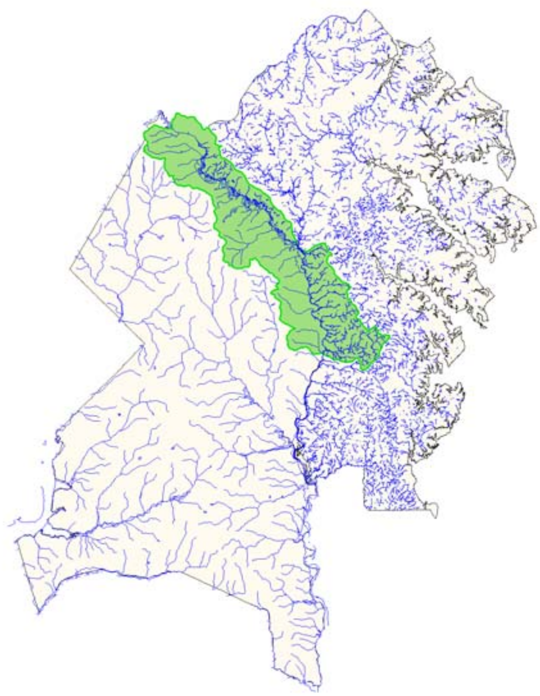
Upper Patuxent River
Watershed Restoration Action Strategy
for
Anne Arundel and Prince George's Counties, Maryland

Prince George's County Volume

Final Report
July 2003



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PRINCE GEORGE'S COUNTY MARYLAND

A Watershed Restoration Action Strategy for the Upper Patuxent River Watershed in Anne Arundel and Prince George's Counties, Maryland

Final Report

Prince George's County Volume

July 2003

Prepared by
Prince George's County,
Department of Environmental Resources

Prepared for
Maryland Department of Natural Resources
Chesapeake and Coastal Watershed Service
Coastal Zone Management Division

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I. INTRODUCTION

In 1998, Maryland developed the Clean Water Action Plan (Clean Water Action Plan Technical Workgroup, 1998) to identify and restore watersheds not meeting clean water and other natural resource goals, and to sustain healthy conditions in those watersheds that currently meet these goals. Development of this Plan involved conducting a unified watershed assessment, prioritization for restoration or protection, and developing strategies for restoration or protection. The initial unified watershed assessment classified the Maryland 8-digit watersheds into the following categories:

- Category 1 – Watersheds not meeting clean water and other natural resource goals and needing restoration;
- Category 2 – Watersheds currently meeting goals that need preventive actions to sustain water quality and aquatic resources;
- Category 3 – Pristine or sensitive watersheds that need an extra level of protection; and
- Category 4 – Insufficient data.

As a result of this effort, the Upper Patuxent River Watershed (Maryland 8-digit watershed 02131104) was classified as a Category 1 watershed in need of restoration.

The next step in the Clean Water Action Plan (CWAP) process was to assign restoration priorities to each watershed. Watersheds that failed to meet at least half of their goals (i.e., half of the evaluation indicators had values failing to meet Category 1 benchmarks) were considered Category 1 Priority Watersheds in need of restoration action in the near term (e.g., within 2 years of CWAP publication). The Upper Patuxent River Watershed received a Category I Priority for restoration.

The final component in the CWAP is the development of Watershed Restoration Action Strategies (WRAS) for watersheds in need of restoration or protection. A WRAS is a comprehensive restoration strategy that addresses all aspects of watershed condition and water quality. The WRAS is led by the local government, in partnership with the State, and encourages public participation in the strategy development and implementation. In 2002, Anne Arundel and Prince George's County entered into a cooperative agreement with Maryland Department of Natural Resources, to develop a bi-county WRAS for the portion of the Upper Patuxent River watershed located within these two counties. The cooperative agreement provided the Counties with an avenue to apply for and receive grant monies to assist in watershed assessment and planning, receive technical assistance from Maryland Department of Natural Resources (DNR), and develop the watershed restoration action strategy.

The Upper Patuxent Watershed encompasses 56,399 acres (88 square miles) and lies entirely within the Maryland's Coastal Plain. Within the study area, 40% (22,244 acres) of the watershed is located within Anne Arundel County and 57% (32,410 acres) within Prince George's County The remaining 3% of this watershed (1,745 acres) lies within Howard and Montgomery Counties and is outside of the study area for this WRAS.

The overarching goal of the Upper Patuxent River WRAS is to minimize water quality impacts to the river and its' tributaries from land use changes. To accomplish this goal, action items were developed based on a review of historic and current natural resources and water quality conditions, as well as through watershed stakeholder input.

In the conduct of this WRAS, Anne Arundel and Prince George's Counties worked closely with State staff to collect existing information and develop a watershed characterization, and to field assess current watershed and water quality conditions. Additionally, the WRAS Partners (Anne Arundel and Prince George's Counties, and Maryland DNR) undertook public participation activities to ascertain the perceived issues and assets associated with the Upper Patuxent River watershed. The urban land within this watershed was also reviewed and assessed for the potential to retrofit or implement environmentally sensitive, low impact, development techniques that will address and reduce nonpoint source pollution from site runoff. From the existing information and current assessments, the WRAS Partners developed a methodology to prioritize subwatersheds for restoration and/or protection activities based on differences in ecological conditions (e.g., water quality, habitat conditions, land uses). Restoration and protection action strategies were then developed to address and improve those ecological conditions, and to achieve the overall WRAS goal.

The overall results of the Upper Patuxent WRAS include:

- Prioritized listing of subwatersheds in need of restoration or protection,
- Prioritized listing of associated subwatershed projects that will address those restoration and protection needs,
- Top ten projects prioritized on a watershed-wide basis, and
- Potential programmatic changes to protect and preserve the Upper Patuxent River watershed.

II. Methods

The WRAS Partners employed several methods to assess the ecological condition of the Upper Patuxent River watershed and to determine appropriate action strategies. Descriptions of each component of this study, and the methodology employed, are noted in the following text.

Watershed Characterization

The first step in developing the Upper Patuxent River WRAS was to compile and review the existing information relative to this watershed, and develop a watershed characterization based on this information. Existing data and information pertaining to water quality, land use, living resources and their habitats were identified by the WRAS Partners, and compiled and analyzed by DNR staff with input from Anne Arundel County and Prince George's County staff. Information collected included numerous GIS coverages and associated databases, as well as hard copy data and reports. The information and data were summarized and presented in a succinct format such that the reviewer can readily identify information and issues, as well as sources for additional information. Information contained within the Upper Patuxent River Watershed Characterization is documented in Table II-1. Finally, the characterization provides information on additional resources and how they can be used in the development of the WRAS (Maryland DNR, 2002a). The Upper Patuxent River Watershed Characterization was completed in December 2002 and can be found on DNR's web site at www.dnr.state.md.us/watersheds/surf/proj/wras.html.

Table II-1. Upper Patuxent River Watershed Characterization Report Contents

Water Quality
River Basin Context of Local Water Quality Issues
Water Quality Standards and Designated Uses
303(d) Listing – Water Quality Limitations
Total Maximum Daily Loads
Monitored Water Quality – Status and Trends
Fish Tissue Monitoring Data
Pollution Sources – Point and Nonpoint Sources
Land Use
Landscape Indicators
Land Use in the Watershed
Sand and Gravel Mining
2020 Land Use and Land Cover Projections
Zoning
Impervious Surface Coverage
Sewer and Water Service
Smart Growth and Protected Lands
Green Infrastructure
Forested Natural Resource Areas at the Watershed Scale
Anne Arundel County Greenways Master Plan
Soils
Wetlands

Table II-1. Upper Patuxent River Watershed Characterization Report Contents

Living Resources and Habitat
Living Resource Indicators
Current Biological Monitoring
Historic Biological Monitoring
Recreational and Migratory Fisheries
Sensitive Species
The Patuxent Research Refuge and Wildlife Research Center
Restoration Targeting Tools
2002 Stream Corridor Assessment
Stream Buffer Restoration
Low Impact Development Techniques
Wetland Restoration
Achieving Measurable Water Quality Improvement
Focusing Land Conservation Activities
Potential Benchmarks for WRAS Goal Setting
Coastal Zone Management
Chesapeake 2000 Agreement
Goals from the *Clean Water Action Plan*
Wetland, Stream and Forest Habitat Goals for Maryland's Tributary Strategies
Water Quality Improvement Act of 1998
Total Maximum Daily Loads
Related Projects
Hydrologic Studies for the City of Laurel
Laurel Lakes Watershed Assessment
The Patuxent River Commission
The Patuxent River Watershed Atlas of Resource and Watershed Management Priorities
Environmental Citizens Groups
Stream Monitoring Programs

Current Conditions Assessment

In addition to developing a watershed characterization based on previously collected data and information, this WRAS also includes a current conditions assessment of the Upper Patuxent River Watershed. The various assessment techniques are discussed below.

Stream Corridor Assessment

The Stream Corridor Assessment is one of the technological tools provided to the Counties, by Maryland DNR, to help assess the present environmental condition of the stream network. The Stream Corridor Assessment (SCA) provides a rapid overview of the tributary stream network, provides basic information about those streams, and identifies where potential environmental problems occur. Through this effort, 100 miles of perennial stream were field assessed within the 88 square mile watershed, approximately 50 miles within each County. Because of the size of this watershed and the associated number of stream miles, a subset of perennial streams were chosen for assessment. Those streams targeted for the SCA are contained within drainage basins that exhibit land uses representative of the overall land uses within the watershed.

Members of the Maryland Conservation Corps (MCC), who had completed an intensive training program designed and instructed by Maryland DNR staff, conducted the Upper Patuxent River Watershed SCA. Through the intensive training, the MCC teams learned to assess the general condition of in-stream and riparian habitats, and to identify and assess severity and correctibility for the following environmental problems:

- Channel alterations
- Exposed pipes
- Fish migration barriers
- Construction in or near the stream
- Stream bank erosion sites
- Pipe outfalls
- Inadequate Stream Buffers
- Trash dumping sites
- Unusual conditions observed (e.g., odors, scum, excessive algae, water color/clarity, red flock, sewage discharge, oil)

The Anne Arundel County Upper Patuxent River SCA surveys were conducted between late spring and early summer 2002. The Upper Patuxent River watershed was divided into a northern portion and a southern portion. The northern portion extends south from Maryland Route 198 to the confluence of the Patuxent and Little Patuxent Rivers while the southern portion extends south from the confluence to just below Maryland Route 214. Nine subwatersheds were identified for this assessment, two located in the northern portion of the Upper Patuxent River watershed, and seven in the southern portion. Most of the assessment was concentrated in southern subwatersheds because most of the northern portion subwatersheds area under control of the Patuxent Research Refuge and have very similar land uses. Figures II-2. and II-3. show the subwatersheds chosen for the SCA survey in Anne Arundel County. Table II-2. summarizes basic information about each basin.

MCC teams physically walked along the targeted perennial streams, documenting the location, severity, and potential correctibility of observed environmental problems. Prior to initiating this survey, Anne Arundel County staff sent information letters to all persons owning land adjacent to the targeted stream reaches. These letters also requested property owner permission to access the stream adjacent to the property, and provided a phone number and e-mail address to contact if the landowner did not want the crews to survey the stream on their property. Additionally, survey crews were instructed to not cross fence lines or enter any areas marked as “No Trespassing” unless specific permission to access the property had been granted by the landowner.

In preparation for the field component of the SCA, the survey manager identified representative sites along each stream reach where survey crews were instructed to record specific information regarding in-stream habitat conditions, wetted width of the stream, thalweg depth, and bottom type. These “representative sites” were denoted on the field maps used by the survey crews.

In the physical conduct of the SCA, field survey crews walked each mile of identified stream, documented any observed problems, and recorded required in-stream information for the “representative sites.” Documentation of observed problems also included determining the severity of the problem, the ease of correcting that problem, and the accessibility of the problem site. A unique identification number was assigned to each problem observed and to each

Table II-2. Anne Arundel County Subwatersheds Assessed For The Upper Patuxent River WRAS.

Basin Id (Stream Name)	Drainage Area (Acres)	Length Of Stream Surveyed (Miles)
UPN1 (Unnamed Tributary to the Patuxent River)	358	1.77
UPN7 (Unnamed Tributary to the Patuxent River)	221	0.88
UPS1 (Cox Branch)	988	6.64
UPS3 (Unnamed Tributary to the Patuxent River)	725	4.00
USP4 (Unnamed Tributary to the Patuxent River)	1266	5.57
UPS6 (Unnamed Tributary to the Patuxent River)	600	2.53
UPS9 (Stocketts Run)	4108	23.9
UPS10 (Unnamed Tributary to the Patuxent River)	314	1.96
UPS11 (Unnamed Tributary to the Patuxent River)	129	0.97

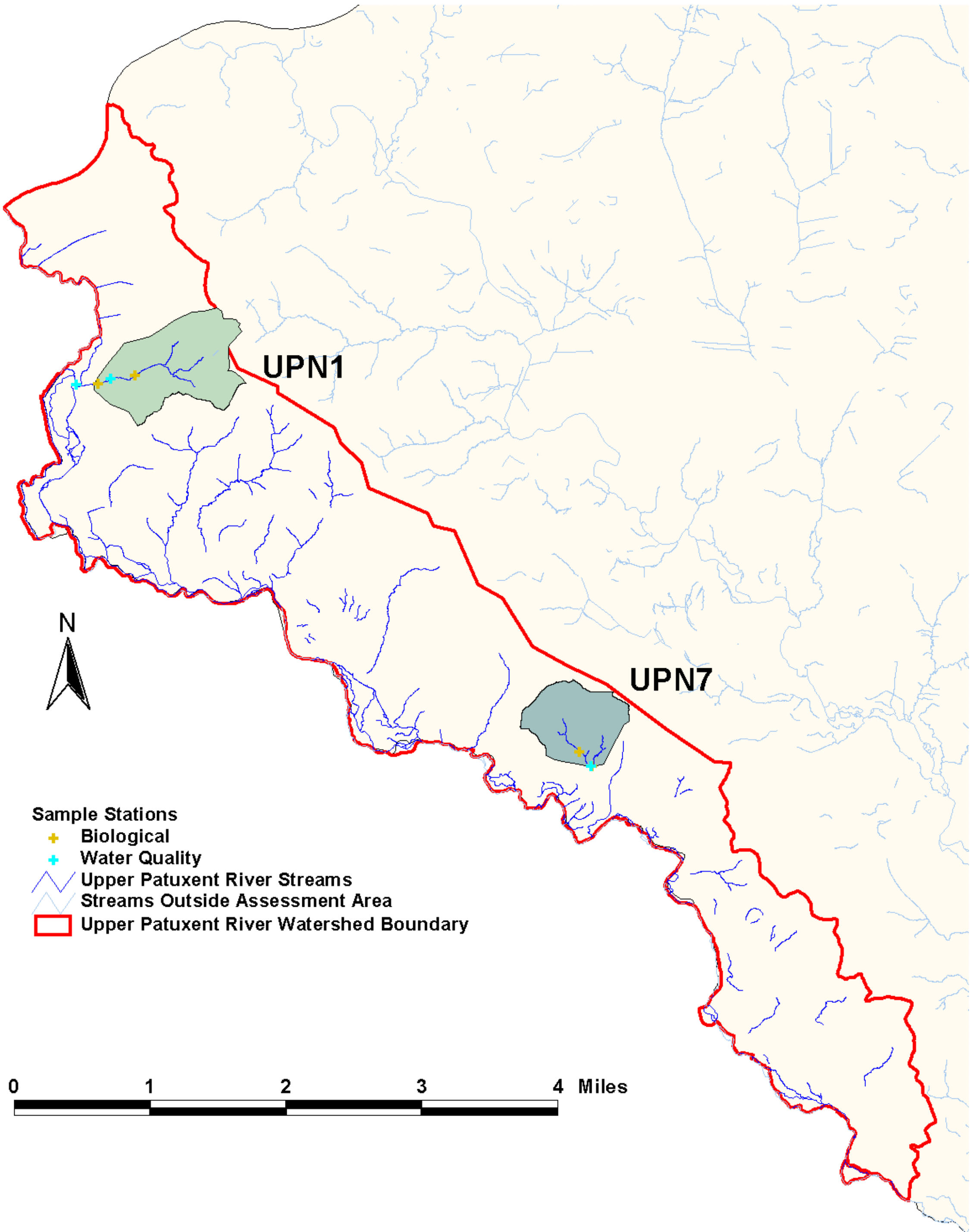

Figure II- 2. Distribution of sampled subwatersheds in the northern portion of the Upper Patuxent River Watershed, Anne Arundel County.

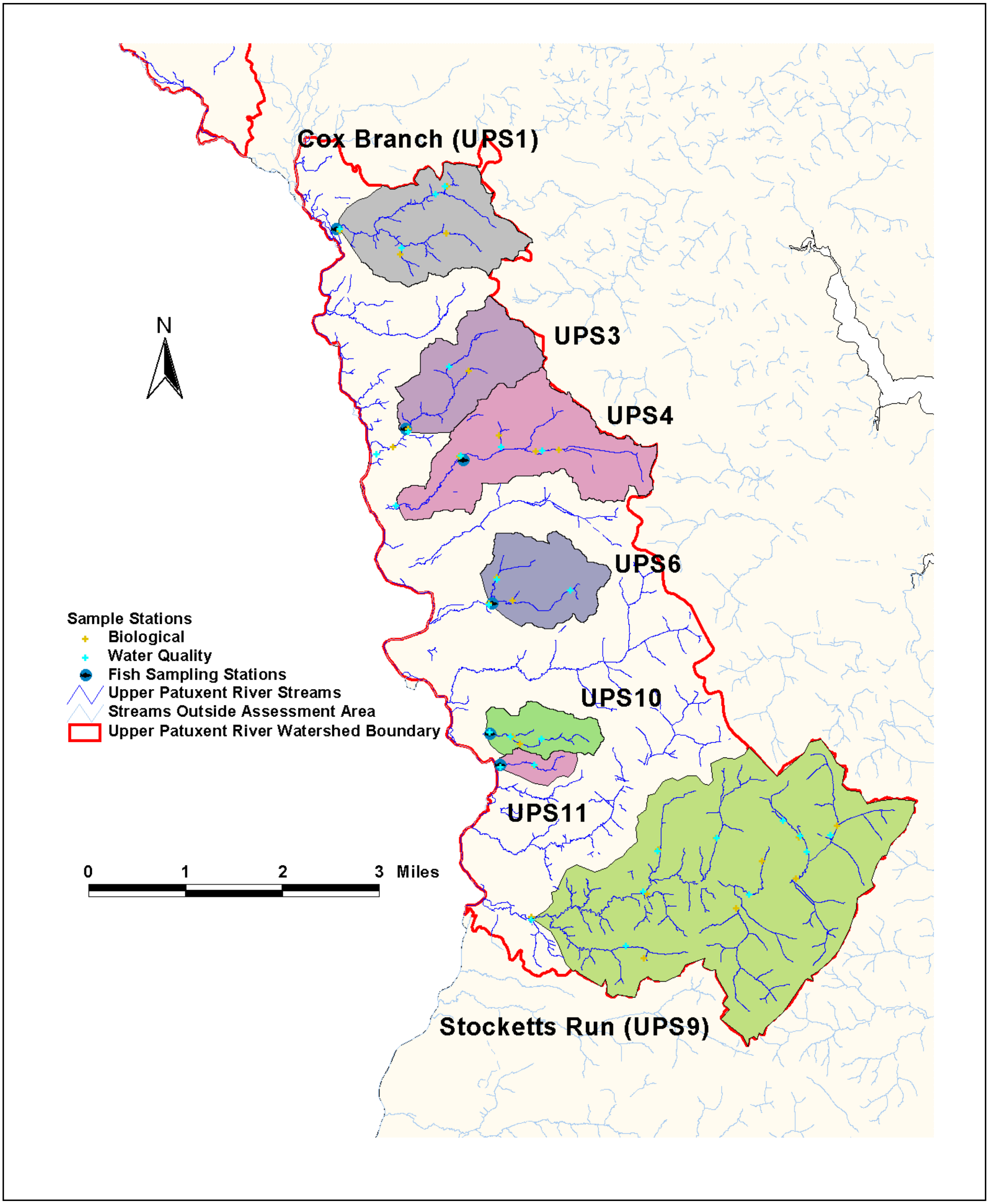

Figure II-3. Distribution of sampled subwatersheds in the southern portion of the Upper Patuxent River Watershed, Anne Arundel County.

reference site identified along each surveyed stream reach. Each identifier was correlated to a location on the field map.

Photographs of the problem areas and the reference sites were taken to document field conditions from both the upstream and downstream views. MCC crews completed field data sheets for each environmental problem observed, as identified above, as well as for the representative sites along the stream reach. The results of the SCA survey efforts were submitted to Maryland DNR staff who compiled the information into a database format, labeled and organized all photographs by site, and incorporated all data and photographs into a readily-usable GIS format.

Complete information on the SCA methodology, including descriptive information for each problem type, and definitions for levels of severity, correctibility, and accessibility, can be found in "Stream Corridor Assessment Survey – Survey Protocols (Yetman, 2001). This document is available on-line, at the Maryland DNR web site, at http://www.dnr.state.md.us/streams/pubs/other.html. The completed Anne Arundel and Prince George's Counties Stream Corridor Assessment are also available to download through the Maryland DNR web site at www.dnr.state.md.us/watersheds/surf/proj/wras.html.

Prince George's County divided the stream corridor assessment areas into two watershed areas, the Upper and Lower Watershed. The Upper Watershed consists of eight subwatersheds and the Lower has 10 subwatersheds. To increase the number of stream miles assessed, Prince George's County performed additional stream corridor surveys. The County surveyed an additional 25.3 miles in Upper Watershed and MDNR completed 57 stream miles. The watersheds surveyed, survey team, length of stream miles and drainage area of each watershed are identified in the Table II-3. The location of each Prince George's County subwatersheds is shown in Figures II-4 and Figure II-5.

Table II-3. Prince George's County Stream Corridor Assessments

Subwatershed	Survey Team	Length of Stream Surveyed (miles)	Drainage Area (acres)
Upper Watershed			
Bear Branch	PGC	6.8	1,562
Walker Branch	PGC	5.5	1,282
Crows Branch	PGC	4.3	1,100
Tributary 5	PGC	3.5	1,115
Tributary 6	PGC	2.3	1,084
Tributary 8	PGC	1.0	402
Patuxent Wildlife Refuge	PGC	1.2	474
Tributary 7	PGC	0.7	347
Total surveyed by PGC		25.3	7,366
Lower Watershed			
Horsepen Branch	DNR	19.4	4332
Mill Branch	DNR	9.4	2270
Green Branch	DNR	6.5	1218
Honey Branch	DNR	2.5	1083
Mount Nebo Branch	DNR	4.2	1186

Tributary 3	DNR	4.5	1640

Table II-3. Prince George's County Stream Corridor Assessments

Subwatershed	Survey Team	Length of Stream Surveyed (miles)	Drainage Area (acres)
Marsh Branch	DNR	4.3	1053
Tributary 4	DNR	2.7	572
Tributary 1	DNR	2.5	746
Tributary 2	DNR	1.0	420
Total surveyed by DNR		57.0	14,520
Grand Total		**82.3**	**21,886**

Synoptic Surveys

The ability of a stream to support a diversity of aquatic life depends on the quality and availability of habitat as well as the physical and chemical characteristics of its water quality. While the habitat features of a stream can be easily observed, measurements of water quality require field sampling and usually some laboratory analyses of the samples. Results of a sampling program can also be highly variable and difficult to interpret, particularly if only a wet weather sampling program is undertaken.

Staff from Maryland DNR, in support of the Upper Patuxent WRAS, conducted synoptic surveys for water quality and biological community (benthic macroinvertebrate and fish) assessment in the spring and summer sampling periods. Maryland DNR synoptic survey sampling locations are denoted on Figures II-4 and II-5 in Prince George's County and in Figures II-2 and II-3 in Anne Arundel County.

Water Quality Sampling

Synoptic water quality sampling, performed by Maryland DNR, occurred in the spring of 2002. Baseflow grab samples were collected at 31 sites in Anne Arundel County and 25 sites in Prince George's County. Samples were collected mid-stream, just below the water surface, and filtered on-site using Gelman GF/C 45µ pore size filters. *In situ* water quality data and stream discharge measurements were taken at the time of sample collection. *In situ* parameters (i.e., water temperature, dissolved oxygen, pH, and conductivity) were measured using a Hydrolab Surveyor II.

The filtered water samples were stored on ice and frozen on the day of collection. Filtered samples were analyzed for dissolved inorganic nitrogen (NO_3, NO_2) and dissolved inorganic phosphorus (PO_4) at the University of Maryland's Chesapeake Biological Laboratory. All analyses were conducted in accordance with U.S. EPA protocols.

Nutrient yields per unit area were calculated using watershed areas determined from digitized watershed maps. Where sampling sites were nested within a subwatershed, the mapped concentration for the downstream site was shown only for the area between that site and the next site upstream. Yield calculations for the downstream site, however, were based on the entire area upstream of that site, but were mapped showing just the area between sites. Therefore, the reported yields for the downstream sites illustrate the cumulative impact from all upstream activities.

Within Prince George's County, supplemental water quality monitoring was performed during the summer months. A cost effective initial water characterization was conducted during dry summer conditions when baseflow is at it lowest and water temperatures at a maximum. This is often a critical period for the survival of aquatic life. Water quality during this period can serve as useful starting point for watershed restoration efforts and for the comparison of the water quality of different watersheds. Unless water is of sufficient quality during summer baseflow, restoration efforts to improve habitat or to reduce impacts on water quality will not be successful. The lower variability of baseflow water quality also allows differences in the water quality between watersheds to be more clearly observed.

The five watersheds selected in Prince George's County for water quality characterization have a total drainage area of 8409 acres and represent 26% of the total Upper Patuxent watershed area (Table II-4: Figures II-4 and II-5 for station locations). They include a range of land uses and watershed sizes. The range in watershed size and land use is also intended to support a comparative analysis of more urbanized watersheds versus a reference forested site. Monthly sampling was completed from June to September for a total of three samples per site. Water quality parameters measured included temperature, pH, nutrients (Total Nitrogen, Total Phosphorus), trace metals (lead, zinc and copper) and Biochemical Oxygen Demand (BOD5). Discharge measurements were taken in conjunction with water sampling to determine baseflow loading estimates of the monitored parameters. The summer baseflow sampling effort augmented the spring baseflow sampling program completed by Maryland DNR in April 2002.

Table II-4. Five Subwatersheds Selected for Supplemental Baseflow Characterization.

Stream	Sampling Location	Drainage Area	Land Uses
Mount Nebo	4-H Club Access Road south of Queen Anne Road	1114 Acres	Forested (50%) Low-density residential (20%) Agriculture (20%) Transportation (10%)
Horsepen Branch	At intersection with MD 197	3900 acres	Medium Density Residential (65%) Forested (25%) Golf Courses (5%) Commercial (5%)
Green Branch	Adjacent to Ballpark Road	531 Acres	Medium Density Residential (45%) Commercial (30%) Transportation (15%) Forested (10%)
Unnamed Tributary Draining to Blue Gill Pond (Reference Site)	Adjacent to exit road for the Patuxent Wildlife Refuge or alternatively adjacent to Loblolly Pine Drive	350 Acres	Forested (95%) Transportation (5%)
Crows Branch downstream of Confluence with Bear Branch	Adjacent to Bowie Road	2514 Acres	Commercial (15%) Medium Density Residential (50%) High Density Residential (10%) Forested (15%); Other 10%

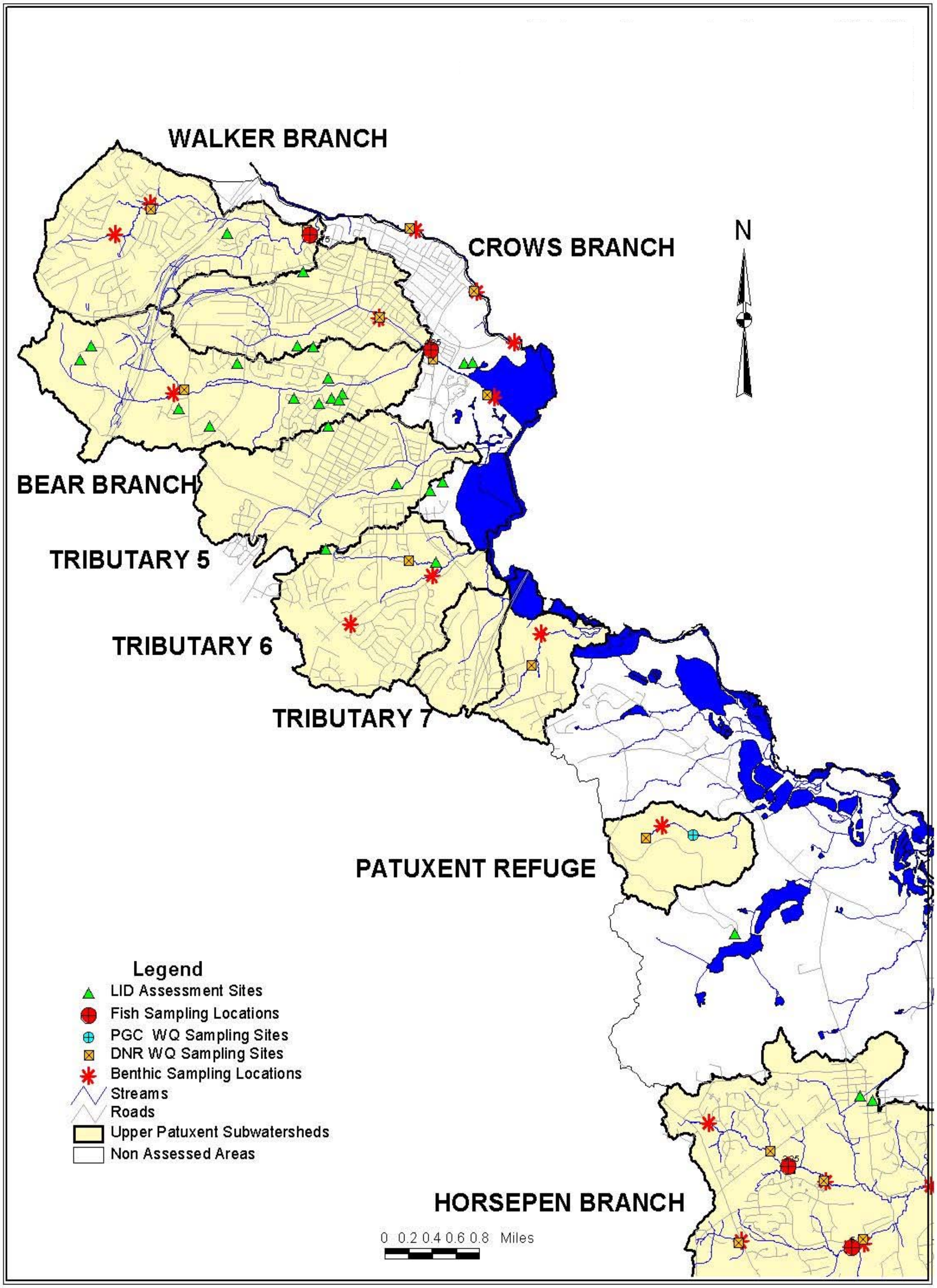

Figure II-4. WRAS subwatersheds in the northern portion of the Upper Patuxent River Watershed, Prince George's County.

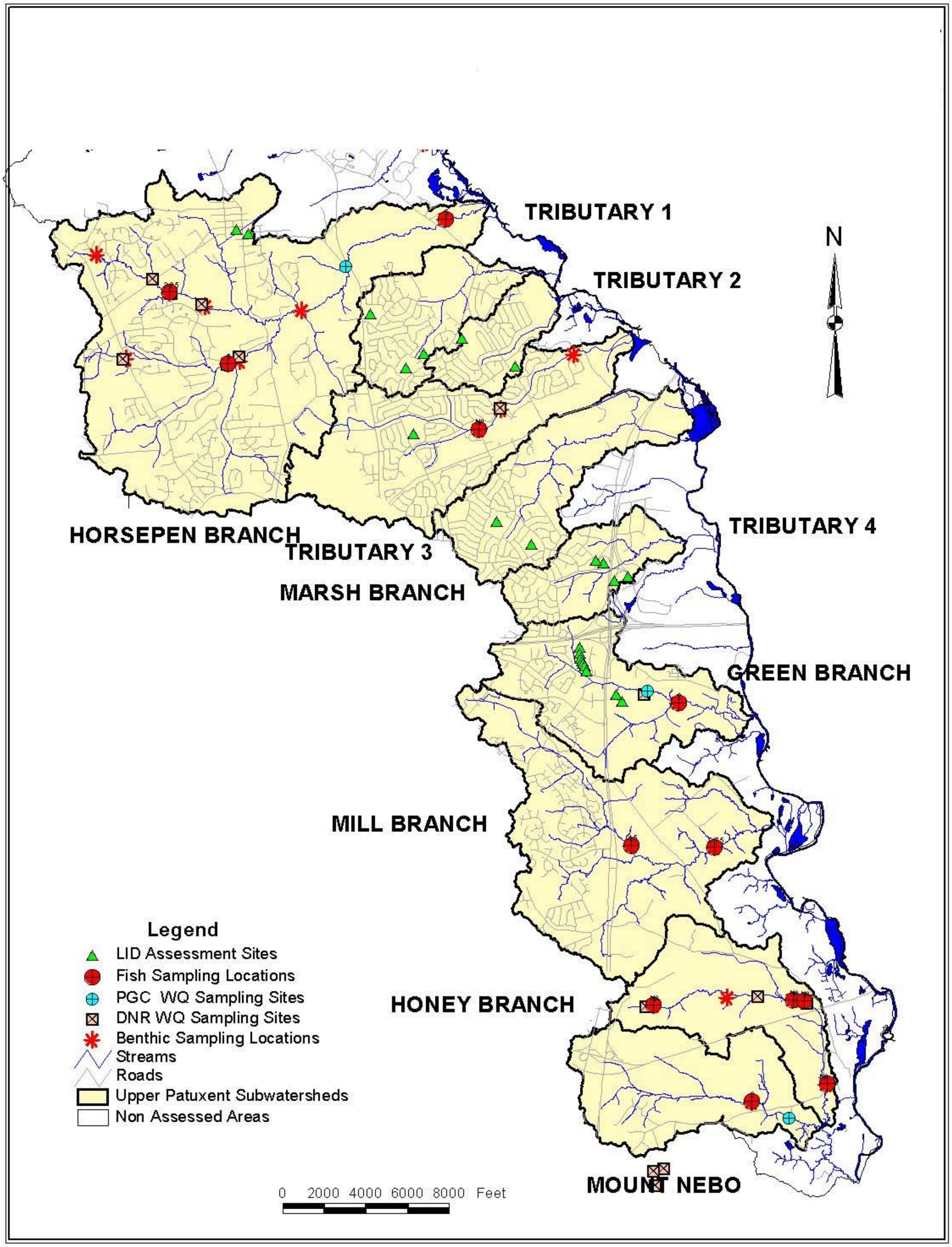

Figure II-5. WRAS subwatersheds in the southern portion of the Upper Patuxent River Watershed, Prince George's County.

Benthic Macroinvertebrate Sampling

Aquatic benthic macroinvertebrates were collected during the spring indexing period, concurrent with the synoptic water quality sampling. Samples were collected at nine sites in Anne Arundel County and six sites in Prince George's County. These sites were also targeted for water quality sampling.

Macroinvertebrates were collected over a $20m^2$ area of best available habitat using a 500-µ mesh size, 0.3m wide D-frame net. The best available habitats were defined as gravel riffles, snags, submerged vegetation, and root mats. Habitats were sampled in proportion to their occurrence at the designed sampling area. Samples were composited in a sieve bucket, fine sediments washed out, and large debris rinsed and discarded in the field. The remaining sample was transferred to a storage container, preserved with 70% ethanol, and returned to the laboratory for processing. In the laboratory, a 100-organism subsample was randomly collected from the field sample using a gridded tray. Organisms were identified to genus, recorded on a bench sheet, and archived for future reference. From these data, a macroinvertebrate index of biotic integrity (IBI) was calculated to facilitate ranking of site quality.

Macroinvertebrate Habitat Assessment

In-stream and riparian habitat quality was assessed at the nine macroinvertebrate sampling sites in Anne Arundel County and the six sites in Prince George's County. This assessment, modified from Plafkin et al. (1998) to focus on the macroinvertebrate habitat, rates the in-stream structure, channel and lower bank morphology, and the upper bank and riparian area using a series of metrics. The metrics are weighted to provide more scoring potential to the parameters most directly influencing the macroinvertebrate community.

The primary habitat metrics rate the in-stream habitat quality and quantity available for use by the macroinvertebrate community. These metrics include the amount and type of woody debris, prevalence of undercut banks, degree of embeddedness in riffles, pool depth, water velocity, and flow. These metrics are also given the most weight because of their direct importance to the health and diversity of the in-stream macroinvertebrate community. Secondary metrics assess channel morphology, rating the quality of the lower bank and structure of the stream channel. These metrics include relative measures of riffle extent, channel sinuosity, and extent of channel alterations caused by high flow events. These metrics receive less weight than the primary metrics because of their less direct impact on the in-stream macroinvertebrate communities. The tertiary metrics rate the quality of the upper bank and adjacent riparian areas. These metrics include scoring of the type and amount of bank vegetation, amount and frequency of bank erosion, and land use in the riparian area. These characteristics of the watershed are given the least weight because they are less important to the in-stream macroinvertebrate community.

Fish Community Assessment

In the summer of 2002, fish were collected at six sites in Anne Arundel County and four sites in Prince George's County using backpack electroshocking gear. This sampling occurred in the summer to coincide with the MBSS index period for fish sampling. Block nets were placed at each end of a 75-meter reach of stream to preclude the fish from escaping. Two passes through this 75-meter reach were made with the backpack electroshockers. Fish were collected, weighed, enumerated, and identified to species. These data were then used to determine fish community taxa richness and biomass estimates.

Additional information regarding the Synoptic Surveys, methods employed, and the complete Synoptic Survey report for the Upper Patuxent River Watershed can be found on the DNR web site at www.dnr.state.md.us/watersheds/surf/proj/wras.html.

Supplemental Biological and Physical Stream Assessment

Anne Arundel County supplemented the synoptic data collection provided through Maryland DNR. Through this work effort, additional indicators of stream integrity were sampled or measured at 24 additional targeted sites, in nine subwatersheds, within the Anne Arundel portion of the Upper Patuxent River Watershed (see Figures II-2 and II-3 and the subwatershed maps in Section III for details on all station locations). Indicators assessed included additional benthic macroinvertebrate data, physical habitat quality, sediment particle size distribution, and channel area.

Supplemental benthic macroinvertebrate sampling and the macroinvertebrate habitat assessments used the same methods as described above (see Synoptic Surveys). The supplemental macroinvertebrate and habitat data were combined with those collected by Maryland DNR during the same indexing period to derive biological condition scores (IBIs) for a total of 33 sites in Anne Arundel County.

Additional physical stream assessment information collected included substrate particle size distribution and stream channel cross sectional area. Substrate particle size distribution was determined using a modified Wolman Pebble Count method. This method consisted of measuring 100 particles in ten transects, per assessment reach, distributed proportionally to reach features. For example, if an assessment reach consisted of 50% riffles and 50% pools, then 5 transects would be in riffles and five in pools. Stream cross sectional area was measured at a representative riffle as near the center of the assessment reach as possible. At this location, metal rebar monuments were installed on each side of the channel to provide a permanent location for subsequent future measurements and a topographic survey of the area between the two monuments was performed.

Complete information regarding the methods employed, the data collected, and conclusions and recommendations resulting from this effort are found in "Anne Arundel County, Biological Assessment of the Upper Patuxent River Watershed" (Pavlik and Stribling, 2003).

Prince George's County also supplemented the biological data collection efforts provided through the Synoptic Survey. Prince George's County sampled 32 sites for benthic macroinvertebrates and 14 sites for fish over three years in their 5-year rotating basin stream-monitoring program (Figures II-4 and II-5 for all biological sampling stations). Five streams were sampled during the year 2000, nine in 2001, and 20 in 2002. Approximately 65% of the sites sampled were on first order tributaries, and all were in small watersheds draining directly to the Patuxent River mainstem. Through this monitoring and assessment program, the county gathered information on the benthic and fish Indices of Biological Integrity (B-IBI and F-IBI), physical habitat quality, sediment particle size distribution, stream channel cross-sectional area, selected field chemistry, and land use/land cover distributions. Biological and physical habitat methods used were comparable to those used by the MBSS, and all fieldwork was performed during the same index period (March – April). All of these data, and a description of the methods and sites were provided in the WRAS report, the "*Upper Patuxent River Watershed*

Restoration Action Strategy (WRAS) Biological Assessment. Spring 2002, Prince George's County, Maryland."

Basin Condition Score

WRAS Partners realized, early in the WRAS process, that an acceptable and scientifically sound methodology was needed whereby restoration and protection decisions could be made given the quantity of information collected. Therefore, the WRAS Partners initiated development of an assessment methodology to assist in the review and assimilation of data, and to provide a means to prioritize subwatersheds for restoration and/or protection actions.

The Basin Condition Score (BCS) is comprised of a series of metrics that score various characteristics of each subwatershed. These metrics include water quality conditions, living resources conditions, habitat conditions, landscape conditions, and hydrologic conditions. Each metric consists of selected indicators that describe that metric. For example, the indicators used to score the water quality condition metric are inorganic dissolved nitrogen and phosphorus concentrations as measured during the synoptic surveys (Maryland DNR 2002b). The BCS metrics evaluate overall subwatershed conditions and are based upon data collected during the SCA (Pellicano and Yetman, 2002), the synoptic survey data (Maryland DNR 2002b), supplemental biological and habitat assessment data (Pavlik and Stribling, 2003), and GIS data developed by Maryland DNR (Maryland DNR 2002a) and the partner Counties.

Some indicators within metric groups are believed to better characterize critical ecological processes. Consequently, selected indicators are weighted to emphasize their importance over others when evaluating subwatershed health. Each indicator within a metric group is either unweighted or given a weighting factor of two or three. The decision about which indicators to weight is based upon scientific literature and the best professional judgment of the authors. A metric indicator is unweighted if that metric has a lesser influence on ecological processes in a subwatershed of interest, or if lesser quality data had to be used to score that metric. Data quality decisions were made in consultation with GIS professionals and through discussions with the data collection participants (e.g., SCA survey manager).

Points for all the indicators are summed, giving a metric group score. The metric group scores are summed to develop the BCS, leading to a condition classification as illustrated in Table II-5. In addition, since individual metric groups are scored, it is possible to evaluate where problems exist within a particular subwatershed even if an overall score indicates only moderate or low impairment. Using the ranges, subwatershed conditions are classified as described in Table II-5. Method documentation can be found in Appendix A.

RESTORATION PROJECT RANKING

One of the products of the SCA Methodology application is a list of potential restoration sites associated with the problem identification process. As described in Yetman (2001), each observed problem is scored for severity, correctibility, and accessibility. Table II-6 provides brief definitions of how each category is scored in the SCA

Table II-5. Scoring ranges for BCS Methodology

Metric Group	Subwatershed Quality Rating			
	Good	Fair	Poor	Very Poor
Water Quality Conditions	<5	5-11	12-17	>17
Living Resource Conditions	<18	18-38	39-65	>65
Habitat Conditions	<38	38-83	84-128	>128
Landscape Conditions	<33	33-72	73-111	>111
Hydrologic Conditions	<8	8-17	18-26	>26
Overall BCS	**<101**	**101-220**	**221-345**	**>345**

Table II-6. Problem evaluation categories scored during the SCA. Definitions are summarized from Yetman (2001).

Category	Condition Rating Description (Assigned Point Value)		
	Low	Moderate	High
Severity	Problems generally are low intensity or only occur over a short distance of stream channel. Problems judged not significant. **(5)**	Problem somewhat widespread, assessment crews have observed worse during assessment. **(3)**	Problems generally widespread with large impact on system health. Magnitude and/or extent of problem relatively great**. (1)**
Correctability	Easy to correct. Typically, low intensity problems that might be solved with volunteer labor or little engineering analysis. **(1)**	More difficult to correct. Might require significant volunteer labor, or a small piece of construction equipment to correct. **(3)**	Most difficult. Impacts extensive and likely require professional expertise to diagnose and determine corrective actions. Large, expensive, construction projects typical. **(5)**
Accessibility	Easy to access. Near road crossings or on public property. **(1)**	Project might be accessible by foot but not easily by vehicle. **(3)**	Project difficult to access by foot and by vehicle. **(5)**

For Anne Arundel County, the SCA project rating data were used to rank projects within each subwatershed in the following manner. First, only projects with a severity rating of moderate or high were considered in the ranking process. Then, the scores for each category were summed and the projects with the lowest scores were judged the highest priority projects for implementation. The rational for this approach is that projects that were judged highly severe but were also judged relatively easy to access and easily correctable would be the easiest to implement and have the largest "bang for the buck" in improving the subwatershed of interest. Projects that were somewhat more difficult to access and/or were judged more difficult to correct got lower scores using this approach. Prioritized project lists were generated for each subwatershed and are presented in the individual subwatershed write-ups in Section III.

Prince George's County's ranking criteria and results are described in Section III. Forty-eight LID sites were ranked watershed wide and within the County's subwatersheds. Biological monitoring sites were ranked individually and the subwatersheds were also ranked. Water quality site results were compared to the U. S. EPA region III's reference.

Low Impact Development Retrofit Assessment

As summarized in the Characterization document, the Upper Patuxent River Watershed failed several watershed indicators associated with land development and stormwater management described in the watershed's Clean Water Action Plan. These indicators are: percent impervious surface, population density and soil erodibility. Three other failing indicators are associated with aquatic living resources (Non-tidal Benthic Index of Biotic Integrity, Non-tidal Instream Habitat Index and Imperiled Aquatic Species Indicator).

Conventional land development techniques can dramatically alter natural hydrologic functions. Such site development techniques quickly remove stormwater from developed lands using roofs, gutters, downspouts, driveways, curb and gutter, roads, pipes, drainage swales, and other efficient drainage systems that convey runoff to end-of-pipe collection systems (stormwater management ponds). Resulting changes in hydrologic function include increased stormwater runoff, which amplifies the volume, frequency and rate of discharge; increased impervious surface, decreased infiltration and groundwater recharge; decreased time of concentration; decreased runoff travel times; and increased hydraulic connection. Natural features including vegetation are removed and/or dramatically altered. These changes adversely affect the ecosystems that were present before development.

Conventional stormwater management systems such as ponds have been shown to reduce pollutant runoff to some degree but have not been effective in protecting the habitat structure or hydrology of streams. Fish and macroinvertebrate studies have shown that SWM ponds alone are not enough to protect physical habitat structure (cover, substrate, sedimentation) or hydrology (baseflow, thermal fluxes or flashiness). Therefore, the implication is that SWM ponds are limited in their ability to protect streams and cannot reproduce predevelopment hydrological functions.

In both Prince George's and Anne Arundel Counties, there are developed areas with little or no stormwater management (SWM) or older SWM technology that is inadequate to protect the ecological structure of aquatic systems. Both Counties believe that a more holistic and site specific SWM approach is needed, particularly, for urban retrofit. In contrast to conventional stormwater management, Low Impact Development's main goal is to provide maximum protection of the ecological integrity of the receiving waters by maintaining the watershed's hydrologic regime. This goal is met by creatively designing hydrologic functions into the site design with the intent of replicating the predevelopment hydrology. This provides a significant positive impact on stream stability, habitat structure, baseflows, and water quality.

Low Impact Development (LID) is a comprehensive technology based approach to manage urban stormwater. Stormwater is managed in small, cost-effective landscape features located on each lot (as compared to conveying it to an end of pipe control such as SWM pond). Source control employing reduced impervious surfaces, functional grading, open channel sections, disconnection and reduction of drainage areas and flowpaths, and bioretention/filtration landscape features maintain hydrologic functions (infiltration. groundwater recharge, frequency and volume of discharges).

Multifunctional site design is a key component to LID. LID controls reduce runoff by integrating stormwater controls throughout the site in many small, discrete units. These controls are located on-lot at the source of impacts. Using this type of design, environmental features are preserved and incorporated into the development. Examples of LID controls are bioretention (rain gardens), rain barrels, rooftop storage, green roofs and amended soils. Forming micro drainage areas and disconnecting drainage paths are in sharp contrast to the efficient drainage systems practiced in conventional land development.

In addition to developing a catalog of information relative to the natural resources health of the Upper Patuxent River Watershed, an assessment of urban lands was conducted. The purpose of this assessment was twofold. First, an attempt was made to identify areas appropriate for stormwater management retrofits such that the levels of control required by each County's stormwater management regulations could be met. Second, evaluations were conducted to determine if lands ripe for development/redevelopment could be managed with environmentally sensitive and low impact development (LID) site design techniques.

Site Selection

Selection of viable retrofit and LID implementation sites was needed to facilitate the management of restoration efforts and to support the targeting of limited assessment resources. For the Prince George's County efforts, the initial step in the site selection process was the subdivision of the State's Upper Patuxent River Watershed into subwatersheds based on drainage area and land use criteria. The subdivision of the Upper Patuxent River watershed resulted in 17 subwatersheds ranging in size from 350 to 4330 acres, with an average subwatershed size of 1250 acres. The subdivided subwatersheds had relatively homogenous land uses. The location of the 18 subwatersheds within the Prince George's County portion of the Upper Patuxent River Watershed is denoted in Figures II-4 and II-5.

In Prince George's County, BCS results, stream condition information, and biological and water quality assessment information were used to identify individual parcels for evaluation as potential retrofit sites. It was expected that focusing on a single parcel would increase the homogeneity of features recorded on the site evaluation forms. Homogeneous features on a parcel were needed to facilitate the ranking of sites. The parcels had various levels of urban and suburban land uses. Some parcels had storm water management (SWM) within or downstream of their watersheds. The parcels had various ownership types and opportunity criteria.

In Anne Arundel County, candidate areas of developed land were initially identified through use of GIS land use data and aerial photography. From this initial assessment, approximately 30 potential evaluation sites in subwatersheds were identified for further field investigation. Most of these sites were residential land uses. Preliminary investigations (windshield surveys) were then performed at six of the sites. During this time, it was determined that most of these residential sites did not require retrofitting. Most were large lot (1-3 acre) residential with many LID-type practices in place (e.g., large buffers, open section roadways, disconnected downspouts). Consequently, a decision was made to focus on an identified commercial site in the Crofton area. As shown in Figure II-6, the targeted site is a compact industrial park, allowing for the potential implementation of a variety of LID techniques for use as a demonstration site. Additionally, the site was developed under older County stormwater regulations using conventional facilities. This site is partially contained within one of the most impacted Anne Arundel County subwatersheds assessed through the SCA. The balance of the site drains directly into the Patuxent River.

Site Evaluation Procedures for LID Feasibility Determinations

Concurrent with the site selection process, both Counties developed a methodology for evaluating the feasibility of retrofitting LID to residential and commercial/industrial areas. As part of this process, an assessment of available data and required data was conducted, in-office assessments and site characterizations using GIS data were performed, and extensive field work was done at the focus areas to collect site-specific data to determine the most feasible types of LID best management practices for installation. The assessment of the data requirements and availability was needed to develop the evaluation procedure with the objective to rank the sites as to their potential for LID implementation and / or storm water management (SWM) retrofits. Data needs include mapping, impervious area, storm drain system layout, utilities, topography, parcel ownership, land use, and existing storm water management. Available information included the County's GIS and soils information. The parcel evaluation procedure included the development of data collection forms. The data collection forms, which were used in both office assessments and field assessments, were structured to facilitate collection of information and to rank the sites in a consistent manner. Three forms were developed to facilitate collection of data and subsequent analysis. Examples of the forms and a complete description of the assessment methods used in both Counties can be found in Appendix B.