: the proposed watershed management plan goals, highlights of GIS and field investigations conducted within the watershed, and work in progress/next steps. Several maps showing different land use and landscape characteristics (e.g., impervious cover map, 100-foot stream buffer map, zoning map) were shown. Most of the presentation focused on the results of the field investigations and assessments that were conducted October 2013 through January 2014.

WPW Meeting #3 (April 10, 2014; 11 attendees)

Versar staff led a discussion with a PowerPoint presentation on the watershed plan development process, highlights of Retrofit Reconnaissance Investigations (RRIs), and highlights of the interim report. WPW members provided comments to be incorporated into the final interim report and the Watershed Management Plan.

WPW Meeting #4 (June 5, 2014; 9 attendees)

Versar staff led a discussion with a PowerPoint presentation on several topics. Updated recommendations for stormwater pond conversions and stream restoration were presented, reflecting new information that the project team had incorporated. In addition, updated pollutant load modeling results were discussed. The workgroup discussed the upcoming June 2014 Community Meeting and ways to distribute information to homeowner associations and other groups, both for the meeting and for involvement in future watershed plan implementation. A representative from Willowsford Conservancy described the management of open space within the Willowsford developments in the western part of Upper Broad Run watershed.

1.4 Upper Broad Run Watershed Overview

The Upper Broad Run watershed is within the Piedmont physiographic region of Virginia, located south of the City of Leesburg and west of Washington Dulles International Airport (Figure 1-1). It serves as the headwaters to Broad Run, which drains directly into the Potomac River. The 16,863 acres (approximately 26 square miles) of the Upper Broad Run watershed are completely contained within Loudoun County and include parts of several communities including Brambleton, Arcola, and Lenah. Table 1-1 summarizes the key watershed characteristics of Upper Broad Run.

While characterizing the baseline conditions of the entire watershed is necessary for creating a watershed management plan, a thorough evaluation of potential pollution sources and restoration strategies within smaller drainages is also critical. The Upper Broad Run watershed was divided into seven smaller drainage areas called subwatersheds (Figure 1-2). Further information regarding the characteristics of the Upper Broad Run watershed and its seven subwatersheds is provided in Chapter 3.

Table 1-1: Key Characteristics of Upper Broad Run Watershed

Drainage Area	16,863 acres (26.3 sq. mi.)	
Stream Length	43.3 miles	
Subwatersheds	7	
Jurisdictions	Loudoun County, VA	
Land Use/Land Cover	Barren:	0.2%
	Cropland:	17.5%
	Forest:	39.4%
	Pasture:	12.2%
	Urban Impervious:	8.0%
	Urban Pervious:	20.7%
	Water:	1.2%
	Missing:	0.8%
Impervious Cover	1,527.9 acres (9.1% of watershed)	

Table 1-2: Key Characteristics of Upper Broad Run Watershed

Soils*	A Soils (low runoff potential):	0%
	B Soils:	9.2%
	C Soils:	22.8%
	D Soils (high runoff potential):	48.7%
	[#]B/D Soils:	5.0%
	[#]C/D Soils:	5.9%

*There is no soil data for approximately 8.4% of the watershed.
[#]Dual Hydrologic Soil Group. See Chapter 3 for further detail.

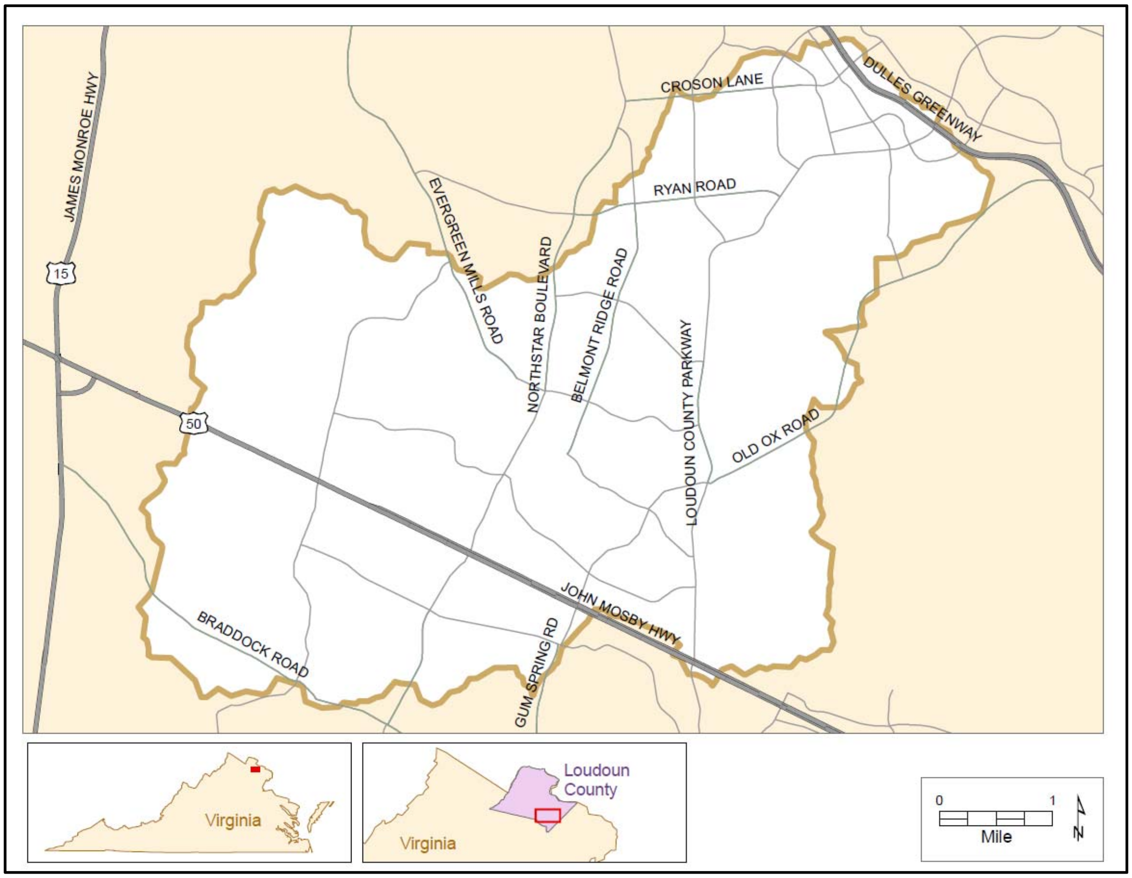


Figure 1-1: Upper Broad Run Watershed

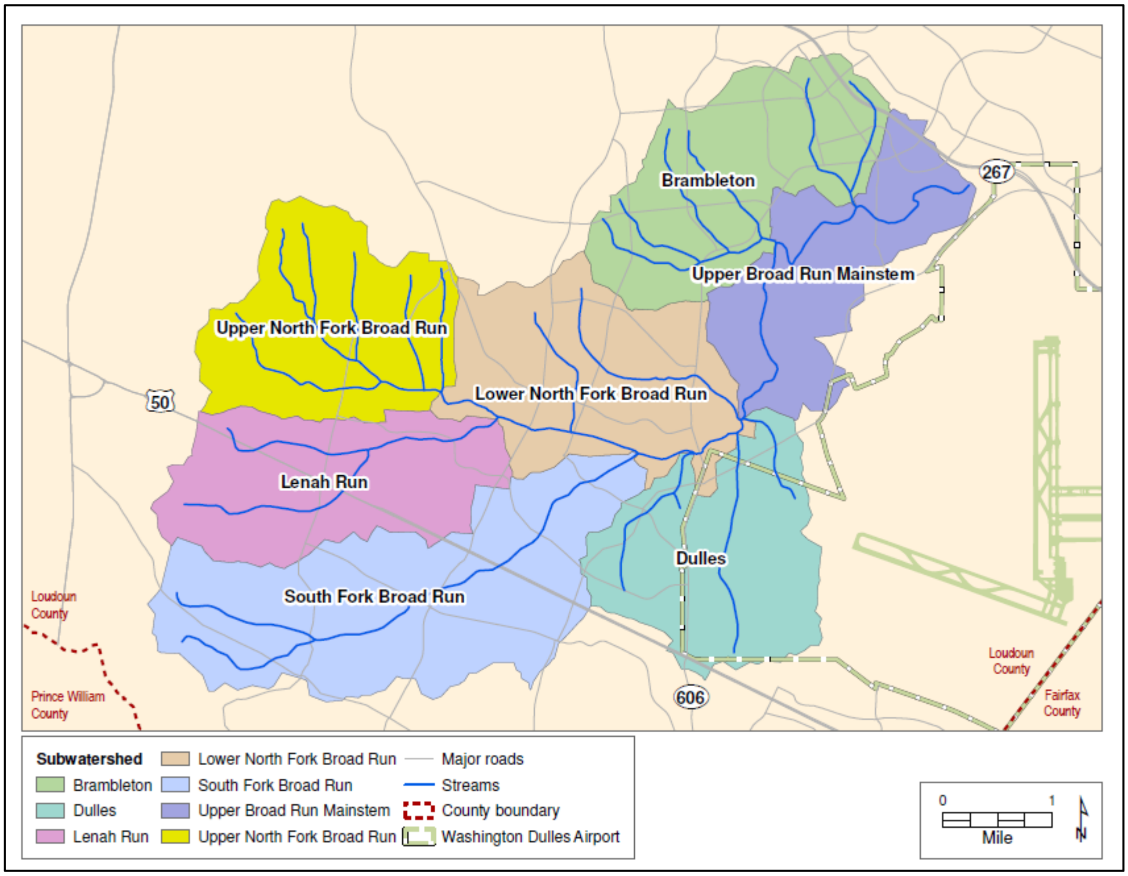


Figure 1-2: Upper Broad Run Subwatersheds

1.5 Report Organization

This report is organized into the following 12 chapters:

Chapter 1 explains the purpose of this report, provides background on the initiation of the Upper Broad Run Pilot Project, summarizes the public's involvement in the project, and gives an overview of the report and project area.

Chapter 2 covers the vision, goals, and objectives of the Upper Broad Run Watershed Management Plan agreed upon by the WPW and members of the community.

Chapter 3 summarizes the watershed characteristics obtained from GIS analyses. This includes information about the natural landscape features such as geology, topography, soils, forest cover, and streams, as well as information pertaining to the human modified landscape such as population, impervious cover, stormwater structures, water distribution, discharge permits, and zoning. This chapter also summarizes the water quality data that are available for the watershed, including the locations and types of surface water quality impairments.

Chapter 4 summarizes the field work completed for the watershed plan. Field work was completed to identify pollutant sources and restoration opportunities in selected stream reaches, neighborhoods, hotspots, institutions, pervious areas, and existing stormwater management facilities.

Chapter 5 presents descriptions of restoration strategies that are applicable to the Upper Broad Run watershed and are designed to reduce pollutant loading within the watershed.

Chapter 6 explains the modeling approach used in the watershed management plan. This includes an estimate of existing pollutant loads and estimated reductions based on the proposed restoration strategies.

Chapter 7 gives a detailed summary of the restoration strategies proposed for each subwatershed.

Chapter 8 explains the methods used to calculate scores for criteria that evaluate the restoration potential within each subwatershed. The chapter provides a final subwatershed ranking based on the scores calculated for the evaluation criteria.

Chapter 9 provides an analysis of projected future land use and estimates of future pollutant loads.

Chapter 10 includes concepts and planning-level costs for potential stream restoration and stormwater pond conversion opportunities that were identified as part of developing the watershed plan.

Chapter 11 discusses considerations for plan implementation, including cost estimates for various plan elements, a proposed timeframe, programmatic recommendations, and recommendations for public involvement.

Chapter 12 provides a list of sources that are cited within this report.

CHAPTER 2: VISION, GOALS, AND OBJECTIVES

2.1 Vision Statement

This plan proposes the following vision statement to serve as a guide in the development of management recommendations and strategies for the Upper Broad Run watershed. This statement was created based on input from the Watershed Partnership Workgroup and from community members who participated in Upper Broad Run watershed management planning workshops:

> *Our vision for the future is that Upper Broad Run becomes a noticeable asset to the community and is seen as a natural resource to be enjoyed and preserved in healthy condition. We envision a watershed that sustains streams with good water quality that is free of contamination or excessive erosion, allowing for recreation in areas in and adjacent to Broad Run and its tributaries. We envision a watershed where forest cover is protected and where development is conducted in a manner that minimizes adverse impacts to streams.*

2.2 Upper Broad Run Goals & Objectives

Five goals were identified for restoring the Upper Broad Run watershed based on the vision statement and input gathered from both the Watershed Partnership Workgroup and community meetings. These goals are:

- **Improve local watershed/stream conditions** to meet Clean Water Act goals of supporting aquatic life use and contact recreation.
- **Prevent further degradation** of stream habitat, physical integrity, and water quality as watershed lands are developed.
- **Promote access** to streams and streamside areas for recreation.
- **Educate** local businesses and watershed residents about watershed stewardship.
- **Create a template** for developing watershed management plans for other watersheds in Loudoun County.

The following sections discuss each of the five goals for restoring the Upper Broad Run watershed. For each goal, a series of objectives was developed to facilitate progress toward the goal. Action strategies describe the method that will be used to achieve each objective and ultimately, the watershed goal. The action strategies developed to achieve these objectives and goals will be summarized in the final watershed management plan.

The general types of restoration strategies proposed for the Upper Broad Run watershed are discussed further in Chapters 5 and 7. An adaptive management approach will be emphasized as the watershed management plan is implemented. This approach includes evaluating the success of plan implementation over time and modifying action strategies based on community acceptance and availability of funding.

2.2.1 Goal 1: Improve local watershed/stream conditions to meet Clean Water Act goals such as supporting aquatic life use and contact recreation

The Clean Water Act requires that waters meet standards set by Virginia, such as for aquatic life use, which are generally measured by sampling the streams' macroinvertebrate community and comparing the organisms present to similar, healthy streams within the same region and stream type. Contact recreation depends on having streams free of unhealthy levels of bacteria and other pathogens.

- **Objective 1A. Make recommendations for actions that will help the County meet the Phase II WIP "Pollution Diet" targets for reducing nitrogen, phosphorus, and sediment.** While there are currently no local TMDLs for Upper Broad Run, the entire watershed is subject to the Chesapeake Bay TMDL for nutrients and sediment. Watershed Implementation Plans (WIPs) have been developed by the Commonwealth of Virginia to provide a roadmap for achieving the nutrient and sediment reductions necessary to implement the TMDL. Meeting these TMDL goals will go a long way toward improving overall water quality in the Upper Broad Run and achieving the community's vision for the watershed.
- **Objective 1B. Identify locations and opportunities for stormwater retrofits, in support of the County's stormwater (MS4) permit.** To further reduce pollutant loads from existing developed areas, the County should identify opportunities to upgrade or enhance existing stormwater management facilities. In addition, stormwater runoff from impervious areas not currently controlled can be treated by implementing new stormwater treatment methods.
- **Objective 1C. Prepare to address future Total Maximum Daily Load (TMDL) requirements that will be developed as a result of local impairments.** In 2008 Virginia listed segment VAN-A09R_BRB04A08 of the Upper Broad Run as impaired for aquatic life use as measured by the biological integrity (based on benthic macroinvertebrates) and bacteria. Impaired waters will require development of TMDL by 2020 that will specify improvements needed to restore these segments to a condition that fully supports water quality standards for aquatic life. In 2012 this river segment was listed for bacteria levels which exceeded the recreational water use standard. A bacteria TMDL is required to be written by 2024 (Virginia DEQ 2012). VA DEQ has tentatively scheduled to address the benthic and bacteria TMDL in 2016 (J. Carlson, personal communication, July 10, 2014).

2.2.2 Goal 2: Prevent further degradation of stream habitat, physical integrity, and water quality as watershed lands are developed

Planned urban/suburban development is a major factor in the future of the Upper Broad Run watershed. Rapid population growth, road development, commercial areas, a transportation center, residential neighborhoods, and new schools are all planned for the Upper Broad Run watershed. Careful planning prior to development can identify the highest quality stream and riparian habitats for preservation and help to put in place appropriate protections for maintaining water quality and stream channel integrity throughout the watershed.

- **Objective 2A. Select areas for protection as well as restoration**. "Saving the pieces" is a well-known refrain in ecology. It is often far less expensive and more successful to maintain healthy ecosystem components in good condition than to attempt to restore or re-create that condition after ecosystems become degraded.
- **Objective 2B. Mimic pre-development hydrologic condition, through the use of appropriate stormwater management.** Future development will need to adhere to the latest regulatory requirements for stormwater management, which focus on employing Environmental Site Design (ESD) approaches to achieve post-development hydrologic conditions similar to pre-development.

2.2.3 Goal 3: Promote access to streams and streamside areas for recreation

- **Objective 3A. Improve public access to Upper Broad Run and its tributaries.** There is no substitute for engaged and involved citizens participating in the protection of their local watersheds. A good first step to engaging citizens is making them aware of their connections to the Upper Broad Run, its tributaries, and the issues particular to this watershed. In a modern, suburban landscape, it is easy to become disconnected from the natural environment, because few people have a stream running through their backyard. By raising awareness about the issues facing a nearby stream, citizens can act on a local scale, where they are more likely to see the positive effects of their actions, and thus continue their efforts. Recreational opportunities and access via parks and other open space areas should be promoted, so that residents have opportunities to appreciate the natural environment of their local streams. When people have hiked along a trail or paddled a stream or river, and seen firsthand the impact of trash and pollution, they are usually more motivated to participate in clean-ups and advocate for the health of the watershed.

2.2.4 Goal 4: Educate local businesses and watershed residents about watershed stewardship

- **Objective 4A. Conduct educational outreach to schools, residents, and business communities throughout the watershed to encourage and support actions that reduce pollutant loads to local waterways.** Providing information can encourage both residents and businesses to implement practices that benefit the natural environment (e.g., recycling, using environmentally friendly car-washing and landscaping practices).
- **Objective 4B. Encourage community stewardship through watershed restoration and cleanup activities**. There are many ways for people to develop a connection to the local streams that feed Upper Broad Run. People are empowered when they can physically make a

difference and improve their community. Clean-ups, tree plantings, and other restoration projects are great opportunities for education and involvement. Students, families, and community groups (civic, corporate, religious, etc.) are readily available labor sources.

2.2.5 Goal 5: Create a template for developing watershed management plans for other watersheds in Loudoun County

Upper Broad Run was selected, in part, because it contains natural, cultural and planned development elements that are anticipated to be encountered throughout Loudoun County.

CHAPTER 3: DESKTOP ASSESSMENT OF CURRENT CONDITIONS

This chapter describes the current conditions in the Upper Broad Run watershed, including natural landscape characteristics, development activities, existing water quality monitoring efforts, and local water quality impairments. Natural landscape related parameters such as geology and topography strongly influence the formation of drainage patterns and the baseline quality of the water that they transport. For example, streams located within a watershed containing carbonate bedrock, such as limestone, are more likely to have higher pH values than streams in a watershed containing igneous bedrock, such as granite. Human-modified landscape parameters such as impervious cover and land use strongly influence the quantity and quality of watershed runoff. For example, the amount and rate at which precipitation will be absorbed by the ground surface depends on the infiltration capacity of a soil for pervious areas; impervious surfaces (e.g., paved areas and rooftops) impede rainfall infiltration which can result in greater runoff rates and volumes, along with a decrease in groundwater supply. In addition, the type and extent of pollutants carried by stormwater is affected by land use characteristics. The information presented in this chapter provides the quantitative perspective needed to characterize the entire Upper Broad Run watershed and its seven subwatersheds so that the appropriate restoration recommendations and strategies can be developed.

3.1 Natural Landscape

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

3.1.1 Climate

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

The average annual temperature at Washington Dulles International Airport is 55.3 ºF; based on 30 years of data (1981-2010) (NOAA 2014). The monthly averages range from 33.2 ºF in January to 76.7 ºF in July. The average annual rainfall at Washington Dulles International Airport is 41.54 inches, and monthly average rainfall is 3.5 inches, based on the same 30-year data set. Rainfall is uniformly distributed through the year, with monthly averages ranging from 2.68 inches in January to 4.55 inches in May. Most snowfall occurs in December, January, February, and March; an average annual snowfall of 22.2 inches is based on 31 years of data (1981-2011).

3.1.2 Watershed Delineation

A watershed-based approach for evaluating water quality conditions and improvement potential involves determining the drainage area that contributes runoff and groundwater to a specific water body. Drainage areas vary greatly depending on the scale of the stream system of interest. Drainage areas for large river, estuary, and lake systems are typically on the order of several thousand square miles, and are usually referred to as basins. For example, the Potomac River basin covers over

14,000 square miles and includes portions of four different states. Basins consist of sub-basins, which are on the order of several hundred square miles and may consist of one or more major stream networks. Virginia has 50 sub-basins, including the Middle Potomac-Catoctin sub-basin. These units are then further subdivided into watersheds and subwatersheds, which are a practical size for watershed assessment, management, and restoration planning.

The Upper Broad Run watershed covers approximately 26 square miles in southern Loudoun County. For the purposes of Loudoun County watershed management planning, the project team used stream maps and topographic data to divide the Upper Broad Run watershed into seven subwatersheds, ranging in size from 2.93 to 5.62 square miles (Figure 1-2).

3.1.3 Geology

The Upper Broad Run watershed lies completely within the Piedmont physiographic province. The Piedmont province contains several rift basins that originated during the early Mesozoic, a time when the African and North American plates were separating. The Upper Broad Run watershed is entirely contained within the Culpeper rift basin (or just the Culpeper Basin), which spans from Culpeper County, VA to Frederick County, MD. The Culpeper Basin contains mainly clastic sedimentary rocks of fluvial and lacustrine origin (Lee and Froelich 1989), with chiefly siltstone and shale being present within the Upper Broad Run watershed. The Culpeper basin and the Upper Broad Run watershed also include numerous intrusions of igneous diabase rock. The geologic formations of the Upper Broad Run watershed are shown in Figure 3-1, and a complete breakdown of bedrock type percentages by subwatershed is given in Table 3-1. Note that some thermally altered metamorphic rocks likely border most of the diabase intrusions, but are not shown at this scale.

The geology of the Upper Broad Run watershed has a strong influence on many of the other characteristics of the watershed, including the distribution of different slope classifications and the physical and chemical properties of soils, all of which are discussed in the next two sections.

Table 3-1: Geological Composition by Subwatershed (%)

	Bedrock Type				
Subwatershed	Conglomerate, Sandstone	Sandstone,Siltstone, Conglomerate, Shale	Sandstone, Siltstone	Shale, Siltstone	Diabase
Brambleton	0.0	0	61.3	27.7	10.9
Upper Broad Run Mainstem	0.0	0	14.8	58.3	26.8
Dulles	0.0	0	0.0	73.2	26.7
Lenah Run	23.7	36.6	0.0	31.7	8.0
Lower North Fork Broad Run	0.0	0	2.7	87.8	9.1
South Fork Broad Run	10.1	18.6	0.0	45.6	25.8
Upper North Fork Broad Run	10.3	33.7	0.0	19.2	36.9
Total	6.6	13.2	10.5	49.0	20.7

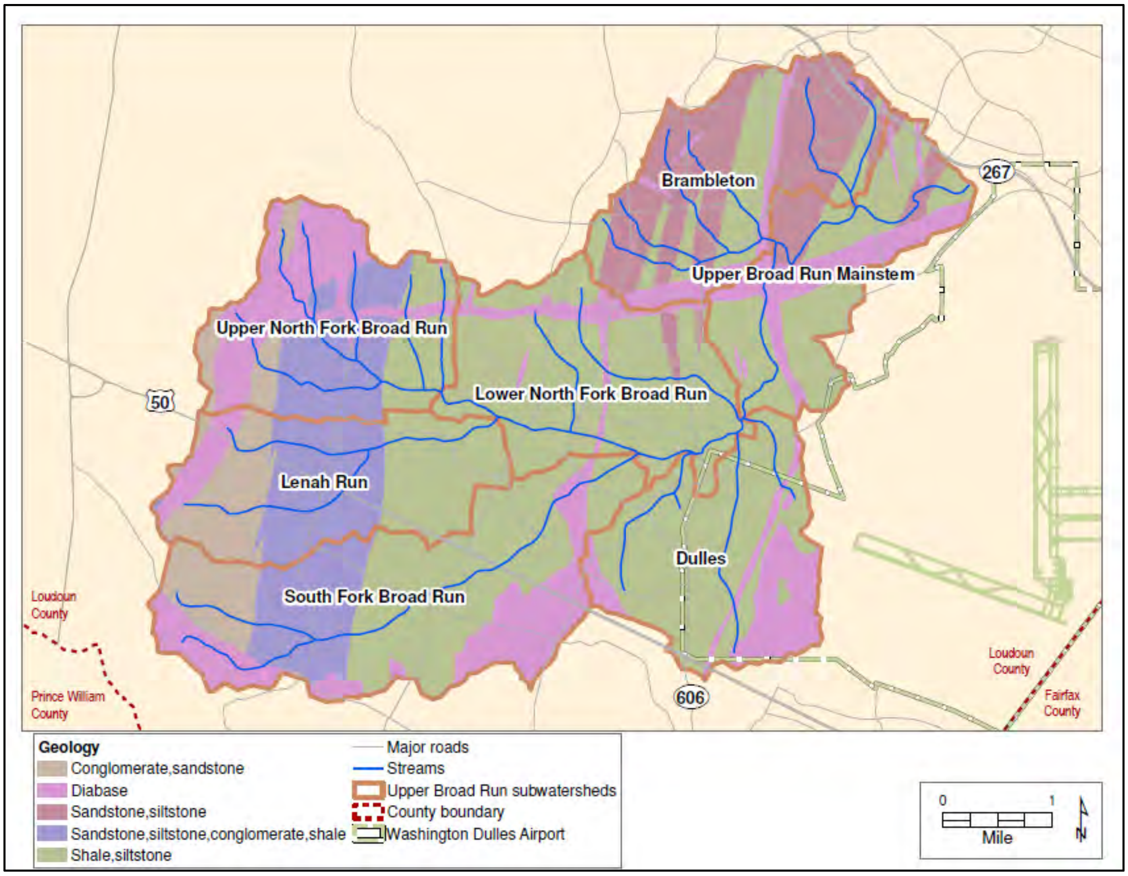


Figure 3-1: Upper Broad Run Watershed Geology

3.1.4 Topography

The topography of a region describes the relative elevations of surface features, such as ridges and valleys. Land surface shape, including degree of slope and concavity, is important as it affects the flow of surface water, soil erosion patterns, and suitability for development. For example, steep slopes are more prone to overland flow and soil erosion than flatter slopes, and thus have a greater potential for generating pollutants. Slopes were based on Loudoun County's GIS Steep Slope data and divided into two categories, derived through a modeling process based on topography:

- (15-25% slopes) and
- (> 25% slopes).

Table 3-2 summarizes the percent breakdown of each steep slope category by subwatershed. The distribution of these slope categories within the Upper Broad Run watershed is depicted in Figure 3-2. Only a small percentage of the watershed has greater than 15% slopes. The slopes within this watershed are generally gentler than those found in portions of the surrounding Piedmont due to a lack of tectonic forces occurring after the deposition and lithification of the fluvial and lacustrine sediments in the Culpeper Basin. Only a few small areas scattered throughout the watershed have slopes that are categorized as > 25%, and would be more prone to erosion, depending on development and land use.

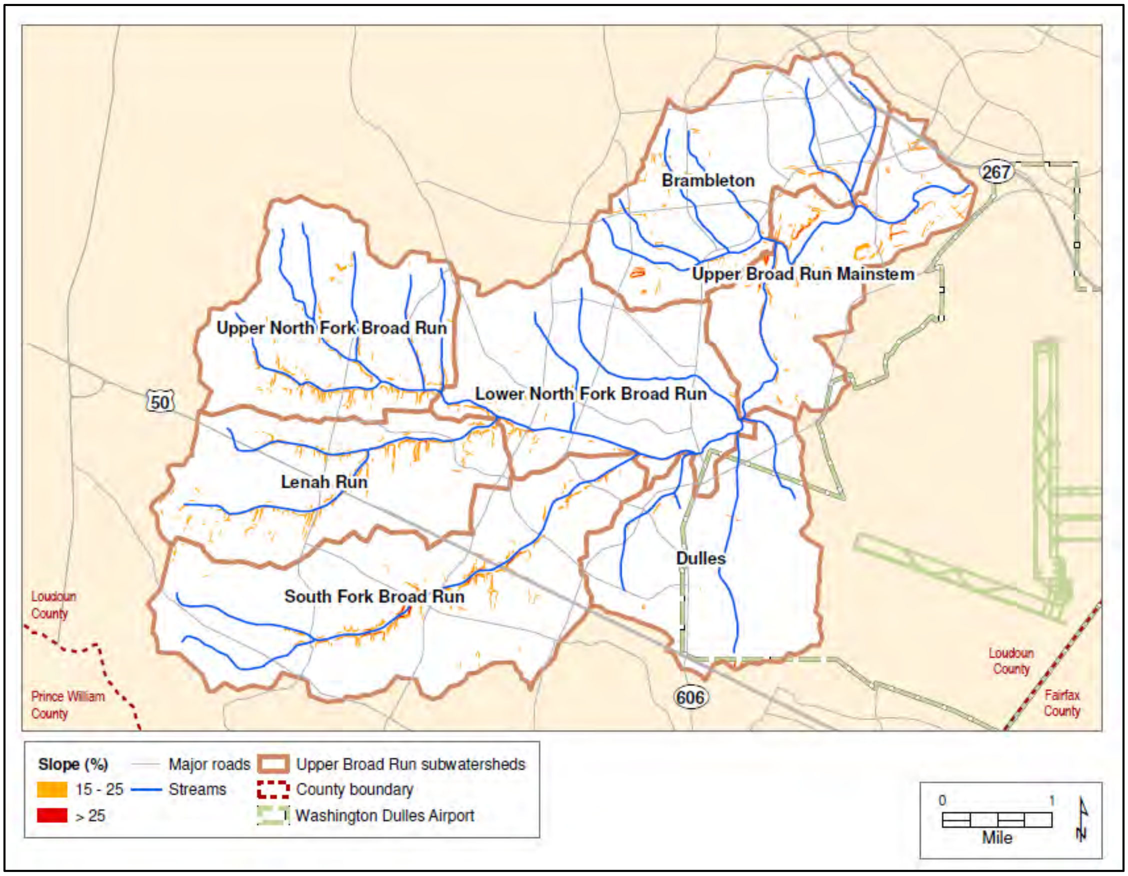


Figure 3-2: Upper Broad Run Watershed Topography Based on Steep Slopes

Table 3-2: Upper Broad Run Steep Slope Categorization

Subwatershed	Slope (Percent)	
	15-25%	> 25%
Brambleton	1.3	0.3
Upper Broad Run Mainstem	2.7	1.1
Dulles	0.3	0.1
Lenah Run	3.2	0.3
Lower North Fork Broad Run	0.7	0.1
South Fork Broad Run	1.9	0.4
Upper North Fork Broad Run	2.8	0.2
Total	1.8	0.4

3.1.5 Soils

Soil conditions are important when evaluating how a watershed affects water quantity and quality in streams and rivers. Soil type and moisture conditions, for example, impact how land may be used and its potential for vegetation and habitat. Soils are an important consideration for projects aimed at improving water quality and/or habitat. Loudoun County's GIS soils layer was used for the soils data analysis and is a representation of the Loudoun County Soil Survey (Loudoun County 2000).

3.1.5.1 Hydrologic Soil Groups

The Natural Resource Conservation Service (NRCS) classifies soils into four hydrologic soil groups (HSG) based on runoff potential. Runoff potential is the opposite of infiltration capacity (ability for the soil to absorb precipitation). Soils with high infiltration capacity will have low runoff potential, and vice versa. Infiltration rates are highly variable among soil types and are also influenced by disturbances to the soil profile (e.g., land development activities). For example, urbanization in watersheds with high infiltration rates (e.g., sands and gravels) will have a greater impact than urbanization in watersheds consisting mostly of silts and clays, which have low infiltration rates. Factors that affect infiltration rate include soil permeability (influenced mostly by texture and structure), slope, degree of soil saturation, and percentage of leaf litter cover. The four hydrologic soil groups are A, B, C, and D, where group A soils generally have the lowest runoff potential and Group D soils have the greatest. Some soils are classified as group D because of a high water table that creates a drainage problem, but can be placed in another soil group if effectively drained. These types of soils are assigned to a dual hydrologic soil group (A/D, B/D, or C/D), where the first letter corresponds to the drained condition, and the second to the undrained condition (USDA 2009).

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

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

with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very low rate of water transmission.

As shown in Table 3-3 and Figure 3-3, the majority of soils in the Upper Broad Run watershed are soil groups with higher runoff potential. The high density of C and D soils within the watershed are due to the large amounts of silt and clay derived from the siltstone, shale, and diabase bedrock. A higher density of B soils are present in the western portion of watershed due to the increased presence of sandstone and conglomerate that formed from the lithification of sands and gravels in an alluvial fan environment that was present in the Late Triassic and Early Jurassic. The location of soils with a high runoff potential (C and D soils) is important to note for land use planning purposes, as the low infiltration rates of these soils mean that they are more susceptible to flooding and provide a poor porous medium for stormwater ponds and Environmental Site Design (ESD) opportunities as shown in Figure 3-4.

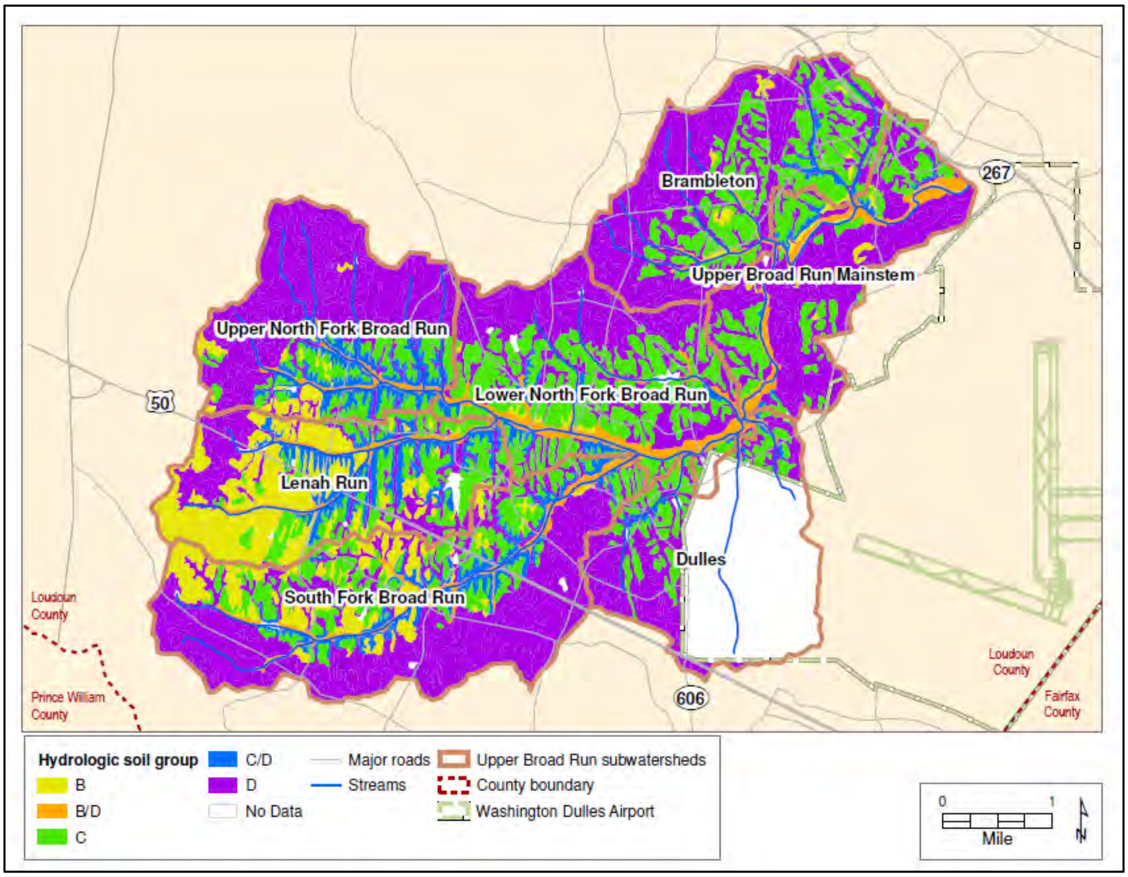


Figure 3-3: Upper Broad Run Watershed Hydrologic Soil Groups

Table 3-3: Upper Broad Run Watershed Hydrologic Soil Group Categorization

Subwatershed	Soil hydrologic group (%)				
	B	C	D	B/D	C/D
Brambleton	2.1	30.6	63.6	2.3	1.4
Upper Broad Run Mainstem	2.4	22.7	62.2	9.2	2.0
Dulles*	1.2	12.3	26.7	1.2	1.3
Lenah Run	37.6	21.8	20.8	4.9	13.5
Lower North Fork Broad Run	0.7	39.3	44.1	9.5	3.6
South Fork Broad Run	13.8	18.7	54.6	5.0	7.4
Upper North Fork Broad Run	5.1	14.2	66.4	3.3	10.8
Total	9.2	22.8	48.7	5.0	5.9

*Approximately 57% of the Dulles subwatershed has not been assigned a hydrologic soil type

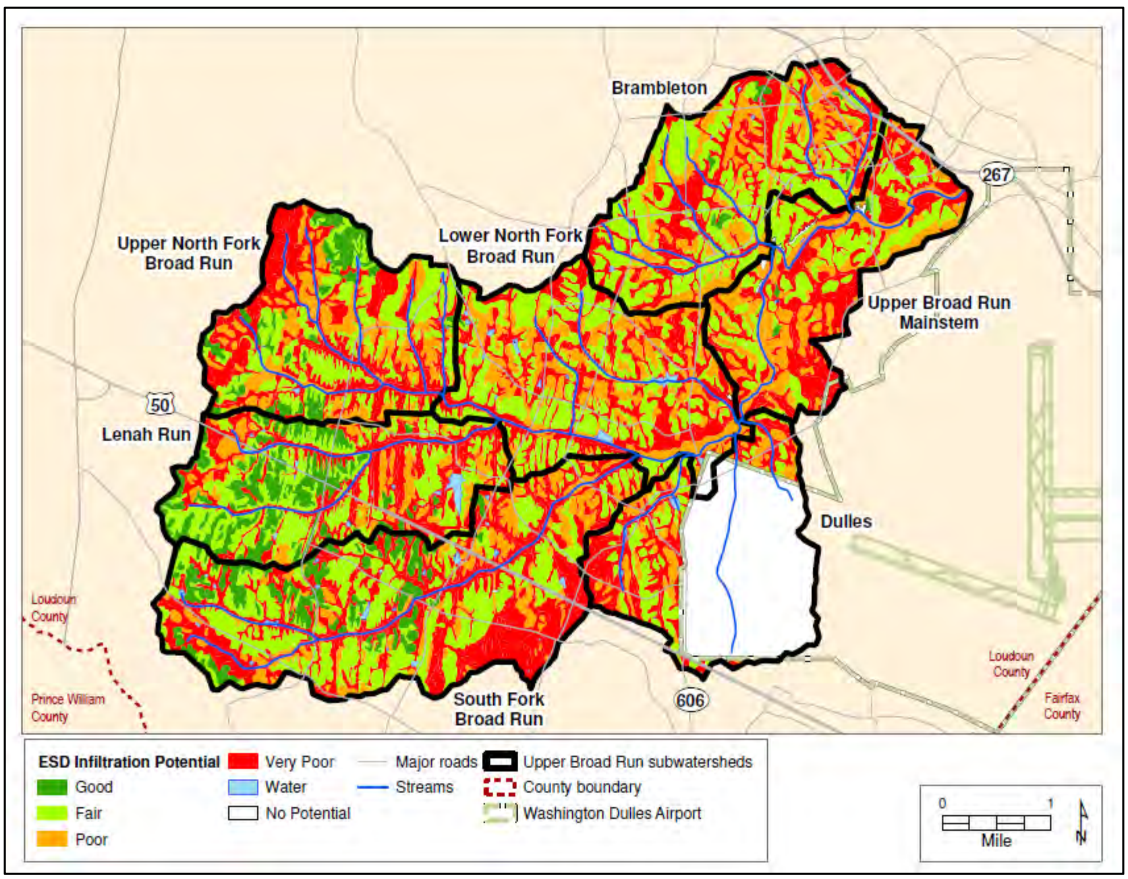


Figure 3-4: Upper Broad Run ESD Potential Based on Soils

3.1.5.2 Erodibility

Erodibility is the susceptibility of soil to erosion. It is quantified by the K factor, which is part of the Revised Universal Soil Loss Equation (RUSLE) developed by USDA's Agricultural Research Service to estimate rate of erosion and soil loss for a particular site. Low K factor values indicate low erodibility or high resistance to detachment and high K factors represent high erodibility potential. Erodibility is based on the physical and chemical properties of the soil, which determine how strongly soil particles cohere with one another. For example, clay soils are cohesive or resistant to detachment and have low K values on the order of 0.05 to 0.15 (Jones et al. 1996).

Soil erodibility was divided into the following four categories, based on the soils data obtained from Loudoun County:

- Low Erodibility (K factor < 0.2);
- Medium Erodibility ($0.2 \leq$ K factor ≤ 0.4);
- High Erodibility ($0.4 \leq$ K factor ≤ 0.65 and
- Very High Erodibility (K factor > 0.65).

Figure 3-5 shows the distribution of soil erodibility in the Upper Broad Run watershed based on these categories and a summary by subwatershed is shown in Table 3-4. Subwatersheds with the largest fractions of highly erodible soils present the greatest potential for addressing soil conservation issues via best management practices (BMPs) such as minimizing bare soil and keeping topsoil in place. Soil erodibility data are also useful in combination with other information such as location of cropland, slope steepness, and distance to streams to determine where retirement of highly erodible land, another BMP, may be appropriate. High K factor values can also serve as a warning for urban activities planned near streams such as road construction or utility placements.

As shown in Table 3-4 and Figure 3-5, very high and high erodibility categories represent over 70 percent of the soil erodibility distribution in the Upper Broad Run watershed. This indicates that more than half of the watershed's soils are prone to high erosion. Nearly all of the Brambleton and Lower North Fork Broad Run subwatersheds consist of highly erodible soils. This is likely due to the high amount of silt present in the surface soils found in these two subwatersheds. These subwatersheds should rank as a priority for maintaining the remaining protective land cover such as forested area.

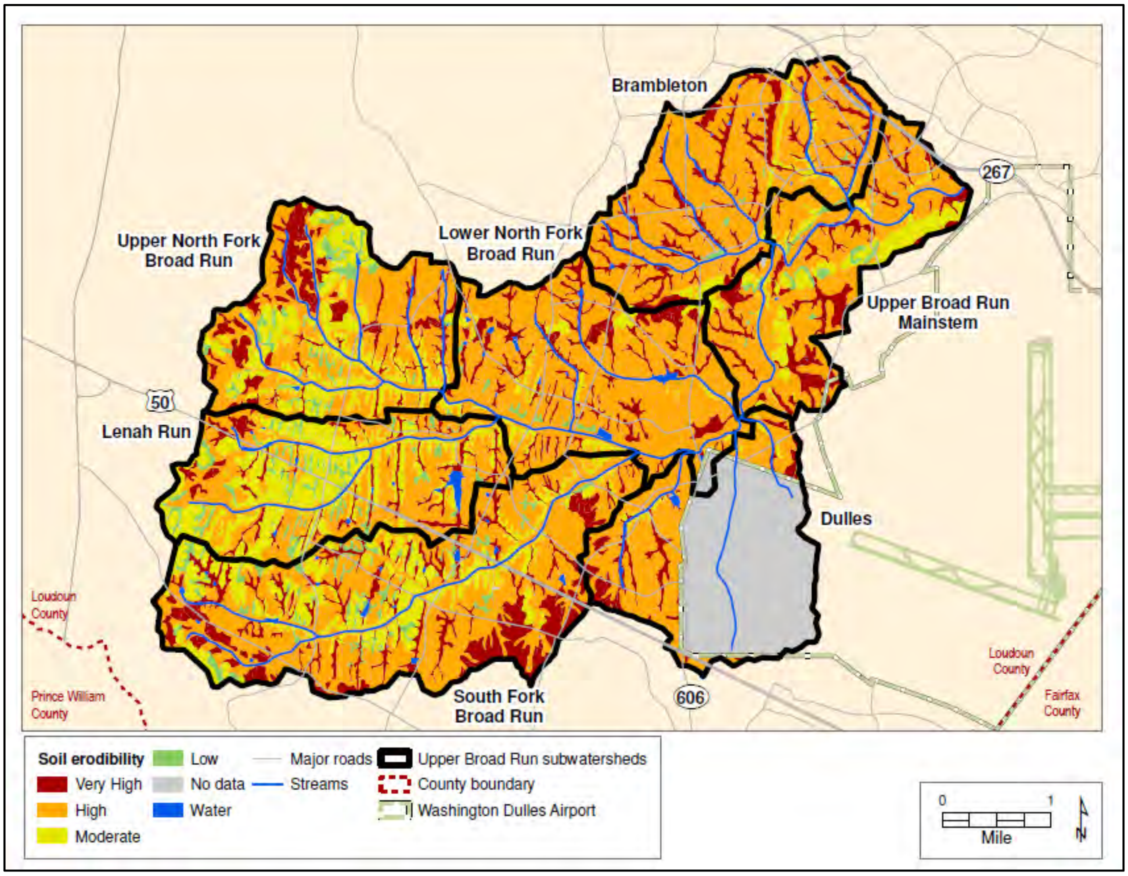


Figure 3-5: Upper Broad Run Watershed Soil Erodibility

Table 3-4: Upper Broad Run Watershed Soil Erodibility Categorization

Subwatershed	Erodibility (%) Very High	High	Moderate	Low	Water	No data
Brambleton	19.2	75.1	4.6	0.7	0.3	0.0
Upper Broad Run Mainstem	18.4	54.8	12.3	2.0	0.6	0.3
Dulles	8.0	32.2	1.2	0.0	0.3	58.3
Lenah Run	10.2	44.5	37.4	6.3	1.6	0.0
Lower North Fork Broad Run	16.5	73.6	5.8	0.9	1.7	1.5
South Fork Broad Run	22.2	52.7	19.8	4.3	1.0	0.0
Upper North Fork Broad Run	17.8	49.5	27.1	5.2	0.4	0.0
Total	16.6	55.9	15.9	2.9	0.9	7.7

3.1.6 Forest Cover

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

While the forested area has been greatly reduced in the Upper Broad Run watershed since European settlement, some subwatersheds have maintained a relatively high percentage of forest cover (e.g., Dulles, Upper North Fork Broad Run and Lenah Run) compared to more urbanized watersheds in the region. Table 3-5 summarizes forested acres and percent forested area by subwatershed and Figure 3-6 shows the distribution of forest cover within the Upper Broad Run watershed based on Loudoun County's generalized GIS Forest layer.

Table 3-5 shows that the Upper Broad Run watershed has approximately 6,566 acres of forested area, which is approximately 39% of the total watershed area. Most of this forest cover is contained within the western portion of the watershed and within Dulles International Airport property, where large tracts of undeveloped, forested land still exist.

Table 3-5: Upper Broad Run Watershed Forest Cover by Subwatershed

Subwatershed	Forested Acres	Forests Total Acres	Percent Forested
Brambleton	379.1	2335.1	16.2
Upper Broad Run Mainstem	650.0	1875.5	34.7
Dulles	1339.6	2160.5	62.0
Lenah Run	905.3	2200.5	41.1
Lower North Fork Broad Run	670.9	2472.6	27.1
South Fork Broad Run	1475.2	3594.7	41.0
Upper North Fork Broad Run	1145.8	2223.9	51.5
Total	6566.0	16862.8	38.9

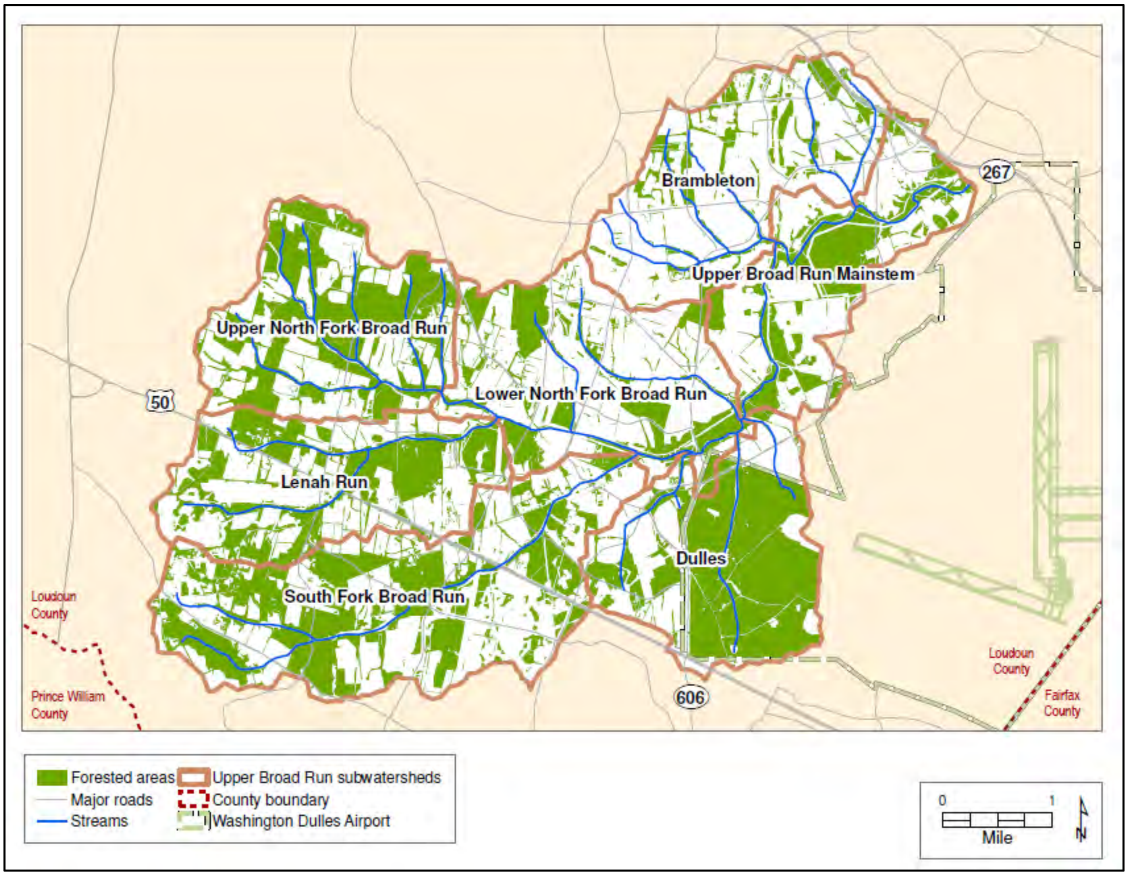


Figure 3-6: Upper Broad Run Watershed Forest Cover

3.1.7 Stream Systems

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 insuring that stream flows and water quality closely mimic the conditions found in un-impacted watersheds.

3.1.7.1 Stream System Characteristics

The Upper Broad Run watershed is one of several watersheds found within the Middle Potomac-Catoctin sub-basin, which is part of the Potomac River basin (VA DCR 2014). This watershed is subdivided into seven subwatersheds, and contains approximately 43 miles of stream. These streams all drain to Broad Run, and ultimately to the Potomac River. A summary of stream mileage and density by subwatershed is included in Table 3-6. Figure 1-2 shows the streams and the seven subwatersheds that make up the Upper Broad Run watershed. The Upper North Fork Broad Run and Brambleton subwatersheds have the largest number of stream miles.

Table 3-6: Upper Broad Run Stream Mileage and Density

Subwatershed	Stream Length (miles)	Subwatershed Area (sq. miles)	Stream Density (miles/sq. mile)
Brambleton	8.01	3.65	2.20
Upper Broad Run Mainstem	4.39	2.93	1.50
Dulles	4.80	3.38	1.42
Lenah Run	4.71	3.44	1.37
Lower North Fork Broad Run	6.75	3.86	1.75
South Fork Broad Run	6.39	5.62	1.14
Upper North Fork Broad Run	8.23	3.47	2.37
Total	43.28	26.35	1.64

3.1.7.2 Stream Riparian Buffers

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

The vegetative condition of the riparian buffer was analyzed based on a 100-foot buffer on either side of the stream system. Three conditions were used to classify stream buffer conditions: forest, open pervious, and impervious. Impervious areas were determined by overlaying the Loudoun County Impervious GIS layer over the 100-foot stream buffer layer. Similarly, the forested areas were determined by overlaying the Loudoun County Forest layer over the 100-foot stream buffer layer. Remaining areas were classified as open pervious areas. Stream buffer conditions are summarized by subwatershed in terms of acres and percentages in Table 3-7. The distribution of the 100-ft stream buffer classification scheme is shown in Figure 3-7. As expected, streams in the recently urbanized Brambleton subwatershed had the lowest percentage of forested land and the greatest proportion of impervious surface within the 100-foot buffer corridor. The Upper North Fork Broad Run subwatershed, the least urbanized of the seven subwatersheds, had the highest percentage of forest cover and the lowest proportion of impervious surface within the 100-foot buffer corridor.

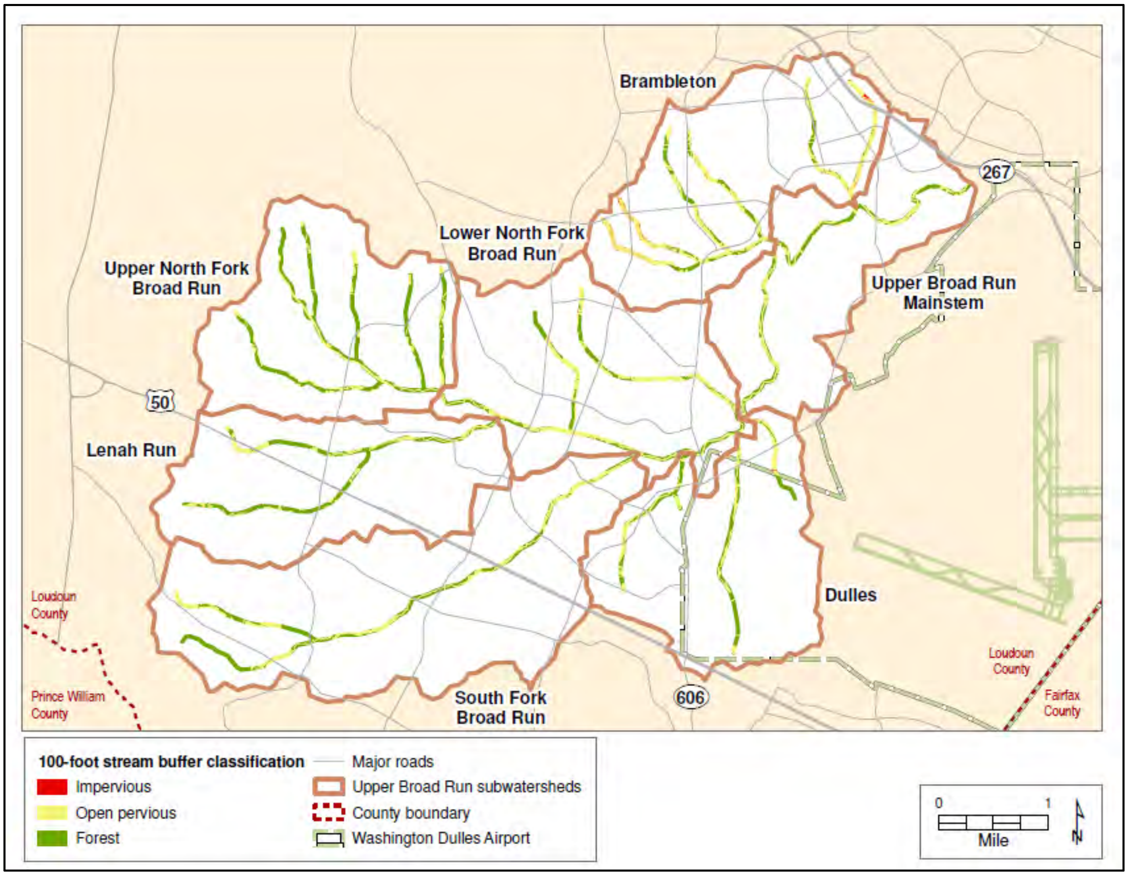


Figure 3-7: Upper Broad Run Watershed 100-foot Stream Buffer Condition

Table 3-7: Upper Broad Run Land Use in 100-foot Stream Buffer by Subwatershed

Subwatershed	Forest		Open Pervious		Impervious	
	Acres	Percent	Acres	Percent	Acres	Percent
Brambleton	61.62	31.7	108.88	55.9	24.16	12.4
Upper Broad Run Mainstem	62.08	58.8	42.68	40.5	0.75	0.7
Dulles	68.35	59.2	45.06	39.0	2.04	1.8
Lenah Run	80.38	70.2	32.06	28.0	2.03	1.8
Lower North Fork Broad Run	79.41	48.8	80.93	49.7	2.40	1.5
South Fork Broad Run	89.58	57.9	64.06	41.4	1.19	0.8
Upper North Fork Broad Run	153.99	77.0	45.21	22.6	0.80	0.4
Total	595.41	56.83	418.88	39.98	33.36	3.18

3.2 Human Modified Landscape

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

3.2.1 Land Use and Land Cover

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

The Upper Broad Run watershed land use layer was developed to represent conditions in 2012, for use in mapping and in watershed modeling (see Chapter 6). The model requires the following categories: Cropland, Forest, Pasture, Urban Pervious (turf), Urban Impervious (pavement), and Water. Data sets developed by Loudoun County staff generally defined the Forest and Water polygons throughout the watershed, and Impervious features in Urban areas. All other data types employed the 2012 Cropland Data Layer available through U.S. Department of Agriculture National Agricultural Statistics Service, which Loudoun County staff had converted to polygons and provided as supporting data. Urban areas were defined as those which were either listed as "developed" in Cropland Data Layer (CDL) data or named in Loudoun County parcel data sets. Neighborhoods delineated by the parcel data through interpretation of aerial photography and other sources were also included under the Urban classification. March 2012 aerial imagery, provided by Loudoun County, was used to inspect each subdivided area for evidence that it was indeed developed (i.e., houses and roads were completely built and at least most of the lots were occupied); and only developed neighborhoods received an Urban classification. Impervious data were designated within Urban areas. Forest and Water land uses were derived from Loudoun County data sets. Within the Urban category, all areas that were not Forest, Impervious, or Water received a Pervious designation. For all non-Urban areas, CDL designations were used to define areas as agricultural cropland or pasture. A summary of land use/land cover percentages by subwatershed is included in Table 3-8. A map of land use/land cover according to the method described above is shown in Figure 3-8. Loudoun County's MS4 permit area was not used in the development of the Upper Broad Run land use map because several areas within the MS4 boundary had not been developed (based on the data sets evaluated), and several areas outside of the boundary were developed. Therefore, this boundary was not viewed as a reliable demarcation between urban and non-urban land uses. A map of the extent of the County's MS4 permit area within the Upper Broad Run watershed is shown in Figure 3-9.

Table 3-8: Upper Broad Run Watershed Land Use/Land Cover Categorization

Subwatershed	Land Use (percent)							
	Barren	Crop-land	Forest	Pasture	Urban Impervi-ous	Urban Pervious	Water	Miss-ing
Brambleton	0.3	13.7	16.2	4.4	20.6	43.1	1.3	0.4
Upper Broad Run Mainstem	0.3	6.3	34.7	9.4	15.7	30.7	1.6	1.3
Dulles	0.2	10.3	64.9	6.7	5.5	11.1	0.8	0.5
Lenah Run	0.0	20.9	41.2	13.6	3.3	18.4	1.5	1.0
Lower North Fork Broad Run	0.2	27.0	27.4	16.5	6.2	20.1	2.0	0.7
South Fork Broad Run	0.2	16.0	41.1	13.6	6.4	20.4	1.2	1.2
Upper North Fork Broad Run	0.0	26.4	51.8	19.3	0.2	1.3	0.3	0.6
Total	0.2	17.5	39.4	12.2	8.0	20.7	1.2	0.8

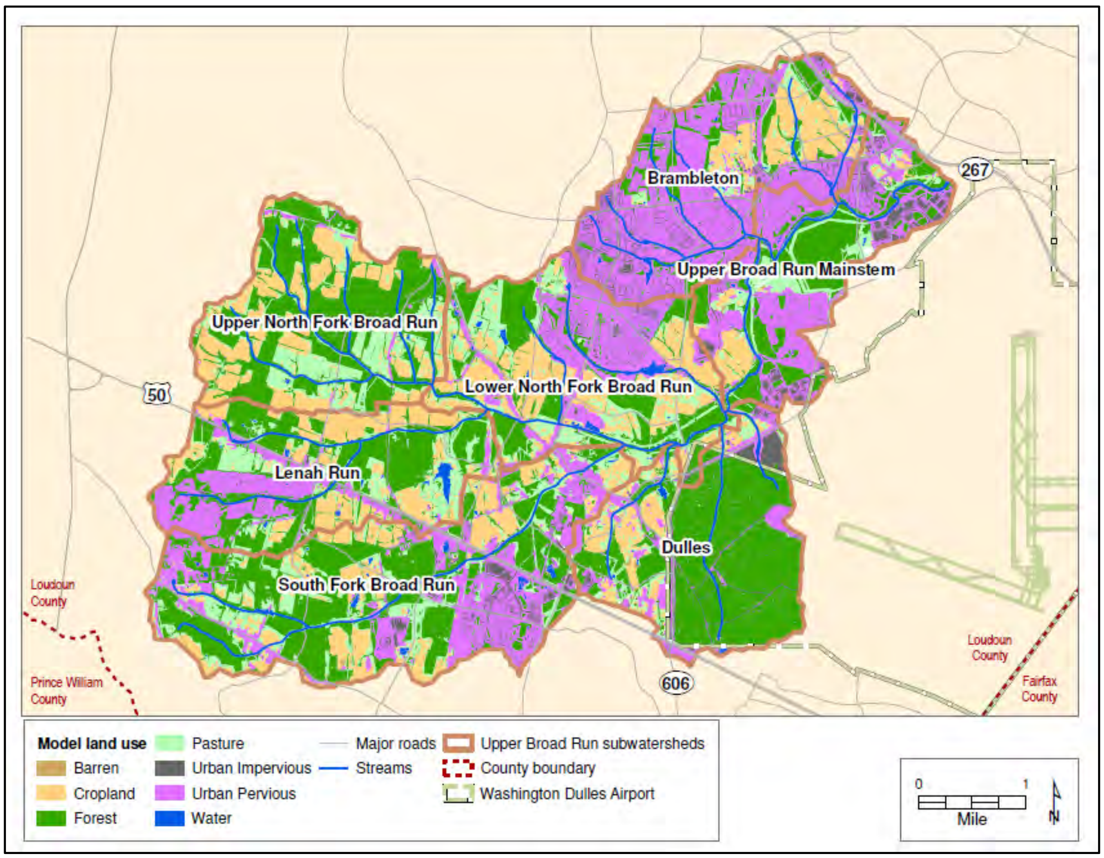


Figure 3-8: Upper Broad Run Watershed Land Use/Land Cover

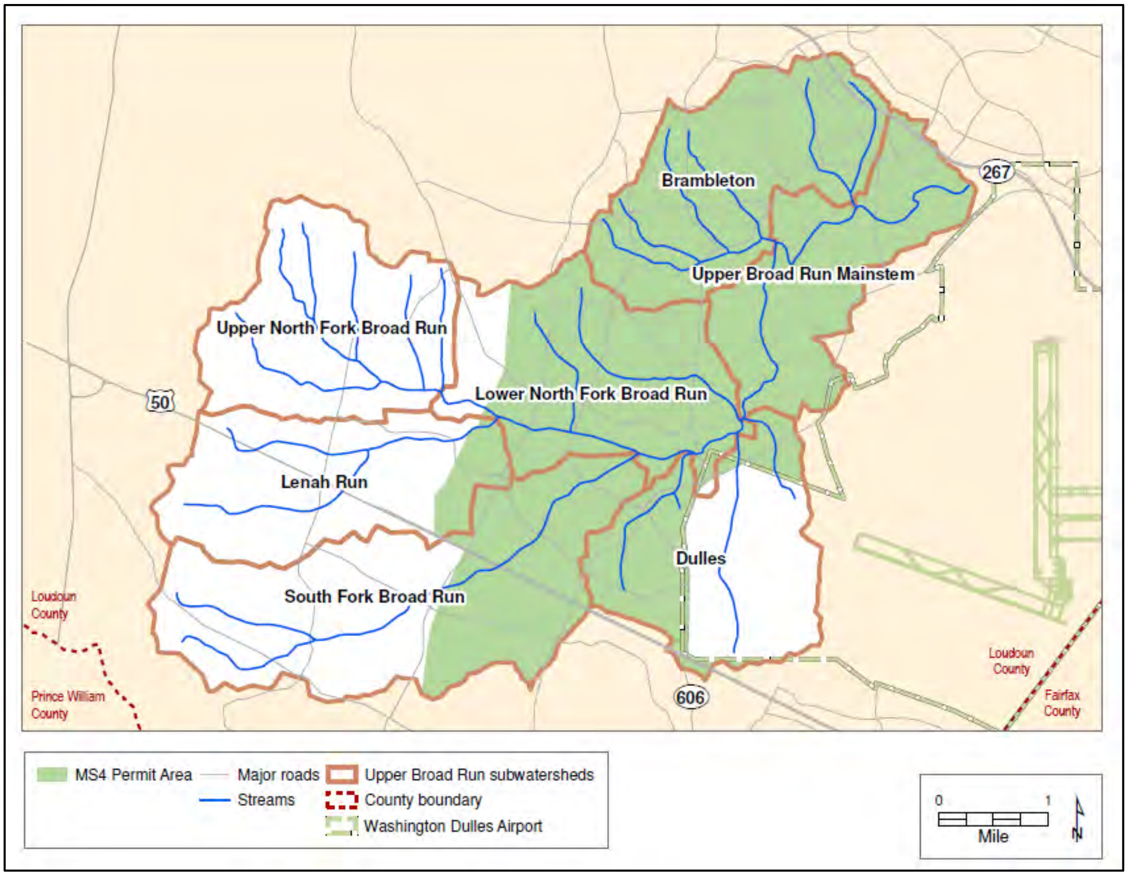


Figure 3-9: Upper Broad Run Watershed MS4 Permit Area

The Upper Broad Run watershed encompasses approximately 16,863 acres (26.3 square miles) of land. The primary land uses in the watershed are Forest (39%), found mainly in the western portion of the watershed and in the Dulles subwatershed, and Urban Pervious (21%), which covers a large portion of the northeastern portion of the watershed. Cropland is spread throughout the entire watershed, but most of this land use type that is located in the eastern portion of the watershed is quickly being converted to urban pervious and urban impervious. Figure 3-10 shows the rapid influx of residential developments in the vicinity of Belmont Ridge Rd. and Creighton Rd., which once was dominated by croplands for several decades. A similar change in land use is likely to occur in the western portion of the watershed in the coming decades, at densities as outlined in county zoning (see Section 3.2.7) or as amended.

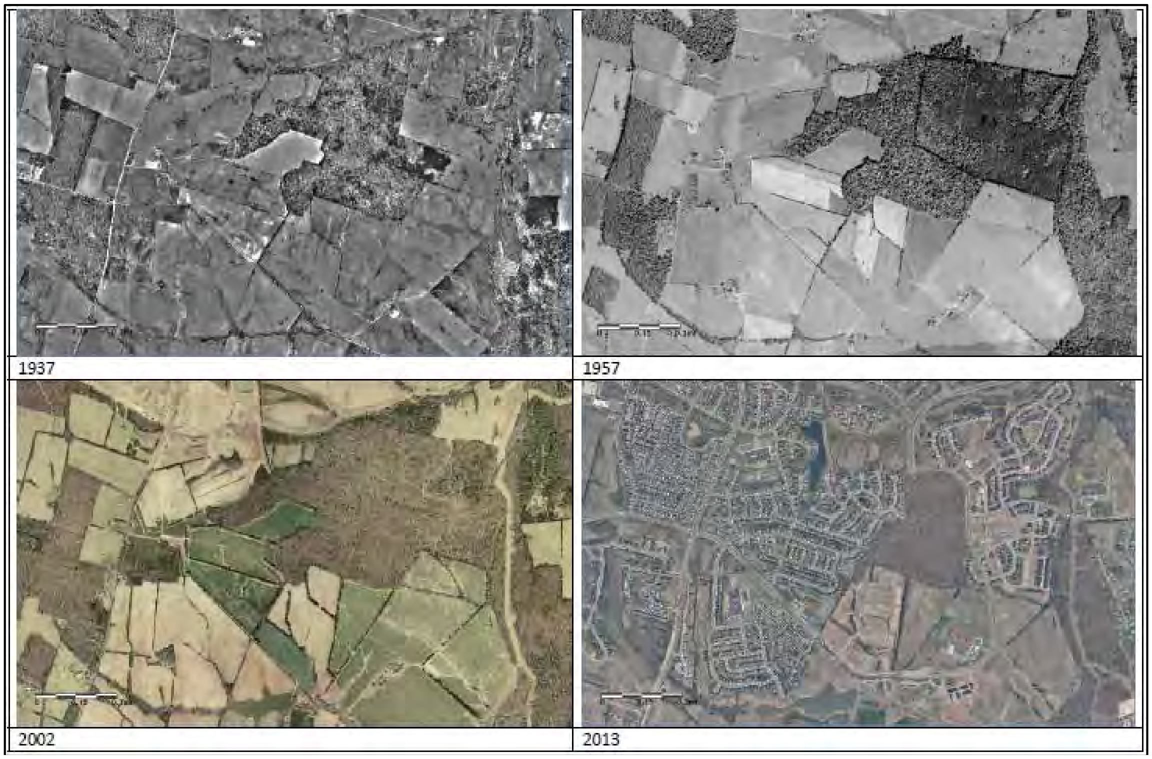


Figure 3-10: Historical Imagery for the Vicinity of Belmont Ridge Rd. and Creighton Rd. in the Upper Broad Run Watershed. Imagery Courtesy of the Commonwealth of Virginia and the County of Loudoun.

3.2.2 Population

Population data provides another way to evaluate the intensity of human influence on the landscape. As previously mentioned, much of the impact of urban/suburban land uses (where population is mainly concentrated) is related to the extent of impervious cover and also conversion of land uses such as forest that protect water resources. A higher population density (persons per acre) represents a more intense use of the land and greater potential for environmental degradation. The majority of the development within the Upper Broad Run watershed has occurred during the past 15 years.

Population patterns in the Upper Broad Run watershed were examined based on 2010 Traffic Analysis Zone (TAZ) data (Loudoun County Department of Planning 2013). The population distribution for the watershed is shown in Figure 3-11 and population density in Figure 3-12. Higher densities are located in the northeastern portion of the watershed, which includes the Brambleton, Upper Broad Run Mainstem and Lower North Fork Broad Run subwatersheds. The watershed is expected to have a rapid increase in population over the next several decades as development continues (Figures 3-13 and 3-14).

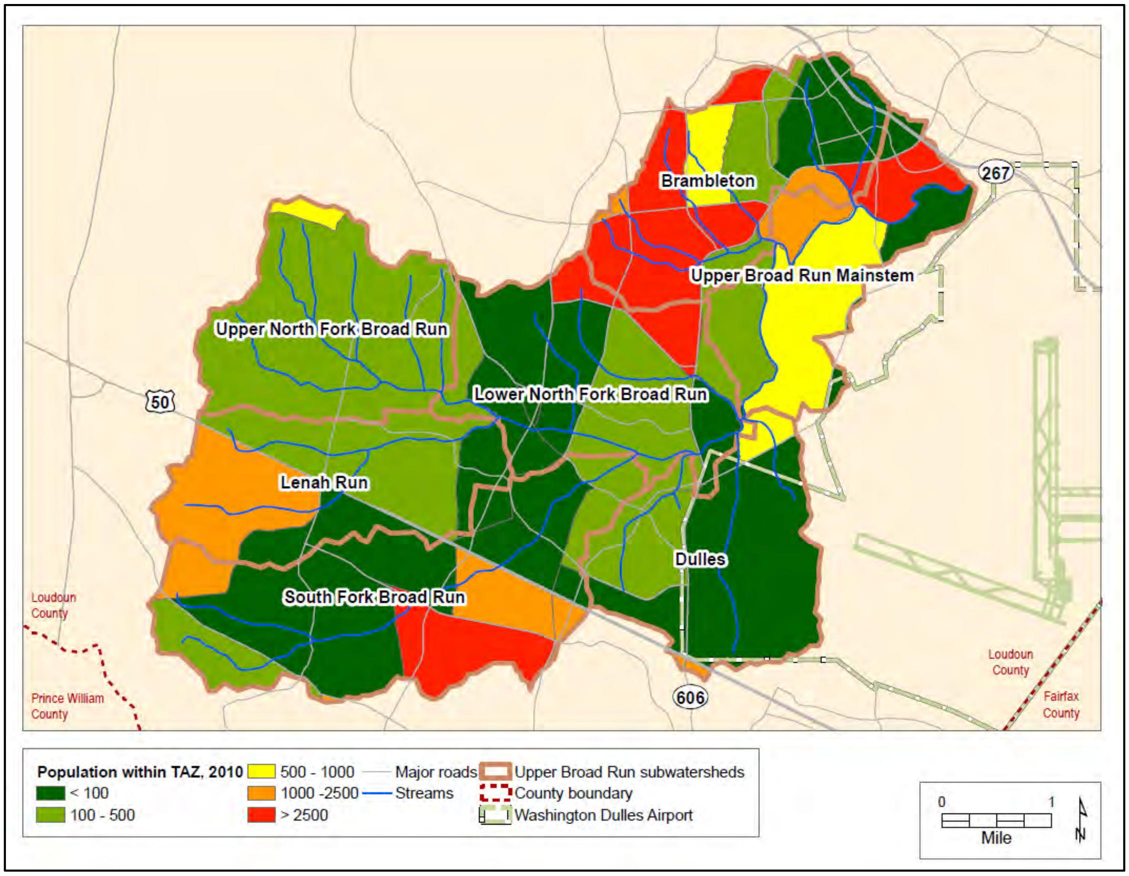


Figure 3-11: Upper Broad Run Watershed Population

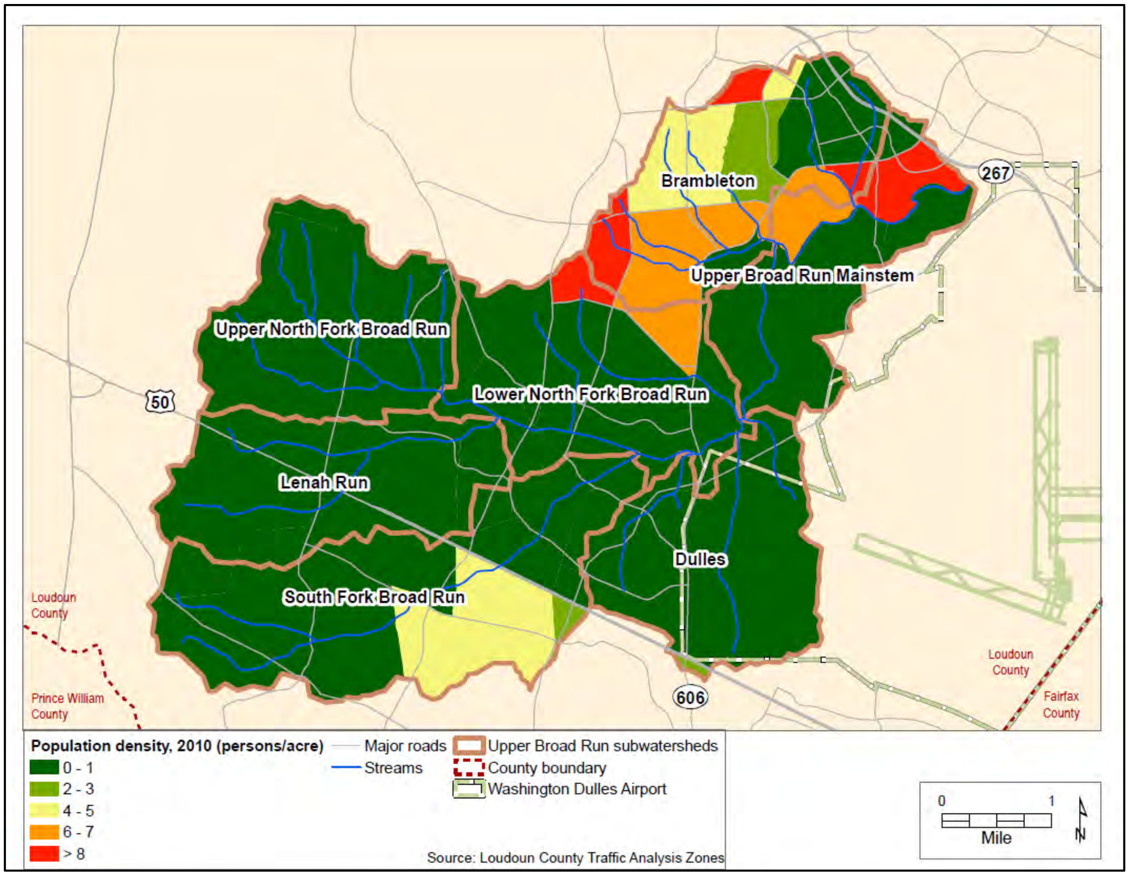


Figure 3-12: Upper Broad Run Watershed Population Density

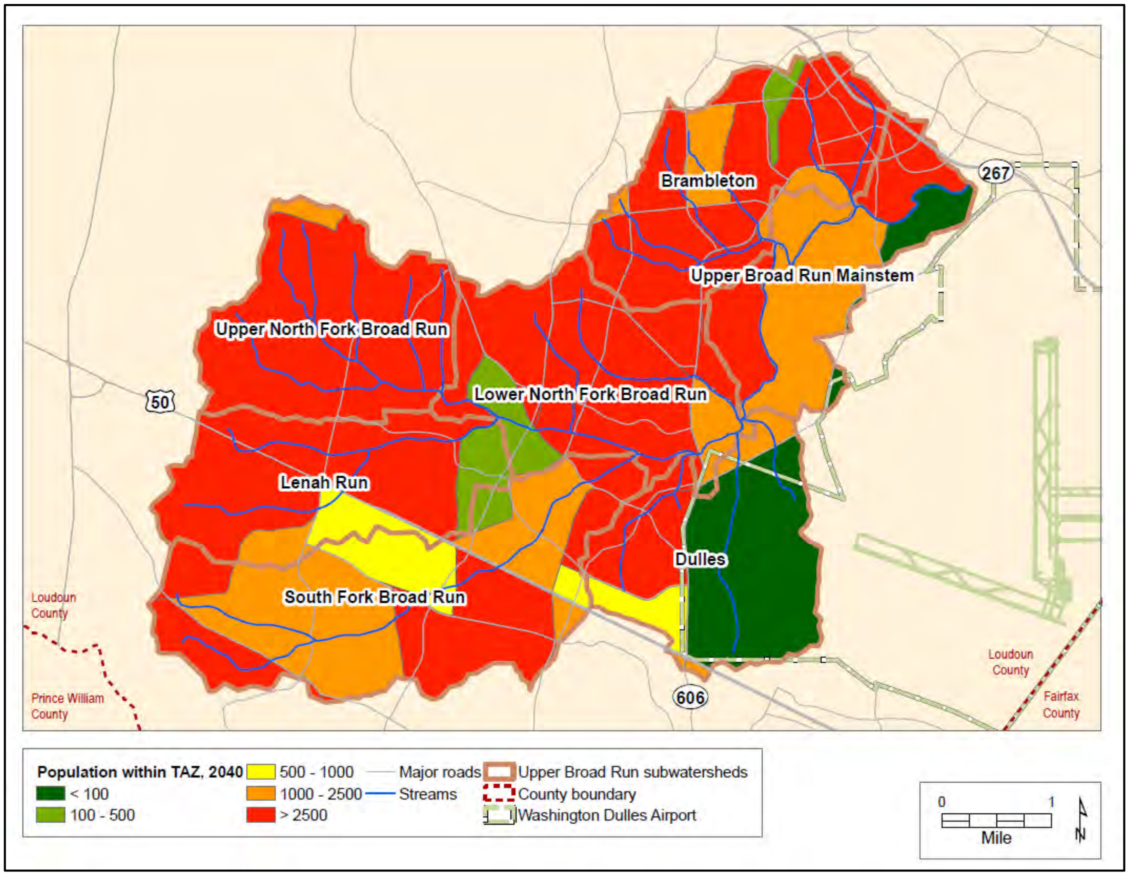


Figure 3-13: Upper Broad Run Watershed 2040 Projected Population

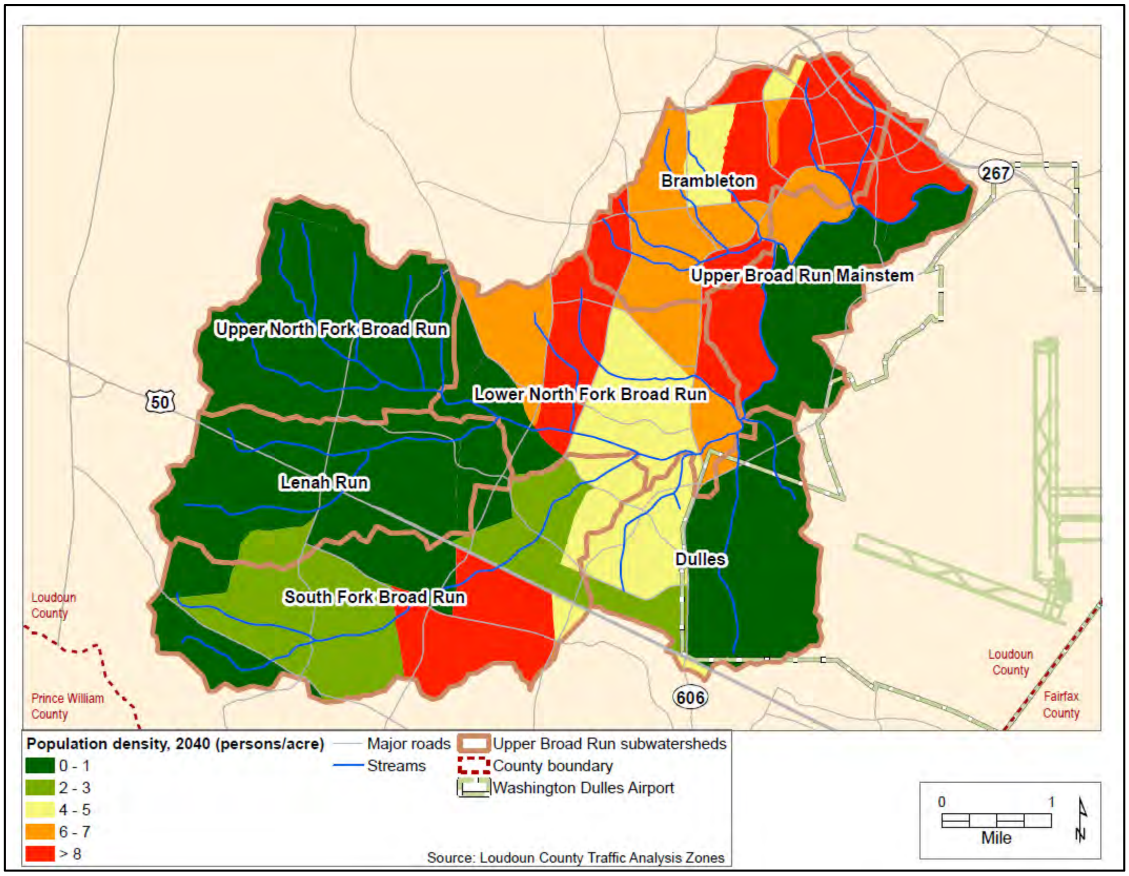


Figure 3-14: Upper Broad Run Watershed 2040 Projected Population Density

3.2.3 Impervious Surfaces

Various studies have shown a correlation between the amount of impervious surface within a watershed and declines in stream quality (e.g., Giddings et al. 2009; Schueler et al. 2009). Impervious surfaces, including roads, parking areas, roofs, and other paved surfaces, prevent precipitation from naturally infiltrating the ground. This prohibits the natural filtration of pollutants and conveys concentrated, accelerated stormwater runoff directly to the stream system. Consequently, stormwater runoff from impervious surfaces can cause stream erosion and habitat degradation from the high energy flow. Furthermore, such runoff is likely more polluted than runoff generated from pervious areas. 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.

Percent impervious cover is the most commonly used single measure of urban impacts to streams. Schueler (2008) defines the following general categories, in this latest version of the Impervious Cover Model (Figure 3-15):

- Sensitive Streams: 2 - 10% impervious cover
- Impacted: 10 - 24%

- Damaged (Non-Supporting): 25 - 59%
- Severely Damaged (Urban Drainage): 60% or more

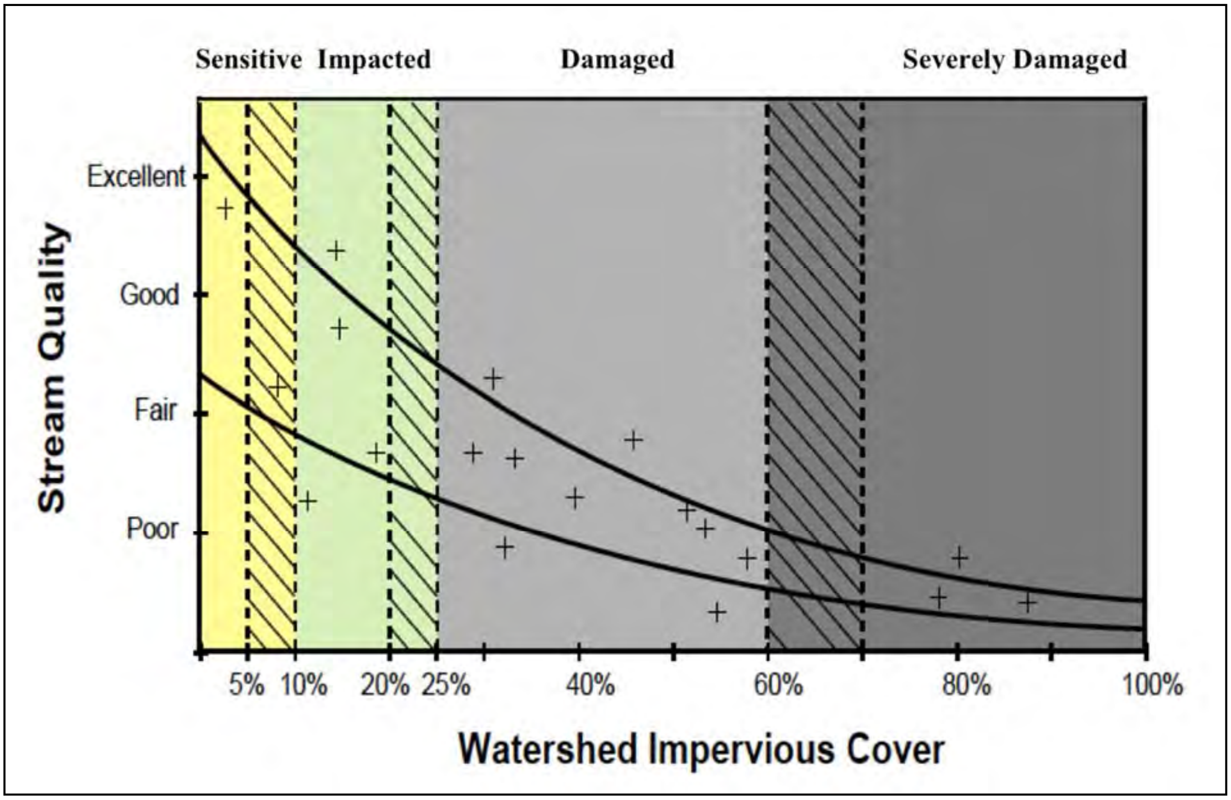


Figure 3-15: Impervious Cover Model (adapted from Schueler et al. 2009) describing the general relationship between the amount of impervious cover in a watershed and stream quality

The impervious cover model also designates transitions between these four categories, e.g., 5 to 10% impervious cover for the transition from sensitive to impacted, and 20 to 25% impervious cover for the transition from impacted to non-supporting.

Studies used to develop the Impervious Cover Model measured stream quality based on a variety of indicators such as the number of aquatic insect species, stream temperature, channel stability, aquatic habitat, wetland plant density, and fish communities. Based on the research compiled, the model describes four general categories to classify and predict stream quality in terms of impervious cover. Watersheds with less than 10 percent impervious cover are referred to as sensitive and typically have high quality streams with stable channels, good habitat conditions, and good to high water quality; sensitive watersheds are susceptible to environmental degradation with urbanization and increases in impervious cover. Between 10 and 25 percent impervious cover, watersheds tend to become impacted and typically show clear signs of degradation such as erosion, channel widening, and a decline in stream habitat quality. 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 or non-supporting. These streams are characterized by fair to poor water quality, unstable channels, severe erosion, and inability to support aquatic life and provide habitat; many streams in this category are typically piped or channelized. When impervious cover exceeds 60 percent, a watershed is classified as severely damaged or urban drainage, meaning that many of the natural stream features are gone. Management of damaged and severely damaged streams may focus on decreasing pollutant loads to downstream receiving waters (e.g., installing stormwater controls) 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 although it is based on research, the impervious cover model is a simplified approach for classifying the quality of urban streams. While impervious cover is a relevant and significant indicator of watershed condition, it is only one of many different factors affecting stream health and contributing to the cumulative impacts of development on water quality. For example, current and historical agricultural land uses contribute sediment and nutrient loads to receiving waters depending on management practices. Also, the ability of Stormwater Control Measures (SCMs) to offset adverse impacts from urbanized areas is not specifically accounted for in this model.

Loudoun County's impervious cover GIS data layer was used to derive impervious cover within the Upper Broad Run watershed (Figure 3-16). Table 3-9 summarizes the area of buildings, recreational courts, driveways, parking lots, roads, pools, ruins or construction in progress, sidewalks or paved trails, and percent impervious area for each subwatershed and the entire watershed. Overall, impervious cover represents about 9 percent of the watershed. Subwatershed impervious cover estimates and ratings according to the impervious cover model are shown in Figure 3-17. Currently, five subwatersheds are classified as sensitive (0-10% impervious cover) and two are classified as impacted (10-25% impervious). At 21.6% impervious cover and with more development planned for the near future, the Brambleton subwatershed is approaching the damaged classification.

Table 3-9: Upper Broad Run Watershed Impervious Area Estimates by Subwatershed

Subwatershed	Impervious type (acres)						
	Road	Buildings	Parking lot	Driveway	Sidewalk or Trail	Other	Impervious (percent)
Brambleton	208.9	177.0	24.9	69.0	22.3	2.0	21.6
Upper Broad Run Mainstem	97.7	99.1	85.9	23.1	9.0	2.5	16.9
Dulles	46.8	5.7	77.4	6.5	0.0	0.0	6.3
Lenah Run	36.6	24.1	9.4	19.3	1.2	0.5	4.1
Lower North Fork Broad Run	88.8	57.6	12.4	23.1	2.6	1.1	7.5
South Fork Broad Run	105.4	64.4	55.1	37.5	6.3	5.0	7.6
Upper North Fork Broad Run	12.3	2.9	0.0	4.6	0.0	0.3	0.9
Total	596.5	430.8	265.0	182.9	41.4	11.4	9.1

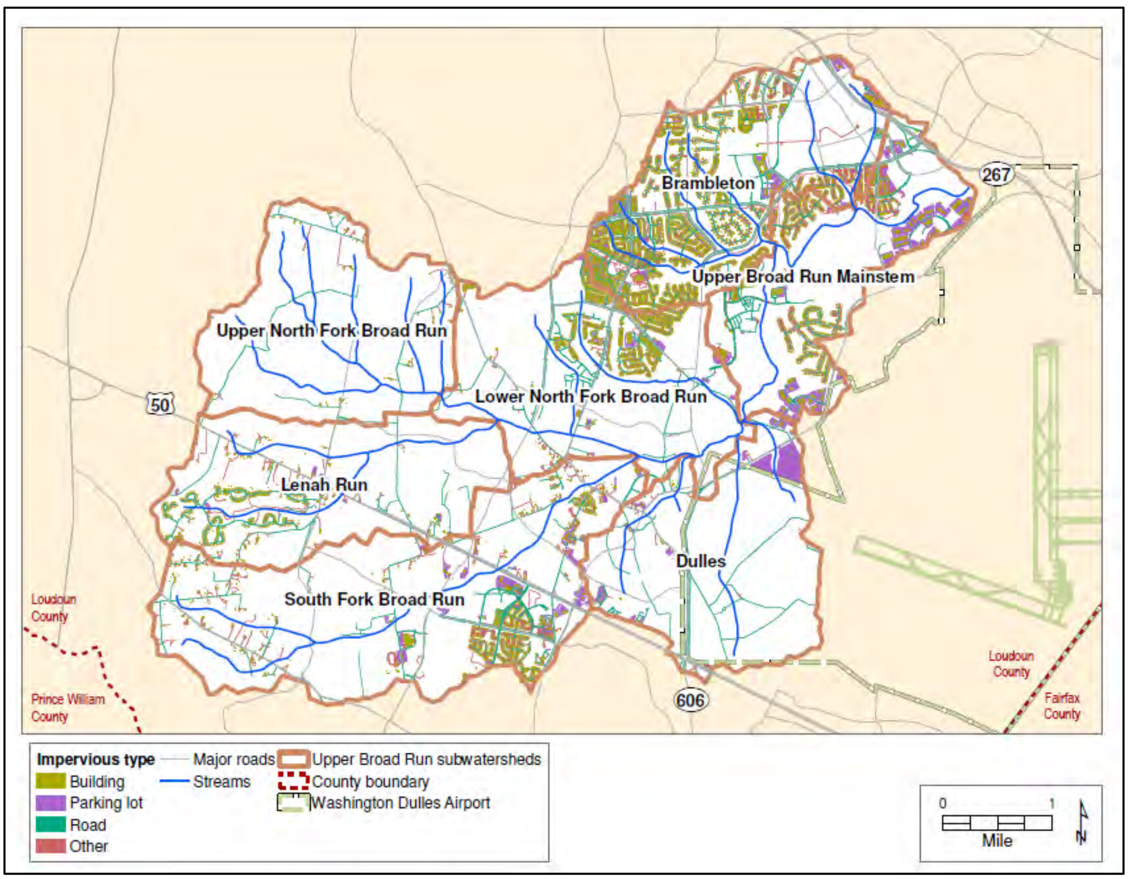


Figure 3-16: Upper Broad Run Watershed Impervious Cover

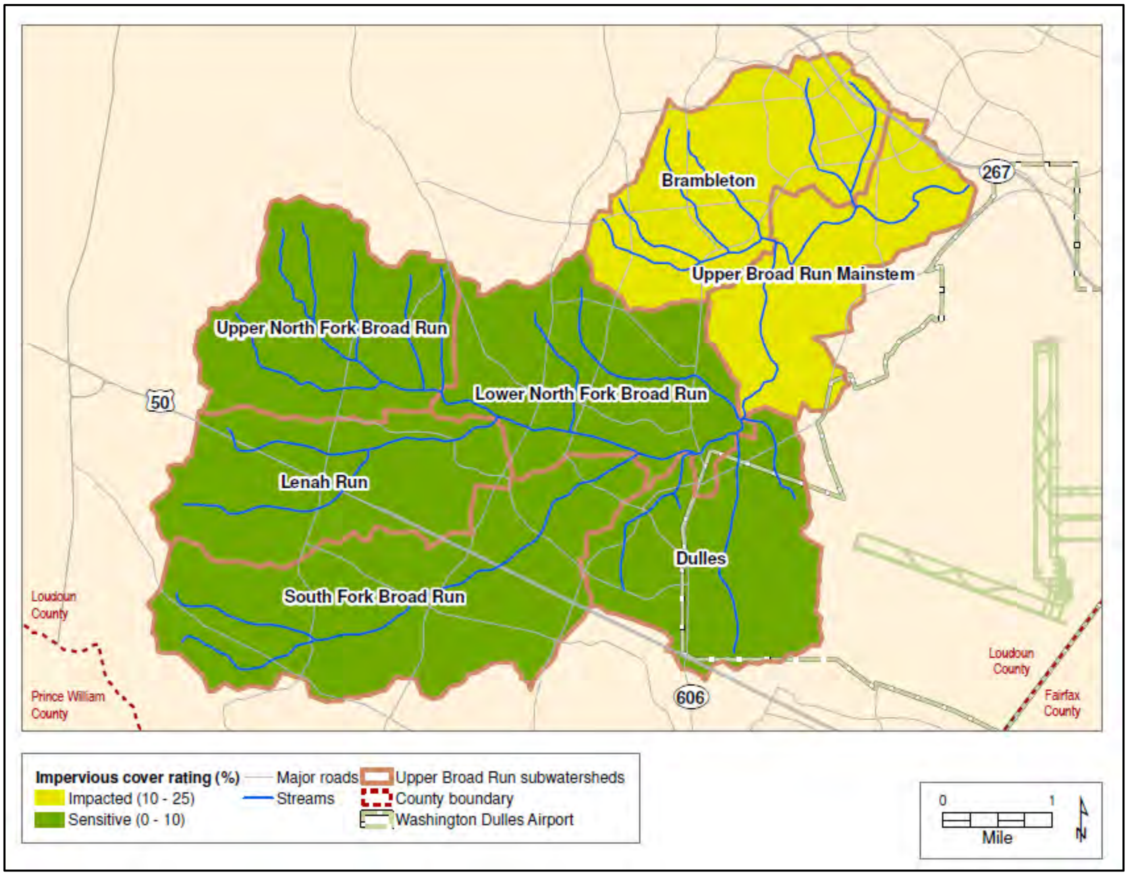


Figure 3-17: Upper Broad Run Watershed Impervious Cover Ratings

3.2.4 Stormwater

Stormwater is water generated by rainfall and snow melt events. Stormwater that does not seep into the ground becomes stormwater runoff and flows into stormwater control facilities or directly to receiving water bodies. The amount and characteristics of stormwater runoff is affected by rainfall amount and intensity, soil properties, slope, and land use/land cover. Concerns associated with stormwater include water quantity (the rate and volume of runoff) as well as water quality.

Stormwater runoff can carry nutrients, sediment, and various contaminants depending on land use characteristics and human activities. Pollutants deposited on impervious surfaces from daily human activities are often carried by stormwater to stream systems. For example, common constituents in urban runoff include sediment, metals, bacteria, nutrients, and petroleum. Pollutants such as these build up over time from various sources such as maintenance activities (de-icing, roadside fertilizer use), vehicles (exhaust, leaks), and accidents/spills, and are washed off during storm events.

3.2.4.1 Stormwater Management Facilities

There are many types of Stormwater Control Measures (SCMs) available for managing stormwater runoff and providing stormwater quality treatment. Stormwater management can target specific objectives depending on the SCM type such as stormwater quality, soil erosion control, and stormwater flow control. In addition, different SCM facilities have different pollutant removal capabilities. For example, basic dry pond designs for stormwater management typically have low pollutant removal efficiency compared to practices that filter the stormwater or allow it to infiltrate into the ground or through plant roots. Several considerations are taken into account when selecting appropriate stormwater treatment measures such as space requirements, maintenance, cost, and community acceptance. Table 3-10 provides a summary of the different SCM facilities located within the Upper Broad Run watershed by subwatershed including bioretention, grass swales, dry and wet ponds, vegetated filters, wetlands, oil-grit separators, infiltration/filtration practices, storm filters, vortex filters, and underground detention SCMs. The distribution of SCM facilities throughout the watershed is illustrated in Figure 3-18.

Table 3-10: Upper Broad Run Stormwater Management Facilities by Subwatershed, with Drainage Area (acres) and Number of Facilities

Subwatershed#	Stormwater Management Facility [acres (number)]*										
	Bio-retention	Grass Swale	Dry Pond	Wet Pond	Vegetated Filter	Wetland	Oil Grit Separator	Infiltration (Filterra)	Storm-filter	Vortex Filter	Under-ground Detention
Brambleton	6.5 (3)	1.6 (1)	387.3 (21)	525.0 (11)	5.0 (1)	97.8 (1)					
Upper Broad Run Mainstem	10.69 (2)		392.4 (14)	105.7 (4)			1.2 (1)	1.6 (5)	4.7 (2)	0.6 (1)	
Dulles	2.4 (1)			119.9 (1)				1.9 (5)			
Lenah Run			71.9 (4)								
Lower North Fork Broad Run	0.7 (1)	2.2 (2)	78.0 (3)	11.1 (1)	1.1 (2)						
South Fork Broad Run			91.9 (4)	129.9 (2)							0.7 (1)
Total	20.29 (7)	3.8 (3)	1,021.5 (46)	891.6 (19)	6.1 (3)	97.8 (1)	1.2 (1)	3.5 (10)	4.7 (2)	0.6 (1)	0.7 (1)

* Drainage areas not available for all stormwater management facilities
# Upper North Fork Broad Run does not have any stormwater management facilities

Dry ponds and wet ponds are the most common types of SCMs within the watershed, both in number and in treatment area. The dry pond facilities represent the best opportunity for conversion to SCMs with higher pollutant removal capabilities. Upper North Fork Broad Run is the only subwatershed that does not contain any SCMs. This is due to the fact that this subwatershed's land use/land cover is mostly cropland, pasture, and forest.

The total area treated by SCM by subwatershed is summarized in Table 3-11. This table shows that approximately 12% of the watershed is treated by SCMs, but Table 3-8 shows that approximately 29% of the watershed is covered by urban land uses (sum of urban impervious and urban pervious). This indicates an opportunity to implement additional stormwater in existing developed areas where no practices are currently in place or to convert existing facilities to provide additional treatment before stormwater reaches the stream system. Refer to Section 4.2 for more details on assessed SCM facilities within the watershed.

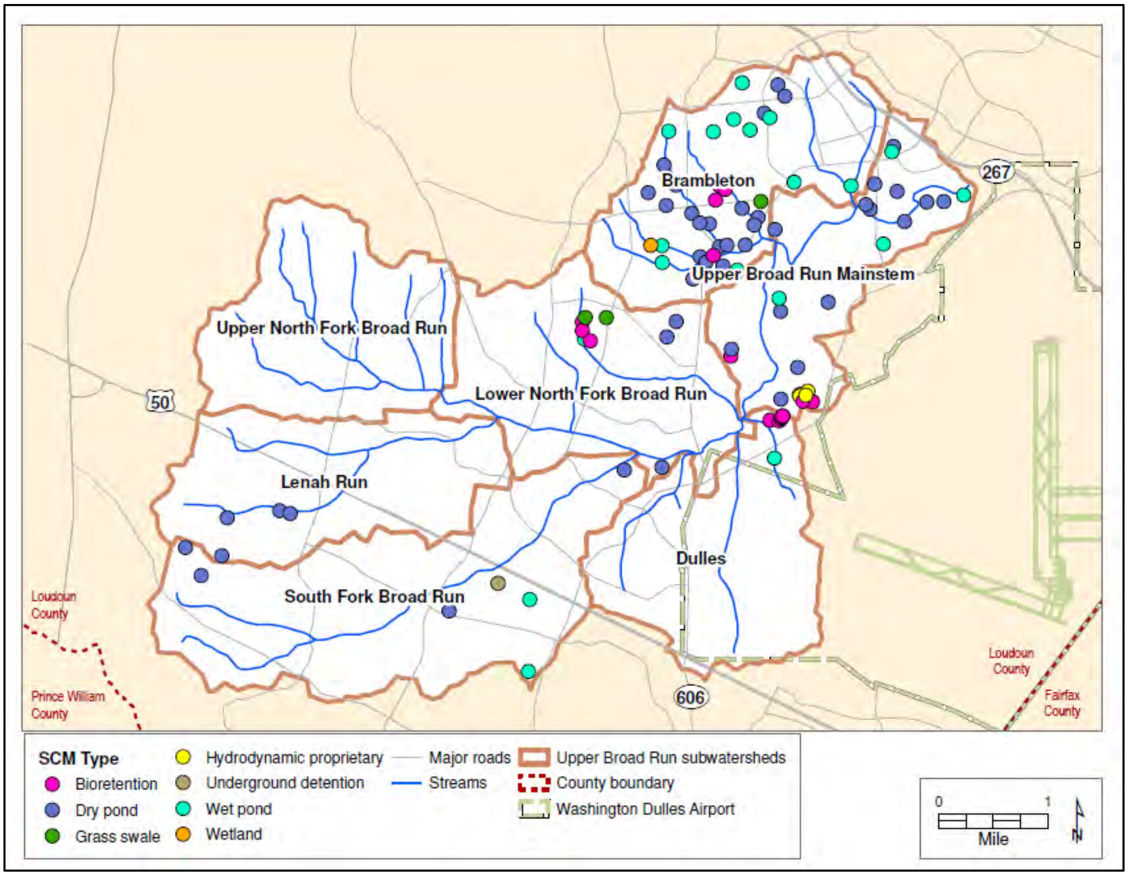


Figure 3-18: Upper Broad Run Watershed Stormwater Management Facilities

Table 3-11: Upper Broad Run Watershed Stormwater Treatment

Subwatershed	Stormwater System Drainage Area (acres)	Percent Treated*
Brambleton	1023.3	43.8
Upper Broad Run Mainstem	516.8	27.6
Dulles	124.1	5.7
Lenah Run	71.9	3.3
Lower North Fork Broad Run	93.1	3.8
South Fork Broad Run	222.5	6.2
Upper North Fork Broad Run	0	0
Total	2,051.7	12.2

* The entire drainage area is assigned to the subwatershed where the facility is located.

3.2.5 Drinking Water and Wastewater

Loudoun Water provides public water and sewer services for approximately 90% of the Upper Broad Run watershed population (Figure 3-19). Drinking water in Loudoun Water's service areas, including the Upper Broad Run watershed, is purchased from Fairfax Water, who supplies the water from the Potomac River and Occoquan Reservoir. Wastewater from areas within Loudoun Water's Central System is treated at the D.C. Water and Sewer Authority's Blue Plains Treatment Plant, and in Loudoun Water's Broad Run Water Reclamation Facility (BRWRF). The BRWRF discharges its effluent into a section of Broad Run that is located approximately 3 miles downstream of the Upper Broad Run watershed outlet.

The Lenah Run community is the only portion of the Upper Broad Run watershed that is not covered by Loudoun Water's Central System. Drinking water is supplied to Lenah Run by two community wells. Wastewater is collected and treated in the community's own wastewater treatment plant before being discharged in a low-pressure distribution system located in community fields (Loudoun Water 2014).

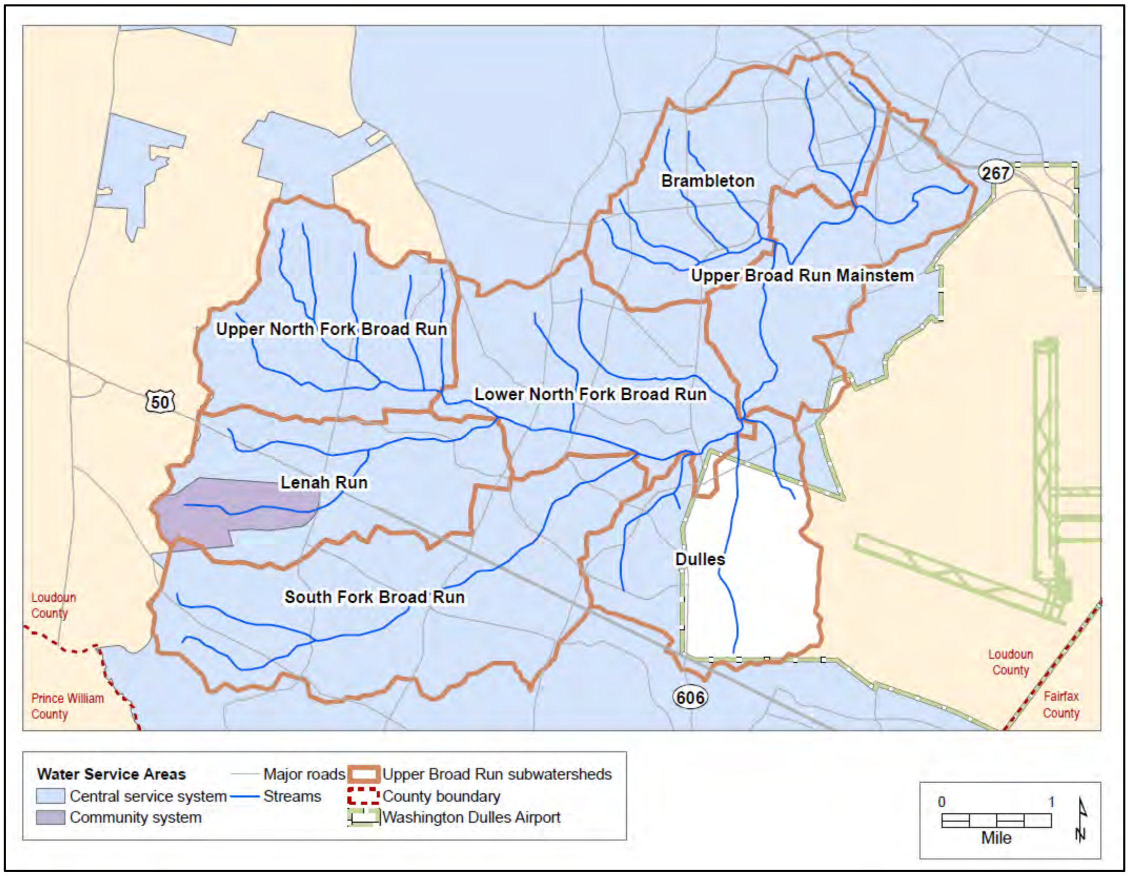


Figure 3-19: Loudoun Water Central System Area

3.2.6 VPDES Discharge Permits

Virginia facilities that discharge municipal or industrial wastewater or conduct activities that can contribute pollutants to a waterway are required to obtain a Virginia Pollutant Discharge Elimination System (VPDES) permit. As of January 2014, there are currently 4 facilities within the Upper Broad Run watershed that have a VPDES general permit (Figure 3-20). Each of these VPDES general permits are for facilities that possess a domestic sewage treatment system with a design flow of less than or equal to 1,000 gallons per day on a monthly average basis, also known as a Single Family Home general permit. The permitted facilities include a fire station, a convenience store, and two residential homes. There are currently no facilities within the watershed that possess a VPDES individual permit.

In addition to a list of VPDES permitted facilities, Virginia Department of Environmental Quality (DEQ) also maintains a list of petroleum tanks and releases. There are currently 9 petroleum tanks registered within the Upper Broad Run watershed, and 13 documented petroleum releases were recorded between 2006 and 2012. The location of the registered petroleum tanks and documented releases is illustrated in Figure 3-20.

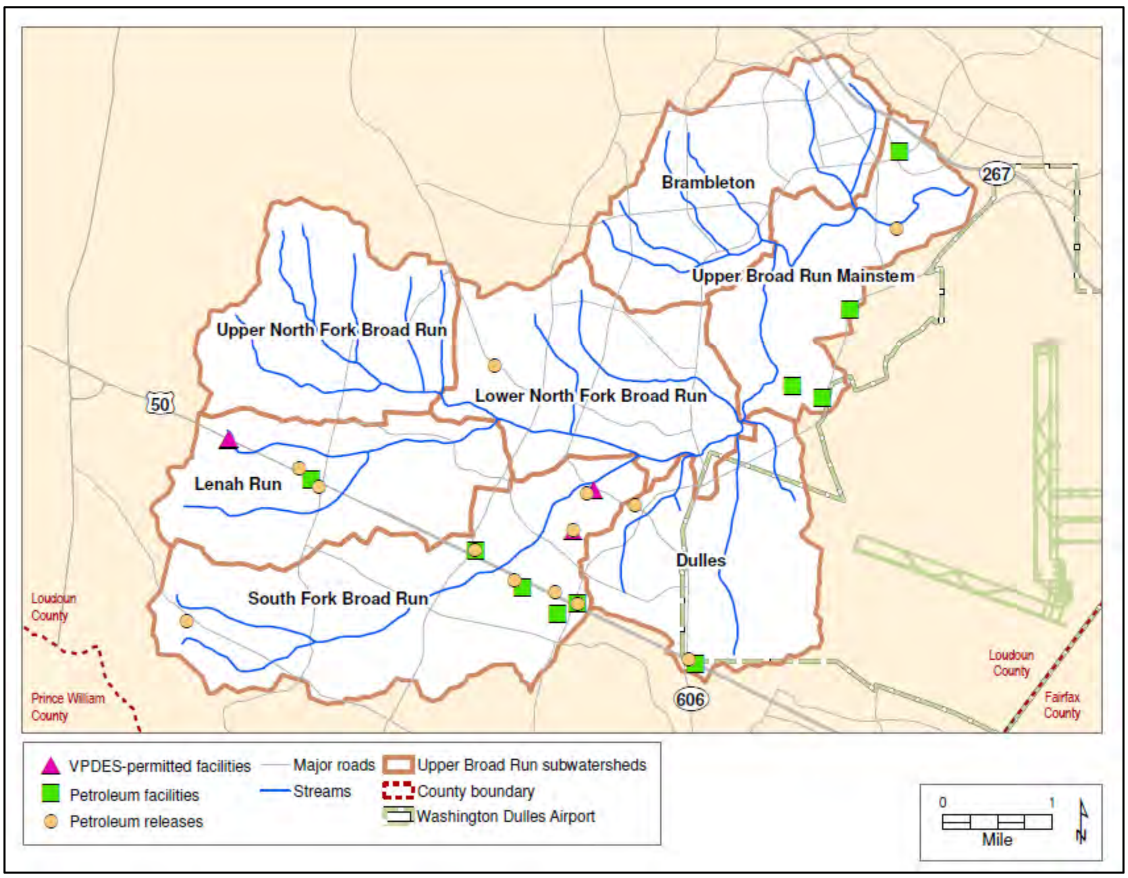


Figure 3-20: Upper Broad Run Watershed VPDES Permitted Facilities and Petroleum Tank and Releases

3.2.7 Zoning

The current zoning for the Upper Broad Run watershed is shown in Figure 3-21. Table 3-12 provides the zoning category name for each of the abbreviations displayed in Figure 3-21. As shown in the figure, a variety of zoning categories are represented in the watershed. The dominant category in the eastern portion of the watershed is planned development ("PD" categories), while the dominant categories in the western portion of the watershed are transitional residential ("TR" categories) and agricultural/residential ("A3" category).

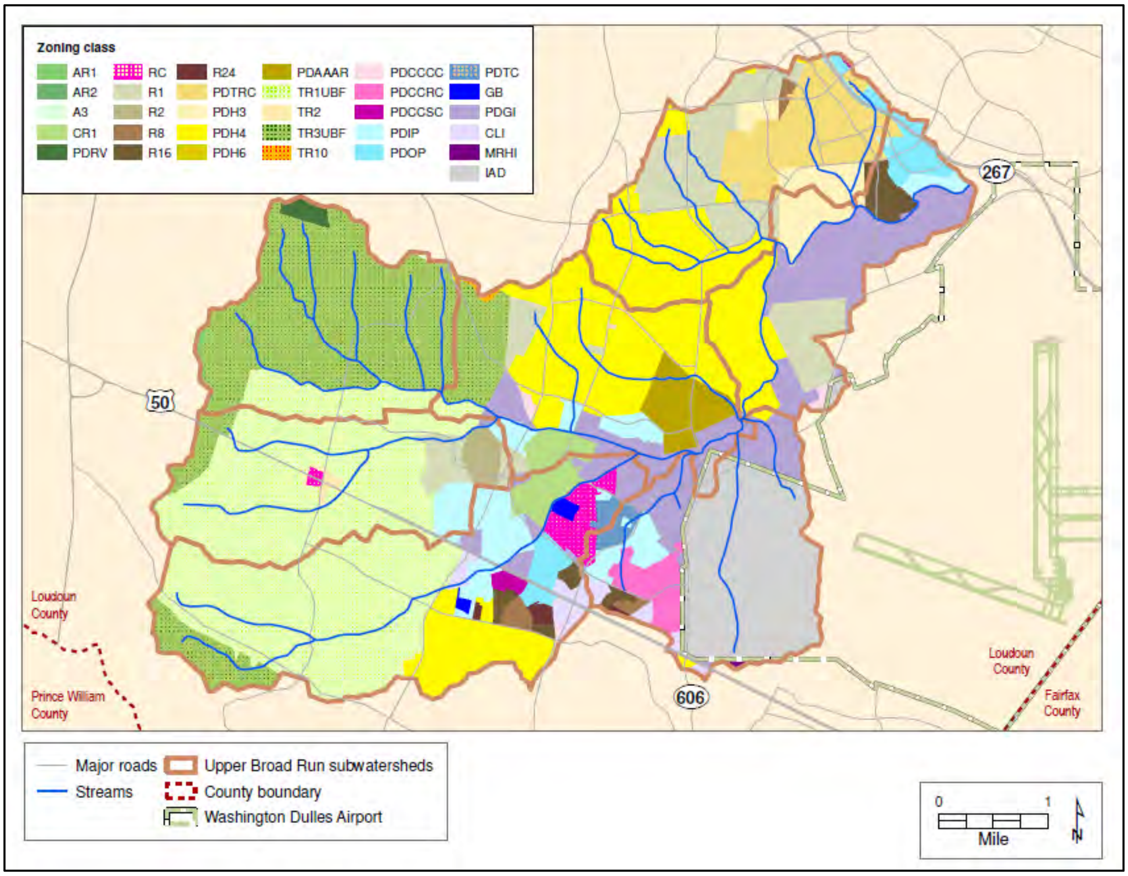


Figure 3-21: Upper Broad Run Watershed Zoning

Table 3-12: Upper Broad Run Watershed Zoning Classes. For additional detail, see http://logis.loudoun.gov/metadata/Zoning.html.

Zoning Codes	Zoning Description
A3	Agricultural/Residential
AR1	Agricultural Rural – 1
AR2	Agricultural Rural – 2
CLI	Commercial/Light Industry
CR1	Countryside Residential – 1 (maximum density of 1 unit per acre)
GB	General Business
IAD	Washington-Dulles International Airport
MRHI	Mineral Resource/Heavy Industry
PDAAAR	Planned Development – Active Adult/Age Restricted
PDCCCC	Planned Development – Commercial Center (Community Center)
PDCCRC	Planned Development – Commercial Center (Regional Center)
PDCCSC	Planned Development – Commercial Center (Small Regional Center)
PDGI	Planned Development – General Industrial
PDH3	Planned Development Housing – 3 (maximum density of 3 units per acre)
PDH4	Planned Development Housing – 4 (maximum density of 4 units per acre)
PDIP	Planned Development – Industrial Park
PDOP	Planned Development – Office Park
PDRV	Planned Development – Rural Village
PDTC	Planned Development – Town Center
PDTRC	Planned Development – Transit Related Center
R1	Single Family Residential – 1 (maximum density of 1 unit per acre)
R16	Townhouse/Multifamily Residential – 16 (maximum density of 16 units per acre)
R2	Low to Moderate Single Family Residential – 2 (maximum density of 2 units per acre)
R24	Multifamily Residential – 24 (maximum density of 24 units per acre)
R8	Moderate to Medium Density Residential – 8 (maximum density of 8 units per acre)
RC	Rural Commercial
TR10	Transitional Residential – 10 (1 dwelling unit per 10 acres)
TR1UBF	Transitional Residential – 1 (1 dwelling unit per acre)
TR2	Transitional Residential – 2 (2 dwellings units per acre)
TR3UBF	Transitional Residential – 1 (1 dwelling unit per 3 acres)

3.2.8 Loudoun Countywide Transportation Plan

Multiple road improvements are planned to accommodate increasing traffic volume associated with the rapid population growth in and surrounding the Upper Broad Run watershed. Figure 3-22 is a map taken from Loudoun County's 2010 Countywide Transportation Plan, amended through May 2, 2012 (Loudoun County 2012). This map shows road improvements that are expected to be completed by 2030. Some of the improvements that are planned to occur within the watershed are widening of U.S. 50 from two lanes to four lanes in the western portion of the watershed, paving the section of Braddock Rd. that is located in the southwestern portion of the watershed, widening Northstar Blvd. to a six-lane divided highway, extending Loudoun County Parkway south to Braddock Rd. and widening to six lanes, widening Evergreen Mills Road from two lanes to four lanes, and widening Ryan Rd. from two lanes to four lanes. A Dulles Corridor Metrorail transit service will also impact the watershed. The Dulles Corridor Metrorail Transit Project will extend from West Falls Church to just west of Dulles International Airport. Metrorail transit nodes are planned to be located in the vicinity of Rt. 606 (Old Ox Rd.) and Rt. 772 (Ryan Rd.) along Rt. 267 (Dulles Greenway).

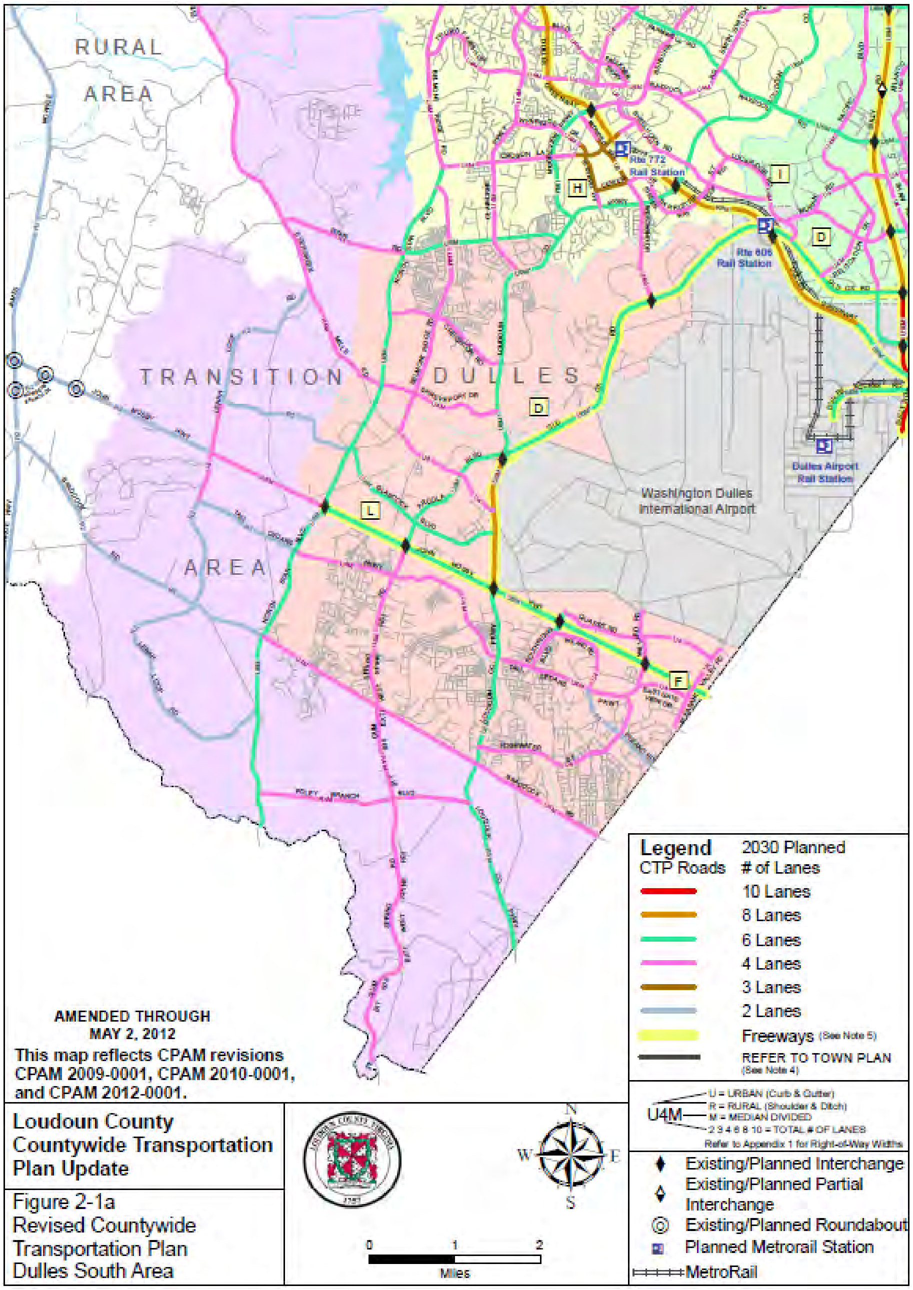


Figure 3-22: Loudoun County Countywide Transportation Plan – Dulles South Area (source: Loudoun County 2012)

3.3 Existing Water Quality Monitoring

3.3.1 Biological Monitoring

Virginia DEQ conducts statewide biological monitoring at fixed (permanent), targeted, and probabilistic (randomly selected) stations each year. Benthic macroinvertebrate samples are collected from fixed stations to represent communities found in natural stream reaches with no to minimal impairments. Virginia Stream Condition Index (VSCI) scores for benthic macroinvertebrate samples collected from the targeted and probabilistic stations are compared to those collected at the fixed stations. Sampled stream segments with low VSCI scores are placed on the 303(d) List of Impaired Water Bodies.

In addition to statewide biological sampling, Loudoun County conducted a countywide stream assessment in 2009. The countywide assessment resulted in the collection of benthic macroinvertebrate samples from a total of 200 sites; 177 randomly selected sites and 23 of Virginia DEQ's pre-existing sites. Of the 200 countywide samples collected in 2009, 8 were collected within the Upper Broad Run watershed (Figure 3-23). All 8 benthic macroinvertebrate sites received a VSCI score that corresponded to either Stress or Severe Stress assessment categories.

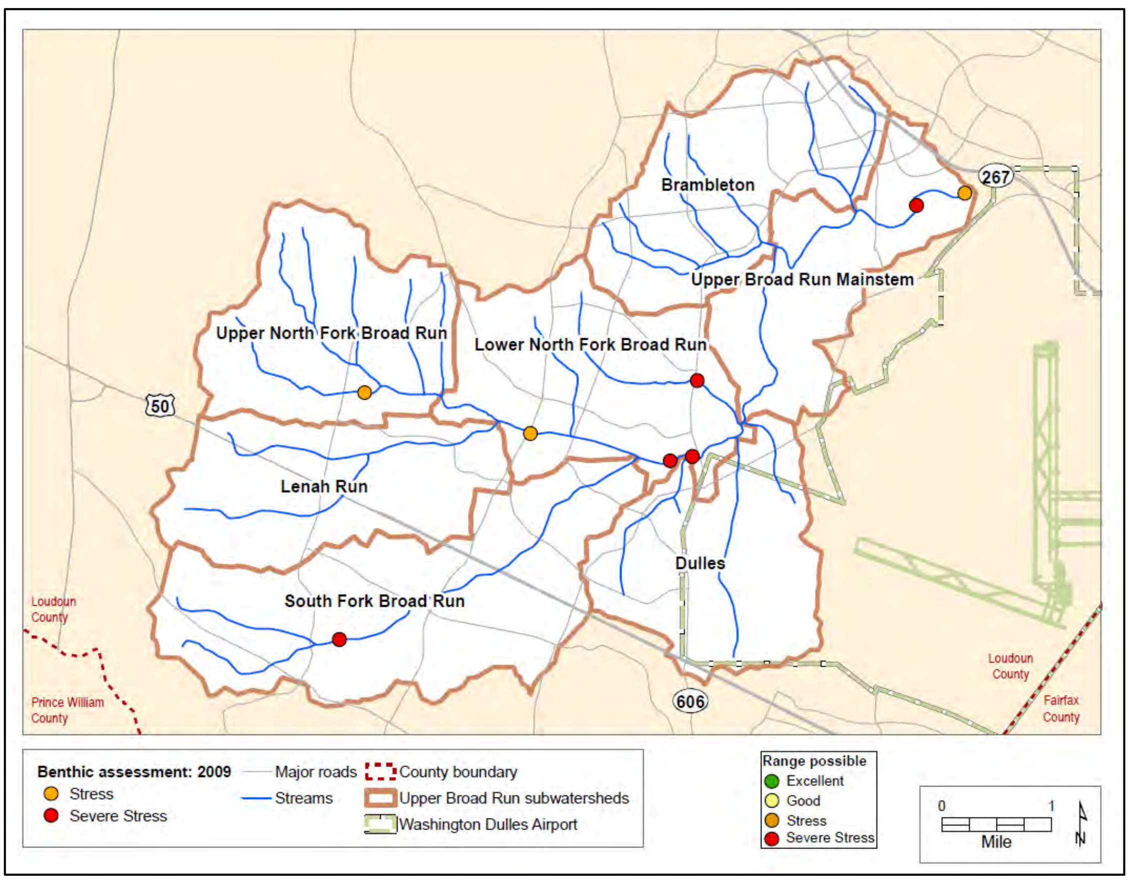


Figure 3-23: Upper Broad Run Watershed 2009 Benthic Assessment Results

3.3.2 Chemical Monitoring

3.3.2.1 Surface Water Quality Monitoring

Virginia DEQ maintains numerous surface water quality sampling stations throughout the state. Surface water quality stations maintained by Virginia DEQ include ambient monitoring and program specific stations, including Chesapeake Bay Program stations. In addition, Virginia DEQ provides funding for further monitoring to citizen and non-agency groups through their Citizen Monitoring Grant Program. Sampled stream segments that have water quality parameter concentrations that exceed the applicable water quality standards are placed on the 303(d) List of Impaired Water Bodies.

There are 7 surface water monitoring stations located within the Upper Broad Run watershed that have either currently or previously been used to collect surface water quality samples (Figure 3-24). Of these 7 stations, 3 are citizen monitoring stations, 2 are ambient monitoring stations, 1 is a Chesapeake Bay Program station, and 1 is a freshwater probabilistic monitoring station.

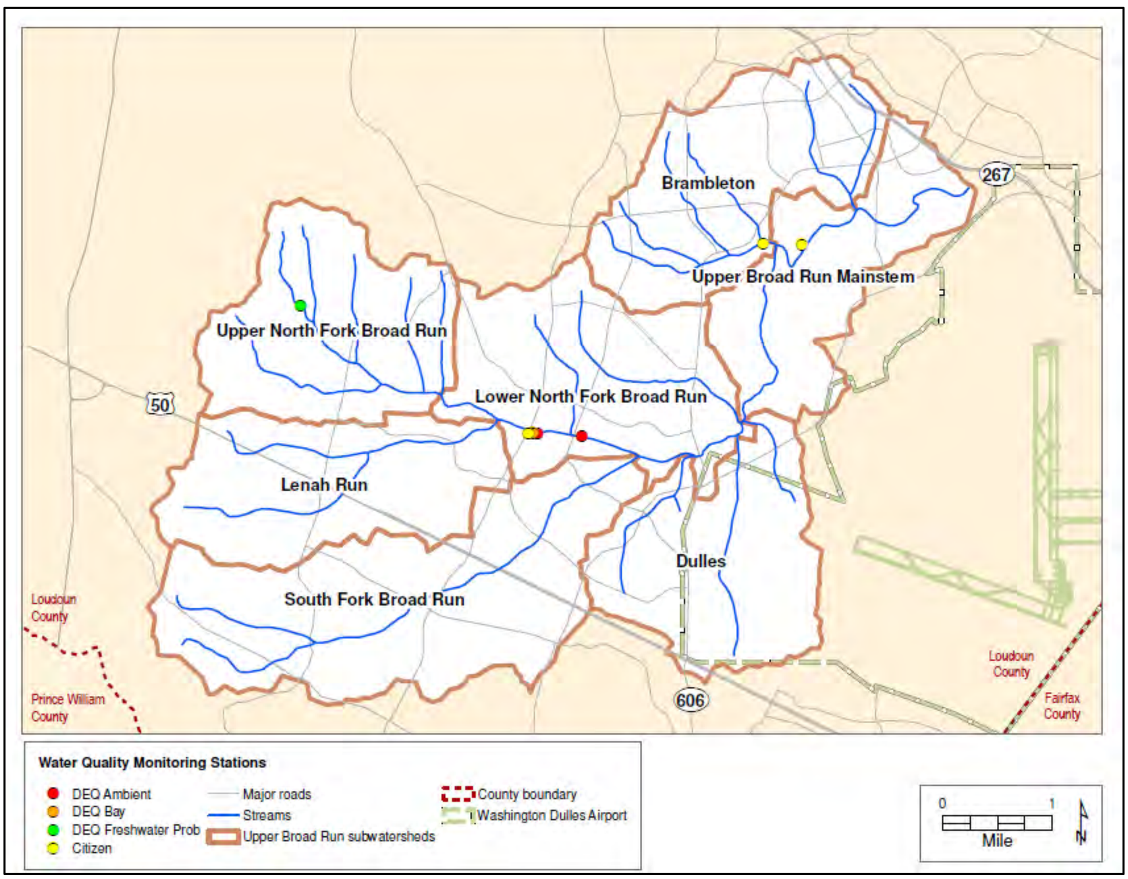


Figure 3-24: Upper Broad Run Watershed Water Quality Monitoring Stations

3.3.2.2 Groundwater Monitoring

In the Upper Broad Run watershed, groundwater serves just under 10% of the population, since most of the area is within the Loudoun Water Central System.

Before new potable water wells can be used, they must be tested and pass drinking water quality standards for a wide range of chemical parameters listed by the County Health Department. In 2012, groundwater samples collected and analyzed from new wells were generally consistent with historical data. There are some areas of the county that have elevated levels of iron and manganese which are aesthetic contaminants and do not adversely affect human health at the concentrations found in the county. In general, groundwater quality in the county is good.

Of the more than three thousand groundwater samples currently in the Loudoun County database, only eight of those samples were collected in the Upper Broad Run watershed. Of those samples, there were no contaminants with concentrations above primary drinking water Maximum Contaminant Levels (MCLs). However, the scarcity of data does not allow for any meaningful statistical analysis.

There are a few isolated locations in the County (but not in the Upper Broad Run watershed) where significant groundwater contamination is known to exist. The most notable location is the Hidden Lane Landfill in northeast Loudoun, which was placed on the EPA's National Priorities List (Superfund). The EPA has developed a fact sheet to update citizens on clean-up and investigation activities at the site. The Hidden Lane fact sheet and more information can be found by visiting the EPA web site.

3.3.3 Potential Pollution Sources

3.3.3.1 Illicit Discharge Detection and Elimination Program

Loudoun County is required to develop, implement, and enforce a program to detect and eliminate illicit discharges into regulated municipal separate storm sewer systems (MS4s). As part of this program, each year Loudoun County screens a portion of the 1,239 originally-defined outfalls that discharge within their MS4 permit area. These MS4 regulated outfalls are categorized as high (358), moderate (190), and low risk (691) outfalls.

During the 2013 permit year, dry weather screening was performed at 362 outfalls, countywide. All outfalls that exhibited or showed evidence of dry weather flow (78 of the 362) were classified as Suspect. Each suspect outfall that exhibited dry whether flow was tested for *E. coli*. Figure 3-25 shows the *E. coli*/Fecal Coliform concentrations of the sampled 2013 outfalls. Several of the high *E. coli/*Fecal Coliform concentration outfalls discharge within the Upper Broad Run watershed.

3.4 303 (d) Listings and Pending TMDLs

Section 303(d) of the 1972 Clean Water Act requires states to develop (and periodically update) a list of impaired waters that fail to meet applicable state water quality standards which are defined by their designated uses. States must also establish priority rankings and develop Total Maximum Daily Loads (TMDLs) for waters on the 303(d) list. According to EPA, a TMDL is a calculation of the maximum amount of a pollutant that a water body can receive and still safely meet state water quality standards. TMDLs can be developed for a single pollutant or group of pollutants of concern, which generally include sediment, metals, bacteria, nutrients, and pesticides. The Upper Broad Run watershed has been listed as impaired in the Virginia 303(d) list of impaired waters for the following causes: Aquatic life use (benthic macroinvertebrate) impairment and Recreational/ swimming use (bacteria) impairment.

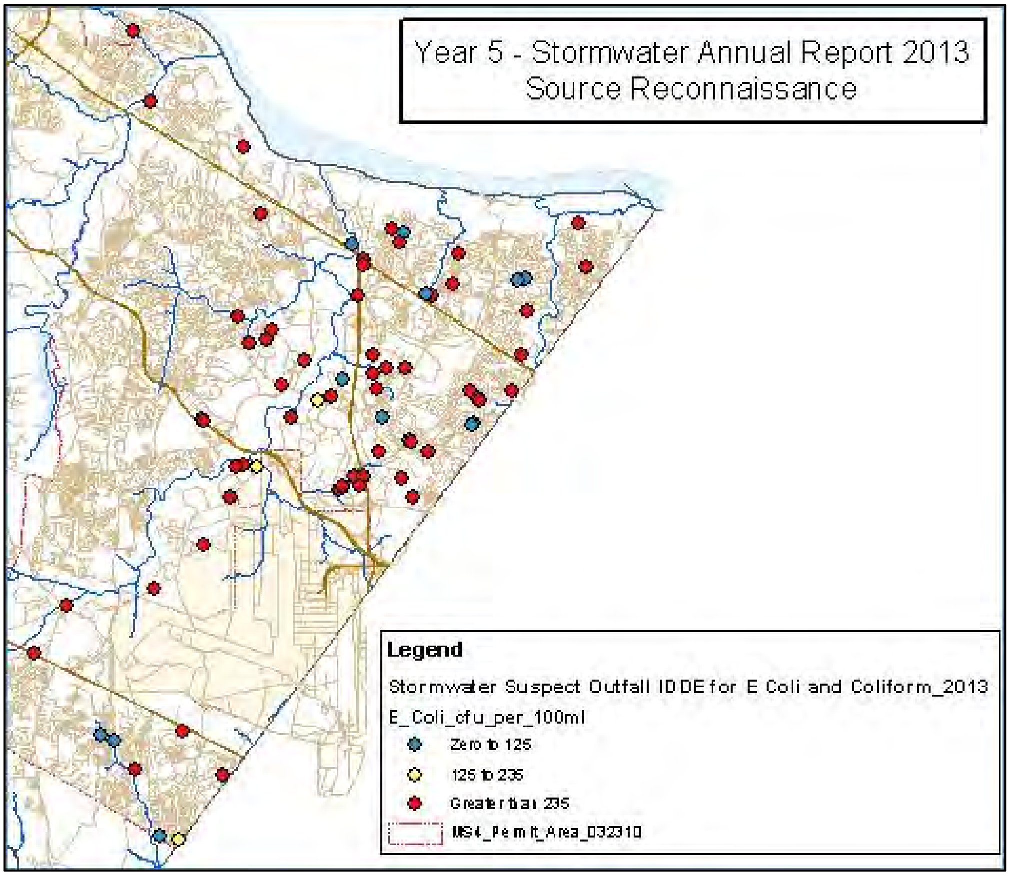


Figure 3-25: Loudoun County 2013 *E. Coli* and Fecal Coliform Monitoring

While there are currently no local TMDLs for Upper Broad Run, the entire watershed is subject to the Chesapeake Bay TMDL for nutrients and sediment. EPA established the Chesapeake Bay TMDL in 2010, a historic and comprehensive "pollution diet" with rigorous accountability measures to initiate sweeping actions to restore clean water in the Chesapeake Bay and the region's streams, creeks, and rivers. Concurrent with the development of the Bay TMDL, EPA charged the Bay watershed states and the District of Columbia with developing watershed implementation plans (WIPs) to provide adequate "reasonable assurance" that the jurisdictions can and will achieve the nutrient and sediment reductions necessary to implement the TMDL within their respective boundaries. "The Phase II planning targets for Virginia were issued by EPA on August 1, 2011. These targets were derived from using the Phase I WIP BMPs applied in the new v5.3.2 model construct. Because of the changes in the model, the planning targets fall short of the previously established Bay wide TMDL loads needed for full attainment of water quality standards."

3.4.1 Aquatic Life Use Impairment

Virginia DEQ has collected a sufficient amount of benthic macroinvertebrate data in three stream segments within the Upper Broad Run watershed to determine if they meet the appropriate aquatic life use water quality standards. Of these three segments, one is located within the Upper North Fork Broad Run subwatershed, one within the South Fork Broad Run subwatershed, and one within the Lower North Fork Broad Run subwatershed. Figure 3-26 shows that the stream segment monitored in the Lower North Fork Broad Run subwatershed is listed as impaired, while the other two segments are fully supporting aquatic life use. VSCI scores from biological monitoring events conducted at the closest monitoring station in 2005, 2007, and 2009 indicated an impaired benthic macroinvertebrate community for this stream segment. The length of the impairment is approximately 1.33 miles. Virginia DEQ is expected to prepare a TMDL report for the benthic macroinvertebrate impairment in 2014 or 2015. A TMDL implementation plan is scheduled to be developed by 2020.

3.4.2 Recreational/Swimming Use Impairment

Virginia DEQ has collected a sufficient amount of bacteria (*E. coli*) data in one stream segment within the Upper Broad Run watershed to determine if it meets the appropriate recreational/ swimming use water quality standards. This is the same 1.33 mile long Lower North Fork Broad Run segment that is impaired for Aquatic Life use. *E. coli* monitoring results show that 3 of the 11 samples collected at the monitoring station located within this stream segment were above the applicable water quality standard, and thus indicated a recreational/swimming use impairment. Figure 3-27 shows the location of the bacteria impairment. Virginia DEQ's schedule for preparing a TMDL report for this impairment is currently unknown. The TMDL implementation plan is scheduled to be developed by 2024.

3.5 Floodplain Mapping

The Federal Emergency Management Agency (FEMA) is funding a floodplain mapping study that is underway in Loudoun County. The study will update the effective Loudoun County floodplain maps from July 2001, including those within the Upper Broad Run watershed. The study is expected to be completed by late 2015.

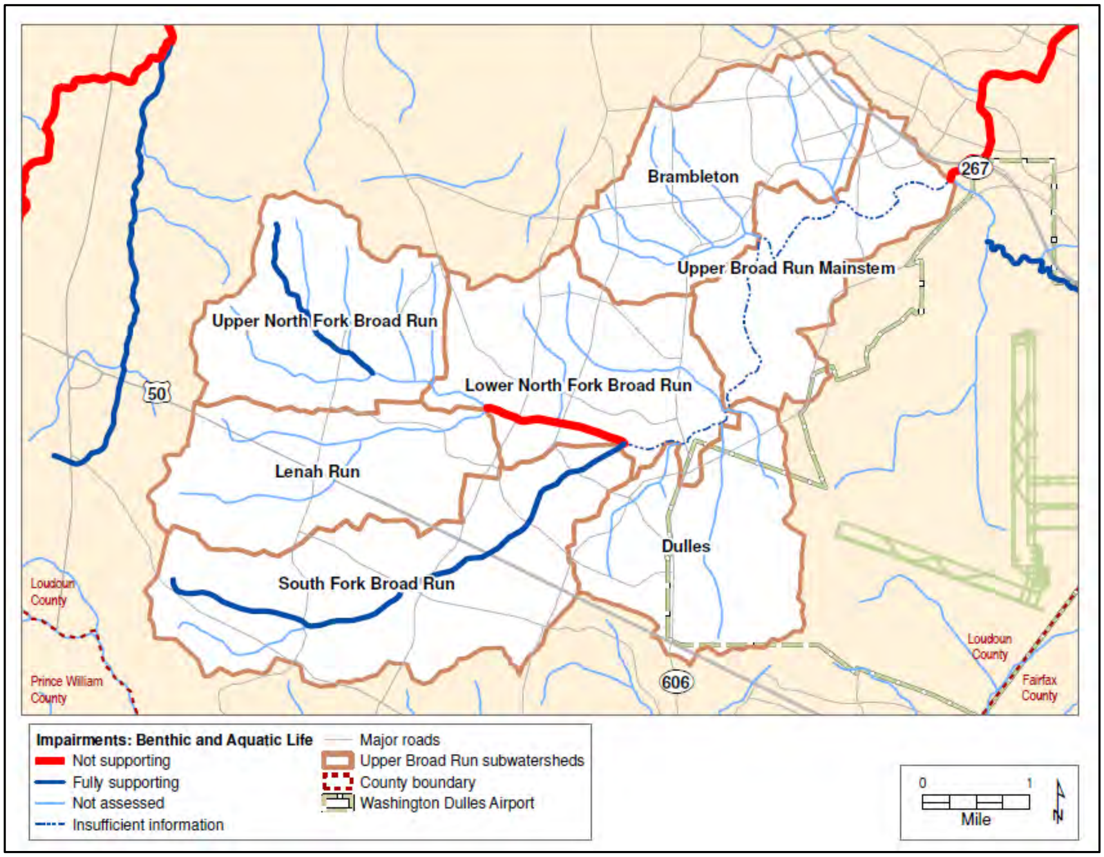


Figure 3-26: Upper Broad Run Watershed Benthic (Aquatic Life) Impairment

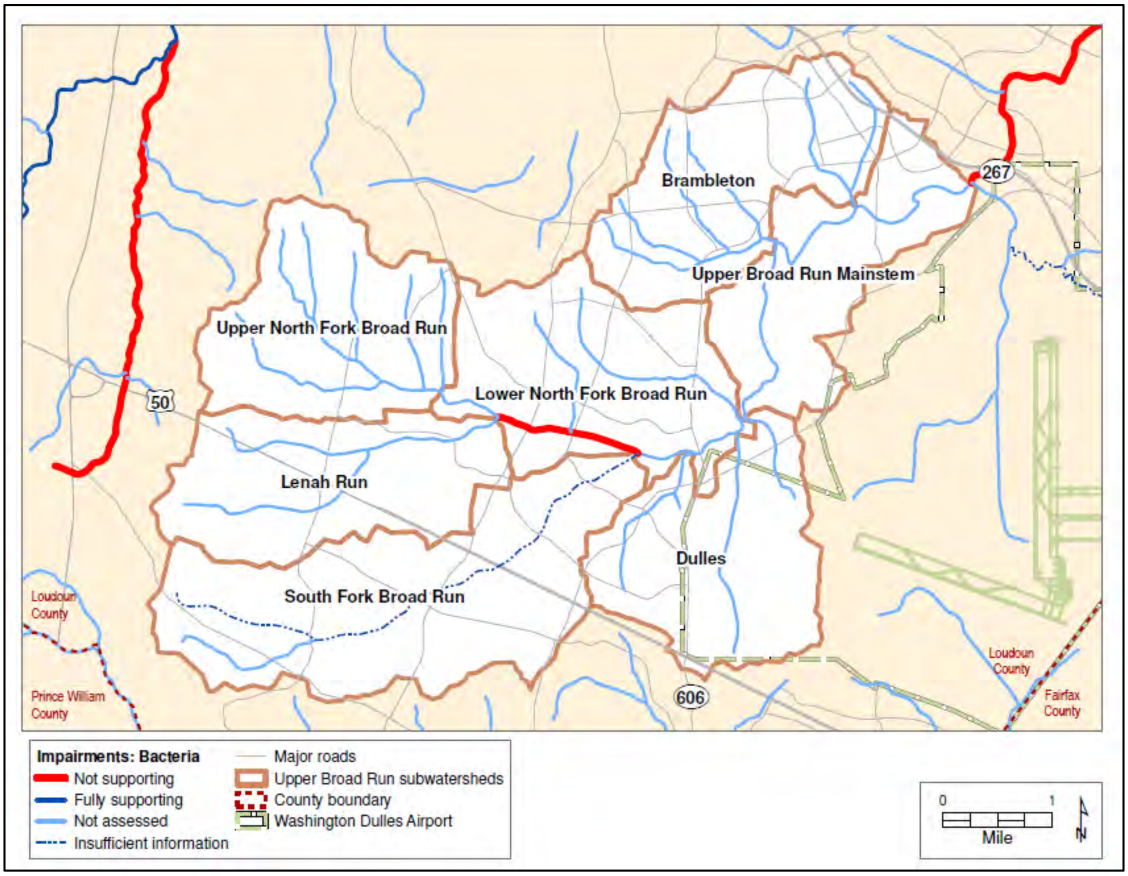


Figure 3-27: Upper Broad Run Watershed Bacteria Impairment

CHAPTER 4: FIELD ASSESSMENT

4.1 STREAM CORRIDOR ASSESSMENT

Stream corridor assessments (SCAs) were conducted for a subset of stream reaches within the Upper Broad Run watershed. The stream reaches were assessed according to the SCA Survey Protocols manual, which was developed to provide a method for the rapid assessment and documentation of environmental problems occurring within stream corridors (Yetman 2001). This method helps identify areas in need of more detailed monitoring, management, or conservation efforts on the watershed and subwatershed scale.

4.1.1 Site Selection

Approximately 13.63 stream miles within the Upper Broad Run watershed were initially selected for SCA surveys. Stream segments selected for SCA surveys were chosen for the following reasons:

- Potential preservation opportunities surrounding headwater streams,
- Potential restoration areas downstream of development,
- Gather data within the stream reach with a benthic and bacteria impairment, and
- Gather data in areas that were not assessed during the Loudoun County Stream Assessment conducted in 2009.

Loudoun County staff mailed permission letters to the owners of each property that intersected a stream segment that was selected for the SCA surveys. Permission was granted for approximately 12.84 of the approximate 13.63 stream miles selected for surveys. Permission to access properties surrounding two additional stream segments was initially requested in case a high percentage of property owners denied access, but these ultimately were not assessed due to the large number of property owners who granted access.

4.1.2 Assessment Protocol

The SCA method is used to quickly assess physical conditions and identify common environmental problems in a stream corridor. Two-person field crews walked the wadeable streams within each of the selected subwatersheds and completed forms for habitat condition and each of the following nine environmental problems that were observed:

- Erosion
- Inadequate Buffers
- In or Near Stream Construction
- Fish Migration Barriers
- Channel Alterations
- Trash Dumping

- Pipe Outfalls
- Exposed Pipes
- Other Unusual Conditions or Comments

The field survey teams walked along the selected stream corridors recording the coordinates of problems from a handheld Global Positioning System (GPS) unit on the appropriate data sheets. At least one photograph was taken at each site to document the conditions observed. After returning from the field, all data were entered into a Geographic Information System (GIS). Each site was assigned a unique identification (ID) number.

The field survey team scored each problem site on a scale of one to five for severity. A score of five denotes a minor problem, or one that is easily fixed, and a score of one is the worst problem observed in a problem category. The criterion for scoring problem severity is dependent on the problem type and is described in detail in the SCA manual (Yetman 2001). The severity rating is a measure of how bad 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. These scores can also help prioritize potential restoration opportunities.

SCA severity and correctability ratings were used to prioritize unstable stream reaches for further study and/or restoration. In addition, habitat assessment scores and a lack of environmental problems were used to prioritize high quality stream reaches for preservation. High quality stream reaches in forested headwaters typically have a higher preservation priority.

4.1.3 Summary of Sites Investigated

SCA surveys were conducted within all seven of Upper Broad Run's subwatersheds. A summary of the length of stream assessed within each subwatershed is presented in Table 4-1. A map showing the location of each assessed stream reach is presented in Figure 4-1. The Lower North Fork subwatershed has the largest number of assessed stream miles due to the importance of assessing the Upper Broad Run watershed's only impaired stream reaches, which are fully contained within this subwatershed. The South Fork of Broad Run had the second largest amount of assessed stream miles due to interest in the potential for land preservation in its forested headwaters, the effects of the active construction occurring in the southwestern portion of the subwatershed, and the impact of the newly developed Stone Ridge area in the eastern portion of the subwatershed.

A summary of the number and location of habitat assessment sites and documented environmental problems is presented in Table 4-2. Erosion and inadequate buffers were the most common problems observed during the SCA surveys. Many of the other environmental problems documented during SCA surveys (e.g., channel alteration, exposed pipes, pipe outfalls) are more common in areas that have been urbanized for several decades, and thus were not observed in the majority of the Upper Broad Run's assessed stream segments. Detailed descriptions of habitat and environmental problem data collected during the field assessments are discussed in Section 4.1.4.

Table 4-1: Miles of Stream Assessed by Subwatershed

Subwatersheds	Stream Miles Surveyed	Total Stream Miles	% Total Stream Miles Surveyed
Brambleton	1.02	8.02	12.7%
Upper Broad Run Mainstem	1.37	4.38	31.3%
Dulles	0.75	4.79	15.7%
Lenah Run	1.99	4.71	42.3%
Lower North Fork Broad Run	2.73	6.74	40.5%
South Fork Broad Run	2.57*	6.39	40.2%
Upper North Fork Broad Run	2.41	8.24	29.2%
Totals	12.84*	43.27	29.7%

* Actual stream miles surveyed is slightly less than reported values due to the denial of access on a few small properties within the South Fork Broad Run subwatershed.

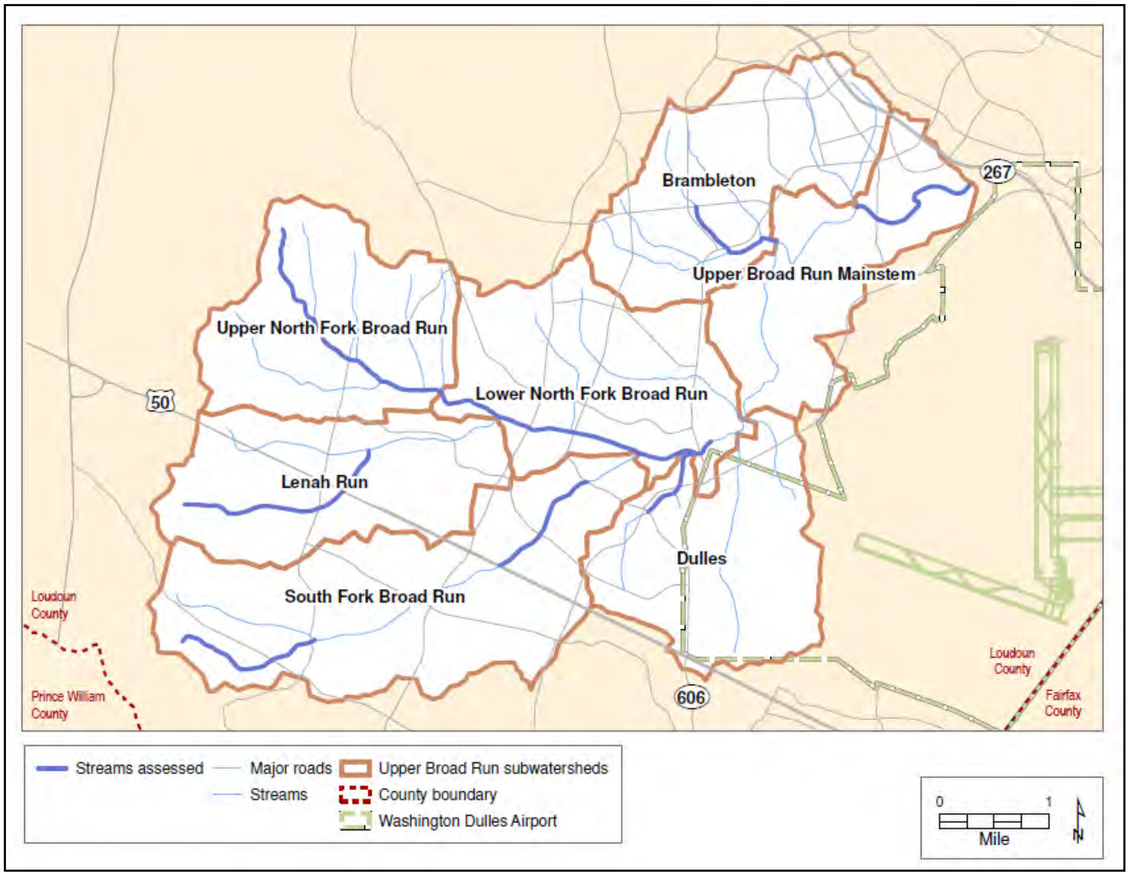


Figure 4-1: Locations of Stream Corridor Assessments Conducted in Upper Broad Run

Table 4-2: Upper Broad Run SCA Survey Results – Habitat Assessments and Environmental Problem Totals

Subwatersheds	Number of Habitat Assessments	Channel Alterations	Erosion	Exposed Pipe	Fish Barrier	In or Near Stream Construction	Inadequate Buffer	Pipe Outfall	Trash Dumping	Unusual Condition or Comment
Brambleton	5	3	6	1	0	0	8	0	0	0
Upper Broad Run Mainstem	2	0	7	0	0	0	4	0	0	0
Dulles	4	1	7	0	1	0	5	0	0	2
Lenah Run	7	3	20	0	0	3	8	2	0	1
Lower North Fork Broad Run	15	0	26	0	5	1	13	1	0	6
South Fork Broad Run	10	6	16	0	3	3	9	0	2	2
Upper North Fork Broad Run	6	0	20	0	0	1	10	0	0	1
Totals	49	13	102	1	9	8	57	3	2	12

4.1.4 General Findings

4.1.4.1 Habitat Assessments

A total of 49 representative habitat assessment sites were selected in the field and were used to characterize the Upper Broad Run in-stream habitat and adjacent stream corridor conditions. Habitat assessments were conducted using methods of Virginia DEQ (2008), which are based on EPA's Rapid Bioassessment Protocol (RBP, Barbour et al. 1999). The high gradient stream methodology was used to qualitatively rate 10 habitat parameters at each representative site as optimal, suboptimal, marginal, or poor based on observed conditions relative to a reference (healthy) stream. Once the field team selected a representative section of stream, they evaluated the 10 habitat parameters that are briefly described below.

- ***Epifaunal Substrate/Available Cover:*** Optimal substrate/cover conditions are those stream bottoms with more than 50 percent of favorable cover characteristics such as mix of snags, undercut banks or other stable habitat. Poor substrate would provide less than 10 percent stable habitat for epifaunal (benthic organisms) and fish colonies.
- ***Embeddedness*****:** The embeddedness evaluation characterizes the extent to which rocks, gravel, cobble, and/or boulders in riffles are covered or sunken into the silt, sand, or mud of the stream bottom. The embeddedness parameter evaluates how much of the substrate present at a site is actually available to the fish and benthic macroinvertebrates in a stream. Excess sediment settled around cobble and gravel can choke stream organisms and fill in the spaces they would otherwise be able to occupy and use for shelter and defense.
- ***Velocity/Depth Regime:*** If there was a balance of fast-shallow, fast-deep, slow-shallow, and slow-deep in a representative stream section, it was rated as optimal for depth regime. Sites where there was little variability in depth regime or where the stream was mostly slow-deep or slow-shallow were rated as marginal or poor.

- ***Sediment Deposition:*** Optimal sediment deposition conditions were those sites with little or no sand bars/islands and little impact to the bottom by sediment deposition. Sites where there were heavy deposits of fine material and indications of a frequently changing bottom were rated as poor.
- ***Channel Flow Status:*** Optimal channel flow status was those sites where there was sufficient flow such that minimal substrate was exposed. Poor channel flow was the opposite, where very little flow was in the channel and water was present as standing pools.
- ***Channel Alteration:*** An optimal rating for channel alteration was assigned to representative sites with a natural stream pattern and little or no evidence of channelization or dredging. A poor rating was given to sites where more than 80 percent of the stream was channelized (concrete, gabions, etc.) and disrupted with little or no in-stream habitat.
- ***Frequency of Riffles (or bends):*** Optimal channel sinuosity is where bends in the stream increase the length by about 3 or 4 times longer than if it were straight. Sites were rated as poor if the channel section was straight or channelized for a long distance, with no riffles.
- ***Bank Stability:*** Representative sites with stable banks and little or no potential for erosion or failure were rated as optimal for bank stability. Poor ratings were assigned to unstable channels with significant erosion along banks.
- ***Vegetative Protection:*** Optimal bank vegetative protection were those sites with more than 90 percent of bank surfaces covered by native vegetation including trees. Sites were rated as poor for this parameter if less than 50 percent of bank surfaces were covered by vegetation.
- ***Riparian Vegetative Zone Width:*** Representative sites with a minimum riparian buffer of 50 to 60 feet and where human activities/development have not impacted the buffer were rated as optimal. Sites with less than 20 feet of riparian buffer zone and where there was little or no vegetation due to human activities were considered as poor for this category.

A total of 49 representative Habitat sites were assessed during the Upper Broad Run SCA, including 6 sites along Upper North Fork Broad Run, 15 sites in Lower North Fork Broad Run, 7 sites in Lenah Run; 10 sites in South Fork Broad Run, 5 sites in Brambleton, 4 sites in Dulles, and 2 sites in Upper Broad Run Mainstem. Table 4-3 presents the collective number of Habitat sites rated as optimal, suboptimal, marginal or poor for each habitat parameter assessed.

As shown in Table 4-3, most habitat sites were rated as suboptimal or marginal for epifaunal substrate and available cover conditions, embeddedness, and sediment deposition. Riparian vegetation zone width conditions received mostly optimal or suboptimal ratings. While these sites consisted of some kind of taller woody vegetation to receive optimal or marginal ratings, grass/turf was occasionally observed rather than wooded buffers. Forested areas are best for riparian buffers, because they provide shading, organic material inputs, etc., that improve water quality and conditions for wildlife. Potential stream restoration efforts are best focused on any parameters with less than optimal ratings (particularly important are vegetative protection and riparian vegetative zone width). Channel flow status was most often good for all representative sites with a rating of either optimal or suboptimal. Similarly, channel alteration, bank stability, and vegetative protection conditions were most often rated as suboptimal or optimal. Comparatively few poor designations were given during the habitat assessment portion of the stream survey.

Locations and overall habitat score ratings for the 2013 SCA representative habitat assessment sites, along with habitat assessment sites from the 2009 Loudoun County Stream Assessment, are shown in Figure 4-2. Figure 4-3 depicts three different example habitat sites with three different ratings for overall habitat score.

Table 4-3: Upper Broad Run SCA Survey Results - Distribution of Habitat Ratings Collectively by Parameter

Parameter	Optimal	Suboptimal	Marginal	Poor
Epifaunal Substrate/ Available Cover	6	24	18	1
Embeddedness	6	16	21	6
Velocity/Depth Regime	4	30	11	4
Sediment Deposition	8	28	12	1
Channel Flow Status	12	24	9	4
Channel Alteration	47	2	0	0
Frequency of Riffles (or bends)	11	22	10	6
Bank Stability	10	31	6	2
Vegetative Protection	13	29	5	2
Riparian Vegetative Zone Width	16	18	10	5
% OF TOTAL	27.1	45.7	20.8	6.3

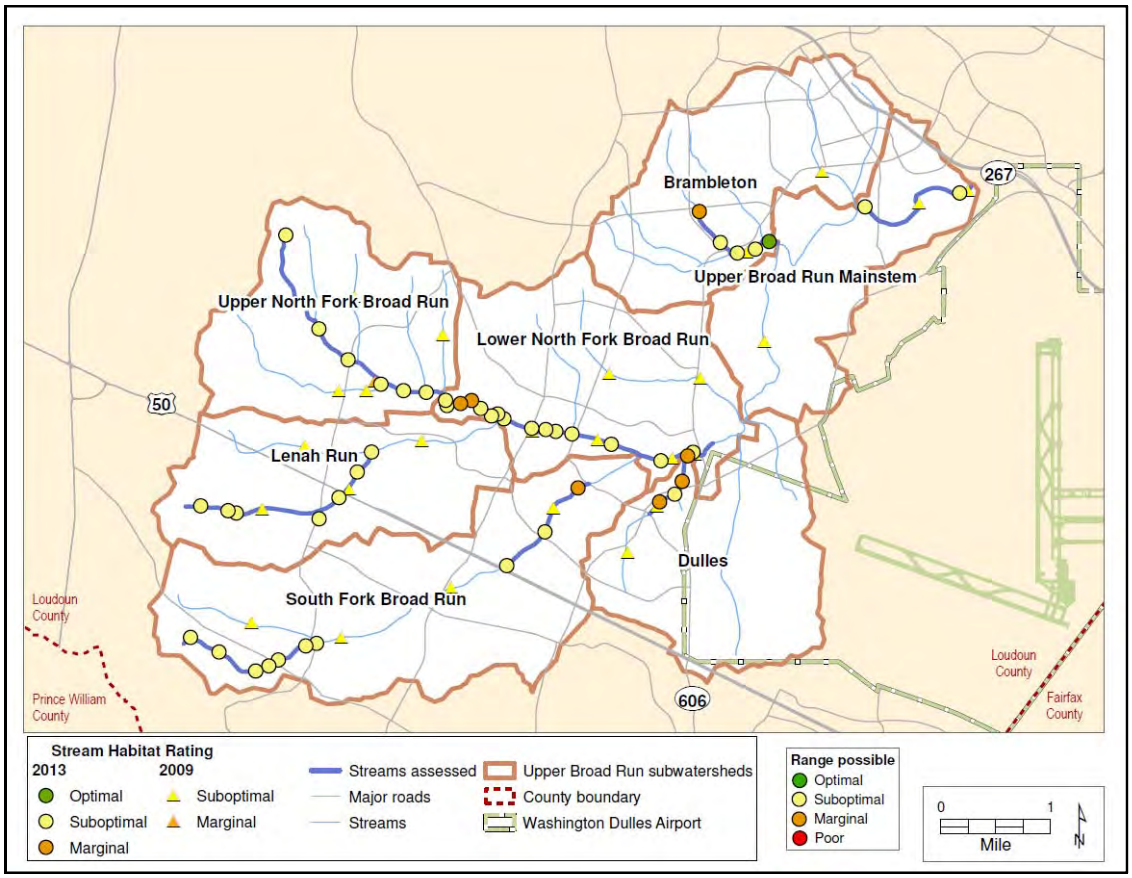
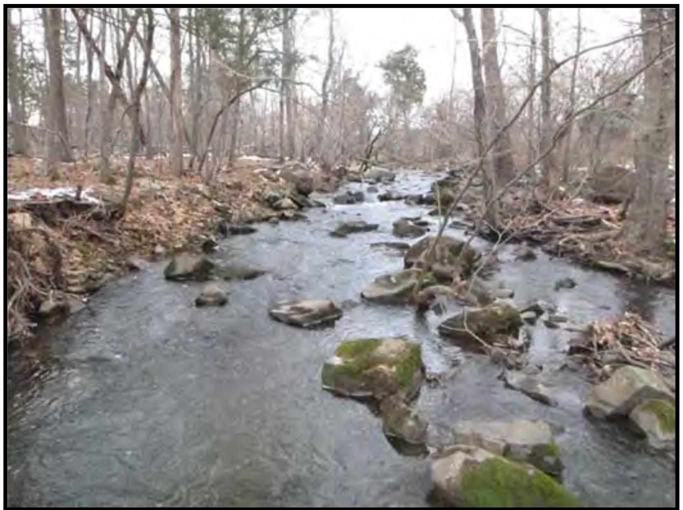


Figure 4-2: Upper Broad Run SCA Habitat Assessment Ratings



Stream reach with an optimal habitat rating

Stream reach with a suboptimal habitat rating

Stream reach with a marginal habitat rating

Figure 4-3: Three Different Upper Broad Run Habitat Sites with Three Different Habitat Ratings

4.1.4.2 Erosion Sites

Stream bank erosion is a natural fluvial process, but anthropogenic changes to a stream's hydrology or sediment supply often accelerate this process. The most common cause of stream bank erosion in urbanized areas with a growing amount of impervious cover is an increase in shear stress applied to the banks from enhanced overland flows. Many newly urbanized watersheds, including Upper Broad Run, have a surplus of sediment that has been stored in their valley bottoms since its erosion from the uplands during the days of poor soil conservation practices, after land was cleared for farming. This excess sediment is mobilized by the increase in stream power associated with the increase in stormwater runoff that occurs during urbanization, ultimately leading to higher sediment loads. It is important to document the occurrence of erosion so the appropriate Stormwater Control Measures (SCMs) can be recommended for areas that are contributing to the high flows that are causing erosion, and so sites can be targeted for stream restoration projects. Locations of erosion sites are shown in Figure 4-4.

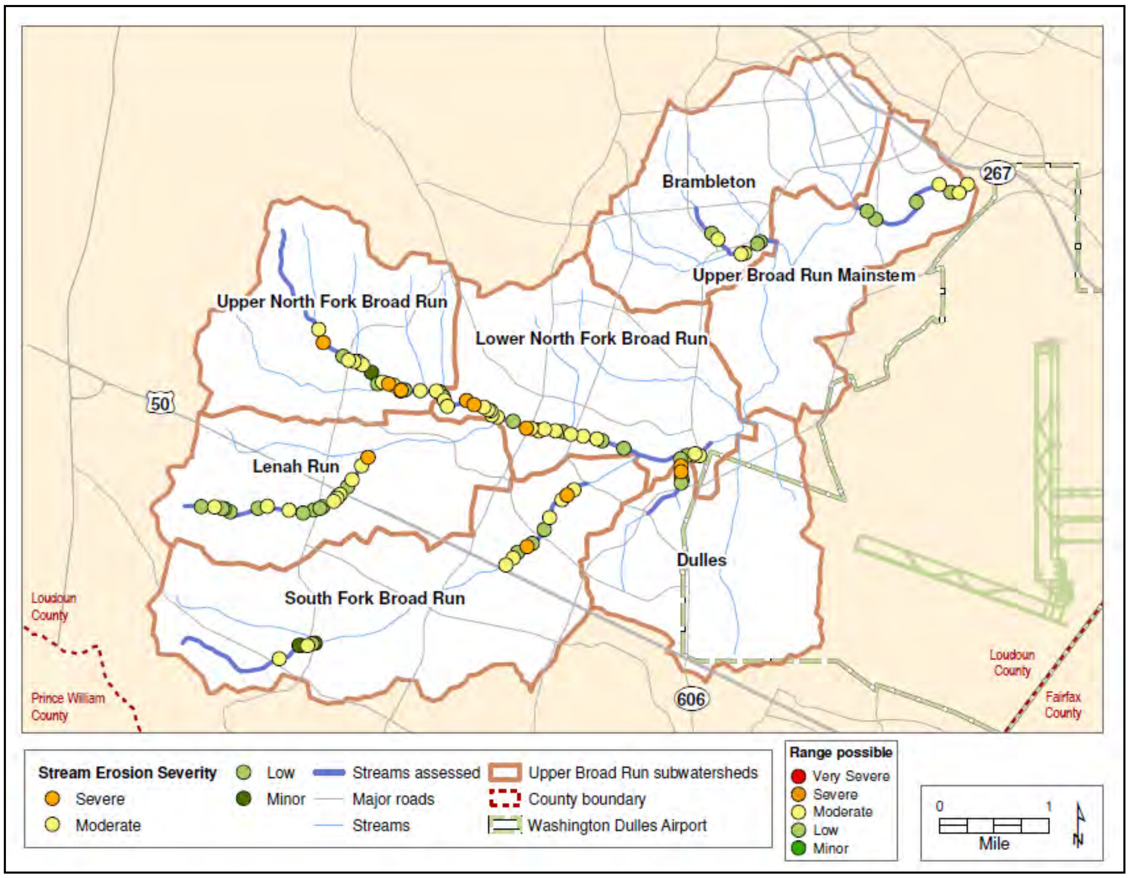


Figure 4-4: Location of Upper Broad Run SCA Erosion Sites

Table 4-4 summarizes the length and severity of erosion documented within each subwatershed. A total of 102 erosion sites were documented within the Upper Broad Run watershed. The total length of erosion identified within the watershed was estimated at 12,193 feet, or approximately 18 percent of the assessed streams. Of the assessed stream reaches, the Lower North Fork Broad

Run subwatershed had the highest number of documented erosion sites and longest stream length affected by erosion, but the Upper Broad Run Mainstem watershed had the highest percentage of surveyed stream miles exhibiting erosion. Upper Broad Run Mainstem is the eastern most sub-watershed and the furthest downstream within the Upper Broad Run watershed, meaning that it was likely developed before the other subwatersheds and feels the cumulative impacts of the stormwater runoff occurring throughout the rapidly developing watershed, either which could explain the prevalence of erosion.

Table 4-4: Upper Broad Run SCA Survey Results – Erosion Sites

Subwatershed	Severity Rating Inventory						Stream Length Exhibiting Erosion		Percent of Total Stream Length Surveyed Exhibiting Erosion
	Very Severe	Severe	Moderate	Low Severity	Minor	Total	Feet	Miles	
Brambleton	0	0	3	3	0	6	320	0.06	5.97
Upper Broad Run Mainstem	0	0	3	4	0	7	1,926	0.36	26.67
Dulles	0	2	0	6	0	8	695	0.13	17.45
Lenah Run	0	1	8	11	0	20	2,315	0.44	22.01
Lower North Fork Broad Run	0	5	20	10	0	35	3,080	0.58	21.40
South Fork Broad Run	0	2	7	4	3	16	2,538	0.48	18.73
Upper North Fork Broad Run	0	1	4	4	1	10	1,320	0.25	10.39
Totals	0	11	45	42	4	102	12,193	2.30	18.00

Approximately 85 percent of the documented erosion sites were rated as either moderate or low severity. Typically erosion sites assigned a severity of "very severe" are greater than 1,000 feet in length and have channels that are incised several feet. None of the streams assessed within the Upper Broad Run watershed fit this description, likely due to the large presence of cohesive soils (i.e., clays) within the watershed. Figure 4-5 depicts erosion sites documented within the watershed that were assigned a rating of severe.

Figure 4-5: Examples of Upper Broad Run Sites with Severe Erosion

4.1.4.3 Inadequate Stream Buffers

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 the SCA, a stream buffer was considered inadequate if it was less than about 50 feet wide from the edge of the stream. Inadequate stream buffers were the second most commonly observed environmental problem within the Upper Broad Run SCA survey area; most of these sites were associated with the sewer line right of way (ROW) that is present directly adjacent to an extensive portion of the stream. Several extensive inadequate stream buffer areas were associated with newly-constructed trunk lines that serve new residential developments in the watershed. The field team identified a total of 57 inadequate buffer sites in the surveyed area, corresponding to a total length of about 36,840 linear feet, with 18,000 linear feet on the left bank, and 18,840 linear feet on the right bank. These data indicate that approximately 27 percent of the total stream miles surveyed on the left bank (3.41 out of 12.84 miles) and 28 percent of the right bank (3.57 out of 12.84 miles) were considered as having inadequate stream buffers.

The severity of inadequate stream buffers was rated according to length and width. The most severe sites received a severity rating of 1 if they had a significant length of stream (> 1,000 feet) that was completely open with no trees on either side. Figure 4-6 depicts one typical site that was rated as possessing a severe inadequate buffer. A few sites represented potential opportunities for stream buffer reforestation, but these were often limited because of the presence of the County sewer line ROW within the stream corridor.

Figure 4-6: Example of an Upper Broad Run Inadequate Buffer Site Rated as Severe. Note the presence of the Loudoun Water sewer line right-of-way.

Table 4-5 summarizes the number of inadequate buffer sites associated with each severity rating and the length of inadequate buffer observed by stream. This table also presents the proportion of the total stream miles surveyed considered to have inadequate stream buffer.

Table 4-5: Upper Broad Run SCA Survey Results – Inadequate Stream Buffers

Subwatershed	Severity Rating Inventory						Stream Length with Inadequate Buffer		Percent of Total Stream Length Surveyed with Inadequate Buffer
	Very Severe	Severe	Moderate	Low Severity	Minor	Total	Feet	Miles	
Brambleton	0	1	5	1	1	8	5,950	1.13	55.46
Upper Broad Run Mainstem	0	2	2	0	0	4	3,715	0.70	25.74
Dulles	1	0	4	0	0	5	1,600	0.30	20.08
Lenah Run	2	2	2	2	0	8	4,935	0.93	23.46
Lower North Fork Broad Run	0	4	8	1	0	13	5,680	1.08	19.73
South Fork Broad Run	0	3	4	2	0	9	9,135	1.73	33.70
Upper North Fork Broad Run	1	2	5	2	0	10	5,825	1.10	22.92
Totals	4	14	30	8	1	57	36,840	6.97	27.19

The number of inadequate buffer sites were somewhat evenly distributed among the seven subwatersheds. Brambleton, South Fork Broad Run, and Upper and Lower North Fork Broad Run, however, had the greatest total lengths of inadequate stream buffer. In particular, the Brambleton subwatershed possessed inadequate buffers along greater than 50 percent of its banks surveyed. Most of the inadequate buffer sites observed were rated as moderate in severity. About 7 percent of the total sites were considered very severe inadequate buffers, and about 25 percent were considered as severe inadequate buffers, which could be a priority for stream buffer restoration. The distribution of inadequate stream buffer locations in the surveyed subwatersheds and their severity ratings are shown in Figure 4-7.

4.1.4.4 In or Near Stream Construction

Sites where construction was observed in or near the stream were documented as in or near stream construction sites. At these sites, the field team quickly noted lack of sediment control measures and any sign of construction-related pollution, particularly sediment. Severity of these sites was rated based on size of the construction site, proximity of construction activities to the stream, adequate sediment controls, and evidence of sediment from construction downstream. A very severe rating was assigned to large construction sites with large amount of disturbance to the stream channel with no or poorly maintained sediment controls. Minor ratings were assigned to construction sites well outside the riparian buffer with no evidence of sediment input to the stream from construction activities.

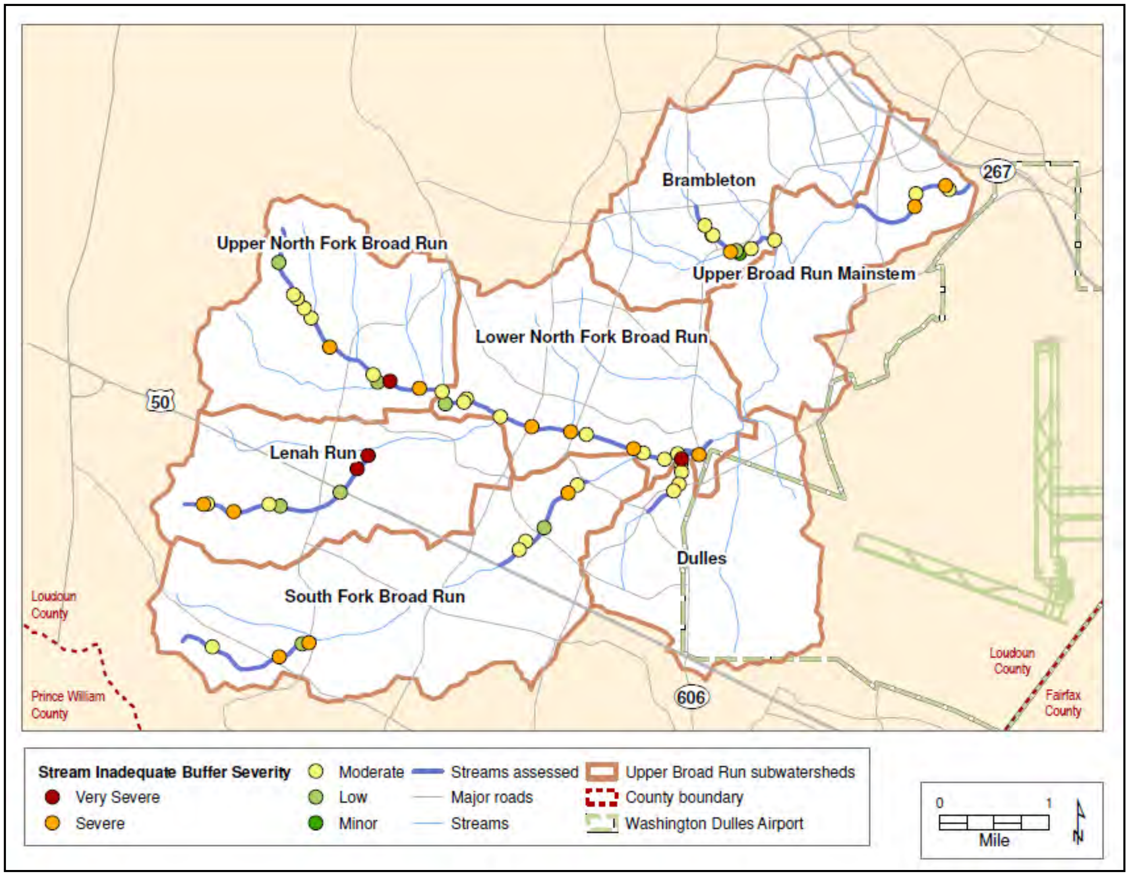


Figure 4-7: Map of Inadequate Stream Buffers in the Upper Broad Run Watershed

A total of 8 in or near stream construction sites were identified during the Upper Broad Run SCA survey, encompassing about 2,970 linear feet of stream. Table 4-6 summarizes the number of these sites associated with each severity rating and the length of construction activity observed by stream. Figure 4-8 shows the locations of in or near stream construction sites noted during the SCA surveys.

Table 4-6: Upper Broad Run SCA Survey Results – In or Near Stream Construction

Subwatershed	Severity Rating Inventory					
	Very Severe	Severe	Moderate	Low Severity	Minor	Totals (feet)
Brambleton						
Upper Broad Run Mainstem						
Dulles						
Lenah Run	2,000 ft.	60 ft.	60 ft.			2,120
Lower North Fork Broad Run			80 ft.			80
South Fork Broad Run		35 ft.; 35 ft.		400 ft.		470
Upper North Fork Broad Run		300 ft.				300
Totals	2,000 ft.	430 ft.	140 ft.	400 ft.	0 ft.	2,970

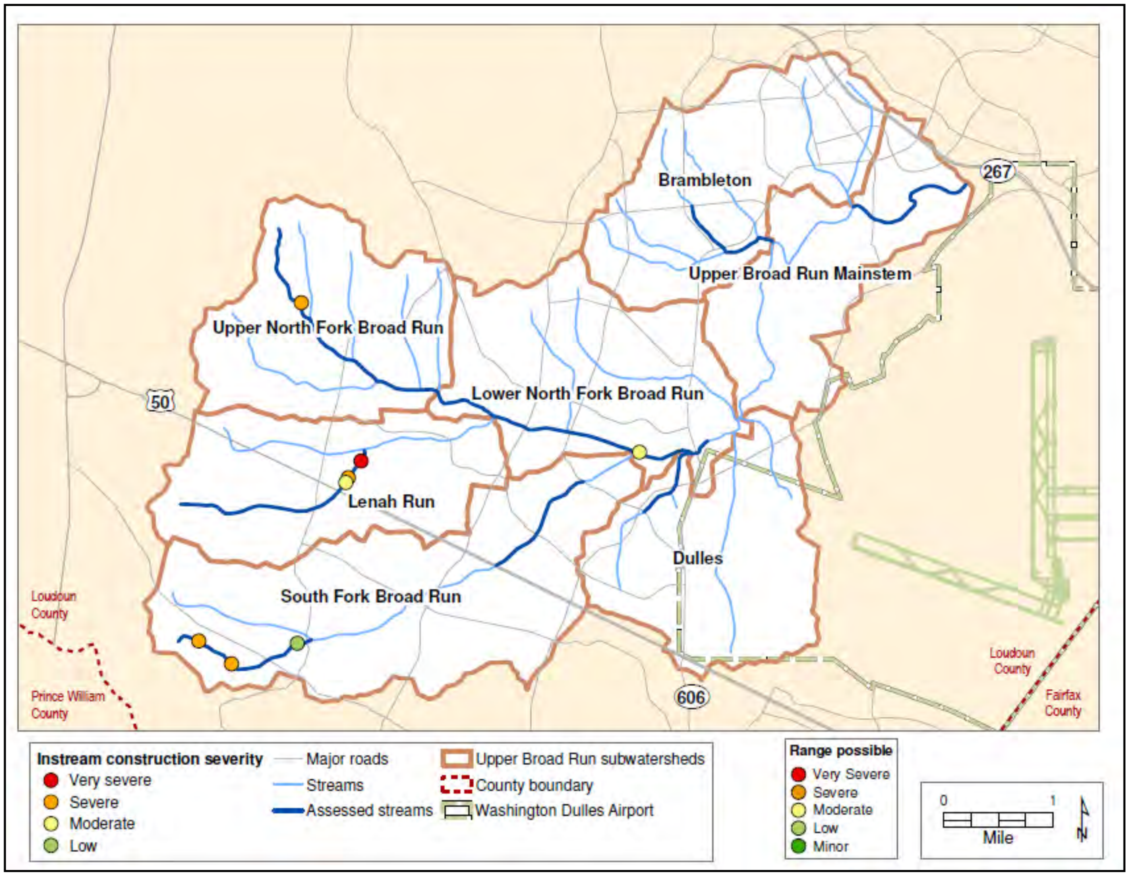


Figure 4-8: Upper Broad Run SCA In or Near Stream Construction Site Locations

As shown in the table above, construction activity rated as very severe was observed along about 2,000 feet of newly-constructed Loudoun Water sewer line right-of-way. Many parts of this reach of stream possessed almost no forested riparian buffer. In addition, four other sites (some of them along other parts of the Loudoun Water sewer line ROW) were rated as severe. Figure 4-9 depicts a few issues observed at Near Stream Construction sites.

4.1.4.5 Fish Migration Barriers

A fish migration barrier denotes any structure within the stream channel that significantly interferes with the upstream movement of fish. Unimpeded upstream movement is important for various species that migrate throughout a stream system during different parts of their life cycles, such as spawning. Significant disruptions in migration can lead to a decrease in fish population and diversity.

Structures can be man-made (e.g., dams or road culverts) or natural (e.g., head cuts, debris jams or beaver dams). All barriers documented within the watershed were either debris jams or beaver dams, and were located in subwatersheds with higher amounts of existing forest cover than impervious cover. Man-made migration barriers were not found within the Upper Broad Run watershed, as they are more common in heavily urbanized areas. The severity rating of the barriers was primarily based on the drop in water level and the percent of the stream channel that was blocked. Figure 4-10 shows the locations of fish migration barriers noted during SCA surveys. Table 4-7 summarizes the number of fish migration barrier sites associated with each severity rating.

Figure 4-9: Near Stream Construction with Super Silt Fence Placed within the Stream in an Area with a Recently Installed Sewer Line, Rated in the Survey as Severe (Left Photo) and Absence of Super Silt Fencing Along Right Bank is Exposing Stream to Runoff from Active Construction Site Rated in the Survey as Severe (Right Photo).

Table 4-7: Upper Broad Run SCA Survey Results – Fish Migration Barriers

	Severity Rating Inventory					
Subwatershed	Very Severe	Severe	Moderate	Low Severity	Minor	Totals
Brambleton	0	0	0	0	0	0
Upper Broad Run Mainstem	0	0	0	0	0	0
Dulles	0	1	0	0	0	1
Lenah Run	0	0	0	0	0	0
Lower North Fork Broad Run	0	1	2	2	0	5
South Fork Broad Run	0	0	0	3	0	3
Upper North Fork Broad Run	0	0	0	0	0	0
Totals	0	2	2	5	0	9

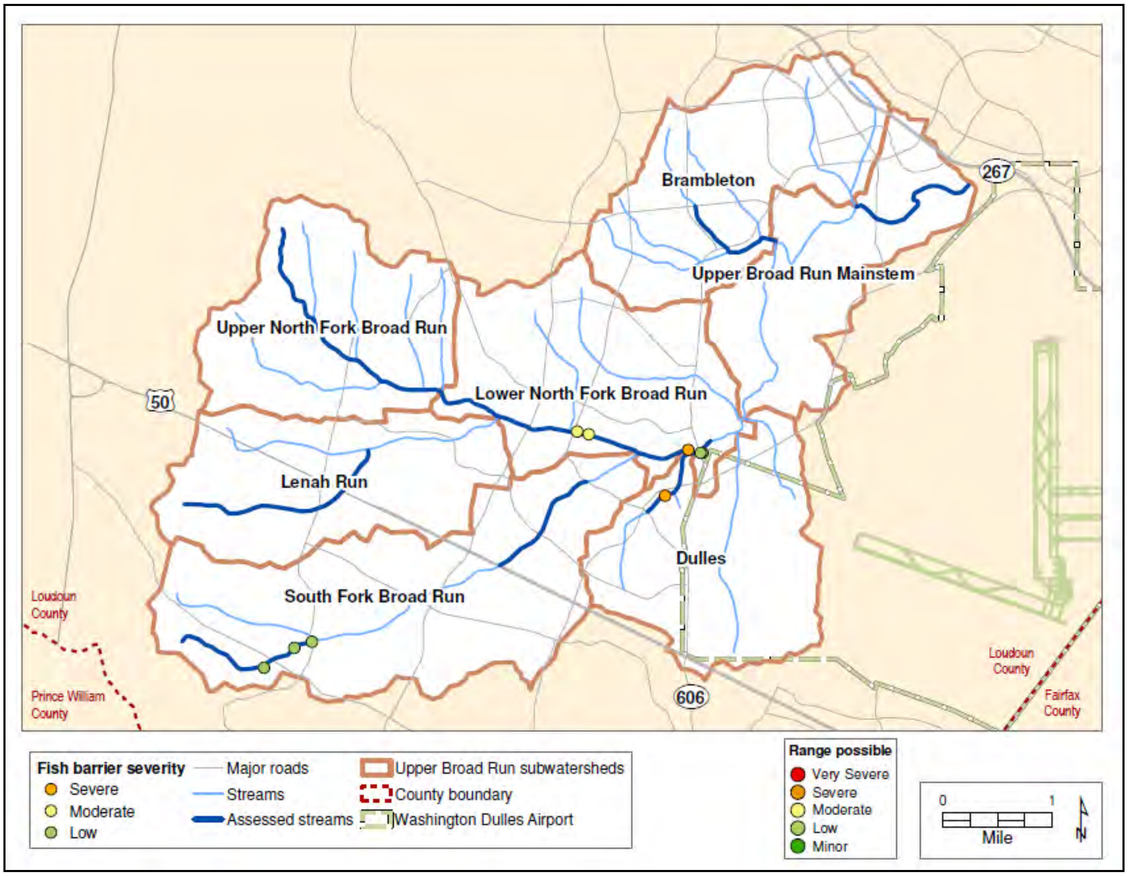


Figure 4-10: Location of Upper Broad Run Fish Migration Barriers

4.1.4.6 Channel Alterations

Channel alteration refers to stream sections where the banks or channel have been significantly modified from their natural condition. This includes channelized stream sections where the channel has been dredged, widened, straightened, and/or covered with concrete. Channelized streams are typically intended to convey higher flows while preventing flooding and stream instability, but often create adverse environmental impacts such as impaired habitat and increased water temperature. A total of 13 sites with altered channel were documented within the Upper Broad Run watershed. No channel alteration sites were greater than 300 feet in length, and nearly every alteration was due to riprap placement above or below road crossings, or on top of utility lines crossing under the stream. None of these sites posed significant risks to stream fauna.

4.1.4.7 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. These sites often represent a chance to engage the community to take action and to see the condition of their local streams.

A total of only two trash dumping sites were documented as part of the Upper Broad Run SCA survey (Figure 4-11). The severity of both these trash dumping sites was rated low, according to the amount and type of trash present, their location, and whether cleaning up the trash would present problems (access and safety). Type of trash was classified as one of the following: residential, industrial, yard waste, floatables, tires, construction, or other. Low severity and minor trash dumping sites are those with easy access and typically where there is potential for a volunteer cleanup. The amount of trash was estimated in terms of number of pick-up truck loads for completely clearing the site. One site was estimated to take one pick-up truck load, and the other would take two pick-up truck loads. One trash pile consisted of concrete rubble, and the other site consisted of tires and construction debris. Figure 4-12 shows an example of a low severity trash dumping site where approximately two truckloads of residential trash (tires and construction debris) was observed. Both of these sites were considered as possible volunteer projects.

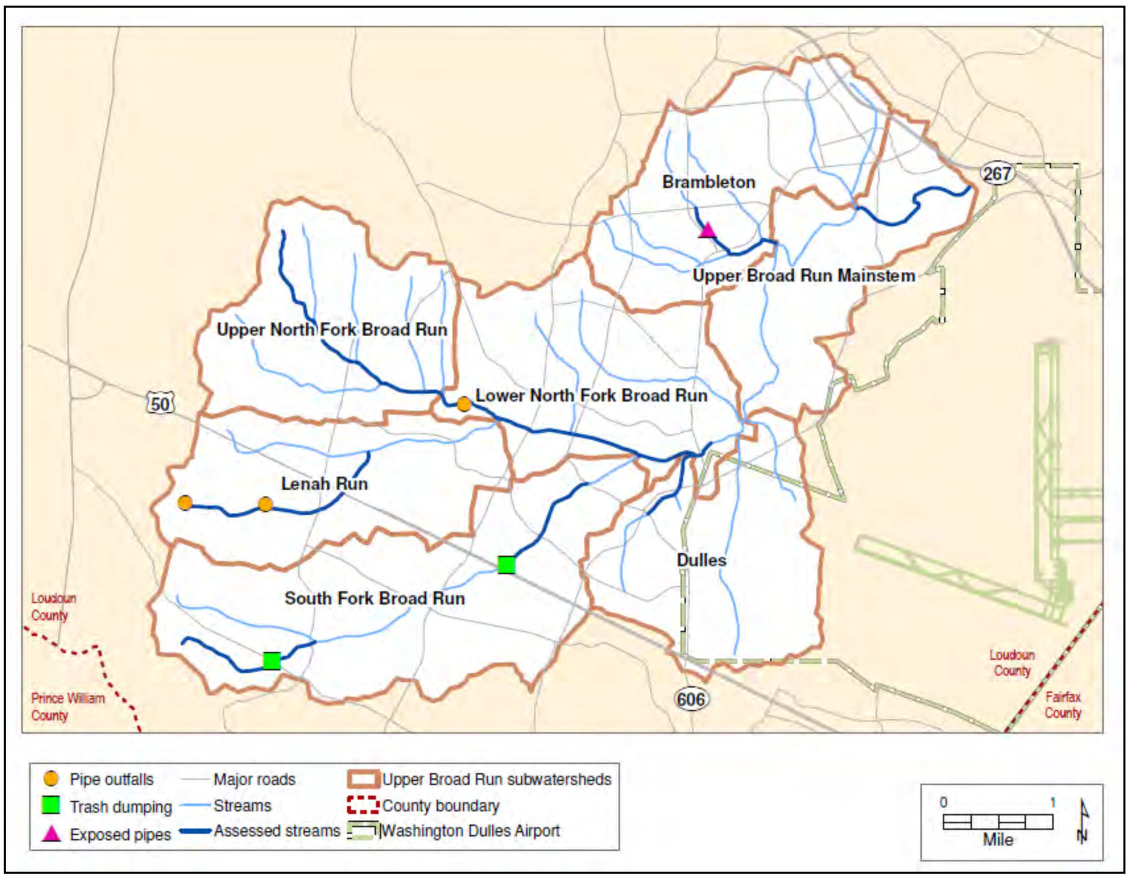


Figure 4-11: Upper Broad Run Trash Dumping, Pipe Outfall, and Exposed Pipe Locations

Figure 4-12: Photo of a Low Severity Trash Dumping Site

4.1.4.8 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. Of particular interest were outfalls that were discharging at the time of the survey for which color and odor of discharge were noted. The pipe material type and size were also recorded. A pipe outfall that had a strong discharge relative to the normal stream flow, a distinct color and/or odor, and where discharge was causing significant impacts downstream would receive the most severe rating. Minor severity ratings were assigned to outfalls intended to carry storm water that did not have dry weather discharge and did not cause erosion problems. The severity rating for a pipe outfall was primarily based on the discharge including whether discharge was present, color, odor, amount, and downstream impacts.

A total of three pipe outfalls were identified during the Upper Broad Run SCA survey. Of these, one was rated as moderate severity, and two were rated as minor severity. The moderate rated pipe outfall was located within the Lower North Fork Broad Run subwatershed and was part of a rock-lined swale that was a conveyance to the stream. It consisted of a 24-inch CMP in an 8-inch-wide swale. The minor severity pipe outfalls were located within the Lenah Run subwatershed and consisted of 4-inch and 6-inch corrugated plastic pipes, respectively, and both exhibited evidence of small amounts of clear stormwater discharge. Access and correctability were rated as best for both of the minor outfalls, but correctability was rated one step lower (more difficult) at the moderate severity pipe outfall, owing to its larger size. Figure 4-11 shows the location of outfalls noted during SCA surveys. Figure 4-13 depicts a moderate severity Pipe Outfall site that drains to the Lower North Fork of Broad Run.

Figure 4-13: Photo of a Moderate Severity Pipe Outfall Site

4.1.4.9 Exposed Pipes

The severity rating for exposed pipes was based on the amount of pipe exposed, location with respect to the stream, whether structural stability of pipe is affected by erosion, and whether the pipe is leaking. A very severe rating represents any pipe that is leaking or immediate threat of failure such as one likely to collapse, a pipe that runs under the stream bed where part is suspended, a long section along the stream edge that is mostly exposed, or a manhole stack in the center of the stream with evidence of cracks. Moderate ratings were assigned to relatively long sections of exposed pipes with no immediate threat of failure. Minor exposed pipe problems are small sections of exposed pipe adjacent to stable stream banks. These sites can represent a potential threat to water quality in Upper Broad Run and to public health. Consequently, they are recommended for follow-up inspection.

A total of only one exposed pipe site, rated as moderate severity, was identified during the Upper Broad Run SCA survey. It consisted of a 6-inch plastic sewer line (though it is listed as a 12-inch plastic pipe in Loudoun Water's Gravity Sewer Line GIS layer) that has become exposed in the stream bed. Correctability and access were both rated as one score less than best, because of the site's location within the streambed, and access to the site could involve impacts to nontidal wetlands. Figure 4-11 shows the location of the exposed pipe. Figure 4-14 depicts the exposed pipe within the streambed.

Figure 4-14: Exposed Pipe within the Streambed of Upper Broad Run

4.1.4.10 Unusual Conditions or Comments

The unusual conditions form was used to document problems that did not fit into another category, or to provide additional comments on a specific problem. Unusual conditions typically include an unusual odor or water color, excessive algae, the presence of oil, or a man-made structure within the stream channel that would not fall into the Fish Migration Barrier category. Unusual conditions were ranked as severe if the potential problem was considered to have a direct and wide-reaching impact on the stream's aquatic resources. A site was rated as minor if it was considered to have no significant impact on the stream's aquatic resources. Figure 4-15 shows the locations of the unusual conditions documented within the Upper Broad Run watershed, and Table 4-8 summarizes the number and severity of unusual conditions recorded within each subwatershed.

Table 4-8: Upper Broad Run SCA Survey Results – Unusual Conditions

Subwatershed	Severity Rating Inventory					
	Very Severe	Severe	Moderate	Low Severity	Minor	Totals
Brambleton	0	0	0	0	0	0
Upper Broad Run Mainstem	0	0	0	0	0	0
Dulles	0	1	1	0	1	3
Lenah Run	0	0	0	0	1	1
Lower North Fork Broad Run	0	2	1	1	1	5
South Fork Broad Run	0	0	1	1	0	2
Upper North Fork Broad Run	0	0	1	0	0	1
Totals	0	3	4	2	3	12

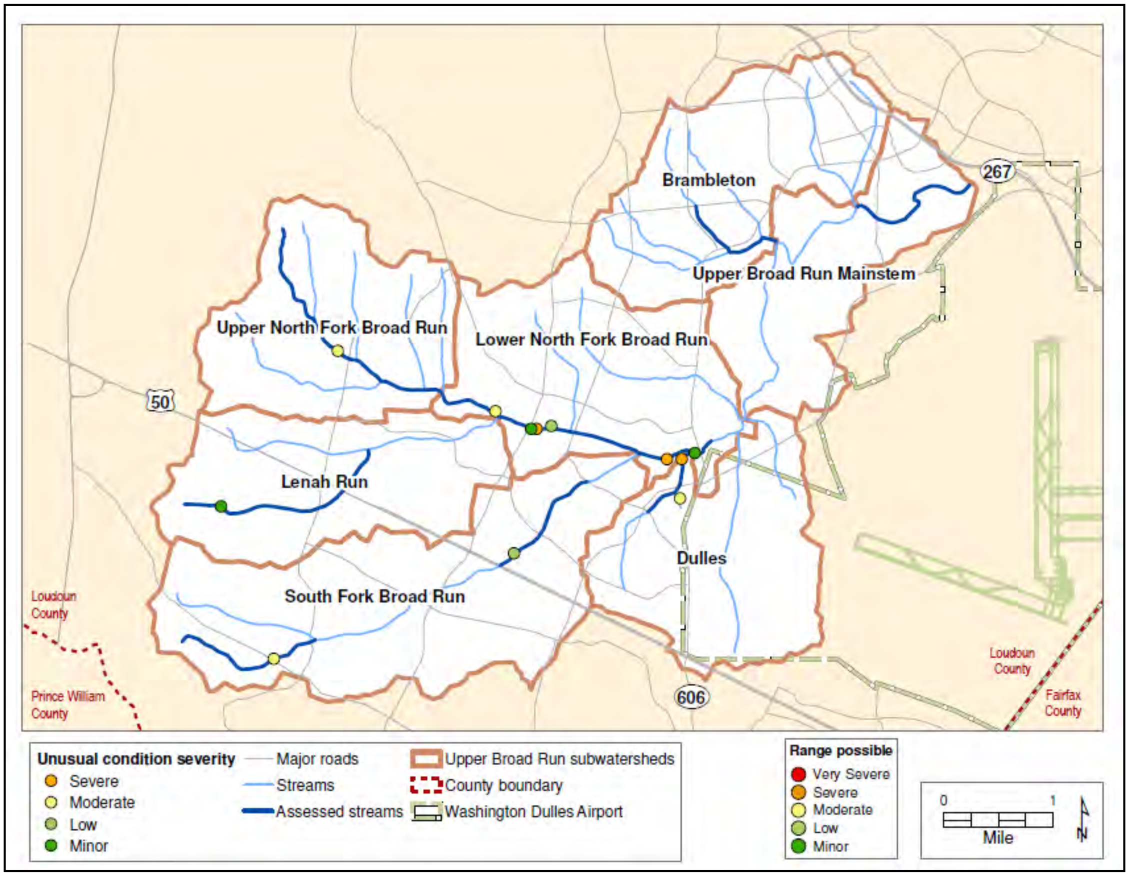


Figure 4-15: Location of Upper Broad Run Unusual Condition/Comment Sites

Three unusual conditions documented within the Upper Broad Run watershed were ranked as severe. The severe unusual condition observed within the Dulles subwatershed was a stream reach within a powerline right-of-way (ROW) that contained several dozen small trees dumped along the stream banks and an oil sheen present in the stream water, presumably after chain saws were used by power company workers to clear the ROW of woody vegetation. The severe unusual condition observed in the downstream portion of the Lower North Fork Broad Run watershed was concrete rubble left behind after the collapse or demolishing of an old bridge. Several slabs of concrete remain in the stream channel (Figure 4-16) and pose a risk to the stream's aquatic resources. The severe unusual condition observed in the upstream portion of the Lower North Fork Broad Run watershed was a large debris jam along the upstream side of the Evergreen Mills road culvert (Figure 4-16). The continued build-up of debris could lead to the channel becoming completely blocked and potentially pose a flooding threat to the roadway.

Figure 4-16: Examples of Unusual Conditions Encountered During SCA Surveys. The photo on the left is the remains of an old bridge and the photo on the right is a large debris jam upstream the Evergreen Mills Road crossing. Both are located within the Lower North Fork Broad Run subwatershed.

4.1.4.11 Candidate Stream Corridor Restoration and Preservation Sites

As described in section 4.2, habitat assessment and environmental problem data were used to recommend specific stream corridors for restoration and preservation. SCA survey results led to the recommendation of a total of 8 stream restoration sites and 2 stream corridor preservation sites within the Upper Broad Run watershed. Five additional stream restoration candidate sites were noted during Retrofit Reconnaissance Investigations (RRI) surveys. Table 4-9 summarizes the number of restoration and preservation sites by subwatershed. A detailed discussion of several candidate stream restoration sites and each candidate stream corridor preservation site is included in Chapter 7.

Table 4-9: Upper Broad Run Candidate Stream Restoration and Preservation Sites

Subwatersheds	Restoration Sites	Preservation Sites
Brambleton	6	0
Upper Broad Run Mainstem	1	0
Dulles	0	0
Lenah Run	0	0
Lower North Fork Broad Run	2	0
South Fork Broad Run	2	1
Upper North Fork Broad Run	2	1
Totals	13	2

4.2 Upland Assessments

Upland areas were assessed according to the Unified Subwatershed and Site Reconnaissance (USSR) Manual developed by the Center for Watershed Protection (CWP 2005) to identify potential pollution sources influencing water quality and to identify restoration project opportunities. The USSR manual is the last manual in a series of 11 regarding techniques for restoring urban watersheds. It provides detailed guidance for field survey techniques and was developed to help watershed groups, municipal staff, and consultants to quickly identify major stormwater pollution sources and to assess subwatershed restoration potential for source controls, pervious area management, and improved municipal maintenance such as education, retrofits, street sweeping, and open space management.

The field survey of upland areas in the Upper Broad Run watershed included five major components:

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

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

4.2.1 Neighborhood Source Assessments (NSA)

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

4.2.1.1 Assessment Protocol

Prior to conducting NSAs in the field, neighborhoods were chosen and delineated using the subdivision GIS layer provided by Loudoun County. Subdivisions that contained only a few homes or lots subdivided for future development were removed from the pool of neighborhoods considered for assessment. Remaining neighborhoods were selected and delineated based on a subdivision containing a group of homes with similar characteristics including lot sizes, set-backs, year built, and type (condominium complex, townhomes, single family detached, etc.). It was decided that an equal mix of neighborhood ages and types would be selected for the field assessments. Based on the existing mix of neighborhood ages within the watershed, an old neighborhood was defined as one constructed before 2007.

Field investigations were conducted from November 2013 through January 2014, using the NSA protocol documented in the USSR (CWP 2005). The field team drove through every street in a defined neighborhood to identify potential pollution sources and restoration opportunities. To standardize the NSA process, and be able to prioritize potential restoration efforts, data were collected in each neighborhood for four main source areas: yards and lawns; driveways, sidewalks, and curbs; rooftop runoff; and common areas. These are each described briefly below. Opportunities for tree planting and new SCMs were also noted.

Yards and Lawns

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

Driveways, Sidewalks, and Curbs

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

Rooftops

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

Common Areas

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

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

After evaluating an entire neighborhood, field staff were able to recommend specific actions recommended for neighborhoods in the Upper Broad Run watershed including:

- Downspout disconnection, rain barrels, and rain gardens;
- Fertilizer reduction/education;
- Sustainable Landscaping;
- Storm drain marking;
- Stream buffer improvements;
- Open space tree planting; and
- Open space bioretention and rain garden SCMs.

The last step of the NSA involved rating the overall neighborhood pollution severity and restoration potential. The severity of pollution generated by a neighborhood is denoted by the Pollution Severity Index (PSI) based on benchmarks and scoring system in the USSR manual (CWP 2005). 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.

4.2.1.2 Summary of Sites Investigated

A total of 25 neighborhoods were assessed throughout the Upper Broad Run watershed (Figure 4-17). The number of neighborhoods assessed within each subwatershed is summarized in Table 4-10. The majority of the assessed neighborhoods are located within the Brambleton subwatershed, which is also the subwatershed with the highest population density and amount of impervious cover. Note that a neighborhood may exist in more than one subwatershed; in this case the neighborhood was assigned to the subwatershed containing the largest portion of the watershed. Of the 25 neighborhoods assessed, one neighborhood was rated as having a severe PSI, two have a high PSI, thirteen were assigned a moderate PSI, and nine were assigned a low PSI (Figure 4-18). Five neighborhoods are considered as having a high ROI, fifteen have a moderate ROI, and five have a low ROI (Figure 4-19). The distribution of PSI ratings is shown in Figure 4-18, and ROI ratings in Figure 4-19.

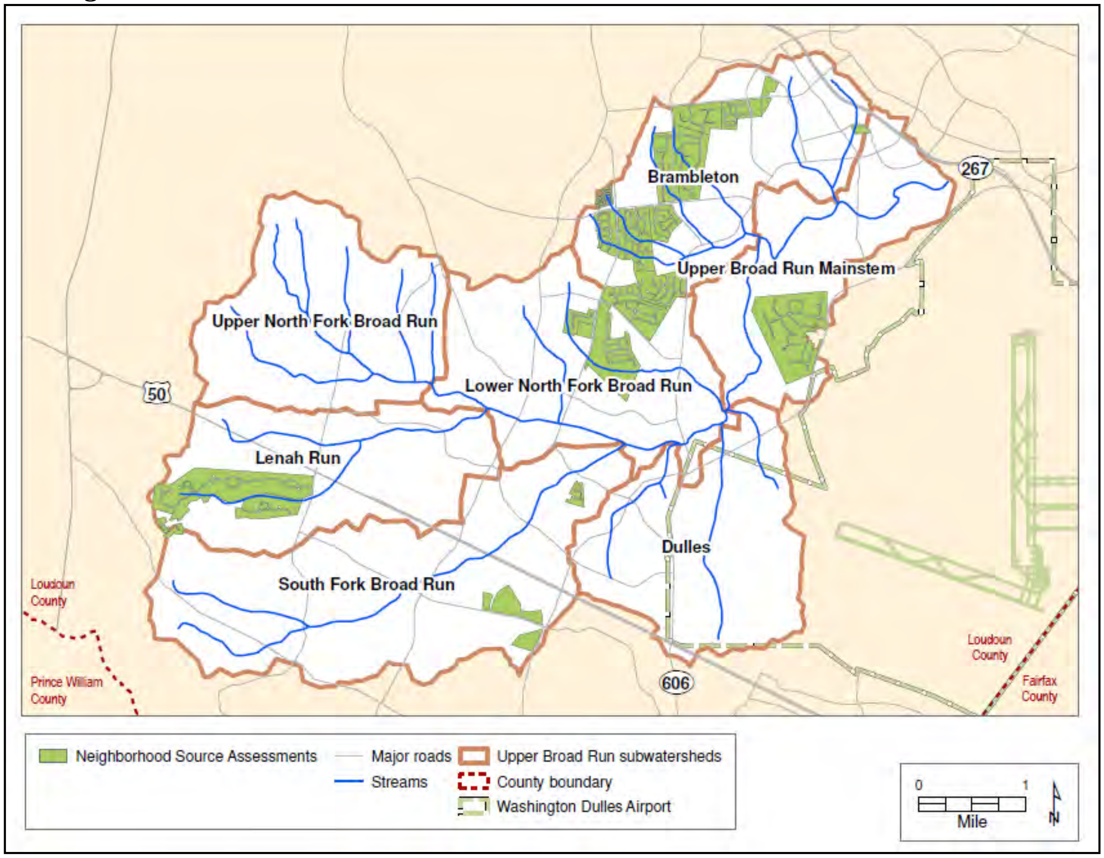


Figure 4-17: Location of Neighborhood Source Assessments Conducted in Upper Broad Run Watershed

Table 4-10: Neighborhoods Surveyed by Subwatershed

Subwatershed	# of NSAs
Brambleton	13
Upper Broad Run Mainstem	1
Dulles	0
Lenah Run	2
Lower North Fork Broad Run	4
South Fork Broad Run	5
Upper North Fork Broad Run	0
Total	25

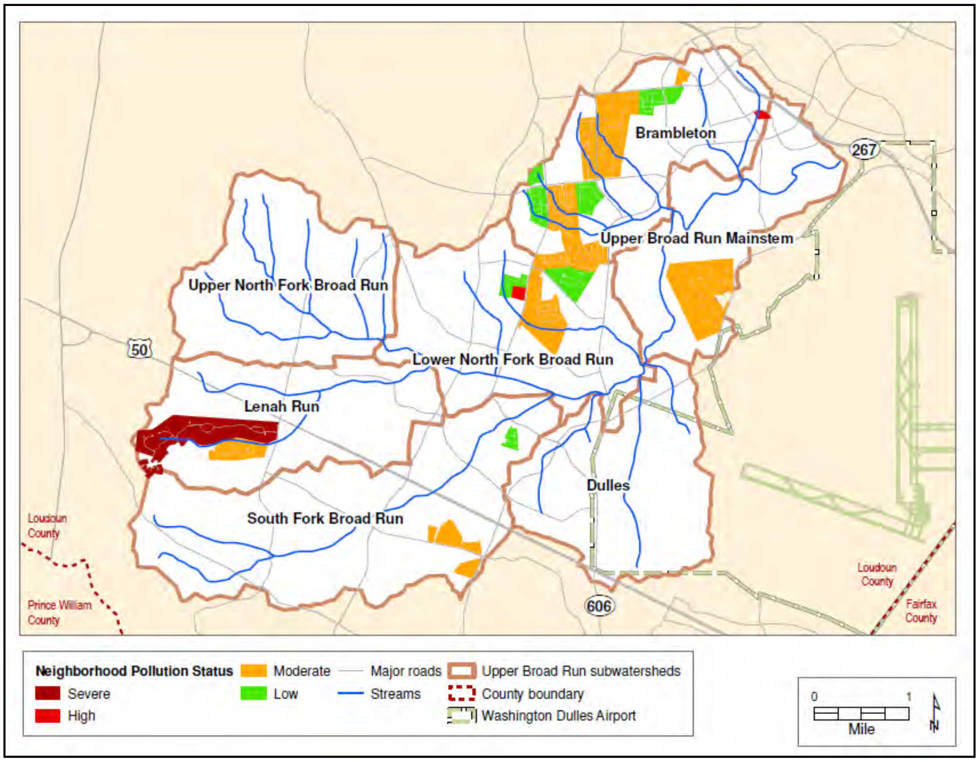


Figure 4-18: Upper Broad Run NSA PSI Ratings

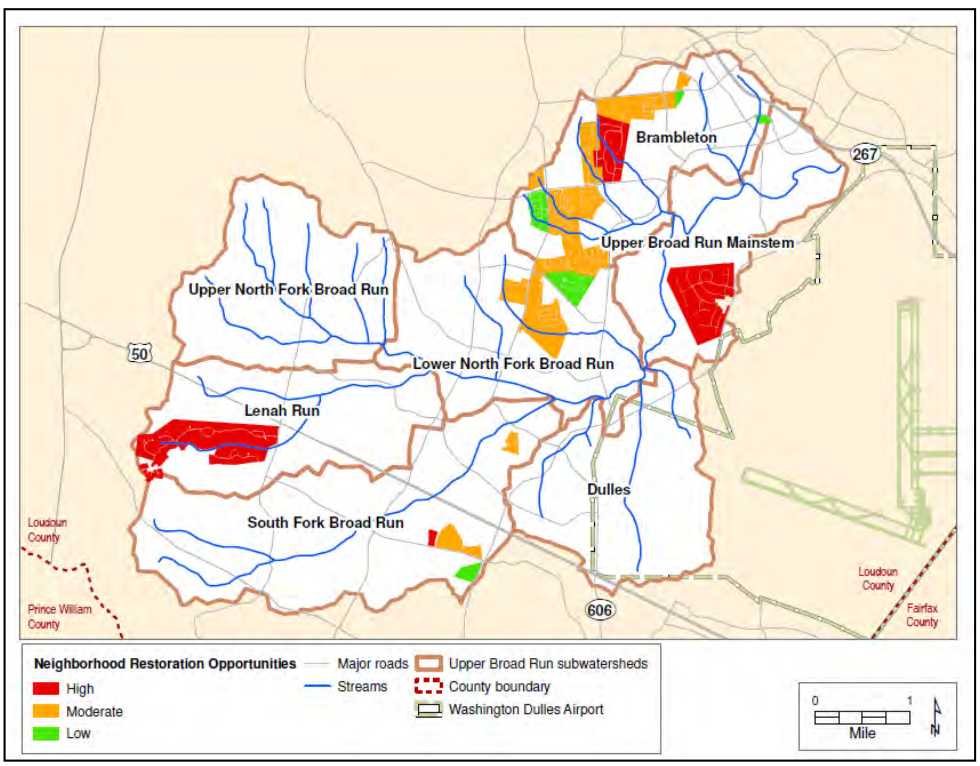


Figure 4-19: Upper Broad Run NSA ROI Rating

4.2.1.3 General Findings

The following subsections describe the actions recommended based on the NSAs. This includes an explanation of the methodologies and criteria used to evaluate the potential for recommended actions and results expected if these actions were applied. Figures showing general locations of neighborhoods recommended for certain actions are included in each subsection.

4.2.1.3.1 Downspout Retrofits: Downspout Disconnection, Rain Barrels, and Rain Gardens

Rooftop runoff is managed via downspouts which are considered as either connected or disconnected to the storm drain system. Directly connected downspouts extend underground, discharging runoff directly to the storm drain system without treatment. Indirectly connected downspouts drain to impervious surfaces such as paved driveways, sidewalk, or curb and gutter system with little or no treatment. Retrofitting may involve redirecting connected downspouts from impervious areas or the storm drain system onto pervious areas such as yards and lawns. Infiltration of rooftop runoff requires at least 15 linear feet of pervious area down gradient from the downspout. Under certain conditions, rain barrels and rain gardens are also retrofit options and may be recommended in lieu of redirection. Rain barrels, for example, may be used to store rooftop runoff for irrigation if there is limited pervious area available for downspout redirection, which is most often seen in condominium and townhouse neighborhoods. Rain gardens are the most desirable option in terms of water quality because they consist of amended soils and native plants that capture and treat runoff; this is a potential option for disconnection if the typical neighborhood has several hundred square feet of lawn area available down gradient from the downspout, which is most often seen in single family detached lots.

Downspout redirection is recommended for neighborhoods where at least 25 percent of the downspouts are connected to impervious area or directly to the storm drain system and where the average lot has at least 15 feet of pervious area available down gradient from the connected downspout for redirection. Table 4-11 includes a summary of the number of neighborhoods recommended for downspout disconnection and the acres of rooftop that would be addressed if downspout disconnection was implemented. Neighborhoods specifically recommended for rain gardens and/or rain barrels are also noted in the table.

Figures 4-20, 4-21, and 4-22 show the location of neighborhoods recommended for disconnection, rain barrels, and rain gardens. Out of the 25 neighborhoods assessed, 15 have the potential for downspout disconnection through redirection, rain barrels, or rain gardens, 8 are specifically recommended for rain barrels, and 4 are specifically recommended for rain gardens. While this report offers recommendations for rain barrels, rain gardens, and other residential stormwater approaches, implementation of specific projects will need to consider what is allowed by local HOAs.

Table 4-11: Downspout Disconnection Recommendations

Subwatershed	# of NSAs Recommended for Downspout Disconnection	Rooftop Acres Addressed	# of NSAs Recommended for Rain Barrels	# of NSAs Recommended for Rain Gardens
Brambleton	5	13.2	4	1
Upper Broad Run Mainstem	1	9.5	0	1
Dulles	0	0	0	0
Lenah Run	2	8.4	0	2
Lower North Fork Broad Run	3	7.2	0	0
South Fork Broad Run	4	8.6	4	0
Upper North Fork Broad Run	0	0	0	0
Total	15	46.9	8	4

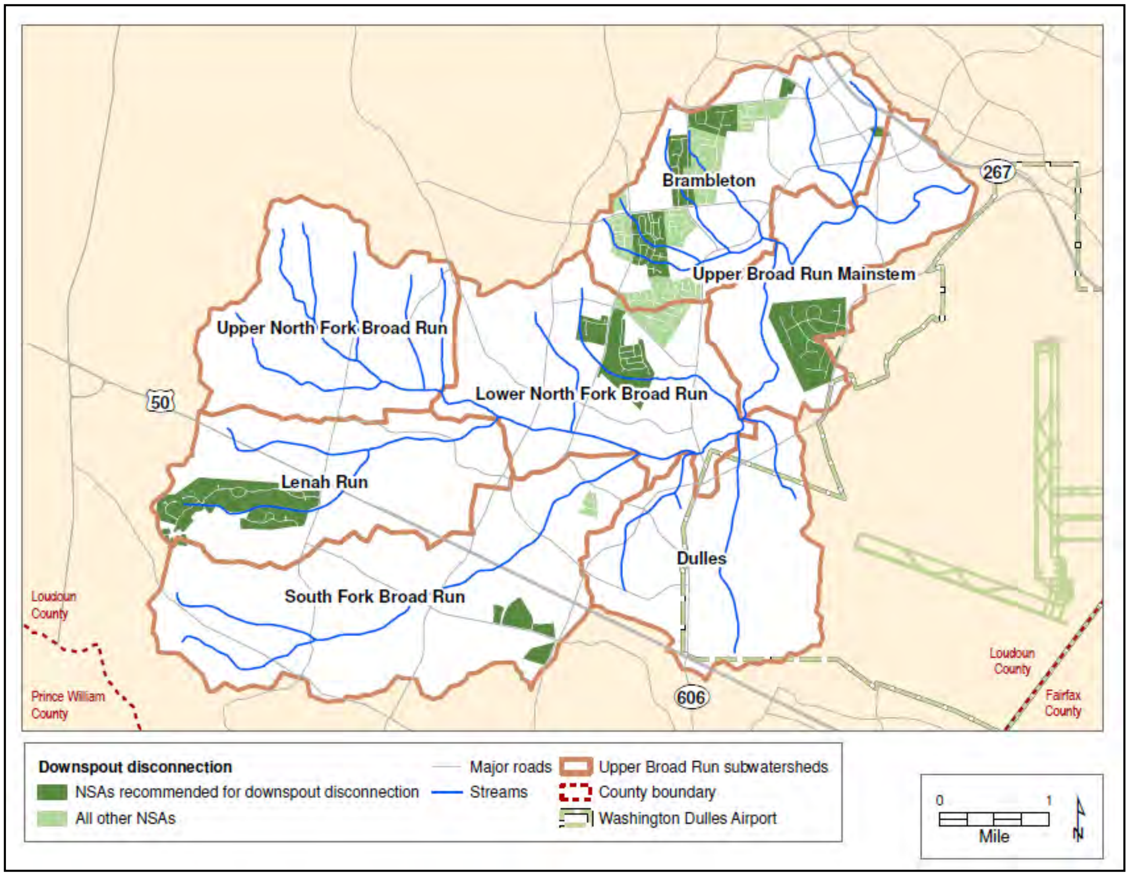


Figure 4-20: Upper Broad Run Neighborhoods Recommended for Downspout Disconnection

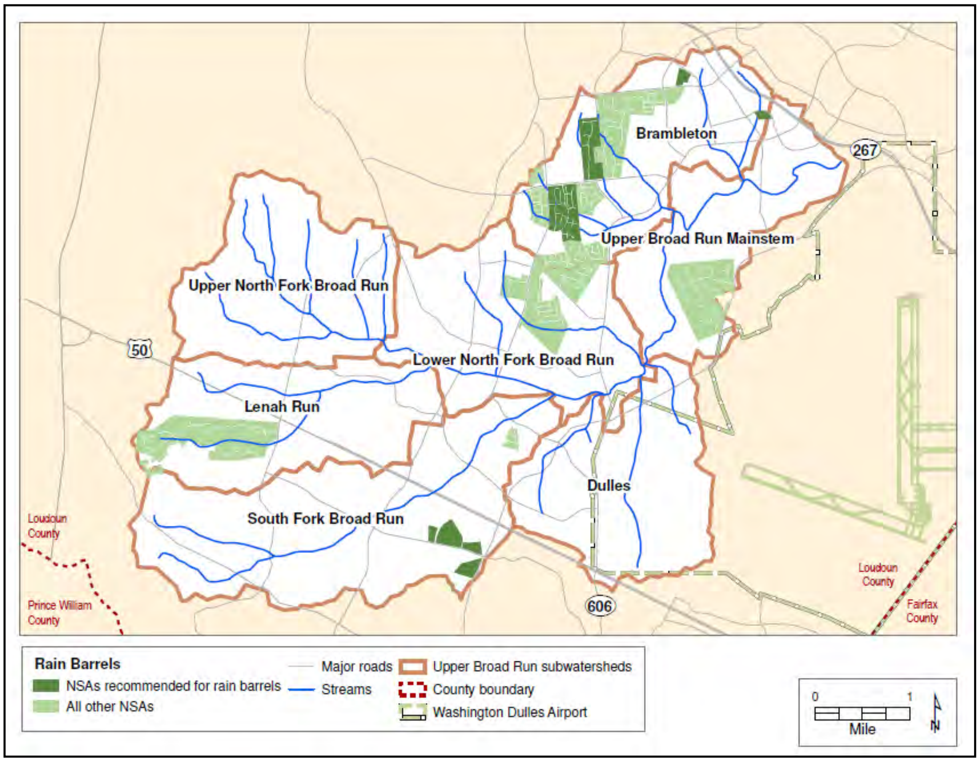


Figure 4-21: Upper Broad Run Neighborhoods Recommended for Rain Barrels

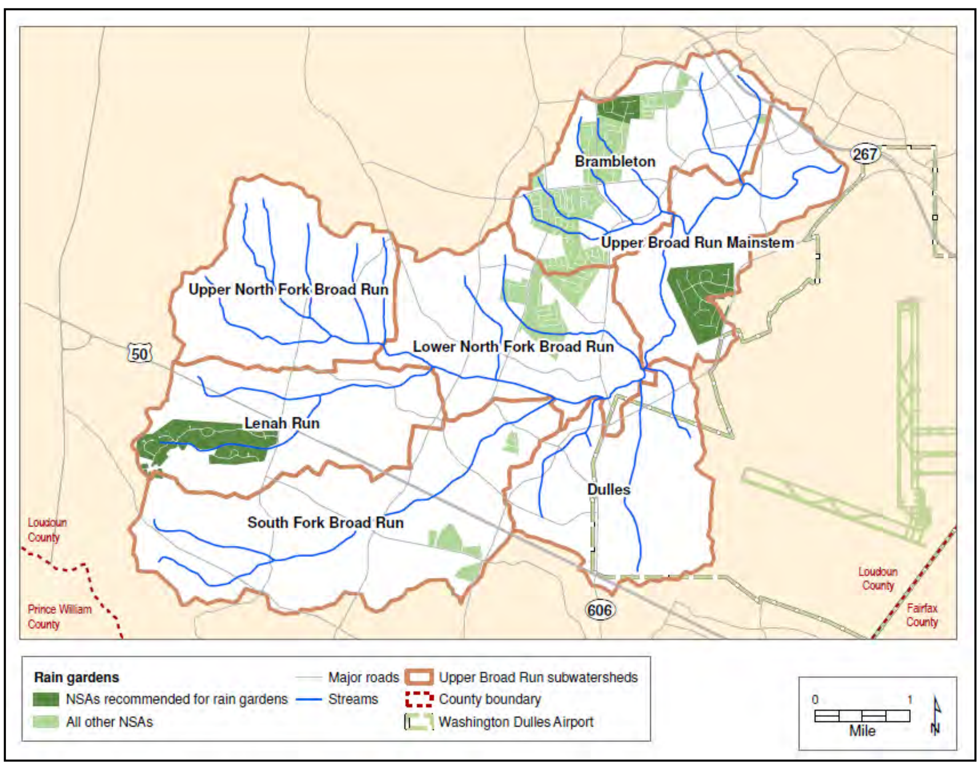


Figure 4-22: Upper Broad Run Neighborhoods Recommended for Rain Gardens

4.2.1.3.2 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, signs warning of the presence of lawn care chemicals, or sprinkler systems indicate high lawn maintenance activities. Neighborhoods where 20 percent or more of the homes appeared to employ high lawn maintenance practices were recommended for fertilizer reduction/education. Table 4-12 includes a summary of the number of neighborhoods recommended for fertilizer reduction/education and the acres of lawn addressed if implemented. Figure 4-23 shows the location of neighborhoods recommended for fertilizer reduction/education (any neighborhood with 20 – 100% high maintenance lawns). Four neighborhoods were recommended for fertilizer reduction/education.

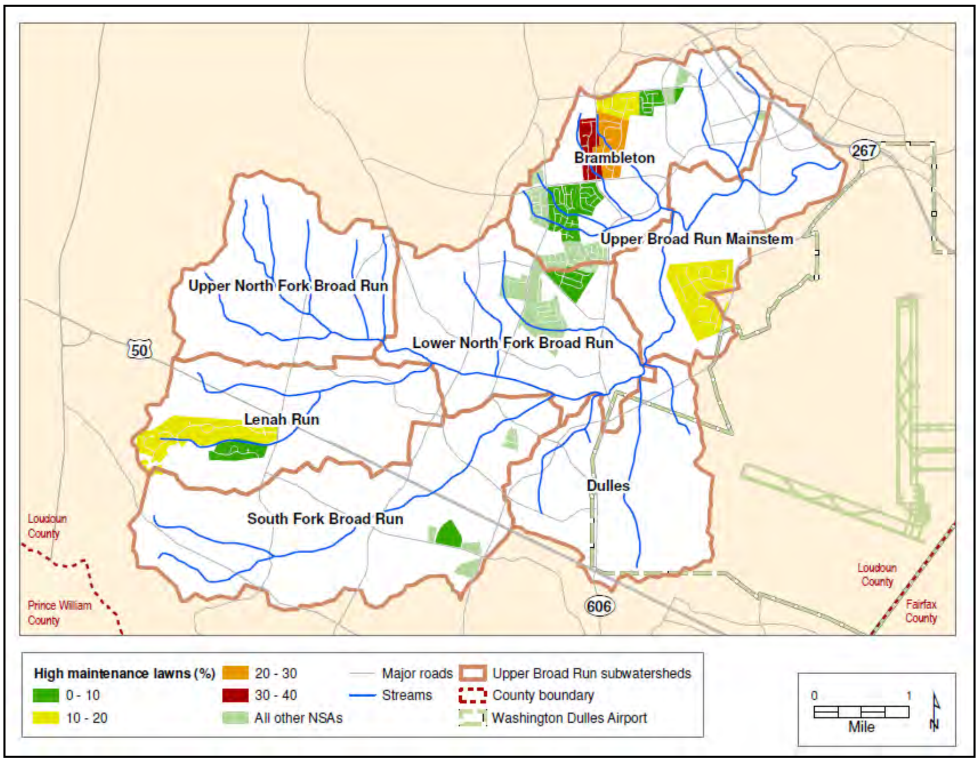


Figure 4-23: Upper Broad Run Neighborhoods by Percentage of High Maintenance Lawns

Table 4-12: Fertilizer Reduction Recommendations

Subwatershed	# of NSAs Recommended for Fertilizer Reduction	Acres of Lawn Addressed
Brambleton	3	30.9
Upper Broad Run Mainstem	0	0.0
Dulles	0	0.0
Lenah Run	1	35.5
Lower North Fork Broad Run	0	0.0
South Fork Broad Run	0	0.0
Upper North Fork Broad Run	0	0.0
Total	4	66.4

4.2.1.3.3 Sustainable Landscaping

Sustainable Landscaping refers to the use of plants native to the local 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. Sustainable Landscaping is also beneficial to wildlife.

All neighborhoods could use more sustainable landscaping; however, the benefits and feasibility of this action are limited by several factors. Sustainable landscaping was recommended in neighborhoods where the typical lot was at least ¼ acre in size, was less than 25 percent landscaped, and where there was sufficient grass area available (i.e., where impervious cover on the lot would not inhibit improvement of this percentage). Table 4-13 includes a summary of the number of neighborhoods recommended for sustainable landscaping and the acres of land addressed if implemented. Figure 4-24 illustrates the location of neighborhoods recommended for sustainable landscaping. Out of the 25 neighborhoods assessed, 8 met the criteria and were recommended for sustainable landscaping.

Table 4-13: Sustainable Landscaping Recommendations

Subwatershed	# of NSAs Recommended for Sustainable Landscaping	Acres of Land Addressed
Brambleton	4	55.4
Upper Broad Run Mainstem	1	35.1
Dulles	0	0
Lenah Run	2	61.4
Lower North Fork Broad Run	0	0
South Fork Broad Run	1	2.1
Upper North Fork Broad Run	0	0
Total	8	154.0

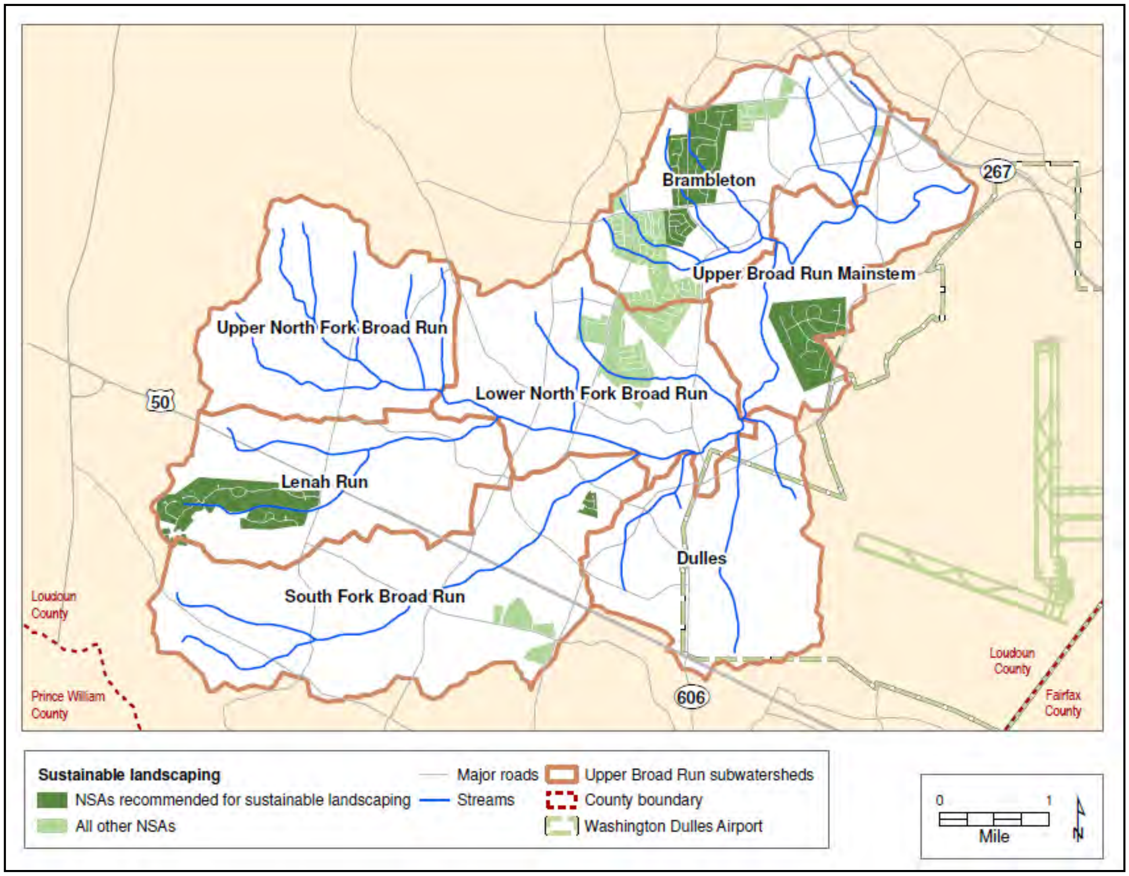


Figure 4-24: Upper Broad Run Neighborhoods Recommended for Sustainable Landscaping

4.2.1.3.4 Storm Drain Marking

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

Neighborhoods recommended for storm drain marking had curb and gutter systems, or roadside ditches with inlets appropriate for marking and where less than 10 percent of the existing inlets were already marked (and legible). Table 4-14 includes a summary of the number of neighborhoods recommended for storm drain marking. Figure 4-25 illustrates the location of neighborhoods recommended for storm drain marking. Out of the 25 neighborhoods assessed, 12 met the criteria and were recommended for storm drain marking. Loudoun County keeps track of storm drain markings and reports the location of marked inlets in their MS4 Annual Report.

Table 4-14: Storm Drain Marking Recommendations

Subwatershed	# of NSAs Recommended for Storm Drain Marking
Brambleton	6
Upper Broad Run Mainstem	1
Dulles	0
Lenah Run	2
Lower North Fork Broad Run	0
South Fork Broad Run	3
Upper North Fork Broad Run	0
Total	12

Note: Loudoun County is currently updating their storm drain data for the Upper Broad Run watershed. The GIS data that would be used to calculate the number of inlets addressed would not accurately depict the current conditions of the watershed, and thus this was not calculated.

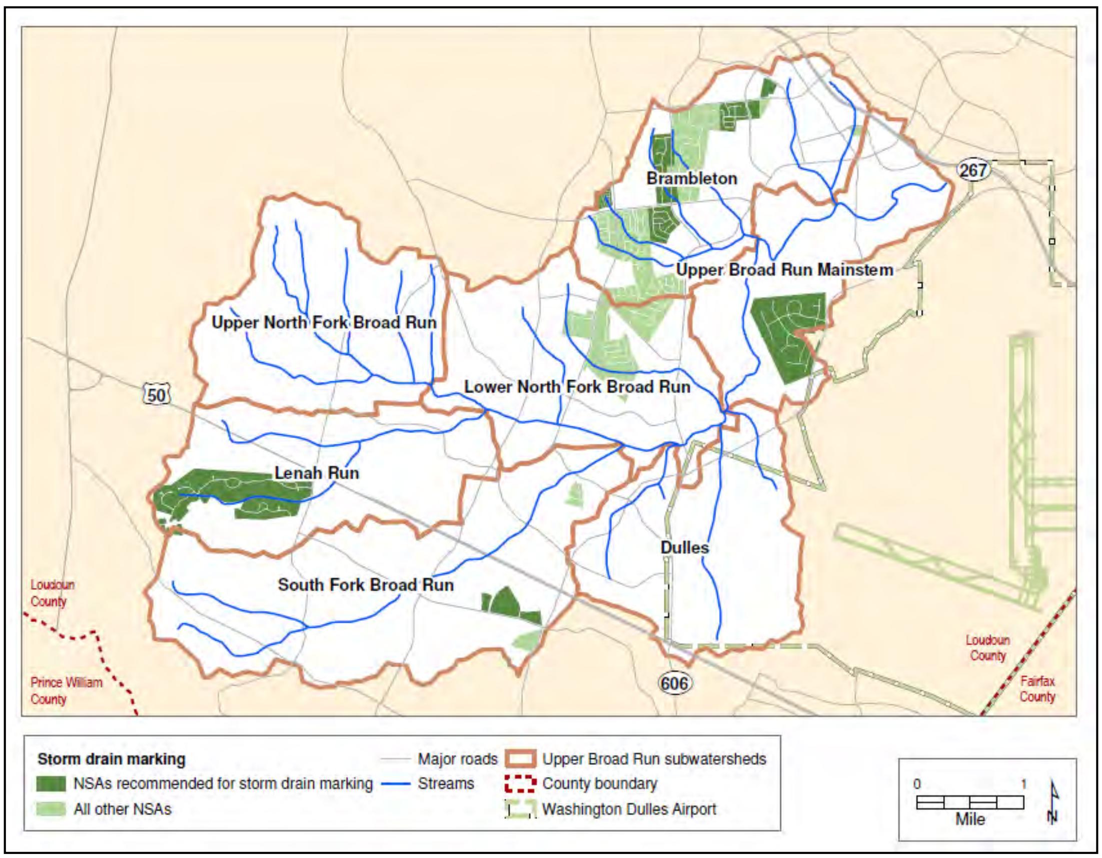


Figure 4-25: Upper Broad Run NSAs Recommended for Storm Drain Marking

4.2.1.3.5 Tree Planting Opportunities

Trees are an asset to a neighborhood aesthetically, and they also improve air and water quality as they intercept precipitation with their leaves and can absorb precipitation and nutrients through their root systems. Interception of precipitation with the leaves or infiltration through the root systems slows stormwater runoff and provides some treatment before it reaches the stream system. Open space trees were recommended for neighborhoods where there were open pervious areas that were not being used by the community for other purposes. The recommended planting density on open space land is 200 trees per acre, or a spacing of approximately 15 to 25 feet between trees. Street trees are typically recommended for neighborhoods where at least 25 percent of the streets had a minimum of 6 feet of greenspace between the sidewalk and curb and less than 75 percent of the suitable areas had trees planted. None of the assessed neighborhoods met this criteria, thus street tree plantings were not recommended for Upper Broad Run. Neighborhoods were not recommended for street trees because they either did not have sidewalks and a curb-and-gutter system, had insufficient greenspace between the sidewalk and curb, or lawn trees already provided shade for the street.

Table 4-15 includes a summary of the number of neighborhoods recommended for open space trees proposed per subwatershed. Figure 4-26 illustrates the location of neighborhoods where open space trees could be planted. Out of the 50 neighborhoods assessed, 10 met the criteria and were recommended for tree planting. In several areas, most of the appropriate areas had been planted. There is potential for planting 5,225 open space trees throughout the watershed.

Table 4-15: Tree Planting Potential by Subwatershed

Subwatershed	# of NSAs Recommended for Tree Planting	# of Potential Open Space Trees
Brambleton	2	1,722
Upper Broad Run Mainstem	1	702
Dulles	0	0
Lenah Run	2	2,634
Lower North Fork Broad Run	1	167
South Fork Broad Run	0	0
Upper North Fork Broad Run	0	0
Total	6	5,225

4.2.1.3.6 Street Sweeping

Neighborhoods where 20 percent or more of the curbs and gutters are covered with excessive trash, sediment, and/or organic matter are typically recommended for street sweeping. No neighborhoods assessed within the Upper Broad Run watershed met this criteria, and thus no street sweeping is recommended for the Upper Broad Run watershed.

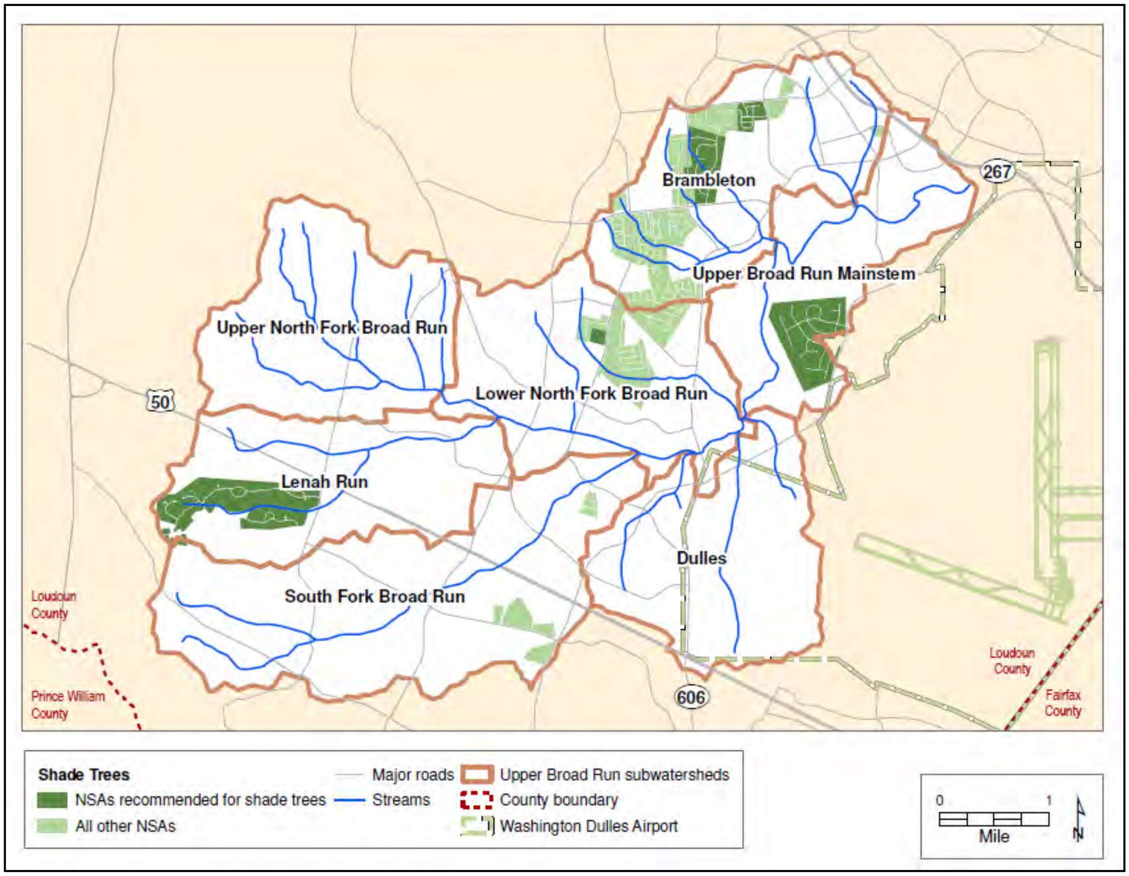


Figure 4-26: Upper Broad Run Neighborhoods Recommended for Tree Planting

4.2.1.3.7 Neighborhood Trash Management

Trash is one of the many types of pollution that may affect a watershed. Neighborhoods where junk or trash was observed in at least 25 percent of yards would be recommended for trash management initiatives. The Upper Broad Run NSA survey revealed that there were no neighborhoods where trash management was an issue. Any ongoing efforts such as community cleanups, trash management education, and working with the Department of General Services (DGS) to manage any bulk trash pick-up programs should be continued in order to prevent the occurrence of trash pollution in the future.

4.2.1.3.8 New SCMs

There are several neighborhoods in the Upper Broad Run watershed that have open common areas or alleys that are down gradient of rooftop downspouts, walkways, and parking lots. Several of these common spaces that see minimal use can be an opportunity for the installation of new SCMs to address runoff from impervious surfaces. This type of opportunity can address a large area of impervious cover within a single design plan. As discussed in Chapter 5, infiltration/filtration practices such as bioretention areas with native plantings could be used to capture and treat storm water runoff from impervious parking lots while requiring minimal maintenance.

Figure 4-27 illustrates the location of neighborhoods where new SCMs were recommended. These only included neighborhoods where sufficient greenspace was available down gradient of impervious cover (mainly rooftop runoff). In addition to the many opportunities for new SCMs, it should be noted that the County is actively engaged in stormwater infrastructure maintenance. While the maintenance program focuses on reconstruction to existing design, there are hundreds of projects annually, as reported in the MS4 Annual Stormwater report.

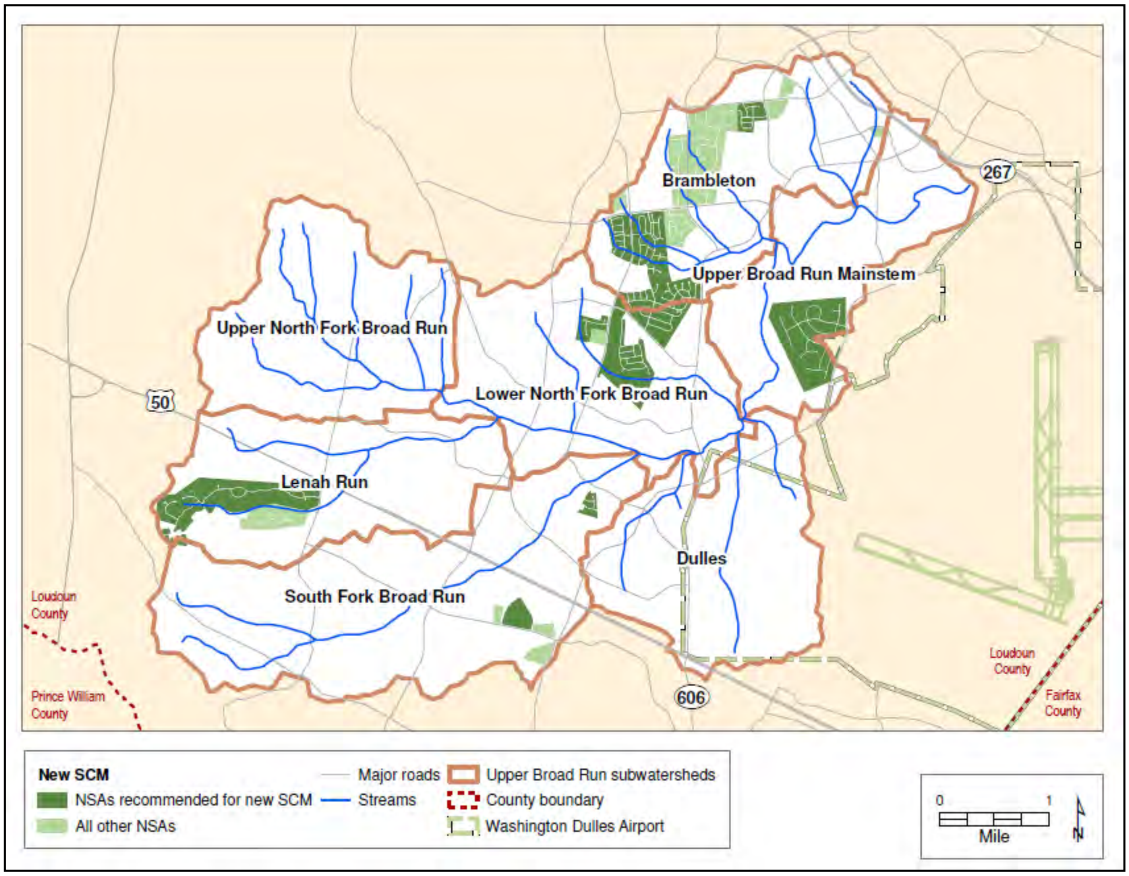


Figure 4-27: Upper Broad Run Neighborhoods Recommended for New SCMs

4.2.2 Hotspot Site Investigations (HSI)

Stormwater hotspots are areas that have the potential to generate higher concentrations of stormwater pollutants than typically found in urban runoff because they run higher risk of spills, leaks, or illicit discharges due to the nature of their operations (CWP 2005). The purpose of hotspot investigations is to evaluate pollution potential from operations and to identify restoration practices that may be necessary to remove, control, or otherwise mitigate the potential pollution source. In general, operations that may pose a higher risk of polluting stormwater runoff can be classified into commercial, industrial, or transport-related and can be regulated or un-regulated. In Upper Broad Run, commercial areas were the predominant type of site assessed.

Commercial hotspots include private businesses whose operations include maintenance, storage, or repair of any kind of equipment, merchandise, or fleet. Maintenance and repair may generate waste, which also must be managed and can be a source of pollution. Common commercial hotspots include auto repair shops, car dealerships, car washes, parking facilities, gas stations, marinas, garden centers, construction equipment and building material lots, swimming pools, and restaurants.

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

Transport-related hotspots normally include large areas of impervious cover and extensive storm drain systems to support transportation activities such as airports, ports, highway construction, and trucking centers.

<u>Regulated</u> hotspots are known sources of pollution that are subject to applicable federal or state laws. U.S. EPA requires that all stormwater associated with industrial activity be regulated by either individual or general discharge permits, which have rigorous self-inspection requirements. A permit is required if there is an opportunity for waterways to be exposed to pollutants from the industrial facility. As long as there is any potential for exposure, a permit is required.

<u>Unregulated</u> hotspots, such as retail and wholesale establishments, and to a lesser degree lawns, employee/customer parking, or roofs of administrative buildings, are not regulated, but the nature of their operations makes them likely to be potential pollutant sources. Stormwater pollutants generated as a result of hotspot operations depend on the specific activities or materials used but typically include nutrients, hydrocarbons, metals, chloride, pesticides, bacteria, and trash. The hotspot investigations described in this watershed plan were targeted toward unregulated hotspots.

4.2.2.1 Field Investigation Protocol

Field teams conducted site visits to several commercial areas within the Upper Broad Run watershed. At each site, investigators examined site conditions using hotspot investigation protocols developed by CWP to obtain an overall assessment of hotspot status. A standard hotspot investigation form, also developed by CWP, was used to guide staff activities.

Following the HSI protocol, each hotspot investigation consisted of an evaluation of six common operations at each potential hotspot: vehicle operations, outdoor materials, waste management, physical plant, turf/landscaping, and stormwater infrastructure. Field teams conducted "windshield" surveys and/or physically walked the geographic extent of the site to document potential or confirmed pollution sources in the six broad categories. Field teams recorded their observations on the standard form and took photographs of site conditions. The six broad categories of hotspots are described briefly below.

Vehicle Operations

Vehicle operations include activities such as maintenance, repair, recycling, fueling, washing or long-term parking. The presence of fleet vehicles at large businesses is an early indicator that a vehicle operations hotspot may exist. Activities taking place outdoors that create exposure to the storm drain system without the benefit of secondary containment or onsite stormwater treatment can be a source of significant pollution from metals and hydrocarbons.

Outdoor Materials

The storage of materials, supplies, and inventory outdoors can be a source of pollution to storm drain systems. Problems may also result from activities related to loading and unloading in the vicinity of loading docks. Poor labeling, storage of material on impervious surfaces in the open, poor condition of containers, and presence of stains are indicators of poor housekeeping practices related to materials storage. Special attention was paid to the impact of material storage areas to nearby stormwater infrastructure.

Waste Management

Waste management encompasses both the nature of the waste generated and the manner that it is stored. Waste management hotspots may occur when waste is stored or placed carelessly, especially when near storm drain inlets, which would provide a direct route for pollutants to enter the system. Field staff examined the condition of dumpsters (open, damaged, leaking) and the general area around the premises for accumulations of discarded material. The presence of hazardous or construction materials and their manner of storage were also noted.

Physical Plant

Physical plant assessments include examining the condition of specific areas of the physical property, such as the parking lot condition, cleaning practices, whether downspout disconnection can occur, and whether excess impervious cover can be removed. The parking lot may become a source of sediment if it is in poor condition. Impervious cover that is non-utilized or under-utilized could be removed to improve infiltration of stormwater. Stormwater could also be diverted from downspouts to treatment areas provided that adequate space and slope exists for rain garden placement. Maintenance practices such cleaning and washing may introduce non-stormwater, polluted flows to storm drains.

Turf/Landscaping

The condition of turf was examined to determine whether maintenance activities could become a source of polluted runoff. High maintenance turf on which much fertilizer, pesticides, and irrigation is applied may become a source of pollution. Neglected turf areas may likewise become an erosion source. Beneficial tree canopy, expanses of bare ground, turf grass area, and areas devoted to landscaping were calculated to determine hotspot status due to undesirable coverage. Areas of more than 20 percent of bare soil in turf/landscaped areas were flagged as a sediment pollution source.

Stormwater Infrastructure

Presence or lack of stormwater treatment practices were noted on the field data sheet. A lack of stormwater control indicates that a site may be a potential pollution source. Field staff examined catch basins and noted those with noticeable accumulations of sediment, organics, and/or trash.

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

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

4.2.2.2 Summary of Hotspot Investigations

Field investigations were conducted in October through December 2013. Table 4-16 shows the locations of the 18 sites visited by watershed. Figure 4-28 shows the location of each candidate hotspot investigated within the watershed.

Table 4-16: Potential Hotspot Sites Assessed by Subwatershed

Subwatershed	Number Assessed
Brambleton	1
Upper Broad Run Mainstem	11
Dulles	3
Lenah Run	0
Lower North Fork Broad Run	1
South Fork Broad Run	2
Upper North Fork Broad Run	0

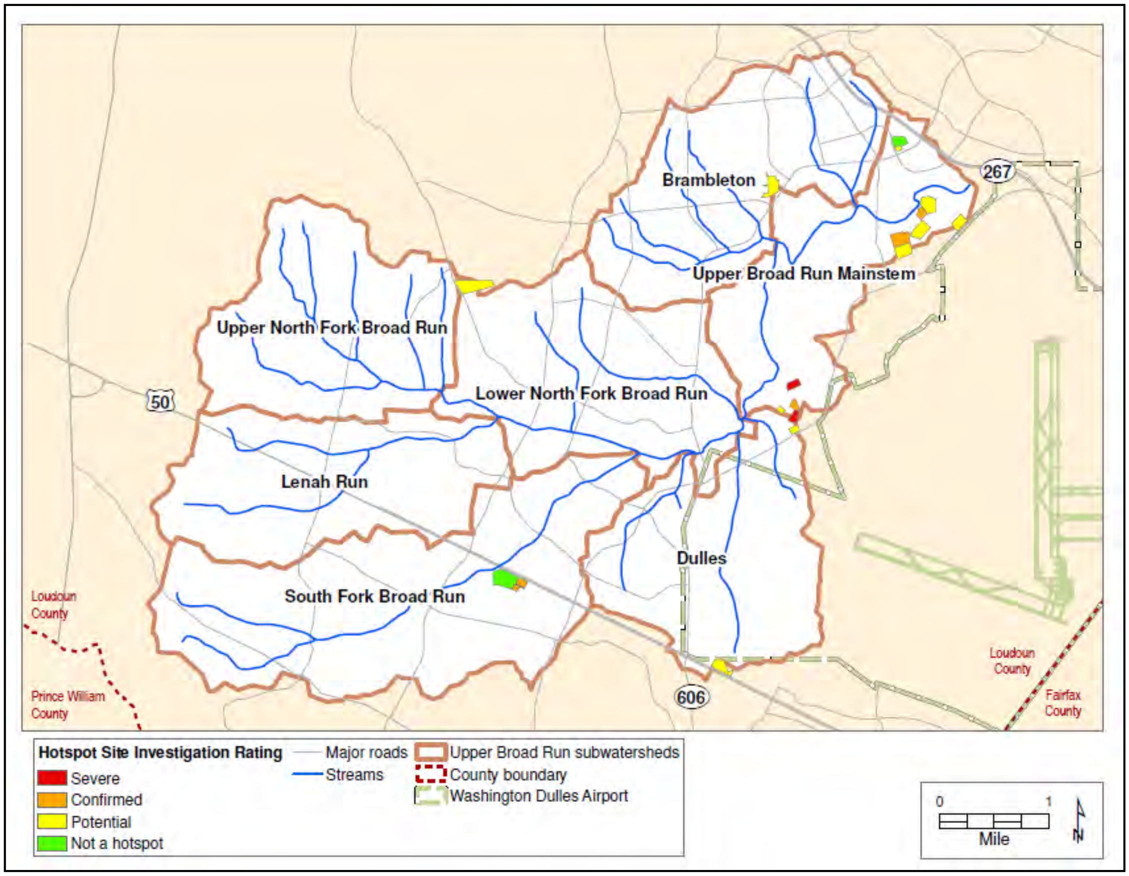


Figure 4-28: HSI Locations in the Upper Broad Run Watershed

4.2.2.3 Results of Investigations

A GIS desktop analysis identified nine potential businesses, shopping centers, or business parks to be investigated. For business parks and shopping centers, field teams conducted preliminary reconnaissance assessments to determine whether individual problem sites would be assessed separately or would be grouped. One of the nine businesses, an auto auction business, was not assessed because it was not possible to obtain permission to access the property to perform the assessment.

A summary of hotspot findings by individual business or grouping is presented in Table 4-17.

Selected photographs of commercial HSIs are included below (Figures 4-29 through 4-32).

Table 4-17: HSI Recommended Actions by Subwatershed

Subwatershed	Active Pollution Observed: Vehicle Operations	Active Pollution Observed: Outdoor Materials	Active Pollution Observed: Physical Plant	Recommended Follow-up Actions: Refer for Enforcement	Recommended Follow-up Actions: Follow Up Inspection	Recommended Follow-up Actions: Include in Future Education
Brambleton	0	0	0	0	0	0
Upper Broad Run Mainstem	1	0	0	0	8	3
South Fork Broad Run	0	1	0	1	1	0
Dulles	1	0	1	1	1	2
Lower North Fork Broad Run	0	0	0	0	0	0
Total	**2**	**1**	**1**	**2**	**10**	**5**

Outdoor Vehicle Maintenance Activity

Outdoor vehicle maintenance, without benefit of canopy cover or garaging, was found at several of the sites investigated. Outdoor maintenance of vehicles was mostly found at businesses with fleets and businesses dedicated to automotive maintenance, for example an auto body shop (Figure 4-29). At HSI-002, several delivery vehicles and box trucks were found in the rear of the property, some undergoing maintenance.

Figure 4-29: Outside Maintenance of a Vehicle at HSI-016

Uncovered Fueling Stations

Uncovered fueling stations were found at a variety of businesses with the common denominator being fleets and the necessity to fuel them. Onsite fueling stations are a convenience, however the proper sheltering of them under canopies was rare. Fueling stations included both diesel and gasoline. Examples of uncovered fueling stations included tanks with nozzles found at a construction company and more advanced designs noted at HSI-014 (Figure 4-30).

Figure 4-30: Uncovered Fueling Station at HSI-014. Note that the liquid near the storm drain inlet is melted snow.

Outside Storage of Materials

Material was found stored outside and uncovered at several locations. If uncovered, such material can leach pollutants or suspended solids to the storm drain system and eventually make its way to surface waters. Material stored outside was occasionally found in pervious areas (i.e., gravel or open ground), such as a construction staging area found within an industrial district. At the construction staging area, boulders, gravel, dirt, and other items were noted being stored in the open (Figure 4-31). Other bulk material storage included mulch yards at garden centers, piping at plumbing contractors, junked equipment parts, and merchandise. In some instances, material was found in close proximity to storm drain inlets, providing a direct pathway for pollutants to be transferred to surface streams via stormwater runoff.

Waste Management

Uncovered and overflowing dumpsters were found at multiple businesses. Open dumpsters were the most frequently found potential pollution source during hotspot investigations. Additionally, many instances of excess or disposed of bulk items being stored in dumpster stalls were found. For example, at a gas station and convenience store, not only was the dumpster overflowing, but other articles, such as disposed of display shelving, were placed in the dumpster stall (Figure 4-32). At an auto body business, discarded car engine parts were placed on the gravel parking area near the dumpster, presumably awaiting disposal.

Figure 4-31: Outside Storage of Bulk Materials without the Benefit of Silt Fencing at HSI-008

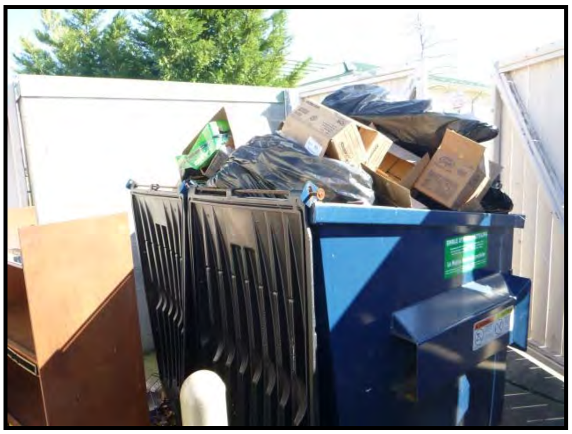


Figure 4-32: Overflowing Dumpster at HSI-006

4.2.3 Institutional Site Investigations (ISI)

For this watershed plan, the hotspot investigation (HSI) protocols were adapted for the purpose of investigating institutional and municipal sites. Institutions may include the following types of facilities: faith-based facilities, hospitals/care centers, public schools, colleges/research centers, municipal facilities (e.g., public libraries), and other public, civic organizations. Not all operations found at commercial and industrial establishments directly correlate to operations commonly found at institutions. Additionally, problems found onsite can often be administratively addressed and corrected, whereas commercial and industrial hotspot problems require a different method of outreach or enforcement.

Additionally, the institutional site investigation (ISI) protocol described herein includes determ-ination of areas for expansion of green infrastructure, a greater focus on SCM opportunities, and attention to stream buffers if streams are present on an institutional parcel. Since institutional parcels (e.g., schools) can cover a large area that is more likely to impact streams and on which trees and SCMs can be readily added, these elements were included in the ISI protocol and field data sheet. The following subsections describe the methods used to identify and evaluate pollution sources and restoration potential at institutional facilities.

4.2.3.1 Assessment Protocol

Nine examples of institutional properties were identified and selected in the office prior to conducting the field assessment. Sites were identified using GIS data. Field maps of the institutional sites were prepared for use by field teams to mark the locations of potentially pollution-causing operations, opportunities for tree planting, potential SCMs, and areas that could accommodate stream buffer expansion.

At each site, the entire property of an institutional site was walked by the field team to collect necessary data and to take photographs. Prior to arrival at public schools, prior arrangement was made with the school system administration to explain the purpose of the investigations. In Upper Broad Run watershed, ISIs were performed at public schools and municipal facilities only.

The ISI field form includes the same broad categories (e.g., vehicle operations, waste management) of operations as the HSI form, but differ in some specific elements within the categories. Some of the types of recommended restoration actions from the NSAs and PAAs are also incorporated into the ISI protocol. A main focus of ISIs is to identify potential restoration opportunities, educate the community, and provide water quality benefits. The information collected by field teams for each of the pollution source and restoration categories is briefly described below.

Tree Planting

Potential tree planting locations at an ISI site were marked on aerial photographs while walking the property. Areas targeted for recommended tree planting included existing green space with small numbers of trees already planted, borders of athletic fields, centers of bus turnarounds, or otherwise underutilized turf areas with no apparent infrastructure constraints. Field maps were digitized to obtain total square footage of tree planting areas and the total number of trees that could be planted at the site was estimated based on a 40-foot spacing between trees.

Exterior

The condition of the building and parking lot were noted. Stained, dirty, and damaged/breaking up building and parking surfaces were noted as potential pollution sources. The absence of stormwater management for impervious parking areas was also considered as a potential pollution source. Storm drain inlets were inspected for evidence (e.g., presence of mop threads, staining) of maintenance or wash water dumping. Exterior building downspouts that were directly connected to the storm drain system or indirectly connected via discharge to impervious surfaces were also recorded as potential pollution sources. Potential restoration opportunities in the exterior category included downspout disconnection.

Waste Management

Waste management at institutions typically encompasses collection of material into dumpsters in designated areas. The field team noted the type of waste generated (e.g., hazardous, garbage, etc.) and the condition and location of the dumpsters in relation to storm drain inlets. 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 noted whether loose trash was present that could leave the site with wind or rain. Dumpster stalls that doubled as storage areas for bulk waste, liquid drums, or other discarded material were also flagged as potential pollution sources.

Vehicle Operations

Vehicle operations are typically not conducted at schools, but are often found at municipal sites. The category of vehicle operations includes maintenance, repair, recycling, fueling, washing, or long-term parking of fleet vehicles. The presence of any of these activities, especially when conducted outdoors without suitable cover, was noted for each site since they can be a source of metals, oil and grease, and hydrocarbons.

Outdoor Materials

Materials such as mulch piles, storage drums, and de-icing salt are sometimes stored on institution grounds in staging areas. Locations where materials were loaded or unloaded and methods of storage were examined to determine if areas were uncovered and draining toward a storm drain inlet.

Turf/Landscaping

As in the HSI, the condition of turf was examined to determine whether maintenance activities could become a source of polluted runoff. High maintenance turf on which much fertilizer, pesticides, and irrigation is applied may become a source of pollution. Neglected turf areas may likewise become an erosion source. Non-target irrigation on impervious surfaces was also noted. Beneficial tree canopy, expanses of bare ground, turf grass area, and areas devoted to landscaping were calculated to determine hotspot status due to undesirable coverage. Areas of more than 20 percent of bare soil in turf/landscaped areas were flagged as a sediment pollution source. Impacts of landscaped areas on impervious surfaces and the storm drain system were noted. Stream buffer encroachment and opportunities for buffer expansion to minimally accepted widths of 100 feet on each bank were evaluated in this section.

Stormwater Infrastructure

The field team checked whether storm drains were marked and whether stormwater treatment practices were present. The locations and types of SCMs or treatment upgrades were marked on field maps.

After conducting the field portion of the ISI, one or more of the follow-up actions listed below were recommended based on the initial field assessment:

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

4.2.3.2 Summary of Sites Investigated

A total of nine institutions were assessed throughout the Upper Broad Run watershed (Figure 4-33). The number and type of institutions assessed within each subwatershed is summarized in Table 4-18.

Table 4-18: Types of Institutions Assessed by Subwatershed

Subwatershed	Public School	Municipal Facility	TOTAL
South Fork Broad Run	2	2	**4**
Brambleton	2	0	**2**
Lower North Fork Broad Run	1	0	**1**
Upper Broad Run Mainstem	2	0	**2**
Total	**7**	**2**	**9**

4.2.3.3 General Findings

The number of the different types of recommended actions for ISIs is summarized in Table 4-19 by subwatershed.

Table 4-19: ISI Recommended Actions by Subwatershed

Subwatershed	# of Trees	Storm Drain Marking	Downspout Disconnect	New SCM	Future Education	Buffer Improvement	Pollution Prevention Plan	Trash Management
South Fork Broad Run	2,412	1	1	3	3	2	0	3
Brambleton	285	1	0	2	1	1	0	1
Lower North Fork Broad Run	510	1	0	1	1	0	0	1
Upper Broad Run Mainstem	1,911	1	1	2	2	1	0	2
Total	5,118	4	2	8	7	4	0	7

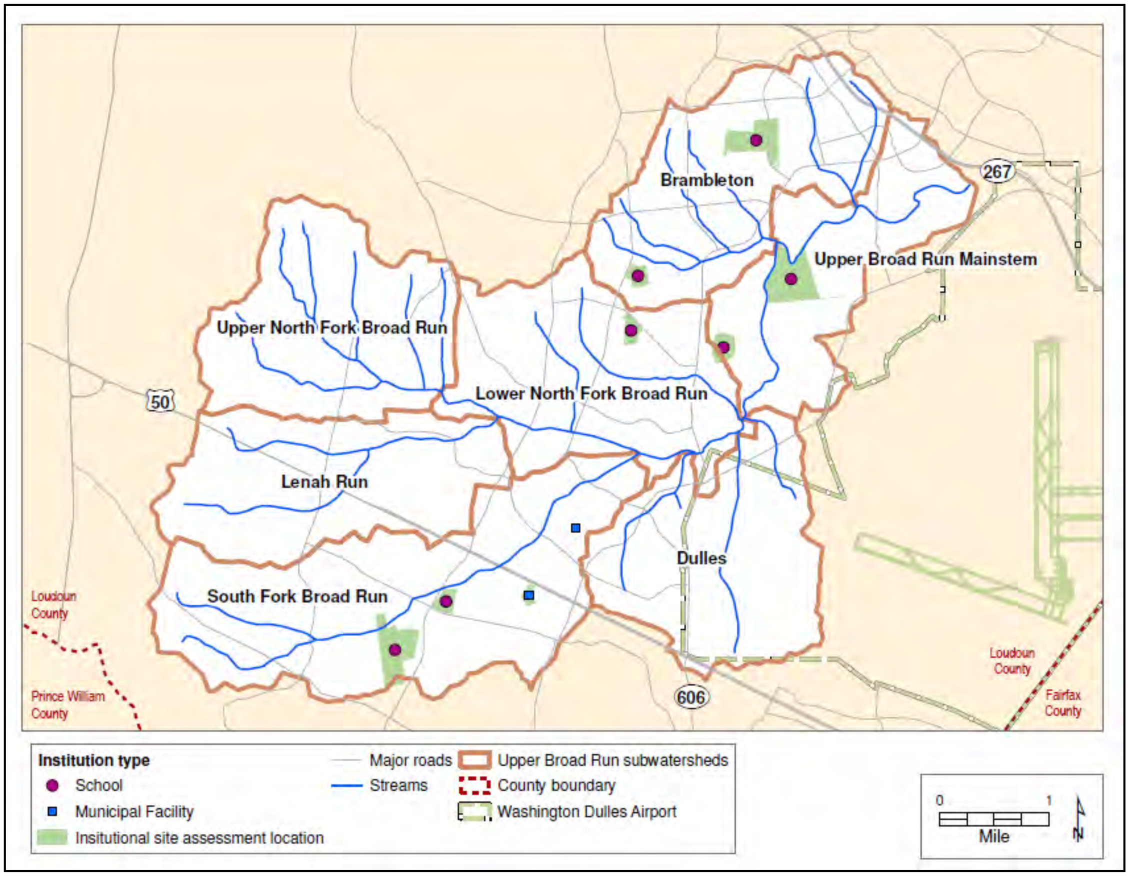


Figure 4-33: ISI Locations in Upper Broad Run Watershed

Tree Planting

An estimated 5,118 trees can be planted at institutions within the Upper Broad Run watershed. Trees were recommended for all nine institutions assessed. During field assessments, tree planting areas were identified in the field and drawn on field maps. Small (i.e., less than 10) quantities of trees were recommended for smaller-acreage institutions such as the Arcola-Pleasant Valley fire station while greater numbers of trees were noted as appropriate for public schools, which tend to have greater quantities of available acreage in which to plant. Two examples of potential tree planting areas are shown in Figure 4-34. At Legacy Elementary School, a sloping area in front of the school near a County road has been planted with young trees; however, additional trees can be planted in the same area to create a more robust canopy. At Creighton's Corner Elementary School, to provide another example, an area adjacent to the main athletic fields contains cedars and other trees that were not removed to accommodate the school. The more sparsely planted areas of this outparcel can be planted with additional trees.

The number of trees was estimated based on 40-foot spacing between trees. Planning-level estimates presented in Table 4-19 can be refined during follow-up site evaluations.

Shade trees provide air and water quality improvement and provide stability to the surrounding terrain. Root systems intercept, treat, and absorb stormwater, thereby reducing excess overland runoff contributions to stream networks.

Figure 4-34: Potential Tree Planting Areas at ISI-004 (left) and at ISI-008 (right)

Stormwater Management Improvements

Stormwater management improvements were recommended for nearly all of the institutions that were investigated. Downspout disconnection was recommended for just two sites, however, where external downspouts were evident and sufficient pervious area down-slope of the roof leader was available to redirect rooftop runoff into rain gardens.

Bioretention treatment utilizes grasses, trees, and shrubs in a planted area to capture, treat, and infiltrate stormwater runoff. At the several public schools that field staff visited, opportunities were found to augment existing stormwater controls or are recommended to correct erosion problems that have developed at these newly-constructed public facilities. For example, at Moorefield Station Elementary School, existing grassy swales at various locations around the school property can be converted to bioretention to improve stormwater treatment prior to entry into the storm sewer system (Figure 4-35). Installation of bioretention or terraces may also reduce erosion and improve safety at impacted playground and athletic field areas at Legacy Elementary School and Creighton's Corner Elementary School. These actions also present an opportunity to educate school children and the community at large about the connection between the schools' storm drain systems and Upper Broad Run.

Figure 4-35: Opportunities for Bioretention at ISI-005 (left) and at ISI-004 (right)

Impervious Cover Removal

Impervious surfaces create a barrier between precipitation and natural recharge of groundwater aquifers. Additionally, impervious surfaces accumulate pollutants which then run off and concentrate during precipitation events. The excess volume and energy of runoff from impervious areas contributes to stream erosion, degradation of stream habitat, and general pollution at points farther downstream. Removing unused or underutilized impervious surfaces can help increase pervious area and improve the watershed's capacity for infiltrating and treating stormwater runoff.

The potential for impervious cover removal was initially noted at three of the nine institutions investigated, all at elementary schools. Two examples include impervious enclosed play areas at Creighton's Corner Elementary School and Rosa Lee Carter Elementary School (Figure 4-36). However, the removal of these impervious areas is not recommended due to safety and maintenance issues. An alternative that should be considered at school facilities in the future is the installation of pervious pavement in schoolyard play areas.

Figure 4-36: Play Area Impervious Cover at ISI-008 (left) and ISI-009 (right)

Buffer Improvement

Forested and native vegetation zones along streams provide both stream stability and water quality improvement benefits. Root systems of trees stabilize banks and the cumulative effect of native grasses, shrubs, and trees planted in the buffer serve to treat and slow down stormwater runoff from the drainage area. Trees are also critical for moderating stream temperature with consequent benefits to aquatic life.

Streams were noted on four of the institutions and all were found to be in need of buffer enhancement. Field teams noted buffer improvement opportunities on field data sheets. In most cases, buffer encroachment has occurred as a result of sanitary sewer installation in stream valleys in order to accommodate new residential and commercial construction in the watershed. Field teams noted that efforts had been made to replant buffers along some streams. An ideal buffer, however, is 100 feet of native vegetation along each bank, therefore ample opportunities exist at the following schools to improve the buffers: Moorefield Station Elementary School, John Champe High School, Arcola Elementary School, and Rosa Lee Carter Elementary School. Near the John Champe High School athletic facility (Figure 4-37), both banks of a stream near a sanitary sewer right of way would benefit from buffer augmentation. At Arcola Elementary School, a sloping grassy area at the rear of the athletic field is particularly suited to buffer improvement.

Figure 4-37: Potential Stream Buffer Restoration at ISI-006 (left) and ISI-007 (right)

Trash and Other Waste Management

All institutions generate waste, which if managed will remove a source of chemical pollution to waterways and minimize washing of litter into streams. Improvements to waste management were recommended for seven of the nine institutional sites. Waste management is improved through education and outreach efforts. Current waste management problems, such as leaking dumpsters, open or uncovered dumpsters where trash can leave the site or rainfall can infiltrate, and dumpster placement near storm drain inlets or streams, as well as signs of past problems such as stains or rust on impervious surfaces near dumpster areas were noted on field data sheets (Figure 4-38).

Figure 4-38: Trash Management Opportunity at ISI-009

Nearly all dumpsters were found in good condition and with lids properly placed except for at one elementary school, and one municipal facility. At another municipal facility, a recycling dumpster was found to be overflowing. Dumpsters were found with evidence of past leakage at nearly all schools. Active leakage from dumpsters was found during field investigations at two elementary schools. Inappropriate storage of material outdoors in dumpster stalls (varnish, waste cooking oil, and unknown drums) was found at four elementary schools. At a municipal facility, a dumpster was found in poor condition and overflowing, and a lay-down area contained junked equipment and was uncovered. These trash management problems may be addressed through various measures such as waste management education.

4.2.4 Pervious Area Assessment (PAA)

Pervious Area Assessments (PAAs) were conducted in open spaces to identify and evaluate sites within the Upper Broad Run watershed with potential for reforestation or re-vegetation. Field investigations took place from October 2013 through December 2013. The following subsections describe the methods used to identify and evaluate restoration potential of pervious areas.

4.2.4.1 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 various printed maps. These were shown and labeled on larger base maps showing the entire watershed. Upon visiting pervious areas identified in the office, a PAA was conducted if the field team verified the site as having sufficient space and potential for restoration. In some cases, additional sites were identified for PAAs while surveying other upland areas such as underutilized areas on institutional property and right of way. The USSR manual recommends assessing publicly-owned pervious areas greater than two acres and privately-owned areas greater than five acres. Because some areas of the four sub-watersheds (of six total) assessed in the Upper Broad Run watershed are newly urbanized, all sites greater than approximately 1 acre were considered.

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

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

Current Vegetative Cover

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

Impacts

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

Reforestation Constraints

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

Other constraints related to reforestation that were noted include overhead wires, underground utilities, pavement, and buildings. Private ownership was noted as a potential constraint.

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

- Good candidate for natural regeneration
- May be reforested with minimal site preparation
- May be reforested with moderate site preparation

- May be reforested with extensive site preparation
- Poor reforestation or regeneration site

4.2.4.2 Summary of Sites Investigated

A total of 8 pervious area assessment sites were assessed within the Upper Broad Run watershed, with potential planting areas totaling 50.36 acres. Figure 4-39 shows the location and size of PAAs within the Upper Broad Run watershed. PAAs were conducted at Briarfield Estates HOA, Broad Run Stream Valley Park North, Broad Run Stream Valley Park South, Hanson Regional Park, Loudoun Valley Villages - West, Loudoun Valley Villages - East, Lyndora Park, and Moorefield Station Elementary School. Totals of potential planting areas at the sites ranged from 0.56-acre to 25.19 acres (Table 4-20). All sites surveyed were considered as open pervious cover type, but in reality were a mixture of treed, shrubby, and open areas.

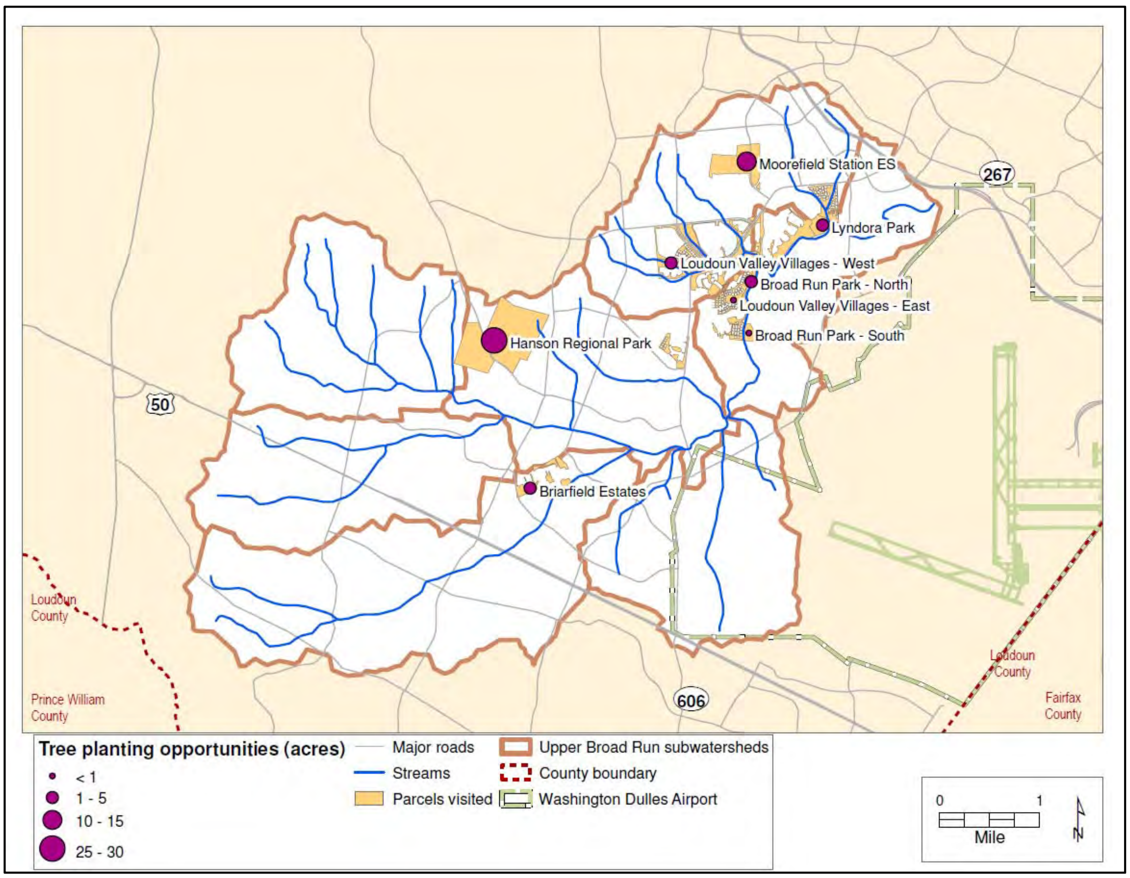


Figure 4-39: PAA Locations in the Upper Broad Run Watershed, Loudoun County, VA

4.2.4.3 General Findings

A summary of PAA results including parcel size (where available), ownership, management, percent maintained turf cover, and site preparation required for the sites assessed is provided in Table 4-20.

Table 4-20: Summary of Loudoun County Upper Broad Run PAA Results

Name	Total Parcel Size (acres)	Total of Potential Planting Areas (acres)	Ownership	Management	Turf %	Site Prep.
Briarfield Estates HOA	N/A	1.97	Private	Green Space	60	Minimal
Broad Run Stream Valley Park North	28.79 (combined N+S)	2.88	Public	Park	75	Minimal
Broad Run Stream Valley Park South	--	0.58	Public	Park	0	Minimal
Hanson Park	256.18	25.19	Public	Park	0	Minimal
Loudoun Valley Villages - West	N/A	4.38	Private	Green Space	70	Minimal
Loudoun Valley Villages - East	N/A	0.56	Private	Green Space	30	Minimal
Lyndora Park	17.00	3.66	Public	Park	20	Minimal
Moorefield Station ES	81.90	11.14	Public	School	5	Minimal (natural regeneration)
Total		**50.36**				

Ownership

The most likely candidates for successful pervious area restoration efforts are those on public lands with minimal site preparation required. Public sites often provide good opportunities for volunteer or community projects. Of the 8 sites surveyed, 5 are under public ownership and most were considered to require minimal site preparation. All 8 pervious area sites assessed are briefly described below.

Briarfield Estates HOA

The Briarfield Estates HOA site is located off of Evergreen Mills Road, near the intersection of Cameron Parish Drive and Youngwood Lane (Figure 4-40). It is privately owned and maintained, and is easily accessible by foot, vehicle, or heavy equipment. About sixty percent (60%) of the site is covered by maintained turf, and it receives full sun exposure. The parcel identified for reforestation is a large, flat open area that appears ideal for tree planting. Reforestation of the site, however, will require verification that it would not interfere with the current planned uses of the site and that tree planting could be a potential community project.

Figure 4-40: Photos of Briarfield Estates HOA Site

Broad Run Stream Valley Park North

The Broad Run Stream Valley Park North site is located directly west of Rosa Lee Carter Elementary School, along Upper Broad Run (Figure 4-41). It is owned and maintained by Loudoun County, and is easily accessible by foot, vehicle, or heavy equipment. A large part of it is currently covered by maintained turf (75%), and it receives full sun exposure. Some areas of the site are directly adjacent to Upper Broad Run. Several small, linear open areas along existing forest may be suitable for planting. Reforestation of the site would require verification; however, that it would not interfere with the current uses of the site and that tree planting could be a potential community project. In addition, a County sewer line ROW is located along parts of this site; tree plantings would have to be planted off this utility, and access must be maintained.

Figure 4-41: Photos of Broad Run Stream Valley Park North

Broad Run Stream Valley Park South

The Broad Run Stream Valley Park South site is located immediately south of Loudoun Reserve Drive (across from Rosa Lee Carter ES), along Upper Broad Run (Figure 4-42). It is owned and maintained by Loudoun County, and is easily accessible by foot, vehicle, or heavy equipment. None of it is currently covered by maintained turf (0%), and it receives full sun exposure. Some areas of the site are directly adjacent to Upper Broad Run. Several small, linear open areas along existing forest may be suitable for planting. Reforestation of the site would require verification; however, that it would not interfere with the current uses of the site and that tree planting could be a potential community project. In addition, a Loudoun Water sewer line ROW is located along parts of this site; tree plantings would have to be planted off this utility, and access must be maintained.

Figure 4-42: Photos of Broad Run Stream Valley Park South

Hanson Regional Park

The Hanson Regional Park site is located in two separate large parcels east and west of Evergreen Mills Road, just south of Fleetwood Road (Figure 4-43). It is owned and maintained by Loudoun County, and is easily accessible by foot, vehicle, or heavy equipment. It is a formerly cultivated and grazed farm site; it completely lacks maintained turf cover (0%), and receives full sun exposure in most areas. Several excellent opportunities exist for tree planting and re-forestation in both the eastern and western parcels of Hanson Park. These opportunities are primarily along existing treed intermittent and perennial stream corridors, fencerows, and on the peripheries of ponds and nontidal wetlands. Reforestation of the site will require verification that it would not interfere with the uses of the site projected in the current Master Plan for the Park, and that tree planting could be a potential community project. Several electric transmission line right of way and a water line right of way exist within the Park and they must be avoided for tree planting (these were avoided for PAA planting opportunity mapping).

Loudoun Valley Villages – West Site

The Loudoun Valley Villages - West site is located south of Ryan Road, off Zion Chapel Drive, south of its intersection with North Brown Square (Figure 4-44). It is owned and maintained by the Loudoun Valley HOA, and is easily accessible by foot, vehicle, or heavy equipment. A large part of the site is currently covered by maintained turf (70%), and it receives full sun exposure. Opportunities for tree planting and re-forestation at this site are located along existing forested buffers of intermittent and perennial stream tributaries. Some of these areas include nontidal wetlands. Reforestation of the site would require verification that these projects would not interfere with the current uses of the site and tree planting could be a potential community project.

Figure 4-43: Photos of Hanson Regional Park

Figure 4-44: Photos of Loudoun Valley Villages - West

Loudoun Valley Villages - East

The Loudoun Valley Villages - East site is located immediately southwest of Golden Bamboo Terrace, near the intersection of Sunbury Street and Loudoun Reserve Drive (Figure 4-45). It is privately owned and maintained, and is easily accessible by foot, vehicle, or heavy equipment. About thirty percent (30%) of the site is covered by maintained turf, and it receives full sun exposure. Opportunities for tree planting and re-forestation at this site are located along the periphery of an existing stormwater detention facility. The stormwater facility drains east to a small tributary that flows directly to Upper Broad Run. Slowing overland stormwater flows to this facility by establishing forested cover would help to improve water quality flowing to Upper Broad Run. Reforestation of the site would require verification that it would not interfere with the current uses of the site and that tree planting could be a potential community project.


Figure 4-45: Photos of Loudoun Valley Villages - East

Lyndora Park

The Lyndora Park site is located off Lucketts Bridge Circle (Figure 4-46). It is owned and maintained by Loudoun County, and is easily accessible by foot, vehicle, or heavy equipment. About twenty percent (20%) of the site is covered by maintained turf, and it receives full sun exposure. The best areas for reforestation at the Park are along its southern parts, where semi-fallow fields (that appear to be currently mowed semi-annually) meet existing forest along Upper Broad Run. Reforestation of the site, however, requires verification that tree planting would not interfere with any projected uses in current master planning for the Park, and that tree planting could be a potential community project. An existing multi-branched sewer line right of way in the central and eastern parts of the site would also have to be avoided, and access to it maintained.


Figure 4-46: Photos of Lyndora Park

Moorefield Station Elementary School

The Moorefield Station Elementary School site is located off Mooreview Parkway, north of Clarendon Square (Figure 4-47). It is owned and maintained by Loudoun County Public Schools, and all parts of the site are easily accessible by foot, vehicle, or heavy equipment. About five percent (5%) of the site is covered by maintained turf, and it receives full sun exposure. The large open, upland fields in parts of this site appear to be ideal for tree planting and reforestation.

Reforesting these areas would help to slow overland stormwater flows to the local tributaries. Reforestation of this site, however, requires verification that it would not interfere with the current school uses of the site, future planning needs, and that tree planting could be a potential community project.

Figure 4-47: Photos of Moorefield Station Elementary School

4.2.5 Retrofit Reconnaissance Investigations (RRI)

For this watershed plan, retrofit reconnaissance investigation (RRI) methods were used primarily for the purpose of investigating existing stormwater management ponds, both private and public, as candidates for conversion to designs with increased pollutant removal efficiencies. If new SCMs were noticed while investigating pond conversions, they would be noted.

The Upper Broad Run watershed contains 65 known stormwater ponds and another 28 small proprietary and non-proprietary SCMs which were not deemed nonconvertible. Nineteen are wet ponds and 46 are dry ponds; there is one wetland. Thirty-five ponds are county-owned, 27 are privately owned and the remaining 3 ponds are owned by the Loudoun County Board of Education.

The screening of the existing ponds in the watershed began with a desktop analysis. To supplement the available data on pond type (e.g., dry pond with or without extended detention or enhanced extended detention), the estimated construction date was used to prioritize ponds for field visit. This was followed by a review of aerial pictometry which in some instances showed the existence of features representative of more modern designs, such as forebays, internal weir walls, and multi-chamber systems. Ponds with features indicative of more modern designs were deprioritized. Additionally, before a final decision on ponds to visit was made, the candidates were vetted with the County's Department of General Services' stormwater staff.

Versar's RRI field visit protocol also includes consideration of the downstream condition, both the pond outfall and its channel and that of the receiving stream. Outfall channels or receiving streams showing signs of erosion or incision were noted as such. Field visits also considered whether or not the pond was draining a headwater and whether the pond was in line with a perennial stream. Inline stormwater management ponds are barriers to fish passage and create an artificial impoundment which prevents normal stream flow. Headwaters are the most sensitive of waterways to erosive forces and they have a disproportionately important impact on downstream biology and as such were noted on field forms.

Figure 4-48 shows all the existing stormwater control facilities in the watershed and those which were visited as candidates for conversion or for some manner of upgrade.

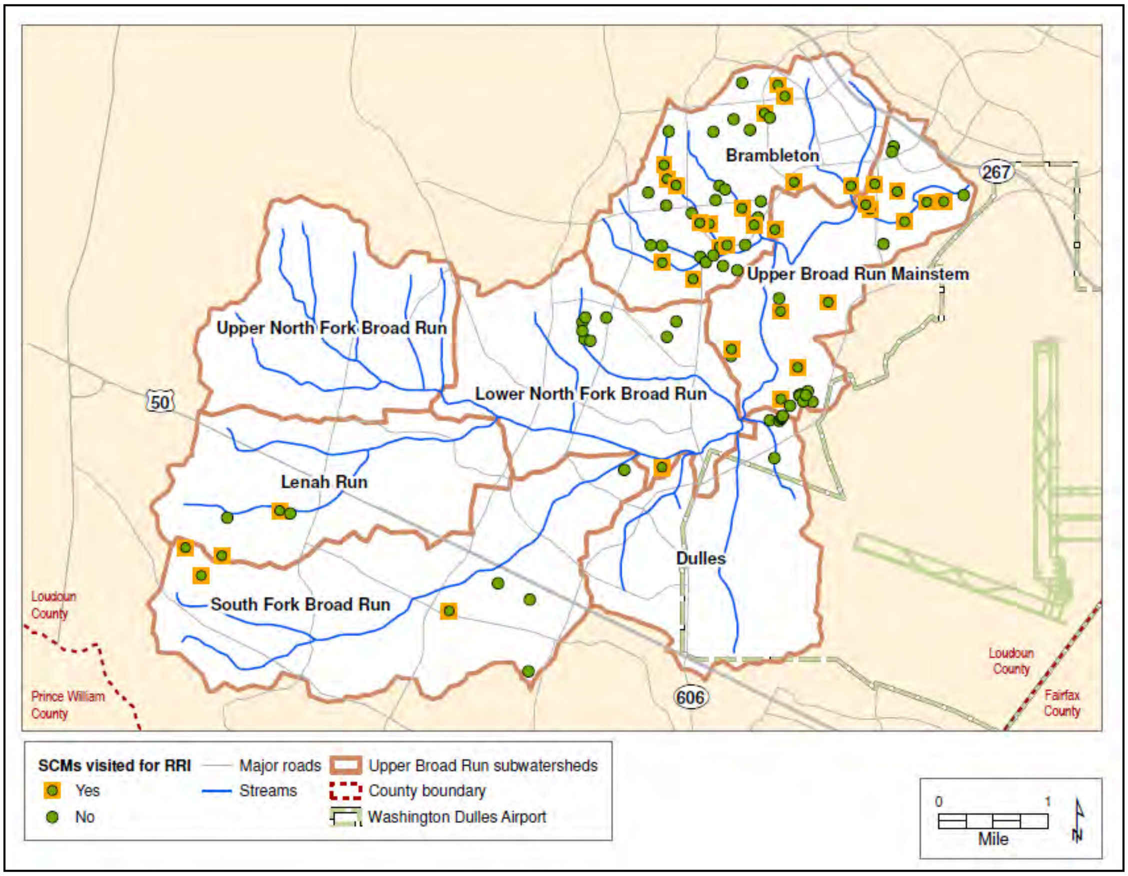


Figure 4-48: Location Map of Stormwater Management Facilities and Those Facilities Visited as Candidates for Upgrade or Conversion

Field observations guiding the viability of creating new SCMs or upgrading existing SCMs included invert elevation (if visible), available space for expansion, potential presence of a shallow ground water table, soil type as indicated on soil maps carried into the field, room for additional control measures within the existing pond basin, prominence of the pond relative to homes nearby and the need to consider aesthetics in the final design, and other considerations. For 15 facilities, stormwater design plans were reviewed to glean additional information. Note that as-built plans were not available for review.

New SCM options or existing SCM upgrades were also given a Priority Designation of Low, Medium, High or No Recommended Upgrade, depending primarily upon the existing pond designation (and pollutant removal efficiency), engineering feasibility of an upgrade and on how much additional reduction was possible under the SCM efficiencies designated by the Virginia Assessment and Scenario Tool (VAST). The SCM efficiencies found in VAST represent SCM efficiencies approved by the Environmental Protection Agency (EPA) Chesapeake Bay Program for meeting nutrient (nitrogen and phosphorus) and sediment reductions required by the Bay TMDL. For example, in more than a few instances an upgrade from an existing extended detention dry pond (ED DP) to a wet pond was feasible but the gains in pollution removal would be restricted to phosphorus and only increase from 25 percent to 45 percent removal efficiency, with sediment and nitrogen removal efficiencies remaining as per the original design. Upgrading an existing pond for a gain of 25% for only one pollutant of concern is difficult to justify when other cheaper alternatives such as nutrient application education could be much more effective per dollar spent. These would therefore be designated a low priority.

Larger ponds would have priority over small ponds because of the inherent economy of scale offered by conversion of a larger pond. Ponds draining commercial sites or institutional sites would be rated as higher priority than those draining residential areas because commercial and institutional drainages are known to be higher in pollutants than residential drainages. Aesthetic and community acceptability concerns were also considered. Ponds were not prioritized by ownership.

4.2.5.1 General Findings

Available options for new SCMs or upgrades of existing SCMs and their effectiveness were focused on those options listed on the VAST *BMP Effectiveness Values by Land Use and HGMR and Pollutant* spreadsheet (see Table 4-21).

Table 4-21: Pollutant Removal Efficiencies of Select BMPs as Provided by VAST February 2014

Select BMPs from the VAST**	Nitrogen Effectiveness (%)	Phosphorus Effectiveness (%)	Sediment Effectiveness (%)
Urban Nutrient Management Plan Low Risk Lawn	6	3	0
Street Sweeping 25 times a year-acres (formerly called Street Sweeping Mechanical Monthly)	3	3	9
Urban Nutrient Management Plan	9	4.5	0
Vegetated Open Channels - C/D soils, no underdrain	**10**	**10**	**50**
Urban Nutrient Management Plan High Risk Lawn	20	10	0
Dry Detention Ponds and Hydrodynamic Structures	**5**	**10**	**10**

Table 4-21: Pollutant Removal Efficiencies of Select BMPs as Provided by VAST February 2014

Select BMPs from the VAST**	Nitrogen Effectiveness (%)	Phosphorus Effectiveness (%)	Sediment Effectiveness (%)
Permeable Pavement w/o Sand, Veg. - C/D soils, underdrain	10	20	55
Permeable Pavement w/ Sand, Veg. - C/D soils, underdrain	20	20	55
Dry Extended Detention Ponds	**20**	**20**	**60**
Wet Ponds and Wetlands	**20**	**45**	**60**
Vegetated Open Channels - A/B soils, no underdrain	**45**	**45**	**70**
Bioretention/rain gardens - C/D soils, underdrain	**25**	**45**	**55**
Urban Forest Buffers	25	50	50
Permeable Pavement w/o Sand, Veg. - A/B soils, underdrain	45	50	70
Permeable Pavement w/ Sand, Veg. - A/B soils, underdrain	50	50	70
Urban Filtering Practices	**40**	**60**	**80**
Bioswale	**70**	**75**	**80**
Bioretention/rain gardens - A/B soils, underdrain	**70**	**75**	**80**
Permeable Pavement w/o Sand, Veg. - A/B soils, no underdrain	75	80	85
Permeable Pavement w/ Sand, Veg. - A/B soils, no underdrain	80	80	85
Urban Infiltration Practices w/o Sand, Veg. - A/B soils, no underdrain	**80**	**85**	**95**
Urban Infiltration Practices w/ Sand, Veg. - A/B soils, no underdrain	**85**	**85**	**95**
Bioretention/rain gardens - A/B soils, no underdrain	**80**	**85**	**90**

***From VAST BMP Effectiveness Values by Land Use and HGMR and Pollutant*, spreadsheet dated *11-5-2013*

Color coded by similar BMP type. Sorted by pollutant removal efficiency. ***Bolded*** *BMPs were considered for this conversion effort.*

The results of field reconnaissance are summarized in Table 4-22. Out of 35 ponds visited, all but 4 were judged to be candidates for either conversion of the entire pond or addition of some additional treatment within the pond boundary or both in order to increase pollutant removal efficiency.

As mentioned above, pond type designations were initially based on County-provided data, but in some cases were modified based on field observations and/or review of design plans. Our final designations of Pond Type are listed in Table 4-22.

Table 4-22: Pond Retrofit Reconnaissance Summary

Strucutre ID	Nearby Landmark	Owner-ship	Subwatershed	Pond Type	Proposed Redesign (s)	Priority Designa-tion	Drainage Area (acres)
WB50081	Mercure Circle behind Wisko Racing	Private	Upper Broad Run Mainstem	DP[1]	Wet Ponds / Wetlands	High	36.6
WB50081 (Option 1)	Mercure Circle behind Wisko Racing	Private	Upper Broad Run Mainstem		Step Pool Conveyance location 1 (Partial DA)	High	1.21
WB50081 (Option 2)	Mercure Circle behind Wisko Racing	Private	Upper Broad Run Mainstem		Step Pool Conveyance location 2 (Partial DA)	High	34.79
WB50081 (Option 3)	Mercure Circle behind Wisko Racing	Private	Upper Broad Run Mainstem		Bioswale at Location 3 (Partial DA)	High	0.6
AJ2205	Pebble Run Place	Private	Upper Broad Run Mainstem	DP[1]	Wet Ponds / Wetlands	High	44.9
AJ2205 (Option 1)	Pebble Run Place	Private	Upper Broad Run Mainstem		Bioswale at location 1 (Partial DA)	High	1.5
AJ2205 (Option 2)	Pebble Run Place	Private	Upper Broad Run Mainstem		Bioswale at Location 2 (Partial DA)	High	16.5
AJ2430	Mercure Circle	Private	Upper Broad Run Mainstem	DP[1]	Wet Ponds / Wetlands	High	15.57
AJ2499	Mercure Circle	County	Upper Broad Run Mainstem	ED DP[1]	Wet Ponds / Wetlands	Low	48.7
AJ2499 (Option 1)	Mercure Circle	County	Upper Broad Run Mainstem		Bioretention C/D soils with flow splitter into Wet Pond / Wetland	Medium	1.19
AJ2499 (Option 2)	Mercure Circle	County	Upper Broad Run Mainstem		Step Pool Conveyance (Partial DA)	High	0.96
AJ2897	Waterlake Court	County	Brambleton	ED DP[2]	Wet Ponds / Wetlands	Low	48.1
AJ4280	Allison Ridge Terrace	County	Brambleton	ED DP[1]	Wet Ponds / Wetlands	Low	4.97
BC45	Claiborne & Zion Chapel	County	Brambleton	ED Wet w/ forebay[2]	N/A	Not Upgradable	28.09
BC46	Loudoun County Parkway	Private	Brambleton	ED DP w/ forebay[2]	Wet Ponds / Wetlands	Low	4.53
BC47	Loudoun County Parkway & Clairborne Pkwy	Private	Brambleton	ED DP w/ forebay[2]	Wet Ponds / Wetlands or Bioretention w/ underdrain	Low	3.47
GC940	Loudoun County Parkway & Clairborne Pkwy	County	Brambleton	ED DP w/ postbay[2]	Wet Ponds / Wetlands or Bioretention w/underdrain	Low	2.74
BC54	Trade West	Private	Lower North Fork Broad Run	Enhanced ED DP[2]	N/A	Not upgradable	16.45
CW1	Goosefoot Square	County	Brambleton	DP[1]	Wet Ponds / Wetlands	Medium	5.08
DD231	Arcola E.S.	School System	South Fork Broad Run	Enhanced ED DP[2]	N/A	Not Upgradable	8.58
GC554	Rogerdale Place	County	Upper Broad Run Mainstem	ED DP[1]	Wet Ponds / Wetlands or Bioretention w/underdrain	Medium	77.33
JC2411	Red Admiral Place	County	Brambleton	ED DP[1]	Wet Pond / Wetlands and/or Bioretention (Partial DA) w flow splitter or Bioswale (Partial DA) inside pond.	Low	28.57
JC3128	State Street & Thorncroft Place	Private	Upper Broad Run Mainstem	ED DP[2]	Wet Pond / Wetlands	Low	28.98
JC3325	High Haven Terrace	County	Upper Broad Run Mainstem	ED DP[1]	Wet Pond / Wetlands, Chambers or Sand Filter and/or Bioswale	Medium	5.12

Table 4-22: Pond Retrofit Reconnaissance Summary

Strucutre ID	Nearby Landmark	Owner-ship	Subwatershed	Pond Type	Proposed Redesign (s)	Priority Designa-tion	Drainage Area (acres)
JC3718	High Haven Terrace	County	Upper Broad Run Mainstem	ED DP[(a)]	Wet Pond / Wetlands or Chamber System or Sand Filter	Medium	2.22
JC3727	Maison Carree Square	Private	Upper Broad Run Mainstem	ED DP[(a)]	Wet Pond / Wetlands	Low	20.46
JC3947	Lyndora Park	Private	Brambleton	WP	Take Pond off-line & Stream Restoration	High (Special Project)	Unknown
JC3947 (Options 1-10)	Lyndora Park	Private	Brambleton		6-10 Bioswales	High	40
JC4162	Gleedsville Manor	County	Brambleton	WP[(a)]	N/A	Not Upgradable	15.56
JC4162 (Option 1)	Gleedsville Manor	County	Brambleton		500 feet of Bioswale in lieu of Concrete Channel Conveyance	High	7.78
JC4375	Zulla Chase Place	County	Upper Broad Run Mainstem	ED DP[(b)]	Wet Pond / Wetlands or Sand Filter or Chambers	Medium	8.13
JC4380	Ryan Rd and Airmont Hunt	County	Brambleton	ED DP[(b)]	Wet Pond / Wetland and or Bioretention Pretreatment in Pond	Low	13.07
JC4577	Airmont Hunt Drive	County	Brambleton	ED DP[(b)]	Wet Pond or Bioretention in Pond (Partial DA)	Low	14.91
JC4579	Glenside Drive	County	Brambleton	WP[(b)]	1 step pool or 2 bioswales within pond boundary	Low	7
JC4796	Forest Run Drive	County	Brambleton	ED DP[(a)]	Wet Pond / Wetlands	Low	15.24
JC50044	Sousa Place	Private	Lenah Run	ED DP[(a)]	Urban Infiltration w/sand, veg or Wet Pond / Wetlands	Medium	10.69
JC5171	Forest Manor Drive	County	Brambleton	DP[(a)]	Wet Pond / Wetlands or Bioretention	High	56.67
JC5181	Still Creek Drive	County	Brambleton	ED DP[(a)]	Wet Pond / Wetlands	Low	19.47
JC6132	Ogden Place	County	Upper Broad Run Mainstem	ED DP[(b)]	Wet Pond / Wetlands or Bioretention (x2) with underdrains	Low	69.78
JC6134	Meadowvale Lane	County	Upper Broad Run Mainstem	ED DP[(a)]	Wet Pond / Wetlands or Bioretention (x2) with underdrains	Medium	22.7
KD50006	Hickory Ridge Place	Private	South Fork Broad Run	ED DP[(b)]	Urban Infiltration w/sand, veg or Wet Pond / Wetlands	Medium	8.62
KD50012	Crooked Oak Ct.	Private	Lenah Run	ED DP[(b)]	Urban Infiltration w/sand, veg or Wet Pond / Wetlands	Low	9.6
KD50014	Sousa Place	Private	South Fork Broad Run	ED DP[(a)]	Wet Pond / Wetlands	Low	51.59
WB50068	Stone Hill Middle School	School System	Upper Broad Run Mainstem	DP[1]	Wet Pond / Wetland or Bioswale (draining grass play fields primarily, Partial DA)	Medium	3.94
JC4978	Forest Run and Ryan Rd.	Private	Brambleton	ED DP[(b)]	Wet Pond / Wetlands	Low	28.9
JC4978 (Option 1)	Forest Run and Ryan Rd.	Private	Brambleton		300ft bioswale	Low	14

DP = Dry Pond, EP = Extended Detention
[(a)] Field verified type without benefit of engineering plans.
[(b)] Type verified with engineering plans (not as-built).

There are more options (52) than ponds (36) listed in Table 4-22 because some ponds offered more than one simultaneous conversion option, such as in the case of dry pond WB50081, which has three recessed and elevated outfalls within the pond boundary that could be altered.

In other cases, more than one option for complete conversion of a pond appears viable, as in the case of extended detention dry pond KD50012 which could be converted to an urban infiltration basin with sand and vegetation or a wet pond or wetland depending on further investigation of as-built plans and consultation with the community. These are singular options for each pond.

In all, 22 High Priority conversion opportunities were identified (at 7 ponds). Another 10 Medium Priority opportunities were identified (at 10 ponds). Again, these options exceed the total number of ponds visited because some ponds offer more than one option with a different priority designation.

The most common conversion suggestion in the watershed is conversion of existing dry ponds to wet ponds or wetlands; 31 instances in total and 13 times as the only available conversion option (including those options ranked as low priority). This is primarily a result of poor soils (C and D soils), very little invert elevation change found at many of the existing SCMs and the need to consider only those SCM options listed by VAST in order to assure that the County will receive credit for any conversions. This precluded the application of infiltration techniques because A/B soils were usually not present and often precluded the recommendation of bioretention techniques because they require underdrains in the C/D soil context which in turn demand adequate invert elevation depth to accommodate positive drainage through the engineered soil media.

Additionally, some good options such as step pool conveyance have not yet been approved for credit by the Chesapeake Bay Program. Other BMPs, such as stream restoration, have interim reduction efficiencies provided through VAST while the Chesapeake Bay Program finalizes removal rates for those BMPs. However, because options for high priority conversions were limited in the watershed, we chose to include step pool conveyance conversions as an option when site characteristics allowed it because we expect it and stream restoration may be given high pollution removal efficiency scores by VAST.

It is important to note that the options in Table 4-22 require additional vetting, including review of as-built plans in order to better estimate constructability. This would be followed by cost estimations for design, construction and permitting which would allow for further prioritization based upon costs per pound of nutrient removed under the new design scenarios.

At this junction, we can state that the Upper Broad Run offers some good pond conversion opportunities if the county and the neighbors living near the existing ponds are willing to embrace wet ponds or wetlands in lieu of dry ponds.

Example Upgrade: Lyndora Park and Loudoun Valley Estates

Wet pond JC3947 (Figure 4-49) drains Loudoun Valley Estates and traverses some of Lyndora Park. It is an inline pond, intercepting a perennial stream. Additionally, the stream channel from

Loudoun County Parkway to initiation of the stormwater management pond has eroding banks (Figure 4-50) and in one instance bank erosion is proximate to a structural wall (Figure 4-51). Enough open space exists in and around Lyndora Park to consider separating the perennial stream channel from the pond, restoring the natural hydrology of the perennial stream, while simultaneously removing the fish blockage caused by the wet pond. The stream channel could be restored through Loudoun Valley Estates and downstream (Figure 4-52) to prevent further erosion, and protect the development. An added benefit of taking the pond offline would be the ability to better control Canada Goose populations which are an obvious source of nutrients and bacteria to the pond and perennial stream which flows through it.

Figure 4-49: Inline Pond JC3947

Figure 4-50: Bank Erosion Along Stream Channel above Pond JC3947 within Loudoun Valley Estates

Figure 4-51: Structural Wall which may Eventually be Threatened by Bank Erosion, Loudoun Valley Estates

Figure 4-52: Streambank Erosion Observed just Downstream of Dewatering Structure of Pond JC3947 at Loudoun Valley Estates and Lyndora Park

CHAPTER 5: STORMWATER MANAGEMENT AND OTHER WATERSHED MANAGEMENT PRACTICES

Loudoun County has implemented stormwater control measures (SCMs) and other watershed management practices since the 1980s. The initial focus of stormwater management was detention of large flows to reduce flooding. Subsequent designs addressed water quality treatment and stream channel protection. Most recently, "green" SCMs known as Environmental Site Design (ESD) or green stormwater infrastructure are being encouraged for new development and to facilitate restoration of watersheds. New Virginia stormwater regulations for new and re-development will require that stormwater management provide for control of water quantity and quality using the latest guidelines.

5.1 Stormwater Control Measures for Urban/Suburban Areas

The following categories of stormwater and watershed management practices were considered in this watershed management plan as the major strategies to address the effects of urban/suburban development in Upper Broad Run. Each has the potential to yield quantifiable benefits in stormwater quality and in quantity control for channel protection and flooding, with the exception of urban nutrient management, which affects only the former.

- Urban nutrient management
- Conversion of dry detention ponds (DP) to extended detention dry ponds (ED DP)
- Conversion of dry ponds to infiltration practices
- Conversion of dry ponds to extended detention wet ponds / wetlands (ED WP)
- Addition of pretreatment or post treatment SCMs within existing dry or wet pond boundaries
- New SCMs retrofits outside of existing dry or wet pond boundaries but which would drain into an existing pond or capture and treat stormwater just outside of the existing pond.
- Reforestation of stream buffers
- Reforestation of upland areas
- Stream restoration for erosion control and nutrient processing
- New Micro-SCMs (LID) such as bioretention, bioswales, urban filtration practices, etc. not associated with an existing dry or wet pond
- Downspout disconnection
- Impervious cover removal

Note that stormwater control measure options chosen here are all recognized by the EPA Chesapeake Bay Program and the Virginia Assessment Scenario Tool (VAST) and have vetted nitrogen, phosphorus and pollutant removal efficiencies.

Urban nutrient management involves the reduction of fertilizer for grass lawns and other urban and suburban manicured pervious areas through efficient application. The implementation of urban nutrient management relies on public education and awareness, targeting urban and suburban residences and businesses, with an emphasis on proper application of fertilizer in order to both reduce excessive fertilizer application and to prevent fertilizer discharge into waterways via precipitation by deliberate timing of fertilizer applications. Urban nutrient management is a source reduction solution and therefore highly cost-effective, particularly in terms of phosphorus which tends to be the limiting element to algal growth in freshwaters.

New stormwater management ponds involves placing new stormwater management ponds, including extended detention dry ponds, urban infiltration ponds, and constructed wetlands (Figure 5-1) and wet ponds at locations that currently have no stormwater quantity or quality controls or where existing SCMs are inadequate and where space is available for a new SCM. Ponds are the traditional method of controlling stormwater flows and the opportunity to retrofit new SWM ponds is not common in the developed environment. However, the resulting benefits to flow volume, velocity control, and water quality improvement can be significant. Benefits may vary depending on the specific design features of the individual ponds.

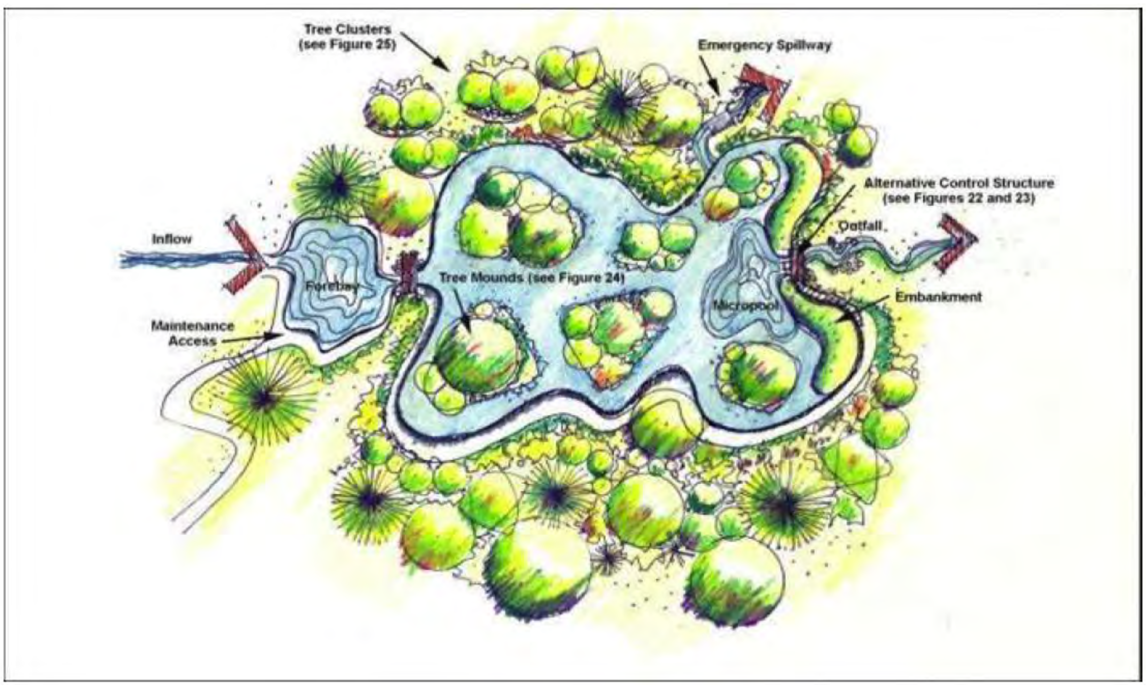


Figure 5-1: Constructed Wetland Standard Concept Design (Virginia DEQ 2011a)

Stormwater pond conversions can include the following general options for the re-design of existing stormwater ponds to provide additional water quantity control or water quality treatment:

- Increasing storage capacity by additional excavation.
- Providing water quality treatment features at facilities that currently have only water quantity control, if the space is available. Examples include: micropools, sediment forebays, or constructed stormwater wetlands.
- Modifying or replacing existing outlet controls to reduce the discharge rate from the stormwater management facility.
- Where soil types are appropriate, adding infiltration (sometime referred to as exfiltration) features to promote groundwater recharge, and improve pollutant removal.
- Where water quality flows can be split or separated from larger events, vegetated areas with engineered soils and underdrain, referred to as bioretention, can sometimes be retrofit into an existing pond as pretreatment or post treatment and yield a significant increase in pollutant removal efficiency.
- Installing proprietary settling, filtering or hydrodynamic devices in parking lots or other areas with a large percentage of impervious area to trap sediments and petroleum products before they flow into a pond. These tend to have low pollutant removal efficiencies but can be good options in the highly urban context, particularly where subterranean treatment is the only option. They have the added benefit of offering inherent quality control during construction by their manufacturers as opposed to SCMs and ponds which are custom built for each application.

Specifically, the following types of conversions are recommended.

- ***Conversion of Dry Stormwater Management Detention Ponds*** to extended detention dry ponds or extended detention wet pond/wetlands or conversion to ponds with infiltration capability, where soils permit. These SCMs typically treat the largest area of impervious cover because they have the largest drainage areas and were originally built as a low cost option for flood control, channel protection and/or water quality control. Conversion of these existing devices is among the most cost effective of pollutant reduction measures because the existing ponds don’t require acquisition of new property, the pipe infrastructure is already in place, most of the excavation is already complete, maintenance responsibilities and easements have already been established and because stormwater flows already concentrate at these devices. Pollution reduction credits may depend on specific design characteristics affecting both runoff time and treatment.

    - <u>Dry and Wet Extended Detention (ED) Basins</u> are depressions that temporarily store (“detain”) runoff and release it at a prescribed rate via surface flow or groundwater infiltration following storms. Dry ED basins are designed to dry out between storm events, in contrast with wet ED ponds, which contain standing water permanently. As such, they (ED type) are similar in construction and function to simple dry or wet detention basins which are primarily for flood control or channel protection, except that the duration of detention of stormwater is designed to be longer, theoretically improving treatment effectiveness by increasing residence time of pollutants which encourages settling of sediments and allows more time for biological and physical processing of nutrients.

- Urban Infiltration Practices are depressions created to allow the collection and infiltration of stormwater in order to trap sediments and nutrients in soil media and simultaneously recharge groundwater aquifers (Figures 5-2 and 5-3). No underdrains are associated with infiltration basins and trenches, because by definition these systems provide complete infiltration. Infiltration basins and trenches cannot be constructed on poor soils, such as C and D soil types. These urban infiltration practices may include vegetation and sand which increases the removal of phosphorus by 5 percent on average compared to infiltration practices without sand or vegetation.

Figure 5-2: Residential Infiltration Trench (Virginia DEQ 2011b)

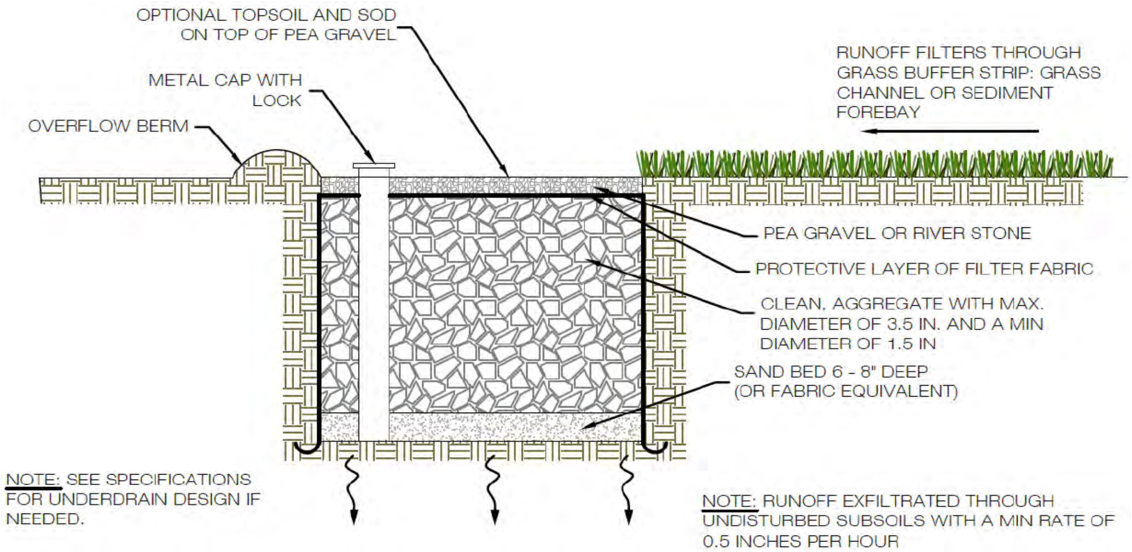


Figure 5-3: Standard Section for Infiltration Trench (Virginia DEQ 2011b)

Reforestation consists of the following two types of tree planting, both of which provide ancillary benefits of enhancing wildlife and amenity values. Planting trees reduces runoff through interception and uptake/transpiration of precipitation, while also providing soil stability, heat island reduction and wildlife habitat benefits.

- Riparian Forest Buffers are areas of trees, shrubs, and other vegetation adjacent to a body of water. The riparian area, typically at least 35 feet wide (on each side of a stream), is managed to maintain the integrity of stream channels, and to reduce the impacts of upland sources of pollution by trapping, filtering, and converting sediment, nutrients, and other chemicals. Planting trees and enhancing existing streamside vegetation with native varieties of trees, shrubs, and wildflowers restores many of the water quality, wildlife, and aesthetic benefits associated with riparian buffers. Vegetation filters sediments and other pollutants from stormwater runoff, moderates water temperatures in streams, and provides shelter and food to both terrestrial and stream organisms. This SCM converts urban or agricultural land to forest land and provides a nitrogen, phosphorus, and sediment reduction benefit proportional to the amount of land converted.

- Upland Tree Planting is planting trees on currently urban or other open pervious areas at a rate that would produce a forest-like condition over time. Benefits include reductions in nutrient and sediment runoff as well as improvements in wildlife habitat and aesthetics.

Stream restoration is used to improve the ecosystem condition in degraded streams by restoring the natural hydrology and landscape of a stream and by enhancing habitat and water quality. Streams damaged by erosive flows, excess sedimentation, and disruptive human activities are often not capable of re-establishing a stable form. Preferred techniques to repair these damaged or degraded streams are based on mimicking natural stream channels and the range of natural variability exhibited by nearby stable streams. Termed ***natural stream channel design***, such repairs focus on establishing natural stream channel shape, size, and habitat features. Restoration can range from minor repairs to restore bank stability to complete reconstruction of the stream channel. Stream restoration also provides significant ancillary benefits through habitat enhancement and improved ecosystem services. Credits may vary depending on the type of stream restoration undertaken.

Micro-SCMs (LID) include the use of innovative practices designed to mimic natural flows by reducing the volume of stormwater runoff at the source. Distributed Micro-SCMs features are a series of smaller landscape features that function as retention/detention areas integrated with developed areas. Micro-SCMs include bioretention areas and rain gardens created by excavating a depression and backfilling with engineered media, mulch, and vegetation. These planted shallow basins temporarily pond stormwater runoff, filter it through the bed components and treat it through biological and biochemical reactions within the soil matrix and root zones of the plants. Micro-SCMs are suitable for stormwater runoff control for new development and re-development projects, which strive to mimic "woods in good condition" and are often paired with ponds in order to meet flood control and channel protection objectives. Practices in this category are variously called ***green stormwater infrastructure***, ***environmental site design practices (ESD)***, or ***low impact development (LID)***. These also include such practices as bioswales or wet swales which both treat and convey stormwater.

The suite of available ESD practices is diverse and many are advocating for a more expansive use of lower-cost vegetation and tree-based practices, especially near outfalls, within existing conveyances, adjacent to parking lots, and as green streets (Cameron et al. 2013). In general, ESD practices most conducive to residential landscapes include rain gardens (typically in front yards), permeable pavement (typically for driveways), rainbarrels or cisterns, turf conversion or sustainable landscaping, dry wells, green roofs, tree canopy, soil decompaction, and pavement removal. ESD opportunities in rights-of-way may include bioretention (in medians, cul-de-sac islands, street bump outs, adjacent open space, as well as behind curbs or sidewalks), permeable pavement (in parking or bike lanes, sidewalks), turf conversion or sustainable landscaping, street trees (including tree pits), and step-pool stormwater conveyances in roadside channels.

The following are general descriptions of common Micro-SCM techniques:

- A Rain garden is a shallow depression designed to detain and treat stormwater runoff from small, frequent storms by using a conditioned planting soil bed and planting materials (Coyman and Silaphone 2010). Pollutants are adsorbed by the soil and plant material, improving water quality. Water slowly infiltrates through the soil bed to recharge groundwater or is used by the plants via transpiration. The term rain garden is typically used for practices without an underdrain. These are often non-engineered, non-permitted SCMs used at a residential scale and not for the purpose of meeting regulatory standards for quantity or quality control.
- Bioretention is a common term for a shallow depression designed to detain and treat stormwater runoff from small, frequent storms by using a conditioned planting soil bed and

planting materials (Figures 5-4 and 5-5). As with rain gardens, pollutants are adsorbed by the soil and plant material, improving water quality. Water slowly infiltrates through the soil bed to recharge groundwater or is used by the plants for transpiration. Unlike rain gardens, bioretention areas typically include an underdrain system to carry treated water draining through the system and, even more importantly, overflows from heavier events, to an existing stormdrain network. In this way, bioretention can be implemented in situations with less infiltration or higher flows than can be accommodated by rain gardens. Bioretention areas are usually only used to treat the water quality event and not for flood control or channel protection.

Figure 5-4: Photo of Bioretention Draining a Rooftop at a Commercial Facility (Virginia DEQ 2011c)

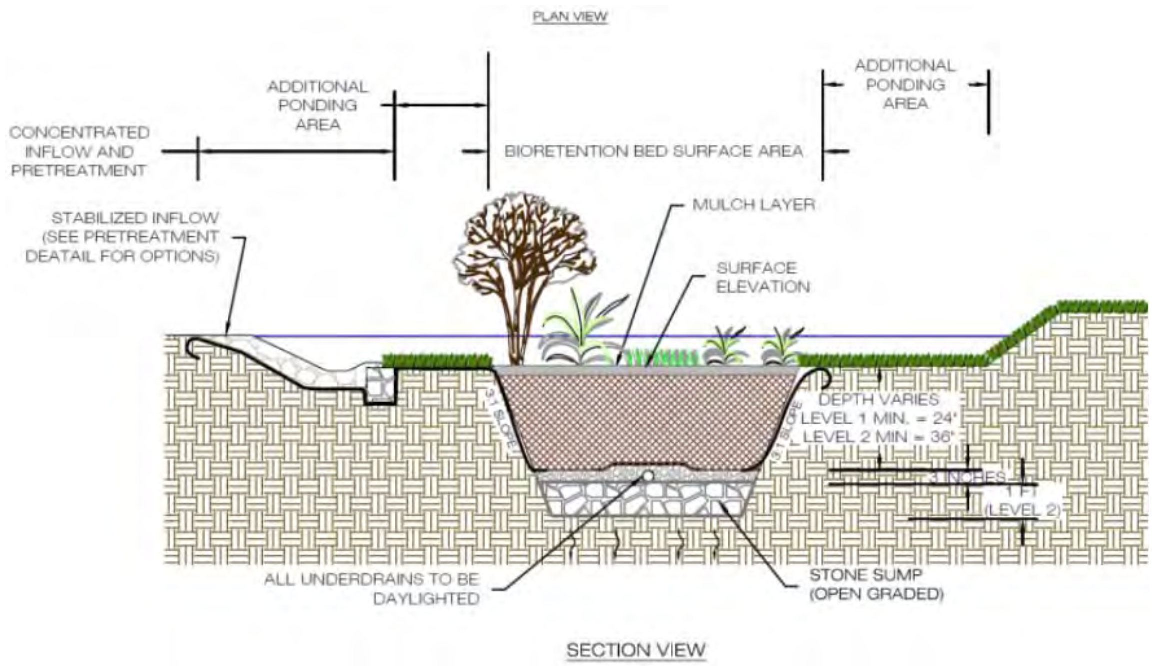


Figure 5-5: Typical Bioretention Detail with Additional Surface Ponding (Virginia DEQ 2011c)

- Dry and wet swales (Figures 5-6 and 5-7) allow for treatment and conveyance simultaneously and can be used as effective enhancement for existing ponds, both as pretreatment or post treatment, when site topography allows it or as stand along new retrofits anywhere were stormwater is conveyed on the surface. Wet swales require the interception of shallow groundwater in order to remain wet at all times. Both are excellent water quality retrofits.
- Rain barrels are low-cost, effective, and easily maintainable detention or retention devices that can be used in residential, commercial and industrial sites. They are connected to downspouts to retain or detain rooftop runoff (Figure 5-8). Rain barrels can be used to store runoff for later use in lawn and garden watering or can discharge into dry wells. The Loudoun County Soil and Water Conservation District actively educates local residents about the many benefits of rain barrels during several rain barrel workshops each year (Loudoun SWCD 2013).
- Rainwater Harvesting uses larger rainwater storage via Cisterns placed either above or below ground (Figures 5-8 and 5-9). The water they capture is suitable for non-potable uses including flushing of toilets and urinals inside buildings (with proper cross-connection prohibition), landscape irrigation, exterior washing (e.g., car washes, building facades, sidewalks, street sweepers, fire trucks, etc.), fire suppression (sprinkler) systems, supply for chilled water cooling towers, replenishing and operation of water features and water fountains, and laundry, if approved by the local authority. Rainwater harvesting via cisterns can be combined with a secondary (down-gradient) runoff reduction practice to enhance runoff volume reduction rates and/or provide treatment of overflow from the rainwater

harvesting system. Runoff reduction volumes are defined by the size of the cistern and contributing drainage area.

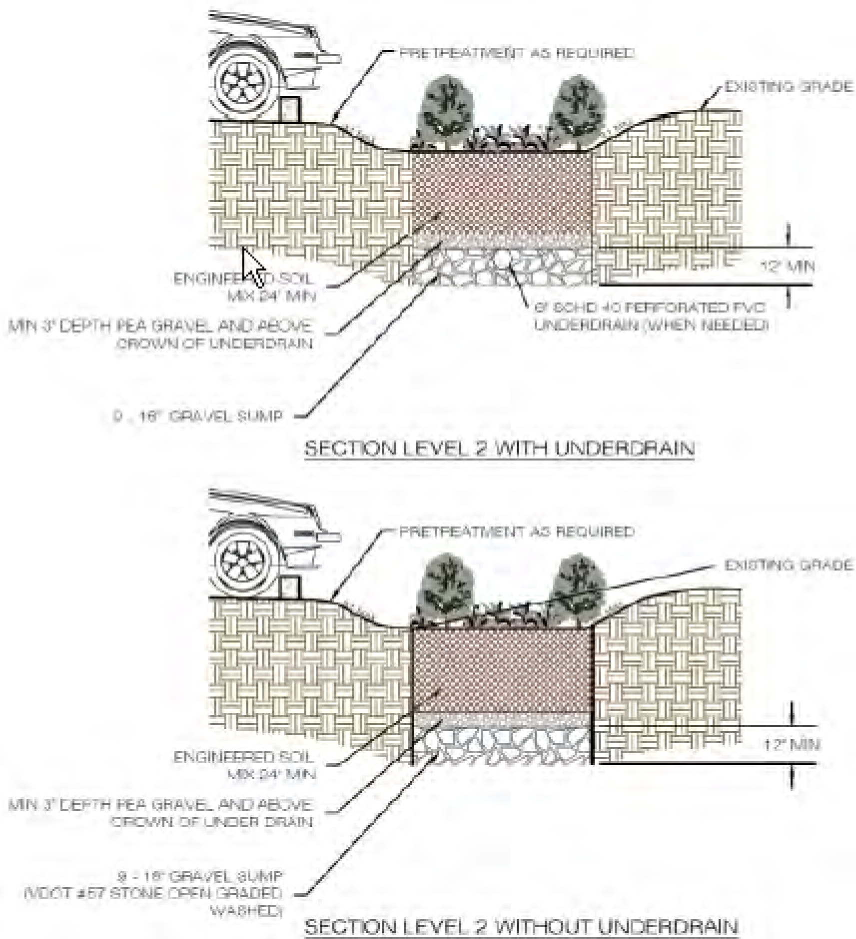


Figure 5-6: Standard Section for a Dry Swale (Virginia DEQ 2011d)

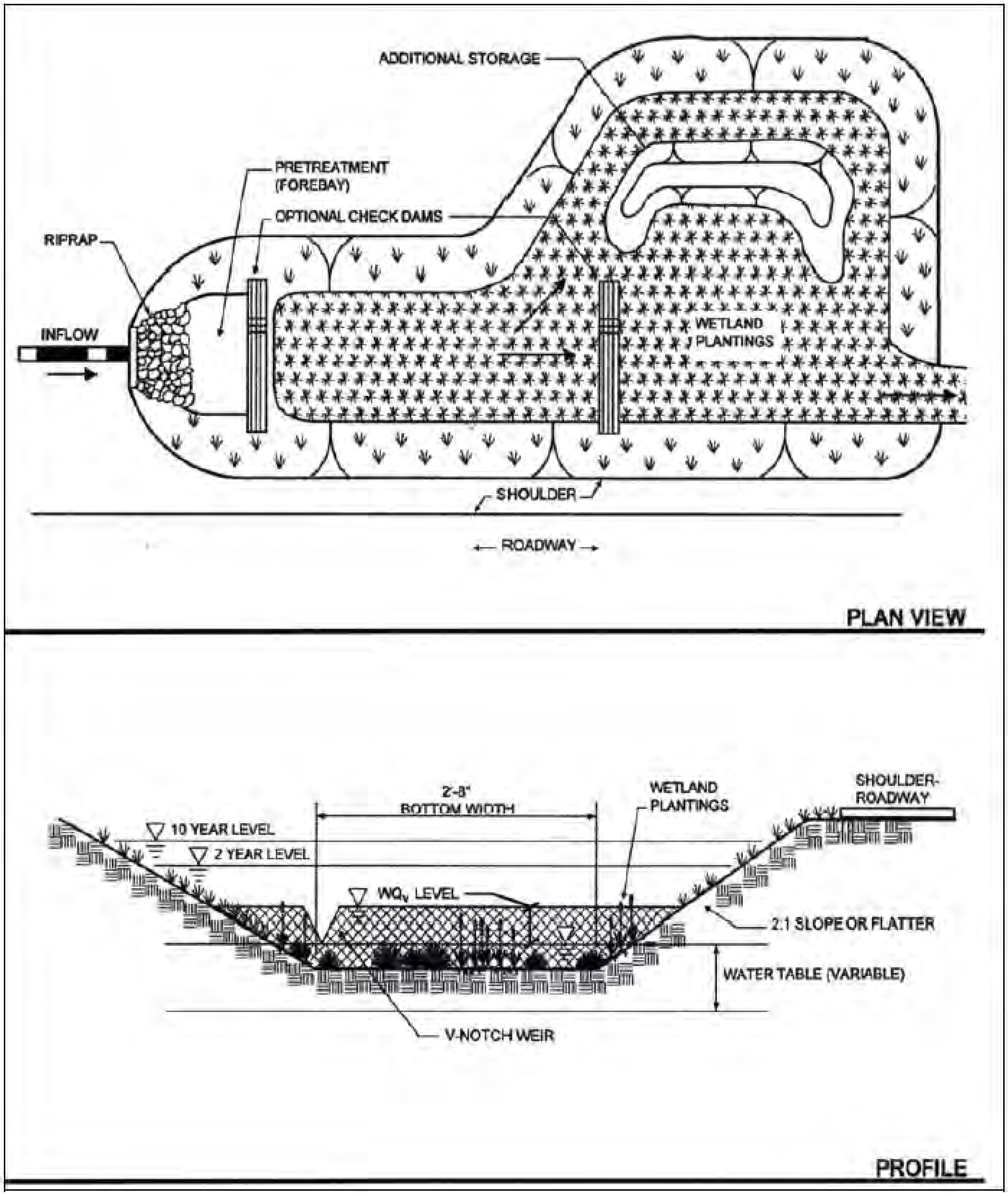


Figure 5-7: Standard Section and Profile for a Wet Swale (Virginia DEQ 2011e)

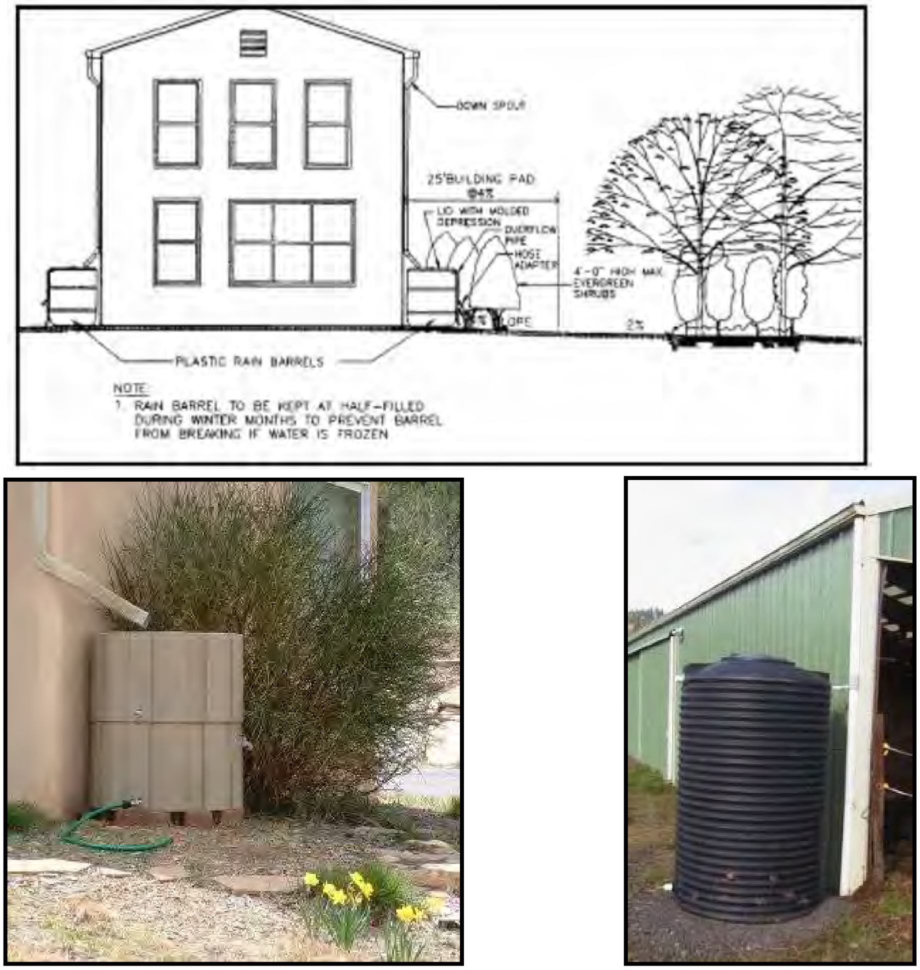


Figure 5-8: Rain Barrel Standard Section and Photos of Rain Barrel and Above-ground Cistern (Sources: Prince George's County 1999; www.aridsolutions.com; and www .plastmo.com)

Figure 5-9: Subterranean Cistern (Virginia DEQ 2011f)

Downspout disconnection can capture stormwater runoff from rooftops that would otherwise be directed to the local storm drain system. Some downspouts are connected to the storm drain system through underground pipes, while others flow onto driveways and sidewalks, which then flow to street inlets. Downspout disconnection refers to practices that capture or treat rooftop runoff through either (1) simple disconnection that allows runoff to spread across pervious areas, such as a lawn, where it infiltrates into the ground, (2) a rain barrel that captures runoff for later use in watering gardens, or (3) a rain garden that infiltrates the runoff.

Impervious cover removal may be an option in areas where existing parking surfaces or other paved surface are not currently needed. In some cases, large parking surfaces were previously built in commercial and institutional developments for events that occur very infrequently. Potentially, these areas could be converted to turf, thus reducing overall impervious cover and thereby reducing runoff. Pervious concrete or asphalt surfaces are another option that can be employed where appropriate.

Additional stormwater control can be achieved through restoration actions not included in the SCMs above, such as street sweeping and public education/outreach efforts (e.g., pet waste, trash, and recycling campaigns). These types of actions are not included in the pollutant removal analysis currently, because they require site-specific analyses or reductions efficiencies are difficult to estimate.

Street sweeping removes floatable trash, sediment, heavy metals and nutrients associated with sediment particles, petroleum associated with sediment, and organic matter such as leaves and twigs from the curb and gutter system, preventing them from entering storm drains and nearby streams. Loudoun County does not currently plan to sweep streets in Upper Broad Run the 26 times a year required for the standard nutrient load reductions, nor does it weigh the collected material to obtain a sediment load reduction.

An effective approach to ***trash and litter reduction*** may be multi-faceted, including public outreach (through targeted public service advertisements), clean-ups, and enforcement. Stream and roadside clean-ups can be targeted to groups such as recreation councils, scout troops, businesses, and religious organizations. Enforcement actions, when needed, usually address businesses or apartments with consistent litter problems, overflowing dumpsters, and dumping.

An ***Illicit Discharge Detection and Elimination*** (IDDE) program has been implemented by Loudoun County to find and stop discharges into streams that are harmful to aquatic life and water quality or that cause erosion/sedimentation problems. Program activities are described in the County's Annual MS4 Stormwater report.

Several programmatic practices, such as illicit discharge detection and elimination, pollutant hotspot improvements, and enhanced sediment and erosion control, are being considered for SCM credit by EPA expert panels. In the future, other innovative SCMs such as floating wetlands may be approved for credit.

A full suite of SCM options will be considered for the watershed management plan, but only the major types described above were used in the pollutant reduction analysis presented in Chapter 6 of this report. Site-specific recommendations are detailed in the subwatershed summaries in Chapter 7.

5.2 Best Management Practices for Agricultural Areas

There are a large number of agricultural practices that are used by farmers to reduce soil loss, trap nutrients, and minimize the amounts of nutrients and pesticides used on the land. For many of these agricultural Best Management Practices (BMPs), there are clear benefits in reductions of nitrogen, phosphorus, and sediment inputs to local waterways.

A ***soil conservation and water quality plan*** is a comprehensive plan that addresses natural resource management on agricultural lands and describes BMPs which will be used to control erosion and sediment loss and manage runoff. Plans include management practices such as crop rotations and structural practices such as grassed waterways and water troughs. The Soil and Water Conservation District can provide assistance to determine the group of practices needed to address specific runoff concerns on a farm. The practices are designed to control erosion within acceptable levels and to be compatible with management and cropping systems or management do not occur. Also included in a plan are recommendations concerning forestry management, wildlife habitat and plantings, and other natural resource management practices. The Loudoun

County Soil and Water Conservation District aided in the development of conservation plans for 908 acres of land in Loudoun County during Fiscal Year 2013 (Loudoun SWCD 2013).

Streamside forest buffers are wooded areas along rivers and streams that help filter nutrients, sediments, and other pollutants from runoff, as well as removing nutrients from groundwater and slowing erosion. Riparian forest buffers also enhance terrestrial and aquatic habitat.

Streamside grass buffers are strips of grass or other non-woody vegetation maintained between the edge of fields and streams, rivers, or tidal waters. These grass strips help filter nutrients, sediment and other pollutants from runoff, as well as removing nutrients from groundwater.

Tree planting on non-riparian agricultural lands can be targeted to lands that are highly erodible or identified as critical resource areas.

Cover crops are small grains such as wheat, barley, or rye that are planted in the fall after the harvest of corn, soybeans, or vegetables to absorb unused nutrients that may remain in the soil. During the winter, nutrients, particularly nitrate, are subject to leaching to groundwater. In addition, the plants and roots of cover crops help anchor the soil to decrease erosion and reduce phosphorus loss, and add organic matter to soil. By timing the springtime cover crop burn or plowdown, the trapped nitrogen can be released and used by the following crop.

Conservation tillage involves planting and growing crops with minimal disturbance of the surface soil. Conservation tillage requires two components: a minimum 30 percent residue coverage at the time of planting and a non-inversion tillage method. No-till farming is a form of conservation tillage in which the crop is seeded directly into vegetative cover or crop residue, with little disturbance of the surface soil. Minimum tillage farming involves some disturbance of the soil, but uses tillage equipment that leaves much of the vegetation cover or crop residue on the surface. The overall benefit is the reduction of surface soil erosion.

Continuous No-Till is a crop planting and management practice in which soil disturbance by plows, disk or other tillage equipment is eliminated. This practice involves no-till methods on all crops in a multi-crop, multi-year rotation.

Stream Protection with Fencing is the installation of fencing along streams to exclude livestock. The fenced areas may be planted with trees or grass, but are typically not wide enough to provide the full benefits of buffers. Stream fencing should be implemented so as to substantially limit livestock access to streams; however, it can allow for the use of limited hardened crossing areas, where necessary, to accommodate access to additional pastures or for livestock watering. By preventing or limiting access of livestock to streams, erosion from hooves and bacteria contamination is curtailed.

Off-Stream Watering provides livestock an alternative drinking water source away from streams. By providing an off-stream watering source, livestock will reduce the time they spend near and in streams and stream banks. This will reduce animal waste deposition and move heavy traffic areas near streams to more upland locations. This practice works in conjunction with the practice of stream protection with fencing.

Animal Waste Management systems are practices designed for proper handling, storage, and utilization of wastes generated from animal operations. They include a means of collecting, scraping, or washing wastes and contaminated runoff into appropriate waste storage structures.

Runoff control systems on agricultural lands work to control or intercept flow in several ways. Gutters, downspouts, and other water conveyance devices prevent roof runoff from causing severe erosion or mixing with animal waste and transporting pollutants to waterways. Roof runoff systems improve water quality, reduce soil erosion, increase infiltration, and protect buildings and other structures. Diversions may be used to direct runoff flows away from a feedlot or to collect and direct water to a pond. Diversions reduce soil erosion, filter runoff improving water quality, and provide cover for wildlife. Grassed waterways use natural drainage to prevent gullies from forming and control soil erosion. Stormwater runoff flows over the grass rather than tearing soil away and forming a gully. Vegetation may act as a filter, absorbing some of the pesticides and nutrients in runoff water, and provides cover for wildlife.

Nutrient management plans are comprehensive plans that describe the optimum use of nutrient inputs for crop yield to minimize loss of excess nutrients to the environment. A nutrient management plan details the type, rate, timing, and placement of nutrients for each crop. Soil, plant tissue, manure and/or sludge tests are used to assure optimal application rates. Though some of these plans are written to cover a three year period, many are revised every year so that they incorporate management, fertility, and technology changes.

5.3 Homeowner, Business, and Volunteer Watershed Stewardship Opportunities

Residents and businesses sometimes engage in activities that can negatively influence water quality, including over-fertilizing lawns, using excessive amounts of pesticides, poor house-keeping practices (such as inappropriate disposal of paints, household cleaners, or automotive fluids), and dumping into storm drains. Alternatively, positive behaviors such as tree planting, disconnecting downspouts, and picking up pet waste can help improve water quality. Targeted education can be used to deliver messages that promote changes in behavior. A recent survey of more than 800 people in the Baltimore metropolitan area regarding people’s knowledge about stormwater concluded that even those who want to reduce the negative impacts of stormwater runoff do not often realize their role in controlling stormwater runoff and pollution (OpinionWorks 2008). Local business associations, homeowner associations, schools, and other civic groups, such as the Master Gardeners, are in a position to effect positive changes using pollution prevention education and outreach to teach residents and business owners how to properly care for the watershed.

Pet waste stations – Pet waste is one of the contributors of bacteria to streams and can cause human health concerns. A pet waste station is a sign reminding pet owners of the importance of proper disposal of pet waste and it usually includes a supply of bags for pet waste cleanup. Often it is located next to an existing trashcan or it includes one. Pet waste stations can help neighborhoods to reduce bacteria flowing into their local streams and help to keep their neighborhood park or school site clean. Residents can participate by monitoring the supply of bags to make sure they are continually available.

Fertilizer reduction – A well-manicured and responsibly maintained lawn is often viewed as an amenity. Often, however, over-fertilization and irresponsible pest management can result in pollutant-charged runoff to local streams. Proper lawn and turf care practices can reduce excess nitrogen, phosphorus, insecticides, and herbicides from getting into local streams. Education on soil testing, fertilizer application, and pesticide use is intended to reduce the amount of these materials applied to the land. Eco-friendly lawn care may also include the use of mulching lawn mowers that reduce the need for fertilizer and decrease the amount of material handled by the yard material collection program.

Trash and recycling

- *Compost bins* – By composting leaves and weeds in backyard bins, the amount of material handled by the municipal yard material collection is reduced. Use of compost is an environmentally friendly way of improving soil and avoids the application of manufactured chemical fertilizer.

- *Stream clean-ups* – Local groups can provide assistance in planning and advertising local stream clean-up projects that involve neighborhoods, businesses, schools, or other groups. These are often an excellent way to promote watershed stewardship and encourage participation in other watershed improvement opportunities.

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

Training workshops can be held to educate watershed residents about downspout disconnection, micro-SCMs, and other practices that can be installed on individual properties.

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

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

***Stream watch volunteers* –** A stream watch program is intended to develop citizen stewardship through participation of volunteers who actively assume the responsibility of caring for segments of the stream network by observing changes in the system, providing stream clean-ups, and participating in planting activities. Trained volunteers can also help to identify potential restoration projects or report on potential illicit discharges.

5.4 Land Preservation

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

These preservation areas may be large, multi-parcel blocks or small, individual parcels. Land preservation complements other long-term, multifaceted efforts to protect natural resources, water supplies, and local economies. The limitations on the property may vary depending on the principle of the easement program, and as specifically limited by the easement.

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

Approximately 790 acres of land within the Upper Broad Run watershed is protected by conservation easements. Loudoun County's Conservation Easement Stewardship Program (http://www.loudoun.gov/index.aspx?NID=2816) works with owners of properties that contain conservation easements to ensure that the terms of the easements continue to be met. Figure 5-10 shows the locations of conservation easements that exist within the Upper Broad Run watershed.

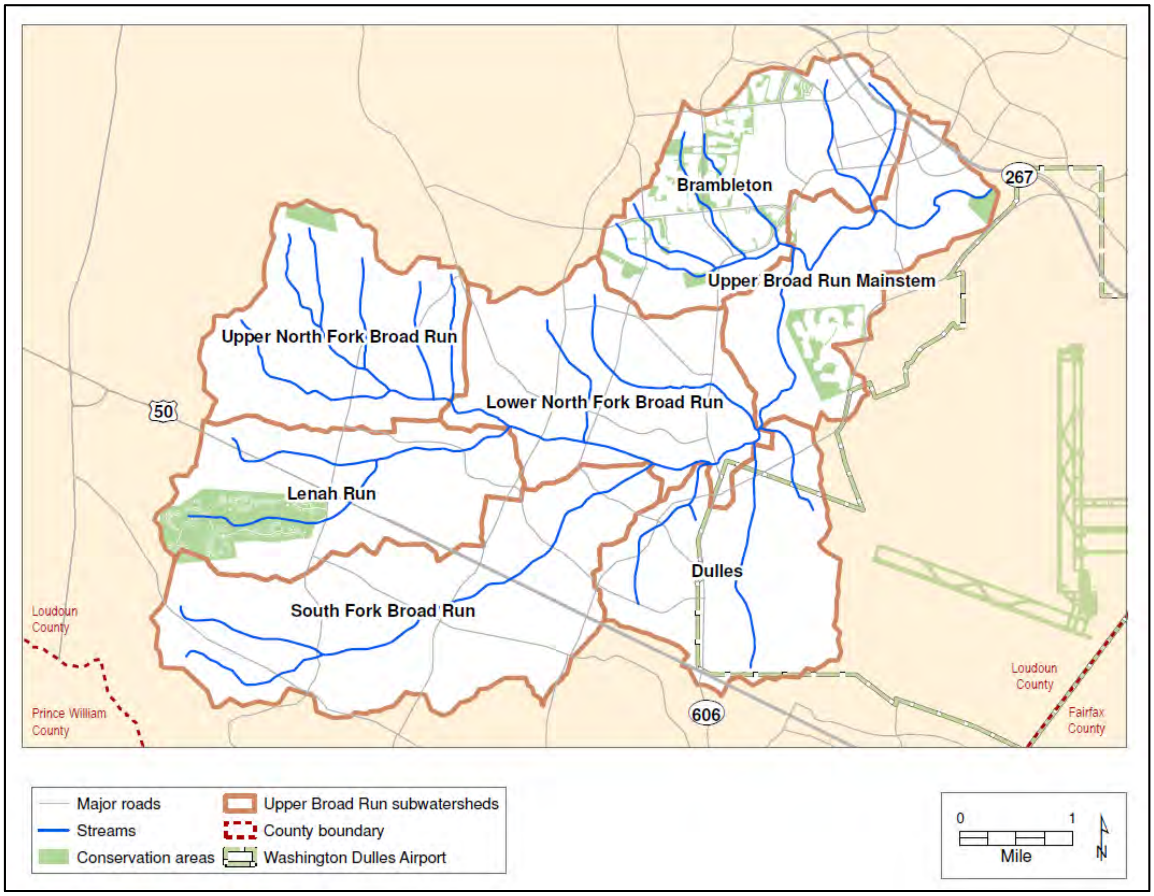


Figure 5-10: Upper Broad Run Watershed Conservation Easements

5.5 Public Lands/Open Space

Lands in the Upper Broad Run watershed area meet various public needs as described. There is one Loudoun County park within the watershed and a second planned County park. HOA-owned lands also provide open spaces within several communities.

Lyndora Park

Lyndora Park is a 17-acre park that includes a soccer field, softball field, tot lot, parking lot, and trails. It is located along the mainstem of Broad Run, adjacent to the Loudoun Valley Estates community (43624 Lucketts Bridge Circle).

Hal and Berni Hanson Regional Park (under development)

The Loudoun County Department of Parks, Recreation and Community Services, in conjunction with the county's Department of Construction and Waste Management, is working to develop a Regional Park on an approximately 257-acre parcel along Evergreen Mills Road, known as the Hal and Berni Hanson Regional Park. The Loudoun County Board of Supervisors approved the park's Master Plan in October 2012. Plans include recreational facilities including several playing fields, baseball diamonds, trails and parking.

Byrne's Ridge Park

Byrne's Ridge is a 26-acre park in Stone Ridge (24915 Mineral Springs Circle) containing three large soccer fields, one baseball field, two softball fields, and an asphalt trail.

Broad Run Stream Valley Park

Adjacent to Loudoun Valley Estates is one portion of the Broad Run Stream Valley Park, including approximately 130 acres along the mainstem of Broad Run. Future plans include extending this linear park westward, upstream along the Broad Run mainstem, providing a trail for walking, bicycling, or running.

CHAPTER 6: MODELING

This chapter presents results of the watershed pollutant loading analysis performed using a watershed management plan model to estimate current pollutant loads generated by the various non-point sources within the Upper Broad Run watershed. Also presented are pollutant removal calculations for proposed stormwater control measures (SCMs) and other watershed management practices that could be implemented to make progress toward TMDL or other pollutant reduction goals for the Upper Broad Run watershed. A custom spreadsheet model was developed for the watershed to estimate current pollutant loadings and reductions from current and proposed SCMs. The Virginia Assessment Scenario Tool (VAST) was used as the source of baseline loading rates for the County along with SCM pollutant reduction factors.

The watershed pollutant loading analysis of current nutrient, sediment, and bacteria loads generated by the various non-point sources within the Upper Broad Run watershed is discussed in Section 6.1. Section 6.2 reviews key restoration strategies that would result in reduced pollutant loads, both in terms of actions that can be implemented by Loudoun County and citizen-based approaches. Section 6.3 discusses the pollutant removal amounts that would result from implementing those key restoration strategies.

6.1 Existing Loads

6.1.1 Nutrients and Sediment

A pollutant loading analysis was performed to estimate total nitrogen, phosphorus, and sediment loads currently generated by all non-point sources (i.e., runoff from all land uses) present within the Upper Broad Run watershed. Estimates were based on Loudoun County's Land Use/Land Cover (LU/LC) GIS layer and pollutant loadings rates developed by the Chesapeake Bay Program (CBP) as implemented in the Virginia Assessment Scenario Tool (VAST) for all land uses.

Watershed-specific pollutant loading rates were derived for nitrogen, phosphorus, and sediment based on the Chesapeake Bay Program (CBP; USEPA 2013) – Watershed Model Phase 5.3.2, July 2011 model run, using specific rates from the Broad Run land-river segment number A51107PM7-4620-4580. This is the smallest unit including Upper Broad Run that can be used. The Virginia Assessment Scenario Tool (VAST) based on the CBP's model was used to develop loadings rates for all land uses except for wetlands, the rate for which was set the same as forest land cover. Pollutant loading rates for different land cover types in the Upper Broad Run (UBR) watershed that were used to estimate pollutant loadings from the watershed are summarized in the Table 6-1.

As discussed in Chapter 3, land use/land cover information for the Upper Broad Run watershed was derived from County GIS analysis. The VAST LU/LC categories present in Broad Run and the corresponding County land cover classes used for the pollutant loading analyses are summarized in Table 6-2.

Consolidated county land uses were used to determine the total acreage for each land cover category. These were multiplied by the corresponding loading rates presented in Table 6-1. Resulting annual pollutant loads for total nitrogen, total phosphorus, and sediment from the Upper Broad Run watershed are summarized by land use in Table 6-3 and Table 6-4, and for the entire watershed in Table 6-5.

Table 6-1: Annual Pollutant Loadings Rates for the Upper Broad Run Watershed (lbs/ac/year)

Land Use	Edge of Stream Loadings Rates			Delivered Loadings Rates		
	N	P	Sediment	N	P	Sediment
Urban Impervious	22.1	2.21	850	18.1	1.04	550
Urban Pervious	14.4	0.45	130	11.8	0.21	84
Cropland	20.5	1.97	282	16.8	0.93	183
Pasture, no Degraded Riparian Pasture	11.1	0.95	138	9.1	0.44	90
Degraded Riparian Pasture	116.0	12.32	1782	94.9	5.78	1154
Forest	6.6	0.15	39	5.4	0.07	25
Water	8.0	0.58	0	6.6	0.27	0

Table 6-2: Grouping of VAST Land Cover Types to Loudoun County Land Cover Model Groups for the Upper Broad Run Watershed

VAST Land Cover Type	Loudoun County Land Cover Type
Alfalfa	Ag - Cropland
Animal feeding operations	Ag - Cropland
Hay with nutrients	Ag - Cropland
Hay without nutrients	Ag - Cropland
Hightill with manure	Ag - Cropland
Hightill without manure	Ag - Cropland
Lowtill with manure	Ag - Cropland
Nursery	Ag - Cropland
Degraded riparian pasture	Ag – Pasture
Pasture	Ag - Pasture
Nonregulated impervious developed	Urban Impervious
Regulated impervious developed	Urban Impervious
Nonregulated pervious developed	Urban Pervious
Regulated pervious developed	Urban Pervious
Water	Water
Forest	Forest
Harvested forest	Forest
Regulated construction	Bare Ground

Table 6-3: Total Edge-of-Stream Loads by Land Use from the Upper Broad Run Watershed

Land Use	Area (ac)	Nitrogen		Phosphorus		Sediment		Runoff		Bacteria	
		Rate (lbs/ac/yr)	Load (lbs/yr)	Rate (lbs/ac/yr)	Load (lbs/yr)	Rate (lbs/ac/yr)	Load (lbs/yr)	Rate (in/yr)	Total Volume (ac-ft./yr)	Rate (billion colonies/ ac/yr)	Load (billion colonies/ yr)
Urban Impervious	1,353	22.1	29,965	2.21	2,991	850	1,149,936	35.41	3,993	30.00	40,605
Urban Pervious	3,485	14.4	50,091	0.45	1,577	130	453,734	3.12	905	30.00	104,548
Cropland	2,954	20.5	60,558	1.97	5,831	282	833,646	0.63	156	39.00	115,200
Pasture	2,049	13.5	27,692	1.21	2,479	176	360,971	0.63	108	39.00	79,910
Forest	6,646	6.6	44,148	0.15	999	39	259,195	0.28	154	12.00	79,752
Water	208	8.0	1,667	0.58	121	0	0	35.41	613	39.00	8,106
Bare Soil	26	59.0	1,557	10.31	272	4,364	115,158	31.86	70	30.00	792
Totals	16,721	12.90	215,678	0.85	14,269	190	3,172,641	4.31	5,999	25.65	428,912
Total Urban	4,838	16.55	80,056	0.94	4,568	331	1,603,670	12.15	4,898	30.00	145,153

Table 6-4: Total Annual Nutrient and Sediment Loads (Edge-of-Stream and Delivered) and Delivery Ratios for Urban, Agricultural, and Undeveloped Land Uses

Land Use	Total Nitrogen			Total Phosphorus			Total Sediment		
	EOS Load (lbs/yr)	Delivered Load (lbs/yr)	Delivery Ratio	EOS Load (lbs/yr)	Delivered Load (lbs/yr)	Delivery Ratio	EOS Load (lbs/yr)	Delivered Load (lbs/yr)	Delivery Ratio
Urban	80,056	65,465	0.82	4,568	2,143	0.47	1,603,670	1,039,007	0.65
Agricultural	88,250	72,166	0.82	8,310	3,898	0.47	1,194,617	773,984	0.65
Forest/Wetlands/Water	45,815	37,465	0.82	1,120	525	0.47	259,195	167,931	0.65
Totals	215,678	176,369	0.82	14,269	6,694	0.47	3,172,641	2,055,533	0.65

Table 6-5: Estimated Loads (sum of all land uses) from the Upper Broad Run Watershed

	Total Nitrogen	Total Phosphorus	Total Sediment
Edge of Stream Load (lbs/yr)	215,678	14,269	3,172,641
Edge of Stream Load (lbs/ac/yr)	12.90	0.85	190
Delivered Loads (lbs/yr)	176,369	6,694	2,055,533
Delivered Loads (lbs/ac/yr)	10.55	0.40	123

Note: Load from "Water" category is not included in edge of stream or delivered load totals, since loading to surface water is from atmospheric deposition, not stormwater.

For the Upper Broad Run watershed, loads delivered to the Chesapeake Bay from urban land uses for average annual flow totaled 65,465 lbs/year for total nitrogen, 2,143 lbs/year for total phosphorus, and 1,039,007 lbs/year for total sediment (Table 6-4). These loads represent 82 percent of urban nitrogen edge of stream (EOS) loads, 47 percent of urban phosphorus EOS loads, and 65 percent of urban sediment EOS loads (nutrient and sediment delivery to the Bay is lower than at the edge-of-stream loading due to nutrient cycling processes occurring downstream of the 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 TMDL goals for urban nonpoint source reduction. Table 6-6 summarizes acreages of land cover categories by subwatershed.

Table 6-6: Upper Broad Run Land Use (ac) by Subwatershed

Land Use	Brambleton	Upper Broad Run Mainstem	Dulles	Lenah Run	Lower North Fork Broad Run	South Fork Broad Run	Upper North Fork Broad Run	Total
Urban Impervious	482	295	117	72	153	231	5	1,353
Urban Pervious	1,007	576	240	405	496	732	29	3,485
Crop	321	119	223	461	667	576	588	2,954
Pasture/Orchards/Ag Build.	103	177	145	300	408	487	430	2,049
Forest	379	650	1,404	907	677	1,478	1,152	6,646
Water	29	30	17	34	50	43	6	208
Bare Ground	6	5	5	0	5	5	0	26
Totals	**2,327**	**1,850**	**2,149**	**2,179**	**2,455**	**3,552**	**2,210**	**16,721**

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

Tables 6-7 through 6-11 show the subwatersheds generating the greatest annual nitrogen, phosphorus, sediment, and bacteria loads and runoff volume per unit area are generally Brambleton, Upper Broad Run Mainstem, South Fork Broad Run, and Lower North Fork Broad Run. Subwatershed pollutant loadings and rates will be used to prioritize restoration efforts. The total planning level pollutant load estimates will be used to determine necessary reductions to meet the Chesapeake Bay TMDL reductions.

6.1.2 Runoff

Annual runoff is calculated using the Simple Method as a product of annual runoff volume and a runoff coefficient (D. Caraco 2013 Watershed Treatment Model (WTM) 2013 Documentation)

Runoff volume is calculated as:

$$R = P \bullet Pj \bullet Rv$$

Where:

R	=	Annual runoff (inches)
P	=	Annual rainfall (41.5 inches) (see section 3.1.1)
Pj	=	Fraction of annual rainfall events that produce runoff (usually 0.9)
Rv	=	Runoff coefficient

In the Simple Method, the runoff coefficient is a function of both impervious and pervious cover. The runoff coefficients in WTM are derived from the “Runoff Reduction Method” as described in Hirschman et al. (2008). A weighted site runoff coefficient (Rv) is calculated for forested, turf, and impervious land covers. If additional land uses are specified by the user (e.g., beyond the seven major land uses), the user will need to add in a Rv for these additional land uses. The weighted Rv is calculated as follows:

Land Cover Rv:

$$Rv = \Sigma (A \text{ land use i, soil type j})(Rv \text{ land use i, soil type j})/A$$

Where:

Rv = Runoff Coefficient
A = Drainage Area (ac)
Rv land use i, soil type j = The runoff coefficient for a particular land use and soil type (see Table 6-12)
A land use i, soil type j = Area of each land use and soil type intersection (ac)

Table 6-7: Upper Broad Run Annual Nitrogen Loads by Subwatershed

Subwatershed	Total Area (ac)	Annual Nitrogen Edge of Stream Loads by Land Cover (lbs/yr)							Edge of Stream	
		Impervious Urban	Pervious Urban	Cropland	Pasture	Forest	Water*	Bare Ground	Total lbs/yr	Total lbs/ ac/yr
Brambleton	2,327	10,668	14,470	6,576	1,388	2,519	237	345	35,966	15.46
Upper Broad Run Mainstem	1,850	6,521	8,273	2,432	2,393	4,318	238	278	24,216	13.09
Dulles	2,149	2,585	3,448	4,562	1,955	9,324	133	307	22,180	10.32
Lenah Run	2,179	1,600	5,825	9,445	4,053	6,023	270	12	26,959	12.37
Lower North Fork Broad Run	2,455	3,386	7,132	13,676	5,511	4,494	402	292	34,491	14.05
South Fork Broad Run	3,552	5,103	10,523	11,810	6,583	9,817	341	322	44,159	12.43
Upper North Fork Broad Run	2,210	102	421	12,056	5,809	7,653	47	0	26,041	11.78
Total	16,721	29,965	50,091	60,558	27,692	44,148	1,667	1,557	214,011	12.80

* Load from "Water" category is not included in edge of stream load totals.

Table 6-8: Upper Broad Run Annual Phosphorus Loads by Subwatershed

Subwatershed	Total Area (ac)	Annual Phosphorus Edge of Stream Loads by Land Cover (lbs/yr)							Edge of Stream	
		Impervious Urban	Pervious Urban	Cropland	Pasture	Forest	Water*	Bare Ground	Total lbs/yr	Total lbs/ ac/yr
Brambleton	2,327	1,065	456	633	124	57	17	60	2,395	1.03
Upper Broad Run Mainstem	1,850	651	260	234	214	98	17	49	1,506	0.81
Dulles	2,149	258	109	439	175	211	10	54	1,245	0.58
Lenah Run	2,179	160	183	909	363	136	20	2	1,754	0.80
Lower North Fork Broad Run	2,455	338	225	1,317	493	102	29	51	2,525	1.03
South Fork Broad Run	3,552	509	331	1,137	589	222	25	56	2,846	0.80
Upper North Fork Broad Run	2,210	10	13	1,161	520	173	3	0	1,877	0.85
Total	16,721	2,991	1,577	5,831	2,479	999	121	272	14,149	0.85

* Load from "Water" category is not included in edge of stream load totals.

Table 6-9: Upper Broad Run Annual Sediment Loads by Subwatershed

Subwatershed	Total Area (ac)	Annual Sediment Edge of Stream Loads by Land Cover (lbs/yr)							Edge of Stream	
		Impervious Urban	Pervious Urban	Cropland	Pasture	Forest	Water*	Bare Ground	Total lbs/yr	Total lbs/ ac/yr
Brambleton	2,327	409,398	131,070	90,528	18,087	14,791	0	25,523	689,396	296.3
Upper Broad Run Mainstem	1,850	250,254	74,941	33,484	31,198	25,350	0	20,560	435,786	235.5
Dulles	2,149	99,208	31,229	62,800	25,480	54,739	0	22,692	296,148	137.8
Lenah Run	2,179	61,386	52,765	130,023	52,833	35,362	0	924	333,293	153.0
Lower North Fork Broad Run	2,455	129,936	64,600	188,269	71,835	26,384	0	21,632	502,656	204.7
South Fork Broad Run	3,552	195,843	95,319	162,576	85,812	57,639	0	23,827	621,016	174.9
Upper North Fork Broad Run	2,210	3,912	3,810	165,967	75,726	44,930	0	0	294,345	133.2
Total	16,721	1,149,936	453,734	833,646	360,971	259,195	0	115,158	3,172,641	189.7

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

Table 6-10: Upper Broad Run Annual Runoff by Subwatershed

Subwatershed	Total Area (ac)	Annual Runoff by Land Cover (ac-ft.)							Annual Runoff	
		Impervious Urban	Pervious Urban	Cropland	Pasture	Forest	Water	Bare Ground	Total (ac-ft.)	Total, inches
Brambleton	2,327	1,422	261	17	5	9	87	16	1,817	9.37
Upper Broad Run Mainstem	1,850	869	149	6	9	15	87	13	1,149	7.45
Dulles	2,149	345	62	12	8	32	49	14	521	2.91
Lenah Run	2,179	213	105	24	16	21	99	1	479	2.64
Lower North Fork Broad Run	2,455	451	129	35	21	16	148	13	813	3.97
South Fork Broad Run	3,552	680	190	30	26	34	125	14	1,100	3.72
Upper North Fork Broad Run	2,210	14	8	31	23	27	17	0	119	0.64
Total	16,721	3,993	905	156	108	154	613	70	5,999	4.31

Table 6-11: Upper Broad Run Annual Bacteria Loads by Subwatershed

Subwatershed	Total Area (ac)	Annual Bacteria Load by Land Cover (billion colonies/yr)							Annual Bacteria Load	
		Impervious Urban	Pervious Urban	Cropland	Pasture	Forest	Water	Bare Ground	Total	Total Rate
Brambleton	2,327	14,456	30,201	12,510	4,004	4,551	1,150	175	67,047	28.82
Upper Broad Run Mainstem	1,850	8,837	17,268	4,627	6,906	7,800	1,155	141	46,734	25.26
Dulles	2,149	3,503	7,196	8,678	5,641	16,843	648	156	42,664	19.85
Lenah Run	2,179	2,168	12,158	17,968	11,696	10,880	1,313	6	56,189	25.79
Lower North Fork Broad Run	2,455	4,588	14,885	26,016	15,902	8,118	1,953	149	71,612	29.16
South Fork Broad Run	3,552	6,915	21,963	22,466	18,997	17,735	1,659	164	89,899	25.31
Upper North Fork Broad Run	2,210	138	878	22,935	16,764	13,825	228	0	54,767	24.79
Total	16,721	40,605	104,548	115,200	79,910	79,752	8,106	792	428,912	25.65

The runoff coefficients provided in Table 6-12 were derived from research by Pitt et al. (2005) (as cited in Caraco 2013), Lichter and Lindsey (1994), Schueler (2001a) (as cited in Caraco 2013), Schueler (2001b) (as cited in Caraco 2013), Legg et al. (1996) (as cited in Caraco 2013), Pitt et al. (1999) (as cited in Caraco 2013), Schueler (1987) and Cappiella et al. (2005).

Table 6-12: Site Cover Runoff Coefficients

Soil Condition	Hydrologic Soil Group			
	A	B	C	D
Forest Cover/Rural Land	0.02	0.03	0.04	0.05
Disturbed Soils/Managed Turf	0.15	0.20	0.22	0.25
Impervious Cover	0.95			

6.1.3 Bacteria

For fecal bacteria, the baseline loading rate from the 2013 version of the Watershed Treatment Model was used. These rates are 30 billion colonies/acre/year for developed land, 12 billion colonies/ acre for forest land and 39 billion colonies/acre for rural land. These rates will provide baseline loads from which reductions from various stormwater management practices will be estimated below.

6.2 Key Restoration Strategies

This section presents an overview of the key restoration strategies and associated pollutant load reductions proposed for restoring the Upper Broad Run watershed. Descriptions of the various stormwater control measures (SCMs) are given in Chapter 5, and summaries of the specific actions proposed for each subwatershed are given in Chapter 7. Although only key, quantifiable restoration strategies are the focus of this chapter, it is important to remember that a combination and variety of restoration practices, from capital stream restoration projects to public education and outreach, will likely be important and well-needed to engage citizens and meet watershed planning goals and objectives.

Ultimately, the Upper Broad Run watershed restoration will occur as a partnership involving Loudoun County government, other agencies (such as Loudoun County Public Schools and the Virginia Department of Transportation, VDOT), homeowner associations, volunteer groups, and other local organizations. The actions of each partner will be critical to the success of the overall watershed restoration strategy. Local governments are able to implement large capital projects such as stream restoration, large-scale stormwater controls, changes in municipal operations, and large-scale public awareness campaigns. Homeowner associations, residents, and other organizations are able to implement locally-based programs such as tree plantings and downspout disconnection. Therefore, key restoration strategies are divided into two broad categories: municipal strategies (Section 6.2.1) and citizen-based strategies (Section 6.2.2). It is important that restoration occurs at all levels to ensure that a wide range and variety of projects are implemented. This will encourage citizen awareness and participation, both critical to the success of restoration efforts.

6.2.1 Municipal Strategies

Key municipal strategies proposed for restoring the Upper Broad Run are discussed in the following sections. In many cases, these strategies will build upon Loudoun County's existing watershed management activities (e.g., stormwater management, development review, illicit discharge detection and elimination).

6.2.1.1 Stormwater Management

There has been a general shift toward adopting practices that mimic natural hydrologic processes, are low impact, and achieve pre-development conditions. Environmental Site Design (ESD) promotes the use of non-structural Stormwater Control Measures (SCMs) and/or other better site design techniques that mimic predevelopment hydrology. The intent of ESD is to distribute flow throughout a development site and reduce stormwater runoff leaving that site. This will also reduce pollutant loads and stream channel erosion.

A total of 94 existing SCM facilities are located within the Upper Broad Run watershed including dry and wet ponds, wetlands, infiltration/filtration practices, extended detention, and proprietary SCMs. Existing SCMs treat a total drainage area of approximately 2,052 acres of urban land or 42 percent of the total urban land use in the watershed.

6.2.1.2 Conversions of Existing Stormwater Control Measures

Modification of existing SCMs is often a good first option for improving stormwater management in developed areas. Detention ponds are typically designed to address water quantity only (channel protection and/or flood control) and therefore provide almost no pollutant removal. Because they have already been created for water management purposes, and because they have established maintenance agreements, these ponds are excellent candidates for conversion to a type of facility that provides pollution control benefits in addition to quantity control. Conversion is relatively simple and certainly cheaper than permitting and constructing a new SCM. For example, dry extended detention ponds are designed to capture and retain stormwater runoff from a storm to allow sediment and pollutants to settle out while simultaneously providing flood control. For Upper Broad Run, 35 existing SCM facilities in the watershed were identified for evaluation of their conversion potential.

6.2.1.3 New Stormwater Control Measures

Another option involves implementing new SCMs in existing developed areas, where SCMs do not currently exist, in order to reduce runoff and help improve water quality. These new SCMs, such as bioretention areas and swales, would capture and treat runoff. For example, based on in field investigations, we identified several opportunities where bioretention could be employed on school properties.

6.2.1.4 Impervious Cover Removal

Underutilized or unmaintained (broken, crumbling) impervious surfaces may in some cases have potential for removal. In Upper Broad Run, a few impervious surface areas at institutional locations were initially identified as potential sites for conversion to pervious cover; these opportunities were subsequently determined not to be feasible because of school safety and use considerations.

6.2.1.5 Stream Restoration

Stream restoration practices are used to enhance the appearance, stability, and ecological function of urban stream corridors. Stream restoration practices range from routine stream cleanups and simple stream repairs, such as vegetative bank stabilization and localized grade control, to comprehensive repairs, such as full channel redesign and realignment. Stream corridor assessments completed in the Upper Broad Run watershed identified several opportunities for stream restoration. These stream lengths were used to estimate pollutant load reductions that would result from restoration. Stabilizing stream channels improves water quality by preventing eroded soils, and the pollutants contained in them, from entering the stream and making their way to the Upper Broad Run, Potomac River, and Chesapeake Bay.

6.2.1.6 Street Sweeping

Some neighborhoods with significant trash and/or organic matter build-up along curbs were recommended for street sweeping during neighborhood source assessments (NSAs). Loudoun County could collaborate with VDOT to determine the amount of increased street sweeping that would be possible for the recommended neighborhoods. Adding a targeted neighborhood to the sweeping route or increasing the frequency of sweeping would reduce the build-up of excessive curb and gutter material. Pollutant reductions expected from street sweeping are not included in the model, because sweeping would not likely be frequent enough to meet EPA criteria for pollutant reduction credits.

6.2.1.7 Illicit Connection Detection/Disconnection

Pollutant reductions associated with the County’s Illicit Discharge Detection and Elimination program are not included in pollutant removal calculations because the contribution of illicit connections to overall pollutant loading rates is uncertain. However, this program will provide a margin of safety in the overall nutrient reduction strategy.

6.2.2 Citizen-Based Strategies

The participation of citizens in watershed restoration is an essential part of the watershed restoration process. When large numbers of individuals become involved in citizen-based water quality improvement initiatives, improvements to the waterways within the watershed can be achieved that would not otherwise be possible. Citizen participation is critical to the implementation and long-term maintenance of restoration activities. Key citizen-based strategies proposed for restoring Upper Broad Run are discussed in the following sections.

6.2.2.1 Reforestation

Trees help improve water quality by capturing and removing pollutants in runoff including removal of excess nutrients. Tree leaves and stems also intercept precipitation which helps to reduce the energy of raindrops and prevent erosion resulting from their impact on the ground. Trees provide additional air quality, wildlife, aesthetic, and economic benefits, including shading effects that can reduce summer cooling costs. Several areas throughout the watershed are targeted for reforestation opportunities, as described in Chapter 7. Large open areas identified in the pervious area assessments (PAAs) should be further investigated for tree planting potential. Publicly-owned lands requiring minimal site preparation are targeted for initial reforestation efforts. Reforestation efforts can be led either by Loudoun County or by other groups.

6.2.2.2 Riparian Buffer

Riparian buffers are critical to maintaining healthy streams and rivers. Forested buffer areas along streams can improve water quality and prevent flooding, since they filter pollutants, reduce surface runoff, stabilize stream banks, trap sediment, and provide habitat for various types of wildlife. Buffer encroachment as a result of development was noted during upland and stream surveys conducted throughout the watershed. Areas on privately-owned land (e.g., residential properties) can be targeted for buffer awareness initiatives to encourage landowners to plant trees and/or create a no-mow area adjacent to streams. Open pervious areas identified within the 100 foot stream buffer areas via GIS analysis (see Chapter 3) are good candidates for tree planting as initial buffer reforestation efforts. Constraints such as the presence of sewer lines will need to be considered in planning plantings along streams.

6.2.2.3 Street and Open Space Tree Plantings

Several opportunities for neighborhood open space tree plantings were identified during NSAs. Opportunities for open space tree plantings were also found at several institutional sites. Canvassing residents and/or contacting homeowner associations can be effective techniques for implementing a tree planting program within a neighborhood. Tree planting incentive programs can also help increase the success of planting efforts.

6.2.2.4 Downspout Disconnection

Downspout disconnection can reduce runoff and pollutants introduced to local streams. This can be achieved through downspout redirection (from impervious to pervious areas), rain barrels, and/or rain gardens. A combination of outreach/awareness techniques and financial incentives can be used to implement a downspout disconnection program in neighborhoods identified as potential candidates during NSAs.

6.2.2.5 Urban Nutrient Management

Yards and lawns typically represent a significant portion of the land cover in an urban subwatershed and, therefore, can be a major source of nutrients, pesticides, sediment, and runoff. Fertilization, pesticide use, watering, landscaping, and trash/yard waste disposal can all affect water quality. Urban nutrient management efforts focused on appropriate lawn maintenance and promoting sustainable landscaping can reduce nutrient inputs to nearby streams. Raising awareness among citizens about how to modify lawn and garden maintenance to reduce negative affect impacts to water quality is an important citizen-based strategy. A number of neighborhoods that would be particularly good candidates for such outreach were identified during field investigations.

6.3 Estimated Load Reductions

6.3.1 Pollutant Reduction Targets

Stormwater runoff is a primary contributor to nutrient and sediment inputs to the Upper Broad Run watershed. A substantial amount of the nitrogen, phosphorus, and sediment reductions required to meet the Chesapeake Bay TMDL goals for the Upper Broad Run watershed will come from control of stormwater runoff. The Chesapeake Bay TMDL analysis determined that a 16.9% reduction in nitrogen, a 26.4 percent reduction in phosphorus, and a 24.7 percent reduction in sediment loads from urban stormwater discharges are necessary to meet 2025 Bay water quality standards for Loudoun County, from the 2010 baseline year. The load reductions needed within the urban portion of Upper Broad Run watershed to achieve these reductions are summarized in Table 6-13.

Table 6-13: Upper Broad Run Watershed Nitrogen, Phosphorus, and Sediment Load Reductions

Source	Area (ac)	TN Load (lbs/yr)	TP Load (lbs/yr)	Sediment Load (lbs/yr)
Urban	4,838	80,056	4,568	1,603,670
Reduction Goal:		13,548	1,206	396,267

6.3.2 Pollutant Removal Analysis

The following sections present a quantitative analysis of pollutant load and runoff volume removal capabilities of the existing and proposed practices to ensure that the required reduction in nutrient loads from urban runoff in the Upper Broad Run watershed is achieved. Note that many of the removal efficiencies used to estimate pollutant and runoff reductions are based on peer-reviewed and CBP-approved nonpoint source BMP tables developed for the Phase 5.3 CBP Watershed Model, the WTM, and the International Stormwater BMP database. Also note that the calculations and estimates presented in the following subsections represent maximum potential pollutant and runoff reductions that could be expected with implementation of each practice. A summary of overall pollutant load and runoff volume reduction estimates is presented at the end of this section for two scenarios: a maximum implementation scenario and one based on projected participation (i.e., estimated rate of implementation) for each practice.

Implemented Projects

Existing projects in the county's various watersheds may include stream restoration, present-day SCMs, and previous conversions of SCMs. There is one existing stream restoration project (totaling 500 linear feet of stream at Moorefield Station) in the Upper Broad Run watershed. Pollutant loads were estimated based on the contributing drainage area (DA) and the corresponding project type's land use-specific pollutant loading rates. Load reduction is calculated as the product of the pollutant load and removal efficiency. For stream restoration projects, nutrient reduction credits are based on the length of stream restored. A summary of existing load reductions is shown in Table 6-14.

Table 6-14: Load Reductions Estimated for Stream Restoration Projects in Upper Broad Run Watershed

Project	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	Sediment Reduction (lbs/yr)
Stream Restorations			
Moorefield Station	100	34	27,125

Existing Stormwater Control Measures

As described in Chapter 3, there are 94 existing SCM facilities in the Upper Broad Run watershed including dry ponds, infiltration/filtration practices, extended detention, proprietary SCMs, and other types of SCMs. The pollutant load and runoff volume removal capability of the existing SCMs in the watershed may not be accounted for in the baseline loading analysis; therefore, it is included in the pollutant removal analysis.

Pollutant and runoff reductions for existing SCM facilities are calculated based on the approximate pollutant load and runoff volume received from the drainage area (DA) and removal efficiencies (RE) recommended by CBP, WTM, and the International Stormwater BMP database for the various types of SCM facilities. The equation used to estimate total nitrogen (TN) load reductions for a particular type of SCM facility is expressed as:

$$[16.6 \text{ (lbs/ac/yr)}*\text{DA (ac)}]*\text{RE (\%)}$$

The equation used to estimate total phosphorus (TP) load reductions for a particular type of SCM facility is expressed as:

$$[0.94 \text{ (lbs/ac/yr)}*\text{DA (ac)}]*\text{ RE (\%)}$$

The equation used to estimate sediment load reductions for a particular type of SCM facility is expressed as:

$$[331 \text{ (lbs/ac/yr)}*\text{DA (ac)}]*\text{ RE (\%)}$$

The equation used to estimate runoff volume reductions for a particular type of SCM facility is expressed as:

[1.01 (ac-ft/yr)*DA (ac)]*RE (%)

The equation used to estimate bacteria load reductions for a particular type of SCM facility is expressed as:

[30 (billion colonies/ac/yr)*DA (ac)]* RE (%)

The pollutant load and runoff volume received from the drainage area contributing to the SCM facility is denoted by the first expression in brackets in the above equations. The pollutant loading rates and runoff volume shown (16.6 lbs TN/ac/yr, 0.94 lbs TP/ac/yr, 331 lbs sediment/ ac/yr, 1.01 ac-ft/yr of runoff, and 30 billion colonies bacteria/ac/yr) represent the weighted average of impervious and pervious urban rates used in the pollutant loading analysis since this represents the likely sources of runoff being treated. Note that impervious and pervious urban loading rates for TN, TP and sediment are based on CBP's Watershed Model Phase 5.3, as implemented in the Virginia Assessment Scenario Tool (VAST) run from March 2014 for the 2010 Progress scenario, for the Broad Run watershed. Impervious and pervious urban loading volume for runoff and rate for bacteria are based on the Watershed Treatment Model. The percent pollutant removal efficiency depends on the type of facility and is based on the values shown in Table 4-21 for TN, TP and sediment, on values presented in the Watershed Treatment Model for runoff, and on values presented in the International Stormwater BMP database for bacteria. The total pollutant load and runoff volume reduction expected from existing SCMs is a sum of the removal capacities of the individual facilities. A summary of existing SCM load reduction calculations and results is shown in Table 6-15.

Stormwater Management Conversions

Preliminary investigations found that 30 dry ponds (including extended detention) could potentially be converted to facilities with higher capacity for nutrient removal, but only facilities with a High or Medium potential for conversion (13 ponds) were included in pollutant and runoff reduction modeling. Pollutant and runoff reductions for SCM conversions are calculated based on the approximate pollutant load and runoff volume received from the drainage area (DA) and the increase in removal efficiency (RE) based on BMP efficiencies by CBP, WTM, and the International Stormwater BMP database for detention and extended detention facilities (Simpson and Weammert 2009). The equation used to estimate total nitrogen (TN) load reductions for SCM conversion is expressed as:

[16.6 (lbs/ac/yr)*DA (ac)]*RE (%)

The equation used to estimate total phosphorus (TP) load reductions for SCM conversion is expressed as:

[0.94 (lbs/ac/yr)*DA (ac)]* RE (%)

Table 6-15: Existing SCM Load Reductions

SWM Facility Type	Soil Type	#	DA (ac)	Total Nitrogen: Load from DA (lbs/yr)	Total Nitrogen: RE	Total Nitrogen: Max Potential Load Reduction (lbs/yr)	Total Phosphorus: Load from DA (lbs/yr)	Total Phosphorus: RE	Total Phosphorus: Max Potential Load Reduction (lbs/yr)	Sediment: Load from DA (lbs/yr)	Sediment: RE	Sediment: Max Potential Load Reduction (lbs/yr)
Bioretention	A&B	7	0.1	2	70%	2	0	75%	0.1	45	80%	36
	C&D		20.7	343	25%	86	20	45%	8.8	6,862	55%	3,774
Dry Pond		9	128.9	2,133	5%	107	122	10%	12.2	42,732	10%	4,273
Extended Dry Pond		38	844.5	13,973	20%	2,795	797	20%	159.5	279,899	60%	167,939
Oil/Grit Separator	C&D	1	1.2	20	5%	1	1	10%	0.1	401	10%	40
Sand Filter	C&D	10	2.7	45	40%	18	3	60%	1.5	897	80%	718
Swale	A&B	6	4.5	75	45%	34	4	45%	1.9	1,507	70%	1,055
	C&D		6.2	103	10%	10	6	10%	0.6	2,063	50%	1,032
Underground Structure	C&D	1	0.7	12	5%	1	1	10%	0.1	245	10%	25
Wet Pond		22	997.3	16,501	20%	3,300	942	45%	423.7	330,547	60%	198,328
Total		94	2,007.0	33,207		6,352	1,895		608.5	665,198		377,219

SWM Facility Type	Soil Type	#	DA (ac)	Runoff: Load from DA (acre-ft/yr)	Runoff: RE	Runoff: Max Potential Load Reduction (lbs/yr)	Bacteria: Load from DA (billion/yr)	Bacteria: RE	Bacteria: Max Potential Load Reduction (lbs/yr)
Bioretention	A&B	7	0.1	0	80%	0	4	66%	3
	C&D		20.7	21	40%	8	621	66%	408
Dry Pond		9	128.9	131	0%	0	3,868	48%	1,857
Extended Dry Pond		38	844.5	855	0%	0	25,334	48%	12,161
Oil/Grit Separator	C&D	1	1.2	1	0%	0	36	0%	0
Sand Filter	C&D	10	2.7	3	0%	0	81	60%	49
Swale	A&B	6	4.5	5	60%	3	136	-5%	-7
	C&D		6.2	6	40%	3	187	-5%	-10
Underground Structure		1	0.7	1	40%	0	22	0%	0
Wet Pond		22	997.3	1,010	0%	0	29,919	79%	23,636
Total				2,032		14	60,209		38,095

* Wet Ponds are a combination of WP and EDSW BMP types. There was one Level Spreader BMP type (0.4 drainage acres) not included in this analysis.

The equation used to estimate sediment load reductions for SCM conversion is expressed as:

[331 (lbs/ac/yr)*DA (ac)]* RE (%)

The equation used to estimate runoff volume reductions for a particular type of SCM facility is expressed as:

[1.01 (ac-ft/yr)*DA (ac)]*RE (%)

The equation used to estimate bacteria load reductions for a particular type of SCM facility is expressed as:

[30 (billion colonies/ac/yr)*DA (ac)]* RE (%)

The pollutant load and runoff volume received from the drainage area contribution to the SCM facility is denoted by the first expression in brackets in the equations above. Similar to existing SCMs, the pollutant loading and runoff volume shown (16.6 lbs TN/ac/yr, 0.94 lbs TP/ac/yr, 331 lbs sediment/ac/yr, 1.01 ac-ft/yr runoff, and 30 billion colonies bacteria/ac/yr) represent the weighted average of impervious and pervious urban rates used in the pollutant loading analysis since this represents the likely sources of runoff being treated. The increased pollutant removal capacity is represented by the third expression in the equations above. This is the difference between percent pollutant removal efficiencies of the facilities, based on CBP guidance shown in Table 4-21 for TN, TP and sediment, on values presented in the Watershed Treatment Model for runoff, and on values presented in the International Stormwater BMP database for bacteria. A summary of SCM conversion load reduction calculations and results are shown in Tables 6-16 and 6-17.

Table 6-16: SCM Conversion Load Reductions

Pollutant	DA for SWM Conversion (ac)	Original RE	New RE	Increase in Efficiency	Max Potential Load Reduction
Convert Dry Ponds to Wet Pond					
TN	106.05	5%	20%	15%	263
TP	106.05	10%	45%	35%	35
Sediment	106.05	10%	60%	50%	17,575
Runoff	106.05	0%	0%	0%	0
Bacteria	106.05	48%	70%	22%	700
Convert Dry Ponds to Urban Infiltration w/sand					
TN	19.31	20%	85%	65%	208
TP	19.31	20%	85%	65%	12
Sediment	19.31	60%	95%	35%	2,240
Runoff	19.31	0%	70%	70%	14
Bacteria	19.31	48%	50%	2%	12
Converted Extended Dry Ponds to Wet Pond					
TN	172.17	20%	20%	0%	0
TP	172.17	20%	45%	25%	41
Sediment	172.17	60%	60%	0%	0
Runoff	172.17	0%	0%	0%	0
Bacteria	172.17	48%	70%	22%	1,136

Table 6-17: SCM Conversion Load Reductions for Individual Ponds

Pond #	Total DA for SCM Conversion (ac)	Potential for Conversion	Convert From	Convert To	Total Nitrogen: Original RE	Total Nitrogen: New RE	Total Nitrogen: Increase in Efficiency	Total Nitrogen: Max Potential Load Reduction (lbs/yr)	Total Phosphorus: Original RE	Total Phosphorus: New RE	Total Phosphorus: Increase in Efficiency	Total Phosphorus: Max Potential Load Reduction (lbs/yr)	Total Sediment: Original RE	Total Sediment: New RE	Total Sediment: Increase in Efficiency	Total Sediment: Max Potential Load Reduction (lbs/yr)
AJ2205	44.86	High	Dry Pond	Wet Pond	5%	20%	15%	111	10%	45%	35%	15	10%	60%	50%	7,434
AJ2430	15.57	High	Dry Pond	Wet Pond	5%	20%	15%	39	10%	45%	35%	5	10%	60%	50%	2,580
JC5171	56.67	High	Extended Dry Pond	Wet Pond	20%	20%	0%	0	20%	45%	25%	13	60%	60%	0%	0
WB50081	36.6	High	Dry Pond	Wet Pond	5%	20%	15%	91	10%	45%	35%	12	10%	60%	50%	6,065
CW1	5.08	Medium	Dry Pond	Wet Pond	5%	20%	15%	13	10%	45%	35%	2	10%	60%	50%	842
GC554	77.33	Medium	Extended Dry Pond	Wet Pond	20%	20%	0%	0	20%	45%	25%	18	60%	60%	0%	0
JC3325	5.12	Medium	Extended Dry Pond	Wet Pond	20%	20%	0%	0	20%	45%	25%	1	60%	60%	0%	0
JC3718	2.22	Medium	Extended Dry Pond	Wet Pond	20%	20%	0%	0	20%	45%	25%	1	60%	60%	0%	0
JC4375	8.13	Medium	Extended Dry Pond	Wet Pond	20%	20%	0%	0	20%	45%	25%	2	60%	60%	0%	0
JC50044	10.69	Medium	Extended Dry Pond	Urban Infiltration w/sand	20%	85%	65%	115	20%	85%	65%	7	60%	95%	35%	1,240
JC6134	22.7	Medium	Extended Dry Pond	Wet Pond	20%	20%	0%	0	20%	45%	25%	5	60%	60%	0%	0
KD50006	8.62	Medium	Extended Dry Pond	Urban Infiltration w/sand	20%	85%	65%	93	20%	85%	65%	5	60%	95%	35%	1,000
WB50068	3.94	Medium	Dry Pond	Wet Pond	5%	20%	15%	10	10%	45%	35%	1	10%	60%	50%	653
AJ2499	48.7	Low	Extended Dry Pond	Wet Pond	20%	20%	0%	0	20%	45%	25%	11	60%	60%	0%	0
AJ2897	48.12	Low	Extended Dry Pond	Wet Pond	20%	20%	0%	0	20%	45%	25%	11	60%	60%	0%	0
AJ4280	4.97	Low	Extended Dry Pond	Wet Pond	20%	20%	0%	0	20%	45%	25%	1	60%	60%	0%	0
BC46	4.53	Low	Extended Dry Pond	Wet Pond	20%	20%	0%	0	20%	45%	25%	1	60%	60%	0%	0
BC47	3.47	Low	Extended Dry Pond	Wet Pond	20%	20%	0%	0	20%	45%	25%	1	60%	60%	0%	0
GC940	2.74	Low	Extended Dry Pond	Wet Pond	20%	20%	0%	0	20%	45%	25%	1	60%	60%	0%	0
JC2411	28.57	Low	Extended Dry Pond	Wet Pond	20%	20%	0%	0	20%	45%	25%	7	60%	60%	0%	0
JC3128	28.98	Low	Extended Dry Pond	Wet Pond	20%	20%	0%	0	20%	45%	25%	7	60%	60%	0%	0
JC3727	20.46	Low	Extended Dry Pond	Wet Pond	20%	20%	0%	0	20%	45%	25%	5	60%	60%	0%	0
JC4380	13.07	Low	Extended Dry Pond	Wet Pond	20%	20%	0%	0	20%	45%	25%	3	60%	60%	0%	0
JC4577	14.91	Low	Extended Dry Pond	Wet Pond	20%	20%	0%	0	20%	45%	25%	4	60%	60%	0%	0
JC4796	15.24	Low	Extended Dry Pond	Wet Pond	20%	20%	0%	0	20%	45%	25%	4	60%	60%	0%	0
JC4978	28.9	Low	Extended Dry Pond	Wet Pond	20%	20%	0%	0	20%	45%	25%	7	60%	60%	0%	0
JC5181	19.47	Low	Extended Dry Pond	Wet Pond	20%	20%	0%	0	20%	45%	25%	5	60%	60%	0%	0
JC6132	69.78	Low	Extended Dry Pond	Wet Pond	20%	20%	0%	0	20%	45%	25%	16	60%	60%	0%	0
KD50012	9.6	Low	Extended Dry Pond	Urban Infiltration w/sand	20%	85%	65%	103	20%	85%	65%	6	60%	95%	35%	1,114
KD50014	51.59	Low	Extended Dry Pond	Wet Pond	20%	20%	0%	0	20%	45%	25%	12	60%	60%	0%	0

New Stormwater Control Measures

Proposed stormwater retrofits for the purposes of this watershed management plan refer to implementing SCMs to capture and treat runoff from urban pervious and impervious surfaces (e.g., parking lots) which are currently untreated. This includes sites identified for retrofit potential during uplands surveys for neighborhoods, institutions, hotspots, and pervious areas. Pollutant and runoff reductions for stormwater retrofits are calculated based on the approximate pollutant loads received from the impervious drainage area (DA) and removal efficiency (RE) of bioretention SCMs. The equation used to estimate total nitrogen (TN) load reductions for stormwater retrofits is expressed as:

$$[16.6\ (\text{lbs/ac/yr})*\text{DA}\ (\text{ac})]*\text{RE}\ (\%)$$

The equation used to estimate total phosphorus (TP) load reductions for stormwater retrofits is expressed as:

$$[0.94\ (\text{lbs/ac/yr})*\text{DA}\ (\text{ac})]*\text{RE}\ (\%)$$

The equation used to estimate sediment load reductions for stormwater retrofits is expressed as:

$$[331\ (\text{lbs/ac/yr})*\text{DA}(\text{ac})]*\text{RE}(\%)$$

The equation used to estimate runoff volume reductions for stormwater retrofits is expressed as:

$$[1.01\ (\text{ac-ft/yr})*\text{DA}(\text{ac})]*\text{RE}(\%)$$

The equation used to estimate bacteria load reductions for a particular type of SCM facility is expressed as:

$$[30\ (\text{billion colonies/ac/yr})*\text{DA}\ (\text{ac})]*\ \text{RE}\ (\%)$$

The pollutant load and runoff volume received from the drainage area contributing to the SCM is denoted by the first expression in brackets in the equation above. The pollutant loading and runoff volume shown (16.6 lbs TN/ac/yr, 0.94 lbs TP/ac/yr, 331 lbs sediment/ac/yr, 1.01 ac-ft runoff, and 30 billion colonies bacteria/ac/yr) represent the weighted average of impervious and pervious urban rates used in the pollutant loading analysis since this represents the likely sources of runoff being treated. Pollutant removal efficiencies are those reported for bioretention, based on CBP guidance shown in Table 4-21 for TN, TP and sediment, on values presented in the Watershed Treatment Model for runoff, and on values presented in the International Stormwater BMP database for bacteria. A summary of stormwater retrofit load reduction calculations and results are shown in Table 6-18.

Table 6-18: Stormwater Retrofit Load Reduction

Pollutant	Impervious Urban Loading Rate*	Impervious Area for SW Retrofit (ac)	Load for DA (lbs/yr)	Removal Efficiency (RE)	Max Potential Load Reduction*
Bioretention/Rain Gardens					
TN	16.55	70.4	1,165	25%	291
TP	0.94	70.4	66	45%	30
Sediment	331	70.4	23,330	55%	12,832
Runoff	1.01	70.4	71	60%	43
Bacteria	30	70.4	2,112	50%	1,056

* Loading Rate has units of lbs/ac/yr for TN, TP and Sediment, acre-feet/yr for runoff and billion colonies/acre/yr for bacteria. Max Potential Load Reduction has units of lbs/yr for TN, TP, and Sediment, acre-feet for runoff and billion colonies/yr for bacteria.

Impervious Cover Removal

Potential sites for impervious cover removal were initially identified at several institutions. Pollutant and runoff reductions for impervious cover removal are calculated based on a land conversion from impervious to pervious urban. The equation used to estimate total nitrogen (TN) load reductions for stormwater retrofit is expressed as:

[22.1 (lbs/ac/yr) – 14.4 (lbs/ac/yr)]*Impervious Area (ac)

The equation used to estimate total phosphorus (TP) load reductions for stormwater retrofits is expressed as:

[2.21 (lbs/ac/yr) - 0.45 (lbs/ac/yr)]*Impervious Area (ac)

The equation used to estimate sediment load reductions for stormwater retrofits is expressed as:

[850 (lbs/ac/yr) - 130 (lbs/ac/yr)]*Impervious Area (ac)

The equation used to estimate runoff volume reductions for stormwater retrofits is expressed as:

[2.95 (ac-ft/yr) – 0.26 (ac-ft/yr)]*Impervious Area (ac)

The equation used to estimate bacteria load reductions for a particular type of SCM facility is expressed as:

[30 (billion colonies/ac/yr) – 30 (billion colonies/ac/yr]*Impervious Area (ac)

Impervious cover removal involves converting impervious surfaces to pervious surfaces. Therefore, the loading rate would be reduced by a factor equal to the difference between impervious and pervious urban loading rates as shown in the first expression in brackets in the equations above. The approximate reduction in pollutant load and runoff volume is then the reduced loading rate or volume multiplied by the area proposed for impervious cover removal. A summary of impervious cover removal reduction calculations and results are shown in the Table

6-19; no areas were recommended at this time, but this framework is included in case similar opportunities are identified later.

Table 6-19: Impervious Cover Removal Load Reductions

Pollutant	Impervious Urban Loading Rate*	Pervious Urban Loading Rate (lbs/ac/yr)	Reduction in Loading Rate (lbs/ac/yr)	Impervious Area (ac)	Max Potential Load Reduction*
TN	22.1	14.4	7.8	0	0
TP	2.21	0.45	1.76	0	0
Sediment	850	130	719	0	0
Runoff	2.95	0.26	2.69	0	0
Bacteria	30	30	0	0	0

* Loading Rate has units of lbs/ac/yr for TN, TP and Sediment, acre-feet/yr for runoff and billion colonies/acre/yr for bacteria. Max Potential Load Reduction has units of lbs/yr for TN, TP, and Sediment, acre-feet for runoff and billion colonies/yr for bacteria.

Stream Buffer Reforestation

The current vegetative condition of the stream riparian buffer (up to 100 feet on either side of the stream system) was analyzed in Chapter 3. Buffer conditions were classified as impervious, open pervious, or forested areas. Open pervious areas are candidate areas to initially target for restoration. Approximately 419 acres of open pervious area were identified within the stream buffer zone.

Pollutant and runoff reductions for stream buffer reforestation are calculated based on a land use conversion from pervious urban to forest plus an additional reduction efficiency per BMP performance guidance from CBP. The equation used to estimate total nitrogen (TN) load reductions for the land use conversion portion of stream buffer reforestation is expressed as:

Land Use Conversion (TN) = [14.4 (lbs/ac/yr) – 6.6 (lbs/ac/yr)]* Open Pervious Area (ac)

The equation used to estimate total phosphorus (TP) load reductions for the land use conversion portion of stream buffer reforestation is expressed as:

Land Use Conversion (TP) = [0.45 (lbs/ac/yr) – 0.15 (lbs/ac/yr)]*
Open Pervious Area (ac)

The equation used to estimate sediment load reductions for the land use conversion portion of stream buffer reforestation is expressed as:

Land Use Conversion (sediment) = [130 (lbs/ac/yr) – 39 (lbs/ac/yr)]*
Open Pervious Area (ac)

The equation used to estimate runoff volume reductions for the land use conversion portion of stream buffer reforestation is expressed as:

Land Use Conversion (runoff) = [0.26 (ac-ft/yr) – 0.02 (ac-ft/yr)]*
Open Pervious Area (ac)

The equation used to estimate bacteria load reductions for the land use conversion portion of stream buffer reforestation is expressed as:

Land Use Conversion (bacteria) = [30 (billion colonies/ac/yr) – 12 (billion colonies/ac/yr)]*
Open Pervious Area (ac)

The first expression in brackets in the equation above represents the difference between pervious urban and forest loading rates and runoff volume used in the watershed pollutant loading analysis. This reduction in loading rate and runoff volume is then multiplied by the available open pervious area for reforestation to determine the loads from land use conversion.

An additional pollutant removal factor is added to the land use conversion to determine the total removal capacity of buffer reforestation for nutrients and sediment. Per the CBP BMP performance guidance, <u>one acre of buffer treats approximately one acre of upland area for nitrogen</u> with an efficiency of 25 percent for urban and mixed open buffers. The total nitrogen (TN) load reduction for the removal efficiency portion of buffer reforestation can be expressed as:

Buffer BMP Removal (TN) = [Open Pervious Area (ac)]*12.9(lbs/ac/yr]*25%

Similarly, <u>one acre of buffer treats approximately one acre of upland area for phosphorus</u> with an efficiency of 50 percent for urban and mixed open buffers. The total phosphorus (TP) load reductions for the removal efficiency portion of buffer reforestation can be expressed as:

Buffer BMP Removal (TP) = [Open Pervious Area (ac)*0.85 (lbs/ac/yr]*50%

Similarly, <u>one acre of buffer treats approximately one acre of upland area for sediment</u> with an efficiency of 50 percent for urban and mixed open buffers. The sediment load reductions for the removal efficiency portion of buffer reforestation can be expressed as:

Buffer BMP Removal (sediment) = [Open Pervious Area (ac)*190 (lbs/ac/yr]*50%

The loading rates shown in the equation above, 12.9 lbs TN/ac/yr, 0.85 TP/ac/yr, and 190 lbs sediment/ac/yr, represent overall watershed loading rates. This is estimated as the total watershed nutrient load (215,678 lbs TN/yr, 14,269 lbs TP/yr, and 3,172,641 lbs sediment/yr) divided by the total area (16,721 ac), which is the area used to calculate the pollutant load from the upland area that would be treated by buffer reforestation. As mentioned, the land use conversion and additional removal efficiency are added to yield a total pollutant load reduction. A summary of stream buffer reforestation reduction calculations and results are shown in Table 6-20.

Table 6-20: Stream Buffer Reforestation Load Reductions

		Land Use Conversion		Buffer BMP Removal			
Pollutant	Open Pervious Area (ac)	Reduced Loading Rate*	Land Use Conversion Reduction*	Reduction Efficiency	Overall Watershed Loading Rate*	Efficiency Load Reduction*	Max Potential Load Reduction*
TN	419	7.73	3,238	25%	12.90	5,403	4,589
TP	419	0.30	127	50%	0.85	357	305
Sediment	419	91	38,201	50%	189.73	79,476	77,939
Runoff	419	0.24	99	0%	0.36	150	99
Bacteria	419	18	7,542	0%	25.65	10,748	7,542

* Loading Rate has units of lbs/ac/yr for TN, TP and Sediment, acre-feet/yr for runoff and billion colonies/acre/yr for bacteria. Max Potential Load Reduction has units of lbs/yr for TN, TP, and Sediment, acre-feet for runoff and billion colonies/yr for bacteria.

Urban Nutrient Management

The nutrient management status of Upper Broad Run lawns was investigated during NSA surveys and was determined through the analysis of the fertilizer reduction data that is summarized in Section 4.2.1.3.2. The Chesapeake Bay Program Urban Nutrient Management (UNM) Expert Panel Report (Schueler and Lane 2013) recommendations include nutrient reduction credits for the acreage of pervious land covered by qualifying nutrients management practices, based on the site risk for N and P export. For low risk lawns, the UNM load reductions for TN and TP are 3% and 6% respectively. The load reductions increase when UNM practices are applied to high risk lawns (20% TN, 10% TP); for lawns of medium risk, load reduction factors of 9% TN and 5% TP are applied. The Panel developed methods for reporting, tracking and verifying the credits to ensure the UNM practices achieve their intended pollutant reduction; these include the need to survey high risk every 5 years and renew the UNM plan every three years. The equation used to estimate total nitrogen (TN) load reductions for residential parcels is expressed as:

[14.4 (lbs/ac/yr) x managed turf (ac)] x
6% (low risk), 9% (medium risk), or 20% (high risk)

The equation used to estimate total phosphorus (TP) load reductions for residential parcels is expressed as:

[0.45 (lbs/ac/yr) x managed turf (ac)] x
3% (low risk), 5% (medium risk), or 10% (high risk)

The pollutant load received from the urban pervious area that the UNM will be applied to is denoted by the first expression in brackets in the equations above. The pollutant loading rates shown, 14.4 lbs/ac/yr of TN and 0.45 lbs/ac/yr of TP, are the pervious urban rates used in the pollutant loading analysis. A summary of fertilizer load reduction calculations and results are shown in Table 6-21.

Table 6-21: Urban Nutrient Management Load Reductions

Pollutant	Pervious Urban Loading Rate (lbs/ac/yr)	Acres of Managed Turf	Removal Efficiency	Max Potential Load Reduction (lbs/yr)
TN (low risk)	14.4	3	6%	2.7
TN (med risk)	14.4	1408	9%	1,821
TN (high risk)	14.4	239	20%	687
TP (low risk)	0.45	3	3%	0.04
TP (med risk)	0.45	1408	5%	28.7
TP (high risk)	0.45	239	10%	10.8

Pervious Area Reforestation

Open pervious areas with reforestation potential have been identified in the Upper Broad Run watershed equaling 50.4 acres. Pollutant and runoff reductions for pervious area reforestation are calculated based on land use conversion from pervious urban to forest. The equation used to estimate total nitrogen (TN) load reductions for pervious area reforestation is expressed as:

Land Use Conversion (TN) = [14.4 (lbs/ac/yr) – 6.64 (lbs/ac/yr)]* Open Pervious Area (ac)

The equation used to estimate total phosphorus (TP) load reductions for the land use conversion portion of stream buffer reforestation is expressed as:

Land Use Conversion (TP) = [0.45 (lbs/ac/yr) – 0.15 (lbs/ac/yr)]* Open Pervious Area (ac)

The equation used to estimate sediment load reductions for the land use conversion portion of stream buffer reforestation is expressed as:

Land Use Conversion (sediment) = [130 (lbs/ac/yr) – 39 (lbs/ac/yr)]* Open Pervious Area (ac)

The equation used to estimate runoff volume reductions for the land use conversion portion of stream buffer reforestation is expressed as:

Land Use Conversion (runoff) = [0.26 (ac-ft/yr) – 0.02 (ac-ft/yr)]* Open Pervious Area (ac)

The equation used to estimate bacteria load reductions for the land use conversion portion of stream buffer reforestation is expressed as:

Land Use Conversion (bacteria) = [30 (billion colonies/ac/yr) – 12 (billion colonies/ac/yr)]* Open Pervious Area (ac)

Pervious area reforestation would involve converting open pervious area to forest. Therefore, the loading rate would be reduced by a factor equal to the difference between pervious urban and forest loading rates used in the watershed pollutant analysis as shown in the first expression in brackets in the equations above. The approximate reduction in pollutant load and runoff volume is then the reduced loading rate multiplied by the open pervious area available for reforestation. A summary of pervious area reforestation reduction calculations and results are shown in Table 6-22.

Table 6-22: Pervious Area Reforestation Load Reductions

Pollutant	Pervious Urban Loading Rate*	Forest Loading Rate*	Reduced Loading Rate*	Open Pervious Area (ac)	Max Potential Load Reduction*
TN	14.4	6.64	7.73	50.37	389
TP	0.45	0.15	0.30	50.37	15
Sediment	130	39	91	50.37	4,594
Runoff	2.95	0.26	2.69	50.37	136
Bacteria	30	12	18	50.37	907

* Loading Rate has units of lbs/ac/yr for TN, TP and Sediment, acre-feet/yr for runoff and billion colonies/acre/yr for bacteria. Max Potential Load Reduction has units of lbs/yr for TN, TP, and Sediment, acre-feet for runoff and billion colonies/yr for bacteria.

Stream Restoration

Preliminary analysis showed several sites, identified during the stream corridor assessments, where stream restoration could potentially be employed to address stream stability issues (i.e., significant erosion and channel alterations) and improve water quality. These sites are discussed in Section 4.1. Pollutant load reduction estimates in pounds per linear foot of stream restoration were developed by Schueler and Stack (2013). These were also used to calculate load reductions for proposed stream restoration activities (i.e., restoration lengths (RL)) in the Upper Broad Run watershed. The equation used to estimate total nitrogen (TN) reductions for stream restoration is expressed as:

$$0.2 \text{ (lbs/ft)} * \text{RL (ft)}$$

The equation used to estimate total phosphorus (TP) load reductions for stream restoration is expressed as:

$$0.068 \text{ (lbs/ft)} * \text{RL (ft)}$$

The equation used to estimate sediment load reductions for stream restoration is expressed as:

$$54.25 \text{ (lbs/ft)} * \text{RL (ft)}$$

Edge-of-Stream removal rates per linear foot of qualifying stream restoration were obtained from Table 3 in Schueler and Stack (2013). The sediment loss between the edge-of-field and the edge-of-stream is incorporated into the Chesapeake Bay Watershed Model (CBWM) as a sediment delivery ratio. This ratio is multiplied by the predicted edge-of-field erosion rate to estimate the eroded sediments actually delivered to a specific reach. Sediment delivery ratios in the Phase 5.3 CBWM range from 0.1 to 0.25; the median of this range, 0.175, was used to adjust the sediment load reduction factor from Table 3 in Schueler and Stack (2013).

Potential stream restoration sites assigned a High or Medium priority were identified for stream lengths totaling up to 5,140 feet. A summary of stream restoration reduction calculations and results are shown in Table 6-23.

Table 6-23: Stream Corridor Restoration Load Reduction

Pollutant	Reduction in Loading Rate (lbs/ft)	Total Stream Length in Watershed	Potential Stream Restoration Length (ft)	Max Potential Load Reduction (lbs/yr)
TN	0.2	228,518	5,140	1,028
TP	0.068	228,518	5,140	350
Sediment	54.25	228,518	5,140	278,845

Downspout Disconnection

A total of 15 neighborhoods (out of 25 surveyed) have potential for downspout disconnection. A neighborhood is recommended for disconnection if at least 25 percent of the downspouts are directly and/or indirectly connected to the storm drain system, and the average lot has at least 15 feet of pervious area available down gradient from the downspout. During the uplands survey, the percentage of homes with connected downspouts was noted. This percentage was used to determine the rooftop area that could be addressed by disconnection in recommended neighborhoods.

Pollutant and runoff reductions for downspout disconnection are calculated based on the pollutant load and runoff volume received from the total rooftop drainage area (DA) recommended for disconnection and the removal efficiency (RE) of filtration type BMPs. The equation used to estimate total nitrogen (TN) load reductions for downspout disconnection is expressed as:

[22.1 (lbs/ac/yr)*DA (ac)]*RE (%)

The equation used to estimate total phosphorus (TP) load reduction for downspout disconnection is expressed as:

[2.21 (lbs/ac/yr)*DA (ac)]*RE (%)

The equation used to estimate sediment load reduction for downspout disconnection is expressed as:

[850 (lbs/ac/yr)*DA (ac)]*RE (%)

The equation used to estimate runoff volume reduction for downspout disconnection is expressed as:

[2.95 (ac-ft/yr)*DA (ac)]*RE (%)

The pollutant load and runoff volume received from the impervious rooftop drainage area recommended for disconnection is denoted by the first expression in brackets in the equations above. The pollutant loading rates and runoff volume shown (22.1 lbs TN/ac/yr, 2.21 lbs TP/ac/yr, 850 lbs sediment/ac/yr, and 2.95 ac-ft/yr runoff) are the impervious urban rates used in the pollutant loading analysis. Pollutant removal efficiencies for TN, TP and sediment are those reported for filtration practices, based on CBP guidance shown in Table 4-21. The runoff volume reduction efficiency is also reported for filtration practices, and is based on WTM guidance. A summary of downspout disconnection load reduction calculations and results are shown in Table 6-24.

Table 6-24: Downspout Disconnection Load Reductions

Pollutant	Impervious Urban Loading Rate*	DA (Rooftop Area Recommended for Downspout Disconnect) (ac)	Removal Efficiency	Max Potential Load Reduction*
TN	22.1	46.9	50%	519
TP	2.21	46.9	60%	62
Sediment	850	46.9	90%	35,862
Runoff	2.95	46.9	38%	52

* Loading Rate has units of lbs/ac/yr for TN, TP and Sediment, and acre-feet for runoff. Max Potential Load Reduction has units of lbs/yr for TN, TP, and Sediment, and acre-feet for runoff.

Tree Plantings

Several opportunities for planting open space trees were identified in neighborhoods throughout the watershed. Similarly, tree planting opportunities were also identified at many institutional sites. For both neighborhood and institutional tree planting opportunities, the number of trees was estimated based on a spacing of one tree per 20 feet. Pollutant and runoff reductions for pervious area reforestation are calculated based on a land use conversion from pervious urban to forest. An approximation of 100 trees per acre is used to calculate the area available for conversion. The equation used to estimate total nitrogen (TN) load reductions for tree plantings is expressed as:

[14.4 (lbs/ac/yr) – 6.64 (lbs/ac/yr)] * [# Trees * (1 ac/100 trees)]

The equation used to estimate total phosphorus (TP) load reductions for tree plantings is expressed as:

[0.45 (lbs/ac/yr) – 0.15 (lbs/ac/yr)] * [# Trees * (1 ac/100 trees)]

The equation used to estimate sediment load reductions for tree plantings is expressed as:

[130 (lbs/ac/yr) – 39 (lbs/ac/yr)] * [# Trees * (1 ac/100 trees)]

The equation used to estimate runoff volume reductions for tree plantings is expressed as:

[0.26 (ac-ft/yr) – 0.02 (ac-ft/yr)]* [# Trees * (1 ac/100 trees)]

The equation used to estimate bacteria load reductions for tree plantings is expressed as:

[30 (billion colonies/ac/yr) – 12 (billion colonies/ac/yr)] * [# Trees * (1 ac/100 trees)]

Tree plantings involve converting open pervious area to forest. Therefore, the loading rate would be reduced by a factor equal to the difference between pervious urban and forest loading rates used in the watershed pollutant loading analysis, as shown in the first expression in brackets in the equations above. The approximate reduction in pollutant load and runoff volume is then the reduced loading rates and volume multiplied by the open pervious available for reforestation (i.e., the expression in the second brackets in the equations above). A summary of tree planting load and runoff volume reduction calculations and results are shown in Tables 6-25 and 6-26.

Table 6-25: Neighborhood Tree Planting Load Reductions

Pollutant	Pervious Urban Loading Rate*	Forest Loading Rate*	Reduced Loading Rate*	Estimated # Trees	Equivalent Forest Area (ac)	Max Potential Load Reduction*
TN	14.4	6.64	7.73	5,225	52	404
TP	0.45	0.15	0.30	5,225	52	16
Sediment	130	39	91	5,225	52	4,765
Runoff	0.26	0.02	0.24	5,225	52	12
Bacteria	30	12	18	5,225	52	941

* Loading Rate has units of lbs/ac/yr for TN, TP and Sediment, acre-feet/yr for runoff and billion colonies/acre/yr for bacteria. Max Potential Load Reduction has units of lbs/yr for TN, TP, and Sediment, acre-feet for runoff and billion colonies/yr for bacteria.

Table 6-26: Institution Tree Planting Load Reductions

Pollutant	Pervious Urban Loading Rate (lbs/ac/yr)	Forest Loading Rate (lbs/ac/yr)	Reduced Loading Rate (lbs/ac/yr)	Estimated # Trees	Equivalent Forest Area (ac)	Max Potential Load Reduction (lbs/yr)
TN	14.4	6.65	7.73	5,118	51	396
TP	0.45	0.15	0.30	5,118	51	15
Sediment	130	39	91	5,118	51	4,668
Runoff	0.26	0.02	0.24	5,118	51	12
Bacteria	30	12	18	5,118	51	921

* Loading Rate has units of lbs/ac/yr for TN, TP and Sediment, acre-feet/yr for runoff and billion colonies/acre/yr for bacteria. Max Potential Load Reduction has units of lbs/yr for TN, TP, and Sediment, acre-feet for runoff and billion colonies/yr for bacteria.

Overall Pollutant Load Reductions

The sum of maximum potential pollutant load and runoff volume reductions calculated for individual practices represent the overall pollutant removal capacity for a maximum implementation scenario (i.e., 100% of the projects implemented). A practicable pollutant load and runoff volume reduction was estimated for each practice as the maximum potential load reduction multiplied by a projected participation factor. Participation factors were estimated based on area available as well as amount needed to reach overall targets. In practice, other considerations such as public interest will affect participation rates. An overall projected pollutant removal and volume reduction capacity is the sum of practicable pollutant load reductions for individual practices. Projected participation factor assumptions are described in Table 6-27.

Table 6-27: Projected Participation Factors

Practice	Projected Participation	Basis of Assumption
Existing SCMs	100	Existing - SCM already implemented
SCM Conversion	100	Completion of 30 conversions recommended
New SCMs (NSA, ISI, PAA, HSI)*	50	General estimate to achieve reduction goal
Impervious Cover Removal (ISI)	0	No areas were identified for this practice
Reforest Stream Buffer	65	General estimate to achieve reduction goal
Pervious Area Reforestation	50	General estimate to achieve reduction goal
Stream Restoration	75	General estimate to achieve reduction goal
Downspout Disconnection (NSA)	33	33% willingness factor
Tree Plantings (NSA)	33	33% willingness factor
Tree Plantings (ISI)	66	66% of estimated trees located on public lands
Urban Nutrient Management	50	Watershed Treatment Model

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

Tables 6-28 and 6-29 present a summary of estimated pollutant load and runoff volume reductions for both scenarios – maximum implementation and projected practicable implementation – including how reductions were credited, pollutant and runoff volume removal efficiencies, maximum potential load reductions, units available for restoration, projected participation, and projected load reductions.

The projected, practicable implementation of proposed restoration practices, shown in Table 6-28 and Figure 6-1, would make progress toward the 16.9 percent reduction for nitrogen and would meet the 26.4 percent reduction for phosphorus needed to meet water quality standards for the Upper Broad Run watershed as specified by Chesapeake Bay TMDL for nutrients. There is opportunity to achieve greater extent than those assumed by projected participation factors. Greater reductions may also be achieved through restoration actions not included in this analysis such as public education/outreach efforts (e.g., watershed trash and recycling campaign and tours of completed projects). These types of actions are not included in the pollutant removal analysis because reductions efficiencies are not well known and are difficult to estimate.

Table 6-28: Summary of Pollutant Load Reduction Estimates (TN, TP, and Sediment)

Practice	How Credited	TN Efficiency	TP Efficiency	Sediment Efficiency	Max Potential TN Load Reduction (lbs/yr)	Max Potential TP Load Reduction (lbs/yr)	Max Potential Sediment Load Reduction (lbs/yr)	Units Available		Projected Participation (%)	Projected TN Load Reduction (lbs/yr)	Projected TP Load Reduction (lbs/yr)	Projected Sediment Load Reduction (lbs/yr)
Existing Stream Restoration	Lbs per Linear Feet	0.2	0.068	54.25	100	34	27,125	500	ft	100	100	34	27,125
Existing SCMs	Efficiency	varies	varies	varies	6,352	608	377,219	2,007	acres	100	6,352	608	377,219
SCM Conversion	Efficiency	varies	varies	varies	471	88	19,815	298	acres	100	471	88	19,815
New SCMs (NSA, ISI, PAA, HSI)	Efficiency	varies	varies	varies	291	30	12,832	70	acres	50	145.6	14.95	6,416
Impervious Cover Removal (ISI)	LU Conversion	N/A	N/A	N/A	0	0	0	0.00	acres	50	0	0	0
Reforest Stream Buffer	LU Conversion + Efficiency	25%	50%	50%	4,589	305	77,939	419	acres	65	2,983	198	50,660
Pervious Area Reforestation	LU Conversion	N/A	N/A	N/A	389	15	4,594	50	acres	50	195	7.61	2,297
New Stream Restoration	Lbs per Linear Feet	0.2	0.068	54.25	1,028	350	278,845	5,140	ft	75	771	262	209,134
Downspout Disconnection (NSA)	Efficiency	50%	60%	90%	519	62	35,862	47	acres	33	171	21	11,834
Tree Plantings (NSA)	LU Conversion	N/A	N/A	N/A	404	16	4,765	52	acres	33	133	5	1,572
Tree Plantings (ISI)	LU Conversion	N/A	N/A	N/A	396	15	4,668	51	acres	66	261	10.21	3,081
Urban Nutrient Management	Efficiency	varies	varies	N/A	2,511	40	N/A	1,650	acres	50	1,256	20	N/A
Total					17,051	1,563	843,663				12,839	1,269	709,153
Total Existing Urban Load (lbs/yr)					80,056	4,568	1,603,670				80,056	4,568	1,603,670
Reduction Achieved					21.3%	34.2%	52.6%				16.0%	27.8%	44.2%

Table 6-29: Summary of Pollutant Load Reduction Estimates (Runoff and Bacteria)

Practice	How Credited	Runoff Efficiency	Bacteria Efficiency	Max Potential Runoff Load Reduction (ac-ft/yr)	Max Potential Bacteria Load Reduction (billion colonies/yr)	Units Available		Projected Participation (%)	Projected Runoff Load Reduction (ac-ft/yr)	Projected Bacteria Load Reduction (billion colonies/yr)
Existing Stream Restoration *	N/A	N/A	N/A							
Existing SCMs	Efficiency	varies	varies	14	38,095	2,007	acres	100	14	38,095
SCM Conversion	Efficiency	varies	varies	14	1,848	106	acres	100	14	1,848
New SCMs (NSA, ISI, PAA, HSI)	Efficiency	varies	varies	43	1,056	70	acres	50	21	528
Impervious Cover Removal (ISI)	LU Conversion	varies	varies	0.0	0	0.00	acres	50	0.0	0
Reforest Stream Buffer	LU Conversion + Efficiency	N/A	varies	99	7,542	419	acres	65	64	4,902
Pervious Area Reforestation	LU Conversion	varies	varies	136	907	50	acres	50	68	453
New Stream Restoration*	N/A	N/A	N/A							
Downspout Disconnection (NSA)	Efficiency	varies	N/A	52	N/A	47	acres	33	17	N/A
Tree Plantings (NSA)	LU Conversion	varies	varies	12	941	52	acres	33	4	310
Tree Plantings (ISI)	LU Conversion	varies	varies	12	921	51	acres	66	8	608
Urban Nutrient Management*	Efficiency	N/A	N/A							
Total				382	51,309				211	46,745
Total Existing Urban Load				4,898	145,153				4,898	145,153
Reduction Achieved				7.8	35.3%				4.3%	32.2%

*Existing Stream Restoration, New Stream Restoration, and Urban Nutrient Management do not result in reductions of Runoff and Bacteria.

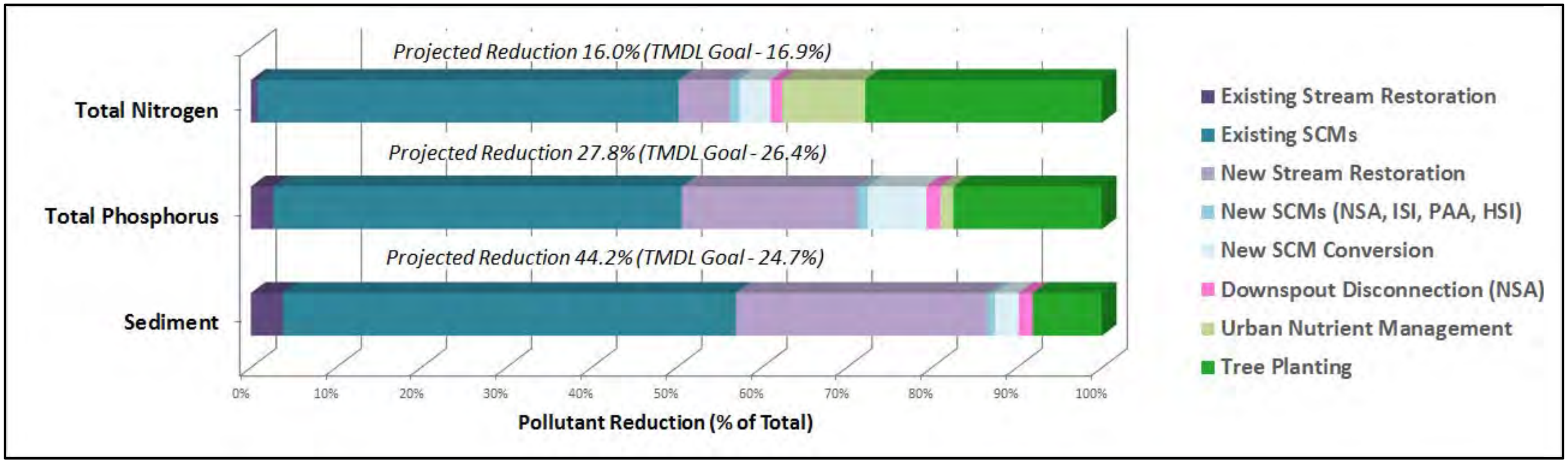


Figure 6-1: Projected Pollutant Load Reduction Estimate

CHAPTER 7: SUBWATERSHED RESTORATION STRATEGIES

Restoration strategies for each subwatershed are presented in the following subsections. A description of key watershed characteristics is presented for each subwatershed including drainage area, stream length, population, land use/land cover, impervious cover, soils, and stormwater control measures (SCMs). Assessment results for neighborhoods, hotspots, institutions, pervious areas, stream corridors (including potential stream restoration and preservation sites), and stormwater conversions are also summarized for each subwatershed. Lastly, a subwatershed management strategy including recommended citizen and municipal actions is presented at the end of each subsection.

7.1 Brambleton

Brambleton is the third largest subwatershed in the Upper Broad Run watershed. It is the most densely populated (see Figure 3-12) and has the highest percentage of impervious cover (21.6%), according to data available based on spring 2012 aerial imagery. Several of the large HOAs present in the Upper Broad Run watershed have multiple communities located within this subwatershed, which is why the majority of the Neighborhood Source Assessments were conducted here. Figure 7-1 shows the existing conditions (as of 2012) within the subwatershed. Table 7-1 summarizes the key characteristics of Brambleton subwatershed.

Table 7-1: Key Characteristics - Brambleton Subwatershed

Drainage Area	2,335.1 acres (3.6 sq. mi.)	
Stream Length	8.0 miles	
Land Use/Land Cover	Barren:	0.3%
	Cropland:	13.7%
	Forest:	16.2%
	Pasture:	4.4%
	Urban Impervious:	20.6%
	Urban Pervious:	43.1%
	Water:	1.3%
	Missing:	0.4%
Impervious Cover	504.0 acres	21.6%
Soils	A Soils (low runoff potential):	0%
	B Soils:	2.1%
	C Soils:	30.6%
	D Soils (high runoff potential):	63.6%
	*B/D Soils:	2.3%
	*C/D Soils:	1.4%
SCMs	43.8% of subwatershed treated	

*Dual Hydrologic Soil Group. See Chapter 3 for further detail.

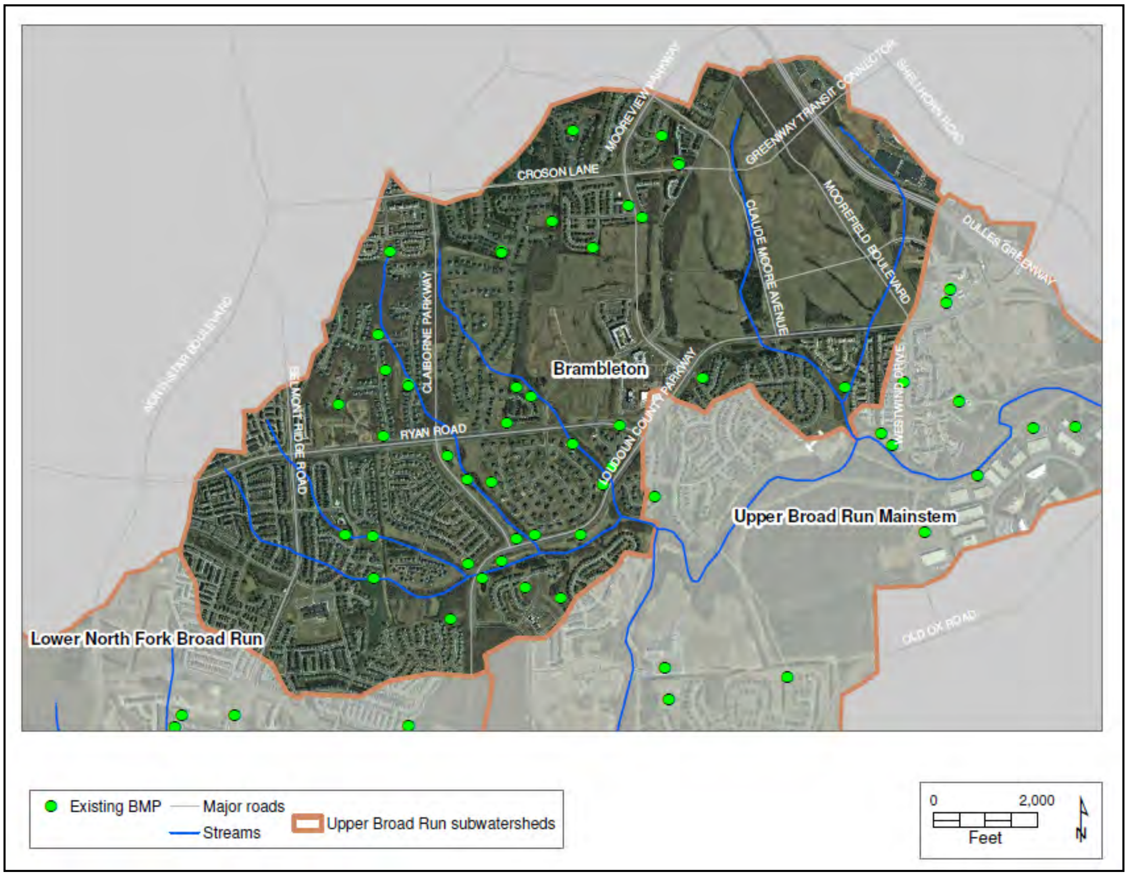


Figure 7-1: Existing Conditions - Brambleton Subwatershed (Spring 2012 aerial imagery provided by Loudoun County)

Neighborhoods

A total of 13 distinct neighborhoods were identified and assessed within the Brambleton subwatershed during the uplands assessment of the Upper Broad Run watershed. Preliminary recommendations for neighborhoods in this subwatershed included actions to reduce stormwater volume and pollutants including downspout disconnection, use of rain barrels, installation of rain gardens, conservation planting, storm drain marking, fertilizer reduction, stream buffer improvements, new SCMs, and tree planting. A map that shows the location of each neighborhood assessed along with their Site IDs is presented in Figure 7-2. A summary of preliminary neighborhood recommended actions for the Brambleton subwatershed is presented in Table 7-2.

Table 7-2: Neighborhood Source Assessment (NSA) Recommendations – Brambleton Subwatershed

PRELIMINARY RECOMMENDED ACTIONS													
Site ID	Lot Size (acres)	%Opportunity for Downspout Disconnection	Rain Barrels	Rain Gardens	Storm Drain Marking	Conservation Planting	Increase Lot Canopy	Pet Waste Management	Fertilizer Reduction	Buffer Improvement	New SCM	# of Open Space Trees	Notes
NSA-1A	N/A	10			✓		✓						
NSA-1B	1/4	22			✓		✓				✓	170	Rain gardens can be installed around yard drains in common area.
NSA-4A	< 1/4	25					✓	✓			✓		
NSA-6	N/A	50	✓		✓		✓						
NSA-7	1/2	75	✓		✓	✓			✓	✓			One of the few neighbor-hoods assessed that has several lots with a high percentage of tree canopy.
NSA-8	1/2	50		✓		✓	✓		✓				
NSA-11	1/4	15			✓	✓	✓						
NSA-13	< 1/4	20					✓				✓		Clean neighborhood that has done a great job of reducing its stormwater runoff footprint.
NSA-14	N/A	20			✓		✓						
NSA-15	<1/4	40	✓				✓				✓		Large area behind houses contains scattered boulders and yard drains. Could be a good area for bioretention.
NSA-16	N/A	10					✓						A few tree box filters inter-cept some of the parking lot runoff near common area. SCM pond located on southwest side of neighbor-hood.
NSA-17	N/A	100	✓				✓	✓					A large portion of the down-spouts drain to pervious strips that are less than 15 feet long and likely do not allow for much infiltration.
NSA-21	1/2	22				✓	✓		✓	✓		1,552	Large amount of open space. Good tree planting candidate.

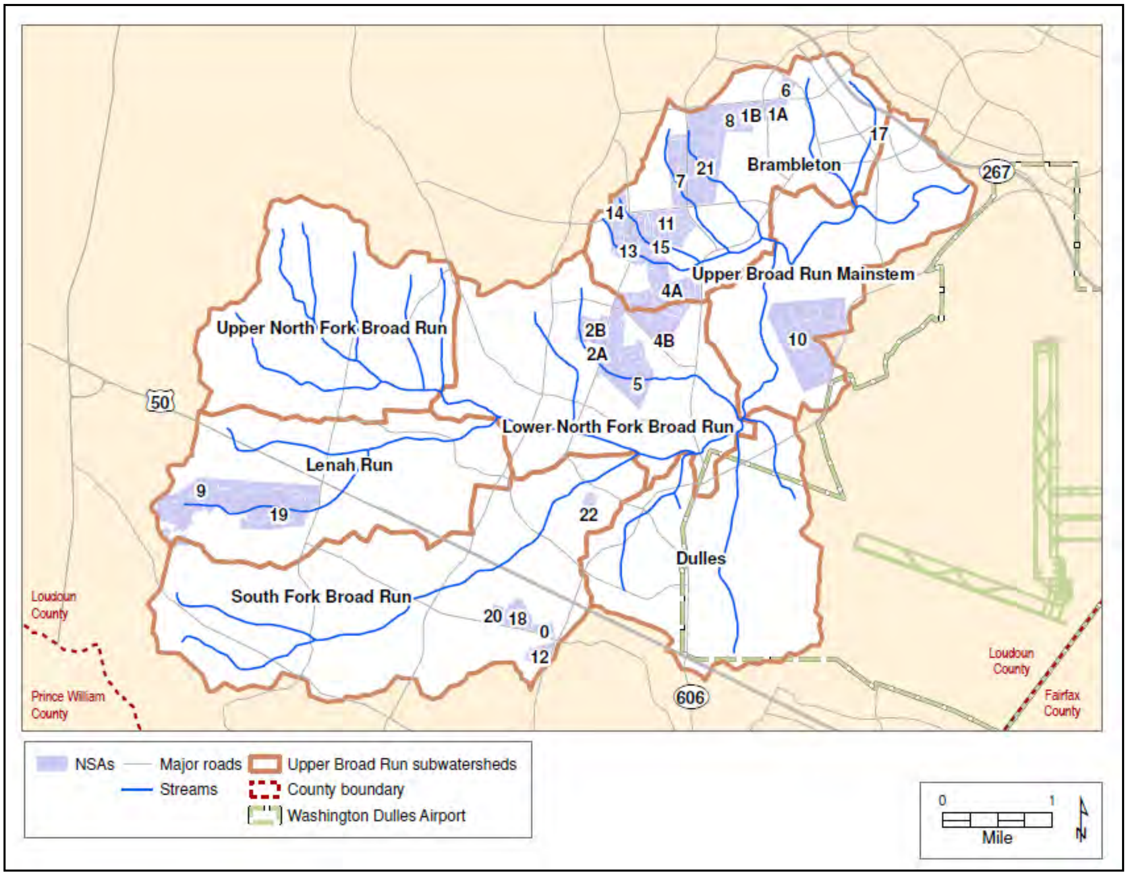


Figure 7-2: Location and Site IDs of Neighborhood Source Assessment (NSA) Areas in Upper Broad Run Watershed

All of the neighborhoods assessed within the Brambleton subwatershed had opportunities for improvement. Storm drain marking (Figure 7-3), rain barrels, conservation planting, and new SCMs were widely recommended. Storm drain marking is popular because this relatively easy and inexpensive action can have a great effect by reminding residents not to dump potentially dangerous materials into the storm drain. It can also be easily paired with other education efforts, for example, with education regarding the effects of pet waste on water quality, in neighborhoods where both were recommended. Rain barrels serve as temporary storage of roof runoff, decreasing the volume of stormwater running off site, but also do a great job of promoting stormwater runoff awareness. NSA-21 has a large amount of open space in several portions of the neighborhood and is considered a great site for a tree planting project (Figure 7-4). NSA-1B, NSA-4A, NSA-13, and NSA-15 are good sites for bioretention area/rain garden installation projects. Projects on this scale may encourage widespread community engagement and are ideal opportunities for children and families to become involved with their watershed in a concrete way. In addition, actions as simple as adjusting mowing practices and planting trees along stream channels and drainage ditches may help to slow down high stream flows that cause bank erosion and to intercept nutrients and toxins before they enter the aquatic ecosystem.

Figure 7-3: Unmarked Storm Drain in Brambleton Neighborhood

Figure 7-4: Tree Planting Opportunity at NSA-21

Hotspots

One site was inspected in the Brambleton subwatershed, consisting of a shopping center. The site included a multi-story building containing small shops and businesses, a standalone supermarket, and a building of storefront businesses with residences above. The shopping area had not completed construction and several vacant parcels were noted. The buildings were assessed in aggregate as one site. A summary of field findings and preliminary recommended actions is presented in Table 7-3.

Table 7-3: Hotspot Site Investigation (HSI) Results and Recommendations – Brambleton Subwatershed

Site ID	Active Pollution Observed			Recommended Follow-up Actions			Hotspot Status			
	Vehicle Operations	Outdoor Materials	Physical Plant	Refer for Enforcement	Follow Up Inspection	Include in Future Education	Not	Potential	Confirmed	Severe
HSI-001								✓		

Note: No active pollution observed or follow-up actions recommended for this subwatershed.

At the supermarket, signs of leakage into a storm drain inlet were found behind the building. Near the two-story miscellaneous business building, a dumpster was found near a storm drain inlet, though it was not leaking. The dumpster had been placed outside of the dumpster stall; neither area had secondary containment. For this site, a more judicious placement of the dumpsters away from the storm drain inlet, and adding secondary containment, would reduce the chances of direct input of pollution from dumpsters to the storm sewer system.

Institutions

Two elementary schools were investigated in the Brambleton subwatershed. A summary of potential opportunities for restoration at each are presented in Table 7-4.

Opportunities to provide demonstration projects and real-world examples of watershed restoration are plentiful at ISI-004. Visible tree planting areas are readily available in the grassy lawn areas on the northwest corner of the property and along the nearby roadway. The former area is already planted, but could easily be amended to create a dense wooded canopy to benefit stormwater infiltration, parcel cooling, and extension of wooded areas in the neighborhood to the east of the school property. Other available areas on the school property include the bus turnaround drive and small areas near impervious parking areas. SCMs that would infiltrate and treat sheetflow runoff from playground areas behind the school consist of bioretention and berms. Field staff noted an erosion problem developing near a yard drain and down-gradient of a culvert underneath footpaths (Figure 7-5). Bioretention would remediate sediment transport to the storm drain system from these eroded areas. An additional eroded area at the edge of the athletic track would benefit from installation of terraces. An exercise that would create an enthusiastic response from children is storm drain stenciling. Lastly, a problem with dumpster leachate that was noted by field staff could be addressed by waste management training. A barrel of possible waste cooking oil stored outside in the dumpster stalls was found loosely sealed, which may cause a pollution problem when exposed to precipitation.

Table 7-4: Institutional Site Investigation (ISI) Recommendations – Brambleton Subwatershed

PRELIMINARY RECOMMENDED ACTIONS								
Site ID	Storm Drain Marking	# Trees for Planting	Downspout Disconnection	New SCM	Impervious Cover Removal	Buffer Improvement	Trash Management	Notes
ISI-004	✓	285		✓			✓	Staff says areas are reseeded but seed washes off
ISI-005		See PAA		✓		✓		Overall clean site, as expected of a new school

Figure 7-5: Terracing Opportunity to Address Erosion (left) and Stains Leading from Dumpster to Storm Drain Inlet (right) at ISI-004

ISI-005 is a recently constructed elementary school in the Brambleton subwatershed. New environmental education initiatives could include activities such as tree planting to improve forest cover and stream buffer sizes. Field staff noted buffer encroachment issues at both the front (east) and rear (west) property lines (Figure 7-6). The school is maintaining portions of these areas as meadows; however, the planting of trees would improve stormwater infiltration and stream buffer character even more. For stormwater management, the school features level spreading and infiltration. To augment treatment, bioretention can be installed in areas where grassy swales currently handle stormwater runoff from impervious areas, particularly playground areas to the rear and to the north of the school building. These demonstration projects would be just steps away from the school doors and provide a valuable connection between human activities and stormwater quality and what steps can be taken to improve instream conditions.

Figure 7-6: Opportunities for Stream Buffer Augmentation (left) and Bioretention (right) at ISI-005

Pervious Areas

Pervious area restoration has the potential to convert areas of turf and other maintained cover, which often have high nutrient inputs to forest, which can absorb and filter rather than contribute nutrients. Two pervious areas were assessed for restoration potential in the Brambleton Branch of Broad Run; Loudoun Valley Estates **-** West and Moorefield Station Elementary School. The **Loudoun Valley Villages - West** site is located off Zion Chapel Drive, near its intersection with North Brown Square. The site is privately-owned by the HOA. The site possesses several long, narrow potential tree planting areas bordering a perennial tributary and associated nontidal wetlands; it is a green space essentially surrounded by residences. The planting area is easily accessed, and could be planted with minimal site preparation. A large part of the site currently possesses maintained turf (70%). Benefits of tree planting here would include slowing of surface flow runoff to the adjacent stream corridor and wetlands. The **Moorefield Station Elementary School** site is located off Mooreview Parkway, north of Clarendon Square. The site is publicly-owned, and would be a good candidate for tree planting with minimal site preparation. Only a small portion of the site (5%) currently possesses maintained turf (close to the school); other parts of the site consist of upland meadow and shrub/scrub (former pastured land), and deciduous forest. One small area to the immediate south of the school possesses scattered mature trees (primarily oaks); this area would greatly benefit from allowing it to re-generate naturally (i.e., no mowing) with greater numbers of small trees and shrubs. The deciduous forested areas in the eastern and the western parts of the site both contain perennial stream corridors and nontidal wetlands. Benefits of tree planting along the outer edges of these areas would definitely include the slowing of surface flow runoff to the adjacent stream corridors, as well as enhancing protections for the stream buffers and wetlands.

A summary of these sites is provided in Table 7-5.

Table 7-5: Pervious Area Assessment Summaries – Brambleton Subwatershed

Site ID	Location in Subwatershed	Description	Acres	Ownership
Loudoun Valley Villages - West	North-central	Private Open Space	Parcel – N/A Recommended planting – 4.38	Private
Moorefield Station Elementary School	Southwest	County School	Parcel – 81.90 Recommended planting – 11.14	Public

Stream Corridor Assessments

Field crews walked 1.02 miles of stream (12.7% of total stream miles) within the Brambleton subwatershed to identify potential water quality problems, restoration opportunities, and stream corridor preservation opportunities. This survey focused on first through second order stream reaches. A total of 18 problems were identified throughout the Brambleton subwatershed. The predominant issues were erosion (generally rated overall as low to moderate) and inadequate buffer (generally rated overall as moderate, with one severe point near the center of the reach). Maps showing key findings of the stream corridor assessments are found in Section 4.1.

An exposed pipe was observed in the eastern-most part of the reach assessed, at an open area along the stream. The observed pipe was a 6-inch plastic sewer line that crosses the stream perpendicularly at this location. This sewer line should be fixed and re-set at the required depth under the stream bed, preferably through use of horizontal directional drill (HDD) technology. All necessary nontidal wetlands and other permits would need to be secured from Virginia DEQ (and possibly other regulatory agencies) prior to initiating the work.

Additionally, native trees and shrubs should be planted on the stream side of the Loudoun Water sewer line ROW where they would not interfere with operation and maintenance of the sewer line, and in other places near the center of the reach. These planted areas would enhance very inadequate stream buffers in several locations, and would provide positive benefits to the stream and wildlife.

During stream corridor assessments and retrofit reconnaissance, six potential stream restoration opportunities were identified in Brambleton subwatershed (3 High Priority, 1 Medium, and 2 Low). See Chapter 10 for additional details on these potential stream restoration projects.

Stormwater Conversions

Existing stormwater management ponds in the Brambleton subwatershed were targeted during the Retrofit Reconnaissance Investigations, to identify opportunities for facility conversions or upgrades to improve water quality. Among the opportunities identified, 3 were ranked High, 1 Medium, and 13 Low. See Table 4-22 and Chapter 10 for more information on specific opportunities.

Subwatershed Management Strategy

Figure 7-7 provides a visual summary of potential restoration opportunities in the Brambleton subwatershed.

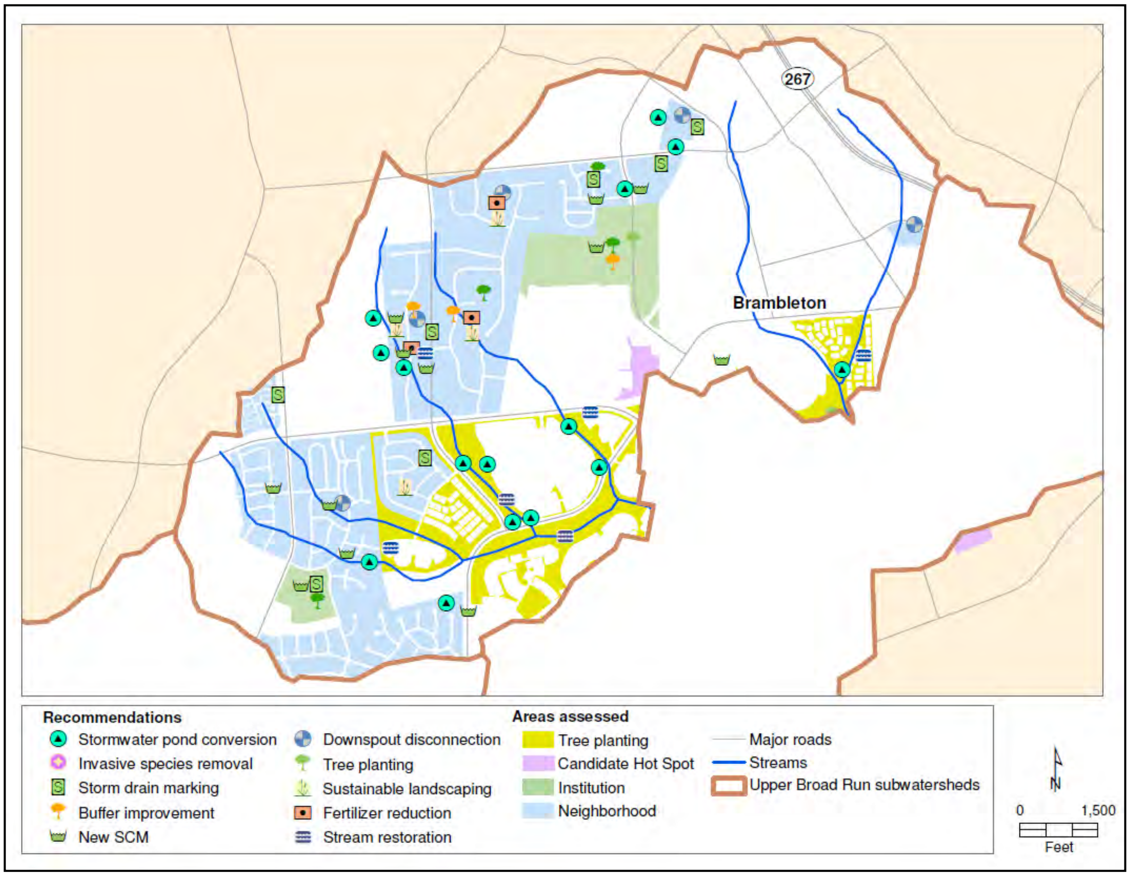


Figure 7-7: Potential Restoration Opportunities in Brambleton Subwatershed

<u>Non-Governmental Action (Citizens, HOA and Watershed Groups)</u>

1. Conduct appropriate downspout rain barrel and rain garden installation measures in neighborhoods according to Table 7-2.
2. Engage citizens in a storm drain marking program and conduct marking activities in the neighborhoods indicated in Table 7-2.
3. Educate citizens about the benefits and importance of conservation planting and its effects on water quality for neighborhoods indicated in Table 7-2.
4. Educate property owners about improving stream buffer management at locations indicated in Table 7-2.
5. Educate property owners about the water quality benefits of reducing fertilizer use on lawns as indicated in Table 7-2.

6. Encourage communities to plant open space trees. Table 7-2 shows potential neighborhoods for planting as many as 1,722 open space trees.
7. Engage institutional sites listed in Table 7-4 in tree planting and new SCMs.
8. Investigate the pervious areas described in Table 7-5 for potential tree planting.

Municipal Actions (Loudoun County Government, Loudoun Water and Town Governments)

1. Continue to monitor conditions at potential hotspots indicated in Table 7-3.
2. Educate staff of ISI-004 about the importance of proper trash management as listed in Table 7-4.
3. Consider re-setting the exposed sewer pipe noted during the SCA.
4. Investigate feasibility of recommendations for stream restoration in areas noted during SCA and RRI surveys, as outlined in Chapter 10.
5. Consider upgrading the stormwater management ponds described above, particularly those with opportunities that ranked High or Medium for their potential to improve water quality; see Table 4-22 and Chapter 10.

7.2 Upper Broad Run Mainstem

Upper Broad Run Mainstem is the smallest subwatershed in the Upper Broad Run watershed. The mainstem of Broad Run is the only perennial stream within this subwatershed, and its furthest downstream point serves as the Upper Broad Run watershed outlet. It is the second most densely populated subwatershed and has the second highest amount of impervious cover (13.6%), according to data available based on spring 2012 aerial imagery. Upper Broad Run Mainstem is the location of two large business parks containing dozens of commercial facilities, many of which were visited for hotspot site investigations. Figure 7-8 shows the existing conditions (as of 2012) within the subwatershed. Table 7-6 summarizes the key subwatershed characteristics of Upper Broad Run Mainstem.

Neighborhoods

One neighborhood was assessed within the Upper Broad Run Mainstem subwatershed during the uplands assessment of the Upper Broad Run watershed (see Figure 7-2). Preliminary recommendations for the neighborhood in this subwatershed included actions to reduce stormwater volume and pollutants including downspout disconnection, installation of rain gardens, conservation planting, storm drain marking, stream buffer improvements, new SCMs, and tree planting. A summary of preliminary neighborhood recommended actions is presented in Table 7-7.

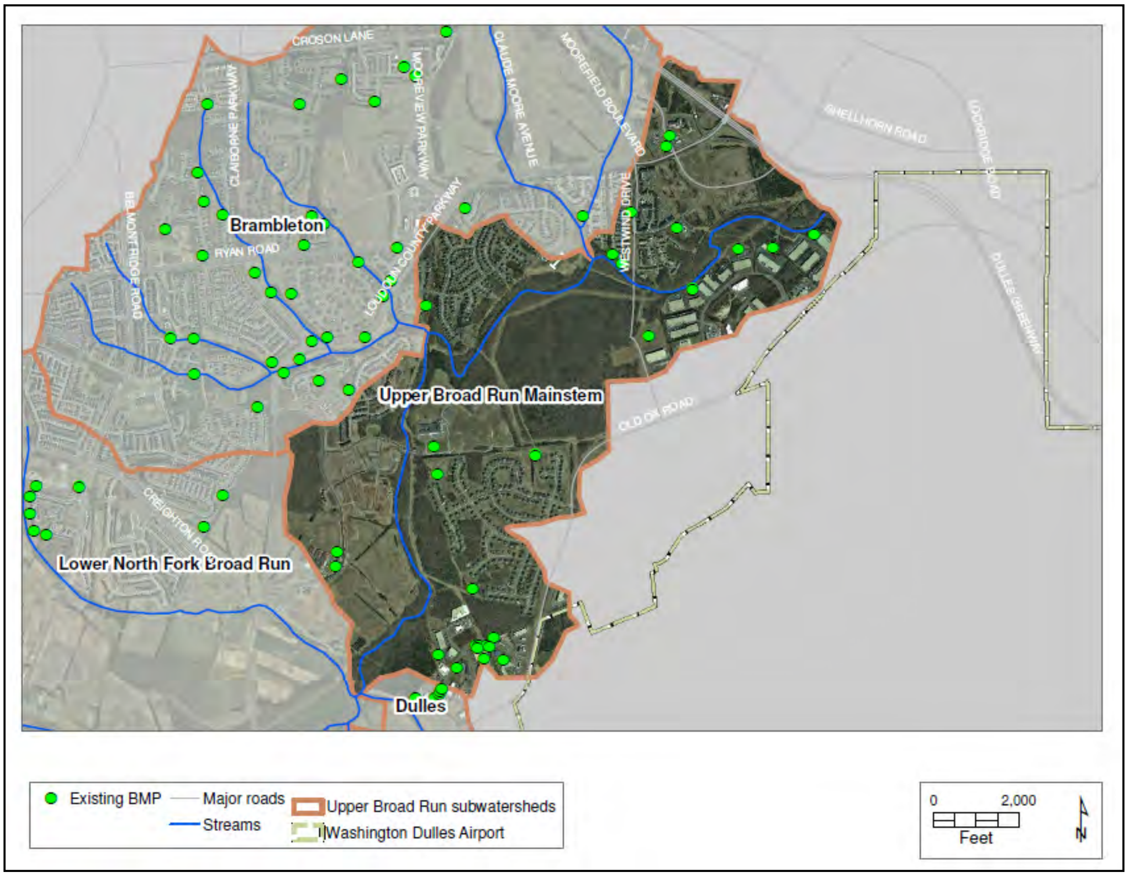


Figure 7-8: Existing Conditions – Upper Broad Run Mainstem Subwatershed

Table 7-6: Key Characteristics – Upper Broad Run Mainstem Subwatershed

Drainage Area	1,875.5 acres (2.9 sq. mi.)	
Stream Length	4.4 miles	
Land Use/Land Cover	Barren:	0.3%
	Cropland:	6.3%
	Forest:	34.7%
	Pasture:	9.4%
	Urban Impervious:	15.7%
	Urban Pervious:	30.7%
	Water:	1.6%
	Missing:	1.3%
Impervious Cover	317.2 acres	16.9%
Soils	A Soils (low runoff potential):	0%
	B Soils:	2.4%
	C Soils:	22.7%
	D Soils (high runoff potential):	62.2%
	*B/D Soils:	9.2%
	*C/D Soils:	2.0%
SCMs	27.6% of subwatershed treated	

*Dual Hydrologic Soil Group. See Chapter 3 for further detail.

Table 7-7: NSA Recommendations – Upper Broad Run Mainstem Subwatershed

PRELIMINARY RECOMMENDED ACTIONS													
Site ID	Lot Size (acres)	% Opportunity for Downspout Disconnection	Rain Barrels	Rain Gardens	Storm Drain Marking	Conservation Planting	Increase Lot Canopy	Pet Waste Management	Fertilizer Reduction	Buffer Improvement	New SCM	# of Open Space Trees	Notes
NSA-10	1/2	50		✓	✓	✓	✓			✓	✓	702	Great bioretention area opportunity in common area. Good opportunity to enhance buffer around the ephemeral channel that carries stormwater offsite.

The neighborhood assessed within the Upper Broad Run Mainstem subwatershed had several opportunities for improvement. It was estimated that 50% of the downspouts within this neighborhood are directly or indirectly connected to the storm drain. The large portion of the neighborhood covered by mowed lawns provides a great opportunity for rain garden installation and conservation planting. Storm drain marking, which offers an opportunity to not only engage residents, but to serve as a visual reminder of the downstream effects of residents' actions, was also recommended for this neighborhood. A large amount of open space in common areas that is suitable for bioretention areas/rain gardens and tree planting was noted in several portions of the neighborhood (Figure 7-9). In addition, actions as simple as adjusting mowing practices and tree plantings along the ephemeral channel that carries stormwater offsite may help to slow down high flows that cause bank erosion and to intercept nutrients and toxins before they enter the aquatic ecosystem.

Figure 7-9: Bioretention Opportunity (left) and Tree Planting Opportunity (right) Within NSA-10

Hotspots

Investigations were conducted in two business parks and an area near two hotels in Upper Broad Run Mainstem. Since the business parks contained a multiplicity of businesses and opportunities, each major building or business was given its own site ID to facilitate hotspot investigations and isolate problems. Field findings and preliminary recommendations are presented in Table 7-8.

Table 7-8: HSI Results and Recommendations – Upper Broad Run Mainstem Subwatershed

Site ID	Active Pollution Observed			Recommended Follow-up Actions			Hotspot Status			
	Vehicle Operations	Outdoor Materials	Physical Plant	Refer for Enforcement	Follow Up Inspection	Include in Future Education	Not	Potential	Confirmed	Severe
HSI-002					✓				✓	
HSI-003					✓			✓		
HSI-004									✓	
HSI-005							✓			
HSI-006					✓			✓		
HSI-007					✓			✓		
HSI-008					✓			✓		
HSI-009					✓			✓		
HSI-016					✓	✓			✓	
HSI-017					✓	✓				✓
HSI-018						✓		✓		

At the two business parks, a preliminary field reconnaissance was performed to identify those buildings and businesses where issues were readily apparent. Special attention was paid to outdoor fueling, material storage, and housekeeping problems, especially if they were in the immediate vicinity of storm drain inlets. At HSI-002, a number of housekeeping problems were apparent. Substantial inventory, stored material, and discarded material was placed out in the open on the rear parking lot. Materials included: floating barrels, concrete blocks, bundles of material, fencing, pallets, barrels, and scrap metal. Other items were stored inside and under trailers. Some material was stacked and placed near a storm drain inlet (Figure 7-10). For these storage problems, a network of canopy covers or hardened shelters would be highly beneficial and would reduce the likelihood of washing of pollutants to storm drain inlets.

Evidence of vehicle maintenance activities was inferred from the presence of at least one truck with an open hood. Fleet fueling operations without the benefit of a canopy was therefore noted. Two dumpsters were found onsite with tops open and with noticeable trash accumulation along a tree line behind the rear parking and inventory storage area. Recommended improvements to the site include the addition of sheltering structures for the fueling area, waste management training for employees, and movement of truck maintenance activity indoors as not to be exposed to precipitation.

Figure 7-10: Inventory Stored Outside, on Impervious Surface, Near Storm Drain Inlet

The property housing HSI-003 straddles two watersheds. The northern half is in Upper Broad Run watershed; only the portion of the property contained within the Upper Broad Run watershed was assessed, with one exception: a dumpster was found open and adjacent to a storm drain inlet in an area outside of the Upper Broad Run watershed.

At another storm drain inlet, substantial gravel was found deposited near the opening, likely contributing to sediment transport to the storm drain system. The gravel appears to be tracked from a pervious storage yard, which contains inventory of cast iron, concrete, and plastic piping. In addition to the outside storage of inventory, one barrel of lacquer was noted in the rear parking lot, stored in the open. For this site, a sweeping plan is recommended to reduce tracking and transport of gravel material out of the yard and into the vicinity of the storm drain inlet. Secondary containment is recommended for liquid materials. Lastly, a network of canopies or hardened shelters is recommended to reduce the exposure of inventory items to precipitation.

HSI-004 consists of two adjacent buildings. A large fueling station is situated between the buildings. The fuel tank appears to be double-walled to contain spills, but the overall fueling facility lacks a canopy that would reduce the risk of pollutants washing into a storm drain inlet during storms. A rollaway dumpster was noted on the site, which showed signs of leaking onto the impervious parking area between the buildings (Figure 7-11). Evidence of outdoor vehicle maintenance was also observed. Field staff also found a drum of liquid material resting on a pallet and a small number of bales of cardboard material stored outside. Given the facility’s extensive building size, material could likely be stored inside and out of the reach of the erosive and leaching properties of rainfall. The pollution exposure profile could also benefit from modifying procedures to move servicing of vehicles indoors.

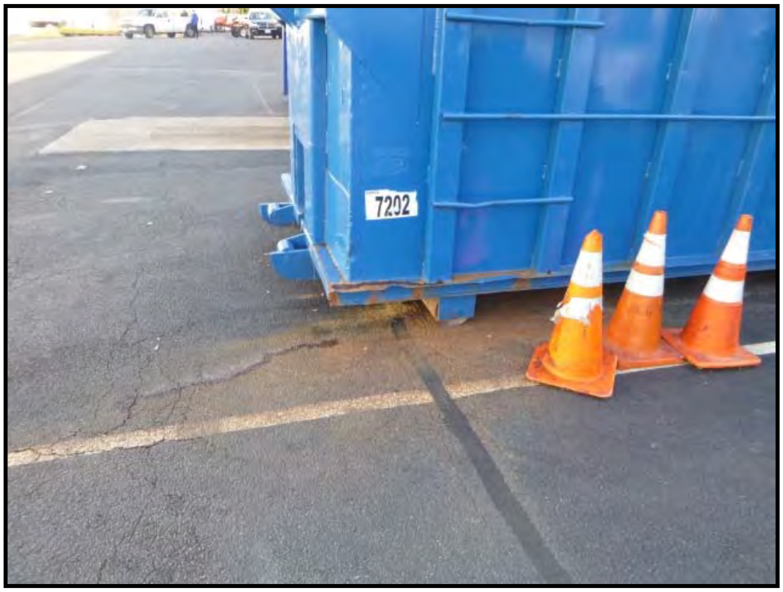


Figure 7-11: Rollaway Dumpster with Signs of Leakage at HSI-004.

Multiple businesses are housed within HSI-007. A number of fleet vehicles were found onsite, along with a small fueling station. The fueling station, though small, lacked a canopy and would benefit from sequestration in a secondary containment area with proper sheltering. Also lacking protective awnings were the several loading docks noted onsite. A dumpster was found open and with evidence of past staining on the impervious surface. Employee training in the best practices of waste management would decrease the likelihood of transporting pollution to the stream network.

A construction staging area was found inside one of the business parks. The address of this parcel is unknown. Field staff found a number of construction vehicles (e.g., backhoe, pavement roller), trucks (e.g., semi-trailers, dump trucks), and other vehicles on the site. Staff also noted piles of boulders, gravel, exposed dirt, and piles of scrap metal. An employee mentioned to field personnel that the site was a construction area for a new building; however, staff did not see any silt fencing. Staff could not ascertain ownership or responsible parties for the staging area. For this site, super silt fencing is recommended if it is indeed an active construction area. If it is a staging area, proper sheltering of bulk material and stormwater controls appropriate to the site (e.g., sediment basin) are highly recommended.

At HSI-009, field staff identified a number of housekeeping problems in the rear lot. Storm drain inlets were found blocked by absorbent logs. In another area, bundles of used and broken up tire treads were found stacked along a gutter pan that led to a storm drain inlet (Figure 7-12). One bundle was found resting on top of a storm drain inlet. Junked or inoperable equipment was also found parked along the same gutter pan; a Bobcat had obvious oil staining underneath. Staff also identified a scrap metal pile on an impervious surface, a rollaway dumpster full of waste construction material, scrap metal bins and lumber and chain link fencing inventory stored in the open on impervious surfaces.

Figure 7-12: Junked Equipment and Tires Awaiting Disposal on Impervious Surface

For inventory and equipment storage, especially on this impervious rear lot, canopies and shelters are recommended. Staff would also benefit from training on the proper storage of waste materials. Sediment and hydrocarbon runoff should be addressed with modifications to onsite procedures and not by relying on berms at storm drain inlet orifices. Increasing the frequency of inoperable equipment removal would also greatly benefit the site by removing pollution-causing materials from a direct route to storm drain inlets at this site.

Two hotels comprising HSI-005 were evaluated for hotspot status. Both hotels and their environs were found in good condition as they appeared to be newly constructed. Staff found that the only potentially pollution-causing conditions were the areas around the dumpster stalls. The dumpster at one of the hotels was found with a collapsed lid and was open to the elements. The dumpster stall for the other hotel had noticeable papers and pieces of discarded material strewn about on the inside. The staffs at both of these hotels would contribute to watershed stewardship by modifying waste management procedures and increasing their and their guests' awareness of their actions on the subwatershed.

At a gas station and convenience store, project field staff identified waste management problems. Specifically, dumpsters in the designated stalls were found to be open or overflowing. Additionally, discarded bulk material, retail racks, a 55-gallon drum, and stacks of plastic product frames were found in the dumpster stall. All material was open to the elements which could potentially allow pollutants to be transported to a trench drain in close proximity to the stall. The trench storm drain immediately in front of the dumpsters was filled with enough material to allow grass to sprout. In a peripheral parking area near the gas pumps, staff found substantial staining of the asphalt, probably due to trucks and contractor vehicles visiting the convenience store. Improvements in waste management procedures and training of staff so that accumulation of potentially pollution-causing material does not accumulate or leach from the areas around the stalls is recommended for this site. Maintenance on the trench drain would also remove another source of pollution to the stormwater network.

An auto body shop was one of many businesses visited within a business park to assess for hotspot status. Field staff noted substantial repair and storage of automobiles outside and without the benefit of cover. Vehicles were being washed indoors; however, excess water was flowing out of the indoor areas and toward a storm drain inlet (Figure 7-13). Other materials, such as car parts and drums, were being stored likewise in the open, potentially creating a source of pollution to the storm sewer system. Dumpster stalls, and their immediate vicinity had collections of discarded material, car parts, and barrels placed nearby. For this site, a cleanup and assessment of storage procedures is recommended. The area and the subwatershed would benefit from modifications to waste management procedures including attention to placement of material into dumpsters and expeditious removal of discarded items such as car parts. A car wash capture system would also eliminate another source of direct input of pollution to the storm drain system.

Figure 7-13: Excess Water from Washing Flowing Toward Storm Drain Inlet

At a vehicle maintenance business in a business park, field staff identified several housekeeping issues in the back equipment lot. The company manages, stores, and repairs a fleet of vehicles and construction equipment and has a fueling station on the property. The fueling station does not have a canopy cover and is located within close proximity to a storm drain inlet (Figure 7-14). Staff also documented discarded material, such as an open bin of used tires. The rear lot also serves as a transfer area for dirt, gravel, and waste rubble, all of which is open to the elements and increases the storm drain system's and stream network's exposure to polluted and sediment-laden runoff. Other liquid material in barrels is stored outside without the benefit of secondary containment. Dumpsters placed near storm drain inlets were found to be overflowing.

Figure 7-14: Uncovered Fueling Station

The contribution by the business to polluted runoff could be reduced by placing material and conducting activities under canopy covers or shelters. Bulk waste, such as the bins of tires, should be removed quickly so that metals such as zinc are not accumulated and washed to the storm drain system. Bulk material, such as dirt, should be protected from the elements by using, at the very least, tarps. Training of employees, along with modification of waste management, equipment repair, and fueling procedures, would go a long way toward reducing this business' contribution of pollutant and sediment load to local streams.

Nearby, a construction company manages a large fleet, has outside fueling stations, stores liquid material outdoors without secondary containment, and places quantities of inventory and bulk material (dirt) on impervious surfaces, thus increasing the likelihood of polluted runoff entering the storm drain system. A rollaway dumpster was also found on the site. Field investigators found evidence of outside vehicle repair. Used tires and other discarded material were found stored outside in the open. Centralized areas where discarded material is collected should, at the very least, be underneath a canopy cover or placed into a warehouse. Liquid material should have secondary containment. Improvements to site operations should also include placing a canopy cover over outdoor fueling areas and conducting vehicle repair indoors or under an appropriate sheltering system. Lastly, staff should update their training of waste management procedures, so that excess material does not concentrate onsite where it can be transferred to streams.

Institutions

A middle school and elementary school were investigated in Upper Broad Run Mainstem sub-watershed. A summary of potential opportunities for restoration at each are presented in Table 7-9.

Table 7-9: ISI Recommendations – Upper Broad Run Mainstem Subwatershed

PRELIMINARY RECOMMENDED ACTIONS								
Site ID	Storm Drain Marking	# Trees for Planting	Downspout Disconnection	New SCM	Impervious Cover Removal	Buffer Improvement	Trash Management	Notes
ISI-003		567	✓	✓			✓	
ISI-009	✓	1,344		✓		✓	✓	Only assessed elementary school portion of property due to construction.

As is the case with all schools surveyed in the Upper Broad Run watershed, ISI-003 provides many opportunities for watershed restoration. Visibility of the watershed restoration measures is an added bonus since examples for environmental education are readily available. Adjacent to athletic fields are many opportunities for tree planting to convert unused or under-utilized grassy areas to forest canopy. Tree planting on the property would provide a much-needed contrast to the prevailing lack of trees in the immediate area. The property currently features bioretention areas adjacent to parking lots as pretreatment of stormwater. Stormwater treatment onsite could be further enhanced by installation of bioretention at strategic locations around the building and along a drainage swale between the back drive and the athletic fields. Bioretention servicing the faculty parking lot to the southwest could be expanded to infiltrate and treat a larger portion of the lot. This type of pretreatment reduces chemical and temperature pollution of stormwater effluent from the lot. Berms could be installed at the upstream end of the culvert that travels the width of the rear athletic area near the rear drive. These berms would capture and infiltrate sheetflow from athletic fields and points up-gradient. Lastly, the dry stormwater facility on the east side of the property can be converted to a wet pond to better settle out pollutants (Figure 7-15). Trash dumpsters located on the southwest portion of the school were found to be leaving stains on the impervious surface. Such staining is evidence of pollutants leaching from the dumpster and ultimately reaching storm drain inlets. A waste management training session for school staff would improve waste handling and reduce the possibility of pollution transport to the storm drain system.

At ISI-009, a large expanse of grass was found immediately in front of the school building and adjacent to the roadway (Figure 7-16). The grassy area provides an excellent opportunity for reforestation. A drainage swale that runs through the grassy zone could be converted to bio-retention to provide an extra measure of stormwater treatment and infiltration. A tree planting, outreach, and education effort could be undertaken to restore the buffer along Broad Run, which forms the western border of the school. Approximately 300 feet of buffer has been eliminated due to sanitary sewer line construction; areas outside of the sanitary sewer line easement can be planted. Other areas near ballfields could also be planted with trees to extend the buffer. Waste management could also be improved through staff training. On the east side of the school, a dumpster was found to be leaking contents onto the impervious surface in near proximity to a storm drain inlet. Additionally, a waste cooking oil drum was found loosely capped and with rain water ponding on the lid. Implementation of restoration measures such as these will decrease the local stream's exposure to increased volumes of polluted stormwater effluent from the school and will establish the school as a positive example of environmental stewardship.

Figure 7-15: Tree Planting (left) and Dry Pond Conversion (right) Opportunities at ISI-003

Figure 7-16: Tree Planting Opportunity at ISI-009

Pervious Areas

Pervious area restoration has the potential to convert areas of turf and other maintained cover, often with high nutrient inputs, to forest, which can absorb and filter rather than contribute nutrients. Four pervious areas were assessed for restoration potential in the Upper Broad Run Mainstem subwatershed of Upper Broad Run; these include Broad Run Stream Valley Park North; Broad Run Stream Valley Park South; Loudoun Valley Villages - East; and Lyndora Park.

The **Broad Run Stream Valley Park North** site is located directly west of Rosa Lee Carter Elementary School, along Upper Broad Run. It is a medium-sized publicly-owned park that is divided into north and south parcels, bisected by Loudoun Reserve Drive. The Park essentially comprises a narrow greenway along Broad Run. Much of this part of the Park is covered by maintained turf (75%). Several small, linear open areas along existing forest may be suitable for planting. Reforestation of the site would require verifying that planting would not interfere with the current uses of the Park. In addition, a Loudoun Water sewer line ROW would have to be avoided and access maintained. Tree planting here (in current turf areas) would buffer the existing forest and stream corridor, and would slow surface runoff.

The **Broad Run Stream Valley Park South** site is located immediately south of Loudoun Reserve Drive (across from Rosa Lee Carter ES), along Upper Broad Run. It is a medium-sized publicly-owned park that is divided into north and south parcels, bisected by Loudoun Reserve Drive. The Park essentially comprises a narrow greenway along Broad Run. None of this part of the Park is covered by maintained turf (0%). Several small, linear open areas along existing forest may be suitable for planting. Reforestation of the site would require verification, however, that it would not interfere with the current uses of the Park, and that tree planting could be a potential community project. In addition, a Loudoun Water sewer line ROW is located along parts of this site; tree plantings would have to be planted off this utility, and access must be maintained. Tree planting here would provide the opportunity to add to and buffer the existing forest and stream corridor, and would help to slow surface runoff.

The **Loudoun Valley Villages - East** site is located immediately southwest of Golden Bamboo Terrace, near the intersection of Sunbury Street and Loudoun Reserve Drive. It is privately owned and maintained, and is easily accessible by foot, vehicle, or heavy equipment. Opportunities for tree planting and re-forestation at this site are located along the periphery of an existing stormwater detention facility. The stormwater facility drains east to a small tributary that flows directly to Upper Broad Run. About thirty percent (30%) of the site is covered by maintained turf, and it receives full sun exposure. Slowing overland stormwater flows to this facility by establishing forested cover would help to improve water quality flowing to Upper Broad Run. Reforestation of the site would require verification that it would not interfere with the current use of the site and that tree planting could be a potential community project.

The **Lyndora Park** site is located off Lucketts Bridge Circle. It is publicly-owned and maintained, is easily accessible by foot, vehicle, or heavy equipment. About twenty percent (20%) of the site is covered by maintained turf, and it receives full sun exposure. The best areas for reforestation at the Park are along its southern and southeastern parts, where semi-fallow fields (that appear to be currently mowed semi-annually) meet existing forest along Upper Broad Run. Forest re-establishment in these locations would help to buffer the existing stream and its wetlands, and would enhance the aesthetic beauty of the Park. Reforestation of the site, however, requires verification that tree planting would not interfere with any projected uses in current master planning for the Park, and that tree planting could be a potential community project. An existing multi-branched sewer line right-of-way in the central and eastern parts of the site would also have to be avoided, and access to it maintained.

A summary of these sites is provided in Table 7-10.

Table 7-10: PAA Summaries – Upper Broad Run Mainstem Subwatershed

Site ID	Location in Subwatershed	Description	Acres	Ownership
Broad Run Stream Valley Park North	West	County Park	Parcel – 28.79 (combined) Recommended planting – 2.88	Public
Broad Run Stream Valley Park South	West	County Park	Parcel – 28.79 (combined) Recommended planting – 0.58	Public
Loudoun Valley Villages - East	West	Private Open Space	Parcel – N/A Recommended planting – 0.56	Private
Lyndora Park	Northwest	County Park	Parcel – 17.00 Recommended planting – 3.66	Public

Stream Corridor Assessments

Field crews walked 1.37 miles of stream (31.2% of total stream miles) within the Upper Broad Run Mainstem subwatershed to identify potential water quality problems, restoration opportunities, and stream corridor preservation opportunities. This survey focused on the main branch of Broad Run, which is a third order stream reach. A total of 11 problems were identified throughout the Upper Broad Run Mainstem subwatershed. The predominant issues were erosion (mostly rated as moderate in the eastern parts of the reach assessed), and inadequate buffer (generally rated as moderate to severe in the eastern parts of the reach assessed). Maps showing key findings of the stream corridor assessments are found in Section 4.1.

Three utility rights-of-way were encountered along the assessed reach of Broad Run, including a Loudoun Water sewer ROW, a County water line ROW, and an electric transmission line ROW. Each of these ROWs contribute to degradation of the stream, owing to the inadequate stream buffers that exist (resulting in increased bank erosion and other problems), as well as occasional required access to the stream by maintenance vehicles. Because ROWs typically must be kept permanently clear of woody vegetation, there may be only limited opportunities to enhance the stream buffers at these sites. Where possible, however, native trees and shrubs should be planted on the stream side of the ROW where they would not interfere with operation and maintenance of the sewer line or other utilities. These planted areas would enhance very inadequate stream buffers in many locations, and would provide positive benefits to wildlife.

During stream corridor assessments and retrofit reconnaissance, one potential stream restoration opportunity was identified in Upper Broad Run Mainstem subwatershed (Medium Priority). See Chapter 10 for additional details on this potential stream restoration project.

Stormwater Conversions

Existing stormwater management ponds in the Upper Broad Run Mainstem subwatershed were targeted during the Retrofit Reconnaissance Investigations, to identify opportunities for facility conversions or upgrades to improve water quality. Among the opportunities identified, 9 were ranked High, 7 Medium, and 4 Low. See Table 4-22 and Chapter 10 for more information on specific opportunities.

Subwatershed Management Strategy

Figure 7-17 provides a visual summary of potential restoration opportunities in the Upper Broad Run Mainstem subwatershed.

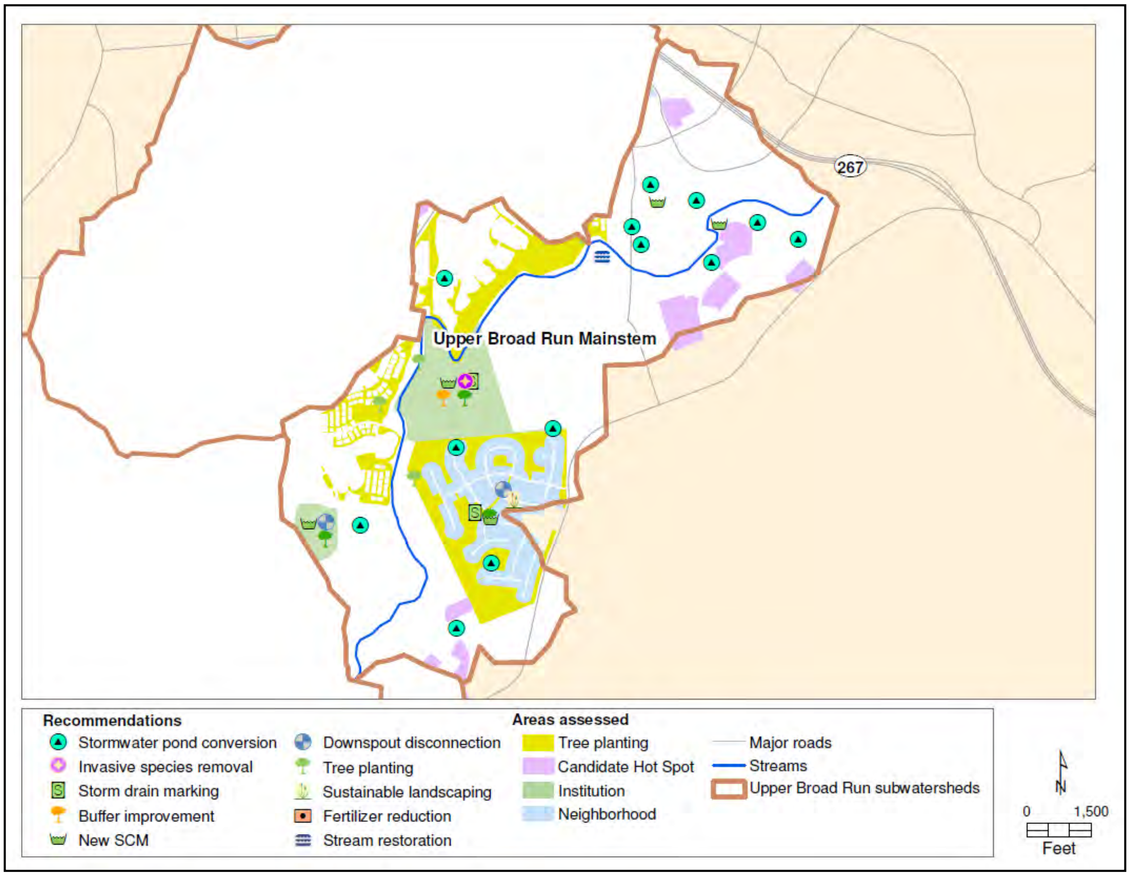


Figure 7-17: Potential Restoration Opportunities in Upper Broad Run Mainstem Subwatershed

<u>Non-Governmental Action (Citizens, HOA and Watershed Groups)</u>

1. Conduct appropriate downspout rain garden installation measures in the neighborhood according to Table 7-7.
2. Engage citizens in a storm drain marking program and conduct marking activities in the neighborhood indicated in Table 7-7.
3. Educate citizens about the benefits and importance of conservation planting and its effects on water quality for the neighborhood indicated in Table 7-7.
4. Educate property owners about improving stream buffer management at the location indicated in Table 7-7.

5. Encourage the community to plant open space trees. Table 7-7 shows the potential for planting as many as 702 open space trees in the neighborhood that was assessed.
6. Engage institutional sites listed in Table 7-9 in tree planting and new SCMs.
7. Investigate the pervious areas described in Table 7-10 for potential tree planting.

Municipal Actions (Loudoun County Government, Loudoun Water and Town Governments)

1. Follow-up regarding conditions at confirmed and severe hotspots and continue to monitor conditions at potential hotspots indicated in Table 7-8.
2. Educate staff of the two schools about the importance of proper trash management as listed in Table 7-9.
3. Consider enhancing the forested stream buffer in places where there are no utility conflicts.
4. Investigate feasibility of recommendations for stream restoration in area noted during SCA and RRI surveys, as outlined in Chapter 10.
5. Consider upgrading the stormwater management ponds described above, particularly those with opportunities ranked as High or Medium for their potential to improve water quality; see Table 4-22 and Chapter 10.
6. Seek involvement of Loudoun County Department of Parks and Recreation in tree planting opportunity at Lyndora Park.

7.3 Dulles

Dulles is the second smallest subwatershed in the Upper Broad Run watershed. The majority of the subwatershed is located on Dulles International Airport property, and therefore only a small portion of the subwatershed could be assessed. Field crews were able to conduct hotspot site investigations on a few business properties in the subwatershed and assess only the flowing streams outside of airport property. Figure 7-18 shows the existing conditions (as of 2012) within the subwatershed. Table 7-11 summarizes the key subwatershed characteristics of Dulles.

Neighborhoods

No neighborhood source assessments were performed within the Dulles subwatershed.

Hotspots

Dulles subwatershed of the Upper Broad Run watershed, contains a portion of a business park. Teams investigated two businesses in the business park and a separate landscaping business elsewhere in the subwatershed. One business is located within both Dulles and Upper Broad Run Mainstem subwatersheds, but is included in the Dulles narrative section. A summary of field results and preliminary recommendations is presented in Table 7-12.

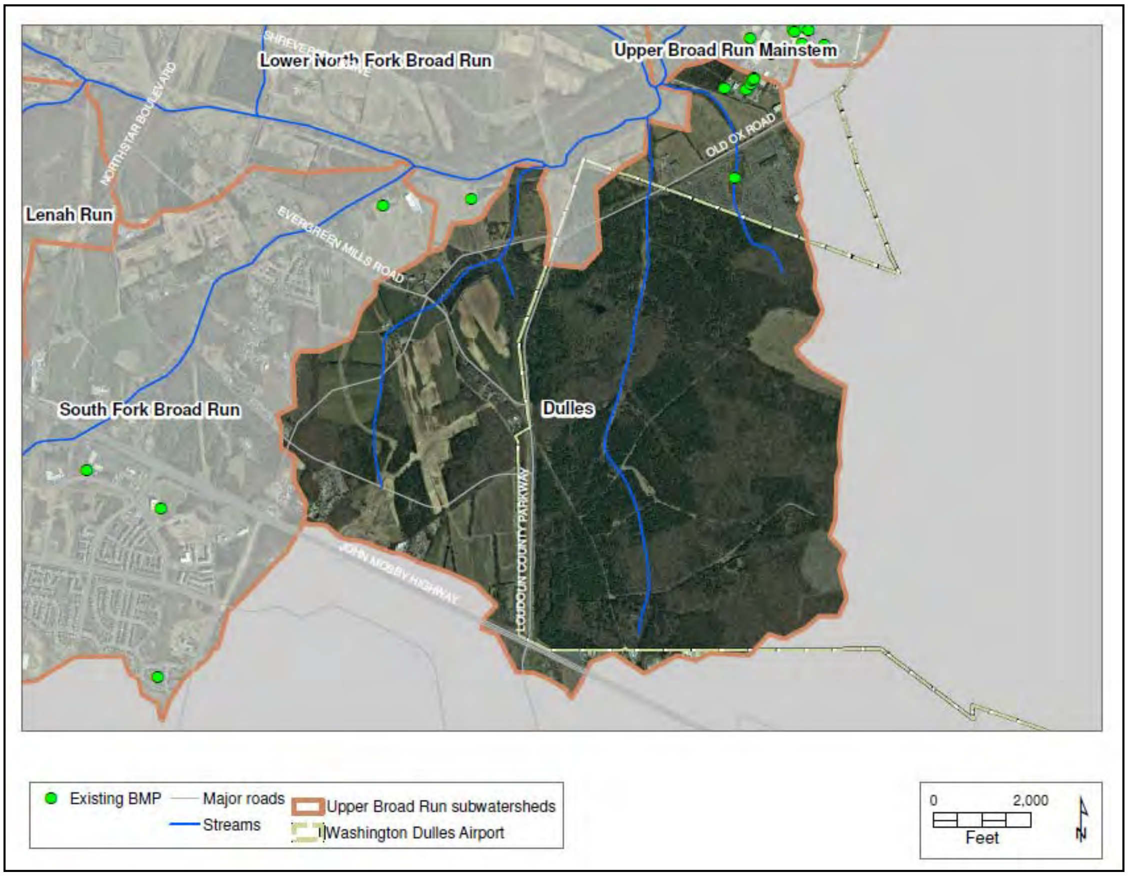


Figure 7-18: Existing Conditions - Dulles Subwatershed

Table 7-11: Key Characteristics – Dulles Subwatershed

Drainage Area	2,160.5 acres (3.4 sq. mi.)	
Stream Length	4.8 miles	
Land Use/Land Cover	Barren:	0.2%
	Cropland:	10.3%
	Forest:	64.9%
	Pasture:	6.7%
	Urban Impervious:	5.5%
	Urban Pervious:	11.1%
	Water:	0.8%
	Missing:	0.5%
Impervious Cover	136.4 acres	6.3%
Soils	A Soils (low runoff potential):	0%
	B Soils:	1.2%
	C Soils:	12.3%
	D Soils (high runoff potential):	26.7%
	No Data:	57.3%
	*B/D Soils:	1.2%
	*C/D Soils:	1.3%
SCMs	5.7% of subwatershed treated	

*Dual Hydrologic Soil Group. See Chapter 3 for further detail.

Table 7-12: HSI Results and Recommendations – Dulles Subwatershed

Site ID	Active Pollution Observed			Recommended Follow-up Actions			Hotspot Status			
	Vehicle Operations	Outdoor Materials	Physical Plant	Refer for Enforcement	Follow Up Inspection	Include in Future Education	Not	Potential	Confirmed	Severe
HSI-012								✓		
HSI-014	✓		✓	✓	✓	✓				✓
HSI-015						✓		✓		

Upon arrival at HSI-014, investigators immediately noted an employee power washing equipment in an impervious area behind the building. After documenting conditions elsewhere on the business property, field staff returned to the loading dock area to find an employee dumping floor cleaning machine contents into a storm drain inlet. The activity would potentially be considered an illicit discharge; therefore, County staff were promptly notified. In addition, staff identified a number of potential pollution causing practices onsite. The company stores, maintains, and repairs its equipment and vehicles outside. Additionally, an outdoor fueling station is present and was found not to have a canopy cover. Vehicle parts and a pile of gravel were found outdoors. Beneficial actions for HSI-014 include instructing employees on the proper disposal of material to avoid illicit discharges. The site can be retrofit so that any equipment washing required takes place indoors and the effluent directed to a sanitary sewer. Inventory, parts, and equipment stored outside, as well as the fueling station, should be sheltered to decrease the likelihood of pollutants washing onto impervious surfaces and being transported to the storm drain system.

HSI-015 includes three transportation maintenance businesses. On the site, field staff found open, overflowing dumpsters. Field staff also noted fleet vehicles likely belonging to one of the companies. To reduce pollution problems, fleet vehicles should be stored under canopy cover and if repair is required, the service should be performed indoors. To reduce the possibility of blowing trash leaving the site and being washed into a storm drain, and to reduce the possibility of dumpster leachate doing the same, employees should be trained in proper waste management techniques.

Investigators visiting a garden center (HSI-012) identified a number of housekeeping issues that could potentially lead to introduction of pollution into storm drains and subsequently to streams. The garden center has a large yard on a pervious (gravel) base. On the pervious portion was situated an array of stalls that had bulk mulch, sand, and other material. Near the entrance of the business, a portion of a mulch stall was placed on hardened asphalt (impervious) near a curb cut leading to a ditch. The ditch, located next to U.S. Route 50, had self-converted to a wetland. Bulk materials such as these that could easily suspend and wash into waterways during heavy downpours would benefit from canopy cover.

Elsewhere on the property, field teams found large tanks that at one time had contained fuel, according to an employee. At least one other tank appeared to be still in use for fueling purposes, though without a canopy cover. A canopy cover over the fueling station would reduce the possibility of pollutants and hydrocarbons being transported to waters of Dulles subwatershed. The station would also benefit from secondary containment to keep spills localized in the first place. Investigators found and documented collections of discarded material (e.g., pallets), an overflowing rollaway dumpster, garden center supplies (e.g., pots), and inventory (e.g., boulders on pallets), all of which were stored outside without canopy cover, though mostly on pervious surfaces. Employee training and placement of material under canopies would help improve the quality of stormwater runoff leaving the site.

Institutions

No institutional site investigations were performed within the Dulles subwatershed.

Pervious Areas

No pervious area assessments were performed within the Dulles subwatershed.

Stream Corridor Assessments

Field crews walked 0.75 miles of stream (15.7% of total stream miles) within the Dulles subwatershed to identify potential water quality problems, restoration opportunities, and stream corridor preservation opportunities. This survey focused on first through second order stream reaches. A total of 16 problems were identified throughout the Dulles subwatershed. Maps showing key findings of the stream corridor assessments are found in Section 4.1.

The predominant issues were erosion (several areas rated as severe were located in the northern-most part of the reach assessed), and inadequate buffer (generally rated overall as moderate, with one very severe point near the northern-most part of the reach). One unusual condition consisted of a site on the stream (located close to its confluence with the mainstem of Broad Run) where black, unusually colored water in the stream possessed an odor of sewage. This site is adjacent to the existing sewer line ROW, and it is possible that a leak had occurred (or continues to occur) here, though it is also possible that the color and odor were due to decaying leaf litter. This site should be investigated as soon as possible, and checked for leaks in the adjacent sewer lines. An appropriate level of cleanup should take place at this location (and other downstream locations, as necessary) after leaks are fixed.

Stormwater Conversions

No existing stormwater management ponds were assessed within the Dulles subwatershed.

Subwatershed Management Strategy

As shown in Figure 7-19, no site-specific restoration opportunities were identified in the Dulles subwatershed at this time.

Municipal Actions (Loudoun County Government, Loudoun Water and Town Governments)

1. Follow-up regarding conditions at severe hotspot, and continue to monitor potential hotspots as indicated in Table 7-12.
2. Investigate cause of black stream water color and odor (possibly due to decaying organic matter) in assessed stream reach.

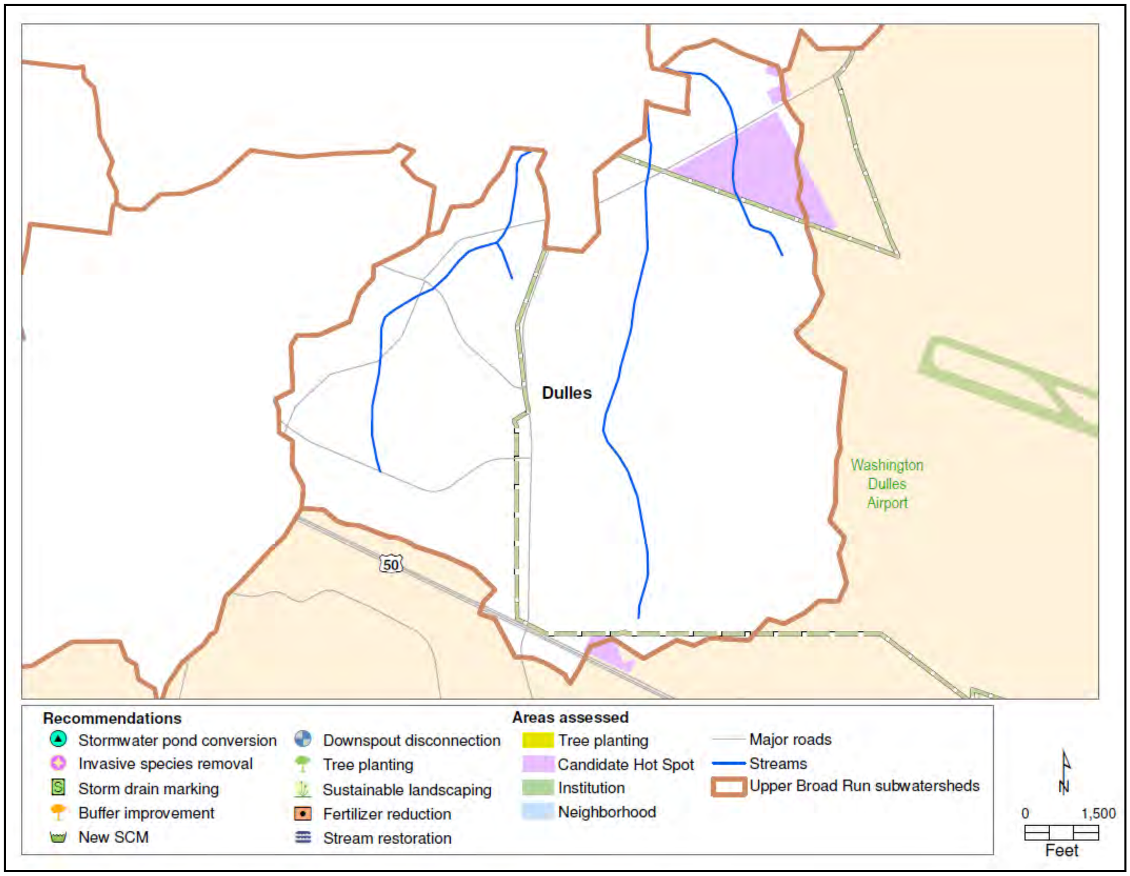


Figure 7-19: Potential Restoration Opportunities in Dulles Subwatershed

7.4 Lenah Run

Lenah Run is the third smallest subwatershed in the Upper Broad Run watershed. The subwatershed is mainly cropland and forest, with the Lenah Run community (the largest neighborhood assessed in the watershed) covering most of the non-agricultural and non-forested portions of the subwatershed. The population density in Lenah Run subwatershed is currently less than one person per acre (see Figure 3-12), but population is expected to grow rapidly within the next few decades. Figure 7-20 shows the existing conditions (as of 2012) within the subwatershed. Table 7-13 summarizes the key subwatershed characteristics of Lenah Run.

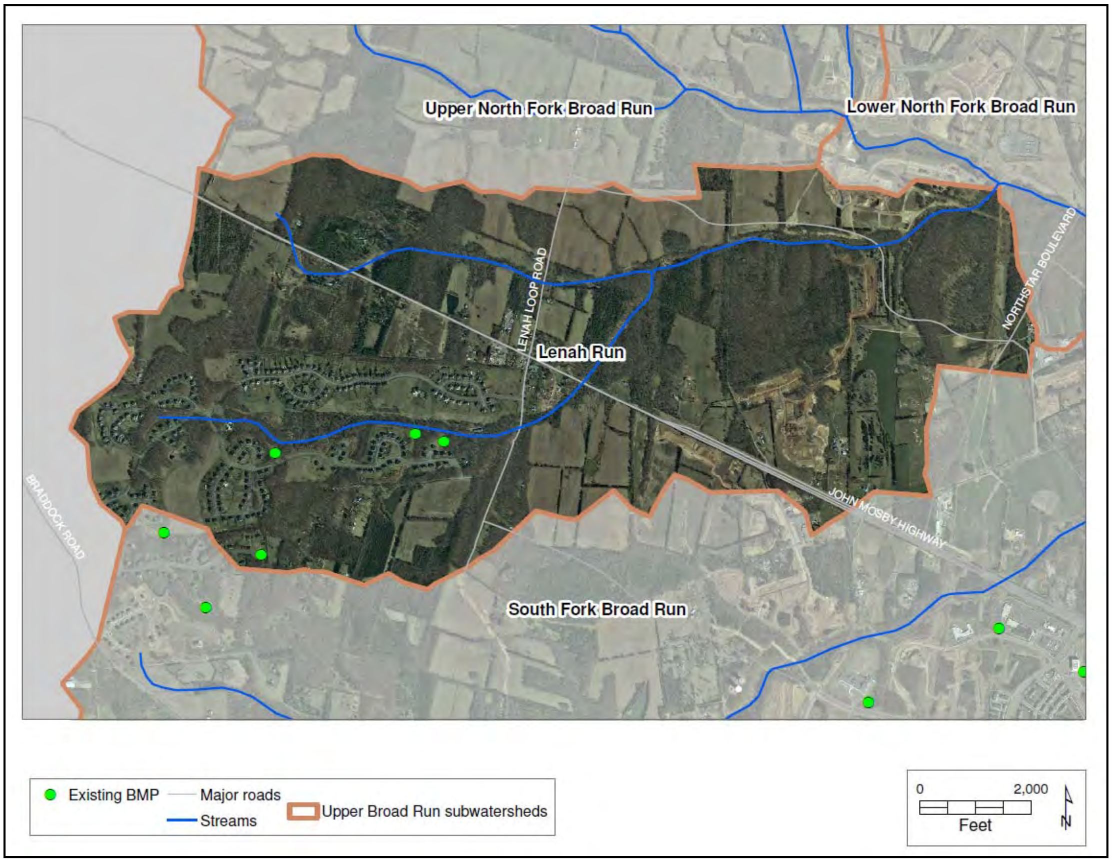


Figure 7-20: Existing Conditions – Lenah Run Subwatershed

Table 7-13: Key Characteristics – Lenah Run Subwatershed

Drainage Area	2,200.5 acres (3.4 sq. mi.)	
Stream Length	4.7 miles	
Land Use/Land Cover	Barren:	0.0%
	Cropland:	20.9%
	Forest:	41.2%
	Pasture:	13.6%
	Urban Impervious:	3.3%
	Urban Pervious:	18.4%
	Water:	1.5%
	Missing:	1.0%
Impervious Cover	91.0 acres	4.1%
Soils	A Soils (low runoff potential):	0%
	B Soils:	37.6%
	C Soils:	21.8%
	D Soils (high runoff potential):	20.8%
	*B/D Soils:	4.9%
	*C/D Soils:	13.5%
SCMs	3.3% of subwatershed treated	

*Dual Hydrologic Soil Group. See Chapter 3 for further detail.

Neighborhoods

A total of two distinct neighborhoods were identified and assessed within the Lenah Run subwatershed during the uplands assessment of the Upper Broad Run watershed. Preliminary recommendations for neighborhoods in this subwatershed included actions to reduce stormwater volume and pollutants including downspout disconnection, installation of rain gardens, conservation planting, storm drain marking, stream buffer improvements, new SCMs, and tree planting. A summary of preliminary neighborhood recommended actions is presented in Table 7-14.

Table 7-14: NSA Recommendations – Lenah Run Subwatershed

		PRELIMINARY RECOMMENDED ACTIONS											
Site ID	Lot Size (acres)	% Opportunity for Downspout Disconnection	Rain Barrels	Rain Gardens	Storm Drain Marking	Conservation Planting	Increase Lot Canopy	Pet Waste Management	Fertilizer Reduction	Buffer Improvement	New SCM	# of Open Space Trees	Notes
NSA-9	1	60		✓	✓	✓	✓		✓	✓	✓	2,104	Great neighborhood restoration candidate. A lot of open space for tree planting and little obvious stormwater treatment. Some debris in roadside ditches.
NSA-19	1/2	60		✓	✓	✓	✓			✓		530	Similar to NSA-9, but lots are smaller and some SCM facilities present.

Both neighborhoods assessed within the Lenah Run subwatershed had opportunities for improvement. Storm drain marking, rain gardens, conservation planting, and stream buffer improvements were recommended in both neighborhoods, while fertilizer reduction and new SCMs were also recommended in NSA-9. NSA-9 has more open space than any other neighborhood assessed within the Upper Broad Run watershed, which is why it has the largest number of recommended tree plantings. This neighborhood also has a new SCM recommended for an area of mowed lawn that currently conveys stormwater runoff from a large portion of the neighborhood to the local stream (Figure 7-21). Installation of a bioretention area, among other SCM options, would allow for a greater removal of pollutants. In addition to treating stormwater on a neighborhood scale, the large percentage of lots covered by mowed lawns in both neighborhoods provides a great opportunity to reduce stormwater runoff at the individual lot scale through rain garden installation and conservation planting.

Hotspots

No hotspot site investigations were performed within the Lenah Run subwatershed.

Figure 7-21: Grassy Field that Conveys Stormwater Runoff from Impervious Surfaces within NSA-9 to the Local Stream

Institutions

No institutional site investigations were performed within the Lenah Run subwatershed.

Pervious Areas

No pervious area assessments were performed within the Lenah Run subwatershed.

Stream Corridor Assessments

Field crews walked 1.99 miles of stream (42.3% of total stream miles) within the Lenah Run subwatershed to identify potential water quality problems, restoration opportunities, and stream corridor preservation opportunities. This survey focused on first through second order stream reaches. A total of 37 problems were identified throughout the Lenah Run subwatershed. Maps showing key findings of the stream corridor assessments are found in Section 4.1.

The predominant issues were erosion (worst in the northeastern reach) and inadequate buffer (worst in the northeastern reach where it was rated very severe; also bad in the western reach, where it was rated severe). Two pipe outfalls were also noted, both consisting of small diameter plastic drain pipe; both exhibited evidence of stormwater discharge (both were rated as minor). One unusual condition, consisting of a likely former dam site (judging by the presence of non-native rock materials on the streambank and stratified bank sediments), was noted in the central reaches of the subwatershed. This site did not appear to be posing any obvious issues, and was rated as minor. All areas of the northeastern and western reaches that possess very severe and severe stream buffers should be planted with native shrubs and trees wherever possible to improve stream conditions, and for wildlife.

Stormwater Conversions

Two existing stormwater management ponds in the Lenah Run subwatershed were targeted during the Retrofit Reconnaissance Investigations, to identify opportunities for facility conversions or upgrades to improve water quality. Of the 2 opportunities identified, 1 was ranked Medium, and 1 Low. See Table 4-22 and Chapter 10 for more information on specific opportunities.

Subwatershed Management Strategy

Figure 7-22 provides a visual summary of potential restoration opportunities in the Lenah Run subwatershed.

<u>Non-Governmental Action (Citizens, HOA and Watershed Groups)</u>

1. Conduct appropriate downspout rain garden installation measures in neighborhoods according to Table 7-14.
2. Engage citizens in a storm drain marking program and conduct marking activities in the neighborhoods indicated in Table 7-14.
3. Educate citizens about the benefits and importance of conservation planting and its effects on water quality for neighborhoods indicated in Table 7-14.
4. Educate property owners about the water quality benefits of reducing fertilizer use on lawns as indicated in Table 7-14.
5. Educate property owners about improving stream buffer management at locations indicated in Table 7-14.
6. Encourage communities to plant open space trees. Table 7-14 shows potential neighborhoods for planting as many as 2,634 open space trees.

<u>Municipal Actions (Loudoun County Government, Loudoun Water and Town Governments)</u>

1. Consider enhancing the forested stream buffer in places where there are no utility conflicts.
2. Work with the residents of NSA-9 to pursue the large SCM opportunity noted in Table 7-14.
3. Consider upgrading the stormwater management ponds described above to improve water quality; see Table 4-22 and Chapter 10.

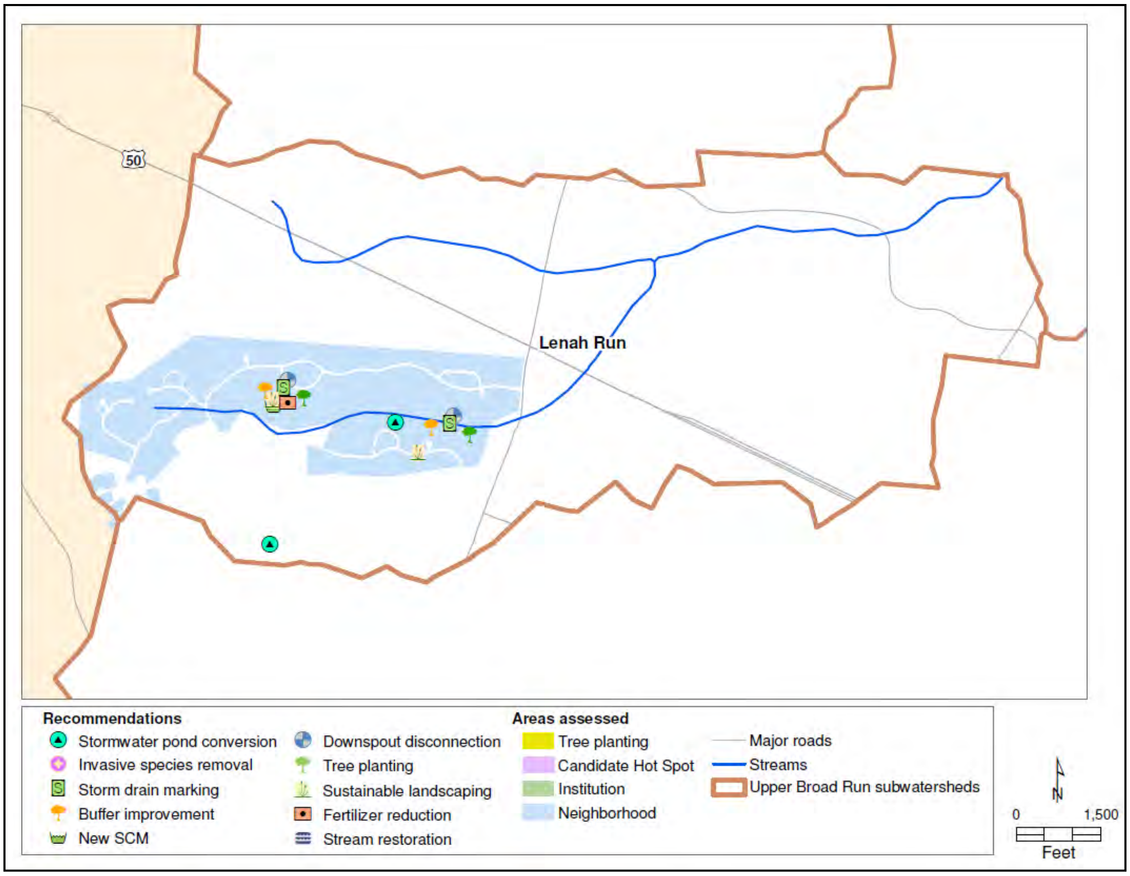


Figure 7-22: Potential Restoration Opportunities in Lenah Run Subwatershed

7.5 Lower North Fork Broad Run

Lower North Fork Broad Run is the second largest subwatershed in the Upper Broad Run watershed. As of 2012, the subwatershed was mainly cropland and forest, though the northeastern corner was heavily residential due to the presence of several Brambleton Landbay communities. The largest number of stream miles was assessed within this watershed due to its benthic and bacteria impairments. Figure 7-23 shows the existing conditions (as of 2012) within the subwatershed. Table 7-15 summarizes the key subwatershed characteristics of Lower North Fork Broad Run.

Neighborhoods

A total of four distinct neighborhoods were identified and assessed within the Lower North Fork Broad Run subwatershed during the uplands assessment of the Upper Broad Run watershed. Preliminary recommendations for neighborhoods in this subwatershed included actions to reduce stormwater volume and pollutants including downspout disconnection, stream buffer improvements, new SCMs, and tree planting. A summary of preliminary neighborhood recommended actions is presented in Table 7-16.

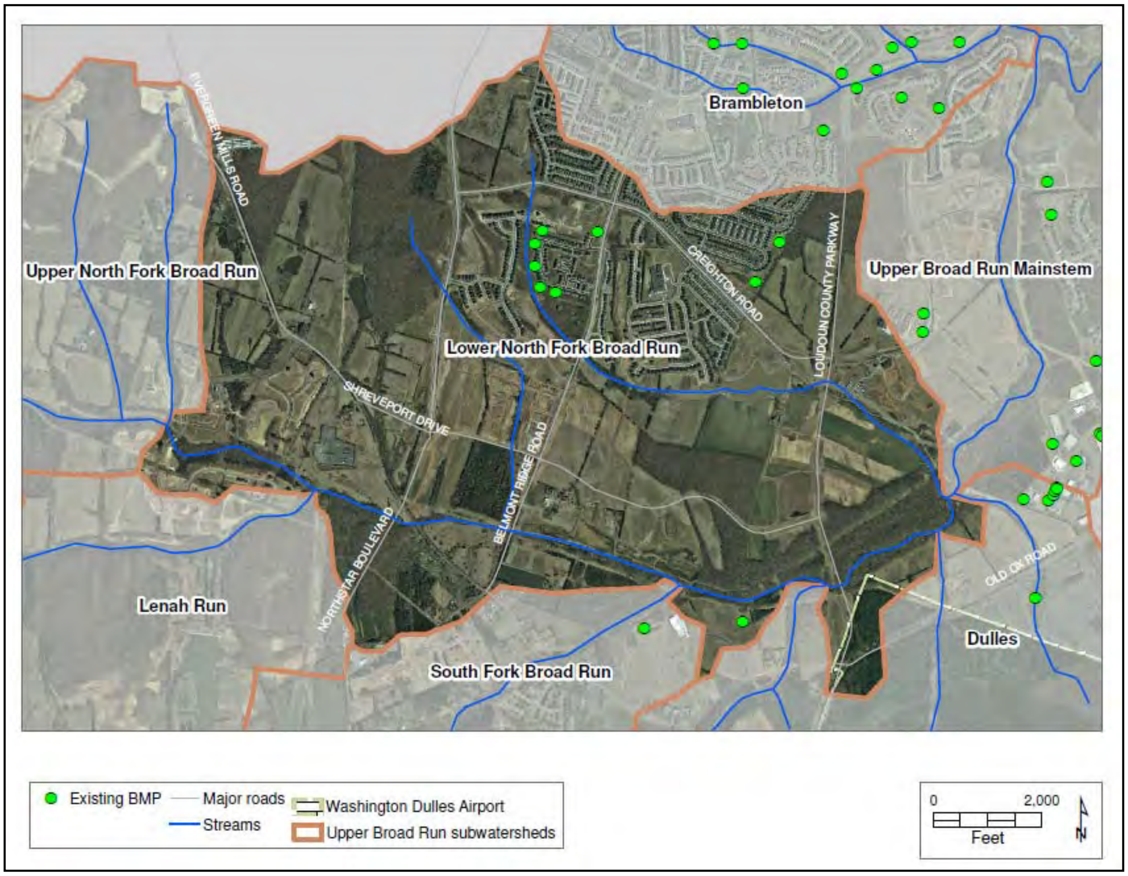


Figure 7-23: Existing Conditions – Lower North Fork Broad Run Subwatershed

Table 7-15: Key Characteristics – Lower North Fork Broad Run Subwatershed

Drainage Area	2,472.6 acres (3.9 sq. mi.)	
Stream Length	6.8 miles	
Land Use/Land Cover	Barren:	0.2%
	Cropland:	27.0%
	Forest:	27.4%
	Pasture:	16.5%
	Urban Impervious:	6.2%
	Urban Pervious:	20.1%
	Water:	2.0%
	Missing:	0.7%
Impervious Cover	185.6 acres	7.5%
Soils	A Soils (low runoff potential):	0%
	B Soils:	0.7%
	C Soils:	39.3%
	D Soils (high runoff potential):	44.1%
	*B/D Soils:	9.5%
	*C/D Soils:	3.6%
SCMs	3.8% of subwatershed treated	

*Dual Hydrologic Soil Group. See Chapter 3 for further detail.

Table 7-16: NSA Recommendations – Lower North Fork Broad Run Subwatershed

			PRELIMINARY RECOMMENDED ACTIONS										
Site ID	Lot Size (acres)	% Opportunity for Downspout Disconnection	Rain Barrels	Rain Gardens	Storm Drain Marking	Conservation Planting	Increase Lot Canopy	Pet Waste Management	Fertilizer Reduction	Buffer Improvement	New SCM	# of Open Space Trees	Notes
NSA-2A	N/A	65										167	Tree planting opportunity in large open field between basketball court and gazebo.
NSA-2B	1/4	30									✓		
NSA-4B	< 1/4	20									✓		
NSA-5	< 1/4	45								✓	✓		

All of the neighborhoods assessed within the Lower North Fork Broad Run subwatershed had at least one opportunity for improvement. Three neighborhoods had greater than 25% of their downspouts draining directly or indirectly to the storm drain. The average lot in these neighborhoods had enough space to redirect the downspout runoff to pervious surfaces (Figure 7-24), but individual rain garden installations were not recommended due to site constraints. NSA-2B, NSA-4B, and NSA-5 all had opportunities for new SCMs in common areas (Figure 7-25). NSA-2A was not recommended for the addition of SCMs, but had a tree planting opportunity in an upland area that is currently mowed lawn.

Hotspots

One site was investigated within the Lower North Fork Broad Run subwatershed of Upper Broad Run: a landscaping and nursery business whose property is now owned by a developer. The property manager informed field staff that they (the former owners) are leasing back the property from the developer and that they expect to be requested to vacate so that development of the parcel may proceed. A summary of field findings and preliminary recommendations at this site is presented in Table 7-17.

Staff assessed the site anyway and noted the following potential pollution causing activities: storage of soil, mulch, and building materials in the open without a cover; greenhouse infrastructure open to the elements; storage of building materials in the open; an open dumpster; and other bulk material, tools, equipment, and discarded items stored in the open in piles or scattered on the property. All of the items above were stored on pervious surfaces such as grass, dirt, or gravel. An ephemeral channel was also noted on the parcel in the midst of an open yard area. Material stored outside should be appropriately sheltered to shield potential pollution causing material from the washing effects of precipitation. Additionally, the tributary of Lower North Fork Broad Run which forms on the property should be buffered to prevent erosion and help filter out harmful pollutants in developed areas.

Figure 7-24: Typical Downspouts and Front Yards in NSA-5 with an Opportunity to Redirect Downspouts to Pervious Area

Figure 7-25: Rain Garden Installation Opportunity in NSA-5 (left) and NSA-4B (right)

Table 7-17: HSI Results and Recommendations – Lower North Fork Broad Run Subwatershed

	Active Pollution Observed			Recommended Follow-up Actions			Hotspot Status			
Site ID	Vehicle Operations	Outdoor Materials	Physical Plant	Refer for Enforcement	Follow Up Inspection	Include in Future Education	Not	Potential	Confirmed	Severe
HSI-013								✓		

Note: No active pollution observed or follow-up actions recommended for this subwatershed.

Institutions

In the Lower North Fork Broad Run subwatershed, just one institution was investigated by field staff. A summary of potential opportunities for restoration at ISI-008 are presented in Table 7-18.

Table 7-18: ISI Recommendations – Lower North Fork Broad Run Subwatershed

PRELIMINARY RECOMMENDED ACTIONS								
Site ID	Storm Drain Marking	# Trees for Planting	Downspout Disconnection	New SCM	Impervious Cover Removal	Buffer Improvement	Trash Management	Notes
ISI-008	✓	510		✓			✓	

Restoration and opportunities to communicate and learn about them are plentiful at ISI-008. Field staff noted substantial grassy square footage that could be converted to more stormwater-friendly tree stands. Field staff noted areas on the southeast periphery, in the center of the bus turnaround drive, and adjacent to and between athletic fields. Further, an area at the north corner of the property has not been cleared for construction and which should be preserved and augmented with additional trees. These tree planting measures, if taken, would increase the forest canopy coverage at the school from 25% to nearly 50%. Tree planting would promote stormwater infiltration as well as reduce maintenance costs involved with mowing and maintaining turf areas around the school. Where trees would not be appropriate, conservation planting could be used instead. Adding to stormwater management opportunities around the school are areas where sheetflow from grassy and athletic areas are causing erosion problems. The southwest corner of the baseball diamond is such an example. Installation of bioretention in conjunction with terraces along the impacted hillside would reduce transport of sediment to the nearby storm drain inlet (Figure 7-26). Like many schools, the staff could benefit from waste management training so that pollutants are not transported from dumpsters to storm drain inlets.

Figure 7-26: Tree Planting Opportunity in Bus Turnaround Area (left) and Bioretention Opportunity (right)

Pervious Areas

Pervious area restoration has the potential to convert areas of turf and other maintained cover, which often have high nutrient inputs to forest, which can instead absorb and filter nutrients. One pervious area was assessed for restoration potential in Lower North Fork Broad Run; this site is Hanson Regional Park. The **Hanson Regional Park** site is located on two separate parcels to the east and west of Evergreen Mills Road, near its intersection with Founders Drive. As of January 2014, the Park is still in its planning stages, and no facilities exist at the site yet. It will be publicly-owned and maintained, however, and is easily accessible by foot, vehicle, or heavy equipment. Owing to the fact that the site is part of a historic area farm, nearly the entire site was either grazed or cropped. Consequently, no turf cover (0%) currently exists at the site. The Park site includes primarily large fallow fields, with various small woodlots and fencerows, particularly along several unnamed intermittent and perennial tributaries. The streams were historically dammed into a series of four small ponds and one medium-sized pond. The 2013 Hanson Regional Park Master Plan was reviewed for planned uses of the Park. Several areas of the Park without specific planned future uses were recommended for reforestation with minimal site preparation to buffer the existing streams, ponds, and nontidal wetland buffers throughout both major Park parcels. Forest re-establishment in these locations would help to buffer the existing streams and wetlands, and would enhance the aesthetic beauty of the Park.

A summary of this site is provided in the Table 7-19.

Table 7-19: PAA Summaries – Lower North Fork Broad Run Subwatershed

Site ID	Location in Subwatershed	Description	Acres	Ownership
Hanson Regional Park	Northwest	County Park	Parcel – 256.18 Recommended planting – 25.19	Public

Stream Corridor Assessments

Field crews walked 2.73 miles of stream (40.4% of total stream miles) within the Lower North Fork Broad Run subwatershed to identify potential water quality problems, restoration opportunities, and stream corridor preservation opportunities. This survey focused on a third order stream reach. A total of 52 problems were identified throughout the Lower North Fork Broad Run subwatershed. Maps showing key findings of the stream corridor assessments are found in Section 4.1.

The predominant issues were erosion (worst in the western-most reaches) and inadequate buffer (worst in the central reaches) throughout. Also noted were several unusual conditions, two of them log jams relating to beaver activity, and causing elevated water levels. Another condition, consisting of a large exposed area of bedrock and nearly vertical faces of shale (roughly 500 feet in length) along the stream in the east-central part of the subwatershed, was noted because it is a unique geologic feature.

During stream corridor assessments, two potential stream restoration opportunities were identified in Lower North Fork Broad Run subwatershed (1 High Priority, 1 Medium). See Chapter 10 for additional details on these potential stream restoration projects.

Stormwater Conversions

One existing stormwater management pond in the Lower North Fork Broad Run subwatershed was examined during the Retrofit Reconnaissance Investigations. No opportunities for conversion or upgrade were identified at this facility.

Subwatershed Management Strategy

Figure 7-27 provides a visual summary of potential restoration opportunities in the Lower North Fork subwatershed.

Non-Governmental Action (Citizens, HOA and Watershed Groups)

1. Conduct appropriate downspout disconnections in neighborhoods with greater than 25% opportunity for disconnection as shown in Table 7-16.
2. Engage citizens in a storm drain marking program and conduct marking activities in the neighborhood indicated in Table 7-16.
3. Educate property owners about improving stream buffer management at locations indicated in Table 7-16.
4. Encourage communities to plant open space trees. Table 7-16 shows a potential neighborhood for planting as many as 167 open space trees.
5. Engage the institutional site listed in Table 7-18 in tree planting and new SCMs.
6. Investigate the pervious areas described in Table 7-19 for potential tree planting.

Municipal Actions (Loudoun County Government, Loudoun Water and Town Governments)

1. Continue to monitor conditions at the potential hotspot indicated in Table 7-17.
2. Work with the institution owners to pursue SCM opportunities at public institutions noted in Table 7-18.
3. Investigate feasibility of recommendations for stream restoration in areas noted during SCA surveys, as outlined in Chapter 10.
4. Consider enhancing the forested stream buffer in places where there are no utility conflicts.
5. Evaluate land preservation options for areas adjacent to high quality streams, as identified in the stream corridor assessment.

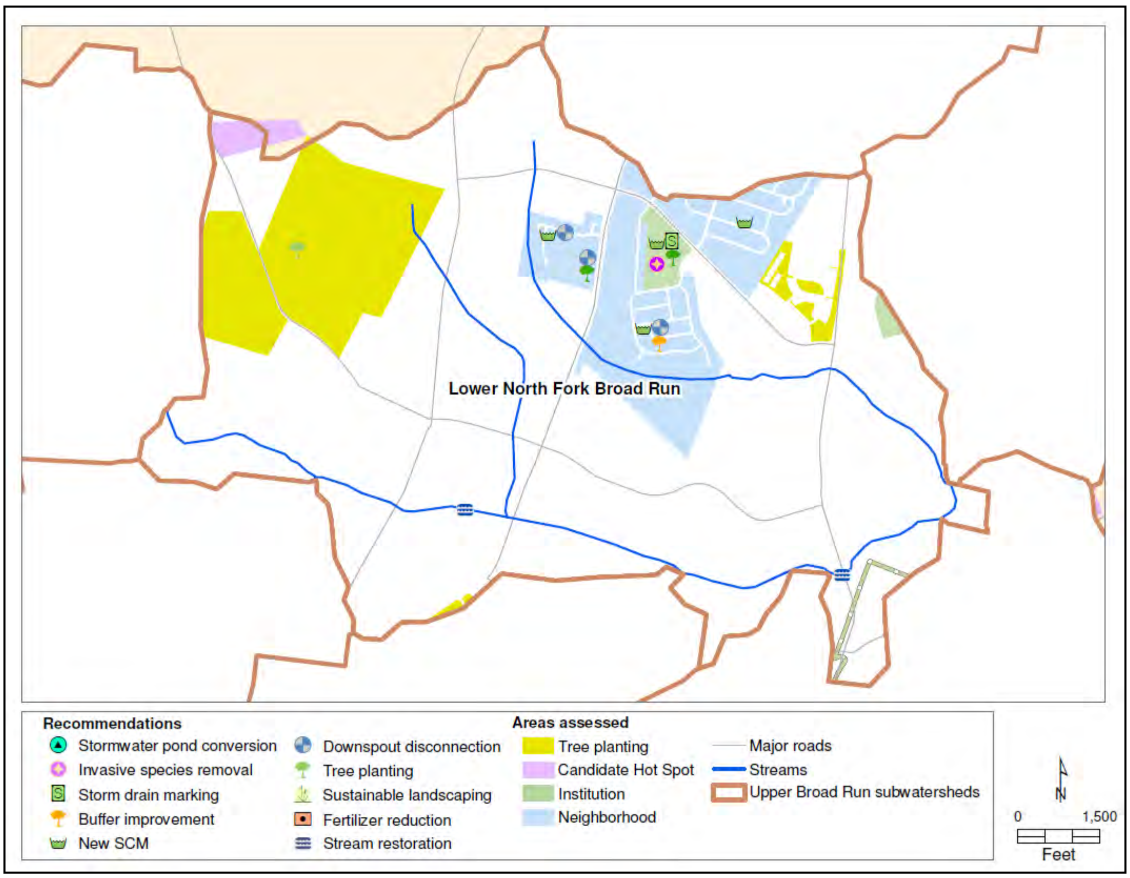


Figure 7-27: Potential Restoration Opportunities in Lower North Fork Broad Run Subwatershed

7.6 South Fork Broad Run

South Fork Broad Run is the largest subwatershed in the Upper Broad Run watershed. The subwatershed is mainly residential in the south-central portion and forested in the western and eastern portions, though residential land use is shifting towards the west as several new residential developments are currently being constructed there. High quality forests and wetlands are also located in the western portion of the subwatershed and are described in the stream corridor discussion. Figure 7-28 shows the existing conditions (as of 2012) within the subwatershed. Table 7-20 summarizes the key subwatershed characteristics of South Fork Broad Run.

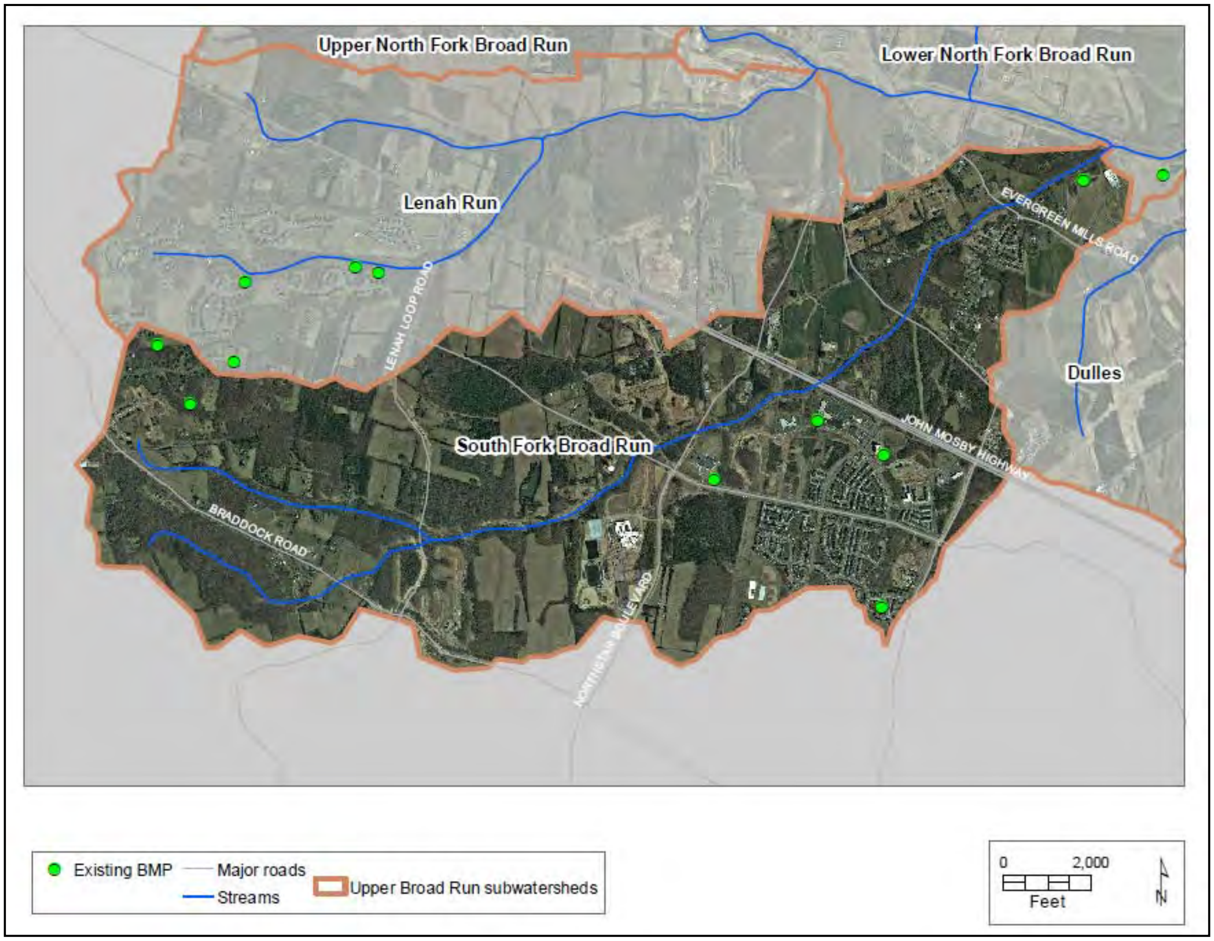


Figure 7-28: Existing Conditions – South Fork Broad Run Subwatershed

Table 7-20: Key Characteristics – South Fork Broad Run Subwatershed

Drainage Area	3,594.7 acres (5.6 sq. mi.)	
Stream Length	6.4 miles	
Land Use/Land Cover	Barren:	0.2%
	Cropland:	16.0%
	Forest:	41.1%
	Pasture:	13.6%
	Urban Impervious:	6.4%
	Urban Pervious:	20.4%
	Water:	1.2%
	Missing:	1.2%
Impervious Cover	273.6 acres	7.6%
Soils	A Soils (low runoff potential):	0%
	B Soils:	13.8%
	C Soils:	18.7%
	D Soils (high runoff potential):	54.6%
	*B/D Soils:	5.0%
	*C/D Soils:	7.4%
SCMs	6.2% of subwatershed treated	

*Dual Hydrologic Soil Group. See Chapter 3 for further detail.

Neighborhoods

A total of five distinct neighborhoods were identified and assessed within the South Fork Broad Run subwatershed during the uplands assessment of the Upper Broad Run watershed. Preliminary recommendations for neighborhoods in this subwatershed included actions to reduce stormwater volume and pollutants including downspout disconnection, use of rain barrels, conservation planting, storm drain marking, stream buffer improvements, and SCMs. A summary of preliminary neighborhood recommended actions is presented in Table 7-21.

All neighborhoods assessed within the South Fork Broad Run subwatershed had opportunities for improvement. Storm drain marking, rain barrels, stream buffer improvements, and SCMs were each recommended for several neighborhoods. Four of the neighborhoods assessed were either condominiums or attached townhomes with little green space, which is why downspouts are recommended for redirection to rain barrels. These rain barrels can serve as temporary storage of roof runoff, decreasing the volume of stormwater running off site, but can also do a great job of promoting stormwater runoff awareness. Stream buffer improvement was recommended for two neighborhoods, one of which, NSA-20, has a parking lot located within 15 feet of a stream (Figure 7-29). NSA-18 and NSA-22 were both recommended for new SCMs (Figure 7-30).

Table 7-21: NSA Recommendations – South Fork Broad Run Subwatershed

		PRELIMINARY RECOMMENDED ACTIONS											
Site ID	**Lot Size (acres)**	**%Opportunity for Downspout Disconnection**	**Rain Barrels**	**Rain Gardens**	**Storm Drain Marking**	**Conservation Planting**	**Increase Lot Canopy**	**Pet Waste Management**	**Trash Management**	**Buffer Improvement**	**New SCM**	**# of Open Space Trees**	**Notes**
NSA-0	N/A	100	✓		✓		✓			✓			Nearly all downspouts draining the back half of condo rooftops drain directly to impervious. Downspouts in front drain to small grass strips that are less than 15 feet long, and likely do not allow for much infiltration.
NSA-12	N/A	45	✓				✓						
NSA-18	N/A	70	✓		✓		✓				✓		
NSA-20	N/A	90	✓		✓		✓			✓			Parking lot within 15 feet of stream channel.
NSA-22	1/4	5				✓	✓				✓		Good opportunity for rain gardens behind houses.

Figure 7-29: Stream Buffer Encroachment in NSA-20

Figure 7-30: Opportunity for Rain Garden Installation within NSA-22 (left) and NSA-18 (right)

Hotspots

Field staff investigated one site in South Fork Broad Run subwatershed of Upper Broad Run, consisting of a shopping center. The retail area consists of three strip shopping center buildings plus standalone businesses, including one gasoline fueling business. Due to the multiplicity of businesses and possible hotspots, the investigation was broken down into two sub-investigations: western buildings (encompassing a supermarket and shops located in two largest buildings) and eastern buildings (remaining smaller buildings aggregated). Field results and preliminary recommendations are summarized in Table 7-22.

Table 7-22: HSI Results and Recommendations – South Fork Broad Run Subwatershed

	Active Pollution Observed			Recommended Follow-up Actions			Hotspot Status			
Site ID	Vehicle Operations	Outdoor Materials	Physical Plant	Refer for Enforcement	Follow Up Inspection	Include in Future Education	Not	Potential	Confirmed	Severe
HSI-010							✓			
HSI-011		✓		✓	✓				✓	

Dumpsters located in the loading dock area of a supermarket were found to be covered, but close to a storm drain inlet. Dumpsters such as these would benefit from implementation of secondary containment. In the loading dock ramp area, field staff noted several pieces of bulk trash, which are a potential pollution source. Along a walkway to the rear of one of the businesses were several waste cooking oil containers, which could be placed in secondary containment.

Behind the adjacent strip of businesses, a fenced in loading dock area behind a restaurant was found to be filled with surplus items and bulk trash, including a torch, keg storage rack, and pieces of furniture. Storage areas such as these could benefit from canopy cover or a permanent structure to redirect rain away from potential pollution sources.

The eastern portion of the shopping center included free-standing convenience stores, a fueling station, bank, a restaurant, and other businesses arranged in one strip building. These were investigated together and comprise site HSI-011. Investigators found instances of bulk material storage in dumpster stalls, overflowing trash cans, and a leaking trash compactor. At a convenience store, staff noted a small pile of deicing salt stored in the open near the store entrance. At the same store, crates, bins and other material were found in the open within a dumpster stall. Waste management improvement and remedying of misplaced deicing chemical could be gained by training of employees.

Two compactors were found attached to a pharmacy, at least one of which had leaked greasy material onto the impervious surface. The area of the compactors was near a storm drain inlet. At one site, a dumpster was found in good condition; however, it was situated next to a curb cut leading to a stormwater facility. Secondary containment to contain potential spills would be beneficial in both of these situations.

Institutions

In the South Fork Broad Run subwatershed, field staff investigated two public schools and two public institutions. A summary of potential opportunities for restoration are presented in Table 7-23.

Table 7-23: ISI Recommendations – South Fork Broad Run Subwatershed

	PRELIMINARY RECOMMENDED ACTIONS							
Site ID	Storm Drain Marking	# Trees for Planting	Downspout Disconnection	New SCM	Impervious Cover Removal	Buffer Improvement	Trash Management	Notes
ISI-001		23					✓	Minor pretreatment opportunities.
ISI-002		8	✓	✓			✓	No storm water infrastructure other than ditch/swale.
ISI-006		1,746		✓		✓		
ISI-007	✓	636		✓		✓	✓	

ISI-001 is a recently constructed institution featuring a large stormwater treatment pond that serves the surrounding commercial and residential areas and treats runoff from the institution's parking area. The available land is highly utilized, providing limited restoration opportunities.

Nevertheless, this public institution provides an excellent showcase for communicating the need for Upper Broad Run watershed restoration to patrons. Measures that are already visible on the property include the provision of pet waste bags along the walking path adjacent to the wet pond, pre-stenciled manhole covers, and placement of a recycling dumpster. The planting of additional trees on the berm along the north corner of the property would be an excellent, specific action to promote stormwater infiltration and increase the size of the tree canopy on the property (Figure 7-31). Improvements to waste management include upsizing the recycling container, which was found by field staff to be overflowing with cardboard.

Figure 7-31: Tree Planting Opportunity

In contrast to ISI-001, ISI-002 is an older institution with stormwater management challenges characteristic of older facilities. The site features older impervious surface (a portion of the parking lot is breaking up) and in topography it slopes gradually toward Gum Spring Rd. General measures to improve stormwater infiltration on the site include the addition of bioretention in front of and to the side of the maintenance building and in a zone adjacent to Gum Spring Road. At present, the only stormwater treatment offered on the site is a grassy swale along Gum Spring Road (Figure 7-32). Bioretention would increase infiltration of stormwater runoff and reduce the net impervious footprint of the fire station. A further measure to increase stormwater infiltration would be the installation of rain barrels on downspouts. The risk of polluted stormwater would be lessened by implementation of waste management training. Field staff noted the presence of a rusted and overflowing dumpster and a collection of discarded equipment stored on impervious surfaces on the property. Lastly, extending the forested portion of the property to a grassy area behind the main building would further improve onsite stormwater infiltration and provide additional shade to the building.

Figure 7-32: Bioretention Opportunity at ISI-002

ISI-006 is an extensive school facility that provides ample opportunities for watershed restoration. Field staff noted that the main student parking lot is already provided with modern stormwater treatment in the form of a sand filter and bioretention. The stormwater facility, however, is in need of maintenance due to washout of gravel on the east edge of the lot by runoff originating from a culvert under a nearby roadway. Pervious asphalt is also provided on the northwest faculty parking lot. Potential restoration measures that can improve upon onsite stormwater management include installation of bioretention at a yard drain off the northwest corner of the student lot. A curb cut would divert stormwater runoff in the parking lot to the treatment area. Additionally, a grassy swale running east-to-west along a recently removed road could be converted to linear bioretention to both (a) treat and infiltrate stormwater runoff and (b) mitigate an erosion issue developing on the western edge of the property. Tree cover could be increased on the school campus by utilizing current mowed grass areas along the northern and southern peripheries (Figure 7-33). The trees would partially shade the athletic field complex, improve infiltration of stormwater that currently sheets off compacted, grassed areas, and provide habitat for animal populations. Construction of a sanitary sewer right-of-way off the southwestern edge of the property has encroached on a first order stream buffer as well as the South Fork of Broad Run. Replanting the buffer on both sides of the stream (but outside of the sanitary sewer easement) as well as along tributaries near the southern and northern borders of the high school property would improve water quality by promoting stormwater infiltration, providing bank stability, and improving instream habitat by increasing shading.

ISI-007 is another recently constructed school that provides many candidate restoration opportunities that can improve water quality in the tributary and stream that run along the north and east edges of the property. The availability of grassed areas presents an excellent opportunity to improve the stream buffer and augment existing tree stands near these waterways. Additionally, a large area between faculty parking and the nearby roadway presents an opportunity to demonstrate improved stormwater infiltration and interception via tree planting. Improvements to stormwater management can also be incorporated into environmental education by encouraging students to select and plant native species in a bioretention area to improve stormwater infiltration along a grassy swale. Such a new treatment area would absorb and treat runoff from the adjacent drive leading toward the rear recreation area. Training of staff would also be useful to better management of waste. Field staff noted stains leading from the dumpster area toward a storm drain inlet. Stains indicate a problem with waste material leaching out of the dumpster and being transported into the storm sewer network.

Figure 7-33: Tree Planting (left) and Bioretention Opportunity (right) at ISI-006

Pervious Areas

Pervious area restoration has the potential to convert areas of turf and other maintained cover, which often have high nutrient inputs to forest, which can absorb and filter rather than contribute nutrients. The **Briarfield Estates HOA** site is located off of Cameron Parish Drive, near Evergreen Mills Road. It is privately-owned, and has one medium-sized potential tree planting area adjacent to a small existing stormwater facility. A large amount of the site currently possesses turf (60%). Benefits of tree planting here would include the slowing of surface flow runoff to the adjacent stream corridor (southeast of the planting site), and aesthetic improvements to adjacent homeowners.

A summary of this site is provided in the Table 7-24.

Table 7-24: PAA Summaries – South Fork Broad Run Subwatershed

Site ID	Location in Subwatershed	Description	Acres	Ownership
Briarfield Estates HOA	Northeast	Private Open Space	Parcel – N/A Recommended planting – 1.97	Private

Stream Corridor Assessments

Field crews walked 2.57 miles of stream (40.2% of total stream miles) within the South Fork Broad Run subwatershed to identify potential water quality problems, restoration opportunities, and stream corridor preservation opportunities. This survey focused on first through second order stream reaches. A total of 41 problems were identified throughout the South Fork Broad Run subwatershed. Maps showing key findings of the stream corridor assessments are found in Section 4.1.

The predominant issues were erosion (worst areas in the northern-most part of the eastern reach, where it was rated as severe in places) and insufficient buffer (worst areas in the northern-most part of the eastern reach where it was rated as severe in places, and in the northern part of the western reach, where it was rated severe in places).

During stream corridor assessments, two potential stream restoration opportunities were identified in South Fork Broad Run subwatershed (both ranked Low Priority). See Chapter 10 for additional details on these potential stream restoration projects.

One unusual condition consisted of a very large pile of discarded sod rolls within about 25 feet of the stream at an adjacent sod farm. This pile has apparently contributed to excess sedimentation in a small area of the adjacent streambed. It is advisable that this sod pile be moved to an upland location at least 300 feet from the stream. Additionally, two separate large, dense stands of non-native, invasive bamboo were noted along the banks of the stream downstream of the sod farm. Some of the bamboo on the outer edges of the streambank was falling into the stream and pulling away the streambank, exacerbating further erosion. These bamboo stands should be eliminated as soon as possible before they spread even further; native trees and shrubs should be planted in place of the bamboo.

South Fork Broad Run's headwater area was recommended for stream corridor preservation (Figure 7-34). This headwater stream was broken into many small, braided channels connected directly to, or only inches above, the floodplain. Little flow was present here, and almost no bank erosion existed. Most of the upper area possessed broad, forested nontidal wetland buffers; though some recent land clearing activity was encroaching on these buffers in certain areas. The forested buffers possessed moderately large, second-growth deciduous trees, consisting of mainly of pin and white oaks, red maple, and boxelder. Spicebush, cinnamon fern, and Virginia chain fern were the principal species in the shrub and herbaceous layers.

It is important that headwater areas such as these in the Upper Broad Run watershed be preserved wherever possible. Scientific evidence clearly shows that healthy headwaters are inextricably linked to the health of downstream and river ecosystems (Meyer et al. 2003). Well-buffered, undisturbed headwaters supply organic matter that contributes to the growth and productivity of higher organisms, including insects and fish. Headwaters also help to keep sediment and pollutants out of the stream system's lower reaches. In addition, they enhance biodiversity by supporting flora and fauna that are uniquely acclimated to this habitat.

Stormwater Conversions

A total of 3 existing stormwater management ponds in the South Fork Broad Run subwatershed were considered during Retrofit Reconnaissance Investigations. The conversion feasibility, along with subsequent potential to improve water quality, was ranked for each facility. Of the opportunities identified, 1 was ranked as Medium, and 1 as Low. For details, see Table 4-22 and Chapter 10.


Figure 7-34: Downstream Section (left) and Upstream Section (right) of Stream Corridor Recommended for Preservation within South Fork Broad Run

Subwatershed Management Strategy

Figure 7-35 provides a visual summary of potential restoration opportunities in the South Fork Broad Run subwatershed.

<u>Non-Governmental Action (Citizens, HOA and Watershed Groups)</u>

1. Conduct appropriate downspout rain barrel installation measures in neighborhoods according to Table 7-21.
2. Engage citizens in a storm drain marking program and conduct marking activities in the neighborhoods indicated in Table 7-21.
3. Educate citizens about the benefits and importance of conservation planting and its effects on water quality for the neighborhood indicated in Table 7-21.
4. Educate property owners about improving stream buffer management at locations indicated in Table 7-21.
5. Engage institutional sites listed in Table 7-23 in tree planting and new SCMs.
6. Investigate the pervious areas described in Table 7-24 for potential tree planting.

<u>Municipal Actions (Loudoun County Government, Loudoun Water and Town Governments)</u>

1. Follow-up regarding conditions at confirmed hotspot indicated in Table 7-22.
2. Educate institutions about the importance of proper trash management as listed in Table 7-23.

3. Work with the institution owners to pursue SCM opportunities at public institutions noted in Table 7-23.
4. Engage sod farmers about relocating discarded sod away from the stream channel.
5. Evaluate land preservation options (including potentially promoting the use of conservation easements) for the forested wetland areas adjacent to high quality streams, recommended for preservation by the stream corridor assessment.
6. Investigate feasibility of recommendations for stream restoration in areas noted during SCA surveys, as outlined in Chapter 10.
7. Consider enhancing the forested stream buffer in places where there are no utility conflicts.
8. Consider the eradication of bamboo stands along the stream corridor.
9. Consider upgrading the stormwater management ponds described above for their potential conversion to improve water quality. See Chapter 10 for further details.

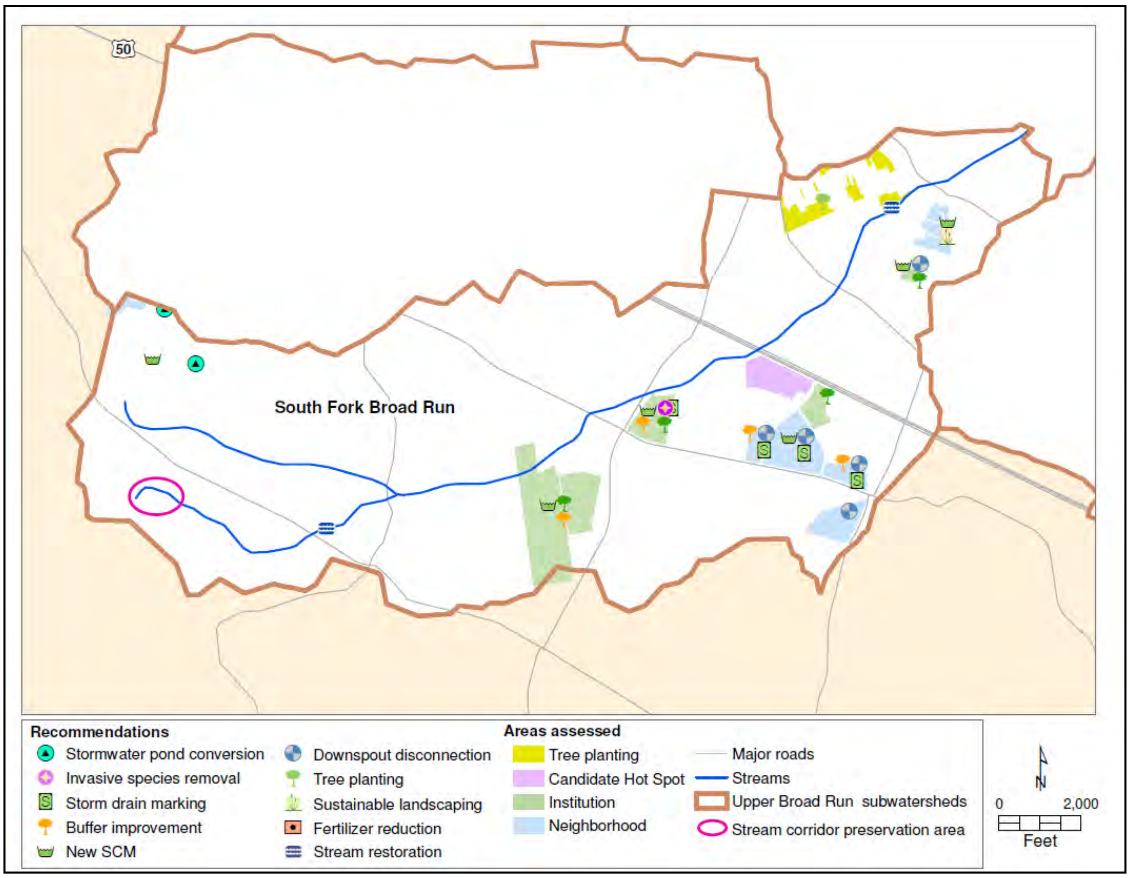


Figure 7-35: Potential Restoration Opportunities in South Fork Broad Run Subwatershed

7.7 Upper North Fork Broad Run

Upper North Fork Broad Run is the fourth largest subwatershed in the Upper Broad Run watershed. The subwatershed is mainly cropland, pasture and forest, though new residential developments are starting to appear. High quality forests and wetlands are also located in the western portion of the subwatershed, and are described in the stream corridor discussion. Figure 7-36 shows the existing conditions (as of 2012) within the subwatershed. Table 7-25 summarizes the key subwatershed characteristics of South Fork Broad Run.

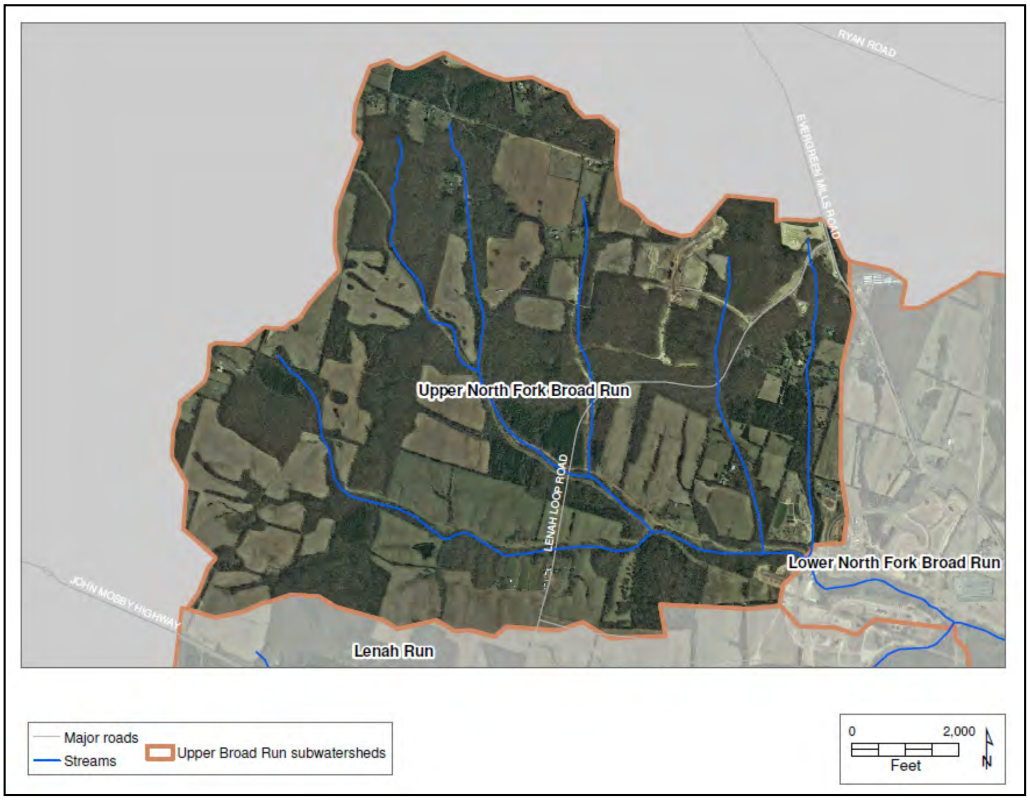


Figure 7-36: Existing Conditions – Upper North Fork Broad Run Subwatershed

Neighborhoods

No neighborhood source assessments were performed within the Upper North Fork Broad Run subwatershed.

Hotspots

No hotspot site investigations were performed within the Upper North Fork Broad Run subwatershed.

Table 7-25: Key Characteristics – Upper North Fork Broad Run Subwatershed

Drainage Area	2,223.9 acres (3.5 sq. mi.)	
Stream Length	8.2 miles	
Land Use/Land Cover	Barren:	0.0%
	Cropland:	26.4%
	Forest:	51.8%
	Pasture:	19.3%
	Urban Impervious:	0.2%
	Urban Pervious:	1.3%
	Water:	0.3%
	Missing:	0.6%
Impervious Cover	20.0 acres	0.9%
Soils	A Soils (low runoff potential):	0%
	B Soils:	5.1%
	C Soils:	14.2%
	D Soils (high runoff potential):	66.4%
	*B/D Soils:	3.3%
	*C/D Soils:	10.8%
SCMs	0% of subwatershed treated	

*Dual Hydrologic Soil Group. See Chapter 3 for further detail.

Institutions

No institutional site investigations were performed within the Upper North Fork Broad Run sub-watershed.

Pervious Areas

No pervious area assessments were performed within the Upper North Fork Broad Run sub-watershed.

Stream Corridor Assessments

Field crews walked 2.41 miles of stream (29.2% of total stream miles) within the Upper North Fork Broad Run subwatershed to identify potential water quality problems, restoration opportunities, and stream corridor preservation opportunities. This survey focused on first through second order stream reaches. A total of 32 problems were identified throughout the Upper North Fork Broad Run subwatershed. Maps showing key findings of the stream corridor assessments are found in Section 4.1.

The predominant issues were erosion and inadequate buffer, although these problems were somewhat localized. Some of the bank erosion was exacerbated by cows from an adjacent farm that had free, unfenced access to a long reach of stream. One location during the field survey exhibited an unusual condition, noted as being moderately severe (score = 3). This condition was at a foot trail crossing that is also currently used as a motor vehicle ford crossing (likely in part as an access to the adjacent sewer line ROW). Motor vehicles should be denied direct access to the stream here; a driveable bridge should be constructed, preferably with its base out of wetlands and the floodplain. In addition, cattle from adjacent farms should be denied free access to long reaches of the stream by use of appropriate fencing.

During stream corridor assessments, two potential stream restoration opportunities were identified in Upper North Fork Broad Run subwatershed (1 Medium Priority and 1 Low). See Chapter 10 for additional details on these potential stream restoration projects.

Upper North Fork Broad Run's headwater area was recommended for stream corridor preservation (Figure 7-37). This headwater stream was broken into many small, braided channels connected directly to, or only inches above, the floodplain. Little flow was present here, and almost no bank erosion existed. Most of the upper area possessed broad, forested buffers; some of the forest here was wider than 300 feet on each bank. The forested buffers possessed moderately large, second-growth deciduous trees, consisting of pine, white, and willow oaks, red maple, boxelder, and green ash. The shrub and herbaceous layers were relatively sparse, likely owing to the generally dense tree canopy, but spicebush and sensitive fern were the principal species. Several areas with particularly low topographies along the braided channels comprised forested nontidal wetlands.

Figure 7-37: Upper North Fork Broad Run Stream Corridor Recommended for Preservation

It is important that headwater areas such as these in the Upper Broad Run watershed be preserved wherever possible. Scientific evidence clearly shows that healthy headwaters are inextricably linked to the health of downstream and river ecosystems (Meyer et al. 2003). Well-buffered, undisturbed headwaters supply organic matter that contributes to the growth and productivity of higher organisms, including insects and fish. Headwaters also help to keep sediment and pollutants out of the stream system's lower reaches. In addition, they enhance biodiversity by supporting flora and fauna that are uniquely acclimated to this habitat.

Stormwater Conversions

No existing stormwater management ponds were assessed within the Upper North Fork Broad Run subwatershed.

Subwatershed Management Strategy

Figure 7-38 provides a visual summary of potential restoration opportunities in the Upper North Fork Broad Run subwatershed.

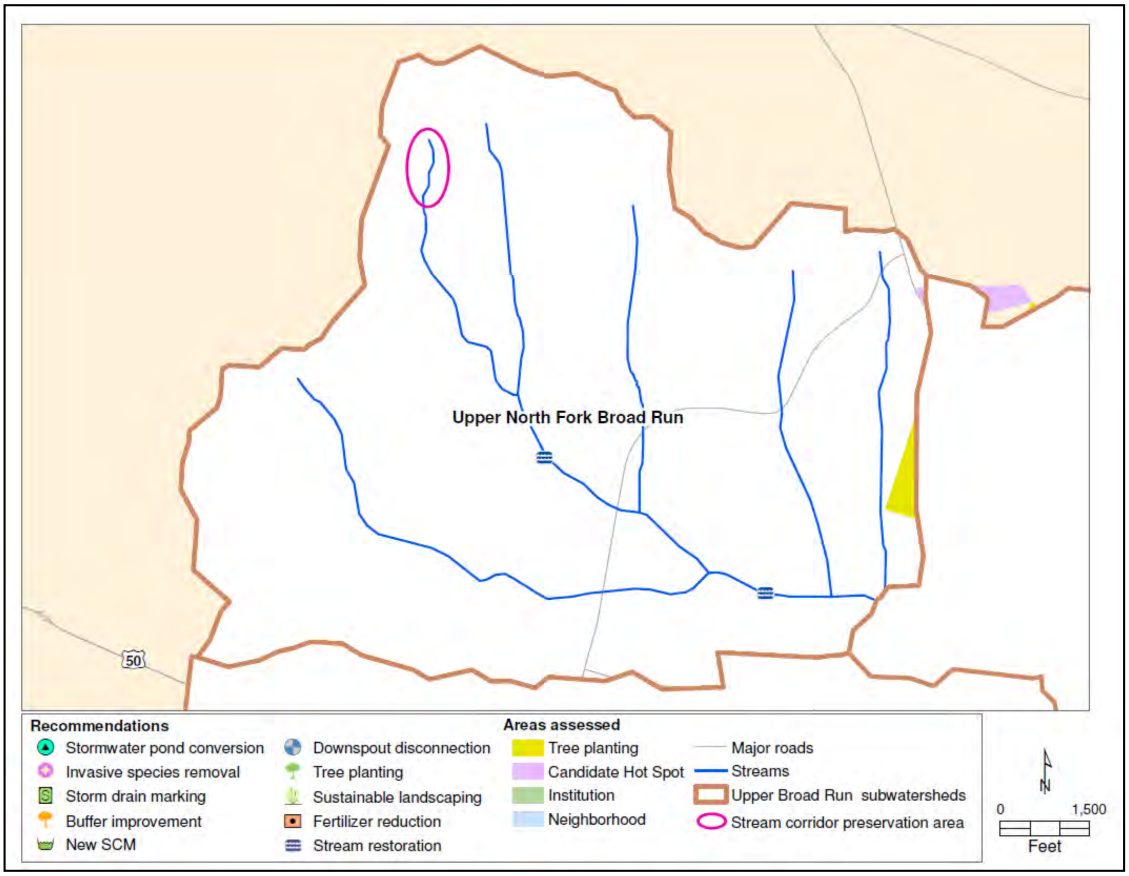


Figure 7-38: Potential Restoration Opportunities in Upper North Fork Broad Run Subwatershed

<u>Non-Governmental Action (Citizens, HOA and Watershed Groups)</u>

1. Engage property owners about fencing animals out of stream corridors.

<u>Municipal Actions (Loudoun County Government, Loudoun Water and Town Governments)</u>

1. Evaluate land preservation options (including potentially promoting the use of conservation easements) to protect the headwater stream corridor, recommended for preservation by the stream corridor assessment.

2. Investigate feasibility of recommendations for stream restoration in areas noted during SCA surveys, as outlined in Chapter 10.
3. Educate property owners about the importance of keeping motorized vehicles out of streams; pursue alternatives to the existing stream crossing, to replace the ford with a bridge.

CHAPTER 8: SUBWATERSHED RANKING

8.1 Introduction

Data from the seven Upper Broad Run subwatersheds are useful for assessing patterns of watershed condition and for evaluating restoration potential of the different areas. As reported in previous chapters, results of the field assessments and desktop analysis provide insight into the levels of ecological conditions and stressors present within the different portions of Upper Broad Run watershed (Figure 1-2), as documented by various measurements. A combined evaluation approach estimates the severity and potential for correction within each subwatershed. The extent and magnitude of stressors can be used as indicators to understand which factors are contributing to water quality degradation; combined, the suite of measures may indicate priorities for restoration efforts. The subsections below describe the criteria and methodology we used to develop rankings based on indicators, as applied to the seven subwatersheds. This subwatershed priority ranking method provides a tool for targeting restoration actions by location.

8.2 Subwatershed Ranking Criteria

Criteria describing environmental stressors within a subwatershed provide information to support a priority ranking method for identifying restoration need and potential. The subwatershed restoration priorities identified with this method are based on a sum of ranking scores for a number of criteria which describe declining water quality, as well as opportunities for improving conditions. This analysis integrates results from the field surveys, desktop GIS analysis, and pollutant loading model described earlier in this report. The restoration priority total score for a subwatershed is comprised of ranked conditions of the following criteria:

- Phosphorus and Nitrogen loads
- Impervious surface
- Neighborhood restoration opportunity/Pollution source index
- Neighborhood downspout disconnection
- Institutional Site Investigations
- Pervious Area Assessments
- Municipal stormwater management facility conversions
- Stream buffer improvement
- Stream restoration potential

To develop a restoration priority total score, each contributing criterion receives a ranking score of 1 to 4, with 4 representing the most severe condition recorded during the assessments or the greatest opportunity to bring about change. In general, the initial analysis approach intended to separate the evaluation results for each criterion into four classes that would result in at least one subwatershed in each ranked class (i.e., 1, 2, 3, or 4). In some cases, the data distribution did not facilitate a balanced spread across the classes; for instance, a narrow range of values, clustered values, or occurrence of null values (zero) where measured conditions did not exist within the subwatershed.

The criteria combined to calculate the restoration priority total scores reflect watershed management goals and make use of information compiled during the watershed characterization and field efforts. The sections below provide descriptions and ranking levels for each of the selected criteria. These are followed by a summary of the rankings and restoration priority total scores for the subwatersheds within Upper Broad Run watershed.

8.2.1 Phosphorus and Nitrogen Loads

One of the objectives of the watershed management plan is to improve and maintain water quality in Upper Broad Run and to help meet Chesapeake Bay WIP targets by reducing annual average total phosphorus and nitrogen loads. The model used for the analysis applied the loading rates established by the Chesapeake Bay Program to calculate nitrogen and phosphorus loads for each subwatershed. Chapter 6 provides more detail on the pollutant loading analysis for Upper Broad Run watershed.

To compare loading rates by subwatershed, the ranking analysis approach involved dividing annual nitrogen and phosphorus loads by subwatershed area. This represents pollutant loading rates (lbs/acre/year) and allows a direct comparison among the seven subwatersheds. Higher pollutant loading rates indicate higher priorities for restoration within the Upper Broad Run watershed; therefore, higher pollutant loading rates are assigned high ranking scores to denote greater water quality impacts and restoration needs.

Subwatershed nitrogen loading rates ranged from 0.2 to 21.6 lbs/acre/year. The following point system assigns a nitrogen loading ranking score to each subwatershed based on the loading rate calculated by the model:

- > 20 lbs/acre/year = 4 points
- 11 - 20 lbs/acre/year = 3 points
- 5 - 10 lbs/acre/year = 2 points
- < 5 lbs/acre/year = 1 point

Subwatershed phosphorus loading rates ranged from 0.01 to 1.23 lbs/acre/year. The following point system assigns a phosphorus loading ranking score to each subwatershed based on the calculated loading rates:

- > 1 lbs/acre/year = 4 points
- 0.6 - 1 lbs/acre/year = 3 points
- 0.25 - 0.5 lbs/acre/year = 2 points
- < 0.25 lbs/acre/year = 1 point

Table 8-1 presents a summary of the nitrogen and phosphorus loading rates and corresponding ranking scores by subwatershed.

Table 8-1: Nitrogen and Phosphorus Loading Rates and Ranking Scores by Subwatershed

Subwatershed	Nitrogen Loading Rate (lbs/acre/yr)	Nitrogen Loading Ranking Score	Phosphorus Loading Rate (lbs/acre/yr)	Phosphorus Loading Ranking Score
Brambleton	21.6	4	1.23	4
Upper Broad Run Mainstem	16.6	3	0.95	3
Dulles	6.1	2	0.32	2
Lenah Run	3.46	1	0.2	1
Lower North Fork Broad Run	6.49	2	0.37	2
South Fork Broad Run	6.77	2	0.39	2
Upper North Fork Broad Run	0.22	1	0.01	1

8.2.2 Impervious Surfaces

Impervious surfaces, including roads, parking lots, roofs and other paved surfaces, prevent precipitation from infiltrating into the ground as it would naturally in a forest or meadow in good condition. As a result, impervious surface runoff can result in decreased times of concentration of stormwater to receiving streams ("flashy flows") leading to erosion, flooding, habitat degradation, and increased pollutant loads to receiving water bodies. As illustrated by the Impervious Cover Model (Schueler 2008, detailed in Chapter 3), watershed areas with high proportions of impervious cover are more likely to have degraded stream systems and to be significant contributors to water quality problems than those that are less developed.

As described in the Chapter 3, Loudoun County's impervious cover data layer (comprised of roads, buildings, driveways, and other impervious surfaces) provides the information to support estimation of impervious cover for Upper Broad Run watershed. Overall, impervious surfaces cover about 9 percent of Upper Broad Run watershed, as determined by the 2012 data layer used in the analysis. Subwatershed impervious cover percentages range from approximately 1 to 22 percent of subwatershed area. Subwatersheds with higher percentages of impervious cover indicate higher priorities for restoration; higher scores denote greater water quality impacts and restoration needs. The following point system assigns impervious ranking scores to the seven subwatersheds based on subwatershed impervious surface percentages, roughly following guidance from the Impervious Cover Model:

- 16 - 25% = 3 points
- 11 - 15% = 2 points
- 0 - 10% = 1 point

Table 8-2 presents a summary of the percent impervious cover values and corresponding ranking scores by subwatershed.

Table 8-2: Percent Impervious Cover Ranking Scores by Subwatershed

Subwatershed	Percent Impervious Cover	Impervious Ranking Score
Brambleton	21.6	3
Upper Broad Run Mainstem	16.9	3
Dulles	6.3	1
Lenah Run	4.1	1
Lower North Fork Broad Run	7.5	1
South Fork Broad Run	7.6	1
Upper North Fork Broad Run	0.9	1

8.2.3 Neighborhood Restoration Opportunity/Pollution Source Indexes

As described in Chapter 3, neighborhood source assessments (NSAs) included estimations of neighborhood pollution severity and restoration potential. The Pollution Severity Index (PSI) reflects, in general, the severity of pollution generated by a neighborhood; field crews rated PSI as severe, high, moderate, or none. The Restoration Opportunity Index (ROI) reflects the neighborhood's potential for residential restoration projects; field crews rated ROI as high, moderate, or low. Out of the 25 neighborhoods assessed, one received a severe or high rating for both PSI and ROI, and five neighborhoods received a high rating for either PSI or ROI and a moderate rating for the other index. Neighborhoods with severe or high PSI and ROI ratings represent the best areas to initially focus restoration efforts. The Dulles and Upper North Fork Broad Run subwatersheds did not include neighborhoods at the time of the analysis, so these areas did not involve NSA surveys.

The subwatershed with the severe rating for PSI/ROI received the highest score (4 points), regardless of the assessments for any other neighborhood in the subwatershed. Of the remaining subwatersheds, those with a high PSI or ROI and a moderate score for the other index received a ranking score of 3 points if there were other PSI/ROI assessments in the subwatershed; 2 points if there were not. All other subwatersheds with neighborhoods received a ranking score of 1 point. The following point system summarizes PSI/ROI ranking scores for the seven subwatersheds:

- Severe/High = 4 points
- High/Moderate or Moderate/High and other neighborhoods ranked lower = 3 points
- High/Moderate or Moderate/High only = 2 points
- All other ratings = 1 point
- No NSAs performed in subwatershed = 0 points

Table 8-3 presents a summary of the number of NSAs associated with various PSI/ROI ratings and corresponding PSI/ROI ranking scores by subwatershed.

Table 8-3: NSA PSI/ROI Ranking Scores by Subwatershed

Subwatershed	Number of NSAs with PSI/ROI Rating				NSA PSI/ROI Ranking Score
	Severe/High	High/Moderate	Moderate/High	Other	
Brambleton			1	12	3
Upper Broad Run Mainstem			1		2
Dulles					0
Lenah Run	1		1		4
Lower North Fork Broad Run		1		3	3
South Fork Broad Run			1	4	3
Upper North Fork Broad Run					0

8.2.4 Neighborhood Downspout Disconnection

Rooftops with connected downspouts discharge runoff directly to the storm drain system or to impervious surfaces. In either case, there is little or no treatment of stormwater runoff before it reaches the stream system. Disconnected downspouts drain to pervious areas such as lawns, rain barrels, or rain gardens, and allow rooftop runoff to infiltrate the ground and enter streams through the groundwater system in a slower, more natural manner. Downspout disconnection is desirable because it decreases flow and reduces pollutant loads to streams during storm events.

Neighborhood Source Assessments recommended downspout disconnection for neighborhoods where at least 25 percent of the downspouts were directly connected to impervious surfaces or the storm drain system, and where the average lot had at least 15 feet of pervious area available down-gradient from the connected downspout for redirection. This criterion applies to a subwatershed restoration priority approach because it has a quantitative pollution reduction efficiency related to nutrient reduction goals.

Chapter 4 includes a summary of the NSA results regarding the acres of rooftop that would be addressed if downspout disconnection were initiated in the recommended neighborhoods. The analysis for downspout disconnection ranking included a calculation of the percentage of subwatershed rooftop area that would be addressed; these results contribute to the estimate of restoration potential for the seven subwatersheds. Subwatersheds with the highest percentages of impervious rooftop acres addressed through downspout disconnection would likely have the greatest restoration potential and therefore received the highest ranking scores. According to field assessment results, percentages of subwatershed areas that could be addressed through downspout disconnection range from 0 to approximately 35 percent.

The following point system assigns downspout disconnection ranking scores to the seven subwatersheds based on the distribution and range of percentages of subwatershed rooftop area that could be addressed:

- > 20% = 4 points
- 10 - 20% = 3 points
- < 10% = 2 points
- No NSAs performed in subwatershed = 0 points

Table 8-4 presents a summary of the percentage of rooftop area that would be addressed by downspout disconnection and the corresponding ranking scores by subwatershed.

Table 8-4: Rooftop Downspout Disconnection Ranking Scores

Subwatershed	Rooftop Area that Would be Addressed (%)	Downspout Disconnection Ranking Score
Brambleton	7	2
Upper Broad Run Mainstem	9	2
Dulles	0	0
Lenah Run	35	4
Lower North Fork Broad Run	12	3
South Fork Broad Run	13	3
Upper North Fork Broad Run	0	0

8.2.5 Institutional Site Investigations

Institutions offer unique opportunities for watershed restoration. Typically, institutional properties encompass considerable portions of land that contain various natural resources. In addition, they offer the opportunity to engage a wide range of citizens in restoration activities; this raises community awareness while also providing water quality improvement benefits in the watershed. Institutional Site Investigations (ISIs) in Upper Broad Run watershed involved nine community-based facilities (public schools and municipal facilities). The focus of an ISI is to identify potential restoration opportunities, particularly those with opportunities for community education and water quality benefits.

Subwatersheds with more institutional sites present more opportunities for implementing restoration actions (e.g., tree planting, stormwater facility retrofits, community clean-ups, etc.) and encouraging citizen participation. Public institutional sites are good candidates for initial restoration efforts because there are opportunities to make use of and build upon existing partnerships, and, in many cases, incorporate student projects. The ISI criterion ranked each subwatershed based on the number of institutions it contained at the time of the assessment, according to the following point system:

- 4 ISIs = 4 points
- 2 ISIs = 2 points

- 1 ISI = 1 point
- No ISIs performed in subwatershed = 0 points

Table 8-5 presents the Institutional Site Investigation ranking scores by subwatershed.

Table 8-5: Institutional Site Investigation Ranking Scores by Subwatershed

Subwatershed	Number of ISIs	ISI ranking score
Brambleton	2	2
Upper Broad Run Mainstem	2	2
Dulles	0	0
Lenah Run	0	0
Lower North Fork Broad Run	1	1
South Fork Broad Run	4	4
Upper North Fork Broad Run	0	0

8.2.6 Pervious Area Reforestation

The most likely candidates for successful pervious area reforestation efforts are those on public lands with minimal site preparation required. Larger open parcels have greater potential for reforestation and water quality benefits than smaller areas.

Pervious Area Assessments (PAAs) recommended pervious area reforestation in several areas throughout Upper Broad Run watershed (Chapter 4). Subwatershed ranking for pervious area reforestation accounts for the acres of tree planting opportunities identified in the PAAs. Based on this calculation, the recommended areas for reforestation within the seven subwatersheds range from 0 to approximately 25 acres. The ranking scores reflect the area deemed suitable for reforestation, as follows:

- > 20 acres = 4 points
- 11 - 20 acres = 3 points
- 5 - 10 acres = 2 points
- < 5 acres = 1 point
- No PAAs performed in subwatershed = 0 points

Table 8-6 presents the Pervious area reforestation acreages and corresponding ranking by sub-watershed.

Table 8-6: Pervious Area Reforestation Acreages and Ranking by Subwatershed

Subwatershed	Acres Recommended for Reforestation	Pervious Area Reforestation Ranking Score
Brambleton	16.91	3
Upper Broad Run Mainstem	6.29	2
Dulles	0.00	0
Lenah Run	0.00	0
Lower North Fork Broad Run	25.17	4
South Fork Broad Run	1.97	1
Upper North Fork Broad Run	0.03	1

8.2.7 Stormwater Management Facility Conversions

As part of field investigations, project staff investigated a number of existing stormwater ponds within the Upper Broad Run watershed for potential conversion to water quality management facilities. The assessment's main target was dry ponds since they have the greatest potential for conversion to a type of facility, such as a dry extended detention facility, that provides water quality benefits in addition to quantity control. By design, dry extended detention ponds capture and retain stormwater runoff from a storm for a minimum duration to allow sediment and pollutants to settle out while also providing flood control.

During the survey of stormwater control measures (SCMs) in Upper Broad Run, staff assessed 35 existing ponds for their potential to be converted to increase their efficiency of treatment. Information documented at each facility included orifice, riser, ponding, debris, vegetation, adjacent land use, physical expansion capabilities, outfall, and downstream conditions. The field assessment identified four facilities with a high potential for successful conversion and 12 facilities with a medium potential for conversion.

The following point system assigns stormwater management facility conversion ranking scores to the seven subwatersheds based on conversion potential of ponds assessed in the recent field survey:

- 2 ponds with high potential; at least 1 pond with medium potential = 4 points
- 1 ponds with high potential; at least 2 ponds with medium potential = 3 points
- 1 pond with high potential; 1 pond with medium potential = 2 points
- 1 pond with medium potential = 1 point
- 0 ponds with high or medium potential = 0 points

Table 8-7 presents the number of SCM facilities with significant conversion potential and the corresponding ranking scores by subwatershed.

Table 8-7: SCM Facilities with Significant Conversion Potential and Ranking Scores by Subwatershed

Subwatershed	Number of SCM Facilities by Conversion Potential		SCM Facility Conversion Ranking Score
	High	Medium	
Brambleton	1	1	2
Upper Broad Run Mainstem	3	6	4
Dulles	0	0	0
Lenah Run	0	1	1
Lower North Fork Broad Run	0	0	0
South Fork Broad Run	0	1	1
Upper North Fork Broad Run	0	0	0

8.2.8 Stream Buffer Improvements

Forested buffers along streams play a crucial role in improving water quality and flood mitigation. They can reduce surface runoff and pollutant loads, stabilize stream banks, trap sediment, and provide habitat for various types of terrestrial and aquatic life. Healthy forest buffers help to reduce nutrient and sediment loadings to waterways. When forested stream buffers are removed (e.g., converted to turf or paved), their beneficial functions are lost and stream health declines. Forested stream buffer zones can be re-established or preserved, to reduce land use impacts by intercepting and controlling pollutants entering the water body.

Chapter 3 presented the results of GIS analysis of the vegetative condition of a 100-foot buffer zone on either side of the stream system within Upper Broad Run watershed. The assessment classified stream buffer conditions as impervious, open pervious, or forested. The analysis included calculations of acreages and percentages of each condition, summarized by subwatershed. Open pervious areas (e.g., mowed lawns) represent the greatest opportunity for stream buffer reforestation. Subwatersheds with greater percentages of open pervious buffer areas denote the greatest potential for stream buffer improvement and received the highest ranking scores.

Open pervious stream buffer area percentages range from approximately 22 to 56 percent of the buffer zones of the seven subwatersheds. The point system employed for this criterion assigned stream buffer improvement scores based on the distribution and range of open pervious buffer area percentages, as follows:

- > 50% = 4 points
- 40 - 50% = 3 points
- 30 - 40% = 2 points
- 20 - 30% = 1 point

Table 8-8 presents the percentages of open pervious stream buffer areas and corresponding ranking scores by subwatershed.

Table 8-8: Percentages of Open Pervious Stream Buffer Areas and Ranking Scores by Subwatershed

Subwatershed	Open Pervious Stream Buffer (%)	Stream Buffer Ranking Score
Brambleton	55.9	4
Upper Broad Run Mainstem	40.5	3
Dulles	39.0	2
Lenah Run	28.0	1
Lower North Fork Broad Run	49.7	3
South Fork Broad Run	41.4	3
Upper North Fork Broad Run	22.6	1

8.2.9 Stream Restoration Potential

During the Stream Corridor Assessments (SCA) and Retrofit Reconnaissance Investigations (RRI) conducted in Upper Broad Run, field crews assessed the extent of stream bank erosion and evaluated the potential for correction. The stabilization of stream banks and other stream restoration techniques can provide numerous benefits including nutrient and sediment load reductions and improved habitat health for aquatic biota. Stream restoration potential ranking uses the summary of the lengths of eroded banks for each subwatershed as the basis for the ranges. Subwatersheds with a greater length of stream that would be candidates for stream restoration present a greater opportunity for restoration and pollutant load reductions and are therefore ranked higher.

The sums of erosion lengths per subwatershed range from 0 to approximately 4,130 feet. The ranking system for stream restoration potential assigned scores to the seven subwatersheds based on the range of lengths of stream in need of restoration, as determined during the SCA:

- > 4000 feet = 4 points
- 1000 - 4000 feet = 3 points
- 100 - 1000 feet = 2 points
- < 100 feet = 1 point
- No restoration potential documented in subwatershed during SCA = 0 points

Table 8-9 presents the lengths of stream banks with potential for restoration as estimated during field visits and the corresponding ranking scores by subwatershed.

Table 8-9: Lengths of Stream Banks with Potential for Restoration and Ranking Scores by Subwatershed

Subwatershed	Potential Stream Restoration Length (feet)	Stream Restoration Ranking Score
Brambleton	4,130	4
Upper Broad Run Mainstem	1,000	3
Dulles	0	0
Lenah Run	0	0
Lower North Fork Broad Run	200	2
South Fork Broad Run	38	1
Upper North Fork Broad Run	240	2

8.3 Summary of Subwatershed Restoration Priority Scores

The analysis for subwatershed restoration priority adds the ranked criteria scores described above to derive a total score for each of the seven subwatersheds in Upper Broad Run watershed. Table 8-10 summarizes the rankings by individual criteria and total scores, which illustrate the relative restoration potential. Restoration priority analysis assigned each subwatershed a priority category based on the following total ranking score ranges:

- >30 points = High
- 20 - 30 points = Medium
- < 20 points = Low

Table 8-10: Subwatershed Ranking Criteria Results and Restoration Priority Categories

Subwatershed	Ranking scores										Total Score	Priority Category
	Nitrogen load	Phosphorus load	Impervious	NSA PSI/ROI	Downspout disconnection	Institutional Site Investigation	Pervious area reforestation	SCM facility conversion	Riparian reforestation	Stream restoration		
Brambleton	4	4	3	3	2	2	3	2	4	4	31	High
Upper Broad Run Mainstem	3	3	3	2	2	2	2	4	3	3	27	Medium
Dulles	2	2	1	0	0	0	0	0	2	0	7	Low
Lenah Run	1	1	1	4	4	0	0	1	1	0	13	Low
Lower North Fork Broad Run	2	2	1	3	3	1	4	0	3	2	21	Medium
South Fork Broad Run	2	2	2	3	3	4	1	1	3	1	21	Medium
Upper North Fork Broad Run	1	1	1	0	0	0	1	0	1	2	7	Low

Figure 8-1 illustrates the restoration priority levels for the subwatersheds in Upper Broad Run watershed. Brambleton subwatershed (31 points) scored in the highest category. Three sub-watersheds (Upper Broad Run Mainstem, Lower North Fork Broad Run, and South Fork Broad Run) were rated as Medium. The remaining three subwatersheds (Dulles, Lenah Run, and Upper North Fork Broad Run) were rated as Low. While restoration efforts will potentially benefit the entire Upper Broad Run watershed, the priority categories presented here may help guide initial restoration efforts for the most efficient approach.

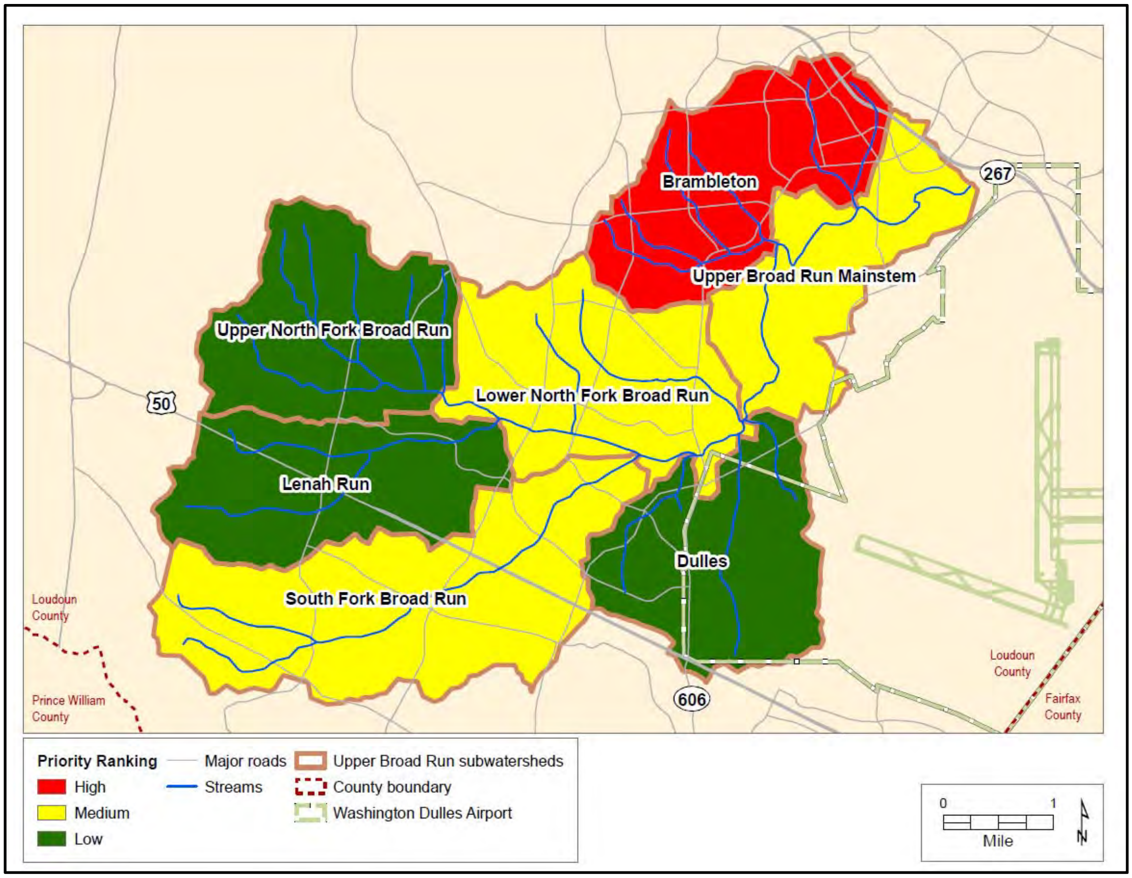


Figure 8-1: Upper Broad Run Subwatershed Overall Priority Rankings

CHAPTER 9: FUTURE LAND USE AND POLLUTANT LOADS

Upper Broad Run watershed is already experiencing rapid development, and the watershed is slated for additional future growth, as described in Chapter 3 (see zoning map, Figure 3-21). Most of the eastern half of the watershed is planned for residential and commercial uses, while the western portion is zoned as transitional area, where development will occur but with requirements to maintain substantial open space, as a transition to the rural areas to the west.

This chapter presents projections of future land use for the years 2025 (Chesapeake Bay WIP final milestone) and 2040 (timeframe of the County's Traffic Analysis Zone forecast). In addition, this chapter presents results of calculated pollutant loads and runoff under each of the following scenarios:

- Current land use/development conditions – without implementation of the suite of watershed management practices proposed in this plan
- Current land use/development conditions – with implementation of the proposed suite of watershed management practices
- Future land use/development – without implementation of the proposed suite of watershed management practices
- Future land use/development – with implementation of the proposed suite of watershed management practices

9.1 Future Land Use

Future land use for the Upper Broad Run watershed was projected from current land use (Figure 3-8), zoning (Figure 3-21), and ancillary information. First, existing GIS data were used to quantify land uses for existing built areas (in the land use classifications urban impervious, urban pervious, forest, cropland, pasture, water, barren). For zoning classes not represented at present, the proportions of projected land use types were estimated. Estimates were based on literature values characterizing impervious coverage for developed areas (as summarized in Bochis and Pitt 2009) and consultation with County staff familiar with local development patterns and plans. GIS was used to designate land areas subject to change v. areas not changing (e.g., lands already developed or with conservation easements, Figure 5-10). Next, the land-use-by-zoning-class proportions (Table 9-1) were applied to areas subject to change. This allowed for a projection of a buildout scenario for land use and impervious cover (beyond 2040). This represents a "maximum potential development scenario" of what the impervious surface percentages would be if full buildout were to occur at some time in the future, likely well beyond 2040, assuming no zoning changes.

For the four Transitional zoning classes (TR2, TR1UBF, TR3UBF, and TR10, in order of decreasing density allowed), because the open space requirements are an important part of these designations (50% for the first three TR classes; 70% for TR10), a gradient of expected urban pervious and impervious cover was applied over these four classes (decreasing across TR2 to

TR10). Also, a gradient of remaining crop, forest, and/or pasture (increasing across TR2 to TR10) was applied. The proposed percentage breakdowns are summarized in Table 9-1.

Table 9-1: Predicted Land Use Percentages, by Zoning Class

Zoning Class	Cropland	Forest	Pasture	Urban Impervious	Urban Pervious
A3	6.5	71.4	9.0	2.4	10.7
AR1	37.2	29.8	23.2	1.4	8.3
AR2	37.2	29.8	23.2	1.4	8.3
CLI	0.0	6.5	1.6	57.6	34.3
CR1	0.6	21.6	1.4	18.1	58.2
GB	0.0	0.0	0.0	89.5	10.5
IAD	0.2	92.0	0.1	1.8	5.8
MRHI	0.0	5.1	0.0	65.0	29.9
PDAAAR	0.0	17.2	0.1	40.7	42.0
PDCCCC	0.0	1.6	0.0	54.6	43.9
PDCCRC	0.0	6.5	1.6	57.6	34.3
PDCCSC	0.0	6.5	1.6	57.6	34.3
PDGI	0.3	20.1	0.3	49.1	30.2
PDH3	0.0	14.9	0.4	26.9	57.8
PDH4	0.1	14.5	0.1	28.3	56.9
PDIP	0.0	0.0	0.1	61.1	38.8
PDOP	0.0	8.0	0.0	47.6	44.3
PDRV	0.6	21.7	1.4	18.1	58.2
PDTC	0.0	11.8	0.8	48.9	38.5
PDTRC	0.0	6.1	0.0	55.1	38.8
R1	0.6	21.6	1.4	18.1	58.2
R16	0.0	17.1	0.1	40.1	42.7
R2	1.0	15.6	3.0	15.0	65.4
R24	0.0	10.0	0.0	44.0	46.0
R8	0.0	18.0	0.5	35.0	46.5
RC	3.7	23.3	6.0	16.0	51.0
TR10	10.0	25.0	10.0	5.0	50.0
TR1UBF	2.0	15.0	3.0	18.0	62.0
TR2	2.0	15.0	3.0	20.0	60.0
TR3UBF	5.0	20.0	5.0	10.0	60.0

Projected future land use percent breakdowns are provided for Upper Broad Run and by sub-watershed for the current, 2025, 2040, and full build-out scenarios (Tables 9-2 and 9-3, Figures 9-1 to 9-3). The zoning-projected impervious surface and land use estimates represent a picture of the long-term future, at final buildout, beyond 2040. For the purpose of estimating conditions in the near term, we estimated that 25% of the expected development will occur by 2025 and another 25% by 2040. For subwatersheds already near buildout, such as Brambleton (Figure 9-2), future changes will be less extensive, while some subwatersheds like Upper North Fork (Figure 9-3) will experience more extensive change.

Table 9-2: Current and Projected Future Land Uses (%) for Upper Broad Run Watershed

	2012 (Current)	2025 (Projected)	2040 (Projected)	Buildout (Projected)
Cropland	17.5	13.4	9.4	1.2
Forest	39.4	34.4	29.4	19.3
Pasture	12.2	9.5	6.8	1.5
Urban Impervious	8.0	12.1	16.1	24.2
Urban Pervious	20.7	28.4	36.1	51.4
Water	1.2	1.2	1.2	1.2
Barren	0.2	0.2	0.2	0.2

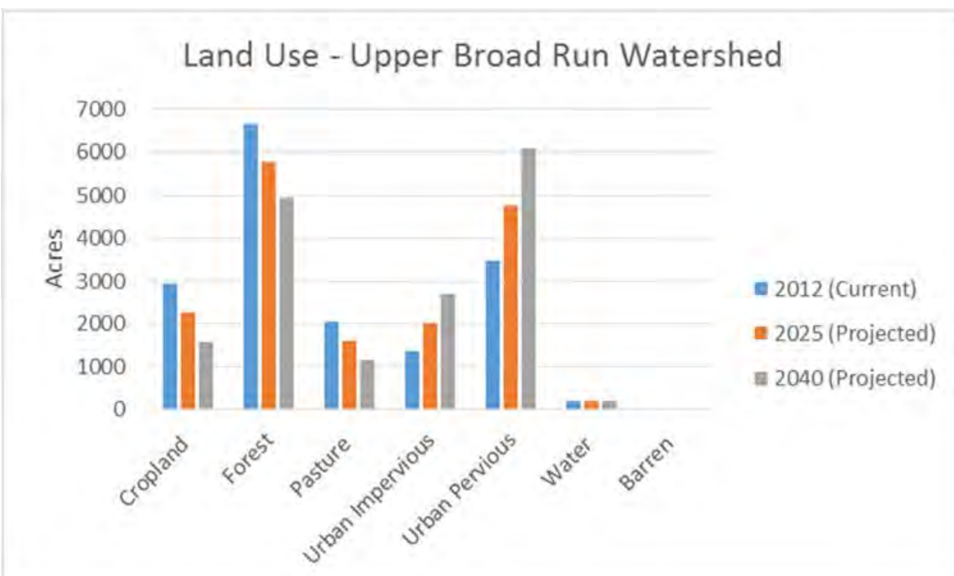


Figure 9-1: Current and Predicted Future Land Use in Upper Broad Run Watershed

Table 9-3: Current and Projected Future Land Use for Upper Broad Run Watershed and for Individual Subwatersheds, as Area (acres) and Percentages

Current Condition

Subwatershed	Cropland (acres)	Forest (acres)	Pasture (acres)	Urban Impervious (acres)	Urban Pervious (acres)	Water (acres)	Barren (acres)	Missing (acres)	Sum (acres)
Brambleton	320.8	379.2	102.7	481.9	1006.7	29.5	5.8	8.6	2335.0
Upper Broad Run Mainstem	118.6	650.0	177.1	294.6	575.6	29.6	4.7	25.3	1875.5
Dulles	222.5	1403.6	144.6	116.8	239.9	16.6	5.2	11.4	2160.5
Lenah Run	460.7	906.7	299.9	72.3	405.3	33.7	0.2	21.8	2200.5
Lower North Fork	667.1	676.5	407.8	152.9	496.2	50.1	5.0	17.3	2472.6
South Fork	576.1	1477.9	487.1	230.5	732.1	42.5	5.5	43.1	3594.7
Upper North Fork	588.1	1152.1	429.8	4.6	29.3	5.9	0.0	14.3	2223.9
Upper Broad Run Watershed	2953.8	6646.0	2049.0	1353.5	3484.9	207.8	26.4	142.0	16862.7

Current Condition

Subwatershed	Cropland (%)	Forest (%)	Pasture (%)	Urban Impervious (%)	Urban Pervious (%)	Water (%)	Barren (%)	Missing (%)	Sum (%)
Brambleton	13.7	16.2	4.4	20.6	43.1	1.3	0.3	0.4	100.0
Upper Broad Run Mainstem	6.3	34.7	9.4	15.7	30.7	1.6	0.3	1.3	100.0
Dulles	10.3	65.0	6.7	5.4	11.1	0.8	0.2	0.5	100.0
Lenah Run	20.9	41.2	13.6	3.3	18.4	1.5	0.0	1.0	100.0
Lower North Fork	27.0	27.4	16.5	6.2	20.1	2.0	0.2	0.7	100.0
South Fork	16.0	41.1	13.6	6.4	20.4	1.2	0.2	1.2	100.0
Upper North Fork	26.4	51.8	19.3	0.2	1.3	0.3	0.0	0.6	100.0
Upper Broad Run Watershed	17.5	39.4	12.2	8.0	20.7	1.2	0.2	0.8	100.0

2025

Subwatershed	Cropland (acres)	Forest (acres)	Pasture (acres)	Urban Impervious (acres)	Urban Pervious (acres)	Water (acres)	Barren (acres)	Missing (acres)	Sum (acres)
Brambleton	242.0	341.7	80.5	568.6	1058.5	29.5	5.8	8.6	2335.0
Upper Broad Run Mainstem	89.4	562.8	133.4	376.5	653.8	29.6	4.7	25.3	1875.5
Dulles	167.6	1361.2	109.9	196.2	292.4	16.6	5.2	11.4	2160.5
Lenah Run	353.9	768.4	236.3	149.3	636.8	33.7	0.2	21.8	2200.5
Lower North Fork	505.0	586.8	310.9	286.0	711.7	50.1	5.0	17.3	2472.6
South Fork	442.6	1201.2	380.7	396.2	1083.0	42.5	5.5	43.1	3594.7
Upper North Fork	466.9	977.9	349.0	63.9	346.1	5.9	0.0	14.3	2223.9
Upper Broad Run Watershed	2267.5	5800.0	1600.6	2036.6	4782.4	207.8	26.4	142.0	16862.7

2025

Subwatershed	Cropland (%)	Forest (%)	Pasture (%)	Urban Impervious (%)	Urban Pervious (%)	Water (%)	Barren (%)	Missing (%)	Sum (%)
Brambleton	10.4	14.6	3.4	24.4	45.3	1.3	0.3	0.4	100.0
Upper Broad Run Mainstem	4.8	30.0	7.1	20.1	34.9	1.6	0.3	1.3	100.0
Dulles	7.8	63.0	5.1	9.1	13.5	0.8	0.2	0.5	100.0
Lenah Run	16.1	34.9	10.7	6.8	28.9	1.5	0.0	1.0	100.0
Lower North Fork	20.4	23.7	12.6	11.6	28.8	2.0	0.2	0.7	100.0
South Fork	12.3	33.4	10.6	11.0	30.1	1.2	0.2	1.2	100.0
Upper North Fork	21.0	44.0	15.7	2.9	15.6	0.3	0.0	0.6	100.0
Upper Broad Run Watershed	13.4	34.4	9.5	12.1	28.4	1.2	0.2	0.8	100.0

2040

Subwatershed	Cropland (acres)	Forest (acres)	Pasture (acres)	Urban Impervious (acres)	Urban Pervious (acres)	Water (acres)	Barren (acres)	Missing (acres)	Sum (acres)
Brambleton	163.2	304.1	58.3	655.3	1110.3	29.5	5.8	8.6	2335.0
Upper Broad Run Mainstem	60.1	475.6	89.7	458.4	732.0	29.6	4.7	25.3	1875.5
Dulles	112.8	1318.9	75.1	275.5	345.0	16.6	5.2	11.4	2160.5
Lenah Run	247.2	630.1	172.8	226.3	868.4	33.7	0.2	21.8	2200.5
Lower North Fork	342.9	497.0	214.0	419.0	927.3	50.1	5.0	17.3	2472.6
South Fork	309.2	924.4	274.2	561.9	1433.9	42.5	5.5	43.1	3594.7
Upper North Fork	345.8	803.8	268.1	123.3	662.9	5.9	0.0	14.3	2223.9
Upper Broad Run Watershed	1581.1	4954.0	1152.3	2719.7	6079.8	207.8	26.4	142.0	16862.7

2040

Subwatershed	Cropland (%)	Forest (%)	Pasture (%)	Urban Impervious (%)	Urban Pervious (%)	Water (%)	Barren (%)	Missing (%)	Sum (%)
Brambleton	7.0	13.0	2.5	28.1	47.5	1.3	0.3	0.4	100.0
Upper Broad Run Mainstem	3.2	25.4	4.8	24.4	39.0	1.6	0.3	1.3	100.0
Dulles	5.2	61.0	3.5	12.8	16.0	0.8	0.2	0.5	100.0
Lenah Run	11.2	28.6	7.9	10.3	39.5	1.5	0.0	1.0	100.0
Lower North Fork	13.9	20.1	8.7	16.9	37.5	2.0	0.2	0.7	100.0
South Fork	8.6	25.7	7.6	15.6	39.9	1.2	0.2	1.2	100.0
Upper North Fork	15.5	36.1	12.1	5.5	29.8	0.3	0.0	0.6	100.0
Upper Broad Run Watershed	9.4	29.4	6.8	16.1	36.1	1.2	0.2	0.8	100.0

Full Buildout

Subwatershed	Cropland (acres)	Forest (acres)	Pasture (acres)	Urban Impervious	Urban Pervious	Water (acres)	Barren (acres)	Missing (acres)	Sum (acres)
Brambleton	5.6	228.9	13.9	828.8	1213.9	29.5	5.8	8.6	2335.0
Upper Broad Run Mainstem	1.5	301.3	2.2	622.3	888.5	29.6	4.7	25.3	1875.5
Dulles	3.0	1234.2	5.6	434.3	450.1	16.6	5.2	11.4	2160.5
Lenah Run	33.6	353.6	45.7	380.3	1331.5	33.7	0.2	21.8	2200.5
Lower North Fork	18.8	317.6	20.3	685.1	1358.4	50.1	5.0	17.3	2472.6
South Fork	42.4	371.0	61.4	893.3	2135.7	42.5	5.5	43.1	3594.7
Upper North Fork	103.4	455.5	106.4	241.9	1296.5	5.9	0.0	14.3	2223.9
Upper Broad Run Watershed	208.4	3262.1	255.5	4085.9	8674.6	207.8	26.4	142.0	16862.7

Full Buildout

Subwatershed	Cropland (%)	Forest (%)	Pasture (%)	Urban Impervious	Urban Pervious	Water (%)	Barren (%)	Missing (%)	Sum (%)
Brambleton	0.2	9.8	0.6	35.5	52.0	1.3	0.3	0.4	100.0
Upper Broad Run Mainstem	0.1	16.1	0.1	33.2	47.4	1.6	0.3	1.3	100.0
Dulles	0.1	57.1	0.3	20.1	20.8	0.8	0.2	0.5	100.0
Lenah Run	1.5	16.1	2.1	17.3	60.5	1.5	0.0	1.0	100.0
Lower North Fork	0.8	12.8	0.8	27.7	54.9	2.0	0.2	0.7	100.0
South Fork	1.2	10.3	1.7	24.8	59.4	1.2	0.2	1.2	100.0
Upper North Fork	4.7	20.5	4.8	10.9	58.3	0.3	0.0	0.6	100.0
Upper Broad Run Watershed	1.2	19.3	1.5	24.2	51.4	1.2	0.2	0.8	100.0

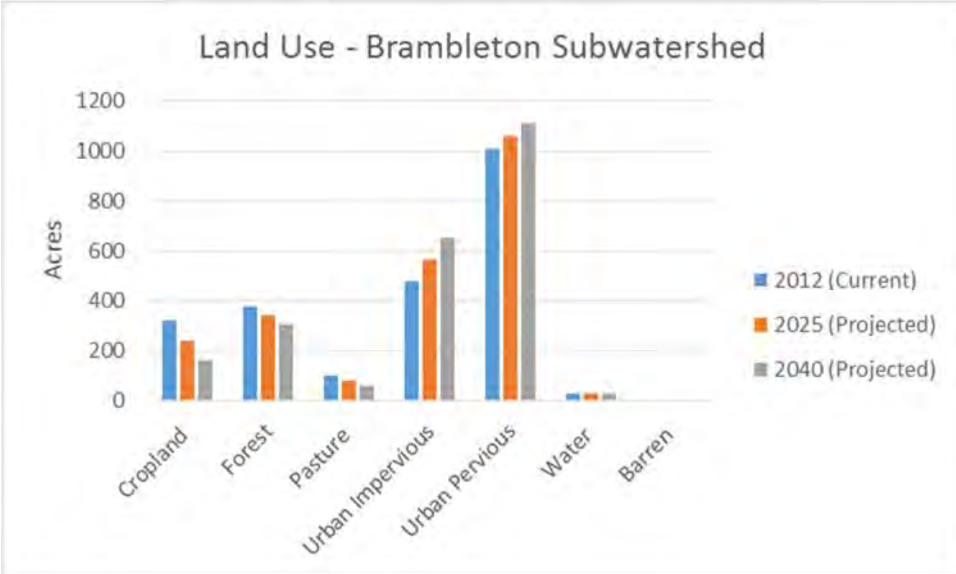


Figure 9-2: Current and Predicted Future Land Use in Brambleton Subwatershed

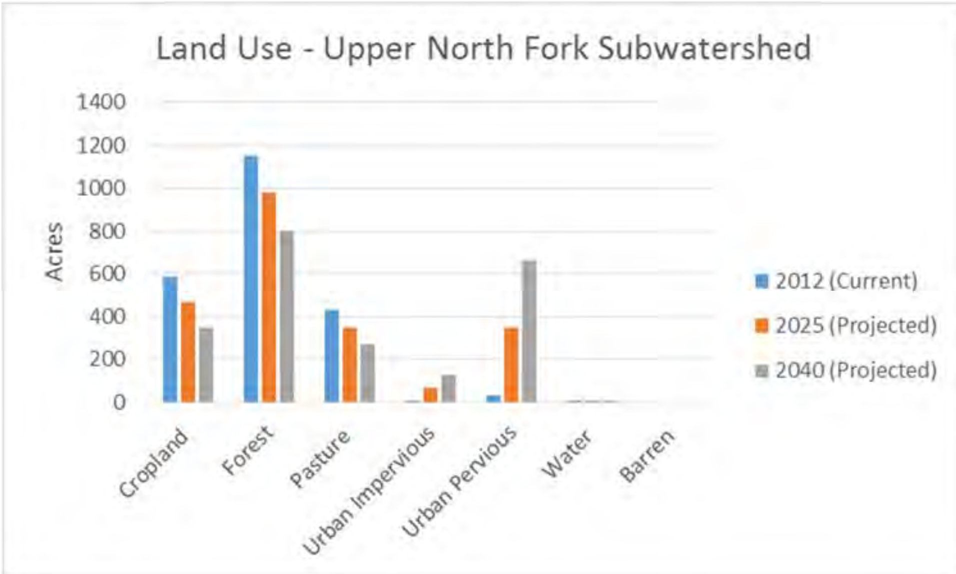


Figure 9-3: Current and Predicted Future Land Use in Upper North Fork Subwatershed

Urban impervious cover, currently at 8.0% for the watershed, is estimated to increase to 16.1% by 2040. For individual subwatersheds, urban impervious cover currently ranges from 0.2% to 20.6%; these values are projected to increase to 5.5% to 28.1% urban impervious by 2040.

For comparison, we projected future impervious cover for 2025 and 2040 from a population v. impervious relationship provided by Loudoun County. This relationship is a fairly good predictor for residential parts of the watershed, but not unexpectedly, it underpredicts impervious cover for commercial/industrial areas. This was particularly noticeable in the northeastern and central parts of the watershed, where commercial/industrial uses exist and are planned.

9.2 Future Pollutant Loads and Runoff

Current total annual pollutant loads and runoff amounts were calculated as listed in Table 6-3. Reductions provided by current SCMs and stream restoration were calculated as listed in Tables 6-28 (for nutrients and sediment) and 6-29 (for runoff) in the top two rows; reductions provided by the suite of recommended watershed management practices are listed in the remaining rows of those tables.

Future development is expected to include SCMs as required by State and County regulations to control nutrients, sediment, and runoff. Since the specific types of SCMs which may be used will not be known until various developments are proposed, we applied a range of values to estimate the overall pollutant and runoff reduction that may be expected to result from SCMs employed in future development.

- For a moderate estimate of expected pollutant reductions, the suite of SCMs as currently implemented in the watershed was used to estimate reductions. Overall removal efficiencies would be 20% for total nitrogen, 32% for total phosphorus, 57% for sediment and 1% for runoff.

- To estimate a higher pollutant reduction scenario, the removal efficiency for bioretention practices (which would likely be implemented within extended detention facilities) was applied. Overall removal efficiencies (for the soil types occurring in the watershed) would be 30% for total nitrogen, 48% for total phosphorus, 58% for sediment and 44% for runoff.

These removal efficiencies were used to adjust the future urban pervious and urban impervious loading rates to estimate the net loading rate in these areas with the types of SCMs which would likely be used in these areas. While these estimates were derived using reduction efficiencies approved by the Chesapeake Bay Program, stormwater pollutant reductions for future development in the Upper Broad Run will be met using newer Virginia stormwater control regulations that took effect in July of 2014 (Loudoun County 2014; Virginia DEQ 2014). The Virginia stormwater regulations rely on reductions associated with runoff reduction methodologies and may employ several SCMs within a "treatment train", rather than one particular SCM type. The anticipated reductions achieved using the Virginia stormwater regulations should be similar to those used for the "higher pollutant reduction scenario" referenced above.

Total watershed loadings from all land use types of nitrogen, phosphorus, sediment, and runoff were compared for the following scenarios:

- Current (2012) land use with SCMs that have already been implemented
- Current (2012) land use with current SCMs and implementation of watershed management practices proposed in this plan
- Future (2025) land use with SCMs already implemented, plus stormwater controls on new developed areas (with a moderate and high range of future stormwater treatment, known as “moderate reduction” and “high reduction” scenarios)
- Future (2025) land use with SCMs already implemented, plus stormwater controls on new developed areas (moderate and high range) AND implementation of proposed watershed management practices
- Future (2040) land use with SCMs already implemented, plus stormwater controls on new developed areas (moderate and high range)
- Future (2040) land use with SCMs already implemented, plus stormwater controls on new developed areas (moderate and high range) AND implementation of proposed watershed management practices

Results for these scenarios are shown in Figures 9-4 through 9-7. Modeling results indicate that both the implementation of watershed plan recommendations and the type of stormwater treatment employed with future development will likely have a great effect on pollutant loads. For example, if new urban development proceeds with no changes to the suite of SCM practice types commonly used today (“moderate reduction” scenario), annual TN loads would actually increase in 2025 and 2040. However, with improved practices on new urban lands (“high reduction” scenario), TN loads would be expected to decrease. Implementation of the watershed management measures proposed in this plan will further decrease TN loads (Figure 9-4). According to the model, annual loads of TP would actually be expected to decrease (as a result of converting agricultural lands to urban). Implementing watershed recommendations will further decrease TP loads (Figure 9-5). Sediment loads are expected to increase under either moderate- or high-reduction scenarios; implementation of watershed recommendations would reduce sediment loads (Figure 9-6). Annual runoff volume is expected to increase substantially as a result of increased urbanization of the watershed. This increase would be mitigated to a large degree by implementing both a high-reduction approach to stormwater treatment on new development as well as carrying out proposed plan recommendations (Figure 9-7).

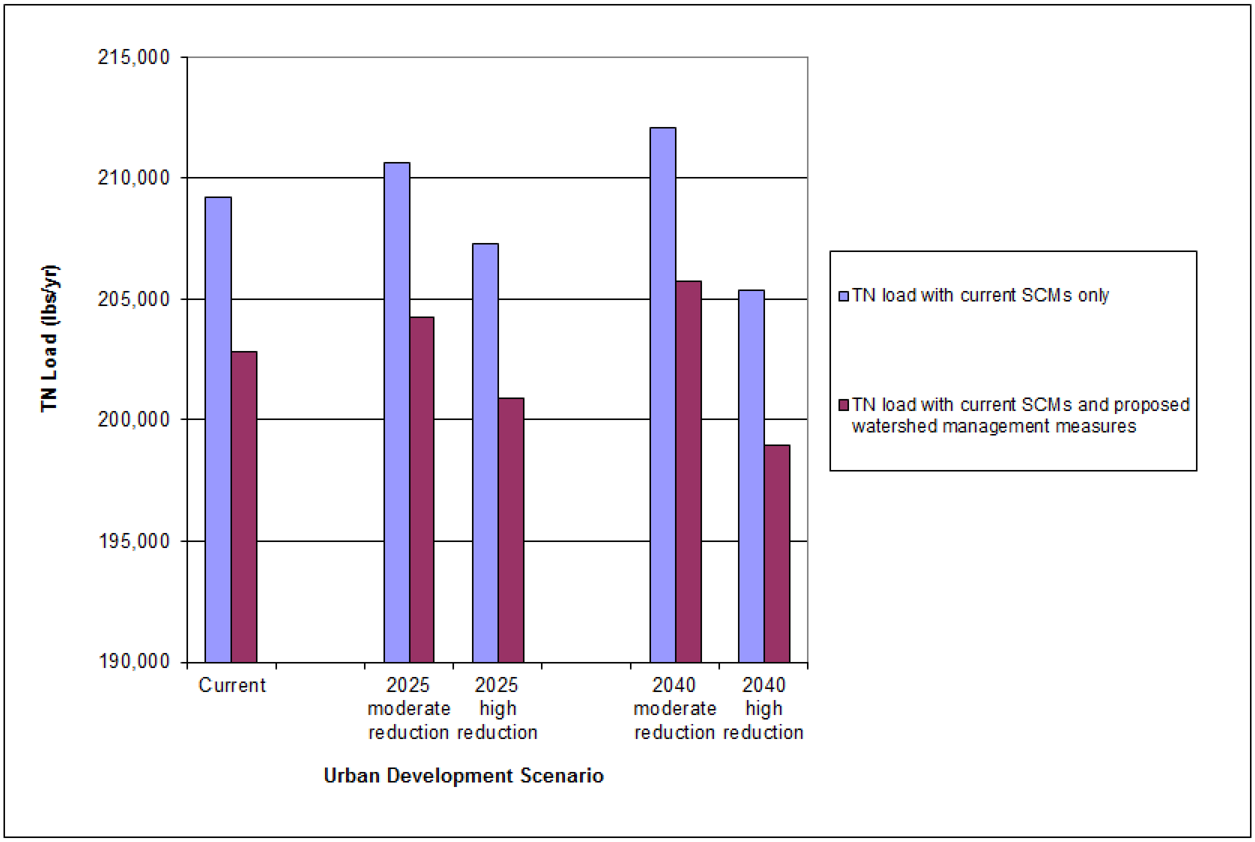


Figure 9-4: Upper Broad Run Total Nitrogen (TN) Loads Estimated for Current, 2025, and 2040 Land Use, Without and With Implementation of Watershed Management Measures Proposed in this Plan. Two scenarios are presented for each of the future land use scenarios: "moderate reduction" assumes stormwater from new urban areas is treated at rates comparable to current levels, "high reduction" assumes enhanced water quality and quantity treatment.

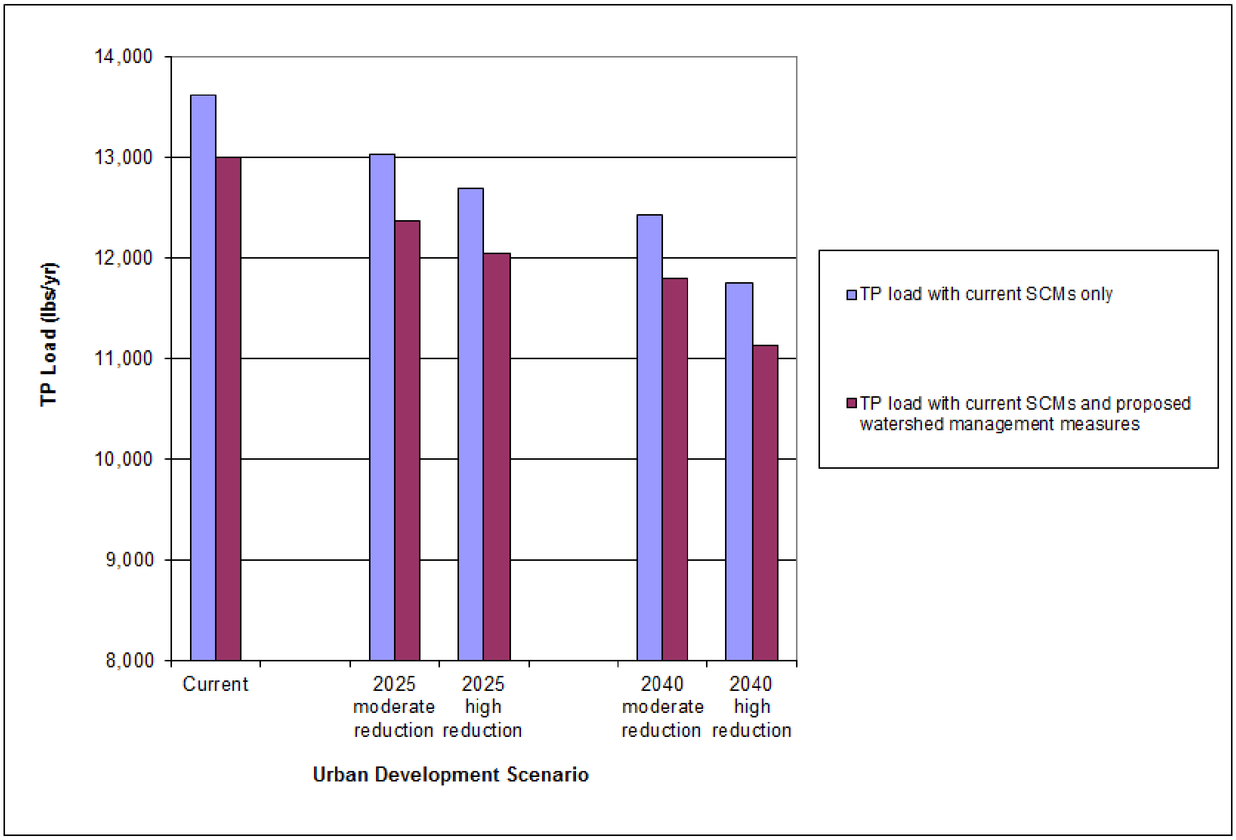


Figure 9-5: Upper Broad Run Total Phosphorus (TP) Loads Estimated for Current, 2025, and 2040 Land Use, Without and With Implementation of Watershed Management Measures Proposed in this Plan. Two scenarios are presented for each of the future land use scenarios: "moderate reduction" assumes stormwater from new urban areas is treated at rates comparable to current levels, "high reduction" assumes enhanced water quality and quantity treatment.
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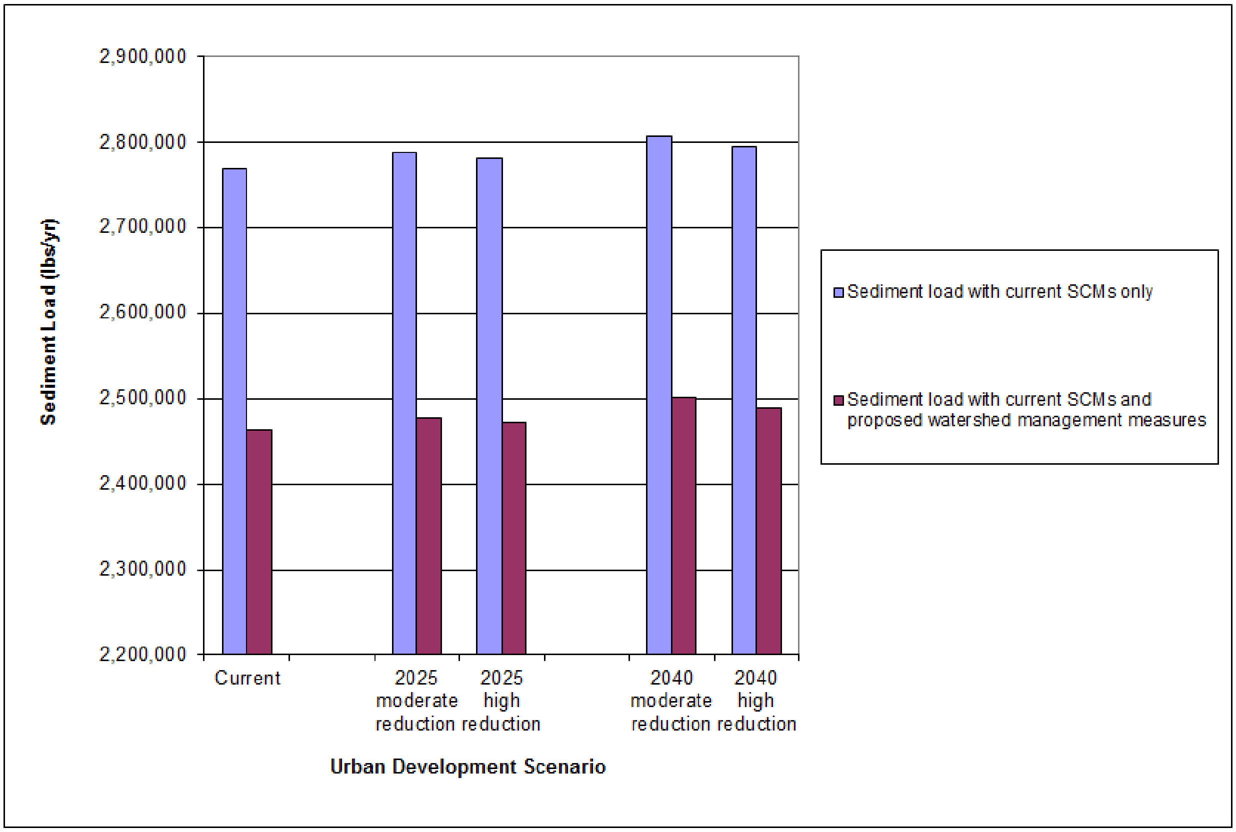

Figure 9-6: Upper Broad Run Sediment Loads Estimated for Current, 2025, and 2040 Land Use, Without and With Implementation of Watershed Management Measures Proposed in this Plan. Two scenarios are presented for each of the future land use scenarios: "moderate reduction" assumes stormwater from new urban areas is treated at rates comparable to current levels, "high reduction" assumes enhanced water quality and quantity treatment.

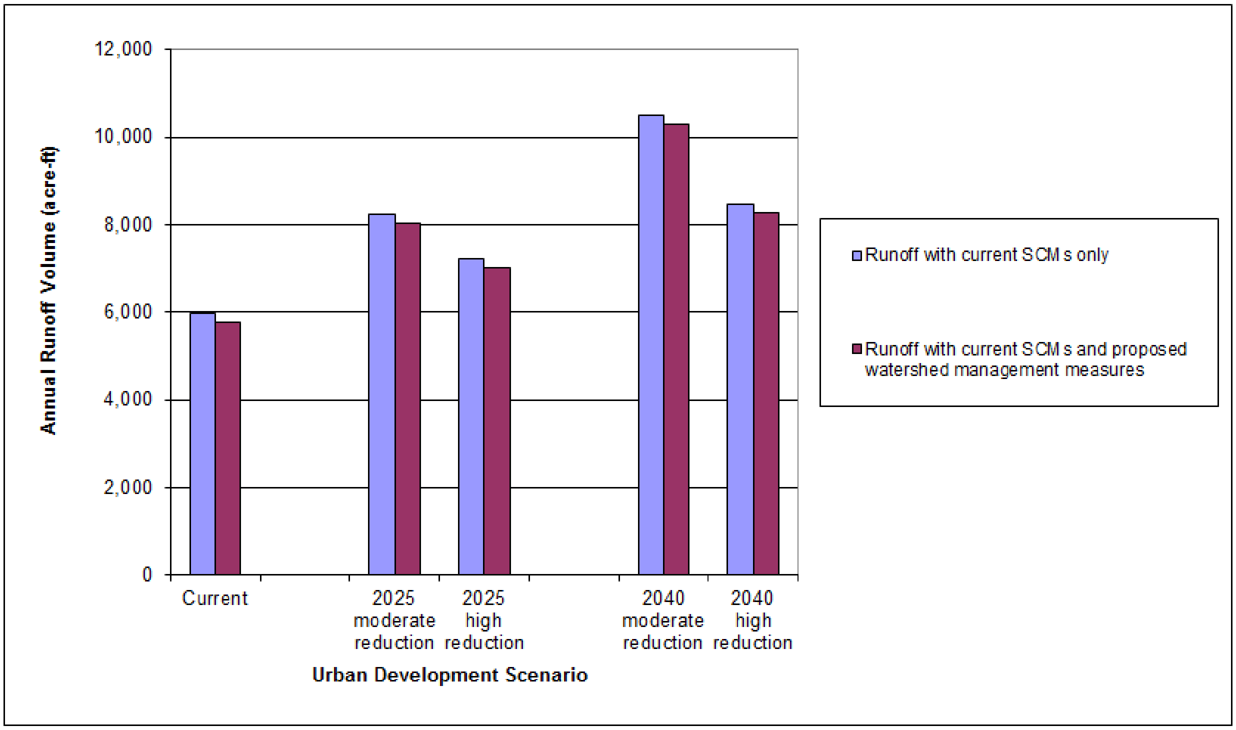

Figure 9-7: Upper Broad Run Annual Runoff Volume Estimated for Current, 2025, and 2040 Land Use, Without and With Implementation of Watershed Management Measures Proposed in this Plan. Two scenarios are presented for each of the future land use scenarios: "moderate reduction" assumes stormwater from new urban areas is treated at rates comparable to current levels, "high reduction" assumes enhanced water quality and quantity treatment.

CHAPTER 10: STREAM RESTORATION AND SCM CONVERSION PROJECTS

10.1 Stream Restoration Sites

A total of 13 candidate stream restoration sites were identified during SCA and RRI field assessments (see Chapter 4 for more detail). All candidate restoration sites were assigned a priority rating of High, Medium or Low, which primarily depended on the proposed length of restoration (and thus the amount of pollutant reduction), the severity of erosion and deposition along the targeted stream reach, and the number and type of potential project constraints. Stream restoration project ratings and planning-level cost estimates are shown in Table 10-1, and project locations are shown in Figure 10-1. Cost estimates are intended to provide a relative estimate only, and a detailed engineering study will be required to determine more accurate project costs prior to moving forward with any of the listed candidate stream restoration projects. The planning-level costs presented in Table 10-1 were derived from unit information provided by the Loudoun County WIP II Technical Advisory Committee (TAC). The TAC gives an estimate of $500 (in 2012 dollars) per linear foot of restored stream, which is multiplied by the proposed project length to obtain the estimated initial project cost. A description of the assumptions and references used to develop the TAC cost estimates can be found at: http://www.loudoun.gov/DocumentCenter/Index/1197. A one page summary of each High and Medium Priority project is provided in Appendix A.

Table 10-1: Stream Restoration Project Pollutant Reductions, Priority Ratings, and Estimated Costs

Site ID	Subwatershed	Project Length (LF)	Potential TN Reduction (lbs/yr)	Potential TP Reduction (lbs/yr)	Potential TSS Reduction (lbs/yr)	Priority	Estimated Initial Project Cost
LNF-ES-077-2014	Lower North Fork	35	7	2.38	1,899	High	$17,500
BRAM-ES-059-2014	Brambleton	90	18	6.12	4,883	High	$45,000
BRAM-RS-265-2014	Brambleton	2500	500	170	135,625	High	$1,250,000
BRAM-RS-263-2014	Brambleton	700	140	47.6	37,975	High	$350,000
UNF-ES-123-2014	Upper North Fork	25	5	1.70	1,356	Medium	$12,500
LNF-ES-114-2014	Lower North Fork	750	150	51.0	40,687	Medium	$375,000
BRAM-ES-060-2014	Brambleton	40	8	2.72	2,170	Medium	$20,000
UBRM-RS-264-2014	Upper Broad Run Mainstem	1000	200	68.0	54,250	Medium	$500,000
UNF-ES-156-2014	Upper North Fork	125	25	8.50	6,781	Low	$62,500
SF-ES-139-2014	South Fork	35	7	2.38	1,898	Low	$17,500
SF-ES-106-2014	South Fork	3	0.6	0.204	163	Low	$1,500
BRAM-RS-262-2014	Brambleton	120	24	8.16	6,510	Low	$60,000
BRAM-RS-266-2014	Brambleton	1,000	N/A	N/A	N/A	Low (Special Project)	N/A

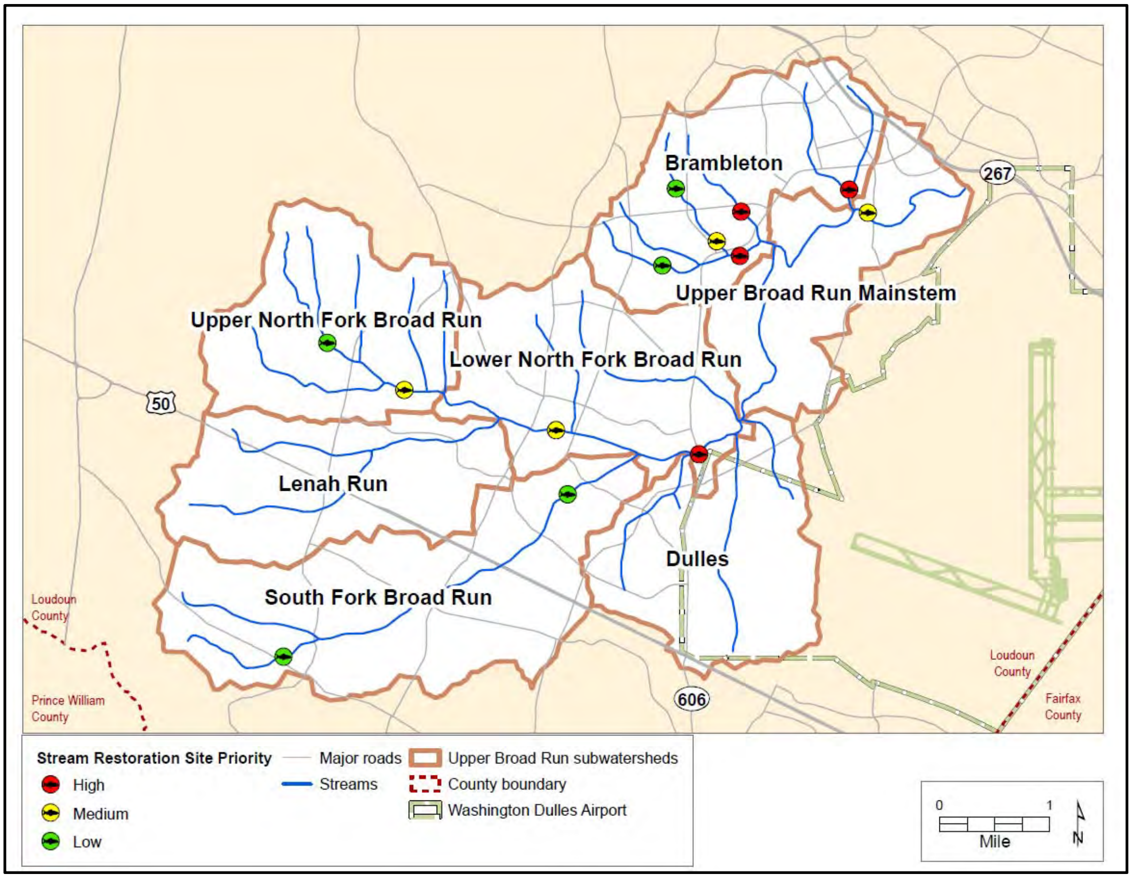

Figure 10-1: Candidate Stream Restoration Site Locations and Priority Ratings

10.2 SCM Conversion Sites

A total of 35 candidate SCM conversion sites were identified during RRI field assessments (see Chapter 4 for more detail). Of the 35 sites visited, 31 have the potential to be upgraded to a SCM with higher pollutant removal efficiencies. The 31 upgradable SCM conversion sites were assigned a priority rating of High, Medium or Low, which primarily depended upon the existing pond designation (and pollutant removal efficiency), engineering feasibility of an upgrade, and on how much additional reduction was possible under the SCM efficiencies as determined by the Chesapeake Bay Program and used in the Virginia Assessment and Scenario Tool (VAST). More than 50 opportunities for SCM improvements were identified at these sites, since some sites presented more than one opportunity. SCM conversion project ratings and planning-level cost estimates are shown in Table 10-2, and project locations are shown in Figure 10-2. Pollutant reductions expected to result from SCM conversions are shown in Table 6-17. Cost estimates are intended to provide a planning level estimate only, and a detailed engineering study will be required to determine more accurate project costs prior to moving forward with any of the listed candidate SCM conversion projects. The planning-level costs presented in Table 10-2 were derived from unit information provided by the Loudoun County WIP II Technical Advisory Committee (TAC) and several other relevant studies. The TAC gives an estimated cost of

$13,556 per acre of land treated by a new wet pond or wetland, which is multiplied by the proposed project drainage area to obtain the estimated initial project cost. Bioretention, bioswales, vegetated open channels, and urban infiltration with sand unit costs are from University of Maryland (King and Hagan 2011). King and Hagan give an estimated cost of $49,875 per impervious acre treated by new bioretention, $44,000 per impervious acre treated by new bioswales, $26,000 per impervious acre of land treated by vegetated open channels, and $66,250 per impervious acre treated by new infiltration practices with sand. A Step Pool Conveyance cost of $40,000 per acre treated is a conservative estimate based on several prior Step Pool Conveyance studies (Brown 2009; Flores et al. 2011; and Anne Arundel County 2012). The entire drainage area of the bioretention, bioswale, vegetated open channel, and urban infiltration SCMs listed in Table 10-2 was assumed to be impervious in order to simplify the cost estimation process and to provide conservative cost estimates. A one page summary of each High and Medium Priority project is provided in Appendix A.

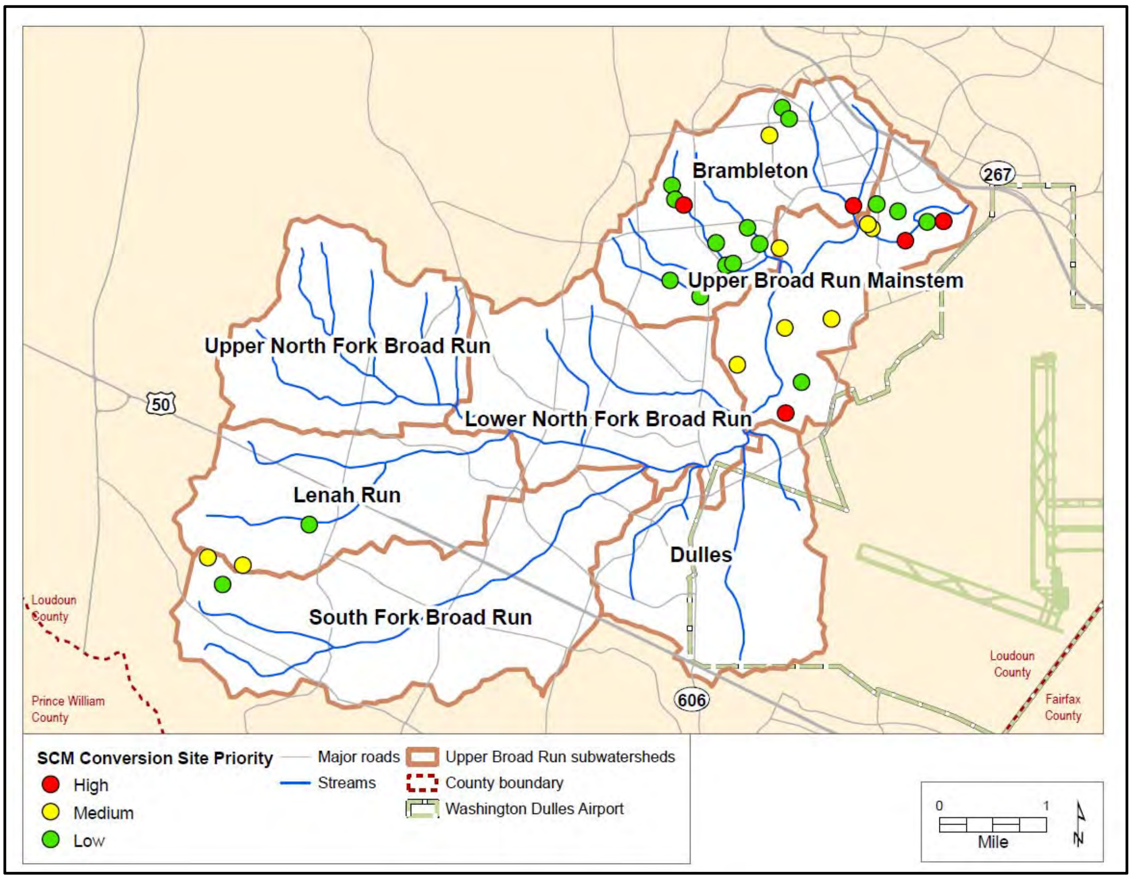

Figure 10-2: Candidate SCM Conversion Site Locations and Priority Ratings

Table 10-2: SCM Conversion Project Details

Structure ID	Subwatershed	Ownership	Pond Type	Proposed Redesign(s)	Priority	Drainage Area (acres)	Estimated Initial Project Cost*	TN Load Reduction (lbs/yr)#	TP Load Reduction (lbs/yr)#	Sediment Load Reduction (lbs/yr)#	Bacteria Reduction (billions/yr)#	Runoff Reduction (acre-ft/yr)#
AJ2205	Upper Broad Run Mainstem	Private	DP(a)	Wet Ponds / Wetlands	High	44.86	$609,000	111.3	14.8	7,434	296	0
AJ2205 (Option 1)	Upper Broad Run Mainstem	Private		Bioswale at location 1 (Partial DA)	High	1.5	$39,000	17.4	1.1	398	23	0.91
AJ2205 (Option 2)	Upper Broad Run Mainstem	Private		Bioswale at location 2 (Partial DA)	High	16.5	$429,000	191.1	11.7	4,375	248	10.0
AJ2430	Upper Broad Run Mainstem	Private	DP(a)	Wet Ponds / Wetlands	High	15.57	$211,000	38.6	5.1	2,580	103	0
JC5171	Brambleton	County	DP(a)	Wet Pond / Wetlands or Bioretention	High	56.67	$768,000	0.0	13.4	0	374	0
WB50081	Upper Broad Run Mainstem	Private	DP(a)	Wet Ponds / Wetlands	High	36.6	$496,000	90.8	12.1	6,065	242	0
WB50081 (Option 1)	Upper Broad Run Mainstem	Private		Step Pool Conveyance location 1 (Partial DA)	High	1.21	$48,000	8.0	0.7	321	0	0
WB50081 (Option 2)	Upper Broad Run Mainstem	Private		Step Pool Conveyance location 2 (Partial DA)	High	34.79	$1,392,000	230.3	19.7	9,225	0	0
WB50081 (Option 3)	Upper Broad Run Mainstem	Private		Bioswale at Location 3 (Partial DA)	High	0.6	$16,000	6.9	0.4	159	9	0.4
CW1	Brambleton	County	DP(a)	Wet Ponds / Wetlands	Medium	5.08	$69,000	12.6	1.7	842	34	0
GC554	Upper Broad Run Mainstem	County	ED DP(a)	Wet Ponds / Wetlands or Bioretention w/ underdrain	Medium	77.33	$1,048,000	0.0	18.3	0	510	0
JC3325	Upper Broad Run Mainstem	County	ED DP(a)	Wet Pond / Wetlands, Chambers or Sand Filter and/or Biosale	Medium	5.12	$69,000	0.0	1.2	0	34	0
JC3718	Upper Broad Run Mainstem	County	ED DP(a)	Wet Pond / Wetlands or Chamber System or Sand Filter	Medium	2.22	$30,000	0.0	0.5	0	15	0
JC4375	Upper Broad Run Mainstem	County	ED DP(b)	Wet Pond / Wetlands or Sand Filter or Chambers	Medium	8.13	$110,000	0.0	1.9	0	54	0
JC50044	Lenah Run	Private	ED DP(a)	Urban Infiltration w/sand, veg or Wet Pond / Wetlands	Medium	10.69	$708,000	115.0	6.6	1,240	6	7.6
JC6134	Upper Broad Run Mainstem	County	ED DP(a)	Wet Pond / Wetlands or Bioretention (x2) with underdrains	Medium	22.7	$308,000	0.0	5.4	0	150	0
KD50006	South Fork Broad Run	Private	ED DP(b)	Urban Infiltration w/sand, veg or Wet Pond / Wetlands	Medium	8.62	$571,000	92.7	5.3	1,000	5	6.1
WB50068	Upper Broad Run Mainstem	School System	DP(a)	Wet Pond / Wetland or Bioswale (draining grass play fields primarily, Partial DA)	Medium	3.94	$53,000	9.8	1.3	653	26	0
AJ2499	Upper Broad Run Mainstem	County	ED DP(a)	Wet Ponds / Wetlands	Low	48.7	$660,000	0.0	11.5	0	321	0
AJ2499 (Option 1)	Upper Broad Run Mainstem	County		Bioretention C/D soils with flow splitter into Wet Pond / Wetland	Medium	1.19	$59,000	4.9	0.5	217	24	0.72
AJ2499 (Option 2)	Upper Broad Run Mainstem	County		Step Pool Conveyance (Partial DA)	High	0.96	$38,000	6.4	0.5	255	0	0
AJ2897	Brambleton	County	ED DP(b)	Wet Ponds / Wetlands	Low	48.12	$652,000	0.0	11.4	0	318	0
AJ4280	Brambleton	County	ED DP(a)	Wet Ponds / Wetlands	Low	4.97	$67,000	0.0	1.2	0	33	0
BC46	Brambleton	Private	ED DP w/forebay(b)	Wet Ponds / Wetlands	Low	4.53	$61,000	0.0	1.1	0	30	0
BC47	Brambleton	Private	ED DP w/forebay(b)	Wet Ponds / Wetlands or Bioretention w/underdrain	Low	3.47	$47,000	0.0	0.8	0	23	0
GC940	Brambleton	County	ED DP w/postbay(b)	Wet Ponds / Wetlands or Bioretention w/underdrain	Low	2.74	$37,000	0.0	0.6	0	18	0

Table 10-2: (Continued)

Structure ID	Subwatershed	Ownership	Pond Type	Proposed Redesign(s)	Priority	Drainage Area (acres)	Estimated Initial Project Cost*	TN Load Reduction (lbs/yr)#	TP Load Reduction (lbs/yr)#	Sediment Load Reduction (lbs/yr)#	Bacteria Reduction (billions/yr)#	Runoff Reduction (acre-ft/yr)#
JC2411	Brambleton	County	ED DP(a)	Wet Pond / Wetlands and/or Bioretention (Partial DA) with flow splitter or Bioswale (Partial DA) inside pond	Low	28.57	$387,000	0.0	6.7	0	189	0
JC3128	Upper Broad Run Mainstem	Private	ED DP(b)	Wet Pond / Wetlands	Low	28.98	$393,000	0.0	6.8	0	191	0
JC3727	Upper Broad Run Mainstem	Private	ED DP(a)	Wet Pond / Wetlands	Low	20.46	$277,000	0.0	4.8	0	135	0
JC4380	Brambleton	County	ED DP(b)	Wet Pond / Wetland and/or Bioretention Pretreatment in Pond	Low	13.07	$177,000	0.0	3.1	0	86	0
JC4577	Brambleton	County	ED DP(b)	Wet Pond or Bioretention in Pond (Partial DA)	Low	14.91	$202,000	0.0	3.5	0	98	0
JC4579	Brambleton	County	WP(b)	1 step pool or 2 bioswales within pond boundary	Low	7	$280,000	46.3	3.9	1,854	0	0
JC4796	Brambleton	County	ED DP(a)	Wet Pond / Wetlands	Low	15.24	$207,000	0.0	3.6	0	101	0
JC4978	Brambleton	Private	ED DP(b)	Wet Pond / Wetlands	Low	28.9	$392,000	0.0	6.8	0	191	0
JC4978 (Option 1)	Brambleton	Private		300 ft. bioswale	Low	14	$364,000	162.1	7.9	3,712	210	0
JC5181	Brambleton	County	ED DP(a)	Wet Pond / Wetlands	Low	19.47	$264,000	0.0	4.6	0	129	0
JC6132	Upper Broad Run Mainstem	County	ED DP(b)	Wet Pond / Wetlands or Bioretention (x2) with underdrains	Low	69.78	$946,000	0.0	16.5	0	461	0
KD50012	Lenah Run	Private	ED DP(b)	Urban Infiltration w/sand, veg or Wet Pond / Wetlands	Low	9.6	$636,000	103.2	5.9	1,114	6	6.8
KD50014	South Fork Broad Run	Private	ED DP(a)	Wet Pond / Wetlands	Low	51.59	$699,000	0.0	12.2	0	340	0
BC45	Brambleton	County	ED Wet w/forebay (b)	N/A	not upgradable	28.09	N/A	N/A	N/A	N/A	N/A	N/A
BC54	Lower North Fork Broad Run	Private	Enhanced ED DP(b)	N/A	not upgradable	16.45	N/A	N/A	N/A	N/A	N/A	N/A
DD231	South Fork Broad Run	School System	Enhanced ED DP(b)	N/A	not upgradable	8.58	N/A	N/A	N/A	N/A	N/A	N/A
JC3947	Brambleton	Private	WP	Take Pond off-line & Stream Restoration		TBD	Special Project	N/A	N/A	N/A	N/A	N/A
JC3947 (Option 1)	Brambleton	Private		6-10 Bioswales	High	40	$1,040,000	463.3	22.7	10,606	600	291.6
JC4162	Brambleton	County	WP(a)	N/A	not upgradable	15.56	N/A	N/A	N/A	N/A	N/A	N/A
JC4162 (Option 1)	Brambleton	County		500 feet of Bioswale in lieu of Concrete Channel Conveyance	High	7.78	$342,000	90.1`	4.4	2,063	117	56.7

DP = Dry Pond, ED = Extended Detention
*Estimated project costs rounded to the nearest $1,000.
Load Reductions can not be summed to obtain a total reduction with the Options included.
(a) Field verified type without benefit of engineering plans.
(b) Type verified with engineering plans (not as-built).

CHAPTER 11: IMPLEMENTATION

This chapter discusses considerations for plan implementation, including cost estimates for various plan elements, schedule considerations, a series of programmatic recommendations, and specific suggestions for involving the community in future watershed planning efforts.

11.1 Cost/Benefit Analysis

A total of 11 types of new practices were recommended for the Upper Broad Run watershed. Some of these practices have similar or identical costs and pollutant removal efficiencies (e.g., NSA Tree Plantings and Stream Buffer Reforestation), but in other cases, costs and removal efficiencies differ among the recommended practices, which suggests that certain practices may be more cost effective when trying to meet watershed specific pollutant reduction goals. A detailed discussion of removal efficiencies, including their sources, is provided in Chapter 6. Table 11-1 summarizes the cost per pound of TN, TP, and sediment removed, cost per acre-foot of runoff reduction, and cost per billion colonies of bacteria removed for each recommended practice type. All costs for nutrient management, reforestation, tree planting, and impervious cover removal recommendations are based on the size of the project area (per acre), and all costs for new SCMs, SCM conversions, and downspout disconnection recommendations are based on the size of the treatment/drainage area (per acre). Stream restoration costs are based on the length of the project (per linear foot). Practices listed in Table 11-1 are ordered from smallest to largest per acre costs.

11.2 Timeframe

A generalized schedule for Loudoun County's implementation of specific watershed restoration projects is given below. Implementation of other recommendations will depend on coordination among various agencies and organizations, as described in Table 11-2.

Generalized schedule for SCM conversions and stream restoration projects:

- <u>Step 1 (Year 1):</u> Review site priorities for SCM conversion projects. For High and Medium priority SCM conversion opportunities, evaluate feasibility, land ownership, utilities, or other constraints. Review Low priority sites for additional opportunities.
- <u>Step 2 (Years 2-3):</u> Design phase for high priority SCM conversion projects.
- <u>Step 3 (Years 4-5):</u> Bid/construction of high priority SCM conversion projects.
- <u>Step 4 (Years 6-7):</u> Design phase for medium priority SCM conversion projects.
- <u>Step 5 (Years 8-9):</u> Bid/construction of medium priority SCM conversion projects.
- <u>Step 6 (Year 10):</u> Review site priorities for stream restoration. For High and Medium priority stream restoration opportunities, evaluate feasibility, land ownership, utilities, or other constraints. Review Low priority sites for additional opportunities.

11.3 Programmatic Recommendations

In addition to the site-specific actions identified throughout this Upper Broad Run watershed plan, we offer a list of programmatic recommendations that will support Loudoun County in implementing effective measures to protect and restore the watershed (Table 11-2). Many of these suggestions will have benefits for other watersheds throughout the County. Although developed independently, many of these recommendations are consistent with recommendations in Loudoun County's 2008 Comprehensive Watershed Management Plan, and are consistent with the programs, actions and efforts associated with the Phase I Watershed Management Program Work Plan currently undertaken by the county's Water Resources Technical Advisory Committee (see http://www.loudoun.gov/DocumentCenter/View/103772).

In Upper Broad Run, Loudoun County Government would be the lead organization for many of the actions listed in Table 11-2. In some cases, the recommendations may involve enacting of regulations, codes, or zoning ordinances by the regulatory body. In other watersheds, incorporated Towns would also be responsible for these actions within their jurisdictions. Many of the recommendations can be facilitated through cooperative partnering, grants, targeting of existing resources, or other non-regulatory means.

11.4 Public Involvement in Watershed Plan Development

Development of the Upper Broad Run Watershed Management Plan included opportunities for the community to get information about the planning process and to provide input to plan development (see Section 1.3), including community meetings, participation in a community outreach event, website updates, and a Watershed Partnership Workgroup (WPW).

Two open community meetings were held: one at the beginning of the project (to solicit input on problems and areas of concern) and one to review project findings and watershed management recommendations. Both meetings were held on weeknights and employed a presentation and small-group discussion format. One meeting featured an interactive electronic map, which proved to be quite popular and a good way to capture participants' attention and record site-specific comments. Loudoun County's Public Affairs staff publicized community meetings through press releases, County Board of Supervisor email lists, Twitter, Facebook, and other outlets. Meeting announcements were picked up and run as calendar items by local media (e.g., Loudoun Times, Washington Post). Community meeting attendance was not high but included key stakeholders: interested members of the general public, the business community (Loudoun Chamber of Commerce), the environmental community, Board of Supervisors staff, a Loudoun Times reporter, and HOA managers. Some members of the project's WPW were recruited based on their attendance at the initial community meeting.

In future watershed planning efforts, we recommend that community meetings be held to solicit public input, but that methods for boosting attendance be explored. Tying in with another community event, such as Earth Day, or a hands-on nature activity (e.g., a streamside trail hike or stream cleanup) would likely broaden participation. In addition, contacting existing organizations that already meet regularly—such as the Master Gardeners, Chamber of Commerce, or networks of local HOA managers—and asking to be part of their agenda would be an additional avenue to promote collaboration.

Throughout the project, updates and workgroup presentations were made available through a dedicated page on the Loudoun County website (http://www.loudoun.gov/upperbroadrunwatershed). This was a convenient way to get information out to the public and to the WPW. Future enhancements could include (1) more frequent, high visibility updates; (2) email and phone contact information for those interested in volunteering for watershed stewardship events; and (3) links to public outreach information on what-you-can-do to help improve water quality (see examples, Appendix B).

Participation in the 12th Annual Family Stream Day event sponsored by Loudoun Watershed Watch and the Loudoun Environmental Stewardship Alliance (http://www.loudounwatershedwatch.org/subitem4_17.html) provided an opportunity for the project team to reach more than 100 local residents and to interact with local environmental education groups. In the future, this annual event could be used to provide more direct opportunities for residents to participate in watershed stewardship activities (e.g., hold a drawing for free rain barrel, sign up for storm drain marking or other volunteer projects), once these opportunities have been established.

The project's WPW met regularly and provided valuable input as members reviewed project findings, provided information on local conditions and problems, and suggested refinements to watershed recommendations. For example, local HOA participants concurred on specific restoration project concepts, particularly when those would address well-known community concerns (e.g., addressing pollution from goose populations, improving aesthetics, addressing flooding). Additional time for interaction with and among group members would be beneficial. In addition to four meetings and email exchanges, we recommend further avenues for communication such as periodic conference calls, particularly because members often were unable to attend meetings (held late afternoon) because of other commitments. Holding meetings during various times of the day might also promote participation.

The WPW formed can become a driving force for the next stage, watershed plan implementation. We recommend that County staff continue to coordinate with the WPW and consider expansion of its membership to include additional HOAs (e.g., Stone Ridge HOA). HOAs can help host and publicize events, hold workshops, and promote good stewardship practices (e.g., via newsletter articles), with assistance and content provided by the County and other educational resources.

Table 11-1: Practice-Specific Unit Costs, Cost Per Unit of Pollutants Reduced, and Projected Total Cost By Practice

Practice	Units Available		Cost/ Acre ($)	Cost/ Pound TN Reduced ($/lbs)	Cost/ Pound TP Reduced ($/lbs)	Cost/ Pound Sediment Reduced ($/lbs)	Cost/ Acre-foot Runoff Reduced ($/ acre-ft)	Cost/ Billion Colonies Bacteria Reduced ($/billion colonies)	Estimated Maximum Total Cost ($)[a]	Estimated Projected Total Cost ($)[a]
Urban Nutrient Management[b]	1,650	acres	20	13	835	N/A	N/A	N/A	33,000	16,500
Reforest Stream Buffer[b]	419	acres	7,000	639	9,604	38	29,584	389	2,932,000	1,906,000
Pervious Area Reforestation[b]	50	acres	7,000	905	23,164	77	2,601	389	353,000	176,000
Tree Plantings (NSA)[b]	52	acres	7,000	905	23,164	77	29,592	389	366,000	121,000
Tree Plantings (ISI)[b]	51	acres	7,000	905	23,164	77	29,592	389	358,000	236,000
Dry Pond to Wet Pond Conversion[b]	106	acres	13,556	5,462	41,024	82	N/A	2,054	1,438,000	1,438,000
Extended Detention Dry Pond to Wet Pond Conversion[b]	172	acres	13,556	N/A	729	N/A	N/A	26	2,334,000	2,334,000
Downspout Disconnection (NSA)[c]	47	acres	49,000	4,427	36,955	64	44,287	N/A	2,298,000	758,000
New SCMs (NSA, ISI, PAA, HSI)[d]	70	acres	49,875	12,057	117,394	274	82,108	3,325	3,511,000	1,755,000
Extended Detention Dry Pond to Infiltration Trench Conversion[d]	19	acres	66,250	6,160	107,956	571	91,378	106,607	1,279,000	1,279,000
Impervious Cover Removal (ISI)[b]	0	acres	90,000	N/A	N/A	N/A	N/A	N/A	-	-
New Stream Restoration[b]	5140	feet	500*	2,500	7,353	9	N/A	N/A	2,570,000	1,927,500

* Stream Restoration Cost is per linear foot.
[a] Total costs are rounded to the nearest $1,000.
[b] Cost based on Loudoun County Phase II WIP Technical Advisory Committee.
[c] Cost based on CWP (2007).
[d] Cost based on King and Hagan (2011).

Table 11-2: Programmatic Watershed Management Recommendations

Recommended Action	Description	Timing
Stormwater Management and Stream Restoration		
Target funds for stormwater improvements	Target CIP funds for stormwater pond conversions as identified in this report. Coordination between Loudoun County Building and Development and the County Department of General Services will help to bring about improvements that will also make progress toward the County MS4 and Chesapeake Bay WIP requirements.	Start immediately
Cluster implementation of stormwater improvements	Cluster the early implementation of recommended new SCMs and pond conversions so that positive results can help to build public support.	Start immediately
Stormwater management on future development	Require that all new development employ rigorous stormwater management that mimics predevelopment hydrology to the extent possible and provides sufficient water quality treatment. Provide "Green Seal" as incentive for developers that go beyond minimum stormwater control requirements.	Start immediately
Stormwater management at future public schools	Coordinate with Loudoun County Public Schools as future schools are developed to encourage ESD approaches, seeking to incorporate more advanced stormwater management into designs.	Start immediately
Stream restoration	Improve stormwater management controls upstream of potential stream restoration sites before initiating stream restoration projects. We recommend delaying large-scale restoration of stream morphology until stream flows in the upstream catchment have been stabilized. Stream restoration projects can then be designed to accommodate long-term flows.	Within 5-10 years, depending on timing of stormwater conversion projects
Conservation		
Forest conservation	Preserve existing forest to the greatest extent possible. Strictly enforce forest conservation requirements.	Start immediately
Conservation easements	Encourage the use of permanent conservation easements for open space areas (e.g., naturally vegetated lands and agricultural land with healthy riparian buffers).	Start immediately
Develop green infrastructure network	Develop a green infrastructure network for preservation through easements of high quality areas.	Within 3 years
Designate high quality waters	Designate special protection areas for high quality waters, including tiered impervious surface caps. Consider designation of Exceptional State Waters (Tier III).*	Within 3 years
Public Outreach, Education, and Stewardship Activities		
Develop public outreach strategy	Involve the community: Develop a coordinated public outreach strategy for enhancing resident awareness and motivation to take actions that improve the watershed. The strategy would identify key messages, target audiences, intended outcomes, delivery techniques, and measures of success.	Start immediately
Identify partnership opportunities with local agencies and organizations	Along with Loudoun County Government, partners such as Loudoun County Public Schools, Loudoun Water, Loudoun Soil and Water Conservation District, Virginia Department of Transportation, Loudoun Chamber of Commerce and other business contacts, Master Gardeners, homeowner associations (HOAs), and many others can make valuable contributions to carrying out plan recommendations, including tree plantings, new SCMs, better housekeeping practices, and other recommendations.	Start immediately

Table 11-2: Programmatic Watershed Management Recommendations

Recommended Action	Description	Timing
Urban nutrient management education	Encourage reduced use of fertilizers and pesticides on both residential and commercial properties.	Within 1 year
Watershed education and activities through coordination with Loudoun Soil and Water Conservation District, Master Gardeners, HOAs, and other organizations	Develop and promote educational programs that encourage residents to take actions and encourage communities to implement recommended practices on community lands. Specific community involvement activities could include the following: • Implementation of a watershed stewards training program • Include stewardship training in recreation programs curriculum (e.g., community classes on how to create a rain garden) • Regular offerings of community stewardship events (e.g., tree plantings, invasive plant removal on community property, stream clean-ups, rain garden/rain barrel workshops, storm drain marking) • Distribute free trees (seedlings) to all residents with streams on their property • Awards program for outstanding stewardship projects.	Within 1 year
Better housekeeping practices at commercial/ industrial facilities	Educate local business owners and employees about improving housekeeping practices to eliminate potential pollution hotspots. Conduct training workshops.	Within 2 years
Public outreach materials	Engage with local conservation/environmental organizations to target public outreach efforts to the watershed's neighborhoods, businesses, and schools. Examples of successful watershed outreach materials, which could be used or adapted for Loudoun County, are included in Appendix B.	Within 2 years
Other watershed education and activities at businesses	Educate business owners and employees about ways to better manage stormwater runoff and improve water quality, through projects such as tree plantings, rain gardens/rain barrels and other downspout disconnection techniques, and storm drain marking.	Within 3 years
Develop volunteer opportunities	Develop volunteer programs for (1) stream monitoring, (2) raingarden planting design (through Master Gardeners and other local experts), and (3) education and outreach.	Within 4 years
Promote watershed education at local schools, through coordination with Loudoun County Public Schools	Develop core watershed education materials that can be used throughout the County. Within Upper Broad Run, promote watershed education through local schools, including the existing five elementary schools, one middle school, and one high school, along with future schools that are planned for the watershed. Identify key points of contact who can promote watershed educational experiences, including hands-on stewardship activities.	Within 4 years
Agriculture		
Agricultural BMPs	Loudoun Soil and Water Conservation District can promote fencing of livestock (e.g., cattle, horses) out of streams and encourage other BMPs on agricultural lands.	Start immediately

Table 11-2: Programmatic Watershed Management Recommendations

<table>
<tr><th>Recommended Action</th><th>Description</th><th>Timing</th></tr>
<tr><td colspan="3">Coordination</td></tr>
<tr><td>Coordinate plan implementation</td><td>Dedicate county staff time to spearhead plan implementation and coordinate with other governmental and non-governmental organizations, for example:
• Loudoun County Departments of Building and Development, General Services, Planning and Zoning, and others
• Loudoun County Public Schools
• Metropolitan Washington Council of Governments (MWCOG)
• Northern Virginia Regional Commission (NVRC)
• Loudoun Soil and Water Conservation District
• Virginia Extension / Master Gardeners
• Loudoun Water
• Natural Resource Conservation Service (NRCS)
• Virginia Departments of Transportation, Forestry, Environmental Quality, and Conservation and Recreation.
• HOAs
• Loudoun Watershed Watch
• Other environmental organizations</td><td>Start immediately</td></tr>
<tr><td>Watershed Partnership Workgroup</td><td>Continue to coordinate with the Upper Broad Run WPW to foster community and organizational involvement in plan implementation. Begin with an invitation to current WPW members to extend their involvement and consider adding other interested members of the community (e.g., additional HOAs).</td><td>Start immediately</td></tr>
<tr><td>Interagency coordination</td><td>Form interagency committee with quarterly meetings to foster better coordination among county, state, and regional agencies to facilitate implementation of recommended actions.</td><td>Start immediately</td></tr>
<tr><td>Secure funding</td><td>Identify and apply for available grants, CIP, and other funding sources.</td><td>Start immediately</td></tr>
<tr><td>Evaluate plan implementation</td><td>Re-evaluate pollutant load model and load reductions at regular intervals, as land is developed and watershed recommendations are implemented. An adaptive management approach can be taken so that the effectiveness of implemented actions can be evaluated and the plan adjusted to address changing conditions and opportunities.</td><td>Within 5 years</td></tr>
<tr><td>Monitor for results</td><td>Monitoring for results. It is important that the County's watershed management efforts include continuing monitoring to demonstrate improvements and support adaptive management. We recommend developing an overall strategy for tracking and monitoring restoration of Loudoun County watersheds that includes one or more of the following indicators:
• Reduction in amount of nutrient and sediment loading downstream in pounds per year
• Improvement or maintenance of biological condition of streams as measured by biological indicator (i.e., Virginia Stream Condition Index) scores or the number of stream miles with desired VSCI scores
• Increase in the acres of impervious surface with enhanced stormwater control
• Linear feet of eroding stream that have been stabilized
• Increase or conservation of forest acres</td><td>Begin within 2 years and continue to monitor at regular intervals</td></tr>
</table>

* For more information, see http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityStandards/ExceptionalStateWaters(TierIII).aspx

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APPENDIX A

PROPOSED PROJECT FACT SHEETS

STREAM RESTORATION PROJECT FACT SHEETS

Upper Broad Run Watershed Management Plan - Proposed Project

Project ID:	BRAM-ES-059-2014	**Restoration Priority:**	High
Subwatershed:	Brambleton	**Erosion Length (feet):**	90
Project Type:	Stream Restoration	**Erosion Height (feet):**	2.5
Nearest Address:	Addlestone Place	**Existing SCM:**	N/A

Site Description:

Within highly impervious catchment. Bank erosion is undermining trees along stream bank and several are close to falling into the stream. Within a narrow, wooded area with residential housing to the south and Loudoun County Parkway to the north.

Tree falling over into stream

Bank erosion undermining several trees along stream channel

Proposed Action: Stabilize stream bank and reconnect with floodplain

Benefits:

Improve stream stability, erosion, and instream habitat
Improve floodplain connectivity and nutrient cycling functions
Prevent property and structural loss

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking restoration design, must first manage flow issues from upstream development

Known Utilities and Other Constraints: No apparent utility conflicts; however, the presence or absence of utilities should be confirmed prior to restoration

Estimated Cost and Pollutant Load Reductions

Initial Project Cost:
$45,000

Total Nitrogen (lbs/yr):	18
Total Phosphorus (lbs/yr):	6.12
Sediment (lbs/yr):	4,883

Upper Broad Run Watershed Management Plan - Proposed Project

Project ID:	BRAM-ES-060-2014	**Restoration Priority:**	Medium
Subwatershed:	Brambleton	**Erosion Length (feet):**	40
Project Type:	Stream Restoration	**Erosion Height (feet):**	1.5
Nearest Address:	Claiborne Parkway & Loudoun County Parkway	**Existing SCM:**	N/A

Site Description:

Within a narrow, wooded corridor. Residential yards close to eroding stream bank. Heavy deposition on opposite bank.

Stream bank erosion

Deposition occurring on bank opposite of eroding bank

Proposed Action: Stabilize stream bank and reconnect with floodplain

Benefits: Improve stream stability, erosion, and instream habitat
Improve floodplain connectivity and nutrient cycling functions

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking restoration design, must first manage flow issues from upstream development

Known Utilities and Other Constraints: Residential yards 10-15 feet from left streambank

Estimated Cost and Pollutant Load Reductions

Initial Project Cost:
$20,000

Total Nitrogen (lbs/yr):	8
Total Phosphorus (lbs/yr):	2.72
Sediment (lbs/yr):	2,170

Upper Broad Run Watershed Management Plan - Proposed Project

Project ID:	BRAM-RS-262-2014	**Restoration Priority:**	Low
Subwatershed:	Brambleton	**Erosion Length (feet):**	120
Project Type:	Stream Restoration	**Erosion Height (feet):**	2
Nearest Address:	Belmont Ridge Road	**Existing SCM:**	JC4579

Site Description:

Eroded channel downstream of large regional pond. Fairly dense housing throughout upstream catchment. No headwaters, all is piped.

Tree undermined by bank erosion falling over into stream

Bank erosion downstream of stormwater pond

Proposed Action: Stabilize stream bank

Benefits:
Improve stream stability, erosion, and instream habitat
Improve floodplain connectivity and nutrient cycling functions
Prevent property and structural loss

Key Issues for Implementation

Project Sequencing Concerns: None noted during initial site review

Known Utilities and Other Constraints: Within sewer pipeline right-of-way

Estimated Cost and Pollutant Load Reductions

Initial Project Cost: N/A

Total Nitrogen (lbs/yr):	24
Total Phosphorus (lbs/yr):	8.16
Sediment (lbs/yr):	6,510

Upper Broad Run Watershed Management Plan - Proposed Project

Project ID:	BRAM-RS-263-2014	**Restoration Priority:**	High
Subwatershed:	Brambleton	**Erosion Length (feet):**	700
Project Type:	Stream Restoration	**Erosion Height (feet):**	4
Nearest Address:	Ryan Road & Airmont Hunt Drive	**Existing SCM:**	JC4380

Site Description:

Stream with eroded banks beside stormwater pond. Site is downstream of a lot of recent and ongoing development, including Moorefield Station Elementary School.

Bank erosion occurring where stream runs along stormwater pond

Very narrow, forested riparian buffer along eroding bank

Proposed Action: Stabilize stream bank

Benefits:
- Improve stream stability, erosion, and instream habitat
- Improve floodplain connectivity and nutrient cycling functions
- Prevent property and structural loss

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking restoration design, must first manage flow issues from upstream development

Known Utilities and Other Constraints: No apparent utility conflicts; however, the presence or absence of utilities should be confirmed prior to restoration

Estimated Cost and Pollutant Load Reductions

Initial Project Cost:
$350,000

Total Nitrogen (lbs/yr):	140
Total Phosphorus (lbs/yr):	47.6
Sediment (lbs/yr):	37,975

Upper Broad Run Watershed Management Plan - Proposed Project

Project ID:	BRAM-RS-265-2014	**Restoration Priority:**	High
Subwatershed:	Brambleton	**Erosion Length (feet):**	2,500
Project Type:	Stream Restoration	**Erosion Height (feet):**	6
Nearest Address:	Westwind Drive & Loudoun County Parkway	**Existing SCM:**	JC3947

Site Description:

Pond within Lyndora Park. Restoration may include the inline pond, channels leading to the pond, and the outflow channel. Stream downstream of pond is very unstable.

Severe bank erosion

Bank erosion undermining trees causing them to fall over into stream

Proposed Action: Take pond off-line, remove geese, convert upstream channels to bioswales, and stabilize downstream erosion

Benefits:
- Improve stream stability, erosion, and instream habitat
- Improve floodplain connectivity and nutrient cycling functions
- Prevent property and structural loss
- Improve community usage
- Opportunity for public education

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking restoration design, must first manage flow issues from upstream development

Known Utilities and Other Constraints: Sewer pipeline right-of-way and footpath in close proximity to candidate project. Portions of Lyndora Park may be impacted.

Estimated Cost and Pollutant Load Reductions

Initial Project Cost:
$1,250,000

Total Nitrogen (lbs/yr):	500
Total Phosphorus (lbs/yr):	170
Sediment (lbs/yr):	135,625

Upper Broad Run Watershed Management Plan - Proposed Project

Project ID:	BRAM-RS-266-2014	**Restoration Priority:**	Low (Special
Subwatershed:	Brambleton	**Erosion Length (feet):**	1,000
Project Type:	Stream Restoration	**Erosion Height (feet):**	N/A
Nearest Address:	Claiborne Parkway	**Existing SCM:**	JC5171 & JC4796

Site Description:

Inline dry ponds between Forest Manor Drive and Forest Run Drive. Most of the catchment is forested upstream of dry ponds.

Pond Structure ID JC5171 is one of the two inline ponds being recommended for restoration

Pond Structure ID JC4796 is one of the two inline ponds being recommended for restoration

Proposed Action: Take ponds offline

Benefits:

Improve floodplain connectivity and nutrient cycling functions
Improve community usage
Opportunity for public education
Reconnect stream to headwaters

Key Issues for Implementation

Project Sequencing Concerns: None noted during initial site review

Known Utilities and Other Constraints: Beside Forest Manor Drive. Water and sewer pipelines run along roadway. Ponds surrounded by residential housing.

Estimated Cost and Pollutant Load Reductions

Initial Project Cost: N/A

Total Nitrogen (lbs/yr):	N/A
Total Phosphorus (lbs/yr):	N/A
Sediment (lbs/yr):	N/A

Upper Broad Run Watershed Management Plan - Proposed Project

Project ID:	LNF-ES-077-2014	**Restoration Priority:**	High
Subwatershed:	Lower North Fork Broad Run	**Erosion Length (feet):**	35
Project Type:	Stream Restoration	**Erosion Height (feet):**	6
Nearest Address:	Loudoun County Parkway	**Existing SCM:**	N/A

Site Description:

Severe erosion of right bank occurring where Loudoun County Parkway is proposed to cross Broad Run. Large debris jam downstream is causing erosion. Transmission line right-of-way on other side of stream.

Debris jam that is causing erosion

Severe stream bank erosion

Proposed Action: Stabilize stream bank

Benefits: Improve stream stability, erosion, and instream habitat
Prevent property and structural loss

Key Issues for Implementation

Project Sequencing Concerns: Should consider potential restoration in conjunction with road construction

Known Utilities and Other Constraints: Adjacent to transmission line right-of-way and planned road crossing

Estimated Cost and Pollutant Load Reductions

Initial Project Cost:
$17,500

Total Nitrogen (lbs/yr):	7
Total Phosphorus (lbs/yr):	2.38
Sediment (lbs/yr):	1,899

Upper Broad Run Watershed Management Plan - Proposed Project

Project ID:	LNF-ES-114-2014	**Restoration Priority:**	Medium
Subwatershed:	Lower North Fork Broad Run	**Erosion Length (feet):**	750
Project Type:	Stream Restoration	**Erosion Height (feet):**	4.25
Nearest Address:	Belmont Ridge Road	**Existing SCM:**	N/A

Site Description:

Along mainstem of North Fork Broad Run, adjacent to transmission line right-of-way and old crop field. Very little tree cover. Erosion is prevalent in the vicinity of this site. The stream banks are actively slumping.

Severe stream bank erosion

Bank erosion undermining trees along stream

Proposed Action: Stabilize stream bank and reconnect with floodplain

Benefits:
- Improve stream stability, erosion, and instream habitat
- Improve floodplain connectivity and nutrient cycling functions
- Prevent property and structural loss

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking restoration design, must first manage flow issues from upstream development

Known Utilities and Other Constraints: Adjacent to transmission line right-of-way

Estimated Cost and Pollutant Load Reductions

Initial Project Cost: $375,000

Total Nitrogen (lbs/yr):	150
Total Phosphorus (lbs/yr):	51
Sediment (lbs/yr):	40,687

Upper Broad Run Watershed Management Plan - Proposed Project

Project ID:	SF-ES-106-2014	**Restoration Priority:**	Low
Subwatershed:	South Fork Broad Run	**Erosion Length (feet):**	3
Project Type:	Stream Restoration	**Erosion Height (feet):**	3.5
Nearest Address:	Braddock Road	**Existing SCM:**	N/A

Site Description:

Headcut beside culvert that conveys stream under farm road. Upstream of site lacks riparian buffer.

Headcut occurring beside pipe culvert

Proposed Action: Consider installing larger pipe or adding armoring around the pipe

Benefits: Prevent property and structural loss

Key Issues for Implementation

Project Sequencing Concerns: None noted during initial site review

Known Utilities and Other Constraints: Stream runs through a culvert under farm road

Estimated Cost and Pollutant Load Reductions

Initial Project Cost: $1,500

Total Nitrogen (lbs/yr):	0.6
Total Phosphorus (lbs/yr):	0.204
Sediment (lbs/yr):	163

Upper Broad Run Watershed Management Plan - Proposed Project

Project ID:	SF-ES-139-2014	**Restoration Priority:**	Low
Subwatershed:	South Fork Broad Run	**Erosion Length (feet):**	35
Project Type:	Stream Restoration	**Erosion Height (feet):**	2.5
Nearest Address:	Evergreen Mills Road	**Existing SCM:**	N/A

Site Description:

Some erosion occurring at sewer pipeline crossing. Site near end of Bishop Meade Place.

Bank erosion near sewer crossing, unforested riparian

Close up of eroding stream bank beneath overhanging vegetation

Proposed Action: Stabilize stream bank

Benefits: Improve stream stability, erosion, and instream habitat
Prevent property and structural loss

Key Issues for Implementation

Project Sequencing Concerns: None noted during initial site review

Known Utilities and Other Constraints: Within sewer pipeline right-of-way

Estimated Cost and Pollutant Load Reductions

Initial Project Cost: $17,500

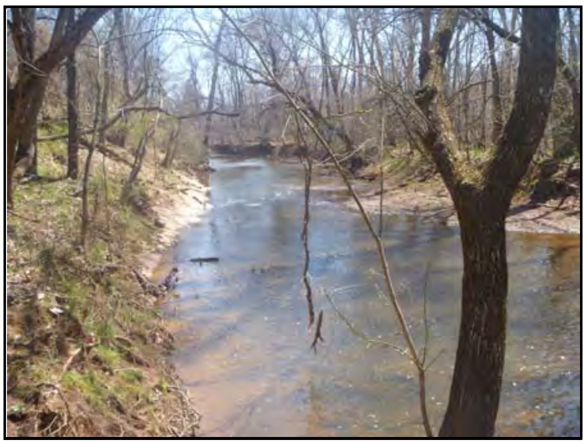
Total Nitrogen (lbs/yr):	7
Total Phosphorus (lbs/yr):	2.38
Sediment (lbs/yr):	1,898

Upper Broad Run Watershed Management Plan - Proposed Project

Project ID:	UBRM-RS-264-2014	**Restoration Priority:**	Medium
Subwatershed:	Upper Broad Run Mainstem	**Erosion Length (feet):**	1,000
Project Type:	Stream Restoration	**Erosion Height (feet):**	4.5
Nearest Address:	Westwind Drive	**Existing SCM:**	JC3325 & JC3718

Site Description:

Erosion along both sides of mainstem near High Haven Terrace. Both sides of stream are forested for most of the length of erosion. This site is close to the Upper Broad Run watershed outlet.



Severe bank erosion

Bank erosion undermining trees and causing slumping

Proposed Action: Stabilize stream bank

Benefits:
Improve stream stability, erosion, and instream habitat
Improve floodplain connectivity and nutrient cycling functions
Prevent property and structural loss

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking restoration design, must first manage flow issues from upstream development

Known Utilities and Other Constraints: Water and sewer pipeline cross stream near this site. Multiple property owners within proposed project area.

Estimated Cost and Pollutant Load Reductions

Initial Project Cost:
$500,000

Total Nitrogen (lbs/yr):	200
Total Phosphorus (lbs/yr):	68
Sediment (lbs/yr):	54,250

Upper Broad Run Watershed Management Plan - Proposed Project

Project ID:	UNF-ES-122-2014	**Restoration Priority:**	N/A
Subwatershed:	Upper North Fork Broad Run	**Erosion Length (feet):**	30
Project Type:	Stream Restoration	**Erosion Height (feet):**	0
Nearest Address:	Lenah Loop Road	**Existing SCM:**	N/A

Site Description:

Grass next to stream trampled by livestock. Site located approximately 1000 feet upstream of Fleetwood Road.

Trampled stream bank

Proposed Action: Add fencing

Benefits: Improve stream stability, erosion, and instream habitat

Key Issues for Implementation

Project Sequencing Concerns: None noted during initial site review

Known Utilities and Other Constraints: No apparent utility conflicts; however, the presence or absence of utilities should be confirmed prior to restoration

Estimated Cost and Pollutant Load Reductions

Initial Project Cost: N/A

Total Nitrogen (lbs/yr):	6
Total Phosphorus (lbs/yr):	2.04
Sediment (lbs/yr):	1,628

Upper Broad Run Watershed Management Plan - Proposed Project

Project ID:	UNF-ES-123-2014	**Restoration Priority:**	Medium
Subwatershed:	Upper North Fork Broad Run	**Erosion Length (feet):**	25
Project Type:	Stream Restoration	**Erosion Height (feet):**	3
Nearest Address:	Fleetwood Road	**Existing SCM:**	N/A

Site Description:

Approximately 10 feet upstream of Fleetwood Road

Bank erosion and slumping near road crossing

Proposed Action: Stabilize stream bank

Benefits:

Improve stream stability, erosion, and instream habitat
Prevent property and structural loss
Reduce road flooding

Key Issues for Implementation

Project Sequencing Concerns: None noted during initial site review

Known Utilities and Other Constraints: Beside roadway

Estimated Cost and Pollutant Load Reductions

Initial Project Cost:
$12,500

Total Nitrogen (lbs/yr):	5
Total Phosphorus (lbs/yr):	1.7
Sediment (lbs/yr):	1,356

Upper Broad Run Watershed Management Plan - Proposed Project

Project ID:	UNF-ES-150-2014	**Restoration Priority:**	Low
Subwatershed:	Upper North Fork Broad Run	**Erosion Length (feet):**	80
Project Type:	Stream Restoration	**Erosion Height (feet):**	2
Nearest Address:	Lenah Loop Road	**Existing SCM:**	N/A

Site Description:

Stream banks trampled by livestock and also impacted by high flows. Site approximately 700 feet downstream of the proposed location of Lenah Loop Road.

Severe bank erosion

Trampled stream bank where cattle access stream

Proposed Action: Add fencing and stabilize stream bank

Benefits: Improve stream stability, erosion, and instream habitat
Prevent property and structural loss

Key Issues for Implementation

Project Sequencing Concerns: None noted during initial site review

Known Utilities and Other Constraints: No apparent utility conflicts; however, the presence or absence of utilities should be confirmed prior to restoration

Estimated Cost and Pollutant Load Reductions

Initial Project Cost: N/A

Total Nitrogen (lbs/yr):	16
Total Phosphorus (lbs/yr):	5.44
Sediment (lbs/yr):	4,340

Upper Broad Run Watershed Management Plan - Proposed Project

Project ID:	UNF-ES-153-2014	**Restoration Priority:**	N/A
Subwatershed:	Upper North Fork Broad Run	**Erosion Length (feet):**	35
Project Type:	Stream Restoration	**Erosion Height (feet):**	2
Nearest Address:	Fleetwood Road	**Existing SCM:**	N/A

Site Description:

Stream banks trampled by livestock. Site is approximately 250 ft. downstream of proposed location of Lenah Loop Road.

Trampled stream bank where cattle cross stream

Trampled stream bank where cattle cross stream

Proposed Action: Add fencing

Benefits: Improve stream stability, erosion, and instream habitat

Key Issues for Implementation

Project Sequencing Concerns: None noted during initial site review

Known Utilities and Other Constraints: No apparent utility conflicts; however, the presence or absence of utilities should be confirmed prior to restoration

Estimated Cost and Pollutant Load Reductions

Initial Project Cost: N/A

Total Nitrogen (lbs/yr):	7
Total Phosphorus (lbs/yr):	2.38
Sediment (lbs/yr):	1,899

Upper Broad Run Watershed Management Plan - Proposed Project

Project ID:	UNF-ES-156-2014	**Restoration Priority:**	Low
Subwatershed:	Upper North Fork Broad Run	**Erosion Length (feet):**	125
Project Type:	Stream Restoration	**Erosion Height (feet):**	1.5
Nearest Address:	Lenah Loop Road	**Existing SCM:**	N/A

Site Description:

Stream channel is within gas pipeline right-of-way. Dense forest on both sides of right-of-way.

Pipeline that crosses stream bed

Unstable stream channel

Proposed Action: Stabilize stream bed

Benefits: Improve stream stability, erosion, and instream habitat
Prevent property and structural loss

Key Issues for Implementation

Project Sequencing Concerns: None noted during initial site review

Known Utilities and Other Constraints: Within gas pipeline right-of-way

Estimated Cost and Pollutant Load Reductions

Initial Project Cost:
$62,500

Total Nitrogen (lbs/yr):	25
Total Phosphorus (lbs/yr):	8.5
Sediment (lbs/yr):	6,781

SCM CONVERSION PROJECT FACT SHEETS

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: AJ2205 **Option:** N/A
Restoration Priority: High
Subwatershed: Upper Broad Run Mainstem
Drainage Area: 44.9 acres
Ownership: County

Project Type: Wet Pond/Wetlands
Project Name: Pebble Run Dry Pond Conversion
Nearest Address: Pebble Run Place

Site Description:

Dry pond with one major outfall entering it immediately adjacent to a dewatering structure. Lots of trash, dumping of some tires and 55-gallon drums.

Existing dry pond facility

Trash and floatables accumulated in ponds

Proposed Action: Convert pond to wet pond/wetland

Benefits:
Improve stormwater quality controls
Recharge
Channel protection
Flood control

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking project design, engage nearby businesses and residents to promote the benefits of stormwater control and encourage support for the project; if selected, optional elements should be installed at the time of pond conversion

Known Utilities and Other Constraints: Site appears to be near a sewer pipeline; will need access to parking area

Estimated Cost and Pollutant Reductions

Total Project Cost: $609,000

Total Nitrogen (lbs/yr):	111.3
Total Phosphorus (lbs/yr):	14.8
Sediment (lbs/yr):	7,434
Bacteria (billions/yr):	296
Runoff (acre-ft/yr):	0

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: AJ2205 **Option:** 1
Restoration Priority: High
Subwatershed: Upper Broad Run Mainstem
Drainage Area: 1.5 acres
Ownership: County

Project Type: Conveyance & Infiltration
Project Name: Pebbly Run Location 1 Bioswale
Nearest Address: Pebble Run Place

Site Description:

Dry pond with one major outfall entering it immediately adjacent to a dewatering structure. Lots of trash, dumping of some tires and 55-gallon drums.

Riprapped channel from parking lot to pond where a bioswale is recommended

Proposed Action: Install bioswale

Benefits:
Improve stormwater quality controls
Recharge
Channel protection

Key Issues for Implementation

Project Sequencing Concerns: If selected, optional elements should be installed at the time of pond conversion

Known Utilities and Other Constraints: Site is adjacent to a transmission line right-of-way; potential tree impacts

Estimated Cost and Pollutant Reductions

Total Project Cost: $39,000

Total Nitrogen (lbs/yr): 17.4
Total Phosphorus (lbs/yr): 1.1
Sediment (lbs/yr): 398

Bacteria (billions/yr): 23
Runoff (acre-ft/yr): 0.91

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: AJ2205 **Option:** 2

Restoration Priority: High

Subwatershed: Upper Broad Run Mainstem

Drainage Area: 16.5 acres

Ownership: County

Project Type: Conveyance & Infiltration

Project Name: Pebble Run Location 2 Bioswale

Nearest Address: Pebble Run Place

Site Description:

Dry pond with one major outfall entering it immediately adjacent to a dewatering structure. Lots of trash, dumping of some tires and 55-gallon drums.

Riprapped channel from parking lot to pond where a bioswale is recommended

Proposed Action: Install bioswale

Benefits:
Improve stormwater quality controls
Recharge
Channel protection

Key Issues for Implementation

Project Sequencing Concerns: If selected, optional elements should be installed at the time of pond conversion

Known Utilities and Other Constraints: Site is adjacent to a transmission line right-of-way; potential tree impacts

Estimated Cost and Pollutant Reductions

Total Project Cost: $429,000

Total Nitrogen (lbs/yr): 191.1
Total Phosphorus (lbs/yr): 11.7
Sediment (lbs/yr): 4,375

Bacteria (billions/yr): 248
Runoff (acre-ft/yr): 10

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: AJ2430 **Option:** N/A

Restoration Priority: High

Subwatershed: Upper Broad Run Mainstem

Drainage Area: 15.6 acres

Ownership: Private

Project Type: Wet Pond/Wetlands

Project Name: Mercure Circle #2 Dry Pond Conversion

Nearest Address: Mercure Circle

Site Description:

Large commercial area drains to existing pond.

Outfall draining to dry pond; accumulated debris in foreground

Damaged dewatering structure

Proposed Action: Convert pond to wet pond/wetland

Benefits:
Improve stormwater quality controls
Opportunity for outreach to business community
Improve aesthetic quality

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking project design, engage nearby businesses and residents to promote the benefits of stormwater control and encourage support for the project

Known Utilities and Other Constraints: Site is adjacent to a transmission line right-of-way; steep slopes may be a limiting factor; no space for lateral enlargement

Estimated Cost and Pollutant Reductions

Total Project Cost: $211,000

Total Nitrogen (lbs/yr):	38.6
Total Phosphorus (lbs/yr):	5.1
Sediment (lbs/yr):	2,580
Bacteria (billions/yr):	103
Runoff (acre-ft/yr):	0

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: AJ2499 **Option:** N/A

Restoration Priority: Low

Subwatershed: Upper Broad Run Mainstem

Drainage Area: 48.7 acres

Ownership: County

Project Type: Wet Pond/Wetlands

Project Name: Mercure Circle #3 Dry Pond Conversion

Nearest Address: Mercure Circle

Site Description:

Large extended detention dry pond with two large, recessed outfalls and three additional surface outfalls. Pond has some de facto wetland areas due to a clogged dewatering structure. Area downstream seems to be relatively stable.

Existing stormwater management pond

Dewatering structure clogged with sediment and debris

Proposed Action: Convert to a wet pond/wetland

Benefits: Improve stormwater quality controls
Improve aesthetic quality

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking project design, engage nearby businesses and residents to promote the benefits of stormwater control and encourage support for the project; if selected, optional elements should be installed at the time of pond conversion

Known Utilities and Other Constraints: Site is adjacent to transmission line right-of-way

Estimated Cost and Pollutant Reductions

Total Project Cost: $660,000

Total Nitrogen (lbs/yr):	0
Total Phosphorus (lbs/yr):	11.5
Sediment (lbs/yr):	0
Bacteria (billions/yr):	321
Runoff (acre-ft/yr):	0

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: AJ2499 **Option:** 1
Restoration Priority: Medium
Subwatershed: Upper Broad Run Mainstem
Drainage Area: 1.2 acres
Ownership: County

Project Type: Infiltration & Treatment
Project Name: Mercure Circle #3 Bioretention
Nearest Address: Mercure Circle

Site Description:

Large extended detention dry pond with two large, recessed outfalls and three additional surface outfalls. Pond has some de facto wetland areas due to a clogged dewatering structure. Area downstream seems to be relatively stable.

Portion of stormwater pond may have flow diverted with a berm and converted to a bioretention cell

Proposed Action: Install a bioretention and flow splitter

Benefits: Improve stormwater quality controls

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking project design, engage nearby businesses and residents to promote the benefits of stormwater control and encourage support for the project

Known Utilities and Other Constraints: Site is adjacent to transmission line right-of-way

Estimated Cost and Pollutant Reductions

Total Project Cost: $59,000

Total Nitrogen (lbs/yr):	4.9
Total Phosphorus (lbs/yr):	0.5
Sediment (lbs/yr):	217
Bacteria (billions/yr):	24
Runoff (acre-ft/yr):	0.72

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: AJ2499 **Option:** 2

Restoration Priority: High

Subwatershed: Upper Broad Run Mainstem

Drainage Area: 1.0 acres

Ownership: County

Project Type: Conveyance & Infiltration

Project Name: Mercure Circle # 3 Step Pools

Nearest Address: Mercure Circle

Site Description:

Large extended detention dry pond with two large, recessed outfalls and three additional surface outfalls. Pond has some de facto wetland areas due to a clogged dewatering structure. Area downstream seems to be relatively stable.

Riprapped flow path to pond that may be converted to a step pool conveyance

Proposed Action: Install step pool conveyance

Benefits: Improve stormwater quality controls

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking project design, engage nearby businesses and residents to promote the benefits of stormwater control and encourage support for the project

Known Utilities and Other Constraints: Site is adjacent to transmission line right-of-way

Estimated Cost and Pollutant Reductions

Total Project Cost: $38,000

Total Nitrogen (lbs/yr):	6.4
Total Phosphorus (lbs/yr):	0.5
Sediment (lbs/yr):	255
Bacteria (billions/yr):	0
Runoff (acre-ft/yr):	0

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: AJ2897 **Option:** N/A
Restoration Priority: Low
Subwatershed: Brambleton
Drainage Area: 48.1 acres
Ownership: County

Project Type: Wet Pond/Wetlands
Project Name: Waterlake Dry Pond Conversion
Nearest Address: Waterlake Court

Site Description:

Extended detention pond. Area downstream of pond is in stable condition.


Existing extended detention dry pond


Houses adjacent to pond

Proposed Action: Convert to a wet pond/wetland

Benefits: Improve stormwater quality controls

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking project design, engage nearby businesses and residents to promote the benefits of stormwater control and encourage support for the project

Known Utilities and Other Constraints: No apparent utility conflicts; however the absence of utilities should be confirmed prior to restoration

Estimated Cost and Pollutant Reductions

Total Project Cost: $65,000

Total Nitrogen (lbs/yr):	0
Total Phosphorus (lbs/yr):	11.4
Sediment (lbs/yr):	0
Bacteria (billions/yr):	318
Runoff (acre-ft/yr):	0

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: AJ4280 **Option:** N/A

Restoration Priority: Low

Subwatershed: Brambleton

Drainage Area: 5.0 acres

Ownership: County

Project Type: Wet Pond/Wetlands

Project Name: Allison Ridge Dry Pond Conversion

Nearest Address: Allison Ridge Terrace

Site Description:

Existing dry pond is situated immediately adjacent to houses in neighborhood. Dewatering structure was underwater, possibly due to settling of structure and minor amount of elevation change.

Existing stormwater detention facility, with a small amount of water pooled in front of dewatering structure

Grass swale leading between townhomes to the stormwater pond

Proposed Action: Convert to a wet pond/wetland

Benefits: Improve stormwater quality controls

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking project design, engage nearby businesses and residents to promote the benefits of stormwater control and encourage support for the project

Known Utilities and Other Constraints: Pond is situation close to townhomes and road; utilities (electric, cable) present in area

Estimated Cost and Pollutant Reductions

Total Project Cost: $67,000

Total Nitrogen (lbs/yr): 0
Total Phosphorus (lbs/yr): 1.2
Sediment (lbs/yr): 0

Bacteria (billions/yr): 33
Runoff (acre-ft/yr): 0

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: BC46 **Option:** N/A
Restoration Priority: Low
Subwatershed: Brambleton
Drainage Area: 4.5 acres
Ownership: County

Project Type: Wet Pond/Wetlands
Project Name: Loudoun County Parkway Dry Pond Conversion
Nearest Address: Loudoun County Parkway

Site Description:

Modern extended detention pond with forebay. Three piped outfalls and one overland, riprapped swale. Area downstream of pond appears to be stable. There is room for expansion if utilities not present south of the pond.

Stormwater pond situated behind rows of townhomes

Riprapped swale leading to pond

Proposed Action: Convert to a wet pond/wetland

Benefits: Improve stormwater quality controls
Opportunity for public education

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking project design, engage nearby businesses and residents to promote the benefits of stormwater control and encourage support for the project

Known Utilities and Other Constraints: Steep slope and adjacent fences may be limiting factors

Estimated Cost and Pollutant Reductions

Total Project Cost: $61,000

Total Nitrogen (lbs/yr): 0
Total Phosphorus (lbs/yr): 1.1
Sediment (lbs/yr): 0

Bacteria (billions/yr): 30
Runoff (acre-ft/yr): 0

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: BC47 **Option:** N/A

Restoration Priority: Low

Subwatershed: Brambleton

Drainage Area: 3.5 acres

Ownership: County

Project Type: Wet Pond/Wetlands or Bioretention w/Underdrain

Project Name: Loudoun & Claiborne Parkway #1 Dry Pond Conversion

Nearest Address: Loudoun County Parkway & Claiborne Parkway

Site Description:

Existing facility is an extended detention dry pond; facility appears well-maintained and seems to be functioning properly.

Dry pond in excellent condition close to existing homes

Trees planted along flow path leading to pond

Proposed Action: Convert to a wet pond/wetland or a bioretention with underdrain

Benefits: Improve stormwater quality controls

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking project design, engage nearby businesses and residents to promote the benefits of stormwater control and encourage support for the project

Known Utilities and Other Constraints: No apparent utility conflicts; however the absence of utilities should be confirmed prior to restoration

Estimated Cost and Pollutant Reductions

Total Project Cost: $47,000

Total Nitrogen (lbs/yr): 0

Total Phosphorus (lbs/yr): 0.8

Sediment (lbs/yr): 0

Bacteria (billions/yr): 23

Runoff (acre-ft/yr): 0

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: CW1 **Option:** N/A **Project Type:** Wet Pond/Wetlands

Restoration Priority: Medium

Subwatershed: Brambleton **Project Name:** Goosefoot Dry Pond Conversion

Drainage Area: 5.1 acres

Ownership: County **Nearest Address:** Goosefoot Square

Site Description:

Existing flood control/dry pond has morphed into wet pond/wetland.

Stormwater pond is adjacent parking lot

Existing drainage swales provide an excellent opportunity for conversion to bioswales

Proposed Action: Convert to a wet pond/wetland and install bioswale

Benefits: Improve stormwater quality controls

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking project design, engage nearby businesses and residents to promote the benefits of stormwater control and encourage support for the project

Known Utilities and Other Constraints: Pond is prominent in neighborhood, so need to consider aesthetics

Estimated Cost and Pollutant Reductions

Total Project Cost: $69,000

Total Nitrogen (lbs/yr):	12.6	*Bacteria (billions/yr):*	34
Total Phosphorus (lbs/yr):	1.7	*Runoff (acre-ft/yr):*	0
Sediment (lbs/yr):	842		

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: GC554 **Option:** N/A
Restoration Priority: Medium
Subwatershed: Upper Broad Run Mainstem
Drainage Area: 77.3 acres
Ownership: County

Project Type: Wet Pond/Wetlands or Bioretention w/Underdrain
Project Name: Rogerdale Dry Pond Conversion
Nearest Address: Rogerdale Place

Site Description:

Existing dry pond has three outfall draining to it, two of which have made preferential channels to the dewatering structure. Plenty of space available for additional treatment, however the soils are a poor.

Stormwater management facility

Flow path being created between outfall and dewatering structure

Proposed Action: Convert to a wet pond/wetland

Benefits:
Improve stormwater quality controls
Channel protection
Flood control

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking project design, engage nearby businesses and residents to promote the benefits of stormwater control and encourage support for the project

Known Utilities and Other Constraints: Aesthetics will be an important consideration due to the site's proximity to houses

Estimated Cost and Pollutant Reductions

Total Project Cost: $1,048,000

Total Nitrogen (lbs/yr):	0
Total Phosphorus (lbs/yr):	18.3
Sediment (lbs/yr):	0
Bacteria (billions/yr):	510
Runoff (acre-ft/yr):	0

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: GC940 **Option:** N/A
Restoration Priority: Low
Subwatershed: Brambleton
Drainage Area: 2.7 acres
Ownership: County

Project Type: Wet Pond/Wetlands or Bioretention w/Underdrain
Project Name: Loudoun & Claiborne Parkway #2 Dry Pond Conversion
Nearest Address: Loudoun County Parkway & Claiborne Parkway

Site Description:

Existing facility is an extended detention dry pond and appears to be well-maintained and functioning properly.

Existing extended detention dry pond

Outfall enters a vegetated area of pond

Proposed Action: Convert to a wet pond/wetland or a bioretention with underdrain

Benefits: Improve stormwater quality controls

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking project design, engage nearby businesses and residents to promote the benefits of stormwater control and encourage support for the project

Known Utilities and Other Constraints: No apparent utility conflicts; however the absence of utilities should be confirmed prior to restoration

Estimated Cost and Pollutant Reductions

Total Project Cost: $37,000

Total Nitrogen (lbs/yr):	0
Total Phosphorus (lbs/yr):	0.6
Sediment (lbs/yr):	0
Bacteria (billions/yr):	18
Runoff (acre-ft/yr):	0

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: JC2411 **Option:** N/A

Restoration Priority: Low

Subwatershed: Brambleton

Drainage Area: 28.6 acres

Ownership: County

Project Type: Wet Pond/Wetlands or Bioretention

Project Name: Red Admiral Dry Pond Conversion

Nearest Address: Red Admiral Place

Site Description:

Extended detention dry pond with two piped outfalls and a long swale along tree line from the south carrying overland flow. Pond seems to be well-maintained and functioning properly; area downstream appears to be stable.

Existing stormwater pond with nearby houses in the background

Pipe outfall draining to pond

Proposed Action: Convert to a wet pond/wetland or install a bioretention with underdrain

Benefits:
Improve stormwater quality controls
Channel protection
Flood control

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking project design, engage nearby businesses and residents to promote the benefits of stormwater control and encourage support for the project

Known Utilities and Other Constraints: This site may have potential site limitations and tree impacts; adjacent structures are another potential site limitation

Estimated Cost and Pollutant Reductions

Total Project Cost: $387,000

Total Nitrogen (lbs/yr):	0
Total Phosphorus (lbs/yr):	6.7
Sediment (lbs/yr):	0
Bacteria (billions/yr):	189
Runoff (acre-ft/yr):	0

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: JC3128 **Option:** N/A

Restoration Priority: Low

Subwatershed: Upper Broad Run Mainstem

Drainage Area: 29.0 acres

Ownership: County

Project Type: Wet Pond/Wetlands

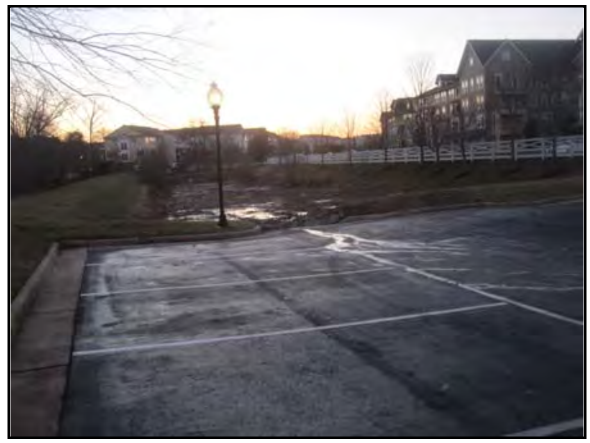
Project Name: State & Thorncroft Dry Pond Conversion

Nearest Address: State Street & Thorncroft Place

Site Description:

Existing extended detention pond - treatment is somewhat short-circuited due to primary outfall being located in front of dewatering structure. Pond also receives runoff from Community Center parking lot to the east.

Pipe outfall enters pond directly in front of dewatering structure



Parking lot drainage entering BMP

Proposed Action: Convert to a wet pond/wetland and/or install bioswale

Benefits:
Improve stormwater quality controls
Channel protection
Flood control

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking project design, engage nearby businesses and residents to promote the benefits of stormwater control and encourage support for the project

Known Utilities and Other Constraints: No apparent utility conflicts; however the absence of utilities should be confirmed prior to restoration

Estimated Cost and Pollutant Reductions

Total Project Cost: $393,000

Total Nitrogen (lbs/yr):	0
Total Phosphorus (lbs/yr):	6.8
Sediment (lbs/yr):	0
Bacteria (billions/yr):	191
Runoff (acre-ft/yr):	0

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: JC3325 **Option:** N/A
Restoration Priority: Medium
Subwatershed: Upper Broad Run Mainstem
Drainage Area: 5.1 acres
Ownership: County

Project Type: Wet Pond/Wetlands
Project Name: High Haven #1 Dry Pond Conversion
Nearest Address: High Haven Terrace

Site Description:

Existing simple dry pond with one pipe outfall and one riprap swale. Channel downstream of pond is stable.

Small neighborhood stormwater management pond

Swale between townhomes enters grate inlet before entering pond

Proposed Action: Convert to a wet pond/wetland

Benefits: Improve stormwater quality controls

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking project design, engage nearby businesses and residents to promote the benefits of stormwater control and encourage support for the project

Known Utilities and Other Constraints: Steep slopes and close proximity to houses may be limiting factors at this site

Estimated Cost and Pollutant Reductions

Total Project Cost: $69,000

Total Nitrogen (lbs/yr):	0
Total Phosphorus (lbs/yr):	1.2
Sediment (lbs/yr):	0
Bacteria (billions/yr):	34
Runoff (acre-ft/yr):	0

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: JC3718 **Option:** N/A
Restoration Priority: Medium
Subwatershed: Upper Broad Run Mainstem
Drainage Area: 2.2 acres
Ownership: County

Project Type: Wet Pond/Wetlands or Chamber System
Project Name: High Haven #2 Dry Pond Conversion
Nearest Address: High Haven Terrace

Site Description:

Existing facility is a simple dry pond. Area downstream of pond is relatively stable.

Small stormwater pond behind townhomes

Pipe outfall draining to pond

Proposed Action: Convert to a wet pond/wetland or a chamber system under parking lot with sand filters

Benefits: Improve stormwater quality controls

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking project design, engage nearby businesses and residents to promote the benefits of stormwater control and encourage support for the project

Known Utilities and Other Constraints: No apparent utility conflicts; however the absence of utilities should be confirmed prior to restoration

Estimated Cost and Pollutant Reductions

Total Project Cost: $30,900

Total Nitrogen (lbs/yr):	0
Total Phosphorus (lbs/yr):	0.5
Sediment (lbs/yr):	0
Bacteria (billions/yr):	15
Runoff (acre-ft/yr):	0

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: JC3727 **Option:** N/A

Restoration Priority: Low

Subwatershed: Upper Broad Run Mainstem

Drainage Area: 20.5 acres

Ownership: Private

Project Type: Wet Pond/Wetlands

Project Name: Maison Carree Dry Pond Conversion

Nearest Address: Maison Carree Square

Site Description:

Existing dry pond with two pipe outfalls. Facility drains directing into MS4. There is no room available above this facility for swales or rain gardens.

Elongated dry pond situated between houses and a road

Riprapped pipe outfall entering pond

Proposed Action: Convert to a wet pond/wetland

Benefits: Improve stormwater quality controls

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking project design, engage nearby businesses and residents to promote the benefits of stormwater control and encourage support for the project

Known Utilities and Other Constraints: No apparent utility conflicts; however the absence of utilities should be confirmed prior to restoration

Estimated Cost and Pollutant Reductions

Total Project Cost: $277,000

Total Nitrogen (lbs/yr):	0
Total Phosphorus (lbs/yr):	4.8
Sediment (lbs/yr):	0
Bacteria (billions/yr):	135
Runoff (acre-ft/yr):	0

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: JC3947 **Option:** N/A
Restoration Priority: Special Project
Subwatershed: Brambleton
Drainage Area: 40.0 acres
Ownership: County

Project Type: Pond offline
Project Name: Lyndora Park inline Wet Pond Conversion
Nearest Address: Lucketts Bridge Circle

Site Description:

Large residential neighborhood served by large inline wet pond. The inline stream is very poor condition, such that it is threatening some homes and sidewalks and contributing sediment to pond. Downstream channel is very unstable with high bank erosion.

inline pond facility passing under a footbridge

Eroding stream channel downstream of inline pond

Proposed Action: Convert pond to an offline structure

Benefits:
Improve stormwater quality controls
Recharge
Channel protection/Flood control
Opportunity for public education
Repair

Key Issues for Implementation

Project Sequencing Concerns: Bioswales should be installed when the wet pond is converted to an offline facility

Known Utilities and Other Constraints: There is the potential for utility conflicts at this location (sewer and gas pipelines)

Estimated Cost and Pollutant Reductions

Total Project Cost: N/A

Total Nitrogen (lbs/yr): N/A
Total Phosphorus (lbs/yr): N/A
Sediment (lbs/yr): N/A

Bacteria (billions/yr): N/A
Runoff (acre-ft/yr): N/A

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID:	JC3947 **Option:** 1	**Project Type:**	Infiltration & Treatment
Restoration Priority:	High		
Subwatershed:	Brambleton	**Project Name:**	Lyndora Park Bioswales
Drainage Area:	40.0 acres		
Ownership:	County	**Nearest Address:**	Lucketts Bridge Circle

Site Description:

Large residential neighborhood served by large inline wet pond. The inline stream is very poor condition, such that it is threatening some homes and sidewalks and contributing sediment to pond. Downstream channel is very unstable with high bank erosion.

Opportunity at a pipe outfall for installing bioswales

Additional opportunities in the neighborhood for converting riprap and grass swales to bioswales

Proposed Action: Install bioswales

Benefits:
Improve stormwater quality controls
Recharge

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking project design, engage nearby businesses and residents to promote the benefits of stormwater control and encourage support for the project

Known Utilities and Other Constraints: There is the potential for utility conflicts at this location (sewer and gas pipelines)

Estimated Cost and Pollutant Reductions

Total Project Cost: $1,040,000

Total Nitrogen (lbs/yr): 463.3
Total Phosphorus (lbs/yr): 22.7
Sediment (lbs/yr): 10,606

Bacteria (billions/yr): 600
Runoff (acre-ft/yr): 291.6

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: JC4162 **Option:** 1
Restoration Priority: High
Subwatershed: Brambleton
Drainage Area: 7.8 acres
Ownership: County

Project Type: Infiltration & Treatment
Project Name: Gleedsville Manor Bioswale
Nearest Address: Gleedsville Manor Drive

Site Description:

500 foot concrete channel within a residential development leading to existing aerated wet pond with two piped outfalls and riprap spillway. Channel carries drainage from backyards and roads.

Concrete swale

Concrete swale

Proposed Action: Convert to bioswale

Benefits:
Improve stormwater quality controls
Opportunity for outreach to business community
Improve aesthetic quality

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking project design, engage nearby businesses and residents to promote the benefits of stormwater control and encourage support for the project

Known Utilities and Other Constraints: No apparent utility conflicts; however the absence of utilities should be confirmed prior to restoration

Estimated Cost and Pollutant Reductions

Total Project Cost: $342,000

Total Nitrogen (lbs/yr): 90.1
Total Phosphorus (lbs/yr): 4.4
Sediment (lbs/yr): 2,063

Bacteria (billions/yr): 117
Runoff (acre-ft/yr): 56.7

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: JC4375 **Option:** N/A
Restoration Priority: Medium
Subwatershed: Brambleton
Drainage Area: 8.1 acres
Ownership: County

Project Type: Wet Pond/Wetland or Chamber System
Project Name: Zulla Chase Dry Pond Conversion
Nearest Address: Zulla Chase Place

Site Description:

Small extended detention dry pond with one outfall draining to it. Area downstream of pond is in stable condition.

Existing stormwater pond facility

Area downstream of stormwater pond

Proposed Action: Convert to a wet pond/wetland or install a chamber system

Benefits:
Improve stormwater quality controls
Improve stormwater quantity controls

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking project design, engage nearby businesses and residents to promote the benefits of stormwater control and encourage support for the project

Known Utilities and Other Constraints: No apparent utility conflicts; however the absence of utilities should be confirmed prior to restoration

Estimated Cost and Pollutant Reductions

Total Project Cost: $110,000

Total Nitrogen (lbs/yr):	0
Total Phosphorus (lbs/yr):	1.9
Sediment (lbs/yr):	0
Bacteria (billions/yr):	54
Runoff (acre-ft/yr):	0

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: JC4380 **Option:** N/A

Restoration Priority: Low

Subwatershed: Brambleton

Drainage Area: 13.1 acres

Ownership: County

Project Type: Wet Pond /Wetland or Bioretention

Project Name: Ryan & Airmont Dry Pond Conversion

Nearest Address: Ryan Road & Airmont Hunt Drive

Site Description:

Existing new extended dry detention pond with opportunistic wetland in bottom. The stream channel in the vicinity of the pond is eroding and unstable.

Existing stormwater pond

Eroding stream channel downstream of stormwater pond

Proposed Action: Convert to a wet pond/wetland or install bioretention

Benefits: Improve stormwater quality controls

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking project design, engage nearby businesses and residents to promote the benefits of stormwater control and encourage support for the project

Known Utilities and Other Constraints: No apparent utility conflicts; however the absence of utilities should be confirmed prior to restoration

Estimated Cost and Pollutant Reductions

Total Project Cost: $177,000

Total Nitrogen (lbs/yr):	0
Total Phosphorus (lbs/yr):	3.1
Sediment (lbs/yr):	0
Bacteria (billions/yr):	86
Runoff (acre-ft/yr):	0

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: JC4577 **Option:** N/A

Restoration Priority: Low

Subwatershed: Brambleton

Drainage Area: 14.9 acres

Ownership: County

Project Type: Wet Pond or Bioretention

Project Name: Airmont Hunt Dry Pond Conversion

Nearest Address: Airmont Hunt Drive

Site Description:

Large, flat extended detention dry pond had two outfalls. One is proximate to dewatering structure.

Existing stormwater dry pond

Standing water in the dry pond

Proposed Action: Convert to a wet pond/wetland or install bioretention systems with underdrains

Benefits:
Improve stormwater quality controls
Channel protection
Flood control

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking project design, engage nearby businesses and residents to promote the benefits of stormwater control and encourage support for the project

Known Utilities and Other Constraints: No apparent utility conflicts; however the absence of utilities should be confirmed prior to restoration

Estimated Cost and Pollutant Reductions

Total Project Cost: $202,000

Total Nitrogen (lbs/yr):	0
Total Phosphorus (lbs/yr):	3.5
Sediment (lbs/yr):	0
Bacteria (billions/yr):	98
Runoff (acre-ft/yr):	0

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: JC4579 **Option:** N/A
Restoration Priority: Low
Subwatershed: Brambleton
Drainage Area: 7.0 acres
Ownership: County

Project Type: Conveyance & Infiltration
Project Name: Glenside Step Pools
Nearest Address: Glenside Drive

Site Description:

Large wet pond designed primarily for flood control. Fourteen formal outfalls into pond and overland flow from forested areas. Downstream condition is poor due to constrained flow path; stream channel incised for the first 200 feet below the pond.

Extensive wet pond provides flood control for large neighborhood

One of the many pipe outfalls that discharge to the wet pond

Proposed Action: Install a step pool conveyence or bioretention

Benefits:
Improve stormwater quality controls
Opportunity for public education

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking project design, engage nearby businesses and residents to promote the benefits of stormwater control and encourage support for the project

Known Utilities and Other Constraints: Steep slopes and private ownership may restrict restoration possibilities; tree impacts are also possible

Estimated Cost and Pollutant Reductions

Total Project Cost: $280,000

Total Nitrogen (lbs/yr):	46.3
Total Phosphorus (lbs/yr):	3.9
Sediment (lbs/yr):	1,854
Bacteria (billions/yr):	0
Runoff (acre-ft/yr):	0

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: JC4796 **Option:** N/A
Restoration Priority: Low
Subwatershed: Brambleton
Drainage Area: 15.2 acres
Ownership: County

Project Type: Wet Pond/Wetlands
Project Name: Forest Run Dry Pond Conversion
Nearest Address: Forest Run Drive

Site Description:

Existing extended detention dry pond is in great condition; it appears to be well maintained and is functioning properly. There is not enough space for pre-treatment in pond. Pond receives stormwater from residential area but probably also from nearby for

Existing pond is in very good condition and seems to be functioning well

Channel downstream of pond is in stable condition and has little erosion

Proposed Action: Convert to a wet pond/wetland

Benefits:
Improve stormwater quality controls
Channel protection
Flood control

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking project design, engage nearby businesses and residents to promote the benefits of stormwater control and encourage support for the project

Known Utilities and Other Constraints: No apparent utility conflicts; however the absence of utilities should be confirmed prior to restoration

Estimated Cost and Pollutant Reductions

Total Project Cost: $207,000

Total Nitrogen (lbs/yr):	0
Total Phosphorus (lbs/yr):	3.6
Sediment (lbs/yr):	0
Bacteria (billions/yr):	101
Runoff (acre-ft/yr):	0

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: JC4978 **Option:** N/A

Restoration Priority: Low

Subwatershed: Brambleton

Drainage Area: 28.9 acres

Ownership: County

Project Type: Wet Pond/Wetlands

Project Name: Forest Run Dry Pond Conversion

Nearest Address: Forest Run & Ryan Road

Site Description:

Existing extended detention pond is in fine working condition; two outfalls drain to this facility.

Existing stormwater management facility

Stormwater pond dewatering structure

Proposed Action: Convert to a wet pond/wetland

Benefits: Improve stormwater quality controls

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking project design, engage nearby businesses and residents to promote the benefits of stormwater control and encourage support for the project; if selected, optional elements should be installed at the time of pond conversion

Known Utilities and Other Constraints: Potential site constraints include sewer and gas pipelines; additionally restoration at this site may include tree impacts

Estimated Cost and Pollutant Reductions

Total Project Cost: $392,000

Total Nitrogen (lbs/yr):	0
Total Phosphorus (lbs/yr):	6.80
Sediment (lbs/yr):	0
Bacteria (billions/yr):	191
Runoff (acre-ft/yr):	0

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: JC4978 **Option:** 1
Restoration Priority: Low
Subwatershed: Brambleton
Drainage Area: 14.0 acres
Ownership: County

Project Type: Conveyance & Infiltration
Project Name: Forest Run Bioswale
Nearest Address: Forest Run & Ryan Road

Site Description:

Existing extended detention pond is in fine working condition; two outfalls drain to this facility.

Potential path for bioswale

Sewer and gas pipelines may restrict where restoration takes place at this site

Proposed Action: Install bioswale

Benefits: Improve stormwater quality controls

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking project design, engage nearby businesses and residents to promote the benefits of stormwater control and encourage support for the project

Known Utilities and Other Constraints: Potential site constraints include sewer and gas pipelines; additionally restoration at this site may include tree impacts

Estimated Cost and Pollutant Reductions

Total Project Cost: $364,000

Total Nitrogen (lbs/yr): 162.1
Total Phosphorus (lbs/yr): 7.9
Sediment (lbs/yr): 3,712

Bacteria (billions/yr): 210
Runoff (acre-ft/yr): 0

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: JC50044 **Option:** N/A

Restoration Priority: Medium

Subwatershed: Lenah Run

Drainage Area: 10.7 acres

Ownership: County

Project Type: Urban Infiltration w/Sand or Wet Pond/Wetlands

Project Name: Sousa Place #1 Dry Pond Conversion

Nearest Address: Sousa Place

Site Description:

Dry pond draining cul -de-sac and a grouping of large-scale homes. No preferential flow path within basin and downstream area is relatively very stable.

Fairly flat dry pond structure

Dry pond control structure

Proposed Action: Convert to bioretention or extended detention dry pond

Benefits: Improve stormwater quality controls

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking project design, engage nearby businesses and residents to promote the benefits of stormwater control and encourage support for the project

Known Utilities and Other Constraints: No apparent utility conflicts; however the absence of utilities should be confirmed prior to restoration

Estimated Cost and Pollutant Reductions

Total Project Cost: $708,000

Total Nitrogen (lbs/yr):	115
Total Phosphorus (lbs/yr):	6.6
Sediment (lbs/yr):	1,240
Bacteria (billions/yr):	6
Runoff (acre-ft/yr):	7.6

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID:	JC5171 **Option:** N/A	**Project Type:**	Wet Pond/Wetlands or Bioretention
Restoration Priority:	High	**Project Name:**	Forest Manor Dry Pond Conversion
Subwatershed:	Brambleton	**Nearest Address:**	Forest Manor Drive
Drainage Area:	56.7 acres		
Ownership:	County		

Site Description:

Complex structure; existing large dry pond designed for flood control with four outfalls draining to it, one of which received dry weather flow. Area downstream of pond seems to be stable.

Large flood control pond

Area downstream appears to be stable

Proposed Action: Convert to a wet pond/wetland and installation of bioswales

Benefits:
- Improve stormwater quality controls
- Channel protection/Flood control
- Recharge
- Opportunity for public education
- Repair

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking project design, engage nearby businesses and residents to promote the benefits of stormwater control and encourage support for the project; may want to consider possibility of re-establishing perennial flow through system

Known Utilities and Other Constraints: No apparent utility conflicts; however the absence of utilities should be confirmed prior to restoration

Estimated Cost and Pollutant Reductions

Total Project Cost: $768,000

Total Nitrogen (lbs/yr):	0
Total Phosphorus (lbs/yr):	13.4
Sediment (lbs/yr):	0
Bacteria (billions/yr):	374
Runoff (acre-ft/yr):	0

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: JC5181 **Option:** N/A
Restoration Priority: Low
Subwatershed: Brambleton
Drainage Area: 19.5 acres
Ownership: County

Project Type: Wet Pond/Wetlands
Project Name: Still Creek Dry Pond Conversion
Nearest Address: Still Creek Drive

Site Description:

Existing extended detention dry pond drains a large residential neighborhood; it appears to be well-maintained and functioning properly.

Existing stormwater pond facility

Pipe outfall that discharges to pond

Proposed Action: Convert to a wet pond/wetland and install bioswale

Benefits: Improve stormwater quality controls

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking project design, engage nearby businesses and residents to promote the benefits of stormwater control and encourage support for the project

Known Utilities and Other Constraints: No apparent utility conflicts; however the absence of utilities should be confirmed prior to restoration

Estimated Cost and Pollutant Reductions

Total Project Cost: $264,000

Total Nitrogen (lbs/yr):	0
Total Phosphorus (lbs/yr):	4.6
Sediment (lbs/yr):	0
Bacteria (billions/yr):	129
Runoff (acre-ft/yr):	0

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: JC6132 **Option:** N/A

Restoration Priority: Low

Subwatershed: Upper Broad Run Mainstem

Drainage Area: 69.8 acres

Ownership: County

Project Type: Wet Pond/Wetlands or Bioretentions w/Underdrains

Project Name: Ogden Place Dry Pond Conversion

Nearest Address: Ogden Place

Site Description:

Large detention pond draining residential neighborhood. Facility accepts drainage from two pipe outfalls.

Existing stormwater detention pond

Control structure for existing dry pond

Proposed Action: Convert to a wet pond/wetland or a bioretention with underdrains

Benefits:
Improve stormwater quality controls
Channel protecion
Flood control

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking project design, engage nearby businesses and residents to promote the benefits of stormwater control and encourage support for the project

Known Utilities and Other Constraints: There is a potential conflict at this site with a gas pipeline

Estimated Cost and Pollutant Reductions

Total Project Cost: $946,000

Total Nitrogen (lbs/yr): 0
Total Phosphorus (lbs/yr): 16.5
Sediment (lbs/yr): 0

Bacteria (billions/yr): 461
Runoff (acre-ft/yr): 0

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: JC6134 **Option:** N/A

Restoration Priority: Medium

Subwatershed: Upper Broad Run Mainstem

Drainage Area: 22.7 acres

Ownership: County

Project Type: Wet Pond/Wetlands or Bioretentions w/Underdrains

Project Name: Meadowvale Dry Pond Conversion

Nearest Address: Meadowvale Lane

Site Description:

Treatment of dry pond facility is being short-circuited; one outfall is draining proximate to pond's dewatering structure. Plenty of unused surface area within pond provides room for additional treatment. Beaver pond has been built downstream.

Existing stormwater pond

Dewatering structure for existing stormwater pond

Proposed Action: Convert to a wet pond/wetland

Benefits:
Improve stormwater quality controls
Channel protection
Flood control

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking project design, engage nearby businesses and residents to promote the benefits of stormwater control and encourage support for the project

Known Utilities and Other Constraints: No apparent utility conflicts; however the absence of utilities should be confirmed prior to restoration

Estimated Cost and Pollutant Reductions

Total Project Cost: $308,000

Total Nitrogen (lbs/yr):	0
Total Phosphorus (lbs/yr):	5.4
Sediment (lbs/yr):	0
Bacteria (billions/yr):	150
Runoff (acre-ft/yr):	0

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: KD50006 **Option:** N/A
Restoration Priority: Medium
Subwatershed: South Fork Broad Run
Drainage Area: 8.6 acres
Ownership: County

Project Type: Urban Infiltration w/Sand or Wet Pond/Wetlands
Project Name: Hickory Ridge Dry Pond Conversion
Nearest Address: Hickory Ridge Place

Site Description:

Dry pond appears to be very well-maintained and functioning properly. Very little evidence of channelization or flow from outfall; pond seems to receive very little flow even on rainy days. Area downstream of pond seems to be very stable.

Existing stormwater dry pond

Drainage path carrying flow to dry pond

Proposed Action: Convert to bioretention/infiltration or wet pond/wetlands

Benefits: Improve stormwater quality controls
Channel protection

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking project design, engage nearby businesses and residents to promote the benefits of stormwater control and encourage support for the project

Known Utilities and Other Constraints: No apparent utility conflicts; however the absence of utilities should be confirmed prior to restoration

Estimated Cost and Pollutant Reductions

Total Project Cost: $571,000

Total Nitrogen (lbs/yr):	92.7
Total Phosphorus (lbs/yr):	5.3
Sediment (lbs/yr):	1,000
Bacteria (billions/yr):	5
Runoff (acre-ft/yr):	6.1

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: KD50012 **Option:** N/A

Restoration Priority: Low

Subwatershed: Lenah Run

Drainage Area: 9.6 acres

Ownership: County

Project Type: Urban Infiltration w/Sand or Wet Pond/Wetlands

Project Name: Crooked Oak Dry Pond Conversion

Nearest Address: Crooked Oak Court

Site Description:

Existing extended detention dry pond appears to be well-maintained and functioning properly; area downstream of site appears stable. Large-scale home lots drain to this small pond. Pathway for local residents is adjacent to pond.

Existing stormwater dry pond

Residential neighborhood that drains to pond in background

Proposed Action: Convert to bioretention or wet pond/wetland

Benefits:
- Improve stormwater quality controls
- Recharge
- Channel protection
- Flood control
- Opportunity for public education

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking project design, engage nearby businesses and residents to promote the benefits of stormwater control and encourage support for the project

Known Utilities and Other Constraints: No apparent utility conflicts; however the absence of utilities should be confirmed prior to restoration

Estimated Cost and Pollutant Reductions

Total Project Cost: $636,000

Total Nitrogen (lbs/yr):	103.2
Total Phosphorus (lbs/yr):	5.9
Sediment (lbs/yr):	1,114
Bacteria (billions/yr):	6
Runoff (acre-ft/yr):	6.8

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: KD50014 **Option:** N/A
Restoration Priority: Low
Subwatershed: South Fork Broad Run
Drainage Area: 51.6 acres
Ownership: County

Project Type: Wet Pond/Wetlands
Project Name: Sousa Place #2 Dry Pond Conversion
Nearest Address: Sousa Place

Site Description:

Existing dry pond is completely destabilized, though it looks recently built. Embankment is bare soil and pond bottom is muddy. Long conveyance via open soil channel from roadway and large-scale houses nearby contributes sediment to pond. Algae present.

Pond with bare soil embankments and a muddy bottom

Channel cutting a path through sediments in bottom of pond

Proposed Action: Stabilize banks of pond, install bioswales and possible convert to wet pond/wetlands

Benefits:
Improve stormwater quality controls
Channel protection
Repair

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking project design, engage nearby businesses and residents to promote the benefits of stormwater control and encourage support for the project

Known Utilities and Other Constraints: No apparent utility conflicts; however the absence of utilities should be confirmed prior to restoration

Estimated Cost and Pollutant Reductions

Total Project Cost: $699,000

Total Nitrogen (lbs/yr): 0
Total Phosphorus (lbs/yr): 12.2
Sediment (lbs/yr): 0

Bacteria (billions/yr): 340
Runoff (acre-ft/yr): 0

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: WB50068 **Option:** N/A
Restoration Priority: Medium
Subwatershed: Upper Broad Run Mainstem
Drainage Area: 3.9 acres
Ownership: School

Project Type: Wet Pond/Wetlands
Project Name: Stone Hill Middle School Dry Pond Conversion
Nearest Address: Evergreen Ridge Drive

Site Description:

Two bioretention cells from school drain from the south into this dry pond. Playing fields and some landscaped areas drain into the pond from the north and west.

Small stormwater management facility treating drainage from multiple areas of school property

Pipe outfall from school property draining to BMP

Proposed Action: Convert to a wet pond/wetland and install bioreteion or bioswale at school

Benefits:
Improve stormwater quality controls
Channel protection
Flood control

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking project design, engage Loudoun County Public Schools to promote the benefits of stormwater control and encourage support for the project

Known Utilities and Other Constraints: No apparent utility conflicts; however the absence of utilities should be confirmed prior to restoration

Estimated Cost and Pollutant Reductions

Total Project Cost: $53,000

Total Nitrogen (lbs/yr):	9.8
Total Phosphorus (lbs/yr):	1.3
Sediment (lbs/yr):	653
Bacteria (billions/yr):	26
Runoff (acre-ft/yr):	0

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: WB50081 **Option:** N/A

Restoration Priority: High

Subwatershed: Upper Broad Run Mainstem

Drainage Area: 36.6 acres

Ownership: Private

Project Type: Wet Pond/Wetlands

Project Name: Mercure Circle #1 Dry Pond Conversion

Nearest Address: Mercure Circle

Site Description:

Dry pond turned into de facto wetland draining headwaters. Area downstream of pond appears to be very stable.

Stormwater pond currently filled in with cattails

Proposed Action: Convert pond to wet pond/wetland

Benefits: Improve stormwater quality controls
Improve aesthetic quality

Key Issues for Implementation

Project Sequencing Concerns: Prior to undertaking project design, engage nearby businesses and residents to promote the benefits of stormwater control and encourage support for the project; if selected, optional elements should be installed at the time of pond conversion

Known Utilities and Other Constraints: Site is adjacent to a transmission line right-of-way; potential tree impacts

Estimated Cost and Pollutant Reductions

Total Project Cost: $496,000

Total Nitrogen (lbs/yr):	90.8
Total Phosphorus (lbs/yr):	12.1
Sediment (lbs/yr):	6,065
Bacteria (billions/yr):	242
Runoff (acre-ft/yr):	0

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: WB50081 **Option:** 1

Restoration Priority: High

Subwatershed: Upper Broad Run Mainstem

Drainage Area: 1.2 acres

Ownership: Private

Project Type: Conveyance & Infiltration

Project Name: Mercure Circle #1 Location 1 Step Pools

Nearest Address: Mercure Circle

Site Description:

Dry pond turned into de facto wetland draining headwaters. Area downstream of pond appears to be very stable.

Current flow path to pond recommended for step pool conveyance

Proposed Action: Install step pool conveyance

Benefits: Improve stormwater quality controls
Improve aesthetic quality

Key Issues for Implementation

Project Sequencing Concerns: If selected, optional elements should be installed at the time of pond conversion

Known Utilities and Other Constraints: Site is adjacent to a transmission line right-of-way; potential tree impacts

Estimated Cost and Pollutant Reductions

Total Project Cost: $48,000

Total Nitrogen (lbs/yr):	8	*Bacteria (billions/yr):*	0
Total Phosphorus (lbs/yr):	0.7	*Runoff (acre-ft/yr):*	0
Sediment (lbs/yr):	321		

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: WB50081 **Option:** 2

Restoration Priority: High

Subwatershed: Upper Broad Run Mainstem

Drainage Area: 34.8 acres

Ownership: Private

Project Type: Conveyance & Infiltration

Project Name: Mercure Circle #1 Location 2 Step Pools

Nearest Address: Mercure Circle

Site Description:

Dry pond turned into de facto wetland draining headwaters. Area downstream of pond appears to be very stable.

Current flow path to pond recommended for step pool conveyance

Proposed Action: Install step pool conveyance

Benefits:
Improve stormwater quality controls
Improve aesthetic quality

Key Issues for Implementation

Project Sequencing Concerns: If selected, optional elements should be installed at the time of pond conversion

Known Utilities and Other Constraints: Site is adjacent to a transmission line right-of-way; potential tree impacts

Estimated Cost and Pollutant Reductions

Total Project Cost: $1,392,000

Total Nitrogen (lbs/yr):	230.3
Total Phosphorus (lbs/yr):	19.7
Sediment (lbs/yr):	9,225
Bacteria (billions/yr):	0
Runoff (acre-ft/yr):	0

Upper Broad Run Watershed Management Plan - Proposed Project

Structure ID: WB50081 **Option:** 3
Restoration Priority: High
Subwatershed: Upper Broad Run Mainstem
Drainage Area: 0.6 acres
Ownership: Private

Project Type: Conveyance & Infiltration
Project Name: Mercure Circle #1 Location 3 Bioswale
Nearest Address: Mercure Circle

Site Description:

Dry pond turned into de facto wetland draining headwaters. Area downstream of pond appears to be very stable.

Riprapped channel from parking lot to pond where a bioswale is recommended

Proposed Action: Install bioswale

Benefits:
Improve stormwater quality controls
Improve aesthetic quality

Key Issues for Implementation

Project Sequencing Concerns: If selected, optional elements should be installed at the time of pond conversion

Known Utilities and Other Constraints: Site is adjacent to a transmission line right-of-way; potential tree impacts

Estimated Cost and Pollutant Reductions

Total Project Cost: $16,000

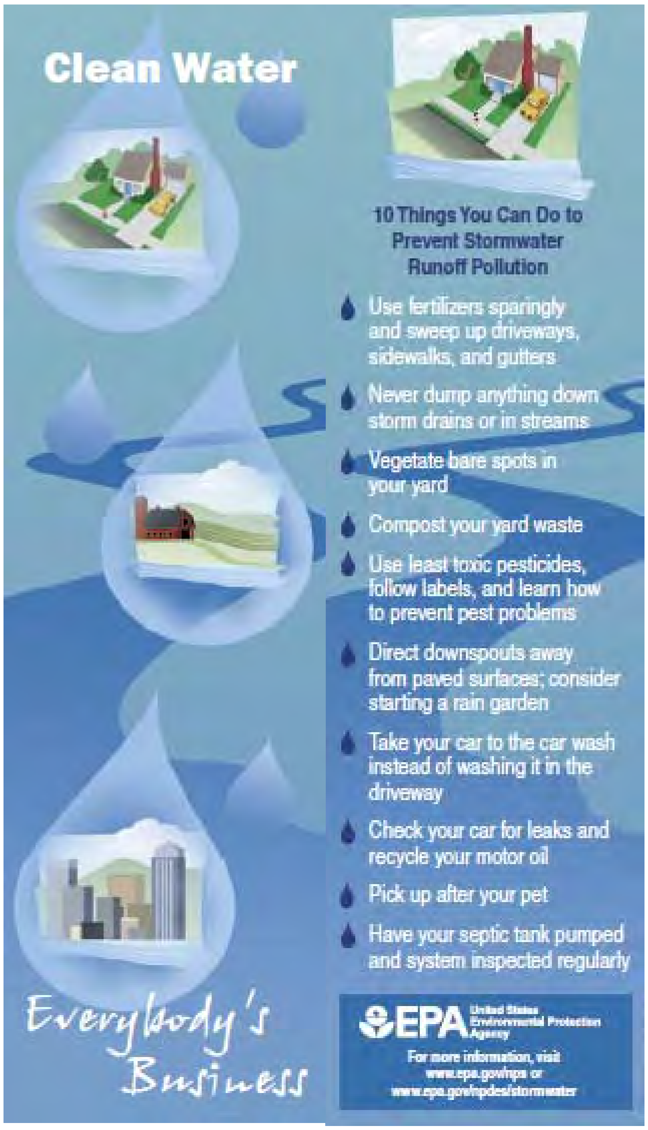
Total Nitrogen (lbs/yr):	6.9
Total Phosphorus (lbs/yr):	0.4
Sediment (lbs/yr):	159
Bacteria (billions/yr):	9
Runoff (acre-ft/yr):	0.4

APPENDIX B

OUTREACH EXAMPLES

Examples: Watershed Management Public Outreach Materials

General tips for reducing nonpoint pollution



Source: U.S. EPA Nonpoint Source Program (http://cfpub.epa.gov/npstbx/files/epa_nps_bookmark.pdf)

Local Government Website

Source: Howard County, Maryland (http://livegreenhoward.com/green/clean-water-howard/)

Local Government Consortium Web Site

Source: Puget Sound Action Team (http://www.streamteam.info/actions/pssh/)

Pet Waste Cleanup

WHEN YOUR PET GOES ON THE LAWN,

REMEMBER IT DOESN'T JUST

GO ON THE LAWN.

When our pets leave those little surprises, rain washes all that pet waste and bacteria into our storm drains. And then pollutes our waterways. So what to do? Simple. Dispose of it properly (preferably in the toilet). Then that little surprise gets treated like it should.

A cooperative venture between the Puget Sound Action Team, Department of Ecology, King County and the cities of Bellevue, Seattle and Tacoma.

CLEAN WATER IS IMPORTANT TO ALL OF US

It's up to all of us to make it happen. In recent years sources of water pollution like industrial wastes from factories have been greatly reduced. Now, more than 60 percent of water pollution comes from things like cars leaking oil, fertilizers from farms and gardens, and failing septic tanks. All these sources add up to a big pollution problem. But each of us can do small things to help clean up our water too—and that adds up to a pollution solution!

Why do we need clean water?

Having clean water is of primary importance for our health and economy. Clean water provides recreation, commercial opportunities, fish habitat, drinking water and adds beauty to our landscape. All of us benefit from clean water—and all of us have a role in getting and keeping our lakes, rivers, marine and ground waters clean.

What's the problem with pet waste?

It's a health risk to pets and people, especially children. It's a nuisance in our neighborhoods. Pet waste is full of bacteria that can make people sick. If it's washed into the storm drain and ends up in a lake, stream or marine water, the bacteria ends up in shellfish. People who eat those shellfish can get very sick. The waste produced by Seattle's dogs and cats is about what a city the size of Renton or Kennewick—about 50,000 people—would produce. Unless people take care of it, the waste enters our water with no treatment.

This information is brought to you by the Water Quality Consortium, a group of public agencies working together to reduce nonpoint water pollution through education.

Partially funded by a Centennial Clean Water Fund grant from Washington State Department of Ecology.

CLEAN WATER TIP:

How can you get rid of pet waste and help keep our waters clean?

Here are some options.

Scoop it up and flush it down the toilet. That's best because then your community sewage treatment plant or your septic system treats the pet waste.

Seal the waste in a plastic bag and throw it in the garbage. (This is legal in most areas, but check local laws.)

Bury small quantities in your yard where it can decompose slowly. Dig a hole one foot deep. Put three to four inches of waste at the bottom of the hole. Cover the waste with at least eight inches of soil. Bury the waste in several different locations in your yard and keep it away from vegetable gardens.

To find out more about the problems of pet waste and what you can do to prevent water pollution, call the number of your local community listed below.

[Place your logo, address and phone number here]

Source: Puget Sound Action Team (http://cfpub.epa.gov/npstbx/files/psatpet.pdf)

Car Washing

WHEN YOU'RE WASHING YOUR CAR IN THE DRIVEWAY, REMEMBER YOU'RE NOT JUST WASHING YOUR CAR IN THE DRIVEWAY.

WATER QUALITY CONSORTIUM

All the soap, scum, and oily grit runs along the curb. Then into the storm drain and directly into our lakes, streams and Puget Sound. And that causes pollution, which is unhealthy for fish. So how do you avoid this whole mess? Easy. Wash your car on grass or gravel instead of the street. Or better yet, take it to a car wash where the water gets treated and recycled.

A cooperative venture between the Puget Sound Action Team, Department of Ecology, King County and the cities of Bellevue, Seattle and Tacoma.

CLEAN WATER IS IMPORTANT TO ALL OF US

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Why do we need clean water?

Having clean water is of primary importance for our health and economy. Clean water provides recreation, commercial opportunities, fish habitat, drinking water and adds beauty to our landscape. All of us benefit from clean water—and all of us have a role in getting and keeping our lakes, rivers, marine and ground waters clean.

What's the problem with car washing?

There's no problem with washing your car. It's just how and where you do it. Most soap contains phosphates and other chemicals that harm fish and water quality. The soap, together with the dirt and oil washed from your car, flows into nearby storm drains which run directly into lakes, rivers or marine waters. The phosphates from the soap can cause excess algae to grow. Algae look bad, smell bad, and harm water quality. As algae decay, the process uses up oxygen in the water that fish need.

This information is brought to you by the Water Quality Consortium, a group of public agencies working together to reduce nonpoint water pollution through education.

Partially funded by a Centennial Clean Water Fund grant from Washington State Department of Ecology.

CLEAN WATER TIP:

How can you wash your car and help keep our waters clean?

Use soap sparingly. Use a hose nozzle with a trigger to save water.

Pour your bucket of soapy water down the sink when you're done, not in the street. Or wash your car on a grassy area so the ground can filter the water naturally.

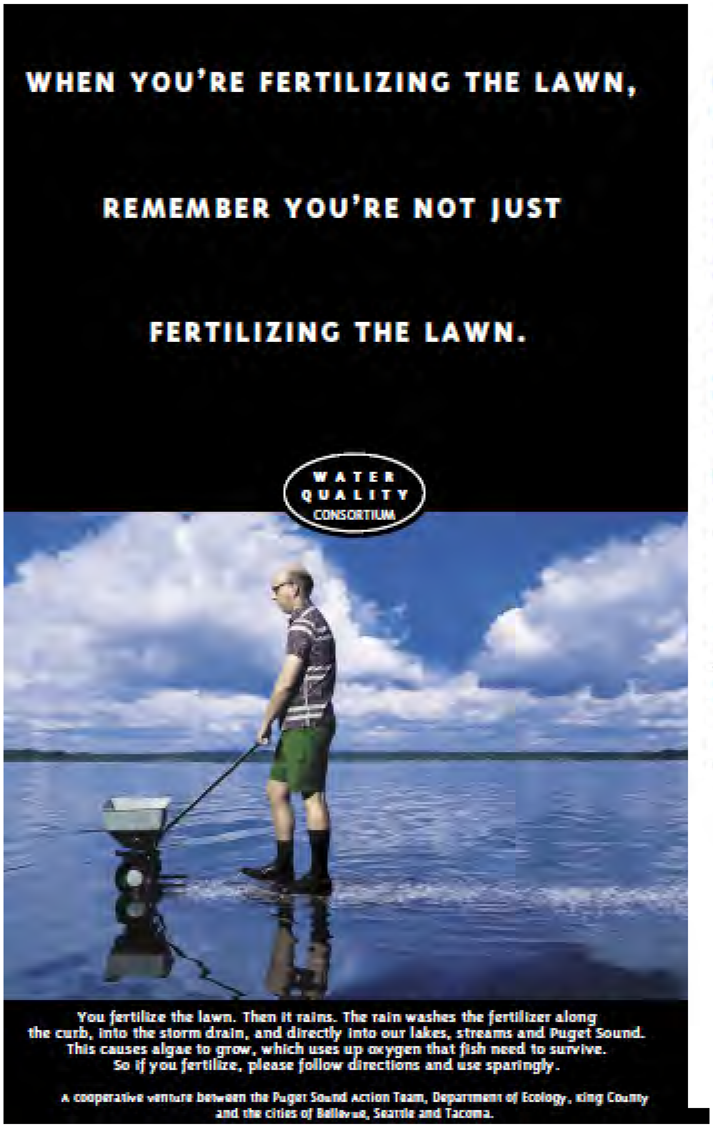
Best of all, take your car to a commercial car wash, especially if you plan to clean the engine or the bottom of your car. Most car washes re-use wash water several times before sending it to the sewer system for treatment.

To find out more about the impacts from washing your vehicle and what you can do to prevent water pollution, call the number in your community listed below.

[Place your logo, address and phone number here]

Source: Puget Sound Action Team (http://cfpub.epa.gov/npstbx/files/psatautowash.pdf)

Reducing Fertilizer Use



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What's the problem with fertilizer?

Fertilizer isn't a problem if it's used carefully. If you use too much fertilizer or apply it at the wrong time, it can easily wash off your lawn or garden into storm drains and then flow untreated into lakes or streams. Just like in your garden, fertilizer in lakes and streams makes plants grow. In water bodies, extra fertilizer can mean extra algae and aquatic plant growth. Too much algae harms water quality and makes boating, fishing and swimming unpleasant. As algae decay, they use up oxygen in the water that fish and other wildlife need.

This information is brought to you by the Water Quality Consortium, a group of public agencies working together to reduce nonpoint water pollution through education.

Partially funded by a Centennial Clean Water Fund grant from Washington State Department of Ecology.

CLEAN WATER TIP:

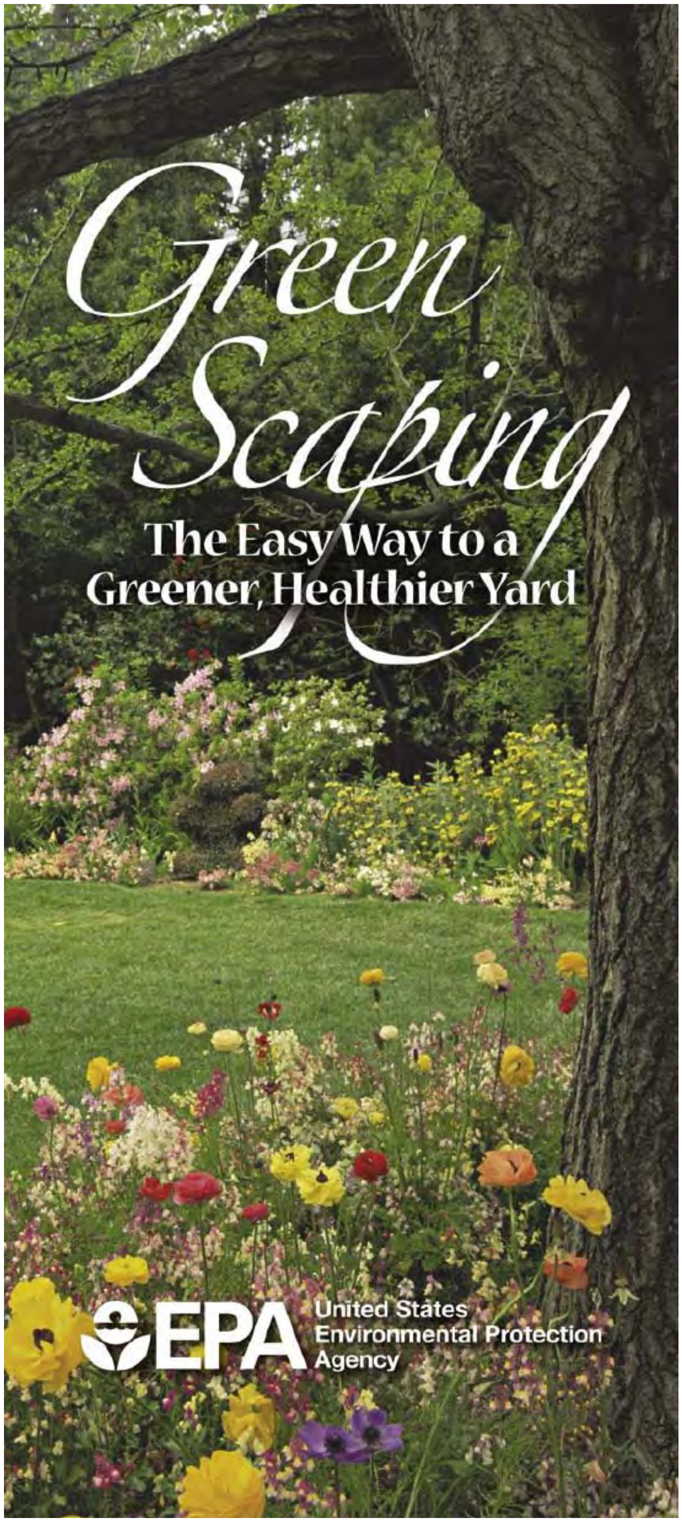
How can you fertilize and help keep our waters clean?

- Use fertilizers sparingly. Many plants do not need as much fertilizer or need it as often as you might think.
- Don't fertilize before a rain storm.
- Consider using organic fertilizers; they release nutrients more slowly.
- Use commercially available compost or make your own using garden waste. Mixing compost with your soil means your plants will need less chemical fertilizer and puts your waste to good use. Commercial compost and soil amendments may be available from your solid waste or wastewater utility as well as your local garden store.
- For more information on fertilizing alternatives and composting, call your County Extension's Master Gardeners program or the number in your community listed below.

[Place your logo, address and phone number here]

Source: Puget Sound Action Team (http://cfpub.epa.gov/npstbx/files/psatlawn.pdf)

Greenscaping



Source: U.S. EPA Nonpoint Source Program (http://cfpub.epa.gov/npstbx/files/epa_greenscaping.pdf)

Raingardens

Homeowner Guide
For a More Bay-Friendly Property

June 25, 2014

This guide presents a step by step approach for analyzing your property to find out whether it makes sense to install a rain garden or other residential stewardship practices. We then take you through the design and installation of several of the homeowner practices, so that you can install them on your own. Many Bay communities offer technical and financial assistance to help you install stewardship practices on your lot.

Source: Chesapeake Stormwater Network
(http://chesapeakestormwater.net/2013/04/homeowner-bmp-guide/)

Septic System Maintenance

Source: U.S. EPA Nonpoint Source Program (http://cfpub.epa.gov/npstbx/files/epa_septic_short.pdf)