CHAPTER 1

INTRODUCTION

Fairfax County is recognized as one of the world's premiere technology business centers. Its population, which has grown dramatically in the past fifty years, has expanded to almost one million residents. The landscape has been transformed from one of rural character, when the area led the entire state in dairy production, into an urban/suburban community of buildings, parking lots and roads which supports business and residential needs. Although the County does not have to contend with the more serious forms of pollution associated with heavy industry, the conversion of land to urban uses has impacted streams countywide. This, in turn, has contributed to degraded water quality in downstream environments, influencing conditions in the Potomac River and, ultimately, the Chesapeake Bay.

This shift from natural, vegetative ground cover to extensive areas of impervious surface dramatically increases rainfall runoff and stream flow volumes during storm events. Rather than infiltrating the soil as it would under natural conditions, rainwater instead flows rapidly from rooftops, parking lots and roadways, and is quickly directed toward streams via a conveyance system of roadside gutters, ditches and storm sewer drains. The resulting high flows rapidly erode the channel of the receiving stream, leading to degradation of the entire aquatic environment. At the same time, rainwater flowing over the urban/suburban environment picks up oil, grease and heavy metals from roads; trash and sediment from construction sites; and pesticides and fertilizers from lawns. The associated increase in the concentrations and volume of pollutants entering our waterways poses a threat to both humans and the environment as a whole.

Since the 1970's, the County has adopted ordinances to implement stormwater management and Best Management Practices (BMPs) to combat the problems associated with the quality of stormwater runoff and flooding. In the late 1970's Proposed Drainage Plans (Parsons, Brinckerhoff, Quade and Douglas), consisting of an "Immediate Action Plan" and a "Future Basin Plan," were prepared for all watersheds in the County. The establishment of the Water Supply Protection Overlay District (WSPOD) in the Occoquan watershed in the early 1980's required BMPs for all new developments in the southwest areas of the County draining into the Occoquan reservoir, one of the major sources of drinking water for the County. This was followed by the adoption of the Chesapeake Bay Preservation Ordinance in the early 1990's, which required BMPs for all other areas of the County outside the WSPOD. These are but a few examples of the many measures employed by the County in an attempt to mitigate the impacts of new development.

Purpose for a Stream Protection Strategy (SPS)

The need to protect the living environment while planning for orderly development and redevelopment of the County has long been recognized. There is a direct link between the vitality of ecological resources and the quality of life for citizens. Streams originating in Fairfax County flow into the Potomac River and eventually enter the Chesapeake

Bay, and the measures taken by the County to improve stream quality within its boundaries have also been aimed at protecting the downstream environment.

However, despite the efforts taken over the years to mitigate the harmful effects of increasing urbanization, stream degradation continues within the ecosystem. This degradation is evident through increasing stream channel erosion, loss of riparian buffers, decreased aquatic life, high fecal coliform counts and poor water quality in general within the County's streams. The purpose of the SPS program is to:

- Determine the extent and severity of stream degradation.
- Formulate measures to effectively reverse the negative trends.
- Identify and prioritize areas with the greatest needs.
- Recommend streams for preservation and restoration efforts where appropriate.
- Support detailed comprehensive watershed planning or stormwater master plans.
- Integrate applicable environmental policies, initiatives and regulatory requirements under one umbrella.
- Provide an additional information base to aid future planning efforts.
- Encourage environmental stewardship by supporting established and new citizen stream monitoring programs and public education.

The results of the SPS Baseline Study are not aimed at restricting new development but to provide the basis for more ecologically sensitive and sustainable developments.

The Background of SPS

The development of the SPS program was initiated in September 1997, when the Fairfax County Board of Supervisors (Board) requested that staff from the Department of Public Works and Environmental Services (DPWES) evaluate the need to implement a comprehensive assessment of County streams. At the time, Montgomery County, Maryland had completed a similar stream protection strategy study and provided some support and assistance to Fairfax County during the feasibility stage of this SPS baseline study. In September 1998, staff presented to the Board the results of a feasibility evaluation, a preliminary scope of work, and the associated costs to implement such a program. The Board approved a total funding allocation of $500,000 during the 1998 Fiscal Year Carryover Budget proceedings to implement the SPS Program. Work was initiated in September 1998 with several meetings involving representatives from stakeholder organizations and other interested individuals. DPWES sought their input in developing the study framework as well as coordinating citizen volunteer efforts, which are to become a key component of the SPS monitoring program. At present, a number of citizen volunteer organizations work closely with the County in recruiting and training volunteers and in developing the scope of citizen monitoring.

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The SPS baseline study entailed sampling of all major streams and tributaries throughout the County to assess overall environmental quality. Field monitoring focused on measuring various chemical parameters, visually assessing physical stream habitat characteristics and examining in detail the biological indicators of ecosystem health, including aquatic insects (benthic macroinvertebrates) and fish. This initial phase was designed to be a comprehensive baseline study (or a snapshot during 1999) of general County stream conditions, the results of which are outlined in this report. This study presents a ranking (**Excellent, Good, Fair, Poor and Very Poor**) of individual sites based on overall quality, recommends management categories and strategies to restore and preserve areas on a subwatershed basis, prioritizes areas for allocation of scarce resources and establishes the framework for long-term stream water quality assessment. This baseline study is regarded as the commencement of a dynamic stream assessment process that will be executed on a continual basis as conditions warrant and as more detailed results are desired in some targeted areas within the County.

STUDY GOALS

As directed by the Fairfax County Board of Supervisors, the countywide Stream Protection Strategy (SPS) Program does the following:

- Provides comprehensive baseline information on stream conditions through an assessment of biological, chemical, physical and habitat parameters within the County's watersheds.
- Provides a basis for continual/long term monitoring and assessment of water quality in County streams (i.e. 5-year rotating schedule of sampling).
- Evaluates the progress and effectiveness of implemented measures.
- Develops strategies for stream restoration and protection.
- Promotes inter-jurisdictional cooperation to restore and maintain the quality of shared watersheds.
- Recommends changes to County ordinances as necessary to achieve and enhance water quality goals.
- Conforms to past, present and future goals of the County.
- Develops a formal report outlining:

    a) stream assessment data and analysis;
    b) stream rankings based on stream assessment data;
    c) assignment of stream protection and stormwater management strategies for each watershed (i.e. methods of controlling stormwater);
    d) a classification system according to land use and biological quality in the watershed (i.e. protection area, restoration area, etc.);
    e) assignment of watershed priorities within the County; and
    f) the utilization of the County's Geographic Information System (GIS) to present results graphically in an easily understandable manner.

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STUDY OBJECTIVES

The assessment of stream quality within Fairfax County does the following:

- Identifies and confirms areas of seriously impaired water quality requiring immediate attention to reverse impairment to the maximum extent practicable.
- Provides a basis to identify priority areas for water quality/stream restoration programs and measures.
- Identifies and confirms areas of good water quality and develops strategies to continue or enhance preservation.
- Provides a basis for implementing strategies and techniques to bring all streams into compliance with prevailing State and Federal clean water standards, including Clean Water Act (CWA), potential requirements for Total Maximum Daily Load (TMDL) and the County's Chesapeake Bay Preservation Ordinance.
- Promotes and supports public outreach and education to provide greater citizen awareness and involvement.

Overall County Water Quality Goals

1. To comply with the Chesapeake Bay Preservation Ordinance (Section 118-1-5 of the Fairfax County Code): "The purpose and intent of this Chapter is to encourage and promote: (1) the protection of existing high-quality state waters; (2) the restoration of all other state waters to a condition or quality that will permit all reasonable public uses and will support the propagation and growth of all aquatic life, including game fish, which might reasonably be expected to inhabit them; (3) the safeguarding of the clean waters of the Commonwealth from pollution; (4) the prevention of any increase in pollution; (5) the reduction of existing pollution; and (6) water resource conservation in order to provide for the health, safety, and welfare of the present and future citizens of Fairfax County and the Commonwealth of Virginia." (16-93-118.)

2. Protect, maintain, and restore high quality chemical, physical and biological conditions in the waters of the County.

3. Other goals to be determined or adopted through a coordinated effort with other County and state agencies and stakeholder organizations for possible adoption in the County's ordinances.

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EVOLUTION OF STORMWATER MANAGEMENT

The Early Years: Pre 1941

In the early part of the last century, Fairfax County was still largely agricultural, with dairy farming being the most important single industry. In 1900, the population of the County was only slightly over 12,000; four decades later, it was still under 50,000. Throughout this entire period, development was essentially unregulated, and stormwater controls consisted mostly of ditching fields or pastures to prevent flooding. Several privately owned reservoirs, such as Lake Barcroft, served to control flooding as well as provide a municipal water supply.

The rural community of Centerville at Braddock Road in 1902.

As early as the 1920's, County planners realized the need for a comprehensive plan for the development of the County. In 1938, the first Planning Commission was formed to address these issues. The 1941 zoning ordinance, the first attempt at regulation of development within the County, defined categories of land use such as "rural-residential" or "urban-commercial." The basic goal of stormwater controls during this time period was to prevent expensive and catastrophic flooding in municipal areas.

Construction of Lake Barcroft dam 1913-1915.

The Suburban Explosion: 1941-1972

Beginning in the early 1940's, the County's economy shifted from agriculture to one that was largely commercial and based on providing services to an increasingly suburban population. After World War II, many people moved into Fairfax County from Washington, D.C., migrating into developed areas of Alexandria, Falls Church and Arlington. Subsequent expansion moved westward into Fairfax and Vienna. During this period the population of the County grew from roughly 50,000 to 500,000.

Under a Federal grant, a series of impoundments were built beginning in the late 1960's in the Pohick Creek Watershed as a part of a pilot program (Public Law 566) of the Soil Conservation Service. The purpose of these impoundments was to limit runoff volumes and allow suspended materials to settle out. Those six impoundments are known as

Lakes Woodglen, Royal, Braddock, Barton, Huntsman, and Mercer, all of which are currently operated and maintained by the County.

Lake Barton at Burke Centre, one of the six dams built as part of the Soil Conservation Service (PL566) pilot program.

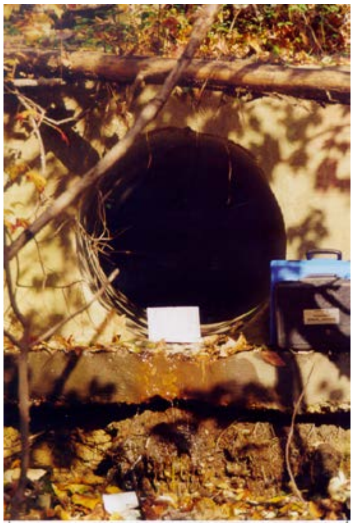
The year 1964 saw the adoption of the first Policy and Guidelines Manual, the forerunner of the current Public Facilities Manual (PFM) which established clear guidelines for construction of municipal infrastructure. Stormwater management at this time only meant adequate drainage, a modest goal that was usually achieved through simple curb-and-gutter construction leading to concrete pipes or channels, which emptied into the nearest stream. Flood prevention was the main focus of stormwater management at this time, and these systems were designed to quickly carry stormwater away from property. While this goal was largely achieved, intense peak flows in receiving streams also led to erosion problems, a situation that continues to this day. Several large floods, such as Hurricane Agnes, occurred during this period. Many homes that had been built on the floodplain required costly flood control structures, prompting the County to rigidly limit and control new construction within the 100-year floodplain of any waterway.

Sediment from a development site entering Sandy Run via a small tributary.

The Regulation Revolution: 1972-1993

Starting in the early 1970's, concerns began to rise nationwide about the health of our environment in general. The federal Clean Water Act, passed in 1972, required states and their municipalities to meet certain established water quality standards primarily based on chemical water quality. Regionally, nutrient and bacterial pollution, much of which was being carried into streams by stormwater runoff, was contributing to the decline of the Chesapeake Bay. This was compounded by heavy inputs of fine sediments from development in the surrounding watersheds.

During this period, the population of Fairfax County grew dramatically, reaching almost 900,000 residents. Much of the increase was driven by new technology-based businesses, which were less dependent upon urban centers than conventional industry, and migrated with the moving workforce. This new suburban expansion resulted in additional increases in impervious surfaces, which further contributed to bank erosion in



The NPDES program monitors water quality at stormwater outfalls within Fairfax County.

the receiving streams, and caused vast quantities of sediment to be carried into the Potomac from the County every year.

In 1982, Best Management Practices (BMPs) were adopted in the Occoquan watershed as part of an effort to reduce nutrient pollution and to preserve the Occoquan Reservoir, which supplies drinking water for many Fairfax County residents. Some of the BMPs were structural in nature, such as detention ponds, while others were land-use controls, such as the establishment of a special zoning district for roughly two-thirds of the Occoquan watershed in Fairfax County. This established a minimum residential lot size of five acres.

The BMP Era: 1993-Present

As a whole, the County is largely developed. The 1999 Demographic Reports document indicates that only 17.3% of the County's land area is considered to be underutilized residential land or vacant residential or nonresidential land (data are not available for underutilized nonresidential land). The County's population is expected to exceed one million people within the next three years.

In 1993, Fairfax County adopted BMPs countywide as a result of the Chesapeake Bay Ordinance, which established stream corridor areas as Resource Protection Areas (RPAs) and the remainder of the County as a Resource Management Area (RMA) in an effort to protect water resources. As a part of the National Pollutant Discharge Elimination System (NPDES), Fairfax County received a permit from the Virginia Department of Environmental Quality (DEQ) to discharge stormwater into State waters. To obtain this permit, Fairfax County was required to demonstrate that it had an effective stormwater management and monitoring program.

Many other measures at the local, state and federal levels have since been enacted to protect wetlands, stream valleys, the Chesapeake Bay and general water quality. The SPS program will have benefits that extend beyond the County's boundaries, and the ongoing effort will become an important and integral component of many of these initiatives. (For further discussion of these programs, see Chapter 4).

Today, assessments are being made countywide of the effectiveness of many old management measures as well as the suitability of new approaches and technologies aimed at further reducing stormwater runoff and associated pollution.

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EFFECTS OF URBANIZATION

When rainwater initially reaches the ground in a natural environment, it has four possible routes: evaporating into the air, filtering through the soil, running directly into a stream or being absorbed by plants. In an undeveloped watershed, only a small percentage of rainwater becomes surface runoff, the majority entering the soil where it is taken up by plants, evaporates, or infiltrates to the groundwater table. Abundant natural riparian vegetation helps retain precipitation, slows sheet flow, enables downward percolation through root systems and resists erosion by stabilizing the stream bank. This vegetative cover also recycles rainwater back into the atmosphere via evapo-transpiration.

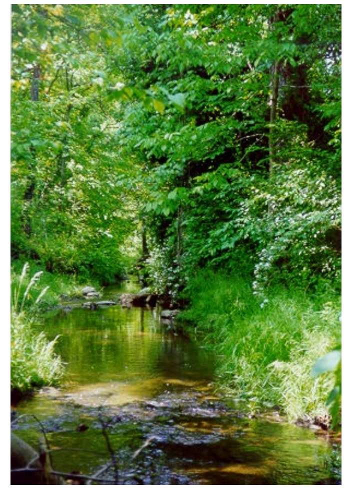
A headcut along Wolftrap Creek in the Difficult Run Watershed is indicative of erosive "downcutting."

When natural land is cleared to make way for commercial, residential, or other uses, vegetation is removed and bare soil is exposed. In this situation, rainwater is not absorbed, and the soil is substantially destabilized. More importantly, if proper controls are not in place during the construction process, there is great potential for sediment, one of the greatest threats to instream habitat quality, to run off directly into waterways.

Tree falls are indicative of stream channel widening along Pikes Branch in the Cameron Run Watershed.

Natural streams follow a predictable meandering pattern, which helps dissipate energy and minimize scouring of the streambed and banks. Increasing impervious surface area causes substantially higher peak flows during storm events. To compensate for the extra energy generated by the altered flow regime, streams undergo a predictable sequence of changes in channel morphology (Schumm, 1984).

Stream morphology will adjust over time to accommodate increased peak flows. Initial increases cause "downcutting," or incision of the channel bottom. Over time, stream banks begin to erode as well, resulting in an overall widening of the channel. This instability will persist until flow regimes within the drainage have become stable, a process that can only occur once increases in impervious cover have ceased. Once this takes place, a stream will establish a new equilibrium with the development of a new floodplain. However, the amount of time required to reach this stage is typically measured in decades.



Low gradient, vegetated stream banks indicate stabilization along Little Rocky Run.

Throughout this period of readjustment within streams, large volumes of sediment are eroded and transported into downstream receiving waters. This sediment smothers substrate particles and other forms of instream habitat, effectively denying many organisms access to shelter that is necessary for their survival. It may also deprive many fish species of suitable spawning habitat.

In addition to the physical damage done to streams by increased storm flows, urban/suburban runoff may bring with it many forms of pollution, any one of which has the potential to significantly impact biological communities. Types of pollution to streams can be lumped into two main categories: those that come from a distinct concentrated source (called point source pollution), and those that are diffuse, originating from large geographic areas (called nonpoint source). A pipe discharging untreated effluent would be an example of a point source of pollution, while fertilizer from an entire neighborhood washing off of the land during a storm event would be classified as coming from a nonpoint source. While each type may impact only a very specific element of a given biological community (Table 1), they all have the potential to impact the entire stream system, degrading conditions throughout its length.

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Table 1. Major pollutants (stressors) in urban or suburban areas and their effect on streams.

Stressor	Source	Environmental Effect
Nutrients (Nitrogen and Phosphorous)	Improper use (over application) of lawn fertilizers.	Stimulate algae blooms. May reduce sunlight reaching stream bottom, limiting plant growth. Rapid accumulation of dead algae decomposes aerobically, robbing other stream animals of oxygen.
Toxics	Various. Underground storage tank leakage, surface spills, illegal discharges, chlorine from swimming pool drainage, etc.	Can have an immediate (acute) affect on stream biota if levels are high enough. May be chronic, eliminating the more sensitive species and disrupting ecosystem balance over time.
Sediment	Poorly managed construction areas, winter road sand, in-stream erosion, bare soils.	Clogs gills of fish and insects, embeds substrate, reducing available habitat and potential fish spawning areas.
Organic Loading	Sewage leaks, domestic and livestock wastes, yard wastes dumped into streams.	Human health hazard (pathogens), similar oxygen depletion situation as Nutrients. Causes benthic community shift to favor filter feeders as well as organisms with low oxygen requirements.
Exotic Species	Human transportation and release (intentional and unintentional).	Invade ecosystem and out compete native species for available resources (food and habitat). Some introduced intentionally to control other pests.
Thermal Loading	Water impoundments (lakes or ponds). Industrial discharges and power plants. Removal of riparian tree cover. Runoff from hot paved surfaces.	Biological community structure altered, shift to species tolerant of higher temperatures, sensitive species lost. Dissolved oxygen depletion.
Channel Alteration	In very urban areas, concrete, metal and rip-rap stabilization of stream banks. Stream channelization, flood erosion control.	Major habitat reduction/elimination, changes flow regime dramatically. Dramatic alteration of biological communities, can cause Thermal Loading and Sediment problems. Transfer erosion potential downstream.
Altered Hydrology	Conversion of forested/natural areas to impervious surfaces. Increases amount and rate of surface runoff and erosion.	Overall channel instability, habitat degradation or loss.
Riparian Loss	Development. Clearing or mowing of vegetation all the way up to stream banks.	Increase water temperature, greater pollutant input, less groundwater recharge, greater erosion potential from streambanks. Alters community composition.

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IMPORTANCE OF BIOLOGICAL MONITORING

Nationwide, there has been a shift in focus from chemical monitoring for point source pollution to a broader assessment of nonpoint source pollution. Urban/suburban runoff is now recognized as a significant cause of stream degradation, an issue that is especially relevant to the environment of Fairfax County. At levels of 10-20% imperviousness, stream quality becomes adversely impacted (Klein, 1979, Booth, 1991, Schueler et al, 1992, Booth et al, 1993, Booth and Jackson, 1994 and Boward et al, 1999 (Figure 1)). In recognition of this fact, current stream assessments rely heavily on methods of biological monitoring that highlight anthropogenic impacts of land use that most influence living stream communities.

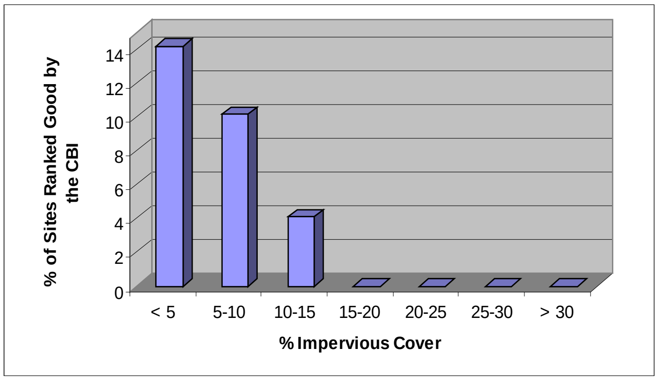

Figure 1: Stream health is directly related to the level of impervious cover in the surrounding watershed. Combined measures of biological integrity (in this case, a Combined Biotic Index (CBI) reflecting various components of living aquatic communities) are useful in highlighting potential threshold levels of development within stream drainages (ranking of sites from Maryland Biological Stream Survey (MBSS) (Boward et al, 1999)).

Fish and aquatic insect communities respond to the various forms of environmental degradation in a predictable manner, and aspects of their respective community structure can provide a useful measure of overall environmental quality within a given system. Such responses, often evident as changes in community composition and/or relative species abundance, can highlight single-source environmental stressors or the cumulative impact of multiple stressors.

Benthic macroinvertebrate communities are a major component of any healthy stream system. They are an important link in any aquatic food web, forming the core of the diet of many stream fishes. These organisms are useful indicators of water quality generally due to their varying tolerances to chemical, nutrient and sediment pollution. As a group, they integrate conditions in a watershed over time, yet are also useful in highlighting immediate problems due to their relatively quick responses to many environmental stressors.

Fish assemblages represent the apex of most stream communities. They are very sensitive to both natural and anthropogenic changes within a given system and are, therefore, useful indicators of stream health as well. Fish are also more readily understood and appreciated by the public than are other biological components of stream systems and can be useful tools for developing community interest in environmental and water management issues.

The chemical constituents of water are still recognized for their potential to influence stream biota and should be a component of any biological assessment. The impact of various chemical inputs on living organisms can be acute (immediate) or chronic (occurring over a long period) and may limit stream communities even when quality habitat is available. Measurement of a variety of basic chemical parameters is therefore useful in assessing areas of immediate concern and for highlighting situations where more detailed chemical analysis may be required.

With its emphasis on biological monitoring, the SPS program is an important first step toward improving environmental quality by viewing streams as more than mere conduits of stormwater flow. By tying together information on stream morphology, habitat condition, water chemistry, and current and projected land use patterns, it will provide an important base for the planning and decision-making framework that will be needed to protect and restore stream ecosystems within Fairfax County.