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March 14, 1980

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Ms. Florence Beck Kurdle
Office of Planning and Zoning
Anne Arundel County
Arundel Center
Annapolis, Maryland 21401

Dear Ms. Kurdle:

CH2M HILL is very pleased to present this final report, "Severn Run Watershed Management Study: Summary Report" to Anne Arundel County. It was both a pleasure and an honor to work with the County on their first watershed management study.

This report presents one of the two major products of the study effort. The second product, flood plain plan and profile sheets, have been previously sent to the County.

The conceptual and technical information as well as the recommendations contained in the report has many applications to watershed management and can help lay the foundation for the County's continuing watershed management program.

We have enjoyed working with the County and greatly appreciate the opportunity for providing our services.

Sincerely yours,

Wesley H. Blood

Wesley H. Blood, Ph.D.
Project Director

Skip Ellis
Project Manager

cs
Enclosures

TW79/Y

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ACKNOWLEDGEMENTS

This study represents the combined efforts of many individuals either in a working or review capacity. All contributions to the study and preparation of this report are gratefully acknowledged.

Considerable information and guidance was provided by staff members from the Anne Arundel County Office of Planning and Zoning, Department of Public Works, Department of Inspections and Permits, and the Soil Conservation District. Valuable input was also obtained from the Maryland Water Resources Administration, the Maryland Geological Survey, and interested citizens of Anne Arundel County.

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This report is provided under Agreement 1084 dated March 1, 1978 between Anne Arundel County, Maryland and CH2M HILL Southeast, Inc.. The information contained herein and any conclusions or recommendations offered represent the findings and opinions of the consultant based on his knowledge and understanding of the facts as they existed at the time this report was prepared.

LIST OF FIGURES

Note: Figure numbers are as they appear in the main technical report.

LIST OF TABLES

Note: Table numbers are as they appear in the main technical report.

SEVERN RUN WATERSHED MANAGEMENT STUDY
SUMMARY REPORT

This Summary Report is a very condensed version of the Severn Run Watershed Management Study. To aid in finding more detailed descriptions in the main report, the numbers of tables and figures repeated from the detailed study have not been changed. Also, major subjects are followed by the chapter numbers that discuss the topic.

To act as a general outline, the chapters and titles of the main report follow:

GOALS AND WATERSHED DESCRIPTION

GOALS (Chapter 1)

The Severn Run Watershed Management Study was undertaken to help fulfill the following goals:

1. Protection of human and animal life;
2. Elimination of property losses from stormwaters and floods;
3. Preservation of the natural character of streams, stream valleys, wetlands, and aquifer recharge areas;
4. Preservation of the natural aesthetics of the stream valleys, including characteristic flora and fauna;
5. Enhancement of the watershed's water quality; and
6. To act as prototype study and identify watershed management concerns on a countywide basis.

STUDY ANALYSIS PROCEDURE

To accomplish the above, the following tasks were performed:

1. The watershed hydrology was simulated using the Soil Conservation Service's (SCS) computer model TR20 for the 2-, 5-, 10-, 25-, 50-, and 100-year storms.
2. Water surface elevations for the floods resulting from the above storms were determined by using the Corps of Engineers' HEC-2 model for 22 miles of stream.

3. Based on the hydrology and hydraulic analysis, flooding problems were determined, and the 2- and 100-year storms were plotted on plan and profile sheets for existing and ultimate land use conditions. In addition, the simulated floods that just topped existing roads and bridges were determined, as well as floods that just inundated structures.

4. An inventory of physical characteristics and resources was performed, as well as biologic field work.

5. Problems were identified in four major areas: flooding, land surface erosion, stream channel erosion, and water quality and environmental concerns.

6. Various management alternatives were determined for flooding, construction site erosion, and stream channel erosion.

7. Alternatives to control the identified problems were determined, and a recommended program described.

8. A case study showing possible problems resulting from urbanization is presented. The effects of the existing Stormwater Management Ordinance and other control alternatives are discussed.

The study considers the spectrum of watershed management, covering various problems, watershed characteristics, and means to deal with some of the problems. Watershed management includes land use planning, flooding, stream channel erosion (stormwater management), land surface erosion, sedimentation, water quality, environmental features, groundwater and ecological concerns. The common thread uniting all these various factors is their response to rainfall and their natural surroundings and how man's activities change this response. The study attempts to deal in sufficient detail with most subjects so that knowledgeable watershed management can be possible.

WATERSHED DESCRIPTION (Chapters 3 and 4)

Location

The Severn Run watershed is located in the northwestern portion of Anne Arundel County, Maryland. The watershed is approximately 4 miles south of Baltimore-Washington International Airport, 14 miles northwest of Annapolis, and 23 miles northeast of Washington, D.C. Severn Run is the primary source of fresh water inflow to the Severn River, a tidal estuary of the Chesapeake Bay. Severn Run watershed has an area of approximately 24.21 square miles or 15,494 acres. Figure 3-1 is a general location map of the watershed.

The watershed's boundary is roughly defined by Route 3 on the east and Route 175 on the south. Route 175 and Fort George Meade establish the western boundary, while the northern boundary is generally comprised of Severn Road and Clark Station Road.

Stream System

Figure 3-2 shows the Severn Run watershed boundaries and stream system. The main channel of the Severn Run is approximately 9 miles in length, originating from Lake Marion in the northwest section of the watershed. There are six major tributaries to the Severn Run, with Jabez Branch in the southeast portion of the basin having the largest tributary area. The aerial photograph was taken in March 1977.

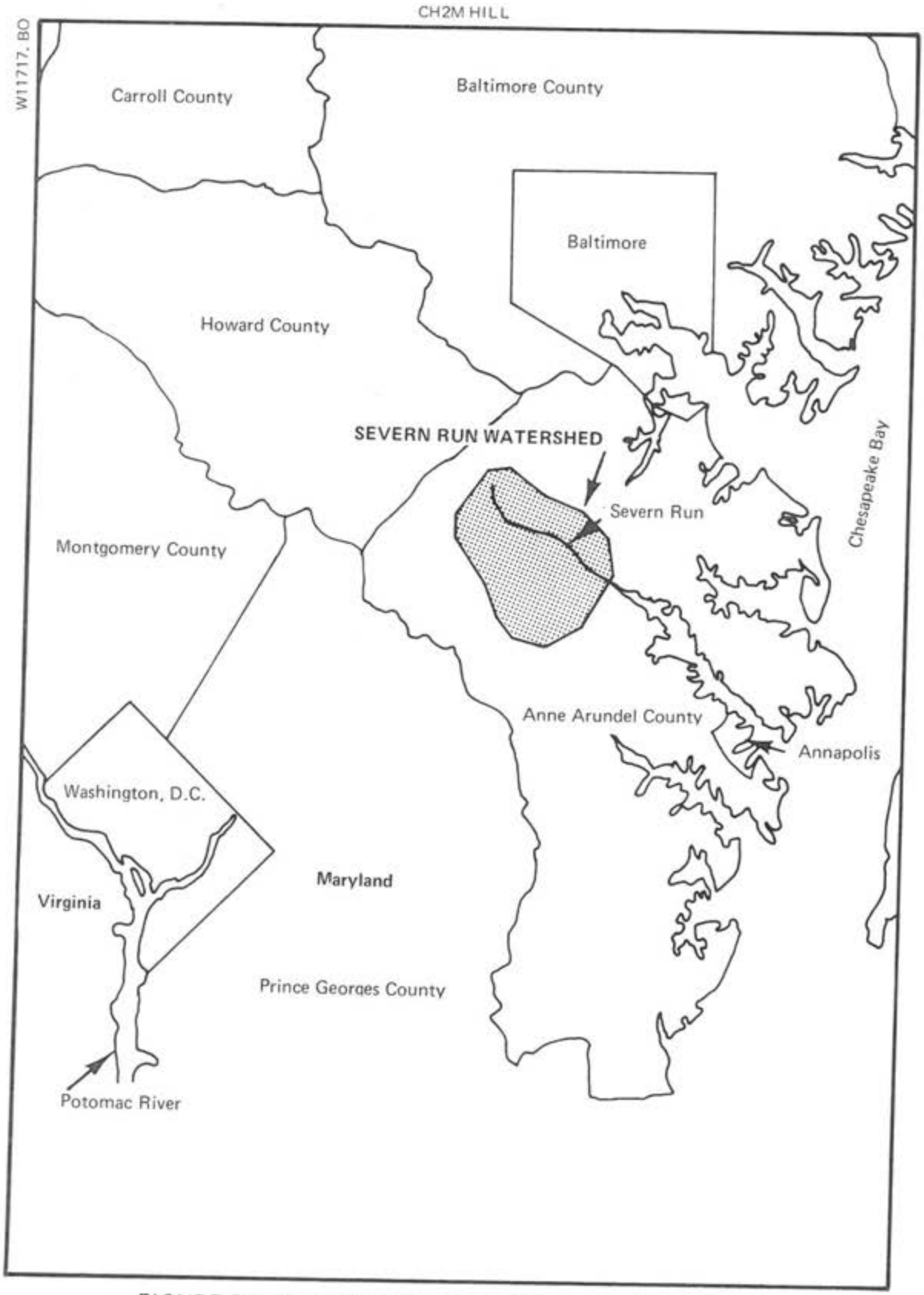


FIGURE 3-1: General Location Map of Severn Run Watershed

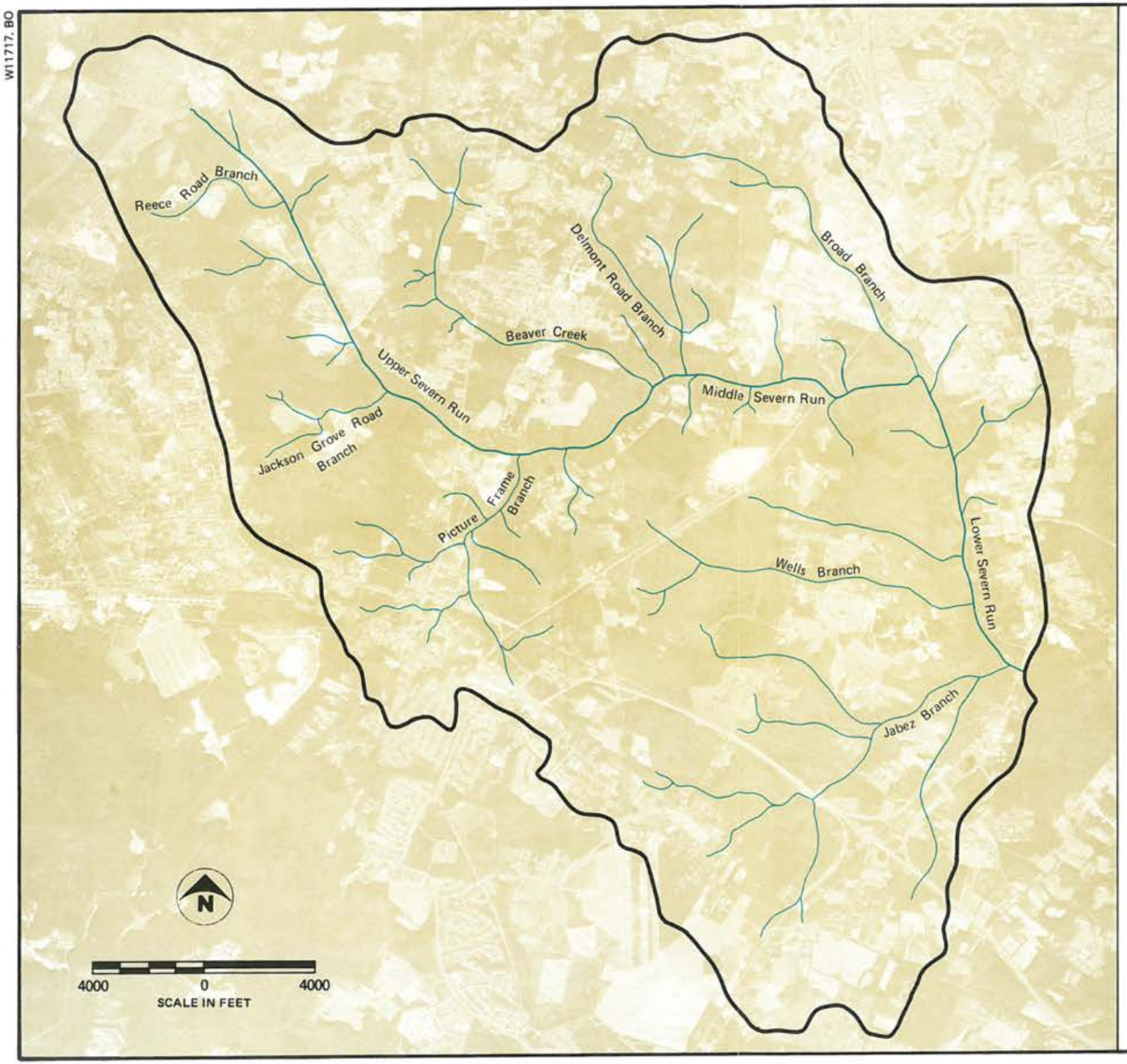


FIGURE 3-2: Severn Run Watershed And Stream System

Topography

The elevation within the watershed ranges from 5 feet to 283 feet, with an overall channel slope of 0.55 percent. A majority of the watershed has a slope of less than 5 percent, although there are some portions of the southeastern section of the watershed with slopes in excess of 15 percent, as shown by Figure 4-2.

Soils

The watershed is generally divided into two areas with predominant soil types. The southeastern section consists mainly of Sassafras and Rumford soils which belong to the Soil Conservation Service hydrologic soil group B classification. These soils have moderate infiltration rates when thoroughly wetted and make up 44 percent of the watershed. On the other hand, group A soils, which comprise 43 percent of the watershed, have high infiltration rates even when thoroughly wetted. The group A soils are primarily of the Evesboro classification and have a lesser runoff potential than group B soils. Notice in Figure 4-1 that most of the hydrologic group B soils are in the Jabez Branch drainage area.

Minerals

The watershed has minimal mining or quarry operations.

Groundwater

An abundance of groundwater is available in the Severn Run Watershed.

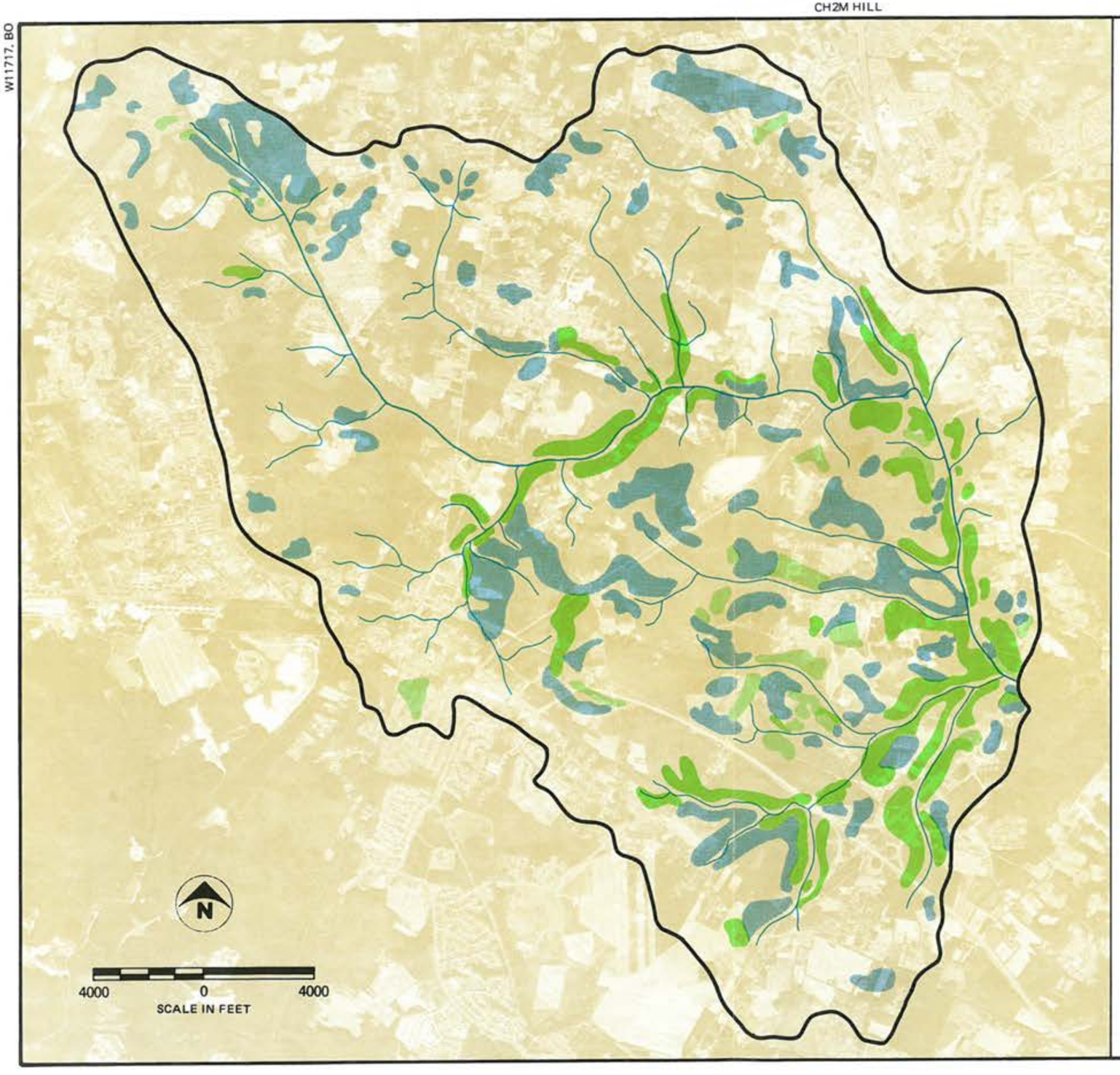
Parks and Historic Sites

The locations of county and state parks in the watershed are given in Figure 4-7, as well as the location of Bill Himer's residence and barn, the only known historic site within the Severn Run basin. The Severn Run Environmental Area is the major park and is owned by the state. It is not intensively developed as a recreational area and future plans are for it to remain a scenic wildlife area. Another major recreation area will be the Millersville Sanitary Landfill (3 in Figure 4-7). When individual cells are filled, they will be converted to a variety of recreational uses. Other parks or recreational areas include the Meade Village Recreation Center (1), the Upton Road Recreation Center (2), and the Severn-Danza Recreation Center (4).

Wildlife and Plants

Previous studies plus five field trips by a professional biologist were used to study wildlife and plants in the watershed. The Severn Run watershed has a rich variety of animals and plants. The number and species of algae found in Lake Marion indicate that it is having problems with premature aging--cultural eutrophication--which will result in the lake becoming more and more shallow and algae-covered.

Several upland swamps/wetlands were discovered during field investigations. These areas offer unique ecological system and act as storage areas for stormwater runoff. These areas, as well as the Severn Run Environmental Area and the region of Severn Run from New Cut Road to



PERCENT SLOPE

LEGEND

- 0 - 5%
- 5 - 10%
- 10 - 15%
- > 15%

SOURCE: Soil Conservation Service And Anne Arundel County Of Office Of Planning And Zoning

FIGURE 4-2: Slope Map

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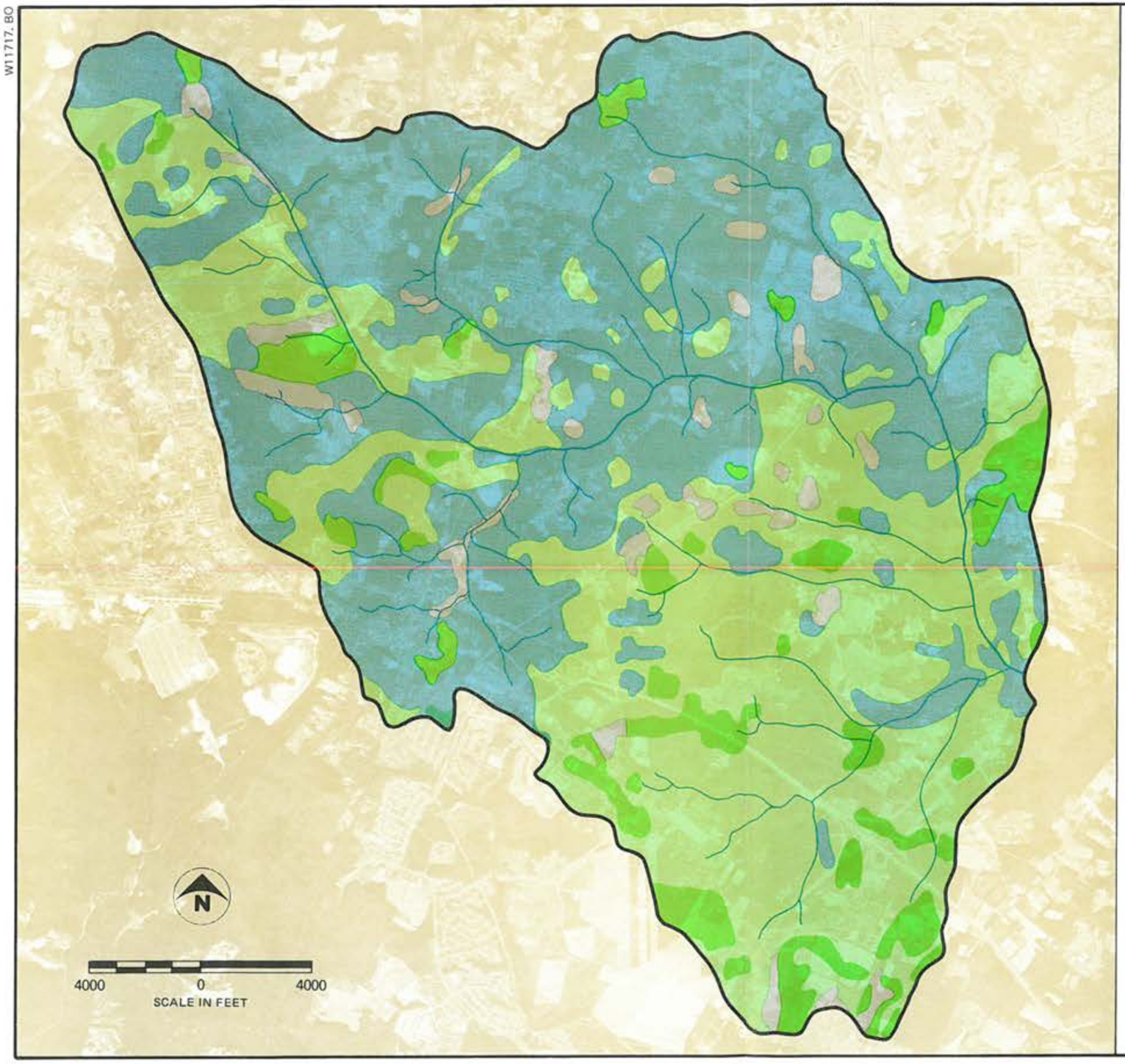

HYDROLOGIC SOIL GROUPS

LEGEND

- Group A
- Group B
- Group C
- Group D

SOURCE: U.S.D.A. Soil Conservation Service

FIGURE 4-1: Soils Map

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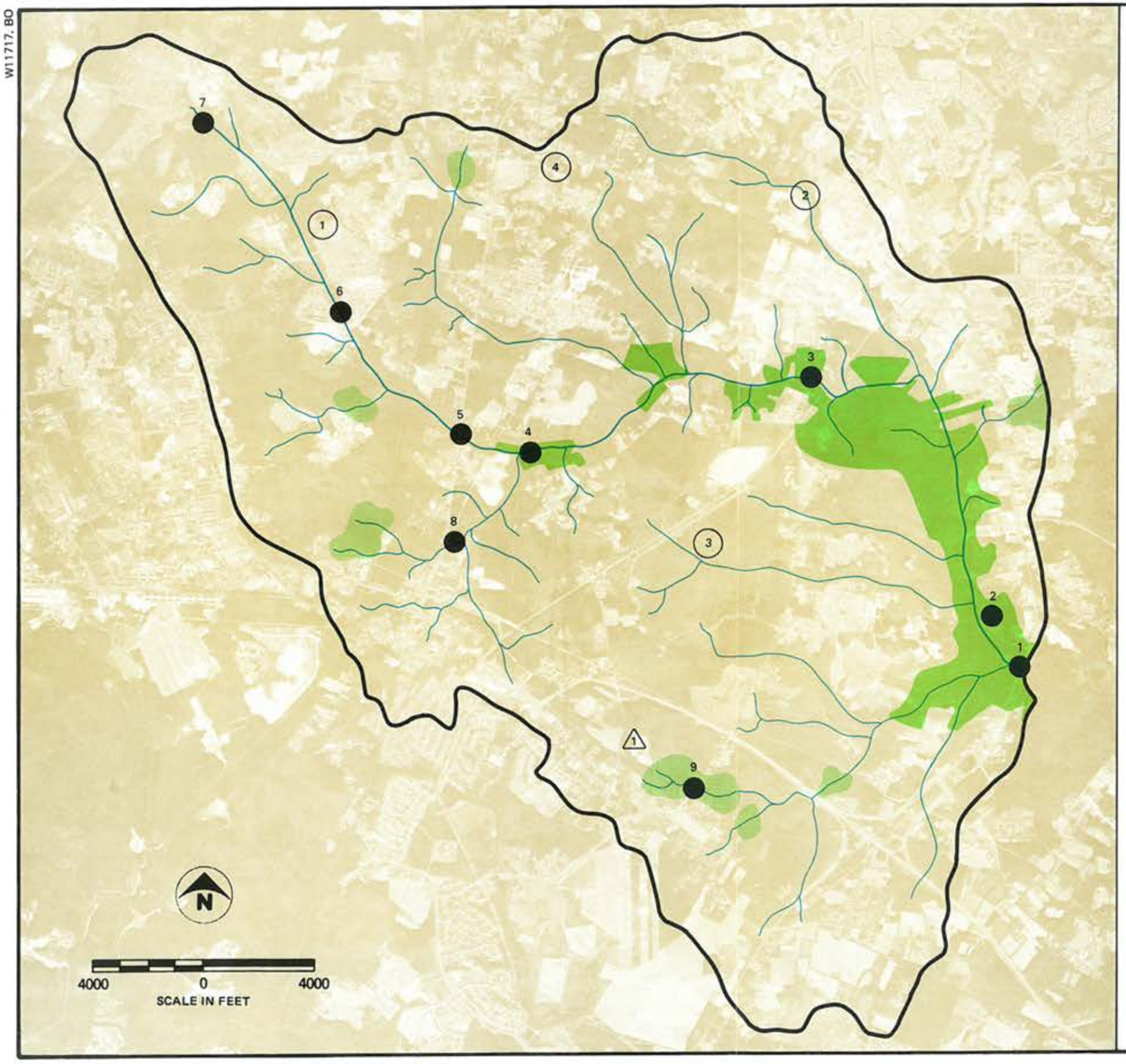


LEGEND

- Historic Site
- Parks
- Environmentally Sensitive Areas
- Severn Run Environmental Area
- Biological Sampling Sites

Refer To Table 4-4

SOURCE: Anne Arundel County Office Of Planning And Zoning

FIGURE 4-7: Parks, Historic Sites, And Environmentally Sensitive Areas

Telegraph Road, should be considered as environmentally sensitive areas. This would be a prime area for expansion of the Severn Run Environmental Area.

No endangered species were found within the watershed although the sheep laurel (Kalmia augustifolia) is considered rare and Lycopodium obscurum (a stiff club moss) and species of Cypripedium (lady's-slipper) are protected in many midwestern states.

Transportation

Major north-south transportation through the watershed is provided by Route 3 (Robert Crain Highway), Route 170 (Telegraph Road), New Cut Road, and Burns Crossing Road. Primary east-west transportation travels on Route 175 (Annapolis Road/Jessup Road), Route 32 (Patuxent Freeway), Route 554 (Reece Road) and Donaldson Avenue. The Penn Central Railroad passes through the watershed, nearly paralleling Telegraph Road.

Existing Land Use

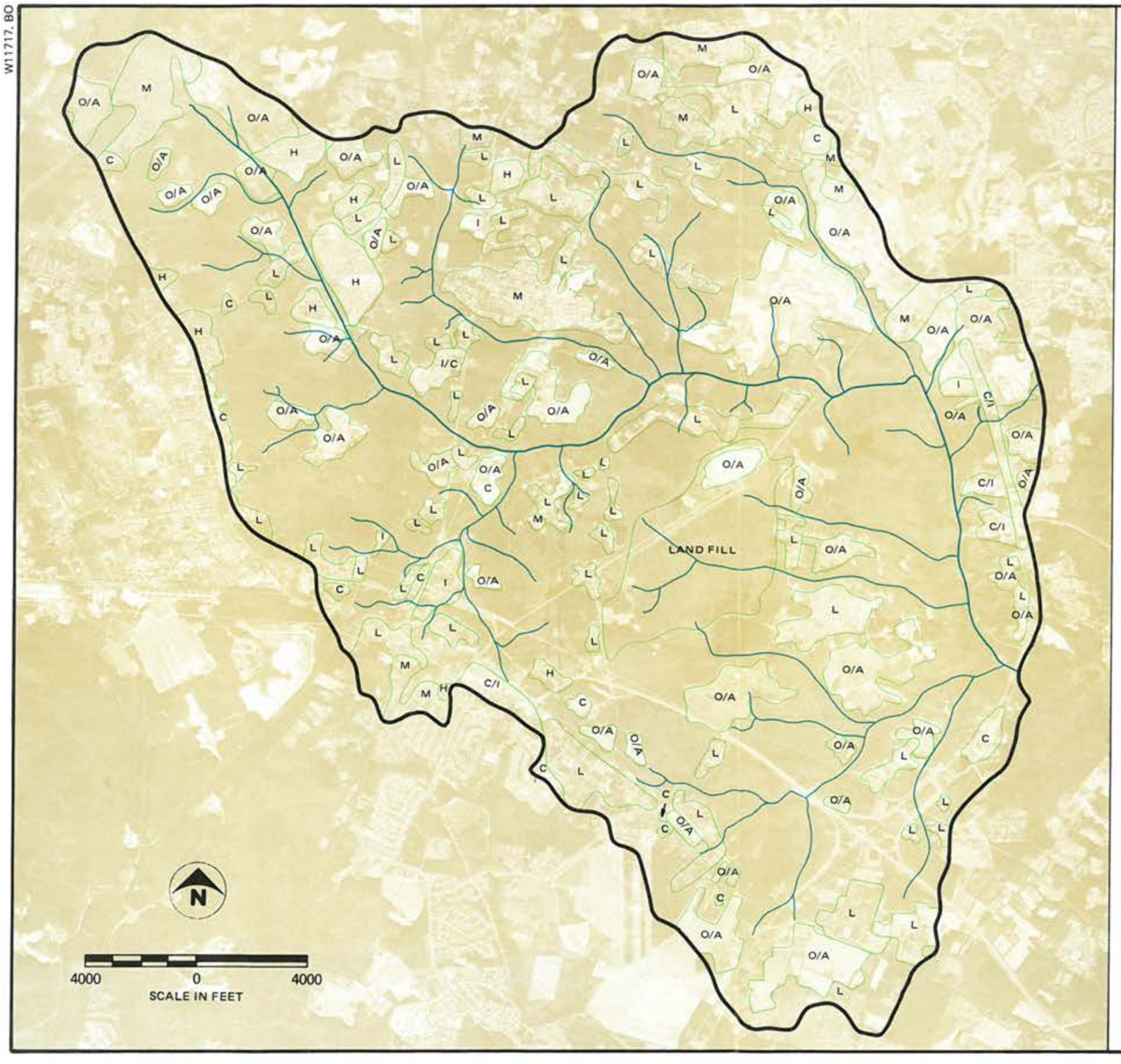
The watershed's present land use is comprised of 16 percent residential, 4 percent commercial or industrial, 17 percent open or agricultural, and 63 percent forest. As can be seen from Figure 4-11, no major urban areas exist within the watershed. Most of the development has taken place in the vicinity of Fort Meade, Odenton, Millersville, and Glen Burnie.

Future or Ultimate Land Use

The General Development Plan (1978), prepared by Anne Arundel County Office of Planning and Zoning, calls for future growth in a contained pattern that encourages most new growth in and near existing developed areas. The plan also encourages growth in the western part of the county. This growth policy impacts the Severn Run watershed since the southwestern portion of the basin borders Fort Meade and industrial growth would be expected at the Midway Industrial Park located at the intersection of Routes 170 and 175. Industrial areas such as this are encouraged by the General Development Plan.

The intent of the General Development Plan is reflected in the county's land use zoning and the projection of future land uses within the watershed.

Ultimate hydrologic land use based on the county's land use zoning map is shown in Figure 4-12. The western and northern areas of the basin will be experiencing the most development. The drainage basin for Picture Frame Branch in particular will be very highly developed, including a proposed town center, industrial growth, and high density residential growth. Based on this projected growth, 36 percent of the watershed will be forested compared to an existing 63 percent, and 11 percent will be open or agricultural lands compared to an existing 17 percent. The undeveloped area will decrease from 80 percent to 47 percent of the watershed.



EXISTING LAND USE

LEGEND

Residential

L — Low Density — 2-5 dwelling units/acre

M — Medium Density — 5-10 dwelling units/acre

H — High Density — 10 or more dwelling units/acre

C — Commercial

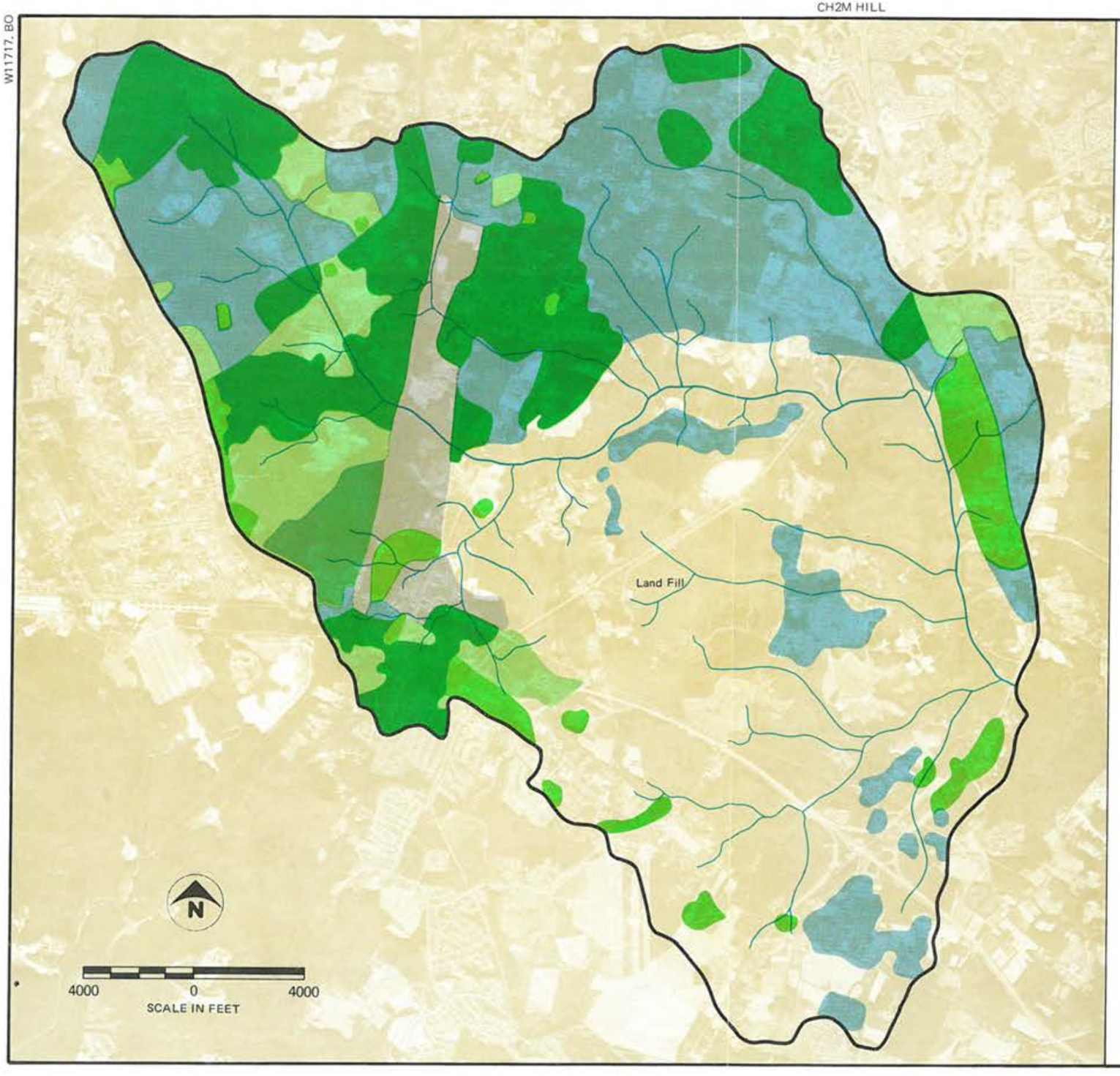
I — Industrial

C/I — Mixed Commercial/Industrial

O/A — Open Area

Forests Are Dark Unlabeled Areas

FIGURE 4-11: Existing Land Use



HYDROLOGIC ULTIMATE LAND USE CLASSIFICATIONS

LEGEND

- Open Areas
- Low Residential
- Moderate Residential
- High Residential
- Commercial
- Industrial

SOURCE: Anne Arundel Zoning Map 1978

FIGURE 4-12: Ultimate Land Use

HYDROLOGY AND HYDROLOGIC MODELING (Chapters 3 and 5)

HYDROLOGIC MODEL

Flood flows are a necessary element of a watershed management study and are obtained by computer simulation of the hydrologic process or from long-term streamflow records. A computer model was used in this study for three primary reasons:

1. Severn Run is not gaged, so no streamflow records exist.
2. Estimates of the hydrologic impacts of future land use conditions were desired.
3. The effectiveness of many control alternatives can be determined.

The Soil Conservation Service's Technical Release No. 20, "Computer Program for Project Formulation Hydrology, TR20" was used as the hydrology model. TR20 is a single event (i.e., it considers one storm at a time), rainfall-to-runoff computer model. Its major input data consist of the area, time of concentration and runoff curve number for each subbasin and either a stage-discharge relationship for stream cross sections or a routing coefficient. Curve numbers, which are based on land use and soil types, determine the amount of rainfall that becomes overland flow. The higher the curve number, the more flow. TR20 does not explicitly consider evaporation, transpiration, interflow or groundwater flow.

In order to apply TR20 to the Severn Run watershed, numerous smaller subbasins had to be established as well as

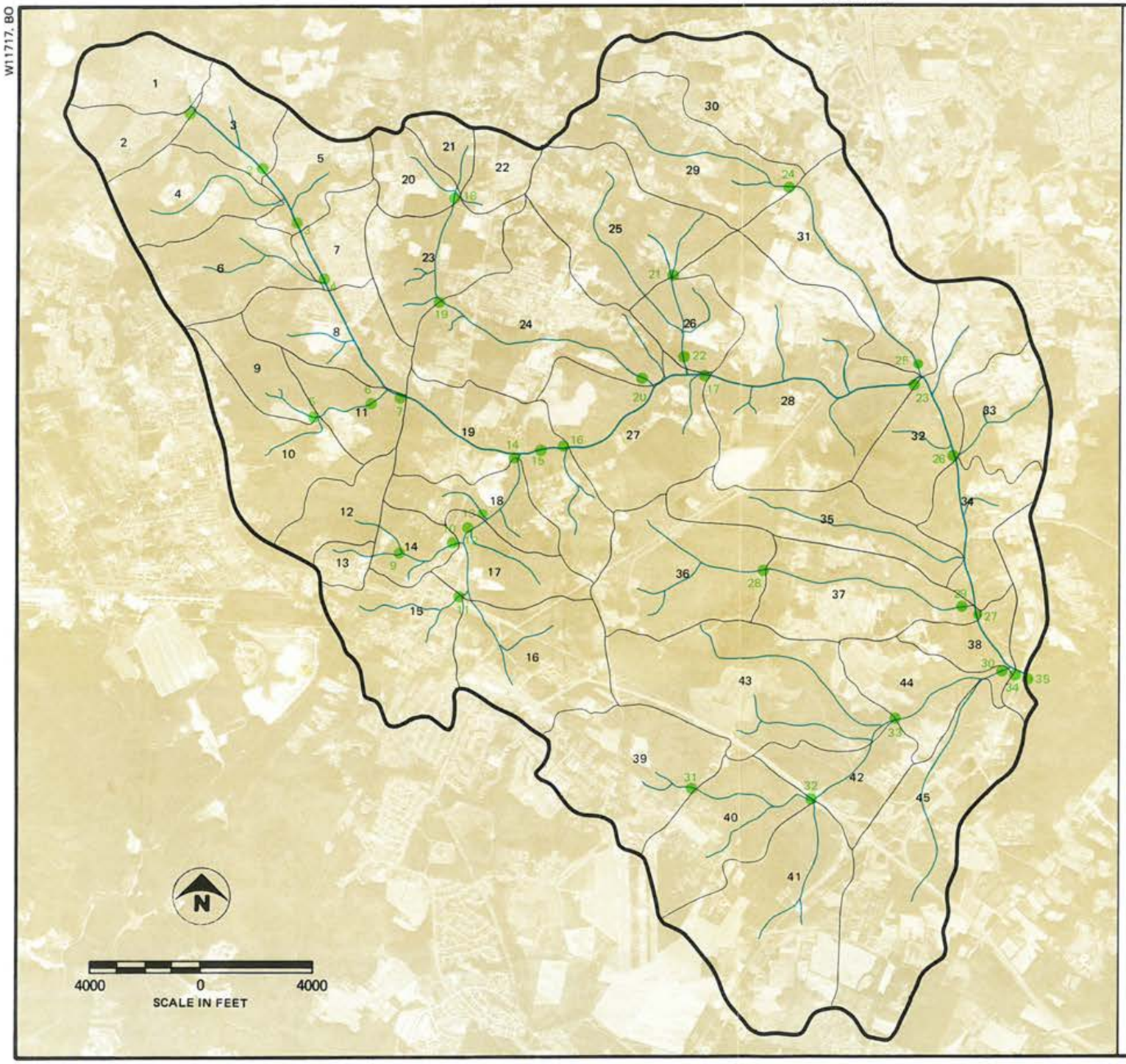
stream cross sections for routing purposes. Forty-six subbasins, shown in Figure 3-4, were used to accurately reflect the changes that future development will have on the flood flows. Thirty-five stream cross sections were used to account for channel routing effects on the flood peaks.

The runoff curve numbers were determined for each subbasin using soils data, slope data, land use data and a table in TR55 published by the Soil Conservation Service. Weighted average values of the curve number were used to predict the amount of flow resulting from the various return interval rainstorms. There is a significant increase in curve numbers for those subbasins undergoing the most intense urbanization as reflected by ultimate land use. Figure 4-13 shows the subbasins affected. Most of the changes are in the southwestern portion of the basin in the vicinity of Fort Meade and the Midway Industrial Park. These areas can be expected to have dramatic increases in flood peak flows.

HYDROLOGY

The differences between existing and ultimate land use conditions for the 2-year and 100-year flood peaks on the Severn Run are shown by Figures 5-6 and 5-7. Areas of significant flow increases are upper Severn Run near the Penn Central Railroad, Jackson Grove Road Branch, Picture Frame Branch, middle Severn Run, Beaver Creek, and lower Severn Run to Dicus Mill Road.

Note that although there are significant increases in flow for the lower Severn Run, the flow does not change significantly for cross section 35, Route 3. The peak flow at Route 3 is dominated by the flow from Jabez



SUBBASINS AND CROSS SECTIONS

LEGEND

1 ● TR-20 Stream Cross Sections

1 Subbasin Number

FIGURE 3-4: Hydrology Subbasin Map

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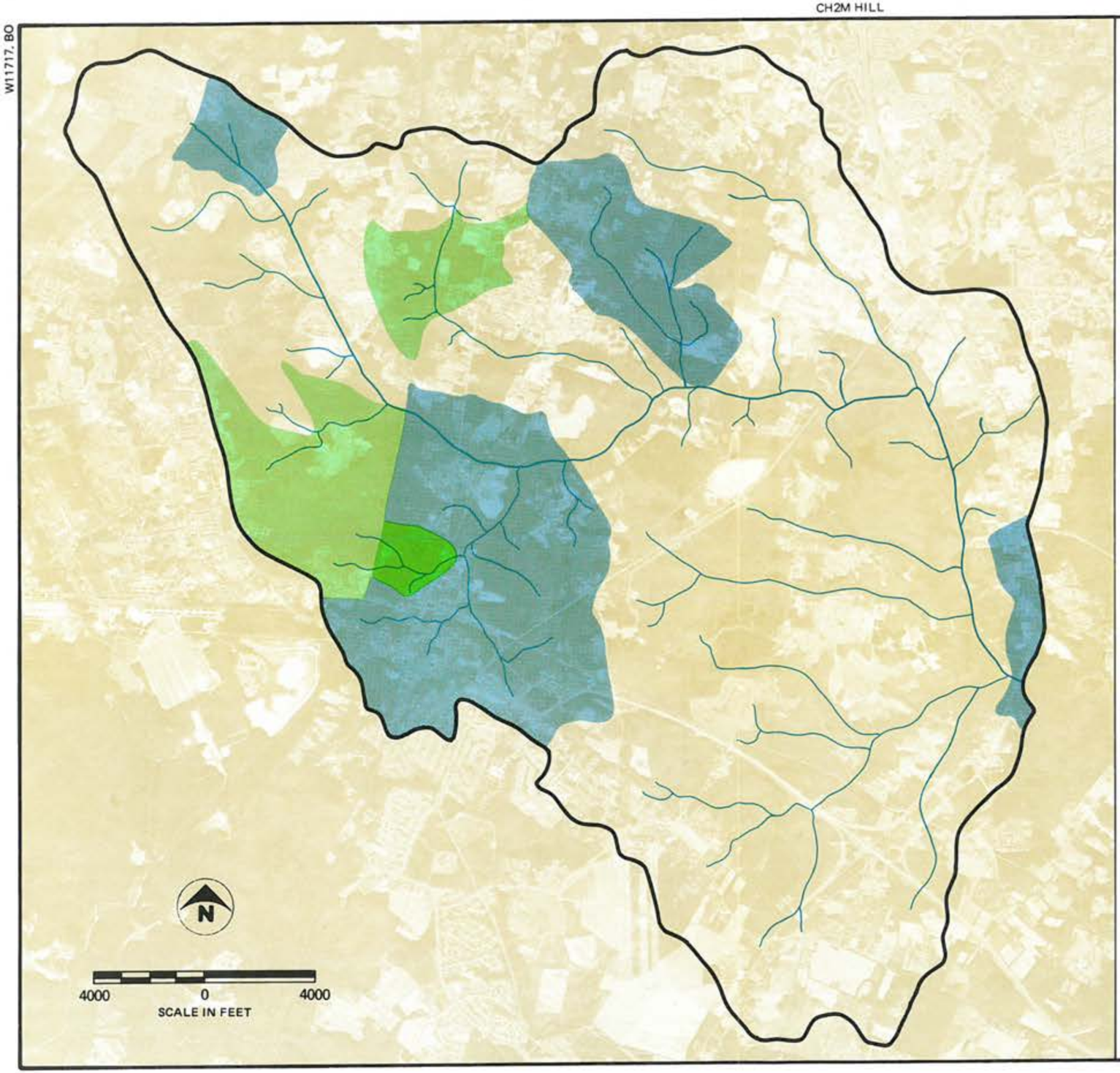

INCREASE IN CURVE NUMBER

LEGEND

- Less Than 25% Change
- 25-50% Change In CN
- 50-75% Change In CN
- Greater Than 75% Change

FIGURE 4-13: Increase In CN's As A Result Of Ultimate Urbanization

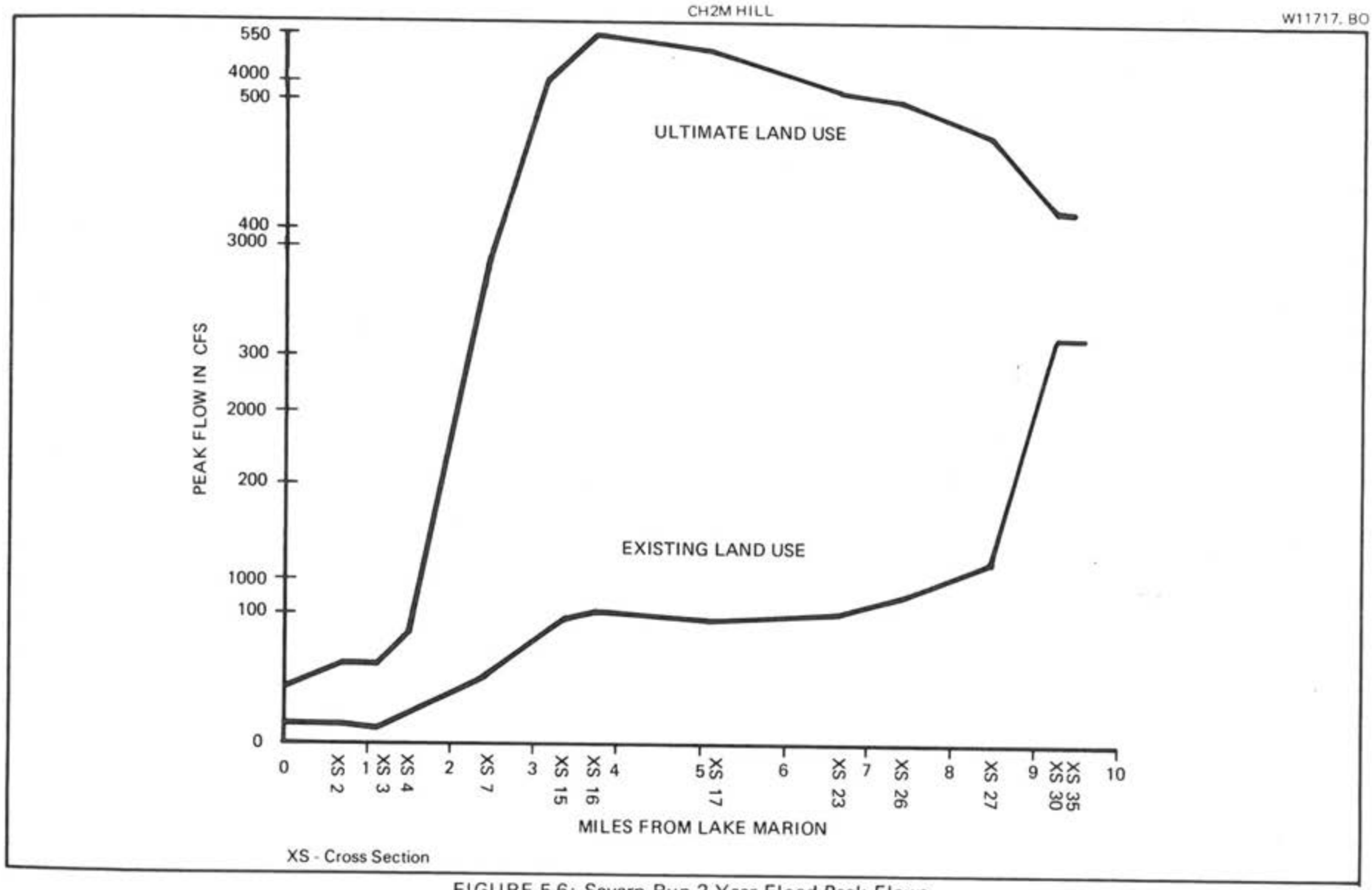

FIGURE 5-6: Severn Run 2 Year Flood Peak Flows

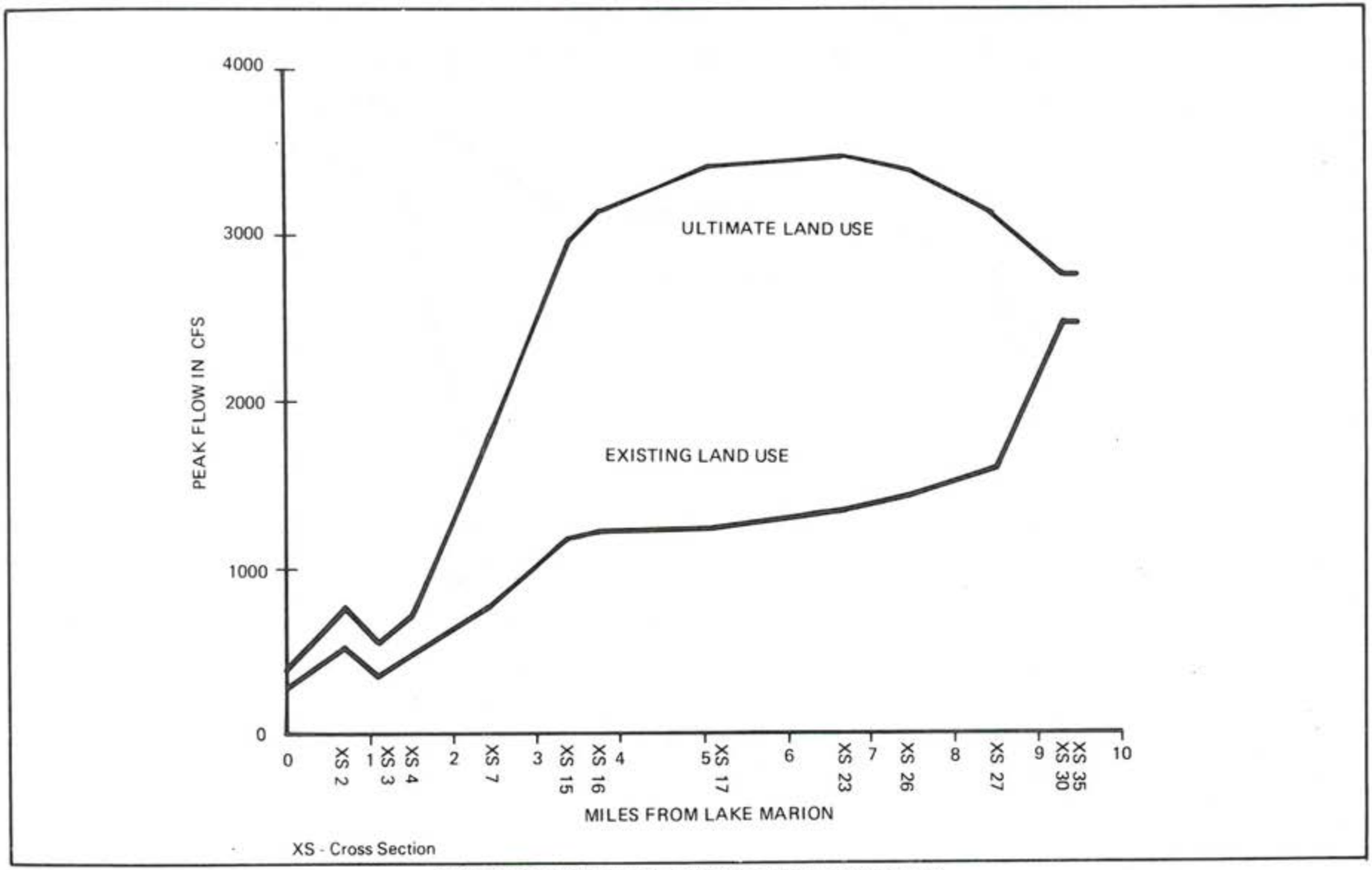

FIGURE 5-7: Severn Run 100 Year Flood Peak Flows

Branch. The drainage area for Jabez Branch is predominantly composed of group B soils which have a higher runoff potential than the group A soils which make up the rest of the Severn Run watershed. This results in the large peak flow for Jabez Branch. The peak flow for Jabez Branch changes very litle for the ultimate land use condition because the area will experience minimal development. As a result, the peak flow at Route 3 remains nearly constant for the ultimate land use condition, even though Middle and Lower Severn Run experience significant increases in the peak flows.

Also note that the peak flows for the middle Severn Run are almost constant for a given land use condition; i.e., existing or ultimate. In this region, the incoming tributary flows are nearly balanced by the attentuation of the flood peak due to channel routing. Severn Run has wide flood plains with significant flow resistance because of the high density of brush and trees. The flood plains act to store water and hence reduce the flow, while the brush and trees slow down the flow of water and reduce its peak flow.

Although Severn Run is ungaged and hence TR20 could not be calibrated to observed flows, an comparison of the simulated flows to flows from nearby gaged watersheds showed the simulated results to be quite reasonable.

FLOOD PLAIN MAPPING AND WATER SURFACE ELEVATIONS
(Chapters 3 and 6)

FLOOD PLAIN MAPPING

Flood plains are the land areas adjoining a stream or watercourse which become inundated during or after a storm. Flood plain mapping is a prerequisite to any

management strategy designed for the protection of watersheds. Such mapping delineation not only defines present and potential problem areas, but also allows for their regulation and management, thereby precluding expensive public works or disaster relief measures.

Flood plain maps have been prepared for major streams within the Severn Run watershed and, by reference, are incorporated as a part of this study. A typical flood plain map shows streambed profiles, location and hydraulic characteristics of structural crossings (bridges), water surface profiles, and areas inundated by 2-year and 100-year water surface profiles (Figure 6-1). Profiles were also computed for 50-year, 25-year, 10-year and 5-year design floods. Figure 3-7 shows the streams studied in Severn Run for which flood plain maps were prepared, and provides an index to the flood plain maps. The maps are available for review at the Office of Planning and Zoning.

WATER SURFACE ELEVATIONS

Water surface elevations are needed in order to plot plan and profile sheets. The elevations were determined using the U.S. Army Corps of Engineers HEC-2 computer program to perform hydraulic backwater analyses. Hydraulics is the study of water in motion, and for this study, the hydraulic analysis consists of studying the floodwaters in the Severn Run watershed once they have reached a stream.

The flooding in streams was analyzed at discrete locations along each stream where cross section information was collected. Cross section locations were chosen such that stream characteristics did not change significantly between sections. In the 22 miles studied, approximately 175 sections were required to adequately describe the hydraulic flow characteristics of the stream.

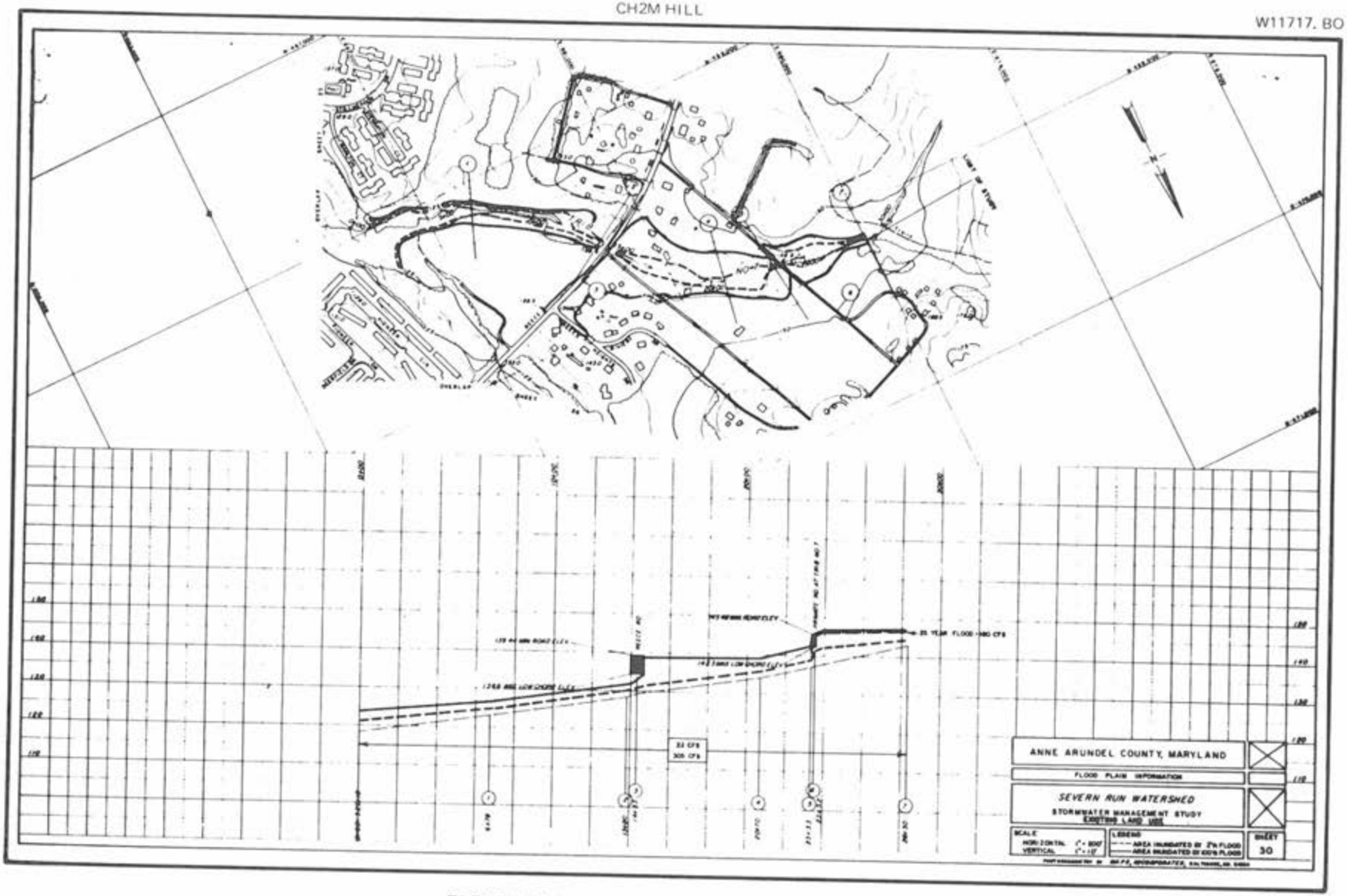

FIGURE 6-1: Sample Plan and Profile Sheet

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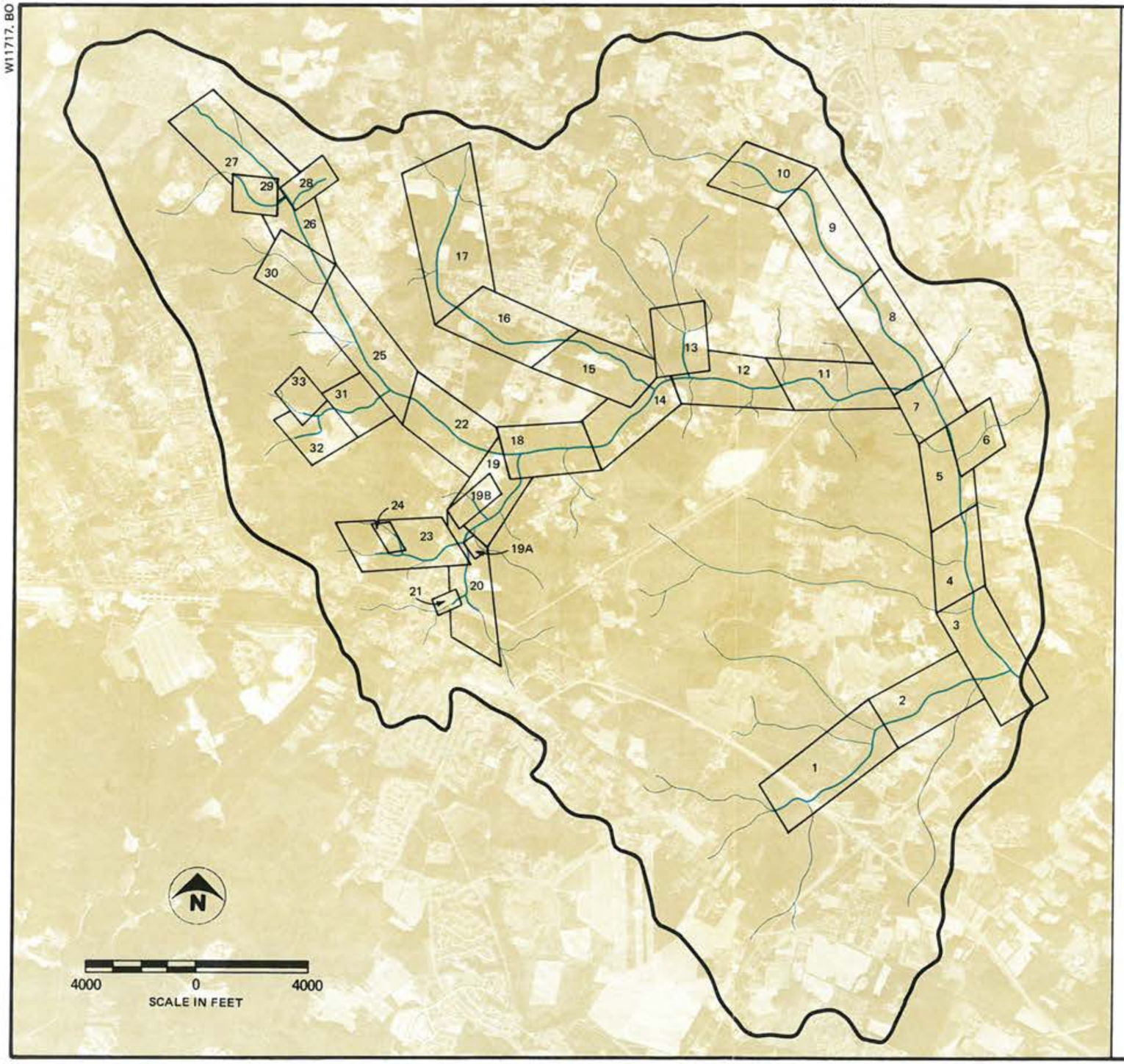

1 Plan And Profile Sheet Number 1

FIGURE 3-7: Plan And Profile Map Index

HEC-2 is an excellent tool for testing hypothetical changes in the watershed being studied. After the program is set up for existing conditions, future conditions can be analyzed with a minimum of effort. Changing flood flows for future land use, removing or rearranging bridges, straightening or clearing the channel, widening culverts and filling in parts of the flood plain are some of the changes which can be considered.

The hydraulic analysis and the plan and profile sheets were used in the determination of flooding problems.

PROBLEMS (Chapter 7)

In order to formulate workable alternatives to deal effectively with problems resulting from stormwater runoff in the undeveloped as well as the developed areas of the Severn Run watershed, the affected areas must first be identified. The areas of concern are flooding, construction site erosion, stream channel erosion, and environmental and water quality problems or opportunities. Management alternatives, specific recommendations and implementation methods are discussed in other chapters.

FLOODING

Three categories of flooding problems are considered--roads, developed areas, and planned developments. Criteria used to identify problem areas include the existing and ultimate 100-year flood plains, the hydraulic capacity of stream crossings, and planned changes in land use. The 100-year flood plain as delineated on the existing and ultimate land use plan and profile sheets was the basis used to identify problems relating to developed areas. The ability to

adequately pass the 100-year flood for state roads and the 50-year flood peak for county roads was the basis to determine problems at stream crossings.

Roads

Roads impacted by flooding are listed in Table 7-1 and shown in Figure 7-1. Table 7-1 gives the depth of the existing and ultimate 100-year flood peaks over the top of the road and the percent chance of the road's being flooded in any year. Those roads with an asterisk are not capable of passing the 50-year flood and are considered to be potential problems. The numbers on Table 7-1 are keyed to Figure 7-1. The most crucial problems are Telegraph Road, Reece Road and Burns Crossing Road.

Developed Areas

Six houses, two trailers, a barn, and several sheds are subject to some flooding. The affected areas are shown in Figure 7-1 and summarized below.

No.	Location	Plan & Profile Sheet No.	Problem
1	Upton Road area	9	A barn and shed are flooded.
2	Rogers Lane	16	Beaver Creek barely floods a house and shed.
3	Diamond International Corp. area	17	Several shacks, sheds and trailers are flooded.
4	Reece Road area (This is identical to flooded road #2)	30	Five houses, a pool, a private road, and ruins of a house are flooded.

Table 7-1
Roadway Flooding

Problem Number and Name of Road	Stream	Depth of Flooding For 100-Year Flood (feet)		Chance of Being Flooded in Any Year (percent)	
		Existing	Ultimate	Existing	Ultimate
STATE ROADS					
1. Telegraph Road (170)	Beaver Creek	1.2	1.7	2-4*	>50*
2. Reece Road (554)	Reece Road Br.	0.2	2.2	4-10*	20-50*
COUNTY ROADS					
3. Burns Crossing Road	Beaver Creek	1.4	2.0	4-10*	20-50*
4. Burns Crossing Road	Severn Run	1.8	3.5	4-10*	>50*
5. Old Mill Road	Severn Run	1.0	4.0	10-20*	>50*
6. New Cut Road	Broad Branch	0.5	0.6	2-4*	2-4*
7. Upton Road	Broad Branch	0.6	0.9	2-4*	10-20*
8. Lokus Road	Picture Frame Br.	-	0.3	<1	>50*
9. Gambrills Road	Jabez Branch	1.0	1.5	4-10*	4-10*
10. Hog Farm Road	Jabez Branch	1.1	1.2	20-50*	>50*
11. Dicus Mill Road	Severn Run	3.8	5.0	4-10*	10-20*
12. Jackson Grove Road	Jackson Grove Br.	0.6	1.9	4-10*	>50*
13. WB&A Road	Beaver Creek	-	0.7	<1	10-20*
14. Private Road	Reece Road Br.	0.8	0.9	4-10*	20-50*

* Indicates flooding by the 50-year storm

Planned Developments

Future developments should not be permitted within the 100-year flood plain. The plan and profile sheets can be used as a guide to restrict development for the areas considered in the hydraulic backwater analysis. An area not considered in the detailed hydraulic analysis that will influence future development plans is shown in Figure 7-2. The area is upstream of two restrictive railroad culverts on Picture Frame Branch and is zoned for a town center. As shown in Figure 7-2, a significant area--5.7 acres--is flooded due to the backwater from the culverts. This flooded area could easily be designed into the town center as a lake, the projected land use could be changed to reduce the flood peaks, or the culverts could be enlarged to pass the flows. This latter option is not recommended since it would result in flooding Telegraph Road. Creative planning could easily incorporate the needed storage volume in the site plans for the town center. The use of a fountain in a permanent wet lake would keep the water aerated and "fresh." A regular maintenance program would be needed to remove sediment from the pond, or it would fill up and not provide the needed 25 acre-feet of storage capacity.

WATER QUALITY

Water quality concerns should be based on the intended use of the water. Severn Run has a Class IV Recreational Trout Water classification. Rainbow trout with some brook trout are stocked in Severn Run in the spring and largely fished out by early summer. No attempt is made to spawn trout in Severn Run; it is solely a put/take trout stream. However, there are several species of fish that are indigenous to the run, and along with the stocked trout, make Severn Run a popular game fishing stream.

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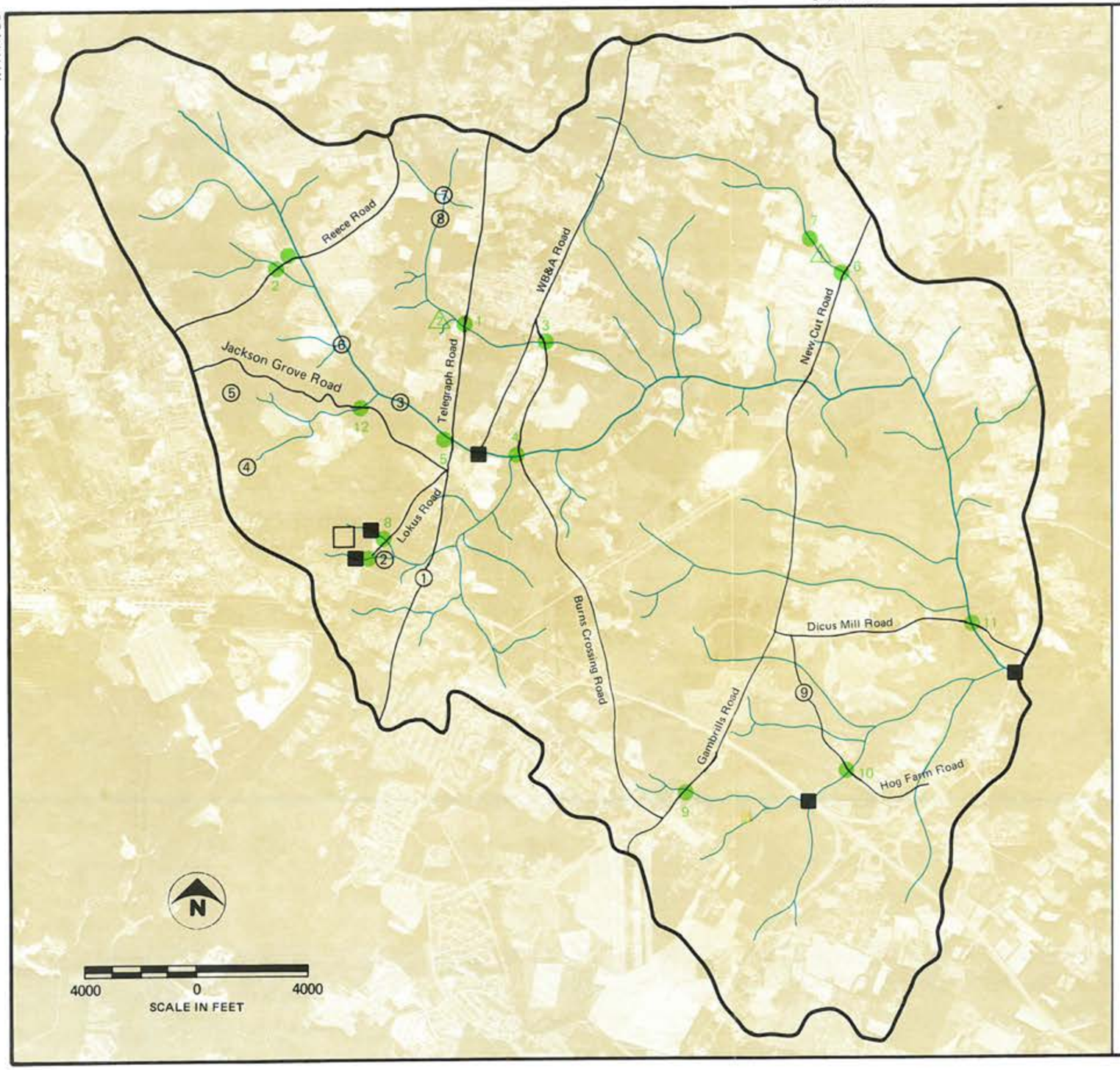

LEGEND

- Restrictive Culvert or Bridge
- Flooded Bridges Or Roads
- Inundated Structures
- Flooding At Proposed Town Center
- ① Trash And Dump Sites

FIGURE 7-1: Flooding Areas And Approximate Loacations Of Trash And Dump Sites

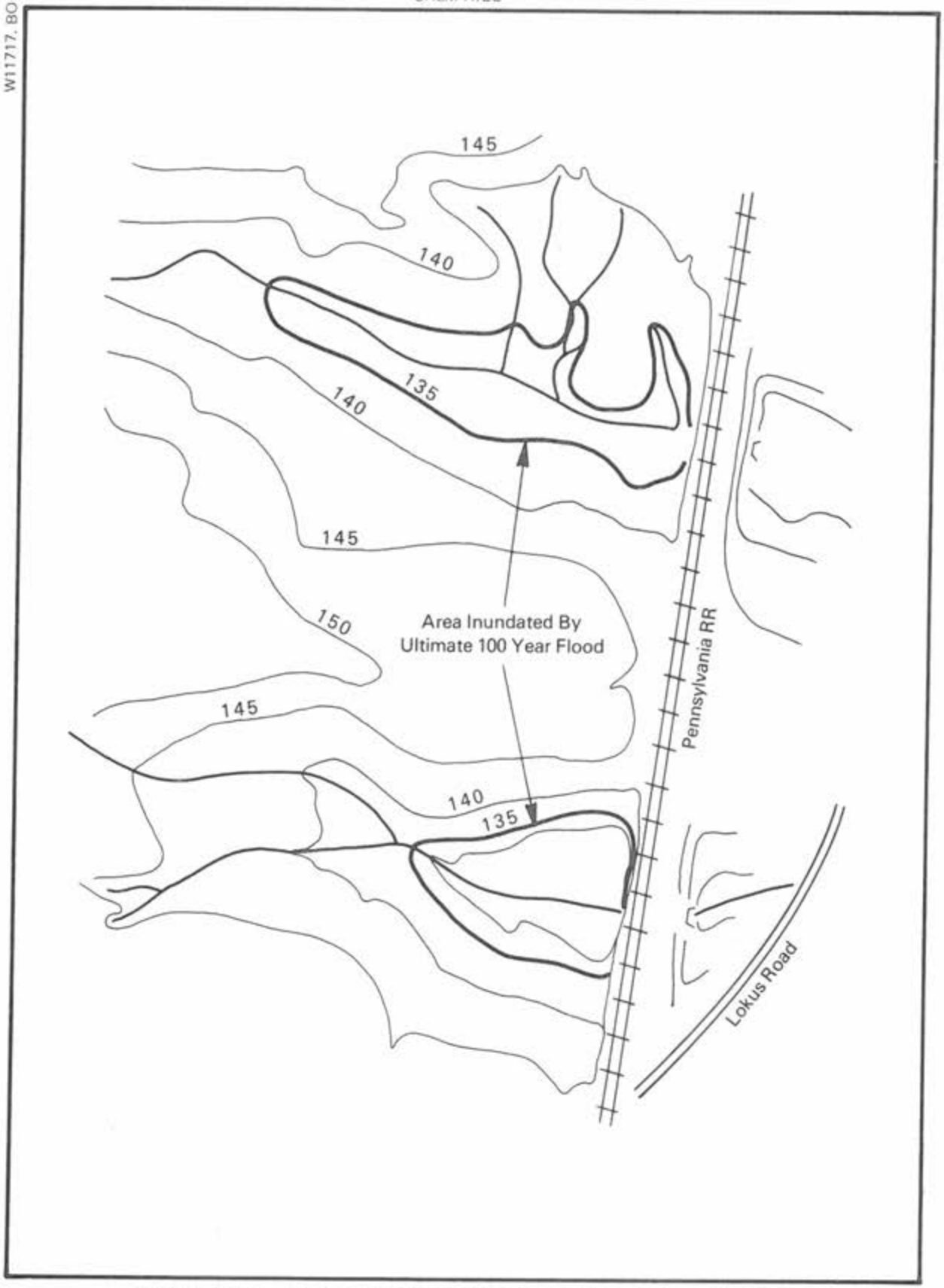

FIGURE 7-2: Flooding In Area Designated For Future Town Center In Picture Frame Branch Watershed

The locations of the water quality sampling sites are shown by Figure 7-3. Three potential problems are evident from the limited data; water temperature, pH, and fecal coliform. The water temperature problems were limited to Picture Frame Branch and Severn Run just downstream from Picture Frame Branch. There are several industries that discharge cooling water to Picture Frame Branch and thereby raise the temperature. The industries now have holding ponds with the intention of allowing the effluent to cool below 75°F prior to discharging to Picture Frame Branch. The last sample of the area impacted by the industries was in 1976, so it is not known if thermal pollution from the industries is a current problem.

A frequently-occuring violation is low pH which, except for one case, is too acidic to be in the desired range of 6.5-8.5. Most of the values are only slightly below 6.5 and may well be natural values for Severn Run, since no known point sources or nonpoint sources should contribute to low pH values. The low values occur throughout Severn Run, further indicating a possible natural source.

Five out of six recorded fecal coliform values are well in excess of state standards. There is an insufficient number of samples to tell if this is a chronic problem. Possible sources of fecal coliform include: wild animals, pets, farm animals, failing septic systems, leaking sanitary sewers, or pumping station overflows. There is an abundance of animal life in the watershed that could be a source of the fecal contamination. Coincident measurements of fecal coliform and fecal streptococci can be used to determine if the source is most likely of human or nonhuman origin. Reported failures of septic systems have occurred in the Ridgeway, Elmhurst, Oakdale, Danza Village and Clark Heights subdivisions. A separate study

of septic systems is required to determine how extensive failing systems are and whether they contribute to water quality problems.

There is one recorded high turbidity value. There would be many more if wet weather data were collected. Observation of Severn Run during and after a rainfall event shows that very turbid conditions exist. Future water quality studies should include sampling during wet weather conditions.

The BOD, dissolved oxygen, and nutrient levels show no problems, except for one dissolved oxygen value on Picture Frame Branch. The nutrient levels are fairly typical for a stream with no major point sources of effluent discharge. Again, wet weather data should be taken to see if the agricultural activities and urban runoff significantly contribute any nutrients.

Lake Marion has not been sampled for water quality purposes, but personal observations indicate that the lake has an algae problem. This is common for urban lakes and typically results in low dissolved oxygen levels near the lake bottom. The contributions of algae and water with low dissolved oxygen levels from the lake could create problems for Severn Run. Future water quality studies should consider the existing sites and additional sites at Lake Marion, Hog Farm Road, WB&A Road on Beaver Creek, and at/or below Route 3, as they appear in Figure 7-3.

A nonpoint source pollutant that is frequently encountered within the watershed is trash dumps and debris in and near the streams. Numerous trash dumps were sighted during field trips to the watershed and these are not only eyesores, but also a potential source of pollutants--especially oil and grease, metals, COD, solvents,

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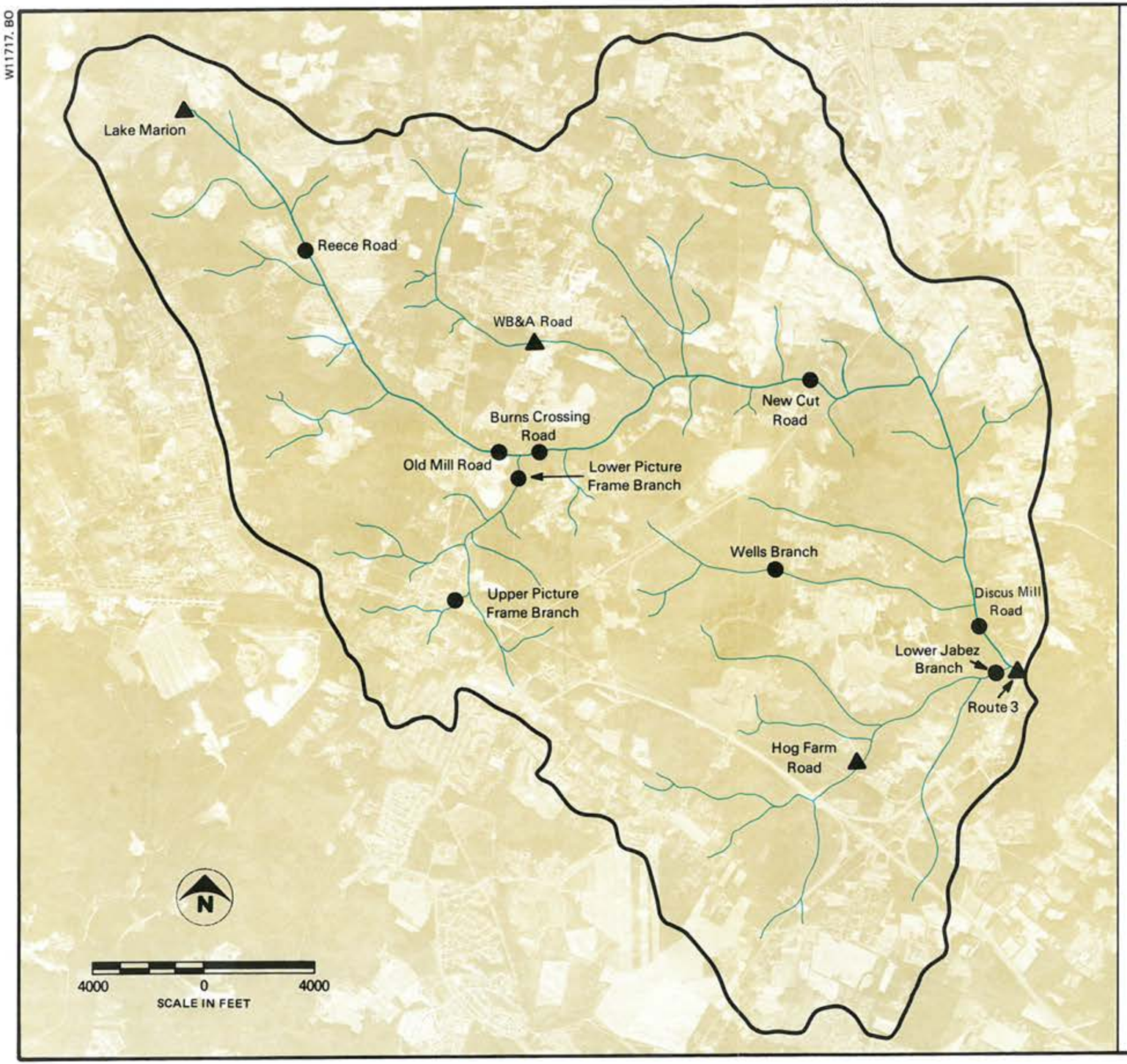

SAMPLING STATIONS

LEGEND

- ● Existing Stations
- ▲ Additional Recommeded Stations

FIGURE 7-3: Water Quality Sampling Stations

and other potential toxins. The streams in the vicinity of most of the dumps were littered with debris washed off or carried from the dump.

Several abandoned cars were found in Severn Run, which is indicative of a general lack of concern for the stream. Industrial dumps without runoff controls were also sighted. Stricter enforcement of dumping and littering laws is needed, as well as a general public education program.

CONSTRUCTION SITE EROSION

Severn Run is a natural sandy-bottomed stream that is additionally subject to some fairly severe erosion and sedimentation problems. Two forms of erosion are considered--land surface erosion and, in the next section, stream channel erosion. Both are naturally occurring phenomena; problems arise when the processes are accelerated or adversely modified by man's activities.

Land surface erosion causes several potential problems. The removal of the top layers of soil constitutes a valuable resource loss that is very difficult and expensive to replace. The eroded soil must eventually settle somewhere, and it frequently does--in streams and estuaries or on downstream land surfaces. Sedimentation in streams and estuaries can cover bottom organisms, resulting in their death or relocation, which has subsequent impacts on the remainder of the ecologic system. Auld and Schusel have reported that white perch hatching and yellow perch larvae survival are reduced by high sediment concentrations. Sediment is also frequently the carrier of numerous pollutants which can have adverse biological effects. Deposited sediment can fill in the stream channel, reducing its ability to transmit floodwaters and thus increasing flooding problems.

Within the Severn Run watershed, land surface erosion results largely from construction and agricultural activities. Figure 7-4 is a soil erodibility map derived from the Anne Arundel Soil Survey. Soils that have undefined erodibility are shown by blank areas on the map. Approximately the northwestern two-thirds of the watershed consists of very highly erodible and highly erodible soils. Unfortunately, this same area is planned for the greatest degree of urbanization (refer to Figure 4-12, Ultimate Land Use), while the moderately and low erodible areas will remain rural. Obviously, the potential for severe land surface erosion problems due to construction are great. Without strict erosion controls, the Severn Run, its tributaries, and the Severn River could experience serious sedimentation problems and the watershed will lose a valuable resource--its topsoil.

Observed problems were noticed just downstream of Route 3 where a sand bar extended two-thirds across the width of the stream. This area also has several inches of relatively loose sediment, partially accounting for the large number of aquatic plants and lack of aquatic invertebrates. Similar conditions were observed at Dicus Mill Road, New Cut Road, Telegraph Road, and downstream from Jacobs Road.

A very rough estimate of the soil loss due to uncontrolled (no erosion or sediment controls at all) construction site erosion over the next 20 years is 650,000 to 950,000 tons or 7.8 million to 11.7 million cubic feet of soil (assuming a specific gravity of eroded soil equal to 2.65).

Based on field inspections in October 1978 and January 1979, the Maryland Department of Natural Resource found

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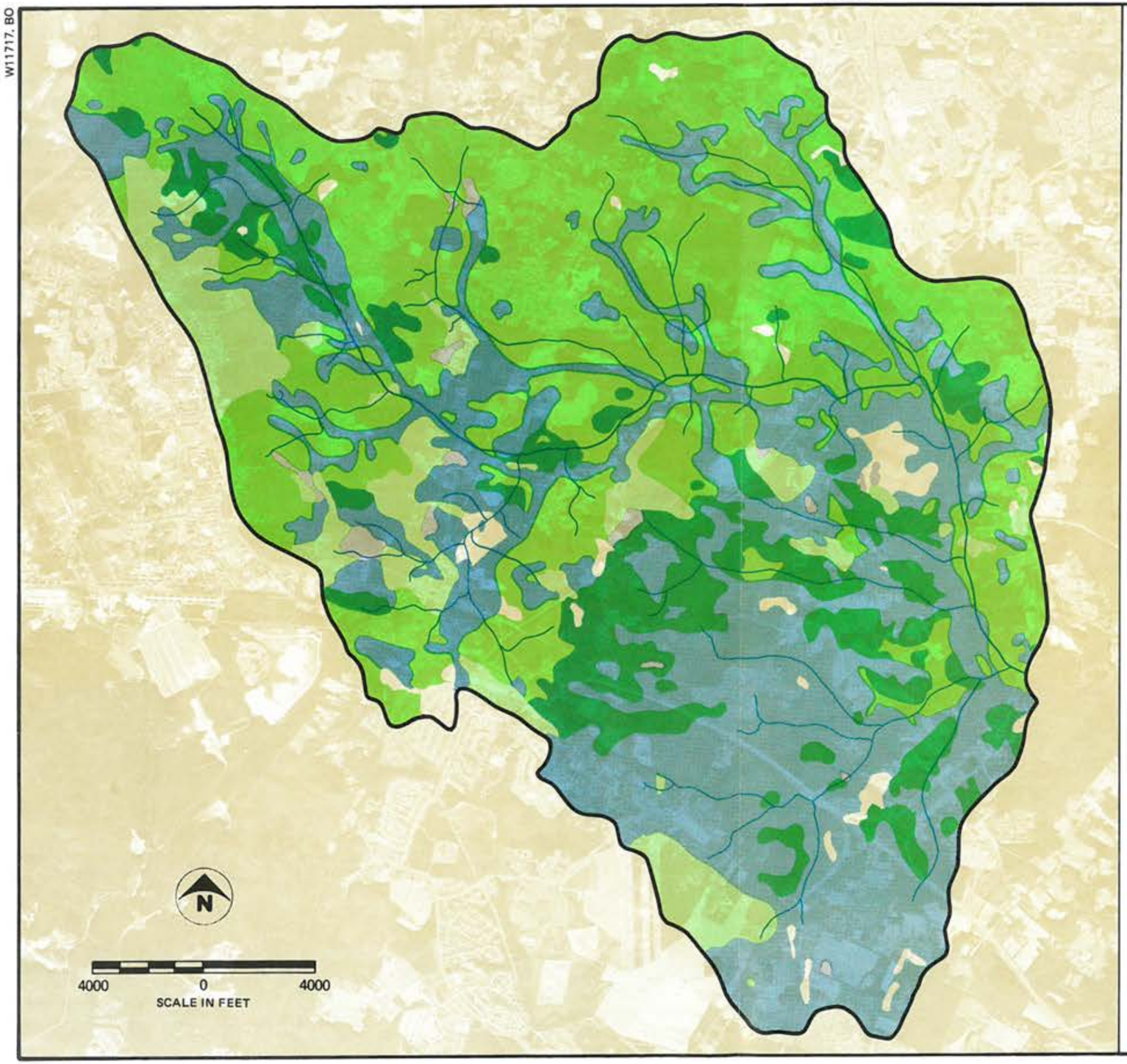

LEGEND

- Very Highly Erodible If Dried, Subject To Wind Erosion
- Very Highly
- Highly
- Moderate
- Low

FIGURE 7-4: Soil Erodability Map

Anne Arundel County's Sediment Control Program unacceptable. Another inspection was made in October 1979, and the County's program was found to be acceptable.

STREAM CHANNEL EROSION

Stream channel erosion is the widening or deepening of a stream's banks or bottom. It is determined in part by the nature of the bottom and side material, the stream gradient and alignment, and the flow in the stream. There are three major processes in stream channel erosion: hydraulic action, solution, and corrasion. Hydraulic action results from the force of the water striking the stream channel. It is a function of the streamflow and channel materials. The water flowing in a stream dissolves some of the channel material while corrasion is the hitting of transported soil particles against the channel, causing removal of some channel material.

It must be recognized that stream channel erosion is a natural process of a stream reaching an equilibrium with its flow and channel materials. Accelerated stream channel erosion can become a problem when increased flows due to urbanization, forest clear cutting, and other land changes cause the stream to seek a new equilibrium. It is generally thought that a stream channel reaches an equilibrium with the 1.4- to 2-year flood peak (bank full discharge) and that large floods have only a temporary effect on the channel width and depth.

When urbanization or other factors increase the flows in a stream, the channel will adjust itself until the bank full discharge meets two conditions (Wolman and Leopold).

1. The discharge can maintain the channel shape without scour of the banks or bed, and without sediment deposition.

2. The banks are not topped frequently enough for berm buildup to be appreciable.

This discharge is close to the 2-year discharge. Therefore, the 2-year storm will largely control stream channel erosion.

Figure 5-6 (page 10) shows that significant increases in the 2-year peak flow are to be expected as the watershed urbanizes. Very large increases are expected on the Severn Run from Jacobs Road to Dicus Mill Road, on Jackson Grove Road Branch, Picture Frame Branch, and Beaver Creek. Unless the 2-year flood is controlled or stream bank protection measures are taken, considerable stream channel erosion and resultant sedimentation problems can be expected from these areas, up to 360,000 tons or 4.3 million cubic feet of soil.

Land surface erosion from construction sites and stream channel erosion could result in a total soil loss in excess of 16 million cubic feet (1,330,000 tons) of soil over the next 20 years. This is a significant loss of a valuable natural resource and is a problem that must be addressed. Land surface erosion from agricultural areas was not included in this estimate because the Soil Conservation Service has ongoing programs in this area.

POLICIES (Chaper 9)

Various federal, state, and county laws, ordinances and policies apply to watershed management. The problems addressed by state and county ordinances and policies are summarized in Table 2-2.

Table 2-2
Problems Addressed by Existing Ordinances and Policies

Ordinance or Policy	Problems Addressed			
	Flooding	Land Surface Erosion	Stream Channel Erosion	Water Quality and Environment
COUNTY				
General Development Plan	X	X	X	X
Storm Waters 16-77	X		X	
Grading and Sediment Control		X	X	
Subdivision Regulations	X			X
Zoning Ordinance	X		X	X
Storm Water Management Order No. 1	X			
STATE				
Sediment Control Act		X	X	
Watershed Management Policy	X	X	X	X
Construction on Flood Plains	X		X	X

X indicates that ordinance addresses problem.

RECOMMENDATIONS AND IMPLEMENTATION

(Chapters 2, 8, 11, and 12)

The recommendations presented in the study are based on a consultant's viewpoint of problems noted within the Severn Run watershed and the county as a whole. The county should decide which recommendations warrant implementation, then initiate appropriate programs or changes.

Those recommendations that the consultant feels are most important will be given first, followed by recommendations for each problem area and general recommendations. For the sake of completeness within each section, some repetition may occur.

PRIORITY RECOMMENDATIONS

The most essential recommendations to consider are:

1. An active, multiagency and broad-based watershed management program should be formed that will consider all the topics discussed in this report. The program should be under the leadership of the Office of Planning and Zoning, which has already undertaken the appropriate steps to begin such a program. Other participants should include the Department of Public Works, the Department of Inspections and Permits, the Health Department, interested citizens, appropriate state agencies, the Soil Conservation District and other desired groups.

   The purpose of the watershed management program would be to ensure that decisions and plans for the county take full consideration of watershed problems and characteristics. A key element of the program is the commitment to provide a trained staff knowledgeable in watershed concerns and the necessary computer simulation models. The Department of Public Works and the Office of

Planning and Zoning should have these personnel on a permanent staff basis. The single most important aspect of a watershed management program is the dedication and desire of all involved to work together to preserve and protect the county's watershed resources. A program that just "goes through the motions" will not succeed, while a program that embodies the spirit of watershed management will.

2. Several roads and homes are flooded. Corrective action must be taken to ensure the protection of the county's citizens--its most important resource.

3. The stormwater ordinance needs substantial revision to fulfill its goal of protecting citizens from flood hazards and preventing stream channels from erosion beyond natural conditions.

4. A stormwater management program that allows onsite, offsite, or regional controls should be considered. The effects of controls on downstream flows must be taken into account.

5. The county's sediment control program must continue to improve. The intent of sediment and erosion control should be met--not just the fulfilling of an ordinance. Public works and Capital Improvement Projects should receive the same treatment, inspection, and enforcement as all other projects.

6. An active public education program regarding water quality and ecology must be initiated. The adverse impacts of trash dumps and litter in streams must be stressed, as well as the need for preserving upland swamps that provide unique ecological systems.

7. Future efforts should include water quality and other watershed studies.

FLOODING

Highway Improvements

This section addresses flooding problems that may be solved or greatly reduced by improvements to roadway bridges or culverts. The problems to be solved are

impassable roads, inundated structures, and extensive flood plains due to impounded flows.

Guidance was provided by the Department of Public Works as to which roads to consider. In general, those roads not considered in detail can solve their flooding problems by providing a culvert or bridge opening of 100 square feet.

Method of Analysis

In most of the flooding problem areas encountered in the Severn Run watershed, the problem is caused by inadequate capacity of the culverts under roads. When a culvert is too small to pass the floodwaters, the water backs up behind the embankment and eventually flows over the road. This problem can usually be corrected by enlarging the bridge or culvert opening under the road.

In problem areas where the roadway was high enough above the stream, the required culvert area was computed, using the existing elevation of the roadway. In cases where the roadway was too low to provide the necessary flow area under the bridge, a combination of a larger opening and a higher road or "critical elevation" was used to solve the problem. The 100-year event was used as the design criteria for state roads while the 50-year event was used for county roads.

Improvements as given in Table 2-3 should be made for Reece Road (Rt. 554), Telegraph Road (Rt. 170), and Burns Crossing Road to enable them to safely pass floodwaters. Due to the large number of homes that are flooded by the restrictive culvert, Reece Road improvements should have

Table 2-3
Summary of Recommended Roadway Improvements

Road	Stream	Necessary Increase in Culvert Opening (sq ft)	Necessary Increase in Top of Roadway Elevation (ft)	Resultant Increase in Flow Capacity (cfs)
STATE ROADS				
Reece Road	Reece Road Branch	79	-	475
Telegraph Road	Beaver Creek	74	1.2	690
COUNTY ROADS				
Burns Crossing Road	Severn Run	255	2.2	2150
Burns Crossing Road	Beaver Creek	87	-	450

the highest priority. Telegraph Road and Burns Crossing Road will require that the road be raised and the culvert under the road increased in size. Because flooding behind Reece Road inundates several homes, improvements to Reece Road should receive the highest priority. Details of the improvements are in the main report.

Great care needs to be exercised during the repair and upgrading of these roads to prevent problems in the Severn Run. The potential for locally severe erosion and sedimentation problems is very high. Strict enforcement and inspection of the sediment control plans will be required in order to prevent serious degradation of Severn Run and its tributaries.

There are other potential problems that can be caused by the repair of the roads. These include oil and grease pollution, debris and litter accumulation, solvents or other potential toxics pollution, and destruction of habitat. The agency responsible for the repairs needs to make sure that the construction crews and supervisors are aware of the possible negative impacts and that they take every conceivable precaution to minimize damage to the streams. Spot checks by the Department of Inspections and Permits, the Office of Planning and Zoning, and interested citizens should help assure that these precautions are being vigorously followed.

Structural Damage and Planned Developments

Despite these roadway improvements, two houses, two trailers, and a barn will still be within the 100-year flood plain. The trailers should be moved to higher ground. One of the houses (Rogers Lane) is on the fringe

of the flood plain, so minor flood proofing or flood insurance should be considered. The other house (Reece Road Branch) is well within the flood plain. Purchase of the house by the county, flood proofing, and/or flood insurance are the more feasible alternatives.

The county should consider modifying the subdivision regulations to ban development within the ultimate land use 100-year flood plain for those areas that have undergone detailed hydrologic and hydraulic studies. The Stormwater Ordinance should be changed to allow onsite, offsite, in-stream or off-stream flood control structures and alternatives. The proposed town center will need to provide for the required storage volume of the water impounded by the restrictive railroad culverts, approximately 3.2 acres for the northernmost culvert and 2.5 acres for the lower culvert.

CONSTRUCTION SITE EROSION

Recommendations from DNR, the county's 208 Soil Erosion Committee, and the Severn Run Watershed Management Study should be given serious consideration. The Severn Run Watershed Management Study recommends:

1. A more positive and cooperative attitude should be taken by Anne Arundel County in dealing with the state regarding the unacceptable rating given the county's Sediment Control Program. Further, it must be realized that in order to accomplish a high sediment reduction efficiency, the intent and spirit of erosion and sediment control will have to be willingly accepted and practiced by construction contractors. An inspection program, no matter how diligently applied, cannot force a high percentage of

sediment removal efficiency throughout the county. It will take the resolve of the citizens of Anne Arundel County to let contractors know that they demand sediment control. Violations or suspected violations need to be reported to the Department of Inspections and Permits, which must receive these reports in a positive manner and act upon them immediately. With close cooperation of the county government, its citizens, the state, and contractors, effective sediment control can be accomplished.

2. The Grading and Sediment Control Ordinance should be revised to require that Anne Arundel County Capital Improvements and Public Works Projects undergo the same review, inspection, and enforcement procedures as all other projects. Complete inspection responsibility should be shifted to the Department of Inspections and Permits.

3. The number of unscheduled construction site inspections should be increased. Unscheduled inspections should be required in the Grading and Sediment Control Ordinance. This requires that manpower requests be met. The addition of two more inspectors is recommended.

4. The Grading and Sediment Control Ordinance should be revised to include the Office of Planning and Zoning's Environmental Resources Section as a reviewing agency for development on slopes greater than 15 percent. This review would ensure that small developments on steep slopes do not adversely impact critical areas or unique ecologic systems. Also, revisions to the Subdivision Regulations which would prohibit construction on steep slopes without retaining a ground cover buffer zone should be considered.

5. An index to the Grading and Sediment Control Ordinance would be helpful. Provisions for construction site entrance mud and dirt removal should be included for sites near environmentally sensitive areas.

6. Sediment control plans should be more preventive than curative. Stopping or reducing erosion by proper planning and vegetative measures is more desirable than the sole use of straw bales or settling basins to trap eroded sediment.

In fact, the following were observed during site visits within the watershed that, if corrected, could greatly reduce the potential for erosion and sedimentation:

1. Natural vegetation was not maintained and protected.

2. Large areas of soil were needlessly exposed for long durations (in excess of 8 months).

3. Very little temporary vegetation or mulching was used.

4. Topography controls were not used to reduce the potential for erosion. It is important to realize the fine but distinct difference between erosion and sediment control. Erosion controls are designed to prevent or reduce soil erosion, while sediment controls are designed to prevent or reduce eroded soil from leaving the construction site. Sediment controls can be consdered curative in nature; i.e., the problem (erosion) has already occurred and the intent is to prevent offsite damage. Erosion controls are preventive in nature. By preventing or reducing erosion, the need for sediment controls diminishes.

   Figure 11-1 can help to explain this difference and illustrate how various controls interact with the erosion process. Preventive (erosion) controls such as vegetation, mulch, diversion dikes, and grading practices act to reduce the detachment or transport of soil. Once the soil has been detached and transported it can be removed by sediment ponds, filtering in straw bales or vegetation, or it could be deposited by slope controls designed to reduce the transport capacity of the runoff. Again, more emphasis should be placed on erosion controls rather than relying solely on sediment controls.

Stream Channel Erosion

The single most important improvement that could be made to reduce stream channel erosion is control of 100 percent

of the increase in the flow of the 2-year storm, rather than 70 percent as called for in the Stormwater Management Ordinance. The effect of the 70 percent control is to reduce but not prevent increased stream channel erosion since the 1.4 to 2-year event (dominant discharge) controls the eventual width and depth at which a stream channel will stabilize. An idea of the possible severity of stream channel erosion is given by the erosion factor. The erosion factor is discussed in Chapter 7 and is the square root of the ratio of the ultimate 2-year peak flow to the existing 2-year peak flow. An erosion factor greater than 2.0--a potential doubling of the channel width--is considered a serious problem. There are 19 subbasins that have serious problems if no controls are used. If controls are used in accordance with the existing bill, the number of subbasins with serious stream channel erosion problems will be reduced to 12, while control of 100 percent of the increase in the dominant discharge should prevent accelerated stream channel erosion.

The existing ordinance results in around a 60 percent reduction in the volume of soil lost when compared to uncontrolled stream channel erosion. However, significant losses of soil still occur. The volume lost is around 1.8 million cubic feet or 150 thousand tons. This is a considerable amount of soil to lose from the watershed, and could have adverse impacts not only on Severn Run, but on the Severn River upper tidal areas as well.

Although some extensive revisions are required, the Stormwater Management Ordinance has some very good sections. Particular strengths of the Stormwater Management Ordinance

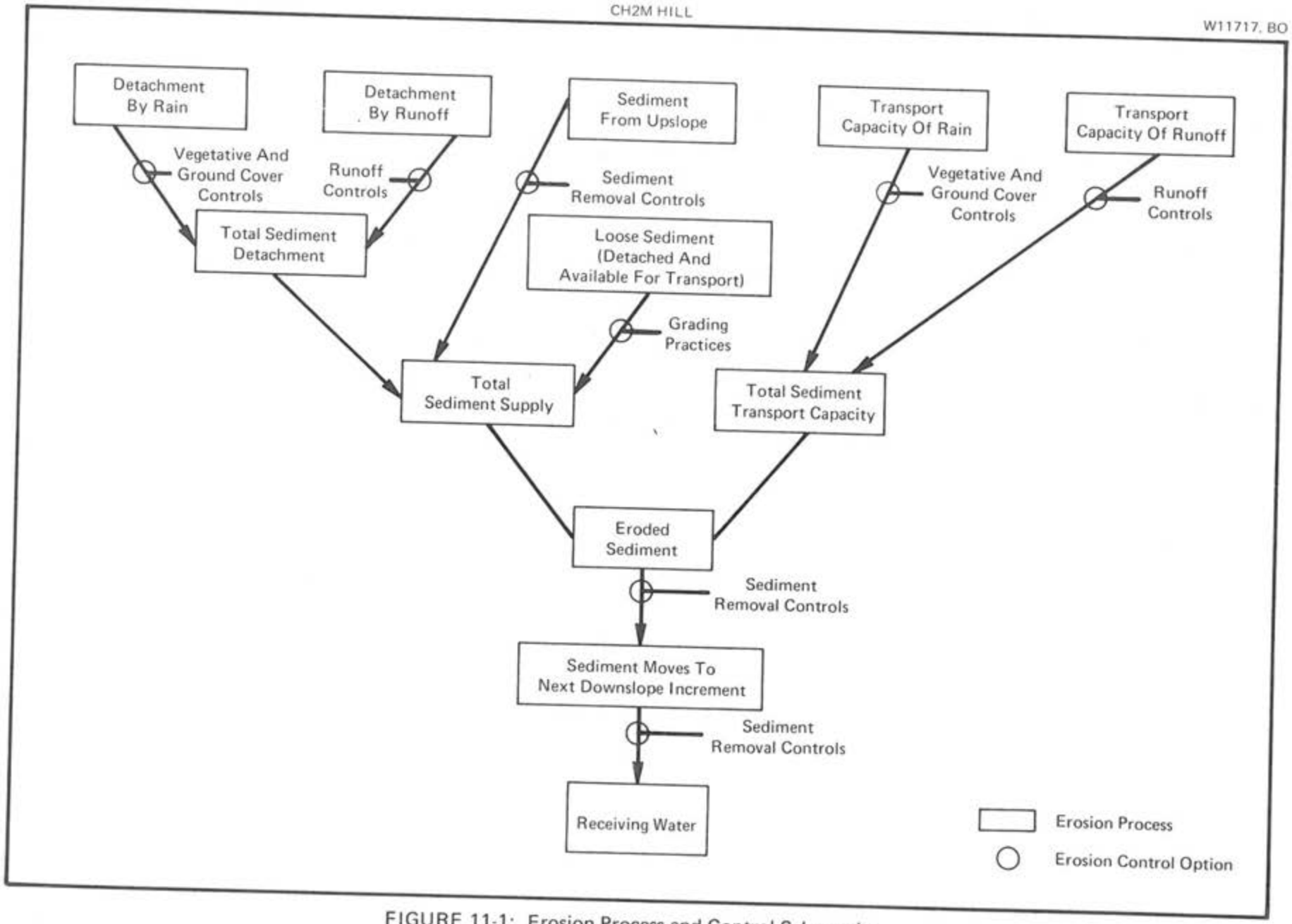

FIGURE 11-1: Erosion Process and Control Schematic

are its application to projects undertaken by the county, the requirement for a construction bond, and either a maintenance bond and fee or a stormwater management account.

Additional recommendations include:

1. Onsite, offsite and regional controls should be allowed. Regional offsite controls could serve several developments, either existing or planned, and would be funded by the county. Eventual users would contribute to a regional offsite management program as their developments are built. Multiple use facilities could be encouraged by the regional offsite management program.

2. The effect of control measures on downstream peak flows should be considered in the design and choice of control alternatives.

3. Going to a more regional concept of management will require changes in the Department of Public Works' Storm Water Management Order No. 1. As currently written, the order does not provide for the ability to develop runoff hydrographs. It should allow for methods developed by the SCS or other methods acceptable to the Soil Conservation District to be used. Runoff hydrographs are required so that the effects of multiple developments adding their flows together can be analyzed, as well as the effects of reservoir routing on the timing of hydrographs. The routing techniques called for in the ordinance cannot properly evaluate hydrograph lags due to reservoir routing. This can be very important in some cases, since it is possible for a structure to not decrease downstream peak flows and to make them even larger.

4. The Department of Public Works and the Office of Planning and Zoning should become familiar with hydrologic and hydraulic modeling and analysis techniques. In order for a regional concept of stormwater management to be effectively implemented,

an engineer assigned the responsibility of using TR20 will need to have as his primary responsibility the analysis of stormwater management alternatives. If this engineer is burdened with other responsiblities that overly detract from the time he can spend on stormwater and watershed problem analysis, the recommended regional concept may well create downstream problems or inadequately accomplish its goal. At first there may not be a very large demand for the use of TR20. However, as additional watersheds are studied and the usefulness of hydrologic computer simulation is recognized, using TR20 could develop into a full time job. In order to meet this eventual demand, two new engineers above current staffing should be added to the Roads Design Division. Hiring may be staged to allow the demand for the use of TR20 to develop. One engineer should be hired soon to allow for the completion of training on TR20 as well as some "hands on" experience.

5. Some of the control alternatives discussed in Chapter 8 have met with operational difficulties in other Maryland counties. Infiltration devices can be easily clogged by oil and grease and should be used for rooftop drainage only. Rooftop storage is difficult to inspect and easily subject to tampering. Because of this, rooftop storage should be linked to government buildings and large commercial or industrial buildings. Parking lot storage needs to be carefully designed to minimize automotive and pedestrian hazards. Porous pavement for parking areas shows great promise, but long-term (5-10 years) tests are not yet complete.

WATER QUALITY AND ENVIRONMENTAL CONCERNS

The programs of the Office of Planning and Zoning and the 208 agency should be given continued support. A water quality study that obtains physical-chemical and biological data should be initiated for the Severn Run because existing data is insufficient to assess water quality problems and sources.

If the number of dumps and amount of litter were reduced, the aesthetic value of the Severn Run and its tributaries would greatly improve. The general public should be advised that our streams are not garbage receptacles, but are instead a valuable resource that must be protected.

A means of preserving the unique biota of some of the upland swamps should be determined. One suggestion is the inclusion of these areas as open space in low-density residential developments. The Severn Run Environmental Area should be expanded beyond New Cut Road toward Burns Crossing Road.

The Subdivision Regulations should be modified to prevent the clearing of trees adjacent to streams, particularly for headwater tributaries which often are not subject to the ban on development within the 100-year flood plain. Sediment and pollutants transported by sediment are a major problem in the Severn Run. As development continues, nonpoint sources from urban areas will contribute more and more pollutants. Figure 11-3, used with Table 11-10 and the 208 report, describe many of the controls that should be investigated for urban nonpoint source pollution control.

CASE STUDY

To illustrate the principles just discussed, a case study of a section of the Picture Frame Branch area is presented. The area of concern is shown in Figure 11-4. For illustrative purposes, the existing subbasins and land uses were used, except that within subbasin 14 development was allowed in new subbasins 19, 20, and 21. Subbasins 19 and 20 will be assumed to be planned shopping centers, while subbasin 21 is assumed to be a large single commercial establishment. The effects of this development will be investigated.

Table 11-10
Summary of Best Management
Practices For Urban Runoff

Source Controls

- Litter
- Fertilizer and Pesticide Application
- Commercial and Industrial Stockpiles
- Road Maintenance
- Vegetative Debris
- Illegal Storm Sewer Discharges
- Refuse Pickup
- Industrial Spills
- Animal Control
- Road Salting

Air Pollution Control

Accumulated Pollutant Removal

- Street Sweeping
- Private Parking Lot Sweeping
- Animal Control

Runoff Control

- Natural Drainage
- Contour Landscaping
- Swale Drains
- Parking Lot Storage
- Rooftop Storage
- Recreational Area Storage
- Dutch Drains
- Porous Pavement
- Grass-lined Ditches

Conveyance System Cleaning

- Catch Basin Cleaning
- Ditch Cleaning
- Sediment Basin Cleaning

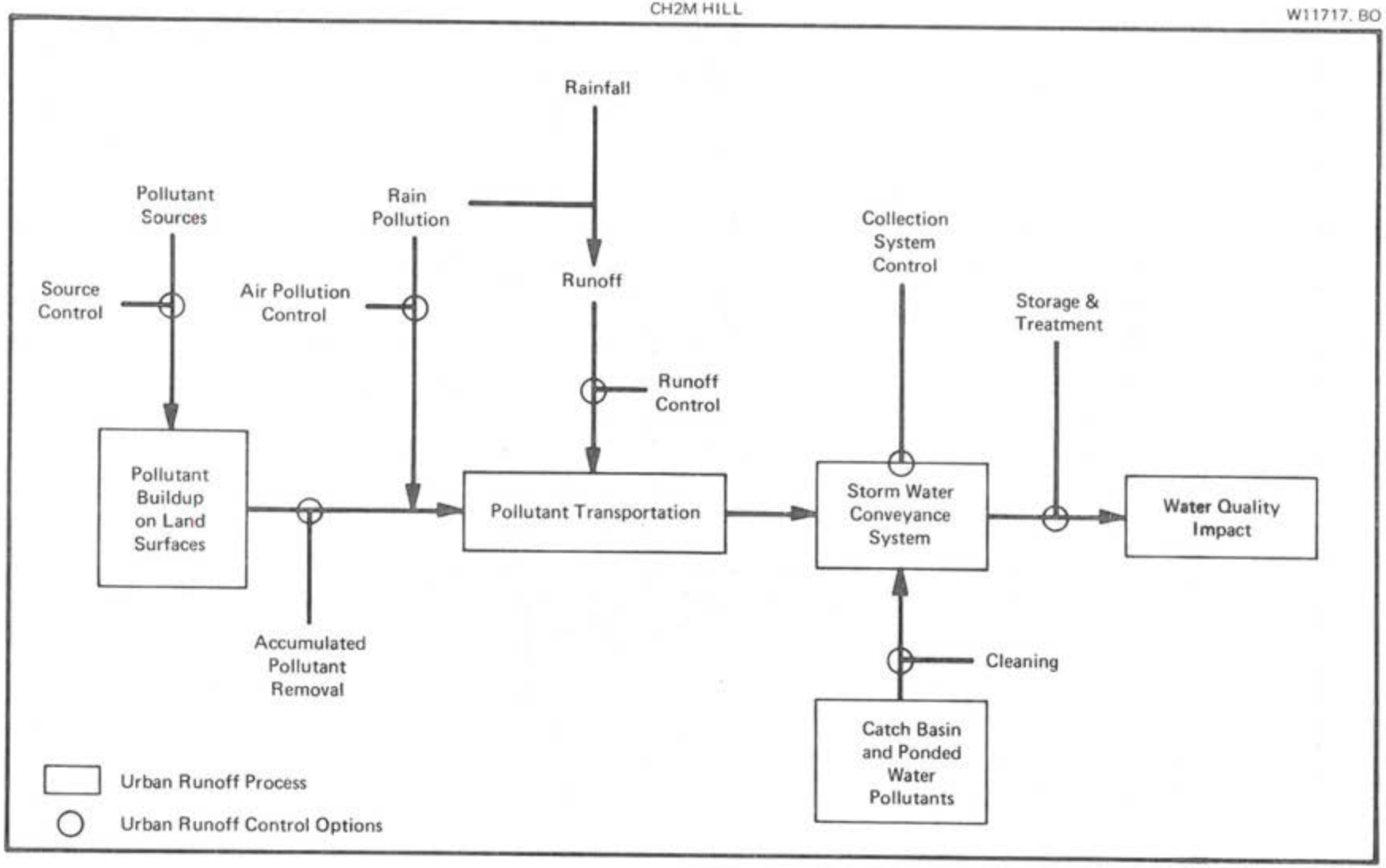

FIGURE 11-3: Urban Runoff Process & Control Schematic

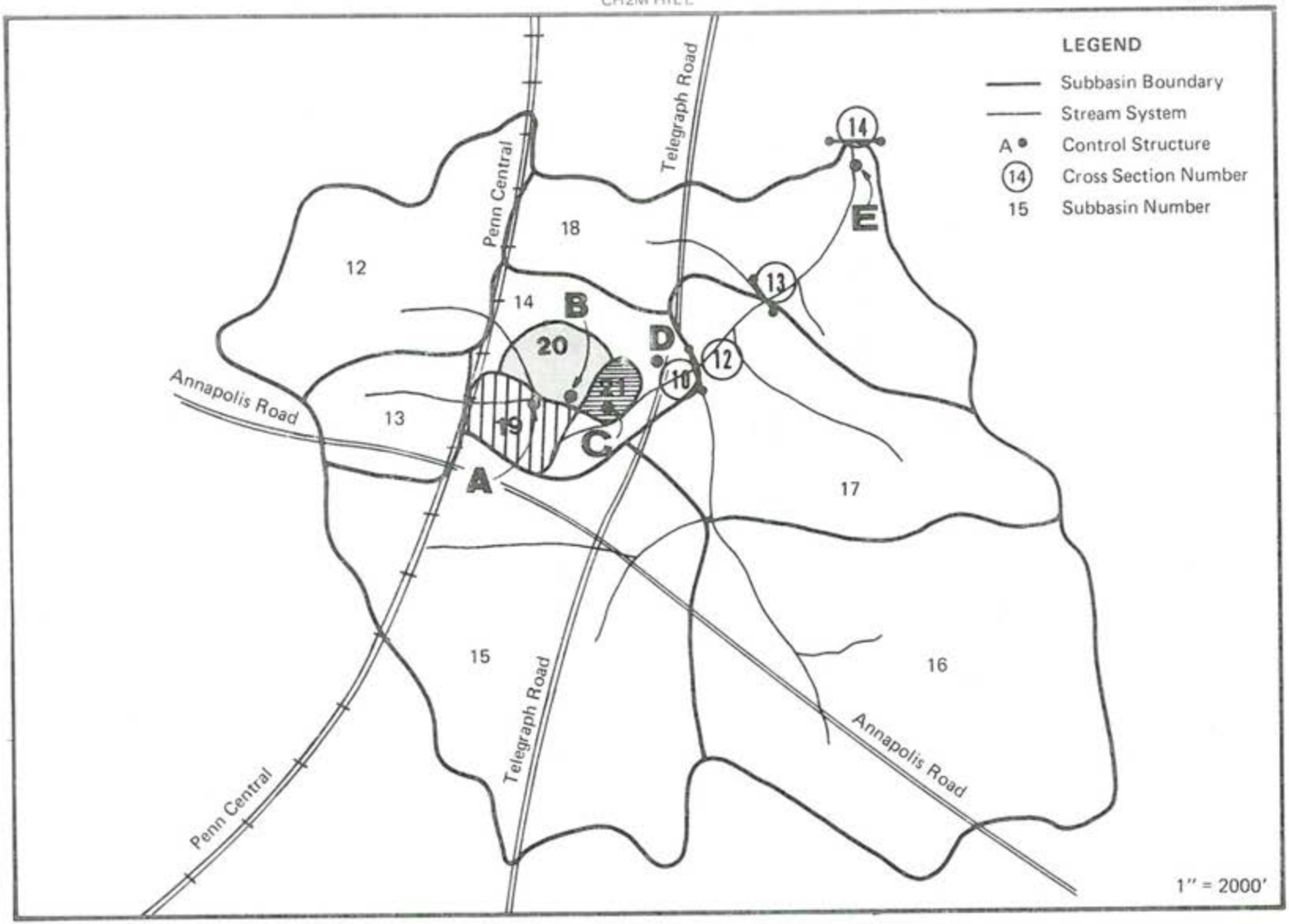

FIGURE 11-4: Picture Frame Branch Case Study

TR20 was used to simulate this development, and the increase in flow peaks and required storage to prevent the increase in runoff are given in Table 11-11. The erosion factors (square root of the ratio of the ultimate 2-year peak flow to the existing 2-year peak flow) for the cross sections considered are:

Cross Section	Erosion Factor
10	5.2
12	1.7
13	1.3
14	1.2

The major problem area for stream channel erosion is downstream from the development on the tributary to Picture Frame Branch (cross section 10). The existing stormwater management ordinance would reduce the erosion factors to:

Cross Section	Erosion Factor
10	3.0
12	1.2
13	1.1
14	1.1

The existing stormwater management ordinance would allow a possible tripling in the width of the tributary. To prevent this, the 2-year peak flow needs to be maintained at or near its predevelopment level.

Numerous control alternatives can be used to reduce the peak runoff rate. These alternatives will not be analyzed in detail; instead, an approach to the problem will be discussed. As recommended earlier, DPW should use TR20 to analyze proposed solutions. Possible alternatives

Table 11-11
Flows and Storage Volumes
For Case Study

Subbasin	Flows (cfs) 2-Year Existing	2-Year Ultimate	10-Year Existing	10-Year Ultimate	100-Year Existing	100-Year Ultimate	Storage (acre/ft) 2-Year	10-Year	100-Year
19	0.0	68.3	2.4	140.6	15.2	199.3	3.33	5.38	8.00
20	0.0	54.7	1.9	112.5	12.1	159.4	2.66	4.30	6.40
21	0.0	27.3	0.9	56.2	6.1	79.7	1.33	2.15	3.20
Cross Section									
10	5.5	150.3	47.4	310.2	185.4	446.6	7.35	11.88	17.53
12	52.7	150.4	287.7	335.3	910.8	983.4	6.99	11.65	17.47
13	54.6	87.4	289.0	338.2	990.8	1,075.5	8.33	12.50	18.05
14	51.4	71.0	263.6	316.9	971.1	1,058.8	6.27	12.54	17.25

include onsite storage ponds (A, B, and C), a regional storage pond (D), a large scale in-stream impoundment (E), rooftop storage, parking lot storage, porous pavement, and underground storage. The effects of onsite storage could be easily simulated with TR20 if a stage-discharge-storage volume relationship were determined for the structures. The effects of timing delays on the peak flows should be investigated.

This area lends itself to a regional in-stream or off-stream storage facility, possibly located at site D in Figure 11-4. An in-stream facility would not reduce the stream channel erosion on the tributary upstream from the structure where the greatest potential for erosion exists. In fact, depending on hydrograph timing relationships, the structure could aggravate erosion problems for the rest of Picture Frame Branch.

An off-stream regional facility could solve the increased runoff problems but may require extensive stormwater conveyance systems to carry the runoff to the facility. Also, overflow precautions need to be taken in the design of the facility in case the volume of runoff exceeds the available storage volume. Delay of runoff from this structure could act to increase downstream peak flows. If such a site were considered, DPW should apply TR20 to the area and determine what impacts the structure would have. Consideration should be given not only to existing conditions in the watershed, but also to planned growth in determining the suitability of possible control alternatives. A regional facility at D could be designed for additional future urbanization and incorporated as a multi-use facility in other potential developments.

Rooftop and parking lot storage can effectively be used for onsite controls. The areas of the subbasins are 0.05 square miles for subbasin 19, 0.04 square miles for subbasin 20, and 0.02 square miles for subbasin 21. Considering subbasin 19 only, the Zoning Ordinance allows 80 percent of the area to be covered with buildings or parking areas. This gives 0.04 square miles or 25.6 acres of impervious area. Fifty percent of the impervious area or 12.8 acres will be assumed to consist of buildings. If these buildings have flat roofs and are designed to store 1.5 inches of rainfall, nearly half the storage required for the 2-year storm could be obtained.

Using parking lot storage of 6 inches on one-eighth of the parking lot, 0.8 acre-feet of storage can be obtained. Combined with rooftop storage, 2.40 acre-feet or 72 percent of the required 2-year storage volume is possible. This significantly reduces the size of additional storage facilities. Up to 3 inches can be stored on rooftops, which would provide nearly all the storage needed for the 2-year storm.

If control of stream channel erosion on Picture Frame Branch were not desired, but control for Severn Run were desired, a structure could be located at site E. The effects of a structure at this location were investigated and found to have essentially no beneficial results due to coincident peaks from Severn Run and the outflow of the structure.

This case study raises several other interesting points. What should be done with the tributary running through the planned commercial development? During the summer

the stream experiences periods of no flow, yet a definite channel and flood plain exist. The Zoning Ordinance calls for the 50-year flood plain to be zoned as open space, and the subdivision regulations, forbid development within the 100-year flood plain. To what extent are these ordinances meant to apply to small tributaries? The county must answer this question to prevent possible future conflicts.

This area is one that was considered in the HEC-2 hydraulic analysis and is downstream of the restrictive culverts under the Penn Central Railroad. If the culverts were enlarged to avoid ponding in the proposed town center on the western side of the railroad, the 50- and 100-year flood plains would significantly increase, since the flow from subbasins 12 and 13 would no longer be reduced by the restrictive culverts and could impact the proposed shopping center. The increased flow could be large enough to create flooding problems at Telegraph Road. The hydraulic analysis of this study used the reduced flows from the culverts. If the culverts were enlarged, HEC-2 would have to be rerun to determine whether Telegraph Road would be flooded or back water up and inundate a large portion of the land planned for development. This case demonstrates the need for the county to have in-house expertise in both TR20 and HEC-2. It also shows that regional or watershed considerations may be required even if onsite storage is initially planned.

This area is one that has severe debris problems in the stream channels. If the channels are to be protected and maintained, the developer or the county should be made responsible for cleaning up the stream. Otherwise, control devices could be impaired or rendered ineffective by blockage with debris.

Because the stream is intermittent, local water quality concerns are difficult to address. However, changing a wooded area to a large shopping center will increase nonpoint source pollutant loads and could adversely impact Picture Frame Branch and Severn Run. Therefore, the area should be considered for the control options that the 208 agency will be formulating.

The proposed development is located in generally highly erodible soils, and without a sound sediment control plan, could produce significant amounts of eroded soil. This eroded soil would probably settle in Picture Frame Branch and could degrade the existing water quality and adversely effect the ecology of the area. Phased construction designed to minimize exposed soil and provide ongoing runoff controls would greatly reduce the erosion potential.

In summary, the case study shows the multitude of concerns that are involved in watershed management. It demonstrates the need for DPW to expand its hydrologic and hydraulic modeling capabilities so that regional concerns can be addressed. Obviously many agencies and departments are involved in watershed planning, and mutual cooperation and communication are necessities for proper watershed management.

General Recommendations

General recommendations include:

1. The Anne Arundel County Office of Planning and Zoning is the appropriate lead agency to coordinate watershed management studies.

2. Future studies should be conducted. The next watershed should have a gaged stream so that the hydrologic computer model used may be calibrated. The use of a continuous hydrologic model should be considered, along with the development of a methodology to address the needs of the Department of Public Works and the Soil Conservation District.

3. The Office of Planning and Zoning and the Department of Public Works should make a commitment to training permanent staff in the theory and use of appropriate computer models (TR20 and HEC-2). A staff member of the Environmental Resources Section should be provided to run the models in conjunction with a staff member from the Department of Public Works.

4. The Office of Planning and Zoning should follow up watershed management studies with water quality studies designed to obtain adequate data to determine problems, pollution sources, and possible control alternatives. Nonpoint sources as well as point sources should be considered. Computer modeling may or may not be a part of a water quality study, depending upon the goals and needs of the study.

5. Groundwater is an abundant resource in Anne Arundel County that needs to be properly managed. Potential problems include saltwater intrusion into the Magothy aquifer and reduction in recharge potential for all aquifers due to urbanization, both within and outside of the county. A potential also exists for pollution of some aquifers from failing septic systems, improperly designed and operated landfills, and wastewater injection. Anne Arundel County should continue to study its groundwater system and implement comprehensive management of its primary potable water source.

6. Current county and state laws call for county government agencies to perform a majority of the design, review, approval, inspection and enforcement of the numerous programs that influence watershed management. The appropriate agencies must carry out and follow through on their existing responsibilities and those additional responsibilities they may acquire in the future.

IMPLEMENTATION AND COSTS

The agencies, their areas of concern for implementing the recommendations and costs are summarized in Table 11-12.

WATERSHED MANAGEMENT PROGRAM

Some initial suggestions regarding the establishment of a watershed management program follow. These suggestions should be considered preliminary and as food for thought rather than as inflexible dictates. An effective, enthusiastically supported watershed management program will have to evolve with time to adequately reflect the county's needs and concerns. Unless the program is genuinely desired by the county it will fail. As stated by Mr. Colby B. Rucker, a member of the Citizens Advisory Committee, "Any plan [program] is only as good as the resolve of the people and their government to make it work."

It is hoped that the recommendations and considerations of this study will lead to the formation of an active, full-time multiagency watershed management program. The agencies involved should include: the office of Planning and Zoning, Department of Inspections and Permits, Department of Public Works, Health Department, Soil Conservation District, Anne Arundel County and 208 staff personnel, and state agencies as the need arises. Representative citizens' groups should be involved in the program.

The purpose of the program would be to ensure that decisions and problems regarding flooding, land surface erosion, stream channel erosion, water quality, environmentally endangered areas, recreation and park areas, land use planning, traffic planning, groundwater, water

Table 11-12

SUMMARY OF SEVERN RUN WATERSHED STUDY RECOMMENDATIONS, RESPONSIBILITIES AND COST

	Recommendations	Agency Responsible	Cost	Status
STATE	Expansion of Severn Run Environmental Area	DNR	Purchase of approximately 440 ac.	On-going project
	Increase culvert opening of Reece Road crossing	SHA	$144,000	Future capital project
	Raise elevation of Telegraph Road 1 Foot	SHA	$160,000	Future capital project
	Periodic monitoring of Industrial Discharges	WRA		Current work element
		SUBTOTAL	$304,000	
CAPITAL IMPROVEMENTS	Increase culvert opening of New Cut Road at Broad Branch	DPW		DPW recommends that this project not be considered for a future capital program.
	Raise elevation of Burns Crossing Road at Severn Run - 2 ft. and increase culvert size	DPW	$432,000	Future capital project
	Increase opening under Burns Crossing Road at Beaver Creek to 100 sq. ft.	DPW	$147,000	Future capital project
	Increase culvert opening under WB&A Road by 35 square feet	DPW		DPW recommends that this project not be considered for a future capital project.
		SUBTOTAL	$579,000	

Table 11-12 (Cont'd)

SUMMARY OF SEVERN RUN WATERSHED STUDY RECOMMENDATIONS, RESPONSIBILITIES AND COST

Recommendations	Agency Responsible	Cost	Status
Two trailers remaining in flood plain move to higher ground - notification of owners	P & Z, Zoning Enforcement, Law Office		*Future Project
Survey of house and flood plain at Rodger's Lane - notification of owners	DPW		*Future Project
Correct flooding problem at Reece Road Branch through county acquisition/flood proofing/ flood insurance	DPW Relocation Section Right of Way Div.	Appraisal needed	*Future appraisal to determine acquisition costs.
Correct flooding problem at barn at Broad Branch	P & Z		*Future Project
Assure awareness of construction crews and supervisors of negative impacts to streams associated with roadway repair.	DPW	Possible training program	Future Work Element
County should consider a park system along stream valleys in Severn Run	Rec. & Park	Acquisition or easement	For Future Consideration
Establish watershed management program	P & Z		On-going project
- P & Z staff should include a - permanent water resources planner	P & Z	$24,000/yr (includes overhead)	*Contract
- permanent water shed/sector planner	P & Z	$26,730/yr (includes overhead)	Permanent Staff
- addition of 2 engineers to Roads Design Division	DPW	$41,800 - $52,900 per year includes overhead	*For future consideration
- staff training program in theory and use of appropriate computer modeling programs	P & Z - DPW	$2300	*1 week training session be given by consultant
- watershed should be gauged	P & Z		Initial steps have been taken to determine what direction to take in watershed management for future consideration

IN-HOUSE

Table 11-12 (Cont'd)

SUMMARY OF SEVERN RUN WATERSHED STUDY RECOMMENDATIONS, RESPONSIBILITIES AND COST

Recommendations	Agency Responsible	Cost	Status
- methodology should stress needs of DPW & SCD	P & Z, SCD, DPW		*For Future Consideration
- use of continuous model should be considered	"		*For Future Consideration
- studies should include task for detailed evaluation of limited number of construction sites	P & Z & I & P		*For Future Consideration
- DPW should enlarge capabilities for use of hydrograph generation, addition and routing in stormwater management orders	DPW, SCD, WRA		*Future working agreement for sharing facilities
Preventive erosion controls should be emphasized rather than curative sediment controls	I & P & SCD		Erosion control is a part of an inspection program.
Sediment ponds and dry stormwater management ponds should be provided with positive drainage and entrances to construction sites should be stabilized.	I & P, DPW, SCD		Positive drainage is provided for in DPW stormwater management order #1. Stabilized entrances to construction site are incorporated on all sediment and erosion control plans.
The following revisions should be made to the Grading and Sediment Control Ordinance	I & P, DPW, P & Z, Law Office, SCD	6 man/months for all revisions	Future Work Element
- Capital Improvement and Public Works projects should be required to follow same procedures for inspection and enforcement of sediment controls plans as other projects.	"		Capital improvement project plans currently approved by SCD and major grading operations approved by I & P.
- Add an index similar to that in subdivision regulations	I&P, DPW, P&Z Law Office, SCD		Future Work Element
- A separate sediment and erosion control ordinance should be considered.	"		DPW recommends revision to existing ordinance and stricter enforcement of existing laws.

IN-HOUSE

Table 11-12 (Cont'd)

SUMMARY OF SEVERN RUN WATERSHED STUDY RECOMMENDATIONS, RESPONSIBILITIES AND COST

	Recommendations	Agency Responsible	Cost	Status
	- Approval by P & Z should be required for sediment control measures on steep slopes	I&P, DPW, P&Z Law Office, SCD		Future work element
	- Predevelopment meetings between inspectors and contractors should be required and I & P should be authorized to require additional plans or modifications.	"		Predevelopment meetings are required now. I&P can make minor changes in field per SCD - I&P Policy
	- A maintenance bond requirement should be considered.	"		Future work element
	- All sediment control plans should undergo the same review, inspection and enforcement, and I&P should assume complete inspection responsibility	"	Additional staff needed for SCD & I & P	"
	- Provisions for construction site entrance mud and dirt removal should be added.	"		"
IN-HOUSE	The following revisions should be made to the Subdivision Regulations and Zoning Ordinance	P & Z	7½ man/ months	Subdivision regulations are currently under consideration for revision by P & Z.
	- Prohibit construction within the projected 100 yr. flood plain for areas which have been studied in detail.	P & Z SCD	$12,000 salary (cost figures are for entire revision of subdivision regulations not just those listed here.)	
	- Prohibit construction of steep slopes without retaining a ground cover buffer	P & Z SCD		
	- Prevent clearing of trees adjacent to streams	P & Z		
	- Open Space zoning should include the 100 yr. flood plain	P & Z		
	Countywide program of collection water quality data should be continued	P & Z AACC?	1 man/month per year	Recently begun by P & Z. Could be considered in work program of AACC proposal.

Table 11-12 (Cont'd)

SUMMARY OF SEVERN RUN WATERSHED STUDY RECOMMENDATIONS, RESPONSIBILITIES AND COST

Recommendations	Agency Responsible	Cost	Status
Modify stormwater management ordinance to consider - keep pre & post development peak flow the same - onsite, offsite or regional controls - deleting Class I and Class II Structures	P & Z lead DPW, I & P SDC, Law Office, WRA	6 man/months	*To be incorporated into work program
Initiate an active public education program regarding water quality, ecology, and impacts of illegal dumping	P & Z	1 man/month	Currently implemented under 208 program, needs more emphasis
Increase the number of non-scheduled inspections of erosion control projects	I & P	$95,700 - $115,300	*4 additional inspectors needed
County should cooperate and work with DNR in terms of sediment and erosion control.	I & P		Coordination ongoing
County should consider DNR's recommendations regarding field inspections and reports and investigate the need for a more formalized and documented training programs.	I & P with DPW?		Currently training program being carried out with inspectors attending 4 field training sessions
Land protection measures should be emphasized in planning construction sites.	P & Z and		Accomplished now. Enforcement needs administrative support.
County should continue study of groundwater resources	P & Z MGS	$17,500 FY 80	County share of Aquia Auifer study, 4th study done in County
County should participate in a regional comprehensive groundwater supply study	P & Z RPC, MGS DNR	$5,354	County share of 4th year 208/RPC groundwater study
County should preserve the unique biota of some upland swamps.	P & Z DNR, SCD	6 man/months	*Future Work Element

IN-HOUSE

Table 11-12 (Cont'd)

SUMMARY OF SEVERN RUN WATERSHED STUDY RECOMMENDATIONS, RESPONSIBILITIES AND COST

Recommendations	Agency Responsible	Cost	Status
County should perform a comprehensive study of septic systems and contribution to water quality problems	P & Z Health Department	a. $4718 b. $5354	*County Health Department has on-going survey of septic systems. This currently does not include Severn Run. 208 4th year progam a. septic system data management b. WQ monitoring program assessment
County should develop a program of placing high water marks in county	DPW	about 1-2 man/months	DPW determined marks for tropical storms Agnes and Eloise and will continue to maintain records for storms of significant magnitudes.
County should consider a system of parks along ultimate 100 year flood plains in Severn Run and as a County Policy	Rec. & Parks P & Z	3 man/months	*Include in future County open space study
	SUBTOTAL	$288,356	

IN-HOUSE

Table 11-12 (Cont'd)

SUMMARY OF SEVERN RUN WATERSHED STUDY RECOMMENDATIONS, RESPONSIBILITIES AND COST

Recommendations	Responsible	Consultant Costs	In-House Costs	In-House Requirements and Status
Design of stormwater management control alternatives should be tested with hydrologic and hydraulic computer simulation models	DPW P&Z DNR SCD	Approximately $1000 per review	2 man/days engineer 1 man/day technician $100 computer costs per review	*Existing staff would require training. *Future work element for new engineers; hiring trained engineers would eliminate training costs.
Design of town center in Picture Frame Branch should include hydrologic and hydraulic simulations of stormwater control provisions.	P&Z DPW DNR	See Above	See Above	*See Above
Watershed management studies should be followed up by water quality studies, first one to be done is Severn Run. (example costs are for a 4 day synoptic study with 10 sampling sites on Severn Run)	P&Z DPW	I. STUDY DESIGN $800 - 1,000 II. SAMPLE COLLECTION $15,480 Labor + Transportation (varies with location of consultant + lab III. LAB COSTS $15,860 IV. DATA REVIEW $3,000	$650 $8,640 Labor + $293 Transportation (county veh.) + $275 training $7,150 $1,950	*In-house costs assume trained staff members in data collection and analysis. Full scale program would require availability of sampling crews and lab technicians. A test study might be done with CETA or college student workers and adjustment of existing staff work programs. WQ sampling program might be included in work program of AACC proposal for environmental center.

IN-HOUSE AND/OR CONSULTANT

Table 11-12 (Cont'd)

SUMMARY OF SEVERN RUN WATERSHED STUDY RECOMMENDATIONS, RESPONSIBILITIES AND COST

Recommendations	Responsible	Consultant Costs	In-House Costs	In-House Requirements and Status
		TOTAL FOR 4 DAY STUDY		
		$35,340	$18,683	
		+		
		Transportation		
APPROXIMATE SUBTOTAL		$35,340	$18,683	
GRAND TOTAL (everything Done In-House) =			1,190,039	
GRAND TOTAL (Consultant Hired for Water Quality Studies) =			1,206,696	

*Recommendations that are new initiatives and will require additional staffing and funding. All others can likely be integrated into existing work programs and staffing.

and sewer services, and other items are considered from a watershed viewpoint as well as a local viewpoint. The program would also serve as a means to increase communication and cooperation between agencies so that watershed management and protection becomes a viable day-to-day concern and is actively considered in the decision making process.

The initial steps for a watershed management program have already been taken. By establishing the Environmental Resources Section, the Office of Planning and Zoning has taken the lead role in watershed management. Included on the staff of the Environmental Resources Section (ERS) are 208 program staff members and water resources, coastal zone, solid waste, and environmental planners, some of whom are contract rather than permanent staff.

It is suggested that the ERS staff include a permanent water resources planner and a permanent watershed/sector planner. Permanent positions are desirable to allow a continuous, long-term commitment to watershed concerns, rather than facing the annual uncertainties of staff position and program continuation.

Increasing the capabilities of the Environmental Resource Section by learning to use hydrologic models is recommended and could be quite valuable in land use planning. By running a model that has previously been applied to a watershed, the hydrologic and hydraulic impacts of land use changes can be evaluated. Sector plans could include testing various land use scenarios to determine which causes the least amount of flood damage and stream channel erosion. Detailed knowledge of how to completely apply a model would not be required. The stream channel routing configuration would remain the same with the various land

uses applied. For TR20 this implies changing the curve numbers for the subbasins and leaving the rest of the input stream intact. The ability to conduct these tests could result in more meaningful and useful land use planning.

Integrating sector plans and watershed management planning would be an essential element of the watershed management program. Also required is the inclusion of stormwater management into sector/watershed plans to ensure that land use plans will provide the desired results. This will require close cooperation between the Office of Planning and Zoning and the Department of Public Works as well as a commitment from DPW to provide staff time to analyze stormwater management alternatives and assist the Office of Planning and Zoning. The primary duty of this staff engineer should be stormwater and watershed management.

Land use plans may be formulated to protect certain unique ecological areas or require very strict erosion controls during and after construction. To provide this protection, adequate sediment control plans must be prepared and strictly followed. Any such areas should be noted by Planning and Zoning and given extra attention by the Department of Inspections and Permits and the Soil Conservation District. Spot checks by other agencies to help the Department of Inspections and Permits monitor the construction sites could be considered.

Establishing a successful watershed management program will require a strong commitment from the people of Anne Arundel County and their government. The program will require close interagency cooperation and maintenance of

sufficient staff to allow those charged with the responsibilities of watershed management to work on the program, rather than other projects. With a strong and dedicated watershed management program, the waters and land of Anne Arundel County will continue to be a valuable resource for generations to come.