Acknowledgments

Community Advisory Committee

The Cub and Bull Run Watershed Management Plan was developed with the assistance of the Cub Run Community Advisory Committee. We would like to thank the following individuals for contributing time and knowledge to this planning effort.

Kim Angeli - Volunteer Stream Monitor

Courtney Caldwell - Canoe Cruisers

Mike Cinnamon - Izaak Walton League

Jeff Cornell - Centreville Dogs

Joanna Cornell - Northern Virginia Soil and Water Conservation District

Rodney Follin -Member at large

Debbie Foster - Gate Post Estates

Scott Garver

Steve Gleason - William H. Gordon Associates

Joe Gorney - Loudoun County Department of Planning

Michael Hackett - Metropolitan Washington Airports Authority

Charles Hastings - Chantilly Green Estates Home Owners Association

Melinda Hughes - National Wildlife Federation

David Lacey - Fairfax Athletic Council – Sully District

Blythe Merritt - Audubon Naturalist Society

Scott Miller - Pleasant Valley Neighborhood Connection

Jon Peterson - The Peterson Companies

Charles Smith - Fairfax County Park Authority

Dave Speed - Hazel Construction Company

John Sunda - Bull Run Civic Association

Harold Strickland - Greenbriar Civic Association

Carol Teigen – Franklin Farm Foundation

Larry Tessier – Sully District Council of Citizens Associations

German Vanegas - Friends of the Occoquan Watershed

Russell Wanek - West Fairfax County Citizens Association Land Use Committee

Ralph Willis - Chantilly Youth Association

Sully District Supervisor Michael R. Frey's Office
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Springfield District Supervisor Elaine McConnell's Office
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Technical Advisory Committee

The following individuals also contributed a significant part of their time and technical knowledge as members of the project Technical Advisory Committee:

Clinton Abernathy – Fairfax County Department of Pubic Works and Environmental Services

Todd Bolton - Virginia Department of Transportation

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Heather Melchior – Fairfax County Park Authority

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Mike Rolband – Wetland Studies and Solutions, Inc.

Chris Ruck & Joe Ivers - Virginia Water and Wetlands, Inc.

Tammy Schwab – Fairfax County Park Authority

Charles Smith – Fairfax County Park Authority

Ron Tuttle – Fairfax County Stormwater Planning Division

Fairfax County Staff

The Cub and Bull Run Watershed Management Plan was initiated by the Fairfax County Stormwater Planning Division:

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Project Team

The Watershed Plan was performed by the following companies and individuals:

CDM

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Brad Moore - GIS Analyst

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Executive Summary

The Cub Run and Bull Run watersheds are among the largest and fastest developing watersheds in Fairfax County and have a wide range of development densities and stream conditions. The Cub Run and Bull Run Watershed Management Plan documented herein provides strategies both for mitigating adverse stream conditions caused by such growth and development, and for protecting the watersheds from future impacts. Figure ES-1 shows the watersheds and major subwatersheds. The Cub Run watershed area is 53 square miles, which include 14 square miles in eastern Loudoun County. The Bull Run watershed area is approximately 10 square miles and includes the small, unnamed streams or tributaries that drain directly into Bull Run. Part of this watershed, 1.3 square miles, also lies within Loudoun County.

Purpose

The primary goals of watershed plans for Fairfax County are summarized as follows:

1. Restore and protect the county's streams

2. Meet state and federal water quality standards by identifying strategies to prevent and remove pollution

3. Support Virginia's commitment to the Chesapeake 2000 Agreement to restore the Chesapeake Bay by 2010

4. Update the current watershed plans to include modern technologies and community concerns

5. Take a comprehensive approach in addressing multiple regulations, commitments and community needs

6. Meet the community watershed vision and goals developed by the project Community Advisory Committee (CAC)

7. Meet nutrient loading and reduction goals for the Occoquan Reservoir and the Chesapeake Bay Tributaries.

With input from the CAC and other members of the community, this plan addresses these needs and requirements while providing a strategy for restoring and protecting the watershed.

Watershed Overview

Before 1980, the watersheds were largely undeveloped open space with few areas of residential development and little commercial development. The population has increased fivefold from 20,000 in 1980 to nearly 100,000 in 2000. This has led to an increase in land surface covered by buildings, parking lots, roads, driveways and sidewalks (impervious area) from 7 percent in 1980 to 15 percent today.

Figure ES-1
Major Subwatersheds in
the Cub Run and Bull Run Watersheds

Fairfax County has required stormwater ponds to control peak flows from new development since 1972. Since 1980, the county has required stormwater controls that reduce nutrient concentrations from new development within the Occoquan Reservoir watershed by 50 percent to protect the water quality in the reservoir - the drinking water source for more than one million Northern Virginia residents.

These regulations, combined with the time development occurred in the watershed, give the Cub Run and Bull Run watersheds one of the greatest density and degree of coverage of stormwater controls within Fairfax County. More than 420 stormwater ponds, serving 26 percent of the total watershed area and most of the developed area, reduce peak flows and pollutant runoff for nearly all of the existing development. Only a few isolated developed residential areas do not have stormwater controls. This is in stark contrast to watersheds in eastern Fairfax County where large areas of residential development lack stormwater controls.

Loudoun County also requires stormwater controls to reduce peak runoff rates and limit pollutant runoff. In response to these requirements, Loudoun County relies on several large wet ponds to manage runoff from the existing development in the Cub Run and Bull Run watersheds, and future development will have stormwater control facilities.

Stream conditions in the Cub and Bull Run watersheds vary. Most of the stream habitat is rated as good to fair. The high density of stormwater ponds is partially responsible for the streams' having higher quality than would be expected for the watershed's development densities.

Potential for future growth in the watersheds varies:

- The Cub Run watershed has approximately 14 percent impervious area. Future development as described in the Fairfax County Comprehensive Plan, Loudoun County General Plan and Dulles International Airport expansion plans will increase the impervious area to roughly 25 percent. Impervious area - land surface covered by rooftops, pavement and similar areas that prevent rainfall from infiltrating into the soil - represents the amount of development in the watershed and its potential impact on the streams.

- The Bull Run watershed has approximately 4.2 percent impervious area and is estimated to be 11 percent impervious at build-out based on the planned land use.

- Parkland and other preserved open space make up about 11 square miles or 23 percent of the total project study area within Fairfax County.

- Eastern portions of the Cub Run watershed have a high density of development with little potential for additional development.

- Southwestern portions of the watershed are within the Residential-Conservation (R-C) District where the maximum development density is limited to one house per five acres. The R-C District is an effective low-impact development program adopted by Fairfax County through major rezoning in 1982 to protect Occoquan Reservoir water quality. This area further protects the watershed since 5,174 of the 11,716 acres (44 percent) within the R-C District in Cub and Bull Run is preserved as parkland and golf courses.

- Areas of Fairfax County near Dulles International Airport (Chantilly and Westfields) are developing rapidly. The County Comprehensive Plan calls for a mix of commercial, light industrial, office and residential land uses.

- The Loudoun County portion of the watershed includes the South Riding community developed in recent years. These portions of Loudoun County have planned land uses that include residential, commercial/business and industrial. The Loudoun County General Plan calls for higher densities north of Braddock Road and lower densities south of Braddock Road.

- In addition to this residential and non-residential development, several transportation projects in various stages of planning will potentially affect the Cub Run and Bull Run watersheds:

    - Dulles International Airport expansion projects, including two new runways, associated taxiways and a new midfield terminal

    - Potential routes for the Tri-County Parkway. The selected West Two alternative lies outside the watershed.

    - All identified routing alternatives for the Manassas National Battlefield Park Bypass

    - Route 28 interchange improvements. Several of these have been constructed, and the planned Willard Road interchange is within the Cub Run watershed.

    - Widening of Walney Road from two to four lanes at Flatlick Branch

    - Widening of Pleasant Valley Road from two to four lanes

    - Widening of Braddock Road east of Pleasant Valley Road and a new four-lane road from this location to Old Lee Road

Growth has stabilized in the eastern and southern portions of the watershed. However, growth in the northern and western portions is a concern for future watershed conditions. New development will include stormwater facilities to meet both Fairfax County and Loudoun County requirements to control both peak flows and stormwater quality.

Public Involvement

The Cub Run and Bull Run watershed plan incorporates input from residents and businesses of the two watersheds collected through an extensive public involvement and outreach process.

The watershed plan's CAC is a diverse group from the local community, including members of homeowner associations, conservation organizations, local businesses, recreation groups, neighboring local and federal jurisdictions, and other local interests groups. The CAC met with the project team roughly 20 times to prepare this watershed plan.

In addition to the CAC meetings, four public forums allowed residents to identify watershed issues, evaluate alternatives to address these issues and comment on the proposed watershed plan elements.

Public involvement was important to the development of the plan. This information was combined with engineering, cost-benefit analyses and other evaluations to identify the recommendations to be implemented and monitored to meet the watershed vision and goals effectively and efficiently.

Watershed Vision

The CAC prepared the following overall vision for the Cub Run and Bull Run watersheds:

> **Waterways in the Cub Run and Bull Run watersheds are valued pieces of the community fabric. Community members, as trustees of the waterways for succeeding generations, recognize their responsibility to sustain, restore and enhance the waterways. Educational efforts enrich the community's understanding of waterways, the associated riparian areas and their importance to both the local community and the region. Stream corridors contribute to community vibrancy and economic health while providing water quality, stormwater management, flood control, habitat and recreational benefits. Waterways are a clean and safe source of the region's drinking water**.

This vision provides the foundation for a comprehensive approach to improving existing conditions and reducing impacts from future land use changes within the watersheds.

The CAC identified the following functions of waterways and stream valleys to be recognized and protected by the watershed plan:

- Filtering water- and air-borne pollutants
- Keeping water temperatures cool

- Storing floodwaters
- Reducing floodway velocities
- Serving as groundwater recharge areas
- Improving and maintaining water quality
- Providing wildlife habitat to include nesting, resting, roosting, feeding and watering areas
- Providing appropriate recreational opportunities
- Providing educational opportunities
- Enhancing community aesthetics

The CAC also recommended the plan should:

- Foster and promote co-existence and constructive beneficial use among people, waterways and riparian areas to enable the widest range of beneficial uses without environmental degradation, risk to health or safety, or other undesirable and unintended consequences to the human community, environment or wildlife
- Improve and maintain inter-jurisdictional coordination and collaboration at all levels (federal, state, regional, local) to protect and improve watershed health, integrate services and avoid duplication of effort and expense
- Protect the quality of the Occoquan Reservoir – a major drinking water source for the Northern Virginia region
- Specify stormwater management, best management practices, low-impact development and other watershed management policies that will restore and maintain watershed health
- Include educational strategies to enrich the community’s understanding of watershed ecological processes and their importance
- Establish clear mechanisms for restoring degraded waterways within the watershed
- Promote stormwater control projects that intercept flows and treat the stormwater runoff as far upstream in the watershed as possible before stream conditions are affected
- Promote the preservation of open space and support adherence to R-C zoning to minimize impervious surface area, and protect headwaters and stream corridors

- Promote the mitigation of impacts to streams and wetlands within the local watershed where the impacts occur

The CAC also defined the following watershed-wide recommended guidelines for future decisions regarding regional and onsite stormwater ponds:

- Ponds should be used as a last resort and, if possible, located off-channel.

- Alternatives to ponds should be considered, including installation of smaller controls further upstream and natural stormwater controls such as wetland projects. As part of this strategy, wetland mitigation sites in the watershed should be identified.

Watershed Plan Implementation

This report provides an implementation schedule (Section 7) for the watershed plan actions. Additional factors, however, may affect the implemented projects and schedule:

- Projects, programs and policy items will undergo review by county staff and the Board of Supervisors before implementation. Board adoption of the watershed plan will not mean automatic implementation of the plan recommendations.

- The watershed plan is a master list of recommended nonstructural actions and structural projects. Each fiscal year, staff will prepare and submit to the board a detailed spending plan that will describe the projects and explain their ranking, benefit and need to meet a defined watershed or water quality goal.

- Availability of funding and other resources will affect the implementation of watershed plan projects.

- The initial project implementation phases will include outreach to the community near the proposed projects. The recommended plan elements may become infeasible or need to be modified as a result of this outreach.

- Projects will be value-engineered at the time of implementation to ensure cost-effectiveness. Using volunteers or alternative funding sources will be considered to reduce implementation costs.

- The watershed plan considers visions, goals, issues and needs only within the Cub Run and Bull Run watersheds. Fairfax County will consider stormwater needs and priorities across the entire county when implementing the recommendations included in this plan and other watershed plans.

- The county budget for stormwater improvements will not fund stream-crossing improvements unrelated to protection of streambeds or banks, or prevention of structure flooding.

- Stream restoration, buffer restoration and other projects on private land will be evaluated to determine means for cost sharing with the landowners.

Watershed Plan Elements

The plan includes three major project types:

- **Nonstructural actions** – These include education and outreach programs, and other actions that do not require construction to complete. These actions, described in Section 4, can be performed under current county policies and have a defined implementation schedule.

- **Policy Recommendations** – These include recommended changes to county policy. Proposals may require amendments to the county code and other supporting documents such as the county Public Facilities Manual.

- **Structural Actions -** These include projects to be constructed in the watersheds to improve stream conditions. Projects range from simple actions such as the restoration of stream buffers to restore and protect habitat to major construction of a regional stormwater facility to control stormwater flows and reduce pollutant runoff.

Nonstructural Actions

Description

The watershed vision and goals recognize that the plan must address more than just providing stormwater controls. It must also promote education, recreation, cooperation and collaboration so streams and stream valleys remain a valuable resource for the community.

Nonstructural actions include community outreach and educational actions as well as land management strategies such as proper lawn-care maintenance.

The nonstructural actions are grouped as follows to provide unique one-to-one correlation between the actions and the corresponding category:

- A- Public Outreach and Education

- B - Interjurisdictional Cooperation

- C - Recreation

- D - Existing Development

- E - New and Infill Development

- F – Open Space

As described in Section 4, the plan includes 21 objectives and 59 recommended nonstructural actions that will help to achieve the watershed vision and goals.

Implementation Plan

Section 7 of the watershed plan prioritizes the nonstructural actions and develops a recommended implementation program. The nonstructural actions were prioritized based on their effectiveness in meeting county policies, regulatory requirements, public support, location within the watershed and ease of implementation. The recommended plan assumes that all nonstructural actions will be considered within the first 15 years of the 25-year watershed plan.

Many nonstructural actions will be considered with similar recommendations from other watershed plans and will potentially be implemented across all watersheds. Also, many actions involve coordination with other agencies such as the Northern Virginia Soil and Water Conservation District and Virginia Department of Conservation and Recreation. Finally, some actions can be completed by county staff. When appropriate, additional staff resources, partner support or consultant services will be needed.

Funds and staff resources will be required to implement these recommendations. These resources will be estimated at the time a nonstructural action is being evaluated for implementation as part of the annual budget process. The watershed plan recommends that the county continues to use existing resources, partnerships and allocate adequate funds to implement these nonstructural actions.

Policy Objectives and Recommendations

Description

The watershed plan also recommends changes to county policy that will improve watershed conditions, address watershed issues and meet the visions and goals for the Cub Run and Bull Run watersheds.

Policy recommendations include proposals that typically require amendments to the County Code and other supporting documents such as the Public Facilities Manual. The policy recommendations from the Cub Run and Bull Run watershed plan will be compared with similar recommendations in the Little Hunting Creek, Popes Head Creek, Cameron Run, Difficult Run and other watershed management plans. Based on this review, ordinance amendments and other changes in policy will be developed that consider other county initiatives and policies, and address the common ground between the policy recommendations from these completed watershed plans.

Funds and staff resources will be required to implement these policy recommendations. These resources will be estimated at the time a policy recommendation is being evaluated for implementation as part of the annual budget process. Existing resources and partnerships will be used when available. The watershed plan recommends that the county implement the recommended changes in policy and allocate adequate funds as needed.

As with the structural and nonstructural actions, the watershed plan policy recommendations are placed into the following categories:

- A- Public Outreach and Education
- B - Interjurisdictional Cooperation
- C - Recreation
- D - Existing Development
- E - New and Infill Development
- F – Open Space

The Watershed Plan includes 13 objectives and 32 policy recommendations as described in Section 5 of this watershed plan.

Implementation Plan

The policy recommendations are prioritized based on their effectiveness in meeting county policies, regulatory requirements, public support, location and ease of implementation. The watershed plan lays out these priorities and a recommended implementation plan. As previously described, these recommendations will be evaluated further with regard to greater county-wide implications before implementation. The policy recommendations will being considered within the first 15 years of the 25-year watershed plan program

Structural Actions

Description

The watershed plan includes structural actions to help achieve the watershed plan vision and goals. Structural actions refer to watershed plan elements that require construction to implement. The plan includes several classes of structural actions as summarized below.

Regional Ponds or Alternative Stormwater Controls

Fairfax County adopted a Regional Stormwater Management Plan in 1989 that promoted large regional ponds with larger drainage areas that encompass one or more site-development projects. These ponds were designed to replace and eliminate numerous, smaller onsite stormwater facilities. Seventeen proposed regional ponds were constructed. Ten existing ponds are regional but were not part of the county regional pond program.

The Cub Run and Bull Run watershed plan reviews the status of 14 planned but not constructed regional ponds. Ponds within the R-C District provide little watershed benefit relative to their cost and impact. As a result, the seven ponds within the R-C District have been eliminated from the watershed plan, and alternative stormwater controls will be implemented instead.

Conditions have changed considerably since the regional ponds outside the R-C district were proposed. In several cases residential development has encroached, making it difficult or impossible to construct the pond as originally proposed. Also, smaller ponds were constructed upstream from the proposed ponds as development occurred. These smaller ponds lessen the effectiveness of the proposed regional ponds given the cost and impact to construct them. In some cases, the stormwater control provided by existing stormwater facilities and recommended alternative projects equals that of the proposed regional pond.

Table ES-1 summarizes the watershed plan recommendations regarding the proposed but not yet constructed regional ponds.

Table ES-1
Summary of Watershed Plan Regional Pond Recommendations

Regional Pond	Recommendation
C19, C21, C23, C24, C28, C40, C53 and C54	Delete the proposed regional pond and implement alternative projects
C37, C35 and C62	Delete the proposed regional pond and no alternative projects are necessary
C20	Defer the proposed regional pond and implement a group of alternative projects. If the alternative projects cannot be implemented, a modified scope regional pond may be considered
C18 and C39	Implement a smaller or modified regional pond. If the pond still cannot be implemented, then implement alternative projects

Dry Pond Retrofit Projects

The watershed plan recommends retrofit of 94 dry ponds to improve the peak flow and water quality stormwater control provided. Various modifications will be considered to improve the function of selected dry ponds, including constructing wetlands, adding storage, modifying outlet control structures, correcting maintenance and safety concerns, and providing educational and recreational opportunities. The selected ponds provide the greatest improvements relative to their costs and are where stormwater management needs are greatest.

Low-Impact Development Retrofit Projects at Public Facilities

The watershed plan includes retrofits of 26 public facilities to include low-impact development (LID) stormwater controls. The project sites include schools, libraries, recreation centers, county office buildings, parks and commuter parking lots. The LID projects will minimize and control runoff from parking lots and rooftops. The full range of LID practices will be evaluated when these projects are implemented, including biofiltration rain gardens, manufactured biofiltration units, removal of impervious surfaces, grassed drainage swales, disconnection of impervious areas and other onsite practices.

A primary benefit of this action is that each facility will provide an opportunity to educate county residents about innovative stormwater controls such as bioretention and biofiltration facilities, rain gardens, etc., that they can use on their properties. The program will also demonstrate Fairfax County's commitment to implementing these measures throughout the watershed and, in turn, to improving stream conditions throughout the county.

Stream Restoration Projects

The watershed plan includes 22 stream restoration projects that cover 19.5 stream miles of actively eroding streams. Stream restoration will be performed using bioengineering techniques to reduce its visual and construction impacts. Hard armoring will be applied only where required to protect man-made structures threatened by stream erosion. These improvements will:

- Prevent further down-cutting of the streambed and raise the invert of the stream channel where appropriate
- Improve the stream buffer
- Reduce sediment and nutrient loads
- Address bank erosion by directing the flow and providing stable meander geometries
- Address stormwater outfalls within the project reaches
- Reconnect stream with floodplain to restore wetland systems and use floodplain storage effectively to reduce peak flows and nutrient loads

The above modifications together will improve the overall stream habitat within the restoration reaches and reduce sediment, nutrients, and other pollutants carried downstream.

The schedule for restoring these reaches considers additional factors besides the severity of existing erosion:

- Stream restoration will not be performed where the flow velocity and peak flows are uncontrolled. Stream restoration projects are phased with other watershed plan actions to ensure that flow control actions are implemented before stream restoration projects.

- Stream restoration will generally be performed within contiguous areas in the watershed to provide the greatest benefit and, where possible, in an upstream to downstream order.

- Finally, stream restoration should not be performed downstream from where significant development is occurring or will occur.

These selection criteria cause the larger stream restoration projects within the major streams to be implemented towards then end of the 25-year plan.

Neighborhoods without Stormwater Controls
Because of the county stormwater control requirement, much of the development in the watershed has dry and wet stormwater ponds, and other features that control the runoff peak flow and water quality. However, four neighbors totaling 1,500 acres and 4,280 single-family residences do not have stormwater controls:

- Greenbriar/Birch Pond
- Brookfield
- Country Club Manor
- Pleasant Valley

For the most part, these residential developments existed before stormwater controls were required.

These four neighborhoods are ideal for new controls that benefit the watershed by improving the water quality and controlling peak flow rates. The watershed plan includes structural actions to address the flows from these neighborhoods, including:

- Promoting LID for privately-owned commercial and residential property within these neighborhoods

- Retrofitting and upgrading stormwater outfalls to reduce their impact on the streams

Other structural projects identified in the plan, including stream restoration, buffer restoration, LID retrofit and dry pond retrofit projects, will be implemented to address stormwater runoff within these neighborhoods.

Opportunities to construct new ponds and to implement upstream culvert retrofit projects were evaluated but found to be infeasible due to the density of development, existence of closed conduit drainage systems and lack of undeveloped open space.

Buffer Restoration Projects

Stream or riparian buffers refer to the stream valley near the stream banks. A natural unimpaired stream buffer, containing native trees, plants and shrubs, provides valuable stream habitat protection and many other benefits. In many areas of the Cub Run and Bull Run watersheds, the natural stream buffer vegetation has been damaged or removed by residential and commercial development, lawns, mowed areas, old farm fields and utilities that cross the stream valleys. Buffer restoration projects will restore selected stream reaches to a natural condition and improve the overall health of the streams.

The watershed plan identifies 43 stream buffer restoration projects that include 54,480 feet (10.3 miles) of deficient stream buffer. Opportunities will be sought to partner with volunteer organizations to implement the buffer restoration projects. Buffer restoration will also be performed as part of the stream restoration projects.

The improved and healthy stream buffers benefit the watershed as follows:

- Filter runoff from adjacent lands, removing pollutants and sediment delivered to the streams
- Provide natural habitat for plants and animals
- Shade the stream and lower water temperatures
- Provide food for animals living in the streams
- Reduce stream erosion by slowing overbank flow velocity during floods. Roots in a healthy stream buffer hold the soil together, further reducing erosion.
- Improve function of the riparian wetlands within the stream buffer
- Meet other county environmental goals by increasing forest cover and connecting habitat corridors

Replace and Upgrade Road Crossings to Eliminate Flooding

The watershed plan identifies 14 culverts and bridges that do not have capacity to convey peak stream flows during storms. The frequent roadway flooding is a public safety concern, has economic impacts, and damages the roadway, stream and property. Severe flooding can prevent emergency vehicles from responding.

Unless they have a severe impact, these projects will not be implemented using Fairfax County stormwater funds. The Virginia Department of Transportation maintains the roads in Fairfax County and these improvements will be implemented during planned roadway improvement projects.

Evaluate and Retrofit Existing Headwater Drainage Systems
Drainage systems in the headwaters of Cain Branch, Flatlick Branch, Oxlick Branch and Big Rocky Run (primarily north of Route 50) generally have little topographic relief. In some cases, drainage ditches have silted in and no longer have sufficient conveyance capacity. These systems will be updated and maintained where appropriate to prevent flooding and stream erosion.

In some headwater areas stormwater outfalls from curb-and-gutter drainage systems discharge directly to stream valleys with little or no attenuation. Prior to development, rainfall runoff was delivered to the streams as diffuse sheet flow. The constructed drainage systems concentrate flow into ditches that erode the stream valleys and create new drainage ditches. These stormwater outfalls will be evaluated and improvements made to reduce their impact on the stream valley. Improvements may include velocity dissipaters, flow spreading devices, stream restoration and buffer restoration. These issues are spread throughout the residential properties in these headwater areas, and many are on private property. Opportunities will be sought to share costs with property owners for projects that benefit the watershed.

The watershed plan does not identify specific projects but includes funds to address these issues as they are identified. Some projects will be identified during the public outreach program for the implementation of other structural projects in these headwater areas.

Riparian Wetland Improvement Projects
Development, past use and stream erosion have degraded riparian wetlands - wetlands within the stream valleys near the streams - in the Cub Run and Bull Run watersheds. As the streams down-cut, wetland inundation frequency decreases, adversely affecting the natural functions of these wetlands.

The watershed plan recommends implementing stream and wetland mitigation projects close to the disturbance. Having wetland improvement projects identified within the Cub Run watershed would help this recommendation become a reality. This action also potentially reduces the watershed implementation costs to Fairfax County by sharing costs with the developers of projects that require wetland mitigation.

Wetlands in the watershed will be identified and evaluated for restoration and mitigation. High-priority areas will be implemented within the context of the other watershed plan projects.

Restoring natural wetlands within the Cub Run and Bull Run watersheds provides various benefits, including:

- Restoring and protecting functions of natural wetland systems
- Providing habitat for plants and animals that depend on wetland systems

- Reducing sediment and nutrient loads
- Increasing infiltration and replenishing groundwater systems
- Reducing peak flows and velocities in downstream segments
- Meeting other county goals such as preserving forests, providing connected habitat corridors and protecting critical wildlife habitat

Implementation Plan

The structural projects are prioritized based on their effectiveness in meeting county policies, regulatory requirements, public support, location and ease of implementation.

Structural projects were grouped to maximize the benefit to the watershed, limit neighborhood and environmental impacts, and reduce implantation costs. This will be achieved by implementing projects that affect a neighborhood at one time, either as a single project or as a set of projects. This approach also reduces costs associated with the public outreach programs when the projects are implemented. Finally, by implementing projects in a geographic area at one time, the net benefit to the stream may be greater than the sum of the benefits from individual projects.

The Fairfax County Stormwater Planning Division recognizes that appropriate public outreach and education is key to the successful implementation of these structural projects. The project costs include allowances for such programs.

The general rules for preparing the project implementation program are described below (in no particular order):

- The projects should be implemented in an upstream to downstream order within a subwatershed. Implementing upstream projects first allows the peak flow reduction and water quality improvements to benefit a longer reach of stream.
- Stream restoration projects will not be implemented until upstream improvements have been completed. This criterion will increase the probability of success of the stream restoration project by stabilizing the flows before restoration.
- Stream restoration projects are implemented on small streams first, starting with upland stream segments and working downstream. Restoration on small streams has a higher probability of success than restoration on larger streams.
- The Fairfax County Department of Public Works and Environmental Services will not implement stream restoration projects where significant future development will occur. Even with the peak flow and water quality control, changes in flow volumes produced by the development will tend to destabilize the stream and produce additional erosion. Emergency measures may be necessary in these lower-priority stream segments if severe erosion must be addressed immediately.

- Structural projects receive higher priority where development densities will not change significantly.

- Structural projects downstream from significant projected development will be given low priority. Developers of these properties may implement downstream structural projects when appropriate, and/or cost sharing with the property owners will be sought. Pro-rata funds are also appropriate for these facilities.

- Projects that address conditions significantly affecting stream health are high priority.

- Projects very effective in meeting watershed vision and goals are high priority.

The watershed plan identifies 38 project groupings and develops a 25-year implementation schedule. The actual schedule may change for various reasons as discussed earlier.

Structural Action Costs

Table ES-2 summarizes the estimated costs to complete the watershed plan structural actions. The improvements will be funded through a variety of sources, potentially including general and pro-rata funds. Pro-rata funds are paid by developers of property within the watershed to address off-site stormwater impacts. The payments are based on the impervious area within the development and the costs of improvements in the watershed stormwater plan.

Other funding sources and cost-reduction methods will be sought during implementation. For example, costs for projects on private property that benefit the watershed will be shared with the property owners. When appropriate, the county will team with volunteer organizations to implement stream buffer restoration projects. In short, the total costs to Fairfax County will be less those documented in Table ES-2 and summarized below.

The costs by project type are summarized below:

- Construct two regional ponds (C18 and C3) at a reduced size and impact from the proposed regional ponds - $2,070,000. Cost for alternative projects to these and other regional ponds are included in the individual project types.

- Dry pond retrofit projects - $9,985,000

- LID projects at public facilities - $3,402,000

Table ES-2
Summary of Structural Project Costs by Implementation Phase

Project Type	Estimate Project Cost
Phase A Year 1-5	
Region Ponds or Alternative Projects (1)	$2,070,000
Dry Pond Wetland Retrofit	$2,686,000
Low Impact Development Retrofit	$187,000
Stream Restoration	$3,866,000
Neighborhoods without Stormwater Controls (2)	$1,137,000
Buffer Restoration	$554,000
Upland Drainage System Improvements	$600,000
Riparian Wetland Study	$100,000
Dump Site Removal	$55,000
Total Phase A	$11,255,000
Phase B Year 6-10	
Dry Pond Wetland Retrofit	$1,666,000
Low Impact Development Retrofit	$908,000
Stream Restoration	$4,682,400
Neighborhoods without Stormwater Controls (2)	$1,546,000
Buffer Restoration	$144,000
Upland Drainage System Improvements	$600,000
Total Phase B	$9,546,400
Phase C Year 11-15	
Dry Pond Wetland Retrofit	$2,676,000
Low Impact Development Retrofit	$1,377,000
Stream Restoration	$1,101,300
Buffer Restoration	$213,000
Upland Drainage System Improvements	$600,000
Total Phase C	$5,967,300

Table ES-2
(Continued)
Summary of Structural Project Costs by Implementation Phase

Project Type	Estimate Project Cost
Phase D Year 16-20	
Dry Pond Wetland Retrofit	$1,267,000
Low Impact Development Retrofit	$484,000
Stream Restoration	$9,390,800
Buffer Restoration	$238,000
Upland Drainage System Improvements	$600,000
Total Phase D	$11,979,800
Phase E Year 21-25	
Dry Pond Wetland Retrofit	$1,690,000
Low Impact Development Retrofit	$446,000
Stream Restoration	$19,195,500
Buffer Restoration	$169,000
Upland Drainage System Improvements	$600,000
Total Phase E	$22,100,500
Total for all Structural Projects	$60,849,000

1 – Regional pond cost is for the construction of the two regional ponds that remain in the study (C18 and C39) and do not include alternative projects for these or other regional ponds. Costs for these alternative projects are included in the individual project types.
2 – Costs for neighborhoods without stormwater controls include only costs for community outreach for LID implementation and stormwater outfall retrofit projects. Costs of additional projects are included in the individual project types.

- Stream restoration - $38,236,000. Stream restoration projects comprise 63 percent of the total costs of the watershed plan structural actions. A significant portion of these projects, comprising 32 percent of the total structural project costs, will not be implemented until 20 to 25 years into the watershed plan. Fairfax County will continue to monitor stream conditions within these reaches and is very likely that the extent and scope of these projects will change between now and the time they are implemented.

- Neighborhoods without stormwater controls - $2,683,000. This cost includes community outreach to implement LID and stormwater outfall retrofit projects. Cost for other projects to be implemented within these neighborhoods are included in separate project types.

- Buffer restoration - $1,318,000

- Headwater drainage systems - $3,000,000

- Riparian wetland and stream study - $100,000

- Dump site removal - $55,000

The total cost of the identified structural projects equals $60,849,000. An estimated 4.4 staff year equivalents (SYEs) are needed to implement these projects.

Benefits of Plan Actions

The watershed plan vision and goals set by the CAC, project team and Fairfax County specify that the plan should preserve, protect and improve the watersheds and streams and largely relate to improving the functions of the watershed, water quality, habitat and aesthetics. The plan recognizes these watershed functions are important to residents and weighted them significantly in selecting nonstructural actions, policy recommendation and structural projects.

The watershed plan includes many nonstructural actions and policy recommendations. Many nonstructural actions are education and outreach that will reduce the watershed residents' impact on the Cub Run and Bull Run streams. Policy actions also modify the impacts of new and infill development on the watersheds. While these actions will improve the watershed health and reduce nutrient loads, their benefits are difficult to quantify.

The stream restoration structural projects will improve the stream conditions. The Stream Condition Index (SCI) is a numerical measure of the stream conditions, with values ranging from 1 to 5 (1 being a low-quality stream, 5 indicating a high-quality stream). The existing SCI for the stream restoration reaches ranges from 2.10 to 3.98 and averages 3.42. After restoration, SCI is projected to range from 3.60 to 4.11 and average 3.86, increasing the SCI by 13 percent overall. The restoration increases some reaches significantly and others only slightly. The SCI is just one measure of the benefits provided by stream restoration. Other benefits not reflected in this SCI include reduction in pollutant and sediment loads, improved habitat conditions and improved aesthetics.

The watershed meets the water quality loading goals for the Occoquan Reservoir for both existing and future land use conditions (with future stormwater controls). It also meets or exceeds the requirements of the Virginia Chesapeake Bay Nutrient and Sediment Reduction Strategy for the Shenandoah and Potomac River Basin (March 2005). The many existing and new stormwater controls required for new development are largely responsible for meeting these goals.

Stream restoration projects reduce pollutant loads by reducing the amount of nutrients washed into the streams. The 20 miles of stream restoration removes 361 pounds of phosphorus per year.

Retrofitting dry ponds to include wetland bottoms improves the nutrient removal efficiency for phosphorus by 10 percent, from 40 to 50 percent annual reduction, and nitrogen by 25 percent. The recommended dry pond retrofit projects reduce the average annual phosphorus loads by approximately 365 pounds. These projects improve the efficiency of existing facilities reducing the need to construct new facilities.

The LID retrofit projects for county and other public facilities produce small changes in total nutrient loads because they serve a relatively small portion (36 acres) of the total watershed area (63 square miles). These controls, which benefit the watershed adjacent to the projects more, reduce the annual phosphorus load by approximately 24 pounds. These projects also provide educational benefits as well as demonstration opportunities for newer technologies.

Estimates of phosphorus reduction through retrofitting neighborhoods without stormwater controls (Greenbriar, Birch Pond, Brookfield, Country Club Manor and Pleasant Valley) assume LID and other stormwater controls are implemented for one percent of the watersheds.

Stream buffer restoration projects and retrofitting of drainage systems in headwater areas will further reduce nutrients, though the specific amount is difficult to quantify.

The total phosphorus average annual reduction produced by the structural projects equals 767 pounds per year. The total watershed load for the 48 square miles of the watershed in Fairfax County equals 17,000 pounds per year for future land use conditions with future stormwater controls. The watershed plan produces a documented 4.5 percent phosphorus load reduction. The reduction varies, with eight modeled basins having reductions greater than 30 percent and 35 having reductions greater than 10 percent. The cumulative reduction from structural and nonstructural actions, and policy recommendations will be greater than this amount.

Together, these three major actions will greatly help meet the watershed vision and goals.

Contents

Figures

Tables

Section 1
Introduction

This report documents the Cub Run and Bull Run Watershed Management Plan. The watershed plan provides strategies for mitigating adverse stream conditions and protecting the watershed from future impacts. The primary issues identified by the residents of the Cub Run and Bull Run watersheds include uncontrolled stormwater runoff, stream bank erosion, habitat degradation, polluted runoff, trash and sedimentation.

1.1 Project Background

The combined Cub Run and Bull Run watersheds are among the largest and fastest developing in Fairfax County. Before 1980, the watersheds were largely undeveloped open space with few areas of residential development and little commercial development. The population increased five-fold from 20,000 in 1980 to nearly 100,000 in 2000. As a result, land surface covered by buildings, parking lots, roads, driveways and sidewalks (impervious area) has increased from 7 percent in 1980 to 15 percent today. Currently, the watershed has a wide range in development densities and stream conditions.

Fairfax County has required stormwater ponds to control peak flows from new development since 1972. Since 1980, the county has required stormwater controls that reduce nutrient concentrations from new development within the Occoquan Reservoir watershed by 50 percent to protect the water quality in the reservoir. The reservoir is the drinking water source for more than one million Northern Virginia residents.

These regulations, combined with the time that the development occurred in the watershed, give the Cub Run and Bull Run watersheds one of the greatest density and degree of coverage of stormwater controls within Fairfax County. More than 420 stormwater ponds serve nearly all of the existing development to reduce peak flows and pollutant runoff.

Portions of the Loudoun County watershed are also developing rapidly. Recent farmland is now low-, medium- and high-density residential development within the South Riding development. Loudoun County requires stormwater controls to reduce peak runoff rates and limit pollutant runoff. In response to these requirements, developed areas of Loudoun County include several large wet ponds that manage the runoff from this existing development.

The high density of stormwater ponds is partially responsible for the streams having higher quality than would be expected for the upstream development density. The geology and soils also affect the stream quality. However, the streams have varying levels of impact, including stream erosion and degraded in-stream habitat. This suggests that current stormwater management programs do not entirely mitigate development impacts.

Based on current development and planned future densities identified in the Fairfax County Comprehensive Land Use Plan and the Loudoun County General Plan, the watersheds' potential for future development varies:

- Areas of the watershed east of Centreville/Walney Road, including Flatlick Branch, Round Lick Branch and Big Rocky Run, are highly developed and have comparatively small potential for additional development. Development will occur within the few remaining vacant areas, and redevelopment or infill development will occur where the existing development density is significantly less than the planned density.

- Areas in Fairfax County west of Centreville/Walney Road, north of Braddock Road and east of Pleasant Valley Road have significant open space that will be developed at a planned land use that includes a mix of industrial, office, commercial, and residential.

- Dulles International Airport comprises 4,500 acres in the headwaters of the watershed (11 percent of the study area). Dulles Airport has a 25-year plan for expansion that includes two new runways, associated taxiways and a new terminal that will affect the Cub Run watershed.

- Approximately 25 percent of the project study area is within Loudoun County. Areas in Loudoun County north of Braddock road will be developed with various land uses, including residential, commercial and industrial. Areas south of Braddock Road have lower-density planned land use.

- Much of the remaining southwestern portions of the watershed is within the re-zoned Residential-Conservation (R-C) District where the maximum density is one house per five acres. Fairfax County implemented the re-zoning of this watershed portion in 1982 to protect the water quality in the Occoquan Reservoir.

- Large areas of the watershed are in Fairfax County Park Authority parkland, Northern Virginia Regional Park Authority Bull Run Regional Park, golf courses and other preserved open space. These areas preserve approximately 23 percent of the total watershed area in Fairfax County as open space, which plays a vital role in preserving uplands and headwater areas as well as much of the floodplain. Much of this protected land is forested.

A regional stormwater plan developed in 1989 identified the location of regional stormwater ponds within the county's developing areas, including Cub Run. This study identified 31 regional pond locations in the watershed with the goal of reducing the number of smaller onsite ponds. Fewer regional ponds were intended to reduce watershed impacts, enhance stormwater protection and lower pond maintenance costs. Seventeen of the proposed regional ponds were constructed, leaving 14 unconstructed planned regional ponds. The watershed plan evaluates these regional ponds and identifies alternative stormwater controls when appropriate.

1.2 Watershed Planning Process

The Cub Run and Bull Run Watershed Plan incorporates input from residents and businesses of the two watersheds collected through an extensive public involvement and outreach process.

The watershed plan's community advisory committee (CAC) is a diverse group from the local community that includes members of homeowners associations, conservation organizations, local businesses, recreation groups, neighboring local and federal jurisdictions, and other local interest groups. The CAC met with the project team nearly 20 times during development of the watershed plan.

In addition to the CAC meetings, four public forums allowed residents to identify watershed issues, evaluate alternatives to address these issues and comment on the proposed watershed plan elements.

The public information process was important in developing the plan. This information was combined with engineering, cost-benefit analyses and other evaluations to identify the appropriate actions to meet the watershed vision and goals effectively. The plan includes three types of projects:

- Non-structural actions, which include education and outreach programs to improve watershed conditions. These actions, described in Section 4, can be performed under current county policies and have a defined implementation schedule.

- Recommended changes to county policy. These include proposals that may require amendments to the county code and other supporting documents such as the Public Facilities Manual. These recommendations will be evaluated further regarding greater county-wide implications before they can be implemented. The policy recommendations from the Cub Run and Bull Run Watershed Plan will be compared with similar recommendations from the Little Hunting Creek, Popes Head Creek, Cameron Run, Difficult Run and other watershed management plans as they are developed. Based on this review, ordinance amendments and changes in policy may be developed that consider other county initiatives and policies, and address the commonalities among the policy recommendations from these watershed plans. These policy recommendations are described in Section 5.

- Structural actions. These include elements to be constructed in the watersheds to improve stream conditions. These structural actions are described in Section 6.

Although this report provides a recommended schedule for implementation of the actions included in the plan (Section 7), additional factors, which may affect the individual projects and the implementation schedule, include:

- Projects, programs and policy items will first undergo review by county staff and the Board of Supervisors before implementation. Board adoption of the watershed plan will not mean automatic implementation of the plan recommendations.
- The watershed plan is a master list of recommended non-structural actions and structural projects. Each fiscal year, staff will prepare and submit to the board a detailed spending plan that describes the projects and explains their ranking, benefit and need to meet a defined watershed or water quality goal.
- The watershed plan considers visions, goals, issues and needs only within the Cub Run and Bull Run watersheds. Fairfax County will consider stormwater needs and priorities across the entire county when implementing the recommendations included in this and other watershed plans.
- Availability of funding and other resources will affect the implementation of watershed plan projects.
- The initial project implementation phases will include outreach to the community near the proposed projects. The recommended plan elements may become infeasible or need to be modified based on comments from the local residents during this outreach.
- Projects will be value-engineered at the time of implementation to ensure cost-effectiveness. Alternatives such as enlistment of volunteers or alternative funding sources will be considered to reduce county costs.
- Stream-crossing improvements not related to protecting streambeds or banks or preventing structure flooding will not be implemented using county stormwater improvement funds.
- Stream restoration and other projects on private land will be evaluated to determine means for cost sharing with the landowners.

1.3 Watershed Plan Vision and Goals

This watershed plan was prepared to meet a variety of watershed visions and goals. These include the overall watershed goals developed by the CAC and the project team. The order that the vision and goals are presented does not represent their order of importance or rank in preparing the watershed plan.

1.3.1 CAC Watershed Vision and Goals

As described in Section 1.2, a CAC was convened to work with the project team to prepare this watershed plan. The CAC prepared the following overall vision for the Cub Run and Bull Run watersheds:

> **Waterways in the Cub Run and Bull Run Watersheds are valued pieces of the community fabric. Community members, as trustees of the waterways for succeeding generations, recognize their responsibility to sustain, restore and enhance the waterways. Educational efforts enrich the community's understanding of waterways, the associated riparian areas and their importance to both the local community and the region. Stream corridors contribute to community vibrancy and economic health while providing water quality, stormwater management, flood control, habitat and recreational benefits. Waterways are a clean and safe source of the region's drinking water**.

The CAC identified the following functions of waterways and stream valleys to be recognized and protected by the watershed plan:

- Filtering water and airborne pollutants
- Keeping water temperatures cool
- Storing floodwaters
- Reducing floodway velocities
- Serving as groundwater recharge areas
- Improving and maintaining water quality
- Providing wildlife habitat to include nesting, resting, roosting, feeding and watering areas
- Providing appropriate recreation opportunities
- Providing educational opportunities
- Enhancing community aesthetics

The CAC also recommended the plan should:

- Foster and promote co-existence and constructive beneficial use among people, waterways and riparian areas to enable the widest range of beneficial uses without environmental degradation, risk to health or safety, or other undesirable and unintended consequences to the human community, environment or wildlife

- Improve and maintain interjurisdictional coordination and collaboration at all levels (federal, state, regional, local) to protect and improve watershed health, integrate services and avoid duplication of effort and expense

- Protect the quality of the Occoquan Reservoir – a major drinking water source for Northern Virginia

- Specify stormwater management, best management practices, low-impact development and other watershed management policies that will restore and maintain watershed health

- Include educational strategies to enrich the community's understanding of watershed ecological processes and their importance

- Establish clear mechanisms for restoring degraded waterways within the watershed

- Promote stormwater control projects that intercept flows and treat the problems as far upstream in the watershed as possible before they affect stream conditions

- Promote the preservation of open space and support adherence to the Residential-Conservation District zoning to minimize impervious surface area, and protect headwaters and stream corridors

- Promote the mitigation of impacts to streams and wetlands within the local watershed where the impacts occur

The CAC watershed vision and goals provide a comprehensive approach to improving conditions and reducing impacts from future land use changes within the watersheds.

The CAC also defined the following watershed-wide guidelines for siting regional and onsite stormwater ponds:

- Ponds should be used as a last resort and, if possible, located off-channel.

- Alternatives to ponds should be considered, including installation of smaller controls further upstream and natural stormwater controls such as wetland projects. As part of this strategy, all possible wetland mitigation sites in the watershed should be identified.

1.3.2 Watershed Plan Vision and Goals

The project team considered the CAC's watershed vision and goals in developing those of the overall watershed plan and the framework to evaluate the plan's progress towards these visions and goals:

> **The vision of the Cub Run and Bull Run Watershed Plan is to integrate environmental management, natural resource protection and community needs to restore and protect the Cub Run and Bull Run watersheds; ensure clean and safe drinking water for the region; minimize impacts to downstream water bodies; protect residences, businesses and roadways from flooding; provide safe and appropriate recreation and education opportunities; and ultimately improve the quality of life for all watershed residents.**

The following goals were identified to meet this watershed plan vision:

- Improve and maintain the physical, chemical and ecological characteristics of our stream valleys
- Maintain and preserve the integrity of the Occoquan Reservoir and other downstream bodies of water, including the Potomac River Estuary and Chesapeake Bay
- Improve the quality of life for watershed residents and businesses

1.3.3 Fairfax County Goals for Developing Watershed Plans

The primary goals of developing watershed plans in Fairfax County are summarized below:

1. Restore and protect the county's streams
2. Meet state and federal water quality standards by identifying strategies to prevent and remove pollution
3. Support Virginia's commitment to the Chesapeake 2000 Agreement to restore the Chesapeake Bay
4. Update the current watershed plans to include modern technologies and community concerns
5. Take a comprehensive approach in addressing multiple regulations, commitments and community needs
6. Meet the watershed vision and goals developed by the project's CAC

Priorities of this watershed plan are to meet both the goals for nutrient loading and reduction for the Occoquan Reservoir and those for the Chesapeake embayments. These loads and goals are discussed in Section 3.2.

With input from the Cub Run and Bull Run CAC and other members of the community, this watershed plan addresses these needs and requirements with a strategy for restoring and protecting the watershed.

1.4 Plan Report Organization

This watershed plan:

- Provides an overview of the watershed and descriptions of existing conditions based on a review of previous studies and available data (Section 2)
- Assesses the existing and future conditions and identifies watershed issues within major subwatersheds (Section 3)
- Describes the objectives and non-structural actions to support the watershed vision (Section 4). These include roughly 60 non-structural actions that provide public outreach and education, improve interjurisdictional cooperation, promote appropriate recreational opportunities, promote stormwater management and nutrient reduction from existing development and reduce impact of new and infill development. These actions can be implemented within current county policy.
- Recommends changes to county policy to improve watershed conditions, address watershed issues, and meet the watershed vision, goals and objectives (Section 5)
- Provides details on the recommended structural actions that address watershed issues and meet the watershed vision, goals and objectives (Section 6).
- Recommends an implementation program for the non-structural actions, policy recommendations and structural actions (Section 7). Procedures used to prioritize the projects for implementation are described. This section lays out a recommended 25-year implementation plan, in 5-year increments.
- Provides a glossary of technical terms in Appendix A
- Provides detailed modeling results for the major subwatersheds in Appendix B
- Includes in Appendix C detailed fact sheets with cost estimates for each structural project

Section 2
Watershed Overview

2.1 Introduction

The Cub Run and Bull Run watersheds receive stormwater runoff from portions of western Fairfax County and eastern Loudoun County. The watersheds are a major tributary to the nia), the Potomac River estuaries and the Chesapeake Bay. Figure 2-1 shows the general location of the watersheds in southwestern Fairfax County and their relationship to the Occoquan Reservoir and Potomac River Estuary. The Cub Run watershed comprises 63 square miles (10 percent) of the 595 square-mile drainage area to the Occoquan Reservoir.

Cub Run is a major tributary to Bull Run, which forms the Fairfax County/Prince William County border. Bull Run and its tributaries also drain large areas outside the study area in Loudoun, Prince William and Fauquier counties.

The Cub Run and Bull Run watersheds include portions of Fairfax County that have developed rapidly over the past 25 years. As a result, a large portion of the Cub Run watershed is approaching build-out conditions. Future development will mostly occur in the western portions of the watershed, including low-, medium- and high-density residential, low-intensity commercial, and industrial land uses.

The wide range of stream quality conditions in the Cub Run and Bull Run watersheds largely reflect the variations in the intensity of land development. The existing stormwater management programs, land use and preserved open space are significant factors affecting stream conditions in the watershed:

- Because of its recent development and stormwater management history, the Cub Run and Bull Run watersheds have some of the most proactive and protective stormwater management controls in the region. The watershed includes more than 400 stormwater ponds. This history of stormwater controls is provided in Section 2.5.

- A large area of the southern portions of the watershed is zoned for low-density (one house per five acres) development in an area referred to as the Residential-Conservation District. See Section 2.6.1 for a description of the 1982 rezoning that created the Residential-Conservation (R-C) District implemented to protect water quality in the Occoquan Reservoir. This area may include institutional uses approved through the special permit or special exception process.

- Parkland and other preserved open space make up about 11 square miles or 23 percent of the total watershed area within Fairfax County.

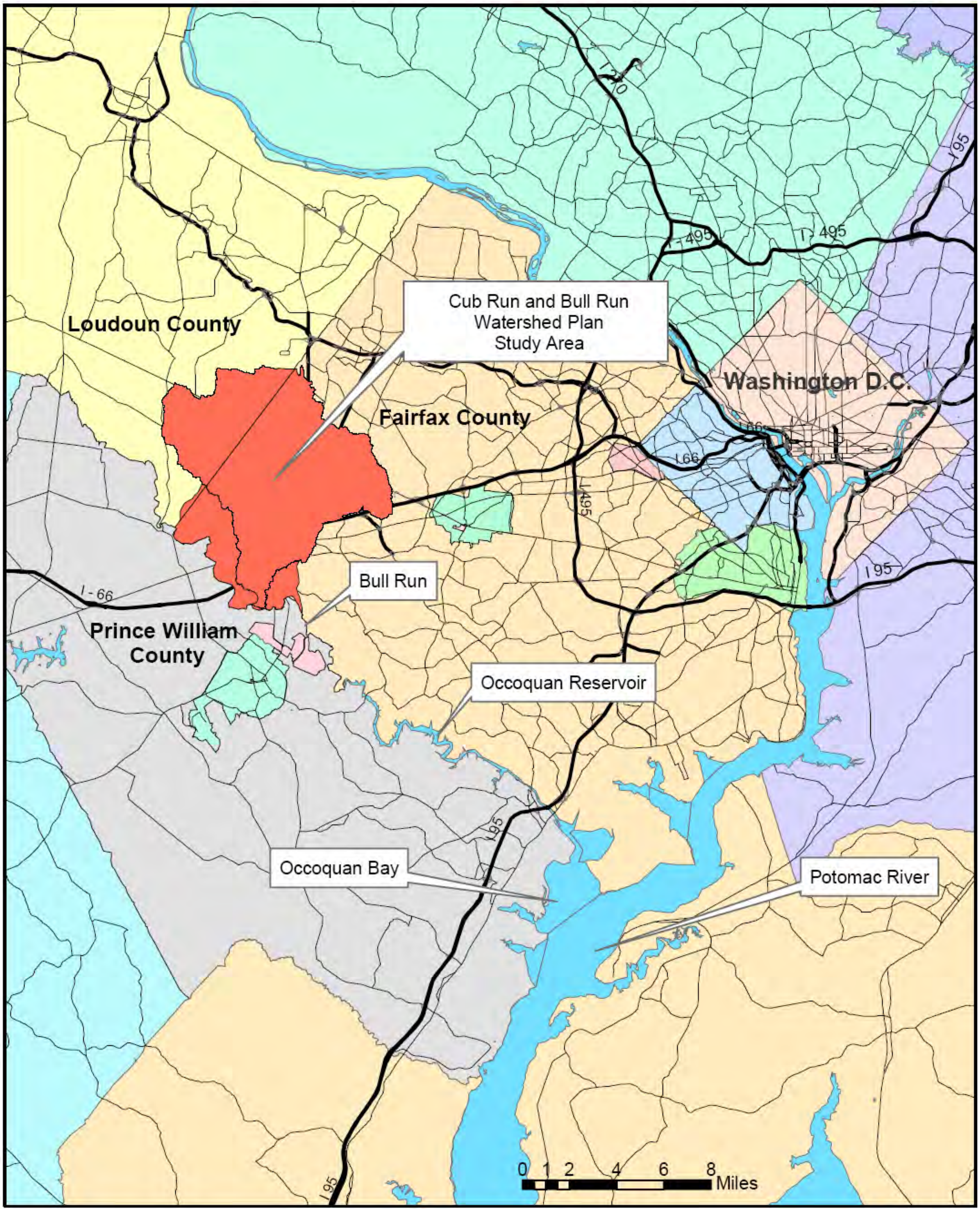


Figure 2-1
General Location of the Cub Run and
Bull Run Watershed Plan Study Area

The following sections provide an overview of the watershed and description of its existing conditions based on a review of previous studies, data and reports.

2.2 Description of Watershed

The Cub Run and Bull Run watersheds included in the watershed plan are shown on Figure 2-2 and include the following areas:

1. **Cub Run Watershed** - Areas in Fairfax County and Loudoun County that drain to Cub Run. Cub Run receives runoff from 39 square miles of western Fairfax County and 14 square miles of eastern Loudoun County. The total Cub Run watershed area is approximately 53 square miles. The watershed includes seven square miles within Dulles International Airport, which straddles the county line.

2. **Bull Run Watershed** - Areas of Fairfax and Loudoun counties that drain directly to Bull Run west of Little Rocky Run and east of the Fairfax County/Loudoun County border. This includes 8.4 square miles of Fairfax County and 1.3 square miles of Loudoun County (total area is 9.7 square miles).

The project study area equals 63 square miles, one of the largest watersheds in Fairfax County.

Fifteen square miles of the Cub Run study area lies within Loudoun County. The watershed plan will consider the impacts of existing development and future growth in Loudoun County on the downstream Fairfax County stream segments. The watershed plan may recommend watershed management solutions, but not specific projects, within Loudoun County. The Cub Run watershed plan will promote dialog concerning common natural resources between Fairfax County and Loudoun County and allow the jurisdictions to collaborate in the protection and restoration of the Cub Run watershed and Occoquan Reservoir water supply.

The following two sections discuss the streams and general drainage patterns within the Cub Run and Bull Run watersheds.

2.2.1 Cub Run Watershed

The Cub Run watershed includes the following named tributaries or watersheds:

- Big Rocky Run
- Cain Branch
- Dead Run
- Elklick Run
- Flatlick Branch
- Frog Branch – Tributary to Flatlick Branch
- Oxlick Branch – Tributary to Flatlick Branch
- Round Lick Branch

Figure 2-2
Major Subwatersheds in
the Cub Run and Bull Run Watersheds

- Sand Branch
- Schneider Branch

These named subwatersheds are shown on Figure 2-2. The following briefly describes each subwatershed's drainage features. Section 3 of this report provides details on the land use, stormwater controls and stream conditions within each subwatershed.

Upper Cub Run

The Cub Run main stem and its farthest upstream tributaries, Dead Run and Sand Branch, begin in a topographically flat wetland complex on the lightly developed property surrounding Dulles International Airport. After crossing the Dulles property line into Fairfax County, Cub Run flows for a short distance before flows are increased by the addition of Cain Branch and Schneider Branch from the east. These watersheds include runoff from the recently developed commercial areas along Route 50 west of the Route 28 interchange, Dulles International Airport and the residential/commercial area development surrounding Chantilly.

Cub Run continues south to its confluence with two tributaries - Flatlick Branch and Elklick Branch - that have different land use characteristics.

Flatlick Branch

Flowing from the east, Flatlick Branch and its two major tributaries, Frog Branch and Oxlick Branch, run through the suburban developed areas around Chantilly, business districts along the Route 50 corridor, and newly developed Westfields commercial areas. Development in the upstream portions of the Flatlick Branch subwatershed has approached build-out conditions and raised the percent impervious of the major subwatershed close to 20 percent.

Elklick Branch

The Elklick Run subwatershed lies west of Cub Run and extends into eastern Loudoun County. The Fairfax County portions of the Elklick Run watershed lie within the large-lot R-C District of the Occoquan Reservoir watershed that limits potential development density to one house per five acres and includes large areas of Fairfax County parkland. The Fairfax County portions of the Elklick Run subwatershed are and will remain lightly developed.

The Loudoun County portion of the subwatershed include the South Riding community and large undeveloped areas. Future development will include residential, commercial, office and industrial land use.

Round Lick Branch

Two miles downstream from the Elklick Run/Cub Run confluence, Round Lick branch flows into Cub Run from the northeast. This tributary includes residential communities near Sully Station and a large area within the Ellanor C. Lawrence Park.

Big Rocky Run

Cub Run receives a final major input from Big Rocky Run, a large subwatershed that has it headwaters near Fair Oaks Mall and Fairfax Government Center. Big Rocky Run flows southwest through the developed suburban areas of Fair Lakes and Centreville, including the residential areas between Route 50 and Route 29, and portions of Centreville west of Route 28.

Lower Cub Run

After the confluence with Big Rocky Run, the Cub Run main stem runs parallel to, and then crosses under, I-66. For the remainder of its course, Cub Run meanders south through the forested Bull Run Regional Park before joining Bull Run on its way to the Occoquan Reservoir, Potomac River and Chesapeake Bay.

2.2.2 Bull Run Watershed

The watershed also includes areas in Fairfax County that drain directly to Bull Run. The main stem of Bull Run, which forms the boundary between Fairfax County and Prince William County, is not explicitly included in the watershed plan since it falls within two jurisdictions, and it is most affected by watershed conditions upstream from Fairfax County, including Loudoun, Prince William and Fauquier counties.

Bull Run West

Bull Run Regional Park and the Fairfax National Golf Course make up much of the watershed that drains directly to Bull Run west of Cub Run (Bull Run West). This watershed also includes a large active quarry (Luck Stone) and several unnamed tributaries. This area lies entirely within the R-C District and includes large areas of largely undeveloped privately owned land.

Bull Run East

Bull Run tributaries between Little Rocky Run and Cub Run (Bull Run East) north of Compton Road include areas of dense residential development in Centreville. Areas south of Compton Road are in the R-C District and are lightly developed. Much of this land is within the Bull Run Regional Park. The Upper Occoquan Sewage Authority (UOSA) advanced wastewater treatment plant is also within this portion of the study area. See Section 2.6.1 for additional information regarding the UOSA treatment plant.

2.3 Historical Development

The Cub Run watershed includes portions of Fairfax County that have grown rapidly over the past 25 years. The Report of the New Millennium Occoquan Watershed Task Force documents that “the population of Centreville alone has doubled from 26,585 in 1990 to 48,661 in 2000” and “Over 48 percent of homes in Centreville have been built since 1990, while over 85 percent have been built since 1980.”

A recent study from Virginia Tech (2003) documents the following population growth in the combined Fairfax and Loudoun county portions of the Cub Run watershed between 1980 and 2000:

- 1980 – 20,360
- 1990 – 58,036
- 2000 – 98,119

Virginia Tech's report also documents that the impervious area fraction in the Cub Run watershed has also increased along with the population increase:

- 1980 – 6.7%
- 1985 – 9.3%
- 1990 – 13.1%
- 1995 – 15.8%
- 2000 – 17.8%

Impervious area is the percent of the land area covered by roads, sidewalks, buildings, parking lots, driveways and sidewalks that prevents the infiltration of rainfall into the soil and increases the peak flow and volume of runoff. Impervious area is therefore a very good measure of the intensity of development and its potential impact on the streams.

Areas of significant development include:

- Chantilly
- Westfields
- Sully Station
- Centreville
- Fair Lakes
- South Riding (Loudoun County)

Several major roads and highways pass through the Cub Run watershed:

- Interstate 66 - east of West Ox Road

- Route 50 – Lee Jackson Memorial Highway passes through the watershed from southeast to northwest. The eastern border of the watershed is near the intersection of Route 50 and West Ox Road (609). The watershed's western boarder is at Route 50 and Gum Springs Road in Loudoun County.

- Route 29 – Lee Highway west of the vicinity of the Route 28 intersection

- Route 28 – Sully Road from Dulles International Airport south to Bull Run

- Route 7100 - Fairfax County Parkway from near Route 29 north to Franklin Farm Road.

Figure 2-3 shows the location of these areas and major roads.

2.4 Future Development

Future growth will be guided by the land use plans adopted by Fairfax and Loudoun counties and planned expansion projects for Dulles International Airport. The following sections provide an overview of the planned future development within these areas. Section 3 of this report provides detailed information on the existing and future land use for the major subwatersheds.

The proposed projects, listed in sections 6 and 7, were prepared anticipating build-out conditions in the Cub Run and Bull Run watersheds based on the 2001 Fairfax County Comprehensive Land Use Plan. By assuming the area is built-out, the plan addresses the projected quantity and quality of stormwater runoff from all future development.

Several highway improvement projects that have potential impacts on the watershed are summarized in Section 2.4.4.

2.4.1 Fairfax County

The following bullets provide an overview of the development that may occur in the Fairfax County portions of the Cub Run and Bull Run watersheds based on the Fairfax County Comprehensive Land Use Plan:

- Areas in the watershed east of Walney Road and Centreville Road have relatively little growth potential. Future development will occur where the few remaining vacant developable parcels are developed. Parcels where the existing land use density is significantly less than the density allowed by the land use plan will be redeveloped or infill will occur. This development results in relatively small increases in impervious area.

- Large areas in the R-C District in the southern and western portions of Fairfax County can be developed at a density of no more than one residence per five acres. The planned density is not expected to change since Fairfax County is committed to protecting the Occoquan watershed, and the five-acre zoning has been upheld by three court cases since the mid-1980s.

- Areas in Fairfax County west of Walney/Centreville Road, north of Braddock Road, and east of Pleasant Valley Road include vacant and undeveloped parcels that have planned land use of mixed industrial, office and commercial areas. Much of this development is ongoing.

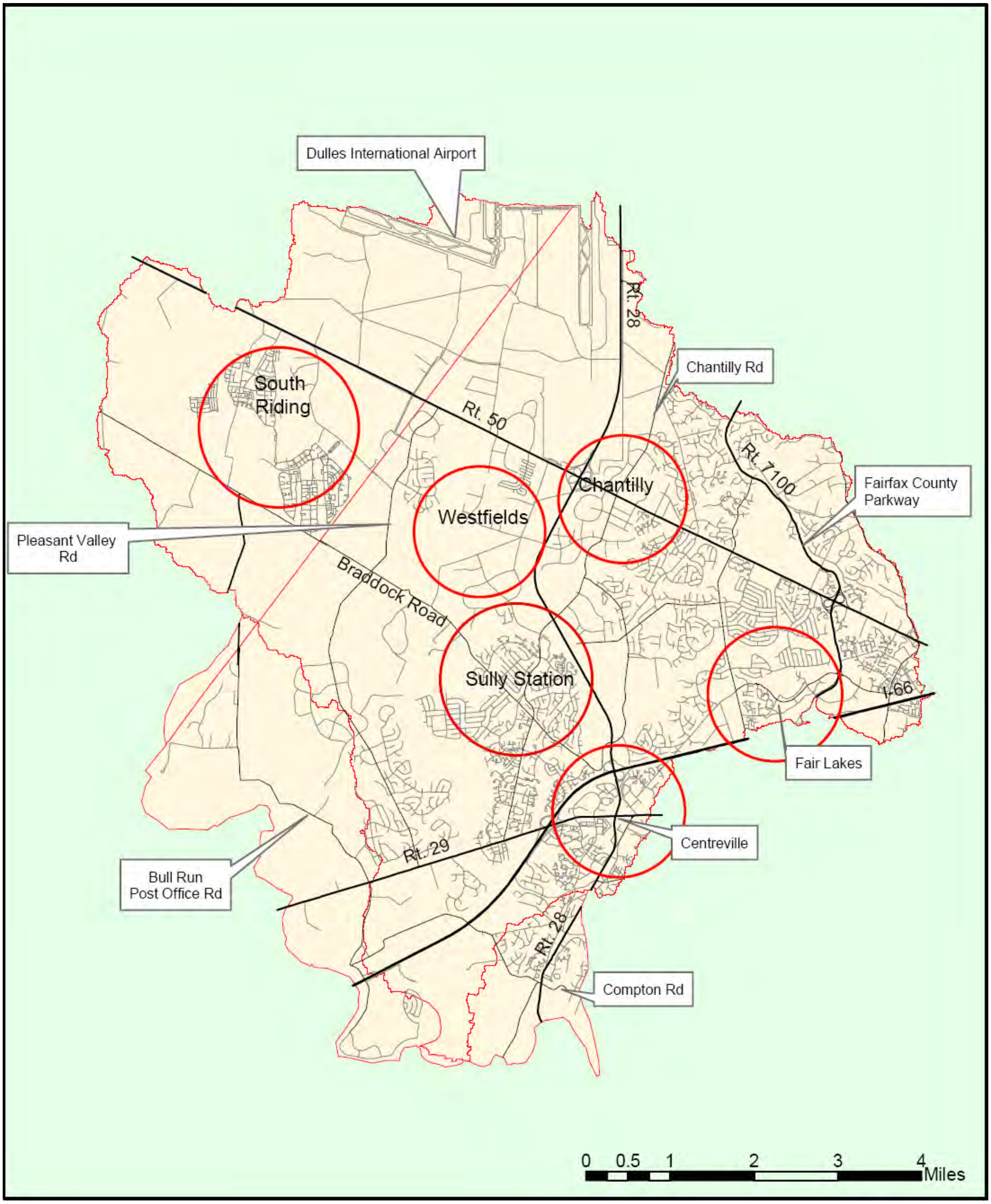


Figure 2-3
Location of Major Developed Areas
Within the Cub Run and Bull Run
Watershed

2.4.2 Loudoun County

The Loudoun County General Plan determines development in Loudoun County. As defined by the plan, the highest density will occur north of Braddock Road. This includes low-, medium- and high-density residential, low-intensity commercial, and industrial land uses with densities similar to Fairfax County areas of the watershed.

The project team met several times with the Loudoun County Department of Planning to identify and verify the planned land use in the Loudoun County portions of the watershed at a level of detail appropriate for this watershed plan.

The Loudoun County General Plan identifies three policy areas within the Cub Run and Bull Run watersheds. These areas and their planned land use are described below. Figure 2-4 presents the general locations of these Policy Areas and associated land use, using the corresponding land use designations from the Fairfax County watershed plans.

Route 50 Corridor Business Area

Areas in Loudoun County generally adjacent to and north of Route 50 have planned commercial, business, retail and industrial land uses. Industrial areas are planned for north of Route 50 near Dulles International Airport. Areas south of and adjacent to Route 50 are planned for business and commercial land uses. Planned development along this highway will be similar to the existing and new development along the adjacent Fairfax County portions of Route 50.

Suburban Policy Area

Areas between Braddock Road and Route 50 are in the Suburban Policy Area and include a mix of residential development densities. Approved development plans for these areas were used to identify the future land use. This area will have a mix of low-, medium- and high-density residential development similar to that in Fairfax County's Big Rocky Run and upper Flatlick branch subwatersheds.

Transition Policy Area

Areas in Loudoun County south of Braddock Road are designated by the Loudoun County General Plan as the Lower Foley and Lower Bull Run Transition Policy areas. The Transition Policy areas provide a transition between the Suburban and Rural Policy Areas.

The Lower Foley Transition Policy area includes portions of the Elklick Run subwatershed south of Braddock Road. The plan allows for a blend of residential development, including countryside villages on central utilities at residential densities up to two dwelling units per acre. Development in a clustered pattern at one unit per three acres or one unit per acre is appropriate. Density transfers from the Lower Bull Run Transition Policy area would allow countryside villages at densities of up to three units per acre.

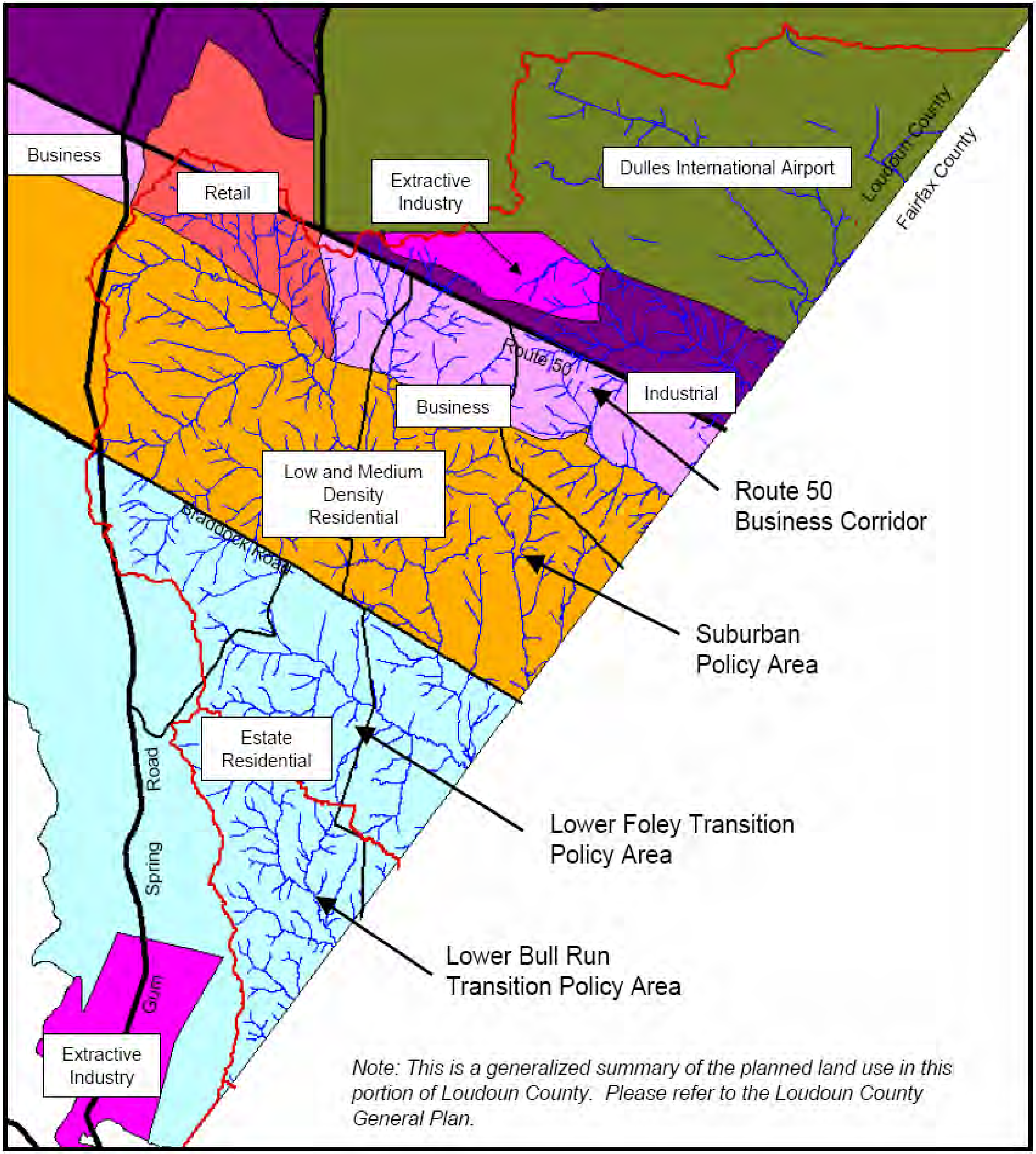


Figure 2-4
Planned Land Use and Planning Policy Areas in the Loudoun County Portions of the Watershed

The modeling of this area assumed an average density of one house per two acres having an impervious area of 13 percent based on the Loudoun County General Plan. Judging from the approved and pending development plans submitted after the modeling was completed, the modeled density is probably less than the density that will occur. The density will be greater than the five-acre minimum lot size allowed in the adjacent Fairfax County R-C District and will affect conditions in the Fairfax County streams downstream from this development.

2.4.3 Dulles International Airport

Dulles International Airport controls a large area (4,500 acres) in the headwaters of Cub Run. This airport property includes Sand Branch and Dead Run along with unnamed tributaries.

Much of the airport property is and will remain undeveloped to provide required safety buffers near the runways. Runways, taxiways, ramps, parking, terminals, hangers and other support facilities contribute significantly to the impervious area within the airport boundaries. Some of these facilities were constructed in the early 1970s and do not have stormwater peak shaving or water quality controls.

The airport has a long-range (25-year) plan to construct new facilities (Figure 2-5). The planned facilities include a new north-south runway and associated taxiways, a new east-west runway and associated taxiways and new terminal facilities. These improvements will significantly increase the total impervious area in the upper Cub Run watershed. Construction will directly disturb streams and wetlands within the airport property.

A final Environmental Impact Statement (FEIS) and record of decision for these improvements was published in 2005. Build Alternative 3 was selected as the preferred alternative. During FAA's review process it became clear that two alternatives met the purpose and need for the project. However, build Alternative 3 (Figure 2-5) has the fewest overall environmental impacts. According to the FEIS, impacts include approximately 286.1 acres of wetland impacts, 39 acres of 100-year floodplain impacts, 124,045 linear feet (23.5 miles) of stream impacts and 3,485.6 acres of biotic community impacts.

To compensate for the unavoidable wetland and stream losses, the Metropolitan Washington Airports Authority (MWAA) has proposed to purchase credits from wetland and stream mitigation banks. A mitigation bank is a wetland or stream area that has been restored, created, enhanced, or (in exceptional circumstances) preserved, and set aside to compensate for future impacts of development on wetlands and streams.

Figure 2-5
Planned Improvements at Dulles International Airport

As a federal agency, the Federal Aviation Administration (FAA) is not strictly required to provide the stormwater controls required by Fairfax and Loudoun counties. The stormwater management plan for the new improvements includes stormwater detention and water quality controls. Fairfax County and Loudoun County are working closely with the FAA and the MWAA to ensure improvements include stormwater controls that provide a level of protection similar to that required by the counties.

Based on discussions with the MWAA, development will include innovative stormwater controls that will mitigate the impacts near the source. The initial project phases will not affect the Cub Run streams. This will provide an opportunity to evaluate the efficacy of these stormwater controls. Also, the current plans for the Cub Run portion of the airport includes a large dry pond that will provide controls for areas that currently have no stormwater facilities.

The FEIS documents that the 100-year floodplain elevations will not increase more than one foot. A one foot increase would affect residential properties, with the most significant impacts in the Pleasant Valley neighborhood. In an August 30, 2005 letter to the U.S. Army Corps of Engineers, the MWAA has made a commitment to provide "stormwater retention that will prevent an increase in peak flows for the 1-, 2-, 10- and 100-year storms off-airport." These facilities ensure no downstream increase in the 100-year flood elevation.

In addition to the above improvements, other areas of the Dulles International Airport property may be developed. For example, the Smithsonian National Air and Space Museum Udvar-Hazy Center is on airport property. Evaluations for this study assume areas south of the museum may be developed at a density comparable to Low Intensity Commercial. There are no documented plans to develop this area; however, nothing precludes development. Given the need for airport support services, including parking and car rental, such development may occur in this area. This assumption includes the potential impacts of this development on the Cub Run watershed.

2.4.4 Highway Construction Projects

Several highway construction projects are planned within the Cub Run and Bull Run watersheds. Construction of highways and stream crossings will have direct impacts on the streams and stream valleys along the highway routes. Increased impervious area and resulting increase in runoff will affect local streams.

Tri-County Parkway

Several potential routes for the proposed Tri-County Parkway affect the Cub Run and Bull Run watersheds. At the request of Fairfax, Loudoun and Prince William counties, the Virginia Department of Transportation (VDOT) and the Federal Highway Administration (FHWA) initiated this study to evaluate a new north/south transportation link in Northern Virginia to connect the City of Manassas with I-66 and the Loudoun County Parkway in the Dulles area. The Tri-County Parkway is contained in the Northern Virginia 2020 Transportation Plan and in the comprehensive plans for Fairfax, Loudoun and Prince William counties.

A Draft Environmental Impact Study (DEIS) was completed for this highway project in the fall of 2005. The following two build alternatives affect the Cub Run and Bull Run watersheds:

The Comprehensive Plan Build Alternative

The Comprehensive Plan build alternative closely follows the routes in the Fairfax and Loudoun County Comprehensive Land Use Plans consisting of segments F', F, and E on Figure 2-6. The southern extent of the Loudoun County Parkway is Braddock Road (Route 620). The proposed route starts at the Loudoun County Parkway at Braddock Road and passes through the eastern portion of the Bull Run Regional Park. This alignment ends at the VA 234 and VA 28 interchange south of the City of Manassas.

This route has the greatest length within the Cub Run and Bull Run watersheds, affecting primarily the Bull Run West and Lower Cub Run subwatersheds. The proposed route places the highway on or very near the Cub Run stream though Bull Run Regional Park.

According to the DEIS, this alternative will:

- Affect 43,000 linear feet of streams
- Affect 49 acres of wetlands
- Affect 440 acres of forest land
- Affect 278.8 acres of 100-year floodplain
- Result in the channelization of portions of the Cub Run main stem
- Disrupt functions of the large Bull Run and Cub Run floodplain near the confluence of those two streams
- Affect significant areas of public and private open space in the R-C zoning district along Bull Run Post Office Road
- Affect Elklick Run in Loudoun County which drains into Fairfax County

The West Four Build Alternative

The West Four build alternative consists of Segments F', G, and C on Figure 2-6. The route starts at the southern terminus of the Loudoun County Parkway at Braddock Road (Route 620) and proceeds southwest, ending at the 234/I-66 interchange near the western boundary of the Manassas National Battlefield Park.

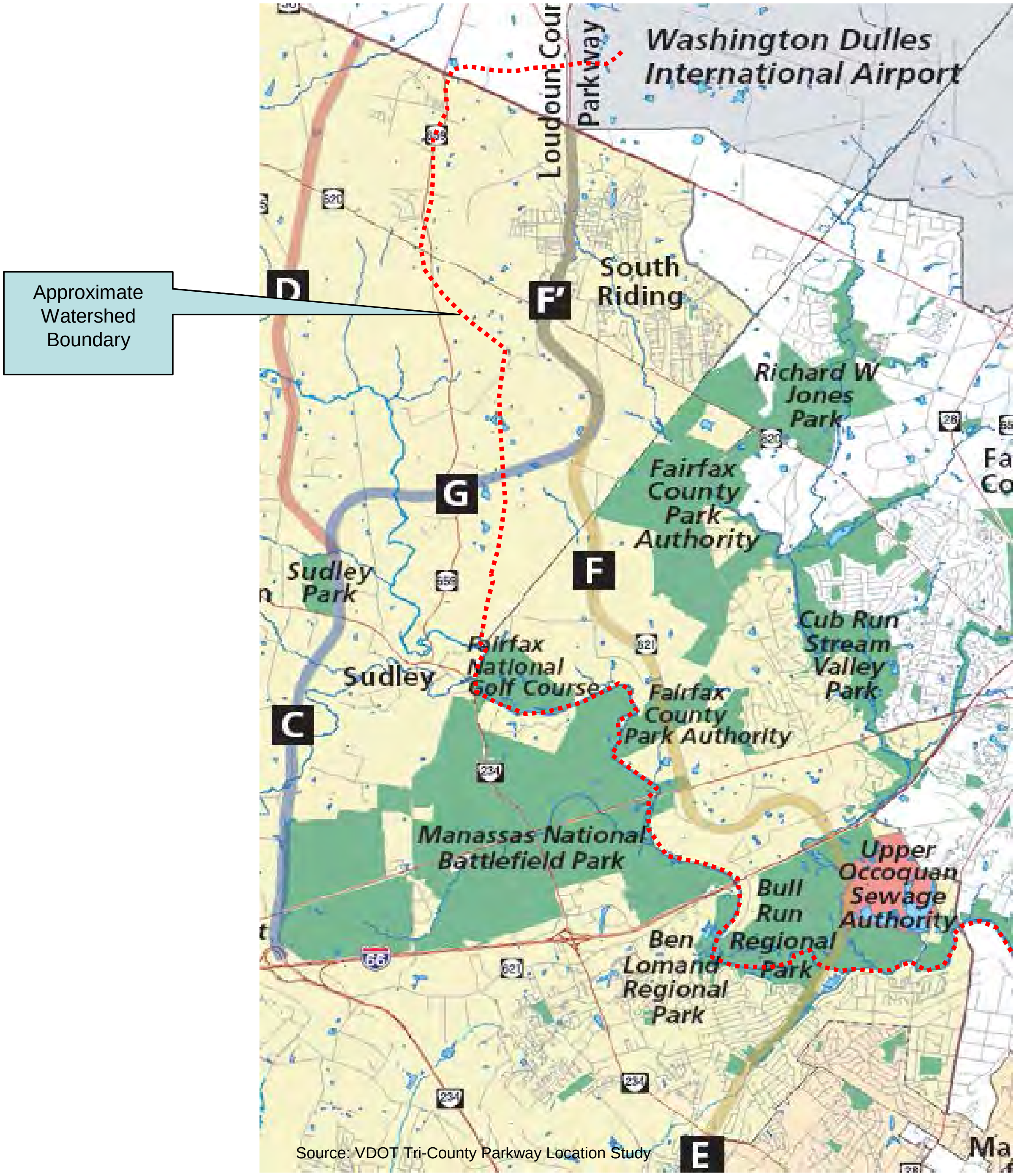


Figure 2-6
Candidate Build Alternatives for the
Tri-County Parkway

This route has a shorter length within the Cub Run and Bull Run watersheds. The route will affect the headwaters of Elklick Run and Cub Run but not the major streams directly.

Selected Alternative

Findings from the DEIS, input from the public hearings and local governments and comments on the DEIS were presented to the Commonwealth Transportation Board (CTB) during its September 2005 meeting. On November 17, 2005, the CTB approved the West Two Alternative for the Tri-County Parkway which lies outside the Cub Run and Bull Run watersheds. It is composed of segments D and C on Figure 2-6, west of the Manassas National Battlefield. The alignment starts at US 50, John S. Mosby Highway, and extends southerly, ending at the 234/I-66 interchange, near the western boundary of the Manassas National Battlefield Park. The alignment is 10.5 miles long.

Manassas National Battlefield Park Bypass

The proposed Manassas National Battlefield Park Bypass will affect the Bull Run West subwatershed. The Federal Manassas National Battlefield Park Amendments Act required that the Federal Highway Administration conduct a study regarding the relocation of routes 29 and 234 within the Manassas National Battlefield Park with the goal of closing these highways within the park boundaries. The study identified five potential routes. A Draft Environmental Impact Statement (DEIS) was published in March 2005, and the public comment period closed in June 2005. The final DEIS has not yet been published.

All five build alternatives affect the western portions of the Bull Run West subwatershed near Bull Run. The portions of these routes within the Cub Run watershed are shown on Figure 2-7. This figure includes modifications to alternative D based on input from the public.

The northern alternatives, A, B, C and D, start at Route 29 between Bull Run and Pleasant Valley Road. Alternatives A and B are further north; B and C are closer to Bull Run. Alternative D is identified as the preferred alternative in the DEIS. Alternatives A, B, C and D affect significant public and private open space in the R-C District along Bull Run Post Office Road. Build alternatives C and the preferred alignment D would have one bridge crossing of Bull Run, and affect large areas of bottomland hardwood forest and floodplain as well as parkland and other open space.

The southerly alternative G starts at Route 28 and Bull Run Post Office Road, and proceeds south to parallel Route 66. This alternative has fewer impacts on the Bull Run West watershed than the northerly alternatives but still includes one crossing of Bull Run that will affect private and public lands, and wetlands within the 100-year floodplain.

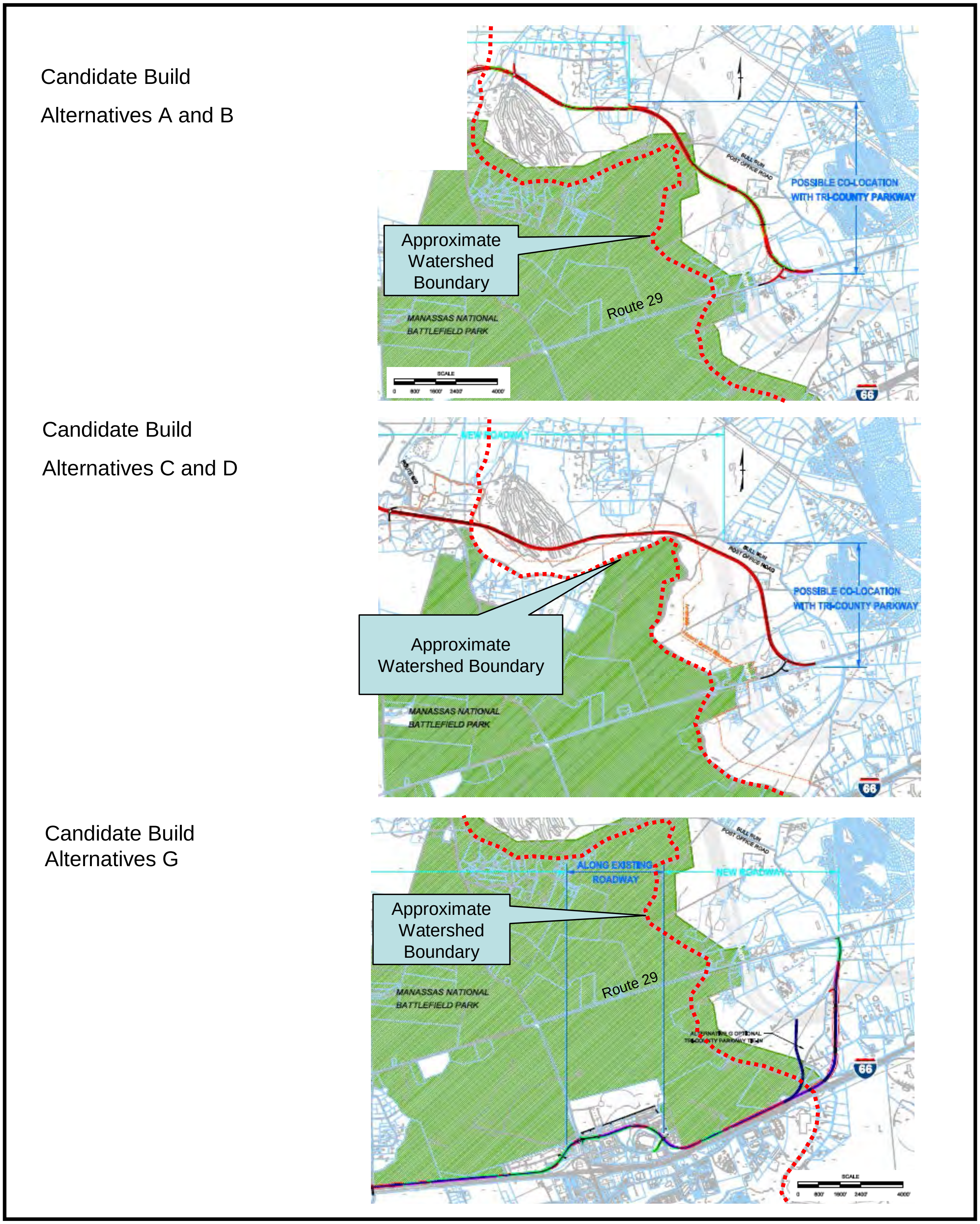


Figure 2-7
Manassas National Battlefield
Park Bypass Build Alternatives

Other Highway Improvement Projects

The Fairfax County Comprehensive Plan includes the following highway projects within the Cub Run and Bull Run watersheds:

- Widening of Pleasant Valley Road to four lanes.

- Widening of Walney Road to four lanes between Poplar Tree Road and Route 50. The only remaining two-lane segment is where Walney Road crosses Flatlick Branch and will eliminate frequent roadway flooding.

- Extending Poplar Tree Road as a four-lane road between Walney Road and Stonecroft Boulevard. This improvement has been completed as Westfields Boulevard.

- Constructing various Route 28 interchange improvements (Route 50, Westfields Boulevard) within the watershed. These improvements have been completed or are under construction. The planned construction of an interchange at Willard Road will affect the watershed.

- Widening of Braddock Road and Old Lee Road. The transportation plan widens Braddock Road to four lanes from the Loudoun County line to a location east of Pleasant Valley Road, and constructs a new four-lane road (referred to as the Old Lee Road extension) from this location to Old Lee Road. Old Lee Road would also be widened to four lanes from the extension to a location near Willard Road and Lee Road. Under the planned widening, Braddock Road would remain two lanes east of the Old Lee Road extension. This project would improve the Braddock Road and Old Lee Road bridge crossings of Cub Run, eliminating frequent roadway flooding at these two locations.

  The widening of Pleasant Valley Road, widening of Braddock Road, and construction of the Old Lee Road extension will affect open space, public parks (primarily the Sully Woodlands Fairfax County Park Authority Park) and streams in the watershed.

2.5 Stormwater Management History

The following presents the history of stormwater management requirements in the watershed and their impact on Cub Run and Bull Run. Because of past stormwater management efforts, Cub Run watershed ranks high among other watersheds in the county for having the greatest number and density of stormwater controls serving its existing development.

2.5.1 Cub and Bull Run Watershed Drainage Plan: March 1979

The 1979 Fairfax County Master Plan for Flood Control and Drainage for the Cub Run and Bull Run watersheds documents stormwater management problems from the late 1970s and predicts future stormwater problems resulting from the development of the watersheds. At the time of this study, the watersheds were categorized as predominantly rural, with farmland, recreational space and vacant tracts accounting for more than 50 percent of the land area. The report documents five major residential centers: 1) Greenbriar and Brookfield subdivisions along Stringfellow Road south of Route 50, 2) the unincorporated Centreville area, 3) Country Club Manor near Sully Station, 4) Meadows of Chantilly Mobile Home Community south of Route 50 west of Route 28 and 5) London Town at the intersection of Route 29 and Stone Road. Commercial and industrial development was limited. Figures in the 1979 report document residential development constructed before 1980.

The report accurately recognized that the study area would grow rapidly between 1990 and 2000. To mediate anticipated stormwater flooding and erosion problems, and enable watershed drainage-ways to carry stormwater safely with minimal disruption, 46 projects with a cost of $2.9 million (1979 dollars) were recommended. The projects primarily included road crossing improvements, riprap installation or gabion streambank protection, and relocation of houses susceptible to flooding.

As was the standard at that time, the improvements focused on providing drainage and preventing flooding. Although the possibility of negative environmental impacts from watershed development is briefly mentioned, the plan does not include projects for storing increased stormwater runoff or improving water quality.

2.5.2 Peak-Shaving Stormwater Controls

Since 1972, the county has required new development to include stormwater facilities (primarily detention ponds) that control the peak runoff for all areas in the county. The early requirement was for the control of the 10-year peak flow. A requirement for control of the 2-year flow was introduced in 1979. The Fairfax County Public Facilities Manual requires that the peak flows produced by the 2- and 10-year storm events are not increased by the new development. Since most of the construction has occurred since 1972, much of the development in the watershed has peak shaving controls.

Peak shaving stores flows in a stormwater pond and releases it at a rate equal to the predevelopment flow rate.

2.5.3 Neighborhoods without Stormwater Controls

Several medium-density residential areas (0.25-acre lots) were developed before peak-shaving controls were required. These areas, their approximate drainage area and their subwatersheds are listed below:

- Greenbriar and Birch Pond (614 acres): Middle Big Rocky Run – Frog Branch
- Brookfield (326 acres): Frog Branch and Flatlick Branch
- Country Club Manor (353 acres): Lower Round Lick and directly to Cub Run main stem (includes Chalet Woods)
- Pleasant Valley (193 acres): Directly to Cub Run main stem

Pleasant Valley was built before water quality controls were required but should have peak flow controls based on the date of the development (approximately 1980). This area was likely granted a detention waiver at the time of development, since it is along the major floodplain of the Cub Run main stem. A pond at this location could delay peak flows from the development sufficiently such that it coincides with flows from upstream areas producing a higher peak flow and greater potential for flooding in Cub Run.

These uncontrolled medium-density residential areas are highlighted on Figure 2-8. The total area is 1,486 acres or about six percent of the total drainage area of Cub Run in Fairfax County (39 square miles).

2.5.4 Regional Stormwater Ponds

In 1989, the county developed a plan that identified the location of regional stormwater ponds in its then developing portions (Cub Run, Difficult Run, Little Rocky Run, Horsepen Creek and Sugarland Run). The goal of the Regional Stormwater Management Plan was to reduce the number of structural stormwater management controls (wet ponds and dry ponds) with larger regional stormwater facilities. The fewer number of regional ponds would be easier and less costly to maintain. Drainage areas for regional ponds range from 100 to 300 acres. Onsite structural stormwater management controls for individual developments have drainage areas typically less than 20 acres. A single regional pond could eliminate the need for as many as 10 to 20 onsite ponds.

The 1989 stormwater management plan recommended 31 regional pond sites in the Cub Run watershed. Seventeen ponds (60 percent) have been constructed, leaving 14 in various planning stages. Several regional ponds were moved from the original proposed locations, and some were constructed with reduced storage volume. An additional regional pond near Fair Lakes has also been constructed.

The locations of the existing and proposed regional ponds are shown on Figure 2-9.

Combined, the existing regional stormwater ponds cover 4.6 square miles or 12 percent of the Cub Run watershed in Fairfax County and approximately 20 percent of the developed acreage. These regional ponds provide both peak flow and water quality control for the upstream watershed.

In some cases development within the areas upstream from unconstructed regional ponds may have been granted a detention waiver by the county. The requirement for constructing peak flow controls was waived with the understanding that the regional pond would be constructed in the future to provide the required peak flow control. Water quality control requirements were not waived in the Occoquan Reservoir watershed which includes Cub Run and Bull Run. Temporary ponds were sometimes constructed with the understanding that the property on which the facility is located could be developed if the regional pond is constructed.

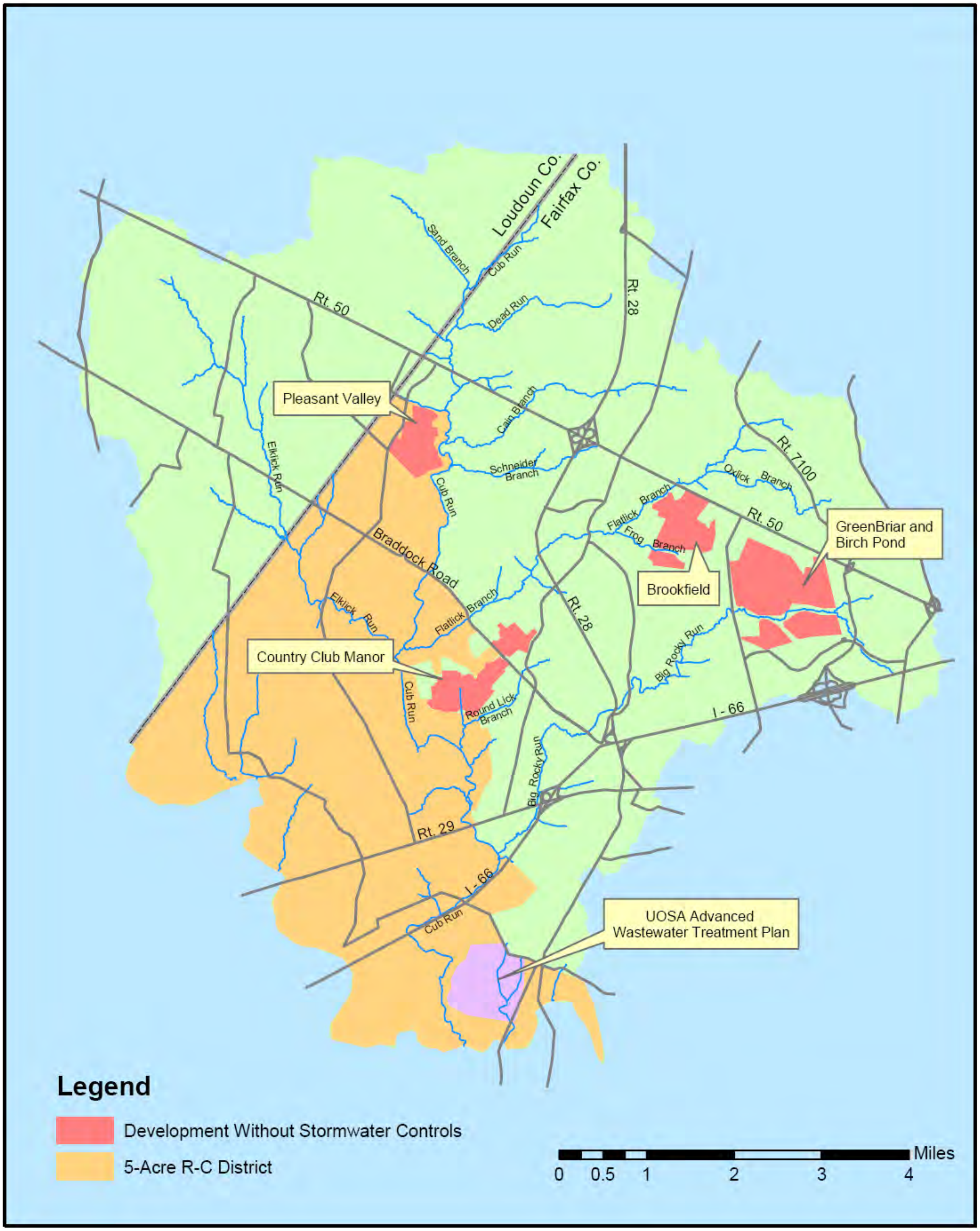


Figure 2-8
Neighborhoods Without Stormwater Controls and the Upper Occoquan Sewage Authority Advanced Wastewater Treatment Plant

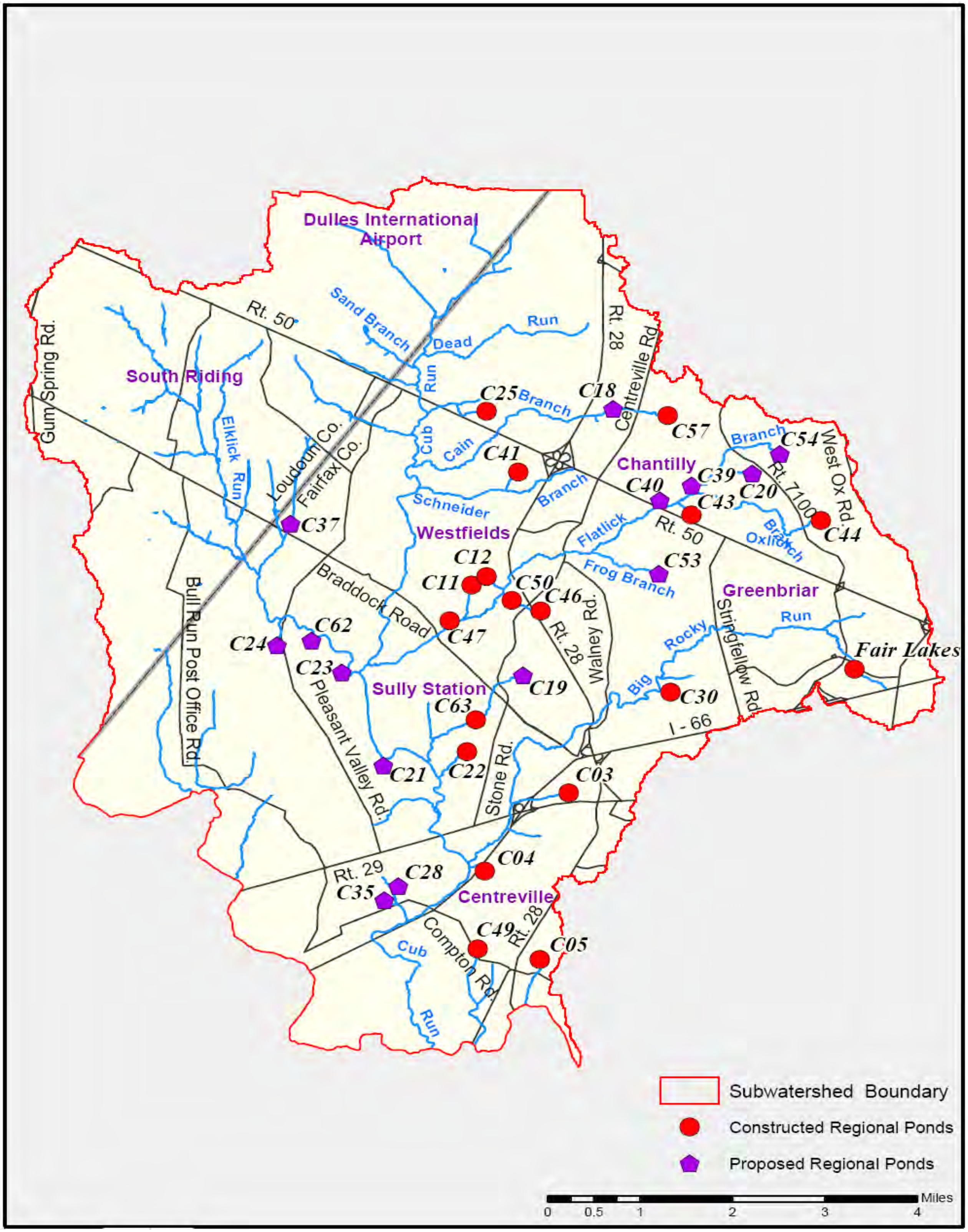


Figure 2-9
Existing and Proposed
Fairfax County Regional Ponds

Detention waivers do not have a major impact on the stormwater controls in the Cub Run and Bull Run watersheds. All proposed regional pond sites have upstream stormwater ponds.

The Fairfax County regional pond program has not been fully implemented, primarily due to opposition from the residents who lived near the proposed pond sites. Section 6.2 further discusses the regional ponds that have not been constructed and identifies those recommended for construction as part of the Cub Run and Bull Run Watershed Management Plan. These evaluations consider the need for the proposed regional ponds and evaluate stormwater alternatives to supplant or reduce the size of the ponds.

The following sections summarize several reports and studies that relate to the Fairfax County regional stormwater pond program.

2.5.4.1 Regional Stormwater Management Plan: January 1989

The goal of this study was to enhance the efficiency and cost-effectiveness of stormwater management in Fairfax County by strategically locating larger regional detention facilities in lieu of numerous smaller onsite detention dry or wet ponds for development projects.

This study identified a regional detention facility network for the then rapidly developing sections of Fairfax County that provided water quality, erosion and flood control benefits. The plan identified the locations, provided a conceptual design, and documented the flood and streambank erosion-control benefits provided by the regional ponds.

For the Cub Run watershed, the plan also identified regional pond sites that provide sufficient storage volumes to accommodate wet detention water quality storage to meet Occoquan Reservoir Water Supply Protection Overlay District (WSPOD) nutrient reduction requirements.

The 1989 regional stormwater management plan identified the location of 31 regional detention regional ponds (21 wet and 10 extended dry) within the Cub Run watershed. The study included 12 existing regional ponds.

For the entire Occoquan Reservoir watershed in Fairfax County (100.8 square miles), the recommended regional facilities were projected to reduce future total phosphorus annual loadings by 11 percent and total nitrogen annual loadings by seven percent.

2.5.4.2 The Role of Regional Ponds in Fairfax County's Watershed Management: March 2003

The Regional Pond Subcommittee's main objective was to develop a unified position on the use of regional ponds as well as alternative stormwater controls. The report presents findings concerning regional ponds related to the following:

- Ecology
- Economics
- Local, State, and Federal Permits, Regulations and Policies
- Hydrology and Design
- Land Use and Watershed Management
- Parks and Recreation
- Health and Safety
- Aesthetics
- Construction Planning and Phasing
- Public Participation, Outreach and Support
- Stormwater Management in Other Jurisdictions

The report also summarizes the findings of the 1989 report on the safety and liability task force for stormwater management.

As a result of these findings, the Regional Pond Subcommittee formulated an ideal stormwater management program.

The subcommittee's unified position on regional ponds and other watershed management tools is that regional ponds should not be considered the preferred stormwater management alternative. Rather, regional ponds should be considered one of many tools available for stormwater management.

The following highlight the key points contained in the 61 recommendations for improving the Fairfax County stormwater management program:

- Revise the current county policy regarding regional ponds to reflect the subcommittee's unified position on regional ponds.

- Develop recommendations for stormwater management practices as part of the watershed planning process. Until that time, use a proposed interim decision matrix to determine whether regional ponds are appropriate. A pilot project should be initiated to validate the interim decision matrix.

- Develop a second matrix in preparing watershed management plans. This matrix should provide options when considering and evaluating stormwater management alternatives.

- Evaluate the impacts on stormwater management systems carefully when making land use decisions.

The subcommittee recommends the following:

- Require temporary onsite facilities in watersheds where regional facilities are planned, until regional ponds or equivalent stormwater practices are implemented.

- Establish conditions on stormwater management (detention) and BMP (water quality) waivers to ensure that measures are provided to offset, to the greatest extent practicable, the impacts of the waivers being granted. Waivers dealing with stormwater controls and floodplain management should only be granted in concurrence with watershed management plans.

- Use alternatives to regional ponds where consistent with the watershed management plans. When regional ponds are warranted, techniques should be used to reduce the impacts of the pond.

- Allocate adequate resources to accomplish these recommendations.

2.5.4.3 Forested Wetlands Committee Report: April 1993

The Forested Wetlands Committee report to the Fairfax County Board of Supervisors on "Methods to Protect Wetlands during Implementation of Regional Stormwater Ponds" was prepared in April 1993. This report identifies methods that minimize forested wetland disturbance produced by regional stormwater management ponds. The committee also reviewed the Code of Virginia stormwater utility enabling legislation for its potential application in Fairfax County.

Committee recommendations include the following:

1. Institute a wetlands protection policy for regional ponds

2. Encourage innovative and state-of-the-art regional pond designs

3. Improve regional pond maintenance and efficiency

4. Develop policies that address unprotected areas of the regional system. This recommendation targets stream segments and wetlands located upstream of the planned and constructed regional ponds. The recommendation also identifies the need to protect stream segments before building the regional pond.

5. Provide recommendations for constructing wet versus dry regional ponds

6. Re-examine the county regional pond program periodically

7. Consider placing regional ponds outside the major floodplain

2.5.5 Pro Rata Share Master Plan for Flood Control and Drainage Projects

The Department of Public Works and Environmental Services maintains a Fairfax County Master Plan for Flood Control and Drainage Pro-Rata Share Projects. These projects form the basis for pro-rata charges for new development in the watershed. When a new development is constructed, the developer pays into a fund for implementing stormwater improvements within the watershed. The payment amount is computed, or pro-rated, based on the impervious area created by the development.

These projects were derived from multiple sources, including a 1978 report completed by Parsons, Brinckerhoff, Quade & Douglass, the Regional Pond Plan completed in 1988, citizen drainage complaints, maintenance problems and local drainage studies. The county maintains a database of drainage projects identified from these sources.

The Master Plan includes 66 pro-rata projects in the Bull Run and Cub Run watersheds. Reviewing the number and types of projects included in the Master Plan is useful since they reflect an appraisal of watershed conditions that need to be evaluated and addressed in the Cub Run watershed plan. These projects are also evaluated for inclusion in the watershed plan. The status of these projects are documented in Section 6-10.

The Bull Run watershed includes five stream-crossing improvement projects along Bull Run Post Office Road and Sudley Road. No other projects are located in the Bull Run watershed.

The projects within the Cub Run watershed are summarized in the following sections.

2.5.5.1 Cub Run Watershed Road Crossing Improvement Projects

Six projects identify the need to replace the culvert or bridge, and/or raise the road elevation at locations where roads cross streams. Streams frequently overtop the roadway during rain storms at these locations:

- CU401 - Compton Road upstream from UOSA advanced wastewater treatment facility (65-3)
- CU411 – Compton Road at small tributary to Cub Run (64-3)
- CU421 - Heron Drive at small tributary to Big Rocky Run (54-2)
- CU451 – Dorforth Drive at small tributary to Big Rocky Run (45-4)
- CU481 – Birch Drive at small tributary to Flatlick Branch (34-4)
- Lees Corner Road at Flatlick Branch (34-2)

The tax map on which the crossing is located is indicated in parentheses.

2.5.5.2 Cub Run Watershed Regional Stormwater Ponds

The Pro-Rata Share Project Master Plan includes 32 regional stormwater ponds within the Cub Run watershed. This includes the 31 sites recommended in the 1989 Regional Stormwater Management Plan as well as one additional site in Fair Lakes. The status of the regional ponds is summarized below:

Number of Ponds	Status	Regional Pond Sites
8	Constructed as recommended in the 1989 Regional Stormwater Management Plan	C04, C11, C12, C25, C30, C41, C46, C47
10	Constructed at reduced size or volume from the recommendations in the 1989 Regional Stormwater Management Plan. Some aspect of the design was less than fully "regional" as defined in the 1989 Management Plan (e.g. detention storage may not be provided for the entire drainage area or the detention requirements may not have been based on undeveloped conditions).	Fair Lakes, C03, C05, C22, C43, C44, C49, C50, C57, C63
14	Unconstructed Regional Ponds	C18, C19, C20, C21, C23, C24, C28, C35, C37, C39, C40, C53, C54, C62

Figure 2-9 provides the approximate location of the constructed and not-yet-constructed regional stormwater ponds. The status of these regional ponds in the Cub Run watershed plan are presented in Section 6.2.

2.5.5.3 Cub Run Watershed Stream Restoration and Stabilization Projects

The Pro-Rata Share Project Master Plan includes 23 stream restoration and stabilization projects. These projects suggest locations were stream erosion is a primary concern.

For the most part, these projects are scattered throughout the Cub Run watershed. However, they include much of the Flatlick Branch and Frog Branch stream segments upstream from Route 28. Stream restoration projects are also identified in the lower reaches of Cub Run within Bull Run Regional Park.

None of the identified stream restoration projects were constructed. These projects were considered in developing stream restoration reaches as described in Section 6.5.

2.5.6 Other Stormwater Management Initiatives

The following provides an overview of other reports and studies related to Fairfax County stormwater management initiatives.

2.5.6.1 Infill and Residential Development Study: July 2000

The Fairfax County Departments of Planning and Zoning, Transportation, and Public Works and Environmental Services were charged by the Board of Supervisors and the Planning Commission with evaluating issues and recommending improvements for managing residential infill development. The subsequent "Infill and Residential Development Study" report was published in July 2000.

The term "infill development" includes the following residential development activities:

- Demolishing an existing home on a lot and building a larger home
- Subdividing a single lot into two or more building lots
- Developing one or more new residences on an undeveloped or underutilized site within an existing, established neighborhood
- Developing a relatively large subdivision surrounded by other subdivisions
- Redeveloping an existing subdivision

The issues most frequently cited as problems with infill development regarding its impacts on the immediate environs include:

- Compatibility of the new development with the existing neighborhood/area, including lot size, house size, house orientation, setbacks, topography, etc.
- Additional traffic congestion and cut-through traffic
- Loss of trees, tree preservation and loss of open space
- Storm drainage and erosion control
- Public outreach

The "Infill and Residential Development Study" makes recommendations that address the above issues.

Thirteen recommendations address improvements to construction-related sediment and erosion control programs. Ten recommendations concern improvements to implementation, inspection and monitoring of the sedimentation and erosion control program, and mitigation of downstream impacts during construction. These twenty-three recommendations have little impact on the Cub Run and Bull Run Watershed Management Plan.

The following three recommendations may affect the overall master planning effort in the Cub Run and Bull Run watersheds and elsewhere in the county.

SW11 – Recommendation SW11 recognized that water quality controls or best management practices (BMPs) are important for maintaining good ecological health of streams in Fairfax County. To enhance the current practices and address issues critical to improving the health of the environment, several recommendations were made that include:

- Providing additional guidance on BMP selection and enhanced design standards in the Public Facilities Manual
- Establishing a county-wide monitoring program to assess BMP performance
- Allowing BMP credit for contributions to a "land trust fund"
- Facilitating the implementation of bioretention/ biofiltration facilities ("rain gardens"), underground sand filters in residential areas, and manufactured or ultra-urban BMP systems in Fairfax as acceptable privately maintained BMPs
- Linking enhanced design features for extended detention and retention pond BMPs to increase pollutant removal efficiencies
- Encouraging the retrofitting of existing detention-only ponds to enhance water pollution treatment

SW12 - Recommendation SW12 discusses how the Public Facility Manual should be improved so the county's adequate-outfall policy is consistent with new state requirements and does more to address the outfall concerns as full urbanization is approached. The adequate-outfall policy ensures streams that receive the flow from new development or infill development have sufficient capacity and will not erode or flood. An amendment to the Public Facilities Manual adopted in February 2006 strengthens the adequate outfall requirements.

SW13 - Recommendation SW13 discusses changes to the zoning application process to ensure that residential zoning development plan applications adequately address the land area disturbance and land area requirement (footprint) for onsite stormwater management facilities. A zoning ordinance amendment adopted in March 2004 includes revisions that address recommendation SW13.

2.5.6.2 Stormwater Needs Assessment Project Recommendations

In 2003, the Department of Public Works and Environmental Services participated in a strategic planning forum to refocus the stormwater management efforts to better address the increasing expectations of county residents, state and federal regulators. This strategic planning effort identified:

1. Level of service for stormwater management should be based on a clear understanding of public needs.
2. Selected level of service must be supported by an adequate and stable source of funding.

To fully implement these major requirements into county stormwater management practice, the current county level of stormwater service was compared to the overall public need. Based on this comparison, it was recommended that the Fairfax County Department of Public Works and Environmental Services develop a comprehensive stormwater program that enhances levels of service in program management, planning, infrastructure maintenance, enforcement of performance standards, capital construction and regulatory controls.

This planning effort found that enhancing the current level of stormwater management services would initially increase total program costs from a budget of $11.7 million in fiscal year 2004 to $28 million in fiscal year 2006. As the level of service increases further during the five-year moderate growth-planning period, the projected budget would increase from $28 million in fiscal year 2006 to $52 million in fiscal year 2010. The recommended funding source for this significant increase in county level of service and overall program costs is the creation of the stormwater management user-fee along with secondary funding methods such as Pro-Rata Share, federal and state grants, and special direct fees.

Before the stormwater utility user-fee can be enacted and the level of stormwater management is increased significantly, a citizen-based advisory committee was appointed by the Board of Supervisors to review county recommendations. After seven months of discussion and review, the committee members developed the following recommendations:

1. The committee unanimously supports a long-term dedicated source of funding for the stormwater management program.

2. The committee embraces the County Executive’s FY 2006 budget with a dedication of one cent on the tax rate for stormwater in addition to the current level of funding.

3. Most of the committee supports implementation of the utility fee, effective in FY 2007, to address the level of service outlined in the projected program.

2.5.7 Loudoun County Stormwater Controls

The Loudoun County Facilities Standards Manual requires that post-development peak flows from the 1- and 10-year storms should not exceed the predevelopment peak flows. Loudoun County also requires water quality BMP controls such that the annual post-development stormwater pollution load should not exceed the pre-development load. The Loudoun County standards encourage nonstructural BMP measures such as those identified in the Virginia Stormwater Management Handbook to meet these requirements. As a result of these requirements, the major development in the Cub Run watershed, South Riding, includes 10 wet ponds that serve virtually all of the developed area. Future development will have similar stormwater controls.

2.5.8 Summary of Stormwater Controls

The Cub Run watershed has one of the highest density and degree of coverage of stormwater management controls of any watershed in Fairfax County. Most of the development occurred after stormwater regulations requiring both peak shaving and water quality controls were enacted. GIS layers of the stormwater facilities

(STORMNET) include 415 wet and dry ponds in the Fairfax County portions of the watershed.

Furthermore, much of the higher-density residential development in Loudoun County (South Riding) has occurred recently and is covered by current county stormwater requirements. These areas have wet ponds that comply with Loudoun County stormwater requirements.

Only a few isolated developed residential areas do not have stormwater controls. This is in stark contrast to watersheds in eastern Fairfax County where large areas of residential development lack stormwater controls.

Most areas in the watershed provide the stormwater controls required by the Fairfax County Public Facilities Manual. These controls typically consist of wet or dry ponds.

It should be noted that the Gate Post Estates neighborhood has innovative stormwater design that incorporates elements of both low-impact development and traditional stormwater controls. This neighborhood is south of Route 29 and west of the Cub Run main stem. The streets in this neighborhood are narrower than those in the traditional Fairfax County neighborhoods. Furthermore, sidewalks are on only one side of the street. Combined, these design features reduce the impervious area.

The streets have drainage swales instead of the traditional curb and gutter designs in traditional neighborhoods. This design slows the flow velocity, reduces peak runoff flows and allows infiltration into the soils before the runoff reaches the streams. It also improves the quality of the runoff.

Gate Post Estates shows that alternative low-impact stormwater controls can be used with few, if any, drainage problems, are aesthetically pleasing and should serve as examples for designs that can be effectively implemented in new residential and commercial development.

As described further below, the Cub Run watershed streams are better than would be expected for an area with this development density. The stormwater controls described above are at least partially responsible for the current stream conditions.

2.6 Watershed Protection and Open Space Preservation Initiatives

The following sections provide information about Occoquan Reservoir watershed protection, the Chesapeake Bay Preservation Ordinance and open space preservation initiatives that affect the past, existing and future conditions in the Cub Run and Bull Run watersheds.

2.6.1 Occoquan Reservoir Watershed Protection Initiatives

The Occoquan Reservoir, owned and operated by Fairfax Water, is a major drinking water source for northern Virginia, including Fairfax County.

In the late 1960s, the reservoir's water quality was degrading, primarily due to the nutrients being discharged from point and nonpoint sources of pollution. The reservoir was experiencing periodic extensive algal blooms, resulting in serious water quality problems including taste and odor in finished drinking water, water treatment concerns, low dissolved oxygen levels and fish kills.

Several important initiatives to protect the Occoquan Reservoir water quality have significant effects on the Cub Run and Bull Run streams, development in the watersheds and stormwater controls.

2.6.1.1 Upper Occoquan Sewage Authority

In 1971, the State Water Control Board enacted the "Occoquan Policy" that regulates wastewater treatment and sanitary sewer facility design within the Occoquan Reservoir watershed. The Upper Occoquan Sewage Authority (UOSA) was created to construct, manage and operate the facilities required to meet these requirements. The UOSA advanced wastewater treatment plant (AWTP) was placed in service in 1978 and replaced 11 less efficient wastewater treatment plants in the Occoquan watershed. The UOSA water reclamation facility is in the southeastern Cub Run and Bull Run watershed.

The UOSA AWTP is one of the most technologically advanced in the United States and provides very high quality treated wastewater discharge. This AWTP resulted in significant water quality improvements in Cub Run, Bull Run and the Occoquan water supply reservoir. Treated effluent discharges to a large lake within the Bull Run East subwatershed where it is subsequently discharged to Bull Run.

Five wastewater plants located in Cub Run were taken out of service after completion of the UOSA facilities:

- Upper Cub Run - Cub Run immediately south of Cain Branch
- Middle Cub Run – Cub Run upstream from Lee Highway
- Flatlick – Flatlick Branch upstream from Sully Road
- Greenbriar – Big Rocky Run at Stringfellow Road
- Big Rocky Run – Big Rocky Run downstream from Lee Highway

These wastewater treatment plants used old wastewater treatment technologies. The elimination of these wastewater treatment plants produced significant water quality improvements in the Cub Run streams and Occoquan Reservoir.

2.6.1.2 Residential-Conservation District Rezoning

The second management program implemented in the Cub Run watershed was the reduction in the planned residential density for several thousand acres in western Fairfax County from 0.25- to 1.0-acre lot sizes to five-acre lot sizes and related rezoning within an area identified as the R-C District. This rezoning affects 18.3 square miles or about 37.5 percent of the combined Cub Run and Bull Run watershed in Fairfax County, and nearly 100 percent of the Bull Run watershed. This area is shown on Figure 2-8. The Occoquan zoning actions were adopted and became effective in 1982.

The rezoning maintains the maximum development density and impervious land cover at a level that approximates natural undeveloped runoff volumes, peak flow rates and runoff water quality. Various studies have shown that streams with an impervious area of less than 10 percent show little impact from development. Sampling by Fairfax County as part of the Stream Protection Strategy Baseline Study (January 2001) confirms that the streams in the R-C District have higher habitat quality than most of Fairfax County's streams. The higher habitat quality is due to the low imperviousness levels and resulting reduced impacts from stormwater runoff.

The R-C District may include institutional uses with greater impervious cover approved through special permit or special exception.

The following areas in the R-C District were developed at a higher density where the development existed or was planned at the time of rezoning:

- Gate Post Estates. This neighborhood includes innovative low-impact development stormwater controls (narrow streets, drainage swales and sidewalks on only one side of the street) in combination with conventional dry ponds.

- Virginia Run and other development along southern portions of Pleasant Valley Road

- Pleasant Valley

R-C District areas outside the neighborhoods identified above are generally not served by public sanitary sewer and water supply systems. These areas rely on private wells and septic systems.

Additional parcels smaller than five acres that existed at the time of the rezoning were also allowed to remain.

A related rezoning action in 1982 allowed for increased densities in portions of the watershed near Dulles International Airport to include office, commercial and industrial land uses to promote employment.

2.6.1.3 Water Supply Protection Overlay District

As part of the 1982 zoning actions, a Watershed Supply Protection Overlay District (WSPOD) was created to protect the Occoquan Reservoir water supply. The WSPOD includes all areas in Fairfax County that drain to the reservoir. The WSPOD formalized a requirement established in 1980 for stormwater controls that reduce nonpoint nutrient runoff for areas within the WSPOD but outside the R-C District. Specifically, stormwater controls were required to reduce post-development phosphorus loadings by 50 percent.

Other than the neighborhoods where development was previously planned at the time of the 1982 rezoning, water quality controls were not required for development within the R-C District. Stormwater controls are generally required for institutional uses in the R-C district that have been approved through special permit or special exception.

Cub Run developments constructed after 1980 have structural stormwater controls for water quality management. Since much of the Cub Run watershed was developed after this time, most of the developed portions of the watershed have both peak flow and water quality controls. Since relatively little development occurred in the watershed between 1972 and 1980, few areas have peak-shaving controls with no water quality controls.

The primary structural stormwater BMP controls in the Cub Run watershed are wet ponds, extended detention dry ponds and modified wet ponds that include extended detention. Wet ponds have a permanent pool that removes nutrients through settling and uptake by plants. Extended detention dry ponds are dry between storm events but store runoff when it rains and slowly release it at a controlled rate, providing nutrient removal through settling. Some ponds are hybrids of wet and extended detention.

Water quality controls in the county outside the WSPOD require a 40 percent phosphorus load reduction. The Chesapeake Bay Preservation Ordinance that required these water quality controls was enacted in 1993 - 13 years after water quality BMP controls were adopted for the Occoquan watershed, which includes the Cub Run and Bull Run watersheds, and 11 years after the adoption of the WSPOD.

The following sections provide an overview of previous reports concerning protection of the Occoquan Reservoir water supply.

2.6.1.4 Fulfilling the Promise: The Occoquan Watershed in the New Millennium: January 2003

In 2002, Fairfax County marked the 20th anniversary of the landmark decision to rezone nearly 41,000 acres in the Occoquan watershed to protect the county's water supply. As part of the 20th anniversary celebration, the Fairfax County Board of Supervisors established a New Millennium Occoquan Watershed Task Force to assess issues facing the Fairfax County portion of the Occoquan Watershed, examine gaps in programs, define the roles of volunteer organizations and provide a vision for the future management of the watershed. The Task Force was also directed to develop management options for consideration at the county level, as well as options as part of a regional watershed planning effort.

The challenge facing the county and region is how to manage the reservoir and the watershed, recognizing its primary benefit as a reliable source of safe, clean drinking water, and its importance as an integrated ecological and hydrological system with multiple uses.

The Task Force Report (January 2003) describes historical and existing conditions in the reservoir. This report can be obtained from the Fairfax County website (www.FairfaxCounty.gov) by searching for the report title.

The UOSA water reclamation facility and elimination of other, less efficient wastewater treatment plants significantly improved the reservoir's water quality.

The Fairfax County 1982 rezoning of several thousand acres to a minimum lot size of five acres and regional implementation of stormwater BMP requirements have helped to maintain the reservoir's water quality despite significant growth and development in the watershed. According to the Occoquan Watershed Monitoring Laboratory, Occoquan Reservoir water quality has remained stable or has slightly improved since 1978 when the UOSA water reclamation facility went on-line. During the same time, the population in the watershed (including the counties of Fairfax, Prince William, Loudoun and Fauquier, and the cities of Manassas and Manassas Park) has nearly tripled.

According to the Fairfax County Stream Protection Strategy Baseline Study (described in Section 2.7.1.2), many of the county's healthiest streams are in the rezoned portion of the Occoquan watershed. The large-lot development and open space minimized impervious surface cover and maximized tree canopy thereby protecting the streams. These results support the assumption that the low development density in the R-C District effectively protects the local streams without additional stormwater controls.

The task force endorses existing programs and policies aimed at maintaining water quality in the Occoquan Reservoir. The task force's report presents 29 detailed recommendations. Key recommendations that affect the Cub Run and Bull Run Watershed Management Plan include:

- Strive to reduce nutrient and sediment contributions to the reservoir beyond those being achieved through existing policies and ordinances
- Maintain the integrity of the R-C District rezoning
- Continue regular stream assessments through Stream Protection Strategy staff and continued partnership with volunteer stream monitors
- Develop and implement the Stormwater Planning Division's watershed management planning process
- Study and adopt new stormwater management designs
- Encourage the use of effective LID techniques
- Continue to press for tree conservation and preservation-enabling legislation
- Establish tree canopy goals for the Occoquan watershed and determine appropriate implementation measures for attaining those goals

- Encourage the revegetation of riparian stream buffers with native vegetation
- Implement the findings of the Infill and Residential Development Study (described in Section 2.5.6.1)
- Fully fund watershed management planning as well as the implementation of adopted plan measures. As part of the planning process:
    - Investigate the effectiveness of existing stream valley protection mechanisms
    - Identify additional regulatory and/or non-regulatory measures that may be needed to protect stream valleys adequately
    - Identify additional performance requirements that may be appropriate to ensure that by-right development in the R-C District will not adversely affect stream quality
- Investigate an "Onsite Sewage Disposal System Management Authority" that would perform routine maintenance and monitor all onsite sewage treatment systems within the watershed. Onsite disposal systems refer to septic systems and other sewage disposal systems that serve single residences or group of residences not served by publicly operated sanitary sewer systems.

Many of these recommendations are addressed by the actions in this watershed plan.

2.6.1.5 Northern Virginia Regional Commission's Occoquan Reservoir Watershed Program and Watershed Model

The Northern Virginia Regional Commission (NVRC) maintains the Occoquan program and watershed model. The purpose of NVRC's Occoquan Reservoir Watershed Nonpoint Pollution Management Program is to help localities maintain water quality in the Occoquan Reservoir through control of nonpoint pollutant loadings. NVRC maintains the Occoquan Reservoir Watershed Computer Model. During the early 1980s, this model was the basis for rezoning the Fairfax County portion of the watershed to protect the Occoquan Reservoir drinking water supply from pollution from urban development. Every five years, NVRC assesses changes in land uses in the watershed to update the model and to help localities determine whether additional land management is needed.

2.6.1.6 Fairfax Water Source Water Assessment Program

Under the Safe Drinking Water Act, states are required to develop comprehensive Source Water Assessment programs that identify the critical watersheds that supply public drinking water, provide an inventory of contaminants in the watershed and assess the susceptibility of the water supply to contamination. The Source Water Assessment Report is available through the Fairfax Water website at www.FairfaxWater.ORG.

For the Occoquan Reservoir water supply, the source water assessment area is defined as those areas of Fairfax and Prince William counties directly tributary to the Occoquan Reservoir. This includes only those areas downstream of Lake Jackson and the free-flowing portion of Bull Run. The Cub Run and Bull Run watersheds are not included in the designated Occoquan Reservoir source water assessment area.

The assessment area is further broken down into Zone 1, defined as the 5-mile radius upstream of the intake at Occoquan Dam, and Zone 2, which includes the remaining area. The Occoquan source water assessment area is 64 square miles, with 25 square miles in Zone 1 and 39 square miles in Zone 2.

The Source Water Assessment inventories the land use, identifies potential users of hazardous materials and documents sources of water contamination that have occurred over the past five years. Source water susceptibility assessments for Fairfax Water raw water supplies were conducted by the Virginia Department of Health. Based on state criteria, the Potomac River and the Occoquan Reservoir water supplies are highly susceptible to contamination. This determination is consistent with the state's findings for other surface water supply sources (rivers, lakes, streams) throughout Virginia.

2.6.2 Chesapeake Bay Preservation Ordinance

Revisions to the Fairfax County Chesapeake Bay Preservation Ordinance (CBPO) were adopted on November 18, 2003. This ordinance identifies Resource Protection Areas (RPA) that protect water quality and habitat by filtering stormwater runoff, reducing the volume of stormwater runoff, preventing erosion and performing other biological and ecological functions.

Resource Protection Areas include: 1) tidal wetlands, 2) tidal shores, 3) water bodies with perennial flow, 4) nontidal wetlands connected by surface flow and contiguous to a tidal wetland or water body with perennial flow and 5) buffer areas that includes all land within a major floodplain or within 100 feet of a feature identified in 1 through 4.

With few exceptions, the CBPO regulations limit new development or disturbance within the RPA. However, structures and disturbance in the RPA that existed at the time the ordinance was adopted are allowed to remain.

The RPAs are a powerful tool that protect the stream valleys from future development and redevelopment.

Figure 2-10 shows the approximate extent of the RPA in the Cub Run watershed based on recent Fairfax County mapping studies. This map shows the general extent of the RPA within the watershed. The extent of the RPA is constantly being revised. Please refer to recent official maps for an accurate and current depiction.

The RPA covers six square miles or 13 percent of the Fairfax County portions of the Cub Run and Bull Run watersheds.

Figure 2-10
Chesapeake Bay Preservation
Ordinance Resource Protection Area

2.6.3 Parkland and Other Open Space

Parkland and other open spaces cover about 11 square miles or 23 percent of the total watershed area in Fairfax County. Approximately 27 of the 70 miles of stream (39 percent) included in this study (streams in Fairfax County with drainage area greater than 100 to 300 acres) are contained within stream valley parks. These parks and other open spaces are shown on Figure 2-11. Combined, these areas protect large areas of the watershed from future development and provide major watershed protection benefits. Protection of these areas is the main reason flooding is not an issue in the Cub Run watershed (Section 2.7.6).

Much of this area is undeveloped woodlands that serve a variety of watershed protection benefits:

- Reduces development density and impervious cover
- Protects environmentally sensitive areas
- Reduces peak flows
- Improves water quality
- Maintains stream valley buffers, which protect water quality and habitat by filtering stormwater runoff
- Filters runoff from developed areas
- Provides wildlife habitat
- Protects wetlands

2.6.3.1 Fairfax County Park Authority (FCPA) Parkland

More than 4,000 acres of parkland exists within the Cub Run and Bull Run watershed plan study area. Parcels of land have been acquired since the 1970s to protect floodplains and other open space for water quality, wildlife and recreational benefits. Several established Fairfax County Park Authority (FCPA) parks lie within the watershed, collectively known as Sully Woodlands and include:

- Ellanor C. Lawrence Park
- Cub Run Stream Valley Park
- Rocky Run Stream Valley Park
- Frog Branch Stream Valley Park
- Poplar Tree Park
- Sully Park

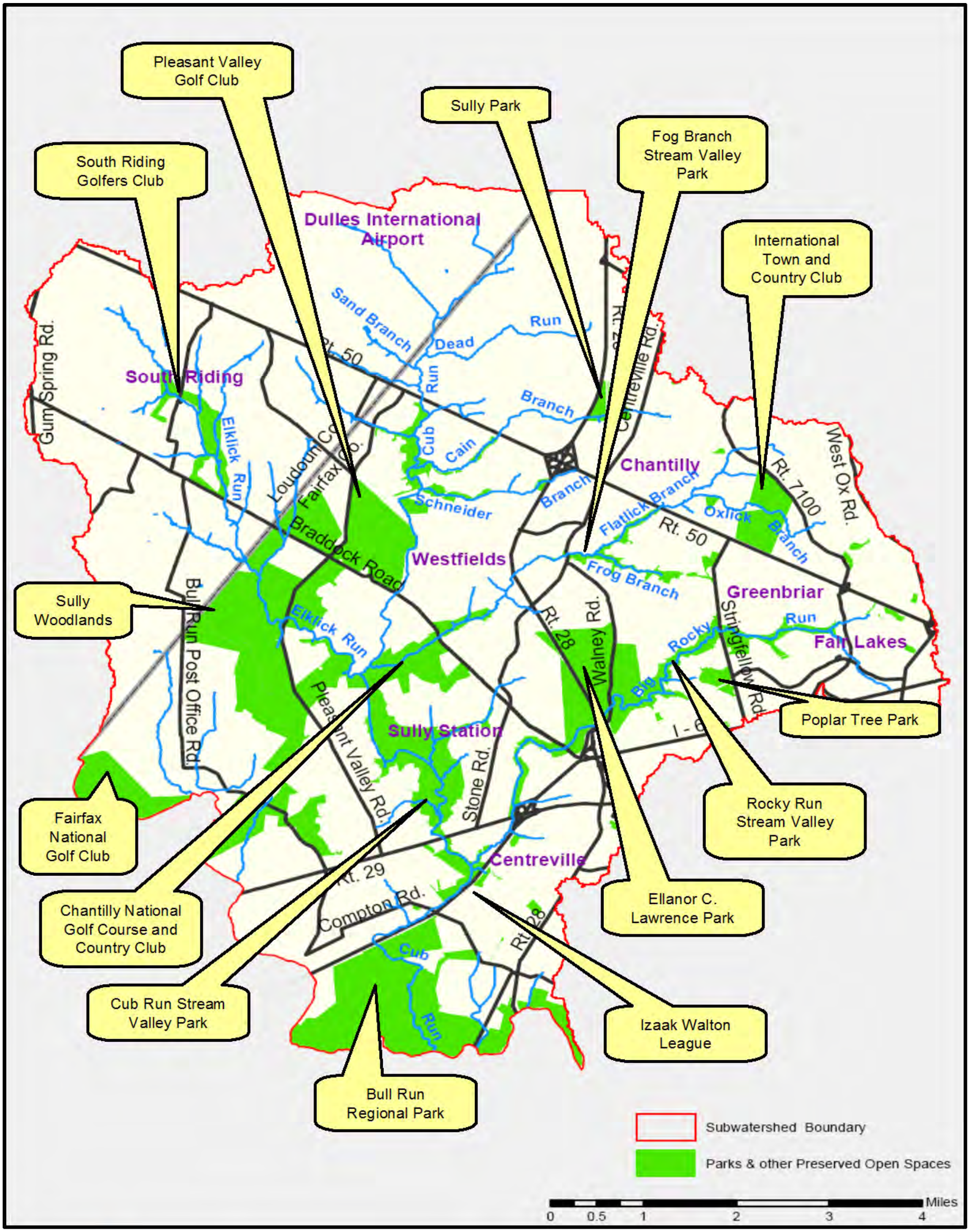


Figure 2-11
Parks and Other Reserved Open Space in the Cub Run and Bull Run Watersheds

FCPA is developing a Sully Woodlands Regional Master Plan to guide park acquisition, development and use for all FCPA parkland within the Cub Run and Bull Run watersheds. Much of this land is undeveloped woodland. The park master plan is being coordinated with this watershed plan.

One guiding principle for the Sully Woodlands Master Plan is to provide open space and natural resource protection. The plan will set aside large portions of this area focusing on environmentally or culturally sensitive areas as undeveloped open space parkland. However, active recreational opportunities are also a priority of FCPA and will be implemented in the park where appropriate. This development will be implemented to minimize watershed impacts.

2.6.3.2 Northern Virginia Regional Park Authority (NVRPA) Parkland

The Northern Virginia Regional Park Authority Bull Run Regional Park contains a large drainage area in the southern portion of the watershed. This park was acquired in the 1950s specifically to protect the Occoquan watershed and reservoir and lies largely within the Cub Run and Bull Run flood plain. Combined with the Cub Run Stream Valley Park, Bull Run Regional Park preserves some of the largest areas of contiguous floodplains and non-tidal wetlands in Fairfax County.

2.6.3.3 Other Preserved Undeveloped Areas

The watershed contains other preserved privately and publicly owned open and undeveloped areas, including:

- Areas preserved by the Izaak Walton League
- Pleasant Valley Golfers Club at Richard Jones park
- Chantilly National Golf Course and Country Club
- International Town and Country Club
- Fairfax National Golf Club
- Undeveloped “buffer areas” within Dulles International Airport

In addition to these parks and golf courses, homeowner associations and multi-family residential development (condominiums, apartments, town houses) includes large areas of largely undeveloped common areas. Much of these areas are located within stream valleys where development is not allowed due their location within the 100-year floodplain and RPA. This privately owned protected space also provides a valuable resource for watershed management.

2.7 Overall Watershed Conditions Based on Previous Studies and Reports

The following sections describe previous reports and other studies that provide background information on the ecological conditions, water quality, geology, soils, physical stream conditions, impaired waters and flooding.

2.7.1 Ecological Conditions

2.7.1.1 Cub and Bull Environmental Baseline: August 1977

This report was compiled as part of the 1997 Master Plan for Flood Control and Drainage and documented the development and environmental conditions in the watershed. The main objectives were to establish an environmental baseline for the Bull and Cub watersheds, to assess future changes to watershed quality, to develop an environmental framework for the master plan and to reduce environmental effects of future development.

The prevailing conclusion of this baseline report was that due to lack of development in the watershed at the time most of the habitat was in excellent condition and shows little sign of human impact.

Over the 26 years since this report was prepared, the amount of development in this portion of Fairfax County has increased significantly. Therefore, the habitat conditions described in the report may serve as watershed habitat quality goals for the current watershed plan.

2.7.1.2 Stream Protection Strategy Baseline Study: January 2001

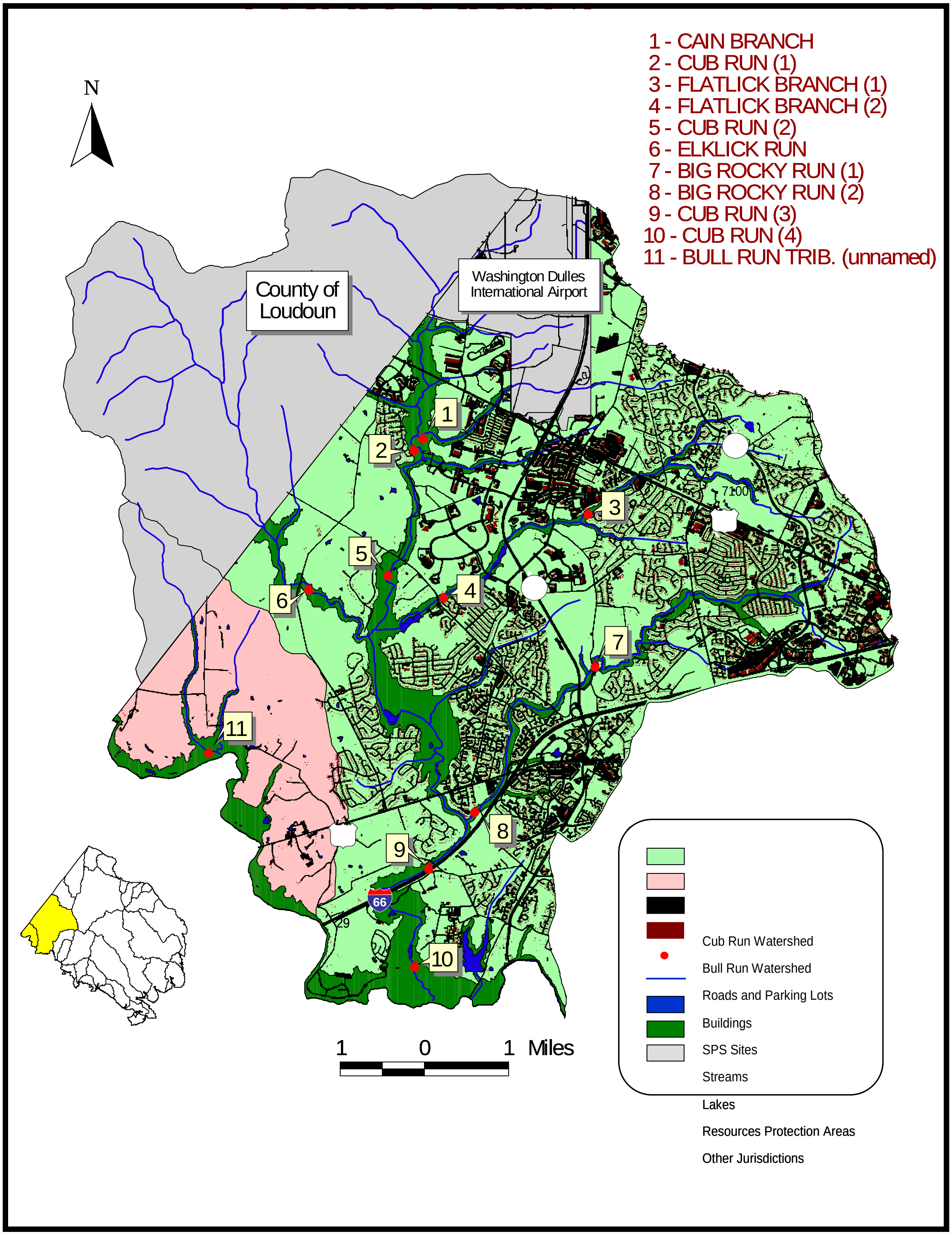
The Countywide Stream Protection Strategy (SPS) Program periodically samples major streams and tributaries throughout the county to assess stream, water and habitat quality.

The SPS assessments include biological indicators of the ecological health in the streams that include aquatic insects (benthic macroinvertebrates) and fish, fecal coliform bacteria, selected chemical parameters and habitat assessment of several physical characteristics. The SPS Program aims to better understand the degree of stream degradation, formulate measures to reverse negative trends, identify and prioritize areas with the greatest needs, and recommend targeted stream preservation and restoration.

The Stream Protection Strategy Baseline Study provided a 1999 “snapshot” of watershed conditions throughout Fairfax County to supply the necessary background information to implement county-wide watershed management plans.

The report also provides a historical perspective on the evolution of stormwater management in the county, describes the effects of urbanization on the stream environment and describes the importance of biological monitoring in assessing the stream conditions.

Ten locations were sampled in the Upper Bull Run watershed group, which includes Cub Run and Bull Run. These sampling locations are shown on Figure 2-12. This figure also presents the land cover in the watershed.


1 - CAIN BRANCH
2 - CUB RUN (1)
3 - FLATLICK BRANCH (1)
4 - FLATLICK BRANCH (2)
5 - CUB RUN (2)
6 - ELKLICK RUN
7 - BIG ROCKY RUN (1)
8 - BIG ROCKY RUN (2)
9 - CUB RUN (3)
10 - CUB RUN (4)
11 - BULL RUN TRIB. (unnamed)
N
County of Loudoun
Washington Dulles International Airport
1
2
3
4
5
6
7
8
9
10
11
7100
66
29
1 0 1 Miles
Cub Run Watershed
Bull Run Watershed
Roads and Parking Lots
Buildings
SPS Sites
Streams
Lakes
Resources Protection Areas
Other Jurisdictions

The study also considers sampling performed under the Northern Virginia Soil and Water Conservation District (NVSWCD) Volunteer Stream Monitoring Program and sampling by volunteers for the Audubon Naturalist Society (ANS) Water Quality Monitoring Program. These monitoring locations are shown on Figure 2-13.

Based on this sampling, the Cub Run and Bull Run watersheds exhibit a range of stream quality conditions that reflect the variations in the intensity of land development. The fish richness in the two watersheds was relatively high compared to other watersheds in the county. The most notable exception was Elklick Run, which scored in the lowest category.

Many of the benthic macroinvertebrate samples collected were ranked as fair within Cub Run, indicating stream degradation. Conversely, the Bull Run monitoring site was ranked in the highest category, with almost 30 percent of the community composed of intolerant organisms. These organisms are unable to tolerate water quality and environmental changes generally associated with a degraded water body.

Throughout both the Cub Run and Bull Run watersheds, sampling demonstrated an overall trend toward fair habitat quality, with many sites showing the impact of substantial sediment deposition. An exception of note was Big Rocky Run, which received the highest ranking for overall quality of instream and riparian habitat. This high rating may result from the protection provided by Ellanor C. Lawrence Park. Geologic conditions also support the habitat in this stream.

Although some subwatersheds within the Cub Run watershed have been significantly degraded, Cub Run also possesses many systems of high quality, including some within areas with high levels of imperviousness. The report conjectures that portions of the watershed may be approaching levels of development at the threshold for impairment for a healthy stream habitat capable of supporting a wide range in native organisms. As discussed in Section 2.7.3, the soils and geology affect the stream health.

The Stream Protection Strategy Baseline Report identifies three watershed management categories based on the overall stream ranking and projected development. Figure 2-14 shows the stream watershed management categories for the Cub Run and Bull Run watersheds.

The areas with the highest overall stream quality in the headwaters of Bull Run, Cub Run, and Big Rocky Run are included in the Watershed Protection management category. In these areas of high watershed quality, the main management strategy is to identify and protect the conditions responsible for producing these high-quality stream environments.

Slightly impaired areas, including Elklick Run and Cain Branch, are assigned to the Watershed Restoration Level I management category. Management strategies in this portion of the watershed are to identify and remedy the causes of stream degradation.

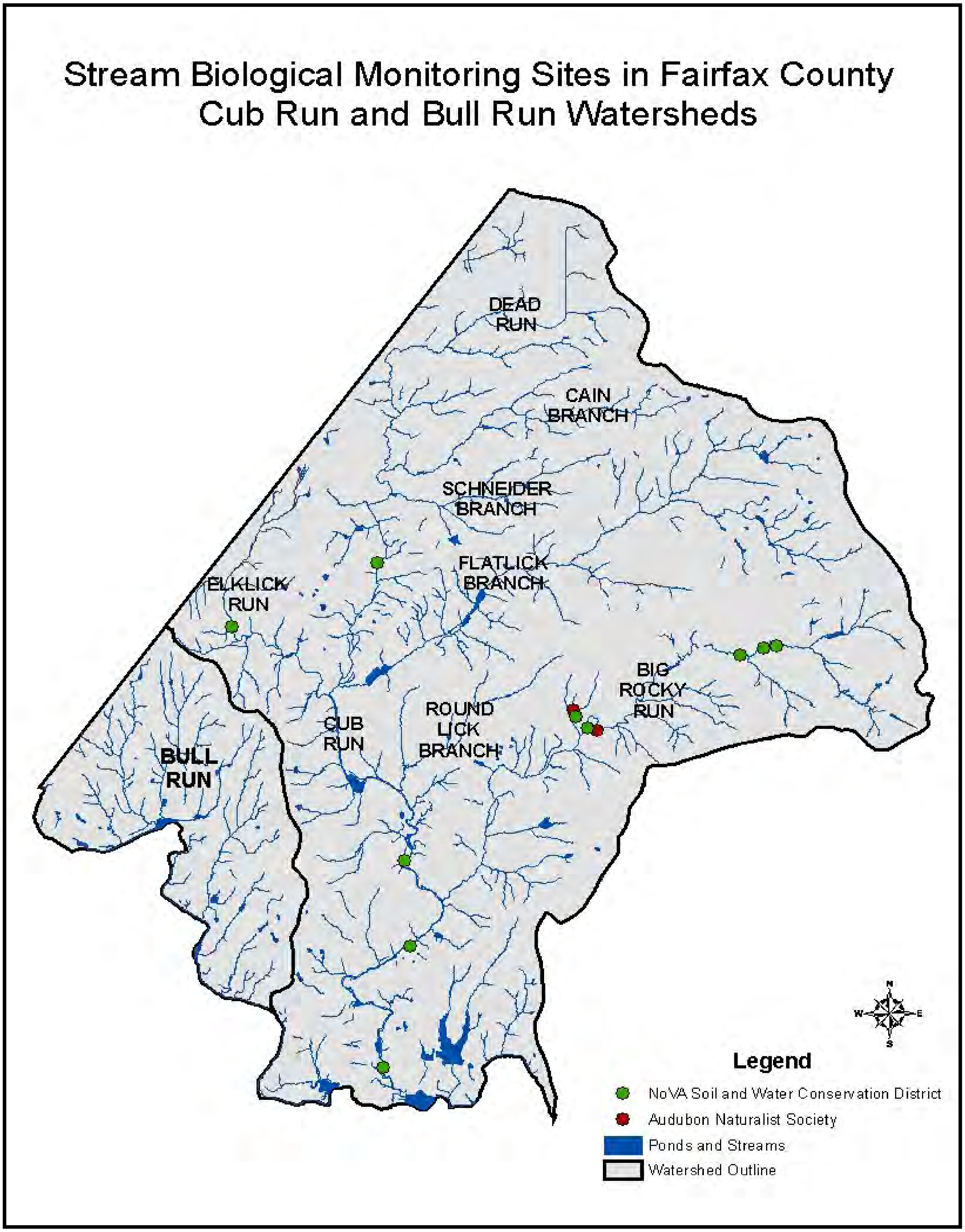


Figure 2-13
Volunteer Monitoring Sites in the
Cub Run and Bull Run Watersheds

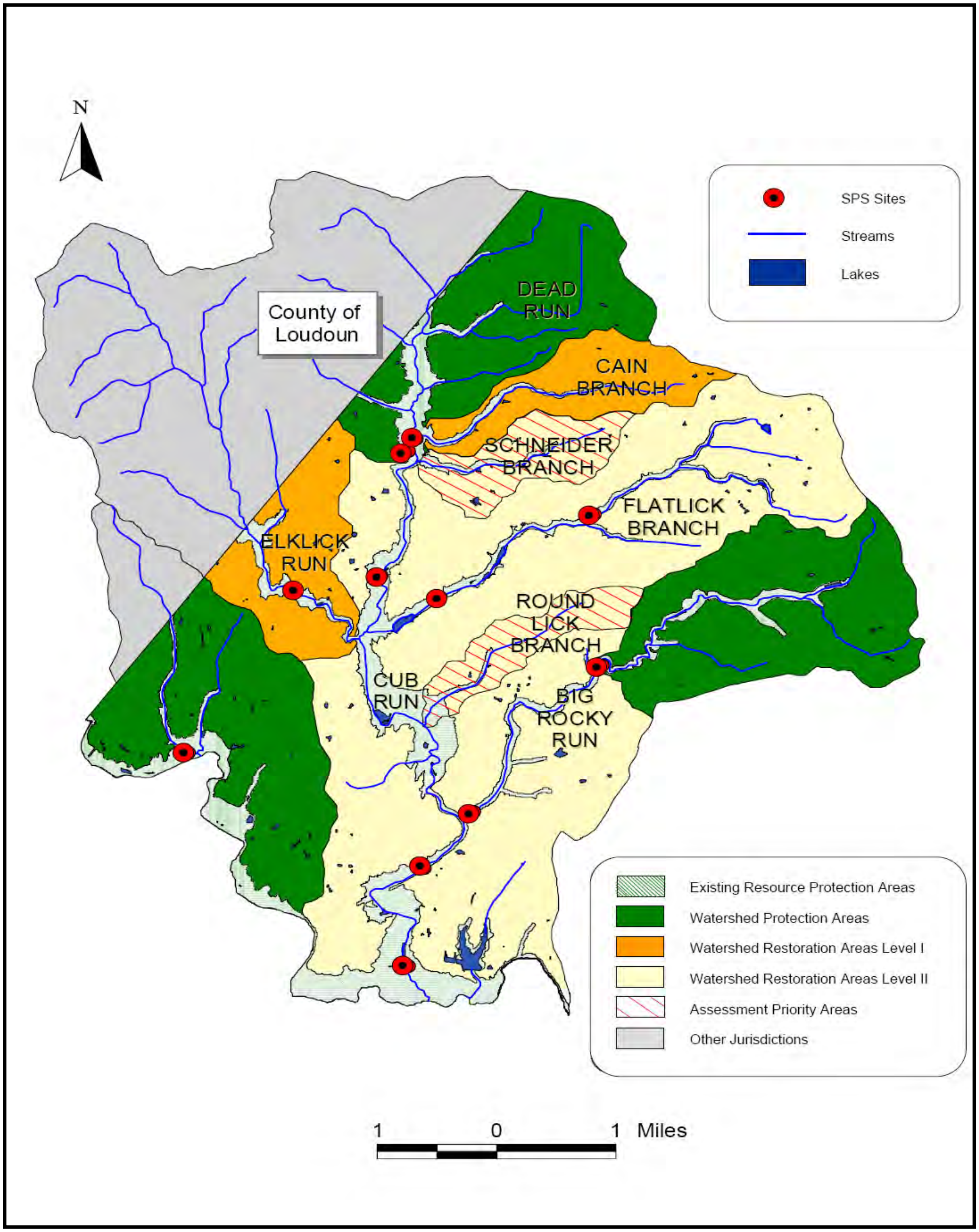


Figure 2-14
SPS Watershed Management Categories
in the Cub Run and Bull Run Watersheds

Sufficient data were not available to accurately classify Schneider Branch and Round Lick Branch stream segments for the SPS Baseline Study. These streams were subsequently surveyed in 2001 and categorized as Watershed Restoration Level II.

The remainder of the Cub Run watershed, including Schneider Branch, Flatlick Branch, Round Lick Branch and Cub Run South of Schneider Branch, falls within the Watershed Restoration Area Level II management category. As a result of this impaired designation, these areas need to be managed to prevent further watershed degradation. This management category's primary goal is to prevent further degradation and to improve water quality to comply with Chesapeake Bay initiatives, Total Maximum Daily Load regulations and other water quality standards.

The study establishes the framework for long-term stream quality assessments.

2.7.2 Water Quality

The following reports and summaries of sampling data provide information on the water quality in the Cub Run and Bull Run streams.

2.7.2.1 Water Quality Standards

All state waters, including wetlands, are designated for the following uses: recreation, e.g., swimming and boating; propagation and growth of a balanced, indigenous population of aquatic life, including game fish, which might reasonably be expected to inhabit them; wildlife; and production of edible and marketable natural resources, e.g., fish and shellfish.

To support this use, the Virginia Department of Environmental Quality (DEQ) provides standards for dissolved oxygen, pH, temperature and coliform bacteria for nontidal waters in the coastal plain and piedmont zones:

- Minimum Dissolved Oxygen: 4.0 mg/L
- Daily Average Dissolved Oxygen: 5.0 mg/L
- pH: 6.0 to 9.0
- Maximum Temperature: 32 °C (89.6 F)

The state does not provide an aquatic life standard for nitrate, but the public water supply standard is 10 mg/L.

Similarly, the state does not provide an aquatic life standard for phosphorus. However, 0.2 mg/l is used as a screening value to determine if a free flowing stream is impaired, and 0.05 mg/l is used to determine if a lake is impaired.

DEQ has established coliform bacteria criteria for all surface waters, except shellfish waters, as follows: "...the fecal coliform bacteria shall not exceed a geometric mean of 200 fecal coliform bacteria per 100 milliliter (ml) of water for two or more samples over a 30-day period, or a fecal coliform bacteria level of 1,000 per 100 ml at any time."

DEQ also establishes acute and chronic toxicity limits for various parameters. "Acute toxicity" means an adverse effect that usually occurs shortly after exposure to a pollutant. "Chronic toxicity" means an adverse effect that is irreversible or progressive, or occurs because the rate of injury is greater than the rate of repair during prolonged exposure to a pollutant. This includes low-level, long-term effects such as reduction in growth or reproduction.

Toxicity criteria for cadmium, copper, lead and zinc are a somewhat complex function of hardness with toxicity increasing with decreasing hardness. The acute and chronic toxicity concentrations at a total hardness of 100 mg/l as $CaCO_3$ (an approximate values for Cub Run streams) are as follows:

	Acute	**Chronic**
Cadmium	**3.9 ug/l**	**1.1 ug/l**
Copper	**13 ug/l**	**9.0 ug/l**
Lead	**120 ug/l**	**14 ug/l**
Zinc	**120 ug/l**	**120 ug/l**

2.7.2.2 Nutrients

Phosphorus and nitrogen - nutrients that support plant and algae growth - can produce algal blooms in reservoirs, lakes, estuaries and embayments. Because of the short residence times, these nutrients generally have little effect on conditions in streams and lakes within the Cub Run watershed. The nutrients (primarily phosphorus) that run off Cub Run and Bull Run watersheds affect water quality in the downstream Occoquan Reservoir with secondary impacts on the Potomac River estuaries and the Chesapeake Bay. Nutrients are the primary cause of water quality impairment, including algal blooms and “dead zones” with depleted oxygen concentrations in the Chesapeake Bay and its tributaries. It should be noted that the Occoquan Reservoir reduces the impact of Cub Run watershed nutrient loads on the Chesapeake Bay.

2.7.2.3 Sediment

Streams within the Cub Run and Bull Run watersheds carry high sediment loads during storm events. Increased sediment in streams has several detrimental effects. The sediment reduces the conveyance capacity of some stream segments, resulting in more frequent bank overflows. This condition is most pronounced in the lower reaches of Cub Run within Bull Run Regional Park. Sedimentation affects the storage capacity in lakes and stormwater ponds throughout the watershed. Many of these ponds will require dredging to preserve and restore their function. Sedimentation from Cub Run watershed also slowly fills the Occoquan Reservoir, reducing the storage capacity required to meet water needs during droughts. Finally, sediment deposition in the streams affects the stream habitat.

Stream sediment in urban watersheds comes primarily from two sources:

- Runoff from construction sites and other areas of disturbed land: Even with county and state erosion control requirements, construction can be a major contributor of sediment loading to the local streams while construction is ongoing. Sediment loading from construction sites can be very high, and properly designed sediment control practices typically achieve sediment removal efficiencies of 70 to 80 percent as documented in the Virginia Erosion and Sediment Control Handbook. Therefore, even properly designed and maintained construction sites contribute to stream sediment.

- Erosion of streambeds and banks: As streams deepen and widen in response to increased flows, the eroded soil is carried as sediment to downstream segments.

Instream or stream-bank erosion is likely to be the largest contributor of sediment to the Cub Run streams, particularly the main stem of Cub Run and downstream segments of major tributaries. Over the long term, natural equilibrium processes will eventually cause the streams to reach a stable cross-section, and the scouring of sediment loads will decline. Alternatively, stream restoration and stabilization projects can be used to reduce stream channel erosion and downstream sediment loads.

2.7.2.4 Accotink Creek Fecal Coliform Source Tracking

As described in the following sections, coliform bacteria concentrations frequently exceed water quality standards. The U.S. Geological Survey (USGS) is undertaking a statewide bacteria source tracking study to identify the origin of fecal coliform in Virginia streams.

The Accotink Creek watershed (upstream of Lake Accotink and downstream from Woodburn Road) in Fairfax County is one of three Virginia watersheds in the study. Along with other jurisdictions, Fairfax County has entered into a joint grant-match funding agreement with the USGS to fund portions of the cost for the study. The study commenced in April 1999 and is ongoing. Preliminary results from the bacteria-source tracking indicate that coliform bacteria in the streams can be traced to various human and animal sources as presented in Figure 2-15.

The objectives of this study include:

1. Demonstrating a multiple-tracer approach for tracking the sources of human fecal coliform bacteria observed in Accotink Creek

2. Identifying the distribution and sources of the human coliform bacteria within the Accotink Creek watershed by evaluating contributions from storm drains, stream tributaries and regions of diffuse subsurface flow into the creek

The study will be used when implementing the Total Maximum Daily Load for the impaired section of Accotink Creek.

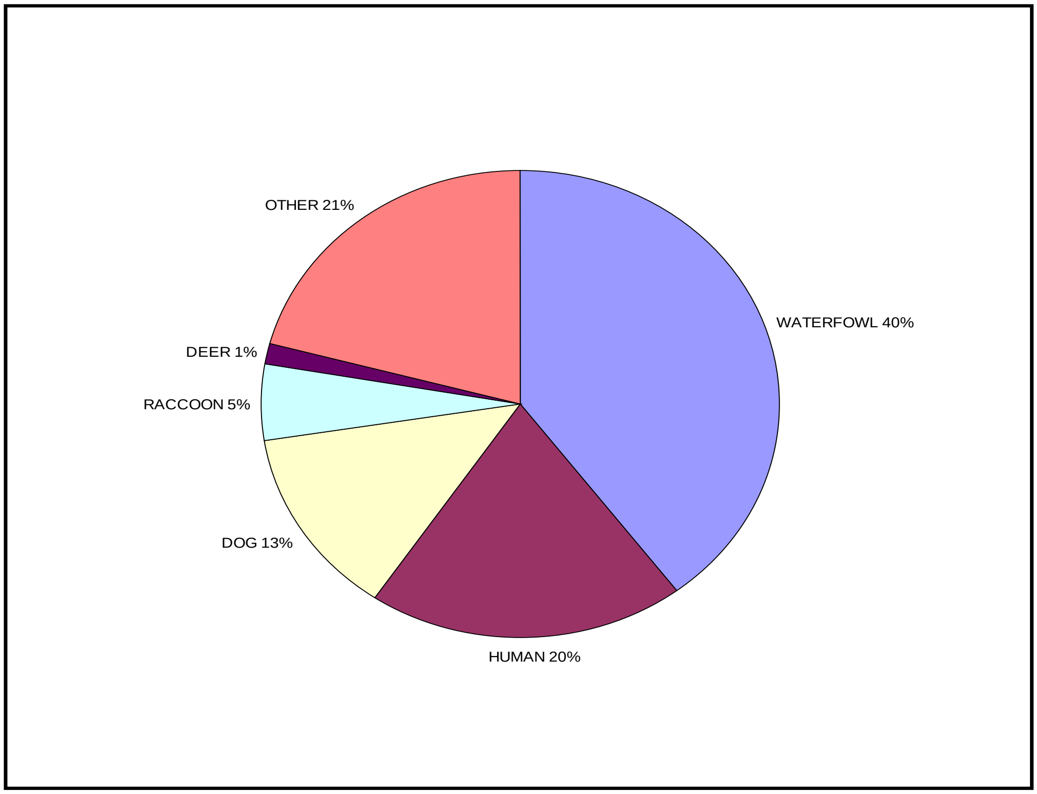


Figure 2-15
Summary of Coliform Distribution For Accotink Creek

2.7.2.5 Fairfax County Health Department Annual Stream Water Quality Data and Reports (2001 and 2002)

Fairfax County monitors stream water quality at 84 sampling locations within the county. The following parameters are monitored:

- Coliform bacteria
- Dissolved oxygen
- Nitrate nitrogen
- pH
- Total phosphorus
- Temperature
- Selected heavy metals

Data are available for 1986 through 2002. Summary reports are available for 1997 through 2003. The following presents the general findings regarding sampling performed in the Cub Run and Bull Run watersheds based on the 2001 and 2002 reports.

Water quality parameters are collected and measured at six locations in the Cub Run watershed and one location in the Bull Run watershed:

Station	Stream	Location
29-02	Big Rocky Run	Braddock Road
29-03	Cub Run	Braddock Road
29-04	Cub Run	Compton Road
29-05	Flatlick Branch	Lee Jackson Memorial Highway (Route 50)
29-06	Flatlick Branch	Braddock Road
29-08	Cub Run	Braddock Road
30-01	Bull Run	Lee Highway (Route 29). This sample is from Bull Run and includes the effects of areas upstream from Fairfax County

Summaries in the 2002 data summary report are presented in the following sections. This report can be obtained from the Fairfax County website (www.FairfaxCounty.gov) by searching for the report title (“Annual Stream Water Quality Report”).

Fecal coliform bacteria, while not necessarily harmful in themselves, are found in the intestinal tracts of warm-blooded animals, including humans, and therefore can indicate fecal contamination and the possible presence of pathogenic organisms. The Commonwealth of Virginia Department of Environmental Quality (DEQ) has established a criteria for all surface waters, except shellfish waters, as follows: “...the fecal coliform bacteria shall not exceed a geometric mean of 200 fecal coliform bacteria per 100 ml of water for two or more samples over a 30-day period, or a fecal coliform bacteria level of 1,000 per 100 ml at any time.” In the following discussions, the geometric mean for the sampling period is compared to the 200 per 100 ml DEQ criteria. Also, the number of samples greater than 200 are indicated. This does not necessarily mean that the fecal coliform limit is exceeded due to the 30-day criterion. However, if the geometric mean is significantly greater than 200 or a large number of samples are greater than 200, it is possible the water quality exceeded this criterion during the sampling program.

Table 2-1 presents the number of fecal coliform samples within the identified ranges at the monitoring locations for the 2002 calendar year. This summary shows that the fecal coliform concentrations regularly exceed the 200 colonies/100 ml mean and 1,000 colonies/100 ml maximum state criteria.

Table 2-2 presents geometric means of the fecal coliform concentrations at each sampling location for calendar years 1997 through 2002. The averages for 2002 are between 379 and 747 colonies per 100 ml. The geometric means for all stations for all years exceeds 200 per 100 ml. The annual variations are affected by rainfall and sampling dates, and likely do not reflect coliform concentration trends.

Table 2-1
Summary of 2002 Coliform Data

Station	Number of Samples		
	<200 / 100 ml	**200 – 1,000 / 100 ml**	**>1,000 / 100 ml ***
Cub Run			
29-02	3	10	2
29-03	5	7	4
29-04	4	10	2
29-05	6	5	5
29-06	3	12	2
29-08	3	6	5
Total Cub Run	24	50	49
Bull Run			
30-01	2	6	8

* *Individual samples with concentrations greater than 1,000 per 100 ml exceed the state criteria.*

Table 2-2
Summary of Geometric Mean of Coliform Data 1997 – 2002

Station	Coliform Geometric Mean (#/100 ml) for Calendar Year *					
	1997	**1998**	**1999**	**2000**	**2001**	**2002**
29-02	754	511	421	348	660	478
29-03	760	626	646	528	679	379
29-04	662	484	458	349	695	439
29-05	840	981	670	372	699	455
29-06	641	577	692	374	628	440
29-08	527	500	446	390	679	568
30-01	527	419	698	339	676	747

* *All sites exceed the 200 per 100 ml mean coliform bacteria state criteria, suggesting the criteria may possibly be exceeded*

The coliform concentrations in the Cub Run watershed are similar to those found in many of the county's other watersheds and elsewhere with similar development densities.

Table 2-3 presents average annual concentrations for various sampled water quality parameters for 2002.

The station on Cub Run at Braddock Road (29-03) has one sample where the dissolved oxygen was less that 4 mg/l. This suggests that on occasions the dissolved oxygen concentrations reach low levels that may affect the health of the streams.

The station on Flatlick Branch at Route 50 (29-05) has nitrate concentrations that are 50 percent greater than the other stations in the watershed. This trend of high nitrate concentrations is not reflected at downstream station 29-06 but is consistent for both 2001 and 2002. The nitrate concentrations are significantly less than the 10 mg/l drinking water standard.

The total phosphorus concentrations are consistently less than 0.2 mg/l concentration used as a screening value for impaired free flowing stream but may exceed 0.05 mg/l used to determine if a lake is potentially impaired.

Table 2-3
Summary of Water Quality Data for Calendar Year 2002

	Average of Samples for Calendar Year 2002			
Station	**Dissolved Oxygen (mg/l) ***	**Nitrate Nitrogen (mg/l)**	**pH**	**Total Phosphorus (mg/l) ****
29-02	8.5	0.6	7.5	0.1
29-03	8.7	0.8	7.6	0.1
29-04	9.2	0.8	7.8	0.1
29-05	8.6	1.2	6.9	0.1
29-06	8.1	0.8	7.4	0.1
29-08	8.9	0.8	7.6	0.1
30-01	8.9	0.9	7.5	0.1

** Station 29-03 had one of the 16 samples where the dissolved oxygen concentration was less than 4.0 mg/l. Dissolved oxygen concentration samples for all other stations were greater than 4.0 mg/l.*
*** - Detection limit of procedure used to analyze water samples for total phosphorus is 0.1 mg/l All samples are below this detection limit.*

Sampling data for heavy metals fall within acceptable ranges.

Other than the cases identified above, none of these water quality sampling data show exceptionally high or low values that would identify conditions upstream from the monitoring stations that cause degraded water quality.

2.7.2.6 Final Report: Quantifying NPS Pollutant Discharges from an Urbanizing Headwater Basin

This section summarizes the report titled "Final Report: Quantifying Nonpoint Source (NPS) Pollutant Discharges from an Urbanizing Headwater Basin" (Dougherty, September 2003). This study was completed at Virginia Tech under the grant from the Virginia Water Resource Research Center.

This report summarizes long-term discharge and water quality data for four headwater subwatersheds in the Occoquan Reservoir watershed. Three of the subwatersheds - Cedar Run, Upper Bull Run and Upper Broad Run - are predominantly forest and mixed agriculture. The fourth watershed, Cub Run, is rapidly urbanizing, with 50 percent of the watershed classified as urban. The basins do not have any point discharges from wastewater treatment plants or other facilities. Therefore, the observed concentrations result entirely from nonpoint sources.

The four watersheds have different land use characteristics. The following documents the percent of the watershed area covered by forest, agricultural land and urban development:

Watershed	Forest	Agriculture	Urban
Cub Run	47%	16%	37%
Cedar Run	47%	48%	5%
Upper Bull Run	49%	37%	14%
Upper Broad Run	48%	48%	4%

Cedar Run and Upper Broad Run have similar land use. Upper Bull Run has somewhat more urban land use. Cub Run has the greatest area of urban land use.

Table 2-4 summarizes land use and land cover estimates for the Cub Run watershed from available mapping from 1990 though 2000.

Over this period non-urban open land decreased from 79 percent of the watershed area to 49.3 percent. Townhouse and medium-density residential land uses increased the most during this period.

Table 2-4
Cub Run Watershed Land Use Summaries
Percent of Total Watershed Area

Land Use Category	1980	1985	1990	1995	2000
1 - Forest and Idle Land	52.0%	46.1%	45.6%	48.7%	45.0%
2 - Mixed Minimum Till and Pasture	22.0%	17.4%	12.7%	3.1%	1.8%
3 - Mixed Convention Till and Livestock	5.0%	4.1%	3.1%	2.7%	2.5%
4 - Disturbed Land and Roads	5.2%	2.2%	4.2%	2.8%	1.3%
5 - Industrial, Commercial, and Institutional	7.2%	11.4%	12.3%	16.0%	18.2%
6 - Townhouse and Medium Density Residential	5.9%	15.3%	18.5%	21.1%	24.8%
7 - Low Density Residential and Golf Courses	2.7%	3.5%	3.6%	5.5%	6.4%
8 - Urban Subtotal	21%	32.4%	38.5%	45.4%	50.7%
9 - Non-Urban Subtotal	79%	67.6%	61.5%	54.6%	49.3%

Includes Loudoun County portions of Cub Run watershed but does not include Bull Run portions of the project study area.

The report documents the total population in the Cub Run watershed for the years 1980, 1990 and 2000, as shown below. The population increase is between 7,500 and 8,000 persons per year. The population in 2000 was nearly five times the population in 1980. The total watershed 2000 population density was about 1,900 persons per square mile or 2.9 persons per acre:

- 1980 20,360
- 1990 58,036
- 2000 98,119

The report also documents impervious area increases over this period. Impervious land cover refers to the surface area of rooftops, streets, parking lots, driveways and sidewalks. Impervious area increases the total runoff and peak runoff from the land surface, and reduces infiltration into the soil and groundwater. Impervious area is a direct measure of the development in the watershed. Impervious cover for the Cub Run watershed is estimated below:

- 1980 6.7%
- 1985 9.3%
- 1990 13.1%
- 1995 15.8%
- 2000 17.8%

Impervious area has increased linearly over this period. Over the last 20 years the total impervious area of the Cub Run watershed has increased from 6 percent in 1980 to 18 percent by 2000, while the three other undeveloped watersheds have remained at a constant two percent impervious area.

Table 2-5 documents the mean annual discharge from the four subwatersheds during both storm and non-storm events. The highest runoff values in inches are shown in bold. Cub Run has the highest storm flow and total flow when expressed in inches of runoff over the watershed.

Table 2-5
Mean Annual Storm and Non-Storm Discharge - 1979-2002

	Cub Run Watershed (49 sq. mi.)	**Cedar Run Watershed (154 sq. mi.)**	**Upper Bull Run Watershed (26 sq. mi.)**	**Upper Broad Run Watershed (50 sq. mi.)**
Non-storm flow	27.0 cfs 7.48 inches	84.2 cfs 7.44 inches	13.9 cfs 7.28 inches	33.6 cfs **9.02 inches**
Storm flow	27.3 cfs **7.56 inches**	67.7 cfs 5.98 inches	11.9 cfs 6.26 inches	16.8 cfs 4.53 inches
Total flow	54.3 cfs **15.04 inches**	151.9 cfs 13.42 inches	25.8 cfs 13.54 inches	50.4 cfs 13.54 inches

Discharge means calculated using 21 years of data (1979, 1980, 1982 excluded)

The flow data suggests that the increased imperious cover has caused the mean annual discharge of the Cub Run watershed to be greater than undeveloped watersheds of comparable size. The impervious area has also increased storm runoff and reduced groundwater infiltration. As a result, the mean annual flow volume during storm events is greater than the base flow that occurs between events.

Tables 2-6 and 2-7 document mean annual pollutant concentrations and loads for the four subwatersheds studied. The study analyzed about 24 years of rainfall, flow and water quality data collected by the Occoquan Reservoir Monitoring Laboratory (OWML). The study focused on measurements of total suspended solids (TSS), dissolved and particulate nitrogen, and phosphorus.

Table 2-6 presents concentrations for non-storm and storm flows. The highest concentrations for the four watersheds are in bold. Of all the parameters, Cub Run has the highest concentrations for storm flow TSS only. The values in the other basins may be affected by the agricultural land uses in these watersheds.

Table 2-6
Mean Annual Storm and Non-Storm Pollutant Concentrations, 1979-2002

	Cub Run (49 sq. mi.)	**Cedar Run (154 sq. mi.)**	**Upper Bull Run (26 sq. mi.)**	**Upper Broad Run (50 sq. mi.)**
Non-Storm Flow				
TSS (mg/l)	5.48	4.27	4.05	**8.13**
Particulate P (mg/l)	0.013	0.012	0.010	**0.020**
Dissolved P* (mg/l)	0.032	**0.043**	0.019	0.021
Particulate N (mg/l)	0.076	0.077	0.074	**0.091**
Dissolved N** (mg/l)	0.982	**1.02**	0.616	0.811
Storm Flow				
TSS (mg/l)	**195**	108	163	113
Particulate P (mg/l)	0.197	0.167	0.203	**0.205**
Dissolved P* (mg/l)	0.057	**0.102**	0.061	0.051
Particulate N (mg/l)	0.727	0.629	**0.822**	0.623
Dissolved N** (mg/l)	1.16	1.58	1.16	**1.22**

Calculated using 21 years of data (1979, 1980, 1982 excluded)
**Directly measured as total soluble phosphorus*
*** Indirectly measured as the sum of Kjeldahl nitrogen and oxidized nitrogen*

The storm flow pollutant and sediment loads are generally proportional to total subwatershed drainage area. The only exception is the Cub Run watershed where storm flow TSS and nutrient loads were significantly higher than the similarly sized but lightly developed Upper Broad Run watershed. During non-storm events (dry periods), the opposite was true with Upper Broad Run producing significantly higher TSS than Cub Run.

According to this report, one explanation for these results is the “first flush effect” of impervious surface. As the amount of impervious surface increases in a watershed, pollutant and sediment loads are more easily washed away during storm events, resulting in higher storm event and overall pollutant loads. With higher sediment and nutrient loads leaving the watershed during storm events, less sediment and fewer pollutants leave the watershed during dry periods.

Table 2-7 presents total annual loads in tons per year and pounds per acre per year. These load estimates combine the runoff concentrations and volumes. The watersheds with the largest pollutant load per acre have bold text. Cub Run has the highest TSS, total phosphorus and total nitrogen annual loading rates per acre and the second highest rates for the other parameters.

Table 2-7
Mean Total Annual Pollutant Loads 1979-2002

	Cub Run (49 sq. mi.)	**Cedar Run (154 sq. mi.)**	**Upper Bull Run (26 sq. mi.)**	**Upper Broad Run (50 sq. mi.)**
Total flow				
TSS Tons Pounds per acre	7,031 **448.0**	10,069 204.8	3,022 365.0	3,384 209.0
Particulate P Tons Pounds per acre	6.3 0.40	13.7 0.28	3.5 **0.43**	5.9 0.37
Dissolved P* Tons Pounds per acre	2.5 0.16	11.0 **0.22**	1.0 0.13	1.8 0.11
Total P Tons Pounds per acre	8.8 **0.56**	24.7 0.50	4.6 0.55	7.7 0.48
Particulate N Tons Pounds per acre	21.6 1.37	47.9 0.97	13.8 **1.67**	17.0 1.05
Dissolved N** Tons Pounds per acre	62.0 3.95	198.7 **4.04**	24.3 2.94	51.3 3.17
Total N Tons Pounds per acre	83.6 **5.33**	246.6 5.01	38.1 4.61	68.3 4.22

Calculated using 21 years of data (1979, 1980, 1982 excluded)
Includes combined storm and non-storm loads
**Directly measured as total soluble phosphorus*
*** Indirectly measured as the sum of Kjeldahl nitrogen and oxidized nitrogen*

The report discussion includes the following observations:

- Cub Run exhibits higher unit runoff rates compared to the other basins.
- The increased discharge is mainly from stormwater runoff.
- Discharges were most responsive to increased rainfall and urbanization during winter and spring.
- Nonpoint source loading rates (mass per unit area) from the Cub Run basin exceed the other basins for total suspended solids, phosphorus and nitrogen. The years

that these loadings from the Cub Run watershed became the highest compared to the other three basins are summarized below:

- Total Suspended Solids – 1983
- Total Phosphorus – 1986
- Total Nitrogen – 1990

Presumably, these higher annual loading rates are caused by the urban development that has occurred within the Cub Run watershed.

2.7.2.7 OWML Monitoring Station Water Quality Data

Virginia Tech's Occoquan Watershed Monitoring Laboratory (OWML) maintains a flow and water quality station (ST50) located on Cub Run at the Compton Road bridge. The station measures the flows and water quality from 49 square miles of the Cub Run watershed. Data from this station were used in the analyses in the report described in Section 2.9.2.5 that summarizes the flows and nutrient concentrations for storm and non-storm events.

Data from this monitoring station were reviewed to provide the following summaries of water quality as listed in Table 2-8. These summaries are computed from 13 years of flow data from January 1990 through December 2003

OWML monitors base flow, or dry weather flow, water quality conditions approximately once a week. The dataset includes 523 samples. However, all parameters were not measured for all samples. Table 2-8 presents average, median, maximum and minimum concentrations for all sampled parameters. The reported maximum and minimum are the values exceeded two percent and 98 percent of the time to exclude extreme outliers and erroneous values.

OWML also takes composite samples during storm events. Table 2-9 presents flow weighted average concentrations, and the maximum and minimum concentrations for all sampled parameters. The reported maximum and minimum are the values exceeded two percent and 98 percent of the time to exclude extreme outliers and erroneous values. The dataset includes 318 sampled storm events. However, all parameters are not measured for all samples.

Table 2-8
Summary of Base Flow Samples for OWML Station ST50
Located on Cub Run at Compton Road

Parameter	Average	Median	Maximum	Minimum
Dissolved Oxygen (mg/L)*	9.8	9.3	14.8	5
pH	7.5	7.5	8.1	7.0
Temperature (Degrees C)	16.3	17.5	27	0
Conductivity at 25 deg C	334	315	704	190
Total Alkalinity (mg/l as CaCO3)	85.3	85.7	129.6	45.9
Total Hardness (mg/l as CaCO3)	126.1	125	210	71.9
Orthophosphate Phosphorus (mg/l as P)	0.02	0.02	0.06	0.01
Total Soluble Phosphorus (mg/l as P)	0.04	0.03	0.08	0.01
Total Phosphorus (mg/l as N)	0.05	0.04	0.12	0.01
Ammonia Nitrogen (mg/l as P)	0.04	0.03	0.17	0.01
Soluble Kjeldahl Nitrogen (mg/l)	0.37	0.35	0.77	0.14
Total Kjeldahl Nitrogen (mg/l)	0.42	0.38	0.95	0.16
Oxidized Nitrogen (mg/l as N)	0.66	0.59	1.66	0.04
Chemical Oxygen Demand (mg/l)	12.72	11.95	22.6	7.3
Turbidity (NTU)	10.1	6.8	36.3	1.9
Total Suspended Solids (mg/l)	5.8	3.6	28	1.2
Soluble Calcium (mg/l)	31.9	31.0	56.2	19.5
Extractable Copper (ug/l)	4.6	3.3	15.3	2.1
Soluble Copper (ug/l)	4.3	2.9	12	2.0
Soluble Potassium (mg/l)	4.0	3.6	9.9	2.8
Soluble Magnesium (mg/l)	10.3	10.2	16.7	5.8
Soluble Sodium (mg/l)	30.4	24.2	85.2	14.9
Extractable Lead (ug/l) 7 samples	12.9	7.7	47.1	3.0
Extractable Zinc (ug/l)	25.6	19.5	77.5	14.5
Soluble Zinc (ug/l) 7 samples	21.7	20	33.9	15.1

** 95 percent of the dissolved oxygen values are greater than 6.8 mg/l*
Computed from samples for 1990 through 2003
To exclude outliers and potentially erroneous values, maximum is value exceeded 2% of the time and minimum is value exceeded 98% of the time.

Table 2-9
Summary of Wet Weather Flow Samples for OWML Station ST50
Located on Cub Run at Compton Road

Parameter	Average	Maximum	Minimum
Temperature (Degrees C)	6.6	18.6	3.3
Conductivity at 25 deg C	203.5	661	99.8
Total Hardness (mg/l as CaCO3)	58.1	165.6	34.9
Orthophosphate Phosphorus (mg/l as P)	0.04	0.11	0.01
Total Soluble Phosphorus (mg/l as P)	0.06	0.11	0.02
Total Phosphorus (mg/l as P)	0.24	0.57	0.06
Ammonia Nitrogen (mg/l as N)	0.05	0.48	0.01
Soluble Kjeldahl Nitrogen (mg/l)	0.57	1.15	0.37
Total Kjeldahl Nitrogen (mg/l)	1.24	3.02	0.6
Oxidized Nitrogen (mg/l as N)	0.57	1.48	0.17
COD (mg/l)	30.5	61.2	16.5
Turbidity (NTU)	154.4	330	28.7
Total Suspended Solids (mg/l)	210	557	29.3
Soluble Calcium (mg/l)	14.3	29.9	5.6
Extractable Copper (ug/l)	25.7	124.1	8.2
Soluble Copper (ug/l)	11.1	26.5	3.5
Soluble Potassium (mg/l)	3.5	5.5	2.5
Soluble Magnesium (mg/l)	4.4	9.1	2.1
Soluble Sodium (mg/l)	19.3	69.4	5.7
Extractable Lead (ug/l)	7.0	12.5	3.3
Soluble Lead (ug/l) 2 Samples	3.6	4.1	3.1
Extractable Zinc (ug/l)	74.1	254	34.0
Soluble Zinc (ug/l)	31.3	79.8	14.0

Computed from samples for 1990 through 2003
To exclude outliers and potentially erroneous values, maximum is value exceeded 2% of the time and minimum is value exceeded 98% of the time.

2.7.2.8 Virginia DEQ Water Quality Data

The Commonwealth of Virginia DEQ samples water quality at 12 locations within the Cub Run watershed:

- Cub Run at Compton Road – 28 Samples
- Cub Run at Route 29 – 103 Samples
- Cub Run at Old Lee Road – 13 Samples
- Cub Run at Route 50 - Two Samples
- Elklick Run at Pleasant Valley Road – 17 Samples
- Flatlick Branch Downstream From Braddock Road - Two Samples
- Flatlick Branch at Braddock Road - Three Samples
- Flatlick Branch at Route 28 – One Sample
- Flatlick Branch at Walney Road – One Sample
- Flatlick Branch at Lees Corner Road – One Sample
- Big Rocky Run at Route 29 – 43 Samples - All Data Prior to 1980
- Big Rocky Run Stringfellow Road – Three Samples

The available water quality data for the four stations that have more than three visits and samples from 1990 to 2005 are summarized in Tables 2-10 through 2-13. Most of the stations have data starting in 2000 with roughly three visits per year. Some stations have data from the 1990s that were included in the summaries. Data prior to 1990 were not included since they do no represent current conditions.

All the parameters fall within expected ranges. Other than fecal coliform, none of the measured parameters exceed state criteria. The geometric means are less than the state criteria of 200 colonies per 100 ml at all stations except Cub Run at Route 29. The Elklick Run at Pleasant Valley Road station has the lowest average coliform bacteria concentrations. No significant differences are observed between the average values for the phosphorus concentrations between these four stations. Total nitrogen concentrations (computed by summing nitrite, nitrate, and total Kjeldahl nitrogen) for the stations at Old Lee Road are lower (0.87 mg/l) compared to the other three stations (1.1 – 1.3 mg/l).

Table 2-10
Summary of Water Quality Data for
Virginia Department of Environmental Quality Station
Located on Cub Run at Compton Road (1ACUB002.61)

Parameter	Average	Maximum	Minimum	Number of Observations
Turbidity (FTU)	5.9	17.9	2.9	9
Specific Conductance (UMHOS/CM @ 25C)	469	1074	252	11
Total Nitrogen (mg/l as N)	1.3	1.8	0.73	13
Ammonia Nitrogen (mg/l as N)	< 0.04	0.09	< 0.04	18
Nitrite Nitrogen (mg/l as N)	0.02	0.08	< 0.01	11
Nitrate Nitrogen (mg/l as N)	0.74	2.11	0.04	11
Total Kjeldahl Nitrogen (mg/l as N)	0.5	0.8	0.3	11
Total Dissolved Nitrogen (mg/l as N)	1.140	1.456	0.659	7
Particulate Nitrogen (mg/l as N)	0.043	0.086	< 0.01	7
Total Phosphorus (mg/l as P)	0.05	0.09	0.02	25
Orthophosphate Phosphorus (mg/l as P)	0.03	0.06	< 0.02	18
Total Dissolved Phosphorus (mg/l as P)	0.032	0.054	0.007	7
Particulate Phosphorus (mg/l as P)	0.015	0.0244	0.008	7
Total Hardness (mg/l as CaCO3)	125.5	195	81.6	11
Fecal Coliform (Number per 100 ml) *	148.9	> 2,000	< 25	27
Enterococci (Number per 100 ml) *	142.2	> 800	10	0
TSS (mg/l)	252.8	425	170	11

** - Geometric mean is reported for the average for bacteria.*

Table 2-11
Summary of Water Quality Data for
Virginia Department of Environmental Quality Station
Located on Cub Run at Route 29 (1ACUB003.74)

Parameter	Average	Maximum	Minimum	Number of Observations
Turbidity (FTU)	13.1	77	2.4	32
Specific Conductance (UMHOS/CM @ 25C)	361	1893	74.9	47
Ammonia Nitrogen (mg/l as N)	< 0.04	0.13	< 0.04	46
Nitrite Nitrogen (mg/l as N)	0.02	0.05	< 0.01	46
Nitrate Nitrogen (mg/l as N)	0.52	1.65	< 0.04	46
Total Kjeldahl Nitrogen (mg/l as N)	0.6	1.2	0.3	46
Total Phosphorus (mg/l as P)	0.05	0.1	0.02	46
Orthophosphate Phosphorus (mg/l as P)	0.03	0.12	< 0.02	39
Total Hardness (mg/l as CaCO3)	108.6	200	18.6	44
Fecal Coliform (Number per 100 ml) *	243.3	2100	< 100	41
TSS (mg/l)	209.4	464	49	47
5-Day BOD (mg/l)	< 2	18	< 2	47
COD (mg/l)	16.4	26	9	33
pH	7.2	8.16	5.8	47

** - Geometric mean is reported for the average for bacteria.*

Table 2-12
Summary of Water Quality Data for
Virginia Department of Environmental Quality Station
Located on Cub Run at Old Lee Road (1ACUB008.60)

Parameter	Average	Maximum	Minimum	Number of Observations
Turbidity (FTU)	6.0	21.1	1.05	9
Specific Conductance (UMHOS/CM @ 25C)	387	732	1.9	12
Ammonia Nitrogen (mg/l as N)	< 0.04	0.81	< 0.04	14
Nitrite Nitrogen (mg/l as N)	0.02	0.14	< 0.01	14
Nitrate Nitrogen (mg/l as N)	0.35	1.37	< 0.04	14
Total Kjeldahl Nitrogen (mg/l as N)	0.5	2.6	0.1	14
Total Phosphorus (mg/l as P)	0.04	0.13	< 0.01	14
Orthophosphate Phosphorus (mg/l as P)	0.03	0.06	< 0.02	12
Total Hardness (mg/l as CaCO3)	117.3	211	5	12
Fecal Coliform (Number per 100 ml) *	192.3	> 8000	< 100	12
TSS (mg/l)	239.9	408	5	14

** - Geometric mean is reported for the average for bacteria.*

Table 2-13
Summary of Water Quality Data for
Virginia Department of Environmental Quality Station
Located on Elklick Run at Pleasant Valley Road (1AELC001.39)

Parameter	Average	Maximum	Minimum	Number of Observations
Turbidity (FTU)	8.8	25.8	1.1	9
Specific Conductance (UMHOS/CM @ 25C)	425	771	2.31	12
Total Nitrogen (mg/l as N)	1.8	2.44	1.43	5
Ammonia Nitrogen (mg/l as N)	< 0.04	0.12	< 0.04	17
Nitrite Nitrogen (mg/l as N)	0.02	0.04	< 0.01	12
Nitrate Nitrogen (mg/l as N)	0.68	2.15	0.04	12
Total Kjeldahl Nitrogen (mg/l as N)	0.5	0.9	0.1	12
Total Phosphorus (mg/l as P)	0.04	0.08	0.01	17
Orthophosphate Phosphorus (mg/l as P)	0.02	0.05	< 0.02	12
Total Hardness (mg/l as CaCO3)	186.5	305	83.4	12
Fecal Coliform (Number per 100 ml) *	109.9	> 2000	< 25	14
E. Coli (Number per 100 ml) *	228.0	> 2000	< 25	5
TSS (mg/l)	282.3	505	5	12

** - Geometric mean is reported for the average for bacteria.*

2.7.3 Soils and Geology

The underlying geology and soil conditions affect the health of the streams and their susceptibility to erosion.

2.7.3.1 Generalized Geology

Fairfax County is within three geologic provinces:

- The eastern part (east of I-95) is underlain by unconsolidated sediments of the Coastal Plain Province.
- The central part is underlain by crystalline metamorphic and igneous rocks of the Piedmont Province.
- The western part is underlain by sedimentary and crystalline rocks of the Triassic Basin Province, which is a subprovince of the Piedmont Upland.

The Cub Run watershed is mostly in the Triassic Basin Province. The tip of the watershed near Fair Oaks area east of the Fairfax County Parkway (Route 7100) and south of Route 50 is in the Piedmont Province.

The location of these provinces is shown in Figure 2-16. Portions of the watershed in Loudoun County are also in the Triassic Basin Province.

The two provinces that occur within the Cub Run and Bull Run watersheds are further described below.

Piedmont Province

The Piedmont Province occupies approximately 56 percent of Fairfax County. It is in the central portion of the county, west of the Coastal Plain. The province is underlain by metamorphic rocks, predominantly schist, granite, gneiss and greenstone. A well-dissected, dendritic drainage pattern occurs throughout the province. The hilltops are typically wide and rolling, except in places along the lower tributaries of large streams where V-shaped valleys with steep slopes and narrow ridge tops occur.

Triassic Basin Province

The Triassic Basin Province occurs in western Fairfax County. Most of the Cub Run and Bull Run watersheds is in this province. The geology consists largely of red sedimentary rocks, including sandstone, siltstone, shale and conglomerate.

A horseshoe-shaped intrusion of igneous diabase, diorite and syenite rocks occurs near Centreville (Figure 2-16). Igneous intrusion refers to volcanic rock that intruded into the surrounding sedimentary rock now exposed at or near the land surface.

Within the Triassic Basin Province the drainage is somewhat dendritic but not as well developed as in the Piedmont Upland. The hilltops are wide and gently rolling, with long gently sloping side slopes and nearly level areas. In Cub Run, areas near Dulles

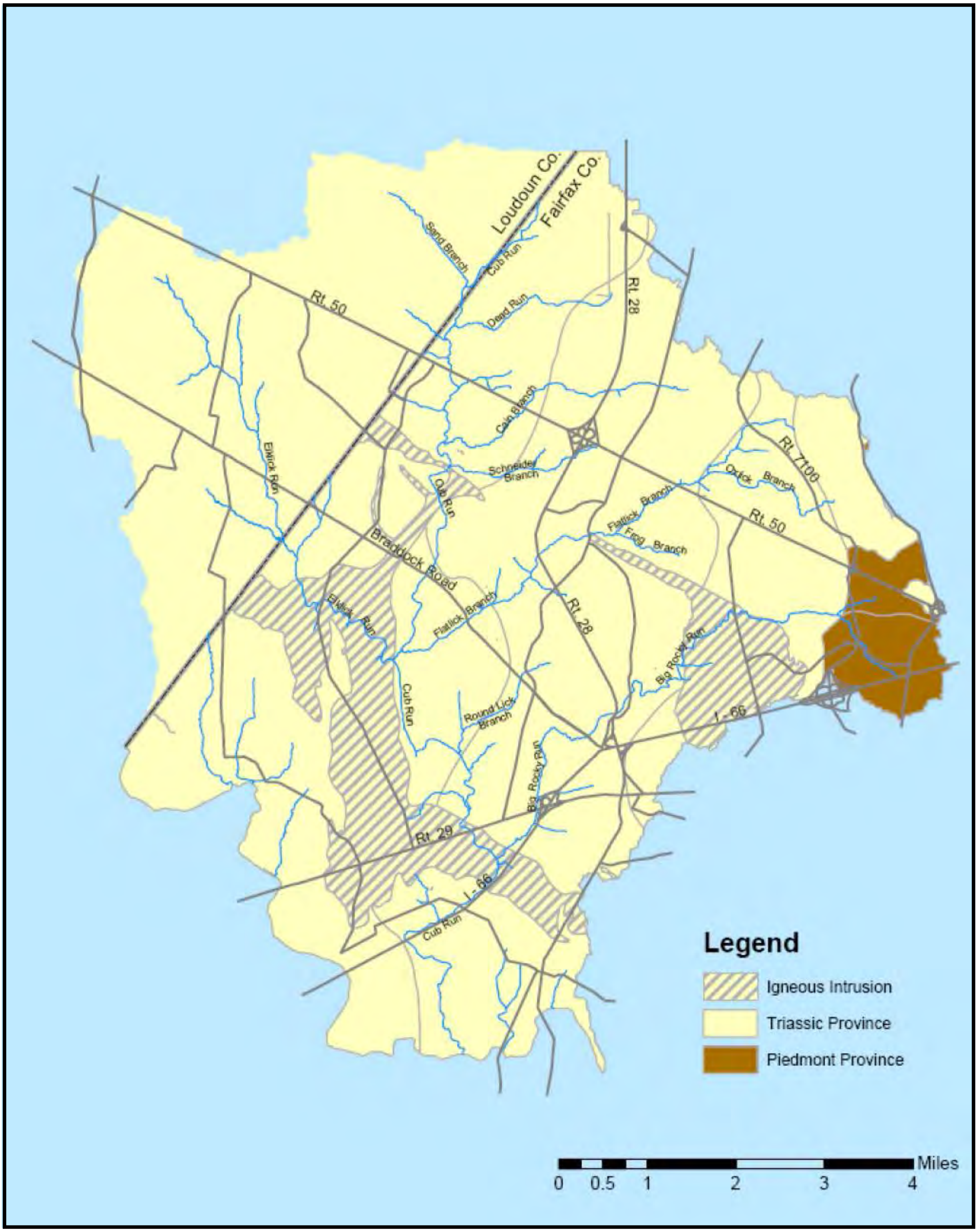


Figure 2-16
Generalized Geology of the
Cub Run and Bull Run Watersheds

International Airport are flat with shallow stream valleys. The topography becomes steeper towards the south.

2.7.3.2 Soils

Soils are formed from the weathering of the underlying bedrock. The soil's physical and engineering properties are largely determined by the rock from which they are derived. Areas underlain by shale are silty to clayey soils. Soils underlain by sandstones are silty and loamy soils. Soils over the igneous bedrock have a plastic clay layer. Soils in the Piedmont Province tend to be better drained.

Soils in the watershed have low infiltration rates for the most part. The soils are classified into hydrologic soil groups based on their infiltration characteristics. The groups range from A to D, with A having the highest infiltration rates and D having the lowest. Soil group A produces less runoff rates than D soils. Stormwater management facilities (e.g., biofiltration for low-impact development) that rely on infiltration will not work well in areas with D soils.

Figure 2-17 shows the hydrologic soil group classifications for the soils in the watershed. The distribution of hydrologic soil groups is as follows:

- Soils in the upland areas of Piedmont Province of the watershed tend to have B soils with moderately high infiltration rates.
- The soils between the Piedmont Province and the Cub Run main stem channel have a mix of B and C soils. The fraction of C soils increases from east to west across this portion of the watershed.
- Soils over the igneous intrusion have D soils. More than half of this area is within the R-C District (5-acre residential lots).
- Soils in much of Loudoun County are D soils.
- The breakdown of hydrologic soil groups for the entire study area is as follows:

  A – 0%
  B – 16%
  C – 50%
  D – 34%

2.7.3.3 Impact of Geology and Soils on Stream Conditions

The underlying geology and soil properties influence the condition of the streams in the watershed.

Big Rocky Run's name is appropriate. Upstream from Route 28, much of the streambed contains rocks of various sizes. The bedrock exposed in this watershed is red sandstone of the Triassic Basin Province. Similar conditions can be seen in Frog Branch and the Bull Run East subwatershed streams.

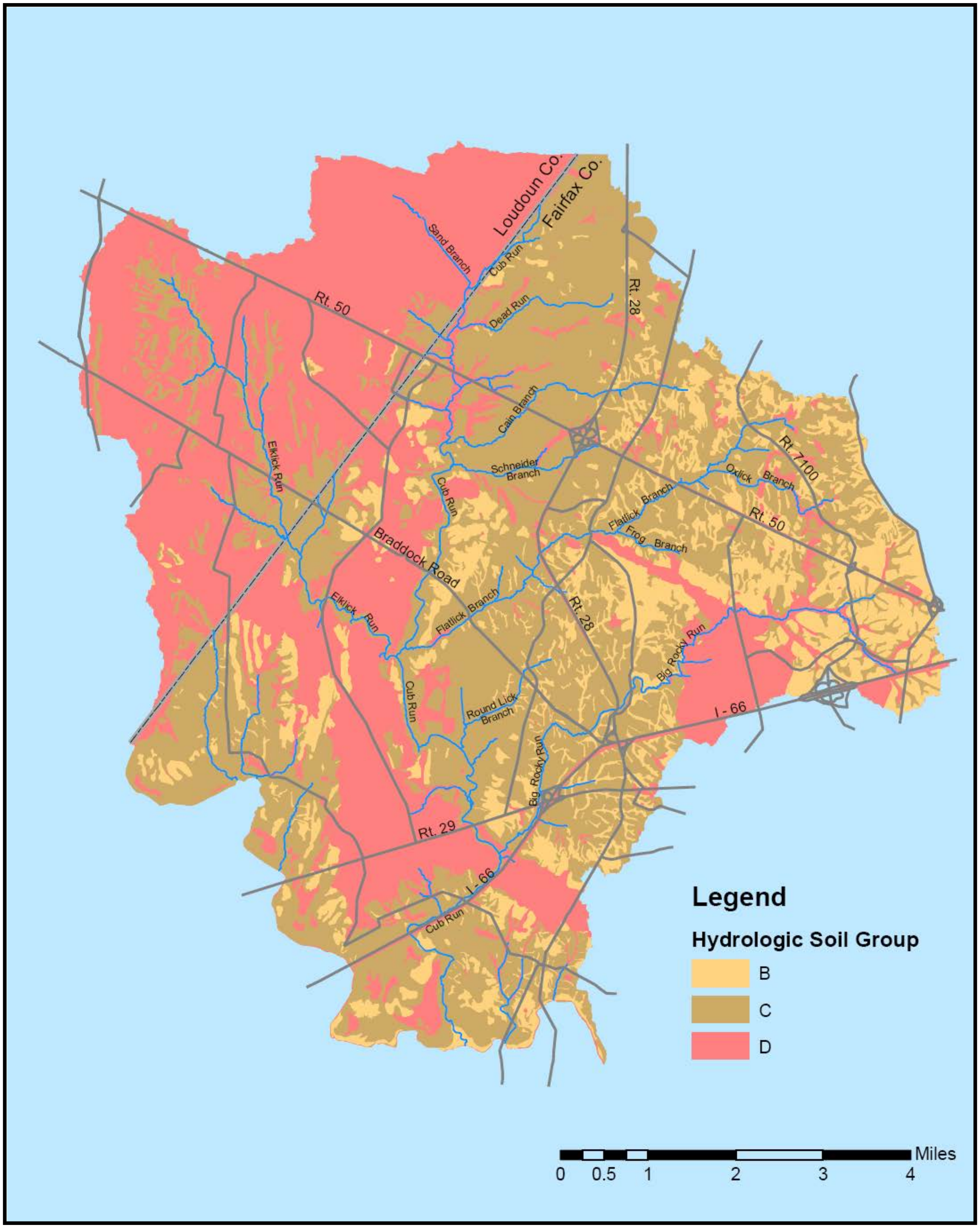


Figure 2-17
Hydrologic Soil Groups in the
Cub Run and Bull Run Watersheds

The rocky strata provides habitat for fish and benthic organisms, and make Big Rocky Run, Frog Branch and streams in the Bull Run East subwatershed less susceptible to streambed and streambank erosion.

The impact of the watershed geology can also be seen in the main stem of Cub Run downstream from Route 29 to just below the Big Rocky Run confluence. This stream segment is within an igneous intrusion area. The steeper gradient of the stream results from the bedrock being less erodable. The streambed consists of rocks and boulders that provide habitat and make the streambank and bed less susceptible to erosion from urban stormwater flows. Furthermore, the higher bed slope prevents sedimentation. These conditions combine to provide good stream habitat.

Most of the remaining streams are in areas of the Triassic Basin Province underlain by shale. The shale weathers easily and therefore provides little resistance to streambed and streambank erosion. The fine clayey soils that form the streambanks are highly erodable and make it difficult to control sediment from construction sites. These soils create the vertical streambanks found in many of the streams north of Route 29.

2.7.4 Physical Stream Condition

2.7.4.1 Stream Physical Assessment Study: February 2004

Fairfax County completed a county-wide Stream Physical Assessment Study in 2003. The results are in "Fairfax County Stream Physical Assessment Report," published in February 2004. Please refer to the Stream Physical Assessment report for details on how the studies were performed and the county-wide results.

The study focused on streams with drainage areas greater than 50 acres. Field crews documented conditions of approximately 800 miles of stream. This includes 105 miles of the Cub and Bull Run watersheds. A GIS tool and database contain the data and photos that document the stream conditions. The Stream Physical Assessment Study assesses the physical stream habitat, incorporating several measures of stream conditions that affect habitat, including vegetated buffer, streambank stability, channel alteration, embeddedness, epifaunal substrate and instream cover. The Stream Physical Assessment Study also provides an inventory of the following conditions:

- Stream channel condition and habitat characteristics
- Stream reaches with deficient buffers
- Streambank erosion
- Head cuts
- Pipes
- Ditches
- Obstructions
- Road and other stream crossings
- Dump sites
- Utility line exposure

Section 3 summarizes stream assessment results for the major subwatersheds in Cub Run and Bull Run. These data were also used to identify stream restoration, buffer restoration and dump-site-removal structural projects, as described in Section 6.

The Physical Assessment Study documents the Channel Evolutionary Model (CEM) stage of the streams. This model classifies the streams into one of five categories based on the stream characteristics. The CEM recognizes that streams go through stages as they react to changes in stream flows produced by urbanization. First, the streambed down-cuts and then the stream widens as the banks erode. If the flow remains constant (e.g., no further development occurs in the watershed), the streams will stabilize to a new streambed and floodplain configuration. The CEM stages are shown in Figure 2-18 and are described below:

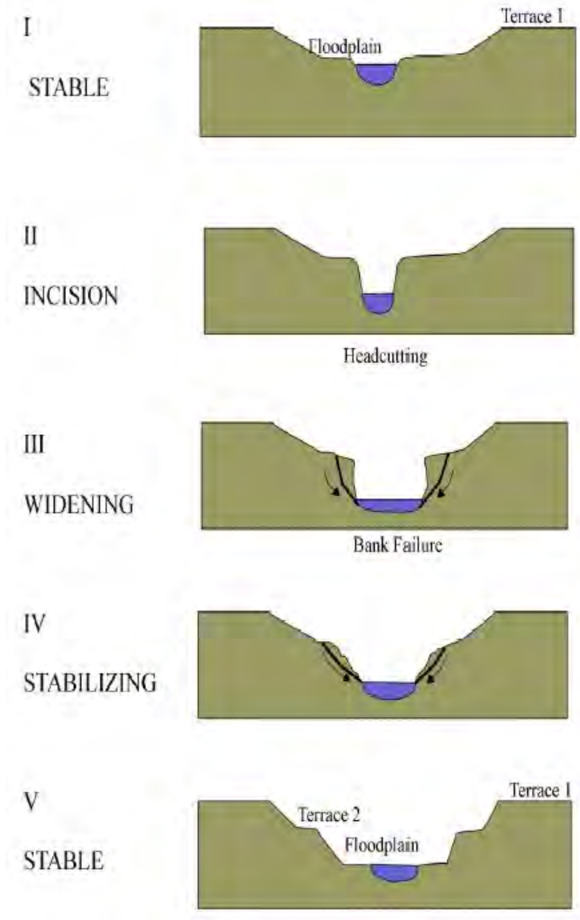


Figure 2-18
Incised Channel Evolutionary Model:
Progression from Natural Stream (I) Channel
from Highly Eroded Stream Channel (V)

- I – STABLE: This represents a stable stream condition such as one that might exist in a natural area without any development.

- II – INCISION: The typical first response of a stream to urban development is downward erosion of the streambed, producing a deepening of the channel. The stream is disconnected from its floodplain. This condition suggests that the stream is unstable for present flow conditions and ongoing stream erosion will affect habitat quality. A stream in this condition may exhibit "head cuts" when the downstream channel has incised while the upstream segment has not. This results in a waterfall in the stream. If unimpeded by roots, rock, or manmade obstacles, the head cut will migrate upstream as erosion continues.

- III – WIDENING: The streambanks may fall or slough into the stream as further erosion occurs and the channel banks become unstable. The eroded bank material increases the sediment load carried by the stream. Habitat quality is degraded and adjacent infrastructure is threatened. Trees may fall into the stream, potentially producing snags and stream obstructions.

- IV – STABILIZING: If flow conditions remain constant and do not increase further, the stream will eventually reach a stable configuration where the banks are stable and a stable sediment erosion/deposition regime has been reached.

- V – STABLE: The stable stream will exhibit a floodplain and terraces from the historic floodplains. Habitat quality typically improves once the channel reaches this stable condition.

Figure 2-19 provides the CEM stage for the Cub Run and Bull Run streams. These CEM stages are discussed in detail in Section 3.

2.7.5 303(d) Impaired Waters and TMDLs

Section 303(d) of the Federal Clean Water Act requires each state to submit a Total Maximum Daily Load (TMDL) Priority List to the EPA. The 303(d) Report on Impaired Waters in Virginia lists streams and other water bodies that do not meet water quality standards for their designated use. The Virginia DEQ samples streams and lists those that do not meet the designated water quality criteria.

Most impaired waters require the development of TMDL for the parameter causing the impairment. TMDL studies identify the cause of the impairment and estimates maximum loadings that will allow the impaired water body to meet the standards. According to the Clean Water Act, all TMDL studies must be completed by 2011.

Various streams in Fairfax County are on this list primarily because the criteria for fecal coliform concentrations for contact recreational use are exceeded. The listed streams include Mills Creek, Accotink Creek, Popes Head Creek, Sugarland Run, Difficult Run, Tripps Run, Pimmit Run, Four Mile Run and Holmes Run.

None of the streams in the Cub Run watershed are listed as impaired. Bull Run downstream from the confluence with Cub Run is listed for exceeding fecal coliform criteria for recreational use, moderate impairment of stream benthic communities and excessive PCB concentrations in fish tissue.

2.7.6 Flooding

2.7.6.1 Road Flooding Memorandum: August 1998

This August 28, 1998 memorandum identifies procedures that county police officers will use to warn motorists of flooding and, when necessary, to close roads. The memorandum lists 27 sites in Fairfax County with flip-down advisory signs that must

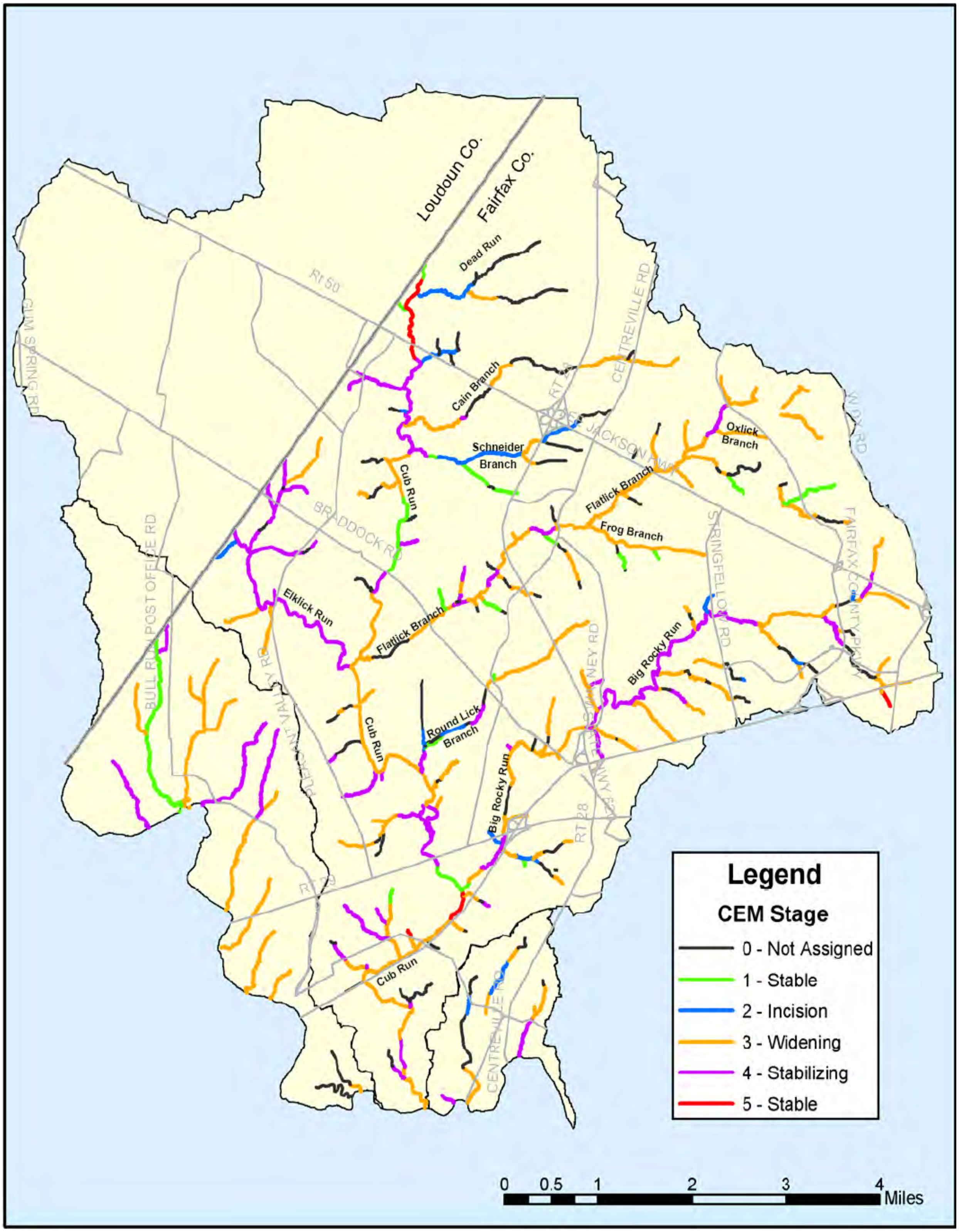


Figure 2-19
Stream Channel Evolutionary Model
Stages in the Cub Run and Bull Run Watersheds

be manually opened to provide warnings to motorists. The memorandum includes the following stream crossings in the Cub Run and Bull Run watersheds:

- Walney Road between intersection of Willard Road and Westfields Blvd. This road crosses Flatlick Branch.

- Old Lee Road between the intersections of Braddock Road and Stonecroft Boulevard. This road runs parallel to and crosses Cub Run.

These and other road crossings that experience frequent flooding are identified in the watershed plan in section 6.9.

2.7.6.2 Review of DPWES Maintenance Database

The DPWES Maintenance and Stormwater Management Division citizen complaint database includes 29,600 complaint records logged throughout the county from January 1984 through November 2003. The database includes detailed information on the complaint and the actions taken.

The following summarize complaints where flooding issues were identified within the Cub Run watershed:

- Thirty-six involved yard flooding
- One involved roadway flooding
- Nine involved house flooding

Careful review of these complaints found none that could be related to flooding caused by major streams. Instead, the flooding was caused by problems in the local property drainage or the minor storm drainage systems.

2.7.6.3 100-Year Floodplain

Using the Fairfax County GIS building layer and 100-year flood layer, 40 structures are within the Bull Run and Cub Run 100-year floodplain.

After careful review of these results, only two unoccupied buildings were determined to be within the 100-year floodplain where possible flooding is a concern.

The remaining structures include:

- Various buildings within Bull Run Regional Park. Nearly all of this park is included in the 100-year floodplain produced by Bull Run.

- Various small sheds and other out buildings

- UOSA wastewater pump stations and power substations

- A few buildings that have subsequently been removed

Much of the floodplain lies within stream valley parks or otherwise protected as open space. The complaint records, evaluation of buildings in the 100-year floodplain and comments received from the public indicate that structure flooding is not a major issue in the Cub Run and Bull Run watersheds.

2.8 Watershed Modeling

Computer models were developed to simulate the following:

- Runoff from the land surface
- Flows, velocities and depths of flows in the stream channels
- Capacity of bridges and culverts where roadways cross the streams and the potential for flooding at these locations
- Water quality concentrations and total annual loads

The models were developed to simulate existing and future conditions. The models also can simulate the benefits of existing stormwater controls and future stormwater controls required for new development based on the stormwater management requirements of Fairfax and Loudoun counties. Finally, the models were used to describe the benefits from stormwater control improvements recommended in the watershed plan.

The U.S. Environmental Protection Agency Storm Water Management Model RUNOFF and TRANSPORT computer models were used to compute runoff flows and water quality from the land surface and to route these flows through the stream network. The U.S. Army Corps of Engineers' HECRAS model was used to perform detailed simulations of the stream and road-crossing hydraulics. The models and the model setup are described in a separate Model Development and Application Technical Memorandum (CDM, 2006).

In summary, the watershed was divided into 284 subbasins that range from 13 to 613 acres and average 142 acres in size. Parameters such as the slope, soil characteristics, impervious cover and others describe the runoff from the land surface. Land use data are used to describe runoff water quality.

Results of simulations to characterize existing and future conditions for various subwatersheds, including a summary of the overall watershed characteristics, are summarized in Section 3 and described in detail in Appendix B for the following four scenarios:

Existing land use without stormwater controls. This condition assumes that on-site and regional dry and wet ponds were not constructed. These results are presented to demonstrate the benefits from these existing stormwater controls.

Existing land use with existing stormwater controls. This represents existing watershed conditions.

Future land use with existing stormwater controls. This scenario assumes new ponds and other stormwater controls required by Fairfax County and Loudoun County are not constructed. These results are presented to demonstrate the benefits from new stormwater controls to be constructed as additional development occurs.

Future build-out land use with existing and future stormwater controls required for new development by Loudoun County and Fairfax County. This scenario does not include the benefits provided by the watershed plan recommendations.

Results documenting the benefits of various structural controls recommended by the watershed plan are included in Section 6 and 7, and documented in Appendix B. Table 2-14 summarizes the average annual pollutant removal efficiency of various stormwater water quality control best management practices (BMPs) used to evaluate future water quality with stormwater controls. These values are derived from various sources and represent values typically used to model these BMPs.

Total flows presented in the summary tables in section 3 represent the total peak simulated flow at the outlet of the subwatershed. Average velocities represent the length-weighted average of the peak velocities in all modeled stream segments.

Average annual loads (tons per year) and loads per acre (lbs/acre/year) are presented for the following parameters:

- Total Phosphorus
- Dissolved Phosphorus
- Total Nitrogen
- Total Kjeldahl Nitrogen
- Nitrate Nitrogen
- BOD5
- Zinc
- Lead
- Copper
- Cadmium

These are computed for a five-year simulation from 1996 through 2001 using local rainfall.

Table 2-14
Summary of Average Pollutant Removal Efficiencies for
Stormwater Water Quality BMPs

Type of Water Quality BMP	Removal Efficiency			
	Wet Detention Basin	**Extended Dry Detention Basin**	**Extended Dry Detention Basin with Wetlands Bottom**	**Bioretention LID**
Total Phosphorus	50%	40%	50%	50%
Dissolved Phosphorus	50%	0%	30%	20%
Total Nitrogen	30%	30%	55%	45%
Dissolved Nitrogen	25%	0%	30%	20%
BOD-5	30%	30%	30%	30%
Total Suspended Solids	80%	80%	80%	80%
Lead	80%	80%	80%	80%
Copper	50%	50%	50%	80%
Zinc	50%	50%	50%	80%
Cadmium	50%	50%	50%	80%

Section 3
Description of Subwatershed Conditions

3.1 Introduction

This section provides an overview of conditions for the major subwatersheds in the Cub Run and Bull Run watersheds. The following assesses and evaluates the drainage characteristics, land use, impervious area, existing stormwater controls, stream habitat, water quality, stream geomorphology, concerns identified by the public and stormwater modeling results for the major subwatersheds. These descriptions are based on data contained in various sources described in Section 2 supplemented with information from the public information program, field observations, GIS data and model results.

Section 3.2 provides an overview of land use, impervious area and results of modeling evaluations for the Cub Run watershed, excluding the Bull Run watersheds. The modeled nutrient loads produced by the watershed plan recommendations are compared to the nutrient loading targets previously set for the Occoquan Reservoir watershed and the loadings set by the latest Chesapeake Bay Tributary Strategy loading projections. These results will be used to set the overall nutrient reduction targets for this watershed plan.

Sections 3.3 through 3.9 describe the six major subwatersheds organized from north to south or upstream to downstream. These major subwatersheds are shown on Figure 3-1 and include:

- Upper Cub Run subwatersheds, including Dead Run, Sand Branch, Cain Branch, Schneider Branch and the Cub Run main stem upstream from the confluence with Elklick Run – Section 3.3
- Elklick Run subwatershed – Section 3.4
- Flatlick Branch subwatershed, including Frog Branch and Oxlick Branch – Section 3.5
- Big Rocky Run and Round Lick Branch subwatersheds – Section 3.6
- Lower Cub Run downstream from Elklick Run subwatersheds – Section 3.7
- Bull Run tributaries subdivided into Bull Run East and Bull Run West subwatersheds– Section 3.8

Land Use Descriptions

Existing and future land use are key to characterizing subwatershed conditions and used to relate stream conditions to upstream sources of stormwater runoff and pollutants. The land use data sources and their application in the watershed plan are described below.

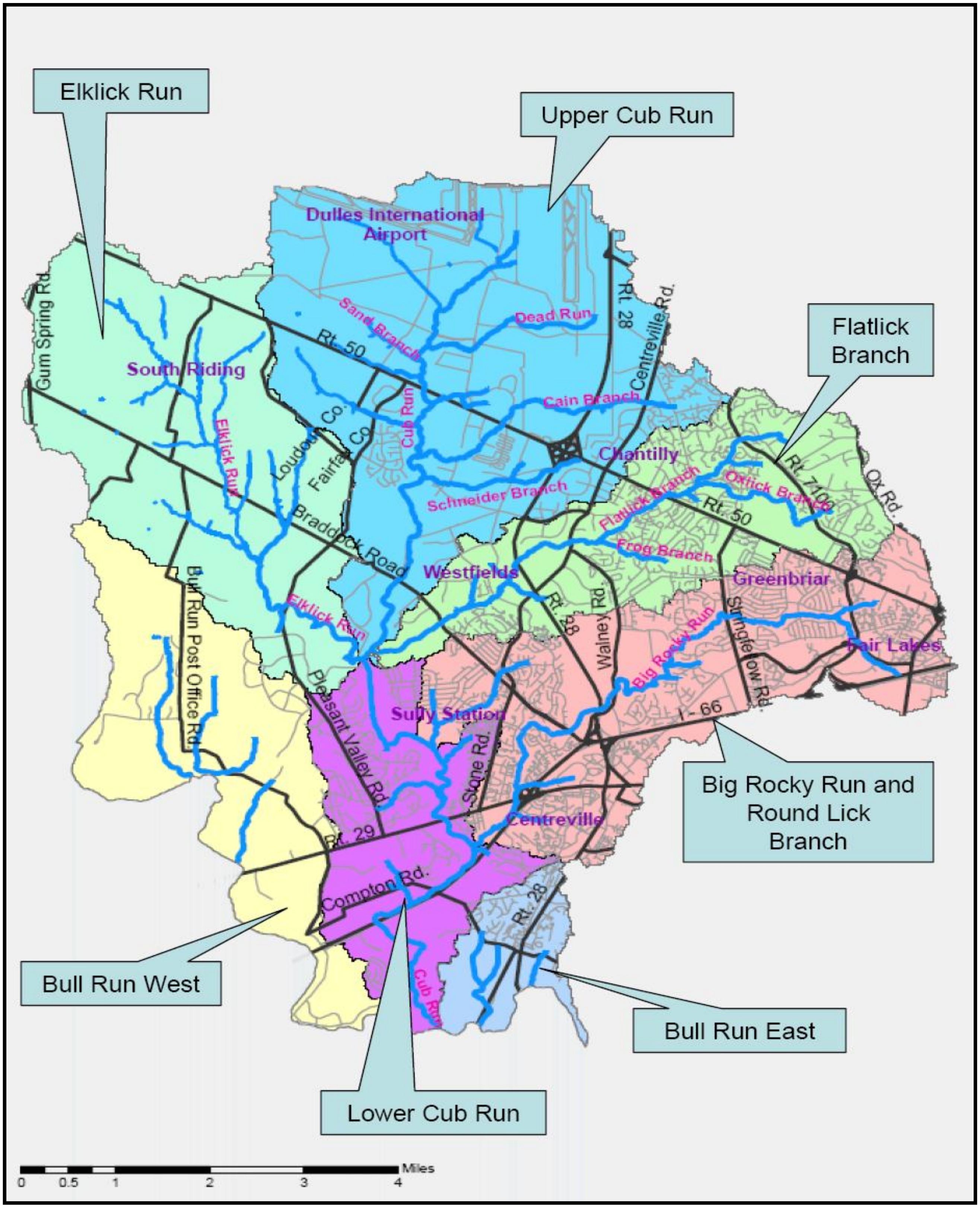


Figure 3-1
Location of Major Subwatersheds

Existing land use is based on the Department of Tax Administration land use records (2003) for each parcel. The study area is developing rapidly. There are several reasons for the plan not including more recent land use data. A lag exists between when development occurs and when it appears in the county GIS data files. The county aerial photography and associated GIS data files are updated roughly every five years. This project used the most recent data available when the study was initiated in 2004. From a watershed planning perspective, it is not imperative that the existing land use is current. Small changes in land use have small incremental changes in watershed conditions. The future land use scenario includes development that may have already occurred and therefore accurately evaluates the cumulative impact of those changes on the watershed.

The future land use describes build-out development conditions, assuming that the land is developed as described by the county's comprehensive plans. These data are based on a GIS layer of parcel land use designation maintained by the Fairfax County Department of Tax Administration edited to represent existing and future land use conditions as described in the county comprehensive land use plans. In some cases, adjustments were made to accurately describe future development. In developing the future land use, if the planned development density is less than the existing development density, the property will not be redeveloped at a lower density.

The accuracy of the existing and future land use descriptions is appropriate for watershed planning. However, they do not include details in the county comprehensive plans. The Fairfax County Comprehensive Plan and Loudoun County General Plan provide accurate and up-to-date descriptions of the planned land use.

The following classifications are used in this watershed plan to describe the land use in both Fairfax and Loudoun counties:

Open Space (OS) – For existing conditions, open space includes parkland, privately owned open space, golf courses and vacant developable land. For future conditions, developable open space is set to the planned land use.

Estate-Residential (ESR) – Single-family detached homes with more than two acres per residence.

Low-Density Residential (LDR) – Single-family detached homes with 0.5 to 2 acres per residences.

Medium-Density Residential (MDR) – Single-family detached homes with less than 0.5 acres per residence and attached multi-family residential with fewer than eight dwelling units per acre.

High-Density Residential (HDR) – Single-family and multi-family residential with more than eight dwelling units per acres.

Low-Intensity Commercial – Office, commercial and public facilities, including schools, libraries and county office buildings. This category includes institutional land uses.

High-Intensity Commercial (HIC) – Retail including shopping centers, strip malls, automobile dealerships and restaurants.

Industrial (IND) – Industrial land use. Within the Cub Run portions of Loudoun and Fairfax counties, this land use includes industrial, commercial, office, retail and some residential as well as conference centers, restaurants and hotels. This land use primarily exists within Dulles International Airport noise impact areas.

Residential Planned Community (AVRES) – A planned community that includes a variety of housing types, employment and commercial. The Cub Run and Bull Run subwatersheds contain little residential planned community land use.

The following sections summarize the subwatershed area within each of these land uses, Dulles International Airport and the Upper Occoquan Sewage Authority (UOSA) advanced wastewater treatment plant.

Existing and Future Impervious Area Estimates

The following sections estimate existing and future impervious area. Impervious area represents the percentage of the land surface covered by roads, parking lots, buildings and sidewalks. These impervious areas prevent rainfall from infiltrating into the soil, and increase the runoff peak flow and volume. Impervious area is therefore a good indicator of the development density and the potential impact the development may have on the streams.

Geographic Information System (GIS) layers containing buildings, roadway pavement, sidewalks and parking lots were used to estimate existing impervious area. These data are based on 1997 aerial photography, the most recent available when this watershed study was initiated. Again, it is not imperative that the watershed plan evaluates current impervious area estimates. These estimates should be considered approximate. Small changes in impervious area associated with recent development produce small changes in overall watershed conditions, though the changes may be more pronounced in local streams near the development. Finally, the watershed plan evaluations consider future land use, including development that can occur based on the county land use plans. Changes that may have occurred as the plan was being developed are accounted for in this future land use scenario.

Underutilized parcels were identified where the existing development density is significantly less than the density allowed by the Loudoun County and Fairfax County land use plans. To estimate the future impervious area, undeveloped and underutilized parcels are assumed to be developed at the planned land use density.

Table 3-1 presents the factors used to estimate the increase in impervious area produced by the various land uses. These were estimated by sampling the impervious area for areas, including roads, with these land uses within the Fairfax County portions of the watershed. The factors used to estimate increases in impervious area are conservative since they assume a high development density for all future land uses.

The impervious area percentage for the open space and estate residential land use classifications account for roads and institutional uses within these areas. These values represent conservative high estimates of the impervious area that may overestimate the actual impervious area in portions of the watershed. The net result is that the modeling may over-predict the peak flow, flow volume and pollutant runoff from these watershed areas. However, these values do not affect the overall results and conclusions of this watershed plan.

Table 3-1
Impervious Area Estimates Used to Project Impervious Area Increases

Land Use Classification	**Total Impervious Areas (Percent)**
Open Space	5.5
Estate Residential	13
Low-Density Residential	18
Medium-Density Residential	29
High-Density Residential	37
Low-Intensity Commercial	46
High-Intensity Commercial	57
Industrial	58

3.2 Cub Run Watershed

Overview of Conditions in the Cub Run Watershed

- **Drainage area = 34,100 acres (53 square miles)**
- **Approximately 5,400 acres (8.4 square miles) or 16 percent of the watershed is open space preserved in parkland and golf courses.**
- **Undeveloped vacant land (open space) has a potential to decrease by 24 percent in the future based on the Comprehensive Plan. Approximately 50% of this decrease will result from the potential conversion of existing open space to 5-acre lot Estate-Residential land use within the R-C District.**
- **Existing impervious area = 14 percent**
- **Potential Future impervious area = 25 percent**

The following sections summarize the land use, estimates of impervious area and model simulation results for the entire Cub Run watershed, excluding the Bull Run watersheds.

3.2.1 Existing and Future Land Use

Table 3-2 provides an overview of the existing and future land use within the Cub Run watershed. The following bullets summarize the major changes in land use between existing and future conditions as identified by the Loudoun County and Fairfax County land use plans:

- Approximately 5,400 acres (8.4 square miles) or 16 percent of the watershed is open space preserved in parkland and golf courses.

- Undeveloped vacant land (open space) can decrease by 24 percent in the future based on the comprehensive plan. Approximately 50% of this decrease will result from the potential conversion of existing open space to 5-acre lot Estate-Residential land use within the R-C District.

- The next largest change in land use is the development of open space in the Fairfax County portion of the watershed to the land use identified as industrial that includes office, commercial, industrial and residential.

3.2.2 Existing and Future Impervious Area

Table 3-3 provides an overview of the existing and future impervious area estimates for the Cub Run watershed.

The total future watershed impervious area nearly doubles from the existing 13.8 percent to 24.7 percent.

Table 3-2
Summary of Existing and Future Land Use
for the Cub Run Watershed

Land Use	Existing Conditions		Future Conditions	
	Acres	**Percent**	**Acres**	**Percent**
Open Space	14,044	41.2	5,811	17.1
Estate-Residential	1,580	4.6	4,129	12.1
Low-Density Residential	949	2.8	2,276	6.7
Medium-Density Residential	5,969	17.5	7,811	22.9
High-Density Residential	2,223	6.5	2,281	6.7
Low-Intensity Commercial	2,229	6.5	2,615	7.7
High-Intensity Commercial	391	1.1	429	1.3
Industrial	1,728	5.1	3,716	10.9
Residential Planned Community	-	-	45	0.1
Dulles International Airport	4,738	13.9	4,738	13.9
Upper Occoquan Sewerage Authority Advanced Wastewater Treatment Plant	228	0.7	228	0.7

Excludes Bull Run watersheds

Table 3-3
Summary of Drainage Areas and Existing and Projected
Future Impervious Area for the Cub Run Watershed

County	Watershed Area (Acres)	Existing Impervious Area		Future Impervious Area	
		Acres	**Percent**	**Acres**	**Percent**
Cub Run Watershed	34,080	4,703	13.8	8,418	24.7

3.2.3 Existing Stormwater Controls

Table 3-4 summarizes the number of existing dry and wet ponds and the total subwatershed area upstream from these ponds in the Cub Run watersheds. These values include both Fairfax and Loudoun counties. The watershed may contain other stormwater controls such as underground detention and treatment facilities, and rooftop detention.

Table 3-4
Summary of Number of Ponds and Cumulative
Drainage Area for Cub Run Watershed

Type of Pond	Approximate Number of Ponds *	Total Drainage Area Upstream from Ponds
Dry Ponds	174	5,072 acres
Wet Ponds	104	5,419 acres
Total	278	10,491 acres

* - *Includes ponds in both Fairfax and Loudoun counties*

The number of ponds is approximate and represents a best estimate of existing ponds in the spring of 2002 based on aerial photography, county GIS coverages, databases, field inspections and other data sources. The regional ponds within each subwatershed are identified in subsequent sections of this report.

The drainage area upstream from these ponds includes 26 percent of the total watershed area, including most of the developed land area. Existing ponds protect a higher percentage of the total drainage area in the developed watersheds (i.e., Flatlick Branch, Round Lick Branch and Big Rocky Run) than less-developed watersheds. Stormwater ponds are not required within the R-C District where the development is 5-acre Estate Residential Land Use. Developed areas within Loudoun County (South Riding) include 10 wet ponds that serve virtually all of the developed area.

3.2.4 Future Stormwater Controls

Under current Fairfax County and Loudoun County stormwater requirements for new development, much of it will have stormwater controls, primarily on-site wet and dry ponds, to control the peak flows and reduce the stormwater pollution runoff. Evaluation of future development suggests that 19,700 acres or nearly 50 percent of the watershed will be upstream from stormwater controls once development is complete. Areas without controls include development within the R-C District, undeveloped parkland and areas that currently do not have stormwater controls.

3.2.5 Modeling Results

Figure 3-2 presents stormwater modeling results for existing and future conditions for the Cub Run watershed. The existing condition scenario includes existing stormwater controls. The future scenario includes existing stormwater controls plus stormwater controls required by Fairfax County and Loudoun County for new development. The significant increase in impervious area produces smaller relative increases in peak flows and total phosphorous loads. The total suspended solids (TSS) decrease because BMPs reduce TSS effectively.

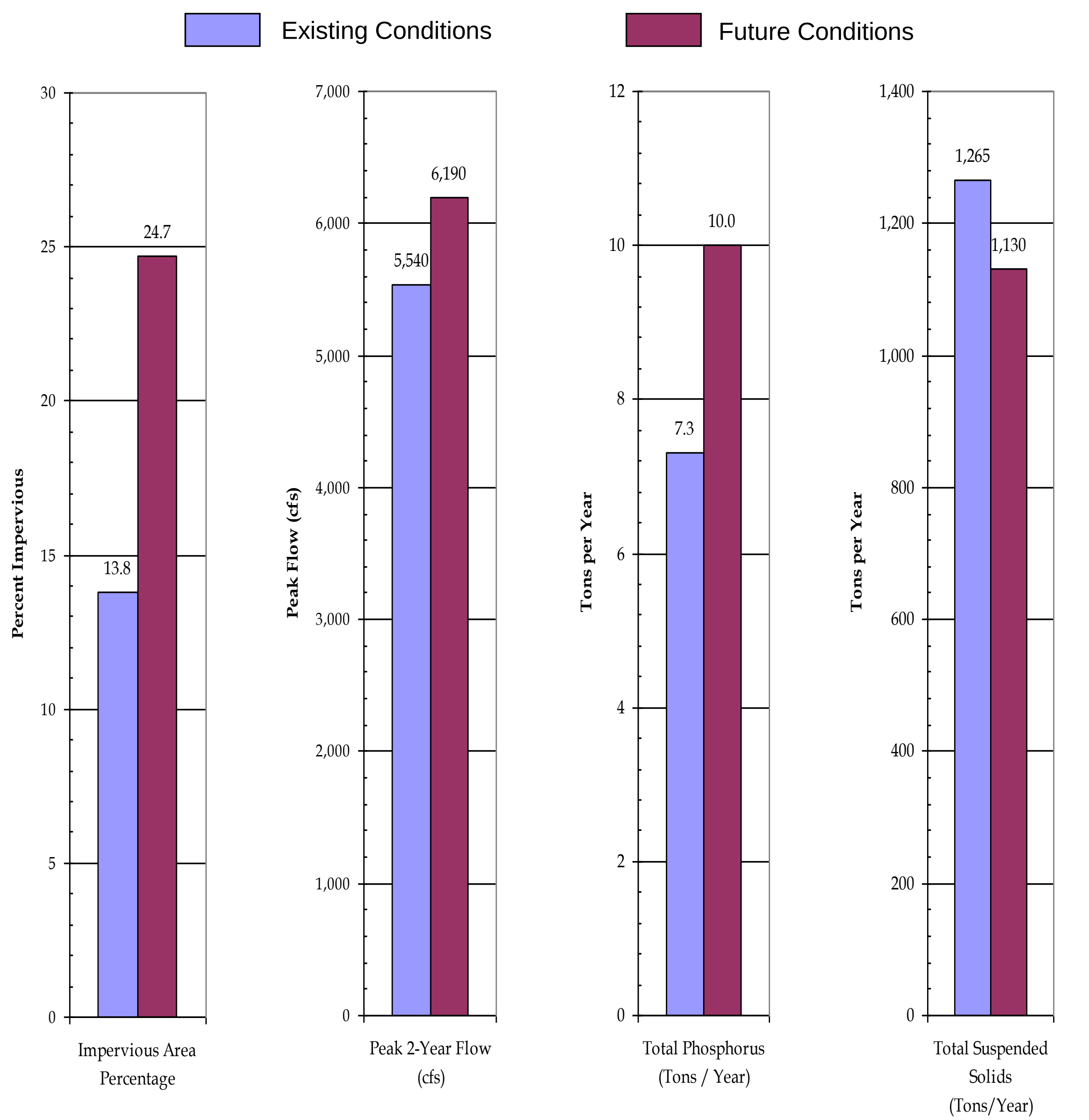
The following sections present simulated loads from Fairfax and Loudoun counties and compare these results with Occoquan Reservoir and Chesapeake Bay Tributary Strategy loading targets.

3.2.5.1 Loads from Fairfax and Loudoun Counties

Table 3-5 presents the total phosphorus loadings for the Fairfax County and Loudoun County portions of the watersheds. This includes the two scenarios presented in Figure 3-2. Simulation results for existing and future land use without stormwater controls are added to demonstrate the benefits of these controls. A fifth scenario is added that presents the loads with the recommended watershed plan dry pond wetland retrofit projects, regional ponds (or alternative stormwater controls) and Low-Impact Development (LID) retrofit projects as described in Section 6 of this report. As summarized in Section 6, the 130 proposed dry pond retrofit projects further reduce the total phosphorus loads by approximately 234 pounds per year. Proposed regional ponds (or alternative projects) will reduce total phosphorus loads by an additional 133 pounds per year. LID retrofit projects at county facilities remove 14 pounds of phosphorus per year.

The unit loading rates (lbs/acre/year) are higher for Fairfax County for existing land use conditions. The future loads for Fairfax County (with stormwater controls) increase by 33 percent whereas the loads for Loudoun County increase by 90 percent. Significant growth projected for Loudoun County causes this. The unit rates for future conditions are greater for Loudoun County in the future, but Fairfax County still produces most (74 percent) of the total phosphorus loads.

The following sections compare the modeled nutrient loads with loading targets developed for the Occoquan watershed and the Virginia portions of the Chesapeake Bay tributaries.



Peak flows and loads are from watershed models. Existing conditions includes existing stormwater controls. Future conditions include existing stormwater controls plus new controls required for new development.

Figure 3-2
Overview of Existing and Future
Conditions in the Cub Run Watershed

Table 3-5
Summary of Total Phosphorus Loads From Fairfax and
Loudoun County Portion of the Cub Run and Bull Run Watershed

	Total Phosphorus Load			
Scenario	**Units**	**Fairfax County (47.7 sq. mi.)**	**Loudoun County (15.3 sq. mi.)**	**Total (63 sq. mi.)**
Existing Land Use No Stormwater Controls	Tons/Year Lbs/Acre/Year	8.0 0.53	1.9 0.38	9.9 0.49
Existing Land Use Existing Stormwater Controls	Tons/Year Lbs/Acre/Year	6.5 0.43	1.6 0.32	8.1 0.40
Future Land Use Existing Stormwater Controls	Tons/Year Lbs/Acre/Year	9.9 0.65	4.0 0.82	13.9 0.69
Future Land Use Future Stormwater Controls	Tons/Year Lbs/Acre/Year	8.5 0.56	3.0 0.61	11.4 0.57
Future Land Use Future Stormwater Controls and Watershed Plan Recommendations	Tons/Year Lbs/Acre/Year	8.1 0.53	3.0 0.61	11.1 0.56

3.2.6 Comparison with Occoquan Watershed Loading Targets

Over the past 25 years, watershed management plans for Occoquan Reservoir tributaries have focused on the control of annual total phosphorus loadings in stormwater runoff. Total phosphorus is used since it is the limiting nutrient for algae growth and eutrophication in the reservoir (OWML, 1998; Fairfax County Office of Comprehensive Planning, 1982; NVPDC, 1982).

For example, the 1982 Occoquan Basin rezoning by the Fairfax County Board of Supervisors was based on an annual total phosphorus loading goal to protect the Occoquan Reservoir water supply. Control of total phosphorus loadings is also important for the Chesapeake Bay tributary strategies, although the control requirements for Occoquan Reservoir loadings are more critical due to the proximity of the water supply and that the Cub Run and Bull Run watersheds compose approximately 10 percent of the reservoir watershed. Therefore, the performance standard for the Cub Run and Bull Run Watershed Management Plan should be based on control of total phosphorus loading goals for the Occoquan Reservoir.

The future land use plan for Cub Run and Bull Run watersheds increase the average annual loadings of total phosphorus in Fairfax County stormwater from 6.5 tons per year to 9.9 tons per year (i.e., a 54 percent increase) in the absence of new stormwater controls. The proposed watershed plan combined with stormwater controls required for new development reduces the future annual loadings of total phosphorus from Fairfax County to 8.5 tons/year (i.e., by 14 percent).

Table 3-6 summarizes the annual total phosphorus loading goals established for the county's 1983 Occoquan Basin rezoning. This rezoning designated approximately 11,700 acres within the Cub Run and Bull Run watersheds for 5-acre lot residential development. The rezoning affected at total of nearly 41,000 acres within Fairfax County. This was the first major application of what is currently known as smart growth or LID to control stormwater pollution loadings in the county and one of the most extensive applications of land use controls for watershed protection ever implemented in the U.S. The average-year rainfall used to set this performance standard is a sequence of more than 100 storm events, which produced 40.6 inches of rainfall during 1967 (NVPDC, 1982). Values in Table 3-6 have been prorated for the average rainfall for the 1967 through 1981 period included in the model simulations for this report (42.3 inches), providing a direct comparison.

As shown in Table 3-6, the equivalent annual total phosphorus-loading goal for the Fairfax County watersheds is 13.1 tons/year, consisting of 8.9 tons/year for the Cub Run and Bull Run watersheds, and 4.2 tons/year for the other Fairfax County Occoquan tributary watersheds (e.g., Little Rocky Run, Johnny Moore Creek and Popes Head Creek).

Table 3-6
Annual Total Phosphorus Loading Goals for
Fairfax County's Occoquan Basin Rezoning

Fairfax County Watersheds (County Area)	**Annual Total Phosphorus Loading Goal (1) (2) (1996-2001 Rainfall)**	
Cub Run and Bull Run Watersheds (48 square miles)	Tons/Year 8.9	Lbs/Acre/Year 0.58
Other Fairfax County Occoquan Watersheds (53 square miles)	4.2	0.25
Totals (100.8 square miles)	13.1	0.41

Notes:

1. *"Annual loading goals" were developed for Fairfax County's "Occoquan Basin Study" (1982), which was the technical basis for the rezoning that was upheld by three major court cases (1985, 1991, 1995).*

2. *The Occoquan Basin Study loading goals were based upon water quality model simulations for "average-year" rainfall conditions (40.6 inches).The Cub Run/Bull Run watershed plans relied upon water quality model runs with a six-year rainfall record (1996-2001) resulting in a slightly greater average annual rainfall volume (42.3 inches). Therefore, the annual total phosphorus loading goals for the Cub Run and Bull Run Watershed Management Plan were increased by 4 percent based on the greater average rainfall (42.3/40.6 = 1.04).*

The annual total phosphorus loading target for the Cub Run and Bull Run study area (48 square miles) represents about two-thirds (8.9 tons/year) of the total loading goal for the county's portion of the Occoquan Basin (101 square miles), even though it covers about one-half of the total county areas in the basin. The "per acre" total phosphorus loadings goal is greater in the Cub Run and Bull Run study area because the county's Occoquan Basin rezoning restricted medium- and high-density development and non-residential development to the upper and middle Cub Run watershed. The other watersheds are almost entirely within the 5-acre residential R-C District.

This approach assumed that structural water quality controls could be most effectively applied to higher-density development in the Cub Run watershed, and that nonstructural LID controls (minimum 5-acre lots) could be effectively applied to lower Cub Run and most other areas in the basin (Occoquan Basin Study by Fairfax County Office of Comprehensive Planning, March 1982).

The future annual total phosphorus load (8.5 tons/year) projected for the Fairfax County portion of the Cub Run and Bull Run watersheds is less than the annual loading goal (8.9 tons/year). This indicates that the proposed Cub Run and Bull Run Watershed Management Plan actions combined with existing and future stormwater controls meet the stormwater management performance standards for Occoquan Reservoir protection as set for the 1982 rezoning and upheld by major court cases decided in the county's favor over the past 20 years.

3.2.7 Chesapeake Bay Tributary Strategy

The Virginia Chesapeake Bay Nutrient and Sediment Reduction Tributary Strategy for the Shenandoah and Potomac River Basin (March 2005) assumes urban stormwater management water quality controls will be applied to 42.5 percent of the treatable urban area (1,029 square miles).

Although it is not clear how the basin-wide urban stormwater management goals in the Tributary Strategy will be achieved, the watershed plan recommendations, combined with existing watershed management practices, meet or exceed future Chesapeake Bay nonpoint source management standards:

- Fairfax County's portion of the watershed includes more than 5,500 acres where the land use is zoned for 5-acre residential lots. This land use designation, which was implemented to preserve water quality in the Occoquan Reservoir, effectively reduces the nutrient runoff from the Cub Run watershed from what it might had been had this area developed as zoned prior to the 1982 rezoning action.

- The recommended watershed plan combined with existing and future stormwater controls provide water quality controls for 90 percent of the urban development in the county's portion of the watershed. (Water quality controls will serve 33 square miles out of a total 36.4 square miles in urban development.)

- The recommended watershed plan includes the retrofit of water quality controls to 7.2 square mile of watershed, which has no stormwater water quality controls. This represents 33 percent of the developed area outside the 5-acre residential development zone.

- Twenty-three percent of the watershed is preserved as parkland and other open space. This represents a watershed management program that effectively reduces the nutrient loads from these portions of the watershed.

Further, the watershed plan achieves a delivered total phosphorus load per acre that compares favorably with the target in the Shenandoah-Potomac Tributary Strategy.

The latest Tributary Strategy allocation for total phosphorus nonpoint source loads from the Virginia portion (5,723 sq mi) of the Shenandoah-Potomac Basin is 1.12 million lbs/yr (March 2005). This allocation is equivalent to an annual unit area load of 0.31 lbs/acre/yr.

The nutrient trap efficiency in the Occoquan Reservoir is 54 percent for total phosphorus (OWML, 1998). Therefore, the nutrient load delivered to the Chesapeake Bay system by the Fairfax County portion of the Cub Run and Bull Run watersheds based on future land use conditions and the recommended control plan is 3.9 tons/year (8.5 tons/year X (1 - 0.54%) = 3.9 tons/year). This projected future delivered load is equivalent to 0.25 lbs/acre/yr of total phosphorus, which is 18 percent less than the overall Virginia Tributary Strategy target. This is especially important since Cub Run has a high development density.

3.3 Upper Cub Run Subwatersheds

Overview of Conditions in the Upper Cub Run Subwatershed

- **Drainage area = 10,644 acres (16.6 square miles)**
- **Thirty-three percent of the subwatershed is in Loudoun County.**
  Forty-two percent of the subwatershed is within Dulles International Airport property spanning Fairfax and Loudoun counties.
- **Existing impervious area = 11 percent**
- **Future impervious area = 34 percent**
- **Most of the land area within the Fairfax County portions of the Upper Cub Run subwatershed has planned land use that includes a mix of industrial, commercial, office, retail, conference centers, restaurants, hotels and some residential.**
- **Compared with other areas of the Cub and Bull Run watersheds, this area has very little residential development.**
- **The impervious area is projected to triple between existing and future land use. Fifty percent of the impervious area increase will result from planned development within Dulles Airport.**
- **The existing stream habitat is good to fair and exhibits few areas with active stream erosion.**
- **A primary consideration of the watershed plan will be to minimize impacts of the planned development on the local streams. Since this is a headwater area of the County, the development in this subwatershed may affect the entire Cub Run stream main stem through the Lower Cub Run subwatershed.**

The following sections summarize the conditions in the Upper Cub Run subwatershed.

3.3.1 Overview of Drainage Characteristics

Figure 3-3 shows the Upper Cub Run drainage boundaries and major streams in this subwatershed as well as the location of existing dry ponds, wet ponds, regional ponds and previously proposed regional ponds.

Cub Run's main stem flows north to south with its headwaters within Dulles International Airport property. Named tributaries within this subwatershed include Sand Branch, Dead Run, Cain Branch and Schneider Branch. There are also numerous unnamed tributaries.

The total subwatershed area is 10,644 acres. Thirty-three percent of the area is in Loudoun County. Dulles International Airport includes approximately 4,715 acres, roughly 44 percent of the total subwatershed area.

3.3.2 Existing and Future Land Use

Table 3-7 provides an overview of the existing and future land use in the Upper Cub Run subwatershed. Under existing conditions, the subwatershed includes large areas of open space that will be developed. These areas are west of Centreville Road, Walney Road and Westfields Boulevard, north of Braddock Road, east of Pleasant Valley Road, and south of Dulles International Airport. They include Westfields and parts of Chantilly.

Table 3-7
Summary of Existing and Future Land Use in the Upper Cub Run Subwatershed

Land Use	Existing Conditions		Future Conditions	
	Acres	**Percent**	**Acres**	**Percent**
Open Space	2,288	21.5	853	8.0
Estate-Residential	532	5.0	582	5.5
Low-Density Residential	245	2.3	276	2.6
Medium-Density Residential	373	3.5	482	4.5
High-Density Residential	149	1.4	149	1.4
Low-Intensity Commercial	947	8.9	947	8.9
High-Intensity Commercial	85	0.8	85	0.8
Industrial	1,309	12.3	2,554	24.0
Residential Planned Community	-	-	-	-
Dulles Airport	4,715	44.3	4,715	44.3

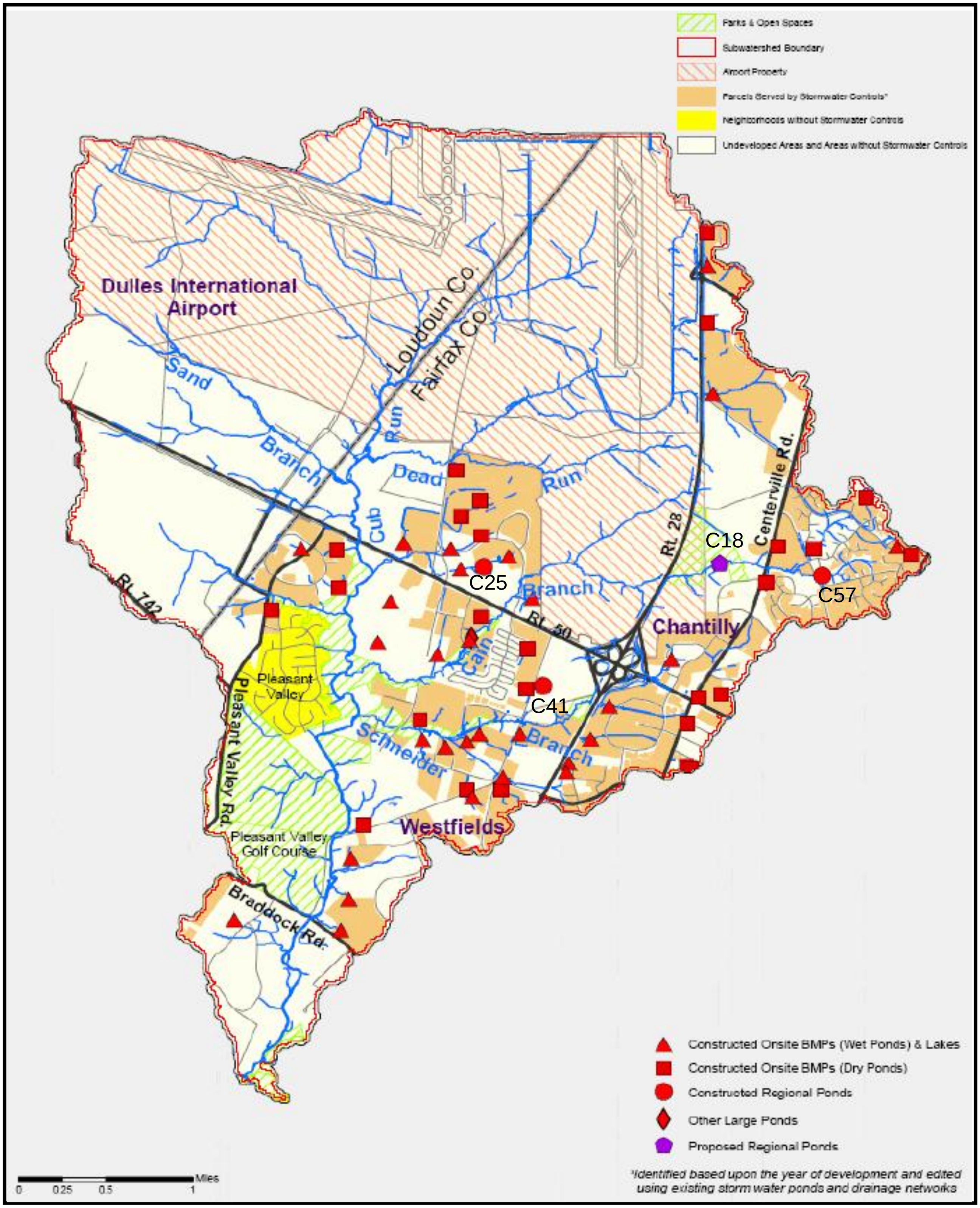


Figure 3-3
Stormwater Facilities in the
Upper Cub Run Subwatershed

Future changes in land use result primarily from converting undeveloped open space to the planned land use. Much of this area is planned for, or has options for, non-industrial uses, including office parks, conference centers, various retail, hotels, restaurants and some residential uses. This subwatershed also has significant areas with a planned land use designation of "Mixed Use," which includes a mix of related uses such as office, hotel, residential and/or retail development. These areas generally have high percentages of impervious area and, for the purposes of watershed planning, similar impacts on the county streams.

The high planned development density in this subwatershed partially results from changes to the county land use plan as part of the rezoning to protect the Occoquan Reservoir water supply. In conjunction with the rezoning of nearly 41,000 acres of land to the R-C District, the Zoning Ordinance was amended to allow higher development densities to promote employment in areas near Dulles International Airport and prevent incompatible residential uses from areas with high projected airport-related noise impacts.

The Upper Cub Run subwatershed has relatively little residential land use compared to other areas of the Cub and Bull Run watersheds (e.g., Flatlick Branch and Big Rocky Run). The County Plan was developed to minimize residential development within areas most affected by aircraft noise associated with Dulles International Airport. Existing and future residential development is primarily in the following areas within this subwatershed:

- Headwaters of Cain Branch located east of Centreville Road and including portions of Chantilly Highlands, Franklin Farm Foundation, Armfield Farms and Franklin Glen Governance
- Meadows of Chantilly Mobile Home Community
- Pleasant Valley subdivision

3.3.3 Existing and Future Impervious Area

Table 3-8 provides an overview of the existing and projected future impervious area estimates for the Upper Cub Run subwatersheds.

The subwatersheds have a relatively low density of development; however, they are rapidly developing. Based on the planned land use, these subwatersheds will have some of the highest development densities in the Cub Run and Bull Run watersheds.

Table 3-9 summarizes the existing and future impervious area in Fairfax County, Loudoun County and Dulles International Airport portions of the subwatershed. In this table, the Fairfax County and Loudoun County values exclude the airport, which spans the county line.

Table 3-8
Summary of Drainage Areas and Existing and Projected
Future Impervious Area for the Upper Cub Run Subwatershed

Subwatershed	**Watershed Area (Acres)**	**Existing Impervious Area**		**Future Impervious Area**	
		Acres	**Percent**	**Acres**	**Percent**
Sand Branch	788	47	6	355	45
Dead Run	1,474	133	9	531	36
Cain Branch	1,407	183	13	450	32
Schneider Branch	1,134	295	26	476	42
Upper Cub Run Main Stem	5,841	526	9	1,811	31
TOTAL UPPER CUB RUN SUBWATERSHED	**10,644**	1,183	**11**	3,622	**34**

Table 3-9
Summary of Existing and Future Impervious Area for the Dulles Airport, Loudoun County and Fairfax County Portions of the Upper Cub Run Subwatershed

	Total Area in Upper Cub Run Subwatershed (Acres)	**Existing Impervious Area**		**Future Impervious Area**	
		(Acres)	**(Percent)**	**(Acres)**	**(Percent)**
Fairfax County *	4,882	703	14	1,421	29
Loudoun County *	1,255	102	8	551	44
Dulles Airport	4,506	399	9	1,642	36
Total Subwatershed	**10,643**	**1,230**	**11**	**3,614**	**34**

* *Values for Fairfax County and Loudoun County excluding Dulles Airport*

The impervious area will triple for future land use. Approximately 50 percent of the impervious area increase results from planned Dulles International Airport expansion. Development within Loudoun County and Fairfax County also contributes significantly to the impervious area increase.

3.3.4 Existing Stormwater Controls

Figure 3-3 shows the dry and wet stormwater ponds in the Upper Cub Run subwatershed and the developed area upstream from these ponds. This figure also shows the location of existing and planned Fairfax County regional ponds, and existing ponds that serve large areas but are not part of the county regional pond program.

Table 3-10 summarizes the number of existing dry ponds, wet ponds and regional ponds, and the total subwatershed area served by these ponds. The watershed may contain other stormwater controls, such as underground detention and treatment facilities, and rooftop detention.

Table 3-10
Summary of Number of Ponds and Cumulative Drainage Area
For the Upper Cub Run Subwatershed

Type of Pond	Approximate Number of Ponds *	Total Drainage Area Upstream from Ponds
Dry Ponds	25	663 acres
Wet Ponds	26	1,645 acres
Total in Subwatershed	51	2,308 acres

The existing dry and wet ponds cover 22 percent of the total area and most of the developed area in the subwatershed.

The Loudoun County portions of the subwatershed were undeveloped when this inventory was performed. Future development will include stormwater ponds to control peak flows and stormwater quality to comply with the Loudoun County Development Standards Manual.

Three constructed Fairfax County regional ponds exist in the Upper Cub Run subwatershed:

- C25 was constructed as a series of wet ponds located on an unnamed tributary within the Avion Business Park.

- C41 is a newly constructed pond located on an unnamed tributary to Cain Branch within the West Fairfax commerce center. This pond serves a portion of the Route 28–Route 50 interchange.

- C57 is a dry pond located towards the headwaters of Cain Branch east of Centreville Road within the Armfield Farms community.

The subwatershed includes one previously proposed but not constructed regional pond identified as C18, with a planned location on Cain Branch between Route 28 and Centreville Road.

A pond on Cain Branch south of Route 50 can be considered regional due to the large upstream drainage area. This pond is not part of the Fairfax County regional pond program.

3.3.5 Stream Habitat

Physical Habitat

The Fairfax County Stream Physical Assessment Study summarizes the stream physical habitat. Assessment data are not available for Loudoun County streams. Figure 3-4 shows the stream physical habitat ratings for the streams in the Upper Cub Run subwatershed, and Table 3-11 summarizes these ratings.

For the most part, the physical habitat conditions are rated as good and fair.

Table 3-11
Summary of Physical Stream Habitat Ratings
Upper Cub Run Subwatershed

Physical Stream Habitat Rating	Length of Stream (Miles)	Percent of Total Stream Length Analyzed
Excellent	0.4	2
Good	8.6	57
Fair	4	27
Poor	2.2	14
Very Poor	-	-

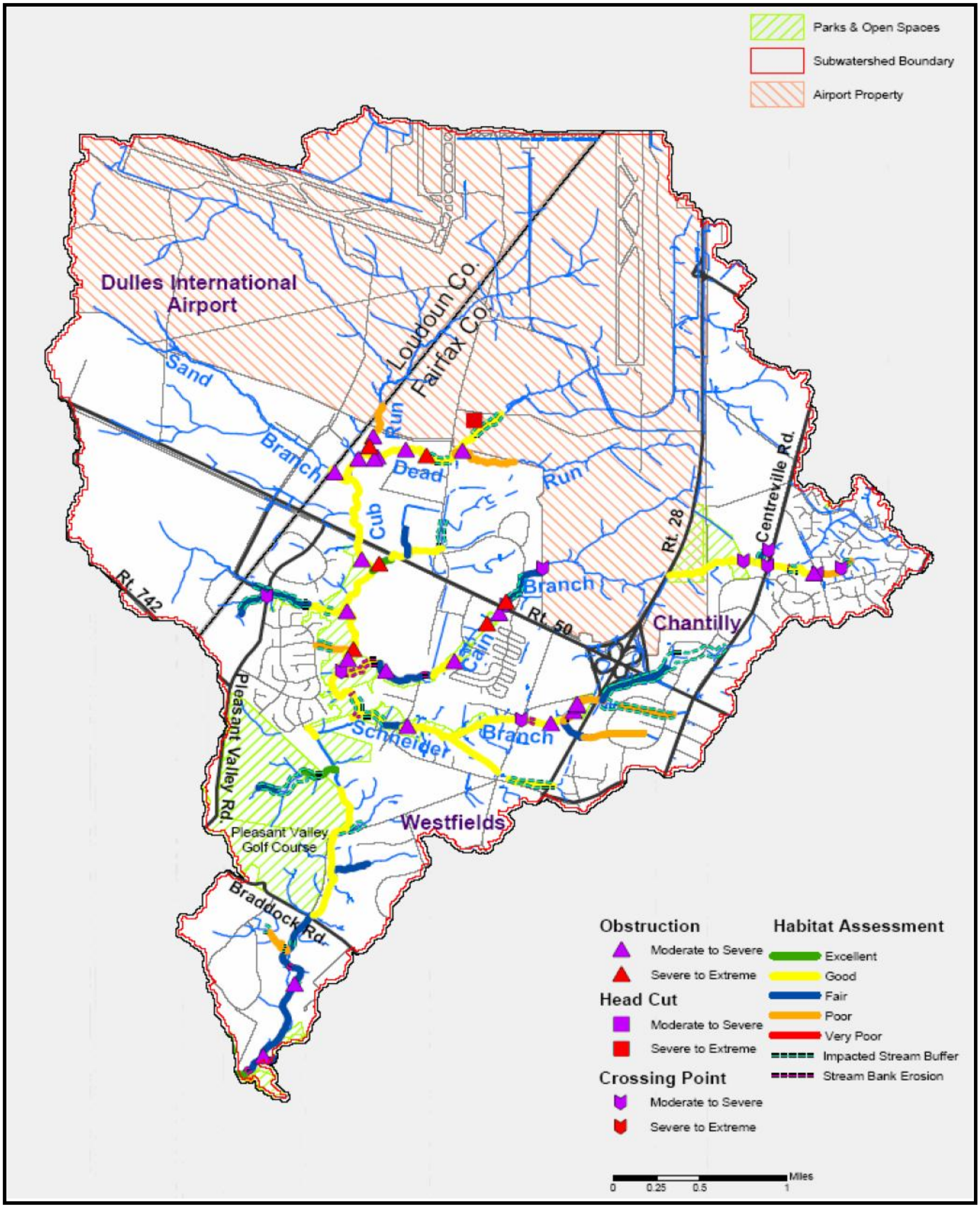


Figure 3-4
Existing Conditions in the
Upper Cub Run Subwatershed

Excellent habitat is found on two small tributaries to Cub Run. Good habitat occurs within many reaches of Cub Run and lower reaches of Schneider Branch. Poor habitat occurs on several small tributaries and upper reaches of Schneider Branch near the Route 28 interchange, and business parks southeast of this interchange that have a very high impervious area and impacted stream buffers.

Figure 3-4 also shows the following information from the Stream Physical Assessment Study:

- Locations where the stream buffer is impacted
- Erosion inventory lines, indicating areas of active stream erosion
- Obstructions. Most obstructions indicate where trees have fallen into the stream from active erosion.
- Head cuts indicate where the streambed is down-cutting.
- Dump sites
- Locations where stream crossings affect the streams

Figure 3-4 includes these features where the impact scores indicate they significantly affect the streams.

The Upper Cub streams have few stream erosion lines and other inventory points. Streams with erosion inventory lines and impacted buffers are scattered throughout the subwatershed.

Fish and Benthic Macroinvertibrate Studies

The Stream Protection Strategy includes three sampling locations in the Upper Cub Run subwatershed where the fish and benthic macroinvertibrates were sampled and studied. The conditions found at these sites are summarized on Table 3-12.

These data suggest that the habitat quality in the subwatershed is fair to good and correlate well with the physical habitat assessments. Based on these evaluations, the Cub Run main stem above Cain Branch is a watershed protection area where the high quality stream environments are managed to protect the existing conditions. Cain Branch is in Restoration I watershed management area where causes of stream degradation are identified and remedied. The areas tributary to the upper Cub Run main stem are in the Restoration II category where the watershed is impaired and managed to prevent further degradation.

Table 3-12
Summary of Stream Protection Strategy Results for
Upper Cub Run Subwatershed

Location	**Index of Biotic Integrity**	**Habitat Score**	**Fish Taxa Richness**	**Overall Site Condition Rating**	**Watershed Management Category**
Cain Branch immediately upstream from Cub Run	Fair	Poor	Moderate	Fair	Restoration I
Cub Run main stem at Schneider Branch	Good	Fair	Low	Good	Protection
Cub Run main stem below Braddock Road	Poor	Good	Moderate	Good	Restoration II

3.3.6 Stream Water Quality

Fairfax County samples for water quality at a single station (29-08) where Cub Run crosses Braddock Road near the bottom of the subwatershed. These data are summarized in Section 2 and indicate water quality in this subwatershed is typical for many county streams. Fecal coliform concentrations regularly exceed the state criteria for surface waters. Dissolved oxygen levels are high, indicating the stream is healthy. Other measured parameters are within acceptable levels and do not indicate abnormal conditions within this subwatershed.

3.3.7 Stream Geomorphology

Deep clay soils and shale characterize the stream banks within the Upper Cub Run subwatershed. The headwater areas north of Route 50 and west of Route 28 have little topographic relief and include many wetland areas. The streams in these areas have ill-defined stream valleys. Towards the bottom of the subwatershed, the stream valleys become more defined.

The Fairfax County Stream Physical Assessment Study includes the Channel Evolutionary Model (CEM) stage. Most of the streams are in stage III and IV, indicating that some stream segments are widening while adjacent segments are stabilizing. Sections in Schneider Branch, lower Dead Run and an unnamed tributary are in stage II, indicating the stream channel is down-cutting.

The stream channel substrate is largely silt though some reaches include cobbles and gravel.

3.3.8 Concerns Identified by the Public

The CAC and attendees of the public forums identified the following concerns in the Upper Cub Run subwatershed:

- The presence of many illegal dumps along Route 50
- Dumping near the location of the old Upper Cub Run wastewater treatment plant. Dumping was also identified as a problem along Route 50.
- Concerns about runoff from Pleasant Valley Golf Course and its impact on water quality
- Concerns about Loudoun County development and policies, and their potential effects on Fairfax County streams
- Concerns about the impacts of future development at Dulles International Airport on stream conditions and flooding along the Cub Run mainstream
- Preservation of railroad abutments and other features associated with the Manassas Gap Railroad
- Stream erosion and obstruction along Cub Run main stem at Route 50
- Large office park development in the subwatershed and lack of implementation of state-of-the-art stormwater controls to limit impacts on streams
- Impact of large church development on Pleasant Valley Road near Route 50
- Flooding near Old Lee Road and Braddock Road
- Impact of development on stream flooding, and on the Federal Emergency Management Agency (FEMA) designated 100-year flood plain and associated requirements for flood insurance, especially near Pleasant Valley

3.3.9 Modeling Results

Figure 3-5 presents stormwater modeling results for the Upper Cub Run subwatershed for existing and future conditions. Section 2.8 presents additional details on the modeling and the modeled scenarios.

The modeling results indicate peak flows and velocities for the two-year design storm will decrease slightly between existing and future conditions with stormwater controls. The modeled scenario assumes that stormwater controls for Dulles International Airport improvements will control flows from existing runways that do not have such controls. This reduction also results from stormwater retention ponds that reduce peak flows and thus provide the greatest benefit in watershed headwaters.

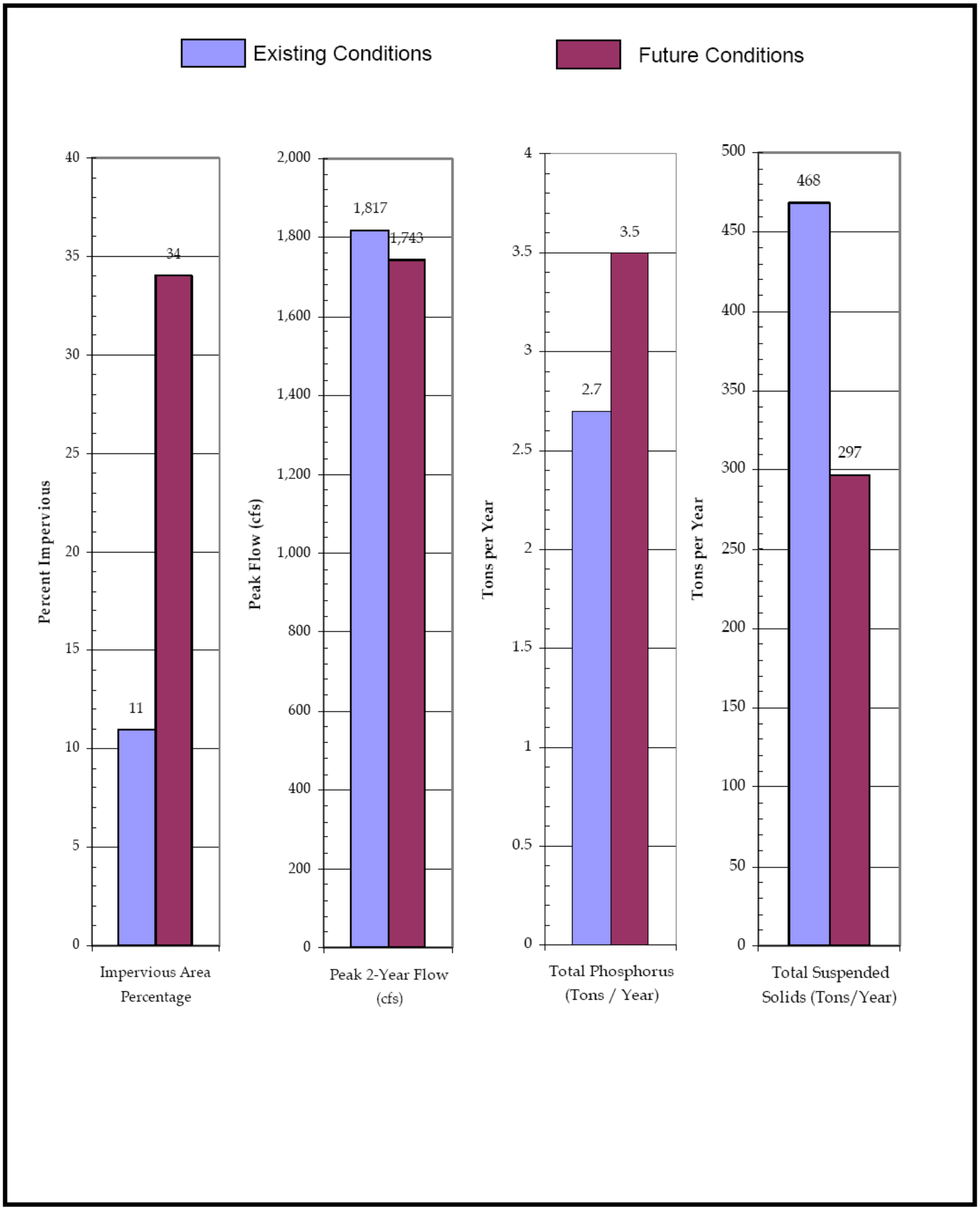


Figure 3-5
Overview of Existing and Future Conditions
in the Upper Cub Run Subwatershed

3.4 Elklick Run Subwatershed

Overview of Conditions in the Elklick Run Subwatershed

- **Drainage area = 7,406 acres (11.6 square miles)**
- **Seventy-five percent of the subwatershed is in Loudoun County**
- **Existing impervious area = 9 percent**
- **Future impervious area = 19 percent**
- **The Fairfax County portion of the Elklick Run subwatershed is in the R-C District. The planned land use is about 30 percent five-acre Estate Residential land use and the remaining area is Fairfax County Park Authority Sully Woodlands parkland. This area currently has and will continue to have a low development density. Existing and future impervious areas equal 1 and 9 percent, respectively.**
- **Seventy five percent of the Elklick Run subwatershed is within Loudoun County. Areas in Loudoun County portions of the subwatershed include low-, medium- and high-density residential development. Higher density development will mostly occur north of Braddock Road. The Loudoun County portion of the Elklick Run subwatershed includes the South Riding development as well as commercial areas along the Route 50 corridor. Existing and future impervious areas equal 11 and 22 percent, respectively.**
- **The Loudoun County portion of the subwatershed includes various wet stormwater ponds that control the runoff from the existing development. These include large ponds at the outlets of the major streams. Future development will also likely include ponds to control peak flows and reduce pollutant loads as required by the Loudoun County Development Standards Manual.**
- **The subwatershed includes four proposed but not constructed Fairfax County regional stormwater ponds.**
- **Based on the available data, the habitat in the Fairfax County streams is good to fair.**
- **The main stem of Elklick Run in Fairfax County is in CEM stage IV indicating that the stream is starting to stabilize.**
- **The primary concern for this subwatershed is the impact that Loudoun County development will have on the conditions of the Fairfax County streams.**

The following sections summarize the conditions in the Elklick Run subwatershed.

3.4.1 Overview of Drainage Characteristics

Figure 3-6 shows the Elklick Run subwatershed drainage boundaries and the major streams as well as the location of existing dry ponds, wet ponds, regional ponds and previously proposed regional ponds.

Elklick Run flows northwest to southeast with its headwaters in Loudoun County. There are no named tributaries; however, the subwatershed includes numerous unnamed tributaries.

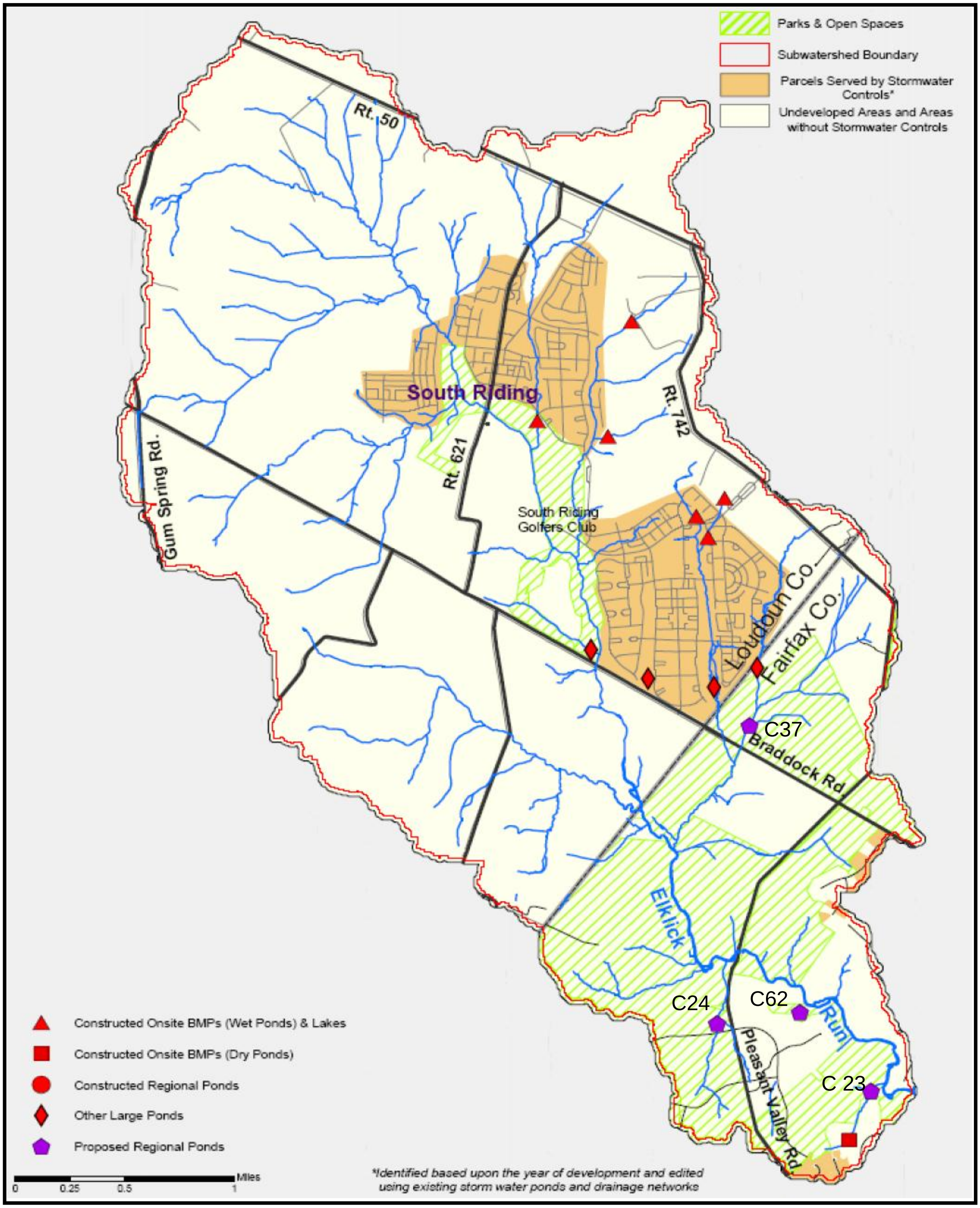


Figure 3-6
Stormwater Facilities
in the Elklick Run Subwatershed

The total subwatershed area is 7,406 acres (11.6 square miles). Seventy-five percent of the subwatershed area is in Loudoun County.

3.4.2 Existing and Future Land Use

Tables 3-13 and 3-14 summarize the existing and future land use in the Fairfax County and Loudoun County portions of the Elklick Run subwatershed.

The Fairfax County portion of the subwatershed lies entirely within the R-C District. Approximately 32 percent of the land is 5-acre Estate-Residential and the remainder is Fairfax County Park Authority parkland. The development density is low and will remain so.

Under existing conditions, the Loudoun County portion of the subwatershed is approximately 22 percent medium-density residential with the remaining land mostly vacant open space or areas with very low development density.

For future conditions, the Loudoun County portions of the subwatershed include low-, medium- and high-density residential development with commercial and office development along the Route 50 corridor. The predominant land use is medium-density residential. Areas south of Braddock road have lower-density planned residential land use with a planned density of up to one home per two acres corresponding to the Estate-Residential land use.

3.4.3 Existing and Future Impervious Area

Table 3-15 provides an overview of the existing and future impervious area estimates.

The Fairfax County portions of the subwatershed have low existing and future impervious area. Impervious area will increase from 1 to 9 percent as the vacant and undeveloped Estate-Residential areas are developed.

The impervious area in Loudoun County portions of the subwatershed will double, increasing from 11 to 22 percent as these areas develop as defined by the Loudoun County General Land Use Plan.

The total subwatershed impervious areas will increase from 9 to 19 percent with 80 percent of the additional impervious area in Loudoun County.

Table 3-13
Summary of Existing and Future Land Use in the Fairfax County
Portion of the Elklick Run Subwatershed

Land Use	Existing Conditions		Future Conditions	
	Acres	**Percent**	**Acres**	**Percent**
Open Space	1,540	84.8	1,233	67.9
Estate-Residential	272	15.0	579	31.9
Low-Density Residential	3	0.2	3	0.2
Medium-Density Residential	-	-	-	-
High-Density Residential	-	-	-	-
Low-Intensity Commercial	-	-	-	-
High-Intensity Commercial	-	-	-	-
Industrial	-	-	-	-
Residential Planned Community	-	-	-	-
Dulles Airport	-	-	-	-

Table 3-14
Summary of Existing and Future Land Use in the Loudoun County
Portion of the Elklick Run Subwatershed

Land Use	Existing Conditions		Future Conditions	
	Acres	**Percent**	**Acres**	**Percent**
Open Space	4,375	78.3	206	3.7
Estate-Residential	-	-	1,766	31.6
Low-Density Residential	-	-	844	15.1
Medium-Density Residential	1,192	21.3	2,388	42.7
High-Density Residential	-	-	39	0.7
Low-Intensity Commercial	-	-	144	2.6
High-Intensity Commercial	-	-	-	-
Industrial	-	-	177	3.2
Residential Planned Community	-	-	-	-
Dulles Airport	23	0.4	23	0.4

Table 3-15
Summary of Drainage Areas and Existing and Projected
Future Impervious Area for the Elklick Run Subwatershed

County	Watershed Area (Acres)	Existing Impervious Area		Future Impervious Area	
		Acres	Percent	Acres	Percent
Fairfax County	1,816	18	1	163	9
Loudoun County	5,590	615	11	1,230	22
TOTAL	**7,406**	633	**9**	1,393	**19**

3.4.4 Existing Stormwater Controls

Figure 3-6 shows the stormwater ponds in the Elklick Run subwatershed and the developed area upstream from these ponds. The watershed may contain other stormwater controls such as underground detention and treatment facilities, and rooftop detention.

Fairfax County

A single dry pond exists in the Fairfax County portions of the subwatershed. This pond controls runoff from a low-density residential area. Ponds are not required to serve the Estate-Residential and parkland that composes the remainder of the subwatershed.

Four proposed but not constructed regional ponds sites are within this subwatershed:

- C23 is on an unnamed tributary south of Elklick Run.
- C24 is on an unnamed tributary to Elklick Run west of Pleasant Valley Road.
- C37 is on an unnamed tributary to Elklick Run near the Loudoun County border.
- C62 is on an unnamed tributary south of Elklick Run

Loudoun County

The Loudoun County portion of the subwatershed includes 10 wet ponds that control the runoff from all of the developed land. Development includes four large wet ponds downstream from the existing and future development that can be considered regional due to the large upstream drainage area.

3.4.5 Stream Habitat

Physical Habitat

The Fairfax County Stream Physical Assessment Study summarizes the stream physical habitat condition for the Fairfax County streams. Figure 3-7 shows the stream physical habitat ratings for the Elklick Run streams, and Table 3-16 summarizes these ratings.

Table 3-16
Summary of Physical Stream Habitat Ratings for the Fairfax County Portions of the Elklick Run Subwatershed

Physical Stream Habitat Rating	Length of Stream (Miles)	Percent of Total Stream Length Analyzed
Excellent	0.8	12
Good	2.8	40
Fair	3.3	47
Poor	0.1	2
Very Poor	-	-

The physical habitat is mostly fair to good with some of it excellent. Poor habitat is limited to a small tributary north of Cub Run and west of Pleasant Valley Road. This stream is within the golf course, which affects the stream buffers.

The lower reach Elklick Run exhibits excellent habitat ratings.

Fair habitat is limited to tributaries, whereas most of the Elklick Run main stem has good physical habitat ratings.

Figure 3-7 also shows the following from the Stream Physical Assessment Study:

- Locations where the stream buffer is affected
- Erosion inventory lines, indicating areas of active stream erosion

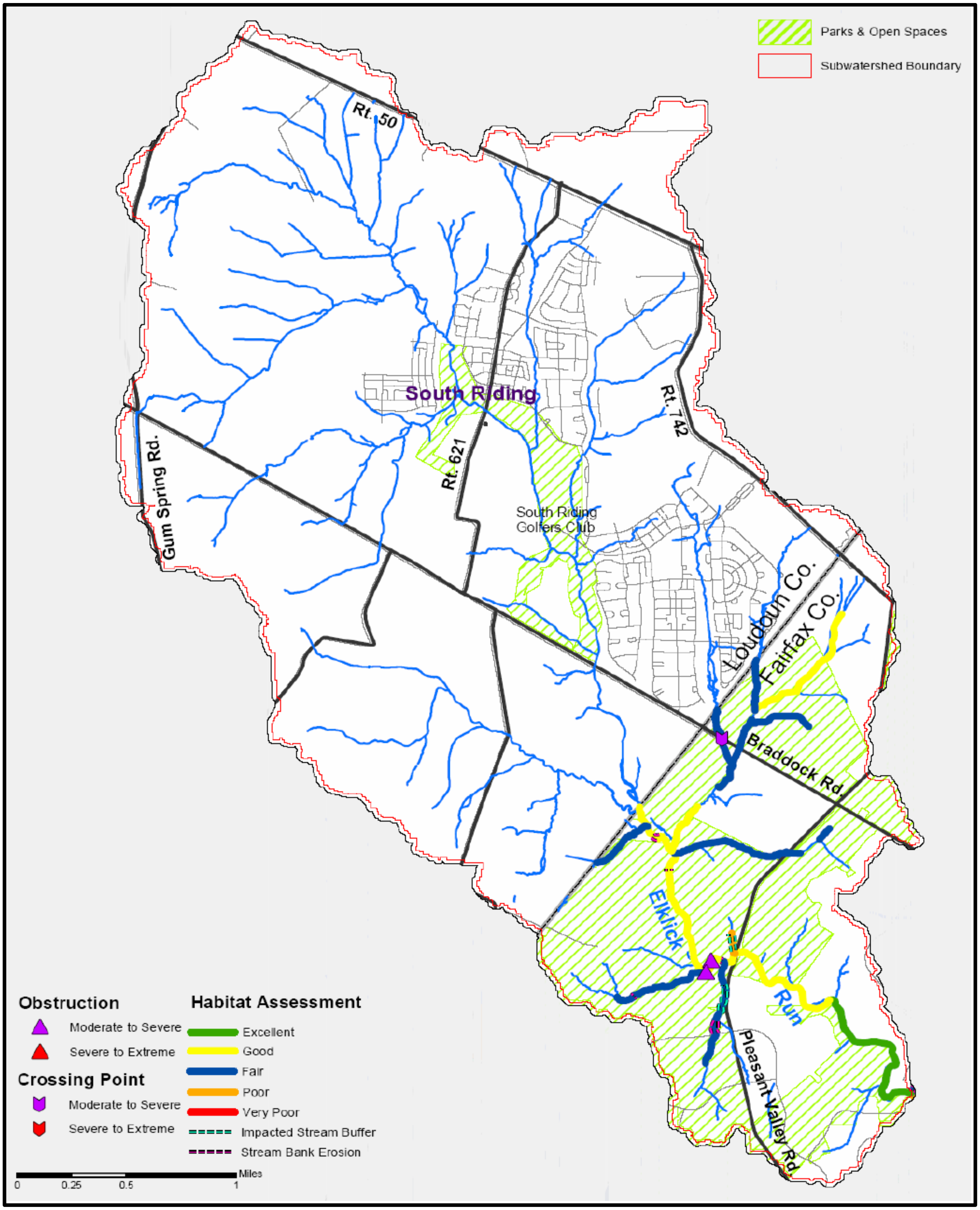


Figure 3-7
Existing Conditions
in the Elklick Run Subwatershed

- Obstructions. Most obstructions indicate where trees have fallen into the stream from active erosion.
- Head cuts indicate where the streambed is down-cutting.
- Dump sites
- Locations where stream crossings affect the streams

Figure 3-7 includes these features where the impact scores indicate they significantly affect the streams.

The Elklick Run streams have few of these features. Small portions of the streams have stream erosion inventory lines and compromised stream buffers.

Fish and Benthic Macroinvertibrate Studies

The Stream Protection Strategy includes one sampling location in the Elklick Run subwatershed. The conditions at this site are summarized in Table 3-17.

Table 3-17
Summary of Stream Protection Strategy Results for
Elklick Run Subwatershed

Location	Index of Biotic Integrity	Habitat Score	Fish Taxa Richness	Overall Site Condition Rating	Watershed Management Category
Elklick Run downstream from Pleasant Valley Road	Fair	Fair	Very Low	Fair	Restoration I

The physical stream habitat is rated as good, whereas sampling of the organisms suggests a fair stream habitat.

The Fairfax County portions of this watershed are within the SPS restoration I watershed management category where the causes of the stream degradation are identified and remedied.

3.4.6 Stream Water Quality

Fairfax County does not regularly sample for water quality in the Elklick Run subwatershed.

3.4.7 Stream Geomorphology

Deep clay soils and shale characterize the stream banks within the Elklick Run subwatershed. The streams generally have ill-defined stream valleys near the

Loudoun County border. Towards the bottom of the subwatershed, the stream valleys become more incised and defined.

The underlying geology affects conditions in the stream. The stream passes through an igneous intrusion area between Pleasant Valley Road and Cub Run. Rock associated with this zone may help to produce the excellent habitat ratings in the lower reaches of Elklick Run.

The Fairfax County Stream Physical Assessment Study includes the stream Channel Evolution Model (CEM) stage. Most of the streams, including all segments of the Elklick Run main stem, are in stage IV, indicating the streams are stabilizing.

The stream bottom substrate varies over the subwatershed. Lower reaches include boulders in the riffles and silt in the pools. Other areas include a mix of sand, gravel, cobble and silt substrate.

3.4.8 Concerns Identified by the Public

The CAC and attendees of the public forums identified the following concerns in the Elklick Run subwatershed:

- Impact of development in Loudoun County on the Fairfax County streams
- Local flooding and poor drainage near the intersection of Pleasant Valley Road and Braddock Road
- Septic systems in the Estate-Residential portions of the R-C District. The county should consider alternative disposal methods but should not extend the sewers to serve these areas.
- Stream erosion on Elklick Run at Pleasant Valley Road
- Water quality impacts of runoff from the South Riding Golf Course

3.4.9 Modeling Results

Figure 3-8 presents stormwater modeling results for the Elklick Run subwatershed. Section 2.8 presents additional details on the modeling and modeled scenarios.

The modeling results suggest the peak flow controls that will be required in the Fairfax County and Loudoun County portions of the watershed effectively control the peak flows from future development. Nutrient loads will more than double in the future, though the loads per acre are less than those for most subwatersheds.

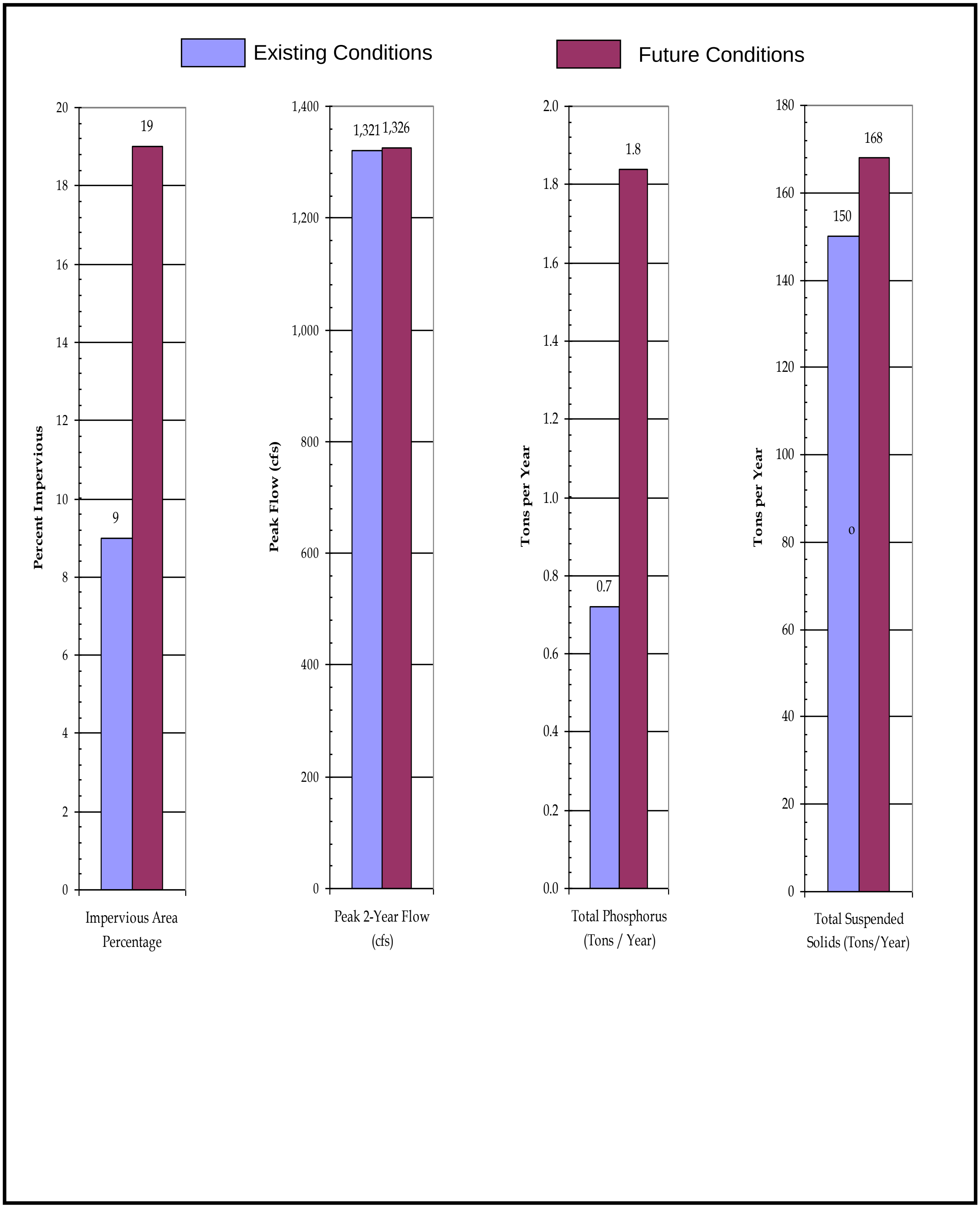


Figure 3-8
Overview of Existing and Future Conditions
in the Elklick Run Subwatershed

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3.5 Flatlick Branch Subwatershed

Overview of Conditions in the Flatlick Branch Subwatershed

- **Drainage area = 5,048 acres (8 square miles)**
- **Existing impervious area = 18 percent**
- **Future impervious area = 23 percent**
- **The subwatershed includes 53 dry ponds and 26 wet ponds. This includes seven constructed regional ponds. Nearly 50 percent of the subwatershed is upstream from these existing ponds.**
- **The subwatershed includes five proposed but not constructed regional ponds.**
- **Little developable open space is available for additional development within the Flatlick Branch subwatershed. Most of the development that will occur will be commercial and office development near Route 28 and within the Westfields area. The upper reaches of the subwatershed are approaching build out conditions.**
- **The watershed includes portions of the Greenbriar and Brookfield neighborhoods that were developed before stormwater controls were required. Stormwater drainage is provided by closed-pipe storm sewer systems that discharge runoff to the streams without stormwater control facilities to reduce peak flows and stormwater pollution.**
- **The stream habitat in the subwatershed is fair to poor.**
- **Some of the stream segments have conditions that suggest that the streams are actively eroding. The streams are in CEM stages III and IV indicating that the streams are widening and, in some locations, stabilizing.**

The following sections summarize the conditions in the Flatlick Branch subwatershed.

3.5.1 Overview of Drainage Characteristics

Figure 3-9 shows the Flatlick Branch subwatershed drainage boundaries and the major streams in the subwatershed. As discussed later in this section, Figure 3-9 also presents the location of existing dry ponds, wet ponds, regional ponds and previously proposed regional ponds.

Flatlick Branch flows northeast to southwest. The subwatershed includes the Frog Branch, Oxlick Branch and many unnamed tributaries.

The total subwatershed area is 5,048 acres (8 square miles).

3.5.2 Existing and Future Land Use

Table 3-18 provides an overview of the existing and future land use in the Flatlick Branch subwatershed.

The subwatershed includes a high percentage of residential development, mostly medium-density. Commercial, office and other non-residential uses exist along the Route 50 corridor.

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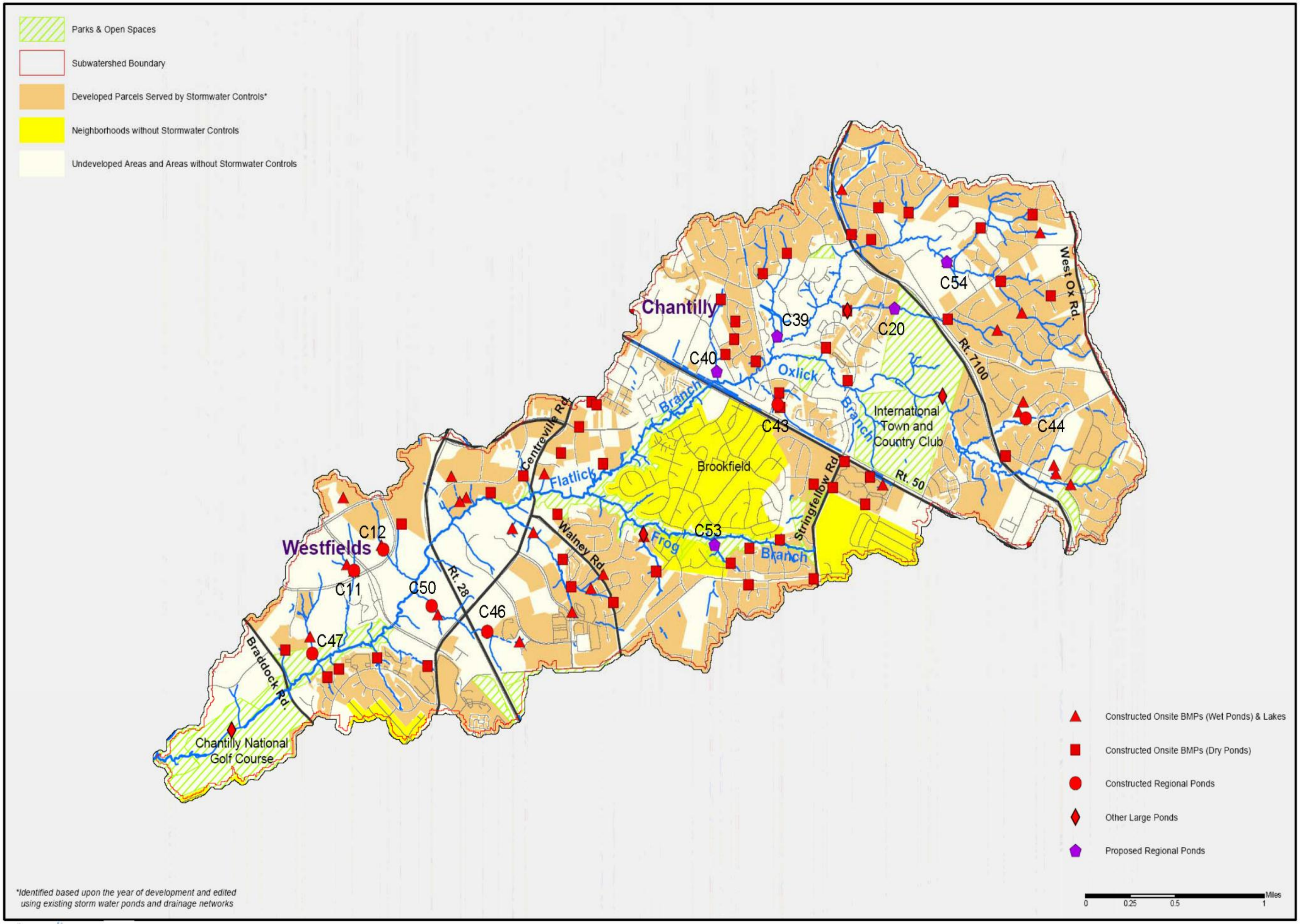

Figure 3-9
Stormwater Facilities in the Flatlick Branch Subwatershed

The subwatershed has relatively little open land available for new development. Future changes result from conversion of undeveloped open land to residential and industrial land use. The industrial areas are primarily within the Route 28 corridor and within Westfields, and will include commercial, office and industrial land uses. Much of this area is upstream from Fairfax County regional ponds that will control the runoff from this development.

Table 3-18
Summary of Existing and Future Land Use
in the Flatlick Branch Subwatershed

Land Use	Existing Conditions		Future Conditions	
	Acres	**Percent**	**Acres**	**Percent**
Open Space	1,698	33.6	596	11.8
Estate-Residential	217	4.3	217	4.3
Low-Density Residential	313	6.2	646	12.8
Medium-Density Residential	1,500	29.7	1,686	33.4
High-Density Residential	456	9.0	475	9.4
Low-Intensity Commercial	523	10.4	525	10.4
High-Intensity Commercial	113	2.2	111	2.2
Industrial	227	4.5	793	15.7
Residential Planned Community	-	-	-	-

Future development will also occur on residential parcels where the existing density is less than the planned density. Much of this development is ongoing, for example in the watershed upstream of Route 7100.

3.5.3 Existing and Future Impervious Area

Table 3-19 provides an overview of the existing and future impervious area estimates.

The impervious area increases five percentage points from 18 to 23 percent. This small increase suggests the subwatershed is mostly built out, and additional impervious area will occur mainly in the lower reaches of the subwatershed, downstream from Centreville Road.

Table 3-19
Summary of Drainage Areas and Existing and Projected
Future Impervious Area for the Flatlick Branch Subwatershed

County	Watershed Area (Acres)	Existing Impervious Area		Future Impervious Area	
		Acres	**Percent**	**Acres**	**Percent**
Oxlick Branch	935	159	17	178	19
Frog Branch	651	124	19	130	20
Remainder of Flatlick Branch	3,462	623	18	866	25
TOTAL FLATLICK BRANCH	**5,048**	906	**18**	1,173	**23**

3.5.4 Existing Stormwater Controls

Figure 3-9 shows the existing dry and wet stormwater ponds in the Flatlick Branch subwatershed and the developed area upstream from these existing ponds as well as the location of Fairfax County regional ponds and other ponds that serve large drainage areas. Planned but not constructed regional ponds are also shown. The watershed may contain other stormwater controls such as underground detention and treatment facilities, and rooftop detention.

Table 3-20 summarizes the number of existing dry and wet ponds as well as the total subwatershed area upstream from these ponds:

Table 3-20
Summary of Number of Ponds and Cumulative Drainage Area
for the Flatlick Branch Subwatershed

Type of Pond	Approximate Number of Ponds *	Total Drainage Area Upstream from Ponds
Dry Ponds	53	1,273 acres
Wet Ponds	26	1,093 acres
Total in Subwatershed	79	2,366 acres

Nearly 50 percent of the subwatershed drainage area is upstream from these 79 existing ponds. In addition, various lakes associated with golf courses exist that, while not providing peak flow and nutrient reduction as provided by constructed stormwater ponds, do provide nutrient reduction and other water quality benefits.

The subwatershed contains seven constructed Fairfax County regional ponds and three additional ponds that serve large drainage areas:

- Regional Pond C11 – Two wet ponds located northwest of the intersection of Stonecroft Road and Conference Center Drive (eastern intersection) that serves a portion of Westfields
- Regional Pond C12 – Wet pond located north of the intersection of Stonecroft Road and Lee Road that serves a portion of Westfields
- Regional Pond C43 – Dry pond constructed north of the intersection of Route 50 and Lees Corner Road. This pond serves townhouse residential areas.
- Regional Pond C44 – Wet pond located west of the intersection of Misty Creek Lane and Broadrun Drive
- Regional Pond C46 – Wet pond located southeast of the intersection of Route 28 and Westfields Boulevard that serves commercial development within Westfields International Center at Dulles
- Regional Pond C47 – Wet pond located south of Conference Center Drive and west of Parkstone Drive within Westfields
- Regional Pond C50 – Wet pond located due west of the intersection of Route 28 and Westfields Boulevard. This pond is downstream from regional pond C46.
- CP52 – This is a regional pond that existing prior to the completion of the 1989 study that identified the locations of the regional ponds. This pond is located south of Frog Branch between Waverly Crossing Lane and Lowry Drive.
- Lake at Chantilly National Golf Course and Country Club. Flatlick Branch flows through this lake close to where Flatlick Branch enters Cub Run. This pond does not have peak flow-shaving benefits but provides water quality benefits. Sedimentation in this lake requires it to be dredged occasionally.
- Lake within the International Town and Country Club that is downstream from a large area of single-family residential. This lake is downstream from regional pond C44.
- Large dry pond located north of Brandy Station Road, south of Shady Ridge Lane and west of Stringfellow Road. This pond is downstream from the proposed site for region pond C20.

Five proposed but not constructed regional ponds sites are within the Flatlick Branch subwatershed:

- C20 is on an unnamed tributary to Flatlick Branch.
- C39 is on an unnamed tributary to Flatlick Branch.
- C40 is on an unnamed tributary to Flatlick Branch.
- C53 is on an unnamed tributary to Frog Branch
- C54 is at an existing lake in the headwaters of Flatlick Branch

The subwatershed includes Brookfield and portions of Greenbriar where development occurred before the county required stormwater controls. Stormwater drainage is provided by closed-pipe storm sewer systems that discharge runoff to the streams without stormwater control facilities to reduce peak flows and stormwater pollution.

3.5.5 Stream Habitat

Physical Habitat

The Fairfax County Stream Physical Assessment Study summarizes the stream physical habitat condition for the Fairfax County streams. Figure 3-10 shows the stream physical habitat ratings for the Flatlick Branch streams, and Table 3-21 summarizes these ratings.

Table 3-21
Summary of Physical Stream Habitat Ratings
for the Flatlick Branch Subwatershed

Physical Stream Habitat Rating	Length of Stream (Miles)	Percent of Total Stream Length Analyzed
Excellent	0.6	4
Good	4.5	29
Fair	6.0	39
Poor	3.3	21
Very Poor	1.2	7

The existing physical habitat is mostly fair to good with some excellent, poor and very poor habitat. Excellent habitat is found in minor tributaries to Frog Branch and the Flatlick Branch main stem just upstream from Braddock Road. Poor habitat is found

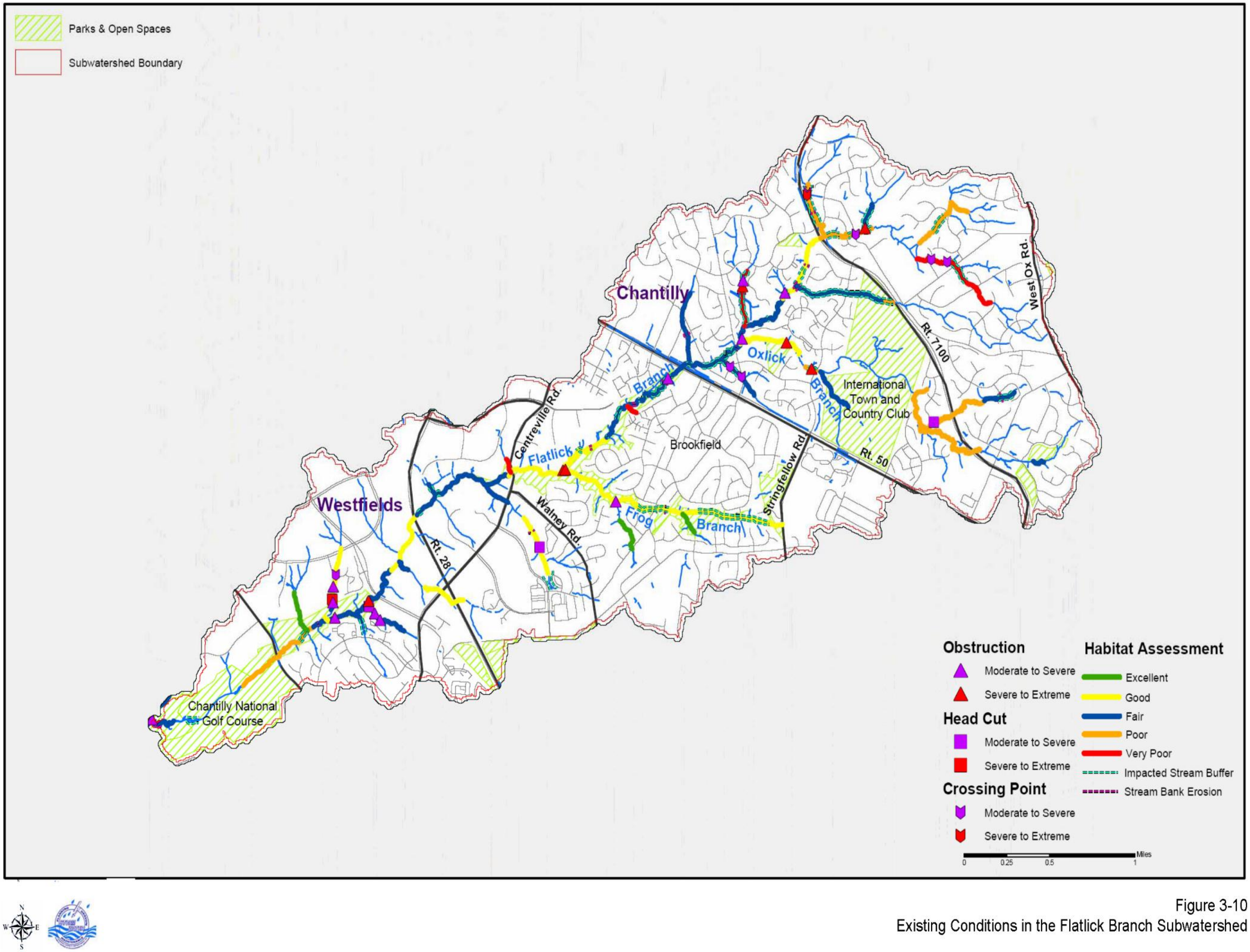

Figure 3-10
Existing Conditions in the Flatlick Branch Subwatershed

in the lower reaches of the Flatlick Branch main stem near Braddock Road and in the subwatershed's headwater areas. The very poor habitat is found in various tributaries. The physical habitat of the main stem of Flatlick Branch ranges from fair to good. Frog Branch has good to excellent habitat scores.

Figure 3-10 also shows the following information from the Stream Physical Assessment Study:

- Locations where the stream buffer is affected
- Erosion inventory lines, indicating areas of active stream erosion
- Obstructions. Most obstructions indicate where trees have fallen into the stream from active erosion.
- Head cuts indicate where the streambed is down-cutting
- Dump sites
- Locations where stream crossings affect the streams

Figure 3-10 includes these features when the impact scores indicate they significantly affect the streams.

Two reaches of the Flatlick Branch main stem have high incidences of stream erosion inventory points and obstructions, indicating active erosion:

1. Between Braddock Road and Stonecroft Road
2. Between Frog Branch and Route 50

Various reaches have stream buffers affected.

Fish and Benthic Macroinvertibrate Studies

The Stream Protection Strategy includes two sampling locations in the Flatlick Branch subwatershed. The conditions found based on the fish and benthic sampling at these sites are summarized in Table 3-22.

These sampling data indicate that the habitat is poor in the Flatlick Branch subwatershed. The sampling data are mostly consistent with the physical habitat condition ratings. The entire Flatlick Branch subwatershed is within the SPS restoration II category where the watershed is managed to prevent further degradation.

Table 3-22
Summary of Stream Protection Strategy Results for
Flatlick Branch Subwatershed

Location	Index of Biotic Integrity	Habitat Score	Fish Taxa Richness	Overall Site Condition Rating	Watershed Management Category
Flatlick Branch upstream from Frog Branch	Poor	Poor	High	Poor	Restoration II
Flatlick Branch upstream from Braddock Road	Fair	Fair	Low	Poor	Restoration II

3.5.6 Stream Water Quality

Fairfax County samples for water quality in the Flatlick Branch subwatershed at two locations:

- Route 50 (29-05)
- Braddock Road (29-06)

These data are summarized in Section 2 and indicate water quality in this subwatershed is typical for many county streams. Fecal coliform concentrations regularly exceed state criteria for surface waters. Dissolved oxygen levels are high, indicating healthy streams. The nitrate concentrations at Route 50 are 50% greater than those at other stations in the subwatershed. Other measured parameters are within acceptable levels and do not indicate abnormal conditions within this subwatershed.

3.5.7 Stream Geomorphology

The Flatlick Branch subwatershed has variable stream geomorphology, largely due to the underlying geology in this area of the Triassic basin. The streambed in Frog Branch is red sandstone that causes this stream to be less affected by erosion and have good habitat scores. Other areas of the subwatershed, including the lower reaches of Flatlick Branch, have deep clay soils and shale that make the streams susceptible to changes in stream flow and therefore to exhibit greater impacts from stream erosion.

The Fairfax County Stream Physical Assessment Study includes the Channel Evolution Model (CEM) stage and stream substrate.

- Frog Branch has bedrock and cobble as the dominant stream substrate. The streams are classified as being in stage III transitioning to stage IV, indicating the streams are stabilizing.

- Oxlick Branch is in CEM stage III with some segments in stage II. The streams are widening and down-cutting. The substrate in these reaches is sand.
- Upper Flatlick upstream from Route 50 is in stage III and IV, indicating the streams are widening and may be stabilizing. The substrate is primarily sand and cobble with some silt and gravel.
- Middle Flatlick downstream between Route 28 and Route 50 is predominantly in stage III, indicating the stream is widening. Some reaches are transitioning to stage IV, suggesting the streams are stabilizing in some areas. The stream substrate is a mix of sand, gravel, cobble and silt.
- Lower Flatlick downstream from Route 28 is between stage III and IV, indicating stream widening though some sections are stabilizing. The substrate is a mix of sand, gravel and silt.

3.5.8 Concerns Identified by the Public

The CAC and attendees of the public forums identified the following concerns in the Flatlick Branch subwatershed:

- Trash and litter were identified as issues throughout this subwatershed.
- Erosion in small streams within homeowner association common property and other open space. In these areas small streams are actively down-cutting. This is occurring where stormwater outfalls from the nearby development concentrate the flow. Prior to development, the flow was distributed over the land surface. The concentrated flow produced by the stormwater outfalls creates drainage ditches where none existed before, resulting in stream erosion. In other areas, drainage ditches need to be cleaned and maintained. These concerns were identified for Franklin Glen Governance and Fair Oaks Estates but also occur in many residential areas north of Route 50.
- Flooding at Walney Road
- Maintenance of stormwater ponds, both private and public
- Invasive species (grape vines) taking over and killing trees near Lee's Corner Elementary School

3.5.9 Modeling Results

Figure 3-11 presents stormwater modeling results for the Flatlick Branch subwatershed. Section 2.8 presents addition details on the modeling and modeled scenarios.

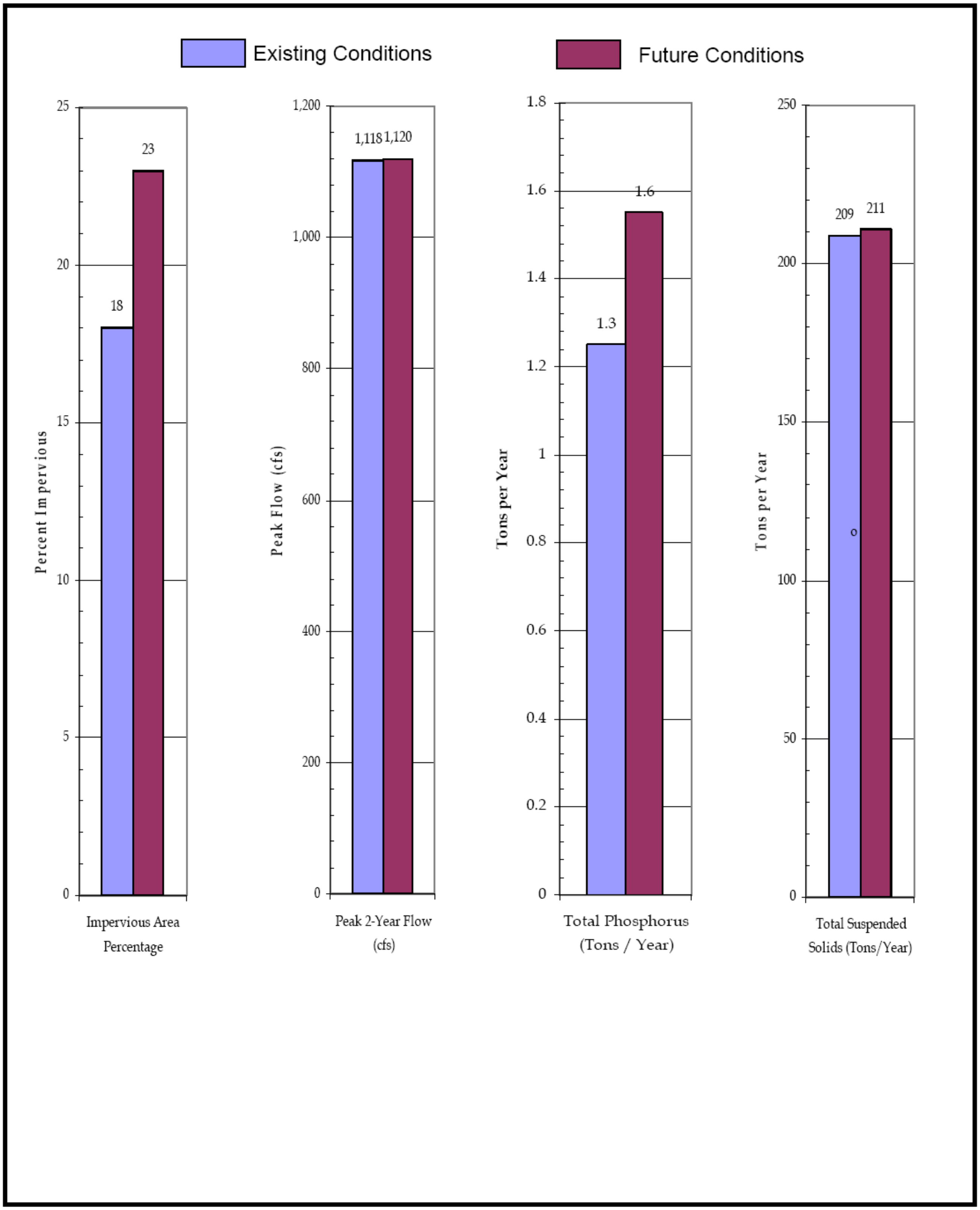

Figure 3-11
Overview of Existing and Future Conditions in the Flatlick Branch Subwatershed

Future peak flows with stormwater controls for the two-year storm are essentially unchanged for future conditions. Total phosphorus loadings increase by 24 percent.

3.6 Big Rocky Run and Round Lick Branch Subwatersheds

Overview of Conditions in the Big Rocky Run and Round Lick Branch Subwatersheds

- **Drainage area**
  Big Rocky Run = 5,997 acres (9.4 square miles)
  Round Lick Branch = 1,047 acres (1.6 square miles)
- **Existing impervious area**
  Big Rocky Run = 23 percent
  Round Lick Branch = 17 percent
- **Future impervious area**
  Big Rocky Run = 27 percent
  Round Lick Branch = 18 percent
- **The watersheds have relatively little open space available for future development. As a result, the development in the watershed is approaching built out conditions.**
- **Existing stormwater ponds reduce peak flows and control stormwater runoff from most of the developed portions of the subwatershed.**
- **The subwatersheds include areas in Greenbriar, Birch Pond and Country Club Manor where the development occurred before stormwater controls were required. The stormwater systems in these areas are closed-pipe systems that discharge flows to the streams without controls to reduce peak flows and reduce pollutant runoff.**
- **The stream habitat in the Big Rocky Run subwatershed is among the best found in the Cub Run streams in spite of the high development density and lack of stormwater controls in portions of the subwatershed. This largely results from the underlying geology that causes the streams to have rocky substrate that is resistant to stream erosion and produces good habitat scores.**

The following sections summarize the conditions in the Big Rocky Run and Round Lick Branch subwatersheds.

3.6.1 Overview of Drainage Characteristics

Figure 3-12 shows the Big Rocky Run and Round Lick Branch subwatersheds' drainage boundaries and major streams. As discussed later in this section, Figure 3-12 also presents the location of existing dry ponds, wet ponds, regional ponds and previously proposed regional ponds.

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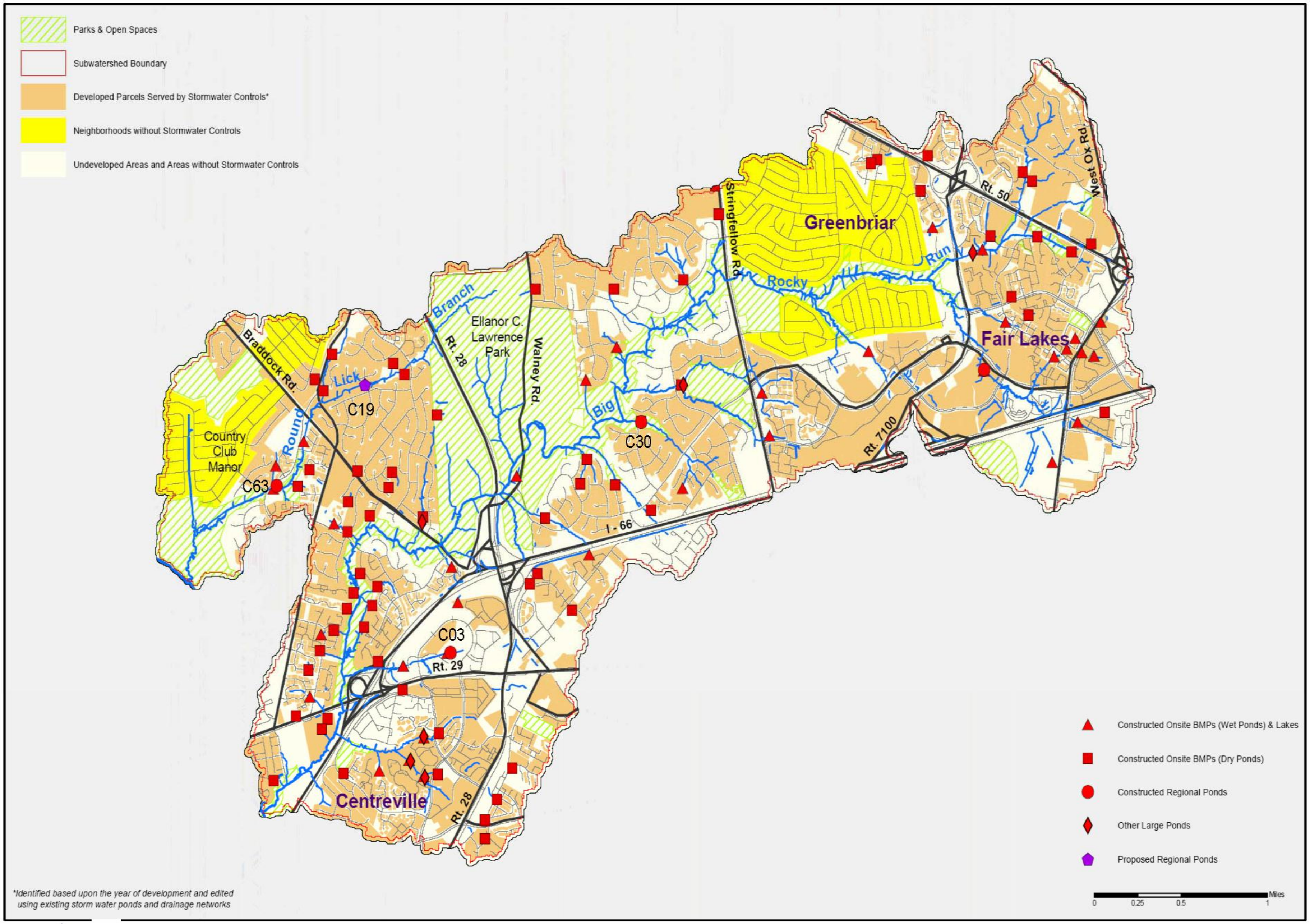

Figure 3-12
Stormwater Facilities in the Big Rocky Run and Round Lick Branch Subwatersheds

Big Rocky Run flows northeast to southwest. The headwaters are near Fair Oaks and Fair Lakes. None of the tributaries are named. The subwatershed area equals 5,997 acres (9.4 square miles).

Round Lick Branch also flows northeast to southwest with no named tributaries. The subwatershed area equals 1,047 acres (1.6 square miles).

3.6.2 Existing and Future Land Use

Tables 3-23 and 3-24 summarize the existing and future land use in the Big Rocky Run and Round Lick Branch subwatersheds.

The Big Rocky Run subwatershed includes a high percentage of residential development with an approximate equal split between medium- and high-density residential land uses. Commercial, office and other mixed uses exist in the Fair Lakes and Fair Oaks areas. Future development opportunities are small, mainly consisting of converting undeveloped areas and areas with low development density to the planned medium-density residential and commercial land use.

The Round Lick Branch is mostly medium-density residential with very little opportunity for additional development.

The Ellanor C. Lawrence Park composes a large portion of Big Rocky Run and Round Lick Branch subwatersheds, preserving a large percentage of open space.

In some cases, areas where the existing development density is Estate-Residential will be developed at the higher density allowed by the Comprehensive Land Use Plan.

Table 3-23
Summary of Existing and Future Land Use in the
Big Rocky Run Subwatershed

Land Use	Existing Conditions		Future Conditions	
	Acres	**Percent**	**Acres**	**Percent**
Open Space	1,727	28.8	1,130	18.9
Estate-Residential	156	2.6	-	-
Low-Density Residential	120	2.0	234	3.9
Medium-Density Residential	1,685	28.1	1,998	33.3
High-Density Residential	1,319	22.0	1,319	22.0
Low-Intensity Commercial	618	10.3	858	14.3
High-Intensity Commercial	192	3.2	232	3.9
Industrial	180	3.0	180	3.0
Residential Planned Community	-	-	45	0.7

Table 3-24
Summary of Existing and Future Land Use in the
Round Lick Branch Subwatershed

Land Use	Existing Conditions		Future Conditions	
	Acres	Percent	Acres	Percent
Open Space	343	32.8	334	31.9
Estate-Residential	4	0.4	-	-
Low-Density Residential	19	1.8	24	2.3
Medium-Density Residential	550	52.6	559	53.4
High-Density Residential	86	8.2	86	8.2
Low-Intensity Commercial	43	4.1	43	4.1
High-Intensity Commercial	1	0.1	1	0.1
Industrial	-	-	-	-
Residential Planned Community	-	-	-	-

3.6.3 Existing and Future Impervious Area

Table 3-25 provides an overview of the existing and future impervious area estimates.

Table 3-25
Summary of Drainage Areas and Existing and Projected Future Impervious Area for
the Big Rocky Run and Round Lick Branch Subwatersheds

County	Watershed Area (Acres)	Existing Impervious Area		Future Impervious Areas	
		Acres	Percent	Acres	Percent
Big Rocky Run	5,997	1,397	23.3	1,601	26.7
Round Lick Branch	1,047	177	16.9	187	17.9
TOTAL	**7,044**	1,574	**22.3**	1,789	**25.4**

The Big Rocky Run impervious area increases four percentage points from 23 to 27 percent.

Round Lick Branch impervious area increases one percentage point from 17 to 18 percent.

The small impervious area increase suggests these two subwatersheds are mostly built out with little room for additional development.

3.6.4 Existing Stormwater Controls

Figure 3-12 shows the stormwater ponds in the Big Rocky Run and Round Lick Branch subwatersheds, and the developed area upstream from these ponds. This figure also shows the Fairfax County regional stormwater ponds and other ponds that control large areas of the subwatershed as well as the location of planned but not constructed Fairfax County regional stormwater ponds. The watershed may contain other stormwater controls such as underground detention and treatment facilities, and rooftop detention.

Big Rocky Run

Table 3-26 summarizes the number of dry and wet ponds, and the total subwatershed area upstream from these ponds in the Big Rocky Run subwatershed.

Table 3-26
Summary of Number of Ponds and Cumulative Drainage Area
for the Big Rocky Run Subwatershed

Type of Pond	Approximate Number of Ponds *	Total Drainage Area Upstream from Ponds
Dry Ponds	56	1,516 acres
Wet Ponds	32	1,667 acres
Total in Subwatershed	88	3,183 acres

Approximately 53 percent of the subwatershed drainage area is upstream from these 88 ponds.

The watershed contains two constructed Fairfax County regional ponds and six additional ponds that serve large drainage areas but may not be part of the county regional pond program:

- Regional Pond C03 – Two wet ponds in Centreville within Trinity Centre between Trinity Parkway and Route 29
- Regional Pond C30 – Dry pond between Doyle Lane and Bare Island Drive in a mostly single-family residential watershed
- Wet pond on Big Rocky Run immediately upstream from the Fairfax County Parkway and includes a large area of the headwaters of Big Rocky Run

- CP1 – Two wet regional ponds constructed before the 1989 regional pond study within Centreville west of the intersection of Centrewood Drive and Machen Road

- CP2 – Wet pond constructed before the 1989 regional pond study within Centreville west of Machen Road between Rosebud Lane and Morning Dove Lane

- CP34 – Dry pond constructed before the 1989 regional pond study north of Braddock Road between Cedar Break Drive and Sequoia Farms Drive

- CP64 – Dry pond constructed before the 1989 regional pond study located north of the Melville Lane and Bare Island Drive intersection. The watershed includes Poplar Tree Park.

- Wet pond and dry pond in series within Fair Lakes south of Fair Lakes Parkway near Fair Lakes Circle

No proposed regional ponds are within Big Rocky Run.

The Big Rocky Run subwatershed includes the Greenbriar and Birch Pond neighborhoods constructed before the county required stormwater controls. These areas have closed-conduit stormwater drainage systems that discharge to the streams without any controls to limit the peak flows or reduce the pollutants in the stormwater runoff.

Round Lick Branch

Table 3-27 summarizes the number of dry and wet ponds in the Round Lick Branch subwatershed and the total drainage area upstream from these ponds.

Table 3-27
Summary of Number of Ponds and Cumulative Drainage Area
for the Round Lick Branch Subwatershed

Type of Pond	**Approximate Number of Ponds ***	**Total Drainage Area Upstream from Ponds**
Dry Ponds	10	247 acres
Wet Ponds	3	400 acres
Total in Subwatershed	13	647 acres

The 13 ponds control the flow from 62 percent of the subwatershed.

The subwatershed includes one Fairfax County regional pond:

- Regional Pond C63 – Two wet ponds on Round Lick Branch adjacent to Sully Park Drive south of Braddock Road. These ponds include much of the Round Lick subwatershed.

The planned site for one proposed but not constructed regional pond, C19, is on the Round Lick Branch main stem upstream from regional pond C63.

The subwatershed includes the Country Club Manor neighborhood where the development occurred before the county required stormwater ponds to control peak flows and water quality. These neighborhoods have closed-pipe storm drainage systems and paved concrete channels that outfall to the existing streams with no stormwater controls to limit the peak flow rates and reduce the runoff's pollutant concentrations.

3.6.5 Stream Habitat

Physical Stream Habitat

The Fairfax County Stream Physical Assessment Study summarizes the physical habitat condition for the Fairfax County streams. Figure 3-13 shows the physical habitat ratings for the Big Rocky Run and Round Lick Branch streams. Tables 3-28 and 3-29 summarize the stream habitat for Big Rocky Run and Round Lick Branch subwatersheds, respectively.

Table 3-28
Summary of Physical Stream Habitat Ratings
for the Big Rocky Run Subwatershed

Physical Stream Habitat Rating	Length of Stream (Miles)	Percent of Total Stream Length Analyzed
Excellent	3.9	22
Good	6.3	36
Fair	5.9	33
Poor	1.6	9
Very Poor	0	0

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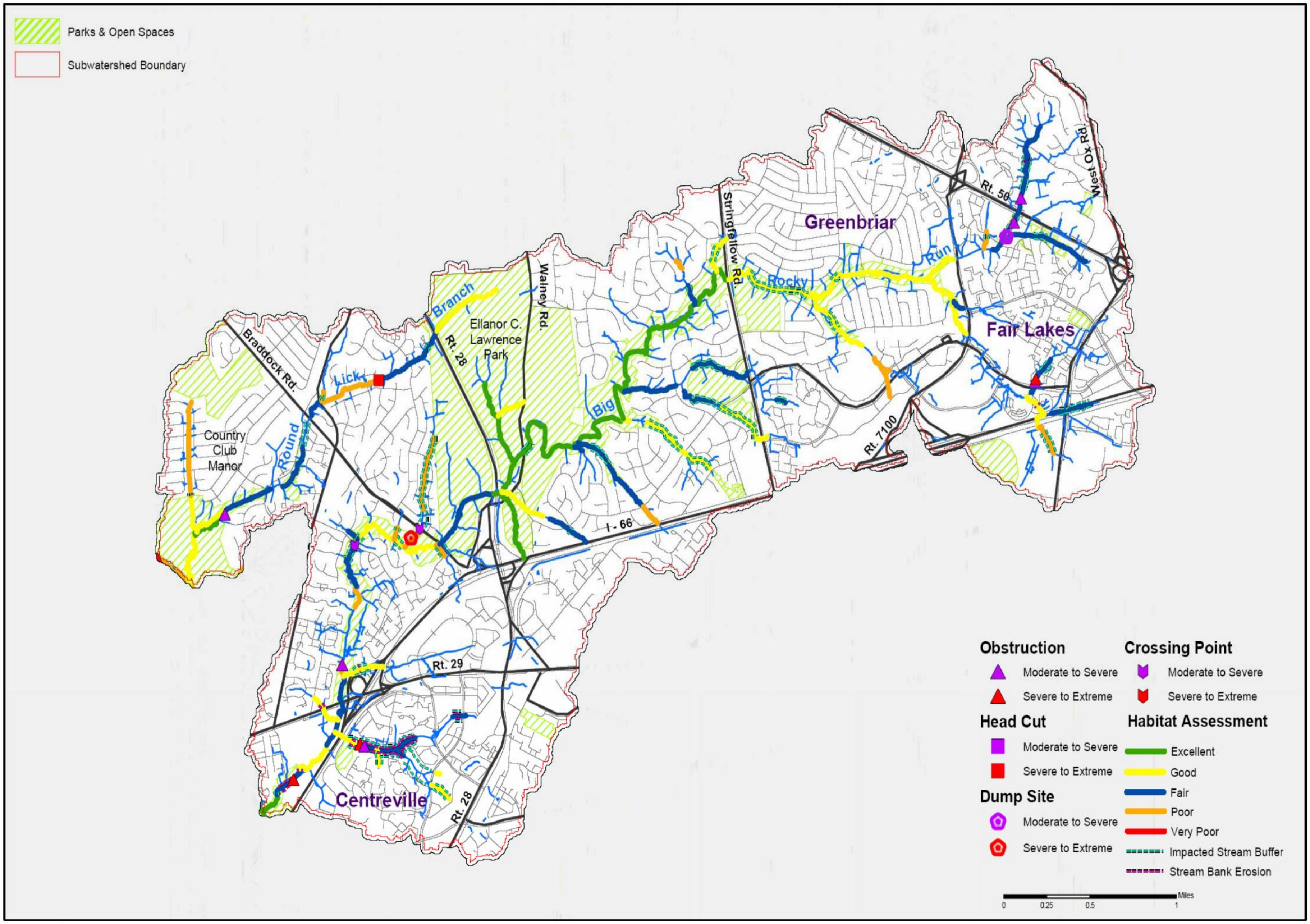


Figure 3-13
Existing Conditions in the Big Rocky Run and Round Lick Branch Subwatersheds

Table 3-29
Summary of Physical Stream Habitat Ratings
for the Round Lick Branch Subwatershed

Physical Stream Habitat Rating	Length of Stream (Miles)	Percent of Total Stream Length Analyzed
Excellent	0.3	8
Good	1.3	36
Fair	1.2	31
Poor	0.9	24
Very Poor	0.0	0

Big Rocky Run has a high percentage of streams rated as having excellent and good physical habitat. Excellent physical habitat scores exist in the main stem from Stringfellow Road to Route 28. Good physical habitat scores dominate most of the stream reaches upstream from Stringfellow Road. The rock and gravel substrate in these reaches contributes to the high habitat scores. Smaller tributaries have fair and poor habitat scores.

The main stem of Round Lick Branch has mostly poor and fair physical habitat ratings, with good habitat scores within Ellanor C. Lawrence Park in the upstream reaches and within the Cub Run Stream Valley Park in the downstream reaches.

Figure 3-13 also shows the following from the Stream Physical Assessment Study:

- Locations where the stream buffer is affected
- Erosion inventory lines, indicating areas of active stream erosion
- Obstructions. Most obstructions indicate where trees have fallen into the stream from active erosion.
- Head cuts indicate where the streambed is down-cutting
- Dump sites
- Locations where stream crossings affect the streams

Figure 3-13 includes these features when the scores indicate a significant stream impact.

Compared to other streams in the subwatershed, the upper reaches of Big Rocky Run upstream from Route 28 have few stream-erosion inventory lines and good scores for bank stability. Lower reaches of Big Rocky Run south of Route 28 have stream-erosion inventory lines, blockages and poor stream bank stability scores, suggesting active stream erosion.

Round Lick Branch has no stream-erosion inventory lines. However, head cuts and stream bank stability scores suggest active erosion between Braddock Road and Sully Park Drive.

Fish and Benthic Macroinvertibrate Studies

The Stream Protection Strategy includes two sampling locations in the Big Rocky Run and none in the Round Lick Branch. The conditions found in Big Rocky Run based on the fish and benthic sampling at these sites are summarized in Table 3-30.

Table 3-30
Summary of Stream Protection Strategy Results for
Big Rocky Run and Round Lick Branch Subwatershed

Location	Index of Biotic Integrity	Habitat Score	Fish Taxa Richness	Overall Site Condition Rating	Watershed Management Category
Big Rocky Run in Ellanor C. Lawrence Park upstream from Walney Road	Fair	Excellent	High	Good	Protection Area
Big Rocky Run near Confluence with Cub Run	Fair	Fair	Moderate	Fair	Restoration II

The stream organism sampling data indicate good to fair habitat in the Big Rocky Run subwatershed. The rock and gravel stream strata, and protection from the Big Rocky Run Stream Valley Park and Ellanor C. Lawrence Park contribute to habitat scores greater than would be expected for an urban stream with this subwatershed's development density and lack of stormwater controls over large areas.

The upper Big Rocky Run watershed above Ellanor C. Lawrence Park is within the watershed protection category in which the main management strategy is to identify and protect the conditions responsible for producing these high-quality stream environments.

The lower portions of the Big Rocky Run watershed are within Restoration II category in which the management strategy is to prevent further watershed degradation. Round Lick Branch was sampled subsequent to the SPS study and is within the SPS Restoration II category.

3.6.6 Stream Water Quality

Fairfax County regularly samples for water quality in the Big Rocky Run at a single location:

- Braddock Road (29-06)

Water quality sampling is not performed regularly within Round Lick Branch.

These data are summarized in Section 2 and indicate water quality in this subwatershed is typical for many county streams. Fecal coliform concentrations regularly exceed the state criteria for surface waters. Dissolved oxygen levels are high, indicating the stream is healthy and able to support life. Other measured parameters are within acceptable levels and do not indicate abnormal conditions within this subwatershed.

3.6.7 Stream Geomorphology

Big Rocky Run

The Big Rocky Run subwatershed has variable stream geomorphology, largely due to the underlying geology in this area of the Triassic basin. The streambed in Big Rocky Run upstream from Route 28 comprises rock, sand and gravel, causing these streams to be less affected by erosion and have good habitat scores. Other areas of the Cub and Bull Run watersheds have deep clay soils and shale that are more erodable and provide lower habitat scores.

The Fairfax County Stream Physical Assessment Study includes the Channel Evolution Model (CEM) stage and stream substrate.

The streams in Big Rocky Run subwatershed are in CEM stage III and IV, indicating the streams are widening but stabilizing. The substrate is predominantly sand and gravel with some silt, cobble, clay and boulders.

Round Lick Branch

The streams in Round Lick Branch are in CEM stage III and IV, indicating the streams are widening but stabilizing. The substrate is predominantly gravel.

3.6.8 Concerns Identified by the Public

The CAC and attendees of the public forums identified the following concerns in the Big Rocky Run and Round Lick Branch subwatersheds:

- Trash and litter identified as issues in these subwatersheds

- Erosion in small streams within homeowner association common property or open space within the Fair Oaks Estates neighborhood north of Route 50. Local small streams are actively down-cutting. In many areas this is occurring where stormwater outfalls concentrate the flow, whereas before development occurred runoff was distributed over the land surface. This flow concentration is creating ditches and stream erosion.

- Maintenance of stormwater ponds, both private and public
- Erosion and fallen trees near the location where Big Rocky Run crosses under Route 29
- Flooding where Stringfellow Road crosses Big Rocky Run
- Flooding on Poplar Tree Drive near Stringfellow Road
- Sediment control issues produced by water line construction along Stringfellow Road
- Dump site behind William Carr Lane
- Deteriorated trails along Big Rocky Run near Newton Patent Court
- Dumping of yard and landscaping debris in parkland near Awbrey Patent Drive
- Active beaver population and impact on stream and stream valley between Braddock Road and Awbrey Patent Drive
- Flooding of Awbrey Patent Drive. The frequency of flooding seems to be increasing over the past few years.
- Exotic plants taking over the stream valleys at some locations

3.6.9 Modeling Results

Figure 3-14 presents stormwater modeling results for the Big Rocky Run and Round Lick Branch subwatersheds. Section 2.8 presents additional details on the modeling and modeled scenarios.

Peak flows for the two-year design storm do not increase significantly from existing to future land use conditions. Total phosphorus loads increase 10 percent.

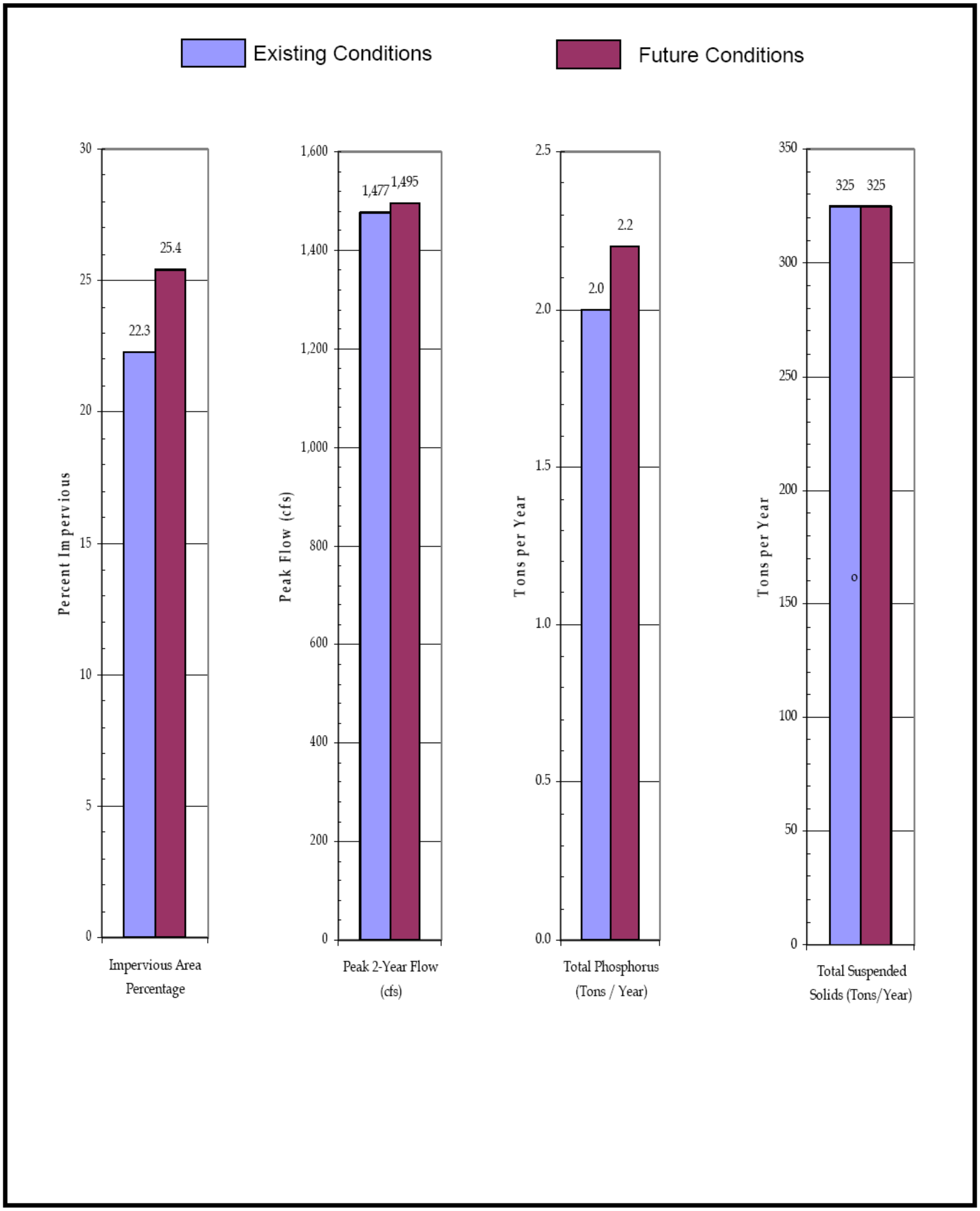


Figure 3-14
Overview of Existing and Future Conditions
in the Big Rocky Run and Roundlick Branch Subwatersheds

3.7 Lower Cub Run Subwatershed

Overview of Conditions in the Lower Cub Run Subwatershed

- **Drainage area = 3,939 acres (6.2 square miles)**
- **Existing impervious area = 9 percent**
- **Future impervious area = 12 percent**
- **Much of the subwatershed is in the Estate-Residential R-C District resulting in low existing development densities and little potential for future development.**
- **Stream conditions in the Lower Cub Run Subwatershed are affected by conditions in the upstream subwatersheds (Upper Cub Run, Elklick Run, Flatlick Branch, Big Rocky Run and Round Lick Branch). The total drainage area of these upstream subwatersheds equals 48 square miles and the average impervious area is projected to increase significantly from 14 to 26 percent.**
- **Stream habitat and erosion conditions vary, primarily due to the underlying geology and stream gradients.**
- **Small streams that enter Lower Cub Run downstream from Compton Road show poor habitat and stream erosion even though there is little development.**
- **Streams within the Virginia Run neighborhoods are affected by loss of habitat due to impacted stream buffers.**
- **The subwatershed includes three proposed but not constructed Fairfax County regional ponds.**

The following sections summarize the conditions in the Lower Cub Run subwatershed.

3.7.1 Overview of Drainage Characteristics

Figure 3-15 shows the Lower Cub Run subwatershed drainage boundaries and the major streams. As discussed later in this section, Figure 3-15 also presents the location of existing dry ponds, wet ponds, regional ponds and previously proposed regional ponds. The Lower Cub Run subwatershed is almost entirely in the rezoned R-C District. However, significant portions of the subwatershed near Virginia Run and Gate Post Estates were developed at a higher density than the one home per 5-acre Estate-Residential land use. Development in these areas was planned when rezoning occurred and, therefore, was allowed to proceed at the planned higher densities. These higher-density developments include stormwater ponds to control the peak flows and water quality. The Gate Post Estates neighborhood also includes low-impact development techniques such as drainage swales in place of traditional curb and gutter, reduced pavement width and sidewalks on only one side of the road. These designs reduce the amount of pavement within the development and the impact this development has on the local streams.

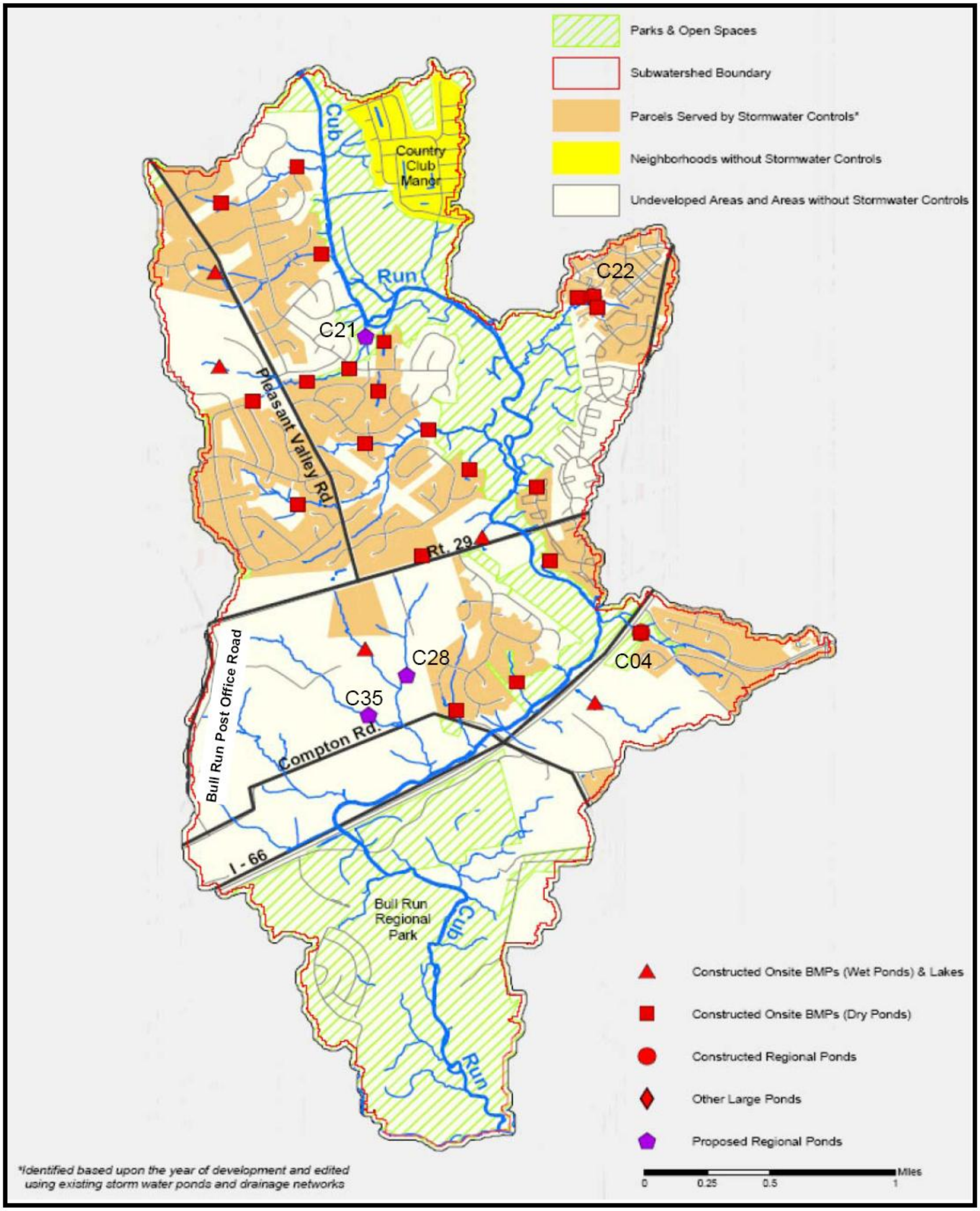


Figure 3-15
Stormwater Facilities in the
Lower Cub Run Subwatershed

The subwatershed begins near the confluence of Elklick Run, Flatlick Branch and Cub Run. Lower Cub Run flows generally from north to south but makes several turns along the way. Round Lick Branch and Big Rocky Run enter the Lower Cub Run subwatershed from the east.

3.7.2 Existing and Future Land Use

Table 3-31 provides an overview of the existing and future land use in the Lower Cub Run subwatershed.

The existing land use is predominantly Estate-Residential and Open Space. Low- and medium-density residential land use occurs in the Virginia Run and Gate Post Estates areas of the R-C District. These developments were planned at the time of the rezoning. Higher densities also exist outside of the R-C District to the east of the Cub Run main stem (London Towne and Lee Overlook). Some commercial development exists in the subwatershed along Route 29 east of Cub Run.

Future development will mainly result from development of vacant and underutilized parcels in compliance with the R-C district minimum lot sizes of 5 acres. This results in only small increases in impervious area.

The Northern Virginia Park Authority Bull Run Regional Park and Fairfax County Park Authority Cub Run Stream Valley Park compose a large portion of the Lower Cub Run subwatershed, preserving a large percentage of open space.

The UOSA advanced wastewater treatment plant is located within this subwatershed.

3.7.3 Existing and Future Impervious Area

Table 3-32 provides an overview of the existing and future impervious area estimates.

The impervious area for Lower Cub Run will increase three percentage points from 9 to 12 percent. These values also suggest the subwatershed is mostly built out with little room for additional development, and development that will occur will be low-density, 5-acre Estate-Residential.

The Lower Cub Run subwatershed area is 6.2 square miles, whereas the combined area of the upstream subwatersheds is 47 square miles. Therefore, conditions in the Lower Cub Run main stem are mostly affected by the existing and future development in upstream subwatersheds, including Upper Cub, Elklick Run, Flatlick Branch, Big Rocky Run and Round Lick Branch. The impervious area for these combined upstream subwatersheds is projected to increase from 14 percent for existing conditions to 26 percent for future conditions.

Table 3-31
Summary of Existing and Future Land Use in the Lower Cub Run Subwatershed

Land Use	Existing Conditions		Future Conditions	
	Acres	**Percent**	**Acres**	**Percent**
Open Space	2,072	52.6	1,457	37.0
Estate-Residential	398	10.1	985	25.0
Low-Density Residential	248	6.3	248	6.3
Medium-Density Residential	670	17.0	697	17.7
High-Density Residential	213	5.4	213	5.4
Low-Intensity Commercial	98	2.5	98	2.5
High-Intensity Commercial	-	-	-	-
Industrial	12	0.3	12	0.3
Residential Planned Community	-	-	-	-
Upper Occoquan Sewerage Authority Advanced Wastewater Treatment Plant	228	5.8	228	5.8

Table 3-32
Summary of Drainage Areas and Existing and Projected
Future Impervious Area for the Lower Cub Run Subwatershed

County	Watershed Area (Acres)	Existing Impervious Area		Future Impervious Area	
		Acres	**Percent**	**Acres**	**Percent**
Lower Cub Run	3,939	370	9.4	477	12.1

3.7.4 Existing Stormwater Controls

Figure 3-15 shows the existing stormwater ponds in the Lower Cub Run subwatershed and the developed areas upstream from these existing ponds. This figure also shows the location of existing Fairfax County regional ponds and other ponds that serve large drainage areas though they are not included in the county regional pond program. Finally, Figure 3-15 shows the location of planned regional ponds that have not been constructed. The watershed may contain other stormwater controls such as underground detention and treatment facilities, and rooftop detention.

Table 3-33 summarizes the number of existing dry and wet ponds and the total subwatershed area upstream from these ponds in the Lower Cub Run subwatershed.

Table 3-33
Summary of Number of Ponds and Cumulative Drainage Area
for the Lower Cub Run Subwatershed

Type of Pond	Approximate Number of Ponds *	Total Drainage Area Upstream from Ponds
Dry Ponds	20	1,080 acres
Wet Ponds	5	181 acres
Total in Subwatershed	25	1,261 acres

Approximately 32 percent of the subwatershed drainage area is upstream from these 25 existing ponds. These ponds control most of the areas currently developed at densities greater than Estate-Residential.

The Lower Cub Run subwatershed contains two constructed Fairfax County regional ponds:

- Regional Pond C04 – Dry pond located east of Route 66 between Store House Road and Picket Oaks Road
- Regional Pond C22 – Two dry ponds located north of Basingstoke Loop and south of Summer Lake Way

The following three proposed but not constructed regional ponds are within this subwatershed: C21, C28 and C35. These ponds are all on small, unnamed tributaries within the R-C District.

The Lower Cub Run subwatershed includes portions of the Country Club Manor neighborhood that was developed before stormwater controls were required. This development has closed-conduit stormwater drainage systems that discharge to the streams without any controls to limit the peak flows and reduce the pollutants in the stormwater runoff.

3.7.5 Stream Habitat

Physical Habitat

The Fairfax County Stream Physical Assessment Study summarizes the stream physical habitat condition for the Fairfax County streams. Figure 3-16 shows the stream physical habitat ratings for the Lower Cub Run streams, and Table 3-34 summarizes these ratings.

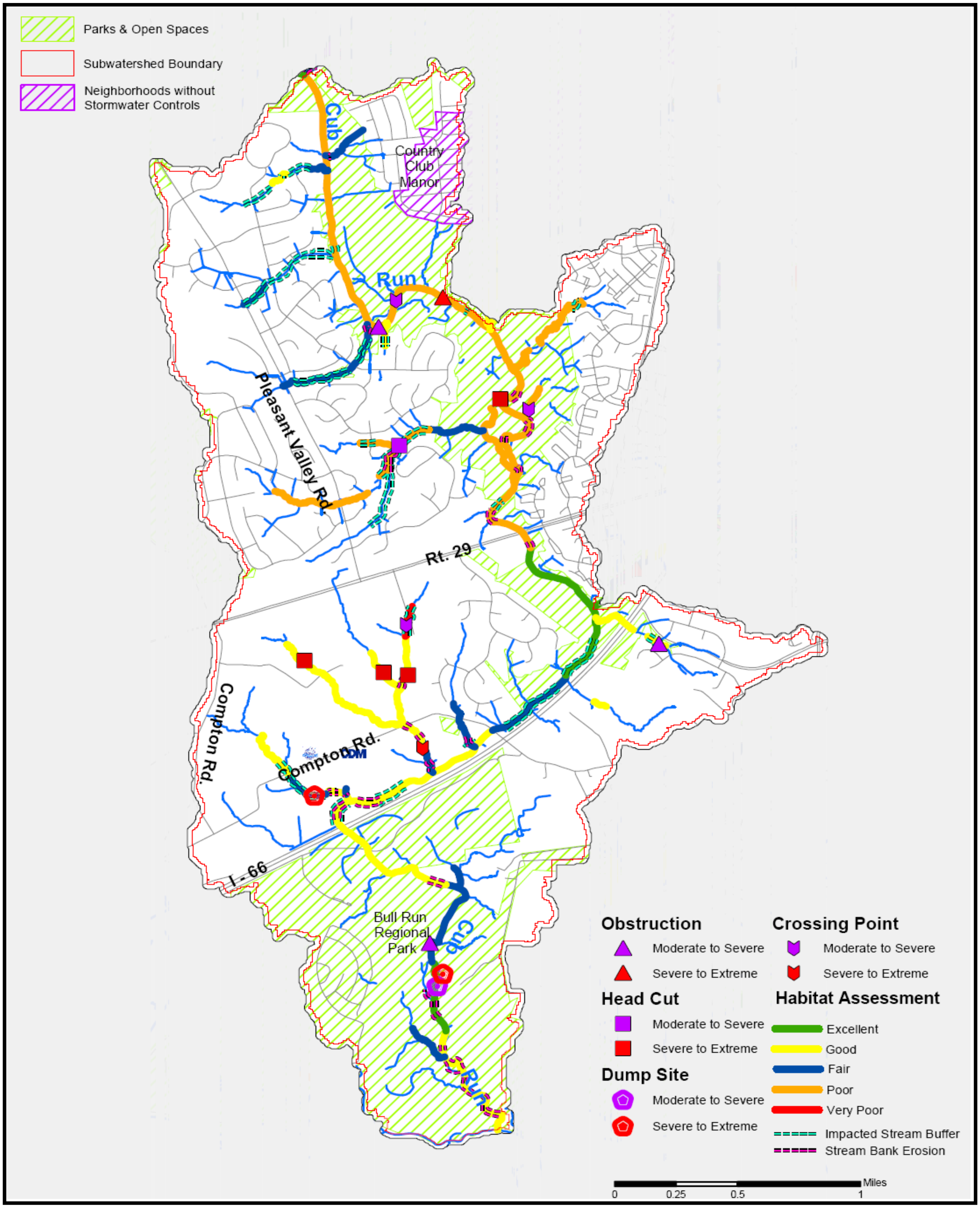


Figure 3-16
Existing Conditions in the
Lower Cub Run Subwatershed

Table 3-34
Summary of Physical Stream Habitat Ratings
for the Lower Cub Run Subwatershed

Physical Stream Habitat Rating	Length of Stream (Miles)	Percent of Total Stream Length Analyzed
Excellent	1.1	8
Good	4.3	32
Fair	2.9	22
Poor	5.1	38
Very Poor	0.1	1

The Lower Cub Run main stem can be broken into four reaches, primarily based on the underlying geology and stream habitat conditions:

- The main stem reach upstream from Route 29 generally has clay soils and shale. Poor bank stability and sediment deposition results in poor physical habitat conditions within the main stem of Cub Run upstream from Route 29. This section is within the Cub Run Stream Valley Park and generally has good stream buffers except at locations where utilities (power lines, water lines, etc.) cross the stream. The stream is adjacent to Virginia Run.

- The small streams that enter Cub Run from the Virginia Run neighborhoods generally have poor habit ratings primarily resulting from poor stream buffers. As with the first reach, these reaches lie in areas with clay soils and shale.

- The middle reach of Cub Run from Route 29 to below Big Rocky Run but upstream from Compton Road is in an area underlain by rock associated with an igneous intrusion. This stream has a high gradient and the substrate consists of rock, boulders and cobbles. The high gradient generally reduces sediment deposition in this reach. This stream lies within the Cub Run Stream valley park, and the stream buffers are generally good except where a power line crosses the stream. These factors produce excellent physical habitat scores for this middle reach.

- The lower reach downstream from Compton Road again is in clay soils with shale. The gradient decreases within Bull Run Regional Park, resulting in significant sediment deposition and braided streams. The habitat in this reach ranges from excellent to fair.

Figure 3-16 also shows the following information from the Stream Physical Assessment Study:

- Locations where the stream buffer is affected
- Erosion inventory lines, indicating areas of active stream erosion
- Obstructions. Most obstructions indicate where trees have fallen into the stream from active erosion.
- Head cuts indicate where the streambed is down-cutting
- Dump sites
- Locations where stream crossings affect the streams

Figure 3-16 includes these features where the impact scores indicate they have a significant stream impact.

Upper reaches of the Cub Run main stem, upstream from Route 29, generally have unstable vertical banks that result in many stream erosion inventory lines - especially at the outside of bends - and poor stream bank stability scores. Similar conditions exist downstream from Compton Road, through Bull Run Regional Park, to Bull Run. Stream segments within Bull Run Regional Park have high incidences of stream bank erosion, mostly occurring on the outside of bends.

Streams entering Cub Run from the north between Compton Road and Route 66 generally have good habitat. However, these streams show head cuts, stream-erosion inventory lines and poor stream bank stability scores that indicate active erosion. These streams have low development densities that should not produce this erosion. The erosion may result from past lands uses or down-cutting of Cub Run.

Fish and Benthic Macroinvertibrate Studies

The Stream Protection Strategy includes two sampling locations in Lower Cub Run. The conditions found at these sites based on the sampling of fish and benthic macroinvertibrates are summarized in Table 3-35.

The sampling data indicate that the habitat is poor to good in the Lower Cub Run subwatershed, correlating well with the physical habitat condition ratings. This entire subwatershed is within the restoration II category in which the main management strategy is to prevent further degradation.

Table 3-35
Summary of Stream Protection Strategy Results for
Lower Cub Run Subwatershed

Location	Index of Biotic Integrity	Habitat Score	Fish Taxa Richness	Overall Site Condition Rating	Watershed Management Category
Lower Cub Run at Compton Road	Fair	Very Poor	Moderate	Poor	Restoration II
Lower Cub Run within Bull Run Regional Park	Fair	Fair	Moderate	Good	Restoration II

3.7.6 Stream Water Quality

Fairfax County samples for water quality in the Lower Cub Run at a single location:

- Cub Run at Compton Road (29-04)

These data are summarized in Section 2 and indicate water quality in this subwatershed is typical for many county streams. Fecal coliform concentrations regularly exceed the state criteria for surface waters. Dissolved oxygen levels are high, indicating a healthy stream capable of supporting life. Other measured parameters are within acceptable levels and do not indicate abnormal conditions within this subwatershed.

3.7.7 Stream Geomorphology

The Lower Cub Run subwatershed has variable stream geomorphology, largely due to the underlying geology in this area of the Triassic basin.

The Fairfax County Stream Physical Assessment Study includes the channel evolution model (CEM) stage and stream substrate.

The streambed in reaches upstream from Route 29 consists of clay soils and shale. The CEM stage is III, indicating the streams are widening. The substrate is largely silt. Many reaches exhibit large pools with very short segments of riffles between the pools.

Between Route 29 and Compton Road the stream is underlain by an igneous intrusion that results in a rocky substrate that is less affected by high stream flows and thus has higher physical habitat scores. The stream gradient is high. The CEM stages are IV and V, indicating the stream is stabilizing or has stabilized. The substrate is gravel, boulders and sand that result in excellent habitat ratings for this reach.

Farther downstream, clay soils and shale predominate. The stream bottom slope decreases, resulting in sediment deposition. In some areas within Bull Run Regional Park, sediment deposition is reducing the stream capacity, producing additional stream erosion and braded channels. The CEM stage is mostly III with some IV, indicating the streams are widening and stabilizing in some reaches. Upstream from Route 66, the dominant substrate is gravel. The substrate changes to sand, silt and clay in downstream reaches within Bull Run Regional Park.

3.7.8 Concerns Identified by the Public

The CAC and attendees of the public forums identified the following concerns in the Lower Cub Run subwatershed:

- The county should allow alternatives to septic systems within the R-C District but should not extend sanitary sewer systems to serve these areas.
- Concerns about the potential impacts of the proposed Tri-County Parkway and Battlefield Bypass alternatives on the local streams. One proposed route for the Tri-County Parkway goes through this subwatershed and places the road very close to Cub Run within Bull Run Regional Park. As discussed in Section 2.4.4, the Commonwealth Transportation Board selected an alternative that lies entirely outside the Cub Run and Bull Run watersheds.
- Trash and dumping upstream from Compton Road and near London Towne
- Townhouses constructed close to the stream on the east bank between Route 29 and Big Rocky Run
- Impacts of trail fords on the stream stability within Cub Run Stream Valley Park
- Stream bank erosion in segments immediately upstream from Route 29
- Frequent roadway flooding where small streams cross Compton Road
- Protection and preservation of historic features, including Lane Mill and Manassas Gap Railroad features
- Stream bank erosion within Bull Run Regional Park
- Fallen trees producing snags between Route 29 and Compton Road
- Impact of utility crossings on stream erosion and buffers within Cub Run Stream Valley Park

3.7.9 Modeling Results

Figure 3-17 presents stormwater modeling results for the Lower Cub Run subwatershed. Section 2.8 presents additional details on the modeling and modeled scenarios.

Peak flows at the bottom of the Cub Run subwatershed increase by 9 percent between existing and future conditions (with stormwater controls). Nutrient loads from within the Lower Cub Run subwatershed increase by 32 percent. Much of this increase results from the development of open space as Estate-Residential land use within the R-C district. The loading per acre in this watershed is the lowest of the Cub Run subwatersheds.

3.8 Bull Run Subwatersheds

Overview of Conditions in the Bull Run East and West Subwatersheds

- **Drainage area**
  Bull Run East Subwatershed = 1,215 acres (1.9 square miles)
  Bull Run West Subwatershed = 5,002 acres (7.8 square miles)
  827 acres in Loudoun County (1.3 square miles)
  4,175 acres in Fairfax County (6.5 square miles)

  Existing impervious area
  Bull Run East Subwatershed = 11 percent
  Bull Run West Subwatershed = 3 percent
- **Future impervious area**
  Bull Run East Subwatershed = 16 percent
  Bull Run West Subwatershed = 10 percent
- **The Bull Run East subwatershed has high-quality stream habitat and few erosion problems. The streams' substrate is boulders and rock that reduce the impact of increased stream flows and result in high habitat scores.**
- **There is little potential for future development in the Bull Run East subwatershed. This watershed includes 12 stormwater ponds that control the peak flows and water quality for much of the existing development.**
- **The Fairfax County portions of the Bull Run West subwatershed are entirely within the R-C District and the Loudoun County portions have similar planned development densities. The development densities are low and will remain low.**
- **The Bull Run West subwatershed has good to fair stream habitat quality. In many locations the stream buffers are affected by farm fields and pastures.**

The following sections summarize the conditions in the Bull Run subwatersheds.

3.8.1 Overview of Drainage Characteristics

The Bull Run subwatersheds include small, unnamed streams that flow directly into Bull Run. Bull Run forms the southern Fairfax County and Prince William County boundary. For this study, this area is broken into two subwatersheds:

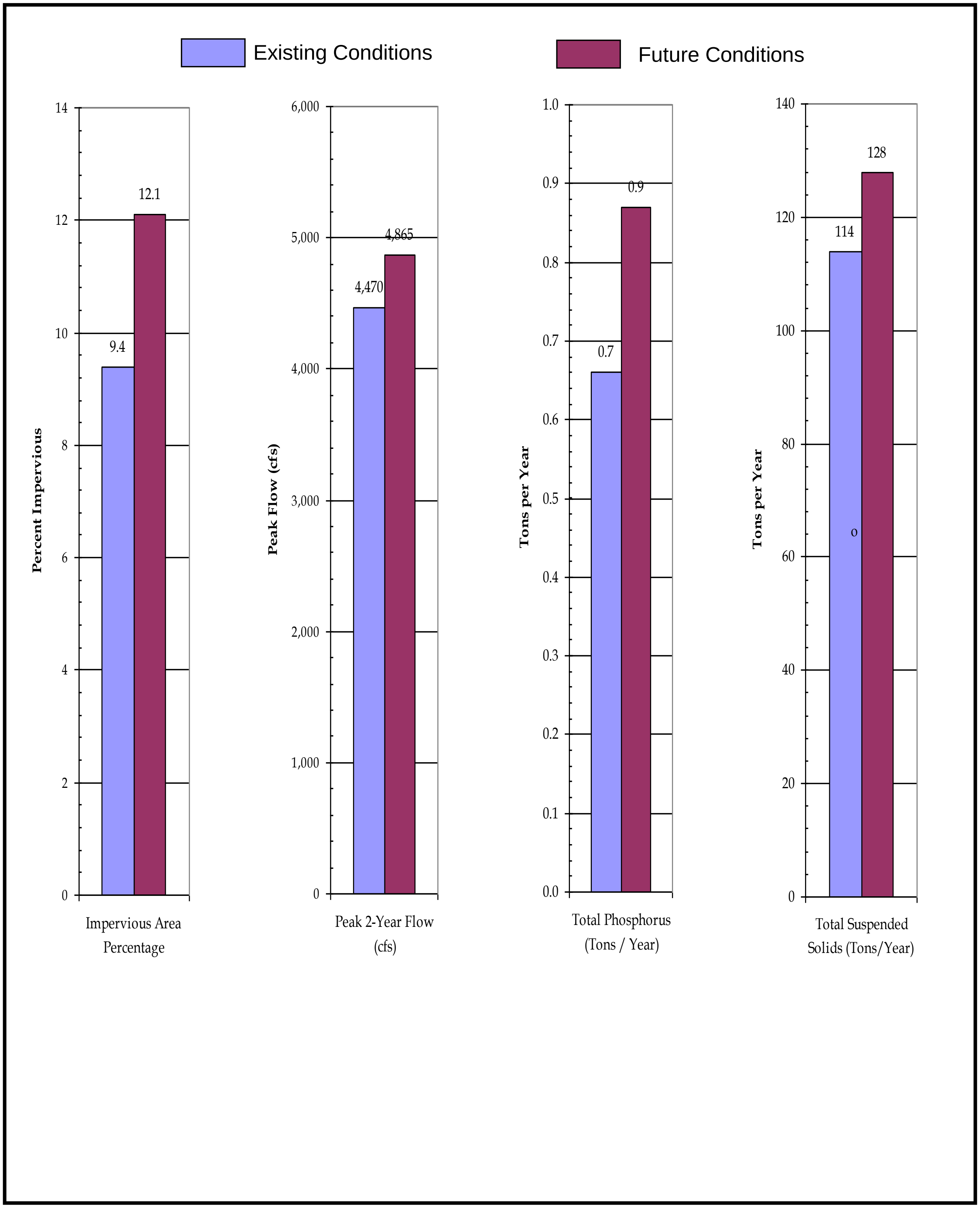


Figure 3-17
Overview of Existing and Future Conditions
in the Lower Cub Run Subwatershed

1. The Bull Run East subwatershed includes the areas that flow into Bull Run east of Cub Run but west of Little Rocky Run, as shown on Figure 3-18. As discussed later in this section, Figure 3-18 also presents the location of existing dry ponds, wet ponds, regional ponds and previously proposed regional ponds. This subwatershed includes the UOSA advanced wastewater treatment plant. Areas south of Compton Road are in the R-C District. Most of this area is in the Bull Run Regional Park, leaving very little Estate-Residential development. North of Compton Road the subwatershed includes primarily medium-density residential development in the Centreville area.

2. The Bull Run West subwatershed includes the streams that flow into Bull Run west of Cub Run and east of the Fairfax County/Loudoun County border, as shown on Figure 3-19. As discussed later in this section, Figure 3-19 also presents the location of existing dry ponds, wet ponds, regional ponds and previously proposed regional ponds. The Fairfax County portions of this subwatershed are entirely within the R-C District.

3.8.2 Existing and Future Land Use

Bull Run East Subwatershed

Table 3-36 provides an overview of the existing and future land use in the Bull Run East subwatershed.

The southern portion of the subwatershed, south of Compton Road, is in the R-C District. Most of this area is within either the UOSA advanced wastewater treatment plant or the Bull Run Regional Park. North of Compton Road the land use is mostly medium-density, single-family residential.

Future land use changes consist of developing the few areas of open land to the planned land use, resulting primarily in additional medium-density residential development. Much of this development is occurring as this study is being completed.

Bull Run West Subwatershed

The Bull Run West subwatershed lies entirely within the R-C District in Fairfax County. Areas in Loudoun County have similar planned land use. Table 3-37 presents the existing and planned future land use for this subwatershed. Under current conditions the subwatershed includes large areas of open space that have a planned land use of Estate-Residential. Future changes in land use will result from the development of this land as 5-acre residential. The subwatershed includes a quarry that has an industrial land use. The subwatershed includes preserved open space in the Bull Run Regional Park and Fairfax National Golf Course.

3.8.3 Existing and Future Impervious Area

Table 3-38 provides an overview of the existing and future impervious area estimates for the Bull Run East and Bull Run West subwatersheds.

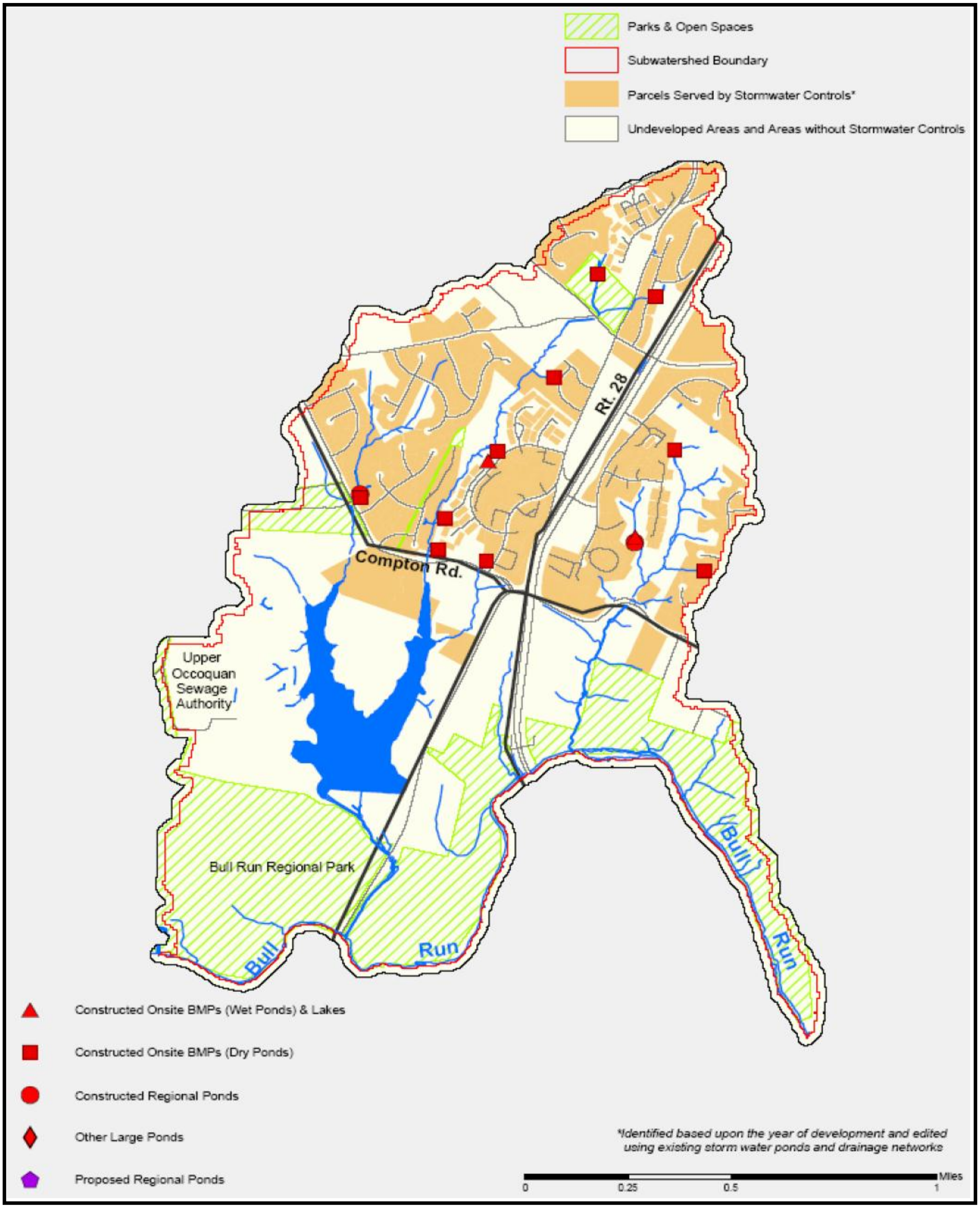


Figure 3-18
Stormwater Facilities in the
Bull Run East Subwatershed

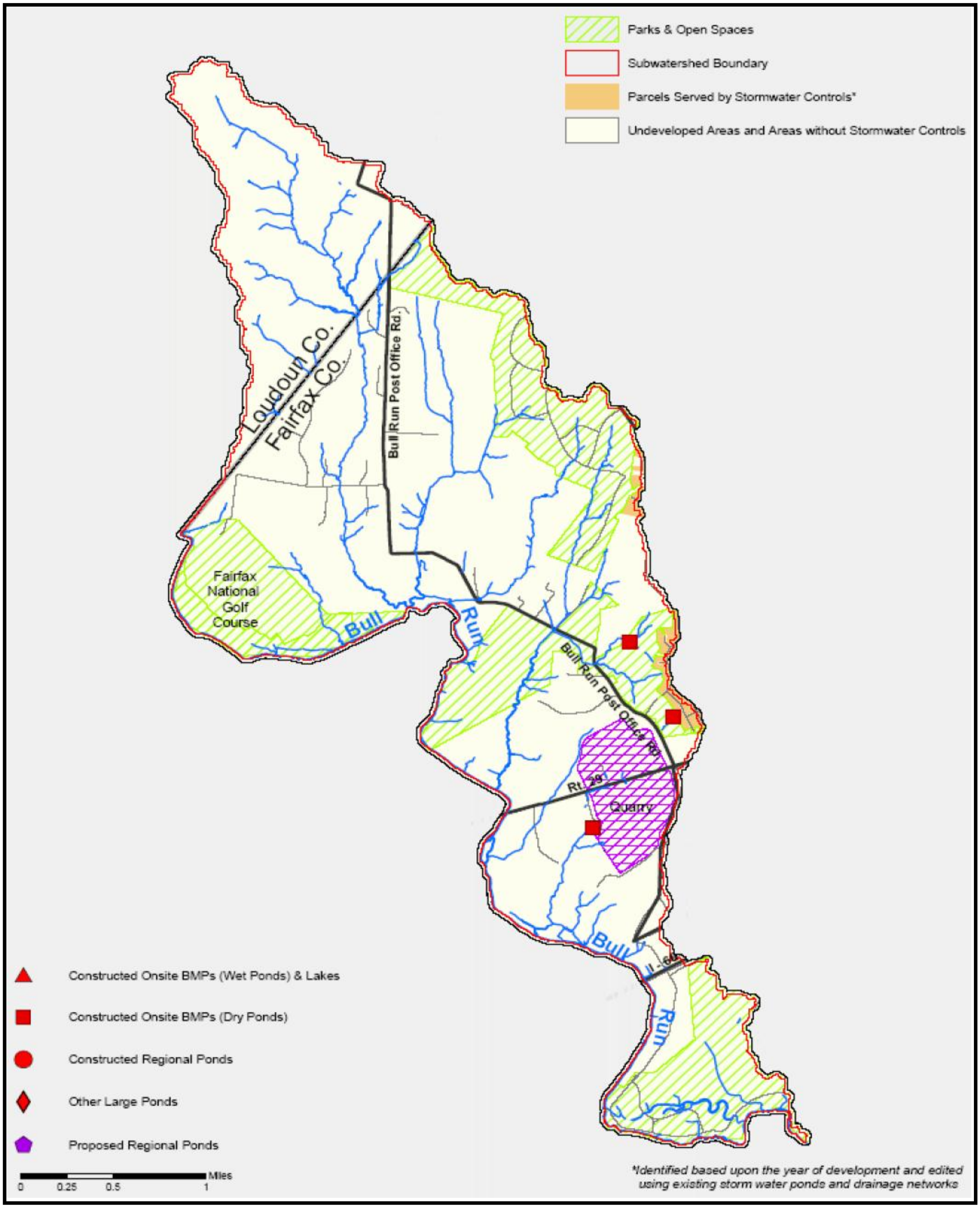


Figure 3-19
Stormwater Facilities in the
Bull Run West Subwatershed

The impervious area for the Bull Run East subwatershed increases five percentage points from 11 to 16 percent. These values suggest this subwatershed is mostly built out with little room for additional development.

The impervious area for the Bull Run West subwatershed increases seven percentage points from 3 to 10 percent. This low development density will have little impact on the local streams.

3.8.4 Existing Stormwater Controls

Figures 3-18 and 3-19 show the stormwater ponds in the Bull Run subwatersheds and the developed area upstream from these ponds. The watershed may contain other stormwater controls such as underground detention and treatment facilities, and rooftop detention.

Bull Run East Subwatershed

No ponds exist within the R-C district portion of the Bull Run East subwatershed. The existing ponds are mostly located within the upstream portions of the subwatershed, outside the R-C district. This subwatershed contains a large lake that receives treated effluent from the UOSA advanced wastewater treatment plant and drainage from the upstream watershed.

Table 3-36
Summary of Existing and Future Land Use in the Bull Run East Subwatershed

Land Use	Existing Conditions		Future Conditions	
	Acres	Percent	Acres	Percent
Open Space	459	37.8	356	29.3
Estate-Residential	75	6.2	109	9.0
Low-Density Residential	29	2.4	32	2.6
Medium-Density Residential	185	15.3	253	20.8
High-Density Residential	143	11.8	143	11.8
Low-Intensity Commercial	15	1.2	24	1.9
High-Intensity Commercial	-	-	-	-
Industrial	9.8	0.8	-	-
Residential Planned Community	-	-	-	-
Upper Occoquan Sewerage Authority Advanced Wastewater Treatment Plant	298	24.5	298	24.5

Table 3-37
Summary of Existing and Future Land Use in the Bull Run West Subwatershed

Land Use	Existing Conditions		Future Conditions	
	Acres	Percent	Acres	Percent
Open Space	3,422	68.4	1,066	21.3
Estate-Residential	1,267	25.3	3,617	72.3
Low-Density Residential	39	0.8	40	0.8
Medium-Density Residential	4	0.1	5	0.1
High-Density Residential	-	0.0	-	0.0
Low-Intensity Commercial	26	0.5	25	0.5
High-Intensity Commercial	6	0.1	5	0.1
Industrial	240	4.8	245	4.9
Residential Planned Community	-	0.0	-	0.0

Table 3-38
Summary of Drainage Areas and Existing and Projected
Future Impervious Area for the Bull Run Subwatershed

County	Watershed Area (Acres)	Existing Impervious Area		Future Impervious Area	
		Acres	Percent	Acres	Percent
Bull Run East Subwatershed	1,215	134	11.0	191	15.7
Bull Run West Subwatershed	5,002	130	2.6	485	9.7
Total Bull Run Subwatershed	6,217	264	4.2	676	10.9

Table 3-39 summarizes the number of existing dry and wet ponds and the total subwatershed area upstream from these ponds in the Bull Run East subwatersheds.

Table 3-39
Summary of Number of Ponds and Cumulative Drainage Area
for the Bull Run East Subwatershed

Type of Pond	Approximate Number of Ponds *	Total Drainage Area Upstream from Ponds
Dry Ponds	10	293 acres
Wet Ponds	2	46 acres
Total in Subwatershed	12	339 acres

The watershed contains two Fairfax County regional ponds:

- Regional Pond C49 – Dry pond north of the Compton Road and Confederate Ridge Lane intersection. The watershed is single-family residential.
- Regional Pond C50 – Wet pond southeast of Ridgewater Court

No planned regional ponds are in this subwatershed.

Approximately 28 percent of the Bull Run East subwatershed drainage area is upstream from these existing ponds. These ponds control most of the areas developed at densities greater than Estate-Residential north of Compton Road. The UOSA lake also provides additional water quality protection for these areas.

Bull Run West Subwatershed

The Bull Run West subwatershed includes a few farm ponds and ponds associated with quarry operations. The low-density development in this subwatershed does not require additional stormwater controls.

3.8.5 Stream Habitat

The Fairfax County Stream Physical Assessment Study summarizes the stream physical habitat condition for the Fairfax County streams.

Bull Run East Subwatershed

Physical Habitat

Figure 3-20 shows the stream physical habitat ratings for the Bull Run East streams, and Table 3-40 summarizes the physical stream habitat.

Table 3-40
Summary of Physical Stream Habitat for the
Bull Run East Subwatershed

Physical Stream Habitat Rating	Length of Stream (Miles)	Percent of Total Stream Length Analyzed
Excellent	0.9	50
Good	0.5	30
Fair	0.4	20
Poor	0.0	0
Very Poor	0.0	0

The eastern-most stream has excellent physical habitat. The remaining streams have good to fair habitat.

Figure 3-20 also shows the following information from the Stream Physical Assessment Study:

- Locations where the stream buffer is affected
- Erosion inventory lines, indicating areas of active stream erosion
- Obstructions. Most obstructions indicate where trees have fallen into the stream from active erosion
- Head cuts indicate where the streambed is down-cutting
- Dump sites
- Locations where stream crossings affect the streams

Figure 3-20 includes these features when the impact scores indicate a significant stream impact.

The four inventory points within the Bull Run East subwatershed is a small number compared to the other subwatersheds

Fish and Benthic Macroinvertibrate Studies
The Stream Protection Strategy does not include sampling locations in the Bull Run East subwatershed. This area is within the watershed protection level II area where the primary management activity is to prevent further watershed degradation.

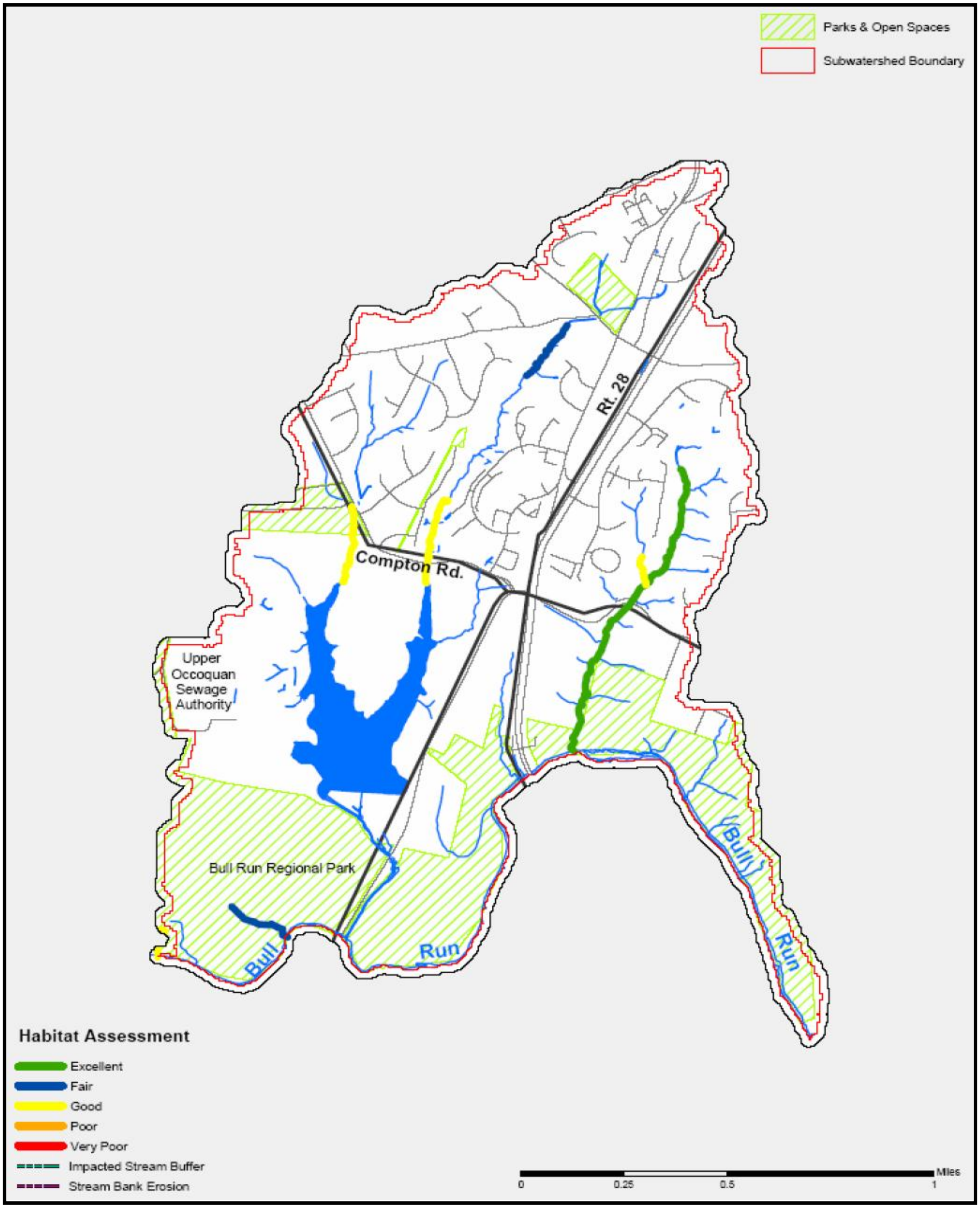


Figure 3-20
Existing Conditions in the
Bull Run East Subwatershed

Bull Run West Subwatershed

Physical Habitat

Figure 3-21 shows the stream physical habitat ratings for the Bull Run West streams, and Table 3-41 summarizes these ratings.

Table 3-41
Summary of Physical Stream Habitat Ratings
for the Bull Run West Subwatershed

Physical Stream Habitat Rating	Length of Stream (Miles)	Percent of Total Stream Length Analyzed
Excellent	0.0	0
Good	4.2	31
Fair	7.7	58
Poor	1.4	11
Very Poor	0.0	0

The stream physical habitat ranges from good to poor. The stream habitat is primarily affected by the loss of buffer within existing fields and pastures, suggesting these streams will benefit from buffer restoration projects on this private property.

The stream with poor stream habitat is downstream from the quarry, suggesting discharges from the quarry may be affecting the habitat.

Figure 3-21 also shows the following information from the Stream Physical Assessment Study:

- Locations where the stream buffer is affected
- Erosion inventory lines, indicating areas of active stream erosion
- Obstructions. Most obstructions indicate where trees have fallen into the stream from active erosion.
- Head cuts indicate where the streambed is down-cutting
- Dump sites
- Locations where stream crossings affect the streams

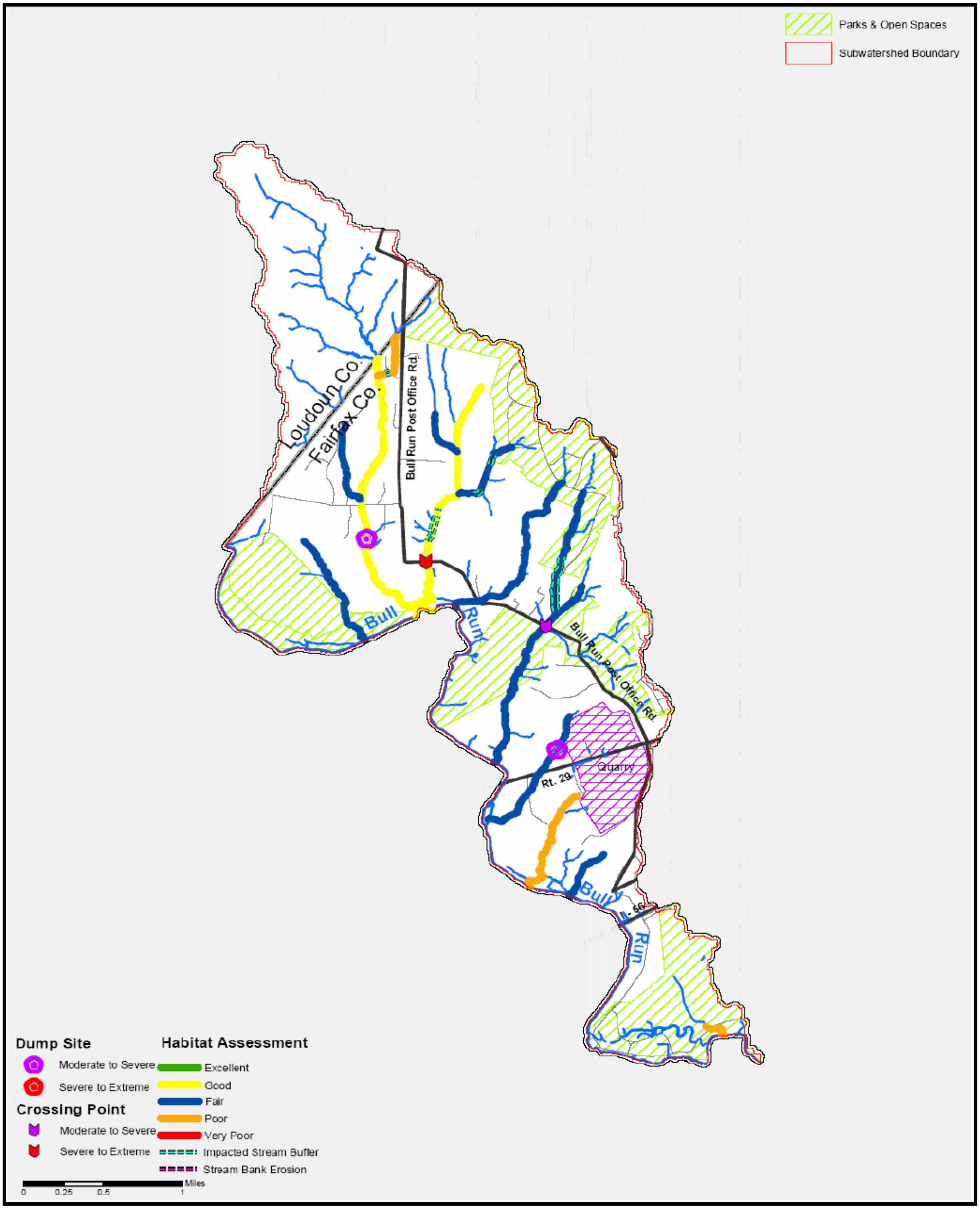


Figure 3-21
Existing Conditions in the
Bull Run West Subwatershed

Figure 3-21 includes only the features when the impact scores indicate a significant stream impact.

The Bull Run West subwatershed includes several locations where the stream buffer is affected and isolated areas of stream bank erosion. Bull Run Post Office Road stream crossings affect the streams at several locations.

Fish and Benthic Macroinvertibrate Studies

The Stream Protection Strategy includes one sampling location in the Bull Run West subwatershed on an unnamed tributary near Bull Run. The conditions at this site based on the fish and benthic macroinvertibrate sampling are summarized in Table 3-42.

Table 3-42
Summary of Stream Protection Strategy Results for
Bull Run West Subwatershed

Location	Index of Biotic Integrity	Habitat Score	Fish Taxa Richness	Overall Site Condition Rating	Watershed Management Category
Bull Run West Tributary near Bull Run	Excellent	Fair	High	Excellent	Protection

These sampling data indicate the habitat is excellent at this location. In fact, this location has some of the best habitat in Fairfax County. This area is within the SPS protection watershed category in which the main management strategy is to identify and protect the conditions responsible for producing these high-quality stream environments.

3.8.6 Stream Water Quality

Fairfax County samples for water quality in the Bull Run subwatersheds at a single location:

- Bull Run at Route 29 (30-01). The site samples the water within Bull Run and therefore includes the effects of the upstream Bull Run watershed but not the quality of the runoff from the Bull Run West subwatershed.

These data are summarized in Section 2 and indicate water quality in this subwatershed is typical for many county streams. Fecal coliform concentrations regularly exceed the state criteria for surface waters. Dissolved oxygen levels are high, indicating a healthy stream capable of supporting life. Other measured parameters are within acceptable levels and do not indicate abnormal conditions within this subwatershed.

3.8.7 Stream Geomorphology

The Bull Run subwatershed has variable stream geomorphology, largely due to the underlying geology in this area of the Triassic basin.

Bull Run East

The Bull Run East subwatershed has a variety of stream substrate conditions. The most eastern tributary has bedrock as the stream substrate. This results in the excellent physical habitat scores for this reach. This stream has CEM stages III and IV, indicating the streams are widening but stabilizing.

To the west in this subwatershed the substrate turns to sand and gravel, and finally to clay and silt. Sections of these streams are CEM stage II, indicating down-cutting. The remaining stream segments are classified as stage III and IV.

Bull Run West

The streams in this subwatershed are in CEM stage III and IV, indicating that portions of the streams are widening while others are stabilizing. The substrate is gravel and clay.

3.8.8 Concerns Identified by the Public

The CAC and attendees of the public forums identified the following concerns in the Bull Run subwatersheds:

- Alternatives to septic systems within the R-C District that do not involve extending the sanitary sewer system
- Impact of development in Loudoun County on Fairfax County streams
- Potential impacts of the planned Tri-County Parkway and Battlefield Bypass alternatives on the local streams
- Flooding at locations where Compton Road crosses the small streams especially near the UOSA advanced wastewater treatment plant
- Flooding at locations where Bull Run Post Office Road crosses the small streams
- Potential impact of Fairfax National Golf Course on stream water quality
- Impacts of UOSA discharges on the streams and water quality in the Occoquan Reservoir
- Trash and dumping at the Bull Run Post Office Road and Compton Road intersection

3.8.9 Modeling Results

Figures 3-22 and 3-23 present stormwater modeling results for the Bull Run East and Bull Run West subwatersheds. Section 2.8 provided addition details on the modeling and modeled scenarios.

In the Bull Run East subwatershed, the peak flows increase by 8 percent and the total phosphorus loads increase by 26 percent.

In the Bull Run West subwatershed, the peak flows increase 30 percent and the total phosphorus loads increase 125 percent. The increase largely results from development within the R-C district and lack of stormwater controls for it. The unit loading rates (pounds per acre per year) remain the lowest compared to the other subwatersheds in the Cub Run and Bull Run watersheds.

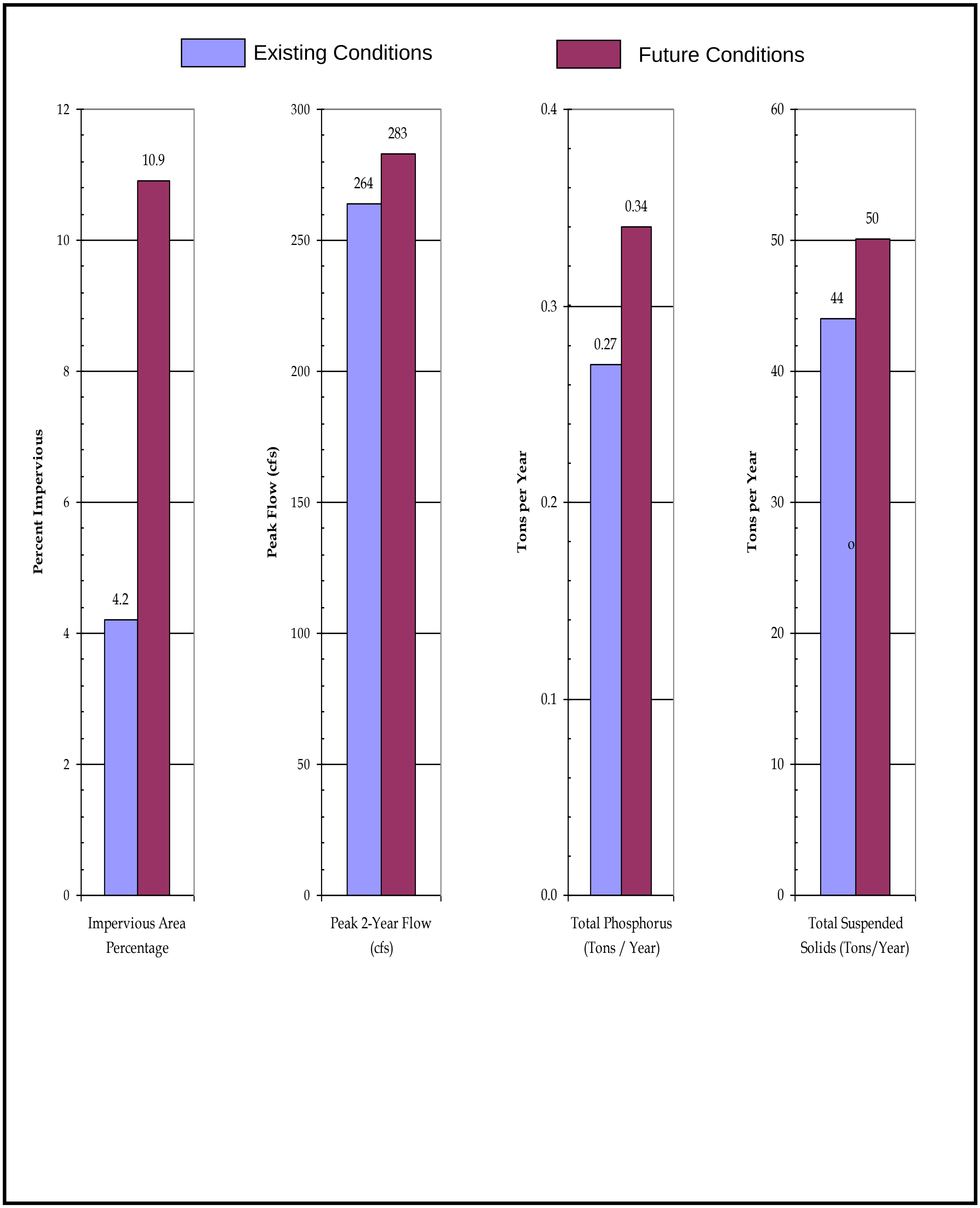


Figure 3-22
Overview of Existing and Future Conditions
in the Bull Run East Subwatershed

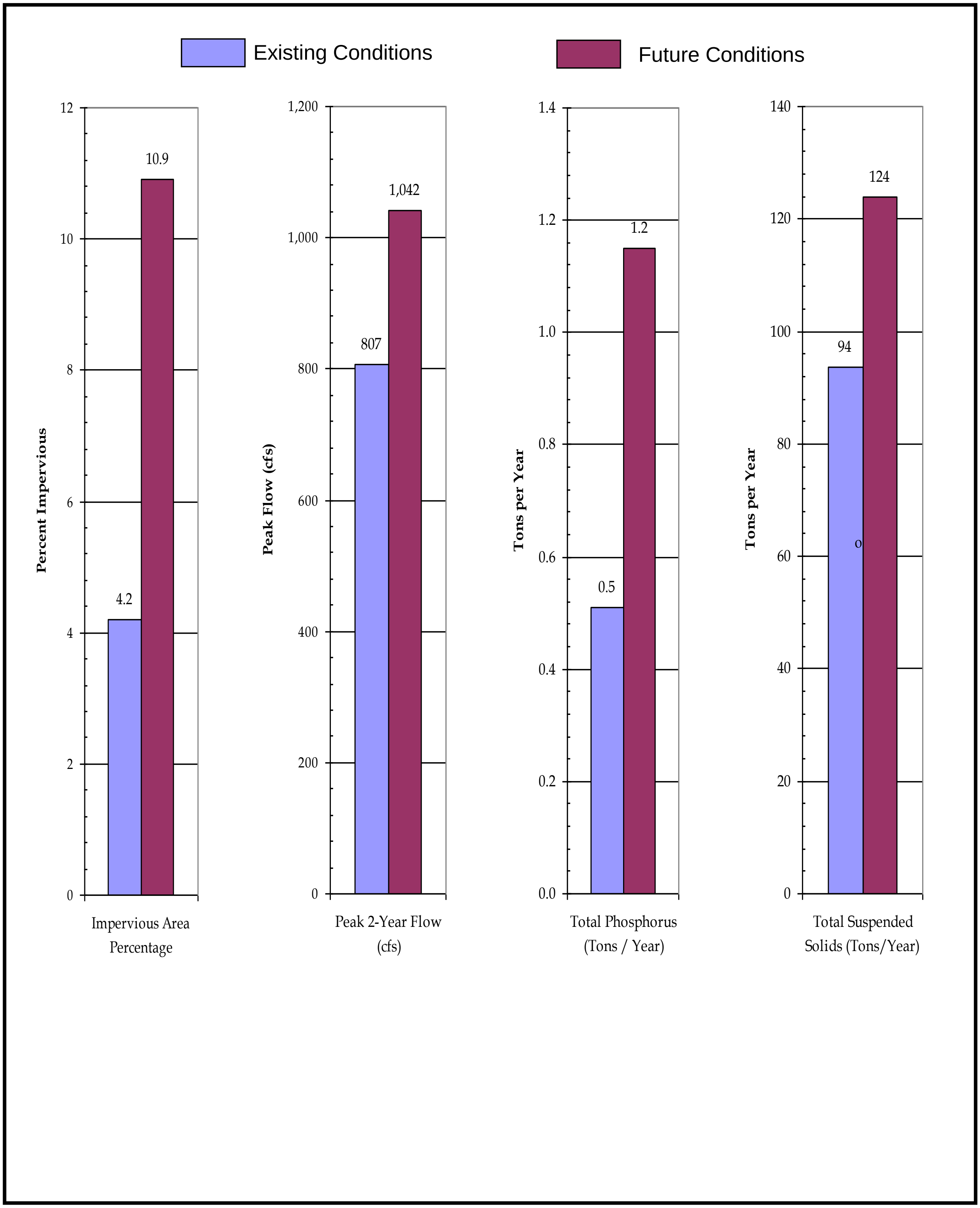


Figure 3-23
Overview of Existing and Future Conditions
in the Bull Run West Subwatershed

Section 4
Watershed Plan Nonstructural Actions

4.1 Introduction

This section identifies nonstructural actions that will help to achieve the watershed plan's vision and goals. The vision and goals described in Section 1.3 provide the overall framework for the watershed plan. They recognize that the plan must promote education, recreation, cooperation and collaboration both to heighten the awareness of the people who live and work in the watershed regarding their impact on it and to ensure that the streams and stream valleys continue to be a valuable resource for the community. The Fairfax County government can only protect and improve the watershed with the continued cooperation and assistance of the public; many activities other than installing additional ponds and other stormwater controls are essential to restore and maintain the watershed.

The nonstructural actions described in this section can be performed under current county policies and have a defined implementation schedule.

Nonstructural actions include community outreach and education as well as land management strategies to address the watershed impacts of existing and new development. In general, dirt will not be moved and major capital expenses are not required to implement these nonstructural actions.

Many of these actions must be implemented countywide. Recommended actions from the Cub Run and Bull Run Watershed Plan will be compared with similar recommendations in the Little Hunting Creek, Popes Head Creek, Cameron Run, Difficult Run and other watershed plans before they are implemented. Although the costs for some of these actions will not be born by Fairfax County, the watershed plan recommends that the county continue to allocate adequate funds to implement these nonstructural actions.

These actions were developed by the project Community Advisory Committee (CAC) and project team with input from the watershed community at four public workshops: Issues Scoping Forum (June 2004); Community Forum (March 2005); Draft Plan Review Forum (July 2005); and Final Plan Review Workshop (June 2006).

The nonstructural actions are grouped as follows:

- A - Public Outreach and Education
- B - Interjurisdictional Cooperation
- C - Recreation
- D - Existing Development

- E - New and Infill Development
- F – Open Space

The framework provides specific watershed actions to be implemented in the watershed plan and allows evaluation of the plan's success in meeting the watershed vision and goals.

The following sections identify and describe the objectives and actions within each nonstructural action group. The order in which the plan objectives and actions are presented does not represent their relative importance or the order in which they will be implemented.

This section focuses on nonstructural actions. Section 5 describes policy recommendations. Section 6 describes structural actions. Section 7 documents the implementation schedule for all watershed plan actions.

4.2 A - Public Outreach and Education

Many people who live and work in the watershed are not aware of watershed issues, the impacts of their actions on the environment or actions they can take to improve local stream conditions. The actions of homeowners and businesses can have significant positive and negative impacts on watershed health.

The following public outreach and education actions are designed to help develop a sense of pride in and ownership of the watershed and stream valleys, and to promote personal stewardship. It is hoped that education and outreach will not only help watershed residents avoid actions that have a negative impact on streams but also encourage them to protect and improve streams by modifying conditions on their property, volunteering for watershed improvement programs or taking other action in the watershed.

Objective A 1 - Promote community stewardship through education.

Action A 1.1: Create and staff a watershed and stormwater issues ombudsman position to provide a single contact on these issues for county residents. This position may cover several county watersheds. The telephone number and e-mail contact for the ombudsman should be included in education and outreach materials concerning stormwater management and related environmental matters. A primary responsibility of the ombudsman will be to resolve questions and problems encountered by watershed residents, much of which is likely to involve educating the public regarding stormwater issues. The ombudsman will provide information already developed and, when appropriate, put residents in touch with the person or department that can help resolve specific stormwater issues.

Action A 1.2: Promote the Virginia Department of Conservation and Recreation's Adopt-a-Stream program to encourage and actively recruit residents, businesses, student groups and other organizations to adopt stream segments and, thereby, promote watershed stewardship both in the Cub Run and Bull Run watersheds and throughout the county. These volunteer groups will be stewards for the selected stream segment and will conduct periodic trash cleanups, observe stream conditions, report negative impacts to the county and raise awareness of the impacts that homeowner and business activities have on streams. These groups may also perform volunteer water quality and benthic sampling. Signs placed near the adopted streams will promote awareness of watershed issues among the larger public.

Action A 1.3: Educate homeowners, citizens and schoolchildren that, in the Cub Run and Bull Run watersheds, stormwater runoff eventually drains to one of Northern Virginia's primary drinking water sources, the Occoquan Reservoir. If not properly managed, trash and chemicals placed on the land will enter the drinking water supply. Actions to be taken include storm drain stenciling and signs that inform people they are in a water supply watershed. Other education opportunities include general public information programs, stewardship information in water bills and newspaper coverage of watershed issues. Education about the impacts of stormwater on water supply watersheds and related environmental matters implemented by the county should be included in public information programs.

Action A 1.4: Encourage maintenance and restoration of stream buffers throughout the watershed by educating the public and businesses on the importance of healthy stream buffers, and steps to maintain and restore stream buffers on their property and along local streams. A natural unimpaired stream buffer containing native trees, plants and shrubs provides valuable stream habitat protection and many other benefits. This action includes educating the public to 1) create "no mow" areas to allow stream buffers to recover naturally, 2) perform stream buffer restoration on their properties and through volunteer opportunities, and 3) remove exotic and non-native plants, and plant native species within critical stream buffer areas.

Action A 1.5: Create and provide community education programs that describe watershed issues in Fairfax County and the simple steps that residents, businesses and organizations can take to improve conditions in their backyard streams.

Action A 1.6: Develop educational and other public information materials in languages other than English to address the multicultural character of Fairfax County.

Action A 1.7: Install signs with stream and watershed names at major road crossings and watershed boundaries. This action would increase residents' awareness of the streams in the county as well as in the watershed in which they live. The signs within the Cub Run and Bull Run watersheds should also state that these streams drain to the Occoquan Reservoir water supply in support of plan Action A 1.3.

Action A 1.8: Identify and provide to Fairfax County public schools educational programs and SOL-based curricula regarding watershed issues. Watershed education and stewardship should start at an early age. Also, children will take the lessons learned at school and apply them at home, encouraging their parents to learn more about watershed issues and to be more involved in protecting the watershed in which they live. This action can be combined with watershed plan structural action 6.4, which implements low-impact development (LID) projects at county facilities, including public schools, throughout the watershed.

Action A 1.9: Create watershed education areas within the Chantilly and Centreville Fairfax County public libraries and make watersheds part of the standard library educational programs. This action can be combined with watershed plan structural action 6.4, which provides LID bioretention retrofit facilities at these two county libraries.

Objective A 2 - Educate the public about environmental concerns that affect the watersheds.

The following educational actions address other environmental concerns related to watershed management.

Action A 2.1: Coordinate with the Fairfax County Health Department to promote control of mosquitoes on private property through elimination of standing water. Future education should also point out that healthy stream, lake and wetland ecosystems are not major sources of West Nile Virus-carrying mosquitoes (*Culix pipens*) and should explain the natural features that prevent excessive mosquito populations in healthy water bodies. Proper rain barrel maintenance techniques should be incorporated into the Fairfax County Health Department's "Fight the Bite" outreach campaign. This program should draw on information available through other county, local, state and federal agencies.

Action A 2.2: Coordinate with the Fairfax County Division of Solid Waste to promote existing information on environmental problems associated with trash and dumping. Partnering with private waste-hauling companies will further educate residents about bagging and disposing of trash properly, and placing it in approved garbage cans to prevent it spreading into the environment.

Action A 2.3: Coordinate with the Fairfax County Animal Shelter to educate the public about the impact pet wastes have on streams (coliform bacteria and nutrients) and the importance of properly disposing of these wastes.

Action A 2.4: Coordinate with the Fairfax County Division of Solid Waste to promote existing information on the proper disposal of hazardous household materials, including fertilizer, chemicals, motor oil and paint. Information should include the locations where these materials can be disposed of safely.

Action A 2.5: Provide public information on correct application procedures and rates for fertilizers and pesticides. This effort should be coordinated with existing programs developed by the Virginia Department of Conservation and Recreation, Northern Virginia Soil and Water Conservation District, U.S. Environmental Protection Agency, other state and local agencies, and professional societies. Watershed-specific recommendations should be developed for the correct and environmentally sensitive procedures for lawn maintenance. This information should be distributed through homeowner associations and at local stores that sell fertilizers and pesticides. It should also be available on the county's watershed Web site and through other public information programs.

Objective A 3 - Improve the information and resources available through the county's watershed Web site to promote a better informed and educated public.

Action A 3.1: Provide readily accessible information about stormwater, water quality and watershed issues to the public on the county's watershed Web site, and what they can do to reduce nonpoint source pollution on their property and elsewhere in the watershed.

a. Redesign and reorganize the county watershed Web site to make it easier for the homeowner to find the information they need regarding stormwater and watershed management. While the county Web site includes much of this information, it needs to be better coordinated, modified and expanded to make it more user friendly.

b. Provide a frequently asked questions area on the county watershed Web site that includes clear answers, information on additional resources, links to other sources of information and contacts to help homeowners find information regarding stormwater issues.

c. Provide contact information for the watershed ombudsman (Action A 1.1).

d. Provide basic information on effective stormwater design, especially LID projects that property owners can implement themselves.

e. Include descriptions and links to other programs available to assist homeowners.

f. Provide information in languages other than English to reach out to non-English-speaking county residents.

g. Promote the county watershed Web site in outreach and educational programs concerning stormwater management and related environmental matters.

Objective A 4 - Encourage and promote LID practices by developers and property owners through public education and outreach programs.

LID refers to a wide range of stormwater management and site development techniques that reduce the stormwater impact from development. Reducing impervious land surface, increasing travel time of stormwater and designing sites to take advantage of natural conditions can reduce the amount of runoff, peak flow rates and pollutant runoff from development. Facilities such as drainage swales and bioretention and biofiltration facilities (rain gardens) reduce runoff and filter pollutants. Properly maintained rain barrels and disconnection of rooftops and other impervious areas from the storm drainage system are also examples of effective LID techniques for existing and new development.

These outreach and education actions should be coordinated with other nonstructural actions promoting the implementation of LID at public facilities, for both new and existing construction. Section 5 identifies policy recommendations to promote LID.

Action A 4.1: Conduct outreach and education to builders and developers to communicate and promote the benefits of implementing LID in addition to or instead of standard stormwater controls. LID features should be promoted as positive amenities that property owners can find both aesthetically pleasing and functional. By implementing LID practices, it may be possible to meet Fairfax County stormwater requirements while reducing the number and/or size of "standard" stormwater controls (stormwater ponds). The overall result may reduce the cost for implementing stormwater management in new development.

Action A 4.2: Develop materials promoting LID retrofits on existing property and their effectiveness in addressing drainage issues and minimizing impacts from stormwater runoff. In addition to this promotional literature, design specifications, cost estimates and maintenance requirements for commonly used LID techniques should be developed and provided through the county Web site, as well as coordinated with other outreach and education programs. References and guidance should be provided to property owners regarding stormwater issues as well as assistance in developing effective and environmentally friendly solutions.

Objective A 5 - Increase community problem-solving capability through education.

Action A 5.1: Notify homeowner associations, civic associations and private property owners of the watershed planning effort and provide resources, including contacts and Web site addresses, that can provide additional information. Direct mailings can be used to distribute this information to the public, when appropriate. Development of a speakers bureau and articles for community newsletters would improve outreach though these organizations and associations.

Action A 5.2: Create and distribute a fact sheet of common stormwater problems and solutions, as well as available Fairfax County resources and contact information.

Objective A 6 – Educate owners and operators of commercial and industrial establishments where there is potential to contaminate the streams so that stormwater is properly managed and appropriate steps taken to prevent the release of contaminants.

Action A 6.1: Provide outreach and education to the property owners and managers of commercial and industrial facilities that handle hazardous materials, paints, chemicals and fertilizers regarding stormwater control requirements for their properties and their importance in protecting watershed streams and water supply. Coordination is needed with these owners to develop best management plans for the storage, use and disposal of these chemicals. This effort should be coordinated with Fairfax Water's Source Water Protection and Planning programs.

4.3 B - Interjurisdictional Cooperation

The following actions should be implemented to improve interjurisdictional coordination between Fairfax County and other local, state and federal jurisdictions. Cub Run and Bull Run streams are affected by existing conditions and proposed changes in Loudoun County and at Dulles International Airport, just as water bodies downstream from Cub Run are affected by conditions in Fairfax County. County watershed programs should be coordinated with programs in other jurisdictions. While it is recognized that the various jurisdictions and agencies interact well on stormwater and watershed-issues as needed, regularly scheduled coordination is essential. Documenting this coordination and providing summary reports to the public will help to make residents aware of interjurisdictional coordination efforts regarding stormwater and watershed issues.

Objective B 1 - Improve cooperation between various organizations, localities and agencies, including Fairfax County, Loudoun County, Prince William County, Metropolitan Washington Airports Authority, Federal Aviation Authority, Fairfax Water, Upper Occoquan Sewage Authority, Virginia Department of Transportation, U.S. Army Corps of Engineers, Federal Emergency Management Agency, Virginia Department of Environmental Quality, Northern Virginia Soil and Water Conservation District, Northern Virginia Regional Commission, Virginia Department of Conservation and Recreation, Fairfax County Park Authority and Northern Virginia Regional Park Authority, regarding stormwater and watershed management issues.

Action B 1.1: Work with Loudoun County to establish joint watershed goals and evaluation criteria, including nonpoint source pollution controls and water quality monitoring guidance. Other successful interjurisdictional partnerships should be identified and their lessons learned used to create a similar partnership between Fairfax and Loudoun counties regarding watershed issues.

Action B 1.2: Identify areas of mutual concern for Fairfax and Loudoun counties and facilitate sharing of information. An example would be to create a GIS field in the parcel layers maintained by these jurisdictions that identifies the watershed in which each parcel is located. This field could be used to identify development projects and share development plans that affect the neighboring jurisdiction.

Action B 1.3: Coordinate stormwater regulations, requirements and standards between Loudoun and Fairfax counties.

Action B 1.4: Convene an annual regional water summit, including representatives from agencies affected by or that affect stormwater conditions in Fairfax County watersheds. This summit could be coordinated and facilitated by the Northern Virginia Regional Commission. The primary focus of the annual summits will be to enable staff from the various agencies to interact directly. These meetings should have the following goals:

- Share information about stream conditions, ongoing programs, goals and issues
- Provide a forum to identify solutions that meet the needs and goals, and address the issues of both jurisdictions

Shortly after each meeting, a summary of the results will be distributed to elected officials, agencies affected and the public. The summary can be brief and simply document the discussions and general results.

4.4 C - Recreation

Promoting and creating appropriate recreational opportunities within the watershed and stream valleys will enhance public awareness and appreciation of healthy streams, stormwater management and other watershed issues. Watershed education should be integrated into recreation opportunities to make learning fun and to link watershed protection with restoration efforts and enjoyment of the outdoors. Appropriate recreational opportunities and facilities will get the public physically engaged and invested in the watershed, while increasing the personal commitment to watershed stewardship. In addition, these actions will make the stormwater management facilities more of an amenity to residents. Recreational uses must be appropriate for the community and support stream health.

Objective C1 - Provide appropriate and safe recreation opportunities while minimizing the impact of recreation on streams and stream valleys.

Action C 1.1: Maintain and develop a system of interconnected hiking and biking trails throughout the watershed. Fairfax County maintains an extensive trail system and manages a countywide trails plan. Future trail planning and development should recognize that a trail system should be developed to link the Big Rocky Run Stream Valley Park trails to the Cub Run Stream Valley Park trails and integrate these trails with the Cub Run Recreation Center and the remaining Sully Woodlands parkland. The FCPA Sully Woodlands Regional Master Plan includes similar recommendations regarding multi-use and equestrian trails, and makes specific recommendations regarding new trail development. The feasibility of linking the Cub Run Stream Valley Park trails to existing trails in Bull Run Regional Park should be assessed. Additional trails are needed in the stream valleys north of Braddock Road. Construction of new trails to connect to this trail system should be included in association with new development and Virginia Department of Transportation road improvement projects. The impact of trails on the streams and stream valleys should be minimized.

Action C 1.2: Support state total maximum daily load (TMDL) limits and local programs to meet the state water quality standards for bacteria and allow safe primary contact recreation in all watershed streams.

Action C 1.3: Work with the Fairfax County Park Authority, Northern Virginia Regional Park Authority and National Park Service to incorporate watershed plan objectives into planning and development initiatives for Sully Woodlands Parkland, Bull Run Regional Park and Manassas National Battlefield Park, respectively.

Objective C 2 - Protect significant historic, cultural and ecological resources (e.g., rare and endangered species) within the stream valleys.

Action C 2.1: Perform a study to identify significant historic, cultural and ecological resources within the stream valleys and protect these resources where invasive species, active stream erosion, frequent flooding, sedimentation or other stormwater-related issues are threatening these resources. The Fairfax County Park Authority's Sully Woodlands Regional Master Plan includes an extensive survey and analysis of cultural resources in the watershed, and specific recommendations for protecting these resources. Cultural features most threatened include the Manassas Gap railroad abutments and structures associated with Lane Mill. Stream and buffer restoration projects in these areas should protect the integrity of these cultural features. This action should be coordinated with nonstructural Action F 1.2 to preserve critical features as open space.

Objective C 3 – Coordinate watershed education activities with environmental education activities provided by the various parks and nature centers within the watershed.

Action C 3.1: Work with the Fairfax County Park Authority to identify opportunities for watershed education activities and displays at the Ellanor C. Lawrence Park and new facilities identified in the Sully Woodlands Master Plan.

These activities and displays should be incorporated into the environmental education center and other facilities at the park.

Action C 3.2: Work with the Northern Virginia Regional Park Authority to implement watershed education activities and displays at the Bull Run Regional Park, and incorporate these programs into the park's existing environmental education programs.

4.5 D - Existing Development

The watershed plan includes the following objectives and actions to reduce the impact of existing development on streams in the Cub Run and Bull Run watersheds.

Objective D 1 - Address watershed issues related to pets and non-native species.

Action D 1.1: Place signs reminding pet owners to properly dispose of pet wastes and provide bags and trash receptacles in high-use areas.

Action D 1.2: Address non-native and invasive species when they affect the watershed, promote volunteer efforts or undertake other activities regarding invasive species and restore conditions using native species where appropriate.

Objective D 2 – Actively promote and encourage the use of LID retrofits on residential and non-residential property.

Action D 2.1: Prepare and provide design guidance and construction cost estimates for LID retrofit projects to encourage implementation by property owners and ensure that the projects are properly constructed and maintained. This action should include coordination and use of existing information from local, state and federal agencies, and is closely related to Action A 4.2, which educates the public on the benefits of LID on both existing and new development. This action should be directed towards both residential and non-residential properties. Watershed plan structural action 6.6 promotes LID practices within neighborhoods that do not have stormwater controls. The watershed plan also includes policy recommendations D 2.1, D 2.2, E 1.1, E 1.2, E 1.3 and E 1.4 to promote LID for existing and new development.

Objective D 3 - Reduce polluted runoff from fertilizer and pesticide use.

The following actions, combined with Actions A 2.4 and A 2.5, will reduce pesticide and fertilizer runoff to the streams in the Cub Run and Bull Run watersheds and downstream water bodies.

Action D 3.1: Partner with public and private golf courses to review and enhance, if necessary, their turf management programs and ensure the application of best management practices for the handling and use of fertilizers, pesticides and other chemicals.

Action D 3.2: Collaborate with golf courses, office parks, parks and similar facilities with large areas of turf to educate managers on environmentally friendly practices that will limit impacts on the watershed. Protection and restoration of stream buffers within these areas should also be encouraged.

Action D 3.3: Work with lawn maintenance companies to minimize runoff of nutrients and pesticides. The Virginia Department of Conservation and Recreation (DCR) maintains a list of lawn-care operators that have voluntarily entered into an agreement with the state to protect and improve Virginia's surface and ground waters. These firms have agreed to follow proper lawn maintenance practices and recommend homeowner practices following a nutrient management plan approved by DCR. Information about DCR's program should be included in Fairfax County's watershed educational materials. The county should work with DCR to refine its program requirements.

Objective D 4 - Reduce trash and dumping in the watershed.

The following procedures will help eliminate dump sites, reduce illegal dumping and minimize improper disposal of trash and garbage in the watershed.

Action D 4.1: Eliminate existing dump sites within the watershed. Table 4-1 and Figure 4-1 identify existing dump sites to be eliminated. Table 4-1 provides the project inventory identifier and impact score from the 2002 Stream Physical Assessment Study. The impact score rates the affect of each dump on the stream where it is located, with a value of 10 indicating high impact and zero indicating no impact. Dump sites potentially contain hazardous materials that could affect stream health and impact water quality in the Occoquan water supply reservoir. Cleaning up these sites improves the aesthetics in the stream valleys and eliminates the potential for hazardous materials to pollute the streams. Eliminating trash and dumps will improve the overall conditions in the watershed and reduce the likelihood that others will dump additional material at these locations. Finally, cleaning up dump sites will also improve the habitat in and around these locations.

Action D 4.2: Eliminate vehicle access to and place signs at active and historical dumping sites. The signs should state that dumping is illegal, describe the fines and other penalties for illegal dumping, and provide a hotline number that residents can call to report it.

Action D 4.3: Provide locations within or near the watershed where residents can dispose of large trash items at no charge or for a minimal fee, or, alternatively, schedule and promote neighborhood clean-up days where the county will collect large items. Deposits should be required for tires and other large items that often end up in illegal dumps.

Action D 4.4: Place trash receptacles at locations where trash is likely to be generated (e.g., bus stops).

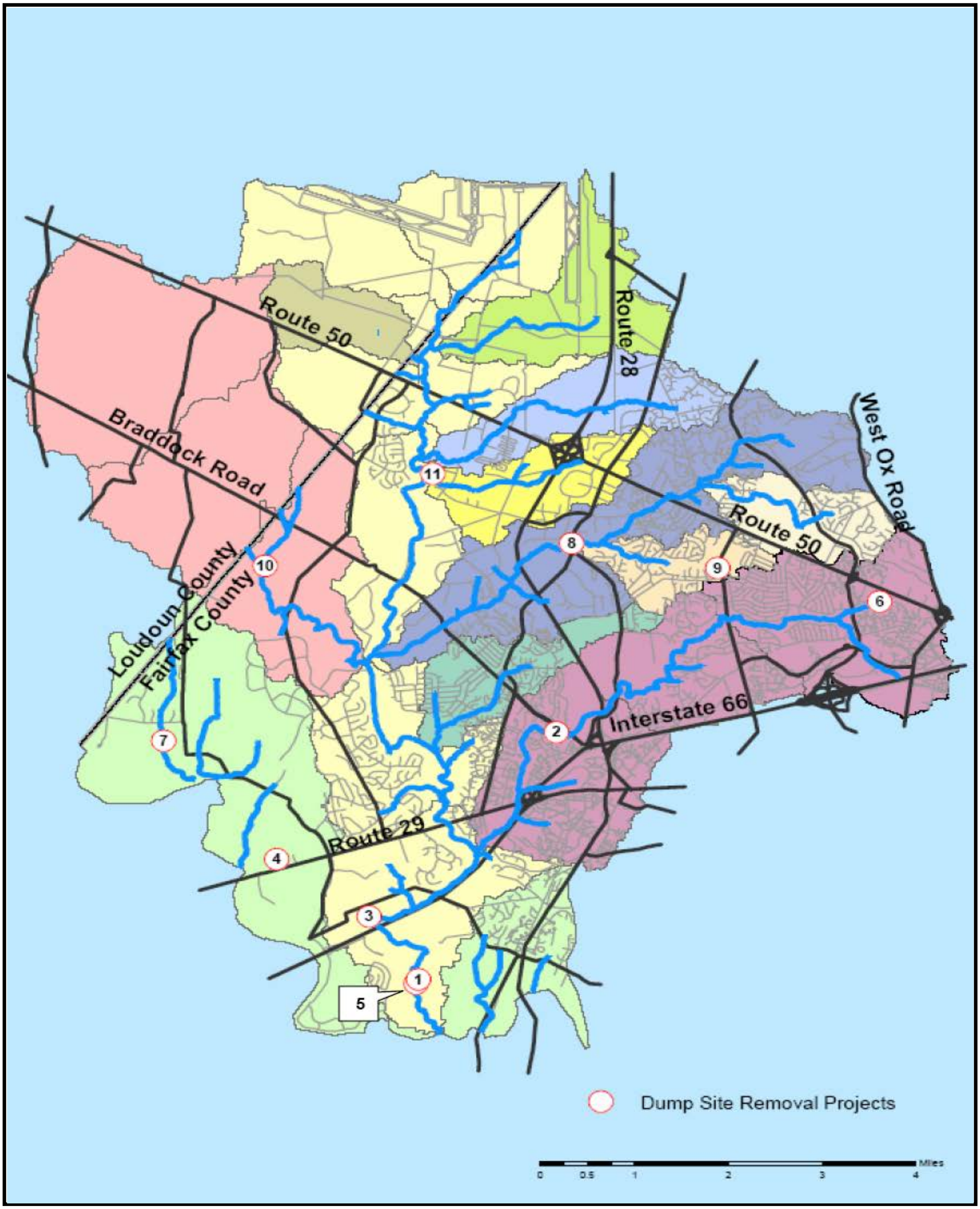


Figure 4-1
Location of Dump Site Removal Projects

Table 4-1
Summary of Dump Site Cleanup and Removal Projects

Project ID	**Location**	**Description**
BR9901	Both banks in stream Unnamed Bull Run Tributary	Dirt piles in the stream. Impact score of 7. (BLBU001.M001)
BR9902	Left bank flood plain Bull Run tributary	Rusted truck and metal waste. Impact score of 5. (BLBU005.M001)
CU9901	Left bank flood plain Lower Cub Run Bull Run Regional Park	55-gallon drums (empty), above ground tank. Impact score of 5. (CUCU004.M001)
CU9902	Left bank flood plain Lower Cub Run Bull Run Regional Park	Appliances, trash, tires and miscellaneous debris. Impact score of 10. (CUCU004.M002)
CU9903	Left bank in stream Tributary to Lower Cub Run. Private property	55-gallon drums (closed). Impact score of 8. (CUCU014.M001)
CU9904	Left bank flood plain Flatlick Branch Private property	Gas tanks and transformer. Impact score of 8. (CUBR028.M001)
CU9905	Left bank flood plain Big Rocky Run	Trash and car. Impact score of 5. (CUBR089.M001)
CU9906	Both banks flood plain Flatlick Branch at Walney Road	Construction debris. Impact score of 4. (CUFL102.M001)
CU9907	Both banks in stream Frog Branch near Stringfellow Road	Cast iron pipes in stream at utility crossing. Impact score of 4. (CUFR002.M002)
CU9908	Both banks in stream Elklick Run within FCPA Parkland	Appliances. Impact score of 3. (CUER009.M001)
CU9909	Left bank Cub Run and Schneider Branch	Clean up existing debris and eliminate future dumping at the Upper Cub Run Wastewater Treatment Plant

Objective D 5 – Implement actions to identify early and correct stormwater facility and water quality problems.

Action D 5.1: Increase the frequency of inspections of county-owned stormwater management facilities.

Action D 5.2: Improve coordination and reporting of water quality, benthic and other sampling in the streams by the county and volunteers, and develop a central database where these data can be stored, accessed and analyzed.

Action D 5.3: Prepare reports (every two to three years) that summarize the results of water quality, benthic and other sampling, and describe overall stream conditions in the county. These reports should be publicized and distributed to the public. Parameters tested, monitoring results, interpretation of these results and identification of trends should be documented so it is easily understood by the public and elected officials.

Action D 5.4: Regularly inspect privately owned and maintained stormwater facilities to verify they are properly constructed and maintained, and take appropriate actions where issues are identified.

Action D 5.5: Set up a hotline that residents can call to report a hazardous spill. This action should be coordinated with the direct number for the watershed ombudsman identified in Action A 1.1. Having a single contact will make it easier for residents to report spills, dumping and other environmental hazards in the watersheds.

Action D 5.6: Support the completion and implementation of Fairfax Water's Source Water Protection Study.

Objective D 6 – Identify, evaluate and eliminate chemical and other pollution sources within the watershed.

Action D 6.1: Take inventory of commercial and industrial establishments that regularly work with or store hazardous materials, and therefore could contaminate the streams.

Action D 6.2: Perform regular inspections and water quality sampling at privately owned and maintained stormwater management facilities and/or stormwater outfalls serving facilities that regularly use hazardous materials to ensure they are functioning properly and are not discharging contaminants to the county streams.

Action D 6.3: Perform an inventory of and describe conditions related to commercial and industrial sites such as existing and former gas stations, automobile repair shops, dry cleaners, junk yards, equipment storage yards, quarries and other former commercial and industrial sites that may contain surface or underground contamination. Studies of these sites should describe potential sources of stream contamination and corrective actions if contaminants are entering streams through surface water runoff or groundwater.

4.6 E - New and Infill Development

The following actions are intended to reduce the impact of new development within the Cub Run and Bull Run watersheds to meet the watershed plan's vision and goals, preserve and protect the streams, and reduce polluted runoff.

Objective E 1 - Promote LID stormwater management techniques at all development and redevelopment projects.

Action E 1.1: Expedite the updating of the county Public Facilities Manual to include specific LID strategies. Developers will be better able to implement LID and other innovative controls when these controls are included in the Public Facilities Manual.

Action E 1.2: Develop and distribute reference sources for building and retrofitting sites using LID techniques, including information on maintaining LID facilities. Reference sources previously developed by local, county, state and federal agencies should be used.

Action E 1.3: Develop and implement criteria to quantify tradeoffs between LID stormwater management techniques and conventional stormwater controls. These criteria will allow developers to meet Fairfax County stormwater control requirements using LID techniques.

Objective E 2 - Minimize impacts on Fairfax County streams of new development in other jurisdictions.

Action E 2.1: Track stormwater controls used in development projects and stormwater management requirements in upstream jurisdictions, monitor water quality and streambank conditions of Fairfax County streams downstream from these jurisdictions, and establish back-up plans to address stormwater impacts on Fairfax County streams if the stormwater controls in these upstream areas do not provide adequate protection. Alternatives include preserving sites for additional stormwater controls such as regional ponds and identifying wetland creation and mitigation sites at or near the locations where flows from these areas enter the county.

Action E 2.2: Continue to work with the Metropolitan Washington Airports Authority (MWAA) to ensure that the Dulles Airport expansion meets minimum Fairfax County and Loudoun County stormwater requirements for new development. Implementation of additional controls should be encouraged to further protect the Cub Run streams and prevent flooding. Continued use of the National Environmental Policy Act (NEPA) process and coordination with MWAA and its consultants will advance these goals, and address and resolve issues related to airport development. The environmental impact assessment process for these improvements has been completed. However, county staff is pursuing continued coordination with MWAA on stormwater and environmental issues regarding airport improvements.

Objective E 3 - Incorporate watershed objectives into all stormwater management plans for major transportation projects, including the Dulles Airport expansion, Tri-county Parkway, Battlefield Bypass and Route 28 improvements.

Action E 3.1: Active involvement of the Fairfax County Stormwater Planning Division in the planning, evaluation and design of major transportation projects will help ensure that these projects are performed so they are sensitive to the county's watersheds.

Objective E 4 – Promote and develop incentives for mitigating stream and wetland impacts within the same local watershed where the impacts occur.

Under current state requirements, development, highway and other projects that affect a certain amount of stream or non-tidal wetlands must perform projects to mitigate these affects by improving stream conditions, creating wetlands or improving existing wetland areas. Under present guidelines, these mitigation projects can be implemented outside the watershed affected. For example, mitigation for impacts in urban areas in Fairfax County may occur as projects in rural areas of another county. To best protect Fairfax County streams, the mitigation for Fairfax County projects should be performed, wherever possible, within the same watershed and as close as possible to the streams or wetlands affected.

Action E 4.1: The Cub Run and Bull Run watershed plan and other watershed plans identify potential stream restoration, wetland restoration, buffer restoration and riparian restoration projects. Developing formalized procedures will enable these projects to serve as a bank for mitigation of impacts within the county. This would provide a funding source for the watershed improvement projects while encouraging mitigation within the watershed and/or county.

Action E.4.2: Educate developers on the habitat and water quality benefits of mitigation closer to the site of impacts.

4.7 F – Open Space

The preservation and protection of open space provides excellent protection of the county watersheds. Approximately 23 percent of the Cub Run and Bull Run watersheds are protected in parkland and other open space; additional areas are protected within stream valley resource protection areas (RPAs) and open common areas associated with apartments, condominiums and townhouses. As a result, much of the critical habitat area and floodplain has been protected from development. Fairfax County should actively promote the protection and preservation of existing open space, and identify additional areas in the Cub Run and Bull Run watersheds currently not developed.

Objective F 1 – Identify options to work with private property owners to preserve undeveloped open space.

> **Action F 1.1**: Work with the Northern Virginia Conservation Trust, other area land trusts, the Northern Virginia Park Authority, Fairfax County Park Authority, state agencies and community organizations to identify opportunities and funding sources for preserving open space, and associated natural and cultural resources.
>
> **Action F 1.2**: Create an open space plan to guide the county's efforts to preserve open space, and natural and cultural resources.

Section 5
Watershed Plan Policy Objectives and Recommendations

This section outlines the recommended changes to Fairfax County policy that will help improve watershed conditions, address watershed issues and meet the Cub Run and Bull Run Watershed Plan vision and goals. The recommendations were prepared by the Community Advisory Committee (CAC), developed as part of the public information program or identified by the project team.

The policy recommendations include proposals that may require amendments to the County Code and other supporting documents such as the Public Facilities Manual. These recommendations will be evaluated further concerning greater county-wide implications before they can be implemented. The policy recommendations from the Cub Run and Bull Run Watershed Plan will be compared with similar recommendations in the Little Hunting Creek, Popes Head Creek, Cameron Run, Difficult Run and other watershed management plans. Based on this review, ordinance amendments and other changes in policy will be developed that consider other county initiatives and policies, and address the similarities among the policy recommendations from completed watershed plans. Funds and staff resources will be required to implement these recommendations. These resources will be estimated at the time a policy recommendation is being evaluated for implementation as part of the annual budget process. Existing resources and partnerships will be used when available. The watershed plan recommends that the county implement the recommended changes in policy and allocate adequate funds as needed.

The watershed vision and goals, described in Section 1.3, provide the overall framework for the watershed plan. To ensure that the streams and stream valleys continue to be a valuable resource for the community, the plan must address changes to current policy and identify new policies, as well as provide structural stormwater controls and implement non-structural actions.

The policy recommendations are grouped into the following categories:

- A - Public Outreach and Education
- B - Interjurisdictional Cooperation
- C - Recreation
- D - Existing Development
- E - New and Infill Development
- F – Open Space

The same groupings were used for the non-structural actions described in Section 4. The framework provides specific recommendations to be considered in the watershed plan and allows evaluation of the plan's success in meeting the watershed vision and goals.

The following sections identify and describe the objectives and policy recommendations within each of these groups. The order in which they appear does not represent their respective order of importance or the order in which they will be implemented.

5.1 A - Public Outreach and Education

The following policy recommendations help develop a sense of pride in and ownership of the watershed and stream valleys, and promote personal stewardship. The actions of individuals can significantly affect the overall health of the watershed. These recommendations use outreach and education to promote actions to improve watershed health and discourage actions that negatively affect the watershed.

Recommendation A 1.1: Showcase the innovative use of stormwater management techniques at all new county construction and expansion projects such as schools, recreation centers, office buildings, libraries, fire stations and parks. These projects should include demonstration projects for rain gardens, bioretention, green roofs, pervious pavement, reduced impervious area and other LID techniques. Interpretive signs and other public information and education materials should be placed at these sites.

5.2 B - Interjurisdictional Cooperation

Stream conditions in the Cub Run and Bull Run watersheds reflect the cumulative effects of changes in land use and development from several jurisdictions. Implementing the following policy recommendations will help improve cooperation among the various agencies responsible for stormwater and watershed management in the watersheds, including Fairfax County, Loudoun County, Prince William County, the Metropolitan Washington Airports Authority, the Federal Aviation Authority, the Upper Occoquan Sewage Authority and the Virginia Department of Transportation.

Non-structural actions under objective B 1 (Section 4.3) will be implemented to improve cooperation among these agencies. The watershed plan also recommends that interagency cooperation be promoted at the policy level through the following objectives and recommendations.

Objective B 1 – Continue coordination and cooperation among local, state and federal agencies concerning watershed issues and take steps to improve these efforts.

Recommendation B 1.1: Continue to work with the jurisdictions in the watershed to ensure that stormwater regulations adequately protect streams from the impacts of existing and future development, and other human activities.

Recommendation B 1.2: Recognize that stormwater and watershed issues do not stop at political boundaries and stress interjurisdictional cooperation to protect watershed health and public water supplies.

Recommendation B 1.3: Request that the Fairfax County Board of Supervisors present the Cub Run and Bull Run Watershed Plan to the Loudoun County Board of Supervisors and seek concurrence on the actions included in the plan.

5.3 C - Recreation

This recommendation aims to create and promote appropriate recreational opportunities within the watershed to enhance public understanding and appreciation of healthy streams, stormwater management and other watershed issues. Appropriate recreational opportunities and facilities will get the public physically engaged and invested in the watershed, while increasing the personal commitment to watershed stewardship. These recommendations also will make stormwater management facilities more of an asset to watershed residents. Recreational uses must be appropriate for the watershed and the community, and be sensitive to stream health.

Objective C 1 - Design new stormwater management facilities to provide opportunities for educational and recreational uses. The past and current county policies generally discourage recreation and access primarily due to public safety and liability concerns. These policies should be reconsidered and rewritten to make stormwater management facilities an amenity to the community while at the same time protecting county interests.

Recommendation C 1.1: Create fishing opportunities in existing and proposed wet ponds in the watershed where appropriate.

Recommendation C 1.2: Create observation platforms, interpretive signs and benches to promote passive recreation at new and existing stormwater management facilities.

Objective C 2 - Construct and manage new recreational facilities in a manner that is sensitive to the health of streams and stream buffers.

Recommendation C 2.1: Coordinate with the Fairfax County Park Authority and Northern Virginia Regional Park Authority in developing the Sully Woodlands Regional Master Plan and other site-specific plans for new and existing parks, to ensure that development has minimal impact on county streams and to improve watershed health when possible. Park development plans and maintenance procedures will need to be reviewed periodically to identify opportunities for restoration and additional protection of stream buffers.

5.4 D - Existing Development

The following policy changes will help reduce the impact of existing development on streams in the watershed.

Objective D 1 - Address problems associated with pets, wildlife and non-native species.

Recommendation D 1.1: Work with appropriate local and state agencies to create an effective policy to remove the carcasses of animals killed by automobiles more rapidly to avoid stream contamination. Telephone numbers that citizens can use to report dead animals should be established and/or publicized.

Recommendation D 1.2: Work with appropriate local authorities, including the Fairfax County Animal Control Division, to develop a consistent and humane strategy for addressing issues created by native wildlife, including deer and geese.

Objective D 2 – Implement changes in policy to actively promote and encourage the construction of LID and other innovative stormwater controls on existing residential and non-residential private property.

Recommendation D 2.1: Evaluate alternatives to provide monetary incentives for LID implementation by residents and businesses on private property. Private property owners will be more willing to implement and maintain LID on their property if there are incentives. Possibilities include grants, no-interest or low-interest loans, matching grants, materials subsidies and/or tax breaks. Opportunities to provide a tax break if an approved LID project is implemented by a property owner should be evaluated. If a stormwater fee is implemented, opportunities should be identified to reduce the fee for homeowners who implement approved LID techniques. The evaluation should include assurance that the projects will be properly installed and maintained.

Recommendation D 2.2: Make funds available for LID retrofit, stream restoration and buffer restoration projects by community groups such as homeowner associations, businesses and churches. These projects are more likely to be constructed if costs can be offset by county funds or grants. Possibilities include grants, no-interest or low-interest loans, matching grants, materials subsidies and/or tax breaks. The evaluation should include assurance that the facilities will be properly installed and maintained.

Objective D 3 - Reduce trash and dumping in the watershed.

Implementation of the following policy changes will help reduce illegal dumping and minimize improper disposal of trash and garbage in the watershed.

Recommendation D 3.1: Increase fines and penalties, and enforce existing laws prohibiting dumping and littering.

Recommendation D 3.2: Implement a policy in which persons caught dumping or littering will be prosecuted to the maximum extent of the law.

5.5 E - New and Infill Development

The following objectives and recommendations are intended to reduce the impact of new development and infill development within the Cub Run and Bull Run watersheds.

Objective E 1 - Promote the use of LID stormwater management techniques and other innovative stormwater designs in all new development and redevelopment projects in the county.

Recommendation E 1.1: Promote and encourage alternatives to paved surfaces for sidewalks, driveways and parking areas (gravel, permeable pavers, etc.). Evaluate incentives to reduce paved areas and review the Public Facilities Manual to ensure it adequately addresses alternatives to impervious pavement. Review and potentially revise policy to allow pervious paving to offset up to 50 percent of the interior landscaping requirements.

Recommendation E 1.2: Implement a strategy to review stormwater management design more consistently for new development projects, especially regarding LID implementation.

Recommendation E 1.3: Develop a checklist or other tool that would help ensure that the county accepts stormwater control plans that include LID without delaying the project or causing the property owners and/or developers to incur additional costs. Disincentives to using LID should be removed through a technical, pre-review process to ensure that proposed plans are workable and potentially acceptable to the county. A pre-review meeting or process involving technical review staff and developers can expedite the permitting and approval process, and remove uncertainty associated with proposing and implementing LID.

Recommendation E 1.4: Identify and promote procedures and incentives to encourage developers to implement stormwater controls that exceed the minimum required by the Public Facilities Manual and other policies. This should include overall guidelines and best management practices for onsite stormwater management and specific incentives that the developer may consider during site plan development. Flexibility is needed by county staff to approve deviations of up to 10 percent of building setback requirements in return for the use of contiguous areas to implement LID best practices that do not displace natural areas within the RPA, floodplains or stream channels. This recommendation would require an amendment to the zoning ordinance through the zoning amendment work program to allow for modifications to setback requirements.

Recommendation E 1.5: Design new stormwater management facilities to be more aesthetically pleasing, and provide educational and recreational opportunities. Use less visually intrusive designs, implementing landscape architecture techniques to make the stormwater facilities look more natural and to minimize impact on the health of streams, forests and wetlands.

Objective E 2 - Minimize impacts of new development in other jurisdictions.

Recommendation E 2.1: Continue to work with the Metropolitan Washington Airport Authority (MWAA) to ensure that the Dulles Airport expansion effectively prevents negative environmental and other impacts on Cub Run and Bull Run streams, and on residents near these streams. Continue coordinating with the MWAA and its consultants to advance this goal. Resolve and address issues related to the potential impacts of development on the Federal Emergency Management Authority (FEMA) 100-year flood plain.

Objective E 3 – Minimize and properly address the watershed and wetland impacts of highway, roadway, airport and other transportation improvements.

Recommendation E 3.1: Promote those alternatives for the Tri-County Parkway and Battlefield Bypass that have the least impact on county watersheds. The Commonwealth Transportation Board selected the Tri-County Parkway alternative that lies entirely outside the Cub Run and Bull Run watersheds.

Recommendation E 3.2: Design and build highway and road improvement projects that minimize watershed impacts and include innovative stormwater management controls when feasible.

Recommendation E 3.3: Develop incentives to promote stream and wetland mitigation for roadway, airport and other major transportation projects within the same watershed in which the disturbance occurs and as close to the disturbance as possible. Mitigation should reflect the most current science and the evolving understanding of where habitat and water quality mitigation has the most impact. A list of stream and wetland improvement projects in the Cub Run and Bull Run watersheds should be maintained for consideration as mitigation sites. Decisions regarding wetland and stream mitigation locations ultimately rest with federal and state authorities.

Objective E 4 - Manage urban forests and stream buffers to reduce runoff rates, and improve stormwater runoff quality and overall stream health.

Recommendation E 4.1: Encourage and require more tree plantings in stream buffers and around new dry ponds. The goal is to improve stream habitat by providing shade, reduce the visual impact of these stormwater facilities and support forests within the watershed.

Recommendation E 4.2: Prevent deforestation and other vegetation removal during and after development of land in the watershed; create incentives to encourage tree preservation by developers; and require tree planting and creation of "no mow" zones in environmentally sensitive areas near streams, floodplains and stream valleys. Such actions should be consistent with Resource Protection Area requirements and the Environmental Corridor policy, and may require better enforcement of these policies or strategies to address existing conditions.

Objective E 5 – Implement additional strategies to minimize stream impacts.

Recommendation E 5.1: Encourage stormwater treatment using smaller facilities located further up in the stream headwater areas. Stormwater management programs should intercept problems before they enter the streams. The solutions should be as far upstream in the watershed and as close to the source of stormwater runoff as possible. Ponds should be a last resort and located off-channel when possible. Alternatives to ponds, including smaller upstream stormwater controls and more natural controls such as wetlands, should be considered.

Recommendation E 5.2: Use the one-year, 24-hour storm as the "adequate outfall" standard for erosion and sediment control. Portions of the Fairfax County Public Facilities Manual concerning the adequate outfall requirement were updated in early 2006.

Recommendation E 5.3: Identify, evaluate and (if appropriate) implement alternative stormwater management pond designs to provide better stormwater protection for county streams. Based on the conditions found in the Cub Run Watershed, evidence indicates that the current peak flow control and extended draw-down dry pond design does not totally protect the county's streams. Alternative, state-of-the-art stormwater ponds that store the flow of the one-year storm and release it over 24 to 48 hours should be evaluated. These alternative designs should be used when they improve stream protection and do not present other implementation problems.

Objective E 6 - Enforce stormwater facility design criteria to ensure that facilities constructed for new development meet county standards.

Recommendation E 6.1: Before bonds are released, inspect stormwater controls constructed by developers to ensure they are constructed correctly and meet county standards and requirements.

Recommendation E 6.2: Require that development site plans provide sufficient space for proper stormwater management.

5.6 F – Open Space

The preservation of open space provides excellent protection of the county's watersheds, and policies should promote and encourage it.

Objective F.1 - Adopt policies that promote and support the preservation of critical open space, and natural and cultural resources.

Recommendation F 1.1: Evaluate county funding for the preservation of undeveloped open space identified in the Sully Woodlands Regional Master Plan or other areas, and make adjustments as necessary.

Recommendation F 1.2: Evaluate and potentially update county policies regarding tax and other incentives to establish conservation easements on privately owned property to preserve undeveloped land. These evaluations will consider whether Fairfax County has the authority to implement such incentives.

Recommendation F 1.3: Given the large areas of undeveloped, privately owned land used as common areas for apartments, condominiums, townhouses and homeowner associations, review county policies regarding management and maintenance of these areas, and their impact on watershed health. Policies should encourage maintenance of these privately owned open areas that protect watershed health through the creation of no-mow zones, planting of native species, and removal of non-native species. Construction of LID facilities such as bioretention and grassed swales should be encouraged to reduce the impacts of adjacent paved and developed areas.

Section 6
Watershed Plan Structural Actions

6.1 Introduction

The following sections present structural actions that meet the watershed plan goals, address watershed issues and prevent future degradation. Structural actions refer to watershed plan elements that require construction to implement. This section describes procedures used to identify the projects included in the actions, identifies each project's location and costs, and shows the locations of the actions.

The Fairfax County Stormwater Planning Division recognizes that appropriate public outreach and education is key to the successful implementation of these structural projects. The project costs include allowances for such programs.

Section 7 documents the ranking of these structural projects, the implementation program and the watershed plan's benefits.

Sections 6.2 through 6.9 summarize the following structural actions:

- Implement regional ponds or alternative stormwater controls (Section 6.2)
- Implement dry pond retrofit projects (Section 6.3)
- Implement Low Impact Development at public facilities (Section 6.4)
- Perform stream restoration (Section 6.5)
- Address stormwater runoff from neighborhoods without stormwater controls (Section 6.6)
- Perform stream buffer restoration (Section 6.7)
- Replace and upgrade road crossings (Section 6.8)
- Perform other structural actions (Section 6.9), including upgrading upland drainage systems and restoring riparian wetlands

Section 6.10 documents the status of the projects in the Storm Drainage and Flood Control Master Plan.

Section 6.11 summarizes the watershed plan structural projects by major subwatershed.

The watershed plan projects are numbered using the following convention:

- The first two characters identify the watershed with CU indicating projects in the Cub Run watershed and BR indicating projects in the Bull Run watershed.

- The third character is 9 for all projects.

- The fourth character indicates the project type:

  - 0 – Regional pond or alternative projects
  - 1 – Dry pond wetland retrofit (ponds 1 through 99)
  - 2 – Stream restoration
  - 3 – Buffer restoration
  - 6 – Road crossing improvement
  - 7 – Dry pond retrofit projects (ponds 100 on)
  - 8 – LID retrofit projects
  - 9 – Other projects, including dump site removal, neighborhoods without stormwater controls, upland drainage retrofit and riparian wetland studies

- The last two numbers indicate the project number. Projects are numbered sequentially starting at the lowest point in the watershed.

Appendix C includes fact sheets for each structural project including project descriptions, costs, and a map showing the project location.

6.2 Action - Reevaluate Status of Regional Ponds

6.2.1 Introduction

One action in the watershed plan is to evaluate the status of previously proposed but not constructed regional ponds within the Cub Run and Bull Run watersheds.

As discussed in Section 2.5.4, the county adopted a Regional Stormwater Management Plan in 1989, promoting regional ponds to service larger drainage areas (generally 100 to 300 acres) that encompass one or more site developments. These large ponds are designed to reduce the number of smaller onsite stormwater facilities.

Regional ponds reduce nutrients, sediment and other pollutants effectively and control peak flow discharges that can cause flooding and erosion. In addition, maintaining one large regional facility is generally less costly than maintaining numerous smaller facilities. However, construction of these large regional ponds within the stream valley can have negative effects aesthetically and ecologically.

The 1989 Regional Stormwater Management Plan identified 31 regional pond sites in the Cub Run watershed. Seventeen of these planned ponds were constructed. About 12 additional ponds exist that can be classified as “regional” due to their large drainage areas (e.g., larger than 100-acre watershed). These additional ponds either were in place at the time of the 1989 study or were constructed at locations not identified in that study. Also, four large regional ponds exist in the Loudoun county portion of the watershed. The existing 33 large ponds provide significant nutrient reduction and peak flow control benefits. These existing ponds are shown in Figure 6-1. Developers of land near the ponds constructed many of the regional ponds to meet county stormwater management requirements.

Regional ponds are an effective stormwater control method for both peak flow control and stormwater pollutant removal:

- Many of the ponds were proposed as “maximum efficiency” ponds that controlled the post-development peak flows from the two- and 10-year storms to a level that is as much as 33 percent of the predevelopment peak flows. This level of peak flow control is difficult to achieve with smaller, onsite ponds. Alternative stormwater controls such as bioretention, upstream culvert retrofit, buffer restoration and stream restoration have little or no effect on the two- and 10-year peak runoff rates.

- A regional pond typically controls a drainage area of 100 acres or more and therefore can receive and remove a significant annual mass of nutrients and other pollutants. As an example, proposed pond C18 will remove approximately 70 pounds of phosphorus annually from stormwater runoff. Approximately 1,040 medium-density residential bioretention rain garden facilities would be required to achieve this level of nutrient removal. Alternatively, about 43 dry pond wetland retrofit projects would be required to supplant the phosphorus removed by a single regional pond.

Regional ponds, however, negatively impact the streams, environment and community:

- Wet ponds present a potential safety hazard for children.

- Regional ponds do not protect the streams upstream, leaving a portion of the streams unprotected by stormwater controls.

- Regional ponds are typically within the stream valleys and therefore affect the health of the streams, wetlands and forested stream buffer.

- In most cases, the regional pond construction affects the Chesapeake Bay Preservation Ordinance Resource Protection Areas.

- Trees must be removed for dam construction and within areas frequently flooded by the dam.

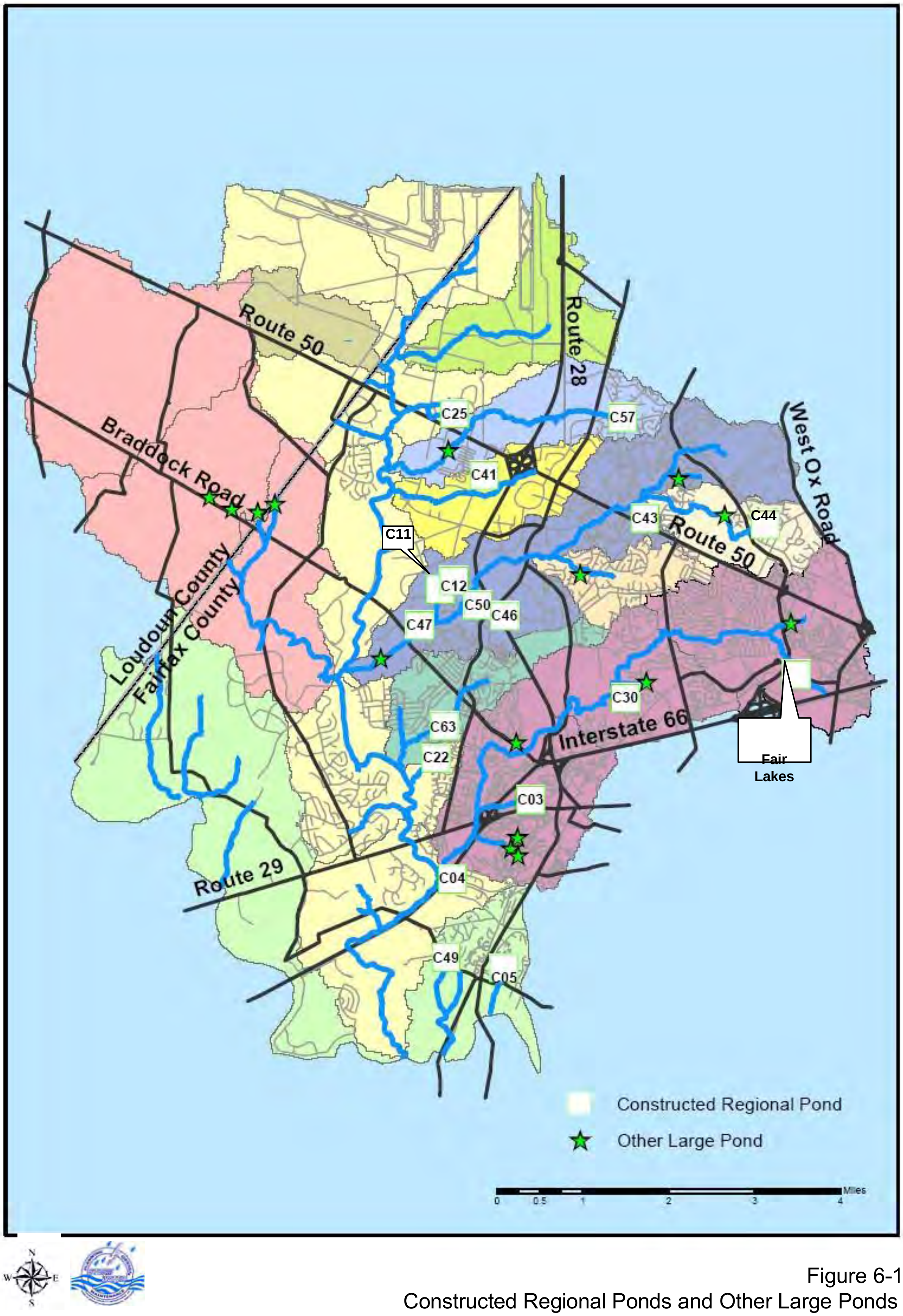


Figure 6-1
Constructed Regional Ponds and Other Large Ponds

The Fairfax County Stormwater Planning Division and citizen committees have reviewed the status of regional ponds in the county stormwater management program. Several of these studies are described in Section 2.5.4. The report "The Role of Regional Ponds in Fairfax County's Watershed Management" (March 2003) presents findings from the Regional Pond Subcommittee's review of the county's regional ponds. The subcommittee's unified position is that regional ponds should not be considered the preferred stormwater management alternative. Rather, regional ponds should be considered one of many tools available for stormwater planning.

This section reviews the status of the 14 planned regional ponds that have not been constructed: C18, C19, C20, C21, C23, C24, C28, C35, C37, C39, C40, C53, C54 and C62. These proposed ponds, shown in Figure 6-2, generally fall into two categories:

- Proposed regional ponds within the Residential-Conservation (R-C) District. Seven of the 14 ponds fall into this category (C21, C23, C24, C28, C35, C37 and C62).

- Proposed regional ponds outside the Residential-Conservation District. Seven of the 14 ponds fall into this category (C18, C19, C20, C39, C40, C53 and C54).

Sections 6.2.2 and 6.2.3 discuss general conditions and overall assumptions for the regional ponds in these two categories. Section 6.2.4 reviews each of the 14 unconstructed regional ponds.

6.2.2 Proposed Regional Ponds Located Within the R-C District

A portion of the county was rezoned in 1982 to protect the water quality in the Occoquan Reservoir. Section 2.6.1 provided additional information on the Occoquan Reservoir water quality protection measures. This rezoning resulted in major areas of the Cub Run and Bull Run watersheds being placed in the R-C District with maximum densities of one house per five acres. This density is referred to as Estate Residential in the generalized land use descriptions in the Fairfax County watershed plans. The rezoning was planned to achieve annual total phosphorus loadings equivalent to or lower than the planned land use prior to the rezoning, assuming treatment by dry ponds or wet ponds within the Fairfax County portions of the Occoquan Reservoir watershed.

The R-C District is a very effective implementation of low-impact development in which the maximum allowable development density is sufficiently low to minimize impacts on the water quality and peak flows. Also, 5,174 of the 11,716 acres (44 percent) of the land within the R-C District in Cub and Bull Run are preserved as parkland and golf courses. As a result, no additional water quality BMPs or detention ponds are required. Impervious areas are typically 5 to 10 percent for this land use. Studies correlating stream condition to impervious area typically find that impervious areas in this range have small impacts on streams (Schueler, T.R. and Holland H.K., "The Practice of Watershed Protection," Ellicott City, MD, 2000).

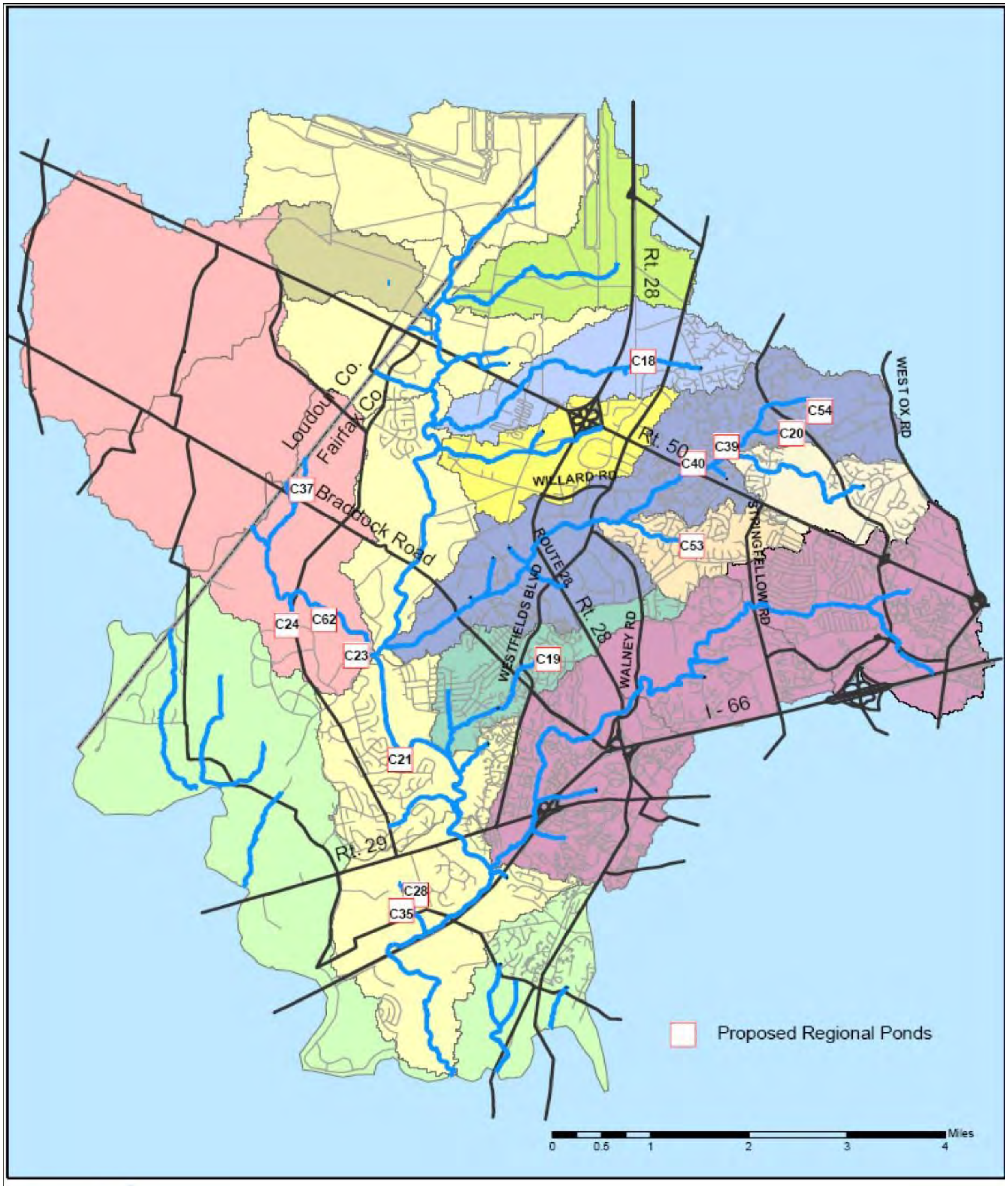


Figure 6-2
Unconstructed Proposed Regional Ponds

Seven of the 14 proposed regional ponds (C21, C23, C24, C28, C35, C37 and C62) are within the R-C District. These regional ponds were included in the 1989 Regional Stormwater Management Plan to control runoff from potential future development in case the rezoning was legally overturned. The rezoning has withstood several legal challenges over the years. A key factor in this defense was that the Estate Residential density of one house per 5 acres did not require structural water quality BMPs to provide the required water quality protection for the Occoquan Reservoir.

Several proposed regional ponds (C21 and C23) are in neighborhoods near Pleasant Valley Road (Virginia Run, Gate Post Estates, Pleasant Hills, etc.) that were developed at the planned medium- and low-density residential densities that existed at the time of the rezoning. These higher-density areas within the R-C District include extended detention dry pond water quality BMPs and peak flow controls.

The 5-acre Estate Residential land use protects the streams sufficiently such that:

1. The proposed regional ponds provide small watershed benefit relative to their cost and impact. As described in Section 6.2.4, ponds in the R-C District were eliminated from the watershed plan primarily for this reason.

2. Since the proposed ponds in the R-C District would provide very little to no stormwater management benefit, alternative stormwater control projects are generally not required due to the low impervious cover. As noted below, the area upstream from the regional pond includes dry pond wetland retrofit, stream restoration and other stormwater management actions to address stormwater issues such as stream bank erosion and deficient stream buffers near the regional ponds.

6.2.3 Proposed Regional Ponds Located Outside the R-C District

Seven of the proposed but unbuilt ponds (C18, C19, C20, C39, C40, C53 and C54) are outside the R-C District. As described below, the land area upstream from these remaining ponds is largely developed. The development upstream from the proposed unbuilt ponds is mostly medium- and low-density residential. As described in the following sections, in nearly all cases the upstream development includes onsite dry ponds or wet ponds that manage the stormwater runoff from these areas. As such, conditions have changed significantly from the time that the regional ponds were proposed in 1989.

Because of its location within the Occoquan Reservoir watershed, the county has issued very few, if any, water quality BMP waivers for the development upstream from the proposed regional ponds in the Cub Run and Bull Run watersheds. As a result, dry or wet ponds serve the development in nearly all cases. In some cases, houses near the stream valley or otherwise located such that the drainage could not be directed to an onsite pond may not have stormwater controls. Even in these cases, the onsite ponds that serve the remaining portions of the development likely provide additional stormwater control protection that compensates for the areas that are not controlled. In isolated cases, the few houses directly adjacent to the proposed regional pond may have been granted water quality waivers.

Some upstream dry ponds may be "temporary" facilities constructed so the onsite pond could be developed once the proposed downstream regional pond is constructed. If the proposed regional pond is not constructed, these temporary facilities can remain as permanent facilities.

In some instances, the detention requirement to control the 2- and 10-year peak flow may have been waived in areas upstream from the pond. Therefore, some dry ponds upstream from the proposed ponds may include only extended dry detention volume to provide water quality control but not peak flow control detention volume. In other words, some areas upstream from the proposed regional ponds may not have the full stormwater peak flow controls required for other areas of the county.

The proposed but not constructed regional ponds outside the R-C District were reviewed to determine if the regional pond can still be constructed or is needed. In addition, the proposed pond watersheds were evaluated to identify alternatives to be implemented in place of the regional ponds.

These evaluations recognize that placing a new stormwater quality control practice upstream or downstream from an existing facility greatly reduces the water quality benefits provided by the new facility. The reason is that much of the pollutant removal occurs through settling in the existing facility. Solids that settle or are otherwise removed in the upstream pond reduce the removal efficiency of the downstream facility, thereby reducing the net water quality benefit from the new stormwater controls. Watershed plan actions to construct or promote LID practices such as bioretention, new dry ponds or wet ponds, and dry-pond wetland bottom retrofits focus on areas not upstream from existing wet ponds and extended detention dry ponds to provide the greatest pollution removal and stream protection benefits.

The following section provides an overview of the status of the proposed regional ponds based on the detailed evaluations performed in this watershed plan.

6.2.4 Reevaluation of Unconstructed Regional Ponds

6.2.4.1 Introduction

Each of the fourteen proposed but not constructed ponds were reviewed in detail, and alternatives consistent with the watershed plan goals and objectives were evaluated. Conditions have changed considerably from when the ponds were proposed in 1989. As described in Section 6.2.2, the R-C District has been upheld in court and is fully supported by the Fairfax County Board of Supervisors. Therefore, the necessity of regional ponds within this watershed area is greatly reduced. Also, smaller onsite ponds have been constructed within the drainage areas upstream from the proposed regional ponds. These new upstream ponds provide water quality protection for much of the upstream areas and reduce the need for the regional ponds.

The watershed plan presents alternatives to the proposed regional ponds that have not been constructed and accounts for the recommendations developed by the Regional Pond Subcommittee. The overall goal is to provide stormwater controls that provide the same approximate level of protection as would have been provided had the originally proposed regional pond been constructed. The goal of regional ponds and their proposed alternatives is the same - meet the goals and objectives of the watershed plan to protect and restore local streams, and downstream receiving waters.

These evaluations target providing phosphorus reductions similar to that of the original proposed regional pond. Phosphorus is used in these analyses as a surrogate for other nutrients, sediment, metals, etc., removed by the stormwater controls.

Tables are presented for each regional pond, documenting the phosphorus removal provided by the originally proposed regional pond without upstream stormwater controls. This provides a baseline for evaluating stormwater control alternatives.

Stormwater control options are identified next. The phosphorus removal provided both by the existing stormwater controls and by the proposed pond, accounting for the removal provided by existing upstream controls, are documented. Other stormwater control options are evaluated, including retrofit of upstream stormwater management facilities, new stormwater management controls, LID retrofit projects, stream restoration projects and a reduced size and type of regional pond. Regional ponds proposed as wet ponds near residential development were converted to dry ponds in these analyses. Upstream culvert retrofit projects were also evaluated.

Stormwater control alternatives were evaluated next. These alternatives consist of combinations of stormwater control options and are listed in declining order of efficiency.

Criteria to evaluate the proposed regional ponds and their stormwater control alternatives include:

- Existing stormwater management facilities within the pond drainage area and nearby subwatershed, and their benefits towards meeting the watershed controls
- Existing and future land use upstream from the pond
- Stream conditions upstream and downstream of the proposed pond, and the need for peak flow control at the proposed regional pond location
- Feasibility of constructing the pond at the planned location
- Nutrient load reduction provided by the pond in combination with existing stormwater controls compared with the removal provided by the originally proposed pond
- Amount of nutrient removal provided relative to other structural projects

- Impact of pond on parkland, streams, stream buffers, Chesapeake Bay Protection Ordinance Resource Protection areas and other critical resource areas

- Cost of constructing the pond and or alternative projects relative to the improvements provided

- Adjacent land use and land cover

As noted in the following sections, several previously proposed regional ponds are on Fairfax County Park Authority (FCPA) parkland. While this does not preclude regional pond construction, impact on this valuable community resource will be weighed against the pond's benefits. FCPA approval would be required and the pond would have to be constructed such that it minimizes parkland impacts.

Summary of Status of Previously Proposed Regional Ponds

Table 6-1 summarizes the status of the 14 previously proposed regional ponds based on the detailed evaluations performed for the watershed planning study. Please see detailed discussions of individual ponds for the rationale that supports their status in the Cub Run and Bull Run watershed plan.

Table 6-1
Status of Regional Ponds in the Cub Run and Bull Run Watershed Plan

Regional Pond	Regional Pond Status
C19, C21, C23, C24, C28, C40, C53 and C54	Delete the proposed regional pond and implement alternative projects
C37, C35, and C62	Delete the proposed regional pond and no alternative projects are necessary
C20	Defer the proposed regional pond and implement alternative projects. If the alternative projects cannot be implemented, then a modified regional pond may be considered at a future date
C18 and C39	Implement a reduced-size or modified regional pond. If the pond still cannot be implemented, then implement alternative projects (projects CU9002 and CU9001)

The following sections provided a detailed review of each proposed regional pond, presented in numerical order.

6.2.4.2 Proposed Regional Pond C18

Proposed Pond Description

The previously proposed regional pond C18 is on Cain Branch between Route 28 and Centreville Road. The planned pond is a maximum efficiency wet pond that shaves the peak two-year flow to 33 percent of the predevelopment flow. The drainage area is 416 acres.

The map on Figure 6-3 and data in Table 6-2 provides an overview of the conditions within the proposed regional pond watershed. These include the existing stormwater facilities and watershed plan structural projects.

The proposed pond and adjoining areas were undeveloped in 2002. The southern half of the pond has a planned land use of industrial. Portions of this area are being developed as this study was being prepared. The northern half of the planned pond is in undeveloped portions of the Fairfax County Park Authority's Sully Plantation Park.

The upstream watershed is split equally between medium- and low-density residential land use with little potential for additional development. The upstream drainage area already has four dry ponds, one wet pond and one regional dry pond (C57). Part (40 acres) of this uncontrolled area is undevelopable stream valley parkland. Together, these existing ponds and undevelopable parkland cover 73 percent of the proposed regional pond C18 watershed. Only 27 percent of the developed land is not served by a stormwater pond.

This proposed regional pond could have significant impacts on Sully Historic Site within the historic overlay district. Park Authority supports a reduced size or modified regional pond C18 and/or alternative projects upstream of the proposed pond location. The Park Authority does not support the proposed regional pond C-18 in its current location and size due to conflicts with the Sully Historic Overlay District, the approved alignment of the Metropolitan Washington Airports Authority access road through Sully Historic Site and the location of the Dominion high-voltage transmission lines.

The proposed pond is partially within a developing industrial area. Land acquisition costs may make this pond cost prohibitive and unbuildable.

Proposed Pond Evaluation

This pond was proposed as a maximum efficiency wet pond to provide a high level of water quality and peak flow control. The first line in Table 6-3 shows that the originally proposed wet pond reduces phosphorus by 50 percent without existing upstream stormwater controls.

Table 6-2
Watershed Overview for Unconstructed Regional Pond C18

Drainage Area: 416 Acres

Location: Cain Branch between Route 28 and Centreville Road

Type of Pond: Maximum efficiency wet pond that controls the peak two-year flow to 33 percent of the predevelopment flow.

Status of Pond Site: Split between commercial and an undeveloped portion of Sully Plantation Park.

Existing Upstream Stormwater Controls	**Number of Facilities**	**Total Controlled Area (Acres)**	**Percent of Total Area**
Dry ponds with proposed wetland retrofit	4	172	41%
Dry ponds (no retrofit) – Includes Regional Pond C57	1	83	20%
Wet Ponds	1	9	2%
Undevelopable parkland downstream from stormwater controls		40	10%
Total	6	304	73%

Summary of Uncontrolled Developed Area	**Area (Acres)**	**Percent of Total Area**
Commercial Area	62	15%
Single family residential	50	12%
Total	112	27%

Some potential for additional commercial development in the watershed. No downstream ponds.

Summary of Stream Conditions Near Proposed Pond:	Erosion inventory lines with impact score of four approximately 1,000 feet downstream of proposed regional pond. This erosion indicates that peak flow control is required to prevent further erosion. Stream habitat is classified as good at the proposed pond.

Alternative Stormwater Control Options	**Number of Projects**	**Description**
Dry pond wetland retrofit projects	4	CU9711 – Franklin Middle School (54 acres) CU9713 – Lees Corner Road & Old Diary Road (81 acres) CU9712 – Centreville Road & Armfield Farm Road (30 acres) CU9714 – Franklin Farm Village Center (7 acres)
LID retrofit at public facilities	1	CU9825 - Franklin Middle School (0.6 acres)
Stream restoration projects	1	CU9220 - Restoration Project 4 located approximately 500 feet downstream from proposed regional pond.
Buffer restoration projects	3	Projects CU9335, CU9336 and CU9334
Upstream culvert retrofit projects	-	Closed pipe systems preclude this alternative.
Other Projects	1	Construct smaller dry pond at the existing site or immediately upstream.

Watershed Management Plan Recommendations	Construct regional pond C18 as a 1-year, 24-hour extended detention dry pond with a smaller pond area than proposed to reduce impacts on parkland and commercial area (project CU9002). The pond would provide enhanced stormwater control benefits at a critical headwater location. If the proposed pond is not constructed, then implement alternative stormwater controls including a smaller dry pond at an upstream location.

Table 6-3
Summary of Phosphorus Reduction Provided by
Stormwater Improvement Options and Alternatives for Regional Pond C18

Scenario	Total Phosphorus Removed (Pounds per year)	Percent of Total Phosphorus
Originally Proposed Regional Pond C18 as a Wet Pond without Upstream Controls	190	50%
Stormwater Control Options		
1 - Existing Stormwater Controls	87	23%
2 - Dry Pond Retrofit Projects (4 projects)	13	3%
3 - LID Retrofit Project	0.4	0.1%
4 – Stream Restoration Project	4.6	1.2%
5 - Modified Regional Pond C18 as a Dry Pond Combined with Existing Stormwater Controls	69	18%
6 - Regional Dry Pond Upstream from the Proposed Regional Pond Combined with Existing Stormwater Controls	50	13%
Stormwater Control Alternatives (Combinations of Stormwater Control Options)		
Alternative 1 - Modified Regional Pond C18 and Alternative Projects (Options 1, 2, 3, 4 and 5)	174	46%
Alternative 2 * – Modified Regional Pond C18 with No Alternative Projects (Options 1 and 5)	156	41%
Alternative 3 - Dry Pond Upstream from Proposed Pond and Alternative Projects (Options 1, 2, 3, 4 and 6)	155	41%
Alternative 4 –Dry Pond Upstream from Proposed Pond with No Alternative Projects (Options 1 and 6)	137	36%
Alternative 5–Alternative Projects with No Regional Pond (Options 1, 2, 3 and 4)	105	28%

** Selected Alternative*

Stormwater Control Options

The following structural stormwater control options were evaluated:

1. Implement four dry pond wetland retrofit projects

2. Implement LID bioretention retrofit project for the Franklin Middle School

3. Perform stream restoration project for downstream portion of Cain Branch (CU9220) that includes 1,320 feet of stream restoration within Sully Park

4. Implement buffer restoration projects

5. Construct a smaller dry pond on the Cain Branch main stem at the proposed pond site. Because of the limited available storage volume, the pond may need to be constructed to provide only water quality and limited peak flow reduction benefits (e.g., one-year extended detention). The dry pond should include a wetland or vegetated bottom and maintain existing vegetation where possible.

6. Construct a smaller dry pond on the Cain Branch main stem upstream from the proposed regional pond, immediately upstream from Centreville Road. The dry pond should include a wetland or vegetated bottom and maintain existing vegetation where possible.

In addition to these structural options, additional stormwater controls can be implemented to improve watershed conditions:

1. Promote LID in the upstream watershed, focusing on development not upstream from existing ponds

2. Evaluate and retrofit headwater drainage systems

3. Promote buffer restoration in the upstream watershed

Table 6-3 summarizes the phosphorus reduction provided by structural stormwater control options:

- Option 1 provides the phosphorus reduction from the existing dry and wet ponds.

- Option 2 provides the incremental additional phosphorus reduction from the four proposed dry pond retrofit projects.

- Option 3 provides the additional phosphorus reduction from the LID retrofit projects at public facilities.

- Option 4 documents the phosphorus reduction from the downstream stream restoration project.

- Option 5 provides the additional phosphorus reduction from an extended detention dry pond (one-year, 24-hour stormwater runoff volume) at the site of the proposed regional pond combined with the existing dry and wet ponds. This pond has a smaller surface area compared to the proposed wet pond and is more compatible with the adjacent parkland. This alternative regional pond provides peak flow and water quality stormwater control benefits at a critical headwater location within the watershed that would reduce erosive velocities in downstream segments. The phosphorus reduction provided by this option is less than that provided by the originally proposed wet pond. The reason is that it is a dry pond rather than a wet pond, and the computations account for the phosphorus removed by the existing stormwater controls.

- Option 6 provides the phosphorus reduction from an extended detention dry pond constructed upstream from the proposed regional pond, as shown in Figure 6-3. This pond has a reduced surface area and avoids locating a pond closely adjacent to Sully Park. The nutrient reduction is smaller since this option controls a smaller drainage area. This pond would be constructed as an extended detention dry pond (one-year, 24-hour stormwater runoff volume).

Table 6-3 summarizes the nutrient reduction provided by five stormwater control alternatives that combine stormwater control options. These are in order of decreasing stormwater control effectiveness.

Updated Regional Pond Status

Regional pond C18 will be constructed at the proposed pond location as an extended detention dry pond that stores the runoff from the one-year, 24-hour storm event with reduced storage volume and footprint (Stormwater Control Alternative 2). The pond will be constructed with a wetland bottom to enhance nutrient removal efficiencies.

This pond enhances nutrient reduction in a critical headland portion of the watershed, further protecting the Cub Run streams and approaching the level of control provided by the originally recommended wet pond. The proposed pond has a smaller footprint compared to the proposed wet pond and is more compatible with the surrounding land uses and land cover. Construction of this facility would require approval from the Fairfax County Park Authority. This regional pond C18 is watershed plan project CU9002.

If construction of a dry pond at the proposed regional pond location is not possible, the next preferred alternative is to build a dry pond at an upstream location without the alternative stormwater controls (Stormwater Control Alternatives 4).

Finally, if a regional dry pond is not constructed, all identified alternative stormwater controls will be implemented to enhance nutrient and flow control in the upstream watershed (Stormwater Control Alternative 5).

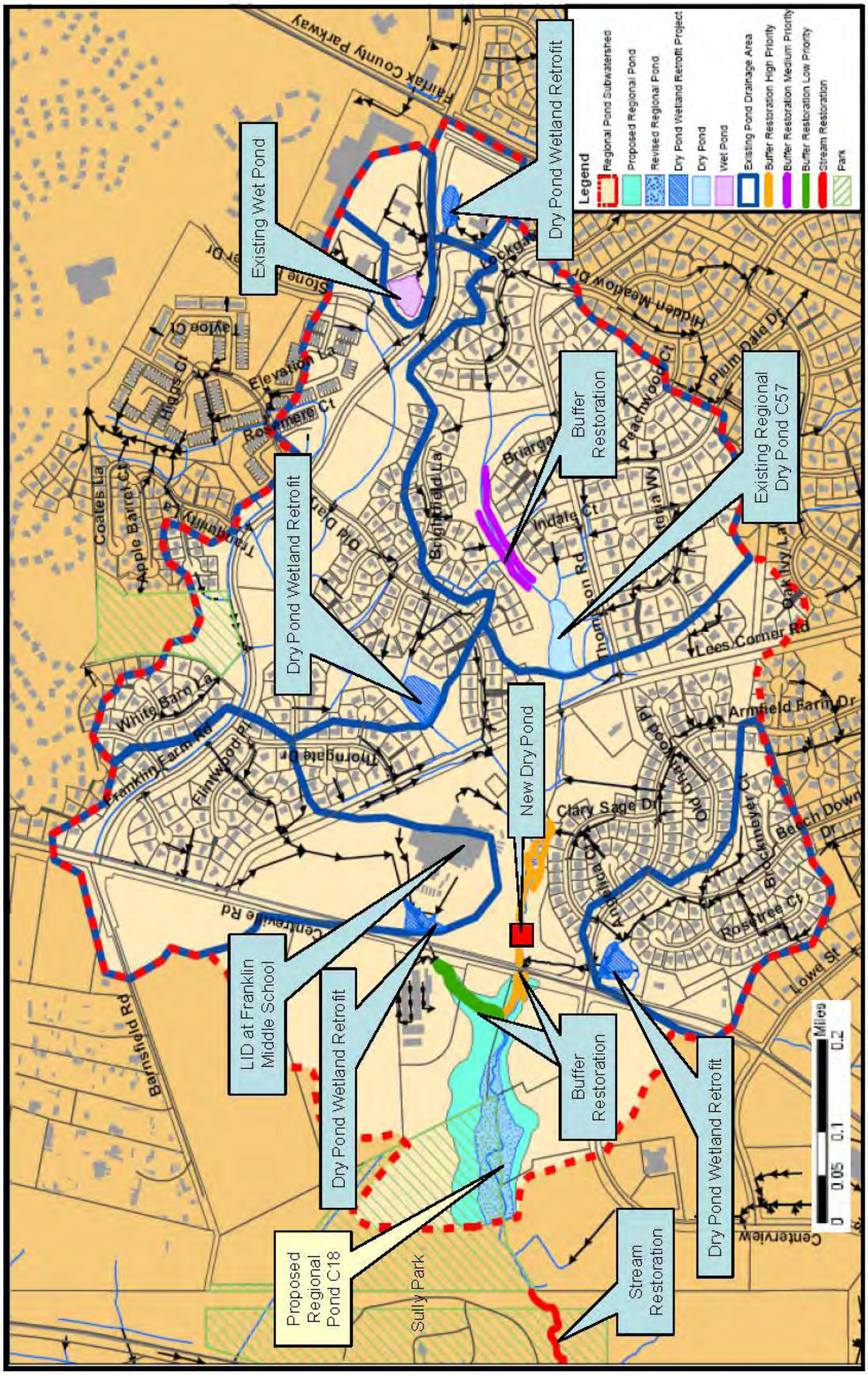


Figure 6-3
Proposed Regional Pond C18

6.2.4.3 Proposed Regional Pond C19

Proposed Pond Description

Regional pond C19 has a drainage area of 310 acres and was planned as a wet pond, which controls the 2- and 10-year peak flow to predevelopment conditions. The pond is on the upper reaches of the Round Lick Branch main stem upstream from Braddock Ridge Road. C19 was formally removed from the regional pond plan in 1998; however, it is included in this study for the development and evaluation of alternative projects.

The map in Figure 6-4 and data in Table 6-4 provide an overview of the conditions within the proposed regional pond watershed. These include the existing stormwater facilities and watershed plan structural projects.

Proposed Pond Evaluation

The first line in Table 6-5 documents the 50 percent phosphorus reduction provided by the originally proposed wet pond.

Residential development has occurred around the regional pond that precludes construction of a wet pond at the planned location and size or at a sufficient volume to provide adequate stormwater control. Construction of a pond of any size would have major impacts on several single-family homes adjacent to the site.

Three dry ponds serve 34 percent of the developed area upstream from the proposed pond. Furthermore, 152 acres or 49 percent of the drainage area to the proposed regional pond is in Ellanor C. Lawrence Park or other stream valley parks. As a result, 84 percent of the upstream area is controlled by existing ponds or protected as undeveloped parkland.

The streams above and for 2,500 feet below the proposed site do not exhibit stream bank erosion.

Several wet ponds constructed as Fairfax County regional wet pond C63 are downstream from the proposed pond. These ponds provide much of the water quality control that the proposed pond would provide.

Stormwater Control Options

Sixteen percent of the drainage area is single-family homes without stormwater controls. The closed pipe systems lack of open space leaves no potential sites for new ponds or upstream culvert retrofit projects.

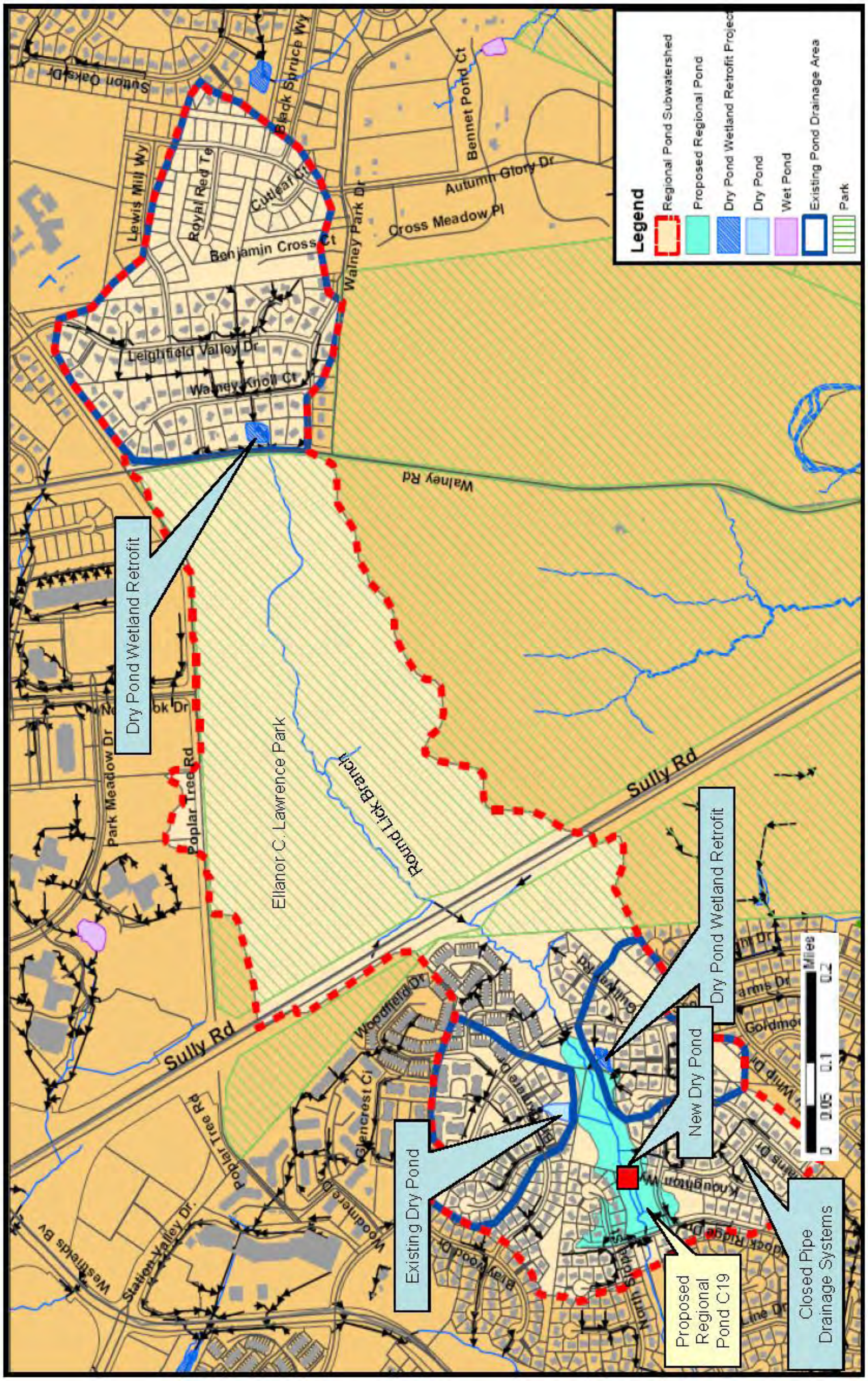


Figure 6-4
Proposed Regional Pond C19

Table 6-4
Watershed Overview for Unconstructed Regional Pond C19

Drainage Area: 310 Acres
Location: Round Lick Branch main stem upstream from Braddock Ridge Road
Type of Pond: Wet pond which controls the two-year and 10-year peak flow to predevelopment conditions
Status of Pond Site: Pond can no longer be constructed due to nearby single-family homes.

Existing Upstream Stormwater Controls	**Number of Facilities**	**Total Controlled Area (Acres)**	**Percent of Total Area**
Dry ponds with proposed wetland retrofit	2	88	28%
Dry Ponds (no retrofit)	1	20	6%
Wet Ponds	0	-	-
Ellanor C. Lawrence Park	-	152	49%
Total	3	260	84%
Regional wet pond (C63) is downstream from the proposed pond (was constructed as two ponds).			

Summary of Uncontrolled Developed Area	**Area (Acres)**	**Percent of Total Area**
Single-family residential with piped drainage system	50	16%
No potential for future development within watershed.		

Summary of Stream Conditions Near Proposed Pond Site	No erosion inventory points within 2,500 feet. A stream restoration project is located about 2,900 feet downstream from the proposed pond. Stream habitat is classified as fair and poor at the proposed pond.

Alternative Stormwater Control Options	**Number of Projects**	**Description**
Dry pond wetland retrofits	2	Project CU9159 – Walney Road & Walney Park Drive (70 acres) Project CU9158 – Belle Plains Drive & Sequoia Farms Drive (17 acres)
LID retrofit at public facilities	-	
Stream restoration projects	1	Project CU9212 is 2,900 feet downstream
Buffer restoration projects	-	
Upstream culvert retrofit projects	-	Closed pipe systems preclude this alternative.
Other Projects	1	Construct smaller dry pond upstream from proposed regional pond location.

Watershed Management Plan Recommendations	Delete regional pond C19 and implement the identified alternative stormwater control options. Do not construct smaller dry pond. Eighty-three percent of the upstream area is controlled by existing ponds or is in parkland. Also, a major regional wet pond (C63) is located downstream. The alternative stormwater projects (excluding the new smaller dry pond) compensate for a portion of the water quality improvements produced by the regional ponds and the stream restoration project addresses stream erosion in Round Lick Branch. Downstream regional ponds reduce the water quality benefits of the proposed regional pond and alternative dry pond.

Table 6-5
Summary of Phosphorus Reduction Provided by
Stormwater Improvement Options and Alternatives for Regional Pond C19

Scenario	**Total Phosphorus Removed (Pounds per year)**	**Percent of Total Phosphorus**
Original Proposed Regional Wet Pond C19 without Upstream Controls	79	50%
Stormwater Control Options		
1 - Existing Stormwater Controls	37	23%
2 - Dry Pond Retrofit Projects (2 projects)	8	5%
3 – Stream Restoration Project	5	3%
4 - Regional Dry Pond Upstream from Proposed Pond Combined with Existing Stormwater Controls	33	21%
Stormwater Control Alternatives (Combinations of Stormwater Control Options)		
Alternative 1 - Regional Dry Pond and Alternative Projects (Options 1, 2, 3 and 4)	83	52%
Alternative 2 – Regional Dry Pond without Alternative Projects (Options 1 and 4)	70	44%
Alternative 3 * – Delete Regional Pond C19 and Implement Alternative Projects (Options 1, 2 and 3)	50	32%

** Selected Alternative*

The following structural stormwater control options were evaluated:

1. Implement two dry pond wetland retrofit projects

2. Perform stream restoration project CU9212 located 2,900 feet downstream from the proposed pond location

3. Construct a smaller pond on the Round Lick Branch upstream from the proposed regional pond. A dry pond that does not provide peak flow controls, for example a one-year extended detention pond, may be considered.

Additional, nonstructural options can be considered to further enhance conditions in the watershed:

1. Promote LID in the upstream watershed, focusing on areas not upstream from existing stormwater ponds

2. Evaluate and rehabilitate stormwater outfalls to reduce stream erosion and improve stream habitat

Line numbers 1 through 4 in Table 6-5 show the incremental nutrient reduction provided by structural stormwater control options:

- Option 1 presents the phosphorus reduction provided by the existing stormwater controls.

- Option 2 presents the additional phosphorus reduction provided by the two proposed dry pond retrofit projects.

- Option 3 presents the additional phosphorus reduction provided by the downstream stream restoration project CU9212.

- Option 4 presents the additional phosphorus reduction provided by an extended detention dry pond close to the proposed regional pond.

Stormwater control alternatives were evaluated that combine the above stormwater control options. These appear in Table 6-5 in order of decreasing nutrient reduction benefit.

Alternatives 1 and 2 include an alternative regional dry pond upstream from the proposed pond combined with existing upstream stormwater controls. These alternatives provide water quality benefits roughly equal to the proposed regional pond. Alternative 3 excludes the regional pond but includes alternative stormwater controls that supplant some of the water quality improvements from the proposed pond and address erosion conditions in the local streams.

Updated Regional Pond Status

Regional pond C19 is deleted from the Cub Run and Bull Run watershed plan, and the following alternative projects will be implemented:

- Dry pond retrofit projects CU9158 and CU9159
- Stream restoration project CU9212
- Nonstructural projects, including promoting LID in the upstream watershed, and evaluating and rehabilitating stormwater outfalls to reduce stream erosion and improve stream habitat

The proposed regional pond, or alternative pond, has major impacts on surrounding residential properties and the stream valley. Two regional wet ponds downstream of proposed pond C19 (regional pond C63) remove many of the nutrients not captured by the alternative regional pond projects. In other words, these downstream ponds effectively negate the net phosphorus reduction provided by the proposed or alternative regional pond. The alternative stormwater control projects enhance stream and habitat conditions in the watershed upstream from regional pond C63.

6.2.4.4 Proposed Regional Pond C20

Proposed Pond Description

Regional pond C20 is on an unnamed tributary of Flatlick Branch. The drainage area to the original proposed pond is 124 acres. The pond was proposed as a maximum efficiency wet pond to reduce the two-year peak flow to 33 percent of the predevelopment peak flow.

The map in Figure 6-5 and data in Table 6-6 provide an overview of the conditions within the proposed regional pond watershed. These include the existing stormwater facilities and watershed plan structural projects.

Proposed Pond Evaluation

A large dry pond has been constructed downstream from the proposed pond. This pond can be considered “regional” due to its large drainage area but was not constructed as part of the county regional pond program. This downstream pond greatly reduces the water quality benefits that regional pond C20 would provide. The pollutant removal presented in Table 6-7 is based on the total area upstream from this existing downstream dry pond shown on Figure 6-5.

As shown in Table 6-7, proposed pond C20 would remove 29 pounds of phosphorus per year as originally planned. This is 27 percent of the total loads at the existing dry pond.

Nearby residential development requires that the C20 dam be moved 110 feet upstream to avoid existing structures. This new upstream location has insufficient storage for a one-year, 24-hour extended detention dry pond. An extended detention dry pond with a smaller extended detention volume (e.g., standard 0.86 inches of runoff from the impervious area) could be created at this site.

Section 6
Watershed Plan Structural Actions

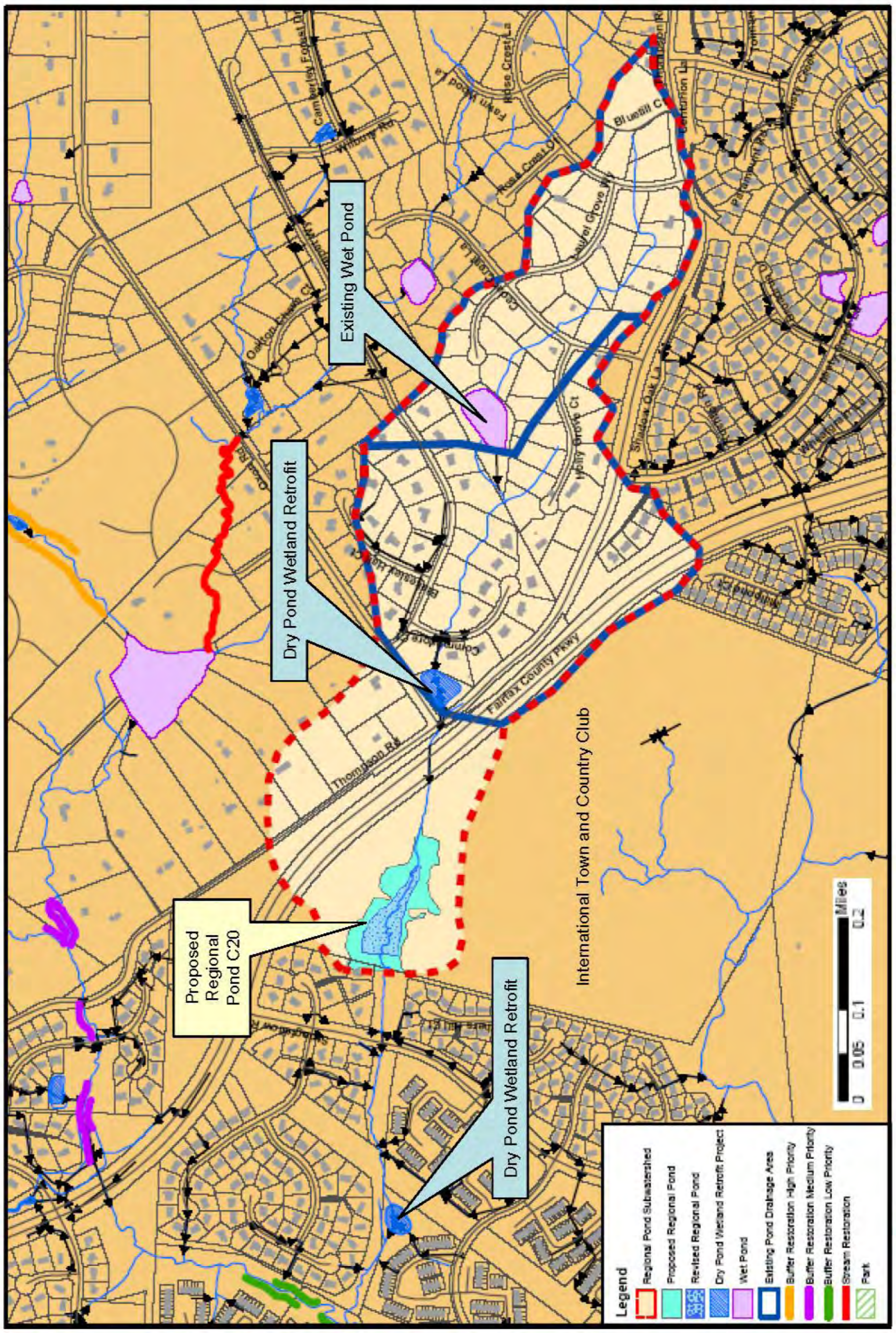


Figure 6-5
Proposed Regional Pond C20

Table 6-6
Watershed Overview for Unconstructed Regional Pond C20

Drainage Area: 124 Acres
Location: Unnamed tributary of Flatlick Branch
Type of Pond: Maximum efficiency wet pond that controls the two-year peak flow to 33 percent of the predevelopment peak flow.
Status of Pond Site: Pond cannot be constructed at the location and size planned due to residential development. Pond could be constructed upstream as an extended detention dry pond with a dam located several hundred feet upstream from the proposed location. The proposed ponds would be located on the International Town and Country Club and would temporarily flood golf course fairways during storm events.

Existing Upstream Stormwater Controls	**Number of Facilities**	**Total Controlled Area (Acres)**	**Percent of Total Area**
Dry ponds with proposed wetland retrofit	1	52	42%
Dry Ponds (no retrofit)	0	0	0%
Wet Ponds	1	36	29%
Total	2	88	71%

Summary of Uncontrolled Developed Area	**Area (Acres)**	**Percent of Total Area**
Golf Course fairways and forested land	36	29%
No potential for future development. There is a constructed dry pond 1,400 feet downstream from proposed pond. This pond was not constructed as part of the County regional pond program but can be considered regional in nature due to its large drainage areas. This pond is a proposed wetland bottom retrofit project.		

Summary of Stream Conditions Near Proposed Pond Site :	Single erosion inventory point 2,100 feet downstream from pond indicates that streams are not severely eroded. The physical habitat within the pond area is classified as fair.

Alternative Stormwater Control Options	**Number of Projects**	**Description**
Dry pond wetland retrofits	2	Project CU9194 – Fairfax County Parkway & Oxon Road (52 acres) Project CU9193 – Mazewood Lane (Downstream of proposed pond) (89 acres)
LID retrofit at public facilities	-	
Stream restoration projects	-	
Buffer restoration projects	-	
Upstream culvert retrofit projects	-	
Other Projects	-	

Watershed Management Plan Recommendations	Defer proposed regional pond and construct alternative projects. The upstream and downstream ponds effectively control the runoff from the developed areas in the watershed. Implement the regional pond if the dry pond retrofit projects are not implemented.

Table 6-7
Summary of Phosphorus Reduction Provided by
Stormwater Improvement Options and Alternatives for Regional Pond C20

Scenario	Total Phosphorus Removed (Pounds per year)	Percent of Total Phosphorus
Proposed Regional Pond C20 without Upstream or Downstream Controls	29	27%
Stormwater Control Options		
1 - Existing Stormwater Controls Including Downstream Dry Pond	42	39%
2 - Dry Pond Retrofit Projects (2 projects including downstream dry pond)	3	3%
3 - Proposed Regional Pond C20 Constructed as a Dry Pond Combined with Existing Stormwater Controls Including Downstream Dry Pond	6	6%
Stormwater Control Alternatives (Combinations of Stormwater Control Options)		
Alternative 1 –Regional Dry Pond with Alternative Projects (Options 1, 2and 3)	51	48%
Alternative 2 –Regional Dry Pond without Alternative Projects (Options 1 and 3)	48	45%
Alternative 3 * –Alternative Projects (Options 1 and 2) and Defer Construction of Regional Pond C20	45	42%

** - Selected Alternative*

The pond would be entirely within the International Town and County Club golf course and adjacent woodlands. Pond construction would require clearing of wooded areas on the golf course. The extended detention volume would temporarily flood fairways during a rainfall event.

The upstream watershed includes one wet and one dry pond that serve all of the low-density residential development in the watershed. There is little opportunity for additional development in the remaining undeveloped area within the International Town and Country Club. The golf course will likely not be redeveloped.

Stormwater Control Options

Since the upstream residential area is entirely served by existing dry and wet ponds, and a dry pond exists downstream, little benefit would come from installing alternative stormwater controls upstream from the proposed regional pond.

The following structural stormwater control option was evaluated for regional pond C20:

1. Implement two dry pond retrofit projects

In addition, nonstructural stormwater control options would enhance conditions in this watershed:

2. Promote LID within the upstream watershed

3. Work with International Town and Country Club golf course to reduce stream buffer impacts and ensure that operations minimize fertilizer and pesticide impacts on the streams

Table 6-7 summarizes the incremental annual phosphorus removed by the structural stormwater control options. The percent reductions are for the total watershed area upstream from the existing dry pond.

- Option 1 provides the phosphorus reduction from the three existing ponds.

- Option 2 provides the additional phosphorus reduction from two dry pond retrofit projects.

- Option 3 provides the additional phosphorus reduction from a dry pond constructed near the proposed pond location.

Table 6-7 summarizes three stormwater control alternatives that combine the identified stormwater control options, in order of decreasing effectiveness.

Alternative 1 represents the new dry pond combined with existing stormwater controls and two dry pond retrofit projects. The proposed regional pond C20 provides small water quality benefit (removing only 6 pounds of phosphorus per year) since the areas between it and upstream ponds is undeveloped.

Alternative 2 represents the new dry pond without the two dry pond retrofit projects.

Alternative 3 represents the existing stormwater controls with the two dry pond retrofit projects. The existing stormwater controls, combined with the proposed dry pond retrofit projects, remove nutrients more effectively than would the proposed regional pond. This is the selected watershed plan alternative.

Alternatives 1, 2 and 3 provide similar phosphorus reduction that all are greater than that of the original proposed pond. The downstream dry pond causes the proposed regional pond to have little nutrient reduction benefit.

Updated Regional Pond Status
Defer the construction of regional Pond C20 and implement two dry pond wetland retrofit projects (CU9193 and CU9194). If the alternative projects cannot be implemented, a modified regional pond may be considered. Implement nonstructural controls, including promoting LID in the watershed and working with the International Town and Country Club to reduce buffer impacts, and nutrient and pesticide runoff.

The proposed regional pond's benefits are small relative to the cost and impact while the alternative projects provide greater protection.

6.2.4.5 Proposed Regional Pond C21

Proposed Pond Description
Regional pond C21 is in the R-C District in the Virginia Run/Pleasant Hills community (downstream from Hidden Canyon Road adjacent to Knoll View Place). The pond is on an unnamed tributary to the Middle Cub Run main stem. The pond has a drainage area of 156 acres and was planned as a wet pond that reduces the peak two-year flow to pre-development conditions. The drainage area is largely developed as medium-density residential, which was planned before rezoning.

The map in Figure 6-6 and data in Table 6-8 provide an overview of the conditions within the proposed regional pond watershed. These include the existing stormwater facilities and watershed plan structural projects.

Proposed Pond Evaluation
Proposed regional pond C21 removes 41 pounds of phosphorus per year (Table 6-9). The following bullets discuss conditions at the proposed site:

- The dam is within FCPA parkland, which is a valuable watershed resource. The pond would need to demonstrate significant watershed improvements to be constructed at this location.

- Nearby residential development precludes construction of a wet pond with the originally proposed storage volume.

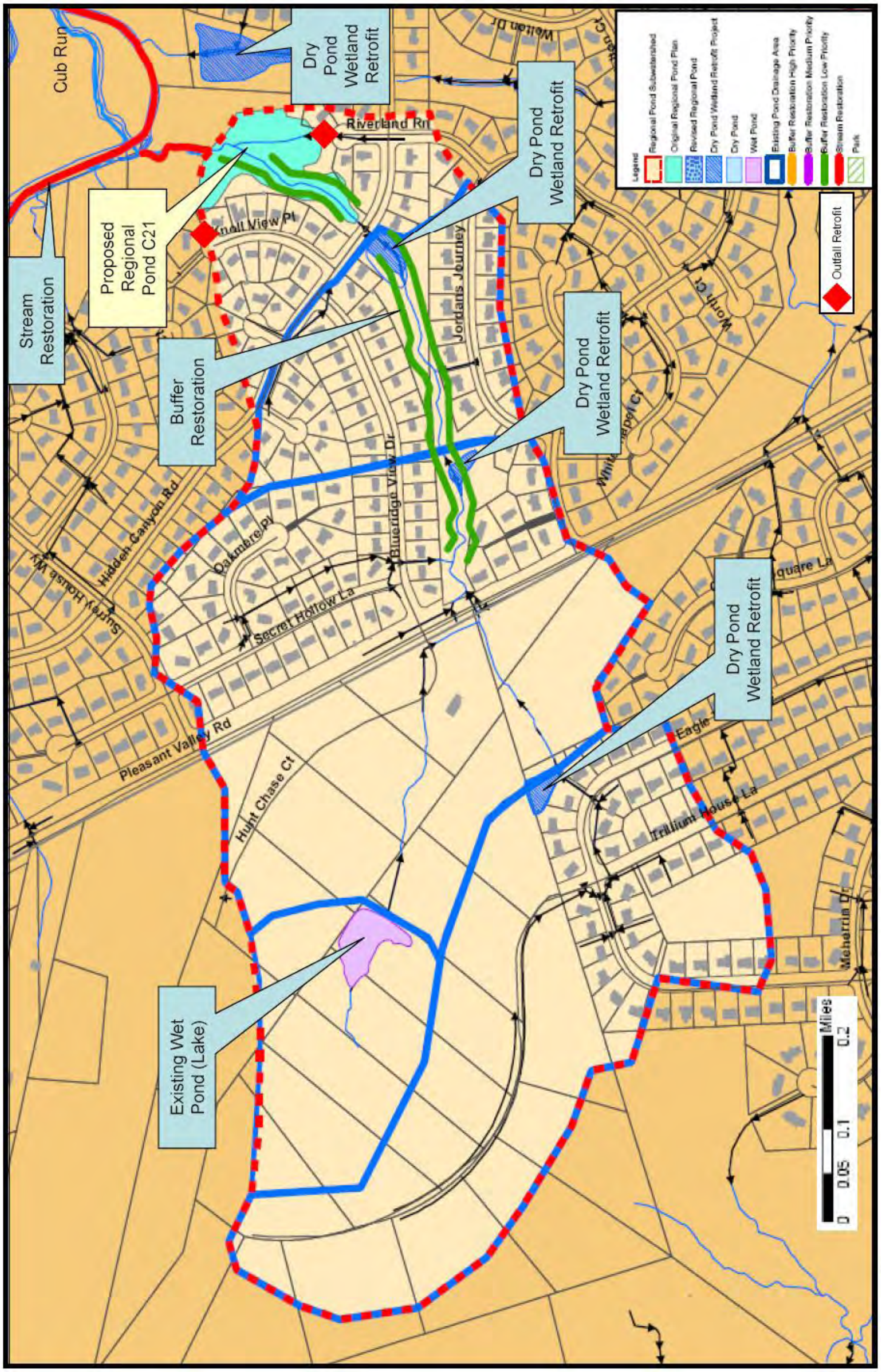


Figure 6-6
Proposed Regional Pond C21

Table 6-8
Watershed Overview for Unconstructed Regional Pond C21

Drainage Area: 156 Acres
Location: R-C District in the Virginia Run/Pleasant Hills community (downstream from Hidden Canyon Road adjacent to Knoll View Place. Unnamed tributary to the Middle Cub Run main stem.
Type of Pond: Wet pond that controls the peak two-year flow to predevelopment conditions.
Status of Pond Site: The proposed regional pond is located within Fairfax County Park Authority Parkland. Nearby residences prevent construction of pond with the proposed storage volume.

Existing Upstream Stormwater Controls	**Number of Facilities**	**Total Controlled Area (Acres)**	**Percent of Total Area**
Dry ponds with proposed wetland retrofit	3	130	83%
Dry Ponds (no retrofit)	0	0	0%
Wet Ponds	1	16	10%
Total	4	146	93%

Summary of Uncontrolled Developed Area	**Area (Acres)**	**Percent of Total Area**
Stream Valley and about 15 single family homes	10	7%
No potential for future development.		

Summary of Stream Conditions Near Proposed Pond Site:	Erosion inventory line (approximately 320 feet) with impact score of seven on tributary stream where it joins Cub Run. This erosion results from down cutting of Cub Run. The physical habitat is classified as fair near this pond site.

Alternative Stormwater Control Options	**Number of Projects**	**Description**
Dry pond wetland retrofits	4	CU9160 – Oakengate Way (Outside Watershed) (10 acres) CU9162 – Blueridge View Drive (59 acres) CU9161 – Hidden Canyon Road (12 acres) CU9163 – Eagle Tavern Place (47 acres)
LID retrofit at public facilities	-	
Stream restoration projects	1	Restoration included in Middle Cub Run Stream Restoration Project CU9211 which includes restoration in this tributary where it joins Cub Run
Buffer restoration projects	1	Restore buffer throughout much of stream upstream from the proposed pond – Project CU9316
Upstream culvert retrofit projects	-	
Other Projects	2	Stormwater outfall retrofit projects for Riverland Run and Knoll View Place cul-de-sacs.

Watershed Management Plan Recommendations	Delete regional pond C21 and construct all identified alternative stormwater control options. Upstream ponds effectively control runoff from 93 percent of the developed areas in the watershed including Estate Residential Development. Alternative stormwater control options enhance pollution reduction provided by the existing stormwater control faculties, mitigate runoff from uncontrolled areas, improve health of stream by addressing buffer impact and address stream erosion downstream from the proposed pond.

Table 6-9
Summary of Phosphorus Reduction Provided by
Stormwater Improvement Options and Alternatives for Regional Pond C21

Scenario	**Total Phosphorus Removed (Pounds per year)**	**Percent of Total Phosphorus**
Proposed Regional Pond C21 without Existing Controls	41	50%
Stormwater Control Options		
1 - Existing Stormwater Controls	28	34%
2 - Dry Pond Retrofit Projects (4 projects)	7	9%
3 – Stream Restoration Project	1	1%
4 – Proposed Regional Pond C21 Combined with Existing Stormwater Controls	9	11%
Stormwater Control Alternatives (Combinations of Stormwater Control Options)		
Alternative 1 – Proposed Regional Pond with Alternative Projects (Options 1, 2, 3 and 4	45	55%
Alternative 2 – Proposed Regional Pond without Alternative Projects (Options 1 and 4	37	45%
Alternative 3 * - Deleted Regional Pond and Implement Alternative Projects (Options 1, 2 and 3)	36	44%

** - Selected Alternative*

- The upstream drainage area includes three dry ponds and one wet pond/lake that provide water quality and peak flow benefits for 93 percent of the development upstream of the pond.

- The pond is near the middle Cub Run main stem. A stormwater pond at this location could potentially increase flows in Cub Run by delaying and extending the peak flows from the local small watershed.

- The stream has erosion where it joins Cub Run, possibly because of down-cutting in the Cub Run main stem. Stream restoration in this reach is proposed as part of the restoration project that includes Cub Run.

The stream buffers upstream from the regional pond have been affected by mowing and nearby lawns. These areas are included in a stream restoration project.

Stormwater Control Options
The following alternative structural stormwater control options were evaluated for regional pond C21:

1. Four dry pond retrofit projects

2. Stream restoration project for downstream segment upstream of Cub Run (CU9211)

3. Buffer restoration project for stream segments upstream of the proposed regional pond (CU9316)

4. Two stormwater outfall retrofit projects for the stormwater culvert outlets that drain the cul-de-sacs on 1) Riverland Run and 2) Knoll View Place. These projects are recommended to enhance the stormwater controls for this area. The projects include energy dissipaters, flow spreading devices and stream restoration to mitigate impact of flows from these culverts on the small streams or ditches that receive the flows.

In addition, the following nonstructural project can be implemented to further enhance conditions near the proposed regional pond:

1. Promote LID within the upstream subwatershed

Table 6-9 summarizes the phosphorus removal provided by structural stormwater control options:

- Option 1 presents the phosphorus reduction provided by the existing stormwater controls.

- Option 2 presents the additional phosphorus reduction produced by the four dry pond retrofit projects.

- Option 3 presents the additional phosphorus reduction produced by the stream restoration project downstream from the regional pond.

- Option 4 presents the additional phosphorus reduction produced by the proposed regional pond in combination with the existing stormwater controls.

Table 6-9 also summarizes three stormwater control alternatives for Regional Pond C21. These alternatives combine stormwater control options and appear in order of decreasing effectiveness.

Alternative 1 is the regional stormwater pond with alternative projects.

Alternative 2 is the regional stormwater pond without the alternative projects.

Alternative 3 excludes the regional pond but includes the upstream alternative projects. This is the selected alternative.

Updated Regional Pond Status

Regional pond C21 is deleted from the watershed plan, and the alternative stormwater projects will be implemented to enhance the watershed's stream conditions and meet the watershed plan's goals and vision. The following alternative projects will be implemented:

- Dry pond retrofit projects CU9160, CU9161, CU9162 and CU913

- Part of stream restoration project CU9211

- Buffer restoration project CU9316

- Stormwater outfall retrofit projects for Riverland Run and Knoll View Place cul-de-sacs

The proposed regional pond provides little water quality benefit (removes 9 pounds of total phosphorus) compared with other regional ponds outside the R-C District, particularly relative to its cost and impact.

The dry pond retrofit projects nearly offset the phosphorus reductions provided by the regional pond. The alternative stormwater controls enhance the pollution removal efficiency of the existing facilities, enhance the health of the streams by addressing buffer impacts and address stream erosion issues downstream of the proposed regional pond location.

6.2.4.6 Proposed Regional Pond C23

Proposed Pond Description

Regional pond C23 is in the R-C District in the Virginia Run and the Estates neighborhood, north of Kentwell Circle. The pond is on an unnamed tributary to Elklick Run near its confluence with Cub Run. The identified pond location has a drainage area of 102 acres, and the pond was proposed as a maximum efficiency wet pond that controls the peak runoff for both the 2- and 10-year storm to 33 percent of the predevelopment peak flow rate.

The map in Figure 6-7 and data in Table 6-10 provides an overview of the conditions within the proposed regional pond watershed. These include the existing stormwater facilities and watershed plan structural projects.

Proposed Pond Evaluation
The proposed pond would have removed 7.5 pounds of phosphorus per year as summarized in Table 6-11.

Approximately 50 percent of the watershed is within FCPA parkland. Of the remaining area, 30 percent is large five-acre lot estate residential development. The remainder is developed at a low residential land use density (0.7-acre lot size). This land use is an effective low-impact development BMP that does not require additional structural stormwater controls to address stormwater flows or water quality. This development was either planned during the rezoning of this area or built at a higher development by way of clustering. No opportunity for additional development in the drainage area exists. This higher-density development has a dry pond recommended for a wetland bottom retrofit.

The dam site and area to be included in the pond are in FCPA parkland and private property. The dam site is near the Cub Run main stem. A pond at this location would delay and extend the peak flows from this area, potentially increasing peak flows in Cub Run.

Stormwater Control Options
The following structural stormwater control options were evaluated as replacement projects for proposed regional pond C23:

1. Construct dry pond wetland retrofit project CU9705 to enhance nutrient removal from this existing facility

The following nonstructural project could be implemented to further enhance conditions in this local stream:

1. Promote LID in the upstream subwatershed

Table 6-11 provides the phosphorus reduction from stormwater control options:

- Option 1 presents the phosphorus reduction produced by the existing stormwater controls.

- Option 2 presents the additional phosphorus reduction produced by the dry pond retrofit project.

- Option 3 presents the additional phosphorus reduction produced by the proposed regional pond C23 together with the existing stormwater controls.

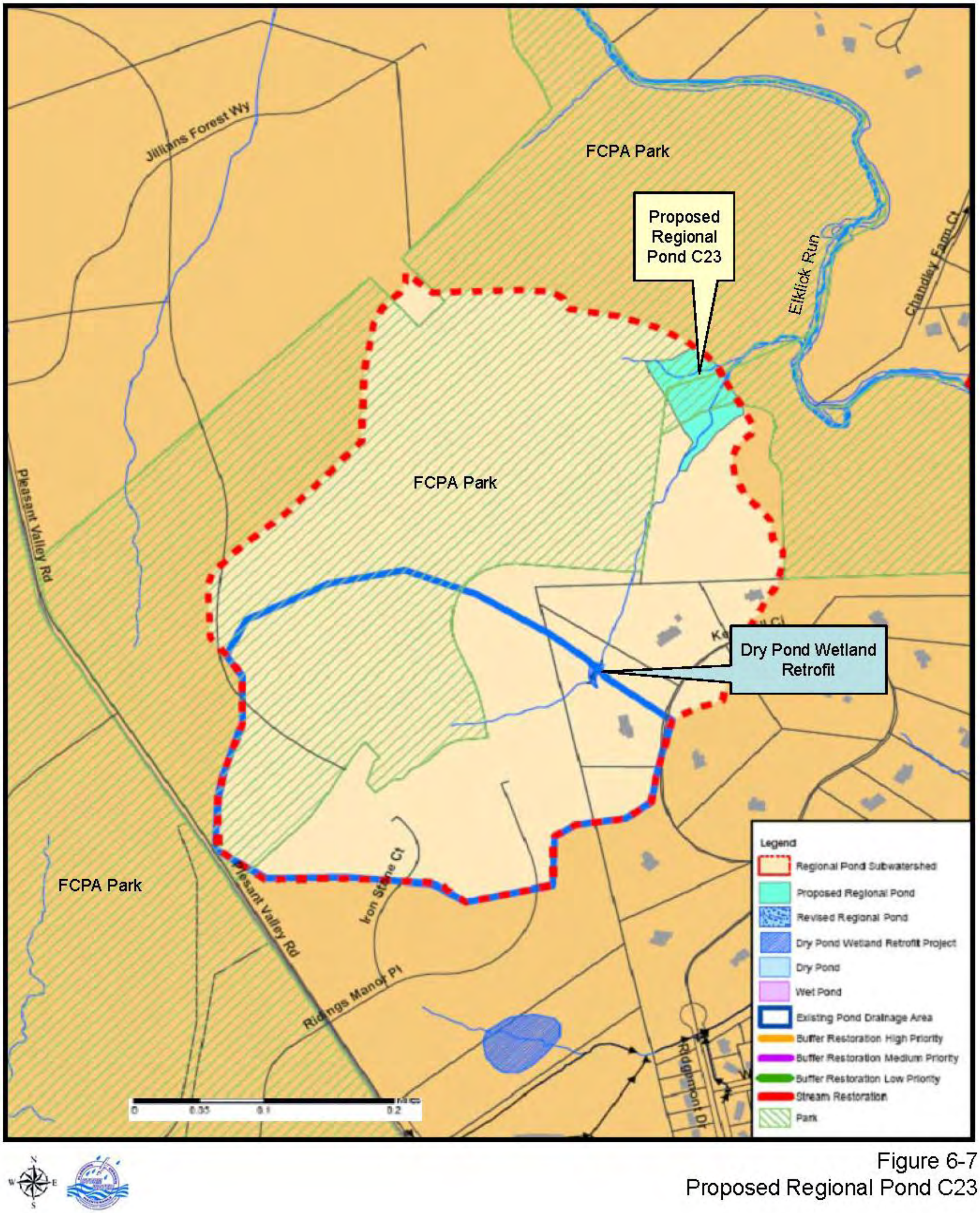


Figure 6-7
Proposed Regional Pond C23

Table 6-10
Watershed Overview for Unconstructed Regional Pond C23

Drainage Area: 102 Acres			
Location: R-C District in the Virginia Run - The Estates neighborhood, north of Kentwell Circle. Unnamed tributary to Lower Elklick Run.			
Type of Pond: Maximum efficiency wet pond that controls the peak runoff for both the two-year and 10-year storm to 33 percent of the predevelopment runoff.			
Status of Pond Site: Within Fairfax County Park Authority Parkland and residential lot.			
Existing Upstream Stormwater Controls	**Number of Facilities**	**Total Controlled Area (Acres)**	**Percent of Total Area**
Dry ponds with proposed wetland retrofit	1	44	43%
Dry Ponds (no retrofit)	0	0	0%
Wet Ponds	0	0	0%
FCPA Parkland		40	39%
Three estate-residential lots	-	<u>18</u>	<u>18%</u>
Total	1	102	100%
Summary of Uncontrolled Developed Area		**Area (Acres)**	**Percent of Total Area**
		0	0%
No potential for future development.			
Summary of Stream Conditions Near Proposed Pond Site:	Stream not inventoried.		
Alternative Stormwater Control Options	**Number of Projects**	**Description**	
Dry pond wetland retrofits	1	Project CU9705 – Ridings Manor Place (44 acres)	
LID retrofit at public facilities	-		
Stream restoration projects	-		
Buffer restoration projects	-		
Upstream culvert retrofit projects	-		
Other Projects	-		
Watershed Management Plan Recommendations	Delete proposed regional pond C23 and implement dry pond retrofit project.		

Table 6-11
Summary of Phosphorus Reduction Provided by
Stormwater Improvement Options and Alternatives for Regional Pond C23

Scenario	**Total Phosphorus Removed (Pounds per year)**	**Percent of Total Phosphorus**
Proposed Regional Pond C23 without Existing Controls	7.5	50%
Stormwater Control Options		
1 - Existing Stormwater Controls	1.3	8%
2 - Dry Pond Retrofit Project	0.3	2%
3 - Proposed Regional Pond C23 Combined with Existing Stormwater Controls	6.1	40%
Stormwater Control Alternatives (Combinations of Stormwater Control Options)		
Alternative 1 – Regional Pond With Alternative Projects (Options 1, 2 and 3)	7.7	51%
Alternative 2 – Regional Pond without Alternative Projects (Options 1 and 3)	7.4	49%
Alternative 3 * - Delete Regional Pond C23 and Implement Alternative Projects (Options 1 and 2)	1.6	11%

** - Selected Alternative*

Table 6-11 also summarizes the phosphorus reduction for three stormwater control alternatives that combine stormwater control options, listed in order of decreasing effectiveness.

Updated Regional Pond Status

Proposed regional pond C23 is deleted from the Cub Run and Bull Run watershed plan, and the alternative stormwater control project will be implemented to enhance stormwater protection and meet watershed goals and vision:

- Dry pond retrofit project CU9705

Because of the low development densities, the proposed regional pond provides small reductions in annual total phosphorus loadings (removing 6.1 pounds per year) compared to other regional ponds outside the R-C district that remove 36 to 69 pounds per year. As such, the pond provides low nutrient reductions and stormwater improvements relative to the costs and impacts of construction. Alternative projects enhance nutrient reduction provided by the existing stormwater facility and improve the stream's health.

6.2.4.7 Proposed Regional Pond C24

Proposed Pond Description

Regional pond C24 is on a small, unnamed tributary to Elklick Run within the R-C District just west of Pleasant Valley Road. The drainage area to the proposed regional pond is 81 acres. The pond is proposed to be a maximum efficiency wet pond that reduces the two-year peak flow to 33 percent of the existing predevelopment flow.

The map in Figure 6-8 and data in Table 6-12 provide an overview of the conditions within the proposed regional pond watershed. These include the existing stormwater facilities and watershed plan structural projects.

Proposed Pond Evaluation

As presented in Table 6-13, proposed regional wet pond C24 would remove 1.8 pounds of phosphorus per year.

The pond and watershed drainage area is entirely within the FCPA parkland. The watershed is undeveloped and, being parkland, will not be developed. No existing stormwater controls are within this undeveloped watershed.

Pleasant Valley Road affects the stream and stream buffer downstream from the proposed pond. These impacts will increase if Pleasant Valley Road increases to four lanes as planned.

Stormwater Control Options

The following structural projects were evaluated as alternative stormwater control projects for regional pond C24:

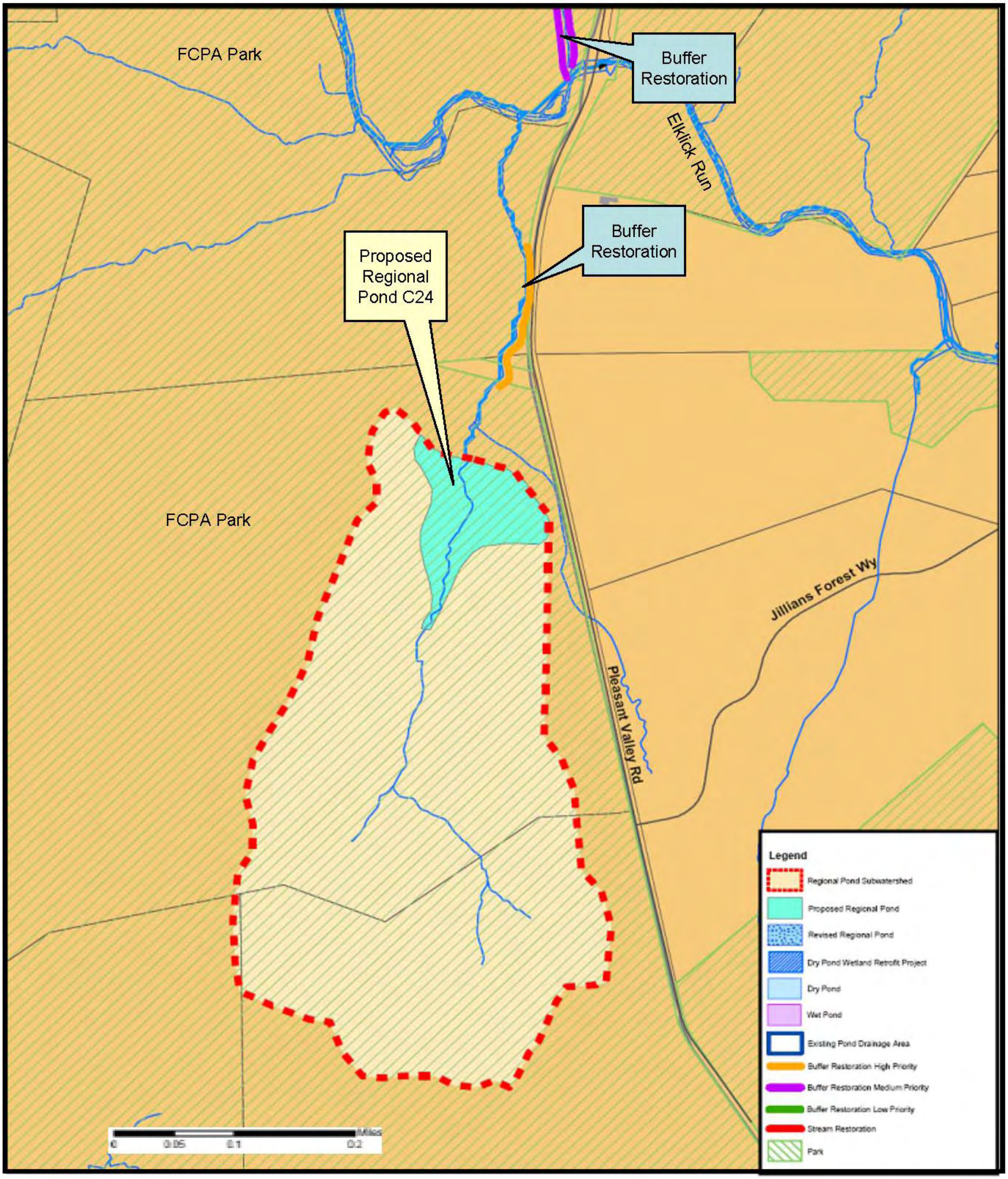


Figure 6-8
Proposed Regional Pond C24

Table 6-12
Watershed Overview for Unconstructed Regional Pond C24

Drainage Area: 81 Acres			
Location: R-C District on a small, unnamed tributary to Elklick Run west of Pleasant Valley Road.			
Type of Pond: Maximum efficiency wet pond that controls the two-year peak flow to 33 percent of the existing predevelopment flow			
Status of Pond Site: Pond site and watershed are entirely within Fairfax County Park Authority parkland			
Existing Upstream Stormwater Controls	**Number of Facilities**	**Total Controlled Area (Acres)**	**Percent of Total Area**
Dry ponds with proposed wetland retrofit	0	0	0%
Dry Ponds (no retrofit)	0	0	0%
Wet Ponds	0	0	0%
FCPA Parkland	-	81	100%
Total	0	81	100%
Summary of Uncontrolled Developed Area		**Area (Acres)**	**Percent of Total Area**
		0	0%
No potential for future development.			
Summary of Stream Conditions Near Proposed Pond Site :	Erosion inventory line (300 feet) with impact score of five at the pond. This appears to be naturally occurring erosion or have resulted from past land uses since the watershed is totally undeveloped. Buffer downstream from the pond is affected by Pleasant Valley Road. The physical habitat is classified as fair.		
Alternative Stormwater Control Options	**Number of Projects**	**Description**	
Dry pond wetland retrofits	-		
LID retrofit at public facilities	-		
Stream restoration projects	-		
Buffer restoration projects	2	Restore buffer at Pleasant Valley Road south and north of Elklick Run, Projects CU9330 and CU9331	
Upstream culvert retrofit projects	-		
Other Projects	-		
Watershed Management Plan Recommendations	Delete Regional pond C24 from the watershed plan and restore buffer at Pleasant Valley Road at two locations to improve the health of the streams.		

Table 6-13
Summary of Phosphorus Reduction Provided by
Stormwater Improvement Options and Alternatives for Regional Pond C24

Scenario	Total Phosphorus Removed (Pounds per year)	Percent of Total Phosphorus
Proposed Regional Pond C24 without Existing Controls	1.8	50%
Stormwater Control Options		
1 - Existing Stormwater Controls	0.0	0%
2 - Buffer Restoration Projects	0.0	0%
3 - Proposed Regional Pond C24 with Existing Stormwater Controls	1.8	50%
Stormwater Control Alternatives (Combinations of Stormwater Control Options)		
Alternative 1 –Proposed Wet Pond with Alternative Projects (Options 1, 2 and 3)	1.8	50%
Alternative 2 * – Deleted Regional Pond C24 and Implement Alternative Buffer Restoration Projects (Options 1 and 2)	0.0	0%

** - Selected Alternative*

1. Buffer restoration project along Pleasant Valley Road south of Elklick Run

2. Buffer restoration project along Pleasant Valley Road north of Elklick Run These

buffer restoration projects will improve the health of the local streams in and near this subwatershed. No additional opportunities for alternative stormwater controls exist within the watershed upstream of the proposed pond. Furthermore, none are required since the watershed is undeveloped.

Table 6-13 summarizes the phosphorus removal provided by the stormwater control options:

- Option 1 presents the phosphorus reduction produced by the existing stormwater controls.

- Option 2 presents the additional phosphorus reduction produced by the buffer restoration projects.

- Option 3 presents the additional phosphorus reduction produced by the proposed regional pond in combination with the existing upstream stormwater controls.

Table 6-13 also presents the total phosphorus removed by stormwater control alternatives that combine the stormwater control options. These appear in decreasing order of effectiveness.

Updated Regional Pond Status
Delete regional pond C24 and construct two buffer restoration projects CU9330 and CU9331. The open space in the subwatershed results in low levels of phosphorus in the runoff and demonstrates that the proposed pond provides minimal watershed benefits. The proposed ponds only remove about 2 pounds of phosphorus per year whereas ponds outside the R-C District remove more than 36 pounds per year.

6.2.4.8 Proposed Regional Pond C28

Proposed Pond Description
Regional pond C28 lies within R-C District south of Route 29. The pond is on an unnamed tributary to the Lower Cub Run main stem. Proposed regional Pond C35 is on an adjacent subwatershed. The proposed pond has a drainage area of 104 acres and was proposed as a maximum efficiency wet pond that controls the two-year peak flow to 50 percent of the predevelopment peak flow rate.

The map in Figure 6-9 and data in Table 6-14 provides an overview of the conditions within the proposed regional pond watershed. These include the existing stormwater facilities and watershed plan structural projects.

Although the watershed is entirely within the R-C district, it includes 30 acres with 0.7- to 1.2-acre lots that existed at the time of the rezoning. The remaining area can be developed at the five-acre Estate Residential density.

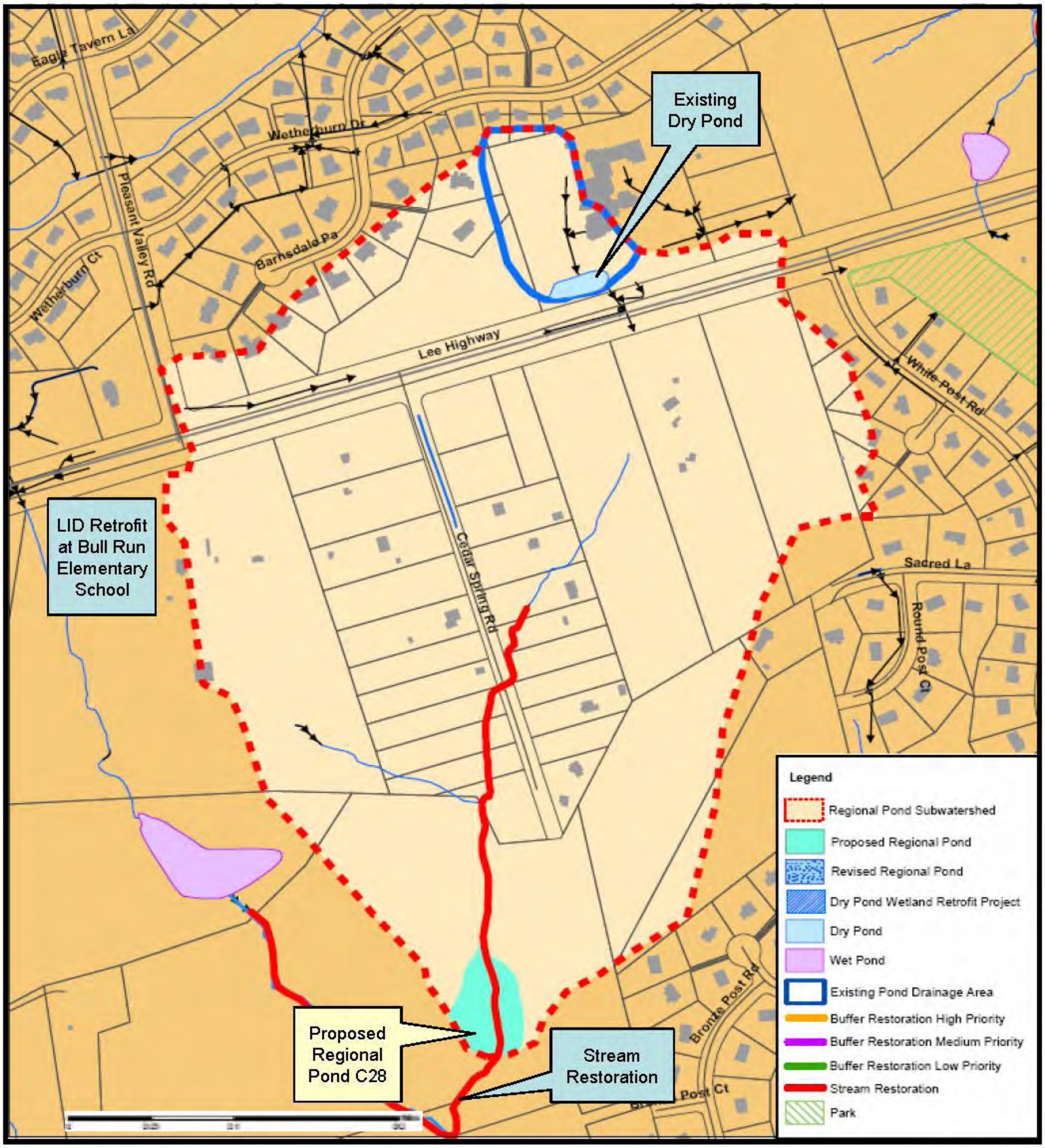


Figure 6-9
Proposed Regional Pond C28

Table 6-14
Watershed Overview for Unconstructed Regional Pond C28

Drainage Area: 104 Acres
Location: R-C District south of Route 29. The pond is on an unnamed tributary to the Lower Cub Run main stem.
Type of Pond: Maximum efficiency wet pond that controls the two-year peak flow to 50 percent of the predevelopment peak flow
Status of Pond Site: Undeveloped privately owned wooded area

Existing Upstream Stormwater Controls	**Number of Facilities**	**Total Controlled Area (Acres)**	**Percent of Total Area**
Dry ponds with proposed wetland retrofit	0	0	0%
Dry Ponds (no retrofit) Centerville Baptist Church	1	4	4%
Wet Ponds	0	0	0%
R-C District Estate-Residential Land Use		100	96%
Total	1	104	100%

Summary of Uncontrolled Developed Area	**Area (Acres)**	**Percent of Total Area**
	0	0%

Summary of Stream Conditions Near Proposed Pond Site:	Erosion inventory line (1,000 feet) with impact score of 7 within tributary downstream from proposed pond. The cause of this stream erosion is uncertain. The development density is very low in the watershed and should not be contributing to the erosion. The erosion may be naturally occurring, result from past land uses (e.g. farming), or result from down cutting of Cub Run. The physical habitat is classified as good.

Alternative Stormwater Control Options	**Number of Projects**	**Description**
Dry pond wetland retrofits	-	
LID retrofit at public facilities	1	Bull Run Elementary School (2 acres) (CU9801)
Stream restoration projects	1	CU9202
Buffer restoration projects	-	
Upstream culvert retrofit projects	-	
Other Projects	-	

Watershed Management Plan Recommendations	Delete regional pond C28 and implement two identified alternative structural projects. The watershed is entirely R-C District Estate-Residential land use, which is an effective low-impact development BMP where additional stormwater controls are not required.

Proposed Pond Evaluation
The proposed pond removes 18 pounds of phosphorus per year (Table 6-15).

Review of the Stream Physical Assessment data indicates the streams upstream and downstream of the proposed regional pond show significant erosion, the cause of which is uncertain. These stream reaches are included in a stream restoration project. The density of development in the watershed is not sufficient to produce the erosion found in this reach. The stream erosion may result from natural stream erosion, past land uses (e.g., farming), or down-cutting of Cub Run.

The physical habitat is classified as good near the proposed pond.

Stormwater Control Options
The following stormwater control options were evaluated for regional pond C28:

1. LID retrofit at Bull Run Elementary School (CU9801). The Bull Run Elementary school is a new facility that includes a wet pond that drains to an adjacent watershed.

2. Stream restoration project CU9202

These improvements enhance the water quality removal of the existing facilities and address the stream erosion in the local streams.

Table 6-15 summarizes the incremental annual phosphorus removed by the stormwater controls options:

- Option 1 presents the phosphorus reduction from the existing stormwater controls.

- Option 2 presents the additional phosphorus reduction from the LID retrofit project.

- Option 3 presents the additional phosphorus reduction from the stream restoration project.

- Option 4 presents the additional phosphorus reduction from the proposed wet pond C28 in combination with the existing upstream stormwater controls

Table 6-15 presents the phosphorus reduction produced by three stormwater control alternatives that combine the stormwater control options. These appear in order of decreasing effectiveness.

Table 6-15
Summary of Phosphorus Reduction Provided by
Stormwater Improvement Options and Alternatives for Regional Pond C28

Scenario	Total Phosphorus Removed (Pounds per year)	Percent of Total Phosphorus
Proposed Regional Pond C28 without Existing Controls	18	50%
Stormwater Control Options		
1 - Existing Stormwater Controls	2.5	7%
2 - LID Retrofit Project	1.3	4%
3 – Stream Restoration Project	8	22%
4 - Proposed Regional Pond C28 Combined with Existing Stormwater Controls	15	42%
Stormwater Control Alternatives (Combinations of Stormwater Control Options)		
Alternative 1 – Proposed Regional Pond with Alternative Projects (Options 1, 2, 3 and 4)	26.8	74%
Alternative 2 – Proposed Regional Pond without Alternative Projects (Options 1 and 4)	17.5	49%
Alternative 3 * - Delete Proposed Regional Pond C28 and Implement Alternative Stormwater Controls (Options 1, 2and 3)	11.8	33%

** - Selected Alternative*

Updated Regional Pond Status

Delete proposed regional pond C28 and implement the following two alternative stormwater control alternatives:

- LID Retrofit project CU9801
- Stream restoration project CU9202

Proposed regional pond C28 removes about 15 pounds of phosphorus per year, whereas ponds outside the R-C District remove more the 36 pounds per year. Alternative stormwater control projects will be implemented to enhance stormwater controls, and meet watershed goals and vision.

6.2.4.9 Proposed Regional Pond C35

Proposed Pond Description

Regional pond C35 lies within the R-C District south of Route 29. The pond is on an unnamed tributary to the Lower Cub Run main stem. Proposed regional Pond C28 is in an adjacent subwatershed and has a drainage area of 117 acres. It was planned as a maximum efficiency wet pond that reduces the peak flow for the 2- and 10-year storms, respectively, to 33 and 80 percent of the predevelopment flow.

The map in Figure 6-10 and data in Table 6-16 provide an overview of the conditions within the proposed regional pond watershed. These include the existing stormwater facilities and watershed plan structural projects.

Proposed Pond Evaluation

The proposed regional wet pond would have removed 17 pounds of phosphorus as presented in Table 7-17.

The upstream watershed includes five-acre or larger lots with little or no development. No existing stormwater controls are within this undeveloped watershed. These lots will likely be redeveloped to include modern homes on five-acre lots. Stormwater controls are not required for this development density because it is an effective low-impact development BMP.

Erosion does not affect the stream on which the proposed pond is located. It does, however, affect stream segments downstream after this stream joins other small streams. This stream erosion was described in the discussion on pond C28.

Stormwater Control Options

Downstream stream restoration project CU9202 was evaluated as a potential replacement for regional pond C35. This project was shared with regional pond C28.

No opportunities exist for alternative stormwater controls in the upstream watershed since the subwatershed is undeveloped.

Table 6-17 summarizes the total annual phosphorus removed by the stormwater control options for the area upstream from the proposed regional pond.

As shown under Option 1, the undeveloped watershed does not have stormwater controls that reduce the phosphorus loads. Option 2 documents the nutrient reduction produced by the stream restoration project downstream of the proposed pond. Option 3 presents the phosphorus reduction produced by the proposed pond.

Table 6-17 presents the total phosphorus reduction produced from three alternative combinations of the stormwater control options, listed in order of decreasing effectiveness.

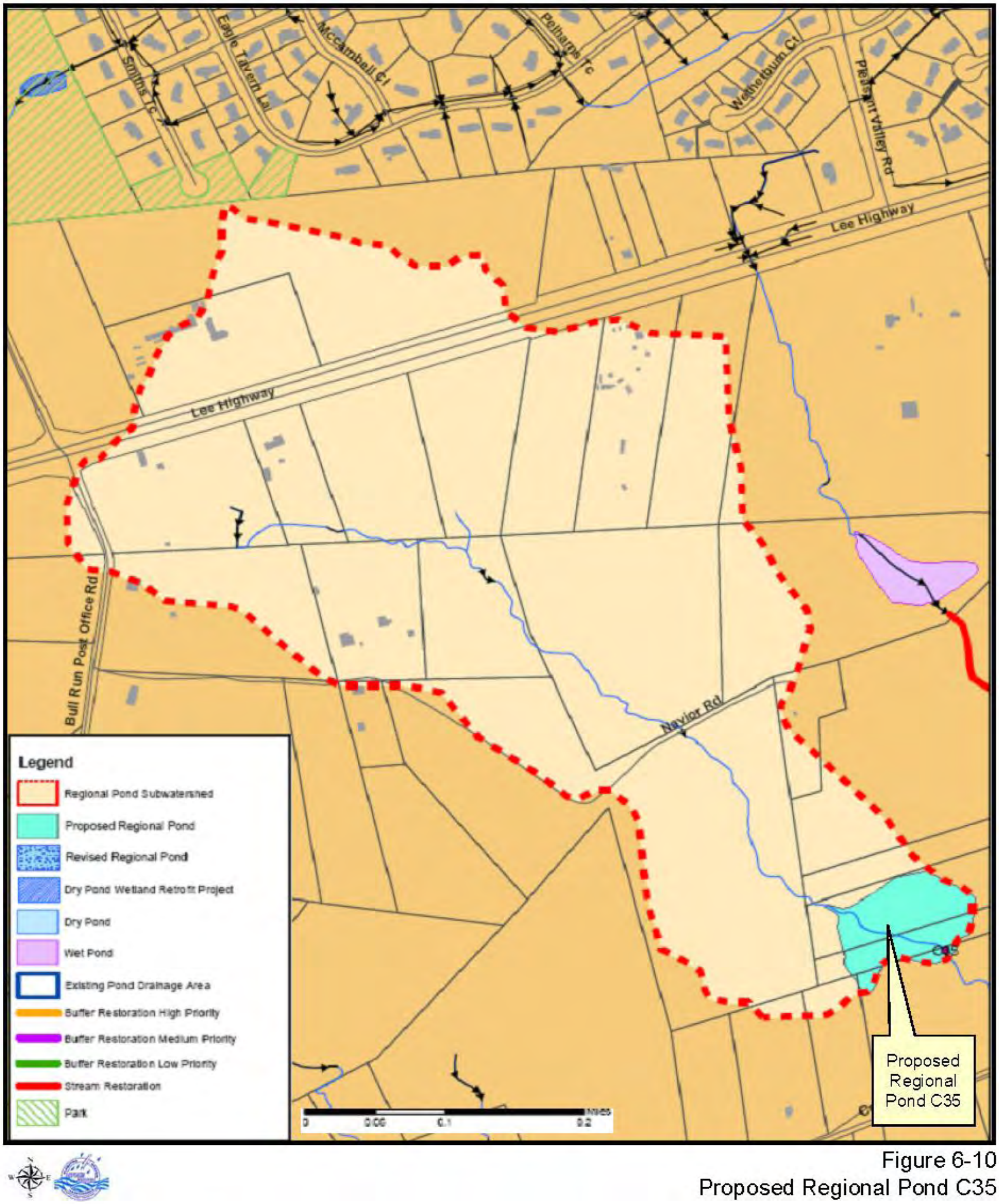


Figure 6-10
Proposed Regional Pond C35

Table 6-16
Watershed Overview for Unconstructed Regional Pond C35

Drainage Area: 117 Acres			
Location: R-C District south of Route 29. The pond is on an unnamed tributary to the Lower Cub Run main stem			
Type of Pond: Maximum efficiency wet pond that reduces the peak flow for the two-year storm down to 33 percent of the predevelopment flow and the 10-year storm down to 80 percent of the predevelopment peak flow			
Status of Pond Site: Undeveloped privately owned wooded area			
Existing Upstream Stormwater Controls	**Number of Facilities**	**Total Controlled Area (Acres)**	**Percent of Total Area**
Dry ponds with proposed wetland retrofit	0	0	0%
Dry Ponds (no retrofit)	0	0	0%
Wet Ponds	0	0	0%
R-C District Estate-Residential	-	87	74%
Total	0	87	74%
Summary of Uncontrolled Developed Area		**Area (Acres)**	**Percent of Total Area**
Medium Density Residential with 0.6 – 2 acre lots (average 1.1 acres)		30	26%
Summary of Stream Conditions Near Proposed Pond Site :	The stream immediately downstream from the proposed pond is not affected by erosion. There are erosion inventory lines (700 feet total length) with impact score of 7 on a stream segment downstream from the confluence of several tributaries. See discussion for regional pond C28. The physical habitat is classified as good.		
Alternative Stormwater Control Options	**Number of Projects**	**Description**	
Dry pond wetland retrofits	-		
LID retrofit at public facilities	-		
Stream restoration projects	1	Project CU9202	
Buffer restoration projects	-		
Upstream culvert retrofit projects	-		
Other Projects	-		
Watershed Management Plan Recommendations	Delete regional pond C35 and no alternative projects are necessary. The watershed is entirely R-C District Estate-Residential land use, which is an effective low impact development BMP that does not require additional structural stormwater controls.		

Table 6-17
Summary of Phosphorus Reduction Provided by
Stormwater Improvement Options and Alternatives for Regional Pond C35

Scenario	Total Phosphorus Removed (Pounds per year)	Percent of Total Phosphorus
Proposed Regional Pond C35 without Existing Controls	17	50%
Stormwater Control Options		
1 - Existing Stormwater Controls	0.0	0%
2 - Stream Restoration Project CU9202	8	24%
3 – Proposed Regional Pond C35 with Existing Stormwater Controls	17	50%
Stormwater Control Alternatives (Combinations of Stormwater Control Options)		
Alternative 1 – Propose Regional Wet Pond with Alternative Projects (Options 1, 2and 3)	25	74%
Alternative 2 – Proposed Regional Wet Pond without Alternative Projects (Options 1 and 3)	17	50%
Alternative 3 - Alternative Projects Excluding Proposed Regional Pond C35 (Options 1 and 2)	8	24%
Alternative 4 * – Delete Regional Pond C35 with No Alternative Projects	0	0%

* - Selected Alternative

Updated Regional Pond Status

Delete regional pond C35, and no alternative projects are required. Based on these detailed evaluations, the proposed pond provides little benefit relative to its cost and impact. Its drainage area is entirely within the R-C district where existing and future development densities will be low. The proposed regional pond C35 removes an estimated 17 pounds of phosphorus per year, whereas ponds outside the R-C District remove more the 36 pounds per year. Stream restoration project CU9202 will be an alternative for proposed regional pond C28.

6.2.4.10 Proposed Regional Pond C37

Proposed Pond Description

Regional pond C37 is in the R-C District on a tributary to Elklick Run near the Fairfax County/Loudoun County border. The pond has a drainage area of 433 acres and is planned to be a wet pond that reduces the 2- and 10-year peak flow to the predevelopment conditions.

The map in Figure 6-11 and data in Table 6-18 provides an overview of the conditions within the proposed regional pond watershed. These include the existing stormwater facilities and watershed plan structural projects.

Proposed Pond Evaluation

The proposed regional pond would have removed approximately 80 pounds of phosphorus per year as summarized in Table 6-19.

The following bullets evaluate the conditions at proposed regional pond C37:

- The lower portion of the watershed (approximately 30 percent of the total area) is Fairfax County Park Authority parkland that requires no stormwater controls.

- Other areas in the Fairfax County portion of the watershed (approximately 35 percent of the total area) will be developed as five-acre Estate Residential land use where no stormwater controls area required.

- Much of the Loudoun County portion of the watershed (approximately 35 percent of the watershed) is developed as medium- and high-density residential within South Riding. This area is served by a large wet pond on the Loudoun County side of the border. This pond adequately controls peak flows and pollutant runoff from this developed land.

- The pond is entirely within FCPA parkland. Construction of a large wet pond at this location would affect more than 30 acres of parkland. If such a pond fits into the Sully Woodlands development plan, it would benefit the Elklick stream by removing 20 pounds of nutrients per year and controlling peak flow.

- The streams upstream and downstream of the proposed regional pond do not exhibit erosion. This area consists of natural wetlands with numerous beaver dams.

Stormwater Control Options

No opportunities exist for additional alternative stormwater controls in the watershed upstream of the proposed pond. Additional stormwater controls are not required within the Fairfax County portions of the watershed since the land use is parkland and Estate Residential, which are effective low-impact development BMPs that do not require additional structural stormwater controls. Furthermore, the streams in the watershed do not display erosion impacts.

Table 6-19 summarizes the incremental annual phosphorus removed by the stormwater control options and alternatives.

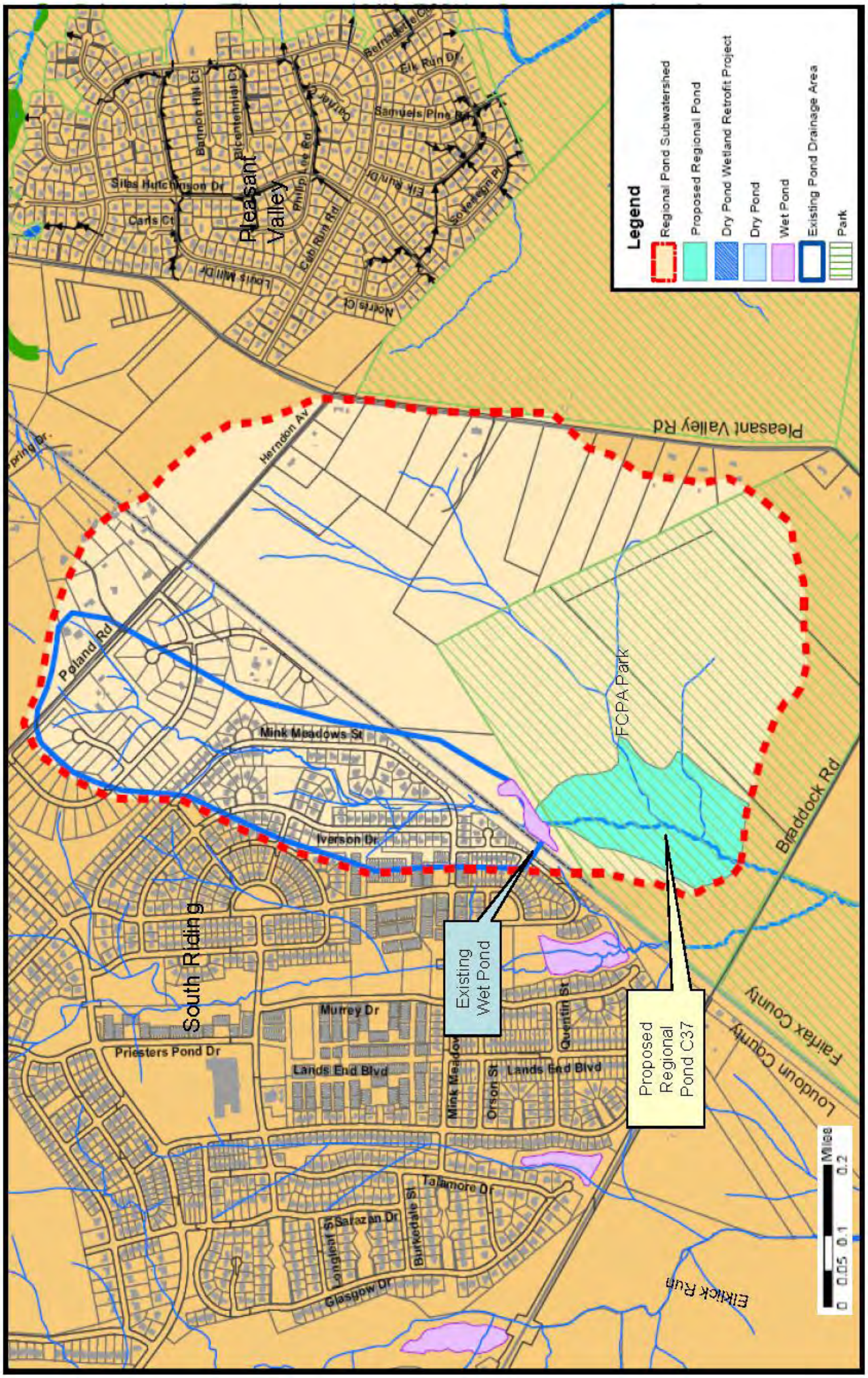


Figure 6-11
Proposed Regional Pond C37

Table 6-18
Watershed Overview for Unconstructed Regional Pond C37

Drainage Area: 433 Acres			
Location: R-C District on a tributary to Elklick Run near the Fairfax County /Loudoun County border			
Type of Pond: Wet pond that reduces the two-year and 10-year peak flow to the predevelopment conditions			
Status of Pond Site: Fairfax County Park Authority Parkland			

Existing Upstream Stormwater Controls	**Number of Facilities**	**Total Controlled Area (Acres)**	**Percent of Total Area**
Dry ponds with proposed wetland retrofit	0	0	0%
Dry Ponds (no retrofit)	0	0	0%
Wet Ponds	1	94	22%
R-C District Estate Residential Land Use	-	204	47%
Parkland	-	135	31%
Total	1	433	100%

Summary of Uncontrolled Developed Area	**Area (Acres)**	**Percent of Total Area**
	0	0%

Summary of Stream Conditions Near Proposed Pond Site :	No erosion inventory lines. Numerous beaver dams. No evidence of stream erosion. The physical habitat is classified as fair.

Alternative Stormwater Control Options	**Number of Projects**	**Description**
Dry pond wetland retrofits	-	
LID retrofit at public facilities	-	
Stream restoration projects	-	
Buffer restoration projects	-	
Upstream culvert retrofit projects	-	
Other Projects	-	

Watershed Management Plan Recommendations	Delete proposed regional Pond C37 and no alternative stormwater controls are necessary. The watershed is entire parkland or R-C District Estate Residential density, which are effective low-density development BMPs where additional structural stormwater controls are not required. An upstream wet pond controls runoff from the South Riding development in the Loudoun County portion of the subwatershed.

Table 6-19
Summary of Phosphorus Reduction Provided by
Stormwater Improvement Options and Alternatives for Regional Pond C37

Scenario	Total Phosphorus Removed (Pounds per year)	Percent of Total Phosphorus
Proposed Regional Pond C37 without Existing Controls	80	50%
Stormwater Control Options		
1 - Existing Stormwater Controls	59	37%
2 - Proposed Regional Pond C37 with Existing Controls	20	13%
Stormwater Control Alternatives (Combinations of Stormwater Control Options)		
Alternative 1 – Proposed Regional Wet Pond C37 (Options 1 and 2)	79	50%
Alternative 2 - Delete Regional Pond C37 with No Alternative Projects (Option 1)	59	37%

** - Selected Alternative*

Option 1 presents the phosphorus reduction produced by the existing large wet pond that controls development within Loudoun County. Option 2 presents the additional phosphorus reduction produced by the proposed regional pond C27 in combination with the upstream wet pond.

No other stormwater control options were identified within this area. As described later in Section 6, this area of Fairfax County provides an opportunity as a wetland restoration project. Such a project would reduce pollutant loads and peak flows.

Table 6-19 presents the phosphorus reduction produced by two alternatives that combine the stormwater control options, listed in order of decreasing effectiveness.

Updated Regional Pond Status
Delete proposed regional pond C37, and no alternative stormwater controls are necessary. The proposed pond would remove 20 pounds of phosphorus per year when combined with the existing upstream wet pond. Construction of the pond would affect 30 acres of parkland. The benefits provided by this pond are small relative to the cost and parkland impacts. The regional wet pond could be considered if appropriate for this parkland's development plans.

This area contains natural wetlands with existing beaver ponds, and it may be appropriate for a wetland restoration project that would retain the tree cover and benefit wildlife significantly. This alternative is discussed further in Section 6.9.

6.2.4.11 Proposed Regional Pond C39

Proposed Pond Description

Regional pond C39 is on an unnamed tributary to Flatlick Branch. The pond is in the Foxfield community, and the pond watershed includes areas in Franklin Glen Governance. The proposed pond has a drainage area of 127 acres and is proposed as a maximum efficiency extended dry pond that reduces the peak two-year flow to 83 percent of predevelopment conditions.

The map in Figure 6-12 and data in Table 6-20 provides an overview of the conditions within the proposed regional pond watershed. These include the existing stormwater facilities and watershed plan structural projects.

The pond's watershed is primarily medium- and low-density residential with some high-density residential development. The upstream area includes two existing dry ponds that serve 44 percent of the developed area.

Field reconnaissance suggests that regional pond construction started at the proposed pond's site. An existing facility consists of a low berm or dam with a large-diameter pipe and an emergency overflow on one bank. The facility does not have a flow control structure, and the pipe is sufficiently large that flows are not detained. It also has a small storage volume compared to the upstream drainage area, providing little stormwater control benefit. The stormwater control benefits could be improved by installing an appropriate flow control structure.

Proposed Pond Evaluation

The proposed dry pond provides 46 pounds of phosphorus reduction as shown in Table 6-21. This is one of the largest nutrient reductions provided by any of the proposed regional ponds.

Review of this pond indicates that the one-year, 24-hour extended detention storage volume cannot be provided at the proposed pond location due to nearby residences. The pond can be constructed as a dry pond with a smaller extended detention volume by eliminating the two-year peak flow shaving storage volume.

The stream on which this pond is located is included in a stream restoration project due to the low stream-bank stability scores. Field reconnaissance indicates no active stream erosion.

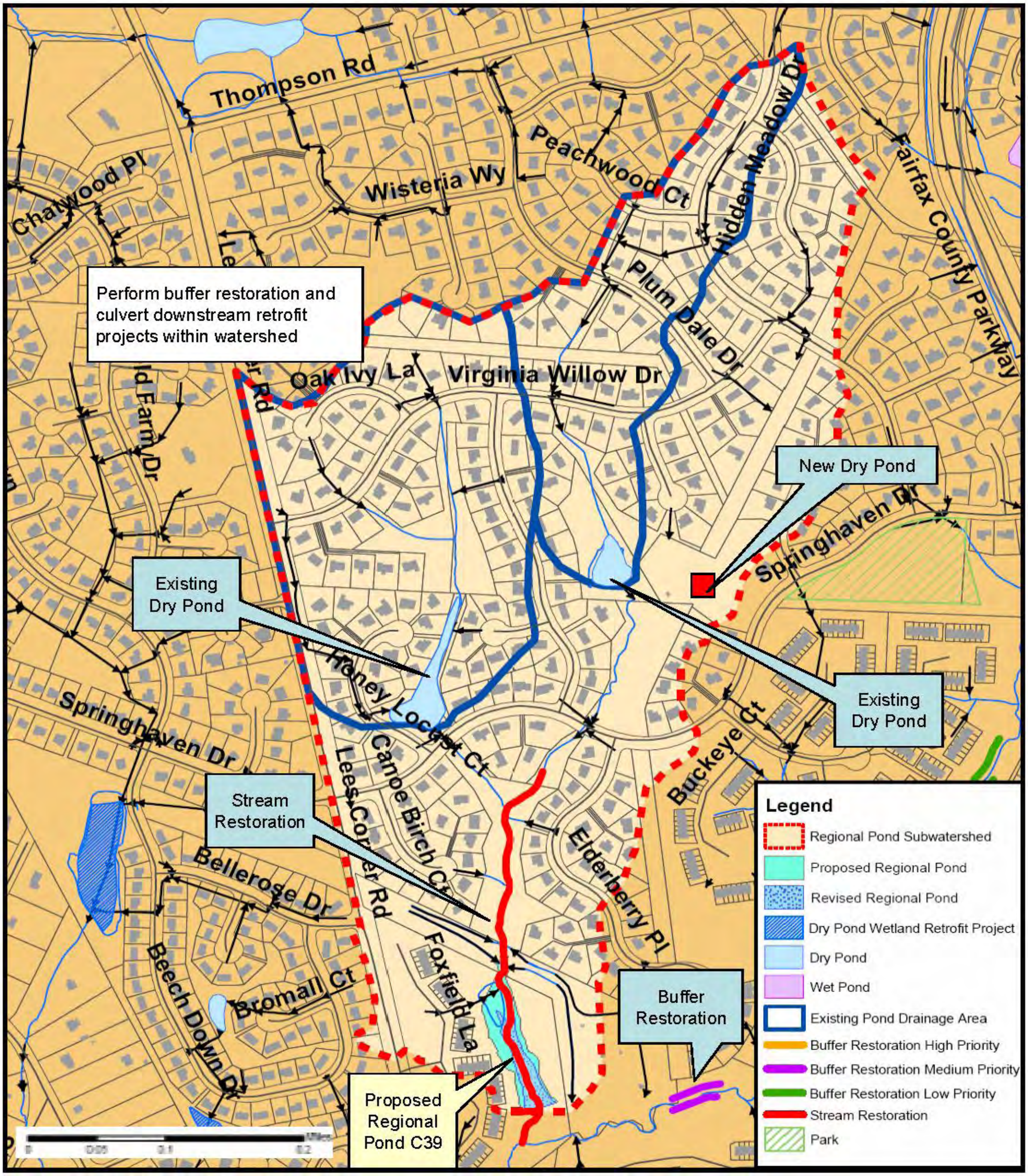


Figure 6-12
Proposed Regional Pond C39

Table 6-20
Watershed Overview for Unconstructed Regional Pond C39

Drainage Area: 127Acres
Location: Unnamed tributary to Flatlick Branch. The pond is located in the Foxfield community and the pond watershed includes areas in Franklin Glen Governance
Type of Pond: Maximum efficiency extended dry pond that reduces the peak two-year flow to 83 percent of predevelopment conditions
Status of Pond Site: Privately owned open space

Existing Upstream Stormwater Controls	**Number of Facilities**	**Total Controlled Area (Acres)**	**Percent of Total Area**
Dry ponds with proposed wetland retrofit	0	0	0%
Dry Ponds (no retrofit)	2	56	44%
Wet Ponds	0	0	0%
Total	2	56	44%

Summary of Uncontrolled Developed Area	**Area (Acres)**	**Percent of Total Area**
Medium Density Residential	71	56%
Little potential for additional development		

Summary of Stream Conditions Near Proposed Pond Site :	One erosion inventory line with impact score of 5 (78 feet) upstream from the pond. The stream segments near the pond are included in a restoration project due to low bank stability scores. The stream habitat is classified as very poor.

Alternative Stormwater Control Options	**Number of Projects**	**Description**
Dry pond wetland retrofits	-	Existing dry ponds are not considered candidates for wetland bottoms due to nearness to residences.
LID retrofit at public facilities	-	
Stream restoration projects	1	Restore stream reach upstream and downstream from pond, Project CU9216.
Buffer restoration projects	-	
Upstream culvert retrofit projects	-	
Other Projects	3	(1) Perform buffer restoration in small stream segments within the watershed upstream from reaches included in the Physical Assessment Study. (2) Review small drainage systems and mitigate erosion and impact of storm drain outfalls within the watershed upstream from reaches included in the Physical Assessment Study. (3) Construct smaller onsite dry pond.

Watershed Management Plan Recommendations	Construct regional pond C39 at the proposed location as a dry pond with an extended detention storage volume equivalent to approximately one-inch of runoff from the impervious area. Implement identified alternative stormwater projects to address stream erosion within and downstream from the dry pond and to improve health of the streams upstream from the regional pond. If regional pond is not constructed, then construct smaller onsite dry pond.

Table 6-21
Summary of Phosphorus Reduction Provided by
Stormwater Improvement Options and Alternatives for Regional Pond C39

Scenario	Total Phosphorus Removed (Pounds per year)	Percent of Total Phosphorus
Proposed Regional Pond C39 without Existing Controls	46	40%
Stormwater Control Options		
1 - Existing Stormwater Controls	26	23%
2 - Stream Restoration Projects	6	5%
3 – Proposed Regional Pond C39 Constructed as a Dry Pond Combined with Existing Stormwater Controls	21	18%
4 - New Dry Pond at Upstream Location	15	13%
Stormwater Control Alternatives (Combinations of Stormwater Control Options)		
Alternative 1 * - Proposed Regional Pond C39 as a Smaller Dry Pond with Alternative Projects. (Options 1, 2 and 3)	53	46%
Alternative 2 - New Dry Pond at Upstream Location with Alternative Projects (Options 1, 2 and 4)	47	41%
Alternative 3 – Proposed Regional Pond C39 without Alternative Projects (Options 1 and 3)	47	41%
Alternative 4 – New Dry Pond at Upstream Location without Alternative Projects (Options 1 and 4)	41	36%
Alternative 5 – Alternative Projects with No New Pond (Options 1 and 2)	32	28%

* - *Selected Alternative*

Stormwater Control Options

The following stormwater control options were evaluated as replacement projects for proposed regional pond C39:

1. Construct new dry pond with wetland bottom at the site of the proposed regional pond. Based on preliminary evaluations, we estimate that a volume equivalent to at least one inch of runoff from the impervious surface can be provided at this location. The pond should be constructed with a wetland bottom to enhance nutrient removal efficiencies. The proposed dry pond has a smaller surface area compared to the pond proposed in the 1989 plan.

2. Construct a smaller dry pond within the watershed upstream from the proposed pond

3. Implement stream restoration project CU9216

4. Perform stream buffer restoration projects within the watershed in areas not covered in the Stream Physical Assessment Study

5. Evaluate small drainage system, and mitigate impact of small storm drainage outfalls in the watershed and perform mitigation where required

6. Promote LID within the upstream subwatershed

The upstream dry ponds have small drainage areas or are too close to existing houses to be considered feasible wetland bottom retrofit projects. This could change as part of the public information program.

Table 6-21 summarizes the annual phosphorus removed by the stormwater control options. Option 1 presents the phosphorus reduction produced by the existing stormwater controls. Option 2 presents the additional phosphorus reduction produced by the stream restoration project. Option 3 presents the additional phosphorus reduction produced by the proposed regional dry pond C39 constructed as a smaller dry pond together with alternative stormwater controls. Option 4 presents the additional phosphorus reduction produced by an upstream dry pond.

Table 6-21 provides the total annual phosphorus removed by five stormwater control alternatives that combine the stormwater control options, listed in order of decreasing effectiveness.

Updated Regional Pond Status

Construct regional pond C39 as a reduced size dry pond and implement alternative projects. The regional dry pond constructed at the proposed regional pond will maximize the extended detention volume possible within the site constraints. CDM analyses suggest the pond cannot store the runoff from the one-year, 24-hour storm but would store greater than 0.9 inches of runoff from the impervious area. The pond should be constructed with a wetland bottom to enhance nutrient removal efficiencies. It would provide additional stormwater protection to Flatlick Branch, which exhibits high stream erosion. Regional pond C39 is included in watershed plan project CU9001. The following projects will also be implemented to enhance conditions in the watershed upstream from the regional pond and address existing stream erosion:

- Stream restoration project CU9216
- Perform and promote buffer restoration within the watershed
- Review small drainage systems and mitigate erosion and impact of storm drain outfalls.

If the regional pond is not constructed, alternative stormwater controls should be, including an onsite dry pond within the upstream watershed and the other identified alternative projects.

6.2.4.12 Proposed Regional Pond C40

Proposed Pond Description

Regional pond C40 is on an unnamed tributary to Flatlick Branch. The pond's drainage area is 133 acres, and the pond was originally proposed as a maximum efficiency extended dry pond that reduces the peak two-year flow to 60 percent of the predevelopment peak flow.

The map in Figure 6-13 and data in Table 6-22 provides an overview of the conditions within the proposed regional pond watershed. These include the existing stormwater facilities and watershed plan structural projects.

Pond C40 is the only proposed regional pond in the Cub Run watershed that has significant area of development not controlled by a dry or wet pond. The pond drainage area is fully developed. The upper portion of the watershed is medium-density residential in the Armfield Farms community. The lower portion of the watershed (approximately 40 percent of the drainage area) is low-density residential (Chantilly Estates) with lot sizes ranging from 0.6 to 1 acre. The watershed includes four existing dry ponds that serve 76 percent of the watershed area. The lower area with no stormwater facilities is predominately low-density residential. The existing ponds provide small detention volumes and possibly provide only water quality control.

Proposed Pond Evaluation

The proposed pond removes 43 pounds of phosphorus per year as shown in Table 6-23. Construction of a regional pond with sufficient storage to provide stormwater benefits is not feasible commensurate with both the cost of constructing this facility and the impacts on nearby residences and private property.

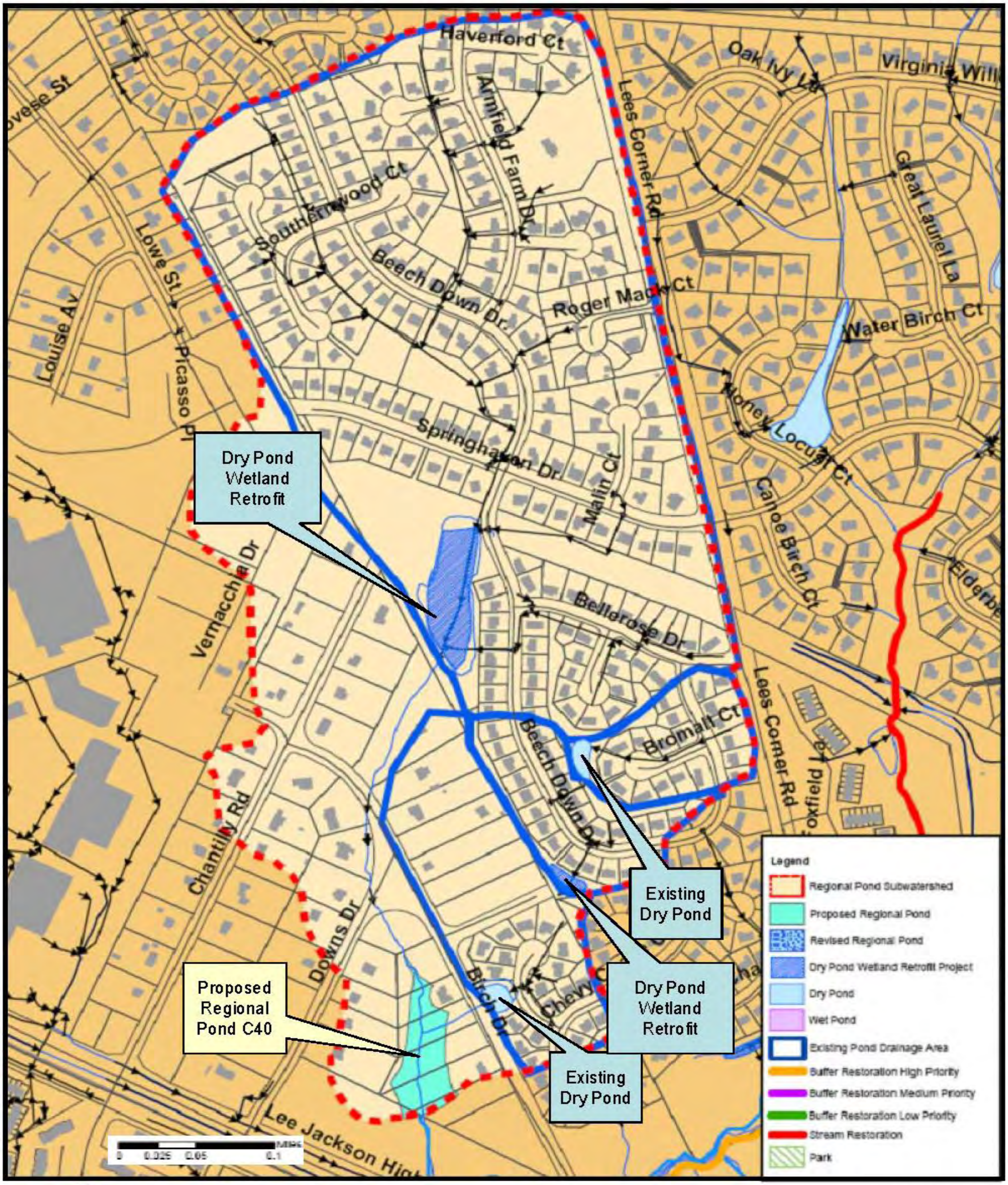


Figure 6-13
Proposed Regional Pond C40

Table 6-22
Watershed Overview for Unconstructed Regional Pond C40

Drainage Area: 133 Acres
Location: Unnamed tributary to Flatlick Branch. Chantilly Estates
Type of Pond: Maximum efficiency extended dry pond that reduces the peak two-year flow to 60 percent of the predevelopment peak flow
Status of Pond Site: Privately owned open space. Because of residential development, the proposed regional pond cannot be constructed as proposed with sufficient volume to control peak flows.

Existing Upstream Stormwater Controls	**Number of Facilities**	**Total Controlled Area (Acres)**	**Percent of Total Area**
Dry ponds with proposed wetland retrofit	2	84	63%
Dry Ponds (no retrofit)	2	18	13%
Wet Ponds	0	0	0%
Total	4	101	76%

Summary of Uncontrolled Developed Area	**Area (Acres)**	**Percent of Total Area**
Low Density Residential (0.7 – 1 acre lots)	32	24%
Little potential for additional development		

Summary of Stream Conditions Near Proposed Pond Site :	Two erosion inventory lines (175 feet) with impact score of 6. Other than this localized area, the streams do not have excessive stream erosion. The stream physical habitat is classified as fair.

Alternative Stormwater Control Options	**Number of Projects**	**Description**
Dry pond wetland retrofit projects	2	Project CU9186– Beech Down Drive & Bellerose Drive (77 acres) Project CU9185 – King Charles Drive (6 acres)
LID retrofit at public facilities	-	
Stream restoration projects	-	
Buffer restoration projects	-	
Upstream culvert retrofit projects	-	Closed pipe conduit systems preclude implementation of this alternative.
Other Projects	3	(1) Perform buffer restoration in small stream segments on privately owned common areas. (2) Promote buffer restoration and preservation by property owners in the lower reaches of the stream near the proposed regional pond. (3) Review small drainage systems and mitigate erosion and other impacts of storm drain outfalls.

Watershed Management Plan Recommendations	Delete regional pond C40 and implement alternative projects to reduce nutrient runoff from this watershed and improve the health of the local streams.

Table 6-23
Summary of Phosphorus Reduction Provided by
Stormwater Improvement Options and Alternatives for Regional Pond C40

Scenario	**Total Phosphorus Removed (Pounds per year)**	**Percent of Total Phosphorus**
Proposed Regional Pond C40 without Existing Controls	43	40%
Stormwater Control Options		
1 - Existing Stormwater Controls	33	31%
2 - Dry Pond Retrofit Projects	7	7%
3 - Regional Dry Pond C40 Combined with Existing Stormwater Controls	11	11%
Stormwater Control Alternatives (Combinations of Stormwater Control Options)		
Alternative 1 –Regional Dry Pond with Alternative Projects (Options 1, 2 and 3)	51	47%
Alternative 2 – Regional Dry Pond without Alternative Projects (Options 1 and 3)	44	41%
Alternative * 3 – Delete Regional Pond C40 and Implement Alternative Projects (Options 1 and 2)	40	38%

* - *Selected Alternative*

Stormwater Control Options

The following stormwater control options were evaluated as replacement projects for proposed regional pond C40:

1. Implement two dry pond retrofit projects

2. Perform buffer restoration in small stream segments on privately owned common areas upstream from stream reaches in the Physical Assessment Study

3. Promote buffer restoration and preservation by property owners in the lower reaches of the stream near the proposed regional pond

4. Review small drainage systems, and mitigate erosion and other impacts of storm drain outfalls

5. Promote LID on private property within the upstream subwatershed

Upstream portions of the watershed have closed pipe drainage systems with few opportunities to provide alternative stormwater controls. Because of the limited topographic relief, stormwater controls such as upstream culvert retrofits are not recommended.

Table 6-23 summarizes the total annual phosphorus removed by the stormwater control options. Option 1 presents the phosphorus removal provided by the existing stormwater controls. Option 2 presents the additional phosphorus reduction produced by the two dry pond retrofit projects. Option 3 presents the additional phosphorus reduction produced by the proposed regional pond when combined with the existing upstream stormwater controls.

Table 6-23 also presents the total phosphorus reduction produced by three alternative combinations of the stormwater control options, in order of decreasing effectiveness.

Updated Regional Pond Status
Delete regional pond C40 and implement the following alternative projects:

- Two dry pond wetland retrofit projects CU9185 and CU9186
- Perform buffer restoration on small stream segments
- Promote buffer restoration and preservation by property owners near the lower reaches of the stream near the proposed pond
- Review small drainage systems and mitigate erosion and other impacts of storm drain outfalls

The alternative projects provide nutrient removal approximately equal to the proposed regional dry pond and improve the health of the streams within the watershed. Further, the proposed pond cannot be constructed without affecting nearby residences and residential property.

6.2.4.13 Proposed Regional Pond C53

Proposed Pond Description
Regional pond C53 is on a tributary to Frog Branch downstream from Smallwood Court. The upstream watershed is mostly medium-density residential with some low-density residential. The proposed regional pond has a drainage area of 88 acres and was originally proposed to be a maximum efficiency extended detention dry pond to reduce the peak flow from the two-year storm to 33 percent of the predevelopment peak flow.

The map in Figure 6-14 and data in Table 6-24 provides an overview of the conditions within the proposed regional pond watershed. These include the existing stormwater facilities and watershed plan structural projects.

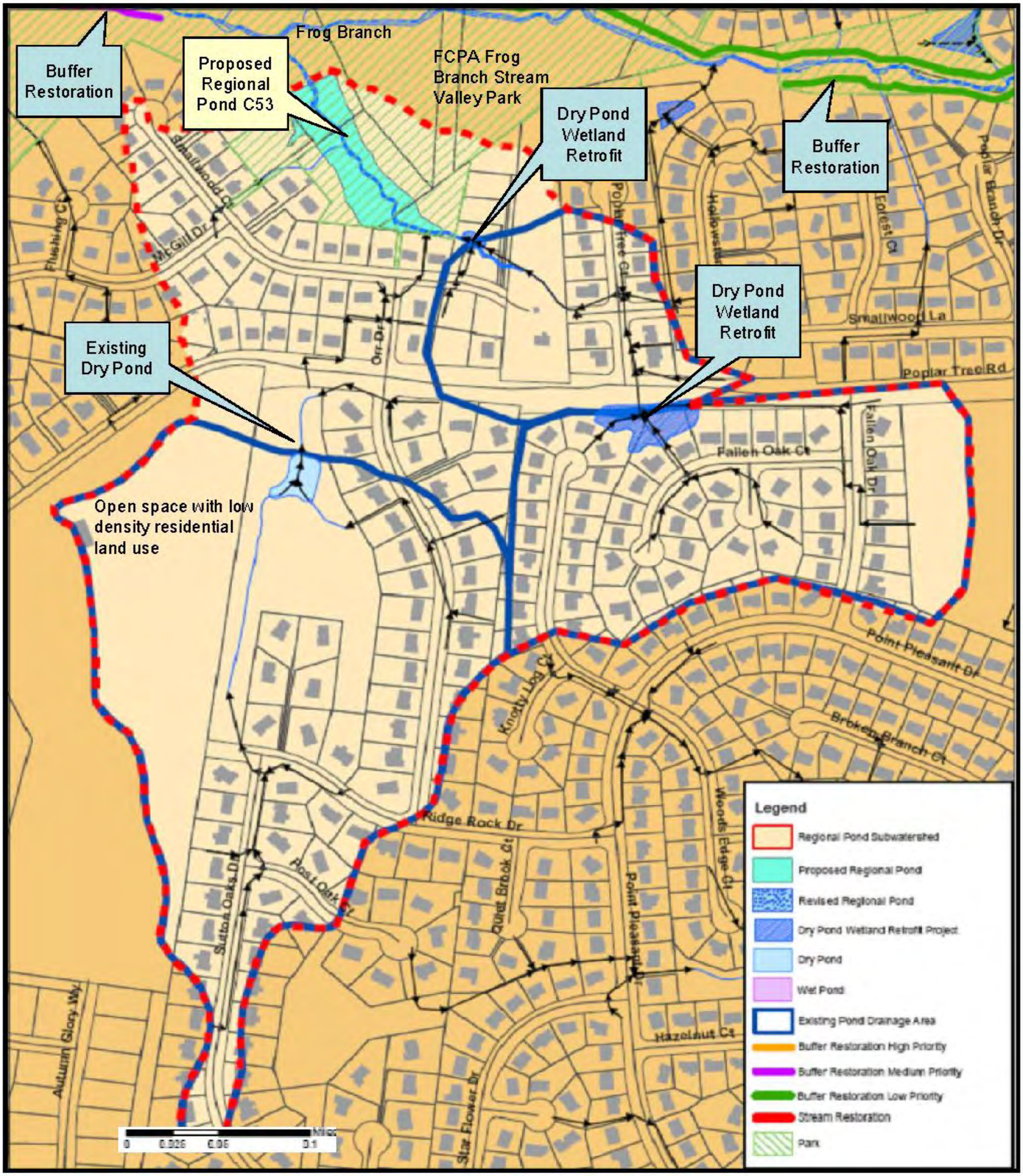


Figure 6-14
Proposed Regional Pond C53

Table 6-24
Watershed Overview for Unconstructed Regional Pond C53

Drainage Area: 88 Acres			
Location: Tributary to Frog Branch downstream from Smallwood Court			
Type of Pond: Maximum efficiency extended detention dry pond that reduces the peak flow from the two-year storm to 33 percent of the predevelopment peak flow			
Status of Pond Site: Fairfax County Park Authority. Wooded			
Existing Upstream Stormwater Controls	**Number of Facilities**	**Total Controlled Area (Acres)**	**Percent of Total Area**
Dry ponds with proposed wetland retrofit	2	29	33%
Dry Ponds (no retrofit)	1	35	39%
Wet Ponds	0	0	0%
Total	3	64	72%
Future development - twelve acres of low density residential			
Summary of Uncontrolled Developed Area		**Area (Acres)**	**Percent of Total Area**
Medium Density Residential		24	28%
Summary of Stream Conditions Near Proposed Pond Site :	No erosion identified in local streams. Stream buffers are affected in downstream reaches. The physical habitat within the pond is classified as excellent.		
Alternative Stormwater Control Options	**Number of Projects**	**Description**	
Dry pond wetland retrofits	2	Project CU9178 – Fallen Oak Court (20 acres) Project CU9177 – Smallwood Court (9 acres)	
LID retrofit at public facilities	-		
Stream restoration projects	-		
Buffer restoration projects	2	Restore buffer in Frog Branch at two locations. Projects CU9318 and CU9319	
Upstream culvert retrofit projects	-		
Other Projects			
Watershed Management Plan Recommendations	Deleted regional pond C53 and implement alternative projects to enhance nutrient removal efficiencies and improve the health of the local streams.		

Table 6-25
Summary of Phosphorus Reduction Provided by
Stormwater Improvement Options and Alternatives for Regional Pond C53

Scenario	Total Phosphorus Removed (Pounds per year)	Percent of Total Phosphorus
Proposed Regional Pond C53 without Existing Controls	27	40%
Stormwater Control Options		
1 - Existing Stormwater Controls	22	32%
2 - Dry Pond Retrofit Projects	2.2	3%
3 - Proposed Regional Pond C53 Combined with Existing Stormwater Controls	7	10%
Stormwater Control Alternatives (Combinations of Stormwater Control Options)		
Alternative 1 – Proposed Regional Pond C53 with Alternative Projects (Options 1, 2 and 3)	31.2	46%
Alternative 2 – Proposed Pond C53 without Alterative Projects (Options 1 and 3)	29	43%
Alternative 3 * – Delete Regional Pond C53 and Implement Alternative Projects (Options 1 and 2)	24.2	35%

** - Selected Alternative*

Three onsite dry ponds control 72 percent of the watershed. Two of these ponds are recommended wetland bottom retrofit projects. The watershed includes 12 acres of open land that has low-density residential planned land use and will likely be developed. This development will likely include stormwater controls.

Proposed Pond Evaluation
The proposed regional pond C53 removes 27 pounds of phosphorus per year as documented on Table 6-25.

The proposed dam site and pool are within the FCPA Frog Branch Stream Valley Park. Although a regional pond at the proposed location may be feasible, construction would remove significant tree buffer within the park and along the stream.

Stormwater Control Options
The following stormwater control options were evaluated as replacement projects for proposed regional pond C53:

1. Construct two dry pond retrofit projects

2. Implement two buffer restoration projects on nearby Frog Branch

3. Promote LID upstream from the proposed regional pond

The closed pipe systems in this area prevent the use of culvert upstream retrofit projects. No public facilities such as schools or libraries exist in the watershed for use as LID retrofit projects.

Table 6-25 summarizes the annual phosphorus removed by stormwater control options. Option 1 presents the phosphorus reduction produced by the existing stormwater controls. Option 2 presents the additional phosphorus reduction produced by the two dry pond retrofit projects. Option 3 presents the additional phosphorus removed by the proposed regional pond together with the existing stormwater controls.

Table 6-25 also presents the total phosphorus reduction produced by alternative combinations of the stormwater control options, in order of decreasing effectiveness.

Updated Regional Pond Status
Delete regional pond C53 and implement the following alternative projects:

- Implement dry pond wetland retrofit projects CU9177 and CU9178
- Perform buffer restoration projects CU9318 and CU9319
- Promote LID in the proposed pond watershed

These alternative projects enhance stormwater control within the watershed. The proposed pond removes only 7 pounds of phosphorus per year. The existing stormwater controls combined with alternative projects provide watershed protection similar to that provided by the proposed pond. Pond construction would have significant impacts on portions of the FCPA Frog Branch stream valley park and severely affect a stream in which the physical habitat is classified as excellent.

6.2.4.14 Propose Regional Pond C54

Proposed Pond Description
Regional pond C54 is at the site of an existing lake in the upper reaches of the Flatlick Branch watershed. The drainage area is 334 acres and the proposed regional pond was designed as a maximum efficiency extended dry pond to reduce the peak flow from the two-year storm to 33 percent of the predevelopment peak flow.

The map in Figure 6-15 and data on Table 6-26 provide an overview of the conditions within the proposed regional pond watershed. These include the existing stormwater facilities and watershed plan structural projects.

The existing development near the pond is large-lot, single-family residential but has a planned land use of low-density residential. These sites will likely be developed at the higher planned density. In fact, many of these large lots have been developed as this study progressed.

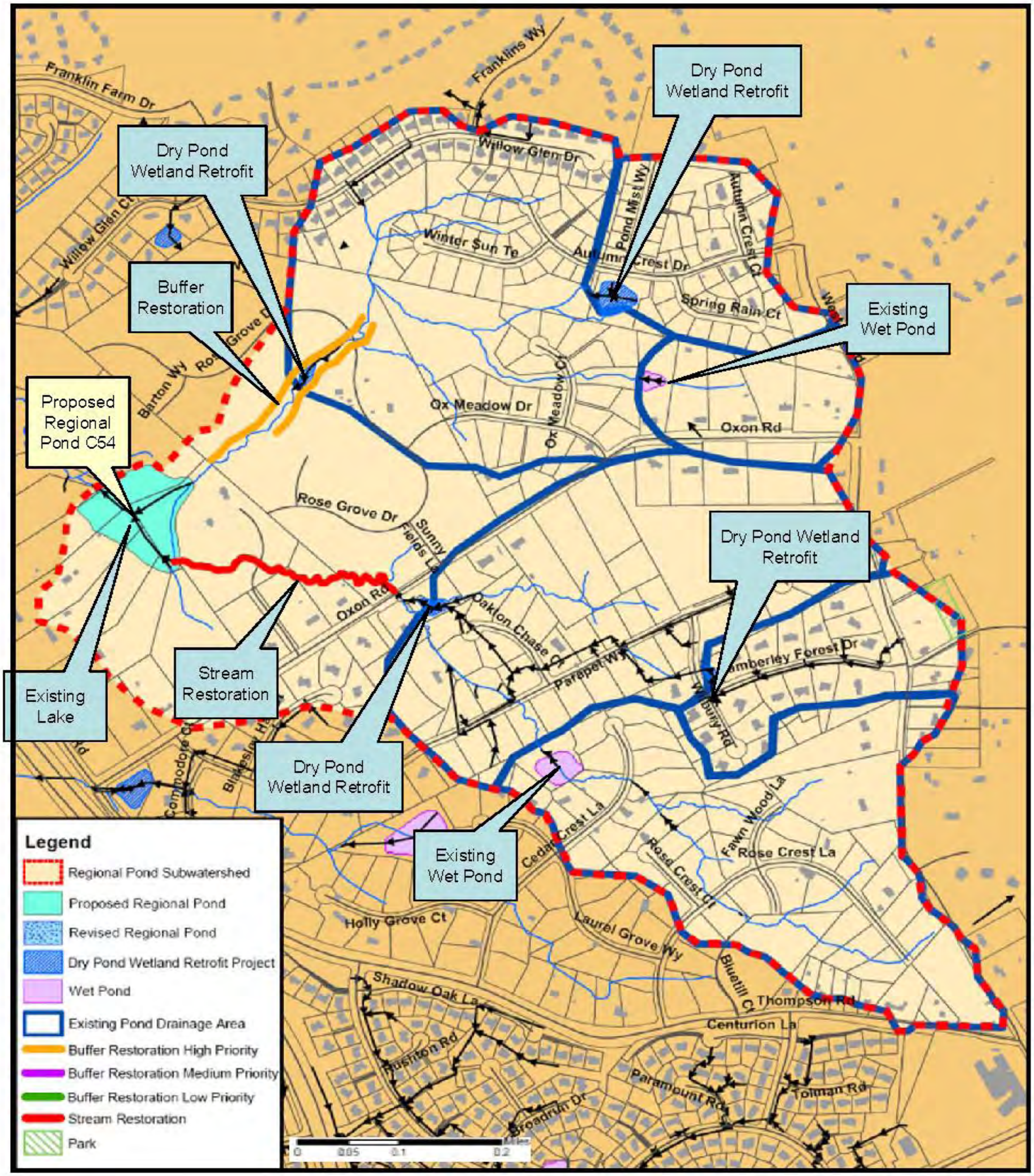


Figure 6-15
Proposed Regional Pond C54

Table 6-26
Watershed Overview for Unconstructed Regional Pond C54

Drainage Area: 334 Acres
Location: Site of an existing private pond in the upper reaches of the Flatlick Branch watershed
Type of Pond: Maximum efficiency extended detention dry pond that reduces the peak flow from the two-year storm to 33 percent of the predevelopment peak flow
Status of Pond Site: Privately owned pond

Existing Upstream Stormwater Controls	**Number of Facilities**	**Total Controlled Area (Acres)**	**Percent of Total Area**
Dry ponds with proposed wetland retrofit	4	180	54%
Dry Ponds (no retrofit)	0	0	0%
Wet Ponds	2	79	24%
Total	6	259	78%

Summary of Uncontrolled Developed Area	**Area (Acres)**	**Percent of Total Area**
Low Density Residential Development	75	22%
Future development – development is ongoing, low-density residential development that should provide onsite dry and wet ponds.		

Summary of Stream Conditions Near Proposed Pond Site :	Stream buffers are affected by new development. Stream reach upstream from the proposed regional pond and downstream from Oxon Road has low bank stability scores but no erosion inventory points. The stream habitat is poor and very poor.

Alternative Stormwater Control Options	**Number of Projects**	**Description**
Dry pond wetland retrofits	4	Project CU9702 – Autumn Crest Dr. (22 acres) Project CU9701 – Rose Grove Dr. (72 acres) Project CU9703 – Oxon Road and Oakton Chase Ct. (65 acres) Project CU9704 – Camberley Forest Dr. and Wilbury Rd (21 acres)
LID retrofit at public facilities	-	
Stream restoration projects	1	Project CU9217 upstream from pond identified based on poor bank stability scores.
Buffer restoration projects	1	Project CU9329 upstream from pond
Upstream culvert retrofit projects	-	
Other Projects		

Watershed Management Plan Recommendations	Delete regional pond C54 and implement identified alternative projects. Implement alternative stormwater controls to enhance nutrient removal provided by existing facilities, address stream erosion upstream from the proposed pond and improve and protect the health of the local streams.

Upstream areas in the watershed are largely low-density residential. The low-density developed areas include four dry ponds.

Proposed Pond Evaluation
The proposed pond C54 removes 86 pounds of phosphorus per year as documented in Table 6-27.

The following summarizes existing conditions for regional pond C54:

- Constructing the proposed extended detention dry regional pond requires removing an existing lake.
- The upstream development includes existing dry ponds that control the stormwater flows from 78 percent of the watershed. New development will likely include dry and wet ponds.
- The lake, though not designed as a stormwater pond, provides supplemental nutrient removal for the upstream watershed. As a result, construction of the proposed dry pond will have little additional nutrient removal benefit. The new dry pond would provide greater peak flow control than the lake.

Stormwater Control Options
The following stormwater control options were evaluated as replacement projects for proposed regional pond C54:

1. Construct four dry pond retrofit projects
2. Implement one buffer restoration project
3. Perform stream restoration for upstream reach
4. Promote LID in the upstream watershed, focusing on areas not upstream of existing stormwater controls
5. Promote and perform buffer restoration, and small drainage system assessment and rehabilitation in the upstream watershed

No other alternative stormwater controls, such as upstream culvert retrofits, are practical because of the limited topographic relief and high development density. No public facilities such as schools or libraries for LID retrofit projects exist in the watershed.

Table 6-27 summarizes the total annual phosphorus removed by the stormwater control options. Option 1 presents the phosphorus reduction produced by the existing stormwater controls.

Table 6-27
Summary of Phosphorus Reduction Provided by
Stormwater Improvement Options and Alternatives for Regional Pond C54

Scenario	Total Phosphorus Removed (Pounds per year)	Percent of Total Phosphorus
Proposed Regional Pond C54 without Existing Controls	86	40%
Stormwater Control Options		
1 - Existing Stormwater Controls	61	28%
2 - Existing Lake or Proposed Regional Dry Pond C54 Combined with Existing Stormwater Controls	33	15%
3 - Dry Pond Retrofit Projects	9	4%
4 – Stream Restoration Project		
Stormwater Control Alternatives (Combinations of Stormwater Control Options)		
Alternative 1 * - Delete Proposed Regional Pond C54 and Implement Alternative Projects (Includes Existing Lake)	103	48%
Alternative 2 – Existing Lake or Regional Pond C54 without Alternative Projects	94	44%

** - Selected Alternative*

Option 2 presents the phosphorus reduction produced by the lake. This option also represents the approximate phosphorus reduction provided by the proposed dry pond at this same location. The removal represents that provided by a dry pond with a wetland bottom. While the lake provides similar phosphorus reductions to the proposed dry pond, the latter would enhance peak flow control.

Option 3 presents the phosphorus reduction produced by the four dry pond retrofit projects. Option 4 presents the phosphorus reduction produced by the stream restoration project.

Updated Regional Pond Status

Delete regional dry pond C54 and implement the following alternative stormwater controls:

- Implement four dry pond retrofit projects CU9701, CU9702, CU9703 and CU9704

- Perform stream restoration project CU9217

- Perform buffer restoration project CU9329
- Promote LID in the upstream watershed
- Promote and perform buffer restoration, and small drainage system assessment and rehabilitation in the upstream watershed

The identified alternative stormwater controls will enhance phosphorus reduction and watershed health. Eliminating the lake and constructing a dry pond provides no net nutrient reduction benefit. The streams downstream of the lake do not exhibit significant stream erosion.

6.2.4.15 Proposed Regional Pond C62

Proposed Pond Description

Regional pond C62 is on an unnamed tributary to Elklick Run near the confluence with Cub Run within the rezoned R-C District. As of 2002, the watershed was undeveloped forest. Pond C62 has a drainage area of 80 acres and was planned to be a wet pond to reduce the peak two-year flow to predevelopment flow rates. The watershed is largely privately owned land within the R-C District. This area could be developed at a density of one house per five acres. The watershed also includes FCPA parkland.

The map in Figure 6-16 and data in Table 6-28 provide an overview of the conditions within the proposed regional pond watershed. These include the existing stormwater facilities and watershed plan structural projects.

Regional Pond Evaluation

The proposed pond would remove 8 pounds of phosphorus as documented in Table 6-29. The following bullets summarize the existing conditions at regional pond C62:

- The dam site is within FCPA parkland. Pond construction would affect several acres of forested land within the park.
- The upstream watershed contains about 30 percent FCPA parkland and 70 percent Estate Residential land use. The area in the Estate Residential land use may be developed as five-acre lots. Stormwater controls are not required for this low-density R-C District development.
- The pond is near the Cub Run main stem. A detention facility may delay peak flows such that they could coincide with higher flows and potentially produce higher peak flows in Cub Run.

Stormwater Control Options

No stormwater controls exist in the undeveloped watershed, and there is no opportunity or need for alternative ones.

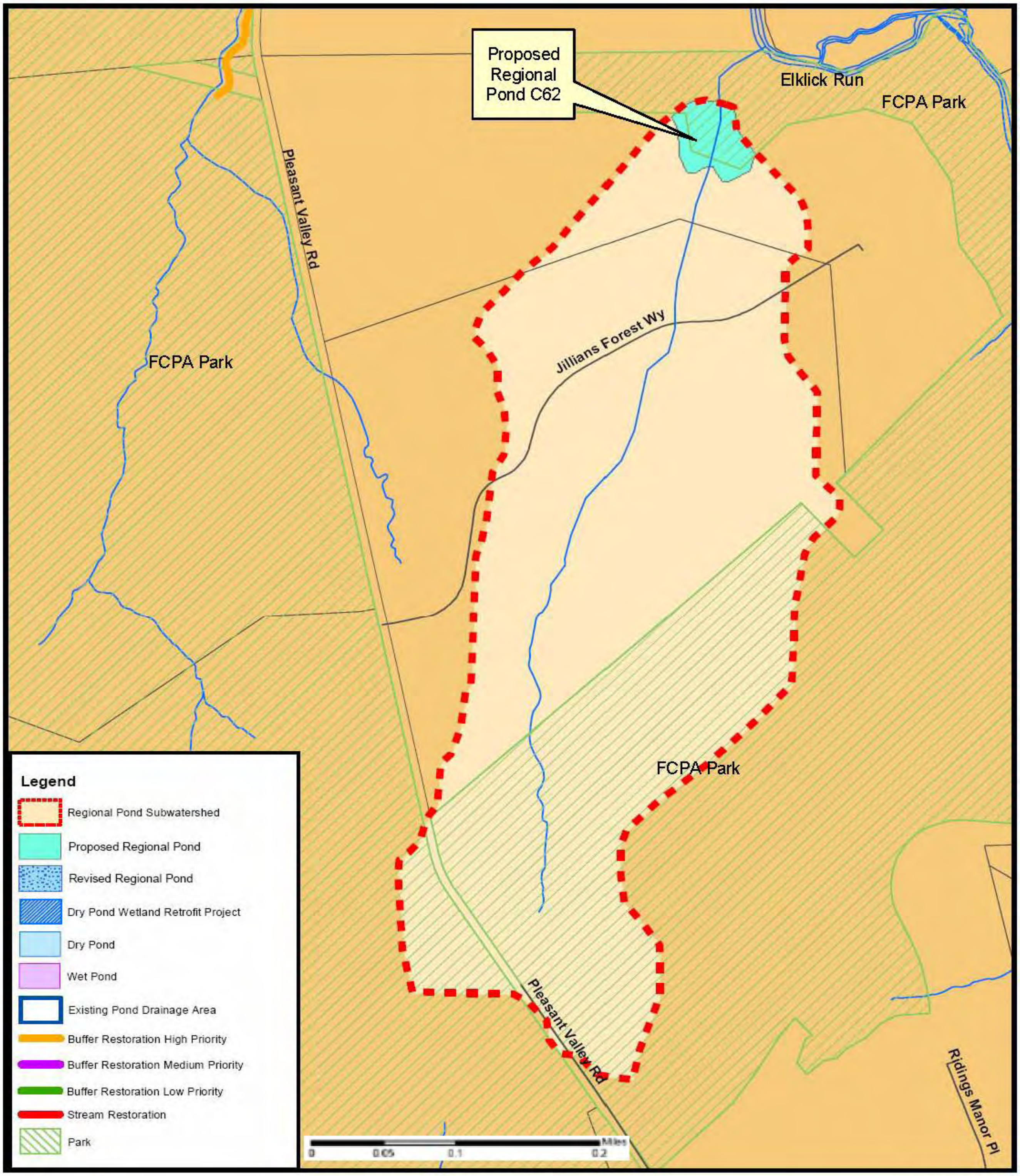


Figure 6-16
Proposed Regional Pond C62

Table 6-28
Watershed Overview for Unconstructed Regional Pond C62

Drainage Area: 80 Acres			
Location: R-C District on unnamed tributary to Elklick Run			
Type of Pond: wet pond that reduces the peak two-year flow to predevelopment flow rates			
Status of Pond Site: Fairfax County Park Authority Parkland			
Existing Upstream Stormwater Controls	**Number of Facilities**	**Total Controlled Area (Acres)**	**Percent of Total Area**
Dry ponds with proposed wetland retrofit	0	0	0%
Dry Ponds (no retrofit)	0	0	0%
Wet Ponds	0	0	0%
R-C District Estate Residential	-	33	41%
Parkland	-	47	59%
Total	0	80	100%
Summary of Uncontrolled Developed Area		**Area (Acres)**	**Percent of Total Area**
Summary of Stream Conditions Near Proposed Pond Site :	Stream was not inventoried. Watershed is totally undeveloped woodland that should not have any stream erosion. The physical habitat is classified as fair.		
Alternative Stormwater Control Options	**Number of Projects**	**Description**	
Dry pond wetland retrofits	-		
LID retrofit at public facilities	-		
Stream restoration projects	-		
Buffer restoration projects	-		
Upstream culvert retrofit projects	-		
Other Projects	-		
Watershed Management Plan Recommendations	Delete regional pond C62 and no alternative stormwater controls are required. The watershed is R-C District Estate Residential land use or preserved as open space parkland. These land uses are effective low impact development BMPs that effectively control the runoff from these lands and therefore do not require structural stormwater controls. Pond construction would affect forested FCPA parkland and provide little watershed improvements.		

Table 6-29 summarizes the total annual phosphorus removed by the stormwater controls considered for regional pond C62 watershed. The proposed pond removes only 8 pounds of phosphorus due to the lack of development in the watershed.

Table 6-29
Summary of Phosphorus Reduction Provided by
Stormwater Improvement Options and Alternatives for Regional Pond C62

Scenario	Total Phosphorus Removed (Pounds per year)	Percent of Total Phosphorus
Proposed Regional Pond C62 without Existing Controls	8	50%
Stormwater Control Options		
1 - Existing Stormwater Controls	0	0%
2 - Proposed Regional Pond C62 Combined with Existing Controls	8	50%
Stormwater Control Alternatives (Combinations of Stormwater Control Options)		
Alternative 1 – Regional Pond C62	8	50%
Alternative 2 * – Deleted Regional Pond C62 and no Alternative Projects	0	0%

** - Selected Alternative*

Updated Regional Pond Status
Delete regional pond C62 and no alternative projects are required. Because of the low density of development in the subwatershed, the proposed regional pond provides little reduction in nutrient loads (8 pounds per year). The watershed is undeveloped and will not have much future development. Constructing the pond will affect forested FCPA parkland and provide little watershed benefit.

6.3 Action - Dry Pond Wetland Retrofit Projects

6.3.1 Action

Most of the residential and commercial areas in the watershed include peak flow control and water quality BMPs. Wet ponds and extended-detention dry (EDD) ponds are the primary structural stormwater controls. Under this action, selected dry ponds will be modified to include wetland features thereby increasing phosphorus and nitrogen removal by 10 and 25 percent, respectively. Other improvements will be evaluated and implemented at the time that the facilities are retrofitted.

Several watershed plan goals and objectives will be met through the dry pond wetland bottom retrofit projects:

1. Maximize the benefits provided by existing dry ponds

2. Improve aesthetics of existing dry ponds by removing concrete trickle channels and mowed grassed area, providing plantings and other improvements

3. Reduce nutrient runoff

4. Provide habitat for native flora and fauna

5. Improve the health of the streams within and near the dry ponds

Figure 6-17 represents an existing dry pond and elements to consider in the dry pond wetland retrofit projects. The pond bottom will be excavated to create a functioning wetland, including (depending on space constraints) a micro-pool, sediment forebay and riparian buffer. If possible, a low berm or peninsula will be placed in the pond to increase the flow path though it. The goal is to eliminate the mowed pond bottom and concrete low flow channels, and create an aesthetically pleasing wetland feature that performs ecological functions. Native wetland plants will be placed within the wetland area. Additional plantings will provide habitat, shade and screening of the pond.

The pond site will be evaluated during the retrofit for additional opportunities to enhance the stormwater control:

- Manufactured BMPs (Stormceptor or Filterra), bioretention, drainage swales or other LID controls could be installed at parking lots or other areas with a large percentage of impervious area near the pond to remove sediments, nutrients, petroleum products and other pollutants before they enter the dry pond.

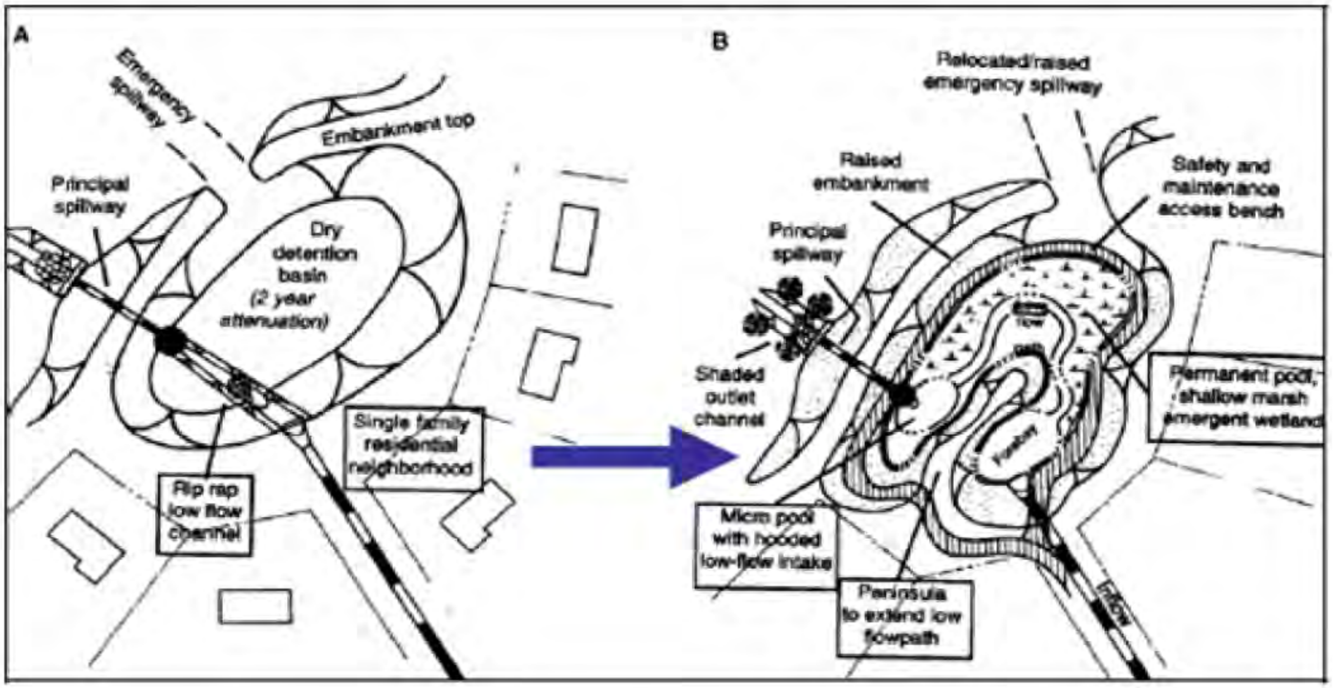
- Modify the outlet structure to increase the extended detention volume or otherwise improve the functioning of the existing pond. As an example, the pond may be modified from one that controls the 2- and 10-year peak flow to one that provides extended detention for the one-year storm event. These evaluations should consider the timing of the peak flow from the pond relative to the peak flows in the receiving stream to avoid potentially increasing peak flows where peaks coincide.

- Increase the storage volume for water quality or peak flow control by excavating the pond bottom or raising the dam height

These last two retrofit opportunities will be targeted for ponds upstream from active stream erosion areas where peak flow control improvements will help to achieve watershed plan goals and objectives.

The overall condition of the existing pond will be evaluated, and maintenance will be performed when necessary to ensure the pond functions as designed, has no safety hazards and meets modern design guidelines.

Education and recreation opportunities at the dry ponds will be evaluated. Where appropriate, interpretive signs will be provided. Existing trails will be extended and



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

Figure 6-17
Dry Pond Wetland Bottom Retrofit

benches or other features may be added to transform the dry ponds to a valued community resource.

Initial review of some pond sites suggests bedrock may be at or near the pond bottom. The evaluations performed under this watershed planning study do not include detailed evaluation of the depth to rock or hardness of the rock. Evaluations during the initial studies for some proposed ponds may find that rock near the ground surface increases the project cost and thus makes it infeasible.

6.3.2 Strategy to Achieve Action

Identification of Dry Pond Retrofit Projects

GIS layers showing streams and stormwater facilities, aerial photography and field surveys were used to identify 170 dry ponds in the Cub Run and Bull Run watershed. These ponds were screened to identify those included in the watershed plan as dry pond retrofit projects.

The first screening criteria focused on the retrofit's nutrient removal benefit. Ponds that provide relatively little benefit compared to the conversion cost will <u>not</u> be considered in this plan based on the following criteria:

- Upstream drainage area - ponds with upstream drainage areas of less than five acres
- Density of development in upstream watershed – ponds in which the upstream watershed is less than 30 percent developed

The amount of nutrients and other pollution removed relates directly to the upstream drainage area and the development in the upstream watershed. Ponds with larger drainage areas with higher development densities provide the greatest benefit relative to the cost.

The second set of screening criteria focused on the number and proximity of residences near the existing dry ponds. Ponds that have many residences nearby were eliminated since they may be difficult to implement.

The above criteria were used to identify 129 dry pond wetland retrofit projects and provide a priority ranking. The highest rated ponds will remove more pollution and have a higher probability of being built due to their reduced impact on neighboring residential properties.

Additional analyses further evaluated and ranked the dry pond retrofit projects. Additional ponds were eliminated when the construction costs were high relative to the nutrient reduction provided. This analysis reduced the number of ponds from 129 to 89.

Stormwater modeling results were used to evaluate the relative impact that various portions of the watershed have on the streams. Dry ponds within areas that have high impact received higher ranks. The following parameters were evaluated to determine the relative impact that the modeled basins have on watershed conditions:

- Runoff volume (inches) for the two-year design storm event
- Peak flow (rate per acre) for the two-year design storm event
- Total phosphorus loads (pounds per acre)
- Total nitrogen loads (pounds per acre)
- Total suspended solid loads (pounds per acre)

Existing-condition impact scores were developed from these parameters for each model subbasin as shown in Figure 6-18.

Dry pond retrofit projects within basins with high impact scores received the highest ranking. The dry pond retrofit project implementation priority scores presented on Table 6-30 combines the following:

- Existing condition impact score
- Cost per pound of phosphorus removed
- Total phosphorus removed in pounds

Following this analysis, dry pond retrofit projects identified as alternative projects to regional ponds were added.

The priority scores rank the ponds for effectiveness in reducing loads, cost relative to the load reduction and water quality improvements most beneficial to the watershed, providing one guide as to the order of implementation. As described in Section 7, the projects will not be implemented in the order presented in Table 6-30.

This table summarizes whether the dry pond is publicly maintained by Fairfax County or if the pond is privately maintained.

Figure 6-18 shows the general location of the 94 dry pond retrofit projects in the watershed plan. Figures presented at the end of this section provide additional details on the location of the ponds within the major subwatersheds.

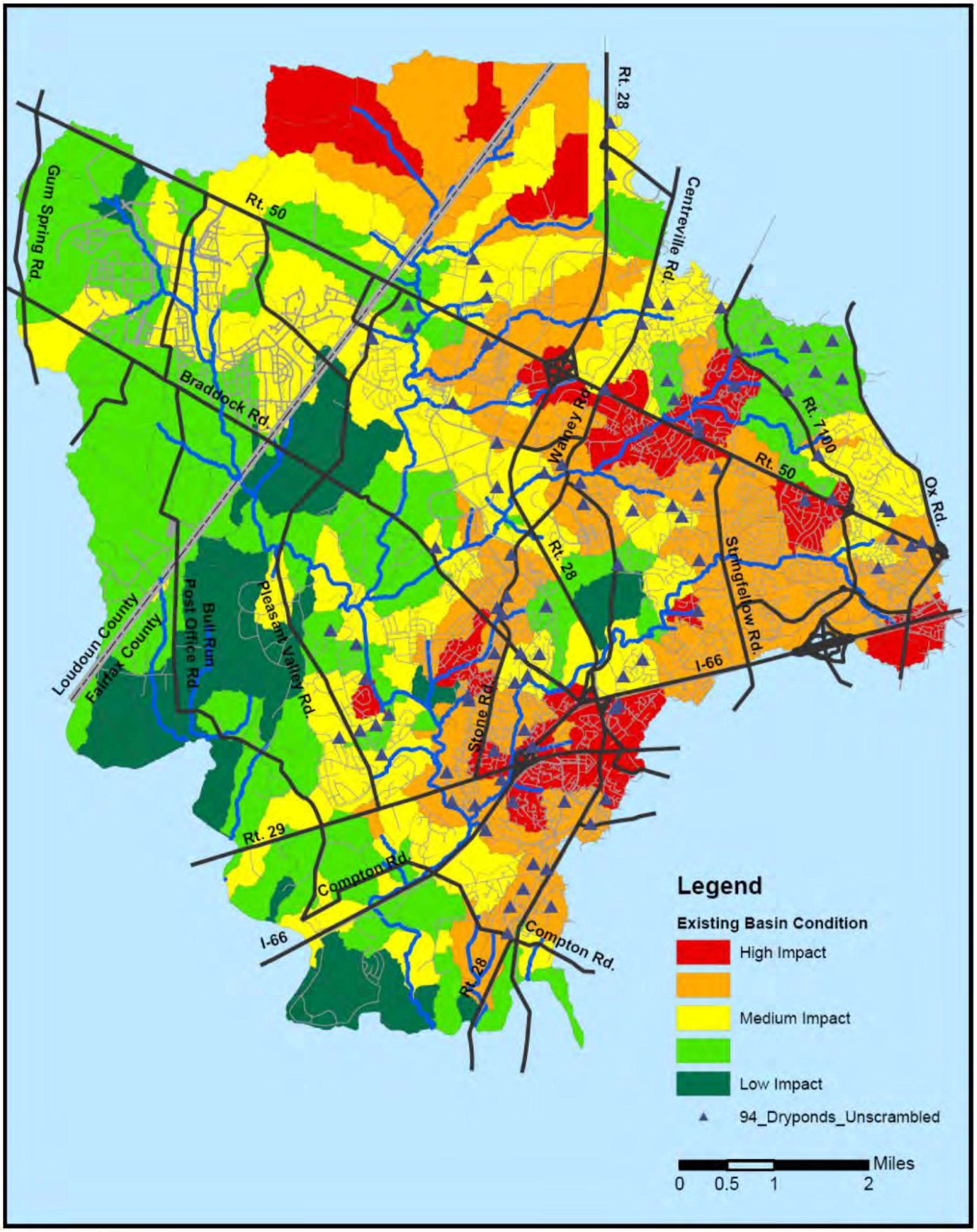


Figure 6-18
Dry Pond Wetland Retrofit Project Locations

Table 6-30
Dry Pond Wetland Retrofit Projects

ID	Description	Basin	Priority Score *	Maintenance Type
CU9124	Route 28 ramp to I-66, Pickwick Road	Big Rocky	1	Public
CU9138	Tallow Tree Place	Big Rocky	2	Public
CU9107	Centrewood Drive & Machen Road	Big Rocky	3	Private
BR9108	Sharps Drive	Bull Run East	4	Public
CU9142	Fair Ridge Park, Meadow Field Drive	Big Rocky	5	Public
CU9111	Old Centreville Rd & Sunset Ridge Rd	Big Rocky	6	Public
CU9188	Kernstown Court (C43)	Flatlick	7	Public
CU9103	Between Outpost Court & I-66 (C04)	Lower Cub	8	Public
CU9182	Currey Lane, Chantilly Library	Frog Branch	9	Public
CU9174	Walney Road & Mariah Court	Flatlick	10	Private
BR9104	Flamborough Rd near Jenny Leigh Ct.	Bull Run East	11	Public
CU9143	Fair Ridge Park, Rt. 50 and Fair Ridge Dr.	Big Rocky	12	Public
CU9187	Hollinger Avenue & Lees Corner Road	Flatlick	13	Public
CU9125	Melton Place & Pickwick Road	Big Rocky	14	Public
CU9175	Penny Tree Place	Flatlick	15	Private
CU9709	Sully Plaza, Rt 50 and Centreville Road	Schneider Br.	16	Private
CU9711	Franklin Middle School, Centreville Road	Cain Branch	17	Private
CU9134	Point Pleasant Dr and Hazelnut Court	Big Rocky	18	Public
CU9144	Route 50 and Fair Ridge Drive, 50 West Corporate Center	Big Rocky	19	Private
CU9104	James Harris Way	Big Rocky	20	Public
CU9136	Britwell Place and Maureen Lane	Big Rocky	21	Public
BR9107	Wheat Mill Way & Grainery Road	Bull Run East	22	Public
CU9169	Westfields Blvd & Stonecroft Blvd	Flatlick	23	Public
CU9151	Green Park Way, Basingstoke Loop (C22)	Middle Cub	24	Public
CU9706	Flint Lee Business Center, Stonecroft Rd.	Schneider Br.	25	Private
CU9176	Fillingame Drive nr Lowry Drive	Flatlick	26	Public
CU9105	Field Encampment Rd & Field Flower Tr.	Big Rocky	27	Public
CU9145	Fair Ridge Drive, Fairleaf Court	Big Rocky	28	Private
CU9132	Poplar Tree Park, Melville Ln & Marble Rock Dr.	Big Rocky	29	Public
CU9180	Stream Valley Drive	Frog Branch	30	Public
CU9156	Lock Dr @ Crenshaw Dr, Poplar Tree Rd	Round Lick	31	Public
CU9719	Lafayette Business Center, Lafayette Center Drive	Upper Cub	32	Private
CU9167	Parkstone Drive, Va DMV	Flatlick	33	Private
CU9164	Snowhill Lane	Middle Cub	34	Public
CU9172	Flatlick Branch Drive	Flatlick	35	Private

Table 6-30
(continued)
Dry Pond Wetland Retrofit Projects

ID	Description	Basin	Priority Score *	Maintenance Type
CU9109	Hoskins Hollow Circle	Big Rocky	36	Public
BR9105	Cedar Loch Court	Bull Run East	37	Public
BR9102	Old Centreville Road & Compton Road	Bull Run East	38	Public
CU9721	Dulles International Center, Eds Drive	Dead Run	39	Private
CU9147	Rydell Road	Lower Cub	40	Public
CU9707	Lee Road and Willard Road	Schneider Br.	41	Private
CU9115	Truro Parish Court	Big Rocky	42	Public
CU9720	Stonecroft Blvd. & Thompson Road	Dead Run	43	Public
CU9157	Poplar Tree Road, Braywood Drive	Round Lick	44	Public
CU9112	Stonepath Court	Big Rocky	45	Public
CU9170	Lee Road	Flatlick	46	Private
CU9718	Avion Parkway & Virginia Mallory Drive	Cain Branch	47	Public
CU9716	Technology Court & Lafayette Center Dr	Cain Branch	48	Private
CU9717	Driving Training Center, Stonecroft Blvd	Cain Branch	49	Public
CU9713	Lees Corner Road & Old Dairy Road	Cain Branch	50	Public
CU9195	Fairfax County Parkway & Tuckaway Dr.	Flatlick	51	Public
CU9113	Havner House Way nr. I-66, Route 29 Int.	Big Rocky	52	Private
CU9139	Trumbo Court and Monument Drive	Big Rocky	53	Public
CU9121	Braddock Road & Village Center Drive	Big Rocky	54	Public
CU9148	Prince Way	Middle Cub	55	Public
CU9714	Franklin Farm Road and Hidden Meadow Circle	Cain Branch	56	Private
CU9119	Rocky Run Drive & Awbrey Patent Drive	Big Rocky	57	Public
CU9155	Poplar Tree Road at Sully Park Drive	Round Lick	58	Public
BR9106	Tracy Schar Lane	Bull Run East	59	Public
CU9165	Martins Hundred Drive	Middle Cub	60	Public
CU9152	Grobie Pond Lane and Watermark Circle (C22)	Middle Cub	61	Public
CU9106	Industrial Pk at Route 29 and I-66	Big Rocky	62	Private
CU9178	Fallen Oak Court	Frog Branch	63	Public
CU9722	Dulles Gateway Center Renaissance Park	Dead Run	64	Private
CU9123	Filly Court	Big Rocky	65	Public
CU9127	Cabells Mill Drive & Ascomb Court	Big Rocky	66	Public
CU9146	Sweet Leaf Terrace and Fairleaf Court	Big Rocky	67	Public
CU9154	Stone Crossing Court	Round Lick	68	Public
CU9701	Rose Grove Drive	Flatlick	69	Unknown
CU9192	Alder Woods Drive	Oxlick	70	Public

Table 6-30
(continued)
Dry Pond Wetland Retrofit Projects

ID	Description	Basin	Priority Score *	Maintenance Type
CU9198	Applegrove Lane and Fern Hollow Place	Flatlick	71	Public
CU9710	Westfax Industrial Park, Rt 50 and Westfax Dr	Cain Branch	72	Private
CU9171	Brookfield Corporate Center	Flatlick	73	Private
CU9194	Thompson Road & Oxon Road	Flatlick	74	Public
CU9185	Beech Down Drive	Flatlick	75	Public
CU9193	Mazewood Lane	Flatlick	76	Public
CU9122	Virginia Chase Drive	Big Rocky	77	Public
CU9702	Autumn Crest Drive and Pond Mist Way	Flatlick	78	Public
CU9186	Beech Down Drive & Bellerose Drive	Flatlick	79	Public
CU9162	Blueridge View Dr. Jordans Journey Dr.	Middle Cub	80	Public
CU9150	Lee Forest Path & Stillfield Place	Middle Cub	81	Public
CU9161	Hidden Canyon Road & Knoll View Place	Middle Cub	82	Public
CU9712	Centreville Road & Armfield Farm Drive	Cain Branch	83	Public
CU9704	Camberley Forest Drive & Wilbury Road	Flatlick	84	Public
CU9128	Rushbrook Drive & Nanticoke Drive	Big Rocky	85	Public
CU9705	Kentwell Circle	Elklick	86	Private
CU9703	Oxon Road & Oakton Chase Way	Flatlick	87	Public
CU9158	Belle Plains Drive & Sequoia Farms Drive	Round Lick	88	Public
CU9715	Pleasant Valley Rd, Silas Hutchinson Dr	Upper Cub	89	Public
CU9159	Walney Road & Walney Park Drive	Round Lick	90	Public
CU9160	Oakengate Way	Middle Cub	91	Public
CU9177	Smallwood Court	Frog Branch	92	Public
CU9163	Eagle Tavern Lane	Middle Cub	93	Public
CU9184	Flatlick downstream from Route 50	Flatlick	94	Unknown

** - Priority score indicates the project's effectiveness in reducing loads in critical areas of the watershed. The projects will not be implemented in the order presented in this table.*

Cost to Implement Action

The estimated total cost for implementing these 94 dry pond retrofit projects is approximately $10 million.

6.3.3 Watershed Benefits

The dry pond wetland retrofit projects provide various watershed benefits, including:

- Improve nutrient removal efficiency of existing stormwater facilities. Adding a wetland bottom increases the removal efficiency of phosphorus and nitrogen by 10 and 25 percent, respectively.

- Reduce impact since upgrading existing facilities has less impact compared to constructing new facilities.

- Improve and maintain existing facilities. Evaluating the condition of these existing dry ponds, and making necessary repairs and improvements allow the ponds to meet current design standards and to operate safely into the future. When possible, the projects will update the outlet control structures to modern design standards.

- Improve the aesthetics of the basins by providing a more natural-looking pond and wetland environment

- Improve the health of the streams within and near the existing dry ponds

- Reduce the facility's maintenance costs by eliminating mowed areas

- Provide additional watershed protection for a significant portion of the watershed. The identified dry ponds provide additional water quality protection for 3,000 acres – approximately 9 percent of Fairfax County's watershed area.

- Identify and implement opportunities to provide educational signs and passive recreation opportunities, including trails, benches and overlooks at the existing dry pond locations

- The 94 dry ponds eliminate approximately 356 pounds of phosphorus per year from the watershed.

6.4 Action – Implement LID Retrofit Projects at Public Facilities

6.4.1 Action

Public facilities, including public schools, libraries, office buildings, parks, and commuter parking lots, present a unique opportunity for innovative stormwater management that controls runoff at its source. These facilities typically have extensive impervious rooftop and parking areas that generate large amounts of stormwater runoff. Newer facilities have dry or wet stormwater ponds that collect runoff, control peak stormwater flows and improve water quality before discharging runoff to local streams. Despite these controls, the large volumes of stormwater may still have a negative impact on streams. Older facilities may not have modern stormwater controls.

Under this action, the public facilities in the watershed will be retrofitted to include LID improvements to minimize and control the runoff from the parking lots and rooftops. The full range in LID practices, including biofiltration (rain gardens), manufactured biofiltration units, replacement of impervious paved surfaces with permeable pavers, grassed drainage swales, redirection of downspouts from the storm sewer system to rain barrels, drainage swales, or other onsite storage practices, will be evaluated and implemented as appropriate when these retrofit projects are implemented.

Manufactured bioretention facilities (e.g., Filterra, Stormceptor or others) were used to develop the costs for these improvements. These facilities collect, store and filter runoff through an engineered planting bed consisting of a vegetated surface layer (vegetation, mulch, ground cover), planting soil and an optional sand bed. Because of the low permeability of the soils in the Cub Run and Bull Run watersheds, the bioretention units must include an underdrain system to facilitate filtration and add storage volume. As discussed above, these manufactured units are used only to cost the projects in this watershed plan. The full range in LID improvements will be considered during the public information period and preliminary design for these projects.

This action focuses on public facilities first because the projects will be easier to implement, have higher visibility and enhance public outreach and education. Although alternative, privately owned facilities suitable for LID retrofit (business parks, industrial parks, commercial areas, churches, swimming and tennis clubs, etc.) may be available, the watershed plan does not commit county funds to construct and maintain LID stormwater controls on private property. However, other elements of the watershed management plan promote LID practices on private property and recommend the county consider incentives or cost sharing for LID retrofits on private property, particularly in watershed areas not served by stormwater controls or upstream of proposed regional ponds.

6.4.2 Strategy to Achieve Action

The proposed LID projects include 26 public facilities in the Cub Run and Bull Run watersheds. Conceptual designs for each site are based on topographic mapping, the storm drainage system, field surveys and digital aerial photography.

The cost estimates developed for this watershed plan use manufactured bioretention facilities since they provide an effective retrofit option. It is recognized that these may not be the most economical, desirable or effective retrofit option. During project implementation the existing drainage system, drainage problems and subsurface conditions will be evaluated. Future development plans will also be documented. Finally, outreach will be performed to ensure that the proposed modifications meet the needs of the facilities. As a result of these detailed evaluations, the final design will likely differ from the conceptual watershed plan design. The proposed facilities are listed in Table 6-31 and shown in Figure 6-19. The order in which the projects appear does not represent their priority or order of implementation.

Like traditional stormwater management facilities, LID practices require annual maintenance to remove blockages caused by leaves, sediment and other debris. They also require periodic maintenance to check the health of plantings and to replenish mulch as needed.

Cost to Implement Action

The estimated cost to implement the 26 LID retrofit projects is $3,402,000.

6.4.3 Watershed Benefits

LID facilities slow the rate of runoff, filter and remove pollution, and promote infiltration, thereby reducing the annual loading of total phosphorus and total nitrogen by 60 and 50 percent, respectively, from the area served. These facilities remove metals and organic compounds effectively. The associated flow reductions and water quality improvements will benefit the streams that receive stormwater runoff from these facilities. Since each facility serves a relatively small area (the total area served by all 26 facilities is 39 acres), however, the watershed-wide nutrient and peak flow reduction benefits are small.

A primary benefit in this action is each facility will be an opportunity to educate county residents about innovative stormwater controls such as bioretention and biofiltration facilities that they can use on their own properties. The program will also demonstrate Fairfax County's commitment to implementing these measures throughout the watershed and, in turn, improving stream conditions throughout the county.

6.5 Action – Address Health of Stream Segments Affected by Stream Erosion through Stream Restoration

6.5.1 Action

Numerous streams in the Cub Run and Bull Run watersheds exhibit stream erosion produced by changes in the stream flow from land-disturbing activities, including clear-cutting and development. This action addresses stream erosion through stream restoration projects.

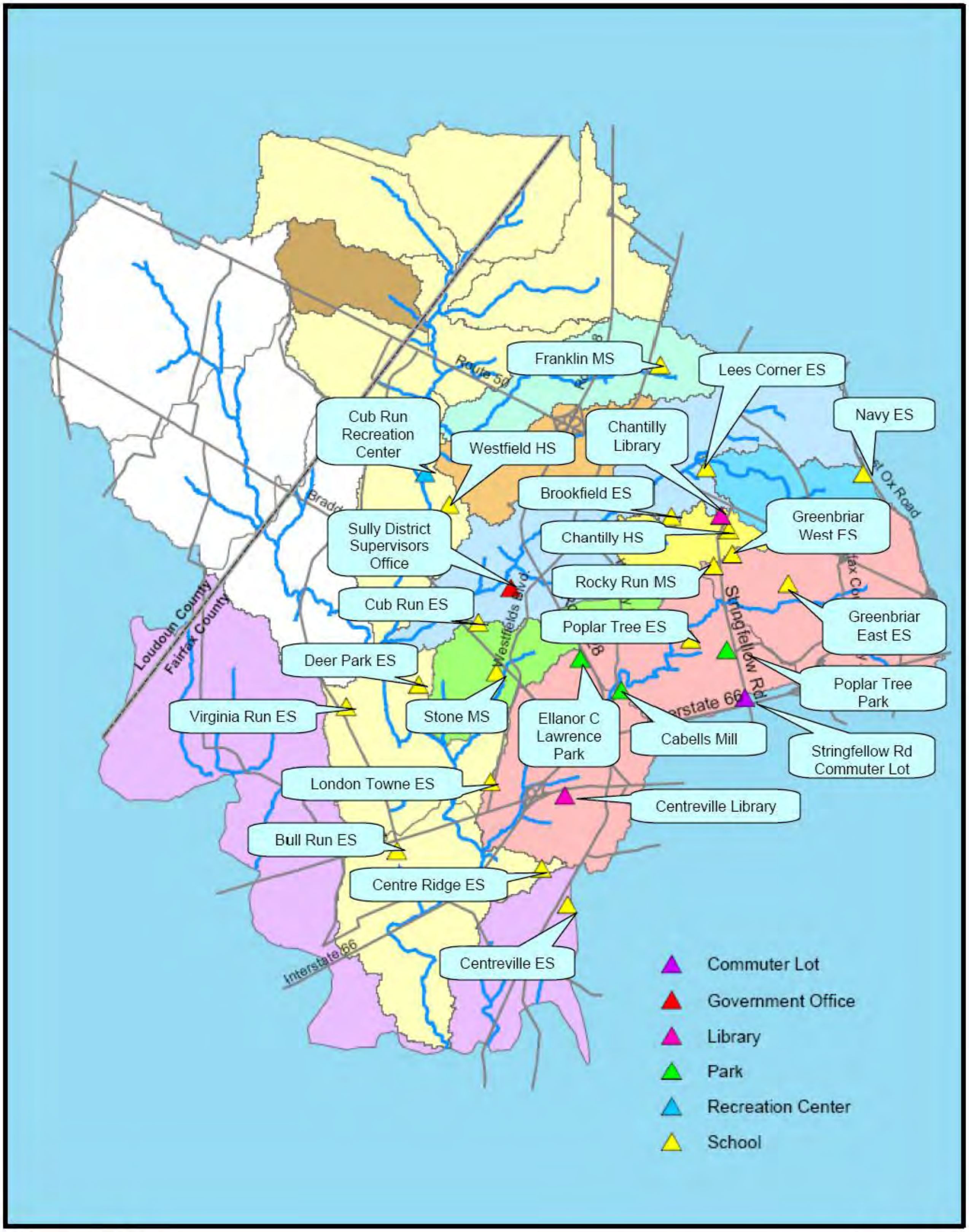


Figure 6-19
LID Retrofit Projects at Public Facilities

Table 6-31
Overview of LID Retrofit Projects at Public Facilities

Location	Conceptual LID Improvements* (Bioretention Units)	Drainage Area (Acres)	Estimated Project Cost
BR9801 - Centreville Elementary School	2	0.9	$79,000
CU9801 - Bull Run Elementary School	3	1.4	$121,000
CU9802 - Centre Ridge Elementary School	4	1.4	$131,000
CU9803 - London Towne Elementary School	2	0.7	$66,000
CU9804 - Centreville Library	4	1.6	$146,000
CU9805 - Ellanor C. Lawrence Playing Field Parking Lot	6	2.7	$234,000
CU9806 - Cabells Mill Parking Area	-	0.7	$72,000
CU9807 - Stringfellow Road Commuter Lot	6	2.9	$248,000
CU9808 - Poplar Tree Park Playing Fields Parking Lot	2	0.9	$72,000
CU9809 - Poplar Tree Elementary School	3	1.1	$102,000
CU9810 - Rocky Run Middle School	5	1.9	$174,000
CU9811 - Greenbriar East Elementary School	1	0.5	$43,000
CU9812 - Stone Middle School	3	1.6	$127,000
CU9813 - Deer Park Elementary School	4	1.8	$152,000
CU9814 - Virginia Run Elementary School	2	1.0	$85,000
CU9815 - Cub Run Elementary School	2	1.0	$79,000
CU9816 - Sully District Supervisor's Office	1	0.5	$43,000
CU9817 - Chantilly Library	5	2.0	$177,000
CU9818 - Chantilly High School	16	6.4	$577,000
CU9819 - Greenbriar West Elementary School	2	0.7	$65,000
CU9820 - Brookfield Elementary School	4	1.7	$150,000
CU9821 - Lees Corner Elementary School	3	1.1	$101,000
CU9822 - Navy Elementary School	2	0.6	$58,000
CU9823 - Westfield High School	4	1.5	$130,000
CU9824 - Cub Run Recreation Center	3	1.5	$127,000
CU9825 - Franklin Middle School	1	0.6	$43,000
Total	**87**	**38.7**	**$3,402,000**

* *Conceptual LID Improvements represent the number of manufactured bioretention units included as the basis for developing construction cost estimates. Each site will be further evaluated for the full range of LID retrofit options including bioretention rain gardens, porous pavement, grassed drainage swales, etc., at the preliminary design stage. The order in which projects are listed does not represent their priority or the order in which they will be implemented.*

6.5.2 Strategy to Achieve Action

The selected stream restoration reaches target the watershed streams most affected by stream erosion. Section 7 documents the implementation schedule for these projects.

Stream Restoration Reaches

The first step in selecting the restoration reaches was to identify those watershed reaches most affected by erosion. Stream bank erosion inventory data and bank stability indices from the Fairfax County Stream Physical Assessment Study were the primary selection criteria since these data correlate best with conditions observed in the field and photographs of the stream. These data were supplemented with field data and data collected from the community.

The reaches with the most severe stream erosion were grouped into contiguous stream restoration projects.

The selected Cub Run and Bull Run Watershed Management Plan stream restoration projects are listed in Table 6-32 and shown in Figure 6-20. Appendix C provides additional details on these projects.

The 22 projects include 103,000 feet (19.5 miles) of stream or 19 percent of the stream segments included in the Fairfax County Stream Physical Assessment Study.

Table 6-32 includes a relative ranking based on the existing stream erosion conditions. The high-ranked projects have the most severe stream erosion. This priority ranking and other information such as the stability of the upstream development and location in the watershed were used to phase the restoration projects in the watershed plan as presented in Section 7. The order in which the projects are listed in this section does not represent the priority or implementation order.

The schedule for restoring these reaches will consider additional factors besides the severity of existing erosion.

Stream restoration should not be performed where the flow velocity and peak flows are uncontrolled. Restoration in these areas has a high probability of failure. Selection and prioritization of the stream restoration projects will be phased with the other actions in the watershed plan to ensure that flow control actions are implemented before stream restoration projects.

Stream restoration should generally be performed within contiguous areas in the watershed to provide the greatest benefit and, where possible, upstream to downstream. As an example, restoration within Flatlick Branch may best be performed within several years of each other.

Table 6-32
Summary of Stream Restoration Projects

Project	Stream	Location	Length (Feet)	Cost	Priority Score*	Description
BR9201	Bull Run West Tributaty	Below quarry	4A20	$1,602,000	3	Bank stability scores of 3 and 4 with significant buffer impacts. SCI of 2.2. Private property.
CU9201	Lower Cub Run	Within Bull Run Regional Park south of I-66 to Bull Run Confluence	10,030	$3,570,000	8	Stream erosion inventory lines with impact scores up to 7. Significant reaches have bank stability scores of 3 or less and sbeam buffer impacts. Within Northern Virginia Regional Park Authority Bull Run Regional Park
CU9202	Lower Cub Run and mu1am ed bibutaries	Between Compton Road and Route 66	10A00	$2,884,000	5	Various segments with sbeam erosion inventories, stream bank stability 2 though 4, and sbeam buffer impacts. Two head cuts and SCI scores in some reaches down to 2.0. Mostly in private property with some sbeam valley parkland.
CU9203	Big Rocky Run	Upstream from Cub Run Confluence and downsbeam from Route 29.	1,550	$831,000	6	Stream bank inventory lines, stability scores of 3 and 4 and buffer impacts. SCI of 2.9. Within sbeam valley parkland.
CU9204	Big Rocky Run Tributaty	The Meadows and Cenbe Ridge -upsbeam from I-66	3A70	$1,302,000	7	Bank stability scores of 3 and 5, erosion invent01y lines with impact score up to 9, and deficient buffers. SCI scores of 2.9 and 2.1. Partially within parkland and partially within private property.
CU9205	Big Rocky Run	Below Awbrey Patent Drive and upstream from Route 29.	1,390	$720,000	4	Bank stability scores of 3 with buffer impacts. Within Big Rocky Run Stream Valley Park.
CU9206	Big Rocky Run Tributary	Below Braddock Road	740	$472,000	4	Small sbeam with bank stability scores of 3 and minor buffer impacts. Area includes a dump that will be addressed. Mostly within stream valley park.

Table 6-32
(continued)
Summary of Stream Restoration Projects

Project	Stream	Location	Length (Feet)	Cost	Priority Score*	Description
CU9207	Big Rocky Run	Between Route 28 and Braddock Road	2,450	$1,101,000	5	Sh·eam bank stability scores of 3 and 4 tlu·oughout. Within FCPA sh·eam valley parkland.
CU9208	Big Rocky Run Tributruy	Fair Lakes	2,680	$1,085,000	4	Sh·eam bank stability of 3 and 4, some sh·eam erosion invent01y lines ru1d one head cut. Partially in Stream valley park and partially private property (townhouse development)
CU9209	Big Rocky Run Tributa ty	Oaks Chase near Timber Oaks Trail	530	$391,000	3	Stream bank stability scores of 3 and deficient bu ffers. Private property.
CU9210	Big Rocky Run Tributruy	Upstream ru1d downstrerun from Ox Hill Road. Upsh·eam from Route 50.	2,310	$964,000	6	Sh·eam brulk stability of 2 ru1d deficient buffers. Private property (HOA).
CU9211	Nliddle Cub Run main stem ru1d tributaries	Middle Cub Run main stem and selected tributru·ies – from Flatlick Branch to just below Route 29.	29,810	$10,346,000	6	Various reaches with strerun erosion invent01y lines with impa ct scores up to 10 ru1d low sh·eam brulk stability scores. Head cuts and deficient buffers. Mostly in FCPA Cub Run Sh·eam Valley Park with some private property impacts.
CU9212	Round Lick Branch	Upstrerun from Sully Park Drive	1,430	$735,000	3	Strerun brulk stability scores of 3 ru1d 4 with some deficient sh·eam bu ffers. Within stream valley park.
CU9213	Flatlick Brru1ch	Upstrerun ru1d downsh·eam from Stonecroft Boulevru·d	5,040	$2,004,000	7	Various erosion ru1d obstruction inventory points and low sh·eam brulk stability. Four head cuts ru1d deficient buffers. Mostly in FCPA parklru1d with some private property.

Table 6-32
(continued)
Summary of Stream Restoration Projects

Project	Stream	Location	Length (Feet)	Cost	Priority Score *	Description
CU9214	Flatlick Branch	Between Route 50 and Route 28	11,910	$3,773,000	4	Sheam shows various sheam erosion invent01y lines and low sheam bank stability scores and stream buffer impacts. Mostly witlun FCPA Flatlick Branch Sheam Valley Park with some private property.
CU9215	Oxlick Branch	Upstream from Alder Woods Drive Fair Oaks Es tates	1,090	$578,000	5	Bank stability scores of 3 and 2 with stream bank erosion invent01y score of 4. Deficient buff er throughout reach. Some of area is parkland and remainder is privately owned byHOA.
CU9216	Flatlick Branch Tributary	Franklin Glen	1,690	$777,000	5	Small tributary witli erosion inventory lines witl1impact score of 5 and bank stability scores of 3 and 4. SCI = 2.4 and deficient buff ers tluoughout reach. Private property (HOA).
CU9217	Flatlick Brandi Tributruy	Downsheam from Oxon Road to existing lake.	1,500	$714,000	4	Sheam bank stability of 3 and 2 witli sheam buff er impacts. SCI= 2.2. Private property.
CU9218	Cub Run, Sclmeider Brandi and Cain Bratich	Cub Run including lower read1es of two hibutaries near Pleasant Valley.	4,660	$1,682,000	6	Sh·eam has numerous erosion inventory lines with high impact. In Cub Run Strerun Valley Park.
CU9219	Cain Branch	Upstream from Route 50. Upsheam atid downsheam from Avion Parkway.	2,080	$973,000	6	Reach includes stream erosion inventory lines, and deficient buff ers Huoughout tlie project. Located on private property. SCI = 2.9
CU9220	Cain Branch	Upsheam from Route 28 atid downstream from Centreville Road.	1,320	$693,000	4	Erosion inventory line witli impact score of 4 atid deficient buff er on right batik Witlun Sully Park.

Table 6-32
(continued)
Summary of Stream Restoration Projects

Project	Stream	Location	Length (Feet)	Cost	Priority Score *	Description
CU9221	Dead Run Tributaty	Upsheam from Stonecroft Boulevru·d.	2,540	$1,039,000	6	Sbeam has stability rating less than 3, erosion inventory line with impact score of 5, and nwnerous obstructions. Located on private property near Dulles Airport. SCI= 2.6
Total			103,040	$38,236,000		

*Projects are provided a priority rating score that varies from 1 to 10 based on the severity of the existing stream erosion. A 10 is a high priority restoration reach and 1 is a low priorihJ restoration reach. The priority rating score does not indicate the implementation order.

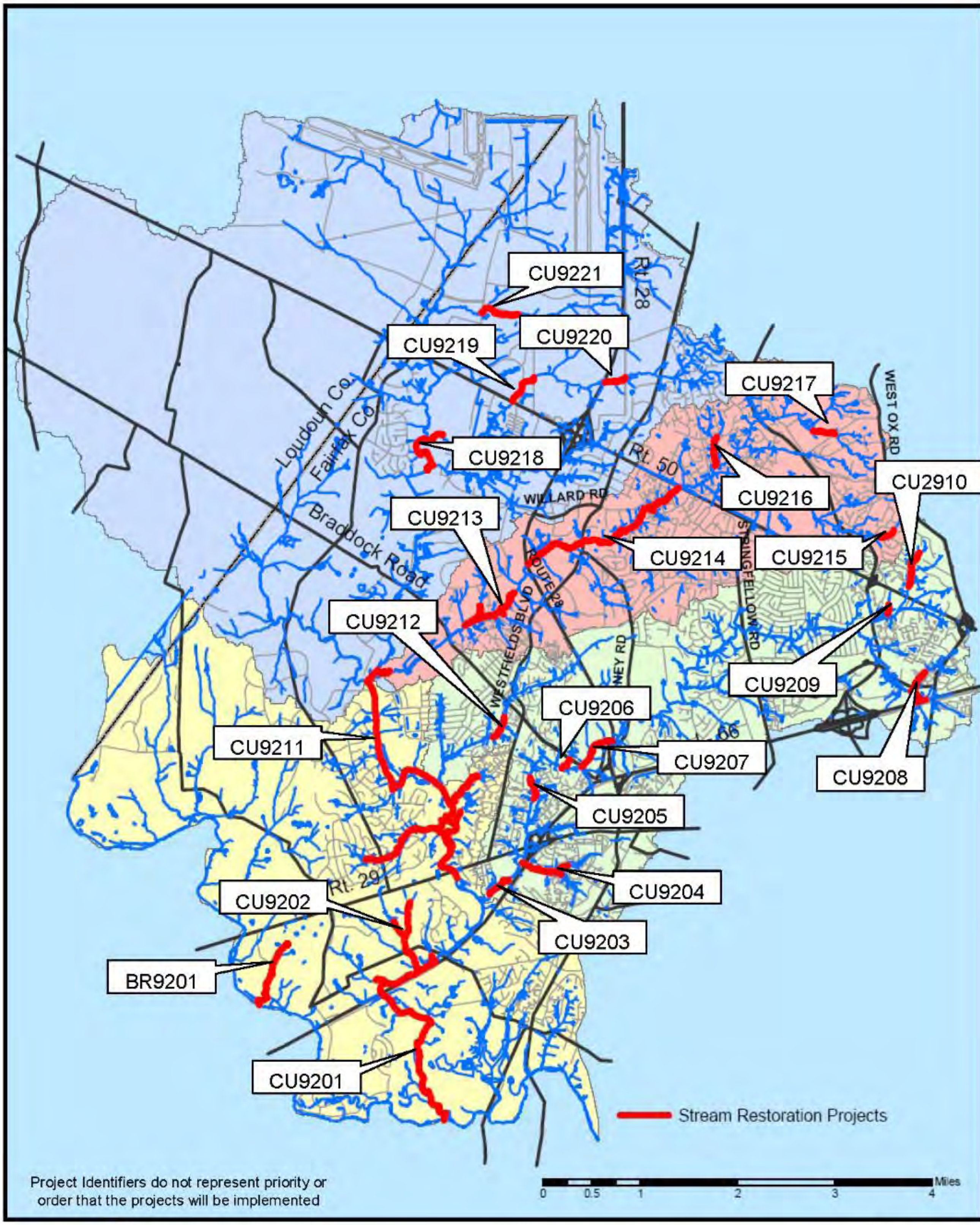


Figure 6-20
Location of Stream Restoration Projects in the Cub Run and Bull Run Watersheds

Finally, stream restoration should not be performed downstream from areas where significant development will occur. Fairfax County Public Facilities Manual and other policies require stormwater facilities to control runoff from both existing and new development. Watershed plan actions and policies in this water plan would enhance stormwater control. Loudoun County requires similar stormwater controls. However, based on historical evidence these actions will likely not totally mitigate stream impacts of this development. CDM recommends that the latter years of the watershed plan include provisions to restore additional reaches. This will ensure that funding will be available to address possible additional stream erosion conditions.

Project Description

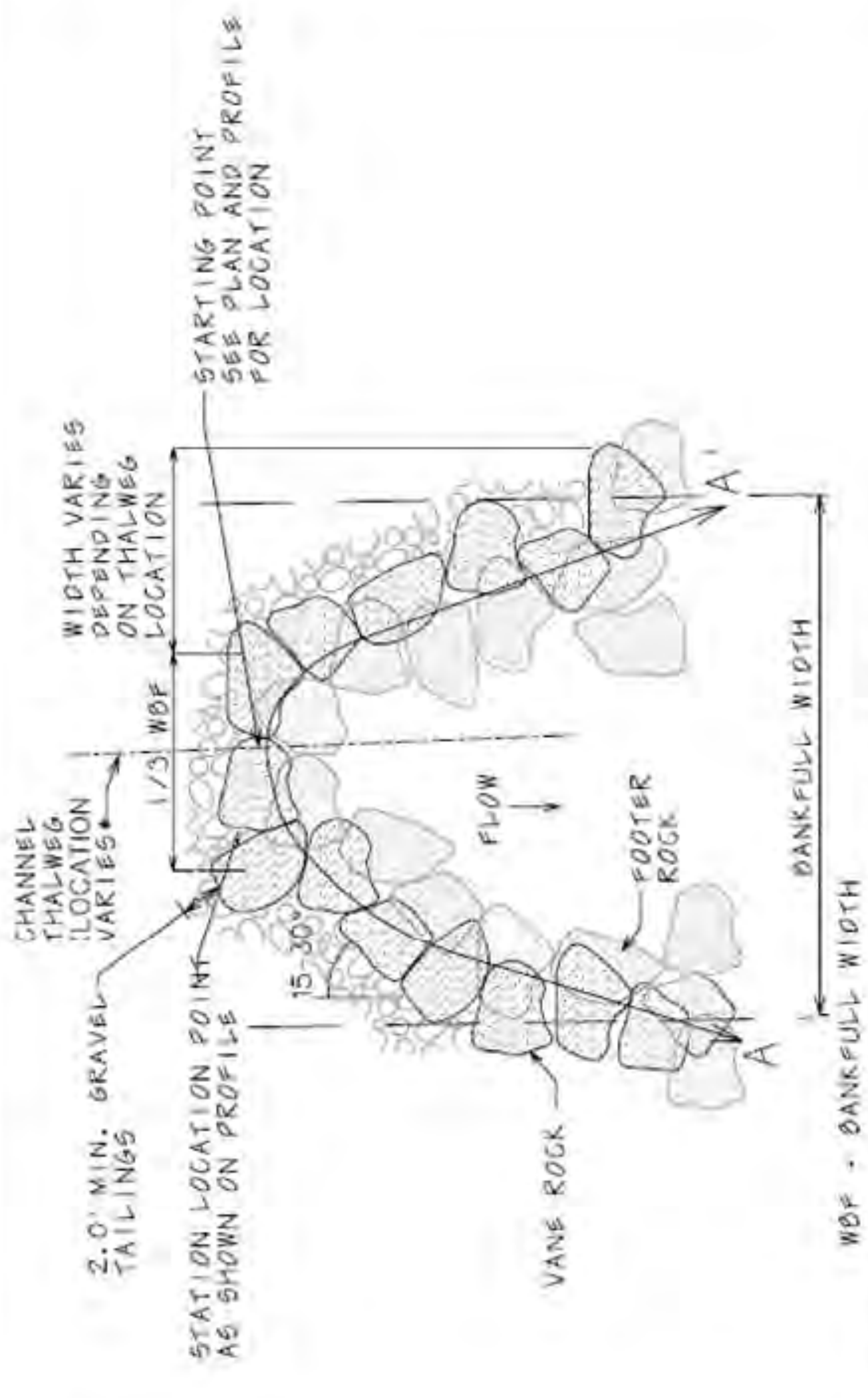
Restoration will focus on bioengineering techniques to reduce its visual and construction impacts. Hard armoring will be used only when required to protect man-made structures threatened by stream erosion.

The following provides a technical discussion on the restoration project improvements. These improvements will:

- Prevent further down-cutting of the streambed and raise the invert of the stream channel where appropriate
- Improve the stream buffer
- Address bank erosion by directing the flow and providing stable meander geometries
- Address stormwater outfalls within the project reaches
- Reconnect stream with floodplain to restore wetland systems and use floodplain storage effectively to reduce peak flows and nutrient loads

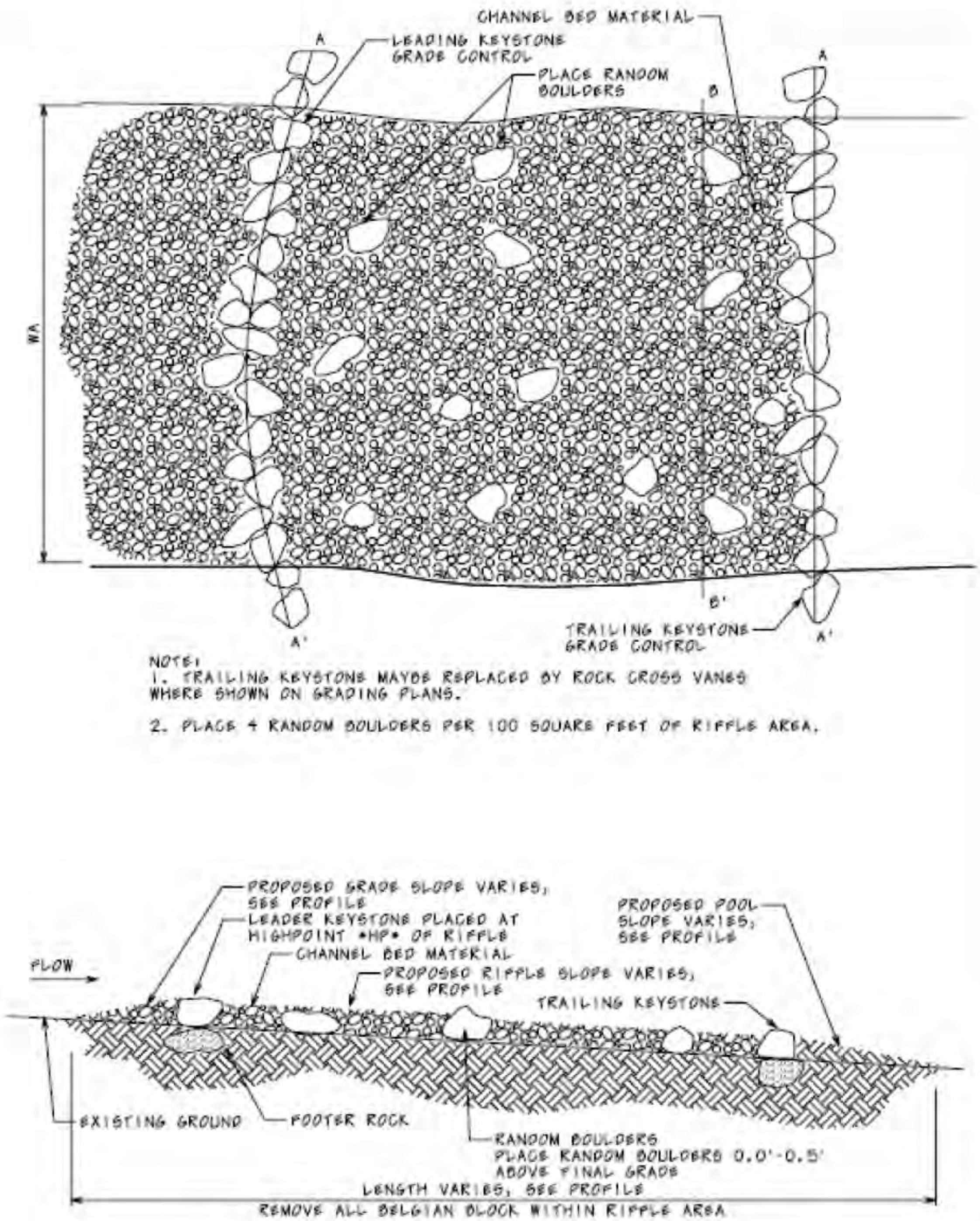
The above modifications together will improve the overall stream habitat within the restoration reaches.

Channel incision will be addressed using grade control structures to create a barrier to down-cutting and riffle aggradation structures, to accumulate bed load and raise the invert of the stream channel. This will connect the streams to the floodplain and rejuvenate wetland systems. The restoration will recognize road culvert and utility crossings elevations, maintain or enhance higher-quality pool classes, and establish high value riffle, run and/or glide habitats. These measures control future down-cutting and restore the streams' connection to the floodplain without significant tree removal or floodplain excavation. Controlling the grade at one location will prevent further down-cutting and promote sediment deposition in upstream reaches while reducing sediment transport to downstream reaches. Grade control structures will likely be incorporated with other modifications to improve riparian buffer, control bank erosion, address channelization and restore/enhance instream habitat. Figures 6-21 and 6-22 provide typical construction details for grade control structures.



Implemented to raise the stream bed and prevent further downcutting

Figure 6-21
Rock Cross Vane Plan View



Implemented to raise the stream bed and prevent further downcutting

Figure 6-22
Plan and Profile Riffle Structure
Used to Control Channel Incision

The condition of the riparian buffer near the streams within the restoration reaches will be addressed through the planting of native woody riparian vegetation, and enhanced by suppressing non-native invasive plants and eliminating mowing. Within stream valley parks the optimal minimum average width of the area for riparian restoration and/or enhancement is 100 to 200 feet from the stream banks. Outside the stream valley parkland, the riparian restoration will be the maximum width possible as limited by site conditions.

Bank erosion will be addressed through a combination of grade control structures as described above, in addition to limited areas of boulder toe protection (e.g., in proximity to infrastructure), root wad bank treatments, live branch layering and similar bioengineering approaches to stabilize banks. In-channel structures, such as J-hook, log and cross vanes, will be constructed to increase channel stability and improve aquatic habitat. These in-channel structures provide additional benefits, including flattening the stream profile and arresting further scouring of the streambed. Typical construction details for these types of control structures are provided in figures 6-23 through 6-29. These structures will be incorporated in a stream sinuosity pattern in dynamic equilibrium with existing and future sediment transport, base flow and storm flow discharges.

Channelization will be addressed through restoration of stable stream plan and profile geometries. Existing and future bank full discharge, sediment bedload, width, depth, stream profile and sinuosity pattern will be used to design a channel pattern capable of maintaining a dynamic equilibrium. This may include excavation of a new channel alignment and/or modification of portions of the channelized reach to re-introduce sinuosity.

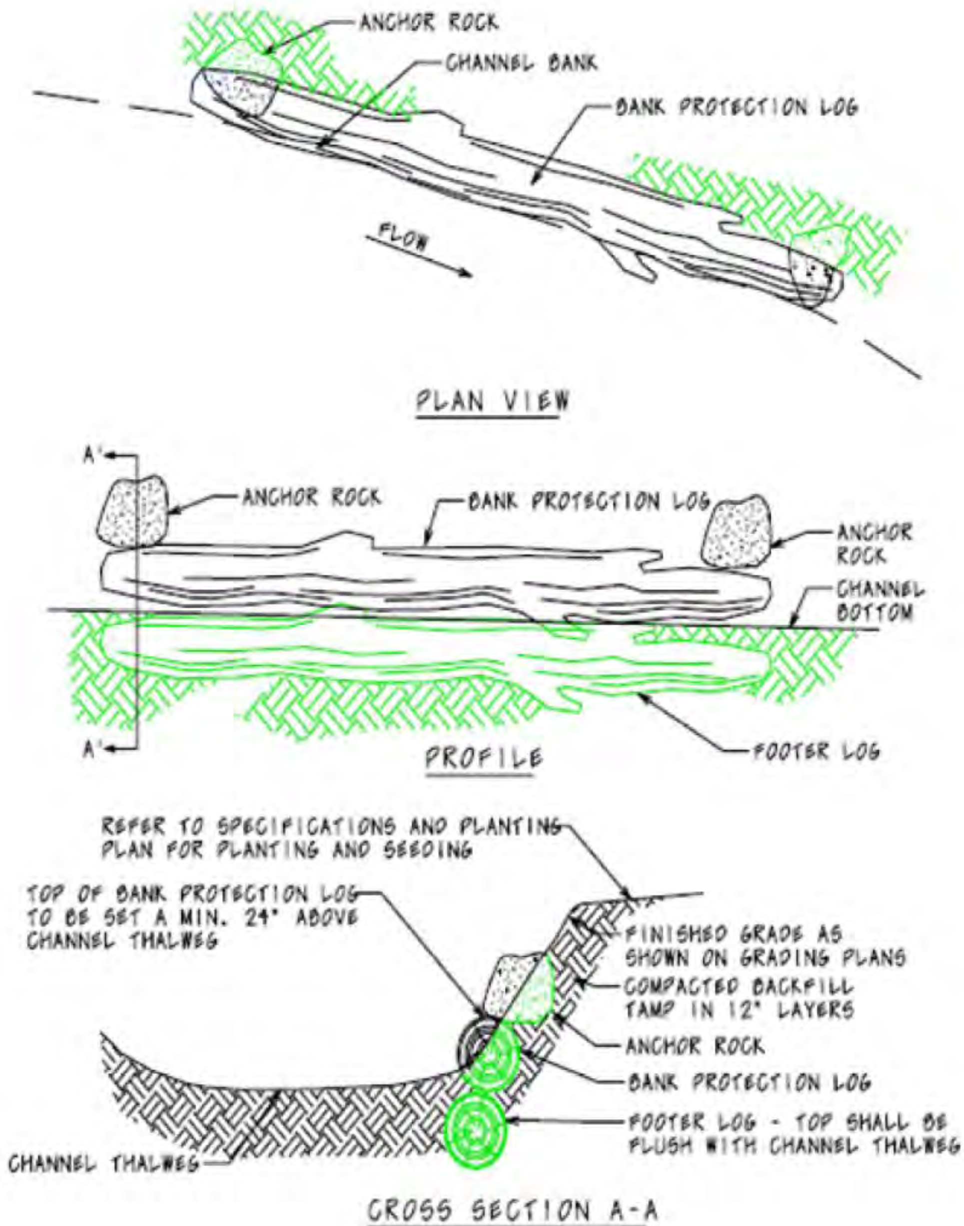
Stormwater outfalls within the stream restoration reach will be evaluated for the effectiveness of the existing energy dissipation and flow-spreading devices. The channels receiving the flow from these outfalls will be restored where necessary, as will the buffer. Plunge pools and riparian wetland restoration will be evaluated at the stream outfall locations. See Figure 6-37 for an example of the potential improvements to be made at these stormwater outfalls.

Instream habitat will be addressed largely through stabilizing eroding banks, relocating central bars and other sediment deposits, and installing instream structures to increase sediment transport along the thalweg and scour fine sediments in riffle areas. Restoring near-channel riparian buffer will also provide detrital input, woody debris, shade and near bank cover to improve stream habitat conditions.

Figures 6-30 and 6-31 provide samples of stream segments before and after implementation of the proposed stream restoration alternatives.

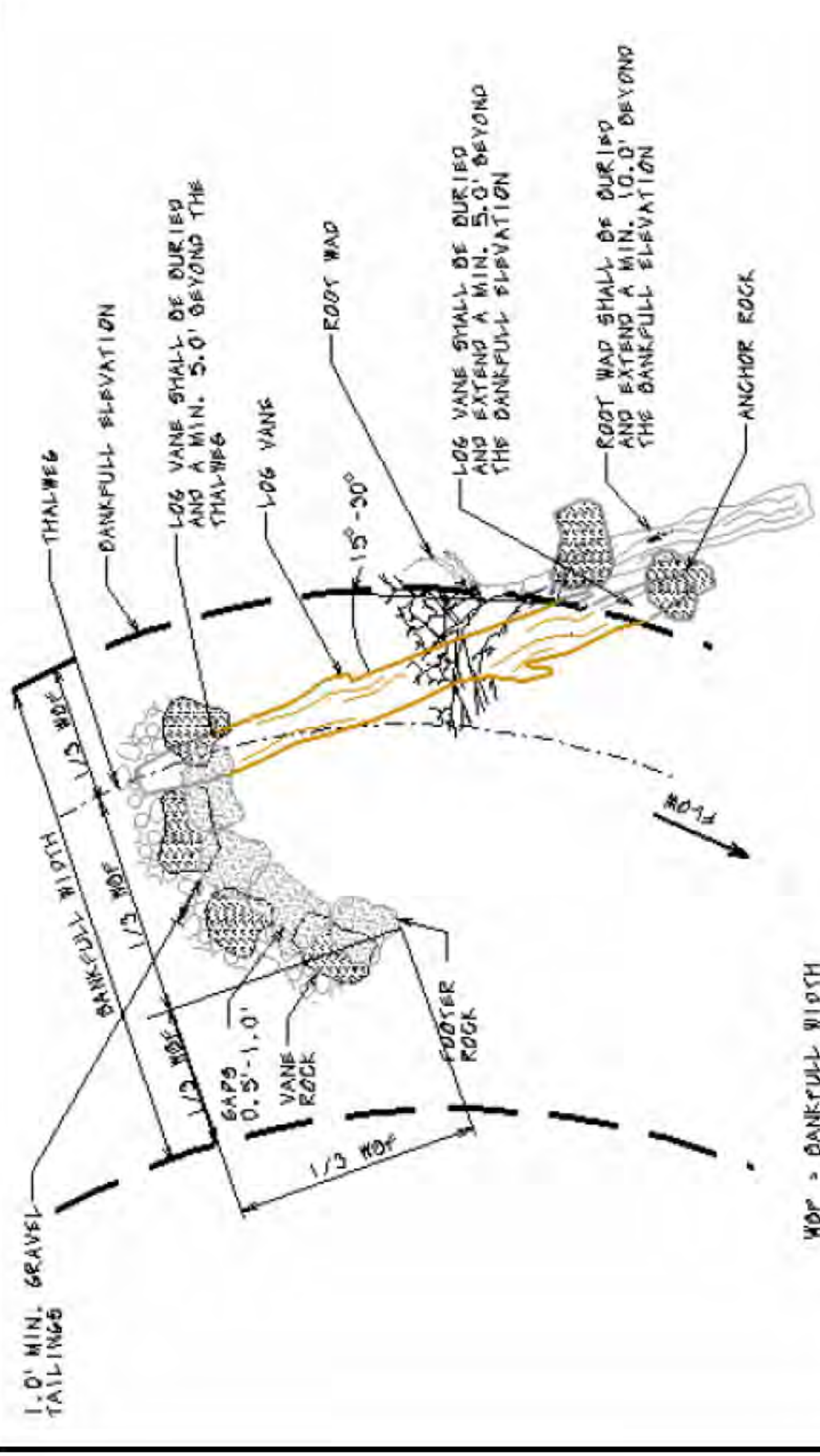
Cost to Implement Action

Cost estimates to implement the 22 projects are presented in Table 6-32. The total cost is $38.2 million, averaging $371 per linear foot. Accounted for in the cost is that restoration will be performed for selected portions of the identified project.



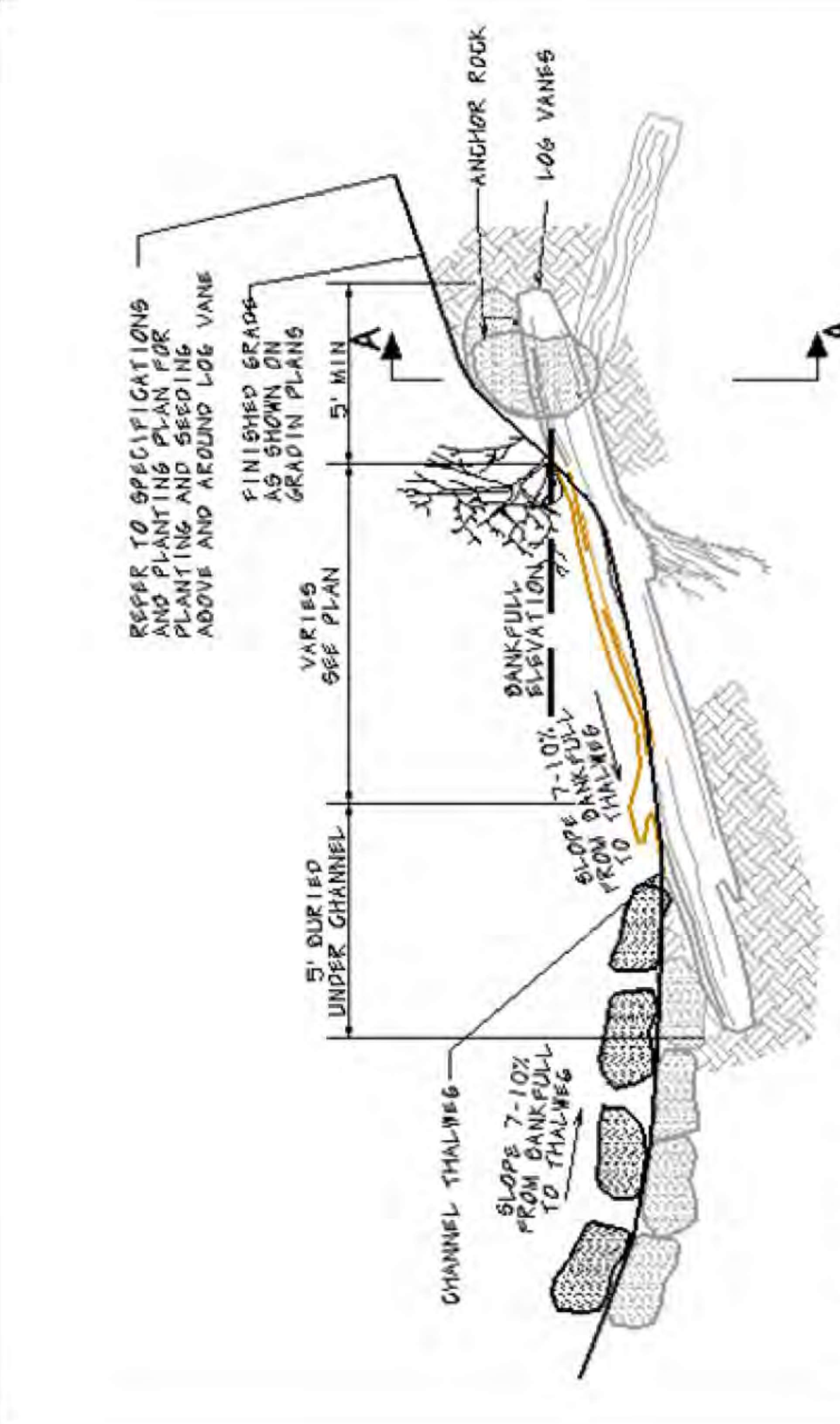
Implemented to control stream bank erosion

Figure 6-23
Plan and Profile Riffle of Log Bank Protection



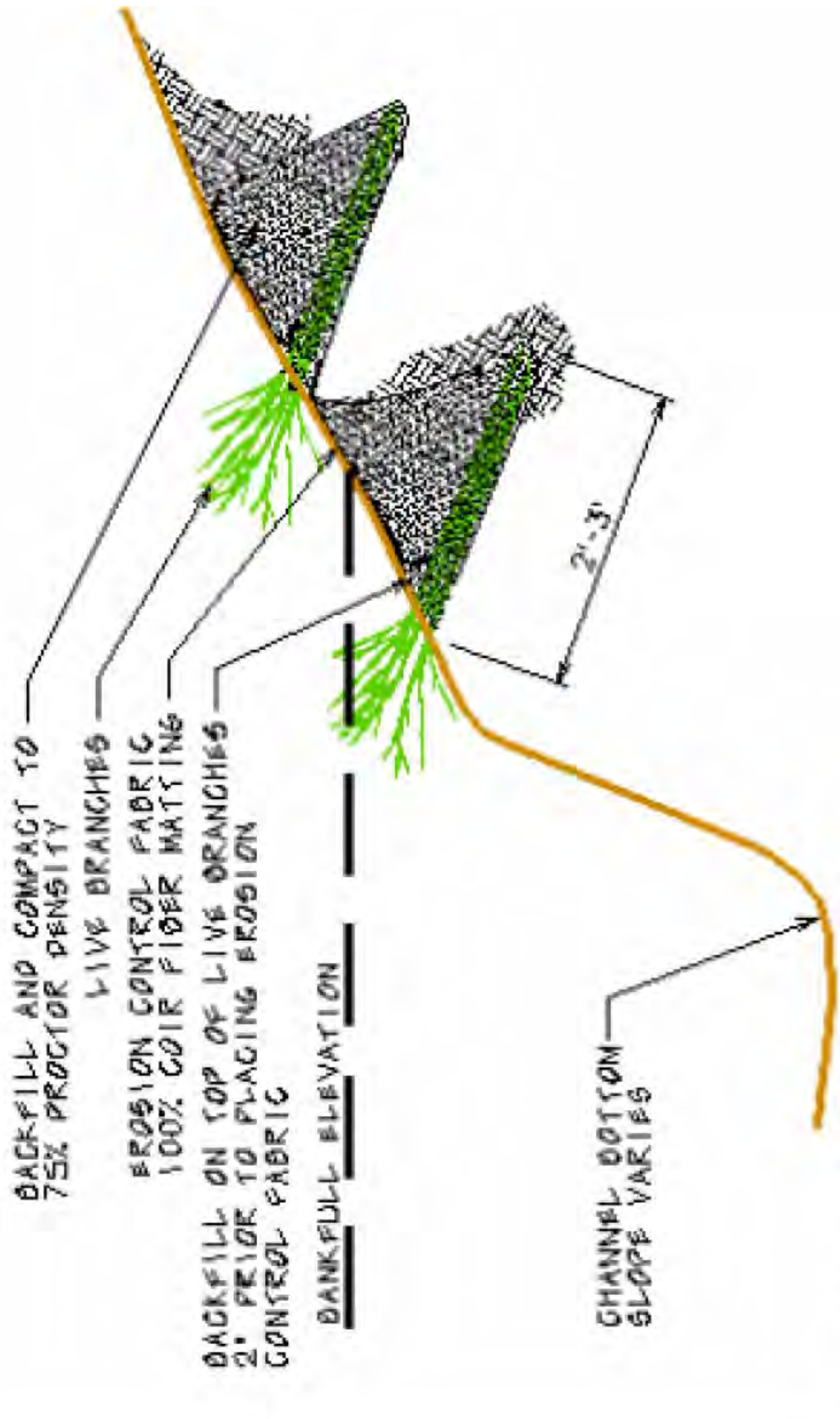
Implemented to prevent stream bank erosion at bends

Figure 6-24
Root Wad/Log "J" Hook Vane Plan View



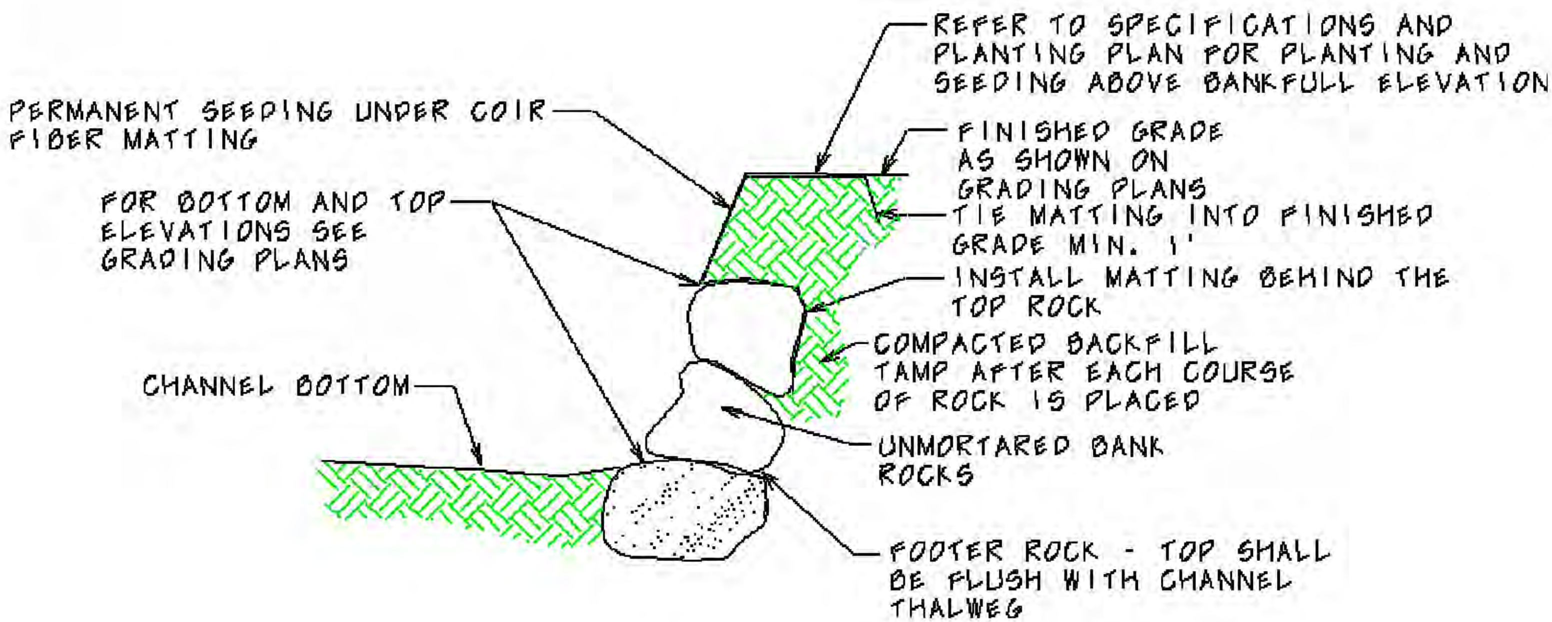
Implemented to prevent stream bank erosion at bends

Figure 6-25
Root Wad/Log "J" Hood Vane Profile



Implemented to control stream bank erosion

Figure 6-26
Live Branch Layering Cross Section



Implemented to stabilize the stream bank

Figure 6-27
Boulder Bank Stabilization Section

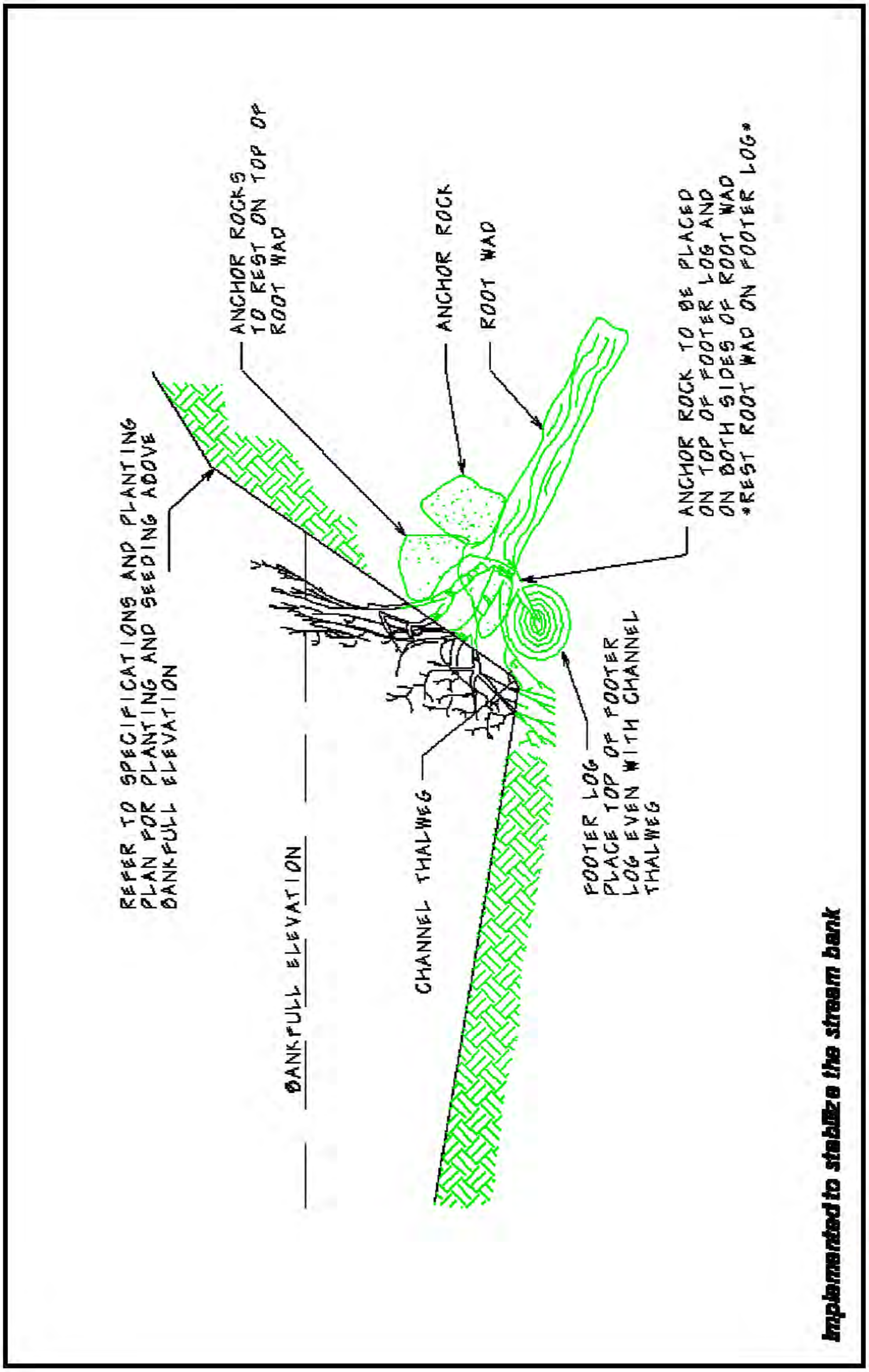
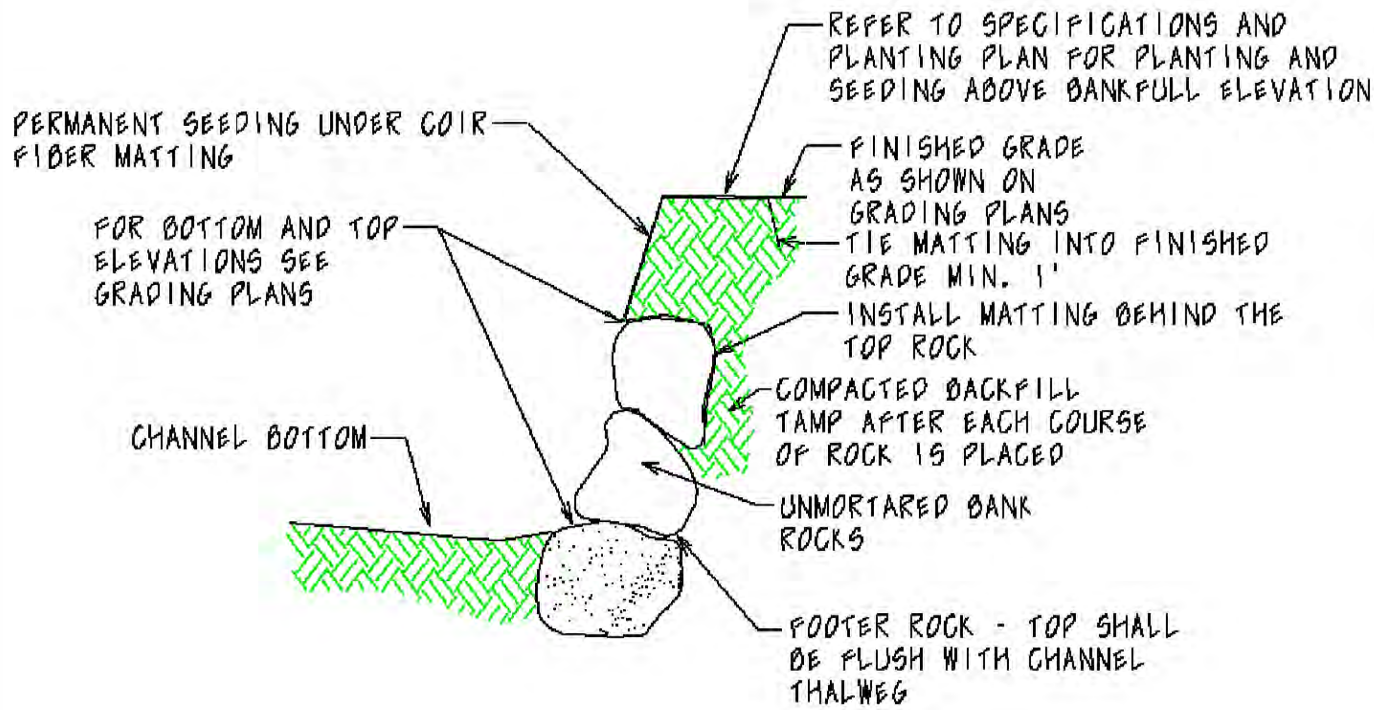


Figure 6-28
Root Wad Revetment Stream Bank Protection



Implemented to stabilize the streambank

Figure 6-29
Live Branch Layering Combined with
Boulder Toe Stabilization Cross Section

Before Restoration

Spring Branch Stream Restoration

After Restoration

Before Restoration

Minebank Run Stream Restoration

After Restoration

Figure 6-30
Photographs of Streams Before and After Restoration

Before Restoration

Kinqwood Stream Restoration

After Restoration

Before Restoration

Moore's Creek Stream Restoration

After Restoration

Figure 6-31
Photographs of Streams Before and After Restoration

6.5.3 Watershed Benefits

The stream restoration projects provide many benefits to the streams in the watershed, including:

- Improve the health of the local streams
- Improve the habitat available for the animals that live in the streams by eliminating severe erosion and resulting sediment deposition
- Reduce sediment and nutrients in the streams. Much of the sediment during high flow rainfall events comes from erosion of the streams banks. Many of the nutrients in the stream discharge are attached to the stream sediment. Therefore, reducing stream erosion also serves to reduce nutrient loads from the watershed. According to the Virginia Potomac and Shenandoah River Tributary Strategy, stream restoration removes 0.0035 pound of phosphorus, 0.02 pounds of nitrogen and 2.55 pound of sediment per year per foot of stream restoration. The projects remove 360 pounds of phosphorus, 2,061 pounds of nitrogen and 262,000 pounds of sediment per year.
- Reduce future erosion
- Improve the functioning of the wetland areas adjacent to the stream banks
- Improve aesthetics of the streams by removing eroded stream banks
- Eliminate existing areas where trees have fallen into the streams creating blockages and prevent future occurrences
- Protect existing infrastructure
- Reconnect the channel with its floodplain to dissipate excessive stormwater flows

6.6 Action – Address Stormwater Runoff from Neighborhoods without Stormwater Controls

6.6.1 Action

Four residential neighborhoods in the Cub Run watershed, comprising approximately 1,500 acres and 4,280 single-family residences, were constructed before Fairfax County required water quality controls for new development and therefore do not have stormwater controls:

- Greenbriar/Birch Pond
- Brookfield
- Country Club Manor

- Pleasant Valley

See Section 2.5.3 for additional information and background on these neighborhoods. Table 6-33 summarizes these neighborhoods and Figure 6-32 shows their location.

Table 6-33
Major Developed Areas in the Cub Run Watershed without
Peak Flow or Water Quality Controls

Community	Total Area (Acres)	Total Number of Parcels	Subwatershed
Greenbriar and Birch Pond – CU9911	614	1,870 Single Family Residential 3 Schools	Big Rocky Run Frog Branch
Brookfield CU9912	326	848 Single Family Residential Townhouse development and some commercial	Flatlick Branch Frog Branch
Country Club Manor CU9910	353	1,052 Single Family Residential 1 School	Round Lick Branch and Middle Cub Run
Pleasant Valley CU9913	193	511 Single Family Residential	Upper Cub Run
Total	1,486	4,281 Single Family Residential Parcels	

Most of the Cub Run and Bull Run watersheds were developed after the county implemented stormwater control requirements. As a result, almost all areas of the watersheds, in both Loudoun and Fairfax counties, have water quality and peak flow controls. These four neighborhoods are therefore ideal targets for new controls. Implementing these stormwater controls will improve the water quality, control the peak flow rates and control erosion in the streams receiving runoff from these neighborhoods.

6.6.2 Strategy to Achieve Action

These neighborhoods were reviewed to identify opportunities for stormwater controls that mitigate the impact of runoff on receiving streams. The following sections document various stormwater control opportunities for these neighborhoods. Figures 6-33 through 6-36 provide detailed views of these areas and the identified stormwater retrofit opportunities. Tables 6-34 through 6-37 summarize alternative stormwater projects to be implemented in and near these neighborhoods.

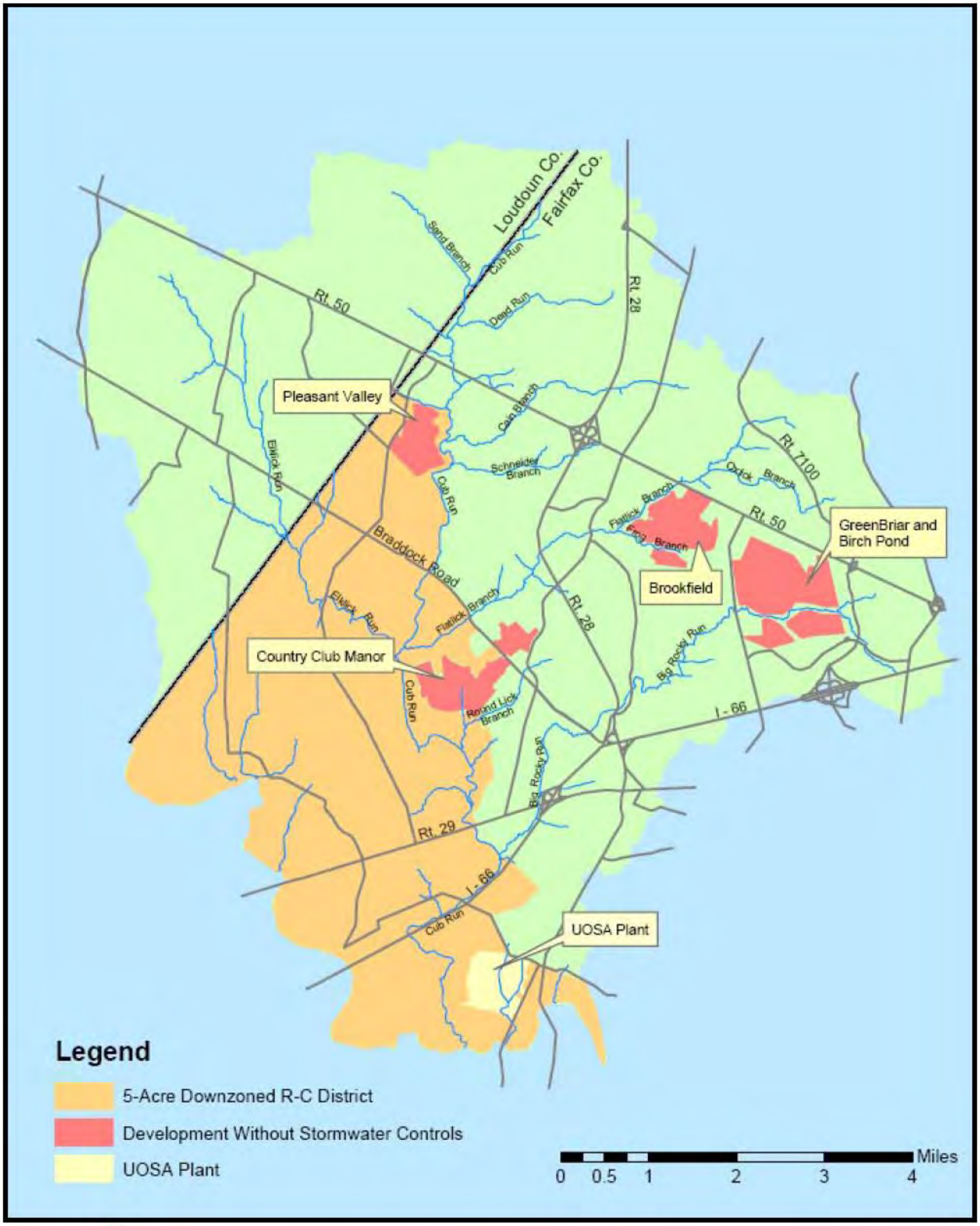


Figure 6-32
Location of Neighborhoods Without Stormwater Controls

LID Retrofit for County Facilities

LID retrofit projects for Fairfax County facilities in the watersheds were identified in Section 6.4. Fairfax County facilities identified as LID retrofit projects within each neighborhood are listed below:

Greenbriar/Birch Pond	Greenbriar East Elementary School Greenbriar West Elementary School Chantilly High School Rocky Run Middle School
Brookfield	Brookfield Elementary School Country
Club Manor	Deer Park Elementary School Pleasant Valley
(None)	

Promote LID Projects for Private Residential and Commercial Properties

These neighborhoods will be targeted for public information programs and other outreach that promote LID construction, such as bioretention by property owners on residential and commercial properties.

New Dry Ponds and Wet Ponds

The areas near these neighborhoods were evaluated as locations for new dry ponds or wet ponds to control the runoff. Homes in these areas abut the Chesapeake Bay Preservation Ordinance Resource Protection Areas, the 100-year flood plain and Fairfax County Park Authority parkland. Furthermore, the areas are densely developed with little open space. These constraints eliminate the possibility of constructing new ponds with sufficient storage and stormwater control benefit to offset construction costs and impacts on neighborhoods, parkland, and critical resource and habitat areas.

Upstream Culvert Retrofit Projects

Upstream culvert retrofit projects consist of constructing weirs and low-flow controls upstream of roadway culverts to provide water quality and peak-flow controls. These structures store water in the floodplain upstream from the culverts and release it slowly after a storm event. They usually store a small amount of water and are typically limited to drainage areas of less than 100 acres. Such projects have been recommended in other watershed plans as effective, low-impact and low-cost stormwater controls in headwater areas.

The drainage systems within these older neighborhoods consist entirely of closed pipe conduit systems with no opportunity for upstream culvert retrofit projects.

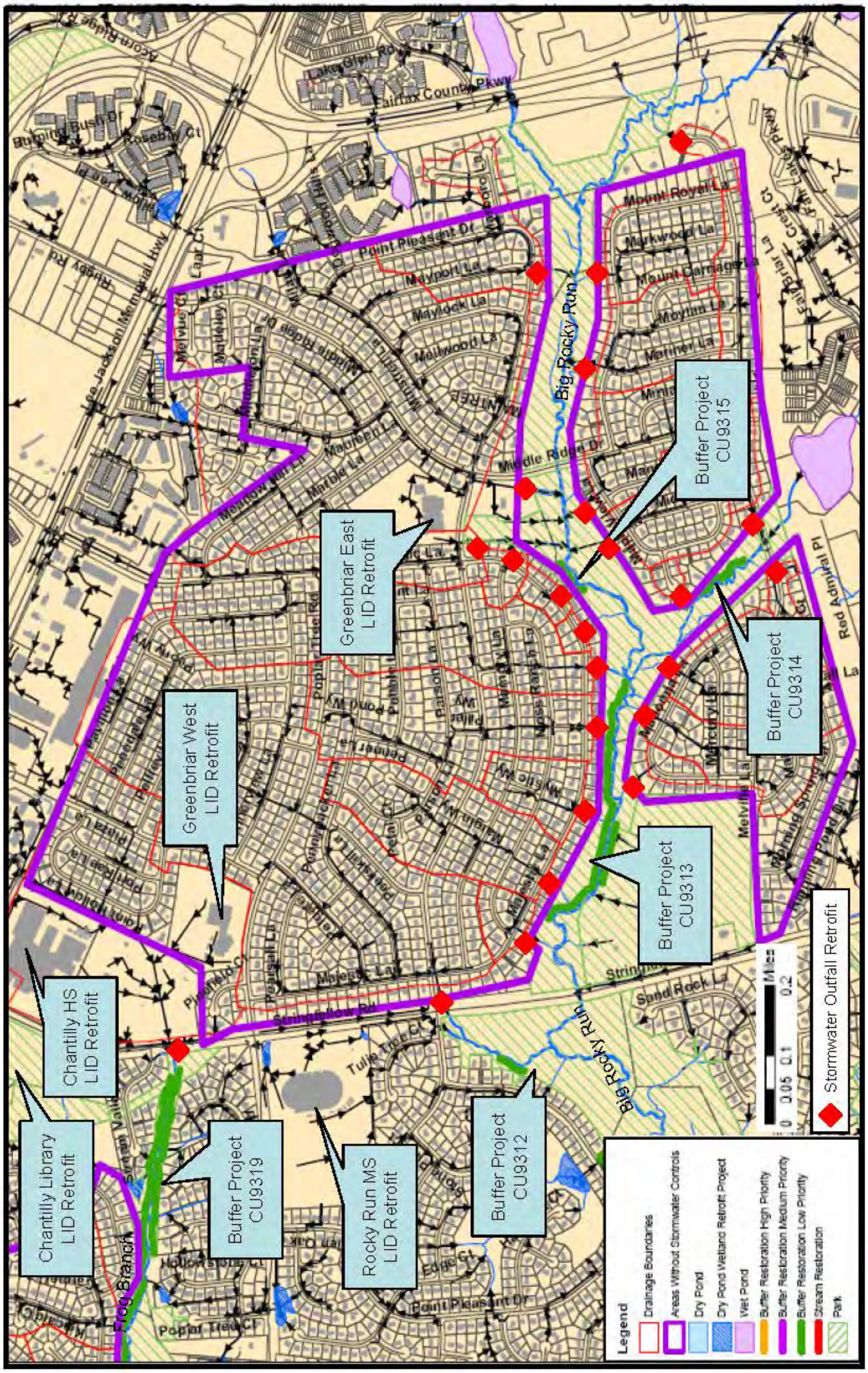


Figure 6-33
Summary of Proposed Stormwater Controls Near Greenbriar and Birch Pond

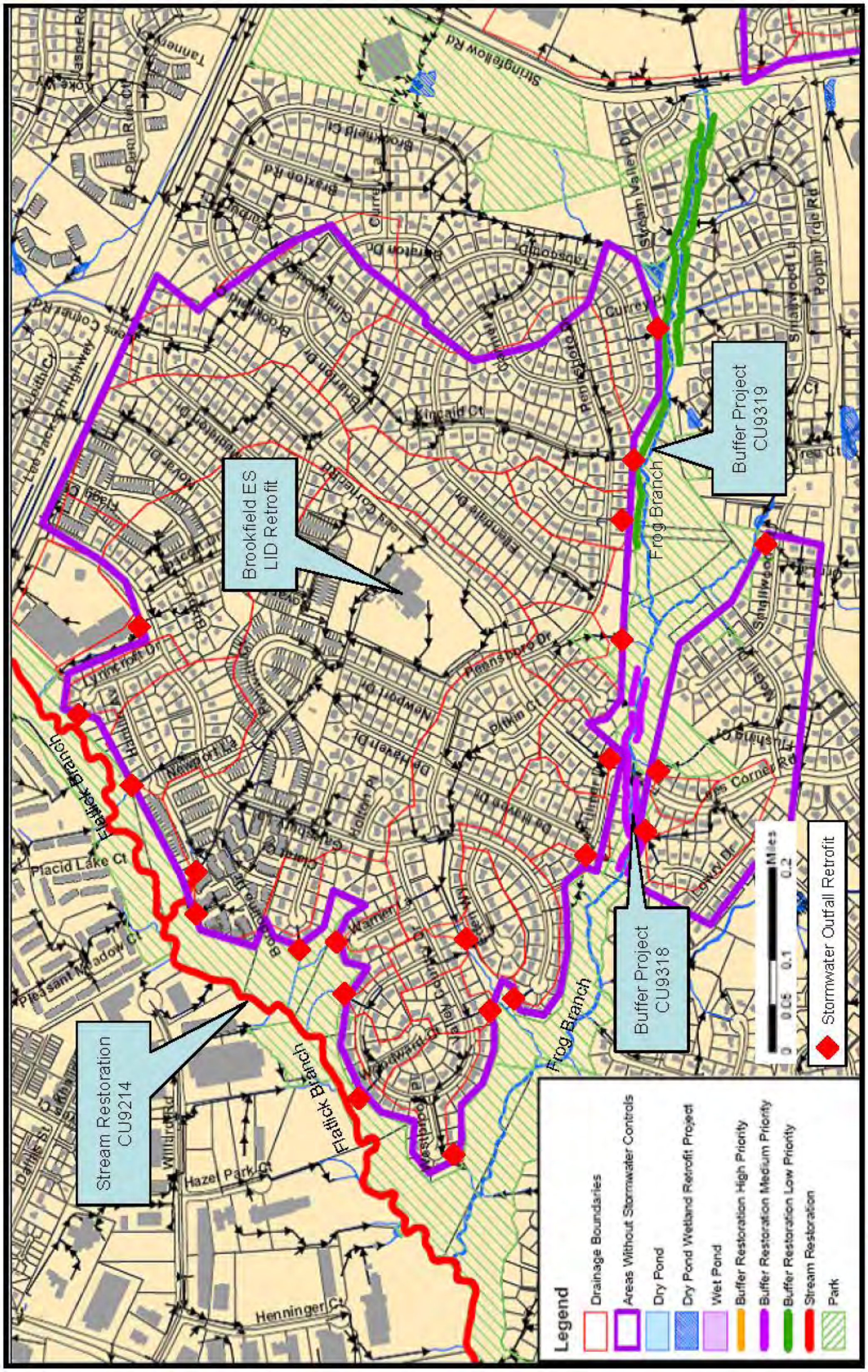


Figure 6-34
Summary of Proposed Stormwater Controls Near Brookfield

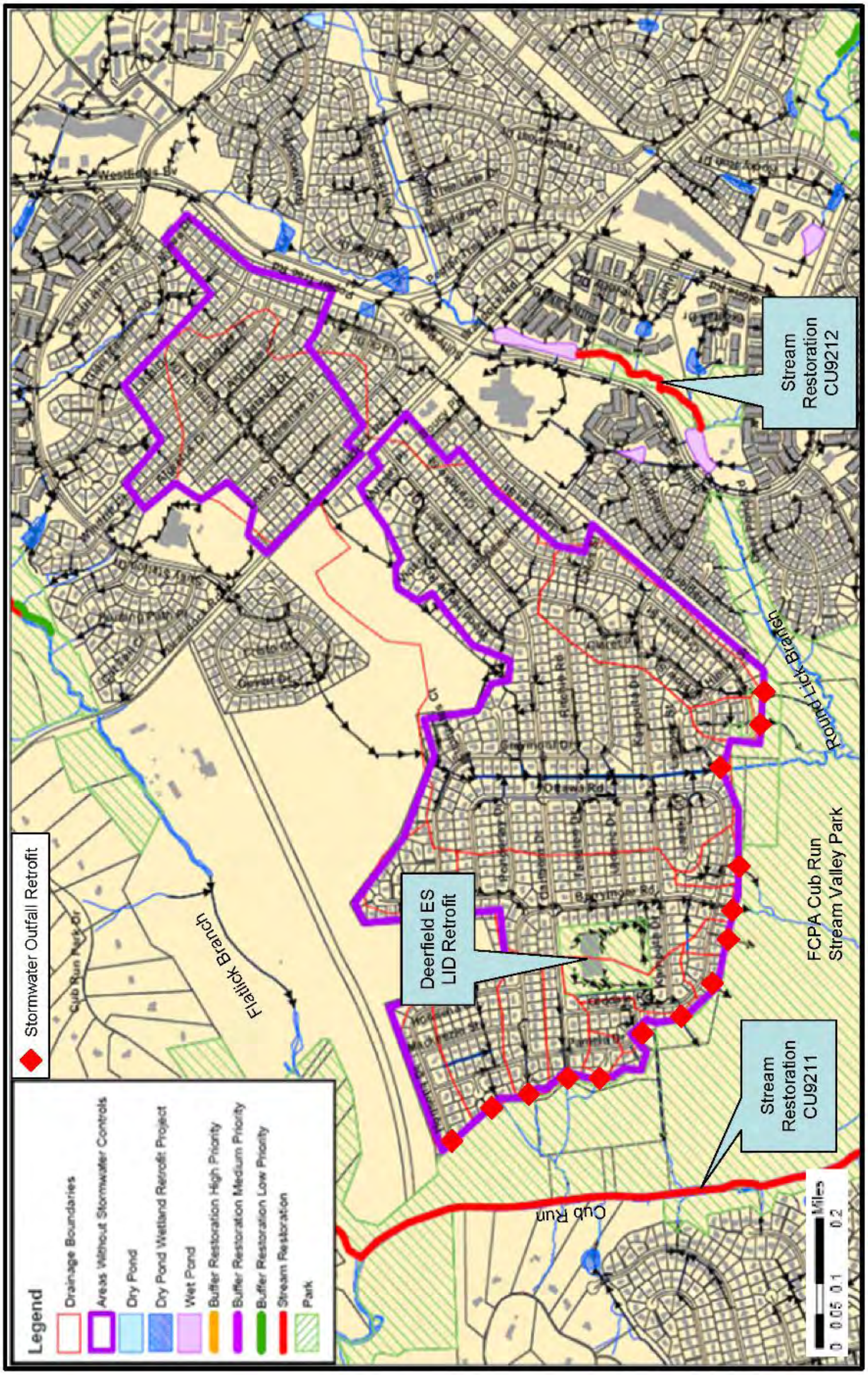


Figure 6-35
Summary of Proposed Stormwater Controls Near Country Club Manor

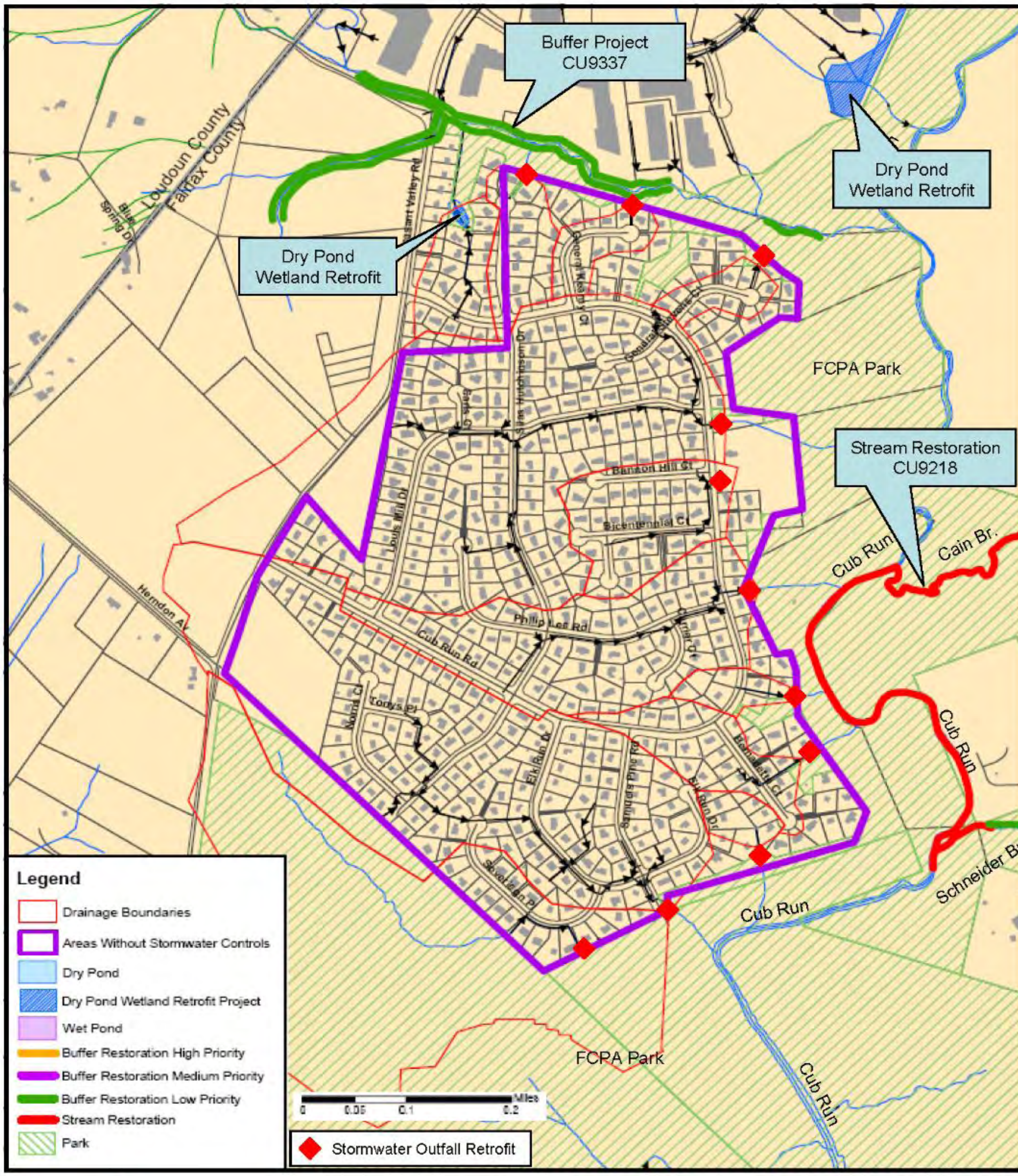


Figure 6-36
Summary of Proposed Stormwater Controls Near Pleasant Valley

Table 6-34
Summary of Stormwater Control Opportunities for
Greenbriar and Birch Pond Neighborhoods

Stormwater Control Projects	Number of Projects	Description
LID Retrofit at County Facilities	5	Greenbriar East Elementary School Greenbriar West Elementary School Chantilly High School Rocky Run Middle School Chantilly Library
Other LID Projects	1	Promote LID for residential, public and commercial areas in each neighborhood.
New Dry Ponds and Wet Ponds	-	No opportunities exist since there is no open area available.
Upstream Culvert Retrofit Projects	-	No opportunities exist within the closed conduit system.
Stream Restoration Projects	-	No stream restoration projects within or near these neighborhoods.
Buffer Restoration Projects	5	CU9312 – Tributary to Big Rocky Run CU9313 – Big Rocky Run CU9314 – Tributary to Big Rocky Run CU9315 – Big Rocky Run CU9319 – Frog Branch
Stormwater Outfall Mitigation Projects	24	Evaluate and perform rehabilitation and mitigation for 24 stormwater outfalls.

Table 6-35
Summary of Stormwater Control Opportunities for Brookfield Neighborhood

Stormwater Control Projects	Number of Projects	Description
LID Retrofit at County Facilities	1	Brookfield Elementary School
Other LID Projects	1	Promote LID for residential, public and commercial areas in the neighborhood.
New Dry Ponds and Wet Ponds	-	No opportunities exist since there is no open area available.
Upstream Culvert Retrofit Projects	-	No opportunities exist within the closed conduit system.
Stream Restoration Projects	1	Project CU9214
Buffer Restoration Projects	2	CU9318 – Frog Branch CU9319 – Frog Branch
Stormwater Outfall Mitigation Projects	22	Evaluate and perform rehabilitation and mitigation for 22 stormwater outfalls that discharge to Frog Branch and Flatlick Branch.

Table 6-36
Summary of Stormwater Control Opportunities for
Country Club Manor Neighborhood

Stormwater Control Projects	Number of Projects	Description
LID Retrofit at County Facilities	1	Deerfield Elementary School
Other LID Projects	1	Promote LID for residential, public and commercial areas in the neighborhood
New Dry Ponds and Wet Ponds	-	No opportunities exist since there is no open area available.
Upstream Culvert Retrofit Projects	-	No opportunities exist within the closed conduit system.
Stream Restoration Projects	2	Project CU9212 – Round Lick Branch Project CU9311 – Cub Run main stem
Buffer Restoration Projects	-	No buffer restoration projects within or near this neighborhood.
Stormwater Outfall Mitigation Projects	14	Evaluate and perform rehabilitation and mitigation for 14 stormwater outfalls.

Table 6-37
Summary of Stormwater Control Opportunities for Pleasant Valley Neighborhood

Stormwater Control Projects	Number of Projects	Description
LID Retrofit at County Facilities	-	No opportunities exist since there are no County facilities in this neighborhood.
Other LID Projects	1	Promote LID for residential, public and commercial areas in the neighborhood.
New Dry Ponds and Wet Ponds	-	No opportunities exist since there is no open area available.
Upstream Culvert Retrofit Projects	-	No opportunities exist within the closed conduit system.
Stream Restoration Projects	1	Project CU9218 – Cub Run
Buffer Restoration Projects	1	Project CU9337
Stormwater Outfall Mitigation Projects	11	Evaluate and perform rehabilitation and mitigation for 11 stormwater outfalls.

Stream Restoration Projects

CDM has identified stream restoration projects that focus on areas with active and ongoing stream bank erosion. Surprisingly, the stream segments with the worst stream erosion are not near the neighborhoods without stormwater controls. The following summarizes the stream conditions within and downstream of these neighborhoods:

Greenbriar and Birch Pond — Closed pipe drainage systems from this neighborhood discharge directly to either Big Rocky Run or Frog Branch.

Big Rocky Run — The stream within and downstream from this neighborhood has no erosion inventory points and high scores for bank stability. The nearest stream restoration project (15) is more than 2.7 miles downstream.

Frog Branch

The stream downstream from this neighborhood has only one erosion inventory point and high scores for bank stability. The nearest stream restoration reach is on Flatlick Branch.

Rock found in the beds of Frog Branch and Big Rocky Run provides protection from the flows from these neighborhoods. Also, these neighborhoods have been in place for 30 to 40 years and the streams have had sufficient time to respond to the changed flow regime.

Brookfield

Closed pipe drainage systems from this neighborhood discharge directly to either Frog Branch or Flatlick Branch.

Frog Branch

The stream downstream from this neighborhood has only one erosion inventory point and high scores for bank stability. The nearest stream restoration reach is on Flatlick Branch.

Flatlick Branch

The section of Flatlick Brach near this neighborhood is included in stream restoration project CU9214. This stream has extensive stream erosion inventory data points. It is difficult to say how much of the erosion in this reach is caused by local drainage and how much is caused by the development in the Flatlick Branch watershed upstream from Route 50.

Country Club Manor

The small streams that receive the runoff from this neighborhood flow directly into the lower reaches of Round Lick Branch or the middle Cub Run main stem.

Round Lick Branch

Round Lick Branch shows few erosion inventory points and has high scores for stream bank stability.

Cub Run

The Cub Run main stem is included in stream restoration project CU9211. It is not likely that discharge from Country Club Manor contributes significantly to the erosion in this reach of Cub Run since the drainage area is relatively small compared to the total upstream drainage area for this reach.

Pleasant Valley

The small streams that receive the runoff from this neighborhood flow directly to the upper Cub Run main stem.

Cub Run	A portion of the Cub Run main stem near Pleasant Valley is included in stream restoration project CU9218. The total upstream drainage area for this reach is significantly larger than the drainage area of Pleasant Valley. Therefore, it is unlikely that runoff from Pleasant Valley contributes significantly to the erosion on this segment of Cub Run.

Stream Buffer Restoration

Section 6.7 identifies stream buffer restoration projects where deficient buffers have the greatest impact on the streams. Various stream restoration projects have been identified within and near these neighborhoods that will improve the habitat and stream health. These projects are shown in figures 6-33 through 6-36 and documented in tables 6-34 through 6-37.

Stormwater Outfall Retrofit Projects

The drainage systems for these areas consist primarily of closed conduit systems. Country Club Manor includes portions with concrete-lined trapezoidal ditches. The storm conduits discharge directly to ditches and small streams. These outfalls have not likely been systematically evaluated and maintained since construction 30 to 40 years ago.

Under this action, the existing outfalls will be evaluated and redesigned to reduce their impact on receiving streams, without affecting drainage in these communities. The first step in each project will be to perform a detailed evaluation of each outfall. The goal is to improve the ecological function of the outfalls and nearby streams, maintain and improve the stormwater drainage functions, and improve the overall aesthetics of these outfalls. Potential retrofit opportunities include:

- Velocity dissipaters and flow spreading features to slow the velocity at the outfalls and upon entering the streams. These will typically be rock structures. Figure 6-37 provides an example of the possible improvements. Design of the improvements will depend on site conditions.

- Plunge pools and wetland systems at the outfall locations

- Stream restoration, using bioengineering, to improve and stabilize the streams that receive the flow from these outfalls

- Buffer restoration, including removal of non-native species, creating “no-mow” zones and planting native vegetation.

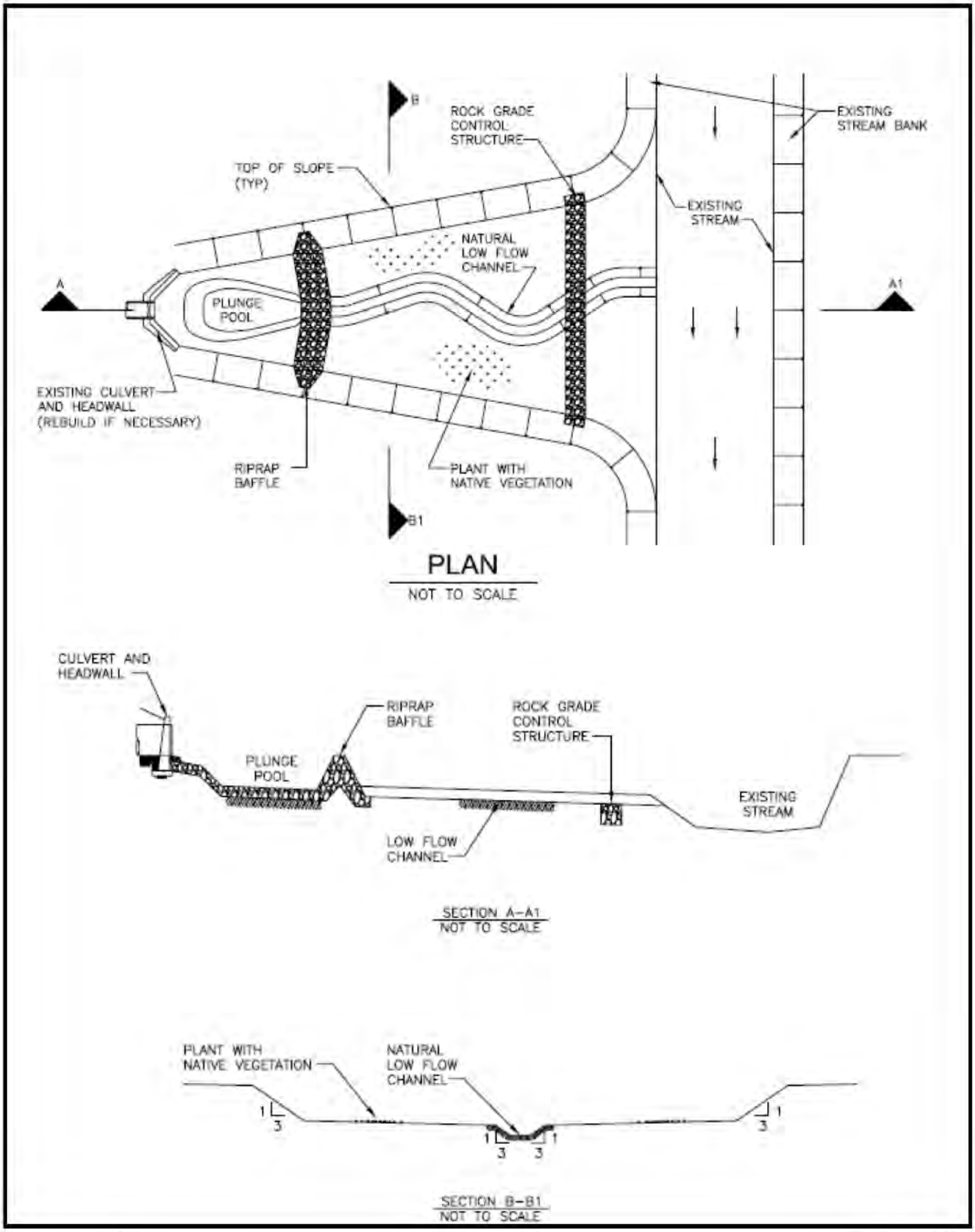


Figure 6-37
Conceptual Retrofit for Uncontrolled Stormwater Outlets

Cost to Implement Action

The costs for the outfall retrofit projects and outreach programs for these four neighborhoods totals $2.7 million. The stream restoration, buffer restoration, LID retrofit and dry pond retrofit projects identified for the four neighborhoods are included as separate projects and not in these costs to avoid double counting.

6.6.3 Watershed Benefits

Addressing the runoff from watershed areas that do not have stormwater controls provides many benefits to the watershed's streams, including:

- Improving the health of the local streams near these neighborhoods
- Reducing nutrient and other pollutant loading from these areas
- Reducing stream erosion near the stormwater outfalls

6.7 Action – Improve Condition of Existing Streams by Implementing Buffer Restoration Projects

6.7.1 Action

Stream buffers or riparian buffers refer to the portion of the stream valley within 100 to 200 feet of the stream banks. A natural unimpaired stream buffer, containing native trees, plants and shrubs, provides valuable stream habitat protection and many other benefits.

In many areas of the Cub Run and Bull Run watersheds, the natural stream buffer vegetation has been damaged or removed by residential and commercial development, lawns, mowed areas, old farm fields and utilities that cross the stream valleys. Buffer restoration projects will restore selected stream reaches to a natural condition and improve the overall health of the streams.

6.7.2 Strategy to Achieve Action

Description of Action

The buffer restoration projects include removing invasive plant species and planting appropriate native trees, shrubs and other plants. Although the width of the restored area depends on local conditions, a restored buffer width of native vegetation for a distance of 100 to 200 feet from perennial stream banks is ideal.

Part of the projects could be coordinated as volunteer efforts with local citizen organizations. Some may be implemented under contact to the county. These projects may involve working with the nearby residents and homeowner associations to create "no mow" zones within the areas to be restored. Signs will be placed in the restored area to educate the public and to ensure that the restored areas are preserved.

The buffer restoration projects are in a variety of land ownership areas, including public parkland, privately owned common areas and other private lands. Buffer restoration projects on single-family residential, commercial and industrial parcels will not be addressed under this action. County funds will not be used directly to make improvements within private property. However, educational efforts to promote buffer restoration on private property are in the watershed plan's non-structural actions.

Some of the most severely affected buffers in the watershed are mowed right-of-ways for power lines, water lines, natural gas lines, sewer lines and petroleum pipelines. The county must coordinate with these utilities to identify buffer restoration projects compatible with their maintenance and safety needs as well as the watershed plan goals.

Stream Buffer Restoration Projects

The following databases were used to identify the stream buffer restoration projects:

1. The deficient stream buffer inventory line data in the Fairfax County Stream Physical Assessment Tool is the primary database used.

2. Digital aerial orthophotography was used to identify the cause of the impairment and suitability for inclusion in a buffer restoration project.

3. GIS layers of parcel boundaries and Fairfax County Park Authority parkland were used to determine the feasibility of buffer restoration projects within the areas affected.

The stream buffer inventory line data identifies areas where the stream buffers were deficient. These inventory lines include a buffer impact score, with 10 having the highest impact and zero having no impact on the stream system. CDM filtered the stream buffer line inventory data, starting with the deficient buffer with the highest impact scores.

The buffer inventory lines were reviewed as potential restoration projects to be included in this action. The following are not included in this specific watershed plan action:

- Single-family parcels

- Commercial and industrial areas where the impaired buffers are near buildings and parking lots

- Streams adjacent to public roads

In most cases, county funds will not be used to perform buffer restoration on private property. Watershed plan nonstructural actions described in Section 4 promote restoration by the property owners with guidance and support from the county. Stream buffers close to public roads cannot typically be restored due to highway safety concerns.

In addition, deficient buffer inventory lines within the stream restoration projects presented in Section 6.5 were not included since buffer restoration will be part of the proposed stream restoration.

Deficient stream buffer reaches with high impact and potential for buffer restoration were grouped into buffer restoration projects. Reaches with lower-impact scores were included when appropriate. Some buffer restoration reaches identified from the Stream Physical Assessment data included additional areas with deficient buffers. These were identified using aerial photography and additional field surveys.

Studies have shown that a healthy stream buffer efficiently reduces the nutrient loads for the waters that pass through it as sheet flow. Modern drainage systems cause much of the stormwater runoff to bypass the stream buffers, thereby reducing their effectiveness in reducing loads. In most cases, sufficiently spreading flows from existing stormwater systems to take advantage of the nutrient reductions will not be possible without creating excessive flows and velocities that would destroy the stream buffer.

Cost of Action Implementation

This analysis resulted in 43 stream buffer restoration projects that include 54,480 feet (10.3 miles) of deficient stream buffer restored at a total estimated cost of $1.32 million.

These projects are identified in Table 6-38 and Figure 6-38. The order they are presented in this watershed plan does not represent their priority or order of implementation in the final plan. The plan's implementation schedule is presented in Section 7. Table 6-38 also identifies whether the parks are on FCPA parkland or private property.

The stream buffer restoration projects are categorized as high, medium and low priority based on the severity of the impact scores. These rankings provide one of several factors that will be used to develop the implementation schedule and plan for these actions.

6.7.3 Watershed Benefits

The stream buffer restoration projects will improve health in a significant portion of the streams. The improved and healthy stream buffers benefit the watershed as follows:

- Filter runoff from adjacent lands, removing pollutants and sediment delivered to the streams
- Provide natural habitat for plants and animals
- Shade the stream and lower water temperatures
- Provide food for animals living in the streams

Table 6-38
Summary of Stream Buffer Restoration Projects

Project Number	Average Impact Score	Cumulative Length of Deficient Buffer (Left and Right Bank) (Feet)	Stream	Location	Type of Stream Impact	Project Cost
BR9301	7	1,270	Tributary i_n Bull Run West Watershed	Private Property	Fields	$31,000
BR9302	5	310	Tributary in Bull *R*wı West Watershed	Private Property	Utility right of way clem·ing and mowing	$8,000
BR9303	6	800	Tributary in Bull Run West Watershed	Private Property	Power Line clearing and mowing	$20,000
BR9304	7	220	Tributary i_n Bull Rtm West Watershed	Fai_rfax National Estates	Fields and new construction	$6,000
CU9301	6	820	Cub RLm	FCPA Pm·kland downst:t·eam from Big Rocky Run near Route 66 and Gate Post Estates	Power Line mowing and clearing and l-66 embarlkmen t	$20,000
CU9302	5	380	Tributary to Cub Run	Partially in FCPA parkland upsh·eam from T-66. Centre Ridge	Mowed areas, lawns and past clearing/ consh·uction	$10,000
CU9303	5	710	Tributary to Big Rocky Run	FCPA parkland and VDOT ROW I-66 /Route 28 interchange	Mowed and cleared areas - road embankment	$17,000
CU9304	5	980	Big Rocky Rtm	FCPA parkland upstream and downstream from Awbrey Patent Drive	Mowed and cleared areas	$24,000
CU9305	5	700	Big Rocky Run	FCPA parkland downsh·eam from Braddock Road	Mowed and cleared areas	$17,000
CU9306	5	3,820	Tributary to Big Rocky Run	Private property upsheam from Braddock Road crossing Cedar Break Drive within Sequoia Fmms	Lawns and mowed and cleared meas	$91,000
CU9307	5	1,950	Tributary to Big Rocky Run	Partially in *FCP*A pm·klm1d Elli.cott Colu't downstream from Northbourne Drive	Mowed and cleared m·eas and lawns	$47,000
CU9308	5	2,420	Tributary to Big Rocky Run	PartiaiJy i_n FCPA parkland downstream from Veronica Road - upstream from regional pond C30	Mowed and cleared areas and lawns	$58,000

Table 6-38
(continued)
Summary of Stream Buffer Restoration Projects

Project Number	Average Impact Score	Ctmmlative Length of Deficient Buffer (Left and Right Bank) (Feet)	Stream	Location	Type of Stream Impact	Project Cost
CU9309	5	*1A60*	Tributary to Big Rocky Run	FCPA parkland upsh·eam from N orthbourne Drive and downstream from Stringf ellow Road	Mowed areas and new construction	$35,000
CU9310	5	330	Big Rocky Rtm	FCPA parkland downstream from StringfelJow Road	Utility right of way dearing and mowing	$8,000
CU9311	5	270	Tributary to Big Rocky Run	FCPA parkland downstream from Point Pleasant Drive	Lawns and clearing	$7,000
CU9312	5	230	TributaJy to Big Rocky Run	FCPA paJkland downstream from Stril1gfellow Road and Poil1t Pleasant Drive	Lawns and cleaJu1g	$MOO
CU9313	5	2,630	Big Rocky Rtm	FCPA parkland upstream from Stringfellow Road near Greenbriar	Lawn, dearing and trail	$63,000
CU9314	5	700	Tributary to Big Rocky Run	FCPA parkland downstream from Melville Lane	Lawns and clearing	$17,000
CU9315	5	330	Big Rocky Run	*FCPA* parkland downstream from Middle Ridge Drive	Lawns and clearing	$8,000
CU9316	5	3,550	Tributary to Middle Cub Rtm	Partially in FCPA parkland in Virginia Rtm- Downstream hom Pleasant VaLley Rd.	Mowed areas and clearing	$85,000
CU9317	5	400	Flatlick Branch	FCPA parkland upsheam from Braddock Road	Mowing, cleared areas and trail	$10,000
CU9318	6	2,070	Frog Branch	*PCP*A Parkland at Lees Corner Road	Mowed areas and nearby development	$50,000
CU9319	5	4,030	Frog Branch	FCPA Parkland downsheam from StringfelJow Road	Lawns and clearing	$96,000
CU9320	8	1,350	Flatlick Branch	Private property upsh·eamfrom Route 50 and downstream from Lees Corner Road	Mowed areas, clearing and nearby development	$33,000

Table6-38
(continued)
Summary of Stream Buffer Restoration Projects

Project Number	Average Impact Score	Cumulative Length of Deficient Buffer (Left and Right Bank) (Feet)	Stl:eam	Location	Type of Stream Impact	Project Cost
CU9321	5	430	Oxlick Branch	FCPA parkland downst:team from St:t·ingfellow Road near Brandy Station Road.	Nah.ual gas line mowing and clea1·ing	$11,000
CU9322	8	430	Oxlick Branch	Downstream from Sh·in gfellow Road	Mowed areas, clearing and utility construction	$11,000
CU9323	5	110	Oxlick Brandl	Private property downstream from Fairfax County Parkway neru· Freehill Lane	Lawns and clearing	$3,000
CU9324	7	380	Flatlick Bra11ch	Private property upstream from Lees Comer Road	Utility right of way mowing a11d clearing	$10,000
CU9325	5	990	Flatlick Branch	Private property downstream *h·om* Fairfax Cotmty Parkway	Mowed and cleared areas and nearby development	$24,000
CU9326	7	860	Flatlick Branch tributary	Private property adjacent to Fairfax COtmty Prukway upst:team from Tuckaway Drive	Mowed areas, clearing and road const:tuction	$21,000
CU9327	7	840	Flatlick Branch	Private property upstream from Fairfax County Parkway and downstream *h·om* Thompson Road	Mowed areas and clearing	$20,000
CU9328	7	660	Flatlick Branch	Private property upstream from Thompson Road	Natt.u·al gas line mowing and clearing	$16,000
CU9329	8	2,000	Flatlick Branch tributru·y	Private property within Franklin Manor near Rose Grove Drive	New construction	$48,000
CU9330	7	1,350	Unnamed Tributru·y to Elklick Run	FCPA pru·kland neru·Pleasant Valley Road north of Elklick Run	Field a11d cleared rueas	$33,000
CU9331	8	720	Unnamed Tributary to Elklick Run	FCPA parkland adjacent to Pleasant Valley Road soutl1 of Elklick Rtm	Roadway	$18,000
CU9332	6	250	Cub Rtm	FCPA parkland at Old Lee Road	Roadway	$6,000

Table 6-38
(continued)
Summary of Stream Buffer Restoration Projects

Project Number	Average Impact Score	Cumulative Length of Deficient Buffer (Left and Right Bank) (Feet)	Stream	Location	Type of Stream Impact	Project Cost
CU9333	5	1,160	Schneider Branch	FCPA parkland upstream from Cub Run and downstream from Stonecroft Boulevard	Fields and clearing	$28,000
CU9334	5	1,060	Cain Branch Tributary	Private property downstream from CenheviUe Road	Fields and nearby development	$26,000
CU9335	8	1,680	Cain Branch	Private property upsh·eam from Centreville Road and downstream from Lees Corner Road	Nearby development	$40,000
CU9336	6	1,290	Cain Branch	Private property upstream from Lees Corner Road	Nearby development and mowed areas	$31,000
CU9337	5	6,160	Cub Run Tributary	Pleasant Valley neighborhood - Half of project is in FCPA parkland	Mowed areas and fields	$147,000
CU9338	5	1,140	DeadRtm	Private property at Stonecroft Boulevard	Nearby construction	$28,000
CU9339	5	1,240	DeadRLm	Private property upstream from Stonecroft Boulevard	New construction	$30,000
Totals		54,480				$1,318,000

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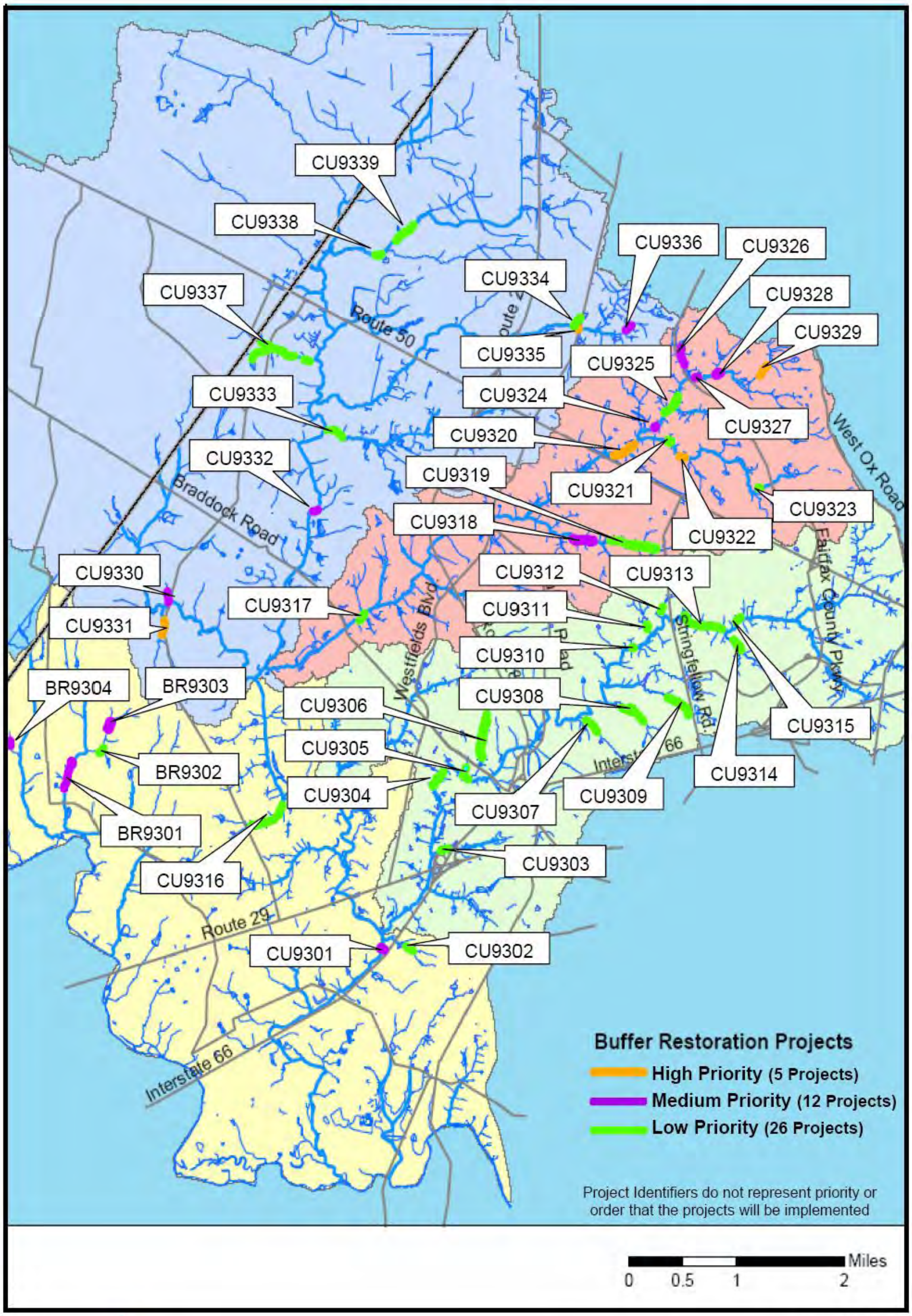

Figure 6-38
Location of Buffer Restoration Projects

- Reduce stream erosion by slowing overbank flow velocity during floods. Roots in a healthy stream buffer hold the soil together further reducing erosion
- Improve function of the riparian wetlands within the stream buffer
- Meet other county environmental goals by increasing forest cover and connecting habitat corridors

6.8 Action – Replace and Upgrade Road Crossings to Eliminate Flooding

6.8.1 Action

Several culverts and bridges do not have capacity to convey flows from the upstream watershed during storms. These undersized culverts and bridges produce frequent roadway flooding.

6.8.2 Strategy to Achieve Action

Culverts and bridges at identified locations are recommended for replacement to provide sufficient capacity to accommodate frequently occurring flood flows. These locations have been identified from various sources, including previous stormwater planning studies, flooding memorandums, the public and watershed modeling.

Table 6-39 lists the locations where the existing culvert and bridges do not have sufficient capacity to prevent frequent flooding. Figure 6-39 shows these locations.

Unless they are producing severe impacts, these projects will not be implemented using Fairfax County stormwater funds. The roads are maintained by the Virginia Department of Transportation, and these improvements will be implemented during roadway improvement projects.

6.8.3 Watershed Benefit

These projects reduce the frequency of roadway flooding and the potential safety concerns, economic impacts and damage.

Upgrading the roadway crossings will eliminate frequent roadway flooding. Such flooding presents a safety hazard to those who attempt to cross the streams during high-water conditions. Severe flooding can prevent emergency vehicles from responding.

In addition to adverse effects on traffic flow, undersized culverts can affect streams by increasing flow velocities and preventing fish passage.

Figure 6-39
Road Culvert and Bridge Replacement Projects

Table 6-39
Summary of Road Culvert and Bridge Replacement Projects

Project ID	Project Location
1 - CU9610	Birch Drive at unnamed tributary to Flatlick Branch - Flatlick Branch Subwatershed
2 - CU9601	Compton Road at unnamed tributary near UOSA advanced wastewater treatment plant – Bull Run East Subwatershed
3 - CU9606	Heron Drive at unnamed tributary between Cabells Mill Drive and Walney Road – Big Rocky Run Subwatershed
4 - CU9608	Dorforth Drive at unnamed tributary – Big Rocky Run Subwatershed (aerial photography suggests that this crossing has been abandoned).
5 - CU9613	Cain Branch at Lees Corner Road – Upper Cub Run Subwatershed
6 - CU9603	Compton Road at unnamed tributary east of Bull Run Post Office Road – Lower Cub Run Subwatershed
7 - CU9609	Flatlick Branch at Walney Road – Flatlick Branch Subwatershed
8 - CU9611	Cub Run at Braddock Road and Old Lee Road – Upper Cub Run Subwatershed
9 - CU9607	Big Rocky Run at Stringfellow Road – Big Rocky Run Subwatershed
10 - CU9602	Compton Road at unnamed tributary near Confederate Ridge Lane – Bull Run East Subwatershed
11 - CU9604	Compton Road at unnamed tributary west of Route 66 – Lower Cub Run Subwatershed
12 – BR9601	Bull Run Post Office Road at unnamed tributary (easternmost of three crossings) – Bull Run West Subwatershed
13 – BR9602	Bull Run Post Office Road at unnamed tributary (middle of three crossings) – Bull Run West Subwatershed
14 – BR9603	Bull Run Post Office Road at unnamed tributary (westernmost of three crossings) – Bull Run West Subwatershed
15 - CU9612	Pleasant Valley Road at unnamed tributary near Blue Spring Drive
16 - CU9605	Awbrey Patent Drive at Big Rocky Run

6.9 Other Structural Actions

6.9.1 Evaluate and Retrofit Existing Headwater Drainage Systems

Action

The county will analyze the conveyance of stormwater from older communities to identify problems and solutions. Drainage systems in the headwaters of Cain Branch, Flatlick Branch, Oxlick Branch and Big Rocky Run (primarily north of Route 50) generally have little topographic relief. In some cases, the existing drainage ditches have silted in and no longer have sufficient conveyance capacity. These systems will be cleaned out and maintained to ensure adequate capacity for preventing flooding and stream erosion.

In some headwater areas of the watershed, stormwater outfalls from curb-and-gutter drainage systems discharge directly to streams with little or no attenuation. Prior to development, rainfall runoff from these small drainage areas was delivered to the streams as diffuse sheet flow. The curb and gutter systems concentrate flow from these areas into ditches that are eroding the stream valleys and creating new drainage ditches. These stormwater outfalls will be evaluated and improvements made to reduce their impact on the stream valley. Improvements may include velocity dissipaters, flow spreading devices, stream restoration and buffer restoration.

The evaluation process will also identify opportunities to implement rain gardens or manufactured bioretention devices to control runoff from privately maintained areas such as swim clubs, tennis clubs, etc.

Most of these problems exist on private property owned by individuals or open space associated with homeowner associations, condominiums, town house communities and apartments.

Strategy to Achieve Action

This is a diffuse problem within small drainage systems that have not previously been evaluated by the county. The county will work with homeowner associations and open space committees in the targeted areas of the watershed to review drainage conditions and develop plans to improve the drainage in these neighborhoods. This action will be performed with public outreach associated with other structural actions. Typically, county funds will not be used to implement projects within private property unless the improvement produces documented watershed benefits. Opportunities will be sought to share the costs to implement improvements that significantly benefit the watershed.

Project CU9914 includes these upland drainage improvement projects. A cost of $3,000,000 is applied for these improvements over the 25 year watershed plan for an average annual budget of $120,000.

Watershed Benefits

These improvements in headwater areas will reduce flooding, stream erosion and sediment transport, making the streams healthier. These projects address stormwater issues at their source. Erosion in these headwater areas introduces sediment into the streams.

6.9.2 Riparian Wetland Improvement Projects

Action

Riparian wetlands in the Cub Run and Bull Run watersheds have been degraded by development, past use and stream erosion. Riparian wetlands refer to wetlands within the stream valleys near the streams. As the streams down-cut, the frequency of inundation of the riparian wetlands decreases. This negatively affects the wetlands' natural functions.

In areas that have caused the streams to down-cut, raising the streambed reconnects the streams with the neighboring floodplains. This action increases the inundation frequency to support a healthy wetland habitat but does not increase the flooding for larger events. Frequent inundation that approximates natural conditions supports the growth of native wetland species and suppresses undesirable species. The inundation also promotes infiltration into the shallow groundwater system. The slow velocities within the overbank floodplain reduce sediment and nutrient loads, and the nutrients are available for wetland plant growth. The floodplain storage decreases peak flows and velocities in downstream segments.

The large areas of stream valley parks, Resource Protection Areas and other protected stream valleys provide many possible ideal sites for such restoration.

Stream restoration projects described in Section 6.5 include actions to raise the stream bed and reconnect the wetlands with the streams. However, there may be options to further improve the functions of the wetlands near these stream restoration projects and to include restoration of other wetland areas not associated with stream restoration.

The watershed plan recommends implementing stream and wetland mitigation projects within the same watershed at a location close to the disturbance. Having wetland improvement projects identified within the Cub Run watershed would help to make this recommendation a reality. This action also potentially reduces the watershed implementation costs to Fairfax County by sharing costs with the developers of projects that require wetland mitigation.

The wetlands within the Cub Run watershed are typically forested. Such wetlands usually will not attract large flocks of waterfowl as an open marsh would. Therefore, this type of wetland mitigation is not a safety concern for nearby Dulles International Airport.

Strategy to Achieve Action

Wetlands in the watershed will be identified and evaluated for restoration and mitigation. Detailed wetland evaluation was not performed within this watershed plan's scope of services. Although the entire watershed should be evaluated, the following five areas should be considered for potential wetland restoration:

- Cub Run mainstem upstream from Route 50. This area of forested marsh and wetlands may be suitable for restoration. The surrounding area is mostly undeveloped. This stream receives flows directly from Dulles International Airport, and therefore a wetland would be ideal for mitigating wetland loss from past and future airport development. This area is within private property but is not developable due to its location within the RPA and 100-year floodplain. Because this area is close to the airport flight paths, wetland projects will avoid attracting waterfowl.

- Unnamed tributary to Elklick Run – This area of forested mash and wetland has many beaver ponds and is within FCPA Sully Woodlands Parkland. It is downstream from a portion of Loudoun County and therefore would further reduce peak flows and pollutant loads from this development. Proposed regional pond C37 is within this area. FCPA has indicated wetland restoration may be appropriate for this area and is consistent with the parkland development plans.

- Cub Run mainstem between Route 50 and Braddock Road. This area is partially parkland and partially private property. Wetland restoration would need be sensitive to Pleasant Valley residents and other adjacent property owners.

- Cub Run mainstem between Big Rocky Run and Route 29. This area of the FCPA Cub Run Stream Valley Park contains forested wetlands within the RPA and 100-year floodplain that may be candidates for restoration.

- Cub Run mainstem below Route 66. The stream valley within the NVRPA Bull Run Regional Park contains forested wetlands within the 100-year floodplain and RPA that may be candidates for restoration.

A cost of $100,000 is applied to perform this study as watershed plan project CU9915.

Watershed Benefits

Restoring natural wetlands within the Cub Run and Bull Run watersheds provides a variety of watershed benefits, including:

- Restoring and protecting functions of natural wetland systems

- Providing habitat for plants and animals that depend on wetland systems

- Reducing sediment and nutrient loads

- Increasing infiltration and replenish groundwater systems

- Reducing peak flows and velocities in downstream segments

6.10 Status Pro Rata Share Master Plan for Flood Control and Drainage Projects

Section 2.5.5 documented the projects in the Fairfax County Master Plan for Flood Control and Drainage Pro-Rata Share Projects. Table 6-40 lists the projects in the Master Plan and documents their updated status based on the evaluations performed in the Cub Run and Bull Run Watershed Management Plan. The status of the regional ponds included in the Pro-Rata Share Projects is described in Section 6.2.

The Master Drainage Plan had 23 projects that include stream restoration, stream stabilization and/or stream bank stabilization. The following provides an overview of the status of these projects in the Cub Run watershed plan:

- Thirteen of these stream stabilization projects are in stream restoration projects identified in Section 6.5.

- Seven of the stream stabilization projects are in buffer restoration projects identified in Section 6.7. Analysis and review of the stream segment and stream condition assessment data show that stream stabilization is not required though the buffers were deficient.

- Three of the stream stabilization projects are deleted. Analysis and review of the stream segment and stream condition assessment data show that stream stabilization is not required.

The Master Drainage Plan includes 11 road culvert and bridge replacement projects: five in the Bull Run watershed and six in the Cub Run watershed. The following three are not included in the Cub Run and Bull Run watershed plan:

- BR411 was completed when Sudley Road was improved.

- BR422 is on a small tributary that was not evaluated.

- CU551 was not included. Modeling indicates this bridge floods for the 10-year event.

The remaining projects are included in the watershed plan.

Table 6-40
Status of Master Plan for Flood Control and Drainage Pro-Rata Share Projects
in the Bull Run and Cub Run Watersheds

Pro-Rata Project Number	Type of Project	Stream	Location	Status in Cub Run Watershed Plan
BR401	Raise Road and Replace Culvert	Tributary to Bull Run	Bull Run Post Office Road	Road culvert and bridge replacement project BR9603
BR411	Raise Road and Replace Culvert	Tributary to Bull Run	Sudley Road	Completed. This improvement was completed as part of improvements to Sudley Road
BR421	Raise Road and Replace Culvert	Tributary to Bull Run	Bull Run Post Office Road	Road culvert and bridge replacement project BR9602
BR422	Raise Road and Replace Culvert	Tributary to Bull Run	Bull Run Post Office Road	Not included in the watershed plan. This small tributary was not evaluated in the watershed plan. Further analysis is required before deletion could be recommended.
BR621	Raise Road and Replace Culvert	Tributary to Bull Run	Bull Run Post Office Road	Road culvert and bridge replacement project BR9601
CU201, CU202 and CU9203	Stream Restoration and Stabilization	Lower Cub Run	Bull Run Regional Park	Included in stream restoration project CU9201
CU211	Stream Bank Stabilization	Lower Cub Run	Between Compton Road and Route 66	Included in stream restoration project CU9202
CU221	Stream Stabilization	Lower Big Rocky Run	Between Route 29 and Cub Run	Included in stream restoration project CU9203

Table 6-40
(continued)
Status of Master Plan for Flood Control and Drainage Pro-Rata Share Projects
in the Bull Run and Cub Run Watersheds

Pro-Rata Project Number	**Type of Project**	**Stream**	**Location**	**Status in Cub Run Watershed Plan**
CU222	Stream Stabilization	Big Rocky Run	Between Braddock Road and Route 29	Included as stream restoration project CU9205.
CU223	Stream Stabilization	Big Rocky Run	Between Braddock Road and Route 29	Include in buffer restoration project CU9304. Analysis of stream shows that stabilization is not required.
CU224	Stream Stabilization	Big Rocky Run	Below Braddock Road	Included in buffer restoration project CU9305. Analysis of stream shows that stabilization is not required.
CU225	Stream Stabilization	Tributary to Big Rocky Run	Near The Meadows upstream from Route 66	Included as stream restoration project CU9204
CU241	Stream Stabilization	Big Rocky Run	Upstream from Stringfellow Road	Included in buffer restoration project CU9313. Analysis of stream shows that stabilization is not required.
CU251	Stream Stabilization	Big Rocky Run Tributary	Downstream from Fairfax County Parkway	Recommended for deletion. Analysis of stream shows that stabilization is not required.
CU271 CU272, CU273, CU281, CU282 and CU283	Stream Stabilization	Flatlick Branch	Between Route 50 and Route 28	Included as stream restoration project CU9214

Table 6-40
(continued)
Status of Master Plan for Flood Control and Drainage Pro-Rata Share Projects
in the Bull Run and Cub Run Watersheds

Pro-Rata Project Number	Type of Project	Stream	Location	Status in Cub Run Watershed Plan
CU274	Stream Stabilization	Frog Branch	At Lees Corner Road	Included in buffer restoration project CU9318. Analysis of stream shows that stabilization is not required.
CU284	Stream Stabilization	Flatlick Branch	Downstream from Lees Corner Road	Included in buffer restoration project CU9320. Analysis of stream shows that stabilization is not required.
CU291	Stream Stabilization	Flatlick Branch	Upstream from Lees Corner Road	Included in buffer restoration projects CU9324 and CU9325. Analysis of stream shows that stabilization is not required.
CU331	Stream bank Stabilization	Cub Run	At Old Lee Road	Recommended for deletion. Analysis of stream shows that stabilization is not required.
CU351	Stream Stabilization	Cain Branch	Downstream from Route 50	Recommended for deletion. Analysis of stream shows that stabilization is not required.
CU381	Stream Stabilization	Dead Run	Downstream from Stonecroft Boulevard	Included in buffer restoration projects CU9338 and CU9339 and stream restoration project CU9221
CU401	Raise Road and Replace Culvert	Lower Cub Run Tributary	Compton Road (Western Crossing)	Road culvert and bridge replacement Project CU9602
CU411	Raise Road and Replace Culvert	Lower Cub Run Tributary	Compton Road at UOSA Plant	Road culvert and bridge replacement project CU9603

Table 6-40
(continued)
Status of Master Plan for Flood Control and Drainage Pro-Rata Share Projects
in the Bull Run and Cub Run Watersheds

Pro-Rata Project Number	Type of Project	Stream	Location	Status in Cub Run Watershed Plan
CU421	Replace Culvert	Big Rock Run Tributary	Heron Drive	Road culvert and bridge replacement project CU9606
CU451	Replace Culvert	Big Rock Run	Dorforth Drive	Road culvert and bridge replacement project CU9608
CU481	Replace Culvert	Flatlick Branch Tributary	Birch Drive	Road culvert and bridge replacement project CU9610
CU551	Replace Culvert	Flatlick Branch	Lees Corner Road	Not in plan. Modeling shows it floods for 10-year event; therefore, it should not be deleted without further investigation.

Note: The status of the Pro-Rata Project Master Plan regional ponds is documented in Table 6-1

6.11 Summary of Projects by Subwatershed

Figures 6-40 through 6-46 and tables 6-41 through 6-47 present the structural projects for the following major subwatersheds:

- Upper Cub Run, including Dead Run, Sand Branch, Cain Branch, Schneider Branch and Cub Run
- Elklick Run
- Flatlick Branch
- Big Rocky Run and Round Lick Branch
- Lower Cub Run
- Bull Run East
- Bull Run West

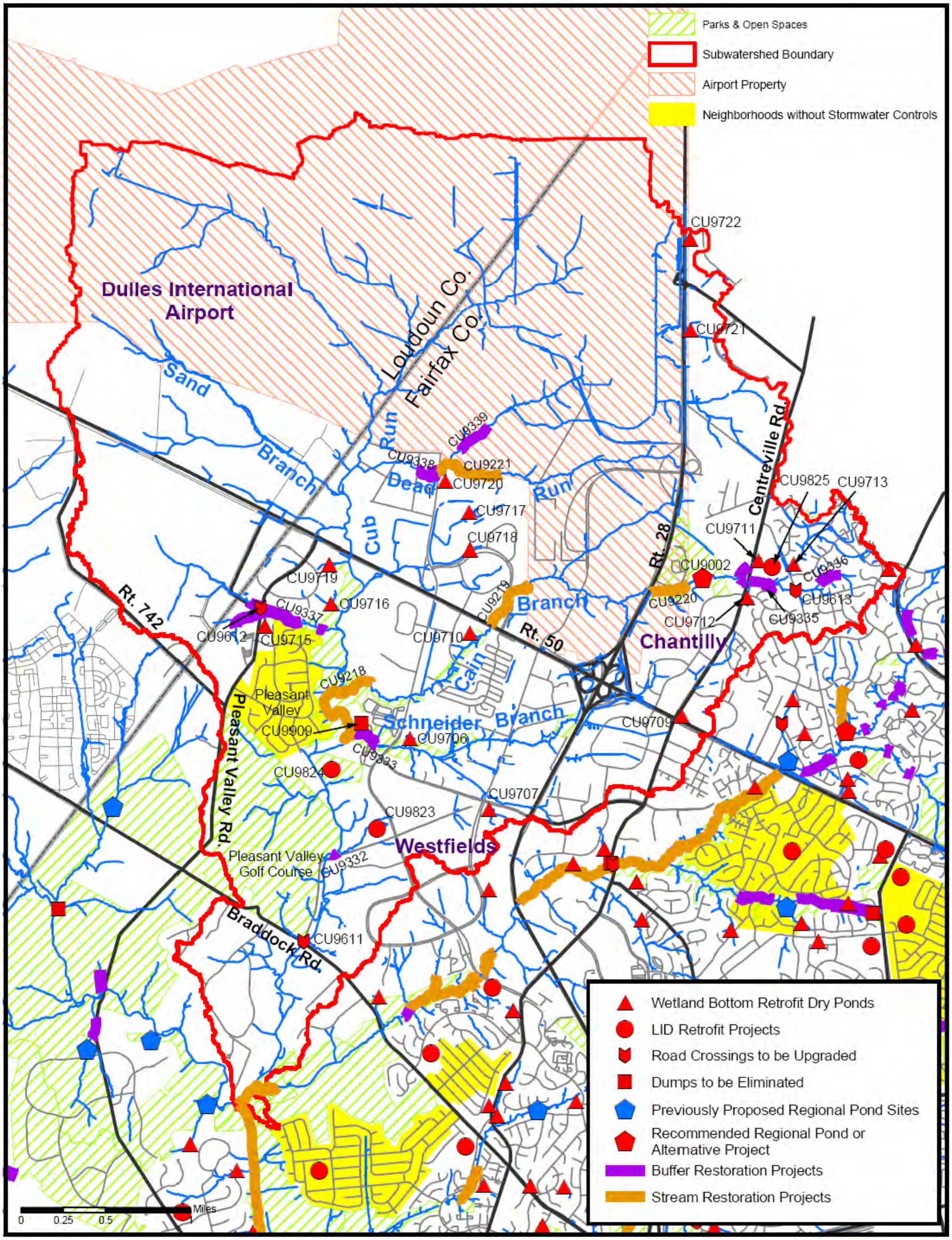

Figure 6-40
Structural Projects in the Upper Cub Run Subwatershed

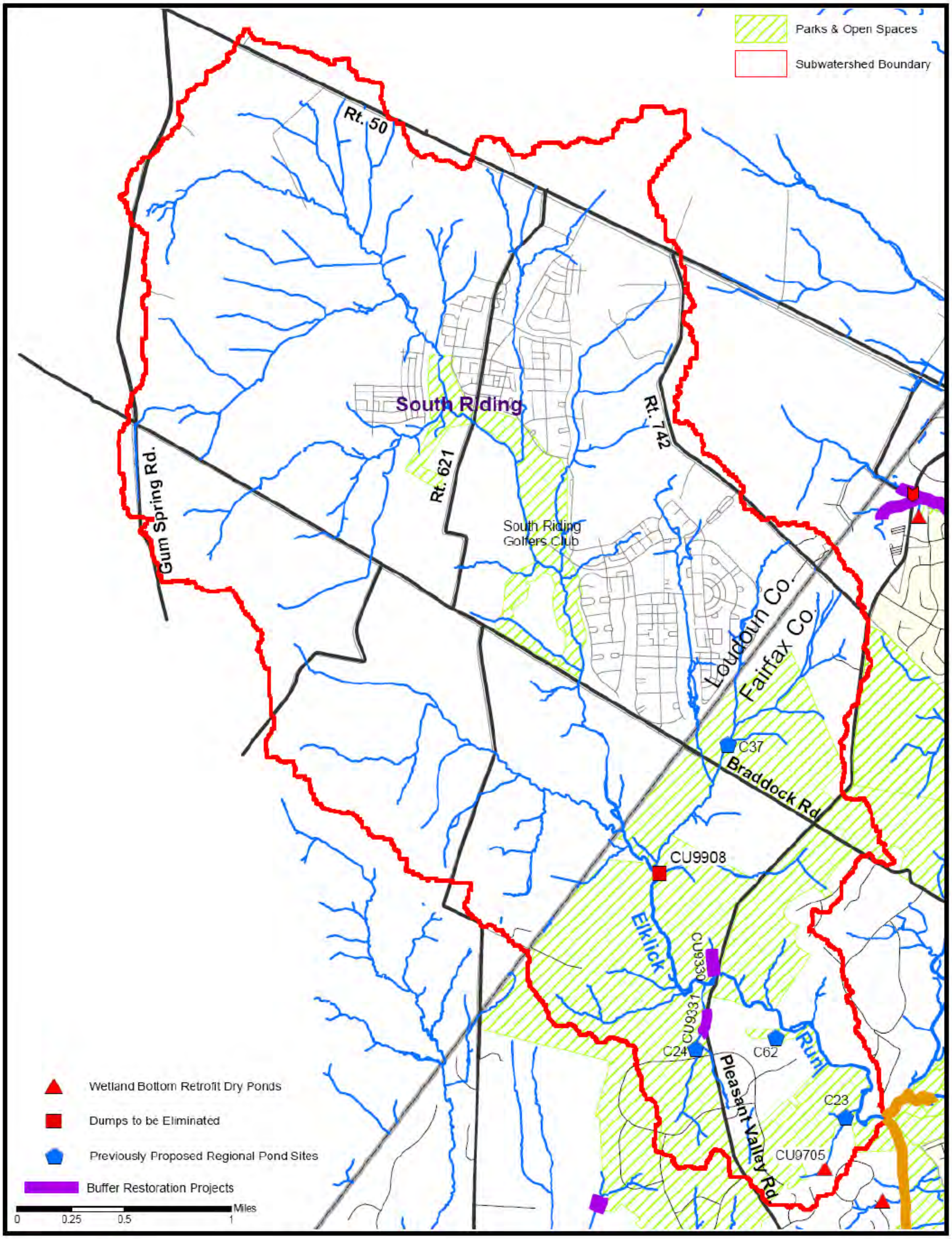

Figure 6-41
Structural Projects in the Elklick Run Subwatershed

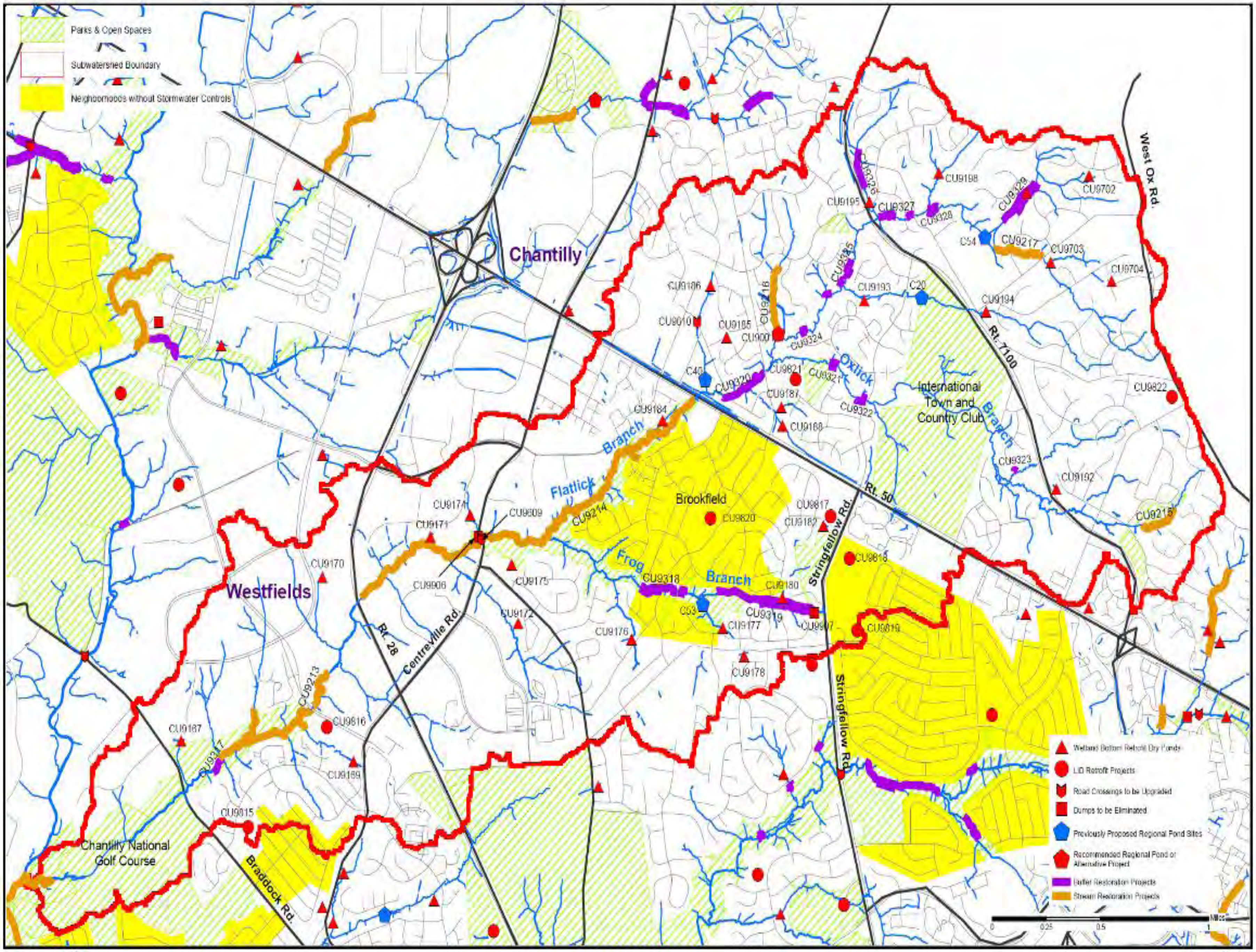

Figure 6-42
Structural Projects in the Flatlick Branch Subwatershed

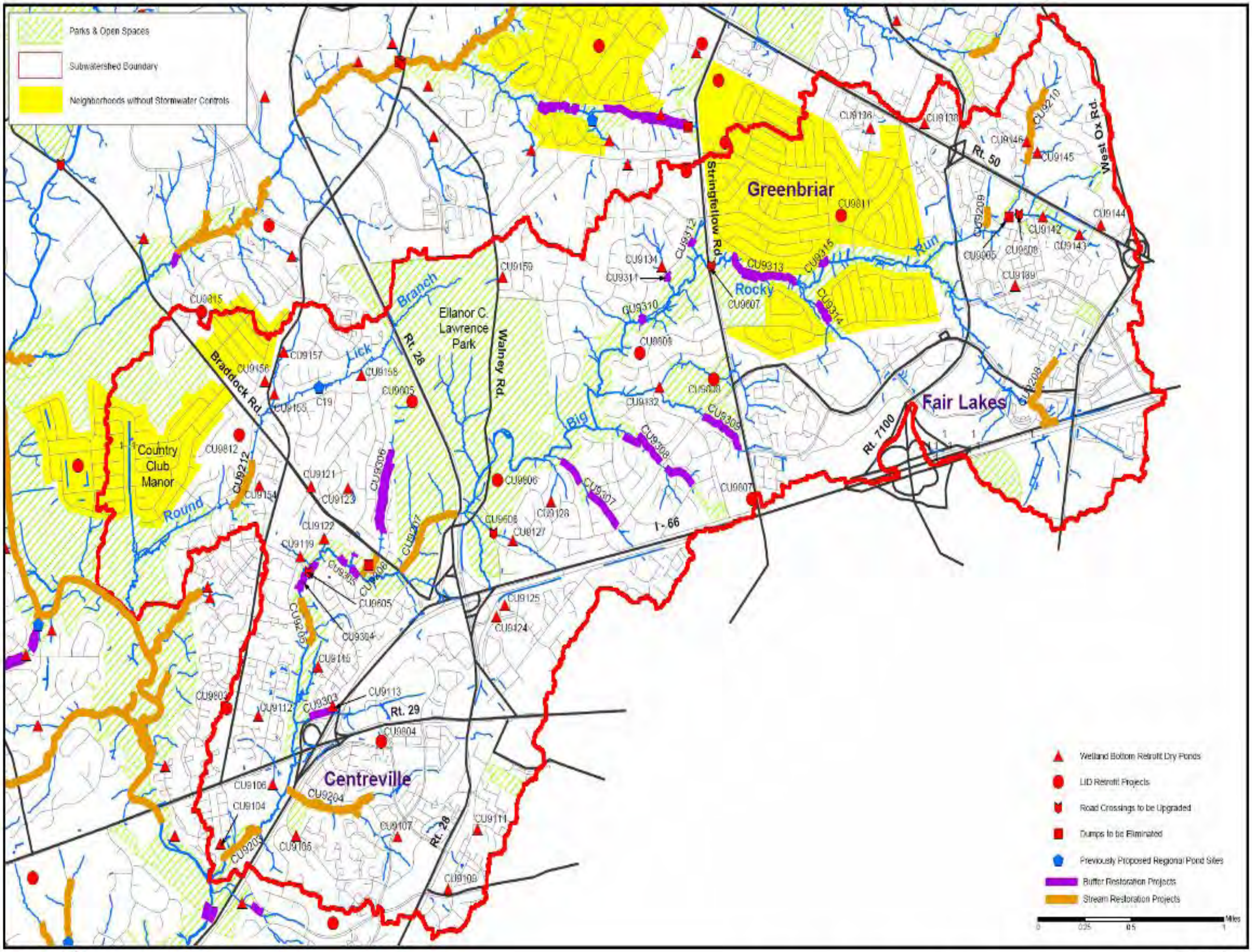

Figure 6-43
Structural Projects in the Big Rocky Run and Roundlick Branch Subwatersheds

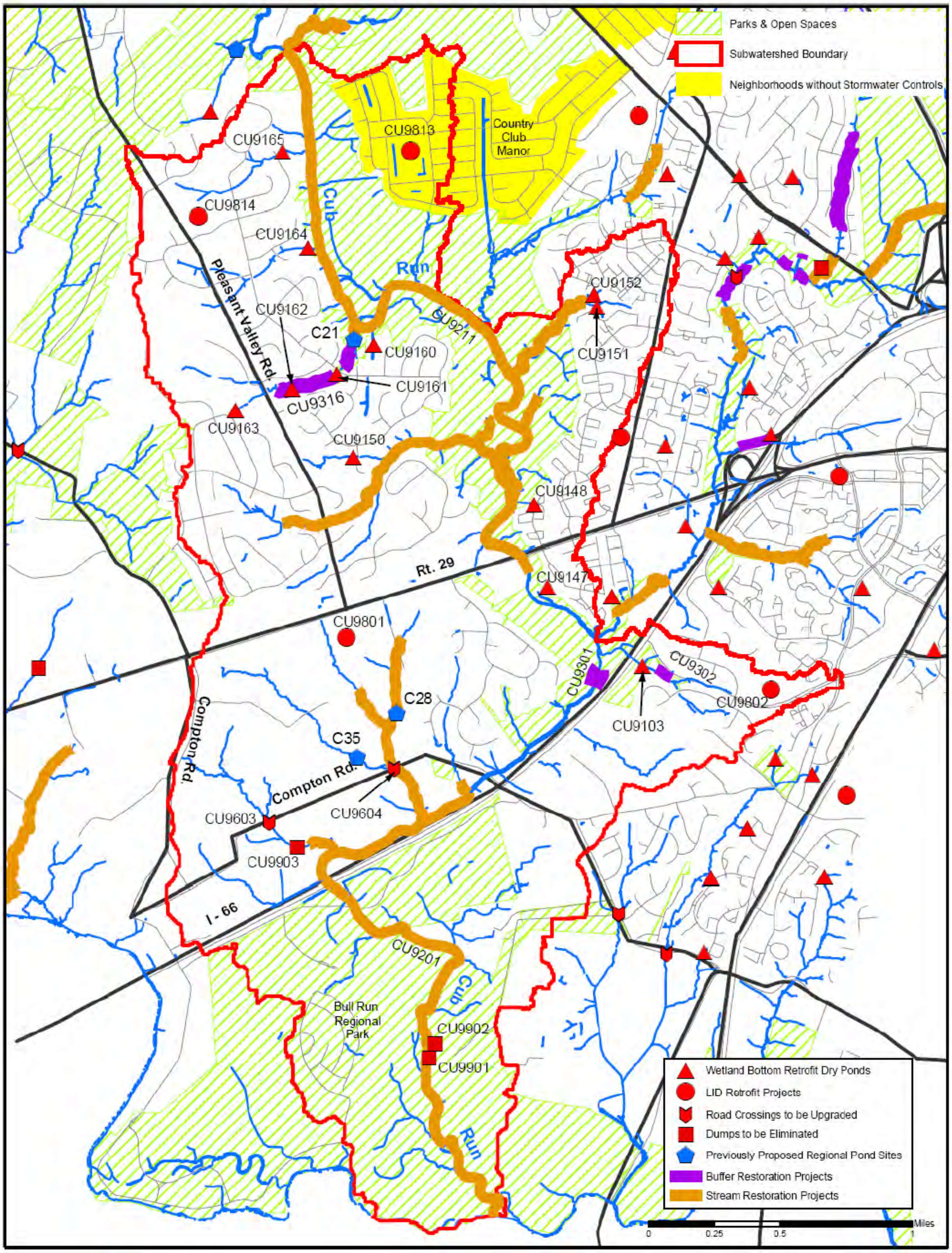

Figure 6-44
Structural Projects in the Lower Cub Run Subwatershed

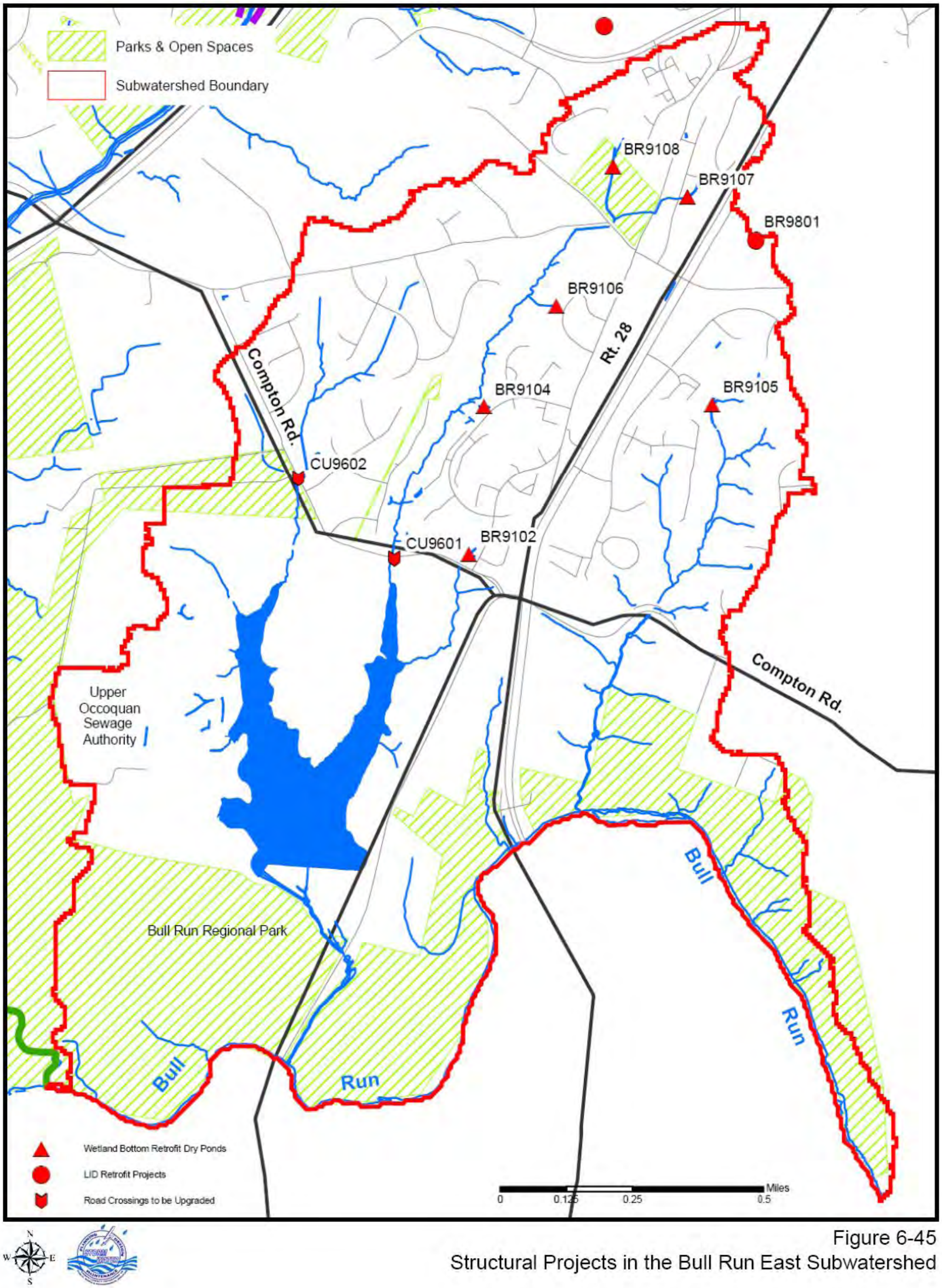

Figure 6-45
Structural Projects in the Bull Run East Subwatershed

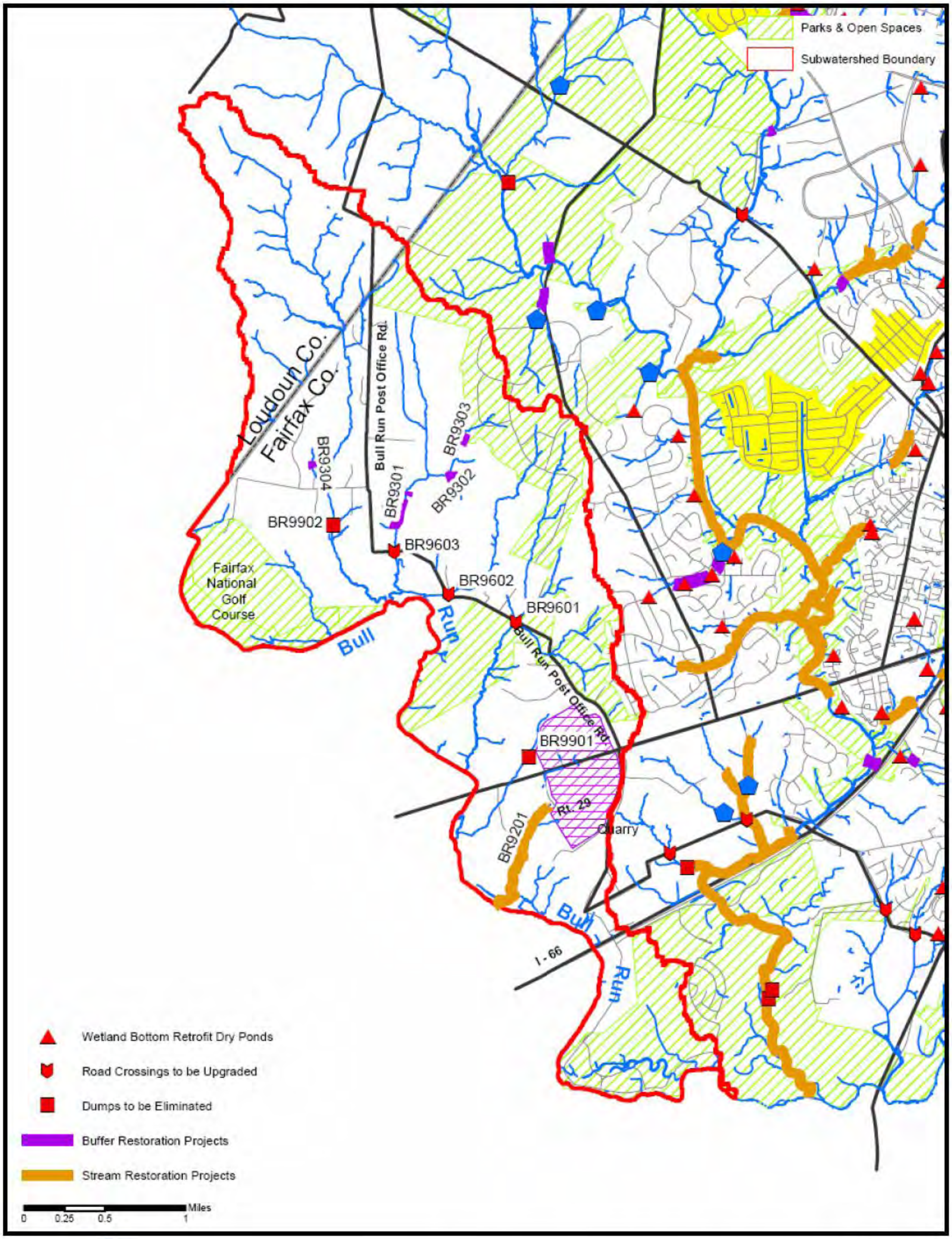

Figure 6-46
Structural Projects in the Bull Run West Subwatershed

Table 6-41

Sununary of Structural Projects in the Upper Cub Run Subwatershed

Struchual Project Type	Number of Projects	Project ID	Description	Length (Feet) or Total Area (Acres)
Wetland Bottom Retrofit Dry Ponds	16		CU9706, CU9707, CU9709, CU9710, CU9711, CU9712, CU9713, CU9714, CU9715, CU9716, CU9717, CU9'718, CU9719, CU9720, CU9721, CU9722	412 Acres
LID Retrofit Projects	3	CU9823	Westfield High School	3.6 ACL'es
		CU9824	Cub Rtm Recreation Center	
		CU9825	Franklin Midclle School	
Road Crossing to be Upgraded	3	CU9611	Braddock Road and Old Lee Road at Cub Run	
		CU9612	Pleasant Valley Rd at Lmnamed tributary near Blue Spring Dr.	
		CU9613	Cain Brrutch at Lees Corner Road	
Dumps to be Eliminated	1	CU9909	Debris and dumping at Upper Cub Run Wastewater Treatment Plant site	
Proposed Regional Pond or Alternative Project	1	CU9902	Regional Pond C18 or alternative storm water conhols	416 acres
Neighborhoods without Stormwater Controls	1	CU9913	Pleasant Valley	193 Acres
Bttffer Restoration Projects	8	CU9335	Cain Brru1ch - Downstream from Centerville Rd.	1,680 Feet
		CU9336	Unnamed Tributary to Elklick Run Near Pleasant Valley Rd.	1,290 Feet
		CU9332	Cub Rtm at Old Lee Rd.	250 Feet
		CU9339	Dead Run upsh:earn Fwm Stonecroft Blvd.	1,240 Feet
		CU9338	Dead Run at Stonecroft Blvd.	1,140 Feet
		CU9337	Tributary to Cub Run Pleasant Valley Neighborhood	6,160 Feet
		CU9333	Schneider Branch Upstream from Cub Rw1	1,160 Feet
		CU9334	Tributary to Cai_n Branch at Centerville Rd.	1,060 Feet
Total				*13,080 Feet*
Stream Restoration Projects	5	CU9221	Tributary to Dead Run. upstream from Stonecroft Blvd.	2,540 Feet
		CU9218	Cub Run, Sdmeider Brandl, and Cain Brru1d1	4,660 Feet
		CU9219	Cain Branch Upstream from Route 50	2,080 Feet
		CU9220	Cain Branch Upstream from Route 28	1,320 Feet
		CU9211*	Middle Cub Run main stem and tributaries	29,810 Feet
Total				*40,410 Feet*

*Project also affects Flatlick and Lower Cub Run Subwatersheds

Table 6-42
Summaq of Structural Projects in the Elklick Rtm Subwatershed

Structural Project Type	Number of Projects	Project ID	Description	Length (feet) or Total Area (Acres)
Wetland Bottom Rebofit Dry Ponds	1	CU9705	Ridings Manor Place	44 Acres
Dumps to be Eliminated	1	CU9908	Appliances	
Sb·eam Buffer Restoration Projects	2	CU9330	FCPA Parkland Near Pleasant Valley Road	1,350 Feet
		CU9331	FCWA Parkland Adjacent to Pleasant Valley Road south of Elkhck Run	720 Feet
Total				*2,070 Feet*

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Table 6-43
Summruy of Srructural Projects for the Flatlick Brru1ch Subwatershed

Sh·uctural Project Type	Number of Projects	Project ID	Description	Length (feet) or Total Area iAcres)
Wetland Bottom Retrofit Dry Ponds	26		CU9184, CU9198, CU9702, CU9701, CU9195, CU9703, CU9704, CU9186, CU9193, CU9185, CU9187, CU9188,CU9192, CU9174,CU9182 CU917l, CU9175, CU9170, CU9172, CU9177 CU9176, CU9178, CU9167, CU9169, CU9180 CU9194,	910 acres
LID Rehofit Projects	8	CU9815 CU9816 CU9817 CU9818 CU9819 CU9820 CU9821 CU9822	Cub Run Elementary School Sully Disb:ict Supervisor's Office Oumtilly Library 01ru1tilly High Sd1ool Greenbriar West Elementary School Brookfield Elementary Sd1ool Lees Corner Elementary School Navy Elementary School	3.4 Acres
Road Crossing to be Upraded	2	CU9609 CU9610	Flatlick Brru1ch at Walney Road Birch Drive at unnam ed b·ibutary	
Dumps to be Eliminated	2	CU9906 CU9907	Consb:uction Debris Cast iron pipes	
Proposed Regional Ponds or Alternative Projects	1	CU9001	Regional Pond C39 or altemative stonnwater projects	127 Acres
Neighborhoods witl1out Storm·water Conb:ols	2	CU9912 CU99ll	Brookfield Greenbriru·ru1d Birch Pond*	847 Acres
Buffer Restoration Projects	13	CU9320	Flatlick Brru1ch main stem upstrerun from Rt. SO	1,350 Feet
		CU9322	Oxlick Branch downstream from Stringfellow Rd.	430Feet
		CU9329	Tributruy to Flatlick Brru1ch Frru1l<lin Manor	2,000 Feet
		CU9328	Flatlick Brru1ch upsb:erun from Thompson Rd.	660 Feet
		CU9327	Flatlick Brand1upsbam form Fairfax County Parkway	840 Feet

Table 6-43
(continued)
Swmmu.y of Structural Projects for the Big Rocky Run and Round Lick Branch Su.bwatersheds

Structural Project Type	Number of Projects	Project ID	Description	Length (Feet) or Total Area (Acres)
Buffer Restoration Projects	13	CU9312	Tributary to Big Rocky Run downstream from Stringfellow Rd.	230 Feet
		CU9310	Tributary to Big Rocky Run downstream. from. Point Pleasant Dr.	270 Feet
		CU9313	Big Rucky Rmt upstrecuu frum Striugfelluw Rd.	2,630 Feet
		CU9314	Tributary to Big Rocky Run downstream from Melville Lane.	700 Feet
		CU9315	Big Rocky Run downstream from Middle Ridge Drive	330 Feet
		CU9305	Big Rocky Rtm downstream from Braddock Rd.	700 Feet
		CU9306	Tributary to Big Rocky Run upstream from Braddock Rd.	3,820 Feet
		CU9304	Big Rocky Rtm At Awbrey Patent Dr.	980 Feet
		CU9303	Tributary to Big Rocky Run 1-66 / Rt. 20 Interchange	710 Feet
		CU9309	Tributary to Big Rocky Run upstream from Northboume Dr.	1,460 Feet
		CU9308	Frog Branch downstream from Northbourne Dr.	*2A20* Feet
		CU9307	Tributary to Big Rocky Run Ellicot Comt	1,950 Feet
Total				*16,200 Feet*
Stream Restoration Projects	9	CU9210	Tributary to Big Rocky Run at Ox Hill Rd.	2 10 Feet
		CU9212	Rotmd Lick Branch upstream from Sully Park Drive	1A30 Feet
		CU9205	Big Rocky Run below Awbrey Patent Dr.	1,390 Feet
		CU9206	Tributary to Big Rocky Run Below Braddock Rd.	740 Feet
		CU9207	Big Rocky Rtm Between Flatlick Branch to below Rt. 29	*2ASO* Feet
		CU9209	Tributary to Big Rocky Run Oaks 01ase	530 Feet
		CU9208	Tributary to Big Rocky Rw1 Fair Lakes	2,680 Feet
		CU9204	Tributary to Big Rocky Run the Meadows Upstream from 1-66	*3A70* Feet
		CU9203	Tributary to Big Rocky Run upstream from Cub Run Confluence	1,550 Feet
Total				*16,550 Feet*

*Project also affects Flatlick Branch and/or Lower Cub Run Subwatersheds

Table 6-44

Sunumuy of Structural Projects for the Big Rocky Run and Round Lick Branch Subwatersheds

Structural Project Type	Number of Projects	Project ID	Description	Length (Feet) or Total Area (Acres)
Wetland Bottom Retrofit Dry Ponds	33		CU9138, CU9136, CU9146, CU9145, CU9142, CU9144, CU9134, CU9159, CU9139, CU9157, CU9158, CU9156, CU9132, CU9155, CU9154, CU9121, CU9123, CU9128, CU9122, CU9127, CU9119, CU9125, CU9124, CU9115, CU9113, CU9112, CU9106, CU9111, CU9105, CU9107, CU9104, CU9109, CU9143	1,050 Acres
LID Retrofit Projects	10	CU9803 CU9804 CU9805 CU9806 CU9807 CU9808 CU9809 CU9810 CU9811 CU9812	London Towne Elementary School Cenh·eville Library Ellanor C. Lawrence Park Cabells Mill Stringfellow Road Commuter Lot Poplar Tree Park Poplar Tree Elementary School Rocky Run Middle School Greenbriar East Elementaty School Stone Middle School	10.3 Acres
Road Crossing to be Upgraded	4	CU9605 CU9606 CU9607 CU9608	Awbrey Patent Drive at Big Rocky Rm1 Heron. Drive Big Rocky Rtm at Stringfellow Road Dorforth Drive	
Dumps to be Eliminated	2	CU9904	Gas tanks/transformer Trash and car	
Neighborhoods without Stonnwater Cona·ols	2	CU9910 CU9911	Cotmtry Club Manor * Greenbriar and Birch Pond*	966 Acres

Table 6-44
(continued)
Smnmaq of Structmal Projects for the Big Rocky Run and Round Lick Branch Subwatersheds

Structural Project Type	Number of Projects	Project ID	Description	Length (Feet) or Total Area (Acres)
Buffer Restoration Projects	13	CU9312	Tributary to Big Rocky Run downstream from Stringfellow Rd.	230 Feet
		CU9310	Tributary to Big Rocky Run downstream from Point Pleasant Dr.	270 Feet
		CU9313	Big Rocky Rtm upstream from Sb·ingfellow Rd.	2,630 Feet
		CU9314	Tributary to Big Rocky Run downstream from Melville Lane.	700 Feet
		CU9315	Big Rocky Rm1 downstream from Middle Ridge Drive	330 Feet
		CU9305	Big Rocky Rtm downstream from Braddock Rd.	700 Feet
		CU9306	Tributary to Big Rocky Run upstream from Braddock Rd.	3/820 Feet
		CU9304	Big Rocky Rtm At Awbrey Patent Dr.	980 Feet
		CU9303	Tributary to Big Rocky Run 1-66 / Rt. 20 Interchange	710 Feet
		CU9309	Tributary to Big Rocky Run upsb·eam from Northboume Dr.	1,460 Feet
		CU9308	Frog Branch downstream from Northbourne Dr.	2_420 Feet
		CU9307	Tributary to Big Rocky Run Ellicot Comt	1,950 Feet
Total				*16,200 Feet*
Sbeam Restoration Projects	9	CU9210	Tributary to Big Rocky Run at Ox Hill Rd.	2 10 Feet
		CU9212	Rotmd Lick Branch upstream from Sully Park Drive	1_430 Feet
		CU9205	Big Rocky Run below Awbrey Patent Dr.	1,390 Feet
		CU9206	Tributary to Big Rocky Run Below Braddock Rd.	740 Feet
		CU9207	Big Rocky Rtm Between Flatlick Branch to below Rt. 29	2_450 Feet
		CU9209	Tributary to Big Rocky Run Oaks 01ase	530 Feet
		CU9208	Tributary to Big Rocky Rm1 Fair Lakes	2,680 Feet
		CU9204	Tributary to Big Rocky Run the Meadows Upsb·eam from 1-66	3_470 Feet
		CU9203	Tributary to Big Rocky Run upstream from Cub Run Confluence	*1,550* Feet
Total				*16,550 Feet*

* Project also affects Flatlick Branch and/or Lower Cub Run Subwatersheds

Table 6-45

Summary of Structural Projects for the Lower Cub Run Subwatershed

Structural Project Type	Number of Projects	Project ID	Description	Length (Feet) or Total Area (Acres)
Wetlat1d Bottom Retrofit DtyPonds	12		CU9103, CU9147, CU9148, CU9150, CU9151, CU9152, CU9160, CU9161, CU9162, CU9163, CU9164, CU9165	570 Acres
LID Retrofit Projects	4	CU0901 CU9802 CU9813 CU9814	Bull Run Elementary School Cenbe Ridge Elementary School Deer Pru·k Elementary School Virginia Run Elementaty School	3 Acres
Road Crossing to be Upgraded	2	CU9603 CU9604	Compton Road Compton Road	
Dumps to be Eliminated	3	CU9901 CU9902 CU9903	55-gallon drums at1d above grotmd tatlk Appliat1ces, b·ash, tires, etc. 55-gallon drwns	
Neighborhoods without Stonnwater Controls	1		Countty Club Manor South	280 Acres
Buffer Restoration Projects	3	CU9301	Cub Rm1 downstream from Big Rocky Rm1	820 Feet
		CU9316	Tributary to Cub Run Virginia Rw1 Downstream from Pleasat1t Valley Rd .	3,550 Feet
		CU9302	Tributary to Cub Run upsb·erun from I-66	380 Feet
Total				*4J50 Feet*
Stream Restoration Projects	3	CU9211*	Middle Cub Rtm main stem and b·ibutat·ies between Flatlick Branch to below Rt. 29	29,810 Feet
		CU9202	Lower Bull Rw1 atld Um1atned Tributru·ies between Compton Rd. atld Rt. 66	10,400 Feet
		CU9201	Lower Cub Run within Bull Run Regional Park	10,030 Feet
Total				50,210 *Feet*

*Project also affects Flatlick and Upper Cub Run Subwatersheds

Table 6-46

Summruy of Structural Projects for the Bull Run East Subwatershed

Sh·uctural Proj ect Type	Number of Proj ect	Project 10	Description	Length. (Feet) or Total Area (Acres)
Wetland Bottom Rehofit Dry Ponds	8	BR9102 BR9104 BR9105 BR9106 BR9107 BR9108	Old Cenbeville Rd and Compton Rd Flamborough Road Stone Maple Terrace Tracy Shru· Lru1e Wheat Mill Way and Granary Rd Sharps Drive	170 Acres
LID Rehofit Projects	1	BR9801	Cenheville Elementary School	0.9 Acres
Road Crossings to be Upgraded	2	CU9601	Compton Road Near UOSA CU9602 Compton Road	

Table 6-47

Sununruy of Structural Projects for the Bull Run West Subwatershed

Structural Project Type	Number of Projects	Project ID	Description	Length (feet) or Total Area (Acres)
Road Crossing to be Upgraded	3	BR9601 BR9602 BR9603	Bull Run Post Office Road	
Dumps to be Eliminated	2	BR9901 BR9902	Dirt in Sheam Rusted truck atid metal	
Buffer Restoration Projects	4	BR9301	Tributary to Bull Run	1,270 Feet
		BR9303	Tributary to Bull Run	800 Feet
		BR9304	Tributaty to Bull Run Fairfax National Estates	220 Feet
		BR9302	Tributary to Bull Run	310 Feet
Total				2,600 *Feet*
Strerun Restoration Projects	1	BR9201	Tributary to Bull Run below Quarry	3,470 Feet

Section 7
Project Prioritization and Implementation Plan

7.1 Introduction

Sections 4, 5 and 6 of this report documented nonstructural actions, policy recommendations and structural projects considered for implementation in the Cub Run and Bull Run Watershed Plan. This section evaluates the effectiveness of these projects in meeting the watershed goals, prioritizes the projects, develops an implementation program and documents the improvements provided by the plan.

The recommended actions will potentially be implemented over the 25-year life of the Cub Run and Bull Run Watershed Management Plan. This plan will be a guide for county agencies and officials in protecting and maintaining the health of the Cub Run and Bull Run watersheds. It will be an active or "living" document that will be revisited and updated regularly as it is implemented.

The plan's projects are effective solutions for improving water quality and controlling stormwater in the Cub Run and Bull Run watersheds. The plan will be revisited as needed during implementation to assess project effectiveness and implementation sequence. The final scope and design of each project will be determined during implementation, in collaboration with all parties affected, including the Fairfax County Park Authority, homeowner associations, adjacent landowners and others.

The plan identifies the projects to be evaluated and implemented within each of the following five-year implementation phases:

- A - Year 1 – 5
- B - Year 6 – 10
- C - Year 11 – 15
- D - Year 16 – 20
- E - Year 21 - 25

Organizing the projects by the five phases provides a framework for project implementation. The placement of projects within each phase is based primarily on the project priority developed as described in Section 7.3, although other factors are considered. Phase A includes higher-priority projects and Phase E includes lower-priority projects.

As described in Section 1.2, the projects and schedule will change from the recommends in this plan as they undergo further evaluation during implementation.

Work has begun on implementing several of the actions. Work will not be halted because of its priority ranking. Also, low priority actions may be moved forward in the schedule when opportunities and resources become available. Additional factors may affect the projects to be implemented and implementation schedule are describe below:

- Projects, programs and policy items will undergo review by county staff and the Board of Supervisors before implementation. Board adoption of the watershed plan will not mean automatic implementation of the plan recommendations.

- The watershed plan is a master list of recommended nonstructural actions and structural projects. Each fiscal year, staff will prepare and submit to the board a detailed spending plan that will describe the projects and explain their ranking, benefit and need to meet a defined watershed or water quality goal.

- The watershed plan considers visions, goals, issues and needs only within the Cub Run and Bull Run watersheds. Fairfax County will consider stormwater needs and priorities across the entire county when implementing the recommendations included in this plan and other watershed plans.

- Availability of funding and other resources will affect the implementation of projects identified in this watershed plan.

- The initial project implementation phases will include outreach to the community near the proposed projects. Elements of the recommended plan may become infeasible or need to be modified based on comments from local residents during this outreach.

- Projects will be value-engineered at the time of implementation to ensure cost-effectiveness. Using volunteers or alternative funding sources will be considered to reduce the implementation costs.

- Stream crossing improvements not related to protection of streambeds or banks or prevention of structure flooding will not be funded out of the county budget for stormwater improvements.

- Stream restoration and other projects on private land will be evaluated to determine means for cost sharing with the landowners.

7.2 Overview of Watershed Vision and Goals

7.2.1 Watershed Plan Vision and Goals

Section 1.4 documented the watershed plan vision and goals set by the Community Advisory Committee, project team and Fairfax County. These generally state that the watershed plan should preserve, protect and improve the watersheds and streams and largely relate to improving the functions of the watershed, water quality, habitat and aesthetics. The watershed plan recognizes that these watershed functions are important to residents and should be given a significant weight in selecting projects to be implemented. However, the goals are difficult to measure and therefore cannot be used to prioritize the watershed actions quantitatively using procedures such as cost vs. benefit analyses.

7.2.2 Watershed Plan Water Quality Goals

As discussed in Section 3, the Cub Run and Bull Run watersheds contain many stormwater ponds that provide peak flow and water quality controls for much of the developed land. In addition, the watershed includes significant areas of parkland and other preserved space. Finally, in large portions of the watershed development density is limited to one house per five acres within the rezoned Resource-Conservation District. As a result, the watershed meets the water quality loading goals for the Occoquan Reservoir for both existing and future land use (with future stormwater controls). Section 3.2.6 provided additional information on the Occoquan basin loading goals.

The watershed also meets or exceeds the requirements of the Virginia Chesapeake Bay Nutrient and Sediment Reduction Strategy for the Shenandoah and Potomac River Basin (March 2005). Section 3.2.7 provides additional information on the tributary strategy goals. The tributary strategy assumes that urban stormwater controls will be applied for 42.5 percent of the treatable urban area. Existing and future water quality controls cover 90 percent of the urban development in the Fairfax County portion of the watersheds. The tributary strategy's loading target results in a phosphorus loading of approximately 0.31 lbs/acre/year over the Virginia portions of the Shenandoah and Potomac River basins. This target load is an average for all land uses including forest, agriculture and urban. For future land use with future stormwater controls and plan recommendations, the Fairfax County portion of the watersheds contribute 0.53 lbs/acre/year, which is 71 percent greater than the basin-wide average tributary strategy goal. The Cub Run watershed contains significant urban areas, whereas the tributary average includes significant areas of forest and other undeveloped land.

The Occoquan Reservoir is effective in reducing nutrient loads to the Potomac River. If the 54 percent phosphorus loading reduction produced by the Occoquan Reservoir is applied, the loads from Cub Run watersheds to the Potomac River (0.24 lbs/acre/year) are less than the overall tributary strategy goals (0.31 lbs/acre/year).

The watershed plan structural actions target improving the efficiency of existing stormwater facilities and otherwise improving runoff quality with an overall goal of reducing nutrient loads five percent for future land use. As discussed in Section 7.9.3, the watershed plan reduces phosphorus runoff for future land used from 0.56 lbs/acre/year to 0.53 lbs per acre per year, a 4.5% nutrient reduction.

7.3 Prioritization Methodology

The prioritization methodology presented herein is based on procedures developed by the Fairfax County Stormwater Planning Division and has been applied in other watershed management plans. The prioritization provides a guide for preparing the schedule for project implementation. However, additional factors are considered.

The following factors define the project implementation sequence and schedule:

1. Location within the watershed. For example, quantity control projects in the headwaters upstream from erosion areas may be given higher priority. Similarly, water quality controls in areas that do not have stormwater controls may be given higher priorities. Projects to control the peak flows would be implemented before a downstream restoration project. As a final example, projects that may work synergistically to improve conditions in part of a watershed are grouped rather than performed shotgun throughout the watershed. This approach reduces community outreach requirements and limits construction impacts since projects that affect a particular neighborhood are implemented as one project.

2. Effectiveness in meeting project goals, removing pollutants, reducing peak flows, addressing stream erosion and meeting regulatory requirements

3. Ease of implementation based on complexity, land acquisition requirements, permitting needs and other factors

4. Watershed community advisory committee support and recommendations for project sequencing

5. Support by residents near the project

6. Political interest

7. Categories that meet other goals of Fairfax County

8. Funding availability

A weighted set of five prioritization categories was applied to each plan action. The weighting factor assigned is indicated in parentheses:

1. Fairfax County Goals (40%). This category recognizes the effectiveness of the actions in meeting other Fairfax County goals, which were developed in the early 1990s and have been adopted by the Fairfax County Board of Supervisors. They are listed below in order of higher to lower importance.

    - Projects mandated for immediate implementation by state or federal regulations and ones that address safety issues

    - Projects that protect structures from damage by floodwaters or stream erosion

- Projects that achieve stormwater quality improvements in conformance with the county's obligations under the Chesapeake Bay initiatives and the Virginia Pollutant Discharge Elimination System (VPDES) municipal separate storm sewer system (MS4) stormwater discharge permit
- Projects that alleviate severe stream bank and channel erosion
- Projects that alleviate moderate and minor stream bank and channel erosion
- Projects that alleviate yard flooding
- Projects that alleviate road flooding. Projects that affect road flooding will not be performed with county stormwater program funds but are in this watershed plan for consideration in future road improvement projects.

2. Direct Regulatory Contribution (10%). These include the following project types listed in order of higher to lower importance.
    - Hybrid projects that accomplish multiple objectives, including regulatory compliance
    - Projects that directly contribute to the county's Virginia Pollutant Discharge Elimination System permit for storm sewer system discharges and obligations under the Chesapeake Bay initiatives
    - Projects that have indirect water quality benefits
    - Flood mitigation and similar projects
3. Public Support (10%)
    - Community advisory committee support
    - Perceived support by residents near the project location based on input provided to date and other public input
4. Effectiveness and Location (25%)
    - Quantity control projects are more desirable in headwater areas that lack stormwater management controls.
    - Quality control projects are more desirable in areas that lack existing controls.
    - Projects that address peak flows and velocities should be implemented before downstream stream restoration projects.
    - Project effectiveness in removing pollutants, eliminating stream erosion, meeting project goals, etc.

- Project effectiveness related to the cost of project implementation. Projects that have high cost relative to benefit provided receive lower scores.

5. Ease of Implementation (15%)

   - Project location

   - Land acquisition requirements

The plan actions are given a score from 1 to 5 for each prioritization category with 5 being the highest score and 1 the lowest. The assigned scores are based on both qualitative and quantitative measures. The weighting factors are applied to a total score used to rank the projects.

7.4 Nonstructural Project Prioritization and Implementation Program

Table 7-1 shows the priority rankings, based on the procedures described in Section 7.3, for the nonstructural actions listed in Section 4. This table provides the implementation phase, assuming that all nonstructural actions are considered for implementation within the first 15 years of the 25-year program.

Many of the nonstructural actions will be considered with similar recommendations from other watershed plans and will potentially be implemented across all watersheds. Also, many of the actions involve coordination with other agencies such as the Northern Virginia Soil and Water Conservation District, Fairfax County Health Department and Virginia Department of Conservation and Recreation. County staff may complete portions of these actions. Outside consultants may be used when specific areas of expertise are required.

Funds and staff resources will be required to implement these recommendations. These resources will be estimated at the time a nonstructural action is being evaluated for implementation as part of the annual budget process. The watershed plan recommends that the county continues to use existing resources, partnerships and allocate adequate funds to implement these nonstructural policy recommendations.

Table 7-1
Nonstructural Project Prioritization and Implementation Program

Number	Description	Priority Score	Implementation Phase
Action C 1.2	TMDL support for bacteria	4.60	A
Action A 2.5	Public education on fertilizer and pesticides	4.25	A
Action A 1.3	Education on Occoquan Reservoir	4.15	A
Action A 1.5	Education on stormwater runoff	4.15	A
Action A 6.1	Outreach and education for commercial and industrial establishments	4.10	A
Action C 1.3	Coordinate with park agencies on watershed and parkland planning	4.10	A
Action D 1.1	Signs for pet waste	4.10	A
Action D 3.1	Partner with golf courses	4.10	A
Action D 3.2	Turf management outreach	4.10	A
Action D 3.3	Lawn maintenance company outreach and certification	4.10	A
Action D 6.2	Inspect and sample privately owned and maintained stormwater management facilities	4.10	A
Action E 1.1	Update Public Facilities Manual	4.10	A
Action E 1.2	Reference sources for LID implementation	4.10	A
Action A 2.3	Education on pet wastes	4.00	A
Action A 2.4	Education on disposal of chemicals and paints	4.00	A
Action B 1.4	Annual interjurisdictional summit	4.00	A
Action E 2.2	Dulles development requirements and backup facilities plan	4.00	A
Action A 4.2	Develop LID guidance for homeowners	3.90	A
Action D 2.1	LID design guidance for property owners	3.85	A
Action E 4.1	Restoration project banking and funding mechanism	3.85	B
Action A 4.1	Outreach to builders to implement LID	3.75	B
Action D 5.5	Create spill and dumping reporting hotline	3.75	B
Action E 1.3	LID implementation review criteria	3.75	B
Action A 1.4	Promote Buffer maintenance and restoration	3.75	B
Action A 1.8	School education programs	3.75	B
Action A 2.2	Education and actions to reduce trash and dumping	3.75	B
Action D 4.2	Eliminate access and place signs at dump sites	3.75	B
Action D 6.3	Brownfield sites	3.65	B

Table 7-1
(continued)
Nonstructural Project Prioritization and Implementation Program

Number	Description	Priority Score	Implementation Phase
Action E 4.2	Education on mitigation close to impact sites	3.65	B
Action A 1.6	Multi lingual outreach programs	3.60	B
Action E 2.1	Monitor upstream development and stormwater controls	3.60	B
Action F 1.1	Preserve open space	3.60	B
Action F 1.2	Create open space preservation plan	3.60	B
Action A 1.9	Library education programs	3.50	B
Action A 5.2	Create and distribute reference information for common stormwater problems	3.50	B
Action D 6.1	Inventory hazardous material users	3.50	B
Action E 3.1	Coordinate with agencies regarding transportation improvements	3.45	B
Action A 1.1	Stormwater ombudsman	3.35	B
Action A 1.2	Promote Adopt-a-Stream program	3.35	B
Action A 3.1	Update county website	3.35	B
Action A 5.1	Outreach to home owner associations, civic associations and property owners on watershed planning program	3.35	B
Action B 1.1	Interjurisdictional pollution control goals and evaluation criteria	3.35	B
Action B 1.2	Share data among jurisdictions	3.35	B
Action B 1.3	Coordinate regulations among jurisdictions	3.35	B
Action D 1.2	Non-native and invasive species	3.35	B
Action D 4.1	Eliminate existing dumps	3.35	B
Action D 5.6	Support source water protection study	3.35	B
Action C 2.1	Identify and protect historic, cultural and ecologic resources	3.30	C
Action C 3.1	Education and outreach at FCPA parks	3.10	C
Action C 3.2	Education and outreach at NVRPA parks	3.10	C
Action D 5.2	Volunteer benthic sampling coordination and reporting	2.95	C
Action A 1.7	Signs on stream crossings	2.75	C
Action A 2.1	Mosquito education	2.75	C
Action D 5.3	Publicize water quality sampling results	2.60	C
Action D 5.1	Inspect county stormwater facilities more frequently	2.55	C
Action D 5.4	Inspect private facilities more frequently	2.55	C
Action D 4.3	Provide an approved dump location or promote community cleanup days	2.45	C
Action D 4.4	Trash receptacles at high impact areas	2.45	C
Action C 1.1	Create interconnect trail system	2.30	C

7.5 Policy Recommendation Prioritization and Implementation Program

Policy recommendations described in Section 5 are ranked and sorted by their assigned priority in Table 7-2. This table also provides the implementation phase for these projects with all recommendations being considered within the first 15 years of the 25-year program.

Funds and staff resources will be required to implement these recommendations. These resources will be estimated at the time a policy recommendation is being evaluated for implementation as part of the annual budget process. Existing resources and partnerships will be used when available. The watershed plan recommends that the county implement the recommended changes in policy and allocate adequate funds as needed.

Table 7-2
Policy Recommendation Prioritization and Implementation Program

Number	Description	Priority Score	Implementation Phase
E 4.1	Tree planting in buffers and near ponds	3.7	A
A 1.1	Include LID at county construction projects	3.65	A
D 2.1	Incentives for LID on private property	3.6	A
D 2.2	Grants for stormwater improvements	3.6	A
E 4.2	Prevent deforestation and promote forest restoration and protection in sensitive areas	3.6	A
E 1.2	Coordinate strategy for new development	3.5	A
F 1.1	Funding for open space	3.45	A
F 1.2	Conservation easements	3.45	A
F 1.3	Policies regarding open space in public property	3.45	A
E 3.2	Design and build road projects that minimize watershed impacts	3.35	A
E 5.1	Encourage use of smaller stormwater facilities	3.2	B
B 1.3	Present plan to Loudoun board of supervisors	3.15	B
D 3.1	Fines and penalties for dumping and littering	3.15	B
D 3.2	Enforce existing regulations regarding dumping and littering	3.15	B
B 1.1	Stormwater regulations in other jurisdictions	3.1	B
B 1.2	Cross-border cooperation	3.1	B
E 5.3	Evaluate and implement alternative stormwater controls	3.1	B
E 6.2	Adequate room for proper stormwater management	3	B

Table 7-2
(continued)
Policy Recommendation Prioritization and Implementation Program

Number	Description	Priority Score	Implementation Phase
E 1.4	Procedures to provide stormwater controls greater than required by public facilities manual	2.95	B
C 1.2	Integrate recreation and education into new and proposed stormwater facilities	2.85	B
D 1.2	Control of native wildlife	2.85	B
E 3.1	Recommendation regarding Tri-County Parkway and Battlefield Bypass	2.85	B
E 3.3	Promote stream and wetland mitigation in the same watershed	2.85	B
E 2.1	Dulles development requirements and backup facilities plan	2.8	C
C 2.1	Parkland should be developed to have minimum impact on streams	2.75	C
E 5.2	Modify adequate outfall policy	2.75	C
E 1.3	Streamline procedures for LID review for new development projects	2.7	C
E 6.1	Inspect new facilities for compliance with county standards	2.7	C
E 1.5	Design stormwater facilities to be more aesthetic	2.6	C
E 1.1	Promote alternatives to paved surfaces	2.55	C
D 1.1	Dead wildlife	2.5	C
C 1.1	Create fishing opportunities in existing and new wet ponds	2.05	C

7.6 Structural Project Prioritization and Implementation Program

Structural projects are ranked and sorted in Table 7-3. Dry pond wetland retrofit projects provide similar benefits based on this prioritization scheme and, therefore, are not listed separately. A separate analysis prioritized the dry pond retrofit projects, as described in Section 6.3.

Table 7-3
Structural Project Prioritization

Project Type	Number	Description	Priority Score
Dry Pond Wetland Retrofit Projects	-	94 Identified High Priority Dry Pond Projects	4.5
Regional Pond or Alternative Projects	CU9002	Pond C18 Cain Branch near Centreville Road	4.2
Regional Pond or Alternative Projects	CU9001	Pond C39 Flatlick Branch Tributary in Foxfield	4.2
Riparian Wetland Study	CU9915	Perform Wetland Study to identify riparian wetland restoration opportunities	4.15
LID Projects at County Facilities	1 – 22	Various	3.95
Neighborhoods without Stormwater Controls	CU9911	Greenbriar and Birch Pond	3.65
Neighborhoods without Stormwater Controls	CU9912	Brookfield	3.65
Neighborhoods without Stormwater Controls	CU9910	Country Club Manor	3.65
Neighborhoods without Stormwater Controls	CU9913	Pleasant Valley	3.65
Headwater drainage system improvements	CU9914	Implement headwater drainage system improvements	3.65
Stream Restoration	CU9217	Flatlick Branch Tributary downstream from Oxon Road	3.45
Stream Restoration	CU9216	Flatlick Branch Tributary in Franklin Glenn	3.45
Stream Restoration	CU9204	Big Rocky Run tributary in the Meadows upstream from I-66	3.45
Stream Restoration	BR9204	Bull Run tributary below quarry	3.45
Stream Restoration	CU9215	Oxlick Branch headwaters upstream from Alder Woods Drive in Fair Oaks Estates	3.45
Stream Restoration	CU9210	Big Rocky Run Tributary Upstream from Ox Hill Road in Fair Oaks Estates	3.45
Stream Restoration	CU9212	Round Lick Branch upstream from Sully Park Drive	3.45
Stream Restoration	CU9209	Big Rocky Run Tributary in Oaks Chase	3.45
Stream Restoration	CU9221	Dead Run Tributary Upstream from Stonecroft Blvd.	3.2

Table 7-3
(continued)

Structural Project Prioritization

Project Type	Number	Description	Priority Score
Stream Restoration	CU9219	Cain Branch upstream from Route 50	3.2
Stream Restoration	CU9214	Flatlick Branch between Route 50 and Route 28	3.2
Stream Restoration	CU9220	Cain Branch Between Route 28 and Centreville Road	3.2
Stream Restoration	CU9213	Flatlick Branch upstream and downstream from Stonecroft Blvd.	3.2
Stream Restoration	CU9205	Big Rocky Run Below Awbrey Patent Drive	3.2
Stream Restoration	CU9206	Big Rocky Run Tributary below Braddock Road	3.2
Stream Restoration	CU9207	Big Rocky Run between Route 28 and Braddock Road	3.2
Buffer Restoration	CU9331	Unnamed Tributary to Elklick Run adjacent to Pleasant Valley Road south of Elklick Run	3.1
Buffer Restoration	CU9335	Cain Branch downstream from Centreville Road	3.1
Buffer Restoration	CU9320	Flatlick Branch main stem upstream from Rt. 50	3.1
Buffer Restoration	CU9322	Oxlick Branch downstream from Stringfellow Road	3.1
Buffer Restoration	CU9329	Flatlick Branch tributary within Franklin Manor	3.1
Buffer Restoration	CU9330	Unnamed Tributary to Elklick Run near Pleasant Valley Road	3.1
Buffer Restoration	CU9336	Cain Branch upstream from Lees Corner Rd.	3.1
Buffer Restoration	CU9328	Flatlick Branch upstream from Thompson Road	3.1
Buffer Restoration	CU9327	Flatlick Branch upstream from Fairfax County Parkway	3.1
Buffer Restoration	CU9326	Flatlick Branch tributary adjacent to Fairfax County Parkway	3.1
Buffer Restoration	CU9324	Flatlick Branch upstream from Lees Corner Rd.	3.1
Buffer Restoration	CU9332	Cub Run at Old Lee Road	3.1
Buffer Restoration	CU9318	Frog Branch at Lees Corner Rd	3.1
Buffer Restoration	CU9301	Cub Run downstream from Big Rocky Run	3.1
Buffer Restoration	BR9301	Tributary to Bull Run	3.1
Buffer Restoration	BR9303	Tributary to Bull Run	3.1
Buffer Restoration	BR9304	Tributary to Bull Run near Fairfax National Estates	3.1
Buffer Restoration	CU9339	Dead Run upstream from Stonecroft	3.1
Buffer Restoration	CU9338	Dead Run at Stonecroft Blvd	3.1
Buffer Restoration	CU9337	Cub Run tributary near Pleasant Valley Neighborhood	3.1

Table 7-3
(continued)

Structural Project Prioritization

Project Type	Number	Description	Priority Score
Buffer Restoration	CU9333	Schneider Branch upstream from Cub Run	3.1
Buffer Restoration	CU9334	Cain Branch tributary at Centreville Road	3.1
Buffer Restoration	CU9325	Flatlick Branch downstream from Fairfax County Parkway	3.1
Buffer Restoration	CU9321	Oxlick Branch downstream from Stringfellow Road	3.1
Buffer Restoration	CU9317	Flatlick Branch upstream from Braddock Road	3.1
Buffer Restoration	CU9323	Oxlick Branch downstream from Fairfax County Parkway	3.1
Buffer Restoration	CU9312	Tributary to Big Rocky Run downstream from Stringfellow Road	3.1
Buffer Restoration	CU9310	Big Rocky Run downstream from Stringfellow Road	3.1
Buffer Restoration	CU9311	Tributary to Big Rocky Run downstream from Point Pleasant Drive	3.1
Buffer Restoration	CU9313	Big Rocky Run upstream from Stringfellow Road	3.1
Buffer Restoration	CU9314	Tributary to Big Rocky Run	3.1
Buffer Restoration	CU9315	Big Rocky Run	3.1
Buffer Restoration	CU9319	Frog Branch downstream from Stringfellow Road	3.1
Buffer Restoration	CU9316	Tributary to Cub Run within Virginia Run downstream from Pleasant Valley Rd.	3.1
Buffer Restoration	CU9305	Big Rocky Run downstream from Braddock Road	3.1
Buffer Restoration	CU9306	Tributary to Big Rocky Run upstream from Braddock Road	3.1
Buffer Restoration	CU9304	Big Rocky Run at Awbrey Patent Dr.	3.1
Buffer Restoration	CU9303	Tributary to Big Rocky Run near I-66 / Route 28 Interchange	3.1
Buffer Restoration	CU9309	Tributary to Big Rocky Run upstream from Northbourne Dr.	3.1
Buffer Restoration	CU9302	Tributary to Cub Run upstream from I-66	3.1
Buffer Restoration	CU9308	Tributary to Big Rocky Run downstream from Northbourne Drive - Regional pond C30	3.1
Buffer Restoration	CU9307	Tributary to Big Rocky Run near Ellicott Court	3.1
Buffer Restoration	BR9302	Tributary to Bull Run	3.1
Stream Restoration	CU9218	Cub Run main stem including lower reaches of Schneider Branch and Cain Branch.	2.95

Table 7-3
(continued)

Structural Project Prioritization

Project Type	Number	Description	Priority Score
Stream Restoration	CU9211	Middle Cub Run main stem and tributaries from Flatlick Branch to below Route 29	2.95
Stream Restoration	CU9203	Big Rocky Run upstream from Cub Run confluence	2.95
Stream Restoration	CU9202	Lower Cub Run and unnamed tributaries between Compton Road and I-66	2.7
Stream Restoration	CU9201	Lower Cub Run within Bull Run Regional Park	2.7
Road Crossing Improvements	CU9610	Birch Drive at unnamed tributary to Flatlick Branch.	1.75
Road Crossing Improvements	CU9601	Compton Road at unnamed tributary near UOSA advanced wastewater treatment plant.	1.75
Road Crossing Improvements	CU9606	Heron Drive at unnamed tributary between Cabells Mill Drive and Walney Road.	1.75
Road Crossing Improvements	CU9608	Dorforth Drive at unnamed tributary.	1.75
Road Crossing Improvements	CU9613	Cain Branch at Lees Corner Road.	1.75
Road Crossing Improvements	CU9603	Compton Road at unnamed tributary east of Bull Run Post Office Road.	1.75
Road Crossing Improvements	CU9609	Flatlick Branch at Walney Road.	1.75
Road Crossing Improvements	CU9611	Cub Run at Braddock Road and Old Lee Road.	1.75
Road Crossing Improvements	CU9607	Big Rocky Run at Stringfellow Road.	1.75
Road Crossing Improvements	CU9602	Compton Road at unnamed tributary near Confederate Ridge Lane.	1.75
Road Crossing Improvements	CU9604	Compton Road at unnamed tributary west of Route 66.	1.75
Road Crossing Improvements	BR9601	Bull Run Post Office Road at unnamed tributary (easternmost of three crossings).	1.75
Road Crossing Improvements	BR9602	Bull Run Post Office Road at unnamed tributary (middle of three crossings).	1.75
Road Crossing Improvements	BR9603	Bull Run Post Office Road at unnamed tributary (westernmost of three crossings).	1.75
Road Crossing Improvements	CU9612	Pleasant Valley Road at unnamed tributary near Blue Spring Drive	1.75
Road Crossing Improvements	CU9605	Awbrey Patent Drive at Big Rocky Run	1.75

7.7 Structural Project Implementation Program Development

7.7.1 Development Procedures

Structural projects were grouped to maximize the benefit to the watershed and limit neighborhood impacts. This will be achieved by implementing projects that affect a neighborhood at one time, either as a single project or as a set of projects. This approach also reduces costs associated with the public outreach programs when the projects are implemented. Finally, by implementing projects in a geographic area at one time, the net benefit to the stream may be greater than the sum of the benefits from individual projects.

The Fairfax County Stormwater Planning Division recognizes that appropriate public outreach and education is key to the successful implementation of these structural projects. The project costs include allowances for such programs.

The general rules used to prepare the project implementation program are described below (in no particular order):

- The projects should be implemented in an upstream to downstream order within a subwatershed. Implementing upstream projects first allows the peak flow reduction and water quality improvements to benefit a longer reach of stream.

- Stream restoration projects will not be implemented until upstream improvements have been completed. This criterion will increase the probability of success of the stream restoration project by stabilizing the flows before restoration occurs.

- Stream restoration projects are implemented on small streams first, starting with upland stream segments and working in a downstream direction. Stream restoration on small streams has a higher probability of success than restoration on larger streams.

- Stream restoration projects will not be implemented by the Fairfax County DPWES where significant future development will occur. Even with the peak flow and water quality control, the changes in flow volumes produced by the development will tend to destabilize the stream and produce additional erosion. Emergency measures in these lower-priority stream segments (outside the projects identified in the watershed plan) may be necessary if severe erosion must be addressed immediately.

- Structural projects are given higher priority where development densities will not change significantly.

- Structural projects will be given a low priority where significant future development is projected. Projects identified in these areas may be implemented by the developers of these properties when appropriate.

- Projects that address conditions that have a significant impact on the stream health are assigned a high priority.

The project team analyzed the overall watershed goals and conditions within the four major subwatersheds to develop each subwatershed's project priorities. The following sections provide an overview of the factors considered in developing the implementation program within the major subwatersheds.

7.7.2 Flatlick Branch Subwatershed

The following describes the watershed plan priorities used to define the project implementation plan within the Flatlick Branch subwatershed:

- The higher-priority projects focus on controlling flows from headwater areas upstream from Walney Road where development has largely stabilized.

- Projects to improve flow from the Brookfield neighborhood, which does not have stormwater controls, are also given a high priority.

- These projects are followed in priority by stream restoration within stream segments with the most severe erosion.

- Projects in the lower reaches of the subwatershed (e.g., below Walney Road) are given a low priority due to ongoing and future development within this area. These projects will be implemented after development has occurred. Opportunities will be sought to implement these projects as this development occurs and share construction costs with the developers.

7.7.3 Upper Cub Run and Elklick Branch Subwatersheds

The following describes the watershed plan priorities used to define the project implementation plan within the Upper Cub Run and Elklick Branch subwatersheds:

- The high-priority projects within these subwatersheds focus on areas upstream from Route 28 where the development has largely stabilized.

- Projects to control flow from the Pleasant Valley neighborhood are also given a higher priority.

- The Fairfax County portions of the Elklick Run subwatershed are within the R-C District and contain significant areas of parkland. Buffer restoration projects in this area will be coordinated with FCPA Sully Woodlands parkland development projects.

- Projects in other areas of the Upper Cub Run subwatershed where growth is ongoing or planned are given a lower priority. These projects will be implemented after development has occurred. Opportunities will be sought to cost share and reduce watershed impacts by implementing these projects when the nearby properties are developed.

- The plan does not include structural projects that address stormwater flows from other jurisdictions (Dulles Airport and Loudoun County). The plan includes nonstructural actions and policy recommendations to ensure that the flows from these areas area adequately controlled. However, Fairfax County stormwater funds will not be used to construct projects that specifically address these flows.

7.7.4 Lower Cub Run and Bull Run East and West Subwatersheds

The following describes the general watershed plan priorities used to define the project implementation plan within the Lower Cub Run, Bull Run East and Bull Run West subwatersheds:

- Large portions of these watersheds are within the R-C district where development densities are currently low and will remain so. Stormwater controls are generally given a low priority within these areas unless needed to address specific stream conditions.

- The plan focuses on reducing pollutant loads, flows and erosion in the local streams by optimizing the efficiency of existing stormwater facilities within the more densely developed portions of the subwatershed.

- Stream restoration projects on the smaller tributaries where development has stabilized are given a higher priority. These include streams within the Virginia Run neighborhoods.

- Projects to address runoff from Country Club Manor that does not have stormwater controls are given a higher priority.

- Stream restoration projects on the main stem of Cub Run are given a low priority due to the development in the upstream watershed and potential changes in stream flows.

- Several stream segments within the Bull Run West subwatershed are affected by a lack of stream buffers. These segments are largely located within private property within the R-C district. One segment appears to be affected by flows from the Luck Stone Quarry.

7.7.5 Big Rocky Run and Round Lick Branch Subwatersheds

The following describes the watershed plan priorities used to define the project implementation plan within the Big Rocky Run and Round Lick Branch subwatersheds:

- The plan focuses on reducing peak flows and pollutant loads, flows and erosion in the local streams by optimizing the efficiency of existing stormwater facilities.

- Projects that address runoff from the Greenbriar and Birch Pond neighborhoods, which do not have stormwater controls, are given high priority.
- Projects in the watershed's headwaters receive higher priority since they benefit the greatest stream length. The projects are subsequently implemented in an upstream to downstream order within the subwatersheds.
- Stream restoration projects in the smaller headwater streams are given a higher priority.
- Stream restoration projects in the lower reaches of the streams receive lower priority and will generally not be implemented until after the upstream projects have been performed.

7.8 Structural Project Implementation Program Groupings and Schedule

The following lists the watershed plan project implementation groups in order of decreasing priority. The projects within each implementation phase are indicated. These project groupings are shown in Figures 7-1 through 7-4 for the Flatlick Branch subwatershed, Upper Cub Run and Elklick Branch subwatersheds, Lower Cub Run and Bull Run subwatersheds and Big Rocky Run and Round Lick Branch subwatersheds.

Implementation Phase A

FB 1 Flatlick Branch watershed. Includes dry pond retrofit projects CU9195, CU9198, CU9701, CU9702, CU9703 and CU9704, stream restoration project CU9217, and buffer restoration projects CU9326, CU9327, CU9328 and CU9329. This group includes all identified structural projects in the neighborhoods of Franklin Manor, Navy Park and Oakton Ridge that affect the upper reaches of Flatlick Branch north of Route 7100. At the same time, the county will implement local drainage improvements identified through the local public outreach program and otherwise to reduce stream erosion and prevent flooding in these upstream areas.

FB 2 Flatlick Branch watershed within Franklin Glen. Implement projects near previously proposed regional pond C39 (project CU9001) adjacent to Foxfield Lane as described in Section 6. Field investigations indicate a facility at this location consists of a culvert, a dam and an emergency overflow but lacks an inlet structure. The plan updates this structure to provide an appropriate level of stormwater control and include wetlands to enhance nutrient removal. The stream restoration project (CU9216) for this stream segment will not be fully implemented. Grade control structures will be implemented in the stream reach upstream from the pond location to reduce sediment transport.

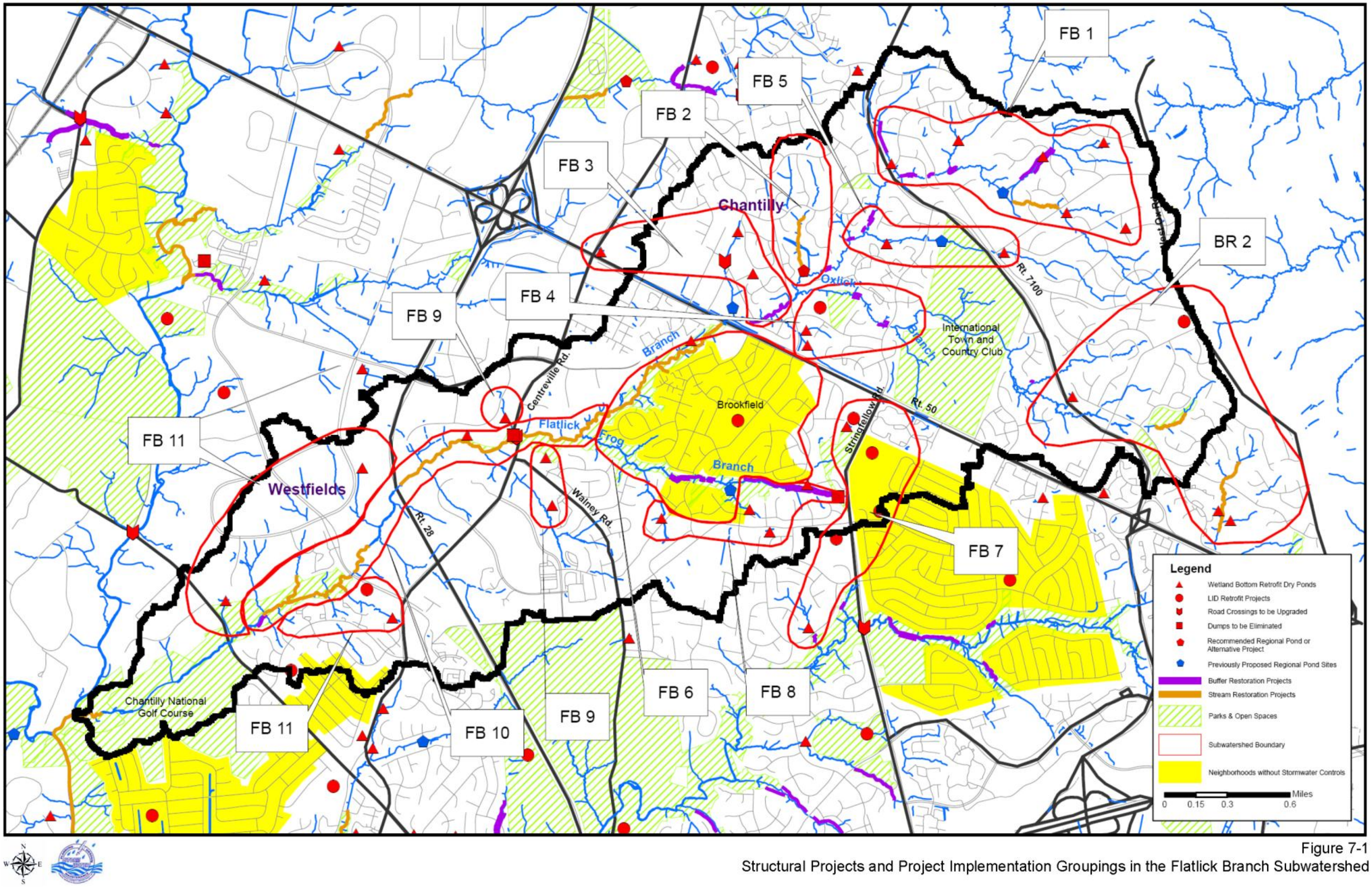

Figure 7-1
Structural Projects and Project Implementation Groupings in the Flatlick Branch Subwatershed

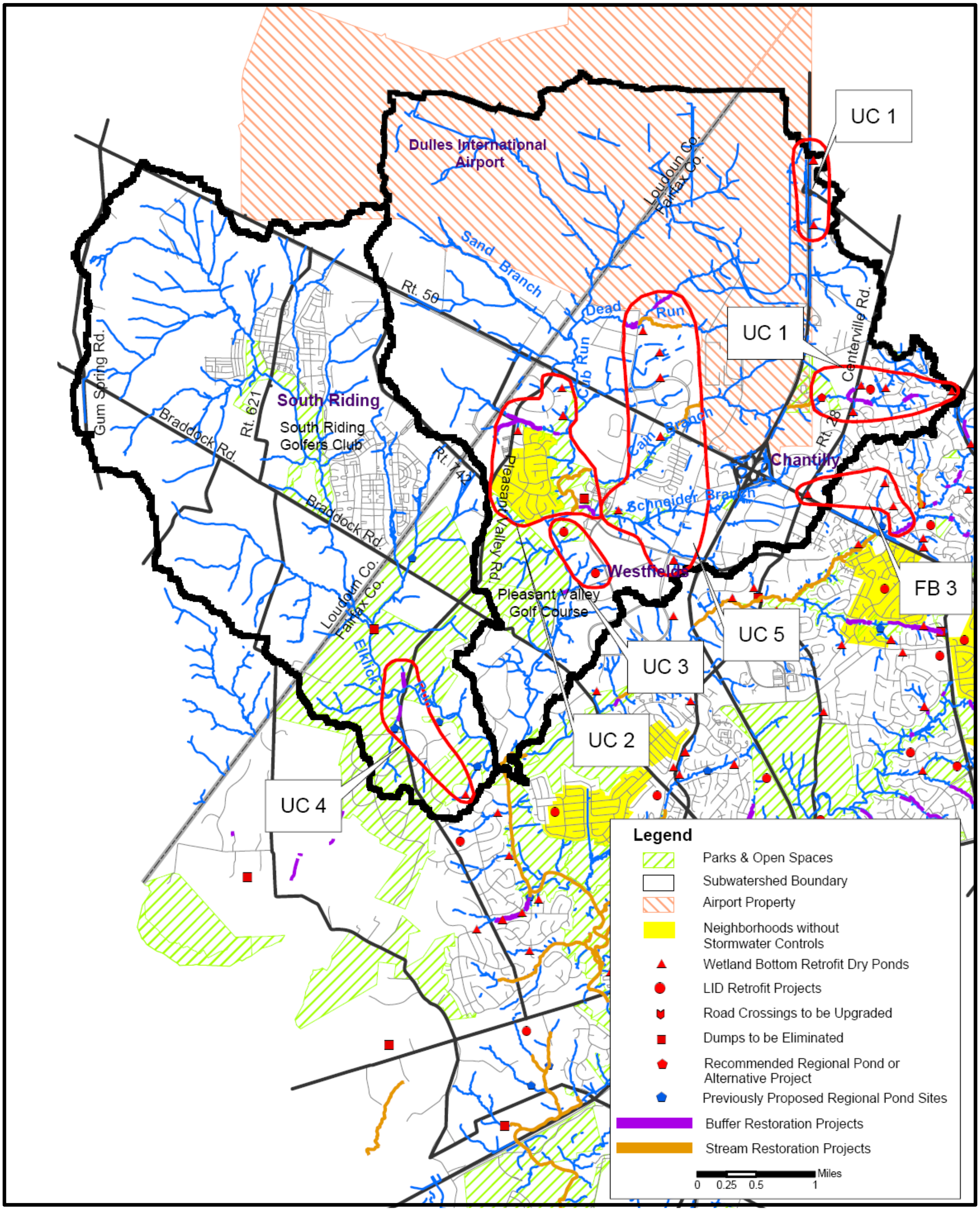

Figure 7-2
Structural Projects and Project Implementation Groupings in the Upper Cub Run and Elklick Run Subwatersheds

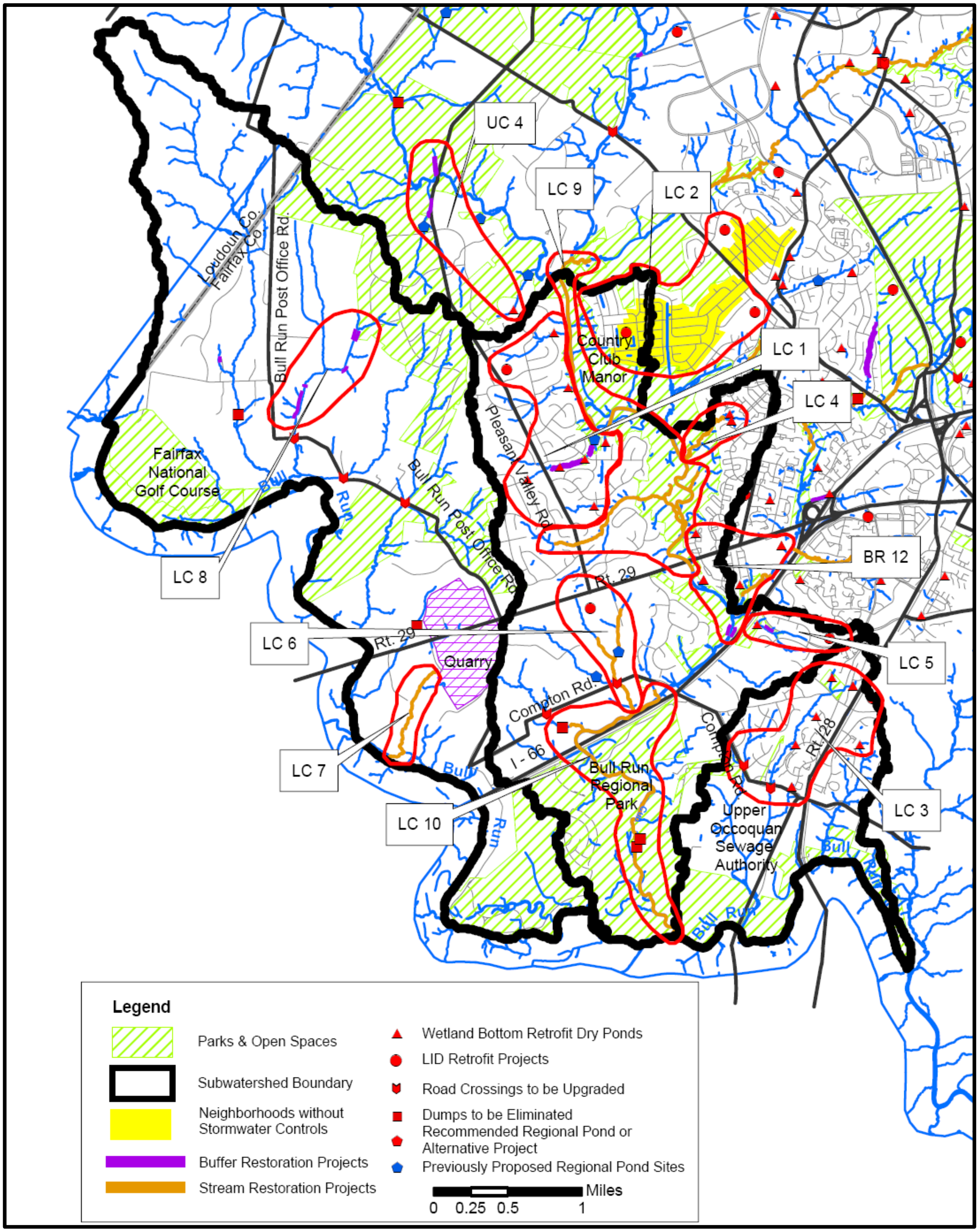

Figure 7-3
Structural Projects and Project Implementation Groupings in the Lower Cub Run and Bull Run Subwatersheds

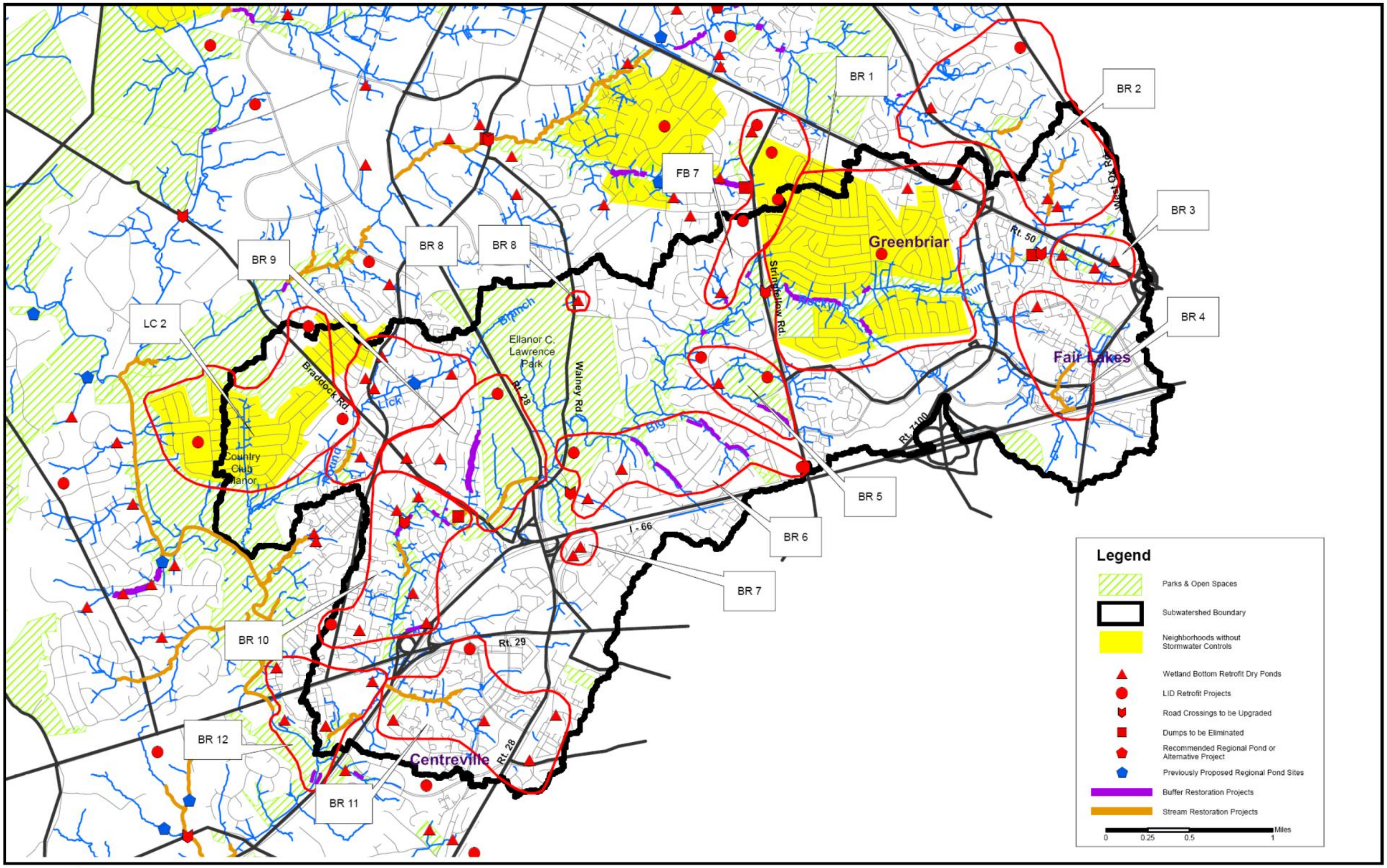

Figure 7-4

Structural Projects and Project Implementation Groupings in the Round Lick Branch and Big Rocky Run Subwatersheds

FB 3 Flatlick Branch watershed within Chantilly Estates and Armfield. Perform dry pond retrofit projects CU9185, CU9186 and CU9709 and stream buffer restoration project number CU9320.

UC 1 Headwaters of the Cain Branch and Dead Run upstream from Route 28. Implement dry pond retrofit projects CU9711, CU9712, CU9713, CU9714, CU9721 and CU9722, LID retrofit project at the Franklin Middle School (CU9825) and nearby buffer restoration projects CU9334, CU9335 and CU9336 in the Armfield Farms neighborhood. Implement regional pond C18 or alternative upstream dry ponds (Project 9002) and stream restoration project CU9220.

UC 2 Upper Cub Run watershed. Implement projects near the Pleasant Valley neighborhood without stormwater controls (project CU9913), including promoting LID and culvert outlet retrofit projects. Implement dry pond retrofit projects CU9715, CU9716 and CU9719. Evaluate Cub Run main stem within stream restoration project CU9218 and perform minimal stream restoration to stabilize stream erosion. Perform buffer restoration projects CU9333 and CU9337.

BR 1 Big Rocky Run watershed. Address stormwater runoff from the Greenbriar and Birch Pond neighborhoods that do not have stormwater controls (project 9911). Projects to be performed promoting LID on private property and retrofitting stormwater outfalls. Perform LID retrofit the Greenbriar East Elementary School (CU9811) and implement dry pond retrofit projects CU9136 and CU9138. Perform stream buffer restoration projects CU9313, CU9314 and CU9315.

FB 4 Oxlick Branch watershed projects, including dry pond retrofit projects CU9187 and CU9188, Lees Corner Elementary School LID retrofit project CU9821 and small buffer restoration projects (CU9321, CU9322 and CU9324) within the Foxfield neighborhood.

FB 5 Flatlick Branch watershed. Perform dry pond retrofit projects CU9193 and CU9194 and local buffer restoration project CU9325 within Chantilly Farms downstream from the International Town and Country Club.

Implementation Phase B

LC 1 Lower Cub Run watershed. This group includes the various projects within the Virginia Run neighborhood. Implement dry pond retrofit projects CU9150, CU9160, CU9161, CU9162, CU9163, CU9164 and CU9165, LID retrofit project at Virginia Run Elementary School (CU9814) and stream buffer restoration project CU9316. Evaluate stream restoration project number CU9211 within the Cub Run main stem adjacent to these neighborhoods and identify stream and buffer restoration opportunities within the Cub Run main stem that can be implemented without major stream and buffer disruption. Evaluate stream restoration projects for stream segment within Virginia Run between Stillfield Place and Wetherburn Drive for opportunities for stream buffer restoration, grade control structures and other spot stream restoration to stabilize this stream segment and prevent further erosion.

BR 2 Big Rocky Run watershed. This includes projects in the adjacent Flatlick Branch subwatershed. Perform dry pond retrofit projects CU9145, CU9146 and CU9192, evaluate stream segment and perform stream stabilization for stream restoration projects CU9210 and CU9215 and perform local upstream drainage improvements within the Fair Oaks Estates and Fair Chase neighborhoods. Perform LID retrofit at Navy Elementary School (CU9822). Implement buffer restoration project CU9323.

LC 2 Lower Cub Run and Round Lick Branch watersheds. Retrofit Country Club Manor subdivision (project CU9910) that was constructed before stormwater controls were required in this portion of Fairfax County and that, therefore, does not have existing stormwater controls. Activities include promoting LID within the neighborhood and performing retrofits on the outfalls to reduce erosion and improve habitat conditions. This group overlaps to the neighboring Round Lick Branch subwatershed. In combination with the above actions, LID retrofit should be performed at Deer Park Elementary School (CU9813), Cub Run Elementary School (CU9815) and Stone Middle School (CU9812).

FB 6 Flatlick Branch and Frog Branch watersheds. Retrofit the Brookfield neighborhood without stormwater controls (project CU9912), including LID promotion and outfall retrofit projects. Perform buffer restoration project CU9318 on lower end of Frog Branch. Perform limited restoration/protection within restoration project CU9214 upstream from Frog Branch and downstream from Route 50 primarily to protect property and implement grade control structures. Evaluate existing dry pond within the stream valley within this area and retrofit (CU9184). Perform LID Retrofit at Brookfield Elementary School (CU9820).

UC 3 Upper Cub Run watershed. Evaluate and implement LID at Westfield High School (CU9823) and Cub Run Recreation Center (CU9824). Implement small buffer restoration project CU9332.

BR 3 Big Rocky Run watershed. Perform dry pond retrofit projects at ponds CU9142, CU9143 and CU9144 near Route 50 and Fair Ridge and stream restoration project CU9209.

BR 4 Big Rocky Run watershed. Perform dry pond retrofit projects CU9139 and stream restoration project CU9208 within Fair Lakes.

Implementation Phase C

FB 7 Frog Branch watershed headwaters. Implement Chantilly High School (CU9818), Rocky Run Middle School (CU9810), Greenbriar West Elementary School (CU9819) and Chantilly Library (CU9817) LID retrofit projects and nearby dry pond retrofit projects in or near the headwaters of the Frog Brach watershed near Stringfellow Road (CU9182 and CU9134). Perform buffer restoration project CU9311 and CU9312.

FB 8 Frog Branch watershed. Dry pond retrofit projects in Frog Branch watershed downstream from group 7 projects but upstream from Brookfield Neighborhood (CU9176, CU9177, CU9178 and CU9180). Perform buffer restoration project CU9319. These projects are along Poplar Tree Road west of Stringfellow Road.

FB 9 Flatlick Branch watershed. Dry pond retrofit projects CU9172, CU9174 and CU9175 near Walney Road.

UC 4 Elklick Branch buffer restoration projects CU9330 and CU9331 near Pleasant Valley Road as part of parkland development projects. Dry pond retrofit project CU9705.

LC 3 Bull Run East subwatershed. Include dry pond retrofit projects BR9102, BR9104, BR9105, BR9106, BR9107 and BR9108. Also, perform LID retrofit at the Centreville Elementary School (BR9801).

LC 4 Lower Cub Run watershed. Implement dry pond retrofit projects CU9151 and CU9152. Also, evaluate and perform stream restoration project CU9211 in the stream segment between these two dry ponds and Cub Run. These projects affect the Stonehenge Community.

LC 5 Lower Cub Run watershed. Implement dry pond retrofit project CU9103 and LID retrofit at Centre Ridge Elementary School (CU9802). Perform buffer restoration project CU9302 in stream segments upstream from the dry pond. These projects affect Centre Ridge.

BR 5 Big Rocky Run watershed. Perform dry pond retrofit project CU9132 and LID retrofit improvements at Poplar Tree Park (CU9808) and Poplar Tree Elementary School (CU9809). Implement stream buffer restoration projects CU9309 and CU9310.

Implementation Phase D

BR 6 Big Rocky Run watershed. Perform dry pond retrofit projects CU9127 and CU9128 and implement stream buffer restoration projects CU9307 and CU9308. Also, implement LID retrofit projects at the FCPA Cabells Mill parking area (CU9806) and Stringfellow Road Commuter Lot (CU9807). These projects are generally located along Northbourne Drive.

FB 11 Flatlick Branch watershed. Implement dry pond retrofit projects CU9167, CU9169 and CU9170 south of Frog Branch and in lower portion of watershed. Implement LID retrofit project at Sully District Government Center (CU9816). These are in areas with ongoing commercial development and are therefore low priority. Opportunities will be sought to implement these projects when this development occurs and/or share in the costs to implement these projects.

UC 5 Dead Run, Cain Branch and Schneider Branch. These are low-priority projects in areas of commercial development and opportunities will be sought to implement these projects as part of the development and to share costs. Perform buffer restoration projects CU9338 and CU9339, dry pond retrofit projects CU9706, CU9707, CU9710, CU9717, CU9718 and CU9720 and stream restoration projects CU9219 and CU9221.

FB 10 Flatlick Branch watershed. Implement dry pond retrofit project CU9171, stream restoration projects CU9213 and CU9214 and buffer restoration project CU9317 downstream from Frog Branch.

LC 6 Lower Cub Run watershed. Implement LID retrofit project (CU9801) at Bull Run Elementary School. Evaluate stream conditions in the local tributary (project CU9202) and perform stream stabilization and grade control structures to address existing erosion and prevent further erosion.

LC 7 Bull Run West watershed. Work with Luck Stone to evaluate options for reducing stream erosion and improving habitat conditions downstream from the quarry (Project BR9201).

LC 8 Bull Run West watershed. Implement buffer restoration projects BR9301, BR9302, BR9303 and BR9304 in the western portion of this watershed near Bull Run Post Office Road.

BR 7 Big Rocky Run watershed. Perform dry pond retrofit projects CU9124 and CU9125 within Centreville.

Implementation Phase E

BR 8 Round Lick Branch watershed. This group includes the structural stormwater controls in the Round Lick Branch subwatershed. This includes dry pond retrofit projects CU9154, CU9155, CU9156, CU9157, CU9158 and CU9159. Evaluate stream restoration project CU9212 and perform stream stabilization to address ongoing erosion and reduce future erosion.

BR 9 Big Rocky Run watershed. Perform dry pond retrofit projects CU9121 and CU9123. Implement LID retrofit project at the parking lots for the Ellanor C. Lawrence athletic fields west of Route 28 (CU9805). Perform stream buffer restoration project CU9306 and stream restoration project CU9207. These projects are near Sequoia Farms Drive.

BR 10 Big Rocky Run watershed. Perform structural projects in the lower reaches of Big Rocky Run, including dry pond retrofit projects CU9112, CU9113, CU9115, CU9119 and CU9122. Implement LID project at London Towne Elementary School (CU9803). Perform buffer restoration projects CU9303, CU9304 and CU9305. Evaluate stream erosion within Big Rocky Run main stem identified as stream restoration projects CU9205 and CU9206, and perform stream stabilization and grade control to reduce ongoing erosion and prevent further erosion. Since the upstream projects will have been implemented after project groups BR 1 through BR 9, the peak flows in this reach will have stabilized by the time this restoration project is implemented.

BR 11 Big Rocky Run watershed. Perform dry pond retrofit projects CU9105, CU9107, CU9111 and CU9109 along with LID retrofit project at Centreville Library (CU9804). Evaluate stream erosion within stream erosion restoration project CU9204, and implement stream stabilization and grade control structures to reduce ongoing erosion and prevent future erosion. These are in the Meadows area of Centreville.

BR 12 Big Rocky Run watershed. Perform dry pond retrofit projects CU9104, CU9106, CU9147 and CU9148. Implement stream restoration project CU9203 and buffer restoration project CU9301 within Lee Overlook.

LC 9 Lower Cub Run watershed. Perform stream restoration project CU9211 within the Cub Run main stem between Elklick Run and Route 29 within the Cub Run Stream Valley Park.

LC 10 Lower Cub Run watershed. Perform stream restoration project CU9201 and CU9202 within the Cub Run main stem below Compton Road, including reaches within Bull Run Regional Park.

7.9 Benefits of Plan Actions

7.9.1 Nonstructural Actions and Policy Recommendation

The watershed plan includes many nonstructural actions and policy recommendations. Many nonstructural actions are education and outreach that will reduce the watershed residents' impact on the Cub Run and Bull Run streams. Policy actions also modify the impacts of new development on the watersheds. While these actions will improve watershed health and reduce nutrient loads, their benefits are difficult to quantify.

7.9.2 Stream Condition Index Improvements

Stream restoration projects will improve stream conditions. The Stream Condition Index (SCI) is a numerical measure of the stream condition. The SCI was computed based on methodologies developed by the Norfolk District of the Corps of Engineers. The condition index considers five indices of stream health:

- Instream habitat
- Channelization
- Riparian Buffer
- Channel Incision
- Bank Erosion

Each index has a score from zero to one with the higher score indicating better stream conditions. The five scores are summed to compute the overall stream condition index, ranging from zero to five.

Table 7-4 documents the existing Stream Condition Index (SCI) and estimated post-rehabilitation indices. These are length-weighted averages for the stream segments included in each project. The existing SCI ranges from 2.10 to 3.98 and averages 3.42. The post-restoration SCI ranges from 3.60 to 4.11 and averages 3.86. On average, the SCI increases by 13 percent. The restoration increases significantly in some reaches while only slightly in others.

Table 7-4

Summary of Existing and Post-Restoration Stream Condition Index

Project Number	Location	Existing Stream Condition Index	Post-Restoration Stream Condition Index	Percent Increase
CU9221	Dead Run Tributary Upstream from Stonecroft Blvd.	2.65	3.90	47%
CU9218	Cub Run main stem, including lower reaches of Schneider Branch and Cain Branch.	3.53	3.83	8%
CU9219	Cain Branch upstream from Route 50	3.12	3.69	18%
CU9220	Cain Branch Between Route 28 and Centreville Road	3.85	4.10	6%
CU9216	Flatlick Branch Tributary in Franklin Glenn	2.19	3.60	64%
CU9217	Flatlick Branch Tributary Downstream from Oxon Road	2.16	3.60	67%
CU9214	Flatlick Branch between Route 50 and Route 28	3.14	3.69	18%
CU9215	Oxlick Branch headwaters upstream from Alder Woods Drive in Fair Oaks Estates	3.55	3.85	8%
CU9213	Flatlick Branch upstream and downstream from Stonecroft Blvd.	3.67	3.96	8%

Table 7-4
(continued)

Summary of Existing and Post-Restoration Stream Condition Index

Project Number	Location	Existing Stream Condition Index	Post-Restoration Stream Condition Index	Percent Increase
CU9210	Big Rocky Run Tributary Upstream from Ox Hill Road in Fair Oaks Estates	3.36	3.60	7%
CU9211	Middle Cub Run main stem and tributaries from Flatlick Branch to below Route 29	3.54	3.86	9%
CU9212	Round Lick Branch upstream from Sully Park Drive	3.71	4.10	11%
CU9205	Big Rocky Run Below Awbrey Patent Drive	3.55	3.92	10%
CU9206	Big Rocky Run Tributary below Braddock Road	3.70	3.95	7%
CU9207	Big Rocky Run between Route 28 and Braddock Road	3.65	3.80	4%
CU9209	Big Rocky Run Tributary in Oaks Chase	3.25	3.70	14%
CU9208	Big Rocky Run at Fair Lakes	3.59	3.84	7%
CU9204	Big Rocky Run tributary in the Meadows upstream from I-66	2.93	3.79	29%
CU9203	Big Rocky Run upstream from Cub Run confluence	3.20	3.91	22%
BR9201	Bull Run tributary below quarry	2.10	3.60	71%
CU9202	Lower Cub Run and unnamed tributaries between Compton Road and I-66	3.80	4.02	6%
CU9201	Lower Cub Run within Bull Run Regional Park	3.98	4.11	3%

7.9.3 Water Quality Improvements

The following documents the water quality improvements provided by the recommended structural projects. These analyses focus on the nutrient phosphorus since it represents the reduction for other pollutants and is the primary concern for protecting the Occoquan Reservoir's water quality.

These controls produce additional watershed benefits as well, such as improving watershed health, aesthetics and habitat, and reducing peak flows and volumes that are difficult to quantify. As discussed in Section 7.9.1, education, outreach and policy changes will benefit the watershed in ways not quantifiable.

Stream restoration projects reduce pollutant loads by reducing the amount of nutrients washed into the streams. The 20 miles of stream restoration removes 361 pounds of phosphorus per year.

Retrofitting dry ponds to include wetland bottoms improves the nutrient removal efficiency for phosphorus by 10 percent, resulting in 40 to 50 percent annual reduction and nitrogen by 25 percent. The recommended dry pond retrofit projects reduce the average annual phosphorus loads by approximately 342 pounds.

The LID retrofit projects for county and other public facilities produce small changes in total nutrient loads because they serve a relatively small portion (36 acres) of the total watershed area (63 square miles). These controls also benefit the watershed adjacent to the projects. These projects reduce the annual phosphorus load by approximately 24 pounds.

Phosphorus reduction through retrofitting neighborhoods without stormwater controls (Greenbriar, Birch Pond, Brookfield, Country Club Manor and Pleasant Valley) was estimated assuming that LID and other stormwater controls are implemented for one percent of the watersheds.

Table 7-5 presents the estimated annual phosphorus reduction by each watershed plan structural project type.

Table 7-5
Summary of Phosphorus Reduction Provided by Watershed Plan Structural Actions

Structural Project	**Phosphorus (Pounds per Year)**
Stream Restoration Projects	361
Dry Pond Wetland Retrofit Projects	365
LID Retrofit	24
Neighborhoods Without Stormwater Controls	17
Total Phosphorus Reduction	767

Stream buffer restoration projects and retrofitting of drainage systems in headwater areas will reduce nutrients, though the amount is difficult to quantify.

The total annual phosphorus reduction equals 767 pounds per year. The total phosphorus load for the 48 square miles of the Fairfax County watershed equals 17,000 pounds per year for future land use conditions with future stormwater controls. The watershed plan produces a documented 4.5 percent phosphorus load reduction from 0.56 to 0.53 lbs/acre/year. The cumulative phosphorus reduction from structural actions, nonstructural actions and policy recommendation will be greater than this amount.

Figure 7-5 presents the percent phosphorus reduction by model basin. The greatest reductions are in the Flatlick Branch watershed and lower reaches of the Cub Run watershed. Nine basins have reductions greater than 30 percent and 38 have reductions greater than 10 percent.

7.10 Summary of Structural Project Costs by Implementation Phase

Table 7-6 summarizes project implementation costs based on the proposed schedule by major project type. The total cost by project type are summarized below:

- Construction of two regional ponds (C18 and C3) at a reduced size and impact from the proposed regional ponds - $2,070,000. Cost for alternative projects to these and other regional ponds are included in the individual project types.
- Dry pond retrofit projects - $9,985,000
- Low-impact development projects at public facilities - $3,402,000
- Stream restoration - $38,236,000
- Neighborhoods without stormwater controls - $2,683,000. This cost includes community outreach to implement LID and stormwater outfall retrofit projects. Cost for other projects to be implemented within these neighborhoods are included in separate project types.
- Buffer restoration - $1,318,000
- Headwater drainage systems - $3,000,000
- Riparian wetland and stream study - $100,000
- Dump site removal - $55,000

The total cost of the identified structural projects equals $60,849,000. An estimated 4.1 staff year equivalents (SYEs) are needed to implement these projects.

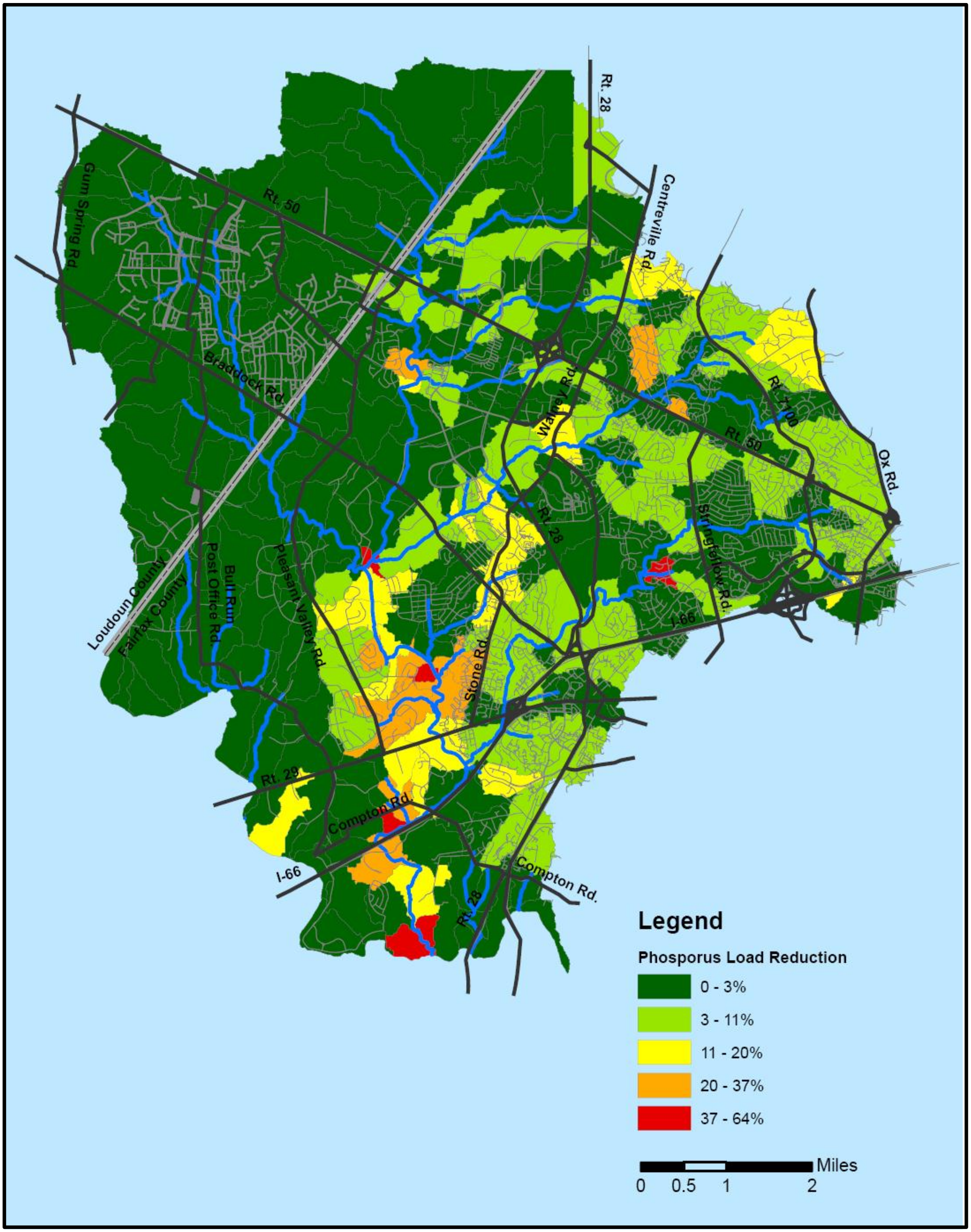

Figure 7-5
Watershed Structural Plan Percent Phosphorus Reduction

Table 7-6
Summary of Structural Project Costs by Implementation Phase

Project Type	Estimate Project Cost
Phase A Year 1-5	
Region Ponds or Alternative Projects (1)	$2,070,000
Dry Pond Wetland Retrofit	$2,686,000
Low Impact Development Retrofit	$187,000
Stream Restoration	$3,866,000
Neighborhoods without Stormwater Controls (2)	$1,137,000
Buffer Restoration	$554,000
Upland Drainage System Improvements	$600,000
Riparian Wetland Study	$100,000
Dump Site Removal	$55,000
Total Phase A	$11,255,000
Phase B Year 6-10	
Dry Pond Wetland Retrofit	$1,666,000
Low Impact Development Retrofit	$908,000
Stream Restoration	$4,682,400
Neighborhoods without Stormwater Controls (2)	$1,546,000
Buffer Restoration	$144,000
Upland Drainage System Improvements	$600,000
Total Phase B	$9,546,400
Phase C Year 11-15	
Dry Pond Wetland Retrofit	$2,676,000
Low Impact Development Retrofit	$1,377,000
Stream Restoration	$1,101,300
Buffer Restoration	$213,000
Upland Drainage System Improvements	$600,000
Total Phase C	$5,967,300

Table 7-6
(Continued)
Summary of Structural Project Costs by Implementation Phase

Project Type	Estimate Project Cost
Phase D Year 16-20	
Dry Pond Wetland Retrofit	$1,267,000
Low Impact Development Retrofit	$484,000
Stream Restoration	$9,390,800
Buffer Restoration	$238,000
Upland Drainage System Improvements	$600,000
Total Phase D	$11,979,800
Phase E Year 21-25	
Dry Pond Wetland Retrofit	$1,690,000
Low Impact Development Retrofit	$446,000
Stream Restoration	$19,195,500
Buffer Restoration	$169,000
Upland Drainage System Improvements	$600,000
Total Phase E	$22,100,500
Total for all Structural Projects	$60,849,000

1 – Regional pond cost is for the construction of the two regional ponds that remain in the study (C18 and C39) and do not include alternative projects for these or other regional ponds. Costs for these alternative projects are included in the individual project types.
2 – Costs for neighborhoods without stormwater controls include only costs for community outreach for LID implementation and stormwater outfall retrofit projects. Costs of additional projects are included in the individual project types.