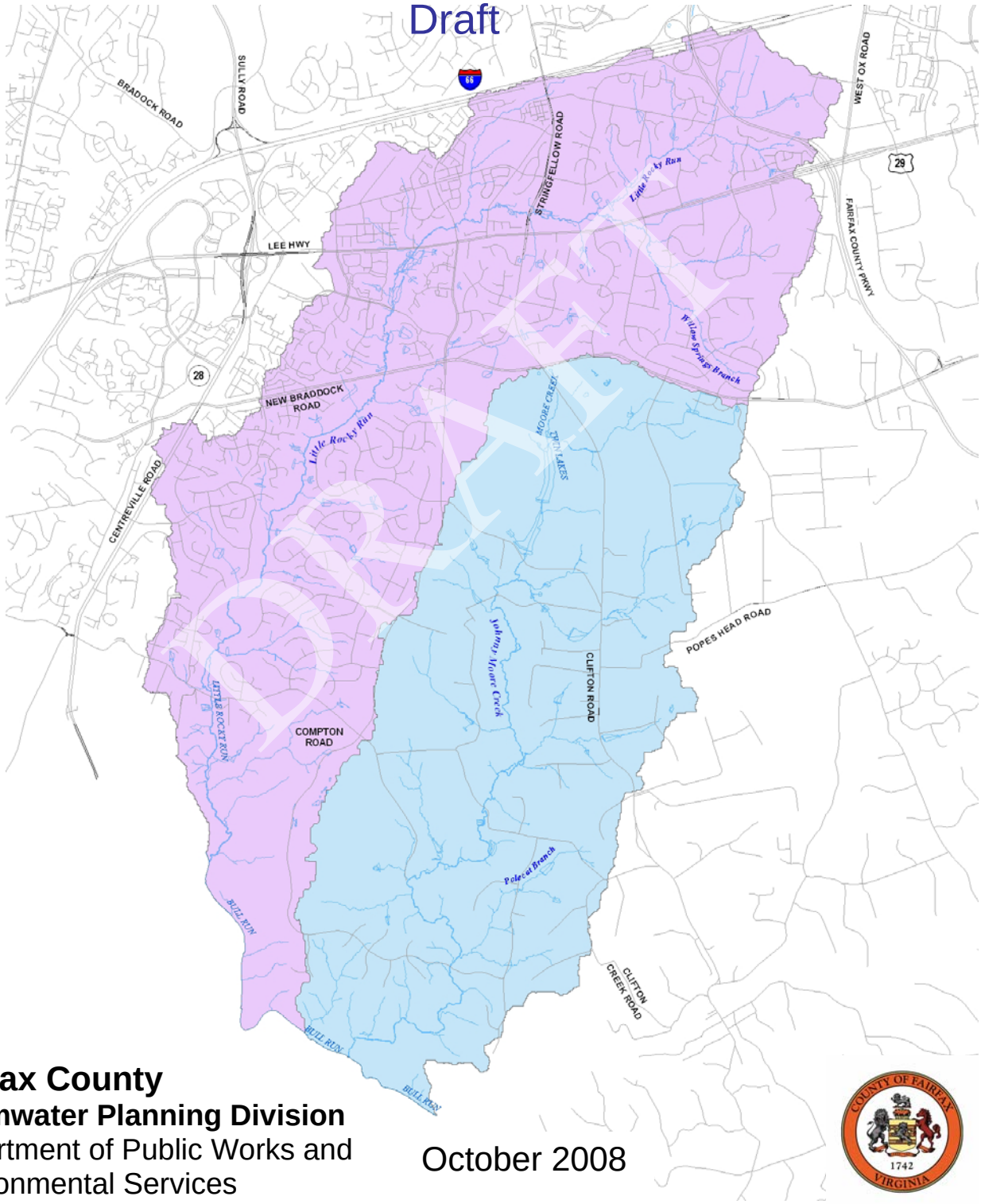
Appendix A – Draft Watershed Workbook

The Draft Watershed Workbook provides background on existing studies on the Little Rocky Run and Johnny Moore Creek watersheds. The draft document was published in October 2008 for the Issues Scoping Forum held October 1, 2008. It was not intended to be updated past this point in the characterization process. Please note that the modeling and mapping information provided in this workbook has since been updated.

Little Rocky Run
Johnny Moore Creek

Watershed Workbook

Draft



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Fairfax County
Stormwater Planning Division
Department of Public Works and Environmental Services

October 2008

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Preface

The Little Rocky Run – Johnny Moore Creek Watershed Management Plan is a strategic plan that will protect and improve the water quality within the watershed over the next 25 years. The planning process is in its early stages and will include the participation and recommendations of a watershed advisory group.

Chapter 1 of the plan provides a summary of the data currently available for the watersheds, the policy documents that impact the watershed planning process and proposed projects and improvements that have been identified in the watersheds during previous County studies.

Chapter 2 of the plan provides details about the subwatershed characterization. The information is organized per Watershed Management Area (WMA) and these sections provide more detail about the current watershed conditions. The preliminary modeling that has been performed by the County at this point in the planning process is also summarized. The subwatersheds are ranked based on various indicators and the preliminary results are available to begin the identification of problem areas in the watershed.

When complete, the Little Rocky Run – Johnny Moore Creek Watershed Management Plan will provide strategies for protecting the watersheds and mitigating adverse stream impacts that have occurred, such as stream bank erosion and poor water quality.

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Chapter 1: Compilation of Overall Watershed Condition Data

1.1 Introduction

The Little Rocky Run and Johnny Moore Creek watersheds drain into Bull Run and eventually to the Chesapeake Bay, and are located in the southwestern part of Fairfax County, Virginia, as shown on Figure 1-1. They are bounded to the east by the Popes Head Creek watershed and to the west and north by the Cub Run watershed.

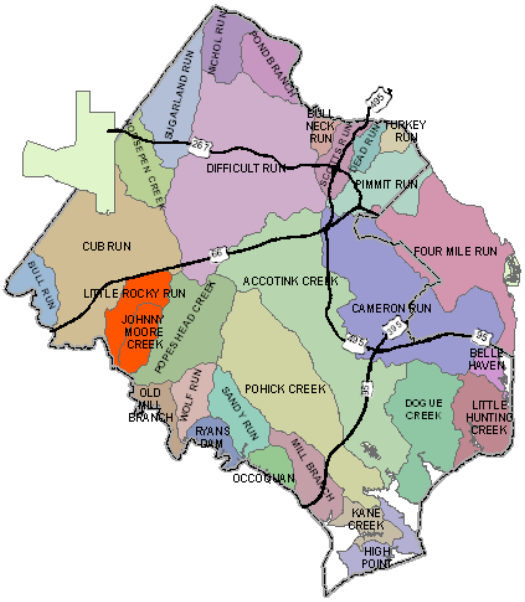


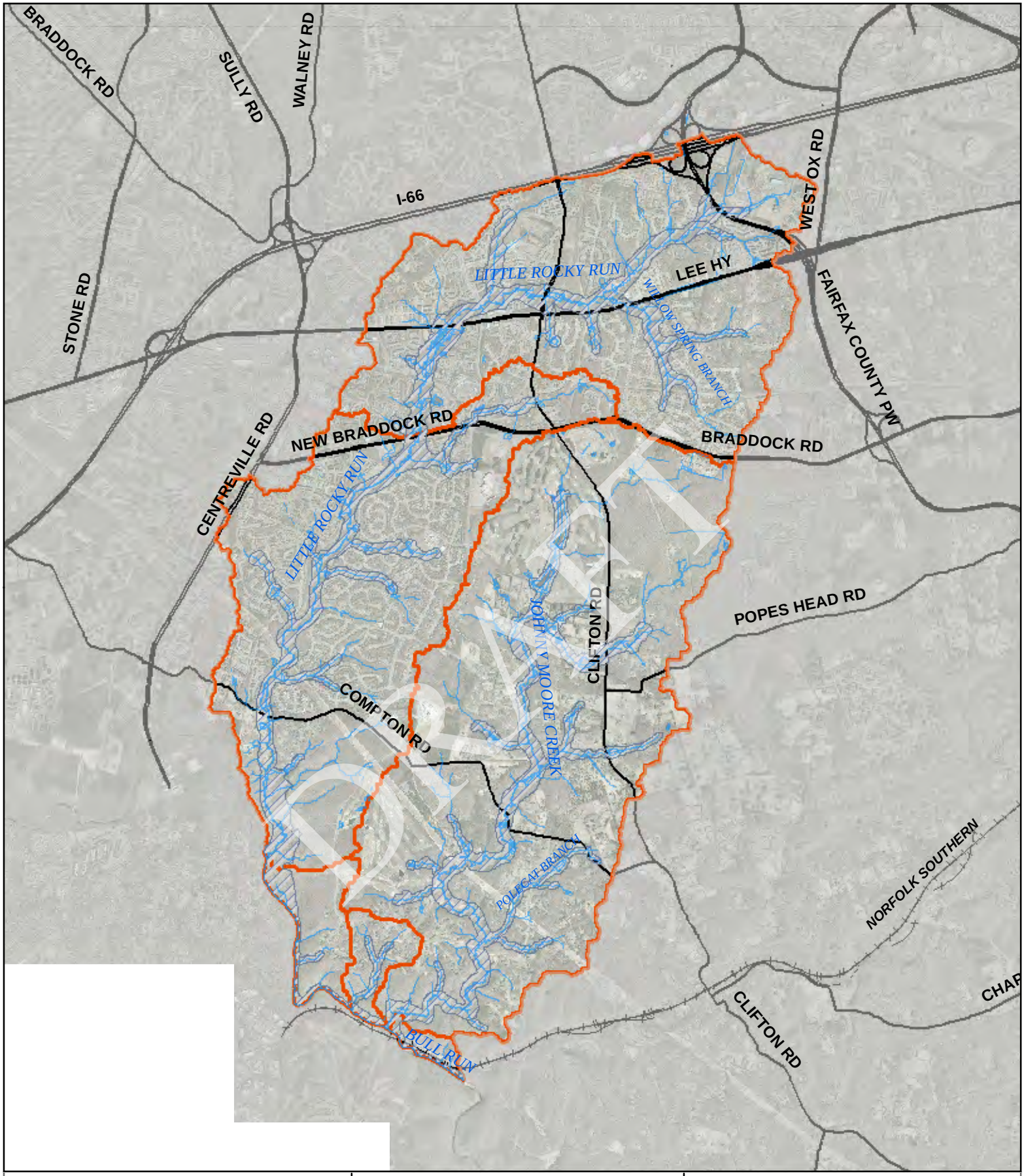
Figure 1-1: Location of the Little Rocky Run and Johnny Moore Creek Watersheds

The Little Rocky Run watershed encompasses 4,605 acres (7.2 square miles) and the Johnny Moore Creek watershed encompasses 3,374 acres (5.3 square miles). Both watersheds are located in the piedmont physiographic province, a region characterized by gently rolling hills, deeply weathered bedrock, and very little solid rock at the surface.

The headwaters of Little Rocky Run are located near the intersection of West Ox Road and Lee Highway. The creek flows in a southwesterly direction to its confluence with Bull Run. The headwaters of Johnny Moore Creek are located along Braddock Road near its intersection with Clifton Road. The creek flows in a southerly direction to its confluence with Bull Run. Major roads in the watersheds include: Interstate 66, Lee Highway (Route 29), Braddock Road, and Clifton Road.

The Little Rocky Run and Johnny Moore Creek watersheds are part of the Chesapeake Bay Preservation Area (CBPA) and both main stream corridors are located in the County's designated Resource Protection Area (RPA). The RPA is designated around all water bodies with perennial flows to protect the quality of water flowing to the Chesapeake Bay. The RPA totals approximately 683 acres (1.1 square miles) in the Little Rocky Run watershed and totals approximately 463 acres (0.7 square miles) in the Johnny Moore Creek watershed. The remainder of the watershed area is part of the County's designated Resource Management Area (RMA), which is designed to protect water quality by preserving or enhancing the functional value of the RPA. Map 1-1 shows the RPA areas in both watersheds.

The Little Rocky Run and Johnny Moore Creek watersheds have been subdivided into watershed management areas. The watershed management areas will be used to evaluate portions of the watershed with similar land use and development characteristics. Map 1-2 shows the watershed management areas that will be used for Little Rocky Run and Johnny Moore Creek.



Scale

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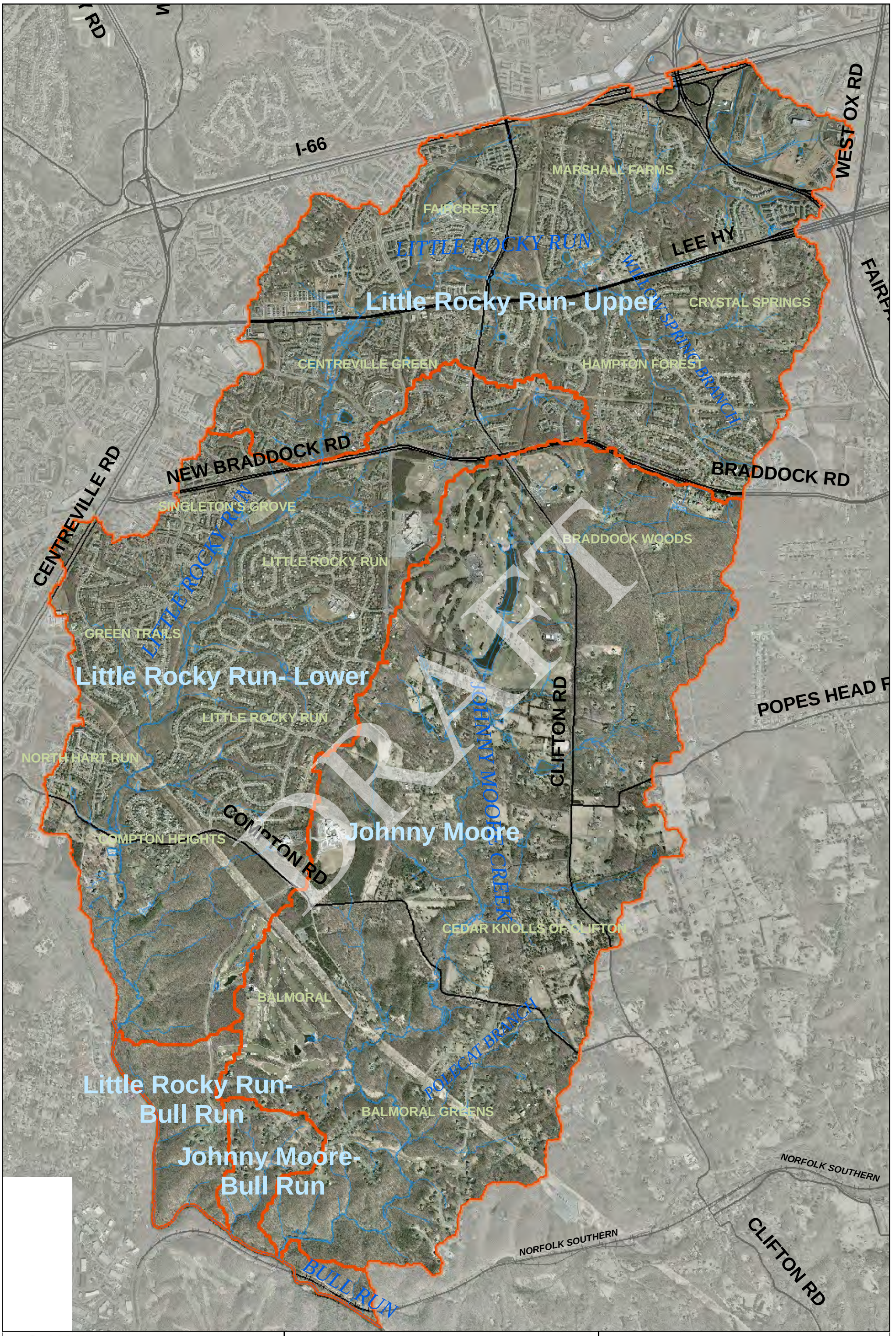
Streams
Resource Protection Areas (RPA)
Watershed Management Areas
Major Roads
Railroad

Map 1-1
Resource Protection Areas (RPA)

Little Rocky Run / Johnny Moore Creek Watersheds



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Streams
Watershed Management Areas
Major Roads
Railroad

Map 1-2
Watershed Management Areas

Little Rocky Run / Johnny Moore Creek

1.2 Land Use

A large portion of the Johnny Moore Creek watershed consists primarily of large lot residential development. On July 26, 1982, the Fairfax County Board of Supervisors approved a rezoning of more than 41,000 acres in the Occoquan watershed, which includes the Johnny Moore Creek watershed and a portion of the Little Rocky Run watershed, in order to protect the Occoquan Reservoir, which supplies drinking water to the County. Land in the rezoned area is classified as a Residential-Conservation (R-C) District, designating a maximum density of one dwelling unit per 5 acres. The entire Johnny Moore Creek watershed is located in the R-C District. The portion of Little Rocky Run south of Compton Road and the area south of Braddock Road and east of Union Mill Road are in the R-C District.

The predominant existing land use in the Little Rocky Run watershed is open space, as shown in Table 1-1, with 31 percent of the watershed area designated as open space. The next major land use is medium-density residential at 23 percent. The future land use designations show that only 4 percent of the watershed is expected to change. The amount of open space in the watershed will decrease by 186 acres. The amount of residential acreage will increase by 199 acres and high-intensity commercial development will increase by ten acres.

The predominant existing land use in the Johnny Moore Creek watershed is estate residential (39 percent) closely followed by open space (37 percent). In the future, open space will decrease 50 percent from 1,243 acres to 620 acres. The amount of estate residential in the watershed will increase from 39 percent of the watershed in existing conditions to 57 percent in the future. Map 1-3 shows the existing and future land use designations for each watershed.

Table 1-1 Existing and Future Land Use in the Little Rocky Run and Johnny Moore Creek Watersheds

Land Use Description	Little Rocky Run				Johnny Moore Creek			
	Existing		Future		Existing		Future	
	Area (acres)	%	Area (acres)	%	Area (acres)	%	Area (acres)	%
Open space	1,433	31	1,247	27	1,243	37	620	19
Golf Course	41	1	41	1	535	16	535	16
Estate residential	207	4	191	4	1,305	39	1,928	57
Low-density residential	372	8	520	11	141	4	141	4
Medium-density residential	1,054	23	1,078	24	1	0	1	0
High-density residential	542	12	569	12	0	0	0	0
Low-intensity commercial	13	0	10	0	0	0	0	0
High-intensity commercial	38	1	48	1	0	0	0	0
Institutional	141	3	137	3	2	0	2	0
Industrial	51	1	51	1	10	0	10	0
Transportation	668	15	668	15	87	3	87	3
Water	45	1	45	1	50	1	50	1
TOTAL	4,605	100	4,605	100	3,374	100	3,374	100

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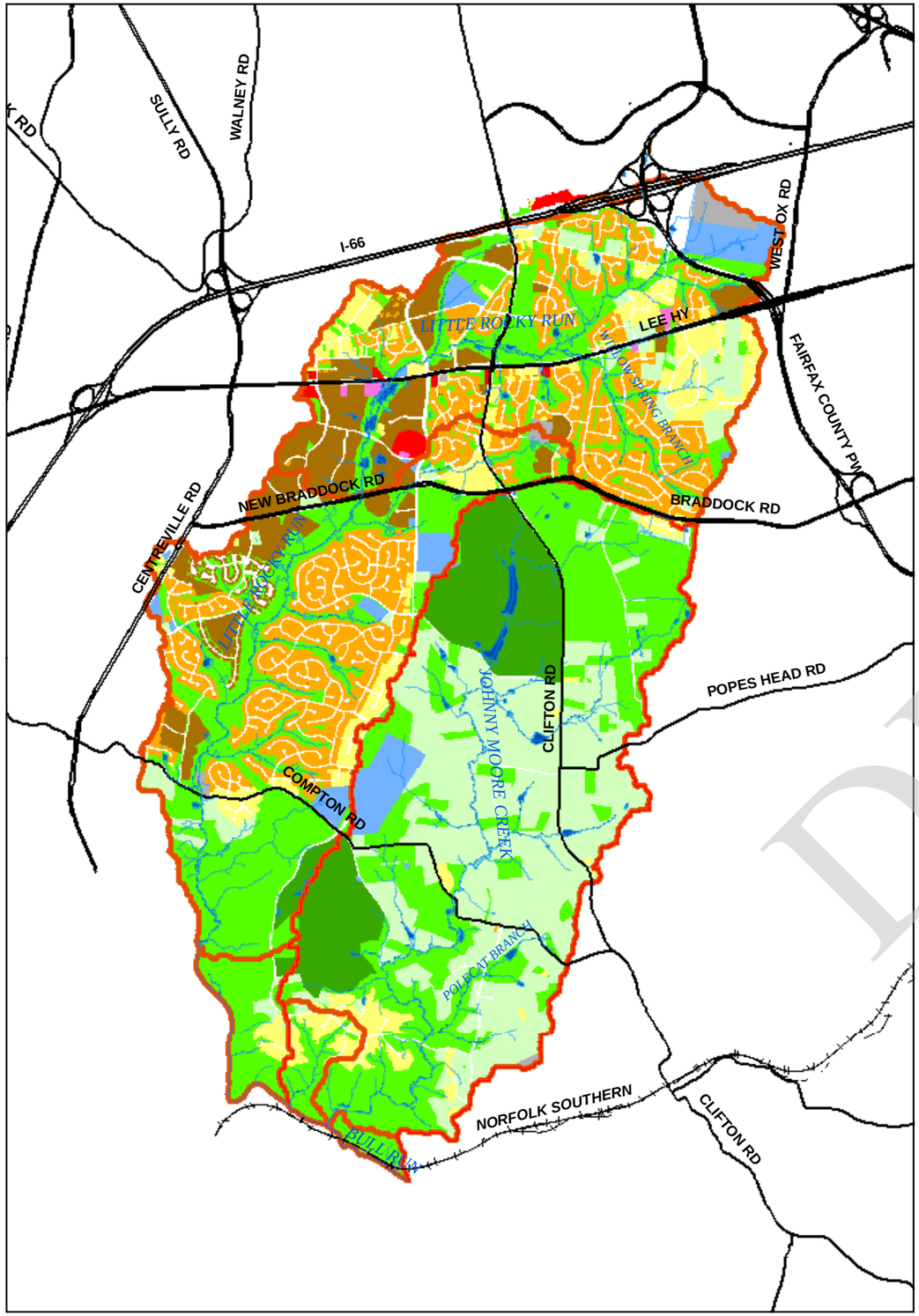
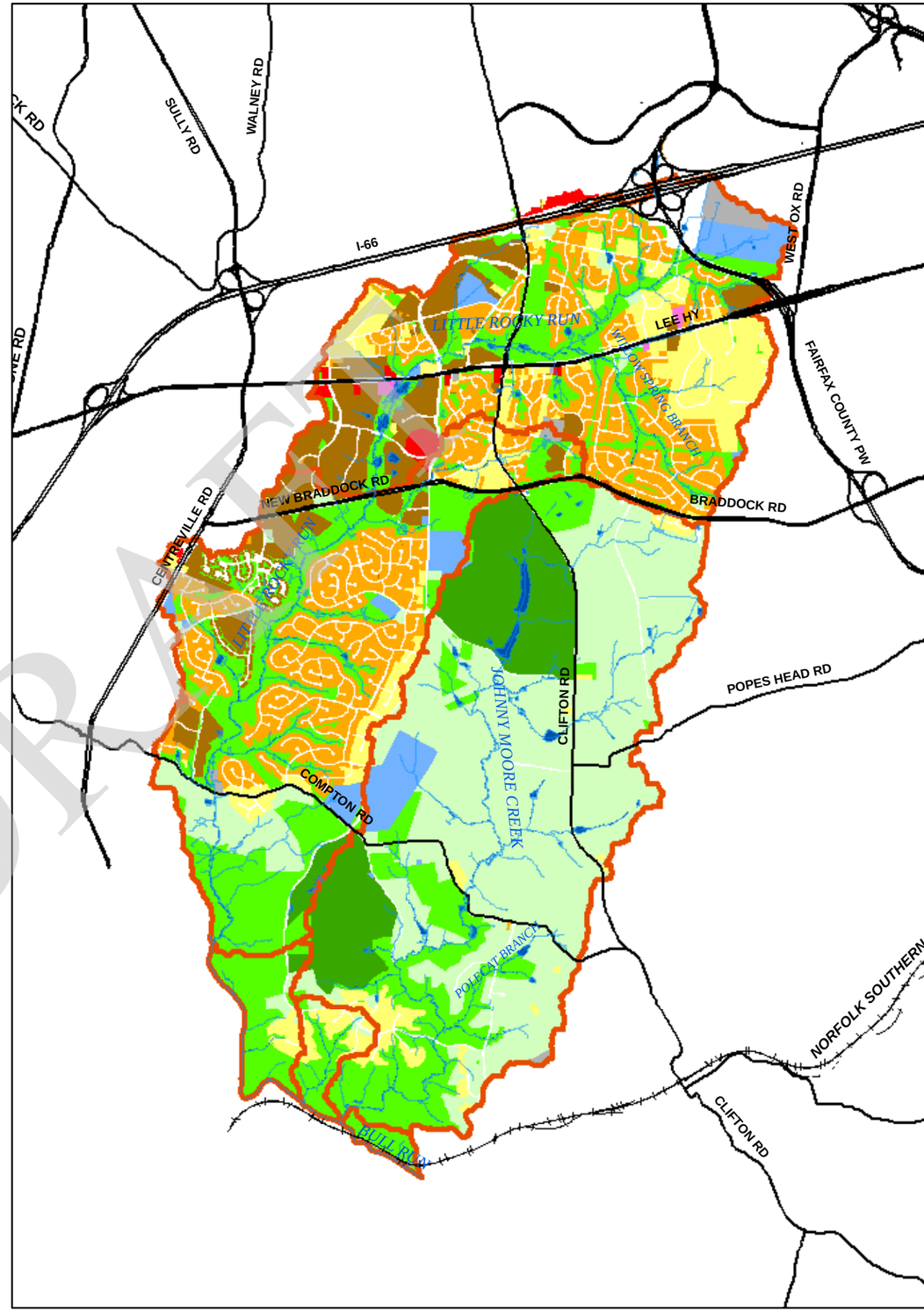
Map 1-3: Existing and Future Land Use

Existing Conditions Land Use Map



Future Conditions Land Use Map



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Map 1-3
Existing and Future Land Use Maps

Little Rocky Run / Johnny Moore Creek Watersheds

Legend

- Streams
- Major Roads
- Railroad
- JMwatershed
- Watershed Management Areas

Land Use

- Estate Residential
- Low Density Residential
- Medium Density Residential
- High Density Residential
- Low Intensity Commercial
- High Intensity Commercial
- Industrial
- Institutional
- Golf Course
- Open Space
- Water
- Transportation

Scale

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1.3 Little Rocky Run and Johnny Moore Creek - Review of Previous Studies and Data

Fairfax County has collected data and prepared reports on its watersheds for over 20 years. These reports were prepared by various agencies within the County with different missions and goals; therefore, the documents focus on a multitude of issues. In this chapter, the data and reports are summarized and their context and purpose is described.

Table 1-2 provides a listing of the available reports grouped according to their main topic area and presented in chronological order.

Table 1-2 List of Reports Reviewed by Topic and Date

Report	Date	Prepared By
Topic: Data		
Occoquan Environmental Baseline Report	February 1978	Parsons, Brinckerhoff, Quade & Douglas
Fairfax County Stream Water Quality Reports	Annually 1997-2002	Fairfax County Health Department
Fairfax County Stream Protection Strategy Baseline Study	January 2001	Fairfax County Department of Public Works & Environmental Services, Stormwater Planning Division
Fairfax County Stream Physical Assessment	August 2005	CH2M Hill
Annual Report on Fairfax County's Streams	November 2005 October 2006	Fairfax County Department of Public Works & Environmental Services, Stormwater Planning Division
Virginia Department of Environmental Quality Data: • Virginia 2006 305(b)/303(d) Water Quality Assessment Integrated Report, October 2006 • Benthic TMDL Development for Bull Run, Virginia, June 2006 • Bacteria TMDLs for Popes Head Creek, Broad Run, Kettle Run, South Run, Little Bull Run, Bull Run and the Occoquan River, Virginia, October 2006		Various: VA Department of Environmental Quality The Louis Berger Group, Inc. George Mason University
Virginia Natural Heritage Resource Database	Continuously updated	VA Department of Conservation and Recreation
Topic: Policy		
Infill and Residential Development Study	July 2000	VA Department of Planning & Zoning VA Department of Public Works & Environmental Services VA Department of Transportation
Fulfilling the Promise: The Occoquan Watershed in the New Millennium	January 2003	New Millennium Occoquan Watershed Task Force
Fairfax County Park Authority, Natural Resource Management Plan, 2004-2008	October 2004	Fairfax County Park Authority Natural Resource Management Project Team
Topic: Proposed Projects and Improvements		

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Report	Date	Prepared By
Proposed Drainage Plan, The Occoquan Watersheds	April 1979	Parsons, Brinckerhoff, Quade & Douglas
Fairfax County Master Plan Drainage Projects	Continuously Updated	Fairfax County Department of Public Works and Environmental Services
Regional Stormwater Management Plan	January 1989	Camp Dresser & McKee
The Role of Regional Ponds in Fairfax County's Watershed Management	March 2003	Fairfax County Environmental Coordinating Committee, Regional Pond Subcommittee

The previous studies conducted by Fairfax County and others indicate that the Little Rocky Run and the Johnny Moore Creek watersheds are in fair to good condition. The studies recommended the use of innovative Best Management Practices (BMPs) and new Low Impact Development (LID) techniques, the preservation of trees and open space, and identified the need to update the Public Facilities Manual (PFM). The studies also identified opportunities to educate and involve the public, and to promote regional cooperation between agencies, citizens, and nongovernmental organizations.

1.3.1 DATA

Occoquan Environmental Baseline Report, 1978

The *Occoquan Environmental Baseline Report* was written by Parsons, Brinckerhoff, Quade & Douglas in February 1978, based on data collected in 1976. The report presented a comprehensive review of the environmental baseline conditions for the 11 watersheds in the southern area of the County that drain into Bull Run and the Occoquan Reservoir. The baseline water quality of the 11 watersheds in the study was rated "very good." Two sites were sampled on Little Rocky Run at Lee Highway and Compton Road and one site was sampled on Johnny Moore Creek at Compton Road. The yearly log average fecal coliforms in 1976 (Table E-4 in the report) were 35 fecal coliforms per 100 milliliters of water (35/100 ml) and 24/100 ml for the Little Rocky Run site and 33/100 ml for the Johnny Moore Creek site.

The report also assessed the aquatic environment by surveying the aquatic fauna at two sites in the Little Rocky Run watershed and at two sites in the Johnny Moore Creek watershed (Table 7 and Figure 13 in the report). The sites along Little Rocky Run were at Braddock Road and at Compton Road, and the sites along Johnny Moore Creek were at Twin Lakes Road and near the confluence with Polecat Branch. The stream fauna quality was ranked "good" to "very good" on Little Rocky Run at Compton Road and on Johnny Moore Creek near Polecat Branch, "good" on Little Rocky Run at Braddock Road, and "fair" to "good" on Johnny Moore Creek at Twin Lakes Road.

Severe erosion was noted at several locations on Little Rocky Run, Johnny Moore Creek, and their tributaries. Along Little Rocky Run, severe erosion was noted in four areas upstream of Lee Highway, two areas upstream of Compton Road, and one area downstream of Compton Road. Along Willow Spring Branch, severe erosion was noted in one area slightly upstream of Lee Highway. An unnamed tributary to Little Rocky Run located south of Interstate 66 and west of Stringfellow Road was also experiencing one

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area of severe erosion. Along Johnny Moore Creek, severe erosion was noted in one location downstream of Twin Lakes Drive, two locations downstream of Compton Road and the power line, and one location near the confluence with Polecat Branch.

The *Occoquan Environmental Baseline Report* noted severe sedimentation at three locations in the Little Rocky Run watershed and one location in the Johnny Moore Creek watershed. Two locations were noted along Little Rocky Run, one upstream of Lee Highway and one upstream of Compton Road. One location within the Little Rocky Run watershed was noted along Willow Spring Branch, upstream of Lee Highway. The one location within the Johnny Moore Creek watershed was noted on Polecat Branch, upstream of the power line.

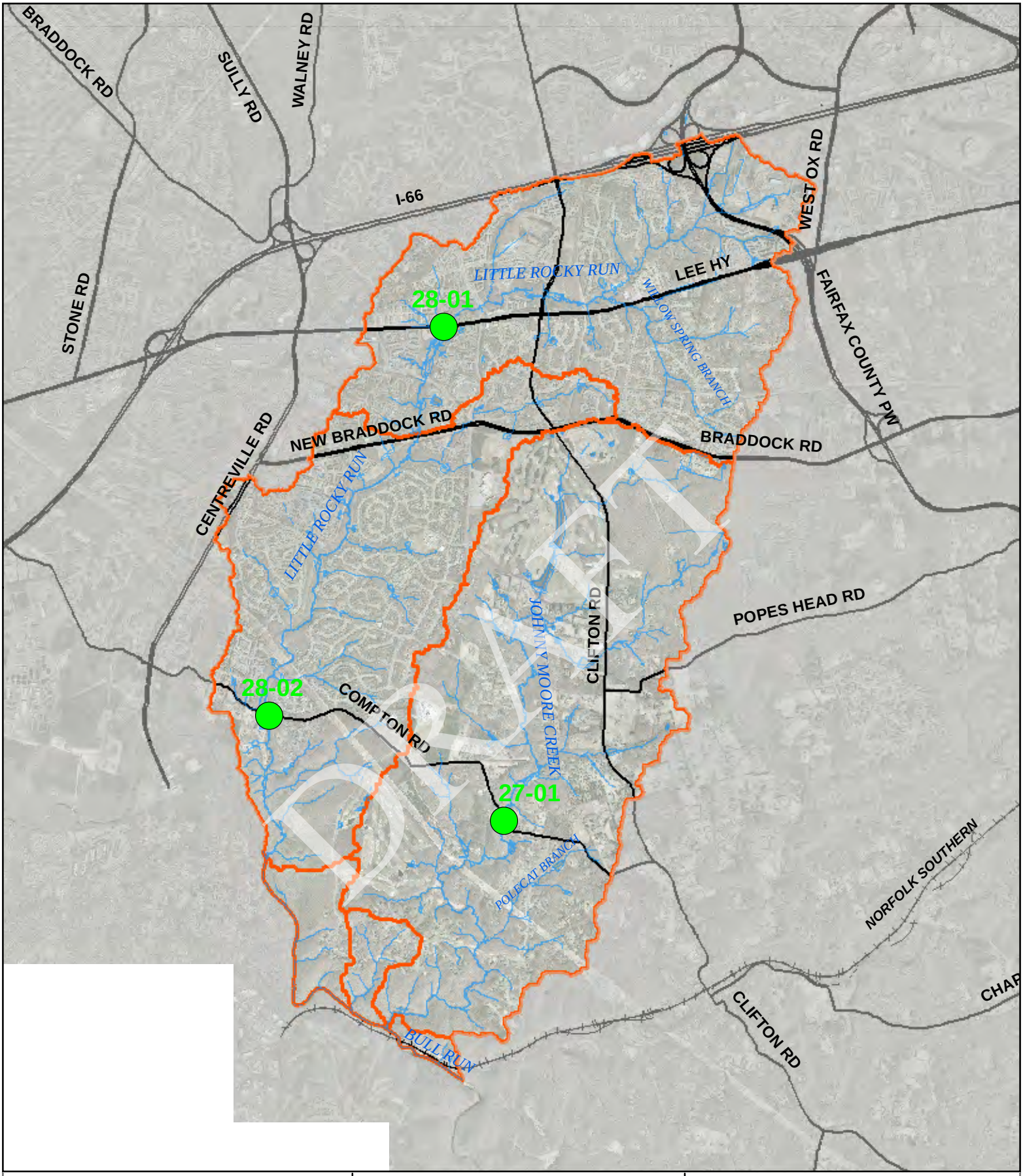
The data in this report provide baseline information that can be compared to more recent data collected for the *Stream Physical Assessment* and the *Stream Protection Strategy* reports. Little Rocky Run and Johnny Moore Creek have more recent stream physical assessments that were performed in 2003 (*Fairfax County Stream Physical Assessment*, 2005). The more recent assessments and field observations conducted as part of this watershed planning study will be used to identify erosion and sedimentation areas for mitigation in the Watershed Management Plans.

Fairfax County Annual Stream Water Quality Reports, 1997 through 2002

The Fairfax County Health Department monitored stream water quality at 72 sampling sites throughout the County from 1986 to 1999. In 2000, 13 new sites were added, totaling 85 sampling sites. In 2001 and 2002, only 84 sites were sampled. The water quality sampling program was transferred to the Department of Public Works and Environmental Services in 2002 (see the *Annual Report on Fairfax County's Streams*). Reports from 1997 to 2002 were reviewed in preparation of this document.

Two water quality sampling sites were located in the Little Rocky Run watershed and one water quality sampling site was located in the Johnny Moore Creek watershed. The locations of the sampling sites are shown on Map 1-4. Site 27-01 is located on Johnny Moore Creek, and sites 28-01 and 28-02 are located on Little Rocky Run. The three sampling stations from the *Occoquan Environmental Baseline Report* are approximately in the same locations as those used in the *Stream Water Quality* reports. In 2002, 15 water samples were collected from site 27-01, 16 water samples were collected from site 28-01, and 18 water samples were collected from site 28-02. These samples were evaluated for fecal coliform, dissolved oxygen, nitrate, nitrogen, pH, total phosphorous, temperature, and heavy metals. These parameters indicate the amount of pollution contributed from manmade sources and help to evaluate the quality of the aquatic environment. Information regarding the parameters and data collected for the *Fairfax County Annual Stream Water Quality Reports* (1997-2002) can be found on the Fairfax County website at http://www.fairfaxcounty.gov/hd/streams/.

The average dissolved oxygen concentration for all three sites in the two watersheds was between 6 and 10 milligrams per liter (mg/l). This is above the minimum standard of 4.0 mg/l considered suitable for aquatic life. None of the samples from site 27-01 on Johnny Moore Creek or site 28-02 on Little Rocky Run had dissolved oxygen concentration less than 4.0 mg/l. However, 18 percent of samples collected from site 28-01 on Little Rocky Run showed a dissolved oxygen concentration of less than 4.0 mg/l. The 2002 report states that 54 percent of the samples measured below 4 mg/l were collected during the



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Monitoring Sites
Streams
Watershed Management Areas
Major Roads
Railroad

Map 1-4
Water Quality Monitoring Sites

Little Rocky Run / Johnny Moore Creek Watersheds

months of June and July, and that the summer water temperatures may be a contributing factor in the low dissolved oxygen levels. The three samples from site 28-01 that measured below 4 mg/l were taken in June and July.

For sites 27-01, 28-01, and 28-02, fecal coliform counts in 2002 were in the "good" range for 13 percent, 31 percent, and 17 percent of the samples, respectively. Countywide, 17 percent of the samples collected in 2002 were in the "good" range. In the 2002 report, a fecal coliform count less than 200/100 ml (geometric mean) was considered "good" water quality and a count of 250,000/100 ml was indicative of a direct sewage discharge. Figure 1-2 shows the values for the geometric mean of fecal coliforms from 1993 to 2002. The geometric mean is used to measure the central tendency of the data.

The data collected for the *Annual Stream Water Quality Reports* indicated a higher concentration of fecal coliforms at the three sampling sites than the fecal coliform data collected for the *Occoquan Environmental Baseline Report*. Data from 1976 and 2002 are compared in Table 1-3.

Figure 1-2: Yearly Geometric Mean of Fecal Coliforms for Little Rocky Run and Johnny Moore Creek

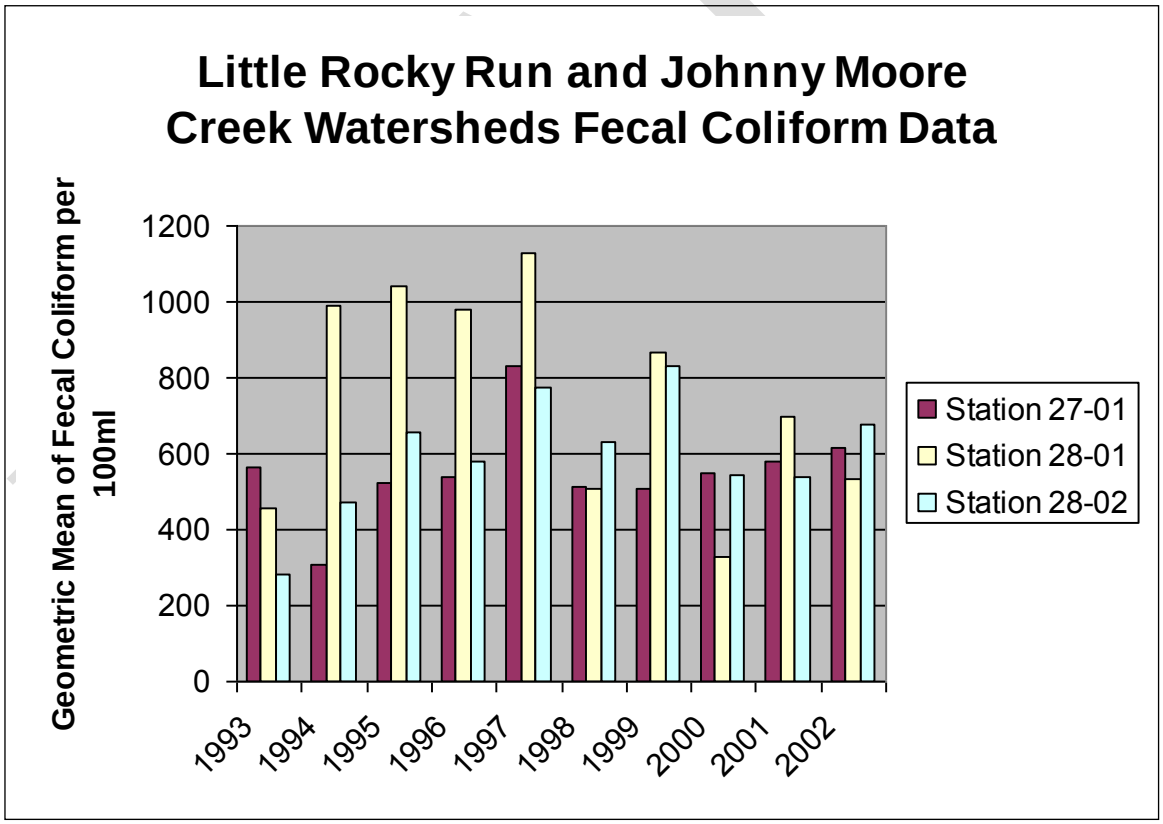

Table 1-3 Comparison of Fecal Coliform Levels – Occoquan Environmental Baseline Report and Stream Water Quality Reports

Sample Location	1976 Yearly Log Average Fecal Coliforms per 100 ml	2002 Geometric Mean Fecal Coliforms per 100 ml
Johnny Moore Creek at Compton Road (27-01)	33	615
Little Rocky Run at Lee Highway (28-01)	35	535
Little Rocky Run at Compton Road (28-02)	24	676

The stream water quality reports included analyses of sampling data that provide valuable information about the water quality in the Little Rocky Run and Johnny Moore Creek watersheds. These data will be used in conjunction with other County data to identify problem areas.

Fairfax County Stream Protection Strategy Baseline Study, 2001

The *Fairfax County Stream Protection Strategy (SPS) Baseline Study* evaluated the quality of streams throughout the County. The purpose of the SPS was to assess the continuing stream degradation within the ecosystem as evidenced by increasing stream channel erosion, loss of riparian buffers, decreased aquatic life, and poor water quality. The general objectives of the SPS program were to provide "recommendations for protection and restoration activities on a subwatershed basis, prioritization of areas for allocation of limited resources, establishment of a framework for long-term stream quality monitoring, and support for overall watershed management."

Little Rocky Run received "fair" composite site condition ratings in the upper and lower watershed, and a "good" rating in the central portion of the watershed. Johnny Moore Creek received "excellent" composite site condition ratings at both sites in the watershed. These ratings were based on the numeric scores of four components of stream/watershed conditions (environmental parameters): an index of biotic integrity; a general evaluation of watershed features, and a specific evaluation of 10 habitat quality parameters (habitat assessment); fish taxa richness (number of fish species); and percent imperviousness. Table 1-4 provides information regarding the macroinvertebrate and fish species and percent impervious surfaces at the five testing sites according to the *SPS Baseline Study Data Summary*. Faunal quality results at similar locations from the *Environmental Baseline Report* are also shown. Map 1-5 shows the location of the five SPS sampling sites.

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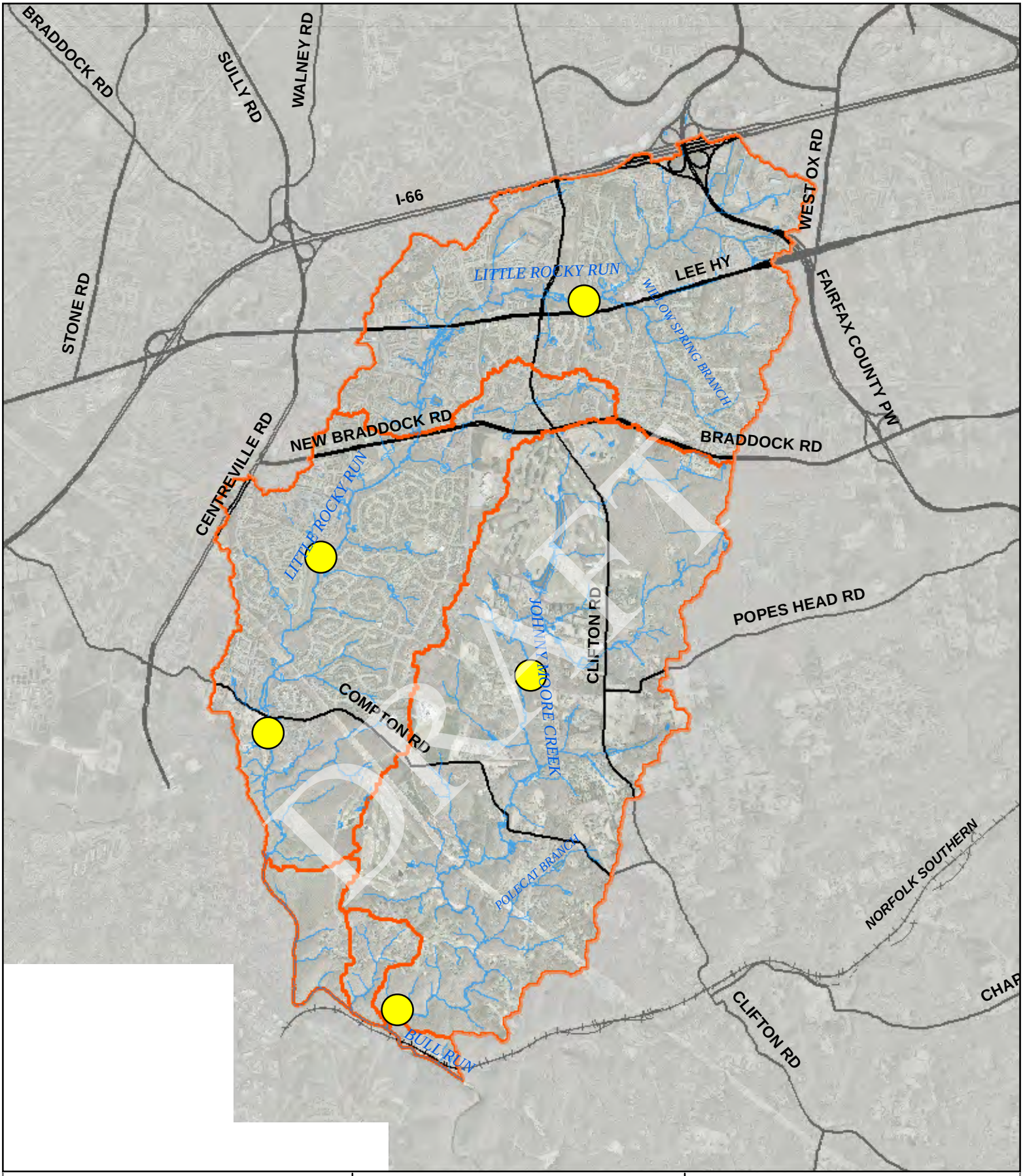

SPS Sampling Sites

Streams

Watershed Management Areas

Major Roads

Railroad

0 2,000 4,000 Feet

Map 1-5
Stream Protection Strategy
Sampling Sites

Little Rocky Run / Johnny Moore
Creek Watersheds

Table 1-4 Macroinvertebrate Assessment and Fish Species

Stream Name and Location	Composite Site Condition Rating	Macro-invertebrate Assessment	Number of Fish Species	1978 Faunal Quality	2001 Percent Impervious Surfaces
Little Rocky Run upstream of Stringfellow Road	Fair	Poor	High	No data available	14.6
Little Rocky Run downstream of New Braddock Road (and Springstone Drive)	Good	Fair	High	Good	17.7
Little Rocky Run downstream of Compton Road	Fair	Poor	Moderate	Good to Very Good	19.1
Johnny Moore Creek downstream of Johnny Moore Lane	Excellent	Good	High	Fair to Good	2.6
Johnny Moore Creek upstream of the confluence with Bull Run	Excellent	Poor	High	Good to Very Good	2.4

The Little Rocky Run watershed differs from the Johnny Moore Creek watershed in terms of level of development. The Johnny Moore Creek watershed has a greater percentage of forested land and fields/pastures than the Little Rocky Run watershed. Little Rocky Run has a greater percentage of low intensity residential, high intensity residential, and commercial/ industrial development than Johnny Moore Creek. This is evident in the difference in percent imperviousness in the two watersheds. Johnny Moore Creek has a substantially lower percent imperviousness than Little Rocky Run.

Polluted stormwater runoff affects the number and diversity of macroinvertebrate and fish species. Twenty-one individual species of fish were found in each of the two watersheds, accounting for the high fish taxa richness. The generally poor rating for the benthic macro-invertebrate community for both watersheds was due to aquatic worms and/or midges (organisms generally considered tolerant of degraded conditions) dominating the community. The volunteer monitoring conducted by the Northern Virginia Soil and Water Conservation District indicated a generally healthy benthic community at four sites within the Johnny Moore Creek main stem. For the macroinvertebrate assessment, the number

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of unique species and the balance between pollution-tolerant and intolerant species were measured. The SPS rankings ranged between excellent, good, fair, poor, and very poor. A fair rating indicates a marked decrease in intolerant species and a shift to an unbalanced community; a poor rating indicates decreased diversity with intolerant species being rare or absent. For the number of unique fish species collected, the SPS ratings were high, moderate, low, or very low.

Sediment deposition and bank stability ratings negatively impacted overall habitat rankings. Specifically, active channel widening was identified on some reaches of Little Rocky Run, indicating bank instability. Little Rocky Run was considered a semi-degraded aquatic system with the potential for improvement. Sediment deposition and bank stability ratings also lowered overall habitat scores across the region; however, in-stream and riparian zone conditions were generally "good" throughout both watersheds (some exceptions being portions of Little Rocky Run with evidence of instability, often in the form of active channel widening). The Little Rocky Run and Johnny Moore Creek watersheds still contain some of the higher quality stream systems found within the Piedmont Upland Region in Fairfax County.

In the *SPS Baseline Study*, the central portion of Little Rocky Run watershed and all of Johnny Moore Creek watershed were classified as Watershed Protection Areas, with the goal of preserving biological integrity by taking active measures to identify and protect, as much as possible, the conditions responsible for the current high-quality rating of these streams. The upper portion of Little Rocky Run watershed was classified as a Watershed Restoration Area Level I, with the goal of reestablishing healthy biological communities by taking active measures to identify and remedy causes of stream degradation. The lower portion of Little Rocky Run watershed was classified as a Watershed Restoration Area Level II, with the goal of maintaining areas to prevent further degradation and implementing measures to improve water quality to comply with Chesapeake Bay initiatives, Total Maximum Daily Load (TMDL) regulations, and other water quality measures. It was also designated as an Assessment Priority Area, indicating a need to select sites and implement monitoring within that area. This reflects the uncertainty over the dramatic change in condition between monitoring sites along the system's main stem. These designations were based on the composite biological ranking and estimated imperviousness (future development potential based on current zoning information). The Countywide representation in each of the management categories was as follows:

- Watershed Protection: 31.5 percent of the County
- Watershed Restoration Level I: 7.2 percent of the County
- Watershed Restoration Level II: 61.3 percent of the County

The entire Johnny Moore Creek watershed and a portion of the Little Rocky Run watershed are under the zoning ordinance of the Water Supply Protection Overlay District (WSPOD) to protect the quality of water draining directly into the Occoquan reservoir. The Centreville area within the Little Rocky Run watershed is exempt from the ordinance, a fact that explains the abrupt differences in land use and imperviousness between the two watersheds.

Based on the SPS goals of protecting and restoring stream quality within Fairfax County, a diverse management approach will be necessary. It will require active and ongoing stream

monitoring, targeted restoration projects, public outreach and education, enhanced stormwater controls, and improved communication with the development community.

The recommendations generated by the baseline study were as follows:

- Promote use of innovative BMPs and reduction of imperviousness for infill and redevelopment.
- Conduct public education in stream stewardship.
- Promote programs like Adopt-A-Stream to increase public involvement.

Additional recommendations are discussed in the Executive Summary and Chapter 5 of the *SPS report* which can be found on the Fairfax County website at: http://www. fairfaxcounty. gov/dpwes/environmental/sps_main.htm.

The SPS report provides data on a number of factors affecting the quality of Little Rocky Run and Johnny Moore Creek. The watershed characterization level from the SPS will guide the types of improvements recommended for the watershed management areas.

Fairfax County Stream Physical Assessment, 2005

The County initiated a stream physical assessment for all of its watersheds in August 2002, resulting in the final *Stream Physical Assessment Report* dated August 2005. The report included a habitat assessment, infrastructure inventory, stream characterization, and stream geomorphologic assessment. The assessment data are described for each of the subwatersheds in the following sections.

Habitat Assessment

As part of the assessment, the following characteristics were evaluated to determine the stream habitat quality for each stream reach:

- In-stream cover (fish)
- Epifaunal substrate (benthic)
- Embeddedness
- Channel/bank alteration
- Frequency of riffles
- Channel flow status (drought & normal flow)
- Bank vegetative protection
- Bank stability
- Vegetated buffer zone width

The scores assessed for the various physical parameters representing the stream habitat conditions were combined for each stream segment to obtain a total habitat score. The majority of the stream habitat was assessed as “fair” for both watersheds. The score of 102 for Little Rocky Run watershed is considered in the lower middle range of quality as compared with the rest of the County, and the score of 104 for Johnny Moore Creek watershed is considered in the middle range of quality as compared with the rest of the County. Tables 1-5 and 1-6 describe the percentage of length for each habitat quality rating for the streams according to the total score.

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Table 1-5 Summary of Stream Habitat Quality for Little Rocky Run Watershed

Stream	Percent of Stream Length				
	Very Poor	Poor	Fair	Good	Excellent
Little Rocky Run	0%	11%	60%	21%	8%
Tributary to Bull Run	0%	0%	100%	0%	0%
Tributary to Little Rocky Run	0%	76%	24%	0%	0%
Willow Springs Branch	0%	0%	100%	0%	0%
Total Watershed	**0%**	**19%**	**62%**	**14%**	**5%**

Table 1-6 Summary of Stream Habitat Quality for Johnny Moore Creek Watershed

Stream	Percent of Stream Length				
	Very Poor	Poor	Fair	Good	Excellent
Johnny Moore Creek	0%	0%	53%	47%	0%
Polecat Branch	0%	35%	65%	0%	0%
Tributary to Bull Run	0%	0%	0%	100%	0%
Tributary to Johnny Moore Creek	2%	28%	66%	4%	0%
Tributary to Polecat Branch	0%	0%	100%	0%	0%
Total Watershed	**1%**	**15%**	**60%**	**24%**	**0%**

Vegetative Buffer Zone Width

Vegetative buffers filter pollutants entering a stream from runoff and minimize erosion along the stream. Approximately 37 percent of stream buffers in the Little Rocky Run watershed have a severe impact score, while 21 percent have a moderate to severe impact score, and 42 percent have a minor to moderate impact score. Approximately 5 percent of stream buffers in the Johnny Moore Creek watershed have a severe impact score, while 36 percent have a moderate to severe impact score, and 59 percent have a minor to moderate impact score.

Bank Stability

Stable stream banks have minimal erosion and gently sloping banks while unstable banks have steep slopes with evident erosion and bank failure. In the Little Rocky Run watershed, 46 percent of the banks were classified as moderately unstable and 54 percent were classified as moderately stable. In the Johnny Moore Creek watershed, 89 percent of the banks were classified as moderately unstable and 11 percent were classified as moderately stable.

Embeddedness

The assessment documented the degree of streambed embeddedness. Embeddedness, the degree to which cobbles and gravel on the streambed are covered with or sunken into sediment, is a measure used to quantify the impact of sedimentation on stream habitat. As the streambed becomes more embedded, the habitat of bottom dwelling organisms is

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increasingly impaired. In the Little Rocky Run watershed, embeddedness rankings were: 4 percent poor, 61 percent marginal, 32 percent suboptimal and 3 percent optimal. In the Johnny Moore Creek watershed, embeddedness rankings were: 8 percent poor, 65 percent marginal, and 27 percent suboptimal.

Infrastructure Inventory

The assessment identified and characterized the following significant characteristics and features within the watersheds:

- Deficient buffer vegetation
- Dumpsites
- Erosion locations
- Head cuts
- Obstructions
- Pipe and ditch outfalls
- Public utility lines
- Roads and other crossings

An impact score was assigned to those inventory items causing a negative impact to the stream. Based on the impact score, the degrees of impact were classified into four groups: minor, moderate, severe, and extreme. Table 1-7 describes the classifications for each of the stream inventory items. These impacts are further categorized by watershed management area in Chapter 2.

Table 1-7 Description of Impacts

Impact	Description
Deficient Buffer Vegetation (within 100 feet of stream bank)	
Extreme	Impervious/commercial area in close proximity to a stream. The stream banks may be modified or engineered. The stream character (bank/bed stability, sediment deposition, and/or light penetration) is obviously degraded by adjacent use.
Severe	Some impervious areas and/or turf located up to the bank and water. Very little vegetation aside from the turf exists within the 25-foot zone. Home sites may be located very close to the stream. The stream character is probably degraded by adjacent use.
Moderate	Encroachment mostly from residential uses and yards. There is some vegetation within the 25-foot zone, but very little aside from turf exists within the remainder of the 100-foot zone. The stream character may be changed slightly by adjacent use.
Minor	Vegetated buffer primarily consists of native meadow (not grazed).
Dumpsites	
Severe to Extreme	Active and/or threatening sites. The materials may be considered toxic or threatening to the environment (concrete, petroleum, empty 55-

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Impact	Description
	gallon drums, etc.) or the site is large (greater than 2,500 square feet) and appears active.
Moderate	Dumpsite less than 2,500 square feet with non-toxic material. It does not appear to be used often, but clean-up would definitely be a benefit.
Minor	Dumpsite appears small (less than 1,000 square feet) and the material stable (will not likely be transported downstream by high water). This site is not a high priority.
Erosion Locations	
Extreme	Impending threat to structures or infrastructure
Severe	Large area of erosion that is damaging property and causing obvious in-stream degradation. The eroding bank is generally five feet or greater in height.
Moderate	A moderate area of erosion that may be damaging property and causing in-stream degradation. The eroding bank is generally two feet or greater in height.
Minor	A minor area of erosion that is a low threat to property and causes no noticeable in-stream degradation.
Head Cuts	
Severe to Extreme	Greater than two-foot head cut height
Moderate	One- to two-foot head cut height
Minor	One-half to less than one-foot head cut height
Obstructions	
Severe to Extreme	The blockage is causing a significant erosion problem and/or the potential for flooding that can cause damage to infrastructure. The stream is usually almost totally blocked (more than 75% blocked).
Moderate to Severe	The blockage is causing moderate erosion and could cause flooding. The stream is partially blocked, but obstructions should probably be removed or the problem could worsen.
Minor to Moderate	The blockage is causing some erosion problems and has the potential to worsen. It should be looked at and/or monitored.
Pipes and Ditch Outfalls	
Severe to Extreme	Stormwater runoff from a ditch or pipe is causing a significant erosion problem to the stream bank or stream. Discharge that may not be stormwater is coming from the stormwater pipe.
Moderate	Stormwater runoff from a ditch or pipe is causing a moderate erosion problem and should be fixed; it may get worse if left unattended. Discharge is coming from the pipe. It is probably stormwater, but it will be uncertain without further investigation.
Minor	Stormwater runoff from a ditch or pipe is causing a minor erosion problem and some discharge is occurring.

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Public Utility Lines	
Extreme	A utility line is leaking.
Severe	An exposed utility line is causing a significant erosion problem and/or obstruction (blockage). The potential for the sanitary line to burst or leak appears high.
Moderate	A partially exposed utility line is causing a moderate erosion problem. The line is partially visible (mostly buried in a stream bed with little if any erosion).
Minor	A utility line is exposed but stabilized with concrete lining and stable anchoring into the bank.
Road and other Crossings	
Extreme	The condition of debris, sediment, or erosion poses an immediate threat to the structural stability of the road crossing or other structure. Major repairs will be needed if the problem is not addressed.
Severe	The condition probably poses a threat to a road crossing or other structure. The problem should be addressed to avoid larger problems in the future
Moderate	The condition does not appear to pose a threat to a road crossing or other structure but should be addressed to enhance stream integrity and the future stability of the structures.
Minor	The condition is noticeable but may not warrant repair.

Source: *Fairfax County Stream Physical Assessment Protocols*, December 2002

Stream Geomorphologic Assessment

The geomorphologic assessment of the stream channels in the Little Rocky Run and Johnny Moore Creek watersheds was based on the conceptual incised channel evolution model (CEM) developed by Schumm, et al. (1984). Based on visual observation of the channel cross section and other morphological observations of the channel segment, the CEM type was assigned for the channel segment. The CEM types are summarized in Table 1-8. The CEM type for the stream segments is shown on maps in Chapter 2.

Table 1-8 Summary of CEM Types

CEM Type	Description
1	Stable stream banks and developed channel
2	Deep incised channel
3	Unstable stream banks and actively widening channel
4	Stream bank stabilizing and channel developing
5	Stable stream banks and widened channel

The data obtained from the stream physical assessment will be used as a starting point to determine problem areas in the watersheds. The assessment data will be field verified and projects to mitigate the problem areas will be recommended as part of the *Watershed Management Plan*.

Annual Report on Fairfax County's Streams, 2005 and 2006

In 2004, the County's biological sampling strategy was reevaluated and long-term goals were established. The Fairfax County Stormwater Planning Division developed the *2005*

Annual Report on Fairfax County's Streams. It was determined that annual Countywide conditions and trends were best determined from a probability-based sampling procedure, rather than the targeted sampling approach employed in the *Stream Protection Strategy Baseline Study*. The biological monitoring program focused on bacteria levels, biotic integrity, and stream quality. Three biological monitoring sites were located within the Little Rocky Run watershed. Additionally, there were three coliform bacteria monitoring sites located within Little Rocky Run and Johnny Moore watersheds. There were also six sites monitored by Audubon Naturalist Society (ANS) and Northern Virginia Soil and Water Conservation District (NVSWCD) volunteer groups within the two watersheds. The index scores and condition ratings for the 2004 sampling locations based on benthic macroinvertebrate and fish data are shown in Table 1-9.

Table 1-9 Table 1-9: Benthic and Fish Indices from 2004 Sampling

Sampling Site ID	Stream Order	Benthic Index Score	Rating	Fish Index Score	Rating
Little Rocky Run (LR0401)	3	27.36	Poor	25	Fair
Little Rocky Run (LR0402)	1	30.80	Poor	No fish sampling	
Little Rocky Run (LR0403)	1	15.56	Very Poor	No fish sampling	

In 2006, Fairfax County Stormwater Planning Division published the *2006 Annual Report on Fairfax County's Streams*. The 2005 and 2006 reports can be found on the Fairfax County website at: http://www.fairfaxcounty.gov/dpwes/stormwater/streams/streamreports.htm. The biological monitoring program focused on bacteria levels (fecal-related), benthic macroinvertebrates, fish communities, and water chemistry. There was one randomly selected biological and bacteriological monitoring site located within the Little Rocky Run watershed. Additionally, there was one ANS volunteer monitoring site located on Little Rocky Run. Page 38 of the 2006 annual report contains a detailed map showing monitoring results from 1999 through 2005.

Data from this report provided further documentation of water quality and habitat issues in the watershed and will provide additional focus in development of the Watershed Management Plan.

Virginia Department of Environmental Quality Water Quality Data

None of the stream segments in either the Little Rocky Run watershed or the Johnny Moore Creek watershed are listed as Category 5 impaired water bodies in the 2006 305(b)/303(d) Water Quality Assessment (WQA) Integrated Report prepared by the Virginia Department of Environmental Quality (DEQ). United States Environmental Protection Agency (EPA) Category 5 impaired water bodies are defined as "impaired or threatened and a TMDL is needed." Two segments from the watersheds are listed in the *2006 Integrated List of All Assessed Waters in Virginia*. A 4.98-mile segment of Little Rocky Run (VAN-A23R_LIP01A06) is designated as a Virginia Category 2B, which is a subcategory to EPA Category 2. EPA Category 2 waters meet some of their designated uses, but there are insufficient data to determine if remaining designated uses are met. Virginia Category 2B waters are of concern to the state, but no water quality standards exist for an identified pollutant, or the water exceeds a state screening value. The waters

are considered fully supporting their uses with observed effects. Map 1-6 shows the location of the 303(d) impaired waters.

A 3.78-mile segment of Johnny Moore Creek (VAN-A23R_JOH01A02) is listed as a Virginia Category 3C, which is a subcategory to EPA Category 3. EPA Category 3 waters are defined as those that have insufficient data to determine whether any designated uses are met. Virginia Category 3C waters may have data collected by a citizen monitoring group or other organization which indicate water quality problems, but the methodology or data quality has not been approved for a determination of attainment of designated uses. These waters are considered to have insufficient data with observed effects. These waters will be prioritized for follow-up monitoring.

There have been changes in the criteria for identifying impaired waters since the 2002 assessment. One significant change was the assessment of fish tissue data. In order to protect human health, waters were listed as impaired when two or more of the human health surface water criteria were exceeded in samples collected at the same station. In addition, Virginia Department of Health (VDH) approved a trigger value for mercury.

Once a water body has been listed as impaired, DEQ must develop a TMDL report identifying the sources causing the water quality problem and the reductions needed to resolve it, and submit the report to the EPA for approval. Upon approval, DEQ must develop a TMDL Implementation Plan to restore water quality. Once the TMDL report is approved by EPA, the loading reductions are incorporated into Fairfax County's Virginia Stormwater Management Program (VSMP) permit to discharge stormwater into waters of the state. As a result, the loading reductions become mandatory for the County.

A report titled *Benthic TMDL Development for Bull Run, Virginia* was prepared by the Louis Berger Group, Inc. in June 2006 and submitted to DEQ. EPA Region III approved the TMDL for aquatic life use impairments on Bull Run (VAN-A23R-01) on September 26, 2006. Bull Run was first listed on Virginia's Section 303(d) list in 1994, and again in 1998 and 2002. It was listed more specifically as an impaired water, due in part to benthic impairment, on the 2004 WQA 305(b)/ 303(d) Integrated Report. It was also listed in the 2004 WQA Integrated Report due to exceedances of the water quality standards for fecal coliform bacteria and PCB concentrations in fish tissue samples. DEQ conducted bioassessments at the DEQ monitoring station located at the intersection of Bull Run and Route 28, which indicated a moderately impaired benthic macroinvertebrate community, resulting in the 303(d) listing.

The June 2006 report documented efforts to determine and identify the stressors (causal pollutants) and sources within the watershed. Several candidate stressors were reviewed in the report, including: dissolved oxygen, temperature, pH, metals, organic chemicals, nutrients, toxic compounds, and sediments. These were evaluated based on available monitoring data, field observations, and consideration of potential sources in the watershed. Sedimentation, caused by higher runoff flows, was identified as a primary stressor impacting benthic macroinvertebrates in this segment of Bull Run. Potential sources of sediment loading in the watershed included urban stormwater runoff, stream bank erosion, and sediment loss from habitat degradation associated with urbanization. The report suggested that reducing sediment loadings through stormwater control and restoring instream and riparian habitat to alleviate the impacts of urbanization on the river were key to improving the benthic community.

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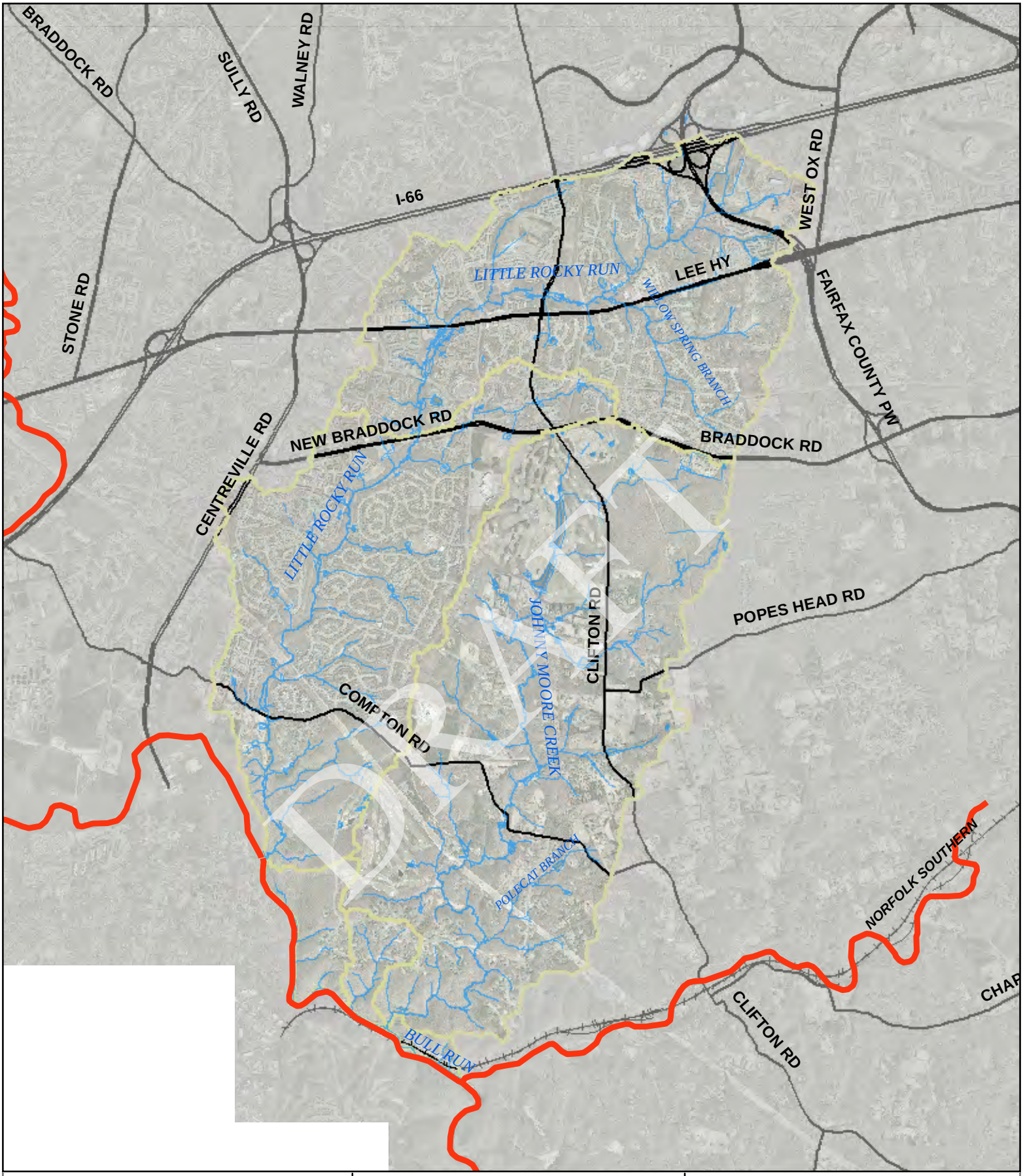

0 2,000 4,000 Feet

Virginia 303(d) Impaired Waters
Streams
Watershed Management Areas
Major Roads
Railroad

Map 1-6
Virginia 303(d) Impaired Waters

Little Rocky Run / Johnny Moore Creek Watersheds

The report indicated that the overall sediment load in the Fairfax County municipal separate storm sewer system (MS4) area contributing to Bull Run should be decreased by 77.1 percent. The Fairfax County MS4 area includes the Virginia Department of Transportation (VDOT) and Fairfax County Public Schools as permit holders. The *Watershed Management Plan* will focus on reducing sediment loading in the watershed by addressing stormwater control, stream bank erosion, and riparian buffers.

A report titled *Bacteria TMDLs for Popes Head Creek, Broad Run, Kettle Run, South Run, Little Bull Run, Bull Run and the Occoquan River, Virginia* was prepared by George Mason University and the Louis Berger Group, Inc. in August 2006. EPA Region III approved this TMDL on November 12, 2006. Segments of the streams covered by the TMDL were listed as impaired on Virginia's 1998 303(d) TMDL Priority List and Report because of violations of the state's water quality standard for fecal coliform bacteria. These segments were also included on Virginia's 2002 303(d) Report on Impaired Waters and the 2004 305(b)/303(d) WQA Integrated Report. The impaired segment of Bull Run (VAN-A23R-01) begins at the confluence with Cub Run and continues to the confluence with Popes Head Creek. Four out of 34 samples (11.8 percent) collected between January 1, 1998 and December 31, 2002 were recorded as exceeding the instantaneous fecal coliform bacteria criterion of 400/100 ml.

At the time of the TMDL listings, the Virginia bacteria standard was expressed in fecal coliform bacteria. However, the standard has recently changed and is now expressed in *E. coli*. Virginia's current bacteria water quality standard currently states that *E. coli* bacteria shall not exceed a geometric mean of 126 *E. coli* counts per 100 ml of water for two or more samples within a calendar month, or an *E. coli* concentration of 235 counts per 100 ml of water at any time. The TMDL was expressed in *E. coli* by converting modeled daily fecal coliform concentrations to daily *E. coli* concentrations using an in-stream translator.

The report indicated that the overall *E. coli* load in the Fairfax County MS4 area (including VDOT and the Fairfax County Public School permit holders) contributing to Bull Run should be decreased by 89 percent. The report suggested possible methods for reducing *E. Coli* such as: septic tank education, septic system repair/replacement program, sanitary sewer inspection and management, more restrictive ordinances on pet waste, improved garbage collection and control, and improved street cleaning. The *Watershed Management Plan* will consider recommendations for reducing *E. coli* in the Little Rocky Run and Johnny Moore Creek watersheds.

Virginia Natural Heritage Resource

The Virginia Natural Heritage Resources Database describes the status and rank of rare plant and animal species for subwatersheds in Virginia. Little Rocky Run and Johnny Moore Creek are both located within the Lower Bull Run subwatershed, which is within the Middle Potomac – Anacostia -Occoquan watershed. Two resources were listed in the database for the Lower Bull Run subwatershed. The Manassas stonefly was given a state ranking of SH (possibly extirpated). The trailing stitchwort vascular plant was given a state ranking of S1 (critically imperiled). Neither of these resources was given a federal or state status for endangerment.

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1.3.2 POLICY

Infill and Residential Development Study, 2000

The *Fairfax County Infill and Residential Development Study, Draft Staff Recommendations Report* was released by the County in July 2000. Any residential development occurring proximate to or within already established neighborhoods is referred to as infill development. The primary focus of this study was the identification of recommendations to better address issues associated with the impacts of new residential development on its immediate surroundings. The issues that have been cited most frequently as problems associated with infill development with respect to the immediate environs were divided into four main categories on which staff presented recommendations: Site Design and Neighborhood Compatibility (SC), Traffic and Transportation (TR), Tree Preservation (TP), and Stormwater Management and E&S Control (SW). Problems associated with infill development may negatively impact upper parts of the Little Rocky Run watershed where the most development has taken place.

The following recommendations from the report which address water quality and stormwater management may be evaluated as part of the *Little Rocky Run and Johnny Moore Creek Watershed Management Plan*.

- TP 1: Reduce grading to increase tree preservation;
- TP 3: Request conservation easements where appropriate;
- SW 1: Improve the awareness, planning, and financial resolution capability of the County for land disturbing projects upstream of sensitive sites;
- SW9: Require additional conditions associated with stormwater detention/water quality waivers to address potential problems associated with land disturbance;
- SW10: Require reports from applicants that identify baseline data for properties downstream, corrective measures planned for implementation in the event that impacts occur, and a commitment to implement those measures;
- SW11: Enhance the use of Best Management Practices (BMP) through additional guidance on BMP selection and enhanced design standards in the PFM; and,
- SW13: Modify requirements and procedures as they relate to the consideration of stormwater management during the zoning process.

Fulfilling the Promise: The Occoquan Watershed in the New Millennium , 2003

The New Millennium Occoquan Watershed Task Force prepared a report titled *Fulfilling the Promise: The Occoquan Watershed in the New Millennium* in January 2003. The Board of Supervisors established the Task Force to provide an assessment of issues facing the Fairfax County portion of the Occoquan watershed; to examine gaps in programs not being carried out by local, State and regional agencies; to define the role of volunteer organizations that have interests in the watershed; and to provide a vision for the future management of the watershed. The report presented recommendations on: the reservoir, streams and ecosystems, land use and open space, tree preservation, erosion and sediment control and stormwater management, onsite sewage disposal, citizen involvement, and regional coordination.

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The following recommendations from the report which address water quality and stormwater management may be evaluated as part of the *Little Rocky Run and Johnny Moore Creek Watershed Management Plan*.

Occoquan Reservoir Recommendations:

1. Promote existing programs and policies aimed at maintaining acceptable levels of water quality in the Reservoir;
2. Reduce nutrient and sediment contributions to the Reservoir above and beyond those being achieved through existing policies and ordinances; and,
3. Actively participate in State and Federal regulatory and/or policy initiatives that might result in requirements for additional nutrient and sediment reductions.

Streams and Ecosystems Recommendations:

1. Rigorously maintain the integrity of the Occoquan downzoning;
2. Continue regular long-term stream assessments by the Stream Protection Strategy staff;
3. Fully develop and implement the Stormwater Planning Division's watershed management planning process in the Occoquan watershed;
4. Study and adopt new stormwater management designs that have been demonstrated to protect or improve the health of stream ecosystems; and,
5. Encourage the use of those LID techniques that have been proven effective under local conditions, both where new development is planned and, to the extent feasible, for retrofitting of existing development.

Land Use and Open Space Recommendations:

1. Continue the County's commitment to the successful strategy for water quality protection of Occoquan Reservoir;
2. Establish a broad-based advisory committee, to include stakeholders, County staff, and one or more members of the County's Planning Commission, to review standards and guidelines associated with Special Permit, Special Exception, and public uses that may be approved in the R-C District in the Occoquan watershed and to report its findings and recommendations to the Board of Supervisors;
3. Establish a more proactive easements program that provides for outreach efforts to owners of land in the Occoquan watershed that contains environmentally sensitive resources;
4. Fully fund watershed management planning efforts as well as the implementation of adopted plan measures; and,
5. Complete the ongoing review of impediments to the application of low impact site design techniques and identify disincentives and policy/regulatory conflicts associated with the implementation of these techniques.

Tree Preservation Recommendations:

1. Continue to press for tree preservation and preservation enabling legislature;

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2. Establish tree canopy goals for the Occoquan watershed and determine appropriate implementation measures for attaining those goals; and,
3. Encourage the revegetation of lost riparian stream buffers with native woody vegetation by identifying potential reforestation areas, providing citizen education, and encouraging citizen reforestation efforts.

Citizen Involvement Recommendations:

1. Strengthen partnerships with public and citizen organizations to broaden participation in education and stewardship activities;
2. Encourage growth of the network of organizations and citizen groups concerned with and/or actively involved in watershed and water quality issues, and seek assistance on methods of reaching more citizens to seek participation in stewardship activities;
3. Sponsor programs, meetings, seminars and festivals on water quality and natural resource protection that attract people who may become active volunteers in existing or new programs and help to educate others on the value of good stewardship;
4. Support the expansion of existing outreach and education programs, such as those sponsored by the Northern Virginia Soil and Water Conservation District, the Audubon Naturalist Society, and the Fairfax County Park Authority;
5. Investigate proactive outreach to property owners who have property in or abutting Resource Protection Areas (RPAs) and/or other stream valley areas; and,
6. Develop a strategy for strengthening the role of citizens in code and ordinance enforcement.

Fairfax County Park Authority Natural Resource Management Plan, 2004-2008

The *Natural Resource Management Plan* was prepared by the Fairfax County Park Authority in January 2004, and describes the system-wide resource preservation vision of the Park Authority for 2004 through 2008. The plan recognized that the impacts from urbanization and development place tremendous stress on natural areas. Among those impacts are stormwater runoff, water and air pollution, invasive plants, wildlife conflicts, and encroachment by adjoining property owners. The plan contains strategies for seven elements: Natural Resource Management Planning, Vegetation, Wildlife, Water Resources, Air Quality, Human Impacts on Parklands, and Education.

The following recommendations from the report which address water quality and stormwater management may be evaluated as part of the *Little Rocky Run and Johnny Moore Creek Watershed Management Plan*.

Plan Element: <u>Natural Resource Planning</u>

Issue 1: Natural Resource Inventories and Planning

- Strategy 1.9: Promote partnerships and volunteer participations in resource management inventories, plans and management.

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- Strategy 1.12: Pursue opportunities through open space easements, proffered dedications, acquisitions and partnerships to preserve and protect additional open space – particularly land with significant natural, cultural or horticultural resources. Educate citizens about their opportunities to participate in these programs and to protect natural resources on their land.
- Strategy 1.13: Participate in County revitalization projects to identify areas appropriate for resource and open space preservation, as well as passive recreation.
- Plan Element: Wildlife

Issue 3: Resolving Conflicts with Wildlife

- Strategy 3.3: Provide information to increase citizen and staff awareness of the benefits and dangers of wildlife, the role of wildlife management and methods to peacefully coexist with wildlife.

Plan Element: Water Resources

Issue 2: Baseline Inventories for Water Resources

- Strategy 2.1: Continue to expand partnerships with DPWES, NVSWCD, ANS, DEQ, Fairfax County Public Schools and others to involve Park Authority volunteers in producing certified water quality monitoring data from park sites. Seek expanded coordination of data and information among participating organizations and volunteers.
- Strategy 2.2: Complete inventory and assessment of stormwater management facilities on parklands to determine their condition and effectiveness, as well as maintenance actions required and responsibility for ongoing maintenance.
- Strategy 2.3: For parks with water bodies, include water quality physical and biological assessments in natural resource baseline inventories as part of park master plans.
- Strategy 2.4: In cooperation with DWPES, begin an assessment of stormwater outfalls on or directly adjacent to parkland to identify locations of greatest concern for erosion and related damage. Explore options to mitigate damage at the sites of greatest concern.
- Strategy 2.5: Review the stream assessment data compiled by DPWES that are available for park stream valleys, identify problem areas on parklands, and develop a prioritized action plan for the most critical needs (including cost estimates for each project).

Issue 3: Protecting Water Resources

- Strategy 3.1: Participate in and closely monitor the Fairfax County Watershed Planning process being coordinated by DPWES.
- Strategy 3.2: As Fairfax County Watershed Plans are adopted by the Board of Supervisors, incorporate their requirements and recommendations in park master planning, design and construction in those watersheds and as may be applicable countywide.
- Strategy 3.5: Seek partnership opportunities and volunteer projects with the Potomac Conservancy, the Virginia Department of Forestry, the Northern Virginia Conservation Trust, DPWES, Department of Planning and Zoning, the

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Northern Virginia Regional Park Authority, the Fairfax County Tree Commission, and others to enhance riparian buffers and other aquatic habitats.

- Strategy 3.6: Pursue opportunities to utilize Best Management Practices (BMPs) and Low-Impact Development (LID) such as green buildings, rain gardens, and other innovative techniques to reduce water quality and other impacts of new or renovated Park Authority facilities.

1.3.3 PROPOSED PROJECTS AND IMPROVEMENTS

Proposed Drainage Plan, The Occoquan Watersheds, 1979

The *Proposed Drainage Plan, The Occoquan Watersheds* report was written by Parsons, Brinckerhoff, Quade & Douglas in April 1979. The report identified 12 projects for the Little Rocky Run watershed at an estimated cost of $905,000, and one project for the Johnny Moore Creek watershed at an estimated cost of $22,000. The various projects included 12 culvert/road improvement projects and one stream stabilization project. The purpose of these projects includes protecting houses, alleviating roadway flooding, and abating bank erosion. The status of the projects is shown in Table 1-10. The location of the projects is shown on Map 1-7.

Table 1-10 Little Rocky Run-Johnny Moore Creek Drainage Plan Project Status

Project Number	Description	Status
Willow Springs Segment – Little Rocky Run		
WS-1	Raise Road and Replace Culvert at Stringfellow Road	Inactive
WS-2	Lower Invert and Replace Culvert at Lee Highway	Inactive
WS-3	Lower Invert and Replace Culvert at Lee Highway	Completed
Centreville Segment – Little Rocky Run		
CV-1	Install Riprap Bank Protection in Vicinity of Stringfellow Road	Inactive
CV-2	Realign Channel and Install Culverts at Braddock Road	Completed
CV-3	Install Berm and Replace Culvert at Clifton Road	Completed
CV-4	Raise Road and Replace Culvert at Braddock Road	Completed
CV-5	Lower Invert and Replace Culvert at Lee Highway	Inactive
CV-6	Add Culvert to Existing Bridge at Lee Highway	Inactive
CV-7	Channelize Stream and Replace Culvert at Private Drive	Completed
CV-8	Lower Invert and Replace Culvert at Leland Road	Deleted
Little Rocky Segment – Little Rocky Run		

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Project Number	Description	Status
LR-1	Replace Culvert at Compton Road	Completed
Johnny Moore Creek Watershed		
JM-1	Lower Invert and Replace Culvert at Compton Road	Inactive

The inactive projects will be evaluated to determine if they are viable and needed, and will be included in the Watershed Management Plan as appropriate.

Fairfax County Master Plan Drainage Projects

Fairfax County currently has 34 master plan drainage projects designated for the Little Rocky Run and Johnny Moore Creek watersheds. This list includes the projects identified in the *Proposed Drainage Plan Report* and the *Regional Stormwater Management Plan*.

The 34 projects include the 13 projects from the *Proposed Drainage Plan*, 14 regional ponds from the *Regional Stormwater Management Plans*, and 7 other projects: two active dam repair projects, the completed Landfill Downshoot drainage system design, the deleted flood protection project at Battle Rock Drive, the inactive floodproofing project at 5410 Stringfellow, and two watershed studies (Little Rocky Run and Johnny Moore Creek).

Regional Stormwater Management Plan, 1989

In January 1989, the Fairfax County Board of Supervisors adopted a plan prepared by the engineering firm of Camp, Dresser and McKee. The plan, intended to be a pilot program, consists of a network of 134 detention facilities to directly control 35 square miles of drainage area. Many regional ponds described in the *Regional Stormwater Management Plan* already have been constructed. Several more facilities are in various stages of implementation. There are potential facilities that are in the final design phase either as County managed projects or by developers through rezoning. A summary of the regional pond facilities in the Little Rocky Run watershed is provided in Table 1-11 and the location of the facilities is shown on Map 1-7.

Table 1-11 Regional Pond Status

Regional Pond Identifier	Status	Taxmap Id
Clifton Manor R-11	Completed	66-1
Faircrest R-161	Completed	55-3
Pond R-02	Completed (not fully regional as constructed)	65-4
Pond R-05	Inactive	65-2
Pond R-06	Completed	55-4
Pond R-07	Completed (not fully regional as constructed)	55-3
Pond R-08	Completed	55-4
Pond R-09	Completed	55-2
Pond R-10	Inactive	55-4
Pond R-12	Inactive	55-2

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Regional Pond Identifier	Status	Taxmap Id
Pond R-13	Inactive	66-1
Pond R-16	Completed (not fully regional as constructed)	55-3
Pond R-17	Active, partially funded	55-3
Pond R-19	Completed	55-4

This *Stormwater Management Plan* has been reevaluated, and recommendations for changes have been made by the Regional Pond Subcommittee, which is an ad hoc subcommittee of the Fairfax County Environmental Coordinating Committee. One of the objectives of this *Watershed Management Plan* will be to evaluate ponds in all phases while incorporating watershed protection and restoration goals, allowing for innovative management techniques to be utilized throughout the watersheds.

The inactive regional pond sites in the Little Rocky Run watershed will be evaluated for incorporation of a variety of stormwater management techniques that will provide the water quality and stormwater detention that would have been provided by the regional ponds.

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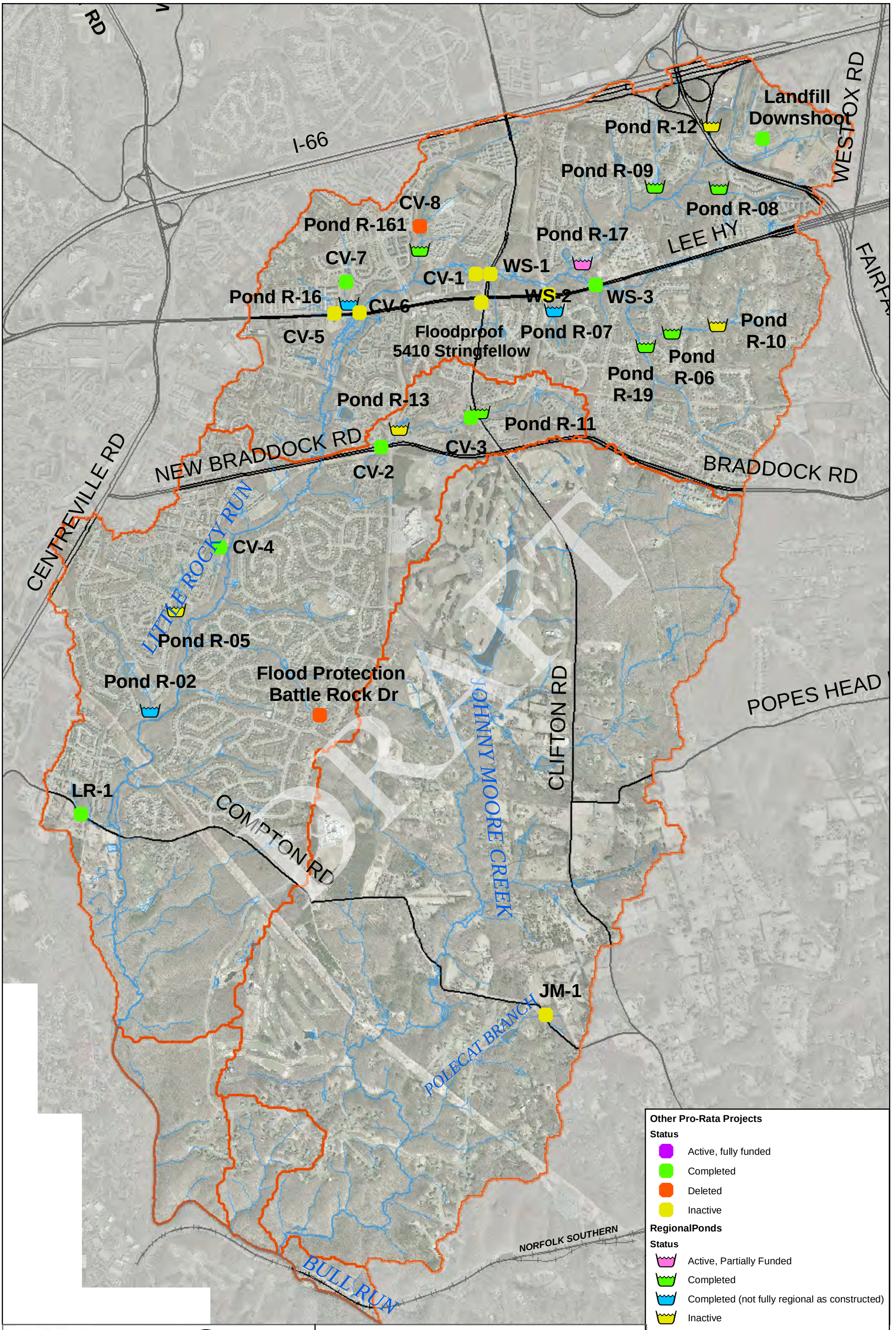

Map 1-7
Current County Projects and Status

Little Rocky Run / Johnny Moore Creek Watersheds

Chapter 2: Subwatershed Characterization

2.1 Introduction

A **watershed** is an area of land and an associated network of steams or drains that convey stormwater downstream, generally to a single outlet point. A watershed acts like a funnel, channeling all water that falls within its boundaries into a waterway. Each watershed is separated from other watersheds by a physical barrier such as a ridge, hill or mountain and as a result water quantity and quality in an area depend upon the land use and land cover that exists within that watershed.

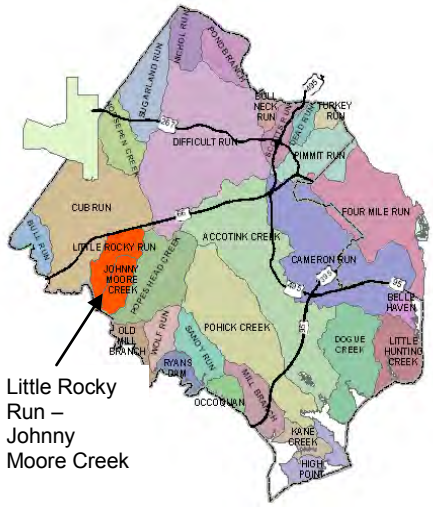

Figure 2-1: Location of Little Rocky Run and Johnny Moore Creek Watersheds in Fairfax County

Watersheds drain into other watersheds based on a geomorphological hierarchy, meaning that a larger watershed can be broken down into numerous subwatersheds based on the topography of an area. The Little Rocky Run watershed and the Johnny Moore Creek watershed are each divided into smaller **Watershed Management Areas** (WMAs) to make it easier to evaluate the characteristics of a portion of the watershed with similar land use and development characteristics. Using the WMAs, goals and objectives for the watershed can be refined to meet the needs of different problems and development types in the watershed.

Little Rocky Run watershed is divided into three WMAs: Little Rocky Run-Upper, Little Rocky Run-Lower and Little Rocky Run-Bull Run. Johnny Moore Creek watershed is similarly divided into two WMAs, Johnny Moore and Johnny Moore-Bull Run. Both the Little Rocky Run-Bull Run and Johnny Moore-Bull Run WMAs are smaller areas that drain directly to Bull Run and are located in the southern part of the respective watersheds.

WMAs are generally about 4 square miles in area and are further broken down for this study into **subwatersheds** of between 100 and 300 acres. The subwatersheds provide further detail about the WMAs, especially the water quality and quantity issues of smaller tributaries and land use patterns that are not covered at the WMA scale. By examining data at the subwatershed level, drainage patterns, problem areas and possible solutions can be assessed in manageable work units. The information gained from the subwatershed assessment will be used to help prioritize possible future investments in water quality. Map 2-1 shows the WMAs and subwatersheds used in our water quality examination.

Sections 1-2 of this Chapter provide an introduction and a description of the methodologies used to assess the stream conditions in the watersheds. Sections 3-5 provide a summary of the stream conditions in the WMAs as follows:

- Section 3 Johnny Moore Creek and Johnny Moore Creek – Bull Run WMAs
- Section 4 Little Rocky Run – Lower and Little Rocky Run – Bull Run WMAs
- Section 5 Little Rocky Run – Upper WMA

Section 6 provides a summary of the subwatershed characterization results.

2.2 Watershed Characterization Approach

The successful development of a Watershed Management Plan (WMP) requires the assessment of the interaction between pollutant sources, watershed stressors and conditions within streams and other water bodies. Each watershed must be evaluated in light of its unique conditions. Management opportunities should then be identified based on the effects of pollutants and stressors on watershed functions, both in the immediate vicinity of these stressors, as well as farther downstream. Watershed characterization was performed using consistent methods for evaluating watershed management needs while ensuring that the WMPs are developed with appropriate attention to watershed-specific conditions.

The County has developed goals and objectives to be applied to all watersheds during the WMP development process. The countywide goals and objectives will allow WMP recommendations to be linked to a Countywide Watershed Assessment. The countywide watershed planning goals are to:

1) Improve and maintain watershed functions in Fairfax County, including water quality, habitat and hydrology.
2) Protect human health, safety and property by reducing stormwater impacts.
3) Involve stakeholders in the protection, maintenance and restoration of County watersheds.

The countywide objectives are linked to the above goals. These objectives were consolidated from a list of over 50 stakeholder-defined objectives from previous WMPs. The shorter list of objectives allows for a countywide evaluation that addresses stakeholder concerns while providing an efficient and effective means of assessment. The final objectives are presented in the Table 2-1. This table also shows how each objective is linked to the three watershed planning goals. The countywide goals and objectives will be applied to all WMP assessments and recommendations. Additional watershed-specific goals and objectives that are recommended by local stakeholders may also be incorporated into the WMP development process. The objectives listed under Category 5 (Stewardship) will be considered during countywide watershed assessment but are not addressed in the ranking approach used in development of this workbook.

Table 2-1. Fairfax County Watershed Planning Final Objectives

Objective		Linked to Goal(s)
CATEGORY 1. HYDROLOGY		
1A.	Minimize impacts of stormwater runoff on stream hydrology to promote stable stream morphology, protect habitat and support biota.	1
1B.	Minimize flooding to protect property, human health and safety.	2
CATEGORY 2. HABITAT		
2A.	Provide for healthy habitat through protecting, restoring and maintaining riparian buffers, wetlands and instream habitat.	1
2B.	Improve and maintain diversity of native plants and animals in the County.	1
CATEGORY 3. STREAM WATER QUALITY		
3A.	Minimize impacts to stream water quality from pollutants in stormwater runoff.	1, 2

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Objective		Linked to Goal(s)
CATEGORY 4. DRINKING WATER QUALITY		
4A.	Minimize impacts to drinking water sources from pathogens, nutrients and toxics in stormwater runoff.	2
4B.	Minimize impacts to drinking water storage capacity from sediment in stormwater runoff.	2
CATEGORY 5 STEWARDSHIP		
5A.	Encourage the public to participate in watershed stewardship.	3
5B.	Coordinate with regional jurisdictions on watershed management and restoration efforts such as Chesapeake Bay initiatives.	3
5C.	Improve watershed aesthetics in Fairfax County.	1, 3

2.2.1 Watershed Impact Indicators

The purpose of the subwatershed ranking approach is to provide a systematic means of planning management implementation countywide that will achieve the County's watershed management goals and objectives. Since the objectives cannot be directly measured, the methods require measurable indicators that are directly linked to the objectives. One or more indicators for each objective were selected, including predictive and non-predictive, or observed, indicators. Predictive indicators, such as simulated data, can be used to compare existing and future conditions. Non-predictive indicators cannot measure future conditions but will still be useful in assessing existing watershed impacts within Fairfax County.

The watershed impact indicators used in the subwatershed ranking approach are described below:

Benthic Communities: Benthic communities consist of aquatic insects that are good indicators of watershed health. The scoring for this indicator is based on the 1999 *Fairfax County Stream Protection Strategy Baseline Study* that provided scoring based on the number and diversity of the benthic community at sampling sites.

Fish Communities: The scoring for this indicator is based on the 1999 *Fairfax County Stream Protection Strategy Baseline Study* that provided scoring based on the number and diversity of the fish community at sampling sites.

Aquatic Habitat: The scoring for this indicator is based on the *Fairfax County Stream Physical Assessment* that provided scoring based on a number of stream features that provide data about the diversity of the habitat and its ability to support a diverse aquatic community.

Channel Morphology: The scoring for this indicator is based on the *Fairfax County Stream Physical Assessment* and the *Fairfax County Stream Protection Strategy Baseline Study*. A channel evolution model (CEM)-based geomorphic assessment was performed in these studies to assess the evolutionary stage of the stream reaches. The CEM was used to identify stream successional stages from an early stable system through an unstable changing environment to a stable system.

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Instream Sediment: The scoring for this indicator is based on bank vegetative protection and bank stability assessment from the *Fairfax County Stream Physical Assessment* and the *Fairfax County Stream Protection Strategy Baseline Study*.

Residential Building Hazards: The scoring for this indicator is based on the number of residential buildings in the floodplain per square mile. This number was generated using the County's Geographic Information System (GIS) data.

Non-residential Building Hazards: The scoring for this indicator is based on the number of non-residential buildings in the floodplain per square mile. This number was generated using the County's GIS data.

Flood Complaints: The scoring for this indicator is based on the number of flood complaints per square mile. This indicator was based on data from the County's Drainage Complaints database.

Resource Protection Area (RPA) Riparian Habitat: The scoring for this indicator is based on the percentage of riparian habitat in the regulated Chesapeake Bay RPA. The riparian habitat was based on the National Wetlands Inventory, George Mason tidal wetland data and the Virginia Department of Forestry's (VDOF) 2005 Virginia Forest Cover Map.

Headwater Riparian Habitat: The scoring for this indicator is based on the percentage of forest or wetland areas within 100-feet of streams for the riparian areas upstream of the RPA boundaries.

Wetland Habitat: The scoring for this indicator is based on the percentage of wetland habitat. The wetland habitat was based on the National Wetlands Inventory and George Mason tidal wetland data.

Terrestrial Forested Habitat: The scoring for this indicator is based on the percentage of forested habitat based on the VDOF forested cover classifications.

***E. Coli*:** The scoring for this indicator is based on the average of all reported *E. coli* concentrations per 100 mL. This data was based on the number of *E. coli* per 100 milliliter (#/100mL) as reported in the EPA STORET database and fecal coliform per 100 milliliter (#/100mL). Additional bacteria data were obtained from available Fairfax County Health Department data. To maximize the amount of data employed for this metric, fecal coliform data were converted to *E. coli* concentrations using the Virginia Department of Environmental Quality (VADEQ) in-stream translator equation (VDEQ, 2003).

Upland Sediment: The scoring for this indicator is based on the modeled average annual sediment load in tons/acre/yr.

Nitrogen: The scoring for this indicator is based on the modeled average annual nitrogen load in pounds/acre/yr.

Phosphorus: The scoring for this indicator is based on the modeled average annual phosphorus load in pounds/acre/yr.

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Table 2-2 lists the selected indicators, noting the indicator type and the objective(s) each indicator is linked to.

Table 2-2. Countywide Watershed Impact Indicators

Indicator	Predictive	Linked to Objectives
Benthic Communities	No	1A, 2B, 3A
Fish Communities	No	1A, 2B, 3A
Aquatic Habitat	No	1A, 2A
Channel Morphology	Yes	1A
Instream Sediment	No	1A, 3A, 4B
Residential Building Hazards	Yes	1B
Non-residential Building Hazards	Yes	1B
Flood Complaints	No	1B
RPA Riparian Habitat	Yes	2A
Headwater Riparian Habitat	Yes	2A
Wetland Habitat	Yes	2A
Terrestrial Forested Habitat	Yes	2A
E. Coli	No	3A, 4A
Upland Sediment	Yes	3A, 4A, 4B
Nitrogen	Yes	3A, 4A
Phosphorus	Yes	3A, 4A

2.2.2 Source Indicators

The watershed impact indicators provide information on how endpoints of watershed processes are impacted by adverse watershed conditions. The source indicators will assist in the evaluation of the sources and stressors that impact these watershed endpoints as well. The recommended source indicators are described below:

- Channelized/Piped Streams – percent channelized/piped by stream length
- Directly Connected Impervious Area (DCIA) (predictive) - % DCIA
- Impervious Surface (predictive) - % Impervious
- Stormwater Outfalls – number of stormwater outfalls per mile of stream length
- Parcels Served by Septic Tanks – number of parcels served per square mile
- Streambank Buffer Deficiency - % buffer area disturbed (non-forest buffer area)

- Total Nitrogen Load (predictive) – see watershed impact indicator for nitrogen
- Total Phosphorus Load (predictive) – see watershed impact indicator for phosphorus

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- Total Suspended Sediment Load (predictive) – see watershed impact indicator for sediment
- Total Urban Land Cover (predictive) – % urban land cover (low, medium and high density residential; low and high intensity commercial; institutional; industrial; and transportation)
- Virginia Pollutant Discharge Elimination System (VPDES) Permitted Point Sources – number of point sources per square mile

These indicators were scored and combined to determine objective composite scores and overall composite scores. These scores were used to compare the subwatersheds with respect to the objectives.

2.2.3 Programmatic Indicators

A third set of indicators, termed "Programmatic Indicators," will also be used to help evaluate watershed management needs. These indicators illustrate the extent and location of existing and past management efforts. The following types of management in each watershed will be inventoried in the WMA:

- Detention Facilities
- Stream Restoration
- Riparian Buffer Restoration
- BMP Facilities
- Low Impact Development
- Inspection and Maintenance of Stormwater Management Facilities
- Inspection and Repair of Stormwater Infrastructure and Outfalls
- Dumpsite Removal
- Regional Ponds
- Volunteer Monitoring
- Subarea Treatment (used in watershed modeling studies)

Data for these indicators will be considered during identification and evaluation of watershed management needs, but were not considered in the composite scoring described above.

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2.3 Johnny Moore Creek Watershed (Johnny Moore Creek and Johnny Moore Creek – Bull Run WMAs)

2.3.1 WMA Characteristics

The Johnny Moore Creek and Johnny Moore Creek – Bull Run WMAs are combined in this summary. The Johnny Moore Creek –Bull Run WMA drains directly into Bull Run and is adjacent to and surrounded on three sides by the Johnny Moore Creek watershed. It is relatively undeveloped and much smaller than the Johnny Moore Creek WMA. The Johnny Moore Creek WMA has an area of approximately 3,213 acres (5.0 mi^2) and the Johnny Moore Creek –Bull Run WMA has an area of approximately 161 acres (0.25 mi^2). The Johnny Moore Creek watershed is located in southern Fairfax County and is bounded to the north by Braddock Road and to the south by Bull Run. Union Mill Road is its approximate western boundary and its eastern boundary extends from the intersection of Colchester Road and Braddock Road to the southern end of Balmoral Forest Road.

The Johnny Moore Creek WMA includes 19.0 miles of perennial streams and the Johnny Moore Creek – Bull Run WMA includes 0.7 miles of perennial streams. The streams flow generally in a southwest direction through predominantly open space and low density residential areas. Johnny Moore Creek flows into Bull Run upstream of the Norfolk Southern Railway Crossing of Bull Run.

In the *Occoquan Environmental Baseline Report (February 1978)* severe erosion was noted in one location downstream of Twin Lakes Drive, two locations downstream of Compton Road and the power line and one location near the confluence with Polecat Branch. The report also noted severe sedimentation on Polecat Branch upstream of the power line. In the erosion areas noted by the *Occoquan Environmental Baseline Report* in 1978 at Twin Lakes Drive, Compton Road and the power line, the banks remain moderately unstable with scattered vegetation; however these areas were not flagged for severe erosion in 2005. The *Stream Physical Assessment (August 2005)* data reflects erosion areas downstream of Polecat Branch and near the confluence with Bull Run. The severe sedimentation on Polecat Branch upstream of the power line noted in the 1978 *Occoquan Environmental Baseline Report* is consistent with the 2005 *Stream Physical Assessment* that also noted severe sedimentation on Polecat Branch upstream of Balmoral Forest Road and also on three other tributaries to Johnny Moore Creek.

2.3.2 Existing and Future Land Use

The existing land use in the Johnny Moore Creek and Johnny Moore Creek – Bull Run WMAs consists primarily of open space and estate residential. This is because both of the WMAs are located in the Residential-Conservation (R-C) District where development is limited to one dwelling unit per 5 acres. This area was rezoned by the Fairfax County Board of Supervisors in 1982 to protect the Occoquan Reservoir. The Johnny Moore Creek WMA is currently 40 percent estate residential development and 36 percent open space. The Johnny Moore Creek – Bull Run WMA is currently 63 percent open space and 26 percent low density residential development. Most of the Twin Lakes Golf Course and the Westfields Golf Course at Balmoral are located in the Johnny Moore Creek WMA. A summary of the land use in the WMAs can be found in Table 2-3.

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Comparing existing land use to future land use, 614 acres or 19% of the WMA shifts from open space to estate residential in Johnny Moore Creek. In the Johnny Moore Creek – Bull Run WMA, 4 acres or 2% of the WMA shifts from open space to estate residential. Map 2-2 shows the existing and future conditions land use in the Johnny Moore Creek watershed.

Table 2-3. Existing and Future Land Use in Johnny Moore Creek

Johnny Moore Creek WMA

Land Use Type	Existing		Future		Change	
	Acres	%	Acres	%	Acres	%
Estate Residential (ESR)	1291	40%	1905	60%	614	19%
Low Density Residential (LDR)	100	3%	100	3%	0	0%
Medium Density Residential (MDR)	0	0%	0	0%	0	0%
High Density Residential (HDR)	0	0%	0	0%	0	0%
Low Intensity Commercial (LIC)	0	0%	0	0%	0	0%
High Intensity Commercial (HIC)	0	0%	0	0%	0	0%
Industrial (IND)	4	0%	4	0%	0	0%
Institutional (INT)	2	0%	2	0%	0	0%
Golf Course (GC)	534	17%	534	17%	0	0%
Open Space (OS)	1137	36%	523	16%	-614	-19%
Water (W)	49	2%	49	2%	0	0%
Transportation (T)	79	2%	79	2%	0	0%
Total	**3200**	**100%**	**3200**	**100%**		**0%**

Johnny Moore Creek - Bull Run WMA

	Existing		Future		Change	
	Acres	%	Acres	%	Acres	%
Estate Residential (ESR)	4	3%	8	5%	4	2%
Low Density Residential (LDR)	40	26%	40	26%	0	0%
Medium Density Residential (MDR)	0	0%	0	0%	0	0%
High Density Residential (HDR)	0	0%	0	0%	0	0%
Low Intensity Commercial (LIC)	0	0%	0	0%	0	0%
High Intensity Commercial (HIC)	0	0%	0	0%	0	0%
Industrial (IND)	4	3%	4	3%	0	0%
Institutional (INT)	0	0%	0	0%	0	0%
Golf Course (GC)	0	0%	0	0%	0	0%
Open Space (OS)	99	63%	95	61%	-4	-2%
Water (W)	1	1%	1	1%	0	0%
Transportation (T)	7	5%	7	5%	0	0%
Total	**156**	**100%**	**156**	**100%**		**0%**

The total impervious area (includes all paved areas and building rooftops) for the Johnny Moore Creek WMA is 117 acres or 3.6 percent of the WMA and for the Johnny Moore Creek – Bull Run WMA the total impervious area is 8 acres or 4.9 percent of the WMA. In general, low amounts of impervious surface indicate good stream water quality.

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2.3.3 Stormwater Infrastructure

Stormwater infrastructure in the WMAs consists of stormwater management facilities, storm sewer and other manmade stormwater conveyances. Stormwater management facilities provide control of stormwater runoff in two ways; by reducing the quantity of stormwater runoff and providing treatment to reduce pollution and thereby improve the quality of stormwater runoff. Stormwater management facilities are designed to improve water quality by reducing the erosive effects of stormwater runoff and by filtering or capturing pollutants in the facility. Earlier facilities (prior to 1980 in the Occoquan basins and prior to 1994 in the rest of the County) provide only water quantity reduction, while facilities constructed later may provide both water quantity and quality treatment or provide quality treatment alone.

There are 47 stormwater management facilities in the County records for the Johnny Moore Creek WMAs: 10 of these are dry ponds and 3 are wet ponds. From field reconnaissance and desktop assessment, it was determined that: 2 are not stormwater facilities, 1 appears to be a constructed wetland, 5 are golf course wet ponds, 14 are small farm ponds that were not designed for stormwater management, 3 are larger wet ponds or farm ponds on private property that were not designed for stormwater management and 9 are unknown because they were inaccessible to field staff. Map 2-3 shows the location of these facilities, locations of drainage complaints and the parcels covered by stormwater management.

The primary land use in the WMAs is estate residential, where the lots are typically developed independently and may not have traditional stormwater management facilities. The stormwater treatment data for the WMAs is summarized in Table 2-4. Future estate residential development in the WMAs should be designed with adequate stormwater control in order to prevent water quality impacts downstream.

Table 2-4. Stormwater Treatment Types in the Johnny Moore Creek WMAs

WMA Name	Current Percent Impervious	Current Treatment Types			
		Quantity (acres)	Quality (acres)	Quantity/Quality (acres)	None (acres)
Johnny Moore	3.6	2	188	114	2909
Johnny Moore – Bull Run	4.9	0	42	5	113
Total		2	230	119	3022

There were 9 complaints related to stormwater in the County's complaints database in the WMAs. The classification of these complaints is summarized below:

- 8 Citizen Responsibility
- 1 Unclassified, but described as a cave-in by a pond

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2.3.4 Stream Condition

The County conducted a *Stream Physical Assessment* (SPA) in August 2005 that assessed the habitat, stream geomorphology and impacts to the streams from crossings, ditches, pipes, headcuts, dump sites, utilities and obstructions. Map 2-4 shows a summary of the SPA data.

11.7 miles of stream habitat in the Johnny Moore WMAs were assessed for the SPA. The results for this study are summarized below:

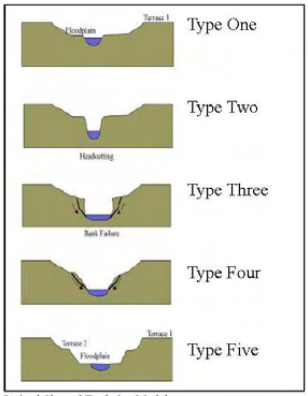
- Very Poor: 0.1 miles or 1%
- Poor: 1.8 miles or 15%
- Fair: 7 miles or 60%
- Good: 2.8 miles or 24%
- Excellent: 0 miles

Figure 2-2: Very poor stream habitat segment – Twin Lakes Golf Course

The stream habitat segment classified as very poor in the above list (shown in Figure 2-2) is located within the Twin Lakes Golf Course and is an altered channel with little to no vegetated buffer. Stream segments with sections classified as "poor" for stream habitat are located on various tributaries to Johnny Moore Creek, but none are on the Johnny Moore Creek main stem.

The geomorphological assessment of the stream channels in the WMAs were performed in 2003 and was based on the conceptual incised channel evolution model (CEM) developed by Schumm et al (1984). The CEM provides information about the evolution of a stream channel in response to disturbance. Based on visual observation of the channel cross section and other morphological observations of the channel segment, the CEM type was assigned for the channel segment. The CEM types are summarized below.

CEM Type	Description
1	Stable stream banks and developed channel
2	Deep incised channel
3	Unstable stream banks and actively widening channel
4	Stream bank stabilizing and channel developing
5	Stable stream banks and widened channel



Incised Channel Evolution Model
(Schumm, Harvey, and Watson, 1984)

The CEM Types 2 and 3 are shown on the stream condition map because these types are considered the most unstable. In the WMAs, all of the assessed reaches are CEM Type 3, except for the tributary that crosses Fox Shadow Lane, which is a CEM Type 4.

The SPA noted two areas of moderate to extreme erosion on Johnny Moore Creek. One near the confluence with Bull Run and one approximately 800 feet downstream of Balmoral Greens Avenue. Photos of the two areas are shown in Figures 2-3 and 2-4 below.

Figure 2-3: Erosion area near confluence with Bull Run

Figure 2-4: Erosion area downstream of Balmoral Greens Avenue

The other impacts found in the SPA are summarized in Table 2-5.

Table 2-5. SPA Impacts in the Johnny Moore Creek WMAs

Impact Type	Number	Comment
Utility	0	
Obstruction	9	All minor to moderate, includes 4 beaver dams
Ditch	0	
Headcut	1	2' Headcut on tributary in Twin Lakes Golf Course
Dump	1	Appliances, Trash on tributary along Union Mill Rd (minor to moderate)
Pipes	4	Minor to Moderate
Crossings	67	3 bridges, 4 box culverts, 32 circular culverts, 2 fords and 26 foot bridges 3 have moderate to severe impact (one ford, one box culvert and one circular pipe)

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The following pictures show some of the impacts found in the WMAs during the 2005 SPA.

Figure 2-5: Headcut on tributary located on Twin Lakes Golf Course

Figure 2-6: Dump Site on tributary along Union Mill Road (no longer there – see below)

Figure 2-7: Pipe Impact near confluence with Bull Run

2.3.5 Field Reconnaissance

Field reconnaissance was conducted to update/supplement existing Fairfax County geographic data so current field conditions were accurately represented. Once this data was acquired, spatial analysis was performed to characterize County watersheds as they currently exist using the County's geographic information system (GIS). The reconnaissance effort included the identification of pollution sources, current stormwater management and potential restoration opportunities across the various watersheds.

During the field reconnaissance performed in June 2008, several areas of concern from 2005 were re-visited and were found to no longer exist. Most of the debris obstructions noted in 2005 had been removed or washed out. Prior to the 2008 field reconnaissance the area received unusually heavy rainfall. The rainfall likely contributed to the washing out of many beaver dams and natural stream obstructions that had previously existed. Evidence of this was observed throughout the watershed with large piles of branches and debris pushed to the side of channels. No evidence of dump sites observed in 2005

existed in 2008. A dump site identified in 2005 on a tributary along Union Mill Road where a hot tub was abandoned is no longer present.

Additionally, many new areas of concern were identified and inspected during the field reconnaissance. Bank erosion was one of the most common and significant impact types identified. Bank erosion was found to occur throughout the watershed and ranged from minor to severe in condition.

Severe erosion was observed on tributaries as well as the main stem of Johnny Moore Creek. The tributary located near the intersection of Clifton Road and Cedar Ridge Drive is experiencing severe erosion and headcuts. The following pictures show the erosion near the intersection.

Figure 2-8: Bank erosion in excess of 3ft on small tributary near Cedar Ridge Drive

Figure 2-9: Bank erosion in excess of 3ft on small tributary near Cedar Ridge Drive

Severe bank erosion was also observed along the main channel of Johnny Moore Creek near the Balmoral Greens neighborhood in the same location as noted in the 2005 SPA. The following pictures show an update of erosion occurring in this area.

Figure 2-10: Bank erosion in excess of 3ft on Johnny Moore Creek near Balmoral Greens Subdivision

Figure 2-11: Bank erosion in excess of 3ft on Johnny Moore Creek near Balmoral Greens Subdivision

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A summary of the new impacts found in the 2008 field reconnaissance are displayed in Table 2-6.

Table 2-6. New Impacts Identified in 2008 Field Reconnaissance

Impact Type	Number of Sites	Comment
Bank Erosion	7	Minor to sever erosion throughout watershed, effecting small tributaries to main channels
Obstruction	4	Minor to moderate, three man made and one natural, causing erosion and head cuts
Headcut	1	Minor cause by natural debris blockage
Wet Ponds	25+	Primarily privately owned, several in poor health due to overgrown vegetation, over fertilization and heavy sedimentation
Pipes	2	Minor to Moderate
Encroachments	2	Standing water is encroaching on Compton Rd and Doyle Rd at tributary crossings, these areas also provides a mosquito habitat

The following pictures show examples of other significant impacts found in the watershed.

Figure 2-12: Standing water encroachment along Compton Rd.

Figure 2-13: Debris obstruction and headcut near Clifton Rd. and Cedar Ridge Dr.

Figure 2-14: Manmade obstruction near Clifton Rd. and Cedar Ridge Dr.

Figure 2-15: Pipe Impact near Clifton Rd. and Cedar Ridge Dr.

2.3.6 Modeling Results

Storm events are classified by the amount of rainfall, in inches, that occurs over the duration of a storm. The amount of rainfall depends on how frequently the storm will statistically occur and how long the storm lasts. Based on many years of rainfall data collected, storms of varying strength have been established based on the duration and probability of that event occurring within any given year. In general, smaller storms occur more frequently than larger storms of equal duration. Hence, a 2-year, 24hr storm (having a 50% chance of happening in a given year) has less rainfall than a 10-year, 24hr storm (having a 10% chance of happening in a given year). Stormwater runoff (which is related to the strength of the storm) is surplus rainfall that does not soak into the ground. This surplus rainfall flows (or 'runs off') from roof tops, parking lots and other impervious surfaces and is ultimately received by storm drainage systems, culverts and streams.

Modeling is a way to mathematically predict and spatially represent what will occur with a given rainfall event. There are two primary types of models that are used to achieve this goal; hydrologic and hydraulic:

- Hydrologic models take into account several factors; the particular rainfall event of interest, the physical nature of the land area where the rainfall occurs and how quickly the resulting stormwater runoff drains this given land area. Hydrologic models can describe both the quantity of stormwater runoff and resulting pollution, such as nutrients (nitrogen and phosphorus) and sediment that is transported by the runoff.

- Hydraulic models represent the effect the stormwater runoff from a particular rainfall event has on both man-made and natural systems. These models can both predict the ability for man-made culverts/channels to convey stormwater runoff and the spatial extent of potential flooding.

The table below shows three storm events and the rationale for being modeled:

Storm Event	Rationale for being Modeled
2-year, 24hr	Represents the amount of runoff that defines the shape of the receiving streams.
10-year, 24hr	Used to determine which road culverts will have adequate capacity to convey this storm without overtopping the road.
100-year, 24hr	Used to define the limits of flood inundation zones

The County is using a customized version of the Environmental Protection Agency's (EPA's) Spreadsheet Tool for the Estimation of Pollutant Loads (STEPL). This customized program (STEPL-FFX) was built in Microsoft (MS) Excel Visual Basic for Application (VBA). It provides a user-friendly interface to create a customized spreadsheet-based model in MS Excel. It employs simple algorithms to calculate nutrient and sediment loads from different land uses and the load reductions that would result from the implementation of various best management practices (BMPs), including Low Impact Development (LID) practices for urban areas. It computes surface runoff; nutrient loads,

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including nitrogen, phosphorus and 5-day biological oxygen demand (BOD); and sediment delivery based on various land uses and management practices. The land uses considered are user-defined land uses from Fairfax County. For each watershed, the annual nutrient loading is calculated based on the runoff volume and the pollutant concentrations in the runoff water as influenced by factors such as the land use distribution and management practices. The annual sediment load (from sheet and rill erosion only) is calculated based on the Universal Soil Loss Equation (USLE) and the sediment delivery ratio. The sediment and pollutant load reductions that result from the implementation of BMPs are computed using BMP efficiencies.

Existing Conditions water-quality data from the STEPL-FFX is shown on Maps 2-5, 2-6 and 2-7. The color gradient map symbols for pollutant loadings are the same for both the Johnny Moore and Little Rocky Run watersheds. Therefore, for Total Nitrogen (TN), Total Phosphorous (TP) and Total Suspended Solids (TSS), the Johnny Moore subwatersheds are producing relatively low loads. The water-quality analysis is driven by land use and the watershed is predominantly open space and low density/estate residential. With less impervious areas and more natural cover, the results are consistent with expectations. One item to note is that the field reconnaissance effort identified several gulley formations throughout the Johnny Moore Creek watershed, which will be included in an updated STEPL analysis for more accurate TSS loadings. While some open space will be converted to estate residential in the future, no changes associated with the County's 25-yr Comprehensive Plan will significantly impact pollutant loadings for this watershed.

Table 2-7 provides a summary of runoff peak values and pollutant loadings at the outlet of the WMA. The second table is normalized by contributing drainage area.

Table 2-7. Johnny Moore Creek Stormwater Peak Values and Pollutant Loadings

WMA	Stormwater Runoff Peak Values		Pollutant Loadings		
	2-yr storm (cfs)	10-yr storm (cfs)	TSS (tons/yr)	TN (lbs/yr)	TP (lbs/yr)
Johnny Moore Creek	542	1591	249.6	7102.5	1255.7
NORMALIZED BY DRAINAGE AREA					
WMA	**Stormwater Runoff Peak Values**		**Pollutant Loadings**		
	2-yr storm (cfs/acre)	**10-yr storm (cfs/acre)**	**TSS (tons/acre/yr)**	**TN (lbs/acre/yr)**	**TP (lbs/acre/yr)**
Johnny Moore Creek	0.169	0.495	0.078	2.211	0.391

The preliminary hydraulic model for Johnny Moore was developed using United States Army Corps of Engineers (USACE) Hydrologic Engineering Centers River Analysis System (HEC-RAS) to compute water surface profiles. The preliminary model results were used to analyze the water surface elevation and flooding of inline structures.

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The input data for the HEC-RAS model was extracted using HEC-GeoRAS. HEC-GeoRAS is a tool that processes the geospatial data within the County's GIS, specifically as it pertains to physical features such as stream geometry and flowpath so that these features can be represented in the model. HEC-RAS models were developed for study streams within Johnny Moore watershed using a naming convention unique for each reach. The study streams were defined as having a drainage area of at least 200 acres.

Bridge and Culvert crossings were coded according to available County or Virginia Department of Transportation (VDOT) engineering documents that depict the facility as it was actually built. Where not available, limited field reconnaissance was performed to obtain the crossing data. The crossing elevation data was determined relative to a point where the elevation could be estimated accurately from the County's topographic data.

Manning's 'n' values, which represent surface roughness, were assigned to the channel and overbank portions of the studied streams based on field visits and aerial photographs.

The flow change locations were extracted from the EPA Storm Water Management Model (SWMM) developed to estimate preliminary stormwater runoff flow values. The 2-yr, 10-yr and 100-yr storm flows were determined at several locations in order to provide a detailed flow profile for the hydraulic model. Map 2-8 provides a graphical representation of the SWMM results for the 10-year storm discharge.

The 2-year storm discharge is regarded as the channel-forming or dominant discharge for the purposes of this study. This discharge is the flow value that transports the majority of a stream's sediment load and therefore actively forms and maintains the channel. A comparison of stream dynamics and channel geometry for the 2-year discharge provides insight regarding the relative stability of the system and helps to identify areas in need of restoration.

The 10-year storm discharge is being included to analyze the level of service of stream crossings. Occurring less frequently than the 2-year storm, the flood stage associated with this storm can result in more significant safety hazards to residents. All stream crossings (bridges and culverts) will be analyzed against this storm to see if they are performing at a level that safely passes this storm.

The 100-year storm discharge is used by the Federal Emergency Management Agency (FEMA) to map floodplain inundation zones and establish flood insurance rates. This provides a means to assess which properties are at risk to flooding and determine the appropriate insurance requirements for these at risk properties. The models developed to analyze the system for watershed planning have been built in compliance with FEMA standards in order to update the Flood Insurance Rate Maps for Fairfax County where appropriate.

In summary, the preliminary results for HEC-RAS are as follows:

- 3 stream road crossings in the watershed do not have the capacity to pass the 10-year storm without the road being over topped.
- The 2-year storm exceeds the channel banks in several locations.
- No residential structures are within the modeled 100-year flood inundation zone.

The limit of the 100-year flood is graphically represented in Map 2-9.

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2.3.7 Subwatershed Ranking

It should be noted that all designations of the preliminary ranking results are relative to the area studied for this report. In other words, a 'low quality' designation does not necessarily indicate a poor quality subwatershed, only relative to the 51 other subwatersheds in the Little Rocky Run/Johnny Moore Creek watersheds.

The Johnny Moore Creek WMA contains mostly high quality subwatersheds as summarized on maps 2-33 (Objective Composite Score) and 2-34 (Source Composite Score). Maps 2-26 to 2-32 describe more specific objective criteria, which have been weighted to determine the objective composite score. Please refer to section 2.2 for a more detailed description of impact, source and programmatic indicators and how they are being used to characterize the subwatersheds.

The main stressors in this WMA come from two golf courses, which tend to result in higher pollutant loadings while also having a negative impact on natural stream buffers. Also, noted in the SPA and in the field reconnaissance, there are many gulley formations and unstable banks throughout this watershed, which will increase sediment load, impacting aquatic life throughout the watershed. Otherwise, this watershed is of higher quality than its Little Rocky Run counterparts because of significant land use differences. The predominant Low Density Residential/Open Space watershed results in more natural measures protecting watershed health.

More specifically, the color gradient for Map 2-26 reflects that Lower Little Rocky is rated higher for 'Stormwater Runoff' than Johnny Moore, which is atypical. Stormwater Runoff is determined from equal weights of 5 indicators, including Benthic Communities, Fish Communities, Aquatic Habitat, ICEM Class and Instream Sediment Loading. One item contributing to this WMA scale anomaly is the Fish Communities Indicator. Though community values were similar (ranging from 25 to 31 across 5 sites), the threshold value of 28 used in the ranking gave the Johnny Moore sites a lower score than Little Rocky Run Lower. Also, as noted previously, the SPS/SPA study revealed several reaches in Johnny Moore are experiencing streambank sloughing and are in an active erosive state. Lower scores for ICEM and Instream Sediment are recorded as a result. The remaining two attributes (Benthic Communities and Aquatic Habitat) were comparable.

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2.4 Little Rocky Run - Lower and Little Rocky Run – Bull Run WMAs

2.4.1 WMA Characteristics

The Little Rocky Run - Lower and Little Rocky Run – Bull Run WMAs are combined in this summary. The Little Rocky Run – Bull Run WMA drains directly into Bull Run and is adjacent to the Little Rocky Run - Lower watershed. It is relatively undeveloped and much smaller than the Little Rocky Run - Lower WMA. The Little Rocky Run - Lower WMA has an area of approximately 2,141 acres (3.3 mi^2) and the Little Rocky Run – Bull Run WMA has an area of approximately 188 acres (0.3 mi^2). Its approximate northern boundary is New Braddock Road and it is bounded to the south by Bull Run. Union Mill Road and Balmoral Greens Avenue are its approximate eastern boundary and its western boundary extends approximately from the intersection of New Braddock Road and Route 28 (Centreville Road) to its confluence with Bull Run.

The Little Rocky Run - Lower WMA includes 12.5 miles of perennial streams and the Little Rocky Run – Bull Run WMA includes 0.5 miles of perennial streams. The streams flow generally in a southwest direction through predominantly medium density and high density residential areas in the upper portion of the WMA and open space and low density residential areas in the lower portion. Little Rocky Run flows into Bull Run between Compton Road and the Norfolk Southern Railway Crossing of Bull Run.

In the *Occoquan Environmental Baseline Report (February 1978),* severe erosion was noted in two areas upstream of Compton Road and one area downstream of Compton Road. The *Stream Physical Assessment (August 2005)* data reflects an area of erosion in the same site downstream of Compton Road and another location on a small tributary near the confluence with Bull Run. In the erosion areas noted in 1978 upstream of Compton Road, the banks remain moderately unstable with scattered vegetation; however these areas were not flagged for erosion in 2005. There was also severe sedimentation noted in 1978 on Little Rocky Run upstream of the power line; however, the 2005 assessment did not find excessive sedimentation in this location.

2.4.2 Existing and Future Land Use

The existing land use in the Little Rocky Run - Lower consists primarily of open space and medium density residential. The Little Rocky Run - Lower WMA is currently 37 percent open space and 26 percent medium density residential development. Approximately 530 acres (25 percent) of the Little Rocky Run – Lower WMA is located in the Residential-Conservation (R-C) District where development is limited to one dwelling unit per 5 acres. This area was rezoned by the Fairfax County Board of Supervisors in 1982 to protect the Occoquan Reservoir. In the Little Rocky Run – Lower WMA, the areas east of Union Mill Road and south of Braddock Road and the area south of Compton Road are in the R-C District.

Little Rocky Run – Bull Run WMA consists primarily of open space. The Little Rocky Run – Bull Run WMA is currently 76 percent open space and 12 percent low density residential development. All of the Little Rocky Run – Bull Run WMA is located in the Residential-Conservation (R-C) District where development is limited to one dwelling unit per 5 acres. This area was rezoned by the Fairfax County Board of Supervisors in 1982 to protect the Occoquan Reservoir. The Twin Lakes Golf Course and the Westfields Golf Course at Balmoral are located partially in the Little Rocky Run - Lower and partially in the Little

Rocky Run – Bull Run WMAs. A summary of the land use in the WMAs can be found in Table 2-8.

Comparing existing land use to future land use in Little Rocky Run - Lower, 93 acres or 4% is expected to shift from open space to estate residential, with other shifts shown at right. Shifts from open space to residential development account for the majority of the shifts; however, the future development in the WMA is predicted to remain fairly stable. In the Little Rocky Run – Bull Run WMA, 2 acres or 1% of the WMA is expected to shift from open space to estate residential. Map 2-10 shows the existing and future conditions land use in the Little Rocky Run – Lower and Little Rocky Run – Bull Run WMAs.

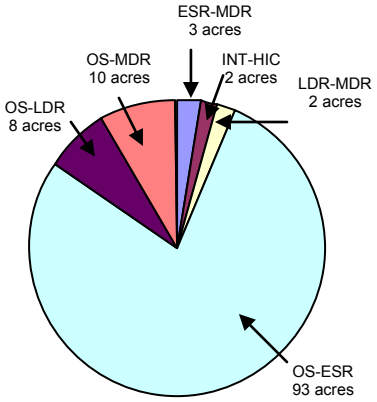

Table 2-8. Existing and Future Land Use in Little Rocky Run – Lower and Little Rocky Run – Bull Run

Little Rocky Run - Lower WMA

Land Use Type	Existing		Future		Change	
	Acres	%	Acres	%	Acres	%
Estate Residential (ESR)	67	3%	157	7%	90	4%
Low Density Residential (LDR)	114	5%	120	6%	6	0%
Medium Density Residential (MDR)	552	26%	567	26%	15	1%
High Density Residential (HDR)	226	11%	226	11%	0	0%
Low Intensity Commercial (LIC)	0	0%	0	0%	0	0%
High Intensity Commercial (HIC)	0	0%	3	0%	3	0%
Industrial (IND)	9	0%	9	0%	0	0%
Institutional (INT)	71	3%	69	3%	-2	0%
Golf Course (GC)	34	2%	34	2%	0	0%
Open Space (OS)	797	37%	687	32%	-111	-5%
Water (W)	17	1%	17	1%	0	0%
Transportation (T)	254	12%	254	12%	0	0%
Totals	**2141**	**100%**	**2141**	**100%**		**0%**

Little Rocky Run - Bull Run WMA

Land Use Type	Existing		Future		Change	
	Acres	%	Acres	%	Acres	%
Estate Residential (ESR)	11	6%	13	7%	2	1%
Low Density Residential (LDR)	22	12%	22	12%	0	0%
Medium Density Residential (MDR)		0%		0%	0	0%
High Density Residential (HDR)		0%		0%	0	0%
Low Intensity Commercial (LIC)		0%		0%	0	0%
High Intensity Commercial (HIC)		0%		0%	0	0%
Industrial (IND)		0%		0%	0	0%
Institutional (INT)		0%		0%	0	0%
Golf Course (GC)	7	4%	7	4%	0	0%
Open Space (OS)	144	76%	142	76%	-2	-1%
Water (W)	0	0%	0	0%	0	0%
Transportation (T)	4	2%	4	2%	0	0%
Totals	**188**	**100%**	**188**	**100%**		**0%**

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The total impervious area (includes all paved areas and building rooftops) for the Little Rocky Run - Lower WMA is 493 acres or 23 percent of the WMA. The high levels of impervious surface in certain areas of the Little Rocky Run – Lower WMA is significant and negatively affects water quality by contributing large quantities of stormwater runoff to area streams.

The total impervious area (includes all paved areas and building rooftops) for the Little Rocky Run – Bull Run WMA is 3.6 acres or 1.9 percent of the WMA. The total amount of impervious surface in Little Rocky Run – Bull Run is relatively low and is not expected to significantly affect water quality or quantity.

2.4.3 Stormwater Infrastructure

Stormwater infrastructure in the WMAs consists of stormwater management facilities, storm sewer and other manmade stormwater conveyances. Stormwater management facilities provide control of stormwater runoff in two ways; by reducing the quantity of stormwater runoff and providing treatment to reduce pollution and thereby improve the quality of stormwater runoff. Stormwater management facilities are designed to improve water quality by reducing the erosive effects of stormwater runoff and by filtering or capturing pollutants in the facility. Earlier facilities (prior to 1980 in the Occoquan basins and prior to 1994 in the rest of the County) provide only water quantity reduction, while facilities constructed later may provide both water quantity and quality treatment or provide quality treatment alone.

There are 44 stormwater management facilities in the County records for the Little Rocky Run – Lower and Little Rocky Run – Bull Run WMAs: 38 of these are dry ponds and 3 are wet ponds. From field reconnaissance and desktop assessment it was determined that: 2 are golf course wet ponds and 1 is a larger wet pond or farm pond on private property that was not designed for stormwater management. Map 2-11 shows the location of these facilities, locations of drainage complaints and the parcels covered by stormwater management.

Table 2-9 shows the treatment type breakdown for the stormwater management facilities.

Table 2-9. Stormwater Treatment Types in the Little Rocky Run – Lower WMAs

WMA Name	Current Percent Impervious	Current Treatment Types			
		Quantity (acres)	Quality (acres)	Quantity/Quality (acres)	None (acres)
Little Rocky Run - Lower	23	6	253	679	1204
Little Rocky Run – Bull Run	1.9	0	4	19	165
Total		6	257	698	1369

There were 171 complaints related to stormwater in the County's complaints database in the WMAs. The classification of these complaints is summarized below:

- 62 Citizen Responsibility
- 54 Storm Drainage
- 49 Stormwater Management/BMP
- 3 Unclassified
- 2 Planning & Design Division
- 1 Walkway

2.4.4 Stream Condition

The County conducted a *Stream Physical Assessment* (SPA) in August 2005 that assessed the habitat, stream geomorphology and impacts to the streams from crossings, ditches, pipes, headcuts, dump sites, utilities and obstructions. Map 2-12 summarizes the SPA data.

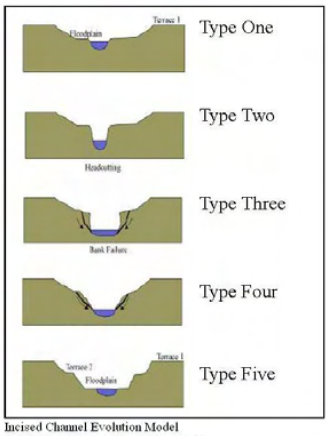
6.7 miles were assessed for stream habitat condition in these WMAs. The study results are summarized below:

- Very Poor: 0 miles
- Poor: 1.2 miles or 18%
- Fair: 3.0 miles or 45%
- Good: 1.8 miles or 27%
- Excellent: 0.7 miles or 10%

The longest segment of stream that was assessed as poor is on a tributary to Little Rocky Run that flows near the intersection of Union Mill Road and Braddock Road. This segment runs through an area developed with medium and high density residential zoning and in many areas the buffer is poorly vegetated. Another poor segment is located upstream of South Springs Drive. No poor segments were located on the main stem of Little Rocky Run.

The geomorphological assessment of the stream channels in the WMA was performed in 2003 and was based on the conceptual incised channel evolution model (CEM) developed by Schumm et al (1984). The CEM provides information about the evolution of a stream channel in response to disturbance. Based on visual observation of the channel cross section and other morphological observations of the channel segment, the CEM type was assigned for the channel segment. The CEM types are summarized below.

CEM Type	Description
1	Stable stream banks and developed channel
2	Deep incised channel
3	Unstable stream banks and actively widening channel
4	Stream bank stabilizing and channel developing
5	Stable stream banks and widened channel



Incised Channel Evolution Model
(Schumm, Harvey, and Watson, 1984)

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The CEM Types 2 and 3 are shown on the stream condition map because these types are considered the most unstable. In the WMAs, 4.6 miles (69%) is Type 2, 1.9 miles (28%) is Type 4 and 0.2 (3%) miles is Type 3.

There were two noted areas of moderate erosion, one on Little Rocky Run approximately 1,800 feet upstream of the confluence with Bull Run and one on a tributary in the Little Rocky Run – Bull Run WMA. A photo of the Little Rocky Run – Bull Run erosion area is shown below.

Figure 2-16: Erosion area on tributary in Little Rocky Run - Bull Run

The other impacts found by the SPA are summarized in Table 2-10.

Table 2-10. SPA Impacts in the Little Rocky Run – Lower WMAs

Impact Type	Number	Comment
Utility	1	Minor impact – sanitary line crossing above base flow
Obstruction	7	3 moderate to severe, 4 minor to moderate (3 beaver dams)
Ditch	0	
Headcut	1	Moderate to Severe 1.5' headcut on tributary upstream of South Springs Drive
Dump	1	Moderate to Severe – trash, lawn waste on tributary upstream of Union Mill Rd
Pipes	34	All Minor to Moderate impact
Crossings	31	1 bridge, 4 box culverts, 20 circular culverts, 3 elliptical and 3 foot bridges 1 has moderate to severe impact (one circular pipe upstream of Union Mill Road – see photo)

The following pictures show some of the more significant impacts found in the watershed during the SPA.

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Figure 2-17: Headcut on tributary located upstream of South Springs Drive

Figure 2-18: Dump Site on tributary along Union Mill Road

Figure 2-19: Pipe Impact upstream of Union Mill Road

2.4.5 Field Reconnaissance

Field reconnaissance was conducted to update/supplement existing Fairfax County geographic data so current field conditions were accurately represented. Once this data was acquired, spatial analysis was performed to characterize County watersheds as they currently exist using the County's geographic information system (GIS). The reconnaissance effort included the identification of pollution sources, current stormwater management and potential restoration opportunities across the various watersheds.

During this field reconnaissance performed in June 2008, several areas of concern from the 2005 SPA were re-visited. The stream segments previously identified as poor still have existing issues.

The tributary segment observed as poor in 2005 near South Springs Dr. is currently experiencing severe erosion problems. The following photos show the severe erosion and headcuts occurring at several different locations in this area. This erosion is affecting several smaller tributaries, however the main channel of the tributary appears fairly stable.

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Figure 2-20: Severe erosion occurring at the end of a concrete trickle ditch in the Little Rocky Run subdivision (Battle Rock Drive)

Figure 2-21: Severe erosion occurring in small tributary channel in the Little Rocky Run subdivision (Stonehaven Court)

Figure 2-22: Headcut occurring in small tributary behind homes in the Little Rocky Run subdivision (Bluestone Court)

The poor tributary segment observed in 2005 near the intersection of Union Mill Road and Braddock Road has poorly vegetated and swampy buffers as well as several obstructions. These problems exist in areas downstream of the intersection and past the tributary's confluence with Little Rocky Run. The following photos show two debris blockages located in this area.

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Figure 2-23: Major debris obstruction at the confluence of a tributary and Little Rocky Run behind the Little Rocky Run subdivision

Figure 2-24: Debris obstruction in main stem of Little Rocky Run

A summary of new impacts found in the 2008 field reconnaissance are summarized in Table 2-11.

Table 2-11. New Impacts Identified in Little Rocky Run – Lower during 2008 Field Reconnaissance

Impact Type	Number of Sites	Comment
Erosion	6	Minor to sever erosion throughout watershed, effecting tributaries
Obstruction	5	Minor to moderate, multiple debris obstructions
Headcut	3	Minor to moderate, affecting tributaries

The following pictures show examples of other significant impacts found in the watershed.

Figure 2-25: Wet Pond with significant amount of litter near Compton Valley Way

Figure 2-26: Pond riser structure is covered with debris near Compton Heights Circle

2.4.6 Modeling Results

Storm events are classified by the amount of rainfall, in inches, that occurs over the duration of a storm. The amount of rainfall depends on how frequently the storm will statistically occur and how long the storm lasts. Based on many years of rainfall data collected, storms of varying strength have been established based on the duration and probability of that event occurring within any given year. In general, smaller storms occur more frequently than larger storms of equal duration. Hence, a 2-year, 24hr storm (having a 50% chance of happening in a given year) has less rainfall than a 10-year, 24hr storm (having a 10% chance of happening in a given year). Stormwater runoff (which is related to the strength of the storm) is surplus rainfall that does not soak into the ground. This surplus rainfall flows (or 'runs off') from roof tops, parking lots and other impervious surfaces and is ultimately received by storm drainage systems, culverts and streams.

Modeling is a way to mathematically predict and spatially represent what will occur with a given rainfall event. There are two primary types of models that are used to achieve this goal; hydrologic and hydraulic:

- Hydrologic models take into account several factors; the particular rainfall event of interest, the physical nature of the land area where the rainfall occurs and how quickly the resulting stormwater runoff drains this given land area. Hydrologic models can describe both the quantity of stormwater runoff and resulting pollution, such as nutrients (nitrogen and phosphorus) and sediment that is transported by the runoff.

- Hydraulic models represent the effect the stormwater runoff from a particular rainfall event has on both man-made and natural systems. These models can both predict the ability for man-made culverts/channels to convey stormwater runoff and the spatial extent of potential flooding.

The table below shows three storm events and the rationale for being modeled:

Storm Event	Rationale for being Modeled
2-year, 24hr	Represents the amount of runoff that defines the shape of the receiving streams.
10-year, 24hr	Used to determine which road culverts will have adequate capacity to convey this storm without overtopping the road.
100-year, 24hr	Used to define the limits of flood inundation zones

The County is using a customized version of the Environmental Protection Agency's (EPA's) Spreadsheet Tool for the Estimation of Pollutant Loads (STEPL). This customized program (STEPL-FFX) was built in Microsoft (MS) Excel Visual Basic for Application (VBA). It provides a user-friendly interface to create a customized spreadsheet-based model in MS Excel. It employs simple algorithms to calculate nutrient and sediment loads from different land uses and the load reductions that would result from the implementation of various best management practices (BMPs), including Low Impact Development (LID) practices for urban areas. It computes surface runoff; nutrient loads, including nitrogen, phosphorus and 5-day biological oxygen demand (BOD); and sediment delivery based on

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various land uses and management practices. The land uses considered are user-defined land uses from Fairfax County. For each watershed, the annual nutrient loading is calculated based on the runoff volume and the pollutant concentrations in the runoff water as influenced by factors such as the land use distribution and management practices. The annual sediment load (from sheet and rill erosion only) is calculated based on the Universal Soil Loss Equation (USLE) and the sediment delivery ratio. The sediment and pollutant load reductions that result from the implementation of BMPs are computed using the known BMP efficiencies.

Existing conditions water-quality data from the STEPL-FFX are shown on Maps 2-13, 2-14 and 2-15. The color gradient map symbols for pollutant loadings are the same for both the Johnny Moore and Little Rocky Run watersheds. Therefore, for Total Nitrogen (TN), Total Phosphorous (TP) and Total Suspended Solids (TSS), the subwatersheds located in Little Rocky Run – Lower are producing relatively high pollutant loadings in the northern portion of the WMA and relatively low pollutant loadings in the southern portion. The water-quality analysis is driven by land use and while the northern portion of the WMA is predominantly medium to high density residential and commercial, the southern portion contains a large portion of Fairfax County Park Authority land, which explains the discrepancy. Areas with more impervious areas and small or non-existent buffer areas will generate more pollutants than undisturbed areas, which is consistent with expectations.

Table 2-12 provides a summary of runoff peak values and pollutant loadings at the outlet of the WMA. The second table is normalized by contributing drainage area.

Table 2-12. Little Rocky Run – Lower Stormwater Peak Values and Pollutant Loadings

WMA	Stormwater Runoff Peak Values		Pollutant Loadings		
	2-yr storm (cfs)	10-yr storm (cfs)	TSS (tons/yr)	TN (lbs/yr)	TP (lbs/yr)
Little Rocky Run - Lower	998	2538	650.4	27796.6	4093.8
NORMALIZED BY DRAINAGE AREA					
WMA	**Stormwater Runoff Peak Values**		**Pollutant Loadings**		
	2-yr storm (cfs/acre)	**10-yr storm (cfs/acre)**	**TSS (tons/acre /yr)**	**TN (lbs/acre/ yr)**	**TP (lbs/acre/yr)**
Little Rocky Run - Lower	0.429	1.090	0.128	5.412	0.792

The preliminary hydraulic model for Little Rocky Run was developed using United States Army Corps of Engineers (USACE) Hydrologic Engineering Centers River Analysis System (HEC-RAS) to compute water surface profiles. The preliminary model results were used to analyze the water surface elevation and flooding of inline structures.

The input data for the HEC-RAS model was extracted using HEC-GeoRAS. HEC-GeoRAS is a tool that processes the geospatial data within the County's GIS, specifically as it pertains to physical features such as stream geometry and flowpath so that these features can be represented in the model. HEC-RAS models were developed for study

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streams within Little Rocky Run - Lower using a naming convention unique for each reach. The study streams were defined as having a drainage area of at least 200 acres.

Bridge and Culvert crossings were coded according to available County or Virginia Department of Transportation (VDOT) engineering documents that depict the facility as it was actually built. Where not available, limited field reconnaissance was conducted to obtain structure dimensions, inverts and material. The crossing elevation data was determined relative to a point where the elevation could be estimated accurately from the County's topographic data.

Manning's 'n' values, which represent surface roughness, were assigned to the channel and overbank portions of the studied streams based on field visits and aerial photographs.

The flow change locations were extracted from the EPA Storm Water Management Model (SWMM) developed to estimate preliminary stormwater runoff flow values. The 2-yr, 10-yr and 100-yr storm flows were determined at several locations in order to provide a detailed flow profile for the hydraulic model. Map 2-16 provides a graphical representation of the SWMM results for the 10-year discharge.

The 2-year storm discharge is regarded as the channel-forming or dominant discharge for the purposes of this study. This discharge is the flow value that transports the majority of a stream's sediment load and therefore actively forms and maintains the channel. A comparison of stream dynamics and channel geometry for the 2-year storm discharge provides insight regarding the relative stability of the system and helps to identify areas in need of restoration.

The 10-year storm discharge is being included to analyze the level of service of stream crossings. Occurring less frequently than the 2-year storm, the flood stage associated with this storm can result in more significant safety hazards to residents. All stream crossings (bridges and culverts) will be analyzed against this storm to see if they are performing at a level that safely passes this storm.

The 100-year storm discharge is used by the Federal Emergency Management Agency (FEMA) to map floodplain inundation zones and establish flood insurance rates. This provides a means to assess which properties are at risk for flooding and determine the appropriate insurance requirements for these properties. The models developed to analyze the system for watershed planning have been built in compliance with FEMA standards in order to update the Flood Insurance Rate Maps for Fairfax County where appropriate.

In summary, the preliminary results for HEC-RAS are as follows:

- 1 of 3 structures identified for analysis in the Little Rocky Run – Lower watershed does not have the capacity to pass the 10-year discharge.
- The 2-year discharge exceeds the channel banks in several locations.
- There is very little if any evidence of flooding impacts to residential/commercial structures within the 100 year flood inundation zone.

The limit of the 100-year flood is graphically represented in Map 2-17.

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2.4.7 Subwatershed Ranking

It should be noted that all designations of the preliminary ranking results are relative to the area studied for this report. In other words, a 'low quality' designation does not necessarily indicate a poor quality subwatershed, only relative to the 51 other subwatersheds in the Little Rocky Run/Johnny Moore Creek watersheds.

Maps 2-26 to 2-32 describe more specific objective criteria, which have been weighted to determine the objective composite score. Please refer to section 2.2 for a more detailed description of impact, source and programmatic indicators and how they are being used to characterize the subwatersheds.

Little Rocky Run - Lower is the one WMA where subwatershed ranking results are not homogenous, which is reflected on maps 2-33 (Objective Composite Score) and 2-34 (Source Composite Score). The northern portion of this WMA has similar characteristics to Little Rocky Run - Upper. A sizeable area located in the southern portion of the WMA is located in Fairfax County Park Authority land is therefore undisturbed or very nearly so. Those subwatersheds are generally of high quality.

The northern portion of Little Rocky Run - Lower is predominantly comprised of medium/high density residential. The stream corridor remains forested, but buffers have been impacted by the development. Unlike Little Rocky Run - Upper, most of the development occurred nearly two decades ago, allowing for the system to stabilize. Although it contains subwatersheds with low quality composite scores, many of them can be described as fair quality for this relative comparison. This portion of Little Rocky Run - Lower is relatively built out and was fairly stable between 2005 (SPA) and the 2008 field reconnaissance. This stability, along with the fact that there is no VPDES point source or commercial/industrial landuse, explain why the subwatersheds in this WMA are on the average rated slightly higher than those in the Little Rocky Run - Upper WMA.

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2.5 Little Rocky Run Upper WMA

2.5.1 WMA Characteristics

The Little Rocky Run - Upper WMA has an area of approximately 2,212 acres (3.5 mi^2). The Little Rocky Run - Upper WMA is located in southern Fairfax County and it is bounded to the north by Interstate 66 and its approximate southern boundary is Braddock Road where it adjoins the Little Rocky Run – Lower WMA. Gunpowder Road is its approximate eastern boundary and its approximate western boundary lies west of Pickwick Road and Little Rocky Run Circle.

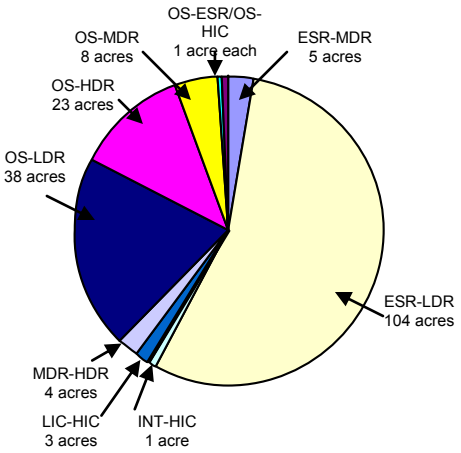
The Little Rocky Run - Upper WMA includes 12.5 miles of perennial streams. Beginning west of the Fairfax County Parkway and south of Interstate Route 66, Little Rocky Run flows generally in a western direction to Lee Highway (Route 29) and then turns and flows south to Bull Run. The land use in the WMA is predominantly medium density and high density residential areas and open space.

In the *Occoquan Environmental Baseline Report (February 1978)* severe erosion was noted in four areas upstream of Lee Highway on Little Rocky Run and along Willow Spring Branch and severe erosion was noted in one area slightly upstream of Lee Highway. An unnamed tributary to Little Rocky Run located south of Interstate 66 and west of Stringfellow Road was also experiencing one area of severe erosion. The *Stream Physical Assessment (August 2005)* data reflects severe erosion on Little Rocky Run upstream of the confluence with Willow Spring Branch that is consistent with one of the erosion sites found in 1978. The other 1978 sites were not flagged for erosion in 2005, although the streams in the WMA were assessed as having moderately unstable to moderately stable banks.

The *Occoquan Environmental Baseline Report* also noted severe sedimentation on Little Rocky Run upstream of the confluence with Willow Springs Branch and on Willow Springs Branch upstream of Lee Highway. This is consistent with the 2005 SPA, although sedimentation effects are more widespread in the later assessment.

2.5.2 Existing and Future Land Use

The existing land use in the Little Rocky Run - Upper consists primarily of medium density residential and open space. Approximately 10 acres (0.5 percent) of the Little Rocky Run – Upper WMA is located in the Residential-Conservation (R-C) District where development is limited to one dwelling unit per 5 acres. This area was rezoned by the Fairfax County Board of Supervisors in 1982 to protect the Occoquan Reservoir. The small areas located south of Braddock Road are in the R-C District. The Little Rocky Run - Upper WMA is currently 23 percent medium density residential development and 22 percent open space. Arrowhead Park is located in the WMA west of Stringfellow Road along Centreville Farms Road. A summary of the land use in the WMAs can be found in Table 2-13.



Comparing existing land use to future land use in Little Rocky Run - Upper, 104 acres or 5% of the WMA

experiences a future shift from estate residential to low density residential, 38 acres shift from open space to low density residential and 23 acres shift from open space to high density residential. Other smaller shifts occur as shown in the pie chart above. This table shows that the amount and density of residential development is predicted to increase in the WMA. Map 2-18 shows the existing and future conditions land use in the Little Rocky Run – Upper watershed.

Table 2-13. Existing and Future Land Use in Little Rocky Run – Upper

Little Rocky Run - Upper WMA

Land Use Type	Existing		Future		Change	
	Acres	%	Acres	%	Acres	%
Estate Residential (ESR)	128	6%	21	1%	-107	-5%
Low Density Residential (LDR)	236	11%	378	17%	141	6%
Medium Density Residential (MDR)	501	23%	511	23%	9	0%
High Density Residential (HDR)	315	14%	342	15%	27	1%
Low Intensity Commercial (LIC)	13	1%	10	0%	-3	0%
High Intensity Commercial (HIC)	28	1%	33	1%	5	0%
Industrial (IND)	42	2%	42	2%	0	0%
Institutional (INT)	69	3%	68	3%	-1	0%
Golf Course (GC)	0	0%	0	0%	0	0%
Open Space (OS)	490	22%	418	19%	-72	-3%
Water (W)	27	1%	27	1%	0	0%
Transportation (T)	370	17%	370	17%	0	0%
	2220	**100%**	**2220**	**100%**		**0%**

The total impervious area (includes all paved areas and building rooftops) for the Little Rocky Run- Upper WMA is 518 acres or 23 percent of the WMA. The large amount of impervious surface in the Little Rocky Run – Upper WMA may negatively affect water quality by contributing large quantities of stormwater runoff and pollution to area streams.

2.5.3 Stormwater Infrastructure

Stormwater infrastructure in the WMA consists of stormwater management facilities, storm sewer and other manmade stormwater conveyances. Stormwater management facilities provide control of stormwater runoff in two ways; by reducing the quantity of stormwater runoff and providing treatment to reduce pollution and thereby improve the quality of stormwater runoff. Stormwater management facilities are designed to improve water quality by reducing the erosive effects of stormwater runoff and by filtering or capturing pollutants in the facility. Earlier facilities (prior to 1980 in the Occoquan basins and prior to 1994 in the rest of the County) provide only water quantity reduction, while facilities constructed later may provide both water quantity and quality treatment or provide quality treatment alone.

There are 48 stormwater management facilities identified in the County records for the Little Rocky Run – Upper WMA: 24 of these are dry ponds, 11 are wet ponds and 7 are other BMP types (manufactured, underground, etc.). From field reconnaissance and desktop assessment, it was determined that: 3 are not facilities. The three remaining facilities are unknown because they were inaccessible during the field reconnaissance.

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Map 2-19 shows the location of these facilities, locations of drainage complaints and the parcels covered by stormwater management.

Table 2-14 shows the treatment type breakdown for the stormwater management facilities per the County's GIS data. This table does not include treatment by Regional Ponds R-16 and R-17.

Table 2-14. Stormwater Treatment Types in the Little Rocky Run – Upper WMA

WMA Name	Current Percent Impervious	Current Treatment Types			
		Quantity (acres)	Quality (acres)	Quantity/Quality (acres)	None (acres)
Little Rocky Run - Upper	23	15	464	276	1457

There were 112 complaints related to stormwater in the County's complaints database in the WMA. The classification of these complaints is summarized below:

- 49 Citizen Responsibility
- 44 Storm Drainage
- 14 Stormwater Management/BMP
- 2 Unclassified
- 1 County Right-of-Way
- 1 Planning & Design Division
- 1 Walkway

2.5.4 Stream Condition

The County conducted a *Stream Physical Assessment* (SPA) in August 2005 that assessed the habitat, stream geomorphology and impacts to the streams from crossings, ditches, pipes, headcuts, dump sites, utilities and obstructions. Map 2-20 shows a summary of the SPA data.

6.5 miles of the WMA, were assessed for stream habitat condition. The results for this study are summarized below:

- Very Poor: 0 miles
- Poor: 1.3 miles or 20%
- Fair: 5.2 miles or 80%
- Good: 0 miles
- Excellent: 0 miles

The longest segment of stream that was assessed as poor is on a tributary to Little Rocky Run that flows through the loop of Centreville Farms Road. This segment runs through an area developed with medium and high density residential development. It appears from the photos taken that this area was undergoing development at the time of the 2005 SPA. Another poor segment is a tributary to Little Rocky Run that flows into the main stem just

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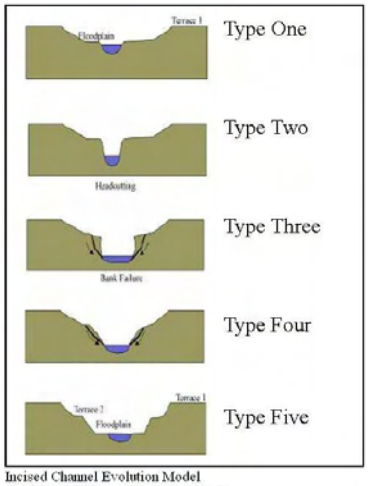
upstream of the Lee Highway crossing. Both reaches were assessed as having poor bank vegetative protection and buffer zone width. No poor segments were located on the main stem of Little Rocky Run.

The geomorphological assessment of the stream channels in the WMA was performed in 2003 and was based on the conceptual incised channel evolution model (CEM) developed by Schumm et al (1984). The CEM provides information about the evolution of a stream channel in response to disturbance. Based on visual observation of the channel cross section and other morphological observations of the channel segment, the CEM type was assigned for the channel segment. The CEM types are summarized below.

CEM Type	Description
1	Stable stream banks and developed channel
2	Deep incised channel
3	Unstable stream banks and actively widening channel
4	Stream bank stabilizing and channel developing
5	Stable stream banks and widened channel



Incised Channel Evolution Model
(Schumm, Harvey, and Watson, 1984)

The CEM Types 2 and 3 are shown on the stream condition map because these types are considered the most unstable. In the WMA, 6.2 (95%) miles is Type 3, 0.2 miles (3%) is Type 4 and 0.1 miles (2%) is Type 2.

A severe erosion site was located on Little Rocky Run just upstream of its confluence with Willow Springs Branch. The picture below shows that this is a dam that appears to have failed. There was also an area of moderate erosion noted on Willow Springs Branch approximately 1,400 feet upstream of Ashleigh Road.

Figure 2-27: Erosion area on Little Rocky Run upstream of Willow Springs Branch

Figure 2-28: Erosion area on Willow Springs Branch upstream of Ashleigh Road

The other impacts found in the SPA are summarized in Table 2-15.

Table 2-15. SPA Impacts in the Little Rocky Run – Upper WMA

Impact Type	Number	Comment
Utility	0	
Obstruction	7	1 moderate to severe, 6 minor to moderate (5 beaver dams)
Ditch	0	
Headcut	0	
Dump	0	
Pipes	14	12 minor to moderate, 2 moderate severe (1 construction related)
Crossings	35	2 bridges, 10 box culverts, 16 circular culverts, 3 fords and 4 foot bridges 2 have moderate to severe impact (ford on tributary downstream of Muddler Way and circular pipe on tributary that confluences with Little Rocky Run just upstream of Lee Highway)

The following pictures show some of the more significant impacts found in the watershed during the SPA.

Figure 2-29: Moderate to Severe Obstruction on Little Rocky Run

Figure 2-30: Moderate to Severe Pipe Impact on Little Rocky Run

Figure 2-31: Crossing Impact on Tributary downstream of Muddler Way

Figure 2-32: Crossing Impact on Tributary upstream of Lee Highway

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2.5.5 Field Reconnaissance

Field reconnaissance was conducted to update/supplement existing Fairfax County geographic data so current field conditions were accurately represented. Once this data was acquired, spatial analysis was performed to characterize County watersheds as they currently exist using the County's geographic information system (GIS). The reconnaissance effort included the identification of pollution sources, current stormwater management and potential restoration opportunities across the various watersheds.

During this field reconnaissance performed in June 2008, several new areas of concern were identified. Two particular sites have a number of existing issues impacting the health of the watershed. These areas are located on the main stem of Little Rocky Run upstream of Stringfellow Road and a tributary to Little Rocky Run upstream of Regional Pond R17.

Little Rocky Run upstream of Stringfellow Road is experiencing erosion and beaver activity, negatively impacting the health of the watershed. The following photographs show these impacts.

Figure 2-33: Severe erosion on Little Rocky upstream of Stringfellow Road

Figure 2-34: Beaver activity on Little Rocky upstream of Stringfellow Road

Figure 2-35: Beaver activity on Little Rocky Run upstream of Stringfellow Road

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The area of the watershed upstream of regional pond R17 is experiencing impacts from man-made obstructions, beaver activity, bank erosion and headcuts. The following photos show several examples from this area.

Figure 2-36: Approximately 2ft headcut in tributary upstream of regional pond R17

Figure 2-37: Man made obstruction in tributary upstream of regional pond R17

Figure 2-38: Major beaver activity in tributary upstream of regional pond R17

A summary of the new impacts found in the 2008 field reconnaissance are summarized in Table 2-16.

Table 2-16. New Impacts Identified in Little Rocky Run – Upper during 2008 Field Reconnaissance

Impact Type	Number of Sites	Comment
Erosion	5	Minor to sever erosion throughout watershed affecting primarily tributaries
Obstruction	8	Minor to moderate, one man made, the rest due to debris and beaver activity
Headcut	1	Moderate

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The following pictures show examples of other impacts found in the WMA.

Figure 2-39: Obstruction in small tributary next to Village Drive

Figure 2-40: Obstruction in pond near Tractor Lane

Figure 2-41: Erosion and heavy sedimentation in several ponds southeast of the intersection of I-66 and Fairfax County Parkway

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2.5.6 Modeling Results

Storm events are classified by the amount of rainfall, in inches, that occurs over the duration of a storm. The amount of rainfall depends on how frequently the storm will statistically occur and how long the storm lasts. Based on many years of rainfall data collected, storms of varying strength have been established based on the duration and probability of that event occurring within any given year. In general, smaller storms occur more frequently than larger storms of equal duration. Hence, a 2-year, 24hr storm (having a 50% chance of happening in a given year) has less rainfall than a 10-year, 24hr storm (having a 10% chance of happening in a given year). Stormwater runoff (which is related to the strength of the storm) is surplus rainfall that does not soak into the ground. This surplus rainfall flows (or 'runs off') from roof tops, parking lots and other impervious surfaces and is ultimately received by storm drainage systems, culverts and streams.

Modeling is a way to mathematically predict and spatially represent what will occur with a given rainfall event. There are two primary types of models that are used to achieve this goal; hydrologic and hydraulic:

- Hydrologic models take into account several factors; the particular rainfall event of interest, the physical nature of the land area where the rainfall occurs and how quickly the resulting stormwater runoff drains this given land area. Hydrologic models can describe both the quantity of stormwater runoff and resulting pollution, such as nutrients (nitrogen and phosphorus) and sediment that is transported by the runoff.

- Hydraulic models represent the effect the stormwater runoff from a particular rainfall event has on both man-made and natural systems. These models can both predict the ability for man-made culverts/channels to convey stormwater runoff and the spatial extent of potential flooding.

The table below shows three storm events and the rationale for being modeled:

Storm Event	Rationale for being Modeled
2-year, 24hr	Represents the amount of runoff that defines the shape of the receiving streams.
10-year, 24hr	Used to determine which road culverts will have adequate capacity to convey this storm without overtopping the road.
100-year, 24hr	Used to define the limits of flood inundation zones

The County is using a customized version of the Environmental Protection Agency's (EPA's) Spreadsheet Tool for the Estimation of Pollutant Loads (STEPL). This customized program (STEPL-FFX) was built in Microsoft (MS) Excel Visual Basic for Application (VBA). It provides a user-friendly interface to create a customized spreadsheet-based model in MS Excel. It employs simple algorithms to calculate nutrient and sediment loads from different land uses and the load reductions that would result from the implementation of various best management practices (BMPs), including Low Impact Development (LID) practices for urban areas. It computes surface runoff; nutrient loads, including nitrogen, phosphorus and 5-day biological oxygen demand (BOD); and sediment

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delivery based on various land uses and management practices. The land uses considered are user-defined land uses from Fairfax County. For each watershed, the annual nutrient loading is calculated based on the runoff volume and the pollutant concentrations in the runoff water as influenced by factors such as the land use distribution and management practices. The annual sediment load (from sheet and rill erosion only) is calculated based on the Universal Soil Loss Equation (USLE) and the sediment delivery ratio. The sediment and pollutant load reductions that result from the implementation of BMPs are computed using the known BMP efficiencies.

Existing Conditions water-quality data from the STEPL-FFX is shown on Maps 2-21, 2-22 and 2-23. The color gradient map symbols for pollutant loadings are the same for both the Johnny Moore and Little Rocky Run watersheds. Therefore, for Total Nitrogen (TN), Total Phosphorous (TP) and Total Suspended Solids (TSS), the subwatersheds located in Little Rocky Run – Upper WMA are producing relatively high pollutant loadings. The water-quality analysis is driven by land use and the watershed is predominantly medium to high density residential and commercial. With more impervious areas and small or non-existent buffer areas, the results are consistent with expectations. The I-66 Transfer Station Complex is located in the headwaters of this WMA and is the only recognized VPDES point source in the Little Rocky Run watershed. This WMA has undergone the most significant development over the past 10 years, owing to medium/high density residential and commercial areas replacing open space and low density residential areas. The field reconnaissance revealed that this system is still responding to these recent changes.

Table 2-17 provides a summary of runoff peak values and pollutant loadings at the outlet of the WMA. The second table is normalized by contributing drainage area.

Table 2-17. Little Rocky Run - Upper Stormwater Peak Values and Pollutant Loadings

WMA	Stormwater Runoff Peak Values		Pollutant Loadings		
	2-yr storm (cfs)	10-yr storm (cfs)	TSS (tons/yr)	TN (lbs/yr)	TP (lbs/yr)
Little Rocky Run - Upper	515	1312	352.9	15196.7	2250.2
NORMALIZED BY DRAINAGE AREA					
WMA	**Stormwater Runoff Peak Values**		**Pollutant Loadings**		
	2-yr storm (cfs/acre)	**10-yr storm (cfs/acre)**	**TSS (tons/acre /yr)**	**TN (lbs/acre /yr)**	**TP (lbs/acre/ yr)**
Little Rocky Run - Upper	0.233	0.594	0.160	6.871	1.017

The preliminary hydraulic model for Little Rocky Run - Upper was developed using United States Army Corps of Engineers (USACE) Hydrologic Engineering Centers River Analysis System (HEC-RAS) to compute water surface profiles. The preliminary model results were used to analyze the water surface elevation and flooding of inline structures.

The input data for the HEC-RAS model was extracted using HEC-GeoRAS. HEC-GeoRAS is a tool that processes the geospatial data within the County's GIS, specifically as it pertains to physical features such as stream geometry and flowpath so that these features can be represented in the model. HEC-RAS models were developed for study

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streams within Little Rocky Run using a naming convention unique for each reach. The study streams were defined as having a drainage area of at least 200 acres.

Bridge and Culvert crossings were coded according to available County or Virginia Department of Transportation (VDOT) engineering documents that depict the facility as it was actually built. Where not available, limited field reconnaissance was performed to obtain the crossing data. The crossing elevation data was determined relative to a point where the elevation could be estimated accurately from the County's topographic data.

Manning's 'n' values, which represent surface roughness, were assigned to the channel and overbank portions of the studied streams based on field visits and aerial photographs.

The flow change locations were extracted from the EPA Storm Water Management Model (SWMM) developed to estimate preliminary stormwater runoff flow values. The 2-yr, 10-yr and 100-yr storm flows were determined at several locations in order to provide a detailed flow profile for the hydraulic model.. Map 2-24 provides a graphical representation of the SWMM results for the 10-year storm discharge.

The 2-year storm discharge is regarded as the channel-forming or dominant discharge for the purposes of this study. This discharge is the flow value that transports the majority of a stream's sediment load and therefore actively forms and maintains the channel. A comparison of stream dynamics and channel geometry for the 2-year discharge provides insight regarding the relative stability of the system and helps to identify areas in need of restoration.

The 10-year storm discharge is being included to analyze the level of service of stream crossings. Occurring less frequently than the 2-year storm, the flood stage associated with this storm can result in more significant safety hazards to residents. All stream crossings (bridges and culverts) will be analyzed against this storm to see if they are performing at a level that safely passes this storm.

The 100-year storm discharge is used by the Federal Emergency Management Agency (FEMA) to map floodplain inundation zones and establish flood insurance rates. This provides a means to assess which properties are at risk to flooding and determine the appropriate insurance requirements for these at risk properties. The models developed to analyze the system for watershed planning have been built in compliance with FEMA standards in order to update the Flood Insurance Rate Maps for Fairfax County where appropriate.

In summary, the preliminary HEC-RAS model results indicate:

- 3 of 10 structures identified for analysis in the Little Rocky Run – Upper watershed do not have the capacity to pass the 10-year discharge.
- The 2-year discharge exceeds the channel banks in several locations
- There is very little if any evidence of flooding impacts to residential/commercial structures within the 100 year flood inundation zone.

The limit of the 100-year flood is graphically represented in Map 2-25.

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2.5.7 Subwatershed Ranking

It should be noted that all designations of the preliminary ranking results are relative to the area studied for this report. In other words, a 'low quality' designation does not necessarily indicate a poor quality subwatershed, only relative to the 51 other subwatersheds in the Little Rocky Run/Johnny Moore Creek watersheds.

Little Rocky Run - Upper contains the majority of 'low quality' subwatersheds. This is best summarized on maps 2-33 (Objective Composite Score) and 2-34 (Source Composite Score). Maps 2-26 to 2-32 describe more specific objective criteria, which have been weighted to determine the objective composite score. Please refer to section 2.2 for a more detailed description of impact, source and programmatic indicators and how they are being used to characterize the subwatersheds.

Little Rocky Run - Upper contains all but one of the low quality subwatersheds shown on map 2-33. The objective composite scores are based on measures of environmental condition. Some indicators (Benthic and Fish Communities) were only sampled at a handful of sites, the results of which were applied for several subwatersheds (based on several factors). The rest were determined using the best available GIS data. A more detailed analysis of individual results will accompany any proposed plan controls for a subwatershed. At the time sampling was performed, a significant portion of the watershed was undergoing development, the impact of which is accurately reflected at the sampling sites. The remaining impact indicators are consistent with a nearly built-out watershed, namely that riparian, wetland and terrestrial forested habitat have been compromised, while pollutant loads are relatively high.

Little Rocky Run - Upper contains the highest percentage of medium/high density residential, commercial/industrial and impervious surfaces, as well as the only VPDES permitted point source. Therefore, its relatively low scores for source indicators, as shown on Map 2-34, appear reasonable. It contains all but two of the low quality subwatersheds.

The only consistent discrepancy from the overall trends described above in Little Rocky Run - Upper is subwatershed LR-WS-0005, which is a headwater subwatershed comprised of Low Density Residential land use, the majority of which is forested. This explains why it often stands out as a high quality subwatershed within the WMA.

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2.6 Subwatershed Characterization

The purpose of the subwatershed ranking approach is to provide a systematic means of compiling available water quality and natural resources information. Ranking subwatersheds based on watershed characterization and modeling results provides a tool for planners and managers to use as they consider which subwatersheds should undergo further study and/or set priorities. The ranking will be updated based on issues and problem areas identified during the introductory and issues scoping forum and advisory group meetings. The resultant data is then utilized to identify key issues and proceed with projects that will achieve the County's watershed management goals and objectives.

Three basic indicator categories as described in Section 2.3 are used to rank subwatershed conditions:

Indicator Type	Description
Watershed Impact	Diagnostic measures of environmental condition (e.g. water quality, habitat health, biotic integrity) which are linked to the County's goals and objectives
Programmatic	Reports the existence, location or benefits of stormwater management facilities or programs
Source	Quantifies the presence of stressors and/or pollutant sources

These scores are rolled up into composite scores which are used in the prioritization and subwatershed ranking process. The following sample maps (2-26 through 2-34) display preliminary results.

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