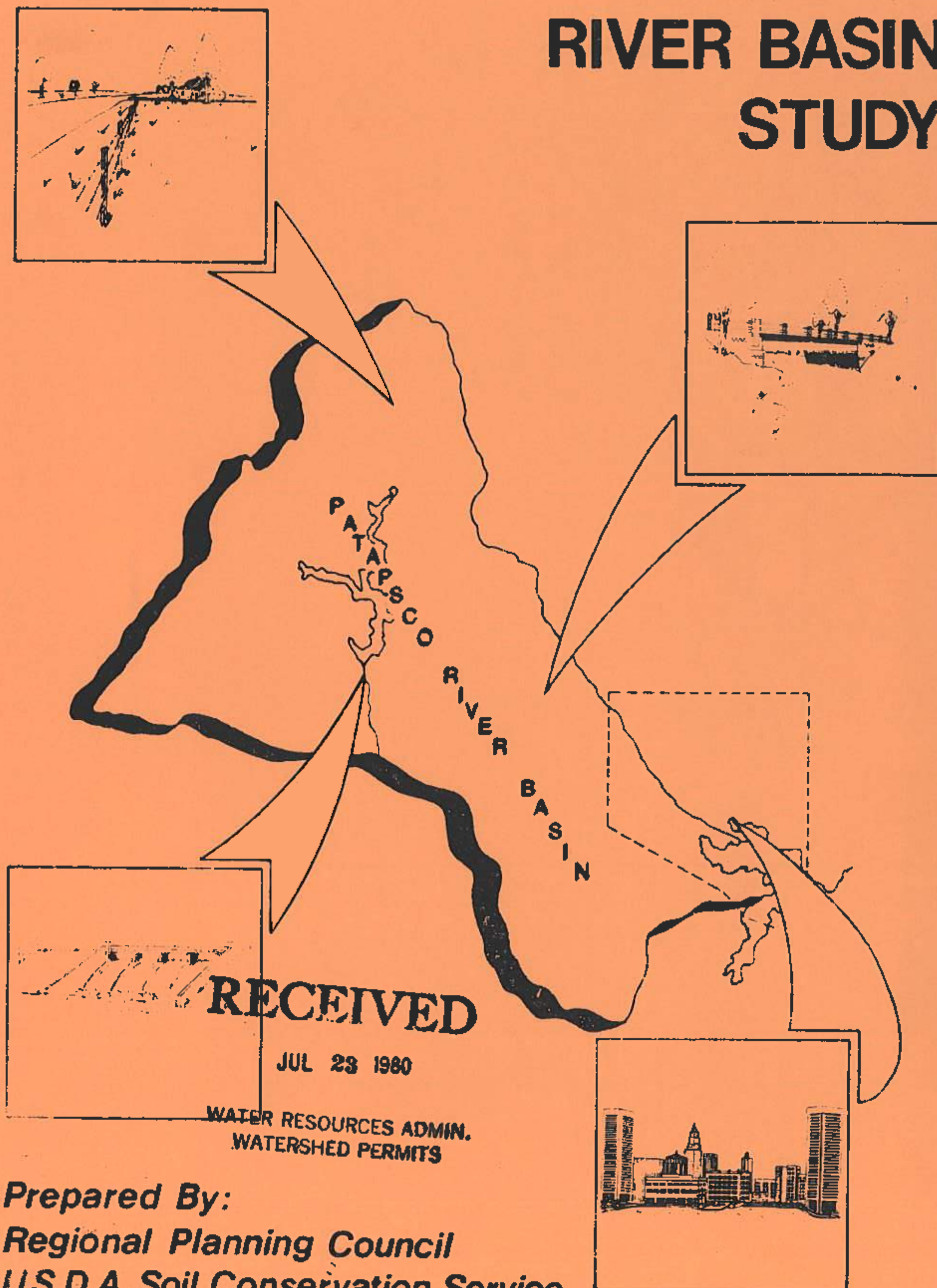
PATAPSCO RIVER BASIN STUDY



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March 1980

PATAPSCO RIVER BASIN STUDY

Prepared by:

Baltimore Regional Planning Council

U.S. Department of Agriculture

Soil Conservation Service

Forest Service

Economics Statistics and Cooperatives Service

for

Sponsoring Member Jurisdictions

Anne Arundel County

Baltimore City

Baltimore County

Carroll County

Howard County

March 1980

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SUMMARY

This is the final River Basin Report for the Patapsco River Basin Study. It is the culmination of a twenty month study coordinated through the Baltimore Regional Planning Council and the USDA Soil Conservation Service. Many other agencies of local, state, and federal governments have cooperated in bringing the report to this stage.

The Patapsco River Basin Study area includes the watersheds of both the Patapsco River and Gwynns Falls. It is located in Anne Arundel, Baltimore, Carroll, and Howard Counties, and Baltimore City.

Most of the water resource problems in the study area relate to urban flood damage along the lower Patapsco and its tributaries, the main stem of Gwynns's Falls, and Maiden's Choice Run. At the initiation of the study in 1978, it was determined by the Patapsco River Basin Coordinating Committee that the major emphasis should be on solving the flooding problems. Thus, the major emphasis of this study was on the flooding problems and possible solutions, with brief discussions of problems in water supply, water quality, erosion and sedimentation, and recreation.

The objectives of the study were: 1) to determine whether a feasible PL-566 flood prevention project existed anywhere in the Study Area, 2) if a project existed, were there potential sponsors for such a project and was it environmentally acceptable, and 3) if a project did not exist, to make recommendations about what other courses of action could be followed.

The initial effort of the Study was to inventory the flood damages. In order to do this, it was necessary to determine the flood levels and the associated damages.

Hydrologic and hydraulic models were developed in cooperation with the Maryland Water Resources Administration. These models were used to determine flood levels for Tropical Storm Agnes, plus the 100 year frequency flood for both present and future land uses.

Flood damages were determined using a damage survey conducted by the U.S. Army Corps of Engineers in conjunction with additional surveys done during the study. This information was then combined with the flood level data to determine amounts of flooding damage for Agnes, the 100-year flood, and lesser floods.

The conclusions reached by the flood damage analysis indicate that although flood damages are high during major floods, these floods do not occur frequently. The ten percent chance (10-year frequency) flood causes minimal damage with the one percent chance (100-year frequency) flood causing relatively major damage, thus making the average annual damages low.

Based on the procedures for economic analysis set forth in the Water Resources Council's Principles and Standards, it was determined that at this time there is no feasible structural flood prevention project under authority of the Watershed Protection and Flood Prevention Act, PL 83-566, as amended. A federally assisted structural flood prevention project must have economic benefits exceeding costs.

No structural alternative examined during this study meets this criterion. However, a nonstructural project may be feasible for portions of the study area.

There are many other avenues which can be followed to help solve the problems in the watershed. Some of these may include U. S. Department of Agriculture participation, mainly in the form of technical assistance. Most of the coordination and funding must come from the local and state governments or other departments within the U. S. Government. Below is a summary of possible sources and types of assistance available from different government agencies.

Source	Type[1]
City and County Government	T, A, N, S
State of Maryland	
Legislative Action	A, N, S
Department of Natural Resources	T, A, N, S
Baltimore Regional Planning Council	T
U.S. Government	
Soil Conservation Service	T, A, N, S[2]
Corps of Engineers	T, A, N, S[2]
National Oceanic Atmospheric Administration	T, N
Bureau of Outdoor Recreation	A

[1]T = Technical Assistance
A = Acquisition
N = Non Structural Measures
S = Structural Measures

[2]Structural projects shown to be non feasible.

The following general suggestions are offered for consideration:

1. Continue and expand the acquisition programs. In areas where people prefer not to accept an offer to purchase, acquire the residences as they become available. Coordinate the land acquisition programs of the State Park with structure acquisition programs of the local jurisdictions.

2. Expand Howard County's flood warning program to include other areas along the Patapsco River. Utilize the hydraulic and hydrologic models developed during the study to increase the lead time in predicting flooding. Expand Baltimore County's program on Gwynns Falls to include Baltimore City.

3. Develop a basin wide stormwater management program. Coordinate policies and requirements of all jurisdictions in order to get the most effective results from the program.

4. Consider methods other than acquisition for flood damage control. In certain areas, dikes, floodwalls, or flood proofing may be more cost effective methods of controlling damages from a 100-year flood. This report notes several areas where this may be true, namely, Woodbine, Elkridge, Pumphrey, Lower Gwynns Falls, and the Brittany Apartments. Also, a water supply impoundment being investigated by Carroll County on Gillis Falls would provide significant flood reduction benefits.

5. Monitor any changes in Federal policy with respect to cost sharing on non-structural practices. It may be possible that the changes would provide cost sharing for non structural measures; include acquisition for cost sharing; or provide cost sharing if the benefit cost ratio is less than 1:1.

6. Investigate the possibilities of developing a land treatment plan for the area. It may be possible to receive funding under PL 83-566 for an accelerated land treatment program to improve water quality.

Suggestions for specific subareas are as follows:

South Branch

1. Howard and Carroll County could consider a minor acquisition program on the South Branch.

2. Efforts could be made to educate people on methods of flood proofing.

North Branch

1. Modification of the bridges under the Western Maryland railroad tracks at Carrollton and Patapsco could be considered.

2. Special efforts could be made to control urban runoff upstream of Carrollton and Patapsco.

3. Baltimore City and the Congoleum Corporation could develop a joint flood hazard management plan for the protection of Liberty Reservoir.

Main Stem

1. Future planning should not be limited to examining major structural measures.

2. Baltimore, Howard, and Anne Arundel County could consider modification of existing floodplain constrictions between Elkridge and Baltimore Harbor.

3. An expanded acquisition program could be considered in Anne Arundel County.

4. The Howard County Flood Warning System could be expanded and refined to include Anne Arundel and Baltimore Counties.

Gwynn's Falls

1. Baltimore County could consider installation of four small impoundments in lieu of or in addition to its acquisition program. The impoundments also provide some benefits to Baltimore City.

2. Baltimore County and City could jointly develop a flood warning system and a flood disaster preparedness plan.

3. Baltimore County and City could consider dikes or floodwalls at two areas of concentrated flood damage.

4. The county and the city could investigate opportunities for retrofitted stormwater control on the Maiden's Choice Run and Dead Run tributaries to Gwynns Falls.

These suggestions are given in more detail near the end of the report.

INTRODUCTION

The Patapsco River and its major tributaries have long been a subject of concern among Water Resource Planning Agencies and the private citizens who are periodically threatened by flooding. In 1968, officials from the five jurisdictions that comprise the Patapsco Basin, the four Soil Conservation Districts represented in the basin, and officials from the state and regional governing bodies, petitioned the Soil Conservation Service (SCS) for assistance through the Watershed Protection and Flood Prevention Act, Public Law 83-566 (as amended). The officials cited flood damage, sedimentation, water management, and recreation as major problems within the Patapsco Basin.

Due to prior commitments of planning resources, the Soil Conservation Service was unable to act on the application. Meanwhile, other agencies took action to define and recommend solutions for the problems in the Patapsco Basin. Studies were conducted by the U. S. Army Corps of Engineers, Maryland Water Resources Administration, U. S. Department of Housing & Urban Development Federal Insurance Administration, and Howard and Baltimore Counties. Most of these studies focused on the problems in one area or on one tributary. There was little effort to coordinate the studies on a basin-wide basis.

In 1976, members of the Patapsco River Watershed Association and the Patapsco State Park Advisory Committee reinitiated their efforts to obtain technical assistance through PL-566. Through the Maryland Congressional Delegation, they petitioned the Soil Conservation Service for assistance.

In February of 1978, the U.S. Department of Agriculture and the Baltimore Regional Planning Council entered into an Intergovernmental Personnel Agreement. This agreement authorized the creation of a three-man technical team to study the water resource problems in the Patapsco River Basin. A Field Advisory Committee was established to coordinate the efforts of agencies within the U.S. Department of Agriculture. This Committee consisted of representatives from the Economics, Statistics and Cooperatives Service, the Forest Service, and the Soil Conservation Service.

During the course of this study many state and local agencies contributed to or participated in the management of the study. Financial sponsorship was given by the Baltimore Regional Planning Council, Baltimore City, and Anne Arundel, Baltimore, Carroll, and Howard Counties. Representatives of these jurisdictions, the Army Corps of Engineers, the Maryland Department of State Planning, and the Maryland Water Resources Administration formed the Patapsco River Basin Coordinating Committee. The Coordinating Committee held periodic meetings to review the progress of the study and to make recommendations which would guide the study efforts. The Committee members submitted formal comments on the Plan of Work, the First and Second Status Reports, and the draft final report. The four Soil Conservation Districts represented within the basin lent their support to the study.

The objective of the study was to determine whether or not an economically feasible PL-566 project existed in all or part of the Patapsco or Gwynn's Falls Basins. Efforts were to be coordinated with those of other water resource agencies which were conducting or had conducted studies in any part of the defined study area. The study would evaluate existing data and generate needed additional technical data to determine feasibility based on economic and environmental criteria. Further, through a program of public involvement, potential project sponsorship and public acceptability would be determined.

The study has relied on information from concurrent studies. Most notable among these were the Maryland Water Resource Administration's hydraulic modeling of the Patapsco River and the Army Corps of Engineers economic damage surveys. The Baltimore Regional Planning Council projected population and land use changes necessary for the hydrologic modeling of the Patapsco River. Background information has been supplied by local and state agencies. Original surveys were conducted when necessary to complement existing data.

Many actions have been initiated or accelerated as a result of this study. This will eventually contribute greatly to water resource management in the basin.

As its contribution to this study, the Maryland Water Resources Administration accelerated its program of hydraulic modeling of the Patapsco River. With some assistance from the study team they have completed hydraulic studies on the Main Stem and South Branch of the Patapsco, some major tributaries on the lower Patapsco, and tributaries in Carroll County. Water surface profiles and cross-section rating curves are available to help local planners in making decisions relative to flood plain management.

A hydrologic model was developed for the entire Patapsco River watershed using the Soil Conservation Service's TR-20 computer program. The model breaks the watershed into 101 subareas. It is calibrated using present hydrologic conditions and can be continually updated as land use changes alter hydrologic response. The model can be used by state and local water resource management personnel to predict peak discharges for storms with given recurrence intervals at critical points throughout the basin. The model can also be used to develop incremental and combined hydrographs to show how different hydrologic subareas interact with each other. The output from the model can be used in conjunction with the hydraulic model to predict the height to which water will rise during various storms at various points along the Patapsco and its tributaries. At the close of this study, both of these models will be maintained by WRA. (See Appendix A - Hydraulics and Hydrology.)

The Baltimore Regional Planning Council contributed to this study by completing a detailed study of anticipated land use/land cover changes. (See Appendix D) The study was based on local and regional population projections and land conversion relationships. Data generated was reviewed by local jurisdictions. As a result, RPC was able to develop a predictive tool that represents the best current data of both the local and regional planning agencies.

This data was initially developed for inclusion as input to the hydrologic model. However, the information is in such fine detail that it will have application in water quality planning as well as other land and water resource management programs which will benefit RPC and its member jurisdictions.

Two ad hoc work groups have been formed during the course of this study. The Storm Water Management Task Force is made up of representatives from state and local governments, the Soil Conservation Service, and the Corps of Engineers. The purpose of this group is to explore the possibilities of a basin-wide stormwater management program and the mechanisms by which such a program could be implemented. Through the efforts of RPC, the group will continue after the current study is complete. A second work group is exploring the possibility of expanding the Howard County flood warning system to include Baltimore and Anne Arundel Counties. This group includes Civil Defense officials, hydrologists, and planners from the affected jurisdictions. The group is considering the use of the hydrologic and hydraulic models developed during this study to increase the predictive capabilities of the system.

The value of committees such as these involving interjurisdictional interaction and coordination is that they strengthen lines of communication. Discourse between committee members increases the exchange of information and ideas for their mutual benefit.

As a result of recent meetings of the Stormwater Management Task Force, the idea of a Water Resources Analyzer Office has developed. The function of such an office would be the continuous monitoring and evaluation of stormwater management throughout the basin. With the hydrologic model, the Analyzer Office could evaluate the impact of the most current land use planning information on the flow regime and suggest the most cost effective means of mitigating any adverse impacts.

NATURAL RESOURCES OF THE BASIN

I. Location

The Patapsco River lies in northcentral Maryland on the western shore of the Chesapeake Bay. The Patapsco flows south and east to its mouth which is the Baltimore Harbor. Within the Harbor the Patapsco is joined by Gwynn's Falls, Jones Falls, Curtis Bay Creek, Jones' Creek, and Bodkin Creek. This River Basin Study includes two distinct drainage systems, the watershed of Gwynn's Falls and the watershed of the Patapsco River above the Baltimore Harbor. (See map inside back cover.)

The Patapsco River drains an area of 365 square miles. The area includes much of Carroll County east of Westminster and south of Manchester, northern Howard County, southern Baltimore County, northwestern Anne Arundel County, and a small part of Baltimore City near the harbor. Gwynn's Falls drains an area of 67 square miles in West Central Baltimore County and Baltimore City. The two watersheds are located in Water Resources Council hydrologic unit 02060003.

On the North Branch, Liberty Reservoir straddles the Carroll County-Baltimore County line at approximately the geographic center of the study area. Baltimore Washington International Airport lies in the extreme southeast corner.

II. Climate

The study area has a humid continental climate with mild winters and warm moist summers. The Appalachain Mountains to the west and the Chesapeake Bay and 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.

Rainfall averages about 41 inches per year with a rather uniform distribution throughout the year. The greatest intensities occur in July and August, the season for severe thunderstorms and part of the hurricane season. Severe droughts are rare. See Table 1.

January is the coldest month and July is the warmest. The growing season or freeze-free period lasts from April to October averaging 177 days near Westminster to 194 days near Baltimore Washington International Airport.

III. Physiography and Geology

The Patapsco River and Gwynn's Falls lie within the Piedmont and the Coastal Plain Physiographic Provinces. The Coastal Plain lies southeast of Elkridge and the Piedmont lies northwest.

The Piedmont portion is made up of metamorphic and igneous rocks which have been intensively folded, fractured, or both. The drainage pattern is irregularly branching with many angular reaches and steep-sided valleys. Metamorphic rocks, in order from oldest to youngest, are the

Baltimore gneiss, the Setters formation (mainly quartzite), Cockeysville marble, and Wissahickon schist. Igneous rocks include the Baltimore gabbro and several granite areas. These rocks originated as molten masses which invaded the older metamorphic rocks.

The Coastal Plain in the basin consists of the Patuxent and Patapsco formations. These units overlap the Piedmont rocks to the west and are made up of sand and clay layers that dip very gently easterly. Valleys in the Coastal Plain tend to be broader than in the Piedmont because of softer materials and flatter stream gradient.

Sand and gravel are surface-mined at several localities. Crushed stone is quarried in the Cockeysville marble near Marriottsville. Slate and marble building stone is also quarried here.

Formerly, granite was quarried downstream from Ellicott City. Iron ore was taken from workings near Elkridge, Sykesville, and Mount Airy. Feldspar and quartz were mined along the Patapsco River below Marriottsville, and flint was quarried from schist in southeastern Carroll County. Soapstone was quarried until recently northwest of Marriottsville. These mines are presently inactive.

The topography is characterized by gently rolling to steep uplands with streams of fairly steep gradient feeding into wide bottomlands. Near Elkridge the River becomes tidal and its valley widens. Elevations range from 1100 feet at Manchester in eastern Carroll County to sea level at the Baltimore Harbor.

IV. Land Resources

The Piedmont portion of the River Basin is dominated by Chester, Glenelg, and Manor soils. These soils are, in general, of moderate fertility. They have moderate infiltration rates and retain moisture well for plant growth, yet are well drained. These characteristics make the area well suited for agriculture although there is potential for erosion problems.

On the coastal plain, soils have a wide range of properties. Among the more dominant soils are the Chillum, Sassafras, and Beltsville series. These soils are not naturally fertile but respond well to good management and fertilizer. Most of this area is being developed for residential, commercial, and industrial uses.

The objectives of the U. S. Department of Agriculture's prime lands program are (1) to prevent our most productive lands from being irrevocably committed to other purposes, and (2) to be advocates for the protection of prime lands. The Department's prime lands program identifies prime lands so they may be considered when planning for other uses.

Prime farmland is the land best suited for producing food, feed, forage, fiber, and oilseed crops, and also is available for these uses. It has the soil quality, growing season, and moisture supply needed to produce sustained high yields of crops economically when treated and managed according to modern farming methods. Prime farmland gives the highest yields with the lowest inputs of energy or money, and with the least damage to the environment. There are approximately 115,000 acres of prime farmland in the Patapsco River Basin. This area includes prime land which is farmland, and prime land which could be converted to farmland. Urban or built-up land is not considered primeland. (See map inside back cover.)

Prime forestland is land that has soil capable of growing wood fiber at the rate of 85 cubic feet per acre per year, and is not in urban or built-up land uses. Currently about 3,300 acres of commercial forest are located on prime forestland. There is considerably more prime forestland within the basin which is not currently forested. It is important to note that there is a considerable overlap of prime farmland and prime forestland.

V. Water Resources

There are no natural lakes in the River Basin. However, there are two important man-made impoundments. Liberty Lake is a 3100 acre water supply reservoir located on the North Branch of the Patapsco River. Piney Run Lake is a 300 acre water supply and flood control reservoir located in southern Carroll County. In addition, several hundred man-made ponds are scattered thoughout the area. Most of these ponds are between one-half and one acre in size. Usually these ponds are designed for fishing, livestock watering, or aesthetics.

The Coastal Plain region contains most of the wetlands within the river basin. Located in this region are four acres of Type 3 wetlands, 140 acres of Type 5, 40 acres of Type 6, one acre of Type 7, and 350 acres of Type 12 wetlands.

The Piedmont region contains small acreages of wetlands scattered throughout the area. Most of these wetlands are classified Type 1 or Type 2.

Surface water flow records have been collected by the U. S. Geological Survey. Peak flood flows and annual low flows are summarized in Tables 2 and 3 for three locations along the Patapsco River.

Water quality and the related beneficial uses of the Patapsco River and its tributaries range from excellent to poor. In the Liberty Reservoir drainage, water quality is generally good. Liberty Reservoir has been identified as "mesotrophic" by EPA studies in 1974. Morgan Run is classified as a natural trout stream and several other streams are capable of supporting adult trout. The fecal coliform standard (an indicator of the possible presence of harmful bacteria) is the only standard which is violated in the Liberty Reservoir drainage. The City of Westminster has experienced occasional taste and odor problems in its municipal water supply.

In the drainage area of the South Branch, wastewater treatment plants contribute to water quality problems. The Mt. Airy plant increases the biochemical oxygen demand and suspended solids while the Freedom District plant has a residual chlorine problem. Sediment deposition and high fecal coliform counts are especially significant due to the existence of highly erodible soils and several large livestock operations in the basin. Swimming and fishing are good in the area with several streams capable of supporting adult trout. The Piney Run water supply reservoir has good water quality.

The main stem has two tributaries, Granite and Mordella Branches, which are designated natural trout streams. Most of the stream is suitable for contact recreation and support of aquatic life. However, sampling programs in 1976 and 1977 noted frequent violations of fecal coliform standards and occasional violations of pH and turbidity standards.

Gwynn's Falls is designated suitable for contact recreation and aquatic life by the Maryland Department of Natural Resources. The upper portion of Red Run is designated as a natural trout stream. Sampling programs indicate frequent violations of fecal coliform and dissolved oxygen standards. The most important potential sources of pollution are sanitary sewers and related facilities.

Groundwater occurrence in the basin is of two main types: that in fractures in the Piedmont rocks and that in pervious layers in the Coastal Plain.

Of the Piedmont rocks, the highest yield seems to be in the Wissahickon formation. Yields are variable but may average 15 gpm. Average well yields tend to be much less than this in the igneous rocks. Most wells in the Piedmont rocks penetrate no deeper than 300 feet.

In the Coastal Plain, groundwater movement occurs principally through gently dipping pervious zones that are confined by relatively impermeable layers. Water enters the exposed (westerly) edges of these permeable layers and moves east-southeasterly. This artesian water will rise in varying degrees in wells intersecting the aquifer.

Most wells in the Coastal Plain portion of the basin are supplied from either recent alluvium or the Patapsco formation. The average well yield for the Patapsco formation is about 50 gpm.

VI. Fish and Wildlife Resources

Wildlife populations are present throughout most of the study area. Carroll County contains some of the best habitat available in Maryland for pheasant, with its numerous fields interspersed with grassy or wooded hedgerows and corners that are not easily cultivated. As the hedgerows become less numerous in Baltimore and Howard Counties and small woods become the major cover, pheasant populations decline and bobwhite quail populations increase. American woodcocks use the bottom lands during migration. Mourning dove populations are high each fall. Other game species are limited in numbers throughout this area. Cottontail rabbit populations are moderate to low due to the clearing of most of the brushy cover and mowing or pasturing of most of the grasslands. Only the large wooded areas around Liberty Reservoir and in Patapsco Valley State Park support fairly high populations of deer. High squirrel populations are supported in the mature forest land that exists throughout this section of the study area.

As one approaches Baltimore, game species decline and small animals, such as raccoon, opossum, and songbirds become more dominant. Leakin-Gwynn's Falls Park provides the largest stands of woodland which provides the best quality wildlife habitat in this section.

The coastal plain region of the Patapsco River provides habitat for several wetland species. Several species of ducks, the least bittern, the cattle egret, and other shore and wading birds can be found. A few plovers and sandpipers can be found here too, especially during migration periods.

The streams throughout the study area provide habitat for raccoons, mink, and muskrat. Beaver have been planted along the South Branch of the Patapsco but are more numerous now near Liberty Reservoir.

A wide variety of sparrows, warblers, and other songbirds are supported in the woods and openlands. Hedgerows and woods edges are abundant for species such as the cardinal, mockingbird, and the bluebird. Several species of woodpeckers can be found in the wooded areas. The Baltimore Oriole is also a common resident in the area. Occasionally, a Bald Eagle may be seen, but it is not known to nest in the area. The Dickcissel can be found and it is listed in the "Threatened Birds of Maryland", a 1973 publication of Chandler S. Robbins. Mallards and wood ducks are the only waterfowl that are common throughout the study area.

The reptile species located here are numerous. Forty nine species of snakes, lizards, amphibians and turtles have been recorded in the Patapsco Valley State Park.

The lower section of the Patapsco River from the harbor to Elkridge is tidal. This segment of the river and the surrounding ponds support a variety of fish. Catfish, carp, brown bullheads, American eel, sunfish, white perch, and white suckers are the most common species present. Occasionally largemouth bass, pickerel, and yellow perch are caught, especially in the old gravel pits surrounding the river. Anadromous runs of yellow perch, herring, alewives, and white perch have been recorded in the river and its tributaries.

From the confluence of the North and South Branches of the Patapsco to the fall line at Elkridge, the river flows through a narrow valley and has a bed consisting mainly of large rocks and boulders. Yellow perch, white suckers, sunfish, rock bass, largemouth bass, catfish, bullheads, and carp are the most common species here.

The South Branch of the Patapsco flows rapidly over shallow, rocky beds interspersed with pools. The most common species present are smallmouth bass, suckers, sunfish, common shiners, and creek chubs. Trout may be found in the streams of this section of the Patapsco.

The North Branch is dominated by the 3,100 acre Liberty Reservoir. The reservoir is stocked with largemouth bass, smallmouth bass, sunfish, carp, and catfish. Several of the tributaries of the reservoir support brook and rainbow trout.

Gwynns Falls has not been sampled for fish since 1940. The watershed has undergone major changes since then due to urbanization. At the time of the sampling, Gwynn's Falls was known as a source for all types of game fish but this is no longer true.

The bog turtle and the bobcat are two species of wildlife in the study area that are classified as endangered or threatened. The bog turtle is found only in the very northern section of the study area in Carroll County near Hampstead and Manchester. The bobcat is found only in the large uninterrupted stands of woodland of the Patapsco State Park and Liberty Reservoir or along wooded stream bottoms.

Table 1 Temperature and Precipitation Data

	Normal Temperature (°F)			Normal Precipitation (inches)		Mean Number of Days With		
	Daily Maximum	Daily Minimum	Monthly	Monthly Water Equivalent	Monthly Snowfall	Precipitation 0.1 in. or more	Temperature 90 °F or above	Temperature 32° F or below
Westminster, Carroll County								
Jan	39.7	23.1	31.4	2.97	7.9	7	-	26
Feb	41.9	24.1	33.0	2.79	8.7	6	-	23
Mar	51.4	30.8	41.1	3.88	8.4	8	-	19
Apr	64.0	40.9	52.5	3.43	0.2	8	-	5
May	73.7	50.3	62.0	3.69	-	8	1	*
Jun	81.8	59.0	70.4	3.65	-	7	5	-
Jul	85.5	63.5	74.5	4.52	-	7	8	-
Aug	83.8	61.6	72.7	4.10	-	7	6	-
Sep	77.4	54.9	66.2	3.04	-	5	2	*
Oct	66.6	44.8	55.7	2.94	T	5	*	33
Nov	53.8	35.2	44.5	3.36	1.3	6	-	13
Dec	41.4	25.4	33.4	3.47	7.0	7	-	25
Year	63.4	42.8	53.1	41.84	33.5	81	22	114
Baltimore Washington International Airport								
Jan	41.9	24.9	33.4	2.91	-	10	0	25
Feb	43.9	25.7	34.8	2.81	-	9	0	21
Mar	53.0	32.5	42.8	3.69	-	11	0	15
Apr	65.2	42.4	53.8	3.07	-	11	*	3
May	74.8	52.5	63.7	3.61	-	11	1	*
Jun	83.2	61.6	72.4	3.77	-	9	7	0
Jul	86.7	66.5	76.6	4.07	-	9	11	0
Aug	85.1	64.7	74.9	4.21	-	10	8	0
Sep	79.9	57.9	68.5	3.12	-	7	3	0
Oct	68.3	46.4	57.4	2.81	-	7	*	2
Nov	56.1	36.0	46.1	3.13	-	9	0	12
Dec	43.9	26.6	35.3	3.26	-	9	0	21
Year	65.1	44.8	55.0	40.46	-	112	31	99

Source: Weather Bureau Cooperative Station in Westminster and National Oceanic & Atmospheric Administration, Weather Service at BWI

Note: Average duration of the frost free period: Westminster - 177 days; BWI Airport - 194 days

TABLE 2

STREAMFLOW RECORDS 1/

Patapsco River

Gage ID Number	Drainage Area sq. mi.	Years of Record
South Branch @ Henryton 01587500	64.4	1949 - 1979
North Branch @ Cedarhurst 01586000	56.6	1946 - 1979
Patapsco River @ Hollofield 2/ 015890000	285.0	1945 - 1979

PEAK FLOOD FLOWS

Recurrence Interval (yrs.)	Percent Chance of Occurrences	Peak Discharges in cubic feet per second (cfs) Henryton	Cedarhurst	Hollofield
100	1	23180	16550	59320
50	2	16670	12320	40140
25	4	11800	9040	26740
10	10	7220	5790	15090
5	20	4770	3970	9380
2	50	2430	2120	4410

MAGNITUDE AND FREQUENCY OF ANNUAL LOW FLOWS

Annual Minimum	Discharge, in cfs, for indicated recurrence interval 2-year	5-year	10-year	100-year
Henryton				
1-day	14.2	7.2	5.0	1.5
7-day	16.1	8.6	6.0	2.0
30-day	20.2	12.1	9.0	4.0
Cedarhurst				
1-day	16.0	11.0	8.5	4.6
7-day	17.5	11.8	9.4	5.0
30-day	21.0	14.4	11.4	6.2
Hollofield				
1-day	41.4	21.0	13.0	-
7-day	47.0	23.6	15.7	-
30-day	56.8	29.4	19.5	-

1/ Source: U. S. Geological Survey Stream Gage Data
2/ Flows modified by Liberty Reservoir since 1954. Data requires modification.

TABLE 3

STREAMFLOW RECORDS 1/

GWYNN'S FALLS

Gage	Drainage Area Sq. Mi.	Years of Record
Gwynn's Falls @ Owings Mills 01589200	4.9	1958 - 1975
Gwynn's Falls @ Villa Nova 01589300	32.5	1957 - 1979

PEAK FLOOD FLOWS

Recurrence Interval (years)	Percent Chance of Occurrence	Peak discharges in cubic feet per second (cfs) Owings Mills	Villa Nova
100	1	6,900	14,130
50	2	4,440	10,080
25	4	2,790	7,050
10	10	1,430	4,220
5	20	800	2,720
2	50	310	1,300

Source: U. S. Geological Survey Stream Gage Data

ECONOMIC RESOURCES

The economy of the Patapsco River Watershed has long been based upon the river. Since Europeans colonized the area the river has been used for transportation. Elkridge was once a prosperous port, rivaling Annapolis in its importance. The Patapsco provided power for many grist mills, textile mills, and iron works. Bloede Dam, near Elkridge, was the world's first underwater power plant. As the country grew the Baltimore and Ohio Railroad laid the first thirteen miles of public railroad track along the river from the harbor to Ellicott City.

As the river became less important for power and transportation, its importance grew in other areas. In 1912, the Patapsco River Forest Reserve was established on a 434 acre parcel donated to the State of Maryland. This site was the home of Americas first Civilian Conservation Corps in the 1930's. This parcel was also the beginning of the Patapsco Valley State Park, which now covers 9,655 acres. Today the park provides the residents of Maryland with tens of thousands of recreational opportunities each year.

In the early 1950's the City of Baltimore constructed Liberty Dam on the North Branch of the Patapsco. Since then the reservoir has provided the millions of gallons of water per day necessary for the economic growth of the region.

The Baltimore Harbor, which is the mouth of the Patapsco, provides the East Coast with one of America's finest ports. Today the port is the focal point of the region's economy.

According to Regional Planning Council estimates, the population of the Baltimore SMSA was 2,142,000 in 1975. This population reflects a 1.5% growth per year over the period 1950-1975. It is expected that growth will continue at a rate of 1.4% per year between 1975 and 2000.

The Regional Planning Council has also projected the population growth for the Patapsco River portion of each jurisdiction. The population in 1975 is estimated to have been 248,000. The population in the year 2000 is projected to be 389,000. This growth is equivalent to 1.8% per year. Thus the growth within the Patapsco area will be slightly greater than for the region as a whole.

Growth varies considerably from jurisdiction to jurisdiction. Baltimore City will experience very limited growth, gaining 1,000 people in the next twenty-five years. Most of the growth in the study area will occur in Baltimore, Howard, and Carroll Counties which will experience 35%, 31%, and 26% of all growth, respectively. Tables 4 and 5 show basic population characteristics.

The density of the population is shown in Table 6. Baltimore City, which is 100% urban, has a density of 11,600 people per square mile. Anne Arundel and Baltimore Counties have significantly lower densities at 700 and 1000 people per square mile, respectively. Howard County has a density of 250 people per square mile and Carroll County, which is 90% rural, has only 150 people per square mile.

Table 8 lists the major industries in the Baltimore Region and the number of people employed by these industries in 1970. The manufacturing and trade industries are by far the most important. Employment is centered around Baltimore City and the Port of Baltimore. Carroll and Howard Counties have fewer employment opportunities. The relative share of employment opportunities for each jurisdiction is closely related to the share of population in each jurisdiction as shown in Table 7. Thus residential and commercial/industrial growth seem to be balanced with each jurisdiction in the Baltimore Region. The distribution of family income, by jurisdiction, is shown in Table 9.

The economy of the entire region is dominated by the Port of Baltimore and its many supporting facilities and services. The economic well-being of the Baltimore area relies heavily on the health of the Port and of world trade. The efficient movement of goods, by land, to and from the Port is of critical importance in maintaining a competitive port facility. Baltimore is fortunate in having an excellent access to the Interstate Highway system. I-95 reaches south and to the northeast, I-70 leads to Pittsburgh and points west, and I-83 permits easy access to the north.

In the western part of the Patapsco River Basin, agri-business is a major influence. Carroll County is one of the most agriculturally productive counties in the state. Within the Patapsco River watershed, 45% of the land is used for agriculture. The acreage devoted to crops and pasture is decreasing and is projected to decrease further but agriculture will remain a major sector in the region's economy. The most important farm products in the Baltimore Region are milk, corn, and hay. Yields are good and are approximately the same as for the state as a whole. Of all counties in Maryland, Carroll County is second in production of hay and milk and third in production of corn. (See Table 11.)

The importance of the agricultural sector to the area goes far beyond the provision of food and fiber. In Maryland, the total farm income in 1977 was 761.7 million dollars. Production expenses were 638.4 million dollars. Thus 84% of the total farm income is spent for feed, seed, fertilizer and lime, repairs, hired labor, depreciation, taxes and other costs. Sixty million dollars were added to the economy of the four-county area for agricultural inputs. Additional millions are added each year for transportation, marketing, and processing of agricultural products. Many businesses rely on the farm base.

Land use figures show that 40% of the Patapsco and Gwynn's Falls watershed are in agriculture. Another 40% is in forest, brush, and other open space. The remaining 20% is in residential, commercial, or industrial use. The majority of this urban land is in the Gwynn's Falls watershed and along the lower portion of the Patapsco. As growth and development occur during the next twenty-five years, significant acreages will be converted to urban uses. (See Table 10.)

As population and the non-agricultural sectors of the region's economy expand, agriculture comes under increasing pressure. Local jurisdictions are attempting to relieve some of the pressure and to preserve a strong agricultural base. Baltimore and Howard Counties have growth management plans which recommend watershed protection areas and conservancy areas.

Carroll County has a zoning classification for agricultural districts which restricts other forms of development. In addition, Howard County has authorized the purchase of development rights on 20,000 acres of agricultural land.

These efforts should reduce some uncertainties associated with development patterns and schedules. Also some farmland owned by non-farmers may be converted to farmer ownership. Both of these policies will increase the willingness of farmers to make capital investments necessary to maintain and improve the productivity of agricultural land.

Forestland covers approximately 67,000 acres in the Patapsco River watershed and 12,500 acres in the Gwynn's Falls watershed. Most of this land is in small holdings. There are only two large blocks of forestland in the river basin, the Patapsco Valley State Park and the reservoir protection zone around Liberty Reservoir. Sixty percent of the forest in the river basin is oak-hickory and 15% is pine. Elm-ash-maple and maple-beech are the next most prevalent types, accounting for 10% and 8% of the forestland, respectively.

Over fifty percent of the commercial forestland supports stands of sawtimber but almost 90% of the forestland is understocked. Current annual growth is approximately 2300 thousand cubic feet. Improved management could increase growth rates to about 4100 thousand cubic feet per year. The major reason for low growth figures is the lack of investment in forestry. Landowners are hesitant to invest in forestry because a return on that investment would not be realized for many years. Additionally, many owners of forestland have primary interest in recreation, wildlife, speculation, or land uses other than fiber production.

In the recent past, annual growth of hardwood species has been almost double the annual harvest. The inventory, thus, is increasing. However, much of the growth occurs on small or less desirable trees. For softwood species, the annual harvest has been more than double the annual growth. This imbalance could seriously reduce softwood inventories if it continues much longer.

The forest sector does add to the local economy. The income to local landowners from the sale of standing timber approximates one million dollars annually. Additional income is generated for those employed in harvesting and transporting wood to mills for processing.

In addition to public facilities, the Baltimore Region has many outdoor recreation facilities on private lands. These facilities provide opportunities for recreation and contribute significantly to the local economy. (See Table 12.)

Table 4 Population Trends and Forecasts, in Thousands

	Baltimore City	Anne Arundel County	Baltimore County	Carroll County	Harford County	Howard County	Total
			Population Trends in the Baltimore Region[1]				
1930	804.9	55.2	124.6	36.0	31.0	16.2	1068
1940	859.1	68.4	155.8	39.1	35.1	17.2	1174
1950	949.7	117.4	270.3	44.9	51.8	23.1	1457
1960	939.0	206.7	492.4	52.8	76.8	36.2	1804
1970	905.8	297.5	621.1	69.0	115.4	61.9	2071
			Population Forecasts for the Baltimore Region[2]				
1975	845.1	342.7	639.6	81.2	135.7	98.0	2142
2000	866	593	923	131	211	266	3010
2025	955	830	1070	195	265	360	3675
			Population Forecasts for the Patapsco River Watershed[2]				
1975	23	32	109	57	--	27	248
2000	24	42	158	94	--	71	389
2025	26	50	183	141	--	95	495

1 Source: U.S. Bureau of Census Data
2 Source: Baltimore Regional Planning Council

Table 5 Population in the Baltimore Region by Age and Sex, in 1970

Age Class (in years)	Population (in thousands)	Age Class as Percent of Total	Males as Percent of Total
under 10	381.1	18.4	50.9
10 to 19	401.9	19.4	50.4
20 to 29	312.2	15.1	49.0
30 to 39	236.2	11.4	48.6
40 to 49	263.9	12.7	48.5
50 to 59	219.3	10.6	48.7
60 to 69	146.7	7.1	45.7
70 to 79	79.6	3.8	39.7
over 79	29.8	1.4	33.5
Total	2070.7	99.9	48.7

Source: U.S. Bureau of Census Data

Table 6 Population Densities, in 1970

	Population per Square Mile	Urban Population as Percent of Total
Baltimore City	11,612.3	100.0
Anne Arundel County	703.4	67.3
Baltimore County	1,038.6	88.7
Carroll County	151.3	10.4
Howard County	246.7	35.3

Source: U.S. Bureau of Census Data

Table 7 Distribution of Population and Employment, in 1970

	Percentage of Total Population	Percentage of Total Employment
Baltimore City	43.7	43.5
Anne Arundel County	14.4	13.3
Baltimore County	30.0	32.0
Carroll County	3.3	3.4
Harford County	5.6	4.9
Howard County	3.0	3.0
Total	100.0	100.1

Table 8 Employment by Industry, in 1970

Industry	Baltimore City	Anne Arundel County	Baltimore County	Carroll County	Harford County	Howard County	Total
Agriculture, Forestry, and Fisheries	1,431	1,506	2,226	1,824	1,389	831	9,207
Mining	212	149	229	76	110	69	845
Construction	18,315	8,569	15,481	2,904	2,996	2,176	50,441
Manufacturing	90,303	21,251	71,469	8,266	8,576	4,019	203.884
Transportation, Communication, and Utilities	27,262	8,521	17,445	1,562	2,425	1,587	58,802
Wholesale and Retail Trade	65,451	20,667	55,920	4,370	6,393	4,088	156,889
Finance, Insurance, and Real Estate	17,776	4,439	15,315	806	1,442	1,119	40,897
Business, Repair and Personal Services	30,623	7,259	13,984	1,616	2,303	1,815	57,600
Entertainment and Recreational Services	3,073	905	2,251	78	280	236	6,823
Hospitals and Health Services	27,066	4,179	13890	1,842	1.606	1,125	49,708
Educational Services	25,401	9,210	19,011	1,753	3,182	2,209	60,766
Welfare, Religious and Nonprofit Organization Services	5,995	1,189	3,497	389	483	389	11,897
Professional Services	10,023	3,412	6,843	508	880	950	22.616
Public Administration	29,769	16,517	21,790	1,349	7,345	3,400	80,170
Total	352,700	107,773	259.351	27.343	39,365	24,013	810,545

Source: U.S. Bureau of Census Data

Table 9 Family Income Distribution in 1970, in Thousands of Families and Percent of Total Families

Income Class (in dollars)	Baltimore City #	%	Anne Arundel County #	%	Baltimore County #	%	Carroll County #	%	Howard County #	%
Under 2000	16.4	7.6	2.2	3.1	3.5	2.1	0.7	4.2	0.3	2.3
2000 - 2999	10.6	4.9	1.5	2.1	2.5	1.5	0.5	2.9	0.2	1.6
3000 - 3999	11.0	5.1	1.7	2.4	3.2	2.0	0.5	3.2	0.3	1.9
4000 - 4999	12.3	5.7	2.2	3.1	3.8	2.4	0.8	4.5	0.4	2.4
5000 - 9999	75.5	35.0	20.3	28.4	42.9	26.4	5.7	33.7	3.2	21.1
10000 - 14999	54.0	25.0	23.2	32.5	54.9	33.8	5.3	31.4	4.5	29.6
15000 - 24999	28.6	13.2	16.4	22.9	39.8	24.5	2.8	16.7	4.9	32.2
Over 25000	7.5	3.5	3.9	5.5	11.7	7.2	0.6	3.4	1.4	8.9
Total	215.8	100.0	71.4	100.0	162.4	99.9	17.0	100.0	15.2	100.0
Median Income	$8815		$11478		$12081		$10204		$13472	

Source: Maryland Department of State Planning, Maryland Family Income Characteristics: 1970 Census

[1]Median family income for Maryland is $11,063

Table 10 Present and Future Land Use for the Patapsco River and Gwynns Falls Watersheds

Land Use Category	1975 Acres	1975 %	2000 Acres	2000 %	2075 Acres	2075 %
			Patapsco River			
Low Density Urban	8,300	3.5	11,900	5.1	17,000	7.3
Medium Density Urban	5,500	2.4	10,200	4.4	17,000	7.3
High Density Urban	1,500	0.6	2,800	1.2	4,650	2.0
Trees	66,800	28.5	62,800	26.8	57,950	24.5
Brush	27,800	11.9	26,100	11.2	23,950	10.2
Grass	57,500	24.6	54,900	23.5	50,700	21.7
Crops	51,000	21.8	48,600	20.8	44,800	19.1
Bare and Undefined	10,600	4.5	11,700	5.0	12,950	5.5
Water	4,400	1.9	4,400	1.9	4,400	1.9
Total	233,400	99.7	233,400	99.9	233,400	99.8
			Gwynn's Falls			
Residential	20,200	47.2			29,200	68.0
Commercial	2,000	4.6			1,700	4.0
Industrial	2,000	4.6			4,300	10.0
Open Space	6,200	14.4			6,400	15.0
Forest	5,400	12.7			900	2.0
Cultivated	2,600	6.0			400	1.0
Grass	4,500	10.6			0	0.0
Total	42,900	100.1			42,900	100.0

Table 11 Agricultural Production

	1000's of Acres Harvested						Milk Production In Millions of Pounds
	Corn	Soybeans	Wheat	Barley	Hay	Vegetables	
Anne Arundel	8	1.7	1.5	0.1	4.5	0.2	4.0
Baltimore	24	3.0	4.5	5.0	15.0	3.1	6.0
Carroll	57	2.5	12.0	8.5	29.7	0.7	251.0
Howard	12	0.5	2.5	1.5	12.3	0.1	41.0
Total	101	7.7	20.5	15.1	61.5	4.1	302.0
Weighted Average Yield	95 bu/acre	29 bu/acre	38 bu/acre	51 bu/acre	2.4 ton/acre		11,500/lb/cow
Price/Unit (1978)	$2.25/bu	$6.50/bu	$3.00/bu	$1.80/bu	$70.00/ton	$470/acre	$11 00/hwt
Value in Millions of Dollars	21.6	1.5	2.3	1.4	10.3	1.9	33.2

Source: Maryland Department of Agriculture. Maryland Agricultural Statistics: Summary for 1978. June, 1979

Table 12 Inventory of Outdoor Recreation Facilities on Private Lands

CAMPING			
Day Camping	181 acres	815 guests	
Resident Camping	1588 acres	1670 guests	
Transient Camping	31 acres	74 vehicle sites	
Vacation Camping	85 acres	155 vehicle sites	24 tent sites
FIELD SPORTS			
Archery	46 ranges	21 positions	
Shooting	32 positions		
Tennis	173 courts		
FISHING			
Ponds or Lakes	120 acres	17	
Enterprises	33 acres	33	
GOLFING			
Driving Range	56 acres	173 positions	
Executive Course	427 acres	63 holes	
Miniature Golf	9 acres	108 holes	
Regulation Course	4020 acres	441 holes	
ARCHAEOLOGICAL			
Historical Sites	3567 acres	92 sites	
HUNTING WILD GAME			
Total Hunting	3358 acres		
Type of Hunting	1787 big game	3213 small game	
NATURAL-SCENIC			
Roads & Railroads	1 mile		
Picnicking	130 acres	492 tables	
Racing (viewing)	486 acres	113431 guests	4 miles track
Outdoor Theater	148 acres		
Shooting Preserve	450 acres		
TRAILS			
Total Trails	57 miles		
Bicycling Trails	25 miles	6 rentals	
Hiking/Nature Trails	36 miles		
Horse Riding Trails	16 miles	189 rentals	342 boarded
BOATS			
Non-motor Boats	72 canoes	190 sailboats	343 other boats
Charter Boats	40 boats		
Dry Storage	8057 boats capacity		
Launch Ramps	237 lanes		
Slips or Moorings	18918 boats capacity		
SWIMMING			
Developed Beach	17655 linear feet		
Swimming Pond	12 acres		
Pools	881804 square feet		

Source: Maryland Association of Soil Conservation Districts, 1974
Note: Includes all of Anne Arundel, Baltimore, Carroll, and Howard Counties and Baltimore City

EXISTING WATER & RELATED LAND RESOURCE PROGRAMS

Currently, much work is being done to meet the water resource needs in the study area through programs of federal, state and local agencies.

Carroll County and other sponsoring agencies, with assistance from the USDA Soil Conservation Service, have constructed Piney Run Lake in southern Carroll County. (See study area map inside back cover.) The lake was recommended as a work of improvement in the Work Plan for the Piney Run Watershed developed under authority of PL 83-566. Problems identified in the Work Plan include flood and sediment damages downstream, lack of water based recreation, and water supply shortages. The lake, associated recreation facilities, and land treatment measures provide water supplv and water based recreation for the region. It also provides significant flood damage reduction in Piney Run, and minor amounts of protection to downstream areas of the Patapsco River.

The local Soil Conservation Districts, in cooperation with the USDA Soil Conservation Service, provide technical assistance on conservation related problems. Land treatment assistance is available on both agricultural and urban land. The amount of land treatment assistance provided is summarized in Table 13. The cooperative state-federal forestry program provides technical assistance in meeting conservation and management needs on private and public forestlands. It also provides forest fire fighting assistance. The USDA Agricultural Stabilization and Conservation Service (ASCS) provides cost sharing to install conservation practices on agricultural land and to implement forest management practices on forest land.

The U.S. Army Corps of Engineers has studied the lower Patapsco and Gwynn's Falls to determine if a project could be implemented under their programs. They have decided there is no feasible project.

There is much local effort aimed at solving the water related problems in the area. Their efforts are concentrated on water supply development, flood damage reduction through flood warning and acquisition, and conservation of open space and agricultural land.

As part of their water supply system, Baltimore City has developed Liberty Lake, Carroll County has developed Piney Run Lake, and Westminster has developed Cranberry Reservoir. Carroll County is investigating a water supply reservoir on Gillis Falls. For a further explanation of water supply, see Appendix D.

Howard County maintains a flood warning system to alert them about impending flooding. A remote alarm attached to a staff gage on the Patapsco River at Woodstock is activated when water reaches a predetermined level. The alarm itself is no cause for immediate concern, but it is designed to alert county officials who then start monitoring the situation. The National Weather Service is contacted for a prediction of additional rainfall, and the water level at Liberty Dam is checked. The Fire Department is asked to monitor rainfall and readings on other staff gages along the Patapsco. Based on these inputs, county officials decide whether the situation is severe enough to evacuate people. If this is the case, they notify the fire stations who work from a master list to notify affected property owners. Howard County also provides some information to the Civil Defense Directors in Anne Arundel and Baltimore County.

Acquisition of structures has been used to reduce flood damages. Several of the jurisdictions have acquired some of the residences damaged by flooding. Howard County has purchased 17 houses, a church, and a community bulding in Elkridge. Anne Arundel County is authorized to purchase 25 houses in Ridgeway Manor and near the Baltimore City line. Baltimore County has purchased 72 houses and plans to purchase 117 more. These houses are located on Gwynns Falls and Herbert Run. Baltimore City is beginning a floodplain acquisition program. For a more detailed explanation of the acquisition programs, see Appendix J.

Acquisition of land can also be used as a method of watershed protection. Land in public ownership can be kept out of urban development, thus reducing flooding and water quality problems. Baltimore City has acquired 6100 acres of land around Liberty Reservoir. Carroll County has acquired 470 acres around the potential site of a water supply reservoir on Gillis Falls and additional land around Piney Run Lake. In addition, all jurisdictions acquire land as part of their open space programs.

The Maryland Department of Natural Resources maintains the Patapsco River State Park, which borders both sides of the Patapsco River. Presently, there are 9655 acres of land in the park. They have been authorized to purchase an additional 1516 acres of land. The Patapsco Valley State Park Draft Master Plan recommends puchase of an additional 3317 acres. This land consists of significant portions of floodplain land. These purchases could aid significantly in flood control and watershed protection.

Land for Morgan Run State Park is currently being acquired. At least 680 acres have already been purchased, with an additional 820 acres to be purchased. This park is designed for passive recreation.

Howard County is presently buying development rights on 20,000 acres of farmland. Under this program, the owner sells the county his right to develop or sell his land for development.

Zoning and designation as special areas is also a method of watershed protection. Carroll County has zoned portions of the county as an Agricultural District in which the average density will be one residence for every 20 acres. As part of their General Plans, each jurisdiction has noted specific areas as conservacy districts or water supply protection areas. This means that limited development should occur in those areas. Each jurisdiction, along with the Maryland Water Resources Administration, has some type of restriction on development in floodplains, either through zoning or a permit process.

Stormwater management programs are designed to prevent damages caused by increased runoff due to urban development. Policies differ among the jurisdictions, but essentially they mandate that it is the developer's responsibility to store or otherwise adequately dispose of any increase in volume of runoff and to maintain post-development peak flows at pre-development levels. The primary purpose is to prevent erosion of streambanks due to more frequent flood flows. The State of Maryland and each juriscition has a stormwater management policy of some type, but their use and effectiveness vary widely.

Each jurisdiction is in the process of mapping the 100-year floodplains. These maps will be used to enforce floodplain ordinances. They also provide a basis for determining where potential problems exist.

Water based recreation in the area is concentrated mainly in stream valley parks, and at Baltimore Harbor, Piney Run Lake and Liberty Reservoir.

The stream valley parks offer hiking, fishing, boating and picnicking. Baltimore Harbor offers fishing and boating. Piney Run Lake offers fishing, picnicking, boating and hiking. Liberty Reservoir offers picnicking, boating, and fishing.

The area has been included as a portion of several reports done on a regional basis. They include: Chesapeake Bay - Existing Conditions Report, December 1973; Northeastern United States Water Supply Study, November 1975; and North Atlantic Regional Water Resources Study, June 1972. There were many agencies involved in the development of these studies. Coordination was provided through the U. S. Army Corps of Engineers.

Table 13 LAND TREATMENT NEEDS

Item	Unit	Total Watershed Needs	Now on The Land	Additional Needs: Provided by Ongoing Program 1/	Additional Needs: Needed in Accelerated Program
Conservation Plans	No.	122,798	42,950	20,901	58,947
Site Plans Review	No.	2,925	1,136	463	1,326
Cropland Protection	Ac.	100,404	55,966	19,417	25,021
Pastureland Protection	Ac.	6,871	4,447	716	1,708
Woodland Protection	Ac.	85,262	65,908	9,554	9,800
Other Land Protection	Ac.	53,476	38,002	4,848	10,626
Conservation Crop System	Ac.	100,404	73,500	8,684	18,220
Grassed Waterway	Ac.	1,004	560	114	330
Diversions	Ft.	334,183	178,000	16,588	139,595
Ponds	No.	545	260	67	218
Critical Area Planting	Ac.	4,363	2,244	367	1,752
Waste Management Systems	No.	120	17	31	72
Spring Development	No.	69	15	20	34
Pasture Establishment	Ac.	2,952	2,300	83	569

Source: Soil Conservation Service
1/ Refers to existing programs of Soil Conservation District and Soil Conservation Service

WATER AND RELATED LAND RESOURCE PROBLEMS

I. FLOODING

Flooding along the Patapsco has been a problem since man first settled in the area. In the early part of the last century, mills and industries which depended on the water power that the Patapsco could supply grew up along the river. In conjunction with these grew the mill towns like Daniels, Oella, Ellicott City, and Ilchester. The railroad, running up the Patapsco valley, provided the transportation needed to move goods down to the port at Baltimore. As the Patapsco's potential as a source of power and transportation was exploited, so too was its potential for destruction felt. In 1869, runoff from the 250 square miles above Ellicott City came roaring down the valley causing great destruction and the loss of 39 lives. Again in 1923, and five times since, the river has caused severe damage. In 1972, Tropical Storm Agnes caused several deaths and millions of dollars in damages. In the 1800's, man colonized the floodplain because he was economically tied to the river. In this century, population increases, increased mobility, and affluence enticed man out of the city. In some cases, the pastoral setting of a rural stream became the ideal setting for his home.

The flooding problems and their causes throughout the study area are different and complex. They are best discussed within the context of each subbasin: South Branch, North Branch, Main Stem, and Gwynn's Falls. The problems in the first three are interrelated, while the problems in the latter can be viewed independently.

A. Major Causes of Flooding

The major causes of the flooding problems that now exist are:

1) Encroachment on the natural floodplain: Homes and businesses have been located within the 100-year floodplain (See Figure 2). This not only jeopardizes the buildings themselves, but it also reduces the efficiency of the natural stream floodplain system to convey water. This can increase flood stages upstream. Preventing encroachment will not reduce present damages, but it will assure that future damages will not increase.

2) Constriction of the natural floodplain by man-made obstructions: Roads and bridges which serve the area must necessarily follow or cross over the floodplain. In many cases they cause constrictions which back water upstream (See Figure 3). Recently man has learned to design such facilities properly so that they have a minimal impact on the ability of the floodplain to convey floodwater. However, in many cases, older or abandoned constrictions still have a great impact on flood levels.

   Many constrictions exist along the Patapsco and its tributaries. This study has noted four that deserve special consideration because they have a large impact on flooding potential. Two of the constrictions are landfills located near the mouth of the Patapsco. A third is an abandoned railroad crossing in Elkridge. The final one is a railroad fill in the floodplain near Carrollton and Patapsco.

There are instances in which flooding is caused by materials being carried downstream and becoming lodged in the opening of a bridge creating a constriction in an otherwise well-designed structure. In many cases, the material lodged at the bridge consists of cars, trucks, uprooted trees, or parts of buildings which are swept downstream by the flood. Some of this material began as trees which were deposited on the floodplain during previous floods or the inventory of a lumber company on the floodplain. If proper precautions and maintenance were undertaken, some of these problems could be reduced.

3) Erosion and sedimentation: Increases in the rate of erosion can lead indirectly to increased flooding. If more soil erodes from farms, forests, construction sites, and urban land, the resulting sediments settle on the bottom of the stream, reducing its carrying capacity. Thus a given amount of water will flow at a higher level then previously. This reduction in carrying capacity will reach an equilibrium at some point in time. It has been documented that considerable sedimentation has occurred in the tidal portions of the Patapsco downstream from Elkridge since barges were brought up the river to load at Elkridge in the 18th century.

Due to the inability to predict future sedimentation rates in the river channel, future increases in flood damages caused by the reduced carrying capacity were not analyzed. The increases will probably be minimal, especially when considered with other long term influences such as rising ocean levels.

4) Urbanization: In the natural course of development, many acres of land become covered with homes, businesses, roads, driveways and parking lots. As land is converted from field, meadows or woodland to more impervious covers, a greater proportion of rainfall runoff flows overland to streams rather than being absorbed by the soil. (See Figures 4 and 5.) When hundreds of acres undergo such a transformation, the increase in runoff can increase the severity of flooding downstream. Although development must continue, it is possible to maintain the peak rate of runoff at or near pre-development levels. Stormwater management measures can be installed during construction to minimize increases in runoff or to temporarily store the increased runoff so it can be released slowly so as not to contribute to flooding downstream.

Increased acreage in urban land uses could dictate that flooding problems will become worse in the future. It is anticipated that in the next 20 years, approximately 30,000 acres of land within the study area will go from agriculture or open space, into residential, commercial, and industrial usage. This represents almost 15% of the total land area in the study area. Also, from 2000 to 2075, it is anticipated that an additional 40,000 acres will develop.

Thus, in the year 2075, it can be anticipated that a 100-year storm lasting a day will produce 3 billion more gallons of surface runoff than the same storm occurring today. This water running rapidly off the land surface into streams benefits no one. It is not available to infiltrate the ground to nourish plants or replenish groundwater. It increases flows in stream channels which causes increased erosion and it increases the volumes, peaks, and stages of floodwaters in the stream, thus increasing the size of the floodplain. (See Figures 4 & 5.)

However, urbanization will not have a significant effect on peak flows on the main stem of the Patapsco River. Near the harbor, future discharges will increase 100-year flood elevations by a maximum of one foot. The problem areas are on the tributaries and along Gwynns Falls.

B. Problems in Specific Areas

To analyze the flood damages, the different areas along the stream were grouped together based on similarities in type of damages, location, and factors affecting the flooding situation. These reaches and their locations, along with number of structures flooded are shown in Table 14 and Figure 1. Estimated monetary damages which would be caused by a recurrence of Agnes and the 100-year flood are shown in Tables 15 and 16. The 100-year flood damages are based on flooding caused by present land use conditions for the Patapsco River and future conditions without stormwater management for Gwynns Falls. Since future flooding will not increase significantly in the Patapsco, damages will also not increase significantly.

Although flooding is relatively infrequent in the basin, the damages during major floods are high. For example, estimated flood damages during the 10-year flood are minimal, but for the 100-year flood, they are major.

The following is a summary by reach of the damages caused by Tropical Storm Agnes in 1972.

South Branch

Agnes caused flood damages in six communities along the South Branch. These included Marriottsville, Henryton, Sykesville, Gaither, Morgan Station, and Woodbine. Almost every bridge over the South Branch had to be repaired or replaced. Also, many roads and bridges crossing tributaries to the South Branch were damaged or destroyed.

In Marriottsville (Reach PR-20), seven homes, one small apartment building, and a church were flooded. Damage levels were high. Water levels ranged from two to twelve feet above the first floor.

At Henryton (PR-21), a greenhouse and a power plant were flooded by seven feet of water. The power plant supplies a hospital with heat and hot water.

Sykesville (PR-22), had more commercial structures damaged than any other area along the South Branch. (See Figure 6.) Six businesses and two homes were flooded. Two taverns on the Howard County side of the river had from five to eight feet of water around them. The other businesses and homes had less of a problem with damage confined to basements and low levels on the first floor. In Gaither (PR-23), five houses were flooded with first floor depths rising to nearly six feet in three of them.

In Morgan Station (PR-25), two homes were flooded. Depths ranged from basement level to four feet above the first floor.

In Woodbine (PR-26), three businesses and one house were flooded. The businesses sustained three to four feet of water above the first floor. The home had basement damage.

North Branch

The flooding problems within the North Branch sub-basin occur in isolated areas. Some flooding in the communities of Carrollton and Patapsco was sustained during Tropical Storm Agnes. The Congoleum Plant in Finksburg, at the headwaters of Liberty reservoir, sustains a great deal of damage during major storm events.

The estimated 100-year flood discharge on the North Branch is less than the Agnes flood discharge, therefore, the depth of flooding that could be expected would be less than that from Agnes.

Near Westminster (PR-31), the filtration plant for the city's water supply is periodically flooded.

In the communities of Carrollton and Patapsco (PR-29 and 30), on the North Branch, a total of twenty residential structures were flooded during Agnes. One church and one store were also flooded. (See Figure 7.) While most of the flooding in these communities was limited to basements, several houses in Patapsco sustained as much as four feet of water on the first floor.

The problems in Carrollton and Patapsco are likely to get worse as upstream areas such as Westminster, Hampstead, and Manchester continue to urbanize. Increased urban runoff will increase the frequency and severity of flooding in the communities unless steps are taken to reduce increased runoff from major storms.

The Congoleum Corporation has a plant near Finksburg (PR-28) at the upstream end of Liberty Reservoir. During Agnes, the plant had as much as twelve feet of water in some of its buildings. The flooding situation at the Congoleum Plant has two unfortunate consequences. First, flooding causes economic hardship for the plant and its workers. Second, the flood washes chemicals and other materials stored at the plant into Liberty Reservoir, causing a potential health problem to the water users.

Lower Patapsco

It is the valley downstream of the confluence of the North and South Branches where the major concentrations of flood damages occur. Towns such as Oella, Ellicott City, and Elkridge, and communities such as North Linthicum, Pumphrey, Raynor Heights, and Baltimore Highlands, as well as isolated homes and businesses along the Main Patapsco are susceptible to flooding. For homes and businesses in the flood fringe area, the flooding may be only a minor nuisance occurring once in a lifetime. But, for buildings in low lying areas, a flood threat may represent a frequently recurring threat to life and property.

The estimated 100-year flood on the main stem of the Patapsco River is much less than Agnes. Agnes was an extremely rare event as far as discharges on the main stem are concerned.

In Brooklyn, located at the mouth of the river (part of PR-1), one hundred twenty-one homes and two businesses were flooded during Tropical Storm Agnes. All but two of the houses flooded were brick row houses. The damage was concentrated in a relatively small area. (See Figure 7.) Almost all of the damage was limited to basements. In every case, Agnes was the only flooding any of the residents could recall.

In Pumphrey, North Linthicum, and Baltimore Highlands, located southeast of Landsdowne (PR-2), twenty commercial establishments, fifty-two houses, and seventeen trailers are susceptible to flooding. Most of the first floor flooding during Agnes was to depths of three feet or less. About twenty homes had basement flooding only. Damages in these communities are spread over a wide area. In Anne Arundel County, structures were flooded along Old Annapolis Road, in North Pumphrey, and in a trailer court on Belle Grove Road. In Baltimore County, houses were flooded in Riverview and Baltimore Highlands. Twenty houses were flooded in the development of Ridgeway Manor, but Anne Arundel County has begun a purchase program to remove them from the floodplain.

In Oak Park, located south of Landsdowne (PR-3), three businesses and one industry were flooded by Agnes. One restaurant had eight feet of water, and the Carling Brewing Company had more than five feet in and around the building.

Approximately twenty-five houses and thirteen businesses were flooded along Herbert Run (PR-4, 5, 6, 7, and 8), a major tributary to the Lower Patapsco. Few residents reported any flooding above the basement and most reported less than three feet in the basement. Baltimore County is presently buying 15 houses on a tributary to Herbert Run. These homes are not included in the above total.

The Patapsco River and Deep Run both caused damage in Elkridge (PR-11 & 14). Twenty-one homes and twelve businesses were flooded. Many of the businesses were seriously flooded, some receiving as much as ten feet of water on the first floor. (See Figure 9.) Seventeen more homes on Church Avenue were flooded by Agnes, but Howard County purchased these, along with a church and community building in 1976 as part of a floodplain acquisition program.

Of the twenty structures flooded in Ilchester, located midway between Elkridge and Ellicott City (PR-15), nine are commercial or industrial buildings associated with Simkins Industries. Flooding in these buildings averaged six feet during Agnes. The houses were, in general, flooded to lesser depths.

In or near Ellicott City and Oella (PR-16), forty-eight businesses and eight homes were flooded during Tropical Storm Agnes. Most of the damage occurred in stores on Main Street in Ellicott City. Water rose to over ten feet in the Historic District, enough to reach the second floor of many buildings. Although most damage was in Howard County, there is significant damage on the Baltimore County side of the river, particularly in the Wilkins-Rogers Plant.

Gwynns Falls

Flooding problems occur at many points along the Gwynns Falls. Flooding of industries at the mouth is caused by enroachment on the natural floodplain. The same is true of flooding in communities upstream such as Dickeyville, Gwynn Oak, Woodlawn, and Owings Mills. The problem is compounded by increased flood flows due to urbanization. The damage areas are spread out over the length of the stream. While there are some major concentrations of damage, such as the Owings Mills Industrial Park and the Brittany Apartments, most damages are so scattered as to make any consideration of structural measures unfeasible.

In the Westport area of lower Gwynns Falls, near the mouth of the stream (GF-1), there were eighty-nine structures flooded by Agnes. Seventy-three were residential structures, and sixteen were commercial or industrial enterprises. If such a flood would occur again, damages in the area would exceed $1.7 million. Although this is a relatively localized problem, the effects are widespread. The sixteen businesses employ many people and even when they are closed for short periods of time, many of the employees could experience temporary financial difficulties.

Along Maiden's Choice Run (GF-2, 3, 4, & 5), there are approximately one hundred fourteen structures which were flooded by Tropical Storm Agnes. No unit, except some basement apartments, received more than three feet of water. About sixty homes had basement flooding only. The greatest amount of damage occurred in a four block area just inside the city line. Along this reach, about 80% of the stream is enclosed. Flooding occurs because the culvert was not designed to carry the stream flow associated with a flood like Agnes.

Dead Run (GF-7 & 8), flooded many more than the fourteen residences shown in this survey. Baltimore County has already purchased many homes in this area. Most of the remaining fourteen residences are on the fringe areas of the floodplain, where they receive minor basement flooding.

In Woodlawn (GF-10), Gwynn's Falls flooded about eighty structures during Agnes. Baltimore County has begun an acquisition program which will reduce the number of susceptible structures along the reach by about one-half. Twenty-eight homes and fourteen businesses would still be flooded by a recurrence of a flood like Agnes. Of these, twelve homes and six businesses would have first floor flooding, usually limited to three feet or less. Most of the residential damage is on Gwynn Oak Avenue, but the houses are widely scattered. (See Figure 10.)

In the vicinity of Villa Nova, Milford, and Willow Glen, located near Woodlawn (GF-11), Agnes flooded about one hundred fifteen structures.

Baltimore County's current acquisition program will reduce that number to fifty-nine structures should such a storm reoccur. Of those forty-four structures, there are forty residences, eighteen businesses, and one church.

The homes are scattered along the reach, sometimes in groups of four or five. Most of the homes are separated from the stream by a street. Thus, the street was flooded as well as the homes above it. This made access to or from the house difficult or dangerous. (See Figure 11.)

In Silver Creek Park, located near I-695 (GF-12), twenty-two single family dwellings would be susceptible to flooding if Agnes were to reoccur. (See Figure 12.) Almost sixty other homes are covered by Baltimore County's acquisition program. Eleven of the homes had basement flooding. Of the others, several had up to 10 feet of water on the first floor. These homes are scattered along the east side of the stream.

Agnes flooded fifty units of the Brittany apartment complex, downstream of I-695 (GF-12). The buildings are close to one another so the damage is concentrated in a small area. Flooding ranged from two to six feet. In addition, residents of the second and third floors of these buildings were inconvenienced or denied access by the flooding occurring on the first floor.

Another area of high damages is in the Owings Mills area (GF-14), downstream of Reisterstown Road. Fourteen structures were flooded by Agnes. Most of the damage occurred in Owings Mills Industrial Park.

II. Erosion

Erosion is a natural geologic process. Problems arise when man interferes with nature by clearing the land for farms and towns.

Urbanizing land produces the greatest rate of erosion. However, relatively small amounts of land are undergoing urbanization at any one time.

Cropland produces the next highest rate of erosion. Due to the large amounts of land dedicated to cropland, this is the largest producer of sediment. Therefore, any attempts at reducing sediment production should concentrate heavily on the cropland.

Other significant sediment producing areas are mine spoil and streambanks. Streambank erosion is accelerated when development increases the flow in the stream channel. These problems are evident in urban stream systems such as Herbert Run and Gwynns Falls. For a complete tabulation of erosion rates and sediment yields see Table 17.

III. Sedimentation

The product of erosion is sediment. Some of this sediment enters the stream system and eventually is deposited. There are three major areas where sedimentation is occuring: Liberty Reservoir, Baltimore Harbor, and the river channel. In each case, different problems are dominant.

Liberty Reservoir is used as a source of raw water for the Baltimore Central (water) Supply System. Sedimentation reduces the water storage capacity of the reservoir. If sediment is deposited at rates greater than had been predicted during the design of the reservoir, this source of Baltimore's water could be reduced. (See Table 18.)

The main concern in the Baltimore Harbor is that shipping channels should be maintained at depths which allow modern ocean-going vessels to use the Harbor facilities when fully laden. There are many sources of sediment being deposited in the Harbor, only two of which are the Patapsco River and Gwynn's Falls. Problems in estimating the relative contribution of each source of sediment preclude an assessment of the harbor maintenance cost which should be assigned to either the Patapsco River or to Gwynn's Falls.

There are indications of sedimentation in the main stream of the Patapsco River, especially in the tidal section below Elkridge. Some of this sedimentation is part of the natural process by which the river changes its course, eroding the streambanks in some spots and depositing sediment in others. The greatest amount, however, is believed to be deposited from the upstream rural and urban land. Most damages caused by this sedimentation are not quantifiable in monetary terms.

IV. Water Quality

Along with erosion and sedimentation, other water quality problems caused by nonpoint sources of pollution are nutrients carried by sediments plus fecal coliform bacteria from septic tanks and animals wastes. In the Statewide Critical Areas for Nonpoint Sources of Soil Erosion and Animal Wastes, June, 1979, the Liberty Reservoir Drainage and South Branch Patapsco River were ranked 3 and 5, respectively, out of 12 critical areas identified throughout the state. This ranking was to be used in assigning priorities for the Rural Clean Water Program pursuant to Section 208 (j), Federal Clean Water Act. The ranking was based mainly on the severity of erosion and animal waste problems.

V. Water Supply

There are no areas where availability of water for municipal and industrial use is a problem at the present time. However, as areas of Carroll County undergo development in the future, such deficiencies may occur. Westminster is likely to experience limitations in the near future if additional sources are not developed. Carroll County obtains some water from the Patapsco/Liberty system under a long term contract with Baltimore City, but not nearly enough for its future needs. The county is looking for new sources of water, either in the form of surface impoundments or groundwater resources.

VI. Recreation

In an intensely urban setting, recreation demand in most major catagories exceeds supply. This is the case in the Baltimore Region according to the State Comprehensive Outdoor Recreation Plan (SCORP). Large deficiencies presently exist and will continue to increase in such activities as boating, fishing, picnicking, hiking, and biking. These activities are either dependant on to an unpolluted and abundant surface water resource. For a detailed breakdown of recreation needs, see Appendix G.

TABLE 14

REACH IDENTIFICATION AND
SUMMARY OF DAMAGE BY REACH

Reach Number	Stream	Reach Location	Est. No. of Structures Subject to Flooding [1] Agnes	100 Yr. Flood [2]
PR-1	Patapsco River	Hanover St. to Tunnel Thruway	123	0
PR-2	" "	Tunnel Thruway to Balto. Beltway	89	26
PR-3	" "	Balto. Beltway to Penn. Cent. R.R.	4	1
PR-4	Herbert Run	Patapsco River to E & W Br. Confluence	3	3
PR-5	East Branch	Confluence to Sulphur Spring Rd.	5	5
PR-6	" "	Sulphur Spring Rd. to Balto. Beltway	4	4
PR-7	" "	Balto. Beltway to Wilkens Ave.	11	11
PR-8	West Branch	Confluence to Shelbourne Ave.	15	15
PR-12	" "	Hanover Road to Rte. 176	3	3
PR-13	No name stream	Pfeiffers Corner	4	4
PR-14	Patapsco River	Penn. Central R.R. to Rte. I-95	16	5
PR-15	" "	Rte. I-95 to Grays Level	12	9
PR-16	" "	Ellicott City & Oella Areas	57	52
PR-17	" "	Hollofield	5	2
PR-19	" "	Woodstock	6	4
PR-20	South Branch	Marriottsville	9	7
PR-21	" "	Henryton	2	2
PR-22	" "	Sykesville	7	4
PR-23	" "	Gaither	5	4
PR-25	" "	Morgan Station	2	3
PR-26	" "	Woodbine	4	4
PR-28	North Branch	Finksburg	1	1
PR-29	" "	Patapsco	13	11
PR-30	West Branch	Carrollton	9	8
PR-31	" "	Cranberry Station to Westminster	1	1
GF-1	Gwynns Falls	Annapolis Rd. to Wilkens Ave.	116	116
GF-2	Maiden Choice Run	Gwynns Falls to Penn. Central R.R.	4	4
GF-3	" " "	Penn Central R.R. to Beechfield Ave.	11	11
GF-4	" " "	Beechfield Ave. to Overbrook Rd.	88	88
GF-5	" " "	North Prospect Ave. to Stoney Lane	11	11
Gf-6	Gwynns Falls	Wilkens Ave. to Dead Run	2	2
GF-7	Dead Run	Gwynns Falls to City Line	2	2
GF-8	" "	City Line to Baltimore Beltway	12	12
GF-9	Gwynns Falls	Dead Run to City Line	20	20
GF-10	" "	City Line to Liberty Road	42	42
GF-11	" "	Liberty Road to Milford Mill Rd.	61	61
GF-12	" "	Milford Mill Rd. to Balto. Beltway	72	72
GF-13	" "	Balto. Beltway to Painters Mill Rd.	2	2
GF-14	" "	Painters Mill Rd. to Reisterstown Rd.	31	31
GF-15	" "	Reisterstown Rd. to Kendig Mill Rd.	1	1

[1] The figures do not include the structures which are part of ongoing acquisition programs by Baltimore County and Howard County.

[2] Based on future without project conditions.

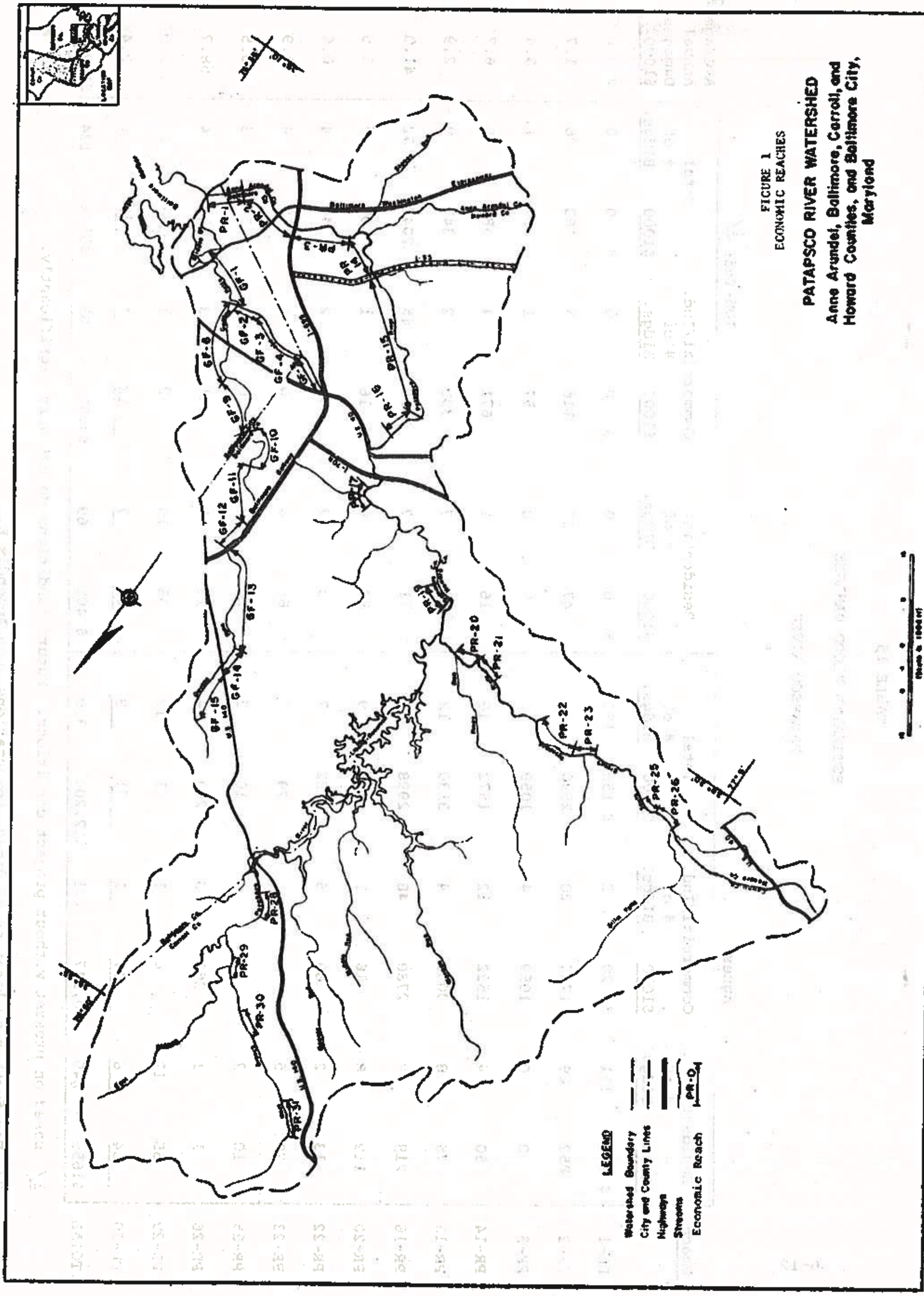


FIGURE 1
ECONOMIC REACHES

PATAPSCO RIVER WATERSHED
Anne Arundel, Baltimore, Carroll, and Howard Counties, and Baltimore City, Maryland

TABLE 15

ESTIMATED FLOOD DAMAGES

PATAPSCO RIVER

Reach	Agnes						100-Year 1/						Average Annual Damages 2/
	Residential		Commercial/Ind.		Total		Residential		Commercial/Ind.		Total		
	$1000	# of Bldgs.	$1000	# of Bldgs.	$1000	# of Bldgs.	$1000	# of Bldgs.	$1000	# of Bldgs.	$1000	# of Bldgs.	$1000
PR-1	$ 130	121	$ 20	2	$ 150	123	$ 0	0	$ 0	0	$ 0	0	$ 0
PR-2	852	69	1744	20	2596	89	47	21	116	5	163	26	1.7
PR-3	0	0	1059	4	1059	4	0	0	57	1	57	1	0.4
PR-14	50	4	1522	12	1572	16	16	1	671	4	687	5	6.7
PR-15	78	8	3052	4	3130	12	17	7	330	2	347	9	2.9
PR-16	218	9	2780	48	2998	57	71	7	1969	45	2040	52	41.0
PR-20	119	8	16	1	135	9	83	6	16	1	99	7	3.9
PR-22	13	2	69	5	82	7	3	2	43	2	46	4	0.6
PR-23	79	5	0	0	79	5	68	4	0	0	68	4	2.9
PR-25	10	2	0	0	10	2	26	3	0	0	26	3	0.5
PR-26	1	1	262	3	263	4	13	1	301	3	314	4	58.7
PR-29	55	12	6	1	61	13	35	10	2	1	37	11	1.0
PR-30	54	8	17	1	71	9	29	7	12	1	41	8	2.4
TOTAL	$1659	249	$10,547	101	$12,206	350	$ 408	69	$3,517	65	$3925	134	$122.7

1/ Based on present without project conditions. Future conditions do not vary significantly.

2/ For further explanation of damage computations, see Appendix B.

TABLE 16

ESTIMATED FLOOD DAMAGES

GWYNN'S FALLS

Reach	Agnes/100-Year 1/						50-Year 1/	10-Year 1/ 2/	Average Annual Damages 3/
	Residential		Commercial/Ind.		Total		Residential Commercial Industrial Damage	Residential Commercial Industrial Damage	
	$1000	# of Bldgs.	$1000	# of Bldgs.	$1000	# of Bldgs.	$1000	$1000	$1000
GF-1	776	73	946	43	1722	116	407	0	26.9
GF-2	3	4	0	0	3	4	0	0	.1
GF-3	48	11	0	0	48	11	0	0	.2
GF-4	627	87	4	1	631	88	0	0	3.2
GF-5	70	8	45	3	115	11	0	0	.6
GF-9	205	17	202	3	407	20	141	22	13.7
GF-10	258	28	255	14	513	42	139	8	10.7
GF-11	306	41	355	20	661	61	312	30	24.6
GF-12	1596	72	0	0	1596	72	1268	72	82.3
GF-13	18	1	11	1	29	2	0	0	.1
GF-14	0	0	738	31	738	31	567	363	116.3
TOTAL	$3907	342	$2556	116	$6463	458	$2834	$ 495	$278.7

1/ Based on future without project conditions.

2/ Zero damage for 2-year flood.

3/ For further explanation of damage computations, see Appendix B.

TABLE 17

Gross Erosion and Sediment Yield by Sources (Average Annual) 1/

SOUTH BRANCH

	Land Use	Acres	Soil Loss (T/Ac)	Total Soil Loss (Tons)	Delivery Ratio (Pct)	Sediment Yield (Tons)
	Cultivated	38083.	7.03	267715.	13.	35606.
	Pasture	823.	1.51	1246.	13.	165.
	Woodland	12761.	2.21	28211.	13.	3752.
	Urbanized	2111.	1.62	3420.	60.	2052.
	Urbanizing	200.	150.00	30000.	10.	3000.
	Mine Spoil	0.	-	-	-	-
2/	Roadbank	110.	3.80	417.	20.	83.
3/	Streambank	439.	18.86	8278.	70.	5795.
	Non-sediment Contributing	0.	-	-	-	-

NORTH BRANCH

	Land Use	Acres	Soil Loss (T/Ac)	Total Soil Loss (Tons)	Delivery Ratio (Pct)	Sediment Yield (Tons)
	Cultivated	64199.	7.46	479019.	18.	88618.
	Pasture	1373.	1.39	1913.	19.	354.
	Woodland	28671.	1.51	43258.	19.	8003.
	Urbanized	5600.	1.11	6196.	60.	3717.
	Urbanizing	400.	150.00	60000.	10.	6000.
	Mine Spoil	0.	-	-	-	-
2/	Roadbank	243.	0.08	19.	20.	4.
3/	Streambank	671.	22.45	15063.	70.	10544.
	Non-sediment Contributing	3123.	-	-	-	-

MAIN STEM

	Land Use	Acres	Soil Loss (T/Ac)	Total Soil Loss (Tons)	Delivery Ratio (Pct)	Sediment Yield (Tons)
	Cultivated	7882.	14.23	112173.	5.	6058.
	Pasture	2861.	2.33	6679.	5.	361.
	Woodland	31978.	2.27	72645.	5.	3923.
	Urbanized	27172.	1.09	29620.	60.	17772.
	Urbanizing	1800.	138.89	250000.	10.	25000.
	Mine Spoil	735.	70.29	51665.	60.	30999.
2/	Roadbank	78.	3.96	308.	20.	62.
3/	Streambank	462.	7.51	3468.	70.	2427.
	Non-sediment Contributing	827.	-	-	-	-

1/ From Erosion and Sediment Survey of Baltimore Regional Planning Council Area U.S.D.A. Soil Conservation Service, College Park, MD. December, 1977 (Tables 12, 13, and 16)

2/ Roadbank Units (In Acres Column) Are Bank Miles

3/ Streambank Units (In Acres Column) Are Bank Miles

TABLE 17 (Cont'd)

Gross Erosion and Sediment Yield by Sources (Average Annual) 1/

PATAPSCO RIVER TOTAL

	Land Use	Acres	Soil Loss (T/Ac)	Total Soil Loss (Tons)	Delivery Ratio (Pct)	Sediment Yield (Tons)
	Cultivated	110164.	-	858907.	-	130282.
	Pasture	5057.	-	9838.	-	808.
	Woodland	73410.	-	144114.	-	15678.
	Urbanized	34883.	-	39236.	-	23541.
	Urbanizing	2400.	-	340000.	-	34000.
	Mine Spoil	735.	-	51665.	-	30999.
2/	Road Bank	431.	-	744.	-	149.
3/	Stream Bank	1572.	-	26809.	-	18766.
	Non-Sediment Contributing	3950.	-	0.	-	0.
	Total Acres	230599.				
	Total Tons			1471313.		254295.

GWYNN'S FALLS

	Land Use	Acres	Soil Loss (T/Ac)	Total Soil Loss (Tons)	Delivery Ratio (Pct)	Sediment Yield (Tons)
	Cultivated	2338.	5.15	12041.	13.	1565.
	Pasture	544.	0.78	426.	13.	55.
	Woodland	5874.	0.73	4283.	13.	557.
	Urbanized	19737.	0.50	9869.	60.	5921.
	Urbanizing	700.	150.00	10500.	10.	10500.
	Mine Spoil	92.	21.68	1990.	60.	1194.
2/	Road Bank	81.	0.50	41.	20.	8.
3/	Streambank	195.	17.86	3488.	70.	2442.
	Non-Sediment Contributing	92.	-	-	-	-
	Total Acres	29376.				
	Total Tons			137138.		22243.

1/ From Erosion and Sediment Survey of Baltimore Regional Planning Council Area U.S.D.A. Soil Conservation Service, College Park, MD. December, 1977 (Tables 12, 13, and 16)

2/ Roadbank Units (In Acres Column) Are Bank Miles

3/ Streambank Units (In Acres Column) Are Bank Miles

Table 18 Effects of Sedimentation on the Storage Capacity of Liberty Reservoir

(1) year	(2) sediment deposits (acre-feet)	(3) reduction in usable storage (acre-feet)	(4) reduction in water supply storage (acre-feet)	(5) reduction in water supply storage (%)	(6) reduction in safe yield (mgd.)	(7) reduction in safe yield (%)
1954	0	0	0	0	0	0
1973	7,185	1,660	1,490	1.3	0.6	0.6
2004	18,800	13,300	12,000	10.5	4.8	5.1
2020	24,900	19,400	17,500	15.3	6.9	7.3
2054	37,700	32,200	29,000	25.4	11.5	12.1

Column (2) 377 acre-feet per year, 1954-1973 average rate of sedimentation. From Reservoir Sediment Data Survey, USDA Soil Conservation Service, College Park, MD., August 1973.

Column (3) Column (2) less 5526 acre-feet allotted to sediment storage.

Column (4) 90% of Column (3).

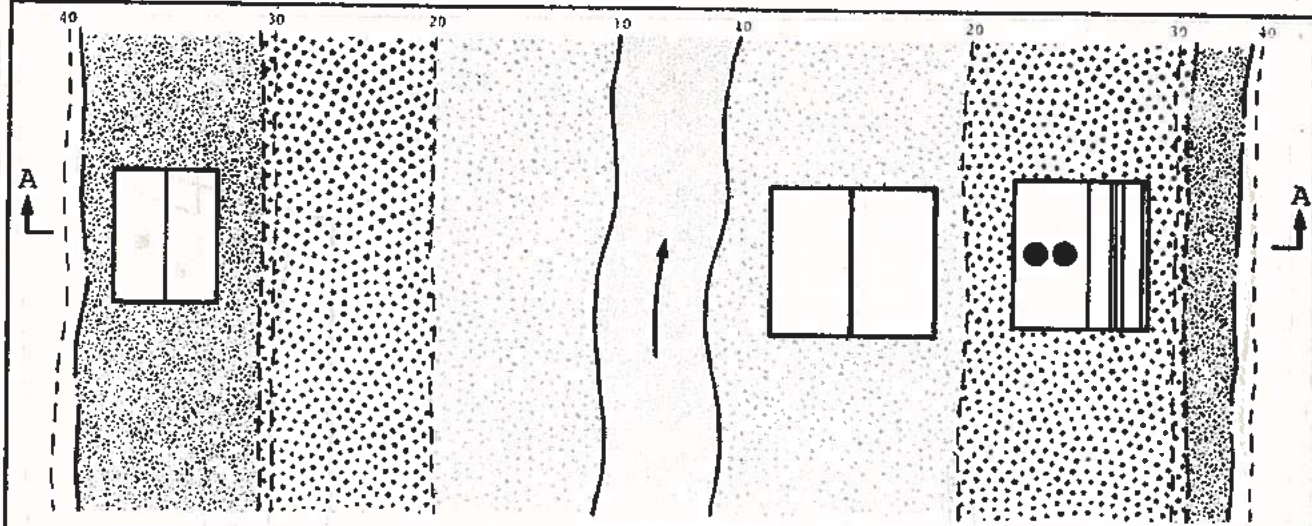
Column (5) Column (4) divided by 114,210 acre-feet, design water supply storage.

Column (6) Column (4) times .000397. $\frac{43560 \text{ cu. ft.}}{\text{acre-feet}} \times \frac{7.5 \text{ gal.}}{\text{cu. ft.}} \div 823 \text{ days}$

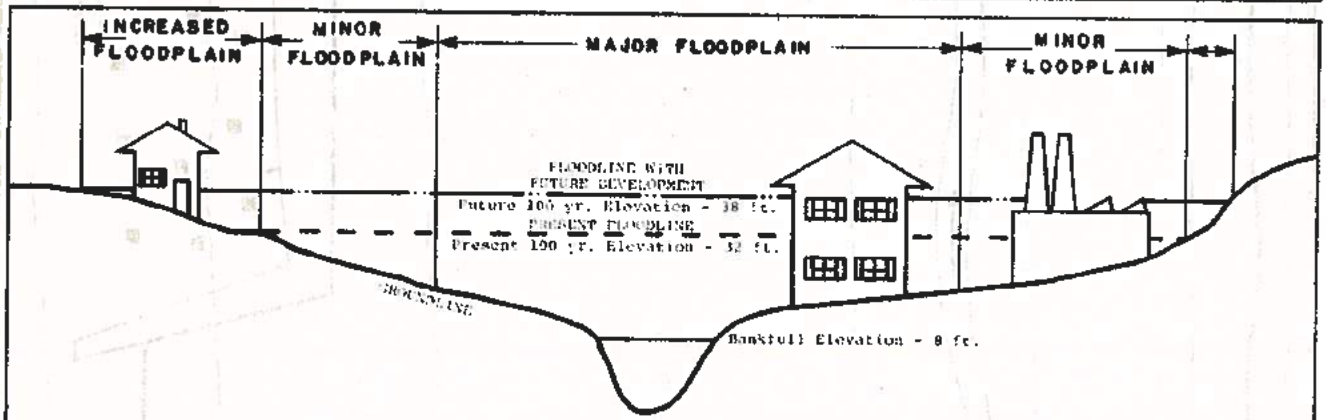
Column (7) Column (6) divided by 95 mgd.

Figure 2

COMPONENTS OF THE FLOOD PLAIN



PLAN VIEW



SECTION A-A

LEGEND

- - - - Lines of Equal Contour Elevation
Buildings
MAJOR FLOODPLAIN
MINOR FLOODPLAIN
INCREASED FLOODPLAIN

MAJOR FLOODPLAIN	Water flowing at reasonable depth; net movement of downstream; greatest threat of loss of life; protect by acquisition, dams, channelization, diking
MINOR FLOODPLAIN	Slack water area, shallow depths, low velocities; small net movement perpendicular to channel flow only; property damage likely; little life threat; protect by floodproofing, warning, diking, channelization, insurance
INCREASED FLOODPLAIN	Increase in flood fringe caused by increased runoff due to urbanization upstream; protect by land use policy, zoning, storm water management

Figure 3

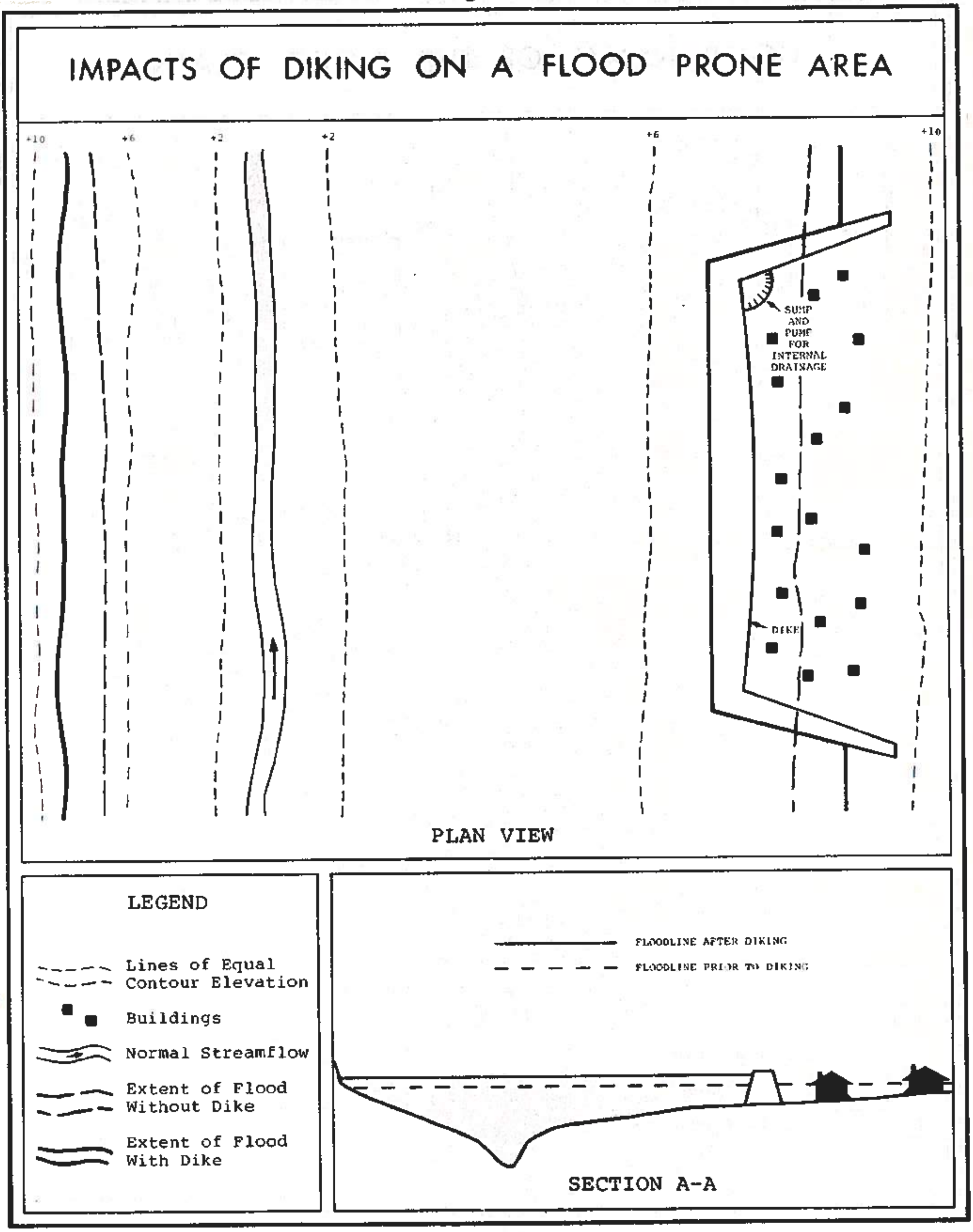
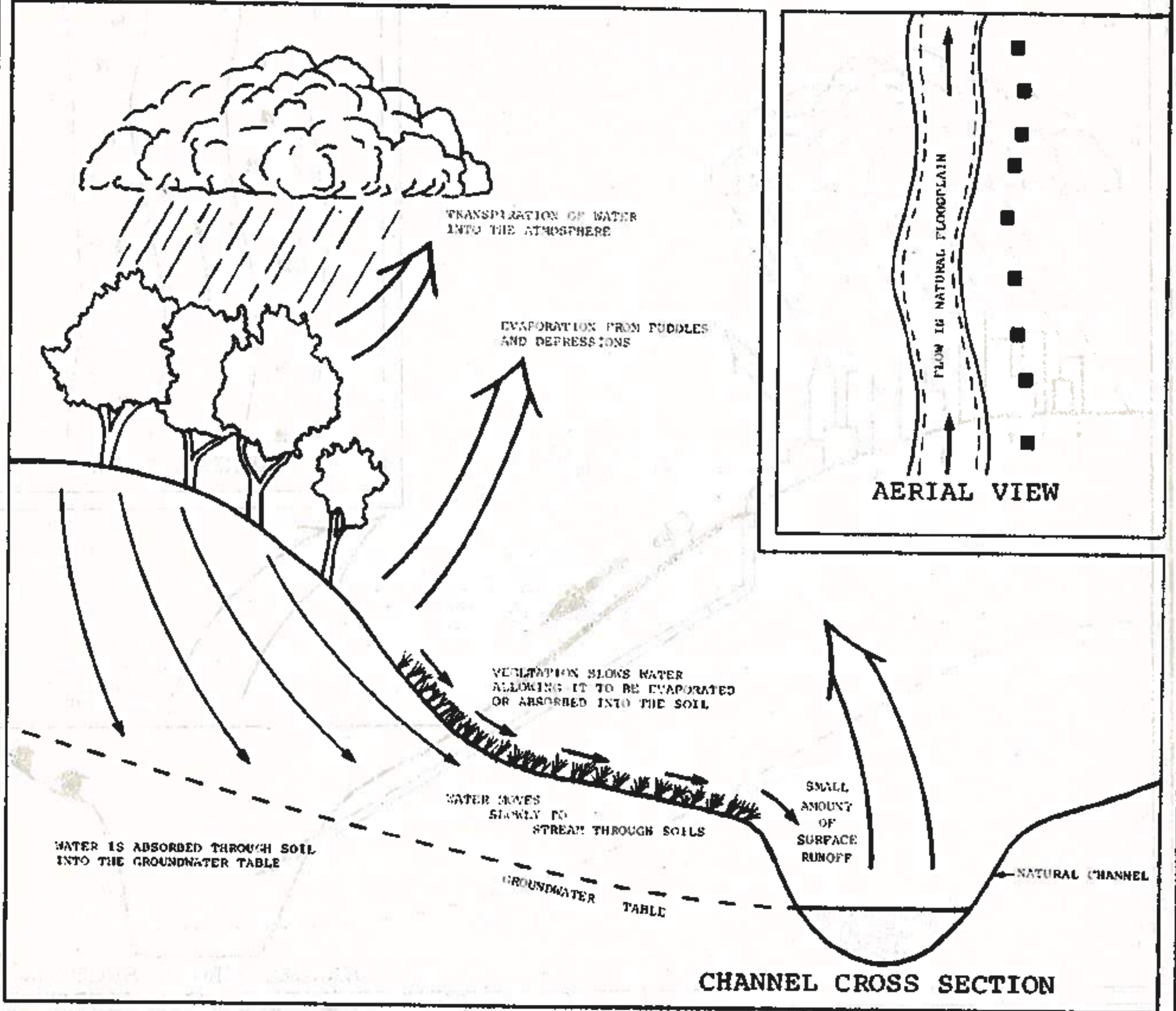

IMPACTS OF DIKING ON A FLOOD PRONE AREA
+10
+6
+2
+2
+6
+10
SUMP AND PUMP FOR INTERNAL DRAINAGE
DIKE
PLAN VIEW
LEGEND
Lines of Equal Contour Elevation
Buildings
Normal Streamflow
Extent of Flood Without Dike
Extent of Flood With Dike
FLOODLINE AFTER DIKING
FLOODLINE PRIOR TO DIKING
SECTION A-A

Figure 4

NATURAL HYDROLOGIC SYSTEM



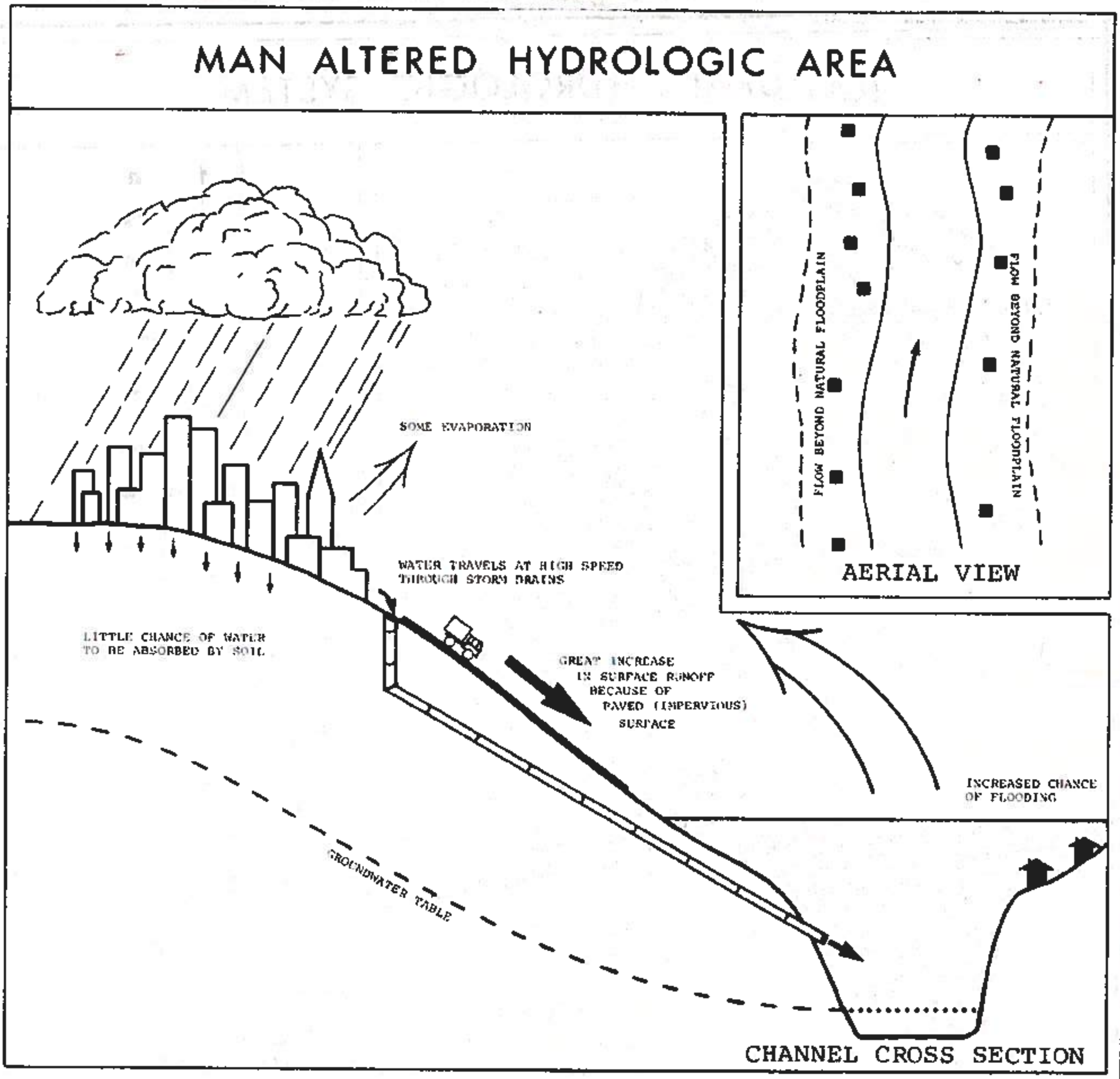
RAINFALL OCCURS IN A NATURAL SYSTEM

- Water is absorbed by trees and used in biological processes
- Water collects in natural depressions and is absorbed by soil or it evaporates
- Water flows slowly overland or through ground to stream
- Some water goes through soil to groundwater table

RESULT

- Water reaches stream slowly, reducing chances that the stream can not carry it
- Water moves slowly, allowing soil particles carried along to drop out (slower moving water is also less likely to erode the soil)
- Pollutants carried by the water are naturally filtered out by the soil

Figure 5



RAINFALL OCCURS ON MAN-ALTERED SYSTEM

- Water runs rapidly over land on impervious surfaces
- Water collects in storm drains and is fed directly to stream or river
- Because of high velocities little evaporation or soil absorption has a chance to occur
- Because of lack of vegetation, transpiration will not occur

RESULT

- Greatly increased volumes of water reaching stream
- High water velocities, great erosive force; danger to human life
- Pollution and litter washed off streets directly into streams
- Erosion of earthen material, leading to sediment in streams and harbors

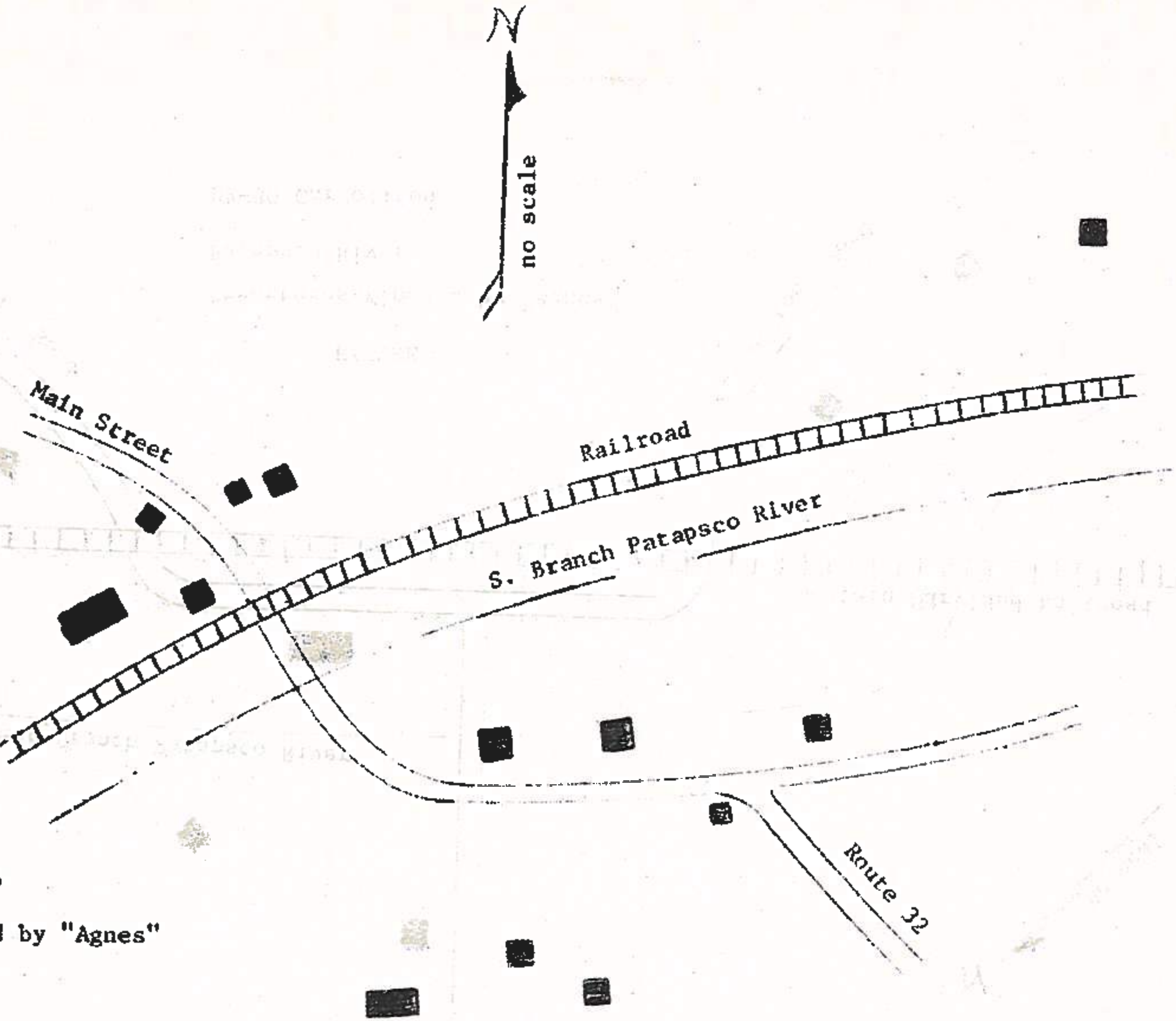


FIGURE 6

Structures Flooded by "Agnes"

Patapsco River

PR-22 Sykesville

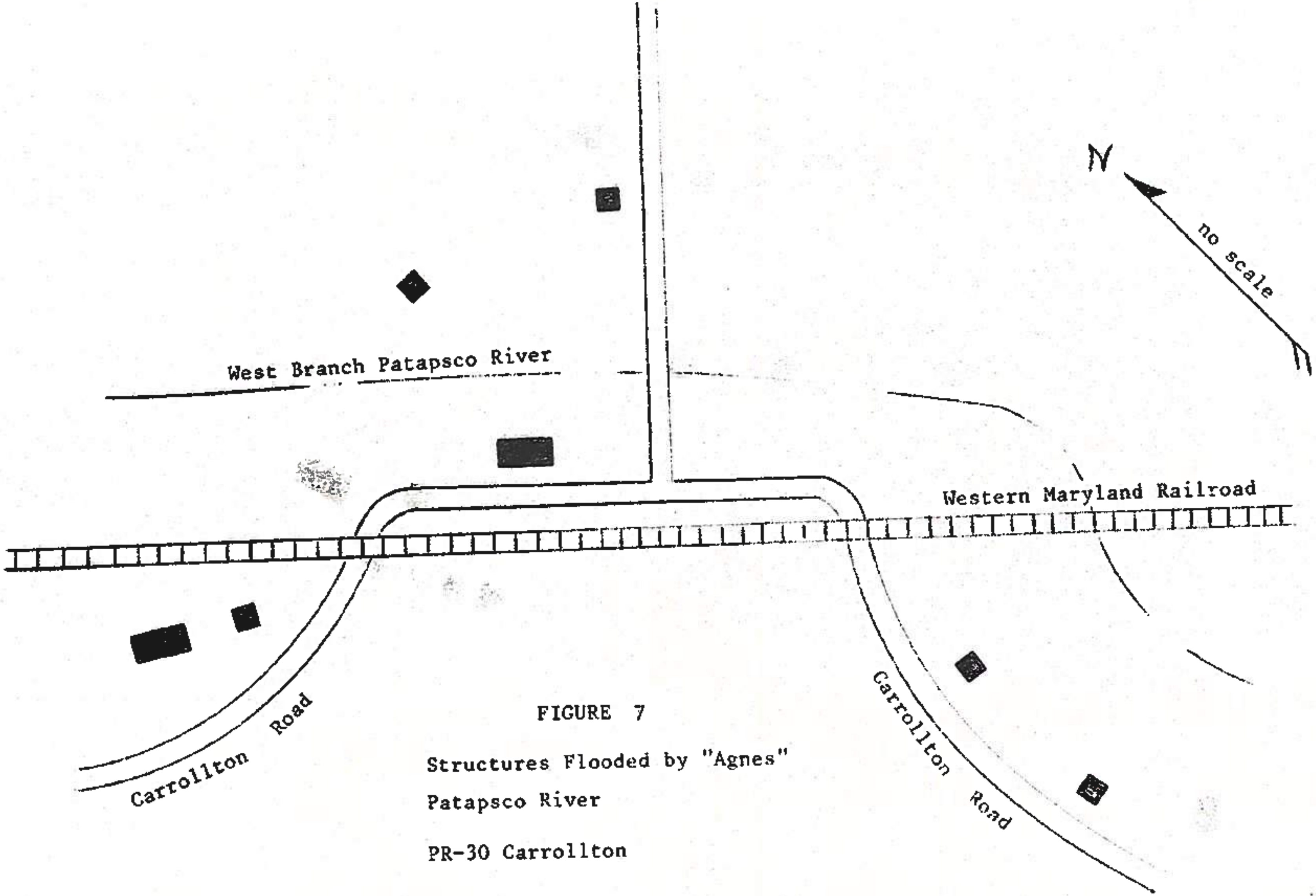


FIGURE 7

Structures Flooded by "Agnes"

Patapsco River

PR-30 Carrollton

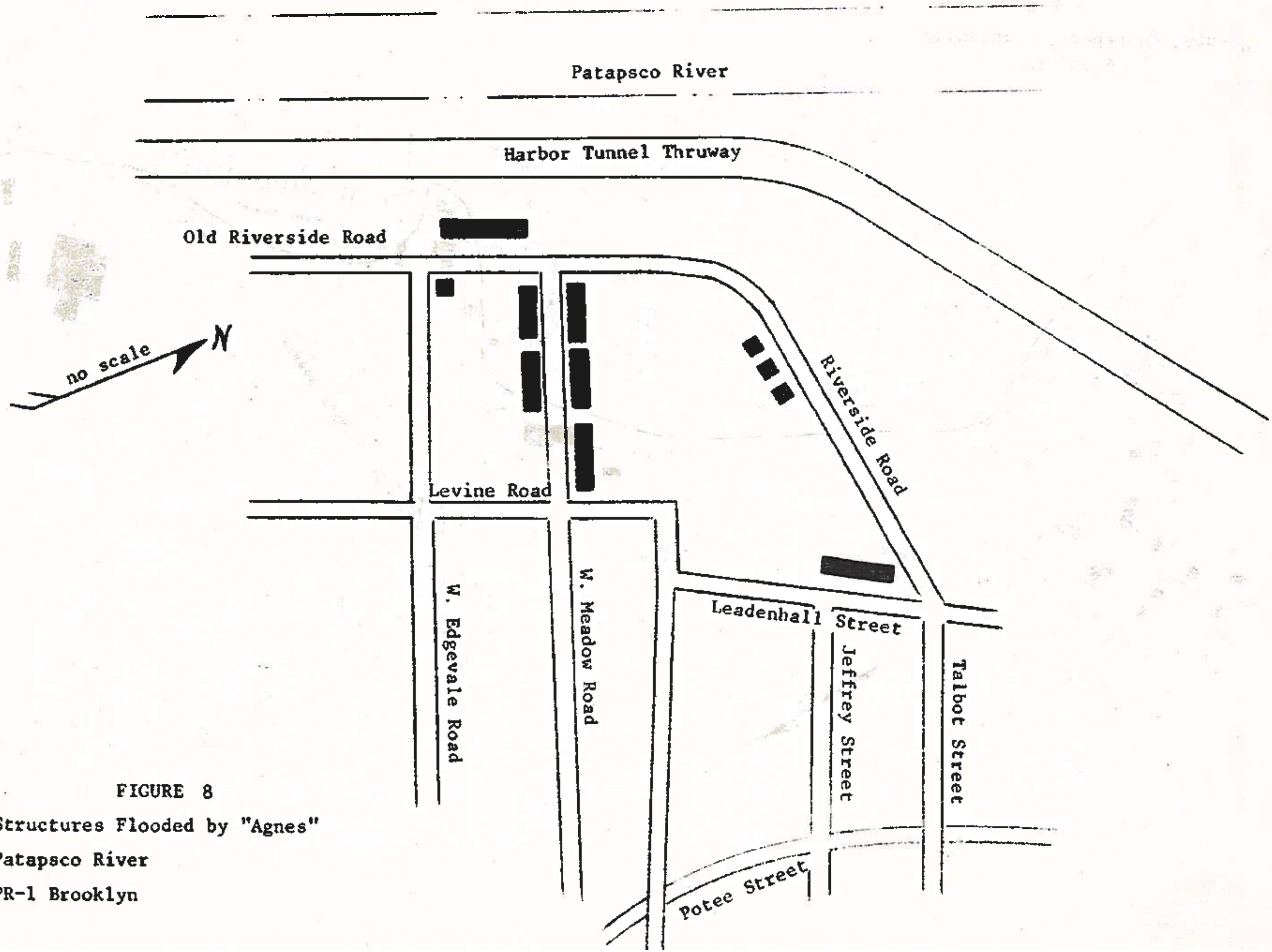


FIGURE 8
Structures Flooded by "Agnes"
Patapsco River
PR-1 Brooklyn

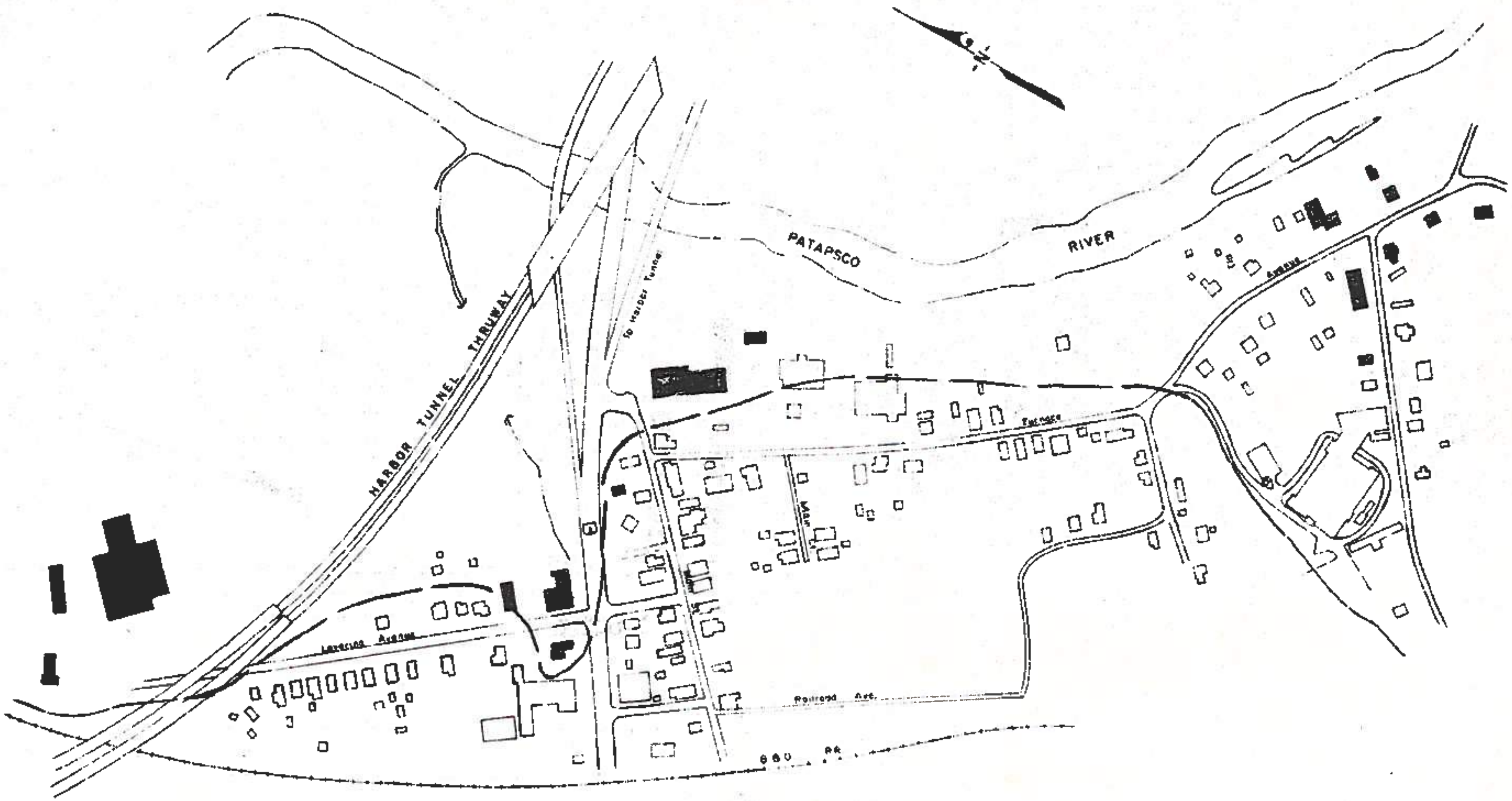
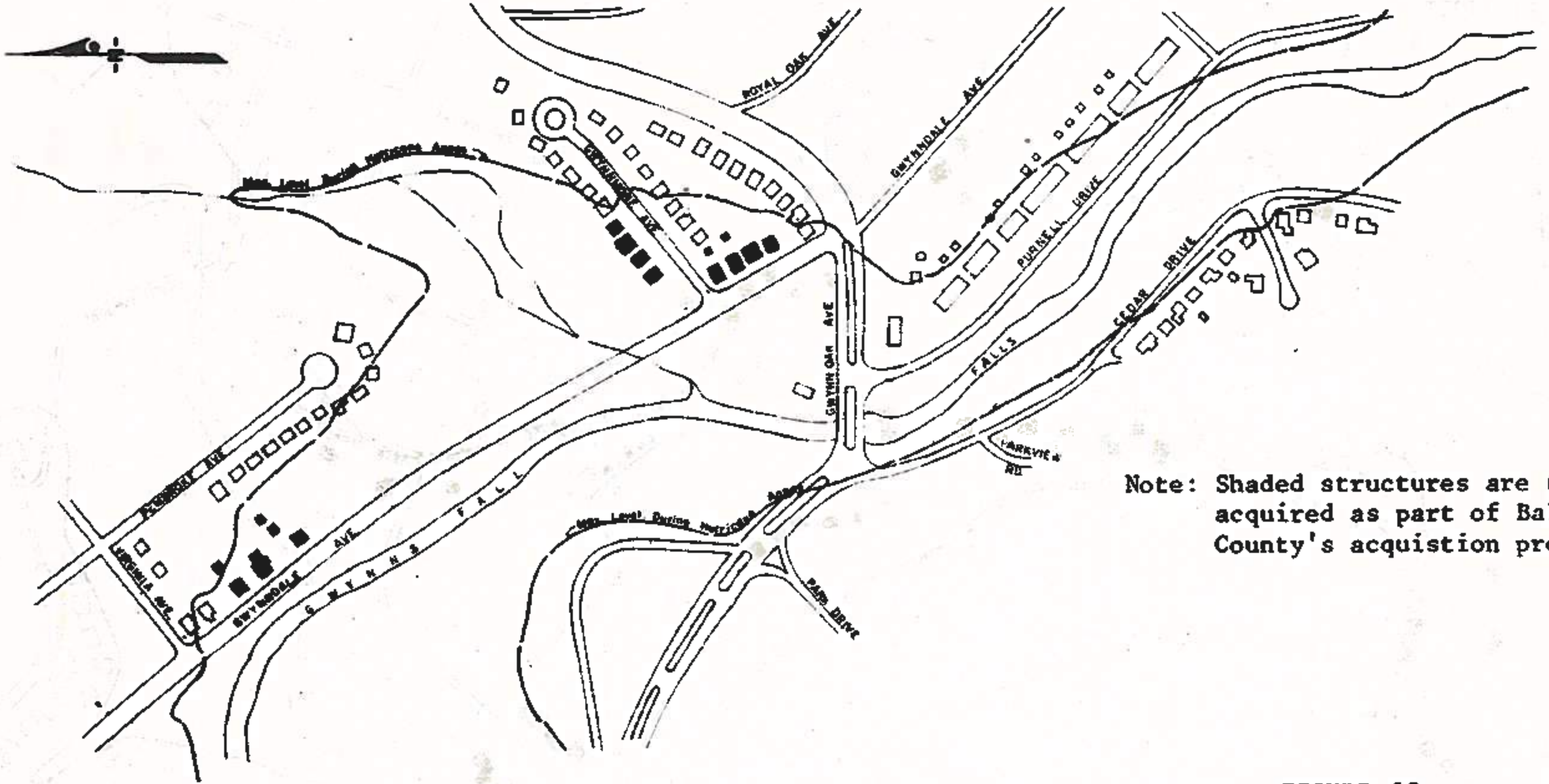


FIGURE 9
Structures Flooded by "Agnes"
Patapsco River
PR-14 Elkridge



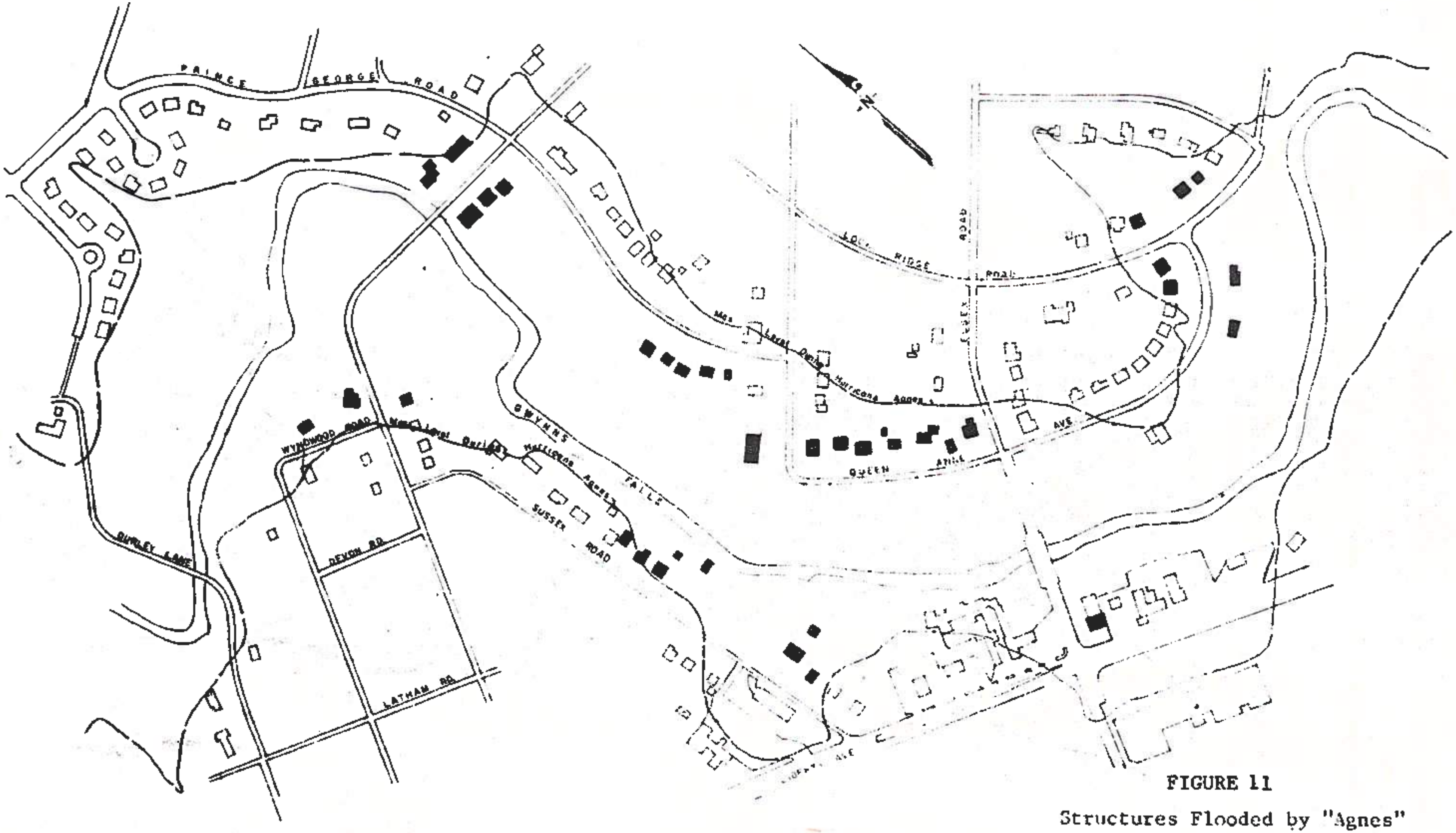
Note: Shaded structures are to be acquired as part of Baltimore County's acquistion program

FIGURE 10

Structures Flooded by "Agnes"

Gwynns Falls

GF-10 Gwynn Oak



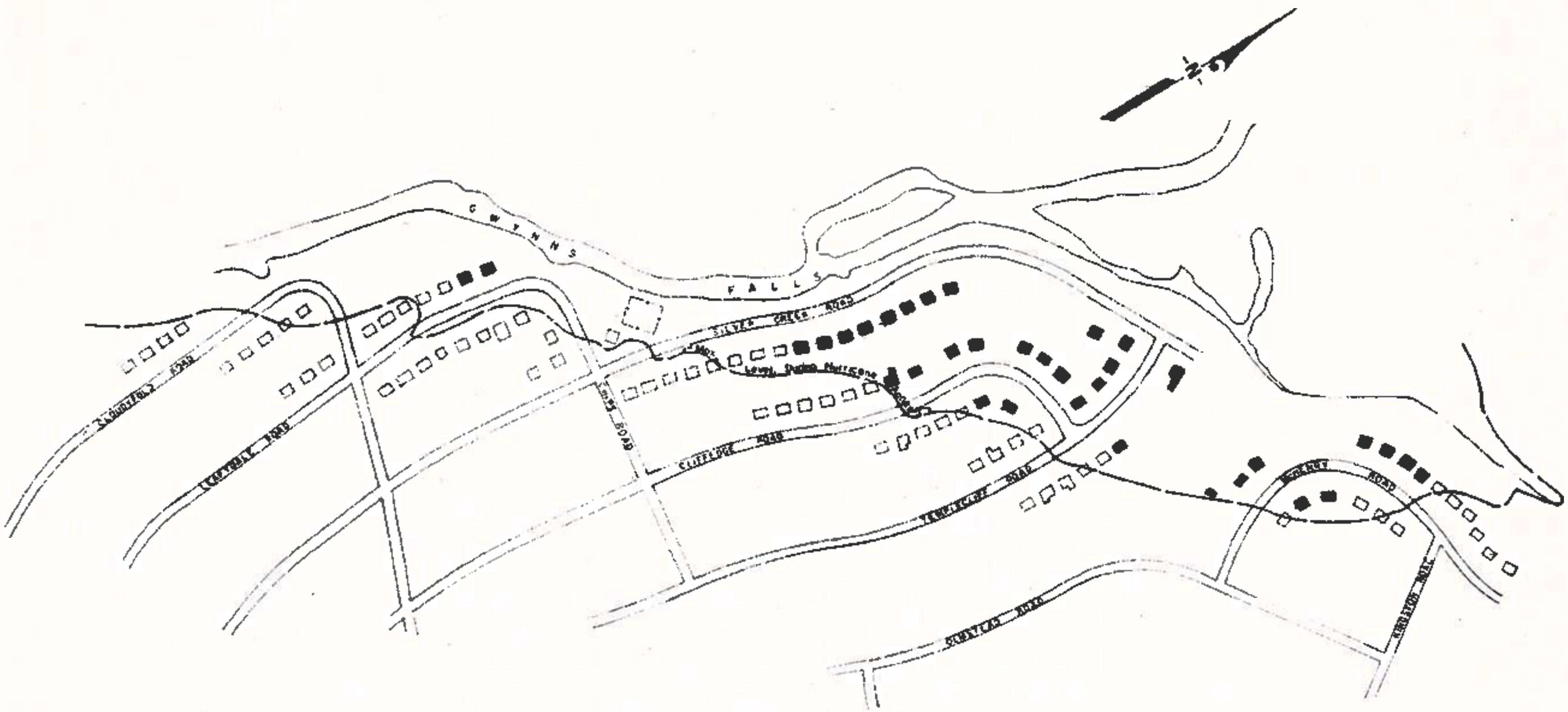
Note: Shaded structures are to be acquired as part of Baltimore County's acquisition program

FIGURE 11

Structures Flooded by "Agnes"

Gwynns Falls

GF-11 Villa Nova



Note: Shaded structures are to be acquired as part of Baltimore County's acquisition program

FIGURE 12

Structures Flooded by "Agnes"

Gwynns Falls

GF-12 Silver creek Park

SOLUTIONS TO WATER AND RELATED LAND RESOURCE PROBLEMS

I. FLOODING

There are many methods available for reducing flooding and flood damages. A partial list would include such measures as flood insurance regulations, flood warning, impoundments, channel improvement, dikes, floodwalls, property acquisition, stormwater management, conservation land treatment, removal of constrictions, and land use controls. All of the above measures were considered when looking at possible solutions for the flooding problems in the Patapsco River and Gwynn's Falls. In the Status Report for the Patapsco River Basin Study, November, 1978, the alternative solutions and their applicability to the problem areas were discussed. This initial screening of alternatives discarded many of the alternatives with little applicability for different areas of the stream systems.

Some of the measures, such as land treatment and flood insurance regulations, have beneficial effects which are difficult to measure. Others, such as stormwater management, do more to prevent future increases in flood damages rather than reducing present flood damages.

Some of the measures are unpopular because they may give a false sense of security. For example, dikes and flood proofing are installed to protect against a certain flood. If a larger flood occurs, the measures will be overtopped and damages would again occur.

The alternatives which were further considered are discussed in this section. First, there will be a discussion of the types of solutions considered and then their applicability to different areas along the river. An evaluation of the environmental effects of the measures is shown in Table 24.

Flood Plain Delineation

The initial step in formulating solutions to flooding problems is to delineate the floodplain.

This involves determining the extent of flooding on a stream for a flood of a particular recurrence interval. This is usually done for the 100-year flood under present development conditions, but may also be done using anticipated future conditions. This information is then displayed on maps to determine what areas are flooded. For the purposes of this study, floodplains were delineated at major damage areas along the Patapsco River and Gwynn's Falls. Using this information, alternatives were formulated using one or a combination of the measures discussed below.

Using the information developed during this study, floodplain maps could be produced. These maps could then be used to enforce floodplain regulations, which would prevent future damages caused by new development in the floodplains.

A. Types of Solutions Considered

Flood Insurance

Flood insurance obviously does not protect against physical flood damage or risk of loss of life. It does provide a peace of mind benefit with regard to the danger of direct economic loss. Flood Insurance Administration regulations require that the jurisdictions that wish to participate in the flood insurance program must enact ordinances limiting development in the floodplain. These regulations help control the growth of future flood damages.

The National Flood Insurance Program (NFIP) was established by Congress in 1968 to reduce flood damages and to relieve the drain on federal tax dollars for disaster relief. When communities elect to adopt appropriate floodplain management, residents become eligible to purchase flood insurance.

There are two phases in the NFIP. In most cases, communities first join the Emergency Program in which a preliminary Flood Hazard Boundary Map is issued by the Federal Emergency Management Agency (FEMA). The community agrees to enforce general floodplain management measures. In the Emergency Program limited amounts of flood insurance (coverages up to $35,000) are available at subsidized rates for all structures regardless of their risk. After a detailed floodplain study (Flood Insurance Rate Study) has been provided by FEMA the community is eligible to join the Regular Program. More comprehensive floodplain management measures are required at this stage and the limits of flood insurance coverage are increased from $35,000 to $185,000 for residential structures. Rates also are computed based on the amount of flooding which can be expected.

Of the jurisdictions affected by the Patapsco River Basin Study, those in the Regular Program are Baltimore City, Carroll County, Howard County and the incorporated areas of Sykesville, Westminster, and Hampstead. Baltimore and Anne Arundel counties are in the Emergency Program, but Flood Insurance Rate Studies are underway and are due for completion in the near future.

Communities may receive assistance on the NFIP through either the regional office of FEMA, or the State Coordinating Office, Maryland Water Resources Administration.

Flood Warning

For communities along the lower Patapsco from Ellicott City down to Baltimore Harbor, the full application of a flood warning system is probably the best, near-term, method of flood protection.

Flood warning involves devising a system whereby conditions monitored at an upstream area can be used to determine when flooding is imminent in downstream areas. Once this is determined, floodplain residents are notified. Depending on the size of the watershed above the damage area and the rate and timing of runoff, it may be possible to devise a system triggered by rainfall and upstream flow conditions. While such a system gives a few hours warning of an impending flood, it does not prevent a flood. It allows downstream areas susceptible to flooding to prepare. This requires development of individual schemes for the removal of damageable material to higher elevations. Such a system can help reduce the risk of loss of life and reduce economic damages.

In most cases, property owners could protect a large percentage of their perishable household or commercial goods if they were given a 4-6 hour warning of imminent flooding. Some businesses indicated that they could have eliminated 50-70% of the flood damage sustained in Tropical Storm Agnes if they had been warned 6 hours in advance.

A flood warning system is already in operation in Howard County. It is coordinated by the Howard County Office of Civil Defense, and involves the cooperation of many branches of the county government. Howard County is already disseminating some information to the Civil Defense Directors in Anne Arundel and Baltimore County. However, a more systematic approach is warranted for the delivery of flood threat information to property owners. There is also a need to prevent the dissemination of misinformation which can cause needless evacuation.

Flood Proofing

In the majority of flooding occurrances, there is no major threat to human life. Homes or businesses located on the flood fringe experience rare instances of floodwater entering and causing property damage either to structures or contents. The water is usually slow moving or still, and is at depths under three feet.

In these cases, flood proofing is often appropriate. Flood proofing can either mean modifying a structure to physically prevent water from entering at or below a certain predetermined elevation; or it can mean modifying the structure to withstand the rigors of flooding with minimal structural damage. Flood proofing can be as simple and inexpensive as raising a sill around a basement door with a few bricks or concrete blocks to techniques as complex as raising an entire structure 8-10 feet vertically. The former extreme can usually be implemented by a private homeowner for $50-$100 with minimal technical advice while the latter extreme can cost $20,000-$30,000 for a single house and usually involves a great deal of technical expertise from engineers.

In the Patapsco, flood proofing is only suggested for those residences and businesses which sustain flooding of two feet deep or less during the 100-year storm. For such structures, flood proofing can usually be accomplished for a small fraction of the value of the property, and can be installed by the individual whose property is being affected with limited technical supervision. See Table 19 for a listing of areas where flood proofing was evaluated.

County governments could sponsor flood proofing seminars in communities where minor flood proofing would eliminate a large percentage of the flooding problem. Citizens have expressed interest in such seminars if they were held at a convenient time and place. Communities where such meetings might be considered include Elkridge, Ellicott City, Arbutus, Linthicum, Raynor Heights, Pumphrey and Carrollton.

The U. S. Army Corps of Engineers has excellent data on flood proofing techniques, and experience in costs of flood proofing implementation, maintenance, and operation. In their recently completed Baltimore Metropolitan Streams, Maryland Study, several areas were identified for possible technical assistance through their Floodplain Management Services Program. That assistance remains open upon request.

Acquisition

Fee simple acquisition of floodplain properties is perhaps the most direct means of eliminating flood problems. Relocation or removal of structures susceptible to damages completely eliminates the possibility of financial loss. Acquisition is often expensive when compared to other solutions. It is generally employed when the flood problem is frequent and severe.

Acquisition is one of the most environmentally sound methods of controlling flood damage. However, relocation of people can have great social costs. It may involve disruption of an old, established neighborhood. It may involve low or middle class housing stock whose availability may be limited elsewhere in the community. Criteria for relocation of persons displaced by Federal projects is established in the Uniform Relocation and Assistance and Real Property Acquisition Policies Act of 1971. This federal legislation guarantees equivalent, safe and sanitary replacement housing for displaced families or small businesses. In areas of Baltimore County, particularly along Gwynn's Falls, the county government has already begun an acquisition program. So far, many homes have been acquired and the families relocated. More homes are slated for acquisition over the next few years. In Howard County, several homes near the confluence of Deep Run and the Patapsco River have been acquired and demolished. The families have been relocated. In Anne Arundel County, several homes in the Brooklyn Park area have been acquired and demolished. Also, twenty-one homes in the Ridgeway Manor subdivision in North Linthicum are slated for acquisition over the next five years.

There is some popular opposition to relocation. Often, long time residents prefer the risk of periodic flooding to disruption of their household or community. Also, many people perceive the acquisition program as arbitrary. They observe floodplain acquisition on one hand and what they perceive as increases in flooding due to uncontrolled development upstream.

For the most part, however, the acquisition program serves a worthwhile purpose. While it may not be economically justifiable using federal criteria, it is, in some instances, the most cost effective, environmentally sound method of protecting people whose homes are susceptible to major, life threatening flooding. See Tables 19 and 20 for an analysis of the acquistion benefits and costs.

Impoundments

Earth impoundments or dams can be used as a flood control measure to retard large amounts of floodwater, thus reducing depths of flooding in downstream areas. The dams impound floodwater, usually that occurring from a 100-year flood, and release it slowly.

The typical dam considered in this report is constructed of zoned earth fill with a concrete pipe-riser release structure. An earthen emergency spillway constructed around one end of the dam is used to carry flows in excess of the 100-year flood.

Depending on the needs and desires of the surrounding community, dams and their attendant reservoirs may be designed to provide multiple uses such as recreation, water supply, and fish and wildlife management.

Because dams do not protect the communities in the areas adjacent to or upstream of their location, they may be looked upon with disfavor by the portion of the public adjacent to them. People further downstream who either receive flood control benefits or, at least, do not have to surrender any land, are generally more tolerant of the idea of a dam.

The streams on which impoundments were considered to reduce flooding are shown in Table 21. They are located on the map on Figure 13. Several alternative combinations of these structures were compiled from this list of possible sites for analysis.

Alternative #1 consisted of all ten of the dams. (The dams were designed as single purpose structures providing only floodwater storage.) This alternative reduces the average annual damages on the South Branch from $66,600 down to $1,500 and on the Main Stem from $52,700 down to $6,800. Of the impoundments on the North Branch, only East Branch and Deep Run would significantly provide localized benefits. The benefit would accrue to the Congoleum Plant at Finksburg. The total cost of this alternative is $26,400,000.

Alternative #2 consisted of only the four largest dams. They included Gillis Falls, Morgan Run, East Branch and Beaver Run. Gillis Falls reduces average annual damages on the South Branch from $66,600 to $6,100. The four dams reduce damages on the Main Stem from $52,700 to $23,100. The total cost of this alternative is $13,000,000.

Alternative 3 consisted of only the Gillis Falls dam. This alternative was evaluated because of the great degree of control it provides. Also, Carroll County is investigating the possibility of constructing a water supply impoundment at that location. The dam reduces average annual damages on the South Branch from $66,600 to $6,100 and from $52,700 to $31,300 on the Main Stem. The total cost of this alternative is $3,600,000.

Tables 22 and 23 show a breakdown of the effect of the impoundment alternatives by economic reach.

Dikes and Floodwalls

To prevent flooding, earthen dikes can be placed in a floodplain between the stream and the area being flooded. Dikes generally encroach on the natural floodplain and thus may cause higher flood elevations than would otherwise occur. This must be taken into consideration in their design. Dikes must be coupled with a sump and pumping system to account for internal drainage, that is, for the area that would naturally drain through the protected area into the stream but will be prevented from doing so by the dike.

Floodwalls are similar in concept to dikes and usually replace them in urban areas or where space is at a premium. Floodwalls are generally vertical walls constructed of reinforced concrete or block.

Both dikes and floodwalls are very effective in preventing flood damages. Their use depends on topography and locations of houses and roads. Depending on their location and the materials used in construction, they may be unsightly. Some homeowners may prefer the risk of periodic flooding to the placement of a dike or floodwall near their properties. Questionnaire results have indicated marginal interest in diking, with interest depending on height of dike and frequency of flooding. Diking may also provide a false sense of security when people assume that the dike will not overtop during a flood larger than the design flood.

Diking is one structural alternative that has engineering feasibility and is applicable in situations where loss of life is a possibility. In some areas along the lower Patapsco, it would be physically possible to build earthen or concrete dikes to prevent floodwaters from encroaching on homes or businesses.

In certain areas, the use of dikes or floodwalls to protect flood-prone property is unfeasible. Gaither is an example. A dike or floodwall protecting homes would essentially isolate the homes from the rest of the community and from proper ingress and egress. See Tables 19 and 20 for an analysis of dikes and floodwalls where applicable.

Channel Improvement

Channel improvement involves altering a natural stream channel to allow it to more efficiently carry large quantities of water, thus lowering the depth of flooding. It changes the shape, capacity, alignment, or lining material of a stream. Channel improvement generally benefits the area immediately adjacent to it, while effects of higher than normal flows may be transferred downstream.

Channels do not involve a great deal of land. Depending on the nature and extent of the channel work, channels may have adverse environmental consequences for the fishery habitat, but such effects can often be mitigated. However, major changes in channel geometry or use of a concrete lining may have irreversible impacts on aquatic species.

Channel improvement could reduce or prevent flood damages along some areas of the river, particularly at Ellicott City. However, the costs would be so high, and environmental consequences so severe, that it was felt that it should not be given further consideration.

Modification of Liberty Reservoir

There have been several suggestions concerning the modification of Liberty Reservoir to afford flood control to the Main Stem of the Patapsco. Due to its location and area controlled, Liberty has much potential for flood control. It already provides significant flood control in conjunction with its operation as a water supply reservoir.

However, it is not reasonable to suggest that the construction or management of Liberty Reservoir be altered to reduce flood damage downstream. The detail necessary to make such decisions is beyond the scope of this study. Also, the legal agreements which would be necessary are very complicated. It would not be advisable to begin long, detailed studies until the parties concerned had established an agreement to consider, in principle, the recommendations of such a study.

Over the years, people have suggested: 1) introducing some flood storage into Liberty Reservoir by allowing water to run out prior to a storm; 2) building some additional storage above the existing reservoir; 3) ringing Liberty with some small floodwater impoundments; and 4) managing water supply withdrawals in order to increase the available flood storage when needed.

Suggestion #1 is extremely risky from a water supply standpoint. Also, it would require major structural modifications to allow timely withdrawal.

Suggestion #2 would require a major engineering evaluation of the existing dam structure to see it if could withstand the surcharges that would be introduced. Also, more land would be temporarily flooded by the lake.

Suggestion #3 is not cost effective. Imposing several impoundments on the hydrologic model does not prevent all damages below Liberty Reservoir. (See Table 20.)

Suggestion #4 would introduce an economic risk to Baltimore City water supply system rate payers, because it would increase the likelihood of having to use water from a more costly source namely the Susquehanna River.

Given the existing constraints, such modifications should be dropped from consideration.

Studies have shown that Liberty Reservoir already has a significant impact on reducing not only the number of flood events downstream, but also the severity. Throughout most of its life, Liberty has been drawn down below its crest. Thus, floodwaters coming in are trapped behind the dam to a large extent. In fact, several "non events" have been documented as a direct result of Liberty storage, the most recent having occurred in early 1979.

Also, even when the reservoir is filled to capacity, the temporary storage that occurs on the top of the lake causes a large reduction in peak discharge. This does not prevent catastrophes such as Agnes, but it does reduce their severity considerably. (See Figure 14.)

Stormwater Management

Urbanization causes many interrelated land and water resource problems which are being studied by experts in many technical disciplines. It is beyond the scope of this study to analyze all of the problems other than to recognize that they are interrelated and to caution land use planners to analyze the interrelationships carefully before making land use decisions.

This report is concerned mainly with flooding and its causes. It will address one simple cause-effect relationship: increased impervious areas associated with urban development cause an increase in surface runoff volume. In recognition of this phenomenon, local jurisdictions, in compliance with the Maryland Sediment Control Law, have adopted local stormwater management policies. Policies differ from jurisdiction to jurisdiction, but essentially they mandate that a developer is responsible for the increase in runoff that his development creates. It is his responsibility, therefore, to store or otherwise dispose of any increase in volume and to reduce peak flows down to pre-development levels. The primary purpose within the jurisdictions is to prevent increased erosion of streambanks due to fairly frequent storm events.

Conservation Land Treatment

Land treatment has many forms and purposes. For example, contour plowing, strip cropping, and properly maintained logging roads reduce runoff and erosion; stream valley buffers and sediment basins reduce downstream sedimentation; and drainage systems remove excess ground water.

Application of conservation practices would have little effect on the discharge from a watershed area during large infrequent storms. They would have the effect of reducing amounts of runoff from small frequent storms. Properly applied practices would reduce non-point pollution and increase groundwater infiltration, thus offering benefits other than flood control.

Removal of Constrictions

Several landfills are located at the mouth of the Patapsco on either side of the river. The land which they occupy used to be part of the floodplain. Through the years, these areas have been used to dispose of solid waste material. These landfills along with other man-made features constrict the Patapsco floodplain at the mouth of the river.

Hydraulic studies have demonstrated that if the landfills were present in 1972, upstream flood stages during Tropical Storm Agnes would have been somewhat higher than they were. Thus, more areas in Baltimore County and Anne Arundel County would have been flooded.

It is unrealistic to suggest removal of the entire landfill, especially portions which are used as utility rights-of-way. However, it is possible that by cutting back portions of the landfills, flooding conditions can be improved somewhat.

The remnants of an old B & O Railroad Crossing in the residential portion of Elkridge has also been demonstrated to have an impact on flooding in that community. Removal and stabilization of the road bed would cost about $275,000 and reduce the 100-year flood stage immediately upstream by four feet.

In Carrollton, the roadbed which was a spur of the Western Maryland Railroad, cuts across the floodplain at the North Branch of the Patapsco. Relocation or removal of a short portion of this roadbed would reduce flood stages in Carrollton.

B. Solutions For Specific Areas

Using the above list of measures, alternatives were formulated for different reaches. The effects of these alternatives are outlined below. For an economic analysis of the alternatives, see Table 22.

South Branch Flooding

The flooding on the South Branch can be reduced or prevented in one of or a combination of methods. Impoundments on Gillis Falls, Hay Meadow Branch, and Piney Branch would reduce flooding in Woodbine, Morgan Station, Gaither, and Sykesville. They would reduce flooding by as much as 6 feet during the 100-year flood in Henryton and Marriottsville. An impoundment on Gillis Falls alone would have nearly the same effect.

Acquisition and flood proofing can serve to reduce flood damages. Diking and channel work could prevent damages at Woodbine and Marriottsville.

In Woodbine (PR-26), channel improvement, flood proofing, diking, impoundments, and acquisition were considered as methods of flood protection. Channel improvement would require the use of a concrete channel and the costs would be high. Diking is impractical due to the location of roads and the layout of the buildings. Since the buildings damaged are commercial enterprises, acquisition was not considered due to the high cost. Impoundments would reduce flooding considerably. Flood proofing of individual buildings could be a partial solution to flooding problems.

At Morgan Station (PR-25) and Gaither (PR-23), acquisition and impoundments were the only available solutions to the problem due to location and type of homes.

The flooding in Sykesville (PR-22) is mostly to commercial enterprises, therefore acquisition was not considered. Channel improvement was considered, but costs were prohibitively high. Diking was not feasible due to location of the buildings. Flood proofing and impoundments were the only measures considered further.

There was nothing that could be done at Henryton (PR-21) due to very small damages.

At Marriottsville (PR-20), measures considered were channel improvement, acquisition, and impoundments. Due to location and depth of flooding, dikes and flood proofing were not considered. Channel improvement costs would be high. Acquisition would require removal of approximately one-third of the homes in the community. Although this would cause a major social impact, the alternative was considered further. Impoundments cannot prevent damages, but they reduce the 100-year flood level by more than five feet, thus reducing damages considerably.

North Branch Flooding

The solutions to the problems on the North Branch are similar in several ways. Diking and channel work are not practical due to the scattering of the buildings and their proximity to the river. Flood proofing would prevent the low levels of flooding that occurs to most of the residences. Impoundments would serve to reduce flooding in Patapsco and at Finksburg, but would not prevent it. Acquisition would be practical everywhere but at the Congoleum Plant at Finksburg.

Lower Patapsco Flooding

Flooding on the lower Patapsco varies from not serious to very serious. The solutions are also varied. In some areas, the structures are scattered, making their protection difficult, while others are concentrated, making their protection easier. Impoundments constructed in Carroll County would reduce the flooding potential downstream considerably.

In Brooklyn (PR-1), most of the damage was limited to basement flooding in row houses. Agnes and tidal flooding in 1933 were the only flooding any of the residents could recall. Since basement flooding creates only minor damage, no extensive structural measures were considered. Minor flood proofing would prevent the damages. Impoundments would prevent it.

In Pumphrey, North Linthicum and Baltimore Highlands (PR-2), the damaged structures were scattered except for concentrations in Pumphrey and at a trailer court on Belle Grove Road. For scattered damages, the only practical solution is impoundments, acquisition, or flood proofing, if depths of flooding are low. For the area at Pumphrey, diking was considered. The trailer court is located in such a way to preclude diking, so acquisition was the only considered measure.

In Oak Park (PR-3), the damage to commercial structures was scattered. This precludes measures such as diking or channel improvement. Due to depth of flooding, flood proofing would not be feasible. Impoundments would reduce the flooding in this area. Acquisition would be too costly since the structures are businesses, including the Carling Brewing Company.

The flooding on Herbert Run (PR-4, 5, 6, 7 and 8) is confined mostly to basements. Minor flood proofing could prevent this type of damage. Diking, acquisition and channel work would be too costly because of the small amount of damage prevented. A present impoundment on the campus of UMBC and others proposed by Baltimore County may prevent or reduce the flood damages.

The residential damage in Elkridge (PR-14) was scattered while the commercial damage was mostly concentrated along Main Street. Diking would not be feasible because of scattered damages and location of the businesses on both sides of Main Street. Acquisition of the businesses would destroy most of the town center. Acquisition of the houses is a practical solution. Flood proofing of some of the structures where flooding depths are low is a viable alternative. Impoundments would also reduce flood damages in this area.

The industrial flooding in Ilchester (PR-15) is a major problem due to their proximity to the river. Diking and channel work are impossible due to space limitations. Acquisition of the industry would be prohibitively high. A concrete floodwall would prevent the damages, but would be costly and inconvenient due to the road closure which would be necessary. Impoundments would reduce the flooding here.

The flooding problem in Ellicott City (PR-16) is a unique situation. Ellicott City is an historic district, therefore, the solutions would have to be ones which would not interfere with the area's historic nature. The area can be divided into 2 sections for analysis; the businesses along Main Street on the west side of the B & O railroad tracks; and the Wilkins-Rogers Plant plus the scattered businesses and redidences on the east side of the tracks.

The flooding on Main Street, is for all intents and purposes, impossible to prevent. Due to its historic nature, acquisition and major flood proofing are not desirable. Minor flood proofing for shallow depths of flooding would be possible. Diking is impractical because the major inflow of the Tiber River would have to be pumped over a dike. Channel improvement would require the use of a concete lined channel which would not only be costly, but would be environmentally undesirable due to both the historic nature of the area and the natural river system.

The flooding at Wilkins-Rogers and other places on the east side of the Patapsco has different solutions. The Wilkins-Rogers plant is located next to the river, not much higher than the river bank. Flooding is almost impossible to prevent. Flood proofing could be used to prevent minor flooding, but major floods would still cause damage. Acquisition is also out of the question. Diking would require a major reduction in floodplain width which would increase flooding upstream on Main Street. Impoundments in Carroll County would only reduce the flood damages, not prevent them. The same types of problems indicated above prevent protection of the remaining homes and businesses on the east side of the river. Acquisition, however, would be a solution to some of the problems.

At Hollofield (PR-17) and Woodstock (PR-19), the damages are to scattered homes and the damages are relatively minor. Minor flood proofing, acquisition and impoundments would be the only viable solutions to the problems.

Gwynn's Falls

The damages in Gwynn's Falls are scattered all along the stream. Structural protection measures are therefore unfeasible in most cases. Another problem arises from urbanization in the watershed. As upstream areas urbanize, the flows in the stream will increase. It has been estimated that future 100-year discharges will be greater than the Agnes discharge.

In Westport (GF-1), there were major damages during Agnes. The structures are scattered throughout the reach, making them difficult to protect. The one area which could be protected is downstream of Route 1. In the Baltimore Metropolitan Region Streams Study, the Corps of Engineer's evaluated a dike around commercial and industrial property and eighty-seven residential structures in this area. Flood proofing against low depths of flooding would be feasible. Acquisition of the residential structures would reduce the flood damages.

Along Maiden's Choice Run (GF-2, 3, 4 and 5), the major problem is an undersized culvert under Frederick Road. The Corps of Engineers evaluated an additional culvert to protect the area. The costs of the culvert were high. Due to the small depths of flooding (less than three feet), flood proofing could be used to protect many of the structures. Acquisition should be considered for the more heavily damaged structures. Dikes and channel work are impractical due to the dense development in the area.

The flooding damages along Dead Run (GF-7 and 8), have been greatly reduced by Baltimore County's acquisition program. The remaining houses are widely scattered along the stream. The only viable solutions in this case would be acquisition or flood proofing if depths of flooding were low.

In Woodlawn (GF-10), and Villa Nova (GF-11), most of the highly damaged residences are being purchased by Baltimore County. The County is not purchasing businesses however. Due to the scattering of the remaining damages, flood proofing and acquisition of the remaining structures is the only viable solution.

Another heavily damaged area is at the Brittany Apartment complex downstream of the Beltway. Due to their proximity to the stream, the depths of flooding incurred and the type of structure (apartments), diking, flood proofing, and acquisition were not considered viable solutions. The only solutions were a floodwall or abandonment of the first floor apartments which were the only ones flooded. The Corps of Engineers analyzed a floodwall to protect the buildings. The costs and benefits of the floodwall are shown in Table 20.

The remaining heavily damaged area is at Owings Mills (GF-14). Most of the damages are to industrial buildings such as those in Owings Mill Industrial Park. The Corps of Engineers analyzed a floodwall in this area to protect the Industrial Park. The costs and benefits are shown in Table 20. Acquisition was ruled out due to the expense of purchasing industrial enterprises. Diking was not practical due to the buildings' proximity to the stream. Channel improvement would be too costly because it would require concrete lining.

II. EROSION AND SEDIMENTATION

Erosion and the resulting sedimentation can best be addressed at the source: erosion of soil particles. Many of the solutions available for controlling erosion and sedimentation also contribute to improvement in water quality problems from non-point sources of pollution.

Landowners can reduce erosion on agricultural land by pursuing an effective land treatment program. This involves efficient use of conservation practices such as minimum tillage, diversions, grass waterways, contour plowing, ponds, and strip cropping. Some of the practices not only reduce erosion but also affect other water quality parameters such as nutrients and fecal coliform.

Some of this land treatment is being provided through on going programs in which the landowner voluntarily installs practices, mostly at his own cost. Some cost sharing is provided through the Agricultural Stabilization and Conservation Service (ASCS) for agricultural practices.

However, this voluntary program is not meeting the total needs of the watershed. An accelerated program is required to meet the needs. This program could provide more technical and financial assistance in applying the practices. For a listing of the land treatment needs see Table 13.

Erosion on urbanizing land can be reduced by continued improvement of the existing Sediment Control Programs of the jurisdictions. Many of the practices used on agricultural land are suitable for erosion control on land being developed.

III. WATER SUPPLY

Carroll County is investigating a water supply site on Gillis Falls to supply its future needs. This site could be utilized as a multiple purpose, water supply-flood control site. This reservoir would reduce flood damages all along the river while supplying adequate water for Carroll County's needs along the South Branch.

IV. RECREATION

The existing stream valley acquisition programs could be utilized to supply much needed water based recreation. The acquired areas could be developed to the fullest extent possible. There are several sites in the watershed where impoundments could be built to provide some of the water based recreation.

TABLE 19

ANALYSIS OF ALTERNATIVES

PATAPSCO RIVER

Reach	Alternative	Description	Average Annual Damages* W/O Project	Average Annual Damages* W/Project	Average Annual Benefits*	Costs*	Average Annual Cost*	Benefit Cost Ratio
PR-2	2-1	Dike @ Pumphrey	1.7	1.4	0.3	450	32.1	0.01
	2-2	Acquire 21 Houses	1.7	1.0	0.7	850	60.6	0.01
	2-3	Acquire 6 Houses						
		Floodproof 15 Houses	1.7	1.0	0.7	410	29.2	0.02
PR-3		Remove Fill @ Beltway	0.4	0.2	0.2	2500	178.3	0.01
PR-14	14-1	Remove Abandoned Railroad Fill	6.7	6.6	0.1	275	19.6	0.01
	14-2	Acquire 1 House.	6.7	6.4	0.3	40	2.9	0.10
PR-15		No Viable Alternative						
PR-16		Channel	41.0	0	41.0	3560	253.9	0.16
PR-17		Acquire 1 House Floodproof 2 Houses	0.7	0	0.7	65	4.6	0.15
PR-19		Acquire 4 Houses " 3 "	2.3	0	2.3	215	14.2	0.15
PR-20	20-1	Acquire 6 Houses	3.9	0.2	3.7	260	18.5	0.20
	20-2	Channel	3.9	0	3.9	2840	202.5	0.02
PR-21		No Viable Solution						
PR-22		Floodproofing 2 Houses	0.6	0.5	0.1	15	1.1	0.09
PR-23		Acquire 4 Houses	2.9	0	2.9	190	13.6	0.21
PR-25		Acquire 3 Houses	0.5	0	0.5	175	12.5	0.04
PR-26	26-1	Floodproof 4 Buildings	58.7	0	58.7	140	10.0	5.87
	26-2	Channel	58.7	0	58.7	1950	139.1	0.42
PR-29								
		Floodproof 7 Houses	0.7	0	0.7	55	3.9	0.18
PR-30								
		Floodproof 4 Buildings	0.4	0	0.4	30	2.1	0.19
PR-31		No Viable Alternative						

*In thousands of dollars

TABLE 20 1/

ALTERNATIVES FOR PATAPSCO RIVER

DAMAGE REACH	COMMENT ON FLOODING SITUATION	ALTERNATIVE	DESCRIPTION	ECONOMICS*		
Tunnel Thruway to Baltimore Beltway					SPF	FOR
PR-2	Flooding of residential structures	PR-2AI Plate 10	Earth levee protecting 55 residential structures around Shenandoah Avenue.	F.C. = AAC = AAB = BCR =	$1,345,400 $102,700 $5,900 0.06	$888,000 $67,800 $2,100 0.03
					SPF	FOR
PR-2	Flooding in Raynor Heights	PR-2AII Plate 11	Earth levee protecting 25 residential structures around Manor Drive from flooding up to the FOR elevation	F.C. = AAC = AAB = BCR =	$1,981,800 $151,300 $10,200 0.07	$817,400 $62,400 $9,200 0.15
Baltimore Beltway to Penn Central RR						
PR-3	Flooding in Patapsco State Park; few structures involved.	No physically applicable alternative				
PR-2&3	Widespread flooding, but scattered development	Levee stream channelization, numerous bridge modifications not practical to protect widely scattered development.				
Penn Central RR * Route I-95					FOR	
PR-14	Flooding in vicinity of Elkridge	PR-14B	Purchase and removal of 2 residential and 2 commercial structures severely damaged by floods up to the FOR elevation	F.C. = AAC = AAB = BCR =	$668,600 $61,500 $8,000 0.13	
Route I-95 to Gray Level						
PR-15	Mostly Patapsco Park Land with scattered commercial near Ilchester	No physically applicable alternative				
Ellicott City and Oella Areas					FOR	
PR-16	Flooding from Patapsco in Ellicott City and all downstream damage reaches	PR-(16-2) Plate 11	Dry dam protecting damage reaches PR-16 to PR-2 from flooding up to the 50-yr. elevation, constructed North of Oella.	F.C. = AAC = AAB = BCR =	$1,368,200 $139,500 $71,900 0.52	

TABLE 20 (cont'd)
ALTERNATIVES FOR GWYNNS FALLS

DAMAGE REACH	COMMENT ON FLOODING SITUATION	ALTERNATIVE	DESCRIPTION	ECONOMICS*			
Annapolis Road to Wilkens Avenue					SPF	100-year	FOR
GF-1	Industrial and commercial between Russell St. and B&O Railroad	GF-1AI Plate 5	Earth levee constructed between the B&O RR and Russell St. protecting commercial and industrial property and 87 residential structures up to the SPF elevation	F.C. = AAC = AAB = BCR =	$1,572,800 $120,100 $54,200 0.45	$1,210,900 $100,100 $26,000 0.26	$1,049,160 $80,100 $13,660 0.17
					SPF	100-year	FOR
GF-1	Inundation of industrial and commercial property near US Route 1 (wilkens Ave.)	GF-1AII Plate 6	Concrete floodwall and earth levee around Industrial Park at US Route 1 protecting commercial and industrial property from flooding up to the SPF elevation.	F.C. = AAC = AAB = BCR =	$544,400 $39,300 $26,300 0.67	$391,600 $29,900 $24,900 0.83	$322,400 $24,600 $21,000 0.88
Gwynn Falls to Penn Central RR							
GF-2 (Maiden's Choice Run)	Flooding in vicinity of Wilhelm Park with very low average annual	No physically applicable alternative					
Penn Central RR to Beechfield Avenue							
GF-3 (Maiden's Choice Run)	No structures flooded	No physically applicable alternatives					
beechfield Avenue to Overbrook Road					100-year		
GF-4 (Maiden's Choice Run)	Flooding in North Bend Area at Frederick Avenue	GF-4A Plate 7	Flood retention area between Boswell Road and downstream culvert, consisting of a concrete retaining wall and a new concrete box culvert, 100-year design discharge.	F.C. = AAC = AAB = BCR =	$3,794,100 $404,500 $9,600 0.02		
N. Prospect Avenue to Stoney Lane							
GF-5 (Maiden's Choice Run)	Inundation of several commercial and residential structures	No physically applicable alternative					
Dead Run to City Line					SPF	100-year(FOR)	
GF-9	Flooding in vicinity of Dickeyville	GF-9A Plate 8	Concrete floodwall protecting 1 residential structure and the commercial district of Dickeyville from flooding up to the SPF elevation	F.C. = AAC = AAB = BCR =	$703,000 $53,000 $31,800 0.60	$451,000 $34,400 $29,200 0.85	

TABLE 20 (cont'd)
ALTERNATIVES FOR GWYNNS FALLS

DAMAGE REACH	COMMENT ON FLOODING SITUATION	ALTERNATIVE	DESCRIPTION	ECONOMICS 1/	
City Line to Liberty Road					
GF-10	Flooding along Gwynndale Avenue. Few structures flooded.	No physically applicable alternative			
GF-10	Flooding in Woodlawn Cemetery and to a few scattered structures.	GF-10A	Purchase and removal of 18 structures damaged by flooding up to the FOR elevation	FOR F.C. = $740,500 AAC = $68,100 AAB = $12,000 BCR = 0.18	
Liberty Road to Milford Mill Road					
GF-11	Flooding in Villa Nova Area to a few scattered structures.	No physcially applicable alternative			
GF-11	"	GF-11A	Purchase and removal of 6 residential structures damaged by flooding up to the FOR elevation.	FOR F.C. = $688,100 AAC = $70,200 AAB = $22,900 BCR = 0.33	
Milford Mill Road to Baltimore Beltway					
GF-12	Flooding of Brittany Apartments	GF-12A Plate 8	Concrete floodwall protecting a 50 dwelling unit apartment community from flooding up to the SPF elevation.	SPF F.C. = $842,800 AAC = $64,400 AAB = $55,800 BCR = 0.87	100-year $748,500 $57,200 $50,700 0.89
Baltimore Beltway to Painters Mill Road					
GF-13	Flooding along Hawksbury Road to scattered development	No physically applicable alternative			
Painters Mill Road to Reisterstown Road					
GF-14	Flooding of commercial area in Owings Mills	GF-14A Plate 9	Concrete floodwall parallel to Gwynns Mill Court protecting commercial and industrial structures from flooding up to the FOR elevation	FOR F.C. = $1,118,000 AAC = $114,000 AAB = $33,500 BCR = 0.29	

*SPF - Standard Project Flood
FOR - Flood of Record
F.C. - First Cost
AAC - Average Annual Cost
AAB - Average Annual Benefits
BCR - Benefit Cost Ratio

1/ Source: Review Report, Baltimore Metropolitan Streams, Maryland, U.S. Army Corps of Engineers

TABLE 21
STREAMS ON WHICH IMPOUNDMENTS WERE CONSIDERED

NUMBER KEY	STREAM	POTENTIAL FOR DEVELOPMENT
	NORTH BRANCH	
1	EAST BRANCH	LOW
2	DEEP RUN	VERY LOW
3	NEAR MT. GILEAD	VERY LOW
4	BEAVER RUN	VERY LOW
5	MIDDLE RUN	VERY LOW
6	MORGAN RUN	VERY LOW
7	LITTLE MORGAN RUN	VERY LOW
	SOUTH BRANCH	
8	GILLIS FALLS [1]	HIGH
9	HAY MEADOW BRANCH	LOW
10	PINEY BRANCH	LOW
	GWYNN'S FALLS	
11	MAIN STEM (DELIGHT) [2]	MODERATE
12	MAIN STEM (WOODLAWN) [2]	MODERATE
13	RED RUN [2]	MODERATE
14	HORSEHEAD RUN [2]	MODERATE

[1] Flood control potential good and Carroll County may develop for water supply.

[2] Will not justify by Federal Economic Criteria. However, Baltimore County is interested in lieu of floodplain acquisition.

Figure 13

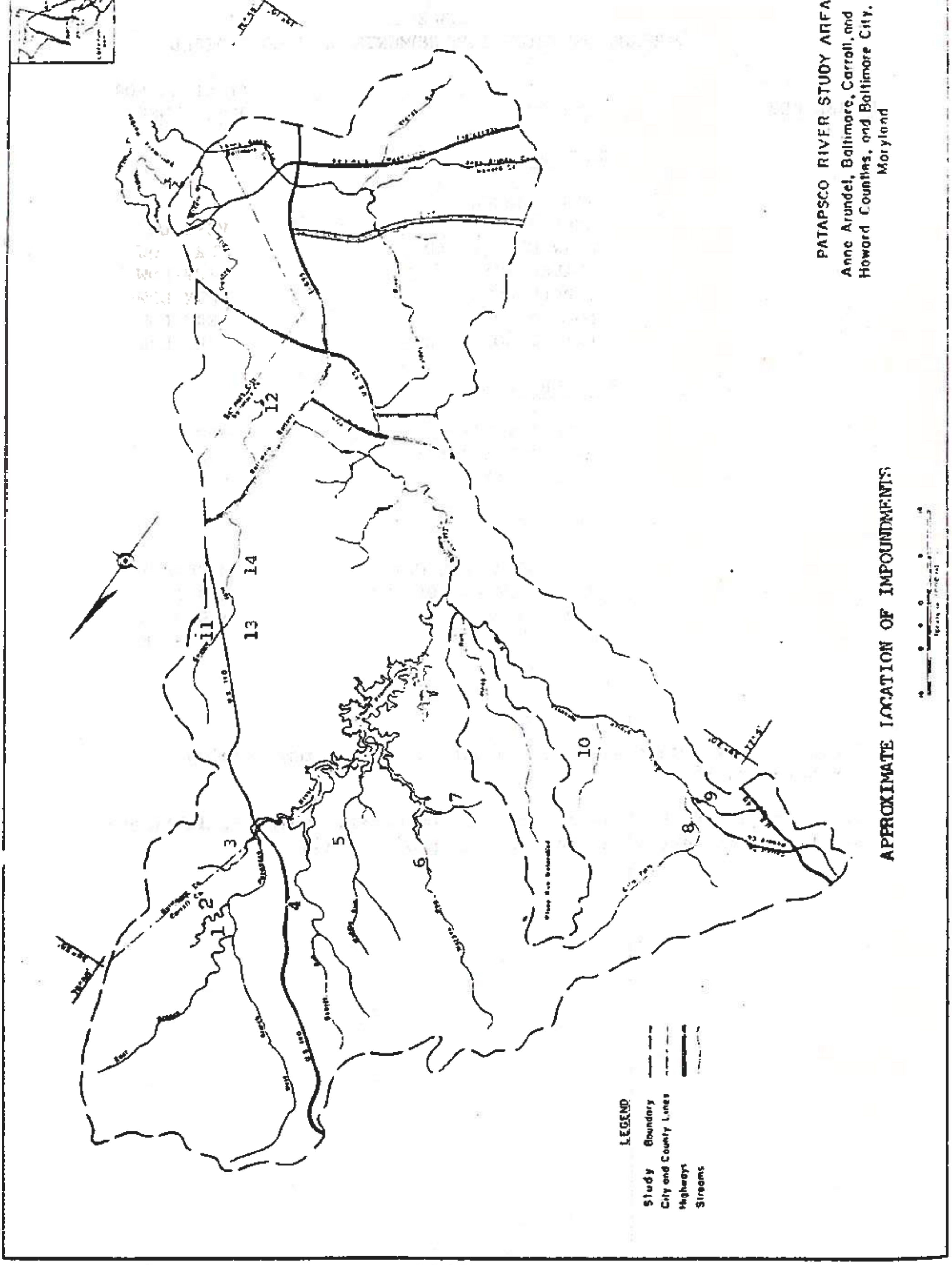

PATAPSCO RIVER STUDY AREA
Anne Arundel, Baltimore, Carroll, and Howard Counties, and Baltimore City, Maryland
APPROXIMATE LOCATION OF IMPOUNDMENTS
LEGEND
Study Boundary
City and County Lines
Highways
Streams
1
2
3
4
5
6
7
8
9
10
11
12
13
14

Table 22 Economic Analysis of Impoundments on the Patapsco River

	Average Annual Damages (AAD) and Average Annual Benefits (AAB), in Thousands of Dollars						
	No Project	Ten Headwater Dams		Four Headwater Dams		Gillis Falls	
	AAD	AAD	AAB	AAD	AAB	AAD	AAB
PR-1	0	0	0	0	0	0	0
PR-2	1.7	0.1	1.6	0.3	1.4	0.7	1.0
PR-3	0.4	0	0.4	0.2	0.2	0.2	0.2
PR-14	6.7	0.4	6.3	1.8	4.9	2.8	3.9
PR-15	2.9	0.1	2.8	0.8	2.1	1.1	1.8
PR-16	41.0	6.2	34.8	20.0	21.0	26.5	14.5
PR-20	3.9	0.6	3.3	2.8	1.1	2.8	1.1
PR-22	0.6	0	0.6	0.2	0.4	0.2	0.4
PR-23	2.9	0.1	2.8	0.2	2.7	0.2	2.7
PR-25	0.5	0	0.5	0	0.5	0	0.5
PR-26	58.7	0.8	57.8	2.9	55.8	2.9	55.8
Total	119.3	8.3	111.0	29.2	90.1	37.4	81.9
Average Annual Cost of Alternative		1880		875		260	
Benefit Cost Ratio		0.06 : 1		0.10 : 1		0.32 : 1	

Table 23 Economic Analysis of Impoundment on Gwynn's Falls

Average Annual Damages (AAD) and Average Annual Benefits (AAB) in Thousands of Dollars

	No Project	Four Headwater Dams	
	AAD	AAD	AAB
GF-1	16.3	5.3	11.0
GF-9	11.5	3.6	7.9
GF-10	8.1	0.1	8.0
GF-11	19.8	1.5	18.3
GF-12	64.1	5.1	59.0
GF-14	149.6	142.1	7.5
Total	269.4	157.7	111.7
Average Annual Cost of Alternative		475	
Benefit Cost Ratio		0.24 : 1	

TABLE 24

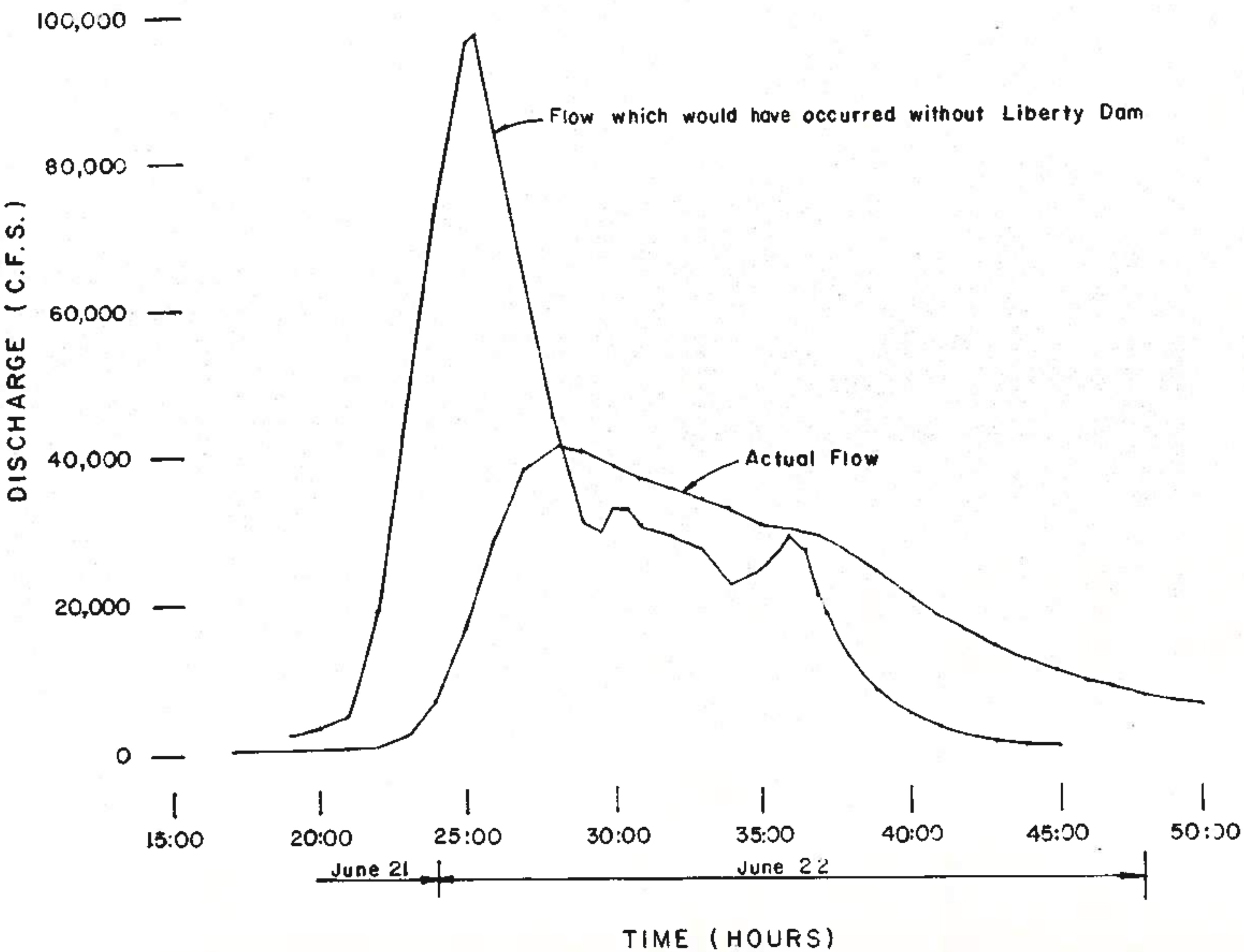
IMPACTS OF FLOOD MANAGEMENT MEASURES ON VARIOUS ENVIRONMENTAL PARAMETERS

PARAMETERS AFFECTED

Flood Management Measure	Water Quality	Fish Habitat	Wildlife Habitat	Vegetation	Archeological and Historic	Mineral	Landscape and Visual	Wetlands	Rare & Endangered Species	Socio-Economic
Channel Improvement	Warmer stream temperature	Less shade, no natural runs, riffles, pools generally negative	Radically modifies habitat in vicinity of stream: adverse to some, beneficial to others	Destroys some woods & brush	Can jeopardize resource if present	May disturb some sand and gravel resource	Alter visual character of stream valley	Jeopardizes wetlands on or near right-of-way	Effect varies depending on species	Little effect
Diking	No effect	Slight negative effect	Destroys continuity of habitat	Destroys some woods & brush	Can jeopardize resource if present	Little effect	Destroy opportunities to view stream by homeowners	May inundate some and create others	-	Could bisect some communities
Impoundments	Generally better quality downstream	Destroys stream continuity; reservoir allows for certain species	Destroys many acres of habitat. Periodically threatens others	Inundates many acres of brush, grass, and woodland	May inundate or protect resource	Inundates resource	Radically alter valley appearance. Introduce land/water edge	May destroy wetland on valley floor, create some on lake edge	-	Remove land from tax base; could destroy character of rural areas
Acquisition & Relocation	No effect	Little effect	Provides opportunity for increase in habitat	May allow for revegetation	May eliminate historic resource	Little effect	Improve visual character of stream valley	May allow for reversion to wetlands	-	Could severely disrupt community structure
Removal of Constrictions	Little effect	-	Little effect	-	Can affect archeologic resource	-	Improve visual character of stream valley	-	Little effect	May have some effect depending on nature of construction
Flood Proofing	No effect	No effect	No effect	No effect	Alters character of historic resource	No effect	No effect	No effect	No effect	Increase peace of mind
Flood Insurance	-	-	-	-	No effect	-	-	-	-	May reduce economic burden Increase peace of mind
Floodplain Regulation	Little effect	-	Protects existing habitat	Protects vegetated areas	Protects setting of historic resource	May prohibit use of resource	Maintain visual quality of floodplain	-	-	No effect
Floodwarning	No effect	-	No effect	No effect	May lessen damage to resource	No effect	No effect	-	-	Increase peace of mind
Stormwater Management	Slight improvement downstream	Opportunity to enhance some hardy warmwater species	Destroys small areas of vegetation	Destroys small areas of vegetation	Little effect	Little effect	May create small water surfaces providing attractive views	May create small wetland areas	Little effect	Little effect

Figure 14

EFFECT OF LIBERTY DAM ON FLOW
IN THE PATAPSCO RIVER DURING HURRICANE AGNES



OPPORTUNITIES FOR USDA INVOLVEMENT

I. Public Law 74-46

Under authority of this law, USDA agencies provide technical assistance and payments or grants-in-aid to landowners for approved soil conserving or soil building practices. This is the basis for the Soil Conservation Service providing technical assistance to landowners through local Soil Conservation Districts and the Agricultural Stabilization and Conservation Service sharing costs of conservation practices through the Agricultural Conservation Program.

The Soil Conservation Service can provide continued technical assistance through its on-going programs in conjunction with the Soil Conservation Districts. These programs are mainly concentrated on applying land treatment. However, the on-going programs will not meet all the needs of the watersheds.

They can also continue to provide some technical assistance on programs which were begun as a result of the Patapsco River Basin Study. They can provide assistance in the use and updating of the TR-20 hydrologic model. Also, they can provide assistance in implementation of a basin-wide stormwater management program and flood warning system.

II. Public Law 83-566 The Watershed Protection and Flood Prevention Act

PL 83-566 authorizes the Soil Conservation Service, the Forest Service, and the Economic, Statistics and Cooperatives Service to provide technical assistance to local sponsoring agencies for watershed planning. It also authorizes financial assistance from the USDA to the local sponsoring agencies if the benefits of a proposed project exceed the costs of the project.

There is no economically feasible PL-566 structural flood prevention project in the Patapsco River or Gwynn's Falls Watersheds. In order to be eligible for cost sharing under PL-566, a project must have a benefit-cost ratio (B/C) of greater than 1:1.

Impoundments reduce or prevent the most damages on the Patapsco River. The highest B/C occurs using Alternative 3, Gillis Falls alone. The average annual damage reduction (benefit) is $85,600 and the average annual cost is $260,000, yielding a B/C of 0.33:1. This is less than required for SCS cost sharing.

Impoundments on Gwynns Falls will also not justify according to PL-566 criteria. The highest B/C occurs using Alternative #1, all four structures. The average annual benefit for this alternative is $111,700, and the average annual cost is $475,000, yielding a B/C of 0.24:1.

None of the other structural alternatives such as dikes, channels or floodwalls have a B/C greater than 1:1. Dikes or floodwalls in the areas of Pumphrey, Lower Gwynn's Falls, and Brittany Apartments are the closest to having a B/C equal to 1. The best of these measures has a B/C of 0.85:1.

In some areas, nonstructural measures could possibly economically justify according to PL-566 criteria. However, no funds have been allotted in the past for nonstructural measures. Therefore, this approach was not addressed with regard to PL-566 funding. It is, however, the most effective solution to some of the problems.

Recently, there have been indications that funds may soon be allotted for nonstructural PL-566 projects. There may also be provisions provided for cost sharing even if the B/C is less than 1. These changes should be monitored and when they become final, their applicability to the Patapsco River should be determined.

There is a possibility that a land treatment only project may exist for the Patapsco River Watershed under the authority of PL-566. This project could provide assistance for an accelerated land treatment program. It could make funds available for technical assistance and cost sharing on construction of conservation practices to improve water quality.

OPPORTUNITIES FOR LOCAL ACTION

Local jurisdictions can do much to reduce the impact of flooding in the future. Of utmost importance is a continued commitment of local and state agencies to act on flood related problems.

Local sponsors and citizens should not view this study as an end in itself. It is part of a continuing process, working toward solving flood problems. A great deal has been learned during this study. Following are several recommendations for the future. These are not necessarily new ideas. Most of them have been suggested long ago. In these cases, the recommendations are a reaffirmation of the present policy. In other cases, recommendations encourage expansion or refinement of existing programs.

I. GENERAL

The ongoing floodplain acquisition programs should continue. The program in Baltimore County prevented considerable damage as recently as Tropical Storm David in September, 1979. In those areas where no program is underway, consideration should be given to starting some type of program. In cases where people do not want to move from the floodplain, other methods could be investigated for their protection.

The Maryland State Park acquisition program should be coordinated with the County programs. Where a parcel of residential property subject to flooding is contiguous with the Park take line, it could be acquired as part of the Park. Possibly, some agreement for cost-sharing for acquisition could be formulated.

The existing Howard County flood warning program on the Patapsco should be expanded to include all jurisdications affected. At present Baltimore City, Anne Arundel, and Baltimore Counties are notified of potential flooding. Information developed by this study could be used to improve the prediction capabilities downstream. Based on stage readings at Woodstock, stages could be predicted for any downstream area using the output from the hydraulic program. Using the hydrologic program, discharges downstream could be predicted using actual rainfall information while it is still raining. This could increase the warning time for predicting flooding by two or three hours. At present, Anne Arundel County gets about four hours lead time after the alarm goes off at Woodstock. Utilization of the hydrologic model could increase this time to six or seven hours.

Individual property owners or entire neighborhoods could develop flood disaster preparedness plans in conjunction with the County Civil Defense Director. Owners of residences and businesses could be offered technical assistance, in the form of a handbook, regarding inexpensive means of preventing damage to perishable goods during a flood.

The system refinements mentioned previously could all be implemented through existing resources. They involve no new equipment or personnel; simply a minor redirection of available resources and a reallocation of time by key personnel.

Further refinements might include the introduction of additional monitoring devices throughout the area. This might include additional remote sensing staff gages, recording streamflow gages, and rain gages. Rain gages could be installed in Carroll County since most of the contribution to discharges on the Main Stem comes from the watershed in Carroll County.

Several meetings were held during this study concerning flood warning. Those involved came from Civil Defense agencies and Departments of Public Works. This dialogue between the agencies should be continued. They could be the coordinators needed for implementing a basin wide system.

Baltimore County also has a flood warning system in operation on Gwynns Falls. The same type of cooperation and refinement as recommended for the Howard County system would be beneficial. Due to its small area, the warning time on Gwynns Falls is short. Any increase in warning time through use of a hydrologic model would be extremely helpful.

A more systematic approach is essential for dissemination of flood threat information to property owners. There is also a need to prevent the dissemination of misinformation which can cause needless evacuation. Assistance in developing flood warning systems is available through National Oceanographic and Atmospheric Administration, National Weather Service.

Technical studies for water quality and water quantity planning could be merged. Water quantity and water quality are intimately related. Techniques for solving the problems in one often lend themeselves to the solution of the other. For instance, debris basins for sediment control are easily modified into stormwater management basins which control increased runoff and reduce streambank erosion. Also, conservation land treatment practices designed to keep chemicals and pesticides on agricultural land have the added benefit of retarding increased surface runoff.

The Baltimore Regional Planning Council could provide the leadership in establishing a regional water resources management team which will jointly analyze water quality and quantity problems and solutions. A trial water resources analyzer program is currently being developed by RPC and WRA.

The stormwater management criteria of the jurisdications could be investigated to determine if they are compatible and solve the problem on a basin-wide basis. The stormwater management program could also be evaluated with a basin wide approach. There may be areas where stormwater management could be waived, while others would require more stringent measures.

It is not the purpose of this report to advocate any particular stormwater management policy, but rather to recognize the potential of a coordinated basin-wide stormwater management program in floodplain management. Certainly much could be gained if state, regional and local governments coordinate their efforts in setting goals and policies for stormwater management. They could analyze the specific resource base and tailor a stormwater management program to complement that base.

Done in piecemeal fashion, thousands of small diverse stormwater management structures will be built throughout the study area at a cost of over $100 million dollars by the year 2000. The combined impact of these facilities several miles downstream from their outlets will be virtually indeterminable. Theoretically, they could actually create a worse situation than if they did not exist.

By planning facilities to handle 100 acres, the required number could be cut to 300 and the cost reduced to $15 million. Also, the hydrologic effect would be more easily ascertained.

By controlling 500 acres per facility, the number of total structures could be reduced to 60 and the cost reduced to $8 million. Also, the hydrologic effect at all points is relatively easy to determine. The trade-off in the latter case is that there are many increments of unprotected stream between the source of runoff and the stormwater management structure. Also, going from smaller to larger structures shifts the responsibility for installation and operation and maintenance from the private to the public sector.

In an intensly urban area such as Baltimore City and its immediate suburbs, consideration could be given to retrofitted stormwater management for areas which have developed prior to the adoption of a Stormwater Management Policy. In the study area, the primary opportunities for application of retrofitted stormwater management are on Dead Run and Maiden's Choice Run, both of which are tributaries to Gwynns Falls with headwaters in Baltimore County. The county and the city have an opportunity to evaluate the feasibility of stormwater management on these streams.

Future land use planning in the basin could be done with due consideration given to the impact of future development on the hydrologic process, not only immediately downstream of the development, but throughout the entire hydrologic system. Alternative development plans could be designed which consider the effects of soil, slope, vegetation, and land use on local hydrology. Developers could be encouraged to urbanize an area so that its post-development hydrology closely reflects its pre-development hydrology. In so doing, many of the structural stormwater management costs would be eliminated.

Encouragement of proper land use planning is a county prerogative. It could be done with the assistance of local Soil Conservation Districts as well as other technical groups knowledgeable in land-use planning.

There are many areas in the watershed which experience flood damage. Most of the flooding damages are relatively infrequent, but damage is high when flooding does occur. It has been the policy of the counties to attack the problem through total protection of the properties. Normally, this is done by purchasing the property and removing or demolishing any structures. This is the most effective means of preventing further damages.

Consideration could be given to protection methods other than acquisition. Often diking or flood proofing would be a more cost-effective method of preventing or reducing damages from a 100-year flood. The problem with any of these types of measures is that at some point in time the dike or flood proofing will be overtopped, thus they may give a false sense of security.

II. SPECIFIC SUBAREAS

South Branch

A. Consideration could be given to public acquisition of twelve residences along the South Branch of the Patapsco, five of which are in Carroll County and seven of which are in Howard County. These residences are those most susceptible to major flood damage. Two taverns in Sykesville also sustain major flooding. However, the owners may rather risk periodic flooding than be relocated. This may also be true of the private residences. Evidence does not indicate that flooding is frequent or severe enough to mandate removal of the homes. Therefore, any such action should be undertaken with the full consent of the owners and a complete explanation of the nature and severity of the problem.

Fifteen homes or businesses along the South Branch are subject to infrequent, minor flooding. Homeowners could be given the opportunity to learn about inexpensive methods of flood proofing.

Responsibility for these actions would most appropriately fall on the county governments involved. Capital costs for Howard County would probably be between $350,000 and $450,000; Capital costs for Carroll County between $300,000 and $350,000. Measurable economic benefits would be far less than these amounts. Environmental benefits of structure removal would be minor. The justification, therefore, would have to come from social well being or peace of mind benefits. The importance of these benefits may be determined by personal contact with the affected individuals.

B. Consideration should be given to developing an impoundment on Gillis Falls. Besides supplying water for Carroll County, it could considerably aid in reducing flood damages along the South Branch and Main Stem.

North Branch

A. Consideration could be given to modification of the bridges on the Western Maryland Railroad track running through Carrollton and Patapsco. This would only be feasible if Western Maryland abandons the railroad. Flooding sustained by these towns during Tropical Storm Agnes could have been lessened if the railroad fill and bridges had not constricted the floodplain. Altogether, approximately 1200 feet of track and roadbed would be involved.

B. The towns of Carrollton and Patapsco are especially susceptible to the effects of increased runoff due to urbanization in Westminster, Hampstead and Manchester. Therefore, it is especially important that development and the resulting increased runoff in these areas be analyzed for its impact on the smaller communities downstream.

C. In Finksburg, the Congoleum Floor Covering Plant is susceptible to periodic flooding. This causes both economic hardship on the plant and a potential threat to Baltimore City's Water Supply in Liberty Reservoir. A flood hazard management plan could be developed for the plant. The plan could include provisions for permanent reloction of some storage facilities as well as perishable goods. The plan could specify emergency ingress and egress routes and could analyze the feasibility of a flood warning system for the plant. The plan would most appropriately be developed jointly by the Congoleum Corporation and Baltimore City Department of Public Works.

D. Collection of data which lends itself to modeling the hydrologic performance and impact of Liberty has been completed. The data could be used to refine the hydrologic model resulting from this study.

Main Stem

A. Certain structural measures to control flooding on the Main Stem could be further analyzed for local jurisdictions' involvement. A Corps of Engineers Study indicated no economic justification for federally financed structural measures along the Main Stem. Headwater impoundments have also been demonstrated to be economically unjustifiable according to federal criteria. Main Stem impoundments are impractical because of the location of the railroad tracks. A large concrete channel could eliminate flooding in Ellicott City. However, its economic justification is questionable and the visual impact on the Historic District may be objectionable. Diking is impractical in most areas because damage areas are scattered, thus increasing the length of dike required and greatly increasing the cost of related pumping facilities.

B. Modification of the landfills on the Lower Patapsco and the abandoned B & O railroad right-of-way in Elkridge could be considered. These constrictions cause some rises in water surface profile upstream. The landfills increase chances for flood damage along the lower Patapsco almost up to Elkridge. The railroad increases chances of flood damage in the town of Elkridge.

Cutting back the landfills would be expensive, probably about $2.5 million for each 100 feet back from the river, and involve multi-jurisdictional cooperation between the State of Maryland, Anne Arundel and Baltimore Counties, and Baltimore City.

Removal of the railroad fill in Elkridge would be far less costly, approximately $275,000, and would involve only the Howard and

Baltimore County governments directly. Impacts, too, would be more localized. Only the community of Elkridge and the highways immediately upstream would benefit.

C. Consideration could be given to acquisition of houses most susceptible to flooding in Elkridge, North Linthicum, Pumphrey, and Brooklyn Park. Acquisition criteria should be based on elevation of the first floor with respect to the peak elevation of the 100-year flood; the greater the differential, the higher priority of acquisition. Acquisition may be undertaken by the appropriate counties. There may be some opportunity to acquire properties in conjunction with the state parkland acquisition program, as some of the properties are adjacent to proposed park taking lines.

D. The flood warning system currently employed in Howard County could be expanded to include Anne Arundel and Baltimore Counties. Prediction capability could be modified using the hydrologic model developed for this study. Flood preparedness plans similar to the one for Howard County should be developed for the other jurisdictions. Stage predictions for the lower counties could be tied to the hydraulic data generated by the study.

Incorporation of readily available data and technology should cost Baltimore and Anne Arundel County no more than $20,000-$30,000 yearly. Additional hardware, if deemed necessary, could cost $50,000-$100,000, in addition to an annual operation maintenance and replacement cost.

E. The fact that it is in an Historic District may preclude the use of structural measures to protect Ellicott City. The town, together with other communities along the lower Patapsco, could develop a flood disaster preparedness plan in conjunction with the County Civil Defense Director. Owners of residences and businesses could be offered technical assistance, in the form of a handbook, regarding flood proofing and other inexpensive means of preventing damage to perishable goods during a flood.

F. A detailed study on localized drainage could be done on Herbert Run. Most of the flooding along that stream seems to be associated with local drainage. Hydrologic and hydraulic data from this study that will assist the county can be made readily available.

<u>Gwynn's Falls</u>

A. Baltimore County may wish to consider reevaluation of its floodplain acquisition program. The basic idea is a valid one in terms of overall water resource management. However, in some instances, there may be a more cost effective way of providing protection.

For instance, in <u>The Report on Gwynns Falls Floodplain Study, July, 1975</u>, the four small impoundments analyzed provide protection for some residents in Upper Gwynn's Falls that are scheduled for acquisition.

While these impoundments do not meet federal economic criteria, they represent a cost effective way of providing flood protection to some of the downstream area. Also, alternatives other than acquisition could be considered in flood fringe areas where depths of water reach two feet or less for the 100-year storm. In these areas, flood proofing may be an appropriate method of protection.

However, the use of flood proofing requires that once installed, flood elevations cannot increase or the structure will again be flooded. This requires that there be no increase in discharge from upstream area. Therefore, effective stormwater management would be needed.

B. Citizens advisory groups could be included more directly in the acquisition process. This would allow the concerns of people whose homes are likely to be acquired to be considered more carefully in determining acquisition priorities. Several people have used the Patapsco study questionnaire to express their views on this matter. Whether or not their concerns are valid is somewhat irrelevant. The fact is they exist and could represent a severe stumbling block in the county's acquisition program.

C. Baltimore County and Baltimore City could work jointly on a flood warning system and a flood disaster preparedness plan. Baltimore County is already working on such a system for the upper Gwynns Falls. The system could incorporate hydrologic and hydraulic data being compiled by WRA and SCS to allow prediction of flood peaks and stages in the harbor area. A model of tidal hydrology would provide an additional refinement.

A warning system is the only feasible alternative for relieving the impacts of flooding on the highly industrial lower Gwynn's. The system would work like the one described on the Main Patapsco. It would involve close coordination between City and County Civil Defense personnel.

Assistance in developing such a system is available through National Oceanographic & Atmospheric Administration, National Weather Service.

D. Structural protection in the form of dikes or floodwalls could be considered in two areas of concentrated flood damage - Owings Mills Industrial Park and Brittany Apartments. The problem is more acute at the latter than at the former. Flooding is infrequent at Owings Mills. Therefore, structural protection would not be justifiable by federal economic criteria. However, because of the social well being benefits and high instance of secondary economic benefits, the county may still want to consider a floodwall.

The Brittany Apartments were seriously damaged by Tropical Storm Agnes. In some cases, flood water represented a clear threat to human life. A floodwall providing protection from the 100-year flood would cost about $1 million according to the Corps of Engineers. The cost is slightly in excess of economic benefits derived.

E. Opportunities for retrofitted Stormwater Management could be explored by the City and the County jointly, especially on the Maiden's Choice and Dead Run tributaries of Gwynn's Falls. It is unlikely that opportunities for significant surface water storage exist on Maiden's Choice. The basin is almost entirely urbanized. However, pipe storage and other subsurface storage could be analyzed in some detail. Dead Run may present a slightly greater opportunity for surface storage.

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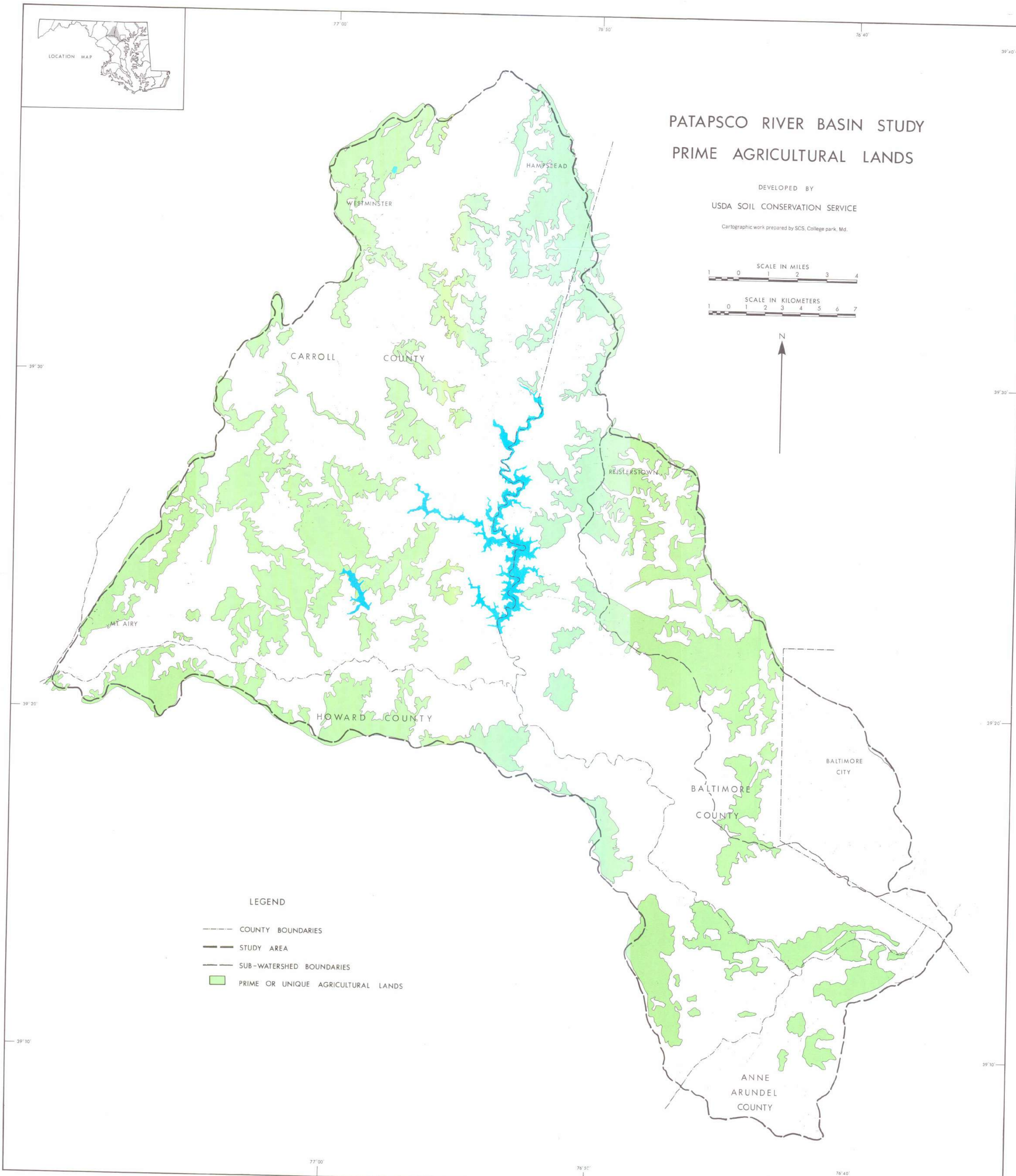

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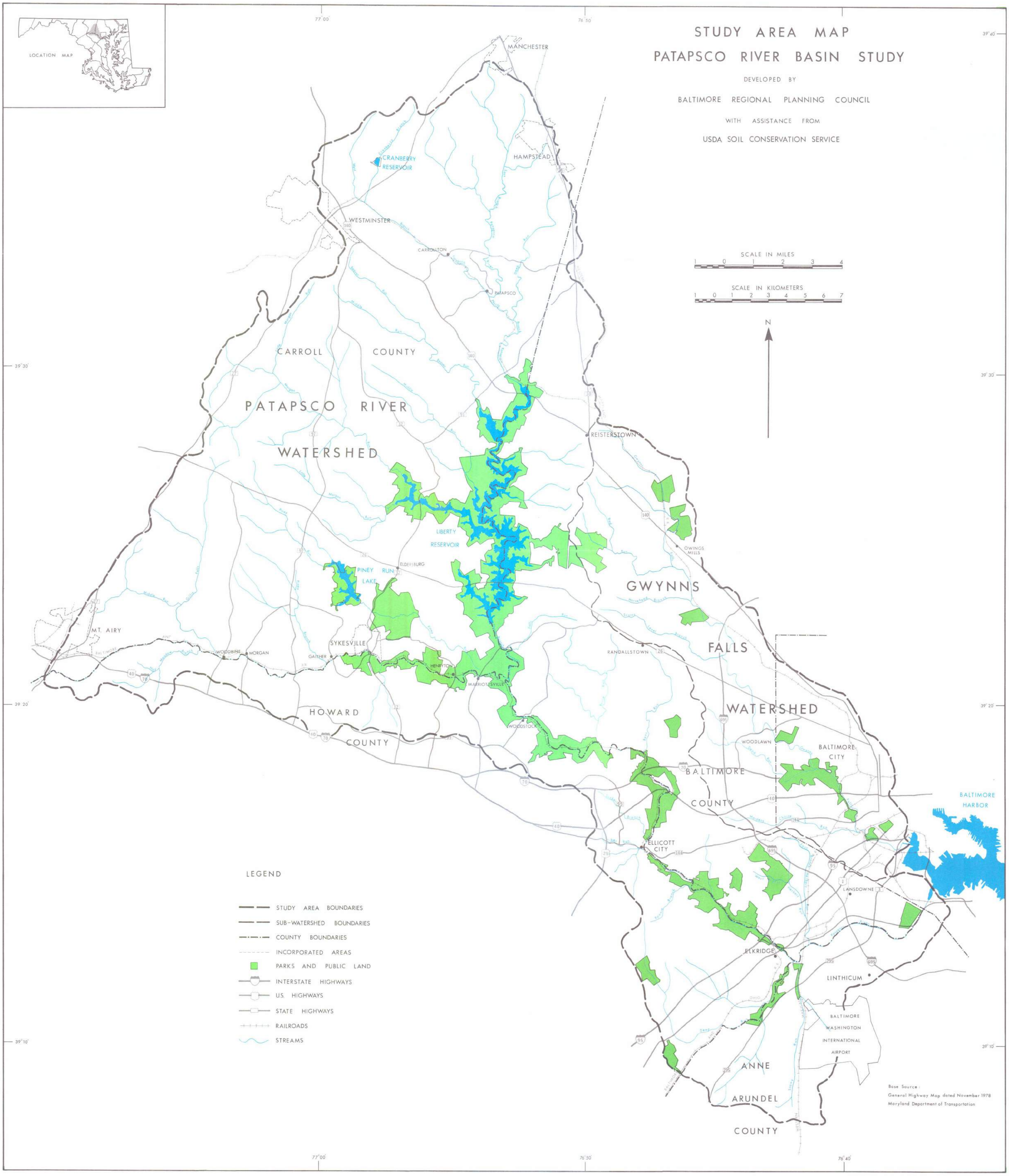
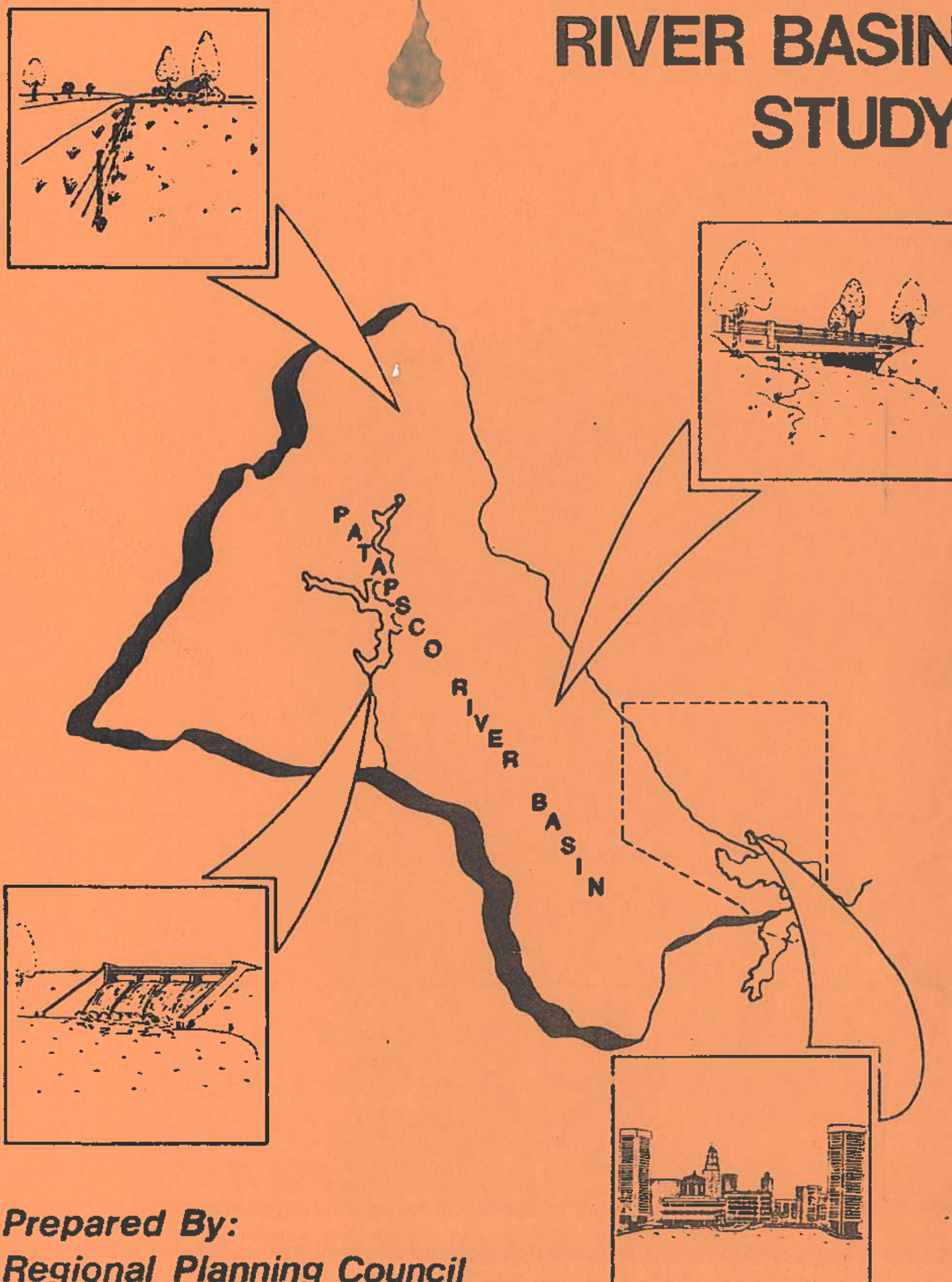


STUDY AREA MAP
PATAPSCO RIVER BASIN STUDY
DEVELOPED BY
BALTIMORE REGIONAL PLANNING COUNCIL
WITH ASSISTANCE FROM
USDA SOIL CONSERVATION SERVICE
LOCATION MAP
SCALE IN MILES
1 0 1 2 3 4
SCALE IN KILOMETERS
1 0 1 2 3 4 5 6 7
N
77°00'
76°50'
76°40'
39°40'
39°30'
39°20'
39°10'
MANCHESTER
HAMPSTEAD
CRANBERRY RESERVOIR
WESTMINSTER
CARROLLTON
PATAPSCO
CARROLL COUNTY
PATAPSCO RIVER WATERSHED
REISTERSTOWN
LIBERTY RESERVOIR
OWINGS MILLS
PINEY RUN LAKE
ELDERSBURG
GWYNNS FALLS WATERSHED
MT. AIRY
WOODBINE
MORGAN
SYKESVILLE
GAITHER
HENRYTON
MARRIOTTSVILLE
RANDALLSTOWN
HOWARD COUNTY
WOODSTOCK
WOODLAWN
BALTIMORE CITY
BALTIMORE COUNTY
BALTIMORE HARBOR
ELLICOTT CITY
LANSDOWNE
ELKRIDGE
LINTHICUM
BALTIMORE WASHINGTON INTERNATIONAL AIRPORT
ANNE ARUNDEL COUNTY
LEGEND
STUDY AREA BOUNDARIES
SUB-WATERSHED BOUNDARIES
COUNTY BOUNDARIES
INCORPORATED AREAS
PARKS AND PUBLIC LAND
INTERSTATE HIGHWAYS
U.S. HIGHWAYS
STATE HIGHWAYS
RAILROADS
STREAMS
Base Source:
General Highway Map dated November 1978
Maryland Department of Transportation

APPENDICES

PATAPSCO RIVER BASIN STUDY



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APPENDICES
PATAPSCO RIVER BASIN STUDY

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U.S. Department of Agriculture

Soil Conservation Service

Forest Service

Economics Statistics and Cooperatives Service

for

Sponsoring Member Jurisdictions

Anne Arundel County

Baltimore City

Baltimore County

Carroll County

Howard County

March 1980

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HYDROLOGY AND HYDRAULICS

Prepared by:

Patapsco River Basin Study Staff

Maryland Water Resources Administration

HYDROLOGY AND HYDRAULICS

PATAPSCO RIVER WATERSHED

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CHAPTER I

SUMMARY

This report contains information about the hydrology and hydraulics of the Patapsco River's Main Stem and South Branch. The information was developed by staff members of the Patapsco River Basin Study (PRBS) and Maryland Water Resources Administration (WRA).

The information has been used to develop the economic data necessary to determine if there is an economically feasible PL-566 flood control project for the Patapsco River. It can be used to develop floodplain maps for the Patapsco River both for present land use conditions and anticipated future land use conditions.

Using the computer models generated by this study, other interested groups could analyze the effects of roads, bridges, fills, stormwater management, and land use changes on flood levels which could be expected. The models could also be used in conjunction with Howard County's floodwarning system in order to lengthen the time available for evacuation in downstream areas.

Copies of the computer models developed are available through the Maryland Water Resources Administration, Flood Management Division.

CHAPTER II

GENERAL

Purpose

This hydrologic study was initially begun by WRA in order to define the limits of the floodplain. When the PRBS was started, the objectives of the hydrologic study were expanded to meet several other purposes. The final objectives of the study are:

1. Define present condition 100 year flood elevations.
2. Determine effects of future land use changes on peak flood discharges and elevations.
3. Provide data necessary for economic evaluation of flood damages and flood damage reduction measures.
4. Provide a tool which will be helpful in the future for use in analyzing effects of land use changes, improving the floodwarning system, analyzing effects of stormwater management, etc.

History

Flooding and the threat of floods from the Patapsco River are a problem dating back over a hundred years. Due to the way in which the area developed along the stream systems, the floodplain areas were developed first and were prone to damage by flooding.

The flood of 1868 was the first serious recorded flood in the Patapsco. It caused the loss of 39 lives and much damage.

The cloudburst of 1923 in the upper reaches of the watershed caused severe flooding and damage in the towns of Ellicott City and Elkridge.

Tidal flooding was a serious problem in the flood of 1933.

Hurricane produced flooding occurred in 1952, 1955, 1972, 1975, and 1979. The worst recorded flooding occurred in 1972 when Tropical Storm "Agnes" dumped rainfall exceeding 10 inches in 3 days on much of the watershed. The latest hurricane induced flooding occurred in September, 1979. Although there was only minor damage in the Patapsco River Watershed, nearby Gwynn's Falls and Jones Falls received much damage.

Due to the history of flooding damage and the public interest in the watershed, this hydrologic study of the Patapsco River was begun in 1977 by the Maryland Department of Natural Resources, Water Resources Administration, Flood Management Division (WRA). They placed a high priority on doing the study as part of their responsibility under the Flood Hazard Management Act of 1976.

In January, 1978, the Patapsco River Basin Study (PRBS) was started under the direction of the Baltimore Regional Planning Council. The PRBS was directed to study the problems in the watershed and recommend solutions. It became immediately apparent that the major concern in the watershed was flooding. In order to quantify the extent of the flood problem, it was necessary to complete a hydrologic study of the watershed. In subsequent discussions, it was determined that in order to complete the study on time, and to avoid duplication of effort, the work that WRA was doing should be merged with the PRBS effort. WRA was in the process of doing the hydraulic study, so they would finish that work and the PRBS staff would complete the hydrologic analysis.

Location

The Patapsco River watershed lies in northcentral Maryland on the western shore of the Chesapeake Bay. The Patapsco River drains an area of 365 square miles. The area includes much of Carroll County east of Westminster and south of Manchester, northern Howard County, southern Baltimore County, northwestern Anne Arundel County, and a small part of Baltimore City near the harbor. Liberty Reservoir straddles the Carroll County-Baltimore County line at approximately the geographic center of the area. Other major water bodies include Piney Run Lake and Cranberry Reservoir.

The Patapsco River Watershed has 3 major subwatersheds. The South Branch has a drainage area of 86 square miles. It runs along the Howard-Carroll County line. The North Branch has a drainage area of 164 square miles. It runs southeast through northwestern Carroll County and then south along the Baltimore-Carroll County line. The remainder of the Patapsco Watershed, 115 square miles, drains directly into the mainstem of the Patapsco, which runs along the Howard-Baltimore County and Baltimore-Anne Arundel County lines. The river then empties into Baltimore Harbor, and ultimately the Chesapeake Bay.

Previous Studies

The watershed has been studied in a "piecemeal" approach prior to this study. This study was an effort in studying the watershed in it's entirety.

The Department of Housing and Urban Development, Flood Insurance Administration, is in the process of studying all counties in the watershed. Howard and Anne Arundel Counties have approximate studies. Baltimore City and Baltimore County have detailed studies done, but they have not been approved yet. Carroll County has an approved detailed study.

Detailed FIA Studies have been done or are near completion on the following streams in the Patapsco Watershed:

Carroll County

Cranberry Branch
West Branch
East Branch
North Branch
Beaver Run
Middle Run
Morgan Run
Little Morgan Run
Piney Run
Parts of South Branch

In addition, the jurisdictions have studied some streams on their own. Howard County has studied Rockburn Branch, Bonnie Branch, Tiber River, and Deep Run. Baltimore County has studied Gwynn's Falls and parts of Herbert Run.

The Water Resources Administration is in the process of, or will be in the near future, studying the following streams:

Stoney Run
Calloway Branch
Tiber River
Sucker Branch
Delaware Bottom Branch
Parts of Piney Run, Middle Run, Beaver Run
Bull Branch
Several unnamed tributaries in Baltimore County
Herbert Run
Gwynn's Falls

The streams which were studied for inclusion in this report are:

South Branch Patapsco
North Branch Patapsco at Carrollton, Patapsco, and below Liberty
Main Stem Patapsco

Methodology

This study was done using hydrologic and hydraulic modelling techniques and computer models of the USDA Soil Conservation Service (SCS) and Department of Army, Corps of Engineers (COE).

The SCS hydrologic computer model, TR-20, was used to develop the hydrology of the watershed. The COE water surface profile computer model, HEC-2, was used to develop the hydraulics of the stream system. The procedures and models are described in further detail later.

CHAPTER III

HYDROLOGY

Introduction

The methods used for the hydrologic analysis in this study are those developed by the United States Department of Agriculture, Soil Conservation Service (SCS). These procedures are outlined in "SCS National Engineering Handbook, Section 4, Hydrology."

These procedures use an index called Runoff Curve Number to convert rainfall to runoff. Other methods are then used to model the transport of this runoff through the stream system. Refer to the above publication for further explanation of the procedures.

In order to facilitate the use of these methods, a computer model, TR-20 has been developed by SCS. The functions of the model are outlined in SCS Technical Release 20 (TR-20). A copy of the document is available through SCS. A copy of the TR-20 program tape is available through the National Technical Information Service.

Use of the computer model requires the collection of some basic data. The data required includes drainage areas, runoff curve number, time of concentration, stream rating curves, structure properties, and rainfall. Once the basic data has been collected and input into the model, the output must be verified (calibrated) using stream gage records where applicable.

A basic tool which is used in organizing the input for the computer model is a schematic map. This is a line diagram showing locations of structures and cross sections. The TR-20 schematics are shown in Figure 1 and the sub-watersheds corresponding to TR-20 cross sections are shown in Table 1.

Drainage Areas

The drainage area for each subwatershed was delineated and planimetered on 1" = 2000' USGS Quad Sheets. The drainage areas are outlined on Figure 2 and the areas tabulated in Table 2.

Runoff Curve Number

Land use and soil type are the variables which go into calculation of the Runoff Curve Number (RCN).

Land use can be used as an indicator of the cover condition of the ground surface in the watershed. For example, industrial land use implies a high percentage of impervious areas, thus creating more runoff, while "open" or "vacant" land use consisting of cropland, grassland, or forestland implies a lower amount of runoff.

Present land cover was taken from NASA Land Sat imagery by the Baltimore Regional Planning Council. This imagery classifies each 1 acre cell by 46 different types of land cover. These 46 types were then combined into 9 categories for use in the model. The categories selected are listed below.

Land Cover Categories

Trees	Bare
Brush	Very low and low density urban
Grass	Medium and high density urban
Crops	Very high density urban
Water	

Future land cover was predicted by RPC based on a regression analysis using past trends, projected land use, and existing conditions in the watershed. These procedures predicted future urban cover, which were then used to reduce the "open" cover categories proportionally.

For a further explanation of the procedures used in determining land cover, see Technical Appendix D , Land use/land cover, done by RPC.

The land cover categories are summarized by subwatershed in Table 4. They are tabulated for the time periods 1975, 2000, 2075.

Soil types can be used as an indicator of the permeability of the ground surface. The Soil Conservation Service has grouped all the soil types into 4 hydrologic soil groups based on their permeability. The 4 groups and their descriptions are:

Group A - (Low runoff potential). Soils having high infiltration rates even when thoroughly wetted and consisting chiefly of deep, well to excessively drained sands or gravels. These soils have a high rate of water transmission.

Group B - Soils having moderate infiltration rates when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.

Group C - Soils having slow infiltration rates when thoroughly wetted and consisting chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine texture. These soils have a slow rate of water transmission.

Group D - (High runoff potential). Soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan of clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission.

For the purpose of the study, these four soil groups were delineated on soil maps from the SCS Soil Surveys of Carroll, Howard, Baltimore, and Anne Arundel Counties.

The amount of soils in each of the four groups was then determined for each subwatershed with the use of a grid-dot counting system.

Land use and soils type were then composited in order to determine land use vs. soils type for each subwatershed. Using these values and the appropriate RCN from below, the weighted RCN was calculated for the whole subwatershed.

Runoff Curve Numbers 1/

Land Cover	Hydrologic Soil Group A	B	C	D
Trees	25	55	70	77
Brush	36	60	73	79
Grass	39	61	74	80
Crops	67	77	84	88
Water	100	100	100	100
Bare	81	89	93	95
Low density urban	61	75	83	87
Medium-high density urban	80	85	90	95
Very high density urban	90	93	95	96

1/ Compiled using values from NEH-4, Hydrology

The Runoff Curve Numbers for present and 100 year future land cover are shown in Tables 2 and 3.

Time of Concentration

Time of concentration is defined as the longest time of flow from a watershed boundary to the mouth of the watershed. The flow path may be made up of a combination of overland flow and channel flow, each having different characteristics.

For this study overland flow times were taken from NEH-4, Hydrology. Channel flow times were taken using velocities calculated from hand-level cross sections or from the water surface profile program, HEC-II. For channels where neither of the above was available, velocities were approximated in the range 5-6 ft./sec. The times of concentration are tabulated in Table 2.

Stream Rating Curves

Once a hydrograph has been calculated at a point in a stream system, it is necessary to route the hydrograph through a reach of the stream. This routing accounts for the travel time through the reach and the reduction in peak discharge due to storage available in the reach.

TR-20 uses the Convex Routing Procedure to route through the stream system. In order to use this procedure, the velocity of the flow must be determined. This requires that a stream rating curve be provided. HEC-II was run using six widely varying discharges to produce the rating which consist of elevation-discharge-end area values. This rating was then input to TR-20. Where no sections were available, the option of specifying a routing coefficient for TR-20 was used.

Structure Properties

TR-20 can also route a hydrograph through a reservoir using the storage indication procedure.

There are three reservoirs in the Patapsco which have significant flood reduction capabilities. They are Liberty Reservoir, Piney Run Lake and the UMBC Stormwater Management Structure.

The required structure data consists of a rating of the spillways and a stage-storage relationship. These are imput into the program as elevation-discharge-storage.

The required information was obtained from the design curves provided by Baltimore City for Liberty, Soil Conservation Service for Piney Run, and Water Resources Administration, Dam Safety Division for UMBC.

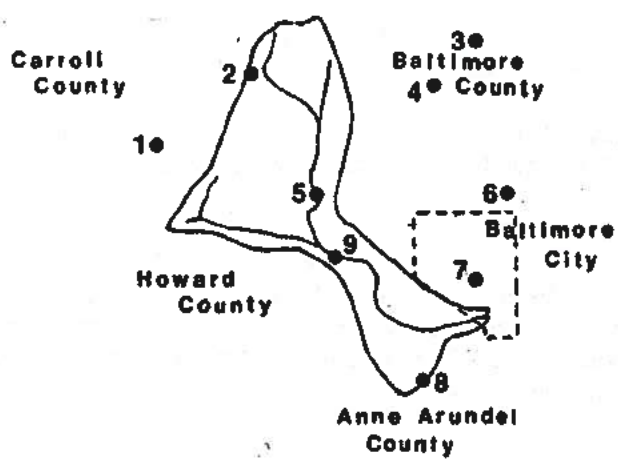
Rainfall

There are several types of rainfall information with varying lengths of record available in the watershed. The locations, type of gage and length of record are shown below.

Rain Gage Information

	Type
1. Unionville	Recording
2. Westminster	Non-recording
3. Parkton	Recording
4. Prettyboy Reservoir	Non-recording
5. Liberty Dam	Recording
6. Parkville	Recording
7. Baltimore-Custom House	Recording
8. Baltimore-Washington Airport	Recording
9. Woodstock	Non-recording

PATAPSCO RIVER WATERSHED



These records were used in the model in several different ways.

For calibration to "Agnes", the gages at Unionville, Parkton, Liberty Dam, and the two at Baltimore were used. They were distributed throughout the watershed using a Thiessen polygon procedure. The actual rainfall distribution was then used for subwatershed in each gages area of influence.

For calibration to the 100 year storm, United States Weather Bureau publication TP-40 was used. This publication is based on values from the rain gages.

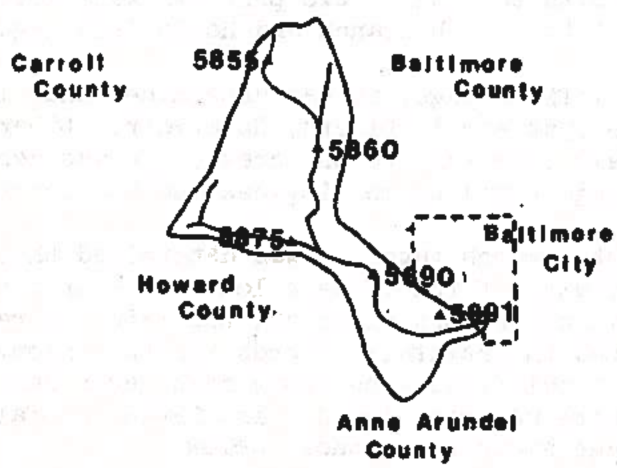
Calibration

Once the computer model is set up and the rainfall values input, it is necessary to compare the peak discharges and hydrographs obtained with those actually measured in the stream system.

There are five operating streamflow gages in the watershed operated by the United States Geological Survey. Their locations and length of record are tabulated below:

Stream gage-location	Length of Record
5855 - Cranberry Branch	1950-1978
5860 - North Branch @ Cedarhurst	1946-1978
5875 - South Branch @Henryton	1949-1978
5890 - Patapsco River @ Hollofield	1945-1978
5891 - East Branch Herbert Run	1958-1978

PATAPSCO RIVER WATERSHED



For purposes of calibration of the South Branch and Main Stem, the stream gages used were on South Branch, North Branch and Patapsco River.

The first step in calibration of the model was to compare "Agnes" discharges obtained using rainfall distribution from rain gages. The hydrographs obtained were compared with hydrographs of "Agnes" flow from stream gage records. A plot of the observed hydrographs versus the simulated hydrographs is shown in Figure 3.

It can be seen that the simulated hydrographs show good correlation with the observed hydrographs except on two points; peak discharge at the South Branch and a higher runoff on the descending limb of the hydrograph.

After reviewing observed discharges from Liberty Reservoir and at Hollofield, it can be shown that the observed discharge from the South Branch gage is inconsistent. Since the gage was flooded out before the peak discharge during the storm, the peak discharge was obtained from high water marks and an extrapolation of the rating curve. This could account for the difference.

Since all the gages were flooded out before the peak discharge occurred, the descending limb of the hydrograph is also suspect.

After taking the above conditions into account, it was decided that TR-20 sufficiently modelled Tropical Storm Agnes.

The next step in calibration was to compare discharges obtained using rainfall values from United States Weather Bureau Publication TP-40 for the 2, 10, 25, 50, 100 year storms.

In order to do the comparison, it was necessary to determine the 2, 10, 25, 50, 100 year streamflows. A frequency analysis was done for the stream gages using procedures documented in the Water Resources Council Bulletin 17, Flood Flow Frequency.

After an initial run with the model, two problems were noted. There was unsatisfactory correlation at the South Branch and Hollofield gages.

In looking at the Hollofield gage, it was determined that it is significantly affected by storage upstream in Liberty Reservoir. Liberty Reservoir, a water supply lake, is rarely ever full to the crest. It was decided that any analysis of the Hollofield gage would be meaningless due to Liberty Reservoir.

In looking at the South Branch gage, it was determined that both the simulated peak discharges and volumes of runoff were low in comparison to observed values. After exhausting all other possibilities, the rainfall records were analyzed. The USWB reanalyzed the rainfall records for the Unionville gage and and calculated new amounts of rainfall. The other rain gages had sufficient lengths of record, so they were not reanalyzed. The TP-40 rainfall amounts and the reanalyzed Unionville gage amounts are shown below.

Frequency	TP-40	Unionville
100 yr.	7.2"	12.2"
50 yr.	6.5"	9.5"
25 yr.	5.6	
10 yr.	5.0"	6.6"
2 yr.	3.2"	4.0"

The new values were then used for the Unionville gage and TP-40 values were used for the other gages. Using a Thiessen polygon method of distribution along with an isohyetal rainfall map, the rainfall values were distributed over the different subwatersheds which they affect.

The final discharges then obtained were plotted on the frequency curves obtained earlier. The plots are shown in Figure 4. The 100 year values closely approximate each other, but the more frequent storms do not. This is a familiar problem with a model such as TR-20. Since we were mainly interested in the 100 year storm, it was felt that the correlation was satisfactory.

The final discharges obtained are tabulated in Table 3.

CHAPTER IV

HYDRAULICS

The water surface profiles were computed using procedures of the United States Army, Corps of Engineers. The procedures use an energy balancing procedure called the Standard Step Method. This procedure balances energy between cross sections, accounting for energy losses in the process. The losses taken into account are friction losses, transition losses, and losses at bridges and culverts. These procedures are outlined in Volume 6 of Hydrologic Engineering Methods for Water Resources Development, prepared by The Hydrologic Engineering Center of the Corps of Engineers.

These procedures were incorporated into a computer model, HEC-2. The model is summarized in the publication, HEC-2 Water Surface profiles, Users Manual, from the Corps of Engineers.

Use of the computer model requires collection of certain basic data. They are cross section and bridge geometry, Mannings "n" values, and discharges.

After input of all the basic data, the model must be calibrated in order to determine if the predicted levels meet observed levels.

Cross Section and Bridge Geometry

Cross sections were located at points along the river where hydraulic properties change. Typical locations are at bridges, constrictions in floodplain width, and changes in grade.

Generally, cross sections are spaced not more than 1000' apart. See Figure 5 for locations of cross sections.

Some cross section data was obtained from one of the contractors for the Department of Housing and Urban Development, Flood Insurance Administration (FIA). The data was from the Flood Insurance Study for Carroll County. The Maryland Water Resources Administration obtained additional field survey data. Section data from both sources was field surveyed using National Geodetic Vertical Datum to affix elevations to the section points.

Section data was supplied by the FIA contractor from the Carroll County Flood Insurance Study for the following streams:

- North Branch Patapsco
- East Branch Patapsco
- Middle Run
- Beaver Run
- Little Morgan Run
- Roaring Run
- Cranberry Branch
- Morgan Run (Small area around Lee's Mill)
- Piney Run

Section data was obtained by Water Resources Administration and county personnel for the following streams:

- Main Stem Patapsco
- South Branch Patapsco
- North Branch to Liberty Dam
- Herbert Run
- Calloway Branch
- Unnamed Tributary at Harbor Tunnel Thruway
- Stoney Run
- Tiber River & Tributaries
- Thistle Run
- Sucker Branch
- Soapstone & Bull Branch
- Delaware Bottom Branch
- Parts of Piney Run
- Parts of Middle Run

Of the previously mentioned streams on which actual sections have been surveyed, only the Main Stem South Branch, and North Branch to Liberty have been analyzed in this study. The remainder of the streams are being studied by the Maryland Water Resources Administration, Flood Management Division, for future publication.

Mannings "n" Values

Mannings "n" values are a measure of the roughness of a cross section. They are used in determining friction losses. "N" values for the study were assembled from field observations throughout the watershed. The final formulation of these values was based on information published in Supplement B of SCS National Engineering Handbook, Chapter 5, Hydraulics and U. S. Geological Survey Water Supply Paper 1849.

Discharges

Initial discharges input to the program were based on a regional stream gage analysis. These values were used to develop rating curves which were then input into the TR-20 computer model. After calibration of TR-20, the discharge for Storm Agnes was determined and then input into HEC-II.

Calibration

Calibration of the model involves comparing an observed water surface elevation or high water mark with one predicted by the model for the same discharge. Calibration of this model was based on high water marks observed after Tropical Storm Agnes in 1972. These high water marks were gathered at several places along the river. Their description and elevation are on file at Water Resources Administration, Flood Management Division. In order to match the observed elevations, it was necessary to adjust several cross sections to account for fill in the river valley which wasn't present during Agnes in 1972. The fill areas are located upstream of I-695 in Baltimore County, downstream of Hammond's Ferry Road in Anne Arundel County, and between the Harbor Tunnel thruway and Patapsco Avenue in Baltimore County. Approximate extent of the fills was estimated using USGS Quad sheets and aerial photographs of the areas taken immediately following Agnes. The Main Street bridge at Sykesville was also removed from the computer run because it was washed out during Agnes.

After accounting for the fills and bridge washouts, the predicted elevations were compared with observed values. There is good correlation at all sections, except where the observed data was inconsistent.

Below is a tabulation comparing the observed high water marks with those predicted by the model.

"Agnes" Observed vs. Predicted Water Surface Elevation

Cross Section	Discharge 1/ (cfs)	Observed Elevation (msl)	Predicted Elevation (msl)
		Main Stem	
114	82,600	18.75	18.80
113	82,600	19.00	19.12
111	82,600	22.00 2/	19.59
110	83,500	20.20 2/	19.98
108	83,500	24.85 2/	22.07
106	83,500	20.35 2/	22.41
97	83,500	27.30	27.03
94	85,000	29.20	28.29
90	86,700	34.5	34.39
85	82,600	39.51	39.75
83.1-83	82,600	46.11	46.30
45	82,200	111.55	112.00
44	82,200	112.92	112.60
35	82,200	126.51	126.61
32	82,200	133.01	133.00
30.2	80,900	137.01	137.10
9	80,200	221.30 222.90	221.79
		South Branch	
37.7	33,200	306.10	306.33
43.1	33,200	317.29	317.61
44.1	33,200	319.00	319.50
54.1	33,200	378.80	378.73
66.1	27,100	428.3	430.00
77.1	15,500	494.6	493.57

1/ From TR-20 Hydrology Model
2/ Inconsistent Data

CHAPTER V

RESULTS OF THE STUDY

After final calibration of HEC-II and TR-20, discharges and corresponding water surface elevations were determined for the 2, 10, 25, 50, and 100 year storms. These values were calculated for both present and anticipated future land use conditions. The discharges and corresponding water surface elevations are shown in Table 6.

FIGURE I

TR-20 SCHEMATIC

SOUTH BRANCH

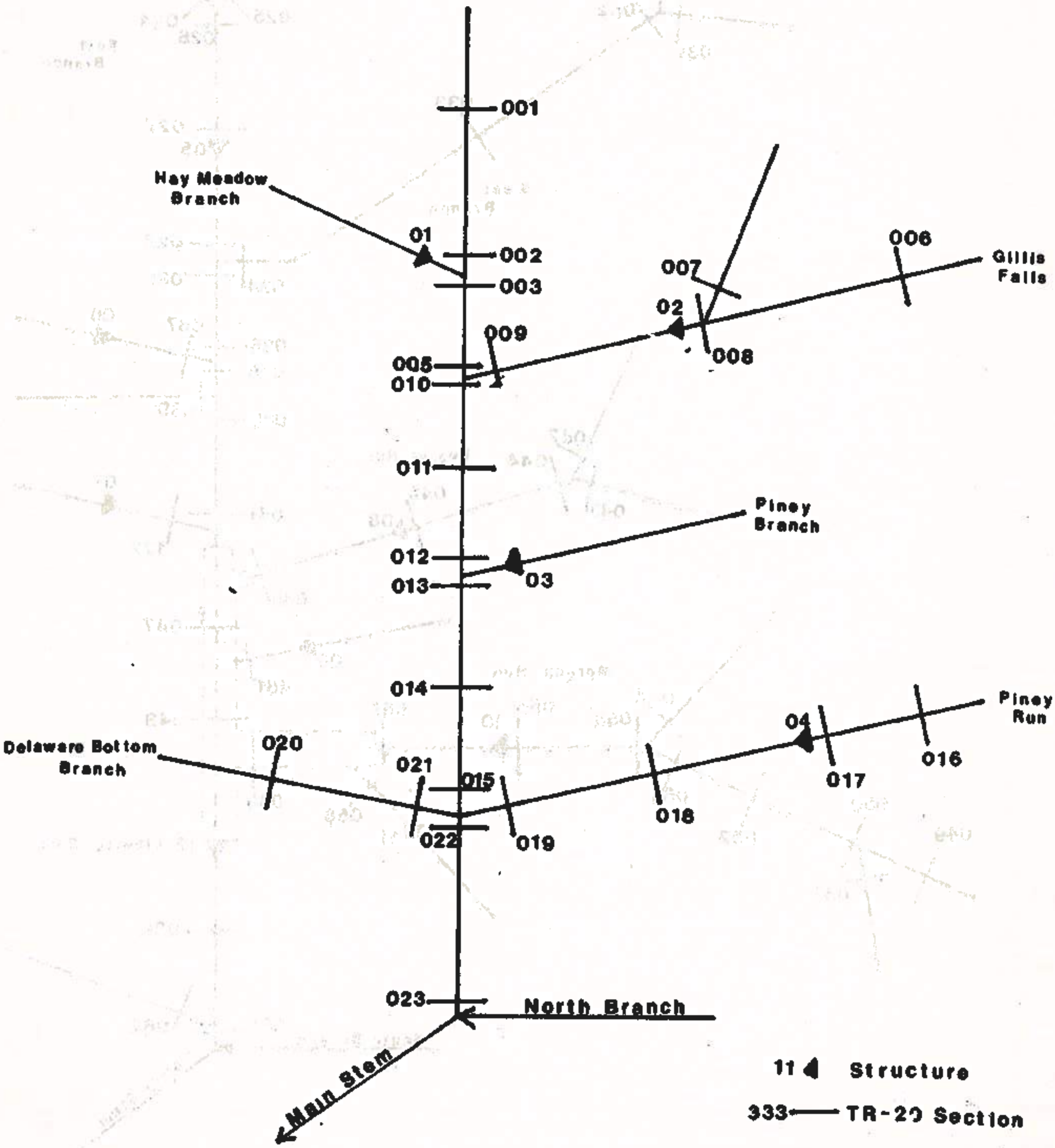


FIGURE 1

TR-20 SCHEMATIC

NORTH BRANCH

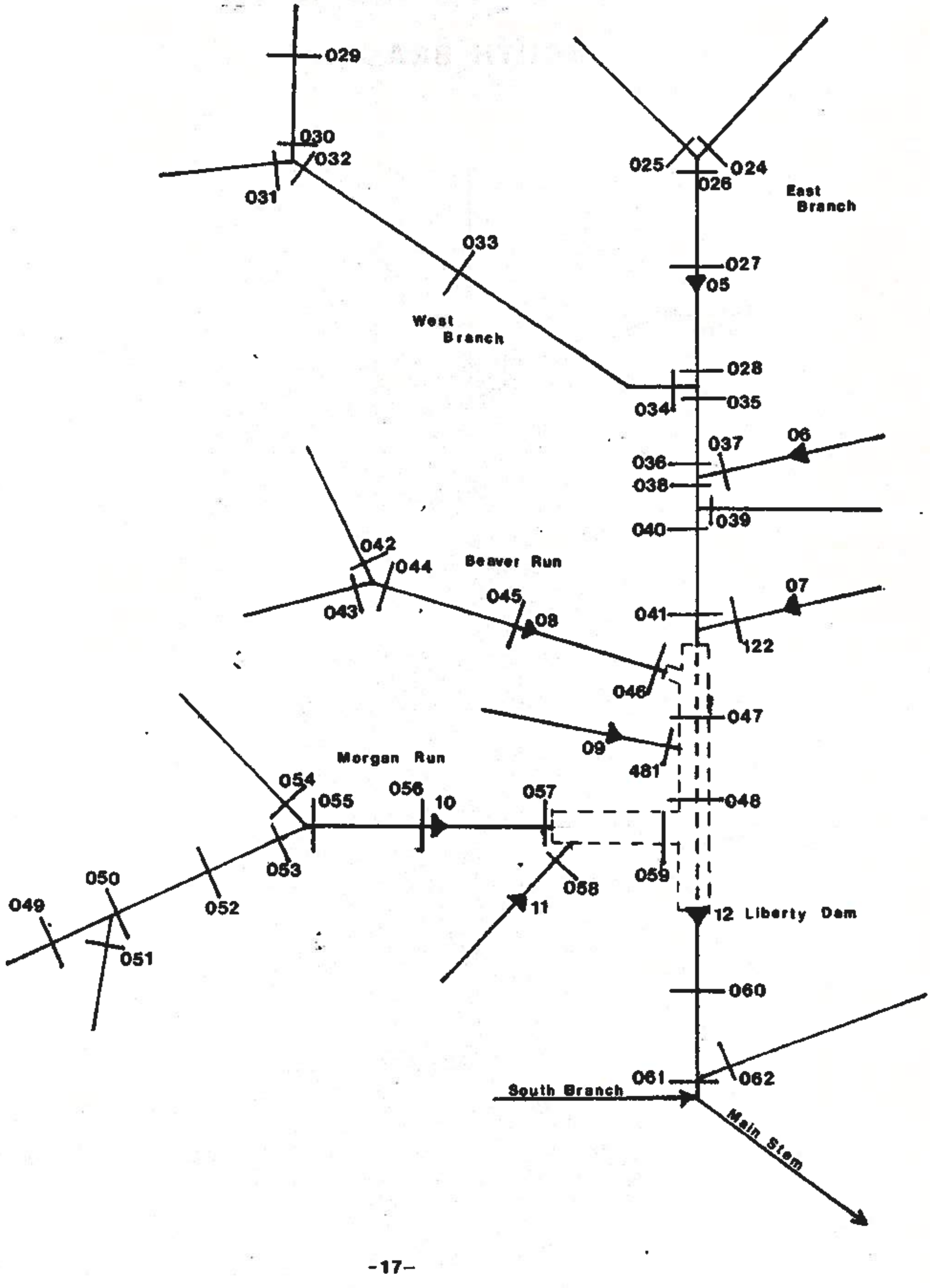


FIGURE 1

TR-20 SCHEMATIC

MAIN STEM

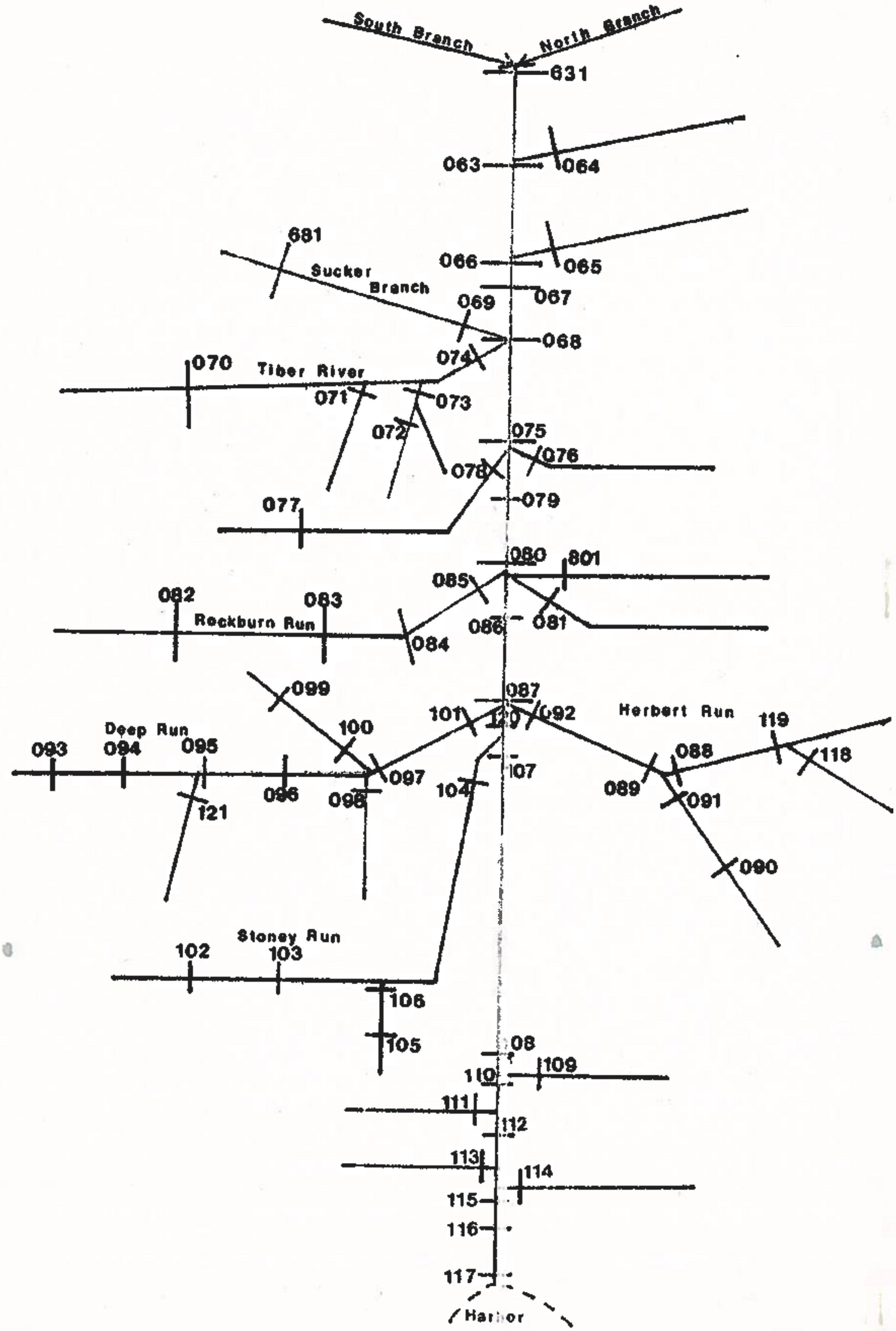
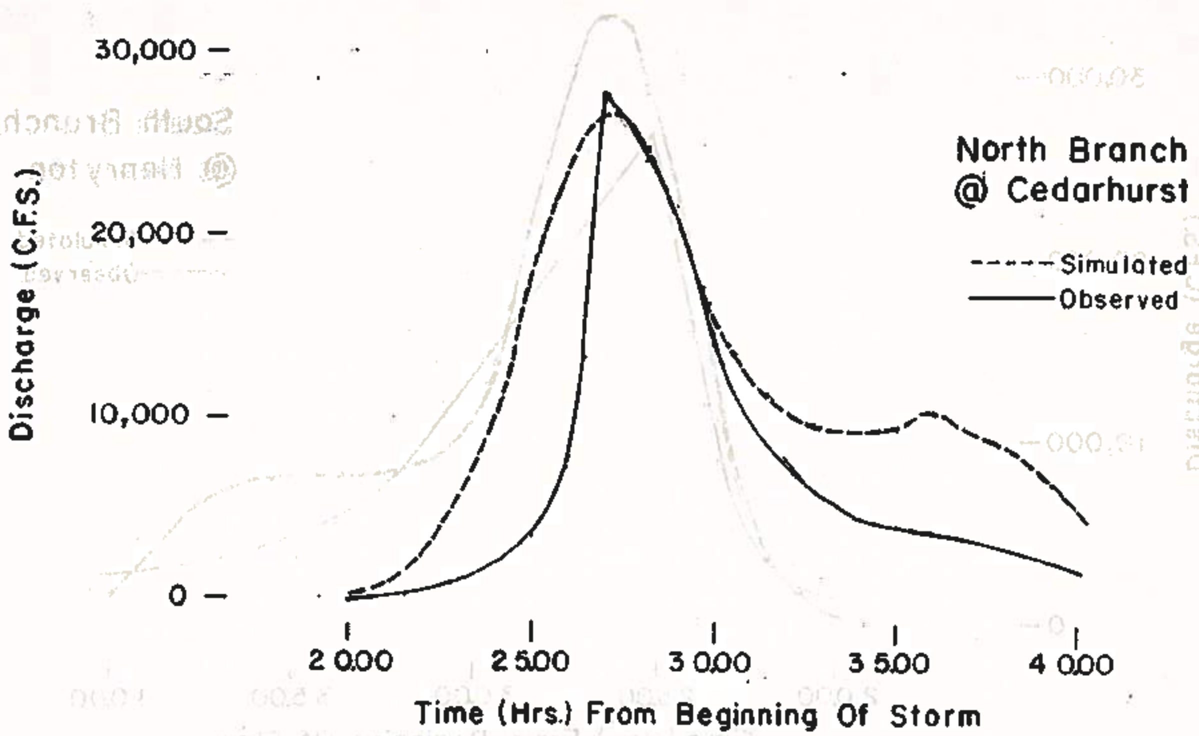
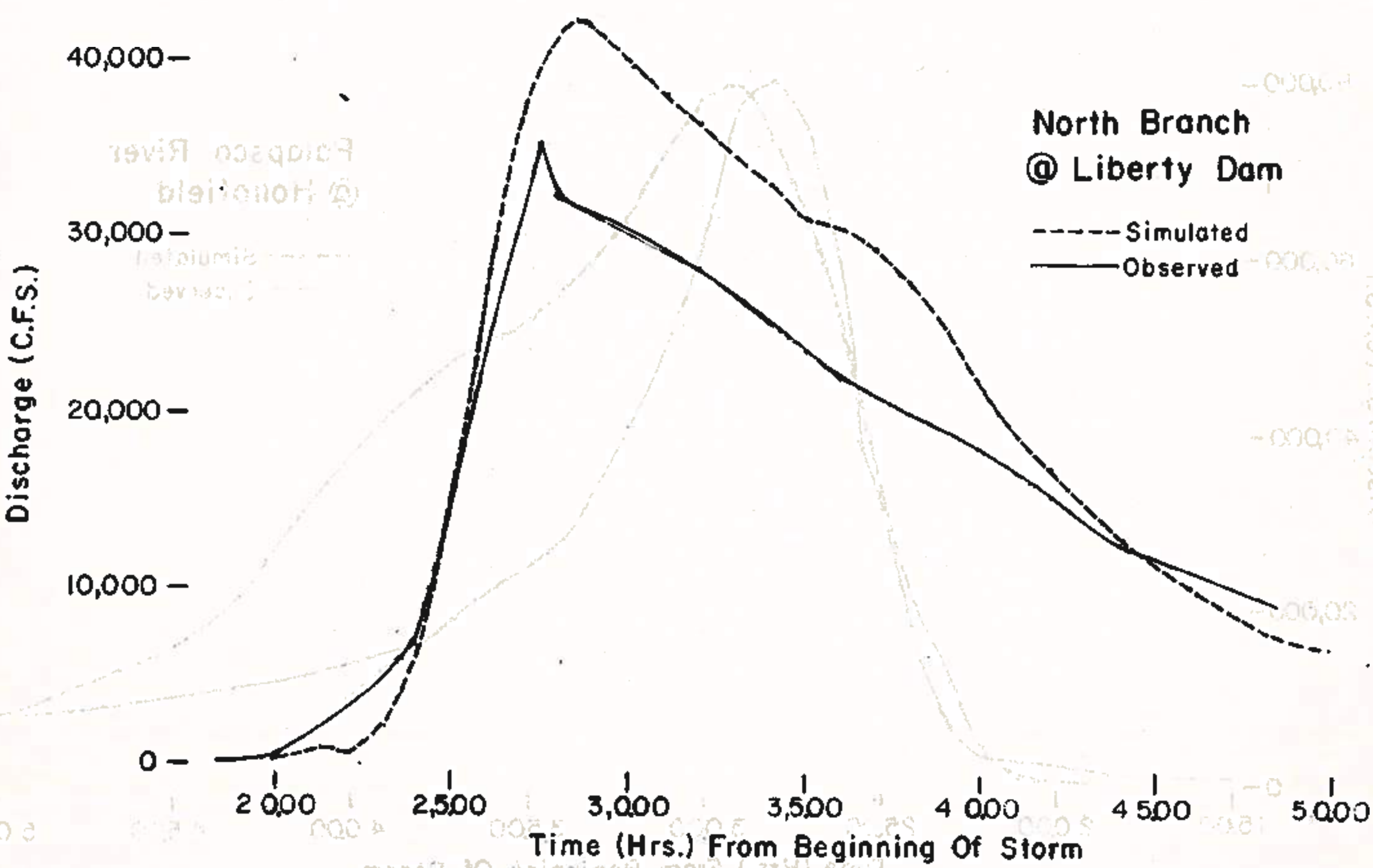
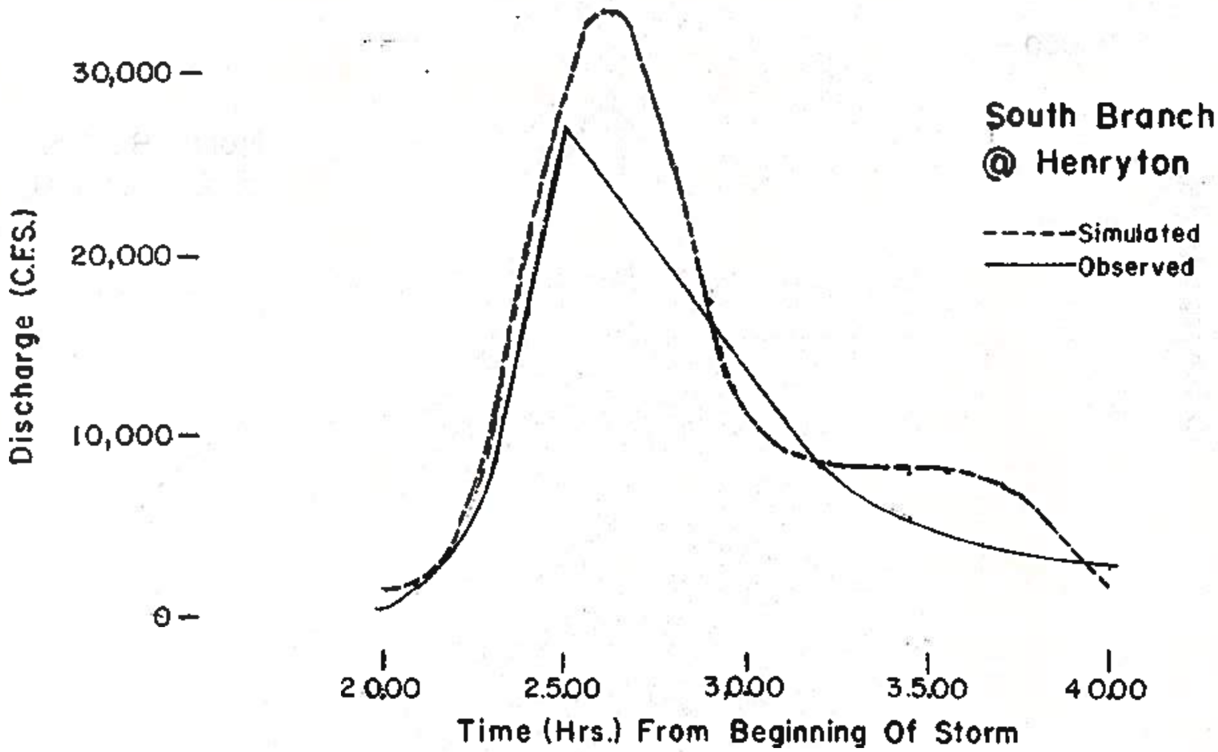


FIGURE 3
"AGNES" Observed and Simulated Hydrographs





"AGNES" Observed and Simulated Hydrographs



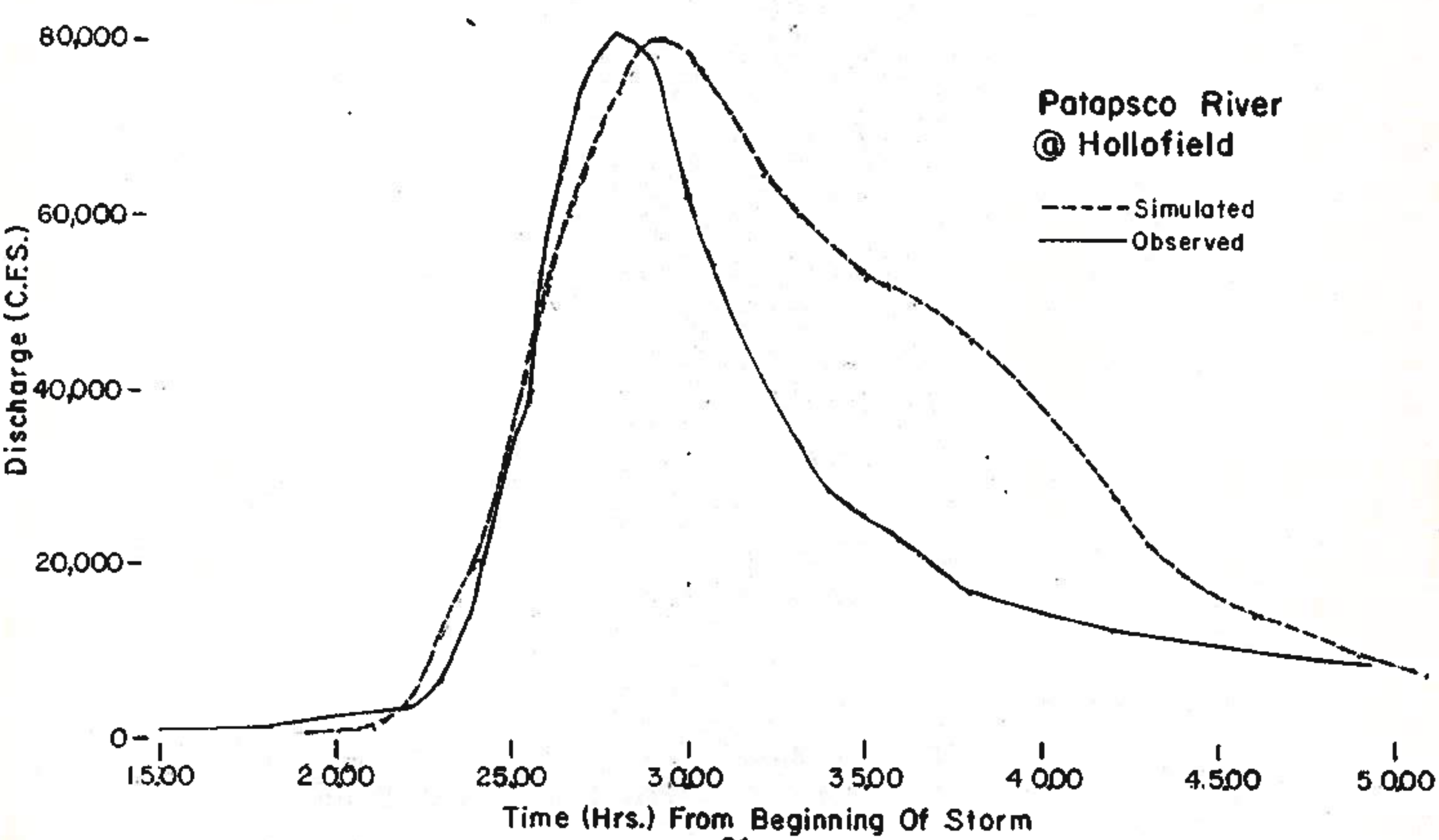


FIGURE 4

FREQUENCY ANALYSIS

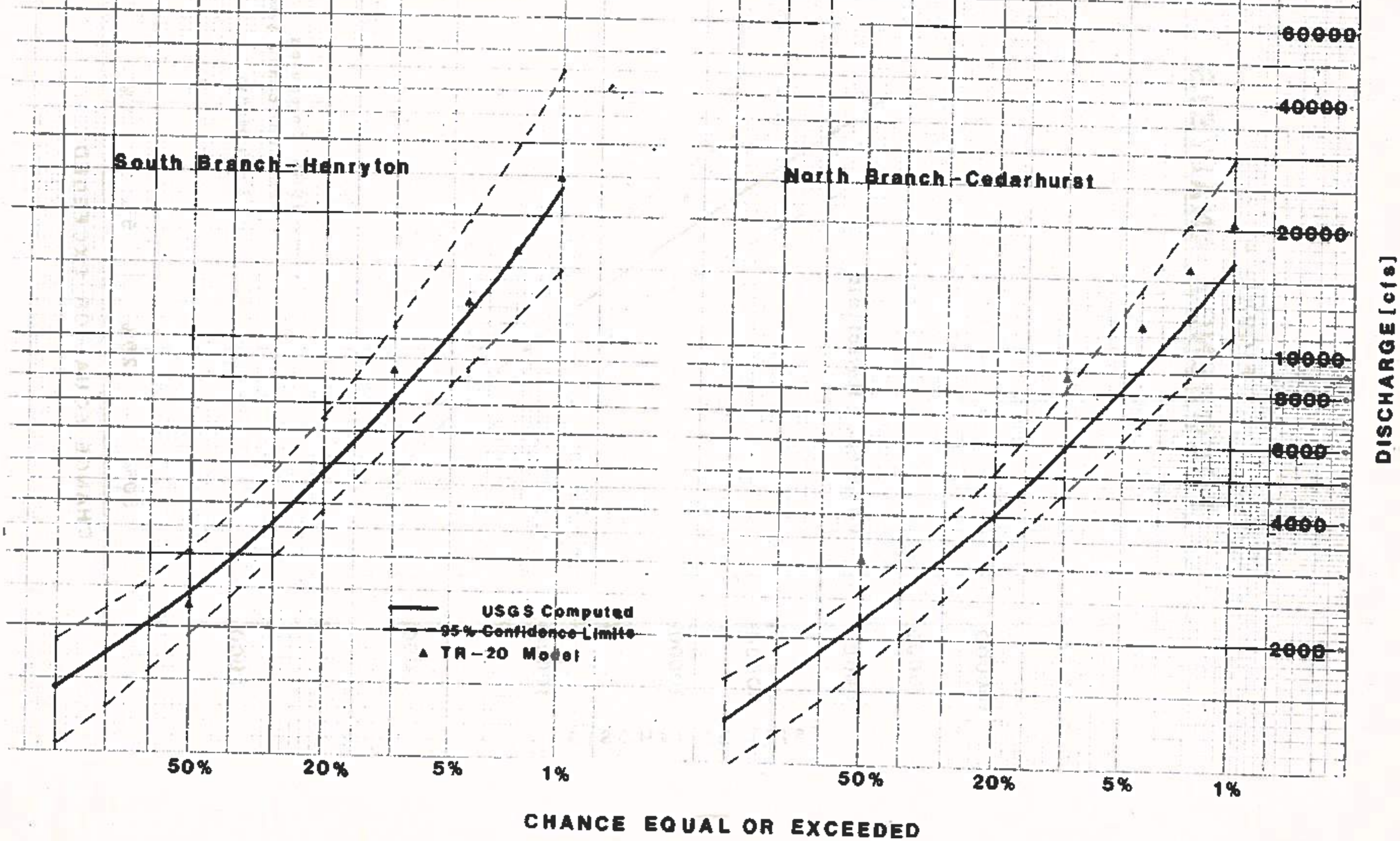
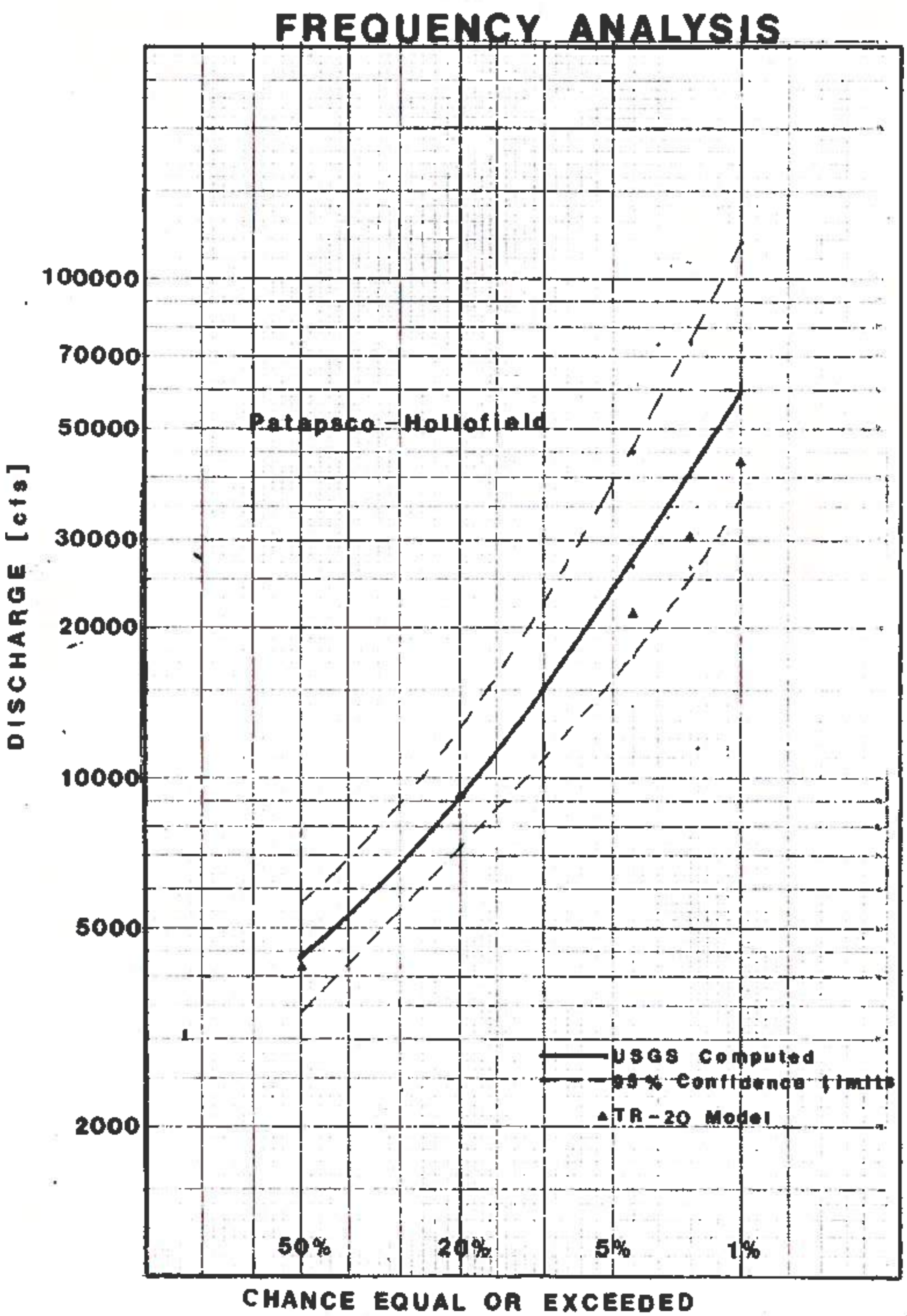
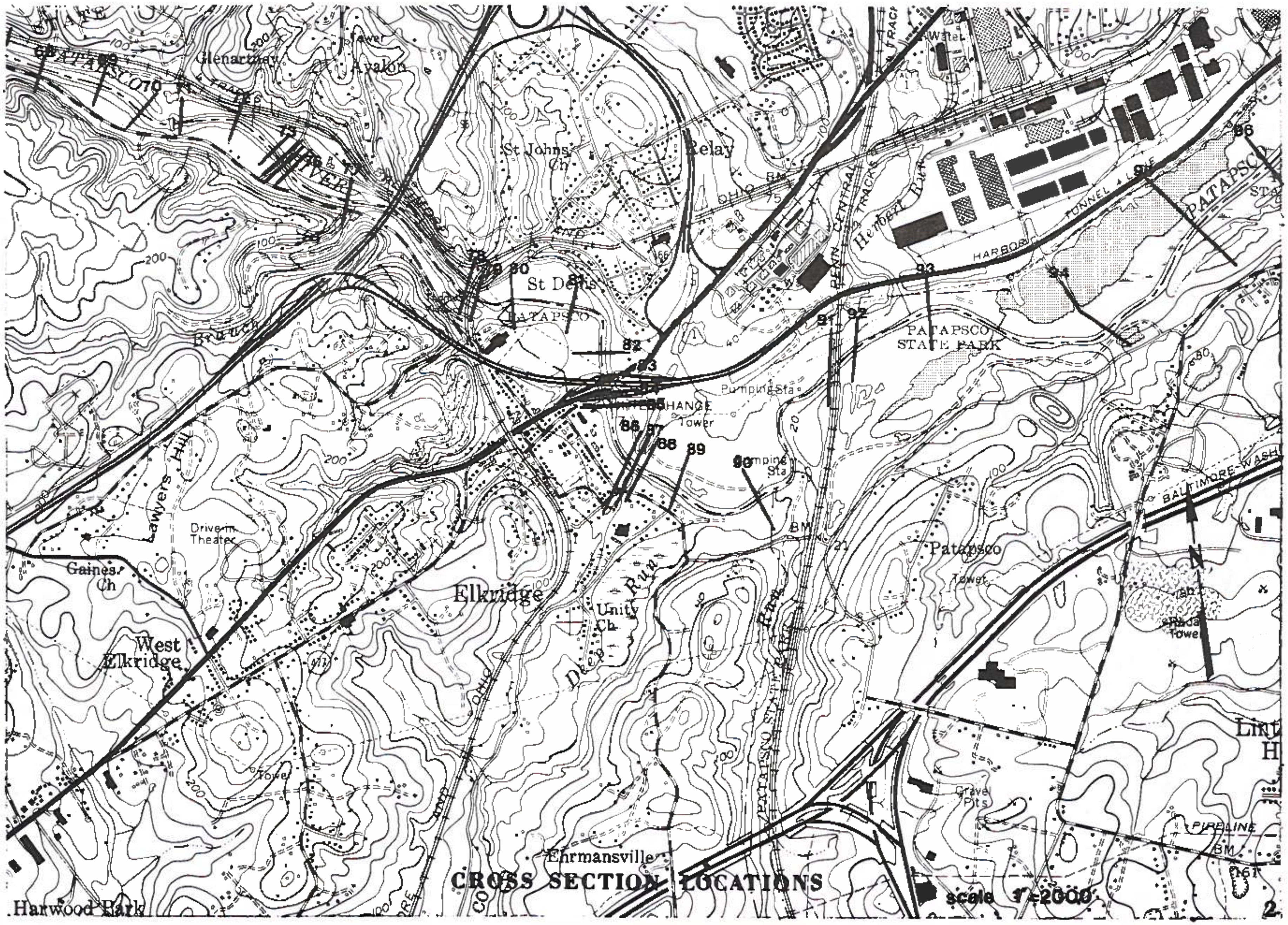


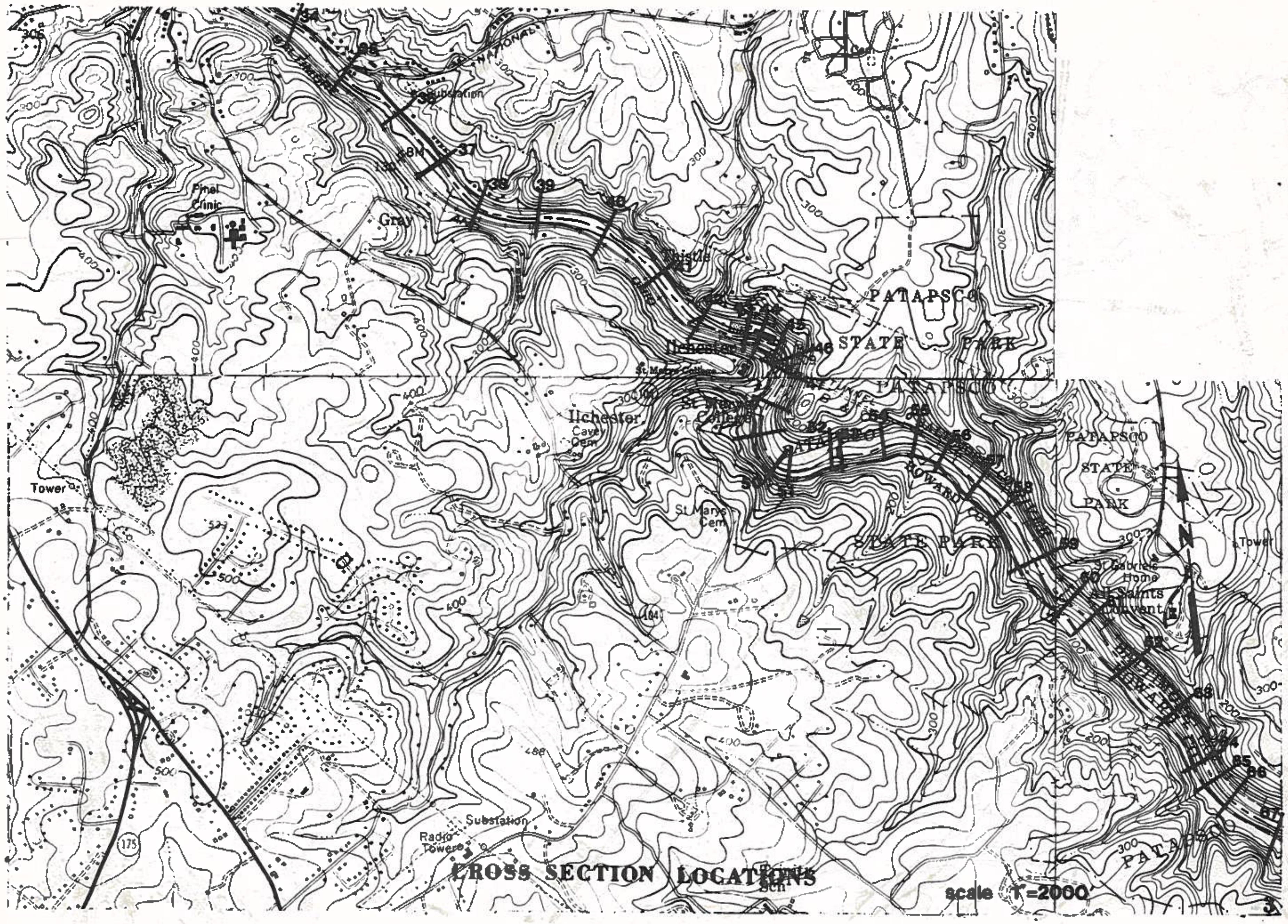
FIGURE 4


FREQUENCY ANALYSIS
DISCHARGE [cfs]
100000
70000
50000
30000
20000
10000
5000
2000
Patapsco - Hollofield
USGS Computed
95% Confidence Limits
TR-20 Model
50%
20%
5%
1%
CHANCE EQUAL OR EXCEEDED

Baltimore Highlands
Rosemont
Brooklyn Park
North Linthicum
Riverview Sch
English Consul
Reed Bird Island
Tidal Flats
PATAPSCO RIVER
BALTIMORE CO
ANNE ARUNDEL CO
Brooklyn Park High Sch
Gravel Pits
TV Tower
PATAPSCO STATE PARK

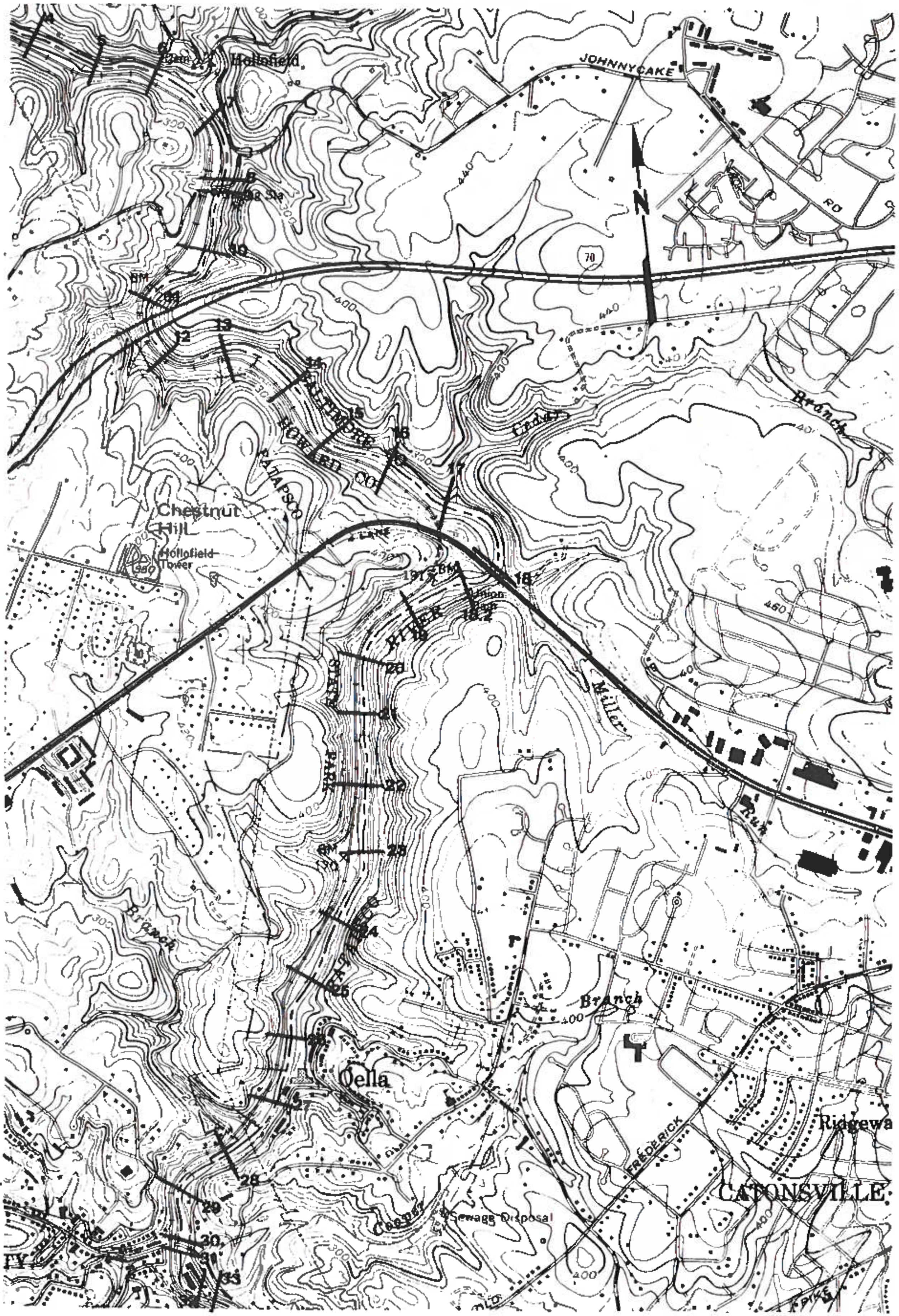
Figure 5

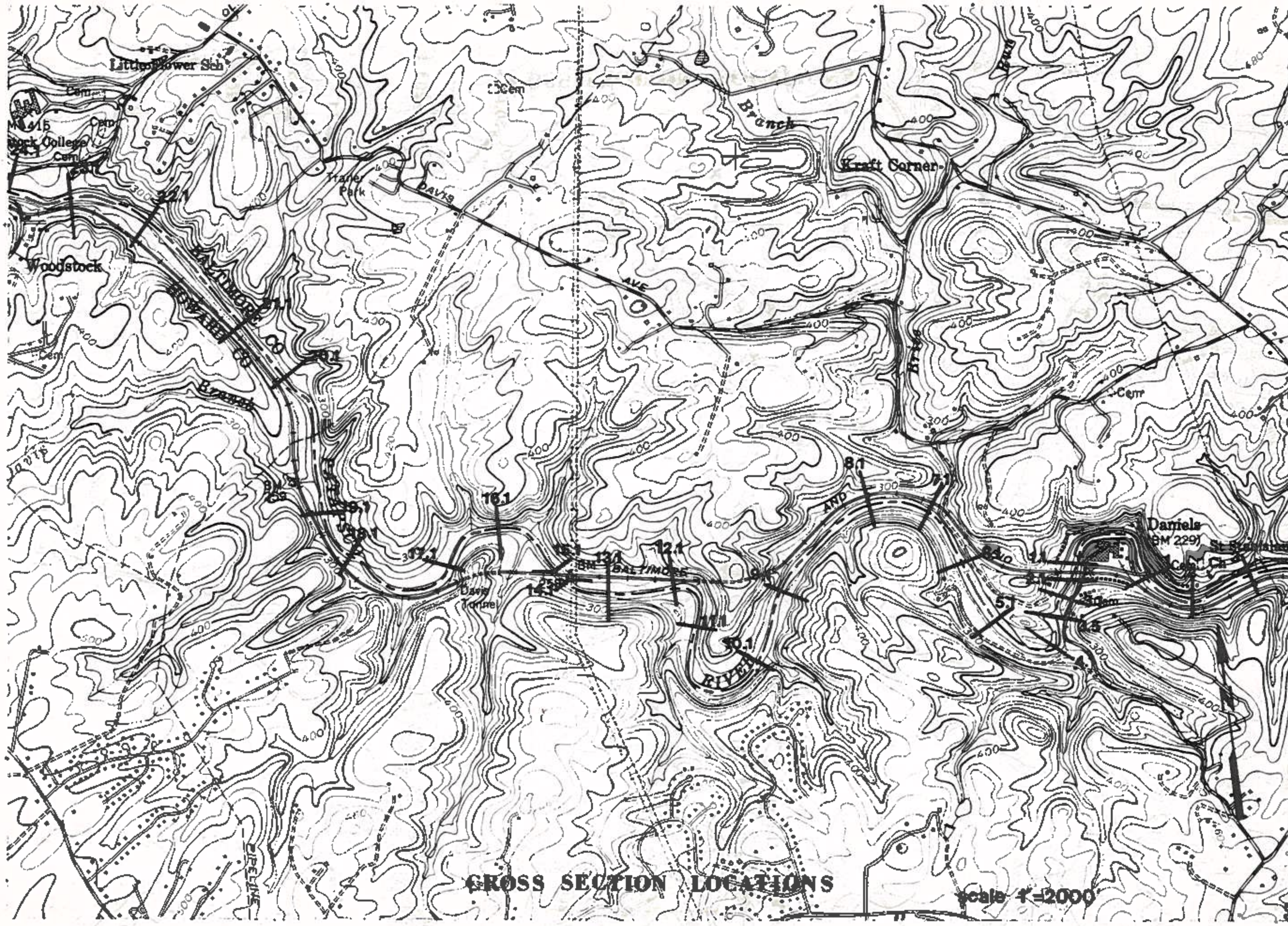

CROSS SECTION LOCATIONS
scale 1"=2000'
Glenartney
Avalon
St Johns Ch
Relay
St Denis
PATAPSCO
PATAPSCO STATE PARK
Pumping Sta
Tower
Elkridge
West Elkridge
Gaines Ch
Drive-in Theater
Lawyers Hill
Deep Run
Unity Ch
Patapsco
Ehrmansville
Harwood Park
Gravel Pits
PIPELINE
BALTIMORE-WASH
PENN CENTRAL
HARBOR TUNNEL
OHIO
2



CROSS SECTION LOCATIONS

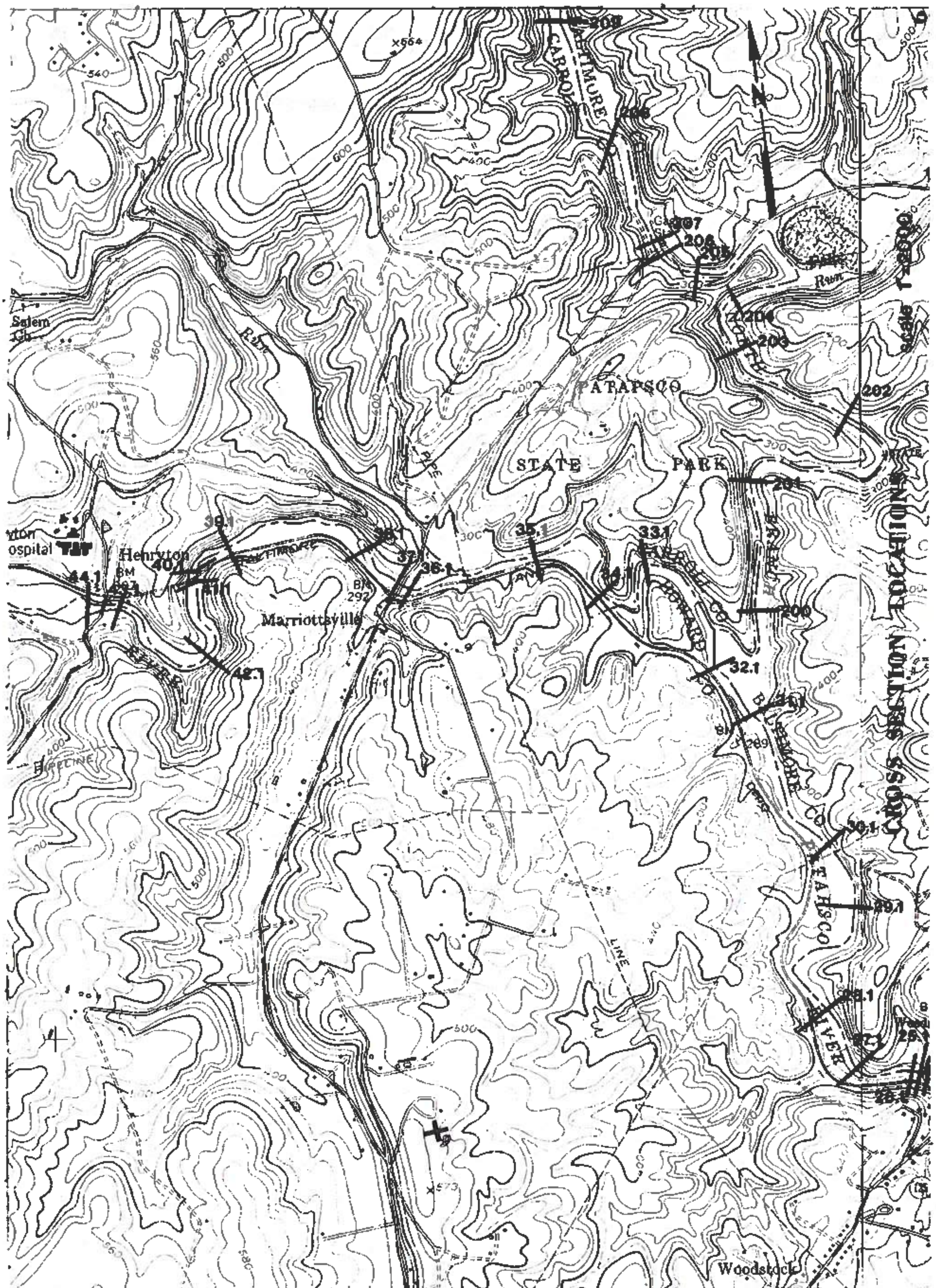
scale 1"=2000'

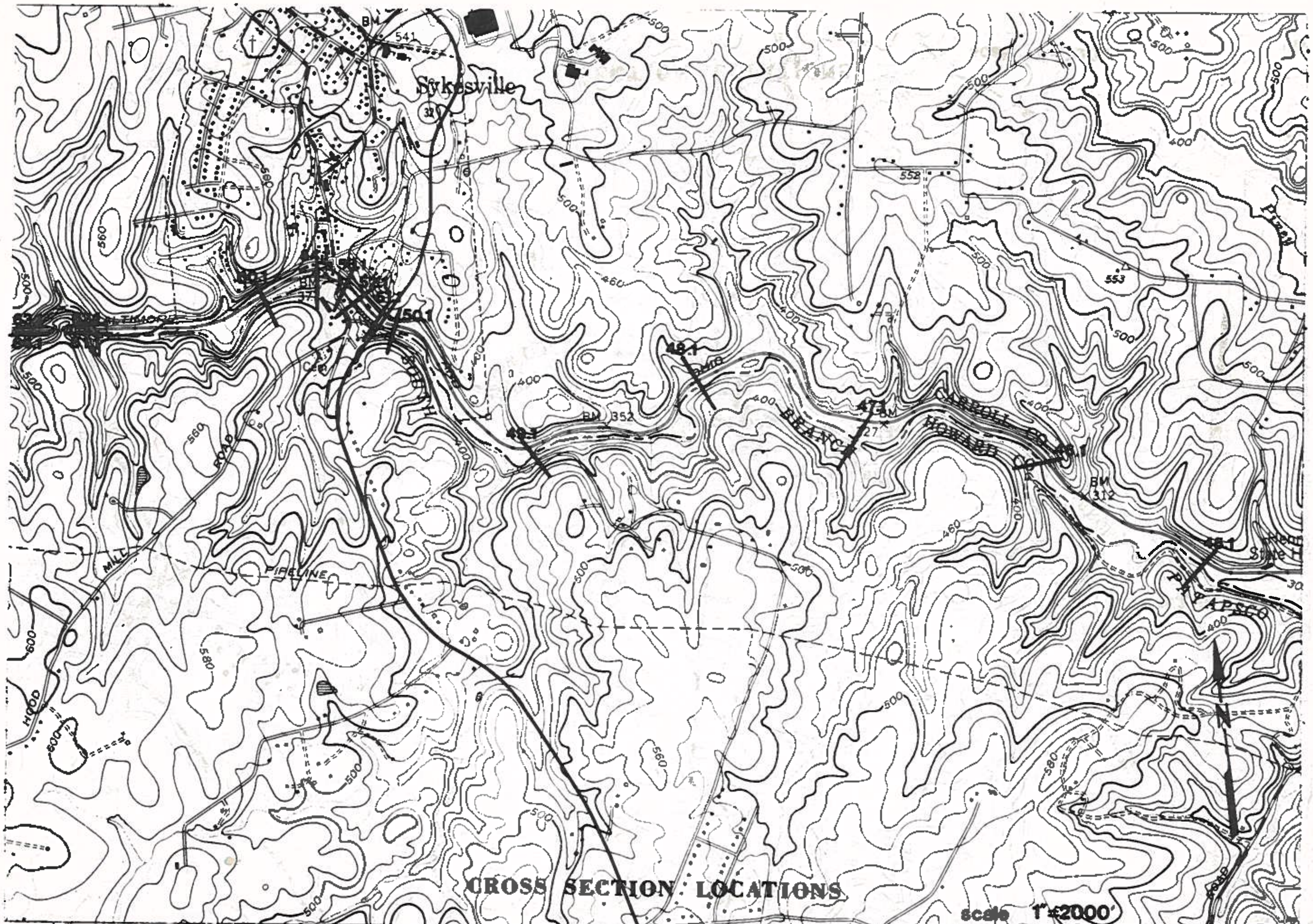

Hollofield
JOHNNYCAKE
RD
70
N
Chestnut Hill
Hollofield Tower
PATAPSCO
BALTIMORE
HOWARD
CO
Cedar
Branch
RIVER
Union Dam
Miller
Run
STATE
PARK
Branch
Oella
FREDERICK
Ridgewa
CATONSVILLE
Cooper
Sewage Disposal
PIKE

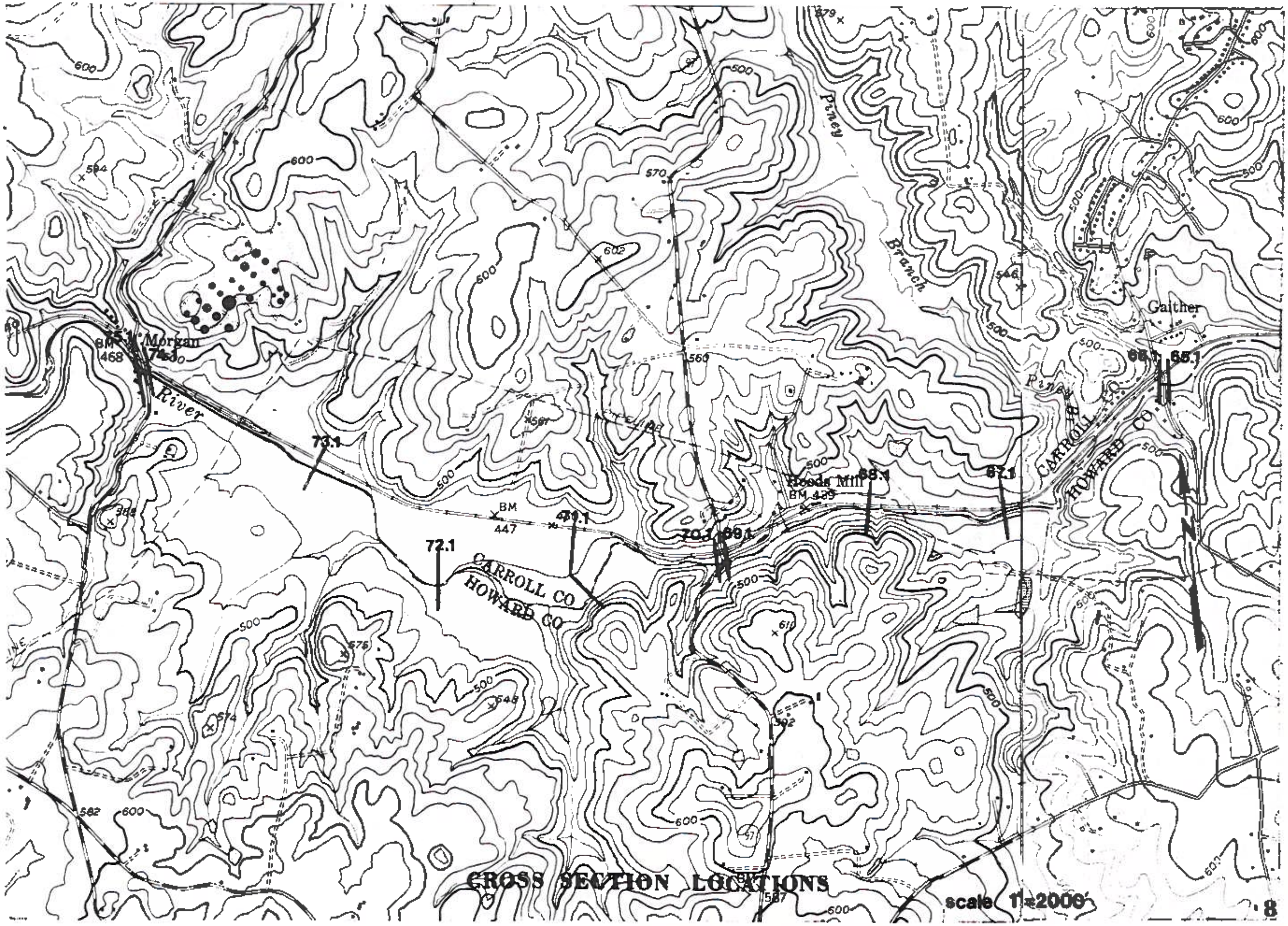


CROSS SECTION LOCATIONS

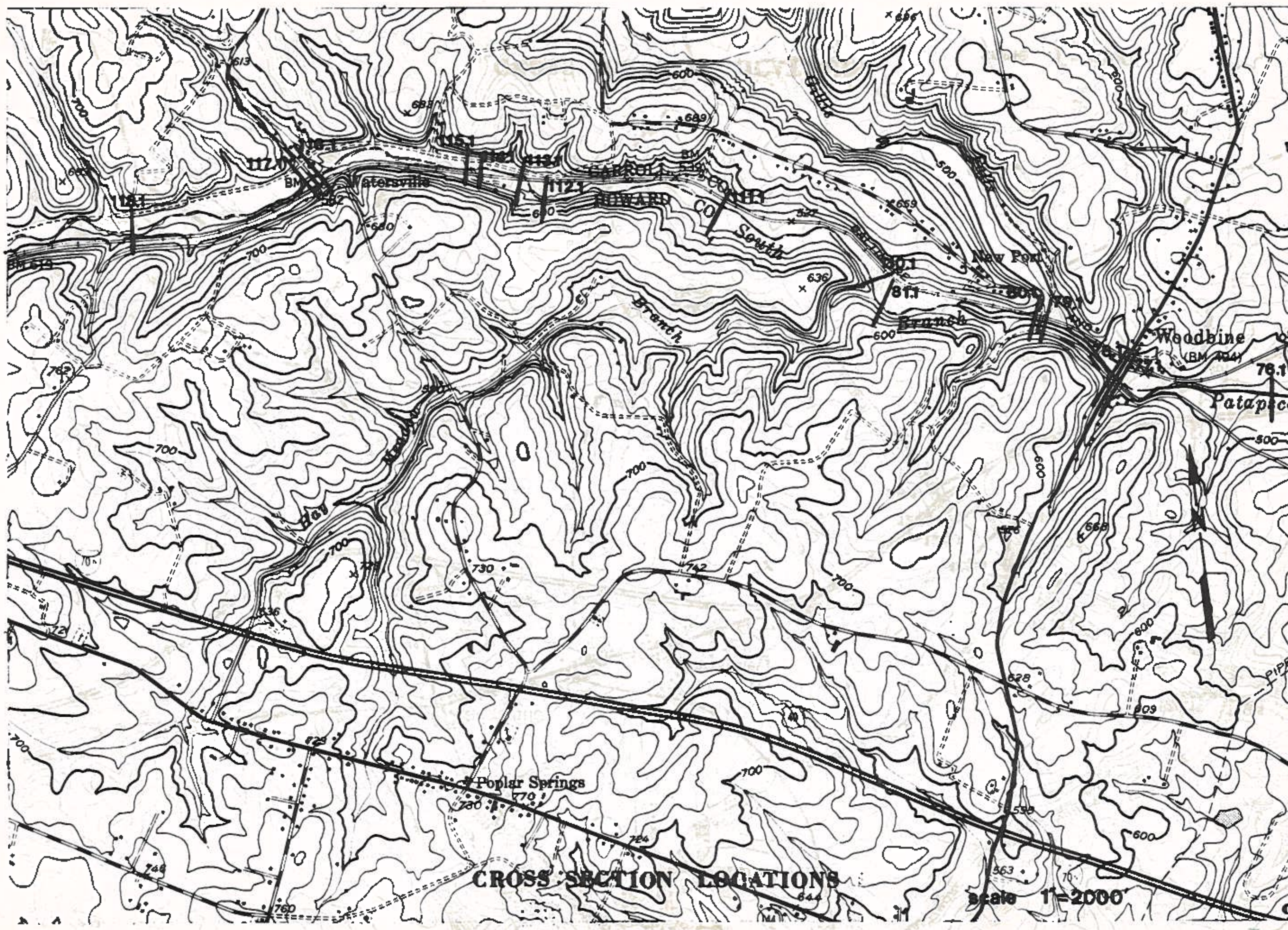
scale 1"=2000'

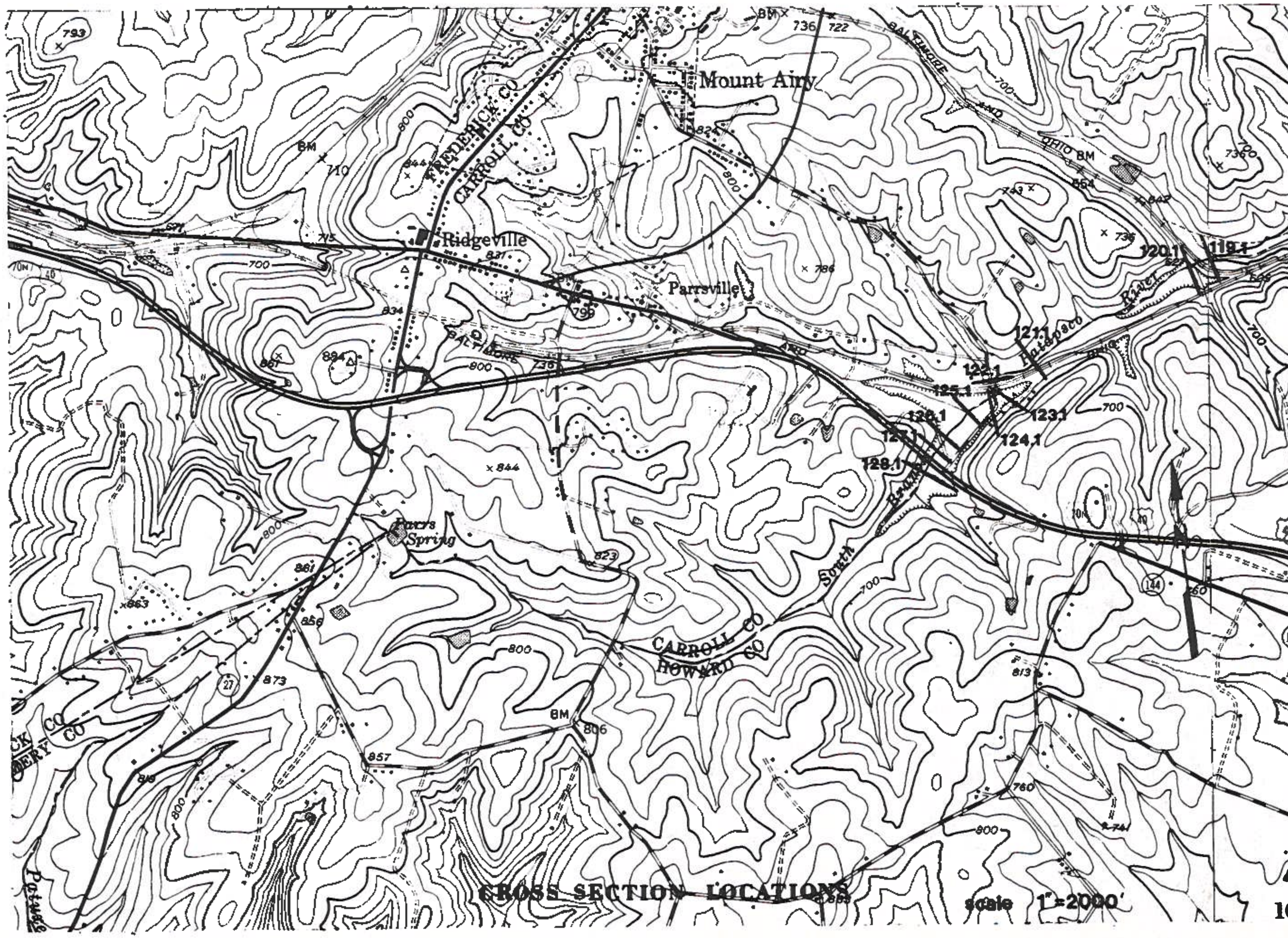

CROSS SECTION LOCATION
PATAPSCO
STATE
PARK
Marriottsville
Henryton
Woodstock
Salem
Ch
Run
PATAPSCO
RIVER
BALTIMORE CO
HOWARD CO
CARROLL
PIPE
LINE
PIPELINE
N
208
206
207
206
205
204
203
202
201
200
33.1
35.1
34.1
32.1
31.1
30.1
29.1
28.1
27.1
26.1
36.1
37.1
38.1
39.1
40.1
41.1
42.1
44.1
564
540
573
500
600
400
300


Sykesville
SOUTH
BRANCH
CARROLL CO.
HOWARD CO.
PATAPSCO
PIPELINE
MILL
ROAD
HOOD
BM 352
BM 312
CROSS SECTION LOCATIONS
scale 1"=2000'



CROSS SECTION LOCATIONS
scale 1"=2000'
8


CROSS SECTION LOCATIONS
scale 1"=2000'
Woodbine
Patapsco
New Port
South Branch
Watersville
Poplar Springs
HOWARD CO
CARROLL CO



CROSS SECTION LOCATIONS

TABLE 1

TR-20 SECTIONS vs. SUBWATERSHEDS

TR-20 Section	Subwatershed	TR-20 Section	Subwatershed
001	83	060	43
002	82	062	42
01 (Structure)	81	063	41
006	80	064	40
007	79A	066	39A
008	79	065	39
009	78	681	38
011	77	069	37
012	76	068	36
03 (Structure)	75	073	35
014	74	072	34
015	73	071	33
016	72	070	32
017	71	074	31
018	70A	075	30
019	70	077	29
020	69	078	28
021	68	080	27C
023	67	081	27B
029	66	076	27A
031	65	801	27
034	64A	082	26
033	64	083	25
025	63	084	24
024	62	085	23
027	61	087	22
028	60	098	21
06 (Structure	59	093	20A
037	58	094	20
039	57	095	19
041	56	121	18
07 (Structure)	55	097	17
043	54A	099	16A
042	54	100	16
045	53	101	15
046	52	102	14
98 (Structure)	51	103	13
481	50	105	12A
052	49C	104	12
051	49B	118	11
049	49A	119	10
050	49	088	9
056	48A	090	8
054	48	091	7
057	47	092	6
11 (Structure)	46	111	5
058	45	109	4
047	44C	114	3
059	44B	113	2
12 (Structure	44A	116	1
048	44		

TABLE 2

PATAPSCO RIVER

PEAK DISCHARGE - PRESENT CONDITIONS

Subwatershed Number	Drainage Area (Sq. Mi.)	Time of Concentration (Hrs.)	Runoff Curve Number	Peak Discharge 2 Year (cfs)	10 Year (cfs)	100 Year (cfs)
1	7.93	4.4	85	1300	2510	2820
2	.77	0.6	76	240	580	1050
3	1.00	1.1	91	610	1040	1550
4	1.77	0.8	80	710	1460	2410
5	1.67	1.0	65	190	660	1380
6	1.58	0.6	76	480	1200	1390
7	1.04	0.5	81	540	1140	1300
8	1.18	0.4	78	600	1340	2310
9	.42	0.4	81	260	540	610
10	.91	0.7	75	270	620	710
11	1.76	0.6	75	510	1270	1480
12	1.95	1.4	68	390	700	830
12A	1.51	1.6	81	430	880	1000
13	2.96	1.2	70	83	1340	1580
14	3.03	1.1	60	170	780	980
15	1.97	1.3	71	320	890	1050
16	3.11	1.3	75	360	1690	1960
16A	2.02	0.8	71	450	1170	1370
17	1.43	1.0	75	400	940	1080
18	2.69	0.9	73	680	1680	1950
19	1.57	1.3	77	410	930	1070
20	1.43	0.7	65	220	600	730
20A	1.43	0.8	69	270	750	890
21	3.96	1.3	65	370	1280	1560
22	2.45	1.1	72	500	1310	1530
23	.77	0.7	69	150	400	470
24	.99	0.5	68	160	580	700
25	.75	0.4	67	140	490	600
26	1.05	0.6	67	160	480	580
27	1.07	0.9	63	110	390	480
27A	1.74	1.0	63	160	600	740
27B	1.80	1.2	65	170	610	750
27C	3.01	1.5	67	320	970	1160
28	.81	0.6	71	180	480	570
29	.88	0.5	70	190	580	690
30	3.52	1.3	68	440	1360	1620
31	.52	0.5	76	190	460	540
32	1.05	0.6	73	360	900	1740
33	.51	0.5	75	170	430	790
34	.62	0.5	76	230	550	640
35	.85	0.6	73	210	560	660
36	5.55	1.6	70	740	2030	2400
37	1.10	0.6	72	260	690	810
38	1.53	0.7	70	320	840	980
39	7.11	1.9	69	780	2220	4330
39A	2.28	1.2	66	240	825	1000
40	9.74	1.8	67	920	2840	5720
41	10.02	2.3	66	890	2511	3360

TABLE 3

PATAPSCO RIVER

PEAK DISCHARGE - FUTURE CONDITIONS (2025)

Subwatershed Number	Drainage Area (Sq. Mi.)	Time of Concentration (Hrs.)	Runoff Curve Number	Peak Discharge 2 Year (cfs)	Peak Discharge 10 Year (cfs)	Peak Discharge 100 Year (cfs)
1	7.93	4.4	90	1660	2920	4420
2	.77	0.6	86	450	860	1370
3	1.00	1.1	94	610	1040	1550
4	1.77	0.8	84	870	1660	2630
5	1.67	1.0	78	560	1230	2100
6	1.58	0.6	76	480	1200	2150
7	1.04	0.5	81	540	1140	1920
8	1.18	0.4	79	640	1400	2380
9	.42	0.4	81	260	540	890
10	.91	0.7	76	290	640	1110
11	1.76	0.6	75	505	1270	2320
12	1.95	1.4	73	350	890	1700
12A	1.51	1.6	81	430	880	1450
13	2.96	1.2	74	660	1620	2930
14	3.03	1.1	63	240	970	2140
15	1.97	1.3	73	370	980	1800
16	3.11	1.3	79	920	1990	3380
16A	2.02	0.8	77	680	1500	2560
17	1.43	1.0	79	510	1090	1840
18	2.69	0.9	76	840	1900	3300
19	1.57	1.3	82	522	1080	1790
20	1.43	0.7	71	320	820	1512
20A	1.43	0.8	72	350	870	1580
21	3.96	1.3	66	409	1360	2820
22	2.45	1.1	74	580	1430	2590
23	.77	0.7	71	440	580	810
24	.99	0.5	72	260	720	1380
25	.75	0.4	75	310	750	1350
26	1.05	0.6	70	210	570	1160
27	1.07	0.9	64	120	420	880
27A	1.74	1.0	69	300	860	1670
27B	1.80	1.2	67	210	690	1400
27C	3.01	1.5	69	380	1080	2090
28	.81	0.6	73	200	530	1000
29	.88	0.5	72	230	640	1230
30	3.52	1.3	70	520	1510	2910
31	.52	0.5	78	220	510	880
32	1.05	0.6	79	500	1100	2000
33	.51	0.5	77	200	470	840
34	.62	0.5	77	240	580	1020
35	.85	0.6	75	240	610	1120
36	5.55	1.6	73	940	2340	4300
37	1.10	0.6	77	360	870	1540
38	1.53	0.7	73	390	960	1720
39	7.11	1.9	72	1000	2580	4800
39A	2.28	1.2	68	290	930	1840
40	9.74	1.8	71	1310	3500	6590
41	10.02	2.3	67	970	2650	5980

PATAPSCO RIVER

PEAK DISCHARGE - PRESENT CONDITIONS

Subwatershed Number	Drainage Area (Sq. Mi.)	Time of Concentration (Hrs.)	Runoff Curve Number	Peak Discharge 2 Year (cfs)	10 Year (cfs)	100 Year (cfs)
42	5.75	1.8	65	550	1650	3880
43	.81	0.4	60	70	360	530
44	8.54	1.0	66	1350	3950	5290
44A	16.02	1.0	70	3590	9090	11800
44B	6.60	0.8	64	970	2930	3960
44C	10.37	0.9	66	1760	5040	6710
45	1.34	0.8	62	160	530	730
46	7.34	1.4	58	360	1530	4300
47	1.29	0.6	56	70	330	470
48	3.61	1.1	50	40	390	1630
48A	5.74	1.5	52	100	670	1070
49	4.94	1.2	62	960	3360	9180
49A	3.78	1.2	61	300	1100	2890
49B	4.23	1.2	59	260	1060	2960
49C	4.99	1.1	58	270	1240	1820
50	0.18	0.3	62	30	110	160
51	8.21	2.3	65	660	1950	4510
52	1.88	1.0	64	240	770	1060
53	3.04	0.7	67	590	1560	2060
54	5.53	1.5	63	490	1560	3820
54A	4.04	1.3	56	154	740	2320
55	5.46	1.4	66	670	1920	4580
56	5.66	1.1	67	900	2560	3410
57	2.01	1.1	65	260	810	1920
58	0.49	0.5	63	60	230	320
59	6.55	2.2	69	760	1970	4270
60	0.84	0.8	60	80	290	410
61	3.81	1.5	61	270	950	2430
62	10.68	1.9	64	880	2780	6700
63	5.80	1.6	60	350	1300	3440
64	7.18	0.7	61	780	2650	3660
64A	3.55	1.3	61	270	950	1380
65	6.73	1.3	69	1100	3000	6560
66	3.28	1.2	61	260	950	2510
67	0.66	0.3	67	200	670	890
68	0.94	0.5	64	130	570	800
69	1.13	0.5	67	210	821	1950
70	3.54	0.9	63	440	1750	2390
70A	4.20	0.8	67	810	2590	5740
71	6.05	0.7	67	1170	3680	8140
72	4.58	1.0	62	470	2030	5090
73	11.31	2.1	65	960	3400	4590
74	2.88	0.8	64	420	1530	2060
75	7.99	1.5	65	860	3040	7120
76	5.94	0.8	66	1050	3500	4630
77	5.62	0.9	63	700	2780	3790
78	1.81	0.8	49	30	430	1690
79	4.03	1.0	52	110	1120	1800
79A	5.94	1.1	59	470	2530	7300
80	7.40	0.9	58	630	3400	9780
81	3.48	1.1	65	550	2060	5130
82	2.63	0.4	53	110	1070	1800
83	5.36	0.8	56	360	2240	6700

PATAPSCO RIVER
PEAK DISCHARGE - FUTURE CONDITIONS

Subwatershed Number	Drainage Area (Sq. Mi.)	Time of Concentration (Hrs.)	Runoff Curve Number	Peak Discharge 2 Year (cfs)	10 Year (cfs)	100 Year (cfs)
42	5.75	1.8	66	600	1740	4020
43	.81	0.4	61	80	390	1080
44	8.54	1.0	67	1480	4170	9350
44A	16.02	1.0	71	3880	9520	19830
44B	6.60	0.8	66	1170	3270	7330
44C	10.37	0.9	67	1930	5310	11770
45	1.34	0.8	63	180	560	1340
46	7.34	1.4	60	600	2030	5110
47	1.29	0.6	57	80	350	980
48	3.61	1.1	51	50	430	1750
48A	5.74	1.5	53	120	740	2490
49	4.94	1.2	64	530	1750	4260
49A	3.78	1.2	63	370	1260	3140
49B	4.23	1.2	60	300	1140	3100
49C	4.99	1.1	59	310	1340	3750
50	0.18	0.3	63	30	120	300
51	8.21	2.3	65	660	1950	4570
52	1.88	1.0	66	300	870	1990
53	3.04	0.7	68	640	1650	3550
54	5.53	1.5	64	540	1660	3960
54A	4.04	1.3	59	240	930	2690
55	5.46	1.4	67	730	2020	4740
56	5.66	1.1	68	980	2700	5990
57	2.01	1.1	66	290	860	1990
58	0.49	0.5	64	70	240	620
59	6.55	2.2	70	820	2070	4400
60	0.84	0.8	61	90	310	780
61	3.81	1.5	62	300	1010	2530
62	10.68	1.9	64	880	2780	6700
63	5.80	1.6	60	350	1300	3440
64	7.18	0.7	63	970	2990	7110
64A	3.55	1.3	62	300	1010	2690
65	6.73	1.3	71	1280	3310	6980
66	3.28	1.2	63	320	1090	2720
67	0.66	0.3	68	220	700	1550
68	0.94	0.5	66	150	650	1570
69	1.13	0.5	69	260	910	2070
70	3.54	0.9	65	550	1940	4510
70A	4.20	0.8	69	950	2830	6060
71	6.05	0.7	67	1170	3680	8140
72	4.58	1.0	63	530	2150	5270
73	11.31	2.1	66	1050	3580	8460
74	2.88	0.8	67	560	1770	3920
75	7.99	1.5	65	860	3040	7120
76	5.94	0.8	68	1250	3820	8310
77	5.62	0.9	65	870	3080	7150
78	1.81	0.8	50	30	470	1770
79	4.03	1.0	53	130	1220	4230
79A	5.94	1.1	60	530	2700	7550
80	7.40	0.9	59	720	3610	10110
81	3.48	1.1	66	610	2160	5270
82	2.63	0.4	54	130	1180	4340
83	5.36	0.8	59	560	268	7410

TABLE 4

1978 LANDSAT LAND USE - PATAPSCO RIVER WATERSHED

(In Acres)

Sub-Watershed	Water	Trees	Brush	Grass	Crops	Low Density Urban	Medium Density Urban	High Density Urban	Other	Total
1	1463	777	465	296	344	256	404	385	682	5072
2	97	138	64	30	30	39	28	18	49	493
3	357	57	31	32	18	36	47	16	46	640
4	0	164	174	132	78	95	216	99	175	1133
5	0	242	158	138	198	74	87	20	152	1069
6	1	254	158	108	53	139	142	52	105	1012
7	0	87	68	98	40	82	136	29	127	667
8	0	134	107	156	50	87	105	21	96	756
9	0	38	21	63	66	13	45	1	21	268
10	0	124	114	181	71	46	23	3	23	585
11	0	185	179	266	124	115	138	40	79	1126
12	0	718	137	82	208	45	16	11	31	1248
12A	3	293	150	98	95	63	97	80	89	968
13	0	421	330	185	321	129	98	13	396	1893
14	3	608	326	148	340	114	115	16	272	1942
15	1	571	183	100	191	86	33	7	91	1263
16	0	539	344	302	239	127	122	55	265	1993
16A	0	539	173	206	162	63	80	12	55	1290
17	0	324	175	85	180	59	22	12	59	916
18	0	753	183	168	232	95	88	35	170	1724
19	0	337	127	116	152	87	84	33	68	1004
20	0	307	174	221	117	54	5	2	34	914
20A	0	166	158	293	166	56	35	1	38	913
21	0	1339	303	182	372	125	82	23	107	2533
22	0	683	228	139	235	93	63	31	95	1567
23	0	296	53	39	67	14	13	1	11	494
24	0	367	62	104	69	16	1	1	15	635
25	0	129	88	142	86	18	1	0	14	478
26	0	127	129	248	118	28	0	1	24	675
27	0	483	52	58	45	32	1	2	11	684
27A	0	634	136	74	101	76	19	21	53	1114
27B	0	537	175	185	88	84	30	19	34	1152
27C	4	1127	208	242	264	41	3	3	37	1929
28	0	328	47	55	54	15	1	0	18	518
29	0	118	123	130	88	59	13	0	35	566
30	3	1159	299	290	311	107	12	10	61	2252
31	0	78	69	62	59	17	24	1	25	335
32	0	165	144	116	74	67	32	37	38	673
33	0	83	78	82	22	34	11	1	14	325
34	0	86	95	100	42	39	11	0	23	396
35	0	195	103	103	85	33	10	0	17	546
36	9	1646	372	439	525	174	153	61	176	3555
37	0	262	101	118	81	56	39	21	26	704
38	0	201	170	213	150	116	76	2	49	977
39	0	1713	687	997	619	146	164	53	169	4548
39A	4	712	153	262	241	38	9	3	39	1461
40	1	2250	920	1577	1053	128	104	8	195	6236
41	4	2789	893	1396	932	169	28	21	178	6410

Sub-Watershed	Water	Trees	Brush	Grass	Crops	Low Density Urban	Medium Density Urban	High Density Urban	Other	Total
42	5	1620	481	648	630	79	21	11	185	3680
43	7	372	26	54	49	4	0	3	2	517
44	508	2516	514	853	837	131	16	7	82	5464
44A	1325	3724	1161	1510	1800	316	112	18	287	10253
44B	358	1380	518	814	833	113	17	18	171	4222
44C	332	2261	756	1286	1492	175	53	14	266	6635
45	0	122	49	300	317	13	13	0	44	858
46	0	715	401	816	942	69	17	2	101	3063
46A	0	381	156	508	518	20	2	1	48	1634
47	0	221	66	250	236	13	10	0	27	823
48	0	621	271	772	511	48	27	2	61	2313
48A	0	1017	385	1055	1000	70	40	4	104	3675
49	0	594	273	984	1062	91	44	1	113	3162
49A	0	438	287	717	773	97	37	1	71	2421
49B	0	544	258	909	738	90	67	3	101	2710
49C	0	781	331	935	957	68	24	4	95	3195
50	0	77	9	4	22	1	0	0	0	113
51	0	948	625	1890	1419	140	46	7	179	5254
52	0	232	126	390	328	44	33	2	48	1203
53	0	544	189	535	506	29	61	3	81	1948
54	0	572	322	1247	935	131	179	22	134	3542
54A	0	509	332	787	707	58	64	2	128	2587
55	1	684	407	1099	1037	105	41	2	119	3495
56	0	801	458	1025	966	119	64	15	177	3625
57	0	260	177	305	463	37	6	0	40	1288
58	0	88	37	95	83	2	0	0	10	315
59	0	709	356	1153	1567	97	45	16	289	4192
60	0	134	53	182	141	8	3	1	16	538
61	2	603	249	645	766	60	23	4	85	2437
62	2	1104	627	2293	2099	224	145	18	322	6834
63	1	803	397	1127	1110	91	45	4	133	3711
64	0	1050	548	1272	1435	127	40	3	123	4598
64A	0	558	216	616	741	60	11	2	70	2274
65	1	398	325	1360	1469	135	341	52	223	4304
66	16	408	232	716	522	74	41	2	85	2096
67	0	265	40	46	52	13	0	0	4	420
68	0	188	100	190	89	11	0	1	20	599
69	0	192	90	271	133	18	2	0	17	723
70	0	874	278	623	387	47	8	3	47	2267
70A	22	422	441	900	592	123	73	6	108	2687
71	230	762	477	1063	1023	93	84	5	133	3870
72	1	550	266	1189	674	97	65	5	87	2934
73	0	2554	791	1881	1487	232	62	12	219	7238
74	0	470	227	495	512	44	13	4	75	1840
75	0	914	521	1833	1450	122	59	5	209	5113
76	0	1128	495	1013	923	102	29	2	111	3803
77	0	773	361	1356	775	116	51	8	157	3597
78	0	369	159	314	264	18	4	2	29	1159
79	0	653	309	831	629	55	27	4	72	2580
79A	0	823	463	1434	690	155	79	8	149	3801
80	0	927	526	1682	1120	183	108	6	182	4734
81	0	408	266	707	590	60	42	2	149	2224
82	0	447	204	594	338	35	18	2	45	1683
83	0	740	431	923	821	216	107	18	173	3429
Total	4761	66531	27750	57354	50816	8324	5585	1618	10593	233332

TABLE 5
FORECASTED LAND COVER, YEAR 2025
PATAPSCO RIVER BASIN

(Acres)

Sub-Watershed	Water	Trees	Brush	Grass	Crops	Low Density Urban	Medium Density Urban	High Density Urban	Other	Total
1	1,463	603	372	238	260	365	634	468	669	5,072
2	47	90	42	20	20	71	76	27	100	493
3	357	57	31	32	18	36	46	16	47	640
4	–	132	141	107	63	118	273	125	174	1,133
5	–	172	112	98	140	122	197	63	165	1,069
6	1	249	155	106	52	142	148	53	106	1,012
7	–	82	65	94	38	85	144	32	127	667
8	–	132	106	154	49	88	108	22	97	756
9	–	38	21	64	67	13	46	1	18	268
10	–	113	105	165	65	54	41	7	35	585
11	–	178	171	254	118	122	155	43	85	1,126
12	–	543	104	62	158	107	134	56	84	1,248
12A	3	261	144	93	91	74	107	61	94	968
13	–	304	238	133	232	215	290	96	386	1,893
14	3	516	276	125	288	206	224	35	269	1,942
15	1	494	157	86	166	142	100	18	99	1,263
16	–	369	236	207	164	265	352	104	276	1,993
16A	–	339	108	130	102	186	259	65	101	1,290
17	–	248	133	62	138	101	109	45	80	916
18	–	575	137	120	181	194	252	91	174	1,724
19	–	202	77	71	92	177	223	69	93	1,004
20	–	217	123	156	82	135	116	20	65	914
20A	–	133	127	234	133	124	105	8	49	913
21	–	1,240	280	169	344	197	154	35	114	2,533
22	–	593	198	121	204	143	139	48	121	1,567
23	–	258	46	34	59	36	37	3	21	494
24	–	293	49	83	55	47	58	13	37	635
25	–	117	78	128	76	31	22	5	21	478
26	–	105	107	207	99	71	47	6	33	675
27	–	458	49	55	43	39	17	6	17	684
27A	–	550	117	64	87	102	79	35	80	1,114
27B	–	480	156	164	78	106	79	27	62	1,152
27C	4	1,033	189	219	242	100	73	11	58	1,929
28	–	274	39	46	45	49	36	4	25	518
29	–	101	104	112	75	88	42	3	41	566
30	3	909	233	229	246	183	164	45	240	2,252
31	–	67	59	54	51	29	41	4	30	335
32	–	103	90	73	46	112	106	80	63	673
33	–	68	65	67	19	54	32	3	17	325
34	–	76	85	89	37	54	28	2	25	396
35	–	165	87	87	72	61	46	4	24	546
36	9	1,409	328	385	455	261	334	121	253	3,555
37	–	172	66	78	54	99	126	48	61	704
38	–	158	134	168	118	174	139	17	69	977
39	–	1,486	595	866	538	255	389	131	288	4,548
39A	4	639	137	232	217	91	70	13	58	1,461
40	1	1,850	757	1,297	867	340	541	177	406	6,236
41	1	2,675	848	1,326	885	289	149	41	196	6,410

SOURCE: See Appendix D, "Land Use and Land Cover in the Patapsco River Basin," by the Regional Planning Council.

Sub-Watershed	Water	Trees	Brush	Grass	Crops	Low Density Urban	Medium Density Urban	High Density Urban	Other	Total
42	5	1,536	456	611	597	140	100	32	203	3,680
43	7	364	26	43	47	9	5	4	12	517
44	508	2,351	479	793	779	211	149	46	148	5,464
44A	1,325	3,512	1,087	1,407	1,680	508	322	67	346	10,253
44B	358	1,333	500	786	605	167	70	28	175	4,222
44C	332	2,130	714	1,214	1,411	278	194	51	311	6,635
45	-	118	47	290	306	25	24	3	45	858
46	-	638	380	835	866	170	135	29	30	3,083
46A	-	362	148	482	491	49	36	12	54	1,634
47	-	214	64	241	229	24	20	3	28	823
48	-	609	267	757	503	66	44	7	60	2,313
48A	-	961	371	1,018	967	124	91	18	105	3,675
49	-	571	263	946	1,021	140	91	14	116	3,162
49A	-	388	254	636	685	204	146	18	90	2,421
49B	-	522	247	871	707	138	112	15	98	2,710
49C	-	751	318	900	919	121	74	17	95	3,195
50	-	75	9	4	22	1	-	-	2	113
51	-	916	604	1,827	1,371	215	117	26	178	5,254
52	-	214	116	359	302	80	70	7	55	1,203
53	-	508	176	498	473	77	110	13	93	1,948
54	-	515	289	1,124	843	245	309	49	168	3,542
54A	-	445	290	687	617	189	197	20	142	2,587
55	1	658	392	1,058	998	161	94	17	116	3,495
56	-	728	416	932	877	235	191	41	205	3,625
57	-	249	170	293	446	58	26	5	41	1,288
58	-	85	36	91	80	7	5	1	10	315
59	-	652	327	1,063	1,326	154	179	62	429	4,192
60	-	129	51	176	136	16	11	3	16	538
61	2	581	239	621	737	98	59	14	86	2,437
62	2	962	547	2,001	1,831	476	483	108	424	6,834
63	1	774	382	1,087	1,070	148	99	19	131	3,711
64	-	974	509	1,181	1,332	246	161	41	154	4,598
64A	-	530	204	587	704	103	53	17	76	2,274
65	1	335	274	1,146	1,239	321	582	112	294	4,304
66	16	379	216	665	485	132	99	11	93	2,096
67	-	263	39	45	51	15	2	-	5	420
68	-	167	89	109	80	32	27	8	87	599
69	-	170	80	241	118	42	36	9	27	723
70	-	810	258	578	359	114	76	12	60	2,267
70A	22	377	394	805	529	203	171	38	150	2,687
71	230	749	469	1,044	1,005	114	106	12	141	3,870
72	1	530	256	1,143	649	139	105	18	93	2,934
73	-	2,438	755	1,796	1,417	353	194	47	238	7,238
74	-	409	193	405	432	142	128	20	111	1,840
75	-	883	503	1,768	1,399	195	128	26	211	5,113
76	-	1,049	457	935	843	194	148	42	135	3,803
77	-	720	336	1,258	721	192	147	45	178	3,597
78	-	353	152	302	255	38	23	7	29	1,159
79	-	629	297	801	605	95	66	14	73	2,580
79A	-	775	436	1,352	650	242	165	25	156	3,801
80	-	892	506	1,618	1,078	256	177	26	181	4,734
81	-	386	251	670	559	110	90	15	143	2,224
82	-	428	195	570	324	61	44	10	51	1,683
83	-	655	367	784	704	368	287	54	210	3,429
TOTAL	4,706	60,118	24,958	52,616	46,409	14,414	13,665	3,785	12,659	233,332

TABLE 6
PATAPSCO RIVER FLOOD STUDY

Discharge and Water Surface Elevations-Present Conditions

Section	100-yr flood		10-yr flood		2-yr flood	
	Discharge cfs	Elevation msl	Discharge cfs	Elevation msl	Discharge cfs	Elevation msl
127.0	42200	3.5	15400	2.0	4600	1.5
126.0	42200	3.9	15400	2.1	4600	1.5
125.0	42200	4.9	15400	2.3	4600	1.5
124.0	42200	6.2	15400	2.9	4600	1.6
123.0	42200	7.0	15400	3.4	4600	1.7
122.0	42200	7.3	15400	3.4	4600	1.7
121.0	42200	8.2	15400	3.6	4600	1.8
120.0	42200	8.8	15400	3.9	4600	1.8
119.0	42200	9.8	15400	4.6	4600	2.0
118.0	42200	10.8	15400	5.1	4600	2.1
117.0	42200	11.7	15400	5.7	4600	2.3
116.0	42200	12.5	15400	6.3	4600	2.5
115.0	42200	14.5	15400	7.2	4600	2.8
114.0	42200	14.9	15400	7.7	4600	3.1
113.0	42200	15.1	15400	7.9	4600	3.6
112.0	42200	15.3	15400	8.3	4600	4.0
111.0	42200	15.4	15400	8.6	4600	4.2
110.0	42300	15.7	15400	8.8	4600	4.3
109.0	42300	17.8	15400	9.0	4600	4.5
108.0	42300	18.4	15400	9.6	4600	4.9
107.0	42300	18.5	15400	9.8	4600	5.1
106.0	42300	18.6	15400	10.0	4600	5.4
105.0	42300	18.6	15400	10.0	4600	5.5
104.0	42300	19.7	15400	10.6	4600	5.7
103.0	42300	19.8	15400	10.8	4600	6.0
102.0	42300	19.4	15400	10.7	4600	6.2
101.0	42300	19.6	15400	11.1	4600	6.4
100.0	42800	21.0	15600	12.7	4600	7.2
99.0	42800	22.5	15600	14.3	4600	8.3
98.0	42800	22.7	15600	14.6	4600	8.5
97.0	42800	22.6	15600	14.5	4600	8.5
96.0	42800	23.2	15600	15.0	4600	9.0
95.0	42800	23.3	15600	15.2	4600	9.0
94.0	42800	23.5	15600	15.4	4600	9.5
93.0	43900	24.1	16000	16.2	4700	10.7
92.0	43900	24.5	16000	16.7	4700	11.1
91.0	43900	24.7	16000	16.4	4700	11.4
90.0	43900	26.7	16000	18.2	4700	12.6
89.0	42500	26.8	15300	18.0	4400	12.3
88.0	42500	27.0	15300	19.2	4400	14.4
87.0	42500	26.8	15300	19.3	4400	14.5

PATAPSCO RIVER FLOOD STUDY

Discharge and Water Surface Elevations-Present Conditions

Section	100-yr flood		10-yr flood		2-yr flood	
	Discharge cfs	Elevation msl	Discharge cfs	Elevation msl	Discharge cfs	Elevation msl
86.0	42500	29.0	15300	20.2	4400	14.7
85.0	42500	30.3	15300	21.1	4400	15.7
84.0	42500	32.6	15300	22.3	4400	16.2
83.0	42500	45.1	15300	30.8	4400	24.3
82.0	42500	45.2	15300	30.8	4400	24.3
81.0	42500	45.4	15300	31.0	4400	24.4
80.0	42400	45.4	15200	31.1	4400	24.5
79.0	42400	45.4	15200	31.1	4400	24.5
78.0	42400	45.7	15200	31.3	4400	24.5
77.0	42400	46.1	15200	32.3	4400	25.1
76.0	42400	46.6	15200	34.0	4400	27.7
75.0	42400	46.6	15200	33.6	4400	27.3
74.0	42400	47.0	15200	37.5	4400	30.6
73.0	42400	47.0	15200	38.7	4400	31.7
72.0	42400	47.3	15200	39.0	4400	31.8
71.0	42400	47.6	15200	40.0	4400	32.0
70.0	42400	48.1	15200	39.4	4400	33.0
69.0	42400	48.2	15200	39.5	4400	32.2
68.0	42400	48.4	15200	39.8	4400	32.6
67.0	42400	49.2	15200	40.5	4400	33.4
66.0	42400	50.4	15200	41.7	4400	34.6
65.0	42400	51.0	15200	42.2	4400	35.0
64.0	42500	51.3	15300	42.5	4400	35.3
63.0	42500	52.4	15300	43.5	4400	36.3
62.0	42500	54.1	15300	44.8	4400	37.6
61.0	42500	55.3	15300	45.9	4400	39.1
60.0	42500	55.8	15300	46.5	4400	40.5
59.0	42500	57.5	15300	49.0	4400	43.7
58.0	42500	59.8	15300	51.2	4400	45.4
57.0	42500	60.4	15300	52.0	4400	46.3
56.0	42500	61.3	15300	53.7	4400	48.5
55.0	42500	64.3	15300	55.8	4400	50.1
54.0	42500	65.3	15300	57.0	4400	51.7
53.0	42500	67.0	15300	58.2	4400	52.3
52.0	42500	90.8	15300	83.1	4400	78.6
51.0	42500	91.9	15300	83.4	4400	78.7
50.0	42500	92.2	15300	83.8	4400	78.8
49.0	42500	92.2	15300	84.3	4400	79.1

PATAPSCO RIVER FLOOD STUDY

Discharge and Water Surface Elevations-Present Conditions

Section	100-yr flood		10-yr flood		2-yr flood	
	Discharge cfs	Elevation msl	Discharge cfs	Elevation msl	Discharge cfs	Elevation msl
48.0	42700	94.7	15300	85.6	4400	79.5
47.0	42700	94.9	15300	86.3	4400	80.1
46.0	42700	96.3	15300	87.4	4400	81.6
45.0	42700	99.3	15300	88.8	4400	82.2
44.0	42700	100.0	15300	89.8	4400	83.4
43.0	42700	100.4	15300	90.4	4400	84.2
42.0	42700	102.2	15300	93.0	4400	87.6
41.0	42700	111.8	15300	104.0	4400	98.4
40.0	42700	113.0	15300	105.0	4400	98.8
39.0	42700	114.2	15300	105.8	4400	99.4
38.0	42700	115.5	15300	106.6	4400	100.0
37.0	42700	116.5	15300	107.3	4400	100.6
36.0	42700	117.3	15300	108.4	4400	101.8
35.0	42700	118.4	15000	109.9	4200	103.2
34.0	42200	120.9	15000	111.7	4200	104.7
33.0	42200	122.6	15000	113.9	4200	107.0
32.0	42200	125.3	15000	115.6	4200	109.2
31.0	42200	130.1	15000	118.8	4200	113.2
30.0	42200	133.8	15000	121.2	4200	116.3
29.0	42200	135.6	15000	127.3	4200	121.2
28.0	42500	140.0	15100	131.6	4300	128.6
27.0	42500	147.5	15100	141.4	4300	135.8
26.0	42500	155.7	15100	147.2	4300	142.3
25.0	42500	160.5	15100	153.7	4300	148.7
24.0	42500	165.0	15100	157.3	4300	151.5
23.0	42500	169.6	15100	160.8	4300	154.5
22.0	42500	172.4	15100	163.8	4300	157.4
21.0	42500	176.6	15100	168.3	4300	162.6
20.0	42500	181.0	15100	173.2	4300	168.0
19.0	42500	185.7	15100	177.7	4300	172.3
18.0	42500	190.3	15100	185.2	4300	181.4
17.0	42500	201.3	15100	191.1	4300	184.2
16.0	42300	202.8	14900	192.5	4200	185.2
15.0	42300	203.9	14900	193.5	4200	186.2
14.0	42300	205.0	14900	194.8	4200	187.2
13.0	42300	206.8	14900	196.4	4200	188.3
12.0	42300	208.0	14900	197.5	4200	189.2
11.0	42300	209.4	14900	199.0	4200	190.4
10.0	42300	211.2	14900	200.3	4200	191.9
9.0	42300	212.0	14900	201.4	4200	193.6
8.0	42300	214.3	14900	201.8	4200	194.3

PATAPSCO RIVER FLOOD STUDY

Discharge and Water Surface Elevations-Present Conditions

Section	100-yr flood		10-yr flood		2-yr flood	
	Discharge cfs	Elevation msl	Discharge cfs	Elevation msl	Discharge cfs	Elevation msl
7.0	42300	214.7	14900	202.7	4200	195.1
6.0	42000	216.0	14700	204.8	4000	198.0
5.0	42000	217.9	14700	206.8	4000	199.5
4.0	42000	219.4	14700	208.7	4000	200.7
3.0	42000	220.4	14700	210.3	4000	202.0
2.0	42000	222.1	14700	211.8	4000	203.4
1.0	42000	223.8	14700	213.3	4000	205.1
1.1	42000	225.6	14700	215.9	4000	207.3
2.1	42000	226.6	14700	216.4	4000	207.6
3.1	42000	226.9	14700	216.7	4000	208.2
4.1	42000	232.5	14700	225.9	4000	222.4
5.1	42000	234.8	14700	227.7	4000	223.0
6.1	42000	236.2	14700	229.0	4000	223.7
7.1	41600	237.8	14300	230.0	3800	224.1
8.1	41600	239.8	14300	231.2	3800	224.5
9.1	41600	243.3	14300	233.1	3800	225.4
10.1	41600	244.3	14300	234.1	3800	226.1
11.1	41600	247.3	14300	236.7	3800	228.1
12.1	41600	248.4	14300	237.5	3800	228.8
13.1	41600	250.5	14300	238.8	3800	229.8
14.1	41600	251.3	14300	239.6	3800	230.5
15.1	41600	252.7	14300	240.2	3800	230.8
16.1	41600	253.4	14300	241.0	3800	231.8
17.1	41600	254.4	14300	242.0	3800	232.9
18.1	41600	256.9	14300	244.7	3800	235.4
19.1	41600	258.1	14300	245.8	3800	236.7
20.1	41600	259.9	14300	247.8	3800	239.4
21.1	41600	260.9	14300	248.9	3800	240.5
22.1	41600	262.4	14300	250.9	3800	242.9
23.1	41600	263.9	14300	252.3	3800	244.0
24.1	41600	264.7	14300	253.5	3800	245.2
25.1	41600	265.2	14300	253.7	3800	245.4
26.1	41600	265.0	14300	253.7	3800	245.4
27.1	41600	267.1	14300	255.6	3800	247.7
28.1	41600	268.3	14300	257.1	3800	249.6
29.1	41600	271.1	14300	260.9	3800	252.9
30.1	41600	272.6	14300	263.0	3800	254.0
31.1	41600	274.3	14300	264.0	3800	254.8
32.1	41600	275.2	14300	264.5	3800	255.2

PATAPSCO RIVER FLOOD STUDY

Discharge and Water Surface Elevations-Present Conditions

Section	100-yr flood		10-yr flood		2-yr flood	
	Discharge cfs	Elevation msl	Discharge cfs	Elevation msl	Discharge cfs	Elevation msl
NORTH BRANCH						
200.0	18500	275.2	6100	264.5	1700	255.1
201.0	18500	277.1	6100	268.4	1700	263.5
202.0	18500	282.0	6100	274.3	1700	268.4
203.0	18500	285.9	6100	277.8	1700	271.5
204.0	18500	287.6	6100	279.4	1700	272.8
205.0	18500	292.2	6100	283.8	1700	276.9
206.0	18500	293.4	6100	284.4	1700	278.0
207.0	18500	295.2	6100	285.7	1700	278.6
208.0	18500	296.6	6100	288.5	1700	282.9
209.0	18500	298.4	6100	290.6	1700	284.6
210.0	18500	298.9	6100	291.4	1700	285.2
SOUTH BRANCH						
33.1	25500	286.0	9200	262.3	2500	257.7
34.1	25500	286.5	9200	282.3	2500	276.7
35.1	25500	297.4	9200	289.5	2500	282.8
36.1	24400	300.3	8600	292.5	2200	285.9
37.1	24400	301.9	8600	293.1	2200	286.2
38.1	24400	303.5	8600	295.0	2200	287.9
39.1	24400	306.6	8600	297.9	2200	290.5
40.1	24400	308.3	8600	299.0	2200	291.2
41.1	24400	309.4	8600	299.4	2200	291.4
42.1	24400	313.1	8600	301.8	2200	293.2
43.1	23800	314.1	8300	303.7	2300	296.7
44.1	23800	316.5	8300	304.7	2300	297.3
45.1	23800	318.5	8300	308.5	2300	301.9
46.1	23800	323.0	8300	314.0	2300	307.1
47.1	23800	332.4	8300	324.2	2300	318.8
48.1	23800	341.8	8300	333.0	2300	326.0
49.1	23800	352.2	8300	346.3	2300	343.0
50.1	23800	371.1	8300	364.3	2300	358.4
51.1	23800	374.8	8300	365.0	2300	359.0
52.1	23800	375.3	8300	365.8	2300	361.5
53.1	23800	375.0	8300	368.0	2300	364.3

PATAPSCO RIVER FLOOD STUDY

Discharge and Water Surface Elevations-Present Conditions

Section	100-yr flood		10-yr flood		2-yr flood	
	Discharge cfs	Elevation msl	Discharge cfs	Elevation msl	Discharge cfs	Elevation msl
54.1	23800	378.0	8300	372.4	2300	367.1
60.1	24000	381.3	8300	375.8	2200	371.6
61.1	24000	405.5	8300	398.4	2200	392.4
62.1	24000	417.2	8300	401.8	2200	397.0
63.1	24000	418.8	8300	408.9	2200	402.4
64.1	24000	420.0	8300	409.7	2200	402.7
65.1	24000	428.6	8300	419.7	2200	412.8
66.1	24000	429.8	8300	421.6	2200	413.8
67.1	24000	433.8	8300	426.4	2200	421.0
68.1	22200	436.7	7500	430.5	1600	425.4
69.1	22200	445.1	7500	435.6	1600	428.0
70.1	22200	447.0	7500	435.5	1600	430.6
71.1	22200	451.1	7500	444.0	1600	440.0
72.1	22200	454.1	7500	451.5	1600	446.5
73.1	22900	461.5	7400	457.4	1500	453.7
74.1	22900	469.1	7400	462.8	1500	458.8
75.1	22900	474.7	7400	467.1	1500	459.8
76.1	22900	487.4	7400	481.8	1500	475.7
77.1	22900	495.4	7400	490.4	1500	484.1
78.1	24200	497.3	7900	492.3	1500	486.0
79.1	8700	504.2	2700	497.2	546	492.0
80.1	8700	504.8	2700	498.1	546	492.5
81.1	8900	508.5	2800	504.6	600	500.4
110.1	6700	510.8	2000	508.5	300	505.4
111.1	6700	529.1	2000	525.2	300	522.0
112.1	6700	545.8	2000	543.6	300	540.3
113.1	6700	550.3	2000	545.6	300	541.7
114.1	6700	553.6	2000	550.0	300	547.0
115.1	6700	556.6	2000	553.0	300	548.4
116.1	6700	568.6	2000	565.9	300	563.2
117.1	6700	576.0	2000	569.4	300	565.3
118.1	6700	585.3	2200	583.7	400	581.8
119.1	6700	613.0	2200	609.2	400	605.1
120.1	6700	624.8	2200	613.0	400	606.4
121.1	6700	629.7	2200	626.8	400	623.1
122.1	6700	636.9	2200	633.3	400	629.4
123.1	6700	649.0	2200	638.9	400	632.2
124.1	6700	649.1	2200	639.0	400	633.7
125.1	6700	649.2	2200	635.9	400	635.9
126.1	6700	649.3	2200	642.9	400	640.9
127.1	6700	654.9	2200	651.6	400	642.7
128.1	6700	670.3	2200	653.9	400	645.8

TABLE 7

PATAPSCO RIVER FLOOD STUDY

DISCHARGES - FUTURE CONDITIONS (2025)

Sections	100 Yr. Flood Discharge (cfs)	10 Yr. Flood Discharge (cfs)	2 Yr. Flood Discharge (cfs)
	MAIN STEM		
127.0 - 111.0	44800	16700	5400
110.0 - 101.0	45100	16800	5200
100.0 - 94.0	45200	10900	5200
93.0 - 90.0	46800	18500	6700
89.0 - 81.0	44800	16500	4900
80.0 - 65.0	44700	16400	4800
64.0 - 49.0	44900	16500	4900
48.0 - 35.0	45000	16500	4900
34.0 - 29.0	44400	16100	4700
28.0 - 17.0	44800	16300	4800
16.0 - 7.0	44600	16100	4600
6.0 - 6.1	44300	16000	4500
7.1 - 32.1	43800	15500	4200
	NORTH BRANCH		
200.0 - 210.0	19700	6600	1900
	SOUTH BRANCH		
33.1 - 35.1	26700	10000	2900
36.1 - 42.1	25600	9200	2500
43.1 - 54.1	25000	8900	2600
60.1 - 67.1	25200	9000	2400
68.1 - 72.1	23400	8200	1900
73.1 - 78.1	24100	8000	1700
79.1 - 80.1	9400	3100	700
81.1	9600	3200	700
110.1 - 128.1	7300	2400	400

APPENDIX B

ECONOMICS

Prepared by:

Patapsco River Basin Study Staff

ECONOMICS

The Water Resource Council requires that all federal water resources planning studies use the Standards and Procedures set forth by the Council. The Patapsco River Basin Study uses USDA Procedures for Planning Water and Related Land Resources in Programs Administered by the Soil Conservation Service. (USDA, March, 1974) This Appendix describes the methods used to evaluate average annual damages to urban properties for the Patapsco River Basin Study. The detailed back up data is on file in the SCS, Maryland State Office, located at 4321 Hartwick Rd., College Park, Maryland.

Figure 1 shows the basic elements of the estimation procedure and the interrelationships between them. The four elements are: (1) The stage-discharge relationship, (2) the discharge frequency relationship, (3) the stage - damage relationship, and (4) the damage-frequency relationship. The last, the damage-frequency relationship is the objective.

Discharge-elevation relationships are determined during hydraulic studies. These rating curves are developed for cross-sections along the portion of the stream being studied. Discharge-frequency relationships are also developed during hydrologic studies. Among the more influential factors in determining discharge-frequency relationships are rainfall, land area, and land use. Appendix A gives a more complete discussion of hydraulics and hydrology.

Stage-damage relationships are developed by generalizing information gathered from home-owners and business-owners who have experienced flood damages in the past. Several sets of generalized curves are available for use by Soil Conservation Service personnel. The SCS Economic Guide states that no set of curves should be used without verifying its applicability to the structures in the area being studied. Interview data can be used to adjust the tables (curves) to more adequately represent local situations.

With these three relationships, the fourth can be determined, that is, the damage frequency relationship. This can be done graphically as in Figure 1 or arithmetically as in Table 1. In practice, SCS uses a computerized system, called URB1, to calculate the estimates.

URB1 requires the following information (2) a rating curve (stage-discharge information) and the valley station of each cross section; (b) stage-damage tables for the various types of structures and their contents; (c) discharge-frequency information for each cross-section; and (d) information on each structure. The information on each structure includes the type of structure and its construction, the value of the structure and its contents, its valley station, and the elevation of several relevant points such as the first floor and the lowest entry point.

The computation process is outlined below.

1) Determine the valley station of a structure.
2) Determine which cross-section lies immediately upstream and immediately downstream of the structure.
3) Use the frequency-discharge and stage-discharge tables to determine the flood elevation at each of the two cross-sections for the relevant frequencies. In this case: 100-year, 50-year, 25-year, 10-uear, and 2-year frequencies.
4) Use the flood elevation at each cross-section to determine the flood elevation at the structure by interpolating flood elevation with valley station.
5) Compare the elevation of the structure with the flood elevation to determine the depth of flooding at that structure. The depth may be less than zero indicating the structure is not flooded.
6) Use the stage-damage table, for the appropriate type of structure, to determine the amount of damage given the depth of flooding.

Once the damages have been determined for each relevant flood (100-year, 50-year, 25-year, 10-year, and 2-year), average annual damages are calculated. This can be done graphically as in Figure 1 or arithmetically as in Table 1. URB1 uses the arithmetic method. These methods are used to expand the information on five particular floods to the average damages which could be expected in any year from floods of any magnitude from a 1-year flood to a 100-year flood. For instance, the method assumes that the damages caused by a 75-year flood can be approximated by adding the damages caused by a 50-year flood to one-half of the difference between the damages caused by the 100-year flood and by the 50-year flood.

Lastly, the average annual damages for each structure in a reach are added to determine average annual damages for the reach. The damages computed for "Agnes", the 100 year, 50-year, and 10-year events are displayed in Table 2.

A second method of determining average annual damages is used by the U.S. Army Corps of Engineers. The Patapsco River Basin Study used this method for some reaches examined in the Corps of Engineers' Baltimore Metropolitan Streams study.

In this method the first floor of each structure is referenced to the flood of record, in this case Tropical Storm Agnes. Using stage-damage tables, DAPROG, a computerized damage evaluation method, determines the damage caused by floods greater than or less than the flood of record. For example: one foot lower than Agnes, two feet lower, three feet lower, and so on until there are no damages. The damages to each structure at each flood elevation are added to obtain a stage-damage table for the entire reach. Finally, calculations similar to those shown in Table 1 are made to determine average annual damages.

The Corps of Engineers' approach uses one cross-section. A cross-section chosen is one whose rating curve is representative of the entire reach. If this is not reasonable, the reach is divided into sections which can be represented by one cross-section.

The Patapsco River Basin Study used a combination of the two methods discussed above. Where possible damage information was borrowed from the Corps of Engineers. For those reaches which were not examined during Stage II of the Baltimore Metropolitan Streams study, the Patapsco River Basin Study collected original data.

The following table shows the source of the information used by the Patapsco River Basin Study.

	Patapsco River			Gwynn's Falls	
	Residential	Com/industrial		Residential	Com/industrial
PR-1	PRBS	PRBS	GF-1	COE	COE
PR-2	PRBS	COE	GF-2	COE	NA
PR-3	NA	COE	GF-4	COE	COE
PR-4-8	PRBS	PRBS	GF-5	COE	COE
PR-14	PRBS	COE	GF-6	NA	COE
PR-15	PRBS	COE	GF-7	COE	NA
PR-16	PRBS	COE	GF-8	COE	COE
PR-20	PRBS	PRBS	GF-9	COE	COE
PR-22	PRBS	PRBS	GF-10	PRBS	COE
PR-23	PRBS	NA	GF-11	PRBS	COE
PR-25	PRBS	NA	GF-12	PRBS	COE
PR-26	PRBS	PRBS	GF-13	PRBS	COE
PR-29	PRBS	PRBS	GF-14	NA	COE
PR-30	PRBS	PRBS			

Average annual benefits attributable to a project can be determined in one of three ways. In all three cases, average annual damages are calculated assuming the project has been implemented. Average annual benefits are determined by subtracting average annual damages with the project from average annual damages without the project.

When impoundments are being evaluated, all calculations are repeated using new discharge-frequency relationships to obtain average annual damages with the impoundment (s). When the stream valley is being changed, as when an embankment is being cut back, the calculations are repeated using new stage discharge relationships for the cross-sections affected. When measures such as dikes, channels, acquisition are assumed to give total protection to a group of structures, the average annual damages with the project are those without the project less any damages attributed to the structures being totally protected by the project.

Other types of damages must also be considered. Crops, pasture, roads, bridges, and recreational facilities all receive damages from floods. The Patapsco River Basin Study did not evaluate fully the types of damages listed above. Below is the rationale for not having done so.

Tropical Storms Àgnes and Eloise caused considerable damage to recreation facilities along the Patapsco, mainly in the Patapsco Valley State Park. However, the Department of Natural Resources current policy prohibits development of facilities within the State Park within the floodplain described by Tropical Storm Agnes. This means that a 100-year flood can do no harm to recreation facilities within the State Park.

It is impractical to use individual protection measures to prevent flood damages on the cropland and pastureland in the Patapsco River Basin. Dikes and channels are far too expensive to be used to protect this type of land. Thus damage to these areas would only be examined in conjunction with the evaluation of an impoundment. Likewise, the only practical method of protecting roads and bridges is by constructing and impoundment upstream.

Of the ten possible sites for impoundments on the Patapsco River, only one has a significant impact on flooding. That site is the Gillis Falls site.

There is little cropland or pastureland within the 100-year floodplain along Gillis Falls or along the South Branch. Also, the forestland and recreation land downstream of the impoundment incurs negligible damage from flooding. Roads and bridges along the South Branch are not likely to sustain significant damages. According to the Bureau of Bridge Design of the Maryland Department of Transportation, every bridge which was destroyed during Agnes and Eloise was damaged by under cutting. New design criteria are such that new bridges are not in danger of being undercut by the river during periods of high flow. Every bridge along the South Branch has been built since Tropical Storm Agnes. The only damage which would be incurred by roads and bridges would be damages to the roadway, shoulders, and embankments. Since these damages only occur during the most infrequent storms and since damages of this type generally average about $2000 to $3000, roads and bridges were not examined in any detail.

The last major category of benefits which might be claimed from a protection measure is reduced emergency costs. Even if emergency costs were evaluated by rule of thumb at ten percent of all damages, the additional benefits would not bring any of the alternative measures near the necessary 1.0 benefit cost ratio.

FIGURE 1

Graphic Determination Of
Average Annual Damages

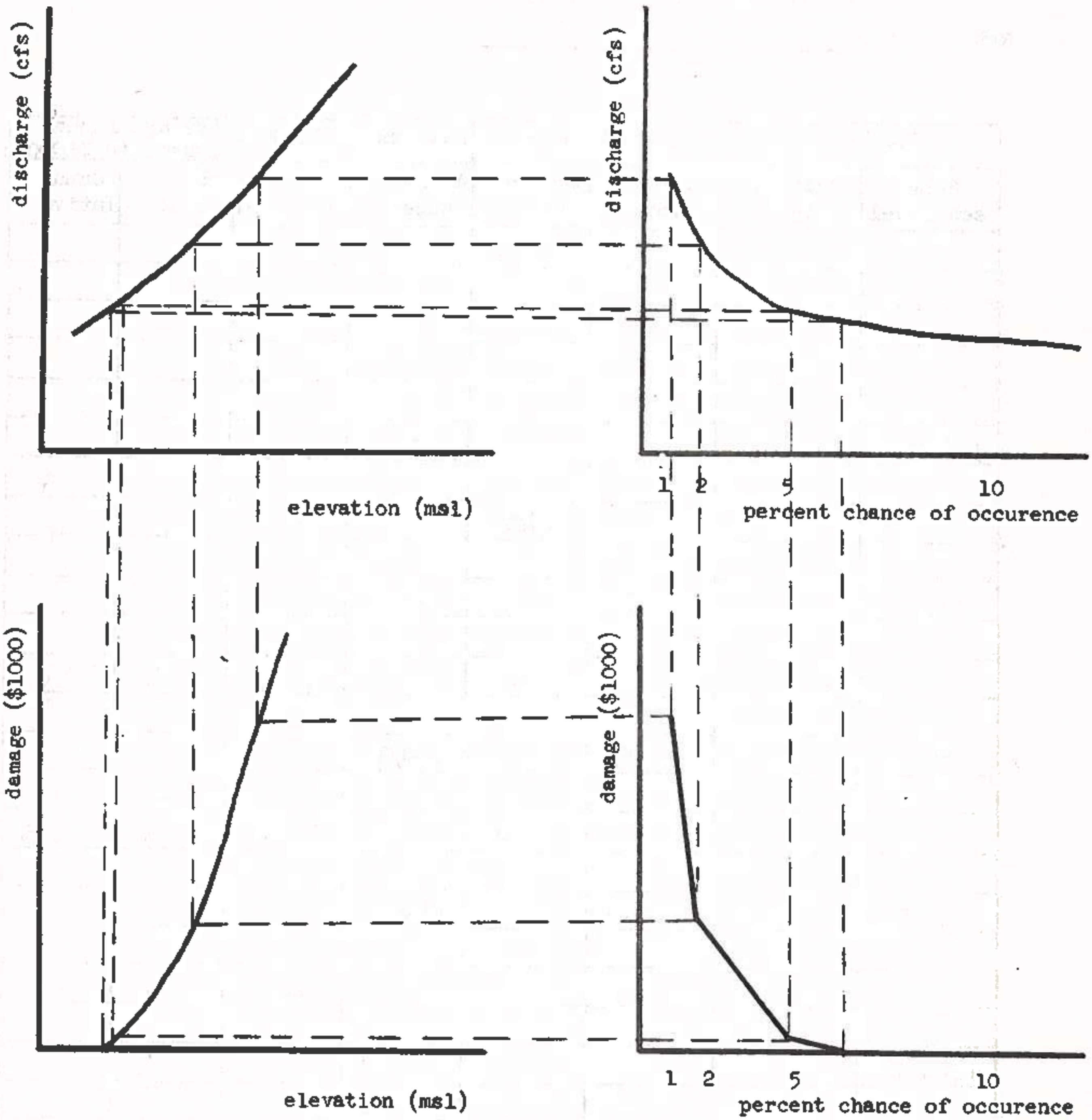


TABLE 1
DETERMINATION OF AVERAGE ANNUAL DAMAGES

Patapsco River Basin

Reach: ______________________ Name: ______________________

Conditions: ______________________ Date: ______________________

Rating Curve: ______________________

Elevation		Annual Chance		Damages in $1000's		Average Annual Damages in $1000's	
mean sea level	Relative to Agnes	At Stage Noted	Increment	At Stage Noted	Avg. for Interval	Increment	Cumulative
116.3		0		0			
			.40		0	0	0
121.3		.10		0			
			.06		144	8.6	8.6
124.4		.04		288			
			.02		734	14.7	23.3
129.0		.02		1180			
			.01		1605	16.1	39.4
132.8		.01		2030			

TABLE 2

ESTIMATED FLOOD DAMAGES

PATAPSCO RIVER

Reach	Agnes Residential $1000	Agnes Residential # of Bldgs.	Agnes Commercial/Ind. $1000	Agnes Commercial/Ind. # of Bldgs.	Agnes Total $1000	Agnes Total # of Bldgs.	100-Year 1/ Residential $1000	100-Year 1/ Residential # of Bldgs.	100-Year 1/ Commercial/Ind. $1000	100-Year 1/ Commercial/Ind. # of Bldgs.	100-Year 1/ Total $1000	100-Year 1/ Total # of Bldgs.
PR-1	130	121	20	2	150	123	0	0	0	0	0	0
PR-2	852	69	1744	20	2596	89	47	21	116	5	163	26
PR-3	0	0	1059	4	1059	4	0	0	57	1	57	1
PR-14	50	4	1522	12	1572	16	16	1	671	4	687	5
PR-15	78	8	3052	4	3130	12	17	7	330	2	247	9
PR-16	218	9	2780	48	2998	57	71	7	1969	45	2040	52
PR-20	119	8	16	1	135	9	83	6	16	1	99	7
PR-22	13	2	69	5	82	7	3	2	43	2	46	4
PR-23	79	5	0	0	79	5	68	4	0	0	68	4
PR-25	10	2	0	0	10	2	26	3	0	0	26	3
PR-26	1	1	262	3	263	4	13	1	301	3	314	4
PR-29	55	12	6	1	61	13	35	10	2	1	37	11
PR-30	54	8	17	1	71	9	29	7	12	1	41	8
TOTAL	$1659	249	$10,547	101	$12,206	350	$ 408	69	$3517	65	$3925	134
GWYNN'S FALLS												
GF-1	776	73	946	43	1722	116	776	73	946	43	1722	116
GF-2	3	4	0	0	3	4	3	4	0	0	3	4
GF-3	48	11	0	0	48	11	48	11	0	0	48	11
GF-4	627	87	4	1	631	88	627	87	4	1	631	88
GF-5	70	8	45	3	115	11	70	8	45	3	115	11
GF-9	205	17	202	3	407	20	205	17	202	3	407	20
GF-10	258	28	255	14	513	42	258	28	255	14	513	42
GF-11	306	41	355	20	661	61	306	41	355	20	661	61
GF-12	1596	72	0	0	1596	72	1596	72	0	0	1596	72
GF-13	18	1	11	1	19	2	18	1	11	1	19	2
GF-14	0	0	738	31	738	31	0	0	738	31	738	31
TOTAL	$3907	342	$2556	116	$6463	458	$3907	342	$2556	116	$6463	458

Reach	50-Year 1/ Residential $1000	50-Year 1/ Commercial/Ind. $1000	50-Year 1/ Total $1000	10-Year 1/ 2/ Residential $1000	10-Year 1/ 2/ Commercial/Ind. $1000	10-Year 1/ 2/ Total $1000
PR-1	0	0	0	0	0	0
PR-2	3	30	33	0	0	0
PR-3	0	8	8	0	0	0
PR-14	8	150	158	0	2	2 2/
PR-15	3	45	48	0	0	0
PR-16	37	1186	1223	0	0	0
PR-20	60	1	61	8 2/	0	8
PR-22	0	17	17	0	0	0
PR-23	42	0	42	6 2/	0	6
PR-25	10	0	10	0	0	0
PR-26	7	290	297	1 2/	182 2/	183
PR-29	18	1	19	5 2/	1 2/	6
PR-30	32	9	41	6 2/	4 2/	10
TOTAL	$ 211	$1737	$1948	$ 20	$ 109	$ 215
GWYNN'S FALLS						
GF-1	Summary of type of damage not available		407	Summary of type of damage not available		0
GF-2			0			0
GF-3			0			0
GF-4			0			0
GF-5			0			0
GF-9			141			22
GF-10			139			8
GF-11			312			30
GF-12			1268			72
GF-13			0			0
GF-14			567			363
TOTAL			$2834			$ 495

1/ Present without project conditions for Patapsco since future conditions do not vary significantly.
Future without project conditions for Gwynn's Falls.

2/ Zero damages for 2-year flood.

APPENDIX C

WATER SUPPLY

Prepared by:

Patapsco River Basin Study Staff

WATER SUPPLY

The water supply needs of the Patapsco River Basin can be most easily examined by dividing the basin into four areas.

1) The area which will be served by the Baltimore City, Baltimore County, and Howard County.

2) The area which will be served by the Freedom filtration plant.

3) The area which will be served by the Westminster filtration plant.

4) The areas in Baltimore County, Carroll County, and Howard County which will depend on groundwater supplied by private wells.

Based on population, the area served by the Baltimore Central System is by far the most important. Table D1 shows the projected requirements of this system. 1/ The needs of each jurisdiction were determined by that jurisdiction and incorporated into the joint agreement for water supply. The volumes listed are based, therefore, on each jurisdiction's projected population and use rate as reflected by the individual General Plans.

The amounts shown in the attached table are the projected requirements for treated water. The volumes of raw water needed will be greater because of the need for wash water in the filtration plants. The demand for raw water in the year 2020 is projected to be approximately 460 million gallons per day (mgd). 2/

Liberty Reservoir has a design safe yield of 95 mgd. The Gunpowder system, consisting of Lock Raven and Pretty Boy Reservoirs, has a design safe yield of 148 mgd. Recent calculations show, however, that the actual current safe yield for the combined Patapsco-Gunpowder system is 235 mgd. rather than 243 mgd. 3/ The Baltimore Central System also has access to raw water from the Susquehanna River in Harford County. The pipeline from Conowingo Dam to the Fullerton filtration plant has a capacity of 250 mgd. Table D2 summarizes the estimated safe yield of raw water available to the Baltimore Central System.

Carroll County has the right to draw as much as 2.4 mgd. from Liberty Reservoir for use at the Freedom filtration plant. Carroll County has petitioned the State Legislature to increase the amount of water it may draw from Liberty Reservoir from 2.4 mgd. to 15 mgd. 4/ The yield of the reservoir would not

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1/ Table D1 is based on the Baltimore Regional Planning Council's General Development Plan (Table 6, page 6-20) and Baltimore City's Report on the Future Central System of the Baltimore Water Supply and Distribution System - 1978 to 2020. (Table 1)

2/ Report on the Future Central System (page 10)

3/ Conversation with Baltimore City DPW personnel

4/ Report on the Future Central System (page 7) change but use rights would be transferred from the Baltimore Central System to Carroll County. Baltimore City is obligated to supply Harford County with 10 mgd. from the Susquehanna pipeline on demand. This obligation is attached to Baltimore's right to use water from the Susquehanna River in Harford County. To date, Harford County has not exercised its right to draw from the City's supply system, although it has been considered. Whether Harford County will or will not draw upon the system depends on whether the County decides to enlarge its own supply systems and become independent of Baltimore. In the meantime, the Baltimore Central System must allow for the possibility of supplying 10 mgd. to Harford County.

Comparing Tables D1 and D2, one can see that the Baltimore Central System does have access to enough water to satisfy the projected needs of its customers through the year 2020.

Although the supply of raw water is adequate, there may be difficulties associated with the treatment and distribution of water. For a more complete discussion, see the two reports previously cited.

The demand for water in the Freedom area has been estimated in the "Comprehensive Mini Plan." Table D3 summarizes the demand projected for the year 2025 when the area will be fully developed. 5/ Total maximum day demands will be 8.2 mgd. The mini-plan also lists the supply resources of the Freedom area. As shown in Table D4, 7.5 mgd. are available to satisfy the projected demand. According to the report, present supplies from Liberty Reservoir, Piney Run Reservoir, and the South Branch of the Patapsco River "are adequate to serve the projected population." 6/

The city of Westminster is currently sutdying their future needs for water supply and water supply protection. Projections for this service area are not available at this time, although officials predict shortages in the near future.

The remaining area includes these portions of Baltimore County, Carroll County, and Howard County which will not be served by public water systems in the foreseeable future. Groundwater is adequate to meet present needs. The future needs of these areas will depend on the development objectives of the individual counties.

In Baltimore County the area outside the 20-year service area is classified for public open space, agriculture, or watershed protection. 7/ In Howard County this area is classified for protection or rural conservation. 8/ In Carroll County the area outside the Westminster and Freedom service areas is classified predominantly for conservation or low-density residential. 9/ There are, however,

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5/ Comprehensive Mini Plan (page 47)

6/ Comprehensive Mini Plan (page 48)

7/ Baltimore County Comprehensive Plan - 1975

8/ General Plan for Howard County - 1971

9/ Carroll County Zoning Maps

general large areas classified as transitional which may need to be served by a public water system.

The water supply is, at present, adequate to meet projections of u ure needs in the Patapsco River Basin. Many factors could influence the supply of or the demand for water. Among the more important tasks for the future are:

(i) Maintaining the integrity and capacity of existing water supply reservoirs.

(ii) Overcome difficulties in treating and distributing water within the Baltimore Central System.

(iii) Review periodically the development objectives for all portions of the River Basin and surrounding areas.

(iv) Encourage more efficient use of water.

These considerations, and others, should be included in any comprehensive water supply study.

TABLE D1

ESTIMATED TREATED WATER DEMANDS ON THE BALTIMORE CENTRAL SYSTEM*

(In Million of Gallons Per Day, mgd)

	1975	1980	1985	1990	1995	2020
Anne Arundel County	3.5	11.2	22.3	26.9	32.2	54.0
Baltimore City	159.7	161.9	164.2	166.5	168.7	180.0
Baltimore County	84.2	95.6	98.9	109.3	119.8	172.2
Howard County	6.0	9.4	12.9	19.3	23.2	43.8
TOTAL	253.4	278.1	298.3	322.0	343.9	450.0

* Based on the Baltimore Regional Planning Council's General Development Plan and conversations with Baltimore City DPW personnel.

TABLE D2

ESTIMATED SAFE YIELD OF RAW WATER SUPPLIES TO THE BALTIMORE CENTRAL SYSTEM

(In Millions of Gallons Per Day, mgd)

Patapsco and Gunpowder system	235.0	
less commitment to Carroll County	-2.4*	232.6
Susquehanna System	250.0	
less commitment to Harford County	10.0	240.6
TOTAL		472.6

* Maximum 90 day flow is 3.0 mgd
Average yearly flow is 2.4 mgd

TABLE D3

ESTIMATED TREATED WATER DEMANDS IN THE FREEDOM AREA

(to the year 2025 at full development)

Class of Use	Population Served	Unit Demand	Average Day Demand mgd.	Max. Day to Avg. Day Factor	Max. Day Demands mgd.
Domestic	36,469 people	110 gpd/capita	4.01	1.5	6.02
Commercial			0.16	1.5	0.24
Light Industrial	526 acres	800 gpd/acre	0.42	1.0	0.42
Public (schools)	14,230 students	12 gpd/student	0.17	1.8	0.31
Sub-total of Mini Plan			4.76		6.99
State Hospital & Laundry			0.75	1.6	1.20
TOTAL DEMANDS			5.51		8.19

TABLE D4

SUPPLY RESOURCES FOR THE FREEDOM AREA

Source	yield (mgd)
Liberty Reservoir	3.0*
Piney Run Reservoir	3.5
South Branch Patapsco River	1.0
TOTAL	7.5

* Maximum 90 day flow is 3.0 mgd.
Average yearly flow is 2.4 mgd.

Source: Comprehensive Mini Plan, Freedom District

TABLE D5

DESIGN SPECIFICATIONS FOR LIBERTY RESERVOIR

Purpose	Volume: Million of gallons	Volume: Acre-feet
Sediment storage	1,800	5,526
Reserved for downstream flow	200	614
Usable storage		
Water Supply (90%)	37,202	114,211
Reserved (10%)	4,134	12,690
Total	43,336	133,041

SAFE YIELD CALCULATIONS FOR LIBERTY RESERVOIR
based on the drought of 1930-32

$$\text{Safe yield} = \text{drought streamflow} + \frac{\text{usable storage}}{\text{length of drought}}$$

$$\text{Safe yield} = 50 \text{ mgd.} + \frac{37200 \text{ mg.}}{823 \text{ days}}$$

$$\text{Safe yield} = 50 \text{ mgd.} + 45 \text{ mgd.}$$

$$\text{Safe yield} = 95 \text{ mgd.}$$

A P P P E N D I X   D

L A N D   U S E / L A N D   C O V E R

Prepared by:

Baltimore Regional Planning Council

SUMMARY

The land use/land cover figures used for the Patapsco River Basin Report were developed by the Baltimore Regional Planning Council. Their final report was not included here in its entirety. Instead, a summary and introduction to their methods is included. For a complete copy of the report, contact the Baltimore Regional Planning Council offices.

An important part of the land use projection process used was a series of LOCAL WORKSHOPS, one held in each of the four counties in the basin. The fundamental objective of these workshops were to assure that local guidance and direction were reflected in both the population forecasts and the resulting land use changes for each subwatershed in the basin.

One unique aspect of this work is the use of LANDSAT land cover data, remotely sensed by the orbitting LANDSAT satellite and classified into types of land cover of interest to water resource planners, in developing runoff curve numbers for use in the hydrologic model. The relationships between land cover and land use which were developed in this study can be used in subsequent water resource studies.

INTRODUCTION

The Patapsco River Basin, over 234,000 acres in size, includes parts of the City of Baltimore and four surrounding counties. Present land use and land cover in the basin have a significant impact on the volume of runoff in the basin. Future changes in land cover will result in changes in runoff volume.

In terms of 1975 land "use," over 79 percent of the land in the basin is still "vacant" and potentially available for development. The remaining 21 percent is composed of public open space (7.3 percent), low density residential (4.2 percent), very low density residential (3.1 percent), industrial, commercial, and institutional (3.9 percent) and other uses (2.5 percent).

In terms of land "cover," 29 percent of the basin is tree-covered. Other natural surface types include grasses and pastureland (25 percent), cropland (22 percent), and brushland (12 percent). Impervious surfaces, including low, medium and high density paving cover 5.7 percent of basin land.

An estimated 248,000 people lived in the basin in 1975. They represented about 11.6 percent of the region's total population. Growth in the basin will result in a forecasted population of 289,000 by the year 2000 and 580,000 by the year 2075.

Residential land development requirements to accommodate basin growth in the four counties (where 99.5 percent of all basin land is located), to the year 2000 include medium density residential (2,400 acres), low density (11,100 acres), very low density residential (15,340 acres). Non-residential uses will require another 3,600 acres.

Except for very low density residential, most of the growth is expected to be located in areas now provided with sewer service, or in growth areas created by planned extensions of sewer service. Very low density residential growth is expected to be scattered in unsewered areas as land becomes available. (Farmland retention programs could serve to redirect some of this growth into sewered areas.) The resulting impact of these changes on runoff volumes, as reflected by changes in runoff curve numbers, will be greatest in the subwatersheds where urban services are being planned.

The net effect of these land use changes, on the land cover distribution in the basin, could add as much as 10,600 acres of additional land to the various impervious land cover types, including bare surfaces, between 1975 and the year 2000. Similarly, there could be a loss of as much as 10,600 acres in the natural land cover types including forestland, cropland, brushland, and grassland.

One of the major accomplishments of the Patapsco River Basin Study is the implementation of a detailed hydrologic model for the basin. This model, the Soil Conservation Service's hydrologic computer model TR-20, implemented by the Patapsco River Basin Study Staff in cooperation with the Maryland Water Resources Administration, simulated various flood events and the effects of alternative controls in order to help evaluate their impact on flooding in the basin. The river basin was divided into 92 subwatersheds to facilitate detailed evaluation of the hydrology.

The purpose of this report is to document the land use and land cover characteristics of the basin representing present conditions (1975) and a series of forecast years. The type of land cover has a significant effect on runoff volume depending on the imperviousness of the cover type.[1] Existing and future land cover distributions for each subwatershed in the basin were required to develop "runoff curve numbers" for each watershed. This number represents the composite effect of land cover and soil type on runoff volume in a watershed.

METHODOLOGY

The land use/land cover methodology involved six important steps:

Step 1. Current Land Use Data. The current land use data were assembled by subwatersheds to serve as a baseline for projected land development in the future, and also to serve as a set of independent variables which were used in estimating the relationships between land cover and land use.

Step 2. Current LANDSAT Land Cover Data. The LANDSAT land cover data in RPC's land use management information system were summarized for each subwatershed. Each land cover has a characteristic effect upon the volume of runoff in a watershed represented by a number in the runoff curve. These land cover distributions were used, along with the distribution of hydrologic soil types, in the calculation of composite current runoff curve numbers of each subwatershed representing present conditions. They were also used as the dependent variable for use in estimating the relationships between land cover and land use.

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[1]Other physical characteristics of the land such as soil type also influence the volume of runoff. Complete documentation of how all these factors influence runoff in the basin is presented in Appendix A, Hydrology and Hydraulics.

Step 3. Relationships Between Land Cover and Land Use. In order to predict land cover changes based on estimates of land use change in the future, a series of estimating equations were derived, using each impervious land cover as the dependent variable, and the land use distributions as the independent variables.

Step 4. Population and Household Forecasts. Current population and household forecasts were assembled based on approved plans, particularly the 208 Water Quality Management Plan.

Step 5. Land Use Forecasts. Forecasts assembled in Step 4 were converted into increments of land use change for a series of forecast years. Then these aggregate amounts of land development "requirements" were allocated among the various subwatersheds.

Step 6. Land Cover Forecasts. The changes in land use by subwatershed, as determined in Step 5, were used to estimate changes in land cover for the forecast years 2000, 2025, and 2075 using the estimating equations derived in Step 3.

APPENDIX E

WATER QUALITY

Prepared by:

Baltimore Regional Planning Council

WATER QUALITY IN THE PATAPSCO RIVER BASIN

Water Quality and the related beneficial uses of the Patapsco River and its tributarties range from excellent to poor. The watershed may be divided into four distinct areas of segments, each with its own existing and potential water uses and water quality problems. The four areas are the Liberty Reservoir drainage, the South Branch drainage, the Lower North Branch and Main Patapsco drainage, and the Gwynn's Falls drainage. The following sections each describe the existing water uses, applicable state water quality standards, water quality conditions, suspected causes of the problems, and present efforts to address the problems.

Liberty Reservoir Drainage

The Liberty Reservoir Drainage incorporates all of the watersheds and streams draining into and including Liberty Reservoir.

Present uses of the area include contact recreation, such as swimming and wading (except in the Reservoir), fishing, and water supply. Recreational fishing is enjoyed in many area streams with Morgan Run being designated by the State as natural trout waters. That is, the stream is of a quality and nature sufficient to maintain a viable trout population. The remaining streams are classified as capable of supporting adult trout for put-and-take fishing.

The Town of Westminster uses Cranberry Branch and Hull Run in the watershed's headwaters for a domestic water supply. Westminster has experienced taste and odor problems in its water supply during wet weather. These water supply problems are suspected to come from a number of possible upstream sources related to stormwater runoff but the cause has not yet been determined.

Liberty Reservoir, owned by Baltimore City, is part of a large metropolitan water supply system which serves most of the Region's jurisdictions. Water quality in the Liberty Reservoir drainage is generally good. Fecal coliform bacteria (an indictor of the presense of disease-causing pathogenic bacteria) is the only parameter which does not meet State Water Quality Standards. While an improvement in bacteria levels in Middle Run has occurred over the last few years, other area streams have maintained fairly constant levels except Gamer Run which had elevated numbers in 1978. The Liberty Reservoir is considered to be in an early mesotrophic state. This essentially means an excess of normally essential nutrients, such as phosphorus, causes excessive algae blooms which, in turn, provide taste and odor problems and increase the cost of water treatment.

Causes of water quality problems in this segment are generally attributed to non-point or diffuse sources of pollution such as agricultural cropland, animal pasturing or feedlot operations, failing septic systems, and soil erosion and sedimentation. The U. S. Environmental Protection Agency in a 1975 study of Liberty Reservoir estimated that 96% of the phosphorus sources were non-point. Aproximately 36% of the segment's present population is served by individual septic systems with about 35 systems reported as failing within the last year.

A sewage facility plan is now in process for the Finksburg-Woolerys area. This, along with expansion of existing facilities into areas of failing septic systems by the Sykesville-Eldersburg wastewater treatment plant, should decrease bacteria levels in area streams. Implementation of Best Management Practices by the agricultural sector and by developers should decrease pollution loads from these non-point sources. Hull Creek, Cranberry Branch and their watersheds will be under extensive study this year by the Maryland Water Resources Administration, The RPC Water Quality Management staffs, and the Town of Westminster. The effects of landuse, current and planned, on the stream system will be evaluated.

South Branch Drainage

The South Branch Patapsco segment is located south of Route 26 in Carroll County and includes a strip along the northern border of Howard County.

Water uses in the segment include swimming, boating, fishing, and water supply. Area waters are used by area residents for wading and unorganized swimming. The South Branch Patapsco can be used for canoeing during early spring while parts of Gillis Falls are appropriate for small rafts or inner-tubes during early spring. Recreational fishing occurs throughout the segment with streams classed as capable of supporting adult trout for put-and-take fishing.

Water quality conditions in the South Branch are complex and varied. A wastewater treatment facility at Mt. Airy contributes heavily to biochemical oxygen demand and excessive suspended solids loadings in the main stem of the Patapsco.

A residual chlorine problem exists at the Freedom District Wastewater treatment plant. Fecal coliform bacteria levels in the South Branch at a station near Henryton Road have improved dramatically since 1974 with a 50% decrease in number of violations and 36% improvement in violations above 750 mpn (most probable number of fecal coliforms).

Failing septic systems are a potential problem in the segment with 17 failures reported last year. Agricultural and construction activities are believed to contribute to degraded conditions in the streams. Sediment deposition and high fecal coliform counts are especially significant due to the existence of highly erodible soils and several large livestock operations in the basin.

Piney Run Reservoir provides water supply storage and recreational boating and fishing. This reservoir, completed only within the last few years, has been asssessed with good water quality.

Improvements in water quality are expected to occur as facilities plans for wastewater treatment plants at Mt. Airy and the Freedom District are implemented and non-point source control programs for agriculture and urbanizing activities are administered. Two landfills proposed for operation in the watershed are expected to have minimal water quality impacts through proper management of the facilities.

Lower North Branch and Main Patapsco

The Lower North Branch or Main Patapsco includes the North Branch below Liberty Reservoir and the main stem of the Patapsco River downstream to the confluence with Baltimore Harbor.

Activities utilizing the segment's waters are recreational swimming, fishing, canoeing, and the activities associated with the several large public parks along the Patapsco main stem. With the exception of Granite and Mordella Branches, which are designated natural trout waters, the major portion of the segment is designated for contact recreation and support of aquatic life.

Although limited water quality data is available for this segment, violations of state standards have occurred. Sampling programs conducted on the main stem in 1976 and 1977 noted frequent violations of the fecal coliform standards and occasional violations of pH and turbidity standards.

Sampling stations in the downstream end of the segment exhibited continuous bacterial violtions and high turbidity associated with sediment loads apparent during and following storm events.

Historically, potential water quality problem sources have included sanitary sewer overflows, isolated unsewered areas, exfiltration from sanitary sewers, industrial discharges, agricultural runoff, urban stormwater runoff, streambank erosion, and construction activity. The relative significance of each of these sources is presently unknown.

However certain sanitary sewer and septic tank overflows and industrial discharges have been eliminated as a result of the extension of the Patapsco Waste Water System into the upper reaches of the segment.

Present wastewater treatment system planning in the Patapsco Basin is addressing exfiltration, overflows of the sanitary sewers, and adequate wastewater treatment for presently unsewered sections within the planning area. Non-point source control programs for agriculture and urbanizing activities are now being implemented to address problems from animal waste, sediment, and other pollutants.

Gwynn's Falls

The Gwynn's Falls watershed segment extends upstream from the Middle Branch of Baltimore Harbor northwesterly to its headwaters near Reisterstown in western Baltimore County.

The watershed has a complex land use distribution with segment waters designated for several uses. Upper stream reaches in Baltimore County are characterized by rocky stream beds and rapidly flowing cold waters. The major portion of land proximal to the main stem is used for public parks. Under the State classification system, the upper portion of Red Run is designated for natural trout waters while the remaining streams are designated for contact recreation and aquatic life.

Segment water quality results from a 1976-1977 sampling program indicates frequent violations of fecal coliforms during dry weather at all sampling stations in the segment. The dissolved oxygen standard of 5 milligrams per liter of water was frequently violated at the most downstream station.

The most significant potential sources of pollution in the segment include isolated combined sewer discharges within Baltimore City, wet weather sanitary sewer overflows, exfiltration from sanitary sewers, and urban non-point source stormwater runoff. Although the entire watershed is serviced by the Baltimore Waste Water System, sanitary sewers parallel and criss-cross the stream valley, thereby creating a continuous potential for water pollution by inadequate maintenance. The relative impact of urban stormwater runoff on the water quality of the segment is not known. Although it is believed to significantly contribute to water quality degradation.

Improvements to water quality in the segment are expected from a number of projects addressing both point and non-point sources of pollution. In January 1979, a major sanitary overflow at Baltimore street and Ellicott Drive which had previously discharged millions of gallons of sanitary sewage into Gwynn's Falls was eliminated by diversion of the overflow into the Southwest Diversion Sewer. Post-diversion sampling revealed a large reduction in fecal coliform levels downstream although the bacteria standard is still not met. The Patapsco system wastewater facilities planning process is investigating exfiltration, rehabilitation needs for the sanitary sewers, and elimination of the sanitary sewer overflows.

Urban stormwater quality/quantity relationships and potential pollutant source control measures will be studied during an upcoming National Urban Runoff Demonstration Grant project proposed for the Gwynn's and Jones' Falls watersheds.

A P P E N D I X   F

F O R E S T R Y   R E S O U R C E S

Prepared by:

USDA Forest Service

PATAPSCO RIVER BASIN

Forest Resource Inventory

There are approximately 66,900 acres of forest land in the Patapsco River Basin and 12,600 acres of forest land in the Gwynn Falls River Basin. Within both Basins forestland accounts for 28 percent of the total land area. About 43,800 acres in the Patapsco Basin and 7,400 acres in the Gwynn Falls Basin are considered to be commercial forest land (Table 1). These commercial forest lands are capable of producing an average annual growth of 20 cubic feet, or more, of wood fiber per acre.

Within the combined basins over 28,000 acres of forestland are classed as non-commercial (Table 1). These lands are either incapable of producing 20 cubic feet of wood fiber annually or, if productive, are reserved for a specific use such as recreation. Although non-commercial forestlands do not contribute to the production of wood fiber they do have an impact on wildlife, recreation, and watershed protection.

From 1965 to 1972 approximately 2000 acres per year were converted from forestland to urban use. This trend has continued to date and future projections indicate the conversion of forestland to other uses will accelerate. A considerable reduction in forestland acreages is expected over the next 20 years.

Existing forest types determine, to some degree, management strategies, silvicultural treatments, and product availability. Oak-hickory is the most prevalent forest type found in either basin (Table 2). Pine is the next most abundant forest type occurring within the area. These two forest types alone account for over three-fourths of all commercial forestland in the combined drainages. Elm-ash-maple and maple-beech are the next most predominate forest types accounting for approximately 5 thousand acres (10 percent) and 4 thousand acres (8 percent), respectively. Oak-pine and oak-gum are the other major types found in the basins.

Stand size is another characteristic useful in determining forestland conditions and availability of products. Four stand categories are recognized and defined as:

1. <u>Sawtimber stands</u>. Stands that are at least 10 percent stocked with growing-stock trees and have half or more of this stocking in sawtimber and poletimber trees, and with sawtimber stocking at least equal to poletimber stocking.

2. Poletimber stands. Stands that are at least 10 percent stocked with growing-stock trees and have half or more of the stocking in sawtimber and poletimber trees, and with poletimber stocking exceeding that of sawtimber stocking.

3. Sapling-and-Seedling stands. Stands that are at least 10 percent stocked with growing-stock trees in which saplings and/or seedlings make up a plurality of this stocking.

4. Nonstocked areas. Commercial forestlands that are less than 10 percent stocked with growing-stock trees.

Sawtimber stands occupy over 60 percent of the commercial forest land in both the Patapsco and Gwynn Falls River Basins. Twenty-three percent of the commercial forestland within the basins is classed as poletimber stands. Seedling/sapling stands are found on 14 percent with only one percent of the commercial forestland considered non-stocked.

Table 1. Commercial and Non-Commercial Forestland by Basins and Counties

BASIN	COUNTY	FORESTLAND		
		Commercial	Non-Commercial	Total
		ACRES		
Patapsco	Anne Arundel	3,400	100	3,500
	Baltimore	15,140	6,600	21,740
	Carroll	16,200	11,800	28,000
	Howard	9,050	4,557	13,607
	PATAPSCO TOTAL	43,790	23,057	66,847
Gwynn Falls	Baltimore	7,382	5,184	12,566
	GRAND TOTAL	51,172	28,241	79,413

Source: USDA Forest Service, Timber Resources of Maryland.

Table 2. Commercial Forestland within the Patapsco and Gwynn Falls River Basins by Forest Types and Counties

BASIN	COUNTY	FOREST TYPES						TOTAL
		Pine	Oak-Pine	Oak-Hickory	Oak-Gum	Elm-Ash-Maple	Maple-Beech	
		ACRES						
Patapsco	Anne Arundel	476	136	2,108	68	340	272	3,400
	Baltimore	2,120	605	9,387	303	1,514	1,211	15,140
	Carroll	2,268	648	10,044	324	1,620	1,296	16,200
	Howard	1,267	362	5,611	181	905	724	9,050
	PATAPSCO TOTAL	6,131	1,751	27,150	876	4,379	3,503	43,790
Gwynn Falls	Baltimore	1,033	295	4,577	148	738	591	7,382
	GRAND TOTAL	7,164	2,046	31,727	1,024	5,117	4,094	51,172

Source: USDA Forest Service, Timber Resources of Maryland.

Table 3. Commercial Forestland within the Patapsco and Gwynn Falls River Basins by Stand Sizes and Counties

BASIN	COUNTY	STAND SIZE				TOTAL
		Sawtimber	Poletimber	Seedling/ Sapling	Non-Stocked	
		ACRES				
Patapsco	Anne Arundel	2,006	816	544	34	3,400
	Baltimore	9,538	3,331	2,120	151	15,140
	Carroll	9,720	3,888	2,430	162	16,200
	Howard	5,882	1,991	1,086	91	9,050
	PATAPSCO TOTAL	27,146	10,026	6,180	438	43,790
Gwynn Falls	Baltimore	4,651	1,624	1,033	74	7,382
	GRAND TOTAL	31,797	11,650	7,213	512	51,172

Source: USDA Forest Service, Timber Resources of Maryland.

Stocking is the degree of occupancy of land by trees compared to that occupancy required to fully utilize the growth potential of the land. Table 4 shows the percent stocking classes of desirable trees. Desirable trees being all growing-stock trees that do now or will have positive stumpage value (primarily for lumber production) and are not likely to be cut or deliberately killed within the next 10 years. Stands that are 70 percent or more stocked with desirable trees are generally considered fully stocked and in need of minimal silvicultural treatments. Stands between 40 and 70 percent stocked will become fully stocked within 10 years. However some silvicultural treatments may be necessary to maintain or increase growth of desirable trees. Those stands with less than 40 percent stocking will need intensive treatment if they are to achieve maximum wood-fiber production.

Net annual growth is the actual wood-fiber added to the inventory each year. Net annual growth occurs in all forest stands regardless of size. In a fully regulated forest, growth and cut should be roughly equal even though net growth may be attributed, in part, to unmerchantable trees. The 51 thousand acres of commercial forest land in both basins should produce about 4078 thousand cubic feet of net annual growth. Presently this forestland is only producing 2320 thousand cubic feet (Table 5). In the basins then is a potential for increasing wood production 75 percent.

Annual cut is that volume of wood fiber removed for utilization by primary and secondary processors. The annual cut for all species approximates 1360 thousand cubic-feet (Table 5). As shown in the Table growth is almost twice the cut causing inventories to increase. However the annual cut of softwood species is greater than twice the annual growth. If this imbalance continues much longer it could seriously reduce the softwood inventory.

Table 4. Commercial Forestland within the Patapsco and Gwynn Falls River Basins by Stocking-Percent Classes of Desirable Trees and Counties

BASIN	COUNTY	DESIRABLE TREE STOCKING CLASS			TOTAL
		70 to 100 Percent	40 to 70 Percent	Under 40 Percent	
		ACRES			
Patapsco	Anne Arundel	34	306	3,060	3,400
	Baltimore	151	1,666	13,323	15,140
	Carroll	162	1,944	14,094	16,200
	Howard	90	996	7,964	9,050
	PATAPSCO TOTAL	437	4,912	38,441	43,790
Gwynn Falls	Baltimore	74	812	6,496	7,382
	GRAND TOTAL	511	5,724	44,937	51,172

Source: USDA Forest Service, Timber Resources of Maryland.

Table 5. Inventory, Net Annual Growth, and Annual Cut on Commercial Forest Lands of Patapsco and Gwynn Falls by Species Group and Counties

		Softwood Species			Hardwood Species			All Species		
		Inventory	Annual Growth	Annual Cut	Inventory	Annual Growth	Annual Cut	Inventory	Annual Growth	Annual Cut
		THOUSAND CUBIC FEET								
Patapsco	Anne Arundel	858.1	3.5	8.1	4453.4	150.7	82.3	5311.5	154.2	90.4
	Baltiomre	2294.3	15.5	35.9	20142.2	670.9	366.3	22436.5	686.4	402.2
	Carroll	1135.0	16.5	38.4	22494.3	717.9	392.0	23629.3	734.4	430.4
	Howard	1083.7	9.2	21.5	12130.0	401.1	219.0	13213.7	410.3	240.5
	TOTAL	5371.1	44.7	103.9	59219.9	1940.6	1059.6	64591.0	1985.3	1163.5
Gwynn Falls	Baltimore	1118.7	7.5	17.5	9821.0	327.1	178.6	10939.7	334.6	196.1
	GRAND TOTAL	6489.8	52.2	121.4	69040.9	2267.7	1238.2	75530.7	2319.9	1359.6

PATAPSCO RIVER BASIN

Conceptual Forest Land Plan

The Patapsco and Gwynn Falls River Basins have a combined area of 369 square miles of which 79,400 acres, or 28 percent of the total land area is classed as forest land. Almost 25,000 acres of this forest land is publicly owned and managed primarily for recreational purposes. Forest land is being converted to other land uses at the rate of 2,000 acres per year. This accelerated loss makes it imperative that the remaining forest lands be properly utilized and managed. The forest land treatment measures recommended in this plan are primarily for the enhancement of the watershed protection capabilities. However, these measures will also provide additional benefits through increased forest products, better wildlife habitat, more recreational opportunities, improvement in water quality and aesthetics, and a reduction in flood peaks.

Forest land treatment measures were developed cooperatively by the Maryland Forest Service and U.S.D.A. Forest Service with land use recommendations and information provided by the Soil Conservation Service. The planned program includes only those measures and goals that can reasonably be accomplished by landowners and land managers during a ten-year period. The technical assistance necessary for installing these forest land treatments will also come through the Maryland Forest Service backed by the U.S.D.A. Forest Service.

Based on estimated total needs for the entire watershed, a yearly program, prorated so that the needs would be accomplished by the year 2020, is shown in Table 6. This can be compared in column three with the yearly average accomplishments for the past few years. The final column shows the percent of needs that can be completed at the going rate of accomplishment to the year 2020.

Table 6
Watershed Works of Improvement

Land Treatment	Unit	Yearly Accomplishment (last 10 years)	Needed Yearly Accomplishment to 2020	Percent of Needs done by 2020 at Present rate
Mgt. Plans	No.	14	31	45
	Acre	322	800	40
Tree Planting	Acre	229	51	450
Harvest Cuts	Acre	103	145	71
T.S.I.	Acre	55	590	9
Grazing Control	Mile	0.2	1.35	15
	Acre	15	20	75
Erosion Control	Mile	1	0.3	333
on logging areas	Acre	48	25	192
Urban Forestry	MD	10	130	8
Wildlife Habitat	Acre	23	155	15 1/

1/ Under proper management for timber growth and environmental well-being, wildlife habitat will improve naturally more than estimated here.

What this table reveals is that tree planting is keeping ahead of the needs; and that forest land erosion presents no problems, since erosion control on logged areas is also keeping up with the needs.

Erosion rates for managed logging areas in the Patapsco Basin are the same as for undisturbed forest land - 0.3 tons per acre per year. Unmanaged logging areas erode at the rate of 2.5 tons/acre/year. Logging roads, the chief source of sediment in logged areas, erode at the rate of 9.4 tons/acre/year. Assuming that about 1,000 acres of forest are logged per year in the Basin, with half of the cuts unmanaged, and approximately 50 acres of logging roads, the total erosion would amount to about 2,000 tons per year, of which 200 tons would become stream carried sediment. Under good management for all logged areas, the erosion would eventually be cut to about 425 tons per year - a reduction of 75 percent.

Logging occurs in the forested areas surrounding the two city reservoirs on the watershed--Liberty Reservoir and Piney Run Lake. Only six percent of the Liberty Reservoir drainage area is owned by the City of Baltimore, although Baltimore City does own all surface water rights on the Patapsco River. Proper management of all municipal, state, and private forest lands on the reservoirs' drainages, and of all other privately owned forest lands in the Patapsco-Gwynn Falls Basin, would seem essential to minimize erosion and sedimentation and thereby maintain or improve water quality, aesthetics, recreation, and wildlife habitat.

Livestock grazing of forest land in the Patapsco-Gwynn Falls River Basin ranges from none in Baltimore and Carroll Counties to very little with no problems in Howard and Anne Arundel Counties. This means that the extent of erosion and sedimentation on grazed forest land is so low as to be practically non-existent. Nevertheless, there are some small areas of forest land which should be fenced or otherwise protected from the effects of grazing.

Recreational areas in the Patapsco Basin area include 5,500 acre Patapsco State Park, which lies along both sides of the Patapsco River for 29 miles, but is only from one quarter mile to one mile wide, and 2,200 acre Soldiers Delight, a unique area of post oak and blackjack oak, which lies just east of Liberty Reservoir and south of Reisterstown.

Large urban population pressure from Baltimore and its suburbs, and even from Washington, DC, only 35 miles away, make it essential to plan for taking care of the recreational needs of hundreds of thousands of people.

When recreational areas are over-used, the problems of tree damage, trampling, and erosion are considerably magnified. Therefore it becomes essential to include in the Basin watershed work plan basic programs for proper forest management in the State Parks so that visitor damages will be minimized and repaired.

Another area of concern in the Basin is the erosion and sedimentation caused by housing developments.

According to recent data, about 2,000 acres per year were converted from forest land to urban uses during the years 1965-1972. At this rate all commercial forest land would be urbanized in 25 years. Housing developments, malls, and industry all are involved in reducing the forest land acreage.

Figures from nearby urbanized watersheds show that construction starts increase the erosion rate initially from 0.23 to 0.44 tons/acre/year; and that with construction well underway the average rate climbs to 1.1 tons/acre/year, while the advanced construction stage erodes at 3.6 tons/acre/year. Another study stated that sediment yields from construction sites increases from 1.1 to 2.8 tons/acre/year per 1000 increase in population in an area.

To illustrate: If 2,000 acres of forest land are developed per year, the erosion would increase from 600 tons to 2660 tons from the construction sites. With proper precautions and overseeing, the erosion rate could be kept lower, to a more reasonable 1000 tons from the 2000 acres.

One publication1/ has suggested various treatments to cope with the increased runoff from the impervious surfaces of developed areas. These methods are as follow:

> Dry wells; infiltration trenches; underground storage trenches; oversized pipe storage; undergound tank storage; roof-top storage; shallow holding areas (swales); parking lot storage; dry ponds; wet ponds with storage above normal pool; and special fill impoundments (road embankment fills and ditches).

Any or all of these methods could be used in a developing area to cut down both the amount and velocity of runoff which are the causes of erosion and sedimentation at construction sites.

Another study has found that because of the increased area of impervious surfaces in developing areas, coupled with a corresponding decrease of infiltrative area (forest), a three inch rainfall will have the same flooding effect as a five inch rain had before urban construction occurred.

Special management plans designed to alleviate or prevent increased runoff and erosion from urbanized areas should be prepared prior to construction.

Forest fires are reported to be no problem in the Basin. Local and county volunteer and paid fire companies cover the area very well. Data for the past five years for the four counties involved show an average of 68 fires per year which burn 110 acres, or 1.6 acres per fire. These are generally light burn fires, so that revegation occurs the next growing season, or even during the same growing season, thus preventing erosion and sedimentation from taking place on the burned areas.

1/ "Lets stop engineering future floods: - March '78 issue of the Landscape Architect Magazine

PATAPSCO RIVER BASIN

Forest Land Treatment Needs

Poor quality growing stock and species composition exists in much of the drainage area. In the past decades the practice of cutting the best trees and leaving the poorest has produced low-quality stands that have a high proportion of growing space occupied by undesirable and defective trees. There are several factors that contribute to this problem among which are:

1. Lack of proper woodland management techniques on the part of landowners.

2. Low quality saw logs which are difficult to market at a profit and which sawmill operators are not interested in handling.

3. Woodland management is discouraging because high initial costs are usually required with a long time before returns are received.

4. Large areas are held in reserve by speculators and will ultimately be developed for urban uses.

5. A large percentage of the forest land ownership is in small parcels making it difficult to efficiently manage.

It is estimated that only about 1 percent of the Basin's forest land is adequately stocked with desirable trees. The vast majority is inadequately stocked or stocked with trees that are now cull or which will be low quality in the future. The low quality of the forest land is indicative of the need for an intensive forest management program. The program should educate the landowners as to the benefits to be derived from properly managed forests and provide the technical guidance for implementing the necessary silvicultural practices. It is estimated that 25,000 acres of privately owned commercial forest land lacks the necessary guidance for proper management (Table 7).

Forests provide both food and habitat for many species of wildlife. The large majority of these species are dependent on the forest; and without it much of the deer, squirrel, raccoon and other game and non-game species would not exist. Properly managed forest lands can produce maximum yields of forest products and still provide sufficient food and cover to sustain a healthy wildlife population.

Undisturbed forest land provides an efficient, natural filtering system. Any precipitation or surface water runoff reaching the forest infiltrates into the litter and humus. Streams with forested watersheds usually have lower flood crests and higher water quality than do those streams with unforested watersheds. This forest land characteristic is a benefit in many ways to all citizens of the basin and those visitors who use its waterways.

The most common pollution problem originating on forested lands is accelerated erosion and subsequent delivery of sediment to lakes and streams. The sediment can affect stream ecology by smothering bottom organisms when deposited and by interfering with the photosynthetic process through a reduction in the amount of light that penetrates the water. Stream flow and velocity are also frequently altered by deposits of sediment.

Potential forest land erosion problems are generally related to activities associated with silvicultural operations or misuse. Table 8 lists some of the activities associated with forest land and gives a relative indication of the erosion hazard. Water quality sampling has not been done to specify or quantify any of the possible sources listed in the Table. The potential does exist, however, that mis-management of forested areas can accelerate erosion rates far in excess of normal geologic rates.

There are about 6,500 acres of forest land in need of harvesting assistance (Table 7). Timber harvesting is a silvicultural practice that not only provides a financial return to the landowners but is instrumental in improving the quality of the residual stand. Selective harvesting would remove low quality trees and improve growth of the more desirable trees. Total removal operations would promote regeneration of more desirable species. In addition to selecting trees to be harvested, professional assistance would determine measures necessary to protect wildlife habitat, aesthetics, and water quality.

Timber stand improvement is needed on 34,400 acres of commercial forest land to improve the quality of growing stock and species composition (Table 7). For the most part this activity could be done in conjunction with the proper harvesting of present timber stands. Done properly species composition and stand density would be improved, insuring a high value timber supply for the future, with minimal disturbance to the environment.

Poorly stocked stands should be planted to desirable tree species to increase both wood production and site protection. In the basin area 6,040 acres are producing below their potential because they are understocked or are open lands that should be forested (Table 7). Currently softwood demands exceed growth and inventories need to be increased through conversion of some of the low quality stands.

Excessive livestock grazing is a principal cause of erosion on forest lands. About 1,440 acres of forest land need to have grazing by domestic livestock reduced or eliminated (Table 7). Such grazing damages trees and their roots thru trampling and destroys seedlings and other ground cover. As a result the growth and quality of timber is reduced and future crops are destroyed. Heavy grazing bares and compacts the soil increasing surface runoff and erosion. Elimination of excessive livestock grazing on forested lands will reduce erosion and sediment and improve water quality and wood fiber production. Wildlife habitat is also improved where heavy grazing is eliminated.

Accelerated soil erosion is occurring on skid trails and access roads. Control measures will be needed on approximately 20 miles of skid roads and access roads each year (Table 7).

Through cooperative State and Federal programs, the forest lands are adequately protected from destructive wild fires. The current annual fire losses are tolerable and unless conditions change, should remain so. The 79,400 acres shown in Table 7 is the total forest land acreage that is protected annually.

Quality of the environment in urban and urbanizing areas is degraded with the removal of the forest. With increasing urbanization in many portions of the basin proper consideration in urban planning must be given for the maintenance of areas in trees and establishment of additional trees. Tree species selected should be adapted to the urban environment; to add shade and beauty to our cities and suburbs; to serve as relief from the monotony of brick and concrete; to act as noise and wind abatement; to screen out wind-borne particle matter; and to provide areas for forest recreational opportunities.

Forests in our urban areas play an important role in reducing rates of water runoff and controlling soil erosion. The trees also provide a valuable source of food and cover for wildlife in urban areas.

Forest land provides social and mental pleasures. The beauty of the forest or a single tree with the varying form, shape, texture and color has a large bearing on everyday attitudes and moods of man.

When man destroys or removes this part of his way of life, he generally strives to replace it through a planting program. Usually it is cheaper to retain existing forests and trees rather than remove and replant and have to wait many years for the benefits provided by the original forest.

Much of the basins recreation is forest orientated and future recreation will, in part, depend on the forest base. Camping, hiking, nature interpretation, hunting and fishing are a few of the forest recreational uses. Whether local, county, state, national or privately maintained facilities, the forest base is of a nature and so located as to provide for increasing recreational needs of our population. With proper planning, funding and development, the public and private forest lands could contribute greatly to meeting these needs.

The tempering effects that trees and plants have on water quality, climate, noise and air pollution, and also the benefits of the use of associated green space for recreation and natural beauty, are values that are a necessity in urban life. The urban forestry assistance shown in Table 7 will enhance these benefits and provide for these necessities in both city and suburban neighborhoods.

Table 7. Commercial Forest Land Treatment Needs by Basin and County Forest Land Treatment Needs

COUNTY	Forest Management Plans		Supervised Harvest	Timber Stand Improvement	Tree Planting	Grazing Control	Fire Control	Log Road Erosion Control	Urban Forestry
	NO.	ACRES						MILES/YR.	MAN DAYS/YR.
PATAPSCO WATERSHED									
Anne Arundal	150	3,000	300	2,400	500	70	3,500	1	50
Baltimore	300	6,000	600	11,300	2,000	500	21,740	3	90
Carroll	500	12,000	5,000	12,000	2,200	800	28,000	12	80
Howard	100	3,000	500	6,200	380	40	13,600	3	60
TOTAL	1,050	24,000	6,400	31,900	5,080	1,410	66,840	19	280
GWYNN FALLS WATERSHED									
Baltimore	50	1,000	100	2,500	960	30	12,560	1	80
GRAND TOTAL	1,100	25,000	6,500	34,400	6,040	1,440	79,400	20	360

Table 8. Effects of Selected Forestry Activities on Erosion Hazard and Persistence

ACTIVITY	EROSION HAZARD	EFFECTS ON EROSION	PERSISTENCE
Preserve forest.	Least possible.	Continues at geologic rates.	Long term.
Tree Cutting.	Increased soil moisture and streamflow, lengthened channels.	Minor increase in particulate matter scoured from channel and in solution from forest floor.	1 to 10 years, depending on severity of cutting.
Skidding logs across the forest floor.	Disrupts litter and compacts soil.	Minor unless logs skidded many times along the same route.	1 to 3 years.
Skidding logs in channels or on banks of streams.	Exposes soil to maximum cutting and carrying power of flowing water.	Can increase enormously. Increased sediment in streams.	From a few to many years.
Logging on prepared roads.	Varies with care in locating, building, and using the roads.	Minor increases given well-managed roads, major increases given poor management.	1 to 5 years.
Burning.	Destroys vegetation and litter.	Negligible unless burned frequently.	1 to 3 years.
Recreation.	Disrupts litter, compacts soil.	Usually severe.	1 to 3 years.
Conversion to land uses other than forest. (Grazing, Urban Development, etc.)	Destroys litter and vegetation. May compact, overturn, or remove soil.	Usually severe.	From 1 to many years.

PATAPSCO RIVER BASIN

Prime Forestland

The objectives of the U.S.D.A. prime forestlands program are to (1) prevent our most productive forestlands from being irrevocably used for other purposes, and (2) to be advocates for the protection of prime forestlands. The Department's prime lands program identifies prime lands so they may be considered when planning for other uses.

The prime forestlands program is directed only toward state and private forestlands. It will not apply to National Forest System lands because the National Forest land management planning system adequately identifies prime timberlands; and protection against irrevocable uses is fully provided by laws and regulations. This same rationale generally applies to other Federal forestlands.

Prime forestland is land that has soil capable of growing wood fiber at the rate of 85 cubic feet per acre per year, and is not in urban or built-up land uses or water. The program is aimed at land currently in forest, but should not exclude qualifying lands that could realistically be returned to forest.

This definition of prime forestland considers only timber production. Identification of lands as prime forestland does not denote a single or dominant use. This designation does not preclude the use of these lands for other forest products and services, but only identifies the most productive forestlands on which the country depends for present and future wood needs. Neither does this constitute a designation of any land area to a specific land use. Such designations are the prerogative of responsible officials.

Because site specific information is lacking, detailed estimates of prime forestland are unavailable for the basin. Identification of prime forestlands is expected to be a lengthy effort taking from 6 to 10 years for a National effort. However, a first approximation of prime forestlands can be made utilizing soil associations and woodland suitability guides.

By assuming uniform distribution of commercial forestland and applying the percent of each soil, capable of meeting timber growth requirements, in each soil association the following approximation of prime forestland by counties was derived.

COUNTY	ACRES OF PRIME FOREST LAND
Anne Arundel	0
Baltimore	1660
Carroll	905
Howard	779

This estimation is limiting because it is based on general classifications of soils. Even on soils with a recognized potential annual growth of less than 85 cubic feet there could be specific sites where growth meets or exceeds this minimum. Only through an intensive survey could these areas be identified and fully utilized.

Unique Forestland

Unique forestlands are lands which do not qualify as prime forestland, on the basis of producing less than 85 cubic feet per acre per year, but are growing sustained yields of specific high value species or species capable of producing specialized wood products under a silvicultural system that maintains soil productivity and protects water quality. Although not as productive as the prime forestlands the sustained yields from unique lands are important to the basin. These unique forestlands will also require an intensive survey to identify.

Timberland of Statewide Importance

This forestland, in addition to prime and unique forestlands, is of Statewide importance for the growing of wood fiber. Criteria for defining and delineating these lands are to be determined by the State Forestry Planning Committee or appropriate State organizations.

Timberland of Local Importance

In some local areas there is concern for certain additional forestlands for the growing of wood even though these lands are not identified as having National or Statewide importance. Where appropriate, these lands are to be identified by a local agency or agencies concerned.

A P P E N D I X   G

R E C R E A T I O N

Prepared by:

USDA Soil Conservation Service

INTRODUCTION

This recreation report was prepared to provide guidance for recreation planning in the Patapsco River Basin. Much of the information could also be used for planning in the entire region.

The report is basically divided into two sections. The first deals with recreation demand and supply for the Patapsco River Basin local area of influence. The second section then analyzes the potential needs which could be supplied in the Patapsco River Basin itself.

RECREATION TYPES AND USER PREFERENCES

The Patapsco Valley State Park User Survey conducted in 1975 by the Land Planning Services revealed some information regarding characteristics of user behavior which will be quite useful in the planning of recreation in the Patapsco Watershed. The survey showed that picnicking and hiking received ranking as first priority activities most often. Leisure resting, fishing, playground activities, ball field activities, and nature study received some mention. Recreation activities which should be evaluated at all feasible sites within the watershed include:

Archery	Leisure Resting
Basketball	Nature Study
Bicycling	Outdoor Concerts
Boating	Picnicking
Field Sports	Playgrounds
Fishing	Softball or Baseball
Golf	Swimming
Hiking Trails	Tennis
Horse Trails	

The study concluded that the most important reasons for coming to the park were the pleasure of being outdoors, associated with a change of environment, and the availability and accessibility of the park and its facilities.

Local Area of Influence and Population Distribution

The entire Patapsco River Basin area, some 247,680 acres or 387 square miles, was used as the focus in the designation of the local area of influence. According to a 1975 user survey conducted at Patapsco State Park by the Land Planning Services of the Maryland Department of Natural Resources, approximately 92% of all park users came from the Baltimore regional counties bordering the park. Another 4% came from other Maryland counties, primarily Montgomery or Prince Georges Counties, and with 3% coming from out of state.

Bearing this in mind, the local area of influence was defined as that area contained within the watershed plus those areas up to a maximum distance of 20 miles outside the watershed. Twenty miles is the equivalent to an approximate 30 minute driving time. This means that a person located along the perimeter of the LAI would have a minimum drive of 30 minutes to reach the nearest recreation site and a maximum travel time of 1½ hours to reach the furthest recreation site. This area includes approximately 99% of the potential recreation users of the Patapsco Watershed and comprises an area of 2,314,290 acres or 3616 square miles.

A table displaying 1978 population estimates for the LAI is included. Areas within the LAI include Anne Arundel, Baltimore, Howard, Carroll, Harford, Frederick, Prince Georges, and Montgomery Counties and Baltimore City. The LAI also extends into York County, Pennsylvania.

POPULATION ESTIMATES FOR PATAPSCO LAI

AREA	1978 POPULATION ESTIMATE
Anne Arundel County	327,665 1/
Baltimore County	657,765 1/
Howard County	110,950 1/
Carroll County	91,410 1/
Baltimore City	832,700 1/
Harford County	61,660 1,2/
Frederick County	90,942 2,3/
Prince Georges County	510,975 2,4/
Montgomery County	441,600 2,5/
York County	30,000 2,6/
TOTALS FOR LAI	3,155,667

1/ Statistics supplied by RPC.

2/ LAI includes only portions of the area.

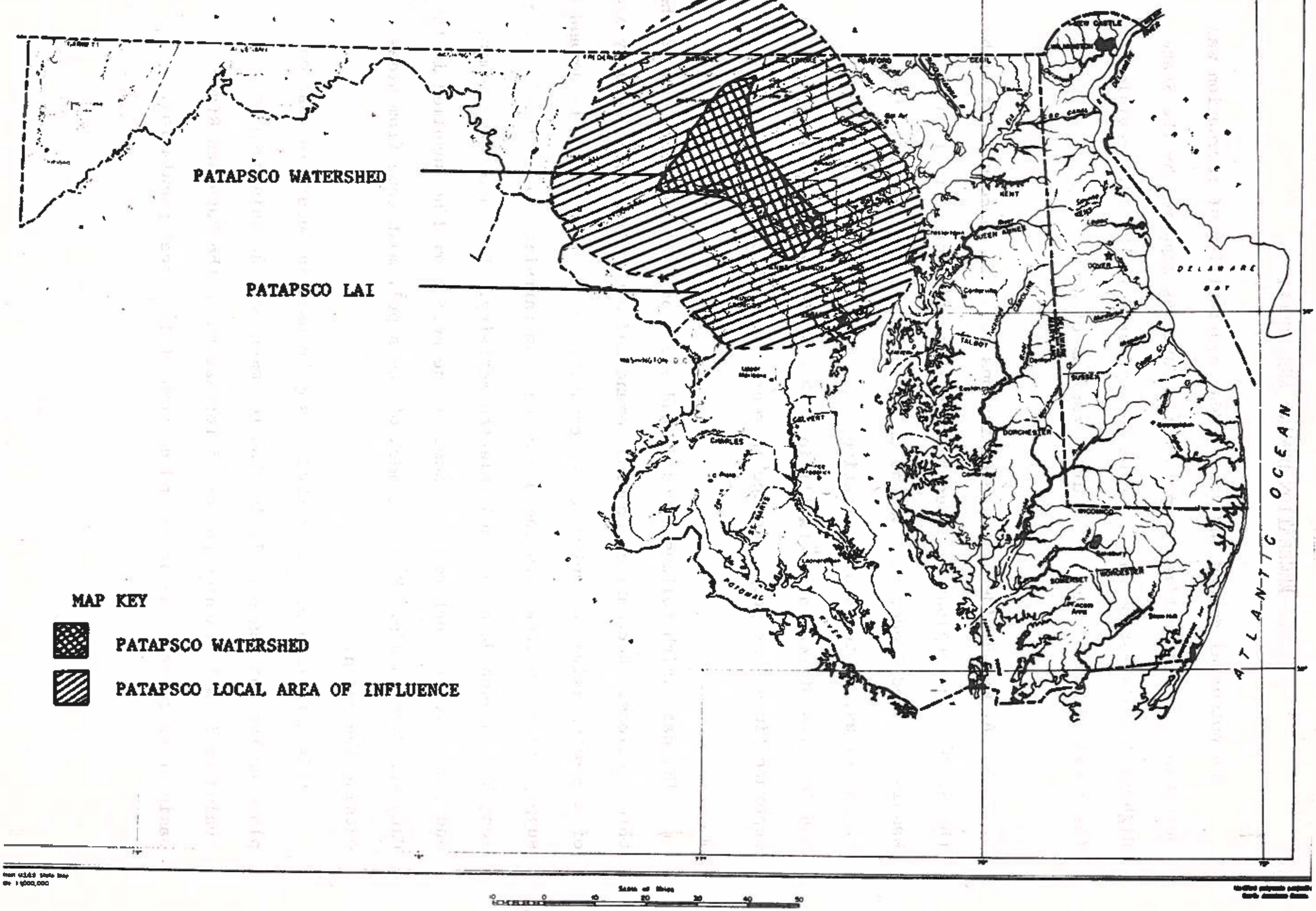
3/ Statistics supplied by Planning and Zoning Commission, Frederick County, Maryland

4/ Economic Development, P.G. County

5/ MNCPPC estimate.

6/ SCS estimate.

MAP OF THE PATAPSCO WATERSHED AND THE RECREATIONAL LOCAL AREA OF INFLUENCE



RECREATION DEMAND AND SUPPLY

The potential demand and the current availability of recreation was determined for the entire Patapsco LAI. Data was supplied by the State Highway Administration and is to be incorporated in the 1978 revision of the Maryland SCORP which is in draft form as of now.

The LAI was divided into three regions so as to be consistent with the SCORP. The regions included Metropolitan Baltimore, Suburban Washington, and Frederick. Demand and supply were examined from two perspectives, in terms of recreation occasions as defined in the SCORP and in terms of recreation facilities. Recreation occasions are the separate times that people engage in recreational activity.

The data which follows gives demand and supply figures for each of the three regions. Recreation occasion demand and supply was determined by means of a comprehensive interview survey conducted statewide. Facility demand and supply was calculated with the use of optimum carrying capacity and average length of season data for each selected activity. The data shows demand and supply for the entire LAI. Some of the needs could be supplied in the Patapsco River Basin. However, much of the supply must come from areas outside the basin.

This data is provided so that it may be used in future recreation planning for the region. It is also recommended that this data be evaluated in all planning phases of recreation in the Patapsco River Basin so as to meet the needs and desires of the local population.

RECREATION DEMAND/SUPPLY for PATAPSCO RIVER BASIN LOCAL AREA of INFLUENCE

RESOURCE AREA: METROPOLITAN BALTIMORE

ACTIVITY	DEMAND	SUPPLY	SUR-PLUS	DEF-ICIT	NET
ARCHERY	2,124,352	204,600		X	-1,919,752
ATTENDING OUTDOOR CONCERTS	4,095,894	13,530		X	-4,082,364
ATTENDING OUTDOOR SPORTS EVENTS	26,027,410	42,377,500	X		16,350,090
BASKETBALL	52,579,348	8,212,400		X	-44,366,948
BICYCLING	123,579,066	11,613,000		X	-111,966,066
BOATING - MOTOR	23,896,861	3,076,642		X	-20,820,219
BOATING - SAIL	3,627,456	3,311,769		X	-315,687
BOATING - CANOE, KAYAK	1,245,826	237,108		X	-1,008,658
CAMPING	6,950,844	555,547		X	-6,395,297
DRIVING FOR PLEASURE	47,745,097	262,800		X	-47,482,296
FISHING - SHORELINE	15,982,142	32,919,425	X		16,937,283
FISHING - SURFACE	16,582,142	1,724,550		X	-14,857,592
GOLFING	3,888,850	7,677,585	X		3,788,735
HIKING	6,427,907	153,216		X	-6,274,691
HORSEBACK RIDING	7,322,875	617,400		X	-6,705,475
HUNTING	1,537,848	89,492		X	-1,448,356
ICE SKATING - POND	1,589,118	831,469,632	X		829,880,514
JOGGING OR RUNNING	36,070,428	-	-	-	-
NATURE WALKS	10,672,433	866,400		X	-9,806,033
OFF - ROAD VEHICLES	4,721,990	-	-	-	-

RECREATION DEMAND/SUPPLY for PATAPSCO RIVER BASIN LOCAL AREA of INFLUENCE

RESOURCE AREA: METROPOLITAN BALTIMORE

ACTIVITY	DEMAND	SUPPLY	SUR-PLUS	DEF-ICIT	NET
PICNICKING	15,557,636	8,098,299		X	-7,459,337
SHOOTING	2,022,049	114,912		X	-1,907,137
SIGHTSEEING	10,172,859	-	-	-	-
SKATEBOARDING	22,244,641	-	-	-	-
SLEDDING OR TOBOGAN-ING	6,136,843	-	-	-	-
SOFTBALL OR BASEBALL	35,691,264	12,894,336		X	-22,796,928
SWIMMING - BEACH	50,822,730	12,430,281		X	-38,392,449
SWIMMING - POOL	169,578,566	12,604,316		X	-156,974,250
TENNIS	33,254,868	4,576,600		X	-28,678,268
WALKING FOR PLEASURE	43,689,667	-	-	-	-
WATERSKIING	3,633,277	1,740,885		X	-1,892,392
FIELD SPORTS	16,944,806	4,939,200		X	-12,005,606

NOTE: The above figures represent total annual outdoor recreation occasions.

RECREATION DEMAND/SUPPLY for PATAPSCO RIVER BASIN LOCAL AREA of INFLUENCE

RESOURCE AREA: SUBURBAN WASHINGTON

ACTIVITY	DEMAND	SUPPLY	SUR-PLUS	DEF-ICIT	NET
ARCHERY	1,506,433	476,280		X	-1,030,153
ATTENDING OUTDOOR CONCERTS	2,789,102	24,600		X	-2,764,502
ATTENDING OUTDOOR SPORTS EVENTS	18,371,666	37,125,000	X		18,753,334
BASKETBALL	29,420,311	17,287,200		X	-12,133,111
BICYCLING	60,641,836	10,976,000		X	-49,665,836
BOATING - MOTOR	6,794,410	175,190		X	-6,619,220
BOATING - SAIL	3,502,092	189,244		X	-3,312,848
BOATING - CANOE, KAYAK	828,296	13,176		X	-815,120
CAMPING	7,426,474	455,411		X	-6,971,063
DRIVING FOR PLEASURE	23,927,088	26,280		X	-23,900,808
FISHING - SHORELINE	7,348,914	189,865,196	X		182,516,282
FISHING - SURFACE	7,348,914	62,475		X	-7,286,439
GOLFING	4,019,413	8,132,553	X		4,113,140
HIKING	4,009,058	127,680		X	-3,881,378
HORSEBACK RIDING	2,818,072	573,300		X	-2,244,772
HUNTING	1,325,736	49,682		X	-1,276,054
ICE SKATING - POND	1,380,324	47,349,115	X		45,968,791
JOGGING OR RUNNING	29,046,301	-	-	-	-
NATURE WALKS	6,627,618	820,800		X	-5,806,818
OFF - ROAD VEHICLES	3,230,146	-	-	-	-

RECREATION DEMAND/SUPPLY for PATAPSCO RIVER BASIN LOCAL AREA of INFLUENCE

RESOURCE AREA: SUBURBAN WASHINGTON

ACTIVITY	DEMAND	SUPPLY	SUR-PLUS	DEF-ICIT	NET
PICNICKING	9,818,828	4,262,436		X	-5,556,392
SHOOTING	1,152,152	268,128		X	-884,024
SIGHTSEEING	6,357,678	-	-	-	-
SKATEBOARDING	8,688,384	-	-	-	-
SLEDDING OR TOBOGAN-ING	3,903,882	39,806		X	-3,864,076
SOFTBALL OR BASEBALL	16,943,167	7,642,728		X	-9,300,439
SWIMMING - BEACH	28,295,363	142,877		X	-28,152,486
SWIMMING - POOL	139,367,814	9,337,539		X	-130,030,275
TENNIS	27,384,401	3,988,600		X	-23,395,801
WALKING FOR PLEASURE	27,900,409	-	-	-	-
WATERSKIING	3,575,497	99,471		X	-3,476,026
FIELD SPORTS	12,576,106	2,914,128		X	-9,661,978

NOTE: The above figures represent total annual outdoor recreation occasions.

RECREATION DEMAND/SUPPLY for PATAPSCO RIVER BASIN LOCAL AREA of INFLUENCE

RESOURCE AREA: FREDERICK COUNTY

ACTIVITY	DEMAND	SUPPLY	SUR-PLUS	DEF-ICIT	NET
ARCHERY	2,398	388,080	X		385,682
ATTENDING OUTDOOR CONCERTS	158,736	61,500		X	-97,236
ATTENDING OUTDOOR SPORTS EVENTS	1,316,386	3,575,000	X		2,258,614
BASKETBALL	747,408	2,077,600	X		1,330,192
BICYCLING	7,530,947	7,399,000		X	-131,947
BOATING - MOTOR	1,377,615	37,802		X	-1,339,813
BOATING - SAIL	4,495	40,421	X		35,926
BOATING - CANOE, KAYAK	60,075	3,162		X	-56,913
CAMPING	977,376	467,757		X	-509,619
DRIVING FOR PLEASURE	1,426,146	1,051,200		X	-374,946
FISHING - SHORELINE	1,160,597	1,117,812		X	-42,785
FISHING - SURFACE	1,160,598	14,994		X	-1,145,604
GOLFING	129,860	511,839	X		381,979
HIKING	169,360	76,608		X	-92,752
HORSEBACK RIDING	109,181	396,900	X		287,719
HUNTING	252,903	391,036	X		138,133
ICE SKATING - POND	84,887	10,222,685	X		10,137,798
JOGGING OR RUNNING	3,166,144	-	-	-	-
NATURE WALKS	637,029	547,200		X	-89,829
OFF - ROAD VEHICLES	170,026	-	-	-	-

RECREATION DEMAND/SUPPLY for PATAPSCO RIVER BASIN LOCAL AREA of INFLUENCE

RESOURCE AREA: FREDERICK COUNTY

ACTIVITY	DEMAND	SUPPLY	SUR-PLUS	DEF-ICIT	NET
PICNICKING	732,874	3,102,948	X		2,370,074
SHOOTING	84,679	210,672	X		125,993
SIGHTSEEING	173,537	-	-	-	-
SKATEBOARDING	652,579	-	-	-	-
SLEDDING OR TOBOGAN-ING	614,573	-	-	-	-
SOFTBALL OR BASEBALL	1,575,955	1,850,904	X		274,949
SWIMMING - BEACH	3,192,686	628,658		X	-3,814,903
SWIMMING - POOL	4,443,561	612,521		X	-2,580,165
TENNIS	1,102,320	445,900		X	-656,420
WALKING FOR PLEASURE	1,545,076	-	-	-	-
WATERSKIING	140,131	21,464		X	-118,667
FIELD SPORTS	662,527	716,184	X		53,657

NOTE: The above figures represent total annual outdoor recreation occasions.

STATUS OF CURRENT RECREATION FACILITIES IN THE PATAPSCO RIVER BASIN LOCAL AREA OF INFLUENCE

RESOURCE AREA: METROPOLITAN BALTIMORE

ACTIVITY	DEMAND	SUPPLY	SURPLUS	DEFICIT	NET
ARCHERY (RANGES)	120	15		X	-105
ATTENDING OUTDOOR CONCERTS (SEATS)	33,300	110		X	-33,190
ATTENDING OUTDOOR SPORTS EVENTS (SEATS)	94,645	154,100	X		59,455
BASKETBALL (COURTS)	2,683	419		X	-2,264
BICYCLING (MILES TRAIL)	2,522	237		X	-2,285
BOATING - GENERAL (RAMP/SLIPS)	-	282 19,124	-	-	-
BOATING - MOTOR (ACRES OF WATER)	143,499	18,475		X	-125,024
BOATING - SAIL (ACRES OF WATER)	3,949	3,605		X	-344
BOATING - CANOE, KAYAK (ACRES OF WATER)	469	450		X	-19
CAMPING (CAMPSITES)	10,134	810		X	-9,324
DRIVING FOR PLEASURE (MILES ROAD)	363	2		X	-361
FISHING (MILES SHORE-LINE/ACRES OF WATER)	261 692.5	537.5 450	X	 X	276.5 -242.5
GOLFING (HOLES)	342	675	X		333
HIKING (MILES TRAIL)	252	6		X	-246
HORSEBACK RIDING (MILES TRAIL)	166	14		X	-152
HUNTING (ACRES)	48,133	2,801		X	-45,332

STATUS OF CURRENT RECREATION FACILITIES IN THE PATAPSCO RIVER BASIN
LOCAL AREA OF INFLUENCE

RESOURGE AREA: METROPOLITAN BALTIMORE

ACTIVITY	DEMAND	SUPPLY	SURPLUS	DEFICIT	NET
ICE SKATING (POND) (ACRES)	43	22,530	X		22,487
JOGGING	*	*	*	*	*
NATURE WALKS (MILES TRAIL)	234	19		X	-215
OFF-ROAD VEHICLES (MILES TRAIL)	587	-		X	-587
PICNICKING (TABLES)	9,446	4,917		X	-4,529
SHOOTING (RANGES)	106	6		X	-100
SIGHTSEEING	*	*		*	*
SKATEBOARDING	*	*		*	*
SLEDDING (MILES TRAIL)	40	-		X	-40
SOFTBALL OR BASEBALL (FIELDS)	4,030	1,456		X	-2,574
SWIMMING (BEACH) (ACRES)	270.5	8.70		X	-261.3
SWIMMING (POOL) (ACRES)	63	27.78		X	-35.22
TENNIS (COURTS)	6,787	934		X	-5,853
WALKING FOR PLEASURE	*	*		*	*
WATERSKIING (ACRES)	38,425	18,475		X	-19,950
FIELD SPORTS (FIELDS)	686	200		X	-486

* Facilities not measured; most of these activities can occur almost anywhere.

STATUS OF CURRENT RECREATION FACILITIES IN THE PATAPSCO RIVER BASIN LOCAL AREA OF INFLUENCE

RESOURCE AREA: SUBURBAN WASHINGTON

ACTIVITY	DEMAND	SUPPLY	SURPLUS	DEFICIT	NET
ARCHERY (RANGES)	85	27		X	-58
ATTENDING OUTDOOR CONCERTS (SEATS)	22,676	200		X	-22,476
ATTENDING OUTDOOR SPORTS EVENTS (SEATS)	66,806	135,000	X		68,194
BASKETBALL (COURTS)	1,501	882		X	-619
BICYCLING (MILES TRAIL)	1,238	224		X	-1,014
BOATING - GENERAL (RAMP/SLIPS)	-	13 774	-	-	-
BOATING - MOTOR (ACRES OF WATER)	40,800	1,052		X	-39,748
BOATING - SAIL (ACRES OF WATER)	3,812	206		X	-3,606
BOATING - CANOE, KAYAK (ACRES OF WATER)	40	25		X	-15
CAMPING (CAMPSITES)	10,828	664		X	-10,164
DRIVING FOR PLEASURE (MILES ROAD)	184	2		X	-182
FISHING (MILES SHORE-LINE/ACRES OF WATER)	119.8 144.0	3,099.8 25.0	X	X	2,908 -119
GOLFING (HOLES)	353	715	X		362
HIKING (MILES TRAIL)	157	5		X	-152
HORSEBACK RIDING (MILES TRAIL)	64	13		X	-51
HUNTING (ACRES)	41,494	1,555	X		39,939

STATUS OF CURRENT RECREATION FACILITIES IN THE PATAPSCO RIVER BASIN LOCAL AREA OF INFLUENCE

RESOURCE AREA: SUBURBAN WASHINGTON

ACTIVITY	DEMAND	SUPPLY	SURPLUS	DEFICIT	NET
ICE SKATING (POND) (ACRES)	37	1,283	X		1,246
JOGGING	*	*	*	*	*
NATURE WALKS (MILES TRAIL)	145	18		X	-127
OFF-ROAD VEHICLES (MILES TRAIL)	401	-		X	-401
PICNICKING(TABLES)	5,962	2,588		X	-3,374
SHOOTING (RANGES)	60	14		X	-46
SIGHTSEEING	*	*	*	*	*
SKATEBOARDING	*	*	*	*	*
SLEDDING (MILES TRAIL)	25.5	.26		X	-25.24
SOFTBALL OR BASEBALL (FIELDS)	1,913	863		X	-1,050
SWIMMING (BEACH) (ACRES)	232.1	.10		X	-232
SWIMMING (POOL) (ACRES)	38.1	20.6		X	-17.5
TENNIS (COURTS)	5,589	814		X	-4,775
WALKING FOR PLEASURE	*	*	*	*	*
WATERSKIING (ACRES)	37,814	1,052		X	-36,762
FIELD SPORTS (FIELDS)	509	118		X	-391

* Facilities not measured; most of these activities can occur almost anywhere.

STATUS OF CURRENT RECREATION FACILITIES IN THE PATAPSCO RIVER BASIN LOCAL AREA OF INFLUENCE

RESOURCE AREA: FREDERICK

ACTIVITY	DEMAND	SUPPLY	SURPLUS	DEFICIT	NET
ARCHERY (RANGES)	1	22	X		21
ATTENDING OUTDOOR CONCERTS (SEATS)	1,291	500		X	-791
ATTENDING OUTDOOR SPORTS EVENTS (SEATS)	4,787	13,000	X		8,213
BASKETBALL (COURTS)	38	106	X		68
BICYCLING (MILES TRAIL)	154	151		X	-3
BOATING - GENERAL (RAMP/SLIPS)	-	10 40	-	-	-
BOATING - MOTOR (ACRES OF WATER)	8,272	227		X	-8,045
BOATING - SAIL (ACRES OF WATER)	5	44	X		39
BOATING - CANOE, KAYAK (ACRES OF WATER)	7	6		X	-1
CAMPING (CAMPSITES)	1,425	682		X	-743
DRIVING FOR PLEASURE (MILES ROAD)	11	8		X	-3
FISHING (MILES SHORE-LINE/ACRES OF WATER)	18.95 24.70	18.25 6		X X	-.70 -18.70
GOLFING (HOLES)	9	45	X		36
HIKING (MILES TRAIL)	7	3		X	-4
HORSEBACK RIDING (MILES TRAIL)	2.5	9	X		6.5
HUNTING (ACRES)	7,916	12,239	X		4,323

STATUS OF CURRENT RECREATION FACILITIES IN THE PATAPSCO RIVER BASIN
LOCAL AREA OF INFLUENCE

RESOURCE AREA: FREDERICK

ACTIVITY	DEMAND	SUPPLY	SURPLUS	DEFICIT	NET
ICE SKATING (POND) (ACRES)	2	277	X		275
JOGGING	*	*	*	*	*
NATURE WALKS (MILES TRAIL)	10	12	X		2
OFF-ROAD VEHICLES (MILES TRAIL)	21	-		X	-21
PICNICKING (TABLES)	445	1,884	X		1,439
SHOOTING (RANGES)	4.5	11	X		6.5
SIGHTSEEING	*	*	*	*	*
SKATEBOARDING	*	*	*	*	*
SLEDDING (MILES TRAIL)	4	-		X	-4
SOFTBALL OR BASEBALL (FIELDS)	178	209	X		31
SWIMMING (BEACH) (ACRES)	6.8	0.44		X	-6.36
SWIMMING (POOL) (ACRES)	3.75	1.35		X	-2.4
TENNIS (COURTS)	233	99		X	-134
WALKING FOR PLEASURE	*	*	*	*	*
WATERSKIING (ACRES)	1,482	227		X	-1,255
FIELD SPORTS (FIELDS)	27	29	X		2

* Facilities not measured; most of these activities can occur almost anywhere.

DAILY OPTIMUM OUTDOOR RECREATION CARRYING CAPACITY 1/

ACTIVITY	OPTIMUM CARRYING CAPACITY
Archery	72 Users/Range/Day
Attending Outdoor Concerts	1 User/Seat/Day
Attending Outdoor Sports Events	1 User/Seat/Day
Basketball	80 Players/Court/Day
Bicycling	200 Bikers/Mile/Day
Boating - General	25 Boats/Ramp/Day 1 Boat/Slip/Day 3 Persons/Boat/Day
Boating - Motor	.91 Users/Acre/Day
Boating - Sail	5.02 Users/Acre/Day
Boating - Canoe/Kayak	288 Users/Mile/Day
Camping	3.22 Users/Site/Day
Driving for Pleasure	360 Persons/Mile/Day
Fishing	250 Fishermen/Mile of Shoreline/Day 10.2 Fishermen/Acre of Water/Day
Golf	53.4 Golfers/Hole/Day
Hiking	84 Hikers/Mile/Day
Horseback Riding	180 Riders/Mile/Day
Hunting	.15 Hunters/Acre/Day
Ice Skating - Lakes, Ponds	605 Users/Acre/Day
Jogging or Running	(Not Applicable)
Nature Walks	150 Users/Mile/Day
Off-Road Vehicles	22.05 Users/Mile/Day
Picnicking	9 Users/Table/Day
Shooting	63 Users/Range/Day

Daily Optimum Outdoor Recreation Carrying Capacity (Cont.)

ACTIVITY	OPTIMUM CARRYING CAPACITY
Sightseeing	(Not Applicable)
Skateboarding	(Not Applicable)
Sledding, Tobogganing	1,701.1 Users/Mile/Day
Softball or Baseball	72 Players/Field/Day
Swimming - Beach	11,616 Users/Mile/Day
Swimming - Pool	4,878.7 Swimmers/Acre/Day
Tennis	20 Players/Court/Day
Walking for Pleasure	300 Walkers/Mile/Day
Waterskiing	.618 Users/Acre/Day
Field Sports	100.8 Players/Field/Day

1/ Source: Guidelines for Understanding & Determining Optimum Recreation Carrying Capacity, USDI Bureau of Outdoor Recreation, 1977.

AVERAGE LENGTH OF SEASON FOR EACH ACTIVITY

ACTIVITY	NUMBER OF MONTHS	NUMBER OF DAYS
Archery	8	245
Attending Outdoor Concerts	4	123
Attending Outdoor Sports Events	9	275
Basketball	8	245
Bicycling	8	245
Boating - Motor	6	183
Boating - Sail	6	183
Boating - Canoe, Kayak	6	183
Camping	7	213
Driving for Pleasure	12	365
Fishing	8	245
Golfing	7	213
Hiking	10	304
Horseback Riding	8	245
Hunting	7	213
Ice Skating (Pond)	2	61
Jogging or Running	12	365
Nature Walks	10	304
Off-Road Vehicles	12	365
Picnicking	6	183
Shooting	10	304
Sightseeing	12	365

Average Length of Season for each Activity (Cont.)

ACTIVITY	NUMBER OF MONTHS	NUMBER OF DAYS
Skateboarding	10	304
Sledding, Tobogganing	3	90
Softball or Baseball	4	123
Swimming (Pool)	3	93
Swimming (Beach)	4	123
Tennis	8	245
Walking for Pleasure	12	365
Waterskiing	5	153
Field Sports	8	245

RECREATION POTENTIAL IN THE PATAPSCO RIVER BASIN

According to the SCS assesment of recreation in the Patapsco River Basin (July 1978), there is high demand for activities such as picnicking, bike riding, hiking, and fishing, in an area which is home to fiftly percent of Maryland's four million citizens. The available outdoor recreation sites in this study area are far from meeting the needs of an expanding population lying between the Metropolitan areas of Baltimore and Washington. The Patapsco watershed lies primarily in Baltimore, Carroll and Howard counties, where one-third of the 247,680 acres are classified as urban. The major concern of the Patapsco study is flood control. Recreation is a land use compatible with many flood damage control measures, and the leisure activities associated with impoundments are in high demand according to the 1978 Maryland "Statewide Comprehensive Outdoor Recreation Plan". Many recreational benefits may be gained through the development of sites for water oriented activities, picnicking, hiking, and nature study, in the rapidly developing lower Patapsco region. The northern reaches of the Patapsco, located in Carroll county, are rural in nature. The majority of recreation in this area takes place on private land. However, population estimates indicate a trend toward development here within the next ten to twenty years.

The existing parks in the Patapsco watershed supply varied opportunities for recreation including small scale urban and rural parks, natural areas, regional parks and state parks. Patpsco Valley State Park, 7000 acres in size, is easily accessible to residents of the metropolitan area. It leads the state in attendance, providing camping, day use sites, games areas and nature activities.

The Gwynns-Leakins park system (1200 acres), is located in Baltimore City within the Gwynns Falls floodplain. Numerous public facilities are available to city residents, but park use is low. This is partly due to a fear of crime because of it's inner city location.

The Soldiers Delight Natural Area lies partly in the Red Run sub-watershed. This 2076 acre tract, acquired by the state, is underlain with serpenti-e rock making this area geologically and botanically unique. Also the site of the first discovery of chromium in the United States, Soldiers Delight is managed for low density types of recreation such as hiking, bird watching, and environmental studies.

An addition to the State Park system is being planned for the Morgan Run Stream Valley in Carroll County. Of 1500 acres planned for acquisition, 680 acres of parkland have been purchased. Unlike Patapsco State Park, management at Morgan Run will focus on limited recreational use. The development objectives of this site are to preserve this heavily wooded valley as open space for the future.

A strong park system is developing in the study area, but population trends project a strain on the current facilities. It is evident that additional recreational opportunities could be created throughout the Patapsco River Basin, but thought and concern must be given to the total costs and benifits associated with change and development.

Impoundment Survey

Fifteen impoundments are being investigated as an alternative in the Patapsco River Basin Study which would inundate an area of 1200 acres, providing flood control as well as increased opportunities for recreation activities. Recreational development in flood plains poses new problems in management. Initial development costs will be higher due to the need for flood resistent structures. Management will involve increased maintenence due to the possibility of flooding.

Though activities associated with impoundments are in high demand, problems may arise when consideration is given to the displacement of families, businesses, and major roads. Limited access across private lands and local opposition to development of sites for recreation will be a concern.

Data associated with reducing recreation deficiencies is given for fishing and boating . Data measuring supply for other activities can not be calculated without specific site measurements. Picnicking can be associated with each site by assuming an acre is available for development at the smaller impoundments. For each acre available, picnicking and related day use activities could supply 2857 recreational visits per year. Other activities compatible with impoundment sites include nature study, hiking, small games, walking and running, and ice skating. Trails and bike paths could follow the perimeter of the water while possibly connecting nearby impoundments.

RECREATION STUDY
PATAPSCO WATERSHED PROPOSED IMPOUNDMENTS

Impoundment	Surface Area	Boating Occasions	Fishing Occasions
East Branch	70 acres	3231 days	4690 days
Deep Run	20 acres	923 days	1340 days
Beaver Run	55 acres	2538 days	3685 days
Middle Run	50 acres	2308 days	3350 days
Morgan Run	75 acres	3462 days	5025 days
Little Morgan Run	25 acres	1154 days	1675 days
Gillis Falls	600 acres	27,692 days	40,200 days
Hay Meadow	30 acres	1385 days	2010 days
Piney Branch	20 acres	923 days	1340 days
Bens Run	16 acres	692 days	1072 days
Brice Run	25 acres	1154 days	1675 days
Delight	50 acres	2307 days	3350 days
Woodlawn	20 acres	923 days	1340 days
Red Run	90 acres	4153 days	6030 days
Horse Head Branch	50 acres	2307 days	3350 days

ACTIVITY	PRESENT DEMAND [1]	SUPPLY [2]	UNMET DEMAND
FISHING	23,289,635 days	74,102 days	23,215,533
BOATING	1,880,691 days	55,152 days	1,825,539

1. From SCS assesment of Recreation in Patapsco River Basin (July 1978)
2. Supply in recreation occasions from above data

RECREATIONAL CONSIDERATIONS

Stormwater Management

State and local storm water management ordinances require the development of small holding ponds. These structures are being considered in the Patapsco River Watershed. These areas consist of small fenced in holes that are unsightly in appearance. Outdoor recreation could be planned for these areas if changes in their design and size were made. Fishing could be associated with these ponds if the water level of the permanent pool was kept within a two foot fluctuation for a ten acre pond. Other activities eould take place in these areas, for example a network of trails connecting the ponds. Wildlife viewing, biking, and hiking would be ideal activities associated with this type of system. The network of ponds would attract wildlife species making these areas ideal for nature study and birding.

Western Maryland Rail Road

The railroad fill and bridges of the Western Maryland Railroad along the West Branch have led to flood damage by reduction of the floodplain area. If this right-of-way were to be xxxopened by re-location of a section of the tracks some benifits in flood control as well as recreation could be gained. IN addition to an increased floodplain area, this right-of-way could be utilized for recreation development. According to a Maryland Department of Natural Resources policy, structual development is not permitted within the Hurricane Agnes flood line. This continuous strip, if opened, would be ideal for development of a multi-purpose stream side trail which could provide an area for hikers, runners and bike riders.

Land Acquisition in the Lower Patapsco Region

A possible solution to flooding in the lower Patapsco would be acquisition of property in the Hurricane Agnes 'take line' for open space. Land acquisition is an expensive proposal, but possibly the state could share in the cost by purchasing land for inclusion in the Patapsco State Park system. These land parcels, adjacent to the existing state park, would extend closer to the urban areas of Baltimore, providing easier access to city residents. This possibility of recreation use would serve a population in great need of facilities and open space closer to home.

BIBLIOGRAPHY of RECREATION CONTACTS in the PATAPSCO LOCAL AREA of INFLUENCE

County Recreation and Parks Departments

Anne Arundel County	Joseph J. McCann Director 301-224-7101	Dept. of Recreation & Parks Anne Arundel County Box 1831 Annapolis, Md. 21404
Baltimore County	Malcom S. Aldrich Director 301-494-3806	Dept. of Recreation & Parks 301 Washington Ave. Towson, Md. 21204
Carroll County	Bruce A. Hildebrand Director 301-848-4500 Ext. 240,241	Dept. of Recreation & Parks Carroll County 225 N. Center St. Westminster, Md. 21157
Frederick County	Gilbert L. Kingsbury Director 301-663-8300 Ext. 238	Parks & Recreation Comm. Frederick County 1611 North Market St. Frederick, Md. 21701
Harford County	Richard L. Rex Director 301-838-6000 Ext. 233	Dept. of Parks & Recreation Harford County 125 N. Main St. Bel Air, Md. 21014
Howard County	Wm. M. Mitchell Director 301-977-7616	Dept. of Recreation & Parks Howard County Gorman Plaza 8950 Route 108 Columbia, Md. 21045
Montgomery County	Neil A. Ofsthun Director 301-468-4164	Dept. of Recreation Montgomery County 6400 Democracy Blvd. Bethesda, Md. 20034

Other Sources

Baltimore City	Douglas S. Tawney Director 301-396-7900	Dept. of Recreation & Parks 2600 Madison Ave. Baltimore, Md. 21217
Maryland Dept. of Natural Resources	Harry W. Hunter Chief 301-269-2459	Office of Recreation & Leisure Services Tawes State Office Bld. Annapolis, Maryland 21401

Other Sources cont.

Maryland Dept. of State Planning (SCORP Plan)	Raymond Puzio Chief 301-383-2452 Mary Kuchta Open Space Planner 301-383-3065	Dept. of State Planning State Office Bld. 301 West Preston St. Baltimore, Md. 21210
Maryland National Capital Park and Planning Commission	Stanton G. Ernst County Director of Parks 301-589-1480	Dept. of Parks Montgomery County Parkside Headquarters 9500 Brunett Ave. Silver Spring, Md. 20901
	Hugh Robey County Director of Parks 301-277-2200 Barry Mangum County Director of Recreation 301-277-2200	Dept. of Parks & Recreation Headquarters 6600 Kenilworth Ave. Riverdale, Md. 20840
Patapsco State Park	Donald Gaver Superintendent 301-747-6602 Gordon Bauer Assist. Superintendent 301-747-6602	Patapsco Valley State Park 1100 Hilton Ave. Baltimore, Md. 21228
Regional Planning Council	Stuart Stainman 301-383-5859	Regional Planning Council 701 St. Paul St. Baltimore, Md. 21202

References Cited

Eisenhower, Donna. 1975 Visitor Use Survey of Patapsco Valley State Park, Land Planning Services, Maryland Department of Natural Resources, Annapolis, Maryland, Summer 1975.

Maryland Department of State Planning and Department of Natural Resources. 1978 Maryland Outdoor Recreation and Open Space Plan, Final Draft, Baltimore, Maryland, June 1978.

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Outdoor Recreation Resources Review Committee. Outdoor Recreation for America, 1962.

USDI Bureau of Outdoor Recreation. Guidelines for Understanding & Determining Optimum Recreation Carrying Capacity, 1977.

A P P E N D I X   H

B I O L O G I C A L   R E S O U R C E S

Prepared by:

USDA Soil Conservation Service

The Patapsco River Study Area is highly diversified in the plant and animal resources that are available within it. This is due to the diversity of the physical characteristics of the land itself and the changes in land use within the watershed. The lower portions of the study area lie in the Coastal Province and consists of a broad valley with many ponds and marshes surrounded by heavily urbanized land. This continues to Elk Ridge where the Patapsco River enters the Piedmont Physiographic Region. Above this point, the land use becomes increasingly more agricultural and less urbanized. Northwestern Howard County and eastern Carroll County are predominately agricultural although pressure for development is increasing. Corresponding to the changes of physical characteristics of the land and in the land use are changes in the flora, fisheries, and wildlife in the study area.

Flora

The forests and openlands have been heavily impacted by man since the arrival of the early colonists in the late 17th century. Early settlers cleared the forests to create fields for tobacco and to obtain charcoal to operate the iron furnaces in the area. Later, with the introduction of water powered mills, wheat became the major agricultural product. After most of the industry on the river was destroyed by floods in 1868, oak-hickory-beech forests began to replace the early forests along the Patapsco River and agriculture remained a major source of income for the area. Intensive farming and urbanization have been the latest stresses to be put on the flora.

Forest land was reduced from 33% to 28% of the watershed from 1965 to 1972. The only large concentrated areas of forest to remain are in the Patapsco State Park and the parkland around Liberty Reservoir. In eastern Carroll and northwestern Howard Counties where agriculture is predominate, wooded aras have been cut away until only the areas along streams or other poor agricultural land remain in trees. The rolling hills of the piedmont create many odd areas that aren't easily cultivated. Small woods or hedgerows occupy these areas.

Species composition of the overstory and understory of the forests is different in the coastal plain than piedmont regions of the study area. The coastal plain area is comprised mainly of maple, sycamore, willow, and river birch in the overstory with alder and spicebush in the understory. Piedmont regions used to have abundant stands of hickory and hemlock but now are comprised mainly of oak, hickory, and beech forests. The Maryland Department of Natural Resources has also planted stands of white, Scotch, and pitch pines in Carroll County along the Patapsco River. Virginia pines are numerous in Howard County between Sykesville and Marriotsville along the South Branch of the Patapsco. Appendix A is a list of the flora of Patapsco State Park which extends from Linthicum to Sykesville and is representative of the forests throughout the study area.

Openland in the study area is intensively used. Pastureland and cropland are abundant especially in the upper reaches. Corn, soybeans, and some small grains are the main crops. Dairy farms and horse farms are numerous in the upper reaches in Carroll and

Baltimore Counties. These crop fields and pastures are interspersed with hedgerows located mainly on ditch banks or property lines. Openland in the area nearer Baltimore City is rapidly being converted from agricultural to urban uses.

Wildlife

Wildlife populations are present throughout most of the study area. The section located in Carroll, western Baltimore, and northwestern Howard Counties support the largest populations of game species. Ring-necked pheasants are abundant in this section of Maryland. Carroll County contains some of the best habitat available in Maryland for pheasant with its numerous crop fields interspersed with grassy or wooded hedgerows along with odd corners that aren't easily cultivated. Taneytown, just northwest of the study area, is considered the pheasant capital of Maryland. As the hedgerows become less numerous in Baltimore and Howard Counties and small woods become the major cover, pheasant populations decline and bobwhite quail populations increase. In Carroll County, quail populations are considered as moderate to low but are considered moderate to good in the other counties in this section of the study area. American woodcocks use the bottom lands during migration and are lightly hunted during these times. Mourning dove populations are high each fall and are heavily hunted during this period. Other game species are limited in numbers throughout this area due to lack of quality habitat in intensive farming with its row crops, hay, pasture, and pasturing of much of the stream bottom lands. Cottontail rabbit populations are moderate to low due to the clearing of most of the brushy cover and mowing or pasturing of most of the grasslands. The absence of large, uninterrupted wooded areas determines the relatively low population of white-tail deer. Only the large wooded areas around Liberty Reservoir and in Patapsco Valley State Park support fairly high populations of deer. High squirrel populations are supported in the mature forest land that does exist throughout this section of the study area.

Hunting is heavily regulated in this section as approximately 75 percent of the privately owned lands are posted for no hunting or as managed hunting areas. Managed hunting areas require a permit from the Maryland Wildlife Administration before being hunted on and are patrolled by the Department of Natural Resources police. In addition to hunting on these private lands, the Hugg-Thomas managed hunting area near Sykesville provides the only public hunting in the study area.

Wildlife populations shift to ones more compatible to the urban environment as one approaches Baltimore. Game species decline and small mammals, such as raccoon and opossum, and songbirds become more dominant. The closer one approaches Baltimore Harbor, the more industrialized and commercialized the land use with a corresponding decline in wildlife able to live there. Patapsco Valley State Park and Leakin-Gwynn's Falls Park provide the largest stands of woodlands and provide the best quality wildlife habitat in this section. These parks are heavily used for hiking, picnicking, etc., and this limits their use by some wildlife species.

In the coastal plain region of the Patapsco River, the slow moving river surrounded by wetlands provide habitat for several wetland species. Waterfowl are fairly common here. Several species of ducks, the least bittern, the cattle egret, and other shore and wading birds can be found. A few plovers and sandpipers can be found here too, especially during migration periods. Muskrat and mink are common. A variety of salamanders, frogs, snakes, and turtles are also found in the numerous ponds and wetlands located in the river valley.

The study area has a fairly great diversity in the species of mammals that are located in it. The streams throughout the study area provide habitat for raccoons and muskrat. Beaver have been planted along the South Branch of the Patapsco but are more numerous now near Liberty Reservoir. Skunk, opossum, woodchucks, squirrels and red and gray fox are also abundant throughout the study area. Occasionally a bobcat is sighted in or around the large wooded sections in and around Patapsco Valley State Park and Liberty Reservoir. The openland areas support high populations of several species of shrews, moles, and field mice. A list of mammals that have been sighted in Patapsco Valley State Park and the immediate surrounding area is contained in appendix B. This list is representative of the mammals that can be found throughout the entire study area.

Over 100 species of birds are common in the study area during some portion of the year. A wide variety of sparrows, warblers, and other songbirds are supported in the woods and openlands. Hedgerows and woods edges are abundant for species such as the cardinal, mockingbird, and the bluebird. Several species of woodpeckers can be found in the wooded areas. The Baltimore Oriole is also a common resident in the area. Occasionally, a Bald Eagle may be seen flying over the area but it is not a permanent resident of the study area. The Dickcissel can be found and it is listed in the "Threatened Birds of Maryland", a publication of Chandler S. Robbins published in 1973. Mallards and wood ducks are the only waterfowl that are common throughout the study area. Appendix C is a list of birds sighted in Patapsco Valley State Park and again is representative of the birds that can be found throughout the entire study area.

The herpetofauna located here is varied. Appendix D lists the reptiles and amphibians that have been found in and around Patapsco State Park. Forty nine species of snakes, lizards, amphibians and turtles have been recorded in the park itself. The appendix also has a list of species probably found in the park due to specimens in collections from areas immediately around the park. The appendix is representative of the herpetofauna of the entire study area. The one species of major importance that was not listed was the Bog Turtle (Clemmys muhlenbergi) which is found only at the extreme northern portion of the Patapsco River watershed near Hampstead and Manchester.

Endangered Species

There are two species of wildlife in the study area that are classified as endangered or threatened by Article 66C, Section 125(c)(5) of the Annotated Code of Maryland. These are the Bog Turtle (Clemmys muhlenbergi) and the Bobcat (Lynx rufus rufus). The Bog

Turtle is found only in the very northern section of the study area in Carroll County near Hampstead and Manchester. The Bobcat is found only in the large uninterrupted stands of woodland of the Patapsco State Park and Liberty Reservoir or along the wooded stream bottoms. The Southern Bald Eagle has been sighted in the study area but is not known to nest anywhere within the area.

Fisheries

This study area's natural characteristics provide a variety of fisheries. The lower section of the Patapsco River from the harbor to Elkridge is tidal. This segment of the river and the surrounding ponds support a variety of fish. Catfish, carp, brown bullheads, American eel, sunfish, white perch, and white suckers are the most common species present. Occasionally a largemouth bass, pickerel, and yellow perch are caught, especially in the old gravel pits surrounding the river. Anadromous runs of yellow perch, herring, alewives, and white perch have been recorded in the river and its tributaries. Fishing pressure is heavy as Baltimore City and heavily populated areas surround the river.

From the fall line at Elkridge to the confluence of the North and South Branches of the Patapsco, the river flows through a narrow valley and has a bed consisting mainly of large rocks and boulders. Several old mill dams are located in this section with Bloede Dam, Union Dam, and the dams at Daniels and Ilchester still slowing the river and creating deeper, slow moving water behind them. Yellow perch, white suckers, sunfish, rock bass, largemouth bass, catfish, bullheads, and carp are the most common species here. Most of this area is located in the Patapsco State Park and provides recreational fishing for the users of the park. The intensity of the fishing pressure is on the increase but is not yet considered as heavily fished except for isolated areas like the pools near the dams.

The South Branch of the Patapsco consists of fast flowing riffles flowing over shallow, rocky beds interspersed with pools. The most common species present are smallmouth bass, suckers, sunfish, common shiners, and creek chubs. An occasional trout may be found out of the streams of this section of the Patapsco too. Fishing pressure is considered low on the South Branch and its tributaries.

Fisheries in the North Branch is dominated by the 3,100 acre Liberty Reservoir and the fisheries it provides. The reservoir is a large source of recreational fishing and it is stocked with largemouth bass, smallmouth bass, and sunfish with carp and catfish available too. Several of the tributaries of the reservoir contain brook and rainbow trout. Morgan Run and Beaver Run are stocked with rainbow trout yearly by the Maryland Fisheries Administration to create a put and take trout fishery. The streams generally run too warm for a carry over or breeding population to survive. The remainder of the streams in this section of the study area are mostly classified as sucker or bass feeder streams with upper reaches classified as Dace trickle. Fishing pressure throughout the North Branch and tributaries is considered low.

Gwynns Falls has not been sampled for fish since Yingling in 1940. The watershed has undergone major changes since then due to urbanization. At the time of the sampling, Gwynns Falls was a source for all types of game fish but now it is no longer known for that. Data on fishing pressure is not available either.

The many small farm ponds throughout the study area are only slightly used for recreational fishing. Most of these have been stocked at some time with largemouth bass and bluegills by the state. In many, especially those under one acre, the fish population is out of balance and other species of sunfish and bullhead have been introduced.

Appendix E contains listing of species found in the anadromous fish study and a study on Liberty Reservoir and its tributaries by Maryland Fisheries Administration. Also included is a listing of species that Yingling found in Gwynns Falls in 1940 that haven't been found in the other studies. This is not a comprehensive listing as most of the study area has not been sampled.

<u>Natural Areas</u>

The <u>Compendium of Natural Features Information</u> (1975) and the <u>Maryland Uplands Natural Area Study</u> lists fourteen sites and areas as natural areas in the Patapsco River Study Area. These areas are listed in Table 1 and located on the map on Figure 1. Baltimore Highlands is the only severely threatened area as it is being converted into a landfill at the present time. Other areas are constantly threatened by urbanization but none are considered as severely threatened. Several areas have been acquired into public ownership for parks. As new information is released in the Uplands Natural Area Study for the piedmont region of Maryland, new areas may need to be included in the study area.

Wetlands

Wetlands in the study area were examined in the field and then typed in accordance with Circular 39 of the U.S. Department of the Interior. The Draft Master Plan for Patapsco Valley State Park was also used for locations of wetlands within the park of five acres or more.

The coastal plain region contains most of the wetlands within the study area. The broad valley contains many old gravel pits which are now inundated to form ponds. Natural marshes are common here too. Located in this area are four acres of Type 3 wetlands, 140 acres of Type 5, 40 acres of Type 6, one acre of Type 7, and 350 acres of Type 12 wetlands. The acreage of the Type 12 is changing rapidly as the 260 acre Type 12 wetland in the Baltimore Highlands area is being converted to a landfill. A large area of Type 2 wetlands is located in the Deep Run area too.

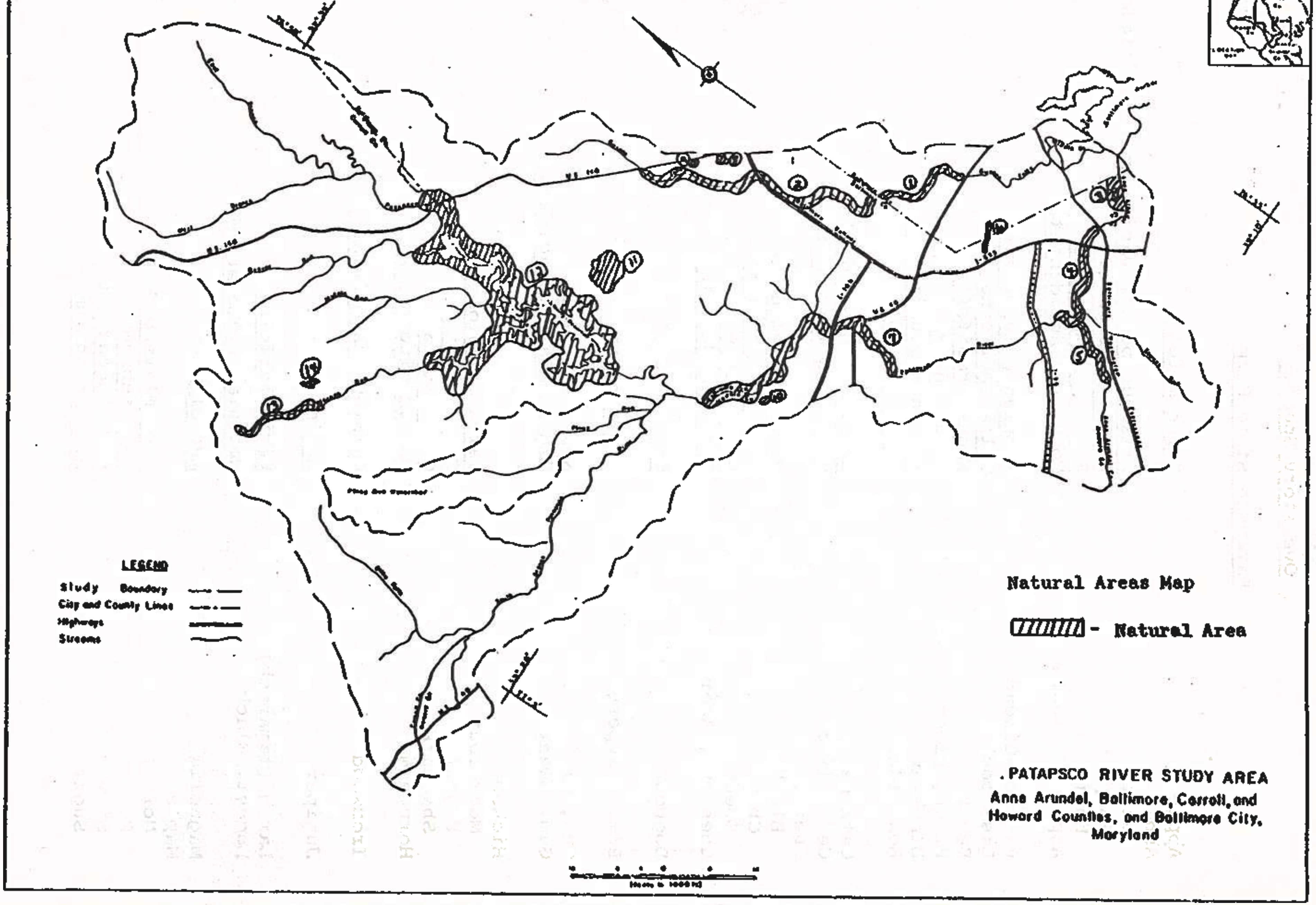
The remaining portion of the study area contains very few wetlands. Most of the wetlands here are classified as Type 1 or Type 2. Fairly large areas of Type 1 wetlands are located along Gillis Falls north of Woodbine. Scattered in these Type 1 areas are isolated sections of Type 7 which total around 1 1/2 acres. The West Branch of the Patapsco near Carrollton has two areas of Type 2 wetland which total approximately 12 acres. Scattered areas of Type 2 wetlands are located in the floodplain throughout the piedmont section of the study area. Type 3 and Type 4 wetlands are located where streams enter Liberty Reservoir but no figures of the acreages are available.

Figure 2 shows the approximate locations of the major wetland locations within the study area.

NATURAL AREAS

Map Number	Name of Area	County	Acres	Features
1	Leakin-Gwynn's Falls Park	Baltimore City	1200	Numerous springs;200 year old oak groves
2	Gwynn's Falls Valley	Baltimore	3500	Unusual plants and woodlands
3	Baltimore Highlands	Baltimore	260	Shallow marsh; Willow Stands; Under severe stress as it is being turned into landfill
4	Patapsco River Marsh	Baltimore-A.A.	704	Least Bittern found here; Heavy development pressure
5	Deep Run	Anne Arundel	182	Lowland deciduous forest; Important breeding area and wintering area for many species of birds
6	Catonsville-Baltimore Trail	Baltimore	10	Woods and streams preserved for hiking
7	Patapsco Gorge	Baltimore-Howard	1500	Deep ravine largely wooded in oak-hickory woods
8	Horsehead Woods	Baltimore	500	Endangered wildflowers; important bird area
9	Ferdinand C. Lee Property	Baltimore	160	Untouched area for over a hundred years; dense ground cover
10	Camel's Den	Howard	5	Archeological Site; Many artifacts found
11	Soldier's Delight	Baltimore	2076	Underlain with serpentine rock; wild flora;archeological site of one of the first U.S. chromium mines
12	Liberty Reservoir	Baltimore-Carroll	5382	Heavily forrested; many small streams; abundant wildlife
13	Morgan Run Valley	Carroll	576	Steeply banked valley; Heavily wooded with oak and hickory predominate
14	Bird Hill Natural Area	Carroll	78	Varied natural area

FIGURE 1


LEGEND
Study Boundary
City and County Lines
Highways
Streams
Natural Areas Map
- Natural Area
.PATAPSCO RIVER STUDY AREA
Anne Arundel, Baltimore, Carroll, and
Howard Counties, and Baltimore City,
Maryland

Appendix A

Overstory Species

Patapsco State Park

Apple	*Pyrus malus*
Ash	
Green	*Fraxinus pennsylvanica* var. *subintegerrima*
Pumpkin	*F. profunda*
White	*F. americana*
Aspen, Bigtooth	*Populus grandidentata*
Balm-of-Gilead	*Populus gileadensis*
Basswood	*Tilia americana*
Beech	*Fagus gradifolia*
Birch, River	*Betula nigra*
Blackhaw	*Viburnum prunifolium*
Box elder	*Acer negundo*
Catalpa	*Catalpa bignonioides*
Cedar (red)	*Juniperus virginiana*
Cherry	
Black	*Prunus serotina*
Choke	*P. virginiana*
Sweet	*P. avium*
Chestnut, American	*Castanea dentata*
Dogwood	*Cornus* sp.
Elm, Slippery	*Ulmus rubra*
Gum, Black	*Nyssa sylvatica*
Gum, Sweet	*Liquidambar styraciflua*
Hickory	
Mockernut	*Carya tomentosa*
Pignut	*C. glabra*
Shagbark	*C. ovata*
Hornbeam	*Ostrya virginiana*
Ironwood	*Carpinus caroliniana*
Juniper	*Juniperus* sp.
Larch (tamarack)	*Larix laricina*
Locust, Black	*Robinia pseudo-acacia*
Magnolia	*Magnolia* sp.
Maple	
Norway	*Acer platanoides*
Red	*A. rubrum*
Silver	*A. saccharinum*
Sugar	*A. saccharum*

Understory Species

Patapsco State Park

(Listing of tree species which will not likely penetrate the overstory in Patapsco)

Apple	*Pyrus malus*
Cedar	*Juniperus* sp.
Cherry	
Choke	*Prunus virginiana*
Pin	*P. pensylvanica*
Sweet	*P. avium*
Dogwood	*Cornus* sp.
Fringetree	*Chionanthus virginicus*
Hackberry	*Celtis* sp.
Ironwood	*Carpinus caroliniana*
Juniper	*Juniperus* sp.
Magnolia	
Bigleaf	*Magnolia macrophylla*
Sweetbay	*M. virginiana*
Maple, Red	*Acer rubrum*
Mulberry	
Red	*Morus rubra*
White	*M. alba*
Oak, Blackjack	*Quercus marilandica*
Persimmon	*Diospyros virginiana*
Pine, Virginia	*Pinus virginiana*
Princess tree	*Paulownia tomentosa*
Redbud. Eastern	*Cercis canadensis*
Sassafras	*Sassafras albidum*
Sourwood	*Oxydendrum arboreum*
Willow	*Salix* sp.

Oak	
Black	Quercus velutina
Blackjack	Q. marilandica
Chestnut	Q. prinus
Pin	Q. palustris
Post	Q. stellata
Red	Q. rubra
Shingle	Q. imbricaria
Swamp	Q. bicolor
Swamp chestnut	Q. michauxii
Water	Q. nigra
White	Q. alba
Paw paw	Asimina triloba
Pine	
Loblolly	Pinus taeda
Red	P. resinosa
Virginia	P. virginiana
White	P. strobus
Poison ivy (vines)	Rhus radicans
Princess tree (empress tree)	Paulownia tomentosa
Redbud, Eastern	Cercis canadensis
Sassafras	Sassafras albidum
Serviceberry	Amelanchier sp.
Spruce	Picea sp.
Sycamore	Platanus occidentalis
Tulip poplar	Liriodendron tulipifera
Walnut, Black	Juglans nigra
Willow	Salix sp.
Witch hazel	Hamamelis virginiana
Yellowwood	Cladrastis lutea

Shrub Layer Species

Patapsco State Park

Alder	*Alnus* sp.
Arrowwood	*Viburnum dentatum*
Azalea	*Rhododendron* sp.
Blackberry	*Rubus allegheniensis*
Blackhaw	*Viburnum prunifolium*
Bladdernut	*Staphylea trifolia*
Blueberry	*Vaccinium* sp.
Elder (elderberry)	*Sambucus canadensis*
Firethorn	*Cotoneaster pyracantha*
Goatsbeard	*Aruncus dioicus*
Hawthorn	*Crataegus* sp.
Hazelnut, American	*Corylus americana*
Hobblebush	*Viburnum alnifolium*
Hydrangea, Wild	*Hydrangea arborescens*
Lespedeza	*Lespedeza bicolor*
Mapleleaf viburnum	*Viburnum acerifolium*
Mountain laurel	*Kalmia latifolia*
Multiflora rose	*Rosa multiflora*
Paw paw	*Asimina triloba*
Poison ivy	*Rhus radicans*
Pokeweed	*Phytolacca americana*
Raspberry	*Rubus idaeus*
Serviceberry	*Amelanchier* sp.
Spicebush	*Lindera benzoin*
Staghorn sumac	*Rhus typhina*
Water hemlock	*Cicuta maculata*
Witch hazel	*Hamamelis virginiana*

Tree Species Reproducing in the Shrub Layer

Apple
Ash, Green
    Pumpkin
    White
Aspen, Bigtooth

Baldcypress
Balm-of-Gilead
Basswood
Beech
Birch, River
Box elder

Cedar
Cherry, Black
    Choke
    Pin
    Sweet
Chestnut, American
Cottonwood, Swamp

Dogwood

Elm, American
    Slippery

Fringetree

Gum, Black

Hackberry
Hickory, Mockernut
    Shagbark
Hornbeam

Ironwood

Juniper

Locust, Black

Magnolia, Bigleaf
    Sweetbay
Maple, Norway
    Red
    Silver
    Sugar
Mapleleaf viburnum
Mulberry, Red
    White

Oak, Black
    Blackjack
    Chestnut
    Red
    Shingle
    Swamp chestnut
    White

Persimmon
Pine, Virginia
Pine, White
Princess tree (empress tree)

Redbud, Eastern

Sassafras
Sourwood
Sycamore

Tulip poplar

Walnut, Black
Willow
Witch hazel

Yellowwood

Ground Cover Species

Patapsco State Park

Agrimony	Agrimonia sp.
Alfafa	Medicago sativa
American bittersweet	Celastrus scandens
Arrowhead	Sagittaria sp.
Asiatic dayflower	Commelina communis
Aster	Aster sp.
Baneberry	Actaea pachypoda
Bedstraw	Galium triflorum
Beech fern	Thelypteris sp.
Bellwort	Uvularia perfoliata
Bindweed	Convolvulus sp.
Black cohosh	Cimicifuga racemosa
Black-eyed Susan	Rudbeckia hirta
Bloodroot	Sanguinaria canadensis
Blue vervain	Verbena hastata
Boneset	Eupatorium perfoliatum
Bouncing Bet	Saponaria officinalis
British Soldier	Cladonia cristatella
Buttercup family	Ranunculus sp.
Butterfly pea	Clitoria mariana
Butterflyweed	Asclepias tuberosa
Campion	Silene sp.
Canada moonseed	Menispermum canadense
Cardinal flower	Lobelia cardinalis
Carex	Carex sp.
Carrion flower	Smilax herbacea
Catbriar	Smilax rotundifolia
Cat grape	Vitis palmata
Chickweed	Stellaria sp.
Chicory	Cichorium intybus
Christmas fern	Polystichum acrostichoides
Cinnamon fern	Osmunda cinnamomea
Cinquefoil	Potentilla sp.
Clover	Trifolium sp.
Club moss	Lycopodium sp.
Common plantain (Broad-leafed plantain)	Plantago major
Crows foot (running ground pine)	Lycopodium complanatum
Daisy	Chrysantheum leucanthemum
Dandelion	Taraxacum officinale
Day lily	Hemerocallis fulva
Deptford pink	Dianthus armeria
Dicentra	Dicentra sp.

Dock	Rumex sp.
Dogbane	Apocynum sp.
Downy false foxglove	Gerardia virginica
Downy rattlesnake plantain	Goodyera pubescens
Enchanter's nightshade	Circaea quadrisulcata
English ivy	Hedera helix
Evening primrose	Oenothera biennis
False Solomon's seal	Smilacina racemosa
Field bindweed	Convolvulus arvensis
Fireweed	Epilobium angustifolium
Foamflower	Tiarella cordifola
Fox grape	Vitis labrusca
Fungus	
Garlic, Field	Allium vineale
Goldenrod	Solidago sp.
Goldie's fern	Dryopteris Goldiana
Grape vine	Vitis sp.
Grasses	Graminacae
Great ragweed	Ambrosia trifida
Greater lobelia	Lobelia siphilitica
Greenbriar	Smilax sp.
Green headed coneflower	Rudbeckia laciniata
Ground ivy	Glechoma hederacea
Ground pine	Lycopodium sp.
Hawkweed	Hieracium sp.
Hepatica	Hepatica americana
Honeysuckle, Japanese	Lonicera japonica
Hop clover	Trifolium sp.
Hornwort (honewort)	Cryptotaenia canadensis
Horsebalm	Collinsonia canadensis
Horsemint	Monarda punctata
Horse nettle	Solanum carolinese
Horse tail	Equisetum sp.
Indian cucumber-root	Medeola virginiana
Indian pipes	Monotropa uniflora
Indian strawberry	Duchesnea indica
Interrupted fern	Osmunda claytoniana
Ironweed, New York	Vernonia noveboracensis
Jack-in-the-pulpit	Arisaema triphyllum
Jewelweed (spotted touch-me-not)	Impatiens capensis
(pale touch-me-not)	I. pallida
Joe-pye weed	Eupatorium sp.
Knotweed	Polygonum sp.

Lichens	
Lily	Lilium sp.
Liverwort	Marchantia polymorpha
Mad-dog skullcap	Scutellaria lateriflora
Maidenhair fern	Adiantum pedatum
Mayapple	Podophyllum peltatum
Meadowrue	Thalictrum sp.
Milkweed, Common	Asclepias syriaca
Purple	A. purpurascens
Mint	Mentha sp.
Morning glory	Ipomoea sp.
Moss (velvet, spoon, broom, white cushion & fern mosses)	
Mullein	Verbascum thapsus
Muscadine (grape vine)	Vitis rotundifolia
Mushroom	
Mustard	Brassica sp.
Myrtle (periwinkle)	Vinca minor
Nettle	Urtica dioica
New York fern	Thelypteris noveboracensis
Onion	Allium stellatum
Oxalis (sorrel, wood sorrel, sour grass)	Oxalis europaea
Partridgeberry	Mitchella repens
Pearly everlasting	Anaphalis margaritacea
Perfoliate bellwort	Uvularia perfoliata
Poison ivy	Rhus radicans
Prickly lettuce	Lactuca scariola
Primrose	Onagraceae sp.
Purslane	Portulaca oleracea
Queen Anne's lace	Daucus carota
Rattlesnake fern	Botrychium virginianum
Rattlesnake plantain	Goodyera pubescens
Rose pink	Sabatia angularis
Royal fern	Osmunda regalis
Saint Johnswort, Common	Hypericum perforatum
Sanicula (Black snakeroot)	Sanicula marilandica
Sarsaparilla	Aralia sp.
Scirpus	Scirpus sp.
Sedge	Carex sp.
Selfheal	Prunella vulgaris
Sensitive fern	Onoclea sensibilis

Silverweed	Potentilla anserina
Skunk cabbage	Symplocarpus foetidus
Smartweed	Polygonum sp.
Smooth ground cherry	Physalis subglabrata
Snakeroot, White	Eupatorium rugosum
Sneezeweed, Purple-headed	Helenium nudiflorum
Solomon's seal	Polygonatum biflorum
Spotted wintergreen	Chimaphila maculata
Starflower	Trientalis borealis
Sunflower family	Helianthus sp.
Sweet basil	
Sweet cicely	Osmorhiza claytoni
Tansy	Tanacetum vulgare
Thistle, Field	Cirsium discolor
Toothed honewort	Cryptotaenia canadensis
Tick trefoil	Desmodium sp.
Violet	Viola sp.
Vipers bugloss	Echium vulgare
Virginia creeper	Parthenocissus quinquefolia
Virginia knotweed	Tovara virginiana
Virginia mountain mint	Pycnanthemum virginiana
Virginia waterleaf	Hydrophyllum virginianum
Watercress	Nasturtium officinale
Water pennywort	Hydrocotyle americana
White vervain	Verbena rticifolia
White wood aster	Aster divaricatus
Whorled loosestrife	Lysimachia quadrifolia
Wild bean	Phaseolus polystachios
Wild geranium	Geranium maculatum
Wild ginger (Canada wild ginger)	Asarum canadense
Wild lettuce (Rattlesnake root)	Lactuca canadensis
Wild licorice	Galium circaezans
Wild pea	
Wild mint	Mentha arvensis
Winter Cress (Early winter cress)	Barbarea vulgaris
Wood anemone	Anemone quinquefolia
Wood rue (Rue anemone)	Anemonella thalictroides
Wood strawberry	Fragaria vesca
Yarrow	Achillea millefolium
Yellow orchid	Cypripedium sp.

Tree and Shrub Species Reproducing in the Ground Cover

American hazelnut
Arrowwood
Ash
  Green
  Pumpkin
  White
Azalea

Beech
Birch, River
Blackberry
Blackgum (Black Tupelo)
Blackhaw
Black locust
Bladdernut
Blueberry
Box elder

Cherry
  Black
  Choke
  Sweet
Chestnut, American

Dogwood, Flowering

Elm, Slippery

Fringetree

Goats beard

Hackberry
Hickory
  Mockernut
  Shagbark
Hobblebush
Holly, American
Hornbeam
Hydrangea, Wild

Ironwood

Maple
  Norway
  Red
  Silver
  Sugar
Mapleleaf Viburnum
Mountain laurel
Mulberry
Multiflora rose

Oak
  Black
  Blackjack
  Chestnut
  Red
  Swamp Chestnut
  White

Paw paw
Pokeweed
Princess tree (Empress tree)

Raspberry, Red
Redbud, Eastern

Sassafras
Serviceberry
Spicebush
Sumac, Staghorn
Sycamore

Tulip poplar

Willow
Witch hazel

Yellowwood

Appendix B

MAMMALS OF PATAPSCO VALLEY STATE PARK

MAMMAL	HABITAT
Opossum	Dense forest near water.
Masked Shrew	Moist coniferous or deciduous woods. Most common around rocks. Mr. I. Hampe in 1936 found nest in Glen Artney.
Southeastern Shrew	Bogs and damp woods as well as open fields.
Pigmy Shrew	Woods and open areas.
Short-Tailed Shrew	Found all over but most abundant in damp woods with thick understory.
Least Shrew	Grass covered fields with scattered brush.
Eastern Mole	Sandy soils, light loams in fields and lawns. Recorded in Patapsco Valley State Park by Mr. I. Hampe in 1939.
Star-Nosed Mole	Low, wet ground by lakes or streams and leaf mold of dense forest.
Hairytail Mole	Sandy loam with heavy vegetation.
Little Brown Myotis (Bat)	Hollow trees and caves.
Keen's Myotis (Bat)	Caves and under the loose bark of trees.
Small-footed Myotis (Bat)	Hibernates in caves in Western Maryland, may pass through Patapsco Valley during late winter and early spring migrations.
Silver-haired bat	Breeds in Wester Maryland and could be in Patapsco Valley during migration.
Eastern Pipistrelle (Bat)	Caves, rock crevices and wooded areas near water.
Big Brown Bat	Caves, hollo trees, under loose bark and sometimes the crevices in cliffs.
Red Bat	Deciduous woods and orchards.
Hoary Bat	Migrates through park and roost in coniferous trees.
Evening Bat	Rare summer resident in hollow trees.
Eastern Cottontail	Marshes and heavy brush.

MAMMAL	HABITAT
Eastern Chipmunk	Deciduous forest, stone walls and rail fences, prefers dry areas. Mr. I. Hampe, Patapsco Valley State Park 1939.
Woodchuck	Forest borders and open fields. Recorded by Mr. I. Hampe in 1939 at Patapsco Valley State Park.
Gray Squirrel	Hardwood and mixed coniferous hardwood forest. Mr. I. Hampe in 1939 said that it is the most common squirrel in the Patapsco Valley State Park and seen every month of the year.
Red Squirrel	Prefers spruce and hemlock. But is often found in deciduous woods. Mr. Hampe in 1939 records them as being uncommon in the pine woods of Patapsco Valley State Park. Grove on Santee before Convent.
Southern Flying Squirrel	Deciduous woods near water. Hampe records fairly common in the Patapsco Valley Park in 1936.
Beaver	Forest area with lake or stream. (Planted on South Branch of Patapsco).
Eastern Harvest Mouse	Old fields, marshes and wet meadows.
Deer Mouse	Open fields.
White-Footed Mouse	Woods, brushy regions, and grassy areas that border woodlands.
Eastern Wood Rat	Cliffs, rock slides, and caves that border rivers and streams.
Meadow Vole	Fields and meadows with a heavy growth of grass. Recorded by Hampe in Patapsco Valley in 1939.
Pine Vole	Old fields, wood borders and cultivated fields, especially loose sandy soil.
Boreal Redback Vole	Damp woods
Muskrat	Edges of streams and rivers.
Southern Bog Lemming	Low damp meadows, some times in beech, maple, oak, hickory and pine woods.
Norway Rat	Burrows in banks near water and foundations of old buildings.
House Mouse	Likes to live near man, but is found in wilds throughout Maryland in fields.

MAMMAL	HABITAT
Meadow Jumping Mouse	Thick vegetation near running water - also woods and farmlands. Record by Hampe in Patapsco Valley State Park in 1939.
Red Fox	Dense weed patches, sparsely wooded edges and brushlands.
Gray Fox	Timbered and Rock areas.
Raccoon	Woods, swamps and marshes.
Ermine	Brushy fields and hedgerows.
Long-Tailed Weasel	Field borders, brushland, open woodland and woods bordering cultivated fields. Hampe 1938.
Mink	Near water in forest and bush areas.
Striped Skunk	Brushland, sparse woods, weedy fields and pastures.
River Otter	Occurs along rivers and streams.
Bobcat	Heavily wooded areas.
White-tailed Deer	Woods edges and second growth timber.

Appendix C
KEY TO THE BIRD LIST OF PATAPSCO

SP - Spring

S - Summer

F - Fall

W - Winter

A - Abundant - Very large numbers

C - Common - Large numbers

FC - Fairly common - Moderate numbers

U - Uncommon - Small numbers

R - Rare - very small numbers

CAS - Casual - Slightly beyond range, in very small numbers

AC - Accidental - Well beyond usual range, only recorded once or twice

O - Never has been seen during the indicated season

BF - Bottomland Forest

UP - Upland Woods

PW - Pine Woods

HG - Hedgerows, Shrubs and Edges of Woods

RV - On or Along the Edge of the Patapsco River

S - Streams

F - Fields

BIRDS OF THE PATAPSCO STATE PARK

SPECIES	REMARKS	SP	S	F	W	HABITAT
Common Loon	Flies northwest over area from 4/10 to 5/10					
Horned Grebe	Pointed bill, narrow head and neck	R	O	R	R	RV
Pied-billed Grebe	Rarely flies, escapes by diving	R	R	R	O	RV
Great Blue Heron	Observed the most on the north branch	U	U	U	R	RV
Green Heron	Most common heron found in park	U	U	U	O	RV & S
Little Blue Heron	Usually white, immature only	O	O	U	O	RV & S
Cattle Egret	Occurs during post-breeding wanderings	O	O	C	O	RV & S
Common Egret	Yellow bill, black legs and feet	R	R	U	CAS	RV
Snowy Egret	Black bill and legs with yellow feet	O	O	U	O	RV & S
Black-crowned Night Heron	Roost during day, active at night	U	U	U	R	RV & S
Yellow-crowned Night Heron	Sometimes seen during the daylight	R	R	R	R	RV & S
Least Bittern	Smallest heron, found in marshes	O	U	U	O	RV
American Bittern	Hides by freezing with head pointed up-ward	R	CAS	R	R	RV
Mute Swam	Recorded only in February, 1971					RV
Whistling Swam	Flies over park during SP and F migration					
Canada Goose	Common in flight over park during migration	R	O	R	O	RV
Mallard	Most common duck seen in park	C	C	C	C	RV
Black Duck	Sexes alike, dark brown with lighter head	FC	R	FC	UC	RV
Pintail	Male has a sharp pointed tail	CAS	O	R	R	RV
Green-winged Teal	Smallest of the puddle ducks	R	O	R	R	RV
Blue-winged Teal	Male has a white crescent on his face	CAS	O	R	O	RV

SPECIES	REMARKS	SP	S	F	W	HABITAT
American Widgeon	Large white patch on furrowing	O	O	R	O	RV
Wood Duck	Nests in tree cavity	FC	FC	FC	R	RV
Redhead	Frequently confused with the canvasback	R	O	R	O	RV
Ring-necked Duck	Male has solid black back	R	O	R	O	RV
Canvasback	Largest duck	R	O	R	O	RV
Greater Scaup	Makes a soft purring whistle when excited	R	O	R	O	RV
Lesser Scaup	Smaller than the greater scaup	R	O	R	R	RV
Common Goldeneye	Male has round white spot on face	R	O	R	R	RV
Bufflehead	Swift and direct flight close to water	R	O	R	R	RV
Ruddy Duck	Chunky duck with a flattened beak and stubby tail	R	R	R	R	RV
Hooded Merganser	Fan-shaped white crest and dark sides	R	O	R	O	RV
Common Merganser	Long white body and dark head	R	O	R	R	RV
Red-breasted Merganser	Male has wide white collar and green head	R	O	R	R	RV
Turkey Vulture	Holds wings in a broad V while soaring	C	C	C	C	F
Black Vulture	Has shorter tail than turkey vulture	U	U	U	U	F
Sharp-shinned Hawk	Preys on small birds	C	R	C	U	HG & UW
Cooper's Hawk	Has long rounded tail	U	R	U	R	HG & UW
Red-tailed Hawk	Lacks barred tail of other hawks	C	FC	C	FC	HG & F
Red-shouldered Hawk	Nests in woods, but feeds in fields	FC	FC	C	FC	HG & BF
Broad-winged Hawk	Adult has broad barred tail	C	FC	C	O	UW
Bald Eagle	Mature bird has white head	R	O	R	O	RV
Marsh Hawk	Has white rump	R	O	R	O	F & RV
Osprey	Fish eater	R	O	R	O	RV
Pigeon Hawk	Flies close to the ground	R	O	R	O	F
Sparrow Hawk	Smallest falcon	C	FC	C	FC	F
Bobwhite	Whistles Bob-Bob-White	C	C	C	C	HG & F

SPECIES	REMARKS	SP	S	F	W	HABITAT
Ring-necked Pheasant	Long Pointed tail and short rounded wings	C	C	C	C	F
Virginia Rail	Runs through grass to escape	R	O	R	O	RV & BF
Semipalmated Plover	Dark back with white collar	U	O	U	O	RV
Killdeer	Like semipalmated but has two neck bands	C	FC	C	R	F & RV
American Woodcock	Nocturnal	UC	UC	UC	R	HG & F
Common Snipe	Flies in a zig-zag pattern	R	O	R	O	RV (mudbanks)
Spotted Sandpiper	Bobs tail up and down	C	UC	C	O	RV
Solitary Sandpiper	Has barred tail feathers	U	CAS	U	O	RV
Greater Yellowlegs	Bright yellow legs	U	O	U	O	RV
Lesser Yellowlegs	Bill is shorter and more slender than greater yellowlegs	U	O	U	O	RV
Semipalmated Sandpiper	Feeds by picking	U	O	U	O	RV
Western Sandpiper	Probes in water	U	O	U	O	RV
Herring Gull	Has pink legs	U	O	U	O	RV
Ring-billed Gull	Black ring on yellow bill, greenish yellow legs	U	O	U	R	RV
Mourning Dove	Like pigeon, but has slimmer body and pointed tail	C	C	C	UC	F
Yellow-billed Cuckoo	Feeds on tent caterpillars	FC	FC	FC	O	HG & UW
Black-billed Cuckoo	Red ring around eye	U	U	U	O	HG & UW
Barn Owl	Heart-shaped face	U	U	U	U	HG
Screech Owl	Smallest of the eared owls	FC	FC	FC	FC	UW
Great Horned Owl	Largest owl	U	U	U	U	PW & UW
Barred Owl	Has dark eyes, no ear tufts	FC	FC	FC	FC	BF
Long-eared Owl	Winters in small numbers	R	R	R	R	PW

SPECIES	REMARKS	SP	S	F	W	HABITAT
Whippoorwill	Seen only at dusk	FC	FC	FC	O	HG & UW
Common Nighthawk	Sits lengthwise on limbs	FC	FC	C	O	F
Chimney Swift	Only swift in the east	C	C	C	O	Old Bldgs.
Ruby-throated Hummingbird	Only hummingbird in the east	U	U	U	O	F & HG
Belted Kingfisher	Dives headlong into water after fish	C	C	C	U	RV
Yellow-shafted Flicker	Feeds on ants on the ground	C	UC	C	UC	HG
Pileated Woodpecker	Seen in all areas of the park	UC	UC	UC	UC	BF & UW
Red-bellied Woodpecker	Climbs tree in a curious, jerky fashion	C	C	C	C	BF & UW
Red-headed Woodpecker	Head of adult is entirely red	U	U	U	U	DW & BF
Yellow-bellied Sapsucker	Drills parallel rows of holes in trees	FC	U	FC	R	BF
Hairy Woodpecker	Like downy, but larger with longer bill	FC	FC	FC	FC	UW & BF
Downy Woodpecker	Most common woodpecker	C	C	C	C	UW & BF
Eastern Kingbird	Broad white terminal band on tail	C	FC	C	O	HG
Great Crested Flycatcher	Only flycatcher with long rusty tail	U	U	U	O	HG & UW
Eastern Phoebe	Has a tail-wagging habit	C	FC	C	O	HG
Yellow-bellied Flycatcher	Only flycatcher with a yellow throat	U	O	U	O	BF & HG
Acadian Flycatcher	Flycatcher with a white throat	C	C	C	O	BF & UW
Traill's Flycatcher	Found in alders	U	O	U	O	BF
Least Flycatcher	Smallest flycatcher in the east	R	O	R	O	BF & HG
Eastern Wood Pewee	Told from phoebe by its light lower mandible and bright wing bars	FC	FC	FC	O	UW & HG
Horned Lark	Shows black tail feathers in flight	FC	FC	FC	U	F
Tree Swallow	Blue or green above, all white below	FC	O	U	O	RV
Bank Swallow	Nests in colonies on river banks	FC	U	U	O	RV & S

SPECIES	REMARKS	SP	S	F	W	HABITAT
Rough-winged Swallow	Nests in burrows in banks or on bridges	U	U	U	O	RV & S
Barn Swallow	Deeply forked tail	C	C	C	O	F & RV
Purple Martin	Large flocks pass over during migration	U	U	U	O	F
Blue Jay	Only bird with a blue crest in east	C	FC	C	FC	PW & UW
Common Crow	Eats anything	C	C	C	A	F
Fish Crow	Told by smaller size and nasal voice	UC	UC	UC	UC	F
Black-capped Chickadee	Fairly common some winters, rare others	FC	U	FC	FC	EG
Carolina Chickadee	White cheek patches	C	C	C	C	PW & UW
Tufted Titmouse	Has gray crest	C	C	C	C	UW & BF
White-breasted Nuthatch	Sometimes feeds facing downward on tree trunk	C	FC	C	C	UW & BF
Red-breasted Nuthatch	Fairly common some winters	O	O	O	R	PW
Brown Creeper	Always feeds from base of tree upwards	FC	O	FC	FC	PW & UW
House Wren	Plainest wren	FC	FC	FC	CAS	HG
Winter Wren	Very short tail	FC	O	FC	U	UW
Carolina Wren	Largest eastern wren	C	C	C	C	HG
Mockingbird	Shows white wing patches in flight	FC	FC	FC	FC	HG
Catbird	Named for its mewing call	C	C	C	CAS	HG
Brown Thrasher	Only thrasher in the east	FC	FC	FC	O	HG
Robin	Most well known bird	A	C	A	R	HG
Wood Thrush	Rusty head	C	C	C	O	BF & UW
Hermit Thrush	Rusty tail	FC	O	FC	R	UW
Swainson's Thrush	Buffy face and eye ring	C	O	C	O	UW & BF
Gray-cheeked Thrush	Gray face, no eye ring	FC	O	FC	O	UW
Veery	Rusty back	FC	R	FC	O	BF
Eastern Bluebird	Blue back, rusty throat and breast	C	FC	C	FC	HG
Blue-gray Gnatcatcher	Looks like a miniature mockingbird	C	C	C	O	UW

SPECIES	REMARKS	SPG	S	F	W	HABITAT
Golden-crowned Kinglet	Brightly striped head	C	O	C	FC	PW
Ruby-crowned Kinglet	Smaller than a warbler, has eye ring	C	O	C	R	BF & PW
Cedar Waxwing	Likes cedar trees	C	U	C	U	HG
Loggerhead Shrike	Impales prey on thorns and barbed wire	U	R	U	R	HG
Starling	Winter plumage is heavily speckled	C	C	C	C	HG & F
White-eyed Vireo	Only vireo with a white iris in the eye	FC	FC	FC	O	HG
Yellow-throated Vireo	Only spectacled vireo with yellow throat and breast	U	U	U	O	UW & BF
Solitary Vireo	Earliest vireo to arrive in spring	U	O	U	O	PW & UW
Red-eyed Vireo	Most common bird	A	A	A	O	UW & BF
Philadelphia Vireo	Yellow breast with plain wings	R	O	R	O	BF & HG
Warbling Vireo	Prefers tall deciduous trees at woods' edge	U	U	U	O	HG
Black-and-white Warbler	Feeds along tree trunks and large branches	C	FC	C	CAS	UW & PW
Prothonotary Warbler	Frequents bushes and low trees near water	U	CAS	U	O	RV & S
Worm-eating Warbler	Prefers dense undergrowth on slopes	U	U	U	O	RV & S
Golden-winged Warbler	Found in all habitats in park	U	O	U	O	
Blue-winged Warbler	Sometimes hangs head downward when eating	U	O	U	O	HG
Tennessee Warbler	Found high in trees	R	O	U	O	BF & HG
Orange-crowned Warbler	Found in all habitats in park	U	O	U	O	
Parula	Only warbler with yellow throat and blue back	C	C	C	O	BF & PW
Yellow Warbler	Resembles the canary bird	C	C	C	O	RV & HG

SPECIES	REMARKS	SP	S	F	W	HABITAT
Magnolia Warbler	Found in hemlocks	C	O	C	O	PW
Cape May Warbler	Chestnut cheeks in spring	U	O	U	O	HG
Black-throated Blue Warbler	Male, blue gray back and black throat	FC	O	FC	O	UW & PW
Myrtle Warbler	Only white-throated, yellow-rumped warbler	C	O	C	R	HG & BF
Black-throated Green Warbler	Voice sounds like the droning of bees	C	O	C	O	UW & PW
Cerulean Warbler	A few breed in the park	U	CAS	U	O	UW & BF
Blackburnian Warbler	Orange throat	FC	O	FC	O	PW & UW
Yellow-throated Warbler		CAS				RV
Chestnut-sided Warbler	Nests and feeds in low bushes	C	UC	C	O	UW & HG
Bay-breasted Warbler	Chestnut throat, upper breast and sides	C	O	C	O	HG & UW
Blackpoll Warbler	Found mostly on low branches	C	O	C	O	HG & UW
Pine Warbler		R	R	R	CAS	PW
Prairie Warbler	Found in deciduous saplings and young pines	FC	C	FC	O	PW & HG
Palm Warbler	Spends most of its time on the ground	U	O	U	CAS	HG
Ovenbird	Builds domed nest on ground	FC	C	FC	O	UW
Northern Waterthrush	Feeds on ground near water	C	O	C	O	BF
Louisiana Waterthrush	Nests in park along streams	C	FC	C	O	RV & BF
Kentucky Warbler	Has black mustache and yellow eye ring	C	C	C	O	BF
Mourning Warbler	Found in thickets	R	O	R	O	BF & HG
Yellowthroat	Male has black mask	C	C	C	O	RV & S
Yellow-breasted Chat	The largest warbler	C	C	C	O	HG
Hooded Warbler	Black hood encircles yellow face and forehead	C	C	C	O	UW & F

SPECIES	REMARKS	SP	S	F	W	HABITAT
Wilson's Warbler	Yellow warbler with a round black cap	U	O	U	O	HG
Canada Warbler	Male has black necklace across breast	C	O	C	O	UW & PW
American Redstart	Prefers the forest understory trees	C	C	C	O	BF & UW
House Sparrow	Not a native bird	A	A	A	A	Bldgs.
Bobolink	Black below and white above in spring	U	R	U	O	F
Eastern Meadowlark	Yellow breast with a black V	FC	FC	FC	U	F
Red-winged Blackbird	Red shoulder patches on males	C	C	C	U	F & RV
Orchard Oriole	Brick-red breast, dark tail	U	U	U	O	HG
Baltimore Oriole	Builds pendant nest high in tree	FC	FC	FC	R	HG
Rusty Blackbird	Has light eyes	C	O	C	R	BF & HG
Common Grackle	Has irridescent green, blue or violet head	C	C	C	U	F
Brown-headed Cowbird	Lays its eggs in the nests of other birds	C	FC	C	U	F
Scarlet Tanager	Only bird with red body and black wings and tail	FC	FC	FC	O	UW
Summer Tanager	Red all over and no crest	R	R	R	O	HG
Cardinal	Only red-crested bird in the east	C	C	C	C	HG
Rose-breasted Grosbeak	Male has a rose-colored bib	FC	R	FC	O	UW & HG
Indigo Bunting	Perches on wires during nesting season	A	A	A	O	HG
Dickcissel	Travels in winter with sparrows	R	R	R	R	HG
Evening Grosbeak	Casual to fairly common some years	R	O	R	R	HG
Purple Finch	Male is wine-colored	FC	O	FC	U	PW
Pine Siskin	Casual to fairly common some years	U	O	U	O	HG & PW
American Goldfinch	Doesn't build nest until July	C	C	C	C	HG
Red Crossbill	Brick-red color with crossed bills	R	O	R	R	PW
Rufous-sided Towhee	Adult has a red eye	C	C	C	U	HG & UW
Savannah Sparrow	Runs and hops, seldom walks	U	R	U	O	F
Grasshopper Sparrow	Very short, narrow tail	U	U	U	O	F
Henslow's Sparrow	Sings from very low perch	U	U	U	O	F

SPECIES	REMARKS	SP	S	F	W	HABITAT
Vesper Sparrow	White outer tail feathers	U	O	U	CAS	F
Slate-colored Junco	Nests in Western Maryland	C	O	C	C	HG & F
Oregon Junco	Recorded winter of 1971	O	O	AC	O	HG & PW
Tree Sparrow	Clear breast with a central spot	FC	O	FC	FC	HG & F
Chipping Sparrow	Rusty cap with white eye strips	C	C	C	O	HG
Field Sparrow	Pink bill and legs	C	C	C	FC	HG & F
Harris' Sparrow	Largest sparrow in the United States	O	O	AC	O	BF & HG
Wnite-crowned Sparrow	Gray throat and breast and black and white streaked crown	U	O	U	U	HG & F
White-throated Sparrow	Yellow lores and white beard	A	O	A	C	HG & BF
Fox Sparrow	Largest sparrow in the east	C	O	C	R	BF & HG
Swamp Sparrow	Red Cap, gray eye stripe and gray face	U	O	U	R	HG & F
Song Sparrow	Heavy streaked breast with a central spot	A	C	A	FC	HG & F

Appendix D

A Checklist of the Amphibians and Reptiles of the Patapsco State Park, Baltimore and Howard Counties, Maryland.

CAUDATA

1. Notophthalmus v. viridescens- Red-Spotted Newt
2. Ambystoma maculatum- Spotted Salamander
3. Ambystoma opacum- Marbled Salamander
4. Desmognathus f. glutinosus- Northern Dusky Salamander
5. Plethodon c. cinereus- Red-backed Salamander
6. Plethodon g. glutinosus- Slimy Salamander
7. Hemidactylium scutatum- Four-toed Salamander
8. Pseudotriton m. montanus- Eastern Mud Salamander
9. Pseudotriton r. ruber- Northern Red Salamander
10. Eurycea b. bislineata- Northern Two-lined Salamander
11. Eurycea l. longicauda- Long-tailed Salamander

SALIENTIA

1. Bufo a. americanus- American Toad
2. Bufo woodhousei fowleri- Fowler's Toad
3. Acris c. crepitans- Northern Cricket Frog
4. Hyla c. crucifer- Northern Spring Peeper
5. Hyla v. versicolor- Eastern Gray Tree Frog
6. Pseudacris triseriata feriarum- Upland Chorus Frog
7. Rana catesbeiana- Bullfrog
8. Rana clamitans melanota- Green Frog
9. Rana pipiens sphenocephala- Southern Leopard Frog
10. Rana p. palustris- Pickerel Frog
11. Rana s. sylvatica- Wood Frog

SQUAMATA (Sauria)

1. Sceloporus undulatus hyacinthinus- Northern Fence Lizard
2. Eumeces fasciatus- Five-lined Skink

SQUAMATA (Serpentes)

1. Natrix s. sipedon- Northern Water Snake
2. Regina s. septemvittata- Queen Snake
3. Storeria d. dekayi- Northern Brown Snake
4. Thamnophis s. sirtalis- Eastern Garter Snake
5. Thamnophis s. sauritus- Eastern Ribbon Snake
6. Haldea v. valeriae- Eastern Earth Snake
7. Heterodon platyrhinos- Eastern Hognose Snake
8. Diadophis punctatus edwardsi- Northern Ringneck Snake
9. Carphophis a. amoenus- Eastern Worm Snake
10. Coluber c. constrictor- Northern Black Racer
11. Opheodrys aestivus- Rough Green Snake
12. Elaphe o. obsoleta - Black Rat Snake
13. Lampropeltis g. getulus- Eastern Kingsnake
14. Lampropeltis doliata triangulum- Eastern Milk Snake
15. Ancistrodon contortrix mokeson- Northern Copperhead

CHELONIA

1. Chelydra s. serpentina- Common Snapping Turtle
2. Sternotherus odoratus- Stinkpot
3. Kinosteron s. subrubrum- Eastern Mud Turtle
4. Clemmys guttata- Spotted Turtle
5. Clemmys insculpata- Wood Turtle
6. Terrapene c. carolina- Eastern Box Turtle
7. Chrysemys p.picata- Eastern Painted Turtle
8. Pseudemys scripta elegans- Red-eared Turtle
9. Pseudemys scripta troosti- Cumberland Turtle
10. Pseudemys rubriventris- Red-bellied Turtle

Probable List

ALIENTIA

1. Scaphiopus h. holbrooki- Eastern Spadefoot. Migrates from Anne Arundel County to Frederick County.

QUAMATA (Sauria)

1. Cnemidophorus sexlineatus- Six-lined Race Runner. Specimnes have been collected near Elkridge.
2. Eumeces laticeps- Broad-headed Skink. Has been found in Anne Arundel, Prince George's, Montgomery, and Frederick Counties.

QUAMATA (Serpentes)

1. Storeria o. occiptomaculata- Northern Red-bellied Snake. One specimen in a 1928 collection in Catonsville.
2. Elaphe g. guttata- Corn Snake. Has been collected in Anne Arundel, Prince George's, Montgomery, and Baltimore Counties.
3. Lampropeltis calligaster rhombomaculata- Mole Snake. A specimen has been found near the Baltimore- Washington International airport.

ELONIA

1. Pseudemys c. concinna- River Cooter. Specimens have found near Elkridge. It is not known whether this a feral or indigenous species.
2. Pseudemys f. floridana- Florida Cooter. This species has collected in Anne Arundel County.

This list is taken from a bulletin of the Maryland Herpetological Society. This does not include the endangered Bog Turtle (Clemmys muhlenbergi) that is found only in the extreme northern section of the Patapsco watershed near Manchester.

Appendix E

Partial Listing of the Fish Species in the Patapsco

Alewife	Alosa pseudoharengus
Blueback Herring	Alosa aestivalis
Herring	Alosa sp.
Hickory Shad	Alosa mediocris
American Shad	Alosa sapidissima
White Perch	Morone americana
Yellow Perch	Perca flavescens
American Eël	Anguilla rostrata
White Sucker	Catostomus commersoni
Hogsucker	Hypentolium nigricans
Carp	Cyprinus carpio
Brown Bullhead	Ictalurus nebulosus
Yellow Bullhead	Ictalurus natalis
White Catfish	Ictalurus catus
Margined Madtom	Noturus insignis
Chain Pickerel	Esox niger
Gizzard Shad	Dorosoma cepedianum
Rainbow Trout	Salmo giardneri
Brook Trout	Salvelinus frontinalis
Stoneroller	Campostoma anomalum
Rosyside Dace	Clinostomus funduloides
Golden Shiner	Notemigonus crysoleucas
Common Shiner	Notropis cornutus
Blacknose Dace	Rhinichthys atratulus
Longnose Dace	Rhinichthys cataractae
Creek Chub	Semotilus atromaculatus
Fallfish	Semotilus corporalis
Rock Bass	Ambloplites rupesris
Redbreast Sunfish	Lepomis auritis
Green Sunfish	Lepomis cyanellus
Pumpkinseed	Lepomis gibbosus
Bluegill	Lepomis machrochirus
Smallmouth Bass	Micropterus dolomieui
Largemouth Bass	Micropterus salmoides
White Crappie	Pomoxis annularis
Black Crappie	Pomoxis nigromaculatis
Tessellated Johnny Darter	Etheostoma olmstedi
Mottled Sculpin	Cottus bairdi

Species Found Only in 1940 Study by Yingling on Gwynn's Falls

Silvery Minnow	Hybognathus nuchalis
River Chub	Nocomis micropogon
Comely Shiner	Notropis amoenus
Satinfin Shiner	Notropis analostanus
Swallowtail Shiner	Notropis procne
Warmouth(?)	Chaenobryttus gulosus

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Information Resources

Baltimore Regional Planning Council

Energy & Coastal Zone Administration: Tom Chaney

Maryland Fisheries Administration: Worrall R. Carter & Dale Weinrich

Maryland Park Service: John Krueger, Park Naturalist, Patapsco Valley State Park

Maryland Wildlife Administration: Al Bourgeois, District Manager, Gwynnbrook District Office and Gary Taylor, Non Game & Endangered Species Program Manager.

APPENDIX I

PUBLIC INVOLVEMENT

Prepared by:

Patapsco River Basin Study Staff

PUBLIC INVOLVEMENT

As a focal point of public involvement for this study, 300 questionnaires were distributed to households and businesses on or near the floodplains of the Patapsco River and Gwynns Falls. It was estimated that there were approximately 900 habitable structures in the study area susceptible to flooding. Thus questionnaires were delivered to about one-third of the people who had experienced flooding. The approximate distribution was as follows:

Anne Arundel County	-	60
Carroll County	-	30
Howard County	-	60
Baltimore County (Patapsco 25, Gwynns Falls 125)	-	150

In addition, questionnaires were delivered to 16 community or civic groups which had expressed interest in water resources.

In most cases, the questionnaires were hand delivered in a packet. The packet contained an eye catching cartoon, an explanatory letter, the questionnaire, and a stamped, pre-addressed return envelope. These packets were delivered during the month of May, 1979.

In all, 81 responses were received. Geographic location of responses was as follows:

Lower Patapsco (below Elkridge)	-	18
Ellicott City - Elkridge	-	8
South Branch	-	3
North Branch above Liberty	-	5
Gwynns Falls	-	45

A sample questionnaire with a summary of responses is attached to this report. Below are some qualitative observations from questionnaire results.

Most of the respondents perceived the flood problem as one which causes major damage and one which is inconvenient and costly. Twenty-five percent even saw it as life threatening.

The overwhelming majority of people felt that the appropriate solution was in the hands of the local, state, or Federal government. Very few felt that there was anything they could or would do personally to reduce their vulnerability.

About two-thirds of the respondents sustained $2500 or more damage during Hurricane Agnes, yet less than half were willing to see their taxes go up more than $25 per year to reduce flooding. In fact, 35 percent said they would not be willing to pay anything to see the threat eliminated.

Almost three-fourths of those questioned are participating in the flood insurance program. Over 95 percent are aware that the program exists. There were some concerns, however, about limits of coverage and exclusions.

Seventy percent of those polled said that they could have prevented no more than half of the flood damage if they had been warned six to eight hours in advance. Almost 30 percent felt they could not have prevented any. This indicates a need for an information and education program about flood disaster preparedness in conjunction with a floodwarning program. In fact, 84 percent of the respondents indicated some willingness to attend an information meeting on floodwarning and flood disaster preparedness.

Fifty percent of the people in the area which the Howard County floodwarning system affects did not know about the system. This may indicate a need for an information program in the area also.

Eighty percent of those polled showed some interest in floodproofing. Two-thirds were willing to consider some form of floodproofing. However, only half would consider paying for the measures themselves, and of that half, less than 50 percent were willing to pay more than $800 to protect their residence.

Almost 30 percent would be willing to be relocated anywhere to get away from the flood threat. Almost 50 percent would not consider moving beyond their present neighborhood to escape flooding, however.

Ninety percent of the people polled felt that government restrictions on the use of the floodplain were necessary.

Concerning structural measures, the following generalizations can be made:

1. The reaction to dikes is generally negative. The higher the dike, the more negative the reaction.

2. The reaction to channelization as a method of flood control is generally favorable. However, the further removed a channel is from being a natural stream, the less positive the reaction.

3. The reaction is generally split on the issue of earth dams. However, those opposed feel more strongly than those in favor.

Only twenty percent of those questioned preferred to remain anonymous. Seventy percent even provided a telephone number. Almost forty percent felt strongly enough about some issue to send along supplimentary comments or a supplimentary letter.

Responses to the questionnaire were also examined with factor analysis and cross tabulation methods by the USDA Economics, Statistics, and Cooperatives Service. The results of this brief analysis showed that respondents were consistent in their response to several closely related questions. Although a majority of the respondents favor actions to alleviate flood damage, there is less enthusiasm for actions which require personal sacrifice or financial expeditures by the individual owner. Government programs would be welcomed, but tax increases to support them might meet resistance even among those property owners who experience significant flood damages.

PATAPSCO RIVER FLOODING QUESTIONNAIRE

(Number of Responses shown in Parentheses)

1. What are your opinions regarding the problem of flooding from the stream near your property?

A Non-Existant (5)
B Infrequent (less than once every five years) and minor damage (8)
C Frequent (more than once every five years) but with minor damage (13)
D Infrequent, but with major damage (31)
E Frequent, and with major damage (20)

2. What was your attitude toward the effect of the flood on you?

A No problem (10)
B Minor nuisance (8)
C Inconvenient and costly (54)
D Life threatening (20)

3. How many times has your house or business been flooded in the ________ years you have been there?
(fill in)

A 0 (12) C 2 (15) E 4 or more (12)
B 1 (27) D 3 (10)

4. Which of these most closely describes the level which the water reached during the most severe flood you've experienced since being here?

A Less than 1 foot in basement or storage area (11)
B 1' - 3' in basement or storage area (3)
C More than 3' in basement or storage area (16)
D Less than 1 foot in living or working area (4)
E 1' - 3' in living or working area (12)
F More than 3' in living or working area (31)

5. What do you personally feel should be done with regard to the flooding in your area?

A Ignore the problem (2)
B Individual self help. It is up to each property owner to protect himself. (4)
C City or county programs should be used to help property owners. (40)
D Large projects by the Federal or State government (42)

6. What is your status of ownership of the property to which this questionnaire was delivered?

A Own (70) B Rent or lease (10)

7. How much monetary damage did you sustain to real and personal property during the most severe flood? (Include value of time lost from work or time spent cleaning up)

A 0 - $500 (21)
B $500 - $2500 (6)
C $2500 - $5000 (14)
D If greater than $5000, estimate amount $________________ (38)

8. What increase in your total annual tax dollars (Federal, State, and local) would you be willing to pay to see the flood threat eliminated?

A $0 (24) C $25 - $50 (5) E $100 - $500 (17)
B $1 - $25 (12) D $50 - $100 (11)

9. Are you aware that owners of homes and small businesses in your community are eligible to purchase insurance through the Federal Flood Insurance Program which will partially protect them from the economic consequences of flooding?

A I am aware and I have such insurance. (57)
B I am aware but I am not participating. (18)
C I am aware and my request for flood insurance was denied. (If so, for what reason?) (2)
____

D This questionnaire is the first I've heard of flood insurance. (2)

10. Would you like more information on the flood insurance program? Yes (28) No (42)

11. Approximately what portion of the damage could you prevent if you were warned of a flood 6 to 8 hours in advance?

A None (22)
B Less than half (33)
C More than half (18)
D All (4)

12. Would you be interested in attending a meeting in your area dealing with advance warning of flooding and development of an individual flood preparedness plan?

A I would not be interested (13)
B I might attend if the time and place were convenient. (33)
C I would definitely have someone from my household or business attend. (33)

12a. Did you know that Howard County presently has a program to alert residences and businesses in the county of a possible flood several hours in advance?

A Before reading this, I did not know. (14)
B Yes, I knew prior to this time. (14)

(This question was not applicable to 53 respondants.)

13. Would you be willing to attend a meeting to learn how to make your property less vulnerable to flood damage?

A No (15)
B Yes, if it was held nearby at a time convenient to me. (27)
C I would make every effort to attend such a seminar. (36)

14. Would you be willing to alter the appearance of your property to make it more flood resistant?

A Absolutely not. (23)
B Only if the changes were very minor (26)
C Yes. (25)

15. If the government was to offer financial assistance to you for floodproofing, how much would you be willing to spend out of your own pocket to help protect your property?

A $0 (27)
B Less than $400 (13)
C More than $400 but less than $800 (10)
D More than $800 but less than $1200 (8)
E More than $1200 (Amount $____________) (9)

16. What would be your attitude if you were told that the government would buy your property at fair market value and assist in relocating your family and personal belongings to an area which was not susceptible to flooding?

A I don't think the problem is severe enough to consider moving. (19)
B I prefer to stay where I am even though my property gets flooded. (11)
C I would consider moving only if it were to another location in my present neighborhood. (5)
D I would consider moving to another location in my town similar to my neighborhood. (16)
E I'd move almost anywhere to reduce my risk of getting flooded. (19)

17. How do you feel about government restrictions on the use of flood prone property?

A Unnecessary (9)
B A nuisance but necessary (18)
C I agree with such restrictions. (45)

It has been tentatively ascertained that major structural works such as large dams, channels, dikes, levees and floodwalls are not economically sound methods of flood control in your area. However, positive public attitude toward such measures might suggest further consideration of such structures.

Please circle the phrase which most nearly reflects your attitude toward the structures mentioned in items 18 to 23.

18. An earthen dike 3' - 5' high on or adjacent to your property (assuming appropriate monetary compensation was made)

(22) A Strongly opposed
(7) B Somewhat opposed
C No opinion (12)
D Somewhat in favor (12)
E Strongly in favor (10)

19. An earthen dike 5' - 12' high on or adjacent to your property (assuming appropriate monetary compensation)

A Strongly opposed
B Somewhat opposed
C No opinion
D Somewhat in favor
E Strongly in favor

20. A widened, deepened channel near your home

A Strongly opposed (5)
B Somewhat opposed (3)
C No opinion (5)
D Somewhat in favor (16)
E Strongly in favor (38)

21. A rock lined channel near your home replacing the natural stream

A Strongly opposed (8)
B Somewhat opposed (10)
C No opinion (8)
D Somewhat in favor (12)
E Strongly in favor (25)

22. A concrete lined channel near your home replacing the natural stream

(12) A Strongly opposed
(7) B Somewhat opposed
C No opinion (11)
D Somewhat in favor (12)
E Strongly in favor (21)

23. A large earth dam on the stream several miles upstream of your home or property

(24) A Strongly opposed
(3) B Somewhat opposed
C No opinion (12)
D Somewhat in favor (9)
E Strongly in favor (13)

We would appreciate having your complete name and address. However, if you wish the information you provide to remain confidential, it is not necessary to provide your name and street address. It is very important, however, that we know the name of the community where you live.

Community in Which You Live ______________________________

Name (optional) ______________________________

House No. & Street Name (optional) ______________________________

Zip Code (optional) ______________

Phone No (optional) ______________

Thank you for taking the time to provide us with this information

PLEASE RETURN THIS IN THE ENVELOPE PROVIDED OR TO THE LOCAL SOIL CONSERVATION DISTRICT OFFICE

A P P E N D I X   J

E X I S T I N G   L O C A L   P R O G R A M S

Prepared by:

Patapsco River Basin Study Staff

ACQUISITION PROGRAMS

Four of the five political jurisdictions within the study area have instituted acquisition programs which concern this study. Each program differs slightly in its purpose. Below is a brief description of each.

Howard County

After Tropical Storm Agnes, Howard County offered to purchase many of the flooded properties in Elkridge. The residents of the area rejected the County's offer, deciding to repair their homes and remain in the area. After Hurricane Eloise caused further damage, several residents approached the County to see if the offer to purchase was still extended. It was.

The County purchased 17 homes, a church, and a community building. The homes were demolished. The area was graded and seeded and is now an undeveloped park area.

Other residents in the area declined the County's offer, hoping that the County would protect the floodplain.

Howard County recently enacted legislation which authorizes the purchase of development rights on 20,000 acres of prime farmland within the county. This land may or may not be floodprone property. The program does have several advantages: 1) Some development pressure will be relieved and farmers will have more incentive to make capital investments, possibly conservation measures which would decrease erosion and sediment yield. 2) The agricultural base will be strenghtened. 3) Population growth will be concentrated in areas more easily served by water supply and sewage disposal systems.

Carroll County

The Department of Public Works (DPW) in Carroll County has a passive acquisition program for the area which had been proposed as a water supply reservoir site on Gillis Falls. The County Commissioners realize that there may be such a need in the future. (The minimum area needed for the impoundment would be approximately 830 acres.) The present acquisition policy is to await offers to sell. When a property owner approaches the County, the DPW contacts the Commissioners for permission to procede. To date, approximately 470 acres have been purchased, some of which lies outside the area needed for a minimum project.

Certain provisions in the program allow the County-owned land to be leased for agricultural use on a short-term basis (1-5 years), thus offsetting reduced property taxes.

Anne Arundel County

Four townhouses near the Baltimore City line and twenty-one single family, detached homes in Ridgeway Manor comprise Anne Arundel County's acquisition progra

The four townhouses and four of the homes in Ridgeway Manor have already been purchased. The remaining seventeen homes are slated to be bought in fiscal years 1980-1983.

The program in Ridgeway Manor is a result of the efforts of the residents in that area. After Tropical Storm Agnes and Hurricane Eloise, the residents approached the County, asking for assistance, After investigating the problem, Anne Arundel County proposed the acquisition program for Ridgeway Manor, knowing that all the concerned homeowners had informally agreed to the proposal.

As properties are purchased, they are handled as rental properties. After all twenty-one properties have been purchased, the County will dispose of them, either by removal or demolition.

Baltimore County

Baltimore County has two acquisition programs which are based on recommendations made by the Baltimore County Flood Control Task Force in 1975.

The Department of Public Works and the Department of Recreation and Parks jointly sponsor the acquisition program in Baltimore County. The homes are to be bought over the five year period from 1977 to 1981. As of June 30, 1979, sixty-nine homes had already been purchased. The program covers 171 properties. Areas with the highest concentration of homes to be purchased include Gwynnmore, Villa Nova, and Silver Creek.

Purchase prices for the homes range from $32,000 to $45,000 plus about $7,500 for relocation of the owner/resident. Whenever possible, costs are partially offset by selling the structure under the condition that it be moved. When this is not possible, there is an additional expense in having the house razed. In all cases, the property is graded and seeded and will remain, at leas temporarily, as undeveloped park land.

In 1979, the County began the purchase of homes in the Herbert Run area. Three have been bought already and fifteen more are to be purchased.

These programs, when complete will extend considerably the amount of stream valley land in public or semi-public ownership.

Morgan Run State Park

A 1500 acre park is planned for the Morgan Run stream valley. At least 680 acres have already been purchased. This program is for the preservation of open space and natural resources rather than for flood damage reduction. However, dedication of this land to passive recreation precludes its development.

Patapsco Valley State Park

The Department of Natural Resources has been authorized by the State Legislature to expand the Patapsco Valley State Park by 1,516 acres, from 9,655 to 11,171 acres. The recent Patapsco Valley State Park Draft Master Plan recommends the authorization of additional purchases of 3,317 acres. No funds have yet been allocated to the expansion program. The Department of Natural Resources has made an application to the Land and Water Conservation Fund in the Heritage Conservation & Recreation Service, U. S. Department of Interior for financial assistance for this program. An Environmental Impact Statement was submitted in September, 1978. The Patapsco Valley State Park Advisory Committee has recommended areas to be purchased. (Land actually purchased will depend on availability and price.) The proposed take-lines in general do not include residential areas. There are two reasons why this is done. Proposing the purchase of residential properties is expensive and may cause opposition to the Park from homeowners fearing displacement.

Comparison of Acquisition Programs

There is one important philosophic difference between the programs of Baltimore and Carroll Counties and those of Anne Arundel and Howard Counties. In the latter cases, programs were initiated after a general agreement had been reached between the County and the homeowners. In the case of Baltimore and Carroll County, the program was initiated without such agreements. The homewoners are not obligated to sell but neither County has experienced serious difficulty in acquiring the properties it feels appropriate to purchase.