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Reviewers: Dean Blackwell and Irene Haske

For information about this report and to request reasonable ADA accommodations or alternative format of materials, call Fairfax County Stormwater Management, 703-324-5500, TTY 711; 12000 Government Center Parkway, Suite 449, Fairfax, Virginia 22035; www.fairfaxcounty.gov/dpwes

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http://www.fairfaxcounty.gov/dpwes/stormwater/streams/assessment.htm

http://www.fairfaxcounty.gov/dpwes/stormwater/resources.htm

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Executive Summary

This Annual Report on Fairfax County Streams presents a summary of water quality data and an assessment of current stream conditions and trends countywide. Several data sources were used to prepare this report, including monitoring data collected by staff of the Department of Public Works and Environmental Services (DPWES), the Virginia Department of Environmental Quality (VDEQ) and volunteer monitors with the Northern Virginia Soil and Water Conservation District (NVSWCD). This report documents overall stream conditions based on the health of fish and benthic macroinvertebrate (aquatic invertebrate) communities. In addition, the potential human health risk associated with wading or swimming in streams is assessed based on fecal-associated bacteria.

The monitoring program is intended to serve the needs of the stormwater management program and to support various initiatives, including the Board of Supervisors' *Environmental Excellence for Fairfax County; a 20-year Vision* ("Environmental Agenda"). The monitoring program provides a comprehensive analysis of stream conditions throughout the county, while simultaneously addressing requirements and/or needs set forth in local, state, and federal regulations, including the:

- Chesapeake Bay 2000 Agreement Initiative – Virginia's Tributary Strategies
- Municipal Separate Storm Sewer System (MS4) Permit for Fairfax County - under the Virginia Pollutant Discharge Elimination System (VPDES) established by the Clean Water Act and administered by the Virginia Department of Conservation and Recreation (VDCR)
- Total Maximum Daily Load allocations (TMDLs) established by the Virginia Department of Environmental Quality (VDEQ)

Results

Bacteria Monitoring: As recommended by the EPA *E. coli* is used by Fairfax County as the indicator of possible fecal contamination in stream water. In 2006, only 20 percent of Fairfax County's bacteria monitoring locations were consistently below VDEQ's standard of 235 units per 100 mL of water (Figure E1). Fairfax County concurs with officials from VDEQ and the Virginia Department of Health, who caution that ***it is impossible to guarantee that any natural body of water is free of risk from disease-causing organisms or injury***.

Based on historical and ongoing bacteria monitoring data, the Fairfax County Health Department issues the following statement related to the use of streams for contact recreation:

> *"In summary, any open, unprotected body of water is subject to pollution from indiscriminate dumping of litter and waste products, sewer line breaks and contamination from runoff of pesticides, herbicides, and waste*

from domestic and wildlife animals. Therefore, the use of streams for contact recreational purposes such as swimming, wading, etc., which could cause ingestion of stream water or possible contamination of an open wound by stream water, should be avoided."

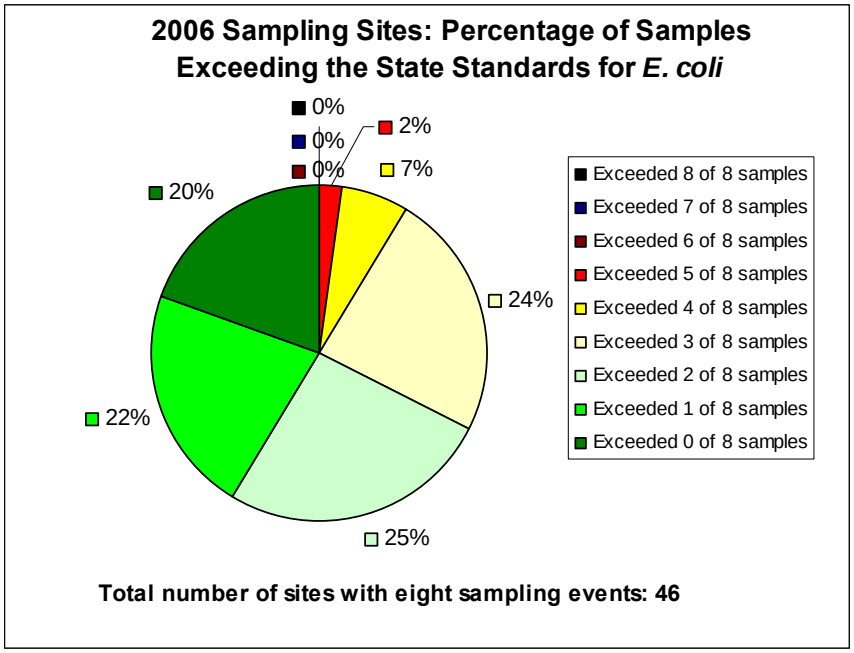

Figure E1: Percentage of sites with exceedances of the state's instantaneous water quality standard for *E. coli* (235 units per 100 mL)

Additional information is available on the Fairfax County Health Department Web site at:

www.fairfaxcounty.gov/service/hd/resourcewater.htm

Biological Monitoring: Results from the fish and benthic macroinvertebrate monitoring conducted in 2006 by county staff and volunteers are similar to previous years' results. The majority of streams are in "fair," "poor" or "very poor" condition based on county assessments, or rated "unacceptable" by volunteer monitors (Figure E2). These three lowest rating classes for the macroinvertebrate indices (as well as the "unacceptable" from the volunteer data) generally correspond to the VDEQ "impaired waters" classification, which indicates the commonwealth's minimum water quality standards are not being met. The percentage of sites classified as "good" and "excellent" showed a very slight decline this year. These sites typically would be considered "unimpaired" based on the commonwealth's aquatic life use standard. In 2006, more sites were found to be in better condition with respect to fish communities. However, strong conclusions cannot be drawn from short-term, relatively minor changes in biological communities. Small fluctuations in countywide stream conditions are typical from one year to the next and may not constitute true trends. True and meaningful trends can be confidently

inferred only after several years' data have been compiled. It can be inferred, however, that approximately three quarters of the stream ecosystems in the county are impacted or impaired.

Figure E2: Ratings of 2006 biomonitoring sites based on the Fish and Benthic Index of Biotic Integrity and volunteer monitoring (benthics).

Countywide Stream Quality Index: A stream quality index (SQI) was developed to establish a performance measure for a key natural resource (streams) that is visible and of great interest to the public. The index, which is based on benthic macroinvertebrate data and spans a possible range from 1 to 5, shows a marked decline in 2006 from previous years. It would be imprudent to make broad statements about trends without a minimum of 5 to 10 years of data. Also, it is uncertain what effects changing climatic conditions (i.e. drought, warming) may have on the index.

Table E1: Stream quality index (SQI) values for sampling completed in 2004, 2005 and 2006.

Sampling Year	Percentage of Total Sites					Index Value
	Very Poor	Poor	Fair	Good	Excellent	
2004	33	27	20	10	10	2.37
2005	15	43	25	8	10	2.55
2006	48	25	14	11	2	1.95

Virginia DEQ list of Impaired Waters: A summary of VDEQ's 2006 Water Quality Assessment and Impaired Waters Report is included in Section 5. VDEQ identifies poor-quality (impaired) streams which do not meet the commonwealth's water quality standards and are not suitable for their intended uses such as swimming, fishing, or aquatic life. The 2006 final report lists 32 water bodies with a total of 90 impairments within or bordering Fairfax County. Many of these water bodies are listed for multiple impairments based on elevated levels of pollutants, high levels of contaminants in fish or reduced numbers of aquatic organisms (aquatic plants, macroinvertebrates and/or fish). The number of stream segments and overall impairments has increased significantly since the last published report in 2004. Once a water body is listed as impaired, the Commonwealth of Virginia (VDEQ and the VDCR) goes through a process to identify specific pollutant sources and to define the Total Maximum Daily Load (TMDL) [of pollutant] within the watershed and develops implementation plans to reduce those pollutants and meet water quality standards. These plans can require VPDES permit holders, including the county (who holds an MS4 permit regulating stormwater discharges into the local waterways), to implement additional controls and management practices to reduce pollutants discharging to a water body from the municipal separate stormwater sewer system or from other sources.

Waters listed as impaired for aquatic life uses typically exhibit substantially suppressed ecosystems. Scores for biological integrity indices of these waters rank at or below 50% of the scores for natural (unimpaired) reference waters. This impaired condition is analogous to "very poor," "poor" and many of the "fair" streams as rated by the macroinvertebrate index used in this annual report.

Additional information on the VDEQ's water quality program and the 2006 report are available at:

http://www.deq.state.va.us/water/

This annual report, past annual reports (including past Health Department stream reports), appendices and protocols are available on the stream quality assessment program page located at:

http://www.fairfaxcounty.gov/dpwes/stormwater/streams/assessment.htm

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1 Introduction

The *2007 Annual Report on Fairfax County's Streams* presents the results of monitoring efforts conducted throughout calendar year 2006 for biological, bacteriological, physical and chemical stream characteristics including:

- Bacteria levels (fecal-related)
- Benthic macroinvertebrates
- Fish communities
- Water chemistry

These data will be used to support watershed planning, stormwater improvement project implementation, permit requirements, outreach/educational efforts, detection of pollution sources and more.

Little Rocky Run

Previous years' data are used for comparison purposes and baseline information. Prior annual stream monitoring reports are available on Fairfax County's web site at:

http://www.fairfax.va.us/dpwes/stormwater/streams/assessment.htm

1.1 Report and Program Goals

The goal of the *Annual Report on Fairfax County's Streams* is to present the results of the county's annual stream water quality monitoring efforts. The results are used to determine the Stream Quality Index (SQI) ranking of the overall health of Fairfax County's waterways (a scale from 1 to 5). It is envisioned that future reports will serve as a central repository for information and data related to the biological, chemical and physical conditions of the county's waterways collected by various county agencies and local organizations. It is envisioned that the next *Annual Report on Fairfax County's Streams* (2007 monitoring data) will be incorporated into the 2007 *Stormwater Status Report* which highlights the accomplishments of Fairfax County's stormwater management program and describes the County's ongoing stormwater programs, the challenges it faces and the partnerships forged to meet those challenges.

The long-term biological and bacteriological monitoring program supports the Board of Supervisor's *Environmental Excellence for Fairfax County; a 20-year Vision* ("Environmental Agenda"). The monitoring program provides a comprehensive, ongoing analysis of stream conditions throughout the county, while simultaneously meeting or exceeding the requirements set forth in the Municipal Separate Storm Sewer System (MS4) Permit issued by the State under the Virginia Pollutant Discharge Elimination System (VPDES), pursuant to the goals and mandates of the Federal Clean Water Act.

While supporting these requirements and initiatives, the program will develop a substantial dataset. Over time, this dataset will provide essential information to

determine the overall rate of change or trends in the conditions of Fairfax County's streams, providing a basis for targeting and prioritizing implementation measures, as well as other opportunities to help restore and protect the county's streams and watersheds.

1.2 Study Area Overview

Fairfax County is located in the northeastern part of the Commonwealth of Virginia (Figure 1). The county is bordered by Arlington County and the Cities of Falls Church and Alexandria on the northeast. The Potomac River borders the county on the north and southeast. The border with Loudon County lies to the north and west, and the Bull Run/Occoquan Rivers form the southern border with Prince William County. Within the borders of Fairfax County are three incorporated towns, Vienna, Herndon and Clifton, and one city, Fairfax City. Two large federal reservations lie within Fairfax County: Dulles International Airport, which straddles the western border with Loudon County, and Fort Belvoir, a large US Army base situated in the southeastern portion of Fairfax. Several smaller federal reservations also lie within the county's borders: CIA-Langley, a US Coast Guard Station, USGS Headquarters in Reston, and Mason Neck National Wildlife Refuge. Waters on federal and state lands (including preserves and parks) are not under county authority or purview.

Figure 1: Location of Fairfax County in the Commonwealth of Virginia

Today, Fairfax County is highly urbanized and approaching ultimate build-out conditions, as envisioned in the county's Comprehensive Plan. The total land area of Fairfax County, including incorporated towns, is 395 square miles. It is the most populous jurisdiction in Virginia, as well as within the Washington D.C. metropolitan area, with the 2006 population estimated to be over 1 million with 387,990 households. Land use is primarily residential; with smaller areas in commercial, recreational, and open-land uses (industrial use areas are present in small pockets).

The county lies within the Chesapeake Bay Watershed. There are approximately 850 miles of stream channels with perennial streamflow draining 30 designated major watersheds (drainage basins), with 23 watersheds falling entirely within the county's borders (Figure 2). The 30 watersheds drain either to the north and east to the Potomac River, or to the south into the Bull Run/Occoquan river system, which

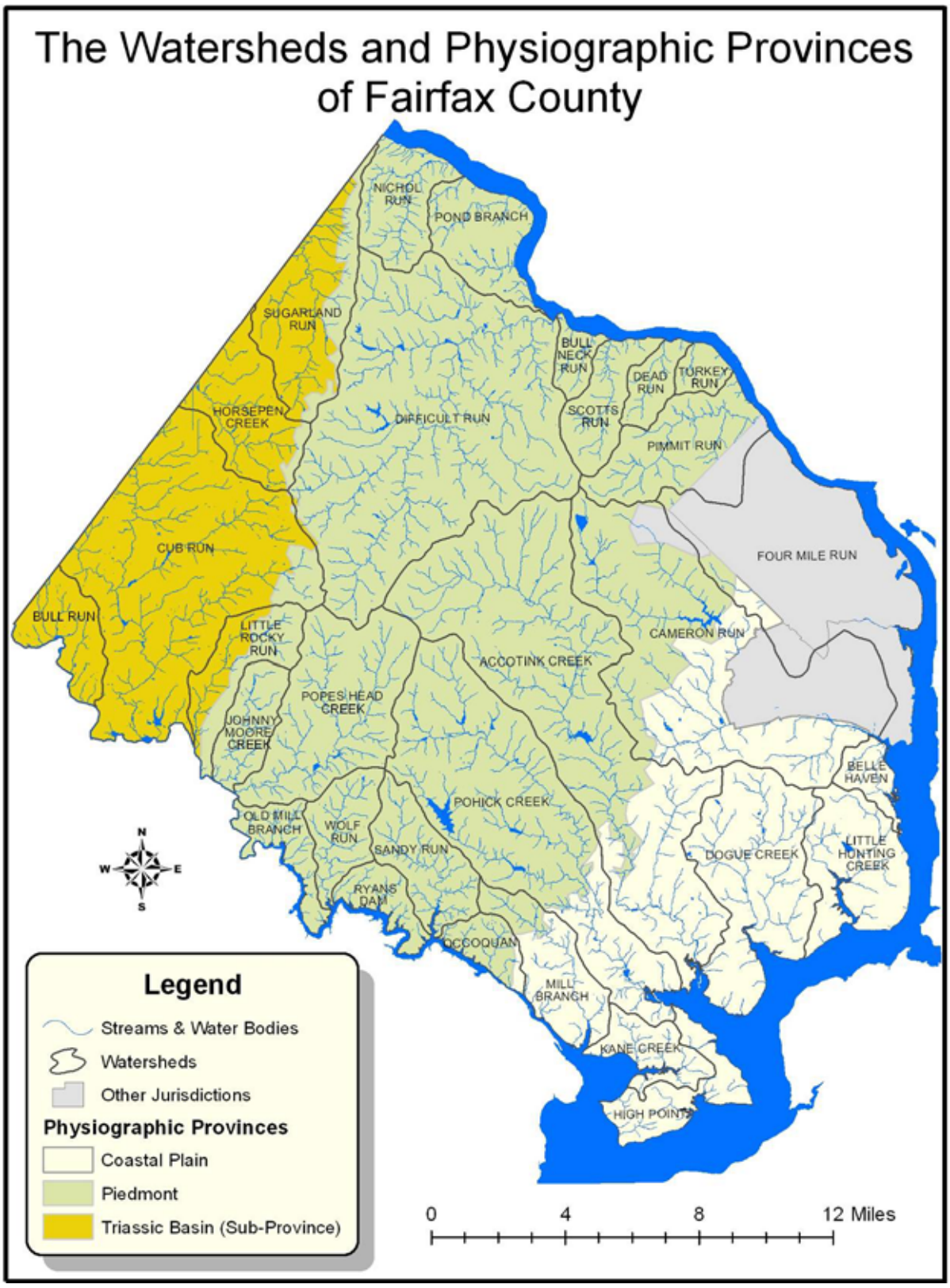


Figure 2: The 30 watersheds and two physiographic provinces in Fairfax County, Virginia

eventually flows into the Potomac. The 30 major watersheds within the county range in size from the two square mile Turkey Run drainage to the 58 square mile Difficult Run basin. The mouths of the streams draining the far southeastern portion of the county are influenced by the tidal rhythm of the Lower Potomac.

All of the major lakes throughout the county are man made impoundments and were designed for municipal water supply, agricultural water supply (remnant farm ponds) stormwater control and/or recreational and aesthetic purposes.

The Occoquan River is impounded just upstream of where it passes under Route 123. The reservoir was created when the river was dammed in 1950, and then enlarged in 1957 by the county to provide a source of drinking water for residents within the region. In July 1982, the Fairfax County Board of Supervisors voted to restrict development on 41,000 of the 64,500 acres within Fairfax County draining to the reservoir. The resultant "down-zoning" limited the number of residences to one home per five acres in a successful effort to improve the quality of stream water draining into the drinking water reservoir.

Fairfax County at a Glance

Total area (incl. water bodies)……..400 mi^2

Total land area..……...395 mi^2

Population in 2006 (estimated)…..1,037,311*

Number of households …….. 387,990

Number of incorporated towns and cities ……..…….. 4
Towns of Vienna, Herndon, and Clifton
Fairfax City

Number of designated watersheds …….. 30
Largest watershed …. Difficult Run, 58 mi^2
Smallest watershed ….. Turkey Run, 2 mi^2

Length of perennial streams..…… ~850 miles

Physiographic Provinces (and sub-Provinces)
Piedmont land area ……..……..... 243 mi^2
Triassic Basin land area …….. 69 mi^2
Coastal Plain land area …… 90 mi^2

* based on U.S. Census Bureau data

Fairfax County lies within two major physiographic provinces, the Coastal Plain and the Piedmont (Figure 2). Physiographic provinces are areas that have common geology, surface processes, and landscape history having characteristic landforms and environments. Each province comprises areas with similar terrestrial and aquatic floral and faunal ecosystems, including certain communities which may be unique to those provinces. These provinces are the basic landscape units by which biological communities can be evaluated and compared.

The Piedmont province covers 60 percent of the county (243 mi^2) and is typified by gently rolling landscapes, deeply weathered bedrock/soils and a relatively low occurrence of solid outcrop. The Triassic basin, which overlies the far western portion of Fairfax County, is a subset of the larger Piedmont province and covers 17 percent of the county (69 square miles). The Triassic basin is actually the remains of a huge prehistoric lake bottom that covered portions of western Northern Virginia and Maryland.

It is typically much flatter and has unique lake sediment type soils as compared to the encompassing Piedmont province.

The Coastal Plain province spans the eastern portion of the county and bounds the Piedmont along the fall line. The fall line is a low, east-facing cliff paralleling the Atlantic coastline from New Jersey to the Carolinas. It marks the boundary between the hard Paleozoic metamorphic rocks of the Piedmont (to the west) from the softer, flatter Mesozoic and Tertiary sedimentary rocks of the Coastal Plain. To the west of this line, the streams are typified by greater-sloping channel bottoms and the resultant higher velocity riffle-run habitats. East of this line, in the Coastal Plain, the landscape generally has more gentle slopes, and results in water bodies dominated by lower velocity pool-and-glide habitats. Historically, this fall line presented an obstacle to further upstream navigation to early European settlers by boat and thus is the location of many major mid-Atlantic cities such as Philadelphia, Baltimore, Washington D.C. and Richmond. Generally, Interstate 95 traverses this geologic feature through Northern Virginia.

2 Monitoring and Sampling Methods

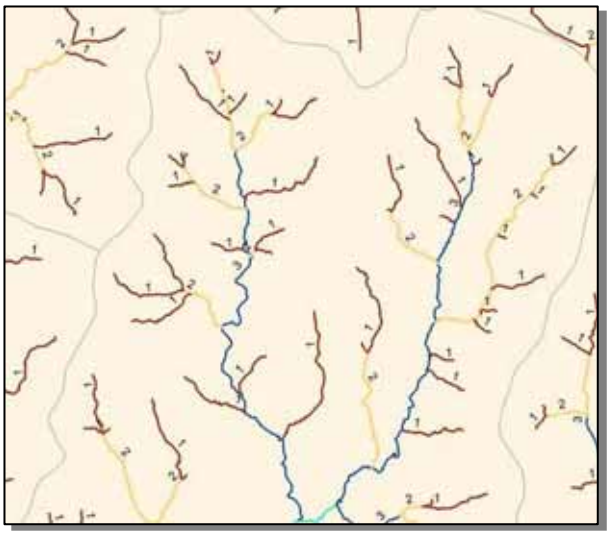
Ebony Jewelwing Damselfly

The fundamental principle of ecology is that everything is interrelated within an ecosystem. This principle is especially important when determining the health of a stream because the composition of the biological communities, chemistry of the water, and characteristics of the surrounding environment must be considered. Bioassessments (evaluating biological communities to indicate overall ecosystem health) are used in concert with abiotic assessments such as habitat quality, water chemistry and contributing watershed characterizations to reveal the overall picture of water quality and watershed health. Fairfax County's monitoring methodologies are modifications of the U.S. Environmental Protection Agency's Rapid Bioassessment Protocols (RBP) (Barbour et al. 1999). These monitoring methods and site selection criteria are fully detailed in the Stormwater Planning Division's Standard Operating Procedures Manual for the Biological Stream Monitoring Program. This can be found online at:

http://www.fairfaxcounty.gov/dpwes/stormwater/streams/assessment.htm

2.1 Site Selection

Fairfax County's monitoring sites are randomly selected using a probability-based stratification model, also known as a stratified random approach, which employs two primary steps. First, streams are grouped into like classes called "strata" so that similar environments are directly compared. Sampling sites are then randomly selected within each stratum. This commonly-used approach, which is employed by VDEQ, eliminates any site selection bias and is an accurate and cost-effective way to derive statistically defensible determinations of stream conditions on a countywide scale.



Example of an ordered stream network in Fairfax County.

The "sampling frame," a set of all potential sampling locations, is created using Fairfax County's physiographic province layer and the perennial stream layer on GIS (geographic information system). These layers are used to stratify all streams into segments of varying lengths based on their province and Strahler stream order (Strahler, 1952). Stream orders range from the numerous small first-order headwaters to the larger fifth-order channels such as the main stem of Difficult Run.

A two-stage site selection technique is used. Within each stratum (group of all streams in the same physiographic province and of the same order), a spot on a stream segment is first selected at random. A 100-meter sampling location is selected around this spot, which is then field-checked to ensure that access and minimum site requirements are met. Sample reaches are allocated in a proportional manner according to the total stream length in each stratum (Table 1). In 2006, 44 site locations from two strata were selected for the annual sampling campaign. A map depicting the locations of the 44 randomly-selected sites is shown in Figure 3.

Table 1: Distribution of 44 sample sites across 2 strata.

Physiographic Province:		**Piedmont/Triassic Basin - 77.6% of County (44 sites x 77.6% = 34 sites)**	
Stream Order	**Total Length (miles)**	**Percentage of Total (%)**	**Number of Sampling Locations in the County**
1	337	50.8	17
2	158	23.7	8
3	115	17.4	6
4, 5*	54	8.1	3
Totals:	664	100	34

Physiographic Province:		**Coastal Plain - 22.4% of County (44 sites x 22.4% = 10 sites)**	
Stream Order	**Total Length (miles)**	**Percentage of Total (%)**	**Number of Sampling Locations in the County**
1	71	55.9	5
2	34	26.5	3
3, 4, 5*	22	17.6	2
Totals:	127	100	10

** These stream orders were combined because they do not cover enough area of the County on their own to allow a site to be selected within them.*

Belle Haven – 1st Order Stream.

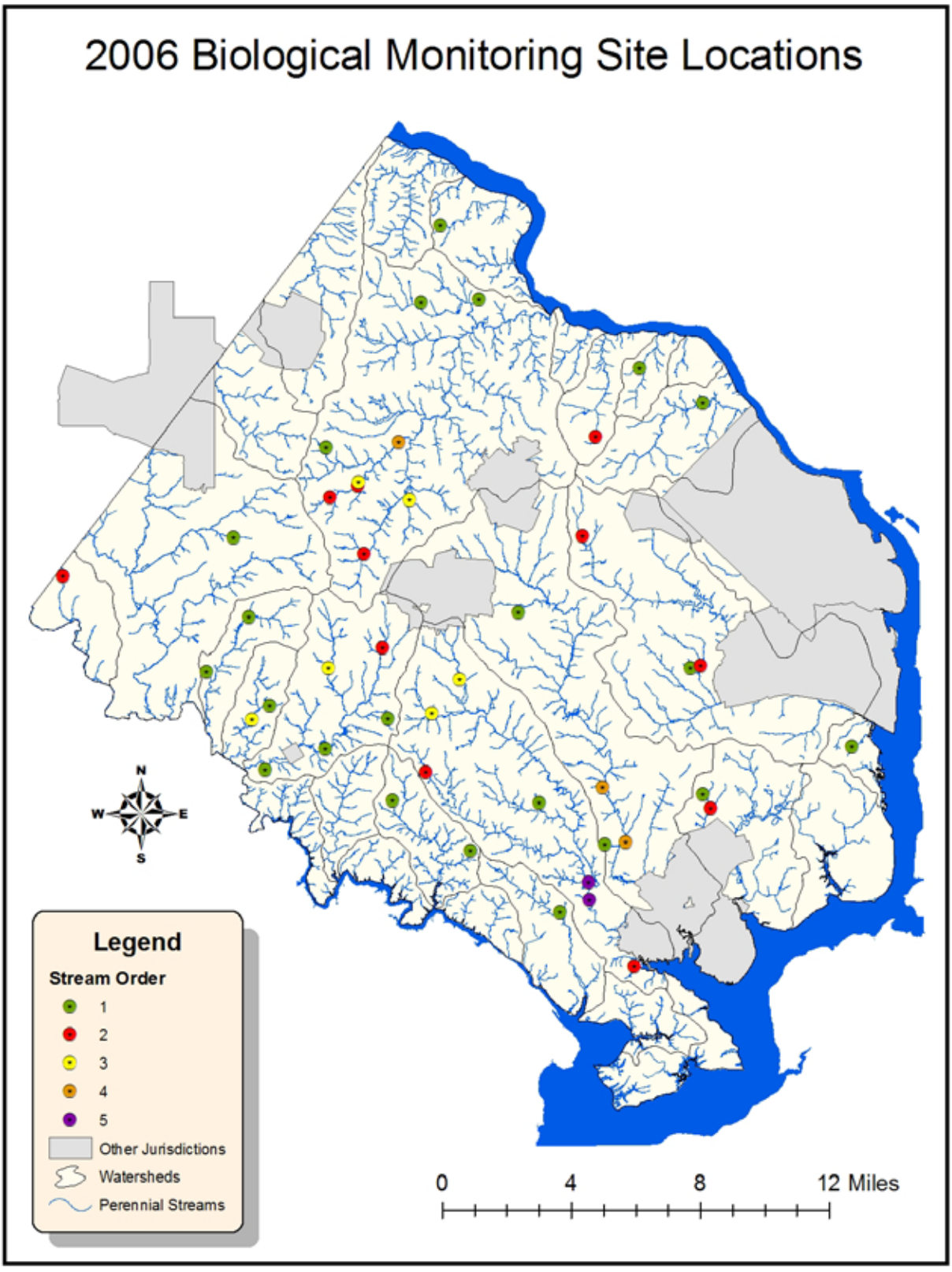


Figure 3: Locations of randomly-selected monitoring sites for sample year 2006

2.2 Bacteria and Water Chemistry

Escherichia coli (*E. coli*) is a type of bacteria commonly used as a water quality indicator because it is found in the intestines and waste of warm blooded animals. Alone, this bacterium in surface waters is generally not harmful to humans, and may exhibit broad natural variability in abundance. However, it may indicate the possible presence of pathogenic (disease-causing) bacteria and viruses. The level of *E. coli* in streams is used by localities to determine if primary recreational contact, such as swimming, fishing and boating, is safe in local and state waterways.

Collecting water samples

To determine the concentration of *E. coli* in streams and to continually screen for possible sewage contaminations, bacteria sampling is conducted at the randomly-selected biological monitoring locations throughout the county. Grab samples of stream water are collected twice each season, starting in the spring. Water chemistry parameters are measured, including nitrate and total phosphorous concentrations, pH, specific conductance and dissolved oxygen along with water temperature. The sampling program was initiated in 1969 by the Fairfax County Health Department (then known as the Department of Health's Division of Environmental Health) to monitor the water quality of the streams in the county. The Stormwater Planning Division assumed the program 2003 in an effort to consolidate stream sampling efforts.

2.3 Benthic Macroinvertebrates

The invasive Red Swamp Crayfish

Benthic macroinvertebrates are aquatic organisms found living on the bottom of the streambed (benthic), are visible without the use of a microscope (macro), and do not have a backbone (invertebrate). Benthic macroinvertebrates include aquatic snails, water mites, worms, leeches, crustaceans and insects. In fact, the majority of them are aquatic insects or the larval forms of many common terrestrial insects such as black flies, mayflies, dragonflies, crane flies, stoneflies, beetles and others.

Benthic macroinvertebrates are a diverse group of organisms with varying tolerances for toxic, nutrient, and sediment pollution, making them well suited as indicators for determining stream health and water quality. Benthic macroinvertebrates also play a

critical role in the aquatic food web by forming the core diet of many stream fishes and amphibians, as well as playing an essential role in many stream functions and processes. As such, they are excellent indicators of the health and integrity of the stream ecosystem and can help reveal specific stressors on the system (if present).

Collecting a benthic sample using the 20-Jab method

Benthic samples are collected every spring between mid-March and mid-April, using the "20-jab" multi-habitat sampling technique. This method involves taking 20 separate "jabs" or collections from different habitat types, such as undercut banks, aquatic vegetation, riffles and snags. Preserved samples are taken to a county laboratory where the macroinvertebrates are separated from vegetative and inorganic debris and identified to the genus taxonomic level with the aid of microscopes.

A multi-metric index is used to categorize the condition of the benthic community. This index employs the numerical combination of several individual metrics based on the tolerance, community composition, habit type and trophic (feeding) structure of the sample. Each metric is scored and then combined into the overall index score called the Index of Biotic Integrity (IBI). Separate indices are used for Piedmont and Coastal Plain samples, as the benthic communities found in each province are markedly different. The Coastal Plain index consists of five separate metrics, while the Piedmont index is composed of ten metrics. The ultimate ratings compare sites to a reference or “least disturbed” condition which then allows them to be categorized as “excellent,” “good,” “fair,” “poor” or “very poor”. Details on the benthic IBI can be found in the Fairfax County Stream Protection Strategy Baseline Study Appendix or in the current Standard Operating Procedures manual (see section 6).

2.4 Fish Community

A Satinfin Shiner

Fish are very sensitive to both natural and human-induced changes within a given stream system and its surrounding watershed. Many fish are dependent upon the smaller organisms, including benthic macroinvertebrates, for survival, and require stable and diverse aquatic habitat in which to thrive and reproduce successfully. As food sources, habitat quality/availability and water quality are stressed or impacted, the quality of the fish community shows a corresponding decline. This makes stream fishes good indicators of stream and watershed health. A balanced and diverse fish community is indicative of good stream health.

A backpack electro-fisher unit is used in wadeable streams to create a small localized electrical field, stunning the fish momentarily, allowing for easy collection with a net. Once collected across the 100-meter sample reach, the fish are identified to the species taxonomic level, counted to track their respective populations within each sampled reach, then released back into the sample reach.

Fish sampling using a backpack electro-fisher

A multi-metric index called the Fish Index of Biotic Integrity (F-IBI) is used to categorize the condition of the fish community for each site. This index employs the numerical combination of several individual metrics based on the pollution tolerance, trophic (feeding) structure, or species diversity of the fish within the sample. Each of the individual metrics measures a certain aspect of the fish community structure. For example, a metric may quantify the proportion of individuals in a sample that are considered to be tolerant to pollution and stress. A sample with a high proportion of these tolerant species indicates that some type of stress is affecting the ecosystem. This individual metric would receive a low score and be combined with the other metric scores for incorporation into the overall index. Separate indices are used to evaluate Piedmont and Coastal Plain sites, as the fish communities found in each province are markedly different. The Coastal Plain F-IBI consists of four separate metrics, while the Piedmont fish index is composed of nine metrics.

The ultimate ratings compare sites to a reference or "least disturbed" condition which then allows them to be categorized as "excellent", "good", "fair," "poor" or "very poor." Specific details on the F-IBI can be found in the 2005 Annual Report on Fairfax County's Streams and in the Standard Operating Procedures manual (see References section).

2.5 Volunteer Monitoring

A volunteer stream monitoring program in Fairfax County is coordinated independently by the Northern Virginia Soil and Water Conservation District (NVSWCD). Volunteers monitor targeted stream sites for habitat quality, water chemistry and benthic macroinvertebrate community composition, usually once each season.

Benthic macroinvertebrate samples are collected using kick-net sampling techniques, in riffle and pool habitats. Samples are processed in the field and benthic macroinvertebrates are identified to the order taxonomic level. The physical condition of the stream is visually assessed for substrate composition, embeddedness, turbidity, bank cover, canopy cover and other features.

Volunteer monitors inspecting a sample

Volunteer data is being used to supplement county-collected data in evaluating general trends and identifying areas in need of more monitoring. By working together with NVSWCD, the county nearly doubles the number of sites it evaluates in a given year. Although these taxonomic identifications are not as high resolution as the county's, they greatly augment the stream monitoring efforts of the county. Volunteer data is collected and evaluated using the modified Virginia Save Our Streams (VASOS) protocol (see references) and rated "acceptable" or "unacceptable." The rating of "acceptable" corresponds well with the county's "excellent" and "good" ratings, while the "unacceptable" generally corresponds to the county's ratings of "fair," "poor" and "very poor."

3 Results: 2006 Monitoring Data

3.1 Bacteria Monitoring Data

As recommended by the EPA and the Virginia Department of Environmental Quality (DEQ), Fairfax County completed its transition in 2005 to using *E. coli* instead of fecal coliform as an indicator of possible fecal contamination. The basis behind this change stems from the 1986 EPA finding that *E. coli* exhibits a stronger correlation to swimming borne illnesses for humans than fecal coliform. The new indicator can produce better recommendations regarding the safety of county waters for recreational uses.

According to DEQ, the following standard now applies for primary contact recreation to all surface water:

- *E. coli* shall not exceed a geometric mean of 126 per 100 mL of water or exceed an instantaneous value of 235 per 100 mL of water.

Since bacteria sampling in Fairfax County is conducted only on a bi-quarterly basis, the geometric mean standard cannot be applied to the data. Therefore, the county's analysis is based on the frequency that the level of *E. coli* exceeds the instantaneous threshold of 235. Because there are several methodologies to determine the level of *E. coli* in surface water, each with its own unit (i.e. MPN, CFU, etc.), all discussion of *E. coli* concentration will remain unit-less at a state level.

Water Chemistry Results

Temperature (◦C)
Minimum…….1.9
Maximum……..26.5
Average …….13.6
Dissolved Oxygen (mg/L)
Minimum…….4.5
Maximum……..16.5
Average …….9.7
Specific Conductance (µs/cm)
Minimum…….9.8
Maximum……..1917
Average …….239.1
pH
Minimum…….5.5
Maximum……..8.4
Average …….6.8
Nitrate (mg/L)
Minimum…….<0.1
Maximum……..6.5
Average …….1.3
Total Phosphorous (mg/L)
Minimum…….<0.1
Maximum……..0.61
Average …….<0.1

E. coli, nitrate and total phosphorous samples are processed at the Fairfax County Health Department laboratory, using the Colilert® Quanti Tray/2000 by IDEXX and Skalar San++ Analyzer, respectively. The upper limit of detection for the Quanti Tray/2000 yields a Most Probable Number (MPN) of 2420. The remaining chemical parameters are recorded in the field using a hand-held YSI meter.

The 2006 sampling year included 46 sites in 17 watersheds. Each of the 46 sites was visited twice each season for a total of eight visits per site.

Some factors that may increase or decrease the total amount of *E. coli* in surface waters include rainfall and sample water temperature. These factors have been noted in past Health Department stream water quality reports as environmental conditions affecting

the fecal coliform results. Plots of *E. coli* counts versus water temperature (Figure 4) and *E. coli* geometric means versus 5-day antecedent rainfall (Figure 5) suggest a closer association with temperature than with rainfall. It should be noted that sampling events were planned as much as possible around periods of no rain to ensure a representative bacteria loading response.

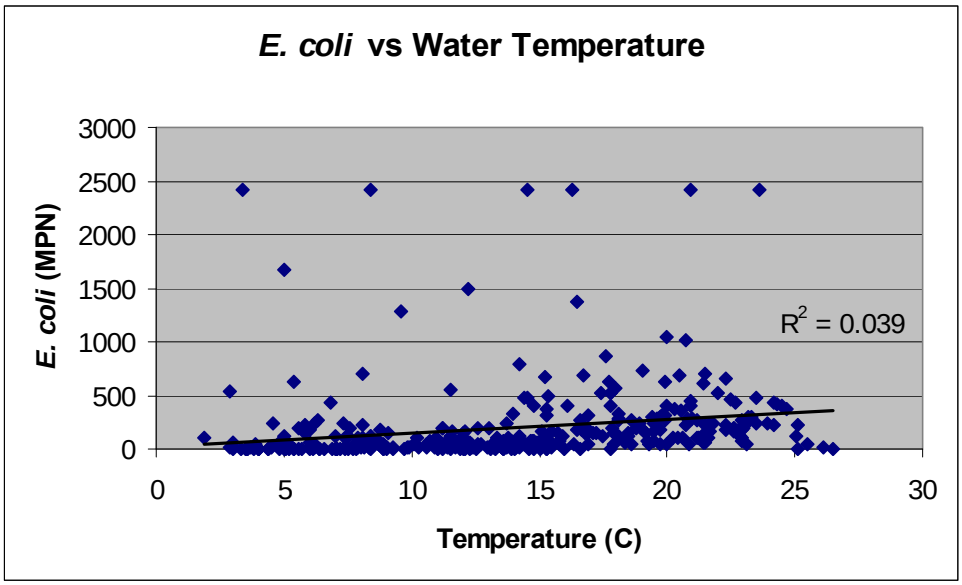


Figure 4: *E. coli* concentrations versus water temperature

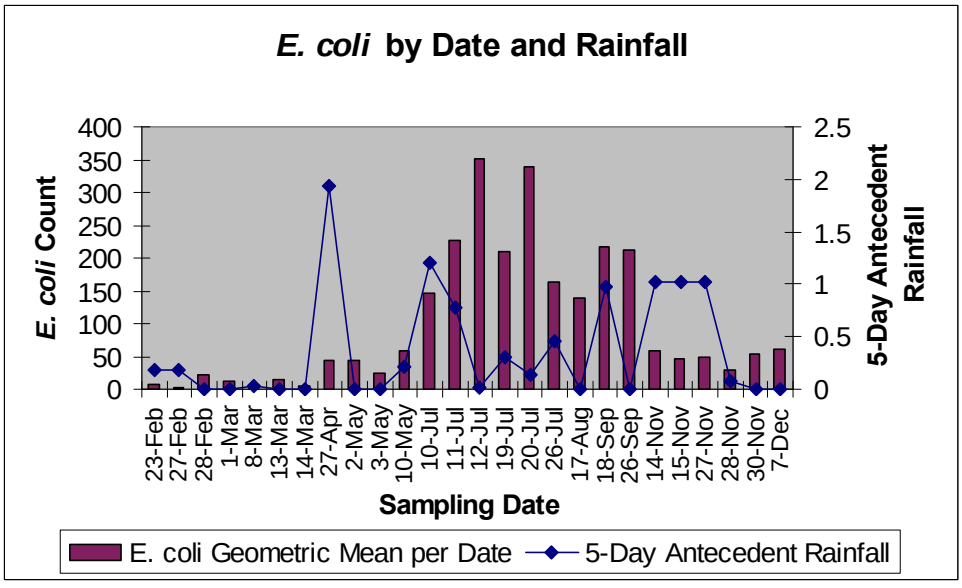


Figure 5: Geometric mean of *E. coli* concentrations versus 5-day antecedent rainfall

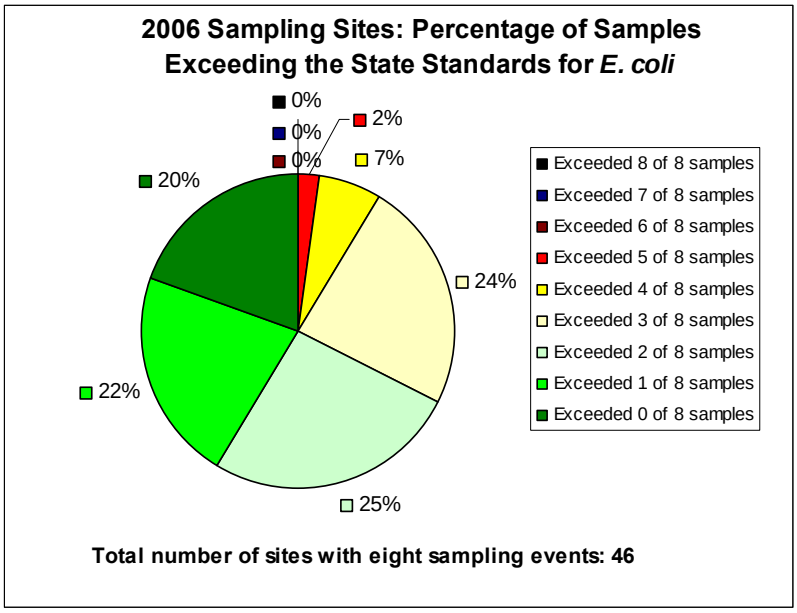


Figure 6: Percentage of sites with exceedances of the state's water quality instantaneous standard (235 per 100 mL) for *E. coli*

In 2006, 20 percent of Fairfax County's bacteria monitoring locations were consistently below DEQ's instantaneous *E. coli* standard of 235 per 100 mL of water. Figure 6 illustrates the breakdown of sites which exceeded the state's instantaneous standard. Though this may seem an improvement from the 2005 data (where only 10 percent of the sites were consistently below 235 per 100 mL), Fairfax County concurs with officials from the Departments of Environmental Quality and Health, who caution that ***it is impossible to guarantee that any natural body of water is free of risk from disease causing-organisms or injury***.

3.2 Benthic Macroinvertebrate Data

All 44 monitoring sites selected in 2006 were sampled for benthic macroinvertebrates. As in the previous annual stream reports and the 1999 countywide baseline study, the majority of the streams (87 percent) are in "fair," "poor" or "very poor" condition based on the Benthic Index of Biotic Integrity (Figure 7). These three lowest rating classes generally correspond to the VDEQ's "impaired" classification for aquatic life uses, which indicates the Commonwealth's minimum water quality standards are not being met. The 1999 baseline study showed that approximately 77

The larval form of the adult Stonefly pictured above is indicative of good water quality.

percent of county streams were in this range, and the 2005 annual stream report (sample year 2004 data) showed that 80 percent of the streams sampled fell into this range. Almost half of the 2006 sites fell into the "very poor" category. This may be an indication that more streams are being impacted by increased human disturbance. It also could be a result of natural variability of the sampling methodology (i.e. more sites in developed watersheds were randomly selected) and should be considered along with previous and future sampling data. The one site that was rated excellent was a small first-order stream located in the Popes Head watershed, which has limited residential growth.

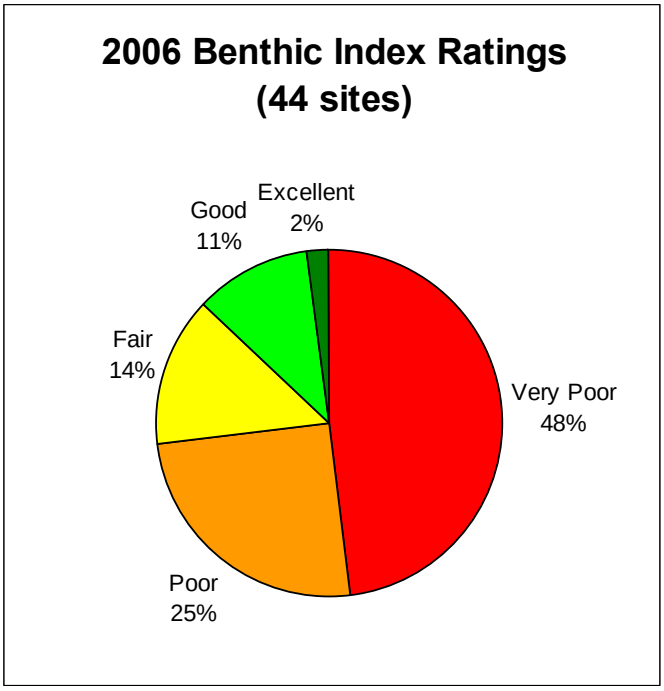


Figure 7: Ratings of 2006 biomonitoring sites based on the Benthic Index of Biotic Integrity

Table 2 shows a simple breakdown of the benthic IBI scores for the 2006 sites by stream order class. Although general condition ratings of "Excellent" through "Very Poor" can be given to each individual site or class of sites, it is important to note where that score falls numerically within the rating scale. For example, all 4th and 5th order 2006 sites, when combined, received a rating of "Poor" based on their average benthic IBI score (22.6). However, that rating was only 2.7 points above the "Very Poor" rating. Scoring ranges for each condition rating category are provided to the right of Table 2 below.

Table 2: Statistics for county Benthic IBI scores from 2006 sampling and score ranges for rating categories.

Stream Order	Number of Samples	Minimum Score	Maximum Score	Standard Deviation	Mean IBI Score	Rating
1	22	7.8	80.3	24.0	33.9	Poor
2	11	11.4	44.3	11.65	24.6	Poor
3	6	3.0	64.7	18.9	29.9	Poor
4	3	6.3	41.5	17.6	23.4	Poor
5	2	13.0	29.7	11.8	21.3	Poor
ALL	44	3.0	80.3	19.8	29.7	Poor

Rating Category	Score Range
Excellent	80 - 100
Good	60 - 79.9
Fair	40 - 59.9
Poor	20 - 39.9
Very Poor	0 - 19.9

The Stormwater Planning Division received data for 41 sites monitored by NVSWCD volunteers in 2006. Overall, 73% (30 sites) were rated as "unacceptable," while 27% (11 sites) were rated "acceptable" (Figure 8). Because these sites are not probabilistically (randomly) selected, they may not be representative of countywide conditions as a whole.

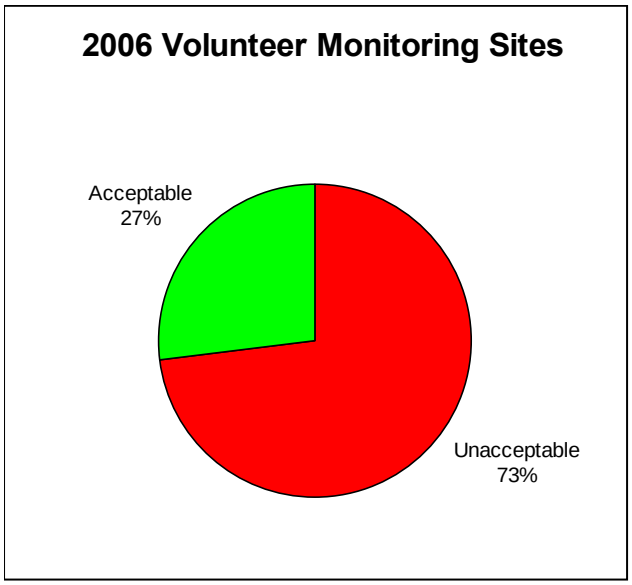


Figure 8: 2006 site ratings from NVSWCD volunteer monitors

In general, the benthic ratings for the volunteer sites corresponded with the ratings for the county sites in the same area (upstream or downstream). By combining these results with all county benthic monitoring results, a larger, more encompassing picture of stream conditions countywide is revealed.

3.3 Fish Sampling Data

Fish are typically not sampled in first order and small headwater streams, as the distribution and permanence of the resident fish populations may subject to a high degree of variability, both spatially and temporally. Using the fish community to assess the health of very small streams would likely result in unreliable conclusions. Therefore, fish communities were sampled at all sites located on second- through fifth-order streams and a few of the largest first-order streams (>300 acres of drainage area) during 2006. This resulted in a total of 22 (out of 44) sites being surveyed for fish.

*The invasive Northern Snakehead (*Channa argus*) was found in the Dogue Creek watershed.*

Using the Fish Index of Biotic Integrity (F-IBI), the majority of sites were roughly split between the "good" and "fair" categories (41% and 36%, respectively) (Figure 9). One site located in Difficult Run Stream Valley Park was rated "excellent," while no sites were rated as "very poor." The data appear to indicate that the fish communities are more resilient to impacts than are the macroinvertebrate communities. Part of this is likely due to the high degree of mobility of fish – they can respond to stressors by

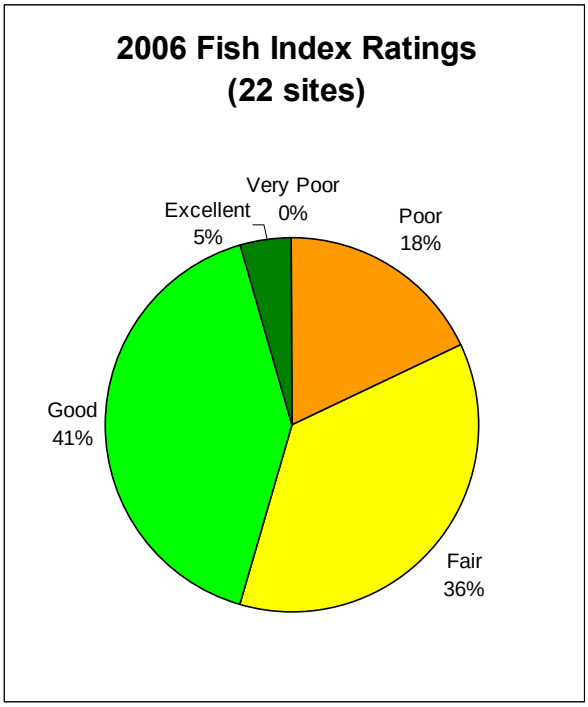


Figure 9: Ratings of 2006 biomonitoring sites based on the Fish Index of Biotic Integrity.

relocating elsewhere, while many benthic species are unable to disperse far enough outside of the zone of stress.

Compared to the previous year's results, more sites were found to be in better condition with respect to the fish community in 2006. The proportion of sites falling in the "excellent", "poor" and "very poor" categories are almost identical between sample years 2005 and 2006. The notable difference in the remaining portion of sites (>70%) is that a larger number of sites were ranked as "good" and fewer ranked as "fair" in sample year 2006. This hints at an upward trend in the fish community scores. However, it may be premature to draw any definitive conclusions on trends in fish community health based on only 3 years' data. Many factors in the urban environment can affect fish communities, including seasonal precipitation fluctuations, physical barriers to fish movement/migration, introduction of exotic species, stocking of lakes for sport fishing purposes, and predation from humans, and others. As more years' data are compiled, a greater understanding of the dynamics exhibited by these communities will be gained.

3.4 Stream Quality Index

A number of key indicators have been developed to support portions of the Fairfax County Board of Supervisors' Environmental Agenda. Among them is an indicator used to measure watershed and stream quality. Benthic macroinvertebrate data from the biological monitoring program (probabilistic design approach beginning in 2004) were used to develop this indicator.

A stream in Pohick Creek showing severe erosion

The number of sites placed in each of five rating categories ("excellent," "good," "fair," "poor," or "very poor" based on the benthic macroinvertebrate monitoring data) was used to develop a stream quality index value of overall stream conditions countywide. This index value is computed by multiplying the fraction of total sites rated "excellent" by 5, those rated "good" by 4, those rated "fair" by 3, those rated "poor" by 2, and those rated "very poor" by 1. These values are then summed, resulting in a single numeric index ranging from 1 to 5, with a higher value indicating better stream biological conditions. Thus, an index value of 5 would correspond to all streams countywide as being rated "excellent." Likewise, an index of 2.5 would indicate conditions intermediate between "fair" and "poor," and an index score of 1 corresponds to "very poor" stream conditions countywide

The stream quality index values for the 2004, 2005 and 2006 sampling years are shown in Table 3. The 2006 stream quality index shows a decrease in overall stream quality from 2005. However, it is difficult to draw any conclusions about trends based on data from three sampling years. Additionally, it is uncertain what effects changing climatic conditions (i.e. drought, warming) may have on the index and inferred trends. This index will be reported annually to evaluate long-term trends in the overall health of

streams countywide. As more data are reported annually, emerging trends can be identified with greater certainty.

Table 3: Stream quality index values for sampling years 2004, 2005 and 2006

Sampling Year	Percentage of Total Sites					Index Value
	Very Poor	Poor	Fair	Good	Excellent	
2004	33	27	20	10	10	2.37
2005	15	43	25	8	10	2.55
2006	48	25	14	11	2	1.95

3.5 2006 Monitoring Station Data

Sample data collected at each of the 44 sites in the 2006 sample year are provided in this section. The data are shown in Table 4. Each site is given a "map code" in the first column of the table, which can be used to determine the location of the site using the map in Figure 10.

Table 4: Site data and monitoring results for 2006 sample year sites

Map Code	Site ID	Watershed	Physiographic Province	Stream Order	Drainage Area		Benthics		Fish		Bacteria
					Acres	$Miles^2$	IBI*	Rating	IBI*	Rating	Percent Exceeding
1	AC0601	Accotink Creek	Coastal Plain	1	12.6	0.02	15.8	Very Poor	N/A		25%
2	AC0602	Accotink Creek	Piedmont	1	22.3	0.03	28.0	Poor	N/A		12.5%
3	AC0603	Accotink Creek	Piedmont	4	24,540.3	38.34	6.3	Very Poor	33	Good	0%
4	AC0604	Accotink Creek	Piedmont	4	22,975.7	35.90	41.5	Fair	25	Fair	12.5%
5	BE0601	Belle Haven	Coastal Plain	1	137.6	0.22	15.9	Very Poor	N/A		50%
6	BL0601	Bull Run	Triassic Basin	2	779.5	1.22	39.6	Poor	N/A		25%
7	CA0601	Cameron Run	Coastal Plain	1	85.2	0.13	44.7	Fair	N/A		12.5%
8	CA0602	Cameron Run	Piedmont	2	807.9	1.26	17.2	Very Poor	23	Poor	50%
9	CA0603	Cameron Run	Coastal Plain	2	1,096.7	1.71	22.4	Poor	14	Fair	37.5%
10	CU0601	Cub Run	Triassic Basin	1	100.2	0.16	11.9	Very Poor	N/A		25%
11	DC0601	Dogue Creek	Coastal Plain	1	82.8	0.13	22.4	Poor	N/A		0%
12	DC0602	Dogue Creek	Coastal Plain	2	438.7	0.69	11.4	Very Poor	14	Fair	37.5%
13	DE0601	Dead Run	Piedmont	1	207.5	0.32	19.0	Very Poor	N/A		37.5%
14	DF0601	Difficult Run	Piedmont	1	63.9	0.10	54.4	Fair	N/A		25%
15	DF0602	Difficult Run	Piedmont	1	104.2	0.16	20.4	Poor	N/A		25%
16	DF0603	Difficult Run	Piedmont	1	64.5	0.10	73.5	Good	N/A		37.5%
17	DF0605	Difficult Run	Piedmont	2	1,517.1	2.37	19.6	Very Poor	33	Good	25%
18	DF0606	Difficult Run	Piedmont	2	263.6	0.41	44.3	Fair	27	Fair	25%
19	DF0607	Difficult Run	Piedmont	2	311.1	0.49	19.9	Very Poor	31	Good	25%
20	DF0608	Difficult Run	Piedmont	4	4,149.9	6.48	22.3	Poor	35	Excellent	12.5%
21	DF0609	Difficult Run	Piedmont	3	1,428.3	2.23	12.0	Very Poor	31	Good	37.5%
22	DF0610	Difficult Run	Piedmont	3	679.0	1.06	19.3	Very Poor	33	Good	0%
23	JM0601	Johnny Moore	Triassic Basin	1	115.8	0.18	12.4	Very Poor	N/A		37.5%
24	JM0602	Johnny Moore	Triassic Basin	3	2,030.2	3.17	64.7	Good	33	Good	12.5%
25	LR0601	Little Rocky Run	Triassic Basin	1	86.8	0.14	14.8	Very Poor	N/A		50%
26	LR0602	Little Rocky Run	Triassic Basin	1	262.0	0.41	19.8	Very Poor	21	Poor	12.5%
27	MB0601	Mill Branch	Coastal Plain	1	28.8	0.05	26.7	Poor	N/A		37.5%
28	PC0601	Pohick Creek	Piedmont	1	176.9	0.28	13.2	Very Poor	N/A		62.5%
29	PC0602	Pohick Creek	Piedmont	2	750.9	1.17	40.9	Fair	23	Poor	37.5%
30	PC0603	Pohick Creek	Coastal Plain	2	147.3	0.23	25.4	Poor	N/A		0%
31	PC0604	Pohick Creek	Coastal Plain	5	6,213.0	9.71	29.7	Poor	18	Good	0%
32	PC0605	Pohick Creek	Coastal Plain	5	13,560.1	21.19	13.0	Very Poor	14	Fair	12.5%
33	PC0606	Pohick Creek	Piedmont	3	1,045.5	1.63	31.7	Poor	27	Fair	25%
34	PC0607	Pohick Creek	Piedmont	3	1,489.0	2.33	18.6	Very Poor	29	Fair	37.5%
35	PH0601	Popes Head Creek	Piedmont	1	55.6	0.09	65.5	Good	N/A		12.5%
36	PH0602	Popes Head Creek	Piedmont	1	73.1	0.11	80.3	Excellent	N/A		37.5%
37	PH0603	Popes Head Creek	Piedmont	1	55.8	0.09	16.6	Very Poor	N/A		37.5%
38	PH0604	Popes Head Creek	Piedmont	2	941.8	1.47	16.3	Very Poor	31	Good	12.5%
39	PH0605	Popes Head Creek	Piedmont	3	1,874.3	2.93	33.4	Poor	33	Good	0%
40	PM0601	Pimmit Run	Piedmont	1	147.9	0.23	7.8	Very Poor	N/A		25%
41	PN0601	Pond Branch	Piedmont	1	112.8	0.18	45.4	Fair	N/A		0%
42	SA0601	Sandy Run	Piedmont	1	121.7	0.19	64.9	Good	N/A		25%
43	SA0602	Sandy Run	Piedmont	1	21.4	0.03	72.7	Good	N/A		12.5%
44	SC0601	Scotts Run	Piedmont	2	285.2	0.45	13.3	Very Poor	21	Poor	25%

* Benthic IBI has a maximum score of 100

** Fish IBI has a maximum score of 45 in the piedmont and Triassic Basin and a maximum score of 20 in the Coastal Plain

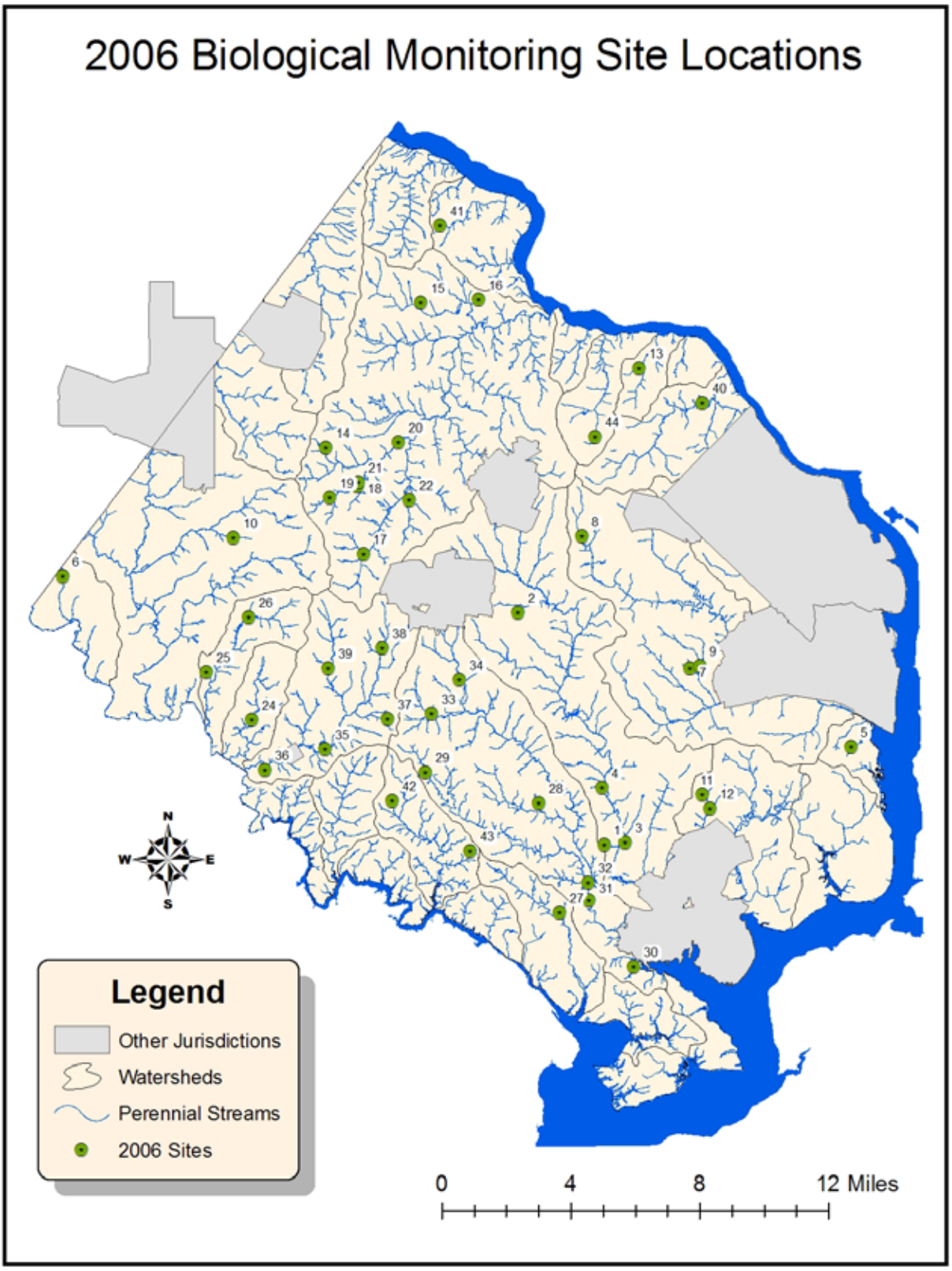


Figure 10: Locations of randomly-selected monitoring sites (biological and bacteriological) for 2006 sample year

4 Watershed Conditions: 1999 - 2006

The following series of maps summarizes biological monitoring results based on the benthic macroinvertebrate data collected from the original 1999 baseline study through 2006. Countywide, more than 275 sites have been monitored over this time period, including the 114 original baseline study sites. Combining these data on maps provides a picture of the range of conditions within and across watersheds. It also allows one to view stream conditions in their own backyard, community or favorite stream valley park.

The Watershed Condition Map Series is organized as follows:

- Index map of the 30 county watersheds
- Nichol Run and Pond Branch Watersheds
- Difficult Run Watershed
- Bull Neck, Scotts, Dead, Turkey and Pimmit Run Watersheds
- Cameron and Four Mile Run Watersheds
- Dogue Creek, Little Hunting Creek, and Belle Haven Watersheds
- Accotink Creek Watershed
- Pohick Creek Watersheds
- Mill Branch, Kane Creek, and High Point Watersheds
- Old Mill Branch, Wolf Run, Ryans Dam, Sandy Run and Occoquan Watersheds
- Popes Head Creek Watershed
- Little Rocky Run and Johnny Moore Watersheds
- Cub Run and Bull Run Watersheds

Fairfax County's program for assessing stream conditions over multiple years is similar to the Virginia Department of Environmental Quality's (VDEQ) method for determining which streams are in poor quality, referred to as impaired, and not suitable for their primary uses including swimming or fishing. VDEQ publishes a water quality report every two years that summarizes monitoring data and lists which streams and lakes are impaired. Monitoring data from a five year period are generally used for these assessments. For example, VDEQ's 2006 water quality report uses data from 2001 through 2005. Additional information on VDEQ's monitoring program and results for Fairfax County is presented in Section 5.

Future annual reports on Fairfax County streams will continue to include summaries of watershed conditions based on the compilation of annual sampling results. Approximately 150 sites will have been randomly sampled during the 2004-2007 period (using the probabilistic design approach initiated in 2004), providing a good basis for assessing individual watershed conditions as more data is collected. This will help in assessing long term trends in water quality, evaluating stormwater management conditions and assist with prioritizing watershed plan implementations. While direct comparisons and trend analysis can be made between the annual conditions of streams sampled under the probabilistic design approach, only general comparisons can be made back to the original Baseline Study sites sampled in 1999 and 2001, since these sites were selected and sampled using a different set of protocols.

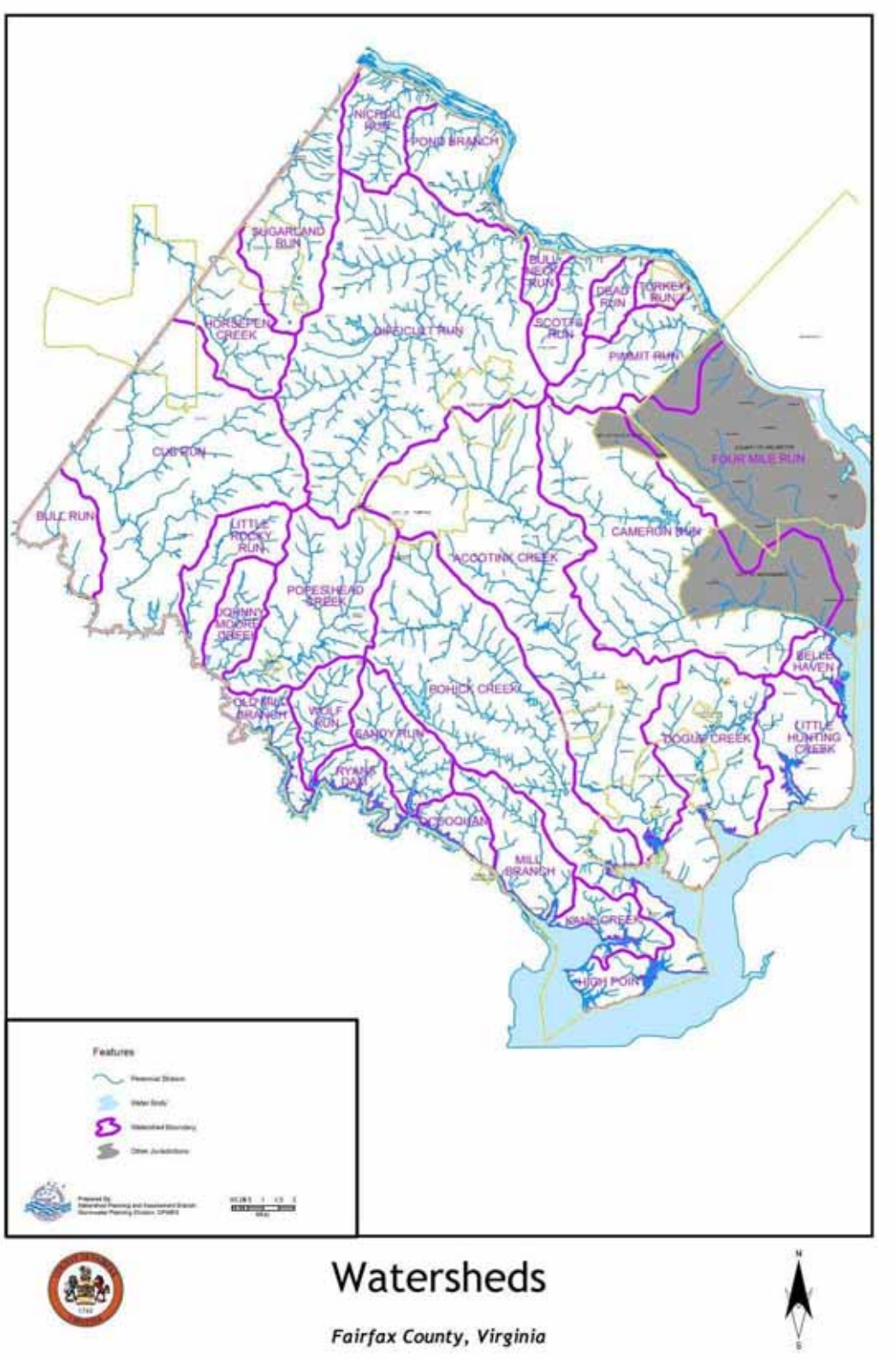


Figure 11: The 30 watersheds in Fairfax County

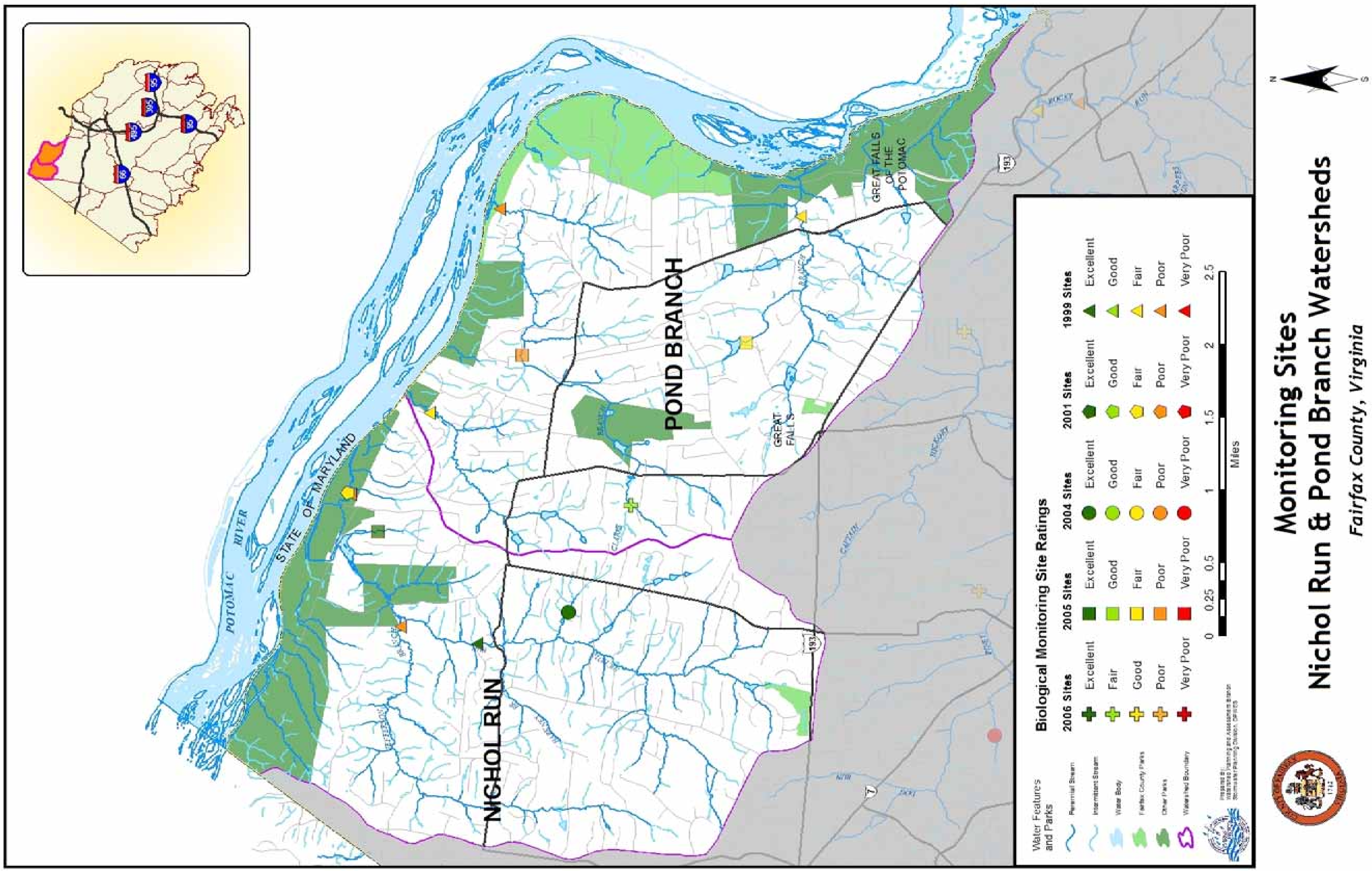
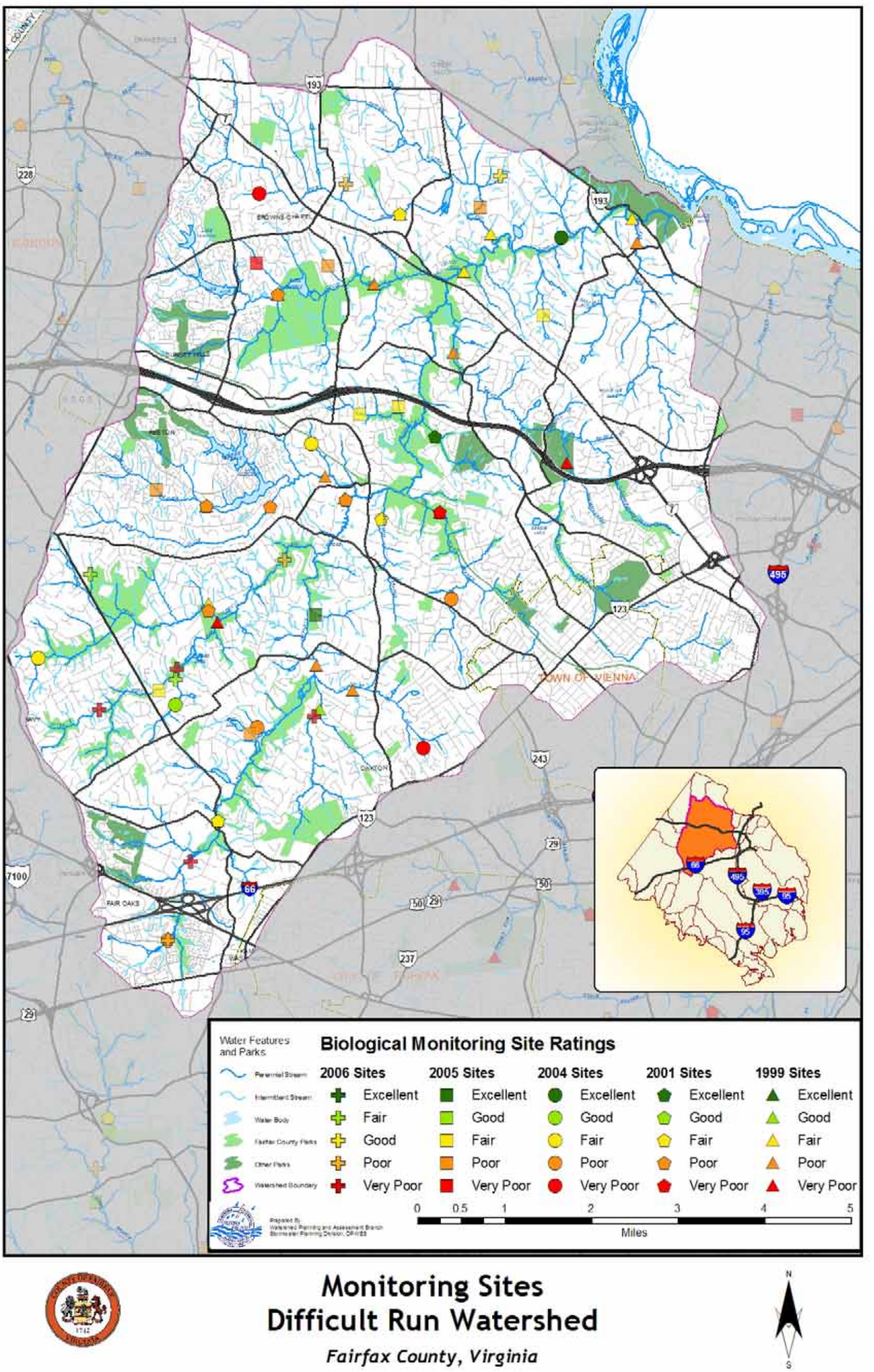


Figure 12: County stream monitoring sites - Nichol Run and Pond Branch

Figure 13: County stream monitoring sites - Difficult Run



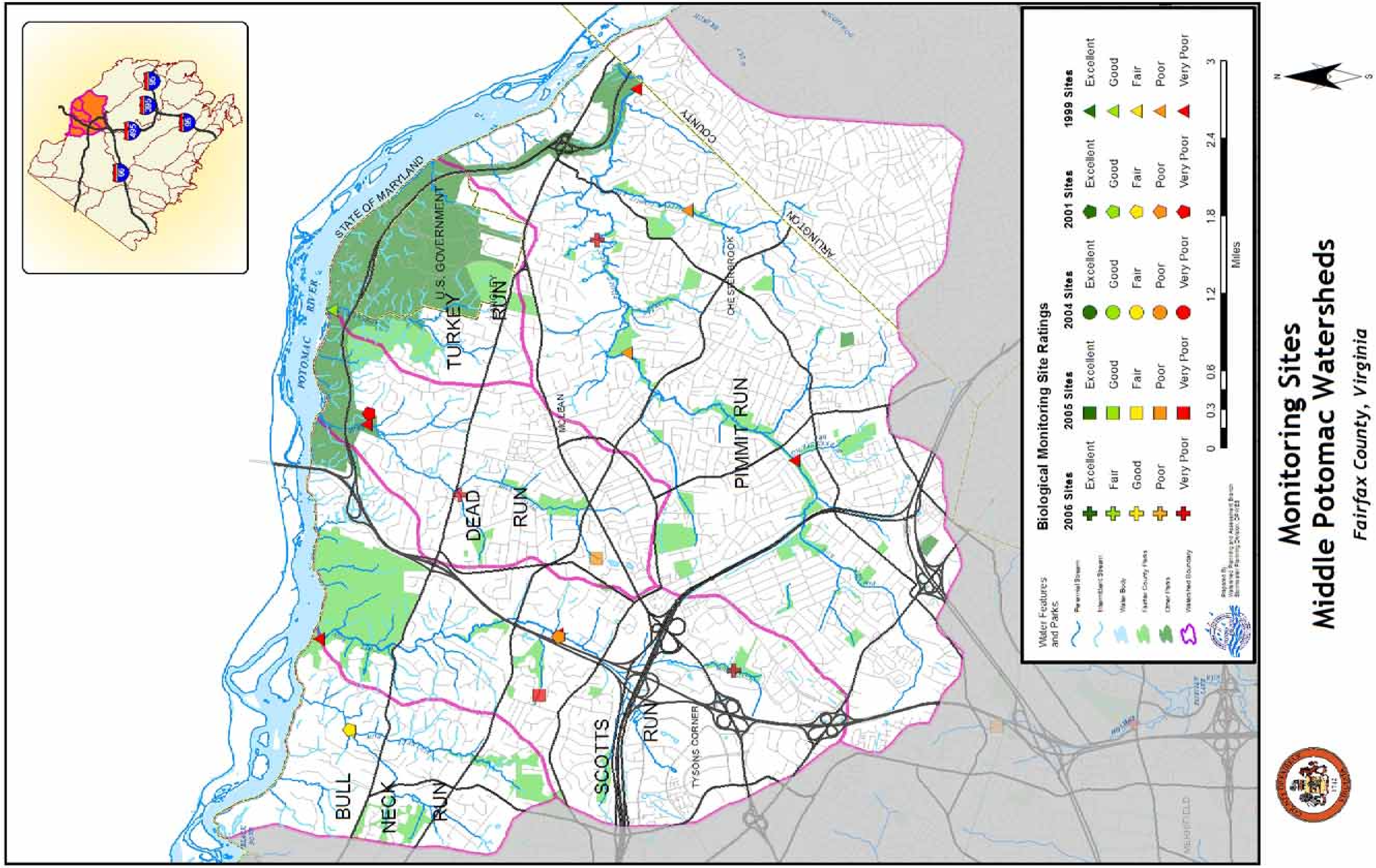


Figure 14: County stream monitoring sites - Bull Neck, Scotts, Dead, Turkey and Pimmit Run Watersheds

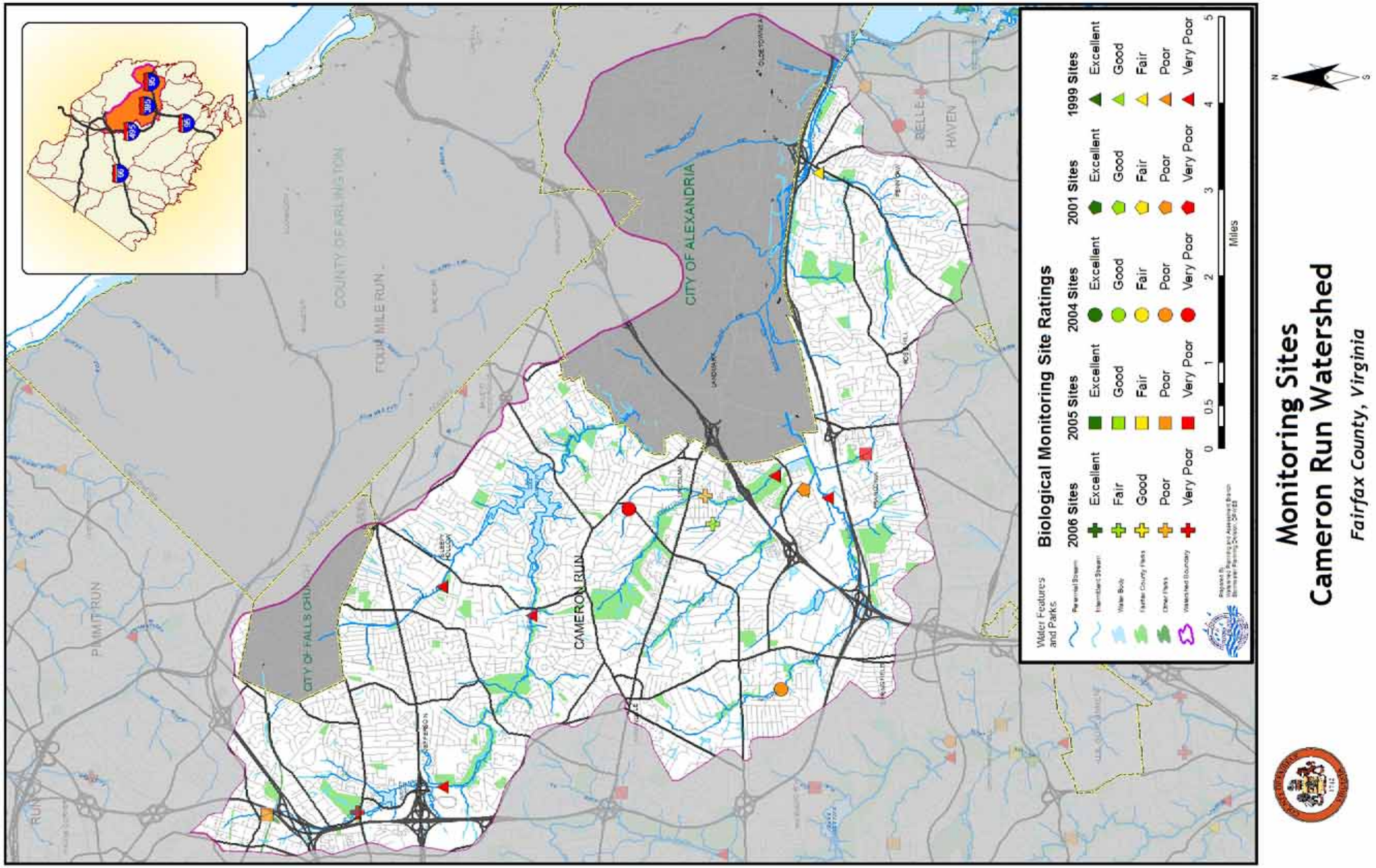


Figure 15: County stream monitoring sites - Cameron Run and Four Mile Run

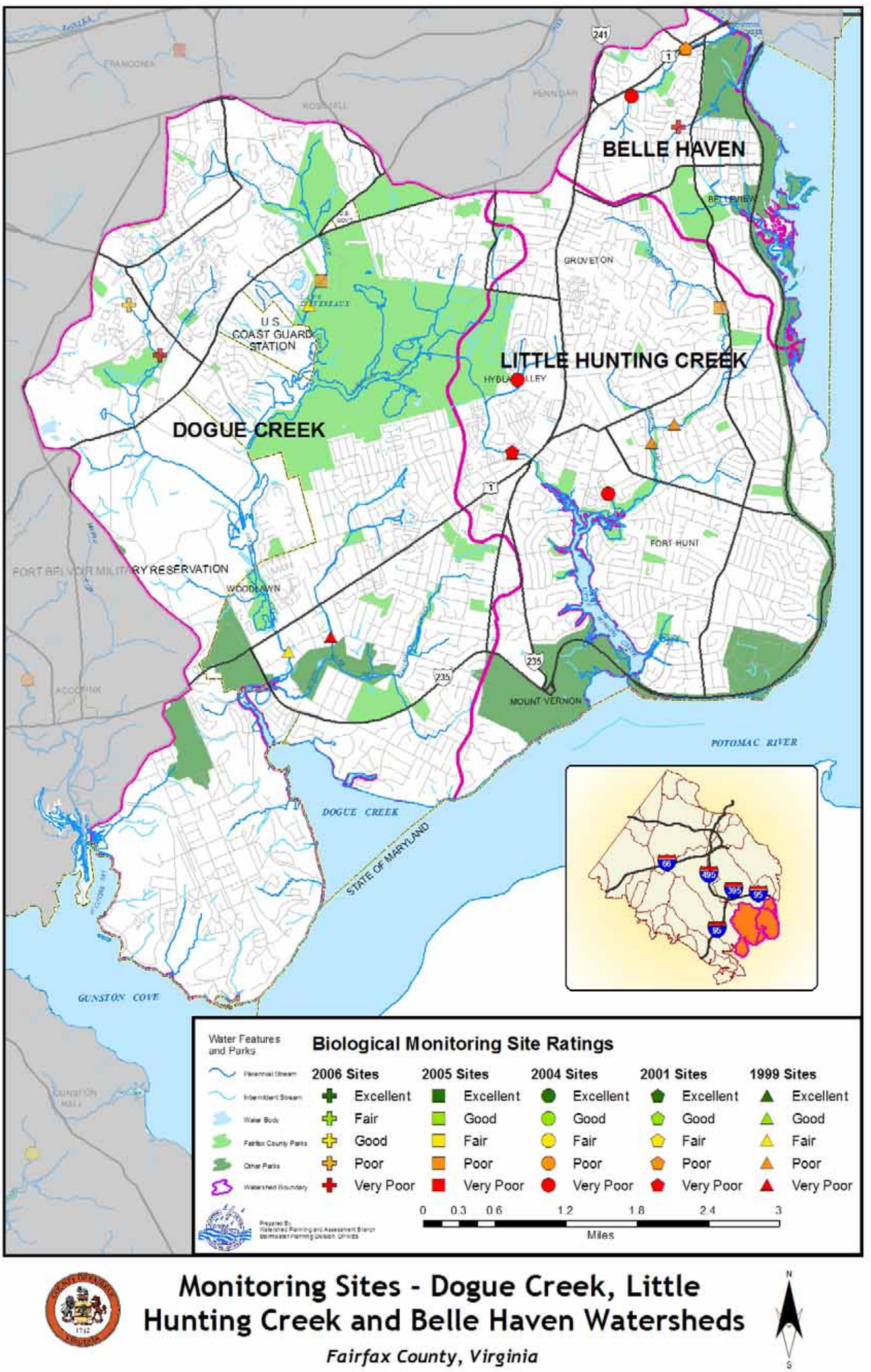


Figure 16: County stream monitoring sites - Dogue Creek, Little Hunting Creek, and Bell Haven

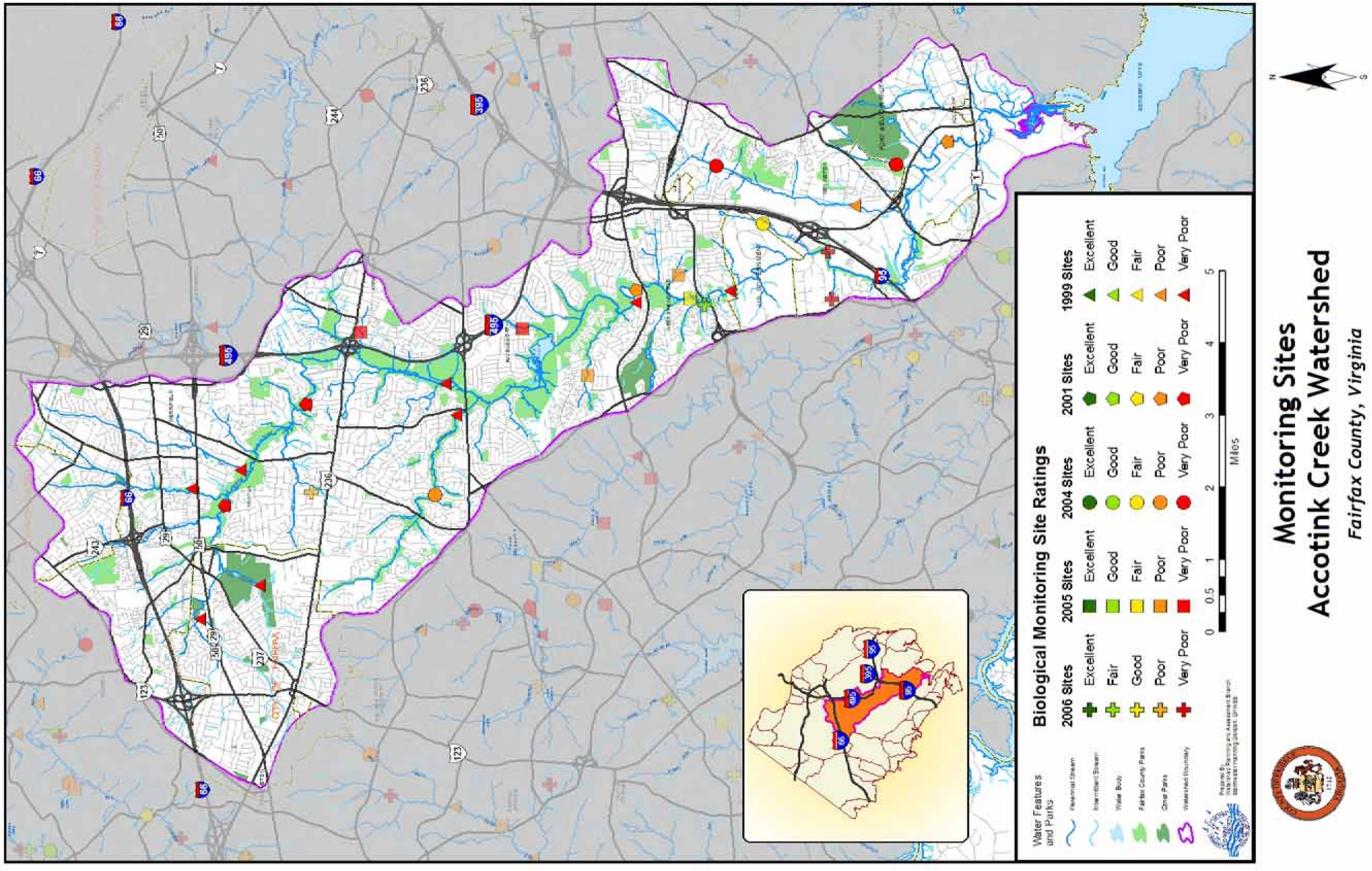
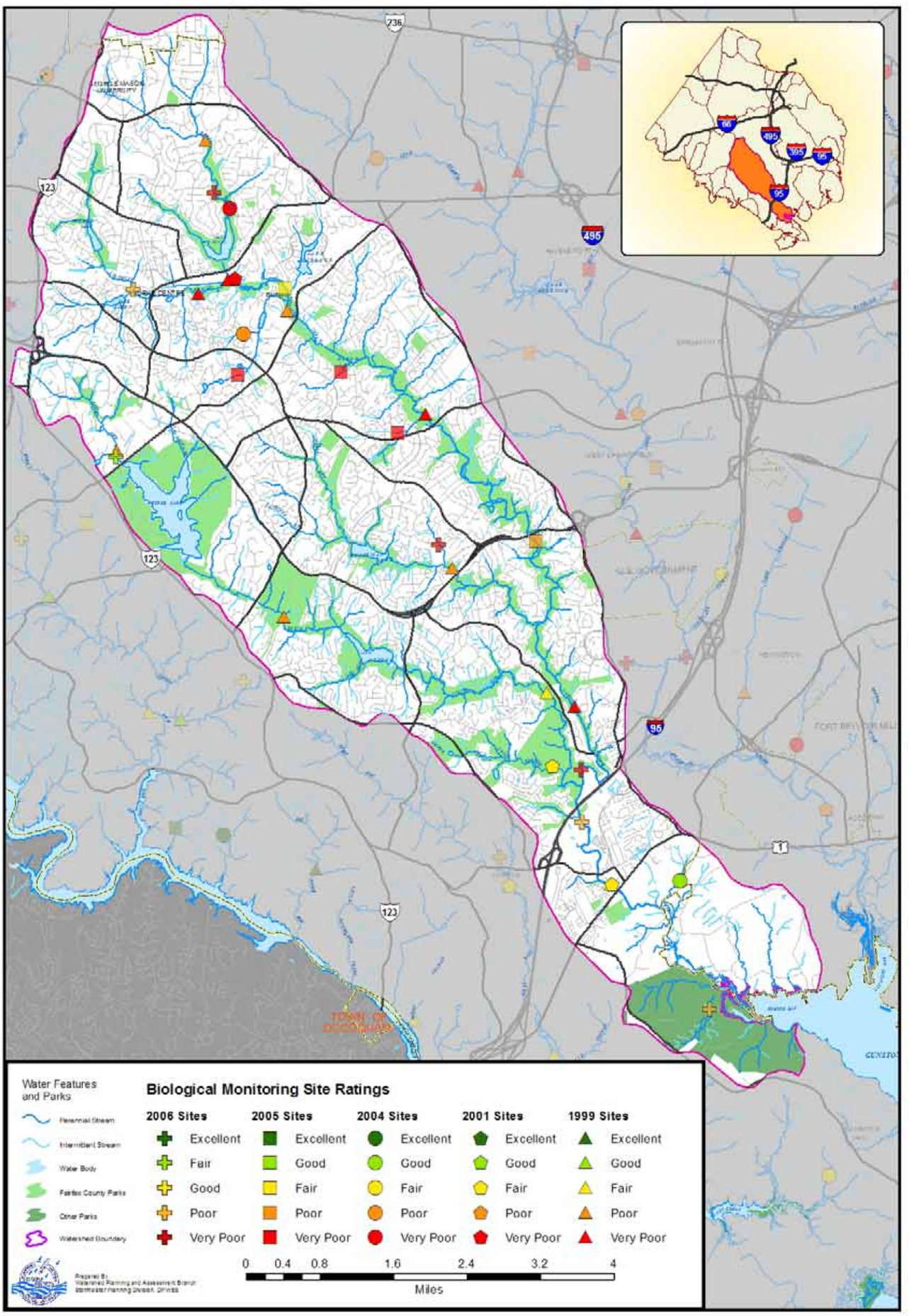


Figure 17: County stream monitoring sites - Accotink Creek

Figure 18: County stream monitoring sites - Pohick Creek



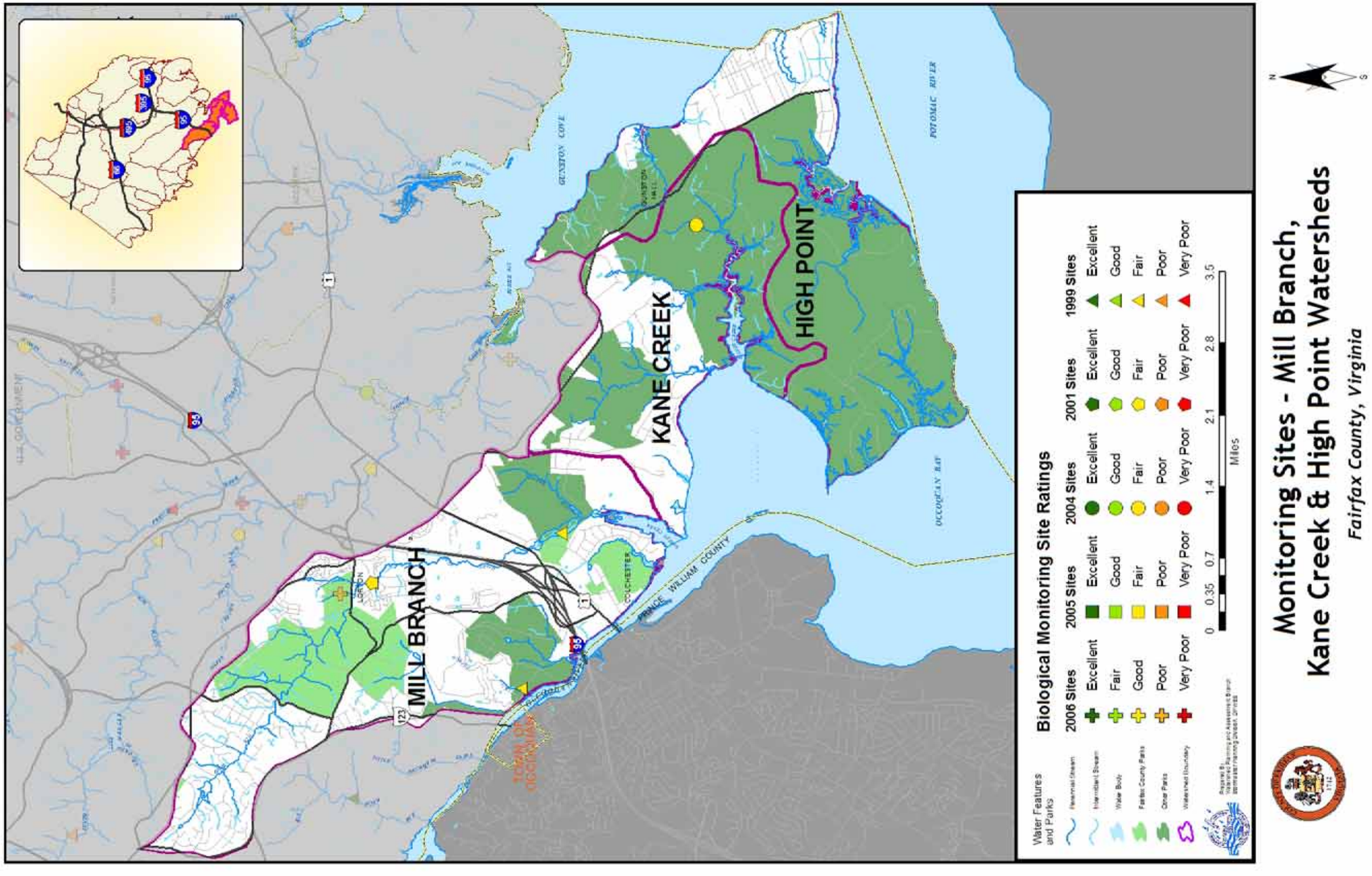


Figure 19: County stream monitoring sites - Mill Branch, Kane Creek, and High Point

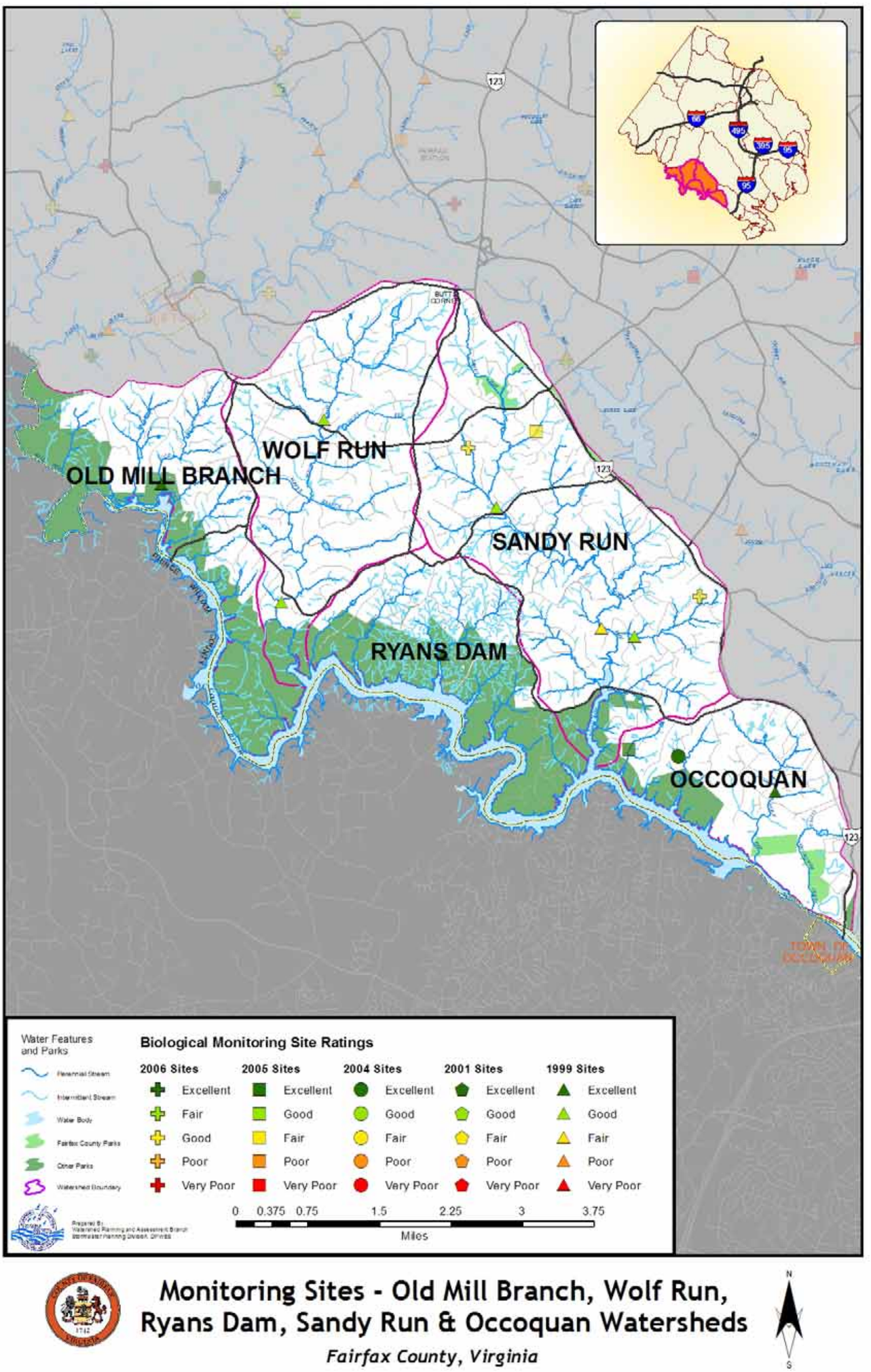


Figure 20: County stream monitoring sites - Old Mill Branch, Wolf Run, Ryans Dam, Sandy Run and Occoquan

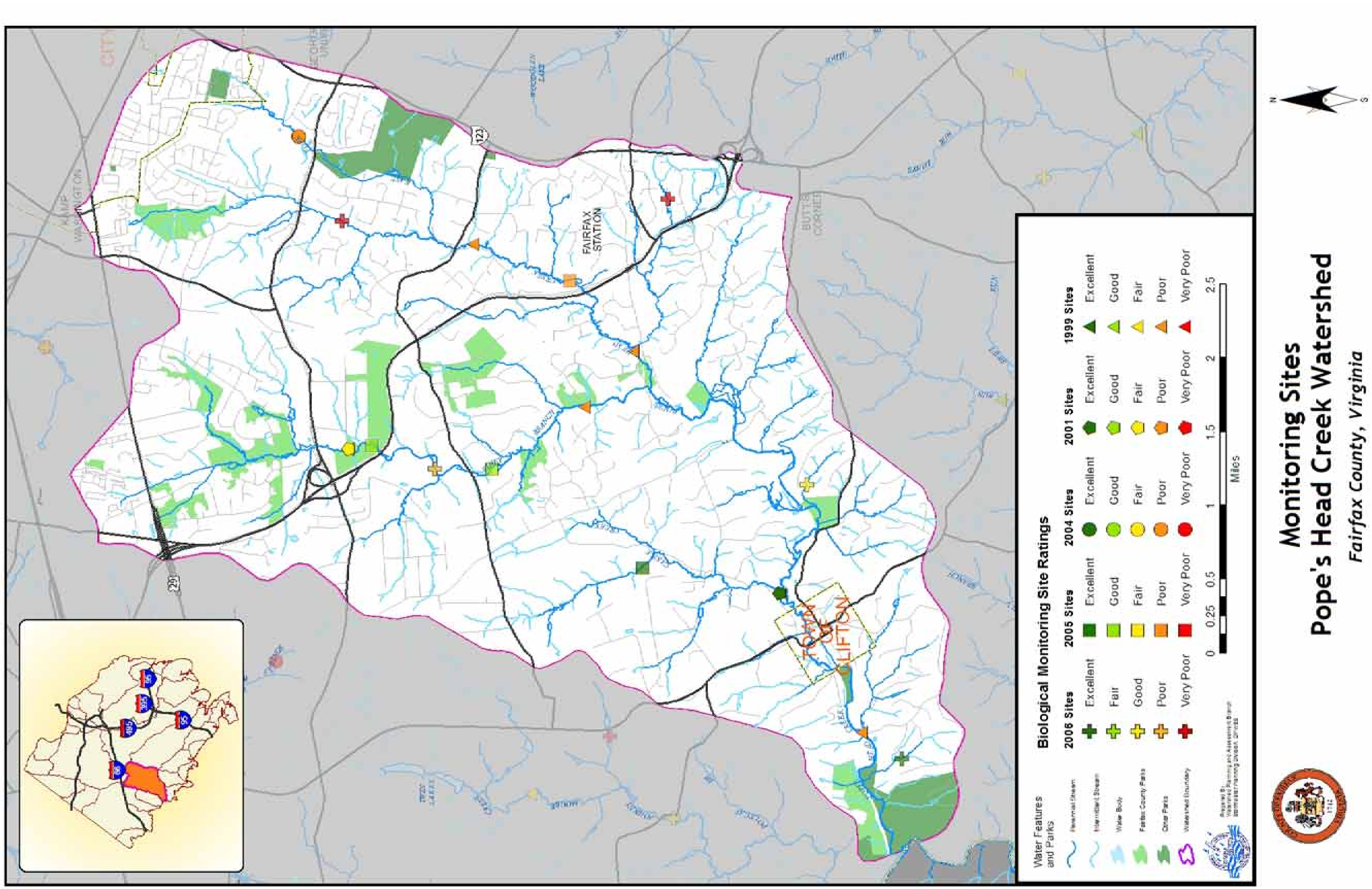


Figure 21: County stream monitoring sites - Pope's Head Creek

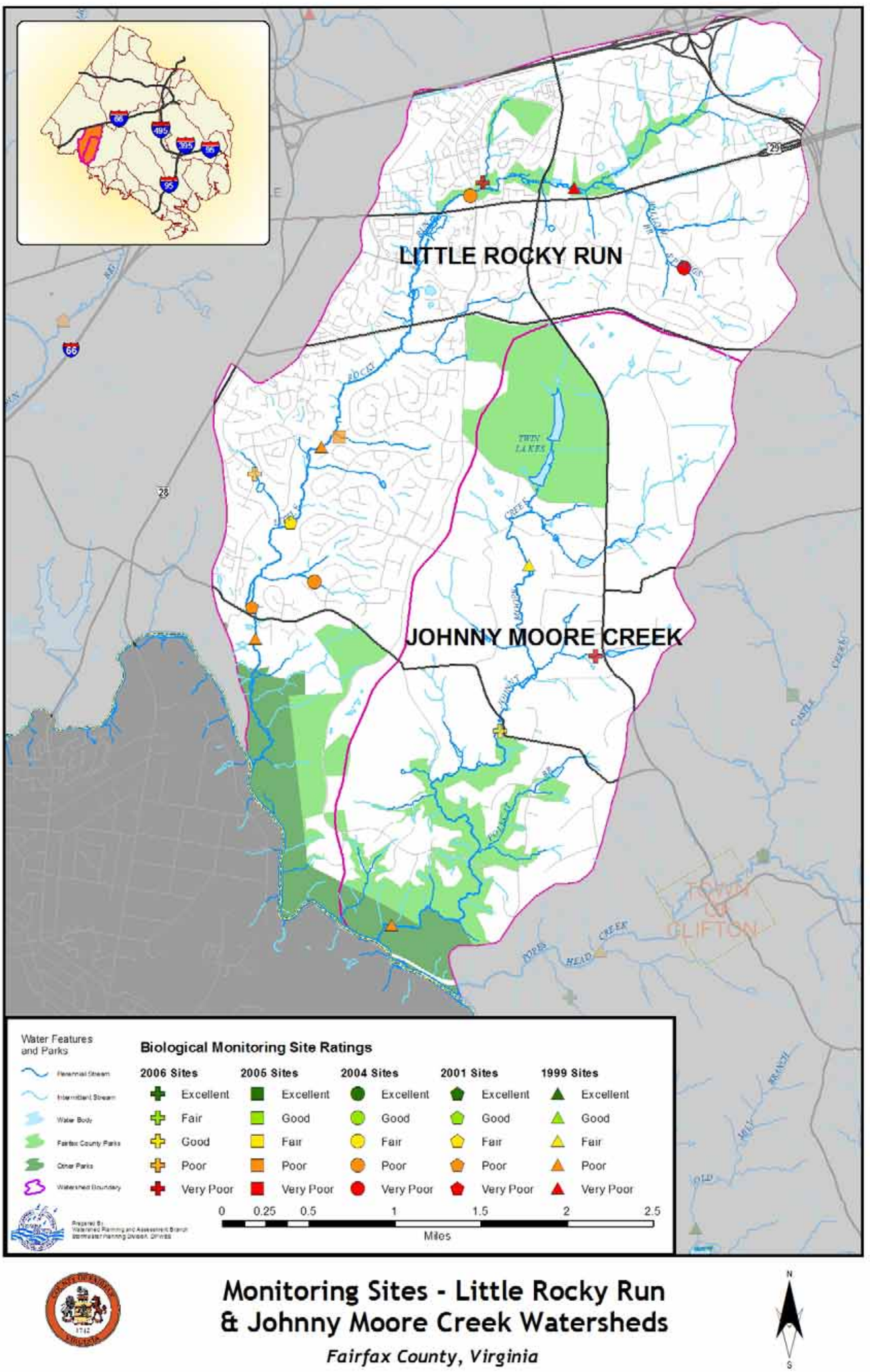


Figure 22: County stream monitoring sites - Little Rocky Run and Johnny Moore Creek

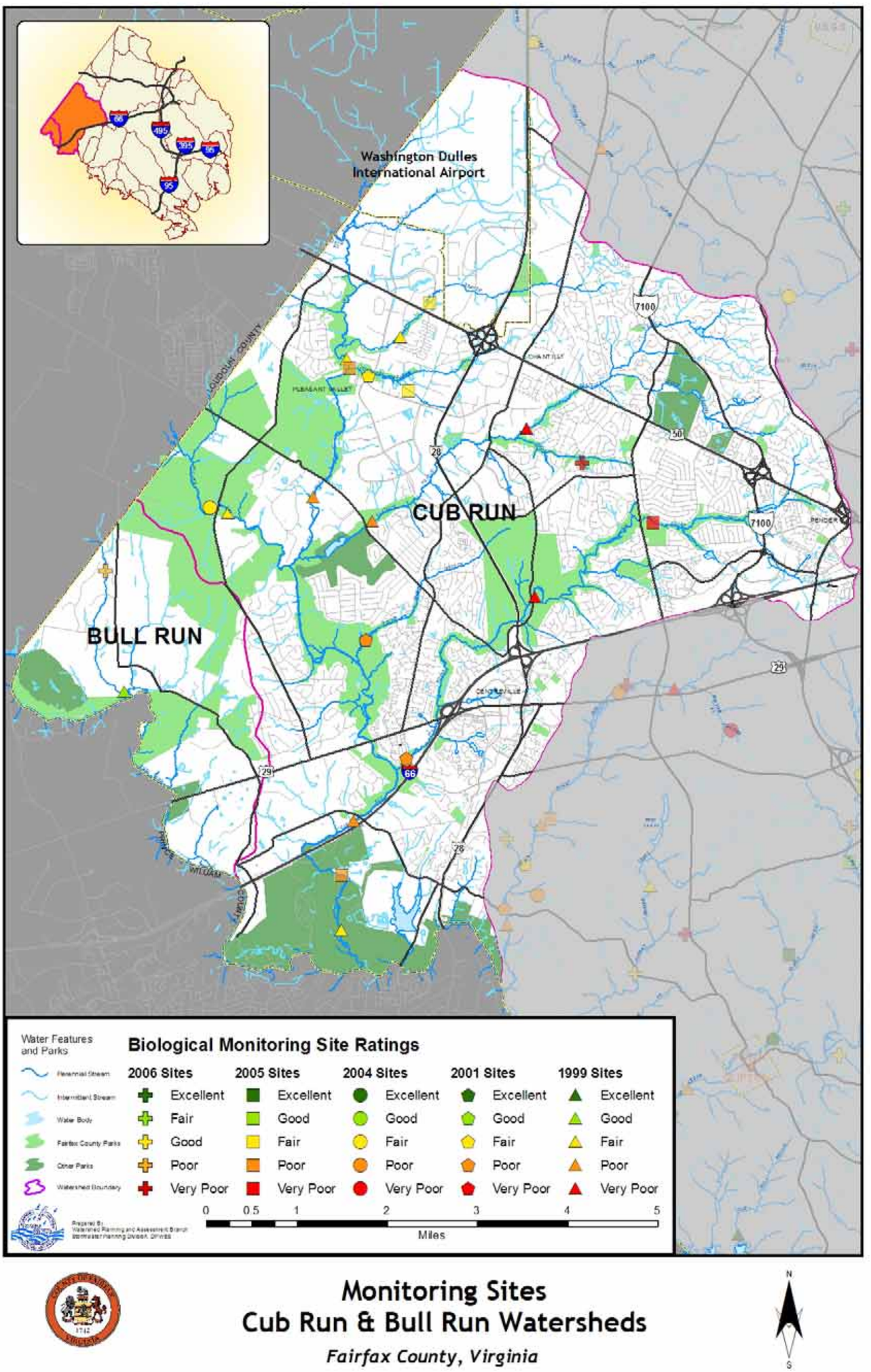


Figure 23: County stream monitoring sites - Cub Run and Bull Run

5 Virginia Department of Environmental Quality 2006 Impaired Waters Listings for Fairfax County

In October 2006, the Virginia Department of Environmental Quality (VDEQ) released the Final 2006 Water Quality Assessment Integrated Report, which is a summary of the water quality conditions in Virginia from January 1, 2000, to December 31, 2004. The goals of Virginia's water quality assessment program are to determine whether water bodies meet water quality standards and then design and implement a plan to restore waters with impaired water quality. Water quality standards designate uses for waters and define the water quality needed to support each use. There are six designated uses for surface waters in Virginia: aquatic life, fish consumption, shellfish consumption, swimming, public water supplies (where applicable) and wildlife. Several new subcategories of the aquatic life use have been adopted for estuarine waters of the Chesapeake Bay and its tidal tributaries. If a water body contains more pollutants than allowed by water quality standards, it will not support one or more of its designated uses. Such waters have "impaired" water quality and are listed on Virginia's 303(d) list as required under the Clean Water Act.

Once a water body has been listed as impaired, a Total Maximum Daily Load (TMDL) report identifying the sources causing the water quality problem and the reductions needed to resolve it must be developed by VDEQ and submitted to the U. S. Environmental Protection Agency (EPA) for approval. Upon approval, state law requires the development of a TMDL Implementation Plan outlining both point and non-point source controls needed to restore water quality. These specific controls may be incorporated into any Virginia Pollutant Discharge Elimination System (VPDES) or Virginia Stormwater Management Program (VSMP) permits identified as contributing to the water quality impairment. These permits are issued by the commonwealth and are used to regulate the inputs of pollution into receiving waters. The county holds a Municipal Separate Storm Sewer System (MS4) permit, which regulates the non-point source pollution entering receiving water bodies through the county's storm sewer (stormwater conveyance) system. Once specific controls are incorporated into a permit, these controls become mandatory.

A summary of the number of water bodies identified as impaired for both the 2004 and 2006 assessment periods is presented in Table 5. Eight new impaired waters were identified in 2006, and the total number of impairments more than doubled from 42 to 89. Table 6 presents more detail on the 2006 list of impaired waters, including the impacted use and related water quality standard for each water body. Figure 24 shows the location of all impaired water bodies within Fairfax County. Figures 25, 26 and 27 show the location of impairments based on the impacted designated use including aquatic life, fish consumption and recreational contact impairments.

Additional information on VDEQ's water quality program and 2006 report is available at:

http://www.deq.state.va.us/water

Table 5: Summary of Impaired Waters in Fairfax County for 2004 and 2006

WATER TYPE	WATER NAME	2004 TOTAL	2006 NEW	2006 TOTAL
ESTUARINE	Accotink Bay	1	1	2
	Belmont Bay	1	1	2
	Belmont Bay (Occoquan River)	1	2	3
	Dogue Creek	1	2	3
	Fourmile Run	3	1	4
	Gunston Cove	1	1	2
	Hunting Creek/Potomac River/Belle Haven	1	2	3
	Little Hunting Creek	1	2	3
	Occoquan Bay	3	2	5
	Occoquan Bay/Belmont Bay	2	2	4
	Occoquan River	2	1	3
	Pohick Bay	2	4	6
TOTAL ESTUARINE WATERS		12	0	12
TOTAL ESTUARINE IMPAIRMENTS		19	21	40
RESERVOIR	Occoquan Reservoir	2	1	3
RIVERINE	Accotink Creek	4		4
	Backlick Run	1		1
	Bull Run	4	4	8
	Cameron Run/Hunting Creek		1	1
	Cub Run		1	1
	Difficult Run	2	4	6
	Elklick Run		2	2
	Fourmile Run		1	1
	Holmes Run	2		2
	Indian Run		1	1
	Mills Branch	1		1
	Mine Run		1	1
	Pimmit Run	3	4	7
	Pohick Creek	2	2	4
	Popes Head Creek	1	1	2
	Snakeden Branch		1	1
	Sugarland Run		2	2
	Tripps Run	1		1
	Wolf Run		1	1
TOTAL RIVERINE WATERS		10	9	19
TOTAL RIVERINE IMPAIRMENTS		21	26	47
TOTAL WATERS		23	9	32
TOTAL IMPAIRMENTS		42	48	90

Table 6: Summary of 2006 VDEQ list of impaired waters in Fairfax County

			AQUATIC LIFE					FISH CONSUMPTION				RECREATION			
WATER TYPE	WATER NAME	IMPAIRMENT ID	Aquatic Plants (Macro-phytes)	Benthic Macro-invertebrate Bioassess-ments (Streams)	Estuarine Bioassess-ments	Oxygen, Dissolved	pH	Benzo[k]-fluoranthene	Chlordane	Heptachlor epoxide	PCB in Fish Tissue	Escherichia coli	Fecal Coliform	TOTAL	UNITS
ESTUARINE	Accotink Bay	VAN-A15E_ACO01A06	0.3								0.3			0.3	Sq. Mi.
	Belmont Bay	VAN-A25E_OCC04A02	0.4								0.4			0.4	Sq. Mi.
	Belmont Bay (Occoquan River)	VAN-A25E_OCC03A04	0.4		0.4						0.4			0.4	Sq. Mi.
	Dogue Creek	VAN-A14E_DOU01A00	0.7								0.7		0.7	0.7	Sq. Mi.
	Fourmile Run	VAN-A12E_FOU01A00	0.1								0.1	0.1	0.1	0.1	Sq. Mi.
	Gunston Cove	VAN-A15E_POH01A00	1.5								1.5			1.5	Sq. Mi.
	Hunting Creek/Potomac River/Belle Haven	VAN-A13E_HUT01A02	1.4								1.4	1.4		1.4	Sq. Mi.
	Little Hunting Creek	VAN-A14E_LIF01A00	0.2								0.2	0.2		0.2	Sq. Mi.
	Occoquan Bay	VAN-A25E_OCC01A04	0.5								0.5			0.5	Sq. Mi.
		VAN-A25E_OCC02A00	0.6				0.6				0.6			0.6	Sq. Mi.
	Occoquan Bay/Belmont Bay	VAN-A25E_OCC20A02	5.4								5.4			5.4	Sq. Mi.
		VAN-A25E_POT20A02	0.2								0.2			0.2	Sq. Mi.
	Occoquan River	VAN-A25E_OCC05A02	0.1								0.1		0.1	0.1	Sq. Mi.
	Pohick Bay	VAN-A15E_POH02A00	0.6								0.6		0.6	0.6	Sq. Mi.
		VAN-A16E_POH01A06	0.3								0.3		0.3	0.3	Sq. Mi.
ESTUARINE TOTAL			12.7	0.0	0.4	0.0	0.6	0.0	0.0	0.0	12.7	1.7	1.7	12.7	Sq. Mi.
RESERVOIR	Occoquan Reservoir	VAN-A24L_OCC01A02				1,265.0								1,265.0	Acres
		VAN-A24L_OCC02A06				63.0					63.0			63.0	Acres
RESERVOIR TOTAL			0.0	0.0	0.0	1,328.0	0.0	0.0	0.0	0.0	63.0	0.0	0.0	1,328.0	Acres
RIVERINE	Accotink Creek	VAN-A15R_ACO01A00		8.6									8.6	8.6	Miles
		VAN-A15R_ACO02A00										4.8		4.8	Miles
		VAN-A15R_ACO04A02										1.2		1.2	Miles
	Backlick Run	VAN-A13R_BAL01A00											6.5	6.5	Miles
	Bull Run	VAN-A21R_BUL01A06									0.2			0.2	Miles
		VAN-A21R_BUL01B06									2.5			2.5	Miles
		VAN-A23R_BUL01A06									2.3			2.3	Miles
		VAN-A23R_BUL01B02									0.6			0.6	Miles
		VAN-A23R_BUL01C04									1.0			1.0	Miles
		VAN-A23R_BUL02A02		4.8							4.8		4.8	4.8	Miles
	Cameron Run/Hunting Creek	VAN-A13R_CAM01A04										2.1		2.1	Miles
	Cub Run	VAN-A22R_CUB01A00										6.8		6.8	Miles
	Difficult Run	VAN-A11R_DIF01A00		2.9						2.9	2.9	2.9		2.9	Miles
		VAN-A11R_DIF01B06									1.1			1.1	Miles
		VAN-A11R_DIF03A02										3.2		3.2	Miles
	Elklick Run	VAN-A22R_ELC01A04										2.2	2.2	2.2	Miles
	Fourmile Run	VAN-A12R_FOU01A00										7.9		7.9	Miles
	Holmes Run	VAN-A13R_HOR01A00											3.6	3.6	Miles
		VAN-A13R_HOR01B00		5.8										5.8	Miles
	Indian Run	VAN-A14R_INA01A06									3.0			3.0	Miles
	Mills Branch	VAN-A25R_WLB01A02											1.8	1.8	Miles
	Mine Run	VAN-A11R_MNR01A04										0.9		0.9	Miles
	Pimmit Run	VAN-A12R_PIM01A00							1.6	1.6	1.6		1.6	1.6	Miles
		VAN-A12R_PIM02A00									2.5		2.5	2.5	Miles
		VAN-A12R_PIM02B06											3.2	3.2	Miles
	Pohick Creek	VAN-A16R_POH01A00						3.2			3.2	3.2		3.2	Miles
		VAN-A16R_POH03A04										1.5		1.5	Miles
	Popes Head Creek	VAN-A23R_POE01A00		4.9								4.9		4.9	Miles
	Snakeden Branch	VAN-A11R_SNA01A02										0.8		0.8	Miles
	Sugarland Run	VAN-A10R_SUG01A00										4.8		4.8	Miles
		VAN-A10R_SUG01B06										0.9		0.9	Miles
	Tripps Run	VAN-A13R_TRI01A00		2.3										2.3	Miles
	Wolf Run	VAN-A24R_WOL01A06										2.2		2.2	Miles
RIVERINE TOTAL			0.0	29.3	0.0	0.0	0.0	3.2	1.6	4.6	25.7	50.4	34.8	101.7	Miles

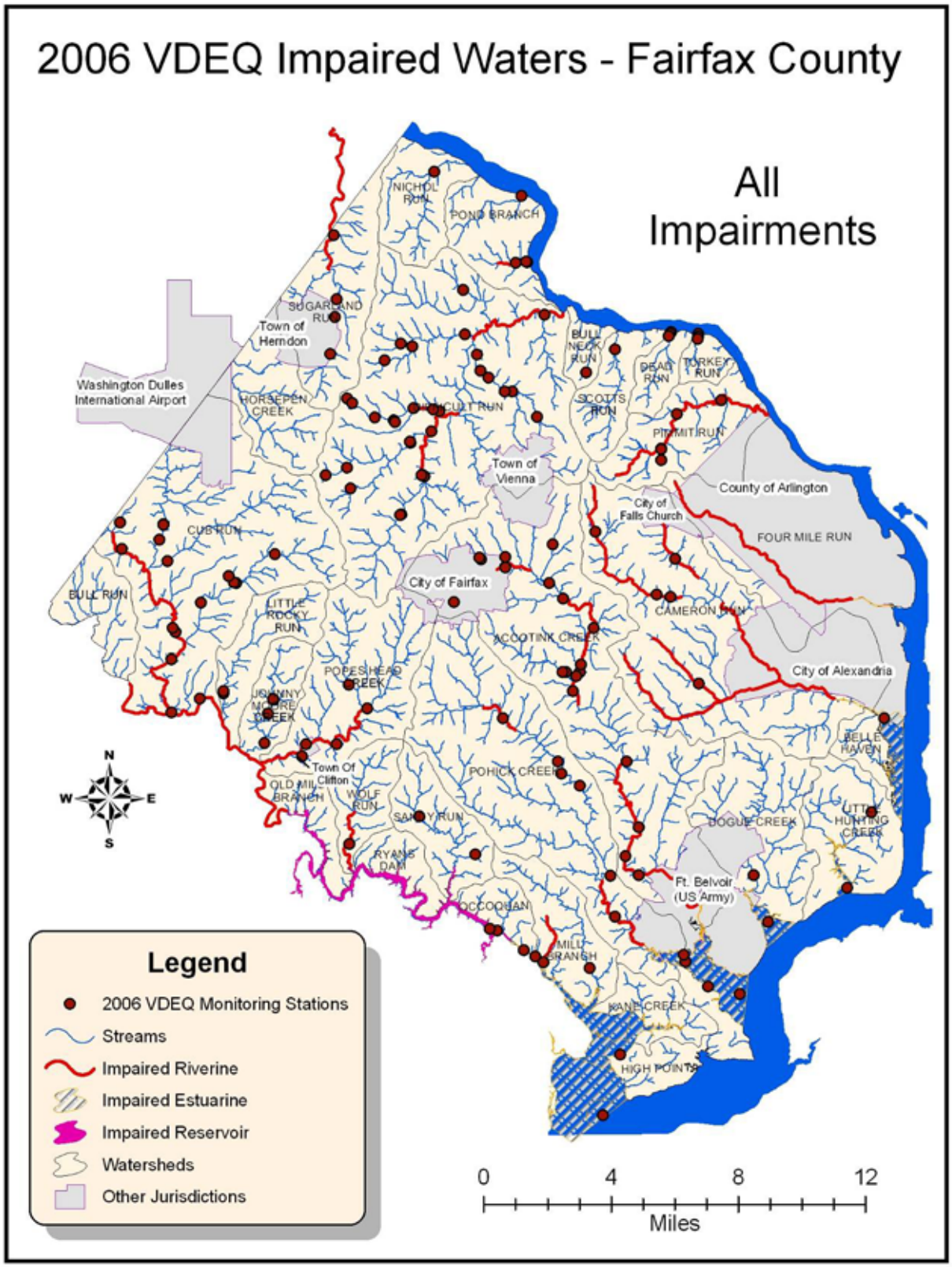


Figure 24: All Impaired waters within Fairfax County as listed on Virginia's 2006 303(d) report to US EPA

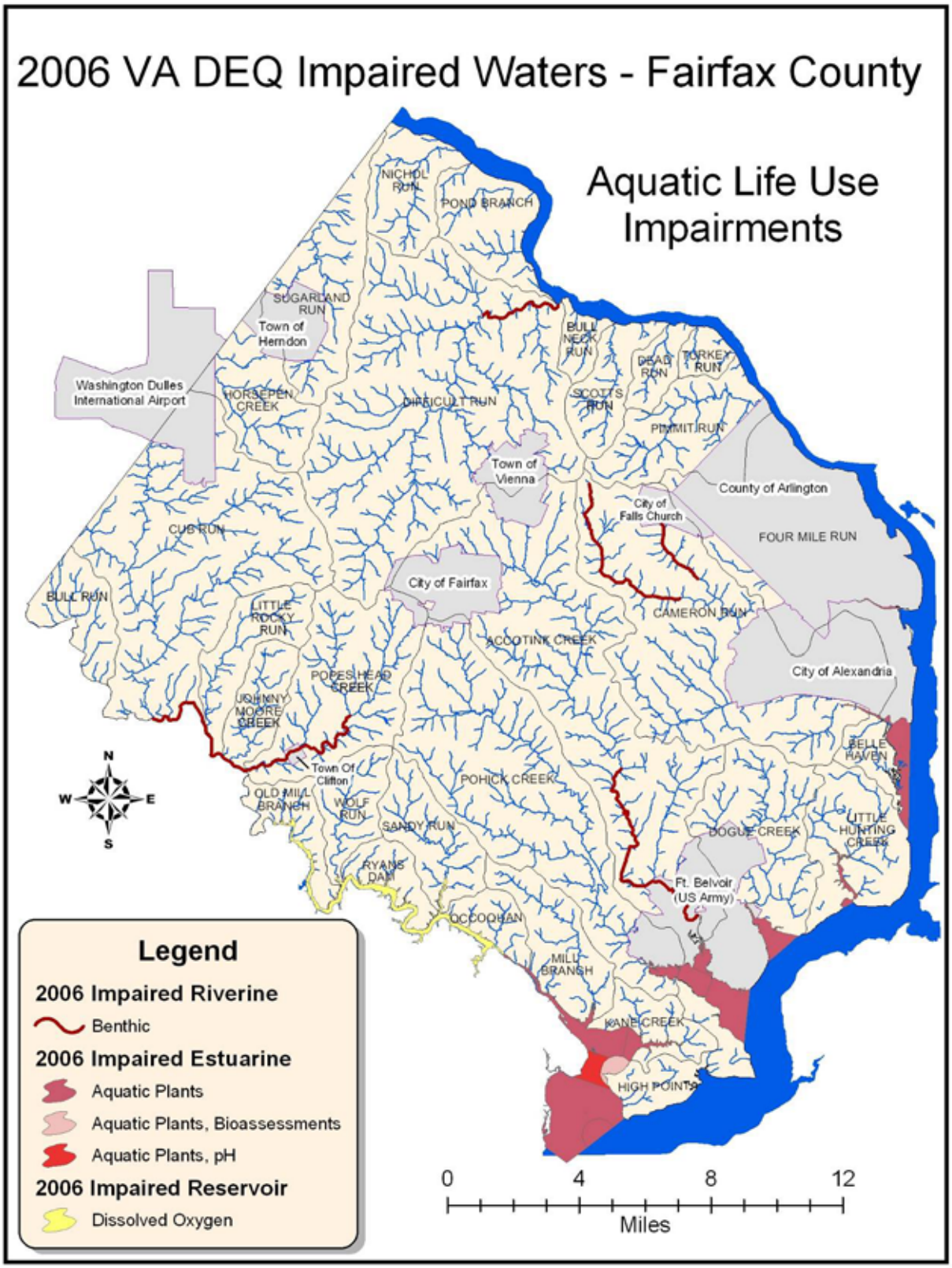


Figure 25: Waters designated as Impaired for aquatic life uses within Fairfax County (as listed on Virginia's 2006 303(d) report to US EPA)

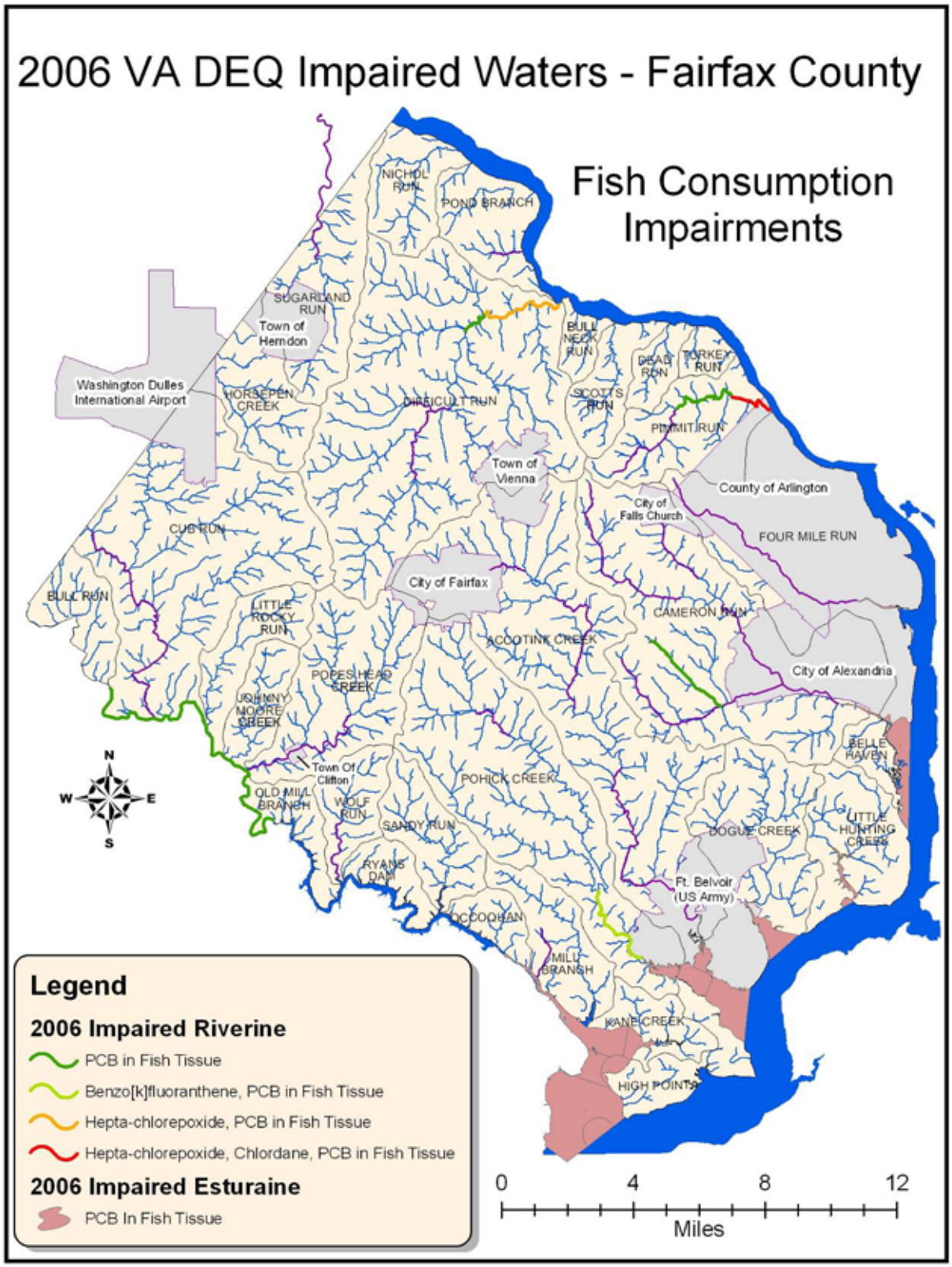


Figure 26: Fairfax County waters designated as Impaired for fish consumption (as listed on Virginia's 2006 303(d) report to US EPA)

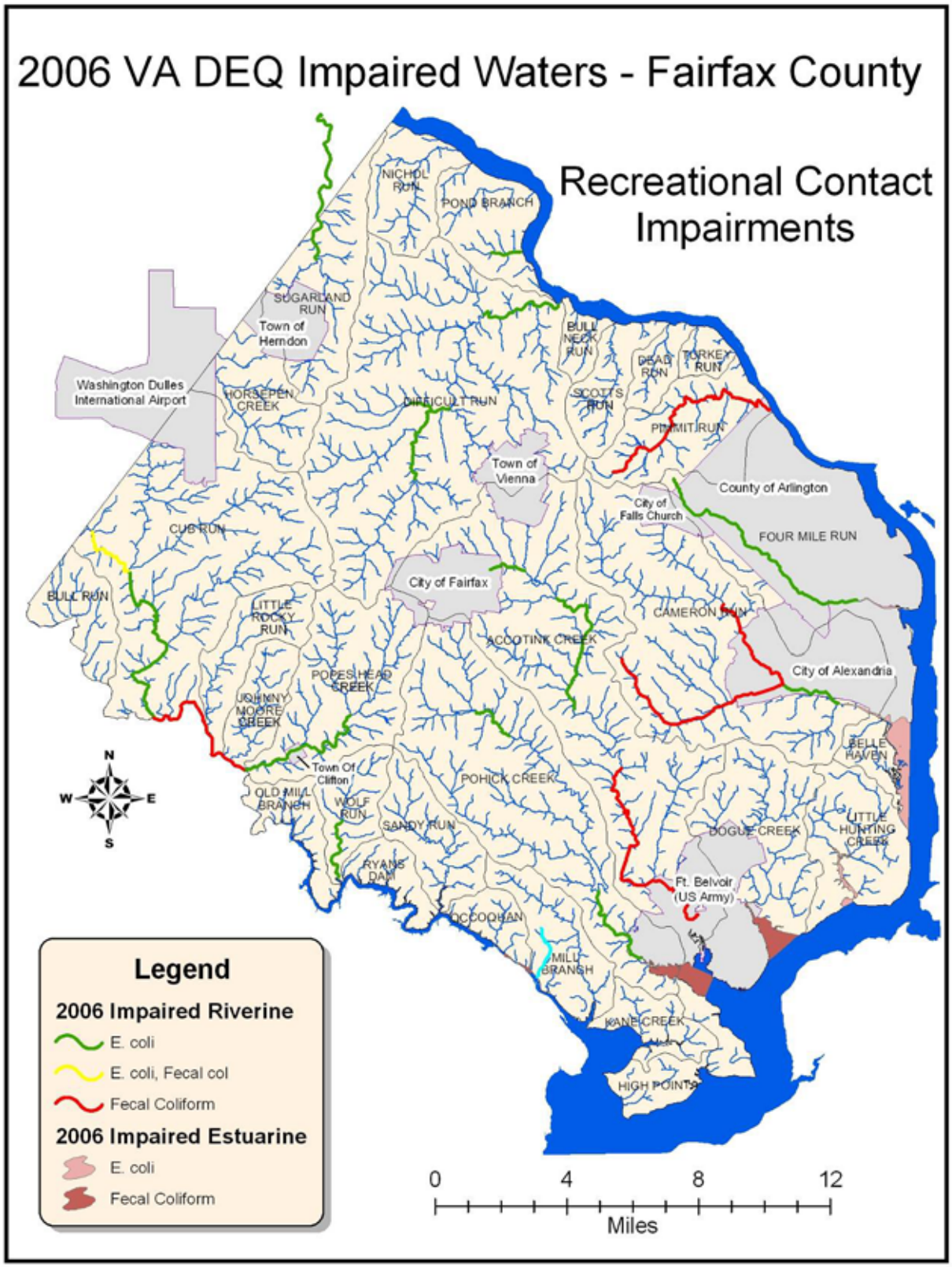


Figure 27: Fairfax County waters designated as Impaired for recreational contact (as listed on Virginia's 2006 303(d) report to US EPA)

6 References

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling, *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish*, 2d ed., U.S. Environmental Protection Agency-Office of Water, Washington, D.C., 1999.

Environmental Excellence for Fairfax County - A 20-Year Vision, Fairfax County Board of Supervisors, Fairfax, Va. <http://www.fairfaxcounty.gov/chairman/environmental_plan.htm>

Fairfax County Stream Protection Strategy Baseline Study, Fairfax County Stormwater Planning Division, Fairfax, Va., January 2001. <http://www.fairfaxcounty.gov/dpwes/environmental/sps_main.htm>

Modified SOS method for sampling riffle streams, Virginia Save Our Streams - Virginia Division of the Izaak Walton League of America, Virginia. <http://www.sosva.com/method.htm>

Standard Operating Procedures Manual, Fairfax County Biological Stream Monitoring Program, Fairfax County Stormwater Planning Division, Fairfax, Va., January 2006.

2005 Annual Report on Fairfax County's Streams, Fairfax County Stormwater Planning Division, Fairfax, Va., November 2005. <http://www.fairfaxcounty.gov/dpwes/stormwater/streams/streamreports.htm>

Strahler, A. N., *Dynamic basis of geomorphology,* Geological Society of America Bulletin, 63, 1952, pp. 923 - 938.

Virginia Department of Environmental Quality Annual Water Quality Monitoring Plan - Monitoring Year 2004, Virginia Department of Environmental Quality, Richmond, Va., 2003.

Virginia Water Quality Standard, Virginia Department of Environmental Quality, Richmond, Va., 2006, p.181. <http://www.deq.virginia.gov/wqs/documents/WQS06_EDIT.pdf>

(DRAFT) Virginia Water Quality Assessment 305 (b) / 303 (d) Integrated Report to Congress and the EPA Administrator for the Period January 1, 2000 to December 31, 2004, Virginia Department of Environmental Quality, Richmond, Va., 2006. <http://www.deq.state.va.us/wqa/305b2006.html>

7 Glossary

B

Baseline Monitoring: Data collection intended to define existing biological conditions and to set up a framework for long-term study.

Benthic: That portion of the aquatic environment inhabited by organisms which live permanently in or on the bottom.

Benthic Macroinvertebrate: An aquatic animal lacking a backbone and generally visible to the unaided eye.

Biomonitoring: The use of living organisms to assess environmental conditions.

C

Canopy Cover: The amount of cover provided by trees and shrubs.

Clean Water Act: A law enacted by the United States Congress in 1972 and enforced by the Environmental Protection Agency on the national level. The Clean Water Act established three main goals: "zero discharge" also known as the elimination of polluting discharges to the nation's waters by 1985; "fishable and swimmable waters" also known as the restoration and protection of water quality and wildlife habitat; and "no toxins in toxic amounts" or the prohibition of the discharge of toxic pollutants in amounts that are toxic to the environment or life.

Coastal Plain: The physiographic province that lies along the Atlantic coast and extends inland to the Piedmont physiographic province. This area is generally characterized by low gradient, meandering streams with mobile sand/silt or gravel substrates.

Community: An assemblage of species living together in a defined area.

D

Dissolved Oxygen: The amount of oxygen freely available in water and necessary for aquatic life and the oxidation of organic materials.

E

***E. coli*:** A species of fecal coliform bacteria that is specific to fecal material from humans and other warm-blooded animals. The EPA states that E. *coli* is the best indicator of health risk from water contact in recreational waters.

Ecosystem: All of the component organisms of a community and their environment that, together, form an interacting system.

Electrofishing: Fish sampling method using electrical currents to temporarily stun fish to facilitate capture. Fish species help indicate stream water quality.

Embeddedness: Refers to the extent to which stream substrate (gravel, cobble, boulders and snags) is filled and/or covered with silt, sand, or mud.

F

Fecal Coliform Bacteria: A group of organisms common to the intestinal tracts of humans and warm-blooded animals. The presence of fecal coliform bacteria in water is an indicator of pollution and of potentially dangerous bacterial contamination.

Fish Index of Biotic Integrity (F-IBI): A stream assessment tool that evaluates the biological integrity of streams based on various characteristics of the fish community at a site.

G

Genus: A taxonomic category.

Geographic Information System (GIS): A method of overlaying spatial land and land use data of different kinds. The data are referenced to a set of geographical coordinates and encoded in a computer software system. GIS is used by many localities to map utilities and sewer lines and to delineate zoning areas.

Glide: Section of a stream with a relatively high velocity and with little or no turbulence on the surface of the water.

H

Habitat: The environment in which an organism lives.

Habitat Generalists: Organisms that are not bound to one particular type of habitat in order to exist and thrive. Systems with degraded habitat are dominated by these organisms. These, therefore, make good indicators for assessing habitat quality.

I

Impervious Cover: A surface composed of any material that significantly impedes or prevents natural infiltration of water into soil (e.g. sidewalks, houses, parking lots, roofs and streets).

Imperviousness: The percentage of impervious cover within a defined area.

Impoundment: A body of water contained by a barrier such as a dam.

Index of Biotic Integrity (IBI): A multi-parameter assessment tool that evaluates the biological integrity of stream ecosystems based on characteristics of the fish or benthic macroinvertebrate community at a site.

Intolerant Species: Populations of animals and/or plants that are adversely affected by low levels of degradation or disturbance to habitat and/or water quality.

M

Metric: A characteristic of a habitat or biological community structure that changes in some predictable way with increased disturbance or divergence from normal, natural conditions. Several metrics are aggregated to form the Index of Biological Integrity

N

Native Species: A species that exists naturally in an area. It is not introduced.

Nitrate: A form of nitrogen which is found in several different forms in terrestrial and aquatic ecosystems. Sources of nitrates include wastewater treatment plants; runoff from fertilized lawns and cropland; failing on-site septic systems; runoff from animal manure storage areas; and industrial discharges that contain corrosion inhibitors.

Non-native species: Species that have been introduced into an area by man. Typically these organisms disturb the ecosystem by competing with the native inhabitants. Usually the degree of ecosystem disturbance is directly related to the proportion of non-native species to the native inhabitants.

Nonpoint Source Pollution (NPS): Contaminants such as sediment, nitrogen, phosphorous, hydrocarbons, heavy metals and other toxins whose sources cannot be pinpointed but rather are washed from the land surface in a diffuse manner by stormwater runoff.

O

Omnivores: An animal that feeds on a variety of foods. Typically, these organisms are more successful in degraded environments due to their diverse diet as opposed to species that have very specific diet dependencies.

P

Perennial Streams: A body of water that normally flows year-round in a defined channel or bed, and is capable, in the absence of pollution or other manmade stream disturbances, of supporting bottom dwelling aquatic animals.

Pervious: Used to describe any material that allows for the passage of liquid through it, or any surface area that allows infiltration.

pH: A term used to indicate the alkalinity or acidity of a substance as ranked on a scale from 1.0 to 14.0. Acidity increases as the pH gets lower.

Phosphate: A form of phosphorus, which is found in terrestrial and aquatic systems.

Physiographic Provinces: A region whose pattern of relief features or landforms differs significantly from that of adjacent regions.

Piedmont: This physiographic province bordered by the Atlantic Coastal Plain to the east and the Appalachian Mountains to the west and is generally characterized by rolling terrain with streams of moderate gradient and cobble/gravel substrates.

Point Source: Any discernible, confined conveyance, including but not limited to, any pipe, ditch, channel, tunnel, well, concentrated animal feeding operation, landfill leachate collection system, or floating craft from which pollutants are discharged. This term does not include return flows from irrigated agriculture or agricultural storm water runoff.

Pollutant: Any substance introduced to water that degrades its physical, chemical or biological quality.

Pool: The reach of a stream between two *riffles*; a small and relatively deep body of quiet water in a stream or river. Natural streams often consist of a succession of pools and riffles.

Q

Quality Assurance/Quality Control (QA/QC): A system of procedures, checks, audits, and corrective actions to ensure that research design and performance, environmental monitoring and sampling, and other technical and reporting activities are of the highest achievable quality.

R

Rapid Bioassessment Protocol (RBP): A synthesis of techniques and methodologies for quickly assessing habitat and biological conditions in stream systems.

Reference Conditions: Conditions (i.e. habitat, chemical, biological) that reflect least impaired or best attainable conditions in a given area.

Reference Streams: Streams which exhibit highest quality or least impaired habitat conditions that are used as a standard to which all other streams are compared.

Resource Protection Area (RPA): That component of the Chesapeake Bay Preservation Area comprised of lands at or near the shoreline of water bodies that have an intrinsic water quality value due to the ecological and biological processes they perform or are sensitive to impacts which may result in significant degradation to the quality of state waters. Inversely, all other land outside RPAs within Fairfax County is considered Resource Management Areas (RMA).

Restoration: Improving conditions within a natural system so that its functional characteristics are comparable to its original, unaltered state.

Riffle: A reach of stream that is characterized by shallow, fast moving water broken by the presence of rocks and boulders.

Riparian Buffer: A transitional area around a stream, lake or wetland left in a natural state to protect the water body from runoff pollution. Development is often restricted within such zones.

S

Specific Conductance: The ability of water to pass an electrical current while taking into account temperature and pressure, both factors which may affect the conductivity of a sample.

Stormwater Runoff: That portion of precipitation that is discharged across the land surface or through conveyances to one or more waterways.

Subwatershed: A defined land area within a watershed drained by a river, stream or drainage way, or system of connecting rivers, streams or drainage ways such that all surface water within the area flows through a specific point.

T

Taxonomic: Relating to a category or group, such as a phylum, order, family, genus, or species within the Linnaeus biological classification system of nomenclature used to distinguish different levels of relationships between living organisms.

Tolerant Species: Animals and/or plants that can withstand high levels of degradation.

Total Maximum Daily Load (TMDL): The maximum levels of a particular pollutant that a water body can receive in a given day without violating pre-established water

quality standards. Total Maximum Daily Loads are the sum of point and nonpoint source loads.

Triassic Basin: This physiographic province is a sub-province of the Piedmont Upland. The geology consists largely of red sedimentary (sandstone, siltstone, shale and conglomerate) rocks characterized by wide and gently rolling hilltops, with long gently sloping sideslopes and nearly level areas.

Trophic: This term is related to an animal's feeding preferences.

Turbidity: A measure of the suspended solids in a liquid.

V

Virginia Pollutant Discharge Elimination System (VPDES): Mandated by Congress under the Clean Water Act, a two-phased national program administered by the state of Virginia to address nonagricultural sources of non point-source pollution and prevent harmful pollutants from being washed into local water bodies via stormwater runoff.

W

Watershed: A discrete unit of land drained by a river, stream, drainage way or system of connecting rivers, streams or drainage ways such that all surface water within the area flows through a single outlet.

Wetland: Land that is saturated with water and which contains plants and animals that are adapted to living on, near, or in water. Wetlands have hydric soils and are usually located between a body of water and land.