Lower Patuxent River

Watershed Restoration Action Strategy

In Calvert County, MD

Prepared by:
Center for Watershed Protection
8390 Main Street, 2nd Floor
Ellicott City, Maryland 21043

For:
Calvert County
150 Main Street
Prince Frederick, MD 20678

In cooperation with:
Maryland Department of Natural Resources

Funded by:
National Oceanic and Atmospheric Administration

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Spring 2004

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Executive Summary

The portion of the Lower Patuxent River watershed in Calvert County is approximately 174 square miles in size (including land and water) and is a tidal estuary to the Chesapeake Bay. Approximately 50 percent of the land in Calvert County resides within the watershed. Calvert County is one of the fastest growing counties in Maryland and the Lower Patuxent River is exhibiting some of the impairments commonly associated with an urbanizing watershed. The water quality problems in portions of the Lower Patuxent River (and associated tributaries) have contributed to the excessive levels of fecal coliform bacteria, methylmercury, nutrients, sediments, or toxic compounds. These impacts are most closely associated with human activities that are affecting virtually all living resources. However, despite these attributes, the watershed maintains a rural character and is home several ecologically diverse and sensitive biological communities including more than 20 State identified sensitive species.

Over the last several years, there has been a significant effort put forth to attempt to assess and improve the overall health of the Lower Patuxent River watershed. The Lower Patuxent River Watershed Restoration Action Strategy (WRAS) has provided a framework for the consolidation of these efforts.

The Lower Patuxent River watershed in Calvert County is made up of 13 subwatersheds. However, the overall efforts of this project have been focused on three target subwatersheds: Hall Creek, Island Creek and Solomons Harbor subwatersheds. These three subwatersheds were identified by the County and watershed stakeholders due to special conditions of interest such as land development (Hall Creek), boating impacts (Island Creek), and septic system impacts (Solomons Harbor).

The WRAS aims to identify pollutant sources, implement environmentally sensitive development techniques, increase community involvement and implement restoration and protection opportunities. Five goals were established to guide the WRAS and address issues important to stakeholders. The watershed goals include:

1. Reduce water quality pollution into the Lower Patuxent River by addressing priority nonpoint pollution sources.
2. Increase the understanding and awareness of watershed issues and promote action and stewardship responsibilities among commercial and residential stakeholders.
3. Have in place programs and development criteria to reduce the impact of future growth on the Patuxent River.
4. Protect and restore sensitive and natural resource areas such as contiguous and interior forests, environmentally sensitive areas, and intact stream buffers.
5. Maintain current character of the county and quality of life.

This report utilized an extensive amount of information provided by Department of Natural Resources, Calvert County, University of Maryland Center for Environmental Sciences and others including data from the Lower Patuxent River Watershed Characterization, Synoptic Survey, Stream Corridor Assessment Survey and Boating Traffic and Water Quality Study.

This data, supported with some additional calculations (current impervious cover, future impervious cover, etc.) and field verifications (stream habitat, contiguous forest, and pollution prevention evaluations), was utilized to develop 23 recommendations for a watershed restoration strategy.

Recommendations and prioritizations were provided on a watershed-wide or target subwatershed-wide (Hall, Island, or Solomons) basis. A summary of the recommendations are provided in Table E1.

Table E1. Summary of the Lower Patuxent River WRAS Recommendations

Recommendation Category	Recommendation
Watershed-wide	Hire Watershed Coordinator
	Establish an Implementation Committee
	Foster Development of Watershed Association
	Complete Watershed Planning Process
	Conduct a Stormwater Retrofit Inventory
	Conduct a Contiguous Forest Inventory and Forest Interior
	Enhance and Restore Riparian Buffers
	Hold a Calvert County Site Planning Roundtable
	Encourage Marina Owners to Participate in Clean Marinas Program
	Ensure Long-term Conservation and Preservation of ESAs
	Implement OSDS Management Strategy Beyond Solomons
Hall Creek	Utilize Infiltration and LID to Retain Stormwater Onsite
	Prohibit the Creation of Fish Barriers to Upstream Spawning Areas
	Conduct Streambank Stabilization Demonstration Project
	Construct Stormwater Retrofit Demonstration Project
Island Creek	Implement Living Shoreline Techniques
	Conduct Additional Studies on Boating and Water Quality
	Conduct Lawn Care and Septic System Education
	Conduct an Operations Assessment of Farming Practices
Solomons Harbor	Promote Good Rooftop Runoff Management
	Initiate a “Scoop the Poop” Campaign
	Promote Good Commercial Housekeeping
	Implement OSDS Management Strategy

Acronyms:
ESAs: Environmentally Sensitive Areas
OSDS: Onsite Sewage Disposal System

Section 1.0 Introduction

This project focuses on the Calvert County, MD portion of the Lower Patuxent River watershed, located in the western portion of the County between the Anne Arundel County border and Solomons Harbor (see Map 1). This portion of the watershed is approximately 174 square miles (including both land and water) and just over 50 percent of the land in the County resides within the watershed. Calvert County is approximately 40 miles southeast of Washington, D.C. and is one of the fastest growing counties in Maryland (Calvert County, 2004). Despite growth pressures, the watershed maintains a rural character and is dominated by forest, agriculture and low density residential land uses. See Map 2 for the location of towns and tributaries found in the watershed.

The watershed includes several ecologically diverse and sensitive biological communities. Notably, the watershed is home to the Battle Creek Cypress Swamp, the northernmost stand of bald cypress trees in North America and the only stand west of the Chesapeake Bay. Additional features include significant spawning areas for anadromous fish in two of the tributaries (Hall and Hunting) and more than twenty sensitive species (DNR, 2003a). Calvert County also has an impressive land preservation program. Between 1998 and 2002, the County preserved three times as much land as has been developed into lots (Calvert County, 2002b).

Despite possessing these attributes, the Lower Patuxent River watershed exhibits some of the same impairments that effect more urbanized watersheds in the State, namely non-point source (NPS) pollution. Nonpoint source pollution encompasses a wide array of pollutants and pollutant sources, ranging from nutrient and pesticide contributions from agricultural fields, septic systems and lawns to heavy metals, hydrocarbons, and sediments running off roads, parking lots, and driveways.

The purpose of this document is to present a strategy to reduce NPS pollution and related impairments in the watershed, while at the same time conserving the unique, high quality natural resources. This strategy was developed through the combined efforts of watershed stakeholders, County government, non-profit organizations and State and Federal agencies. This document outlines the conditions in the watershed, the potential sources of pollution and impairments, and actions that can be taken to address these issues through the Watershed Restoration Action Strategy (WRAS) Program.

The Lower Patuxent River watershed in Calvert County is made up of 13 subwatersheds (see Table 1 and Map 3). However, this document focuses primarily on three target subwatersheds: Hall Creek, Island Creek, and Solomons Harbor subwatersheds. These three subwatersheds were identified by the County and watershed stakeholders due to special conditions of interest such as land development (Hall Creek), boating impacts (Island Creek), and septic impacts (Solomons Harbor) (see Map 3).

Table 1. Lower Patuxent River Subwatersheds	
Subwatershed	**Area (sq. mi.)**
Battle Creek Headwater	10.2
Battle Creek Lower	9.3
Buzzard Island Creek	9.7
Chew Creek	7.7
Deep Landing	5.2
Graham Creek	6.2
Hall Creek	16.4
Hunting Creek	31.8
Island Creek	13.0
Kings Landing	7.7
Ramsey, Caney Creek	6.0
Solomons Harbor	14.7
St. Leonard Creek	35.6
Lower Patuxent in Calvert Co.	**173.7**

Section 1.1 Watershed Restoration Action Strategy Program

Maryland's Clean Water Action Plan (DNR, 1998a) called for the assessment of all State waters to determine the degree of NPS impairment and to establish restoration priorities. The resulting Unified Watershed Assessment (UWA) looked at all 134 watersheds in the State in terms of both watershed impairments and significant water resource values. The assessment categorized watersheds as either in need of protection, restoration, or, in some instances, both. The full assessment report can be found at: http://www.dnr.state.md.us/cwap/cwap.htm.

The WRAS was created to develop and implement plans to restore and protect watersheds identified as priorities in the UWA. Federal grant monies provide for the development and implementation of WRASs. One of these projects is the Lower Patuxent River watershed in Calvert County.

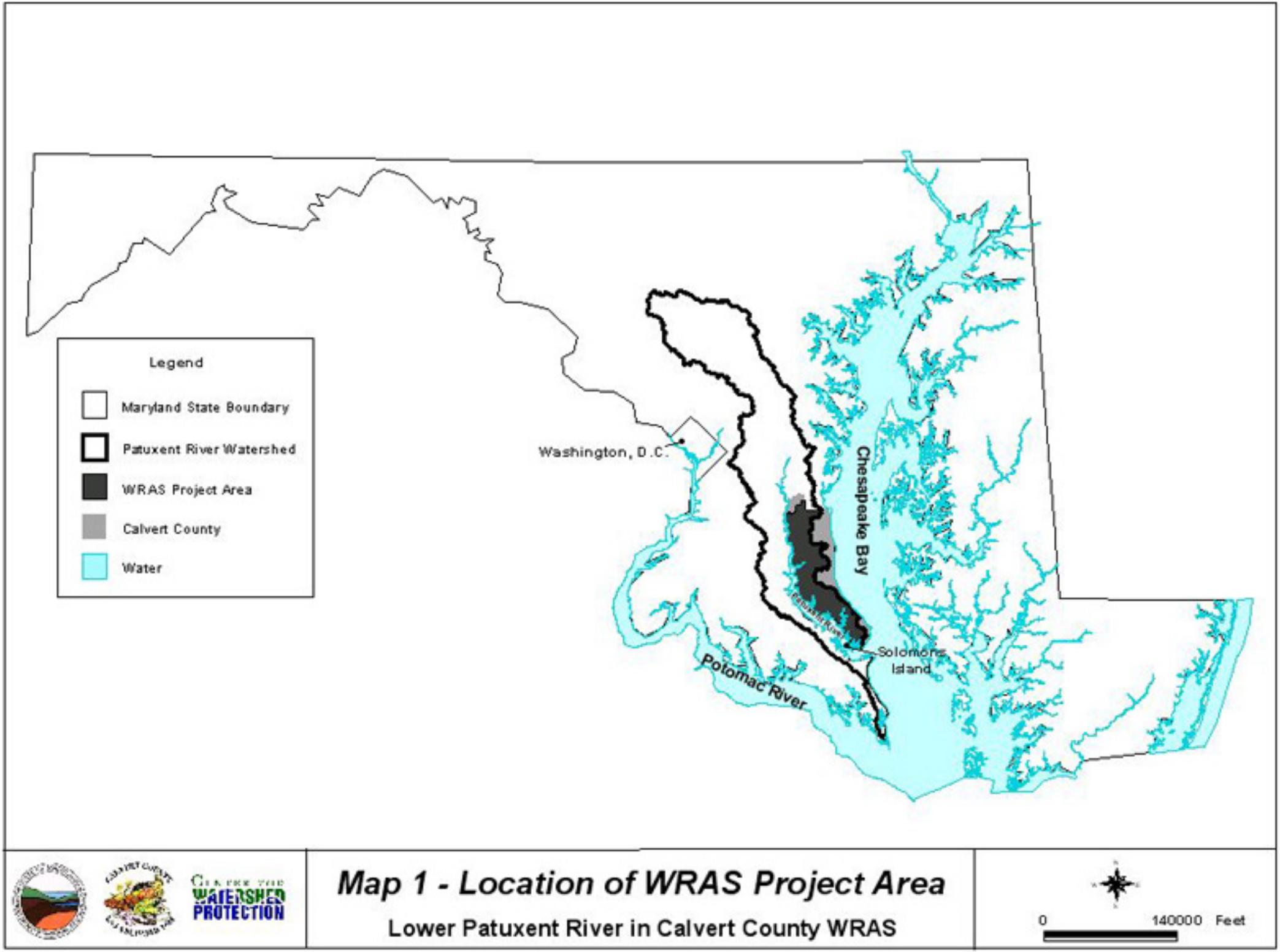
The Lower Patuxent WRAS is a local government led process. Watershed management and planning is primarily a function of county/town governments with assistance or input from other partners such as the Soil Conservation Districts, the public, local watershed associations, the Maryland Department of Natural Resources (DNR), and other State agencies. The WRAS Partnership Program recognizes that most decisions regarding land use, zoning, open space, etc., are the responsibility of local governments and that local governments possess the specific local knowledge needed to develop and implement watershed management plans.

Watershed residents and other stakeholders play a vital role in the creation of a watershed management plan. Stakeholder involvement is a key ingredient in a watershed plan as stakeholders must live with the decisions that are made. Public input was sought during two public meetings held between March and April of 2004. The input at these meetings was critical in determining the WRAS goals (see Section 1.2), outstanding issues and the level of support in the community. A summary of stakeholder input is provided in Appendix A.

Section 1.2 Project Goals

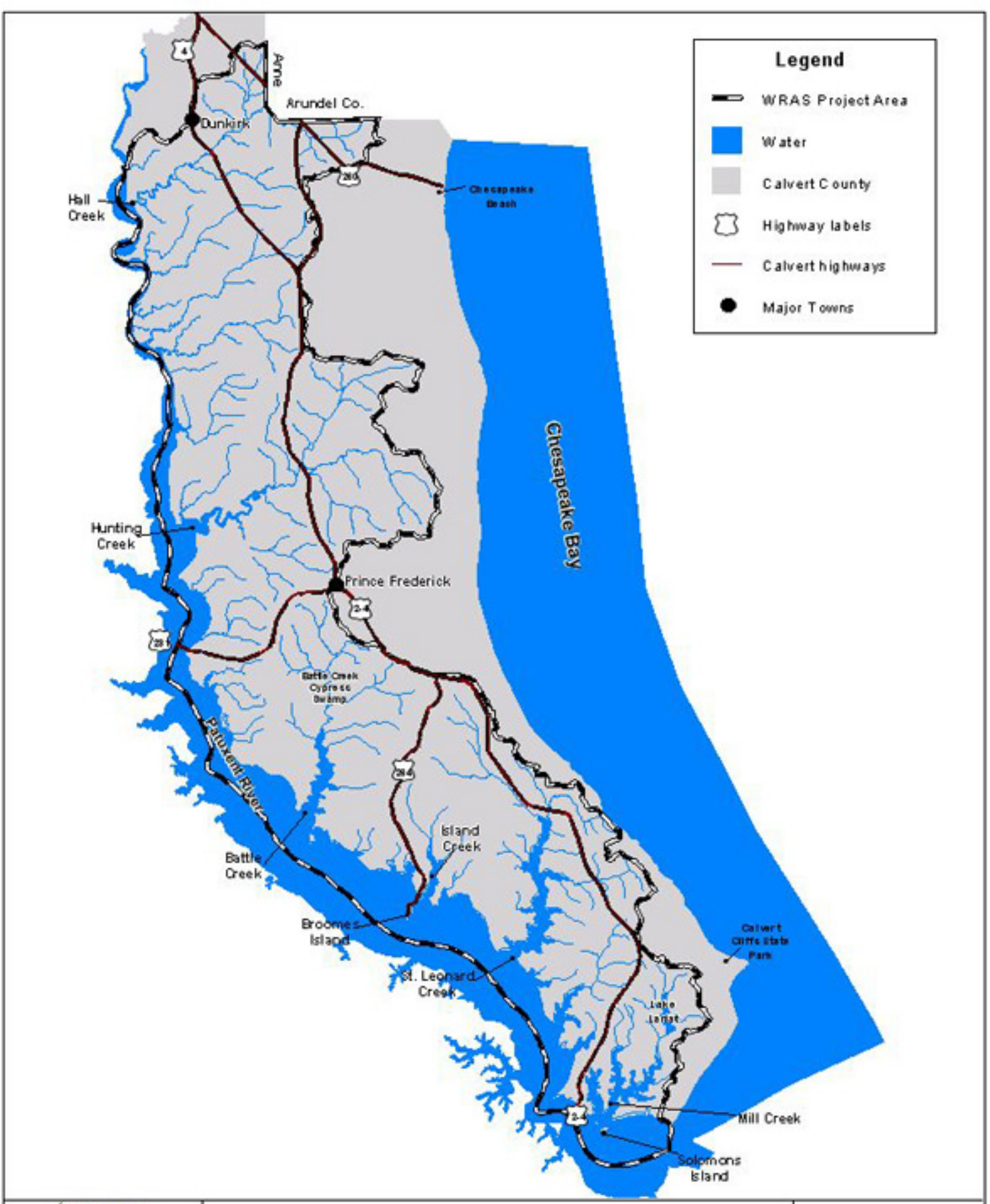
There are five watershed goals that serve as the framework for the overall watershed strategy. These goals were developed to improve the overall conditions of the Lower Patuxent River and address issues important to watershed stakeholders. The goals are as follows:

1. Reduce water quality pollution into the Lower Patuxent River by addressing priority nonpoint pollution sources.
2. Increase the understanding and awareness of watershed issues and promote action and stewardship responsibilities among commercial and residential stakeholders.
3. Have in place programs and development criteria to reduce the impact of future growth on the Patuxent River.
4. Protect and restore sensitive and natural resource areas such as contiguous and interior forests, environmentally sensitive areas, and intact stream buffers.
5. Maintain current character of the county and quality of life.



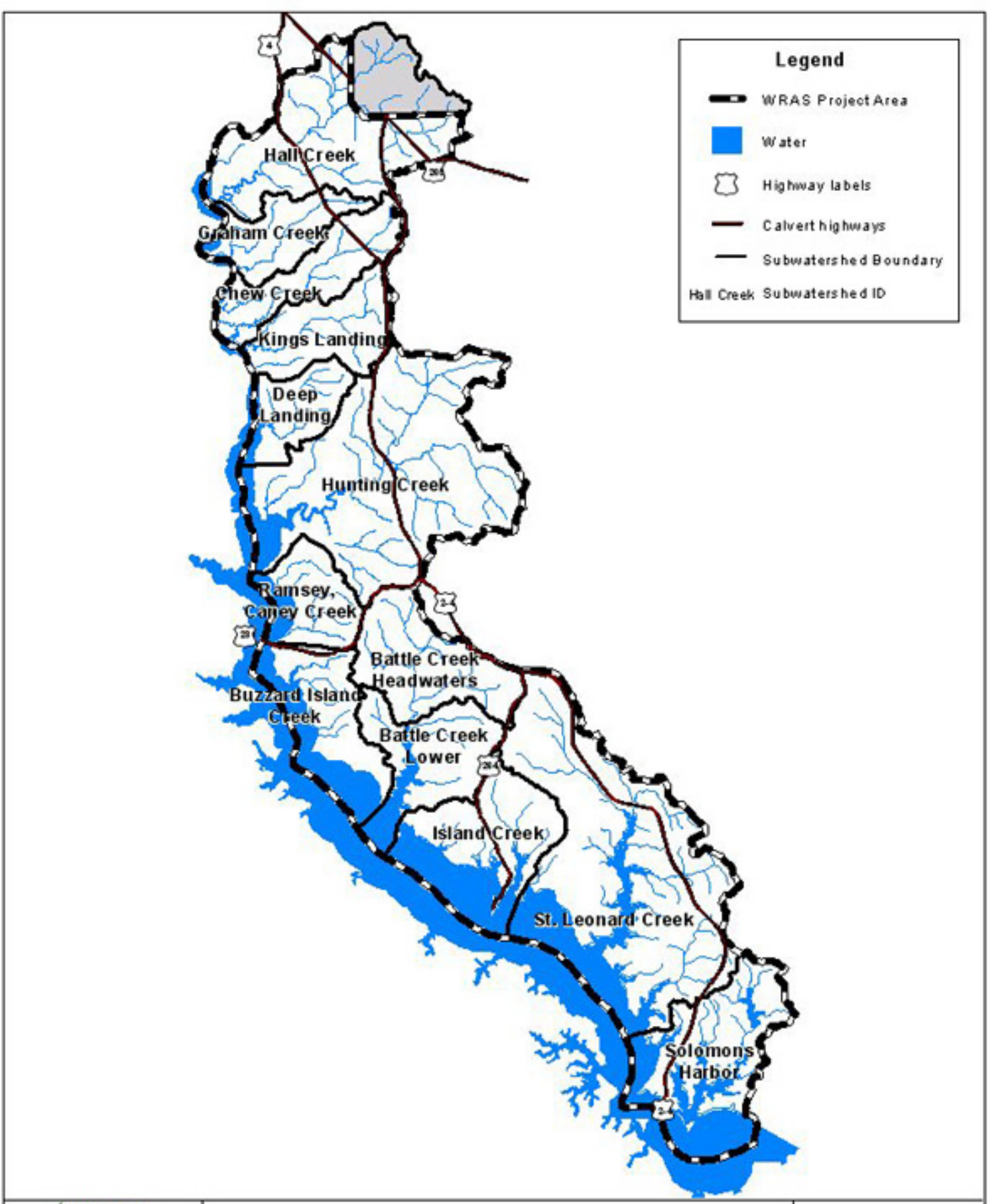
Map 1 - Location of WRAS Project Area

Lower Patuxent River in Calvert County WRAS



Map 2 - Major Tributaries and Towns

Lower Patuxent River in Calvert County WRAS



Map 3 - Subwatershed Delineation

Lower Patuxent River in Calvert County WRAS

Section 2.0 Watershed Assessment

WRASs utilize the services of DNR and the State Departments of Environment, Planning and Agriculture to provide technical assistance and funding, with the participation of other partners. These partners provide technical assistance, community support, volunteers and stewardship opportunities. DNR prepared three research reports to aid in the development of the Lower Patuxent WRAS; 1) a watershed characterization, 2) a synoptic survey of nutrients, aquatic insects, and fish, and 3) an assessment of stream corridor conditions. Information regarding these reports is available at: http://www.dnr.state.md.us/watersheds/surf/proj/wras.html. In addition, the Center for Watershed Protection (CWP) and others conducted estimates of current and future impervious cover estimates and other specialized surveys and assessments (see Table 2). Each of these is discussed in the following sections.

Table 2. Studies Contributing to the Lower Patuxent WRAS

Contributor	Study
Maryland Department of Natural Resources (DNR)	• Watershed Characterization • Synoptic Survey • Stream Corridor Assessment
Center for Watershed Protection (CWP)	• Impervious Cover Analysis • Pollution Prevention Survey • Streambank Erosion Survey • Contiguous Forest Survey
Calvert County Department of Planning	• Onsite Sewage Disposal Systems (OSDS) Management Strategy
University of Maryland Center for Environmental Sciences (UMCES)	• Boat Traffic Study

Section 2.1 Land Use and Growth

Nearly half of the land in the WRAS project area is characterized as forest or brush (based on Maryland Department of Planning land use categories). Agricultural land and developed land occupy nearly one quarter of the WRAS project area each. All other types of land together amount to the remaining 2% of the land use (see Figure 1) (DNR, 2003a).

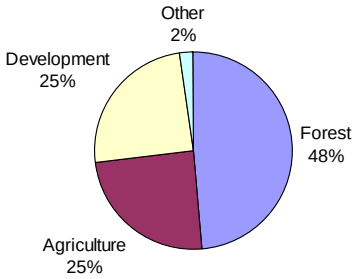


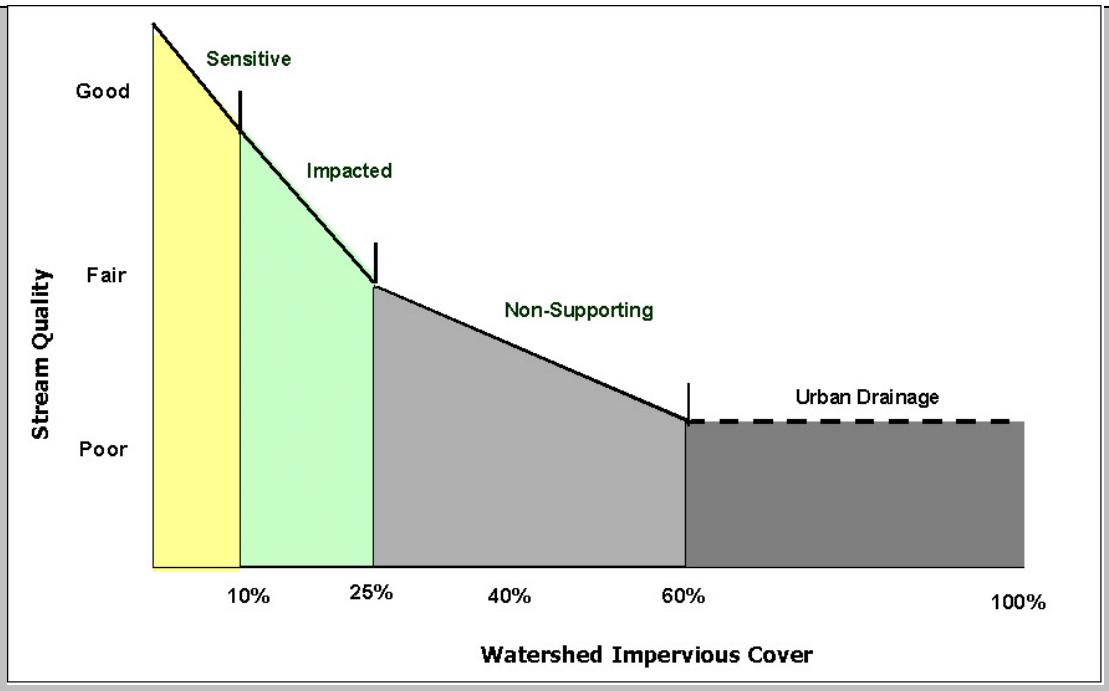
Figure 1. 2000 Land Use
(Source: DNR, 2003a)

According to Maryland DNR, agricultural lands are likely to contribute the greatest pollutant loads to local waterways. However, it is also important to recognize the profound impact that urban lands have on local waterways (CWP, 2003). Calvert County's population has increased over 54 percent since 1990 and is one of the fastest growing counties in the State (Calvert County Department of Economic Development, 2003). These factors make urbanization, or impervious cover, an important indicator to assess in a WRAS.

Impervious cover can be used to explain and predict how stream quality indicators change in response to different levels of development. Impervious cover is defined as the sum of all

surfaces within the watershed that do not allow water to infiltrate through the ground. Examples include roadways, driveways, houses, sidewalks, and parking lots that are covered by concrete, asphalt or other impermeable surfaces.

CWP has developed the impervious cover model (ICM) based on the collaboration of hundreds of research findings (CWP, 2003). The ICM predicts that most stream quality indicators decline when the subwatershed impervious cover exceeds 10% with severe degradation expected beyond 25% impervious cover (see Figure 2).



Note: It is important to keep in mind that ICM stream indicator predictions are general, and will not apply to every stream within the ICM classification. The Model predicts potential rather than actual stream quality. It can and should be expected that some streams will depart from the predictions of the model. While impervious cover can be used to initially diagnose stream quality, supplemental field monitoring is recommended to actually confirm it.

Sensitive Subwatersheds (0 to 10% impervious cover)
The streams in these subwatersheds are of high quality, and are typified by stable channels, excellent habitat structure, good to excellent water quality, and diverse communities of both fish and aquatic insects.

Impacted Subwatersheds (11 to 25% impervious cover)
The streams in these subwatersheds show clear signs of declining stream health. Greater storm flows have begun to alter the stream geometry and both erosion and channel widening are evident.

Non-Supporting Subwatersheds (25 to 60% impervious cover)
Streams in these subwatersheds no longer support their designated uses, as defined by hydrology, channel stability, habitat, water quality and biological indicators.

Urban Drainage (>60% impervious cover)
In these subwatersheds, the stream corridor has essentially been eliminated or physically altered to the point that it functions merely as a conduit for flood waters. Water quality indicators are consistently poor, channels are highly unstable and both stream habitat and aquatic diversity are rated as very poor or are eliminated altogether.

Figure 2. Impervious Cover Model (ICM)
Source: CWP, 2003

Current Impervious Cover Estimate

Current impervious cover was estimated from 2000 Maryland Department of Planning land use. Based on this estimation, only Solomons Harbor subwatershed exceeds 10% impervious cover, classifying it as "Impacted". The rest of the subwatersheds are classified as "Sensitive" (<10% impervious cover). Results of the calculations are presented in Table 3 and Map 4.

Table 3. Current Impervious Cover

Subwatershed	Current Impervious Cover %	IC Management Category
Battle Creek Headwater	3.2	Sensitive
Battle Creek Lower	2.5	Sensitive
Buzzard Island Creek	2.5	Sensitive
Chew Creek	5.0	Sensitive
Deep Landing	5.3	Sensitive
Graham Creek	7.6	Sensitive
Hall Creek	6.8	Sensitive
Hunting Creek	5.0	Sensitive
Island Creek	2.0	Sensitive
Kings Landing	5.9	Sensitive
Ramsey, Caney Creek	3.4	Sensitive
Solomons Harbor	10.5	Impacted
St. Leonard Creek	3.1	Sensitive
Lower Patuxent in Calvert Co.	**4.7**	**Sensitive**

Future Impervious Cover Projection

Future impervious cover estimates were projected based on developable land and available zoning information. If subwatersheds are developed according to the zoning, Hall Creek, Graham Creek, and Hunting Creek will all exceed 10% impervious cover and become "Impacted". The remaining subwatersheds will experience an increase in impervious cover, but are not projected to change classifications. The future impervious cover estimations are presented in Table 4 and Map 5.

It is important to note that the future impervious cover estimates do not reflect the County's recent efforts to downzone and concentrate growth in town centers. However, it is worth noting that these changes will most likely reduce the amount of future impervious cover presented in Table 4 and have long term water quality and habitat benefits.

Table 4. Future Impervious Cover

Subwatershed	Future Impervious Cover %	Future IC Management Classification	Net Increase in Impervious Cover
Battle Creek Headwater	8.3	Sensitive	5.1
Battle Creek Lower	6.8	Sensitive	4.3
Buzzard Island Creek	5.0	Sensitive	2.5
Chew Creek	7.8	Sensitive	2.7
Deep Landing	7.7	Sensitive	2.4
Graham Creek	10.7	Impacted	3.0
Hall Creek	10.8	Impacted	4.0

Table 4. Future Impervious Cover			
Hunting Creek	10.9	Impacted	6.0
Island Creek	5.0	Sensitive	3.0
Kings Landing	9.7	Sensitive	3.8
Ramsey, Caney Creek	6.7	Sensitive	3.3
Solomons Harbor	17.9	Impacted	7.4
St. Leonard Creek	7.6	Sensitive	4.5
Lower Patuxent in Calvert Co.	**9.2**	**Sensitive**	**4.5**

Section 2.2 Watershed Characterization

The Lower Patuxent River in Calvert County Watershed Characterization (DNR, 2003a) compiled available water quality and natural resources information to create an overall picture of the watershed. Only a brief summary is presented here, the full document can be viewed or downloaded at: http://www.dnr.state.md.us/watersheds/surf/proj/lowpat_char.html.

Water Quality

The State has found the water quality in portions of the Lower Patuxent River (and associated tributaries) are listed as impaired water bodies for excessive levels of fecal coliform bacteria, methylmercury, nutrients, sediments, or toxic compounds (MDE 2002a).

High levels of fecal coliform bacteria have affected portions of the Patuxent River and its tributaries, triggering the Maryland Department of the Environment (MDE) to place regulatory restrictions on shellfish harvesting. The elevated counts suggest the presence of contamination by animal or human waste.

Lake Lariat (see Map 2) is listed as an impaired water body for methylmercury. Largemouth and small mouth bass in the lake were found to have levels of methylmercury that could cause human health problems if the fish are eaten too frequently. A fish consumption advisory was issued by MDE and a Total Maximum Daily Load (TMDL) was drafted to address this impairment.

The mainstem of the Patuxent River from its mouth to Ferry Landing is listed for impairment caused by nutrients and sediments. Nutrient loads are dominated by non-point sources including septic systems, fertilizer use and atmospheric deposition. Sediment pollution can arise from construction sites, crop land, bare ground, and eroding stream banks.

Parts of the mainstem have been listed due to elevated levels of toxic compounds, specifically pesticides. Pesticides were found at levels high enough to indicate probable adverse effects on living resources (DNR, 2003a).

Natural Resources

Human activity is affecting virtually all living resources in the Lower Patuxent watershed. DNR's Characterization suggests that significant stressors include alteration and destruction of habitat and excessive sediments and nutrients.

Current oyster populations are significantly less than historical populations. The decline in the population is attributed to sedimentation, poor water quality and a disease that killed a significant portion of the population.

Currently, submerged aquatic vegetation (SAV) covers a relatively small area compared to historic records. As nutrient levels decrease, SAV coverage generally tends to increase. However, as nutrients loads have decreased over time in the Patuxent, the SAV have not shown a similar rebound (Boynton, 2003).

Maryland DNR has been monitoring fish and benthic macroinvertebrates since the early 1990s. While not all the data are directly comparable, generalizations can be made regarding the overall health of the biological conditions in streams. The average rating for both fish and bugs is poor, indicating degraded water resource conditions.

The watershed also supports more than 20 sensitive species. Table 5 lists the sensitive species tracked by DNR in the Lower Patuxent River watershed (DNR, 2003a).

Table 5. Sensitive Species Tracked by Maryland in the Lower Patuxent River Watershed
(Source: DNR, 2003a)

Type	Common Name	Scientific Name	Status
Animals	Northeastern beach tiger beetle	Cicindela dorsalis dorsal	Endangered
	American peregrine falcon	Falco peregrinus anatum	Endangered
	Bald eagle	Haliaeetus leucocephalus	Threatened
Plants	Sensitive joint-vetch	Aeschynomene virginica	Endangered
	Single-headed pussytoes	Antennaria solitaria	Threatened
	Woolly three-awn	Aristida lanosa	Endangered
	Silvery aster	Aster concolor	Endangered
	Midland sedge	Carex mesochorea	Other
	Spurred butterfly-pea	Centrosema virginianum	Other
	Broad-leaved beardgrass	Gymnopogon brevifolius	Endangered
	Carolina satyr	Hermeuptychia sosybius	Other
	Anglepod	Matelea carolinensis	Endangered
	Large-seeded forget-me-not	Myosotis macrosperma	Other
	Kidneyleaf grass-of-parnassus	Parnassia asarifolia	Endangered
	Leafy pondweed	Potamogeton foliosus	Endangered
	Clasping-leaved pondweed	Potamogeton perfoliatus	Other
	Spiral pondweed	Potamogeton spirillus	Other
	Hairy snoutbean	Rhynchosia tomentosa	Threatened
	Engelmann's arrowhead	Sagittaria engelmanniana	Threatened
	Long-beaked arrowhead	Sagittaria longirostra	Other
	Showy goldenrod	Solidago speciosa	Threatened
	Rough rushgrass	Sporobolus clandestinus	Endangered

Section 2.3 Synoptic Survey

During 2003, DNR staff conducted a nutrient synoptic survey in selected Calvert County subwatersheds to supplement knowledge of local conditions. Water quality samples were collected for nutrient analysis at 40 sites with a focus in Hall Creek, Island Creek, and Solomons Harbor subwatersheds. Biological samples were collected at ten of the water quality stations. The full report is available at: http://dnrweb.dnr.state.md.us/download/bays/lowpat_synoptic.pdf.

The nutrient sampling is meant to represent a "snapshot" of nutrient concentrations/loads in the watershed and is intended to identify areas with higher relative nutrient concentrations/loads in the watershed. To fully assess water quality conditions in the watershed, multiple sampling events under differing stream flow conditions would be required.

The sampling results indicated that nutrient concentrations and loads are generally low in the Lower Patuxent River watershed as compared to other watersheds around the state. Eight stations exhibited excessive or high nitrate/nitrite yields while the remainder had moderately elevated or lower yields. The stations with elevated nitrate/nitrite concentrations appear to have drainage areas with significant development and septic systems. Orthophosphate yields were found to be moderate at two stations and baseline for the remainder. The stations with high orthophosphate concentrations also appeared to have drainage areas with higher density residential development (Primrose, 2003).

Biological samples were used to calculate a macroinvertebrate index of biotic integrity (IBI) (DNR, 1998b). The IBI score is another parameter that can be used as a measure of stream health. DNR's samples ranked macroinvertebrate health as fair at one site, poor at five sites, and very poor at the remaining four sites.

Section 2.4 Stream Corridor Assessment

In partnership with Calvert County, DNR conducted a Stream Corridor Assessment in the Lower Patuxent watershed using trained teams from the Maryland Conservation Corps. The Stream Corridor Assessment was developed to provide a rapid examination of the stream network and identify and document problems and restoration opportunities along the stream corridor (see Figure 3). The survey of the Lower Patuxent covered approximately 130 miles of streams and identified more than 100 potential environmental problems (see Table 6). The most commonly cited concern was erosion, which was reported at 39 sites. Other reported concerns included: 22 fish barriers, 13 inadequate buffers, 11 pipe outfalls, 11 trash dumping sites, and 5 channel alteration sites (Pellicano and Yetman, 2004).

Figure 3. Channel Erosion in Island Creek Subwatershed
(Source: Pellicano and Yetman, 2004)

Table 6. Problem Sites Identified During the Stream Corridor Assessment
(Source: Pellicano and Yetman, 2004)

Problem Identified	Severity					
	Very Severe	Severe	Moderate	Low Severity	Minor	Total Number
Channel Erosion	1	1	20	9	8	39
Fish Barriers	-	1	5	4	13	22
Inadequate Buffers	-	-	2	4	7	13
Pipe Outfalls	-	-	6	-	5	11
Trash Dumping Sites	-	1	5	4	1	11
Channel Alterations	-	-	1	1	3	5
Total	**1**	**3**	**38**	**22**	**37**	**101**

Section 2.5 Additional Surveys and Studies

In addition to the extensive amount of data collected and summarized by DNR, there are several other studies and surveys that were conducted in the watershed. These include a pollution prevention and awareness survey, streambank erosion survey, contiguous forest assessment, onsite sewage disposal systems management strategy, and boat traffic study in Island Creek.

Pollution Prevention and Awareness Survey (PPA)

CWP conducted a Pollution Prevention and Awareness Survey (PPA) survey to identify behaviors and activities that may result in avoidable non-point source pollution and provide useful information on methods to meet National Pollutant Discharge Elimination System (NPDES) regulations concerning pollution prevention/good housekeeping, enhancing/creating public education and outreach programs, and increasing public participation/involvement. While the assessment was only conducted in the three target subwatersheds (Hall Creek, Island Creek, and Solomons Harbor), many findings and recommendations can be extrapolated to other subwatersheds within the Lower Patuxent watershed. The survey found that overall, stewardship and pollution prevention practices could use improvement. Detailed recommendations from the PPA survey are included in Section 4.0, Recommendations and the Pollution Prevention Technical Memorandum can be found in Appendix B.

Streambank Erosion Survey

CWP conducted a survey of streambank erosion where Maryland DNR's Stream Corridor Assessment had previously identified significant stream bank erosion within the target subwatersheds (Hall Creek, Island Creek, and Solomons Harbor). The survey consisted of revisiting DNR's erosion sites (particularly those rated as moderate to severe) documenting findings using the Rapid Bioassessment Protocol (RBP) Habitat Assessment, and attempting to identify causes and solutions to the erosion. In many cases, a source or solution was not readily identifiable. However two potential projects were identified in the Hall Creek subwatershed. These projects are described in more detail in Section 4.0, Recommendations. A summary of the RBP data and a blank field sheet are provided in Appendix B.

Contiguous Forest Assessment

CWP also conducted a contiguous forest assessment in the Island Creek subwatershed. GIS mapping of this subwatershed revealed that the land cover mainly consisted of large tracts of forest, making it an ideal candidate for this assessment. The contiguous forest assessment can be utilized to identify and prioritize sites for conservation. Several points were taken throughout the forest areas, although access was extremely limited due to property ownership. The assessment found that these tracts of forest are fairly young (see Figure 4) and are more fragmented than as depicted by the GIS data. Recommendations resulting from the contiguous forest assessment can be found in Section 4.0. A summary of the data and a blank field sheet are provided in Appendix C.

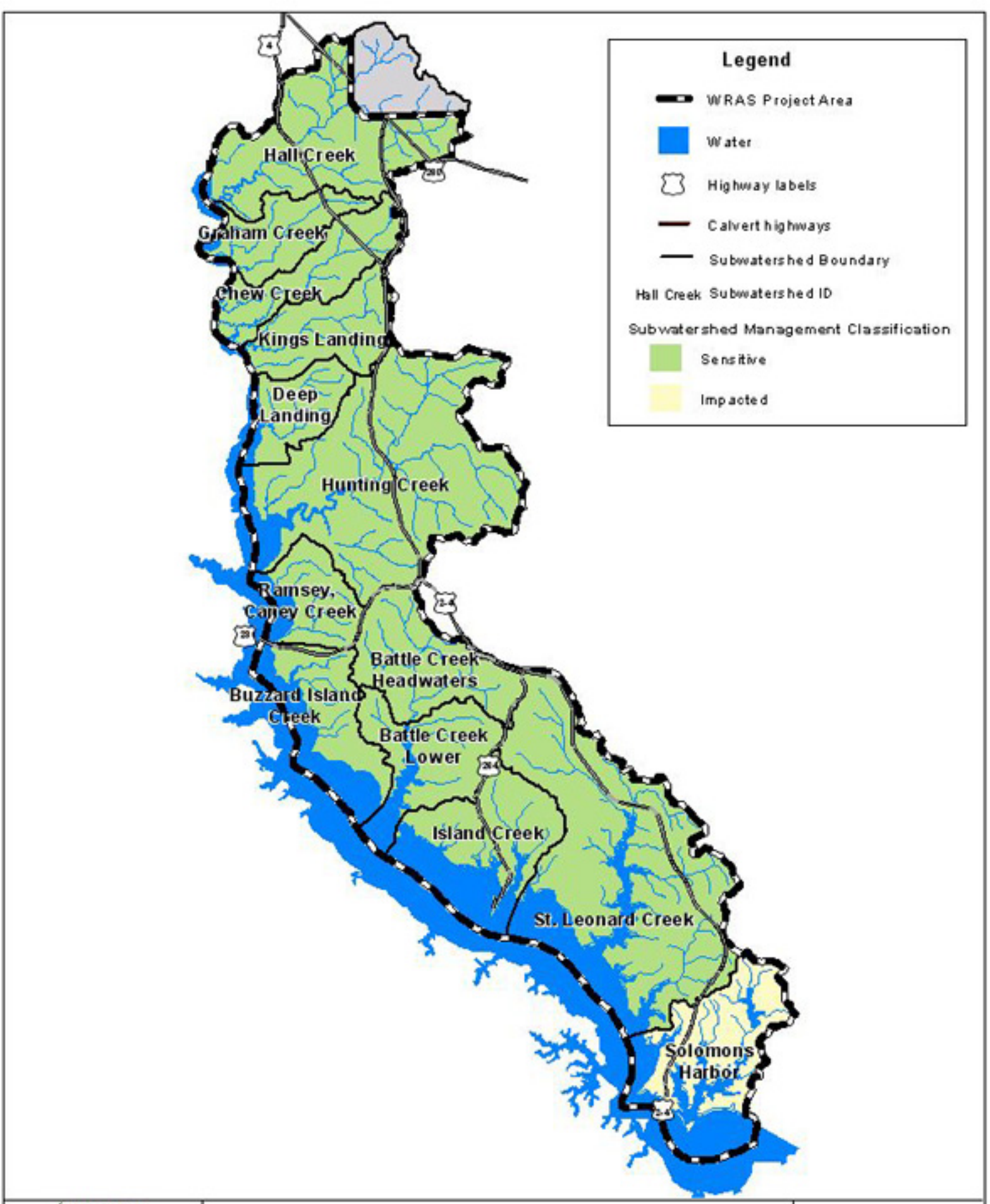
Figure 4. Contiguous Forest Assessment in Island Creek Subwatershed

Onsite Sewage Disposal Systems (OSDS) Management Strategy

The Maryland Department of Planning has estimated that 25% of the nonpoint source nitrogen pollution in Calvert County originates from onsite sewage disposal systems (OSDS) (a.k.a., septic systems). The Chesapeake Biological Laboratory, University of Maryland estimates that septic systems were by far the greatest contributor of nitrogen to the system in Solomons Harbor. Studies like these have prompted the County to begin the process of developing a strategy to reduce nitrogen pollution from septic systems in the Solomons Harbor subwatershed. This project includes holding two public forums and conducting a survey of citizen septic system awareness and maintenance. At a minimum, the goal is to present a series of recommendations to the Board of County Commissioners to change the Calvert County Water and Sewerage Plan. Additional information on the OSDS strategy can be found in Appendix D.

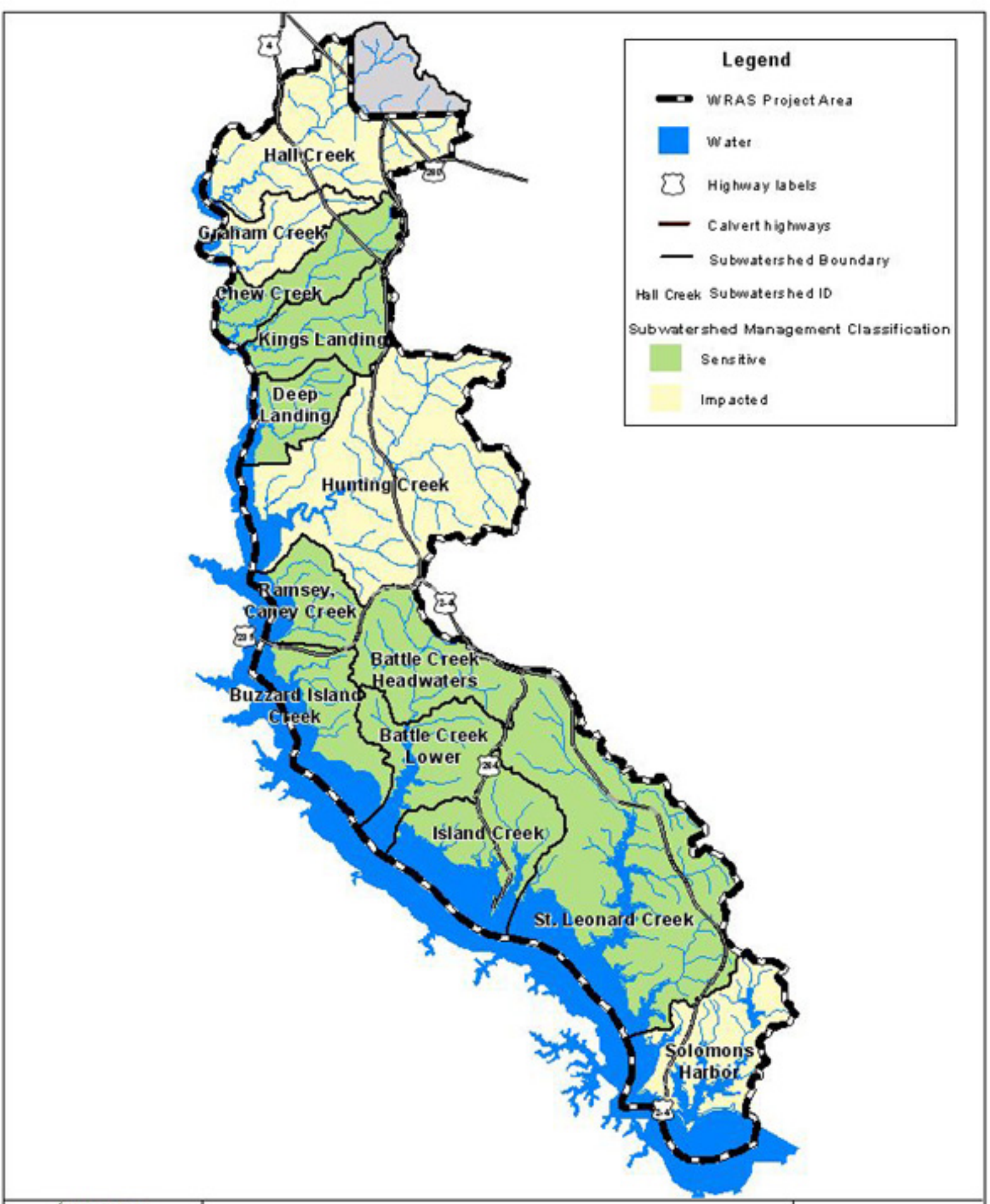
Boat Traffic Study

Prompted by citizen concerns, the County contracted with the University of Maryland Center for Environmental Sciences (UMCES) to determine the influence of boat traffic on the physical and chemical parameters of Island Creek. Various physical and chemical characteristics such as nutrient and hydrocarbon concentrations, wave activity, and boat traffic frequencies were examined along a transect of five sampling stations. The analyses indicate that there is little obvious effect of boat traffic on any measured physical or chemical parameter. However the authors note that the data are inconclusive due to inadequate representation of heavy boat traffic periods. Additional sampling dates are recommended to determine conclusively whether boat traffic has any detrimental effect on Island Creek (Williams *et al*., 2004). The final report can be found in Appendix E.



Map 4 - Current Impervious Cover

Lower Patuxent River in Calvert County WRAS



Map 5 - Future Impervious Cover

Lower Patuxent River in Calvert County WRAS

0 20000 Feet

Section 3.0 Target Subwatersheds

The purpose of this section is to provide characteristics and data on the target subwatersheds: Hall Creek, Island Creek, and Solomons Harbor. These data will serve as the basis for several of the recommendations made in Section 4.0. It is recommended that the County revisit this plan and develop similar strategies for the remaining subwatersheds. Much of the information presented here can be extrapolated to other subwatersheds within the Lower Patuxent watershed with similar characteristics. Summary characteristics for the three target subwatersheds are provided in Table 7.

Section 3.1 Hall Creek Subwatershed

The Hall Creek subwatershed is located at the northern-most point in Calvert County. Its proximity to Anne Arundel County and Washington DC, and accessibility to Route 4 make this area a popular bedroom community. Because of its location, there has been growing concern regarding land development. Currently, the Hall Creek subwatershed is dominated by low density residential, medium density residential and forest. The current impervious cover percentage is 6.8 percent, indicating that impacts to water resources may be beginning to occur. Based on available zoning, it is projected that at buildout, the subwatershed will have an impervious cover level of 10.8 percent. Map 6 illustrates many of the characteristics and data described below.

Currently, at 6.8 percent impervious cover, both DNR and CWP noted several severely eroded streambanks. It would appear that the combination of erodible soils, steep slopes and relatively low levels of impervious cover are enough to cause streambank degradation (see Figure 5). These surveys also revealed several developments that were built prior to significant stormwater regulations. As a result, there are several unmanaged stormwater outfalls that discharge directly into the stream. Additionally, the Maryland Biological Stream Survey (MBSS) rated the quality of benthic macroinvertebrates, stream habitat, and water quality as poor, fair and fair, respectively. Notes from the MBSS survey indicate that the mediocre ratings may be related to unmanaged stormwater.

Figure 5. Channel Erosion in Hall Creek Subwatershed

Grab samples from Maryland DNR's synoptic survey indicate that nitrate/nitrite yields are slightly elevated. Ten out of the twelve stations sampled in Hall Creek exhibit moderate to excessive yields of nitrate/nitrite. None of the stations exhibit high yields of orthophosphate.

While growth and unmanaged stormwater are both clear concerns for Hall Creek, it is also important to consider the environmentally sensitive features. Significant spawning areas and two sensitive species have been identified in the subwatershed. Both of these features merit special protection and the County should take measures to maintain their current status.

The characteristics of this subwatershed indicate that an appropriate management strategy should include a combination of protection and restoration tools.

Section 3.2 Island Creek Subwatershed

Island Creek subwatershed, which encompasses Broomes Island, is located in the southwestern portion of the watershed. The land use is primarily cropland and forest with small pockets of low density residential. Much of this residential development is located in Broomes Island, a designated Priority Funding Area (PFA) by the State. PFAs are existing communities and places where local governments want State investment to support future growth (MDP, 1997). Map 7 illustrates many of the characteristics and data described below.

Citizens have expressed a growing concern regarding boat traffic and subsequent shoreline erosion and water resource degradation. In particular, citizens have noted quality of life issues including noise and water pollution. The study being conducted as a result of this concern is described in Section 2.5 and Appendix E. Citizens have suggested that reduced and enforced speed limits may be a potential solution to the boat-related impacts in Island Creek. With regard to the shoreline erosion, it should be noted that much of the shoreline located around Broomes Island is lined with bulkhead. The use of bulkhead may increase erosion to adjacent properties with natural or "unprotected" shorelines.

There are several studies that have documented the water quality in Island Creek. These include Maryland DNR's Synoptic Survey, University of Vermont Gund Institute for Ecological Economics' Patuxent Landscape Model (PLM), and UMCES Integration and Application Network's Chesapeake Bay Report Card. The grab samples from the Synoptic Survey found that the majority of stations have low nitrate/nitrite yields, but two fell into the high and excessive categories. All of the stations have low orthophosphate yields (Primrose, 2003).

The University of Vermont's PLM did not compute actual nitrogen loads but did estimate that 54% of the relative nitrogen load to Island Creek comes from fertilizers (UVM, 2004). UMCES's Chesapeake Bay Report Card gave Island Creek a D- for ecosystem health. UMCES suspects that this low score is due to localized hotspots of septic discharge within the creek (Jones *et al.*, 2003).

Despite these problems, the subwatershed is 31% contiguous forest and has very low levels of impervious cover (2%), and contains State designated sensitive species. The stable stream reach depicted in Figure 6 is fairly typical for this subwatershed. The characteristics of this

subwatershed indicate that a protection management strategy with an emphasis on stewardship would be appropriate for Island Creek subwatershed.

Figure 6. Nice Stream Reach in Island Creek Subwatershed

Section 3.3 Solomons Harbor Subwatershed

Solomons Harbor, located at the southern most tip of Calvert County, is a major boating center (10+ marinas) and tourist attraction during the summertime. The landscape is dominated by low and medium density residential land use. Current impervious cover estimates place Solomons Harbor streams in the impacted category. In the buildout (future IC) scenario, impervious cover increases by another seven percent (7%). This may be attributed to the fact that much of Solomons Harbor is designated as a PFA, so additional effort is placed on directing growth here. Map 8 illustrates many of the characteristics and data described below.

Subwatersheds like Solomons Harbor, that have a significant amount of low density residential development, sandy soils, and a high water table are susceptible to water quality degradation from septic systems. The Chesapeake Biological Laboratory, University of Maryland concluded that septic systems are by far the greatest contributor of nitrogen in Solomons Harbor based on water quality monitoring and land use. The County is in the process of crafting a septic system management strategy to address these water quality concerns. Additional information on the strategy is available in Section 2.5 and Appendix D.

Grab samples from Maryland DNR's synoptic survey indicate that levels of nitrate/nitrite and orthophosphate are not excessive. One station did reveal slightly elevated yields of nitrate/nitrite. The same survey also rated the quality of macroinvertebrates as poor to very poor. A typical stream reach is shown in Figure 7.

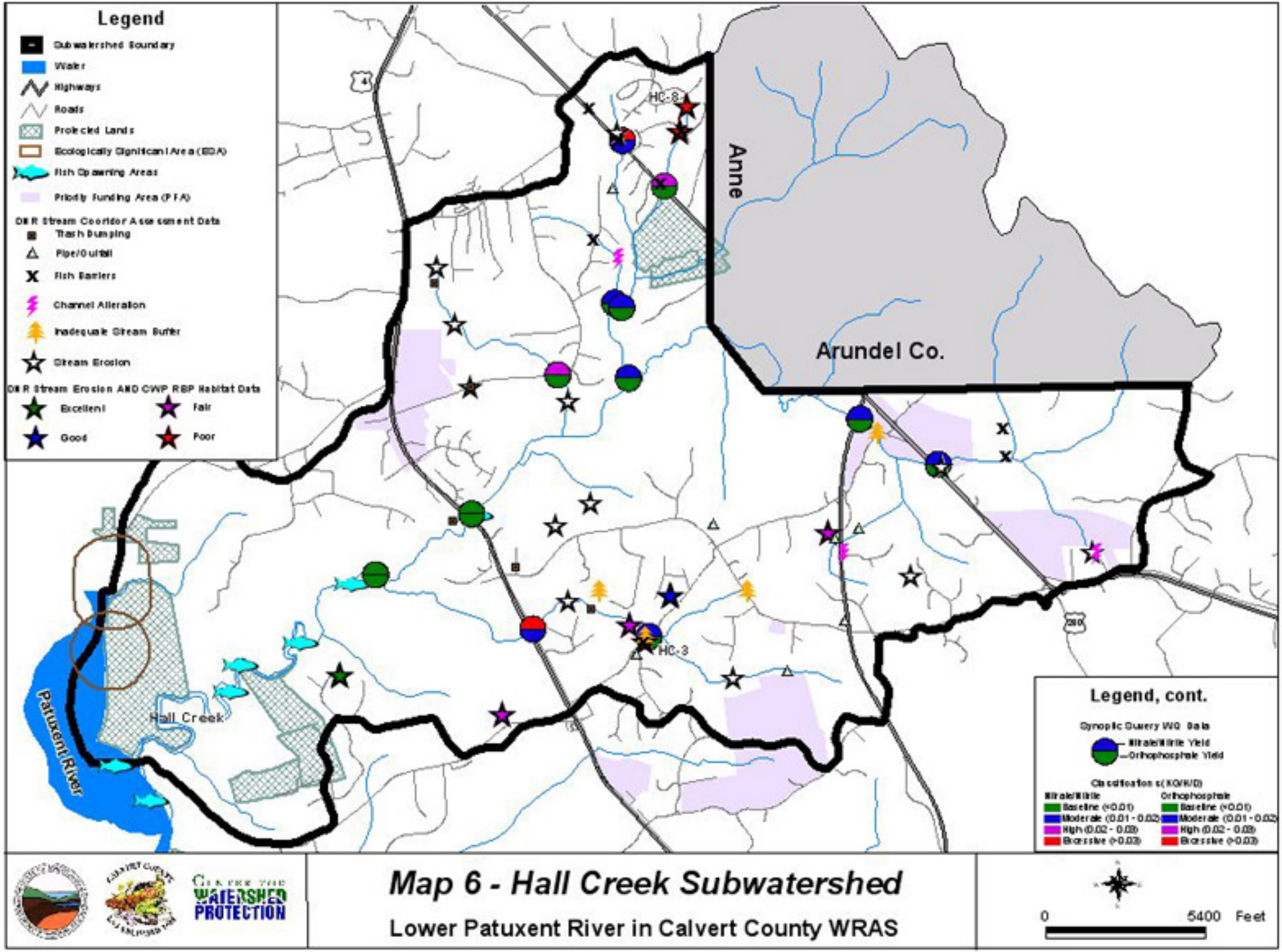
Figure 7. Typical Stream Reach in Solomons Harbor Subwatershed (Source: Pellicano and Yetman, 2004)

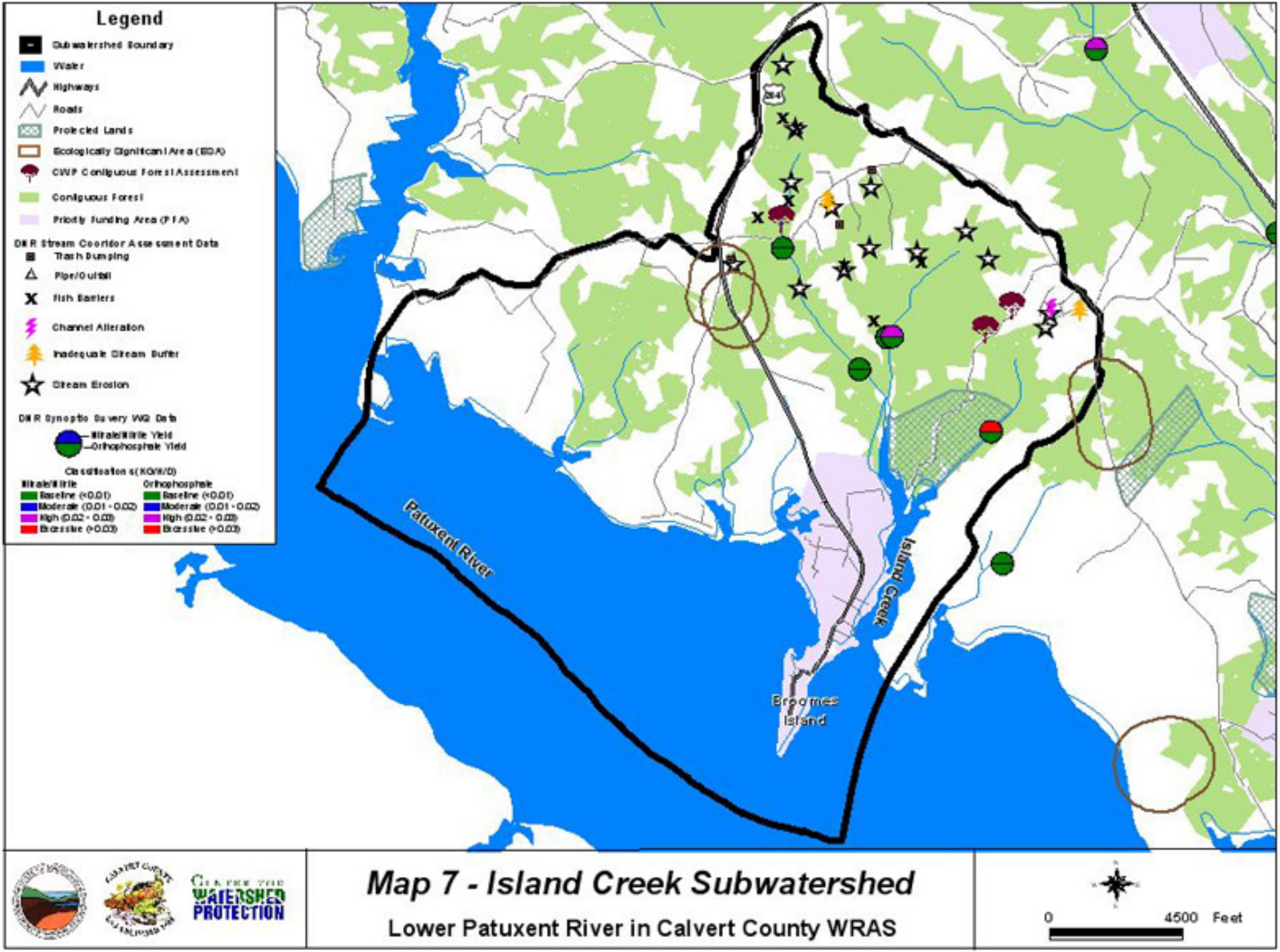
Based on these characteristics, a restoration management strategy with emphasis on stewardship would be appropriate for Solomons Harbor subwatershed.

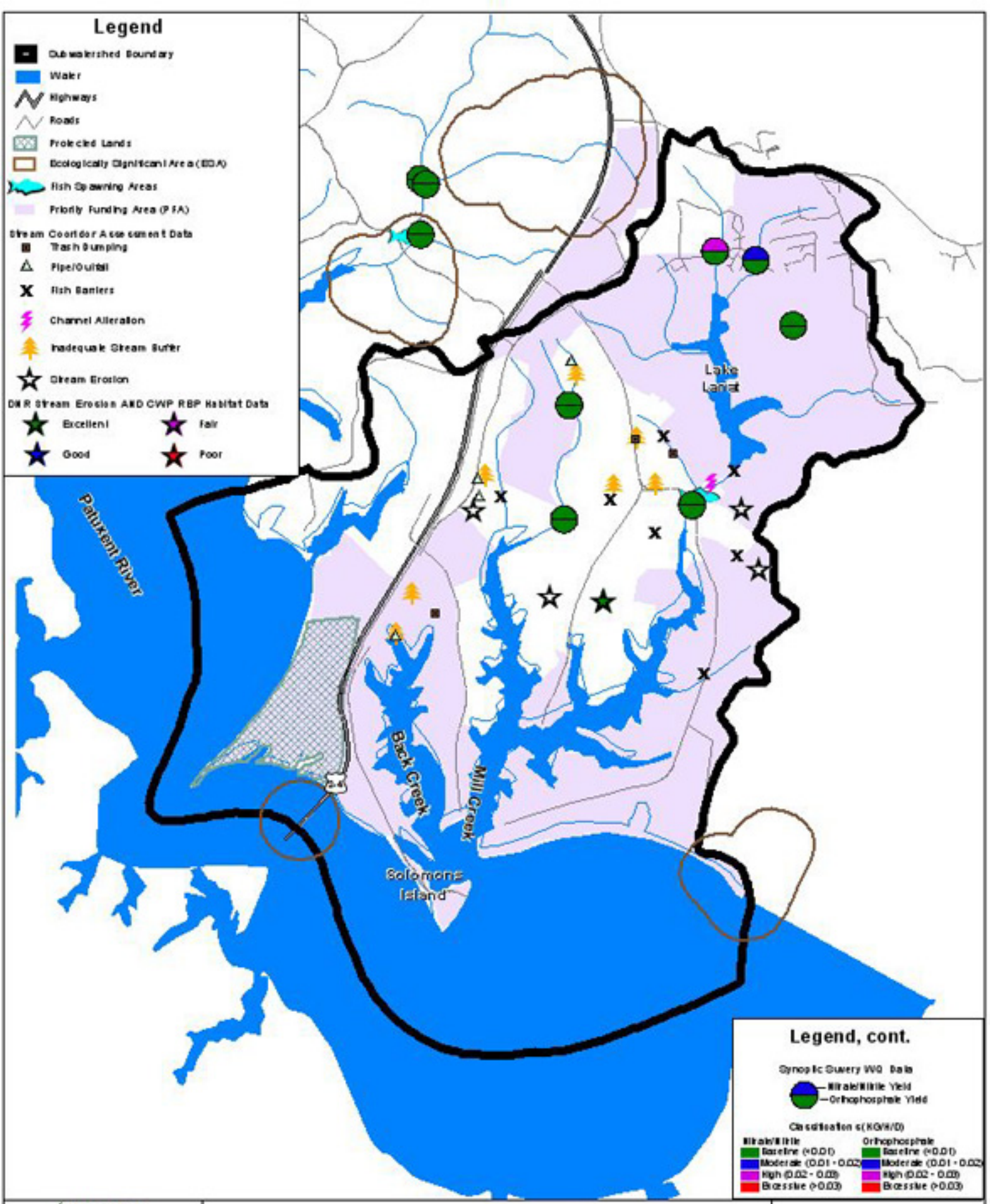
Table 7. Target Subwatersheds Summary Conditions

Subwatershed	Subwatershed Area (ac)[1]	Current IC %	Future IC %	Dominant Land Use(s)	% Protected Land	% Contiguous Forest	# ESAs	Fish Spawning?	Stream Corridor Assessment Sites[2]	
									# Erosion	# Fish Barriers
Hall Creek	10,486	6.8	10.8	low density residential, forest	6	24	2	Y	20	8
Island Creek	8,340	2.0	5.0	cropland, forest	7	31	2	N	14	7
Solomons Harbor	9,412	10.5	17.9	low and medium density residential, forest	7	27	0	N	5	7

Notes:
1: Subwatershed area includes both land and water
2: Stream Corridor Assessment only covered portion of Solomons Harbor subwatershed
ESA: Environmentally Sensitive Areas


Legend
Subwatershed Boundary
Water
Highways
Roads
Protected Lands
Ecologically Significant Area (ESA)
Fish Spawning Areas
Priority Funding Area (PFA)
DNR Stream Corridor Assessment Data
Trash Dumping
Pipe/Outfall
Fish Barriers
Channel Alteration
Inadequate Stream Buffer
Stream Erosion
DNR Stream Erosion AND CWP RBP Habitat Data
Excellent
Fair
Good
Poor
Anne
Arundel Co.
HC-8
HC-3
Hall Creek
Patuxent River
Legend, cont.
Synoptic Survey WQ Data
Nitrate/Nitrite Yield
Orthophosphate Yield
Classification (KG/HA/D)
Nitrate/Nitrite
Orthophosphate
Baseline (<0.01)
Moderate (0.01 - 0.02)
High (0.02 - 0.03)
Excessive (>0.03)
WATERSHED PROTECTION
Map 6 - Hall Creek Subwatershed
Lower Patuxent River in Calvert County WRAS
0
5400 Feet


Legend
Subwatershed Boundary
Water
Highways
Roads
Protected Lands
Ecologically Significant Area (ESA)
CWP Contiguous Forest Assessment
Contiguous Forest
Priority Funding Area (PFA)
DNR Stream Corridor Assessment Data
Trash Dumping
Pipe/Outfall
Fish Barriers
Channel Alteration
Inadequate Stream Buffer
Stream Erosion
DNR Synoptic Survey WQ Data
Nitrate/Nitrite Yield
Orthophosphate Yield
Classification (KG/Yr/D)
Nitrate/Nitrite
Baseline (<0.01)
Moderate (0.01 - 0.02)
High (0.02 - 0.03)
Excessive (>0.03)
Orthophosphate
Baseline (<0.01)
Moderate (0.01 - 0.02)
High (0.02 - 0.03)
Excessive (>0.03)
264
Patuxent River
Island Creek
Broomes Island
WATERSHED PROTECTION
Map 7 - Island Creek Subwatershed
Lower Patuxent River in Calvert County WRAS
0
4500 Feet



Map 8 - Solomons HarborSubwatershed

Lower Patuxent River in Calvert County WRAS

Section 4.0 Recommendations

This section describes the management recommendations for meeting the Lower Patuxent WRAS goals. The recommendations are organized into four parts: watershed-wide, Hall Creek subwatershed, Island Creek subwatershed, and Solomons Harbor subwatershed. While the recommendations focus on only three of the subwatersheds, the recommendation made here can and should be applied to subwatersheds with similar characteristics.

All of the recommendations are based on the assumption of a 10-year planning window. This window should be continually revisited and revised as progress is made. A summary of the recommendations and responsible parties are presented in Table 9.

Section 4.1 Watershed–wide Recommendations

Hire a Watershed Coordinator

Implementation of watershed planning recommendations can be a lengthy and time consuming process. An additional staff person is necessary to ensure the implementation of the watershed plan. Many of the recommendations outlined below are dependant on a dedicated staff person. Responsibilities of the watershed coordinator would include guiding the Implementation Committee (see below), initiating educational efforts, and implementing the project tracking and monitoring plan (see Section 5.2). The watershed coordinator should be a County government employee and be familiar with local conditions and watershed management. DPZ should take the lead on hiring a watershed coordinator as the first order of business in implementing the plan. Stakeholders ranked this as one of the most important recommendations.

Establish an Implementation Committee

To ensure the implementation of the Lower Patuxent River WRAS, the watershed coordinator should establish an Implementation Committee. The purpose of the committee would be to coordinate implementation efforts between agencies and organizations, secure funding for implementation efforts, and track the success of the implementation (see Section 5.0). The committee can also serve to facilitate information exchange between organizations and departments on related efforts. The Implementation Committee should include representatives from DPZ, DPW, Health Department, Forest Service, Calvert Soil Conservation District (SCD), Calvert Cooperative Extension, DNR and other key watershed stakeholders.

Foster the Development of a Lower Patuxent River Watershed Association

The watershed coordinator, along with strong landowner/stakeholder support, should foster the development of a Lower Patuxent River watershed association. Stakeholders have expressed interest in participating in a watershed association. This organization can facilitate community-based stewardship of the Lower Patuxent River watershed. Eventually, this group could organize tree plantings, stream cleanups, environmental education programs, and recreational activities. This recommendation would also help to meet Comprehensive Plan Action No. 156 (Calvert County, 2002a).

Complete the Watershed Planning Process

To complete a watershed plan for the Lower Patuxent River WRAS, several additional elements are needed. A completed watershed plan would include additional:

- Assignment of subwatershed management classifications
- Field work
- Program analyses
- Recommendations

At a minimum, an in-office compilation of available data (land uses, water quality monitoring, etc.) combined with field verification should be conducted to assign management classifications to the remaining subwatersheds. DNR's stream corridor assessment or a similar methodology should be conducted to provide the data necessary to identify specific projects and verify management classifications. Additionally, an analysis of the County's codes, ordinances and programs in the context of watershed protection should be conducted. The analysis can establish a baseline of current strategies and practices within the watershed. By understanding these, strengths and weaknesses can be assessed and future efforts planned. An example of such an analysis is available at www.cwp.org/gcreview.pdf. The final watershed plan should include recommendations for all of the subwatersheds and an implementation/ prioritization schedule. The watershed coordinator should take the lead on this recommendation. Watershed stakeholders have recommended that these final steps utilize the County's updated GIS data and involve the expertise of land use planners.

Conduct a Watershed-wide Stormwater Retrofit Inventory

A portion of CWP's time spent in Hall Creek was to identify potential stormwater retrofit opportunities. Our field work revealed that opportunities for retrofitting are limited in Hall Creek subwatershed. However, it was noted that other areas such as the Hunting Creek subwatershed, near Prince Frederick, may have ample opportunities to provide additional stormwater management (see Miscellaneous Observations in Appendix C). The DPW should conduct a retrofit inventory that targets locations such as existing stormwater detention facilities (dry ponds), immediately below or adjacent to existing storm drain outfalls, and within or adjacent to large parking lots. The County should also considering partnering with the State Highway Administration (SHA) to address unmanaged highway runoff. Ideally, several of the retrofits would serve as demonstration and educational projects on visible, county-owned properties, such as schools and libraries. DPW should utilize the County's stormwater management fund to conduct the inventory and construct at least six retrofits (in addition to the one listed under Hall Creek). Additional information on conducting a retrofit inventory can be found at: www.stormwatercenter.net/Slideshows/retrofits.htm.

Conduct a Watershed-wide Contiguous Forest and Forest Interior Inventory

As part of the WRAS, CWP conducted a small contiguous forest inventory within Island Creek subwatershed. As this survey progressed, it became apparent that a survey within a larger context would be valuable. The County should conduct a watershed-wide survey to identify and prioritize conservation areas based on an area's ability to protect habitat and water quality. The survey should first consist of an in-house, aerial photo analysis to identify the areas of interest (e.g., tracts of forest greater than 100 acres). DNR's Lower Patuxent

Watershed Characterization (2003a) contiguous forest mapping should be utilized as a base (see Map 12 in the Characterization). Next, field verification should be conducted using the data sheet provided in Appendix B. Finally, using the data gathered in the field, the tracts should be prioritized based on quality and contiguousness. Since the Lower Patuxent watershed has a substantial percentage of its headwater streams in interior forests, protection of these forests against impacts from development should factor into the prioritization process.

The County currently has a very robust preservation program. This recommendation should be implemented to compliment and strengthen the County's ongoing efforts, including the development of a Forest Interior Map that will be used to identify and prioritize areas for forest retention when developing site plans. The County should adopt the Forest Interior Map and utilize existing tools and programs (such as Transfer of Development Rights and the Purchase and Retirement Fund) to preserve at least 30% of the current contiguous forest tracts. Prioritization should be given to tracts in a Green Infrastructure Hub which has a state-wide value. This recommendation also works to meet Comprehensive Plan Action Nos. 114, 117, 118 and 119 (Calvert County, 2002a).

Enhance and Restore Riparian Buffers

Enhancing and restoring riparian buffers will improve riparian habitat, protect streambanks, and remove nonpoint source pollutants. Existing federal and state programs such as the Conservation Reserve Enhancement Program (CREP) make planting buffers in agricultural land relatively inexpensive for the County.

Inadequately buffered areas that are not covered by existing programs, such as CREP, should be targeted by the county with a supplemental program that would help to establish buffers on residential lands outside of the Critical Area. Forest Conservation Act fee-in-lieu funds could be targeted solely for stream buffer areas, rather than upland areas, in order to increase water quality benefits on areas that do not qualify for the CREP. Additional funds based on the level of interest from the small farm community (below CREP thresholds) and the non-agricultural community could be allocated to increase implementation of buffers in the Lower Patuxent watershed. Lower residential densities usually indicate single large landowners, making this recommendation fairly easy to implement in these areas.

The watershed coordinator should work directly with the Maryland DNR's Forestry Division, Calvert SCD, and Calvert Cooperative Extension to proactively work with property owners adjacent to streams in the watershed. Implementation of this recommendation should take advantage of other available resources. For example, the Patuxent River Commission will, on occasion, offer free trees to community groups. This program should be modeled after the County's Critical Area reforestation program and should work to increase stream buffers by 40% (approximately an additional 65 miles of vegetated buffers). This recommendation also works to meet Comprehensive Plan Action Nos. 115, 116, 133, 134, and 135 (Calvert County, 2002a).

Hold Calvert County Site Planning Roundtable

Calvert County has a history of promoting environmentally sensitive development, most notably through the mandatory clustering ordinance. However, opportunities within the codes and ordinances may still exist to provide flexibility and remove barriers to promote environmentally sensitive site design that will create less impervious surface, conserve more trees and natural areas, and reduce stormwater runoff. The purpose of a local site planning roundtable is to identify these areas through a consensus-building process that identifies and modifies local codes and ordinances that act to prohibit or impede environmentally sensitive design. Participants would represent a wide range of professional backgrounds and experience related to local development issues including local government officials, planners, developers, engineers, and environmentalists. DPZ should pursue the possibility of holding a Site Planning Roundtable. Additional information regarding the Roundtable process can be found at: www.buildersforthebay.net. Implementation of Roundtable recommendations may help to reduce the amount of future impervious cover projected in Table 4. The County should also take immediate credit for reducing total build-out which will ultimately reduce the amount of future impervious cover. This recommendation would also work to fulfill several Comprehensive Plan actions related to environmentally sensitive design (Nos. 16, 17, 49) (Calvert County, 2002a).

Encourage Marinas Owners to Participate in Clean Marinas Program

The watershed coordinator should coordinate with DNR's Clean Marinas Program to actively encourage 60% of marinas to become certified (approximately 16 of the County's 28 marinas). Discharges of sewage from boats are a concern for water quality because they contribute nutrients, biochemical oxygen demand, pathogens, etc. These discharges are preventable if a sufficient number of pumpout facilities are locally available and boat operators take advantage of these services. Boat maintenance and operation can also contribute petroleum and other noxious materials to the aquatic environment.

The pollution prevention survey conducted by CWP observed a noticeable difference between the marinas participating in the Clean Marinas Program and those that were not. Observations included a lack of:

- Clear signage regarding recycling trash and oil
- Designated fish cleaning stations
- Enclosed maintenance areas
- Lack of information regarding the proper pump-out and fueling procedures

The Clean Marinas Program is a way for marina owners to gain certification and public recognition for voluntarily undertaking a number of actions related to marina design, operation and maintenance intended to properly manage all kinds of marine products and activities, and to reduce and properly manage waste (DNR, 2003a). Certified Clean Marinas will increase compliance with state

Figure 8. Small Dock in Solomons Island Subwatershed

and federal regulations and decrease the release of air and water borne pollutants. Additional information is available at DNR's website: www.dnr.state.md.us/boating. This recommendation compliments Calvert County's Comprehensive Plan Action No. 107 (Calvert County, 2002a).

Ensure Long-Term Conservation and Preservation of ESAs

In addition to contiguous forest tracts, sensitive species habitat also warrants protection as well. The list of ESAs identified in Calvert County is provided in Table 5. Many of the ESAs are not protected. The locations and protection status of these habitats are available through Maryland DNR, many of which are not protected. Several of these habitats located in the Lower Patuxent River watershed are identified in Maps 6, 7, and 8. DPZ should work with DNR's Natural Heritage Program to prioritize and conserve 40% of these areas through site plan development and placement under a permanent conservation easement. DPZ should also identify and display these areas on the Forest Interior Map. Stakeholders ranked this as one of the most important recommendations. This recommendation also works to meet Comprehensive Plan Action Nos. 146, 147, and 148 (Calvert County, 2002a).

Implement OSDS Management Strategy Beyond Solomons Harbor Subwatershed

Calvert County is currently in the process of developing a strategy to reduce nitrogen pollution from septic systems in the Solomons Harbor subwatershed (see Section 2.5 for more information). Once this strategy has been applied to Solomons Harbor, the Health Department and the DPZ should work to implement the recommendations watershed-wide. Ideally, elements of the strategy should include:

- A requirement for septic system inspection at time of sale
- Tax incentives for homeowners to upgrade septic systems
- A strategy to fund and encourage new and old developments to connect to the sewer line
- The development of a septic systems owner's manual for new residents
- Residential education

The Septic System Education Kit available from the Padilla Bay National Estuarine Research Reserve provides excellent guidance for this type of initiative: www.ocrm.nos.noaa.gov/nerr/septickit/welcome.html. Potential funding sources for this recommendation could include the National Fish and Wildlife Foundation (NFWF) and Maryland Section 319 grants. This recommendation supports the County's Comprehensive Plan Action Nos. 87, 88, and 90 (Calvert County, 2002a).

Conduct Battle Creek Shoreline Habitat Restoration

The County should continue to seek funds to restore and enhance wetlands and Battle Creek riparian buffers (Figure 9). The Calvert SCD has completed construction plans and obtained all necessary permits, however, they have not been awarded funds to cover construction costs. While this is a specific project that does not have watershed-wide implications it has several other benefits including the protection of 2,300 feet of stream bank, creation of

Figure 9. Proposed Battle Creek Shoreline Habitat Restoration Project Area

50,625 square feet of tidal marsh, creation of a 30 foot by 180 foot oyster bar, provide protection of an archaeological site and reduced erosion.

Section 4.2 Hall Creek Subwatershed Recommendations

Utilize Infiltration and LID to Retain Stormwater Onsite

CWP's field assessment of Hall Creek subwatershed noted highly erodible soils combined with steep slopes are affecting streambank stability. Even at very low densities of development, significant streambank erosion was observed. DPW and DPZ should revise the site planning criteria to promote infiltration practices and low impact development (LID). These practices promote groundwater infiltration and work to keep and treat stormwater onsite. Utilizing these practices will better replicate pre-development rates and reduce the amount of stormwater runoff to receiving streams, thus reducing the impact of development on streambank stability.

If stormwater cannot be dispersed throughout a site using LID or infiltration practices, site planners should then examine the site for the best place to discharge treated stormwater. Ideally, treated stormwater should be spread over a broad floodplain versus being conveyed down steep slopes.

For additional information on LID and infiltration practices, visit:

- www.lowimpactdevelopment.org
- www.stormwatercenter.net/Slideshows/infiltration-rac/sld001.htm

Prohibit the Creation of Fish Barriers to Upstream Spawning Areas

Hall Creek subwatershed has been identified as a key spawning area in the Lower Patuxent watershed (DNR, 2003a) for herring, white perch and yellow perch (see Map 6). The DPW and DPZ should work together to prohibit the creation of fish barriers to upstream spawning areas. DPZ and DPW should take the lead in establishing river and stream crossing standards. Where stream crossings cannot be avoided, culverts and bridges should utilize these standards to avoid impact and disruption to fish passage. Resources include:

- University of Massachusetts Cooperative Extension's Draft River and Stream Crossing Standards: Technical Guidelines; available at: www.umass.edu/umext/nrec/pdf_files/guidelines_river_stream_crossings.pdf.
- Washington Department of Fish and Wildlife's Design of Road Culverts for Fish Passage; available at: http://www.wa.gov/wdfw/hab/engineer/cm/.

Conduct Streambank Stabilization Demonstration Project

CWP field work revealed a potential streambank stabilization project in Hall Creek subwatershed. A driveway culvert located off of Fowler Road (see station ID HC-3 labeled on Map 6) has created significant downstream scour and erosion (Figure 10). The in-stream habitat for this area was rated as poor. A project here would entail removing the driveway culvert (driveway does not appear to have been in use for several years) and stabilizing the downstream area. Other characteristics that make this area an ideal project include good access for any necessary machinery from Fowler Road and little to no property or disturbance issues.

Figure 10. Hall Creek Streambank Stabilization Opportunity

Under this recommendation, the DPW should take advantage of the USDA's Natural Resource Conservation Service's (NRCS) Plant Materials Center in Cape May, NJ. The Plant Materials Center has offered their assistance with materials for any upcoming stream bank stabilization projects. The Chesapeake Bay Trust (CBT) may be a potential funding source for this recommendation. Maryland's Waterway Construction Guidelines provide additional information on streambank stabilization techniques: www.mde.state.md.us/Programs/WaterPrograms/Wetlands_Waterways/documents_information/guide.asp

Construct Stormwater Retrofit Demonstration Project

CWP field work revealed that the entire Cavalier Country subdivision drains to one unmanaged stormwater outfall that has resulted in significant downstream scour and erosion. The unmanaged stormwater outfall is located on Map 6 at station ID HC-8 (also see Figure 11). It would appear that the stormwater outfall is adjacent to a drainage easement. This vacant lot could easily be converted into a stormwater management practice utilizing the DPW's stormwater management fund. To keep stormwater onsite, the County should explore the feasibility of constructing an infiltration basin (dependant on soils and groundwater). If an infiltration basin is not feasible, consider a stormwater wet pond. The County should determine is State agency assistance is needed and pull in partners as appropriate.

Figure 11. Hall Creek Stormwater Retrofit Opportunity

Section 4.3 Island Creek Subwatershed Recommendations

Implement Living Shoreline Techniques

According to watershed stakeholders, significant erosion is occurring at the tip of Broomes Island. The majority of Broomes Island is bulkheaded and may be contributing to the erosion occurring at unprotected portions of the shoreline. A bulkhead is a structural shoreline erosion control practice that can reflect waves without dissipating wave energy and instead ends up focusing the energy onto adjacent beaches (Macdonald *et al*,. 1994).

The watershed coordinator should work with DNR's shore erosion control program and the watershed association to implement living shoreline techniques to address the Broomes Island erosion caused by the deflection of wave energy from existing bulkheads. This project can serve as demonstration project to help increase the use of living shoreline techniques throughout the watershed. These techniques may include vegetative covers, bank grading, and marsh creation. In addition to stabilizing shorelines, these techniques can also create additional wildlife habitat and act as a filter to adjacent land uses. The County should also consider working with DNR to identify and prioritize additional candidate sites. The CBT and DNR's Shore Erosion Program are potential funding sources. Additional information on living shoreline techniques can be found at: www.psat.wa.gov/Publications/01_proceedings/sessions/oral/4b_johan.pdf.

Conduct Additional Studies on Boating and Water Quality

Prompted by citizen concerns, the County contracted with the University of Maryland Center for Environmental Sciences (UMCES) to determine the influence of boat traffic on the physical and chemical parameters of Island Creek. With only two sampling dates, UMCES noted that the data were inconclusive and recommended additional sampling dates to determine whether boat traffic has any detrimental effect on Island Creek.

In addition to boating and water quality sampling, watershed stakeholders also requested that future studies look at the impact of boating on ESAs and submerged aquatic vegetation (SAV), the impact of jet skis. The ultimate goal of these studies would be a comprehensive approach to ecologically sound boating practices. Maryland Section 319 grants may be a source of funding.

A good resource is the National Clean Boating Campaign's Bibliography of National Clean Boating and Clean Marina Websites: http://cleanboating.com/bibliography/.

Conduct Lawn Care and Septic System Education

A residential stewardship program should be pursed by the watershed coordinator. The purpose of this outreach program would be to minimize nonpoint source pollution in residential areas by generating watershed awareness and active stewardship primarily among residents in the Island Creek subwatershed. Since UMCES and UVM studies have identified septic systems and fertilizers (respectively) as a source of nitrogen pollution, the outreach should target lawn care and septic system practices. In addition to residents, the campaign should also encourage lawn care companies and managed communities to use alternative products or application procedures for fertilizers and pesticides. These education campaigns work best when "good examples" are available to point to. The watershed coordinator and watershed association should consider working with willing parties to implement pollution prevention practices that may serve as demonstration sites. This recommendation supports the County's Comprehensive Plan Action No. 150 (Calvert County, 2002a).

Conduct an Operations Assessment of Farming Practices

In order to effectively reduce the nutrient contribution from agricultural lands, the watershed coordinator should work with the Calvert SCD and Calvert Cooperative Extension to conduct an assessment of the types of practices commonly used in farming. This assessment would look at practices such as nutrient management, livestock fencing, and manure storage and handling. Fertilizer was identified by the Patuxent Landscape Model (UVM, 2004) as the largest contributor of nitrogen in the Island Creek watershed. An assessment may also help to identify the contributors of elevated fertilizer contributions. The results of the assessment should then be utilized to target specific landowners and education programs to improve the current state of farming practices within the Island Creek subwatershed.

Section 4.4 Solomons Harbor Subwatershed Recommendations

Promote Good Rooftop Runoff Management

CWP's pollution prevention survey observed that the majority of residential rooftop downspouts were either directed to impervious surfaces or only traveled over a short distance of lawn before discharging directly into the Patuxent River. The ideal watershed behavior is to disconnect all downspouts so individual rooftops deliver no runoff to the storm drain system or stream. The watershed coordinator and watershed association should initiate a rooftop runoff education campaign that encourages homeowners to disconnect their rooftop drains and utilize rain gardens and/or rainbarrels. This approach can be effective with widespread implementation and also provides excellent opportunities for improved public awareness and involvement. The County should consider utilizing a combination of carrots to promote disconnection retrofits, including:

- Conventional outreach materials (flyers, brochures, posters)
- Free or discounted rain barrel distribution
- Municipal or schoolyard demonstration projects
- Credits or subsidies for disconnection retrofits
- Direct technical assistance
- Provision of discounted mulch, piping or plant materials
- Modification of sewer and storm water ordinances to promote disconnection
- Mandatory disconnection for targeted subwatersheds

The objective of this effort is to educate 50% of homeowners. The County should also leverage the Critical Area program to encourage disconnection. Resources on reducing impacts from individual residential lots, rainbarrels and raingardens are available at:

- www.dnr.state.md.us/criticalarea/10percent_rule.html (Section 5 and Appendix F of document will have most applicability)
- www.cwp.org/Community_Watersheds/educating_constituents.htm
- www.cleanrivers-pdx.org/get_involved/downspout_disconnection.htm

Initiate a "Scoop the Poop" Campaign

Along the water in Solomons Harbor subwatershed, CWP noticed a significant number of dog walkers and observed a noticeable amount of dog waste along waterfront walkways. A nearby park did have small sign on pet waste pick-up; however it was not very prominent or noticeable. These observations were made during the tourist off-season and it may be reasonable to assume that dog walking traffic and subsequent dog waste will only increase during the summer months.

The ideal watershed behavior is to pick up and properly dispose of pet waste. The negative watershed behavior is to leave pet waste on common areas and the yard, where it can be washed off in stormwater runoff. A typical dog poop contains more than three billion fecal coliform bacteria, so it doesn't take many bad dogs (or bad owners) to close a beach, restrict shellfish harvests, or limit water contact recreation in a stream or river.

To encourage the ideal behavior, the watershed coordinator and watershed association should work to post signage and waste disposal stations in high dog walking areas, especially along the water's edge. The objective is to educate 50% of the target population.

Several communities have used both "carrots" and "sticks" to get more dog owners to pick up after their pets, including:

- Mass media campaigns of the water quality impacts of dog waste
- Conventional outreach materials (brochures, flyers, posters)
- Pooper bag stations in parks, greenways and common areas
- Educational signs in same areas
- "Pooper scooper" ordinances and enforcement
- Banning dogs from beaches and waterfront areas
- Providing designated "dog parks"

Gwinnett County Parks & Recreation Department's Pick It Up - Its Your Doodie Campaign is a good example of a pet waste education program: www.gwinnettcitizen.com/0203/doodie.html.

Promote Good Commercial Housekeeping

CWP's pollution prevention survey noted that several businesses and restaurants located on the water's edge in Solomons Harbor conducted poor dumpster management. Dumpsters frequently did not have lids, no secondary containment, and appeared to be poorly maintained overall. This is of particular concern since this is in an area that directly drains to the lower Patuxent River.

Most dumpsters are unregulated hotspots that can be a significant pollution source in many subwatersheds. Many dumpsters are open, which allows rainfall to mix with the wastes, creating a potent brew affectionately known as "dumpster juice." When combined with the inevitable spillage, dumpsters can be a source of trash, oil and grease, metals, bacteria, organic material, nutrients, and sediments. Pollution prevention practices for dumpsters are outlined in Table 8.

Figure 12. Mediocre Dumpster Management in Solomons Island Subwatershed

Table 8: Pollution Prevention Practices for Dumpsters
• Locate dumpsters on a flat concrete surface that does not slope or drain to the storm drain system • A secondary containment system such as a berm or curb should be installed around the dumpster if it is connected to the storm drain • Install protective covers or lids to keep rainfall from accumulating in the dumpster or secondary containment area • Dumpsters at vehicle service areas, fast food restaurants, and convenience stores should have a lid that can be closed after each use. • An oil/grease separator or sump pit should be installed for dumpsters that receive waste with a high moisture content • Clear and visible signs should be placed on dumpsters indicating what kind of waste can be accepted • Oil and grease and other liquids should never be thrown into a dumpster. Provide alternative disposal locations for impermissible substances • The lid should be closed and secured properly when the dumpster is not being loaded or unloaded • Dumpsters should be emptied on a frequent schedule to prevent overfilling or storage outside the dumpster • Leaks and damaged dumpsters should be immediately repaired • Bleach and soap should not be used to clean the container unless the wash water is sent to the sanitary sewer system • Trash and litter around the dumpster should be picked up or swept on a regular basis

To encourage the ideal watershed behavior the watershed coordinator and watershed organization should create a voluntary program that encourages businesses to practice good commercial housekeeping. This program should entail a checklist (using Table 8 as a starting point), inspection, and subsequent certification. Certified businesses should be provided with a certificate that can be publicly displayed and names should be visibly posted on the County's website. The objective is for 20% of Solomons Harbor's businesses to participate in the program.

Good resources include the Clean Charles Coalition's Businesses Best Management Practices Fact Sheets (www.cleancharles.org/resources_business.shtml) and the Alliance for the Chesapeake Bay's Businesses for the Bay program (http://www.chesapeakebay.net/b4bay.htm).

Implement OSDS Management Strategy

Calvert County is currently in the process of developing a strategy to reduce nitrogen pollution from septic systems in the Solomons Harbor subwatershed. The Health Department and DPZ should implement all of the recommendations that result from this strategy. For additional information see the recommendation: "Implement OSDS Management Strategy Beyond Solomons" in Section 4.1.

Table 9. Summary of the Lower Patuxent River WRAS Recommendations		
Recommendation Category	**Recommendation**	**Responsible Party**
Watershed-wide	Hire Watershed Coordinator	DPZ
	Establish an Implementation Committee	WC, All Responsible Parties plus key stakeholders
	Foster Development of Watershed Association	WC, Stakeholders
	Complete Watershed Planning Process	WC
	Conduct a Stormwater Retrofit Inventory	DPW
	Conduct a Contiguous Forest Inventory and Forest Interior	DPZ
	Enhance and Restore Riparian Buffers	Forest Service, SCD, Calvert Cooperative Ext., DPZ, WC
	Hold a Calvert County Site Planning Roundtable	DPZ
	Encourage Marina Owners to Participate in Clean Marinas Program	WC, DNR
	Ensure Long-term Conservation and Preservation of ESAs	DPZ
	Implement OSDS Management Strategy Beyond Solomons	DPZ, Health Dept.
Hall Creek	Utilize Infiltration and LID to Retain Stormwater Onsite	DPW
	Prohibit the Creation of Fish Barriers to Upstream Spawning Areas	DPW, DPZ
	Conduct Streambank Stabilization Demonstration Project	DPW
	Construct Stormwater Retrofit Demonstration Project	DPW
Island Creek	Implement Living Shoreline Techniques	DNR Shore Erosion Control Program, WC, Watershed Association
	Conduct Additional Studies on Boating and Water Quality	UMCES
	Conduct Lawn Care and Septic System Education	WC, Watershed Association
	Conduct an Operations Assessment of Farming Practices	WC, SCD, Calvert Cooperative Ext.
Solomons Harbor	Promote Good Rooftop Runoff Management	WC, Watershed Association
	Initiate a “Scoop the Poop” Campaign	WC, Watershed Association
	Promote Good Commercial Housekeeping	WC, Watershed Association
	Implement OSDS Management Strategy	DPZ, Health Dept.

Acronyms:
DNR: Maryland Department of Natural Resources
DPW: Calvert County Department of Public Works
DPZ: Calvert County Department of Planning and Zoning
ESA: Environmentally Sensitive Areas
LID: Low Impact Development
OSDS: Onsite Sewage Disposal System
SCD: Calvert County Soil and Water Conservation District
UMCES: University of Maryland Center for Environmental Studies
WC: Watershed Coordinator

Section 5.0 Implementation

This section is broken into three parts, prioritization of recommendations for implementation, a strategy for tracking success of the Lower Patuxent River WRAS and the potential pollutant reductions as a result of the implementation of the WRAS. All three components should be continually revisited and updated as progress has been made.

Section 5.1 Prioritization

In this section, the recommendations have been broken into three prioritization tiers (Table 10) with the first tier representing the top watershed recommendations. Tier 2 and 3 recommendations should still be pursued, but monetary and staff resources should initially be directed towards Tier 1 recommendations. The prioritization is based on the following factors:

- Is the recommendation key to the success of overall Lower Patuxent WRAS implementation?
- What is the overall benefit to the Lower Patuxent River health?
- Does the recommendation directly meet Lower Patuxent WRAS goals?
- How did watershed stakeholders rank the recommendation?
- Does the recommendation require more assessment or program development?

Given a ten year planning horizon, Tier 1 recommendations should be implemented within the first five years. The time frame for Tier 2 should roughly be within five to seven and Tier 3 within seven to ten. When certain opportunities such as funding or County and/or State initiatives present themselves, Tier 2 and Tier 3 recommendations should be given priority.

Where possible, planning level cost assumptions for recommendations are summarized. An over-riding assumption is that all recommendations will require some level of staff time, although this cost has not been included in cost per unit.

Table 10. Lower Patuxent WRAS Implementation Strategy			
Rank	**Recommendation**	**Goal(s) Supported** (from Section 1.2)	**Estimated Cost per Unit**
1	Hire Watershed Coordinator	--	$35 - $45K
1	Establish an Implementation Committee	--	Staff time
1	Complete Watershed Planning Process	--	Staff time
1	Conduct a Stormwater Retrofit Inventory	1	For inventory: $10,000[1] For implementation: $140/ac/yr over 25yr design life[10]
1	Conduct a Contiguous Forest Inventory and Forest Interior	3, 4, 5	For inventory: $7,500[2] For land acquisition: ~$20,000/ac[3] OR PDR: $5,600/ac[4]
1	Ensure Long-term Conservation and Preservation of ESAs	4, 5	Land acquisition: ~$20,000/ac[3] OR PDR: $5,600/ac[4]
1	Utilize Infiltration and LID to Retain Stormwater Onsite	1, 3	Staff time
1	Conduct Lawn Care and Septic System Education	1, 2	Staff time and educational materials
1	Implement OSDS Management Strategy	1, 2, 3	Dependant on final strategy recommendations
2	Foster Development of Lower Patuxent Watershed Assoc.	--	Staff time
2	Enhance and Restore Riparian Buffers	1, 4	$1200/ac[5]
2	Implement OSDS Management Strategy Beyond Solomons	1, 2, 3	Dependant on final strategy recommendations
2	Conduct Battle Creek Restoration	1, 2	Total Estimated Const. Cost: $350,000[9]
2	Prohibit the Creation of Fish Barriers to Upstream Spawning Areas	4	Staff time
2	Conduct Additional Studies on Boating and Water Quality	1, 5	~$12,000
2	Conduct an Operations Assessment of Farming Practices	1, 2	Staff time
2	Promote Good Commercial Housekeeping	1, 2	Staff time and educational materials
3	Hold a Calvert County Site Planning Roundtable	1, 3	Staff time
3	Encourage Marina Owners to Participate in Clean Marinas Program	1	Staff time and educational materials
3	Streambank Stabilization Demonstration Project	1,2	$50–100/linear foot[6]
3	Construct Stormwater Retrofit Demonstration Project	1,2	For implementation: $140/ac/yr over 25yr design life[10]
3	Implement Living Shoreline Techniques	1,2	$60/foot[7]
3	Promote Good Rooftop Runoff Management	1, 2	Staff time and educational materials[8]
3	Initiate a “Scoop the Poop” Campaign	1, 2	Staff time and educational materials[8]

Data Sources:
1: Retrofit inventory unit costs: $200/concept (50 sites/10 sq. mi.)
2: Contiguous forest inventory costs assume 4 to 5 parcels assessed/day for 5 days
3: Harford County Land Trust 2002 purchase of the woodland surrounding the Anita C. Leight Estuary Center
4: Loudoun County 2002 PDRs www.loudoun.gov/news/pdrnews.htm
5: Marshall County, TN NRCS
6: modified from Rapid Watershed Planning Handbook (CWP, 1998b)
7: US EPA, Office of Water, 1997
8: Costs vary widely; the EPA’s “Getting in Step: A Guide for Conducing Watershed Outreach Campaign” is a good resource for estimates (www.epa.gov/owow/watershed/outreach/docuemnts/getnstep.pdf)
9: Calvert County SCD, Battle Creek Shoreline Habitat Restoration Project Summary
10: DNR, 2002

Section 5.2 Tracking Success

This section outlines the strategy the County should take to track the success of the implementation of the Lower Patuxent River WRAS. The proposed tracking entails four main components, a quantifiable objective, monitoring component, public involvement, and programmatic change. Table 11 provides details on how tracking for these components apply to the WRAS recommendation (See Section 4.0). Where possible, the objective places a quantifiable target for each recommendation. All watershed plans should contain a monitoring component to measure and evaluate the response of the watershed over the course of implementation. Public involvement is an important part of the watershed implementation process for two reasons. It is necessary for the successful implementation and acceptance of projects (stormwater retrofits, buffer enhancements, etc.) that may be on or adjacent to privately owned land. Secondly, it is also necessary to change the collective behaviors of residents that affect water quality. In Table 11, the public involvement component explains how the public can be involved with each recommendation. Programmatic change indicates what modifications may be necessary to Calvert County's codes or programs in order to implement a recommendation. Programmatic change may not be relevant in all cases. Table 11 is based on the assumption of a 10-year planning window. All of these parameters should be refined as recommendations are implemented and the programs and/or tasks surrounding the implementation of recommendations take shape. The County should utilize DNR's *Technical Reference for Maryland Tributary Strategies: Documentation for Data Sources and Methodology Used in Developing Nutrient Reduction and Cost Estimates for Maryland's Tributary Strategies*.

Tracking projects undertaken in the watershed is an effective tool to measure success. The system assists in interpreting changes in subwatershed quality and assessing program performance. A database should be developed that records information such as:

- Project ID
- Project Type
- Cost Share
- Total Cost
- Sponsoring Agency
- Subwatershed
- Property Owner
- Property Owner Phone#
- Property Owner Address
- Location on Property
- Maintenance Responsibility
- Date Installed
- Description
- Installer/Contractor name
- Installer/Contractor phone#
- Inspection Schedule
- Initial Inspection Date
- Initial Inspection Comments
- Follow-up Inspection
- Follow-up Inspection Comments
- Next Inspection Date

The tracking data should be summarized and reviewed on an annual basis. This will allow for adjustments in program implementation and incremental assessments of program effectiveness.

Table 11. Implementation and Tracking Success of the Lower Patuxent WRAS				
Recommendation	**Objective**	**Monitoring Component**	**Public Involvement**	**Programmatic Change**
Watershed Coordinator	Coordinate and conduct planning and implementation projects	Track overall progress of WRAS implementation	NR	NR
Implementation Committee	Establishment of committee	Track overall progress of WRAS implementation	NR	NR
Complete Watershed Planning Process	Identify appropriate management strategies and recommendations for remaining subwatersheds	Additional recommendations and management classifications recorded in document	Solicit stakeholder input via evening meetings	NR
Stormwater Retrofit Inventory	Minimum, six stormwater retrofits implemented	Track # and type of retrofits implemented; conduct water quality monitoring before and after	Stakeholder meeting with neighborhood or businesses before design	NR
Contiguous Forest Inventory	30% of contiguous forest preserved	Track # of acres preserved	Work with large land owners to put in easement	NR
Conserve and Preserve ESAs	40% of ESAs in long term preservation	Track # of ESAs and acres preserved	Work with landowners or developers	NR
Infiltration and LID Stormwater Mgt.	50% of new development	Track # of approved site plans using LID and/or infiltration	Work with developers	NR
Lawn Care and Septic System Education	Educate 50% of homeowners	Nutrient behavior survey before and after education effort	Public is target audience	NR
OSDS Strategy	Implement all recommendations in Solomons	Continued synoptic surveys	At minimum, education of target audience	Possible, if an incentive program is created
Lower Patuxent Watershed Association	Establishment of Association	Track # of members	Direct community involvement	NR
Enhance Riparian Buffers	Increase buffers by 40%	Track # of miles of buffer planted and # landowners contacted	Awareness education in urban residential areas; volunteer opportunities	New staff to make direct contact with landowners of unbuffered stream segments
OSDS Strategy Beyond Solomons	Implement all recommendations	Continued synoptic surveys	At minimum, education of target audience	Possible, if an incentive program is created
Battle Creek Restoration	Protect 2,300 ft of stream bank Create 50,625 ft^2 of tidal marsh Create 30 by 180 ft oyster bar	Track amount of protected stream bank, created tidal marsh, and created oyster bar	Could utilize as demonstration project; post educational signs	NR
Prohibit Fish Barriers	No fish barriers created	Use aerial photos to verify compliance	NR	Incorporated in codes
Additional Studies on Boating and Water Quality	Determine influence of boat traffic	Data associated with sampling: water quality, boat traffic frequency, etc.	NR	Possible, could result in lowering speed limit
Agricultural Practices Assessment	Completion of assessment	Track % of in-place practices	Work with local farmers	NR
Commercial Housekeeping	20% of businesses participating	Track # of certified businesses	Work with business owners	Creation of new program
Site Planning Roundtable	Incorporate all of recommendations into codes	Less impervious cover and more natural areas in new developments – assessed in GIS	Roundtable process dependant on stakeholder involvement	Changed codes and ordinances
Clean Marina Program	60% of marinas participating	Track # of certified marinas	Work with marina owners	NR
Streambank Stabilization Project	Remove unnecessary stream crossing and stabilize stream reach	Cross-section taken over time to monitor stability	Work with property owners	NR

Table 11. Implementation and Tracking Success of the Lower Patuxent WRAS				
Recommendation	**Objective**	**Monitoring Component**	**Public Involvement**	**Programmatic Change**
Stormwater Demonstration Project	Construction of 1 retrofit demonstration project	Conduct water quality monitoring before and after	Stakeholder meeting with neighborhood or businesses before design	NR
Living Shoreline Techniques	Implement 1 significant demonstration project	Track rate of erosion over time	Possible volunteer opportunities	NR
Rooftop Runoff Management	Educate 50% of homeowners	Behavior survey before and after education effort	Public is target audience	NR
Scoop the Poop Campaign	Educate 50% of target population	Nutrient behavior survey before and after education effort	Public is target audience	Could create new ordinance to help with enforcement mechanisms
Notes: NR = Not relevant				

Section 5.3 Nutrient Reduction Estimates

This section provides expected average reduction in nutrients per recommendation (Table 12). This information should be used to track nutrient reduction goals and monitor the overall effectiveness of the WRAS implementation. For a number of recommendations we were not able to assign a reduction because the measure would result in future benefits that are not quantifiable in terms of pollutant loads.

Table 12. Lower Patuxent WRAS Nutrient Reductions

Recommendation	Reduction
Watershed Coordinator	NR
Implementation Committee	NR
Watershed Planning Process	NR
Stormwater Retrofit Inventory	Will vary based on type of retrofit implemented. Capable of reducing N by 33% and P by 46%.[1]
Contiguous Forest Inventory	Can reduce potential load associated with conversion of forest to developed land
Conserve and Preserve ESAs	Can reduce potential load associated with conversion of forest to developed land.
Infiltration and LID Stormwater Mgt.	Enhanced stormwater management can reduce N by 33% and P b 46%.[1]
Lawn Care & Septic System Education	Urban Nutrient Management can reduce N by 17% and P by 22%.[1]
OSDS Strategy	Septic pumping can reduce N by 5%[3] and septic denitrification (upgrades) can reduce N by 60%. Septic connections reduce N loads by 55%.[1]
Lower Patuxent Watershed Association	NR
Enhance Riparian Buffers	Implementation of forested buffers can reduce N and P by 56% and 70%, respectively.[1]
OSDS Strategy Beyond Solomons	Septic pumping can reduce N by 5%[3] and septic denitrification (upgrades) can reduce N by 60%. Septic connections reduce N loads by 55%.[1]
Battle Creek Restoration	Mean N and P reduction associated with wetland restoration is 42% and 55%, respectively.[1]
Prohibit Fish Barriers	NR
Additional Studies on Boating and Water Quality	NR
Agricultural Practices Assessment	Model derived based on crop type (nutrient management planning)[1]
Commercial Housekeeping	DU
Site Planning Roundtable	When compared with a conventional design, an environmentally sensitive design can reduce nutrient loads by 40%. This number is dependant on the amount of impervious surface reduced and sophistication of STPs utilized.[2]
Clean Marina Program	Marina pumpouts can reduce N and P by 43% and 53%, respectively.[3]
Streambank Stabilization Project	Stream restoration can reduce N by 0.02 lb/linear ft and P by 0.0035 lb/linear ft[4]
Stormwater Demonstration Project	Will vary based on type of retrofit implemented. Capable of reducing N by 33% and P by 46%.[1]
Living Shoreline Techniques	Nonstructural shore erosion controls can reduce N and P by 75%.[3]
Rooftop Runoff Management	This impervious surface reduction is dependant on the number of rooftops disconnected.[5]
Scoop the Poop Campaign	Urban Nutrient Management can reduce N by 17% and P by 22%.[1]

NR: Not relevant
DU: Data unavailable
STP: stormwater treatment practice
1: DNR, 2002
2: CWP, 1998a
3: CBP, 1998
4: Baltimore County, 2002
5: CBP, 2003
6: In order to apply MDE pollutant removal efficiencies, retrofit must meet MDE sizing and site requirements
7: MDE, 2000b

Section 6.0 References

Baltimore County, Maryland. 2002. Spring Branch Stream Study. Towson, MD.

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, DC. Available online at: www.epa.gov/owow/monitoring/rbp/download.html.

Boynton, Walter. "Nutrients Inputs to the Chesapeake Bay: Historical Patterns, Ecological Effects and Future Prospects." Presentation at the public meeting Calvert County Comprehensive Plan Liaison Meeting on Environmental Issues. May 29, 2003.

Calvert County Department of Economic Development. 2003. State of the Economy:2002. Prince Frederick, MD. Available online at: www.co.cal.md.us/cced/StateoftheEconomy2003.pdf.

Calvert County. 2002a. 1997 Comprehensive Plan Implementation Report. Prince Frederick, MD. Available online at: www.co.cal.md.us/planning/compplan/compmain.htm.

Calvert County. 2002b. Agricultural Land Preservation Program Status. Available online at: www.co.cal.md.us/planning/AgriculturalPreservation/ProgramStatus.PDF.

Calvert County. 2004. About the County. Website. www.co.cal.md.us/about/aboutthecounty.htm.

Center for Watershed Protection (CWP). 1998a. Nutrient Loading from Conventional and Innovative Site Development. Ellicott City, MD.

Center for Watershed Protection (CWP). 1998b. Rapid Watershed Planning Handbook. Ellicott City, MD.

Center for Watershed Protection (CWP). 2003. Impacts of Impervious Cover on Aquatic Systems. Ellicott City, MD.

Chesapeake Bay Program (CBP). 1998. Chesapeake Bay Watershed Model Application and Calculation of Nutrient and Sediment Loadings: Appendix H: Tracking Best Management Practice Nutrient Reductions in the Chesapeake Bay Program. Annapolis, MD. Available online at: www.chesapeakebay.net/pubs/777.pdf.

Chesapeake Bay Program (CBP). 2003. Chesapeake Bay Program Data Submission Form for Urban Storm Water BMP Data. Annapolis, MD.

Macdonald, Keith, D. Simpson, B. Paulsen, J. Cox, and J. Gendron. 1994. Shoreline armoring effects on physical coastal processes in Puget Sound. Washington Dept. of Ecology, Olympia. WA. Dept. of Ecology Pub. No. 94-78.

Maryland Department of the Environment (MDE). 2002a. 2002 Integrated 303(d) List. Baltimore, MD. Available online at: www.mde.state.md.us/Programs/WaterPrograms/TMDL/Maryland%20303%20dlist/2002_303d_list.asp.

Maryland Department of the Environment (MDE). 2000b. Maryland Stormwater Design Manual. Baltimore, MD. Available online at: www.mde.state.md.us/Programs/WaterPrograms/SedimentandStormwater/stormwater_design/index.asp.

Maryland Department of Natural Resources (DNR). 1998a. Clean Water Action Plan. Annapolis, MD. Available online at: www.dnr.state.md.us/cwap/cwap.htm.

Maryland Department of Natural Resources (DNR). 1998b. Development of a Benthic Index of Biotic Integrity for Maryland Streams. Annapolis, MD. Available online at: www.dnr.state.md.us/streams/pubs/1998_benthic_ibi.pdf.

Maryland Department of Natural Resources (DNR). 2002. Technical Reference for Maryland's Tributary Strategies: Documentation for Data Sources and Methodology Used in Developing Nutrient Reduction and Cost Estimates for Maryland's Tributary Strategies. Annapolis, MD.

Maryland Department of Natural Resources (DNR). 2003a. Lower Patuxent River in Calvert County Watershed Characterization. Annapolis, MD. Available online at: www.dnr.state.md.us/watersheds/surf/proj/lowpat_char.html.

Maryland Department of Natural Resources (DNR). 2003b. Statewide Restoration Tracking Report: BMP Implementation. Annapolis, MD. Available online at: http://dnrweb.dnr.state.md.us/watersheds/surf/bmp/swbmp.asp.

Maryland Department of Planning (MDP). 1997. Smart Growth Priority Funding Areas Act of 1997. Baltimore, MD. Available online: www.mdp.state.md.us/fundingact.htm.

Pellicano, R. and K. Yetman. 2004. Lower Patuxent Stream Corridor Assessment Survey. Maryland DNR. Annapolis, MD. Available online at: www.dnr.state.md.us/watersheds/surf/proj/lowpat_sca.html.

Primrose, Niles. 2003. Report on Nutrient Synoptic Surveys in the Lower Patuxent Watershed, Calvert County, Maryland, April 2003 as part of the Watershed Restoration Action Strategy. Maryland DNR. Annapolis, MD. Available online at: http://dnrweb.dnr.state.md.us/download/bays/lowpat_synoptic.pdf.

Jones, A., W. Dennison, and F. Pantus. 2003. Assessment of sewage and septic derived nitrogen in the Choptank and Patuxent Rivers. University of Maryland Center for Environmental Sciences (UMCES) Integration and Application Network. Cambridge, MD. Available online at: http://ian.umces.edu/pdfs/chop_pat_final_report.pdf.

United States Environmental Protection Agency (US EPA) Office of Water. 1997. Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters Chapter 6: Management Measures for Hydromodification: IV. Streambank and Shoreline Erosion Management Measure. Washington, DC. Available online at: www.epa.gov/OWOW/NPS/MMGI/Chapter6/ch6-4.html.

United States Environmental Protection Agency (US EPA) Getting in Step: A Guide for Conducting Watershed Outreach Campaigns. Washington, DC. Available online at: www.epa.gov/owow/watershed/outreach/documents/getnstep.pdf

University of Vermont (UVM) Institute for Ecological Economics. 2004. Patuxent Landscape Model. Burlington, VT. Information available online at: www.uvm.edu/giee/PLM/.

Williams, Michael, T. Fisher, and E. Koch. 2003. Final report: Effects of Boat Traffic on Chemical and Physical Parameters of a Patuxent Tributary, Island Creek, Maryland. Horn Point Laboratory, Center for Environmental Sciences, University of Maryland. Cambridge, MD.