Popes Head Creek

Watershed Management Plan

Final

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Prepared for:

Fairfax County
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Department of Public Works and Environmental Services

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Executive Summary

The *Popes Head Creek Watershed Management Plan* is a strategic plan that will protect and improve the water quality within the watershed over the next 25 years. The planning process, initiated by Fairfax County, for development of this watershed management plan included the participation and recommendations of a watershed advisory committee. The Popes Head Creek Citizen's Advisory Committee developed the following guiding principles to aid in formulating the actions and strategies for implementing the objectives of this plan.

- Reduce or eliminate the adverse impacts of recreational activities in riparian areas.
- Actively support the enforcement of the RPA ordinance.
- Encourage small steps that residents can implement easily.
- Concentrate on solutions in the upstream areas first.
- Place an emphasis on protecting the existing high quality streams, including smaller tributaries.

The Popes Head Creek Watershed Management Plan provides strategies for protecting the watershed and mitigating adverse stream impacts that have occurred, such as stream bank erosion and poor water quality.

Background

The Popes Head Creek Watershed is one of the least developed watersheds in Fairfax County. On July 26, 1982, the Fairfax County Board of Supervisors approved a rezoning of more than 41,000 acres in the Occoquan Watershed in order to protect the Occoquan Reservoir, which supplies drinking water to the County. Land in the rezoned area is classified as Residential-Conservation (R-C) District, or one dwelling unit per 5 acres. Eighty-six percent of the Popes Head Creek Watershed is located in this rezoned area.

The history of the county's watershed management began in the 1940s with the conversion of primarily agricultural land use to residential and commercial land uses. Stormwater infrastructure was constructed to quickly carry runoff away from the developed areas to the creeks and streams that serve as the principal drainage system for the county. Starting in 1972, onsite detention was required for new development to minimize the effects of increased runoff from development. In the early 1980s, water quality best management practices (BMPs) were required for new development in the southern areas of the county that drained to the Occoquan drinking water reservoir. BMPs were required for all new development in the county starting in 1993.

Purpose

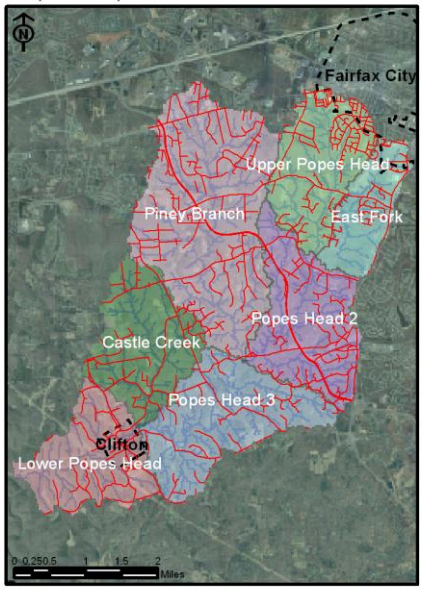
The primary reasons the *Popes Head Creek Watershed Management Plan* was developed can be summarized as follows:

1. To meet state and federal water quality standards by identifying strategies to prevent and remove pollution;
2. To support Virginia's commitment to the Chesapeake 2000 Agreement to restore the Chesapeake Bay;
3. To replace the currently out-dated watershed management plan through the use of new technologies; and,
4. To take a comprehensive approach in addressing multiple regulations, commitments, and community needs.

With input from the Popes Head Creek Citizen's Advisory Committee and other members of the community, this watershed management plan addresses these needs and requirements with a strategy for restoring and protecting the watershed. The Committee was composed of local community members from various interest groups, and represented environmental, business, and homeowner views and concerns. The Committee met with the Project Team regularly over 18 months to provide valuable local input and feedback. This public involvement process helped to ensure that the watershed plan will meet the specific needs and desires of the residents of the Popes Head Creek Watershed.

Watershed Condition

Map E.1 Popes Head Creek Subwatersheds



For the purposes of this watershed plan, the Popes Head Creek Watershed was divided into seven subwatersheds: Upper Popes Head, East Fork, Piney Branch, Popes Head 2, Castle Creek, Popes Head 3, and Lower Popes Head. Residential and commercial development in the northern portion of the Popes Head watershed began in the late 1950s. Commercial development in the upper Piney Branch watershed started in the mid-1980s. The central and southern portions of the watershed consist primarily of large lot residential development. The total impervious area in the watershed is approximately 1,142 acres, or 9% of the total area.

The predominant existing land use in the watershed is estate residential, with 45% of the watershed area consisting of this density of a minimum of 5 acres per dwelling unit. The next major land use consists of undeveloped areas in the watershed. For ultimate future buildout of the watershed, estate residential land use may increase to 59% and the future watershed imperviousness may increase to 11.4%.

The County initiated a stream physical assessment for all of its watersheds in August 2002. The stream physical assessment included a habitat assessment, infrastructure inventory, stream characterization, and stream geomorphologic assessment. The stream physical assessment data is described for each of the subwatersheds in the following sections. The stream habitat was rated as fair or good for approximately 73% of the watershed.

The Fairfax County Health Department formerly monitored stream water quality at three sampling sites in the watershed. The *Fairfax County 2002 Stream Water Quality Report* concluded that the overall water quality for Popes Head Creek is good for the chemical and physical parameters, including excellent dissolved oxygen levels. In 2002, an average of 9% of the samples in the watershed met the good water quality criteria for fecal coliform, as opposed to an average of 15% in 2001.

The *Fairfax County Stream Protection Strategy (SPS) Baseline Study* from January 2001 evaluated the quality of streams throughout the county. Popes Head Creek and its tributaries received "good" composite site condition ratings in the upper and lower watershed and a "fair" rating in the central portion of the watershed. Piney Branch received "fair" composite site condition ratings, while Castle Creek received "excellent" composite site condition ratings. These ratings were based on environmental parameters such as an index of biotic integrity, stream physical assessment, habitat assessment, fish taxa richness, and percent imperviousness.

Popes Head Creek is listed as an impaired waterbody in the 2004 305(b)/303(d) Water Quality Assessment Integrated Report prepared by the Virginia Department of Environmental Quality (DEQ). It was initially listed in 1998 after biological monitoring at Route 645 (Clifton Road) determined that the benthic community, composed of aquatic macroinvertebrates that live on the stream bottom, is moderately impaired. In 2004, Popes Head Creek was also listed as fecal coliform impaired based on water quality data collected at the same DEQ sampling location. The source of the fecal coliform and the benthic impairment are both unknown. As a result of the biological and bacteria listings, the segment was assessed as not supporting the Clean Water Act's Recreation and Aquatic Life Use goals.

Once a waterbody 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 and submitted to the United States Environmental Protection Agency (EPA) for approval. Upon approval, DEQ must develop a TMDL Implementation Plan to restore water quality. Because the impaired segment begins at the mouth of Popes Head Creek, the TMDL will include the creek's entire watershed. DEQ has scheduled TMDLs for both listings to be submitted to EPA in May 2006 and began TMDL development in March 2005.

Plan Goals, Objectives, and Actions

The goals of the Popes Head Creek Watershed Plan were derived from the issues identified by the community and the project team, based on their analysis of the watershed condition.

Goal A: Protect and improve the ecological health of Popes Head Creek and its tributaries.

According to the 2003 Stream Physical Assessment study, Popes Head Creek Watershed is in good condition. Approximately 73% of the stream reaches were assessed as fair or good, with the remaining reaches assessed as poor or very poor. The project team and the community have agreed that it is important to protect this high quality habitat. It provides protection to the Occoquan Reservoir, as well an aesthetically pleasing character that adds to the quality of life for residents of the watershed. This goal will primarily be accomplished by reducing stormwater runoff via retrofitting old stormwater facilities or installing new Best Management Practices (BMPs) in certain areas that currently lack stormwater controls, and by protecting and restoring riparian buffers in stream corridors.

Objective A1: Increase the effectiveness of and use of existing BMPs to reduce impacts from stormwater runoff.

> *Action A1.1* Retrofit suitable existing stormwater management facilities and BMPs to make them more effective. Retrofitting these facilities is intended to exceed the performance criteria or standards that were used to design the facility. The increased performance and/or coverage area will improve water quality in the watershed.
>
> *Action A1.2:* Install new BMP and LID facilities in areas that do not have existing stormwater management facilities, or in areas where retrofitting existing facilities is not feasible.
>
> *Action A1.3:* Install new stormwater management ponds in areas that lack stormwater controls.

Objective A2: Reduce and mitigate the impacts of impervious surface.

> *Action A2.1:* Program to facilitate and encourage homeowners and developers to disconnect impervious areas.
>
> *Action A2.2:* Monthly street sweeping program for parking lots in the watershed and residential streets in the Fairfax Villa subdivision.

Objective A3: Preserve, maintain, and restore streams to benefit stream health and habitat.

> *Action A3.1:* The county and community groups will perform stream restoration projects in the areas identified as good candidates.
>
> *Action A3.2:* Retrofit existing road culverts to reduce stormwater runoff into streams.
>
> *Action A3.3:* Replace road crossings that overtop and flood.
>
> *Action A3.4:* Remove dump sites and obstructions from stream corridors.

Objective A4: Preserve, maintain, and restore riparian buffers to protect stream health and water quality.

Action A4.1: Plant native vegetation next to streams in areas that are identified as good candidates for buffer restoration.

Action A4.2: Monitor the condition of restored and existing riparian buffer with annual stream walks to evaluate the condition and areas needing improvement.

Objective A5: Maintain the open space and pastoral quality of the watershed and preserve the aesthetic quality in both urban and rural areas.

Action A5.1: Facilitate the acquisition and donation of conservation easements by community groups for riparian buffer and stream protection, and public/private open space for the environmental quality corridors described in the *Fairfax County Comprehensive Plan.*

Objective A6: Develop water quality sensitive recreational opportunities.

Action A6.1: Post official County signage that publicizes the existence of the Resource Protection Areas (RPAs) and states that ATV and other usages that destroy vegetation and cause erosion are not permitted in the RPA.

Action A6.2: Coordinate with the Fairfax County Police to target areas with significant ATV impacts for enforcement of existing laws and ordinances (e.g. trespassing and environmental regulations).

Objective A7: Maintain the diversity of wildlife in the watershed.

Action A7.1: Conserve land and water ecosystems to provide high quality habitat for wildlife.

Action A7.2: Preserve large blocks of forest to prevent further fragmentation.

Goal B: Have a well informed community that is actively involved in watershed stewardship.

Public participation and outreach is a vital component of the watershed plan. An educated and active citizen base can promote environmental stewardship to neighbors, co-workers, friends and family members. They can identify new problem areas in the watershed and report them to the proper officials. A well informed and active community can also leverage political or financial support for watershed management projects. This goal will be accomplished through the coordination of volunteer watershed stewardship activities and a public education campaign.

Objective B1: Achieve community sponsorship of the watershed.

Action B1.1: Support the formation of a “Friends of Popes Head Creek” group composed of local citizens.

Action B1.2: Establish a group of volunteer stream monitors and monitoring sites.

Objective B2: Develop and consolidate educational materials that describe the value of the watershed.

Action B2.1: Develop and distribute educational materials that describe beneficial landscaping techniques for homeowners.

Action B2.2: Develop and distribute educational materials that describe beneficial landscaping techniques to landscaping companies and suppliers.

Action B2.3: Develop and distribute educational materials about appropriate horse care and grazing management in the Resource Protection Area.

Action B2.4: Distribute educational materials to private pond owners that describe proper maintenance.

Action B2.5: Develop and distribute educational materials for proper ATV usage in the watershed.

Goal C: Continue to maintain the Occoquan Reservoir as a clean and sustainable source of potable water for Fairfax County.

The Occoquan Reservoir is the major source of potable water for the residents of Fairfax County. It is a 2,100 acre impoundment that is managed by the Fairfax County Water Authority, forming the boundary between Fairfax and Prince William Counties. This goal will be accomplished by installing BMPs in certain areas that currently lack water quality controls or enhancing the performance of existing stormwater management facilities to reduce nitrogen and phosphorus loading in stormwater runoff.

Objective C.1: Reduce the amount of pollutants, such as fecal coliform, nitrogen, phosphorus, and sediment that enters the Occoquan Reservoir.

Action C1.1: Install BMPs or enhance the performance of existing stormwater management facilities to reduce sediment and phosphorus loading in stormwater runoff.

*Action C1.2****:*** Manage large existing areas of lawn at institutional and commercial properties to minimize nutrient loading in streams.

Benefits of Plan Actions

Future conditions and future conditions with proposed BMPs were modeled to compare the condition of the watershed when development is continued without any changes to the watershed, and when projects identified above are completed. Unlike other watersheds within Fairfax County, the Popes Head Creek watershed is currently in good condition, with a future imperviousness of only 11.4%, due to the 1982 rezoning for the Occoquan reservoir. Even though it is not a highly developed watershed, it is still important to implement the proposed actions to preserve the watershed and because Popes Head Creek is a major tributary to the Occoquan Reservoir, which serves as the primary drinking water source for Fairfax County. With this in mind, most of the proposed BMP projects and watershed wide actions are for water quality control, not water quantity control.

The proposed actions in the Popes Head Creek Watershed Management Plan will reduce pollutant loadings throughout the watershed. The future conditions with proposed BMPs model shows a 8.93% decrease in total suspended solids (TSS), a 3.15% decrease in total phosphorus (TP), and a 2.85% decrease in total nitrogen (TN) pollutant loads for the entire Popes Head Creek watershed. It is important to note that the Popes Head Creek watershed will not show significant decreases in pollutant loading due to the relatively pristine existing condition of the watershed. The Piney Branch and Popes Head 2 subwatersheds both show above average improvements. This is important because both subwatersheds were given "fair" Stream Protection Strategy site condition ratings, as shown on Map 2.11. All other subwatersheds have "good" or "excellent" site condition ratings. Table 4.9 shows pollutant reductions by subwatershed if the proposed BMP projects are implemented.

Table 4.9 Pollutant Loading by Subwatershed

Subwatershed	Future TSS (lb/ac/yr)	Future TSS with proposed BMPs (lb/ac/yr)	Reduction in TSS (lb/ac/yr)	% Decrease TSS	Future TP (lb/ac/yr)	Future TP with proposed BMPs (lb/ac/yr)	Reduction in TP (lb/ac/yr)	% Decrease TP	Future TN (lb/ac/yr)	Future TN with proposed BMPs (lb/ac/yr)	Reduction in TN (lb/ac/yr)	% Decrease TN
Castle Creek	31.78	31.03	0.75	2.37	0.39	0.39	0.00	0.76	2.98	2.96	0.02	0.50
Piney Branch	58.84	46.51	12.33	20.95	0.56	0.52	0.04	6.82	4.20	3.97	0.23	5.54
East Fork	152.52	145.63	6.89	4.52	0.88	0.86	0.02	1.71	7.52	7.35	0.17	2.29
Upper Popes Head	91.34	89.37	1.97	2.16	0.85	0.84	0.01	1.29	6.18	6.10	0.08	1.21
Popes Head 2	67.70	60.29	7.40	10.93	0.59	0.57	0.02	4.05	4.91	4.70	0.21	4.30
Popes Head 3	37.75	36.48	1.27	3.36	0.44	0.44	0.01	1.58	3.47	3.45	0.02	0.58
Lower Popes Head	56.32	54.69	1.63	2.89	0.47	0.46	0.01	1.71	4.33	4.26	0.06	1.50
Popes Head Creek Total	63.64	57.96	5.69	8.93	0.57	0.55	0.02	3.15	4.52	4.39	0.13	2.85

Stream Habitat Improvements

The proposed stream restoration projects will also improve the stream habitat and improve water quality. To quantify the benefits of the proposed stream restoration projects, the Army Corps of Engineers (COE) stream condition index (SCI) rating was applied to the stream reaches to determine the increase in stream habitat and reduction in erosion and sediment loss. Briefly, the SCI is determined by looking at 5 variables within the stream and rating them from 1.0 to 5.0. The stream was then ranked from 1.0 (worst) to 5.0 (best) as to it's condition. The potential stream restoration areas have a

SCI ranging from 2.8 to 4.15. Please see table 4.10 below showing the overall rating for the existing and proposed conditions. The table demonstrates that there is an increase in the SCI, showing that the stream restoration projects will improve the stream habitat and water quality of the watershed.

Table 4.10: Stream Condition Index Scores

Project ID	Stream Reach	Existing SCI	Proposed SCI	Increase SCI (%)
PH9201	Clifton Creek #1	4.15	4.50	8
PH9200	Clifton Creek #2	4.15	4.5	8
PH9202	Clifton Road	2.95	3.95	34
PH9210	Wycklow Drive	3.2	4.2	31
PH9204	Young Branch Road - Part 1	3.85	4.35	13
PH9204	Young Branch Road – Part 2	2.8	3.85	38
PH9270	Brookline Drive	2.95	4.55	54
PH9271	Fox Chapel Road	4.05	4.50	11
PH9272	Berwynd Drive	4.05	4.50	11

Again, the watershed plan focuses more on the water quality improvements because of the watershed land usage. The watershed is primarily zoned for 5 acres lots, therefore water quantity control is not as necessary as in a more developed area. The nature of the future development in this watershed is for minimal impervious area and a large increase in water volume is not anticipated. Future development located in the upper watershed outside of the resource conservation district will be required to provide water quantity and quality controls. Additionally, most of the existing development in the upper watershed is relatively new and the SWM ponds that do exist already have stringent water quantity controls in place. This is why the plan projects and watershed wide actions focus on water quality improvements.

Plan Implementation

The recommended plan actions described in Section 4.4 will be implemented over the 25-year life of the Popes Head Creek Watershed Management Plan. This plan will serve as guidance for all County agencies and officials to protect and maintain the health of the Popes Head Creek watershed. The plan will be considered as an active, or “living,” document that is revisited every five years.

Structural and non-structural projects will typically require additional design work, possible land rights acquisition, agreements, or other coordination during the implementation phase. The “policy” recommendations will need to be evaluated further in light of greater County-wide implications. The current planned approach for processing of the policy recommendations from the Popes Head Creek Watershed Plan is to compare these with similar recommendations that will be developed with the Little Hunting Creek, Cameron Run, Cub Run, and Difficult Run Watershed Management Plans within the next few years.

A weighted set of five categories was used to prioritize each plan action. The following prioritization categories were used:

1. Board Adopted Categories (40%)
2. Direct Regulatory Contribution (10%)
3. Public Support (10%)
4. Effectiveness/Location (25%)
5. Ease of Implementation (15%)

Each project was then placed into one of five implementation groups, based on relative priority, as listed below:

Group A: Fiscal Year 2006 – 2010
Group B: Fiscal Year 2011 – 2015
Group C: Fiscal Year 2016 – 2020
Group D: Fiscal Year 2021 – 2025
Group E: Fiscal Year 2026 – 2030

The dates for implementation are target dates, subject to County funding approval and ongoing updates to the plan.

Table 4.12: Implementation of Proposed Projects

Project Number	Project Location	Description	Implementation Timeframe	Total Cost
Action A2.1	Non-structural Practice	Disconnect Imperviousness	A	$200,000 (over 25 years)
Action A2.2	Non-structural Practice	Monthly Street Sweeping in Fairfax Villa	A	$1,000,000 (over 25 years)
Action A5.1	Non-structural Practice	Conservation Easement Acquisition	A	$250,000 (over 25 years)
Action B1.1	Non-structural Practice	Formation of Friends of Popes Head Creek group	A	$120,000 (over 25 years)
Action B1.2	Non-structural Practice	Volunteer Stream Monitoring	A	$200,000 (over 25 years)
Action B1.3	Non-structural Practice	Watershed Stewardship program for schools	A	$200,000 (over 25 years)
Action B2.1	Non-structural Practice	Landowner Education	A	$200,000 (over 25 years)
Action B2.2	Non-structural Practice	Landscape Company Education	A	$120,000 (over 25 years)
Action B2.3	Non-structural Practice	Horse Care Education	A	$120,000 (over 25 years)
Action B2.4	Non-structural Practice	Private Pond Owner Education	A	$120,000 (over 25 years)

Project Number	Project Location	Description	Implementation Timeframe	Total Cost
Action B2.6	Non-structural Practice	Wildlife Education	A	$200,000 (over 25 years)
Action C1.2	Non-structural Practice	Institutional/Commercial Property Nutrient Management	A	$200,000 (over 25 years)
PH9900	Kincheloe Road	Debris Removal	A	$4,000
PH9961	Hope Park Road	Remove fill from stream and restore stream.	A	$1,400,000
PH9960	Hope Park Road	Debris Removal	A	$3,000
PH9970	Washington Street	Automobile/Debris Removal	A	$5,000
PH9962	Popes Head Road	Debris Removal	A	$5,000
PH9981	Crescent Drive	Automobile Removal	A	$5,000
PH9973	Bentonbrook	Obstruction Removal/ collapsed footbridge removal	A	$6,000
PH9190	Marymead Pond	SWM Pond Retrofit	A	$560,000
PH9170	Braddock Road Pond	SWM Pond Retrofit	A	$70,000
PH9192	FCPA-Piney Branch Park Pond	SWM Pond Retrofit	A	$720,000
PH9180	Brentwood Pond	SWM Pond Retrofit	A	$140,000
PH9210	Wycklow Drive	Stream Restoration	A	$60,000
PH9201	Clifton Creek #1	Stream Restoration	A	$90,000
PH9200	Clifton Creek #2	Stream Restoration	A	$120,000
PH9202	Clifton Road	Stream Restoration	A	$360,000
PH9204	Young Branch Drive	Stream Restoration	A	$1,080,000
PH9885	Fairfax Villa Elementary School	2 Bioretention facilities.	B	$60,000
Action A4.2	Non-structural Practice	Monitor Riparian Buffers	B	$250,000 (over 25 years)
Action A6.1	Non-structural Practice	RPA Signage Installation	B	$80,000 (over 25 years)
Action A6.2	Non-structural Practice	ATV Usage Violation Enforcement	B	$250,000 (over 25 years)
Action B2.5	Non-structural Practice	ATV Usage Education	B	$120,000 (over 25 years)
PH9195	Costco East Pond	SWM Pond Retrofit	B	$120,000
PH9194	Piney Branch Road Extention Pond	SWM Pond Retrofit	B	$120,000
PH9193	Sports Authority Pond	SWM Pond Retrofit	B	$120,000
PH9130	Colchester Hunt	SWM Pond Retrofit	B	$140,000
PH9191	Merrifield Gardens Pond	SWM Pond Retrofit	B	$70,000
PH9196	Waples Mobile Home Park Pond	SWM Pond Retrofit	B	$930,000

Project Number	Project Location	Description	Implementation Timeframe	Total Cost
PH9884	Fairfax Villa Subdivision	8 Filterra Manufactured LIDs, 3 bioretention areas, Rain barrel program	B	$400,000
PH9890	University Square Subdivision	2 Filterra Manufactured BMPs.	B	$80,000
PH9131	Innisvale Pond	SWM Pond Retrofit	B	$190,000
PH9872	Willow Springs Elementary School.	1 Bioretention area and 1 Filterra manufactured LID	B	$80,000
PH9880	Brentwood Subdivision	4 grassed swales, 3 bioretention areas	B	$160,000
PH9850	Vannoy Park Subdivision.	2 Grassed swales	B	$100,000
PH9882	Braddox Subdivision.	1 Bioretention area in abandoned road right-of-way.	B	$30,000
PH9883	Buckner Forest Subdivision.	1 Bioretention area.	B	$30,000
PH9891	Glen Alden Subdivision.	1 grassed swale	B	$20,000
PH9821	Fairfax Station Subdivision	3 Grassed Swales, 5 bioretention areas	B	$220,000
PH9800	Clifton Elementary School.	Bioretention area, 1 Filterra manufactured LID	B	$90,000
PH9271	Berwynd Road	Stream Restoration	B	$330,000
PH9270	Brookline Drive	Stream Restoration	B	$30,000
PH9272	Fox Chapel Road	Stream Restoration	B	$310,000
PH9820	Clifton Green Subdivision	Bioretention area and Grassed swale	B	$50,000
PH9860	West Hill Subdivision	2 Grassed swales and 2 Filterra manufactured LIDs	B	$140,000
PH9801	Intersection of Compton and Clifton Roads	Grassed swale	B	$50,000
PH9831	Smoke Rise Subdivision	1 Bioretention area.	B	$40,000
PH9841	Barton Place Subdivision	Grassed swale and 2 bioretention areas.	B	$230,000
PH9870	Brecon Ridge Subdivision	6 grassed swales, 1 bioretention area	B	$160,000
PH9871	Ridges of Glendilough Subdivision.	2 Bioretention areas, 2 Filterra manufactured LIDs	B	$200,000

Project Number	Project Location	Description	Implementation Timeframe	Total Cost
PH9877	Brecon Ridge Woods Subdivision.	1 Grassed swale and bioretention at pipe outfall	B	$110,000
PH9830	Pickwick Woods Subdivision	3 Bioretention areas	B	$90,000
PH9851	Lewis Park	2 Grassed swales	B	$60,000
PH9842	Fairfax Hunt	1 Bioretention Area	B	$50,000
PH9530	Saddle Horn Road	Culvert Retrofit	C	$60,000
PH9580	Fairfax County Parkway	Culvert Retrofit	C	$90,000
PH9540	Smoke Rise Road	Culvert Retrofit	C	$60,000
PH9512	Fairfax Station Road	Culvert Retrofit	C	$70,000
PH9502	Tepper Drive	Culvert Retrofit	C	$40,000
PH9505	Balls Ford Road	Culvert Retrofit	C	$70,000
PH9504	Private Drive near Yates Ford Road	Culvert Retrofit	C	$50,000
PH9403	Newman Road and Castle Creek	Bridge Project	C	$390,000
PH9401	Clifton Road #2 and #3 and Popes Head Creek	Culvert Replacements	C	$260,000
PH9414	Fairfax Station Road and Piney Branch, Popes Head Creek, Trib to Popes Head	Culvert Replacements	C	$4,190,000
PH9452	Popes Head Road and Piney Branch	Bridge Project	C	$10,000
PH9450	Colchester Road and Castle Creek	Drainage Improvements	C	$1,020,000
PH9412	Newman Road and Castle Creek Trib 1	Culvert Replacement	D	$430,000
PH9400	Clifton Road and Popes Head Creek	Bridge Project	D	$1,850,000
PH9461	Popes Head Road and Popes Head Creek	Bridge Project	E	$1,050,000
PH9435	Newman Road and Castle Creek	Culvert Replacement	E	$130,000
PH9470	Brookline Drive and East Fork	Culvert Replacement	E	$300,000
PH9404	Colchester Road and Popes Head Creek	Bridge Project	E	$1,240,000
PH9462	Walcott Avenue and Piney Branch unnamed Trib	Culvert Replacement	E	$100,000

Project Number	Project Location	Description	Implementation Timeframe	Total Cost
PH9453	Popes Head Road and Piney Branch unnamed Trib	Culvert Replacement	E	$180,000
PH9420	Fairfax Station Road and Popes Head unnamed Trib	Culvert Replacement	E	$160,000
			Total Capital Cost	$24.6 million

Policy Recommendations are listed in Chapter 5 and summarized in Table 5.1 below.

Table 5.1: Summary of Policy Recommendations

Policy Recommendation	Description	Benefit
A1.1	Increase the frequency of inspection for private BMPs with maintenance agreements	Ensures that BMPs perform as intended. Will help to maintain existing conditions and aid in preventing the further degradation of the watershed
A1.2	Evaluate and revise the current list of recommended BMPs	Will allow developers to utilize innovative BMPs and submit their site plans for review
A1.3	Expand the allowed placement of integrated LID on individual residential lots	More flexibility in the selection and siting of BMPs for developers. The implementation of LID management practices, will treat stormwater runoff more directly at the source
A2.1	Adopt a policy of implementing natural landscaping and green building approaches at County facilities	The implementation of more suitable landscaping materials and techniques for the watershed increase water quality and quantity benefits
A2.2	More frequent assessment and inspection of VDOT drainage systems	Identification of existing and potential future drainage problems and development of a prioritized approach to correcting any existing inadequacies and schedule future maintenance projects
A2.3	Encourage use of porous pavement	A reduction in impervious areas will decrease the amount of stormwater runoff within the watershed.
A4.1	Encourage replanting efforts within degraded RPA buffer areas of sites undergoing redevelopment.	Restoration of riparian buffers will increase the amount of habitat area, protect the stream bank areas from erosion, and provide filtering of pollutants from runoff

Policy Recommendation	Description	Benefit
A5.1	Enforce the solid waste ordinance and the erosion and sedimentation control ordinance prohibition against illegal dumping	Reduced pollution as a result of illegal dumping. This action would help to improve the health and reduce the amount of pollutants in streams within the watershed.
A6.1	Regulate the use of All Terrain Vehicles (ATVs)	Reduction of illegal ATV use in the RPA. It will reduce erosion, sedimentation, and the destruction of vegetation caused by ATVs.
B1.1	Develop a watershed stewardship message specifically for Fairfax County Public Schools and George Mason University	The children can take the environmental lessons they learn home to their families and discuss environmental issues
C1.1	Encourage all lawn management companies to participate in DCRs Virginia Water Quality Improvement Program	Nutrient management in the watershed. Increased awareness and education of watershed residents and lawn care companies who perform services within the watershed.
D1.1	Establish a dedicated funding mechanism	Proposed projects will not have to compete for funding from the Fairfax County General Fund. Evaluation of a dedicated funding source is being addressed as a countywide initiative

Plan Total Cost

The total cost of the proposed structural and non-structural actions in Table 4.13, as presented in Chapter 4, is approximately $24.6 million. Over the plan's lifespan of 25 years, this will require approximately 1.8 Fairfax County Staff Year Equivalents (SYE) for project management, land acquisition, and construction management, which are factored into the project costs. Actual costs may be reduced by using volunteer organizations to help implement non-structural projects, such as educational campaigns and environmental monitoring.

The total cost of the policy recommendations in Table 5.1, as presented in Chapter 5, is $1.3 million. Over the plan's lifespan of 25 years, this will require approximately 0.9 Fairfax County Staff Year Equivalents (SYE) for project management. These recommendations are not specific to only Popes Head Creek, but are intended to be implemented County-wide where applicable. The recommendations will be evaluated along with the recommendations from the other watershed management plans to determine their applicability in the County.

The total cost for implementing the entire watershed plan is approximately $25.9 million. This includes all structural and non-structural projects and policy recommendations, over the plan's lifespan of 25 years.

Chapter 1: Introduction

1.1 Background

The Popes Head Creek Watershed is one of the least developed watersheds in Fairfax County. On July 26, 1982, the Fairfax County Board of Supervisors approved a rezoning of more than 41,000 acres in the Occoquan Watershed in order to protect the Occoquan Reservoir, which supplies drinking water to the County. Land in the rezoned area is classified as Residential-Conservation (R-C) District, designating a maximum density of one dwelling unit per 5 acres. Eighty-six percent of the Popes Head Creek Watershed is located in this rezoned area.

The Popes Head Creek Watershed Management Plan provides strategies for protecting the watershed and mitigating adverse stream impacts that have occurred, such as stream bank erosion and poor water quality indicators.

The history of the County's watershed management began in the 1940s with the conversion of primarily agricultural land use to residential and commercial land uses. Stormwater infrastructure was constructed to quickly carry runoff away from the developed areas to the creeks and streams that serve as the principal drainage system for the County. Starting in 1972, onsite detention was required for new development to minimize the effects of increased runoff from development. In the early 1980s, water quality best management practices (BMPs) were required for new development in the southern areas of the County that drained to the Occoquan drinking water reservoir. BMPs were required for all new development in the County starting in 1993.

In the late 1970s, the County developed master drainage plans for all of the watersheds in the county, including the Popes Head Creek Watershed as part of the Occoquan Basins master drainage plan. This plan identified projects to solve problems including flooding, erosion, sedimentation, and other environmental problems projected through the year 2000. Recently, the county started a stream restoration and protection study and completed the *Fairfax County Stream Protection Strategy Baseline Study* (http://www.fairfaxcounty.gov/dpwes/environmental/sps_main.htm) in January 2001. This baseline study evaluated the condition of county streams and prioritized the watersheds for protection strategies. The stream protection strategy program is ongoing with further biological monitoring and assessment of stream condition.

Building on the recommendations from the *Stream Protection Strategy Baseline Study*, the County initiated a process to develop watershed management plans for the County's 30 watersheds over a period of five to seven years. The development of the watershed management plans includes a stream physical assessment of over 800 miles of stream; community involvement; modeling of the creeks and streams; and the development of goals, objectives, and strategies for addressing watershed issues.

1.2 Purpose

The primary reasons the *Popes Head Creek Watershed Management Plan* was developed can be summarized as follows:

1. To meet state and federal water quality standards by identifying strategies to prevent and remove pollution;
2. To support Virginia's commitment to the Chesapeake 2000 Agreement to restore the Chesapeake Bay;

3. To replace the currently out-dated watershed management plan through the use of new technologies; and,
4. To take a comprehensive approach in addressing multiple regulations, commitments, and community needs.

With input from the Popes Head Creek Citizen's Advisory Committee and other members of the community, this watershed management plan addresses these needs and requirements with a strategy for restoring and protecting the watershed. The Committee was composed of local community members from various interest groups, and represented environmental, business, and homeowner views and concerns. The Committee met with the Project Team regularly over 18 months to provide valuable local input and feedback. This public involvement process helped to ensure that the watershed plan will meet the specific needs and desires of the residents of the Popes Head Creek Watershed. The meeting minutes from all of the Citizen's Advisory Committee meetings can be found in Appendix A. The meeting minutes from all public workshops and reviews can be found in Appendix B.

1.3 Plan Organization

The *Popes Head Creek Watershed Management Plan* integrates environmental management, natural resource protection, and community goals to improve the watershed. It provides a guide that:

- Describes goals and objectives to support the vision for the watershed;
- Assesses the existing and future condition of the watershed;
- Sets forth strategies for addressing watershed issues; and
- Provides the county and the community with a management tool to make informed decisions regarding short term and long term actions in the watershed.

The watershed plan chapters contain the following information:

Chapter 1 Background, purpose, and plan organization.

Chapter 2 General watershed information, watershed history, land use and impervious cover, subwatershed and tributary information, and summary of existing reports and data.

Chapter 3 Subwatershed characteristics, description of the storm drain infrastructure, stream geomorphology, stream quality, problem areas, and modeling results.

Chapter 4 Plan vision, goals, objectives actions, and implementation strategies.

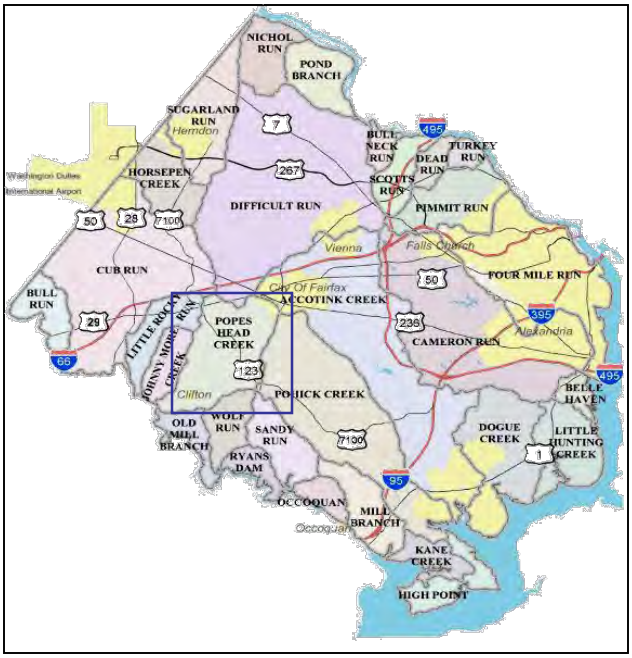
Chapter 5 Policy recommendations and implementation strategies.

Supplemental appendices include a glossary, public meeting minutes, and detailed descriptions of structural and non-structural proposed projects.

Chapter 2:
Watershed Condition

2. 1 General Watershed Information

The Popes Head Creek Watershed drains into the Occoquan Reservoir and eventually to the Chesapeake Bay, and is located in the southwestern part of Fairfax County, Virginia, as shown on Map 2.1. It is bounded to the east by the Pohick Creek Watershed, to the south by the Wolf Run and Old Mill Branch Watersheds, to the west by the Johnny Moore and Little Rocky Run Watersheds, and to the north by the Difficult Run and Accotink Creek Watersheds.



Map 2.1 Location of the Popes Head Creek Watershed

The Popes Head Creek Watershed encompasses 12,137 acres (18.96 square miles) and is located in the piedmont physiographic province, a region characterized by gently rolling hills, deeply weathered bedrock, and very little solid rock at the surface.

The headwaters of Popes Head Creek are in the southwest portion of the City of Fairfax, located at the northeast border of the watershed. The creek flows in a southwesterly direction to its confluence with Bull Run in Hemlock Overlook Regional Park. Bull Run then flows into the Occoquan Reservoir.

The Fairfax County Parkway (Route 7100) bisects the center of the watershed and is the most heavily traveled roadway in the watershed. Other heavily traveled roads in the watershed include: Ox Road (Route 123), located along the eastern boundary of the watershed; Lee Highway (Route 29), located in the northern portion of the watershed and Braddock Road, located south of Route 29 in the north central area of the watershed.

The Popes Head Creek Watershed is part of the Chesapeake Bay Preservation Area (CBPA), and the entire main stream corridor of the Popes Head Creek Watershed is located in the County's designated Resource Protection Area (RPA). The RPA is designated around all water bodies with perennial flows to protect the quality of water flowing to the Chesapeake Bay. The RPA totals approximately 1,610 acres, or 2.5 square miles, in the Popes Head Creek Watershed. The remainder of the watershed area is part of the County's Designated Resource Management Area (RMA), which is designed to protect water quality by preserving or enhancing the functional value of the RPA.

2.2 History of the Watershed

Popes Head Creek first appeared on maps of the Northern Neck Grants in 1710. The name "Popes Head" was possibly taken from a street name in London. A street near the Royal Exchange in London was named Popes Head Alley and was renamed during Henry VIII's reign as Kings Head Alley. The alley was renamed back to Popes Head Alley during Bloody Mary's reign. Many pubs in London were named Popes Head and renamed Kings Head or Bishops Head after the Reformation.

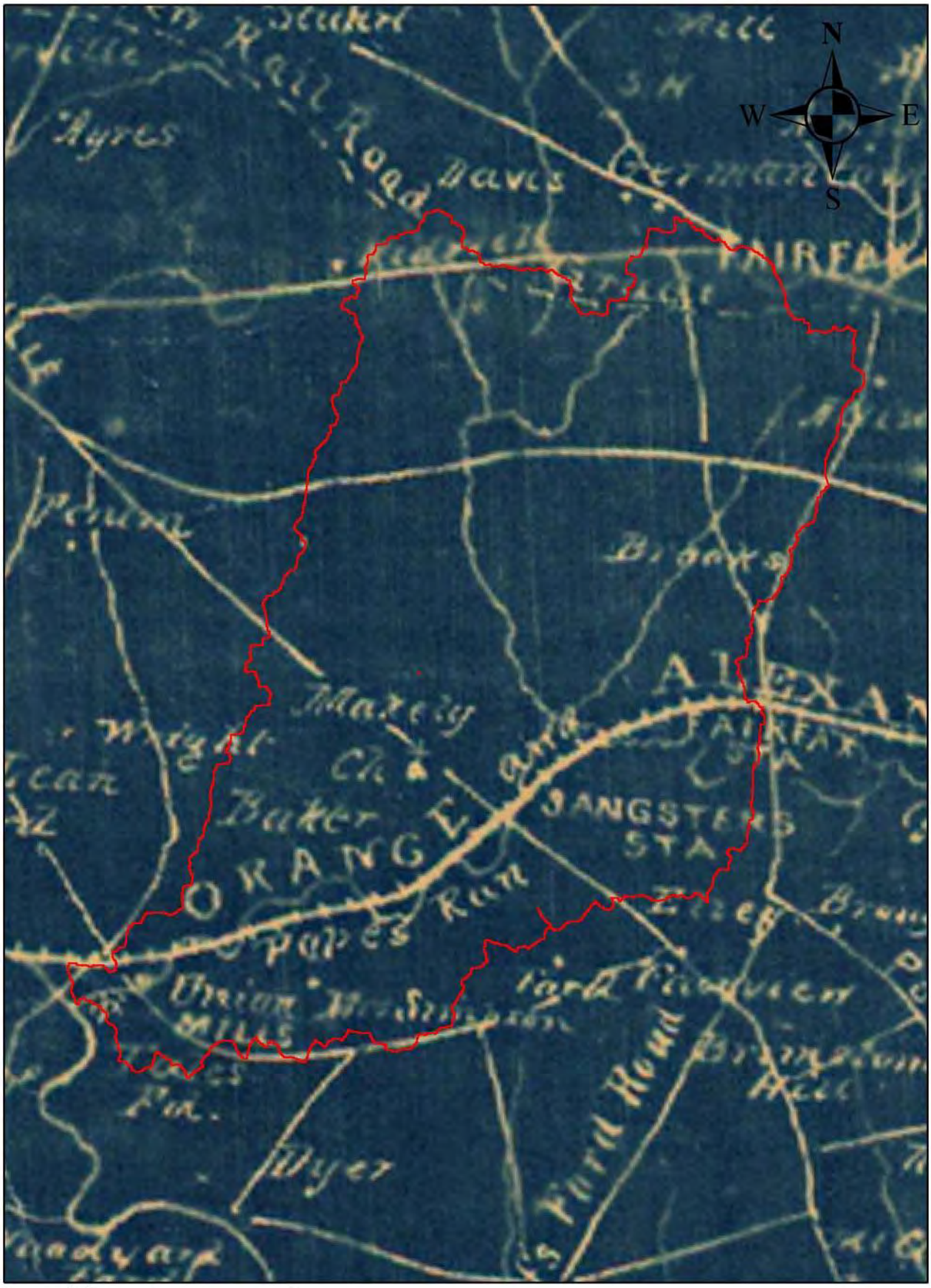
Historical records document that the Hope Park Plantation owned by Edward Payne was located in the watershed. This plantation was located along present day Popes Head Road. In 1765, the election for the Vestry of Truro Parish resulted in the selection of a group which included George Washington of Mount Vernon, George Mason of Gunston Hall, and Edward Payne of Hope Park "in the Forrest." The plantation included over 1,200 acres of land and eighteen outbuildings including a grist mill. The landscape was dramatically changed by widespread logging and the conversion of forest land into agricultural land as settlement continued. Most of the forest that exists now in the watershed is second growth forest.

In 1850-1851, the Orange and Alexandria Railway (now the Norfolk Southern Railroad) was constructed from Alexandria to Manassas Station and beyond. The route ran down Popes Head Creek to its mouth and then along Bull Run before crossing into Prince William County. During the Civil War there was heavy occupation extending south from Centreville through the current site of the Hemlock Overlook Regional Park and a fortified line of trenches were constructed. Control of the Orange and Alexandria Railroad was critical to both the Union and the Confederacy. The railroad consumed many wood products, leading to increased logging in the watershed. Map 2.2 shows a historical map of the watershed, circa 1863.

The Town of Clifton sprang up in the late 1800s on land owned by the Beckwith family. Clifton was a prosperous town that grew and thrived because of local lumbering operations and transportation available on the Southern Railway, which ran through the center of Town. The greatest growth in the Clifton area occurred between 1890 and 1920. Map 2.3 shows a historical map of the watershed circa 1915. Although the station was removed in 1958, the town is noted for its late-19th century architecture. Clifton was declared a National Historic District by the U.S. Department of Interior in 1984.

Hemlock Overlook Regional Park is located at the mouth of Popes Head Creek. The land for the park was purchased by the Fairfax County Park Authority in January 1962 who then sold the property to the Northern Virginia Regional Park Authority (NVRPA) in August 1962. The NVRPA purchased the property to add to its existing holdings acquired for the protection of the Occoquan Watershed. Until 1984, the primary purpose of the Hemlock Overlook camp was to provide local schools access to outdoor recreation. The NVRPA entered into a joint operating agreement with George Mason University in 1984. George Mason University continues to operate an Outdoor Education Center and current programs offered include team development, environmental education, overnight retreats, summer camps and corporate training programs.

Map 2.2: Popes Head Creek Watershed, circa 1863



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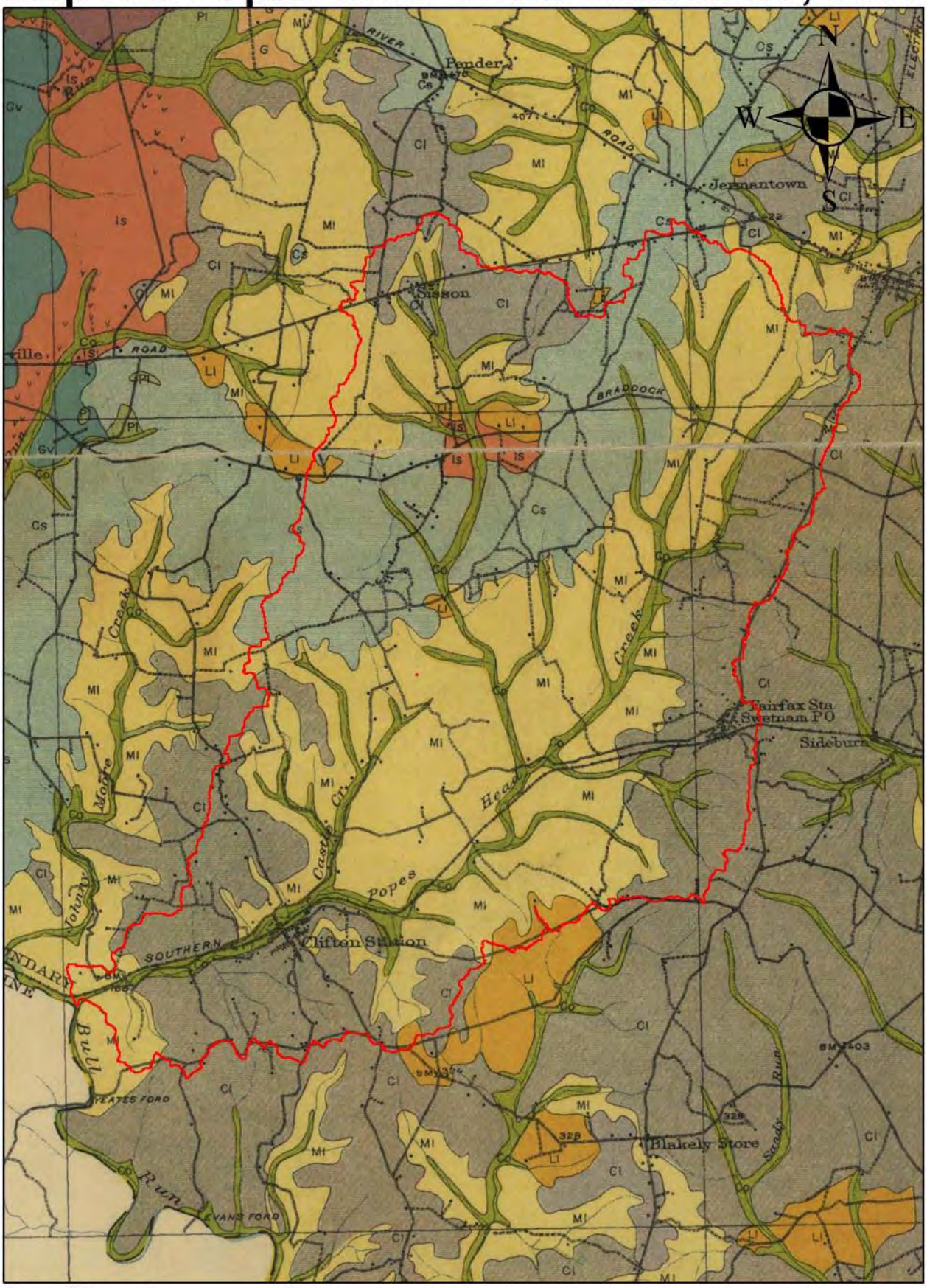
Miles

Source: Library of Congress, Geography and Map Division

Map 2.3: Popes Head Creek Watershed, circa 1915



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Source: Library of Congress, Geography and Map Division

The Country Club of Fairfax is located along the East Fork of Popes Head Creek. Originally known as the Court House Country Club of Fairfax, the Club was founded in 1947 when a group of Fairfax residents felt there was a need for a private Country Club in the Fairfax area. After exploring the territory, an option was taken on the Haight Dairy Farm and the land was purchased on September 17, 1947. The name was changed officially to the Country Club of Fairfax in 1986. The Country Club offers an 18-hole golf course, swimming pool, and 12 tennis courts including a year-round tennis bubble.

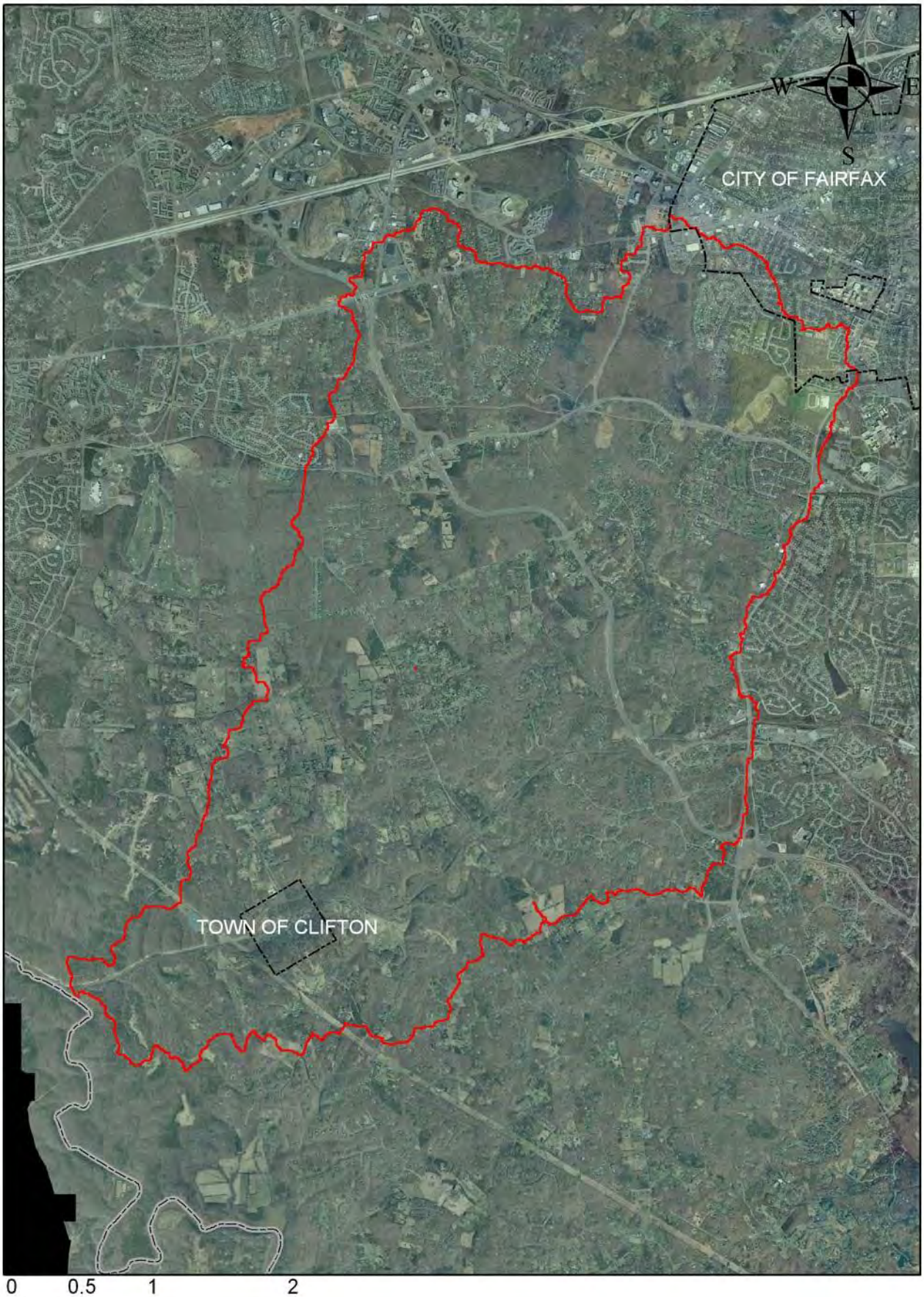
A portion of George Mason University is located in the upper reaches of the Popes Head and East Fork watersheds, north of Braddock Road. The university began as the Northern Virginia branch of the University of Virginia in 1957. The Town (now City) of Fairfax purchased 150 acres in 1958 and donated it to the University of Virginia for a permanent branch campus. In March 1966, the General Assembly authorized the expansion to a four-year, degree-granting institution. In late 1966, the local jurisdictions of Fairfax County, Arlington County and the cities of Alexandria and Falls Church agreed to appropriate money to purchase land adjacent to the existing site to provide for a 600-acre campus. This adjacent property was obtained in 1969 and 1970. In 1972 the Board of Visitors of the University of Virginia recommended that the college separate from its parent institution and on April 7, 1972, the governor signed the legislation that established George Mason University as an independent member of the Commonwealth's system of colleges and universities. Construction of the field house, located in the watershed, began in 1980. Map 2.4 shows a recent map of the watershed, circa 1997.

2.3 Land Use and Impervious Cover

Residential and commercial development in the northern portion of the Popes Head watershed began in the late 1950s. Commercial development in the upper Piney Branch watershed started in the mid-1980s. The central and southern portions of the watershed consist primarily of large lot residential development. On July 26, 1982, the Fairfax County Board of Supervisors approved a rezoning of more than 41,000 acres in the Occoquan Watershed in order to protect the Occoquan Reservoir, which supplies drinking water to the County. Land in the rezoned area is classified as Residential-Conservation (R-C) District, designating a maximum density of one dwelling unit per 5 acres. Approximately 86% of the Popes Head Creek Watershed is located in this rezoned area. The rezoned area is shown on Map 2.5.

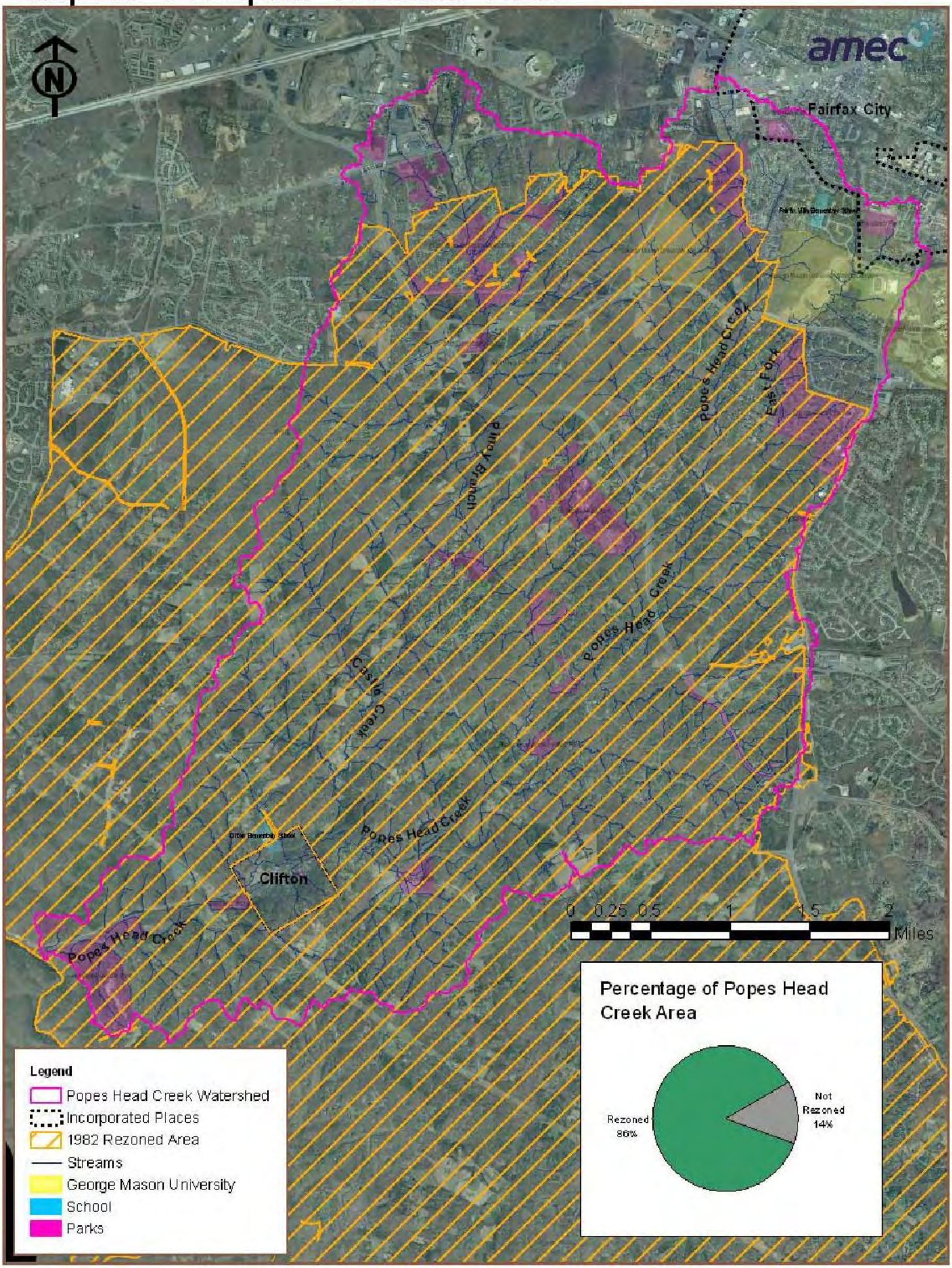
The total impervious area in the watershed is approximately 1,142 acres (9% of the total area). The percentage of each land use category that comprises the total impervious area is shown in Table 2.1. The existing impervious area was delineated from the County's Geographic Information System (GIS) coverages of buildings, roads and parking lots. The County's line coverages for railroads and sidewalks were used to estimate these impervious areas. Driveway impervious area was estimated by using typical values for driveways measured in the watershed for several residential density types. The future impervious cover reflects imperviousness associated with the future land use condition, as shown in Table 2.2. The land use data was derived from the County's 2002 GIS data.

Map 2.4: Popes Head Creek Watershed circa 1997



Source: Library of Congress, Geography and Map Division

Map 2.5 Occoquan "Rezoned" Area



Popes Head Creek Watershed Imperviousness

Land Use	% of Total Impervious Area
Roads/Sidewalks/Railroad	46%
Residential	21%
Driveways	21%
Commercial/Industrial/Parking Lots	12%

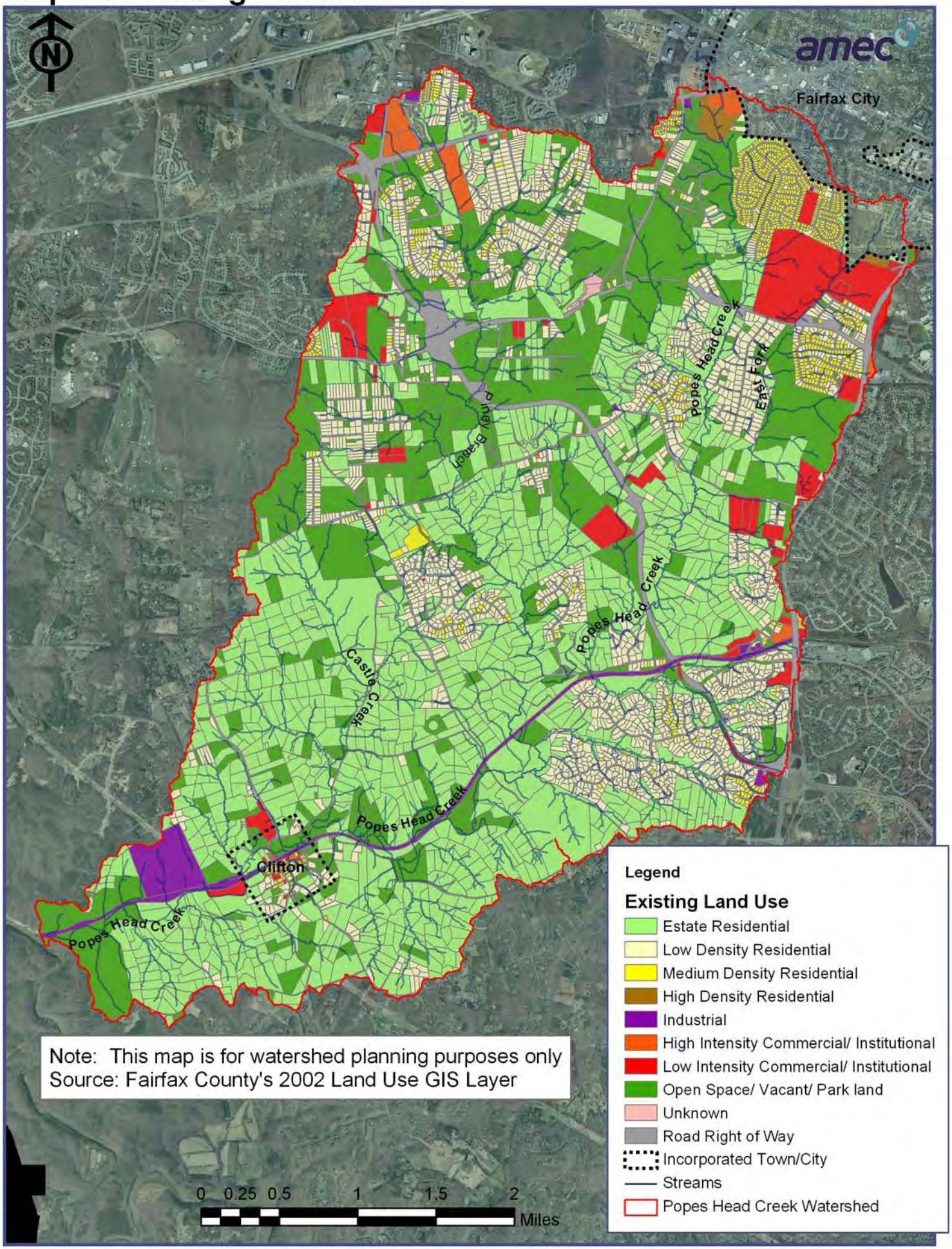
The predominant existing land use in the watershed is estate residential, as shown in Table 2.2, with 45% of the watershed area consisting of this density of a minimum of 5 acres per dwelling unit. The next major land use consists of undeveloped areas in the watershed. The land use descriptions are based upon groupings in the County's *Stormwater Model and GIS Interface Guidelines*, as described in *Technical Memorandum No. 3*, and are for use in the watershed management studies. For ultimate future buildout of the watershed, estate residential land use may increase to 59% and the future watershed imperviousness may increase to 11.4%. The future impervious cover reflects imperviousness associated with the future land use condition. The existing and future land use in the watershed is shown on Maps 2.6 and 2.7.

Table 2.2 Existing and Future Land Use in the Popes Head Creek Watershed

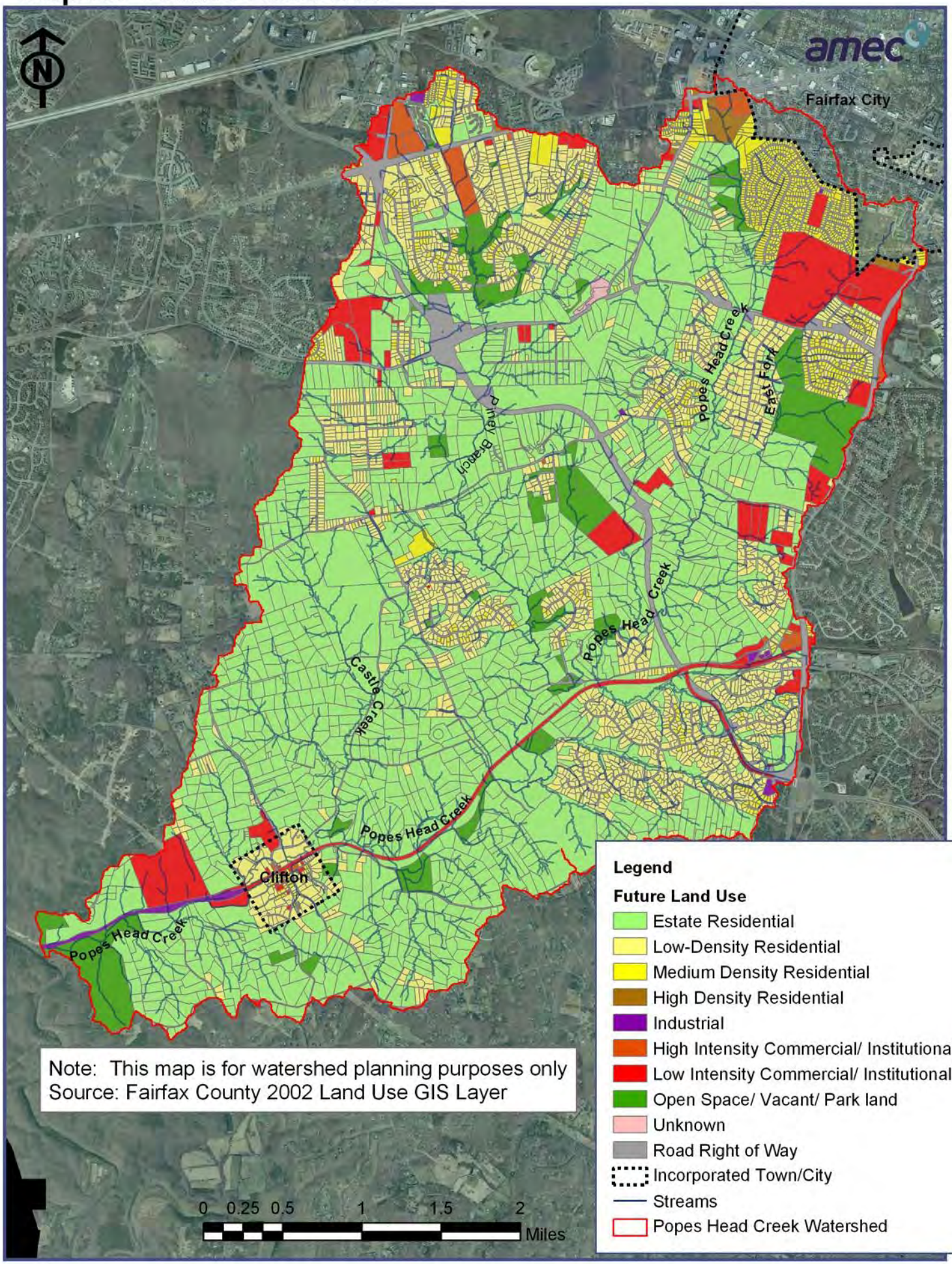
Land Use Description	Existing		Future	
	Area (acres)	%	Area (acres)	%
Open space, parks and recreational areas	728	6	640	5
Estate residential	5,431	45	7,152	59
Low Density residential	1,836	15	2,028	17
Medium-density residential	396	3	498	4
High-density residential	47	0	48	0
Low-intensity commercial/institutional	516	4	698	6
High-intensity commercial/institutional	97	1	99	1
Undeveloped	1,961	16	0	0
Industrial	191	2	40	0
City of Fairfax	185	2	185	2
Unknown	12	0	12	0
Road right-of-way (including shoulder areas)	737	6	737	6
TOTAL	12,137	100	12,137	100

Note: *Based upon Fairfax County's 2002 Land Use GIS Layers.*

Map 2.6 Existing Land Use



Map 2.7 Future Land Use



The locations of vacant and underutilized parcels in the watershed are shown on Map 2.8. The vacant parcel data was obtained from the County's 2002 database and the underutilized parcel information was obtained from the County's 1999 database. Underutilized parcels have a potential zoning density greater than the existing land use on the parcel. The majority of the planned land use for vacant and underutilized parcels is estate residential.

2.4 Subwatersheds and Tributaries

For the purposes of this watershed plan, the Popes Head Creek Watershed was divided into seven subwatersheds, as shown on Map 2.9, to make it easier to evaluate the characteristics of the area draining to each of the major tributaries. The subwatersheds were delineated using the topographic data from the county's GIS and are described in Table 2.3. Table 2.3 also shows the length of the major tributaries in the Popes Head Creek watershed.

Table 2.3 Subwatershed Area and Major Tributary Length

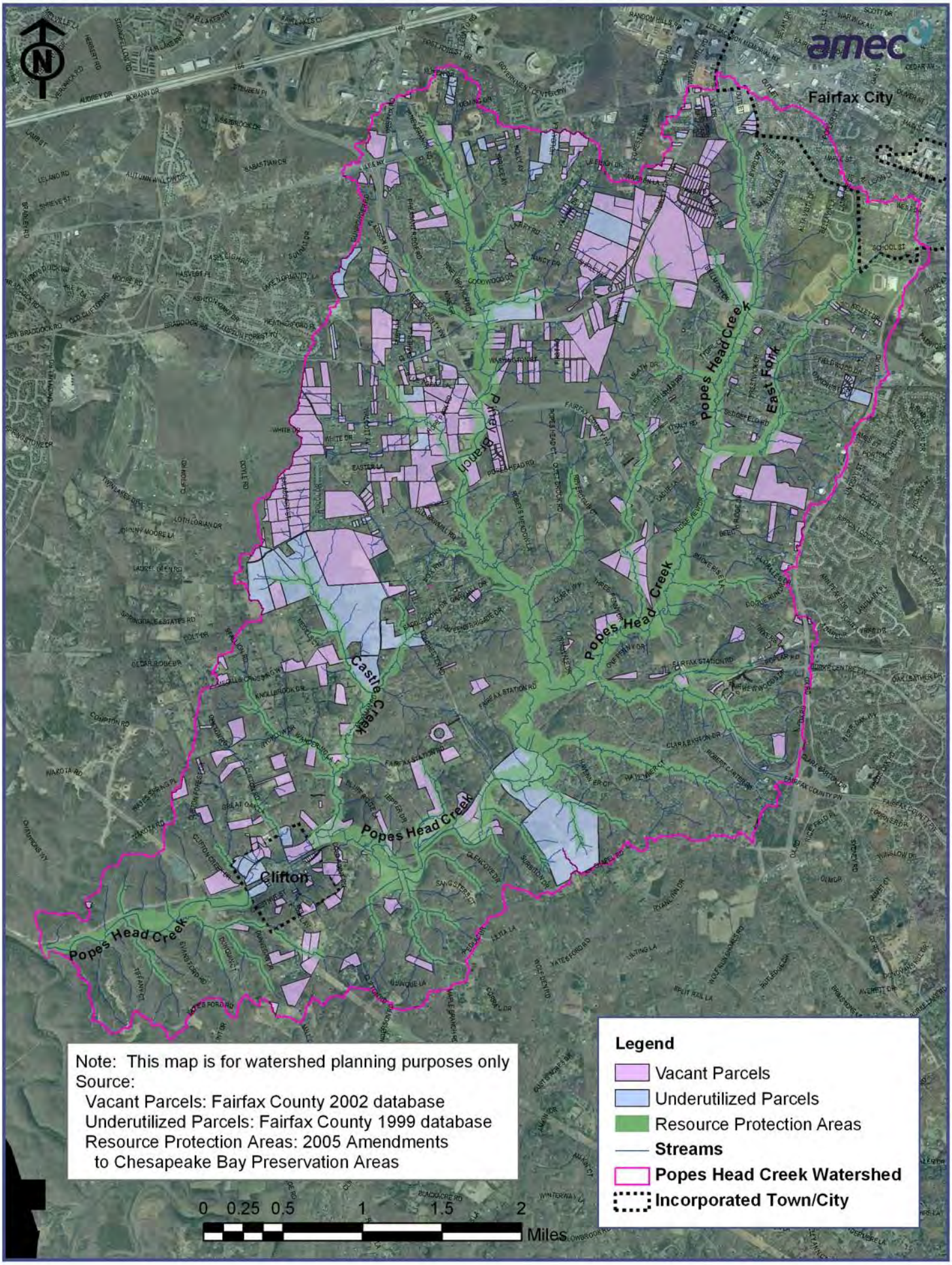
Subwatershed Name	Area (acres)	Tributary Name	Major Tributary Length (miles)
Upper Popes Head	1,430	Popes Head Creek	1.53
East Fork	847	East Fork Popes Head	1.87
Popes Head 2	1,732	Popes Head Creek	2.61
Piney Branch	3,389	Piney Branch	3.98
Popes Head 3	1,870	Popes Head Creek	3.06
Castle Creek	1,477	Castle Creek	2.22
Lower Popes Head	1,392	Popes Head Creek	2.46
TOTAL	12,137		17.73

2.5 Summary of Existing Reports and Data

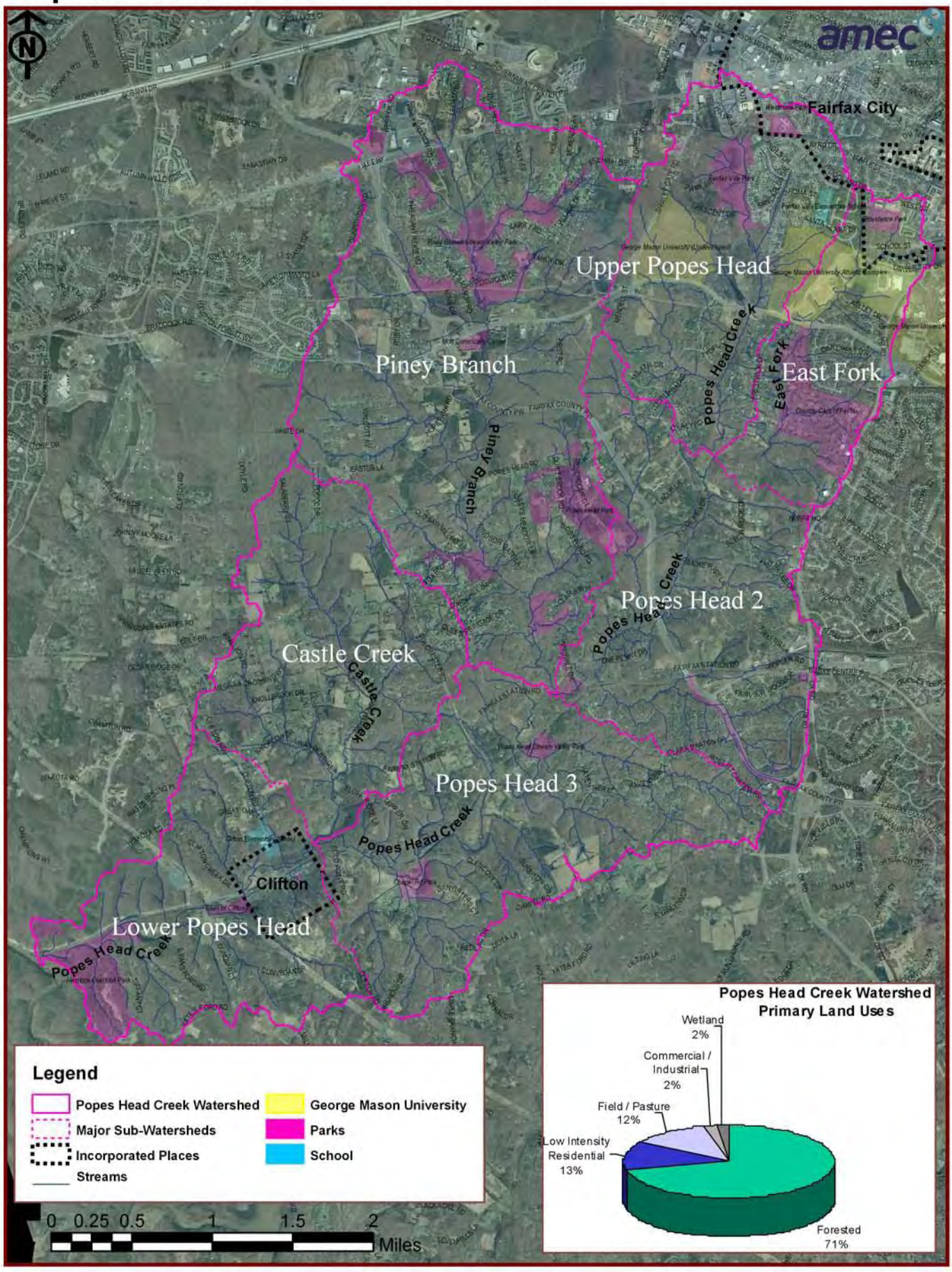
2.5.1 Stream Water Quality Report

The Fairfax County Health Department formerly monitored stream water quality at 84 sampling sites throughout the County. Three water quality sampling sites were located in the Popes Head Creek Watershed and are shown on Map 2.10. Sites 26-02 and 26-05 are located on Popes Head Creek and site 26-03 is located on Piney Branch. In 2002, 18 water samples were collected from each of these sites and evaluated for fecal coliform, dissolved oxygen, nitrated nitrogen, pH, phosphorous, temperature, and heavy metals. These parameters indicate the amount of pollution contributed from manmade sources and help to evaluate the quality of the aquatic environment. Information regarding the parameters and data collected for the *Fairfax County 2002 Stream Water Quality Report* can be found at http://www.co.fairfax.va.us/ service/hd/resourcewater.htm.

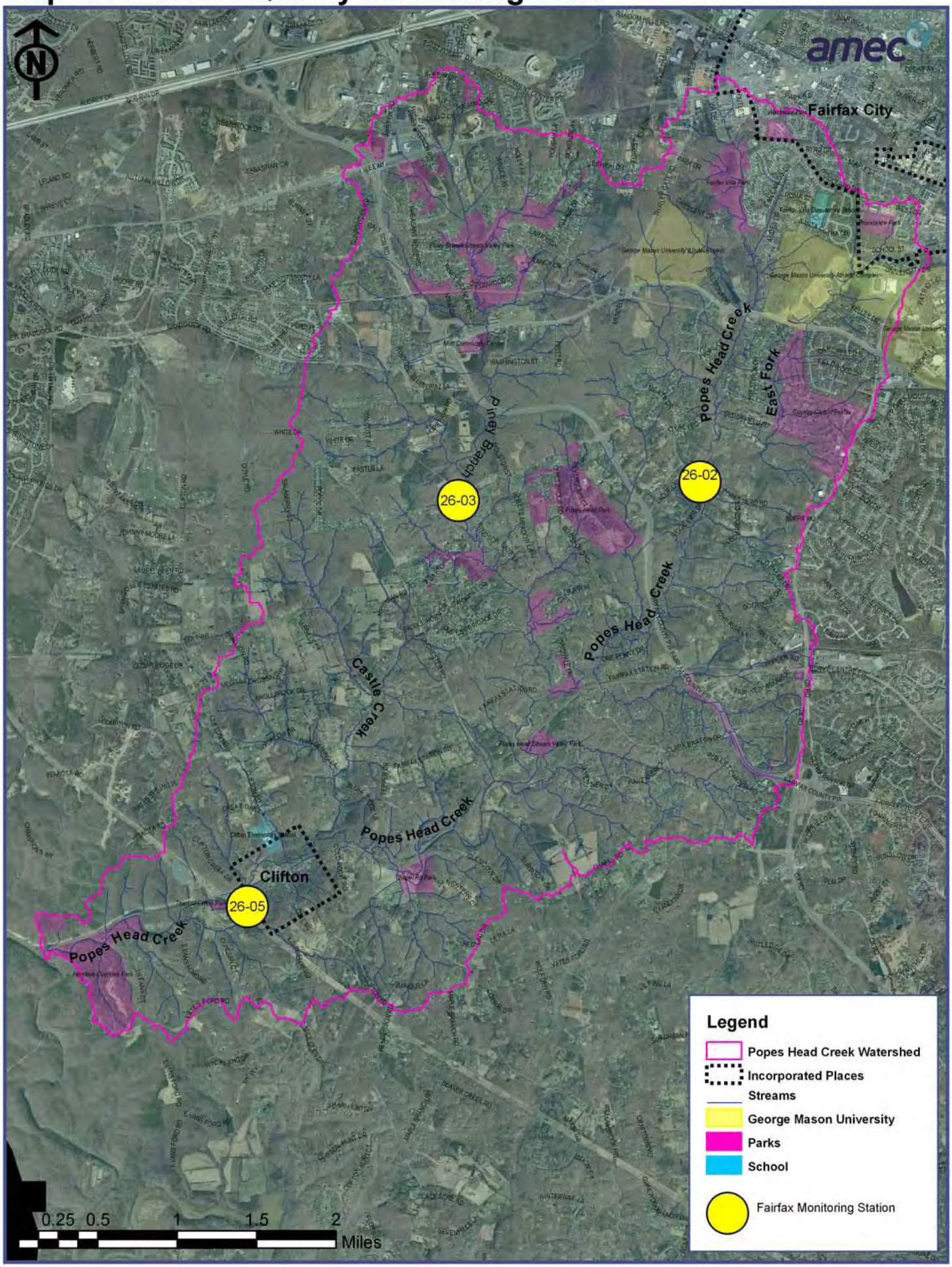
Map 2.8 Vacant and Underutilized Parcels



Map 2.9 Location of Subwatersheds



Map 2.10 Water Quality Monitoring Sites



Five percent of samples collected from sites 26-02 and 26-05 on Popes Head Creek showed a dissolved oxygen concentration of less than 4.0 mg/l, which is the minimum standard considered suitable for aquatic life. None of the samples for site 26-03 on Piney Branch had dissolved oxygen concentration less than 4.0 mg/l. The average dissolved oxygen concentration for all three sites in the watershed were between 9 and 10 mg/l, which is above the minimum standard. Low stream flows due to low rainfall can affect the dissolved oxygen levels.

For sites 26-02, 26-03 and 26-05, fecal coliform counts in 2002 were greater than 1,000/100 ml for 22%, 28% and 33% of the samples, respectively. Countywide, 25% of the samples in 2002 exceeded fecal coliform counts of 1,000/100 ml. For fecal coliform, a count less than 200/100 ml is considered good water quality and a count of 250,000/100 ml is considered a direct sewage discharge. In 2002, an average of 9% of the samples in the watershed met the good water quality criteria as opposed to an average of 15% in 2001. Figure 2.1 shows the values for the geometric mean of fecal coliform from 1993 to 2002. The geometric mean is used to measure the central tendency of the data. The geometric mean is calculated by multiplying a series of numbers and taking the *nth* root of the product where *n* is the number of items in the series.

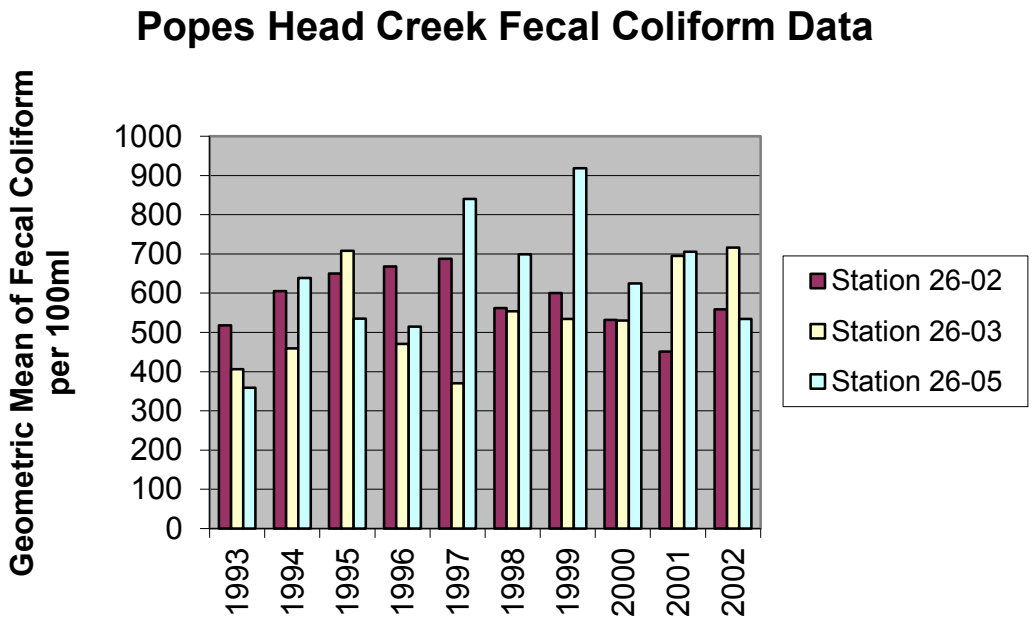


Figure 2.1 Yearly Geometric Mean of Fecal Coliform for Popes Head Creek

2.5.2 Environmental Baseline Report

The *Occoquan Environmental Baseline Report* was written by Parsons, Brinkerhoff, Quade and Douglas in February 1978. The report presented a comprehensive view of the environmental baseline conditions for the 11 watersheds in the southern area of the County that drain into Bull Run and the Occoquan Reservoir. The stream water quality in the Popes Head Creek watershed was assessed in very good condition. To compare to the fecal coliform data presented above, the sampling for this report done in 1976 showed a geometric mean of fecal coliform for the same three stations to be between 36 and 59 per 100 ml. This is significantly lower than the data for 1993 through 2002.

The *Occoquan Environmental Baseline Report* also addressed the aquatic environment by surveying the aquatic fauna at 5 sites in the Popes Head Creek watershed. Two sites were on

Piney Branch at Braddock Road and at Fairfax Station Road, one site was on Castle Creek at Newman Road and two sites were on Popes Head Creek at Popes Head Road and Chapel Road. The stream fauna quality was ranked “very good” on Piney Branch at Braddock Road and “good” on Piney Branch at Fairfax Station Road, Castle Creek at Newman Road and Popes Head Creek at Popes Head Road. The stream fauna quality at the most downstream site on Popes Head Creek at Chapel Road was ranked “fair to poor”. The report states that faunal diversity at this site was fairly low, and only a few pollution-sensitive species were collected.

Severe erosion was noted as several locations on Popes Head Creek and its tributaries. On Popes Head Creek, severe erosion was noted in one area upstream of Braddock Road, three areas between Fairfax Station Road and Popes Head Road, five areas upstream of Clifton Road and one area downstream of Clifton Road. An unnamed tributary to Popes Head Creek located downstream of Fairfax Station Road had seven areas with severe erosion. Piney Branch had three areas of severe erosion located downstream of Popes Head Road. The stream physical assessment performed in 2002 showed that approximately 50% of stream banks in the Popes Head Creek watershed are moderately unstable (40-70% erosional areas). However, no stream banks in the watershed were classified as unstable in the 2002 stream physical assessment (greater than 70% erosional areas).

The *Occoquan Environmental Baseline Report* noted severe sedimentation at two locations on Popes Head Creek, one upstream of Fairfax Station Road and one at the railroad crossing upstream of Clifton Road. The 2002 stream physical assessment results showed that approximately 5% of streams in the watershed were rated poor for embeddedness, that is, the streambeds are75-100% covered by sediment or sunken into sediment. The majority of these poor areas are located in the Castle Creek watershed. Approximately 50% of the streams were rated marginal (50-75% of the streambed was covered by sediment).

2.5.3 Proposed Drainage Plan

The *Proposed Drainage Plan, The Occoquan Watersheds* was written by Parsons, Brinckerhoff, Quade and Douglas in April 1979. The report identified 21 projects for the Popes Head Creek Watershed at an estimated cost of $1,515,000. The various projects included 17 culvert/road improvement projects and four stream stabilization projects. The purpose of these projects includes alleviating roadway flooding and abating bank erosion. Five of the culvert/road improvement projects have been constructed and one stream stabilization project is active with partial funding. The remaining 11 projects are inactive with no funding.

2.5.4 Fairfax County Master Plan Drainage Projects

Fairfax County currently has a 27 master plan drainage projects designated for the Popes Head Creek Watershed. This list includes the projects identified in the *Proposed Drainage Plan* Report. Ten of the master plan drainage projects have been completed. There are two active projects: floodproofing a house in the East Fork subwatershed and a channel stabilization project in the Brecon Ridge subdivision. Fifteen projects are inactive due to a lack of funding.

2.5.5 Fulfilling the Promise: The Occoquan Watershed in the New Millennium

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

The following paraphrased recommendations will be addressed by the Popes Head Creek Watershed Management Plan. For a full text listing of the Report Recommendations, please see Appendix C.

Reservoir Recommendations:

1. *Promote existing programs and policies aimed at maintaining acceptable levels of water quality in the Reservoir;*

3 *Reduce nutrient and sediment contributions to the Reservoir above and beyond those being achieved through existing policies and ordinances;*

4 *Actively participate in State and federal regulatory and/or policy initiatives that might result in requirements for additional nutrient and sediment reductions;*

Streams and Ecosystems Recommendations:

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

Land Use and Open Space Recommendations:

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

Tree Preservation Recommendations:

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

Erosion and Sediment Control and Stormwater Management Recommendations:

1. *Support the stormwater management findings of the study and urge implementation;*
2. *Ensure the frequency of County inspections is sufficient to enforce the Erosion and Sediment Control ordinances.*

Citizen Involvement Recommendations:

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

Regional Coordination Recommendations:

1. *Continued support of regional approaches to Occoquan Watershed Protection.*

2.5.6 Infill and Residential Development Study

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

The following paraphrased recommendations will be addressed by the Popes Head Creek Watershed Management Plan. For a full-text listing of the Study Recommendations, please see Appendix C.

- SC 5: *Allow cluster development by right;*
- SC 6: *Review the Zoning Ordinance and Comprehensive Plan provisions related to open space;*
- TR 1(a): *Modify requirements for horizontal and vertical alignment and street width, including allowance for "traditional street design;"*
- TP 1: *Reduce grading to increase tree preservation;*
- TP 3: *Request conservation easements where appropriate;*
- SW 1: *Improve the awareness, planning, and financial resolution capability of the County for land disturbing projects upstream of sensitive sites*;
- SW2: *Enhance the enforcement of violations including, in certain egregious instances, revoking of land disturbing permits;*
- SW3: *Enhance, through educational programs, the knowledge and awareness of staff, the development industry, and citizens regarding the importance and capabilities of an Erosion and Sedimentation control program;*
- SW4: *Improve the design and installation of Erosion and Sedimentation control silt fences and super silt fences by improving the design standards in the County's regulations;*
- SW5: *Improve the effectiveness of temporary erosion and sedimentation inlet controls on construction sites by reducing the allowable area that may be drained to them;*
- SW6: *Allow the use of an optional 'Faircloth Floating Skimmer' as a dewatering device in temporary sediment traps to increase sediment removal efficiency;*
- SW7: *Allow the use of chemical erosion prevention products on exposed and highly sensitive soils at construction sites in order to reduce erosion which may occur between the time that the exposed area is seeded and mulch and when the grass is fully established;*
- SW8: *Allow the use of bonded fiber matrix products on exposed highly sensitive soils on steep slopes at construction sites in order to reduce erosion which may occur between the time that the exposed area is seeded and mulch and when the grass is fully established;*
- SW9: *Require additional conditions associated with stormwater detention/water quality waivers to address potential problems associated with land disturbance;*
- SW10: *Require reports from applicants that identify baseline data for properties downstream, corrective measures planned for implementation in the event that impacts occur, and a commitment to implement those measures;*
- SW11: *Enhance the use of Best Management Practices (BMP) through additional guidance on BMP selection and enhanced design standards in the PFM;*
- SW12: *Amend the Public Facilities Manual to 1) include technical definitions pertaining to the adequate outfall of stormwater from developments; 2) require a formal adequate outfall analysis in conjunction with review of proposed construction plans; 3) give the Director discretion to require additional measures where a proposal will discharge into an inadequate channel; and 4) better define the design procedure for pipe outlets and suggest consideration*

of the recent Virginia Department of Conservation and Recreation proposal pertaining to hydrologic design stormwater design;

- SW13: *Modify requirements and procedures as they relate to the consideration of stormwater management during the zoning process.*

2.5.7 Natural Resource Management Plan

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

The following paraphrased strategies will be addressed by the Popes Head Creek Watershed Management Plan. For a full text listing of the Report Recommendations, please see Appendix C.

Plan Element: Natural Resource Planning

Issue 1: Natural Resource Inventories and Planning

- Strategy 1.9: Promote partnerships and volunteer participations in resource management inventories, plans and management.
- Strategy 1.12: Pursue opportunities through open space easements, proffered dedications, acquisitions and partnerships to preserve and protect additional open space – particularly land with significant natural, cultural or horticultural resources. Educate citizens about their opportunities to participate in these programs and to protect natural resources on their land.
- Strategy 1.13: Participate in County revitalization projects to identify areas appropriate for resource and open space preservation, as well as passive recreation.

Plan Element: Wildlife

Issue 3: Resolving Conflicts with Wildlife

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

Plan Element: Water Resources

Issue 2: Baseline Inventories for Water Resources

- Strategy 2.1: Continue to expand partnerships with DPWES, NVSWCD, ANS, DEQ, Fairfax County Public Schools and others to involve Park Authority volunteers in producing certified water quality monitoring data from park sites. Seek expanded coordination of data and information among participating organizations and volunteers.

- Strategy 2.2: Complete inventory and assessment of stormwater management facilities on parklands to determine their condition and effectiveness, as well as maintenance actions required and responsibility for ongoing maintenance.
- Strategy 2.3: For parks with water bodies, include water quality physical and biological assessments in natural resource baseline inventories as part of park master plans.
- Strategy 2.4: In cooperation with DWPES, begin an assessment of stormwater outfalls on or directly adjacent to parkland to identify locations of greatest concern for erosion and related damage. Explore options to mitigate damage at the sites of greatest concern.
- Strategy 2.5: Review the stream assessment data compiled by DPWES that is available for park stream valleys, identify problem areas on parklands, and develop a prioritized action plan for the most critical needs (including cost estimates for each project).

Issue 3: Protecting Water Resources

- Strategy 3.1: Participate in and closely monitor the Fairfax County Watershed Planning process being coordinated by DPWES.
- Strategy 3.2: As Fairfax County Watershed Plans are adopted by the Board of Supervisors, incorporate their requirements and recommendations in park master planning, design and construction in those watersheds and as may be applicable countywide.
- Strategy 3.5: Seek partnership opportunities and volunteer projects with the Potomac Conservancy, the Virginia Department of Forestry, the Northern Virginia Conservation Trust, DPWES, Department of Planning and Zoning, the Northern Virginia Regional Park Authority, the Fairfax County Tree Commission, and others to enhance riparian buffers and other aquatic habitats.
- Strategy 3.6: Pursue opportunities to utilize Best Management Practices (BMPs) and Low-Impact Development (LID) such as green buildings, rain gardens, and other innovative techniques to reduce water quality and other impacts of new or renovated Park Authority facilities.

2.5.8 Virginia Department of Environmental Quality Water Quality Data

Popes Head Creek is listed as an impaired waterbody in the 2004 305(b)/303(d) Water Quality Assessment Integrated Report prepared by the Virginia Department of Environmental Quality (DEQ). It was initially listed in 1998 after biological monitoring at Route 645 (Clifton Road) determined that the benthic community, composed of aquatic macroinvertebrates that live on the stream bottom, is moderately impaired. In addition, a citizen monitoring station, located in Chapel Road Park, finds medium probability of adverse conditions for biota. Macroinvertebrates are tiny animals that lack a backbone, such as aquatic insects, leaches, mollusks and worms, which have varying tolerances to pollution, and therefore are used as an indicator of water quality. In 2004, Popes Head Creek was also listed as fecal coliform impaired based on water quality data collected at the same DEQ sampling location. The source of the fecal coliform and the benthic impairment are both unknown. The impaired segment begins at the confluence of Popes Head Creek to Bull Run and continues upstream to the confluence of Piney Branch, approximately one quarter mile downstream of Route 660 (Fairfax Station Road). As a result of the biological and bacteria listings, the segment was assessed as not supporting the Clean Water Act's Recreation and Aquatic Life Use goals.

Once a waterbody 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 and submitted to the United States Environmental Protection Agency (EPA) for approval. Upon approval, DEQ must develop a TMDL Implementation Plan to restore water quality. Because the impaired segment begins at the mouth of Popes Head Creek, the TMDL will include the creek's entire watershed. DEQ has scheduled TMDLs for both listings to be submitted to EPA in May 2006 and began TMDL development in March 2005. When the TMDL is complete, the loading reductions will be incorporated into Fairfax County's Virginia Pollutant Discharge Elimination System (VPDES) permit to discharge stormwater into Waters of the State (including Popes Head Creek). As a result, the loading reductions will become mandatory for the County at that time. While the Popes Head Creek listings are not explicitly addressed in this watershed plan, it is anticipated that actions to control stormwater and reduce pollutant loads proposed in the plan will help reach water quality goals set by future TMDL and VPDES requirements.

2.5.9 Virginia Natural Heritage Resource

The Virginia Natural Heritage Resources Database describes the status and rank of rare plant and animal species for subwatersheds in Virginia. The Lower Bull Run/Popes Head Creek subwatershed had no rare plant or animal species identified in the database.

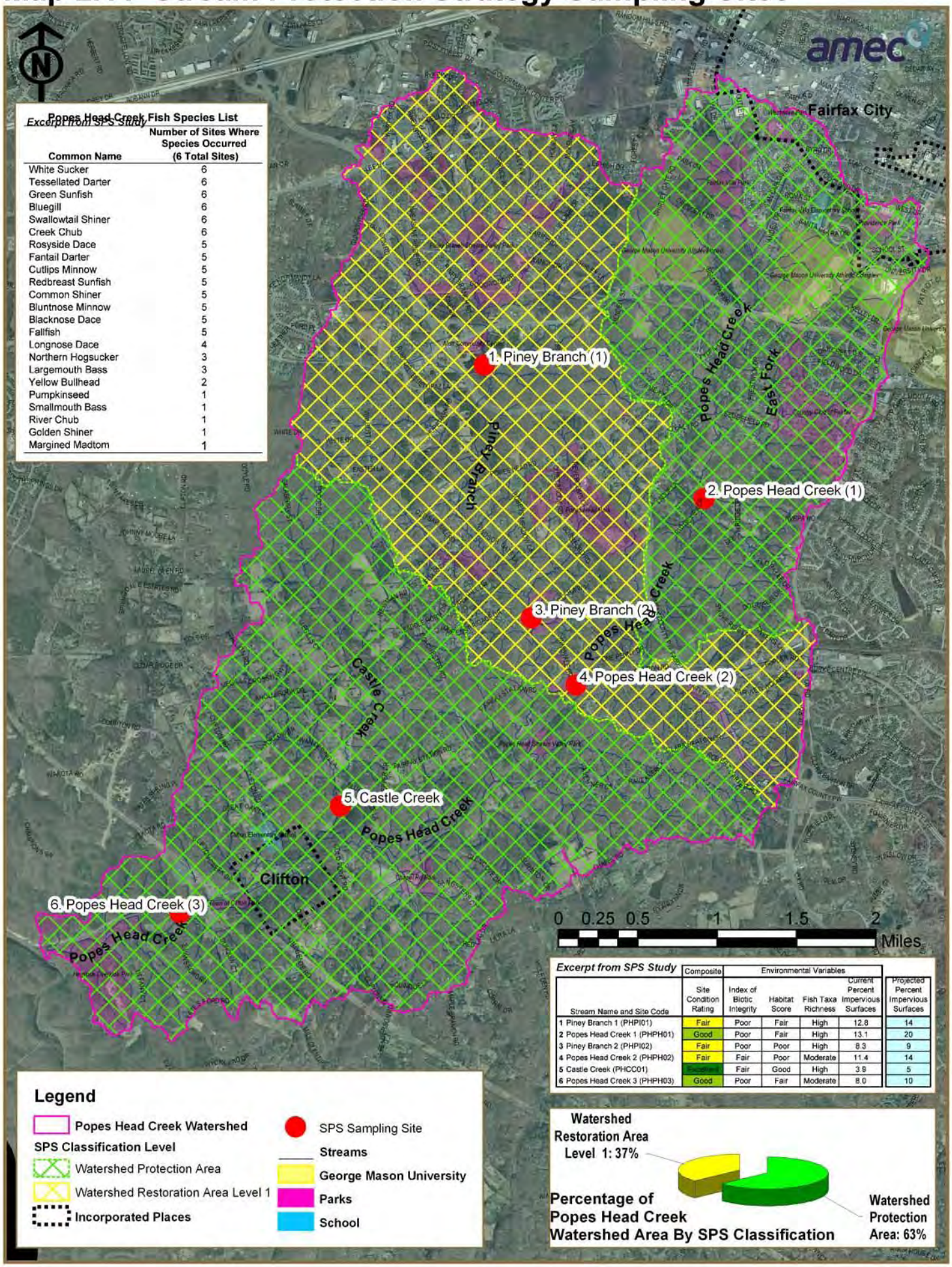
2.5.10 Stream Protection Strategy

The January 2001 *Fairfax County Stream Protection Strategy (SPS) Baseline Study* evaluated the quality of streams throughout the County. Popes Head Creek received "good" composite site condition ratings in the upper and lower watershed and a "fair" rating in the central portion of the watershed. Piney Branch received "fair" composite site condition ratings, while Castle Creek received "excellent" composite site condition ratings. These ratings were based on environmental parameters such as an index of biotic integrity, stream physical assessment, habitat assessment, fish taxa richness, and percent imperviousness. Table 2.4 provides information regarding the macroinvertebrate and fish species at the six testing sites. Map 2.11 shows the location of the six stream protection strategy sampling sites.

Table 2.4 Macroinvertebrate Assessment and Fish Species

Stream Name and Location	Macroinvertebrate Assessment	No. of Fish Species
Popes Head Creek downstream of Popes Head Road	Poor	High
Popes Head Creek downstream of Fairfax Station Road	Fair	Moderate
Popes Head Creek downstream of Clifton	Poor	Moderate
Piney Branch downstream of Braddock Road	Poor	High
Piney Branch upstream of Fairfax Station Road	Fair	Moderate
Castle Creek downstream of Newman Road	Fair	High

Map 2.11 Stream Protection Strategy Sampling Sites



Popes Head Creek Fish Species List
Excerpt from SPS Study

Common Name	Number of Sites Where Species Occurred (6 Total Sites)
White Sucker	6
Tessellated Darter	6
Green Sunfish	6
Bluegill	6
Swallowtail Shiner	6
Creek Chub	6
Rosyside Dace	5
Fantail Darter	5
Cutlips Minnow	5
Redbreast Sunfish	5
Common Shiner	5
Bluntnose Minnow	5
Blacknose Dace	5
Fallfish	5
Longnose Dace	4
Northern Hogsucker	3
Largemouth Bass	3
Yellow Bullhead	2
Pumpkinseed	1
Smallmouth Bass	1
River Chub	1
Golden Shiner	1
Margined Madtom	1

Excerpt from SPS Study

Stream Name and Site Code	Composite: Site Condition Rating	Environmental Variables: Index of Biotic Integrity	Habitat Score	Fish Taxa Richness	Current Percent Impervious Surfaces	Projected Percent Impervious Surfaces
1 Piney Branch 1 (PHPI01)	Fair	Poor	Fair	High	12.8	14
2 Popes Head Creek 1 (PHPH01)	Good	Poor	Fair	High	13.1	20
3 Piney Branch 2 (PHPI02)	Fair	Poor	Poor	High	8.3	9
4 Popes Head Creek 2 (PHPH02)	Fair	Fair	Poor	Moderate	11.4	14
5 Castle Creek (PHCC01)	Excellent	Fair	Good	High	3.9	5
6 Popes Head Creek 3 (PHPH03)	Good	Poor	Fair	Moderate	8.0	10

Legend

- Popes Head Creek Watershed
- SPS Classification Level
  - Watershed Protection Area
  - Watershed Restoration Area Level 1
  - Incorporated Places
- SPS Sampling Site
- Streams
- George Mason University
- Parks
- School

Percentage of Popes Head Creek Watershed Area By SPS Classification

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

In the *SPS Baseline Study*, the upper and lower Popes Head Creek Watershed was classified as a watershed protection area with the goal of preserving biological integrity by taking active measures to identify and protect, as much as possible, the conditions responsible for the current high-quality rating of these streams. The central portion of the Popes Head Creek Watershed and the Piney Branch subwatershed are classified as a watershed restoration level I with the goal of re-establishing healthy biological communities by taking active measures to identify and remedy causes of stream degradation.

2.5.11 Stream Physical Assessment

The County initiated a stream physical assessment for all of its watersheds in August 2002. The stream physical assessment included a habitat assessment, infrastructure inventory, stream characterization, and stream geomorphologic assessment. The stream physical assessment data is described for each of the subwatersheds in the following sections.

Habitat Assessment

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

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

Based on the evaluation scores in the assessment, classifications were designated for embeddedness, bank stability and vegetated buffer zone width for each stream reach as shown in Table 2.5. Maps provided in the following subwatershed sections show the classification of stream reaches for these items.

Table 2.5 Description of Stream Reach Data

Impact	Description
Embeddedness	
Poor	75-100% of streambed area covered by or sunken into sediment
Marginal	50-75% of streambed area covered by or sunken into sediment
Suboptimal	25-50% of streambed area covered by or sunken into sediment
Optimal	0-25% of streambed area covered by or sunken into sediment

Impact	Description
Vegetated Buffer Width	
Poor	0 – 5 foot buffer
Low	5-20 foot buffer
Moderate	20-40 foot buffer
Good	40-60 foot buffer
Excellent	> 60 foot buffer
Stream Bank Stability	
Unstable	>70% erosional areas
Moderately unstable	40-70% erosional areas
Moderately stable	5-40% erosional areas
Stable	< 5% erosional areas

The scores assessed for the various physical parameters representing the stream habitat conditions were combined for each stream segment to obtain a total habitat score with the majority of the stream habitat assessed as fair. Table 2.6 describes the percentage of length for each habitat quality rating for the streams according to the total score. Map 2.12 shows the habitat quality of each stream segment in the watershed.

Table 2.6 Summary of Stream Habitat Quality

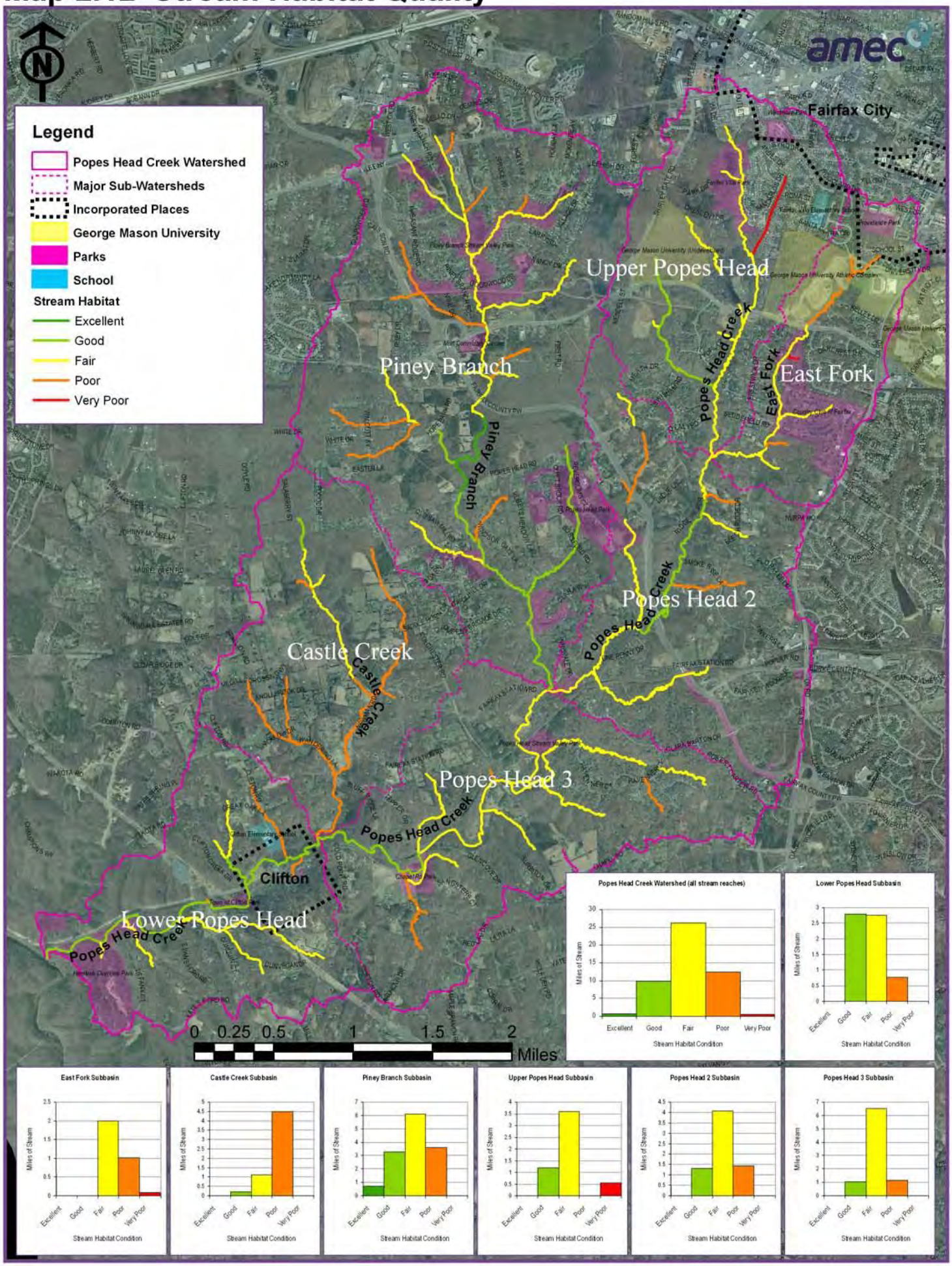
Stream	Percent of Stream Length				
	Very Poor	**Poor**	**Fair**	**Good**	**Excellent**
Popes Head Creek	2%	12%	63%	23%	0%
East Fork Popes Head	3%	33%	64%	0%	0%
Piney Branch	0%	26%	45%	24%	5%
Castle Creek	0%	77%	19%	4%	0%
Total Watershed	**1%**	**25%**	**53%**	**20%**	**1%**

Buffer Loss

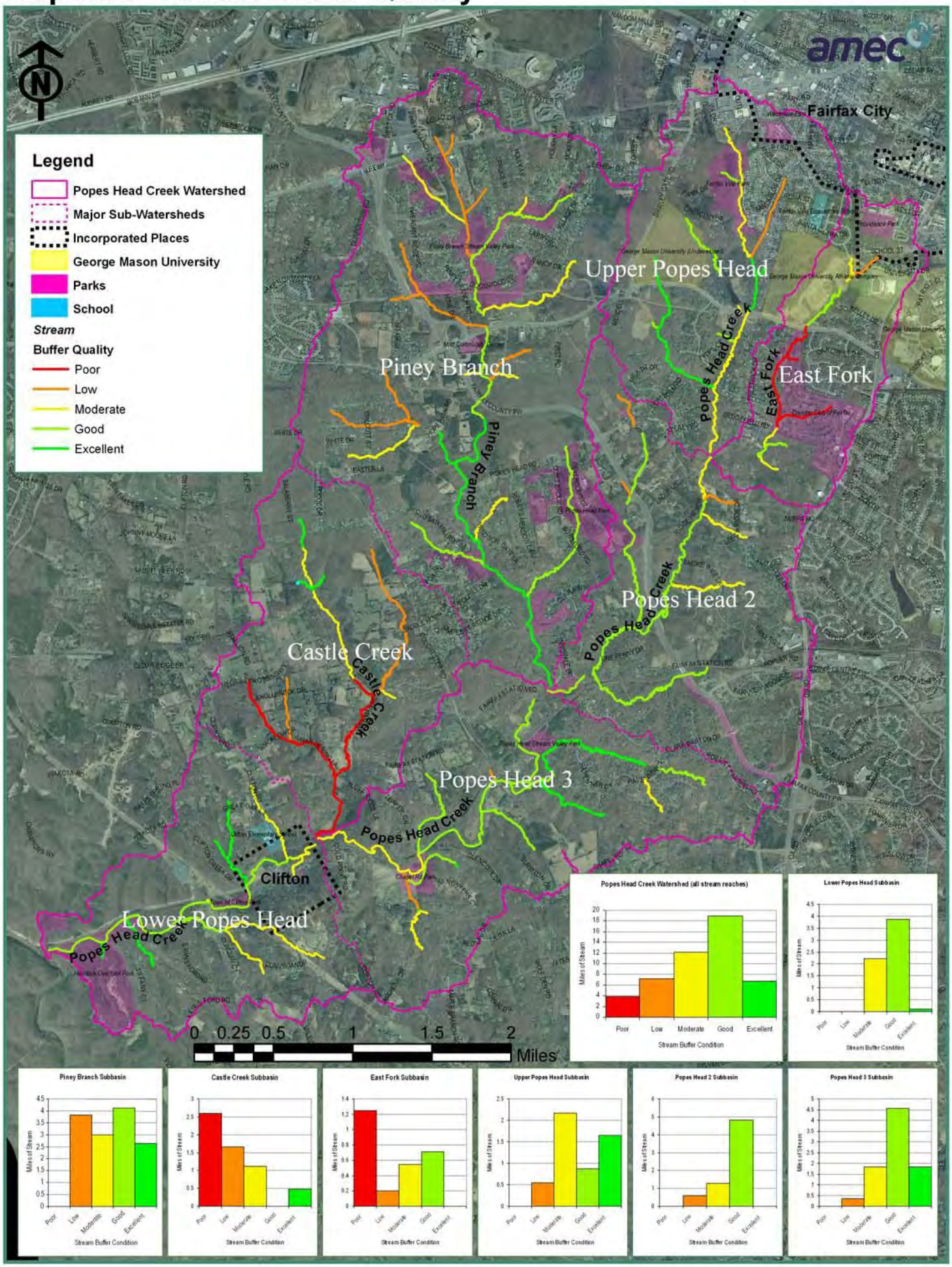
Approximately 48% of stream buffers in the Popes Head Creek watershed are of moderate or lower quality while 52% of stream buffers are of good or excellent quality. The primary cause (63% or 13 miles of stream buffers) for stream buffer loss in this watershed is clearing for lawns. The buffer quality in the Popes Head watershed is shown on Map 2.13.

Streams without sufficient buffers show significant stream degradation as stream banks fail and the stream becomes wider and shallower. The impact continues downstream as sediment from failing stream banks affects downstream stream reaches.

Map 2.12 Stream Habitat Quality



Map 2.13 Stream Buffer Quality



Sedimentation

The stream assessment documented the degree of streambed embeddedness. Embeddedness, referring to the degree to which cobbles and gravel on the streambed are covered with or sunken into sediment, is a measure used to quantify the impact of sedimentation on stream habitat. As the streambed becomes more embedded, the habitat of bottom dwelling organisms is increasingly impaired. Embeddedness is a critical issue in the Popes Head Creek watershed, with roughly 55% of stream reaches exhibiting high levels of embeddedness, thus resulting in marginal to poor habitat for bottom dwelling organisms. This supports the findings of the *Stream Protection Strategy* study, which found that measures of benthic macroinvertebrate community integrity were generally below average. Map 2.14 shows the streambed embeddedness in the Popes Head Creek watershed.

Infrastructure Inventory

The stream physical assessment also identified and characterized the following items at point locations:

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

An impact score was assigned to those inventory items causing a negative impact to the stream. Based on the impact score, the degrees of impact were classified into four groups: minor, moderate, severe and extreme. Table 2.7 describes the impact ranges for each of the stream inventory items. The maps in the subwatershed sections show the locations and severity of impact for the inventoried items.

Table 2.7 Description of Impacts

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

Impact	Description
Dumpsites	
Severe to Extreme	Active and/or threatening sites. The materials may be considered toxic or threatening to the environment (concrete, petroleum, empty 55-gallon drums, etc.) or the site is large (greater than 2,500 square feet) and appears active.
Moderate	Dumpsite less than 2,500 square feet with non-toxic material. It does not appear to be used often, but clean-up would definitely be a benefit.
Minor	Dumpsite appears small (less than 1,000 square feet) and the material stable (will not likely be transported downstream by high water). This site is not a high priority.
Erosion Locations	
Extreme	Impending threat to structures or infrastructure
Severe	Large area of erosion that is damaging property and causing obvious instream degradation. The eroding bank is generally five feet or greater in height.
Moderate	A moderate area of erosion that may be damaging property and causing instream degradation. The eroding bank is generally two feet or greater in height.
Minor	A minor area of erosion that is a low threat to property and causes no noticeable instream degradation.
Head Cuts	
Severe to Extreme	Greater than two-foot head cut height
Moderate	One- to two-foot head cut height
Minor	One-half to less than one-foot head cut height
Obstructions	
Severe to Extreme	The blockage is causing a significant erosion problem and/or the potential for flooding that can cause damage to infrastructure. The stream is usually almost totally blocked (more than 75% blocked).
Moderate to Severe	The blockage is causing moderate erosion and could cause flooding. The stream is partially blocked, but obstructions should probably be removed or the problem could worsen.
Minor to Moderate	The blockage is causing some erosion problems and has the potential to worsen. It should be looked at and/or monitored.

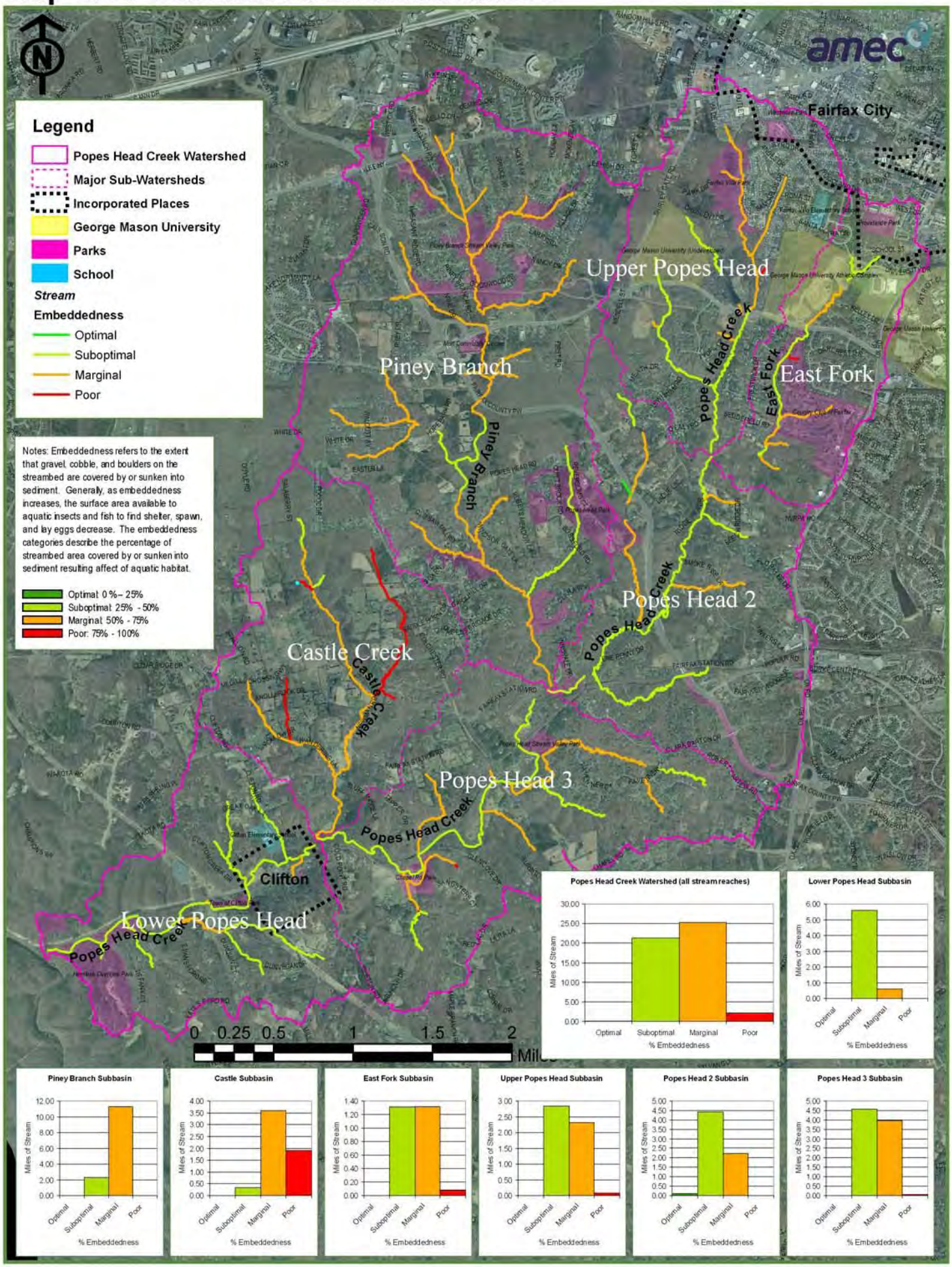
Impact	Description
Pipes and Ditch Outfalls	
Severe to Extreme	Stormwater runoff from a ditch or pipe is causing a significant erosion problem to the stream bank or stream. Discharge that may not be stormwater is coming from the stormwater pipe.
Moderate	Stormwater runoff from a ditch or pipe is causing a moderate erosion problem and should be fixed; it may get worse if left unattended. Discharge is coming from the pipe. It is probably stormwater, but it will be uncertain without further investigation.
Minor	Stormwater runoff from a ditch or pipe is causing a minor erosion problem and some discharge is occurring.
Public Utility Lines	
Extreme	A utility line is leaking.
Severe	An exposed utility line is causing a significant erosion problem and/or obstruction (blockage). The potential for the sanitary line to burst or leak appears high.
Moderate	A partially exposed utility line is causing a moderate erosion problem. The line is partially visible (mostly buried in a stream bed with little if any erosion).
Minor	A utility line is exposed but stabilized with concrete lining and stable anchoring into the bank.
Road and other Crossings	
Extreme	The condition of debris, sediment, or erosion poses an immediate threat to the structural stability of the road crossing or other structure. Major repairs will be needed if the problem is not addressed.
Severe	The condition probably poses a threat to a road crossing or other structure. The problem should be addressed to avoid larger problems in the future
Moderate	The condition does not appear to pose a threat to a road crossing or other structure but should be addressed to enhance stream integrity and the future stability of the structures.
Minor	The condition is noticeable but may not warrant repair.

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

Trash and Dumpsites

The stream physical assessment identified eight dumpsites in the Popes Head Creek watershed. The dumpsites consisted of lawn waste such as leaves and grass, an abandoned car, tires, pallets, tree limbs and a leaking 55 gallon drum. The dumpsites were located in the stream, on the bank, or in the floodplain. The volume of trash found in the stream was not measured.

Map 2.14 Streambed Embeddedness



Stream Geomorphologic Assessment

The geomorphologic assessment of the stream channels in the Popes Head Creek Watershed was based on the conceptual incised channel evolution model (CEM) developed by Schumm et al. (1984). Based on visual observation of the channel cross section and other morphological observations of the channel segment, the CEM type was assigned for the channel segment. The CEM types are summarized in Table 2.8 The CEM type for the stream segments is shown on the stream geomorphology maps provided for each of the subwatersheds.

Table 2.8 Summary of CEM Types

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

2.5.12 Fish and Benthic Macroinvertebrate Studies

To evaluate changes in the water quality in the Popes Head Creek Watershed over time, a comparison of fish and benthic macroinvertebrate data from two different studies was conducted. The intent of the data comparison is to assess whether aquatic life conditions have improved or worsened from 1976 to 2002. The first study took place in the mid-1970s and was conducted by Dr. Donald Kelso of George Mason University, as part of the Occoquan Environmental Baseline study. The second study was conducted by Fairfax County from 1999 to 2002, as part of the Stream Protection Strategy Baseline Study.

Fish and benthic data were compared from five stations in Popes Head Creek. The data used were verified to have been collected from roughly the same locations using comparable methods. Benthic data were collected at different times, primarily during spring and winter in the early study and during spring in the later study. Fish were collected primarily during spring in the earlier study and during summer in the later study. Despite the differences in collection season, the data were thought to be comparable.

The difference in fish abundance was tested using ordinal data from the two collection periods. A nonparametric test showed that fish were more abundant in the later collections at PHCC01, but not at two other stations (PHPH01 and PHPI02). However, fish diversity appears to have improved dramatically from the mid-1970s to the late 1990s/early 2000s at all four stations were there was comparable data. It is possible that this is an artifact of a different sampling technique, as electroshocking was used by the County in the later study and is possibly more efficient than the seining used in the earlier study. It is also possible that the greater apparent species diversity is an artifact of bias introduced by sampling in different seasons.

Because there were so few overlapping benthic species between the two studies, it was not possible to compare abundance between the two periods. While there does not appear to have been an overall increase in species diversity, as was observed in the fish data, there does appear to have been a subtle shift in the species assemblage. There were fewer EPT (*Ephemeroptera, Plecoptera, Trichoptera)* species present; EPT species consist of mayflies, stoneflies, and caddisflies, which are pollution intolerant and are therefore indicators of good water quality. The

data comparison also showed that there are more pollution tolerant species, including aquatic worms (*Oligocheata),* true flies (*Diptera)* and mollusks (*Mollusca)* now than in the previous study. Please see Appendix D for the full report on the comparison between fish and benthic collections.

2.5.13 Summary of Previous Studies

The previous studies conducted by Fairfax County and others agree that the Popes Head Creek Watershed is in fair to good condition. The watershed suffers from several erosion and sedimentation problems, which has impaired the benthic community. The studies recommended the use of innovative BMPs and new Low Impact Development (LID) techniques, the preservation of trees and open space, and identified the need to update the Public Facilities Manual (PFM). They also identified opportunities to educate and involve the public, as well as promote regional cooperation between agencies, citizens, and nongovernmental organizations.

2.6 Hydrologic and Hydraulic Modeling

A Stormwater Management Model (SWMM) was developed for the Popes Head Creek Watershed. Its purpose is to represent current and future watershed conditions, including flow, imperviousness, and pollutant load. For the full SWMM report, please see Appendix E.

The Popes Head Creek Watershed was divided into four basins and 58 subbasins. Impervious area for the watershed was delineated from Fairfax County's GIS coverages of buildings, roads, and parking lots; it also used Fairfax County's GIS land use coverages to evaluate future conditions within the watershed. It modeled existing and future stormwater management (SWM) facilities. The storage and outflow relationship for each SWM facility was defined as peak flows under current conditions and future land use were equal to the peak flows for the two-year and 10-year design storms under undeveloped conditions.

The fully calibrated model was used to evaluate the impact of future development within the watershed on flow rates, velocity, and water quality. Increased flows, velocity, and pollutant loadings were assessed for the three main tributaries (East Fork, Piney Branch, and Castle Creek) as well as the entire watershed. For the tributaries, reported values were taken from the mouth of the tributary before they merge with Popes Head Creek. For the entire watershed, reported values were taken from the main channel as it flows out of basin PH30. Values for peak flow, peak velocity, and pollutant loading rates under current and future conditions for these four main areas are given in Table 2.9 including the percent increase for each value.

Table 2.9 Increase in Flow, Velocity, and Pollutant Loading Rates that Result in Moving from Current to Future Land Use Conditions

	Current Conditions	Future Conditions	Percent Difference
Mouth of East Fork (EFOUT)			
Peak Flow over simulation period (cfs)	257	257	0%
Peak Velocity over simulation period (ft/s)	4.13	4.13	0%
Total Loads (tons/year)			
Biological Oxygen Demand (BOD)	12.6	13.6	8%
Chemical Oxygen Demand (COD)	76.3	82.0	7%
Total Suspended Solids (TSS)	58.6	61.7	5%
Total Dissolved Solids (TDS)	124	129	4%

	Current Conditions	Future Conditions	Percent Difference
Dissolved Phosphorus (DP)	0.117	0.125	7%
Total Phosphorus (TP)	0.346	0.365	5%
Total Kjeldahl Nitrogen (TKN)	1.756	1.888	8%
Total Nitrogen (TN)	2.937	3.113	6%
Total Cadmium (TCd)	0.001	0.001	0%
Total Copper (TCu)	0.024	0.026	8%
Total Lead (TPb)	0.004	0.004	0%
Total Zinc (TZn)	0.118	0.127	7%
Mouth of Piney Branch (PIOUT)			
Peak Flow over simulation period (cfs)	402	414	3%
Peak Velocity over simulation period (ft/s)	3.63	3.67	1%
Total Loads (tons/year)			
BOD	28.0	29.5	5%
COD	165.5	173.4	5%
TSS	88.5	93.8	6%
TDS	468	473	1%
DP	0.286	0.300	5%
TP	0.852	0.896	5%
TKN	3.989	4.163	4%
TN	6.586	6.833	4%
TCd	0.004	0.005	1%
TCu	0.042	0.044	4%
TPb	0.018	0.019	2%
TZn	0.182	0.190	4%
Mouth of Castle Creek (CCOUT)			
Peak Flow over simulation period (cfs)	271	271	0%
Peak Velocity over simulation period (ft/s)	4.26	4.26	0%
Total Loads (tons/year)			
BOD	8.2	8.7	6%
COD	49.8	52.4	5%
TSS	21.7	23.1	7%
TDS	183	185	1%
DP	0.093	0.099	6%
TP	0.270	0.287	6%
TKN	1.243	1.300	5%
TN	2.105	2.177	3%

	Current Conditions	Future Conditions	Percent Difference
TCd	0.002	0.002	2%
TCu	0.014	0.014	3%
TPb	0.008	0.008	3%
TZn	0.055	0.057	4%
Mouth of Popes Head Creek (OUT)			
Peak Flow over simulation period (cfs)	871	906	4%
Peak Velocity over simulation period (ft/s)	5.84	5.90	1%
Total Loads (tons/year)			
BOD	88.4	96.5	9%
COD	529.0	570.7	8%
TSS	281.4	313.4	11%
TDS	1,687	1,721	2%
DP	0.891	0.958	7%
TP	2.632	2.821	7%
TKN	12.988	13.961	7%
TN	22.238	23.730	7%
TCd	0.016	0.016	1%
TCu	0.151	0.163	8%
TPb	0.064	0.066	4%
TZn	0.652	0.717	10%

Chapter 3: Subwatershed Conditions

Introduction

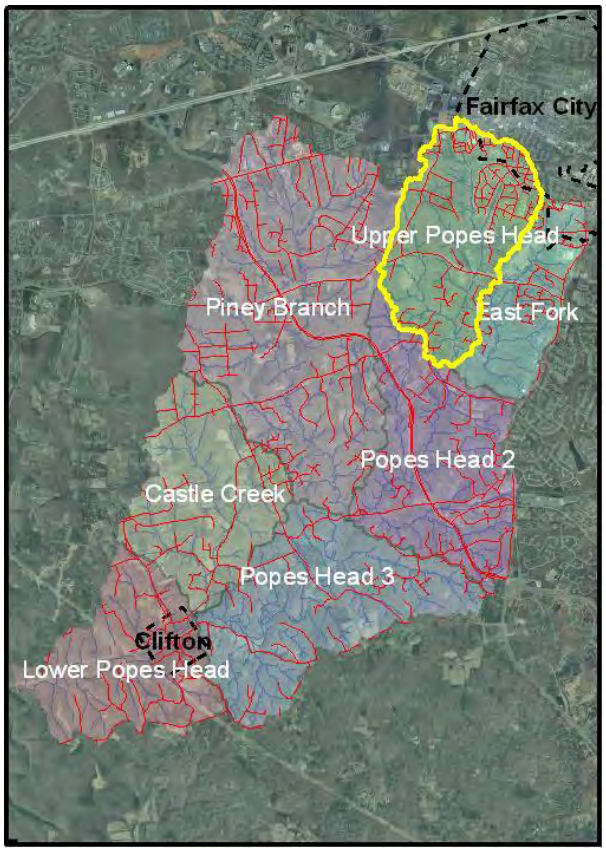
The data used to write this chapter was generated using the Fairfax County GIS layers, specifically the 2002 Stream Physical Assessment GIS layers, along with field assessments by the project team, input from citizens, and hydrologic, hydraulic, and water quality modeling. The Stream Physical Assessment data includes a stream habitat assessment, infrastructure inventory, and stream geomorphologic assessment for each stream in the entire County. The data for the Popes Head Creek watershed was subdivided, or spatially "clipped", to the Subwatershed level, and then recorded in each chapter section.

3.1 Upper Popes Head Subwatershed

The Upper Popes Head Subwatershed has an area of approximately 1,430 acres and contains the north portion of the Popes Head Creek main stem. It is bounded to the north by Lee Highway, Oakwood Drive and Crest Street; to the east by Lamarre Street and Prestwick Drive; to the south by Popes Head Road and Meath Drive; and to the west by Shirley Gate Road and Mattie Moore Court.

This subwatershed contains a portion of the City of Fairfax and George Mason University. Braddock Road and Lee Highway are both major thoroughfares which support low-intensity commercial uses. The Upper Popes Head Creek Subwatershed is shown on Map 3.1 and its condition is summarized below.

Map 3.1: Location of Upper Popes Head



3.1.1 Subwatershed Characteristics

The stormwater runoff from this subwatershed drains into the northernmost portion of Popes Head Creek, which has its headwaters near Lee Highway and the Waples Mobile Home Park. The stream flows in a southward direction for a distance of approximately 1.53 miles before it reaches the Popes Head 2 Subwatershed. Numerous small tributaries flow into Upper Popes Head Creek, ranging from 1,000 to over 5,000 feet in length.

Upper Popes Head Subwatershed Condition Summary

- Current Imperviousness = 15.7% with majority of land use Open Space
- Future Imperviousness = 17.6%
- Area of 1,430 acres
- 66.0% of the subwatershed is in the Rezoned area. Major land uses that are not in the rezoned area include George Mason University, the Fairfax Centre Shopping Center, Fairfax Villa Elementary School, the southern boundary of the City of Fairfax, and the Fairfax Villa neighborhood
- Eight stormwater management facilities currently exist.
- The stream exhibits fair habitat quality.
- Three head cuts were observed.
- Two trash dumps were observed.
- Eight obstructions were observed.
- Four out of seven crossings have minor to severe impacts.

The existing imperviousness in this subwatershed is 15.7% and expected to increase to 17.6% in the future, based upon the planned or zoned land uses in the Fairfax County Comprehensive Plan. Approximately 66% of the subwatershed lies in the area rezoned in 1982 by the Fairfax County Board of Supervisors in order to protect the Occoquan Reservoir. Building density within the rezoned area is reduced, and therefore imperviousness is decreased, reducing the amount of stormwater runoff that is generated. Land use in the subwatershed is predominantly open space, which comprises 33.3% of the area. Estate residential comprises 23.6% of the total subwatershed area. In the future, estate residential is expected to replace open space as the predominant land use, comprising 51% of the total subwatershed area. Roads and sidewalks are not included in the land use data. The existing and future land uses in the Upper Popes Head Subwatershed are described in Table 3.1.

Table 3.1 Upper Popes Head Land Use

Land Use Description	Existing		Future	
	Acres	%	Acres	%
Estate residential	287.5	23.6%	622.2	51.0%
Low-density residential	220.2	18.0%	206.1	16.9%
Medium-density residential	178.2	14.6%	225.2	18.5%
High-density residential	28.7	2.4%	29.8	2.4%
Low-intensity commercial	80.6	6.6%	84.7	6.9%
High-intensity commercial	17.0	1.4%	17.0	1.4%
Industrial	2.1	0.2%	0.4	0.0%
Open Space	406	33.3%	34.9	2.9%
Unknown	0.2	0.0%	0.2	0.0%
TOTAL	1220.5	100.0%	1220.5	100.0%

The subwatershed contains 1,157 parcels, with an average size of 1.05 acres per parcel. Upper Popes Head has the smallest average parcel size of all of the subwatersheds.

There are 22 neighborhoods fully within or apportioned within the subwatershed, as listed below:

- Brecon Ridge
- Cloisters of Fairfax
- Fairfax Woods
- Joyce Heights
- La Bellmont
- Shirley Gate Estates
- Warren Woods
- Brecon Ridge Woods
- Deerfield Forest
- George Mason Woods
- Kiels Gardens
- Popes Head View
- Shirley Gate Park
- Waples Mobile Home Park
- Westmore
- Cavalier Woods
- Fairfax Villa
- Huntwood Manor
- Lake Fairfax Estates
- Ridges of Glendilough
- University Square
- West Hill

The County's list of master plan drainage projects shows that three of the four identified projects in this subwatershed have been completed. Table 3.2 summarizes the type of master plan drainage project, project name/location, and current status. No cost estimates were available for these projects.

Table 3.2 Upper Popes Head Master Plan Drainage Projects

Type of Work	Project Name/Location
Completed Projects	
Raise Road and Replace Culvert	Popes Head Creek at Braddock Rd
Raise Road and Replace Culvert	Popes Head Tributary 1 at Braddock Rd
Raise Road and Replace Culvert	Unnamed Tributary at Braddock Rd
Inactive Project	
Stream Restoration and Stabilization	Popes Head Creek at Byrd Drive

One complaint regarding problems with a drainage swale was processed by the County and included in the database files for this subwatershed.

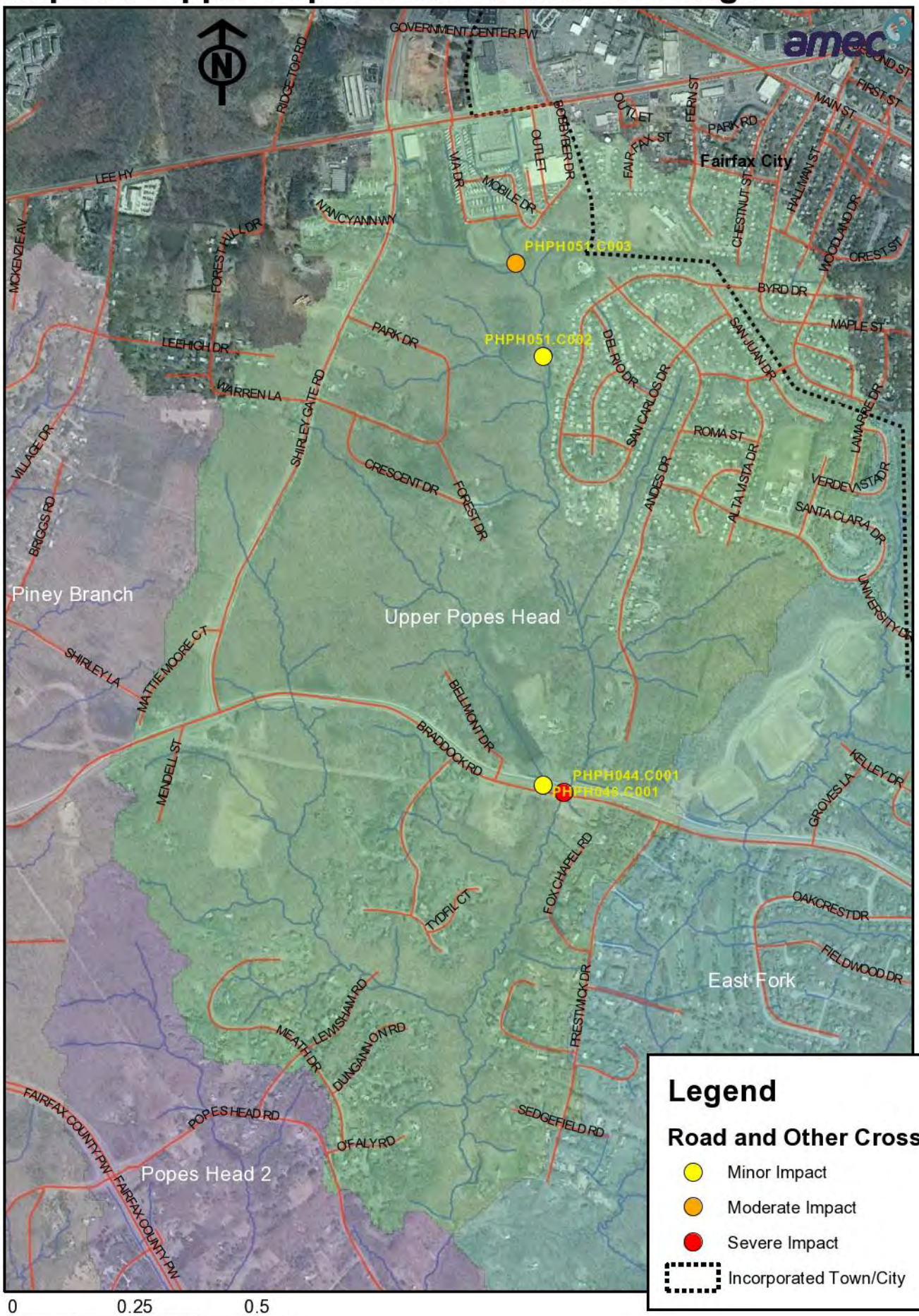
3.1.2 Storm Drain System Infrastructure

The northwestern part of the subwatershed along Lee Highway and the northeastern part of the subwatershed in the Fairfax Villa subdivision are drained through a network of storm drain pipes. The storm sewers outfall into tributaries of Popes Head Creek. In Fairfax Villa, most of the storm sewers drain to an engineered channel that runs to the west and parallel of Andes Drive. These outfalls vary in size, from 27 to 60 inches in diameter.

Map 3.2 shows the location of the four stream crossings that have an impact on the stream. Crossings that do not have an impact on the stream are not listed. The major crossings in this subwatershed, starting from the upstream end of Upper Popes Head, are described as follows:

- Via Drive: A four-foot diameter circular concrete culvert (PHPH051.C003) has a moderate impact on the main stem.
- West of Byrd Road: A five-foot wooden footbridge (PHPH051.C002) has a minor impact on the main stem.
- Braddock Road: A two-foot diameter circular concrete culvert (PHPH046.C001) has a minor impact on the main stem. To the east, a three foot by five foot, triple box

Map 3.2: Upper Popes Head Stream Crossings



concrete culvert (PHPH044.C001) has a severe impact on the main stem, as shown in Photo 3.1.

Two storm drain outfall pipes discharge into Upper Popes Head. Both pipes are composed of Reinforced Concrete Pipe (RCP), are 8 and 16 inches in diameter, respectively, and have no visible impact on the stream.

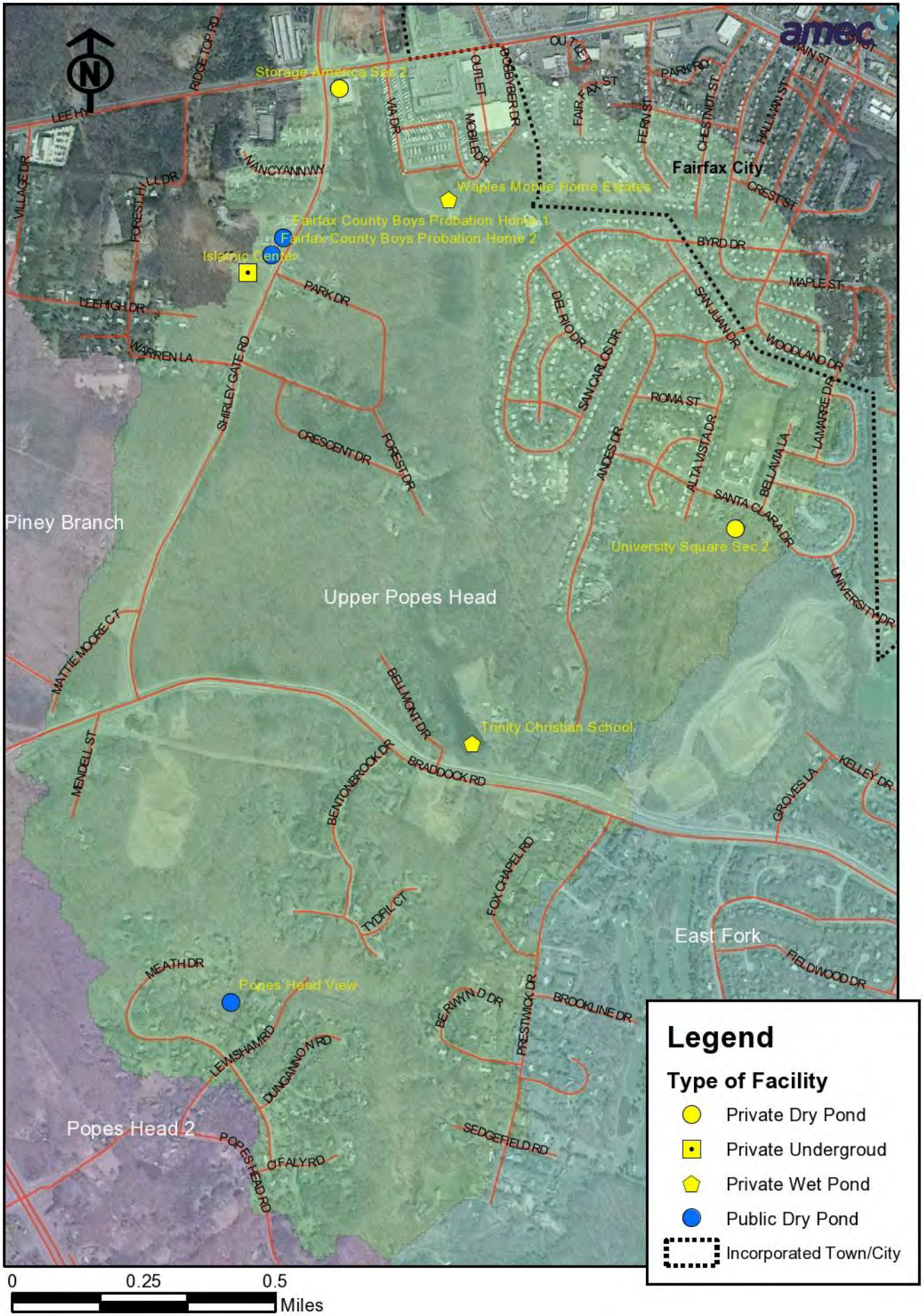
Photo 3.1 A triple box culvert (PHPH044.C001) has at Braddock Road has a severe impact on the stream

Table 3.3 shows the locations of known stormwater management facilities in the subwatershed, as depicted on Map 3.3.

Table 3.3 Upper Popes Head Stormwater Management Facilities

Name	Location	Type of Facility
Privately Owned		
Waples Mobile Home Estates	South of Via Drive and Mobile Dr	Wet Pond
Trinity Christian School	North of Braddock Road at Trinity Christian School	Wet Pond
Islamic Center	Park Drive and Shirley Gate Road	Underground
Storage America	Lee Highway and Waples Mill	Dry Pond
Publicly Owned		
Fairfax Co Boys Probation Home 1	Intersection of Shirley Gate Rd and Park Dr	Dry Pond
Fairfax Co Boys Probation Home 2	Intersection of Shirley Gate Rd and Park Dr	Dry Pond
Popes Head View	East of Popes Head View Lane and Meath Dr	Dry Pond
University Square Sec. 2	South of Fairfax Villa Elementary School	Dry Pond

Map 3.3: Upper Popes Head Stormwater Management Facilities



3.1.3 Stream Geomorphology

The geomorphology of the stream segments of Upper Popes Head can be summarized as follows:

- The dominant substrate in all stream segments is bedrock. Cobble is also present in the majority of the stream segments.
- The majority of the stream reaches are of Channel Evolution Model (CEM) type 4, referring to stabilizing stream banks and channel development as the stream returns to equilibrium.
- Several upstream reaches are of CEM type 2, referring to a deeply incised channel. This is a result of head cutting of the stream bed due to excessive flow.
- Three head cuts and one erosional area were observed.
- Two trash dumps were observed.
- Eight obstructions were observed.

3.1.4 Stream Quality

The stream reaches of Upper Popes Head are classified as riffle/run stream type. Riffles are a source of high-quality habitat and diverse fauna; therefore, an increased frequency of occurrence greatly increases the diversity of the stream community.
The habitat assessment for Upper Popes Head can be summarized as follows:

- Overall, the stream exhibits fair habitat quality.
- In most of the stream reaches, at least four habitat types were common for more than 50% of the reach; in some cases, up to seven different habitats were common.
- The stream reaches have riffles as wide as the stream, and the epifaunal substrate is composed of a mixture of softball sized cobble stones and gravel stones.
- The majority of the stream reaches have 40% - 50% embeddedness by sediment and silt.
- Only 20% - 40% of the stream reaches have disturbed or altered channels or banks.
- The stream reaches contain moderately frequent riffles with adequate depth in pools and riffles.
- The headwaters of the main stem are 35% - 40% full of water during normal flow conditions. The rest of the main stem is 60% - 85% full of water during normal flow conditions.
- The majority of the left banks exhibited 70% vegetation cover, typically of shrubs, grasses and forbes. The right banks exhibited 60% - 70% vegetation cover, with a few barren or thin areas that have fewer plant species.
- The headwaters of the stream banks featured moderately stable banks, with 15% - 30% erosional areas. The remaining stream reaches were moderately unstable, with 40% - 70% erosional areas. In general, the left banks were more stable than the right banks, as nearly all of right banks were moderately unstable.
- Nearly half of the stream reaches exhibited a left bank with a forested vegetated buffer greater than 100 feet wide that included some paths, utility lines, or other minor disturbances. The remaining stream reaches exhibited 25 to 50 feet wide forested buffers, or planted lawn grass yards. The majority of the right banks have a forested vegetated buffer with a minimum of 50 feet wide and often extending beyond 100 feet wide.

The general characteristics of the stream water quality were assessed as follows:

- The water had a clear appearance and no odor was detected at any of the assessed stream reaches.
- Medium fishes of three to six inches in length were observed in several reaches. Attached aquatic plants were not observed.
- Several stream reaches had green algae of heavy density and a slime coating; green algae of light density and a slime coating were also present.

3.1.5 Stream Ecology

The 2001 *Stream Protection Strategy (SPS) Baseline Study* did not include a sampling site in the Upper Popes Head Subwatershed. Therefore, there is no current information available about the condition of the aquatic ecological community in this subwatershed.

3.1.6 Problem Areas from Public Forum

There were no problem areas identified in this subwatershed at the March 27, 2004 Community Watershed Forum.

3.1.7 Modeling Results

The hydrology for Upper Popes Head Creek produced stormwater runoff that is relatively high due to dense development in the upper portions of this subwatershed. A reduction of discharges occurs downstream of Braddock Road due to storage occurring upstream of the Braddock Road culvert. The increase in discharges due to future development is average compared to the other subwatersheds. See Table 3.4 for a comparison of the existing and future 2- and 10-year peak discharges in the subwatershed.

Table 3.4 Upper Popes Head Creek Peak Runoff Flows

Upper Popes Head Discharge Table		Two-Year Rainfall Event			10-Year Rainfall Event		
Location	**Drainage Area**	**Existing Peak Flow (cfs)**	**Future Peak Flow (cfs)**	**% Peak Flow Increase**	**Existing Peak Flow (cfs)**	**Future Peak Flow (cfs)**	**% Peak Flow Increase**
Approximately 1,950 ft upstream of Braddock Road	0.86	1180	1300	10%	2280	2480	9%
Approximately 300 ft downstream of Braddock Road	1.33	890	1010	13%	1690	1870	11%
Just downstream of Berwynd Court	2.00	1200	1270	6%	2280	2380	4%

Velocities produced by the 2-year rainfall event in Upper Popes Head Creek were relatively high, averaging 6.7 feet per second. This would correspond with the stream physical assessment results that show that the majority of the stream bank of Popes Head Creek in this subwatershed has 40-70% erosional areas. The average velocity increases slightly, by approximately 2% in the future conditions.

Both the 2- and 10-year peak discharges overtop the channel banks on Upper Popes Head Creek and Popes Head Tributary 1 throughout the Upper Popes Head subwatershed. The model shows one structure greater than 500 square feet located in the 10-year floodplain near Sedgefield Road. Table 3.5 shows a summary of the flooded structures in the subwatershed for different recurrence intervals.

Table 3.5 Upper Popes Head Creek Flooded Structures

Recurrence Interval	Upper Popes Head	
	Existing	Future
2	1	1
5	1	1
10	1	1
25	1	1
50	1	1
100	1	1

The Upper Popes Head Creek subwatershed has the highest sediment loading rate of the seven subwatersheds due to the commercial area along Lee Highway. The predicted sediment load exceeds the target Tributary Strategy level. For future land use conditions, the average sediment loading rate is predicted to increase by 2% if not controlled by BMPs.

The Upper Popes Head Creek subwatershed has the greatest annual pollutant loading for total phosphorus of the seven subwatersheds. This can be attributed to the relatively high percentage of developed land in the watershed. For total phosphorus, the greater the proportion of medium- and high- density residential area compared to other land uses, the greater the phosphorus loading for the watershed. This subwatershed contains the greatest proportion of high density residential development since it contains the Fairfax Villa subdivision and a portion of the City of Fairfax. The predicted phosphorus load exceeds the target Tributary Strategy level. For future land use conditions, the phosphorus loading rate is predicted to increase by 3%.

This subwatershed also has the greatest annual pollutant loading for total nitrogen of the seven subwatersheds. Large areas of commercial development cause higher nitrogen pollutant loading rates. The predicted nitrogen load is just below the target Tributary Strategy level. For future land use conditions, the nitrogen loading rate is predicted to increase by 3%.

3.1.8 Summary

The Upper Popes Head Subwatershed exhibits fair stream habitat quality and stabilizing, unaltered stream channels. It has large riparian buffers beside the stream banks, despite the large areas of development and imperviousness.

Velocities produced by the 2-year rainfall event in Upper Popes Head Creek were relatively high, averaging 6.7 feet per second. Both the 2- and 10-year peak discharges overtop the channel banks on Upper Popes Head Creek and Popes Head Tributary 1 throughout the Upper Popes Head subwatershed.

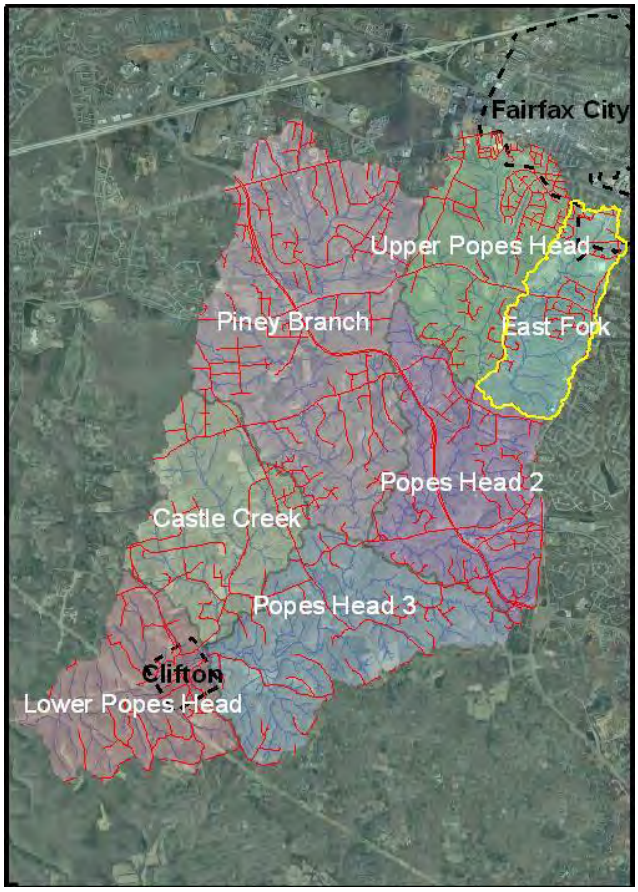
The Upper Popes Head Creek subwatershed has the greatest annual pollutant loading for total phosphorus and total nitrogen of the seven subwatersheds. This can be attributed to the relatively high percentage of developed land in the watershed.

3.2 East Fork Subwatershed

The East Fork Subwatershed has an area of approximately 847 acres and contains the East Fork of Popes Head Creek. It is bounded to the north by West Drive; to the east by Ox Road; to the south by Popes Head Road; and to the west by Lamarre Drive and Prestwick Drive.

This subwatershed contains a portion of the City of Fairfax, George Mason University and the Country Club of Fairfax. Braddock Road is the major east-west thoroughfare. The East Fork Subwatershed is shown on Map 3.4 and its condition is summarized below:

Map 3.4: Location of East Fork



3.2.1 Subwatershed Characteristics

The stormwater runoff from this subwatershed drains into East Fork Popes Head Creek, which has its headwaters inside the City of Fairfax and near the George Mason University campus. It has numerous small tributaries that range from 500 feet long to 2,500 feet long. The stream flows southward for 1.87 miles until it reaches Upper Popes Head Creek at the Popes Head 2 Subwatershed boundary.

East Fork Subwatershed Condition Summary

- Current Imperviousness = 14.7% with majority of land use Open Space
- Future Imperviousness = 23.4%
- Area of 847 acres
- 43.8% of the subwatershed is in the rezoned area. Major land uses that are not in the rezoned area include George Mason University, the southern boundary of the City of Fairfax, the Country Club of Fairfax, and the North Hill neighborhood.
- Eleven stormwater management facilities currently exist.
- The stream exhibits poor habitat quality.
- No dumps were observed.
- No head cuts were observed.
- Six obstructions were observed.
- Two out of 24 crossings have minor impacts.

The existing imperviousness of this subwatershed is 14.7% and expected to increase to 23.4% in the future, based upon the planned or zoned land uses in the Fairfax County

Comprehensive Plan. The existing imperviousness is based on actual impervious cover in the watershed. The future impervious cover reflects imperviousness associated with the future land use condition. The significant increase in imperviousness is due to the future development possible on the George Mason University property. Currently, the George Mason University property within the watershed is primarily athletic fields and open space that do not contribute significant impervious areas. However this impervious difference is not shown on the land use maps because the property was designated low-intensity commercial for both conditions.

43.8% of the subwatershed is in the rezoned area; the rezoned area was established in 1982 by the Fairfax County Board of Supervisors in order to protect the Occoquan Reservoir. Building density within the rezoned area is reduced, and therefore imperviousness is decreased, reducing the amount of stormwater runoff that is generated. Land use in the subwatershed is predominantly open space, comprising 31.2% of the total area. Low-intensity commercial is the next highest land use by area, comprising 26.2% of the subwatershed. Estate residential use is expected to increase to 19% in the future, becoming the third highest land use in the subwatershed. Roads and sidewalks are not included in the land use data. Existing and future land uses in the subwatershed are described in Table 3.6 below.

Table 3.6 East Fork Land Use

Land Use Description	Existing		Future	
	Acres	%	Acres	%
Estate residential	85.1	12.5%	129.5	19.0%
Low-density residential	118.1	17.3%	124.7	18.3%
Medium-density residential	77.8	11.4%	90.5	13.3%
High-density residential	6.2	0.9%	6.2	0.9%
Low-intensity commercial	178.9	26.2%	178.9	26.2%
High-intensity commercial	3.8	0.6%	3.8	0.6%
Industrial	0	0.0%	0	0.0%
Open Space	212.8	31.2%	148.9	21.8%
Unknown	0	0.0%	0.2	0.0%
TOTAL	682.7	100.0%	682.7	100.0%

The subwatershed contains 476 parcels, with an average parcel size of 1.47 acres. There are 9 neighborhoods fully within or apportioned within the subwatershed, as listed below:

- Bell
- Brecon Ridge
- North Hill
- Braddock Forest
- Chancery Square
- University Square
- Braddox Alpine
- Michelson
- West Hill

The County's list of master plan drainage projects shows that one of the three identified projects in this subwatershed has been completed; one project is currently active with full funding, and the remaining project is active with partial funding. Table 3.7 summarizes the type of master plan drainage project, project name/location, and current status. No cost estimates were available for these projects.

Table 3.7 East Fork Master Plan Drainage Projects

Type of Work	Project Name/Location
Completed Project	
Regional Stormwater Pond	George Mason Pond
Active Project, partially funded	
Bank Protection near Brookline Drive	Brecon Ridge Subdivision
Active Project, fully funded	
Floodproof House on Groves Lane	Groves Lane

Four complaints regarding stream bank erosion, flooding, and stream blockages were registered with the County and included in the database files for this subwatershed. The County processed these complaints.

3.2.2 Storm Drain System Infrastructure

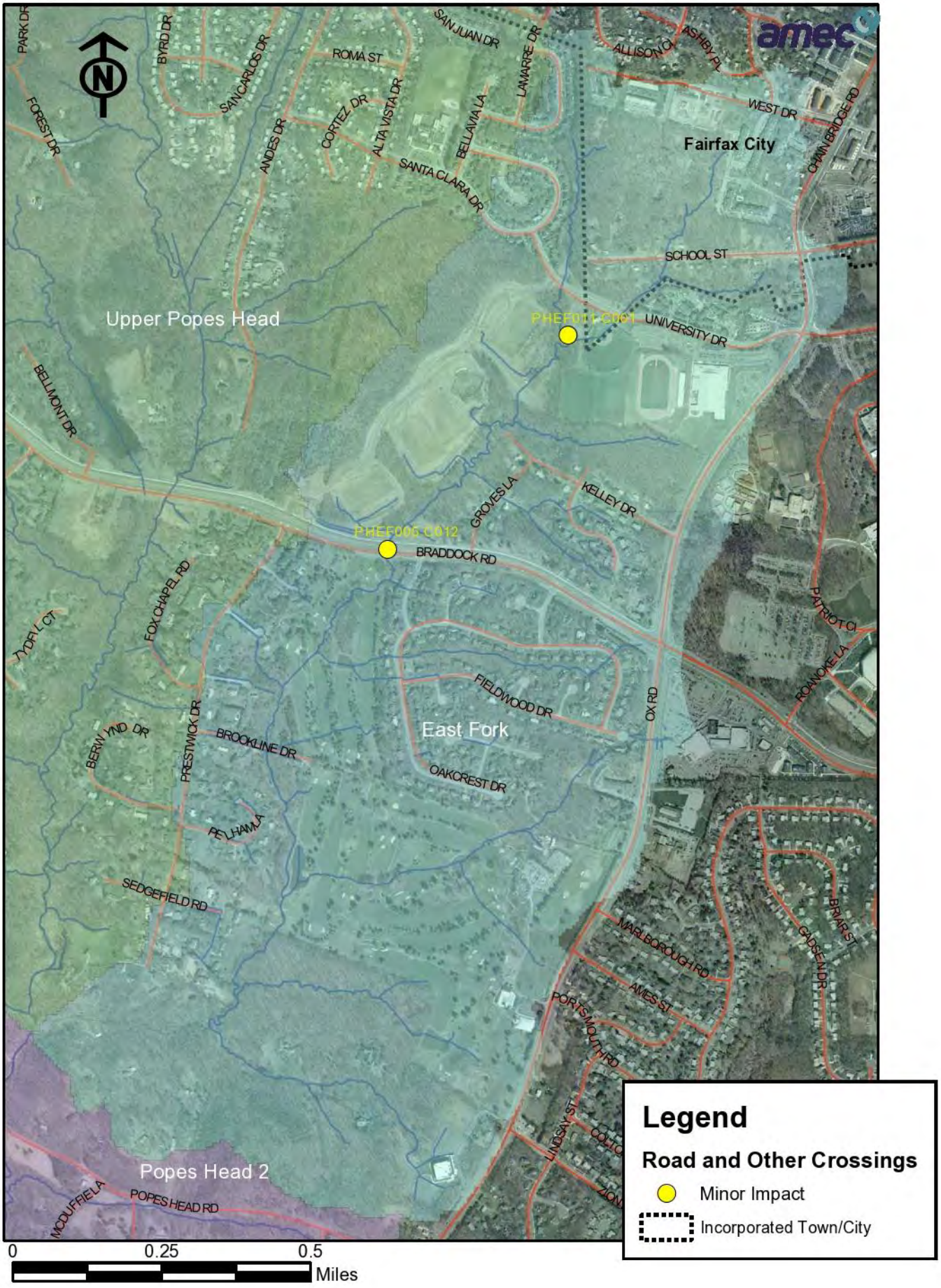
The mid-northern part of this subwatershed is drained by a network of storm drain pipes. The storm sewers outfall into tributaries of East Fork, and range in size from 18 inches to 48 inches. A drain pipe on Western Street discharges water into a dry pond. In North Hill, most of the storm sewers drain into a dry pond located west of Oakcrest drive.

Map 3.5 shows the location of two stream crossings that have an impact on the stream. Crossings that do not have an impact on the stream are not listed. The major crossings in this subwatershed, starting from the upstream end of East Fork, are described as follows:

- South of University Drive: A six-foot diameter circular concrete culvert (PHEF011.C001) has a minor impact on the main stem.
- Braddock Road: An eight-foot by six-foot, two-box concrete culvert (PHEF005.C010) has a minor impact on the main stem.

Four storm drain outfall pipes discharge into East Fork. Two of the pipes discharge stormwater from Fairfax City and George Mason University; they are 36-inches in diameter, composed of RCP, and have no impact on the stream. The other two pipes are located downstream; they are each six-inches in diameter, composed of High Density Polyethylene (HDPE), and have no impact on the stream.

Map 3.5: East Fork Stream Crossings

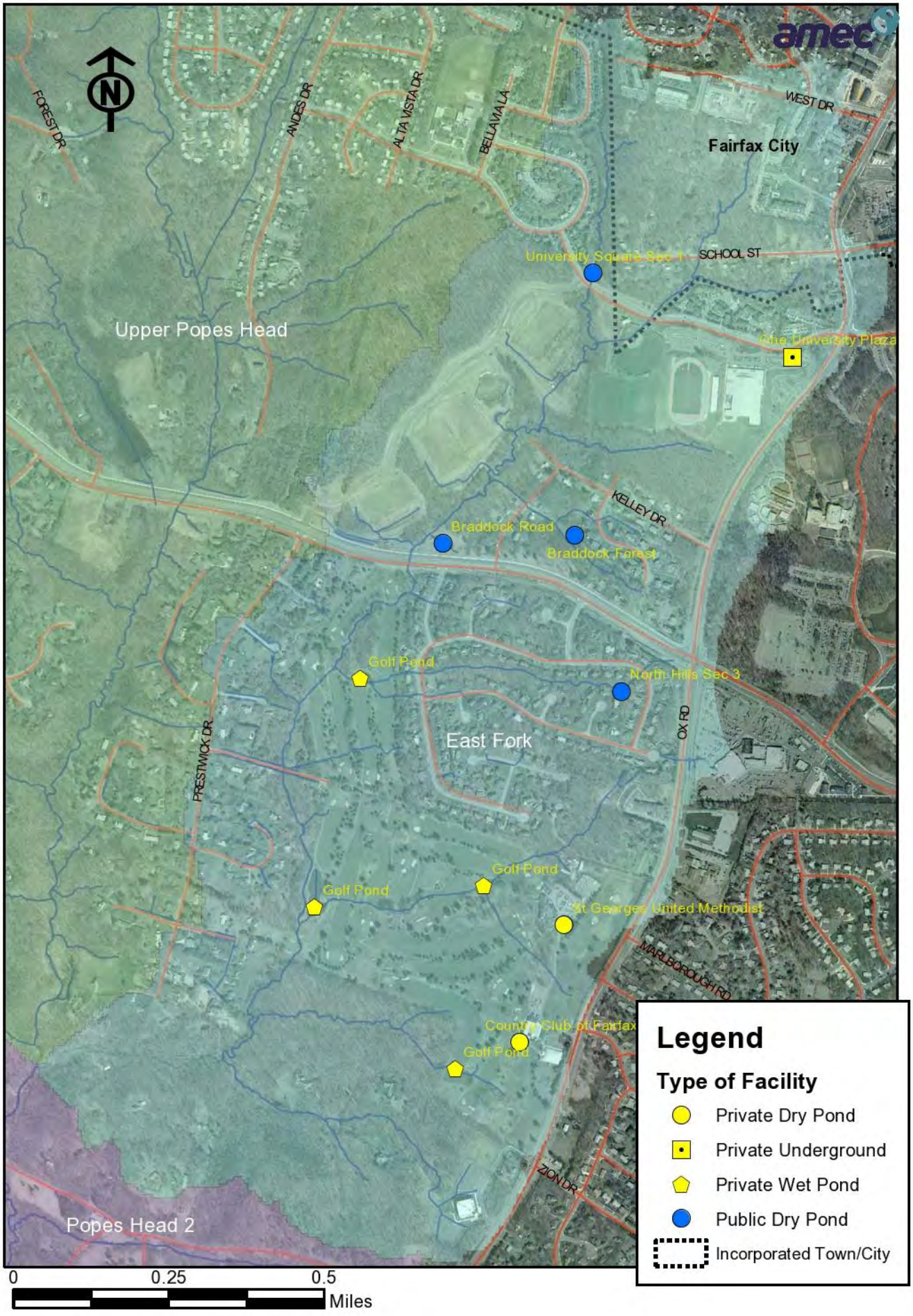


subwatershed, as depicted on Map 3.6.

Table 3.8 East Fork Stormwater Management Facilities

Name	Location	Type of Facility
Privately Owned		
St. Georges United Methodist	Ox Road near Glenmont Lane	Dry Pond
One University Plaza	Ox Road and University Drive	Underground
Country Club of Fairfax	Ox Road and Portsmouth Road	Dry Pond
Golf Pond	Country Club of Fairfax	Wet Pond
Golf Pond	Country Club of Fairfax	Wet Pond
Golf Pond	Country Club of Fairfax	Wet Pond
Golf Pond	Country Club of Fairfax	Wet Pond
Publicly Owned		
University Square Sec. 1	West of Clara Dr on University	Dry Pond
Braddock Forest	West of Western St	Dry Pond
Braddock Road	North of Braddock Road and West of Groves Lane	Dry Pond
North Hills Sec 3	West of Oakcrest Dr	Dry Pond

Map 3.6: East Fork Stream Stormwater Management Facilities



3.2.3 Stream Geomorphology

The geomorphology of the stream segments of East Fork can be summarized as follows:

- The stream reaches exhibit an evenly distributed substrate composed of clay, cobble, gravel, and sand.
- The stream reaches upstream of Braddock Road are of CEM type 3, referring to unstable stream banks and an actively widening channel.
- The stream reaches downstream of Braddock Road are of CEM type 4, referring to stabilizing stream banks and channel development as the stream returns to equilibrium.
- No dumps were observed.
- One erosional area was observed.
- No Head cuts were observed.
- Six obstructions were observed.

3.2.4 Stream Quality

The stream reaches of East Fork are classified as riffle/run stream type. Riffles can be a source of high-quality habitat and diverse fauna; therefore, an increased frequency of occurrence greatly increases the diversity of the stream community. The habitat assessment for East Fork can be summarized as follows:

- Overall, the stream exhibits poor habitat quality.
- The stream reaches upstream of Braddock Road contain two to seven habitat types common in less than 50% of the reach. The stream reaches downstream of Braddock Road contain four different habitat types in more than 50% of the reach.
- The epifaunal substrate of the stream reaches upstream of Braddock Road are composed primarily of a mixture of boulders/bedrock, gravel stones, and/or stable woody debris. Some reaches are composed of rock and sand, with no riffles present. In the stream reaches downstream of Braddock Road, the epifaunal substrate is composed of softball size cobble stones, gravel stones, boulders greater than 10 inches in diameter, and/or stable woody debris.
- The stream reaches upstream of Braddock Road have 60% - 80% embeddedness by sediment and silt. The headwaters have 50% embeddedness by sediment. The stream reaches downstream of Braddock Road have 40% - 50% embeddedness by sediment.
- More than half of the stream reaches have 80% - 90% channel disturbance or stream bank alteration. The remaining stream reaches show 50% - 60% channel disturbance.
- The stream reaches upstream of Braddock Road contain generally flat water or shallow riffles that are not deep enough to allow for fish passage. The stream reaches downstream of Braddock Road contain infrequent riffles or bends with a variable contoured bottom that provide some habitat for aquatic life.
- Water fills 75% of the main stem during normal flow conditions. The remaining stream reaches are 35% - 50% full of water during normal flow conditions.
- The left bank has 50% - 70% vegetation cover composed of shrubs, grasses and forbes. Between 50% - 80% of the right bank has vegetation cover composed of shrubs, grasses and forbes, with a few barren or thin areas present.
- The left banks are moderately unstable and have 40% - 60% erosional areas. The right banks are moderately stable and have 30% - 50% erosional areas.
- The majority of the left and right stream banks have no forested buffer, and are composed primarily of planted lawn grass yards and shrubs.

The general characteristics of the stream water quality were assessed as follows:

- The water had a clear appearance and no odor was detected at any of the assessed stream reaches.
- No fishes or aquatic plants were observed.
- Fertilizer from the Country Club of Fairfax may be washing into the stream.

3.2.5 Stream Ecology

The 2001 *Stream Protection Strategy (SPS) Baseline Study* did not include a sampling site in the East Fork Subwatershed. Therefore, there is no current information available about the condition of the aquatic ecological community in this subwatershed.

3.2.6 Problem Areas from Public Forum

There were no problem areas identified in this subwatershed at the March 27, 2004 Community Watershed Forum.

3.2.7 Modeling Results

The hydrology for East Fork produced stormwater runoff that is relatively high due to dense development in the upper portions of the subwatershed. The increase in discharges due to future development is the highest compared to the other subwatersheds. This is due to the amount of vacant and underdeveloped parcels in the subwatershed. See Table 3.9 for a comparison of the existing and future 2- and 10-year peak discharges in the subwatershed.

Table 3.9 East Fork Peak Runoff Flows

East Fork Discharge Table		Two-Year Rainfall Event			10-Year Rainfall Event		
Location	**Drainage Area**	**Existing Peak Flow (cfs)**	**Future Peak Flow (cfs)**	**% Peak Flow Increase**	**Existing Peak Flow (cfs)**	**Future Peak Flow (cfs)**	**% Peak Flow Increase**
Approximately 900 ft upstream of Braddock Road	0.49	440	530	20%	860	1030	20%
Just downstream of Braddock Road	0.54	570	660	16%	1120	1730	54%
Approximately 1,300 ft downstream of Brookline Drive	1.02	560	660	18%	1180	1790	52%

Velocities produced by the 2-year rainfall event in East Fork were usually below those in the other subwatersheds, averaging 4.8 feet per second. The average velocity is predicted to increase by approximately 28% in the future conditions.

Both the 2- and 10-year peak discharges overtop the channel banks for a majority of the cross sections in the East Fork model. The 2-year is confined to the channel bank in the lower reaches of East Fork. The model shows no structures greater than 500 square feet located in the 10-year floodplain.

While the East Fork subwatershed has the lowest sediment loading rate out of the seven subwatersheds, the predicted sediment load exceeds the target Tributary Strategy level. For future land use conditions, the average sediment loading rate is predicted to increase by 5%.

The East Fork subwatershed has a lower annual pollutant loading for total phosphorus and total nitrogen than five of the seven subwatersheds. This can be attributed to the relatively low percentage of residential development in the watershed. The total phosphorus load exceeds the target Tributary Strategy level and the total nitrogen load is just below the target Tributary Strategy level. For future land use conditions, the loading rate is predicted to increase by 6% for total phosphorus and 7% for total nitrogen.

3.2.8 Summary

The East Fork Subwatershed exhibits poor stream habitat quality throughout the subwatershed. This is likely due to the fact that less than half of the subwatershed is in the rezoned area. Approximately 80% - 90% of the stream channels have been altered, and they have very little vegetated protection to keep the stream banks from eroding. Imperviousness is expected to nearly double, increasing from 14.7% to 27.8%; therefore, stream habitat quality can be expected to continually degrade in the future.

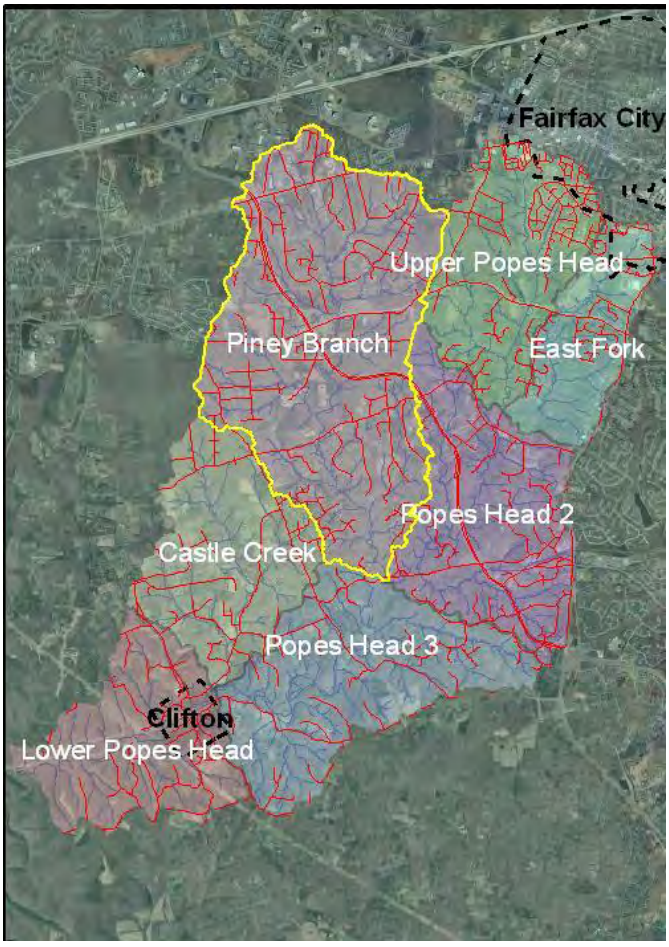
Braddock Road plays an important role in this watershed; in general, the stream reaches upstream of Braddock Road display poorer habitat quality than the stream reaches downstream of Braddock Road. This roughly coincides with the boundaries of the rezoned area in the subwatershed.

3.3 Piney Branch Subwatershed

The Piney Branch Subwatershed is approximately 3,389 acres in area. It is bounded to the northwest by West Ox Road; to the north by Ruffin Drive; to the northeast by the intersection of Lehigh Drive and Village Drive; to the east by Mattie Moore Court, Fairfax County Parkway and Innisvale Drive; to the south by Fairfax Station Road; to the southwest at the intersection of Saddle Horn Drive and Fairfax Hunt Road; and by Colchester Road to the west.

This subwatershed contains several portions of the Piney Branch Stream Valley Park. Braddock Road, Fairfax County Parkway, and Lee Highway are all major thoroughfares in the subwatershed. The Piney Branch Subwatershed is shown on Map 3.7 and its condition is summarized below:

Map 3.7: Location of Piney Branch



3.3.1 Subwatershed Characteristics

The stormwater runoff from this subwatershed drains into Piney Branch, which has its headwaters near the Costco Plaza, located at the intersection of West Ox Road and Lee Highway. Runoff from the Plaza flows southward through the Piney Branch Stream Valley Park and eventually into the Popes Head 3 Subwatershed. Piney Branch is 3.98 miles long, and has many significant tributaries. The existing impervious area of the subwatershed is 10.5% of the total area. Imperviousness is expected to increase to 13.2% in the future, based upon the planned or zoned land uses in the Fairfax County Comprehensive Plan. 83% of the subwatershed is in the rezoned area; the rezoned area was established in 1982 by the Fairfax County Board of Supervisors in order to protect the Occoquan Reservoir. Building density within the rezoned area is reduced, and therefore imperviousness is decreased, reducing the amount of stormwater runoff that is generated. Estate residential is the predominant land use, comprising 35.7% of the total area. Open space is expected to decrease dramatically in the future, providing more space for residential development. Roads and sidewalks are not included in the land use data. Existing and future land uses in the subwatershed are shown in Table 3.10 below.

Piney Branch Subwatershed Condition Summary

- Current Imperviousness = 10.5% with majority of land use Estate Residential
- Future Imperviousness = 13.2%
- Area of 3,389 acres
- 83.0% of the subwatershed is in the rezoned area. Major land uses that are not in the rezoned area include the Costco Plaza and the Piney Branch Stream Valley Park.
- 16 stormwater management facilities currently exist.
- The stream exhibits good to very poor habitat quality
- Active widening and downcutting was observed in the majority of the stream reaches.
- One dump was observed.
- Two head cuts were observed.
- Four obstructions were observed.
- Three out of 47 crossings have minor to severe impacts.

Table 3.10 Piney Branch Land Use

Land Use Description	Existing		Future	
	Acres	%	Acres	%
Estate residential	1104.5	35.7%	1707.9	55.1%
Low-density residential	684.1	22.1%	799.9	25.8%
Medium-density residential	87.2	2.8%	128.8	4.2%
High-density residential	10.7	0.3%	10.6	0.3%
Low-intensity commercial	120.8	3.9%	140.5	4.5%
High-intensity commercial	67.3	2.2%	67.3	2.2%
Industrial	3.8	0.1%	3.8	0.1%
Open Space	1007.3	32.5%	226.7	7.3%
Unknown	11.4	0.4%	11.4	0.4%
TOTAL	3097.1	100.0%	3096.9	100.0%

The subwatershed contains 1,864 parcels, with an average parcel size of 1.66 acres. There are 48 neighborhoods fully within or apportioned within the subwatershed, as listed below:

- Beaumont
- Braddock Farms
- Buckner Forest
- Centennial Hills
- Colchester Heights
- DeBosk
- Fairfax Hunt
- Glen Alden
- Hunt Woods Estates
- Lee Pines
- Legato Acres
- Birchtree
- Braddock Woods
- Cambryar
- Cobbs Corner
- Colchester Hunt
- Decour Estates
- Fairfax Ridge
- Hampton Forest
- Innisvale
- Leehigh Village
- Lincoln Park
- Blevinstown
- Brentwood
- Cannon Ridge
- Colchester Acres
- Colchester Meadow
- Dixie Hill
- Fairfax Woods
- Huntwood Manor
- Lake Fairfax Estates
- Leehigh Woods
- Lewis Park

- Marymead
- Piney Branch
- Robertson Farm
- Station Crossing
- Vannoy Park
- McKay
- Popes Head Estates
- Robeys Meadow
- Ten Penny Woods
- Windsor Gate
- Novak
- Quiet Brook
- Robeys Mill
- Vannoy Acres
- Windsor News

The County's list of master plan drainage projects shows that two of the nine identified projects in this subwatershed has been completed. Table 3.11 summarizes the type of master plan drainage project, project name/location, and current status. No cost estimates were available for these projects.

Table 3.11 Piney Branch Master Plan Drainage Projects

Type of Work	Project Name/Location
Completed Projects	
Raise Road and Replace Culvert	Piney Branch at Braddock Rd
Lower Invert and Replace Culvert	Piney Branch at Lee Highway
Inactive Projects	
Stream Restoration and Stabilization	Near Spruce Avenue
Lower Invert and Replace Culvert	Rochester Drive
Lower Invert and Replace Culvert	Tributary at Braddock Rd
Lower Invert and Replace Culvert	Tributary at Popes Head Rd
Raise Road and Replace Culvert	Piney Branch at Fairfax Station Rd

Three complaints regarding flooding, erosion, and stream channel blockage were registered with the County and included in the database files for this subwatershed. The county addressed two of the complaints by removing the blockages from the drainage system and by preventing erosion.

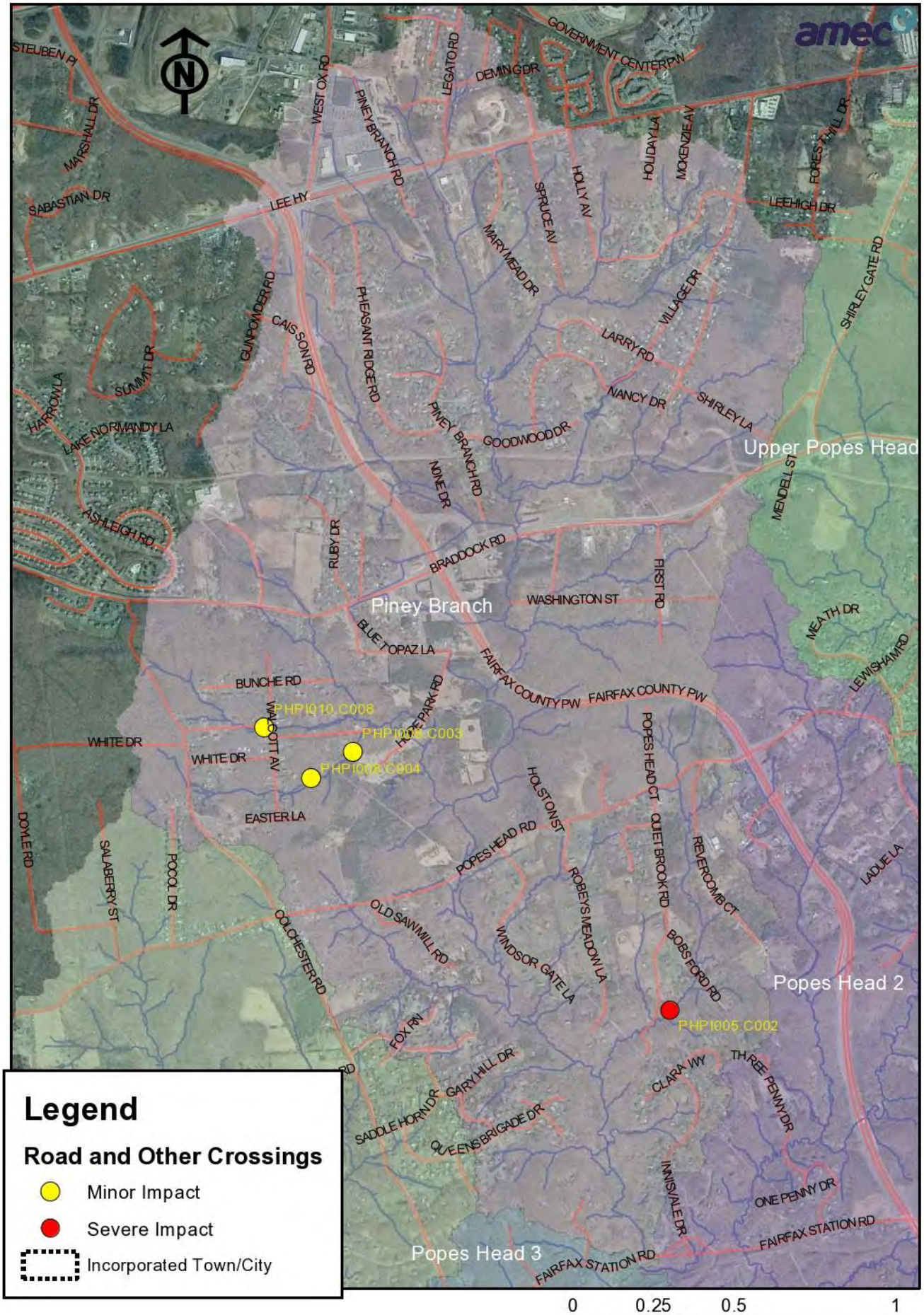
3.3.2 Storm Drain System Infrastructure

Piney Branch does not have a large network of storm drain pipes. Novak contains a small series of storm sewer pipes that discharge into Piney Branch. Colchester Hunt also contains a small network of storm sewer pipes that discharge into three dry ponds. The outfalls vary in size, ranging from 18 inches to 42 inches.

Map 3.8 shows the location of three stream crossings that have an impact on the stream. Crossings that do not have an impact on the stream are not listed. The major crossings in this subwatershed, starting from the upstream end of Piney Branch, are described as follows:

- Rochester Drive: A one-foot diameter, two barrel CMP culvert (PHPI008.C003) has a minor impact on a western tributary.
- Walcott Avenue: A 12-foot natural ford (PHPI008.C004) has a minor impact on the stream, as shown in Photo 3.2
- Quiet Brook Road: A three-foot diameter circular CMP culvert (PBPI005.C001) has no impact on an eastern tributary. To the northeast, a two-foot diameter circular concrete culvert (PHPI005.C002) has a severe impact on the same tributary, as shown in Photo 3.3

Map 3.8: Piney Branch Stream Crossings



Three storm drain outfall pipes discharge into Piney Branch. They range from 24 to 60 inches in diameter, and have no impact on the stream. All of the pipes are made of RCP and discharge from stormwater management ponds.

Photo 3.2 A natural ford (PHPI008.C004) near Walcott Avenue has a minor impact on the stream

Photo 3.3 A concrete culvert (PHPI005.C002) near Quiet Brook Road has a severe impact on the stream

Table 3.12 shows the locations of known stormwater management facilities in the subwatershed, as depicted on Map 3.9.

Table 3.12 Piney Branch Stormwater Management Facilities

Name	Location	Type of Facility
Privately Owned		
St. Mark Coptic Orthodox Church	Braddock Road and 2nd Road	Underground
Sports Authority	North of Lee Hwy and Pheasant Ridge Rd	Wet Pond
Piney Branch Rd Ext.	Lee Hwy and Piney Branch Rd	Dry Pond
Merrifield Garden Ctr.	West of Marymead Rd	Wet Pond
Publicly Owned		
Fairfax Ridge	Lee Hwy and Dixie Branch Rd	Dry Pond
Lee Pines	Pheasant Ridge Rd and Tall Pines Ct	Dry Pond
Marymead	East of Marymead Rd	Dry Pond
Novak	East end of Goodwood Dr	Dry Pond
Brentwood, Sec. 2	Hollow Tree Ln and Piney Branch Rd	Dry Pond
Birchtree Sec. 2	Leehigh Dr and Leehigh Ct	Dry Pond
Braddock Comm. Ctr.	West of 2nd Rd and Washington St (Mott Comm Ctr?)	Dry Pond
Decour Estates Sec. 1	DeCour Court	Dry Pond
Fairfax Hunt Pd 2	West of Fox Run	Dry Pond
Colchester Hunt Sec 2	Kings Color Dr and Brigade Dr	Dry Pond
Fairfax Hunt Pd 3	North end of Fox Run	Dry Pond
Fairfax Hunt Pd 4	North end of Fox Run	Dry Pond

3.3.3 Stream Geomorphology

The geomorphology of the stream segments of Piney Branch can be summarized as follows:

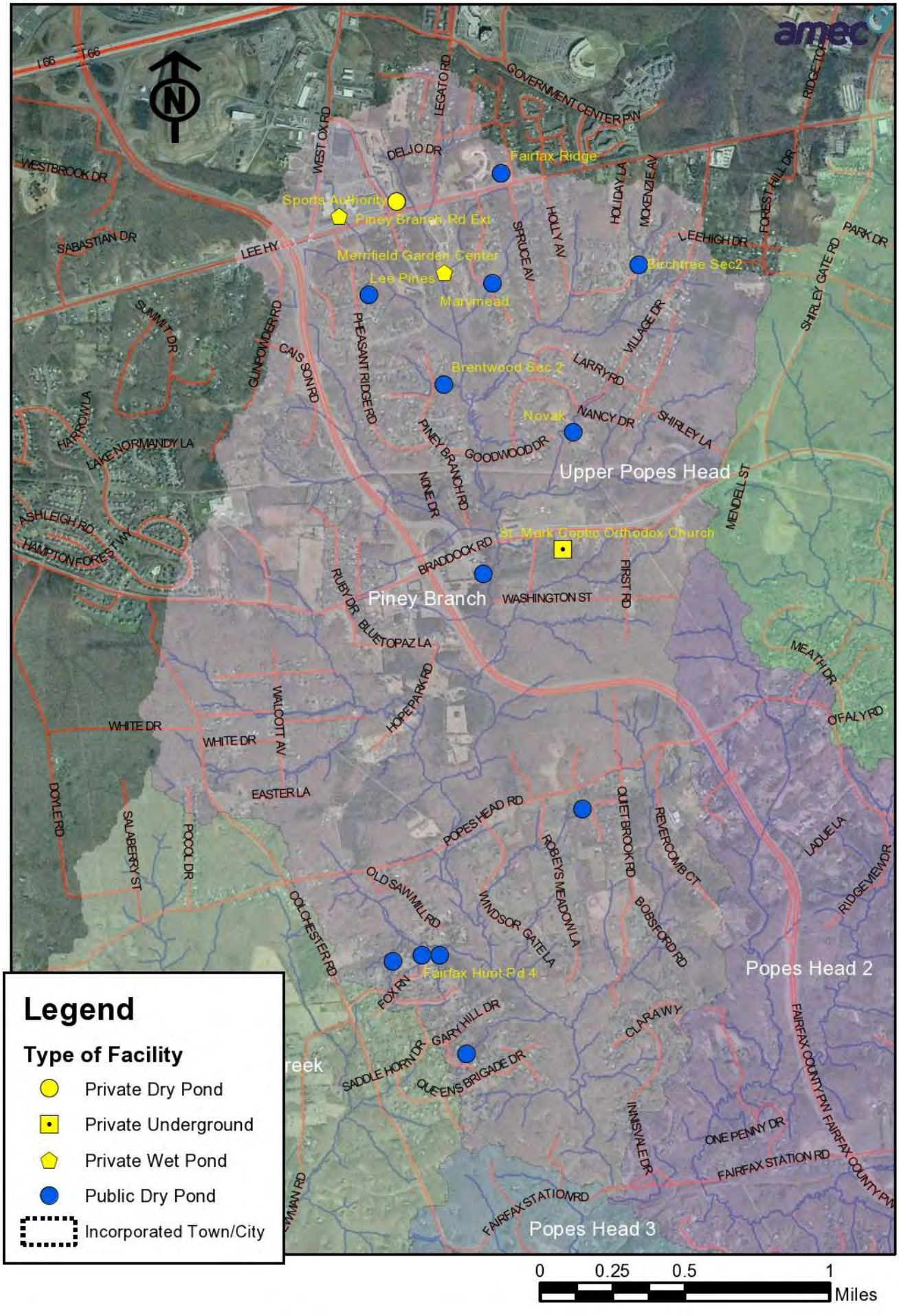
- The dominant substrate of the stream reaches upstream of the Fairfax County Parkway is sand. The dominant substrate of the stream reaches downstream of the Fairfax County Parkway is gravel.
- The majority of the stream reaches are of CEM type 3, referring to unstable stream banks and an actively widening channel. Active widening and downcutting was observed in the majority of the stream reaches.
- The reaches that are downstream of Popes Head Road are of CEM type 4, referring to stabilizing stream banks and channel development. These reaches contain stabilizing point bars that are creating internal meanders.
- One dump was observed.
- No erosional areas were observed.
- Two head cuts were observed.
- Four obstructions were observed.

3.3.4 Stream Quality

The stream reaches of Piney Branch are classified as riffle/run stream type. Riffles are a source of high-quality habitat and diverse fauna; therefore, an increased frequency of occurrence greatly increases the diversity of the stream community. The habitat assessment for Piney Branch can be summarized as follows:

- The stream habitat quality ranges from good to very poor.
- The main stem of Piney Branch downstream of Popes Head Road has four habitat types common in more than 70% of the reach, and seven habitat types common in more than 50% of the reach. The main stem of Piney Branch upstream of Fairfax County Parkway has five habitat types common in more than 50% of the reach. The remaining stream reaches have between two and seven habitat types common in less than 50% of the reach.
- The epifaunal substrate of the main stem of Piney Branch downstream of Popes Head Road is dominated by softball size cobble stones. The main stem upstream of Fairfax County Parkway is composed of a mixture of cobble and gravel stones and/or stable woody debris. The portion of the main stem between Fairfax County Parkway and Popes Head Road contains a well developed riffle run complex composed of gravel stones and boulders/bedrock and/or woody debris. The tributaries of the main stem have smaller riffles that are composed of bedrock and/or gravel stones and/or woody debris, cobble, and boulder stones greater than 10 inches in diameter.
- The stream reaches upstream of Popes Head Road have 60% - 70% embeddedness by sediment and silt. The stream reaches downstream of Popes Head Road have 30% - 50% embeddedness by sediments and silt.
- The stream reaches downstream of Popes Head Road have no evidence of disturbance; the stream follows a normal and natural meandering pattern. The stream reaches between Fairfax County Parkway and Popes Head Road have 5% of

Map 3.9: Piney Branch Stormwater Management Facilities



Legend

Type of Facility

- Private Dry Pond
- Private Underground
- Private Wet Pond
- Public Dry Pond
- Incorporated Town/City

the channel disturbed or altered. The main stem of Piney Branch upstream of Fairfax County Parkway has between 40% - 70% of the channel disturbed, indicating channelization. The remaining tributaries have 30% - 40% of the channel disturbed, indicating artificial embankments and minor alterations.

- The main stem of Piney Branch downstream of Popes Head Road and portions of the upstream stem have infrequent riffles with variable bottom contours that may provide some habitat for aquatic life. The main stem between Goodwood Road and Popes Head Road has moderately frequent riffles which have adequate depth in the pool and riffle system. The remaining tributaries have infrequent riffles, or flat water and shallow riffles which do not provide an adequate passage for fishes.
- Water fills in 35% - 85% of the channel during normal flow conditions.
- The majority of the left and right stream banks for all reaches have 50% - 70% vegetation cover, consisting of shrubs, grasses, and forbes. The remaining reaches have 70% - 80% plant cover, with some areas thin or barren.
- The main stem of Piney Branch has moderately stable left stream banks, with only 30% erosional areas. The tributaries have moderately unstable banks, with 40% - 60% erosional areas. The right banks are also moderately stable, with only 5% - 30% erosional areas. Several of the tributaries are moderately unstable, with 40% - 50% bank erosional areas.
- The main stem of Piney Branch downstream of the Fairfax County Parkway has forested vegetated buffers greater than 100 feet wide on both the left and right banks. The stream reaches upstream of the Fairfax County Parkway have a forested vegetated buffer of 50 – 100 feet wide, a majority of which is composed of shrubs and a few trees, or planted lawn grass yards.

The general characteristics of the stream water quality were assessed as follows:

- Most of the stream reaches contained water with a clear appearance. The main stem had a turbid appearance between Goodwood Drive and Popes Head Road.
- No odor was detected at any of the assessed stream reaches.
- Small fishes of one to two inches in length were observed throughout the main stem.
- Attached aquatic plants were observed in the stream margin and near riffles in less than 10% of the entire stream bank area.
- Green and brown algae of light density and slime coating were observed throughout the main stem of Piney Branch.

3.3.5 Stream Ecology

The 2001 *Fairfax County Stream Protection Strategy (SPS) Baseline Study* sampled fish and aquatic macroinvertebrates in two different locations in the Piney Branch Subwatershed. The first sampling site (PHPI01), as shown on Map 2.11, is located downstream of Braddock Road and exhibited a poor macroinvertebrate community, which is indicative of degraded water quality. A high number of fish species was observed at this site, which is indicative of a strong community structure and good water quality. The second site (PHPI02), as shown on Map 2.11, is located downstream of Popes Head Road, and exhibited the same conditions as the first site. The disparity in water quality indicators is likely due to the degree of embeddedness found throughout Piney Branch, which primarily affects the benthic community.

3.3.6 Problem Areas from Public Forum

Attendees at the March 27, 2004 Community Watershed Forum noted that unauthorized fill was occurring in the floodplain of Piney Branch near 2nd Street, south of Braddock Road. The Fairfax County Department of Public Works and Environmental Services is aware of the illegal fill and is going through legal proceedings to resolve the issue. The majority of the fill site is in the County's Chesapeake Bay Act Resources Protection Area.

A participant at the January 13, 2004 Issues Scoping Forum noted that erosion is occurring adjacent to 12129 Queens Brigade Drive in the Colchester Hunt Subdivision.

3.3.7 Modeling Results

The hydrology for Piney Branch produced stormwater runoff that is average compared to the other subwatersheds. The increase in discharges due to future development is also average compared to the other subwatersheds. See Table 3.13 for a comparison of the existing and future 2- and 10-year peak discharges in the subwatershed.

Table 3.13 Piney Branch Peak Runoff Flows

Piney Branch Discharge Table		Two-Year Rainfall Event			10-Year Rainfall Event		
Location	**Drainage Area**	**Existing Peak Flow (cfs)**	**Future Peak Flow (cfs)**	**% Peak Flow Increase**	**Existing Peak Flow (cfs)**	**Future Peak Flow (cfs)**	**% Peak Flow Increase**
Approximately 0.44 mi upstream of Goodwood Drive	0.69	860	1000	16%	1670	1900	14%
Just upstream of Braddock Road	2.18	770	800	4%	1550	1560	1%
Approximately 2,000 ft downstream of Popes Head Road	4.04	1070	1130	6%	2190	2210	1%

Velocities produced by the 2-year rainfall event in Piney Branch were average compared to those in the other subwatersheds, averaging 5.7 feet per second. The average velocity is predicted to increase by approximately 4% in the future conditions.

Both the 2- and 10-year peak discharges overtop the channel banks for a majority of the cross sections in the Piney Branch model. The model shows three buildings greater than 500 square feet located in the 10-year floodplain, just upstream of Popes Head Road. Table 3.14 shows a summary of the flooded structures in the subwatershed for different recurrence intervals.

Table 3.14 Piney Branch Flooded Structures

Recurrence Interval	Piney Branch	
	Existing	Future
2	1	1
5	1	2
10	3	3
25	3	3
50	4	4
100	4	4

The Piney Branch subwatershed has an average sediment loading rate compared to the other subwatersheds. The predicted sediment load exceeds the target Tributary Strategy level. For future land use conditions, the average sediment loading rate is predicted to increase by 1%.

The Piney Branch subwatershed has an average pollutant loading for total phosphorus and total nitrogen as compared to the other subwatersheds. The total phosphorus load exceeds the target Tributary Strategy level and the total nitrogen load is just below the target Tributary Strategy level. For future land use conditions, the loading rate is predicted to increase by 2% for both total phosphorus and total nitrogen.

3.3.8 Summary

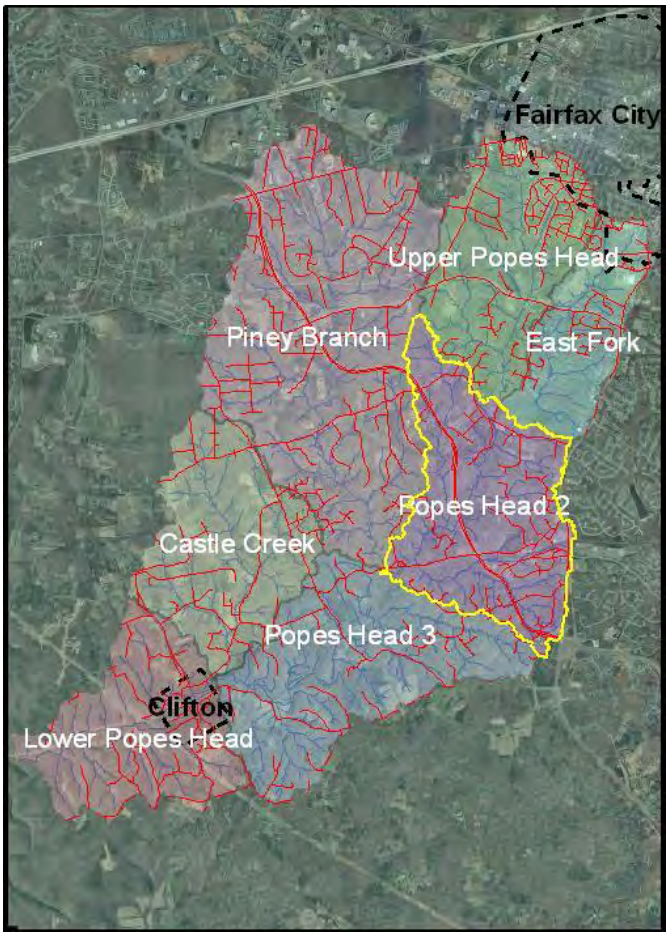
The stream habitat quality in the Piney Branch Subwatershed ranges from good to very poor. In general, the stream reaches upstream of the Fairfax County Parkway are in poorer condition than the stream reaches downstream. The entire main stem exhibited green and brown algae; this might be indicative of excessive nutrients running off from land.

Both the 2- and 10-year peak discharges overtop the channel banks for a majority of the cross sections in the Piney Branch model. The Piney Branch subwatershed has average sediment, phosphorus, and nitrogen loading rate compared to the other subwatersheds. For future land use conditions, the average sediment loading rate is predicted to increase by 1%, and the loading rate is predicted to increase by 2% for both total phosphorus and total nitrogen.

3.4 Popes Head 2 Subwatershed

The Popes Head 2 Subwatershed has an area of approximately 1,732 acres and contains the eastern portion of the Popes Head Creek main stem. It is bounded to the north by Popes Head Road and Meath Drive; to the east by Ox Road; to the south by Robert Carter Road and Clara Barton Road; to the southwest by Innisvale Road, and to the northwest by the Fairfax County Parkway.

Map 3.10: Location of Popes Head 2



The Fairfax County Parkway, Popes Head Road, and Fairfax Station Road are all major thoroughfares in the subwatershed. The Popes Head 2 Subwatershed is shown on Map 3.10 and its conditions are summarized below.

3.4.1 Subwatershed Characteristics

The stormwater runoff from this subwatershed drains into Popes Head Creek, which has its headwaters at the confluence of the Upper Popes Head and East Fork Subwatersheds. It flows southwestward for a distance of 2.61 miles before it reaches the Popes Head 3 subwatershed. There are several small tributaries that are over 1,000 feet long, and one long tributary that is over 8,000 feet long.

The existing imperviousness of this subwatershed is 12% of the total area. Imperviousness is expected to increase to 15.4% in the future, based upon the planned and zoned land uses in the Fairfax County Comprehensive Plan. 97.8% of the subwatershed is in the rezoned area; the rezoned area was established in 1982 by the Fairfax County Board of Supervisors in order to protect the Occoquan Reservoir. Building density within the rezoned area is reduced, and therefore imperviousness is decreased, reducing the amount of stormwater runoff that is generated. Land use in the subwatershed is predominantly estate residential, which comprises 50% of the area. Low-density residential also comprises a significant portion of the watershed area, totaling 24.2% of the total area. Estate residential and low-density residential are expected to total approximately 87.3% of the subwatershed area in the future, while open space area will decrease to 1.5%. Roads and sidewalks are not included in the land use data. The existing and future land uses in the Popes Head 2 Subwatershed are described in Table 3.15.

Popes Head 2 Subwatershed Condition Summary

- Current Imperviousness = 12.0% with majority of land use Estate Residential
- Future Imperviousness = 15.4%
- Area of 1,732 acres.
- 97.8% of the subwatershed is in the rezoned area.
- Six stormwater management facilities currently exist.
- The stream exhibits fair to poor habitat quality.
- Three dumps were observed.
- No head cuts were observed.
- Five obstructions were observed.
- Ten out of 26 crossings have minor impacts.

Table 3.15 Popes Head 2 Land Use

Land Use Description	Existing		Future	
	Acres	%	Acres	%
Estate residential	791.2	50.0%	999.5	63.2%
Low-density residential	383.6	24.2%	381.9	24.1%
Medium-density residential	22.7	1.4%	23.4	1.5%
High-density residential	0.1	0.0%	0.1	0.0%
Low-intensity commercial	103.4	6.5%	136.3	8.6%
High-intensity commercial	7.7	0.5%	9	0.6%
Industrial	35.6	2.2%	9.2	0.6%
Open Space	238.1	15.0%	23	1.5%
Unknown	0	0.0%	0	0.0%
TOTAL	1582.4	100.0%	1582.4	100.0%

The subwatershed consists of 910 parcels, with an average size of 1.74 acres per parcel. There are 20 neighborhoods fully within or apportioned within the subwatershed, as listed below:

- Barton Place
- Chilton Wood
- Fairview Woods
- Oak Brook
- Popes Head Mill Estates
- Smoke Rise
- Ten Penny Woods
- Beaumont
- Colchester Meadow
- Innisvale
- The Patterns
- Popes Head View
- Station Crossing
- West Ridge Estates
- Beech Ridge Estates
- Fairfax Station
- Lincoln Park
- Pickwick Woods
- Ridges of Glendilough
- Station Hills

The County's list of master plan drainage projects shows the one identified project in this subwatershed is inactive. Table 3.16 summarizes the type of master plan drainage project, project name/location, and current status. No cost estimates were available for these projects.

Table 3.16 Popes Head 2 Master Plan Drainage Projects

Type of Work	Project Name/Location
Inactive Project	
Raise Road and Replace Culvert	Popes Head Tributary 3 at Fairfax Station Rd

Twelve complaints regarding erosion, channel blockage, and flooding were registered with the County and included in the database files for this subwatershed. The County addressed six of the complaints by removing the blockages from the drainage system.

3.4.2 Existing Stormwater Management Facilities

Popes Head 2 does not have an extensive network of storm drain pipes; however, it does have several small networks that service the neighborhoods. The outfalls vary in size, ranging from 15 inches to 47 inches. Most of the outfalls discharge into Popes Head Creek. Barton Place is serviced by a small network of storm drain pipes which discharge into an underground storage facility. The Fairfax Station Shopping Center also has a network of storm drain pipes that discharge into an underground storage facility.

Map 3.11 shows the location of 10 stream crossings that have an impact on the stream. Crossings that do not have an impact on the stream are not listed. The major crossings in this subwatershed, starting from the upstream end of Popes Head 2, are described as follows:

- Popes Head Road: A two-foot diameter, circular CMP culvert (PHPH036.C002) has a minor impact on a western tributary, as shown in Photo 3.4. Immediately adjacent to it, a one-foot diameter circular concrete culvert (PHPH036.C001) has a minor impact on the same tributary. To the south, a two-foot diameter circular concrete culvert (PHPH035.C001) has a minor impact on the same tributary.
- Fairfax County Parkway: A three-foot diameter circular CMP culvert (PHPH033.C006) and a three-foot diameter circular CMP culvert (PHPH033.C007) both have minor impacts on the same tributary.
- McDuffie Lane: A two-foot diameter circular CMP culvert (PHPH039.C002) has a minor impact on an eastern tributary, as shown in Photo 3.5.
- Beech Ridge Drive: A three-foot diameter circular CMP culvert (PHPH039.C003) has a minor impact on an eastern tributary.
- Smoke Rise Lane: A six-foot diameter circular CMP culvert (PHPH038.C002) has a minor impact on an eastern tributary.
- Fairfax Station Road: A four-foot diameter elliptical concrete culvert (PHPH028.C002) has a minor impact on the main stem, as shown in Photo 3.6.
- Fairfax County Parkway: A six-foot by six-foot box concrete culvert (PHPH028.C003) has a minor impact on an eastern tributary, as shown in Picture 3.7.

Map 3.11: Popes Head 2 Stream Crossings

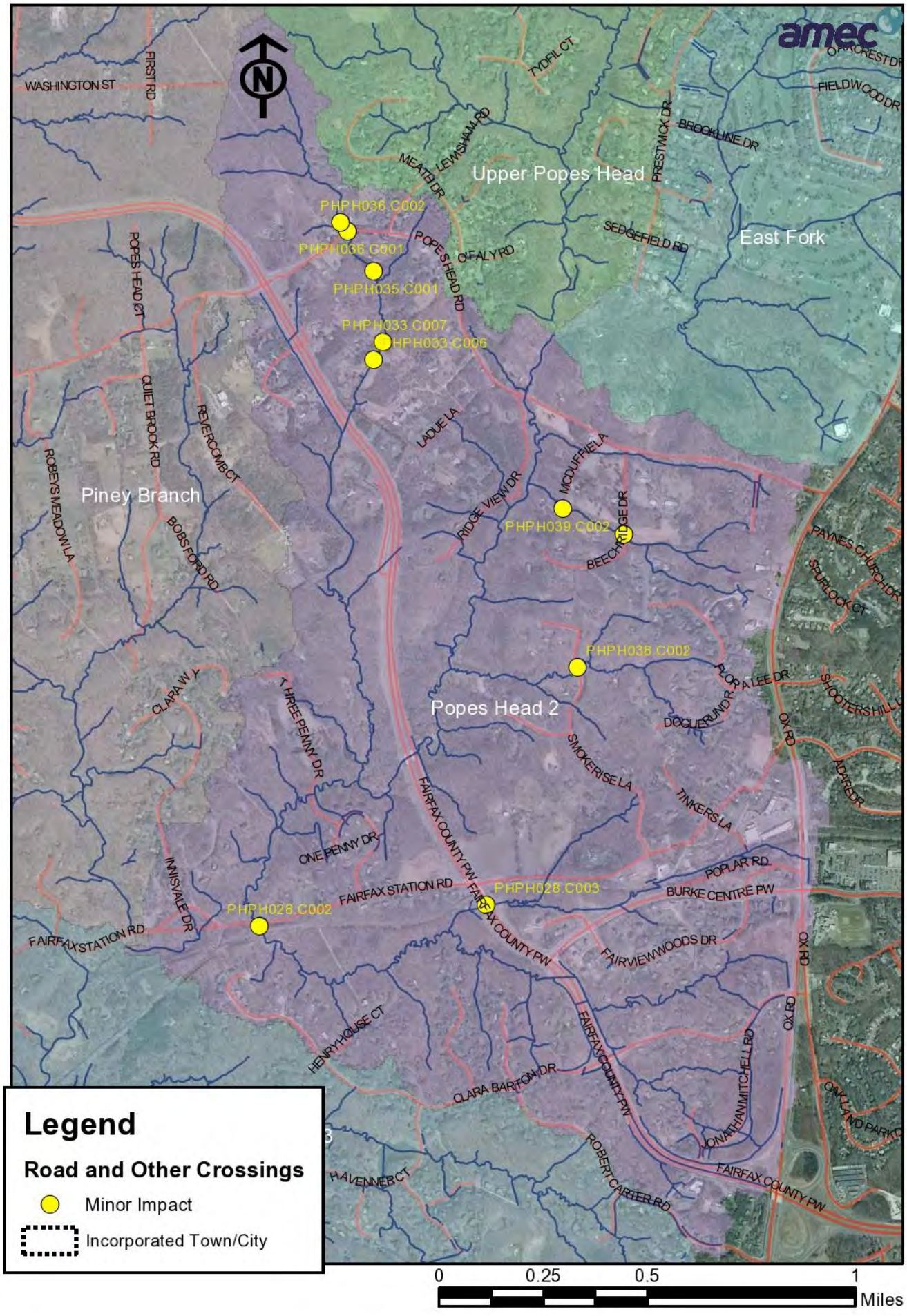


Photo 3.4 A culvert (PHPH036.C002) at Popes Head Road has a minor impact on the stream

Photo 3.5 A culvert (PHPH039.C002) at McDuffie Lane has a minor impact on the stream

Photo 3.6 A culvert (PHPH028.C002) at Fairfax Station Road has a minor impact on the stream

Photo 3.7 A box culvert (PHPH028.C003) near Fairfax County Parkway has a minor impact on the stream

Nine storm drain outfall pipes discharge into Popes Head 2. The pipes are made of PVC, iron, RCP, CMP, and HDPE. The two northernmost pipes have a minor impact on the stream. The remaining pipes have no impact on the stream.

Table 3.17 shows the locations of known stormwater management facilities in the subwatershed, as depicted on Map 3.12.

Map 3.12: Popes Head 2 Stormwater Management Facilities

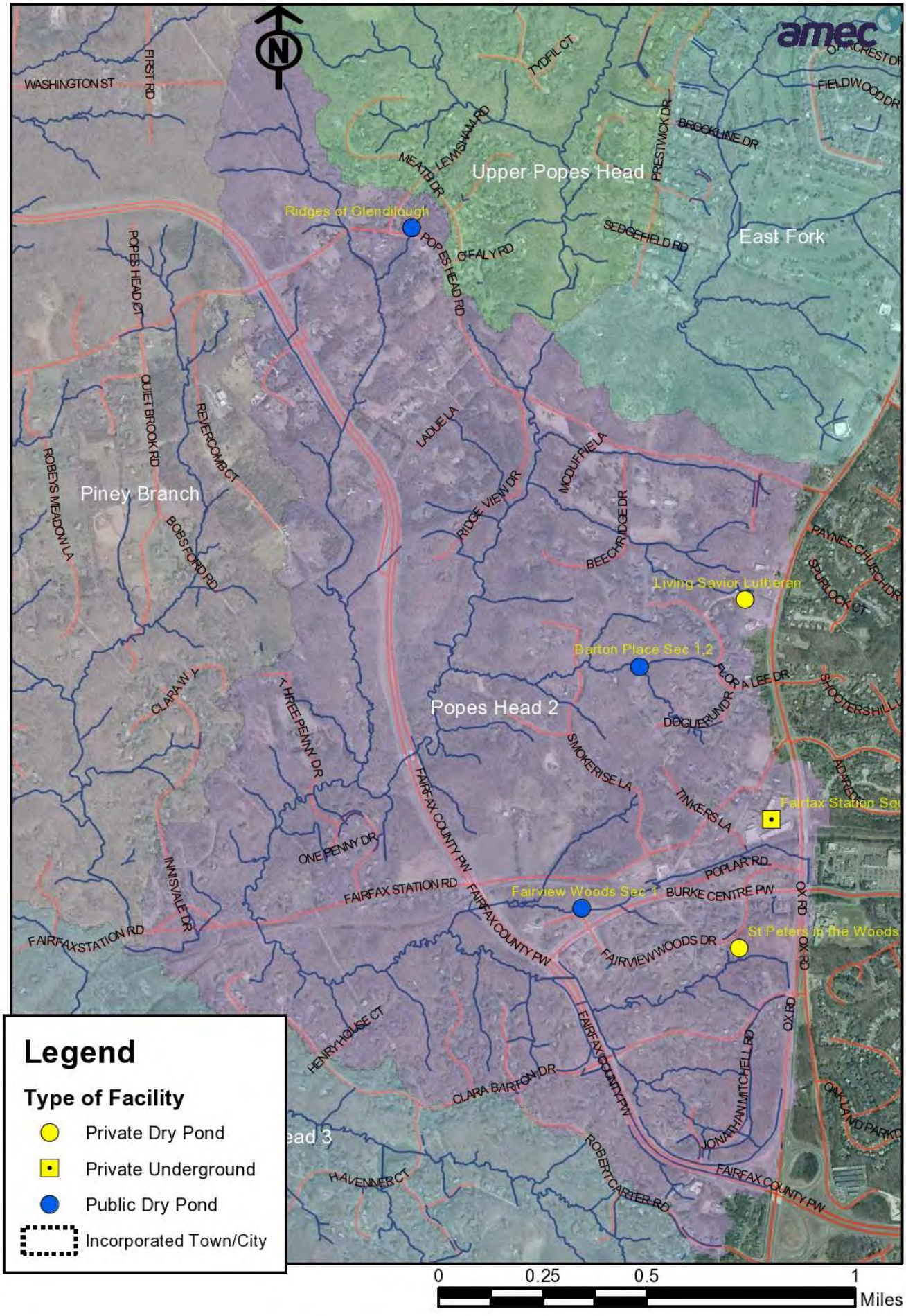


Table 3.17 Popes Head 2 Stormwater Management Facilities

Name	Location	Type of Facility
Privately Owned		
Living Savior Lutheran	North end of Four Stairs Ct	Dry Pond
Fairfax Station Square Shopping Center	Ox Road and CSX Railroad	Underground
St Peters in the Woods	Southeast Fairview Woods Dr	Dry Pond
Publicly Owned		
Fairview Woods Sec. 1	Fairview Woods Dr and North of Burke Center PW	Dry Pond
Ridges of Glendilough	East of Lewisham Rd and Popes Head Rd	Dry Pond
Barton Place Secs 1,2	West of Mary Fairfax Ct	Dry Pond

3.4.3 Stream Geomorphology

The geomorphology of the stream segments of Popes Head 2 can be summarized as follows:

- The dominant substrate throughout the main stem is cobble and cobble/bedrock, with gravel and sand being present in the tributaries.
- The main stem of Popes Head 2 upstream of the Fairfax County Parkway are of CEM type 4, referring to stream bank stabilization and channel deepening.
- The majority of the other stream reaches are of CEM type 3, referring to unstable stream banks and an actively widening channel.
- Three dumps were observed.
- No head cuts or erosion was observed.
- Five obstructions were observed.

3.4.4 Stream Quality

The stream reaches of Popes Head 2 are classified as riffle/run stream type. Riffles are a source of high-quality habitat and diverse fauna; therefore, an increased frequency of occurrence greatly increases the diversity of the stream community. The habitat assessment for Popes Head 2 can be summarized as follows:

- The stream exhibits fair to poor habitat quality.
- The main stem upstream of the Fairfax County Parkway contains between four to seven habitats in greater than 50% of the reach; the tributaries contain three to seven habitats in less than 50% of the reach.
- The majority of the stream reaches has a riffle as wide as the stream, and an epifaunal substrate composed of a mixture of gravel stones and boulders/bedrock and/or stable woody debris, cobble and boulder stones, and softball size cobble stones.
- The main stem has 40% - 50% embeddedness by sediment and silt. The tributaries have 50% - 70% embeddedness by sediment and silt.
- Only 5% - 30% of the stream reaches in the main stem have channel alteration or disturbance; artificial embankments are present but there is no evidence of recent

alteration. The tributary banks are 40% - 70% altered, showing channelization and dredging.

- The main stem contains frequent riffles with adequate depth in pools and riffles; the tributaries have infrequent riffles with variable bottom contours that provide some habitat.
- The main stem upstream of the Fairfax County Parkway is 80% - 85% full of water during normal flow conditions. The remaining stream reaches are 25% - 75% full of water during normal flow conditions.
- The main stem upstream of the Fairfax County Parkway exhibited 70% vegetation cover, typically of shrubs, grasses and forbes on the left and right banks. The remaining stream reaches exhibited 60% vegetation cover on both banks.
- The majority of the stream reaches exhibited moderately unstable banks, with 40% - 70% erosional areas on both the left and right banks.
- The majority of the stream reaches have a forested vegetated buffer zone 50 – 100 feet wide consisting of shrubs, trees, old fields, and planted lawn grass yards. This was observed on both the left and right banks.

The general characteristics of the stream water quality were assessed as follows:

- The water had a clear appearance and no odor was detected.
- Small fishes of one to two inches in length were observed in the southern reaches of the main stem and the connecting western tributary.
- Free floating vegetation in more than 50% of the entire stream bank area was found in an upstream stream segment; this vegetation was accompanied by green algae of heavy density and a slime coating.
- At the southernmost stream reach, attached vegetation was observed in the stream margin in less than 10% of the entire stream bank area; this vegetation was accompanied by brown algae of light density and a slime coating.

3.4.5 Stream Ecology

The 2001 *Fairfax County Stream Protection Strategy (SPS) Baseline Study* sampled fish and aquatic macroinvertebrates in two different locations in the Popes Head 2 Subwatershed. The first sampling site (PHPH01), as shown on Map 2.11, is located downstream of Popes Head Road and exhibited a poor macroinvertebrate community, which is indicative of degraded water quality. A high number of fish species was observed at this site, which is indicative of a strong community structure and good water quality. The second site (PHPH02), as shown on Map 2.11, is located downstream of Fairfax Station Road, and exhibited a fair macroinvertebrate community and a moderate number of fish species present; this is indicative of fair water quality.

3.4.6 Problems from Public Forum

There were no problem areas identified in this subwatershed at the March 27, 2004 Community Watershed Forum.

3.4.7 Modeling Results

The hydrology for the Popes Head 2 subwatershed produced stormwater runoff that is high compared to the other subwatersheds. This is due to a greater percentage of developed areas and commercial areas located along Ox Road. The increase in

discharges due to future development is also slightly higher when compared to the other subwatersheds. See Table 3.18 for a comparison of the existing and future 2- and 10-year peak discharges in the subwatershed.

Table 3.18 Popes Head 2 Peak Runoff Flows

Popes Head 2 Discharge Table		Two-Year Rainfall Event			10-Year Rainfall Event		
Location	**Drainage Area**	**Existing Peak Flow (cfs)**	**Future Peak Flow (cfs)**	**% Peak Flow Increase**	**Existing Peak Flow (cfs)**	**Future Peak Flow (cfs)**	**% Peak Flow Increase**
Just downstream of the confluence with East Fork River	3.56	1460	1680	15%	2700	3200	19%
Approximately 1,850 ft downstream of Popes Head Road	3.98	1500	1710	14%	2810	3240	15%
Approximately 1,500 ft upstream of Fairfax County Parkway	4.38	1730	1990	15%	3420	3800	11%

Velocities produced by the 2-year rainfall event in Popes Head 2 were lower than average when compared to those in the other subwatersheds, averaging 5.2 feet per second. Velocities on Tributaries 2 and 3 were the highest, averaging 7.2 feet per second. The average velocity is predicted to increase by approximately 12% in the future conditions.

Both the 2- and 10-year peak discharges overtop the channel banks along Popes Head Creek and its tributaries in the Popes Head 2 subwatershed. The model shows one building greater than 500 square feet located in the 10-year floodplain, on Sally Ford Court. Table 3.19 shows a summary of the flooded structures in the subwatershed for different recurrence intervals.

Table 3.19 Popes Head 2 Flooded Structures

Recurrence Interval	Popes Head 2	
	Existing	Future
2	0	0
5	1	1
10	1	1
25	1	1
50	1	1
100	1	1

The Popes Head 2 subwatershed has a sediment loading rate higher than five of the seven subwatersheds. This is due to a greater percentage of residential and commercial development than several of the other watersheds. The predicted sediment load exceeds the target Tributary Strategy level. For future land use conditions, the average sediment loading rate is predicted to increase by 3%.

The Popes Head 2 subwatershed has a higher pollutant loading rate for total phosphorus and total nitrogen than five of the seven other subwatersheds. The total phosphorus load exceeds the target Tributary Strategy level and the total nitrogen load is just below the target Tributary Strategy level. For future land use conditions, the loading rate is predicted to increase by 5% for both total phosphorus and total nitrogen.

3.4.8 Summary

The Popes Head 2 Subwatershed exhibits fair to poor stream habitat quality. It is in unexpectedly poor condition considering that it has nearly 98% of its area within the rezoned area. In general, the stream reaches upstream of the Fairfax County Parkway exhibit better stream habitat quality than the other reaches in this subwatershed.

Velocities produced by the 2-year rainfall event in Popes Head 2 were lower than average when compared to those in the other subwatersheds, averaging 5.2 feet per second. Both the 2- and 10-year peak discharges overtop the channel banks along Popes Head Creek and its tributaries in the Popes Head 2 subwatershed.

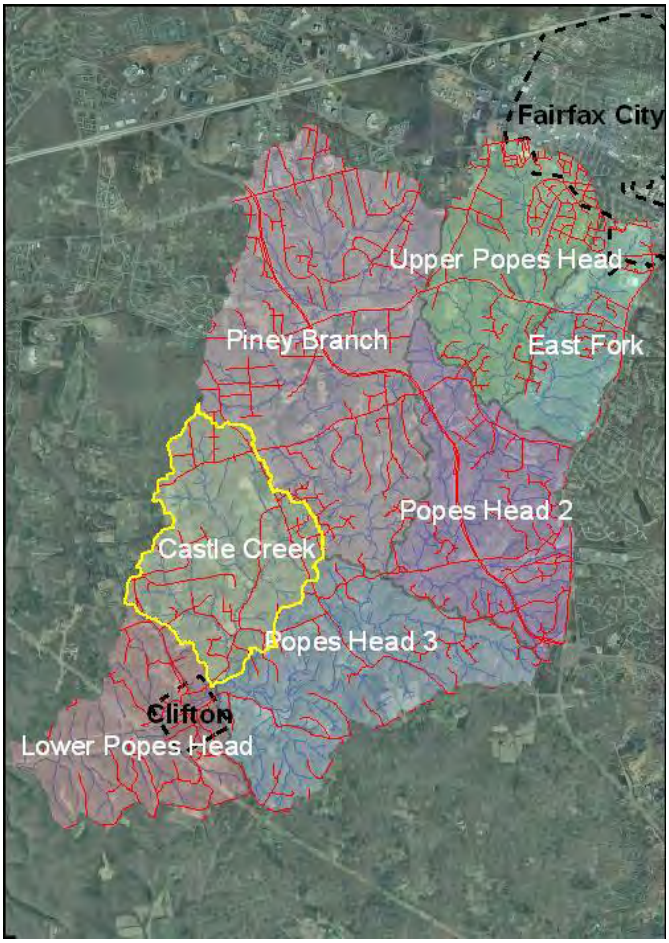
The Popes Head 2 subwatershed has a sediment loading rate higher than five of the seven subwatersheds. This is due to a greater percentage of residential and commercial development than several of the other watersheds. It has a higher pollutant loading rate for total phosphorus and total nitrogen than five of the seven other subwatersheds. The total phosphorus load exceeds the target Tributary Strategy level and the total nitrogen load is just below the target Tributary Strategy level.

3.5 Castle Creek Subwatershed

The Castle Creek Subwatershed has an area of approximately 1,477 acres and contains the main stem of Castle Creek, which is a western tributary of Popes Head Creek. It is bounded on the north and east by Colchester Road; to the south by Clifton Road and Newman Road; and to the west by Stallion Road.

The Castle Creek Subwatershed is shown on Map 3.13 and its condition is summarized below.

Map 3.13: Location of Castle Creek



3.5.1 Subwatershed Characteristics

The stormwater runoff from this subwatershed drains into Castle Creek, which has its headwaters at Popes Head Road. It flows southward for a length of 2.22 miles before reaching the Popes Head 3 Subwatershed.

The existing imperviousness in the subwatershed is 5.6% of the total area. Imperviousness is expected to increase to 8.2% in the future, based upon the planned or zoned land uses in the Fairfax County Comprehensive Plan. All the land in this subwatershed is in the rezoned area; the rezoned area was established in 1982 by the Fairfax County Board of Supervisors in order to protect the Occoquan Reservoir. Building density within the rezoned area is reduced, and therefore imperviousness is decreased, reducing the amount of stormwater runoff that is generated. Land use in the subwatershed is predominantly estate residential, which comprises 71.3% of the area. Open space comprises 20.6% of the total subwatershed area. Estate residential area is expected to increase to 91.6% of the total area, while open space will be consumed, leaving only 0.3% remaining. Roads and sidewalks are not included in the land use data. The existing and future land uses in the Castle Creek Subwatershed are described in Table 3.20.

Castle Creek Subwatershed Condition Summary

- Current Imperviousness = 5.6% with majority of land use Estate Residential.
- Future Imperviousness = 8.2%
- Area of 1,477.0 acres.
- 100.0% of the subwatershed is in the rezoned area.
- Three stormwater management facilities currently exist.
- The stream exhibits poor habitat quality.
- The majority of the stream reaches exhibited active downcutting and channel widening.
- One head cut was observed.
- Three obstructions were observed.
- Four out of 24 crossings have minor to moderate impacts.
- Stream reaches that intersect residential lots are in very poor condition
- A goat pasture near Newman Road might be affecting water quality.
- Waterfowl in a Wycklow Road residential pond may be affecting water quality.

Table 3.20 Castle Creek Land Use

Land Use Description	Existing		Future	
	Acres	%	Acres	%
Estate residential	1029	71.3%	1321.7	91.6%
Low-density residential	107.2	7.4%	107.2	7.4%
Medium-density residential	6.2	0.4%	6.2	0.4%
High-density residential	0	0.0%	0	0.0%
Low-intensity commercial	4.2	0.3%	4.2	0.3%
High-intensity commercial	0	0.0%	0	0.0%
Industrial	0	0.0%	0	0.0%
Open Space	296.8	20.6%	4.1	0.3%
Unknown	0	0.0%	0	0.0%
TOTAL	1443.4	100.0%	1443.4	100.0%

The subwatershed consists of 470 parcels, with an average size of 3.07 acres per parcel. Castle Creek has the largest average parcel size of all of the subwatersheds, due to prevalence of Estate Residential land use. There are 25 neighborhoods fully within or apportioned within the subwatershed, as listed below:

- Braddock Woods
- Chequers of Clifton
- Cloverleaf Farm Estates
- Colchester Hunt
- Debusk
- Lewis Park
- The Patterns
- Ten Penny Woods
- Burwyck
- Clifton Green
- Colchester Acres
- Colewood Estates
- Fairfax Hunt
- MeGills Crossing
- Southern Pines
- Vannoy Park
- Wonderland
- Chadwicke
- Clifton Overlook
- Colchester Hills
- Cranston
- Ferguson Knolls
- Paradise Spring
- Swayze
- Wilguson Hills

The County's list of master plan drainage projects shows that the two identified projects in this subwatershed are inactive. Table 3.21 summarizes the type of master plan drainage project, project name/location, and current status. No cost estimates were available for these projects.

Table 3.21 Castle Creek Master Plan Drainage Projects

Type of Work	Project Name/Location
Inactive Projects	
Raise Road and Replace Culvert	Castle Creek at Newman Rd
Raise Road	Tributary at Newman Rd
Lower Invert and Replace Culvert	Tributary at Colchester Rd
Lower Invert and Replace Culvert	Tributary at Newman Rd

Only one complaint regarding a clogged culvert was processed by the County and included in the database files for this subwatershed.

3.5.2 Existing Stormwater Management Facilities

Castle Creek does not have an extensive network of storm drain pipes; however, it does have a small network that services one of the neighborhoods. Colchester Hunt is serviced by a series of storm drain pipes, ranging from 18 inches to 42 inches in diameter, which discharge into two different dry ponds and Castle Creek.

Map 3.14 shows the location of four stream crossings that have an impact on the stream. Crossings that do not have an impact on the stream are not listed. The major crossings in this subwatershed, starting from the upstream end of Castle Creek, are described as follows:

- Knollbrook Drive: A three-foot diameter circular concrete culvert (PHCC004.C008) has a moderate impact on a western tributary, as shown in Photo 3.8.
- Knollbrook Drive: A two-foot diameter circular CMP culvert (PHCC005.C002) has a minor impact on a western tributary, as shown in Photo 3.9.
- Newman Road: A two-foot diameter, circular CMP culvert (PHCC006.C001) has a minor impact on the main stem, as shown in Photo 3.10.
- Wandering Lane: A two-foot diameter circular concrete culvert (PHCC004.C002) has a moderate impact on the main stem, as shown in Picture 3.11.

Map 3.14: Castle Creek Stream Crossings

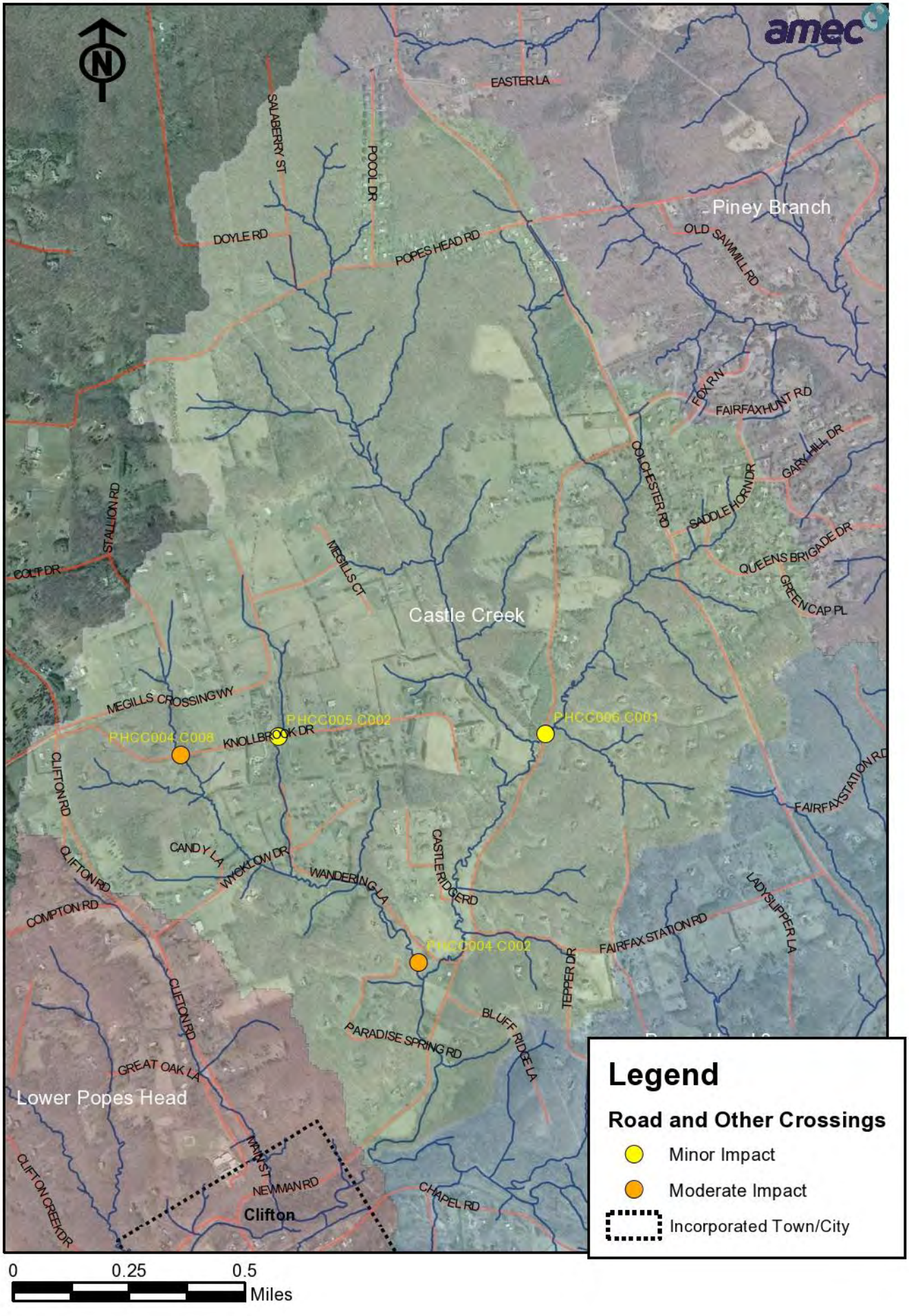


Photo 3.8 A culvert (PHCC004.C008) at Knollbrook Drive has a moderate impact on the stream

Photo 3.9 A culvert (PHCC005.C002) at Knollbrook Drive has a minor impact on the stream

Photo 3.10 A double culvert (PHCC006.C001) at Newman Road has a minor impact on the stream

Photo 3.11 A culvert (PHCC004.C002) at Wandering Lane has a moderate impact on the stream

Five storm drain outfall pipes discharge into Castle Creek. One pipe causes moderate erosion, as shown in Photo 3.12.

Photo 3.12 A storm drain outfall pipe near Wandering Lane has a moderate impact on the stream

Table 3.22 shows the locations of known stormwater management facilities in the subwatershed, as depicted on Map 3.15.

Table 3.22 Castle Creek Stormwater Management Facilities

Name	Location	Type of Facility
Publicly Owned		
Fairfax Hunt Pd 1	Colchester Rd and Newman Rd	Dry Pond
Colchester Hunt Section 4, Pond 1	South of Saddlehorn Dr and Colchester Dr	Dry Pond
Colchester Hunt Section 4, Pond 2	South of Saddlehorn Dr and Colchester Dr	Dry Pond

3.5.3 Stream Geomorphology

The geomorphology of the stream segments of Castle Creek can be summarized as follows:

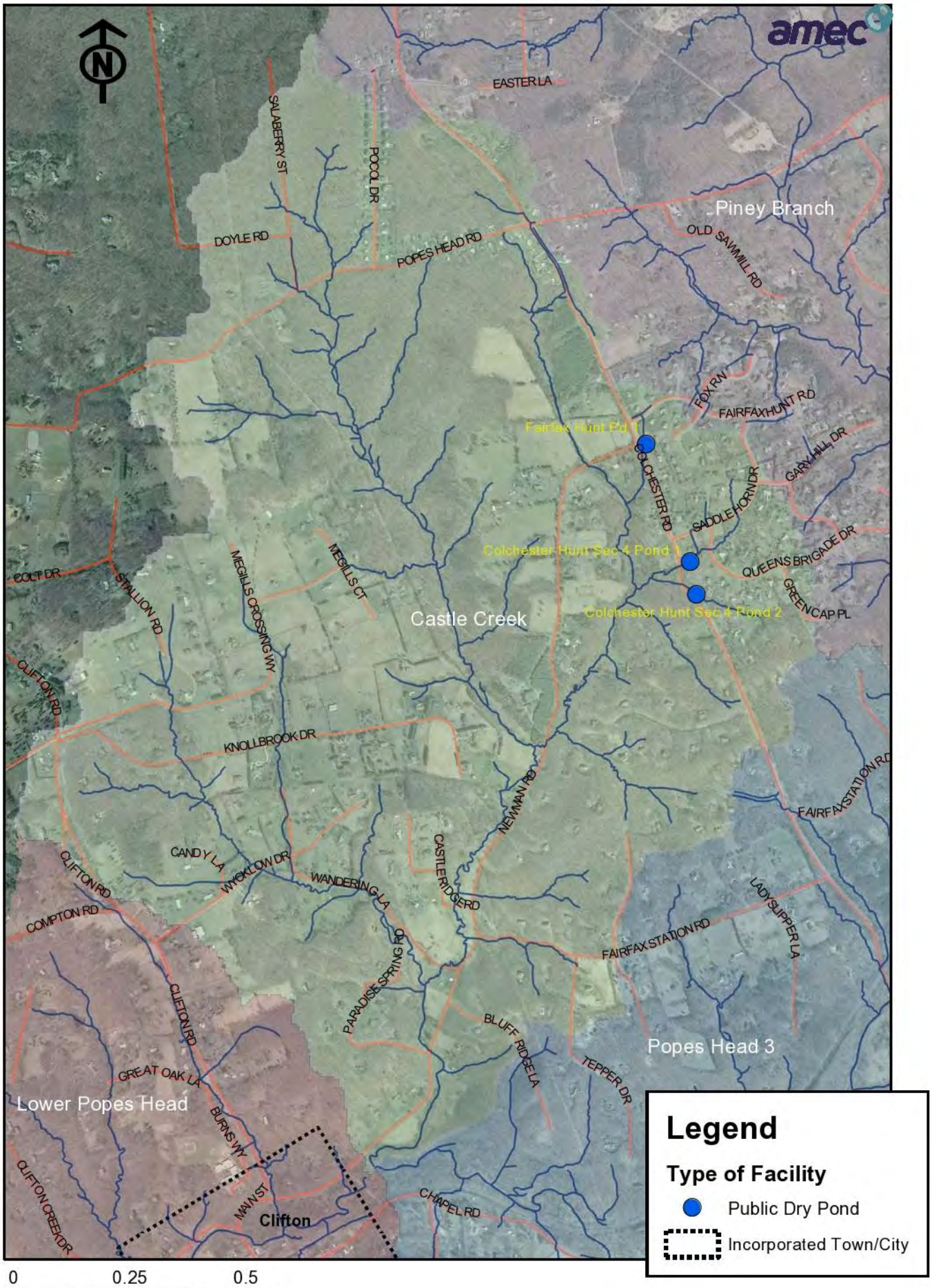
- The dominant substrate throughout the main stem is gravel. The tributaries are predominantly composed of a sand substrate.
- The majority of the stream reaches are of CEM type 3, referring to unstable stream banks and an actively widening channel. The main stem is of CEM type 4, referring to stream bank stabilization and channel development. These stream reaches are found downstream of Popes Head Road, and upstream of Knollbrook Road.
- The majority of the stream reaches exhibited active downcutting and channel widening. Several reaches were observed to have nearly vertical stream banks. A new floodplain is being developed on the main stem downstream of Popes Head Road and upstream of Knollbrook Road.
- One head cut was observed
- Three obstructions were observed

3.5.4 Stream Quality

The stream reaches of Castle Creek are classified as riffle/run stream type. Riffles are a source of high-quality habitat and diverse fauna; therefore, an increased frequency of occurrence greatly increases the diversity of the stream community. The habitat assessment for Castle Creek can be summarized as follows:

- Overall, the stream exhibits poor habitat quality.
- The southern stream reaches exhibited three to seven habitats in less than 50% of the reach. The northeastern stream reaches exhibited only one or two habitats in less than 50% of the reach. The northern stream reaches exhibited less than four to seven habitats in greater than 50% of the reach.
- The majority of the stream reaches contain riffles that are not as wide as the stream, and contain an epifaunal substrate composed of cobble, boulder stones greater than 10 inches wide, and a mixture of bedrock and/or gravel stones and/or woody debris. The main stem upstream of Knollbrook Road contains riffles that are wide as the stream, and a mixture of cobble, gravel stones and/or stable woody debris.
- The eastern tributary has 80% - 90% embeddedness by sediment and silt. The remaining stream reaches have 60% - 70% embeddedness by sediment and silt. Several reaches in the headwaters have 30% - 40% embeddedness by sediment and silt.

Map 3.15: Castle Creek Stormwater Management Facilities



The majority of the stream reaches have 5% - 30% channel disturbance, indicating minor alterations, dredging, or artificial embankments. The remaining stream reaches exhibit 40% channel disturbance and channelization.

- The main stem of Castle Creek features frequent riffles with adequate depth in pools and riffles. The remaining stream reaches feature infrequent riffles with variable bottom contours which provide some habitat.
- Water fills between 50% - 80% of the channels during normal flow conditions.
- The stream banks exhibit 50% - 70% vegetation cover throughout the subwatershed. The vegetation cover is typically composed of shrubs, grasses and forbes, with thin or bare spots visible.
- The majority of the stream reaches have moderately unstable stream banks, with 40% - 60% erosional areas. The headwaters have moderately stable banks, with only 5% - 30% erosional areas. In general, the right banks are more stable than the left banks throughout the main stem.
- The majority of the stream reaches have a forested vegetated buffer zone that is 5 – 25 feet wide, composed of pasture/agricultural land and old fields. The main branch downstream of Popes Head Road and upstream of Knollbrook Road has a forested vegetated buffer zone that is 50 – 100 feet wide, and composed of shrubs and a few trees. In this stretch, the right bank is in poor condition, with a 5 – 25 foot wide buffer. The headwaters feature forested vegetated buffers that are greater than 100 feet wide and very few disturbances.

The general characteristics of the stream water quality were assessed as follows:

- The water had a clear appearance and no odor was detected.
- Attached aquatic plants were observed near riffles in less than 10% of the entire stream bank area in most of the stream reaches.
- Green algae of light density and a slime coating were observed in the headwaters; brown algae of light density and a slime coating were observed in the southernmost tributary. Green filamentous algae were also observed throughout the subwatershed.
- Many portions of the stream that intersect residential lots are very degraded in stream quality.
- A goat pasture near Newman Road might be affecting water quality.
- Waterfowl in a Wycklow Road residential pond may be affecting water quality.

3.5.5 Stream Ecology

The 2001 *Fairfax County Stream Protection Strategy (SPS) Baseline Study* sampled fish and aquatic macroinvertebrates at one location in the Castle Creek Subwatershed. The sampling site (PHCC01), as shown on Map 2.11, is located downstream of Newman Road and exhibited a fair macroinvertebrate community, which is indicative of fair water quality. A high number of fish species was observed at this site, which is indicative of a strong community structure and good water quality.

3.5.6 Problem Areas from Public Forum

There were no problem areas identified in this subwatershed at the March 27, 2004 Community Watershed Forum.

3.5.7 Modeling Results

The hydrology for the Castle Creek subwatershed produced stormwater runoff that is low compared to the other subwatersheds. This is due to a lower percentage of developed areas in the subwatershed. The increase in discharges due to future development is average when compared to the other subwatersheds. See Table 3.23 for a comparison of the existing and future 2- and 10-year peak discharges in the subwatershed.

Table 3.23 Castle Creek Peak Runoff Flows

Castle Creek Discharge Table		Two-Year Rainfall Event			10-Year Rainfall Event		
Location	**Drainage Area**	**Existing Peak Flow (cfs)**	**Future Peak Flow (cfs)**	**% Peak Flow Increase**	**Existing Peak Flow (cfs)**	**Future Peak Flow (cfs)**	**% Peak Flow Increase**
Approximately 0.83 mi upstream of confluence with Castle Creek Tributary No. 1	0.43	340	420	24%	850	990	16%
Approximately 1,000 ft upstream of Fairfax Station Road	1.36	810	910	12%	2000	2160	8%
Just downstream of Wandering Lane	2.20	710	750	6%	1690	1760	4%

Velocities produced by the 2-year rainfall event in Castle Creek were average when compared to those in the other subwatersheds, averaging 5.8 feet per second. The average velocity is predicted to increase by approximately 6% in the future conditions.

Both the 2- and 10-year peak discharges overtop the channel banks along the central portion of Castle Creek, while the 2 year stays within the channel banks in the upper and lower portions of the stream. Both the 2- and 10-year are confined to the channel banks in the upper portion of Castle Creek Tributary 1 and most of Tributary 2. The model shows two structures greater than 500 square feet located in the 10-year floodplain, on Newman Road south of the confluence with Tributary 2. Table 3.24 shows a summary of the flooded structures in the subwatershed for different recurrence intervals.

Table 3.24 Castle Creek Flooded Structures

Recurrence Interval	Castle Creek	
	Existing	Future
2	2	2
5	2	2
10	2	2
25	2	2
50	3	3
100	3	3

The Castle Creek subwatershed has a sediment loading rate lower than five of the seven subwatersheds. This is due to a lower percentage of development than several of the other watersheds. The predicted sediment load exceeds the target Tributary Strategy level. For future land use conditions, the average sediment loading rate is predicted to increase by 2%.

The Castle Creek subwatershed has a lower pollutant loading rate for total phosphorus and than five of the seven other subwatersheds and the lowest pollutant loading rate for total nitrogen. The total phosphorus load exceeds the target Tributary Strategy level and the total nitrogen load is below the target Tributary Strategy level. For future land use conditions, the loading rate is predicted to increase by 6% for total phosphorus and 3% for total nitrogen.

3.5.8 Summary

The Castle Creek Subwatershed exhibits poor habitat quality, which is unexpected because it has 100% of its area within the rezoned area. There are many residential lots that intersect the stream reaches; this may be the cause of habitat degradation, especially in lots with small or no riparian buffers. Castle Creek also exhibits very high embeddedness values, resulting in impaired benthic macroinvertebrate communities.

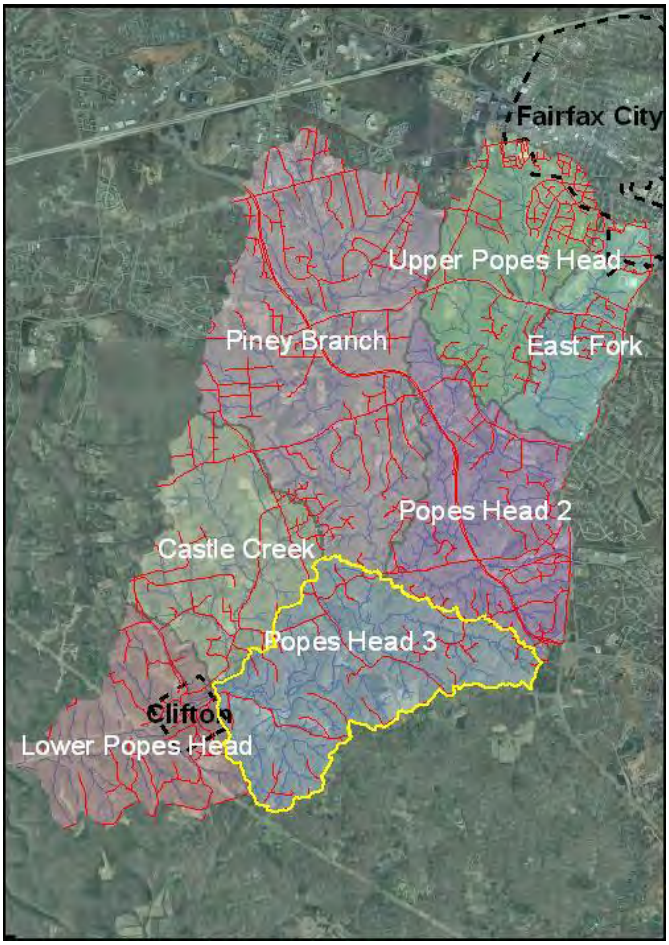
Velocities produced by the 2-year rainfall event in Castle Creek were average when compared to those in the other subwatersheds, averaging 5.8 feet per second. Both the 2- and 10-year peak discharges overtop the channel banks along the central portion of Castle Creek, while the 2 year stays within the channel banks in the upper and lower portions of the stream. The Castle Creek subwatershed has a sediment loading rate lower than five of the seven subwatersheds. This is due to a lower percentage of development than several of the other watersheds. It has a lower pollutant loading rate for total phosphorus and than five of the seven other subwatersheds and the lowest pollutant loading rate for total nitrogen. The total phosphorus load exceeds the target Tributary Strategy level and the total nitrogen load is below the target Tributary Strategy level.

Popes Head 3 Subwatershed

The Popes Head 3 Subwatershed has an area of approximately 1,870 acres and contains the southeast portion of the Popes Head Creek. It is bounded to the north by Fairfax Station Road, Clara Barton Road, and Robert Carter Road; to the southeast by Chapel Road; to the south by Clifton Road; and to the west by Cold Point Road, Colewood Estates Road, and Hanover Heights Trail.

This subwatershed contains a small portion of the Town of Clifton. The subwatershed is shown on Map 3.16, and its condition is summarized below.

Map 3.16: Location of Popes Head 3



3.6.1 Subwatershed Characteristics

The stormwater runoff from this subwatershed drains into Popes Head Creek, which has its headwaters at the confluence of the Piney Branch and Popes Head 2 Subwatersheds. Popes Head 3 flows to the southwest, and has a length of 3.06 miles. It has several tributaries that are longer than 3,000 feet each.

The existing imperviousness in this subwatershed is 6.4% and expected to increase to 7.5% in the future, based upon the planned or zoned land uses in the Fairfax County Comprehensive Plan. Approximately 99.7% of the subwatershed is in the rezoned area; the rezoned area was established in 1982 by the Fairfax County Board of Supervisors in order to protect the Occoquan Reservoir. Building density within the rezoned area is reduced, and therefore imperviousness is decreased, reducing the amount of stormwater runoff that is generated. Land use in the subwatershed is predominantly estate residential, which comprises 73% of the area. Estate residential is expected to increase to 80.5% in the future, while open space will decrease to 3.3% of the total subwatershed area. Roads and sidewalks are not included in the land use data. The existing and future land uses of the Popes Head 3 Subwatershed are described in Table 3.25.

Popes Head 3 Subwatershed Condition Summary

- Current Imperviousness = 6.4% with majority of land use Estate Residential.
- Future Imperviousness = 7.5%
- Area of 1,870.4 acres.
- 99.7% of the watershed is in the rezoned area.
- The stream exhibits fair habitat quality.
- Two stormwater management facilities currently exist.
- One ditch was observed.
- One dump was observed.
- Three head cuts were observed.
- 11 out of 23 crossings have minor impacts.

Table 3.25 Popes Head 3 Land Use

Land Use Description	Existing		Future	
	Acres	%	Acres	%
Estate residential	1335.2	73.0%	1471.8	80.5%
Low-density residential	256.1	14.0%	256.1	14.0%
Medium-density residential	13.1	0.7%	13.1	0.7%
High-density residential	0.5	0.0%	0.5	0.0%
Low-intensity commercial	0.3	0.0%	26.6	1.5%
High-intensity commercial	0	0.0%	0.0	0.0%
Industrial	26.4	1.4%	0.0	0.0%
Open Space	197.6	10.8%	60.9	3.3%
Unknown	0	0.0%	0.0	0.0%
TOTAL	1829.2	100.0%	1829.2	100.0%

The subwatershed consists of 731 parcels, with an average size of 2.5 acres per parcel. There are 24 neighborhoods fully within or apportioned within the subwatershed as listed below:

- Auburn Estates
- Chapel View Estates
- Clifton Overlook
- Colewood Estates
- Fairfax Station
- Haley and Lady
- Popes Head Valley of Clifton
- Southern Pines
- Chadwick
- Clifton Green
- Clifton Trails
- Elgin Corner
- Frog Hill
- The Patterns
- Redlac Forest
- Stonecrest
- Chapel Trails
- Clifton Oaks
- Colchester Hills
- Elistakes Estates
- Frosty Meadows
- Popes Head Mill Estates
- Sangsters Station
- Surrey Acres

The County's list of master plan drainage projects shows the one identified project is this subwatershed is inactive Table 3.26 summarizes the type of master plan drainage project, project name/location, and current status. No cost estimates were available for these projects.

Table 3.26 Popes Head 3 Master Plan Drainage Projects

Type of Work	Project Name/Location
Inactive Project	
Raise Road and Replace Bridge	Popes Head Creek at Colchester Rd

Four complaints regarding channel blockages and alignment were processed by the County and included in the database files for this subwatershed.

3.6.2 Existing Stormwater Management Facilities

Popes Head 3 has a large network of storm drain pipes on the eastern side of the subwatershed, to the east of Colchester Road, and to the south of the CSX Railroad. The Fairfax Station area is serviced by large network of storm drain pipes that discharge into a wet pond. The outfalls vary in size, ranging from 18 inches to 30 inches. To the west, Colchester Hills is serviced by a small series of 18 inch pipes that drain into a rip rap-lined dry pond.

Map 3.17 shows the location of 11 stream crossings that have an impact on the stream. Crossings that do not have an impact on the stream are not listed. The major crossings in this subwatershed, starting from the upstream end of Popes Head 3, are described as follows:

- Havenner Court: A three-foot diameter, two barrel concrete culvert (PHPH025.C002) has a minor impact on an eastern tributary, as shown in Photo 3.13.
- Havenner Court and Blackburn Ford Drive: A 15-foot wooden footbridge (PHPH024.C002) has a minor impact on the same tributary.
- Colchester Road: A 1.5-foot, two barrel CMP culvert (PHPH020.C001) has a minor impact on the main stem, as shown in Photo 3.14. To the south, an 18-foot diameter circular CMP culvert (PHPH020.C002) has a minor impact on the main stem.
- Stonecrest Lane: A three-foot by four-foot diameter, two barrel elliptical CMP culvert (PHPH054.C002) has a minor impact on the main stem.
- Chapel Road: A 75-foot iron bridge (PHPH014.C001) has a minor impact on the main stem, as show in Photo 3.15. To the southeast, a 50-foot iron bridge (PHPHC014.C002) has a minor impact on the main stem. To the south, a two-foot diameter circular CMP culvert (PHPH015.C002) has a minor impact on the main stem. To the south, three circular CMP culverts (PHPH017.C001, PHPH017.C002, PHPH017.C003) have minor impacts on the main stem. Two of the culverts are four-feet in diameter, and the remaining culvert is three-feet in diameter.

Map 3.17: Popes Head 3 Stream Crossings

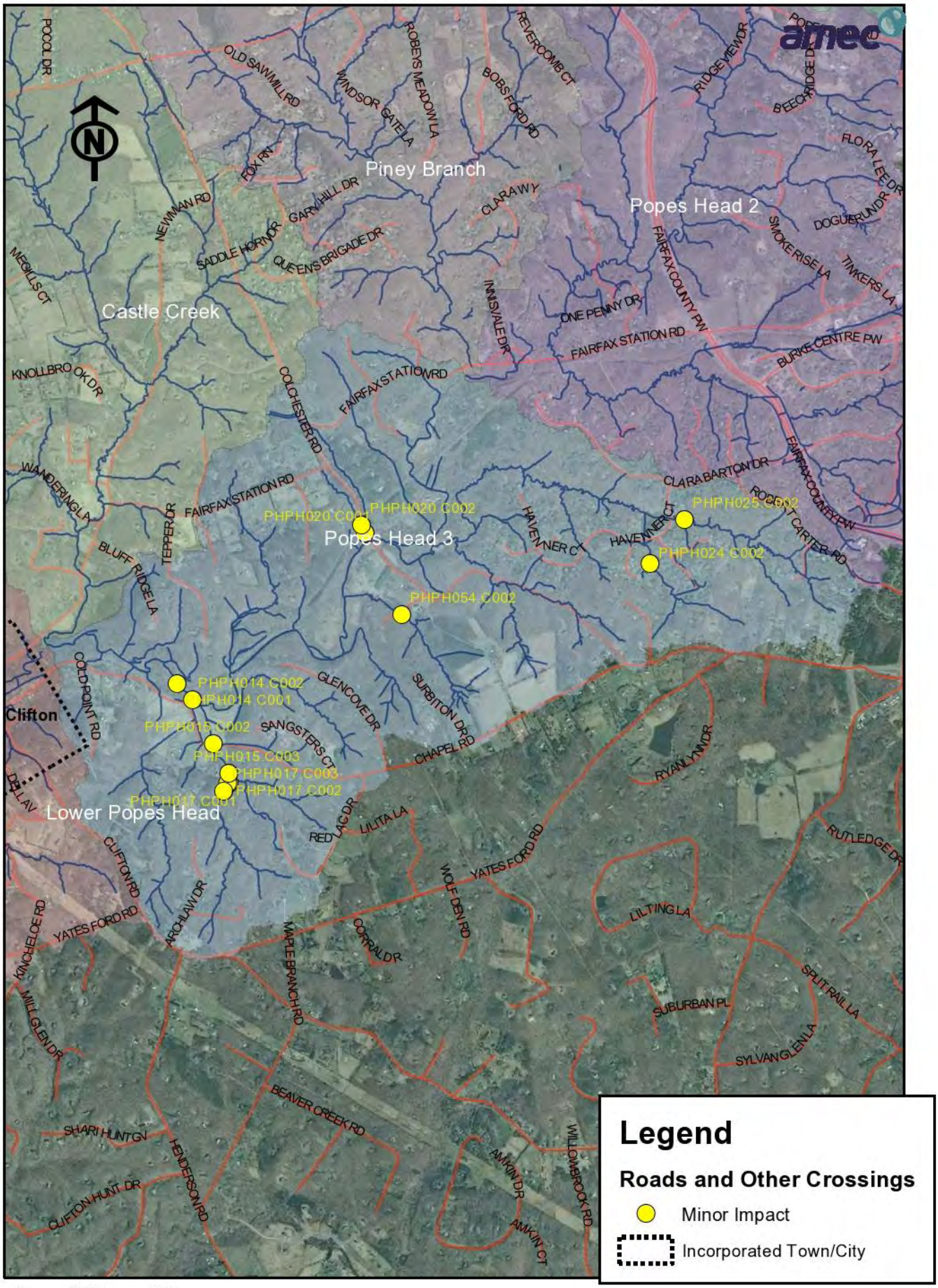


Photo 3.13 A double barrel culvert (PHPH025.C002) near Havenner Court has a minor impact on the stream

Photo 3.14 A double barrel culvert (PHPH020.C001) near Colchester Road has a minor impact on the stream

Photo 3.15 An iron bridge(PHPH014.C001) at Chapel Road has a minor impact on the stream

Photo 3.16 A storm drain pipe outfall is causing moderate erosion

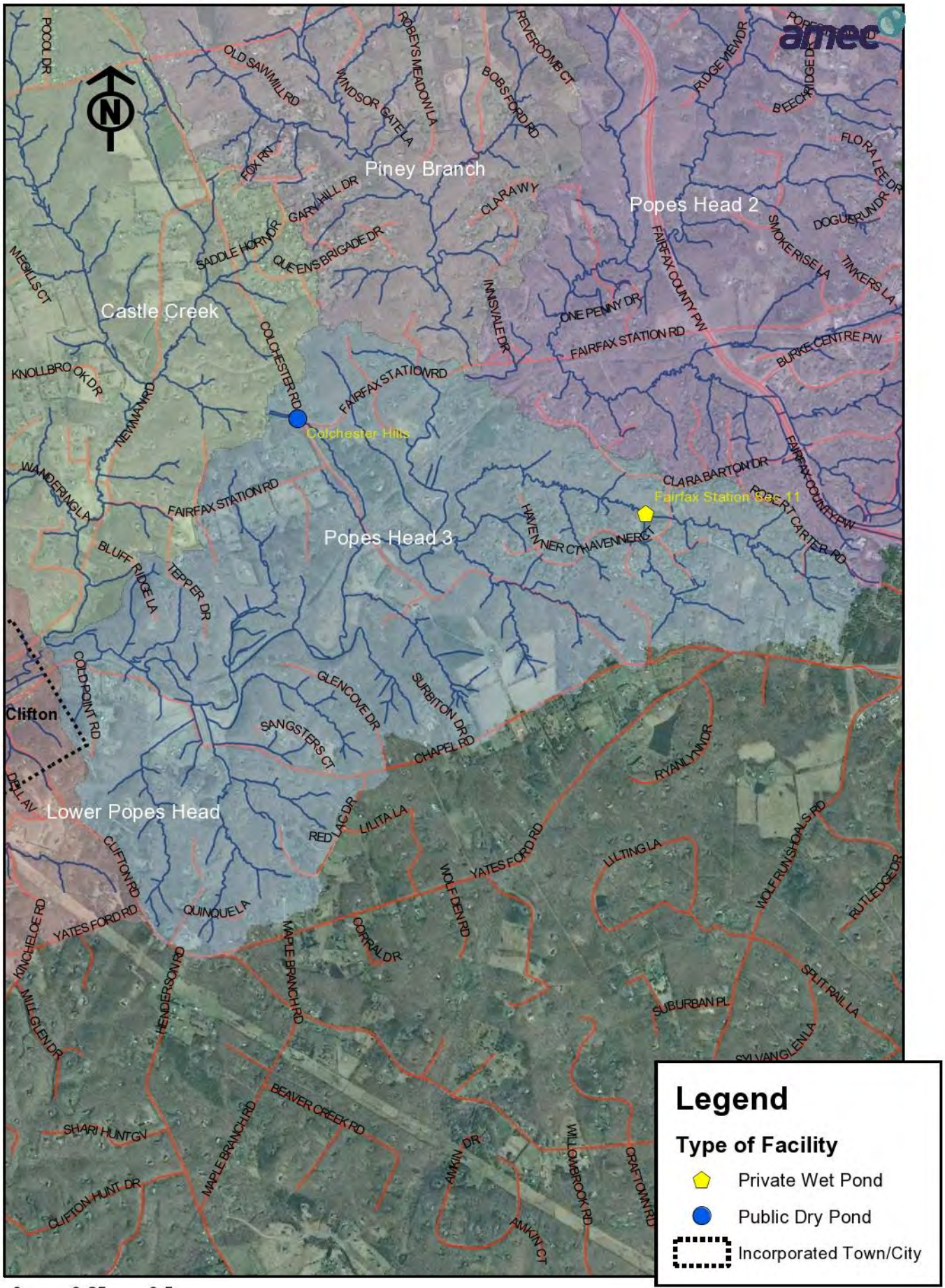
Five storm drain outfall pipes discharge into Popes Head 3. One five-inch diameter PVC pipe outfall is causing moderate erosion, as shown in Photo 3.16. The remaining four pipes are not causing erosion problems.

Table 3.27 shows the locations of known stormwater management facilities in the subwatershed, as depicted on Map 3.18.

Table 3.27 Popes Head 3 Stormwater Management Facilities

Name	Location	Type of Facility
Privately Owned		
Fairfax Station Sec. 11	North of Havenner Rd and East of Sudley Church CT	Wet Pond
Publicly Owned		
Colchester Hills	Fairfax Station Rd and Colchester Rd	Dry Pond

Map 3.18: Popes Head 3 Stormwater Management Facilities



Stream Geomorphology

The geomorphology of the stream segments of Popes Head 3 can be summarized as follows:

- The main stem of this subwatershed has a predominantly cobble and bedrock substrate. The eastern tributaries are characterized by gravel and cobble substrate. The remaining stream reaches are predominantly composed of sand and gravel substrate.
- The majority of the stream reaches are of CEM type 3, referring to unstable stream banks and an actively widening channel. The main stem upstream of Colchester Road and the bottom waters south of Tepper Drive are of CEM type 4, referring to stable stream banks and channel development. Several stream reaches are of CEM type 2, referring to a deeply incised channel.
- One ditch was observed.
- One dump was observed.
- One erosional area was observed.
- Three head cuts were observed.

3.6.3 Stream Quality

The stream reaches of Popes Head 3 are classified as riffle/run stream type. Riffles are a source of high-quality habitat and diverse fauna; therefore, an increased frequency of occurrence greatly increases the diversity of the stream community. The habitat assessment for Popes Head 3 can be summarized as follows:

- The stream exhibits fair habitat quality.
- The main stem upstream of Colchester Road has less than four habitat types present for more than 70% of the reach. The majority of the stream reaches contain four to seven habitat types in more than 50% of the reach.
- The epifaunal substrate of the main stem is composed of boulder stones, cobble, gravel stones, and/or stable woody debris. The riffles are as wide as the stream. The tributaries have riffles that are not as wide as the stream, and are composed of softball size cobble stone, boulder stones greater than 10 inches wide, and a mixture of bedrock and gravel stones, and/or woody debris.
- The main stem has 30% - 50% embeddedness by sediment and silt. The tributaries are 50% - 70% embeddedness by sediment and silt.
- The majority of the stream reaches exhibit 5% - 40% channel disturbance, indicating minor alterations, dredging, or artificial embankments. The remaining stream reaches are 40% - 80% channel disturbance, the result of channelization or dredging.
- The main stem upstream of Colchester Road and the bottom waters south of Tepper Drive feature frequent riffles, with abundant depth in pools and riffles. Several of the stream reaches are generally all flat water or shallow riffles that are not deep enough to allow for free passage of fish. The remaining reaches have infrequent riffles and variable bottom contours that provide habitat for aquatic life.
- The main stem downstream of Colchester Road and its eastern upstream tributary are 80% - 90% full of water during normal flow conditions. All other stream reaches have 25% - 75% full channels during normal flow conditions.
- The majority of the stream reaches have 50% - 70% vegetation cover on the left and right banks, typically composed of shrubs, grasses and forbes. The bottom waters south of Tepper Drive and several tributaries exhibit 70% plant cover, with a few barren or thin areas with fewer plant species present.

- The stream reaches upstream of Colchester Road have moderately unstable banks, with 40% - 70% erosional areas. The reaches downstream of Colchester Road have moderately stable banks, with 30% erosional areas. In some reaches, the right side banks exhibit less than 5% erosional areas and little bank failure.
- The majority of the stream reaches, including the entire main stem upstream of Chapel Road, contain a forested vegetated buffer zone of 25 – 50 feet wide consisting of shrubs and a few trees. The upstream tributaries have forested vegetated buffers that are 50 – 100 feet wide, consisting of shrubs and a few trees. The bottom waters exhibit 5 – 25 foot buffers, consisting of shrubs and plants lawn grass yards.

The general characteristics of the stream water quality were assessed as follows:

- The water had a clear appearance and no odor was detected. The bottom waters south of Tepper Drive had a turbid appearance.
- Small fishes of one to two inches in length were observed in the bottom waters south of Tepper Drive and in the easternmost tributary.
- Attached aquatic vegetation was observed in pools and near riffles in less than 10% of the entire stream bank area in several stream reaches upstream of Colchester Road.
- Green filamentous algae was found in one stream reach.

3.6.4 Stream Ecology

The 2001 *Stream Protection Strategy (SPS) Baseline Study* did not include a sampling site in the East Fork Subwatershed. Therefore, there is no current information available about the condition of the aquatic ecological community in this subwatershed.

3.6.5 Problem Areas from Public Forum

Citizen attendees at the March 27, 2004 Community Watershed Forum identified three different problem areas in the Popes Head 3 subwatershed:

- Horses are contributing to stream bank erosion in Popes Head Creek, downstream of Colchester Road to Sangsters Court.
- Illegal dumping is common near Bunnyman tunnel (Colchester Road and CSX Railroad), causing culverts to clog, flooding the road. Dumping of Christmas trees is common at this area; it is also a known teen hangout.
- The grass is mown short near Popes Head Creek at Chapel Park Road; this area is used for parking on Clifton Day.

3.6.6 Modeling Results

The hydrology for the Popes Head 3 subwatershed produced stormwater runoff that is low compared to the other subwatersheds. This is due to a lower percentage of residential development in the subwatershed. The increase in discharges due to future development is average when compared to the other subwatersheds. See Table 3.28 for a comparison of the existing and future 2- and 10-year peak discharges in the subwatershed.

Table 3.28 Popes Head 3 Peak Runoff Flows

Popes Head 3 Discharge Table		Two-Year Rainfall Event	10-Year Rainfall Event

Location	Drainage Area	Existing Peak Flow (cfs)	Future Peak Flow (cfs)	% Peak Flow Increase	Existing Peak Flow (cfs)	Future Peak Flow (cfs)	% Peak Flow Increase
Approximately 150 ft downstream of the confluence with Piney Branch	11.56	2930	3130	7%	6100	6370	4%
Just upstream of Colchester Road	12.77	3110	4220	36%	6560	7040	7%
Approximately 1 mi downstream of Colchester Road	13.32	3950	6380	62%	6770	7270	7%

Velocities produced by the 2-year rainfall event in Popes Head 3 were higher than average when compared to those in the other subwatersheds, averaging 6.6 feet per second. Velocities on Tributary 4 were the lowest, averaging 4.0 feet per second. The average velocity is predicted to increase by approximately 5% in the future conditions.

Both the 2- and 10-year peak discharges overtop the channel banks along Popes Head Creek and its tributary in the Popes Head 3 subwatershed. The model shows no structures greater than 500 square feet located in the 10-year floodplain. Table 3.29 shows a summary of the flooded structures in the subwatershed for different recurrence intervals.

Table 3.29 Popes Head 3 Flooded Structures

Recurrence Interval	Popes Head 3	
	Existing	Future
2	0	0
5	0	0
10	0	0
25	1	1
50	2	2
100	2	2

The Popes Head 3 subwatershed has an average sediment loading rate when compared to the other subwatersheds. The predicted sediment load exceeds the target Tributary Strategy level. For future land use conditions, the average sediment loading rate is predicted to increase by 2%.

The Popes Head 3 subwatershed has an average pollutant loading rate for total phosphorus and total nitrogen when compared to the other subwatersheds. The total phosphorus load exceeds the target Tributary Strategy level and the total nitrogen load is just below the target Tributary Strategy level. For future land use conditions, the loading rate is predicted to increase by 7% for total phosphorus and 4% for total nitrogen.

3.6.7 Summary

The Popes Head 3 Subwatershed exhibits fair habitat quality. It has medium sized riparian buffers, with the majority being 25 – 50 feet wide. Most of the stream reaches exhibit unstable stream banks and an actively widening channel.

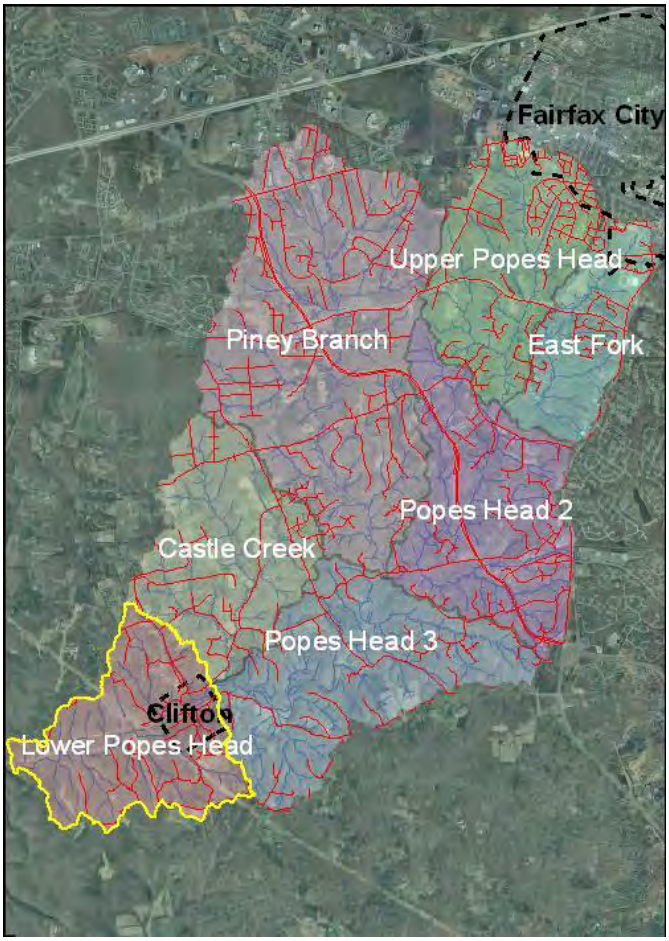
Velocities produced by the 2-year rainfall event in Popes Head 3 were higher than average when compared to those in the other subwatersheds, averaging 6.6 feet per second. Both the 2- and 10-year peak discharges overtop the channel banks along Popes Head Creek and its tributary in the Popes Head 3 subwatershed.

The Popes Head 3 subwatershed has an average sediment loading rate when compared to the other subwatersheds. The predicted sediment load exceeds the target Tributary Strategy level. It has an average pollutant loading rate for total phosphorus and total nitrogen when compared to the other subwatersheds. The total phosphorus load exceeds the target Tributary Strategy level and the total nitrogen load is just below the target Tributary Strategy level.

3.7 Lower Popes Head Subwatershed

The Lower Popes Head Subwatershed has an area of approximately 1,392 acres and contains the southernmost portion of Popes Head Creek. It is bounded to the north by Compton Road; to the east by Clifton Road; to the south by Yates Ford Road; and to the west by Balmoral Forest Road and Ivakota Road.

Map 3.19: Location of Lower Popes Head



This subwatershed contains a portion of the Hemlock Overlook Regional Park and the majority of the Town of Clifton. The Lower Popes Head Subwatershed is shown on Map 3.19 and its condition is summarized below.

3.7.1 Subwatershed Characteristics

The stormwater runoff from this subwatershed drains into Popes Head Creek, which has its headwaters at the confluence of Castle Creek and Popes Head 3. It has a length of 2.46 miles, and flows southwestward to the Hemlock Overlook Regional Park, and eventually discharges into Bull Run, a tributary of the Occoquan River.

The existing imperviousness in this subwatershed is 5.6% and expected to increase to 7.9% in the future, based upon the planned or zoned land uses in the Fairfax County Comprehensive Plan. The existing imperviousness is based on actual impervious cover in the watershed. The future impervious cover reflects imperviousness associated with the future land use condition. The significant increase in imperviousness is due to the future development possible on the Dominion power substation property. Currently, the Dominion power substation property within the watershed is only partially developed. However this impervious difference is not shown on the land use maps because the property was designated industrial in the existing condition and low-intensity commercial in the future.

88.6% of the subwatershed is in the rezoned area; the rezoned area was established in 1982 by the Fairfax County Board of Supervisors in order to protect the Occoquan Reservoir. Building density within the rezoned area is reduced, and therefore imperviousness is decreased, reducing the amount of stormwater runoff that is generated. Land use in this subwatershed is predominantly estate residential, which comprises

58.7% of the total subwatershed area. Open space is another significant land use, totaling 24% of the subwatershed area. Estate residential is expected to increase to 66.1% in the future, while open space will decrease to 10.5% of the total subwatershed area. Roads and sidewalks are not included in the land use data. The existing and future land uses in the Lower Popes Head Watershed are described in Table 3.30.

Lower Popes Head Subwatershed Condition Summary

- Current Imperviousness = 5.6% with majority of land use Estate Residential.
- Future Imperviousness = 7.9%
- Area of 1,392.4 acres.
- 88.6% of the subwatershed is in the rezoned area. Major land uses that are not in the rezoned area include the Town of Clifton.
- Two stormwater management facilities currently exist.
- The stream exhibits fair habitat quality.
- One dump was observed.
- Four head cuts were observed.
- Three obstructions were observed.
- 11 out of 22 crossings have minor impacts and one crossing has a severe impact.

Table 3.30 Lower Popes Head Land Use

Land Use Description	Existing		Future	
	Acres	%	Acres	%
Estate residential	798.7	58.7%	899.4	66.1%
Low-density residential	68.6	5.0%	152	11.2%
Medium-density residential	11.2	0.8%	11.2	0.8%
High-density residential	0.5	0.0%	0.5	0.0%
Low-intensity commercial	29.3	2.2%	126.6	9.3%
High-intensity commercial	1.7	0.1%	1.7	0.1%
Industrial	123.5	9.1%	26.1	1.9%
Open Space	326.1	24.0%	142.1	10.5%
Unknown	0.0	0.0%	0.2	0.0%
TOTAL	1359.6	100.0%	1359.6	100.0%

The subwatershed consists of 450 parcels, with an average size of 3.02 acres per parcel. Lower Popes Head has the second largest average parcel size of all subwatersheds, while Castle Creek has the largest average parcel size. There are 15 neighborhoods fully within or apportioned within the subwatershed, not including the Town of Clifton. The neighborhoods are listed below:

- Balmoral Greens
- Clifton Forest
- Burwyck
- Clifton Heights
- Clifton Creek Ridge
- Clifton North

- Clifton Ridge
- Lee Mill
- Frog Hill
- Noble Estates
- Wyckland
- Glencairn
- Wiltonshire

The County's list of master plan drainage projects shows the two identified projects in this subwatershed are inactive. Table 3.31 summarizes the type of master plan drainage project, project name/location, and current status. No cost estimates were available for these projects.

Table 3.31 Lower Popes Head Master Plan Drainage Projects

Type of Work	Project Name/Location
Inactive Projects	
Replace Culvert and Channel Improvement Downstream	Tributary at Clifton Rd
Replace Culvert	Tributary at Clifton Rd

3.7.2 Existing Stormwater Management Facilities

Lower Popes Head does not have an extensive network of storm drain pipes. There are several pipes located within the Town of Clifton that discharge into Popes Head Creek.

Map 3.20 shows the location of stream crossings that have an impact on the stream. Crossings that do not have an impact on the stream are not listed. The major crossings in this subwatershed, starting from the upstream end of Lower Popes Head, are described as follows:

- Great Oak Lane: A five-foot diameter circular CMP culvert (PHPH011.C001) has a minor impact on a northern tributary, as shown in Photo 3.17.
- Clifton Road: A five-foot diameter circular CMP culvert (PHPH012.C003) has a minor impact on the main stem.
- Newman Road: A five-foot diameter circular CMP culvert (PHPH012.C002) has a minor impact on the main stem.
- Clifton Creek Drive: A 2.5-foot diameter circular CMP culvert (PHPH009.C001) has a minor impact on the main stem, as shown in Photo 3.18.
- Chapel Road: A two-foot diameter circular CMP culvert (PHPH013.C001) has a minor impact on a southern tributary.
- Dunquin Court: A two-foot diameter circular clay culvert (PHPH005.C001) has a minor impact on a southern tributary, as shown in Photo 3.19. To the southeast, a three-foot by two-foot elliptical concrete culvert (PHPH005.C002) has a minor impact on the same tributary. To the southeast, a two-foot diameter circular concrete culvert (PHPH006.C002) has a minor impact on the same tributary. Adjacent, a two-foot diameter circular concrete culvert (PHPH006.C001) has a severe impact on the same tributary, as shown in Photo 3.20.
- Dunvegan Drive: A four-foot diameter circular CMP culvert (PHPH007.C001) has a minor impact on a southern tributary.
- Kincheloe Road: A three-foot diameter circular CMP culvert (PHPH006.C003) has a minor impact on the southeastern tributary. To the southeast, a two-foot diameter circular CMP culvert (PHPH006.C004) has a minor impact on the same tributary.

Map 3.20: Lower Popes Head Stream Crossings

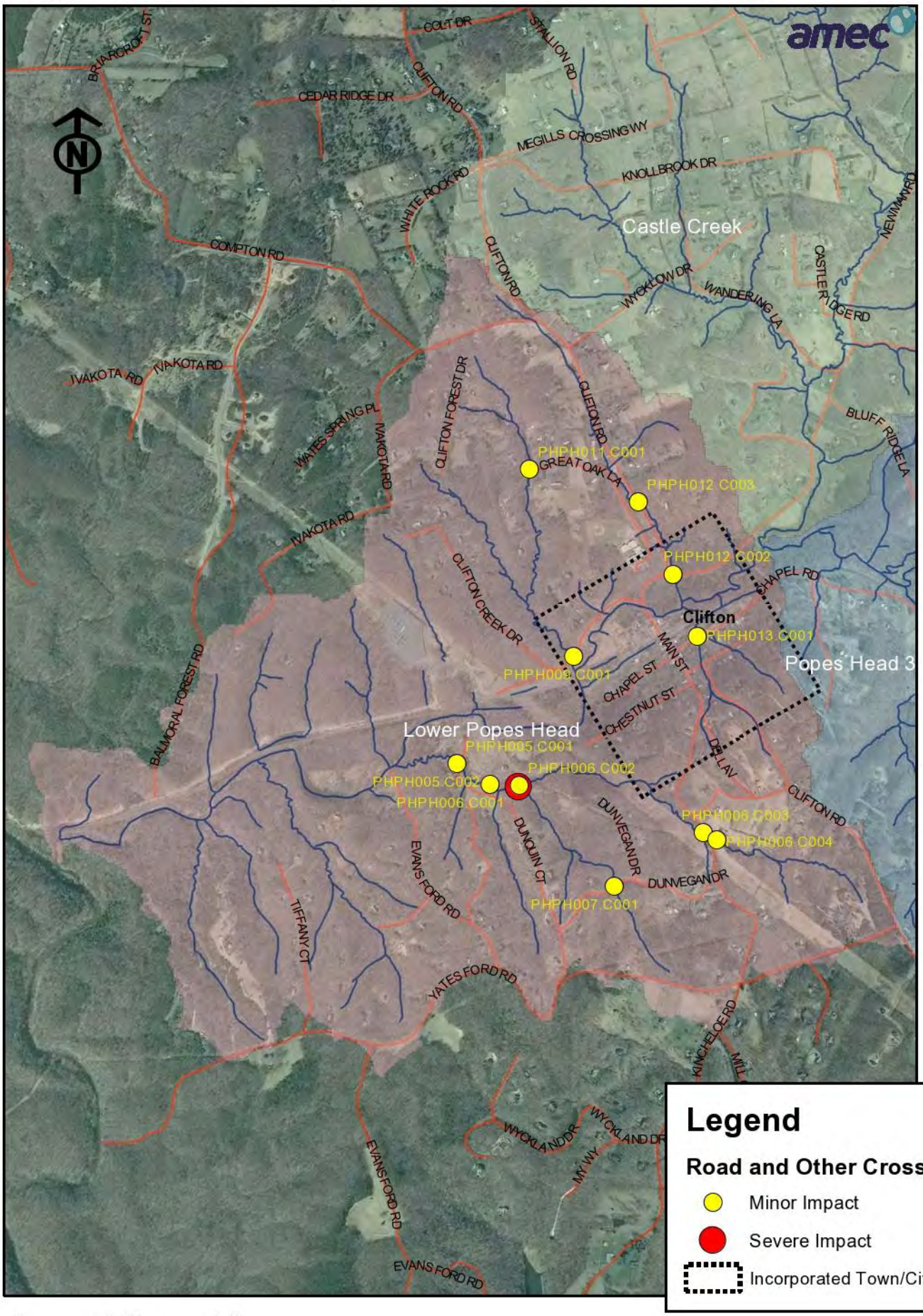


Photo 3.17 A culvert (PHPH014.C001) at Great Oak Lane has a minor impact on the stream

Photo 3.18 A culvert (PHPH009.C001) at Clifton Creek Drive has a minor impact on the stream

Photo 3.19 A culvert at (PHPH005.C001) Dunquin Court has a minor impact on the stream

Photo 3.20 A culvert (PHPH006.C001) at Dunquin Court has a severe impact on the stream

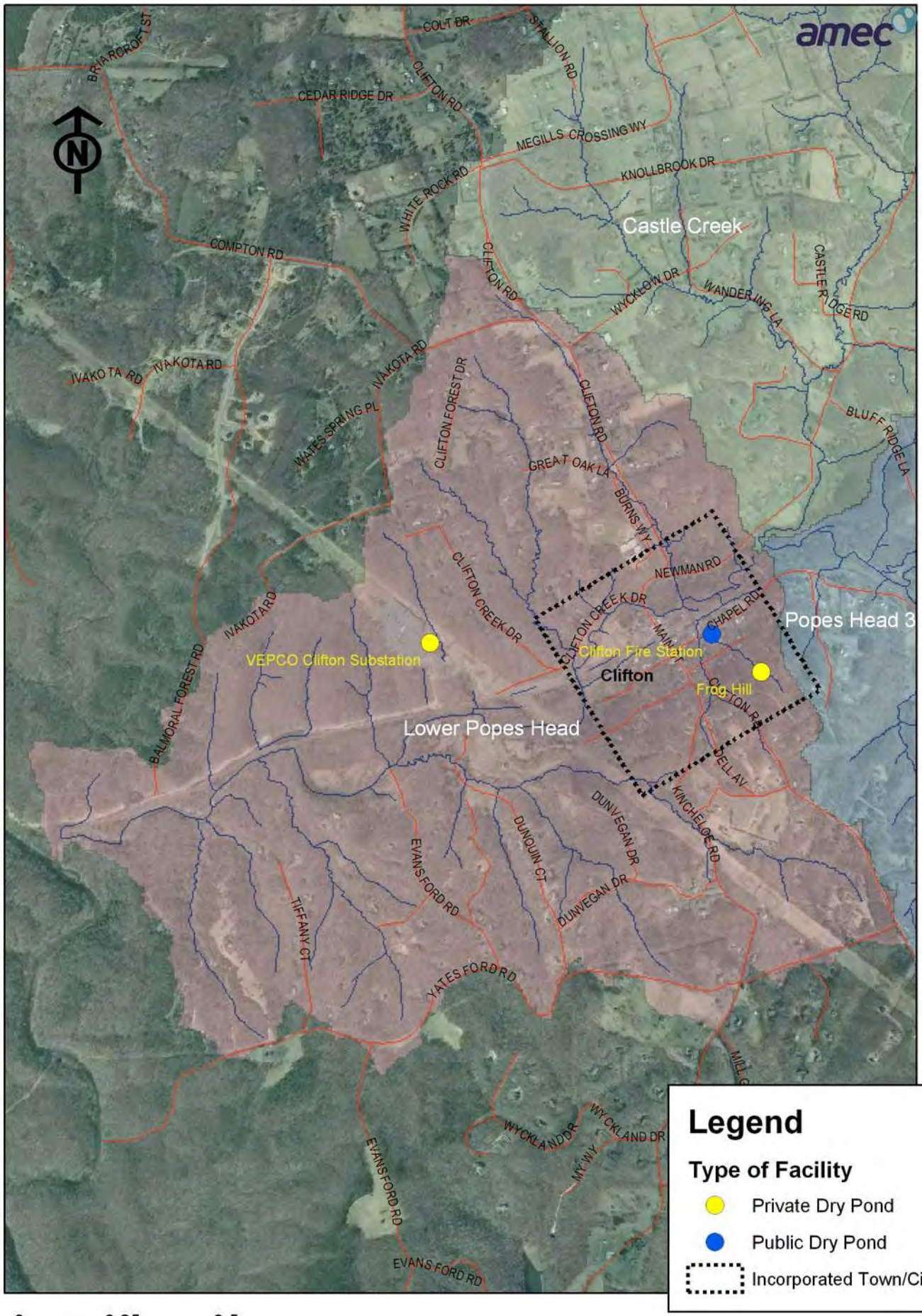
Seven storm drain pipes discharge into Lower Popes Head. They range from four to 36-inches in diameter; none of the which appear to be causing erosion.

Table 3.32 shows the locations of known stormwater management facilities in the subwatershed, as shown on Map 3.21.

Table 3.32 Lower Popes Head Stormwater Management Facilities

Name	Location	Type of Facility
Privately Owned		
VEPCO Clifton Substation	Near Clifton Creek Drive	Dry Pond
Frog Hill Subdivision	Water Street	Dry Pond
Publicly Owned		
Clifton Fire Station	Chapel Rd, East of Main St	Dry Pond

Map 3.21: Lower Popes Head Stormwater Management Facilities



3.7.3 Stream Geomorphology

The geomorphology of the stream segments of Lower Popes Head can be summarized as follows:

- The dominant substrate for the majority of the stream reaches is cobble.
- The main stem is of CEM type 4, referring to stream bank stabilization and channel development. The tributaries are of CEM type 3, referring to unstable stream banks and an actively widening channel. Several reaches are of CEM type 2, referring to a deep incised channel.
- One dump was observed.
- Four head cuts were observed.
- Three obstructions were observed.

3.7.4 Stream Quality

The stream reaches of Lower Popes Head are classified as riffle/run stream type. Riffles are a source of high-quality habitat and diverse fauna; therefore, an increased frequency of occurrence greatly increases the diversity of the stream community. The habitat assessment for Lower Popes Head can be summarized as follows:

- Overall, the stream exhibits fair habitat quality.
- The majority of the stream reaches contain four to seven habitat types in more than 50% of the reach. The tributaries contain two to seven habitat types in less than 50% of the reach.
- The main stem contains riffles that are as wide as the stream, and have epifaunal substrates composed of boulder stones, cobble, softball size cobble stones, and a mixture of gravel stones and boulders/bedrock and/or stable woody debris. The tributaries contain riffles that are not as wide as the stream, and have epifaunal substrates composed of softball size cobble stones, boulder stones, and a mixture of boulders/bedrock, gravel stones, and/or stable woody debris.
- The majority of the stream reaches have 30% - 40% embeddedness by sediment and silt.
- The majority of the stream reaches, including the entire main stem, have 5% - 40% channel disturbance, indicating minor alterations, dredging, or artificial embankments. The channel is mostly recovered and somewhat stable.
- The main stem contains frequent riffles with adequate depth in pools and riffles. The remaining stream reaches contain infrequent riffles with variable bottom contours which provide some habitat.
- The main stem channels are 80% - 90% full during normal flow conditions. The tributary channels are 20% - 75% full during normal flow conditions.
- The main stem has 70% - 80% vegetation cover, typically of shrubs, grasses and forbes, with a few thin or barren areas. The tributaries have 50% - 60% vegetation cover, typically of shrubs, grasses and forbes. In general, the right stream banks have more dense vegetation cover than the left banks.
- The downstream portion of the main stem has moderately stable banks with 30% erosional areas. The upstream portion of the main stem has moderately unstable banks with 40 – 70% erosional areas. In general, the left banks are more stable than the right banks, as the entire right side of the main stem is moderately unstable with 40% - 50% erosional areas.
- The main stem has forested vegetated buffer zones that are 50 – 100 feet wide, consisting of shrubs and a few trees, old fields, and planted lawn grass yards. Several

of the tributaries have buffers that are greater than 100 feet wide. In general, the left stream bank has wider buffer zones than the right side.

The general characteristics of the stream water quality were assessed as follows:

- The water was clear, except for stream reaches inside the Town of Clifton; here the water was turbid and light brown (other than tannin). No odors were detected.
- Small fishes one to two inches in length were observed at the headwaters and in one of the southern tributaries. Medium fishes three to six inches in length were observed in the downstream portion of the main stem.
- Attached aquatic vegetation was observed in pools in 10% - 30% of the entire stream bank area in one stream reach.
- No algae were observed in any of the stream reaches.

3.7.5 Stream Ecology

The 2001 *Fairfax County Stream Protection Strategy (SPS) Baseline Study* sampled fish and aquatic macroinvertebrates at one location in the Lower Popes Head Subwatershed. The sampling site (PHPH03), as shown on Map 2.11, is located downstream of Evans Ford Road and exhibited a poor macroinvertebrate community, which is indicative of degraded water quality. A moderate number of fish species was observed at this site, which is indicative of a strong community structure and good water quality.

3.7.6 Problem Areas from Public Forum

Citizen attendees at the March 27, 2004 Community Watershed Forum identified the following problem areas in the Lower Popes Head Subwatershed:

- Severe erosion along Popes Head Creek occurs downstream of Clifton Road and Eight Acre Park.
- Erosion occurs at two dirt road crossings within the electrical power line right-of-way on Popes Head Creek, downstream of Clifton.
- Runoff and sediment from the construction of six new houses uphill from Clifton Elementary School is flowing into Popes Head Creek.
- The Town of Clifton contains leaking fuel tanks.
- Clifton Road was overtopped by water during Hurricane Isabel.

3.7.7 Modeling Results

The hydrology for the Lower Popes Head subwatershed produced stormwater runoff that is low compared to the other subwatersheds. This is due to a lower percentage of residential development in the subwatershed. The increase in discharges due to future development is average when compared to the other subwatersheds. See Table 3.33 for a comparison of the existing and future 2- and 10-year peak discharges in the subwatershed.

Table 3.33 Lower Popes Head Peak Runoff Flows

Lower Popes Head Discharge Table		Two-Year Rainfall Event			10-Year Rainfall Event		
Location	**Drainage Area**	**Existing Peak Flow (cfs)**	**Future Peak Flow (cfs)**	**% Peak Flow Increase**	**Existing Peak Flow (cfs)**	**Future Peak Flow (cfs)**	**% Peak Flow Increase**
Just downstream of the confluence with Castle Creek	16.79	4440	5240	18%	7730	8000	3%
Approximately 1,500 ft downstream of Main Street	17.50	4580	5790	26%	7930	8330	5%
Approximately 200 ft downstream of Evans Ford Road	18.31	4450	5470	23%	7570	7820	3%

Velocities produced by the 2-year rainfall event in Lower Popes Head were higher than average when compared to those in the other subwatersheds, averaging 6.9 feet per second. Velocities on Tributary 4 were comparable to other tributaries, averaging 4.6 feet per second. The average velocity is predicted to increase by approximately 8% in the future conditions.

Both the 2- and 10-year peak discharges overtop the channel banks along Popes Head Creek and the 2-year is confined to the channel in the upper reaches of Popes Head Tributary 5. The model shows eight structures greater than 500 square feet located in the 10-year floodplain: 6 upstream of Main Street in Clifton, 1 downstream of Main Street in Clifton and 1 off of Tributary 5 near Dunquin Court. Table 3.34 shows a summary of the flooded structures in the subwatershed for different recurrence intervals.

Table 3.34 Lower Popes Head Flooded Structures

Recurrence Interval	Popes Head 3	
	Existing	Future
2	4	8
5	6	8
10	8	8
25	10	10
50	12	12
100	13	16

The Lower Popes Head subwatershed has an average sediment loading rate when compared to the other subwatersheds. The predicted sediment load exceeds the target Tributary Strategy level. For future land use conditions, the average sediment loading rate is predicted to increase by 6%.

The Lower Popes Head subwatershed has an average pollutant loading rate for total phosphorus and total nitrogen when compared to the other subwatersheds. The total phosphorus load exceeds the target Tributary Strategy level and the total nitrogen load is just below the target Tributary Strategy level. For future land use conditions, the loading rate is predicted to increase by 1% for both total phosphorus and total nitrogen.

3.7.8 Summary

The Lower Popes Head Subwatershed exhibits fair stream habitat quality. In general, the main stem of the stream has stable stream banks and a large riparian buffer, ranging 50 feet to greater than 100 feet wide. Several areas of significant erosion are observed around the Town of Clifton, and the stream reaches that flow through Clifton are turbid and brown in color.

Velocities produced by the 2-year rainfall event in Lower Popes Head were higher than average when compared to those in the other subwatersheds, averaging 6.9 feet per second. Both the 2- and 10-year peak discharges overtop the channel banks along Popes Head Creek and the 2-year is confined to the channel in the upper reaches of Popes Head Tributary 5.

The Lower Popes Head subwatershed has an average sediment loading rate when compared to the other subwatersheds. The predicted sediment load exceeds the target Tributary Strategy level. It has an average pollutant loading rate for total phosphorus and total nitrogen when compared to the other subwatersheds. The total phosphorus load exceeds the target Tributary Strategy level and the total nitrogen load is just below the target Tributary Strategy level.

Chapter 4: Watershed Plan Actions

4.1 Summary of Watershed Actions

The proposed actions in this chapter are based upon the recommendations of the project team, with guidance from the community. The actions focus on protecting high quality environments within the Popes Head Creek Watershed and improving areas with degraded stream habitats. The goals of the plan will be accomplished by the following actions:

- Retrofitting existing stormwater facilities;
- Installing new Best Management Practices (BMPs) and Low Impact Development (LID) facilities;
- Retrofitting culverts and road crossings;
- Protecting and restoring riparian buffers and stream habitat; and
- Coordinating volunteer watershed stewardship activities and a public education campaign.

4.2 Watershed Project Descriptions

The projects for the Popes Head Creek Watershed Management Plan are identified using a 6-digit convention (XX9YZZ), where:

XX = Watershed Code = PH

Y = 0 for Regional Pond Projects
1 for Non-regional Ponds or Pond Retrofits
2 or 3 for Stream Restoration or Stabilization Projects
4 for Road Crossing Improvements
5 for Culvert Retrofits
6 for Flood Control Projects
8 for Low Impact Development projects (Bioretention Areas or "rain gardens", manufactured LIDs, grassed swales, and infiltration trenches)
9 for Obstruction Removal Projects

Z = Remaining digits in ascending order throughout the watershed, starting with 00 as the lowest point in the watershed (99 as the highest point).

The following diagrams describe each type of project that is proposed for the Popes Head Creek Watershed.

Stormwater Pond Retrofit

Description: Retrofit options that may be suitable for implementation include:

1. Increasing detention storage by means of additional excavation and grading.

2. Providing water quality improvements to facilities that currently only provide water quantity control. These facilities could be retrofitted to also provide water quality treatment by means of installing a micro-pool, sediment forebay, constructed stormwater wetlands, or by increasing the surrounding riparian buffer.

3. Modifying or replacing the existing riser structure and outlet controls to further reduce the discharge rate from the storm water management facility. A riser is a structure, typically made of concrete with a metal grate on top, which controls the level of water in the stormwater pond.

4. Adding infiltration features such as sand filters or bioretention to promote greater peak flow reduction, groundwater recharge, and improve water quality treatment. A soil survey of the existing facility would be required to verify that this retrofit is suitable. Stormceptors, or equivalent LID products, could be installed in parking lots or other areas with a large percentage of impervious area. These devices are placed in the manhole and trap sediments and petroleum products before they flow into the pond.

Maintenance: The maintenance requirements of a retrofitted pond are not significantly more than a traditional stormwater pond. A typical pond is inspected by County personnel trained in dam safety and pond maintenance, looking at the dam, pipes, and riser structure to ensure it is functioning properly and not failing. Additional items that need to be inspected are any pretreatment facilities for clogging by sediments and large debris items. If sediment buildup or clogging is evident, the area needs to be cleaned. Manufacturer's maintenance recommendations need to be followed for all Manufactured LID products.

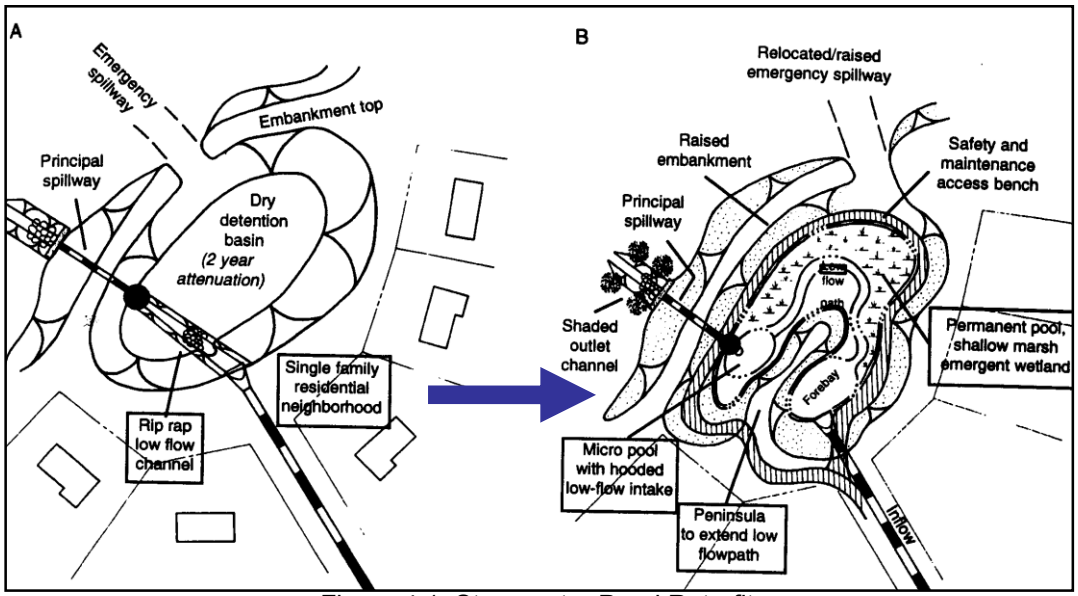


Figure 4.1: Stormwater Pond Retrofit

Source: Schueler, Thomas R. and Holland, Heather K. *The Practice of Watershed Protection.* Article 143. The Center for Watershed Protection, 2000.

Culvert Retrofit

Description: This stormwater retrofit option is installed upstream from existing road culverts by constructing a control structure and excavating a micro-pool. These projects are designed for intermittent or ephemeral streams. The control structure will consist of a gabion weir that will detain and reduce stormwater flow; the micro-pool is a small pool that will infiltrate the first 0.1 – 0.2 inches of stormwater runoff, improving water quality.

Maintenance: Maintenance of the micro-pool area is very minimal. The area needs to be inspected for large debris or sediments that may be clogging the area, dead or stressed plants, and erosion around the gabions. Remove large debris, built-up sediments, and replace dead or stressed plants as necessary. If there is erosion around the gabions, the area needs to be inspected and gabions stabilized, or placement modified as necessary.

These facilities have an expected life span of 25 years.

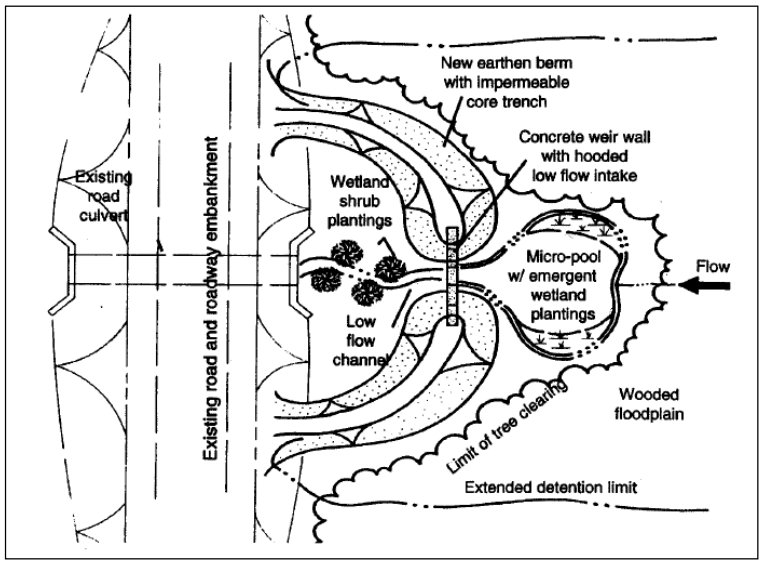


Figure 4.2: Culvert Retrofit

Source: Schueler, Thomas R. and Holland, Heather K. *The Practice of Watershed Protection.* Article 143. The Center for Watershed Protection, 2000.

Low Impact Development: Bioretention Area ("Rain Garden")

Description: Bioretention is a shallow depression utilized to detain and treat stormwater runoff by using a conditioned planting soil bed and planting materials. Pollutants are adsorped by plant material and slowly infiltrate through the soil bed, improving water quality.

Maintenance: Inspection of the treatment area's components and repair or replace as necessary. This area is akin to a landscape feature in general maintenance needs, such as removal of accumulated sediment and debris, replacement of dead or stressed plants, and annual mulching (or as necessary).

These facilities have an expected life span of 25 years.

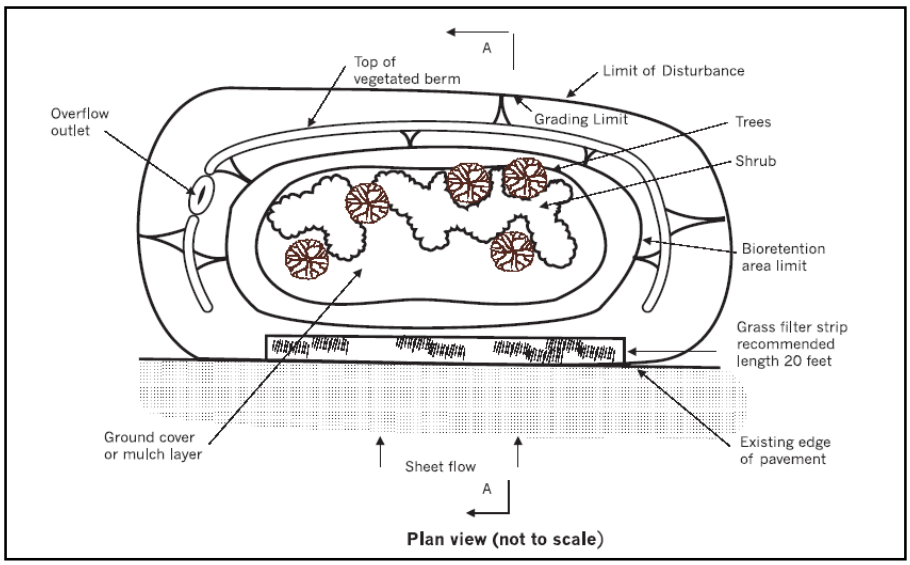
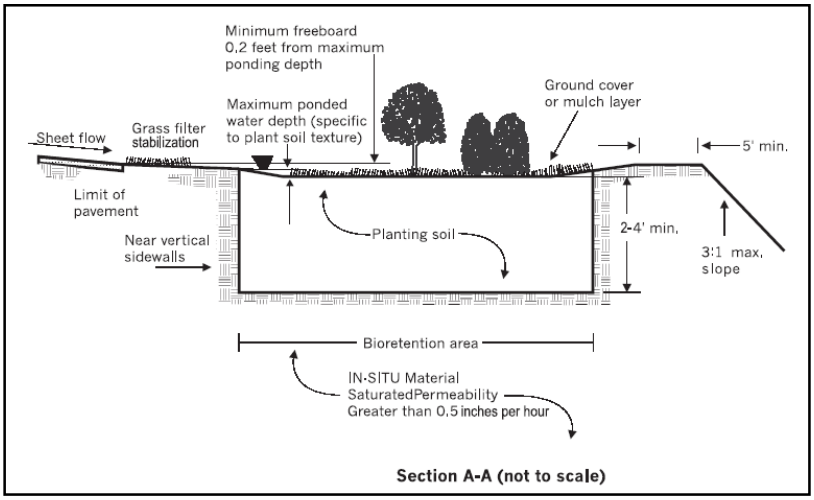


Figure 4.3: Bioretention Area



Source: Low-Impact Development Design Strategies: *An Integrated Design Approach.* Prince Georges's County, Maryland. Department of Environmental Resources Programs and Planning Division. January 2000.

Pipe Outfall Retrofits (Off-line Bioretention)

Description: This stormwater retrofit option is installed immediately downstream of a stormwater drainage pipe outfall. Flow splitters can be utilized to convey the water quality treatment volume to a sand filter, bioretention area, off-line wetland, or wet pond, while larger storms are allowed to bypass the retrofit.

Maintenance: Inspect the treatment area's components and repair or replace as necessary. This area is akin to a landscape feature in general maintenance needs, such as removal of accumulated sediment and debris, replacement of dead or stressed plants, and annual mulching (or as necessary). An observation well can identify if the underdrain is clogged or not working properly

These facilities have an expected life span of 25 years.

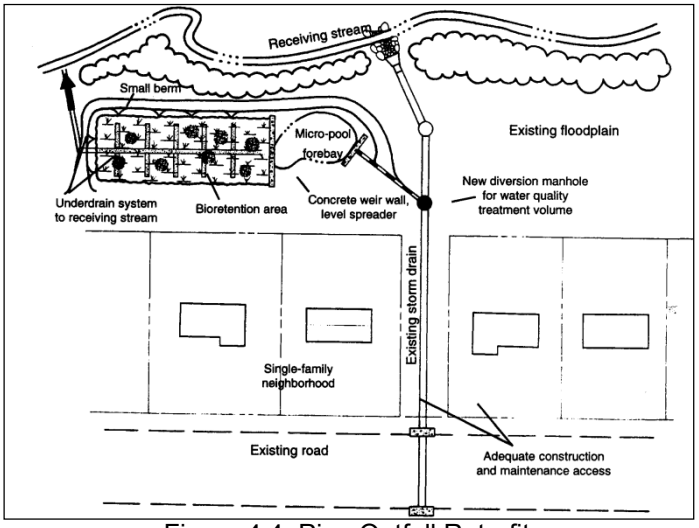


Figure 4.4: Pipe Outfall Retrofit

Source: Schueler, Thomas R. and Holland, Heather K. *The Practice of Watershed Protection.* Article 143. The Center for Watershed Protection, 2000.

Low Impact Development: Infiltration Trench

Description: An infiltration trench is an excavated trench that has been backfilled with stone to form a subsurface basin. Stormwater runoff is diverted into the trench and is stored until it can be infiltrated into the soil, usually over a period of several days. They are ideal for small urban drainage areas, and have a longer life cycle when some form of pretreatment, such as a grass swale, is included in the design.

Maintenance: Prevent sediments and debris from accumulating on the surface and clogging the trench. If a grass filter strip or any other pretreatment BMP is used in conjunction with the trench, maintenance of the BMP is very important. Filter strip maintenance consists of reseeding any eroded areas, and periodically mowing to a height equal or greater than the design flow height.

These trenches have an expected life span of 10 years.

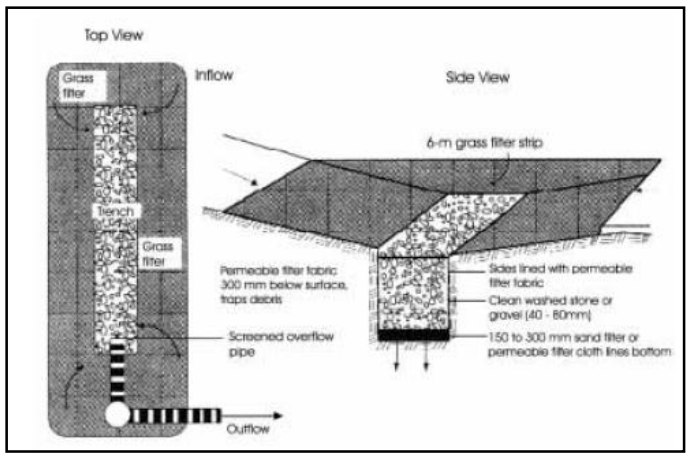


Figure 4.5: Infiltration Trench

Source: Low-Impact Development Design Strategies: *An Integrated Design Approach.* Prince Georges's County, Maryland. Department of Environmental Resources Programs and Planning Division. January 2000.

Low Impact Development: Grassed Swale

Description: Grassed swales provide water quantity and quality control infiltrating stormwater into the soil. Stormwater travels more slowly in a grass swale than it does in a concrete ditch, reducing runoff volume and downstream erosion.

Maintenance: Maintain a dense, healthy grass cover, akin to a mowed sodded area. The area should have periodic mowing (but not letting the grass get lower than the design flow depth), weeding, watering, reseeding of bare areas, and clearing of debris and blockages as necessary. The swale shall be checked periodically and after significant rain storms to fix any problems with sediment buildup and erosion. If sediment buildup occurs, the sediments should be removed manually to avoid concentrated flows in the swale. Fertilizers and pesticides should be avoided, and only used when the grass cover is diseased or dying. Parking shall be avoided on the swale area to avoid compaction.

These swales have an expected life span of 25 years.

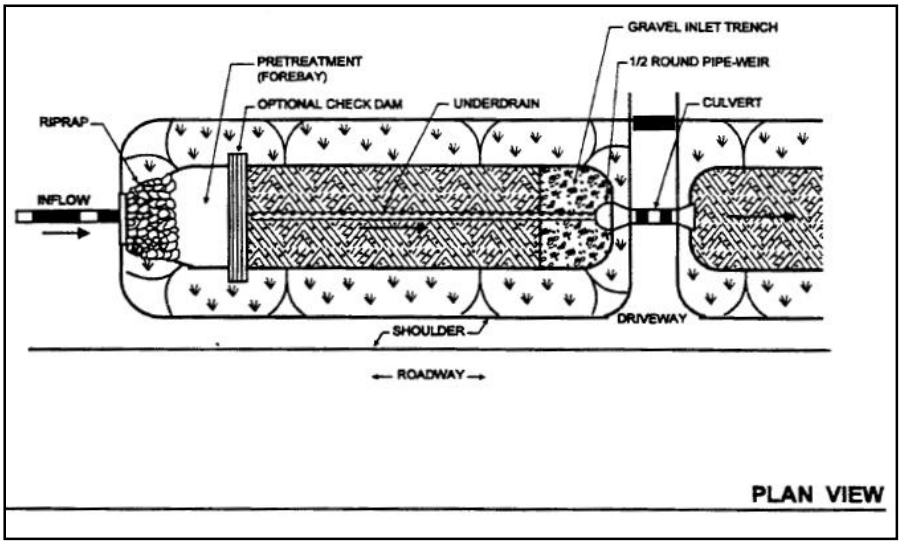


Figure 4.6: Grassed Swale

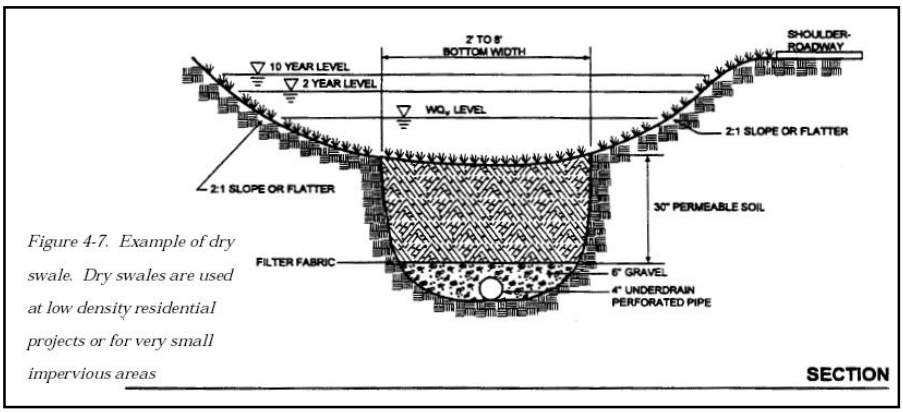


Figure 4-7. Example of dry swale. Dry swales are used at low density residential projects or for very small impervious areas

Source: Low-Impact Development Design Strategies: *An Integrated Design Approach.* Prince Georges's County, Maryland. Department of Environmental Resources Programs and Planning Division. January 2000.

Low Impact Development: Manufactured LIDs

Description: Manufactured LIDs, such as Filterra® or a comparable alternate, allow stormwater to flow through a specially designed filter mixture contained in a landscaped concrete container. The mixture immobilizes pollutants; those pollutants are then decomposed, volatilized and incorporated into the biomass of the Filterra®. Stormwater runoff flows through the media and into an underdrain system at the bottom of the container, where the treated water is discharged.

Maintenance: Debris and sediment removal, replacing dead or stressed plants, and mulching as necessary are the primary maintenance considerations. Most of these Manufactured LID come with an observation well that is to be used to identify if the underdrain is clogged or not working properly. If the system becomes clogged, the filter mixture shall be replaced. Additionally, most manufacturers have their own maintenance guidelines that need to be followed to maintain the performance level.

Manufactured LIDs have an expected life span of 25 years.

Figure 4.7: Manufactured LID

Source: Virginia Stormwater Management Program Technical Bulletin #6: Minimum Standard 3.11C - Filterra Bioretention Filter System (revised 11/01/02).

Low Impact Development: Rain Barrel

Description: Rain barrels are low-cost, effective and easily maintainable retention devices that can be used in both residential and commercial/industrial sites. They are connected to gutters and retain rooftop runoff. Rain barrels can be used to store runoff for later use in lawn and garden watering.

Maintenance: Rain barrels require very little maintenance. The barrel and attachments should be inspected for clogging several times a year and after significant storm events. Minor parts, including spigots, screens, downspouts, or leaders, may require replacement.

Because enclosed rain barrels are ideal breeding habitats for mosquitoes, who may carry the West Nile virus, it is important to completely drain the barrels once a week. A tightly fitting screen at the inlet can also prevent mosquito eggs and other debris from entering the rain barrel, but it is a good practice to drain the barrel weekly.

Rain barrels have an expected life span of 25 years.

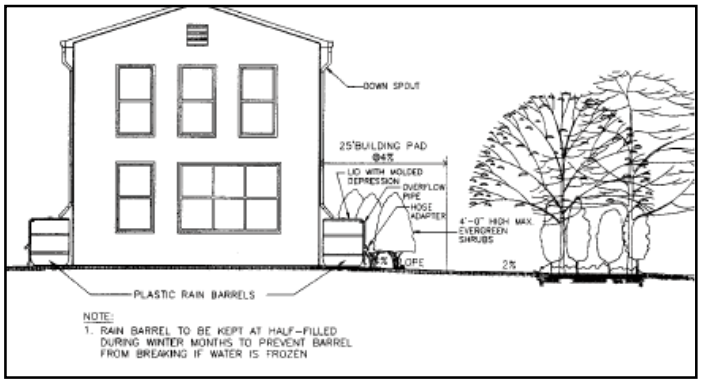


Figure 4.8: Rain barrel

Source: Low-Impact Development Design Strategies: *An Integrated Design Approach.* Prince Georges's County, Maryland. Department of Environmental Resources Programs and Planning Division. January 2000.

4.3 Watershed Plan Vision

The Popes Head Creek Watershed Management Plan will help the State of Virginia meet several commitments to improving water quality in the Chesapeake Bay Watershed. In May 1999, the U.S. EPA included most of Virginia's portion of the Bay and several tidal tributaries on the federal list of impaired waters based on failure to meet standards for dissolved oxygen and aquatic life use attainment. Popes Head Creek is currently listed as an impaired waterbody in the Virginia Department of Environmental Quality Total Maximum Daily Load (TMDL) Priority List, as described in Chapter 2.5.7.

The Chesapeake Bay 2000 Agreement commits Virginia to remove the Chesapeake Bay from the U.S. EPA's list of impaired waters by the year 2010. The draft Shenandoah and Potomac Basins Tributary Strategy, released in April 2004, will implement the nutrient and sediment reduction goals of the Chesapeake Bay 2000 Agreement. The goal is to reduce nitrogen loads from the estimated 2002 level of 22.8 million pounds per year to 12.8 million pounds per year in 2010; the estimated phosphorus load of 1.96 million pounds in 2002 will be reduced to 1.4 million pounds per year in 2010; finally, the estimated 720,000 tons of sediment in 2002 will be reduced to 617,000 tons per year in 2010. The Strategy relies heavily on urban BMPs to achieve the reduction goals, and will include 187,000 acres of urban nutrient management and 71,000 acres of urban retrofits, including bioretention facilities, swales, and other innovative BMPs. By reducing pollutant loads through the use of BMPs and restored stream buffers, the Popes Head Creek Watershed Management plan can contribute to these state goals.

While the Tributary Strategies program is technically voluntary, failure to meet target reductions has the potential to result in the U.S. EPA implementing a TMDL regulatory program under Section 303(d) of the Clean Water Act. This would effectively supplant the voluntary Chesapeake Bay Program and make implementation mandatory through Fairfax County's Virginia Pollutant Discharge Elimination System (VPDES) permit.

The Popes Head Creek Watershed Management Plan is consistent with Fairfax County's *Policy Plan* (the Countywide element of the County's comprehensive plan), within which the Board of Supervisors' adopted goals can be found. The Board of Supervisors' goal for environmental protection states,

> "The amount and distribution of population density and land uses in Fairfax County should be consistent with environmental constraints inherent in the need to preserve natural resources to meet or exceed federal, state, and local standards for water quality, ambient air quality, and other environmental standards. Development in Fairfax County should be sensitive to the natural setting to prevent degradation of the County's natural environment."

The County policy document also notes that,

> "The protection and restoration of the ecological quality of streams is important to the conservation of ecological resources in Fairfax County. Therefore, efforts to minimize adverse impacts of land use and development on the County's streams should be pursued."

This watershed management plan is intended to complement and supplement the County's policies and comprehensive plans over the next 25 years and support its

commitment to the Clean Water Act and Virginia's commitment to the Chesapeake Bay Preservation Ordinance. The County and community members of the Popes Head Creek Watershed are committed to protecting Popes Head Creek and its tributaries from future degradation by promoting watershed-wide management actions that work to restore the creek and other areas to an environmentally healthy ecosystem. This commitment emphasizes the importance of protecting the County's valuable natural resources, including surface waters, and supports the sustainability and improvement of the environment which has a direct impact on the quality of life of the County's residents. Current stream conditions throughout the watershed are predominantly fair or good, and this plan proposes a comprehensive strategy for protecting these areas and improving areas with poor stream conditions. The plan was written to manage future changes in the watershed to protect the creek so it can be enjoyed by future generations. The objectives of the plan will also help the County meet or exceed federal, state, and local regulatory water quality requirements.

The planning process, initiated by Fairfax County, for development of this watershed management plan included the participation and recommendations of a watershed steering committee. The Popes Head Creek Citizen's Advisory Committee was convened to aid and advise the project team, and the committee members served as liaisons between their respective communities or organizations and the project team. Several public workshops were held to receive input from the community regarding the watershed issues and possible solutions. The project team used this information to help evaluate the watershed and provide recommendations for addressing the issues.

The Popes Head Creek Citizen's Advisory Committee developed the following guiding principles to aid in formulating the actions and strategies for implementing the objectives of this plan.

- Reduce or eliminate the adverse impacts of recreational activities in riparian areas.
- Actively support the enforcement of the Chesapeake Bay Preservation Ordinance.
- Encourage small steps that residents can implement easily.
- Concentrate on solutions in the upstream areas first.
- Place an emphasis on protecting the existing high quality streams, including smaller tributaries.

Three Goals were developed to fulfill the Citizen's Advisory Committee's guiding principles.

Goal A: Protect and improve the ecological health of Popes Head Creek and its tributaries.

Goal B: Have a well informed community that is actively involved in watershed stewardship.

Goal C: Maintain the Occoquan Reservoir as a clean and sustainable source of potable water for Fairfax County.

4.4 Goals, Objectives, and Actions

The goals of the Popes Head Creek Watershed Plan were derived from the issues identified by the community and the project team, based on their analysis of the watershed condition. The issues driving each goal are explained in greater detail with the supporting reasons for the goal. Objectives provide direction on how to achieve the goals, and the rationale for each objective describes why it is important to the plan. The actions for each objective describe the strategy for accomplishing the objective.

The following "tracks" have been identified for the implementation of watershed management plan recommendations throughout the County:

1. Structural and Non-structural Projects:
    - County-initiated Projects via the Capital Improvement Program
    - Developer-initiated via the Zoning Approval Process or waiver approval process (proffers and development conditions)
    - Volunteer Group Implementation
2. "Policy" Recommendations

Structural and non-structural recommendations are described in Chapter 4 of the Popes Head Creek Watershed Management Plan. Structural recommendations are summarized in Tables 4.1 – 4.8 and shown in detail in Appendices F - K. Non-structural recommendations are summarized in Table 4.9 and shown in detail in Appendix L.

"Policy" recommendations are described in Chapter 5. The policy recommendations include proposals that would typically involve amendments to the County Code and other supporting documents such as the Public Facilities Manual. These recommendations will need to be evaluated further in light of greater countywide implications. The current planned approach for processing of the policy recommendations from the Popes Head Creek Watershed Plan is to compare these with similar recommendations that will be developed with the Little Hunting Creek, Cameron Run, Cub Run, and Difficult Run Watershed Management Plans starting in 2006. Specific ordinance amendments would then be crafted that factor in other County initiatives and address the common ground that can be established between the various policy recommendations.

One of the frequent questions asked by the public during the watershed plan review process was "How will the County pay for the actions recommended in the plan?" Possible funding sources for the proposed actions in this plan include the general fund, a bond referendum, grants, cost sharing, and a storm water environmental utility fee. Annual general fund storm water allocations have ranged from $760,000 to $2.2 million over the past three years. The last storm water bond referendum to be approved was in 1988 in the amount of $12 million subject to cash flow restrictions. Currently $3.7 million of the storm water bond amount is allocated to existing projects. Since the mid-1990's the County has been considering the feasibility of a stormwater user fee. In the July 2004 preliminary report prepared for the county, "Watershed Community Needs Assessment and Funding Options", various alternatives to support an enhanced Countywide Stormwater Program were evaluated including a stormwater environmental utility fee. This report recommended the implementation of enhanced stormwater programming phased in over a five-year planning period. The estimated program costs ranged from $28 million in year one to $52 million in year five. The County FY 2006 budget included an additional $17.9 million for implementation of stormwater program initiatives including the watershed management plans.

The implementation costs depicted in this final version of the plan are order-of-magnitude cost estimates. Structural and non-structural projects will typically require additional design work, possible land rights acquisition, agreements, or other coordination during the implementation phase. It is assumed that contractors will be hired to execute individual projects. The use of volunteer labor on appropriate projects will reduce costs. As the projects are evaluated further, more detailed cost estimates will be performed.

Goal A: Protect and improve the ecological health of Popes Head Creek and its tributaries.

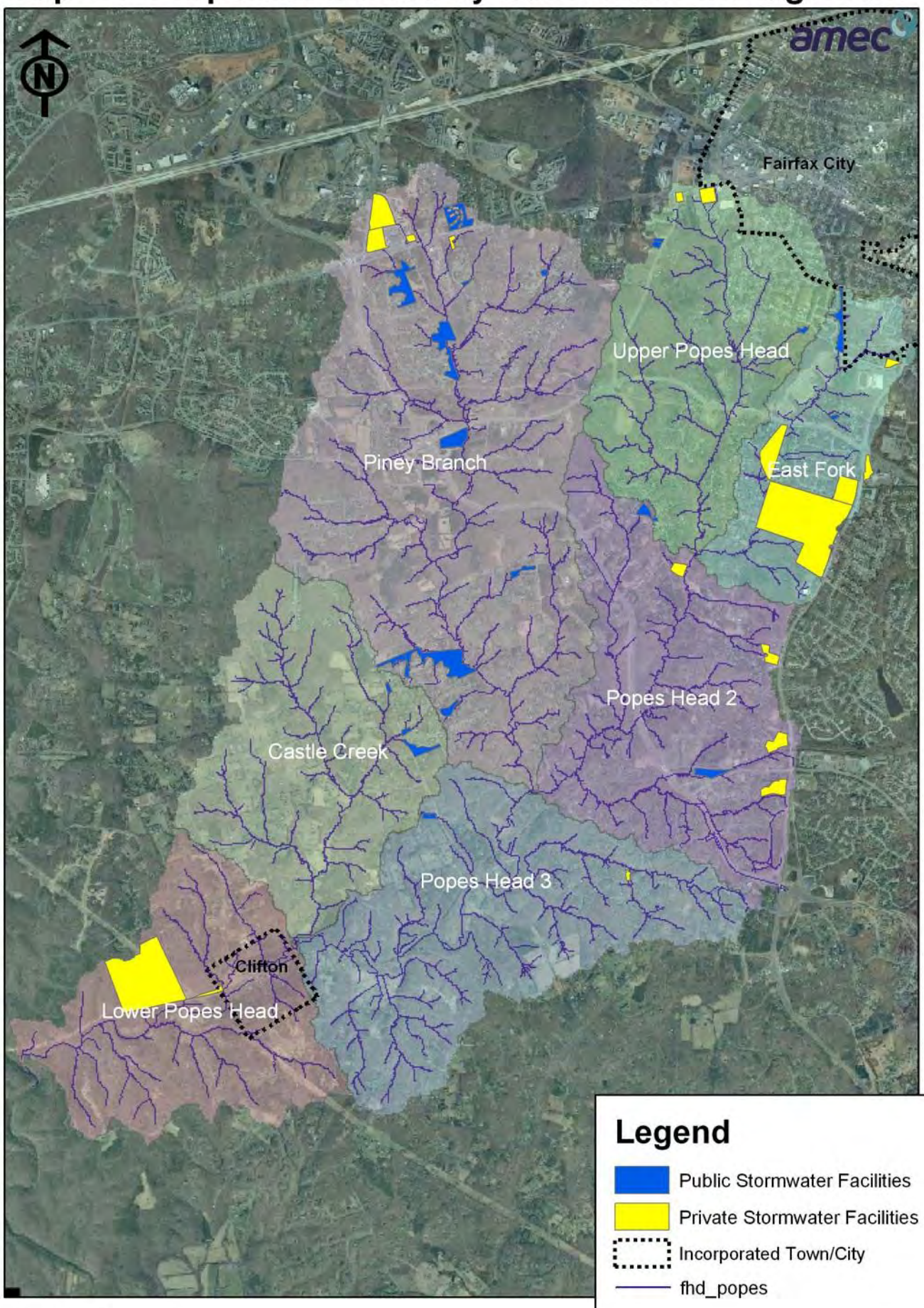
According to the 2003 Stream Physical Assessment study, Popes Head Creek Watershed is in good condition. Approximately 73% of the stream reaches were assessed as fair or good, with the remaining reaches assessed as poor or very poor. The good quality of stream habitat can be attributed to the 1982 rezoning that was approved by the Board of Supervisors in order to protect the health and quality of the Occoquan Reservoir, the potable water source for Fairfax County. Land in the rezoned area is classified as Residential-Conservation (R-C) District, and has a density of one dwelling unit per five acres. The low density has resulted in relatively low imperviousness; this in turn has resulted in less stormwater runoff and flooding when compared to more urban areas in the County. The project team and the community have agreed that it is important to protect this high quality habitat. It provides protection to the Occoquan Reservoir, as well an aesthetically pleasing character that adds to the quality of life for residents of the watershed.

Objective A1: Increase the effectiveness of and use of existing BMPs to reduce impacts from stormwater runoff.

Rationale: Existing privately owned stormwater basins (both dry and wet) may not be functioning as intended due to limited design and/or inadequate maintenance. In addition, the county has identified the need to increase the number and type of BMPs on its list of approved practices (see Industry Letter 01-11). The environment section of the county's Policy Plan, Objective 2, Policy "b" states, "Update Best Management Practice requirements as newer, more effective strategies become available." Policy "f" under Objective 2 also relates to BMP effectiveness, stating, "Where practical and feasible, retrofit older stormwater management facilities to perform water quality functions to better protect downstream areas from degradation." Map 4.1 shows properties with stormwater management facilities in the watershed, based upon the County's current database of stormwater facilities.

Action A1.1 Retrofit suitable existing stormwater management facilities and BMPs to make them more effective. Retrofitting these facilities is intended to exceed the performance criteria or standards that were used to design the facility. The increased performance and/or coverage area will improve water quality in the watershed. Fairfax County will coordinate with all VDOT, Fairfax County Park Authority, and private pond owners to implement the pond retrofit projects.

Map 4.1 Properties Served by Stormwater Management



could be structurally retrofitted by various means. Increasing the area draining to the facility may also be desirable to increase the overall area mitigated by a stormwater management facility; the Stormwater Planning Division could coordinate closely with Land Development Services to determine if there are any implications of a proposed PFM amendment regarding natural drainage divides. Increasing the area draining to the facility would require the existing storm drain system to be modified or a new storm drain system constructed to redirect and convey runoff to the existing facility. The stormwater facility would likely need to be enlarged if more runoff is directed to the facility. One of the goals of retrofitting a stormwater management facility would be to reduce peak runoff downstream of the facility.

These capital projects can be made available to developers via voluntary proffers or development conditions; however, proffers are only applicable in rezoning applications, which are not likely to occur due to the 1982 rezoning to Residential-Conservation District (R-C District) in order to protect the Occoquan Reservoir (please see Chapter 2.3 for more information on the rezoning). Therefore, the applicability of proffers is limited in the Popes Head Creek watershed. The retrofits should result in the facilities being able to provide the necessary routed storage for the one-year storm for an extended detention release rate over 24 hours. Reducing peak flows by means of one-year extended detention over a 24-hour period will help to reduce downstream erosion by controlling the more frequent smaller storms and will also provide volume control benefits for the larger, less frequent storms.

There are 51 existing stormwater management facilities located within the watershed that were identified using the County database. Four facilities are underground storage units that were not considered for retrofit because of constructability issues and the large construction costs with small benefits. Nineteen facilities already were designed with BMP control. The remaining 28 ponds were assessed in the field for retrofit possibilities. After the field reconnaissance, 11 of these ponds were determined to have retrofit possibilities. Most of the ponds that were eliminated from consideration as retrofit possibilities were either located in the rezoned area with low impervious area or had a small drainage area, resulting in very little benefit for the construction cost. Three of the ponds were recreation features, and one pond was located at GMU, outside of the County jurisdiction; therefore, all four were eliminated. After conceptual calculations of the 11 ponds, it was determined that these ponds have retrofit possibilities. The locations of existing stormwater management facilities and BMPs that are suitable for retrofit projects are described in Table 4.1 and shown on Maps 4.2, 4.3, 4.4, and 4.5. Detailed information regarding each pond and possible retrofit options can be found in Appendix F.

Table 4.1: Stormwater Pond Retrofits

Project ID	Map #	Name	Type of Project	Location	Benefit	Estimated Cost
PH9130	4.6	Colchester Hunt	Stormwater Pond Retrofit	Colchester Hunt Subdivision	Provide water quality control for uncontrolled areas.	$140,000
PH9131	4.4	Innisvale Pond	Stormwater Pond Retrofit	West of Innisvale Drive	Prevent dam failure. Increase pollutant removal efficiency	$190,000
PH9170	4.3	Braddock Road Pond	Stormwater Pond Retrofit	Braddock Road Near Groves Lane.	Increase pollutant removal efficiency, remove oil and other urban pollutants before entering pond.	$70,000
PH9180	4.4	Brentwood Ponds	Stormwater Pond Retrofit	West Pond: East of Piney Branch Road; East Pond: East of Goodwood Drive	Increase pollutant removal efficiency.	$140,000
PH9190	4.4	Marymead Pond	Stormwater Pond Retrofit	4805 Marymead Dr.	Add pollutant removal to pond, increase pollutant filtering through buffers.	$560,000
PH9191	4.4	Merrifield Gardens Pond	Stormwater Pond Retrofit	Route 29, on the back of the Merrifield Gardens property.	Increase pollutant removal efficiency of facility, remove oil and other urban pollutants before entering pond.	$70,000
PH9192	4.4	FCPA-Piney Branch Park Pond	Stormwater Pond Retrofit	Piney Branch Stream Valley Park (Route 29 & Pheasant Ridge Rd).	Increase pollutant removal efficiency of facility by 15%.	$720,000
PH9193	4.4	Sports Authority Pond	Stormwater Pond Retrofit	South side of Sports Authority in the Costco Plaza.	Remove oil and other urban pollutants before entering pond.	$120,000
PH9194	4.4	Piney Branch Road Extention Pond	Stormwater Pond Retrofit	Piney Branch Road & Route 29.	Remove oil and other urban pollutants before entering pond.	$120,000
PH9195	4.4	Costco East Pond	Stormwater Pond Retrofit	East of Costco in the Costco Plaza.	Remove oil and other urban pollutants before entering pond.	$120,000
PH9196	4.2	Waples Mobile Home Park Pond	Stormwater Pond Retrofit	Waples Mobile Home Park, on Via Drive.	Increase pollutant removal efficiency of facility by 15%.	$930,000

Watershed Benefit: Increased detention and pollutant removal will reduce the impacts of stormwater runoff on the environment. Increased capacity will also help to prevent flooding. This action will help contribute to the nutrient reduction goals of Virginia's Shenandoah and Potomac Basins Tributary Strategy.

Action A1.2: Install new BMP and LID facilities in areas that do not have existing stormwater management facilities, or in areas where retrofitting existing facilities is not feasible.

Strategy to Achieve Action: Target areas that exhibit high peak flows or flooding. These projects will be placed in areas that lack water quality controls and near headwaters to optimize watershed protection. The locations for the proposed LID projects are described in Table 4.2 and shown on Maps 4.2, 4.3, 4.4, 4.5, 4.6, and 4.8. Detailed information regarding each LID project can be found in Appendix G.

Table 4.2: Low Impact Development Projects

Project ID	Map #	Name	Type of Project	Location	Benefit	Estimated Cost
PH9800	4.8	Clifton Elementary School.	1 Bioretention area, 1 Filterra manufactured LID	Clifton Elementary School.	Reduce pollutants and provide education to faculty and students	$90,000
PH9801	4.8	Intersection of Compton and Clifton Roads	Grassed swale	Intersection of Compton and Clifton Roads	Reduction of pollutants in areas without existing controls.	$50,000
PH9820	4.6	Clifton Green Subdivision	Bioretention area and Grassed swale	Clifton Green Subdivision	Reduction of pollutants in areas without existing controls.	$50,000
PH9821	4.5	Fairfax Station Subdivision	3 Grassed Swales, 5 bioretention areas	Fairfax Station Subdivision	Reduction of pollutants in areas without existing controls.	$220,000
PH9830	4.5	Pickwick Woods Subdivision	3 Bioretention areas	Pickwick Woods Subdivision	Reduction of pollutants in areas without existing controls.	$90,000
PH9831	4.5	Smoke Rise Subdivision	1 Bioretention area.	Smoke Rise Subdivision	Reduction of pollutants in areas without existing controls.	$40,000
PH9841	4.5	Barton Place Subdivision	Grassed swale and 2 Bioretention areas	Barton Place Subdivision	Reduction of pollutants in areas without existing controls.	$230,000
PH9842	4.5	Fairfax Hunt	1 Bioretention area	Fairfax Hunt Subdivision	Reduction of pollutants in areas without existing controls.	$50,000
PH9850	4.6	Vannoy Park Subdivision.	2 Grassed swales	Vannoy Park Subdivision.	Reduction of pollutants in areas without existing controls.	$100,000
PH9851	4.4	Lewis Park Subdivision	2 Grassed swales	Lewis Park Subdivision	Reduction of pollutants in areas without existing controls.	$60,000
PH9860	4.3	West Hill Subdivision	2 Grassed swales, 2 Filterra manufactured LIDs	West Hill Subdivision	Reduction of pollutants in areas without existing controls.	$140,000
PH9870	4.2, 4.3	Brecon Ridge Subdivision	6 grassed swales, 1 bioretention area	Brecon Ridge Subdivision	Reduction of pollutants in areas without existing controls.	$160,000
PH9871	4.2	Ridges of Glendilough Subdivision.	2 Bioretention area and 2 Filterra manufactured LIDs.	Ridges of Glendilough Subdivision.	Reduction of pollutants in areas without existing controls.	$200,000
PH9872	4.4	Willow Springs Elementary School.	1 Bioretention area and 1 Filterra manufactured LID	Willow Springs Elementary School.	Reduce pollutants and provide education to faculty and students	$80,000
PH9877	4.2	Brecon Ridge Woods Subdivision.	1 Grassed swale and bioretention at pipe outfall	Brecon Ridge Woods Subdivision.	Reduction of pollutants in areas without existing controls.	$110,000
PH9880	4.4	Brentwood Subdivision	4 grassed swales, 3 bioretention areas	Brentwood Subdivision	Reduction of pollutants in areas without existing controls.	$160,000
PH9882	4.3	Braddox Subdivision.	1 Bioretention area in abandoned road right of-way.	Braddox Subdivision.	Reduction of pollutants in areas without existing controls.	$30,000
PH9883	4.4	Buckner Forest Subdivision.	1 Bioretention area.	Buckner Forest Subdivision.	Reduction of pollutants in areas without existing controls.	$30,000
PH9884	4.2	Fairfax Villa Subdivision	8 Filterra Manufactured LIDs, 3 bioretention areas, Rain barrel program	Fairfax Villa Subdivision	Reduction of pollutants in areas without existing controls.	$400,000
PH9885	4.2	Fairfax Villa Elementary School	2 Bioretention facilities.	Fairfax Villa Elementary School	Reduce pollutants and provide education to faculty and students	$60,000
PH9890	4.2	University Square Subdivision	2 Filterra Manufactured LIDs.	University Square Subdivision	Reduction of pollutants in areas without existing controls.	$80,000
PH9891	4.4	Glen Alden Subdivision.	1 grassed swale	Glen Alden Subdivision.	Reduction of pollutants in areas without existing controls.	$20,000

Watershed Benefit: New water quality controls will help to reduce nutrient and pollutant inputs into the streams. They will also reduce the volume and velocity of stormwater runoff. This action will help contribute to the nutrient reduction goals of Virginia's Shenandoah and Potomac Basins Tributary Strategy.

Objective A2: Reduce and mitigate the impacts of impervious surface.

Rationale: Large parcels of impervious surface create stormwater runoff, which damages and degrades stream habitat. When total imperviousness within a watershed exceeds 10%, environmental quality begins to show the first signs of degradation. The total imperviousness of the watershed is approximately 9%, just below the 10% threshold for environmental degradation. Four of the seven subwatersheds currently have greater than 10% imperviousness, despite the low-density development that resulted from the 1982 rezoning. Five of the seven subwatersheds are projected to have greater than 10% imperviousness in the future, based upon the planned or zoned land uses in the Fairfax County Comprehensive Plan.

Action A2.1: Program to facilitate and encourage homeowners and developers to disconnect impervious areas.

Strategy to Achieve Action: Homeowners can be encouraged to disconnect their downspouts from their driveways by aiming them towards the lawn; this will reduce water velocity and allow water to infiltrate into the soil, rather than washing directly into the street. Rain barrels can be distributed by the County for free or at a subsidized rate to homeowners in the watershed headwaters. Homeowners must then sign a maintenance agreement in order to obtain a rain barrel. Developers can be encouraged to utilize natural landscaping techniques, including the use of grass swales, to disconnect impervious areas and provide open spaces for stormwater to infiltrate into the soil. Detailed information regarding this non-structural project can be found in Appendix L.

Watershed Benefit: This action will reduce the amount of stormwater runoff by providing areas for infiltration; this will also help to recharge groundwater supplies. Homeowners with rain barrels can use the captured water for lawn and gardening purposes.

Action A2.2: Monthly street sweeping program for parking lots in the watershed and residential streets in the Fairfax Villa subdivision.

Strategy to Achieve Action: Schedule monthly street sweeping frequency on parking lots and residential streets in the Fairfax Villa subdivision. Fairfax Villa is one of the oldest subdivisions in the watershed and does not have any existing stormwater controls. Due to the nature of the built environment, there is no space available to install a new stormwater management facility. Detailed information regarding this non-structural project can be found in Appendix L.

Watershed Benefit: This action will reduce the amount of sediment, debris, and other pollutants from parking lot and road surfaces that are a potential source of pollution impacting Popes Head Creek.

Objective A3: Preserve, maintain, and restore streams to benefit stream health and habitat.

Rationale: Approximately 53% of the streams in the Popes Head Creek Watershed are of fair quality, and 26% are of poor or very poor quality. With the majority of the stream in fair or better condition, there is the opportunity to perform minimal stabilization techniques to stream reaches to prevent future erosion rather than wait for more serious erosion issues. In conjunction with the protection and restoration of the riparian buffers

and other upstream modifications, restoring and maintaining the streams will result in improved water quality and aquatic habitat, as well as a reduction in sedimentation. Additionally, restoring the streams and stabilizing the banks will reduce the loss of land on properties adjacent to the streams.

Action A3.1*:* The county and community groups should perform stream restoration projects in the areas identified as good candidates.

Strategy for Achieving Action: The County's Stream Physical Assessment identified areas of erosion with poor habitat and eroded banks that are potential areas for stream restoration. The project team also examined other areas that have been identified by public comment. In the areas with major erosion, a variety of stream restoration techniques will need to be utilized to achieve an appropriate cross sectional area and plan form. The proper channel size and shape needs to be designed to accommodate the stream flows in order to decrease the velocities, reduce erosion, and increase habitat. Techniques that may be employed include J-hook vanes, rock weirs, vortex rock weirs, toe protection, channel realignment, and removal of large woody debris. In areas with minimal erosion, less invasive techniques such as spot stabilization, removal of invasive/exotic plants, buffer revegetation, as mentioned above, and trash/debris removal can be utilized to reduce future erosion. Larger, more involved projects will be designed and constructed under County or the project team's supervision, while the minimal erosion area projects could be completed by citizen groups or individual homeowners. The locations of proposed stream restoration sites are described in Table 4.3 and shown on Maps 4.3, 4.6, 4.7, and 4.8. Detailed information regarding each stream restoration project can be found in Appendix H.

Table 4.3: Stream Restoration Projects

Project ID	Map #	Name	Type of Project	Location	Benefit	Estimated Cost
PH9200	4.8	Clifton Creek #2	Stabilization bank or minor channel realignment to reduce erosion of bank adjacent to Clifton Creek Drive	Along Clifton Creek Drive, west of Wesley Tyler Road	Reduction of erosion and stabilization of stream banks	$120,000
PH9201	4.8	Clifton Creek #1	Spot Stabilization of approximately 50% of stream along Clifton Creek Drive Increase buffer on private landowner side along entire reach length.	Along Clifton Creek Drive, from Main Street to Wesley Tyler Road	Prevent road failure and reduce future property loss	$90,000
PH9202	4.8	Clifton Road	Spot Stabilization of stream as necessary. Several locations where outfalls to the stream channel are highly eroded. Several locations where the buffer needed to be increased and stream stabilized adjacent to houses.	Along Clifton Road between Newman Road and just upstream of Great Oak Lane.	Reduce future stream and erosion of Clifton Road	$360,000
PH9204	4.7	Young Branch Drive	Stabilize 2-4' tall banks along 85% of reach, and stabilize 5-6' tall banks along 5% of reach. Several locations with 20-40' tall eroded banks adjacent to private homes need stabilization or minor channel realignment near Havener Road.	Adjacent to Young Branch Drive, from outfall to SWM pond. Between Havenner Road cul de-sac and Sudley Church Court respectively.	Prevent sediment flowing to downstream lake. Reduce future property and structure loss	$1,080,000
PH9210	4.6	Wycklow Drive	Increase buffer along entire stream length	Wycklow Drive and Wandering Lane.	Minimize future erosion and decrease pollutants to stream.	$60,000
PH9230	4.5	Queen's Brigade Drive	Ditch stabilization project. Investigate local drainage pattern and armor ditch	Queen's Brigade Drive	Minimize future erosion	$20,000
PH9270	4.3	Brookline Drive	Increase the stream buffer, install check dam	Upstream and downstream of Brookline Drive, surrounded by the County Club of Fairfax.	Mitigate high flows and velocities from the County Club.	$30,000
PH9271	4.2	Berwynd Road	Stabilize 2-4' tall banks along 75% of the reach. Remove large wood debris obstruction from blocking the channel at the south end of the reach.	West of Berwynd Road	Reduction of erosion and stabilization of stream banks, reduction of property loss	$330,000
PH9272	4.2	Fox Chapel Road	Stabilize 2-4' tall banks along 75% of the reach. Restore buffer to prevent future land loss.	South of Braddock Road, west of Fox Chapel Road	Reduction of erosion and stabilization of stream banks, reduction of property loss	$310,000

Watershed Benefit: This action will benefit the watershed by increasing the stream health and habitat, and reduce erosion potential in the future. In a stable stream system there will be minimal erosion and very little loss of sediments that are clogging ponds and culverts, causing more problems downstream.

***Action A3.2**:* Retrofit existing road culverts to reduce flooding and erosion at road crossings.

Strategy to Achieve Action: Install a control structure, such as a gabion dam or concrete weir structure, upstream of the road culvert on ephemeral or intermittent streams. Remove invasive plant species and plant native species to filter runoff and prevent erosion. The locations of proposed culvert retrofit sites are described in Table 4.4 and shown on Maps 4.4, 4.5, 4.6, and 4.7. Detailed information regarding each culvert retrofit project can be found in Appendix I.

Table 4.4: Culvert Retrofit Projects

Project ID	Map #	Name	Type of Project	Location	Benefit	Estimated Cost
PH9502	4.7	Tepper Drive	Install a 2 foot tall gabion dam upstream of the culvert. This will create a micro-pool in the shallow swale in the upstream wooded area.	Tepper Drive	Stormwater quality control	$40,000
PH9504	4.7	Private Drive near Yates Ford Road	Install a 2' high gabion dam upstream.	Private Drive near Yates Ford Road	Stormwater quality control	$50,000
PH9505	4.7	Balls Ford Road	Install a 3' high gabion dam upstream. Have gabion dam detain flow from concrete "V" ditches from road.	Balls Ford Road	Stormwater quality control	$70,000
PH9512	4.7	Fairfax Station Road	Remove blockage within culvert. Install a 3' high gabion dam upstream.	Fairfax Station Road	Stormwater quality control	$70,000
PH9530	4.6	Saddle Horn Road	Install a 3' high gabion dam upstream. Remove invasive/exotic plants and replant with native vegetation	Saddle Horn Road	Stormwater quality control	$60,000
PH9540	4.5	Smoke Rise Road	Install a 3' high gabion dam upstream.	Smoke Rise Road	Stormwater quality control	$60,000
PH9580	4.4	Fairfax County Parkway	Install a 4' high gabion dam upstream of Caisson Road.	Fairfax County Parkway	Stormwater quality control	$90,000

Watershed Benefit: A micro-pool will be formed upstream of the gabion weir structure, reducing stormwater runoff. This action will also allow water to infiltrate into the soil, recharging groundwater supplies.

Action A3.3: Replace road crossings that overtop and flood.

Strategy to Achieve Action: Replace culverts and bridges that overtop during one-year storm events. The 1979 *Proposed Drainage Plan, The Occoquan Watersheds* report (Parsons, Brinckerhoff, Quade and Douglas) identifies 30 road drainage projects in the Popes Head Creek watershed. This plan proposes to "roll over" 10 of the 30 proposed projects; the other 20 projects have been completed or recommended for deletion. Table 4.5 depicts the Master Drainage Plan proposed projects, with projects recommended for deletion shaded in grey.

Table 4.5: Master Drainage Plan Proposed Projects

SEGMENT	TAXMAP	Type of Work	Old Project Name	Old Project Number	Comments
ACADEMY	76-2	RAISE RD & RPL CULV FAIRFAX STATION ROAD		PH471	New Project PH9420
CASTLE CREEK	75-4	RAISE RD & RPL CULV NEWMAN RD		PH411	New Project PH9411
CASTLE CREEK	75-4	RAISE RD @ NEWMAN RD		PH412	Not added to study - based on field visit Feb 11, 2005, not exhibiting erosion or flooding at this time
CLIFTON	76-3	RAISE RD & RPL BRIDGE COLCHESTER ROAD		PH431	New Project PH9403
EAST FORK	68-1	FLOODPROOF HOUSE 4716 GROVESLN	Groves Lane	Z00018	Active project - not added to study
EAST FORK	68-1	RIP RAP	Breacon Ridge Sub	PH0291	New Project PH9270
EAST FORK	68-1	RAISE RD/REG SWM PND	Brookline Drive		Recommended for Deletion
LEGATO	56-1	STREAM RESTOR & STABIL		PH261	No erosion identified in SPA - not added to Plan
LEWIS PARK	66-2	LOWER INV & RPL CULVERT WALCOTT AVENUE		PH452	New Project PH9462
LEWIS PARK	67-1	LOWER INV & RPL CULV BRADDOCK		PH453	From photos - pipes have been enlarged since 1979 study - not added to study
LEWIS PARK	67-1	LOWER INV & RPL CULV		PH451	Recommended for Deletion
PINEY BRANCH	67-3	LOWER INV & RPL CULVERT POPES HEAD ROAD		PH422	New Project PH9453
PINEY BRANCH	76-1	RAISE RD & RPL CULVERT FAIRFAX STATION ROAD		PH441	New Project PH9414
POPES HEAD	75-4	RPL CULV & CHANNEL IMPROVEMENT ALONG CLIFTON ROAD		PH201	New Projects PH9401 and PH9202
POPES HEAD	75-4	RPL CULV @ CLIFTON RD		PH401	New Project PH9402
SHIRLEY GATE	57-3	STREAM RESTOR & STABIL		PH281	No erosion identified in SPA - not added to study
SHIRLEY GATE	57-3	STREAM STABIL	San Carlos DrR0010	X00014	Recommended for Deletion
VANNOY PARK	67-3	LOWER INVERT & RPL CULV NEWMAN		PH422	New Project PH9435
VANNOY PARK	76-1	LOWER INVERT & RPL CULVERT COLCHESTER ROAD		PH421	A swm pond is now located just upstream of this structure - not added to plan

Deleted projects are shaded in grey.

The locations of all proposed road crossing replacement projects, including those rolled over from the 1979 Proposed Drainage Plan, are described in Table 4.6 and shown on Maps 4.3, 4.4, 4.5, 4.6, 4.7 and 4.8. Detailed information regarding each road crossing project can be found in Appendix J.

Table 4.6: Road Crossing Projects

Project ID	Map #	Name	Type of Project	Location	Benefit	Estimated Cost
PH9400	4.8	Clifton Road and Popes Head Creek	Bridge Project	Clifton Road and Popes Head Creek	Reduce road flooding frequency – emergency access.	$1,850,000
PH9401	4.8	Clifton Road #2 and #3 at Popes Head Creek unnamed trib	Culvert Replacement	Clifton Road #2 and #3 at Popes Head Creek unnamed trib	Reduce road flooding frequency – emergency access.	$260,000
PH9403	4.6	Newman Road and Castle Creek	Bridge Project	Newman Road and Castle Creek	Reduce road flooding frequency – emergency access.	$390,000
PH9404	4.7	Colchester Road and Popes Head Creek	Bridge Project	Colchester Road and Popes Head Creek	Reduce road flooding frequency – emergency access.	$1,240,000
PH9412	4.6	Newman Road and Castle Creek Trib 1	Culvert Replacement	Newman Road and Castle Creek Trib 1	Reduce road flooding frequency – emergency access.	$430,000
PH9414	4.4	Fairfax Station Road and Piney Branch, Popes Head Creek, Trib to Popes Head	Culvert Replacement	Fairfax Station Road and Piney Branch, Popes Head Creek, Trib to Popes Head	Reduce road flooding frequency – emergency access.	$4,190,000
PH9420	4.5	Fairfax Station Road and Popes Head Creek unnamed trib	Culvert Replacement	Fairfax Station Road and Popes Head Creek unnamed trib	Reduce road flooding frequency – emergency access.	$160,000
PH9435	4.7	Newman Road and Castle Creek unnamed trib	Culvert Replacement	Newman Road and Castle Creek unnamed trib	Reduce road flooding frequency – emergency access.	$130,000
PH9450	4.6	Colchester Road and Castle Creek Trib 1	Drainage Improvement	Colchester Road and Castle Creek Trib 1	Reduce road flooding identified by community	$1,020,000
PH9452	4.4	Popes Head Road and Piney Branch	Bridge Project	Popes Head Road and Piney Branch	Reduce road flooding frequency – emergency access.	$10,000
PH9453	4.4	Popes Head Road and Piney Branch unnamed trib	Culvert Replacement	Popes Head Road and Piney Branch unnamed trib	Reduce road flooding frequency – emergency access.	$180,000
PH9461	4.5	Popes Head Road and Popes Head Creek	Bridge Project	Popes Head Road and Popes Head Creek	Reduce road flooding frequency – emergency access.	$1,050,000
PH9462	4.4	Walcott Ave and Piney Branch	Culvert Replacement	Walcott Ave and Piney Branch	Reduce road flooding frequency – emergency access.	$100,000
PH9470	4.3	Brookline Drive and East Fork	Culvert Replacement	Brookline Drive and East Fork	Reduce road flooding frequency – emergency access.	$300,000

Watershed Benefit: This action will reduce the number of roads that are flooded during large storm events. It will provide safe access for emergency vehicles and residents of the watershed.

***Action A3.4**:* Remove dumpsites and obstructions from stream corridors.

Strategy to Achieve Action: Dump sites and obstructions were identified in the watershed using the Stream Physical Assessment GIS data. In certain cases, community members and volunteers can assist in the removal and cleanup of small dumpsites. The locations of obstruction removal projects are shown on Maps 4.2, 4.3, 4.4, 4.5, and 4.8. Detailed information regarding each maintenance activity project can be found in Appendix K.

Table 4.7: Obstruction Removal Projects

Project ID	Map #	Name	Location	Type of Project	Benefit	Estimated Cost
PH9900	4.8	Kincheloe Road	Kincheloe Road, south of the Town of Clifton	Debris Removal	Removal of 55-Gallon Drums, tires, and trash	$4,000
PH9960	4.4	Hope Park Road	Hope Park Road, south of Rochester Drive	Debris Removal	Reduce safety risk and eliminate pollutant source	$3,000
PH9961	4.4	Hope Park Road #2	Hope Park Road and Piney Branch Tributary	Debris Removal	Reduce safety risk and eliminate pollutant source	$1,400,000
PH9962	4.5	Popes Head Road	Popes Head Road, west of Fairfax County Parkway	Debris Removal	Removal of debris which includes furniture, pallets, pulleys, and lawn waste	$5,000
PH9970	4.2	Washington Street	Washington Street and 2nd Road	Automobile/Debris Removal	Reduce safety risk and eliminate pollutant source	$5,000
PH9973	4.2	Bentonbrook	West of Bentonbrook	Obstruction Removal /collapsed footbridge removal	Remove dam and return stream to natural slope for fish to be able to swim upstream. Remove wooden footbridge for fish to swim upstream	$6,000
PH9981	4.4	Crescent Drive	South of Crescent Drive	Automobile Removal	Reduce safety risk and eliminate pollutant source	$5,000

Watershed Benefit: This action will remove unsightly debris from the watershed, which poses a safety risk. It will improve the aesthetic quality of the watershed. It also provides an opportunity for public outreach and education. The removal of obstructions will provide passage for fish to swim upstream.

Objective A4: Preserve, maintain, and restore riparian buffers to protect stream health and water quality.

Rationale: Approximately half of the stream buffers in the Popes Head Creek Watershed are of moderate, low, or poor quality. The primary cause for stream buffer loss in this watershed is clearing for lawns. Riparian buffers are needed to support watershed habitats by providing filtering of runoff from adjacent lands and providing a place for native plants and animals to live. The County's Chesapeake Bay Preservation ordinance requires that riparian buffers not be disturbed for perennial streams. The environment section of the County's *Policy Plan*, Objective 9 states: "Identify, protect, and enhance an integrated network of ecologically valuable land and surface waters for present and future residents of Fairfax County." Objective 10 states: "Conserve and restore tree cover on developed and developing sites. Provide tree cover on sites where it is absent prior to development." This watershed plan objective for restoring and managing riparian buffers helps to meet these *Policy Plan* objectives.

Action A4.1: Plant native vegetation next to streams in areas that are identified as good candidates for buffer restoration.

Strategy to Achieve Action: Restoring riparian buffers on public property is the first step. Also, work with private landowners to have them increase any stream buffers on their property. Additionally, place the land in a conservation easement if possible. The need for easements on private property will have to be determined to facilitate the restoration of riparian buffers. The removal of invasive/exotic species and the restoration of native species will be performed for all of the buffer restoration projects. When removing invasive/exotic species the use of herbicides will be limited and other methods, such as manual removal, employed where possible. The County and landowners will coordinate with the Virginia Department of Forestry, the National Wildlife Foundation, and the Virginia Native Plants Society to provide appropriate buffer material and species mixes. The

Virginia Department of Forestry features a Riparian Forest Buffer Establishment Pack and a cost sharing program. The locations of proposed riparian buffer restoration sites are described in Table 4.3 and shown on Maps 4.3, 4.6, 4.7, and 4.8. Detailed information regarding each stream restoration project can be found in Appendix H.

Watershed Benefit: The buffers will increase the amount of habitat area, protect floodplain areas from erosion, protect properties from damage due to lateral stream movement, decrease stormwater runoff, and help filter pollutants from runoff. Buffers also provide shade to the stream. Reduced temperature of water released to streams will reduce mortality of stream animals during peak flow events and increase available oxygen in the base flow. A typical 50-foot riparian buffer can reduce over 90% of suspended solids, 60% of phosphorous, and 70% of nitrogen from stormwater runoff that flows through the buffer area. This action will help contribute to the nutrient reduction goals of Virginia's Shenandoah and Potomac Basins Tributary Strategy.

Action A4.2: Monitor the condition of restored and existing riparian buffer with annual stream walks to evaluate the condition and areas needing improvement.

Strategy to Achieve Action: The County will encourage volunteers to perform annual stream walks to collect information about the condition of the buffer. County personnel will teach the volunteers about the benefits of healthy buffers and identify the appropriate plants to use. Detailed information regarding this non-structural project can be found in Appendix L.

Watershed Benefit: This action will benefit the watershed by providing a way to monitor the success or failure of protecting existing and restored riparian buffers. It also provides an opportunity for public outreach and education.

Objective A5: Maintain the open space and pastoral quality of the watershed and preserve the aesthetic quality in both urban and rural areas.

Rationale: The open space and the pastoral quality in the watershed are a source of community pride, and community members are very interested in protecting these characteristics, stating that they add to their quality of life. Open space and pastoral land allow water to infiltrate into the soil, reducing the amount of stormwater runoff and reducing flooding.

***Action A5.1*:** Facilitate the acquisition and donation of conservation easements by community groups for riparian buffer and stream protection, and public/private open space for the environmental quality corridors described in the *Fairfax County Comprehensive Plan.*

Strategy to Achieve Effort: Increase partnership opportunities with organizations such as the Northern Virginia Conservation Trust (NVCT) and support the acquisition of additional trail and conservation easements in the watershed. The NVCT already holds a 5.5 acre easement and holds in joint ownership with the Town of Clifton approximately 9 acres along Popes Head Creek, both in the Town of Clifton, and is working with landowners and local Park Authorities to create a trail system for recreation.

Landowner education must be a strong component of this action in order to inform owners about potential benefits and tax credits that they might receive. Conservation easements

will be primarily targeted in headwaters areas that lack riparian buffers where possible, or in areas with environmentally sensitive lands that are not otherwise protected by ordinance. Large blocks of forest will also be targeted; this will provide large habitat areas for wildlife and prevent fragmentation. Detailed information regarding this non-structural project can be found in Appendix L.

Watershed Benefit: Although the benefit of this action is not easily quantifiable, its implementation will benefit the watershed by increasing and improving riparian buffers and protecting streams for perpetuity. The benefits of riparian buffers and stream protection are improved habitat, reduced stream and property erosion, and filtering of pollutants from runoff.

Objective A6: Develop water quality sensitive recreational opportunities.

Rationale: The need to balance environmental quality and recreational opportunities has always been a challenge for land managers. Excessive utilization of a resource can lead to a "tragedy of the commons" scenario, whereby the resource is depleted or degraded by the use of many different parties. In the Popes Head Creek Watershed, the use of All Terrain Vehicles (ATVs) is the most common recreational use that has contributed to the degradation of stream habitat. The Code of Virginia presently precludes the operation of ATVs on another person's property without the written consent of the owner; however, this activity continues to occur. Many of the frequently used ATV trails pass through the RPAs, destroying vegetation that holds soil particles together; other trails cross the streams, resulting in erosion and sedimentation.

Action A6.1*:* Post official County signage that publicizes the existence of the Resource Protection Areas (RPAs) and states that ATV and other usages that destroy vegetation and cause erosion are not permitted in the RPA.

Strategy to Achieve Action: The signs will be placed in highly visible locations near known ATV trails. The County will coordinate with local landowners to determine where the optimum placement for the signs is. Detailed information regarding this non-structural project can be found in Appendix L.

Watershed Benefit: The signs may deter ATV riders from damaging vegetation and causing erosion within the RPAs.

Action A6.2: Coordinate with the Fairfax County Police to target areas with significant ATV impacts for enforcement of existing laws and ordinances (e.g. trespassing and environmental regulations).

Strategy to Achieve Action: Establish "neighborhood watch" groups to report ATV violations on private property or Fairfax County parkland. The neighborhood watch groups could coordinate with the local Fairfax County Police community liaison to enforce "no trespassing" and RPA regulations. They could also help educate citizens about the impacts ATVs have on the watershed. Detailed information regarding this non-structural project can be found in Appendix L.

Watershed Benefit: This action will provide a deterrent to illegal ATV use and will reduce the number of ATV violations. It will also provide a good opportunity for public education and outreach.

Objective A7: Maintain the diversity of wildlife in the watershed.

Rationale: Community residents expressed a desire to provide a high quality environment for both humans and wildlife within the watershed. Communities that are highly diverse are indicative of healthy and strong ecosystems.

Action A7.1: Conserve land and water ecosystems to provide high quality habitat for wildlife.

Strategy to Achieve Action: This action will be accomplished by the implementation of Actions A4.1 and A5.1. The County will consult with local landowners to determine key areas to target for protection.

Watershed Benefit: The conservation of habitat will have many different benefits for the watershed. Residents will benefit from increased recreational opportunities, such as bird and wildlife viewing, hiking, and fishing. Trees in the riparian buffer zone will provide shade and food for aquatic life. The riparian buffer will also protect floodplain areas from erosion, protect properties from damage due to lateral stream movement, decrease stormwater runoff, and help filter pollutants from runoff. A typical 50-foot riparian buffer can reduce over 90% of suspended solids, 60% of phosphorous, and 70% of nitrogen from stormwater runoff that flows through the buffer area.

Action A7.2*:* Preserve large blocks of forest to prevent further fragmentation.

Strategy to Achieve Action: Increase partnership opportunities with organizations such as the Northern Virginia Conservation Trust (NVCT) and support the acquisition of large blocks of forest to place under conservation easement. The NVCT already holds a 5.5 acre easement and holds in joint ownership with the Town of Clifton approximately 9 acres along Popes Head Creek, both in the Town of Clifton, and is working with landowners and local Park Authorities to create a trail system for recreation.

Landowner education must be a strong component of this action in order to inform owners about potential benefits and tax credits that they might receive. Conservation easements will be primarily targeted in headwaters areas that lack riparian buffers where possible, or in areas with environmentally sensitive lands that are not otherwise protected by ordinance.

Watershed Benefit: This action will provide large habitat areas for wildlife and prevent fragmentation of habitat. Large blocks of forested land also provide increased stormwater infiltration, reducing stormwater runoff and increasing water quality in the watershed.

Goal B: Have a well informed community that is actively involved in watershed stewardship.

Public participation and outreach is a vital component of the watershed plan. An educated and active citizen base can promote environmental stewardship by “spreading the word” to neighbors, co-workers, friends and family members. They can identify new problem areas in the watershed and report them to the proper officials. A well informed and active community can also leverage political or financial support for watershed management projects.

Objective B1: Achieve community sponsorship of the watershed.

Rationale: Education and involvement in watershed issues will help to drive the actions for all of the goals of this plan. The community has been involved in all phases of the process to develop the Popes Head Creek Watershed Management Plan, and continued involvement will help in improving the state of the watershed. The County will also help to facilitate this goal through its Community Watershed Services Support project. This program will support community education and involvement strategies by distributing educational materials to the public, providing technical assistance to the community, and assisting in conducting outreach to neighborhood groups and associations. Community sponsorship is important for communicating plan successes, monitoring progress, and modifying the plan as necessary to adapt to changing conditions and ensure future success.

Action B1.1: Support the formation of a "Friends of Popes Head Creek" group composed of local citizens.

Strategy to Achieve Action: The current Citizen's Advisory Committee will be encouraged to continue to meet after the watershed planning process has been completed. They will coordinate with other existing organizations to create a robust network of watershed stewards. The County will provide guidance and technical assistance through the Community Watershed Support Services program. Detailed information regarding this non-structural project can be found in Appendix L.

Watershed Benefit: The benefits produced by active citizen involvement cannot easily be quantified; however, there are many different advantages that this action will achieve. The Friends of Popes Head Creek group will coordinate with existing local and state organizations to promote volunteer opportunities such as stream cleanup, stream monitoring, and education activities. They can seek grants and community sponsors to help fund watershed improvement projects. A feeling of community "ownership" of the watershed can also persuade residents to protect their environment.

Action B1.2: Establish a group of volunteer stream monitors and monitoring sites.

Strategy to Achieve Action: The main stem of Popes Head Creek does not currently have any active volunteer stream monitors in the stream monitoring program run by the Northern Virginia Soil and Water Conservation District. The Community Watershed Support Services program or members of the Stream Protection Strategy (SPS) will provide training to volunteers and assign them to the existing SPS sampling sites, as shown on Map 2.11. The volunteers will also coordinate with the existing group of volunteers at the Audubon Naturalist Society's Webb Sanctuary, who monitor an unnamed tributary of Popes Head Creek. The volunteers will conduct sampling at the SPS sites four times a year, and report their findings to the County. Detailed information regarding this non-structural project can be found in Appendix L.

Watershed Benefit: This action will supplement and enhance the level of monitoring that is currently performed in Popes Head Creek and provide a more complete dataset for evaluation. It will engage the citizens and provide them with an opportunity to learn more about biological monitoring. It provides an opportunity for public outreach and

participation. This action can also be used to evaluate the impacts of BMPs and LID projects that have been installed upstream of the monitoring sites.

Objective B2: Develop and consolidate educational materials that describe the value of the watershed.

Rationale: Many community members have expressed a desire to "do their part" to help protect the watershed by improving landscaping and water use practices at home. However, they have stated that existing materials are often hard to find and not specific to their watershed. Many citizens have suggested that new educational materials be developed that will specifically tell homeowners what species of native plants to use, where to obtain the plants, and where to use the plants on their property. They also stressed that consolidation of materials is very important; the materials must be easily accessible to the public, and contain all of the required information in one package.

Action B2.1*:* Develop and distribute educational materials that describe beneficial landscaping techniques for homeowners.

Strategy to Achieve Action: There are numerous existing materials that describe various aspects of watershed protection; the materials that are most applicable to the Popes Head Creek Watershed will be consolidated and packaged together. If the existing materials do not adequately address the specific issues found in Popes Head Creek, then new educational materials will be produced by the County. The materials will, at a minimum, address the following issues:

- Nutrients and proper lawn care;
- The benefits provided by riparian buffers;
- The benefits of using native plants for landscaping, and how to identify and remove invasive plant species;
- Identification keys for native plant species;
- Local nurseries that sell native plants;
- Care of home ponds;
- Contact information for the Fairfax County Master Gardener and the Agricultural Extension Office.
- Easy-to-implement solutions to stormwater runoff, designed for homeowners.

Because Popes Head Creek is primarily composed of Estate Residential land uses, the educational materials will address the management and maintenance of large lots that are greater than one acre. Most existing educational materials for homeowners describe management strategies for medium-density, quarter acre lots, which may not be appropriate for the majority of the watershed.

There are several different strategies for distribution of education materials. They can be mailed annually to homeowner associations (HOAs) for redistribution. The materials can be included in quarterly notices from the Fairfax County Water Authority; however, some residents in the watershed maintain private wells and do not receive mail from the Water Authority. Another strategy is to include educational materials in the Fairfax County Health Department's annual notice to switch septic drain fields. Detailed information regarding this non-structural project can be found in Appendix L.

Watershed Benefits: The benefits provided by this action are not easily quantifiable. However, a well informed and educated community is more likely to engage in stewardship and volunteer opportunities within the watershed. They may also spread the environmental protection techniques they have learned to neighbors, co-workers, friends, and family members, strengthening a network of environmental stewards.

Action B2.2: Develop and distribute educational materials that describe beneficial landscaping techniques to landscaping companies and suppliers.

Strategy to Achieve Action: These brochures will be distributed to landscaping companies and lawn and garden suppliers who are highly active within the watershed. Materials will be printed in multiple languages to facilitate understanding. They will stress the importance of water quality protection, and detail the dangers that result from the over-application of fertilizers and pesticides. Detailed information regarding this non-structural project can be found in Appendix L.

Watershed Benefit: This action will help prevent excessive nutrients from running off into the streams, preventing eutrophication. Eutrophication occurs when algal blooms, stimulated by excessive nutrients, prevent sunlight from reaching other aquatic plants; the algal blooms eventually die and decompose, reducing the amount of dissolved oxygen available for aquatic life. This action will also prevent harmful pesticides from running off into streams. This action will help contribute to the nutrient reduction goals of Virginia's Shenandoah and Potomac Basins Tributary Strategy.

Action B2.3: Distribute educational materials about appropriate horse care and grazing management in the Resource Protection Area.

Strategy to Achieve Action: Coordinate with the Northern Virginia Soil and Water Conservation District (NVSWCD) to promote the existing educational program for horse care and grazing practices. These educational materials will be distributed to local veterinarians who care for horses or other large animals; they can then redistribute the materials to horse owners during annual examinations. Educational materials will also be distributed to suppliers of horse care products and supplies. The materials will also be given to local organizations, such as the Clifton Horse Society. Detailed information regarding this non-structural project can be found in Appendix L.

Watershed Benefit: A significant number of people within the watershed own horses. If horse owners are taught techniques for proper horse management within the RPA, erosion and sedimentation can be decreased. Fecal coliform levels will also decrease if animal waste is stored in an appropriate location, thus protecting water quality.

Action B2.4: Distribute educational materials to private pond owners that describe proper maintenance.

Strategy to Achieve Action: The Virginia Department of Game and Inland Fisheries produces a brochure that describes best management practices for private ponds. These brochures can be distributed to private pond owners and to local realtors who market properties that contain ponds. Detailed information regarding this non-structural project can be found in Appendix L.

Watershed Benefit: Proper pond maintenance can prevent the growth of harmful vegetation and the cultivation of mosquitoes. It can also prevent dam failure.

Action B2.5: Develop and distribute educational materials for proper ATV usage in the watershed.

Strategy to Achieve Action: Distribute educational materials to ATV dealers that describe the impacts of ATVs on the stream corridor, governing regulations, and proper ATV etiquette. Detailed information regarding this non-structural project can be found in Appendix L.

Watershed Benefit: The educational materials may deter ATV riders from damaging vegetation and causing erosion within the RPAs. They will also be informed of the potential penalties that result from illegal usage of ATVs on public or private property.

Action B2.6*:* Develop and distribute educational materials that describe the benefits of wildlife, such as beavers, in the watershed.

Strategy to Achieve Action: Coordinate with agencies, such as the Fairfax County Park Authority and the Virginia Department of Game and Inland Fisheries, to distribute educational materials to landowners in areas where wildlife is abundant. Detailed information regarding this non-structural project can be found in Appendix L.

Watershed Benefit: Wildlife performs many important functions in ecosystems. Beavers can increase plant biodiversity by damming streams, which creates habitat diversity. Beaver dams decrease downstream flooding, and allow pollutants to infiltrate into the ground, therefore increasing water quality benefits.

Goal C: Continue to maintain the Occoquan Reservoir as a clean and sustainable source of potable water for Fairfax County.

The Occoquan Reservoir is the major source of potable water for the residents of Fairfax County. It is a 2,100 acre impoundment that is managed by the Fairfax County Water Authority, forming the boundary between Fairfax and Prince William Counties. As stated previously in this report, over 41,000 acres in the Occoquan Watershed were rezoned in 1982 to protect water quality. Land in the rezoned area is classified as Residential-Conservation (R-C) District, or one dwelling unit per five acres.

Objective C.1: Reduce the amount of pollutants, such as fecal coliform, nitrogen, phosphorus, and sediment that enters the Occoquan Reservoir.

Rationale: Excessive nutrients cause algal blooms to form. These blooms prevent sunlight from reaching other aquatic plants, and eventually die and decompose, reducing the amount of dissolved oxygen available for aquatic life. This process is known as eutrophication, and increases the cost of treatment at the Fairfax County Water Authority water treatment plant.

Action C1.1: Install new LIDs and BMPs or enhance the performance of existing stormwater management facilities to reduce sediment and phosphorus loading in stormwater runoff.

Strategy to Achieve Action: New LIDs and BMPs will be installed in strategic locations to maximize pollutant removal, such as downstream of large impervious areas, or downstream of known sources of nutrient-rich runoff. The retrofit of existing stormwater management facilities will provide a greater pollutant removal benefit through nutrient uptake by plants, or by detaining water for a longer time in detention facilities. The County would not have to obtain an easement for retrofitting existing public stormwater management facilities unless additional areas around the facilities are needed. The cost is minimal to create a wetland in the bottom of an existing dry detention facility and/or reconfigure the outlet structure. This Action will be achieved through the implementation of Action A1.1: *Retrofit Existing Stormwater Management Facilities* and Action The locations of existing stormwater management facilities and BMPs that are suitable for retrofit projects are described in Table 4.1 and shown on Maps 4.2, 4.3, 4.4, and 4.5. Detailed information regarding each pond and possible retrofit options can be found in Appendix F. The locations for new proposed LID projects are described in Table 4.2 and shown on Maps 4.2, 4.3, 4.4, 4.5, 4.6, and 4.8. Detailed information regarding each LID project can be found in Appendix G.

Watershed Benefit: This action would reduce the amount of polluted runoff that enters the Occoquan Reservoir. This will prevent the formation of harmful algal blooms and decrease the treatment costs of the Fairfax County Water Authority Water Treatment Plant. It will also help contribute to the nutrient reduction goals of Virginia's Shenandoah and Potomac Basins Tributary Strategy.

Action C1.2: Manage large existing areas of lawn at institutional and commercial properties to minimize nutrient loading in streams.

Strategy to Achieve Action: Coordinate with large landowners, including George Mason University and the Country Club of Fairfax, to reduce fertilizer and nutrient runoff from athletic fields and other large areas of managed turf. The County will provide education on nutrient management to grounds crews at these properties. The Special Exception Amendment for the County Club of Fairfax (SEA 99-S-012, approved February 23, 2004) requires the County Club to meet various floodplain, water quality, and stormwater management conditions. The Zoning Enforcement Branch and DPWES will monitor the Country Club to ensure that these conditions are being met.

Watershed Benefit: Proper procedures for managing these areas will minimize nutrient and sediment loading in streams. This will help contribute to the nutrient reduction goals of Virginia's Shenandoah and Potomac Basins Tributary Strategy.

4.4.1 Summary of Projects:

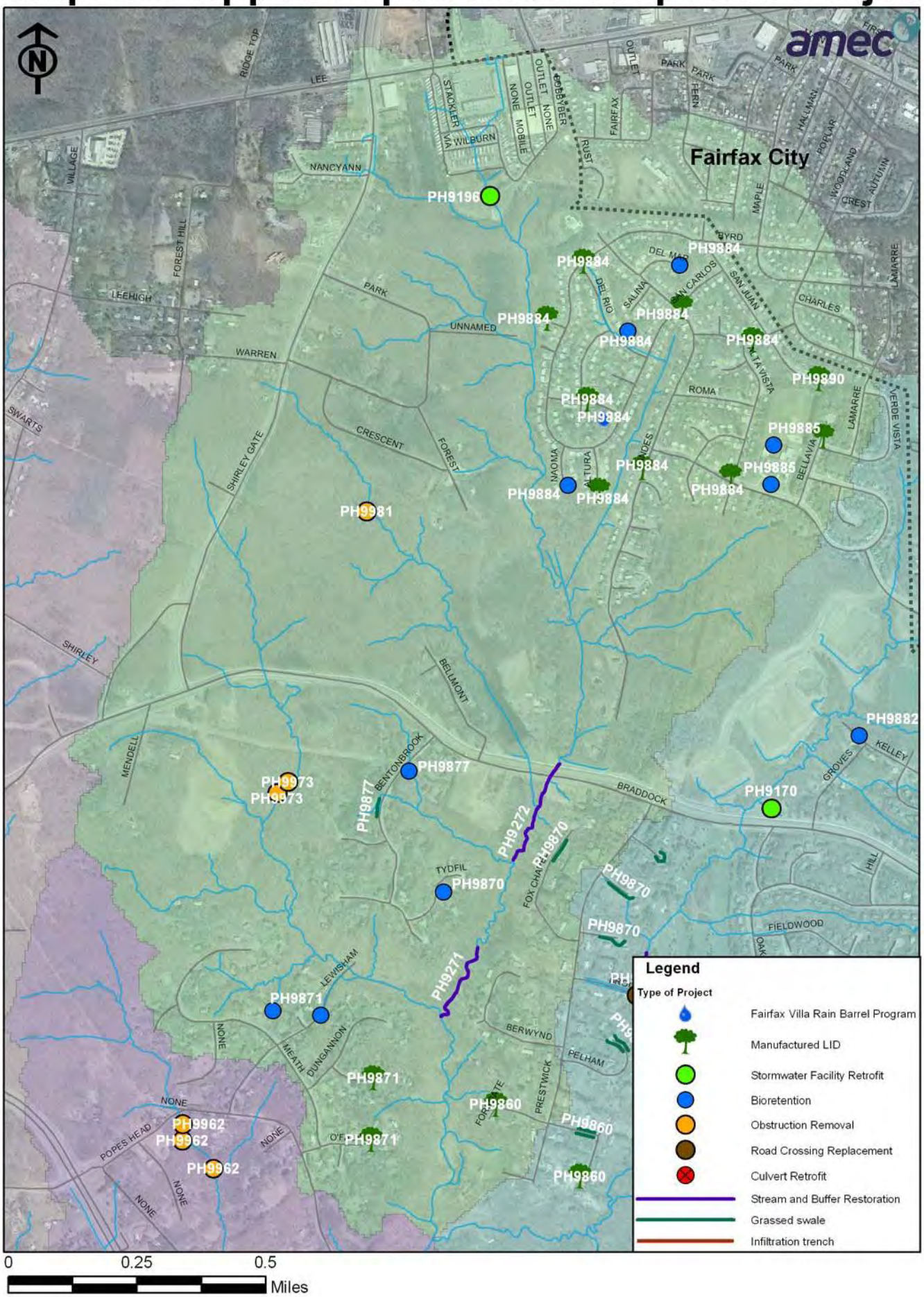
Maps 4.2 – 4.8 show the locations of structural projects in each of the seven subwatersheds. Table 4.8 summarizes the non-structural projects, which do not have a specific location attributed to them.

Table 4.8: Non Structural Projects

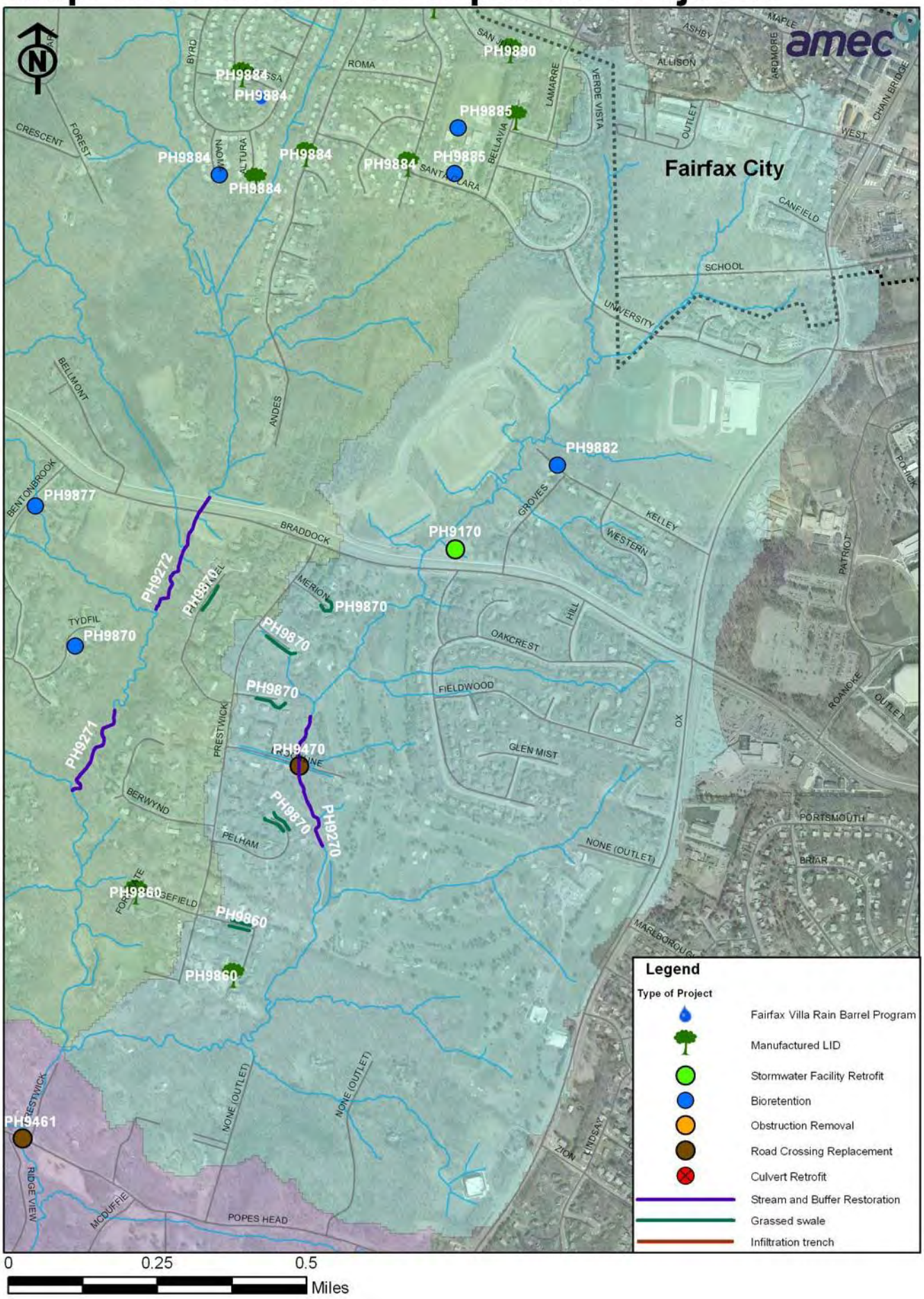
Action ID	Description	Benefit	Estimated Cost
A2.1	Program to facilitate and encourage homeowners and developers to disconnect impervious areas.	Reduction in stormwater runoff flowing directly to the street and storm drain system	$8,000 annual cost
A2.2	Monthly street sweeping program for parking lots in the watershed and residential streets in the Fairfax Villa subdivision	Street sweeping will removed the sediments, debris and gross particulate matter	$40,000 annual cost
A4.2	Monitor the condition of restored and existing riparian buffers	Provides public outreach and a way to monitor the success or failure of protecting existing and restored buffers.	$10,000 annual cost
A5.1	Facilitate the acquisition and donation of conservation easements for riparian buffer and stream protection	Increased and improved riparian buffers to protect the streams for perpetuity. Additionally, this will result in improved habitat	$30,000 annual cost
A6.1	Post official County signage that publicizes the existence of the Resource Protection Areas (RPAs)	The signs may deter ATV users and others from activities that damage vegetation and cause erosion within the RPAs.	$15,000 initial cost, $3,200 annual cost
A6.2	Coordinate with the Fairfax County Police to target areas with significant ATV impacts	Provides a deterrent to illegal ATV use on private land and RPAs and reduce the number of ATV violations.	$10,000 annual cost
B1.1	Support the formation of a “Friends of Popes Head Creek” group composed of local citizens.	Promotes volunteer opportunities such as stream cleanup, stream monitoring, and education activities.	$4,800 annual cost
B1.2	Establish a group of volunteer stream monitors and monitoring sites.	Supplements and enhances the level of monitoring that is currently performed in Popes Head Creek and provides a more complete dataset for evaluation.	$8,000 annual cost
B2.1	Develop and distribute educational materials that describe beneficial landscaping techniques for homeowners.	A well informed and educated community is more likely to engage in stewardship and volunteer opportunities within the watershed.	$8,000 annual cost
B2.2	Develop and distribute educational materials that describe beneficial landscaping techniques to landscaping companies	This will help prevent excessive nutrients and harmful pesticides from running off into the streams, preventing eutrophication.	$8,000 annual cost
B2.3	Develop and distribute educational materials about appropriate horse care and grazing management in the RPA.	Decreased erosion, sedimentation, and fecal coliform levels.	$4,800 annual cost

Action ID	Description	Benefit	Estimated Cost
B2.4	Develop and distribute educational materials to private pond owners that describe proper maintenance.	Proper pond maintenance can prevent the growth of harmful vegetation and the cultivation of mosquitoes.	$4,800 annual cost
B2.5	Develop and distribute educational materials for proper ATV usage in the watershed.	The educational materials may deter ATV riders from damaging vegetation and causing erosion within the RPAs.	$4,800 annual cost
B2.6	Develop and distribute educational materials that describe the benefits of wildlife, such as beavers, in the watershed.	Beavers can increase plant biodiversity by damming streams, which creates habitat diversity.	$4,800 annual cost
C1.2	Manage large existing areas of lawn at institutional and commercial properties to minimize nutrient loading in streams	Proper procedures for managing the athletic fields will minimize nutrient and sediment loading in the stream	$8,000 annual cost

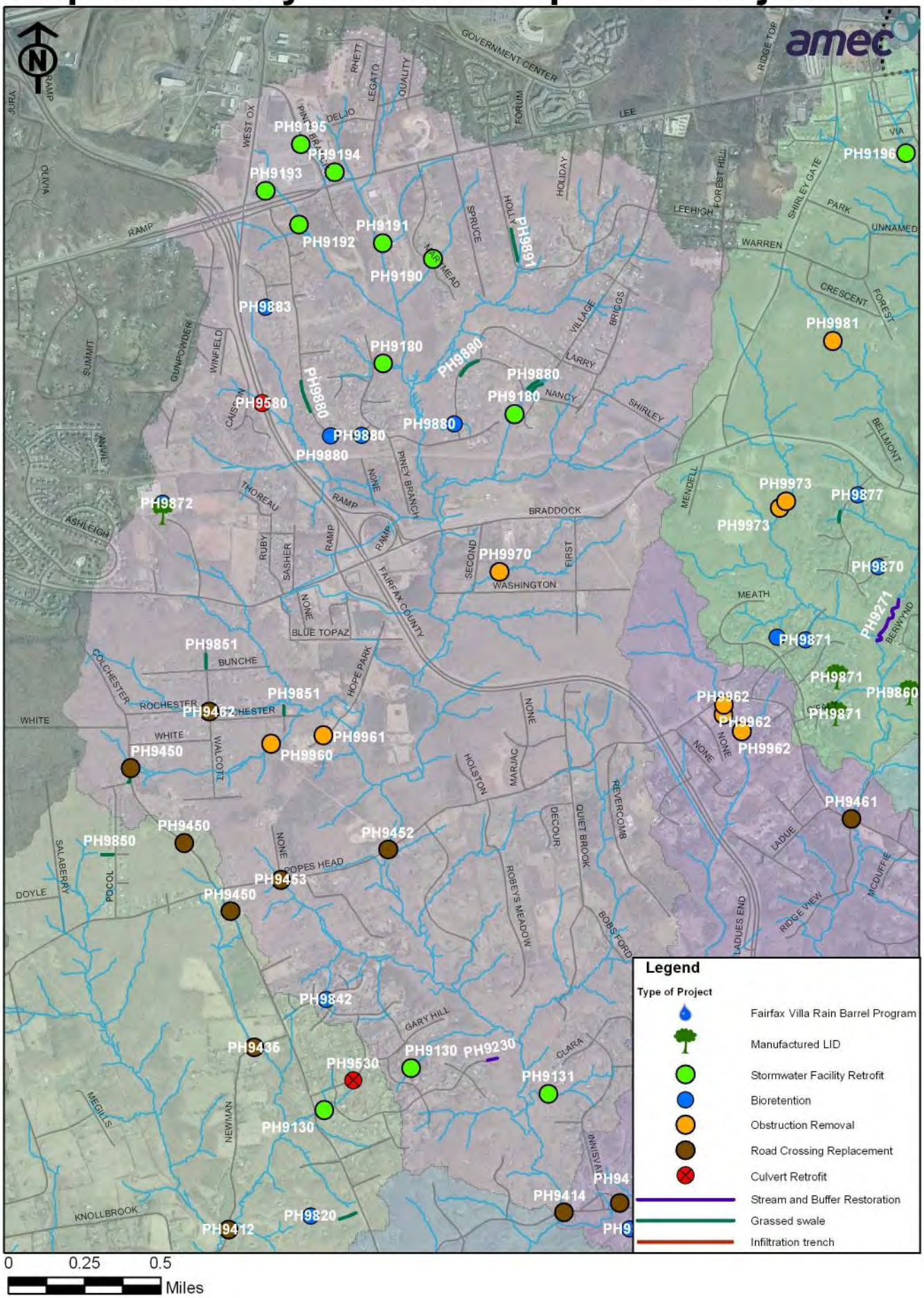
Map 4.2: Upper Popes Head Proposed Projects



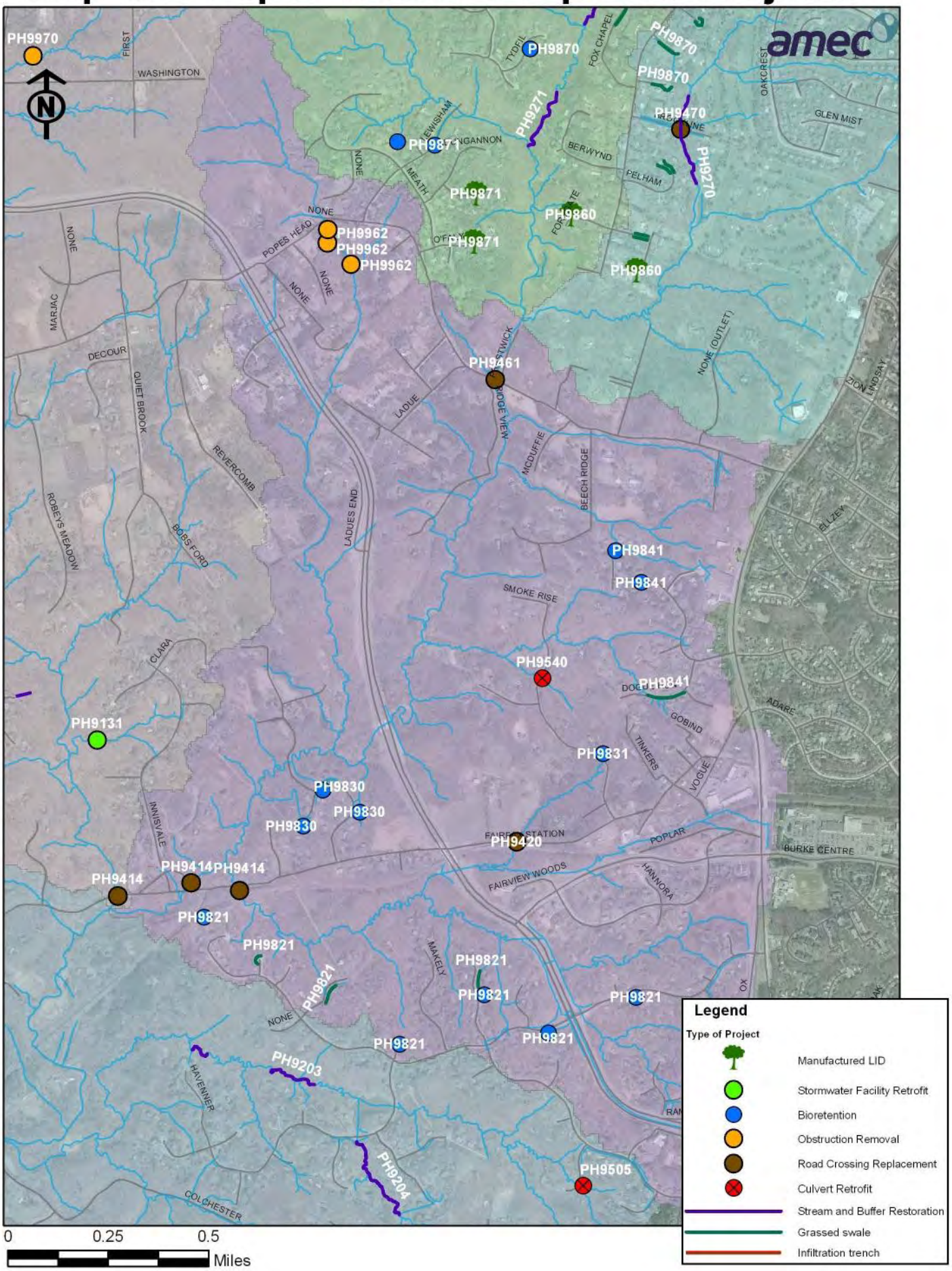
Map 4.3: East Fork Proposed Projects



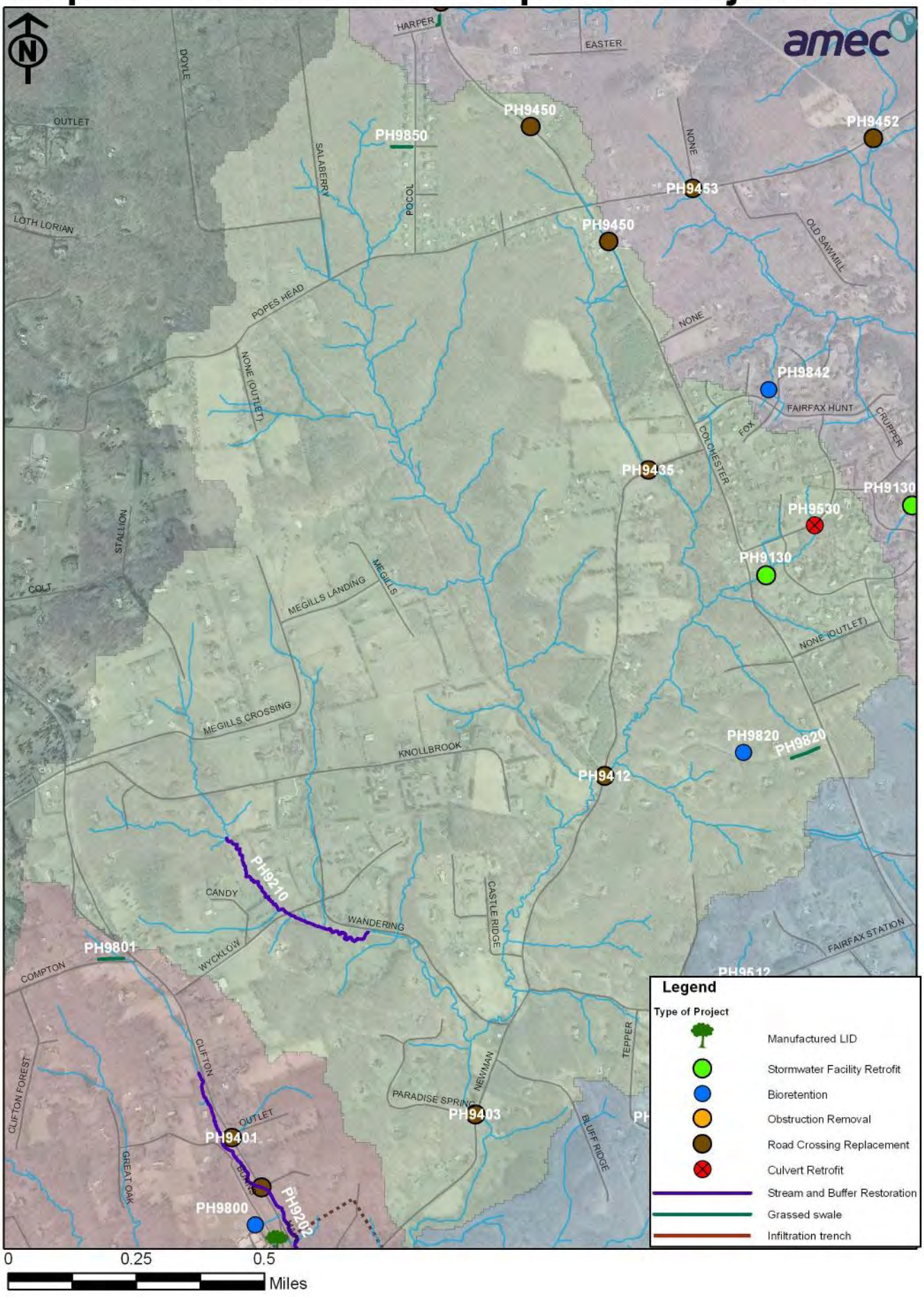
Map 4.4: Piney Branch Proposed Projects



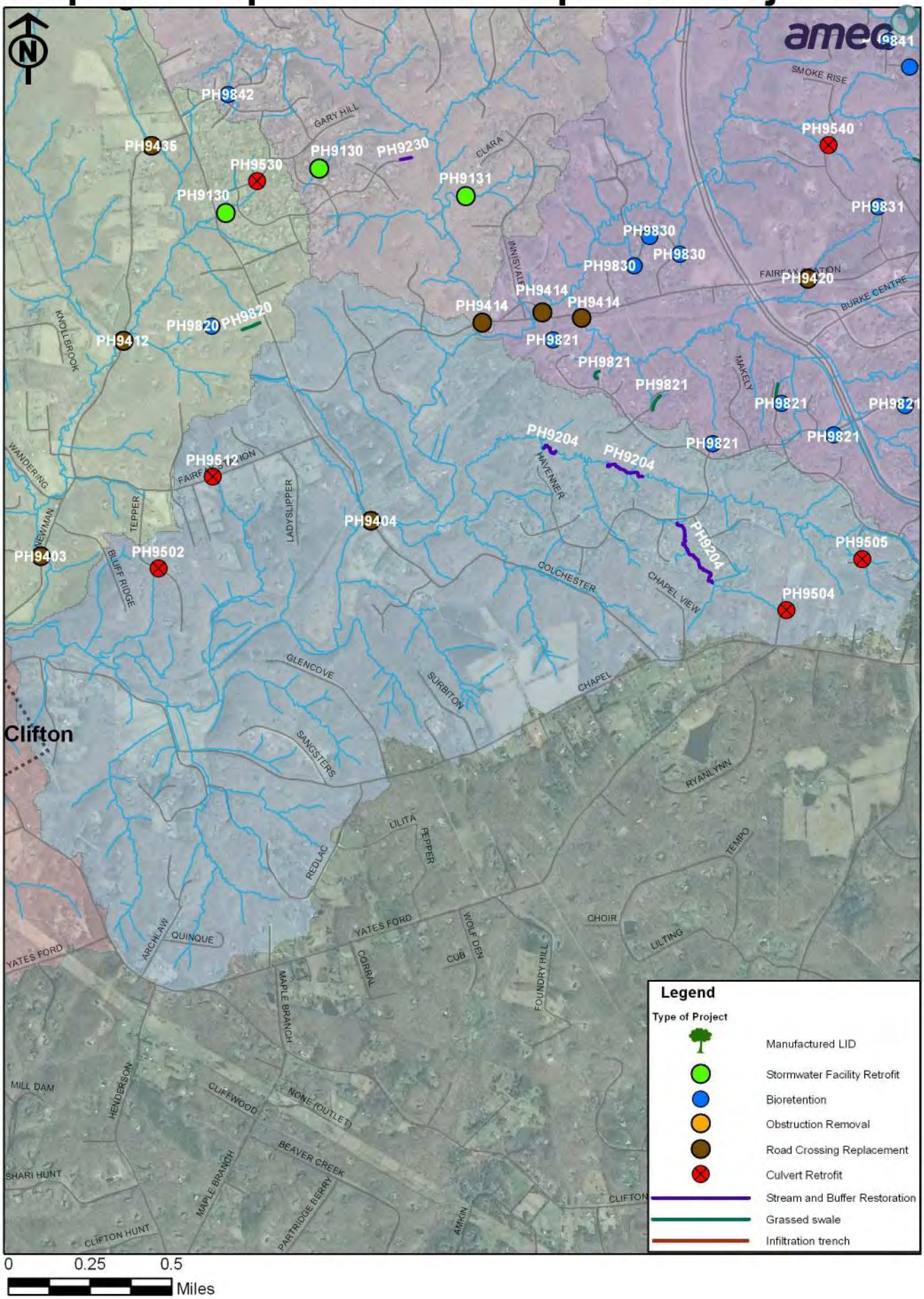
Map 4.5: Popes Head 2 Proposed Projects



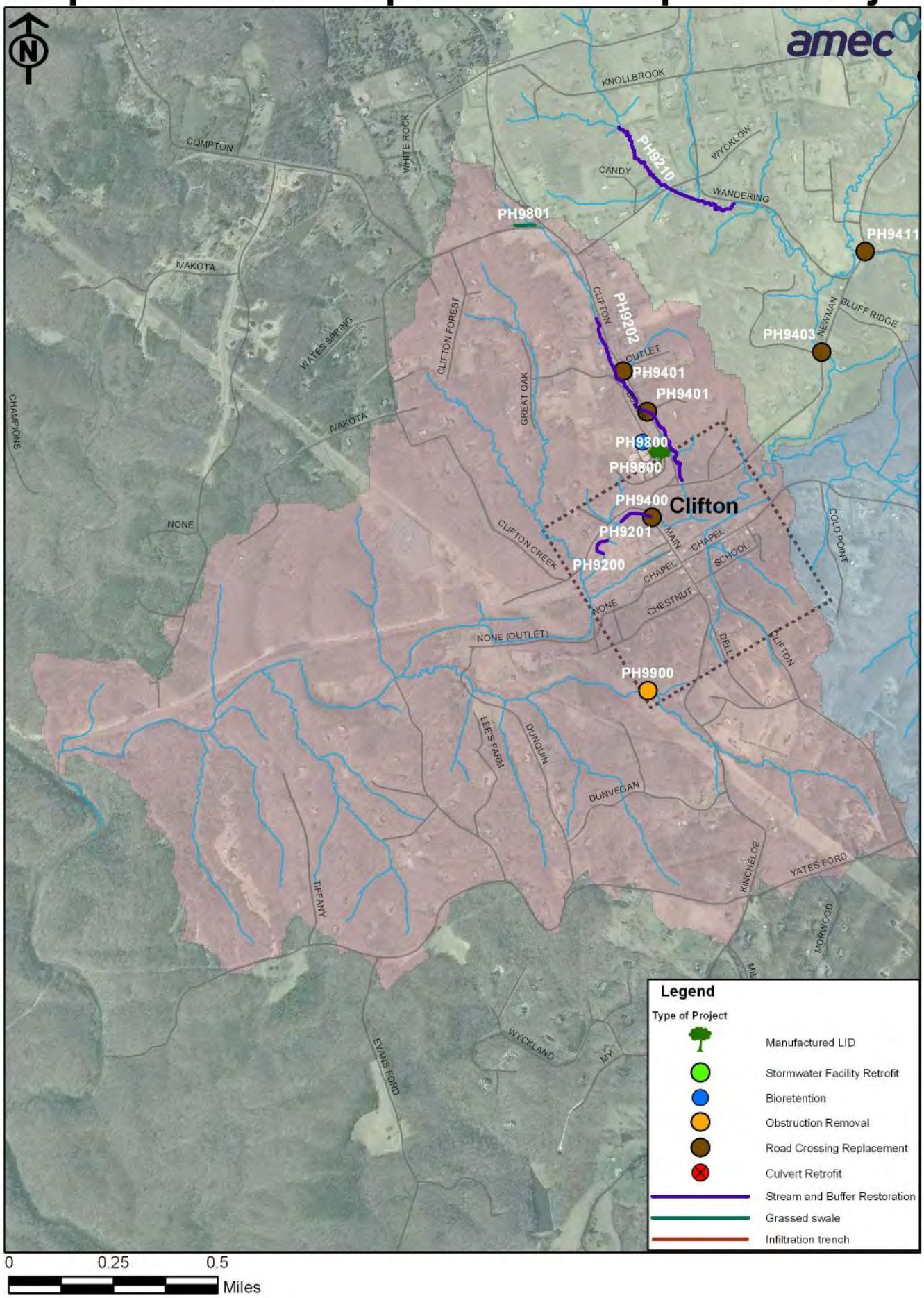
Map 4.6 Castle Creek Proposed Projects



Map 4.7: Popes Head 3 Proposed Projects



Map 4.8: Lower Popes Head Proposed Projects



4.5 Benefits of Plan Actions

Future conditions and future conditions with proposed BMPs were modeled to compare the condition of the watershed when development is continued without any changes to the watershed, and when projects identified above are completed. Unlike other watersheds within Fairfax County, the Popes Head Creek watershed is currently in good condition, with a future imperviousness of only 11.4%, due to the 1982 rezoning for the Occoquan reservoir. Even though it is not a highly developed watershed, it is still important to implement the proposed actions to preserve the watershed and because Popes Head Creek is a major tributary to the Occoquan Reservoir, which serves as one of the primary drinking water sources for Fairfax County. With this in mind, most of the proposed BMP projects and watershed wide actions are for water quality control, not water quantity control.

The proposed actions in the Popes Head Creek Watershed Management Plan will reduce pollutant loadings throughout the watershed. The future conditions with proposed BMPs model shows a 8.93% decrease in Total Suspended Solids (TSS), a 3.15% decrease in Total Phosphorus (TP), and a 2.85% decrease in Total Nitrogen (TN) pollutant loads for the entire Popes Head Creek watershed. It is important to note that the Popes Head Creek watershed will not show significant decreases in pollutant loading due to the relatively pristine existing condition of the watershed. The Piney Branch and Popes Head 2 subwatersheds both show above average improvements. This is important because both subwatersheds were given "fair" Stream Protection Strategy site condition ratings, as shown on Map 2.11. All other subwatersheds have "good" or "excellent" site condition ratings. Table 4.9 shows pollutant reductions by subwatershed if the proposed BMP projects are implemented.

Table 4.9 Pollutant Loading by Subwatershed

Subwatershed	Future TSS (lb/ac/yr)	Future TSS with proposed BMPs (lb/ac/yr)	Reduction in TSS (lb/ac/yr)	% Decrease TSS	Future TP (lb/ac/yr)	Future TP with proposed BMPs (lb/ac/yr)	Reduction in TP (lb/ac/yr)	% Decrease TP	Future TN (lb/ac/yr)	Future TN with proposed BMPs (lb/ac/yr)	Reduction in TN (lb/ac/yr)	% Decrease TN
Castle Creek	31.78	31.03	0.75	2.37	0.39	0.39	0.00	0.76	2.98	2.96	0.02	0.50
Piney Branch	58.84	46.51	12.33	20.95	0.56	0.52	0.04	6.82	4.20	3.97	0.23	5.54
East Fork	152.52	145.63	6.89	4.52	0.88	0.86	0.02	1.71	7.52	7.35	0.17	2.29
Upper Popes Head	91.34	89.37	1.97	2.16	0.85	0.84	0.01	1.29	6.18	6.10	0.08	1.21
Popes Head 2	67.70	60.29	7.40	10.93	0.59	0.57	0.02	4.05	4.91	4.70	0.21	4.30
Popes Head 3	37.75	36.48	1.27	3.36	0.44	0.44	0.01	1.58	3.47	3.45	0.02	0.58
Lower Popes Head	56.32	54.69	1.63	2.89	0.47	0.46	0.01	1.71	4.33	4.26	0.06	1.50
Popes Head Creek Total	63.64	57.96	5.69	8.93	0.57	0.55	0.02	3.15	4.52	4.39	0.13	2.85

Stream Habitat Improvements

The proposed stream restoration projects will also improve the stream habitat and improve water quality. To quantify the benefits of the proposed stream restoration projects, the Army Corps of Engineers (COE) stream condition index (SCI) rating was applied to the stream reaches to determine the increase in stream habitat and reduction in erosion and sediment loss. Briefly, the SCI is determined by looking at 5 variables within the stream and rating them from 1.0 to 5.0. The stream was then ranked from 1.0 (worst) to 5.0 (best) as to it's condition. The potential stream restoration areas have a SCI ranging from 2.8 to 4.15. Please see table 4.10 below showing the overall rating for the existing and proposed conditions. The table demonstrates that there is an increase in the SCI, showing that the stream restoration projects will improve the stream habitat and water quality of the watershed.

Table 4.10: Stream Condition Index Scores

Project ID	Stream Reach	Existing SCI	Proposed SCI	Increase SCI (%)
PH9201	Clifton Creek #1	4.15	4.50	8
PH9200	Clifton Creek #2	4.15	4.5	8
PH9202	Clifton Road	2.95	3.95	34
PH9210	Wycklow Drive	3.2	4.2	31
PH9204	Young Branch Road - Part 1	3.85	4.35	13
PH9204	Young Branch Road – Part 2	2.8	3.85	38
PH9270	Brookline Drive	2.95	4.55	54
PH9271	Fox Chapel Road	4.05	4.50	11
PH9272	Berwynd Drive	4.05	4.50	11

Again, the watershed plan focuses more on the water quality improvements because of the watershed land usage. The watershed is primarily zoned for 5 acres lots, therefore water quantity control is not as necessary as in a more developed area. The nature of the future development in this watershed is for minimal impervious area and a large increase in water volume is not anticipated. Future development located in the upper watershed outside of the resource conservation district will be required to provide water quantity and quality controls. Additionally, most of the existing development in the upper watershed is relatively new and the SWM ponds that do exist already have stringent water quantity controls in place. This is why the plan projects and watershed wide actions focus on water quality improvements.

4.6 Implementation of Plan Actions

The recommended plan actions described in Section 4.4 will be implemented over the 25-year life of the Popes Head Creek Watershed Management Plan. This plan will serve as guidance for all County agencies and officials to protect and maintain the health of the Popes Head Creek watershed. The plan will be considered as an active, or "living," document that is revisited every five years. The initial implementation schedule was developed as described below.

The first step in developing a logical and feasible implementation schedule was to prioritize the actions and evaluate how well they meet the Goals of the plan. A weighted set of five categories was used to prioritize each plan action. Each weight factor is indicated in parenthesis:

1. Board Adopted Stormwater Control Project Prioritization Categories (40%)
    - Projects that are mandated by state or federal regulations for immediate implementation and projects that address critical/emergency dam safety issues.
    - Projects that alleviate structures from damage by flood waters or by being undermined by severe erosion.

- Projects that achieve stormwater quality improvement in specific conformance with the County's obligation under the Chesapeake Bay initiatives and/or the VPDES permit for storm sewer system discharges
- Projects that alleviate severe streambank and channel erosion.
- Projects that alleviate moderate and minor streambank and channel erosion.
- Projects that alleviate yard flooding.
- Projects that alleviate road flooding.

2. Direct Regulatory Contribution (10%)
    - Hybrid projects that accomplish multiple objectives.
    - Contributions directly to MS4 and Virginia Tributary Strategies compliance.
    - Contributions towards TMDL compliance.
    - Indirect water quality benefits.
    - Flood mitigation.

3. Public Support (10%)
    - Citizen's Advisory Committee support.
    - Support for projects by affected residents.

4. Effectiveness/Location (25%)
    - Quantity control projects are more desirable in "headwaters" areas that lack stormwater management controls.
    - Quality control projects are desirable in areas that previously lacked controls.
    - An indication of relative benefit of a project, such as pollutant reduction or efficiency, increased retrofit area, etc.

5. Ease of Implementation (15%)
    - Project Complexity.
    - Land acquisition.

The actions in the plan were scored 1 to 5 for each of the prioritization categories, with 5 as the best score and 1 as the worst score. The information used to score the actions was both quantitative and qualitative. The quantitative data that was used in the prioritization scoring included the amount of peak flow reduction, size of the existing or proposed drainage area.

The actions were ranked according to their total score, from highest to lowest. Policy recommendations were ranked separately from the structural and non-structural projects and are listed in Chapter 5.

Table 4.11: Prioritization of Proposed Projects

Project Number	Project Location	Description	Board Adopted Categories (40%)	Direct Regulatory Contribution (10%)	Public Support (10%)	Effectiveness/ Location Rating (25%)	Ease of Implementation Rating (15%)	Total Score
PH9190	Marymead Pond	SWM Pond Retrofit	5	5	5	5	5	5.00
PH9885	Fairfax Villa Elementary School	2 Bioretention facilities.	5	4	5	5	5	4.90
PH9170	Braddock Road Pond	SWM Pond Retrofit	5	5	5	4	5	4.75
PH9192	FCPA-Piney Branch Park Pond	SWM Pond Retrofit	5	5	5	4	5	4.75
PH9180	Brentwood Pond	SWM Pond Retrofit	5	5	5	4	5	4.75
PH9195	Costco East Pond	SWM Pond Retrofit	5	5	5	5	3	4.70
PH9194	Piney Branch Road Extention Pond	SWM Pond Retrofit	5	5	5	5	3	4.70
PH9193	Sports Authority Pond	SWM Pond Retrofit	5	5	5	5	3	4.70
PH9884	Fairfax Villa Subdivision	8 Filterra Manufactured LIDs, 3 bioretention areas, Rain barrel program	5	5	5	5	3	4.70
PH9890	University Square Subdivision	2 Filterra Manufactured BMPs.	5	5	5	5	3	4.70
PH9872	Willow Springs Elementary School.	1 Bioretention area and 1 Filterra manufactured LID	5	4	5	4	5	4.65
PH9880	Brentwood Subdivision	4 grassed swales, 3 bioretention areas	5	4	5	5	3	4.60
PH9130	Colchester Hunt	SWM Pond Retrofit	5	5	3	4	5	4.55
PH9191	Merrifield Gardens Pond	SWM Pond Retrofit	5	5	5	4	3	4.45
PH9196	Waples Mobile Home Park Pond	SWM Pond Retrofit	5	5	5	4	3	4.45

Project Number	Project Location	Description	Board Adopted Categories (40%)	Direct Regulatory Contribution (10%)	Public Support (10%)	Effectiveness/ Location Rating (25%)	Ease of Implementation Rating (15%)	Total Score
PH9883	Buckner Forest Subdivision.	1 Bioretention area.	5	4	3	5	3	4.40
PH9821	Fairfax Station Subdivision	3 Grassed Swales, 5 bioretention areas	5	4	3	5	3	4.40
PH9800	Clifton Elementary School.	Bioretention area, 1 Filterra manufactured LID	5	4	5	3	5	4.40
PH9820	Clifton Green Subdivision	Bioretention area and Grassed swale	5	4	3	4	3	4.15
PH9860	West Hill Subdivision	2 Grassed swales and 2 Filterra manufactured LIDs	5	4	3	4	3	4.15
PH9831	Smoke Rise Subdivision	1 Bioretention area.	5	4	3	4	3	4.15
PH9841	Barton Place Subdivision	Grassed swale and 2 bioretention areas.	5	4	3	4	3	4.15
PH9870	Brecon Ridge Subdivision	6 grassed swales, 1 bioretention area	5	4	3	4	3	4.15
PH9871	Ridges of Glendilough Subdivision.	2 Bioretention areas, 2 Filterra manufactured LIDs	5	4	3	4	3	4.15
PH9877	Brecon Ridge Woods Subdivision.	1 Grassed swale and bioretention at pipe outfall	5	4	3	4	3	4.15
PH9830	Pickwick Woods Subdivision	3 Bioretention areas	5	4	3	4	3	4.15
PH9842	Fairfax Hunt	1 Bioretention Area	5	4	3	4	3	4.15
PH9131	Innisvale Pond	SWM Pond Retrofit	5	5	3	2	4	3.90
PH9850	Vannoy Park Subdivision.	2 Grassed swales	3	4	3	5	3	3.60
PH9882	Braddox Subdivision.	1 Bioretention area in abandoned road right-of-way.	3	4	3	5	3	3.60
PH9891	Glen Alden Subdivision.	1 grassed swale	3	4	3	5	3	3.60
PH9271	Berwynd Road	Stream Restoration	3	5	5	3	4	3.55

Project Number	Project Location	Description	Board Adopted Categories (40%)	Direct Regulatory Contribution (10%)	Public Support (10%)	Effectiveness/ Location Rating (25%)	Ease of Implementation Rating (15%)	Total Score
PH9801	Intersection of Compton and Clifton Roads	Grassed swale	3	4	3	4	3	3.35
PH9851	Lewis Park	2 Grassed swales	3	4	3	4	3	3.35
PH9210	Wycklow Drive	Stream Restoration	3	5	5	3	2	3.25
PH9270	Brookline Drive	Stream Restoration	3	5	5	3	2	3.25
PH9272	Fox Chapel Road	Stream Restoration	3	5	5	3	2	3.25
PH9201	Clifton Creek #1	Stream Restoration	3	5	5	3	2	3.25
PH9200	Clifton Creek #2	Stream Restoration	3	5	5	3	2	3.25
PH9202	Clifton Road	Stream Restoration	3	5	5	3	2	3.25
PH9204	Young Branch Drive	Stream Restoration	3	5	5	3	2	3.25
PH9230	Queen's Brigade Drive	Ditch Stabilization	3	5	3	3	3	3.20
PH9530	Saddle Horn Road	Culvert Retrofit	2	4	3	1	3	2.20
PH9580	Fairfax County Parkway	Culvert Retrofit	2	4	3	1	3	2.20
PH9540	Smoke Rise Road	Culvert Retrofit	2	4	3	1	3	2.20
PH9580	Fairfax Station Road	Culvert Retrofit	2	4	3	1	3	2.20
PH9502	Tepper Drive	Culvert Retrofit	2	4	3	1	3	2.20
PH9900	Kincheloe Road	Debris Removal	1	2	5	1	5	2.10
PH9961	Hope Park Road	Remove fill from stream and restore stream.	1	2	5	1	5	2.10
PH9960	Hope Park Road	Debris Removal	1	2	5	1	5	2.10
PH9970	Washington Street	Automobile/Debris Removal	1	2	5	1	5	2.10
PH9962	Popes Head Road	Debris Removal	1	2	5	1	5	2.10
PH9981	Crescent Drive	Automobile Removal	1	2	5	1	5	2.10
PH9505	Balls Ford Road	Culvert Retrofit	2	4	3	1	2	2.05

Project Number	Project Location	Description	Board Adopted Categories (40%)	Direct Regulatory Contribution (10%)	Public Support (10%)	Effectiveness/ Location Rating (25%)	Ease of Implementation Rating (15%)	Total Score
PH9504	Private Drive near Yates Ford Road	Culvert Retrofit	2	4	3	1	2	2.05
PH9973	Bentonbrook	Obstruction Removal/ collapsed footbridge removal	1	0	3	1	5	1.70
PH9403	Newman Road and Castle Creek	Bridge Project	2	0	3	1	1	1.50
PH9401	Clifton Road #2 and #3 and Popes Head Creek	Culvert Replacements	2	0	3	1	1	1.50
PH9414	Fairfax Station Road and Piney Branch, Popes Head Creek, Trib to Popes Head	Culvert Replacements	2	0	3	1	1	1.50
PH9452	Popes Head Road and Piney Branch	Bridge Project	2	0	3	1	1	1.50
PH9450	Colchester Road and Castle Creek	Drainage Improvements	2	0	3	1	1	1.50
PH9412	Newman Road and Castle Creek Trib 1	Culvert Replacement	2	0	3	1	1	1.50
PH9400	Clifton Road and Popes Head Creek	Bridge Project	2	0	3	1	1	1.50
PH9461	Popes Head Road and Popes Head Creek	Bridge Project	2	0	3	1	1	1.50
PH9435	Newman Road and Castle Creek	Culvert Replacement	2	0	3	1	1	1.50
PH9470	Brookline Drive and East Fork	Culvert Replacement	2	0	3	1	1	1.50

Project Number	Project Location	Description	Board Adopted Categories (40%)	Direct Regulatory Contribution (10%)	Public Support (10%)	Effectiveness/ Location Rating (25%)	Ease of Implementation Rating (15%)	Total Score
PH9404	Colchester Road and Popes Head Creek	Bridge Project	2	0	3	1	1	1.50
PH9462	Walcott Avenue and Piney Branch unnamed Trib	Culvert Replacement	2	0	3	1	1	1.50
PH9453	Popes Head Road and Piney Branch unamed Trib	Culvert Replacement	2	0	3	1	1	1.50
PH9420	Fairfax Station Road and Popes Head unnamed Trib	Culvert Replacement	2	0	3	1	1	1.50

The structural and non-structural projects implementation plan is shown in Table 4.13. Each project has been grouped into one of five implementation groups, based on relative priority, as listed below:

Group A: Fiscal Year 2006 – 2010
Group B: Fiscal Year 2011 – 2015
Group C: Fiscal Year 2016 – 2020
Group D: Fiscal Year 2021 – 2025
Group E: Fiscal Year 2026 – 2030

The dates for implementation are target dates, subject to County funding approval and ongoing updates to the plan. Maps 4.9 – 4.13 show the implementation grouping for projects that have specific locations.

Some of the actions in the implementation plan were scheduled with the assistance of the Citizen's Advisory Committee according to the following important factors in addition to the prioritization ratings:

- Dump sites when highly visible and if they present an immediate water quality threat.
- Stream Restoration projects if there are no headwaters projects to implement first.

These project types were put into the implementation Group A.

Table 4.12: Implementation of Proposed Projects

Project Number	Project Location	Description	Implementation Timeframe	Total Cost
Action A2.1	Non-structural Practice	Disconnect Imperviousness	A	$200,000 (over 25 years)
Action A2.2	Non-structural Practice	Monthly Street Sweeping in Fairfax Villa	A	$1,000,000 (over 25 years)
Action A5.1	Non-structural Practice	Conservation Easement Acquisition	A	$250,000 (over 25 years)
Action B1.1	Non-structural Practice	Formation of Friends of Popes Head Creek group	A	$120,000 (over 25 years)
Action B1.2	Non-structural Practice	Volunteer Stream Monitoring	A	$200,000 (over 25 years)
Action B2.1	Non-structural Practice	Landowner Education	A	$200,000 (over 25 years)
Action B2.2	Non-structural Practice	Landscape Company Education	A	$200,000 (over 25 years)
Action B2.3	Non-structural Practice	Horse Care Education	A	$120,000 (over 25 years)
Action B2.4	Non-structural Practice	Private Pond Owner Education	A	$120,000 (over 25 years)
Action B2.6	Non-structural Practice	Wildlife Education	A	$120,000 (over 25 years)
Action C1.2	Non-structural Practice	Institutional/Commercial Property Nutrient Management	A	$200,000 (over 25 years)
PH9900	Kincheloe Road	Debris Removal	A	$4,000
PH9961	Hope Park Road	Remove fill from stream and restore stream.	A	$1,400,000
PH9960	Hope Park Road	Debris Removal	A	$3,000
PH9970	Washington Street	Automobile/Debris Removal	A	$5,000
PH9962	Popes Head Road	Debris Removal	A	$5,000
PH9981	Crescent Drive	Automobile Removal	A	$5,000
PH9973	Bentonbrook	Obstruction Removal/ collapsed footbridge removal	A	$6,000
PH9190	Marymead Pond	SWM Pond Retrofit	A	$560,000
PH9170	Braddock Road Pond	SWM Pond Retrofit	A	$70,000
PH9192	FCPA-Piney Branch Park Pond	SWM Pond Retrofit	A	$720,000
PH9180	Brentwood Pond	SWM Pond Retrofit	A	$140,000
PH9210	Wycklow Drive	Stream Restoration	A	$60,000

Project Number	Project Location	Description	Implementation Timeframe	Total Cost
PH9201	Clifton Creek #1	Stream Restoration	A	$90,000
PH9200	Clifton Creek #2	Stream Restoration	A	$120,000
PH9202	Clifton Road	Stream Restoration	A	$360,000
PH9204	Young Branch Drive	Stream Restoration	A	$1,080,000
PH9885	Fairfax Villa Elementary School	2 Bioretention facilities.	B	$60,000
Action A4.2	Non-structural Practice	Monitor Riparian Buffers	B	$250,000 (over 25 years)
Action A6.1	Non-structural Practice	RPA Signage Installation	B	$80,000 (over 25 years)
Action A6.2	Non-structural Practice	ATV Usage Violation Enforcement	B	$250,000 (over 25 years)
Action B2.5	Non-structural Practice	ATV Usage Education	B	$120,000 (over 25 years)
PH9195	Costco East Pond	SWM Pond Retrofit	B	$120,000
PH9194	Piney Branch Road Extension Pond	SWM Pond Retrofit	B	$120,000
PH9193	Sports Authority Pond	SWM Pond Retrofit	B	$120,000
PH9130	Colchester Hunt	SWM Pond Retrofit	B	$140,000
PH9191	Merrifield Gardens Pond	SWM Pond Retrofit	B	$70,000
PH9196	Waples Mobile Home Park Pond	SWM Pond Retrofit	B	$930,000
PH9884	Fairfax Villa Subdivision	8 Filterra Manufactured LIDs, 3 bioretention areas, Rain barrel program	B	$400,000
PH9890	University Square Subdivision	2 Filterra Manufactured BMPs.	B	$80,000
PH9131	Innisvale Pond	SWM Pond Retrofit	B	$190,000
PH9872	Willow Springs Elementary School.	1 Bioretention area and 1 Filterra manufactured LID	B	$80,000
PH9880	Brentwood Subdivision	4 grassed swales, 3 bioretention areas	B	$160,000
PH9850	Vannoy Park Subdivision.	2 Grassed swales	B	$100,000
PH9882	Braddox Subdivision.	1 Bioretention area in abandoned road right-of-way.	B	$30,000
PH9883	Buckner Forest Subdivision.	1 Bioretention area.	B	$30,000
PH9891	Glen Alden Subdivision.	1 grassed swale	B	$20,000
PH9821	Fairfax Station Subdivision	3 Grassed Swales, 5 bioretention areas	B	$220,000

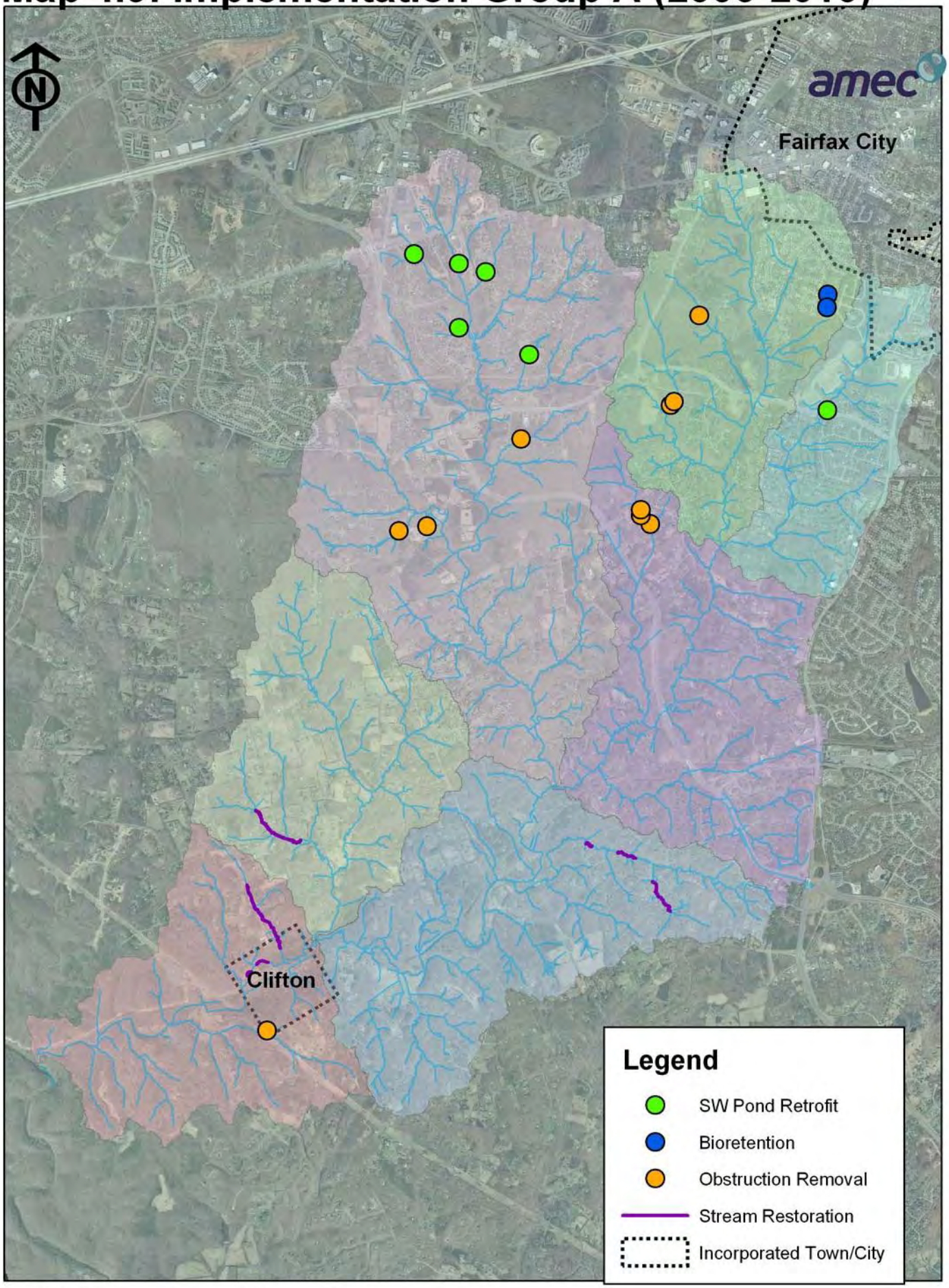
Project Number	Project Location	Description	Implementation Timeframe	Total Cost
PH9800	Clifton Elementary School.	Bioretention area, 1 Filterra manufactured LID	B	$90,000
PH9271	Berwynd Road	Stream Restoration	B	$330,000
PH9270	Brookline Drive	Stream Restoration	B	$30,000
PH9272	Fox Chapel Road	Stream Restoration	B	$310,000
PH9820	Clifton Green Subdivision	Bioretention area and Grassed swale	B	$50,000
PH9860	West Hill Subdivision	2 Grassed swales and 2 Filterra manufactured LIDs	B	$140,000
PH9801	Intersection of Compton and Clifton Roads	Grassed swale	B	$50,000
PH9831	Smoke Rise Subdivision	1 Bioretention area.	B	$40,000
PH9841	Barton Place Subdivision	Grassed swale and 2 bioretention areas.	B	$230,000
PH9870	Brecon Ridge Subdivision	6 grassed swales, 1 bioretention area	B	$160,000
PH9871	Ridges of Glendilough Subdivision.	2 Bioretention areas, 2 Filterra manufactured LIDs	B	$200,000
PH9877	Brecon Ridge Woods Subdivision.	1 Grassed swale and bioretention at pipe outfall	B	$110,000
PH9830	Pickwick Woods Subdivision	3 Bioretention areas	B	$90,000
PH9851	Lewis Park	2 Grassed swales	B	$60,000
PH9842	Fairfax Hunt	1 Bioretention Area	B	$50,000
PH9530	Saddle Horn Road	Culvert Retrofit	C	$60,000
PH9580	Fairfax County Parkway	Culvert Retrofit	C	$90,000
PH9540	Smoke Rise Road	Culvert Retrofit	C	$60,000
PH9512	Fairfax Station Road	Culvert Retrofit	C	$70,000
PH9502	Tepper Drive	Culvert Retrofit	C	$40,000
PH9505	Balls Ford Road	Culvert Retrofit	C	$70,000
PH9504	Private Drive near Yates Ford Road	Culvert Retrofit	C	$50,000
PH9403	Newman Road and Castle Creek	Bridge Project	C	$390,000
PH9401	Clifton Road #2 and #3 and Popes Head Creek	Culvert Replacements	C	$260,000

Project Number	Project Location	Description	Implementation Timeframe	Total Cost
PH9414	Fairfax Station Road and Piney Branch, Popes Head Creek, Trib to Popes Head	Culvert Replacements	C	$4,190,000
PH9452	Popes Head Road and Piney Branch	Bridge Project	C	$10,000
PH9450	Colchester Road and Castle Creek	Drainage Improvements	C	$1,020,000
PH9412	Newman Road and Castle Creek Trib 1	Culvert Replacement	D	$430,000
PH9400	Clifton Road and Popes Head Creek	Bridge Project	D	$1,850,000
PH9461	Popes Head Road and Popes Head Creek	Bridge Project	E	$1,050,000
PH9435	Newman Road and Castle Creek	Culvert Replacement	E	$130,000
PH9470	Brookline Drive and East Fork	Culvert Replacement	E	$300,000
PH9404	Colchester Road and Popes Head Creek	Bridge Project	E	$1,240,000
PH9462	Walcott Avenue and Piney Branch unnamed Trib	Culvert Replacement	E	$100,000
PH9453	Popes Head Road and Piney Branch unnamed Trib	Culvert Replacement	E	$180,000
PH9420	Fairfax Station Road and Popes Head unnamed Trib	Culvert Replacement	E	$160,000
			Total Capital Cost	$24.6 million

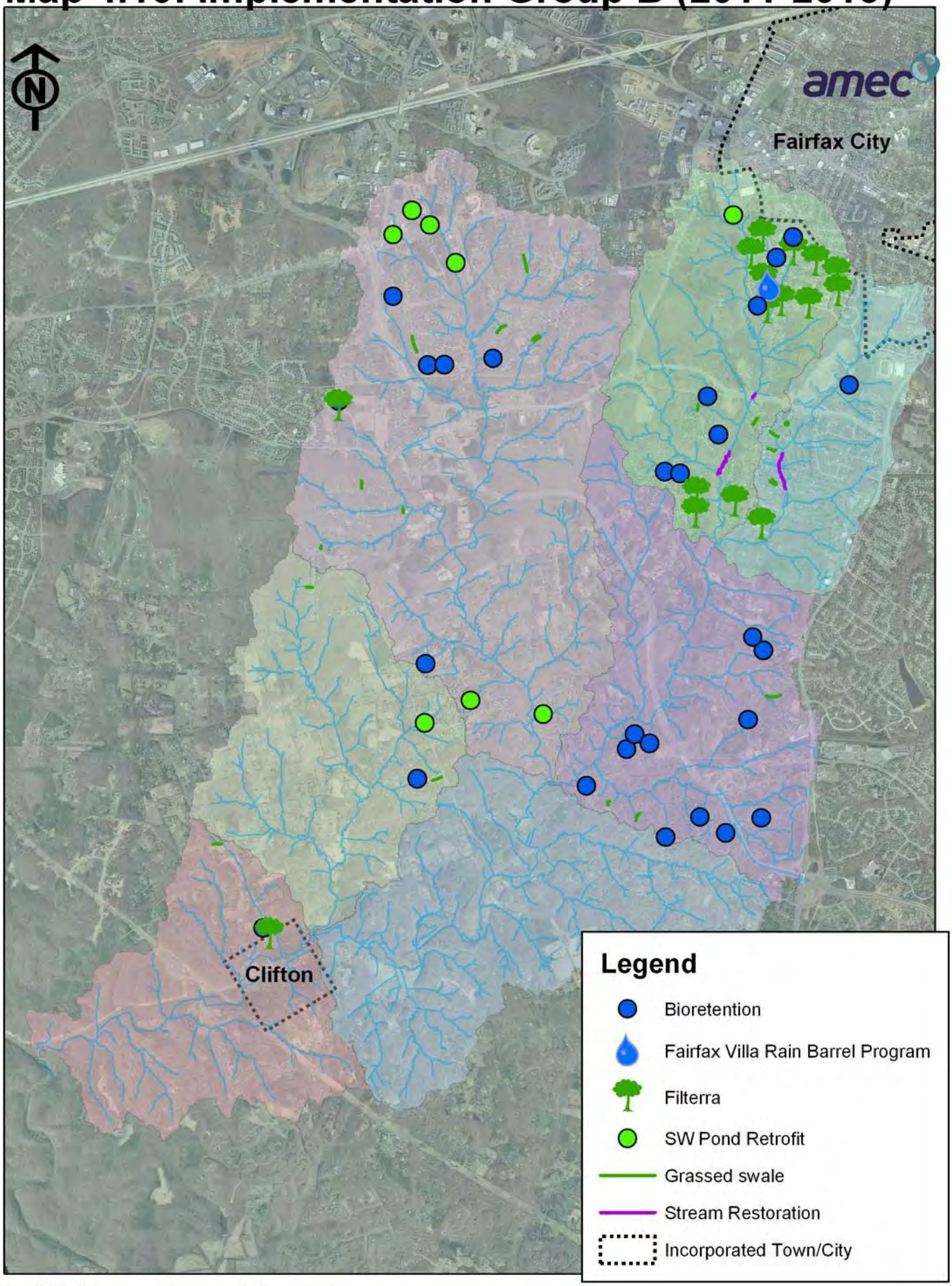
4.6.1 Total Cost of Implementation

The total cost of the proposed structural and non-structural actions in Table 4.13 is approximately $24.6 million. Over the plan's lifespan of 25 years, this will require approximately 1.8 Fairfax County Staff Year Equivalents (SYE) for project management, land acquisition, and construction management, which are factored into the project costs. Actual costs may be reduced by using volunteer organizations to help implement non-structural projects, such as educational campaigns and environmental monitoring.

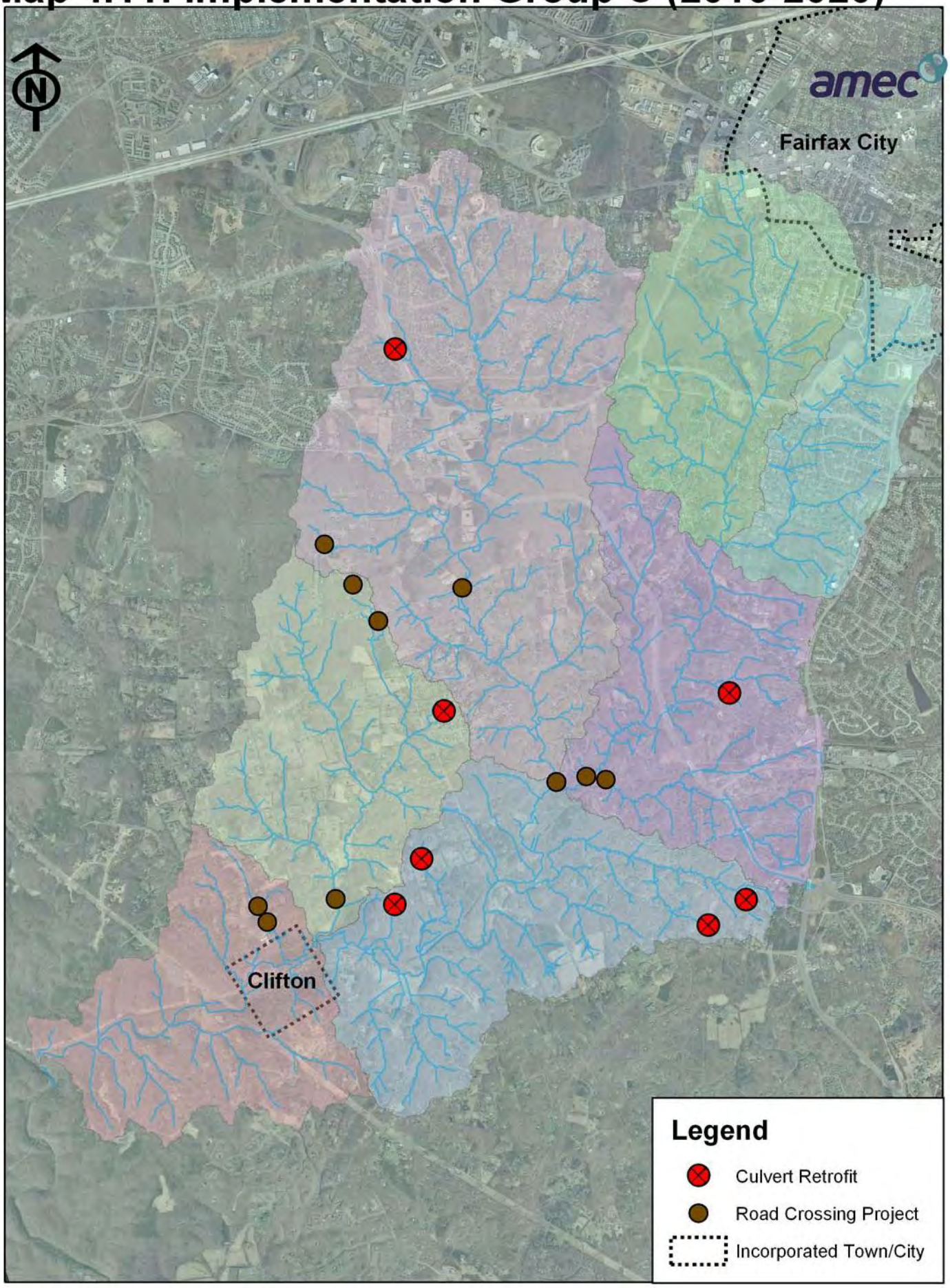
Map 4.9: Implementation Group A (2006-2010)



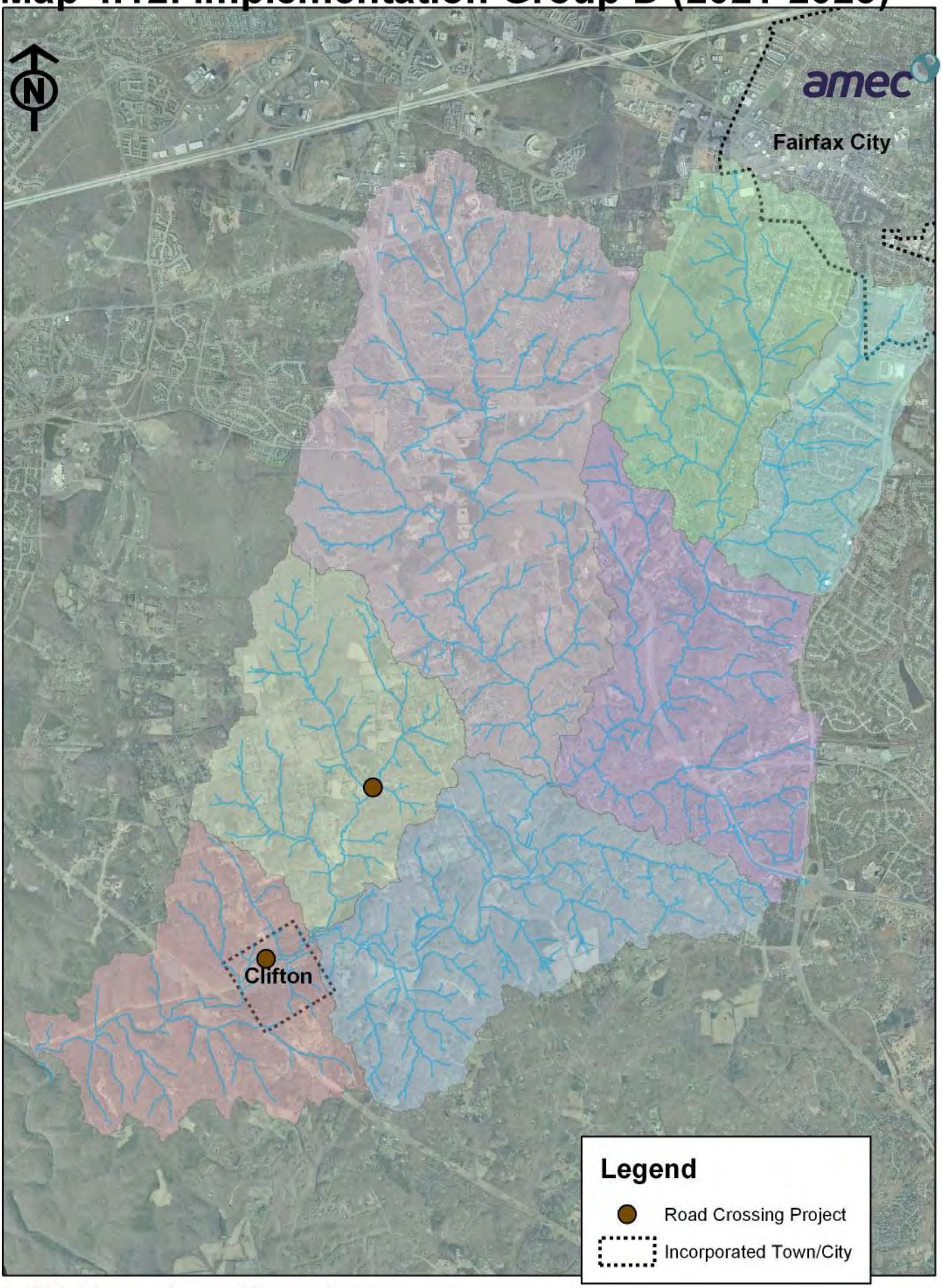
Map 4.10: Implementation Group B (2011-2015)



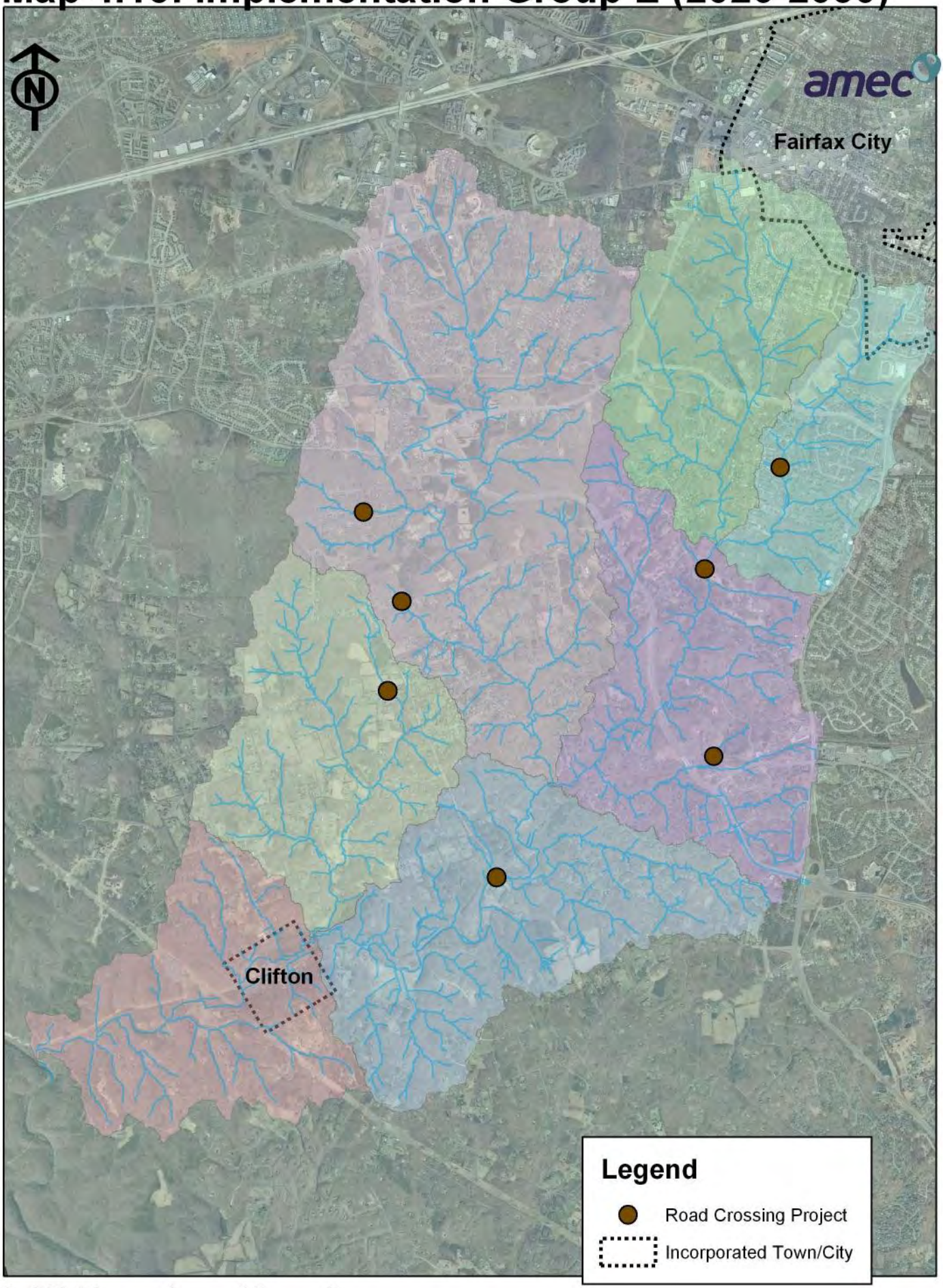
Map 4.11: Implementation Group C (2016-2020)



Map 4.12: Implementation Group D (2021-2025)



Map 4.13: Implementation Group E (2026-2030)



4.7 Monitoring Plan

This section describes the monitoring actions and targets for determining the success or failure of the future structural and non-structural plan actions. The monitoring will help to determine if the plan actions should be modified in the future because of a low success rate or as watershed conditions change.

Action A1.1 Retrofit suitable existing stormwater management facilities and BMPs to make them more effective. Retrofitting these facilities is intended to exceed the performance criteria or standards that were used to design the facility. The increased performance and/or coverage area will improve water quality in the watershed. Fairfax County will coordinate with VDOT, Fairfax County Park Authority, and private pond owners to implement the pond retrofit projects.

Monitor: Number of retrofit projects designed and completed.

Target: Initiate 33% of retrofit projects during Implementation Group A. Complete all retrofit projects during Implementation Group B.

Action A1.2: Install new BMP and LID facilities in areas that do not have existing stormwater management facilities, or in areas where retrofitting existing facilities is not feasible.

Monitor: Number of LID facilities designed and completed.

Target: Complete installation of all LID facilities during Implementation Group B.

Action A2.1: Program to facilitate and encourage homeowners and developers to disconnect impervious areas.

Monitor: Number of homeowners and developers who install rain barrels and sign maintenance agreements; number of disconnected downspouts.

Target: Install rain barrels in 10% of properties in the Fairfax Villa subdivision during Implementation Group A. Install rain barrels in 25% of properties in the Fairfax Villa subdivision during Implementation Group B. Install rain barrels in 50% of properties in the Fairfax Villa subdivision during Implementation Group C.

Action A2.2: Monthly street sweeping program for parking lots throughout the watershed and residential streets in the Fairfax Villa subdivision.

Monitor: Frequency of street sweeping; total volume of sediment collected by street sweeping trucks.

Target: Street sweeping should occur at least once every month. Total sediment load shall be recorded to monitor progress.

Action A3.1*:* The county and community groups shall perform stream restoration projects in the areas identified as good candidates.

Monitor: Number, length, and location of stream restoration projects initiated and completed.

Target: Implement 50% of stream restoration projects during Implementation Group A. Complete all stream restoration projects during Implementation Group B provided that the necessary upstream quantity reduction measures have been implemented.

Action A3.2*:* Retrofit existing road culverts to reduce flooding and erosion at road crossings.

Monitor: Number of culvert retrofit projects initiated and completed.

Target: Implement all culvert retrofit projects during Implementation Group C.

Action A3.3: Replace road crossings that overtop and flood.

Monitor: Number of road crossing projects initiated and completed.

Target: Implement 33% of road crossing projects during Implementation Group C. Complete all remaining road crossing projects during Implementation Group E.

Action A3.4*:* Remove dumpsites and obstructions from stream corridors.

Monitor: Number of dumpsites and stream obstructions removed.

Target: Complete all debris removal projects during Implementation Group A. Record quantity and type of debris removed from stream corridors.

Action A4.1: Plant native vegetation next to streams in areas that are identified as good candidates for buffer restoration.

Monitor: Number of buffer restoration projects initiated and completed.

Target: Implement 50% of buffer restoration projects during Implementation Group A. Complete all remaining buffer restoration projects during Implementation Group B.

Action A4.2: Monitor the condition of restored and existing riparian buffer with annual stream walks to evaluate the condition and areas needing improvement.

Monitor: Number of stream walks performed in each subwatershed; number of citizen volunteers.

Target: Perform one stream walk per year in each subwatershed. Record number of plant species found on stream walk, and if they are native or invasive species and compare to previous years' data. Increase citizen participation by 10% each year.

Action A5.1**:** Facilitate the acquisition and donation of conservation easements by community groups for riparian buffer and stream protection, and public/private open space for the environmental quality corridors described in the *Fairfax County Comprehensive Plan.*

Monitor: Number of acres protected by conservation easement.

Target: Increase number of acres protected by conservation easement by 10% every five years.

Action A6.1*:* Post official County signage that publicizes the existence of the Resource Protection Areas (RPAs) and states that ATV and other uses that destroy vegetation and cause erosion are not permitted in the RPA.

Monitor: Number of complaints and costs related to ATV trespassing and damage. This can be monitored during stream walks from Action A4.2.

Target: Reduce ATV-related complaints by 10% every year.

Action A6.2: Coordinate with the Fairfax County Police to target areas with significant ATV impacts for enforcement of existing laws and ordinances (e.g. trespassing and environmental regulations).

Monitor: Number of complaints and costs related to ATV trespassing and damage. This can be monitored during stream walks from Action A4.2.

Target: Reduce ATV-related complaints by 10% every year.

Action A7.1: Conserve land and water ecosystems to provide high quality habitat for wildlife.

Monitor: Number of acres protected by conservation easement.

Target: Increase number of acres protected by conservation easement by 10% every five years.

Action A7.2*:* Preserve large blocks of forest to prevent further fragmentation.

Monitor: Number of acres protected by conservation easement that have continuity or increase existing forest corridors.

Target: Increase number of acres protected by conservation easement by 10% every five years.

Action B1.1: Support the formation of a "Friends of Popes Head Creek" group composed of local citizens.

Monitor: Number of citizens who participate; number of meetings convened per year, and activities performed.

Target: Convene two meetings per year. Increase participation by 10% every year.

Action B1.2: Establish a group of volunteer stream monitors and monitoring sites.

Monitor: Number of citizens who participate; number of samples collected per year.

Target: Conduct sampling at least four times per year at Stream Protection Strategy sites. Increase participation by 10% every year.

Action B2.1*:* Develop and distribute educational materials that describe beneficial landscaping techniques for homeowners.

Monitor: Number of brochures distributed.

Target: Distribute 300 brochures to homeowners every year in different parts of the watershed to blanket the entire watershed.

Action B2.2: Develop and distribute educational materials that describe beneficial landscaping techniques to landscaping companies and suppliers.

Monitor: Number of brochures distributed

Target: Distribute 200 brochures to landscaping companies and suppliers every year.

Action B2.3: Distribute educational materials about appropriate horse care and grazing management in the Resource Protection Area.

Monitor: Number of brochures distributed.

Target: Distribute 100 brochures to veterinarians and the Clifton Horse Society every year.

Action B2.4: Distribute educational materials to private pond owners that describe proper maintenance.

Monitor: Number of brochures distributed.

Target: Distribute 100 brochures to private pond owners every year.

Action B2.5: Develop and distribute educational materials for proper ATV usage in the watershed.

Monitor: Number of brochures distributed.

Target: Distribute 300 brochures to ATV dealers every year.

Action B2.6*:* Develop and distribute educational materials that describe the benefits of wildlife, such as beavers, in the watershed.

Monitor: Number of brochures distributed.

Target: Distribute 300 brochures to landowners every year.

Action C1.1: Install new LIDs and BMPs or enhance the performance of existing stormwater management facilities to reduce sediment and phosphorus loading in stormwater runoff.

Monitor: Number of new LID and BMP facilities initiated and completed.

Target: Complete installation of all LID facilities during Implementation Group B.

Action C1.2: Manage large existing areas of lawn at institutional and commercial properties to minimize nutrient loading to streams.

Monitor: Review maintenance plan and landscaping plan to ensure proper usage of fertilizer and other equipment for landscaping.

Target: Reduce total amount of fertilizer used by 5% every five years.

Chapter 5: Policy Recommendations

Structural and non-structural recommendations are described in Chapter 4 of the plan. The policy recommendations include various proposals that would typically involve amendments to the County Code and other supporting documents such as the *Public Facilities Manual*. These recommendations will need to be evaluated further in light of greater Countywide implications. The current planned approach for processing of the policy recommendations from the Popes Head Creek Watershed Plan is to compare these with similar recommendations that will be developed with the Little Hunting Creek, Cameron Run, Cub Run, and Difficult Run Watershed Management Plans starting in 2006. Specific ordinance amendments would then be crafted that factor in other County initiatives and address the common ground that can be established between the various policy recommendations.

The proposed goals and objectives from Chapter 4 are restated in this chapter to demonstrate the interaction of these recommendations with the structural and non-structural projects. All of the Policy Recommendations in this Chapter are summarized in Table 5.1.

5.1 Policy Recommendations

Goal A: Protect and improve the ecological health of Popes Head Creek and its tributaries.

Objective A1: Increase the effectiveness and use of BMPs to reduce impacts from stormwater runoff.

Policy Recommendation A1.1*:* Increase the frequency of inspection for private BMPs with maintenance agreements from approximately once every three or five years to annually, and provide education to ensure proper maintenance by owners. County-owned BMPs are currently inspected once a year and are not included in this action.

Strategy to Achieve Recommendation: Hire additional inspectors or a contractor to increase the frequency of inspection of private BMPs. Inform both residential and commercial property owners of private BMPs with existing maintenance agreements about the more frequent inspections. Tenants will also need to be notified. Educational materials and training will be developed and provided to residential and commercial property owners of all private BMPs and their tenants as needed. The educational materials will include checklists and schedules for maintenance actions for different types of BMPs and information about additional resources for proper maintenance of a BMP.

Watershed Benefit: Routine inspection and proper maintenance of existing BMPs will help to ensure that they perform as intended. A typical dry detention BMP provides storage to manage runoff volumes to match predevelopment 2- and 10-year storm flow rates and may also provide water quality treatment for the first half inch of runoff from each rainfall event. Over a 24-hour period, the pollutant removal efficiency is approximately 75% for suspended solids, 45% for phosphorous, and 30% for nitrogen, for a properly functioning dry detention basin with a water quality component. This

action will help to maintain existing conditions and aid in preventing the further degradation of the watershed.

Policy Recommendation A1.2*:* Periodically evaluate and revise the current list of recommended BMPs to enhance the level of stormwater service.

Strategy to Achieve Recommendation: Periodically evaluate the current list of recommended BMPs and integrated BMPs (currently dated October 2, 2001) to determine their effectiveness based on current literature, and revise this list to go beyond those found in the Virginia Stormwater Management Handbook. Porous pavement is permitted for stormwater detention in the county and could be added to the recommended BMP list. Green rooftops could also be added. Details on the applicability and use of porous pavement were distributed to the engineering and development community in a County letter to industry, dated March 2004. The use of experimental BMPs should be allowed with a system for monitoring their effectiveness so as not to preclude innovation.

There is an effort currently underway to amend the County's Public Facilities Manual (PFM) to include six LID practices, with the potential for inclusion of additional practices in the future. The PFM provides guidelines for the design of public facilities which must be built to serve new development. The goal of the standard structures and construction methods specified in the PFM is to expedite construction and obtain economies through the use of methods that are familiar to local contractors and field inspection personnel. The addition of LID practices to the PFM will greatly facilitate the use of these innovative practices by developers. The six practices that are being considered as amendments to the PFM are bioretention filters and basins, bioretention swales, permeable paver blocks, vegetated roofs, tree box filters, and aforestation. These amendments are currently undergoing final review before they are presented to the Board of Supervisors early in 2006.

Watershed Benefit: Many of these practices are currently in use in Fairfax County, and adding them to the PFM and recommended BMP list will make it easier for developers to include them in their site plans for review by County personnel. As new stormwater management technologies become available in the future, they should also be evaluated and, if appropriate, added to the county's PFM and recommended list.

Policy Recommendation A1.3*:* Expand the allowed placement of integrated LID management practices, such as bioretention, on individual residential lots in new developments. Currently, these practices are only allowed on outlots or non-residential lots if they provide service for more than one lot.

Strategy to Achieve Recommendation: Proceed with the amendments to the Public Facilities Manual (PFM) to facilitate and encourage implementation of LID management practices and distribute an industry letter to ensure awareness of BMPs recommended by the County. These practices do not require large parcels of land and can easily be integrated into existing developments.

Watershed Benefit: As mentioned above, Fairfax County has begun to integrate stormwater management LID practices into the PFM. LID management practices will help to reduce nutrient and pollutant inputs into the streams, as well as reduce stormwater volume and velocity. Implementation of this recommendation will help

contribute to attaining the nutrient reduction goals of Virginia's Chesapeake Bay Nutrient and Sediment Reduction Tributary Strategy for the Shenandoah and Potomac River Basins (March 2005). It will also allow developers more flexibility in the selection and siting of the BMPs described in Actions A1.1 and A1.2. By allowing the implementation of LID management practices, stormwater runoff can often be treated more efficiently directly at the source. The typical LID practice treats the first half inch of runoff, which equals 1,815 cubic feet per acre. This policy action will provide developers and the County with consistency and efficiency during the site plan review process. It will also promote the use of effective BMPs to reduce runoff and nonpoint source pollution.

Objective A2: Reduce and mitigate the impacts of impervious surface

Policy Recommendation A2.1*:* Adopt a policy of implementing natural landscaping and green building approaches at County facilities, such as public schools, libraries, fire stations, and other public facilities in the watershed. The County will be a model for implementing these beneficial watershed management approaches, so they can set the example for future development.

Strategy to Achieve Recommendation: Adopt a policy of implementing natural landscaping and green building approaches, as related to stormwater quality, at future County facilities. Land Development Services and Urban Forest Management of DPWES are currently developing a natural landscaping policy that will be forwarded to the Board of Supervisors for consideration by June 2006. Use guidelines developed in the County's pending Natural Landscaping policy and Environmental Protection Agency guidelines for green buildings.

Watershed Benefit: Natural landscaping promotes practices that help retain the essence of the surrounding natural environment and its features, and will help the landscapes at new facilities to maximize the delivery of ecological, environmental and socio-economic benefits, including improvements to water and air quality. Natural landscaping promotes the use of native species, which may not be currently present at County facilities. Green building technologies focus on practices that will provide improved water quality and reduce stormwater runoff, as well as air quality benefits and reduced energy use.

Policy Recommendation A2.2*:* Institute an inspection protocol and perform more frequent assessment of ditches, pipes, and outfalls within the watershed every five years and make repairs as necessary (County and Virginia Department of Transportation (VDOT)).

Strategy to Achieve Recommendation: Based upon the planning team's and advisory committee's review of the watershed, there are numerous locations where road crossings normally flood due to obstructed culverts. Appropriate County or VDOT personnel will document these observations and develop maintenance plans to correct deficiencies. County or VDOT field crews will perform a condition assessment of these drainage conveyances and submit a report to the County and VDOT, to determine responsibility for correction of observed problems.

Watershed Benefit: Evaluating the condition of existing drainage systems will document the adequacy of those conveyances and prevent future drainage problems. This process will help the County and VDOT identify existing and potential future drainage

problems and allow them to develop a prioritized approach to correcting any existing inadequacies and schedule future maintenance projects.

Policy Recommendation A2.3*:* Establish a program to facilitate and encourage the use of porous pavement in commercial and institutional development in the Popes Head Creek watershed.

Strategy to Achieve Action: Porous pavement is permitted for stormwater detention by Fairfax County; details on the applicability and use of porous pavement were distributed to the engineering and development community in a County letter to industry, dated March 2004. In addition, porous pavement is one of the six LID practices currently being evaluated for inclusion in the PFM. Porous pavement is most appropriately used in low traffic volume areas, such as overflow parking areas and walkways, and in headwaters to reduce peak flows. It should not be used on heavily traveled roads or areas with potential for spills, such as gas stations.

Watershed Benefit: A reduction in impervious areas will decrease the amount of stormwater runoff within the watershed and allow infiltration of water into the subsurface.

Objective A3: Preserve, maintain, and restore streams to benefit stream health and habitat.

Objective A4: Preserve, maintain, and restore riparian buffers to protect stream health and water quality.

Policy Recommendation A4.1: Encourage replanting efforts within degraded RPA buffer areas of sites undergoing redevelopment. Native vegetation mixes, suitable for local habitat, will be used.

Strategy to Achieve Recommendation: Review the Chesapeake Bay Preservation Ordinance amendment to determine if the planting of trees in the RPA riparian buffers is required in redevelopment sites that have few or no existing trees in the buffer. This ordinance amendment will also be reviewed against requirements detailed in the County's Public Facilities Manual and the manual will be revised if necessary. The planted trees will count towards the minimum tree cover requirements in the zoning ordinance, i.e. 10% tree coverage for commercial sites, 15% tree coverage for high-density residential sites, and 20% tree coverage for all other residential sites. Guidelines will need to be developed to describe the type of vegetation to be planted in the RPA. The minimum tree cover density in riparian buffer area immediately adjacent to the stream is recommended to be between 40% and 70%. The County Code Analysis Division and the Urban Forestry Division will need to be involved in this policy recommendation to determine if the existing structure of the ordinance is sufficient to address this recommendation and to help write the amendments to address the tree cover densities recommended in the riparian buffer area. The Urban Forestry Division will be consulted to make sure that sites meet all County codes when rezoned.

A future strategy, that may require more public support, could include a requirement for the planting of new and appropriate species mixes in the RPA riparian buffer in addition to the existing minimum tree cover requirements. This strategy will benefit water quality by providing more trees on development properties within the RPA.

Watershed Benefit: This action will benefit the watershed by providing the restoration of riparian buffers which will increase the amount of habitat area, protect the stream bank areas from erosion, and filter pollutants from runoff.

Objective A5: Maintain the open space and pastoral quality of the watershed and preserve the aesthetic quality in both urban and rural areas.

Policy Recommendation A5.1*:* Enforce the solid waste ordinance and the erosion and sedimentation control ordinance prohibition against illegal dumping.

Strategy to Achieve Recommendation: Target the locations experiencing frequent dumping of trash and waste and identify private, potentially illegal dumpsites located in the watershed. Impose fines on persons caught dumping illegally, take legal action against the property owners of illegal dumpsites, and require restoration of the sites. Investigate methods for increasing the enforcement of illegal dumping in the watershed, perhaps by hiring more inspectors or a contractor to perform dumpsite monitoring and investigation of potential illegal dumpsites. One potential illegal dumpsite is located in the southern corner of Clifton, and contains leaking 55 gallon drums. The Department of Public Works and Environmental Services will coordinate with the Zoning Enforcement Branch of the Department of Planning and Zoning to achieve this recommendation.

Watershed Benefit: The watershed benefit will be less pollution as a result of illegal dumping. This action would help to improve the health and reduce the amount of pollutants in streams within the watershed.

Objective A6: Develop water quality sensitive recreational opportunities.

Policy Recommendation A6.1*:* Regulate the use of All Terrain Vehicles (ATVs) to prevent watershed damage.

Strategy to Achieve Recommendation: The illegal use of ATVs in Popes Head Creek Watershed is causing significant stream bank erosion. The Code of Virginia presently precludes the operation of ATVs on another person's property without the written consent of the owner; however, this activity continues to occur. Many of the frequently used ATV trails pass through the RPAs, destroying vegetation that holds soil particles together; other trails cross the streams, resulting in erosion and sedimentation. Community members are very concerned about the illegal use of ATVs in sensitive riparian areas, and have suggested the following recommendations:

- Require licensure of ATVs. This would allow the County to track the use of ATVs and would provide a mechanism to collect fees for restoration. Licensure will require State enabling legislation before it can occur in Fairfax County. The fees could be earmarked for the restoration of areas damaged by ATVs and for the development of ATV recreation areas. This action will require coordination with the Fairfax County Police Department.
- Increase the severity of penalties for unlawful use of ATVs. For example, if a minor is apprehended for trespassing with an ATV, the penalty could result in the inability to obtain a driver's license until they are 18.

Watershed Benefit: This recommendation will aid in the reduction of illegal ATV use in the RPA. It will reduce erosion, sedimentation, and the destruction of vegetation caused

by ATVs. The Department of Public Works and Environmental Services will coordinate closely with the Fairfax County Police Department to ensure that all applicable laws are being enforced. Citizens and landowners will be consulted to identify areas that experience heavy ATV traffic.

Objective A7: Maintain the diversity of wildlife in the watershed.

Goal B: Have a well informed community that is actively involved in watershed stewardship.

Objective B1: Achieve community sponsorship of the watershed.

Policy Recommendation B1.1: Develop a watershed stewardship message specifically for Fairfax County Public Schools and George Mason University.

Strategy to Achieve Recommendation: Develop an environmental stewardship learning module for children in the Fairfax County Public Schools system and for students, faculty, and staff at George Mason University. The module could include environmental education classes, volunteer stream walks and cleanups, or the construction of demonstration LID projects on school facility grounds. Detailed information regarding this non-structural project can be found in Appendix L.

Watershed Benefit: The children can take the environmental lessons they learn home to their families and discuss environmental issues. This will raise the level of environmental awareness for community. Demonstration LID projects will reduce stormwater runoff and filter pollutants; they will also serve as examples to encourage the development community to adopt innovative stormwater management controls.

As part of Phase II stormwater regulations, schools and other small municipal institutions are required to develop stormwater management plans. These plans must include six minimum control measures, including:

- Public Education and Outreach on Stormwater Impacts
- Public Involvement and Participation
- Pollution Prevention and Good Housekeeping for Facilities Operation and Maintenance.

The implementation of this policy recommendation will satisfy three of the six required minimum control measures, and will therefore contribute to a future required stormwater management plan.

Objective B2: Develop and consolidate educational materials that describe the value of the watershed.

Goal C: Maintain the Occoquan Reservoir as a clean and sustainable source of potable water for Fairfax County.

Objective C.1: Reduce the amount of pollutants, such as fecal coliform, nitrogen, phosphorus, and sediment that enters the Occoquan Reservoir.

Policy Recommendation C1.1: Encourage all lawn management companies to participate in the Virginia Department of Conservation and Recreation's (DCR) Virginia Water Quality Improvement Program and to sign agreements to apply nutrients within

established criteria, to better control application rates and timing. Investigate the feasibility of requiring companies selected for work at County facilities to have signed such agreements. Encourage residential and commercial property owners and homeowners' associations to require nutrient application agreements as well.

Strategy to Achieve Recommendation: Implementation of this recommendation will begin with a determination of what legal authority, if any, the County has to require lawn care companies to participate in the DCR program. If legal authority is established, the County Code should be amended to implement this policy recommendation. The requirements for certification should include education of the lawn care retailer or company by the County in the proper application of fertilizer, followed by signing of an agreement with the DCR stating that the company will abide by the proper management methods. As of September 6, 2005, there were 67 contractors throughout the state that had agreed to safeguard the state's natural resources by following a Nutrient Management Plan approved by the DCR. Twenty-one of these contractors are located in Northern Virginia.

If legal authority is not in place for the County to require participation in the DCR program, the County should publicize the program and make the list of "Lawn Care Providers with Water Quality Agreements with the Virginia Department of Conservation and Recreation" available to homeowners and landowners so they can opt to use the services of environmentally-sensitive lawn care providers. This list can be found on DCR's Virginia Nutrient Management Program webpage[1] and could be converted into a brochure and distributed by various County agencies, such as the Stormwater Planning Division, Department of Planning and Zoning, and Fairfax County Park Authority.

Watershed Benefit: The requirements for enrollment in the Virginia Water Quality Improvement Program are minimal but the benefits to the watershed are very large in terms of nutrient management. In addition, knowledge that the program exists could foster greater stewardship by lawn care companies who are more educated about application rates and timing of the application. Based on the program's recent record of accomplishment, it appears to be successful and one that could provide a significant benefit to the watershed.

Goal D: Implement watershed improvement projects County-wide to restore and maintain environmental health in the County.

Objective D.1: Provide a sustained source of funding for watershed improvement projects.

Policy Recommendation D1.1: Maintain a dedicated funding mechanism, such as a stormwater utility fee, to address water quality and stormwater related issues in Fairfax County.

Strategy to Achieve Recommendation: Fairfax County recently considered the countywide implementation of a stormwater environmental utility fee, as noted in Chapter 4.4. Ultimately, the County elected to dedicate a fixed share of the real estate tax revenue for FY 2006 for implementation of the County's watershed management

[1] Virginia Nutrient Management Program: http://www.dcr.state.va.us/sw/docs/wqagree.pdf

plans and other stormwater management program elements. This dedicated funding should be continued in future years to ensure long range program implementation.

Watershed Benefit: This action would provide a dedicated source of funding for the Popes Head Creek Watershed Management Plan actions in future years. The dedicated funding sources will put Fairfax County on a path to:

- Achieve regulatory mandates for water quality protection;
- Achieve goals identified in the 2003 Fairfax Strategic Plan;
- Sustain the viability of the existing investment in infrastructure; and
- Achieve the goals established through the Watershed Management Plan initiative.

Table 5.1: Summary of Policy Recommendations

Policy Recommendation	Description	Benefit
A1.1	Increase the frequency of inspection for private BMPs with maintenance agreements	Ensures that BMPs perform as intended. Will help to maintain existing conditions and aid in preventing the further degradation of the watershed
A1.2	Evaluate and revise the current list of recommended BMPs	Will allow developers to utilize innovative BMPs and submit their site plans for review
A1.3	Expand the allowed placement of integrated LID on individual residential lots	More flexibility in the selection and siting of BMPs for developers. The implementation of LID management practices, will treat stormwater runoff more directly at the source
A2.1	Adopt a policy of implementing natural landscaping and green building approaches at County facilities	The implementation of more suitable landscaping materials and techniques for the watershed increase water quality and quantity benefits
A2.2	More frequent assessment and inspection of VDOT drainage systems	Identification of existing and potential future drainage problems and development of a prioritized approach to correcting any existing inadequacies and schedule future maintenance projects
A2.3	Encourage use of porous pavement	A reduction in impervious areas will decrease the amount of stormwater runoff within the watershed.
A4.1	Encourage replanting efforts within degraded RPA buffer areas of sites undergoing redevelopment.	Restoration of riparian buffers will increase the amount of habitat area, protect the stream bank areas from erosion, and provide filtering of pollutants from runoff

Policy Recommendation	Description	Benefit
A5.1	Enforce the solid waste ordinance and the erosion and sedimentation control ordinance prohibition against illegal dumping	Reduced pollution as a result of illegal dumping. This action would help to improve the health and reduce the amount of pollutants in streams within the watershed.
A6.1	Regulate the use of All Terrain Vehicles (ATVs)	Reduction of illegal ATV use in the RPA. It will reduce erosion, sedimentation, and the destruction of vegetation caused by ATVs.
B1.1	Develop a watershed stewardship message specifically for Fairfax County Public Schools and George Mason University	The children can take the environmental lessons they learn home to their families and discuss environmental issues
C1.1	Encourage all lawn management companies to participate in DCRs Virginia Water Quality Improvement Program	Nutrient management in the watershed. Increased awareness and education of watershed residents and lawn care companies who perform services within the watershed.
D1.1	Establish a dedicated funding mechanism	Proposed projects will not have to compete for funding from the Fairfax County General Fund. Evaluation of a dedicated funding source is being addressed as a countywide initiative

The total cost of the policy recommendations in Table 5.1 is estimated to be approximately $1.3 Million. Over the plan's lifespan of 25 years, this will require approximately 0.9 Fairfax County Staff Year Equivalents (SYE) for project management. These recommendations are not specific to only Popes Head Creek, but are intended to be implemented County-wide where applicable. The recommendations will be evaluated along with the recommendations from the other watershed management plans to determine their applicability in the County.

5.2 Benefits of Policy Recommendations

The policy recommendations will provide many different benefits to the Popes Head Creek watershed. Policies that are implemented County-wide in conjunction with the other ongoing watershed management plans can have a much larger effect, resulting in improved environmental health for all citizens of Fairfax County and the surrounding region. Because these policy recommendations are non-structural in nature, it is difficult to quantitatively measure the benefits of implementation to the watershed.

The policy recommendations will help to improve the enforcement of existing regulations and laws and provide additional protection to areas that are environmentally valuable, but not necessarily located within a Resource Protection Area. The policy recommendation under Goal D can provide a dedicated revenue stream for stormwater management in the County. This is especially important because many regulatory requirements, such as TMDL implementation and Tributary Strategy compliance, are unfunded, placing the burden to pay on local governments.

5.3 Implementation of Policy Recommendations

The policy recommendations described in Section 5.1 will be reviewed by the County to evaluate County-wide implications and to compare with similar recommendations provided in other watershed management plans in the County. If ordinance amendments are needed, they will be developed to include other County initiatives and address the common ground that can be established between the various policy recommendations.

The first step in developing a logical and feasible implementation schedule was to prioritize the actions and evaluate how well they meet the Goals of the plan. A weighted set of five categories was used to prioritize each plan action. The following prioritization categories were used:

1. Board Adopted Stormwater Control Project Prioritization Categories (40%)
    - Projects that are mandated by state or federal regulations for immediate implementation and projects that address critical/emergency dam safety issues.
    - Projects that alleviate structures from damage by flood waters or by being undermined by severe erosion.
    - Projects that achieve stormwater quality improvement in specific conformance with the County's obligation under the Chesapeake Bay initiatives and/or the VPDES permit for storm sewer system discharges
    - Projects that alleviate severe streambank and channel erosion.
    - Projects that alleviate moderate and minor streambank and channel erosion.
    - Projects that alleviate yard flooding.
    - Projects that alleviate road flooding.

2. Direct Regulatory Contribution (10%)
    - Hybrid projects that accomplish multiple objectives.
    - Contributions directly to MS4 and Virginia Tributary Strategies compliance.
    - Contributions towards TMDL compliance.
    - Indirect water quality benefits.
    - Flood mitigation.

3. Public Support (10%)
    - Citizen's Advisory Committee support.
    - Support for projects by affected residents.

4. Effectiveness/Location (25%)
    - Quantity control projects are more desirable in "headwaters" areas that lack stormwater management controls.
    - Quality control projects are desirable in areas that previously lacked controls.
    - An indication of relative benefit of a project, such as pollutant reduction or efficiency, increased retrofit area, etc.

5. Ease of Implementation (15%)

- Project Complexity.
- Land acquisition.

The actions in the plan were scored 1 to 5 for each of the prioritization categories, with 5 as the best score and 1 as the worst score. The information used to score the actions was both quantitative and qualitative. The quantitative data that was used in the prioritization scoring included the amount of peak flow reduction, size of the existing or proposed drainage area.

The actions were ranked according to their total score, from highest to lowest. Table 5.1 shows the Prioritization of Policy Recommendations.

Table 5.2: Prioritization of Policy Recommendations

Policy Recommendation	Description	Board Adopted Categories	Direct Regulatory Contribution	Public Support	Effectiveness/ Location Rating	Ease of Implementation Rating	Total Score
	Weighting Factor	40%	10%	10%	25%	15%	
D1.1	Establish a dedicated funding mechanism	5	5	3	4	3	4.25
A4.1	Encourage replanting efforts within degraded RPA buffer areas of sites undergoing redevelopment.	3	4	5	4	3	3.55
A1.2	Periodically evaluate and revise the current list of recommended BMPs	2	4	3	3	3	2.7
A1.3	Expand the allowed placement of integrated LID on individual residential lots	2	4	3	3	3	2.7
C1.1	Encourage all lawn management companies to participate in DCRs Virginia Water Quality Improvement Program	2	4	3	3	2	2.55
A2.2	More frequent assessment and inspection of VDOT drainage systems	2	2	5	3	2	2.55

Policy Recommendation	Description	Board Adopted Categories	Direct Regulatory Contribution	Public Support	Effectiveness/ Location Rating	Ease of Implementation Rating	Total Score
	Weighting Factor	40%	10%	10%	25%	15%	
A6.1	Regulate the use of All Terrain Vehicles (ATVs)	1	2	5	3	3	2.3
A2.3	Encourage use of porous pavement	2	2	3	2	3	2.25
A5.1	Enforce the solid waste ordinance and the erosion and sedimentation control ordinance prohibition against illegal dumping	1	2	5	2	3	2.05
B1.1	Develop a watershed stewardship message specifically for Fairfax County Public Schools and George Mason University	1	2	5	2	3	2.05
A2.1	Adopt a policy of implementing natural landscaping and green building approaches at County facilities	1	2	3	2	3	1.85
A1.1	Increase the frequency of inspection for private BMPs.	1	2	3	2	3	1.85

5.4 Monitoring Plan

This section describes the monitoring actions and targets for determining the success or failure of the future policy recommendations. The monitoring will help to determine if the plan actions should be modified in the future because of a low success rate or as watershed conditions change.

Policy Recommendation A1.1*:* Increase the frequency of inspection for private BMPs with maintenance agreements from approximately once every three to five years to annually, and provide education to ensure proper maintenance by owners. County-owned BMPs are currently inspected once a year and are not included in this action.

Monitor: Frequency of inspections.

Target: Inspect private facilities per maintenance agreement frequency.

Policy Recommendation A1.2*:* Periodically evaluate and revise the current list of recommended BMPs to enhance the level of stormwater service.

Monitor: Observe emerging BMP and LID technology

Target: Revise the PFM as necessary to include new BMPs that are applicable to Fairfax County.

Policy Recommendation A1.3*:* Expand the allowed placement of integrated LID management practices, such as bioretention, on individual residential lots. Currently, these practices are only allowed on outlots or non-residential lots if they provide service for more than one lot.

Monitor: Observe County policy on facility location.

Target: Revise the PFM to allow BMP facilities on residential lots with an executed maintenance agreement.

Policy Recommendation A2.1*:* Adopt a policy of implementing natural landscaping and green building approaches at County facilities, such as public schools, libraries, fire stations, and other public facilities in the watershed. The County will be a model for implementing these beneficial watershed management approaches, so they can set the example for future development.

Monitor: Observe progress of Environmental Coordinating Committee.

Target: 50% of all County facilities that are built in the future will have natural landscaping and green building technology.

Policy Recommendation A2.2*:* Institute an inspection protocol and perform more frequent assessment of ditches, pipes, and outfalls within the watershed every five years and make repairs as necessary (County and Virginia Department of Transportation (VDOT)).

Monitor: Track number of inspections.

Target: Establish an inspection protocol and inspect all County ditches, pipes, and outfalls annually. Establish database for all inspections and log maintenance actions.

Policy Recommendation A2.3*:* Program to facilitate and encourage use of permeable pavers in commercial and institutional development in the Popes Head Creek watershed.

Monitor: Use of permeable pavers in site plan applications.

Target: Increase use of permeable pavers by 10% every five years.

Policy Recommendation A4.1: Encourage replanting efforts within degraded RPA buffer areas of sites undergoing redevelopment. Native vegetation mixes, suitable for local habitat, will be used.

Monitor: Number of new trees planted in redevelopment sites

Target: Increase tree coverage by 10% in redevelopment sites.

Policy Recommendation A5.1*:* Enforce the solid waste ordinance and the erosion and sedimentation control ordinance prohibitions against illegal dumping.

Monitor: Number of dumping violations and citations issued.

Target: Decrease dumping violations by 25% within two years.

Policy Recommendation A6.1*:* Regulate the use of All Terrain Vehicles (ATVs) to prevent watershed damage.

Monitor: Number of complaints related to ATV trespassing and damage.

Target: Reduce ATV-related complaints by 10% every year.

Policy Recommendation B1.1: Develop a watershed stewardship message specifically for Fairfax County Public Schools and George Mason University.

Monitor: Number of environmental classes and workshops requested and completed.

Target: Complete two environmental education workshops at each public school in the watershed every year.

Policy Recommendation C1.1*:* Encourage all lawn management companies to participate in the Virginia Department of Conservation and Recreation's (DCR) Virginia Water Quality Improvement Program and to sign agreements to apply nutrients within established criteria, to better control application rates and timing. Hire companies that have signed these agreements for work at County facilities. Provide a list of these companies to residential and commercial property owners and homeowners associations.

Monitor: Number of lawn care companies who sign Water Quality Improvement Program agreements.

Target: Increase participation in this program by 25% within five years and include company information in brochure to homeowners regarding lawn care and landscaping.

Policy Recommendation D1.1: Maintain a dedicated funding mechanism, such as a stormwater utility fee, to address water quality and stormwater related issues in Fairfax County.

Monitor: Budget, staff needs and projected CIP costs.

Target: Provide sufficient annual funding for all stormwater programs.

Glossary

A

Acre: A measure of land equating to 43,560 square feet.

Average Land Cover Conditions: The average percent of impervious area within the county, as set forth in the Fairfax County Public Facilities Manual.

B

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

Best Management Practice (BMP): A structural or nonstructural practice that is designed to minimize the impacts of changes in land use on surface and groundwater systems. Structural best management practices refer to basins or facilities engineered for the purpose of reducing the pollutant load in stormwater runoff, such as bioretention, constructed stormwater wetlands, etc. Nonstructural best management practices refer to land use or development practices that are determined to be effective in minimizing the impact on receiving stream systems such as the preservation of open space and stream buffers, disconnection of impervious surfaces, etc.

Bioretention Basin: A water quality best management practice engineered to filter the water quality volume through an engineered planting bed, consisting of a vegetated surface layer (vegetation, mulch, ground cover), planting soil, and sand bed (optional), and into the in-situ material. Also called rain gardens.

Bioretention Filter: A bioretention basin with the addition of a sand layer and collector pipe system beneath the planting bed.

Buffer: An area of natural or established vegetation managed to protect other components of a resource protection area and state waters from significant degradation due to land disturbances. See also *resource protection area* and *riparian buffer*.

C

Capacity: The amount of water that a channel can accommodate up to its bank full condition, which is dependent on its slope, roughness characteristics, and geometric shape.

Channel Evolution Model (CEM): The geomorphologic assessment of the incised stream channels in the Little Hunting Creek watershed developed by Schumm et. al.

Channel: A natural or manmade waterway.

Chesapeake Bay Preservation Areas: Any land designated by the county pursuant to Part III of the Chesapeake Bay Preservation Area Designation and Management Regulations and Code of Virginia, Section 10.1-2107. A Chesapeake Bay Preservation Area shall consist of a resource protection area and a resource management area.

Confluence: The joining point where two or more streams create a combined, larger stream.

Constructed Stormwater Wetlands: Areas intentionally designed and created to emulate the water quality improvement function of wetlands for the primary purpose of removing pollutants from stormwater.

Culvert Retrofit: A Culvert Retrofit is installed upstream from existing road culverts by constructing a control structure and excavating a micro-pool. The control structure will consist of a weir that will detain and reduce stormwater flow; the micro-pool is a small permanent pool that will infiltrate the first 0.1 – 0.2 inches of stormwater runoff, improving water quality.

D

Density: The number of dwelling units per acre.

Design Storm: A selected rainfall hyetograph of specified amount, intensity, duration, and frequency that is used as a basis for design.

Detention: The temporary impoundment or holding of stormwater runoff.

Detention Basin: A stormwater management facility that temporarily impounds runoff and discharges it though a hydraulic outlet structure to a downstream conveyance system. While a certain amount of overflow may also occur via infiltration through the surrounding soil, such amounts are negligible when compared to the outlet structure discharge rates, and therefore, are not considered in the facility's design. Since a detention basin impounds runoff only temporarily, it is normally dry during periods of no rainfall.

Developer: The legal or beneficial owner or owners of all the land proposed to be included in a given development or the authorized agent thereof. In addition, the holder of an option or contract to purchase, a lessee having a remaining term of not less than 30 years, or other persons having an enforceable proprietary interest in such land shall be deemed to be a developer.

Development: The construction, rehabilitation, rebuilding or substantial alteration of residential,commercial, industrial, institutional, recreational, transportation, or utility uses, facilities, or structures.

Dwelling Unit: One or more rooms in a residential building or residential portion of a building that are arranged, designed, used, or intended for use as a complete, independent living facility which includes permanent provisions for living, sleeping, eating, cooking, and sanitation.

E

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

Effective Imperviousness: The fraction of total impervious area with a direct hydraulic connection to the downstream drainage, such as through the storm drainage system. Effective imperviousness area is also known as directly connected area.

Eutrophication: The process of over-enrichment of water bodies by nutrients often typified by the presence of algal blooms.

Extended Detention Basin: A stormwater management facility that temporarily impounds runoff and discharges it though a hydraulic outlet structure over a specified period of time to a downstream conveyance system for the purpose of water quality enhancement or stream channel erosion control. While a certain amount of overflow may also occur via infiltration through the surrounding soil, such amounts are negligible when compared to the outlet structure discharge rates, and therefore, are not considered in the facility's design. Since an extended detention basin impounds runoff only temporarily, it is normally dry during periods of no rainfall.

F

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

First Flush: The first portion of runoff usually defined as a depth in inches considered to contain the highest pollutant concentration resulting from a rainfall event.

Floodplain: Those land areas in and adjacent to streams and watercourses subject to continuous or periodic inundation from flood events with a 1% chance of occurrence in any given year (i.e., the 100-year flood frequency event) and having a drainage area greater than 70 acres. Minor floodplains shall be those floodplains that have a drainage area greater than 70 acres but less than 360 acres. Floodplains shall include all areas of the county which are designated as a floodplain by the Federal Insurance Administration, the United States Geological Survey, or Fairfax County.

Floor Area Ratio: Determined by dividing the gross floor area of all buildings on a lot by the area of that lot.

Frequency (design storm frequency): The recurrence interval of storm events having the same duration and volume. The frequency of a specified design storm can be expressed either in terms of exceedence probability or return period.

Exceedence Probability: The probability that an event having a specified volume and duration will be exceeded in one time period usually assumed to be one year. If a storm has a 1% chance of occurring in any given year, then it has an exceedence probability of 0.01.

G

Gabion: A wire basket or cage that is filled with gravel and generally used to stabilize stream banks and improve degraded aquatic habitat.

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.

Geomorphology: A science that deals with the land and submarine relief features of the earth's surface.

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

Grassed Swale: An earthen conveyance system that is broad and shallow with check dams and vegetated with erosion-resistant and flood-tolerant grasses, engineered to remove pollutants from stormwater runoff by filtration through grass and infiltration into the soil.

H

Head Cut: The geomorphologic incision of the stream due to the hydraulic effects of a channel from head forces. One example is the accelerated cutting of a stream due a manmade or natural constriction where water velocities are increased substantially. Another example is the outlet of a dam, where extreme velocities can occur due to the high static head forces created by the build-up of water from the dam structure.

Headwater: The source of a stream or watershed.

Highly Erodible Soils: Soils (excluding vegetation) with an erodibility index (EI) from sheet and rill erosion equal to or greater than eight. The erodibility index for any soil is defined as the product of the formula RKLS/T, as defined by the Food Security Act (F.S.A.) Manual of August, 1988, in the Field Office Technical Guide of the U.S. Department of Agriculture Soil Conservation Service, where K is the soil susceptibility to water erosion in the surface layer; R is the rainfall and runoff; LS is the combined effects of slope length and steepness; and T is the soil loss tolerance.

Highly Permeable Soils: Soils with a given potential to transmit water through the soil profile. Highly permeable soils are identified as any soil having a permeability equal to or greater than six inches of water movement per hour in any part of the soil profile to a depth of 72 inches (permeability groups "rapid" and "very rapid") as found in the National Soils Handbook of July 1983, in the Field Office Technical Guide of the U.S. Department of Agriculture Soil Conservation Service.

Hydraulics: The physical science and technology of the static and dynamic behavior of fluids.

Hydrograph: A plot showing the rate of discharge, depth, or velocity of flow versus time for a given point on a stream or drainage system.

Hydrology: The science dealing with the distribution and movement of water.

Hyetograph: A graph of time distribution of rainfall over a watershed.

I

Imperviousness or Impervious Cover: A surface composed of any material that significantly impedes or prevents natural infiltration of water into soil. Impervious surfaces include, but are not limited to, roofs, buildings, streets, parking areas, and any concrete, asphalt, or compacted gravel surface. Impervious areas or impervious surfaces do not include the water surface area of a swimming pool.

Infill: A residential development that has occurred proximate to, or within, an already established neighborhoods.

Infiltration Facility: A stormwater management facility that temporarily impounds runoff and discharges it though the surrounding soil. While an infiltration facility may also be equipped with an outlet structure to discharge impounded runoff, such discharge is normally reserved for overflow and other emergency conditions. Since an infiltration facility impounds runoff only temporarily, it is normally dry during periods of no rainfall. Infiltration basins, infiltration trenches, infiltration dry wells, and porous pavement are considered infiltration facilities.

Intensely Developed Area: An area of existing development and infill sites where development is concentrated and little of the natural environment remains as of the date of adoption of the county's Chesapeake Bay Preservation ordinance and which is so designated on the county's map of Chesapeake Bay Preservation Areas.

Invert: The lowest flow line elevation in any component of a conveyance system, including storm sewer, channels, weirs, etc.

L

Land Development: A manmade change to, or construction on, the land surface that changes its runoff characteristics. Certain types of land development are exempted from stormwater management requirements as provided in the Stormwater Management Act, 10.1-603.8 B of the Code of Virginia.

Land Disturbing Activity: Any land change which may result in soil erosion from water or wind and the movement of sediments into state waters or onto lands in the Commonwealth, including but not limited to, clearing, grading, excavating, permanent flooding associated with the impoundment of water, and filling of land.

Landscaping: The improvement of a lot with grass, shrubs, trees, other vegetation and/or ornamental objects. Landscaping may include pedestrian walks, flowerbeds, ornamental objects such as fountains, statues, and other similar natural and artificial objects designed and arranged to produce an aesthetically pleasing effect.

Level Spreader: A Level Spreader is an open channel LID technique that is used to disperse concentrated stormwater runoff over a large area to reduce erosion.

Low-Impact Development (LID): Integrated hydrologically functional site design with pollution prevention measures to compensate for land development impacts on

hydrology and water quality. The primary goal of Low Impact Development methods is to mimic the predevelopment site hydrology.

M

Major Floodplain: Those land areas in and adjacent to streams and watercourses subject to continuous or periodic inundation from flood events with a 1% chance of occurrence in any given year (i.e., the 100-year flood frequency event) and having a drainage area equal to or greater than 360 acres.

Marsh: A wet area, periodically inundated.

Mitigation: To make a scenario less harmful in the original condition; or to provide a habitat in another more conducive, larger, or better-suited area, typically in a different location from the original. Mitigation may result due to constructability, cost, or other site restriction issues.

N

National Pollutant Discharge Elimination System (NPDES): The national program for issuing, modifying, monitoring, and enforcing permits under Sections 307, 402, 318 and 405
of the Clean Water Act. The NPDES permit is for discharges to the waters of the United States and is administered in Virginia under the Virginia Pollutant Discharge Elimination System.

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

O

Off-Site: Any area outside the boundary of a lot.

Open Space: That area within the boundaries of a lot that is intended to provide light and air, and is designed for either scenic or recreational purposes. Open space shall, in general, be available for entry and use by the residents or occupants of the development, but may include a limited proportion of space so located and treated as to enhance the amenity of the development by providing landscaping features, screening for the benefit of the occupants or those in neighboring areas, or a general appearance of openness. Open space may include, but need not be limited to lawns, decorative planting, walkways, active and passive recreation areas, children's playgrounds, fountains, swimming pools, undisturbed natural areas, agriculture, wooded areas, water bodies, and those areas with landscaping. Open space shall not include driveways, parking lots, or other vehicular surfaces, any area occupied by a building, nor areas so located or so small as to have no substantial value for the purposes stated in this definition. Within a residential subdivision, open space shall be composed of only those areas not contained in individually owned lots.

P

Passive Recreation: Recreational activities that are commonly unorganized and noncompetitive, including, but not limited to, picnicking, bird watching, kite flying, bicycling, and walking. Site amenities for such activities include, but are not limited to, picnic tables, photo stands, open play areas where substantial clearing is not required, rest rooms, tot lots, boardwalks, paved paths, pathways, benches, and pedestrian bridges and appurtenant structures.

Peak Discharge: The maximum rate of flow at an associated point within a given rainfall event or channel condition.

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.

Phosphorus: An element found in fertilizers and sediment runoff that can contribute to the eutrophication of water bodies. It is the keystone pollutant in determining pollutant removal efficiencies for various best management practices as defined by the Virginia Stormwater Management Regulations.

Point Source: The discernible, confined and discrete conveyance, including, but not limited to, any pipe, ditch, channel, tunnel, conduit, well, container, concentrated animal feeding operation, landfill leachate collection system from which pollutants may be discharged. This term does not include return flows from irrigated agricultural storm water runoff.

Post-Development: Refers to conditions that reasonably may be expected or anticipated to exist after completion of the land development activity on a specific site or tract of land.

Pre-Development: Refers to the conditions that exist at the time that plans for the land development of a tract of land are approved by the plan approval authority. Where phased development or plan approval occurs (preliminary grading, road, and utilities, etc.), the existing conditions at the time prior to the first item being approved or permitted establishes the pre-development conditions.

Pro Rata Share (PRS): The payment by a subdivider or developer of land for his share of the cost of providing reasonable and necessary drainage facilities located outside the property limits of the land owned or controlled by the subdivider or developer of land and necessitated or required, at least in part, by the new construction or improvement of his subdivision or development.

R

Rain Barrel: Rain barrels are low-cost, effective and easily maintainable retention devices that can be used in both residential and commercial/industrial sites. They are connected to gutters and retain rooftop runoff. Rain barrels can be used to store runoff for later use in lawn and garden watering.

Redevelopment: The substantial alteration, rehabilitation, or rebuilding of a property for

residential, commercial, industrial, or other purposes.

Resource Management Area (RMA): As established in accordance with Chapter 118 of the Code of County of Fairfax, Virginia, that component of the Chesapeake Bay Preservation Area comprised of lands that, if improperly used or developed, have a potential for causing significant water quality degradation or for diminishing the functional value of the resource protection area. A resource management area is a Chesapeake Bay Preservation Area, whose land features typically include floodplains, highly erodible soils, highly permeable soils, nontidal wetlands not in the resource protection area, and other land as designated by the locality. See also *resource protection area*.

Resource Protection Area (RPA): As established in accordance with Chapter 118 of the Code of County of Fairfax, Virginia, that component of the Chesapeake Bay Preservation Area comprised of lands at or near the shoreline or water's edge 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 of the quality of state waters. In their natural condition, these lands provide for the removal, reduction, or assimilation of sediments, nutrients, and potentially harmful or toxic substances from runoff entering the Bay and its tributaries, and minimize the adverse effects of human activities on state waters and aquatic resources. Resource protection areas filter pollutants out of stormwater runoff, reduce the volume of stormwater runoff, prevent erosion, and perform other important biological and ecological functions. A resource management area is a Chesapeake Bay Preservation Area, whose land features generally include tidal wetlands, nontidal wetlands contiguous to tidal wetlands, tidal shores, tributary streams, a buffer area (of not less than 100 feet), and other lands as designated by the locality.

Retention: The permanent storage of stormwater.

Retention Basin: A stormwater management facility that includes a permanent impoundment, a normal pool of water, for the purpose of enhancing water quality and, therefore, is normally wet, even during periods without rainfall. Storm runoff inflows may be temporarily stored above this permanent impoundment for the purpose of reducing flooding or stream channel erosion.

Retrofit: The modification of stormwater management systems through the construction and/or enhancement of wet ponds, wetland plantings, or other best management practices designed to improve water quality.

Return Period: The average length of time between events having the same volume and duration. If a storm has a 1% chance of occurring in any given year, then it has a return period of 100 years.

Rezoned Area: On July 26, 1982, the Fairfax County Board of Supervisors approved a rezoning of more than 41,000 acres in the Occoquan Watershed in order to protect the Occoquan Reservoir, which supplies drinking water to the County. Land in the rezoned area is classified as Residential-Conservation (R-C) District, designating a maximum

density of one dwelling unit per 5 acres. Approximately 86% of the Popes Head Creek Watershed is located in the rezoned area.

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

Riparian Buffer: Strips of grass, shrubs, and/or trees along the banks of rivers and streams that filter polluted runoff and provide a transition zone between water and human land use. Buffers are also complex ecosystems that provide habitat and improve the stream communities they shelter.

Runoff: The portion of precipitation, snow melt, or irrigation water that runs off the land into surface waters.

S

Sediment: Material, both mineral and organic, that is in suspension, is being transported, or has been moved from its original site of origin by water or wind. Sediment piles up in reservoirs, rivers and harbors, reducing channel depth, impeding navigability, destroying wildlife habitat and clouding water so that sunlight cannot reach aquatic plants.

Sedimentation (Settling): A pollutant removal method to treat stormwater runoff in which gravity is utilized to remove particulate pollutants. Pollutants are removed from the stormwater as sediment settles or falls out of the water column. An example of a best management practice utilizing sedimentation is an extended detention basin.

Site Plan: A required submission that contains detailed engineering drawings of the proposed uses and improvements required in the development of a given lot.

Stakeholder: Stakeholders include a range of groups within the watershed (residents, industry, local government, agencies, community groups, etc.), as well as those whose livelihoods take them into the watershed and the marine environment of Little Hunting Creek.

Stormwater Management Facility: A device that controls stormwater runoff and changes the characteristics of that runoff including, but not limited to, the quantity and quality, the period of release or the velocity of flow.

Stream Rehabilitation: Stream rehabilitation is making the land useful again after a disturbance. It involves the recovery of ecosystem functions and processes in a degraded habitat (Dunster and Dunster 1996). Rehabilitation does not necessarily reestablish the predisturbance condition, but does involve establishing geological and hydrologically stable landscapes that support the natural ecosystem.

Stream Restoration: Stream restoration is reestablishment of the structure and function of ecosystems (National Research Council, 1992). Ecological restoration is the process of returning an ecosystem as closely as possible to predisturbance conditions and functions. Implicit in this definition is that ecosystems are naturally dynamic. It is therefore not possible to recreate a system exactly. The restoration process

reestablishes the general structure, function, and dynamic but self-sustaining behavior of the ecosystem.

Stream Valley: A stream and the land extending from either side of it to a line established by the high point of the concave/convex topography as delineated on a map adopted by the Fairfax County Board.

Substantial Alteration: Expansion or modification of a structure or development which would result in disturbance of any land within a resource protection area or land exceeding an area of 2,500 square feet within a resource management area.

Subwatershed: A smaller subsection of a larger watershed, which may have been delineated to describe a particular land use, function, or hydrologic condition.

T

Total Maximum Daily Load (TMDL): A Total Maximum Daily Load is a tool developed by the U.S. Environmental Protection Agency for implementing water quality standards and is based on the relationship between pollution sources and in-stream water quality conditions. The TMDL establishes the allowable loadings or other quantifiable parameters for a waterbody and thereby provides the basis to establish water quality-based controls. These controls should provide the pollution reduction necessary for a waterbody to meet water quality standards. The Virginia Department of Environmental Quality monitors 130 different pollutants annually to determine whether the waters can be used for swimming, fishing and drinking. If waters do not meet these standards, then they are considered impaired and a TMDL must be implemented.

Tree Cover: The area directly beneath the crown and within the dripline of a tree.

U

Urban Runoff: Stormwater from city streets and adjacent domestic or commercial properties that carries nonpoint source pollutants of various kinds into the sewer systems and receiving waters.

Use: Any purpose for which a structure or a tract of land may be designed, arranged, intended, maintained, or occupied; also, any activity, occupation, business or operation carried on, or intended to be carried on, in or on a structure or on a tract of land.

V

Virginia Pollutant Discharge Elimination System (VPDES): This permit program limits pollutant discharges into streams, rivers and lakes. It is administered by the Virginia Department of Environmental Quality as part of the National Pollutant Discharge Elimination System (NPDES) (Section 402 of the Clean Water Act).

W

Water Body with Perennial Flow: A body of water flowing in a natural or manmade channel year-round, except during periods of drought. The term “water body with perennial flow” includes perennial streams, estuaries, and tidal embayments. A perennial stream means any stream that is both perennial and so depicted on the map of

Chesapeake Bay Preservation Areas adopted by the Board of Supervisors pursuant to Section 118-1-9(a). Streams identified as perennial on the adopted map are based on field studies conducted by the Department of Public Works and Environmental Services. Lakes and ponds that form the source of a perennial stream, or through which the perennial stream flows, are a part of the perennial stream. The width of a perennial stream may be measured from top-of-bank to top-of-bank or at the Ordinary High Water Mark (OHWM) as defined by 33 CFR Part 328.3(e). The aerial extent of a pond or lake is measured at the OHWM. Generally, the water table is located above the streambed for most of the year and groundwater is the primary source for stream flow. In the absence of pollution or other manmade disturbances, a perennial stream is capable of supporting aquatic life.

Watercourse: A stream with incised channel (bed and banks) over which waters are conveyed.

Water Quality Standards: State-adopted and EPA-approved ambient standards for water bodies. The standards prescribe the use of the water body and establish the water quality criteria that must be met to protect designated uses.

Water Quality Volume: The volume equal to the first one-half inch of runoff multiplied by the impervious surface of the land of the land development project as defined by the Virginia Stormwater Management Regulations. It should be noted that the runoff frequency spectrum for Washington D.C. and the surrounding Chesapeake Bay watershed is based on the fact that 90% of the annual runoff is generated by storms of one inch of rainfall or less. Therefore, some of the best management practices will require two times the water quality volume, or, the first one inch of runoff to be treated.

Watershed: A defined land area 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 single outlet.

Wetlands: See *wetlands, tidal* and *wetlands, nontidal*.

Wetlands, Nontidal: Wetlands other than tidal wetlands that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.

Wetlands, Nonvegetated: Unvegetated lands lying contiguous to mean low water and between mean low water and mean high water subject to flooding by normal and wind tides but not hurricane or tropical storm tides.

Wetlands, Vegetated: Lands lying between and contiguous to mean low water and an elevation above mean low water equal to the factor one and one-half times the mean tide range at the site of the proposed project in this county; and upon which is growing any of the species as indicated in Chapter 116, Wetlands Zoning Ordinance, of the Fairfax County Code.