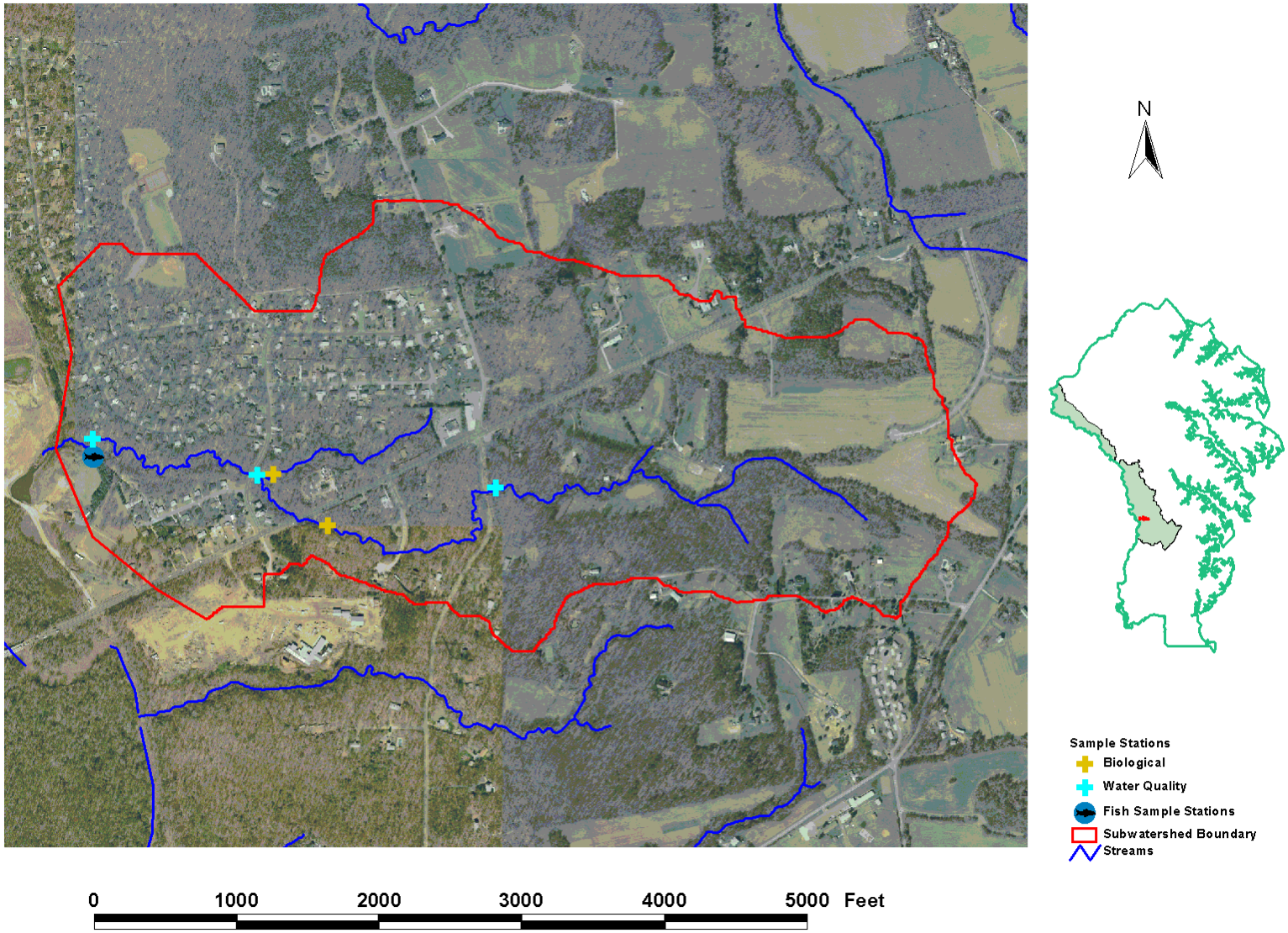

Figure 23. Overview of UPS10.

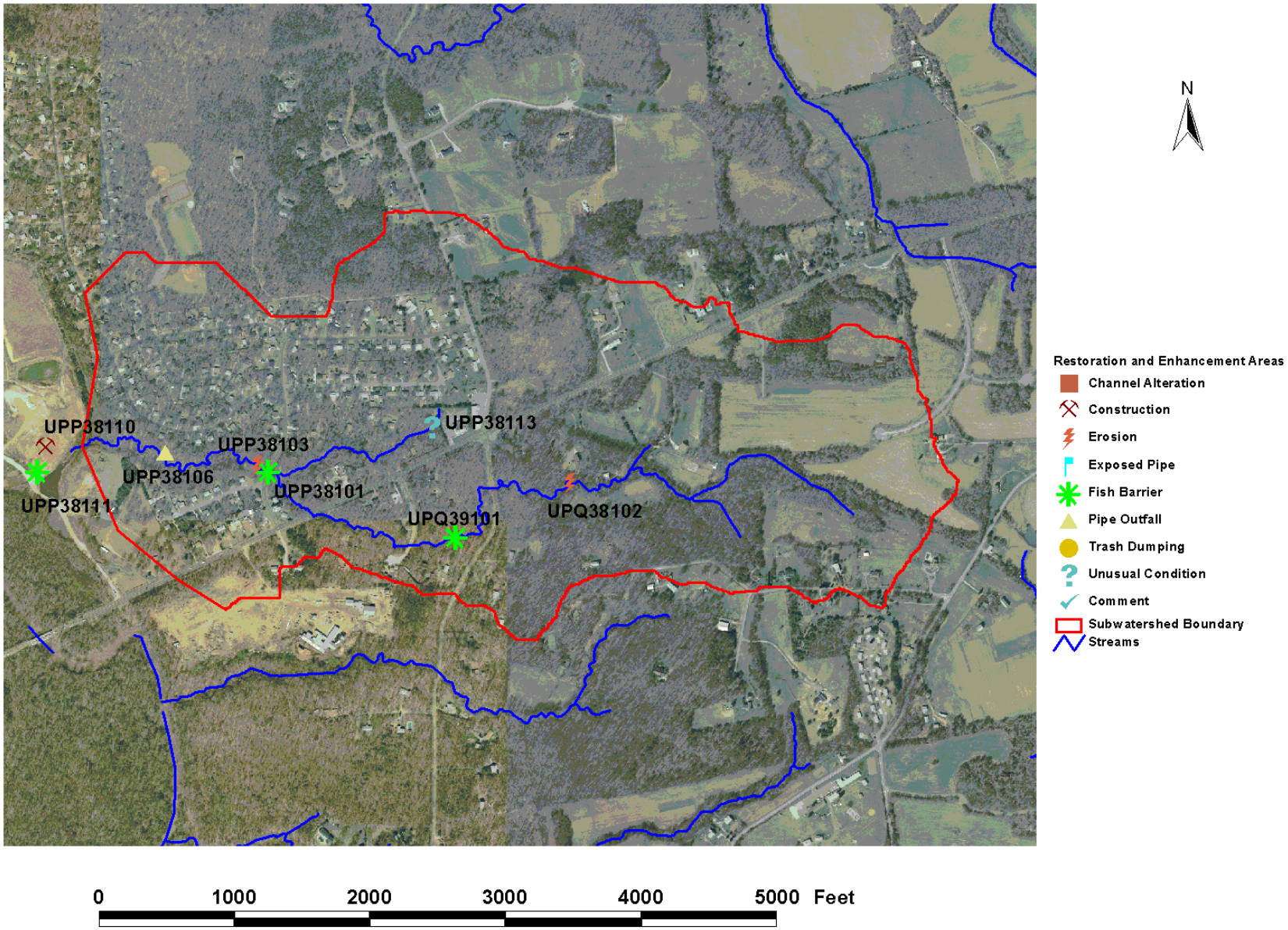

Figure 24. Location of potential restoration sites in UPS10.

UPS11—Unnamed Tributary to Patuxent River.
UPS11 is the smallest subwatershed assessed on the Anne Arundel County side of the Patuxent River at 0.2 square miles. It is located just north of Davidsonville Branch and south of UPS10. The major road crossing in the subwatershed is Patuxent River Road, which crosses north-south in the middle of the subwatershed. Two water chemistry stations, one biological monitoring station, and one fish monitoring station were established in the subwatershed for this assessment (Figure 25).

Land Use. Land use in UPS11 is summarized below:

Table 36. Land Use Summary for UPS11

Land Use	Acres	% of Area
Agriculture	8.9	6.9
Open Space	3.5	2.7
Single Family Residential	39.3	30.4
Industrial	22.2	17.2
Utility/Roadway right-of-way	1.1	0.9
Vacant Land	54.2	41.9
Total Area	***129.2***	***100.0***

As illustrated in Figure 26, this subwatershed is composed primarily of vacant land in forest cover and single family residential development. The residential development is concentrated in the central portion of the subwatershed while the undeveloped, vacant land areas are scattered throughout the subwatershed. A sizable percentage of the subwatershed, 17%, is devoted to industrial land use located mostly in the northwestern corner of subwatershed. Overall, current imperviousness is near 15%, while future impervious cover is predicted to increase to 17%. This assumption is based on current watershed-wide zoning not changing.

Natural Resources. A second order stream at its confluence with the Patuxent River, approximately 1 mile of stream channel drains this subwatershed. An inspection of the National Wetlands Inventory map for this subwatershed shows no wetlands in this subwatershed. Additionally, there are no hydric soils mapped in this subwatershed. As discussed above, approximately 41% of the subwatershed is classified as vacant land, most of which is currently in forest cover. Significant portions (~70%) of this subwatershed were judged desirable for inclusion in the Anne Arundel County greenway (Anne Arundel County, 2002).

Watershed Conditions. The BCS results for UPS11 are summarized below:

Table 37. BCS Summary for UPS11

Metric Group	Metric Group Score	Condition Rating
Water Quality Conditions	8	Fair
Living Resource Conditions	51	Poor
Habitat Conditions	75	Fair
Landscape Conditions	49	Fair
Hydrologic Conditions	9	Fair
Overall BCS	***192***	***Fair***

This subwatershed was classified as being in fair condition as assessed by the BCS. Biological communities and habitat conditions indicate some degradation. As described in Pavlik and Stribling (2003), subwatershed-wide biological conditions were "poor" based on aquatic invertebrate populations. Habitat conditions were "non-supporting," with large amounts of sand observed in the stream channel. Pollutant tolerant organisms dominated the samples. The severe drought that occurred during the sampling period likely impacted stream biological integrity.

Fish passage is a moderately serious problem in this subwatershed. As described in DNR (2002b), only one pollutant tolerant species (blacknose dace, *Rhinichthys atratulus*) was collected in this stream at the fish sampling station. Approximately 50% of potential stream habitat is cut off to fish passage due to a perched culvert at the midpoint of the subwatershed (see Figure 27). In addition, less severe headcuts than the ones described below might also be partial blockages to fish passage in this subwatershed.

Moderate amounts of erosion are taking place in this subwatershed. In particular, a series of headcuts were observed in the upper 1100 feet of this stream (see Table 38). Headcutting usually occurs in response to land use changes in the surrounding watershed. Conversion of forested areas to developed land can cause overall increases in flow and increased frequency of erosive flood events such that the stream adjusts itself by cutting down through its floodplain, resulting in eventual channel widening and delivery of large amounts of sediment to downstream reaches. In fact, channel reaches downstream of this headcutting area show signs of excess sediment deposition (Pavlik and Stribling, 2003). Gully formation via the headcutting process is thought to have extremely adverse impacts on stream stability and biological conditions (Riley, 1998) and erosion is known to have an adverse impact on fish and aquatic insects (Waters, 1995). These headcutting areas are listed in Table 38 as possible habitat restoration projects.

As described in DNR (2002b), no serious water quality problems were observed in this subwatershed. However, an examination of baseflow loading rates shows higher loadings at the most upstream station than at the downstream station. For example, orthophosphate loadings exhibit a fivefold increase (0.0081 lbs/ac/yr most downstream, 0.0016 lbs/ac/yr, most upstream) in the upstream direction while nitrate loadings increase about 5.3 times (0.4729 lbs/ac/yr most downstream versus 0.0890 lbs/ac/yr most upstream), although rates were fairly low throughout the subwatershed. The reason for this is unknown. However, if this held true during storm event loading, this could be indicative of a serious water quality problem depending on the pollutants observed.

Watershed Improvement Activities. Based on conditions and land use characteristics in this subwatershed, the following general recommendations are made:

- Investigate downstream of assessment area to determine if natural or manmade fish passage impediments exist and correct as necessary;
- Work with the Soil Conservation District and the Anne Arundel County Department of Public Works to determine the distribution of best management practices in the subwatershed; and
- Consider performing additional water quality assessments to determine if pollutant loading patterns observed at baseflow are true during stormflow conditions.

Specific restoration or enhancement projects recommended for this subwatershed are described in Table 38 and shown in Figure 26.

Table 38. Description and Ranking of Priority Projects in UPS11

SCA Site Number	Project Type	Project Description	Subwatershed Priority Ranking	Notes
UPQ39108	TD	Trash Dump	1	Moderate yard waste dump. Could be tackled by volunteers.
UPP39101	FB	Perched 48" culvert	1	Cuts off ~50% of stream to fish movement. Additional investigation necessary to determine feasibility.
UPQ39101	ES	8 foot high headcut	3	This reach entire reach should be done as one project. Additional investigation necessary to determine cause of problem, feasibility of restoration.
UPQ39102	ES	5 foot high headcut		
UPQ39104	ES	5 foot high headcut		
UPP39106	TD	Trash Dump	6	Sheet metal, appliances, car
UPQ39105	ES	20 foot high, 100 foot long eroding bank	6	Downstream of headcutting area identified above.
UPP39104	TD	Trash Dump	8	Mix of industrial machines, sand. Not feasible for volunteer clean up.

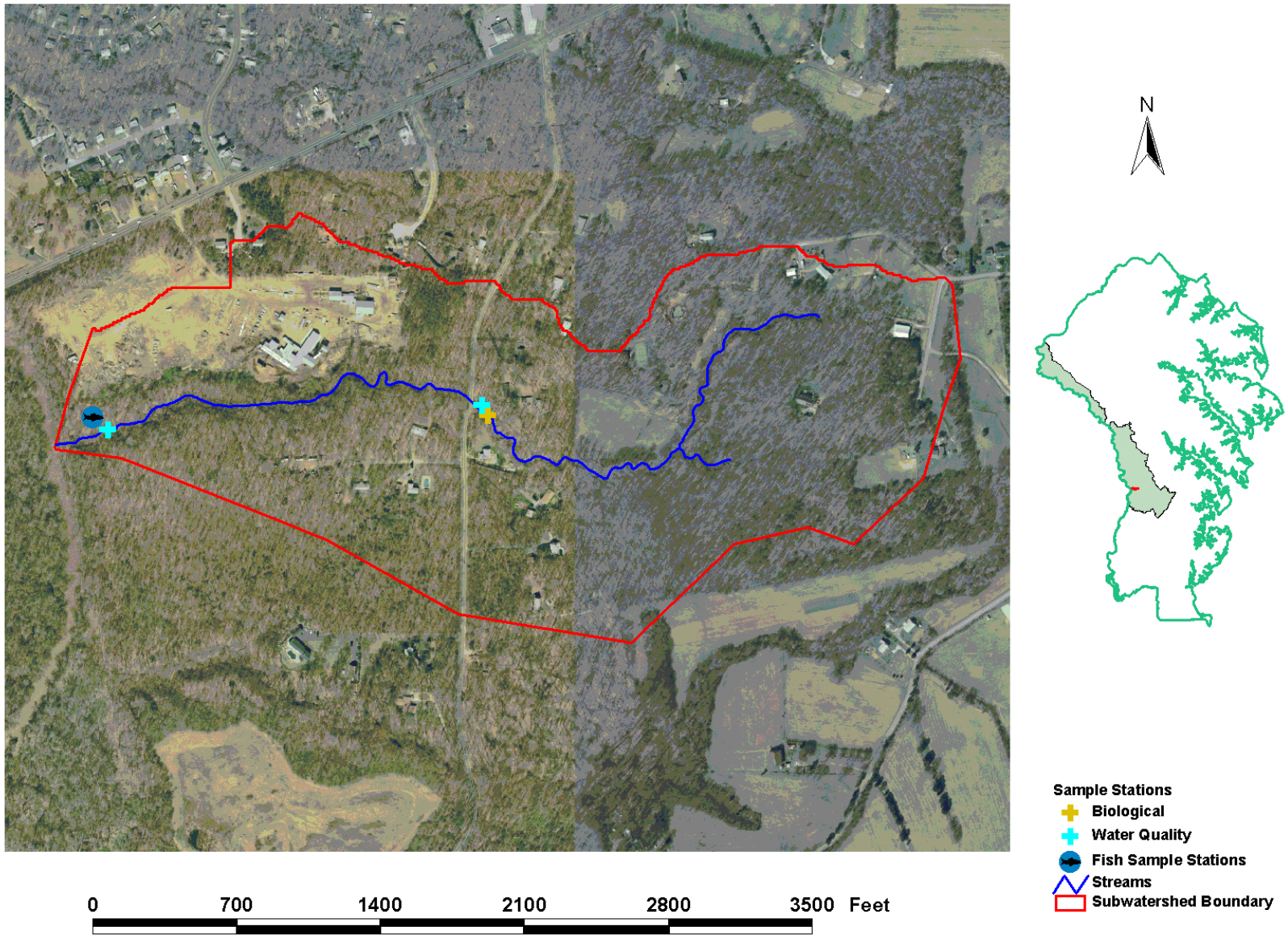

Figure 25. Overview of UPS11.

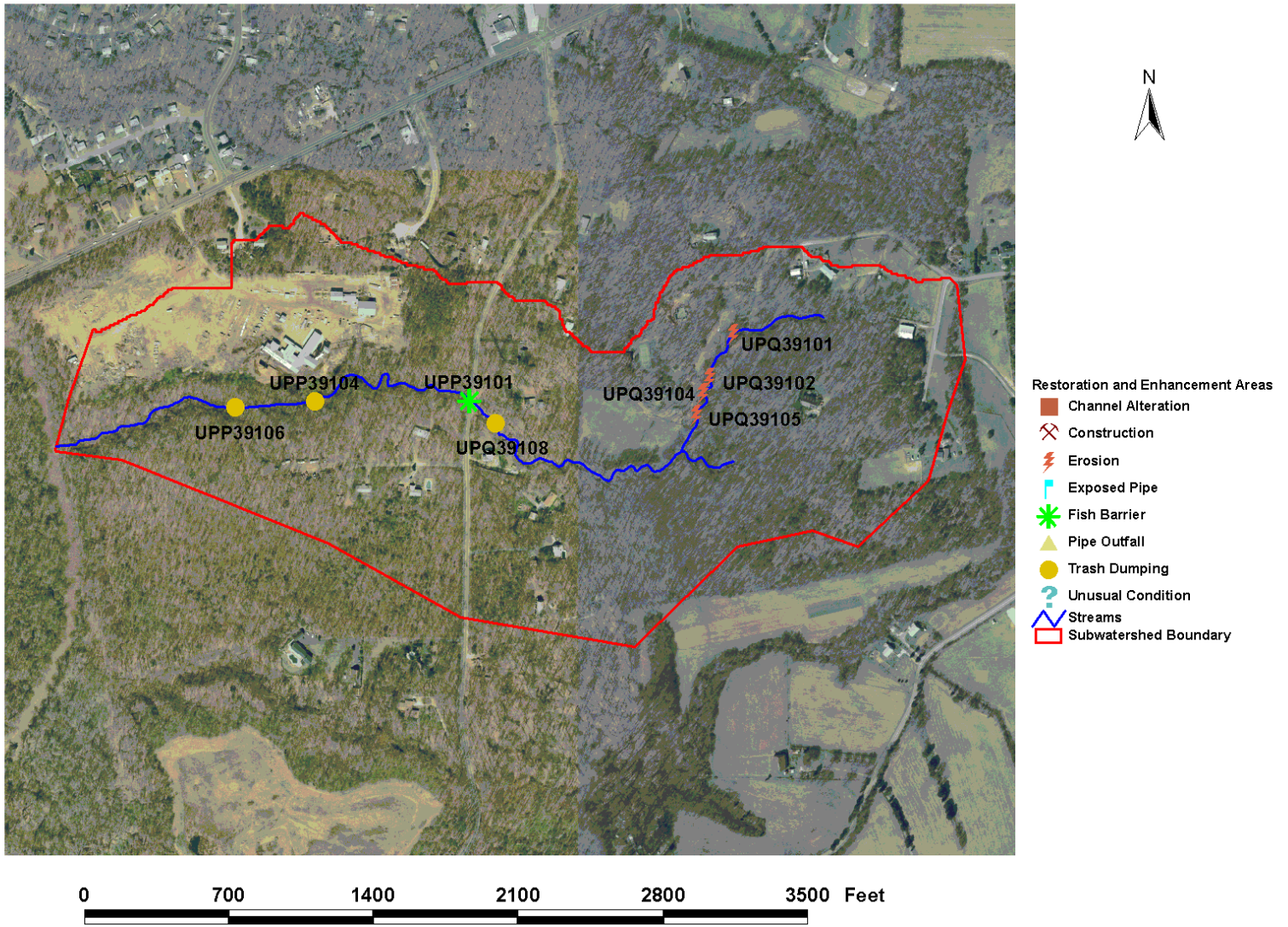

Figure 26. Location of potential restoration sites in UPS11.

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IV. IMPLEMENTATION

The overarching goal of the Upper Patuxent River WRAS is to minimize water quality impacts resulting from land use changes. One means of attaining this goal is to execute identified restoration projects that will rehabilitate and restore living resource habitat (e.g., riparian buffer reforestation, stream channel stabilization, restoration of fish passage). Another means of attaining this goal is to provide for the protection and restoration of sensitive resource habitat through local government programs and policies. Within Anne Arundel County, WRAS implementation will be accomplished through two primary approaches. First, restoration projects in each of the assessed subwatersheds, as identified in Section III, will be implemented in a priority order. Second, a strategy for programmatic changes within local government, designed to further the restoration and protection of living resources and their habitat, will be described.

RESTORATION PROJECT IMPLEMENTATION

Through the BCS process, Upper Patuxent River subwatersheds were assessed and prioritized for restoration. The final BCS scores and impairment rankings for each subwatershed are found in Table 39. The prioritization process found that Cox Branch (UPS1) was the subwatershed in most need of attention, while UPN7 was the subwatershed in least need of attention. As seen in Section III, the SCA process also identified specific restoration projects to correct documented problems within each subwatershed. Problems identified were ranked, through the SCA process, based on their severity, correctability, and ease of access to the problem site. The Upper Patuxent WRAS addressed those identified problem areas with a severity rating of moderate to high, and prioritized the associated restoration projects based on problem correctability and site access. Through this effort, 63 possible restoration projects were identified.

Because of the number of projects identified, a step-wise implementation approach will be taken. Starting with the most degraded subwatershed (Cox Branch), the top five priority projects in each subwatershed will be pursued for further implementation. These projects and their priority rankings are also found in Table 39. As the priority projects are accomplished, new projects will be initiated (in priority order) until all identified projects are addressed.

Implementation of the restoration projects will be coordinated and conducted through a cooperative effort involving Anne Arundel County staff, Anne Arundel Soil Conservation District staff, and watershed stakeholders. Because the identified living resource restoration projects vary in their labor requirements, some projects will be conducted through volunteer labor (e.g., stream clean-ups, riparian area plantings) while other projects will require additional evaluation to facilitate final project design and construction (e.g., fish passage, stream channel stabilization and restoration).

The first step in this implementation process includes a more thorough evaluation of the priority projects to determine those that will require additional professional assessment and those that are amenable to volunteer efforts. Implementation of volunteer projects will be coordinated through County staff, Soil Conservation District staff, and outreach to volunteer organizations. The volunteer-oriented projects will also be incorporated, to the extent practicable, into the development of an Upper Patuxent River Watershed Association. Those projects that require

additional professional effort will be recommended to the County's Capital Improvements Program in a priority order. Through this program, funding can be made available to further evaluate, design, and construct the restoration projects.

Although the Anne Arundel County Capital Improvement Program (CIP) is one means of funding project implementation, availability of funding through this program is limited. Restoration project funding must be assembled from a variety of sources. In addition to the use of County funds, restoration project funding and, consequently, WRAS implementation funding will be augmented or supplanted by grants and/or loans (e.g., Small Creeks and Estuaries Program, Stormwater Pollution Control Program). A listing of potential funding sources is found in Table 40. Additionally, restoration funding will be solicited from the Anne Arundel Soil Conservation District, the Southern Maryland RC&D, the NRCS, and the Department of Agriculture, for projects that occur on agricultural lands. Other funding mechanisms include the U.S. Army Corps of Engineers, and congressional initiatives as described in subsequent text.

The efficacy of restoration efforts will be evaluated in two major ways. At the project site level, all projects completed under our Capital Improvement Project (CIP) program call for 3 to 5 years of performance monitoring to ensure that project goals and objectives are achieved. For example, for stream restoration projects, annual surveys of restored channels are performed to ensure that dimension, pattern, and longitudinal profiles established during the restorative work are being maintained. In addition, visual inspections of habitat structures are done concurrently to make certain that they are functioning as expected. All projects executed under our CIP program will be captured under this monitoring requirement. In addition, as a special component of projects in these subwatersheds, pre- and post-construction biological monitoring (benthic macroinvertebrates) will be performed at all of these sites if conditions warrant such assessments. Very small headwater areas that normally have no baseflow but require restoration will be evaluated only for physical stability as described previously. Methods described in Section II will be used for biological monitoring.

At the subwatershed level, aquatic macroinvertebrate assessments will also be performed annually at the sample station located furthest downstream in each subwatershed being restored, contingent on available funding. The methods used will be the same as those described in Section II. This monitoring will allow for a coarse assessment of the impacts of watershed wide restoration and enhancement activities. Other stations will be added as funding is attained.

Table 39. Priority Restoration Projects within the Upper Patuxent River Watershed

Subwatershed (BCS QUALITY RANKING)*	Project ID	Project Type	Project Description	Subwatershed Priority Ranking	Implementation Group
Cox Branch UPS1 (9)	UPN26105	TD	Large trash dump, mixed appliances, recyclables	1	Volunteer
	UPN25105	PO	Pipe Outfall	2	County
	UPN25104	TD	Yard waste trash dump	2	Volunteer
	UPO24106	FB	Shallow Road Crossing	2	County
	UPO24108	EP	Exposed Pipe	5	County
UPS6 (8)	--	FB	High blockage downstream of Patuxent River Road	1	County
	UPP34102	ES	Eroding bank 5 feet high, 2000 feet long	1	County
	UPP35101	FB	Double corrugated metal pipes too shallow for fish passage	2	County
	UPP35102	ES	Eroding bank 5 feet high, 1800 feet long	3	County
	UPP34108	ES	Eroding bank 8 feet high, 1600 feet long	4	County
UPS4 (7)	UPQ31103	FB	Perched road crossing	1	County
	UPR31101	CA/UC	In-stream pond removal/retrofit, riparian area restoration	1	County
	UPO31104	PO	18-inch pipe from agricultural area.	3	County
	UPO32103	FB	Severely perched culvert road crossing	3	County
	UPO32104	ES	10 feet high, 300 feet long eroding bank	3	County
UPS10 (6)	UPP38101	FB	Twin perched 48” metal corrugated metal pipes	1	County
	UPP38111	FB	Large instream pond at bottom of subwatershed	2	County
	UPQ39101	FB	Small instream impoundment constructed	2	County
	UPP38103	ES	3 foot high, 700 feet long bank	4	County
	UPP38113	UC	Extreme levels of orange flocculent after passing through pipe	4	County
UPN1 (5)	UPB07405 UPB07406	FB/ UC	Shallow culvert under Brock Bridge Road and undercut area of Brock Bridge Road	1	County
	UPC06401	ES	Severe headcut and erosion along tributary to UPN1 that drains residential development	2	County
	UPC06402	PO	Pipe outfall at top of UPC06401	3	County

Table 39. Priority Restoration Projects within the Upper Patuxent River Watershed

Subwatershed (BCS QUALITY RANKING)*	Project ID	Project Type	Project Description	Subwatershed Priority Ranking	Implementation Group
UPN1, cont. (1)	UPB07401	TD	Extensive trash dump	4	County/Volunteer
	UPC07402	ES	Severe headcut and erosion in tributary	5	County
UPS11 (4)	UPQ39108	TD	Trash Dump	1	Volunteer
	UPP39101	FB	Perched 48" culvert	1	County
	UPQ39101	ES	8 foot high headcut	3	County
	UPQ39102	ES	5 foot high headcut		
	UPQ39104	ES	5 foot high headcut		
	UPP39106	TD	Trash Dump	6	Volunteer
	UPQ39105	ES	20 foot high, 100 foot long eroding bank	6	County
Stocketts Run UPS9 (3)	UPQ43104	UC	Stream flow being diverted into pool and garden	1	County
	UPV41101	FB	Shallow box culvert prevent fish movement	2	County
	UPS41301	PO	Stormwater outfall discharging into stream	3	County
	UPQ43102	ES	Eroding bank 8 feet high, 3600 feet long	3	County
	UPT44101	ES	Eroding bank 5 feet high, 400 feet long	5	County
UPS3 (2)	UPO29203	ES	Eroding bank 6 feet high, 1400 feet long	1	County
	UPO29201	ES	Eroding bank 4 feet high, 1000 feet long	2	County
UPN7 (1)	No Projects				

*Higher BCS ranking numbers indicate more degraded conditions

Table 40. Potential Funding Sources for Natural Resource Restoration Projects

Federal Funding Sources
Brownfields (EPA- Environmental Protection Agency)
Environmental Education Grant Program (EPA)
Chesapeake Bay Program (EPA)
Chesapeake Bay Small Watershed Grant (USFWS-United States Fish and Wildlife Service)
Urban Park and Recreation Recovery Program (NPS-National Park Service)
State Funding Sources
Program Open Space (DNR- Department of Natural Resources)
Community Legacy Grant (DHCD)
Community Parks and Playgrounds (DNR)
Section 319 Nonpoint Source Funding (DNR)
Watershed Restoration Action Strategy (DNR)
Small Creeks and Estuaries Program (MDE)
Stormwater Pollution Control Program (MDE)
Transportation Enhancement (MDSHA- Maryland State Highway Administration)
National Recreational Trail Grant (MDSHA)
Waterways Improvement Fund (MDSHA)
Private and Corporate Funding Sources
American Express Philanthropic
Baltimore Gas &Electric Foundation
Alex Brown & Sons Charitable Foundation
Morris & Gwendolyn Cafritz Foundation
Clark Charitable Foundation
Clark-Winchole Foundation
Freed Foundation
Charitable Trust u/w LaVerna Hahn
J. J. Haines Foundation
Sidney L. Hechinger Foundation
Hitachi Foundation
Grayce B. Kerr Fund
Knapp Foundation
Kresge Foundation
Lockheed Martin Corp. Foundation
MARPAT Foundation
Merck Family Fund
Eugene & Agnes Meyer Foundation
Middendorf Foundation
Moriah Fund
T. Rowe Price Associates Foundation
Rouse Company Foundation
Summit Foundation

LOCAL GOVERNMENT PROGRAMMATIC CHANGES

Through the course of the Upper Patuxent WRAS investigation, Anne Arundel County recognized the need to institutionalize a means to implement this comprehensive watershed restoration strategy, and to develop and implement future watershed restoration strategies. Such programmatic changes at the local government level most often require the development of formal administrative procedures and/or legislation that will ensure the institutionalization of those new programs. To that end, Anne Arundel County has identified the following programmatic changes

National Community Decentralized Demonstration Project

The first programmatic change is related to a Low Impact Development (LID) retrofit project slated for the Upper Patuxent River Watershed. As partners in the Upper Patuxent WRAS, both Anne Arundel and Prince George's Counties sought out and obtained $1 million dollars from the United States Congressional Initiative on Decentralized Stormwater and Wastewater Systems for demonstration projects in the Upper Patuxent River Watershed. This effort will allow Anne Arundel County to demonstrate comprehensive stormwater management retrofits using Low Impact Development (LID) at previously developed commercial areas. Moreover, this demonstration project will provide the framework for future stormwater retrofit efforts in the watershed and constitute one mechanism leading to a programmatic change in support of the Upper Patuxent WRAS.

The goal of this project is to institutionalize urban stormwater retrofit technologies and strategies, using LID management techniques, throughout the Upper Patuxent River watershed. The objective is to provide a cost-effective, innovative approach to urban stormwater management for retrofits and redevelopment sites, to institute a public outreach and education program on stormwater issues and LID options, and to demonstrate measurable success of the project components.

Within Anne Arundel County this demonstration project will address stormwater management retrofits to a commercial area located in the Cox Branch subwatershed (UPS1). This commercial site developed prior to stormwater management requirements. The demonstration project will serve to treat currently untreated impervious surfaces in this watershed; it will demonstrate the applicability of the County's stormwater management regulations as they relate to retrofitting existing properties. Lastly, the success of this project will serve as a basis for future stormwater retrofits to commercial areas that can be accomplished in partnership with the business community.

The LID retrofit project will be conducted in partnership with the commercial land owner(s) and resident businesses, and will set the foundation for a stormwater retrofit partnership between the County and the business community. Based on the success of this effort, Anne Arundel County will officially recognize and endorse the implementation of a business-government-community partnership to undertake stormwater management improvements at previously developed sites.

Endorsement and institutionalization of such a partnership program for stormwater management retrofits will be accomplished through the County's Administrative Procedures System. Through this system, County business processes that transcend departmental lines are initiated, reviewed,

approved, incorporated into the County Administrative Procedure Manual, distributed to affected departments, and implemented. Such procedures are used for business processes that do not require a change in County Code. Business-government-community partnership development for implementation of environmentally sensitive stormwater retrofits would be best institutionalized through an Administrative Procedure.

Development of this Administrative Procedure can be accomplished through

- Identifying the purpose of such a procedure
- Garnering support from the affected County Land Use agencies (Office of Planning and Zoning, Office of Environmental & Cultural Resources, Dept. of Inspections & Permits, Dept. of Public Works)
- Documenting each party's overall responsibilities in such an agreement
- Including a requirement for official agreement, specific to each partnership, outlining specific party responsibilities

Following review by the County Attorney, for form and legal sufficiency, the Administrative Procedure becomes official with the approval of the Chief Administrative Officer of the County. The procedure is incorporated into the Procedure Manual, is maintained on the County's Intranet web site, and Department Heads are informed of the need to implement this programmatic change.

Anne Arundel County anticipates the successful completion of the retrofit demonstration project within 24 months of this submittal, pending EPA grant funding availability. The Administrative Procedure setting forth the programmatic requirement for LID retrofits, utilizing a partnership approach, could be accomplished within 6 months of the demonstration project completion.

Stormwater Utility Enterprise

Anne Arundel County has initiated investigations into the development of a stormwater utility enterprise. Implementation of such a utility enterprise will constitute a programmatic change within County government that will result in an increased ability to support habitat protection and restoration of areas degraded by unmanaged stormwater runoff, support rehabilitation of storm water management infrastructure, and assist the County in meeting regulatory requirements (e.g., MS-4 NPDES permit conditions, TMDLs)

Implementing this program, while not a direct result of the Upper Patuxent River WRAS, will provide specifically earmarked funding to the Upper Patuxent WRAS implementation. Numerous degraded habitats could be restored more quickly if such a funding source were available. The results of the Upper Patuxent WRAS clearly support the need for such a utility.

To demonstrate the level of interest in this programmatic change, the County contracted with a consultant to more fully develop the concept of a stormwater utility. This concept was presented to the County Administration in December 2003, and the Administration has responded in a positive manner. Development of a detailed implementation plan is now underway.

Following County Administration agreement with the final implementation plan for a stormwater utility enterprise, legislation setting forth the utility specifics will be drafted for the purposes of

codifying the stormwater utility enterprise. The procedures for codifying this utility enterprise through legislative amendment include:

- Development of legislative request and concept by the Administration or their designee
- County Attorney presents legislative request to Executive Committee for approval or rejection
- If approved, Office of Law and Administration designee produce proposed legislation and legislative summary
- County Attorney submits proposed legislation to Legislative Committee and final legislation to Executive Committee
- On approval, the CAO forwards proposed legislation to Governmental Relations Officer
- Office of Budget prepares a Fiscal Summary and Certification of Funds
- Government Relations Officer submits proposed approved legislation and accompanying information to the County Council's Administrative Officer.
- County Council introduces, holds public hearings, potentially amends, and votes on proposed legislation
- If Council votes to adopt, the ordinance is forwarded to the Office of Law and the County attorney provides the County Executive with an opinion regarding legal sufficiency
- If not approved or vetoed, by the County Executive, within 10 days, the legislation becomes law.

It is anticipated that this utility enterprise legislation will be developed and presented to the County Council for vote prior to the end of calendar year 2005.

Watershed Management Tool

Anne Arundel County is developing a dynamic and interactive computer tool to assist the Land Use Agencies in making land use decisions. This tool, the Watershed Management Tool (WMT), links watershed data and models to give County staff and stakeholders information on how changes in land use, zoning, best management practices, and other environmental conditions affect the watershed. The WMT will assist in identifying actions necessary to improve existing degraded conditions, and to facilitate more informed land use and development decisions by County staff and stakeholders to protect the trust resources of the County.

The WMT is comprised of four major components that function as an integrated system that can be used to examine successful management practices related to watershed health and stream restoration. Data collected during the investigative phase of the Upper Patuxent WRAS has been incorporated into the WMT, allowing that information to be utilized by numerous staff and stakeholder to evaluate watershed response to proposed land activities (including restoration projects). As County-sponsored restoration projects are undertaken in this watershed, the WMT will be utilized to track those projects and to better refine the project scope such that the habitat restoration achieved will meet the living resource goals of the WRAS.

For the WMT to be effective, it must be utilized by all of the County's Land Use Agencies (Office of Planning and Zoning, Dept. of Inspections & Permits, Dept. of Public Works, and Office of Environmental & Cultural Resources). To effect this institutionalization of a new program, several presentations and formal discussions with the County Administration and with

the Land Use Agency directors resulted in support for institutionalizing the WMT as a component of all land use project reviews (e.g., private development projects, capital improvement projects, infrastructure development and maintenance, environmental restoration projects). However, this is just the first step in totally institutionalizing a new program. Additional steps now underway include education and outreach to affected staff to provide group and individual training in utilizing the WMT. More recently, WMT staff has begun an education program for County constituents, engineering firms, and developers to make them aware of this tool and its' benefits. These outreach efforts have been successful, as many of the County's projects (development, environmental restoration) have been incorporated into the WMT and modeling requests have been made.

To formalize this new program, the County is developing Standard Operating Procedures (SOPs) for each affected Land Use department that will prescribe how and when the WMT is utilized in each department's business processes. If these SOPs result in cross-departmental coordination requirements, it is likely that an Administrative Procedure will be developed to support the WMT. The SOPs are scheduled to be completed before December 2004. Development of a resulting Administrative Procedure, if needed, would likely occur in Spring 2005.

Biological Monitoring Program

To allow for future assessment of living resource condition restoration efficacy, a Biological Monitoring Program modeled after the Maryland Biological Stream Survey was recently developed (January 2004) specifically for Anne Arundel County. Implementation of this program will allow for continued assessment of biological community status and trends in the Upper Patuxent River watershed, as well as other County watersheds. Continued biological assessment, in light of the identified site-specific and watershed-wide restoration projects identified in an earlier section, will provide a means to determine if those restoration projects are resulting in habitat and resource improvement in this watershed.

The Biological Monitoring Program site selection procedure is based on a stratified random sampling design, but also provides the County with the opportunity to target specific streams for monitoring. Such targeted sites might include reaches or subwatersheds targeted for restoration activities and would allow for pre- and post- construction monitoring.

Implementation of this program is a priority for the County's recently created Office of Environmental & Cultural Resources (OECR). The mission of this office is to manage, protect, and restore the County's natural, historic, and cultural resources through development and application of sound resource policies, principles, and practices. It is the goal of this Office to ensure that County policies and practices concerning land use activities are not only sensitive to the needs of resource conservation and protection, but are also grounded in the best scientific information available.

For the OECR to successfully undertake this mission, the condition of our living resources must be documented. The OECR will initiate Biological Monitoring Program implementation during the 2004 spring indexing period, and anticipates re-investigating the Upper Patuxent Watershed in 2007. Stream reaches with restoration projects implemented between 2003 and 2007 will be targeted for monitoring.

Other Local Programs and Policy Changes

In addition to implementing and institutionalizing urban stormwater retrofit technologies and strategies, developing a stormwater utility to support watershed restoration efforts, utilizing the WMT to identify restoration needs and potential restoration partnerships, and institutionalizing a biological monitoring program to assess restoration and preservation efficacy; Anne Arundel County will also explore innovative ways to incorporate the lessons learned and recommendations from the Upper Patuxent River WRAS into other local programs and policy. The County is now embarking on a review and update of our Land Use ordinances. Through this effort, staff will endeavor to incorporate and institutionalize environmental strategies designed to benefit the County's living resources and their habitats. One initiative in this review effort is the elevation of the environment to a level on par with other public facilities (e.g., roads, schools, infrastructure). The information developed from the Upper Patuxent River WRAS will be used to substantiate the need to address environmental resources as a public facility in the early stages of any development project.

The Land Use ordinances are currently in draft format and undergoing in-house revision. It is the intent of the OECR to review these ordinances and, to the extent acceptable by the Administration, develop additional language or proposed new and complimentary legislation to address the protection and restoration of Anne Arundel County's trust resources. The data developed through the Upper Patuxent WRAS investigations will be used to substantiate additional language and/or legislation proposed for adoption.

The revision of these Land Use regulations will facilitate the incorporation of environmentally sensitive site design requirements for new development or redevelopment. Language removing steep slopes, wetlands, and floodplains from density calculations will assist in reducing the channel instability that was so often observed in the Upper Patuxent River watershed. Revisions addressing the need to encourage stormwater management retrofits on unmanaged developed sites, regardless of the property owner's intent to redevelop (the current trigger for requiring retrofit), will hasten the ability to improve habitat conditions.

Habitat protection mechanisms are being researched and recommended for inclusion into the land use regulations. Such mechanisms include revising the forest conservation requirements for the development process, including clarification of specimen tree preservation language. The minimum acreage required for forest conservation easements, and for forest interior dwelling bird (FID) habitat protection are being researched and language developed to institutionalize these habitat protection measures.

At a minimum, draft legislation to codify the revisions to the County's Zoning and Subdivision ordinances will be presented to Council by June 2004. County staff will provide comment and propose appropriate additional language to this draft legislation prior to June 2004. The adoption of legislation will follow the procedures previously described. Currently, the County anticipates adoption of revised Land Use regulations no earlier than August 2004.

Migratory Fish

The seven migratory fish species of greatest historical importance in the area were American shad, hickory shad, alewife, blueback herring, yellow perch, white perch, and striped bass.

These seven remain the most important today, although species abundance has dramatically declined in the Patuxent River (and the Chesapeake Bay, overall) throughout the 20th century, attributed primarily to the combined effects of over-harvesting, pollutants, and stream blockages. In 2002, the entire Patuxent River watershed contained 108 stream blockages (primarily dams and culverts), a relatively high number for a relatively small system. In the Upper Patuxent River watershed, the Maryland DNR Fish Passage Program has identified 29 blockages (DNR 2002a). More recently, the Stream Corridor Assessments performed for this WRAS identified 16 blockages in Anne Arundel County alone.

Maryland DNR has documented the historic presence of migratory fish species in their report *Surveys and Inventory of Anadromous Fish Spawning and Nursery Areas* (Mowrer and O'Dell, 1984). The report details numbers of migratory fish found in specific Patuxent tributaries, and provides maps to show where the species were collected. In Prince George's County, Upper Patuxent River subwatersheds identified as having a historical presence of migratory fish include Charles Branch, Collington Branch, Hotchkins Branch, Mattaponi Creek, Horsepen Branch, Mill Branch, Western Branch, and Swanson Creek. Several Anne Arundel County subwatersheds are thought to have had historical anadromous fish populations including Stocketts Run, Davidsonville Branch, and Kings Branch in the Upper Patuxent River Watershed. Up to the time of the Chesapeake 2000 Bay Agreement, migratory fish restoration program success was primarily based on “stream miles reopened,” that is, the number of miles of stream upstream of a blockage that was removed. Using “stream miles reopened” as the only indicator of passage success is an over-simplified measure, and ignores the importance of habitat quality above the blockage.

The Chesapeake 2000 Bay Agreement recognized the importance of “miles reopened,” but also identified the need to quantify and standardize cost, habitat benefits for fish populations, and geographic location. In 2002, the Gemstone Fish Sustainability Team (a part of the Gemstone Program at the University of Maryland, College Park) designed a model to meet the goals of the Chesapeake Bay 2000 Agreement. Their model consists of four factors: (1) historical presence of migratory fish populations; (2) stream miles reopened; (3) indices of the condition of individual Patuxent watersheds compiled by the Chesapeake Bay Program; and (4) recently collected habitat data associated with each blockage. The conceptual design of their model may be a suitable tool for use by Prince George's and Anne Arundel Counties in partnership with Maryland DNR for future anadromous fish monitoring, assessment and restoration programs. The model centralizes a decision-making process that typically involves fisheries managers, biologists, engineers, economists, managers and landowners. Use of the model provides a preliminary prioritization, which establishes a passage (or restoration) priority for a given watershed. This information then allows decision-makers to identify those priority blockages for further study for actual passage implementation.

An interesting aspect in considering the use of the conceptual design of this model is that the Counties and Maryland DNR could use their existing network of biological contractors and volunteers to gather the input information with State monitoring. It's also possible that (in some cases) existing data that's been gathered to date by the contractors and volunteers may by used as model input. The SCA data would also be good input data for the model. An important aspect of this model approach is that it would result in a "benefit rating," or measure of the probability that removing (or bypassing) a blockage will increase migratory fish populations (based on a weighted sum of benefit components — stream miles upstream of the blockage, historic presence

of migratory fish, and the quality of the habitat above the blockage. By collecting simple habitat parameter data at known blockages, combining it with desk-top stream mile measurements and historical fish presence homework, and applying it to the model framework, a method to prioritize locations/watersheds for potential future migratory fish restoration efforts (e.g., blockage removal, fish passage technology installation and/or habitat improvement) can be accomplished.

Maryland has had extensive hatchery and stocking programs for migratory species and Maryland DNR Fisheries Service has been conducting a project to restore populations of American shad and hickory shad in the Patuxent River. It is important to realize that removal of a migration blockage or installation of a passage technology does not guarantee that fish will return, even if habitat is suitable upstream of the blockage. Stocking in upstream habitats with migratory species to encourage spawning in that area (and increase the likelihood that fish will return to the area in subsequent years) is the goal of the project. This is where post-restoration monitoring could be implemented, for example to determine whether fish are naturally returning to the area or whether there is a need for a reintroduction/stocking program.

Both Counties and the Patuxent Wildlife Refuge are interested in coordinating with Maryland DNR on the restocking project. Cooperative efforts may be expanded to include the development of a network of volunteer programs. This network could include existing educational hatching, stocking and monitoring programs (e.g. Chesapeake Bay Foundation) as well as filling the gaps by creating new projects. Cooperative partnerships could be formed with schools, universities, fishing and environmental groups, and community organizations. This effort will dovetail well with both State and national migratory fish initiatives.

Finally, there are no non-wadeable monitoring methods for large rivers for both fish and benthos. Several monitoring methods are being tested in Michigan, Mississippi, and by the USEPA Environmental Monitoring and Assessment Program (EMAP) in western rivers. Testing has not been completed and none of the methods has been generally accepted. However, it seems that the methods are moving in the direction of sampling along the shores for both fish and benthos, on both sides of the channel over very long distances (around 30 to 40 times the wetted width). Boats would be used to sample both benthos and fish and the method would employ electroshocking for fish, and D-frame nets for benthos in snags, vegetation, root mats and other appropriate habitats. Both Counties would pursue, with Maryland DNR and USEPA, a pilot study to test this monitoring method in the Patuxent River. Particularly, it might be a means to determine how development that drains directly into the River affects the biotic community. Grants, congressional initiatives, and cooperative partnerships are several of the ways to fund this type of project.

In addition to the specific fish blockage removal projects identified by subwatershed in Section III, the implementation strategy for restoring historic migratory fish populations may include the following actions:

- Development of a prioritization approach, such as the Gemstone Fish Sustainability Team model, using SCA and County data;
- Coordination with Maryland DNR programs and others for fish stocking and monitoring;
- Development of a volunteer network to support restoration of these fisheries; and
- Implementation of a pilot project for large river monitoring in the Patuxent River.

Watershed Association

Building on the work begun in the development of the WRAS, an Upper Patuxent River Watershed Association will be developed to address WRAS implementation in both Prince George's and Anne Arundel Counties. The core group of members will consist of interested Steering Committee members and stakeholders identified in the WRAS process. The purpose of the watershed association will include being an advocate for sound land use practices in the watershed; assisting with the WRAS implementation; and working with the local jurisdictions to ensure that the WRAS is, indeed, a living document that will be revisited, updated, and continually implemented. Both Prince George's and Anne Arundel Counties have noted that membership in local environmental organizations grows and remains strong only for those organizations whose members are interested and actively participate in activities with tangible results. To that end, the WRAS Partners will propose implementing many of the volunteer-oriented projects, as identified in Table 39, through the watershed association. Concomitantly, volunteer-oriented project implementation should serve to increase the membership of the watershed association.

Stakeholder involvement and input to develop the Watershed Association is key to a successful organization. Both Prince George's and Anne Arundel Counties have successful stakeholder-based volunteer watershed organizations. These organizations will be used as models for the Upper Patuxent River Watershed Association. As the Watershed Association takes form, its members will determine the structure, goals, objectives, by-laws, projects, and other necessary components. The Watershed Association will become the vehicle for sustainable restoration and public education/outreach efforts in the Upper Patuxent River watershed.

CONCLUSION

This WRAS is unique in that it is one of the first interjurisdictional WRASs completed in the State of Maryland. Despite the unique nature of land use history and landscape characteristics, common problems were observed on both sides of the river. Degraded living resources, uncontrolled stormwater runoff, and conversion of open space land uses to developed land uses are examples of these common challenges. This WRAS provides an overview of the ecological health of the Upper Patuxent River and provides guidance to both Counties on enhancing and restoring this watershed. Anne Arundel and Prince George's Counties will continue their partnership throughout the implementation phase of the Upper Patuxent River WRAS.

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