US Army Corps
of Engineers
Baltimore District

July 1996

Patuxent River Water Resources Reconnaissance Study

PATUXENT RIVER WATER RESOURCES STUDY

EXECUTIVE SUMMARY

The Patuxent River Water Resources Reconnaissance Study was authorized by a House Committee on Public Works and Transportation Resolution dated 28 September 1994. The authorization and funding for this study were a result of the efforts of Congressman Steny Hoyer, of Maryland's Fifth Congressional District. The purpose of the study is to develop a watershed plan in cooperation with other agencies and interested parties. This watershed plan lays a framework for managing the water and related land resources of the Patuxent River watershed by identifying efforts to be implemented by local, state, and Federal agencies, including the Corps of Engineers.

Given the variety of problems, needs, and opportunities identified in this study as well as the Corps' desire to use the extensive knowledge of the stakeholders and agency representatives, a multi-agency team was developed, which was called the Coordinating Committee for the Corps' Patuxent River Water Resources Study. Following the recommendations of the watershed stakeholders, the Coordinating Committee was developed as an adaptation of the existing Technical Sub-committee of the Patuxent River Commission. The multi-agency Coordinating Committee was essential for incorporating the extensive knowledge shared by watershed stakeholders and agency representatives, and, more importantly, to achieve buy-in and ownership by these key stakeholders and agency representatives. The Corrdinating Committee included, but was not limited to, representatives from the seven counties in the watershed, the five state agencies (Maryland Office of Planning, Maryland Department of the Environment, Maryland Department of Natural Resources, Maryland Department of Agriculture, and the State Highways Administration); representatives from the Washington Suburban Sanitary Commission, Maryland National Capitol Parks and Planning Commission, and the Chesapeake Bay Program; three research labs located within the watershed, the Jug Bay Wetlands Sanctuary, the U.S. Fish and Wildlife Service, the Natural Resource Conservation Service, the National Biological Survey, and Federal landowners in the watershed.

The Corps of Engineers has been involved in the Patuxent River Watershed since the late 1800's. Four Corps of Engineers projects are located within the Patuxent River watershed: the Nan Cove Navigational Channel, the Bristol Bar Navigational Channel, the Upper Marlboro Local Flood Protection project, and the Solomons Island Shoreline Protection project. Due to the impacts associated with these projects, tidal marshes, wetlands, submerged aquatic vegetation (SAV), riparian habitat, and oyster beds were lost or degraded.

The Patuxent River is the longest river located entirely within the state of Maryland. It is located between the metropolitan areas of Washington, D. C., and Baltimore, Maryland, and drains about 930 square miles of St. Mary's, Calvert, Charles, Anne Arundel, Prince George's, Howard, and Montgomery Counties. It flows in a south-southeasterly direction for

approximately 110 miles to its confluence with the Chesapeake Bay at Solomons, Maryland. Land use in the area is a mix of suburban development, industry, agriculture, Federal land, and open space.

The Patuxent River watershed has experienced significant negative changes in water and habitat quality over the last 50 years. Population in the area has more than doubled in that time and development in the counties along the river has increased: these have stressed the water resources, causing severe streambank and streambed erosion. This erosion, in turn, has resulted in degraded aquatic, wetland, and SAV habitat due to associated turbidity. These effects are felt not only at the source of the problem, but also for many miles downstream. As land and water resource management practices continue in the trend seen during the last 50 years, the characteristics that defined a healthy Patuxent River watershed will continue to be lost or will be substantially altered unless environmental and ecosystem restoration measures are implemented immediately.

In consideration of this study's authorization; the problems, needs and opportunities identified by stakeholders of the watershed; and the Corps of Engineers' construction authorities, five study elements were identified to guide the early information gathering and the plan formulation process: are (1) environmental restoration, (2) navigation, (3) flood damage reduction, (4) environmental infrastructure, and (5) recreation.

The primary objective of the watershed plan is to combine compatible and effective solutions that, when taken as a whole, would achieve the greatest overall benefit for the Patuxent watershed. The watershed plan consists of specific project features that can be implemented by various local, state, and Federal agencies. The plan addresses multi-purpose environmental solutions for the improvement of riparian, wetland, and aquatic habitat, improvements to water quality, recreation development, and flood damage reduction measures. It is a thorough representation of priority efforts within the Patuxent River, and should be viewed as a living document.

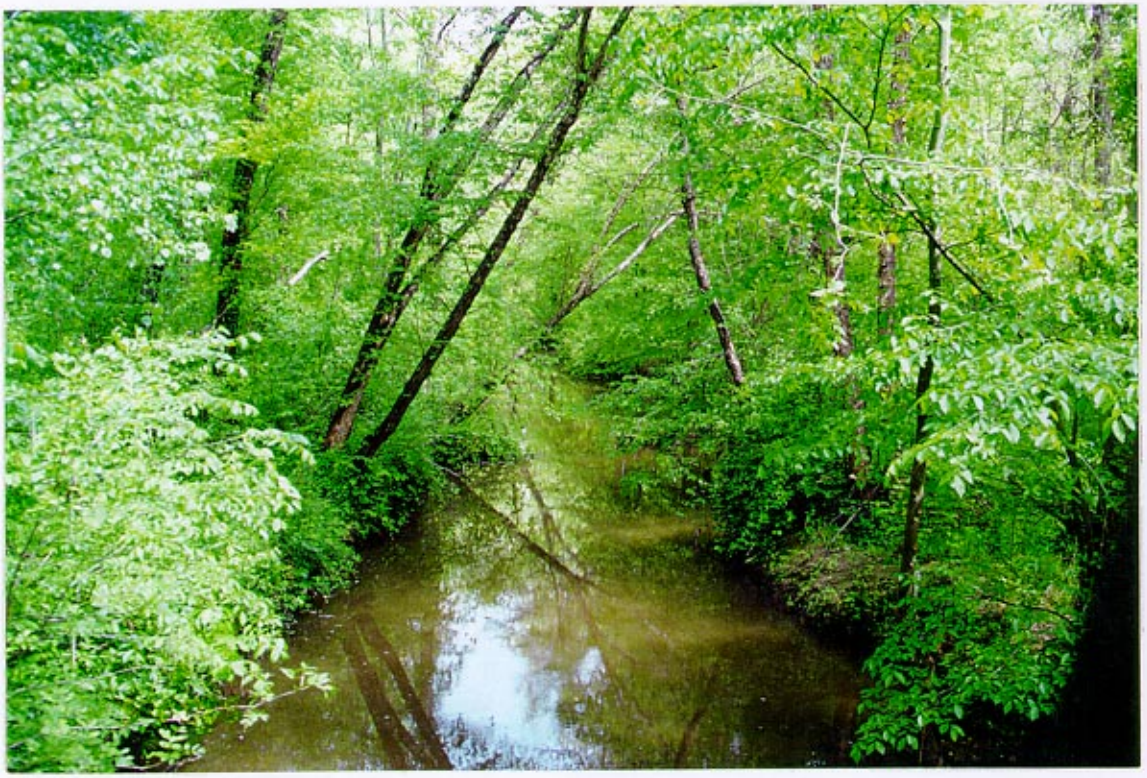
The Patuxent River watershed plan included in this report identifies approximately 100 projects and actions for implementation. These projects range from the construction of small stormwater management ponds to large-scale monitoring projects. Not all are in the Federal interest. Rather, some are project concepts to be implemented by local or State agencies. If all were implemented, there would be 25 streambank protection and restoration projects, 20 stormwater management facilities, 15 aquatic habitat enhancement projects, 5 wetland protection projects, 12 wetland creation projects, 6 riparian buffer creation projects, 15 recreational facilities projects, 2 *Phragmites* control efforts, 22 floodproofed homes, 1 flood attenuation pond, 7 shoreline erosion control projects, 1 packaged wastewater treatment facility, 2 oyster beds restored, and 2 SAV restoration projects. Benefits resulting from the implementation of all the projects identified in the watershed plan would be 107,280 acres of restored wetland, riparian, and aquatic habitat, and 455 miles of restored stream and river bed habitat,

To demonstrate the Corps' capability to restore the environmental quality of the Patuxent ecosystem, four sites were chosen to be prototypical projects, would receive more detailed analysis, schematic design concepts, and drawings. These four sites were viewed as representative examples of recurring problems experienced throughout the watershed. They demonstrate the problems of (1) inadequate stormwater management, (2) streambank erosion and degraded habitat due to inadequately managed stream flow, (3) habitat degradation--specifically, submerged aquatic vegetation, and (4) accelerated shoreline erosion and associated habitat degradation. The solutions developed for these sites will be widely applicable in the watershed, although adaptation would certainly be necessary for a specific site. These prototypical projects are not in final form, nor is the Corps necessarily selecting or committing to implement any of them. The reason for developing such projects was to demonstrate their tremendous potential elements of watershed restoration plans. There are many different measures that could be implemented beyond those identified in these prototypical examples.

The projects identified in the watershed plan, the prototypical projects, and the input from watershed stakeholders and potential non-Federal sponsors all indicate that the Corps of Engineers can play a significant role in the implementation of the watershed plan. Implementation of environmental restoration efforts in several priority sub-watersheds are in both the Federal and non-Federal interest, and would result in the most cost-effective ecosystem benefits to the overall study area. The Corps may also lead the construction effort under its Section 14 authority to provide emergency streambank stabilization at one site in the watershed, Corps-implementable water-related projects described in the watershed plan are anticipated to cost more than $200 million for construction. Likely restoration projects include wetland and submerged aquatic vegetation restoration; re-vegetation and stabilization of streams, streambanks, and riparian buffers; stormwater management improvement; and oyster bed restoration. The projects would restore approximately 77,000 acres and 360 stream miles of fish and wildlife habitat.

As part of implementation of the watershed plan, the Corps will also be involved in providing technical assistance to local entities. Technical assistance may be in the form of Floodplain Management Services or the Section 22 (Planning Assistance to States) program. Section 22 projects in the Patuxent River watershed may include development of Special Area Management Plans (SAMPs), as well as a Master Plan-type study of the conflicting water uses in the estuarine portion of the river. The cost for technical assistance is estimated at $950,000.

Former Senator Bernie Fowler, Chairman of the Patuxent River Commission, leads the June 1996 "wade-in" to monitor the environmental quality of the Patuxent River.



A typical tributary of the Patuxent River, illustrating degraded aquatic habitat associated with streambank erosion and turbidity.

Patuxent River Water Resources
Reconnaissance Study

ACKNOWLEDGMENTS

The Patuxent River watershed truly benefits more than many watersheds in the Chesapeake Bay from its knowledgeable, active, and cooperative stakeholders. Whereas the concepts of water resources planning, watershed approach to planning, or even ecosystem restoration may be new to stakeholders of other watersheds, those in the Patuxent River watershed often already had watershed plans, ideas, or at least direction to provide to the Corps of Engineers team. The stakeholders' wideranging knowledge of the watershed providede the base for much of this report. Again, we want to sincerely thank all stakeholders who were patient with us as we strived to grow in our own understanding of the watershed and its needs.

The study team would like to thank the numerous agencies and individuals who participated in this study, especially those who regularly attended our Coordinating Committee meetings and those who orchestrated the site visits of potential project sites throughout the watershed. Although it is not possible to identify by name all the individuals who have provided assistance in the development of this study, the Baltimore District would like to specifically acknowledge the assistance of the following individuals who provided important insights into the regional problems of the study area, as well as guidance in the identification of problem areas and individual projects.

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PATUXENT RIVER WATER RESOURCES RECONNAISSANCE REPORT

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Patuxent River Water Resources Study

Baltimore District

INTRODUCTION

The US Army Corps of Engineers, Baltimore District, initiated the Patuxent River Water Resources Study on February 1, 1995. The study was authorized by Congress, particularly through the efforts of Congressman Steny Hoyer (MD-05). In all its aspects, the study relied heavily upon available information and input from state, local, and other Federal agencies active in the study area.

1.1 STUDY AUTHORITY

The Patuxent River Water Resources Study is authorized by a House Committee on Public Works and Transportation Resolution, dated 28 September 1994. The relevant section of the resolution states the following:

> *The Secretary of the Army is requested to review the report of the Chief of Engineers on the Patuxent River, Maryland, published as House Document 463, Seventy-first Congress, Second Session, and other pertinent reports to determine whether modifications of the recommendations contained therein are advisable at the present time, with a view to conducting a comprehensive watershed management study in cooperation with other Federal agencies and instrumentalities thereof, for water resources improvements in the interest of navigation, flood control, erosion control, environmental restoration, wetlands protection, and other purposes.*

1.2 STUDY PURPOSE

There are numerous significant water resources related problems in the Patuxent River watershed. Much like other watersheds in the northeastern United States, the Patuxent River watershed is experiencing increasing urban and suburban development resulting in fish and wildlife habitat loss and degradation, overall environmental quality degradation, increased flooding, and erosion of stream and river banks. Based upon these conditions, this study was undertaken to identify water resources problems and their interrelationships, establish the needs of the Patuxent watershed, and identify opportunities to address these needs. Projects that reflect the interest of the Corps and are within the scope of existing Corps authorizations will be recommended for further study during the next study phase, the feasibility phase. The feasibility phase will provide more detailed analysis of possible alternatives, as well as further analysis of associated project costs and benefits. Important projects identified in this study that do not fall within the purview of the Corps are also recommended in this report, but other agencies or organizations will need to implement these efforts.

1.3 STUDY AREA

The Patuxent River Water Resources Study area is comprised of all the land that drains into the Patuxent River and its tributaries, as well as the actual water of the river and tributaries. The Patuxent watershed is comprised of portions of Anne Arundel, Charles, Howard, Montgomery, Prince George's, and St. Mary's Counties, as well as a small portion of Frederick County. The Patuxent River is approximately 110 miles long and drains an area of about 930 square miles directly into the Chesapeake Bay. The watershed is located between Washington, D. C., and Baltimore and includes a mix of urban and rural lands. The study area is depicted in Figure 1-1. Due to the minimal amount of land located in Frederick County that drains into the Patuxent River, there was limited coordination between the Corps and Frederick County, which follows the lead of the Patuxent River Commission.

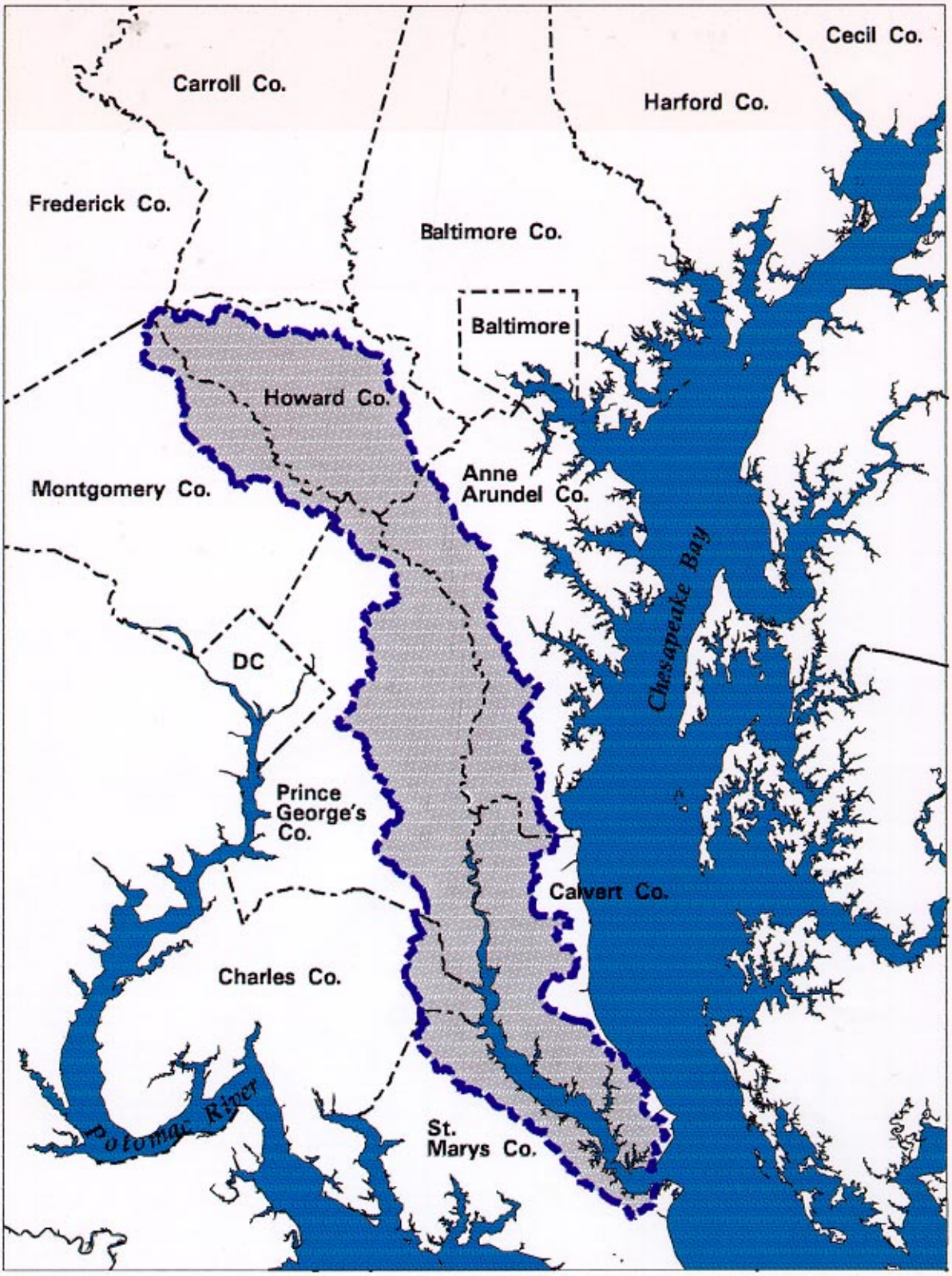
1.4 CORPS OF ENGINEERS' STUDY AND IMPLEMENTATION PROCESS

This study was conducted at the reconnaissance level and was fully federally funded. The reconnaissance study was performed to accomplish four tasks: (1) to identify problems, needs, and opportunities and potential solutions; (2) to determine whether more detailed investigations were warranted as part of a feasibility study, based on a preliminary appraisal of costs, benefits, environmental impacts, and consistency with Corps policies; (3) to develop an initial Project Study Plan (PSP); and (4) to assess the interest and capability of a non-Federal sponsor(s) to participate in a cost-shared feasibility study. In addition to the traditional Corps scope of a reconnaissance study, another purpose of this study was to identify all of the water resource problems and potential solutions, including any outside Corps authority. The objective was to develop a watershed plan for the region that, as a combined effort, Federal, state, and local agencies could implement.

The reconnaissance study depended primarily on information from existing sources, general site inspections, and rudimentary field and/or map measurements. No detailed field surveying, mapping, or subsurface exploration was accomplished for this investigation. Where information was not available, suitable assumptions were made based on standard environmental and engineering practice. Design, quantity, and cost estimates were based on typical cross-sections and generally accepted unit crests. The information that was gathered was used to facilitate comparisons among alternative projects and plans in the decision-making process. Detailed comparisons of plans, design of project features, assessment of environmental impacts, preparation of plans and specifications, and construction of projects will be accomplished in project phases subsequent to the reconnaissance study.

1.4.1 Corps' Four Step Process

The Corps of Engineers follows a four-step process for its Federal water resources projects. The planning process consists of two phases: a reconnaissance phase and a feasibility phase. The construction process also consists of two phases: the pre-construction, engineering and design phase (PED), and the construction phase. The reconnaissance phase, which is the phase of this study, utilizes existing information to analyze the water resources problems of the



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County Boundaries

Study Area

Figure 1-1

study area and to determine whether there would be both Federal and non-Federal interest in further detailed investigations. As stated previously, the reconnaissance phase is conducted at full Federal expense. During the subsequent feasibility phase, new data is collected and detailed analyses are performed to identify the best solution from economic, environmental, social, and engineering standpoints. The cost of the feasibility phase is shared equally between the Federal government and a non-Federal sponsor(s). The non-Federal sponsor(s) may include state, county, or local governments.

The following study process was used for the reconnaissance phase of the Patuxent River Water Resources Reconnaissance Study: (1) define existing conditions; (2) identify problems, needs, and opportunities in the study area; (3) identify potential solutions; (4) perform preliminary plan formulation, in which some alternatives are eliminated from further consideration: (5) identify alternatives to be considered in detail; (6) evaluate the potential impacts of each alternative; (7) estimate the alternative solutions' costs and benefits and determine whether one of the potential solutions is in the Federal interest; (8) identify a potential non-Federal sponsor for the potential solutions; (9) prepare a project study plan (PSP); and (10) negotiate the feasibility cost-sharing agreement (FCSA). The PSP describes the tasks required during the feasibility study and the corresponding costs. The FCSA lays out the management structure and financial obligations that both the Federal government and the non-Federal sponsor(s) agree to execute. This report contains a summary of the investigations, results, conclusions, and recommendations of this study process, which was initiated in February 1995.

The feasibility phase will undertake more detailed examinations of solutions to identify environmental restoration opportunities within the Patuxent River watershed. The feasibility study is cost-shared, with 50 percent of funds coming from the non-Federal sponsor. The feasibility study process is complex, but can be summarized as follows: (1) prepare detailed design using new, updated information; (2) evaluate specific engineering, environmental, and economic effects; (3) identify the optimum project from both a Federal and non-Federal perspective; and (4) recommend one alternative for construction. If a project is recommended, the feasibility report would then be submitted to the U.S. Congress for project authorization. The feasibility study is currently scheduled to be initiated in July of 1997 and completed in July 2000.

The third and fourth phases are the PED phase and the construction phase. If Congress authorizes construction of the project, the final engineering and design are performed, and construction plans and specifications are completed during the PED phase. Actual project construction follows the PED phase. The PED and construction phases are cost-shared 25 percent by the non-Federal sponsor and 75 percent by the Federal government for most types of projects (environmental restoration, flood damage reduction).

1.4.2 Public Involvement

The purpose of the public involvement program was twofold. First and foremost, the program was used to keep the public informed as to the progress of the study and to ensure that public

interests and needs were identified to the Corps. Second, as a scoping mechanism, the program provided the study team information about data sources, local and agency contacts, specific problem areas, and specific projects that the local sponsors have implemented.

Due to the significant interest of the public and various agencies in the development of the study area, coordination with the Patuxent River Commission and with local, state, and Federal agencies was an important part of the study. Public involvement was geared toward informing the public, government agencies and elected officials of the study; collecting input on problems, needs, and opportunities; and identifying specific projects.

1.4.2.a. Relationship To Planning Process: The study was formally initiated on February 1, 1995. Coordination letters were sent to congressional interests, appropriate resource agencies, state and local governments, and previously identified interested parties to announce the initiation of the study and to solicit relevant information.

The public involvement program included formal discussion with interested parties as well as informal discussion. The information gained through these discussions was invaluable and ultimately determined the findings of the reconnaissance study.

Numerous agencies participated in the public information program. The participants provided insights into local conditions and issues and identified potential solutions to known problems. They often had access to unpublished information on the study area and were informed about various plans and issues that were not commonly known. The data gathered and relationships formed as part of the public involvement program added to success of the reconnaissance study.

1.4.2.b. Structure Of Program: The purpose of the program was achieved through a variety of approaches including the following:

i. Initiation Meetings: Initiation Meetings were held in June through August 1995 with all county, state, and Federal agencies and Federal landowners in the watershed to present the study, explain the Corps reconnaissance process, describe the end product, and get input and resources from these agencies.

ii. Patuxent River Commission: The Corps briefed the Patuxent River Commission at their July 1995 meeting. This presentation was similar to the initiation meeting in describing the study, study process, description of the end product, and solicitation of input and information on the watershed. Beginning in October 1995, the Corps of Engineers became a member of the Patuxent River Commission, and in that capacity, has attended and participated in each monthly meeting of the Commission. It should also be noted that in October 1995, the Patuxent River Commission took on the designation and responsibility of being the Patuxent River Tributary Strategy Team.

iii. Coordinating Committee: Given the variety of problems, needs, and opportunities

in the study area as well as a desire to use the extensive knowledge of the stakeholders and agency representatives, a multi-agency team was developed named the Coordinating Committee for the Corps' Patuxent River Water Resources Study. Following the recommendations of watershed stakeholders, the Coordinating Committee was developed as an adaptation of the existing Technical Sub-Committee of the Patuxent River Commission. The creation of the multi-agency Coordinating Committee was essential to incorporate the extensive knowledge shared by watershed stakeholders and agency representatives, and, more importantly, to achieve buy-in and ownership of the study by the key stakeholders and agency representatives. The Committee served as a sounding board to review study progress, identify potential projects, gather input, formulate methods by which study efforts could be accomplished, and discuss any issues relevant to the study, including SAMPs and septic issues. The Patuxent River Commission Technical Committee was a very useful base from which to develop the Corps' Coordinating Committee, since the Patuxent River Commission and its subcommittees include representatives from all seven counties, as well as from state agencies and other entities. The Coordinating Committee included, but was not limited to, representatives from the seven counties in the watershed, from the five state agencies (MD Office of Planning, Maryland Department of Agriculture, MD Department of the Environment, MD state Highway Administration), from Maryland-National Capital Parks and Planning Commission, from the Washington Suburban Sanitary Commission, from the EPA Chesapeake Bay Program, from three research labs located within the watershed, from the Jug Bay Wetlands Sanctuary, from the Soil Conservation Districts, from the U.S. Geological Survey, from the U.S. Fish and Wildlife Service, from the National Biological Survey, and from Federal landowners in the watershed. The Technical Subcommittee of the Patuxent River Commission met every month and when the Technical Committee's business was finished, the meeting would proceed with the Corps' Coordinating Committee's business.

iv. Site Visits: Site visits were conducted with county representatives and Soil Conservation Districts during the period of August through November 1995, to identify problems and potential projects throughout the watershed.

v. News Bulletin: One news bulletin was prepared during the study process to discuss a variety of issues and answer potential questions. The bulletin was distributed in August 1995 to announce the study, provide important background information, and request public participation.

vi. Federal Agency Coordinating Committee (FACC): The study managers briefed the FACC on the study purpose and process to gain input and cooperation from Federal landowners in the watershed.

vii. Coordination Meetings with Federal Landowners in the Watershed: The Federal Facilities Coordinators visited with representatives of each Federal landowner in the

watershed to gain an understanding of the existing conditions of the facilities, as well as to gather input regarding problems, needs, and opportunities for the continued management of the facilities. Once all the information was compiled into a report, the report was circulated to facility representatives to verify its accuracy.

1.5 PRIOR AND ONGOING STUDIES, REPORTS, AND PROJECTS

1.5.1 corps of Engineers studies

The Corps of Engineers has conducted numerous studies in the Patuxent River watershed. The following is a chronological summary of these efforts:

1.5.l.a. Bristol Bar And Swan Point Reports (1886 -1979): Thes internal reports document the history of the navigation dredging at Bristol Bar and Swan Point.

1.5.l.b. Patuxent River Water Supply Reports (1908-1912): These internal reports document the investigation of the Patuxent River as a potential water supply for the District of Columbia.

1.5.l.c. Basin Plan: Patuxent River, Maryland (1961): This brief report presents basic statistics and information on population, physical and economic environments, water supply, pollution abatement, flood control, recreation, fish and wildlife, hydropower, wetlands drainage, irrigation, navigation, and salinity control present in the Patuxent River watershed at that time. The report recommended the development of a comprehensive plan for the watershed.

1.5.1.d. Nan Cove Reconnaissance Report (1962): This reconnaissance report on the need for navigation improvements in Nan Cove, Calvert County, was prepared by the Corps in accordance with Section 107 of the Rivers and Harbors Act of 1960. The report recommended construction of “an entrance channel, 40 feet wide and 6 feet deep with l-foot overdepth, from the 6-foot depth contour in the Patuxent River to and including an anchorage basin, 140 feet wide and 200 feet long in Nan Cove.”

1.5.1.e. Review Report On Flood Control And Allied Purposes, Patuxent River And Tributaries, Maryland (1975): This report stated that “structural or non-structural improvements in the interest of flood control and allied purposes in the Patuxent River Basin, Maryland, are not economically feasible at this time.” The Corps also found that future flood damages could be reduced by appropriate flood plain management techniques. Accordingly, the Corps’ report recommended that Federal participation in structural or non-structural improvements in the interest of flood control and allied purposes was not advisable.

1.5.1.f. Chesapeake Bay Shoreline Erosion Feasibility Study (1989): The purpose of the Chesapeake Bay Shoreline Erosion Study was to evaluate shoreline protection measures

that would protect both land and water resources of the Chesapeake Bay from the adverse effects of continued erosion. Within this broad study purpose, several major study objectives were established. These study objectives were as follows:

- To define the magnitude, location, and effect of shoreline erosion problems around the Chesapeake Bay and its tributaries,

- To examine the range of solutions, both structural and non-structural, that are suitable for the different types of shoreline erosion problems found within the study area.

- To evaluate the effectiveness of certain shoreline protection strategies under actual Chesapeake Bay conditions.

- To recommend specific erosion control projects or measures, if economically and environmentally justified.

- To determine the respective responsibilities of Federal, state, and local agencies for implementing the recommended projects.

While the Corps' earlier comprehensive Chesapeake Bay Study addressed shoreline erosion from a Bay-wide perspective, this study was an effort to conduct detailed evaluations and screenings of the identified critical areas for problem extent and potential solutions. As such, this study was part of the Federal government's continuing commitment to preserve the Chesapeake Bay's resources.

The study area encompasses the Chesapeake Bay and its tributaries to the head of tide. Tidewater counties and communities bordering the Bay included portions of Delaware, Maryland, Virginia, and Washington, D.C. The Chesapeake and Delaware C&D Canal was not included in the study area except to the extent that Canal operation affects shoreline erosion processes in the upper Chesapeake Bay.

The first detailed site investigation was conducted to determine the feasibility of providing shoreline protection for 500 feet of shoreline on Solomons Island in Calvert County, Maryland. At the time of the investigation, a corroding steel sheetpile bulkhead was protecting Maryland Route 2, Solomons Island Road, immediately adjacent to the site. During the reconnaissance study, it was determined that the imminence of failure of the bulkhead supporting the roadway warranted immediate action. Therefore, a Section 14 study was undertaken. The study was officially requested by the state of Maryland Department of Transportation.

To address the Solomons Island problem, three alternative plans were investigated in detail. The first plan examined constructing of a timber bulkhead along the 500-foot reach, about 5 feet seaward of the existing bulkhead location, with fill placed between the old and new bulkheads. The second plan involved constructing a steel sheetpile

bulkhead, also 5 feet seaward of the existing bulkhead and with intermediate fill. The third plan involved constructing a stone revetment along the 500-foot reach. For additional stability, fill material would be placed in front of the existing bulkhead structure, with the filter fabric, filter stone, and armor stone of the revetment placed on top.

The stone revetment plan was recommended for implementation at the Solomons Island site, under Section 14 of the Continuing Authorities Program.

1.5.1.g. Reconnaissance Study Of Solomons Island Harbor, Calvert County (1989): This study was done under the authority of Section 107 of the Rivers and Harbors Act of 1960 to determine the feasibility of providing storm wave protection for Solomons Island Harbor. The report identified a potential project, a floating concrete breakwater, to eliminate approximately 90 percent of the damages occurring to boats, piers, and bulkheads.

A draft feasibility report for the Solomons Island project was prepared and submitted to North Atlantic Division (CENAD) in October 1991. The Draft Feasibility Report identified two viable solutions to the navigation problems at Solomons Harber a rubble mound breakwater east of the harbor entrance, and a floating breakwater at the north side of the entrance. The rubble mound breakwater was the recommended plan.

A draft Local Cooperation Agreement (LCA) for the Solomons Harbor project was provided to Calvert County. Upon review of the draft LCA, the county indicated that they no longer desired to sponsor the project. Without a local sponsor, this project is currently static.

1.5.2 Corps of Engineers Projects

The following is a chronological listing of Corps projects in the Patuxent River Watershed.

1.5.2.a. Swan Point Bar Navigation Dredging: Funds were authorized by Congress in 1890 to dredge at Swan Point bar. A channel 9 feet deep and 132 feet wide was dredged in 1891. Approximate length of this channel is estimated at 1,500 feet, with an estimated area of 4.5 acres.

1.5.2.b. Bristol Bar Navigation Dredging: As referenced in *House Document 170, 56th Congress 1st Session*, a "channel 12 feet deep and 120 feet wide extending from the 12-foot contour at the lower end of the bar to a point about 250 feet above the steamboat wharf" was dredged at Bristol Bar in 1889. Approximate length of this project was 1,000 feet and covered approximately 3 acres. Initial dredging was done to 12 feet; however, the project depth downstream of Bristol was modified to 9 feet.

The Corps made improvements to the Bristol bar project in 1899, including dredging a 100-foot by 300-foot channel to a depth of 10 feet at low water, and creating a 300-foot by 400-foot turning basin. Based on this report, the improvements impacted approximately 4 acres.

The report estimated that approximately 35,000 cubic yards of material was dredged, and it is assumed that this material was placed on barges and towed/pulled towards shore where a dredge bucket removed it and placed it along the shoreline. It is believed that at least some of the material was sidecast, as this was a standard practice at the time. The sizes of fill and sidecast areas are not available.

Funds were allocated by Congress in 1902, and were expended for dredging at Bristol bar in 1904. The dredging produced a channel 100 feet wide and 10 feet deep, and a turning basin about 240 feet wide, 350 feet long, and 10 feet deep. This activity impacted approximately 3.5 acres. Dredge material placement sites and quantities associated with this effort are not known.

The existing Bristol Bar project was completed in 1979, providing a channel 10 feet deep and 100 feet wide through the Bristol Bar (mile 47.5), with a turning basin 240 feet and 350 feet long at Bristol Landing. The remaining dredging of the turning basin to full project dimensions was deauthorized in November 1979.

1.5.2.c. Upper Marlboro Local Flood Protection: The Corps initiated a local flood control project at Upper Marlboro in 1963, under authority of Section 205 of the Flood Control Act of 1948 (P.L. 80-858). This project consists of the improvement of 4,025 feet of channel, the construction of 1350 feet of earth levee and 160 feet of floodwall, the raising of a highway bridge, the clearing of 4,430 feet of floodway, and the construction of appurtenant structures on the Western Branch. On the Collington Branch, the project includes 1,335 feet of channel improvement, 500 feet of levee, 150 feet of floodwall, addition of a span to the old state Rte. 202 bridge, instruction of a combined railroad and highway bridge, and other appurtenant structures. The project provides protection against a flood discharge of 6,800 cubic feet/second (cfs) on the Western Branch, and 3,500 cfs on the Collington Branch. Prince George's County Department of Public works is responsible for operation and maintenance.

1.5.2.d. Nan Cove Navigation Dredging: The Nan Cove reconnaissance report, written in 1962, led to the Nan Cove dredging project. The dredging was completed in 1965, impacting approximately 2.5 to 3 acres. Coordination letters with resource agencies and project mapping indicate that dredged material was placed in marsh areas adjacent to the channel. Approximately 21,300 cubic yards was dredged at that time, impacting approximately 7.3 acres of tidal marsh, eliminating approximately .1 acre of marsh, and hardening approximately 100 feet of shoreline with bulkheads.

A reconnaissance survey for maintenance of the Nan Cove project was completed in 1983 and recommended further dredging. Maintenance dredging of the Nan Cove project was completed in 1985, providing an entrance channel 40 feet wide, 2,045 feet long, and 6 feet deep, and an anchorage basin of the same depth, 150 feet wide and 190 feet long. Overall project size is 2,195 feet by 750 feet, or approximately 3.8 acres.

1.5.2.e. Solomons Island Emergency Shoreline Stabilization: The Corps constructed a stone revetment in 1993, to protect the roadway at Solomons Island under Section 14 of the Flood Control Act of 1946, as amended, which authorizes the Corps to develop and construct emergency streambank and shoreline protection projects to protect endangered roadways and other public facilities.

1.5.2.f. Chesapeake Bay Oyster Recovery Project, Maryland: Oyster populations in the Chesapeake Bay have declined dramatically since the turn of the century, largely due to parasitic diseases, overharvesting, and a loss of habitat. Oysters, which are filter feeders, improve water quality in the Chesapeake Bay, and oyster bars provide valuable habitat for fish, blue crab, and other species. Oyster landings in Maryland have decreased from 1,557,090 bushels in 1986 to 164,300 bushels in 1995.

Section 704(b) of the Water Resources Development Act of 1986 authorized the Corps of Engineers to conduct projects of alternative or beneficially modified habitats for indigenous fish and wildlife, including man-made reefs for fish habitat in the Maryland portion of the Chesapeake Bay. The Energy and Water Appropriations Bill of 1995 provided directive language for the Corps to carry out a project to improve oyster populations in the Maryland portion of the Chesapeake Bay and provided implementing Construction General Funding.

The Baltimore District, in cooperation with the Maryland Department of Natural Resources (Maryland DNR), other agencies, educational institutions, and interested individuals, developed the Chesapeake Bay Oyster Recovery Project. The project presented in this report is a multi-year plan of integrated activities. The recommended plan includes elements of the Maryland Oyster Roundtable Action Plan that could be implemented by the Corps and that are in the Federal interest.

Project activities proposed over a 5 year period will include the following: upgrading of state-owned hatcheries at Piney Point and Horn Point, creation of new oyster bars and rehabilitation of existing non-productive bars, construction of seed bars for production and collection of seed oysters or “spat,” planting of hatchery-produced spat and spat harvested from seed bars on new and rehabilitated bars, and monitoring of implemented projects. Monitoring of project activities will continue for 3 years after implementation. Project activities are planned to occur within Oyster Recovery Areas (ORAs) established by the Maryland Oyster Roundtable Action Plan in the Severe, Nanticoke, Chester, Choptank, Patuxent, and Magothy Rivers, and potentially in other Maryland waters of the Chesapeake Bay. Oyster Recovery Areas may be seen in Figure 1-2.

Dependent on signing of the Project Cooperation Agreement (PCA) in the summer of 1996 and provision of future funding, implementation of the first construction activity, upgrading of the hatcheries, is scheduled for the fall of 1996. Aquatic activities are scheduled to occur from the spring of 1997 through 2000. Monitoring is scheduled to continue through 2003.

1.5.3 Other Projects and Studies

The Patuxent River watershed has been the subject of studies and investigations by numerous Federal, state, and local resource agencies, planning groups, and environmental organizations. Due to the extensive nature of publications, reports, and studies regarding the watershed, it is not possible to provide an exhaustive bibliography in this section. The following list identifies some of the more relevant efforts related to the water resources in the Patuxent River watershed, listed by agency and date. Specific technical studies and reports used in this reconnaissance study are referenced in the bibliography. A complete listing of the organizations and groups working in the Patuxent River watershed is provided in Section 1.6.

CHESAPEAKE BAY PROGRAM (CBP)

"Basin Characterizations." in: *Basin-specific Characterizations of Chesapeake Bay Living Resources Status.* 1994.

Habitat Requirements for Chesapeake Bay Living Resources. 1991.

MARYLAND-NATIONAL CAPITAL PARK AND PLANNING COMMISSION (MNCPPC)

Functional Master Plan for the Patuxent River Watershed, Montgomery County. 1993.

Patuxent River Watershed, Montgomery County, Technical Report. 1990.

MARYLAND DEPARTMENT OF NATURAL RESOURCES (Maryland DNR)

Monitoring Plan for Aquatic Living Resources in the Patuxent Drainage Basin, CBRM-BA-94-1. 1994.

Ecosystem Models of the Patuxent River Estuary, CBRM-GRF-94-2. 1994.

Maryland Biological Stream Survey Report, CBRM-AD-93-1. 1993

Compilation of Aquatic Living Resources Data for the Fluvial Reaches of the Patuxent Drainage System, CBRM-HI-93-1. 1993

Assessment of Chesapeake Bay Benthic Macroinvertebrate Resource Condition in Relation to Water Quality and Watenshed Stressors. CBRM-GRF-94-3. 1993.

Review of Patuxent River Estuary Data Base, Final Report, UMCEES 78-157 CBL. 1978.

MARYLAND DEPARTMENT OF THE ENVIRONMENT (MDE)

Maryland Water Quality Inventory, 1991-1993. 1994

Draft Tributary Strategy for Nutrient Reduction in Maryland's Patuxent Watershed. 1994

Maryland Tributaries Strategies: Restoring the Patuxent Watershed. 1994.

Maryland Tributaries Strategies: Focus on the Patuxent. 1993

MARYLAND OFFICE OF PLANNING (MOP)

Draft Patuxent Watershed Demonstration Project Phase I Interim Guidance Document. 1994.

Annual Report of the Patuxent River Commission, 1992, Publication No. 93-06. 1993.

Patuxent River Commission Action Program, 1991-1992. Publication No. 91-10. 1991.

Patuxent River Commission: Progress Report, 1980-1986. Publication No. 87-6. 1987

Patuxent River Policy Plan: Land Management Strategy. Publication No. 83-21. 1984.

PATUXENT RIVER COMMISSION

Senate (Md.) Bill 791. Patuxent River Commission - Tributary Strategy Implementation. February 16, 1995.

Patuxent Estuary Demonstration Project Rough Draft Interim Guidance Document. 1993.

Patuxent Estuary Demonstration Project Summary. undated.

ANNE ARUNDEL COUNTY

Patuxent River Policy Plan, Progress Report. 1995.

Patuxent Estuary Demonstration Project, Towsers Branch Retrofit. 1994

Towsers Branch Water Quality: Monitoring Success of Nonpoint Pollution Retrofit Measures in a Suburban Watershed. 1990

CALVERT COUNTY

Solomons Harbor Study, UMCEES 94-035 CBL. 1993

Draft Hunting Creek Watershed Management Plan. 1993

1.6 INSTITUTIONAL ANALYSIS

Federal and state agencies, and local organizations and workgroups are very active in the Patuxent River watershed in regards to environmental restoration and preservation. A summary of major contributors in the Patuxent watershed is included in this section. Appendix A details state and Federal laws and policies pertaining to riparian forests, wetlands, and agricultural land.

1.6.1 Patuxent River Commission

The Patuxent River Commission has been in existence for more than 15 years. This commission was established to facilitate, and be a catalyst for, the improved health of the Patuxent River watershed. To accomplish this mission, the Commission developed an action agenda to serve as a guide for the activities of state agencies, local governments, private interests, and citizens with responsibilities to manage, protect, and restore the resources of the watershed. Another goal of the Commission is to tailor the draft Patuxent Tributary Strategy to reflect the varying and changing conditions in different geographic parts of the watershed. The Patuxent River Commission promotes and sponsors many demonstration projects in an effort to restore the watershed.

1.6.2. Maryland Tributary Strategy

The Maryland Tributary Strategy is strongly linked to the Chesapeake Bay Program efforts. Reducing the profound impact of excess nutrients on the inhabitants of the Bay waters was the centerpiece of the 1987 Chesapeake Bay Agreement, a compact among the states of Maryland, Virginia, Pennsylvania, the District of Columbia; the Environmental Protection Agency; and the Chesapeake Bay commission. Maryland has assigned a 40 percent reduction goal for each of its 10 tributaries by the year 2000. This 40 percent reduction applies to point and non-point sources of nitrogen and phosphorus.

1.6.3. Other Stakeholders

1.6.3.a. Chesapeake Bay Program (EPA): SAV monitoring is conducted in the Patuxent River on a yearly basis, as part of the Bay-wide SAV survey. Aerial and ground techniques are used to create maps and species lists of SAV in the Bay and major tributaries. These maps and lists are compiled into annual reports on the status of SAV in the Chesapeake Bay.

1.6.3.b. Maryland Department of the Environment (MDE): MDE has the most diverse water related monitoring program in the watershed.

i. Through its shellfish certification program, MDE monitors water quality at 30 stations in the tidal portion of the river. Each station is sampled twice monthly for fecal coliform, and 14 of the stations additionally test pH, salinity, temperature, and dissolved oxygen levels. This information not only assesses the safety of consuming shellfish from the river, but also provides a comprehensive database for any other monitoring effort in the river.

ii. Physio-chemical sampling is done, in cooperation with USGS, at three CORE stations on Hunting Creek and Killpeck Creek, Western Branch, and the Little Patuxent River near Savage. These stations monitor 27 water quality parameters.

iii. Bay Tributary sampling is done at one station on the Patuxent near Bowie, and one station on the Western Branch. These stations measure 20 water quality parameters.

iv. NPDES stormwater drain sampling is performed by MDE as needed to conform to NPDES regulations.

v. Benthic macroinvertebrates are sampled at 33 stations throughout the non-tidal portion of the watershed. These stations are sampled every other year (even), and provide data for long-term trend analysis.

vi. Fish tissue toxicity sampling is done at two of the CORE stations and in the two reservoirs in the fall of each year. Whole fish and fillets are sampled for heavy metals, chlorinated hydrocarbons, arsenic, and pesticides.

vii. Chesapeake Bay monitoring occurs in the estuarine portions of the River. There are currently four stations (two at Broomes Island, one at Chalk Point, and one at Jug Bay) that monitor benthic macroinvertebrates and depth, salinity, temperature, dissolved oxygen, and sediment type. This ongoing effort produces regular monitoring reports for the Chesapeake Bay Program.

See Appendix B for more information on these programs. These efforts provide valuable information to decision-makers regarding any additional steps necessary to meet the Patuxent's tributary strategies for nutrient reduction goals.

1.6.3.c. U.S. Geological Survey: The USGS, in addition to monitoring water quality in conjunction with MDE, operates a National Stream Quality Accounting Network (NASQUAN) station on the Patuxent River mainstem near Bowie. Samples are taken twice a month, and base and storm flow are sampled automatically. Data is collected a the station for a wide

variety of water quality parameters, including limited toxics monitoring. See Appendix B for more information on this program.

USGS also operates 12 active continuous stream gages in the watershed, and several partial flow stations where peak or low flow is measured.

1.6.3.d. Maryland Department of Natural Resources (Maryland DNR): Maryland DNR is involved in fish community sampling as part of their Patuxent Special Area trout monitoring program. Four stations upstream of the Triadelphia Reservoir are sampled yearly, and other locations in the upper watershed are sampled occasionally. There are also a number of sampling programs in effect in the tidal portion of the river for anadromous and commercially important adults and juveniles.

1.6.3.e. Washington Suburban Sanitary Commission (WSSC): WSSC is responsible for monitoring six streams that flow into the Rocky Gorge and Triadelphia reservoirs, as well as one site in Laurel, downstream of the reservoirs. Nutrients and sediments are sampled at these stations once a month. The stations also monitor pesticides on a monthly basis. A total of 17 parameters, 5 of which are specific pesticides, are tested each month. See Appendix B for more information on this program.

1.6.3.f. U.S. Fish and Wildlife Service (USFWS): The USFWS has recently completed a coastal area survey of the distribution and abundance of *Phragmites,* an invasive plant species, in the Patuxent. The effort thus far has mapped locations of *Phragmites* colonies along the shoreline of the Patuxent.

1.6.3.g. Local Efforts: Locally sponsored flood warning programs in Prince George's and Howard Counties measure streamflow.

i. The Maryland-National Capitol Parks and Planning Commission (MNCPPC) and the Jug Bay Wetlands Sanctuary in Anne Arundel County monitor SAV in the middle sub-watershed of the mainstem and associated tributaries. This is done qualitatively on a yearly basis.

ii. Citizens, under the guidance of USFWS and the Chesapeake Bay Foundation, are involved in SAV monitoring at numerous random sites in the estuarine portion of the Patuxent.

iii. Howard County has a citizens monitoring program for benthic macroinvertebrates at 20 to 25 stations in the county. Sampling at these locations is done on an annual basis, under the guidance of the Department of Recreation and Parks.

iv. Montgomery County Departments of Environmental Protection and Parks have been collecting biological and habitat data in the Upper Patuxent sub-watershed. These county agencies are currently analyzing the data collected through these

efforts.

More information on these programs can be found in Appendix B.

1.6.3.h. Oyster Recovery Program: This program is being conducted by Maryland DNR, the Corps, the Chalk Point Power Plant, and the local Watermen's Association. The Patuxent River has a proposed oyster recovery area (ORA) in the tidal portion that includes two 5-acre habitat enhancement sites. Efforts are underway to complete the design and to begin construction of these sites.

Maryland DNR has also completed construction of small artificial reefs in the mouth of the Patuxent for oysters and fish. These reefs are created of various materials, including rubble, fiberglass, and floating structures. These efforts have shown some success; however, there are no immediate plans for future reef construction in the Patuxent.

1.6.3.i. Anadromous Fish Restoration: This is a multi-faceted approach by Maryland DNR to restore anadromous fish to the Patuxent. In addition to the artificial reefs mentioned above, which provide some habitat for anadromous and resident fish, Maryland DNR is involved in fish blockage removal. Recent reports on this effort indicate that final engineering plans for the breaching of the Western Branch Darn and removal of Horsepen Dam have been completed.

Other Maryland DNR efforts include stocking of American shad and striped bass, in the hopes that the fish will eventually re-colonize the river.

1.6.3.j. PEPCO's Chalk Point Power Plant: This power plant is a very large user of water (for cooling purposes) on the Patuxent River, and is the largest power generator in Maryland. The Potomac Electric Power Company (PEPCO) has worked extensively with the Maryland DNR Power Plant Program to mitigate environmental impacts from the plant, including the loss of fish eggs and larvae that are sucked into the cooling system. The company provides funds to Maryland DNR for fish passage mitigation and has a large forest conservation easement with a public nature trail on the property. In addition, their fish sampling data provides useful baseline information for various reports and studies. The most noticeable activity undertaken by the company is the fish hatchery, located north of Benedict. This hatchery has been instrumental in the restoration of striped bass to the watershed, and is currently helping to stock American shad.

1.6.3.k. Maryland state Highway Administration (MD-SHA): The Intermodal Surface Transportation Efficiency Act enables states to distribute funds for improvement of environmental and recreational resources associated with transportation. MD-SHA is allotted between $5.7 and $6.5 million every year to create bike paths, greenways, wetlands, and other environmentally and recreationally positive features.

1.6.3.1. Maryland Department of Agriculture (MDA): The MDA provides cost-sharing for conservation practices and works in conjunction with the Soil Conservation Service (SCS).

1.6.3.m. Soil Conservation Service (SCS)/National Resource Conservation Service (NRCS): The SCS may provide technical assistance to state agencies and local units of government in carrying out works of improvement to utilize the land and water resources most effectively; it also provides cost-sharing for conservation practices. The SCS goals are to encourage and improve the capability of state and local units of government and local non-profit organizations in rural areas to plan, develop, and carry out programs for Resource Conservation and Development (RC&D).

1.6.3.n. Alliance for the Chesapeake Bay: The Alliance for the Chesapeake Bay is a nonprofit educational program. This group is made up of biologists, ecologists, and other scientists, and serves as a peer review for technical work, and as a public outreach and education provider for groups working within the Chesapeake Bay watershed.

1.6.3.o. National Oceanic and Atmospheric Administration (NOAA): This organization funds research and coordinates directly with the state/Federal Chesapeake Bay program on issues related to living resources, habitat restoration, and coastal zone management.

1.6.3.p. Merkle Wildlife Sanctuary: This 1,670-acre preserve encompasses marshes, old fields, and forests in southern Prince George's County. It is primarily maintained by Maryland DNR for overwintering habitat for Canada geese.

1.6.3.q. Jug Bay Wetlands Sanctuary: This sanctuary was established in 1985, and is operated by the Anne Arundel County Department of Recreation and Parks. The sanctuary seines as a wetlands research and environmental education facility, and is a component of the Chesapeake Bay National Estuarine Research Reserve in Maryland.

1.6.3.r. Patuxent Wildlife Research Center: The Patuxent Wildlife Research Center was established on December 16, 1936 on approximately 2,700 acres by an Executive Order of President Roosevelt as the Nation's first wildlife experiment station. Over time, land acquisitions and transfers to the Refuge have expanded its size to the current 12,750 acres. The main mission of the refuge, which determines the management strategies of the property, is wildlife research. The United States Fish and Wildlife Service (USFWS) owns and manages the wildlife refuge, while the National Biological Service employs and manages the research on the refuge.

1.6.3.s. Center for Environmental and Estuarine Studies (CEES) - Chesapeake Biological Laboratory: This marine laboratory, founded in 1920 and located on Solomons Island, is operated by the University of Maryland. It was founded in 1973, and has an annual budget of $16 million. The center offers graduate classes and environmental education programs and events, while the laboratory performs environmental research on the areas of fisheries and wildlife management, aquiculture, coastal oceanography, aquatic pollution and toxicology, ecological economics, and restoration of disturbed habitats. Some of the most important research at the facility includes studies dealing with the effects of nutrient and sediment loading, chemical pollutants, and overfishing.

1.6.3.t. Federal Facilities: Federal ownership within the watershed totals 4 percent, consisting of 10 Federal facilities representing 7 Federal agencies/departments: Departments of Air Force, Army, Navy, and Agriculture; Federal Communication Commission; National Aeronautics and Space Administration; and United States Fish and Wildlife Service. All facilities are located in the middle segment of the Patuxent watershed, with the exception of the Patuxent River Naval Air Station and Solomons Annex, which are located near the mouth of the Patuxent River.

SECTION 2

EXISTING CONDITIONS

2.1 PHYSICAL SETTING

2.1.1 Location

The Patuxent River watershed study area is located between the metropolitan areas of Washington, D. C., and Baltimore, Maryland. English settlers named the river after the Patuxent tribe. The watershed drains about 10 percent of the land area in Maryland; 930 square miles of St. Mary's, Calvert, Charles, Anne Arundel, Prince George 's, Howard, and Montgomery Counties, and a small portion of Frederick County.

The head of the Patuxent is located in north-central Maryland near Paris Ridge, at an elevation of 242 meters (MGD). It flows in a south-southeasterly direction for approximately 110 miles to its confluence with the Chesapeake Bay at Solomons, Maryland. The State of Maryland defines the upper limit of tidal waters in the Patuxent watershed as occurring at Hills Bridge, near Upper Marlboro. The Patuxent River is the largest river contained wholly within Maryland.

The Patuxent River has been designated as one of Maryland's Scenic Rivers by the Maryland General Assembly, in conjunction with the Scenic and Wild River Review Board. This designation is intended to preserve and protect the natural values of the river. U.S. Senator Barbara Mikulski won designation of the Patuxent River as a National Estuarine Demonstration Project, ensuring additional support for new research opportunities in watershed restoration.

In 1980, the Maryland General Assembly enacted the Patuxent River Watershed Act. The act established the Patuxent River Commission, which is composed of representatives of the seven watershed counties; the Tri-County Council for Southern Maryland; the Office of the Governor; the State Secretaries of the Departments of Agriculture, Environment, Natural Resources and Health and Mental Hygiene; the Maryland Office of Planning; the municipalities of Bowie and Laurel; and the Maryland Association of Soil Conservation Districts.

The duties of the commission include overseeing and evaluating implementation of the Patuxent River Policy Plan, providing a clearinghouse for information on the Patuxent River and its watershed, and reviewing and commenting on plans and reports related to the river.

In February 1995, a bill was introduced into the Maryland legislature to further expand the membership and responsibilities of the Patuxent River Commission. This expansion will add representatives from watershed counties, farmers, citizens, developers, academia,

environmental groups, and the Army Corps of Engineers as a Federal interest. The bill became effective on October 1, 1995.

2.1.2 Physiography and Topography

The study area is located within two physiographic provinces, the Piedmont Plateau and the Coastal Plain. The upper 25 percent lies within the Piedmont and the lower 75 percent lies within the Coastal Plain.

The Piedmont Region of the Middle Atlantic states is an area of gently rolling to hilly land lying between the Appalachian Mountains and the Atlantic Coastal Plain. It is characterized by diversified relief that is dissected by narrow and deep stream valleys with isolated knolls rising above the general upland level. The division between the Piedmont Region and the Coastal Plain is marked by the Fall Line, an ill-defined line of rapids and waterfalls where streams descend from the crystalline rocks of the Piedmont to the erodible sand and clay soils of the Coastal Plain. Geologically, the Piedmont is the ancestral Appalachian Mountains, which now form the foothills to the existing mountains.

The Coastal Plain is characterized by a thin wedge of sedimentary material overlying crystalline rock. These sediments are derived from upland sources and have been deposited periodically over the past 70 million years, since the Lower Cretaceus period. During the Pleistocene epoch of glaciation, and successive rising and falling of the sea level, coarse sands were deposited by glacial rivers, and several of the sequential intervals between high and low stages of the sea are evident in the riverine terraces along the Patuxent River.

2.1.3 Geology and Soils

Geology in the Piedmont Province is characterized by two distinct types of bedrock, both metomorphic in nature. The eastern part of the province contains gneisses, schists, marbles, and granitic and gabbroic rocks. These rocks all originated as molten masses that invaded the older metamorphic rocks. The western portion is characterized by less metamorphosed limestones, sandstones, slates, and shales.

Soils in the Piedmont Province originated from the underlying bedrock. Differences in elevation and shape of the land in the Piedmont Plateau account for some of the differences in elevation and soils formed in the same kind of parent material. The Manor and Brandywine soils are well drained to excessively drained and generally are found on the steeper parts of the landscape. As the relief becomes more gently rolling and the landscape becomes more stable, and well-drained Chester, Elioak, and Glenelg soils are dominant. Where the Piedmont landscape is nearly level, the moderately well-drained and somewhat poorly drained Glenville soils are common.

Coastal Plain geology is a continuation of the crystalline rocks of the Piedmont. Overlying sediments form wedge-shaped layers that thicken toward the east, forming a relatively thin veneer over the crystalline basement rock.

Coastal Plain Province soils consist of unconsolidated layers of sand, silt, clay, and gravel overlying crystalline rocks. The depth of these sediments decreases from west to east, forming a wedge that tapers out at the Fall Line.

Coastal Plain soils just below the Fall Line consist of moderately well-drained Beltsville soils. At the bottom of the Coastal Plain are the poorly drained clayey and loamy soils of the Christiana, Collington, and Westphalia classifications. Poorly drained Hatboro soils makeup most of the soils of the tidal marshes.

2.1.4 Climate

The study area has a humid continental climate with mild winter temperatures and warm moist summers. The Appalachian Mountains to the west and the Chesapeake Bay and the Atlantic Ocean to the east have moderating influences on the local climate. Their effect produces a more equable climate than other continental locations farther inland at the same latitude.

The spring and autumn seasons characteristically exhibit sudden shifts in weather produced by rapid eastward movement of alternating cold and warm fronts. Winters are cool to cold, with mean daily temperatures ranging from 22 to 44° Fahrenheit. Summers are hot and humid due to the Atlantic High. Mean daily temperatures in the summer range from 61 to 87° Fahrenheit. Temperature extremes for the year have varied from -7 to 102° F. January is the coldest month, and July the warmest.

Rainfall averages about 41 inches per year, with a rather uniform distribution throughout the year. The greatest intensities occur in July and August, during the season of severe thunderstorms and hurricanes. Thunderstorms occur, on average, 31 days per year, mostly from May through August. July and August are the wettest months and February is the driest.

Prevailing winds are from the west to the northwest, except during the warm months when they become southerly. The average annual wind speed is about 10 miles per hour. The windiest period is late winter and early spring.

2.2 LAND USE

2.2.1 Historic Land Use

2.2.1.a. Agratian Period (1680-1815): The Chesapeake Bay and its tributaries have had a large impact on historical land use in Maryland. Early settlements in the state occurred mainly along riverbanks, natural embayments, and islands. This was done primarily as a means of easy transportation of goods and people. Ships from England regularly traveled up the Bay and its tributaries to load and unload goods at plantations and small population centers.

The earliest settlements of the Upper Patuxent River area seem to have consisted of plantations stemming from land grants and other acquisitions; trading posts that later developed into

small, commercial communities; and specialized industrial complexes such as grist mills, iron furnaces, and foundries. The early industries were founded largely to support the plantation economy. The plantations were generally tobacco-producing estates, situated on navigable waterways (Payne and Baumgardt, 1990). River-associated cultural resources from the plantation era would have included wharves, docks, tobacco roads, and ferries.

Population centers developed slowly, since most individual land-owners had easy access to the river and its transportation benefits. The Patuxent River afforded a good waterway for colonial planters, and a number of towns were founded on its shores, of which Upper Marlboro (1706) on the western Branch, was the most prominent. The road law, passed in 1666, and a series of town acts did little to change the dispersed settlement pattern, as people were unwilling to move far from the main tributaries and their transportation services.

A few small agricultural villages arose at the river landings, such as Benedict, Nottingham, Pig Point and Upper Marlboro, but the better suited areas near Baltimore and Washington tended to attract most of the population and development. Adding to the reasons for the slow development of the river was the rather rapid rate it was silting in. As late as 1807, the river was navigable to Queen Anne Town for flat-bottomed boats. Queen Anne Town was a small post town (1707) on the west side of the Patuxent River, 13 miles southwest of Annapolis. By 1807, navigation to Queen Anne Town became difficult and finally impossible as a result of sedimentation in the channels

By 1720, the iron industry ranked in importance behind only tobacco and grain production in the Middle Atlantic States (Robbins, 1972). Rich iron-ore deposits were apparently discovered in the 17th century, but the commercial potential of these deposits was not exploited until the early 18th century. In 1734 or 1746 (accounts vary), a patent was granted to the Patuxent Iron Works Company organized by Richard Snowden, Jr., with shareholders from Annapolis, Anne Arundel County, and London (Humphrey and Chambers, 1979).

2.2.1.b. Agricultural-Industrial Transition (1750-1860): The period between 1750 and 1860 was one of general economic stability, due to the relative stability of tobacco as a cash crop and the hold on the land by established families. As late as 1840, Prince George's County still had a one-crop economy, producing 37.3 percent of the tobacco grown in Maryland (Payne and Baumgardt 1990). Other small communities were also established during the early 19th century to serve the increased needs of agricultural services.

2.2.1.c. Industrial Age (1870-1930): As part of a 1899 Corps of Engineers study, it was noted that Bristol Landing was a major port from which freight was shipped. Most of the freight was transported on steamships, but sail vessels were also used to some extent. This landing, as the head of navigation on the Patuxent River, was the outlet for the produce of a fairly large region of Maryland and was reported to be, next to Lower Marlboro, the most important shipping point on the river. Goods shipped from Bristol Landing including coal, lumber, lime, and agricultural products, including tobacco, corn, wheat, poultry, eggs, fruit, and other locally produced items. Additionally, Bristol Landing served as a distribution point

for general merchandise goods being imported to meet local needs. The 1899 report also noted that a canning factory had operated at Bristol Landing as late as 1875.

By 1908, the upriver landings had declined precipitously, and were rapidly falling into decay. The uncertainty of shipping schedules and the uncertainties of delivery compelled merchants to ship by rail at high rates, or to haul goods overland to wharves located on the Chesapeake Bay. A 1907 Corps of Engineers report indicates that nine-tenths of the produce from the area was shipped by water at that time, with the remainder being shipped by rail, due largely to failure of the steamers to maintain their schedules.

Water supply and quality also became an issue during the early 20th century, after disastrous yellow fever outbreaks in Philadelphia, Pennsylvania, and Wilmington, Delaware. The Washington Suburban Sanitary Commission (WSSC) was created by the Maryland State Legislature in 1918 to develop water and sewer services for some 30,000 people living in a 95-square-mile area of Montgomery and Prince George's Counties.

2.2.1.d Modern Period (1930-Present): By 1930, competition from rail and truck, and the diminished economy created by World War I and the Great Depression, made it unprofitable to ship by water. Commercial navigation on the Patuxent at that time consisted mainly of barges and sailing vessels engaged in transporting forest products. A number of small vessels with shallow draft were also engaged in the fish and oyster trade. Incoming freight for destinations upriver was transferred from steamships docking at Solomon's to small motor boats for delivery to points as far upstream as Benedict. A 1930 Corps report re-examined the trends in commercial navigation documented in earlier reports and concluded that improvements to the river for navigation were not warranted. In 1945, it was noted that the "Patuxent River is no longer navigable above Lyons Creek Wharf, some 20 miles below the original head of tidewater, for boats drawing more than 8 feet of water" (Gottschalk, 1945).

The WSSC built the Triadelphia and T. Howard Duckett reservoirs on the Patuxent River in the 1940's and 1950's respectively, to expand the area's water supply. The Triadelphia Reservoir, with its Brighton Dam, was built in response to a severe drought, and flooded the former village of Triadelphia. Both continue to function as holding reservoirs for raw water, while having the additional benefit of providing scenic and recreational sites (Washington Suburban Sanitary Commission, n.d.).

2.2.2 Current Land Use

The total land area for the watershed, according to the State of Maryland's Office of Planning, is 576,492 acres. Of this, forest and wetlands account for about 49.8 percent of the watershed acreage, developed land accounts for approximately 20.5 percent (most of which was developed after 1985), and agriculture accounts for 29.6 percent. Land use and cover types can be seen in Figure 2-1.

According to MDE's *Maryland Water Quality Inventory, 1991-1993,* although the Patuxent River watershed is situated between the Washington, D. C., and Baltimore metropolitan areas, most of the watershed remains forested.

The middle portion of the segment, bordered by Interstate 95 and Maryland Route 214, is the most heavily developed area in the watershed. This section includes the cities of Laurel and Bowie, the communities of Jessup and Savage, and much of the U.S. Army's Fort Meade installation. Other communities include the town of Columbia near the upper Little Patuxent River, and Upper Marlboro on the Western Branch. A number of communities dot the lower, tidal portion of the Patuxent River, including Broomes and Solomons Islands.

Federally-owned acreage within the Patuxent watershed is substantial, presenting potential problems and opportunities for protecting the water quality of the river. The largest concentration of Federal land is in the middle of the watershed. There are five major facilities in this section: Fort George G. Meade, the U.S. Department of the Interior's Patuxent Wildlife Refuge Research Center, the U.S. Department of Agriculture, the Naval Dairy Farm and the U.S. Air Force. In addition, the U.S. Navy has a 6,800-acre facility located at the mouth of the Patuxent River. The Wildlife Research Center is largely an undisturbed natural area that provides a protective buffer on the river.

The lower two-thirds of the watershed has substantial deposits of sand and gravel that are of considerable importance for construction. A great deal of sand and gravel has been mined in Prince George's and Anne Arundel Counties.

The Calvert Cliffs Nuclear Power Plant began operating in 1975. In addition, construction of a plant for processing imported liquefied natural gas was completed in 1978, to be used as a reserve energy source for periods of high demand.

2.3 ENVIRONMENTAL RESOURCES

This section provides information on the status, trends, and constraints of water-related environmental resources in the watershed. The information in this section is derived from existing data sources and consultations with Federal, State, and local resource agencies.

A number of biological resources in the watershed appear to have declined over the last 30 to 40 years: estuarine fish diversity, anadromous fish spawning, oysters, and submerged aquatic vegetation (SAV) in the lower and middle river, woodlands, and riparian buffers. Extensive land development, especially in the middle and upper watershed, has stressed water quality by adding excessive amounts of nutrients and sediments to the river. This development has also resulted in a variety of other forms of habitat degradation. Additionally, wetlands have undergone many changes, natural and human induced, resulting in significant wetland loss with subsequent impacts on fish and wildlife populations.

In 1981, a state health department summit meeting was held to discuss the condition of waters in the Patuxent River. At that time, the State of Maryland committed itself to restoring the water quality of the river to that existing in 1950.

Recent improvement in SAV in the upper tidal river and in benthos in the lower nontidal river appear to be due to water quality improvement from the upgrading of the wastewater treatment plants in the area. Striped bass have rebounded in the river, due mostly to the harvesting restrictions and stocking efforts designed to restore the spawning stock. Increased numbers of some sensitive upper-trophic-level bird species such as bald eagles, ospreys, and great blue herons appear to be due to the restriction of pesticide use and efforts to enhance bird habitat. These improvements offer hope that, if appropriate management steps are taken, the impacts of the development in the area can be significantly lessened.

2.3.1 Historic Conditions

Historically, the Patuxent River watershed supported a wide variety of habitat types and their associated flora and fauna. The estuarine portion of the river supported large colonies of oysters, shorebirds, tidal brackish wetlands, submerged aquatic vegetation, blue crabs, anadromous fish, and forested uplands. The fluvial reaches of the river and its tributaries supported freshwater fish species, nurseries for some anadromous fish species, riverine wetlands, submerged aquatic vegetation, various migratory waterfowl, and forested uplands.

Human inhabitants in the watershed prior to the 20th century had access to abundant natural resources, including fresh streams, deer, gamebirds, gamefish, and lumber. Increased development of agriculture and industry, and the attendant increase in population in the area have created a number of water quality, habitat degradation, and other problems that have had direct and indirect effects on the natural environment and resources of the watershed.

2.3.2. Terrestrial Resources

Upland birds typically found in the study area include quail, meadowlark, dove, woodcock, thrush, vireo, scarlet tanager, wild turkey, vulture, rail, field sparrow and suburban/urban birds such as house sparrows, robin, starling, finches, pigeon. Pheasant and ruffed grouse are also occasionally found in the watershed.

The major constraint on populations of upland birds is the change in land use and land cover. According to 1991 Maryland Office of Planning data, between 1979 and 1990 the seven counties in the study area developed 124,462 acres of land, and lost 57,273 acres of agricultural land and 69,103 acres of forest. According to the Maryland Department of Natural Resources (MD-DNR), neotropical migrant songbirds are continuing to decline in the watershed. This is believed to be the result of fragmentation of large forested tracts in this area. These changes in land use affect not only birds but other upland wildlife as well. (Wolflin and Lubbers, pers. comm.).

A wide variety of reptiles and amphibians exist in the watershed, including turtles, snakes, frogs, toads, and salamanders. The current abundance of box turtles, a fairly sensitive species, is exceptionally good in the Patuxent River, according to Maryland Biological Stream Survey data from 1994. These creatures are found throughout the watershed.

Upland mammals include white-tailed deer, raccoon, squirrels, foxes, cottontail rabbits, and woodchuck. Raccoon and white-tailed deer have become nuisance species in some areas of the watershed.

A number of landowners have protected woodlands as open space and buffer zones. The Columbia Association and the counties own a large proportion of this acreage. Other forested parcels are owned by the various Federal agencies in the watershed or by the Washington Suburban Sanitary Commission (WSSC).

WSSC has approximately 3,960 acres of forested property. This property includes softwood and hardwood plantations, as well as natural stands of mixed hardwoods (oaks, black gum, hickory, sycamore, river birch, big tooth aspen, black walnut, black willow, persimmon, tulip tree, and holly). Forests on the WSSC property create a buffer, which helps to trap sediments, reduce stormwater velocity, and reduce nutrients from inflowing water.

2.3.3 Aquatic Resources

2.3.3.a. Fish: A number of species of environmentally and/or economically important fish are indigenous to the estuarine reaches of the Patuxent River and its tributaries. Data is more readily available for these species than for freshwater species. Estuarine species include the striped bass, American shad, hickory shad, blueback herring, alewife, bay anchovy, spot, yellow perch, white perch, Atlantic menhaden, and eel, as well as softshell clam, eastern oyster, and blue crab. Segments describing the current status of these species can be found in Appendix B. The Annex has a table of freshwater fish species collected in the upper portion of the Patuxent River by Montgomery County.

Overall trends for fish species in the Patuxent are complicated by a number of factors, including fishing pressure, water quality, available ecological niches, and stocking. Many of the commercially important species have been over-fished historically, and have increased their numbers to less than their former estimated populations.

Some species of fish are more sensitive to the increased turbidity in the Patuxent than others. These sensitive fish have either found other suitable habitat areas outside the Patuxent, or have gradually reduced in numbers. The niches left open by the reduction of these species have been filled by other species that are more tolerant of the water quality, and are less desirable for commercial or recreational fishing. The trend for the more tolerant fish, then, is increased populations.

Stocking affects fish populations in one of two ways. First, the “permanent” type of stocking, such as is used for American Shad, generally introduces large numbers of fingerlings into the

river at one time. This creates a fairly large population of fish that are all roughly the same age. The concept behind this type of stocking is that the fish will reach breeding maturity and produce several generations of young, which will become naturally-reproducing fish.

The other stocking method, the "put and take" method, introduces a certain number of adult gamefish into a stream just before fishing season. Most of these fish are caught by anglers, but a few may live for two or three seasons. If conditions in the stream are favorable, a naturally-reproduci.ng population may be established. Stocking efforts in the Patuxent River have improved population trends for the American shad, and have created small populations of game trout, some of which maybe reproducing naturally.

2.3.3.b. Fish Obstructions: Historically, the Patuxent River mainstem was used by finfish species for general distribution, spawning, and breeding areas, with nursery areas concentrated in the upstream reaches of the river. Currently, this upstream habitat is reduced by approximately 133 obstructions to fish passage in the Patuxent watershed. The Dam Safety Section of the Maryland Department of Natural Resources lists 25 dams of various sizes in the Patuxent River watershed. These dams, shown in Figure 2-2 and listed in Table 2-1 in the Annex, create varying degrees of fish obstruction, based on their location and size.

Dams are not the only obstructions to fish passage. Culverts, pipeline crossings, and weirs may also impede migratory fish. The Chesapeake Bay Program and other restoration programs have identified a need to modify structures so that they no longer form barriers to fish passage. As a result, many of the most significant blockages have been modified to permit passage. A notable example is the installation of a Denil fish ladder at a dam at Fort Meade in 1991 (Wolflin, pers. comm.).

Removal of some of these obstructions in areas of otherwise highquality fish habitat would likely result in large benefits to anadromous fish, and allow resident fish to make more effective use of available habitat. A stocking program, implemented in conjunction with the obstruction removals, would augment the beneficial impact to many species.

Currently, MD-DNR is working with landowners and other agencies to remove obstructions to fish passage in the watershed. Their list includes over 100 sites of potential fish passage blockage. While every effort is being made to evaluate and remove these blockages, it will be many years before this effort is completed.

2.3.3.c. Benthos: Bottom-dwelling ("benthic") species of invertebrates are known collectively as "benthos" for any given ecosystem. These species feed on aquatic vegetation and detritus, and in turn become the lowest animal level of the riparian food chain. These creatures are eaten by larger invertebrates, crustaceans, finfish, wading birds, amphibians, turtles, and even some mammals. Therefore, a healthy benthos is essential to a healthy aquatic ecosystem. Benthos is most affected by toxic substances, water-borne sediments, wake energy, and loss of vegetation. Different species comprising the benthos are affected by these factors to differing degrees. Thus, the benthic quality of an ecosystem is a yardstick by which to measure current water and habitat quality and the success of any effort to improve those parameters.

Benthic invertebrates are widely recognized for the important role they play in the aquatic food web. They also influence nutrient and toxicant dynamics through bioturbation and other processes (Diaz and Schaffner 1990). The Chesapeake Bay Program monitors benthic invertebrates because they are good indicators of habitat quality. Ranasinghe et al. (1994) have analyzed the trends in benthos from 1984 through 1993. The benthic assemblages at 2 monitoring stations in the nontidal freshwater segment below the fall line are dominated by a variety of insect larvae (mayflies, caddisflies, beetles, midges, and blackflies), aquatic earthworms, and flatworms. The numbers of sensitive species at these stations have increased over the last decade, indicating an improvement in habitat quality.

The benthic assemblages in the tidal freshwater segment of the river are dominated by oligochaete worms and midge larvae with lesser numbers of arnphipod crustaceans, bivalve mollusks, and spionid polychaete worms. Even though some increase was noted in abundance of organisms and taxa, the trend analysis indicated that the quality of the community had declined slightly, primarily because the increases were in the abundance of oligochaetes and chironomids which are generally tolerant of pollution. However, the authors pointed out that the trend analysis for this segment is questionable because the evaluation metrics were derived from other freshwater habitats and may not be appropriate for the tidal freshwater environment. Since tidal freshwater areas are typically dominated by oligochaetes and chironornids even in pristine environments, their abundance in these areas should not necessarily be taken to indicate a degraded condition.

The benthic assemblage in the low mesohaline mud portion of the river is dominated by isopod and amphipod crustaceans, bivalve mollusks, annelid worms, nemertinean worms, and midge larvae. The quality of this habitat has improved since the rnid-1970's as indicated by an increase in density, total biomass, and sensitive specialized taxa.

Dominant organisms in the high mesohaline mud habitat include polychaete worms, oligochaete worms, bivalve mollusks, and a cumacean crustacean. The condition of the benthos in this habitat appear to have declined over the last decade as indicated by a decrease in the number of taxa, and an increase in the number of opportunistic species relative to more specialized sensitive species.

The spatial patterns in the benthos trends reflect the changes in water quality. That is, the benthic condition showed the most improvement in the nontidal freshwater habitat where water quality has shown the most improvement, with both lower nutrients and higher dissolved oxygen. In the high mesohaline habitat where the water quality is relatively unchanged, the benthos condition declined slightly.

Specific information on benthic sampling can be found in Appendix B.

2.3.3.d. Birds: The makeup and population sizes of waterbird species in the Patuxent River watershed has changed significantly over the last 25 years. Species of waterbirds currently found in the watershed include the wood duck, black duck, canvasbacks, redhead, mallard,

great blue heron, green-backed heron, great egret, snowy egret, bald eagle, and osprey. The Patuxent River watershed is part of the Atlantic Coast Joint Venture area of the North American Waterfowl Management Plan, due to its contribution to migrating birds on the Atlantic flyway.

Other key waterbird species, little blue heron and black-crowned night heron, have not been recorded in the watershed for many years, and the status of these species is unknown for the watershed.

Segments describing the current status of each species can be found in Appendix B.

2.3.3.e. Reptiles and Amphibians: The diamondback terrapin is a common turtle in the estuarine waters of the middle and lower Patuxent. They nest on sandy beaches, especially those that are separated from the mainland by marshes. Dr. Willem Roosenburg of the University of Maryland has made an extensive study of the diamondback terrapin in the Patuxent River. His mark and recapture study has been conducted at a section of the Patuxent shoreline near Mechanicsville since 1987. Trends over the period are not definitive, but the population seems to be in a stable to declining condition (Roosenburg, pers. cornm.).

Long-term terrapin trends are not specifically available for the Patuxent, but probably reflect the historic bay-wide pattern. The Chesapeake Bay terrapin population is thought to have declined to a very low level by 1930 because of the high demand for its meat as restaurant fare. Demand subsequently declined, and turtle numbers rebounded by the 1960's.

In recent times several human-related factors have increasingly affected the turtles. Shoreline protection measures such as bulkheads and riprap revetments have adversely affected nesting habitat. Dr. Roosenburg's research shows that bulkheading and riprap result in severe degradation of terrapin nesting habitat by "hardening" the shoreline (Mountford, pers. corn.). This degradation is particularly damaging in areas that serve as "traditional" nest sites (those which are revisited year after year). Loss of nest habitat is one of the primary causes of reduced terrapin populations in the river. In addition, increasing human use of the shoreline physically disrupts nesting activities, and can attract predators such as raccoons that prey on turtle nests or on the adult turtles themselves. Turtles often drown in crab pots and may be struck by boats when they surface for air.

This species is likely to continue to decline unless measures are taken to protect the species and/or enhance beach habitat for its use.

2.3.3.f. Mammals: Semi-aquatic mammals in the Patuxent watershed include the beaver, otter, and muskrat. Neither population status nor trends have been specifically determined for the Patuxent watershed. However, based largely on anecdotal evidence, Robert Colons, MD-DNR fin-bearer biologist, has provided the following information on beaver, river otter, muskrat, and mink:

- Beaver have been expanding throughout the Patuxent watershed, particularly over the last 6 to 8 years, since the fur market crashed. They have moved into suboptimal habitat like sediment ponds and populated areas where they are creating problems for people.

- Otter appear to be doing fairly well in the watershed and have also increased over the last 6 to 8 years. Besides being helped by the decline in trapping, they have also benefited from wetland creation projects. They show a preference for these areas, including ditches and other artificial wetlands, during their natal period.

- Muskrat are relatively numerous and are maintaining a generally stable population where their habitat has not been altered.

Mink appear to be relatively uncommon in the watershed, yet more numerous in the Piedmont section. They may be declining somewhat. They are known to be very sensitive to pollutants, especially polychlorinated biphenyls (PCBs).

2.3.4 Wetlands and Submerged Aquatic Vegetation

2.3.4.a. Herbaceous Wetlands: McCormick and Somes (1982) determined that, based on the State's 1972 inventory, the Patuxent watershed contained 6,773 acres of tidal wetlands. The Maryland Water Resources Administration (1980), using aerial photography taken between 1974 and 1977, reported that the watershed contained 4,990 acres of nontidal wetlands. Given that the definition of nontidal wetland has been broadened since that time, this figure may be a substantial underestimate. As part of the National Wetland Inventory (NWI), the U.S. Fish and Wildlife Service (USFWS) classified and mapped the wetlands in the watershed based on aerial photography taken about 1981. Table 2-2 in the Annex shows data on wetland types in the watershed from 1994, and Table 2-3 shows wetland types in 1982.

The USFWS has also analyzed the changes in wetlands that occurred during the 1980's for Anne Arundel, Calvert, Charles, Prince George's, and St. Mary's Counties. These analyses were of each entire county, not just those areas within the Patuxent watershed. Nevertheless, these changes should be representative of the changes within the watershed. A major concern is the amount of wetlands that have been or will be converted to upland. Various types of wetlands were converted to upland in each of the 5 counties from 1981 to 1989. Of the 462 acres of wetlands lost by conversion to upland, 75 percent were losses of palustrine forested wetland, and nearly 15 percent were losses of palustrine emergent wetland. Only slightly more than 4 percent were estuarine wetland losses.

Marshes and swamps provide much the same wildlife and water quality benefits as SAVs and riparian forests, but are beneficial to different species from those of the preceding vegetation classes. Wading birds, crustaceans, finfish, amphibians, turtles, and mammals all benefit from healthy wetland areas. In addition, wetlands decrease the erosive forces of boat wakes and storm events, allow for the settling of sediments and the absorption of nutrients, and contribute to the dissolved oxygen in the ecosystem. Marshes are most affected by wake energy and loss

of habitat via sedimentation, erosion, drainage, and navigational dredging. Swamps are most affected by loss of habitat via sedimentation and drainage.

State, local, and Federal laws and regulations applicable to each wetland type can be found in the Annex.

2.3.4.b. Riparian Forests: Riparian forests are areas of trees, shrubs, and associated vegetation located adjacent to flowing waters. These areas have received greater attention lately because of their ability to ameliorate nonpoint source pollution. Through physical and biological processes, these systems intercept surface and subsurface water flows from upland sources, thereby reducing the amount of nutrients, sediment, organic material, or other potential pollutants to the receiving water body (Chesapeake Bay Program, 1993). In addition to this pollutant removal function, these areas frequently provided excellent wildlife habitat and have an important positive impact on the quality of the adjacent aquatic habitat.

Riparian forests provide a number of water quality functions in the Patuxent watershed. Forests reduce the water velocity of stormwater surges, thus protecting stream banks and substrates from erosion; they shade the water, reducing its temperature and increasing its dissolved oxygen carrying capacity; they add leaf litter, which provides a nutrient-rich base to the food chain; and they absorb and hold nutrients and toxic substances, thus reducing pollution within the mainstem of the river, and, ultimately, the Chesapeake Bay. In contrast, hardened shorelines (bulkheads, riprap) provide none of these benefits and can reflect wave energy back into the river, thereby causing further damage to benthic and aquatic communities.

An inventory of the existing riparian forests in the Patuxent River watershed was completed in 1993 (Lade, 1993). This study was based on data derived from satellite imagery taken in 1991 and 1992. Using the assumption that an adequate riparian buffer must be at least 300 feet wide, it was determined that of the 1,413 miles of stream in the watershed, only 32 percent had adequate forest buffers on both sides, and only 66 percent had adequate buffers on at least one side. Additional data may be seen in Table 2-4, in the Annex. It is worth noting that there is not much difference in riparian area degradation between the counties, despite their different rates of development. This maybe due to the more highly developed counties having significant amounts of protected land adjacent to the river and its tributaries.

Riparian forest areas in Maryland are protected by a variety of State, local, and Federal laws. Appendix A outlines the main points of each of these laws.

2.3.4.c. Submerged Aquatic Vegetation (SAV): Submerged aquatic vegetation has very low abundance in the Patuxent River since 1970, as documented by both aerial and ground surveys (Orth, 1995). The aerial surveys conducted in 1978 and from 1984 through 1993 never detected more than 55 hectares of SAVs in the Patuxent watershed for any given year, and no SAVs in 1990, 1991, or 1992. Widgeon grass, homed pondweed, sago pondweed, and Eurasian water-milfoil are the most common species to the lower estuarine and middle tidal reaches of the river. Other species recorded in the freshwater segment of the river and major

tributaries include common elodea, coontail, redhead grass, wild celery, southern naiad, curly pondweed, slender pondweed, and 2 other species of pondweed. SAV acreage data is shown in Table 2-5 in the Annex, along with figures showing the current SAV locations in the Patuxent.

Submerged aquatic vegetation provides many benefits to wildlife and water quality in the riparian ecosystem. SAVs provide food for invertebrate species that are, in turn, utilized as food by upper food chain fish and birds; provide prime nesting habitat for fish and amphibians; provide cover for smaller fish, amphibians, and invertebrates; provide dissolved oxygen to aquatic animals via photosynthesis; and utilize water-borne nutrients, thereby reducing the ambient nutrients in the rnainstem of the river and, ultimately, the Chesapeake Bay. SAVs are sensitive to changes in water quality, especially increased wake energy, toxic substances, and turbidity due to sediment loading and/or algal blooms. Different SAV species are affected by these factors to differing degrees. Thus, the SAV makeup of an ecosystem is a yardstick by which to measure current water and habitat quality and the success of any effort to improve those parameters.

Accounts from 1940 to the late 1960's indicate that SAV species were located in many areas of the Patuxent, and historical aerial photographs clearly show dense SAV beds in the lower Patuxent. Eelgrass *(Zostera maritima)* was reported in the Solomons Island area until 1971. Other species noted between 1940 and 1971 were homed pondweed *(Zannichellia palustris),* waterweed *(Egeria densa),* redhead grass *(Potamogeton perfoliatus),* sago pondweed (Potamogeton pectinatus), northern naiad *(Najas flexilis),* and widgeon grass *(Ruppia maritima).* Data from 1982 indicate that there were 51 acres of SAV in the Patuxent River watershed at that time.

More recent aerial surveys indicate that the Patuxent River currently has very limited stands of SAV; no more than 60 hectares in any given year for the entire river. There were zero hectares of SAV in the Patuxent River from 1990 to 1992, and only 10 hectares in 1993. One bed is located in the upper Patuxent, and the other is located at the mouth of the river, between Solomons Island and Drum Point. In this section, 10.2 percent of the total coverage was considered "moderate," while 89.8 percent was considered "sparse." A total of 11 species were reported in the river in 1993. Of those, 10 species occurred primarily in the marsh creeks of the upper portions of the Patuxent: common elodea *(Elodea canadensis),* coontail *(Ceratophyllum demersum),* wild celery *(Vallisneria americana),* horned pondweed *(Zannichellia palustris),* southern naiad *(Najas guadalupensis),* naiad *(Najas minor),* curly pondweed *(Potamogeton crispus),* slender pondweed *(Potamogeton pusillus),* hydrilla *(Hydrilla verticillata),* and leafy pondweed *(Potamogeton epihydrus).* Homed pondweed and widgeon grass *(Ruppia maritima)* were reported from the lower portion of the Patuxent River in Saint Leonard, Island, Hominy, and Cuckold Creeks; Peterson Point; and Green Holly Pond.

Preliminary results from the 1994 aerial survey indicate no SAV in the lower Patuxent, 1.5 hectares in the middle Patuxent, and 75 hectares in the tidal freshwater segment of the river

(Wilcox, 1995). Ground surveys conducted by the Maryland DNR concur with these findings. These data suggest that a resurgence of SAV is occurring in the tidal freshwater areas of the Patuxent, beginning in the tributaries and now reaching into the mainstem. Eleven species are found in the tributaries, and nine species are found in the rnainstem. Dominant species include elodea, slender naiad, homed pondweed, and *Hydrilla* (Naylor, 1995). It is important to note at this point that the homed pondweed *(Zannichellia palustris)* is a seasonally important SAV species. Its life cycle makes it difficult to determine its overall abundance and relative dominance, because the plant disappears annually, usually before the bay-wide aerial SAV surveys are flown. It is believed, however, that this species has had some increase in population in the past several seasons (Mountford, pers. corn.).

Hydrilla, an aggressive exotic species, currently makes up only a small percentage of the SAV in the river, but it is felt that it may begin to extend its range, perhaps at the expense of less competitive naturally occurring species. There is some debate, however, as to whether *Hydrilla* colonization is detrimental to naturally occurring species in the long run. Some experts feel that it can act as a beneficial species by stabilizing the bottom sediments and clarifying the water such that naturally occurring species can become re-established. (Ruddy and Lubbers, pers. corn.).

The resurgence of SAV in the Patuxent is similar in some respects to the SAV resurgence in the upper tidal Potomac River during the 1980's (Carter and Rybicki, 1986). In both cases, an increase in SAV was noticed after major upgrades to wastewater treatment plants in the watershed. In the DNR ground survey, SAV was found in waters up to 3 feet deep in the mainstem, and up to 5 feet deep in the tributaries. However, as a result of poor light transmittance, even with recent improvements in water quality, significant SAV growth does not occur at depths greater than 1 meter. Historically, SAV in the Chesapeake Bay occurred at depths up to 4 meters. The lack of adequate light penetration severely limits the potential habitat areas for SAV in the watershed, which, in turn, limit the benefits of SAV to the ecosystem (Naylor, 1995).

2.3.5 Rare, Threatened, and Endangered Species

Common elodea *(Elodea canadensis)* and redhead grass *(Potamogeton perfoliatus),* once quite common in the Chesapeake Bay watershed, are now quite scarce. Redhead grass is listed as a State rare species (S2), and is actively tracked by the Maryland Natural Heritage Program. Slender pondweed is listed as a State highly rare species (S1), and is actively tracked by the Maryland Natural Heritage Program. Southern naiad and northern naiad are State watch list species (S3).

Two small populations of the sensitive joint-vetch are located along the river in the vicinity of Lower Marlboro and Magruder Landing. This member of the legume family is federally listed as threatened. It inhabits tidal freshwater wetlands. The Patuxent populations were discovered for the first time in 1994.

The glassy darter (endangered/extirpated), stripeback darter (endangered/extirpated), shield darter, and tessellated darter have been recently reported in the Collington Branch. The glassy and stripeback darters were believed to be rare or absent from the state of Maryland. Their presence in the Collington Branch indicates the possibility of reintroduction and enhancement of species populations in the watershed. It should be noted, however, that their discovery in the watershed is due, in large part, to increased emphasis on biological diversity due to the Maryland Biological Stream Survey.

The bald eagle nests in every county within the Patuxent watershed except Howard. The number of eagles has progressively increased since the late 1960's and early 1970's (only 1 nest was reported in the watershed in 1972). The status of the eagle was recently changed from endangered to threatened throughout the lower 48 states. The improved numbers of eagles is primarily due to the banning of a toxic pesticide (DDT) and enhanced habitat protection efforts.

A small population of the northeastern beach tiger beetle exists at Drum Point, at the mouth of the river. This tiger beetle, which is dederally listed as threatened, inhabits broad sandy beaches. It spends the first 2 years of its life as a carnivorous larva living in a burrow in the sand. It then develops into the adult stage that inhabits the beach surface. Tiger beetles may exhibit considerable variation in numbers. Since the Patuxent population has only been monitored for a few years, it is not possible to define any trend. Threats to tiger beetles include shoreline modifications, use of off-road vehicles on the beach, and even human foot traffic. The "softening" of beaches and protection of these areas would be likely to enhance their recovery.

The Natural Heritage Program's list of Rare, *Threatened, and Endangered Species of Patuxent River Watershed, Maryland* can be found in Appendix B.

2.3.6 Water Quality

Good water quality is essential to the maintenance of a healthy aquatic or wetland system. The Maryland Department of the Environment (MDE) describes the water quality of the Patuxent River watershed as fair (MDE, 1994). The main water quality problems appear to be

- High nutrient levels due to municipal treatment plants
- Urban and agricultural runoff
- High suspended sediment levels

Algal blooms occurring in the upper estuary can be severe enough to cause fish kills. A turbidity maximum zone also occurs in the upper estuary (Keefe, 1976). The bottom waters in the lower estuary exhibit low dissolved oxygen (DO) concentrations in the summer. Toxic sediment contaminants, however, present only a low risk to aquatic species (Chesapeake Bay Program, 1995). The river between the Duckett Reservoir and the Triadelphia Reservoir is

classified as a Class IV recreational trout fishing stream. The river above the Triadelphia Reservoir is classified as a Class III natural trout fishing stream.

In the shellfish harvesting region between Chalk Point and the mouth of the river, there are several localized areas where shellfishing is prohibited by the MDE due to high fecal coliform levels in those waters. Other areas are conditionally open to shellfishing. The current shellfish prohibition zones are shown in Figure 2-3.

Over the last decade, nutrient inflow to the Patuxent River has decreased substantially. Total phosphorous and total nitrogen concentrations, measured at 5 stations in the tidal freshwater segment of the river, decreased by 48 percent and 35 percent, respectively, between 1984 and 1994 (Everett, 1995). There was less improvement in nutrient inflows in the middle and lower portions of the river during the same timeframe. The nutrient reductions are assumed to be due to recent upgrades in the wastewater treatment plants in the watershed, as well as the ban on phosphate-containing detergents in 1985. Despite these recutions, however, nutrient concentrations still remain high in the watershed (CBP, 1995).

In the discussion of the water quality conditions for the Patuxent River watershed, the terms excellent, good, fair, and poor are used and are defined as follows:

> Excellent: Water quality supports all designated uses or meets water quality goals. Biological life is generally dominated by sensitive and intermediate benthic macroinvertebrate species. Pollution-tolerant species occur infrequently.
>
> Good: Water quality generally supports designated uses or meets water quality goals. Pollution is minimal. Sensitive and intermediate benthic macro-invertebrate species are present only in moderate numbers. Pollution-tolerant species may be present in low numbers.
>
> Fair: Water quality is characterized by intermittent severe degradation or by continued low-level degradation. Waters are considered marginal with respect to designated uses or meeting water quality goals. Intermediate species are dominant while pollution-tolerant benthic macroinvertebrate species occur in moderate numbers and few, if any, sensitive species occur.
>
> Poor: Water quality does not support designated uses or achieve water quality goals. Severe degradation is often experienced. Pollution-tolerant benthic macroinvertebrate species are dominant, if present at all. Only a few, if any, individuals from intermediate species occur. No sensitive species are present.

2.3.6.a. Water Quality Summary: The Maryland Department of the Environment's (MDE) *Maryland Water Quality Inventory*, 1991-1993, describes the water quality in the Patuxent River watershed as fair. In most areas it is suited for fishing and water contact activities and,

where appropriate, shellfish harvesting. The Maryland Section 319 report, however, indicates that the lower Patuxent has been impacted by high levels of bacteria (NPDES Permit, Anne Arundel County, 1993). Maryland's 304 report indicated that the Little Patuxent River, the main tributary in the Howard County portion of the watershed, is impacted by conventional wastes and toxic substances due to point and non-point pollution (NPDES Permit, Howard county, 1995). Non-point sources in the county include agriculture, construction, urban runoff, and mining.

High nutrient levels due to municipal treatment plants, urban and agricultural runoff, and high suspended sediment levels due to agricultural runoff and urbanization are the primary water quality problems. Algal blooms occur in the upper estuary because of high nutrient levels and may result in odor problems and fish kills. Elevated suspended sediment levels due to natural conditions and erosion smother fish habitat. Elevated bacterial levels are due to urban and agricultural runoff and have resulted in some shellfish harvesting area closures.

Seasonally low dissolved oxygen levels are observed in bottom waters in the lower section of the watershed during the summer, but are generally above 5 mg/1 at all depths during other seasons. Nitrogen levels remain generally higher in the upper tidal fresh water and decline down river. Ammonium levels generally decrease downstream and, except for summer bottom waters, there is little variation between surface and bottom ammonium levels. During summer, bottom waters below Benedict have high levels of ammonium due to releases from sediment and desorbtion from suspended sediment. Nitrate and nitrite levels generally decline from tidal fresh waters downstream toward the Chesapeake Bay. Orthophosphorous and total phosphorous levels decline downstream from the tidal fresh water region of the river, indicating that these pollutants originate in the freshwater upstream areas. An increase in phosphorous levels are observed in the turbidity maximum zone that occurs near Upper Marlboro.

The extensive monitoring and restoration efforts in the watershed show improvements in some water quality indicators in the upper estuarine portion of the river. Significant declines in phosphorous and nitrogen loading have been observed as a result of reductions in phosphorous due to the phosphate-detergent ban, erosion and stormwater management programs, and improvements in large wastewater treatment plants in the free-flowing river and tributaries. Phosphorous reductions were observed throughout the estuarine portion of the river, and nitrogen reductions were observed only in the upper estuarine portion. Benthic macroinvertebrate communities in the tidal freshwater portion of the river also have improved.

Summaries of water quality for each of the 8 MDE water quality monitoring segments can be found in Appendix B.

MDE also maintains 30 water sampling stations in the tidal Patuxent for its shellfish certification program, shown in Figure 2-4. These stations collect data twice monthly on fecal coliform. In addition, 14 of the stations collect data on temperature, salinity, and dissolved oxygen. This data base has been queried to show trends in these parameters for the period between 1950 and 1994.

a. Fecal Coliform: A sharp increase appeared in the years 1977-79 and then consistently decreased throughout the stations. Since that time, there has been no discernible trend.

b. Temperature: Other than seasonal variations, there is no significant trend in water temperature.

c. Salinity: Salinity was not measurable at most stations until the early 1980's. Since that time, it has fluctuated without any noticeable patterns.

d. Dissolved Oxygen: At the majority of stations, dissolved oxygen increased sharply from 1979-80, followed by a period where there was no dissolved oxygen measured. Also, throughout 1988, dissolved oxygen levels show a marked decrease in all stations, as compared to higher levels in earlier and later years.

2.3.7 Reserves and Preserves

2.3.7.a. Areas of Critical State Concern: Three areas within the Patuxent River watershed have been designated Areas of Critical State Concern as of January 1981. These areas have been identified for protection by the State of Maryland as reserves for rare and endangered community types. These sites are Battle Creek Cypress Swamp, Killpeck/Trent Hall Creeks, and Jug Bay. Each site is considered to be a unique and valuable environmental asset to the state. Each site is described in detail in Appendix B.

2.3.7.b. Chesapeake Bay National Estuarine Research Reserve (CBNERR-MD): Section 315 of the Federal Coastal Zone Management Act of 1972 established the National Estuarine Reserve Research System as a Federal/State cooperative venture. Federal matching grants are made available to coastal states to develop and manage estuarine research reserves that are representative of the estuarine types found in the region. The Tidewater Administration of MD-DNR is the lead agency for Maryland's participation in the program. As a result of public meetings and an exhaustive selection process, Maryland has established a three-part Chesapeake Bay National Estuarine Research Reserve. The three components are Otter Point Creek (Upper Bay), Monie Bay (Lower Middle Bay), and Jug Bay (Patuxent River).

The purpose of this Reserve is to establish and manage the areas within the boundaries as natural field laboratories, and to develop a coordinated program of research and education for the Reserve (NOAA, 1990). A cooperative management approach will be used, involving the MD-DNR Tidewater Administration, private landowners, local government agencies, private organizations, and advisory committees, with the Tidewater Administration acting as the lead agency.

2.3.7.c Maryland State Scenic Rivers: The Patuxent River has been designated as 1 of the 5 original Maryland State Scenic Rivers by the Maryland General Assembly. This designation is designed to preserve and protect the natural values of the river.

2.4 NAVIGATION

The purpose of this section is to describe and evaluate the current status of navigation on the Patuxent River. Although the primary focus of this section relates to the Federal interest in commercial navigation in or on the Patuxent River, navigation issues relevant to state and local interests were also examined. Evaluation of existing problems related to commercial and other types of navigation on the river can provide the means to address future navigation needs and opportunities in the Patuxent River.

Federal interest in navigation is derived from the Commerce Clause of the Constitution, and is limited to commercial activities in or on the navigable waters of the United States. Federal navigation improvements in the waters of the United States are in the general public interest and, therefore, must be open to all on equal terms. The Federal interest in navigation does not extend to Corps maintenance or completion of improvement works by others unless those improvements were specifically authorized by Congress as a Federal project prior to their construction.

Typical Federal improvements related to navigation include channels, jetties or breakwaters, and watersheds or water areas for vessel maneuvering. Improvements of these types may be eligible for development as general navigation features, harbors, or waterway projects. Other navigation improvements in the Federal interest can include activities such as removal of wrecks or debris, bridge replacement, and mitigation of project-induced shore damage.

For this study element, various issues related to both commercial and recreational boating on the Patuxent River and its tributaries were examined. In assessing the changing shallow water environment of the Patuxent River, data on sediment deposition and other riverine processes were evaluated for effects on both recreational and commercial navigation. The primary focus of this work element is the portion of the river located in the coastal plain, since navigation above the fall line is limited to small craft recreational boating on the Triadelphia and T. Howard Duckett reservoirs. The focused study area for this element encompasses portions of Prince George's, Anne Arundel, Charles, Calvert, and St. Mary's counties. For the most part, this portion of the Patuxent River is relatively deep with minimal need for dredging to maintain navigation channels along the length of the river.

All existing navigation channels identified are for shallow draft vessels, which have less than a 20-foot draft. Although deeper draft vessels operate on the river, their operation is primarily near the river's mouth where there is little or no need for dredging.

As transportation facilities adjacent to the river developed after the Civil War, the use of the Patuxent River as a major transportation route has significantly decreased. Transportation facilities in the region surrounding the Patuxent River are now well developed, particularly in the upper reaches of the watershed. Major highways including Interstates 95 and 70, the Baltimore-Washington Parkway, and U.S. Routes 1, 29, 50 and 301, as well as numerous state and county roads, provide excellent vehicular access to the areas adjacent to the river. The

Penn Central and B&O Railroad as well as the Baltimore-Washington International Airport provide alternative methods of transportation.

Currently, commercial activities on the river include private marinas, oystering, charter boat fishing, and the transport of materials to the Patuxent Naval Air Station. Commercial boating on the Patuxent is primarily limited to fishermen and other watermen who live on the river and work the Bay. Commercial navigation associated with charter fishing is limited to approximately 50 vessels operating out of the Solomons area.

The decline of commercial navigation on the river is also due in part to decreases in the available fisheries and shellfish resources. This decline coincided with the rapid increase of development in the watershed, which has contributed to the intensive use of the Patuxent River for recreational boating. Information gathered from marina operators, the Maryland Watermen's Association, MD-DNR Boating Administration, and the U.S. Coast Guard, indicate that approximately 90 to 95 percent of the boating activity on the river is recreational.

As a direct result of the increased interest in recreational boating since the 1970's, the lower Patuxent River has experienced a building boom, as demonstrated by the development of recreational marinas and piers and the increasing numbers of vessels registered and operating in the study area. Within the past 10 years or so, the lower Patuxent River, particularly Solomons Island, has become a major recreational port on the Chesapeake Bay for both sail and power vessels. As such, this area experiences significant traffic congestion and safety problems. For this reason, the State of Maryland has established restricted speed zones in portions of the river.

Maryland Department of Natural Resources (MD-DNR) Licensing and Watercraft Registration Division (LWRD) data indicate there are approximately 80,000 vessels registered in the counties bordering the river. This figure includes approximately 1,100 commercial boats. Table 2-6, in the Annex, lists the number of commercial and recreational vessels registered in each county as well as the number of vessels whose home port is located in that county.

Within the Patuxent River watershed there are approximately 40 private marinas providing permanent and transient mooring for approximately 2,300 vessels. This number includes at least 50 commercial charter fishing vessels. These marinas are all located below the bridge at Benedict's Hallowing Point, and range in size from facilities that accommodate 2 or 3 boats to those that accommodate over 300 vessels. Table 2-7, in the Annex, lists the marinas in operation as of October 1995 on the lower Patuxent River.

The 1992 Federal Clean Vessel Act requires that all public or private marinas that berth boats over 22 feet in length and have at least 50 slips must have a sewage pump-out station and portable toilet waste disposal capability. As of October 1995, there were 6 boat sewage pump-out facilities associated with the marinas on the Patuxent River. Table 2-7 indicates those marinas that currently have such facilities. As of July 1, 1995, Maryland law requires that all marinas with 200 or more slips, berthing boats over 22 feet, have a marine sewage disposal facility (MSDF).

Additional information about navigational issues can be found in Appendix B.

2.5 WATER REGIME

In any watershed study, it is important to note the frequency of flooding, the cause of flooding (whether natural or human-influenced), and the measures being taken to reduce flood damages. This information can then be used to identify additional needs for flood protection, and to identify planning constraints for environmental restoration and water-related infrastructure projects. It is often the case that a degree of flood protection can be incorporated into the design of another project, thereby providing an additional incidental benefit.

This segment will describe the hydrology of the Patuxent River, and measures in place to protect properties from flood damages.

2.5.1 Hydrology and Flooding

Rainfall in the Patuxent River Watershed averages about 40 inches annually. The upper watershed consists of the Upper Patuxent, Middle Patuxent, and Little Patuxent Rivers. The principle tributaries in the middle watershed are the Western, Collington and Charles Branches. The lower watershed is comprised of various small streams flowing into the main branch of the Patuxent. Nearly half of the annual runoff from the watershed occurs during the 3-month period, March to May.

Large extratropical storms, tropical storms or hurricanes, and local thunderstorms contribute to excess water in the Patuxent River Watershed. As a result, flooding results from fluvial flows on the river and its tributaries and/or high water in the estuary from tidal surges in the Chesapeake Bay. Melting snow may sometimes augment excess precipitation. This was the case in January, 1996, when the peak flow at Bowie was 8,280 cfs, more than 17 times the average flow rate.

Dangerous and destructive floods have not occurred on the main channel of the Patuxent River, but large sudden stream rises of minor importance occur almost every year. These sudden rises flood certain areas adjacent to the river below the fall line and do not form a continuous belt, but create broken stretches of flooding that vary in width from 200 to 2,000 feet. Below Lower Marlboro the flooded land amounts to about 4,000 acres, which is nearly all saltwater. Above Lower Marlboro, about 5,000 acres is subject to flooding, consisting chiefly of meadow and swamp lands.

Notable storms in the Patuxent Watershed include storms occurring in May-June 1889, May 1894, August 1928, March 1936, November 1950, September and November 1952, October 1954, August 1955 (Connie and Diane), August 1959, August 1971, June 1972 (Agnes), September 1975 (Eloise), September 1979 (David), and January 1996.

Segments describing the hydrology and flooding history of each county can be seen in Appendix B.

2.5.2 Existing Flood Control Projects

Solutions to flooding include traditional dam projects as well as other non-structural projects such as levees, environmental restoration, emergency flood warning systems, and land acquisition programs. The National Flood Insurance Program (NFIP) was created to protect property within the floodplain from financial liability. If flood damages cannot be prevented, the counties should maximize the benefits available through the NFIP. In this rapidly growing environmental climate, alternate solutions to the traditional dams are now being used in flood control.

2.5.2.a Dams: The Dam Safety Section of the Maryland Department of Natural Resources lists 26 dams of various sizes and purposes within the Patuxent River watershed. Appendix B includes a description of each.

2.5.2.b Other Projects: In response to previous study authorities, the Corps of Engineers along with the State of Maryland and local governments constructed some flood control projects at Upper Marlboro. These projects consist of channel improvements, earthen levees, a floodwall, floodway clearing, highway bridge raising and bridge span construction, combined railroad and highway bridge construction, and construction of other appurtenant structures. Construction was completed in December 1964.

Land acquisition is another way to prevent losses in an area that repeatedly receives flooding damages. Howard and Anne Arundel Counties both have land acquisition programs as a response to the flooding during Hurricane Agnes. No properties have been purchased within the Patuxent watershed, however.

There are also flood warning and response systems to notify residents of a portion of the watershed when flooding is likely to occur. Even with the existing flood protection actions, residual flood damages still exist in the Patuxent River watershed because yearly stream rises still flood scattered areas. Many of the counties in the upper portion of the watershed still do not receive adequate warning to prevent damages from these more localized or flash flood type events.

The source of flooding impacts the effectiveness of flood warning systems and storm water management practices. Small streams and tributaries have a greater potential for flash floods with very short concentration times. These types of streams do not provide the lead time necessary to allow for a cost-effective flood warning system, but may be effective with strict storm water management procedures. Larger streams and rivers that pass a significant amount of flow, would be more likely to benefit from a flood warning system, because the longer lead times will give property owners time to react to the warning. Consequently, these areas do not benefit as much from stormwater management practices.

2.5.3 National Flood Insurance Program

The potential for flooding is related to the number of streams in the area and their respective drainage areas. While it is not always economically feasible to prevent flood damages, counties should maximize the benefits available through the National Flood Insurance Program (NFIP).

The NFIP was established by Congress to protect property within the floodplain from financial liability with federally backed flood insurance. In return, each community must implement floodplain management programs to reduce future flood risks to new development. The self-help criteria includes participation in the NFIP, enforcement of floodplain regulations and the presence of a flood warning system.

The purchase of flood insurance is mandatory for buildings located in the 100-year floodplain in obtaining federally backed mortgages or home improvement loans. The 100-year municipal floodplain area is defined by the Federal Emergency Management Agency (FEMA), which also determines the number of flood insurance policies in each area by evaluating existing structural flood protection measures. The primary area evaluated is the level of protection provided by a structure.

FEMA designated NFIP "communities" to be the same as Maryland's counties. The only exception is the City of Laurel, which is considered to be a "community" in itself. Prince George's County was the first to participate, in 1972. Currently, all communities within the Patuxent River watershed participate in NFIP, as shown in Table 2-8.

The number of policies is a good indication of the number of flood-prone properties, even though the number of such properties usually exceeds the actual number of policies. Total policies of individuals within the counties included in the study area are shown in Table 2-9. The largest number of policies, and also claims, have been from Prince George' and Calvert Counties. From the claims shown in Table 2-10, Calvert County was more affected by flooding caused by Hurricane Gloria in 1985, whereas Prince George's had more claims in 1979, probably due to flooding caused by Hurricane David.

Individual flood insurance rates depend on the effective date of the community's initial Flood Insurance Rate Map (FIRM). Residential buildings are classified as either "Pre-FIRM" or "Post-FIRM." Insurance rates for the pre-FIRM buildings can be more accurately determined and are subsidized. Insurance rates for post-FIRM buildings are set actuarially on the basis of designated flood hazard zones and the elevation of the first habitable floor of the building in relation to the elevation of the expected 100-year flood. This rate structure provides an incentive to property owners to elevate buildings in exchange for receiving lower insurance rates so that after substantial improvement, a pre-FIRM building will become a post-FIRM building.

An analysis was made of flood insurance damages paid throughout the watershed for flood damages. Table 2-11 shows the total amount of damages actually paid to residents in the six

main counties of the Patuxent watershed since their entry into the National Flood Insurance Program (NFIP). The number of flood insurance damage claims in the last 18 years gives a representative sample of flooding throughout the study area. Tables 2-12 and 2-13 show flooding potential of registered lots and bridges in Prince Georges County.

The Community Rating System (CRS) plays an important role in the NFIP by providing an organizational structure for coordinating floodplain management. The CRS provides a consistent rating system for communities throughout the United States. It serves as a self-evaluation tool for communities interested in improving their current conditions with respect to flood reduction. A community's program in floodplain management can then be monitored by tracking its annual CRS submittals and evaluations. Flood insurance rates can be reduced in communities that apply to the CRS and implement floodplain management activities above the minimum requirements of the NFIP. Some of the 18 credited activities are public information programs, technical assistance to residents, higher standard regulations, acquisition and relocation, flood proofing, and flood warning. These activities and their credit points are explained in the CRS *Coordinator's Manual For Local Officials.*

Each activity earns the community credit points, which, totaled, determine the CRS rating for the area. Ratings range between 1 and 10, with "1" being the highest and preferred rating, and "10" being the lowest. Calvert and Prince Georges Counties are currently participating in the CRS with current ratings of "7" and "9" respectively.

Some activities and elements are not directly recognized by the CRS because the items do not directly impact the buildings insured under the NFIP. Many of these activities and elements may indirectly affect the rating, thus altering insurance rates. For example, street and land values are not insured, but they are included in other aspects of the CRS flood insurance rating system such as a storm water drainage plan that collects street and land runoff. Likewise, flood protection projects reduce the size of floodplains, thus reducing the flood insurance premiums in newly protected areas. However, purely aesthetic or ecological activities cannot be measured for CRS credit.

2.6 WATER-RELATED INFRASTRUCTURE

The purpose of this section is to evaluate the services and effectiveness of the existing environmental infrastructure within the Patuxent River watershed, including water supply, wastewater treatment, and urban and rural best management practices. The importance of environmental infrastructure is in its ability to conserve, protect and provide safe water resources for local communities. Evaluation of these facilities and resources provides a means of beginning to accommodate future population growth without a decrease in water quality or quantity. Improvements in water-related infrastructure will also provide cleaner effluent, thus helping to improve the aquatic environment for fish, plants, and waterfowl.

2.6.1 Urban Best Management Practices (BMPs)

Twenty years ago the entire Patuxent watershed in Calvert and St. Mary's Counties were essentially rural, and uncontrolled urban stormwater runoff (USR) impacts were minimal. However, now, from a watershed-wide, nutrient loadings perspective, USR impacts are increasing compared to point source loads and other non-point sources. On a local, tributary stream basis, USRs can have overwhelming impacts on physical and biological conditions. By 1979, the areas of Anne Arundel, Howard, and Prince George's Counties had experienced significantly greater development than the other segments of the watershed. This suggests that these areas of the Patuxent River watershed are most likely to exhibit more immediate USR impacts on water quality with nitrate, phosphorus, sediment and organic chemical loadings.

2.6.1.a USR Impacts: USR in many local areas can be a significant contributor of pollutants to surface waters, as seen in Table 2-14. In urbanized areas, the storage and buffering action formerly afforded by the pervious land cover is lost unless a collected effort is made to plan and implement designs and best management practices (BMPs) that reduce adverse water quality and control runoff quantity. The results of urbanization without use of effective BMPs often include

- higher peak flows and increased flooding after storm events
- shortened time for streams to swell to peaks and then subside
- decreased base flows because of diminished groundwater recharge
- accelerated stream channel and bank erosion
- increased sediment loads from development
- introduction of a broader range of pollutants into the stream areas

2.6.1.b State Requirements: Control of non-point source pollution from developed land in Maryland is primarily dependent on State-mandated efforts by county and municipal governments with State technical and financial assistance. Erosion and sediment control and stormwater management are two key components of Maryland's non-point source management efforts.

By July 1984, all incorporated counties and municipalities were required to adopt, with the assistance of the Maryland Department of the Environment (MDE), criteria and procedures by which the counties, in conjunction with local Soil Conservation Districts, could implement stormwater management, and sediment and erosion control ordinances. The programs at a minimum must address the need for controls on all development that disturbs at least 5,000 feet of land and that significantly changes hydrology.

Of the Patuxent River watershed acreage developed after 1985, all areas are subject to stormwater management and sediment/erosion controls. Maryland has approved stormwater management on 70 percent of the post-1985 lands and sediment controls for 100 percent of construction sites. Using current design criteria, stormwater quality management attains an average of 30 percent removal rate for nitrogen and 40 percent removal for phosphorus. The

removal efficiency is dependent upon the combination of techniques used and the type of BMPs implemented. Techniques are shown in Tables 2-15 and 2-16.

2.6.1.c. State Minimum Requirements for Sediment/Erosion Controls: Maryland's Erosion and Sediment Control Law (Title 4, Subtitle 1, Annotated Code of MD) was erected to help minimize soil erosion and resultant sedimentation when land is disturbed by development activity. Minimizing soil erosion and off-site sedimentation also minimizes damages to public and private property, and assists in the attainment and maintenance of water quality standards. In 1970, state-wide sediment controls were mandated to address the Attorney General's determination that "sediment is a pollutant." State law required local governments to adopt erosion and sediment control ordinances that would require anyone planning to clear, grade or otherwise disturb the earth's surface to develop an erosion and sediment control plan for the project. Exemptions from erosion and sediment control requirements include

- agricultural land management practices and construction of agricultural structures
- single family residences or their accessory buildings on lots of two acres or more that disturb an area less than one-half acre
- clearing or grading activities that disturb less than 5,000 square feet of land area and disturb less than 100 cubic yards of earth
- clearing or grading activities that are subject exclusively to State approval and enforcement under State laws and regulations

Approved plans must include sufficient information to evaluate the environmental characteristics of the affected areas, the potential impacts of the proposed grading on water resources, and the effectiveness and acceptability of measures proposed to minimize soil erosion and off-site sedimentation, inspection and enforcement of erosion and sediment controls. In 1984, the law was amended and the State became responsible for inspection and enforcement; from 1970 to 1984, local jurisdictions had been responsible for these activities. However, the State still has authority to delegate these responsibilities to localities. MDE determines the effectiveness of local erosion and sediment control programs at least once every 2 years.

2.6.1.d. Local Stromwater Management Programs: Appendix B provides a review for each of the seven counties within the Patuxent River watershed. It includes current stormwater and erosion/sediment regulations as they deviate from the state guidelines, the status of the enforcement authority, and significant projects and retrofits in the county as they relate to stormwater management and erosion/sediment control. Table 2-17 summarized the urban BMPs for the Patuxent watershed, as of November 30, 1993, from the Patuxent Demonstration Project.

2.6.2 Rural Best Management Practices (BMPs)

It is the stated policy of the Federal government to promote the conservation of land and water, to protect rivers and harbors from sedimentation problems for navigation and flood

control, and to prevent pollution from agricultural runoff (U.S. Code of Federal Regulations, Title 16, Chapter 3B).

Federal and State assistance and technical support are provided as incentives for volume corrective measures taken by farmers; however, the Maryland Department of the Environment (MDE) retains the formal enforcement authority. As Maryland law authorizes MDE to take enforcement action against all known polluters of state waters, the 1979 agricultural water quality plan specified procedures to be followed when water pollution incidents from farm activities are suspected. A Memorandum of Agreement (MOA), signed in December 1986 by Maryland's Department of Agriculture, the Maryland Department of Natural Resources, and the Maryland Department of Health and Mental Hygiene, formalized roles and responsibilities among agency staff in attaining compliance by farmers. The procedures provide for immediate formal enforcement actions in cases of deliberate water pollution, and a voluntary compliance approach for all other cases of farm-based pollution.

Agricultural best management practices (BMPs) are conservation methods or pollution control methods that manage or reduce animal wastes and sediments, agricultural chemicals, or hazardous materials to minimize the movement of these pollutants into the ground and surface waters. Non-point source BMPs are designed to yield water quality benefits and minimize soil loss. Selection of appropriate BMPs must involve consideration of Federal, state and local regulations, funding restraints, reliability of the technique, technical capabilities, environmental impacts and interagency support.

The most practiced rural BMPs include animal waste storage structures, critical area planting, animal waste treatment lagoons, diversions, grade stabilization structures, grassed waterways and outlets, spring development, and troughs or tanks. BMPs applicable to agricultural land in the Patuxent watershed fit into three categories:

- Conservation Tillage - no till, minimum till, plow/plant system
- Conservation Cropping - crop rotation system, field strips
- Structural Measures - diversions, grassed waterways

Of the 576,492 acres, or 901 square miles, of the Patuxent River watershed, 29.6 percent is used to support agriculture. Of the lands supporting agriculture, 90 percent, or 140,000 acres, is cropland. Agricultural activity is the largest contributor of non-point source nitrogen in the watershed with 46 percent coming from field runoff. Conservation plans are encouraged by the counties' soil conservation districts for all agricultural land within the Patuxent River watershed. These plans are created in conjunction with the Soil Conservation Districts and recommend various conservation practices that control erosion and runoff, and that reduce pesticide and fertilizer pollution. Currently, conservation plans exist for 50 percent of agricultural land in the Patuxent River watershed, and nutrient management plans for 2 percent; conservation tillage is practiced on 30 percent of the agricultural land area.

In 1984, the Maryland Agricultural Cost-Share Program (MACS) implemented a financial incentive to agricultural owners and operators offering to finance 87.5 percent or up to

$10,OOO per program for the construction costs of eligible BMPs on agricultural land that aimed to protect water quality. If the BMP is for control of animal waste, then MACS will finance up to 87.5 percent or $35,000 per project.

2.6.3 Water Supply

The Annotated Code of Maryland (Natural Resources Article, Section 8-801 et seq.) states that "in order to conserve, protect and use the water resources of the State in accordance with the best interests of the people of Maryland, it is the policy of the State to control, so far as feasible, appropriation or use of surface and underground waters of the State." In addition, Section 8-802 states "every person is required to obtain a permit from the Department to appropriate or use, or begin to construct any plant, building or structure which may appropriate or use any waters of the State, whether surface or underground."

The total population for the entire Patuxent River watershed is approximately 800,000 people. Some residents in the Patuxent portions of Anne Arundel and Howard County receive water from Baltimore City. Residents of Montgomery County, much of Prince George's County, and a small portion of Howard County get water from surface water reservoirs through WSSC. Residents in the southern areas of the watershed, including southern Anne Arundel and Prince George's Counties, and Calvert, Charles, and St. Mary's Counties rely on wells that tap the Aquia, Magothy, and Piney Point aquifers. The remainder of the study area relies on water from the Patuxent Water Treatment Plant or on stored water.

2.6.3.a Surface Water Supplies: MDE has the primary enforcement responsibility for the Federal Safe Drinking Water Act through the Safe Drinking Water regulations. The Department regulates approximately 1,000 public water systems in Maryland and carries out its responsibility for ensuring safe drinking water through an enforcement strategy, assistance strategy and emergency response strategy.

Regionalization of water supply involves ownership and/or management of water utilities through an institutional structure that transcends political boundaries. Several benefits, including efficient management of pricing, full cost recovery, and shared water resources allowing for mitigation of drought impacts on any one utility or area, are realized through a regionalization program.

The Washington Suburban Sanitary Commission (WSSC), a major water supplier for the suburban Baltimore-Washington areas, owns and regulates two reservoirs, the Triadelphia and T. Howard Duckett, formed by the Brighton and Rocky Gorge dams. The dams block water from the Patuxent River and have a combined storage capacity of about 14 billion gallons at normal water levels, with additional storage available for flood control. The existing storage is considered adequate for current consumptive needs.

The WSSC reservoirs serve Montgomery, Prince George's, and portions of Howard County in the upper region of the watershed. However, the combined water supply distribution is primarily to Montgomery and Prince George's Counties, with only 5 million gallons per day

going to Howard County. Triadelphia Reservoir, formed by the construction of Brighton Dam in 1944, drains 79 square miles of the northernmost section of the Patuxent River watershed in Howard and Montgomery Counties. The four main tributaries to the Patuxent River at the Triadelphia Reservoir are Cattail Creek, Big Branch, Pigtail Branch, and Nichols Run.

T. Howard Duckett Reservoir, formerly known as the Rocky Gorge Reservoir, is located below the Triadelphia Reservoir, and was completed in 1954. This reservoir has a total watershed area of 132 square miles, 60 percent of which is shared with the Triadelphia Reservoir watershed. The major sources of water for the T. Howard Duckett Reservoir are the Patuxent River, and Hawlings River with a combined drainage area of almost 63 square miles.

The other major supplier of surface water from the Patuxent River is the Patuxent Water Treatment Plant, which processes 65 million gallons per day.

2.6.3.b Groundwater Supplies: Within the Patuxent River watershed, much of the population is supplied potable water from private well systems. Therefore, groundwater and groundwater recharge areas are important resources in the Patuxent River watershed. Recharge areas absorb and filter surface water that eventually reaches sub-surface levels. Water first seeps into the partially saturated zone directly below the surface, then farther into the ground until it reaches an aquifer, where water collects in quantities sufficient to support a well or spring.

Calvert, Charles, and St. Mary's counties, as well as portions of Anne Arundel, Howard and Prince George's counties, rely on aquifers as their primary source of drinking water supply. The recharge areas for these aquifers are located in the upper and middle sections of the watershed, where heavy urban development is occurring. A large belt of lightly developed Federal land protects some of the recharge areas, and non-tidal wetlands on these sites also provide vegetated buffers for parts of the river.

Increased water withdrawals in the southern portion of the watershed are reducing future water supply, allowing saltwater intrusion into freshwater drinking supplies, and may be having additional adverse impacts. The National Oceanographic and Atmospheric Administration (NOAA) has documented that groundwater withdrawals may also be causing land subsidence. As water is pumped from the ground, the remaining coastal plain sediments compact, and the land "sinks". This chain of events causes small islands, wetlands, and marshes to be flooded, and vital ecosystems and organisms to be eliminated. For example, the water levels in wells near Solomon's has dropped 33 feet in the past 10 years, possibly due to increased pumping by the nearby Patuxent Naval Air Station and to the growing population around Lexington Park.

2.6.3.c Quality: WSSC reported that the water quality of the upper Patuxent watershed system and the two reservoirs is considered good for water supply. Although WSSC pursues an active watershed protection program in this rural area, modeling indicates that under existing land use conditions, both reservoirs are under significant stress from nutrient enrichment, making both reservoirs mesotrophic to marginally eutrophic. sediment loading

rates to the reservoirs are lower than historical rates, but are expected to increase with development in the area, creating additional stress on the water quality in the reservoirs.

In addition to surface water quality issues, pollutants can reach the groundwater through the water recharge cycle. Pollutants enter an aquifer from leaking landfills, pesticides and fertilizers, mining and industrial wastes, sewage treatment plants, and failing septic systems. Groundwater pollution can also occur naturally, producing excessive hardness, iron, bacteria, hydrogen sulfide, sodium chloride, acidity or alkalinity. While most inorganic compounds are harmless at low concentrations, others, such as potassium, sodium, fluoride, and arsenic, are toxic.

Over the past 30 years, groundwater quality has remained constant in the Patuxent River watershed. From a trend analysis conducted on water quality parameters, no deterioration in water quality is projected. No major problems exist in the study area, in relation to groundwater quality or quantity, that would adversely affect existing or future development.

The drinking water from the Patuxent Water Treatment Plant is of good quality, in large part due to the high quality source water it receives.

2.6.3.d Quantity: Present water supply of the WSSC for Montgomery, Prince George's and portions of Howard Counties is adequate to meet consumptive demands but may not be sufficient for future increases in growth rates. Siltation of the Triadelphia and T. Howard Duckett reservoirs is reducing the available capacity for storage, such that both reservoirs will lose 50 percent of their original capacity by the year 2100. Additional raw water supplies are projected to be needed by the year 2015 in order to meet growth needs.

Anne Arundel, Calvert, Charles, western Howard, and St. Mary's Counties predominantly rely on the Aquia, Magothy, and Piney Point aquifers for industrial, commercial, and general household uses. The Aquia aquifer is the major source of water and is currently under intense stress from overuse.

2.6.4 Wastewater Treatment

As the Patuxent watershed has expanded in development and population since the late 1950's and early 1960's, each new person has contributed approximately 100 gallons of sewage a day to be treated, 36,500 gallons per year per person. Initially, all the sewage was flushed to the Patuxent until severe degradation to water quality was detected. Citizens and policy makers then took action to save the integrity of the Patuxent River, as well as that of the Chesapeake Bay.

The Patuxent watershed has had a dramatic reduction of point source nitrogen and phosphorus loads due to the implementation of advanced nutrient removal technology at many of the wastewater treatment plants. These activities were encouraged by the 40 percent nutrient reduction goal set by the Chesapeake Bay Program for the year 2000.

2.6.4.a National Pollution Discharge Elimination System (NPDES) Regulations: NPDES permits for point source discharges are required under the Code of Maryland Regulations (COMAR) Title 26, Subtitle 08. Pollutant limits contained in the permits are established through estimates of the absorbent capacities of the receiving bodies of water. All WSSC existing and planned wastewater treatment plants have NPDES permits. NPDES outfalls are depicted in Figure 2-5.

2.6.4.b On-Lot Wastewater Treatment: As of 1994, approximately 169,108 households relied solely upon on-lot disposal systems. Septic tanks remove approximately 30 percent of nitrogen and approximately 48 percent of phosphorus in raw domestic wastewater.

Regulation of septic tanks and other on-lot treatment systems began in 1953, with a State code which set requirements for wells, cisterns, chemical toilets, and septic systems. However, not until March 1972 did percolation testing within Maryland become mandatory. A minimum of 10,000 square feet of reserve area for the septic tank system was established for all lots, except in the Patuxent River watershed, where a minimum of 17,000 square feet of reserve area was required. The larger area was required because of the recognition that this area is not likely to ever be serviced by a community sewer (Asplen, 1991; Kerr, 1991; Teutsch, 1991). By 1985, all counties in Maryland were also required to conduct soil evaluations for septic tank suitability.

Effective November 3, 1986, the Maryland Department of the Environment (MDE) regulates septic tank system siting, design and construction (Title 26, Subtitle 04, Regulation of Water Supply, Sewage Disposal and Solid Waste). This legislation establishes the minimum standards that must be enforced on a state-wide basis, although counties may set more stringent requirements.

As described by the Water Management Administration, "[t]he typical onsite sewage disposal system in use in the State is a conventional system that consists of a septic tank that discharges via gravity to subsurface gravel-filled trenches. The septic tank provides for primary settling and partial digestion of organic matter. Heavier solids accumulate in the bottom, lighter solids accumulate in a scum layer at the top, and partially clarified effluent exits the tank through a baffle. In the unsaturated soil beneath the gravel-filled trench, the septic tank effluent is treated by the processes of physical filtration, biologic competition, ion exchange and adsorption."

It should be noted that older communities, built before 1972, usually do not have septic systems that conform to the State regulations. These communities, therefore, are often primary contributors to nutrient and bacterial pollution in some portions of the study area due to failing or inadequate on-lot treatment systems.

2.6.4.c Wastewater Treatment Facilities: According to MDE, there are 27 wastewater treatment plants providing sewer service within the study area. Of these, the State of Maryland's draft *Tributary Strategy for Nutrient Reduction in Maryland's Patuxent Watershed*

has identified nine as major wastewater treatment plants (WWTPs) in the watershed. These major plants are Dorsey Run, Maryland City, Fort Meade, Parkway, Piney Orchard, Little Patuxent, Patuxent, Bowie, and Western Branch. Of these, Western Branch is by far the largest.

The tributary strategy calls for biological nutrient removal (BNR) of nitrogen and chemical phosphorous removal (CPR) at all WWTPs that currently have a design flow equal to or greater than 0.5 million gallons per day (MGD). If smaller WWTPs are expanded to above 0.5 MGD in the future, BNR and CPR will be required at the time of expansion.

WSSC has the centralized public sewer responsibility for Montgomery and Prince George's Counties. This sewer system prohibits dangerous amounts of raw waste from entering surface and groundwater, thereby preventing the destruction of aquatic life, adverse effects to community health, and contamination of water resources. This structure takes advantage of topographical features between the two counties, and neighboring jurisdictions. Presently over 90 percent of Montgomery and Prince George's counties are connected to a regional wastewater system. All major wastewater treatment plants along the Patuxent River, except the Little Patuxent Wastewater Treatment Plant, use BNR or methanol additions to remove nitrogen below 8 mg/l. The Little Patuxent plant is currently being upgraded.

Figure 2-6 depicts the location of registered wastewater treatment plants in the Patuxent River watershed. Table 2-18, in the Annex, lists the wastewater treatment plants and their average flows.

2.7 RECREATION RESOURCES

2.7.1 Introduction

Recreational resources in the study area include mostly nature-based recreational facilities for passive recreation. Those include facilities for hiking, nature watching, photography, fishing, boating, and picnicking, as well as environmental education opportunities. Within the lower Patuxent there are numerous marinas for boat-launching opportunities and fishing. Public lands within the study -area include various Federal-, state- and county-owned lands and facilities, as well as regional and private facilities.

2.7.2 Historic Conditions

The study area's park system reflects the vision of the early 20th century planning movement. It was the Frederick Law Olmstead brothers who popularized the idea of large open parks. They envisioned a park system in which stream valley parks would be connected by greenways or parkways to other parks. Much of this system was actually created, and the parks in the Baltimore-Washington Metropolitan Area reflect the Olrnsteads' vision.

2.7.3 Current Uses

An Outdoor Recreation Survey conducted in 1986 by the Maryland Office of Planning showed that the most popular resource-related recreational activities among state residents are nature walks, picnicking, hiking, swimming at a beach, fishing, motor boating, and public camping. Facilities that were found to be relatively unavailable in the state include downhill skiing, cross-country skiing, swimming at a beach, horseback riding, canoeing, rafting, kayaking, camping, and hunting.

Boating is one of the major recreational activities that occurs in the watershed. The Patuxent River is recognized as one of Maryland's prime recreational boating areas, supporting contingents dedicated to sailing, water-skiing, powerboatig, and other water-oriented pursuits. In addition to the thousands of boats moored on the Patuxent, many others are brought in by trailer from Washingotn and Baltimore. However, the present distribution of launch ramps and marinas results in concentration of use near the river's mouth. There are private boating facilities in this area that provide launch ramps; however, they are not accessible to the general public. Inventories of existing public launch ramps and marinas can be found in Table 2-19 in the Annex.

Most of the river's marinas and, thus, much of the boating activity, are concentrated around the Solomons, Town Creek, St. Leonard Creek, and Benedict areas. There are 37 rnarinas and/or launch ramps, excluding community marinas, on the lower Patuxent, with approximately 2,000 slips and 15 ramps listed. On the upper Patuxent, most of the boating activity takes place on Triadelphia and T. Howard Duckett reservoirs, where canoes, kayaks, electric motor boats, and small sailboats are allowed. The reservoirs have six public boat ramps and areas where boats can be stored on land. Boating issues on the Patuxent are discussed further in Section 4.

All of Maryland's rivers and streams are classified according to their uses, and all have specific water quality controls. These classifications include the following:

CLASS	DESIGNATED USES
I	Water Contact Recreation, Aquatic Life
I-P	Water Contact Recreation, Aquatic Life and Public Water Supply
I I	Shellfish Harvesting
I I I	Natural Trout Waters
III-P	Natural Trout Waters and Public Water Supply
IV	Recreational Trout Waters
IV-P	Recreational Trout Waters and Public Water Supply

The mainstem river and tidal waters between the mouth and Ferry Landing are classified as Use II for shellfish harvesting. The remaining mainstem river and its tributaries up to Rocky Gorge Dam are classified as Use I for water contact recreation and aquatic life. Upstream of the Rocky Gorge Dam, T. Howard Duckett Reservoir and its tributaries and the upper Little

Patuxent are classified as Use I-P for water contact recreation, aquatic life and public water supply. The mainstem river and its tributaries from Duckett Reservoir through Triadelphia Reservoir are classified as Use IV-P, waters for recreational put-and-take trout fishing and public water supply. Upstream of the Triadelphia Reservoir, the river and its tributaries are all classified as Use III-P waters for natural trout production and public water supply *(Maryland Water Quality Inventory).*

Fishing is another popular recreational activity in the study area. Fishing piers in the area are currently heavily used. All waters between T. Howard Duckett (Rocky Gorge) Reservoir and Triadelphia Reservoir are designated recreational trout waters (Class IV). All water above the Triadelphia reservoir are designated natural trout waters (Class III). In addition, 2 miles of the Patuxent in Prince George's County, from the end of Main Street in Laurel downstream to the B&O Railroad Crossing, and 1 mile of the Cabin Branch in Howard County, from the confluence with the Patuxent upstream to Hipsley Hill Road, is designated a trout stream.

The water quality of the Patuxent is crucial to the reproductive cycles of fish caught for commercial profit or recreation. Anadromous fish contribute heavily to the commercial and sport fisheries and are considered very important economically. The Patuxent provides spawning grounds for herring, shad, yellow and white perch, and striped bass. However, there are over 100 species of fish recorded in the Patuxent River. One-third of these may be described as abundant species *(Patuxent Recreation Program).*

Oysters are found in the Patuxent as far north as the town of Benedict. Populations are scarce in the river due to a combination of poor spat set and disease mortality. The middle and lower Patuxent were once commercially productive but harvests have declined significantly due to the spread of oyster disease. Recreational oystering is allowed in the Patuxent River, but the Maryland DNR Shellfish Program has established laws to regulate this activity.

Greenways are protected corridors of open space, maintained in a largely natural state for a variety of purposes, including water quality protection, wildlife enhancement, aesthetic relief, recreation, non-motorized transportation and environmental education. All greenways serve at least one of these primary functions, and most offer some combination. Greenways are often associated with a linear natural feature like a stream, a coast, or the ridge of a mountain. Ideally, they incorporate or link larger open spaces. Greenways can clearly enhance both urban and suburban areas by providing linked natural corridors and small parks adjacent to developed places that afford safe access to larger park tracts. In addition, wildlife that may suffer in various ways from being locked in a small island-like park will have the opportunity for range extension as greenway links are made *(AA LPROSP).* Greenways are discussed further in Section 2.8.3.b.

Wetlands provide recreation for fishermen, hunters, and naturalists and provide an important educational and scientific resource. There are approximately 34,000 acres of wetlands in the study area (MD-DNR data). Jug Bay Wetlands Sanctuary in Anne Arundel County provides

an excellent example of how to use a wetland for passive recreation, education, and research purposes. Jug Bay Wetlands Sanctuary is described in Section 2.8.3.c.

Forested areas are valuable natural resources for open space conservation, recreational development, and economic growth. They provide opportunities for a multitude of recreational activities, stabilize soil, reduce water runoff, provide a habitat for a variety of wildlife, and retard erosion along streams and rivers. Forested areas within the Patuxent are excellent resources for low intensity recrational areas. They provide the public with areas to hike, picnic, camp, hunt, study nature, and relax *(Patuxent Recreation Program).*

2.7.3.a Federal Recreation Lands: The Federal government provides broad-based recreational services to military personnel and their families. Some facilities are also open to the public. Descriptions of Federal recreational facilities are described in Section 2.11 below.

2.7.3.b State Recreation Lands: The State of Maryland provides outdoor recreation areas and open spaces to meet the recreational needs of the state's residents and visitors (see Figure 2-7). These state recreation areas usually include facilities for bicycling, boating, camping, fishing, hiking, horseback riding, ice skating, picnicking and walking for pleasure. The State also protects natural areas of statewide importance that provide opportunities to participate in nature walks, nature observation/education, hunting, and cross-country skiing.

Maryland Department of Natural Resources (MD-DNR) holds approximately 14,500 acres of land in the Patuxent River Watershed (see Table 2-20). These lands include state parks, wildlife management areas, natural resource management areas, and a natural heritage area. Nearly all of the state's land units contribute to the larger Patuxent Greenway comprised of protected lands under various ownership.

a. State Parks: The primary function of a state park is to preserve open space and natural areas and to offer recreational opportunities for those desiring a natural or wilderness experience. State parks may include wooded areas, open fields and meadows, areas of rugged topography, streams, rivers, lakes, marshlands, or any other type of natural environment. Recreational activities are generally activities that require large acreage, such as camping, fishing, hunting, and hiking. State parks ensure the conservation of large open spaces in their natural state for future generations to experience and enjoy.

   Patuxent River State Park, a 6,600-acre holding in Howard and Montgomery Counties, is a largely undeveloped park that provides opportunities for hunting, fishing, trail activities, and nature study. The park contains about 20 miles of hiking and horseback riding trails and a special environmental study area. There are numerous agricultural leases on the property. Within the park, the Patuxent River is managed as a special trout stream. The park hosted 17,460 visitors in 1992.

   Rosaryville State Park (border Potomac/Patuxent) is located just south of Upper Marlboro in Prince George's County. This 1,000-acre day-use park offers facilities for

hiking, horseback riding, picnicking, boating, fishing, and campsites. This park also contains the historic Mount Airy Mansion plantation, which is available to the public for special occasions.

Greenwell State Park is a 596-acre waterfront park near Sotterly Point. Current visitor uses include programming geared to the needs of physically challenged visitors; it also offers hunting and nature observation. The Patuxent Aeromodelers use 2 acres on the property for model aircraft flights.

Jefferson Patterson Park, in Calvert County, is a 512-acre farm at Patterson's Point that was donated to the State of Maryland in 1983, and that is managed as an archeological park for research and educational opportunities. The park is owned and operated by the Maryland Department of Housing and Community Development.

The Patuxent Regional Greenway is the most expansive recreational resource within the study area. It is a partially established regional greenway extending from central Maryland to southern Maryland. The Patuxent River serves as the spine for the greenway that runs through Howard, Montgomery, Anne Arundel, Prince George's, Calvert, Charles, and St. Mary's Counties. MD-DNR currently owns about 15,000 acres along the Patuxent River and is working with local officials to extend protection along the mainstem. This greenway could potentially extend almost 100 miles.

b. Natural Resources Management Areas (NRMA): There are 12 Natural Resources Management Areas (NRMA) in the Patuxent Watershed. These areas provide habitat for wildlife and are also available for hunting, hiking, and wildlife observation.

Indian Creek NRMA is a 660-acre site in Charles County. The property is used by hunters, fishers, naturalists, and bird watchers. The property forms a "green belt" around the town of Benedict.

Kings Landing NRMA in Calvert County encompasses 1,180 acres on 2 adjacent areas: the Huntingtown area, managed by MD-DNR, and the Kings Landing area, managed by Calvert County. Activities in the Kings Landing area include educational programs, wildlife observation, and hiking. In the Huntingtown Area, activities include hunting, wildlife observation, horseback riding, and hiking. This site is also used for environmental education programs focusing on natural and cultural resources of the area.

The Merkle Natural Resource Management Area is operated as a Wildlife Sanctuary encompassing approximately 1,700 acres, composed of 15 parcels in Calvert and Prince George's Counties. The core of the property, consisting of 400 acres, includes the Wildlife Sanctuary and Visitor Center. This area provides opportunities for nature exploration and study. Exhibits in the Visitor Center mainly focus on the history and management of the Canada Goose. Other display themes include cultural history, agricultural best management practices, wildlife management techniques, and the local

history of the Merkle area. Wildlife observation, hiking, and biking are available at various times of the year on 3 trail systems at the sanctuary. Other special and educational programs are offered at the sanctuary throughout the year. Annual visitation at Merkle NRMA is approximately 40,000.

c. Wildlife Management Areas (WMA): MD-DNR also maintains Wildlife Management Areas for wildlife conservation and public enjoyment. WMA's across the state total more than 91,000 acres. Excellent recreational opportunities exist at WMA's; these include hunting, communing with nature, and photography. WMA's in the Patuxent River watershed include Bowen WMA and Cheltenham WMA, both in Prince George's County, and Globe Comm WMA in Anne Arundel County.

Bowen WMA is accessible primarily by boat and is comprised mostly (90 percent) of tidal marsh area. The area is a stop-over point for migrating and wintering waterfowl, creating an excellent hunting area through its 300 acres. The area is also host to excellent crabbing and fishing opportunities. Other opportunities at Bowen include wildlife viewing and canoeing.

Cheltenham WMA is owned by MD-DNR and the Maryland Department of Juvenile Services. This 25-acre facility provides a state-of-the-art "walk through" archery range, a dove-hunting area, and walking trails.

Globe Comm WMA is a 207-acre property in Anne Arundel County used primarily for wildlife observation and hiking.

d. Other MD-DNR Holdings: There are no designated state forests in the study area except those forested areas within the state parks and other property holdings.

The Patuxent Oxbow Natural Heritage Area is a 50-acre site in Anne Arundel County. The property contains a portion of a unique natural freshwater lake formed by the isolation of a former meander of the Little Patuxent River. This lake is the largest of its type in Anne Arundel County, and is potentially the largest of its type in Maryland. This property is also host to 143 bird species, 106 plant species and a state-listed threatened plant species.

Belt Woods Natural Environment Area (NEA) is a 113-acres site in Prince George's County on the Patuxent/Potomac watershed border. This property is one of the best examples of an "old growth" forest surviving in Central Maryland, which provides shelter to a diverse interior-dwelling bird community. This property is also a designated "State Wildland," which prohibits the construction of roads and structures or the pursuit of other activities inconsistent with a wild natural character.

2.7.3.c County Recreation Lands: County recreation and park agencies, for the most part acquire, develop, and maintain recreation facilities designed mainly to serve local residents. These facilities include tot-lots, playgrounds, neighborhood parks, and community-wide parks.

Most counties also include Board of Education Properties as accessible facilities. A list of the county recreation areas and associated facilities within the study area is located in Appendix B.

a. Anne Arundel County owns approximately 970 acres along the Patuxent and its tributaries. The county has 8 county parks and 7 environmental and special facilities withing the study area. Other recreational opportunities exist at the Jug Bay Wetlands sanctuary.

Jug Bay Wetlands Sanctuary is an Anne Arundel County Department of Recreation & Parks and a Chesapeake Bay National Estuarine Research Reserve facility. The sanctuary offers a visitor center and trail system for hiking and nature observing. Picnic tables are provided at the visitor center. The sanctuary is open to the public by reservation only, and an entrance fee is charged.

b. Calvert County public parks provide opportunities to gain greater understanding and appreciation for the county's historic ties to the water and land through programs and activities sponsored at these sites. The county owns 7 county parks within the study area. Other special facilities in Calvert County include Battle Creek Cypress Swamp, the Calvert Marine Museum, Camp Mohawk, and the Christ Child Society Camp.

Battle Creek Cypress Swamp in Prince Frederick is a 100-acre nature sanctuary managed by the Calvert County Natural Resources Division. This facility is unique in that it is the northernmost naturally occurring stand of bald cypress trees in the United States. The sanctuary offers a quarter mile of elevated boardwalk for touring the swamp and for observation. The sanctuary also offers a visitor center complete with exhibits, demonstrations, and audio-visual presentations. Guided walks and lectures are offered year-round.

Calvert Marine Museum offers educational exhibits, programs, and publications relating to marine paleontology of Calvert Cliffs, estuarine biology of the Patuxent River, and local maritime history. The museum also hosts the Drum Point Lighthouse, one of the three remaining screwpile lights that served the Chesapeake Bay at the turn of the century. This restored lighthouse marked the entrance to the Patuxent River from 1833 until 1962.

Camp Mohawk, a 261-acre property, has nearly 1 mile of shoreline and contains recreational facilities such as picnic tables, campsites, trails, cabins, and a swimming pool.

The Christ Child Society Camp is located on the Patuxent River off Wharf Road and is used as a summer camp for school-age children.

c. Charles County has no developed recreational areas in the study area. The county does have property (640 acres) under cooperative ownership with MD-DNR at Maxwell Hall. A boat launch and trail system are proposed at this site. Another undeveloped

site includes the Indian Creek property, which is available for hunting. A third property, which has a ballfield, is located at Benedict Bridge.

d. Howard County Department of Recreation and Parks provides residents with a wide variety of recreational opportunities. These include passive recreational enjoyment of open space and natural areas, active recreational sports facilities, historical interpretation, cultural programs, trips, classes, and social and educational programs. The county manages 4 county parks and 20 Community and Neighborhood Parks in the study area.

Centennial Park is the county's showcase park, highlighted by its 40-acre lake for fishing and boating. The county is in the design stage of an 80-acre facility known as High Ridge Park, which will be located directly on the Patuxent River. The natural beauty and environmental sensitivity of this site have inspired a design limited in active recreation, but rich in opportunities to enjoy nature.

Howard County is negotiating the acquisition of 950 acres along the Middle Patuxent to be managed as an environmental preserve and an environmental education center. The county envisions that open-space dedications, easements, and additional acquisitions along the Middle and Little Patuxent Rivers could ultimately link the Patapsco and Patuxent Greenways.

Columbia, Maryland, is further served by a multitude of recreation amenities that this planned community provides its residents. These include the Columbia Arts Center, Lake Elkhorn Picnic Pavilion, 7 village community centers, 14 neighborhood centers, the Columbia teen center, 21 neighborhood pools, the Columbia Horse Center, 77 picnic areas, and 6 public tennis courts.

East of Triadelphia and T. Howard Duckett Reservoirs, Howard County is continuing to squire land along the river approaching Route 1. This cooperative land preservation effort, among state, local and private entities, is critical to the protection of the river and the provision of public access.

Howard County continues to acquire land along the Little and Middle Patuxent Rivers through a developer-dedicated open-space process. It is envisioned that these dedications of land coupled with easements and fee simple acquisition will ensure preservation of the watershed and provide public access along these greenway corridors.

e. Montgomery and Prince George's Counties - Parks in these counties are owned and managed through Maryland-National Capital Park and Planning Commission (MNCPPC). See the Regional and Private Lands segment below for further information.

f. St. Mary's County has 7 recreational properties in the county within the watershed. Of these, 2 are undeveloped. These properties are listed in the table in Appendix B.

2.7.3.d Regional and Private Lands: The private sector provides a wide variety of specialized recreation facilities and support services that compliment public recreation facilities and that can operate within parks on a concession basis. Facilities may provide for the following activities: archery, outdoor concerts, sporting events, boating, camping, fishing, golfing, horseback riding, hunting, ice skating, swimming and tennis. Private recreation is also provided by a number of clubs and hobby groups throughout the study area. Such organizations include archery clubs, bicycle clubs, dog clubs, equestrian clubs, fishing clubs, gun clubs, and many more.

a. The Maryland-National Capital Park and Planning Commission (MNCPPC) acquires, develops, maintains, and administers a regional system of parks for Montgomery and Prince George's Counties, with the exception of certain municipalities. The park system developed through the years in these counties provides for the outdoor recreational needs of county residents as well as the conservation and multiple uses of land and water resources. The commission administers stream-valley parks, large regional parks, neighborhood parks, and park/school recreational areas.

MNCPPC of Montgomery County owns 11 park areas in the study area (1,872.1 acres). Of these, 4 are undeveloped: Rachel Carson Conservation Park, Hawlings River Stream Valley Park, Reddy Branch Stream Valley Park, and the Patuxent River Watershed Conservation Park. The Hawlings River Stream Valley Park is a 536-acre park that surrounds a tributary to the Patuxent. The remaining developed park sites are described in Appendix B.

MNCPPC of Prince George's County currently owns approximately 4,750 acres along the Patuxent in Prince George's County. There are now 9 stream valley parks located within the Patuxent River Watershed. Recreational facilities have been developed within stream valley parks when the demand for such facilities is high and where the terrain is suitable, providing that natural and floodplain features of the area are respected.

b. The Patuxent River County Park, a 5,752.46-acre holding in Prince George's County, consists of 21 parcels along the river.

c. White Marsh Park, a 215-acre municipal park several miles west of Bowie, has athletic fields and a bike trail. This park is operated by the City of Bowie.

d. The Washington Suburban Sanitary Commission (WSSC) operates 2 reservoirs along the Patuxent Triadelphia Reservoir at Brighton Dam and T. Howard Duckett (Rocky Gorge). On the 4,400 acres surrounding these reservoirs, the WSSC offers visitors with facilities for picnicking, azalea garden viewing, fishing, boating,

hunting, and horseback riding. More than 500,000 people per year visit and use these facilities.

2.8 SOCIAL AND ECONOMIC SETTING

2.8.1 Political Boundaries

Political boundaries in the area include county, city, Federal, and congressional boundaries. These are shown in Figure 1-1.

2.8.2 Population

The population of the 7 counties within the Patuxent River watershed is over 2,300,000. Although not all of these people reside in the river's drainage watershed, a large proportion do. The drainage watershed's 910 square miles make up approximately 33.9 percent of the total area of the 7 counties combined, for a total population of approximately 800,000 in the Patuxent watershed. The population of the Patuxent watershed grew 245 percent between 1950 and 1980, and is expected to grow another 90 percent between 1980 and 2000 (WSSC). Population trends are depicted in Figure 2-8 and Figure 2-9.

Specific population and income data, by county, can be found in Tables 2-21 and 2-22.

2.8.3 Employment

Employment data from the Maryland Department of Economic and Employment Development are shown in Table 2-23.

The unemployment rate as of November 1994 for each county in the study area is shown in Table 2-24, along with the employment growth rates. Unemployment rates for each county are all below the overall United States unemployment rate of 5.3 percent for the same month, and below the overall Maryland unemployment rate of 4.9 percent.

Employment growth rate figures for Howard, Prince George's, Anne Arundel, and Montgomery Counties were compiled by the Maryland Department of Economic and Employment Development, and are also shown in Table 2-24. Employment growth figures are unavailable for Charles, Calvert, and St. Mary's Counties.

2.8.4 Education

Maryland Department of Economic and Employment Development data on educational attainment for each county are given in Table 2-25, in the Annex.

2.9 CULTURAL RESOURCES

The purpose of this segment is to provide information on cultural resources within the Patuxent River watershed. Additional information on prehistoric and historic events and sites in the watershed can be found in Appendix B.

The Patuxent River watershed area has been a focus of intensive human activity for the past 5,000 years. The river offered a source of transportation and food to the local Native American population, and the Maryland Archeological Site Files note numerous village sites and procurement areas along the entire length of the river. For the most part, the villages were located on the well-drained knolls overlooking the river, but some resources such as lithic collection sites, fish weirs, and temporary encampments would have been located along the edges of the river.

During the historic period, the Patuxent continued to be an important route of transportation and commerce, especially during the tobacco era. Dozens of farms and plantations lined the banks of the river, and landowners built appurtenances such as docks, fords, dams, mill raceways, and other features, which altered the river and left archeological and architectural remains along its banks. There is also incidental evidence of human activity, such as the ships destroyed at Pig Point during the invasion of Washington by the British in 1814.

Given the variety of cultural resource types noted in the records, it is likely that the proposed projects along the Patuxent will have an effect on one or more cultural resources. Field examination is thereby recommended for all proposed projects to identify cultural resources and develop plan alternatives to minimize the effects of Corps' projects on significant cultural resources.

2.10 HAZARDOUS, TOXIC AND RADIOACTIVE WASTES

Verification of existing hazardous, toxic and radioactive waste (HTRW) sites allows for a comprehensive overview of the study area that can lead to comprehensive solutions. Previous land uses/abuses can be identified, effects and dangers to environmental resources (as well as humans) can be assessed, and solutions to prevent further degradation can be explored.

The Chesapeake Bay Program's Toxics Sub-Committee tracks the sources of toxic substances found in the Bay. Their 1994 report on toxic substances loading indicates that, while the Patuxent River has five major sources of toxics, and indeed has the only source of bromodichloromethane in the Bay watershed (1 pound per year), the river is relatively the of toxins. Specific data may be found in Appendix B.

HTRW sites were identified in the study area using EPA databases compiled by GIS. The study area was investigated for the types of sites defined in this section. Information regarding the status of the sites was not investigated for this study. Further information will be obtained if the

projects are funded for design and construction in the future. Table 2-26 lists the HTRW sites by county.

2.10.1 CERCLIS List

The EPA Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) list is comprised of sites that have been investigated or are currently being investigated for a release or threatened release of hazardous substances pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). The CERCLIS was investigated to identify HTRW sites within the study area. There are 26 CERCLIS sites in the Patuxent River watershed, as shown in Figure 2-10. These sites are primarily located in the Baltimore-Washington corridor portion of the upper watershed.

2.10.2 National Priorities List

The National Priority List (NPL) is the EPA database of abandoned or uncontrolled hazardous waste sites identified for priority remedial action under the Superfund program. Their are no NPL sites within the Patuxent River watershed.

2.10.3 RCRA List

The EPA Resource Conservation and Recovery Act (RCRA) regulates facilities that are generators of hazardous waste. The program identifies and tracks hazardous waste from the point of generation to the point of disposal. The RCRA facilities database is the EPA compilation of reporting facilities that generate, transport, treat, store, or dispose of hazardous waste. There are five sites within the Patuxent River watershed where hazardous and toxic chemicals are processed, four in the upper watershed and one at Naval Air Station - Patuxent. These sites can be seen in Figure 2-11.

2.10.4 TRIS List

The Toxic Release Inventory (TRI) keeps a record of those sites which release toxic substances to the land, water, or air. There is one water release site and one land release site, and an unknown number of air release sites, within the Patuxent River watershed. These sites are depicted in Figure 2-12 and Figure 2-13.

2.11 FEDERAL LANDS

2.11.1 Andrews Air Force Base

The information for this segment and the following one came from Air Force reports and interviews with key personnel.

Andrews Air Force Base (AAFB) is located in Prince George's County, southeast of Washington, D.C. The base was established on August 25, 1942, as Camp Springs Airfield.

Currently, the primary mission of the host organization, 89th Airlift Wing, is the transportation of the United States President, the Vice President, and other government officials. The 89th Airlift Wing oversees and manages the base, which includes oversight of environmental programs.

Three Federal properties fall within the jurisdiction of AAFB: the main base, Brandywine Communication Stations (located south of AAFB), and Davidsonville Communication Station (located northeast of AAFB). Brandywine is the communications receiver for government information, and Davidsonville is the transmitter of communications. Both communications stations are accompanied by small (4 to 8 acres each) housing areas with 16 units per area.

Andrews Air Force Base totals 4,321 acres. Approximately 80 percent of the base is developed or intensively managed with a variety of land uses including housing, aircraft runways, taxi-ways and operational aprons, equipment storage, offices, hospitals, vehicle maintenance facilities, sports fields, schools, and clear zones for runways.

The Potomac and Patuxent watersheds divide AAFB. Five ponds, 17 acres of non-tidal wetlands, and several streams are located on the AAFB property. The groundwater table varies at AAFB, ranging between 5 feet and 22 feet below the ground surface.

2.11.2 Davidsonville Communication Station, USAF

The Davidsonville Communication Station is located on 852 acres in Anne Arundel County, all of which lies in the Patuxent River watershed. Andrews Air Force Base operates the communication station, which has the primary mission of providing a secured facility for transmitting information for the United States President.

The communications station is located on a level terrace and rises slightly to the northeast then drops quickly towards the Patuxent River to the west. Several steep slopes form the property's drainage pattern. The property's elevation ranges from 60 feet to 180 feet. Two small tributaries flow through the Davidsonville property and into the Patuxent River. Small non-tidal wetlands are located on the property. The site is predominantly undeveloped land and contains a mixture of vegetation.

2.11.3 Federal Communication Commission (FCC)

Information for this segment was derived from an interview with Charles Magin on September 13, 1995.

Since 1941, the 212-acre communication monitoring station of the Federal Communication Commissions (FCC) is located within the suburbs of Columbia. The property is divided into two parcels, the main property and a couple acres south of Interstate 95. The two main missions of the facility are to be a domestic communication and information bureau (15 employees) and to perform communications equipment testing (35 employees). Future expansion includes seven new employees and additional temporary office space at the

monitoring station. The main property contains two building clusters, one in the center of the property and the other near the western boundary. Both clusters accommodate employee offices and storage buildings. Communications equipment is located in the open grassy area. No development or activity occur on the smaller parcel.

Two streams surrounded by riverine wetlands are located on the monitoring station property. One stream is located north of the communications monitoring building and flows in a northerly direction. The second stream is located in the south central section of the property and flows south. The topography of the property gradually slopes southeast towards the streams. The vegetation on the non-developed land is approximately 50 percent forested and 50 percent grass lands.

2.11.4 Fort George G. Meade

Information from this segment is derived from Fort Meade reports.

Fort Meade is located between Washington, D.C. and Baltimore, Maryland, with portions of the installation in Anne Arundel, Howard, and Prince George's Counties. The property spans 5,148 acres, of which 4,949 lie within the Patuxent River watershed. Approximately 55,000 employees and residents use the installation. The property contains two 18-hole golf course, a pedestrian path, administrative buildings, offices, approximately 70 tenants including the National Security Agency (NSA), housing, and other military support buildings.

Fort Meade encompasses diverse natural resources. The property is divided between two watersheds, most of which drains to the Patuxent River. Two branches of the Patuxent River flow south through the installation: Franklin to the east and Midway to the west. These streams join on the southern portion of the installation property forming the Rogue Harbor Branch. This branch then flows south through the Patuxent Research Refuge and eventually into the Little Patuxent River. The topography of Fort Meade is gently rolling hills with a few steep slopes in some of the undeveloped areas.

Diverse vegetation communities are found on the property. Wetlands, totaling approximately 290 acres, are scattered throughout the property. Some portions of the property are forested. Other green spaces on the property include the golf course, Burba Park, recreation facilities, and residential yards. Eleven rare, threatened, and endangered species have been observed on the property.

2.11.5 Goddard Space FIight Center (NASA [GSFC])

Information for this segment is taken from NASA reports.

National Aeronautics and Space Administration's (NASA) Goddard Space Flight Center (GSFC) is located in Maryland's Prince George's County. The GSFC property was established in 1959 to provide support for space research and exploration. Approximately 12,000 people are employed on the property, including tenants. Of the 1,200 acres on site,

460 acres is developed with parking lots, roads, and approximately 100 buildings. The remaining 740 acres is wooded. Approximately half of the development at GSFC is within the Patuxent watershed.

Two watersheds divide GSFC, the Anacostia and the Patuxent. Approximately 200 acres are in the Patuxent watershed. No designated streams are found within the Patuxent watershed, but there is an unnamed tributary which collects runoff and flows south off the property and eventually into Bald Hill Branch. In addition, a few small wetlands are within the Patuxent River watershed. The vegetative portions of GSFC consist of woods, maintained lawns, and landscaped shrubs and trees. The perimeter of the property is composed of naturally growing forests. The topography of the entire facility is gently rolling hills with the highest elevation at the southeast section, 230 feet, and the lowest elevation, 150 feet, in the northern section.

2.11.6 Naval Academy Dairy Farm

The Naval Academy Dairy Farm is located in the eastern central portion of the Patuxent River Watershed boundary. The Naval Academy Dairy Farm will not be incorporated into the Federal Facilities section of the Patuxent River Water Resource Study because contact was not established with the facility within the time frame necessary to meet the completion deadline of this section.

2.11.7 Patuxent River Naval Air Station

Information in this segment is derived from Navy reports.

The Patuxent River Naval Air Station (NAS) was commissioned in 1943 with the mission of testing naval aircraft. The 6,478 acre facility is located in the southern portion of St. Mary's County at the confluence of the Patuxent River and the Chesapeake Bay. An additional 700 acres, divided amongst nine smaller parcels, are managed by the Naval Air Station, but none are in the Patuxent River watershed. The property is predominantly semi-improved and unimporved land. The developed land is comprised of runways, taxi-ways, hangars, office buildings, and military support buildings. Approximately 45 tenants occupy the Naval Air Station.

Patuxent NAS is divided between two watersheds: the nothern portion flows into the Patuxent River (1,829 acres) and the southern portion flows directly into the Chesapeake Bay (4,649 acres). No streams travel through the property, but some originate on site and then flow to the Patuxent River or the Chesapeake Bay. Six created ponds are found on the property, ranging from 2 to 28 acres in size. The ponds provide stormwater management, aquatic habitat, and recreational opportunities.

Approximately 4,500 acres of the property is categorized as semi-improved and unimproved lands: 2,841 acres of forest (42 percent of total land cover); 642 acres of aquatic ecosystems, including many types of wetlands (ponds, estuaries, forested, saline shrub, freshwater tidal,

and non tidal); 513 acres of leased agricultural lands; 236 acres of old fields; and 716 acres of scrub/shrub vegetation.

2.11.8 Patuxent Wildlife Research Center

Information for this segment was provided by Holliday Obrecht and Susan McMahon in an interview on October 4, 1995.

The Patuxent Wildlife Research Center was established on December 16, 1936 on approximately 2,700 acres by an Executive Order of President Roosevelt as the Nation's first wildlife experiment station. Over time, land acquisitions and transfers to the Center have expanded its size to the current 12,750 acres. The main mission of the refuge, which determines the management strategies of the property, is wildlife research. The U.S. Fish and Wildlife Service (USFWS) owns and manages the wildlife center, while the National Biological Service employs and manages the research on the center.

The property is divided into three tracts: north, central, and south. All tracts are managed for research. North and south tracts allow public use where compatible with the research mission. Overall, the property is managed with minimal negative impact on the environment. Approximately 90 percent of the property encompasses natural habitats of water and wetlands, grasslands, and forests. The general topography is predominantly flat with a few gently rolling hills.

2.11.9 Plant Introduction Station (USDA)

Information for this segment was provided by Dr. Allan Stoner in an interfiew on October 4, 1995.

The U.S. Department of Agriculture (USDA), Agricultural Research Service (ARS), Plant Introduction Station is located on approximately 71 acres of rural land in northern Prince George's County. However, within the next 3 years, the Introduction Station is scheduled to relocate to an area east of the Patuxent Research Refuge.

The Plant Introduction Station contains five greenhouses, rows of planted trees and herbaceous plants, a small office building, various out-buildings, two tenant houses, and an ARS administrative trailer. The area contains thick ground cover with gentle rolling hills. There are no streams that transect the property; however, a stream is located outside the fenced boundary. In addition, there are no wetlands located at the facility. A fence surrounds the site perimeter for security and as a deer deterrent.

In the 1920's, the Introduction Station was one of four USDA sites used for growing ornamental plants, trees, crops, and shrubs collected from other countries to determine its economic value in the U.S. Since the 1970's, the Introduction Station functions as a quarantine station whereby the facility receives and cultivates foreign plants for a 1 to 5 year period to ensure the plants will not infect U.S. agriculture with outside viruses or diseases.

2.11.10 Solomons Annex

Information for this segment was taken from Navy reports and was provided by Chris Davis and Petty Officer Dixon in an interview on December 13, 1995.

Solomons Annex is located near the confluence of the Patuxent River and the Chesapeake Bay, in Calvert County. The annex is bound by the Patuxent River to the west and south, Maryland Routes 2 and 4 on the east, and private property to the north. Solomons Annex is under the jurisdiction of the Naval District of Washington (NDW) headquarters in Washington, D.C.

Uses of the property have changed over the years to its current use of recreation and industrial mechanical support and manufacturing for fleet support. In addition, navy divers train at the site during portions of the year. The recreation facilities encompasses approximately 75 percent of the total 295 acres, and the industrial activities comprise of the remaining 25 percent of land use. The recreation facilities include camping areas for both recreation vehicles and primitive tents, a marina, cottages, bungalows, playgrounds, a community/conference center, storage facilities, and administrative buildings. Solomons Annex operates industrial activities in support of the naval fleet. Activities such as sand blasting and painting of vehicles and planes are the primary operations.

Topography of the annex is nearly level to gently sloping with a few moderate to steep slopes. Elevation ranges from a few feet above sea level to 22 feet above sea level. The annex is completely confined within the Patuxent River watershed. A riverine non-tidal wetland exists on the property. Other water resources located on the property are stormwater collection mechanisms that drain into the Patuxent River. With the exception of a few landscaped areas, vegetation consists primarily of indigenous plant materials. Much of the annex is covered by scrub growth and grasses, but hardwood trees form a sparse canopy over portions of the property.

2.12 PROBABLE FUTURE WITHOUT ACTION

2.12.1 Environmental Resources

Increased urban and suburban populations, inappropriate land management practices, and increased water use and wastewater flow all contribute to the reduction of habitat quality in the Patuxent River watershed. Reduction of habitat quality ultimately leads to degradation of environmental resources quality; human- and pollution-tolerant species (some exotics) dominate areas once home to naturally occurring, less tolerant species. This degradation eventually affects the quality of human life throughout the watershed.

Environmental Resources in the watershed are also affected by pressures from navigational, flood protection, infrastructural, and recreational needs. Competing interests in water use and control are, therefore, an important aspect in environmental restoration efforts in the watershed. A number of Federal, state, and local environmental restoration programs are

already underway in the watershed. While these programs have made great strides toward improving environmental and water quality in the watershed, even more effort will be needed to stave off the effects of increased population pressure.

2.12.2 Navigation

Due to the very limited nature of commercial navigation activities in the river and the current restrictions on commercial fishing, it is anticipated that future conditions relative to commercial navigation will be very similar to those present today. If environmental degradation trends continue, it is possible there will be a decrease in the amount of commercial fishing on the river and the Bay, and this decrease may be evidenced by the decrease of charter boats using the lower river as a home port. Should current environmental trends in the Chesapeake Bay region reverse, and should there be an associated increase in commercial fisheries, it is possible the river will witness an increase in the number of vessels using the Patuxent River as a hove port. These projected conditions and the limited need to dredge navigation channels due to the physical configuration of the river suggest that there will be limited need for navigation projects in the watershed.

Although currently there are no significant navigation problems resulting from insufficient channel depths in state channels, as the popularity of recreational boating increases, the potential need for additional channels to provide access to private docks, marinas, and public boat launches does exist along with the potential for related problems to arise. If measures are not taken either to reduce the amount of sedimentation entering the existing channels or to limit the size of vessels on the river, it is anticipated that the frequency with which these channels must be dredged, and the amount of material that will need to be removed, will only increase.

Should the currently proposed commercial car ferry project be developed at Clarke's Landing in St. Mary's County, potential impacts to existing natural, social, and economic resources will need to be evaluated and addressed. Additionally, the need for access channels, navigation improvements, and potential infrastructure requirements will need to be investigated.

2.12.3 Flooding

Locations have been determined from the information in Section 2.5 that would indicate areas of concern for future flooding. While damages from the most recent flooding (last 18 years) is not considered to be extensive enough to warrant any future flood control project(s), the potential is always there for a 100-year or greater flood in this area. Most of the counties in the study did not show much interest in flood control or flood damage reduction measures. Historic and potential flood damages are summarized, by county, in the paragraphs below.

1. Anne Arundel County has some flood-prone areas in some roadways around Crofton. There is also some concern about the Conway Road and Woodwardville on the Little Patuxent River. The Anne Arundel portion of Laurel also has reported flood problems.

However, there have been very few flood insurance claims in this county in the last 18 years.

2. Calvery County has isolated events such as the flooding in the Owings Bowling Alley and the bridge. Numerous flood insurance claims within the last 15 years and the destruction of Mill Branch bridge near the Huntingtown area also indicate a flooding problem. Flood insurance policies in Lusby suggest that at least 68 houses are prone to flooding in the St. Leonard Creek area. It is believed by the NRCS that most of these problems can be improved by stormwater management.

3. Charles County may need flood damage reduction in Benedict, on the main branch of the Patuxent. The number of flood-insured properties near Benedict indicate some flood- or storm surge-related problems in that area.

4. Howard County has some flood-prone properties in the Columbia area, but nothing that county officials consider to be a major problem.

5. Montgomery County is protected to a certain degree by the Duckett and Triadelphia water supply reservoirs, and is not in any need of specific flood damage reduction measures at this time. However, there may be a need for a study of the emergency spillway on Rocky Gorge Dam to assess the need for dredging the reservoirs. There is also an expressed need to develop a comprehensive reservoir model linked to the existing Patuxent River model.

6. Prince George's County has major flooding potential in the Upper Marlboro area, Western Branch, and Charles Branch HUA. Laurel also has significant flooding problems. While there are many individual flood-prone properties in the county, they are somewhat scattered and have problems that appear to be diverse in nature. Grouping properties with similar problems together creates a picture of the sites most in need of projects. These sites, in order of need are Laurel, on the main branch; Upper Marlboro, on the mainstem and Collington Branch; and the upper Western Branch and Charles Branch sub-watersheds.

7. St. Mary's County has minor flood damages recorded within the last 18 years in the California and Lexington Park areas. However, the county is not considered to have major flooding problems.

2.12.4 Water-Related Infrastructure

Water-related infrastructure investigations in the Patuxent River watershed have included the areas of water supply, wastewater treatment, and rural and urban best management practices for this study. Each of these areas has been negatively affected by past and present land use practices and population growth. Aquifer depletion, private septic disposal system leakages, non-point source nutrient pollution, and stormwater mismanagement are issues that will continue to degrade wetlands, rivers, and streams in the future if solutions to these types of problems are not addressed.

It is necessary to address the recurring water-related infrastructure problems throughout the watershed by providing environmentally sensitive solutions; otherwise, the Patuxent River ecosystem will be limited in species diversity and abundance, habitat suitability, and overall environmental health. Future conditions will be reflective of today's environmental values.

a. Potential Impacts of Wastewater on Water Supplies: Some residential development without sewer service is occurring along the Patuxent River and in areas near the reservoirs because of relatively lower housing costs than in other areas and because of road improvements that allow easier access to Baltimore and Washington D.C. These homes use individual septic tank systems for wastewater treatment and disposal. Septic tank systems provide wastewater treatment and disposal through soil percolation and goundwater recharge. WSSC is concerned that these systems may not be providing adequate treatment and, as a result, may be contaminating the groundwater. If the contaminants travel with the groundwater to the reservoirs, the water supply could be adversely impacted.

   Wastewater can contribute to the taste, odor and aesthetics of surface water supplies. Aesthetics can be compromised by the addition of nutrients, especially phosphorus, to the water, which can cause excessive growth of algae and other aquatic plants. Relatively rapid changes in the trophic status of a reservoir can occur and may result in serious water treatment problems.

   The risk of serious contamination to the Triadelphia and T. Howard Duckett (Rocky Gorge) reservoirs from septic tank systems in the Upper Patuxent River watershed has not been evaluated. It is expected that nitrogen, phosphorus, endotoxins, viruses and other contaminants will reach the groundwater; however, the bottom sediments of these impoundments can be expected to remove many of these contamhnts. A further safeguard is provided by the treatment the water receives before it is pumped into the water supply system.

b. Potential Impacts of Agricultural Activities on Water Supplies: Agricultural practices often contribute pollutants in the form of animal wastes and/or fertilizers to water supplies. These pollutants are added to surface waters through runoff of rain and snowmelt, and to goundwater through seepage. Excessive nutrient additions induce eutrophic conditions and abundant alga growth in surface waters, reducing water quality by decreasing the amount of dissolved oxygen. Overloads of bacteria may not be filtered through natural processes and can enter groundwater supplies, endangering human health and community welfare.

2.12.5 Recreation

Without the development of additional recreation opportunities in the study area, current facilities will continue to become crowded, used beyond capacity, and, folly, degraded. If the Patuxent River Greenway is not continued through the southern end of the study area, facilities will remain inaccessible to residents of the area. Connections such as this are

essential to opening up a more diverse arena of recreational opportunities to residents of the area.

If current conditions and trends relative to recreational boating on the river continue, it can be anticipated that there will be high densities of recreational boats on the river and that boat traffic will become even more congested. It is expected that a demand for recreation and recreational boating facilities in the study area will continue to grow as an offshoot of the tremendous population growth in the southern counties of the Patuxent watershed. With the increasing demand, current impacts and pressures on the environment and users will also increase. Without capitalizing on opportunities to provide additional recreational facilities while developing environmental restoration solutions, opportunities for recreation will be severely curtailed. The result will be insufficient facilities to meet the general recreational needs of the public.

2.13 SUMMARY OF EXISTING CONDITIONS

The Patuxent River watershed encompasses a wide variety of land and water uses, geologic processes, population distributions, and habitat types, which work with and against each other, making the watershed a diverse, complex ecosystem. The quality of environmental resources in the watershed has declined precipitously since 1950. Blue crab and oyster populations have been reduced, along with naturally-occurring shad, yellow perch, and eel. These trends are attributed to poor water quality, mostly due to suspended sediments, and loss of habitat.

Water quality in the watershed is fair to good. High levels of nutrients and sediments impact aquatic habitat and water quality in much of the area. Algal blooms in many areas cause depleted dissolved oxygen during the summer. These factors have direct negative impacts on significant habitat for fish, waterbirds, aquatic vegetation, and benthic organisms.

Wetlands, riparian forests, and submerged aquatic vegetation beds have decreased significantly since 1950. This loss has resulted in the loss of wildlife and fish habitat, and has reduced the buffering capability of the river, thereby impacting water quality.

Commercial mvigation on the Patuxent River is very light, due to the reduced fishery in the area, and competition from other modes of transportation. Areas for recreational boating and fishing, and their associated marinas and boat launches, are the primary boating needs in the area.

Flooding in the Patuxent River is relatively minor, with damage centers occurring primarily in Upper Marlboro, Laurel, Benedict, and Lusby. Much of this flooding has been attributed to improper stormwater management and to upstream development.

Infrastructure is a main concern in the Patuxent watershed. Existing water supply is considered to be adequate for current needs, but there is some concern for the future. Groundwater withdrawals in the lower portion of the study area are already causing subsidence and saltwater intrusion due to the volume of water pumped out of these aquifers. Surface and

groundwater supplies are endangered by bacteria and nutrients, which may be coming from inadequate sewage treatemnt in some areas. Surface water supplies are also threatened by the rates of siltation experienced in the two WSSC reservoirs.

Recreational needs in the Montgomery, Howard, and Prince George's County portion of the study area seem adequate for current needs. There are opportunities to improve or construct recreational facilities throughout the study area. Problems associated with recreational boating, as mentioned above, are of concern in the watershed.

SECTION 3

PROBLEMS, NEEDS, AND OPPORTUNITIES

3.1 INTRODUCTION

The focus of the Patuxent River Water Resources Reconnaissance Study has been to identify the various water resources issues in the Patuxent watershed, establish the needs of the study area, and identify opportunities to address these needs. The following five categories were examined in detail: environmental restoration, navigation, flood damage reduction, environmental infrastructure and recreation. This section provides an overview of the problems, needs, and opportunities for the watershed as a whole, and then for the upper, middle, and lower sub-watersheds.

3.2 ENVIRONMENTAL RESTORATION

3.2.1 Watershed Overview

An increase in industrialization and urbanization from the mid-1800's has led to the degradation of environmental resources and to the loss of habitat in the Patuxent River watershed. Clearing the land of vegetation for the construction of residential and industrial structures, roads, schools, stormwater and wastewater management facilities, power lines, parking lots, and shopping centers has had many ramifications. Removing vegetation that acts as an important buffer for soil and water, and building the structures and associated infrastructure mentioned above, increases the amount of impervious surface in an area. This results in a loss of valuable habitat for wildlife, as well as a loss of critical ecosystems such as wetlands. Stream ecosystems are impacted by low base flows, short-term high flow events, erosion, and increased pollutants.

Industrial development, urbanization, flood protection, and navigation have all had significant environmental impacts on aquatic, wetland, riparian, and terrestrial resources in the study area. Development of upper watershed areas has increased pollutants, nutrients, and sediments entering the lower Patuxent River. Wildlife habitat and critical ecosystems, such as wetlands, have diminished as human population has increased. Stream systems have been destabilized or channelized. Industrial and residential wastes have increased as have noise and air pollution. While some portions of the study area remain in fair condition, most of the land and water is showing the strain of an ever-increasing population base.

There are many valuable natural resources throughout the entire study area in need of restoration. There is a primary need to restore aquatic habitat, including wetlands (especially tidal freshwater wetlands), instream aquatic habitat, riparian habitat, water quality, temperature, and pool/riffle sequences. There is an immediate need to restore and maintain these systems before the degradation of natural resources continues to a point where restoration may not be feasible.

Local townships, city and county governments, and state agencies are actively implementing various levels of habitat restoration projects in the study area. The focus of these projects is to increase the amount and quality of habitat. These activities indicate a strong desire on the part of citizens and local and state governments to improve the quality of the ecosystems in the area.

3.2.l.a Wetlands

Development and urbanization in the Patuxent watershed area has resulted in the loss of tidal and non-tidal wetlands. This reduction in acreage has impacted the life cycles of many species of fish and wildlife and has affected water quality in the Patuxent River and its tributaries. The lack of these critical systems has resulted in a reduction of areas for flood storage, a loss of significant wildlife and vegetative habitat, and the degradation of a crucial water filtering/polishing system.

The USFWS analyzed the changes in wetlands that occurred over the 1980's in five of the seven counties in the Patuxent watershed. These analyses were for each entire county, and not just the portion lying in the Patuxent watershed. However, these trends should be representative of the changes throughout the entire watershed. A major concern is the amount of wetlands that are converted to upland. Approximately 460 acres of wetlands were lost by conversion to upland in the five counties from 1981 to 1989; 75 percent were losses in palustrine forested wetland and almost 15 percent were losses of palustrine emergent wetland. Only slightly more than 4 percent of the losses were estuarine wetlands (Table 3-l).

Recent wetland trends have limited the numbers and effectiveness of wetlands in the Patuxent River watershed. Some anthropogenic causes of degeneration are draining and clearing wetlands for crops; impounding or excavating and flooding wetlands for water supply, flood protection, recreation, and other purposes; and filling wetlands for the construction of houses, industrial facilities, ports, commercial buildings, highways, waste disposal, airports, and other purposes. Others include dredging or channelizing (excavating) wetlands for navigation and flood protection; this often facilitates timber harvest or wetland conversion to farmland or urban land; silviculture; peat, coal, sand, and gravel mining; and oil and gas extraction. Still others are diking and flooding coastal wetlands to create brackish water impoundments for waterfowl use and other purposes, and degrading the quality of wetlands by direct or indirect discharge of various materials including pesticides, herbicides, other chemicals, sediment, domestic sewage, and agricultural wastes.

Floodplain areas and riparian forest buffers have also been impacted by infrastructure and development. These areas have the ability to ameliorate nonpoint source pollution. Through physical and biological processes, they can intercept surface and subsurface water flows from upland sources and can reduce the amount of nutrients, sediment, organic material, or other potential pollutants that are conveyed to the receiving water body. These areas also provide large flood storage area, releasing waters slowly to the surface and ground waters. This action ensures base flow while decreasing erosion and sedimentation. Today, development prevents

this release and forces waters downstream rapidly, creating erosion, sedimentation, and habitat destruction and degradation. Lade (1993) inventoried the extent of riparian buffers in the Patuxent watershed. The inventory was based on data derived from 1991 to 1992 satellite imagery. Using the assumption that an adequate riparian buffer must be at least 300 feet wide, it was determined that of the 1,413 miles of stream surveyed in the watershed, only 32 percent had adequate forest buffers on both sides and only 66 percent had adequate buffers on at least one side (Table 2-4).

There are many opportunities to develop and adopt strategies to increase protection of wetlands within the Patuxent River watershed. This can be done by identifying wetland landscapes in need of restoration and by initiating large-scale proactive restoration efforts to restore ecosystem functions, often termed Special Area Management Plans (SAMPs). It is important to focus on restoring the functions of these systems in order to gain the most benefits for the ecosystem. For example, a degraded wetland that also functions as a stormwater overflow falter should be carefully restored to continue controlling water quantity and quality. It is necessary to go beyond the aesthetic and wildlife characteristics of wetlands.

It is also critical to develop measures and programs to maintain and establish vegetated buffers around wetlands, and to locate stormwater detention watersheds and agricultural sediment ponds outside of wetlands and of streams. These features are important to planned and designed wetlands for evaluating potential project solutions. Support of outreach programs and increasing public education efforts is necessary to encourage private landowners to protect their wetlands and/or to minimize adverse impacts to the ecosystem.

Maryland and Federal Laws and regulations applicable to each wetland type can be found in Appendix A.

3.2.l.b Aquatic Resources

Submerged Aquatic Vegetation (SAV)

Submerged aquatic vegetation provides many benefits to wildlife and water quality in the riparian ecosystem, including significant habitat for critical species. SAV provides food for invertebrate species, which are in turn utilized as food by upper food chain fish and birds; it provides prime nesting habitat for fish and amphibians; it provides cover for smaller fish, amphibians, and invertegrates; it provides dissolved oxygen to aquatic animals via photosynthesis; and it utilizes water-borne nutrients, thereby reducing the ambient nutrients in the mainstem of the river and, ultimately, the Chesapeake Bay. In this way, SAV positively affects nutrient cycling and water turbidity, and increases the stability of shorelines and bottom sediments. SAV is sensitive to changes in water quality, especially increased wake energy, toxic substances, and turbidity due to sediment loading and/or algal blooms. Different SAV species are affected by these factors to differing degrees. Thus, the SAV makeup of an ecosystem is a yardstick by which to measure current water and habitat quality and the success of any effort to improve those parameters.

Submerged aquatic vegetation has been choked out of the bottom of the Patuxent River by the increased sedimentation from erosion and by the increased pollutant levels. SAV has had very low abundance in the Patuxent River since 1970. Aerial and ground surveys were conducted in 1978 and from 1984 through 1993. During these surveys, never more than 55 hectares were detected, and none at all were detected from 1990 through 1992 (Table 2-5). (NOTE: The aerial survey method has been a consistent survey method, but its accuracy is limited in the upper tidal fresh water reaches. Ground surveys are more effective in such areas, but the results of the two methods can not be quantitatively combined). Preliminary results from the 1994 aerial survey indicate zero hectares in the lower Patuxent, 1.5 hectares in the middle Patuxent, and 75 hectares in the tidal fresh segment. Ground surveys have yielded similar results. It appears that there is a resurgence of SAV in the tidal freshwater Patuxent. This is an encouraging indicator, but it is not a sign of major improvement yet. More SAV is being detected primarily because surveys are expanding the search areas and are more diligent in their efforts. The reduction of SAV has led to erosion of hundreds of miles of banks within the Chesapeake Bay area.

The resurgence of SAV in the Patuxent is similar in some respects to the SAV resurgence in the upper tidal Potomac River during the 1980's (Carter and Rybicki, 1986). In both cases, an increase in SAV was noticed after major upgrades to wastewater treatment plants in the watershed. In the DNR ground survey, SAV was found in waters up to 3 feet deep in the mainstem, and up to 5 feet deep in the tributaries. However, as a result of poor light transmittance, even with recent improvements in water quality, significant SAV growth does not occur at depths greater than 1 meter. Historically, SAV in the Chesapeake Bay occurred at depths up to 4 meters. The lack of adequate light penetration severely limits the potential habitat areas for SAV in the watershed, which, in turn, limits the benefits of SAV to the ecosystem (Naylor, 1995).

It should be noted that not only has the total area of SAV decreased, the species making up the SAV component in the river has changed over time. More pollutant-sensitive species have been replaced by hardier species, indicative of a change in water quality over time. Increased density and quality of SAV species will encourage the colonization and maintenance of healthy associations of fishery species by providing areas for spawning, feeding, and resting, as well as suitable food for benthic forage species. *Hydrilla*, an aggressive exotic species, currently makes up only a small percentage of the SAV in the river, but it is felt that it may begin to extend its range, perhaps at the expense of less competitive naturally occurring species (Ruddy, pers. com.). There is some debate, however, as to whether *Hydrilla* colonization is detrimental to naturally occurring species in the long run. Some experts feel that it can act as a beneficial species, by stabilizing the bottom sediments and clarifying the water such that naturally occurring species can become re-established (Lubbers, pers. com.).

Recent development has limited the valuable SAV growth from the tributaries to the Chesapeake Bay. Throughout the Patuxent watershed, there is an opportunity to expand the SAV abundance and diversity to near-past conditions. This would benefit the entire aquatic ecosystem by enhancing water quality, species diversity, and available quality habitat.

Additionally, SAV habitat will be enhanced as erosion is reduced in the watershed with the implementation of stream restoration and stabilization projects.

Fish

A number of species of environmentally and/or economically important fish are indigenous to the Patuxent River and its tributaries. These species include the striped bass, American shad, hickory shad, blueback herring, alewife, bay anchovy, spot, yellow perch, white perch, Atlantic menhaden, and eel.

Fisheries in the Patuxent River have been on the decline, due to the decreasing water quality, limited aquatic and riparian habitat, and increasing numbers of fish passage blockages. The return of anadromous finfish to their historic range requires a systematic approach to both the modification of existing obstructions and the restoration of suitable habitat. A watershed-wide restoration effort for anadromous fish would require restoration of wetlands, riparian forests, and streambeds; consideration of water quality and instream flow needs; fish stocking programs; programs for streambank fencing; establishment of greenway corridors; and efforts to address non-point pollution problems. These habitat restoration alternatives are in addition to the removal of obstructions.

It should be noted that fishery restoration is a very complicated issue. It is necessary to correct many aspects of the fish habitat, including water quality, sedimentation, vegetation, oxygen, and food source, as well as removing the blockages to fish passage. A fish stocking program will also be necessary, in order to establish breeding populations of the desired species. The complete restoration of the Patuxent River fishery is an issue of more complexity than can be accommodated in this section. It is therefore recommended that a separate fish restoration report be prepared to address this multi-faceted topic.

Another concern related to fish resources in the Patuxent are the removal of blockages to diadromous fish passage. There is a need to remove or breach 133 small finfish passage blockages in the watershed, which have been identified by Maryland DNR (Figure 2-2). Of these, 8 blockages have been identified by the CBP as priorities: Dorsey Run at Route 33, Dorsey Run at the Railroad Trestle, Horsepen Branch Dam, Croom Station Road Culvert, Route 214 Dam, and PEPCO's two Sand's Road Culverts and Sand's Road Dam. Of these, all have been completed except the Croom Station Culvert, which is in the final design phase, and the Sand's Road sites, which are on the 5-year priority list. The Croom Station site is anticipated to open 10.6 stream miles to anadromous fish, and the combined Sand's Road projects should open 3.0 miles by 1997. However, there are still numerous opportunities to breach finfish blockages, which will in turn open additional stream miles to anadromous fish.

Benthos

Bottomdwelling (benthic) species of invertebrates are known collectively as "benthos" for any given ecosystem. These species feed on aquatic vegetation and detritus, and in turn become the lowest animal level of the riparian food chain. These creatures are eaten by larger

invertebrates, crustaceans, finfish, wading birds, amphibians, turtles, and even some mammals. Therefore, a healthy benthos is essential to a healthy aquatic ecosystem. Benthos is most affected by toxic substances, water-borne sediments, wake energy, and loss of vegetation. Different species comprising the benthos are affected by these factors to differing degrees. Thus, the benthic makeup of an ecosystem is a yardstick by which to measure current water and habitat quality and the success of any effort to improve those parameters.

Increased density and quality of SAV species will encourage the colonization and maintenance of healthy associations of benthic organisms. There will also be incidental benefits of reduced erosion and sedimentation, decreased suspended solids, and increased survival for benthic organisms.

Commercial benthos in the Patuxent River include the American oyster *(Crassotrea virginica),* softshell clam *(Nya arenaria),* and blue crab *(Callinectes sapidus).* The current oyster abundance in the river is very low. The oyster harvest has undergone a major decline since the early 1970's. Oysters have been impacted by disease and overharvesting, which have caused a decline in population fecundity (smaller oysters are less fecund; larger oysters are more likely to be impacted by disease and harvesting). Some of the factors affecting oysters are beyond human control, such as disease and reduced fecundity. A major influence on the health of the oyster population is the availability of suitable substrate onto which oyster spat (larvae) can set (attach). It has come to the attention of the study team that a relatively inexpensive solution is bagless dredging to realign existing oyster bars and remove excess sediments, thus creating suitable spat set habitat.

3.2.l.c Water Quality

The Maryland Department of the Environment (MDE) describes the water quality of the Patuxent River watershed as fair (MDE, 1994). The main source of water quality problems appear to be high nutrient levels due to municipal treatment plants, urban and agricultural runoff, and high suspended sediment levels.

Nutrients

The total amount of nutrients entering the Patuxent has increased since the 1800’s, when commercial fertilizers became available in the watershed. Increased sewage inflow since the mid-1900’s has also increased the amounts of soluble phosphorous present in local areas (Brush, 1984).

Orgainic matter serves as food for bacteria. When large amounts of organic matter enter a body of water, the bacterial population grows exponentially. This population growth creates a demand for dissolved oxygen. Given a sufficient amount of organic waste, the bacterial population can increase to a point where the dissolved oxygen in the system is exhausted. This dissolved oxygen is then unavailable to fish and benthic organisms, thus resulting in

suffocation of stream-dwelling organisms and reducing stream productivity. This reduced productivity can occur several miles downstream from the pollutant source.

In addition, animal wastes add excessive nutrients to a stream. Animal (livestock and poultry) wastes can cause a significant increase in salinity in the receiving waters. The major problems are attributed to three components of manure, each of which can cause particular problems: organic matter, nutrients, and fecal coliforrn bacteria. The principal nutrients are nitrogen and phosphorous, although other minor elements are also available. Nutrients promote the growth of algae and other aquatic plants which, like organic matter, affect the dissolved oxygen level in the stream. When algae die, they become food for bacteria, creating an oxygen demand and further reducing dissolved oxygen levels in the water.

Fecal coliform bacteria are the naturally occurring bacteria in the intestines of warm-blooded animals. Some fecal bacteria may be pathogenic, so it is necessary to be aware of sources of fecal pollution in water. The bacteria serve as indicators of pollution from animal waste, including humans. When high fecal coliform concentrations occur, the chances for pathogenic contamination are much greater.

Many efforts are currently underway to reduce the amount of nutrients entering receiving waters from point sources, including NPDES regulations and a ban on phosphates, and the Patuxent Tributary Nutrient Reduction strategy. Urban and rural best management practices are being implemented or planned throughout much of the watershed. Implementation in some areas is lagging behind due to financial and practical limitations. Stormwater and sewage treatment retrofits are needed in some areas, as described in the Water-Related Infrastructure section below. These projects should have a positive impact on water-borne nutrients in the Patuxent watershed.

Suspended Sediments

The total amount of suspended sediments and associated nutrients entering the Patuxent River, and, ultimately, the Chesapeake Bay, has increased dramatically since European settlement (Brush, 1984). The increase has been correlated to the increase in cleared land in the watershed since that time. It appears that deforested areas have been most affected by increased sediments, especially in the reaches above Jug Bay (Brush, 1984), where the increase in suspended sediments decreases light in the water column, thereby changing the makeup of the aquatic community by reducing SAV.

sedimentation affects aquatic community health, biomass, and biodiversity. Both bedload and suspended sediment are responsible for these effects. Bedload sediments affect bottom-dwelling organisms by changing stream habitat through scour, abrasion, and deposition, or by destroying them directly via impact, burial, and smothering.

Sedimentation also affects fish during storm and/or other runoff events by causing high turbidity in the water. Sight-feeding fish such as trout and shiner cannot find prey. Also, inorganic particles reduce fish gill efficiency, and suspended sediment can create turbidity high

enough to kill fish by suffocation. Suspended sediments may also act as a barrier to light penetration in surface waters, thereby eliminating some plant species that are vital to the food chain of higher aquatic organisms. Poor light transmission, combined with elevated levels of nutrients in the Patuxent River, have kept submerged aquatic vegetation at low levels for decades.

sediments may also impair reproduction in some fish species. Trout, which spawn on beds of gravel in fast-moving, oxygen-rich streams, are especially susceptible to sediment effects. The growth and productivity of these fish are also influenced by the reduction of the available food supply of invertebrate species, caused by a sediment-laden bottom. Although trout are opportunistic feeders, caddis fly, stonefly, mayfly, and blackfly are preferred foods. These insects are among the most likely species to be affected by sedimentation, thus reducing the food supply for trout in affected streams.

Sedimentation is a high-priority pollutant, because it is not only the greatest contaminant by volume, but it also serves as a carrier of agricultural chemicals that can themselves be potential pollutants. Sediment particles attract various potential pollutants to adsorb to them. Organic materials from surface soils are typical carriers of adsorbed pollutants. This results in sediment having a greater opportunity for pollutant enrichment than the soil from which it was eroded.

A significant portion of the suspended sediments in the Patuxent come from erosion of shoreline in the tidal reaches, and streambanks in the fluvial reaches. The Shoreline Erosion Control section of the Maryland DNR has records of 325 site visits by its personnel in the tidal reach of the river. Of these sites, most are small erosion problems (less than 500 feet) on private land. The large majority of the problems involved less than 300 feet of shoreline, and many required only small, technical assistance type solutions and/or small engineering solutions (stone revetments, timber bulkheads, etc.).

Thirty of the Maryland DNR site visits were on public or semi-public land (churches, community associations, corporations). These areas tended to be larger, and most required some type of engineering solution. These thirty records are synopsized in Table 3-2. Five of these records stand out as being of interest to the study and are all in the lower Patuxent sub-watershed:

- Point Lookout State Park, visited in 1992, reported erosion along 2030 feet of shoreline. The Maryland DNR suggested non-structural solutions to the problem, and made a project out of it.

- Myrtle Point, visited in 1995, was evaluated for possible purchase by St. Mary's county.

- Jefferson Patterson Park, visited most recently in 1993, reported 2,000 feet of shoreline erosion at that time. Maryland DNR assisted in a stone revetment project to correct the

problem. The park has also received assistance on other occasions for smaller shoreline protection projects.

- Greenwell State Park has received assistance from Maryland - DNR on several occasions for its erosion problems. Revetments now protect much of the at-risk shoreline, including the shoreline nearest Rosedale Manor, a historic structure.

- Glascock Insurance, visited in 1989, has the largest reported shoreline erosion problem. Approximately 1.3 miles of shoreline are eroding. Recommended actions at this site were all non-structural.

Toxics and Thermal Issues

Thermally impacted water has been released into the Patuxent River from the Chalk Point Electric Power Plant since 1960 (Brush, 1984). Heated water cannot hold as much oxygen as cold water, and local areas of anoxia can develop along the Patuxent River downstream of the plant, expecially in the summer months. To mitigate these effects, the plant has the largest cooling towers of any power plant in Maryland. PEPCO has been deeply involved in fish monitoring and stocking programs. These programs have been key in the reintroduction of the American shad into the watershed.

Other local temperature problems exist seasonally along the Little Patuxent south of the Route 1 bridge in Howard County. Local geology and the force of storm velocity waters have widened the streambed below the bridge, thus spreading the available water over a larger area, and increasing thermal impacts via insulation. It is possible that upstream stormwater management and on-site engineering could help alleviate this problem, thus improving aquatic conditions downstream.

The increase in toxic metals is proportional to the amount of land cleared in the watershed over time (Brush, 1984). The source of most of these metals is soil erosion due to agriculture, construction, and natural erosive forces. Lead, however, has increased in the watershed largely due to the increase in automobile exhaust. The reduction in the use of leaded fuel by automobiles has dramatically reduced the inflow of lead from this source, but residues of previous emissions still exist.

The 1994 Chesapeake Bay Basin Toxics Loading and Release Inventory indicates that there is very little chemical pollution in the watershed (see tables in Annex).

Pesticides

The application of pesticides (herbicides, insecticides, and fungicides) throughout the Patuxent watershed, and the Chesapeake Bay watershed as a whole, has increased tenfold since 1960 (Brush, 1984).

Pesticides originate from both agricultural and urban nonpoint sources, and can cause water use impairment. Pesticides become a water quality problem when they enter the stream as runoff (both dissolved and attached to sediment), or through groundwater (leachate).

Pesticides affect water uses in two ways: (1) they damage or destroy aquatic animals and plants, and (2) they enter the food chain and pass these toxic effects on up to other species. Pollution problems with pesticides occur because these agents affect other organisms in addition to their primary targets. Animals take in pesticides through their food or water, and store some of these substances in fatty tissues. This accumulation of some types of pesticides (especially insecticides) results in a concentration of chemicals in the animal that is higher than that in the surrounding environment. When the animal is consumed by another, the pesticide is passed up the food chain. Therefore, fish and water birds, who form the top of the food chain in most aquatic systems, have an extraordinarily high level of some pesticides, making them unfit for human consumption.

Herbicides also can damage or destroy vegetation when they enter aquatic systems. Since this vegetation serves as cover and food for many aquatic organisms, herbicides can affect an entire community. Dissolved oxygen levels are often reduced by the decay of the plants killed by herbicides.

Many efforts are currently underway to reduce the amount of pesticides entering receiving waters from point sources. Urban and rural best management practices are being implemented or planned throughout much of the watershed. Implementation in some areas is lagging behind due to financial and practical limitations.

3.2.l.d Terrestrial Resources

Terrestrial resources such as wildlife and vegetation have declined as development and infrastructure have reduced bottomlands, upland forests, and riparian buffer zones. The habitat values of forested/scrub-shrub and old field areas have been severely limited by encroaching development. Infrastructure such as roads and power lines have impacted passage corridors for wildlife species with large home ranges and territories. One of the major impacts of development in the watershed has been the loss of contiguous forest habitat, which is the home of many wildlife species, including migratory songbirds.

Mammals

Human encroachment in previously wild areas, and eradication of predatory species has resulted in conflicts between human and herbivore populations in some areas. Whitetail deer and beaver have reached population levels such that they are becoming problematic for homeowners in some areas. The animals strip trees, eat cultivated plants, and flood properties with their darns. Reintroduction of forested areas will bring aesthetic value to an area, as well as provide valuable habitat for mammals and birds away from human populations.

Reptiles and Amphibians

Several human-related factors have been increasingly affecting reptiles and amphibians in the Patuxent watershed. Shoreline protection measures such as bulkheads and riprap revetments adversely affect nesting habitat. The increasing human use of the shoreline physically disrupts some nesting activities and can attract predators. Opportunity exists to educate watermen on the hazards to sea turtles posed by crab pots. Both diamondbacks and terrapins are able to enter crab pots in search of a meal, but are then unable to extricate themselves. A turtle can survive underwater up to 5 hours, but then is likely to drown. A voluntary program of crab pot checks every 4 to 5 hours could save the lives of some of these creatures. Opportunity also exists to educate recreational and commercial boaters of the hazard posed to turtles of being struck by a boat when surfacing for air.

Birds

The makeup and population sizes of bird species in the Patuxent River watershed has changed significantly over the last 25 years. Species currently found in the watershed include the wood duck, black duck, canvasbacks, redhead, mallard, great blue heron, bald eagle, and osprey. Other key bird species (great egret, snowy egret, little blue heron, green-backed heron, and black-crowned night heron) have not been recorded in the watershed for many years, and the status of these species in the watershed is unknown. The data support the conclusion that wood duck abundance in the Patuxent River watershed is below the long-term average. Overall, it appears that black duck numbers in the Patuxent River are significantly below the long-term average, and are continuing to decline. Data indicate that canvasbacks abundance in the Patuxent River is somewhat below the long-term average, but currently stable. The data available suggest that redhead use of the Patuxent River is well below historic use levels. The mallard was introduced into the Chesapeake Bay watershed in the 1960's to provide recreational hunting. Since that time, the abundance of these birds throughout the Bay has increased dramatically. The mallard is an aggressive competitor, and may be displacing other duck species, such as the wood duck and redhead, for nesting habitat and food resources. Therefore, the increase in mallard population may be more an indicator of an environmental problem than environmental stability. Data indicate that large numbers of these birds are resident in the watershed, and that number is increasing. Data suggest that bald eagle abundance in the Patuxent River is stable or increasing. The available data indicate a steady increase to nearly four-fold the number of active nests in 1973 on the Patuxent River. (Table 3-3).

Black duck and redhead are dependent on SAV species, particularly wild celery, for food. Canvasbacks are somewhat less dependent on this resource, as they can utilize small clams as a food source. An effective way to improve the abundance of these species in the Patuxent River watershed is to provide SAV beds near suitable nesting habitat for these species. Since these species are also sensitive to humans and mallard competition, the areas best suited to species management and reintroduction will have to be streams in more sparsely-populated areas.

3.2.1.e Rare, Threatened, and Dndangered Species

Opportunities exist in several locations in the watershed to improve habitat for naturally occurring plants and animals, including rare, threatened, and endangered species.

The stripeback darter has been observed recently in the Upper Marlboro area. Improvements of water quality and pool and riffle habitat in this area could potentially enhance the survival of the population in this area.

A small population of the northeastern beach tiger beetle *(Cicindela dorsalis dorsalis)* exists at the mouth of the Patuxent River. Since this particular population has been monitored for only a few years, it is not possible to define any trends; however, threats to the tiger beetle include shoreline modifications, use of off-road vehicles on the beach, and human foot traffic. opportunities to protect and enhance the tiger beetle include restricting access to the area where the current population resides and implementing an education program for local residents about the species.

Two small populations of the sensitive joint-vetch *(Aeshynomene virginica)* are located along the Patuxent River in the vicinity of the Lower Marlboro and Magruder Landing. This member of the legume family inhabits tidal freshwater wetlands. Since this population has only been monitored since 1994, it is not possible to define any trends; however, opportunities exist to protect and enhance the joint-vetch through restriction of access and education programs.

Wild rice and other freshwater aquatic plant species are found in the Jug Bay area. Eradication of *Phragmites* in this area would open up additional acreage for these plants.

3.2.2 Sub-Watershed Analysis of Problems, Needs, and Opportunities for Environmental Restoration

Based upon existing information and input from Federal, state, and local agencies, the following list of environmental resources affecting aquatic habitats for the upper sub-watershed, middle sub-watershed, and lower sub-watershed of the Patuxent River have been compiled. This information, however, is not intended to represent all environmental resources and habitat problems within the study area due to limitations such as availability of information, continued analyses, and on-going research.

The three sub-watersheds were determined following two criteria, (1) drainage basin and (2) political jurisdiction. Although it is practical to study a watershed following hydrogeologic boundaries, it was also realistic to address the study from the stakeholders and potential implementors' perspective. The goal is to have the most environmentally effective and most cost-efficient solutions for the identified problems and needs of the watershed. Figure 3-1 depicts the three major sub-watersheds in the study area.

3.2.2.a Upper Sub-Watershed fo the Patuxent:

This sub-watershed includes the following tributaries:

- Patuxent mainstem
- Hawlings River
- Middle Patuxent River
- Little Patuxent River
- Dorsey Run
- Duckett and Triadelphia Reservoirs

Problems of the upper sub-watershed of the Patuxent are characterized mostly by the need for reservoir protection from excessive sediment and nutrient loading. There is also environmental resource and habitat loss and degradation due to excessive sediment loading. This sediment may be coming from erosion due to an intensely populated sub-watershed and inadequate stormwater management. High sediment loads directly affect water quality for the area and contribute to other related problems such as eutrophication and loss and degradation of habitat for aquatic organisms. The following list describes some site specific problems, needs, and opportunities.

Patuxent Mainstem

Nutrients, sedimentation, and erosion have been identified as water quality issues in this part of the tributary, posing a threat to plant and animal habitats. Opportunities exist to expand and enhance local wetlands to provide water quantity and quality controls, as well as to increase habitat. Also, insufficient stormwater management facilities increase degradation of habitat by increasing the erosion and sedimentation process. Opportunities exist to retrofit existing structures or design new stormwater management structures to alleviate this problem.

Hawlings River

Degradation of habitat from uncontrolled stormwater from agricultural and, more recently, from residential development is a major factor affecting the fluvial aquatic habitat in the Hawlings River. The volume of this uncontrolled stormwater has caused severe streambank erosion and stream channel modification, as well as high sediment loads from the contributing land areas. Opportunity exists to provide streambank restoration, stabilization, and protection which would enhance riparian habitat. There is also an opportunity to create forested wetland areas to reduce storm-flow velocities.

Middle Patuxent River

Degradation of habitat from uncontrolled stormwater is impacting the aquatic habitat in the Middle Patuxent River in the upper sub-watershed. The volume of the stormwater has caused streambank erosion and stream channel degradation, as well as high sediment loads.

Opportunities exists to provide streambank restoration, stabilization and protection which would enhance riparian and fish habitat. In addition, rapid development in this area could potentially cause habitat loss and degradation is not planned carefully. An opportunity exists to develop a SAMP that will result in a comprehensive plan providing for natural resource protection and reasonable economic growth.

Little Patuxent River

The Little Patuxent is characterized by unstable streambanks, significant erosion, and loss of aquatic and associated habitat. Some downstream shallow areas are sensitive to temperature and low flows. Opportunities exist to provide stormwater management alternatives, possibly wetlands, to reduce velocity, decrease erosion, provide flood control, and create additional habitat.

Dorsey Run

Degradation of habitat from uncontrolled stormwater is a major factor affecting the aquatic habitat in Dorsey Run. The volume of uncontrolled stormwater has caused severe streambank erosion and stream channel modification, as well as high sediment loads from the contributing land areas. Opportunity exists to provide streambank restoration, stabilization and protection that would enhance riparian habitat, as well as to retrofit existing structures or design new stormwater management structures to better manage stormwater flows.

Duckett and Triadelphia Reservoirs

A number of failing septic systems in the area were identified as possibly contributing to groundwater contamination and degradation of surface waters. There also is a need to improve knowledge about small-lot horse farm practices, stormwater management, and other pollutants that negatively impact drinking water supply. Opportunities exist to educate local communities through pamphlets, workshops, and seminars about urban and rural Best Management Practices (BMPs), and about water conservation practices to ensure high water quality in the reservoirs. An opportunity also exists to develop a database and GIS application to document and assist in resource analysis, which could lead to a SAMP to protect both the existing resources and the quality of drinking water.

3.2.2.b Middle Sub-Watershed of the Patuxent

This sub-watershed includes the following tributaries:

- Patuxent rnainstem
- Western/Collington Branch
- Southwest Branch
- Little Patuxent River
- Towsers Branch

Problems of the middle sub-watershed of the Patuxent are greatly affected by the activities and health of the upper sub-watershed. Sediment and nutrients are carried into this sub-watershed and contribute to the loss and degradation of environmental resources and significant habitat. High sediment loads directly affect water quality for the area and contribute to other related problems such as eutrophication and loss and degradation of habitat for aquatic and semi-aquatic organisms. The following list describes some site-specific problems, needs, and opportunities.

Patuxent Mainstem

A number of failing septic systems in the area may be contributing to groundwater contamination and to the degradation of stream water quality. Potential solutions include -

1. Identifying the affected communities
2. Using public outreach and education to improve land stewardship
3. Implementing small package treatment plants to replace the septic systems

Large and small obstructions exist throughout the Patuxent mainstem and tributaries in the middle sub-watershed. These obstructions create blockages to anadromous and resident fish. Opportunities exist to restore fish habitat and range by removing the blockages. Also impacting the mainstem is degradation of habitat from uncontrolled stormwater resulting from agricultural and residential development, a significant factor affecting the fluvial aquatic habitat. The volume of this uncontrolled stormwater has caused severe streambank erosion and stream channel modification, as well as high sediment loads from the contributing land areas. Opportunities exist to provide streambank restoration, stabilization, and protection, which would enhance riparian habitat. Potential solutions also include wetlands creation projects to filter runoff and provide additional habitat. Increased development and sedimentation has also impacted the SAV populations in the area. Opportunities exist to revegetate areas with locally occurring population of SAV in conjunction with stream stabilization, enhancing aquatic habitat and improving water quality.

Western Branch/Collington Branch

Improper stormwater management has degraded the Collington and Western Branches, causing extreme erosion, degraded habitat, and decreased water quality. *The Collington Branch Stormwater and Water Quality Control Facility Plan and Study* was prepared for Prince George's County. This document outlines 20 potential facilities for regional stormwater management systems, including wet ponds and other ecologically positive facilities to enhance and create habitat as well as stormwater management. Additional opportunities exist to provide streambank restoration, stabilization, and protection that would enhance riparian habitat. Lastly, in 1960, the Corps constructed a levee in Upper Marlboro. The project has since been altered by Prince George's County, by adding 10 feet of soil to raise the elevation and by widening the channel. There is great opportunity for environmental enhancement and wildlife habitat enhancement.

Southwest Branch

Degradation of habitat from uncontrolled stormwater is negatively impacting the fluvial aquatic habitat in the Southwest Branch. The volume of this uncontrolled stormwater has caused severe streambank erosion and stream channel modification. The *Southwest Branch Stormwater and Water Quality Management Analysis* prepared for Prince George's County and WSSC outlines 14 potential sites for regional stormwater systems. In addition, opportunities exist to provide streambank restoration, stabilization, and protection which would enhance riparian habitat. There is also an opportunity to create forested wetland areas to reduce storm flow velocities.

Little Patuxent River

Insufficient stormwater management has caused severe streambank erosion and stream channel degradation. This uncontrolled stormwater is a major factor affecting aquatic habitat, and associated habitat in the Little Patuxent River in the middle sub-watershed. Potential solutions include constructing stormwater management systems, including wet ponds and other ecologically positive facilities, to enhance and create habitat in conjunction with streambank restoration, stabilization, and protection which would enhance riparian habitat. There is also an opportunity to create wetland areas to reduce storm flow velocities.

Towsers Branch

The severe erosion and sedimentation in the Towsers Branch is attributed to unmanaged stormwater from commercial development. The volume of this uncontrolled stormwater has caused severe streambank erosion and stream channel modification. The bank erosion and cutting has exposed 12 to 15 feet of soils and clay, resulting in severe habitat degradation and loss. Also, a sewer pipe, which transports 3.8 to 4.0 MGD of sewage has been exposed. opportunities exist to construct stormwater management systems, including wet ponds and other ecologically positive facilities to enhance and create habitat in conjunction with streambank restoration, stabilization, and protection, which would enhance riparian habitat as well as control stormwater flows.

3.2.2.c Lower Sub-Watershed of the Patuxent

This sub-watershed includes the following tributaries:

- Patuxent mainstem
- Coxtown Creek
- St. Leonard Creek
- Cat Creek
- Battle Creek

- Lewis Creek

Problems of the lower sub-watershed of the Patuxent are characterized by environmental resource and significant habitat loss and degradation due to excessive sediment loading from erosion. High sediment loads directly affect water quality for the area and contribute to other related problems such as eutrophication and loss and degradation of habitat for aquatic organisms. The following list describes some sitespecific problems, needs, and opportunities.

Patuxent Mainstem

Degradation of aquatic and associated habitat from uncontrolled stormwater is a major factor in the Patuxent mainstem in the lower sub-watershed. The volume of this uncontrolled stormwater has caused severe shoreline and streambank erosion. It also contributes high sediment loads to surface water, impacting habitat for SAV, waterfowl, fish, and oysters. Opportunities exist to provide shoreline and streambank restoration, stabilization and protection in conjunction with constructing and upgrading stormwater management systems, which would reduce sedimentation and enhance aquatic and riparian habitat. Also, large and small obstructions are found in the mainstem in the lower sub-watershed. These obstructions create blockages to anadromous and resident fish. Opportunities exist to restore fish habitat and expand the range by removing the blockages. A number of failing septic systems in the area contribute to groundwater and surface water contamination. Potential solutions include-

1. Identifying the affected communities
2. Using public outreach and education to improve land stewardship
3. Implementing small package treatment plants to replace the septic systems
4. Encouraging the development of pump-out schedules for private septic tanks.
5. Constructing a tiered wetland system which could be used to treat wastewater.

Coxtown Creek

Coxtown Creek is experiencing significant shoreline erosion due to improperly managed stormwater associated with increased development. Habitat restoration in conjunction with shoreline stabilization is needed to control shoreline erosion. There is also marsh habitat in need of protection and enhancement.

St. Leonard Creek

Degradation of aquatic and associated habitat from stormwater runoff is a major factor in the Patuxent mainstem in the lower sub-watershed. The volume of this uncontrolled stormwater has caused severe shoreline and streambank erosion and stream channel modification. It also contributes high sediment loads to the creek, impacting habitat for SAV, fish, waterfowl, and benthic organisms. Oyster bars have become silted and misaligned, resulting in fatalities and "dead" oyster bars. A potential solution to restore oyster bars is to clean and realign the oyster bars, seed with larvae, and monitor the success of the program. Additional opportunities exist to provide shoreline and streambank restoration, stabilization, and protection in conjunction

with constructing and upgrading stormwater management systems, which would reduce sedimentation and enhance aquatic and riparian habitat.

Cat Creek

Cat Creek is experiencing extreme siltation from increased development and poor stormwater management. Dredging for recreational boat traffic is occurring every few years. Opportunities include improving stormwater management upstream with stormwater detention ponds and wetlands. Such actions would also create valuable significant habitat.

Battle Creeks

An opportunity exists for riparian forest enhancement and protection along Battle Creek in Calvert County. According to the Chesapeake Bay Program and Calvert County, the Battle Creek Cypress Swamp has been chosen as a Forest Legacy site. As such, funding is pending for the purchase of conservation easements adjacent to the property at fair market value, assuming landowners are willing to sell. This purchase would help Calvert County assist the Chesapeake Bay Program to succeed with its Riparian Forest Buffer Initiative, as well as improve water quality and riparian habitat in that part of the Bay watershed. A copy of the Riparian Forest Buffer Initiative can be found in Appendix A. Riparian forest areas in Maryland are also protected by a variety of state and Federal laws.

Lewis Creek

Storm events send a "wave of mud" down Lewis Creek and eventually into the Patuxent River. This area has had much new development that contributes to extreme sedimentation and erosion and habitat degradation. There is a wetland and small earthen dam that has been degraded. The wetland is a potential site for improving stormwater management and creating additional habitat. The eroded channels could be restored and the water permitted to spread out over the entire area for more retention time and more release of sediment before it reaches the Patuxent River.

3.3 NAVIGATION

3.3.1 Overview

As a result of an evaluation of existing information and discussions with local interests and resource agencies, navigation issues were categorized into three main categories: dredging issues, boating issues, and beneficial uses of dredged material. Dredging issues are discussed primarily from the perspective of maintaining access to particular areas. Although the primary Federal interest in navigation is associated with commercial navigation, boating issues related to recreational boating on the Patuxent River are also included in the discussion of general navigation problems and needs. Specifically, recreational boating issues related to navigation (access) channels as well as health and safety have been identified. An evaluation of past

Federal projects is also included in this section in an effort to identify project-induced impacts associated with those projects.

In terms of boating needs, several key issues were investigated including an examination of existing vessel traffic and the need for new aids to navigation or other safety programs. Health and safety issues related to the disposal and treatment of sewage from boats on the river were also investigated. Since disposal of sewage from boats can directly effect public health, as well as affect aquatic resources through the depletion of available oxygen (BOD) and nutrient loading, marine sewage disposal is an issue that needs to be addressed in conjunction with navigation, environmental restoration, and environmental infrastructure needs. Existing sewage pumpout facilities were identified, and, where possible, the need for additional pumpout facilities was also identified. Public safety issues related to traffic congestion and competition between commercial and recreational boaters was also considered, as was competition between various recreational boating activities. Specific problems, needs, and opportunities related to recreational boating are discussed in detail in Section 3.6.

3.3.2 Dredging problems and needs

The loss of navigable channels, a common problem throughout the Bay and its tributaries, is primarily the result of sediment deposition from shore erosion and runoff from upland areas. Historically, agricultural runoff has been noted as a significant source of sediment in the Patuxent watershed. More recently, increased urbanization in the upper and mid portions of the basin has increased the levels of urban runoff (sediment and stormwater), exacerbating erosion and sedimentation problems. Although sedimentation is occurring along the entire length of the river, deposition is most significant in the upper reaches of the river as areas fill in and become more shallow. In the lower reaches, sediment from a variety of upstream sources including shoreline erosion and runoff is typically being deposited at the mouths of the tributaries to the river. In order to maintain access to some of these tributaries, there is a need to periodically dredge these areas. However, it is difficult to predict the frequency with which these areas need to be dredged. On average, it appears there is a need to perform maintenance dredging every 7 to 10 years. Due to the overall configuration of the river with its fairly wide and deep main channel, shoaling is not a significant obstacle to navigation. At this time, no new specific dredging projects have been identified, and current dredging needs relate to maintaining existing channels for recreational boating.

With the clearing of large amounts of land and the development of tobacco farming in the Patuxent watershed during the 18th and early 19th centuries, sedimentation in the watershed became a significant factor effecting commercial navigation on the river. In addition to affecting the ability to navigate vessels with certain drafts, sedimentation was and still is, responsible for increased turbidity, loss of submerged aquatic vegetation, and the filling in of wetland and other habitat areas. From an environmental perspective, sedimentation is also responsible for the creation of marshes where formerly there were none. Overall, the long-term increase in sedimentation has significantly affected environmental quality. Sedimentation in the lower reaches of the river, coupled with the high levels of recreational boating that require access to the tributaries, increases the need for maintaining adequate

channels at the tributary mouths. Although future maintenance dredging can be anticipated, the relatively small amounts of material that must be removed would seem to indicate that a dredged material management plan is not necessary. As development continues, the need for new channels to provide access to new residential developments will need to be considered in terms of the overall growth management of the region.

Current Corps of Engineer policies preclude the use of Federal funds to dredge navigation channels that are used primarily for recreational purposes. More than 50 percent of the economic benefits required to justify a navigation project must be related to commercial activities. Based on discussions with representatives from the Maryland DNR, the Maryland Watermen's Association, the U.S. Coast Guard, and the Charter Boat Association, there are no needs or opportunities for additional shallow draft navigation projects that meet the above criteria at his time. Consequently, the primary navigation needs identified are related to the maintenance of existing state and local channels. This need to maintain state and local access channels for recreational boating also extends to the need to maintain navigation access to the public launch facilities on the river.

3.3.3 Boating Problems and Needs

In terms of boating needs, several key issues were investigated including an examination of existing vessel traffic and the need for new aids to navigation or other safety programs. Health and safety issues related to the disposal and treatment of sewage from boats on the river were also investigated. Since disposal of sewage from boats can directly affect public health and aquatic resources through the depletion of available oxygen (BOD) and nutrient loading, marine sewage disposal is an issue that will need to be addressed in terms of navigation needs, recreation, environmental restoration, and environmental infrastructure (waste treatment facilities). Specifically, existing sewage pumpout facilities were identified, and, where possible, the need for additional pumpout facilities was also identified. Public safety issues related to competition between commercial and recreational boaters were also considered, as was competition between various recreational boating activities.

This aspect of the study centered on an assessment of boating traffic in the region to determine whether it had reached a level where additional traffic could be accommodated without affecting health and public safety. Since a major portion of the study area below the bridge at Benedict appears to be at capacity, there is a need to ensure maximum safety conditions and avoid potential conflicts between resulting from high densities of recreational users (boats as well as personal watercraft). In particular, safety issues concerning the development of new marinas that might compromise existing resources in the region were reviewed. The need for additional marine sewage disposal facilities (MSDF) was also examined to determine whether additional MSDF sites are required to ensure public health and to reduce nutrient loading from illegal overboard disposal.

3.3.3.a Congestion/Safety: As the lower portions of the river basin become more developed and the number of recreational boaters continues to increase, the demand for navigable waterways will only become greater. Although there is a need for maintaining navigable

channels to provide access to the tributaries, the need for additional anchorage areas that do not conflict with navigation access will need to be explored. Additional details regarding existing conditions relative to recreational boating are discussed further in Section 2.7. Specific recreational boating needs and opportunities are discussed fully in Section 3.6.

Increasing boat traffic on the river has created a potentially serious safety problem. As the region's waterways continue to bear this burden, regulations to govern the use of these waterways must keep pace with the increase in boating to assure the safety of all. In particular the presence of personal water craft (jet skis) poses a significant safety problem in areas that have a high density of boat traffic. Related to the number of recreational vessels on the river, there is a need to restrict vessel speeds to ensure safety as well as protect sensitive environmental areas. Excessive speeds in shallow areas unnecessarily disturbs these sensitive areas by churning the bottom as well as causing erosion along the shore by boat wakes. Specific, sensitive environments (e.g., areas with less than 3 foot depths) need to be identified and speed restrictions established. The State of Maryland does have restricted speed zones in portions of the river and these areas need to be examined to determine whether existing restrictions are appropriate or need to be expanded.

3.3.3.b Health: Sewage disposal from recreational vessels on the river poses an environmental as well as a public health problem, and there is a need for additional pumpout facilities on the river to ensure that, to the maximum extent possible, all boat sewage is disposed of appropriately. Although disposal at appropriate MSDF is required by law, educational programs as well as convenient disposal locations must be developed to ensure compliance. Given the large number of recreational boats on the river, additional pumpout facilities, in excess of those required by law, will further reduce potential health problems as well as reduce nutrient loading in the river and the Chesapeake Bay.

The 1992 Federal Clean Vessel Act requires that all public or private marinas that berth boats over 22 feet in length and have at least 50 slips must have a sewage pumpout station and portable toilet waste disposal facilities. As of October 1995, there were 6 boat sewage pumpout facilities associated with the marinas on the Patuxent River. Starting July 1, 1995, the State of Maryland requires that all marinas with 200 or more slips, berthing boats over 22 feet, have a marine sewage disposal facility (pumpout station). As recreational boating pressures increase with the overall development in the region, there will likely be a need for additional pumpout facilities on the river to ensure convenient access. The need for additional recreational facilitates is discussed relative to recreational boating needs and opportunities in Section 3.6. Specifically, Calvert County representatives have identified the need for additional pumpout facilities along the reach of river bordering the county near Benedict.

3.3.4 Opportunities

The beneficial use of dredged material is simply clef-as the utilization of dredged sediments as resource materials in productive ways. The U.S. Army, Corps of Engineers draft ER 1165-2-27 (January 1994) suggests that projects for the ".. protection, restoration, and creation of aquatic and ecologically-related [projects], in connection with dredging... " could

use dredged material for the restoration and creation of wetlands, the creation of shallow water habitat, and the establishment of beaches or berms to protect eroding wetlands.

For this study, beneficial uses of dredged material were considered relative to current dredging programs as well as future, anticipated dredging needs. Problems and needs associated with the disposal/placement of dredged material was also investigated, and, in particular, the availability of suitable disposal sites was examined. Beneficial uses of dredged material that were considered included habitat restoration and creation as well as other environmentally based alternatives to reduce shoreline erosion.

In evaluating the shallow draft navigation and channel maintenance needs of the study area, particular consideration was given to both the direct and indirect effects of proposed dredging activity. Of particular concern to some interests is how increased recreational boat traffic, resulting from the development of new marinas, might impact environmental resources. Discussions with the Maryland DNR Navigation Division and an examination of existing project maintenance activities indicates that on average, existing projects on the Patuxent River require dredging every 7 years. Although the individual counties are responsible for the dredging, the cost for maintenance is assumed by the state. Accordingly, the state has considerable influence over the disposal of dredged material. Wherever possible, the state attempts to develop beneficial uses for the material. Beach renourishment is one example of such a beneficial use that has been successful in the region. To date, the state has not pursued wetland or habitat creation as a beneficial use for a variety of reasons. Specifically, much of the dredged material is clean sand, which lends itself to beach nourishment; thus, renourishment is a cost-effective methodology. On the other hand, clean sand is not well suited to wetland creation. The state has not pursued habitat creation as a beneficial use due to the assessment that wetland creation is not 100 percent reliable. Other opportunities for beneficial use of this material for shoreline stabilization and environmental restoration are explored and discussed in Section 3.2.

Other beneficial uses of dredged material examined included the potential use of dredged material for the creation of shallow water and aquatic habitat areas such as wetlands and oyster bars. Because wetland creation requires materials with relatively high organic content, the availability and suitability of dredged sediments for wetland or habitat creation will need to be explored on a case-by-case basis.

Issues concerning potential beneficial uses of dredged material were evaluated to identify specific opportunities for utilization of dredged material. Both traditional and non-traditional disposal practices were considered. Due to the relatively limited need for dredging, there does not appear to be a significant need to develop a dredged material management plan (DMMP). An overall strategy as to how to utilize dredged materials when necessary would seem to be a more appropriate approach to addressing multiple objectives related to beneficial uses of dredged material in the Patuxent River watershed.

Because the river is relatively deep and fast flowing in the main channel, sediment deposition in the tributary mouths tends to be sand, with the lighter silts and organic components washed

out. That this sand is well suited for beach renourishment and shoreline stabilization activities has been demonstrated at a number of sites adjacent to state navigation channels. The use of sandy material to replenish beaches adjacent to channel construction or maintenance projects has been successfully accomplished in a number of situations in St. Mary's County and has been demonstrated to be a cost-effective solution to disposal problems. Additional opportunities to employ this methodology will need to be explored, and there appears to be significant opportunities to use this material to counteract or control shoreline erosion. Non-structural methods to control shoreline erosion using locally dredged material can be a cost-effective and environmentally sensitive method to address this problem. Techniques such as elevating the shore or creating wetland areas to control erosion through vegetative stabilization appear possible, and such opportunities will need to be explored. The Maryland DNR Shoreline Erosion Control Division currently has a cost-share program to provide assistance on non-structural stabilization projects. Opportunities to coordinate the beneficial use of dredged materials nom the maintenance of state navigation channels, as well as from the dredging of public boat landings, should be explored. The State of Maryland has indicated a strong interest in developing shoreline stabilization projects on the Patuxent River and has identified approximately 250 potential sites. Efforts to coordinate the use of dredged materials for this program as part of an overall management strategy will need to be fully explored.

St. Mary's County has identified specific areas along the Patuxent River that may be suitable for both structural and non-structural shoreline stabilization. Such projects might include the renourishment of beaches, elevation of shorelines, or possibly vegetative stabilization. Such projects could meet multiple objectives associated with environmental restoration or creation, as well as shoreline protection, and will need to be coordinated with state objectives in the region. Similar opportunities exist in the other counties bordering the river and will also need to be explored.

Currently the Corps of Engineers, in cooperation with Calvert County and the State of Maryland, is in the process of completing the Feasibility Report for a stone breakwater revetment at Solomon's Harbor to protect the entrance channel to the harbor. As part of the feasibility and design analysis of the project, various beneficial uses of dredged material will be considered.

Due to the regional development occurring in Calvert County, the county has identified the need for additional recreational boat launches as well as the need for additional MSDFs. The need for additional navigation projects (channels) to meet the increased demand for recreational boating has also been identified, although specific locations have not. Accordingly, management measures for new marinas and recreational boating facilities need to be developed to preserve existing boating opportunities in the region while ensuring the protection of the regions natural resources. Contrasting with this approach are management issues concerning the development of new facilities that might compromise the existing resources in the watershed. Similarly, the development of recreational channels in certain areas versus others may provide opportunities to protect sensitive environmental areas. Planned developments and appropriate land-use zoning with an awareness of boating and

environmental needs could allow new navigational channels to be developed such that the protection of environmentally sensitive areas is assured.

3.4 FLOOD DAMAGE REDUCTION AND FLOODPLAIN MANAGEMENT

The purpose of this portion of the report is to discuss the particular flood problems in the Patuxent River watershed in order determine needs and objectives. These flooding needs and objectives will be coordinated with the needs and objectives for environmental resources, navigation, and recreation, to provide a multi-objective solution to the over-all and long-term problems in the watershed. Flooding is often related to a number of other issues that may be more or less important depending on their location. This section will attempt to isolate the flooding problems so that they can be studied and analyzed on their own. The results of this analysis can then be used alone to resolve a specific flooding problem or as an integral part of this study to provide a multi-objective approach. It is important to remember that projects and programs are meant to help reduce flooding damages, not eliminate the risk.

3.4.1 Watershed Overview

Problems occur when our usage of the floodplain puts us and our property at risk from the damaging impacts of flood water. As communities grow, so does the risk of losing one's property, house, business, or even life during a flood. In some locations, high floods have disrupted major transportation routes, thus hindering rescue efforts and evacuation as well as commerce.

Local governments, through the use of floodplain management practices and an effective warning system, have had positive impacts on flood damage reductions. Although the current flood damage reduction methods have been successful in the past, areas remain that still receive significant flood damages. These areas may require further protection from either structural or non-structural projects. Two major factors affect the alternatives for flood reduction measures: the density of development and the source of the flooding.

Urban communities are conducive to structural as well as non-structural flood reduction solutions. Because urban areas are dense, they provide larger flood reduction benefits in a concentrated area. Thus, a structural alternative is more likely to be economically justified. The availability of land becomes an issue when choosing between a structural and non-structural project. Many times, affordable land is not available to construct a non-structural alternative.

On the other hand, rural communities can usually justify only non-structural alternatives. First, the area that needs to be protected is usually greater than in an urban community because rural communities are further apart. Second, these properties are mainly residential, with few or no commercial properties present. Thus, the increase in area to be protected and the decrease in flood reduction benefits makes structural solutions economically unjustified. Also, the availability of affordable land is often not an issue.

3.4.2 Sub-Watershed Analysis of Problems, Needs, and Opportunities

Residents of the Patuxent River watershed continue to suffer from periodic flooding. The flood hazards can result from major watershed-wide storms, localized events or a combination of the two. The current and potential flood damages, as reported by local officials and documented data, are summarized in the paragraphs below.

While the flood damages in the past 18 years have not been extensive enough to warrant any future flood control projects, precautions should be taken to minimize the impact of the 100-year storm. Most of the communities did not show much interest in flood control or flood damage reduction measures, but some of the following concerns should be further investigated.

3.4.2.a Upper Patuxent Sub-Watershed

Howard County, located in the upper watershed, reported some minor flooding on business properties in the Columbia area from Hurricane Agnes (June, 1972). The Columbia area was evaluated in 1978, and the only feasible solution that was found would be a dry dam, which at that time could not be economically justified. A current field investigation revealed that no new structures, nor significant changes in the existing physical structures, has occurred in this area since the study in 1978. Thus, the dry dam alternative still cannot be economically justified. There are no major flooding problems recorded in the Patuxent watershed portion of Howard County.

Montgomery County, located in the upper watershed, is protected to a certain degree by the Duckett and Triadelphia water supply reservoirs, and is not in any need of specific flood damage reduction measures. However, there may be a need for study of the emergency spillway on the Duckett Dam to assess the need for dredging the reservoirs. Flooding is not considered to be a major problem for the Patuxent watershed in Montgomery County, although there is a need for a comprehensive reservoir model linked to the existing Patuxent River model to provide more accurate information.

3.4.2.b Middle Patuxent Sub-Watershed

Prince George's County, has major flooding potential in the Upper Marlboro area, Western Branch and Charles Branch sub-watersheds. Due to the intense development pressures and resulting encroachment into floodplains, flooding has occurred throughout Prince George's County. The county will temper continued use of the floodplain areas using ordinances that restrict construction, grading, or falling operations in the 100-year floodplain.

The Laurel area of Prince George's County has reported significant flood problems. The two WSSC dams, Rocky Gorge and Brighton, while not designed for flood control, are operated to reduce flooding in Laurel, when possible. There are current questions outstanding about the hydrology of the area and the frequency analysis used to determine discharge rates. If the discharge rates are incorrect, then the flood elevations that were determined by these flow

rates are also in error. It is believed by FEMA that the flow rate determined by the Corps of Engineers in the 1985 Flood Insurance study are correct. However this has not been sufficiently proven to all concerned.

For the Laurel area, Hurricane Agnes in 1972 is the largest flood of record. The Crows Branch Channel Improvement Project was in the construction stage during Tropical Storm Agnes. Before 1973 and especially during Agnes, Crows Branch was the source of intermittent flooding problems because it was encased in a concrete channel. There was also extensive localized flooding upstream of the Chessie System embankment, which acted as a dam due to the unfinished construction. There are still questions to be answered with respect to the discharge frequencies of the Patuxent River. The 100-year floodplain of the Patuxent River and Crows Branch are highly developed within the City of Laurel, and are periodically subjected to severe flooding. Pending problems occur when culverts and small bridge openings become clogged with debris wash into the streams.

Prince George's County has major flooding potential in the Upper Marlboro area, Western Branch, and Charles Branch HUA. While there are many individual flood prone properties in the county, they are somewhat scattered and have problems that appear to be diverse in nature. The properties with similar problems which were in close proximity were grouped for ease in selecting potential project areas. These groups are Upper Marlboro and Collington Branch, the upper Western Branch, and the Charles Branch sub-watersheds.

Prince George's County was the first county in the Patuxent River watershed to participate in NFIP, and has participated in the CRS since 1992. Its current rating is a 7. An approved Floodplain Management Plan is needed to organize various ways to implement flood proofing projects consistent with CRS criteria that will also include plans for technical assistance and funding. The problem appears to be a "Catch-22" situation. Since little flood proofing had been done in the past, local contractors cannot claim expertise in flood proofing. And because the county cannot provide a list of contractors who can claim expertise in flood proofing, they received no points for flood protection assistance. This problem could be corrected by a community-initiated education program. With an approved Floodplain Management Plan, the county could qualify for a rating of 6 and could realize an additional 5 percent discount in flood insurance premiums.

Anne Arundel County in the middle watershed reported some potential flood areas in some roadways around Crofton. There is also some concern about the Conway Road and Woodwardville on the Little Patuxent River, and along Brock Bridge Road. However, there have been very few flood insurance claims in this county in the last 18 years. Tidal flooding is more significant on the Chesapeake Bay and Patapsco River and not a significant problem on the Patuxent watershed. The existing flood warning system could benefit from improvement. According to the Deputy Director of Emergency Management, during the most recent events of high water on the Patuxent River, the observed readings were not in agreement with the HEC-2 computer model of the Patuxent River watershed, which is based

on gage readings provided by Howard County authorities. Consequently, the Patuxent River flood prediction information based on the river's current configuration should be updated.

3.4.2.c Lower Patuxent Sub-Watershed

Calvert County has experienced isolated events such as the flooding in the Owings bowling alley and the bridge. Numerous flood insurance claims within the last 15 years and the destruction of Mill Branch bridge near the Huntingtown area also indicate a flooding problem. Sixty-eight flood insurance policies in Lusby suggest that at least as many houses in that area are prone to flooding from the St. Leonard Creek. However, NRCS believes that most of these problems can be improved by stormwater management.

Calvert County has had isolated events such as the flooding of the Owings bowling alley and the Mill Branch bridge. In the Hunting Creek area, there have been a total of 13 flood insurance claims within the last 15 years (over half in the Huntingtown area). And although there are 68 flood insurance policies in Lusby, flooding from the St. Leonard Creek is not considered to be a major problem. The NRCS believes that most of the flooding can be reduced by stormwater management.

The county has participated in the NFIP since 1979, and in the CRS since 1992. The community's current rating is 9 out of 10. One major deficiency for the county is the absence of an approved Floodplain Management Plan. These plans include a variety of ways to implement flood proofing projects consistent with CRS criteria, and include plans for technical assistance and tiding. It is recommended that the county prepare a formal Floodplain Management Plan for uniform and consistent future planning efforts in order to receive all available credit points under the CRS, as the addition of such a plan would multiply points received in other categories. By adding a Floodplain Management Plan and other improvements, the county could qualify for a rating of 8 and could realize an additional 5 percent discount in flood insurance premiums.

Charles County has a large number of flood-insured properties near Benedict due to small storm surge-related and flood-related problems on the mainstem of the Patuxent. There are areas in the county that are considered to be "sensitive evacuation areas" with respect to hurricanes and tropical storms. This situation presents difficulties because limited departure routes such as the Route 231 - Patuxent River bridge are quickly inundated. For the rest of the county, there is a potential for flooding in some areas, but there have not been major flood damages in the past because most of the county is rural. A closer look at flood damage reduction may be needed.

St. Mary's County of the lower watershed has minor flood damages recorded within the last 18 years in the California and Lexington Park areas.

Throughout the Patuxent River watershed, residents, homes, businesses, highways, and bridges have been and will continue to be occasionally affected by floods. Many times, the resulting damage is too small to justify the construction of a flood control project. Local

jurisdictions can mitigate flood damages through proper floodplain management, storm water management and an effective flood warning system.

3.5 WATER-RELATED INFRASTRUCTURE

3.5.1 Watershed Overview

The Corps databases were used to examine water infrastructure within the study area. The databases analyzed existing water infrastructure and capacity, locations of point and non-point pollution sources (AMD, septic, stormwater), and census of population. The results of this analysis and review of the information obtained through the public involvement program demonstrated that most of the needs relate to the control of urban and rural runoff. Gaining control of the quantity and quality of runoff will better protect water supplies, ensure efficient wastewater treatment, safeguard aquatic habitats, and prevent ecosystem degradation.

3.5.1.a Water Supply

Surface Water Supply

Surface water and groundwater are two of Maryland's most valuable resources. These two water sources supply drinking water for a significant portion of the study area population. It is important to conserve and protect these waters for human consumption, as well as to maintain aquatic organism functions and the organisms' supporting habitats.

Erosion and resultant sedimentation and turbidity within the reservoirs and adjacent tributaries are major concerns for the upper watershed. The lack of, or inadequate, stormwater management of commercial centers and roadways is causing severe erosion within and near streams. These activities allow silt, sand, and sediments to be transported and deposited in areas of lesser disturbance, most commonly the reservoirs and slower moving stream sections. Downcutting to bedrock and clay layers is common in the streambeds so that sediment is carried further downstream to lower elevations of accumulation. As sediment becomes resuspended, it eventually reaches the Patuxent River.

This increased sedimentation has begun to limit the quantity of water that the reservoirs can hold for supply purposes. As more sediment settles in the two reservoirs, there will be less water available for the growth needs in the surrounding communities. Environmental restoration, conservation methods, and alternative water supplies will help restore current degradation and will ensure future supplies that are both adequate and of good quality.

As erosion continues to deteriorate the streambeds and banks, it is more and more difficult for organisms to locate suitable and stable habitats. Resultant sediment loads further limit potential habitats by blocking breeding sites. Aquatic organism life functions, such as defense mechanisms and respiration, are also inhibited by turbidity created from excess clay, silt, and sediment. Visibility, an integral component of the predator-prey cycle, is decreased and suspended materials can clog gill passages. Also, increased turbidity limits the amount of

sunlight that can reach submerged aquatic vegetation. Again, this narrows viable habitat and can ultimately affect water quality.

Without the proper vegetative exchange media, nutrients entering the streams and reservoirs may cause higher trophic levels, eutrophication, within the ecosystem. Vegetation incorporates excess nutrients to meet growth needs and, in turn, cleans the water of those pollutants. If the vegetation is not present, nutrients remain in the water and can create abundant algal growth, lowered dissolved oxygen levels, and reduced light penetration.

Surface water sources such as lakes, rivers, and streams need to be protected to ensure overall water quality. Protection and preservation can be accomplished through a number of methods including the use of riparian (forest) buffers, establishment of nondevelopment zones, strict enforcement of NPDES permitting, and comprehensive public education on how individual activities affect the health of a watershed.

Groundwater Supply

Most of the lower watershed is supplied with water from groundwater sources. Throughout the Patuxent River watershed, these supplies are becoming stressed and limited in quantity from increased population growth and use. The Aquia aquifer, which spans the lower half of the watershed, is approaching a level where conservation measures will need to be taken and alternative sources of water will need to be found.

Unprotected sources of drinking water, such as wells and springs, are often contaminated by on-lot septic disposal systems. Existing communities that utilize on-lot sewage disposal need education about the importance of correctly designing, constructing, and maintaining current or proposed systems. Old and failing systems need to be removed and replaced with more efficient systems less likely to fail and to contaminate the groundwater.

Groundwater can also be protected through such methods as underground tank registration and evaluation, and the creation of groundwater recharge zones. Such groundwater recharge zones would limit development and its negative impacts (excessive runoff and potential contamination from underground storage tanks and septic systems).

Summary of Drinking Water Problems

Table 3-4 is a summary of drinking water quantity and quality problems within the Patuxent River watershed.

3.5.3.b Wastewater Treatment: The results of the Corps of Engineers' analysis and review demonstrated that there is adequate public sewer infrastructure throughout the upper Patuxent River watershed. Most of the population in the study area has been identified as having access to wastewater infrastructure facilities. The remaining residents rely upon alternative on-lot disposal systems, including septic tanks. These private systems were found to be in need of restorative and alternative measures to maintain adequate treatment in the southern (Charles,

Calvert, and St. Mary's Counties) and very northern portions of the watershed (northern Howard County).

Wastewater Treatment Facilities

Many of the communities in the study area have benefited from a regional approach to wastewater treatment through the WSSC's facilities. A regional approach to wastewater treatment is consistent with watershed planning efforts occurring within Maryland, and addresses the needs of both large and small communities.

Present and future needs have been planned for with recent upgrades to all the major wastewater treatment plants within the watershed. This is mostly in response to the signed Chesapeake Bay Agreement to reduce point sources of pollution, such as heated effluent, improperly treated wastes, and chemical discharges.

As the facilities are innovatively equipped to reduce nutrient loading to the Chesapeake Bay, additional treatment can enhance and ensure safe water quality for humans, and for plant and animal habitat. Other approaches to wastewater management exist that may adequately address the needs of small communities and also enhance water quality for the regional facilities. Some treatment technology processes are designated as "natural systems." This technology relies on nature (as opposed to requiring constant monitoring by skilled operators) to control the treatment and purification of wastewater. Some examples of these processes include overland flow, sand mounds, and constructed wetlands. Wetlands have become an innovative means by which to falter wastewater and reduce nutrients. Their natural systems and cycles allow for extended treatment without chemical additions. Wetland ecosystems may serve as tertiary treatment to many of the wastewater treatment plants in the Patuxent watershed. This would not only benefit wastewater treatment, but would also provide habitat and buffer zones for many plants and animals.

The ultimate disposal of the solid and semi-solid residuals (biosolids) and concentrated contaminants removed during the treatment process is one of the more difficult and expensive problems related to the wastewater treatment process. In the past, oceans were used for disposal purposes but regulations now prohibit this practice. A number of more innovative processes use biosolids to condition agricultural lands and to reclaim abandoned mine lands. Agricultural use of biosolids must be coupled with pre-treatment programs that reduce the concentrations of potentially toxic substances in biosolids, and a biosolids conditioning process that reduces pathogenic bacteria to regulated levels. These innovative uses of biosolids reduce the amount that localities must pay in order to transport and dispose of biosolids in landfills, as is currently practiced.

Sanitary sewer lines are designed to be watertight; however, infiltration of raw sewage into the ground sometimes occurs over time. Both old and new pipes may leak as a result of poor workmanship, defects, intrusion from tree roots, impacts from heavy loads, or settlement. Infiltration of wastewater may introduce high concentrations of minerals, chemicals, and bacteria into the surface and groundwater sources. For example, a site of severe erosion in

Anne Arundel County has exposed an "underground" sewer pipe. This pipe carries approximately 4 MGD to the Little Patuxent Wastewater Treatment Plant. In addition to wastewater infiltration, groundwater may flow into damaged pipes. The infiltration may cause an overload of wastewater at the treatment plant, resulting in increased operational costs.

On-lot Disposal Systems

Many older communities are experiencing a high rate of on-lot disposal system failures. These same communities also utilize non-public water sources that often become contaminated with fecal coliform from the failing disposal systems. The hydrology of groundwater can transport the contaminated water for long distances; therefore, the on-lot disposal system failures affect more than their immediate area.

Localities that can provide adequate water treatment can attract development and associated economic growth. For this reason, many of the plants will not be expanding their service areas so that population within the Patuxent watershed can be maintained, and not increased. Therefore, the areas without service will most likely continue to have their wastewater treated with on-lot disposal systems.

As technology reveals more innovative processes by which to treat wastewater, more options become available to communities without sewer service. For instance, sand mounds, which remove 40 to 50 percent of nitrogen found in septic tank effluent, septic fields, and wetlands have become comparable alternatives to the septic tank. They also may provide better treatment and purification through plant uptake, volatilization of ammonia, and denitrification, with fewer chances of contaminating the surrounding surface or groundwater.

Table 3-5 lists the potential contributions of septic systems to non-point source nitrogen loads in the Patuxent River watershed (Maryland Office of Planning, November 1993).

There are various options and best management practices for mitigating on-site disposal system impacts. They include using watertight septic tanks, using two-compartment septic tanks, installing outlet falters on both new and old septic tanks, and mandating the pumpout of septic tanks.

Summary of Wastewater Problems

Table 3-6 displays a listing of wastewater problems identified within the Patuxent River watershed.

3.5.4.c Urban Best Management Practices: The process of urbanization has been observed to generate a number of detrimental changes to the land surface and to the receiving aquatic environments. These changes include increased peak flow and total volume of stormwater runoff, accelerated stream channel and land surface erosion, decreased low flow volumes in receiving streams, and decreased water quality and aquatic habitat. For this reason, increased

development in the upper watershed may lead to reduced commercial harvest of aquatic resources in the lower watershed.

Stormwater Management

Early forms of stormwater management relied upon routing stormwater through gutters and pipes to move stormwater away from development and toward streams or rivers. In the past, when a municipality discharged stormwater directly into a body of water, no thought was given to potential impacts downstream. Yet this action often did create negative impacts, such as flooding and degraded water quality, in downstream communities.

The objective of stormwater management is to prevent or mitigate negative impacts associated with high rates of runoff from excessive rainfall and snowmelt. While stormwater runoff is a natural component of the hydrologic cycle, unrestricted development and the associated increase in impervious surfaces often create runoff that exceeds the natural runoff regime. As the impervious surface increases, the watershed's ability to naturally absorb and release stormwater is lessened. Inadequate handling of the excessive runoff results in overloaded wastewater treatment facilities, excessive localized flooding, erosion and sedimentation in stream channels and across land surfaces, reduction of groundwater recharge, decreases in stream baseflow levels, increases in water temperature, and water quality degradation from urban (heavy metals and salts) pollutants washed directly into open water sources.

Habitat and water quality of streams, rivers, and lakes are severely altered by the introduction of mismanaged or unmanaged stormwater runoff. Low baseflow levels in streams and rapidly increased temperatures strip aquatic life of all osmoregulatory functions and, hence, threaten their success and survival. sedimentation and pollutant loads interrupt aquatic life cycles and processes by blocking or covering breeding areas, clogging gill membranes, and increasing turbidity that prohibits sunlight from reaching submerged plant life and that results in reduced habitat and food sources for waterfowl and juvenile fish. Suspended sediments also decrease visibility and predator/prey responses, in addition to degrading the water quality (excessive nutrients, toxics, altered pH, low dissolved oxygen) for aquatic organisms and humans.

Stormwater management in the region is required, through statute and regulation, in order to manage both the quantity and quality of runoff from new development. The State has established a goal for a 40 percent reduction of nitrogen and phosphorus loadings to the Chesapeake Bay from urban runoff in existing areas. However, through the Corps public involvement activities, some of the historic communities located along the river and its tributaries have indicated that frequent flooding is more of a concern compared to major flood events. Many of these frequent flood events are directly attributable to a lack of sufficient infrastructure to deal with runoff caused by surrounding and upstream development. Development in this watershed continues to place increased pressure on the natural systems to manage stormwater for both existing and future conditions.

Table 3-7 is a summary of stormwater management problems identified within the Patuxent River watershed.

Successful stormwater management focuses on reducing or managing water quantity and increasing water quality. Water quality is negatively impacted by the accumulation of trash, fertilizers, and pesticides and by sediment from poorly vegetated ground. Nutrients from fertilizers, nitrogen, and phosphorus enter the water and promote unusually rapid algal growth that can block sunlight to submerged plants. As the algae dies, its decomposition reduces or eliminates oxygen needed by fish, shellfish, and other aquatic life for their survival. Excessive sediment clouds water and block sunlight from submerged vegetation, then settles to the bottom of streams to clog gravel beds used by fish for egg laying.

Stormwater management controls non-point source pollution through the use of Best Management Practices (IMPs). The most effective approach is to intercept runoff from developed areas, naturally filter and treat the runoff, and then discharge it to streams and rivers at a controlled rate. This management practice is an attempt to maintain the natural runoff regime. Essentially, good stormwater management can be accomplished either by retaining stormwater and releasing it more slowly or by improving infiltration characteristics to move stormwater into groundwater. Stormwater management can either be structural (pipes and gutters) or non-structural (land use management to protect current pervious surfaces such as, thick vegetation or buffer strips).

Erosion and Sediment Control

Soil erosion is the removal of soil by water, wind, ice or gravity. Raindrop erosion causes soil particles to become detached from the soil mass. After being dislodged, the soil particles can be transported by surface runoff, which occurs when the soil becomes saturated and cannot absorb falling rain or when the rain falls at an intensity greater than the rate at which the water can enter the soil. Scouring of the exposed surface by runoff can cause further erosion. sediment deposition takes place when the rate of surface flow is insufficient for the transport of soil particles. Previously deposited sediment may be resuspended by runoff from another storm and transported further down slope. In this way, sediment is carried intermittently downstream from its upland origin.

The erosion potential of a site is determined by its soil erodibility (percentage of organic material needed to bind soil particles together), vegetative cover (ability to slow velocity and filter sediment), topography (degree of slope length and steepness), climate (amount, intensity, and length of rainfalls), and season (variation in temperature and rainfall).

Erosion and sedimentation exist at natural background levels in the absence of human activities. However, a problem of varying severity occurs as human activities modify the natural landscape. Of special concern is the disturbance of steep slopes, especially those adjacent to or in close proximity to streams or drainage courses, and the disturbance of natural stream channels, floodplains and wetlands. Alteration of these areas compounds watershed erosion and sedimentation, and contributes to water quantity and quality problems.

Land from construction activities that has been topographically disturbed and is unvegetated often contributes excessive loads of sediment to streams and rivers, decreases their carrying capacity and ability to contain flows, and therereby results in additional erosion. storm sewers become a sediment traps; losing their ability to function properly for the conveyance of water, they increase erosion and degradation in other areas.

Controls for erosion and sediment transport include temporary sediment ponds and stormwater management ponds at construction sites, and sediment traps to catch loads before entering streams.

3.5.5.d Rural Best Management Practices: Throughout the Patuxent River watershed, there is a need for rural best management practices to be better implemented and maintained. Applicable BMPs vary from the upper to the lower portion of the watershed; however, there remains a constant need for agricultural program assistance and implementation.

Within the upper Patuxent sub-watershed (Montgomery and Howard Counties) there are highly erodible soils and stream bank degradation that contribute sediment to the streams, rivers, and reservoirs. The large amounts of sedimentation and turbidity at the headwaters of the Patuxent River are not signs of a healthy watershed. The impacts of excess sediment and nutrients, as well as limited water supplies, ultimately decreases sustainable water flows for aquatic organisms and adequate water supply for receiving counties.

In addition, the upper sub-watershed can be characterized by many large-lot residential areas that may include one to a few horses. These small horse farms must be expected to be properly managed and maintained even though they are not large agricultural operations. Contributions of animal waste, and pesticides and fertilizers from many small-lot operations, have a cumulative affect comparable to that of a large agricultural facility.

Decline in the river's water quality and the reservoirs' water quality is seriously impacted by increases of nutrients such as nitrogen and phosphorus, which result in harmful algal blooms and, consequently, in detrimental reductions in dissolved oxygen. The excessive algae coupled with increased sedimentation also increases the turbidity of the water. This further prevents sunlight form reaching submerged aquatic vegetation, limiting food sources and protective cover for aquatic organisms.

The excessive nutrients that reach surface waters via runoff and snowmelt limit viable aquatic habitats. Species diversity and abundance may become characteristic of the altered water quality and, hence, the entire ecosystem may undergo change.

Implementation of soil conservation BMPs is essential for phosphorus control, while nutrient management and cover crops are most important for nitrogen. Forested buffers have the potential to reduce the impacts of both nutrients on local stream systems, as well as the potential to add valuable habitat areas to an ecosystem.

3.5.2 Sub-Watershed Analysis of Problems, Needs, and Opportunities

The upper, middle and lower sub-watersheds are experiencing many of the same problems and limitations, however, to different degrees of severity. Based upon existing information and input from Federal, state, and local agencies, the following list of environmental infrastructure affecting aquatic and riparian habitats for the upper sub-watershed, middle sub-watershed, and lower sub-watershed of the Patuxent River have been compiled. This information, however, is not intended to represent all environmental infrastructure and habitat problems within the study area, however, due to limitations such as availability of information, continued analyses, and on-going research.

3.5.2.a Upper Sub-Watershed of the Patuxent: The upper sub-watershed is characterized by inadequate stormwater management and rural best management practices. These activities contribute excess nutrients that may have adverse impacts on the health of the reservoirs as a drinking water source and/or for aquatic habitat. The sediment loading may also limit stream flows and reservoir storage capacities in the near future.

3.5.2.b Middle Sub-Watershed of the Patuxent: The middle sub-watershed is also experiencing mismanaged stormwater runoff and its adverse effects on the environment. Erosion and sedimentation are highly destructive to this area of the Patuxent River. Much of the aquatic habitat and life cycles of aquatic organisms are altered by the suspension of clay and silt particles in the water. As the water flows downstream, it can only be as healthy as the water it receives from upstream; therefore, the lower sub-watershed is also impacted.

3.5.2.c Lower Sub-Watershed of the Patuxent: The lower sub-watershed is similar to the previous sub-watersheds in that it is being degraded by excessive runoff, erosion and sedimentation. In addition, this sub-watershed has many on-lot disposal systems that are failing, potentially contributing abundant nutrients and bacteria to the vital groundwater supplies. The failing wastewater treatment and large amounts of sediment from upstream threaten the livelihood and diversity of habitat and species within the Patuxent River and, further, the Chesapeake Bay.

3.6 RECREATIONAL RESOURCES

This section will identify the needs within the study area associated with the development of recreational resources and improvements to existing resources. The information contained in this section has been summarized from the Maryland Land Preservation and Recreation Plan (1993) and the Patuxent Recreation and Open Space Program. In addition, an examination of county recreational needs was completed from reviewing county comprehensive outdoor recreation plans. The following information is compiled from information contained in those reports. County reports indicated various types of recreational problems and needs (i.e. programs, playfields); however, they were not included in this report as this is a water resources study.

Translating recreation demand into facilities must be based on the capability and capacity for the natural resource to accommodate the recreational use without degrading the resource. Acquisition of land in the Patuxent watershed will serve a dual purpose: recreation use and resource protection.

The Patuxent Recreation and Open Space Program analyzed the recreational opportunities throughout the Patuxent watershed. This analysis determined the need for land acquisition and facility development to allow for recreational opportunities that are compatible with the abundance of natural resources existing within the watershed. The purpose of the Program was to plan for optimal use of environmentally compatible recreational opportunities to include additional river access. The program concluded that increased access to the river would afford the public the opportunity to recognize the value of the Patuxent River and, thus, to elicit concern and support for its health.

The Patuxent Recreation and Open Space Program recommended the following:

- Concentrate on acquisition along the river and tributaries and in the lower portion of the watershed
- Retain Federal holdings in the watershed for open space and research.
- Prepare an acquisition program for the lower portion of the watershed.
- Develop recreation facilities so there is minimal disturbance to the vegetative buffer along the river and its tributaries.

3.6.1. Watershed Overview

Public recreational opportunities in the Patuxent River watershed are limited by the lack of public access. Although boating is one of the major recreational activities that occurs on the river, there are long stretches on both sides of the middle and lower river where no public launch ramps are provided.

Access to the lower Patuxent for boaters would be improved by the provision of another public launch ramp on the Calvert County side of the river between Hallowing Point and Solomons (a stretch of roughly 20 miles of river) and a public ramp on the St. Mary's side between the Charles County line and Cuckold Creek (a stretch of roughly 16 miles of river with no public ramp). On the Calvert County side, possible locations for a boat ramp are one of the seven wharf sites along the Patuxent between Hallowing Point and Solomons, and the state-owned Camp Mohawk property on Kings Landing Road. The public wharf sites such as William's Wharf and Parker's Wharf, which are located away from established centers of boating activity, might be the most desirable wharf sites to use. On the St. Mary's County side, the undeveloped Greenwell State Park property is a possible location for a boat ramp, as are a number of county roads that extend from Route 235 to the vicinity of the river.

Currently, canoe access to the river in Prince George's and Anne Arundel Counties is impeded by obstacles at road crossings, such as no parking signs, road guards along the highway shoulders, steep banks, and dense vegetation.

Access for boaters to the middle Patuxent between Prince George's County, and Anne Arundel and Calvert Counties, would be improved by the provision of at least one public launch ramp in Anne Arundel and one in northern Calvert County. Potential locations in Anne Arundel County include undeveloped lands owned by the County at Governors Bridge, Queen Anne Bridge, and Rock Branch.

3.6.l.a Upper Sub-Watershed of the Patuxent

Howard County DRAFT Comprehensive Recreation, Parks, and Open Space Plan (1995)

The Howard County plan presented recommendations to continue the protection of major stream valleys with the existing regional open space network along the Patuxent and to extend the Patuxent Park System north into Laurel.

The plan presented the fact that the Western Planning Area residents consider safety and overuse of parks problematic, while the Central Planning Area (Columbia) felt that lack of restrooms was a problem. Safety and overuse were also a concern to county residents.

MNCPPC - Montgomery County Parks, Recreation & Open Space Update (1993)

Montgomery County has expressed a need for recreational facilities along the Patuxent, and is interested in greenway and corridor planning to help satisfy this need. In addition, wide stream valley parks may be needed to accommodate paved hiker-biker trails. High costs and environmental and budgetary constraints are restricting and delaying the construction of these trails.

3.6.l.b Middle Sub-Watershed of the Patuxent

Anne Arundel - Land Preservation, Recreation & Open Space Plan (1994)

Anne Arundel County expressed a need for additional equestrian trails due to the existing high demand for these trails. Canoeing opportunities are also limited due to obstructions in the water, and these areas need extensive clearing and improvements.

Another concern of the county is that not all vacant parcels of undeveloped land are appropriate for protection. Sensitive natural areas are becoming increasingly rare due to various impacts from the population, including runoff, pollution, and thoughtless overuse or outright destruction. As sensitive areas become more rare, it will be even more important to plan for their preservation so that residents and visitors may experience and appreciate the benefits they offer. Regulations, now more than ever before, help protect such areas, but they do not necessarily allow any public access, use, or study. The environmental education potential of these natural areas is great if they are made accessible. Natural areas also serve as protected places for unusual flora and fauna. The county is interested in preserving as much natural diversity as it can.

MNCPPC - Prince George's County Land Preservation and Recreation Program (1992)

Prince George's County recommended continued development of stream valley parks to meet the resource protection and recreational needs of the county. The county also recognized that the greatest deficiency of park facilities exists in the "Community park/Recreation area. " The county defines these areas as generally between 20 and 200 acres with tennis courts, athletic fields, multi-purpose courts, playgrounds, and picnic areas.

The county is also interested in greenway opportunities and has already developed a Greenways Team. Several potential greenway corridors in Prince George's County are within the Patuxent watershed, including the Patuxent Regional Greenway; Western Branch Greenway; Chesapeake Beach Rail Trail; Charles Branch Greenway; and Washington, Baltimore, and Annapolis (WB&A) Trail. With proper development and management, an opportunity exists to combine these efforts to meet the resource protection and recreational needs of the county.

3.6.1.c Lower Sub-Watershed of the Patuxent

Calvert County - Land Preservation & Recreation Plan (1994)

Calvert County has expressed a need for more public waterfront recreational sites to decrease public trespassing on private waterfront property. There is also a lack of recreation at Kings Landing.

Boat traffic and noise are becoming a matter of concern to residents along St. Leonard Creek, the largest navigable creek in Calvert County with a commercial marina (White Sands). The county is interested in greenway and corridor planning, which could also help provide a noise barrier to the mentioned affected areas.

Charles County DRAFT Land Preservation, Recreation & Open Space Plan (1995)

Calvert County has expressed a need for of boat launches at Benedict, as well as county recreational facilities in the Patuxent watershed.

St. Mary's Land Preservation and Recreation Plan (1993)

St. Mary's County has also expressed a need for water access, especially in the northern end of the county along the Patuxent. North of Cuckold Creek there is no public water access and only two private access points associated with restaurants. There is a need for additional trailer parking at many of the public boat ramps, as limited parking severely restricts the capacity of these ramps.

3.6.2 Sub-Watershed Analyses of Problems, Needs, and Opportunities for Recreation

Examination of state and local policies reveals a general consensus in favor of the protection of natural resources in the Patuxent watershed. The proposed land acquisition and open space expansion within the watershed can be achieved through the cooperation of state and local government. This combined effort will result in the development of a Patuxent watershed recreation system amenable to both state and local policies.

3.6.2.a Upper Sub-Watershed of the Patuxent

Howard County

The county plan recommended acquisition of lands adjacent to the 100-year floodplain to act as buffers, and to provide for trail systems, access, and other recreational opportunities. Development in the 100-year floodplain is prohibited for ecological reasons, as well as for the protection of property and lives. Although not suitable for development or active recreation, the floodplains, in conjunction with buffers, provide an extensive green network throughout the county that can be utilized for passive recreation such as walking, hiking, picnicking, and wildlife observation. Buffers located in the floodplain do not allow for the provision of trails and pathways for recreational opportunities because the construction of surfaced trails and development in the floodplain is prohibited. In the future, agricultural easements can provide for the preservation of productive farmlands and can still allow for passive recreation through the implementation of a public use clause in the easement, which would allow recreational passage.

The county expressed needs for equestrian trails, hiking trails, camp sites, and acreage for fishing opportunities. In addition, specialized facility demands include amphitheaters, nature centers, and outdoor environmental education centers.

In response to the county-wide survey, the county should consider providing nature centers and nature facilities, including trails, wildlife observation areas, interpretive signs, and self-guided tour pamphlets at all regional parks. Facility recommendations presented in the plan included adaptive reuse of existing facilities and implementation of a county greenway program that may connect regional parks to a greenway system.

Opportunity exists to link a regional park facility (Schooley Mill Regional Park) to the Patuxent River Greenway and the facilities of WSSC. This connection between park and WSSC property creates unlimited opportunities for equestrian and hiking trails continuing west to the Patuxent River State Park. It also links the active recreation facilities at Schooley Mill to the more passive opportunities along the River. Howard County is hoping to convince private property owners of the need for this connection in the form of easements or fee simple transfers.

Montgomery County

Montgomery County plans to continue parkland acquisition in key stream valleys such as the Patuxent and its tributaries. In addition, the county hopes to connect parks and conservation areas to form an open space and conservation-oriented greenway system. Maximum usage of existing paths should be encouraged through trail signage and good maintenance.

2.6.2.b Middle Sub-Watershed of the Patuxent

Anne Arundel County

The county could use its acquisition programs and public policies to create and expand the county-wide greenway system. In addition, management plans need to be developed for all major park facilities to better regulate problems created by overuse. Overuse accelerates the degradation of facilities and shortens maintenance cycles, thereby making maintenance more costly to the county.

The Patuxent River border offers exciting recreational enhancement opportunities, due to the proximity of the roadways to the existing and future parklands along the river. The historic and scenic roadways that parallel the river from the Patuxent Wildlife Research Center adjacent to Fort Meade to Jug Bay Wetlands Sanctuary could serve as recreational linkages to Anne Arundel's Patuxent River parkland as well as cross-over to the Prince George's side of the river.

Prince George's County

Prince George's County will need a total of 3,834 additional acres of park land to meet national recreation standards for its growing population.

2.6.2.c Lower Sub-Watershed of the Patuxent

Calvert County

The county plan recommends that a major site be acquired on the Patuxent River. This site could be a cultural oreducational attraction as well as a recreation area. The county desires a "waterway trail system" with several recreational sites on the Patuxent. County residents expressed strong interest in horseback riding trails and a willingness to participate in identifying and managing these trails.

The plan recommended establishing canoe launching sites to take advantage of the demand from county residents and the tourism market. Potential launching sites to be explored include Hall Creek, Parkers Creek, Fishing Creek, Hunting Creek, Battle Creek, and St. Leonard Creek. Once sites are established for canoe launching, canoe trails going from site to site could be developed.

The county plan further recommended that additional acreage or scenic easements be acquired adjacent to the Battle Creek Nature Center. In addition, the county could consider providing access to the creek for canoeing, or acquiring trail easements to connect Battle Creek with Parkers Creek.

Solomons Town Center could be a site to develop a boating and fishing pier adjacent to boat ramps that would also include picnic tables and comfort stations. A community park with walkways and a seating area could also be added at a later time.

The plan also recommended, in Huntingtown Town Center, development of a village green linked to an open space corridor along Cocktown Creek through a series of linear parks, eventually connecting with the Kings Landing NRMA. Recreation facilities such as tennis courts and all-purpose play fields at the Hunting Creek Alternative School could be incorporated into the project. An integrated pedestrian pathway through the town could also be constructed, linking sidewalks to a hard-surface hiker/biker trails leading to Huntingtown Elementary School.

The county plan recommended that any developed sites should provide access to water, provide part of a greenway trail system and/or provide access to a unique natural, historic or cultural feature and be capable of connecting with a town center and/or existing or proposed park site by way of an existing or potential trail system.

The county needs an additional 455 acres for 1995 and 1,430 acres by 2010 to meet national recreation standards for its growing population.

Charles County

The county plan presented a need for additional equestrian trails and improved waterfront access to the Patuxent. The Maxwell Hall property presents an opportunity for future park facilities and access to the water. The county needs an additional 1,393 acres of open space/recreation land to meet national standards for its growing population.

St. Mary's County

St. Mary’s County will need additional boat trailer parking at boat ramps and additional water access points particularly along the Patuxent River north of Hollywood. The county recognizes that waterfront acquisition for park purposes is a priority.

The county plan recommended that Greenwell State Park could be developed to provide needed facilities to county residents. In addition, the plan recommend public access along Patuxent between Hollywood and Golden Beach (with boat ramp, trailer parking, and fishing pier), and additional trailer parking at the Forest Landing boat ramp.

3.7 FEDERAL LANDS

3.7.1 Andrews Air Force Base

Four PNO'S were identified at Andrews Air Force Base, the first and second being the most significant:

- Improve and add to the current stormwater management system.
- Restore the stream banks once stormwater management is in place.
- Implement more permanent waterfowl population control measures.
- Continue to manage IRP sites and ensure further contamination does not occur.
- Upgrade sewer system to improve water quality of discharge.

3.7.2. Davidsonville Communications Station

No PNO'S were identified for Davidsonville Communications Station. However, Best Management Practices and general habitat improvement measures could be implemented with little costs.

3.7.3. FCC Monitoring Station

No PNO'S were identified for the FCC Monitoring Station. However, implementation of Best Management Practices and general habitat improvement measures could be implemented with little cost.

3.7.4. Fort George G. Meade

Nine major PNO'S were identified at Fort George G. Meade:

- Improve and add to the current stormwater management system.
- Decrease stream erosion and sedimentation on the unnamed tributary near NSA.
- Decrease sedimentation throughout the installation.
- Stabilize stream banks throughout installation.
- Improve riparian buffers, especially throughout the golf course.
- Create a long term forest protection plan.
- Implement waterfowl and deer population control measures.
- Increase recreational opportunities.
- Replenish soil nutrients.

3.7.5. Goddard Space Flight Center (NASA [GSFC])

Three major PNO'S were identified for the GSFC:

- Improve the existing stormwater management system, especially in the unnamed southern tributary.
- Stabilize stream bank and decrease erosion in southern tributary from the property.
- Identify more permanent deer population control measures.

3.7.6 Patuxent River Naval Air Station

Five major PNO's were identified for the Patuxent River Naval Air Station:

- Increase pollution prevention efforts.
- Restore seven miles of channelized streams.
- Restore efforts downstream of fuel contamination site.
- Implement more permanent population control measures for deer and beaver.
- Implement beneficial use of dredge material.

3.7.7 Patuxent Research Refuge

Five major PNO's were identified for the Patuxent Research Refuge:

- Reduce potential nutrient loading from WSSC wastewater treatment plant upstream on the Big Patuxent River.
- Reduce potential stormwater runoff problem from Montpelier Woods development located on the western boundary of the property along the Big Patuxent River.
- Decrease sedimentation and possible contamination from Sandy Hill Landfill on the southern boundary.
- Reduce the manure runoff into Rogue Harbor Branch from horse stables owned by Fort Meade but on USFWS property.
- Create passage for migratory spawning fish species at the culvert on the Lake Allen tributary, Rogue Harbor Branch outlet, and Lake Allen outlet.

3.7.8 Plant Introduction Station (USDA)

Six major PNO's were identified for the USDA Plant Introduction Station:

- Demolish and cleanup the five greenhouses.
- Remediate any lead or arsenic contamination.
- Cleanup the nutrient-rich drainage pond.
- Create a new stormwater pond.
- Implement more permanent deer population control measures.
- Burn dead vegetation as fire-fighting training mechanism.

3.8 SUMMARY OF PROBLEMS, NEEDS AND OPPORTUNITIES

3.8.1 Watershed Overview

The main problems facing the Patuxent River deal with environmental restoration and are due mainly to streambank and streambed erosion, which in turn degrade aquatic, SAV, benthic, and wetland habitat through increased turbidity. Much of this erosion is not due to construction or agricultural practices, but rather to inadequate stormwater management. Some of the older communities lack stormwater management altogether. Some communities have open sloughs through which stormwater can travel to a nearby stream. Other areas have stormwater management structures, but the volume of flow is higher than the designed capacity. Erosion due to uncontrolled stormwater runoff not only destroys property, but it creates high levels of suspended sediments in the river and its tributaries. These sediments block sunlight from reaching the streambed, thus limiting aquatic plant growth such as SAV or wetlands. Sediments also directly impact fish and other aquatic life by clogging gill structures and inhibiting site feeders as well as impacting benthic organisms. Stormwater-induced erosion and resulting habitat degradation can therefore be said to be the largest single problem in the Patuxent River watershed. As land and water management practices continue, the characteristics that once defined a healthy Patuxent River watershed will continue to be lost or will be substantially altered without steps to correct these problems.

Other environmental restoration related problems in the Patuxent watershed include failing septic systems, which leak polluted water directly into the river; an unmet demand for recreational facilities; and a substantial loss of wetland and woodland habitat. Each and all of these problems have considerable impacts on habitat quality and water quality in the Patuxent River. A matrix displaying the problems, needs, and opportunities in the Patuxent River watershed is shown in Table 3-8.

3.8.2 Sub-Watershed Analysis of Problems, Needs, and Opportunities

3.8.2.a Upper Patuxent Sub-Watershed: The upper Patuxent sub-watershed is characterized by a need for reservoir protection from (1) excessive sediment loadings and (2) nutrients from rural horse farming practices and septic system failures. Much of the environmental degradation occurs within and adjacent to streams. The primary problem in the upper Patuxent River sub-watershed is unmanaged stormwater runoff and unprotected streambanks. The cumulative result is the degradation of physical habitat and impairment of ecosystem functions.

3.8.2.b Middle Patuxent Sub-Watershed: The middle Patuxent River sub-watershed is an area that is greatly affected by the activities and health of the upper watershed. Sediment and nutrients are carried into this main reach of the Patuxent, causing similar degradation as in the upper sub-watershed described previously. In addition, the middle sub-watershed has further habitat degradation as evidenced by the declining populations of submerged aquatic vegetation (SAV), redheads, canvasbacks and migrating Canada geese.

3.8.2.c Lower Patuxent Sub-Watershed: The lower Patuxent sub-watershed has been documented with environmental degradation to shorelines, water supplies, and streams. Unstabilized shorelines are eroding back into tree lines and residential properties on both the St. Mary's and Calvert County sides of the Patuxent River. Residents of the lower sub-watershed rely heavily on groundwater as their water source. This resource is nearing a need for conservation due to increased population growth and likely contamination from on-lot disposal systems. Stream health is deteriorating from large amounts of sediment and nutrients that are entering the system from high flow stormwater. Many older communities lack quality and quantity controls of stormwater runoff.

Table 3-8: Problems, Needs, and Opportunities for the Patuxent River Water Resources Reconnaissance Study

ENTIRE BASIN

DESCRIPTION OF PROBLEM	IDENTIFIED BY	STATE PRIORITY	COUNTY PRIORITY
Need to control streambank and channel erosion to improve water quality	county		
Need for comprehensive resource inventory and evaluation of resource status trends	county		
Need for assessment of stream blockages to both anadromous and resident fish	county		
Need for assessment of septic system impacts (from failures and long-term inputs) and of alternative and innovative on-site disposal systems	county		
Need for developing continued grand and cost-share opportunities for stormwater retrofits and stream restoration	county		
Need for oyster recovery via oyster bar realignment and monitoring	USFWS		
Need for *Phragmites* control via extraction of *Phragmites* and reintroduction of native species	USFWS		
Need to reintroduce anadromous fish via stocking programs for shad and herring	USFWS		
Need to protect/enhance SAV, via boating controls, protected zones, and reintroduction of native species (seed bank, planting)	USFWS		
Need to remove/breach 133 anadromous fish blockages	USFWS		
Need for additional Greenway to provide recreation, environmental restoration, and reservoir protection	COE/counties		
Multi-purpose trails are needed to increase recreational opportunities to meet County demands	county plans		low
Increase recreational acreages to meet growing population and recreation standards for future populations	county plans		
Need to preserve, restore, and protect wetlands throughout basin	DNR/MDE		
USGS gauges may need to be taken over if USGS no longer has funding	USGS		low
Need for public education to enhance stewardship in the basin (fish blockages, land management, *Phragmites* control, etc.)	county		high
Need for Federal Landowners in the basin to be included in the basinwide planning effort	county		
Need for improvement of maintenance of SWM facilities, basinwide	county		
Need for consistency regarding the development, sharing, and utilization of GIS data by Federal, State, and local agencies	county		high
Need for comprehensive inventory and evaluation of resource status and trends	county		high
Need for buffer program along mainstem and major tributaries, to protect streambanks and water quality	State		
Opportunity to use dredged materials from state navigation maintenance for shoreline/streambank nourishment	State	medium	

Table 3-8: Problems, Needs, and Opportunities for the Patuxent River Water Resources Reconnaissance Study

DESCRIPTION OF PROBLEM	IDENTIFIED BY	STATE PRIORITY	COUNTY PRIORITY
UPPER BASIN			
Need SAMP to protect the reservoir watersheds in order to avoid future eutrophication problems	counties		
Need for study on emergency spillway on Duckett Dam to assess whether it will pass probable maximum flood	counties		
Need to assess the need for dredging the reservoirs	counties		
Need to maintain and expand stream buffers along tributary streams to protect reservoirs via park land acquisition or conservation easement	counties		
Need to evaluate the risks of water quality impacts from leakage and spills from the Colonial Pipeline	counties		
Montgomery County			
Need to maintain and enhance riparian forest buffers (habitat for migratory birds)	county		low
Need to restore habitat and streams in the Hawlings River area	county		
Need to identify the sources of and methods of controlling the severe turbidity and sedimentation from Hawlings River	county		
Need to develop a comprehensive reservoir model linked to the existing Patuxent River model	county		
Need to evaluate possible groundwater and reservoir contamination at headwaters from nonpoint sources	COE		
Problem with unrestricted streams and unstabilized stream banks from agricultural activities, including local horse farms	county		
Problem with non-existent or inadequate stormwater management in older developed areas, including the site behind Burtonsville Elementary, Olney Town Center, and Damascus Shopping Center	county		
Need Public education targeted toward the reservoirs and their tributary streams	county		high
Opportunity for trail development along Hawlings River	county		

Table 3-8: Problems, Needs, and Opportunities for the Patuxent River Water Resources Reconnaissance Study

Howard County

DESCRIPTION OF PROBLEM	IDENTIFIED BY	STATE PRIORITY	COUNTY PRIORITY
Problem with erosion in Little Patuxent and Middle Patuxent sub-basins	county		
Need SWM to reduce flooding in Woodland Road area (upstream of Route 108)	county		
Need SWM to reduce streambank erosion and habitat loss at N. Laurel Park (Rt. 1-MD 216-All Saints Rd.-Whiskey Bottom Rd.)	county		
Need SWM to reduce streambank erosion and habitat loss in Davis Ave. area (Rt. 1-Whiskey Bottom Rd.-county line-Patuxent R)	county		
Need SWM to reduce streambank erosion and habitat loss at the Allview Estates area bordering the Little Patuxent River	county		
Need regional SWM plan to reduce streambank erosion, minor flooding, and habitat loss along Route 1 corridor	county		
Need regional SWM plan to reduce streambank erosion, minor flooding, and habitat loss in the Dorsey Run sub-basin	county		
Need SWM to reduce streambank erosion and habitat loss in the Valleymede area	county		
Need SWM to resolve some minor flooding issues in and around the Colombia area (Little Patuxent River)	COE		
Opportunity to guide development in the Hammonds Branch sub-basin, specifically along Route 216	county		
Opportunity to create 1,000 - acre environmental protection area	county		
Opportunity for landowner education regarding manure management, gardening, and lawn maintenance practices	county		

Table 3-8: Problems, Needs, and Opportunities for the Patuxent River Water Resources Reconnaissance Study

DESCRIPTION OF PROBLEM	IDENTIFIED BY	STATE PRIORITY	COUNTY PRIORITY
MIDDLE BASIN			
Tidal Freshwater Benthos Has Declined	EPA		
Need to remove or breach fish blockages	USFWS		
Redheads, canvasbacks, and Canada geese are declining	USFWS/EPA		
Beaver are becoming problematic, due to overpopulation of the species	USFWS		
Mink are very rare in the middle basin, most likely due to PCB sensitivity	USFWS		
Poor maintenance of SWM facilities results in flooding problems which in-turn results in deforestation as emergency management	state		
Anne Arundel county, Millersville Road--Manatail Subdivision; similar site also in Prince George's County			
Opportunity for additional recreational facilities associated with Claggett Farm and Jug Bay	CBP		
Need to control *Phragmites* and other exotic vegetation at identified sites	USFWS		
Prince George's County			
Need to identify locations and impacts of sanitary landfills and rubble fills in county	county		high
Need to identify locations and impacts of septic system failures in the mainstem of the Patuxent River and other locales	county		high
Agricultural BMPs and integrated pest management programs are needed for the county	county		high
Greenway/trail opportunities at Patuxent Regional Greenway, Western Branch Greenway, Chesapeake Beach Rail Trail, Charles Branch Greenway and WB&A Trail.	county		
Need to protect east side of the Patuxent River from stream bank erosion	county		
Interest in bioretention SWM and other innovative solutions	county		
Need to control deer population for ecosystem protection	county		high
Opportunity to preserve large contiguous tracts of forests for migrants, riparian buffers, etc.	county-MNCPPC		
Mouth of Western Branch with dying SAV, near Jug Bay	county-MNCPPC		
Fish habitat threatened, particularly the stripeback darter, identified near Upper Marlboro	COE		
Major flooding in Upper Marlboro area, Western Branch and Charles Branch subwatersheds	COE		
Laurel has significant flooding problems, some possibly due to the Rocky Gorge Dam releases	county		
Need to improve stormwater management to reduce physical degradation of streams	county		high
Need to provide flash flood warning	county		
Need to regulate surface mining to reduce environmental impacts	county		high
Need for public education/outreach re: pollution prevention	county		high
Need to evaluate the water quality in Western Branch	county		
Need to provide flood protection along Charles Branch	county		
Need to provide flood protection along Southwest Branch	county		
Need to improve stormwater management, and provide SWM facilities in the Collington Branch region	county		
Opportunity to improve environmental resources at Laurel Lakes	county		
Opportunity for underwater archaeology as recreation	county		low
Opportunity to provide public access at Patuxent NRM Area	COE		low

Table 3-8: Problems, Needs, and Opportunities for the Patuxent River Water Resources Reconnaissance Study

Anne Arundel County

DESCRIPTION OF PROBLEM	IDENTIFIED BY	STATE PRIORITY	COUNTY PRIORITY
D. C. Children's Center stream channel degradation	county		
Problem with stream channel erosion along unnamed tributaries west of Route 3	county		
Crofton archery range stream channel degradation and lack of SWM	county		
Arrowhead Farms has flooding to access areas	county		
Flood prone areas around Crofton in some roadways, Conway Road, Woodwardville, and Brock Bridge Road	NFIP/county		
Opportunities to recharge groundwater and the Patuxent River from past mining activities and degradation	county		
Need to upgrade/improve access and facilities at Queen Anne's Bridge	county		
Need for equestrian trails	county plans		
Management Plans are needed for park facilities to regulate damage created by overuse	county plans		
Need public outreach and education (septic system maintenance, fertilizer use, horse management, human effects to an ecosystem)	county		
Need to clear snags for canoe access	county		low
Need for flood damage reduction in Anne Arundel portion of Laurel	NFIP		
Opportunity to expand greenway system along Patuxent River mainstem	county		
Need to remove fish blockages along Towsers Branch	county		
Need to retain/restore forested riparian buffers	county		
Problem with horse manure and pasture management throughout Anne Arundel portion of watershed	county		

Table 3-8: Problems, Needs, and Opportunities for the Patuxent River Water Resources Reconnaissance Study

DESCRIPTION OF PROBLEM	IDENTIFIED BY	STATE PRIORITY	COUNTY PRIORITY
LOWER BASIN			
Throughout, boat congestion and limited access	county plans		
Need for plan to manage variety of water use needs-some conflicting: boating, slalom ski course, boat access, environment.	county personnel		
Need for restoration/enhancement of oyster beds	county/USFWS		
Need to improve water quality	EPA		
Low dissolved oxygen levels in bottom sediments throughout lower basin, most likely due to nutrification and turbidity	USFWS/EPA		
Need to restore SAV beds in the lower basin	USFWS/EPA		
Need to remove or breach fish passage blockages throughout lower basin	USFWS		
Need to improve anadromous fish spawning habitat throughout lower basin	USFWS		
Need for protected beaches for Northeastern Beach Tiger Beetle and Diamondback Terrapin nesting	USFWS		
Need to control *Phragmites* and other exotic vegetation at identified sites	USFWS		
Charles County			
Need for flood damage reduction in Benedict	NFIP		low
Benedict has SWM problem, Little if any stormwater drainage pipes, catch basins, or detention areas exist	county		low
Septic systems in the Benedict area are believed to be Failing	county		high
Pump out station may be needed in the area--problem of dumping of wastes from recreational boats into the river	county		high
Erosion may be a problem, likely needs more investigation	county		low
Some small flood/storm surge related problems near Benedict (main branch of Patuxent)	county		low
Maxwell Farm is an opportunity to provide possible recreation, public education, wetland creation	county		high
Need for equestrian trails	county plans		low

Table 3-8: Problems, Needs, and Opportunities for the Patuxent River Water Resources Reconnaissance Study

DESCRIPTION OF PROBLEM	IDENTIFIED BY	STATE PRIORITY	COUNTY PRIORITY
St. Mary's County			
Water supply becoming limited-conservation and alternate supplies may be needed	county		
Possible aquifer water supply contaminated by wastes	county		
Kilpick Creek, a Major tributary, has increased subdivision activity - is WWT adequate to handle increases in population	county		
Area just north of naval base is also building up, septic may be problem there	county		
Inadequate SWM at Golden Beach, Esperanza Farms and Town Creek where development occurred before SWM regs	county		
Lexington Park and Pine Hill Run may have SWM problems and fewer wetlands to catch the sediment	county		
Minor flood damages have been recorded within last 15 years in California and Lexington Park areas	NFIP		
Flooding in the Lexington Park area	county		
Clarke's Landing –possible future need for erosion control associated with potential 60 foot pier for ferry service	county		
17 HTRW sites found on Patuxent River Naval Station	county		
landfill site with basin, CERCLA, erosion into landfill, breakwaters, well site with batteries	county		
SWM has only 2 detention facilities built; whereas, 4 were planned	county		
Myrtle Point provides an opportunity for land acquisition to be used for environmental restoration or recreational facilities	county		
Development of Greenwell State Park could provide an opportunity to meet needed access and/or recreational facilities	county		
Need additional boat trailer parking at boat ramps	county plans		
Recommended public Access at Hollywood and Golden Beach (boat ramp, fishing pier, trailer parking)	county plans		
Provide trailer parking at Forest Landing access point	county plans		
Need for access north of Hollywood	county plans		
Shoreline erosion abatement needed at Half Pone Point on Cuckold Creek	county DPW		
Shoreline erosion abatement needed at Town Point on Patuxent Mainstem	county DPW		

Table 3-8: Problems, Needs, and Opportunities for the Patuxent River Water Resources Reconnaissance Study

Calvert County

DESCRIPTION OF PROBLEM	IDENTIFIED BY	STATE PRIORITY	COUNTY PRIORITY
Nonpoint source pollution is problem	county		
Individual septic systems and wells limit clustering, need on-site innovative systems	county		
Existing septic systems contribute pollution to surface waters	county		
SWM is inadequate or failing at most shopping centers, Prince Frederick, the county hospital,	county		
Flooding in Owings, car dealership and gas station in 100 yr. floodplain (Hall Creek); bridge flooded in 1989	county		
Environmental degradation due to past mining activities at Ferry's Landing	county		
Environmental degradation to Hunting Creek watershed, streambank erosion, habitat loss	county		
Environmental degradation to Hall Creek watershed, stream bank erosion and habitat loss	county		
Enhance Greenway and corridor planning to compliment Clustering	county		
Bank erosion and Lack of recreational facilities at Kings Landing	county		
Septic problems at Broomes Island	county		
Need funding for technical support for agricultural BMPs	county		
68 Flood Insurance policies in Lusby suggest that at least as many houses in that area are prone to flooding (St. Leonard Creek)	NFIP		
Total of 13 flood insurance claims within the last 15 years (over half in Huntingtown area which is near Hunting Creek)	NFIP		
Opportunity to tie in public access with Hall Creek project	county DPW		
Opportunity to tie in public access with Ferry Landing environmental restoration	county		
Need flood reduction along Mill Branch (bridge destroyed in 1990 -- Cocktown Cr. near Huntingtown)	county		
Hunting Creek Canoe Access site purchase and development	county		
Special Area Management Plan for Hall Creek Watershed	county		
Develop Park on Broomes Island	county		
Opportunity for acquisition of conservation easement adjacent to Battle Creek via Forest Legacy Program	county/CBP		high

SECTION 4

OBJECTIVES AND FORMULATION

During the reconnaissance phase, planning efforts were primarily directed toward formulating feasible solutions to problems related to environmental restoration, navigation, flood damage reduction and floodplain management, environmental infrastructure, and recreation. Solutions were formulated based upon objectives established by stakeholders of the Patuxent watershed. The Corps has the authority to implement projects relating to some of these issues, but others are the responsibility of other Federal, State, and local agencies. Although the primary purpose of a reconnaissance report is to recommend to Corps higher headquarters whether or not further studies should be performed, during this study all of the issues were investigated so that a watershed plan could be developed. Portions of the plan will need to be implemented by agencies other than the Corps.

4.1 FEDERAL OBJECTIVES

The traditional Federal objective of water and related land resources project planning is to contribute to the national economic development (NED), consistent with protecting the nation's environment pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. This objective was established by the U.S. Water Resources Council's *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies,* dated March 10, 1983.

Water and related land resources plans, also known as watershed plans (like this study), are formulated to alleviate problems and to take advantage of opportunities that contribute to this objective while ensuring consideration of hydrologic regions. Contributions to NED increase the net value of the national output of goods and services expressed in monetary units (that is, benefits exceed costs). These contributions are the direct net benefits that accrue in the study area as well as in the rest of the nation. They include increases in the net value of goods and services that are marketed (vendible) and also of those that may not be marketed. The original intent of water resources studies to focus on NED was to justify to the Federal Government decision makers that the implementation of an alternative, if it were an NED alternative, was a fiscally responsible manner to invest Federal tax dollars.

The process typically involved several alternatives being formulated to address a particular set of water resource problems. The alternative that maximizes the net contribution (amount by which annual benefits exceed annual costs) to the NED objectives, and is consistent with the environmental objectives, is defined as the NED plan. The goal of the reconnaissance phase for the Patuxent River Water Resources study, however, was not to identify the NED plan; rather, the goal was to formulate alternatives that would contribute to the NED objectives. Optimization for NED purposes would then be accomplished during the subsequent feasibility phase.

In a statement dated June 1, 1995, the Assistant Secretary of the Army for Civil Works directed the Corps of Engineers to utilize new approaches to implement the President's goal of maintaining and restoring the health of the environment. Unlike traditional civil works water resource projects, ecosystem restoration projects need not contribute to national economic development. The Federal objective of ecosystem restoration for the Corps of Engineers is to restore fish and wildlife habitat that is recognized as significant habitat by institutional, public, and technical communities. Based upon the 1995 guidance, environmental restoration efforts need not reflect a link to the degradation of environmental resources from former Corps of Engineers' effort. If such a linkage is demonstrated, these restoration efforts will receive a higher budgetary priority over those efforts which do not demonstrate a linkage to previous Corps activities.

The significance of the fish and wildlife resources of the Patuxent River watershed is widely recognized by the institutional, public, and technical sectors, both within the Patuxent watershed and also in a larger regional context as evidenced by the new emphasis on the tributary strategies to restore the Chesapeake Bay. Over the past 20 years, extensive efforts have been expended to support natural resources management and restoration plans in the Chesapeake Bay region. Additional information is provided on the significance of the resources in Section 7 of this report.

4.2 PLANNING OBJECTIVES AND CONSTRAINTS

Planning objectives and constraints are expressions of public and professional concerns about the use of water and land-related resources in a particular area. These planning objectives and constraints result from the analyses of existing and future conditions within the context of the physical, environmental, economic, and social characteristics of the study area. They are used to guide the formulation of alternatives and to evaluate the effectiveness of those alternatives.

Several factors were considered when determining the planning objectives of this study. Three plans/strategies that are relevant and already partially implemented were studied so that our objectives compliment the existing and ongoing objectives of the watershed stakeholders. The three plans/strategies are as follows: *Developing a Patient Reservoir Protection Strategy, Tributary Strategy for Nutrient Reduction in Maryland's Patient Watershed, Patuxent River Policy Plan,* and the *Patuxent River Policy Plan* update as of November 20, 1995.

The recommendations and objectives from the above-mentioned plans are summarized as follows. The recommendations and objectives in *italics* can be integrated more directly into potential projects by the Corps.

4.2.1 Summary of the *Patuxent Reservoir Protection Strategy*

- Develop a comprehensive watershed database, and encourage dialogue involving all watershed stakeholders:
    - Develop database of existing and potential sources of reservoir contamination.

- Promote constructive dialogue among watershed among the affected watershed interest groups.
- Set priorities for implementing future watershed management efforts.
- Develop a reservoir model, applied in conjunction with existing State watershed and water quality models.

- Develop a multi-parted approach to reservoir protection:
  - *Adopt protected stream buffers.*
  - Acquire sensitive lands.
  - Use low density zoning.
  - Establish requirements for cluster development and stormwater management, even in low density areas.
  - Establish impervious area restrictions within zones and/or stream buffers.
  - Use financial incentives to promote agricultural best management practices for cropland and animal waste management.
  - Restrict septic tank design and increased setback requirements for septic tank drain fields.
  - Certify requirements to demonstrate performance of regular septic tank maintenance.
  - Develop public education programs targeted to watershed residents.
- Develop an interim action plan for reservoir protection, as resources permit:
  - Develop a land use inventory on a GIS database.
  - *Inventory stream erosion and habitat loss problems and potential stormwater retrofit projects.*
  - Inventory existing and projected septic systems.
  - Review options for requiring regular maintenance of septic systems.
  - Estimate pollutant loading impacts from animals.
  - Establish a coordinated interagency watershed stream and reservoir monitoring programs.
  - Evaluate the need for requiring storm water management controls for low density developments that are now exempt from these control requirements.
  - Investigate opportunities to limit allowable impervious areas.
  - *Evaluate existing stream buffer width and vegetation requirements to determine their adequacy for reservoir protection.*
  - *Encourage establishment of riparian tree cover within new stream buffers and existing stream buffers.*
  - Monitor and compare agricultural impacts on streams.
  - Develop programs to make watershed residents aware of pollution management issues and foster citizen stewardship.
- Develop a long-term reservoir protection program.
- Integrate with ongoing State Patuxent watershed management planning efforts.

4.2.2 Summary of the *Tributary Strategy for Nutrient Reduction in Maryland's Patuxent Watershed*

- WWTPs within a design flow equal to or greater than 0.5 MGD will be expected to implement chemical phosphorous removal (CPR) and install biological nutrient removal (BNR) of equivalent technology for nutrient removal. If smaller WWTPs are expanded to above 0.5 MGD in the future, the expectation is that BNR and/or CPR will be implemented at the time of expansion.
- Implement BNRs through adoption of BNR Agreement between MDE and controlling jurisdiction of WWTP. The controlling jurisdiction must design and construct facilities to achieve a seasonal (April through October) total nitrogen concentration of 8 mg/1 and must operate the BNR process for as much of the year as possible in order to maximize the nitrogen removal.
- Full implementation of existing state and local regulatory programs for erosion and sediment control and stormwater management for all newly developed land.
- Implementation of non-regulatory programs for urban lands that contribute to nutrient reductions, which includes retrofitting previously developed land with stormwater control measures and converting existing dry ponds to more effective stormwater management practices.
- Enhancement of educational efforts in a number of areas which affect pollution control on developed land.
- Increase nutrient management efforts for private homes, businesses, roadways, and public land. Outreach and education efforts will be strengthened and improved; educational materials will be developed and published to provide landowners with specific guidance for types of vegetation, landscaping methods, and organic waste and fertilizer management to minimize environmental impacts.
- Improvement of operation and maintenance of septic systems through the use of low-flow plumbing fixtures, reduction in the use of garbage disposals, and regular pumping to remove accumulated solids.

  Implementation of BMPs (including conservation tillage and nutrient management) through the implementation of Soil Conservation and Water Quality Plans (SCWQPs); nutrient management; treatment of lands with high erosion potential conservation tillage; and cover crops.
- Increase the current 50 percent of agricultural land in the Patuxent watershed under a SCWQP to 64 percent by the year 2000.
- Increase nutrient management plans from the current level of 1 percent to 74 percent of applicable acres.
- Increase the treatment of lands with high erosion potential from the current level of 29 percent to 78 percent of applicable acres.
- Accelerate conservation tillage from the current level of 50 percent to 88 percent of cropland (through existing educational programs).
- Plant cover crops on 33 percent of the cropland acres available for timely planting.
- *Plant streamside forests buffers and protect existing buffers on agricultural and developed*

lands.

- *Identify and address existing obstacles to planting forested and grassed buffers and other stream protection measures (this work has been initiated by MDNR and MDA); recommendations include promoting flexible, site-specific solutions; providing incentives to private landowners to protect riparian areas, and providing additional resources for technical assistance.*
- Recognize the benefits of the Forest Conservation Act (which is estimated to reduce forest loss by at least 20 percent between now and the year 2000. The benefits include increased tree planting and a broader coverage of forest harvesting best management practices will be achieved through logger training, enforcement, standardized permit procedures, and monitoring.
- Promote full implementation of existing regulatory requirements (such as sediment and erosion control) and greater coverage of additional voluntary measures that may be appropriate at a given site.
- Focus efforts on educational programs for boaters to encourage pump out use.

4.2.3 Summary of the *Patuxent River Policy Plan*

- Establish a Primary Management (PMA) Area along the river and its tributary system critical to Chesapeake Bay and its tributaries.
- Include the following in local plans and zoning ordinances:
    - Include agriculture, *forest, and recreation* as preferred land use;
    - Minimize dense and intensive development and large impervious areas;
    - Target area as priority area.
    - Limit land practices so that there is no or little adverse impact on water quality;
- Provide Best Management Practices and vegetative *buffers*.
    - State and local governments will provide Best Management Practices (BMP) on their publicly owned land.
    - State will require BMPs on State assisted projects, including buffers.
    - Local governments will adopt subdivision and zoning provisions that require BMPs in all new development.
    - BMPs will be encouraged on agricultural land through education, voluntary action, incentive, compensation, and through implementation of the Maryland Agricultural Water Quality Management Plan.
    - Soil conservation plans will be required on lands acquired in easements.
    - Request Federal government to provide BMPs on its lands.
    - State Department of Transportation will protect roadside buffers by eliminating broadcast herbicide spraying along roadsides.
- Identify (by state and local governments) major non-point pollution sites;
    - Existing State regulatory and corrective programs will consider these sites as priority areas;
- Retrofit existing development;
    - State will develop a cost-sharing program to aid local governments in correcting and managing storm water pollution from existing developed areas

- Local governments will pursue a program of abating pollution in existing developed areas;
- State and local governments will curtail non-point pollution coming from their facilities;
- The State will establish priorities among developed areas causing non-point pollution and address problems in order of priority;

- Accommodate future development in a water quality sensitive manner;
  - Future development will be accommodated in ways to minimize impact on water quality and maximize existing opportunities;
  - Development will be concentrated where possible, outside the PMA;
  - Development will optimize the use of existing facilities and utilities;
  - Development will be sites to maximize use of soil infiltration capacity;
  - Development will be sited away from sensitive areas, e.g., reservoirs, wetlands, steep slopes, aquifer recharge areas;
  - Sites within the watershed that offer unique opportunities for development and redevelopment will be identified and planned;
  - New public facilities will incorporate BMPs;
- *Increase recreation and open space along the river and its tributaries;*
  - Additional recreation and open space lands will be acquired in the Patuxent watershed by State and local governments;
  - State and local governments will review their recreation and open space plans for the Patuxent watershed;
  - Acquisition will be concentrated along the river and tributaries and in the lower portion of the watershed;
  - *Federal holdings in the watershed must be retained for open space and research;*
  - *An acquisition program for land in the lower portion of the watershed will be prepared;*
- Protect forest cover;
  - *Existing forest cover will be retained and important sensitive areas will be reforested to protect water quality;*
  - Existing State programs will be examined and amended for their application to forest protection;
  - *Buffering with forested strips will be encouraged;*
  - *The State* will institute a reforestation program for developed areas;
- Preserve agricultural land;
  - Prime and productive agricultural land will be preserved in the Patuxent watershed;
  - The Agricultural Cost-Sharing program will target the Patuxent watershed;
- Manage the extraction of sand and gravel resources;
  - Sand and gravel activities will be managed to allow extraction of the resources without damage to the river;
  - Sensitive control of active and future sites, particularly those in PMA, will be required;
  - Penalties for allowing sediment to enter the Patuxent river resulting from washing

operations are to be increased to a minimum of $1,000 per day for every a violation is found to exist by the appropriate State agency;

- The location of the resources will be identified and county resource management strategies developed;

- Adopt an annual action program to implement the Plan recommendations;
  - The Patuxent River Commission will annually develop and adopt an action program to implement the strategies;
  - The action program will contain a schedule and indicate responsibilities in carrying out specific actions to implement the plan;
  - A community education program will bean integral part of the action program;

The Commission will prepare an annual report on progress in implementing the plan.

4.2.4 Summary of the *Patuxent Policy Plan Update (November 20, 1995)*

- Implement a comprehensive watershed management approach to control all sources of pollution and resource degradation;
  - Obtain and maintain the Patuxent 40 percent nutrient reduction goal, by the year 2000;
  - Continue to pursue environmentally sound innovative technologies in the watershed to minimize point source pollution;
  - Implement urban and agricultural BMPs and continue to seek cost effective and innovative technologies for these practices;
  - Continue to develop, evaluate, recommend, and implement activities that promote good land use policy, habitat protection, restoration and creation, viable communities and non-point source pollution management;
  - Develop and implement a protection strategy for the reservoirs and related resources in the upper watershed;
  - Restore, improve, and protect the habitat function of aquatic and terrestrial living resources
  - Restore and protect riparian forest buffers to stabilize streams, shade waterways and improve riparian habitat;
  - Protect high quality streams and restore degraded streams to improve spawning ranges and habitats through a combination of stormwater management, retrofit projects, and streamed and channel enhancements;
  - Ensure the long-time viability of wetland ecosystems through comprehensive planning and State or local purchase of conservation easements.
  - Maintain and enhance contiguous tracts of forest
  - Expand existing State and Federal land owner technical assistance programs for multiple benefits
  - Identify and prioritize remaining tracts of contiguous forest in the watershed and establish “habitat corridors” which are maintained and managed as unimproved land;
  - Protect the habitat of all ecologically-valuable species in the Patuxent watershed;
  - Initiate a funding mechanism to establish a Patuxent River Conservancy, which

would operate as a regional land trust for acquiring and managing ecologically valuable lands in the watershed

- Develop and implement a consistent system of biological indicators to measure progress toward Patuxent river recovery;
- Make a long-term commitment to funding for living resources monitoring programs, particularly for ecologically valuable species that may have little economic value;
- Increase the amount of submerged aquatic vegetation and tidal marsh;
- Concentrate new development in and around existing developed areas and population centers;
- Encourage redevelopment, adaptive reuses, and infill in vacant or under used areas in or adjacent to existing communities;
- Encourage growth in concentrated, targeted areas, preferably close to other existing developed areas, where possible;
- Protect and enhance the rural character and function of areas not designated for growth;
- Encourage participation in agricultural preservation programs;
- Encourage the continuation of rural industries through the implementation of rural economic development initiatives;
- *Increase the requirements for open space outside the development districts;*
- Limit the extension of services and infrastructure to rural areas;

- Enhance the environmental quality and community design in new and existing communities;
- Provide incentives to encourage redevelopment, infill, and adaptive reuses;
- Implement flexible zoning and other development regulations that promote innovative site design while creating additional open space or protected sensitive lands;
- Coordinate regulatory programs that affect land development to balance contradictory goals or permit approval requirements, speed reviews, and make these programs more environmentally sensitive;
- Design new stormwater management facilities and retrofit existing stormwater management facilities to be environmentally sound and aesthetically pleasing; and
- Promote tree planting and wildlife habitat planting programs.

4.2.5 Patuxent River Water Resources Reconnaissance Study

The primary objective of the Patuxent River Water Resources Reconnaissance Study that complements the existing and ongoing of the watershed stakeholders is as follows:

> Develop a water resources plan for the Patuxent River watershed. The plan will determine whether or not any improvements are warranted in the areas of environmental restoration, navigation, flood damage reduction and floodplain management, environmental infrastructure, and recreation.

The primary objective can be broken up into more specific sub-objectives. These sub-

objectives are as follows:

1. Document the historical, current, and potential future conditions of the Patuxent River watershed;
2. Determine the impact of previous Federal, State, local, and private actions in view of a current understanding of terrestrial and aquatic ecology, and propose measures to restore environmental values while maintaining the integrity of the existing projects and other development within the watershed;
3. Determine whether actions should be taken to improve navigation in the study area;
4. Determine if damages associated with storms and riverine flooding can be minimized through the use of innovative structural or non-structural measures;
5. Determine what actions should be taken to improve recreational water resources facilities and public access to those facilities; and
6. Identify potential actions which the Corps of Engineers and others must execute to accomplish the goal of the comprehensive plan.

4.3 FORMULATION AND EVALUATION CRITERIA

The formulation process used to develop and evaluate alternatives is based on the consideration of restorative measures with the potential for addressing the planning objectives described in this section as well as meeting technical, environmental, and socio-economic criteria. Specific solutions were selected and analyzed based on the most feasible measure(s) that would contribute to a plan of improvement.

The specific criteria considered in the formulation of alternatives for the Patuxent River Water Resources Reconnaissance Study are listed below:

- Policy Compatibility: Measure meets the following policy guidance.

    1. Corps of Engineers -an engineering measure that meets ecosystem guidance

    2. State of Maryland - an engineering measure that meets state environmental policy and guidance

    3. Local - an engineering measure that meets local environmental need, and the public recognizes and appreciates the need for that measure

- Environmental Feasibility: Measure is technically and environmentally feasible.

    1. Environmental - no significant adverse impacts to the environment

    2. Engineering - measure can be designed under normal engineering practices, and will result in a stable and long-term structure or facility

- Implementability: Measure is implementable.

1. Maintenance - typically requires no or low maintenance

2. Multi-Locational - measure is applicable at many sites

3. Cost-Effective - measure has a favorable long-term benefit output versus cost

4. Cost-Sharing Potential - measure is likely to fit under the local capital plan or other funding source

It is important to note that the Corps of Engineers' authority to implement a particular solution was not specifically identified as a screening criteria. While this study investigated problems and potential solutions which are under the Corps of Engineers' authority to implement, it also documented problems that may be outside of the federal interest to remediate. The intent was for the Corps to develop a watershed plan which identifies necessary and/or critical areas of improvement within the Patuxent River watershed in the areas of navigation, flood damage reduction, ecosystem restoration, environmental infrastructure and recreation. This study focused on the development of multi-purpose solutions for implementation by a variety of agencies or groups.

4.4 POTENTIAL SOLUTIONS AND MEASURES

An array of potential solutions was developed to address the identified water resources problems. These solutions were identified through coordination with resource agencies and review of previous studies, available literature, and existing and proposed projects. The potential solutions were then matched with identified problems. The most feasible potential solutions investigated as part of this study are highlighted in Table 4-1.

FORMULATION OF ALTERNATIVE PLANS

TABLE 4-1

ECOSYSTEM RESTORATION MEASURES	POLICY COMPATIBILITY			ENVIRONMENTAL FEASIBILITY	IMPLEMENTABILITY		
	Corps	State	Local		No or Low Maintenance	Multi-Locational	Cost-Effective
1. STREAM RESTORATION							
TRADITIONAL METHODS							
RIP-RAP ARMORING	X	X	X				
BANK GRADING AND TOE PROTECTION	X	X	X				
BULKHEADS	X		X				
CONCRETE LINING			X				
CHANNELIZATION	X		X				
GABION WALLS	X		X				
DRY STONE WALLS	X		X				
BIO-ENGINEERING METHODS							
MEANDER RECONFIG./PROTECTION	X		X	X	X	X	X
ROOT WAD PLACEMENT	X	X	X	X	X	X	X
LIVE BRANCH PACKING	X	X	X	X	X	X	X
FASCINES (BUNDLES)	X	X	X	X	X	X	X
RIP-RAP AND WILLOW PLANTINGS	X	X	X	X	X	X	X
GEOTEXTILES AND VEGETATION	X	X	X	X	X	X	X
2. INSTREAM HABITAT CREATION							
STREAM DEFLECTORS	X		X	X	X	X	X
ROCK WING DEFLECTORS	X	X	X	X	X	X	X
LOG DEFLECTORS	X	X	X	X	X	X	X
GABION DEFLECTORS	X		X	X	X	X	X
BOULDER PLACEMENT	X	X	X	X	X	X	X
ELEVATED BOULDER STRUCTURES	X		X	X	X	X	X
ROCK VORTEX WEIRS	X		X	X	X	X	X
CHANNEL CONSTRICTORS	X		X	X	X	X	X
COVER LOGS	X	X	X	X	X	X	X
GRAVEL PLACEMENT	X		X	X	X	X	X
REMOVAL OF FISH BLOCKAGES	X	X	X	X	X	X	X
CHANNEL BLOCKS	X		X	X	X	X	X
CHANNEL DREDGING	X		X	X		X	X
BRUSH MATTRESSES	X	X	X	X	X	X	X
MUD SILL	X		X	X	X	X	X
3. TIDAL SHORELINE RESTORATION							
TRADITIONAL METHODS							
REVETMENT	X	X	X			X	
BULKHEAD	X		X				
GROINS	X		X			X	
GRADING AND TOE PROTECTION	X	X	X			X	
BIO-ENGINEERING METHODS							
SHORELINE PLANTINGS	X	X	X	X	X	X	X
GEO-TEXTILE PLANTINGS	X	X	X	X	X	X	X
HABITAT CREATION							
WETLAND ESTABLISHMENT	X	X	X	X	X	X	X
SAV RESTORATION	X	X	X	X	X	X	X
FISH REEF ESTABLISHMENT	X	X	X	X	X	X	X
SEDIMENT CAPPING	X		X	X	X	X	X
ISLAND CREATION	X		X	X	X		
BENTHIC HABITAT MODIFICATION	X		X	X	X	X	X
4. RIPARIAN BUFFER RESTORATION							
REFORESTATION	X	X	X	X	X	X	X
SHRUB AND FASCHE PLANTINGS	X	X	X	X	X	X	X
RETURN FLOODPLAIN HYDROLOGY	X	X	X	X	X	X	X
RE-CREATE FLOODPLAIN	X	X	X	X	X	X	X
5. STORMWATER MANAGEMENT							
DETENTION ONLY BASIN (NEW)	X	X	X			X	
DETENTION/WETLAND BASIN	X	X	X			X	X
STORMWATER RETROFITS	X	X	X			X	X
FLOODPLAIN CREATION	X	X	X		X	X	
STORMWATER DIVERSION	X	X	X			X	
INFILTRATION DITCHES	X	X	X			X	
CURB/GUTTER STORM SEWER SYSTEM	X		X			X	
CULVERTS AND SWALES	X	X	X			X	
CHECK DAMS/WEIRS	X		X			X	
TIMBER CHECK DAMS			X			X	
RIP-RAP CHECK DAMS			X			X	
GABION CHECK DAMS			X			X	
EARTH DIKE	X		X			X	
BIORETENTION BASIN	X	X	X	X		X	X
RECHARGE BASINS	X		X			X	
POROUS PAVEMENT			X			X	
EXTENDED DETENTION WET BASIN	X	X	X			X	X

SECTION 5

PROTOTYPE PROJECTS FOR THE PATUXENT WATERSHED PLAN

During the course of the reconnaissance study, several projects were identified that seemed to be appropriate for use as prototype projects for problems occurring throughout the basin. The four prototype plans for the Patuxent River watershed will provide benefits not only for the immediate area of the projects, but also downstream. These plans will serve as prototypical projects, each providing an example of a method of treating a type of problem at many sites in the watershed. This section will give a brief description of each of the prototypes and describe how these prototype solutions could be applied to solutions for other problems, needs, and opportunities in the study area.

5.1 APPLICABILITY OF PROTOTYPE PROJECTS

During the course of the reconnaissance study, potential projects were analyzed for applicability to other areas, as well as for their economic and environmental potential. Each of the prototype projects described below addresses a problem that is not only specific to the project area, but that also has applicability to other areas throughout the watershed. The applicability of each project type to other areas of the watershed is discussed in each project description.

The problems addressed are all environmental restoration issues, but the projects can also supply incidental benefits to recreation and flood damage reduction. The specific problems to be addressed are stormwater management, riparian habitat restoration, SAV restoration, and shoreline erosion protection.

5.2 DESCRIPTIONS OF PROTOTYPE PROJECTS

5.2.1 Upper Marlboro LFP Riparian Habitat Restoration and Wetland Enhancement

Introduction: In September of 1995, Baltimore District personnel visited the Upper Marlboro local flood protection project in Prince George's County. Local officials expressed interest in increasing wildlife habitat without impacting the current level of the flood protection. Previous studies which proposed extensive plantings and meandering of the river did not progress because of the flood impacts due to increased water surface elevations.

Objective: The objective is to restore riparian habitat and floodplain functions by modifying the existing floodway. Recommended modifications include creation of a new lower floodplain elevation and adjacent wetlands, and establishment of riparian cover to benefit warm water fishes, waterfowl, and amphibians.

Methodology: In January 1996, Baltimore District Engineering and Planning Division personnel participated in a field condition survey of the proposed site. Cross-sectional information was gathered in the field to combine with evaluations of the plan and profile geometry completed in the office. In addition, a reference site downstream of the site was investigated for habitat restoration. Stream types, gauge data, geometry, and habitat of both sites were evaluated to determine the best approach to restoring habitat to the Upper Marlboro site.

Hydraulic analysis of the site was required to ensure that the level of protection provided by the flood control project would not be severely reduced by the implementation of the proposed project. Based on the proposed changes by the Environmental Protection Specialist, the hydraulics were reviewed for any increases in backwater elevations. The most recent Flood Insurance Study model was adjusted to reflect the changes associated with habitat imporovements. These modifications include incorporating excavated areas into the cross-section geometry. Plantings of various types, including plants and bushes, were accounted for by adjusting Manning's roughness coefficients at select cross-sections.

A preliminary review of existing geotechnical information was conducted to assess the acceptability of the proposed design and to ensure that the proposed project would not impact the existing flood protection project.

Results: Although viewed during a higher flow event, adequate depths for habitat and channel maintenance appear to be present and are similar to the reference stream habitat. The top of bank ranged from 2 feet to 8 feet above the water surface elevation compared to only 0.5 feet at the reference reach. The proposal will allow for excavation of a new flood plain area on suitable sites within the floodway. Over-excavation in some areas will be used to promote wetland growth. Banks will be stabilized with shrub plantings and additional tree groups will be planted in small groups in non-conveyance areas. Riparian and wetland habitat will be increased.

For backwater elevation determination, the Manning coefficients were adjusted to represent proposed roughness associated with new vegetation. The existing values of Manning's coefficient ranged from 0.035 to 0.07. For the proposed conditions, the Manning's coefficients for plants and bushes were assumed to be a conservative 0.08 and 0.160, respectively. Tree groves were modeled as completely ineffective flow. Analysis of the revised model determined that the proposed changes increased the backwater elevation less than 0.5 feet. This is not considered significant, especially in light of the very conservative roughness coefficients.

County soils maps indicate that material along the section of river where the wetlands are proposed could vary from a silty loam (ML) to a sandy or gravelly loam or even a clay loam (SM, SC, or SP). Soil properties are indicated to be "highly variable", however, and cannot be estimated accurately. The groundwater table is indicated to be at a depth of 5 feet or more;

however, this should be verified. Foundation exploration should be performed during the feasibility phase.

There are no anticipated problems associated with the existing levee system due to the proposed excavation near the levee. Although the existing mapping reviewed was not clear, it appears that excavation will not be performed within about 80 feet of the riverside levee toe in the one area. The other two areas are on the opposite of the river where no flood protection exists.

Cost Estimating: The total project cost estimate is $500,000. This number reflects costs for furnishing all vegetation, labor, equipment, and materials, and was based on the following:

a. The guidance contained in ER 1110-2-1302, Civil Works Cost Engineering.

b. The estimate was prepared in constant dollars, at a May 1996 price level, with a construction duration assumed to be 180 calendar days.

c. It was assumed that no utilities would be impacted by this conceptual solution.

d. Construction costs were developed by Cost Engineering Branch based on reconnaissance level information and documentation entitled "Case Studies on Biotechnical Stream Bank Protection" from Planning Division. Unit costs were developed using the Army Corps of Engineers MCACES Gold Estimating software, Version 5.20J, containing the 1992 Region II Unit Price Book (escalated to 1996 price level).

e. Labor costs are based on the prevailing Davis-Bacon Wage Rates for Region II as contained in the MCACES database. Equipment costs are taken from EP 1110-1-8, Construction Equipment Ownership and Operating Expense Schedule as contained in the MCACES database. Material costs were based on the MCACES database and from historical data.

f. Costs for lands and damages were provided by the Real Estate Division.

g. Costs for construction management, O&M manuals, and engineering during construction were provided by the design manager, Engineering Division (for planning purposes only).

These criteria were also used for determining the costs fo the other prototype projects.

Contingency:

Contingency amounts were developed for the construction cost by Cost Engineering Branch. Contingency amounts for the real estate items were developed by Real Estate Division.

Contingency amounts for the engineering and design and for the construction activities were developed by the design manager, Engineering Division. Based on the above uncertainties, contingencies were assigned to individual cost items or groups of related cost items to protect against the risk of potential cost increases. The following is a list by element of the uncertainties that were identified and the corresponding contingency percentage that was assigned:

a. 01 Lands and Damages - 20 percent. Contingency amounts were developed for lands and damages based on EM 1110-2-1301, Appendix C, EM 1110-2-263, and EC 1110-2-538. For lands and damages, a contingency of 20 percent is considered reasonable due to the fact that the real estate requirements were so loosely defined. For administrative and contract costs, a contingency of 20 percent is also considered reasonable.

b. 16 Bank Stabiliztion - 25 percent. The uncertainties associated with the labor, material, and equipment costs are relatively low since they are based on Davis-Bacon Wage Rates and EP 1110-1-8. The uncertainty associated with the quantities and scopes of work are relatively high since they were based on a conceptual level of information and may change significantly. Detailed design, however, will reduce the uncertainty of these cost items even further. For now, a contingency of 25 percent is considered reasonable.

c. 30 Planning, Engineering, and Design. The uncertainty associated with the planning, engineering, and design costs are moderate. A Project Study Plan (PSP) has not been prepared, which would outline the tasks through construction. In addition, there is no costs reflected for the feasibility phase. For now, a lump sum of $71,000 is considered reasonable.

d. 31 Construction Management. The uncertainty associated with the construction management cost is moderate. Since construction is a future task and there is no detailed design, it was determined that a contingency is prudent. For now, a lump sum of $31,500 is considered reasonable.

Benefits:

a. Environmental Benefits: Direct, measurable benefits at the site include the improvement of .75 stream mile (approximately 3.7 acres), the planting of trees to create a 0.5-acre woodland, and the creation of approximately .75 acre of riparian wetland. Indirect benefits of this plan include the improvement of water quality and clarity, which should have beneficial impacts for several miles downstream. The creation of wetland and woodland habitat will also have wildlife benefits by creating a higher diversity of niches in the project area.

b. Economic Benefits: Economic benefits for the protection of property are not measurable, because the overall decreases in water surface elevation attributable to the project is less than one-half of a foot. Indirect economic benefits include improved water quality, which will serve to improve the downstream fishery and water supply treatment.

c. Recreational Benefits: This site will yield the most recreational benefits of the four prototype sites. Low-intensive recreational uses, such as hiking, picnicking, bird watching, and educational field trips, are appropriate for this site. Inclusion of benches, trails, and/or picnic tables on the property would enhance the recreational use of the site.

Applicability to Other Areas: The situation addressed at this site is unique in the watershed. However, the overall riparian habitat restoration portion of the project could be applied to other projects within the watershed. The incidental benefits associated with flood damage reduction are what makes this site unique.

There is an opportunity to pursue this project under Section 1135(b) of WRDA 1986, Project Modifications for the Improvement of the Environment.

5.2.2 Burtonsville Elementary School Stormwater Management and Stream Restoration

Introduction: In October of 1995 Corps of Engineers personnel attended a field trip with Montgomery County officials to evaluate potential projects within the county. One specific project of interest was an eroded channel alongside the Burtonsville Elementary School property. The primary causes of this channel are runoff from parking lots associated with the Burtonsville shopping center and a relic drainage tile system that caused an erosion point within the path of runoff. The runoff from the shopping center is collected by concrete lined drainage channels that concentrate water into a swale adjacent to the elementary school property. The swale apparently was designed to carry the runoff alongside the school property and discharge into a forested area. At the discharge point, a relic drainage tile system crossed the swale and created erosion. As time passed, the unconsolidated material was washed away, causing severe erosion and forming a gully. This gully has further eroded into a much larger channel. The incised channel has created a head cut that is working its way back up the original swale and has removed over 2,600 cubic yards of soil, creating a channel approximately 11 feet wide and 15 feet deep.

Objective: The objective is to provide engineering alternatives that meet the following criteria:

1) Stabilize the existing channel to prevent mass erosion and further downcutting.

2) Reduce runoff peaks and passively treats oils, metals, and other contaminates from the parking lots.

Methodology: In January of 1996, Corps personnel conducted field evaluations to determine slope, bank heights, erodibility of material, and overall conditions of the site. Since no mapping was available, cross-section surveys were completed to be used in the development of a reconnaissance-level design. Available information was gathered from the local municipalities, and their representatives were also consulted for input into the solutions for the restoration of the site.

Two alternatives were obvious at this phase of study. Both involved the construction of a stormwater wetland at or near the shopping center to provide some quantity but mostly water quality control. Alternative 1 would involve piping the pond discharge along the existing eroded channel, falling in the channel, and providing energy dissipation prior to discharging into the receiving stream. Alternative 2 would involve the restoration of the channel by providing stabilization measures such as grading and re-vegetating channel side slopes, and providing in-channel grade control structures and placement of rock vortex weirs in the channel to form a step-pool waterway for habitat.

Hydrologic assessments were performed to determine runoff, flow rates, pond size, pipe size, and channel area required to carry a 100-year storm. Design of rock grade control and energy dissipaters was also completed by Engineering's H&H Section.

A preliminary review of existing geotechnical information was conducted to assess the acceptability of the proposed designs and to provide design parameters such as the cross-sectional dimensions of the detention pond embankment.

Results. Both projects include a wetland stormwater detention pond to detain the current 2-year storm for the corresponding drainage area of 11.1 acres. The options differed in the method by which the water was discharged from the pond. The volume calculated for this pond was determined to be 1.3 acre-feet. County regulations require that ponds safely pass the 100-year storm event discharge to a stable channel reach which is approximately 93 cubic feet per second in this location. The pipe was sized with a diameter of 60 inches and extended approximately 1,300 feet to the stable channel reach. Included in this portion of the design was a riprap energy dissipater located at the exit of the pipe. The dissipater dimensions were determined using FHWA HEC-14, where the primary design consideration is the pipe exit velocity that is used in the determination of the riprap, D_{50}. The second option discharged the flows above the 2-year event to the existing channel. The existing channel is then stabilized to accommodate the 100-year discharge. Hydraulic analysis determined the details for spillway design including the weir length, which was calculated to be 7 feet. A total of 10 riprap grade control structures consisting of 12- and 18- inch diameter stone will be required for stabilization.

A review of county soils maps indicates that the foundation material is likely a silt loam, or a gravelly silt loam (probably ML or possibly CL). With the existing structures in the immediate area, and no indication of any existing marshy area, it is not anticipated that any

problems will be associated with founding the low embankment for the pond on this material. The materials excavated in constructing the excavated portion of the pond could probably be used in the construction of the earth embankment.

It is recommended that the dam be constructed of earth embankment material with 3H: IV side slopes and an 8-foot top width. Excavated slopes for the grade control structures should have 2H: lV. These side slopes will likely be stable if seeded or covered with stone protection.

Based on the above evaluations, reconnaissance level designs were completed for both alternatives including the estimation of quantities for cost estimating purposes. During the feasibility study, further evaluation of these and other alternatives will be conducted to determine the most cost-effective measures. Additionally, foundation exploration will be required to verify the design parameters provided above.

Cost Estimating: The total project cost estimate of $660,000 (Alternative 2) to $775,000 (Alternative 1) includes costs for furnishing all vegetation, labor, equipment, and materials and was based on the same criteria as the Upper Marlboro project.

Contingency:

The following is a list by element of the uncertainties that were identified and the corresponding contingency percentage that was assigned.

a. 01 Lands and Damages - 20 percent. Contingency amounts were developed for lands and damages based on EM 1110-2-1301, Appendix C, EM 1110-2-263, and EC 1110-2-538. For lands and damages, a contingency of 20 percent is considered reasonable due to the fact that the real estate requirements were so loosely defined. For administrative and contract costs, a contingency of 20 percent is also considered reasonable.

b. 15 Floodway Control - 25 percent. The uncertainties associated with the labor, material, and equipment costs are relatively low since they are based on Davis-Bacon Wage Rates and EP 1110-1-8. The uncertainty associated with the quantities and scopes of work are relatively high since they were based on a conceptual level of information and may change significantly. Detailed design; however, will reduce the uncertainty of these cost items even further. For now, a contingency of 25 percent is considered reasonable.

c. 30 Planning, Engineering, and Design. The uncertainty associated with the planning, engineering, and design costs are moderate. A Project Study Plan (PSP) has not been prepared which would outline the tasks through construction. In addition, there are no costs reflected for the feasibility phase. For now, a lump sum of $61,000 (for each alternative) is considered reasonable.

d. 31 Construction Management. The uncertainty associated with the construction management cost is moderate. Since construction is a future task and there is no detailed design, it was determined that a contingency is prudent. For now, lump sums of $56,500 (alternative 1) and $45,500 (alternative 2) are considered reasonable.

Benefits:

a. Environmental Benefits: Direct, measurable benefits of this plan include the improvement of 0.7 mile of stream habitat (approximately 3.5 acres), and the creation of 0.4 acre of emergent palustrine wetland and approximately 1 acre of riparian wetland. Indirect benefits include the improvement of downstream water quality. Both the chemical nature and the clarity of the water will be improved, as well as the velocity of the storm surges. Beneficial effects of the project should reach several miles downstream.

b. Economic Benefits: There will be no direct economic benefits realized by this project. Indirect economic benefits include improved water quality for fishing.

c. Recreational Benefits: Because the wetland site is difficult to access behind the shopping center, the stream will not be conducive to recreation. Therefore, no recreational benefits are anticipated for this project.

Applicability to Other Areas: Because the site is similar to many other stormwater-induced erosion sites within the watershed, the method employed here will be widely applicable throughout the basin. It is felt that the success of this prototype project will lead to the construction of other such projects, thus having far-reaching beneficial impacts to the watershed. The solutions proposed for this site can be applied to approximately 20 sites throughout the watershed, creating 9.5 acres of stormwater wetlands and detention ponds. Other similar wetland and flood-attenuation pond projects would result in the creation of an additional 6 acres of wetland habitat.

5.2.3 Jefferson Patterson Park Shoreline Erosion Protection and Environmental Restoration

Introduction: In April of 1996, Corps personnel visited the site of Jefferson Patterson Park in Calvert County, Maryland. The purpose of the site visit was to meet with local sponsors at the project area, discuss and view past and current erosion problems, assess the effectiveness of several existing shoreline stabilization features, and understand the concerns of park personnel in preserving the shoreline while protecting the archaeologically and historically significant park. Jefferson Patterson Park is a 544-acre, state-owned park that is listed on the National Registry of Historic Places.

Objective: Many of the valuable archaeological sites located within park boundaries are located on or near the eroding shoreline of the Patuxent River. In order to protect these areas

and the fastland associated with them, shoreline erosion control measures must be implemented. The primary objective is to provide alternatives to stabilize the existing shoreline, preventing further erosion form occurring while minimizing impacts to archaeologically and historically significant areas.

Methodology: The previously installed erosion control projects along 3,000 feet of the Patuxent River at Jefferson Patterson Park and Museum were identified by park personnel as promoting positive stabilization and reclamation of previously eroded and unstable shoreline. The existing projects consist of (1) a series of offshore breakwaters with sand fill and plantings on the shore side (southernmost reach), (2) revetments with sand fill and plantings on the shore side (middle reach), and (3) stone armoring of the shoreline (northernmost reach). Park personnel appeared most satisfied that the series of offshore breakwaters and revetments best addressed their needs for shoreline stabilization, in addition minimizing impacts to the culturally significant shoreline.

Incorporation of (1) a visual assessment of the shoreline to be protected and (2) the goals of park personnel determined that conditions along the northernmost and middle portions of the existing project locations resemble the currently unstable conditions of the stretch of shoreline, approximately 2,000 feet in length, immediately downstream of the existing project sites. Conditions (i.e. wave, wind, and currents) affecting both upstream and downstream locations were assessed to be similar. One significant difference in project features, however, is the presence of steep bluffs within the proposed project area. In general, similar erosion control measures showing a positive impact (i.e. increase in flora, fauna, and shoreline stability) on upstream locations could be implemented at downstream sites with similar requirements.

In addition to the visual assessment and discussions with park personnel, a hydraulic analysis was completed that determined the predominant characteristics of wave height and fetch. Wave height was determined t obe 6 feet, and the maximum fetch was calculated at 24,000 feet. Based upon this analysis, visual assessment, discussions with park personnel, and Corps guidance, the type, location, and preliminary cross sections of the shore protection features were determined. (For this phase of the project, the jetties were assumed to have the same cross-sectional characteristics as the breakwaters). In addition, preliminary project design(s) were corroborated by Corps geotechnical personnel based upon existing (yet limited) information.

Results: Three types of structural shore protection are proposed: (1) a series of offshore-connected breakwaters with sand fill and plantings on the shore side, (2) stone jetties, and (3) stone revetment with sand fill and plantings on the shore side. The unprotected shoreline can generally be divided into two project areas: (1) the extreme downstream location along the Patuxent near the confluence of the St. Leonard Creek; and, (2) the 1,000-foot reach just south of the existing project area.

a. At the extreme downstream location along the Patuxent River, the best-suited protection measure was determined to be offshore-connected breadwaters and snad fill

and plantings, along with protective stone jetties. The basic design of the breakwaters would primarily be considered for shore stabilization along the southern point beach area. The characteristics of the southern point of the project site is a gently sloping beach with an unacceptable rate of erosion. This type of shoreline has been determined to be suitable for the proposed offshore-connected breakwater feature. The connected breakwater structure would be constructed of armor stone placed offshore to dissipate wave energy. Sand fill would be added to the existing beach and extend out to the breakwater, to replace the lost beach material and to increase the size of the existing beach. The filled beach would resemble the original slope and material found at that site. Vegetation would be planted on the beach fill areas as an erosion control device and to provide habitat for wildlife species. The selection of vegetation would match particular varieties of plants to existing plant species. Additionally, at St. Leonard Creek, an existing timber headwall is recommended to be lengthened to 150 feet to stabilize the sandy downstream point.

b. Just north of the southern point, the bluff along the shoreline becomes very steep, making access to the water impossible. Erosion of the bluff is occurring due to runoff, groundwater seepage, and waves. The proposed alternative to prevent further erosion along the toe of the bluff is to construct a stone revetment structure with a level backfill area on the landward side wide enough to allow public access along the top of the revetment. This type of structure is preferred to bulkheads where groundwater is contributing to the erosion process. The stone revetrnent would consist of a facing of erosion-resistant material. Reduction of the energy of incoming waves is accomplished by the sloping shape of the structure and by its rough surface (armor layer). Filtering qualities result from the use of layers of varying sized stone and other materials. During construction, a geotextile is placed on and attached to the bank. On top of the geotextile is placed a 6- to 8-inch layer of stone. This layer of stone holds the geotextile in place and becomes the bottom layer of the actual structure. Multiple outer layers are placed on top of the stone.

All three types of proposed structures must be stablized against movement by waves, floating ice, logs, and other debris. An armor layer typically consists of rough angular rock. An underlying geotextile layer supports the armor layer against settlement. It allows groundwater drainage through the structure and prevents the soil beneath from being washed though the armor layer by waves or groundwater seepage. Toe protection prevents settlement and protects the edge of the structure from washing away. In areas where large waves are expected, an overtopping (or splash) apron is sometimes added. Generally, the apron consists of a single layer of armor stone about 10 feet wide that extends landward from the top of the structure.

Important design considerations included the proper height and width, protection from erosion in front of the structure, and analysis of the supporting soil characteristics. To deter erosion along the sides, additional stone should be placed perpendicular to the structure. The soils comprising the area under the structure must be analyzed to determine if they can support the structure. If a beach is desired in front of the structure, access should be considered for

recreational activities. If access along the shoreline is desired, a "path" constructed on the landward side may need to be designed.

Cost Estimating. The total project cost estimate of $785,000 reflects costs for furnishing all plant, labor, equipment, materials and was based on the same criteria as the Upper Marlboro project.

Contingency:

The following is a list by element of the uncertainties that were identified and the corresponding contingency percentage that was assigned.

a. 01 Lands and Damages - 20 percent. Contingency amounts were developed for lands and damages based on EM 1110-2-1301, Appendix C, EM 1110-2-263, and EC 1110-2-538. For Lands and Damages, a contingency of 20 percent is considered reasonable due to the fact that the real estate requirements were so loosely defined. For administrative and contract costs, a contingency of 20 percent is also considered reasonable.

b. 10 Breakwaters and Seawalls - 25 percent. The uncertainties associated with the labor, material, and equipment costs are relatively low since they are based on Davis-Bacon Wage Rates and EP 1110-1-8. The uncertainty associated with the quantities and scopes of work are relatively high since they were based on a conceptual level of information and may change significantly. Detailed design, however, will reduce the uncertainty of these cost items even further. For now, a contingency of 25 percent is considered reasonable.

c. 30 Planning, Engineering, and Design. The uncertainty associated with the planning, engineering, and design costs are moderate. A Project Study Plan (PSP) has not been prepared, which would outline the tasks through construction. In addition, there are no costs reflected in the feasibility phase. For now, a lump sum of $113,000 is considered reasonable.

d. 31 Construction Management. The uncertainty associated with the construction management cost is moderate. Since construction is a future task and there is no detailed design, it was determined that a contingency is prudent. For now, a lump sum of $59,000 is considered reasonable.

Benefits:

a. Environmental Benefits: The direct benefits of this project include the stabilization of 2,000 feet of shoreline (approximately 1.8 acres) to reduce erosion, and the creation of approximately 1 acre of riverine wetlands behind the stone revetrnent. The project will also protect the historic property. Indirect benefits include the reduction of sediments

entering the Patuxent that have degraded aquatic habitat, and the creation of habitat for shorebirds.

b. Economic Benefits: Economic benefits of this project include the direct benefits of land erosion protection (in acres) and indirect benefits associated with improved water quality for fishery improvement. In the feasibility study, the protection from loss of land due to erosion will be calculated over the project lifetime based on current land values.

c. Recreational Benefits: Some indirect recreational benefits will be realized by this project. Most importantly, the project will protect park property, which is used primarily for recreation. Secondarily, the revetment could be used by recreationers as a place to sit and view the river or to watch wildlife.

Applicability to Other Areas: There are two other sites in the tidal portion of the river which have been identified for shoreline protection. Similar methods may be used at these sites, improving an additional 4 acres of aquatic habitat and creating 2 acres of wetland habitat. Since there are numerous other sites that are experiencing shoreline erosion in the tidal portion of the Patuxent River, the methods used to correct the problems at the prototype site and the other two sites will be widely applicable along the shoreline in Calvert, St. Mary's, and Charles Counties.

5.2.4 Jug Bay SAV Restoration

Introduction. In January of 1996, Corps personnel coordinated with representatives of the Jug Bay Natural Area to discuss the potential for environmental restoration. Numerous alternatives were discussed including the use of dredging or filling to create additional wetland areas, the removal or eradication of *Phragmites* from the site, and the re-establishment of SAV in specific areas of Jug Bay. It was determined that the use of heavy construction material to modify substrate elevations was not desired by local concerns because of the sensitivity of the area and the lack of opportunity for successful sites. The eradication of *Phragmites* is a major concern at Jug Bay, but was not considered an alternative because of the lack of Corps mission areas for nuisance species control where navigation is not important. The restoration of new habitat areas is under the Corps mission and the re-establishment of SAV was the selected alternative. There was some concern that sedimentation would not allow these areas to re-establish, but the conceptual alternative was completed because of the study's objectives to address over 70 other problems of the watershed that address sedimentation. Sedimentation concerns will be looked at more closely in following feasibility studies to determine whether changes in the watershed will improve or degrade the existing condition.

Methodology: To develop a SAV restoration plan at the reconnaissance level, the Corps worked closely with research biologists and personnel associated with Jug Bay to evaluate the existing SAV beds in the area and to determine appropriate species. Priority areas were developed by research experts, and locations were marked on a topographic map. Areas were

calculated to determine the numbers of plants required based on planting the sites on a 3 foot center grid. Other planting arrangements and patterns may be invetigated during the feasibility phase.

Results: Based on the methodology explained, approximately 10 acres of SAV were designed, including approximately 5,000 individual plants of wild celery *(Valisineria americana).*

Cost Estimating: The total project cost estimate of $150,000 reflects costs for furnishing all vegetation, labor, equipment, and materials, and was based on the same criteria as the Upper Marlboro project.

Contingency:

The following is a list by element of the uncertainties that were identified and the corresponding contingency percentage that was assigned.

a. 01 Lands and Damages - 20 percent. Contingency amounts were developed for lands and damages based on EM 1110-2-1301, Appendix C, EM 1110-2-263, and EC 1110-2-538. For lands and damages, a contingency of 20 percent is considered reasonable due to the fact that the Real Estate requirements were so loosely defined. For administrative and contract costs, a contingency of 20 percent is also considered reasonable.

b. 06 Fish and Wildlife Facilities - 25 percent. The uncertainties associated with the labor, material, and equipment costs are relatively low since they are based on Davis-Bacon Wage Rates and EP 1110-1-8. The uncertainty associated with the quantities and scopes of work are relatively high since they were based on a conceptual level of information and may change significantly. Detailed design, however, will reduce the uncertainty of these cost items even further. For now, a contingency of 25 percent is considered reasonable.

c. 30 Planning, Engineering, and Design. The uncertainty associated with the planning, engineering, and design costs are moderate. A Project Study Plan (PSP) has not been prepared, which would outline the tasks through construction. In addition, there are no costs reflected for the feasibility phase. For now, a lump sum of $13,000 is considered reasonable.

d. 31 Construction Management. The uncertainty associated with the construction management cost is moderate. Since construction is a future task and there is no detailed design, it was determined that a contingency is prudent. For now, a lump sum of $8,000 is considered reasonable.

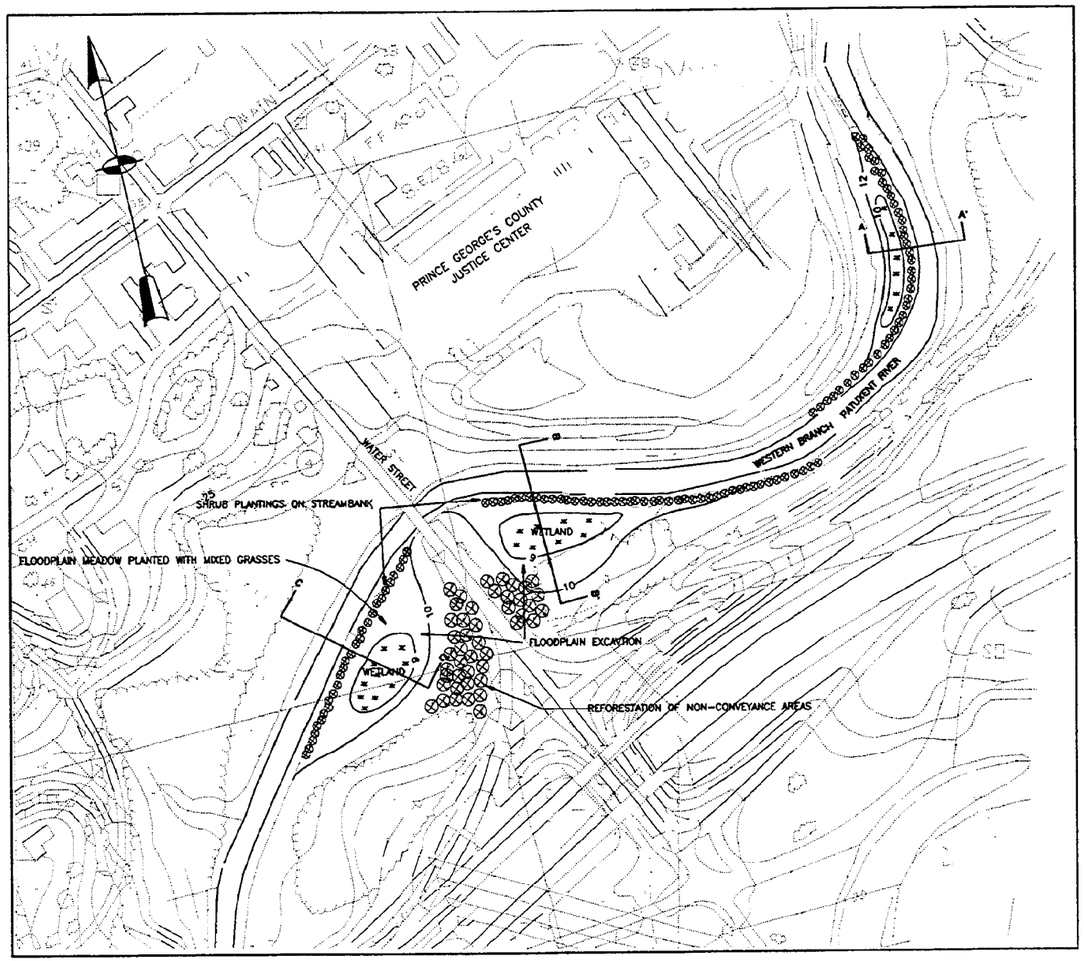
a. Environmental Benefits: Direct benefits of this plan include the creation and enhancement of 10 acres of SAV, and an adjoining 1 acre of tidal freshwater wetland. Indirect benefits include the improvement of water quality by increasing dissolved oxygen, allowing sediments to settle out, and slowing the rate of flow during storm surges. The SAV will also provide valuable habitat for wildlife, including fish, shellfish, and waterbirds.

b. Economic Benefits: There will be no direct economic benefits for this project. Indirect economic benefits include improved water quality for fishing.

c. Recrational Benefits: The recreational benefits of this plan include the improvement of wildlife resources for viewing by reserve visitors. Because visitors come to the reserve for aesthetic as well as educational reasons, this benefit should have far--reaching effects.

Applicability to Other Areas: *Phragmites* control is a need throughout much of the basin. Two sites have been specifically identified as needing such an action, which would improve 40 additional acres of aquatic and wetland habitat. A method to address this specific need will have to be devised at a later date. In the meantime, SAV restoration may be an alternative at some of these sites. The methods developed for the Jug Bay SAV restoration may; therefore, have wide applicability in the basin. However, it must be stressed that analyses that study sedimentation in conjunction with SAV restoration would be required to increase the likelihood that SAV would actually be restored.

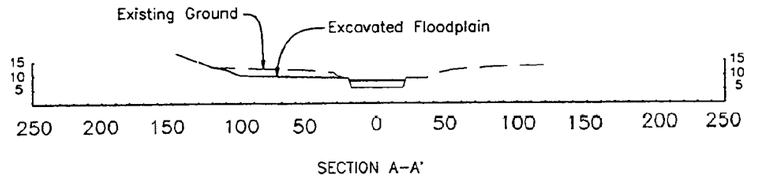
Figure 5-1: Upper Marlboro Project Plan



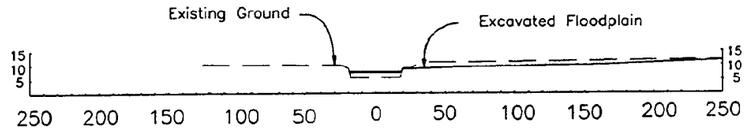
UPPER MARLBORO STREAM AND WETLAND ENHANCEMENT

PLAN VIEW

100 0 100 200



SECTION A–A'



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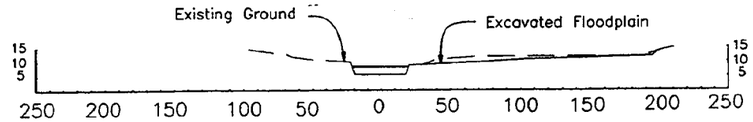


SECTION C–C'

ESTIMATION OF QUANITITES	
EXCAVATION	15,396 cubic yards
WETLAND PLANTINGS	3,893 each
TREE PLAINTINGS	105 each
SHRUB PLANTINGS	460 each

REV	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
BALTIMORE, MARYLAND

PRINCE GEORGE'S COUNTY MARYLAND

UPPER MARLBORO LOCAL FLOOD PROTECTION
ENVIRONMENTAL ENHANCEMENT
PATUXENT RIVER WATER RESOURCES
RECONNAISSANCE STUDY PROTOTYPE

File: UPMAR
Plot Sc. 1 = 100

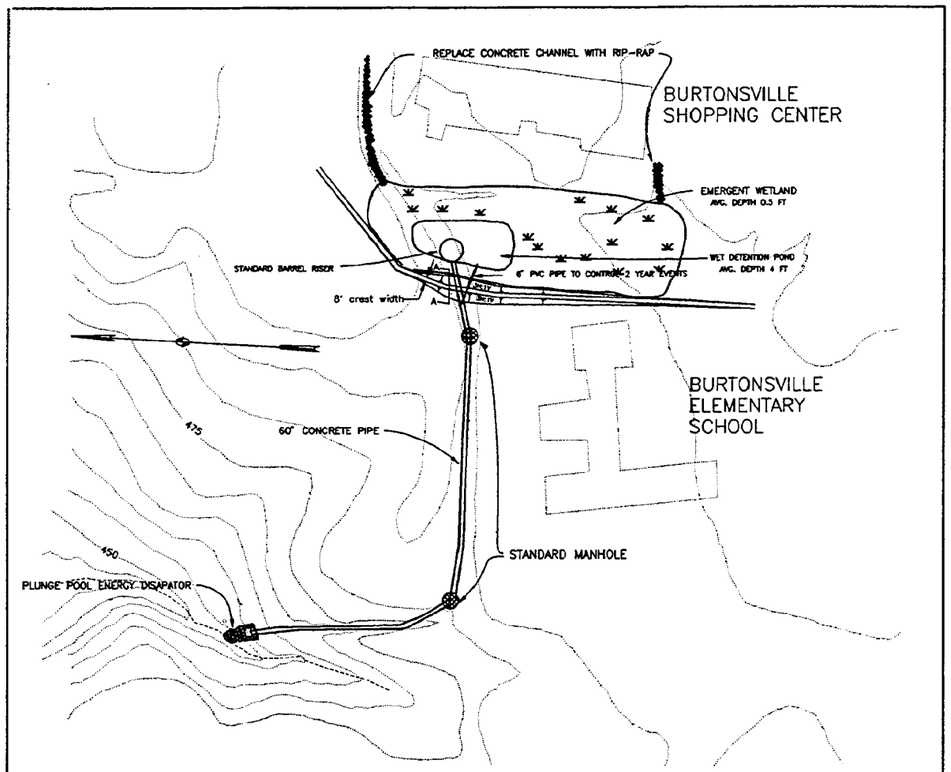
DRAWING NUMBER

PLATE 1

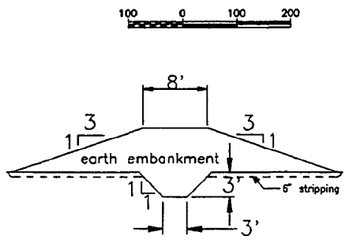
SCALE: DATE: SHEET

CADD

Updated: 5/24/96 ID = E1ENRJFK Plot: 7/01/96

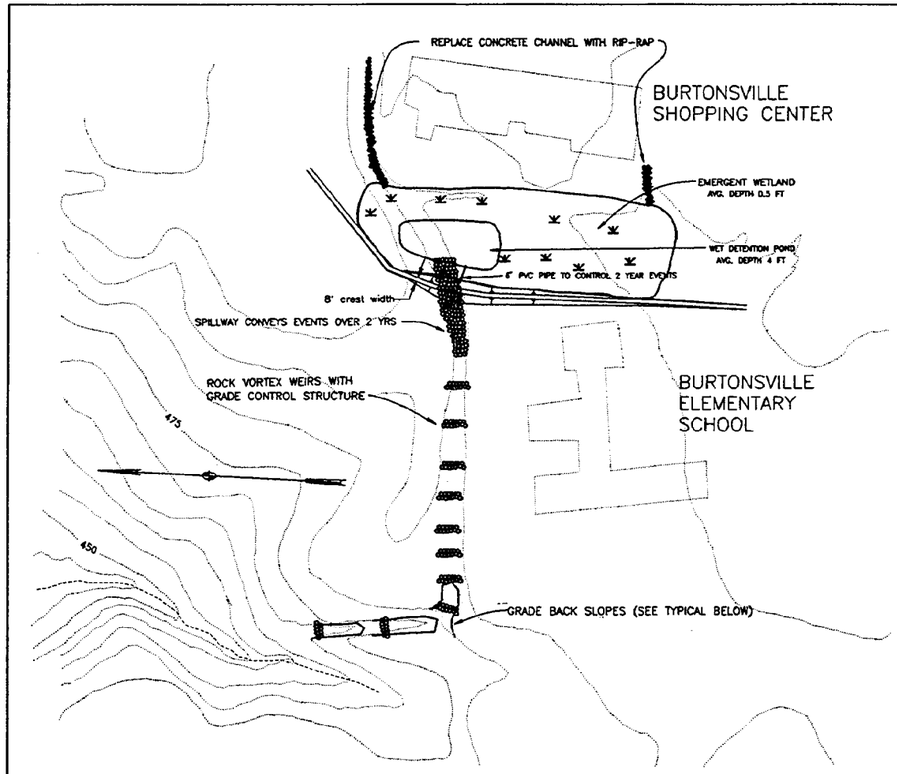


ALTERNATIVE 1 – WETLAND TREAMENT AND PIPING

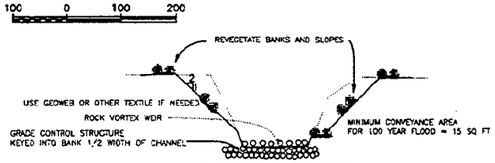


SECTION A–A

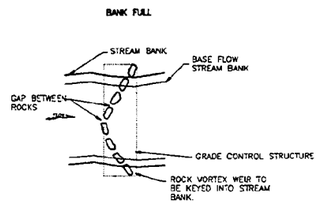
TYPICAL EMBANKMENT SECTION
FOR BOTH ALTERNATIVE 1 AND 2



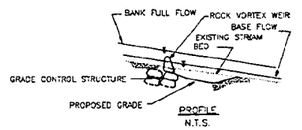
ALTERNATIVE 2 – WETLAND TREATMENT AND OPEN–FLOW CHANNEL



TYPICAL CHANNEL SECTION
N.T.S.



PLAN
N.T.S.



PROFILE
N.T.S.

ROCK VORTEX WEIR
NOT TO SCALE

GENERAL NOTES:

1. ROCK VORTEX WIER IS TO BE MADE UP OF STONES EXCEEDING 750 LBS. FOOTER ROCKS ARE TO BE BURIED IN STREAM BED WITH UPPER TIER OF ROCKS PLACED ON TOP WITH THE UPPER ONE THIRD TO ONE QUARTER OF ROCK ABOVE BASE FLOW WATER SURFACE.
2. GRADE CONTROL STRUCTURES ARE TO BE KEYED INTO BANKS.
3. SEE GENERAL NOTES ON PLANS FOR SPECIFIC STONE WEIGHTS IN EXCESS OF 750 LBS.

REV	DATE	DESCRIPTION	BY
1		Add Embankment	JRS

U.S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
BALTIMORE, MARYLAND

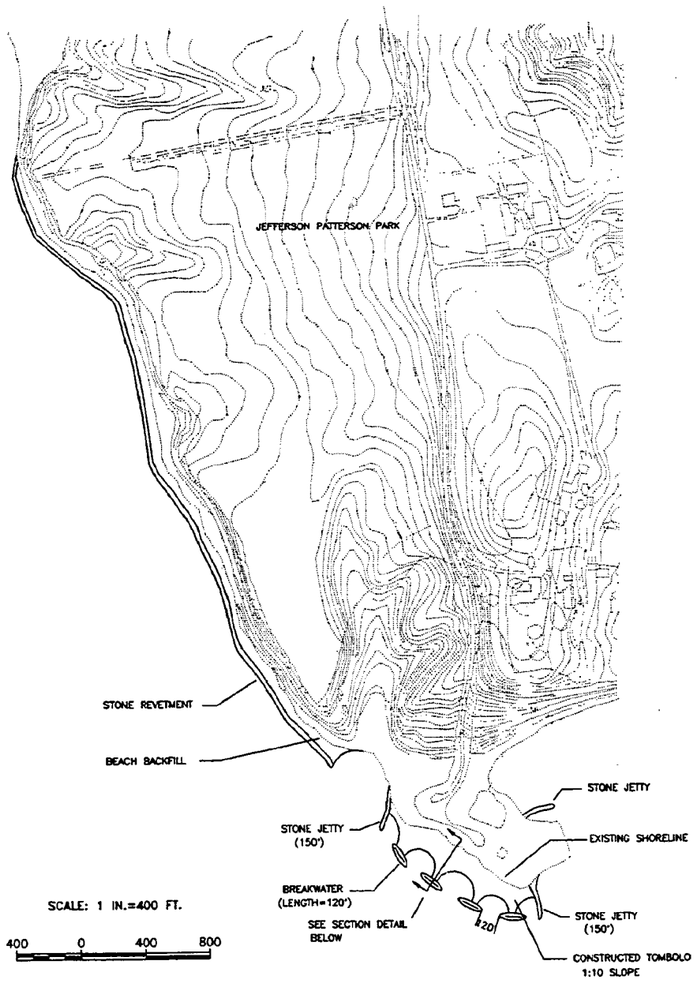
MONTGOMERY COUNTY MARYLAND

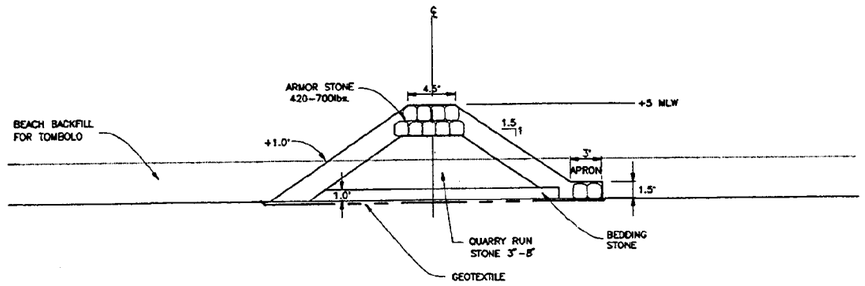
BURTONSVILLE SHOPPING CENTER ENVIRONMENTAL RESTORATION

PATUXENT RIVER WATER RESOUCES RECONNASSAINCE STUDY PROTOTYPE

File: BURT-1 Plot Sc. 1 = 100	DRAWING NUMBER	PLATE 2
SCALE: AS SHOWN	DATE: 1 MAY 96	SHEET

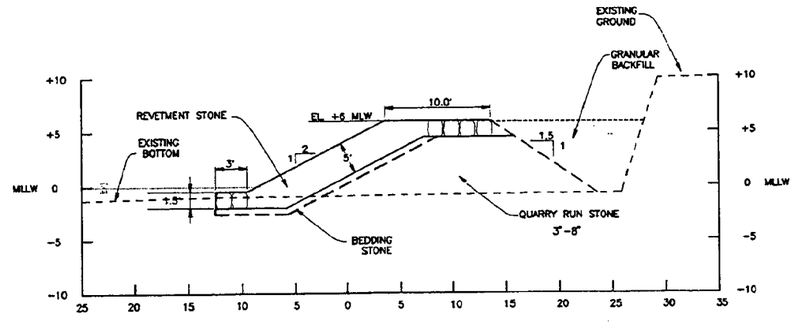
Updated: 7/1/96 ID = E1ENRJFX Plot: 7/01/96





TYPICAL BREAKWATER CROSS SECTION

SCALE: 1 IN. = 4 FT. H.
1 IN. = 20 FT. V.



TYPICAL REVETMENT CROSS SECTION

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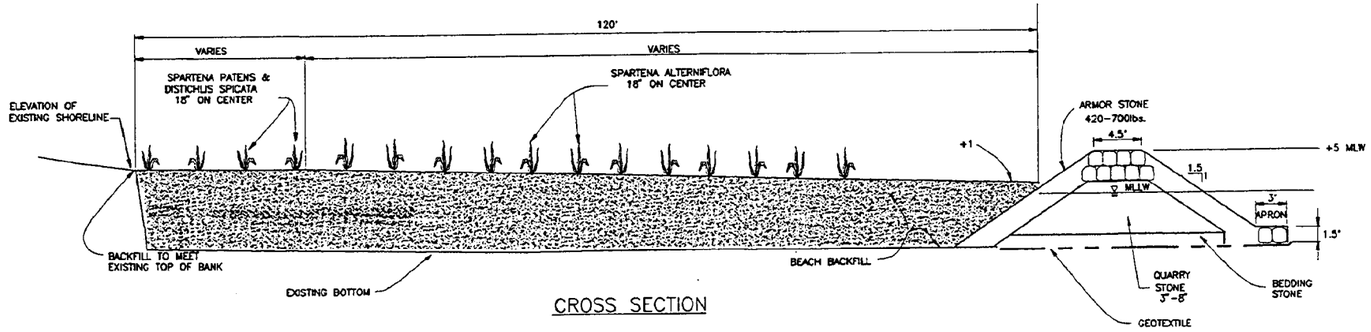
1 IN. = 20 FT. V.



CROSS SECTION

EXTENDED BEACH BACKFILL PLANTINGS AND BREAKWATER

NOT TO SCALE

REV	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
BALTIMORE, MARYLAND

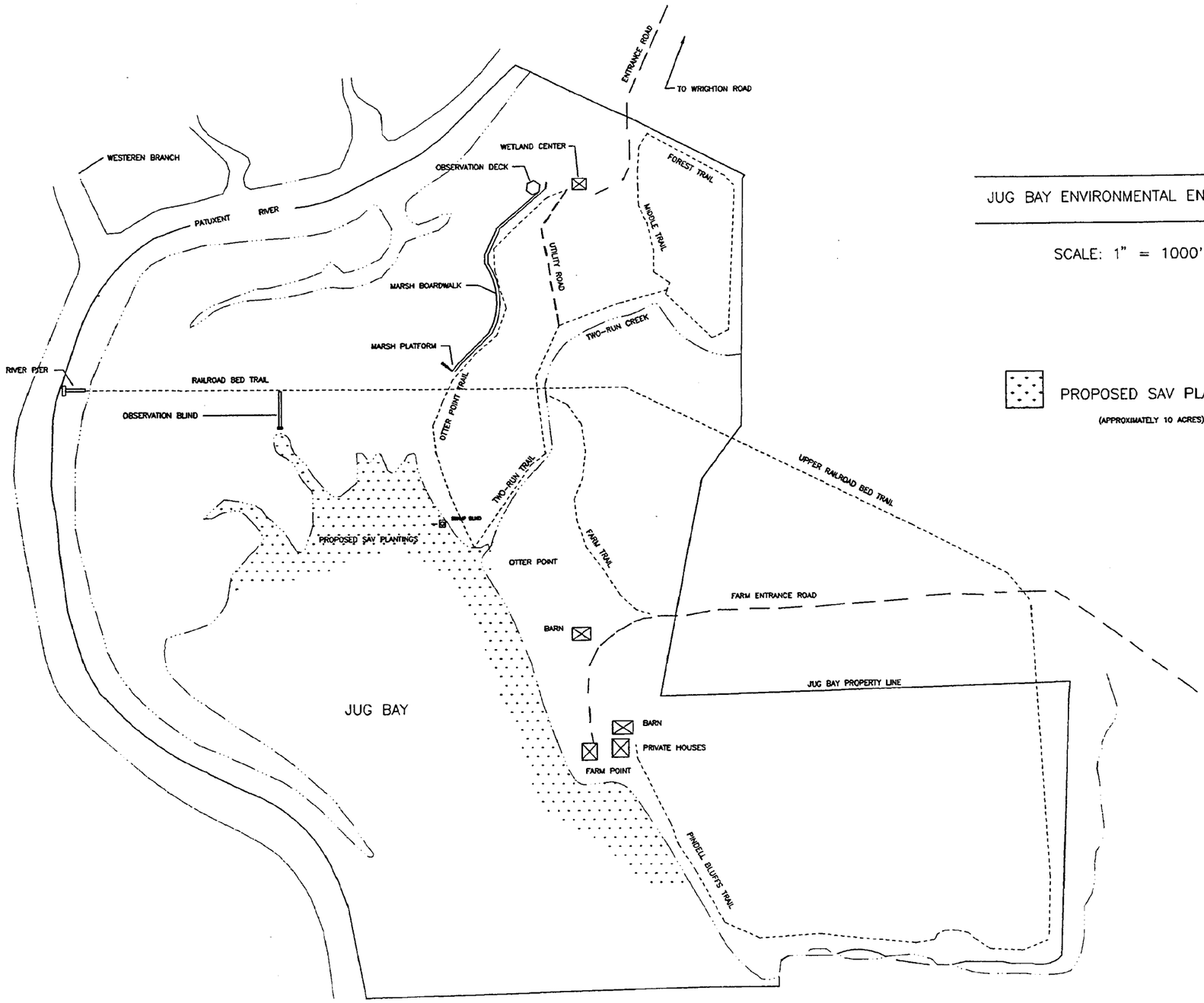
PATUXENT RIVER WATER RESOURCES STUDY
CALVERT COUNTY, MARYLAND

JEFFERSON PATTERSON PARK
SHORELINE EROSION CONTROL

File: JPP Plot Sc. 1 = 500	DRAWING NUMBER	PLATE 3
SCALE:	DATE:	SHEET

Updated: 5/30/96 ID = elsndrjk Plot: 7/01/96

CADD



JUG BAY ENVIRONMENTAL ENHANCEMENT

SCALE: 1" = 1000'

PROPOSED SAV PLANTING

(APPROXIMATELY 10 ACRES)

REV	DATE	DESCRIPTION	BY

US Army Corps of Engineers

U.S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
BALTIMORE, MARYLAND

PATUXENT RIVER WATER RESOURCES STUDY

ANNE ARUNDEL COUNTY, MARYLAND

JUG BAY NATURAL AREA

File: JUGS Plot Sc. 1 = 1	DRAWING NUMBER	PLATE 21 of 27
SCALE:	DATE:	SHEET

Updated: 5/30/96 ID = alandrja Plot: 7/01/98

CADD

SECTION 6

WATERSHED PLAN

This section provides a summary of the watershed plan for the Patuxent River watershed and also describes the methodology used to formulate the watershed plan. The Corps developed this watershed plan to document the watershed stakeholders' priority projects and actions to improve the quality of the Patuxent River watershed. The primary objective of the plan was to combine compatible and effective solutions that, when taken as a whole, would achieve the greatest overall benefit for the Patuxent watershed. The watershed plan consists of specific project features that can be implemented by various local, state, and Federal agencies. The watershed plan addresses multi-purpose environmental solutions for the improvement of riparian, wetland, and aquatic habitat, improvements to water quality, recreation development, and flood damage reduction measures.

The priority projects and actions were individually documented in the form of project data sheets. These project sheets can be found in the Annex, Part II, of this report. The benefit of using the project sheet format is that all applicable information associated with individual projects and their associated problems can be provided in one location. Furthermore, by developing the project sheets in a database format and then linking them into a GIS, the study team was able to draw conclusions at a sub-watershed and HUA level regarding possible relationship among projects and actions as well as which HUAs included numerous priority projects for implementation. This plan is a thorough representation of priority efforts within the Patuxent River, however the watershed plan should be viewed as a living document. Since this plan is based solely upon readily available existing information, ongoing and future investigations by all watershed stakeholders, including Corps feasibility studies, may provide additional clarification of the watershed plan and its associated project sheets.

6.1 WATERSHED PLAN DEVELOPMENT AND PLAN FORMULATION

This section provides an explanation of the integrated watershed management plan for the Patuxent River watershed and an evaluation of its benefits and impacts. The watershed plan addresses the more significant problems, needs, and opportunities as documented in Section 3.

The primary objective of the Patuxent River watershed management plan is to combine compatible and effective solutions with the most demanding needs that will, when taken as a whole, achieve the greatest overall benefit for the watershed. The implementation of a single solution will not comprehensively address the various and geographically diverse problems of the watershed. Therefore, the cumulative impacts and benefits of the watershed plan are essential. The potential effects of the plan have been developed at a reconnaissance level of detail; more detailed analyses are required to completely understand the impacts and benefits.

Throughout the study and plan formulation process, each of the five elements (ecosystem restoration, navigation, flood damage reduction, environmental infrastructure. and recreation)

were investigated independently. This approach allowed for a complete documentation of problems, needs, and opportunities, and for a thorough analysis of conceptual solutions to address these areas of concern. However, in determining project-specific solutions, all of the problems, needs, and opportunities were compiled in order to develop multi-purpose solutions whenever possible. This demonstrates that environmental infrastructure and recreation solutions were best implemented as elements of environmental restoration.

During the development of this plan, it became evident that the Corps could not address all of the waer resources problems within the study area. To develop a comprehensive plan, other Federal, state, and local agencies and organizations were evaluated to determine their applicability to this study. The goals and missions of these programs were evaluated to determine who would have lead or cooperating roles during the implementation phase. The plan was further developed by determining the needs of the study area and by attempting to provide accurate descriptions of sites and solutions. Agency and program contacts responsible for these issues are also provided.

A fundamental element in the implementation of the watershed plan is the availability of supporting programs such as comprehensive watershed clean-up, water quality control, and floodplain management. These programs were developed to enhance the recommended project-specific solutions and are, essentially, recommendations for the development of long-term strategies. Supporting programs are discussed in general terms. No preliminary costs or benefits for the programs were tabulated; rather, the function and need for each program proposed are described. The watershed plan cannot be successfully implemented without addressing programmatic solutions to certain problems within the study area. Following the development of the watershed plan, those areas with potential Corps involvement will be addressed in detail.

6.2 PROJECT IDENTIFICATION PROCESS

The first step in the ecosystem project identification process was the evaluation of sub-watersheds, that included dividing the study area into three smaller sub-watersheds and evaluating them based on the study objectives. Once the sub-watersheds were selected, problem areas were identified and prioritized by the county stakeholders to ensure that major water resource problems were addressed. The end result of the ecosystem project identification is the determination of where the most degraded resources are located. and provides a baseline of where the best opportunities exist to restore the sub-watersheds and. therefore, the entire study area.

The process of selecting potential projects was based on meeting study goals and objectives as they related to the problems, needs, and opportunities identified earlier in this report. In addition, the philosophy and policy included in the Engineering Circular (EC) 1105-2-210, *Ecosystem Restoration Planning in the Civil Works Program,* as well as other applicable sources on ecosystem restoration, guided the development of the selection process. Specifically, the EC states that restoration of ecological resources will be formulated and implemented under the principles of ecosystem restoration.

Recognizing the emphasis placed on ecosystem restoration, the selection process for this study utilized an ecosystem approach for identifying potential restoration projects. Many such approaches developed by others, including local agencies within the study area, use watersheds as their basis for restoration and conservation activities. By focusing on watersheds within an ecosystem, a planning team can better correlate the ecological resources to the hydrologic system.

A watershed also provides a convenient hydrogeographic boundary within which impacts and changes can more easily be predicted, monitored and depicted. Furthermore, a watershed basis for ecosystem restoration maintains the Corps' traditional mandate for involvement in water and related land resources activities. Therefore, a watershed-based approach to ecosystem restoration was implemented for this study. As a result, entire sub-watersheds within the study area were evaluated as potential project areas, rather than the traditional site-specific selections. Once these sub-watersheds were identified, priority problems within each sub-watershed were addressed. The intent of this approach was to propose restoration of feasible, priority, water-related resource problems within a selected sub-watershed by either the Corps or other resource agencies and organizations.

There are several factors that are worth noting about an ecosystem approach to environmental restoration. This restoration approach relies on an ecosystem's framework, the dynamic interrelationship of its structure, function, and species composition. It focuses on biodiversity, which is the variety of life and its processes, including the diversity of living organisms, the genetic differences among and within species, and the communities and ecosystems in which they occur. It is comprehensive and considers the long-term sustainability of all resources in the sub-watershed, rather than looking at small scale, isolated sites. An ecosystem approach concentrates restoration efforts within a defined area, resulting in greater cumulative effects to fish and wildlife habitat (that is, restoration of larger continuous habitat areas). An ecosystem restoration approach is also more effective and efficient in that it establishes a systematic spatial framework to guide and focus restoration activities.

6.3 PROJECT SHEETS

The purpose of this section is to summarize the types of projects identified by state agencies, local interests, and the District. A complete description and cost estimate for each project is located in the Annex, Part H, Project Data Sheets.

The project sheets are a compilation of specific problems and needs throughout the Patuxent River watershed as identified through the cooperation of Federal, state, and local agencies. Each project sheet describes the identified problem or need, including the location. drainage, hydrologic unit area (HUA), size, and cost for implementing the possible solution, as well as a person to contact if more information is desired on the project. Since the project sheets have been developed by the Corps database of information on the Patuxent, queries can be done by HUA in order to facilitate implementing solutions utilizing an ecosystem and watershed approach in order to create measurable positive impacts throughout the Patuxent watershed.

6.4 PATUXENT RIVER WATERSHED PLAN DESCRIPTION BY PROBLEM TYPE

The elements of the watershed plan are designed to provide logical and realistic guidance to assist potential users in developing and restoring water resources in the study area. These elements include plans for environmental restoration, navigation, flood damage reduction, potential conceptual solutions, sub-watershed reviews, plan benefits and costs, and a summary of the watershed plan.

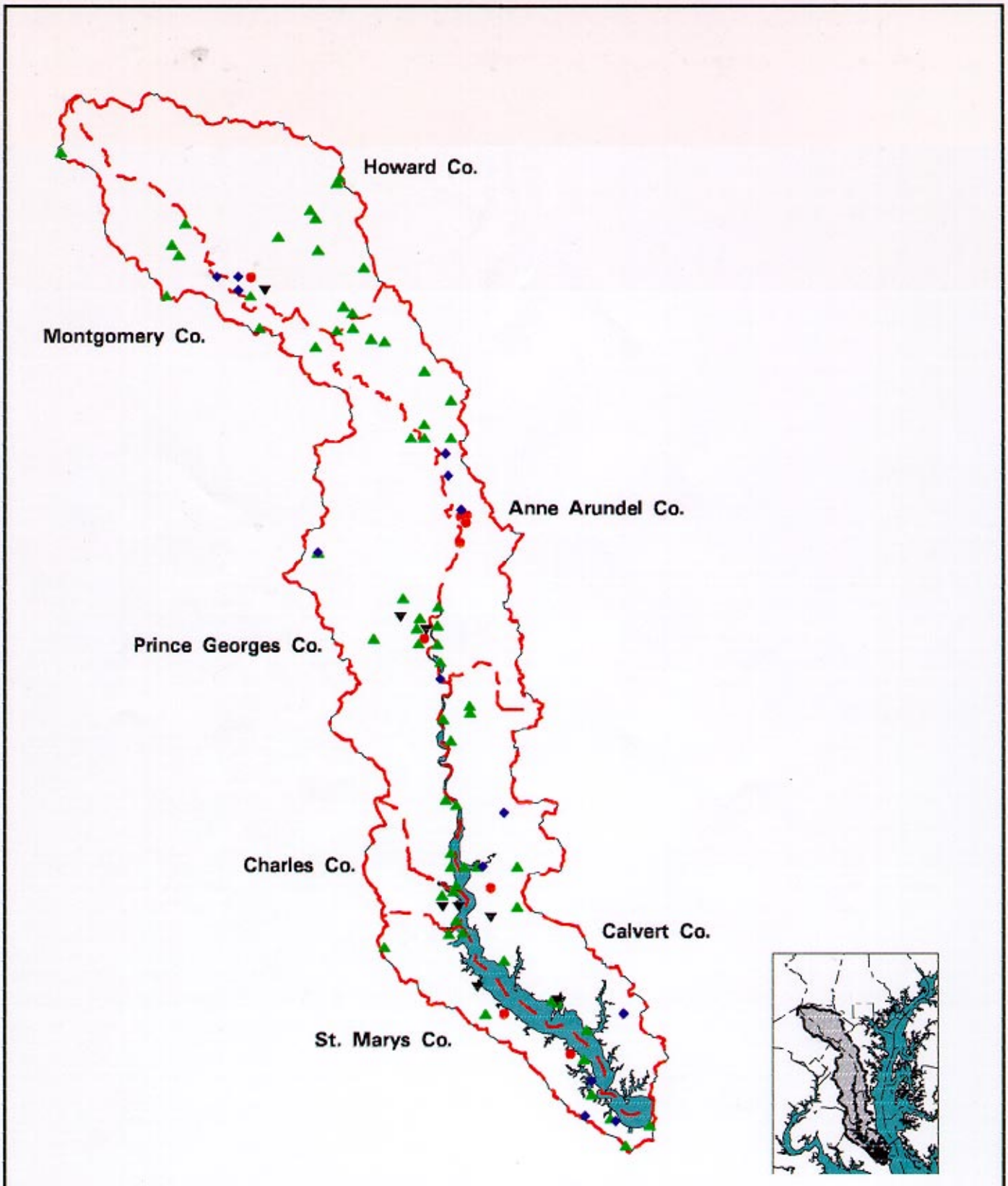
Conceptual solutions are included for each major study element -- ecosystem restoration (including, environmental infrastructure and recreation), navigation, and flood damage reduction. During this phase, it became apparent that the conceptual solutions to best address the problems, needs, and opportunities of environmental infrastructure and recreation involved ecosystem restoration or ecosystem-compatible measures. For this reason, environmental infrastructure and recreation conceptual solutions have been included as subsets within ecosystem restoration for the Patuxent River watershed watershed plan. For each of the three elements, a brief summary of the problems, needs, and opportunities is provided as background for the selected solutions. In addition, a brief description of the types of solutions and ecosystem benefits has been completed. The sites for all potential projects listed are shown on Figure 6-1.

These conceptual solutions will provide a range of alternatives to comprehensively address the majority of water resources problems occurring within the study area. The objective of the watershed plan is to provide enough detail for use by other agencies and local organizations to continue to address their water resource problems and to implement solutions that will enhance the watershed as a whole. In addition, the Corps will utilize this information to strengthen the plan formulation and decision-making processes when considering sub-watershed alternatives for Corps involvement.

6.4.1 Environmental Restoration Plan

Environmental restoration is the return of an ecosystem to a close approximation of its condition before disturbance. In restoration, ecological damage to the resource is repaired to the maximum extent possible. Both the structure and function(s) of the ecosystem are recreated to emulate a natural, fictional, self-regulating system that is integrated with the ecological landscape. Natural resource restoration often requires one or more of the following processes: reconstruction of antecedent physical, hydrological, and morphological conditions; chemical cleanup or adjustment of the environment; and biological manipulation, including revegetation and the reintroduction of absent native species. Because of the highly modified and/or disturbed state of many terrestrial and aquatic ecosystems, particularly those closely associated with large population centers or agricultural areas, there is considerable potential for the use of restoration to solve problems of water quality, water quantity, and urban and rural pollution.

Aquatic environmental restoration solutions can be separated into three categories: aquatic habitat enhancement, stream bank stabilization, and wetland construction. Aquatic habitat



US Army Corps of Engineers
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PATUXENT RIVER WATER RESOURCES STUDY

PROPOSED PROJECTS

JULY 1996

- Recreation
- Environmental
- Multi-Purpose
- Other

Figure 6-1

enhancement techniques such as the creation of pools and riffles are generally best suited to wide, shallow segments of the river, whereas such techniques as channel blocks and log frame deflectors are best suited to small streams in which the aquatic habitat will likely be improved through creation of deeper flow in the main channel. The aquatic habitat enhancement solutions include a vast array of best management practices (BMPs) to curb non-point source pollution (NPS) from a variety of land use activities. These include management techniques in the following areas:

- Agriculture
  - Restrict livestock access to stream banks and streams
  - Use conservation tillage techniques
  - Control nutrients, pesticides, and irrigation water

- Forestry and Mining
  - Use plantings and ground covers to prevent erosion
  - Avoid logging and mining on steep slopes

- Urban runoff
  - Build stormwater management facilities
  - Redirect runoff to avoid sensitive areas

- Marinas and recreational boating
  - Create/enforce no-wake zones in sensitive areas

Stream bank stabilization techniques that re-establish woody vegetation (e.g. live stakes, live fascines, branch packings, and live cribwalls) are the most appropriate for undeveloped stream banks. However, these natural methods are not applicable to every situation. Where space is very limited, where pedestrian traffic is heavy, where open views are desirable, or where sunlight does not penetrate, structural solutions such as stone riprap, dry stone walls, or gabions will prove more successful. In areas where space is limited yet a natural appearance is important, vegetative solutions combined with rootwads or structural solutions are often the best alternative, as each enhances the other.

Wetlands constructed to replace aquatic and wildlife habitat lost as a result of agriculture, development, and mining are typically created in poor quality upland areas having the prerequisite hydrological conditions. Wetland enhancement as a restoration solution is conducted in existing or historic wetland areas.

Wetlands are the vital habitats for many plants and animals. The majority of threatened and endangered plant species and many endangered animals depend on wetlands for survival. Wetlands also provide more direct values to people in many ways, such as improving water quality, reducing flood and storm damages, minimizing erosion of upland, and supporting tourism and the hunting and fishing industries.

6.4.1.a Water-Related Infrastructure: Water-related infrastructure in the Patuxent River Water Resources Study addressed drinking water supplies, wastewater treatment, and urban and rural best management practices. All areas were thoroughly investigated and documented; however, through key interviews, site visits, and reading available literature, it was evident that urban stormwater management and erosion control, and septic system failures were the areas with the largest opportunities and needs for improvement throughout the three sub-watersheds: upper, middle, and lower.

The upper, middle, and lower sub-watersheds are experiencing many of the same problems and limitations, however, to different degrees of severity. The upper sub-watershed is characterized by inadequate stormwater management and rural best management practices. These activities contribute excess nutrients that may have adverse impacts on the health of the reservoirs as drinking water sources or for aquatic habitat. The sediment loading may also limit stream flows, viable aquatic habitat, and reservoir storage capacities in the near future.

The middle sub-watershed is also experiencing mismanaged stormwater runoff and its adverse effects on the environment. Erosion and sedimentation are highly destructive to this area of the Patuxent River. Much of the aquatic habitat and life cycles of aquatic organisms are altered by the suspension of clay and silt particles in the water. As the water flows downstream, it can only be as healthy as the water it receives from upstream; therefore, the lower sub-watershed is also impacted.

The lower sub-watershed is similar to the other two in that it is being degraded by excessive runoff, erosion, and sedimentation. In addition, this sub-watershed has many on-lot disposal systems that are failing, potentially contributing abundant nutrients and bacteria to the vital groundwater and surface water supplies. The failing wastewater treatment and large amounts of sediment from upstream threaten the livelihood and diversity of habitat and species within the Patuxent River and, further, the Chesapeake Bay.

The development and growth of small communities along the Patuxent River has produced numerous infrastructure problems that impact aquatic habitat in the watershed. To improve aquatic habitat, the stormwater systems and failing septic systems must be remedied. Solutions to remediate these problems would include stormwater detention ponds and retrofits, and upgrades or replacements of existing on-lot disposal systems. The remediation of these problems would benefit aquatic life by reducing flashy flows that erode stream banks and sedimentation that smothers aquatic organisms and their habitats. These solutions would also reduce the input of other pollutants such as heavy metals, thermal impacts, and nutrients that can change physiological conditions within the aquatic ecosystem.

6.4.1.b Recration: Examination of state and local policies reveals a consensus for the protection of natural resources in the Patuxent Watershed. The proposed land acquisition and open space expansion within the watershed counties can, therefore, be achieved through the cooperation of state and local government. This combined effort will result in the development of a Patuxent Watershed recreation system amenable to both state and local policies.

Public recreational opportunities in the Patuxent River watershed are limited by the lack of public access. Although boating is one of the major recreational activities that occurs on the river, there are long stretches on both sides of the middle and lower river where no public launch ramps are provided.

Translating recreation demand into facilities must be based on the capability and capacity for the natural resource to accommodate the recreational use without degrading the resource. Acquisition of land in the Patuxent watershed will serve a dual purpose: recreation use and resource protection.

6.4.2 Navigation Plan

As a direct result of the increased interest in boating since the 1970's, the lower Patuxent River has experienced a building boom, as demonstrated by the development of recreational marinas and piers. This area experiences significant traffic congestion and safety problems, as well as other problems associated with boating activities. As this area becomes even more developed, it is anticipated that these problems will only become worse unless regulations are established to govern the use of these waterways.

The decline of commercial navigation on the river is also due in part to decreases in the available fisheries and shellfish resources. This decline coincided with the rapid increase of development in the watershed. Rapid development and population growth in the Patuxent watershed (from 86,000 people in 1950 to approximate y 800,000 in 1990) have increased sediment loads to the river by 500 percent over this time period. However, with the improvements anticipated in the Patuxent watershed from environmental restoration efforts, as well as implementation of the Tributary Strategy goals, water quality and habitat quality within the watershed should improve. This in turn could result in an increase or restoration of available fisheries and shellfish resources, which would then increase the demand for commercial navigation affordances. Although there does not appear to be a current demand, with the improved health of the watershed, this demand may reappear.

6.4.3 Flood Damage Reduction Plan

Development on the flood plains in the vicinity of Laurel and portions of the lower sub-watershed is particularly susceptible to flood damage. This situation was demonstrated by the amount of damage sustained in these areas during Hurricane Agnes in 1972 and during frequent flooding from flash floods.

The Corps' potential involvement in flood damage reduction measures are primarily limited to technical and planning assistance, based on the evaluations performed during the reconnaissance study. While the Corps does have authority to construct small local flood protection projects under the Section 205 authority of the Flood Control Act of 1948, none of the identified areas appears to have economical] y feasible for structural flood protection.

Other avenues for Corps assistance lie in the technical assistance realm. Section 206 of the

Flood Control Act of 1960 provides authority for the Corps of Engineers to use its technical expertise in floodplain management to help local agencies and residents. The objective of the Flood Plain Management Services (FPMS) program is to support comprehensive floodplain management planning with technical services and planning guidance at all appropriate governmental levels, and thereby to encourage and guide local officials toward prudent use of the nation's folldplains for the benefit of the national economy and welfare. Under this program, the Corps can provide planning assistance and guidance for development of floodplain regulations, flood warning and preparedness procedures, floodproofing measures, and permanent evacuation and relocation procedures. Implementation of activities under this program, which is 100 percent federally funded, would be at the specific request of the local or state government.

6.4.4 Federal Lands Recommendations and Implementation

Each Federal facility implements programs for compliance with environmental regulations to minimize its impacts on the environment. However, problems and needs for most facilities described areas of continuing environmental degradation that need further attention; establishing potential opportunities for site improvements. Similar opportunities were identified at several facilities. These opportunities include upgrading stormwater management systems, restoring shoreline/streambank stability, restoring riparian vegetation and buffers, and continuing to investigate hazardous materials contamination and its impacts on surrounding natural resources.

A specific Federal facility watershed plan has not been established to implement these opportunities because the responsibility lies within each facility. Individual facilities will need to assess their own impacts and establish a strategies to reduce those impacts with their available resources.

6.5 PATUXENT RIVER WATERSHED PLAN DESCRIPTION BY SUB-WATERSHED

The first step in this evaluation was to divide the Patuxent River watershed into three sub-watersheds, as depicted in Figure 3-1. This division separates problems that correspond to different geographical areas. This creates smaller areas where the water resources problems and solutions are better understood and are more implementable.

The next step involved site visits and key interviews with the local residents of each county. This approach allowed the study team to document the problems within the Patuxent watershed first hand, ask questions, and establish points of contact for further information and guidance. This was also a very efficient method for noticing trends throughout the watershed as well as differences between the sub-satersheds. Prioritization of sites and potential non-federal sponsorship were also significant aspects of the investigation as the study team documented and understood the problems, needs, and opportunities throughout the watershed.

The following sub-watershed analyses address the major problems for that region and are catagorized by drainage watershed. This analysis will facilitate implementation of the

watershed plan and design of problem solutions on a ecosystem basis. The objective of this evaluation is to restore the natural biological integrity and habitat integrity of the Patuxent River watershed by providing cost-effective measures to reduce erosion, suspended sediment, and nutrient contributions in the Patuxent River and its tributaries.

Projects identified for implementation throughout the study area are listed in Table 6-1.

6.5.1 Upper Patuxent Sub-Watershed

The upper Patuxent River sub-watershed, shown in Figure 6-2, is characterized by the need for reservoir protection from excessive sediment loadings, and nutrients from rural horse farming practices and septic system failures. Much of the environmental degradation is occurring within and adjacent to streams. The primary problems in this sub-watershed are unmanaged stormwater runoff and unprotected streambanks. The cumulative result is the physical degradation of habitat and the fictional degradation of ecosystems.

As indicated by local agencies in the upper sub-watershed, efforts to restore the sub-watersheds and, essentially, the Patuxent watershed, should be focused on the same hydrologic unit area (HUA), or sub-sub-watershed, as a cooperative and collective method for restoration. In the upper sub-watershed, eight HUAs have all been identified and agreed upon by a number of Federal, state, and local agencies as priority areas. These priority areas are the Hawlings River, Little Patuxent River, Middle Patuxent River, Wilde Lake, Lake Kittarnaqundi, the Route 1 corridor, and Dorsey Run.

The Hawlings River area is experiencing exaggerated results of mismanaged stormwater from commercial centers. High velocity and uncontrolled runoff cut deep meandering ravines through once-undisturbed woodlands. The fine soils are easily eroded and transported, often remaining suspended in the water and contributing to increased amounts of turbidity. This disruption also threatens habitat because the streams cannot support organisms under low flow conditions.

The Little Patuxent River, Middle Patuxent, and Dorsey Run are characterized by streambank erosion and resultant dediment bars downstream. Extreme siltation blocks possible breeding spots for fish and inhibits other habitats as well. The deterioration of the Little Patuxent River causes adverse impacts to the Patuxent River as the sediment is transported from the tributary to the mainstem. Habitat degradation is further compromised as silt and sand are continually resuspended and deposited.

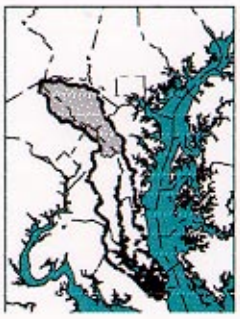
Table 6-2 lists all the identified projects for the upper sub-watershed. Figure 6-3 shows the locations of all the listed projects.

The following list of elements to the sub-watershed plan should in no way preclude the investigation or consideration of items beyond the list below. The list is provided to suggest some elements within the current version of the plan that can be recommended for implementation at the current time, based upon available information. As additional

investigations and discussions occur, the plan elements described as necessary will be modified. Therefore, future versions of the watershed plan and its sub-watershed plans will likely have additional efforts identified.

Basic elements of the upper sub-watershed plan will include the following:

- Initiate implementation of reservoir protection to ensure safe drinking water quality from the two upstream reservoirs, a model may need to be developed to develop the plan (could be Section 22).
- Initiate possible modification to Duckett dam in order to ensure its ability to pass a pmf flow (could be Section 22).
- Implement environmental restoration activities at the Laurel Lakes area.
- Implement environmental restoration activities at the Little Patuxent watershed.
- Implement environmental restoration activities at the Dorsey Run watershed.
- Implement environmental restoration activities and associated recreational access and multipurpose area within the Hawlings River watershed.
- Implement environmental restoration associated with habitat degradation from inadequate stormwater management within the James Creek watershed.
- Implement environmental restoration activities with associated recreational access within the Wilde Lake and Lake Kittimaqundi watershed area.
- Implement environmental restoration activities associated with habitat degradation from inadequate stormwater management within the Route 1 corridor.
- Implement trail/greenway development in Howard County in the watershed of the Patuxent mainstem.
- Acquire land and establish Howard County environmental protection area.
- Implement environmental restoration activities associated with habitat degradation from inadequate stormwater management within the watershed of the Triadelphia Reservoir in the vicinity of the Damascus Shopping Center and Burtonsville. This will be integrated into the reservoir protection effort described above. Also, within this watershed the following things should be incorporated: community natural resource education and public outreach and education.
- After coordination with Fort Meade and their with tenant NSA, implement environmental restoration activities associated with habitat degradation from inadequate stormwater management within the watershed of an unnamed tributary to the mainstem. This effort will also be coordinated with Anne Arundel County since much of the degraded habitat occurs off of the Federal lands on lands owned by the county.



US Army Corps of Engineers
Baltimore District

PATUXENT RIVER WATER RESOURCES STUDY

UPPER BASIN - STREAMS

JULY 1996

Figure 6-2

Table 6-1

PATUXENT RIVER WATER RESOURCES RECONNAISSANCE STUDY

ALL SUB-WATERSHED ANALYSIS OF PROJECTS

Drainage	Project Name	Map ID	Cost	Benefits		
ALL						
	Patuxent River and Tributary Buffer Study	AL4	$25,000	Increased scientific data base		
	Wetlands Enhancement	AL3	$500,000	Improved aquatic and wetland habitat		
	SAV Restoration	AL2	$44,000,000	Improved aquatic habitat		
	Habitat Improvement through Erosion Control	AL1	$144,000,000	Improved water quality and aquatic habitat		
	ALL Drainage Subtotal:		$188,525,000	7050 Acres	Feet	200 Stream Miles
MULTIPLE						
	Transference of USGS Gage Monitoring	AL7	$0	Continuation of monitoring program		
	Septic System Impact Study	AL6	$50,000	Improved water quality, reduced health risk		
	Fish Blockage Removal	AL5	$3,000,000	Restoration of fish habitat and range		
	MULTIPLE Drainage Subtotal:		$3,050,000	Acres	Feet	150 Stream Miles
	ALL SUB-WATERSHED TOTAL:		**$191,575,000**	**7050 Acres**	**Feet**	**350 Stream Miles**

Back of Table 6-1

Table 6-2

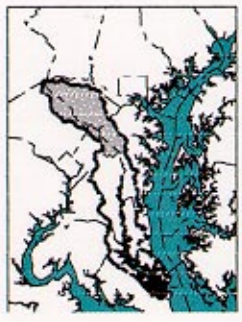
PATUXENT RIVER WATER RESOURCES RECONNAISSANCE STUDY

UPPER SUB-WATERSHED ANALYSIS OF PROJECTS

Drainage	Project Name	Map ID	Cost	Benefits		
Mainstem						
	D.C. Children's Center Stream Restoration and SWM	AA4	$100,000	Improved water quality and aquatic habitat		
	Mainstem Drainage Subtotal:		$100,000	Acres	1200 Feet	Stream Miles
Bear Branch						
	Laurel Lakes Environmental Enhancement	PG8	$1,000,000	Improved aquatic habitat and water quality		
	Bear Branch Drainage Subtotal:		$1,000,000	1363 Acres	Feet	Stream Miles
Duckett Reservoir						
	Reservoir Watershed Resource Inventory/Evaluation	MU4	$50,000	Improved scientific data base.		
	Burtonsville Stream Restoration and SWM	MO3	$800,000	Improved water quality and aquatic habitat		
	Reservoir Watershed Public Outreach and Education	MU3	$50,000	Improved water quality and land stewardship		
	Patuxent River Reservoir Model	MU1	$500,000	Improved scientific data base		
	Community Natural Resources Education	MO7	$50,000	Improved surface water quality		
	Nonpoint Sources Contamination	MO6	$50,000	Improved aquatic habitat, reduced nutrification		
	Damascus Shopping Center SWM Retrofit	MO4	$50,000	Improved water quality and aquatic habitat		
	Duckett Reservoir Drainage Subtotal:		$1,550,000	42238 Acres	1200 Feet	5 Stream Miles
Hammonds Branch/Middle Patuxent						
	Route 216 Corridor/Hammonds Branch SAMP	HO7	$50,000	Reduced stormwater and development impacts		
	Hammonds Branch/Middle Patuxent Drainage Subtotal:		$50,000	100 Acres	Feet	Stream Miles
Hawlings River						
	Projects Assoc w/Hawlings R. Watershed Master Plan	MO5	$1,500,000	Improved terrestrial, riparian, and aquatic habitat		
	Hawlings River Park Multi-Purpose Area	MO1	$500,000	Improved riparian/ aquatic habitat and recreation		
	Hawlings River Drainage Subtotal:		$2,000,000	20050 Acres	Feet	Stream Miles
James Creek						

Drainage	Project Name	Map ID	coat	Benefits		
	SWM and Restoration of Tributary to James Creek	MO2	$300,000	Improved water quality and aquatic habitat		
	James Creek Drainage Subtotal:		$300,000	136 Acres	Feet	Stream Miles
Little Patuxent						
	Little Patuxent River SWM	HO4	$150,000	Improved water quality and aquatic habitat		
	Little Patuxent Stream and Habitat Restoration	HO3	$50,000	Improved aquatic habitat in 1/2 mile of stream		
	N. Laurel Park Area SWM and Wetland Protection	HO2	$150,000	Improved aquatic habitat and water quality		
	Oxbow Natural Heritage Area	AA2	$750,000	Improved wildlife habitat and recreational access		
	Wilde Lake Watershed	HO5	$120,000	Improved water quality end aquatic habitat		
	Russett Streambank Protection/Restoration	AA6	$750,000	Improved water quality and aquatic habitat		
	Dunloggin SWM Improvement	HO1l	$100,000	Water quality, flood protection and aquatic habitat		
	Davis Avenue SWM	HO6	$100,000	Reduced flood damages, improved water quality		
	Plum Tree Branch Stream Restoration	HO9	$500,000	Improved downstream water quality		
	Beaverbrook SWM Improvement	HOl0	$100,000	Water quality, flood protection, and aquatic habitat		
	Piney Orchard Streambank Protection/Restoration	AA5	$150,000	Improved water quality and aquatic habitat		
	Little Patuxent Drainage Subtotal:		$2,920,000	1488 Acres	Feet	2.25 Stream Miles
Little Patuxent/Mainstem						
	Route 1 Corridor Env. Infrastructure Study	HO8	$100,000	Improved infrastructure		
	Little Patuxent/Mainstem Drainage Subtotal		$100,000	6400 Acres	Feet	Stream Miles
Mainstem						
	Duckett Dam Emergency Spillway	MU2	$750,000	Improved flood protection		
	Mainstem Drainage Subtotal		$750,000	Acres	Feet	Stream Miles
Middle Patuxent						
	Howard County Environmental Protection Area	HO1	$400,000	Improved env. protection and public access		
	Middle Patuxent Drainage Subtotal		$400,000	1000 Acres	Feet	Stream Miles
Towers Branch						
	Towsers Branch	AA3	$100,000	Improved water quality and aquatic habitat		

Drainage	Project Name	Map ID	Cost		Benefits	
		Towsers Branch Drainage Subtotal:	$100,000	Acres	2000 Feet	Stream Miles
		UPPER SUB-WATERSHED TOTAL:	***$9,270,000***	***72775 Acres***	***4400 Feet***	***7.25 Stream Miles***



US Army Corps of Engineers
Baltimore District

PATUXENT RIVER WATER RESOURCES STUDY
UPPER BASIN - PROPOSED PROJECTS

JULY 1996

● Proposed Projects

Figure 6-3

6.5.2 Middle Patuxent Sub-Watershed

The middle Patuxent River sub-watershed, shown in Figure 6-4, is an area that is greatly affected by the activities and health of the upper watershed. Sediment and nutrients are carried into this main reach of the Patuxent, causing similar degradation as in the upper sub-watershed described previously. In addition, the middle sub-watershed has further habitat degradation in that there are declining amounts of submerged aquatic vegetation (SAV), redheads, canvasbacks, and migrating Canada geese.

As indicated by local agencies in the middle watershed, efforts to restore the sub-watershed and, essential y, the entire Patuxent watershed, should be focused on the same HUA as a cooperative and collective method for restoration. As the identified as priority areas by a number of federal, state and local agencies, Prince George's County has focused particular attention on the Western Branch - including Upper Marlboro, Laurel Lake, the Charles Branch, Southwest Branch, and Collington Branch. Anne Arundel County has identified Towsers Branch as a priority HUA.

The Upper Marlboro area, in particular, contains a previous Corps project that is having adverse impacts on the environment. The channelized stream has limited aquatic habitat and the constructed levee may not be providing adequate flood protection for the community. This is a very sensitive area with respect to appropriate restoration measures because the endangered/extirpated stripeback and glassy darters are found in this reach. The recommendations for improving the middle sub-watershed include restoring the streambanks and water quality, and providing habitat restoration and community flood protection at Upper Marlboro.

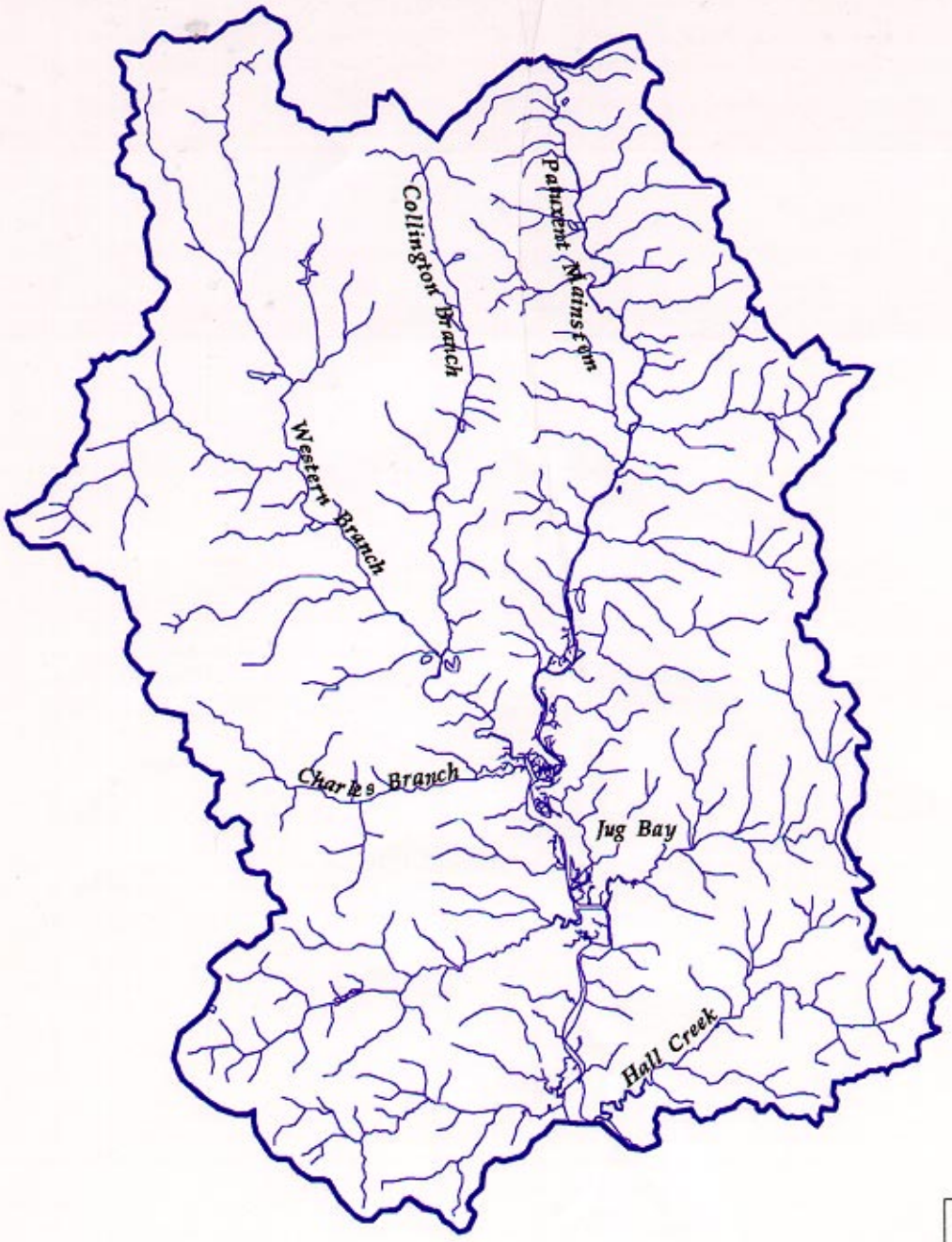
Table 6-3 lists all the identified projects for the middle sub-watershed. Figure 6-5 shows the locations of all the listed projects.

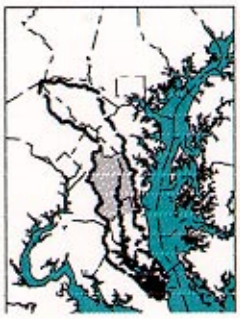
The following list of elements to the sub-watershed plan should in no way preclude the investigation or consideration of items beyond the list below. The following list is provided in order to suggest some elements within the current version of the watershed plan which can be recommended for implementation at the current time, based upon the available information. As additional investigations and discussions occur, the plan elements described as necessary will be modified. Therefore, future versions of the watershed plan and its sub-watershed plans will likely have additional efforts identified.

Basic elements of the middle sub-watershed plan include the following:

- Implement appropriate FPMS applications in order to reduce flood damages at the Arrowhead Farms area.
- Establish equestrian trails for recreation where possible.
- Improve recreational facilities to accommodate over-demand within the middle watershed including canoe access.
- Implement public outreach and education within the sub-watershed regarding issues such as BMPs for horse farms and associated pasture and manure management.

- Implement efforts to address failing septic system problems within the middle sub-watershed.
- Implement appropriate efforts regarding sanitary landfills within the middle sub-watershed.
- Implement actions associated with PCB removal within the middle sub-watershed. Remove fish passage obstructions.
- Implement trail/greenway development in the middle sub-watershed of the Patuxent.
- Implement environmental restoration activities associated with habitat degradation from inadequate stormwater management within the watershed of the Charles Branch.
- Implement environmental restoration activities associated with habitat degradation from inadequate stormwater management within the watershed of the Collington Branch.
- Implement environmental restoration activities such as streambank protection and within the vicinity of Piney Orchard, Russet, and Oxbow Natural Heritage Area which are all in the Little Patuxent watershed.
- Implement environmental restoration activities such as wetland restoration with associated recreational access where appropriate on the mainstem of the Patuxent River in the middle sub-watershed in the vicinity of Queen Anne's bridge, Bristol Bar/Swan Point, the Billingsly property, as well as the Milltown Landing property. Implement environmental restoration activities associated with habitat degradation from inadequate stormwater management within the watershed of the southwest branch of the Patuxent River with additional consideration toward possible flood reduction or FPMS activities.
- Implement environmental restoration activities associated with habitat degradation from inadequate stormwater management within the watershed of Towsers branch of the Patuxent River with particular consideration toward severe erosion problems in this small watershed.
- Implement a Corps of Engineers' Section 14 (Emergency Streambank and Shoreline Protection) project for the Towsers branch for the portion of the eroded stream that has exposed an active sanitary sewer line.
- Implement environmental restoration activities associated with habitat degradation from inadequate stormwater management within the watershed of the Western and Collington Branches of the Patuxent River with particular consideration toward flood damage reduction concerns as well as passive recreational opportunities.





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Baltimore District

PATUXENT RIVER WATER RESOURCES STUDY

MIDDLE BASIN - STREAMS

JULY 1996

Figure 6-4

Table 6-3

PATUXENT RIVER WATER RESOURCES RECONNAISSANCE STUDY

MIDDLE SUB-WATERSHED ANALYSIS OF PROJECTS

Drainage	Project Name	Map ID	Cost	Benefits		
Charles Branch						
	Charles Branch Stormwater Management	PG5	$200,000	Improved aquatic habitat and water quality		
	Charles Branch Drainage Subtotal:		$200,000	5 Acres	Feet	Stream Miles
Collington Branch						
	Collington Branch Regional SWM Facilities	PG7	$14,000,000	Improved aquatic habitat and water quality		
	Collington Branch Drainage Subtotal:		$14,000,000	1600 Acres	Feet	Stream Miles
Hall Creek						
	Hall Creek Environmental & Flood Protection	CA11	$50,000	Improved stormwater management		
	Hall Creek Drainage Subtotal:		$50,000	3840 Acres	Feet	Stream Miles
Mainstem						
	Queen Anne's Bridge Multi-Purpose Area	AA1	$100,000	Improved recreation and terrestrial habitat		
	Ferry Landing Mine Multi-Purpose Area	CA2	$500,000	Improved aquatic & terrestrial habitat and recreation		
	Improve Degraded Habitat -Dunkirk Shopping Center	CA3	$50,000	Improved wetland, water, and aquatic habitat		
	SWM/Habitat Improvement Along Routes 2 and 4	CA4	$40,000	Improved water quality and aquatic habitat		
	Wetland Creation at M-NCPPC Billingsly Property	PG4	$100,000	Improved aquatic & wetland habitat, water quality		
	Jug Bay Environmental Enhancement	AA13	$150,000	Improved SAV and aquatic habitat.		
	Septic System Failure Study	PG10	$50,000	Reduced nitrogen and bacterial inflow		
	Arrowhead Farms Flood Protection	AA7	$50,000	Reduce flooding damages in Arrowhead Farms		
	Mainstem Drainage Subtotal:		$1,040,000	396.7 Acres	Feet	7 Stream Miles
Mainstem/Large Tributaries						
	Canoe Access	AA11	$200,000	Improved recreational access		
	Mainstem/Large Tributaries Drainage Subtotal:		$200,000	Acres	Feet	Stream Miles
Middle/Little Patuxent						

Drainage	Project Name	Map ID	Cost	Benefits		
	Laurel Flood Protection	AA12	$50,000	Reduced flooding damages in Laurel		
	Middle/Little Patuxent Drainage Subtotal:		$50,000	100 Acres	Feet	Stream Miles
MULTIPLE						
	Greenway/Trail Opportunities Study	PG11	$0	Improved recreational access		
	Anne Arundel County Equestrian Trails	AA8	$0	Increased recreational access		
	Park Facilities Management Plans	AA9	$100,000	Improved recreational access		
	Public Outreach and Education	AA10	$50,000	Better land stewardship in much of the county		
	MULTIPLE Drainage Subtotal:		$150,000	Acres	Feet	Stream Miles
Southwest Branch						
	Southwest Branch Flood Protection	PG6	$220,000	Reduced flood damages in this community		
	Southwest Branch Regional SWM Facilities	PG2	$400,000	Wetland/pond habitat and improved water quality		
	Southwest Branch Drainage Subtotal:		$620,000	1611 Acres	Feet	Stream Miles
Western/Collington Branch						
	Upper Marlboro Multi-Purpose Area	PG1	$525,000	Flood protection, recreation, and aquatic and wetland hab.		
	Western/Collington Branch Drainage Subtotal:		$525,000	30000 Acres	Feet	Stream Miles
	MIDDLE SUB-WATERSHED TOTAL:		**$16,835,000**	**37552.7 Acres**	**Feet**	**7 Stream Miles**

US Army Corps of Engineers
Baltimore District

PATUXENT RIVER WATER RESOURCES STUDY

MID-BASIN PROPOSED PROJECTS

JULY 1996

● Proposed Projects

Figure 6-5

6.5.3 Lower Patuxent Sub-Watershed

The lower Patuxent sub-watershed, shown in Figure 6-6, has been documented with environmental degradation to shorelines, water supplies, and streams. Unstabilized shorelines are eroding back into tree lines and residential properties on both the St. Mary's and Calvert County sides of the Patuxent River. Residents of the lower sub-watershed rely heavily on groundwater as their water source. This resource is nearing the need for conservation due to increased population growth and likely contamination from on-lot disposal systems. Stream health is deteriorating from large amounts of sediment and nutrients that are entering the system from high flow stormwater. Many older communities lack quality and quantity controls of storm water runoff.

The main objective for the lower sub-watershed is to decrease the mass sediment and erosion that is occurring to different ecosystems. With root wad stabilization, toe protection, and breakwater structures, habitat will regain its vitality and bring positive impacts to the Patuxent watershed.

Charles County has identified Benedict as a priority region within the lower Patuxent watershed in need of environmental restoration. This area of the mainstem is suffering from unmanaged storm water runoff, failing septic systems, and resultant habitat degradation.

Calvert County has identified Hall Creek, Hunting Creek, Jefferson Patterson Park, and the Route 2 and 4 corridor as priority regions for restoration.

Table 6-4 lists all the identified projects for the lower sub-watershed. Figure 6-7 shows the locations of all the listed projects.

The following list of elements to the sub-watershed plan should in no way preclude the investigation or consideration of items beyond the list below. The following list is provided in order to suggest some elements within the current version of the watershed plan which can be recommended for implementation at the current time, based upon the available information. As additional investigations and discussions occur, the plan elements described as necessary will be modified. Therefore, future versions of the watershed plan and its sub-watershed plans will likely have additional efforts identified.

Basic elements of the lower sub-watershed plan include the following:

- Implement actions to restore the degraded habitat (such as SAV and nesting habitat) caused by the severe shoreline erosion problems in the estuarine portions of the Patuxent River through environmentally sensitive implementation measures. Considerable public involvement and resource agency coordination will be necessary in order to optimize the ecosystem benefits and satisfy the watershed stakeholders.
- Implement efforts to improve the management of water use needs in the lower sub-watershed, especially regarding recreational boating, slalom ski course, boat access, environmental restoration and SAV/wetland protection.

- Implement environmental restoration activities associated with anadromous fish spawning habitat improvement.
- Implement environmental restoration activities associated with oyster beds in close coordination with the ongoing oyster restoration study being conducted by the Corps of Engineers.
- Implement public outreach and education as well as technical support within the lower sub-watershed regarding Agricultural BMPs.
- Implement environmental restoration activities associated with habitat degradation within the watershed of Cat Creek and the mainstem of the Patuxent River.
- Implement environmental restoration activities associated with habitat degradation within the watershed of Coxtown Creek and the of the Patuxent River with particular consideration toward passive recreational opportunities and the creation of a multi-purpose area.
- Implement environmental restoration activities associated with habitat degradation from inadequate storm water management within the watershed of Hunting Creek in the vicinity of Calvert Memorial Hospital.
- Implement environmental restoration activities associated with habitat degradation from inadequate stormwater management within the watershed of Lewis Creek and the mainstem.
- Implement environmental restoration activities associated with habitat degradation within the watershed of the mainstem of the Patuxent River in the lower sub-watershed with particular consideration toward creation of a multi-purpose area in the vicinity of Ferry Landing, Benedict, Myrtle Point, and Maxwell Hall Farm: greenway development throughout the area, improve degraded from inadequate stormwater management in the vicinity of Dunkirk Shopping Center, and Routes 2 and 4; possibility for fish stocking in the lower sub-watershed; and wetland restoration at Nan Cove.
- Implement actions to restore the degraded habitat (such as SAV and nesting habitat) caused by the severe shoreline erosion problems in the vicinity of Jefferson Patterson Park in the watershed of St. Leonard's Creek and the mainstem of the Patuxent. Additional attention should be provided to the need to protect historic resources and also to provide addition and protect existing recreational opportunities at the State Park.
- Integrate sensitivity toward the environment in the development of the design for the landing for a ferry that will transport cars and passengers from the western shore to the eastern shore of the Chesapeake Bay. It is thought that the landing on the western shore will be in the watershed of Town Creek as well as the mainstem of the Patuxent River

Each of the three sub-watershed plans are designed to stand-alone, in that the actions accomplished in one plan are not dependent upon the actions undertaken in another sub-watershed. However, the sub-watershed plans work together toward one goal: the restoration and protection of the Patuxent River watershed. In this sense, each sub-watershed plan is an increment of the Patuxent River watershed plan.

US Army Corps of Engineers
Baltimore District

PATUXENT RIVER WATER RESOURCES STUDY

LOWER BASIN - STREAMS

JULY 1996

Figure 6-6

Table 6-4

PATUXENT RIVER WATER RESOURCES RECONNAISSANCE STUDY

LOWER SUB-WATERSHED ANALYSIS OF PROJECTS

Drainage	Project Name	Map ID	coat	Benefits		
Battle Creek						
	Battle Creek Conservation Easement	CA19	$500,000	Additional protection for this rare habitat type		
	Battle Creek Drainage Subtotal:		**$500,000**	**25 Acres**	**Feet**	**Stream Miles**
Cat Creek/Mainstem						
	Environmental Restoration of Cat Creak	ST5	$86,000	Improved water quality, aquatic& wetland habitat		
	Cat Creek/Mainstem Drainage Subtota;:		**$86,000**	**Acres**	**Feet**	**1.25 Stream Miles**
Coxtown Creek/Mainstem						
	Kings Landiig Park Multi-Purpose Area	CA1	$100,000	Irnproveed environmental protection and recreation		
	Coxtown Creek/Mainstem Drainage Subtotal:		**$100,000**	**1200 Acres**	**Feet**	**Stream Miles**
Cuckold Creek/Mainstem						
	Shoreline Erosion Abatement	ST14	$200,000	Improved water quality and aquatic habitat		
	Cuckold Creek/Mainstem Drainage Subtotal:		**$200,000**	**20 Acres**	**Feet**	**Stream Miles**
Hunting Creek						
	Huntingtowm Local Flood Protection	CA16	$50,000	Reduce flooding damages in Huntingtown area		
	Hunting Creek Environmental Protection	CA12	$50,000	Restoration of envirornmental resources		
	Calvert Memorial Hospital SWM/Habitat Improvement	CA5	$260,000	Improved water quality and aquatic habitat		
	Hunting Creek Drainage Subtotal:		**$360,000**	**3750.2 Acres**	**Feet**	**Stream Miles**
Killpeck Creek/Mainstem						
	Wastewater Treatment Study	ST9	$50,000	Improved water quality and aquatic habitat		
	Killpeck Creek/Mainstem Drainage Subtotal:		**$50,000**	**Acres**	**Feet**	**1.5 Stream Miles**
Lewis Creek/Maitrstem						
	Environmental Restoration and SWM Upgrade	ST6	$284,000	Improved water quality, aquatic and wetland habitat.		

Drainage	Project Name	Map ID	Cost	Benefits		
	Lewis Creek/Mainstem Drainage Subtotal:		**$284,000**	**Acres**	**120 Feet**	**1 Stream Miles**
Mainstem						
	Wetland Creation at Milltown Landing Property	PG3	$60,000	Improved wetland and aquatic habitat. Improved water quality.		
	Golden Beach Habitat and SWM Improvement	ST8	$61,000	Improved water quality and aquatic habitat		
	Myrtle Point Multi-Purpose Area	ST4	$4,500,000	Environmental protection and recreation		
	Patuxent River Greenway Development	ST3	$30,000	Improved recreational access		
	Maxwell Hall Farm Multi-purpose Area	CH1	$2,000,000	Improved wetland & terrestrial habitat and recreation		
	Patuxent River Greenway Development	CA7	$30,000	Improved recreational access		
	Leitches Wharf Recreational Area	CA9	$100,000	Improved recreational access		
	Benedict Septic, SWM, and Recreational Upgrades	CH2	$1,400,000	Improved wetland & aquatic habitat, water quality		
	Boat Trailer Parking	ST2	$20,000	Improved recreational access		
	Greenwell State Park	ST1	$8,200,000	Improved mutational access		
	Water Resources Management Plan	MU8	$20,000	Improved recreation and environmental protection		
	Patuxent River Greenway Development	CH3	$30,000	Improved recreational access		
	California and Lexington Park Flood Protection	ST12	$10,OOO,OO0	Reduced flood damages in this area		
	Broomes Mend Park/Greenway Development	CA18	$250,000	Increased recreational acreage		
	Technical Support for Agricultural BMPs	CA14	$50,000	Improved technical assistance		
	Broomes Island Septic System Repair	CA13	$50,000	Improved water quality		
	Septic Tank Pollution prevention	CA10	$50,000	Reduced nitrogen inflow		
	HTRW Sites at Patuxent River Naval Air Station	ST13	$20,000,000	Reduccd risk of HTRW pollution		
	Nan Cove Wetlands Enhancement	CA8	$295,000	Impmvul wetland, beach, and aquatic habitat		
	Lexington Park SWM and Wetlands Study	ST11	$50,000	Improved water quality and aquatic habitat		
	Water Supply Conservation	ST10	$50,000	Improved water quality and aquatic habitat		
	Patuxent Natural Researce Management Area Public Access	PG12	$200,000	Improved recreational access		
	Patuxent River Erosion Study	CH5	$350,000	Improved water quality end aquatic habitat		
	Benedict Flood Protection	CH4	$50,000	Reduced flooding damages in Benedict area		
	Beach Protection for Habitat and Nesting	MU7	$350,000	Increased populationn of sea turtles and shorebirds		
	Oyster Bar Realignment and Monitoring	MU9	$1,000,000	Increased oyster habitat		
	Mainstem Drainage Subtotal:		**$49,216,000**	**11648.33 Acres**	**100 Feet**	**35 Stream Miles**

Drainage	Project Name	Map ID	Cost	Benefits		
Mainstem/St. Leonard Creek						
	Environmental Projects at JPPM	CA6	$785,000	Improved water quality and aquatic habitat		
	Mainstem/St. Leonard Creek Drainage Subtotal:		**$785,000**	**Acres**	**Feet**	**2.5 Stream Miles**
Mill Creek/Hunting Creek						
	Mill Creek Flood protection	CA17	$50,000	Reducc flooding damages in Mill Creek watershed		
	Mill Creek/Hunting Creek Drainage Subtotal:		**$50,000**	**500 Acres**	**Feet**	**Stream Miles**
MULTIPLE						
	Anadromous Fish Spawning Habitat Improvement	MU6	$5,000,000	Increased population of anadromous fish		
	MULTIPLE Drainage Subtotal:		**$5,000,000**	**Acres**	**Feet**	**50 Stream Miles**
St. Leonard Creek						
	Lusby Local Flood Protection	CA15	$50,000	Reduced flooding damages in Lusby area		
	St. Leonard Creek Drainage Subtotal:		**$50,000**	**500 Acre**	**Feet**	**Stream Miles**
Town Creek/Mainstem						
	Ferry for St. Mary's md Calvert Co. to E. Shore	ST7	$1,600,000	Improved transportation		
	Town Creek/Mainstem Drainage Subtotal:		**$1,600,000**	**2 Acres**	**Feet**	**Stream Miles**
	LOWER SUB-WATERSHED TOTAL:		**$58,281,000**	**17645.53 Acres**	**220 Feet**	**91.25 Stream Miles**

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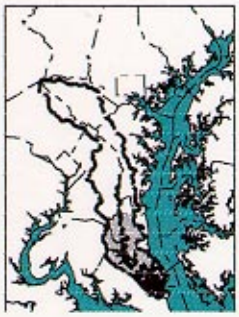

US Army Corps of Engineers
Baltimore District

PATUXENT RIVER WATER RESOURCES STUDY

LOWER BASIN - PROPOSED PROJECTS

JULY 1996

● Proposed Projects

Figure 6-7

6.6 ENVIRONMENTAL RESTORATION BENEFITS AND COSTS

All of the recommended solutions included in the watershed plan have numerous environmental benefits and should be considered for implementation; however, these benefits are not quantifiable nor are the costs easily determined. Therefore, only the estimated plan benefits and costs of solutions that could be implemented within the jurisdiction of the Corps of Engineers were determined and are shown in the project sheets (Annex, Part II). Since the ecosystem restoration projects are the only ones within the immediate jurisdiction and current budgetary policy of the Corps of Engineers to implement, only the benefits and costs associated with ecosystem restoration projects are presented.

Benefits are quantified and listed in the project sheets if there was enough information available during this study to reasonably estimate them. Ecosystem restoration benefits were partially quantified (in acres of wetlands), but monetary benefits were not calculated. Cumulative multi-purpose ecosystem restoration benefits were determined by summing riparian, wetland and aquatic habitat restoration acres or numbers of stream miles improved for aquatic habitat.

The difficulty in estimating monetary benefits for environmental activities is that many environmental improvements produce equally beneficial but immeasurable effects which cannot be compared to the status quo to yield a measurable savings. Savings can be measured only when the activities being compared have defined market values assigned to them. Environmental benefits largely remain defined by and valued through aesthetics or scarcity (as in endangered species) and not by markets. This explanation is important because the approach that this study takes is that environmental improvements are valuable from the standpoint of a national natural resources ethic and stewardship. The criteria used to determine qualitative differences between alternatives are appropriateness to the area, scarcity of the resource, measured space (such as acres), and cost. The alternative that fulfills the qualitative criteria and has the least cost is considered to be the most efficient. To be implemented by the Corps, a linkage must also exist between the restoration project and an existing Corps project.

Table 6-5 summarizes the benefits and costs of all potential projects in the Patuxent River study area, by sub-watershed.

6.7 WATERSHED PLAN SUMMARY

The Patuxent River watershed plan is designed to alleviate some of the most significant problems in the Patuxent River watershed. Theses problems are the results of actions performed by Federal, state, and local agencies, in addition to private companies and the public, over a long period of time. Therefore, implementation of the plan will require marked involvement by a number of Federal, state, and local agencies, in addition to private interests. Successful implementation of the plan will require a significant amount of inter-agency coordination and participation. It offers the unique opportunity for a variety of agencies to

work together toward on goal: restoration and protection of the water resources in the Patuxent River watershed.

Clearly, the overall success of the plan depends on the successes of the individual project features at each implementation level. Therefore, each level may standalone in the sense that the project features it contains will provide an incremental benefit to the water resources within the study area. However, the recreation features of the plan serve more as complements to other elements of the plan than as stand-alone features. As a result, the Patuxent River watershed will be restored incrementally over time as project features outlined in this report are undertaken.

Table 6-5

Benefits and Costs Summaries for Potential Projects, by Sub-Watershed

Sub-Basin	Cost	Benefits		
		ACRES	FEET	STREAM MILES
ALL	$191,575,000	7050 Acres	Feet	350 Stream Miles
LOWER	$58,281,000	17645.53 Acres	220 Feet	91.25 Stream Miles
MIDDLE	$16,835,000	37552.7 Acres	Feet	7 Stream Miles
UPPER	$9,270,000	72775 Acres	4400 Feet	7.25 Stream Miles
Grand Total:	$275,961,000	135023.23 Acres	4620 Feet	455.5 Stream Miles

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SECTION 7

IMPLEMENTATION OF THE WATERSHED PLAN

This section describes alternatives for implementing the watershed plan described in Section 6. Implementation recommendations for the various components of the watershed plan were determined with consideration to the type of problems, solutions, and the programs and missions of the agencies and organizations in the watershed.

It must be stressed that the watershed plan is in its first draft. Modifications to the plan that will include additions and possible deletions once actions are implemented are to occur during the life of the plan. Therefore, the implementation of the plan is described in a general manner since it must accompany the current version of the plan, as well as all future plans. Implementation alternatives will also continue to be modified as the policy and missions of agencies are adjusted.

7.1 POTENTIAL FEDERAL, STATE, AND LOCAL IMPLEMENTATION

For each project in the plan, the agency or agencies able to take a lead role in implementation were identified. This determination was made based upon agencies' missions and current programs. Also identified were cooperating agencies that have a secondary responsibility for implementation. This responsibility primarily involves coordination and input into plan development and management, and technical assistance. Table 7-1 identifies potential lead and cooperating agencies that may be responsible for the implementation of opportunities within the study area. The determination of the status given was based on current missions of the agencies and on known programs of the agencies that may offer assistance with the opportunities. It should be stressed that public involvement and interagency coordination is critical to the successful implementation of the Patuxent River watershed plan.

7.1.1 Federal Responsibilities

The Corps of Engineers has been designated the Federal agency with a primary role in the implementation of the Patuxent River watershed plan. There is a strong need for other key Federal agencies to play a large role, albeit cooperative, in plan implementation. These agencies include the Environmental Protection Agency (EPA), the U.S. Department of Agriculture (USDA), the USFWS, the U.S. Geological Survey (USGS), the National Parks Service (NPS), the Department of Interior, the National Oceanographic and Atmospheric Administration (NOAA), and the Federal Emergency Management Agency (FEMA).

Many of the related programs of these Federal agencies are listed in Table 7-2 which shows the agencies, some of their programs, conditions for obtaining funding from these programs, the types of projects to which the program applies, and finally the application date by which to apply in order to receive program funds.

The Corps of Engineers, as identified in the plan, has authority to restore water resource problems associated with degraded fish and wildlife habitat, flood damage reduction, and recreation. To ensure that the Corps is meeting the needs of this plan, a further evaluation of the problems where the Corps is identified as a lead agency is described in the following sections of this reconnaissance report.

Proposed projects which are implementable by the Corps are listed in Table 7-3

7.1.1.a Corps Involvement in Environmental Restoration

Although all water resource problems do not fall under the Corps of Engineer's purview, many problems identified with this plan could be addressed using current Corps authorities. The Corps has the authority to investigate opportunities related to ecosystem restoration. Therefore, the Corps should conduct a feasibility study to investigate the creation and restoration of terrestrial, riparian, and aquatic habitat. Further economic, environmental, and engineering investigations must be performed to determine the most feasible solutions to the problems. As provided in the Water Resources Development Act of 1986, 50 percent of the feasibility study must be funded by the Federal government and the other 50 percent must be funded by non-Federal sponsors; based upon current policy, follow-on ecosystem restoration projects would be funded 75-percent Federal/25-percent non-Federal. The majority of the environmental restoration efforts identified thus far in the study process appear to fall under this environmental restoration authorization. However, the stormwater restoration efforts identified as necessary on Towsers Branch in the vicinity of the Archery Range could be implemented in part or in whole under the Corps Section 14 (Emergency Streambank and Shoreline Protection) of the Continuing Authorities Program. This particular project may be able to qualify for this program based upon the fact that the streambank stabilization is necessary to protect a recently exposed sewer line for Anne Arundel County.

The recommendation of Section 6 is for the Corps of Engineers to conduct feasibility studies of the potential Corps projects for restoration of fish and wildlife habitat. The Corps has authority to investigate opportunities relating to environmental restoration. Therefore, the Corps should study in more detail the creation and restoration of terrestrial, riparian, and aquatic habitat. Further economic, environmental, and engineering investigations must be performed to determine the most feasible solutions to the problems.

7.1.1.b Corps Involvement in Navigation

The Corps' potential involvement in navigation would require commercial navigation benefits to result from a project. Currently, such a situation does not appear to exist within the watershed. Most navigation issues in the Patuxent River watershed involve state or local implementation efforts. However, with the improvements anticipated in the Patuxent watershed from environmental restoration efforts, as well as implementation of the Tributary Strategy goals, water quality and habitat quality within the watershed should improve. This in turn could result in an increase or restoration of available fisheries and shellfish resources, which would then increase the demand for commercial navigation. Although there does not

Table 7-1

PATUXENT RIVER WATER RESOURCES RECONNAISSANCE STUDY

IMPLEMENTATION OF PROJECTS

Sub-Basin *Drainage* Project Name	Lead Ageney	Coordinating Ageney(s)	county
ALL			
ALL			
Habitat Improvement through Erosion Control	Corps of Engineers	Local Sponsor	ALL
Wetlands Enhancement	Corps of Engineers	State of MD, Counties	ALL
SAV Restoration	Corps of Engineers	State of MD, Counties	ALL
Patuxent River and Tributary Buffer Study	State of Maryland	Corps, Counties, Local	ALL
MULTIPLE			
Transference of USGS Gage Monitoring	USGS	Corps, Counties	ALL
Fish Blockage Removal	Corps of Engineers	State of MD, FWS	ALL
Septic System Impact Study	State	Corps of Engineers	ALL

Sub-Basin *Drainage* Project Name	Lead Ageney	Coordinating Agency(s)	County
LOWER			
Battle Creek			
Battle Creek Conservation Easement	County	State of MD, CBP	CALVERT
Cat Creek/Wainstem			
Environmental Restoration of Cat Creek	Corps of Engineers	State of MD, County	ST. MARY'S
Coxtown Creek/Mainstem			
Kings Landing Park Multi-purpose Area	Corps of Engineers	State of MD, County	CALVERT
Cuckold Creek/Mainstem			
Shoreline Erosion Abatement	Corps of Engineers	County, State of MD	ST. MARY'S
Hunting Creek			
Huntingtown Local Flood Protection	County	Corps, NRCS	CALVERT
Calvert Memorial Hospital SWM/Habitat Improv	Corps of Engineers	County, State of MD	CALVERT
Hunting Creek Environmental Protection	Corps of Engineers	State of MD, County, Local	CALVERT
Killpeck Creek/Mainstem			
Wastewater Treatment Study	County	State of MO, Corps	ST. MARY'S
Lewis Creek/Mainstem			
Environmental Restoration and SWM Upgrade	Corps of Engineers	State of MD, County	ST. MARY'S
Mainstem			
Lexington Park SWM and Wetlands Study	Corps of Engineers	State of MD, County	ST. MARY'S
Leitches Wharf Recreational Area	county	State of MD	CALVERT
Water Supply Conservation	county	State of MD, Corps	ST. MARY'S
Beach Protection for Habitat and Nesting	Corps of Engineers	State of MD, Counties, CBP	MULTIPLE
Patuxent River Erosion Study	Corps of Engineers	State of MD, County	CHARLES
Wetland Creation at Milltown Landing Property	Corps of Engineers	State of MD, SCS, County	PRINCE GEORGE'S
Benedict Flood Protection	county	Corps, State of MD	CHARLES
Nan Cove Wetlands Enhancement	Corps of Engineers	State of MD, County	CALVERT
California and Lexington Park Flood Protection	county	Corps, State of MD	ST. MARY'S
Golden Beach Habitat and SWM Improvement	Corps of Engineers	State of MD, County	ST. MARY'S
Patient Natural Resource Mgmt. Area Public Ac	County	State of MD	PRINCE GEORGE'S
Patuxent River Greenway Development	County	State of MD, Corps	CHARLES
Maxwell Hall Farm Multi-purpose Area	Corps of Engineers	State of MD, County	CHARLES

Sub-Basin ***Drainage*** Project Name	Lead Ageney	Coordinating Ageney(s)	County
Water Resources Management Plan	Counties	Corps, State of MD	MULTIPLE
Greenwell State Park	County	State of MD	ST. MARY'S
Boat Trailer Parking	County	State of MD	ST. MARY'S
Oyster Bar Realignment and Monitoring	Corps of Engineers	State of MD, CBP	MULTIPLE
Benediet Septic, SWM, and Recreational Upgrad	Corps of Engineers	County, State of MD, Local	CHARLES
Septic Tank Pollution Prevention	County	state of MD, Local	CALVERT
Patuxent River Greenway Development	County	State of MD	CACVERT
HTRW Sites at Patuxent River Naval Air Station	Department of the Navy	EPA, Corps	ST. MARY'S
Patuxent River Greenway Development	County	State of MD, Corps	ST. MARY'S
Broomes Island Park/Greenway Development	County	State of MD, Corps	CALVERT
Technical Support for Agricultural BMPs	County	State of MD, SCS, Corps	CALVERT
Broomes Island Septic System Repair	County	State of MD	CALVERT
Myrtle Point Multi-Purpose Area	Corps of Engineers	County, State of MD, CBP	ST. MARY'S
Mainstem/St. Leonard Creek			
Environmental Projects at JPPM	Corps of Engineers	State of MD, County	CALVERT
Mill Creek/Hunting Creek			
Mill Creek Flood Protection	County	Corps, NRCS	CALVERT
MULTIPLE			
Anadromous Fish Spawning Habitat Improvement	Corps of Engineers	State of MD, Counties	MULTIPLE
St. Leonard Creek			
Lusby Local Flood Protection	County	Corps of Engineers	CALVERT
Town Creek/Mainstem			
Ferry for St. Mary's and Calvert Co. to E. Shore	County	State of MD, Corps	ST. MARY'S

Sub-Basin *Drainage* Project Name	Lead Agency	Coordinating Agency(s)	County
MIDDLE			
Charles Branch			
Charles Branch Stormwater Management	Corps of Engineers	County, State of MD	PRINCE GEORGE'S
Collington Branch			
Collington Branch Regional SWM Facilities	Corps of Engineers	County, State of MD	PRINCE GEORGE'S
Hall Creek			
Hall Creek Environmental & Flood Protection	Corps of Engineers	State of MD, County	CALVERT
Mainstem			
SWM/Habitat Improvement Along Routes 2 and	Corps of Engineers	State of MD	CALVERT
Queen Anne's Bridge Multi-Purpose Area	County	State of MD, CBP	ANNE ARUNDEL
Jug Bay Environmental Enhancement	Corps of Engineers	State of MD, County	ANNE ARUNDEL
Ferry Landing Mine Multi-Purpose Area	Corps of Engineers	County, State of MD	CALVERT
Improve Degraded Habitat -Dunkirk Shopping Ce	County	Landowner	CALVERT
Arrowhead Farms Flood Protection	County	Corps, County, State of MD	ANNE ARUNDEL
Wetland Creation at M-NCPPC Billingsly Proper	Corps of Engineers	State of MD, SCS, EPA	PRINCE GEORGE'S
Septic System Failure Study	County	State of MD	PRINCE GEORGE'S
Mainstem/Large Tributaries			
Canoe Access	County	State of MD	ANNE ARUNDEL
Middle/Little Patuxent			
Laurel Flood Protection	County	Corps, State of MD	ANNE ARUNDEL
MULTIPLE			
Public Outreach and Education	County	State of MD	ANNE ARUNDEL
Greenway/Trail Opportunities Study	County	Corps, State of MD	PRINCE GEORGE'S
Park Facilities Management Plans	County		ANNE ARUNDEL
Anne Arundel County Equestrian Trails	County		ANNE ARUNDEL
Southwest Branch			
Southwest Branch Flood Protection	County	Corps, State of MD	PRINCE GEORGE'S
Southwest Branch Regional SWM Facilities	Corps of Engineers	County, State of MD	PRINCE GEORGE'S
Western/Collington Branch			
Upper Marlboro Multi-Purpose Area	Corps of Engineers	State of MD, County	PRINCE GEORGE'S

Sub-Basin *Drainage* Project Name	Lead Agency	Coordinating Agency(s)	County
UPPER			
Mainstem			
D.C. Children's Center Stream Restoration and S	Fort Meade	State of MD, County, Corps, EPA	ANNE ARUNDEL
Bear Branch			
Laurel Lakes Environmental Enhancement	Corps of Engineers	County, State of MD, City of Laurel	PRINCE GEORGE'S
Duckett Reservoir			
Nonpoint Sources Contamination	County	State of MD	MONTGOMERY
Patuxent River Reservoir Model	Chesapeake Bay Program	Corps, County, WSSC	MULTIPLE
Burtonsville Stream Restoration and SWM	County	Corps	MONTGOMERY
Damascus Shopping Center SWM Retrofit	County	Corps, SHA	MONTGOMERY
Reservoir Watershed Resource Inventory/Evaluati	Counties	State of MD, WSSC, Corps	MULTIPLE
Reservoir Watershed Public Outreach and Educat	WSSC	Counties	MULTIPLE
Community Natural Resources Education	County	Corps, WSSC, MDA	MONTGOMERY
Hammonds Branch/Middle Patuxent			
Route 216 Corridor/Hammonds Branch SAMP	Corps of Engineers	State of MD, County	HOWARD
Hawlings River			
Projects Assoc w/Hawlings R. Watershed Master	Corps of Engineers	County, WSSC, CBP, State	MONTGOMERY
Hawlings River Park Multi-Purpose Area	Corps of Engineers	MNCPPC	MONTGOMERY
James Creek			
SWM and Restoration of Tributary to James Cree	Corps of Engineers	County, State of MD	MONTGOMERY
Little Patuxent			
Beaverbrook SWM Improvement	Corps of Engineers	County, State of MD, Columbia Association	HOWARD
N. Laurel Park Area SWM and Wetland Protectio	Corps of Engineers	County, State of MD, City of Laurel	HOWARD
Oxbow Natural Heritage Area	County	State of MD	ANNE ARUNDEL
Little Patuxent River SWM	Corps of Engineers	County, State of MD	HOWARD
Little Patuxent Stream and Habitat Restoration	Corps of Engineers	State of MD, County	HOWARD
Plum Tree Branch Stream Restoration	Corps of Engineers	State of MD, County, Columbia Association	HOWARD
Wilde Lake Watershed	Corps of Engineers	State of MD, County, Columbia Association	HOWARD
Russett Streambank Protection /Restoration	Corps of Engineers	County, State of MD, Local	ANNE ARUNDEL
Dunloggin SWM Improvement	Corps of Engineers	County, State of MD, Columbia Association	HOWARD
Piney Orchard Streambank Protection /Restoratio	Corps of Engineers	County, State of MD, Local	ANNE ARUNDEL

Sub-Basin ***Drainage*** Project Name	Lead Agency	Coordinating Agency(s)	County
Davis Avenue SWM	Corps of Engineers	County, State of MD, City of Laurel	HOWARD
Little Patuxent/Mainstem			
Route 1 Corridor Env. Infrastructure Study	Corps of Engineers	County, State of MD	HOWARD
Mainstem			
Duckett Dam Emergency Spillway	Counties	Corps, WSSC	MULTIPLE
Middle Patuxent			
Howard County Environmental Protection Area	Corps of Engineers	County, State of MD, Columbia Assoc.	HOWARD
Towsers Branch			
Towsers Branch	Corps of Engineers	County, State of MD	ANNE ARUNDEL

Implementation Alternatives

Table 7-2

Agency	Program Name	Funding Available	Conditions to the Funding	Types of Projects	Appl. Date
FEDERAL					
Corps	General Investigation (GI) Program	50/50 Federal/non-Federal cost share for a Feasibility Study; 75/25 Federal/non-Federal cost share for construction	25% of Feasibility Study must be in cash; construction requires non-Federal sponsor to provide lands, easements, etc., plus at least 5% cash, up to 25% of total construction cost	Environmental. restoration, habitat creation, flood damage reduction	N/A
	Section 22/Planning Assistance to States	50/50 cost share, for a study, with non-Federal sponsor	Must be 50% cash from non-Federal sponsor	Any type of water-related study; does not lead to construction	N/A
	Section 14/Emergency Streambank and Shoreline Protection	75/25 cost share with non-Federal sponsor	Federal cost < $500k	Emergency construction projects to protect endangered roadways, bridge approaches, public works, and other public structures	N/A
	1135 Program	75/25 cost share with non-Federal sponsor	25% non-Federal typically, total project < $5M	Modification to an existing Corps project, to restore fish and wildlife habitat adversely affected	N/A
EPA	Section 319 Non-Point Source Program	Based on state needs	Approved State nonpoint source management programs only	Non-point source pollution management programs/projects	August 1st
	Pollution Prevention Incentives for States (PPIS)	50/50 cost share, between $50k and $80k; annual national budget is $5.9M, $520k for Region III	Available only to state environmental regulation agency (MDE or MD-DNR) for pollution prevention and/or source reduction	State pollution prevention programs; Federal and state communication; development of new pollution technology	December, 1994
	Wetlands Protection - State Development Grants	75/25 cost share; grants on a competitive basis; $800k program	State agencies or Federally-recognized Indian Tribes	Development of new wetland protection programs, or refinement of existing programs -- MUST clearly demonstrate an increased ability to protect state wetlands.	December
FEMA	Flood Plain Management Services (FPMS) Program	100% Federal cost or 100% cost recovery	100% Federal cost for services provided to state, regional or local governments, Indian Tribes and other non-Federal public agencies; 100% cost recovery for services provided to the private sector	Technical services (flood formation and timing, flood stages, flood water velocities, etc.) and general planning guidance (flood plain deliniation, dam break analysis, flood warning studies, etc.)	None
USDA					
(CFSA)	Agricultural Conservation Program (ACP)	75/25 cost share; available funds vary from county to county; $930k for FY95.	Agricultural producers (owners, operators) with eligible land; funding limited	Implementation of agricultural BMPs: control soil erosion, reduce agricultural non-point pollution, improve forest lands.	Federal Fiscal Cycle
(CFSA)	Conservation Reserve Program (CRP)	Land rental payments; availability depends on FY budget allocations	Agricultural landowners with highly erodible soils	Payments for 10 years to keep land out of crop production; last sign-up was in 1992.	TBA
(CFSA)	Forestry Incentive Program (FIP)	65/35 cost share; based on need	Private, non-industrial woodland landowners in St. Mary's county	Funds to be used by agricultural landowners to produce timber, provide shelter for wildlife, conserve water, prevent soil erosion, and enhance the natural environment	Federal Fiscal Cycle
(NRCS)	Wetland Reserve Program (PL-99-198)	Direct payments for specified use; easement agreement	Any person or entity owning private cropland	Projects to restore and protect farmed wetlands or converted wetlands and eligible adjacent lands	Annual

Agency	Program Name	Funding Available	Conditions to the Funding	Types of Projects	Appl. Date
FEDERAL					
(NRCS)	Water Bank Program (Pl-91-599)	Direct payments for specified use	Land owners and operators of specified types or wetlands in designated important migratory waterfowl nesting, breeding, and feeding areas	Wetland conservation and improvements for waterfowl	Annual
(USFS)	Stewardship Incentive Program (SIP)	65/35 cost share; based on need	Private, non-industrial landowners	Funds to be used by NIPF owners to produce timber, provide shelter for wildlife, conserve water, prevent soil erosion, and enhance the natural environment	Federal Fiscal Cycle
(USFS)	Forest Legacy Program	Based on need	Available to private landowners, land trusts, and other appropriate entities; States must have a completed "Assessment of Need"	Funds to protect, through conservation easements, environmentally important private forest land threatened with conversion to non-forest uses	Federal Fiscal Cycle
USFWS	Partners for Wildlife	Funding as available maximum of $10k; no minimum match required; Technical assistance also available.	Non-Federal agencies and private landowners	Habitat restoration on private land holdings, generally, but not limited to, wetlands, riparian, and forested areas.	None
	National Coastal Wetlands Conservation Grant Program	Generally 50/50 cost share (can be 75/25 in some other states). $8 M in FY95.	Available to coastal States through DNR. Must coordinate with local USFWS office. Required long-term site protection (maintenance).	Acquisition and restoration of coastal wetlands.	Due Oct. 1 by MD-DNR
	North American Wetland Conservation Act Grant Program	50/50 cost share (minimum); $15 M annual grant program		Conservation, enhancement, restoration, management, and acquisition of wetlands for migratory birds and other fish and wildlife	Set yearly (6 mos. prior to action)
	FWS Challenge Cost Share Program	50/50 cost share (minimum); may include in-kind services; $390k in FY95; small projects	Federal, State, Local governments, private landowners; must coordinate with local USFWS office.	Small habitat restoration, conservation, and/or education projects (wetland projects preferred); goal is wetland conservation and public use of fish and wildlife resources	Due Oct. 1
USGS	Federal/State Cooperative Program	50/50 cost share; range $10k to $200k	State/Local agencies; based on need	Projects to address water, geologic, and/or mapping concerns	Fall of each year
NOAA	Coastal Zone Management & SAMPs	$5M program; grant funding	States with approved CZM plans	Facilitates state action for wetlands and SAV beds, SAMPs, public access, coastal hazards, marine debris	April
DOI-NBS	State Partnership Program	Up to $150k per project	State natural resource agencies	Projects to link State research, inventory and monitoring, information management, and biological information with the NBS	March
	Success with Species at Risk Initiative	Up to $100k per project	Scientists, conservationists, land managers	Projects to generate information and alternatives that lead to the stabilization of declining population of sensitive species	March
	Land and Water Conservation Fund (Federal)	Varies	NPS, USFWS	Acquisition of national recreation lands: national parks, seashores, lakeshores, forest, wild & scenic rivers, trails, national recreation areas, historic areas, wildlife areas, natural areas, wilderness areas	N/A

Agency	Program Name	Funding Available	Conditions to the Funding	Types of Projects	Appl. Date
FEDERAL					
	Challenge Cost-Share Program	50/50 cost share; up to $40,000	Any non-profit org., State, or local government agency	Projects on or off park lands in support of NPS goals: National Trails, Cultural Resources, Natural Resources, or Recreation.	Varies
FHA	FHA Environmental Enhancement Research Fund	$25k	Federal Agencies	Projects dealing with urban runoff or highway impacts on wetlands; habitat restoration and wetland banking projects also possible	July 1

Agency	Program Name	Funding Available	Conditions to the Funding	Types of Projects	Appl. Date
STATE					
	Maryland Environmental Trust Land Trust Specific Grants	Grant program (grants range from $1,000 to $5,000), and revolving loan fund	Must be certified Land Trust	Support of land trusts in their administrative tasks and land acquisition activities	July
	Maryland Environmental Trust Keep Maryland Beautiful Program	Two different grant programs (grants range from $500 to $1,000)	N/A	Education and beautification projects	July
MDE	Small Creek and Estuary Restoration Cost-Share Program	Up to 50% cost-share (75% in special circumstances)	Cannot be combined with any other State funding; may include in-kind services; eligibility based on severity of water quality problem, practicality of solution, demonstrated water quality and cost benefit, applicants resources, and readiness to proceed	Stream channel and streambank restoration; wetland creation; vegetative buffers/riparian zone revegetation/reforestation; lake restoration or dredging with watershed improvements; passive AMD treatment; feasibility studies; monitoring	Applications accepted any time for following year budget (up to 18 mo. turn-around)
	Biological Nutrient Removal (BNR)	50/50 cost share (MDE/WWTP)	WWTPs operating at 500k gallons/day	WWTP upgrades for biological removal of nitrogen and phosphorous	Applications accepted any time for following year budget (up to 18 mo. turn-around)
	Water Quality Revolving Loan Fund	Loans for up to 100% of project cost for up to 20-year payback	Must be local government; project must be on the Priority List and in the County Water and Sewer Plan	WWTP upgrades; BNR; pumping stations, force mains, interceptors; collection systems; sludge handling and disposal facilities; storm sewers; nonpoint source BMPs; landfill leachate conveyance and treatment; UST replacement or removal	Applications accepted any time for following year budget (up to 18 mo. turn-around)

Agency	Program Name	Funding Available	Conditions to the Funding	Types of Projects	Appl. Date
STATE					
	Supplemental Assistance Program	Up to 100% of construction costs; FY96: $2.0 M	Counties and incorporated municipalities only; eligibility based on public health or water quality benefit, financial capacity of the applicant, and readiness to proceed	Wastewater facilities, as a supplement to Water Quality Loan funds	Applications accepted any time for following year budget (up to 18 mo. turn-around)
	Water Supply Financial Assistance Program	30-year loan of up to $500k or 87.5% of costs, whichever is less	Publicly-owned water supply systems with insufficient or limited financial capability; eligibility based on project need, financial capability, previous efforts, and population; projects must be in County Water and Sewer Plan	Water supply systems: wells, treatment facilities, distribution systems	Applications accepted any time for following year budget (up to 18 mo. turn-around)
	Stormwater Pollution Control Cost-Share Program	Grant of up to $500k, or 75% matching. FY96: $1.25 M	Counties and incorporated municipalities	Wet extended detention ponds; retention ponds; shallow marshes; water quality inlets; peat-sand filters, other innovative stormwater management practices.	Applications accepted any time for following year budget (up to 18 mo. turn-around)
DNR	Shore Erosion Control Program	50/50 cost share for projects on private lands; 75/25 cost share for public lands		Nonstructural (vegetative) shoreline stabilization projects, including fringe marsh creation or portection with stone containment groins, sills, or breakwaters	State fiscal cycle
SHA	Intermodal Surface Transportation Efficiency Act (ISTEA) funds	50/50 cost share; $5.7 - 6.5 M per year	MOA; matches could include right-of-way donations, engineering, maintenance, volunteer labor	Creation of bike paths, greenways, wetlands, or other environmentally positive, transportation-related projects	N/A

Agency	Program Name	Funding Available	Conditions to the Funding	Types of Projects	Appl. Date
COUNTY					
	EPA 319 funds	See above under EPA	See above under EPA	See above under EPA	See above under EPA
	NPDES Discretionary Fund	Varies from county to county; range $	Projects must be stormwater related	Stormwater-related projects: retrofits, wetlands creation, detention ponds, etc.	
	Budgeted expenditures				

Agency	Program Name	Funding Available	Conditions to the Funding	Types of Projects	Appl. Date
PRIVATE/ NON-PROFIT					
	Abell Foundation, Inc.	$5M program; Capital Grants, Endowment Grants, Seed Money Grants, and Planning Grants	Non-profit entities	Public education and outreach projects; stream restoration projects; ecological conservation projects	6 times per year
	Chesapeake Bay Trust Financial Support Grants	$5k to $50k	Local governments; specific projects only	Education and outreach projects; small habitat restoration projects	Quarterly
	National Fish & Wildlife Foundation Grants Program	Average $45k		Wetland conservation, conservation education and leadership training, fisheries initiative, neotropical migratory bird conservation, fisheries and wildlife assessments, and wildlife and habitat initiatives	April 15 and August 15
	David and Lucille Packard Foundation	Varies	Local projects	Greenways and trails	N/A

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Table 7-3

POTENTIAL CORPS IMPLEMENTATION

Project Name	Project Code	Map ID	Cost	Benefits		
				Acres	Feet	Stream Miles
SAV Restoration	ENV	AL2	$44,000,000	2,000.0		
Fish Blockage Removal	ENV	AL5	$3,000,000			100.0
Habitat Improvement through Erosion Control	ENV**	AL1	$144,000,000			200.0
Wetlands Enhancement	WET	AL3	$500,000	50.0		
Piney Orchard Streambank Protection /Restoration	ENV	AA5	$150,000	100.0		
Jug Bay Environmental Enhancement	ENV	AA13	$150,000	10.0		
Towsers Branch	ENV**	AA3	$100,000		2,000.0	
Russett Streambank Protection /Restoration	ENV**	AA6	$750,000	700.0		
Hunting Creek Environmental Protection	ENV	CA12	$50,000	3,200.0		
Hall Creek Environmental & Flood Protection	ENV	CA11	$50,000	3,840.0		
Calvert Memorial Hospital SWM/Habitat Improvement	ENV	CA5	$260,000	50.2		
SWM/Habitat Improvement Along Routes 2 and 4	ENV	CA4	$40,000	1.0		2.0
Environmental Projects at JPPM	ENV**	CA6	$785,000			2.5
Ferry Landing Mine Multi-Purpose Area	ENV**	CA2	$500,000	300.0		
Kings Landing Park Multi-Purpose Area	ENV**	CA1	$100,000	1,200.0		
Nan Cove Wetlands Enhancement	WET	CA8	$295,000	7.3	100.0	
Patuxent River Erosion Study	ENV	CH5	$350,000			5.0
Benedict Septic, SWM, and Recreational Upgrades	ENV**	CH2	$1,400,000	150.0		
Maxwell Hall Farm Multi-Purpose Area	ENV**	CH1	$2,000,000	640.0		
Dunloggin SWM Improvement	ENV	HO11	$100,000	100.0		
Wilde Lake Watershed	ENV	HO5	$120,000			0.8
Little Patuxent River SWM	ENV	HO4	$150,000			1.0
Little Patuxent Stream and Habitat Restoration	ENV	HO3	$50,000			0.5
Route 216 Corridor/Hammonds Branch SAMP	ENV	HO7	$50,000	100.0		
Plum Tree Branch Stream Restoration	ENV	HO9	$500,000	100.0		
Beaverbrook SWM Improvement	ENV	HO10	$100,000	100.0		

NOTE: a double asterisk in the Project Code cell means that the project is multi-purpose

Project Name	Project Code	Map ID	Cost	Benefits		
				Acres	Feet	Stream Miles
N. Laurel Park Area SWM and Wetland Protection	ENV	HO2	$150,000	44.0		
Davis Avenue SWM	ENV	HO6	$100,000	44.0		
Route 1 Corridor Env. Infrastructure Study	ENV**	HO8	$100,000	6,400.0		
Howard County Environmental Protection Area	REC	HO1	$400,000	1,000.0		
SWM and Restoration of Tributary to James Creek	ENV	MO2	$300,000	136.0		
Projects Assoc w/Hawlings R. Watershed Master Plan	ENV	MO5	$1,500,000	20,000.0		
Hawlings River Park Multi-Purpose Area	ENV**	MO1	$500,000	50.0		
Oyster Bar Realignment and Monitoring	ENV	MU9	$1,000,000	20.0		
Beach Protection for Habitat and Nesting	ENV	MU7	$350,000	50.0		
Anadromous Fish Spawning Habitat Improvement	ENV	MU6	$5,000,000			50.0
Wetland Creation at M-NCPPC Billingsly Property	ENV	PG4	$100,000	2.5		
Collington Branch Regional SWM Facilities	ENV	PG7	$14,000,000	1,600.0		
Charles Branch Stormwater Management	ENV	PG5	$200,000	5.0		
Wetland Creation at Milltown Landing Property	ENV	PG3	$80,000	2.0		
Southwest Branch Regional SWM Facilities	ENV	PG2	$400,000	1,600.0		
Laurel Lakes Environmental Enhancement	ENV	PG8	$1,000,000	1,363.0		
Upper Marlboro Multi-Purpose Area	ENV**	PG1	$525,000	30,000.0		
Lexington Park SWM and Wetlands Study	ENV	ST11	$50,000	640.0		
Shoreline Erosion Abatement	ENV	ST14	$200,000	20.0		
Myrtle Point Multi-Purpose Area	ENV	ST4	$4,500,000	200.0		
Environmental Restoration of Cat Creek	ENV**	ST5	$86,000			1.3
Golden Beach Habitat and SWM Improvement	ENV**	ST8	$61,000	1,200.0		
Environmental Restoration and SWM Upgrade	ENV**	ST6	$284,000		120.0	1.0
	Grand Total:		**$230,436,000**	**77025.03 Acres**	**2220 Feet**	**364 Stream Miles**

NOTE: a double asterisk in the Project Code cell means that the project is multi-purpose

appear to be a current demand, with the improved health of the watershed this demand may reappear.

7.1.1.c Corps Involvement in Flood Damage Reduction

The Corps' potential involvement in the flood damage reduction measures are primarily limited to technical and planning assistance, based on the evaluations performed during the reconnaissance study. While the Corps does have authority to construct small local flood protection projects under the Section 205 authority of the Flood Control Act of 1948, none of the areas identified as flood prone appear to have economic feasibility for structural flood protection, based upon current conditions and analysis.

Other avenues for Corps assistance lie in the technical assistance realm. Section 206 of the Flood Control Act of 1960 provides authority for the Corps of Engineers to use its technical expertise in floodplain management to help local agencies and residents. The objective of the Flood Plain Management Services (FPMS) program is to support comprehensive floodplain management planning with technical services and planning guidance at all appropriate governmental levels, and thereby to encourage and guide local officials toward prudent use of the nation's floodplains for the benefit of the national economy and welfare. Under this program, the Corps can provide planning assistance and guidance for development of floodplain regulations, flood warning and preparedness procedures, floodproofing measures, and permanent evacuation and relocation procedures. Implementation of activities under this program, which is 100 percent federally funded, would be at the specific request of the local or state governmental entity.

A second avenue for Corps of Engineers' technical assistance is the Planning Assistance to States program, which was authorized by Section 22 of the Water Resources Development Act of 1974. This authority allows the Corps to assist the states in the preparation of comprehensive plans for the development, utilization, and conservation of water and related land resources. The program can encompass many types of studies, including water supply, water quality, water conservation, hydropower development, flood control, erosion, and navigation. Activities under this program are cost shared on a 50-percent Federal/50-percent non-Federal basis, and do not lead to Corps construction projects. Since the FPMS program has more favorable cost-sharing for local communities than the Section 22 program, planning assistance for flood damage reduction measures should be conducted under the FPMS program, subject to the availability of funding.

7.1.2 State Responsibilities

As can be seen in Table 7-1, state agencies play a major role in the implementation of the water resources plan. As partners in the Corps of Engineers construction process, the operation and maintenance of federally implemented projects are the responsibility of the non-Federal sponsors, which are often state agencies. Based upon current laws regarding implementation of Federal projects, non-Federal sponsors must contribute a minimum of 25 percent of the total construction cost. Also as part of their contribution toward implementation

of Federal projects, these non-Federal sponsors would provide all lands, easements, rights-of-ways, relocations, and demolition required for construction of the projects. These costs are considered as part of the 25 percent non-Federal share.

Beyond their role as partners in the implementation of Federal projects as part of the watershed plan, there are several state agencies with a primary role in the implementation of portions of the watershed plan: MDA, MDE, MDDNR, MOP, and SHA. The recommendations of this plan are for state agencies to continue to coordinate their individual efforts with the various Federal and local programs, participate in the Federal programs where feasible, and work to merge these different programs so priority sites in the study area can be restored cost-effectively.

7.1.3 Local Responsibilities

Many of the problems that were identified during the reconnaissance study are outside the authority of the Federal government. In addition to being potential non-Federal sponsors for the Corps' implementation process as described under state responsibilities, many of the local entities are responsible for land use, zoning, and stormwater management. Many of the solutions recommended under the water resources plan involve these issues as well as the modification of policies, regulations, and ordinances.

A recommendation of this plan is to take advantages of the programs listed in Table 7-2 to reduce cost burdens on the local agencies. In addition, local counties, cities, conservation districts, schools, universities, and private citizens should become active in these programs and potential projects to ensure local needs are being met. It is these local groups and organizations whose efforts will be vital in the implementation of the water resources plan. Ultimately, the success of the plan lies with these groups.

7.2 THE CORPS FEASIBILITY PHASE

7.2.1 Purpose of the Feasibility Phase

All water resource studies undertaken by the Corps of Engineers are conducted in two planning phases - a reconnaissance phase and a feasibility phase, and two construction phases. The two phase planning study procedure is designed to encourage non-Federal participation throughout the study process and to increase the certainty that planned projects will be implemented.

The purposes of the feasibility phase areas follows:

. To conduct detailed engineering, economic, environmental, and cultural investigations to support plan formulation and evaluation.

. To identify the National Economic Development (NED) plan (if appropriate).

To identify environmental restoration projects that are linked to existing Corps projects, produce high priority environmental outputs, and are incrementally justified.

- To comply with National Environmental Policy Act (NEPA) requirements by preparing an environmental impact statement.
- To estimate rests and benefits to a level of detail suitable for project justification, if applicable.
- To determine the appropriate construction cost-sharing arrangements and obtain non-Federal support, as necessary.
- To prepare appropriate documentation for Federal project authorization.
- To recommend favorable projects for authorization and construction, if appropriate.

7.2.2 Justification for Proceeding into Feasibiltiy Plans

The justification for ecosystem restoration is based on two factors: (1) the significance of the resource to be restored, and (2) Federal interest, including linkages to Corps actions.

The overall significance of the aquatic resources in the study area is well documented. The use of the existing waterways for industry, recreation, water supply, and commerce make them significant resources in the study area. Most of the communities originally developed along the Patuxent River and its tributaries to make use of them for the transportation of goods and people. The river continues to provide a means of transportation as well as recreation and commerce.

The significance of the fish and wildlife resources of the Patuxent River watershed is widely recognized by the institutional, public, and technical criteria within the study area and, in a larger regional context, as a tributary to the Chesapeake Bay.

Significance of resources is broken down into three categories: institutional, public, and technical. Each of these is described in the following segments.

7.2.2.a Institutional Significance:

Institutional significance of an ecological, cultural, or aesthetic resource means that the importance of that resource is acknowledged in laws, adopted plans, and other policy statements of public agencies or private groups. Institutional recognition of a resource is the most straightforward and easily defensible criterion for significance. Sources of institutional recognition include public laws, executive orders, rules and regulations, treaties, and other policy statements of the Federal government. A number of Federal, state, and local laws and programs address ecosystem restoration in the study area. The purpose of this section is to introduce these sources and discuss their implications for feasibility within the study area.

Federal:

From an institutional standpoint, the significance of wetland functions is nationally recognized, and wetlands are now protected by various executive orders and Federal, state, and local laws and regulations. In addition, wetland and stream habitats support a number of nationally significant species such as anadromous fishes and waterfowl. Numerous Federal laws,

regulations, and executive orders recognize the significance of aquatic, bottomland, and wetland habitats and their related species. Some of these include the following:

- Fish and Wildlife Coordination Act of 1958
- National Environmental Policy Act of 1969
- Executive Order 11990 Protection of Wetlands (1977)
- Emergency Wetlands Resources Act of 1986
- Watershed Protection and Flood Prevention Act (as amended, 1986)
- Federal Water Pollution Control Act of 1987 (Clean Water Act)
- Land and Water Conservation Act of 1987
- Coastal Zone Management Act of 1990
- President's Initiative - Protecting America's Wetlands: A Fair, Flexible and Effective Approach, August 24, 1993
- Executive Order on Recreational Fisheries (1993)

Many Federal programs address needs of the Patuxent River study area. A list of applicable programs is given below, and a synopsis of each program is found in Appendix A.

- National Flood Insurance Program
- Conservation Reserve Program
- Wetlands Reserve Program
- Forest Stewardship Program
- Forestry Incentive Program
- Stewardship Incentive Program
- Agricultural Conservation Program
- Rural Clean Water Program (RCWP)
- Resource Conservation and Development Program
- Watershed Protection and Flood Prevention Program (Small Watershed PL 566 Program)
- Coastal Zone Management Program: Special Area Management Plans
- Coastal Non-Point Pollution Control Program
- Section 1135 Program
- National Coastal Wetlands Conservation Grant Program
- Private Lands Habitat Assistance and Restoration Program
- The Chesapeake Bay Program
- Section 319 Non-Point Source Program
- Coastal America: A Partnership for Action
- Land and Water Conservation Fund
- National Wetlands Priority Conservation Plan
- North American Waterfowl Management Plan
- Intermodal Surface Transportation Efficiency Act (ISTEA) Enhancement Program

An institutional document pertinent to this study is the Agreement of Federal Agencies on Ecosystem Management in the Chesapeake Bay, signed July 14, 1994. The agreement was executed by 13 Federal agencies including the Corps of Engineers. These agencies agreed to cooperate in the Chesapeake Bay Program and to engage in partnerships to achieve ecosystem-based restoration. Specifically, the Corps agreed to take the lead to fully implement all habitat restoration authorities to improve the condition of aquatic, riparian, and upland fish and wildlife habitat. Since the Patuxent River is a direct tributary to the Chesapeake Bay, it is important that this agreement extend to all reaches to ensure full implementation.

State:

The State of Maryland is very active in issues relating to the Chesapeake Bay and the Patuxent River. There is also a broad range of regulations that reflect the significance of aquatic, bottomland, and wetland ecosystems in the study area at the state and local level. Some of these include the following:

- State of Maryland Critical Areas Law (1989)
- State of Maryland Title 8, Subtitle 05, Chapter 9, Wetlands Regulations (1990)
- State of Maryland Non-Tidal Wetlands Protection Act (1990)
- State of Maryland Title 8, Subtitle 05, Chapter 3, Construction on Non-Tidal Waters and Floodplains (1991)
- Chesapeake Bay Critical Area Act
- Forest Conservation Act
- Nontidal Wetlands Act
- Reforestation Act
- Economic Growth, Resource Protection, and Planning Act
- Patuxent River Commission
- Tributary Strategy for Nutrient Reduction in Maryland's Patuxent Watershed
- Local Zoning Ordinances
- Buffer Incentive Program
- Forest Harvest Guidelines
- Woodland Incentive Program
- Greenways Program
- Open Space Program
- Tree-Mendous Maryland
- Maryland Environmental Trust
- Forest Conservation and Management Program
- Reforestation/Timber Stand Improvement Tax Deduction Program
- Agricultural Use Assessment
- Forest Legacy Program
- National Estuarine Demonstration Projects

Maryland's participation in the Chesapeake Bay Partnership Agreement, and the resulting Chesapeake Bay Program (CBP), is evidence of the importance the State attaches to the

restoration of the living resources of the Chesapeake Bay. The CBP is a multi-governmental partnership committed to restoring the health and vitality of the Chesapeake Bay watershed and its tributaries. As the CBP has grown and evolved, its efforts have "moved upstream, " and the health and restoration of the individual tributaries have become important focus areas. Because the CBP is concerned with the overall restoration of the entire watershed, it is only where and when necessary that it focuses in a direct or specific manner on any particular tributary. Consequently, water quality, land-use activities and their impacts in tributaries such as the Patuxent are of concern to the CBP. This agreement has also resulted in the development of the State Tributary Strategies which has as their goal at a 40 percent reduction in the amount of nitrogen and phosphorous entering the Bay by the year 2000. More information on the connection between the Chesapeake Bay Program and this study can be seen in Appendix B.

The Patuxent River Commission was founded 15 years ago to address the many problems facing the Patuxent River. The commission was established to facilitate and catalyze the improved health of the Patuxent River watershed. To accomplish this mission, the commission developed an Action Agenda to serve as a guide for the activities of state agencies, local governments, private interests, and citizens with responsibilities to manage, protect, and restore the resources of the watershed. More recently, the commission has been working to establish a plan to meet the 40 percent nutrient reduction goal for the river, and to tailor the draft Patuxent Tributary Strategy to reflect the varying and changing conditions in different geographic parts of the watershed.

The Patuxent River Tributary Strategy Team is a collaborative effort by state and local governments, a workgroup from the agricultural community, and participants in public meetings. The Maryland Tributary Strategy Implementation Teams were created in response to the regional Chesapeake Bay Agreement and the 1993 Partnership Agreement between Governor Schaefer, the elected officials of the 23 Maryland counties, and the Mayor of Baltimore. The focus of these teams is the Chesapeake Bay Program's nutrient reduction goals, as set forth in the 1987 Chesapeake Bay Agreement. The Patuxent River Tributary Strategy Team participants, including MDE, MD-DNR, MDA, MOP, the Governor's Office, and the University of Maryland, are using a comprehensive approach to reduce nutrient pollution in the watershed. The goal is to achieve 40 percent nutrient reduction in the Patuxent River, as one of Maryland's 10 Chesapeake Bay tributaries, by the year 2000. This 40 percent reduction applies to point and non-point sources of nitrogen and phosphorous. Many of the recommended alternatives have additional purposes such as forested buffer improvement, non-structural shore erosion control, forest and wetlands conservation, and wildlife habitat improvement.

Three areas within the Patuxent River watershed -- Battle Creek Cypress Swamp, Killpeck/Trent Hall Creeks, and Jug Bay have been designated "Areas of Critical State Concern" as of January 1981. These areas have been identified for protection by the State of Maryland as reserves for rare and endangered community types. Each site, described in detail in the Annex, is considered to be a unique and valuable environmental asset to the state.

There is an effort to purchase additional acreage for the Battle Creek Cypress Swamp area through the Forest Legacy Program.

Jug Bay is part of the Chesapeake Bay National Estuarine Research Reserve program in Maryland. Section 315 of the Federal Coastal Zone Management Act of 1972 established the National Estuarine Reserve Research System as a Federal/State cooperative venture to develop and manage estuarine research reserves that are representative of the estuarine types found in the region. The purpose of this reserve is to establish and manage the areas within the boundaries as natural field laboratories, and to develop a coordinated program of research and education for the reserve (NOAA, 1990).

The 110-mile-long Patuxent River has also been designated as one of the five original "Maryland State Scenic Rivers" by the Maryland General Assembly. This designation is to preserve and protect the natural values of the river. U.S. Senator Barbara Mikulski also won designation of the Patuxent River as a "National Estuarine Demonstration Project, " ensuring additional support for new research opportunities in watershed restoration.

Local/Regional:

Several national non-profit organizations operate programs within the study area. These programs are outlined in Appendix A. The charters, by-laws, and formal policy statements from private groups also indicate intense interest from citizens. Some of these groups are listed below:

- Alliance for the Chesapeake Bay
- American Rivers
- Ducks Unlimited
- The Nature Conservancy
- Waterfowl USA
- Chesapeake Bay Foundation
- Alliance for the Chesapeake Bay
- Save Our Streams
- Trust for the Public Lands

These lists demonstrate the substantial Federal, state, local, and private significance placed on the restoration, enhancement, and preservation of these types of habitats in this watershed.

7.2.2.b. Public Significance:

Significance based on public recognition means that some segment of the general public recognizes the importance of an ecological resource. Public recognition of the significance of the resources within the study area is demonstrated in the formation of local citizen groups and in the willingness of the public to be involved in activities designed to restore or enhance the environmental resources. Non-profit organizations such as Save Our Streams have organized programs such as Project Heartbeat, an effort that educates citizens on ways to protect and

improve water sources within the study area. Through this program, volunteers have participated in activities such as stream monitoring and water sampling. In addition, each year numerous clubs and organizations working through the Adopt-A-Stream program of Save Our Streams remove trash from the various streams within the study area. These efforts have been fully supported by the various political jurisdictions in which they have occurred.

The efforts of municipalities to establish linear parks and greenways haven also involved many local citizens and organizations. Many stream valleys have already been incorporated into the county park systems for low-intensive recreational facilities or have been preserved as natural areas. However, types of greenways that have been established in the upper portion of the watershed are still needed in the lower watershed. Local and state governments have modfied land use practices within their jurisdictions, enacted mandatory dedication laws, and developed environmental restoration plans that indicate the level of significance those within the study area place on ecological resources.

Watershed citizens participate in a number of volunteer groups to evaluate water quality and biological conditions in various parts of the watershed: Citizens, under the guidance of USFWS and the Chesapeake Bay Foundation, are involved in SAV monitoring at numerous random sites in the estuarine portion of the Patuxent. Howard County has a citizens monitoring program for benthic macroinvertebrates at 20-25 stations in the county. Sampling at these locations is done on an annual basis, under the guidance of the Department of Recreation and Parks.

Local governments, too, have taken an interest in the Patuxent watershed. Locally sponsored flood warning programs in Prince George's and Howard Counties measure streamflow. Montgomery County Departments of Environmental Protection and Parks have been collecting biological and habitat data in the Upper Patuxent watershed. These county agencies are currently analyzing the data collected through these efforts.

7.2.2.c. Technical Significance

Significance based on technical recognition means that the importance of an ecological resource is based on scientific or technical knowledge or critical resources characteristics. Scarcity, a measure of a resource's relative abundance within a specified area, is one of the many criteria that may assist in determining technical significance. Within the study area and the region, stable, natural stream systems, lush riparian corridors, and well-established floodplains and wetlands are rapidly becoming scarce.

A second criterion used in the establishment of technical significance is resiliency, a measure of a resource's ability to recover from, or adapt to, change that occurs as a result of environmental stresses. Although in nature, wetlands, floodplains, and stream systems are resilient, the scarcity of these resources coupled with development has placed critical stress on their ability to recover. The result has been the deterioration of stream systems, riparian corridors, floodplains, and wetlands.

A third criterion used in the establishment of technical significance is tolerance. Tolerance is the ability of resources to maintain integrity of form and function when subjected to less than acceptable conditions. The historic communities within the study area contained many different kinds of organisms varying from tolerant to intolerant. The environmental stress the study area has undergone has resulted in a loss of habitat and a reduction in the number of tolerant organisms, resulting in less biodiversity.

These concepts of scarcity, resiliency, and tolerance determine the significance of ecological resources. These remaining resources must be restored in order to produce a functioning ecosystem for the native, migratory, and transient fish and wildlife populations.

The concepts of scarcity and significance also play important roles in determining whether or not it is in the Federal interest to undertake a project, and what priority a particular project will have. Recommendations for Corps environmental restoration actions are based on the scarcity and the significance of the environmental resources impacted, as well as on the feasibility of restoring or creating the affected resource.

The scientific community has documented the importance of the restoration of wetlands, streams, and riparian corridors through research conducted to develop the goals of the Chesapeake Bay Agreement. There have also been numerous reports by the CBP on the Patuxent River and water quality, habitat, status of living resources, and development throughout the Bay watershed that have specifically mentioned the Patuxent River. It is of ongoing value to the study of the Chesapeake Bay watershed. The State of Maryland, through various programs under MDE and MD-DNR, has also produced several reports on the Patuxent River, its water quality, and its wildlife and fish habitats. The river has also been the site for numerous theses and dissertations by graduate students of the University of Maryland and other colleges and universities. Each of these studies demonstrates the importance and value of wetlands, streams, and aquatic habitats to the scientific community as well as to the wildlife community.

MDE, working with USGS and the CBP, has done extensive modeling of nutrient flow and of water quality and flow in the Patuxent River. The Patuxent River model research from 1984 to 1987 is the basis for the 40 percent nutrient reduction goals established by the 1987 Chesapeake Bay Agreement. The model is also used as a model for the entire Chesapeake Bay, and information obtained from this model has wide-reaching applicability throughout the Bay.

In addition to the monitoring by the CBP and the State of Maryland, the Patuxent River provides a location for ongoing wildlife, wetland, and estuarine research by various groups. There are two biological laboratories on the mainstem of the river: (1) the Center for Environmental and Estuarine Studies - Chesapeake Biological Laboratory and (2) the Academy of Natural Sciences - Benedict Estuarine Research Laboratory. There are also three sanctuaries on the mainstem: Merkle Wildlife Sanctuary, Jug Bay Wetlands Sanctuary, and the Patuxent Wildlife Research Center. The number and variety of scientific studies going on in

the watershed make the Patuxent River an invaluable technical resource and show irrefutably the importance of protecting and enhancing the natural resources of the watershed.

7.2.2.d Corps of Engineers Environmental Impacts in the Patuxent River Watershed:

Dredging at Swan Point Bar: A channel 9 feet deep and 132 feet wide was dredged in 1891. Approximate length of this channel is estimated at 1,500 feet, with an estimated impact area of 4.5

Bristol Bar Navigation Dredging:

The Bristol Bar Navigation Project was completed in 1889. Approximate length of this project was 1,000 feet, covering approximately 3 acres. Initial dredging was done to 12 feet; however, the project depth downstream of Bristol was modified to 9 feet.

The Corps made improvements to the Bristol bar project in 1899, including dredging a 100-foot by 300-foot channel to a depth of 10 feet at low water, and creating a 300-foot by 400-foot turning basin. Based on this report, the improvements impacted approximately 4 acres. The report estimated that approximately 35,000 cubic yards of material was dredged; it is assumed that this material was placed on barges and towed/pulled towards shore where a dredge bucket removed it and placed it along the shoreline. It is believed that at least some of the material was sidecast, as this was a standard practice at the time. The sizes of fill and sidecast areas are not available.

Funds were allocated by Congress in 1902, and were expended for dredging at Bristol bar in 1904. The dredging produced a channel 100 feet wide and 10 feet deep, and a turning basin about 240 feet wide, 350 feet long, and 10 feet deep. This activity impacted approximately 3.5 acres. Dredge material placement sites and quantities associated with this effort are not known.

The existing Bristol Bar project was completed in 1979, providing a channel 10 feet deep and 100 feet wide through the Bristol Bar (mile 47.5), with a turning basin 240 feet and 350 feet long at Bristol Landing. The remaining dredging of the turning basin to full project dimensions was deauthorized in November 1979.

Upper Marlboro Local Flood Protection

The Corps initiated a local flood control project at Upper Marlboro in 1963, under authority of Section 205 of the Flood Control Act of 1948 (P.L. 80-858). This project consists of 4,025 feet of channel improvement, 1,350 feet of earth levee, 160 feet of floodwall, raising of a highway bridge, 4,430 feet of floodway clearing, and construction of appurtenant structures on the Western Branch. On the Collington Branch, the project includes 1,335 feet of channel improvement, 500 feet of levee, 150 feet of floodwall, addition of a span to the old State Rte. 202 bridge, construction of a combined railroad and highway bridge, and construction of other appurtenant structures. The project provides protection against a flood discharge of 6,800 cubic feet per second (cfs) on the Western Branch, and 3,500 cfs on the Collington Branch. Prince George's County Department of Public Works is responsible for operation and maintenance.

Nan Cove Navigation Dredging

The Nan Cove reconnaissance report, written in 1962, led to the Nan Cove dredging project. The dredging was completed in 1965, impacting approximately 2.5 to 3 acres. Coordination letters with resource agencies and project mapping indicate that dredged material was placed in marsh areas adjacent to the channel. Approximately 21,300 cubic yards was dredged at that time, impacting approximately 7.3 acres of tidal marsh, eliminating approximately .1 acre of marsh, and hardening approximately 100 feet of shoreline with bulkheads.

A reconnaissance survey for maintenance of the Nan Cove project, which recommended further dredging, was completed in 1983. Maintenance dredging of the Nan Cove project was completed in 1985, providing an entrance channel 40 feet wide, 2,045 feet long, and 6 feet deep, and an anchorage basin of the same depth, 150 feet wide, and 190 feet long. Overall project size is 2,195 feet by 750 feet, or approximately 3.8 acres.

Solomons Island Emergency Shoreline Stabilization

The Corps constructed a stone revetment in 1993, to protect the roadway at Solomons Island under Section 14 of the Flood Control Act of 1946, as amended, which authorizes the Corps to develop and construct emergency strearnbank and shoreline protection projects to protect endangered roadways and other public facilities.

7.2.3 Anticipated Product

The anticipated product of the feasibility phase will be a feasibility report that addresses environmental restoration measures for the Patuxent River study area. This report will be accompanied by the appropriate documentation (Environmental Impact Statement or Environmental Assessment) to comply with NEPA. The feasibility report will provide all the necessary documentation to permit project authorization by the U.S. Congress for construction of a Federal project(s), if justified. The feasibility report will build upon the information contained in this reconnaissance report, and will include the following:

- Detailed examination of the Patuxent River watershed.
- Detailed examination of environmental restoration opportunities.
- Reevaluation and prioritization of the various watersheds within the study area to determine where environmental restoration projects should be implemented.
- Data collection and sampling to ascertain existing stream characteristics.
- Formulation of practical alternatives considering the nature of the problem, site characteristics, and area resources.
- Assessment of the environmental effects of the possible solutions and preparation of environmental documentation.
- Investigation of possible impacts to cultural resources with results and determination of effects coordinated in accordance with Section 106 (Public Law 89-665, as amended) responsibilities.

- Coordination with the USFWS, including receipt of a Fish and Wildlife Coordination Act Report.
- Preparation of typical design drawings and quantity estimates.
- Estimation of project costs and benefits.
- Evaluation and ranking of feasible solutions.
- Preparation of a preliminary hazardous, toxic, and radioactive waste assessment in accordance with the Clean Water Act.
- Compliance with other environmental laws and regulations, as appropriate.
- Implementation of a public involvement program to ensure that the public's concerns are addressed and that the public is kept apprised of what the Corps is proposing.
- Analysis of project implementation arrangements, including construction cost-sharing requirements and an ability-to-pay analysis of the non-Federal sponsor's project financing plan.
- Preparation of a Project Study Plan (PSP) that describes the tasks required during the Preinstruction Engineering and Design (PED) phase and associated costs.
- Recommendation for authorization and construction, if a project is economically justified and supported by non-Federal sponsors.

7.2.4 Potential Non-Federal Sponsors

The potential non-Federal sponsors are Anne Arundel, Calvert, Charles, Howard, and Prince George's Counties, as well as Montgomery County MNCPPC, and the State of Maryland. Letters of support from the potential sponsors stating their concurrence with the reconnaissance report recommendations and their willingness to continue negotiating an FCSA are included in Appendix D of this report.

7.2.5 Feasibility Cost-Sharing Agreement (FCSA)

Section 905(b) of the Water Resources Development Act of 1986 requires that Federal funds be expended for all costs associated with the reconnaissance phase. However, Section 105(a)(l) requires that the cost of a subsequent feasibility phase be shared equally (50/50 split) between the Federal government and a non-Federal sponsor(s).

Up to one-half of the non-Federal contribution, or one-quarter of the total cost of the feasibility phase, may be in the form of in-kind services. In-kind services are those tasks performed and paid for by the non-Federal sponsor that are in direct support of the feasibility study effort. An example of an in-kind service by the sponsor would be coordination of the public involvement effort mentioned earlier. While all in-kind services should be in support of the particular study, it is permissible for non-Federal sponsors to re-orient existing programs and ongoing work to complement the Corps feasibility study.

In order to proceed beyond the reconnaissance phase, the Federal government and a non-Federal sponsor(s) must agree that the proposed project is in the Federal and non-Federal interest and must then negotiate a feasibility cost-sharing agreement (FCSA) that commits both parties to equally

sharing the cost of the feasibility phase. The FCSA is intended to promote a partnership for the conduction of the feasibility phase. This agreement sets forth the management structure, obligations of the signatories, methods of payment, resolution of disputes, methods for termination or suspension of the feasibility study, and other general contractual matters. A model FCSA is contained in Appendix D of this report.

Federal funds to initiate the feasibility phase may be allocated only after a negotiated FCSA has been prepared, and all documents have been certified by the Corps' higher authority. The feasibility phase can then begin after execution of the FCSA and receipt of both Federal and non-Federal funds.

7.2.6 Project Study Plan (PSP)

As part of the feasibility cost-sharing agreement, a project study plan (PSP) is prepared and negotiated. The PSP documents the specific Federal and non-Federal efforts that will be required to conduct a particular feasibility phase. The PSP is appended to the FCSA, and lays out the work tasks, costs, and schedules for the entire feasibility phase. It also furnishes a basis for identifying the in-kind services to be provided by the non-Federal sponsor and for negotiating the value of these services. Significant changes to the PSP during the feasibility study will require a modification of the FCSA. The draft PSP for the Patuxent River Water Resources Study is contained in Appendix E of this report. This draft PSP represents a solid foundation from which the individual PSPS for each of the recommended feasibility studies will be developed. The PSP included in Appendix E was developed for a watershed within Howard County, Maryland for another one of our feasibility studies, which suffers from similar problems as the sub-watersheds in the Patuxent River. Therefore, this PSP was developed for a watershed similar in size to many of the sub-watersheds of the Patuxent and will involve similar feasibility-type efforts. During the feasibility study negotiations, the PSP included in Appendix E will be modified to better reflect each of the sub-watersheds of the Patuxent for which feasibility studies will be completed.

7.2.6.a Work Tasks: Major work tasks for a feasibility phase are identified in terms of the general activities that are included in the Corps of Engineers' standard study cost estimate for general investigations. These tasks, in turn, were further divided into subtasks that were specifically applicable to the Patuxent River Water Resources Study. The subtasks cover further refinements of the information already gathered, development of new information where data was not previously available, detailed assessments and evaluations of proposed plans, management and coordination activities, and report preparation and processing. A tentative list of subtasks is provided in the preliminary draft PSP contained in Appendix D.

7.2.6.b Cost Estimate: Once the work effort is identified, a cost estimate is developed for each of the individual subtasks. A preliminary total estimate for the feasibility phase of the Patuxent River Water Resources Study is $3.3 million. The cost of the feasibility study has been broken down by county in case the decision is made to perform several smaller feasibility studies instead of one large feasibility study. The final study cost will be dependent upon the exact scope of activities agreed upon by the Federal government and the non-Federal sponsor(s).

A more detailed list of subtasks and estimates of cost will be prepared if it is decided to proceed into the feasibility phase for the proposed project. The total cost of the feasibility phase will be shared equally between the Federal and non-Federal sponsor(s).

7.2.6.c Schedule: The schedule for a typical feasibility phase covers 24 to 36 months, including a public review period. Development of a firm schedule for the Patuxent River Water Resources Study would be part of the negotiations leading to a final FCSA. The feasibility study initiation date is tentatively scheduled for August 1, 1997. The feasibility phase can begin only after approval and certification of the reconnaissance report, negotiation and signature of the FCSA, and receipt of both Federal and non-Federal funds.

7.2.6.d Management Structure: Negotiations, general study guidance, study conduct, and policy questions will be handled through a formal management structure composed of representatives from both the Federal government and the non-Federal sponsor. A study management team composed of Federal and non-Federal participants will perform routine activities involving problem identification, plan formulation, and project evaluation. An executive committee will also be organized to provide overall study guidance, to participate in issue resolution conferences, and to resolve any disputes that may arise. Membership on the executive committee is expected to include the District Engineer, his chief planner, and personnel of commensurate levels representing the non-Federal sponsor(s).

The management structure of the Corps is such that during the feasibility phase, there will be both a study manager and a project manager. Their primary responsibilities will include tracking the budget and schedule, and communicating with the local sponsors on major issues. The study manager will be from the Planning Division, will be responsible for all of the technical work performed during the reconnaissance and feasibility phases, and will act as a contact on technical issues for local sponsors. The project manager will be from the Programs and Project Management Division and will have less involvement in the everyday workings of the study. This person will maintain continuity throughout the feasibility, PED, and construction phases of the project.

SECTION 8

SUMMARY AND CONCLUSIONS

The two purposes of this reconnaissance study were (1) to develop a water resources plan for the Patuxent River watershed that would address specific resource concerns and (2) to determine whether further Corps of Engineers' involvement in the watershed is recommended. To structure its focus, the reconnaissance study was directed to three major study elements: environmental restoration, navigation, and flood damage reduction. Recognizing the interrelationships between the study's multiple goals, the reconnaissance effort used an ecosystem and watershed focus. This watershed study lays a framework for managing the water and related land resources of the Patuxent River watershed by identifying efforts to be implemented by local, state, and Federal agencies, including the Corps of Engineers. The study findings are summarized below.

8.1 PROBLEMS, NEEDS, AND OPPORTUNITIES

The Patuxent River watershed has experienced great changes in water and habitat quality over the last 50 years. Population in the area has more than doubled in that time, and the increasing development in the counties along the river has stressed the water resources of the river to an extreme, causing severe erosion, sedimentation, habitat loss and degradation, and water supply and treatment problems. These effects are felt not only at the source of the problem, but for many miles downstream.

The main problems facing the Patuxent River deal with environmental restoration. They are due primarily to streambank and streambed erosion, which results in the degradation and loss of aquatic, SAV and wetland habitat due to associated turbidity and sedimentation. Much of this erosion is due not to construction or agricultural practices, but rather to inadequate stormwater management facilities. Some of the older communities lack stormwater management altogether. Some communities have open sloughs through which stormwater can travel to a nearby stream. Other areas have stormwater management structures, but the volume of flow is higher than the designed capacity. Erosion due to stormwater runoff not only destroys property, but it also creates high levels of suspended sediments in the river and its tributaries. The resulting turbidity refracts the sunlight in the water, limiting aquatic plant growth such as SAV which are a food source and provide valuable habitat for many different species. Sediments also directly impact fish and other aquatic life by clogging gill structures and inhibiting site feeders. Stormwater-induced erosion and resulting habitat degradation can therefore be said to be the largest single problem in the Patuxent River watershed. As land and water management practices continue, the characteristics which define a healthy Patuxent River watershed will continue to be lost or be substantially altered if steps are not taken to remedy it.

Other problems related to environmental restoration in the Patuxent watershed include failing septic systems, which leak polluted water directly into the river; an unmet demand for

recreational facilities; and a loss of wetland and woodland habitat. Each of these problems has considerable impacts on habitat and water quality in the Patuxent River.

8.2 WATERSHED PLAN SUMMARY

8.2.1 The Upper Sub-Watershed Plan

Problems of the upper sub-watershed of the Patuxent are characterized mostly by the need for reservoir protection from excessive sediment and nutrient loading. Opportunities exist to educate local communities through pamphlets, workshops, and seminars about urban and rural Best Management Practices (BMPs), and about water conservation practices to ensure high water quality in the reservoirs. An opportunity also exists to develop a database and GIS application to document and assist in resource analysis, which could lead to a SAMP to protect both the existing resources and the quality of drinking water.

Additionally, degradation of habitat from uncontrolled stormwater is impacting the aquatic habitat in the upper sub-watershed. The volume of the stormwater has caused streambank erosion and stream channel degradation, as well as high sediment loads. High sediment loads directly affect water quality for the area and contribute to other related problems such as eutrophication and loss and degradation of habitat for aquatic organisms. Opportunities exist to provide streambank restoration, stabilization, and protection, which would enhance riparian habitat in conjunction with retrofitting existing stormwater structures or designing new management structures to better manage stormwater flows. Opportunities also exist to expand local wetlands to provide water quantity and quality controls, as well as increased habitat.

8.2.2 The Middle Sub-Watershed Plan

problems of the middle sub-watershed of the Patuxent are greatly affected by the activities and health of the upper sub-watershed. Sediment and nutrients are carried into this sub-watershed where they contribute to the loss and degradation of environmental resources and significant habitat. High sediment loads directly affect water quality for the area and contribute to other related problems such as eutrophication and loss and degradation of habitat for aquatic and semi-aquatic organisms. Large and small obstructions exist throughout the Patuxent MainStem and tributaries in the middle sub-watershed. These obstructions create blockages to diadromous and resident fish. Opportunities exist to restore fish habitat and range by removing the blockages. Uncontrolled stormwater resulting from agricultural and residential development is another significant factor affecting the fluvial aquatic habitat in the Middle sub-watershed. The volume of this uncontrolled stormwater has caused severe streambank erosion and stream channel modification, as well as high sediment loads from the contributing land areas. Opportunities exist to provide streambank restoration, stabilization, and protection, which would enhance riparian habitat. Potential solutions also include wetland creation projects to filter runoff and provide additional habitat. Increased development and sedimentation has also impacted the SAV populations in the area. Opportunities exist to revegetate areas with locally occurring population of SAV in conjunction with stream stabilization, enhancing aquatic habitat and improving water quality.

8.2.3 The Lower Sub-Watershed Watershed Plan

Problems of the lower sub-watershed of the Patuxent are characterized by environmental resource and significant habitat loss and degradation due to excessive sediment loading from erosion. High sediment loads directly affect water quality for the area and contribute to other related problems such as the loss and degradation of aquatic habitat. Degradation of aquatic and associated habitat from uncontrolled stormwater is also a factor in the lower sub-watershed. The volume of this uncontrolled stormwater has caused severe shoreline and streambank erosion. It also contributes high sediment loads to surface water, impacting habitat for SAV, waterfowl, fish, and oysters. Opportunities exist to provide shoreline and streambank restoration, stabilization, and protection in conjunction with constructing and upgrading stormwater management systems, which would reduce sedimentation and enhance aquatic and riparian habitat. Also, large and small obstructions are found in the lower sub-watershed. These obstructions create blockages to anadromous and resident fish. Opportunities exist to restore fish habitat and expand the range by removing the blockages. A number of failing septic systems in the area contribute to groundwater and surface water contamination. Potential solutions include identifying the affected communities; using public outreach and education to improve land stewardship; implementing small package treatment plants to replace the septic systems; and encouraging the development of pump-out schedules for private septic tanks.

8.3 OPPORTUNITIES FOR CORPS OF ENGINEERS INVOLVEMENT

The watershed plan development was not constrained by institutional issues. Following its development, an implementation plan was assembled to designate appropriate lead agencies for each specific action. This implementation plan includes a number of actions that could be implemented by the Corps.

Detailed investigations of potential solutions to the identified problems for each sub-watershed are necessary and could be addressed through the Corps' civil works planning process. More detailed investigations would be accomplished through watershed-based feasibility studies for several of the HUA'S described in the above section. Each feasibility study would be geared toward accomplishing activities associated with environmental restoration, with additional consideration toward flood damage reduction measures and recreational access.

Not listed by priority, Feasibility Studies that could be implemented by the Corps of Engineers and non-Federal sponsors include the following, as shown in Figure 8-1:

- Watershed Feasibility Study in Howard County which may include, but not be limited to, the following HUA'S: the Little Patuxent River, the Middle Patuxent River, the Dorsey Run/Route 1 corridor, and Wilde and Kittimaqundi Lakes in the upper sub-watershed
- Watershed Feasibility Study in Montgomery County of the Hawlings River in the upper sub-watershed

- Watershed Feasibility Study in Prince George's County which may include, but not be limited to, the following HUA'S: the Western Branch, the Collington Branch, the Southwest Branch, the Charles Branch, and Laurel Lake in the middle sub-watershed
- Watershed Feasibility Study in Anne Arundel County of the Towsers Branch in the middle sub-watershed
- Watershed Feasibility Study in Calvert County which may include, but not be limited to, the following HUA'S: the Jefferson Patterson Park area, the Hall Creek, and the Hunting Creek in the lower sub-watershed

The cost to conduct any of these Corps of Engineers feasibility studies could range from approximately $500,000 to approximately $1.5 million. Although unlikely if all aforementioned Feasibility studies were undertaken concurrently, the total cost could approximate $3.3 million to conduct these studies. It can be estimated that the implementation of all actions that might be recommended in these feasibility studies would result in the restoration of approximately 77,000 acres and 360 stream miles of fish and wildlife habitat.

Beyond the Corps' involvement in feasibility studies, the Corps may also initiate efforts associated with Section 14 of the Flood Control Act of 1946 to address an emergency streambank stabilization effort on Towsers Branch in the middle sub-watershed. This authority allows the Corps of Engineers to develop and construct emergency streambank and shoreline protection projects to protect endangered roadways, bridge approaches, public works facilities such as water and sewer lines, public and private non-profit schools and hospitals, and other public facilities. Each project is limited to a Federal cost of $500,000, which includes project implementation costs for developing the plans and specifications and for construction. Activities under this program are cost-shared on a 75-percent Federal/25-percent non-Federal basis.

Another authority by which the Corps of Engineers is able to provide technical assistance is the Planning Assistance to the States program, which was authorized by Section 22 of the Water Resources Development Act of 1974. This authority allows the Corps to assist states or other non-Federal entities in the preparation of comprehensive plans for the development, utilization, and conservation of water and related land resources. The program can encompass many types of studies, including water supply, water quality, water conservation, flood control, dam break inundation studies, erosion control, and navigation. Activities under this program are cost-shared on a 50-percent Federal/50-percent non-Federal basis. For the Patuxent watershed, the Corps may initiate Section 22 studies for the development of Special Area Management Plans (SAMPS) for small watersheds that are expecting increases in development, a Master Plan type study of the conflicting water uses in the estuarine portion of the Patuxent River, and a study to evaluate the ability of the Duckett Dam to pass a probable maximum flood (pmf) flow.

Another area in which the Corps could offer assistance and technical support is in flood plain management services. Section 206 of the Flood Control Act of 1960 provides authority for the

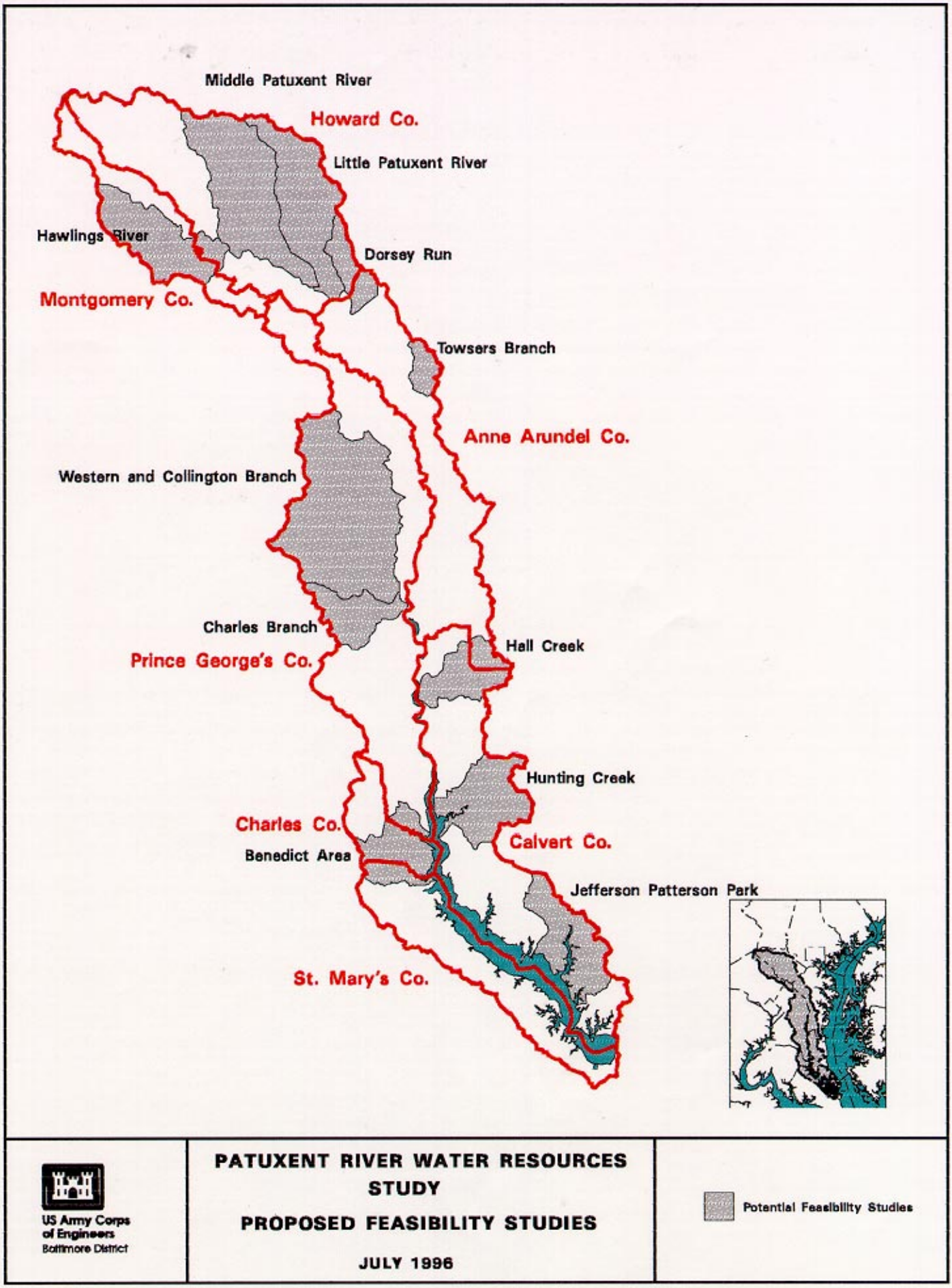
Middle Patuxent River
Howard Co.
Little Patuxent River
Hawlings River
Dorsey Run
Montgomery Co.
Towsers Branch
Anne Arundel Co.
Western and Collington Branch
Charles Branch
Hall Creek
Prince George's Co.
Hunting Creek
Charles Co.
Calvert Co.
Benedict Area
Jefferson Patterson Park
St. Mary's Co.
US Army Corps of Engineers
Baltimore District
PATUXENT RIVER WATER RESOURCES STUDY
PROPOSED FEASIBILITY STUDIES
JULY 1996
Potential Feasibility Studies

Figure 8-1

Corps of Engineers to use its technical expertise in floodplain management to help local agencies and residents. The objective of the Flood Plain Management Services (FPMS) program is to support comprehensive floodplain management planning with technical services and planning guidance at all appropriate government levels, thereby encouraging and guiding local officials toward prudent use of the nation's floodplains for the benefit of the national economy and welfare. Under this program, the Corps can provide planning assistance and guidance for development of floodplain regulations, flood warning and preparedness procedures, floodproofing measures, and permanent evacuation and relocation procedures. Implementation of activities under this program, which is 100 percent federally funded, would be at the specific request of the local or state government. Areas that do not currently appear to quality for Federal assistance in structural flood protection measures, such as Laurel, Columbia, and several areas within the lower sub-watershed, may apply for assistance under this program.

8.4 CONCLUSIONS

Based upon the reconnaissance-level investigations of the Patuxent River watershed, there is both a Federal and a non-Federal interest in the watershed plan for the entire watershed as well as the sub-watershed plans developed as part of this study. These sub-watershed plans will require the participation of a number of Federal, state, and local agencies, in addition to private interests and groups. Implementation of each sub-watershed plan will not only restore valuable fish and wildlife habitats, but will also aim to reduce flood-related damages, improve water quality, and increase recreational opportunities. The overall goal of each sub-watershed plan and the watershed plan as a whole is to restore and protect the water resources of the Patuxent River watershed.

The problems plaguing the Patuxent River and its tributaries will continue to worsen if left unaddressed, adversely affecting not only the quality of life in the Patuxent River watershed, but ultimately the quality of life downriver in the Chesapeake Bay. The Corps of Engineers can play a significant role in the implementation of the watershed plan. The Corps will be involved in construction activities, as well as in providing technical assistance to local entities. Specific Corps actions include feasibility studies, a Section 14 study, Section 22 studies, and floodplain management studies. The total amount of water-related projects amounts to in excess of $200 million in estimated project construction cost. In addition, a total of approximately $950,000 in water-resources technical planning assistance has been identified as needed.