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AN ASSESSMENT
OF THE PATUXENT RIVER RESTORATION EFFORT

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PATUXENT BASIN

The Patuxent River Basin is composed of parts of seven counties encompassing ten percent of the total land area within the State. The watershed is 930 square miles and averages ten miles in width. The river meanders 110 miles on its journey through the seven counties, from its origin at Parris Ridge (the junction of Howard, Montgomery, Frederick amd Carroll counties) to its terminus at the Chesapeake Bay. A map is provided (Figure 1) which indicates the location of the river and the portions of the counties which make up its drainage basin.

The river contains three distinct physiographic regions. The headwater region is in the Piedmont Plateau and extends from the river's point of origin to the fall line, near Laurel. The stream valley is steep with little or no flood plain. Steam flow is swift in this portion of the river. Two reservoirs, Triadelphia and Howard T. Duckett, are located on the mainstem of the river in this segment.

The middle portion of the river extends from the fall line into the upper reaches of the fresh tidal zone. This segment is characterized by broad, flat, low-lying swampy flood plains on both sides of the river. The river's mainstem is narrow and flow is sluggish. The Little and Middle Patuxent and Western Branch are important tributaries which enter the Patuxent in this portion of the river. It is this portion of the river into which most of the wastewater effluents are discharged. The location of sewage treatment plants (STPs) in the basin is shown in Figure 2.

The third physiographic region of the river is composed entirely of the tidal estuary. The first few miles of this segment of the river are narrow with high land close to the edges of the stream. Near Waysons Corner the river's path again becomes dominated by marsh lands. Below Deep Landing the estuary widens to form a saline reach of the Bay. The marsh covered shores give way to tall bluffs sometime 20 feet or more in height.

Along with these physiographic distinctions between portions of the river there are other parameters which divide the basin. Zones of salinity are present along the path of the river. The transition zone from saline to fresh water is bounded by Benedict and Nottingham. Ecological zones and boundaries can also be used to identify specific portions of the watershed. These zones are summarized in Table 1 which was prepared by D'Elia and Boynton (1982).

The Patuxent River lies between the cities of Washington and Baltimore. Both of these cities have expanded over the past decade which have caused populations in the seven basin counties to expand rapidly. As Figure 3 indicates, this growth pattern is anticipated to continue well into the 1990s. Those counties which comprise the upper basin are becoming increasingly urbanized at accelerating rates.

The watershed remains predominantly rural with 85 percent of its land cover in agriculture and forest. The agricultural dominance of the watershed is slowly eroding away. The suburban sprawl is consuming greater and greater tracts of agricultural land as housing demand in the watershed increases.

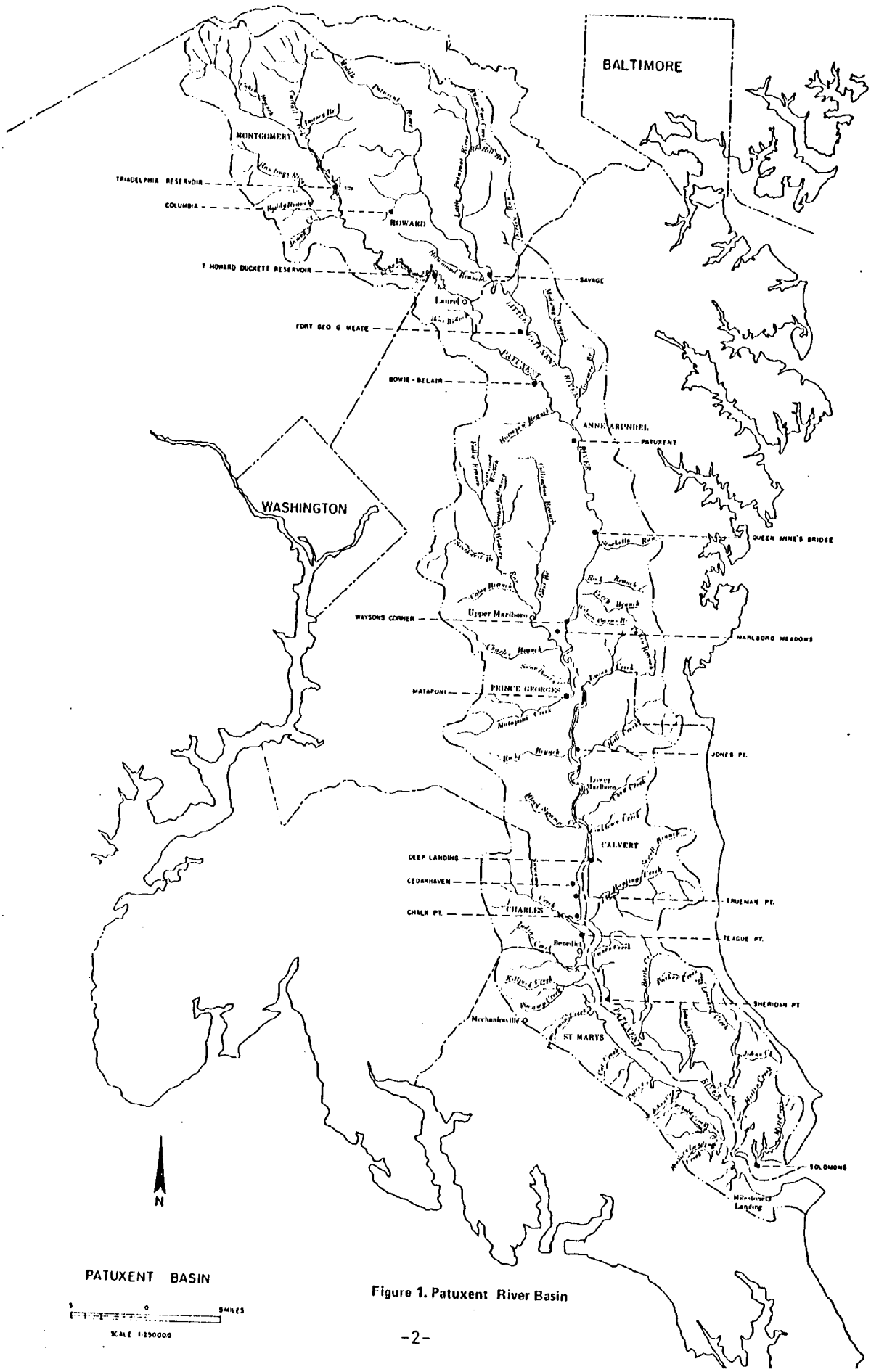


Figure 1. Patuxent River Basin

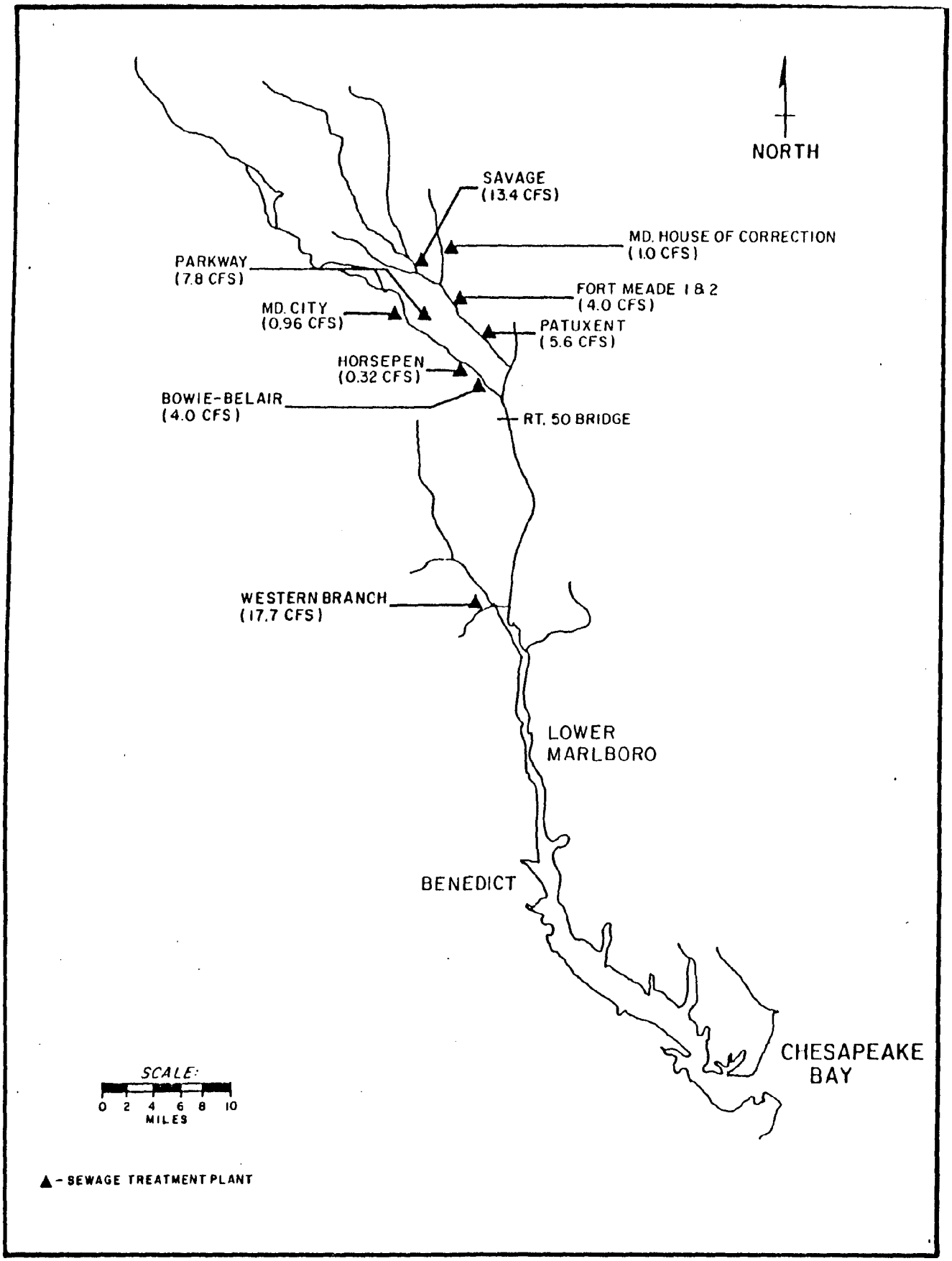
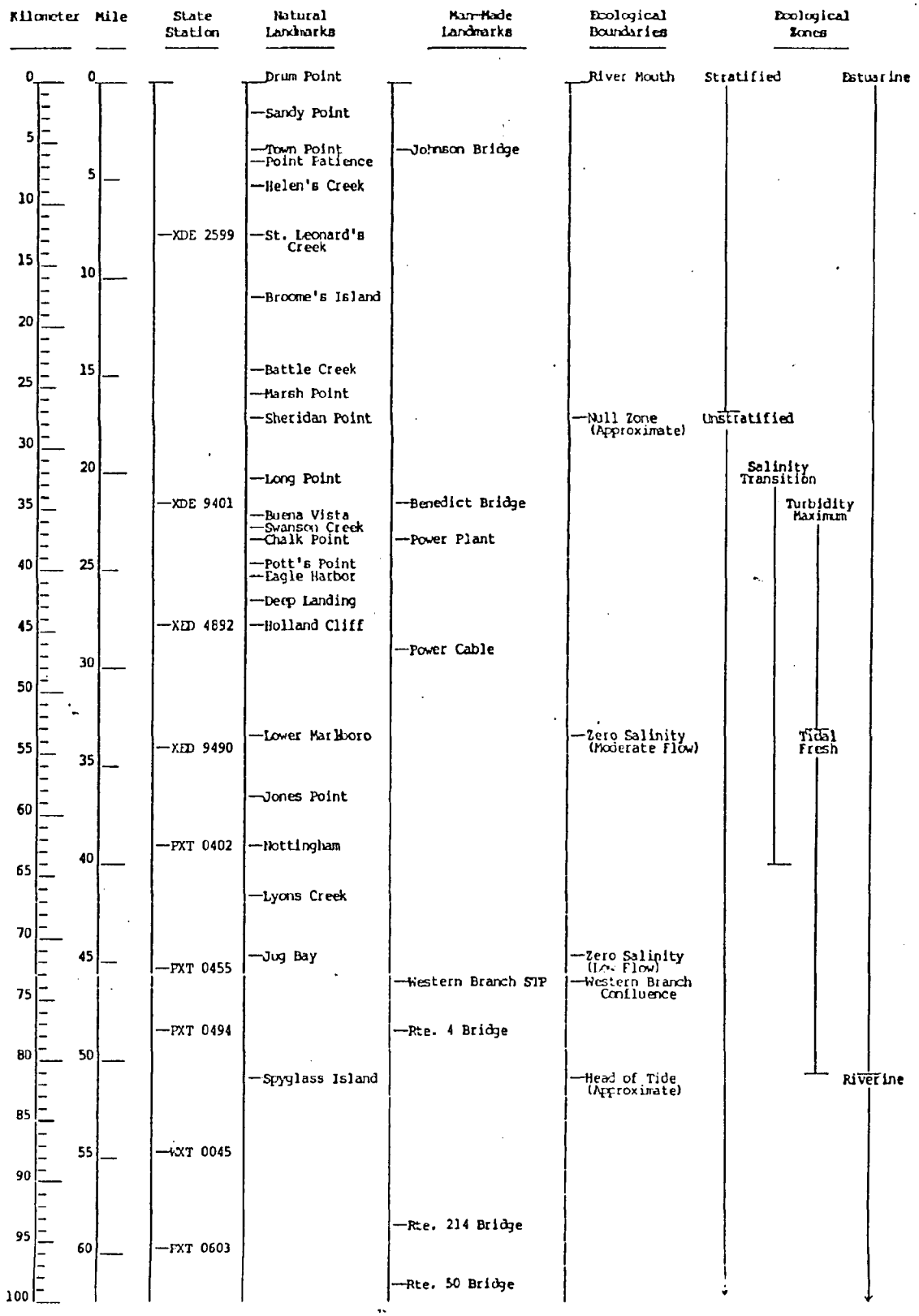


FIGURE 2.

LOCATION OF SEWAGE TREATMENT PLANT DISCHARGES

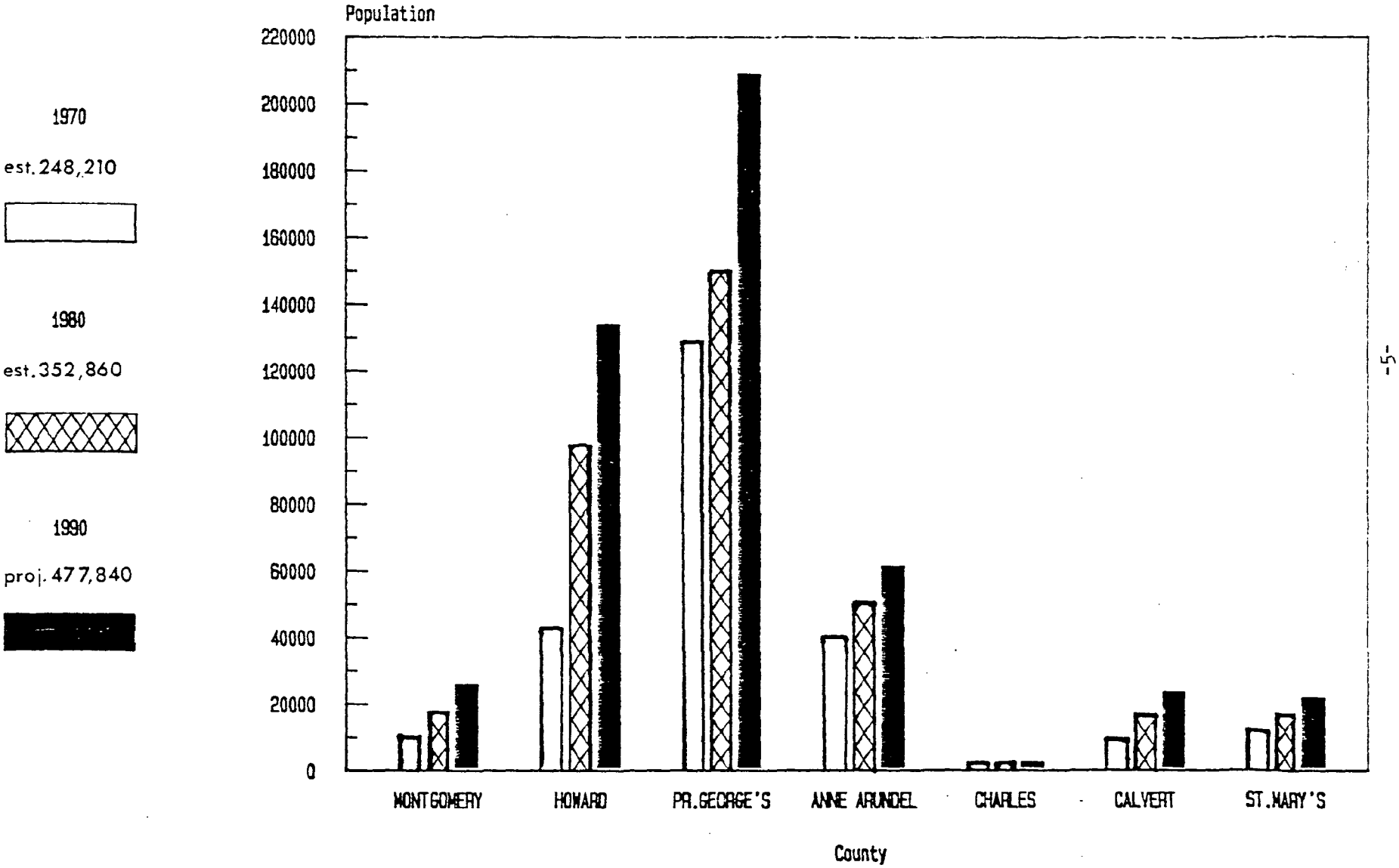
Table 1. Ecological Zones of the Patuxent River.



Source : D'Elia and Boynton (1982)

FIGURE 3.

PATUXENT RIVER BASIN
POPULATION GROWTH BY COUNTY



SOURCE: MARYLAND DEPARTMENT OF STATE PLANNING

Land Use Changes

The Maryland Department of State Planning has conducted land use change analyses for the Patuxent River Watershed in 1973, 1981, and 1985. These analyses showed the increasing urbanization of the watershed, although (to date) it is still predominantly rural. Perhaps even more ominous is the potential future change indicated by the figures in the most recent analysis. Increases have been shown in both the barren and brush land categories over the period from 1981 to 1985. Much of the land which has been converted from other land use types such as agricultural and forested to these land use categories is awaiting development. This would indicate that even greater pressure will be placed on the fragile Patuxent River ecosystem. Forested land categories have all declined while developed land categories have all increased. Thus only those land use changes which do not provide water quality benefits have increased, while those which improve the quality of run-off prior to its deposition in tributaries within the watershed have declined.

A chart of the land use changes which have occurred in the Patuxent River basin is shown in Table 2. The percent of change for each land use category which have occurred over the 1981 to 1985 time period is also included.

Table 2. - PATUXENT RIVER BASIN - 1981 - 1985 LAND USE/COVER CHANGE

TYPE OF LAND USE	1981 ACRES	1985 ACRES	PERCENT CHANGE 1981-1985
DEVELOPED	75,400	81,300	+ 7.8
LOW DENSITY RESIDENTIAL	25,600	29,100	+ 13.7
MEDIUM DENSITY RESIDENTIAL	22,600	23,100	+ 2.2
HIGH DENSITY RESIDENTIAL	4,500	5,000	+ 11.0
COMMERCIAL	5,900	6,800	+ 15.2
INDUSTRIAL	1,200	1,500	+ 25.0
INSTITUTIONAL	8,400	8,500	+ 1.1
EXTRACTIVE	2,100	2,200	+ 4.7
OPEN URBAN LAND	5,100	5,100	0.0
AGRICULTURAL	195,300	189,700	- 2.9
CROPLAND	168,300	165,100	- 1.9
PASTURE	25,200	23,000	- 9.5
ORCHARDS/VINEYARDS/HORTICULTURE	800	500	- 40.0
FEEDING OPERATIONS	100	100	0.0
ROW AND GARDEN CROPS	900	1,000	+ 11.0
FOREST	303,300	301,800	- 0.5
DECIDUOUS FOREST	179,400	177,500	- 1.1
EVERGREEN FOREST	6,300	5,900	- 6.7
MIXED FOREST	112,000	111,000	- 1.0
BRUSH	5,600	7,400	+ 32.0
WETLANDS	7,800	7,800	0.0
BARREN LAND	700	1,900	+ 170.0

SOURCE: MARYLAND DEPARTMENT OF STATE PLANNING - MAGI, 1981, 1985

PROBLEM

The Patuxent River has experienced a decline in water quality which became apparent during the 1970s. The evidence of reduced water quality was increased mortalities of both oyster and fish populations in the river. Reduced water quality also was evident through visual observation.

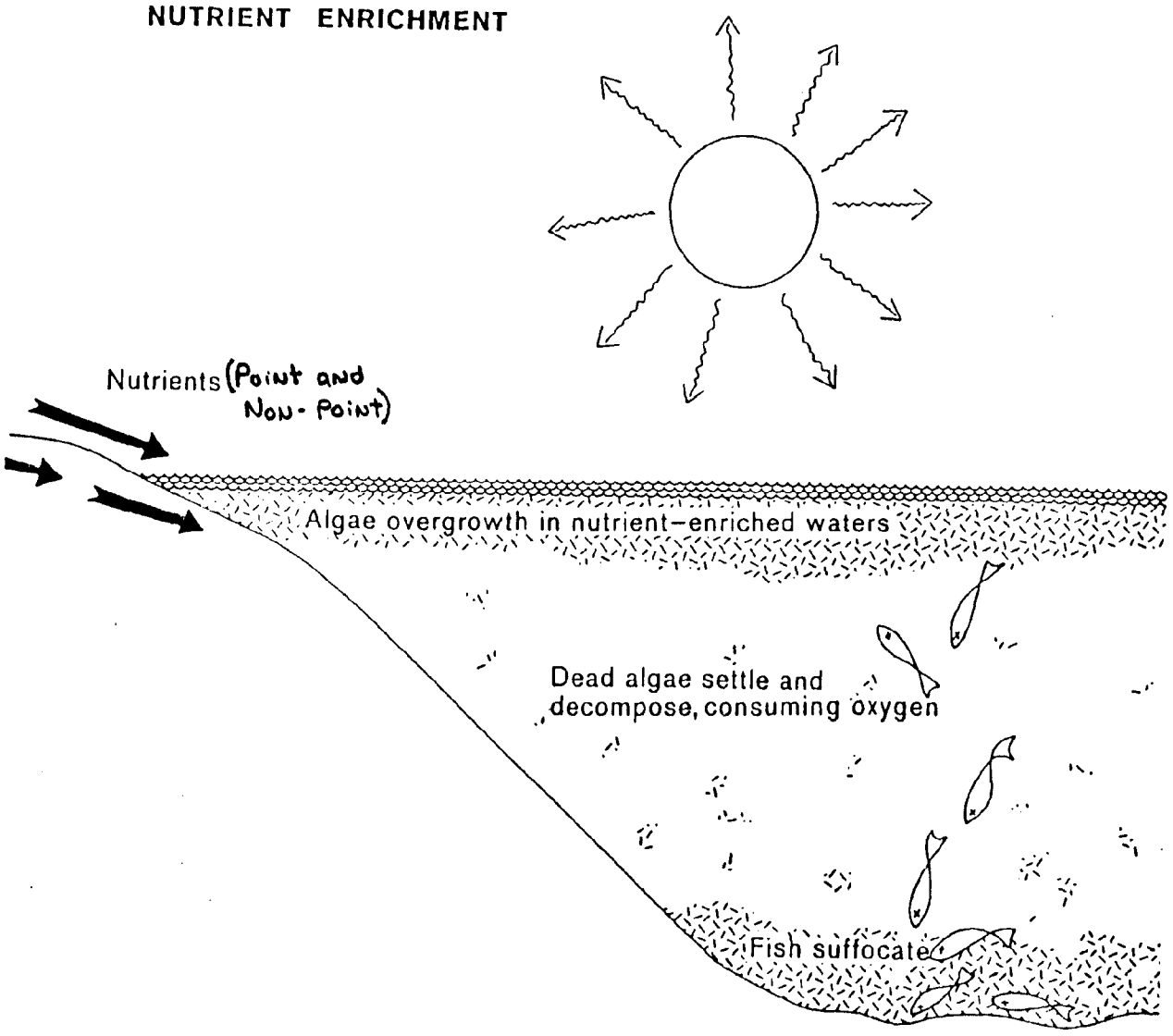
The cause for the decline in water quality is multifaceted. Forested lands have been cleared for development and the exposed soils washed into the river and its tributaries. Without the absorptive capacity of the trees, the quantity and velocity of the stormwater runoff has increased. These factors increase erosion from runoff with the eventual deposition of sediment in the river. The overall result is sedimentation occurring at an unnaturally accelerated rate. Under forested conditions, the sediment delivered to the river from all lands in the basin approximated 160,000 tons during an average year; however, under current land uses, that figure has increased to 710,000 tons (DSP, 1986).

Increased sediment loading reduces the depth to which light can penetrate the water column. The photic zone (the depth to which sufficient light is present to support plant growth) of the river becomes much smaller and many aquatic plants no longer receive sufficient levels of sunlight to survive. Beds of submerged aquatic vegetation are reduced in the river. These plants are important not only for shoreline stabilization but also release oxygen into the water which enables fish and other animal life to prosper.

The Patuxent River basin has experienced rapid growth during the period of declining water quality. Many of the problems which confront the river are a direct result of the urbanization of the watershed. A principle factor associated with population growth is increased sewage. Sources of the nutrients which enter the river can be placed into two categories, point and non-point. Point sources are those derived from specific (point) sources, such as sewage treatment plants and industrial discharges. Non-point sources of nutrients are those that enter waterways in the form of stormwater runoff from agricultural, urban, and forested lands and base flow to streams along with atmospheric deposition on land and water. The nutrients of primary importance in the reduction of water quality in the river are Nitrogen (N) and Phosphorus (P) because both are essential for the growth of plants, such as algae. In 1963 only three million gallons of effluent per day flowed from sewage treatment plants. Today, almost 38 million gallons enter the river each day. This figure is expected to increase to 74 million gallons per day by the year 2005. This effluent contains large quantities of both Nitrogen and Phosporus. Non-point sources are much more difficult to detect and monitor but they cannot be ignored, as they contribute substantially to the elevated levels of Nitrogen and Phosphorus in the river. Fifty percent of the Nitrogen and fifty percent of the Phosphorus deposited in the Patuxent River is derived from non-point source inputs. However control of these non-point inputs is both complex and difficult.

The result of incresed nutrient loading is a rapid acceleration of algal growth commonly referred to as "blooms." These are principally due to an excess of an otherwise limiting nutrient. Blooms choke off the surface water, preventing light from penetrating into the water column and inhibit submerged and rooted vegetation from receiving essential sunlight. As the "bloom" dies off the algal cells sink to the bottom and begin to decompose. The process of decomposition consumes oxygen from the water resulting in oxygen deprivation in the deeper waters of the Patuxent River. Fish, oysters and other aquatic animal life is unable to survive in waters with dissolved oxygen levels below 4 mg/l. This phenomenon is occurring in portions of the river and is diagramed in Figure 4. The low dissolved oxygen conditions are found during the summer months when the river is poorly mixed. The overall result of nutrient enrichment has been a significant decline in the productivity of the river.

Figure 4. - Diagramatic Representation of the Problems Associated with Nutrient Enrichment in the Patuxent River.



SOLUTIONS TO THE PROBLEM

The concerted effort to restore the river to prior levels of water quality, as indicated by measurements of dissolved oxygen, secchi depth, and chlorophyll "A", began with the "Charrette" held in December 1981. The Charrette was selected as a unique method to resolve the differences between upstream and downstream counties regarding use and restoration of not only the river but its entire drainage basin. The goal of the meeting was accomplished as the Charrette produced a united strategy for addressing the river's water quality problems in the future. The goals established by the Charrette are outlined in Appendix A.

A second document which is devoted to the implementation of a strategy aimed at restoring water quality in the Patuxent is the 208 Water Quality Management Plan. This plan contains an assessment of water quality conditions in the basin. The plan outlines a nutrient control strategy which includes both point and non-point sources of pollution. Governor Hughes certified the plan by making it a legal State document in 1983. A summary of the plan is provided in Appendix B.

The third and most recent plan devised to improve water quality in the river is the Patuxent River Policy Plan developed by the Department of State Planning. The Policy Plan was conceived to improve upon the many local, state and federal policies and programs which relate to the protection of the river's fragile ecosystem. Some of these policies and programs are intended for the specific protection of our aquatic resources while others only improve the quality of the river as a side benefit. The plan is an integrated approach with a clear goal of water quality protection and restoration using a whole watershed management approach. The plan was required as part of the State's Patuxent River Watershed Act and has been approved by the General Assembly. In addition the plan has been approved and endorsed by the elected officials in each of the basin's seven counties. The plan is summarized in Appendix C.

With these three documents serving as a guide for the improvement of water quality in the river, many of the participating agencies have set forth on their application. A significant level of commitment has been shown not only through the number of projects conducted but also in the fiscal support provided by the State.

Assessment Goals

This assessment will attempt to gather information concerning projects implemented by the many participating agencies in a condensed format. Projects which have been conducted will be divided among point and non-point source controls. This report will summarize those projects which have been completed through fiscal year 1986 with the specific intention of following those strategies set forth by the plans. Water quality data from the

Department of Health and Mental Hygiene (DHMH) Office of Environmental Program's Patuxent River Monitoring Program (1983-1985) will be reviewed to determine if these projects are improving the condition of the river as indicated by measurements of dissolved oxygen, turbidity and chlorophyll "A". Water quality will be determined from the trend analysis plots provided by OEP. Values will not be quantitative but rather qualitative in nature. This is due to the limited "snapshot" of water quality data produced to date by the monitoring programs which limits its use in precise water quality determination.

The assessment will also evaluate the collection of information concerning improvements in the watershed to facilitate future program reviews to determine effectiveness of the restoration strategy.

Point Source Pollution Reductions

The Nutrient Control Strategy embarked upon by the Maryland Office of Environmental Programs outlined a five year program for the Patuxent Basin to reduce source inputs of both phosphorus and nitrogen. Based on a discussion taking into account scientific as well as economic criteria, the agreed upon limits for these two nutrients were 1.0 mg/l phosphorus and 3.0 mg/l nitrogen. Total basin discharge of phosphorus should be limited to 320 lb./day and limited to 2,000 lb./day for nitrogen from point sources. Federal support for nutrient removal is currently directed only at phosphorus. The State of Maryland, backed with scientific evidence showing nitrogen limitation in the Patuxent River has recognized the unique aquatic habitat represented by estuaries and supported the need for nitrogen removal to restore the Patuxent River.

The implementation of this nutrient strategy has through 1986 produced some progress, but the five year time frame developed in 1981 has been increased to seven years. Thus all of the STPs (sewage treatment plants) in the basin with a flow greater than 0.5 MGD will not be under compliance until 1988. The initial five year period has seen reduced effluent discharge of both phosphorus and nitrogen. By the end of 1986 OEP estimates that 42% (14.4 MGD) of effluent discharged into the Patuxent from the major STPs will comply with the standards for phosphorus set forth by the strategy. By the end of 1987 the percentage will increase to approximately 56%. Construction is underway at specific facilities in the basin to meet the nitrogen removal standards although none are currently on line.

Through 1985 cumulative phosphorus loading into the river from major STPs has been reduced from 1981 levels by approximately 24% while cumulative nitrogen loadings have been reduced by 10%. Phosphorus reduction has accrued principally due to upgrading of two STPs and through improved use of existing equipment at throughout the basin. Nitrogen reduction has been achieved to date solely by a tightening of existing procedures and equipment utilization at STPs in the basin. The reductions in phosphorus and nitrogen plant by plant from 1981 to 1984-85 is shown in Table 3.

Water quality data summaries are only available from the Patuxent River Monitoring Program for the years 1983, 1984, 1985; thus only point source reduction of phosphorus and nitrogen which were in effect during this time frame can be used to assess improvements in water quality. Those plants which would be included under this provision are identified in Figure 5. They are all in the upper portion of the Patuxent River, Little Patuxent (Savage), Horsepen and Fort Meade. The reduction in phosphorus and nitrogen inputs at these facilities has been extracted from OEP's basin with nitrogen and phosphorus reduction summary (Table 1) and summarized in Table 4.

The figures shown in Table 3 represent the actual reduction in point source loading at STPs which have been upgraded prior to 1986. It must be noted that nitrogen removal was not included at any of these facilities and thus reduced nitrogen levels is due to improved techniques at the facilities.

The direct impact of the improvements at these facilities on water quality in the river is thought to be small and directed to the upper reaches. The impact on water quality in the lower portions of the river would be indirect.

Table 3. - NUTRIENT LOADS DISCHARGED BY MAJOR PATUXENT SEWAGE TREATMENT PLANTS[1]

TOTAL PHOSPHORUS

STP Name	Flow Average MGD	Concentration Average mg/l	Pound Loading Average/Day	1981 Base Year Averages MGD	1981 Base Year Averages lbs./Day
Little Patuxent	9.1	0.4	30	7.9	370
Parkway	4.5	3.4	130	5.6	150
Western Branch	10.5	3.3	290	9.9	190
Horsepen	0.36	4.8	14	0.3	10
Maryland City	0.65	5.5	30	0.6	50
Patuxent (A.A.)	4.0	6.2	210	3.6	100
Bowie	2.43	5.1	100	2.5	200
Fort Meade	1.86	0.4	6	2.4	80
Md. House of Correction	1.11	5.0[2]	50	0.7	20
Solomons Island	--	--	--	--	--
TOTALS	34.5	NA	860	33.5	1170

TOTAL NITROGEN

STP Name	Flow Average MGD	Concentration Average mg/l	Pound Loading Average/Day	1981 Base Year Averages MGD	1981 Base Year Averages lbs./Day
Little Patuxent	9.1	21	1590	7.9	1470
Parkway	4.5	19	710	5.6	870
Western Branch	10.5	15	1310	9.9	1650
Horsepen	0.36	18	50	0.3	50
Maryland City	0.65	24	130	0.6	130
Patuxent (A.A.)	4.0	22	730	3.6	750
Bowie	2.43	24	490	2.5	580
Fort Meade	1.86	12	190	2.4	490
Md. House of Correction	1.11	20[2]	190	0.7	50
Solomons Island	--	--	--	--	--
TOTALS	34.5	NA	5390	33.5	6040

[1]Tables are summaries of 1984-1985 self-monitoring data and OEP compliance monitoring data. Though Solomons Island is considered a major Patuxent STP in this plan update, its use of land treatment prevents its inclusion in these tables.

[2]Maryland House of Correction nutrient concentrations are estimates extrapolated from very limited monitoring.

Source : Patuxent River Basin Update, 1986 - Maryland Office of Environmental Programs.

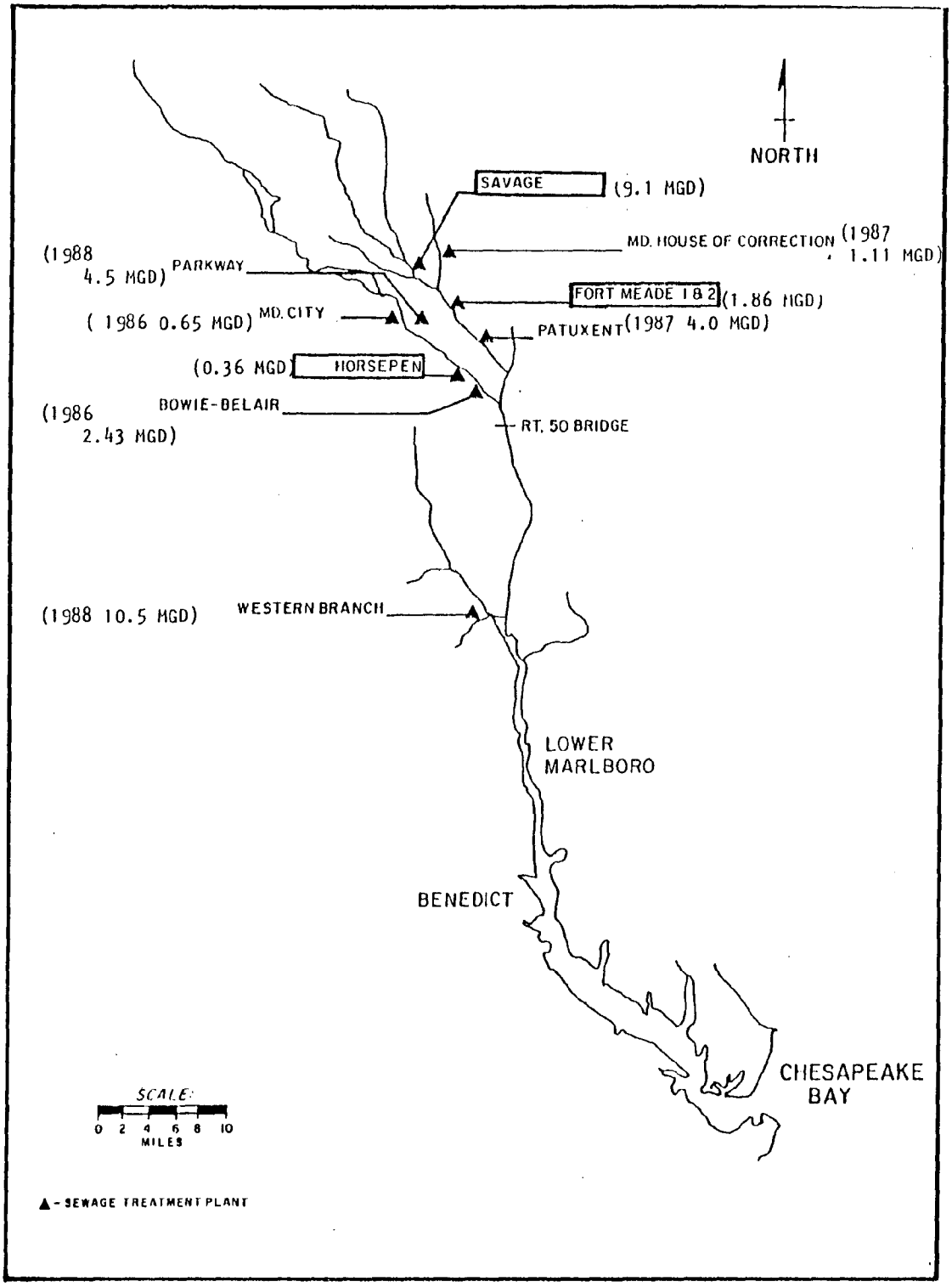


Figure 5: Map indicates the location of STPs in the Patuxent River Basin. Numbers in parentheses are the average daily flow in millions of gallons per day (MGD) and date the plant will comply with the Nutrient Control Strategy. Those STPs circled were under compliance prior to 1986.

TOTAL PHOSPHORUS

STP NAME	1981 DISCHARGE AVERAGES MGD	lbs./day	1984-85 DISCHARGE AVERAGES MGD	lbs./day	CHANGE 1981-1985
Little Patuxent	7.9	370	9.1	30	
Horsepen	0.3	10	0.36	14	Change MGD +0.72
Fort Meade	2.4	80	1.86	6	Change lbs./day -410

TOTAL NITROGEN

STP NAME	1981 DISCHARGE AVERAGES MGD	lbs./day	1984-85 DISCHARGE AVERAGES MGD	lbs./day	CHANGE 1981-1985
Little Patuxent	7.9	1470	9.1	1590	
Horsepen	0.3	50	0.36	50	Change MGD +0.72
Fort Meade	2.4	490	1.86	190	Change lbs./day -180

SOURCE - Patuxent River Basin Update, Maryland Office of Environmental Programs January, 1986.

Table 4. : Average daily discharge changes between 1981 and 1985 for those plants meeting the effluent limits set forth by the Nutrient Control Strategy.

Decreases in algal biomass, as a result of reduced nutrient levels, would reduce the amount of detrital material being received by the lower estuary. This detrital material, derived from the decomposition of algae, is transported by currents to the sediments of the lower river where it may act as a nutrient "sink." Nutrients from this "sink" would be released during periods of low dissolved oxygen and moderate stratification. This pool of nutrients could promote blooms in the lower estuary reducing water quality. Reduced nutrients entering the upper portions of the river can be linked to change in water quality throughout the river.

Non-Point Source Pollution Reductions

Specific reductions in non-point source nutrients are difficult to set and quantify due to the diffuse nature of the inputs. In addition, the extent of non-point source pollution is dependent on the amount of rainfall in a given year. Dry years will reduce nutrient loading while wet years will increase loadings. This dependency on rainfall produces pulses of nutrients entering the system following each storm event. These pulses can result in dramatic localized water quality changes. Even in an average rainfall year non-point sources are significant contributors of nutrients bay wide. Figure 6 is a comparison of point and non-point sources for both nitrogen and phosphorus throughout the bay system. Phosphorus loading is dominated by point sources while non-point sources contribute more nitrogen to the Bay system. This underscores the need to control both of these sources of pollution entering the Patuxent River.

The State of Maryland has recognized the need for the control of non-point source pollution and has incorporated such a program into the Chesapeake Bay Initiatives. Many State agencies are actively involved in controlling non-point source inputs into the Bay as a whole and specifically the Patuxent River. Programs include installation of best management practices, retrofitting existing development, structural and non-structural shoreline erosion control, and stormwater management.

Agricultural Best Management Practices

The cost share program implemented by the Maryland Department of Agriculture is aimed at assisting farmers in the installation of best management practices. This is one of the most important components in the State's overall non-point source control program. Cropland generates the largest share of the non-point source nutrient loadings to the Bay (US EPA 1983). The program has been in effect since 1983 and to date 129 practices have been installed which serves 1,132 acres in the Patuxent River Basin.

The number of projects and acreage served is listed by county on Table 5. In addition this table includes the cost share earned by each county along with the total cost of the practices installed. The level of participation by each county is presented graphically in Figures 7 and 8. (Note: the amount of acreage which lies in the watershed varies greatly among the seven counties.)

Retrofitting Existing Development

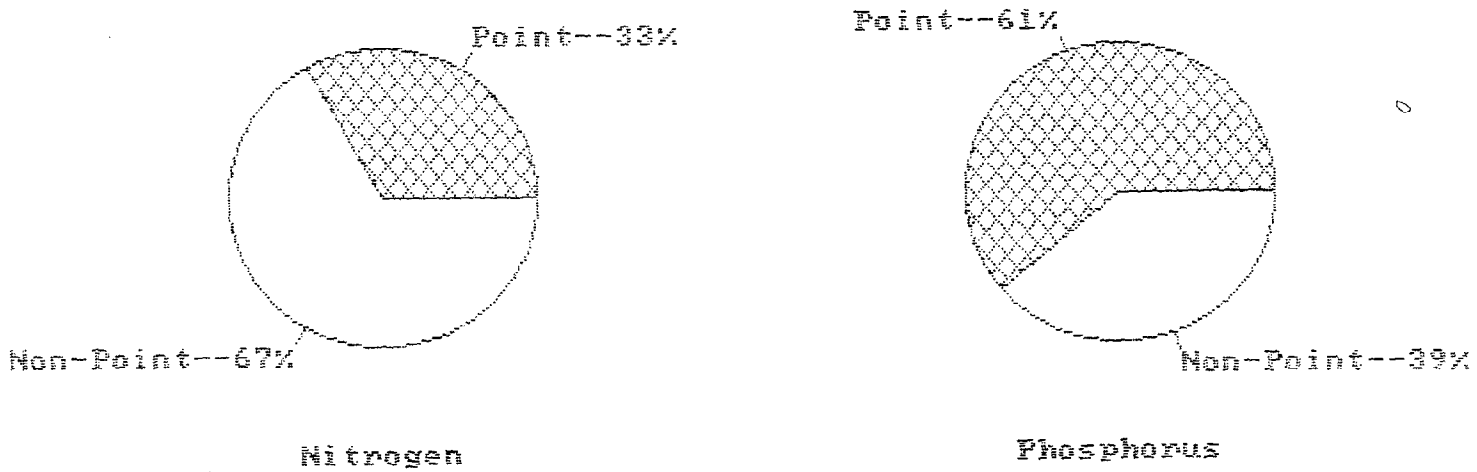
Several projects are planned for the Patuxent River watershed:

A. Lewis Creek, St. Mary's County
B. Fox Hill Park, Prince George's County
C. Towsers Branch, Anne Arundel County

While these projects will have a definite impact on water quality, they have not been completed. This would preclude them from having any impact on water quality in the Patuxent River to date.

Figure 6.

COMPARISON OF POINT AND NON-POINT
SOURCES OF NITOGEN AND PHOSPHORUS
BAY WIDE



Source : United States Environmental
Protection Agency, 1983.

Table 5.

PATUXENT RIVER WATERSHED

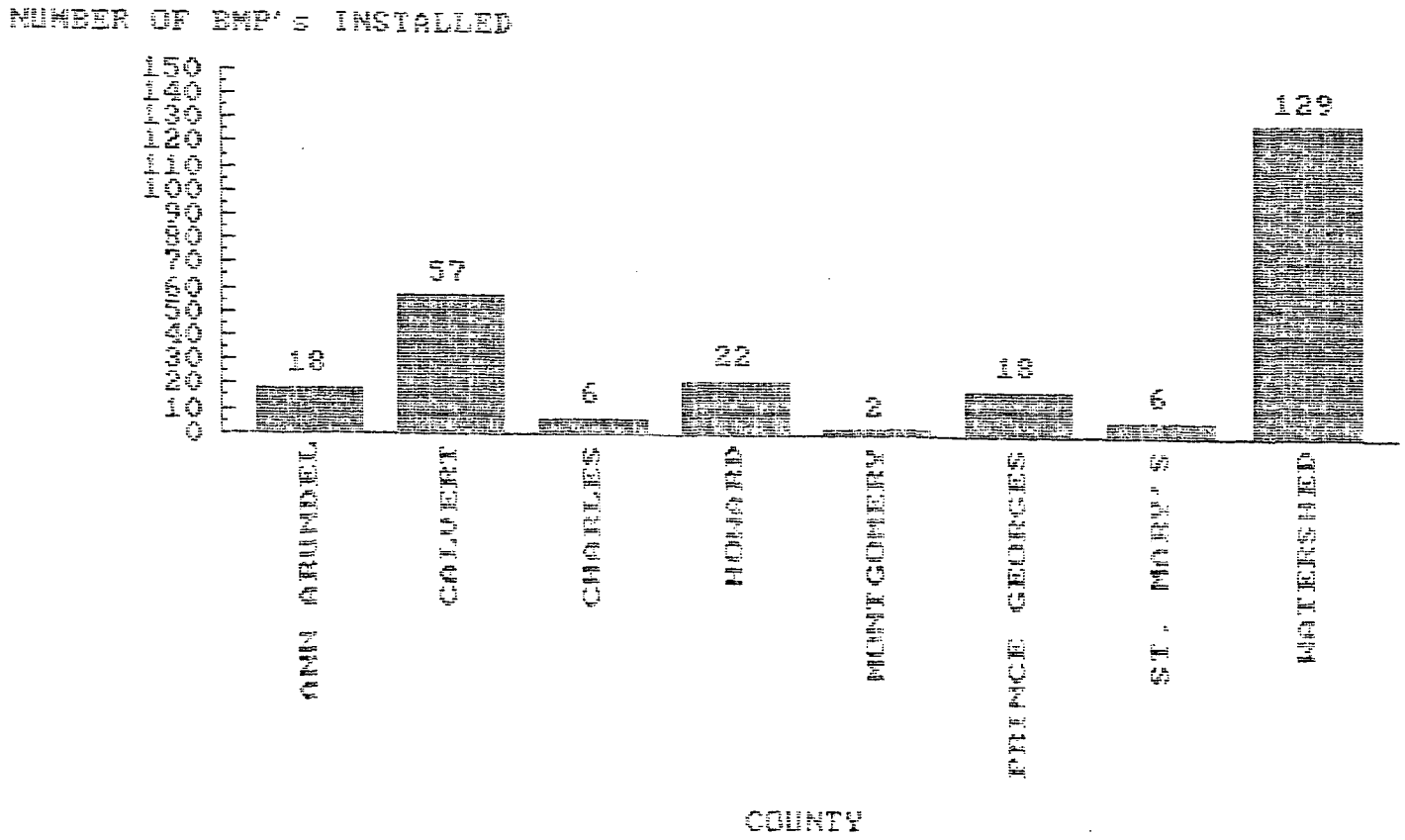
COMPLETED BEST MANAGEMENT PRACTICES
THROUGH MARYLAND AGRICULTURAL COST-SHARE PROGRAM

June 30, 1986

COUNTY	NO. OF BMP'S	TOTAL ACREAGE SERVED	COST SHARE EARNED	COST OF PRACTICES
Anne Arundel	18	231	$ 25,192	$ 44,567
Calvert	57	367	87,074	205,601
Charles	6	37	12,726	18,068
Howard	22	189	33,899	69,282
Montgomery	2	0	3,685	4,094
Prince George	18	233	44,573	107,801
St. Mary's	6	75	23,399	43,626
TOTALS	129	1,132	$230,548	$493,339

Figure 7.

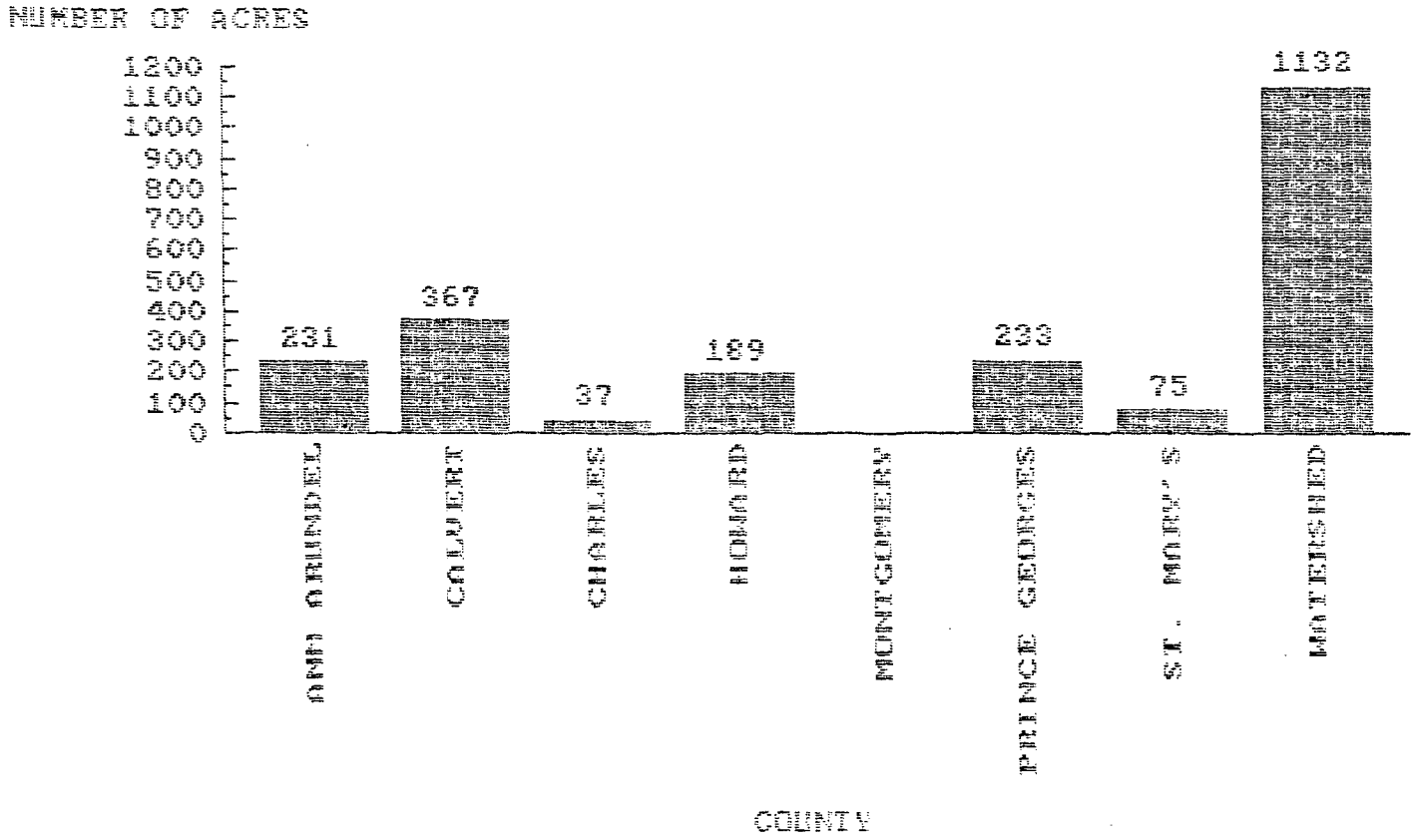
BEST MANAGEMENT PRACTICES INSTALLED UNDER
MDA COST SHARE PROGRAM 1983 - JUNE, 1986
IN THE PATUXENT RIVER WATERSHED.



SOURCE : MARYLAND DEPARTMENT OF AGRICULTURE
STATE SOIL CONSERVATION COMMITTEE

Figure 8.

BEST MANAGEMENT PRACTICES INSTALLED UNDER
MDA COST SHARE PROGRAM 1983 - JUNE, 1986
IN THE PATUXENT RIVER WATERSHED.



SOURCE : MARYLAND DEPARTMENT OF AGRICULTURE
STATE SOIL CONSERVATION COMMITTEE

Shoreline Erosion Control

1. Non-Structural - These shoreline stabilization projects involve grading and/or planting of vegetation along the bank to reduce erosion and resultant sedimentation of the river. These projects will have an impact on water quality in the future by reducing turbidity. This is a new program and few of the projects have progressed beyond the planning stage. A few projects are nearing the construction phase. They are:

A. Mechanicsville, St. Mary's County - Trent Hall Farm - Installation of 500 feet of intertidal marsh grass.

B. St. Leonard, Calvert County - Jefferson Patterson Park - Installation of offshore stone breakwater with 700 feet of intertidal marsh grass

C. Pieds Property, Prince George's County - (1500 feet) bank grading and stabilization with installation of intertidal grass and a 100 foot wide forested buffer

2. Structural - These erosion projects involve the use of rip-rap, bulkheading or other permanent structures to reduce shoreline erosion. A summary of the projects which have been conducted in the Patuxent Basin is shown in Table 6. Information provided includes location, shore length, structure length, type construction and date completed.

Stormwater Management

Many projects are currently being installed throughout the State to reduce the impact of stormwater upon receiving water bodies. As indicated by Table 7 the number of approved projects in each of the seven Patuxent River Basin counties has risen steadily. However these figures are for the entire county as the Water Resources Division does not currently maintain their computer files by watershed.

Table 6.-

Structural Shore Erosion Control Projects Completed in the Patuxent River Watershed

County	General Project Location	Length of Shore	Construction Type	Completion Date	Length of Structure
Fiscal Year 1984					
Calvert	Back Creek	234 L.F.	Timber Bulk-head & Rip Rap	6-25-84	228' Timber 40' Stone
Fiscal Year 1985					
St. Mary's	Esperanza Farms	464 L.F.	Stone Revetment	9-18-84	464'
Calvert	Prison Point	430 L.F.	Stone Revetment	12-11-84	430'
St. Mary's	Greenwell State Park	1134 L.F.	Stone Revetment	4-17-85	1134'
St. Mary's	Greenwell State Park	150 L.F.	Stone Revetment	5-27-85	162'
Fiscal Year 1986					
Calvert	Drum Point	930.5 L.F.	Timber Bulk-head w/ Drain	11-25-85	1032.5'
Calvert	Ships Point	735 L.F.	Timber Bulkhead	12-20-85	782'

Table 7. -

Stormwater Management Plans Approved in the Seven Patuxent River Basin Counties During the Period From 1980 - 1985. (Note: figures are for entire county)

County	1980	1981	1982	1983	1984	1985	Cum.
Ann Arundel	11	17	12	16	16	42	114
Calvert	2	3	3	3	3	7	21
Charles	1	2	9	7	2	7	28
Howard	8	6	10	6	8	13	51
Montgomery	7	5	8	11	7	19	57
Prince Georges	12	16	9	7	12	39	95
St. Mary's	3	2	8	9	11	9	42
TOTAL	44	51	59	59	59	136	408

Source : Maryland Department of Natural Resources - Water Resources Division

Water Quality

The information used to assess water quality parameters was taken from the Office of Environmental Programs Patuxent River Water Quality Monitoring Program over the period of January 1983 to December 1985. The location distance from mouth and identification number is provided for each sampling station in Figure 9. **The interpretation of changes in water quality over this period is a qualitative assessment of the data and is not intended to portray a quantitative difference in the parameter over the period.**

When using such a brief time span to identify trends, variances in environmental conditions will exist over the period. Two significant environmental factors which may produce changes would be fluctuations in temperature and water flow. The temperature pattern has remained stable as shown in Figure 10. The mean daily flow has changed over the period of January 1983 to December 1985. The flow has declined each year with very low flows recorded during 1985. The overall pattern of changes in flow is presented in Figure 10. Reduced flow in the river could lower dissolved oxygen levels as well as reduce turbidity in the river.

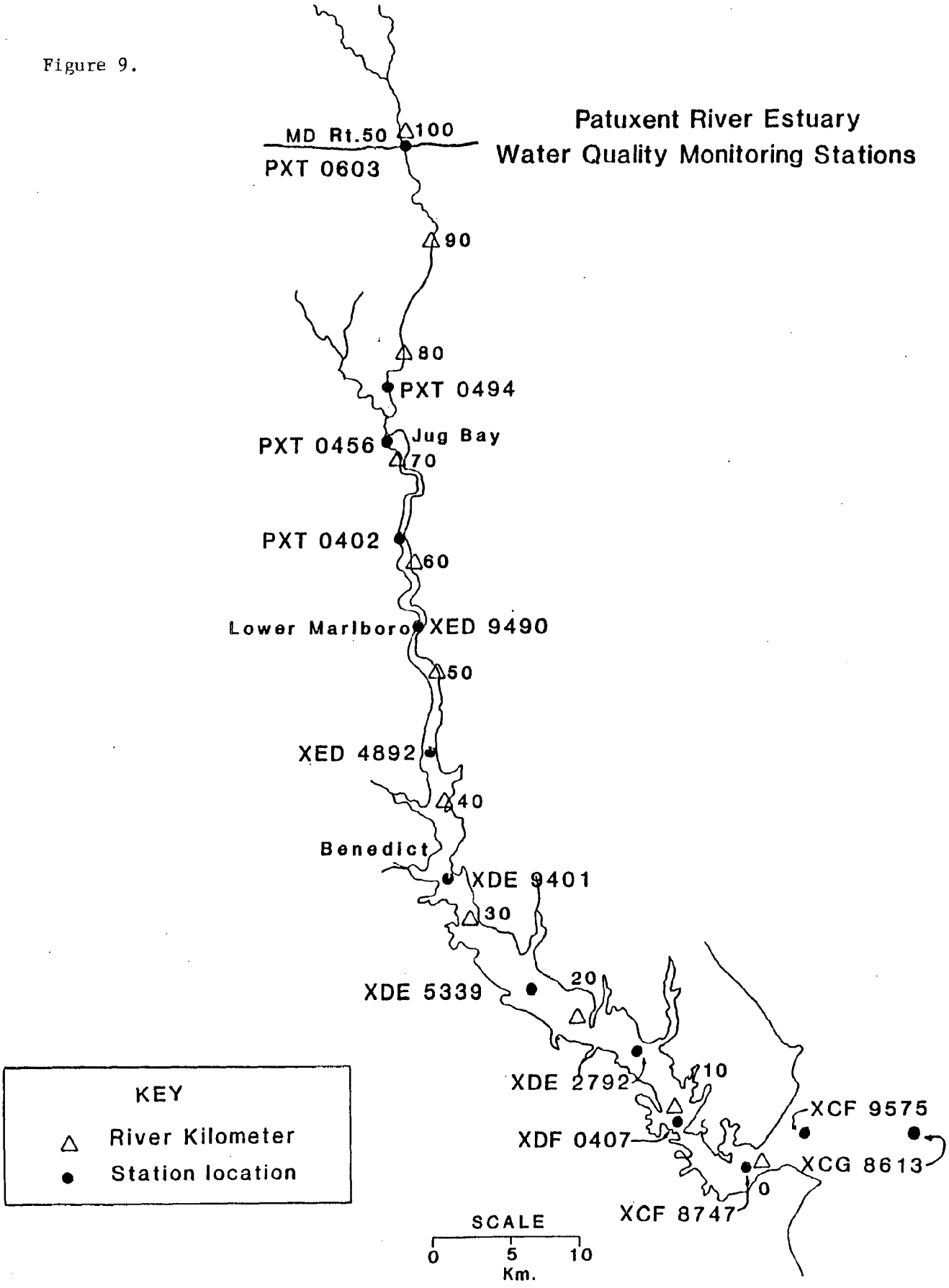
The change which has occurred in the parameters is presented for each ecological zone of the river. Values are shown to have increased, decreased or remained constant over the three year period. The water quality parameters selected, dissolved oxygen, chlorophyll "as" and turbidity were those identified by the Charrette as indicators to monitor improvement in water quality.

Dissolved oxygen can vary greatly depending on the specific environment conditions at the time of sampling. Both water temperature and flow would have an effect on the amount of oxygen able to be held by the water. Because 1985 was a particularly low flow year, it would be anticipated that dissolved oxygen measurements made during this time frame would be lower than during a normal flow condition. Two data points were selected to be used in this assessment, the change observed in the maximum and minimum dissolved oxygen values for each year based on median plots prepared by OEP. The yearly maximum occurs during the winter, as low temperatures increase the oxygen holding capacity of the water. Biota in the river can become stressed when dissolved oxygen levels fall below 4 mg/l. During the summer months the lower portion of the river becomes stratified and increased water temperatures cause dissolved oxygen levels to decline. These levels can fall below the critical value of 4.0 mg/l from 0 to 30 km above the river's mouth.

Chlorophyll "a" is used to determine the amount of algae present in a water sample. Chlorophyll "a" is a component of algae cells and its concentration is directly related to the amount of algae present in the river. High chlorophyll "a" readings would indicate nutrient enrichment of the water body which has promoted increased algal growth. Chlorophyll "a" can be used to determine if excessive amounts of nutrients are entering the river from sources in the watershed.

Turbidity is used to determine the photic zone of a river. This is the depth to which enough light is able to penetrate to support plant growth, either for free floating algae or submerged aquatic vegetation along the shoreline. Turbidity is an indicator of the extent of sedimentation occurring within a

Figure 9.


Patuxent River Estuary
Water Quality Monitoring Stations
MD Rt.50
100
PXT 0603
90
80
PXT 0494
PXT 0456
Jug Bay
70
PXT 0402
60
Lower Marlboro
XED 9490
50
XED 4892
40
Benedict
XDE 9401
30
XDE 5339
20
XDE 2792
10
XDF 0407
XCF 9575
XCG 8613
0
XCF 8747
KEY
River Kilometer
Station location
SCALE
0 5 10
Km.

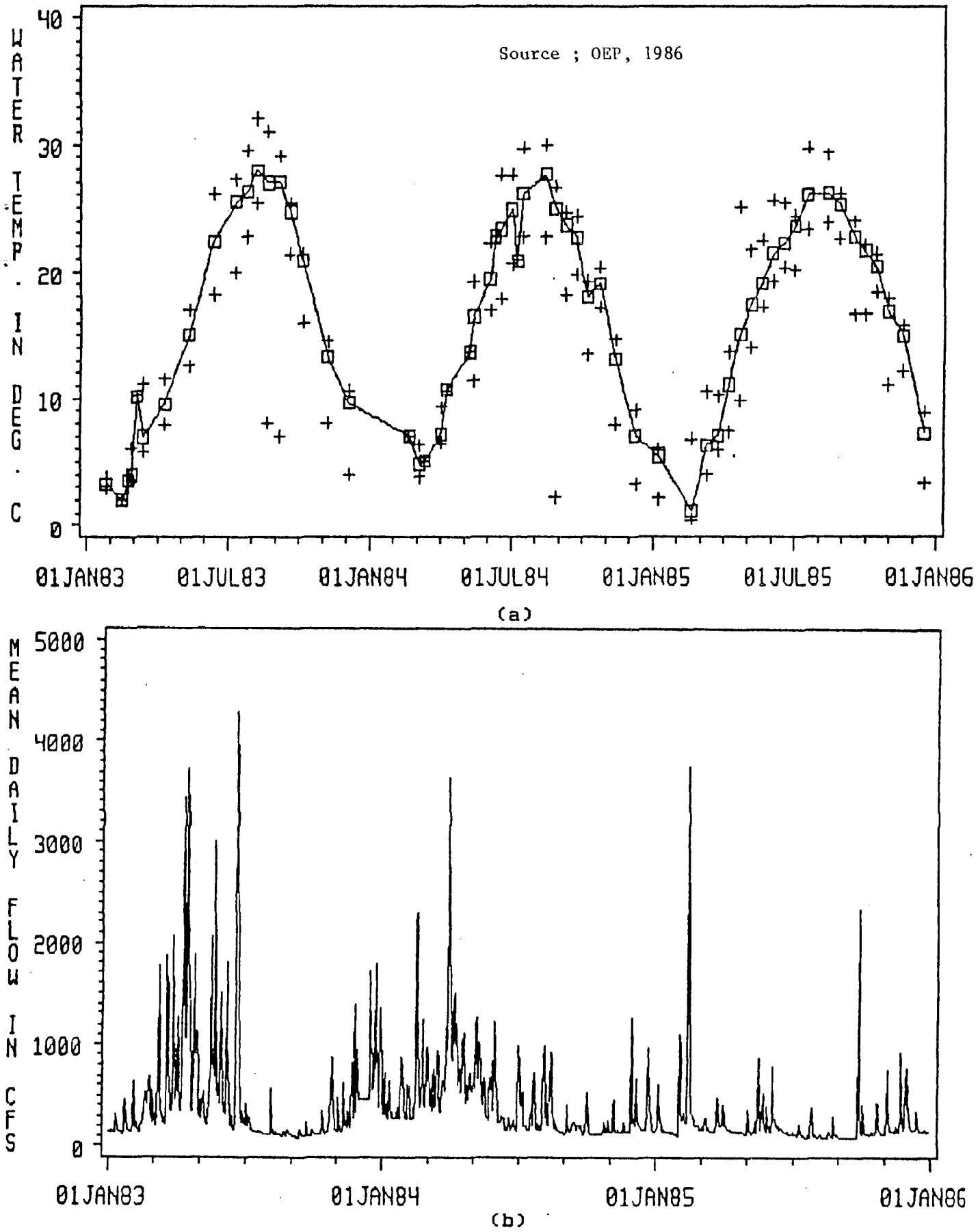


Figure 10. Median and range of water temperature (a) and river flow (b)

river. Turbidity can also indicate the productive health of a river as turbid waters tend to be unproductive due to a lack of available light.

Assessment of water quality in each of the zones of the river over the period from January 1983 - December 1985

Zone 1 - Tidal Fresh

Dissolved oxygen levels have remained constant over the period with a slight increase in the minimum dissolved oxygen level during the summer. Peak and median chlorophyll "a" readings have remained stable over the period. Peaks have not exceeded 60 mg/l in this portion of the river. Turbidity has also remained constant. The overall stability of this portion of the river during this three year period may be due to the segment's swift flow and the reduced phosphorus inputs from sewage treatment plants.

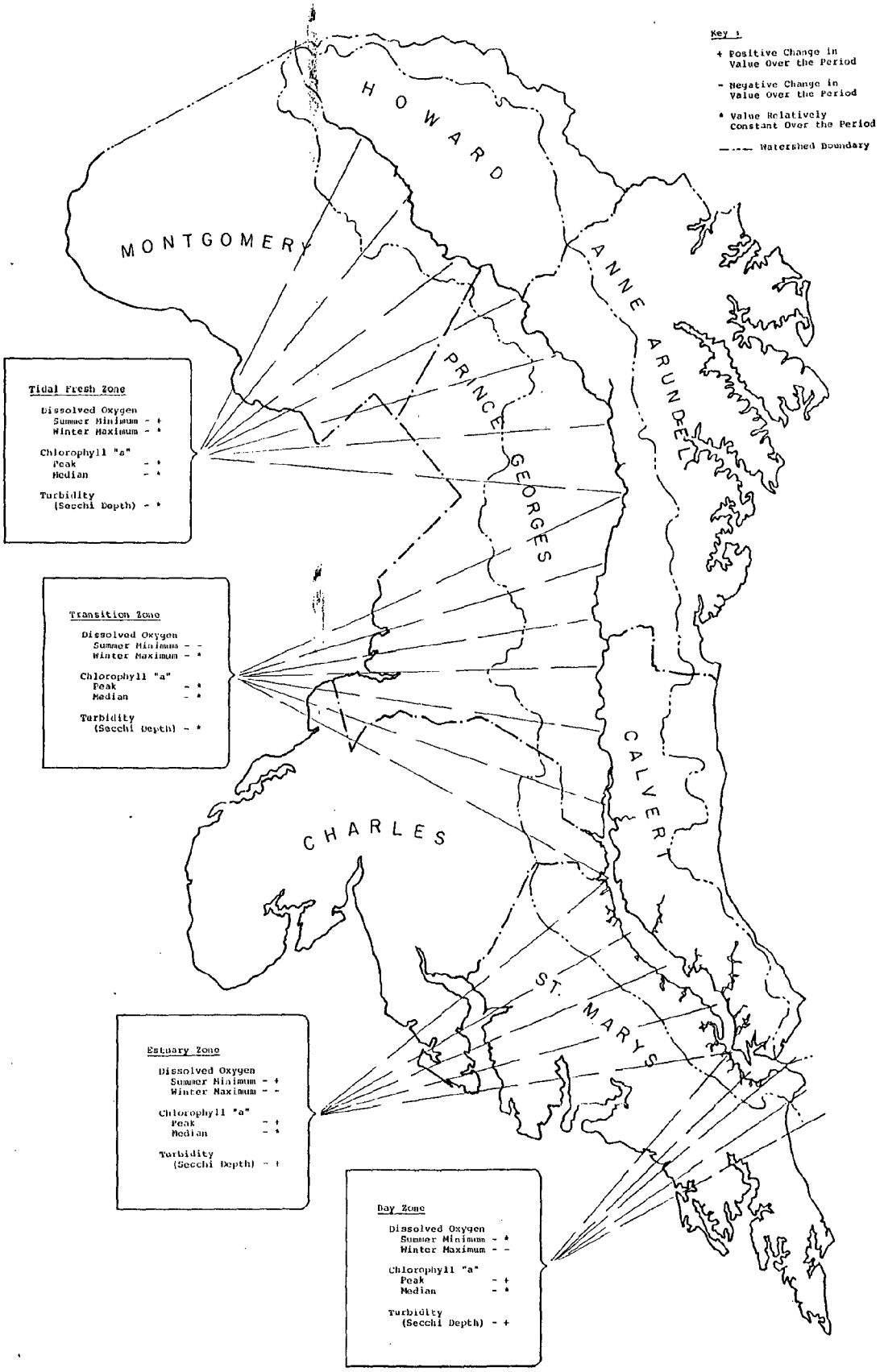
Zone II - Transition Zone

Dissolved oxygen levels have remained constant in this portion of the river, though they tend to be low. The extent of elevated chlorophyll "a" readings increased as well as peak chlorophyll A" readings. The number of readings in excess of 60 mg/l increased over the period. The mixing which occurs in this portion of the river along with reduced flow during 1985 may explain the slight rise in chlorophyll "a" measurements in the transition zone. Turbidity remained constant over the period although it is very high due to the mixing of salt and fresh water which occurs in the transition zone.

Zone III - Estuary

The summer months tend to have low dissolved oxygen recordings in the estuary portion of the river. This trend is continuing although there has been a slight improvement in the summer minimum over the period. The chlorophyll "a" median concentrates remained stable although peaks increased which may be a result of low flows causing periodic increased residence times for nutrients which stimulated algae growth. Turbidity increased in this segment of the river over the three-year period.

CHANGES IN SELECTED WATER QUALITY PARAMETERS FOR THE PERIOD OF JANUARY 1983 TO DECEMBER 1985.



Source: Office of Environmental Programs Patuxent Water Quality Monitoring Program Data Summary Reports - 1984, 1985, 1986.

CONCLUSION

Progress has been made in the effort to restore the Patuxent River to prior levels of water quality. This progress has been slow and results are only now beginning to be manifest.

The reduction in point source nutrient inputs has not occurred in the magnitude initially outlined in 1981. The reduction which has occurred has focused in the element Phosphorus with little or no reduction to date in Nitrogen loading from the STPs in the basin. The control of non-point source inputs has also been delayed and few projects have reached the implementation phase. The point and non-point source control improvements reflect the inability of current State programs to be effective over a short time span such as five years.

The current control program is making progress and conditions are slowly improving in the river. The program for restoring the Patuxent River needs to maintain momentum. Point source controls for both Nitrogen and Phosphorus need to be implemented in a more timely fashion at all STPs in the basin. Those STPs in the basin unable to meet acceptable discharge standards should have stronger actions taken against them to correct the failure of current program in doing this.

The control of non-point source nutrients loading must be made as high a priority as point source control. Future progress reports should not refer to "planned" improvements but to simply state what is in place at that point in time.

In conclusion progress has been made although it has been at a significantly slower pace than anticipated and the time frame for the completion of the restoration effort has expanded.

APPENDIX A

PATUXENT RIVER CHARRETTE

The Patuxent River Charrette was held on December 2-4, 1981 to reach a consensus among State and local leaders on a nutrient control strategy for the watershed. The following statement of goals for the watershed, as taken from the Patuxent 208 Plan, was agreed upon.

Water Quality Goals and Measures

Goal: To restore water quality to the 1950's levels as defined by dissolved oxygen (DO) and turbidity.

Reduce pollutant loadings
Ensure levels to sustain biological life
Maintain sources of potable water in upper river

Measures:

DO Minimum

5 mg/l above Sheridan Pt. (river mile 20)
2 mg/l at Sheridan Pt. in deep water

Turbidity:

1.5 to 2 meters secchi disc visibility at Sheridan Pt.

Recreational and Esthetic Goals and Measures

Restore and improve the potential for recreational uses of the Patuxent River, including boating, sports fishing, swimming, and esthetic pleasure.

1. Enhance the scenic quality of the river

   Measures: refuse cleanup
   rehabilitation and reclamation of sand and gravel sites*
   turbidity reduction
   maintenance of traditional water uses and way of life
   agricultural land preservation
   park development*

2. Preserve and enhance wildlife habitats

   Measures: zoning control of water frontage
   return of indigenous species

*Added from Charrette Action Plan

Productivity Goals

Restore the catch of "desired" species (finfish, shellfish, etc.) in the entire river by maximizing the number of successful year classes. Maintain research capability to identify key environmental life cycle needs.

River System Goals and Measures

1. View of the river as a unit including the impacts of the Chesapeake Bay on the estuary.

2. Prohibit or control (regulate) uses that degrade the river.

3. Manage water quantity to preserve water quality.

   Measures: infiltration and inflow reduction

4. Protect the economic and social needs of both the upper and estuarine jurisdictions.

   Measures: preservation of diversity and quality of life

5. In accommodating growth, develop land-use patterns that protect the water quality goals.

   Measures: quantity and quality of runoff same or better after development as before

6. Set targets for research, program for open space, construction grant money, and enforcement.

7. People who would generate a potential cost (environmental or economic) on the river should pay for the mitigation or prevention measures (including government regulation).

The recommedations that were agreed upon at the Charrette were incorporated into the Office of Environmental Programs' January 14, 1982 Nutrient Control Strategy for the Patuxent River Basin. That strategy, in turn, forms the policy of the Patuxent 208 Plan which is summarized in Appendix II.

APPENDIX B

PATUXENT 208 WATER QUALITY MANAGEMENT PLAN

Executive Summary

The 208 Water Quality Management Plan for the Patuxent River Basin was prepared under the authority of Section 208 of the Clean Water Act (P.L. 95-217), which requires the development and implementation of areawide waste treatment management plans.

The purposes of the plan are to assess water quality conditions in the Patuxent Basin, identify the nature and degree of existing water quality problems, and provide recommendations for alleviating those problems. The plan is arranged in chapters, which include a statement of goals and objectives, a water quality assessment, and descriptions of the impacts of point and non-point sources of pollution on water quality. Also included are discussions of groundwater and residuals management activities.

The following sections summarize the major elements of the plan:

Water Quality Assessment

Available data for the Patuxent River indicates that certain trends in water quality may be developing. These include increases in the levels of chlorophyll a and turbidity since the 1960's, and a decrease in dissolved oxygen (D.O.) levels in the bottom waters of the estuary, although low D.O. concentrations are also observed even under "natural" conditions in the lower estuary. Trend analyses of a variety of finfish indicate that harvest trends in the Patuxent closely parallel trends in the Chesapeake Bay, although there has been a decline in species diversity in the Patuxent.

Data regarding the oyster fishery in the Patuxent suggests that these trends are also similar to those discernable baywide, and indicate general declines in spat sets over recent decades. It is difficult, however, to draw specific conclusions regarding the causes of such declines, since fluctuations in spat set may be caused by a variety of factors. These include changes in water quality as well as other environmental conditions, such as salinity, temperature, disease, and predators.

The plan concludes that water quality problems observed in the Patuxent can be mitigated, to some extent, by reducing nutrient loads to the river from point and non-point sources. A continuing water quality monitoring program is recommended, and several areas where further research is needed are identified. These include, among others, projects which would estimate the rates of exchange of nutrients between the bay and the lower estuary, estimate rates of sedimentation and resuspension of certain nutrients and total sediment, and determine phytoplankton biomass and growth rates in the estuary and their relationship to levels of nitrogen and phosphorus.

Point Sources

In the Patuxent River Basin, 96 percent of the effluent from sewage treatment plants comes from publicly owned treatment works with discharges of over 500,000 gallons per day. Smaller sewage treatment plants and industrial discharges have relatively minor effects on basinwide water quality. This chapter outlines the State's strategy for controlling point source discharges to the Patuxent River. The recommendations were largely derived from the results of a conflict resolution process (called a charrette) which took place in December 1981, and included representatives from various conflicting groups.

The major points of the State's point source control strategy are as follows:

1. All facilities which have discharges that exceed 500,000 gallons per day must meet phosphorus effluent limits of 1.0 mg/l and plan for possible phosphorus limits of 0.3 mg/l.

2. An established goal of the charrette was to reduce nitrogen loadings to the river by point sources by 2,000 pounds from 1981 levels. To accomplish this, certain facilities will meet nitrogen limits of 3.0 mg/l either through conventional nitrogen removal or land treatment. All facilities will plan for possible 3.0 mg/l nitrogen limits and their 201 facilities plans will analyze the various alternatives for achieving this nitrogen limitation.

3. The 201 facilities plans will be the process through which specific decisions for each treatment plant affected by this strategy will be made.

4. Land treatment is the preferred alternative (where it is shown to be cost-effective).

Non-point Sources

In addition to point sources of pollution, water quality can also be affected to a significant degree by non-point sources of pollution. These originate on urban, suburban, and agricultural lands throughout the Patuxent Basin. The State's strategy for controlling non-point sources of pollution consists of the following elements:

1. A Non-point Source Technical Committee will be established to detail and coordinate the implementation of this strategy. The committee will consist of representatives of key State agencies, the seven counties within the Patuxent Basin, the Soil Conservation Districts (SCDs), the scientific community, and EPA.

2. OEP will commit funds to the development and maintenance of a computerized model for the basin, which will serve to test alternative policies and development scenarios for their water quality impacts.

3. A Patuxent Agricultural Task Force will be established, comprised of representatives of the Soil Conservation Service and the SCDs within the basin, and members of key State agencies. The Task Force will detail and coordinate the implementation of the agricultural aspects of the State's strategy.

4. Local SCDs should be strengthened where necessary in order for them to provide adequate technical assistance to farmers for planning and implementing pollution controls.

5. OEP worked with other agencies to develop a State cost-sharing program which was approved by the Maryland Legislature in 1982. Funds will be used to help farmers install best management practices in "critical areas" defined under the State's 208 program for agriculture.

6. OEP will work with local governments to strengthen their stormwater management programs and is calling on these jurisdictions to adequately staff and implement programs for effective stormwater management.

The remainder of the chapter includes brief sections on non-point source pollution from construction sites, surface mines, septic systems, and boating in the Patuxent Basin.

Groundwater

Although Maryland's groundwaters have not suffered widespread or serious contamination, the potential for contamination is present. Maryland is an industrial state and produces significant quantities of toxic or hazardous materials. If these are improperly managed, they may pose a serious threat to the quality of groundwater supplies. Federal and State programs have been implemented to protect groundwater resources throughout the State, and water appropriations control and water supply planning help ensure the conservation of this limited resource.

The plan concludes that no new management programs are necessary to ensure the protection of groundwater quality and quantity in the Patuxent Basin, although careful management is required in a few localized areas to ensure adequate supply. There is also a need to further educate the general public regarding certain actions they may take which might affect groundwater quality, such as improper disposal of toxic household substances.

The plan also concluded that land treatment can be an effective means of treating wastewater, but proper site selection and design must be carefully considered to avoid any adverse impact on groundwater resources.

Residuals

The generation of residuals has increased dramatically in the past few decades as a result of increased population, more stringent requirements for wastewater treatment, and increases in commercial and industrial activities. Landfill space is limited, and improper management or disposal of these wastes may result in surface or groundwater contamination. Federal programs, especially the Resource Conservation and Recovery

Act provide for the development of programs to regulate land disposal of waste materials, and for the development of resource recovery programs. Maryland has developed regulations for the proper management, utilization, and disposal of residuals, including solid waste, sewage sludge, hazardous waste, and resource recovery.

The plan concluded that no new laws or regulations are needed in Maryland to manage residuals waste disposal. There is a continuing need, however, to closely monitor solid waste management facilities and ensure the proper handling of toxic and hazardous wastes. Such monitoring programs should be coupled with strong enforcement programs.

Additional chapters of the plan include Institutional Arrangements, which describe existing local programs related to various aspects of water quality management and provide the reader with contact persons and their phone numbers for various State and local programs.

A chapter on public participation is included, which describes the make-up and functions of various groups which have provided input to OEP during the development of this plan. The chapter also describes the process by which the plan will be reviewed by the public, revised, and submitted to the Governor and EPA for approval.

Several appendices appear at the end of the plan, and serve to provide more detailed information on various subjects dealt with in the body of the plan. These appendices include a discussion of estimated sediment yields in the Patuxent, the State's water quality standards, a glossary, a table summarizing population and land use, a discussion of silviculture, and descriptions of Best Management Practices.

APPENDIX C

PATUXENT RIVER POLICY PLAN

The following recommendations are the strategies of the Patuxent River Policy Plan.

RECOMMENDATIONS

1. ESTABLISHING A PRIMARY MANAGEMENT AREA (PMA)

A PRIMARY MANAGEMENT AREA, DELINEATING THE AREA ALONG THE RIVER AND ITS TRIBUTARIES, WILL BE ESTABLISHED TO IDENTIFY AND MANAGE LAND FROM WHICH POLLUTION IS MOST LIKELY TO BE TRANSPORTED INTO THE RIVER.

The PMA shall be considered to be an area critical to the Chesapeake Bay and its tributaries;

Local governments will include the PMA in their plans and zoning ordinances;

Preferred land uses in the PMA will be agriculture, forest, and recreation;

Local governments will prepare plans for the PMA to minimize dense and intensive development and large impervious areas in the PMA;

State agencies, in regulatory activities, technical assistance, and grant programs, will target the PMA as a priority area; and

State and local governments will ensure that land use practices within the PMA shall be of such a nature so as to have no (or at least minimal) adverse impact on water quality of the Patuxent River.

2. PROVIDING BEST MANAGEMENT PRACTICES (BMP's) AND VEGETATIVE BUFFERS

PROGRAMS FOR PROVIDING BMP's AND VEGETATIVE BUFFERS IMMEDIATELY ADJACENT TO THE RIVER AND ITS TRIBUTARIES WILL BE DEVELOPED.

State and local governments will provide BMP'S on their publicly owned lands, including buffers where appropriate;

The State will require BMP's on State assisted projects, including buffers where appropriate;

Local governments will adopt subdivision and zoning provisions that require BMP's, including buffers where appropriate, in all new development;

BMP's, including filter strips and field borders, will be encouraged on agricultural land through education, voluntary action, incentive, compensation, and through implementation of the Maryland Agricultural Water Quality Management Plan;

Implementation of soil conservation plans, including filter strips and field borders where appropriate, will be required on lands acquired in easements;

The federal government will be requested to provide BMP's including buffers where appropriate, on its lands; and

The State Department of Transportation will protect roadside buffers by eliminating its practice of broadcast spraying of herbicides along roadsides.

3. IDENTIFYING MAJOR NON-POINT POLLUTION SITES

THE STATE, IN CONJUNCTION WITH LOCAL GOVERNMENTS, WILL SURVEY THE WATERSHED AND IDENTIFY MAJOR NON-POINT POLLUTION SITES.

Existing State regulatory and corrective programs will consider these sites as priority areas.

4. RETROFITTING EXISTING DEVELOPMENT

THE 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; and

The State will establish priorities among developed areas causing non-point pollution and address problems in order of priority.

5. ACCOMMODATING FUTURE DEVELOPMENT

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 sited to maximize use of soil infiltration capacity;

Development will be sited away from sensitive areas, such as reservoirs, wetlands, steep slopes, and aquifer recharge areas;

Sites within the watershed that offer unique opportunities for development and redevelopment will be identified and planned; and

New public facilities (schools, parks, highways) will incorporate best management practices.

6. INCREASING RECREATION AND OPEN SPACE

ADDITIONAL RECREATION AND OPEN SPACE LANDS WILL BE ACQUIRED IN THE PATUXENT WATERSHED BY THE 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; and

An acquisition program for the lower portion of the watershed will be prepared.

7. PROTECTING FOREST COVER

EXISTING FOREST COVER WILL BE RETAINED AND IMPORTANT SENSITIVE AREAS WILL BE REFORESTED TO PROTECT WATER QUALITY.

Existing State programs, like Program Open Space and Agricultural Preservation will be examined and amended for their application to forest protection;

Buffering with forested strips will be encouraged; and

The State will institute a reforestation program for developed areas.

8. PRESERVING AGRICULTURAL LAND

PRIME AND PRODUCTIVE AGRICULTURAL LAND WILL BE PRESERVED IN THE PATUXENT WATERSHED.

Easement purchases will include requirements for implementing soil conservation plans including buffer strips where appropriate; and

The Agricultural Cost-Sharing program will target the Patuxent watershed.

9. EXTRACTING SAND AND GRAVEL

SAND AND GRAVEL ACTIVITIES WILL BE MANAGED TO ALLOW EXTRACTION OF THE RESOURCE WITHOUT DAMAGE TO THE RIVER.

Abandoned sand and gravel sites will be reclaimed;

Sensitive control of active and future sites, particularly those in the 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 day a violation is found to exist by the appropriate State agency; and

The location of the resources will be identified, and county resource management strategies developed.

10. ADOPTING AN ANNUAL ACTION PROGRAM

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 be an integral part of the action program; and

The Commission will prepare an annual report on progress in implementing the plan.

The recommendations and proposed actions in this plan are a starting point. The Policy Plan has been approved by county governments and the General Assembly. Approval of the plan indicates concurrence and commitment to improving the Patuxent River. The combined work of local and State governments, citizens, land owners, and private industry is required to transform the proposals into an improved river.

While prepared for the Patuxent, the land management recommendations contained in this plan can serve as a model for managing any watershed and the Chesapeake Bay.

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