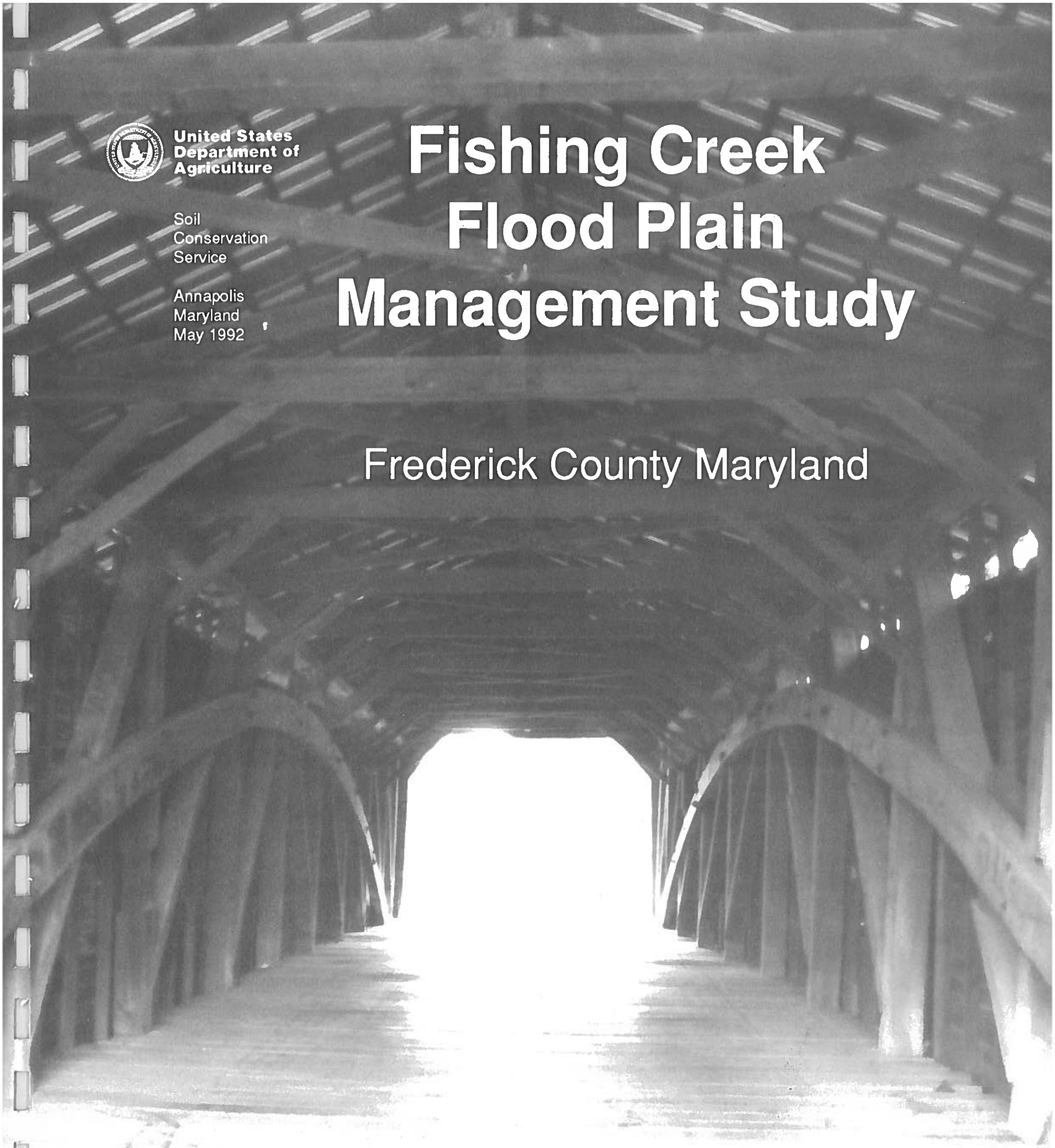


United States Department of Agriculture

Soil Conservation Service

Annapolis Maryland May 1992

Fishing Creek Flood Plain Management Study

Frederick County Maryland

FLOOD PLAIN MANAGEMENT STUDY

for

FISHING CREEK

FREDERICK COUNTY, MARYLAND

May 1992

SPONSORED BY
Frederick County Division of Public Works
MD Department of Natural Resources, WRA

WITH ASSISTANCE FROM
USDA, Soil Conservation Service
John Hanson Business Center
339 Busch's Frontage Road, Suite 301
Annapolis, Maryland 21401

Cover Photo: Covered bridge on Utica Road
taken by G. Cerrelli, SCS

SUMMARY

This study provides water surface elevations and peak stream flows for present condition and future condition 2, 10, 25, 50 and 100 year frequency floods in the Fishing Creek Watershed in Frederick County, Maryland. The present condition 100-year flood plain is mapped and stream profiles are plotted for the present condition flood on the Fishing Creek mainstem below the Fishing Creek Reservoir for 9.6 miles to the Monocacy River.

The narrative describes the watershed briefly with emphasis on the flood plain which is largely woodland with approximately 52 percent in public ownership. Suburban development is not a problem in the watershed at this time. Existing development is mostly resi-dential single family homes with limited development taking place north of Utica in the lower part of the watershed. Flooding to residences along Mountaindale Road below the reservoir is very likely to happen if the watershed experiences a large storm event. This report represents a number of management measures that might be implemented to minimize future flooding.

Information on the models used to develop the water surface elevations may be obtained from the Maryland Department of Natural Resources, Water Resources Administration, Flood Management Division, Tawes State Office Building, Annapolis, Maryland 21401 (phone 410-974-3825). Copies of this report and general information on the watershed may be obtained from the Soil Conservation Service, John Hanson Business Center, 339 Busch's Frontage Road, Suite 301, Annapolis, Maryland 21401 (phone 410-757-0861).

TABLE OF CONTENTS

FLOOD PLAIN MANAGEMENT STUDY
FOR FISHING CREEK
FREDERICK COUNTY, MARYLAND

INTRODUCTION

The U. S. Department of Agriculture, Soil Conservation Service (SCS) and the Maryland Department of Natural Resources, Water Resources Administration (WRA) working under the 1971 Joint Coordinated Agreement conducted the Fishing Creek Flood Plain Management Study.

Maryland's Flood Hazard Management Act of 1976 authorized the Water Resources Administration to establish a statewide flood management program. This authority allows the Administration to designate priority watersheds, perform watershed studies, approve flood management plans and administer a flood management grant program. The objectives of the program are to lessen the impacts caused from flooding by implementing flood management projects and to avoid future damage and hazards by assisting local jurisdictions in the management of flood-prone land. Projects may consist of acquisition of flood-prone buildings, construction of structural measures, or administrative controls. Partial funding may be provided through the State's Flood Management Grant Program. Non-structural projects such as acquisition are preferred although structural measures are eligible for funding.

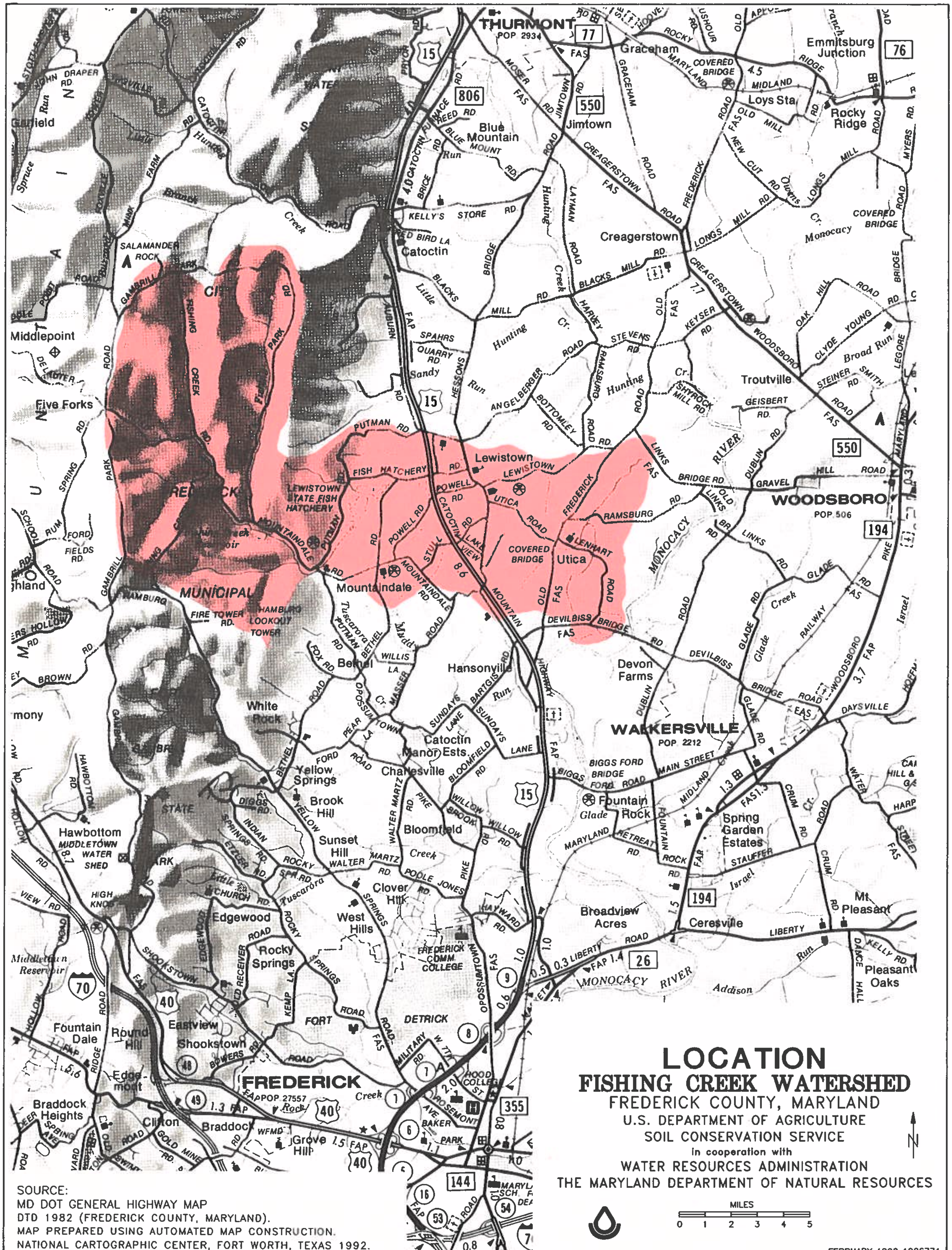
The Soil Conservation Service (U.S. Department of Agriculture) carries out flood plain management studies under the authority of Section 6 of Public Law 83-566, in response to Recommendation 9(c), "Regulation of Land Use," of House Document No. 465, 89th Congress, 2nd Session, and in compliance with Executive Order 11988 (February 20, 1978).

Prior to this study, the Fishing Creek Watershed was partially analyzed by the Federal Insurance Administration (reference 1). This study analyzed the flooding problem on a limited basis. It was subsequently determined that a more indepth study was necessary to identify flooding problems.

The Soil Conservation Service was asked to cooperate with WRA in 1988 to complete the flood plain management study under the 1971 Joint Coordination Agreement.

Limited development is taking place north of Utica in the lower part of the watershed. Existing development is mostly residential consisting of single family residences. Some commercial properties exist in or near Lewistown and Mountaindale.

The County is also concerned with maintaining its natural aquatic resources. Fishing Creek, like most Frederick County streams, supports a natural trout population which requires high water quality and minimal channel and stream bank disturbances. The development of land in the watershed should be care-fully regulated to prevent unnecessary sediment loads from construction sites, which would destroy the natural habitat of the stream's biological community. Agriculture is another use that has the potential to affect water quality adversely. Farming methods and conservation practices, along with animal waste management need to be assessed.



LOCATION

FISHING CREEK WATERSHED

FREDERICK COUNTY, MARYLAND

U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

In cooperation with

WATER RESOURCES ADMINISTRATION

THE MARYLAND DEPARTMENT OF NATURAL RESOURCES

SOURCE:
MD DOT GENERAL HIGHWAY MAP
DTD 1982 (FREDERICK COUNTY, MARYLAND).
MAP PREPARED USING AUTOMATED MAP CONSTRUCTION.
NATIONAL CARTOGRAPHIC CENTER, FORT WORTH, TEXAS 1992.

FEBRUARY 1992 1006771

USDA-SCS-NATIONAL CARTOGRAPHIC CENTER, FT. WORTH, TX.-1992

FIGURE 1

STUDY AREA DESCRIPTION

Fishing Creek, a tributary of the Monocacy River located in northwestern Frederick County, drains an area of 11,438 acres. Woodland is the dominant land use representing 63 percent of the total watershed. Farming occurs in the eastern portion with cropland accounting for 18 percent and pastureland 10 percent. Urban and rural residential use represents 7 percent, with the remaining 2 percent in other uses, mostly fish ponds. Approximately 52 percent of the watershed is in public ownership. The City of Frederick Municipal Forest accounts for 5820 acres with the remaining 194 acres belonging to the Lewistown State Fish Hatchery. The U.S. Geological Survey hydrologic unit number for the study area is 02070009.

The headwaters are 100 percent woodland characterized by rugged valleys and hills on the eastern slopes of Catoctin Mountain. The two major streams, Little Fishing Creek and Steep Creek, meet just north of the Fishing Creek Reservoir, northwest of Mountaindale, forming Fishing Creek. It continues to flow easterly for approximately 9.6 miles before entering the Monocacy River (see Location Map - Figure 1).

The Fishing Creek Watershed lies within two Major Land Resources Areas (MLRA): 130 Blue Ridge Province; and MLRA 148 Piedmont Province. The Blue Ridge component consists of mostly quartzite with small amounts of hard schist with quartzite inclusions. The valley portion in MLRA 148 contains a small strip of limestone brecca and triassic sandstone and shale. This area is characterized by wooded flats or broad ridges on mountain tops with steep side slopes and incised drainage ways. A small area of nearly level and gently sloping soils is near the Lewistown State Fish Hatchery. To the east of the hatchery is a large area of gently sloping and sloping soils developed from red triassic shale and sandstone. The gently sloping Penn soils are shallow to moderately deep, and well to somewhat excessively drained. Sloping Penn soils are commonly shallow, contain more sand, and are somewhat excessively drained. Readingston soils are in low areas and along drainage ways. They are deep, moderately well drained soils with a fragipan.

The upland flats in the mountains consist of the deep, well drained Clymer soils developed in residuum from quartzite sandstone. Soils on the steep mountain-sides consist of Edgemont, Chandler, and Talladega. Edgemont soils are moderately deep to deep, well drained and developed from quartzite or silicious sandstone. Chandler and Talladega soils are deep to very deep and developed from schist with many quartzite intrusions. These mountainous soils are very stony and bouldery with few to common rock outcrops. Deeper soils are on the lower flanks of the side slopes. Colluvium is commonly associated with drainage ways and at the base of the mountains. A small area of nearly level to gently sloping soils occurs southwest of the Lewistown State Fish Hatchery. Thurmont soils are developed in deep colluvium from green stone and quartzite. The poorly drained Roanoke and moderately well drained Augusta soils are adjacent to streams.

Frederick County, has a humid, temperate, continental climate. Summers are short and rather warm. Winters are rigorous but not severe. The average annual tem-perature is about 54 degrees F. In an average year the temperature does not rise above 95 degrees in summer nor fall below 15 degrees in winter, although extremes of 109 degrees and -21 degrees have been recorded. The average frost-free period is 180 days falling mostly between April 19 and October 16.

Average annual precipitation is about 41 inches and is fairly well distributed throughout the year. Extended droughts are not common. Short droughts do damage crops and hayland on the shallower shale and channery soils. However, wet periods cause more crop damage than droughts.

STUDY OBJECTIVES

The objectives of the flood plain management study are to delineate the flood plain, identify problem areas, aid local management, and to evaluate a range of alter-natives for reducing flood hazards and damages. The results will produce data necessary to develop a flood management plan. The plan is to be developed and implemented by Frederick County. It will serve to correct existing flood problems and to avoid the increase of flood damage in the future. The infor-mation from the study may be used to analyze the effects of roads, bridges, stormwater management structures, land use changes, etc. on existing flood-prone areas.

NATURAL VALUES

Wetlands

Wetlands in the Fishing Creek watershed consist primarily of palustrine wetlands, according to the National Wetlands Inventory mapping of the area (Ref: U.S. Fish and Wildlife Service). The palustrine wetlands include forested, scrub-shrub, and emergent cover types, as well as shallow open water areas (ponds and small lakes). The majority of natural wetlands are located in the stream valley adjacent to Fishing Creek and its tributaries. Large areas of artificial wetlands (emergent and shallow open water areas) are associated with the extensive network of ponds at the Lewistown State Fish Hatchery.

Wildlife

Wildlife habitat in the watershed is of moderate to excellent quality for many species. The forested areas are well-suited for woodland animals such as gray squirrels, wild turkeys, deer, and various songbirds. Cropland, pastureland, and hayland provide food and cover for rabbits, small mammals, songbirds, and gamebirds such as pheasant and quail. Palustrine wetlands in the watershed provide habitat for wetland species such as ducks, geese, wading birds, songbirds, muskrats, beaver, snakes, turtles, salamanders, and frogs.

Water Quality

The Fishing Creek watershed is a component of the Middle Potomac River Basin which includes the Monocacy River and Catoctin Creek. According to the 1987 Maryland Water Quality Inventory (the most recent published report), water quality in the basin ranges from fair to good. Problems associated with nutrient enrichment, excessive sediment, and elevated levels of pathogens have been reported. These water quality problems have been attributed to agricultural runoff (cropland and animal operations), municipal wastewater discharges, and faulty septic systems.

Fishing Creek and its tributaries are designated as Class III Natural Trout waters. A sustainable trout fishery is generally indicative of good water quality.

Fisheries

Fishing Creek is classified as a coldwater fishery by the State of Maryland. Water quality is satisfactory to support a naturally reproducing brook trout fishery in the forested portion of the watershed, specifically in Steep Creek and its tributaries, Little Fishing Creek and its tributaries, and in the Oxys Hollow tributary. The remainder of the watershed is periodically stocked with trout for put-and-take fishing. Other finfish include largemouth bass, smallmouth bass, sunfish, carp, and a variety of minnows and darters.

Threatened and Endangered Species

Except for occasional transient individuals, no federally listed or proposed threatened or endangered species are known to exist in the project watershed.

The Maryland Natural Heritage Program (NHP) has indicated that there are eight plant species in the watershed that are on Maryland's rare, threatened, and endangered list. The listed species are climbing fumitory, running juneberry, sharp-scaled mannagrass, bog clubmoss, winged loosestrife, floating-heart, large purple fringed orchid, and yellow nodding lady's tresses.

NHP also reports that the forested areas in the watershed may be utilized as breeding areas by forest interior dwelling birds. The habitat of these birds is rapidly disappearing in Maryland. If any construction work is proposed in this watershed, the project sponsor should contact NHP for additional information and project review to ensure protection of threatened and endangered species.

Cultural Resources of National Significance

With respect to archeology, the Maryland Historical Trust (MHT) has on record 37 documented archaeological sites and three unconfirmed archaeological properties within the boundary of the Fishing Creek watershed. The 37 documented sites have yielded artifacts dating from the Early Archaic period (ca. 7500-6000 B.C.) through historic times.

In addition to the known archaeological sites, there is a high probability that other prehistoric and historic archaeological properties that have not yet been identified exist in the study area. The presence of environmentally attractive features such as ridge tops and streams, and the cartographic evidence for historic occupation in the area, indicate a high potential for finding additional prehistoric and historic sites.

For structures, MHT's records indicate that there are seven documented historic standing structures within the boundaries of the watershed. The structures are the Lenhart Road Bridge, Utica Covered Bridge, St. Paul's Evangelical Church, St. Paul's Parsonage, Mt. Prospect M. E. Church, Samuel Clem House, and H. Stimmel House. In addition to the known structures, there may be other historic standing structures which have not been previously identified.

If any construction work is proposed in this watershed, the project sponsor should contact MHT for additional information and project review to ensure protection of significant cultural resources.

FLOOD PROBLEMS

Historically, the watershed has experienced minimal flood related damages. The reason is the absence of storm events severe enough to produce floods greater than the 10-year flood. Floods occurring in 1972, 1975, and 1976 were the most damaging events recorded. These floods do not follow any particular seasonal pattern, having occurred in the spring, summer, and fall. Damages usually occur to residences, roads, streambanks, lawns, and fences. One of the concerns of residents and public officials is the evidence that the smaller, more frequently occurring storms are causing more problems than in the past, even though limited corrective measures in the form of stream bank stabilization, subsurface drainage, flood-proofing and sump pumps are helping the situation.

A 100-year storm event can expect to cause damages to several residents below the Fishing Creek Reservoir. Affected residential properties would have water 1-2 feet above the first floor elevation with average annual damages estimated to be over $18,000.

Road and bridge damages occur annually. Damages from the smaller events are estimated to be $1,000.00 annually. These damages normally are limited to debris and sand removal usually at road crossings. Appendix B lists the flood frequency that would overtop each bridge. Most bridges will overtop between the 2 and 10-year frequency storm.

EXISTING FLOOD PLAIN MANAGEMENT

On the state level, within the Maryland Water Resources Administration, the Flood Plain Management Division provides technical assistance to local governments to identify, prevent, and mitigate threats from flooding through implementation of the Flood Hazard Management Act of 1976 (Natural Resources Article Section 8-9A-01 (et seq.)). Cooperating with local jurisdictions and other state agencies, the Flood Plain Management Division conducts watershed studies that identify flood-prone areas, investigates the impact of planned development on flood events, and evaluates various techniques to control flooding and to minimize damages. The Flood Hazard Management Act of 1976 also authorizes the Water Resources Administration to administer a comprehensive grant program to assist communities in implementing their flood management projects. Grants may be used for residence acquisition, retention basins, stream channel improvements, flood warning systems, and other measures. To be eligible for a grant, the local jurisdiction must develop a flood management plan that identifies present and potential flood hazards, guides the activities in the watershed to minimize these hazards, and develops alternatives to mitigate them. The Flood Plain Management Division also coordinates at local and Federal level with the National Flood Insurance Program and provides information and education to public and private groups and individuals.

The State of Maryland code requires a permit for any activity that changes in any manner, "the course, current, or cross-section of any stream or body of water," within state waters (Code of Maryland, Natural Resources Article, Section 8-803). State waters are defined to include the flood plain of free flowing waters determined by the Department of Natural Resources on the basis of the 100-year frequency flood.

The Subdivision Regulation of the Frederick County Code states that, "no structure or development will be permitted within the flood plain, provided, however, open shelters, pole-type structures (open on all sides and without walls) and recreational uses and equipment, which are not contained in a building, are exempt from these aforesaid provisions upon obtaining a zoning certificate in order to ensure the type of construction will not alter the flood plain elevation. The elevation of the lowest floor, as defined herein, or all substantially improved or replaced structures shall be at least one (1) foot above the elevation of the one hundred (100) year flood. Basements or cellars are prohibited."

County regulations prohibit filling, buildings, structures, dumping, excavation of any kind, drainage, or alteration of the natural drainage and circulation of surface or ground waters will be permitted in wetland areas.

ALTERNATIVES FOR FLOOD PLAIN MANAGEMENT

Formulation of Alternatives

The flood-prone area as determined by this study is approximately 670 acres. The 100-year flood will impact 11 structures located mostly in the Mountaindale and Lewistown areas. All the bridges in the watershed are impassible during the 100-year flood except Devilbliss Road and US Route 15 (north bound lane).

The alternatives considered but not recommended for detailed analysis were: floodproofing; retention structures; detention structures; channelization; flood warning; flood insurance; and levee/dikes.

Analysis of Alternatives

Present Condition (No Action) - This alternative would preserve the present conditions and the present trends in development. Frederick County has nonstructural flood plain management policies for the county and the watershed.

Land Treatment - Land treatment measures would reduce volume of runoff, but they would not significantly reduce flood peaks, especially in the upper reaches where most of the damages have occurred. Treatment of cropland acres would have more effect on water quality problems in the lower reaches by reducing sediment and nutrients entering the streams from runoff. Streambank erosion due to improper grazing or fencing is a large contributor of sediment in the streams at several locations.

Preservation of Natural Values

The Fishing Creek Flood Plain is somewhat narrow and characterized by large areas of artificial wetlands associated with the extensive network of ponds at the Lewistown State Fish Hatchery. Palustrine wetlands include forested, scrub-shrub, and emergent cover types, as well as shallow open water areas. The opportunity exists to protect these wetlands, thereby protecting the habitat for wetland species.

Protecting the designated Class III natural trout stream and wildlife habitat is of particular concern for the citizens of the watershed. Other than land use and zoning regulations, no attempt has been made to protect any of the above natural values. Measures suggested in the land treatment alternative will have a positive impact on these natural values.

Non-Structural Alternatives - The non-structural alternatives considered were inappropriate because of the following reasons:

- flood warning - the watershed is too small for acceptable warning times.
- flood insurance - although it will relieve some financial burden caused by flood-related damages, it does nothing to correct the problems. All property owners should be encouraged to purchase flood insurance.

Structural Alternatives - Structural alternatives mentioned were considered inappropriate for the following reasons:

- floodproofing - some forms of floodproofing must be physically installed before the flood occurs and insufficient warning time exists for installation. In limited instances, individual property owners may be able to implement measures that provide limited protection.
- retention and detention structures - lack of appropriate sites.
- channelization - negative impacts on existing stream habitat; lack of construction area.

• levees/dikes - lack of sufficient area for construction.

SUGGESTED ALTERNATIVES

Administrative Controls

Preventing increases in flooding and related damage through zoning is vital to any alternative. Less dense zoning may prevent increases in flooding associated with future development. Restriction of flood plain uses to those not susceptible to significant damage is critical to good flood management. Acceptable flood plain uses are open space, recreation areas, parks, tree farms, agriculture, etc.

Elevate Fishing Creek Dam

The alternative of elevating the existing dam for flood control purposes will require a detailed analysis which exceeds the scope of this study. A preliminary analysis was performed demonstrating the dam would have to be raised 32 feet to obtain 100-year flood control. The resulting reduction in peak would only show acceptable benefits to the US route 15 area.

Flood Plain Acquisition - Acquisition is generally considered the most desirable form of flood management when applicable. The benefits are permanent elimin-ation of flood damages, elimination of most risks to safety, increase in open space, minimal maintenance, increased flood storage, and absence of negative environmental impacts.

The Fishing Creek Flood Plain is not densely populated and many of the homes have only minor flooding potential. Consequently, acquisition may be most appropriate for a small number of homes. This alternative may receive the most support only after a flood which causes significant damage.

FLOOD BOUNDARY MAPS

A map showing the 100-year flood plain of Fishing Creek is shown in Appendix A of this report. The base map is an enlargement of a USGS 7 1/2 minute topographic quadrangle. The scale is roughly one inch equals 1,440 feet. Due to its scale, this map is not intended for use in determination of site locations either in or out of the floodplain. Random cross-sections only, are shown on this map to improve readability.

The area shown as diverted flow, near Mountaindale, (called "Overflow" in the profiles of Appendix A) is only approximate as this area was not detailed with the aerial survey performed to aid in the analysis. To determine whether or not a site is in the flood plain in this area, one of two procedures can be employed. First, a 1"=100' map of this area with 2 foot contours could be produced and coupled with the sponsor's map of the same scale (mentioned later). The floodplain could then be plotted on this new map using the profiles on Sheet 8 of Appendix A as the basis. The second method would require that the distance either upstream of Cross Section 2 (of the overflow channel) or downstream of Cross Section 6, to the point of concern, be known. Both of these cross sections are plotted on the sponsor's map. Knowing this distance, it is a simple matter of interpolation of the profiles of Sheet 8 of Appendix A to determine the floodplain elevation at this point.

A slight distance downstream (in the mainstream) of Mountaindale a small division in flow is shown to occur. Flow elevations are different between these two branches as shown in the profiles and tables (labeled "Divided Flow"). Water surface profiles for various cross-sections at selected frequencies are also detailed in Appendix A. Appendix B lists peak water surface elevations for selected flood frequencies at the various cross-sections.

The Frederick County Government, the sponsor of this study, has a set of maps on mylar which delineate the flood plain at a scale of one inch equals 100 feet. These maps, which show all cross-sections, are the ones to use for the most accurate delineation of the flood plain.

To utilize the information in Appendix A (Flood plain Map and Profiles) and Appendix B (Elevation Tables), one should locate a point of interest on the map, and then find the nearest cross-section. Reference to the tables at that cross-section will give the elevations of the various floods. Measuring up and down stream on the profiles from the cross-section an appropriate distance will give an estimate of flood levels at points between the sections. The elevations for specific points should be surveyed in the field if accurate data is needed.

Several cross-sections are plotted in Appendix C, showing the general channel shape and some of the small side channel characteristics of the flood plain. Photographs of features found in the watershed are included in Appendix D. Appendix E, Investigations and Analysis, provides detailed hydrology and hydraulic procedures used to delineate the 100-year flood plain and selected other more frequent events.

GLOSSARY OF TERMS

cfs - Cubic feet per second (unit of stream discharge).

cross-section - Shape and dimensions of a channel and valley perpendicular to the line of flow.

discharge - Rate of water flow, expressed in cubic feet per second (cfs).

elev. - bridge deck - Elevation of a roadway across a bridge or culvert.

elev. - low beam - Elevation of lowest structural "beam" that limits the height of the bridge opening; or may indicate the top of a culvert opening.

elev. low road - Elevation of low point on a roadway approaching or crossing a bridge or culvert.

flood - A overflow of lands not normally covered by water; a temporary increase in streamflow or stage; or the discharge causing the overflow or temporary increase.

flood frequency - An expression of how often a flood of given magnitude can be expected. (Note: The word "frequency" often is omitted to avoid monotonous repetition.)

Examples:

10-year flood or 10-year frequency flood - The flood which can be expected to be equalled or exceeded on an average once in 10 years; and which would have a 10 percent chance of being equalled or exceeded in any given year.

50-year flood - . . two percent chance . . in any given year.

100-year flood - . . one percent chance . . in any given year.

flood peak or peak discharge - The highest stage or discharge attained during a flood.

flood plain - Lands adjoining a stream (or other body of water) which have been or may be covered with water.

profile - A plotted line showing the highest water surface elevations along a stream during a particular flood.

flood routing - Computation of the changes in the rise and fall in stream flow as a flood moves downstream. The results provide hydrographs of discharge versus time at given points on the stream.

frequency-discharge curve - A plotted line showing the frequency of various flood discharges at a surveyed cross-section or other point along a stream. (Used with a stage-discharge curve to determine the high water elevations resulting from selected flood discharge at the point on the stream.)

hydrograph - A plotted curve showing the rise and fall of flood discharge with respect to time at a specific point on a stream.

land use - Classification of type of vegetation, or other surface cover conditions on a watershed used (with a similar classification of soils) to indicate the rate and volume of flood runoff.

peak discharge - The highest rate of runoff (discharge) attained during a flood.

runoff - That portion of the total storm rainfall flowing across the ground or other surface and contributing to the flood discharge.

stage-discharge curve - A plotted curve showing elevations resulting from a range of discharges at a surveyed cross-section, stream gage, or other point on a stream.

watershed - A drainage area which collects and transmits runoff to the outlet of the drainage basin.

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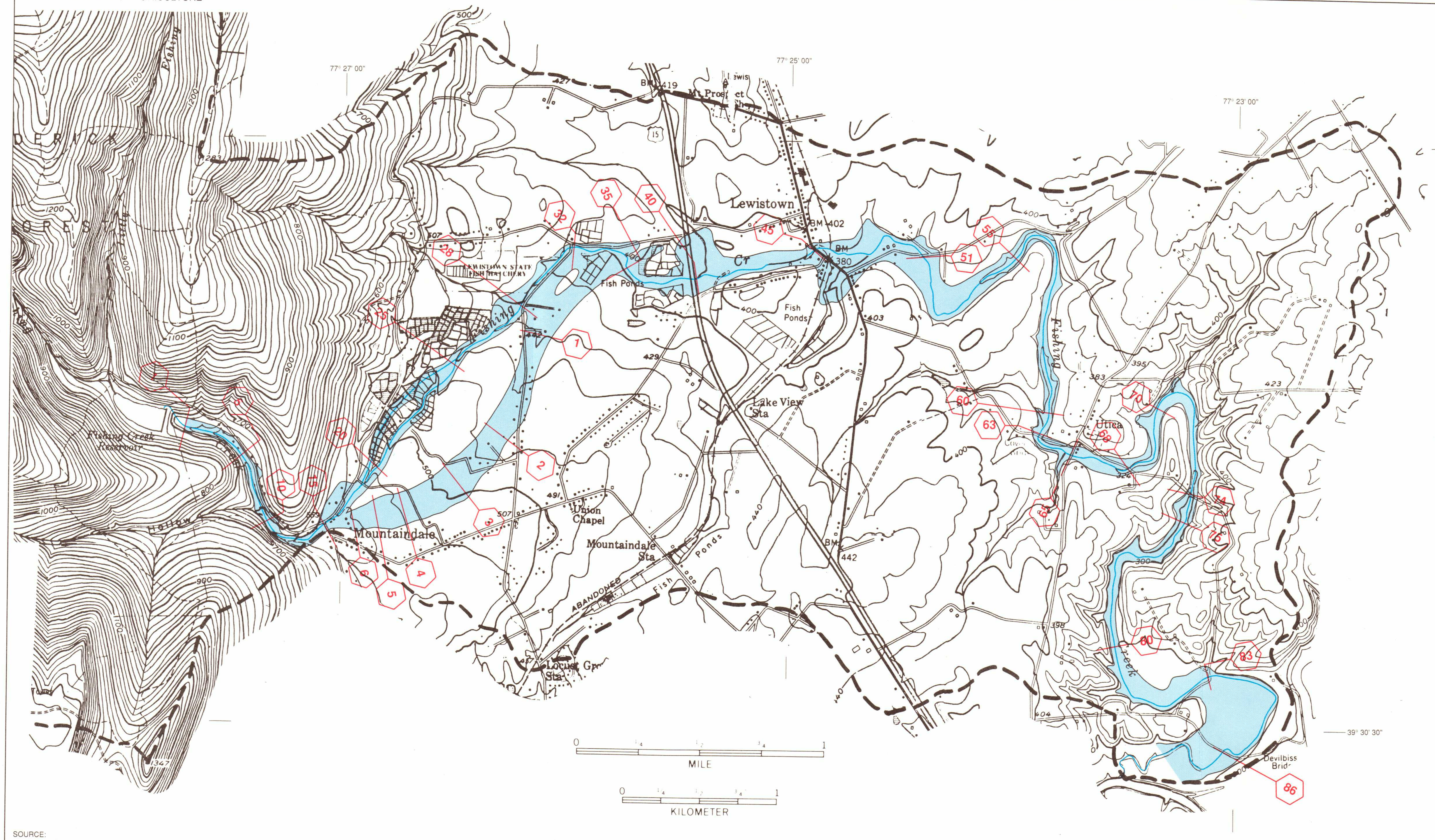
APPENDIX A: FLOOD PLAIN MAPS AND PROFILES

U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE



100 YEAR FLOOD PLAIN

FISHING CREEK

FLOOD PLAIN MANAGEMENT STUDY

FREDERICK COUNTY, MARYLAND

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

MARYLAND DEPARTMENT OF NATURAL RESOURCES
WATER RESOURCES ADMINISTRATION

LEGEND

100 YEAR FLOOD PLAIN

1 CROSS SECTION

SOURCE:
1:24,000 USGS Quadrangles and information from SCS Watershed Planning Staff.

USDA-SCS-NATIONAL CARTOGRAPHIC CENTER, FT. WORTH, TX.-1992

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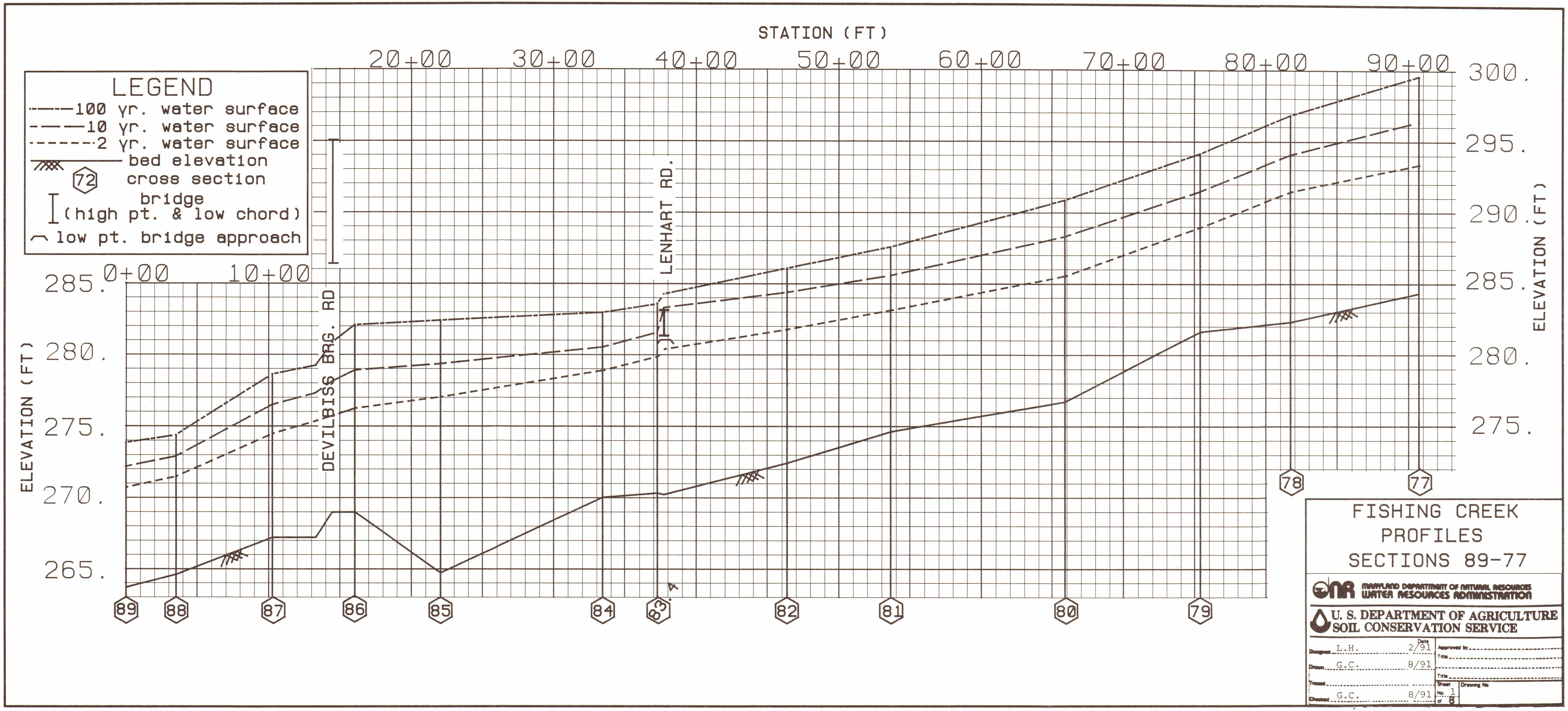
FIGURE A1



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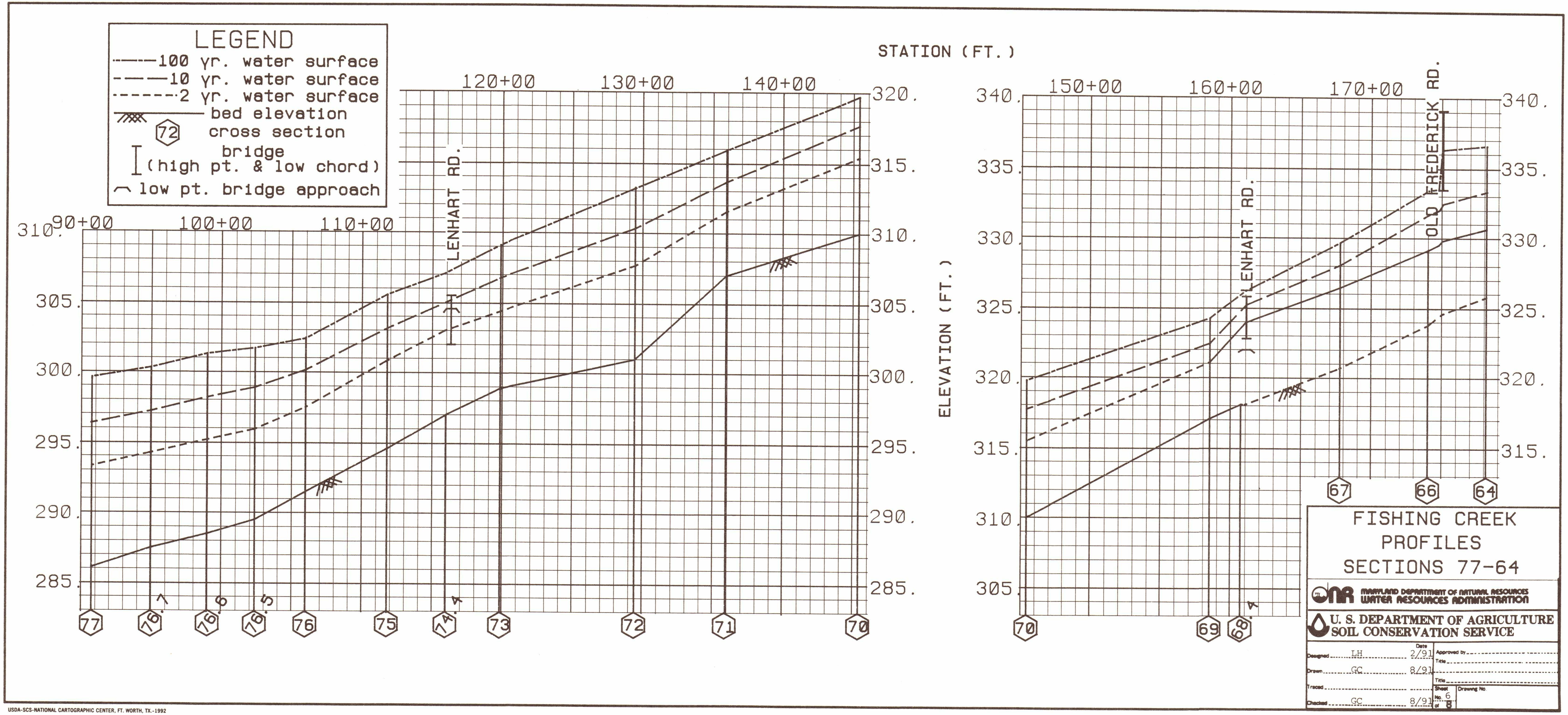

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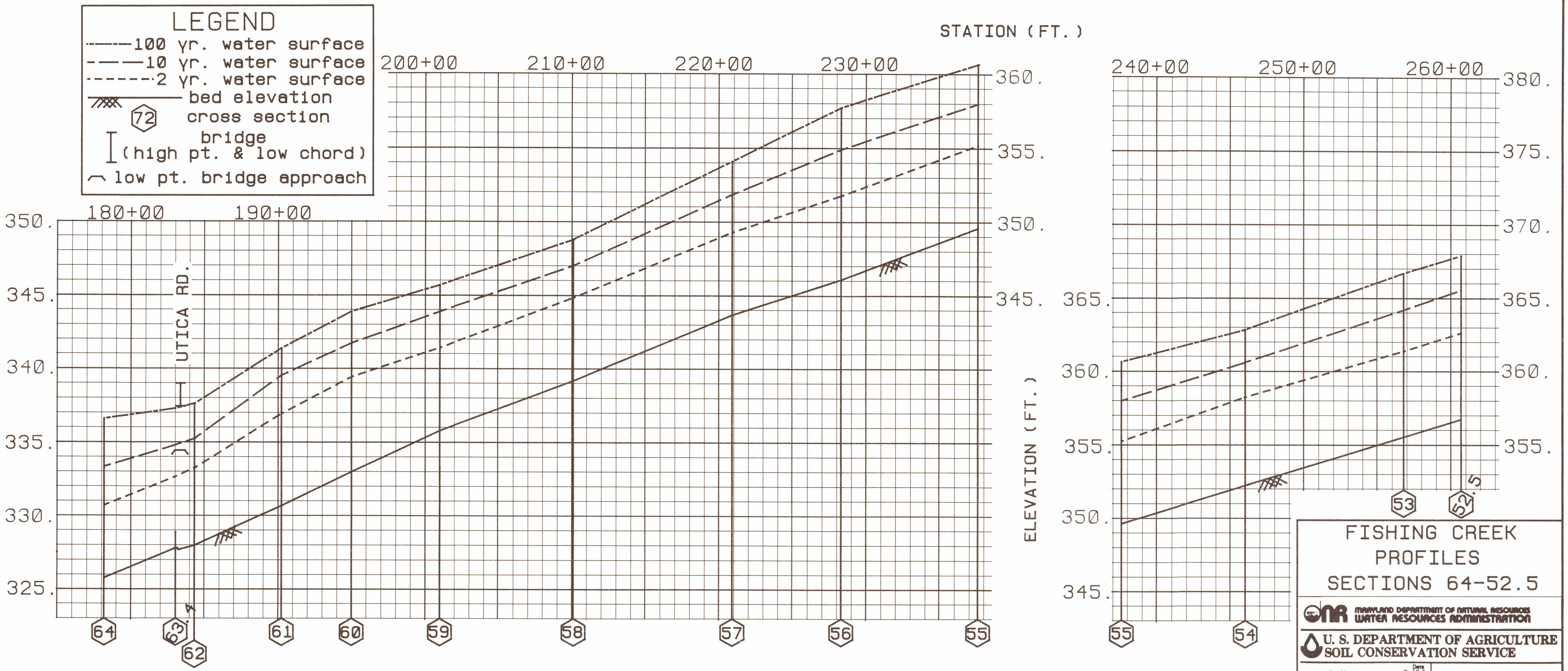

FISHING CREEK PROFILES SECTIONS 64-52.5

MARYLAND DEPARTMENT OF NATURAL RESOURCES WATER RESOURCES ADMINISTRATION

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

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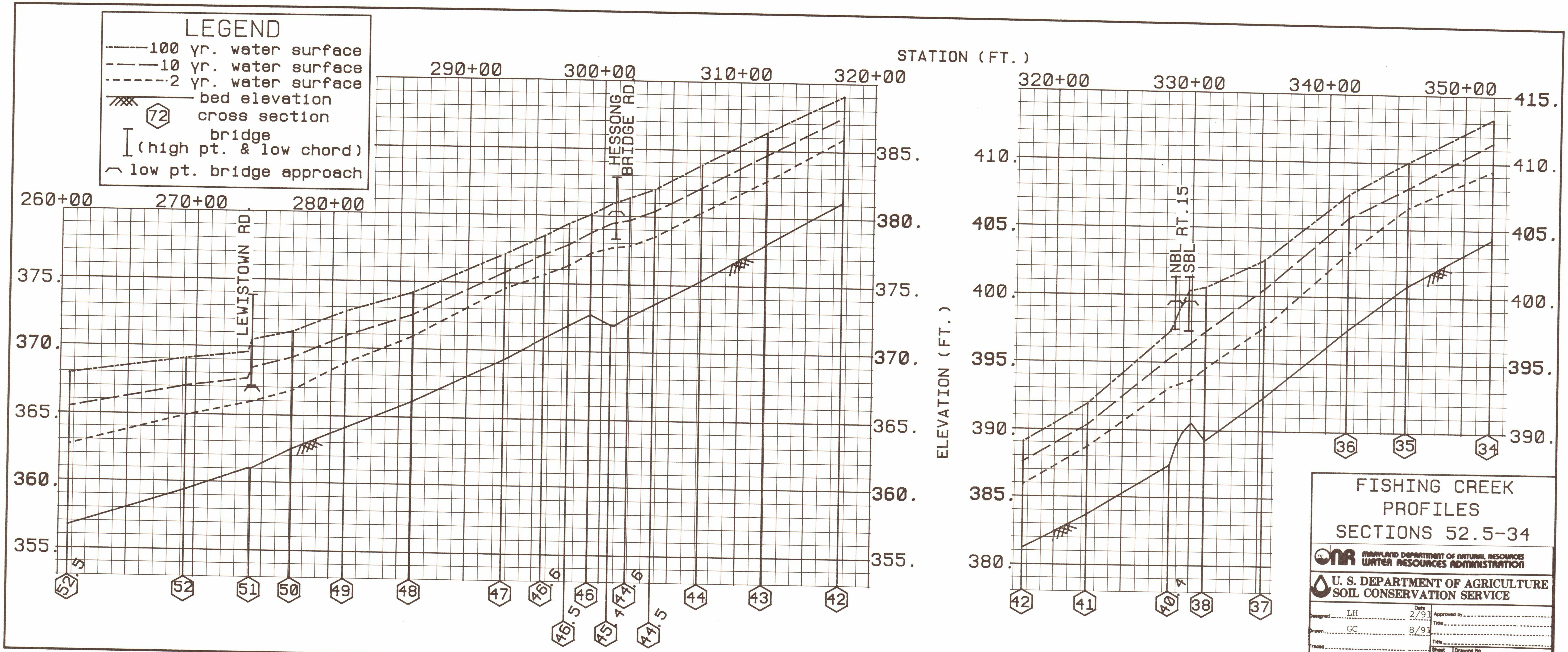

FISHING CREEK
PROFILES
SECTIONS 52.5-34

MARYLAND DEPARTMENT OF NATURAL RESOURCES
WATER RESOURCES ADMINISTRATION

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

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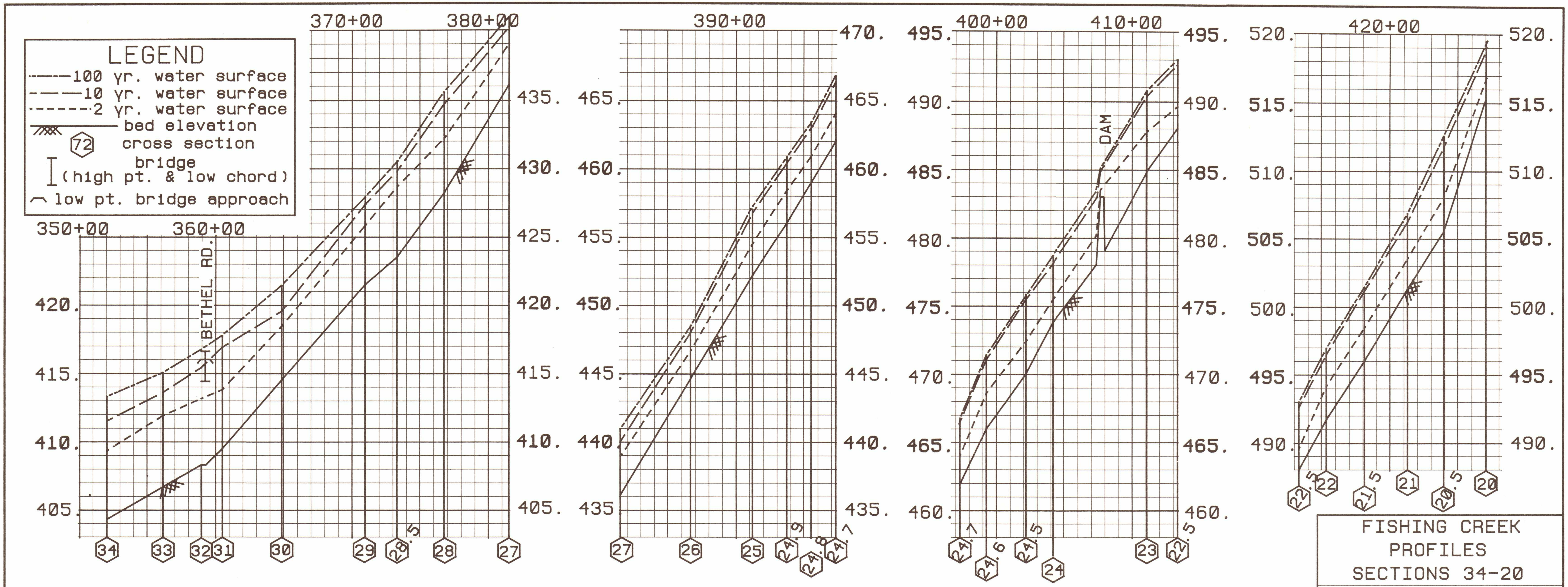

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PROFILES
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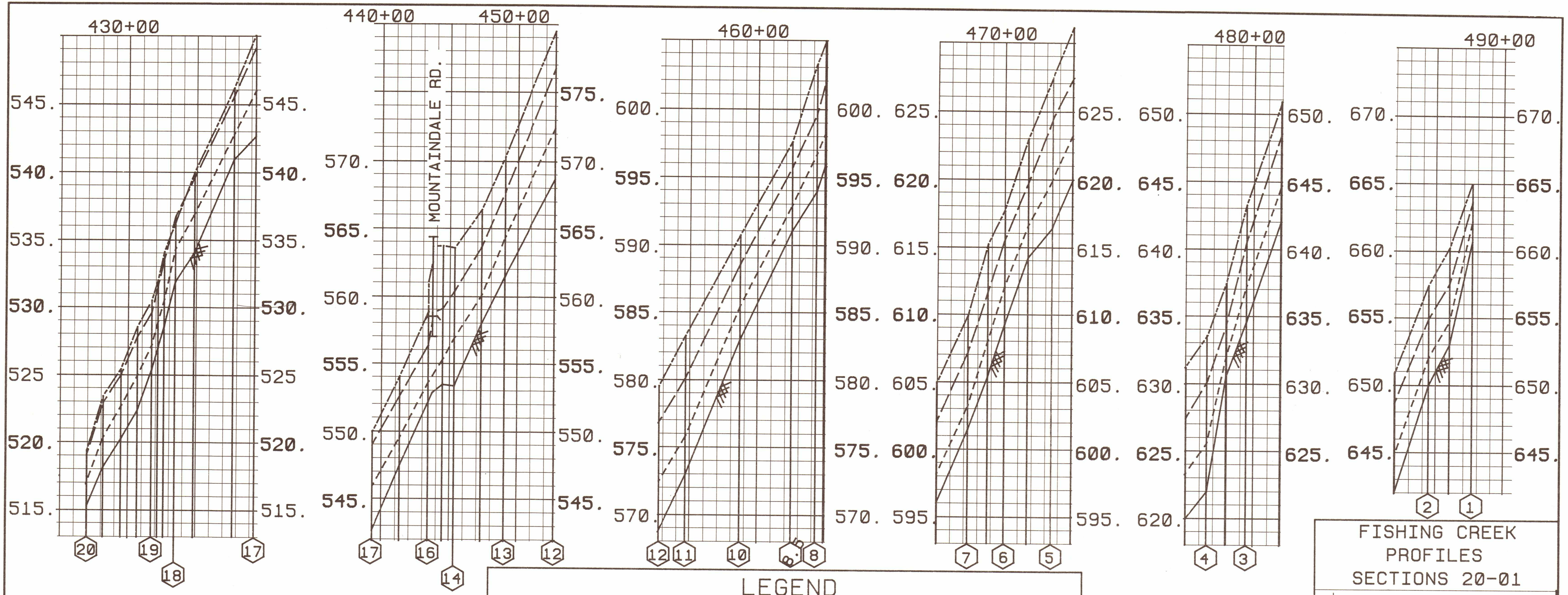
MARYLAND DEPARTMENT OF NATURAL RESOURCES
WATER RESOURCES ADMINISTRATION

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed L.H.	Date 2/91	Approved by	
Drawn G.C.	8/91	Title	
Traced		Title	
Checked G.C.	8/91	Sheet No. 5 of 8	Drawing No.

USDA-SCS-NATIONAL CARTOGRAPHIC CENTER, FT. WORTH, TX.-1992



LEGEND

100 yr. water surface
10 yr. water surface
2 yr. water surface
bed elevation
(72) cross section
bridge (high pt. & low chord)
low pt. bridge approach

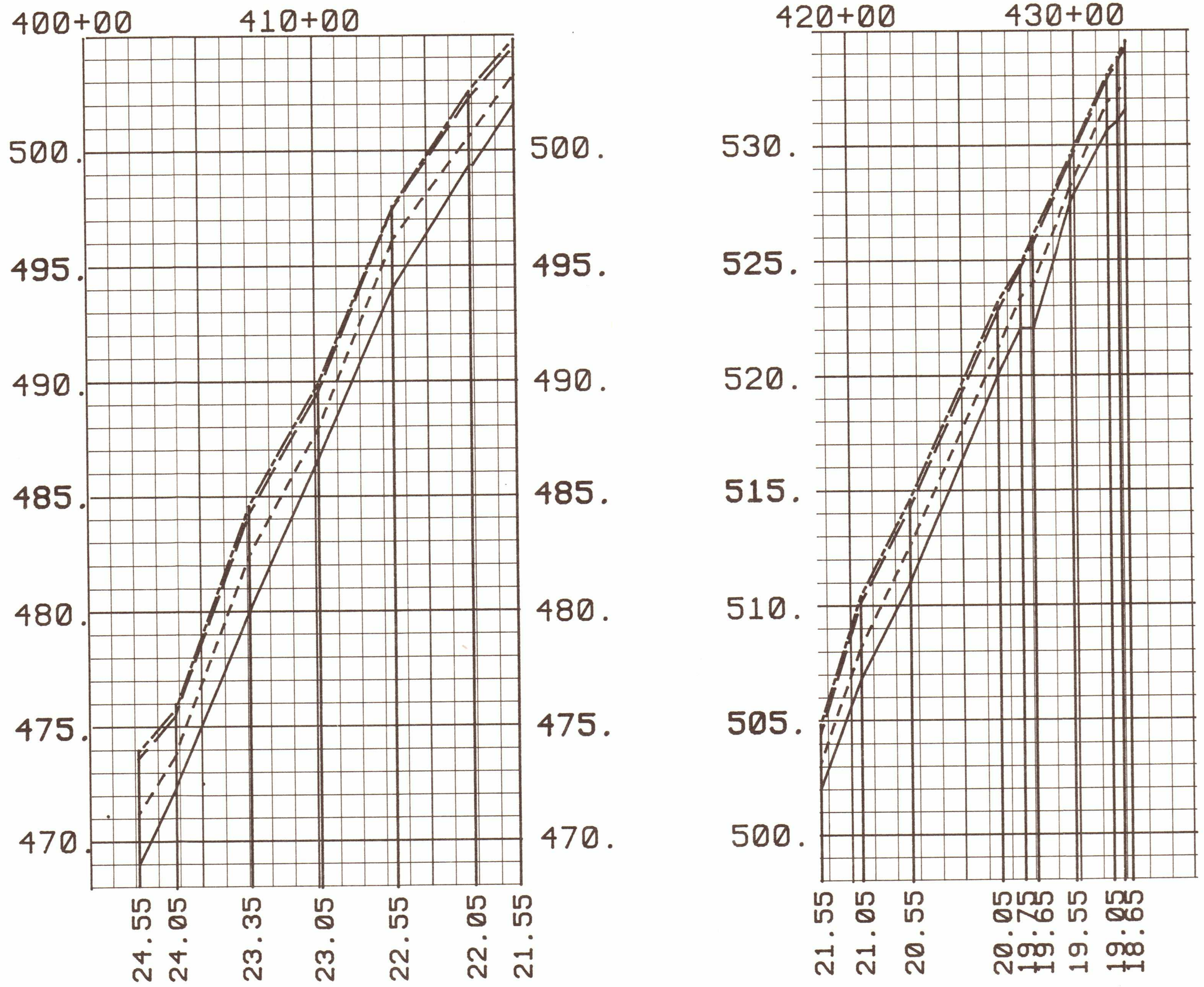
FISHING CREEK PROFILES SECTIONS 20-01

MARYLAND DEPARTMENT OF NATURAL RESOURCES WATER RESOURCES ADMINISTRATION

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

		Date	
Designed	LH	2/91	Approved by
Drawn	GC	8/91	Title
Traced			Title
Checked	GC	8/91	Sheet No. 2 of 8 Drawing No.

USDA-SCS-NATIONAL CARTOGRAPHIC CENTER, FT. WORTH, TX.-1992



LEGEND

- 100 yr. water surface
- 10 yr. water surface
- 2 yr. water surface
- bed elevation
- 21.55 cross section
- bridge (high pt. & low chord)
- low pt. bridge approach

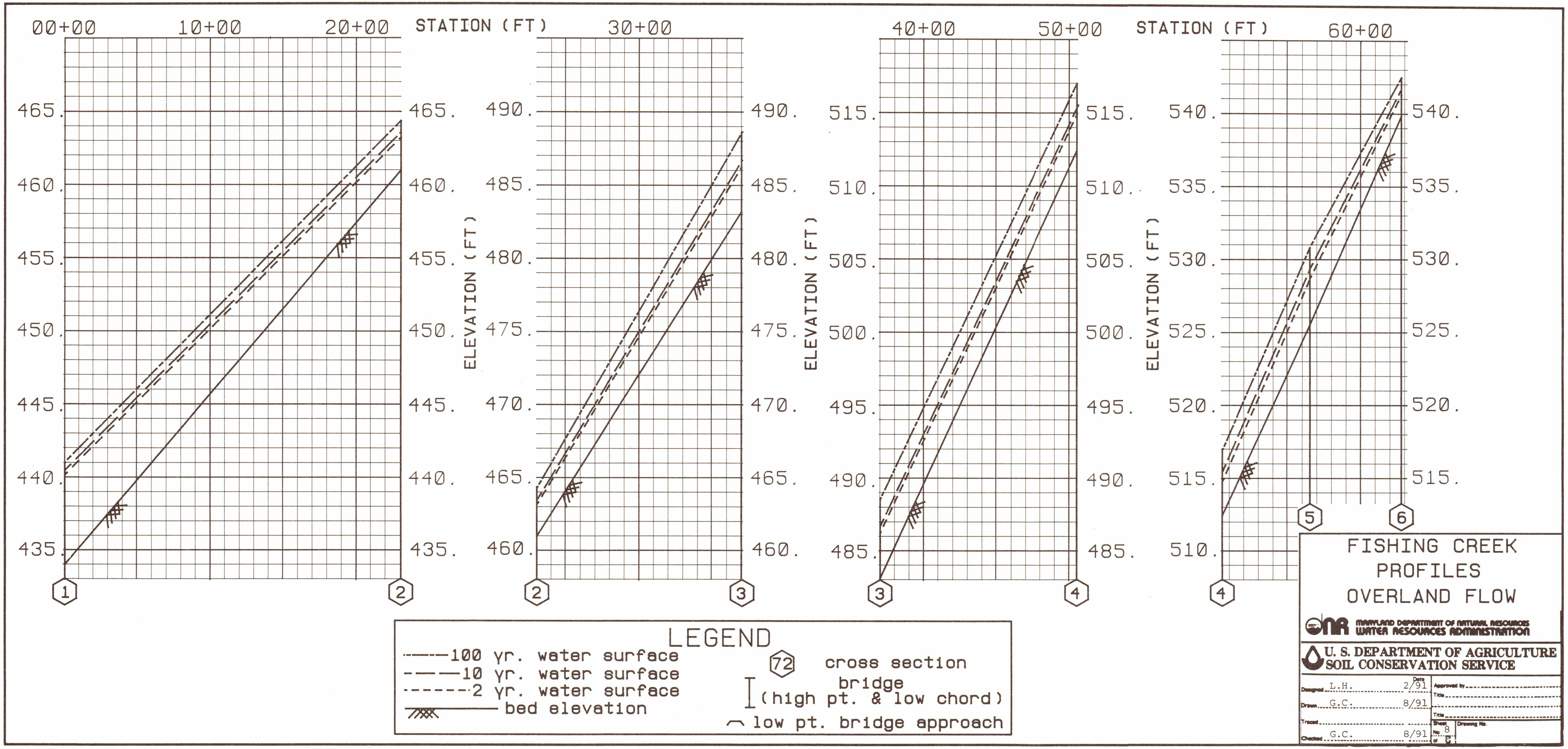
FISHING CREEK PROFILES DIVIDED FLOW CHNL.

MARYLAND DEPARTMENT OF NATURAL RESOURCES WATER RESOURCES ADMINISTRATION

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

		Date	
Designed	L.H.	2/91	Approved by
Drawn	G.C.	8/91	Title
Traced			Title
Checked	G.C.	8/91	Sheet No. 7 of 8 Drawing No.

USDA-SCS-NATIONAL CARTOGRAPHIC CENTER, FT. WORTH, TX.-1992



USDA-SCS-NATIONAL CARTOGRAPHIC CENTER, FT. WORTH, TX.-1992

APPENDIX B: FLOOD ELEVATIONS AT SELECTED FREQUENCIES

Section No. (Channel Distance to Next Section Downstream, Ft.)	Stage, ft. (Q, cfs) for 2, 10, 25, 50, and 100 year flood									
	2 year		10 year		25 year		50 year		100 year	
22.0 (200)	494.19	(182)	496.49	(949)	4796.81	(1093)	496.88	(1136)	496.97	(1194)
21.5 (280)	498.48	"	501.23	"	501.37	"	501.41	"	501.48	"
21.0 (315)	503.53	"	506.17	"	506.59	"	506.70	"	506.83	"
20.5 (265)	508.00	"	511.77	"	512.22	"	512.35	"	512.53	"
20.0 (310)	516.89	"	519.05	"	519.32	"	519.40	"	519.50	"
19.7 (120)	520.35	"	522.90	"	523.21	"	523.30	"	523.42	"
19.6 (130)	522.65	"	525.01	"	525.29	"	525.36	"	525.46	"
19.5 (120)	524.95	"	527.84	"	528.28	"	528.41	"	528.58	"
19.0 (105)	527.13	"	529.60	"	530.24	"	530.36	"	530.50	"
18.7 (45)	528.92	"	531.61	"	531.88	"	531.95	"	532.04	"

END DIVIDED FLOW

24.55 (290)	471.20	(55)	473.66	(284)	473.84	(327)	473.89	(339)	473.96	(357)
24.05 (167)	473.74	"	475.45	"	475.68	"	475.82	"	473.96	"
23.35 (330)	482.39	"	484.25	"	484.47	"	484.53	"	484.61	"
23.25 (1)	282.41	"	484.28	"	484.49	"	484.55	"	484.63	"
23.05 (305)	487.84	"	489.53	"	489.74	"	489.79	"	489.87	"

Section No. (Channel Distance to Next Section Downstream, Ft.)	Stage, ft. (Q, cfs) for 2, 10, 25, 50, and 100 year flood									
	2 year		10 year		25 year		50 year		100 year	
22.55 (330)	496.14	(55)	497.39	(284)	497.53	(327)	497.57	(339)	497.62	(357)
22.05 (340)	500.60	"	502.19	"	502.36	"	502.41	"	502.48	"
21.55 (180)	503.19	"	504.44	"	504.65	"	504.70	"	504.78	"
21.05 (180)	508.23	"	510.10	"	510.28	"	510.34	"	510.41	"
20.55 (220)	512.61	"	514.32	"	514.51	"	514.56	"	514.63	"
20.05 (390)	521.15	"	522.81	"	522.98	"	523.02	"	523.08	"
19.75 (100)	523.30	"	524.63	"	524.76	"	524.79	"	524.83	"
19.65 (55)	523.98	"	525.68	"	525.88	"	525.93	"	526.01	"
19.55 (170)	528.15	"	529.33	"	529.48	"	529.52	"	529.57	"
19.05 (165)	531.82	"	532.80	"	523.91	"	532.94	"	532.98	"
18.75 (45)	532.31	"	533.53	"	533.67	"	533.71	"	533.76	"
18.65 (35)	532.83	"	534.17	"	534.33	"	534.37	(339)	534.43	"

* * * BEGIN DIVIDED FLOW * * *

****

18.6 (45)	530.48	(182)	533.48	(949)	533.77	(1093)	533.93	(1136)	534.08	(1194)
18.0 (80)	534.29	(237)	536.69	(1233)	536.94	(1420)	537.01	(1475)	537.13	(1551)
17.7 (140)	536.81	"	539.67	"	539.87	"	539.92	"	539.95	"

Section No. (Channel Distance to Next Section Downstream, Ft.)	Stage, ft. (Q, cfs) for 2, 10, 25, 50, and 100 year flood									
	2 year		10 year		25 year		50 year		100 year	
17.5 (290)	542.85	(237)	545.53	(1233)	546.09	(1420)	546.15	(1475)	546.21	(1551)
17.0 (160)	546.01	“	549.08	(1372)	549.45	(1759)	549.69	(2271)	550.03	(2700)
16.6 (200)	549.54	“	552.59	(1624)	553.01	(2201)	553.70	(3127)	554.06	(3888)
16.0 (210)	553.64	“	556.33	“	557.18	“	558.18	“	558.84	“
15.3 (1)	554.65	“	556.45	“	556.91	“	560.93	“	561.14	“
Mountaindale Rd.: Low Pt. - 558.5										
15.2 (30)	555.27	“	558.20	“	558.82	“	562.04	“	562.60	“
15.0 (1)	555.31	“	558.82	“	560.30	“	563.09	“	563.75	“
14.5 (75)	555.68	“	559.09	“	560.60	“	563.16	(3208)	563.81	(4376)
14.0 (85)	556.89	“	560.38	“	561.03	“	563.04	“	563.57	(4402)
13.5 (200)	560.09	“	563.66	“	564.40	“	565.51	“	566.41	“
13.0 (170)	564.39	“	567.75	“	568.44	“	569.34	“	570.30	“
12.0 (370)	572.46	“	576.74	“	577.50	“	578.58	“	579.50	“
11.0 (200)	575.87	“	580.14	“	580.97	“	582.14	“	583.28	“
10.0 (400)	585.45	“	588.54	“	589.09	“	589.92	“	590.73	“
8.5 (380)	592.87	“	595.69	“	596.26	“	597.01	“	597.65	“
8.0 (180)	596.68	“	599.6	“	600.72	“	602.15	“	603.25	“

Section No. (Channel Distance to Next Section Downstream, Ft.)	Stage, ft. (Q, cfs) for 2, 10, 25, 50, and 100 year flood									
	2 year		10 year		25 year		50 year		100 year	
7.4 (60)	598.20	(200)	602.07	(1455)	602.96	(1985)	604.12	(2925)	605.01	(4020)
7.3 (1)	598.09	"	602.90	"	603.36	"	604.06	"	605.03	"
7.2 (10)	598.37	"	603.94	"	604.47	"	605.09	"	605.65	"
7.1 (1)	598.55	"	604.06	"	604.54	"	605.10	"	605.62	"
7.0 (240)	603.19	"	607.16	"	607.94	"	608.40	"	609.91	"
6.5 (145)	608.03	"	611.66	"	612.65	"	614.18	"	615.27	"
6.0 (125)	612.02	"	615.46	"	616.12	"	616.92	"	617.67	"
5.5 (170)	616.66	"	619.82	"	620.41	"	621.49	"	623.06	"
5.0 (180)	619.98	"	624.42	"	625.47	"	626.84	"	627.45	"
4.5 (150)	623.30	"	627.44	"	628.42	"	629.77	"	631.17	"
4.0 (155)	625.54	"	630.21	"	631.13	"	632.45	"	633.61	"
3.5 (140)	631.92	"	634.27	"	635.25	"	636.32	"	637.46	"
3.0 (150)	637.23	"	640.57	"	641.09	"	642.39	"	643.25	"
2.5 (250)	644.75	"	648.62	"	649.46	"	650.22	"	650.91	"
2.0 (250)	652.01	"	654.89	"	655.34	"	656.71	"	657.47	"
1.5 (155)	654.71	"	657.53	"	658.35	"	659.32	"	660.23	"
1.0 (165)	662.15	"	663.61	"	663.96	"	664.44	"	664.94	"

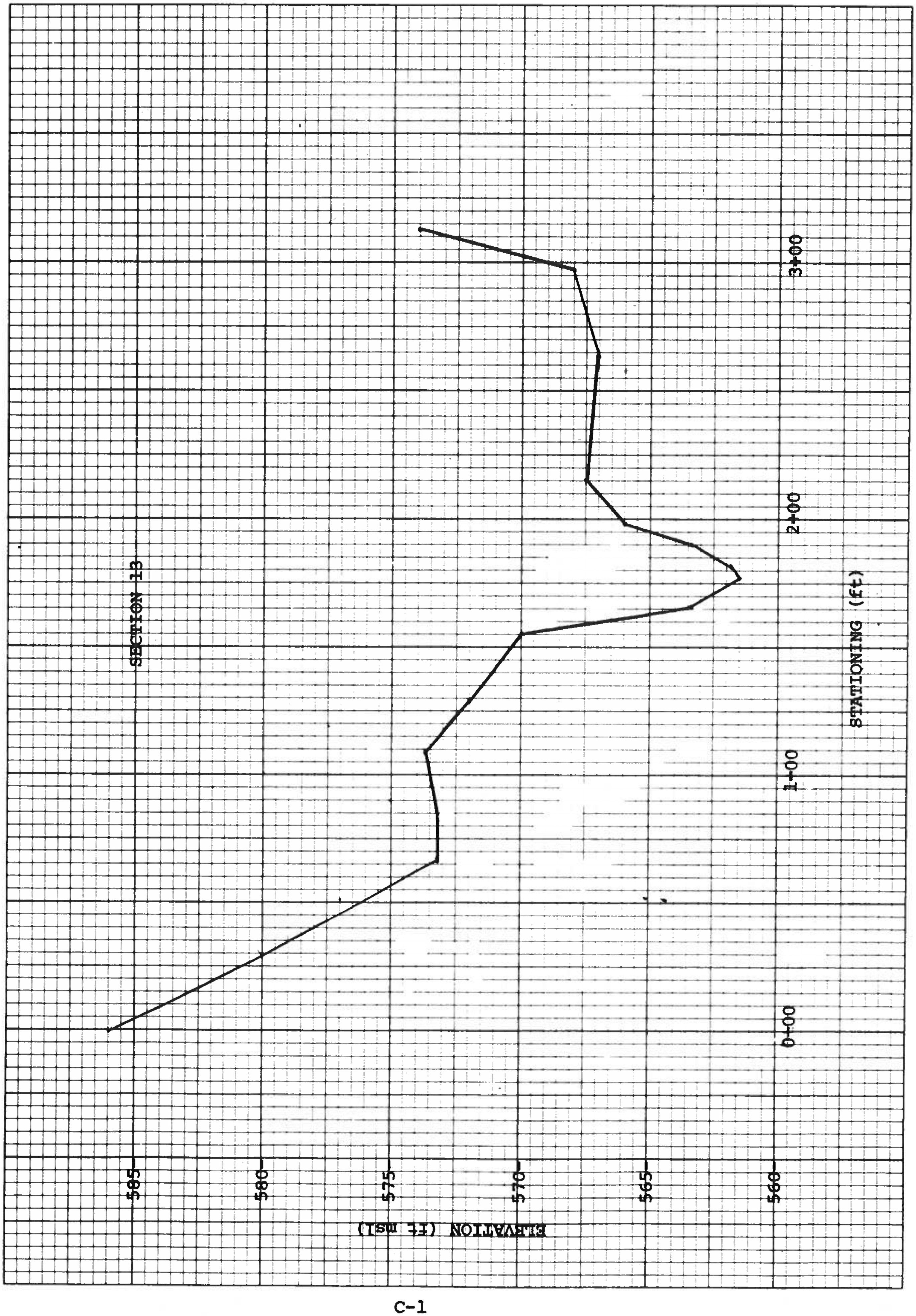
Section No. (Channel Distance to Next Section Downstream, Ft.)	Stage, ft. (Q, cfs) for 2, 10, 25, 50, and 100 year flood			
	2 year	10 year	25 year	50 year	100 year

OVERFLOW (DEPARTS FISHING CREEK NEAR XSEC 16.0

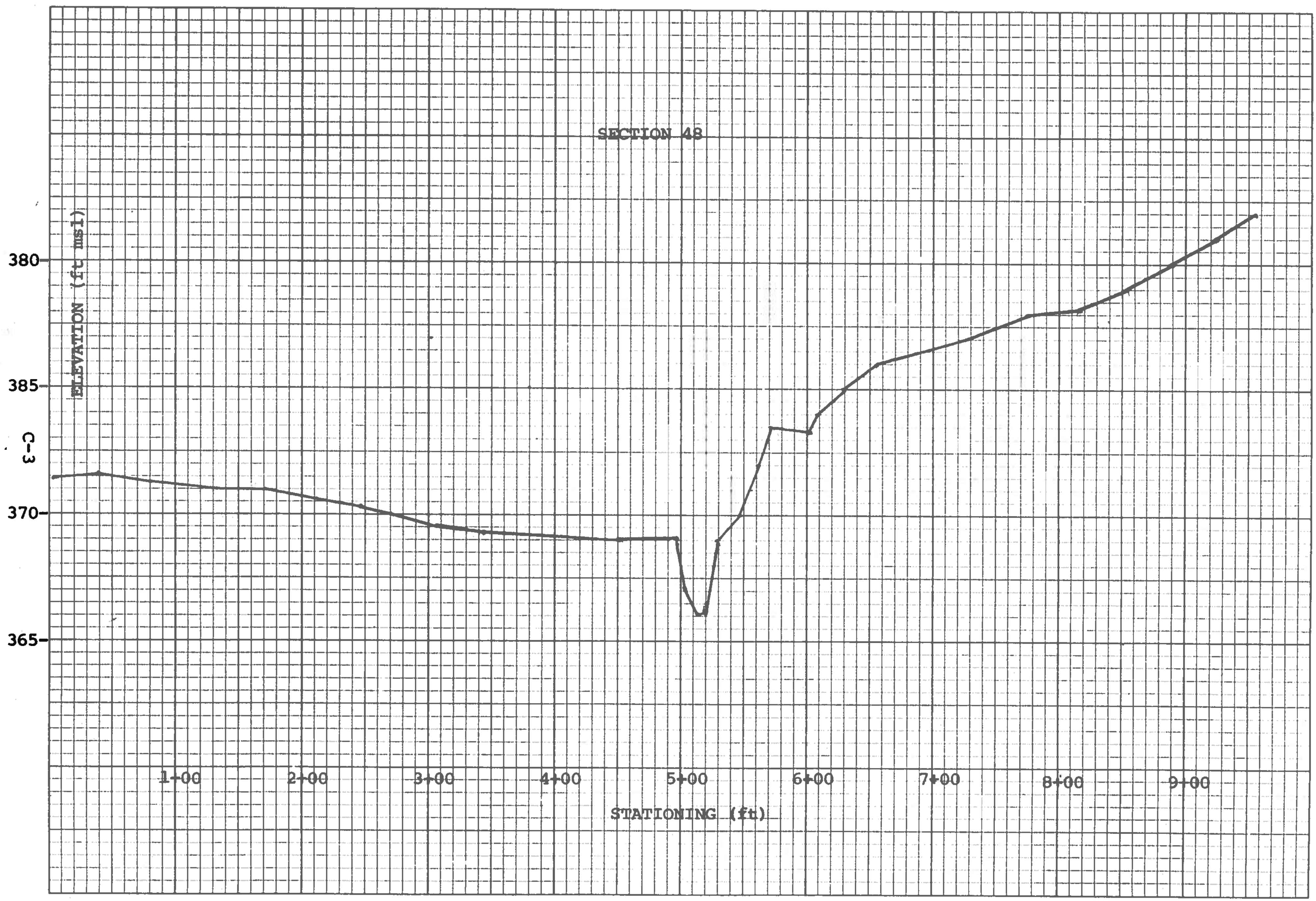
Section	2 year	10 year	25 year	50 year	100 year
1	N/A	440.15 (391)	440.38 (782)	440.62 (1732)	440.95 (2851)
2 (2300)	N/A	463.14 "	463.50 "	463.95 "	454.33 "
3 (1400)	N/A	486.19 "	486.77 "	487.76 "	488.58
4 (1350)	N/A	514.87 "	515.50 "	516.32 "	516.96 "
5 (600)	N/A	528.75 "	529.31 "	530.13 "	530.76 "
6 (625)	N/A	541.18 "	541.54 "	542.05 "	542.45

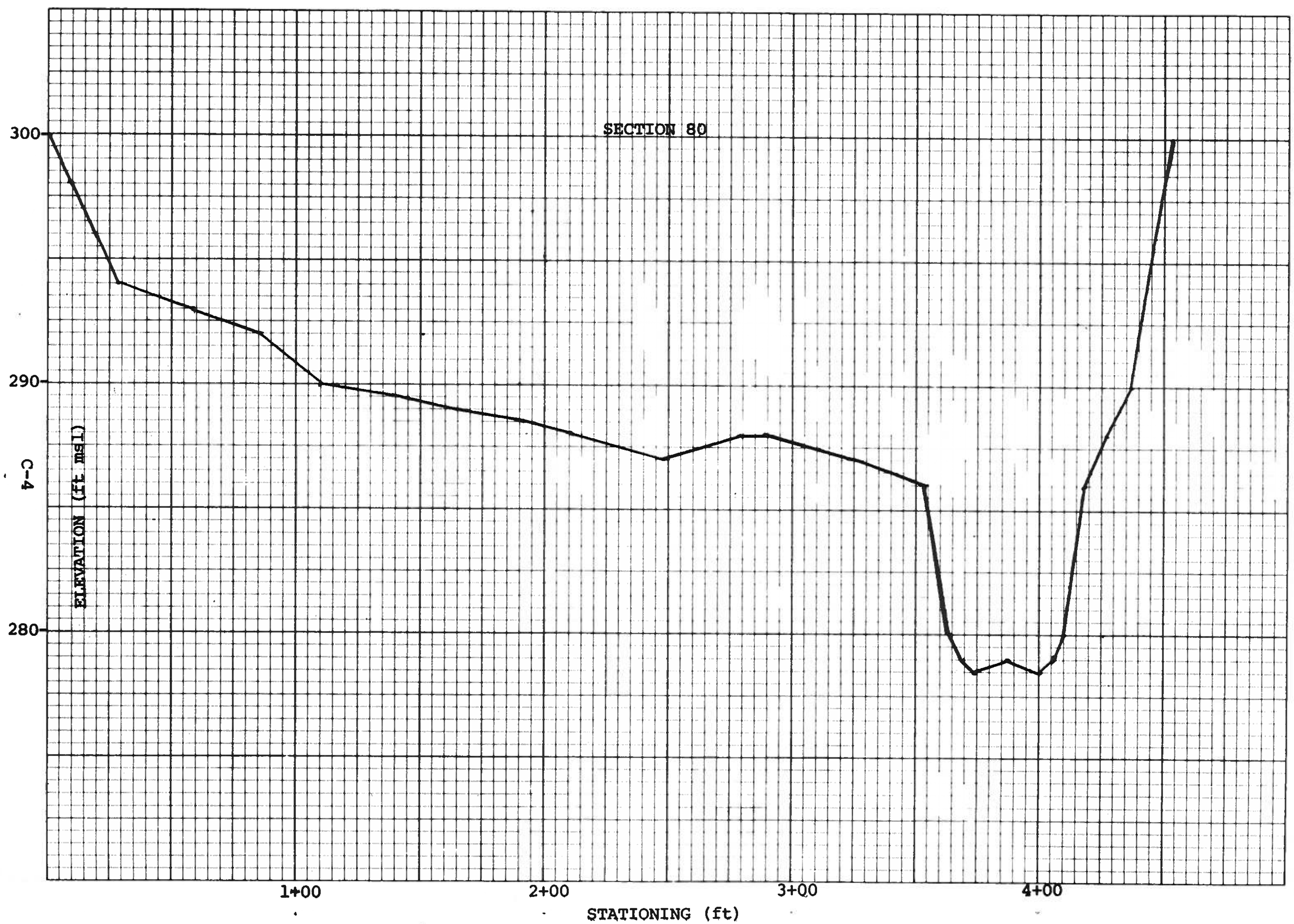
RE-ENTERS NEAR XSEC 28.0

APPENDIX C: TYPICAL CROSS-SECTIONS


SECTION 13
STATIONING (ft)
0+00
1+00
2+00
3+00
ELEVATION (ft msl)
585
580
575
570
565
560

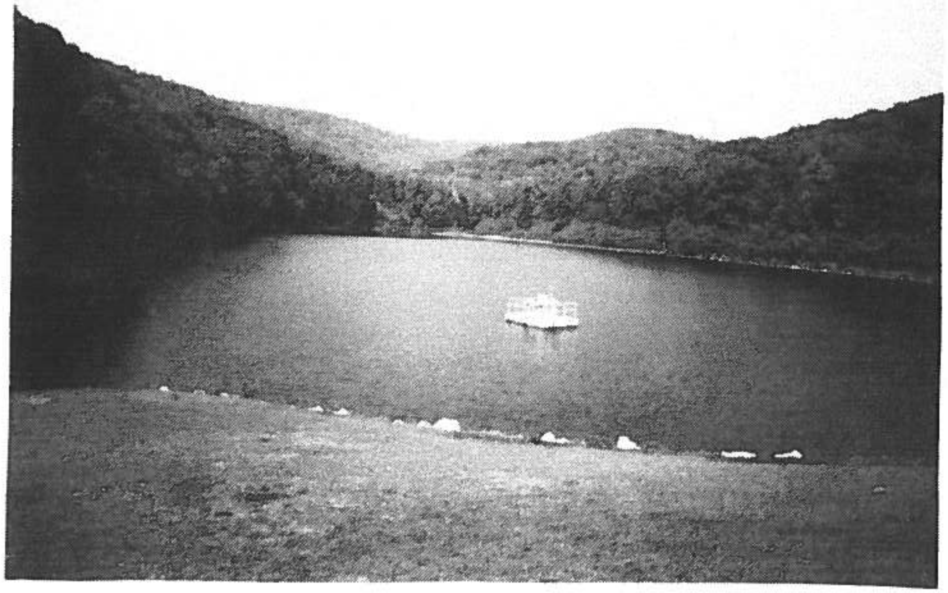

SECTION 21
520
515
510
505
500
ELEVATION (ft msl)
1+00
2+00
3+00
4+00
5+00
6+00
7+00
8+00
9+00
STATIONING (ft)


SECTION 48
ELEVATION (ft msl)
380
385
370
365
1+00
2+00
3+00
4+00
5+00
6+00
7+00
8+00
9+00
STATIONING (ft)



SECTION 80
ELEVATION (ft msl)
300
290
280
STATIONING (ft)
1+00
2+00
3+00
4+00

APPENDIX D: PHOTOGRAPHS

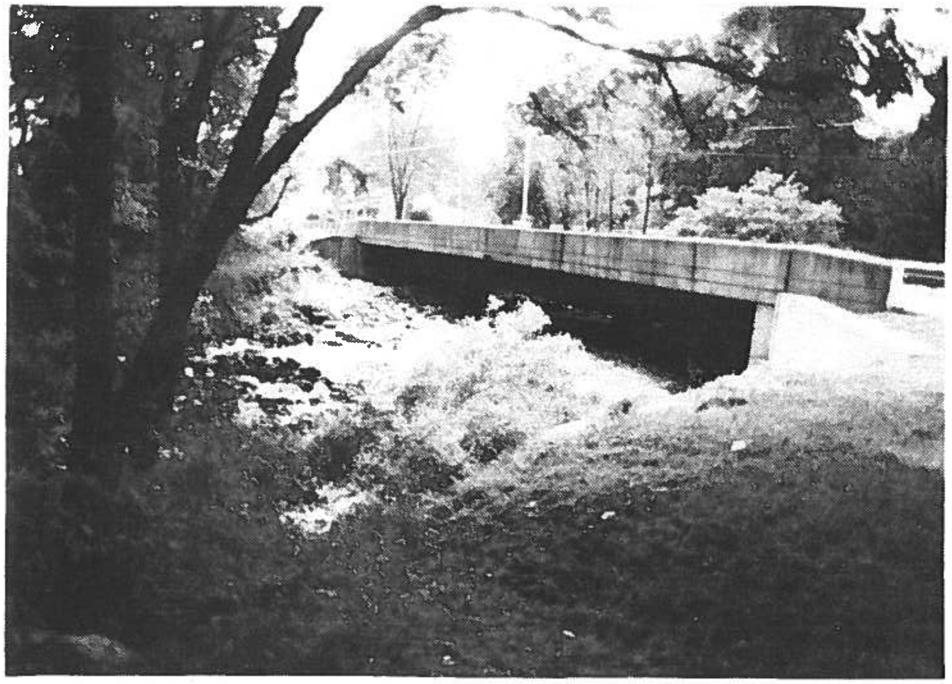


View of the City of Frederick water supply reservoir. Photo taken from atop the dam. The watershed above this point is wooded with no dwellings present. Immediately below the dam is where the 100 year flood damage begins to occur. Raising of this dam for flood control purposes was evaluated in this study but was not found to be a practical alternative due to excessive height (32 ft.) needed to keep the 100 year flood in bank downstream. This major increase in height arises from the low natural storage present and dam safety storage requirements.

Typical view of Fishing Creek just below the water supply reservoir. Of particular note is the steepness of the stream bed slope and cascading of flow over rocks that occurs in this area.

Fishing Creek just upstream of the Rt. 15 bridges. The streambed slope has flattened considerably compared to the prior photo. Also vegetation is more prolific along the banks.

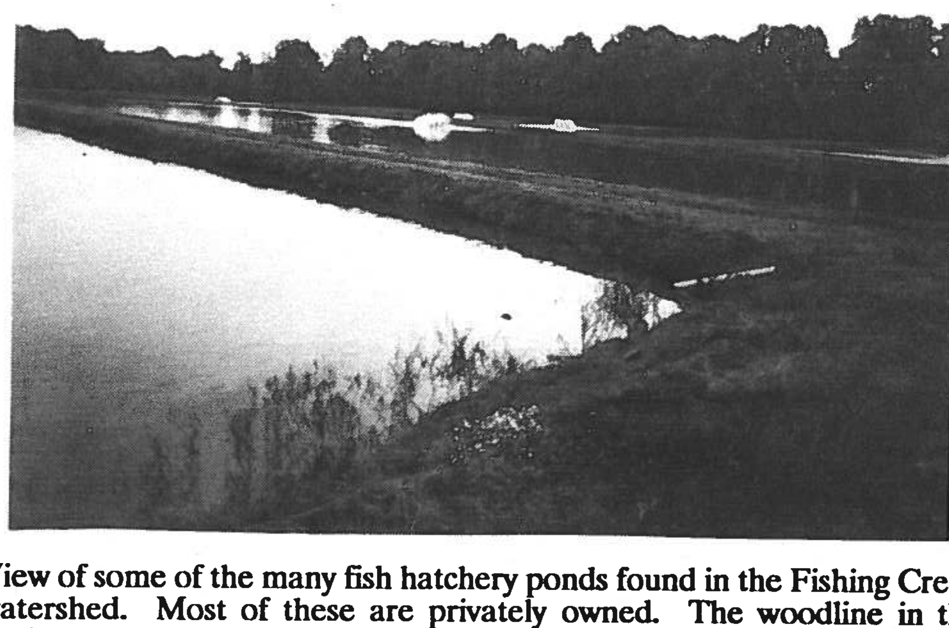
Typical view of the lower portion of Fishing Creek just downstream of the middle Lenhart Road bridge. Trees and brush completely cover the banks. Though this increases the channel "roughness," thereby reducing full-bank capacity, it also serves to stabilize the banks reducing streambank erosion.



Downstream view of the Mountaindale Bridge. This is the vicinity at which flow is anticipated to be diverted (in part) over the far bank when major storms (10% frequency of occurrence or larger) hit the area. Most of the flooding damage along the main stream of Fishing Creek is expected to occur from this area upstream.

The Bethel Road bridge from the upstream side. The flow diverted near the Mountaindale Bridge will begin to rejoin Fishing Creek approximately 2,000 feet upstream of this bridge and continue this merge for another 1,000 feet downstream. Notice the flat terrain past the far bank where this junction of flow will occur.

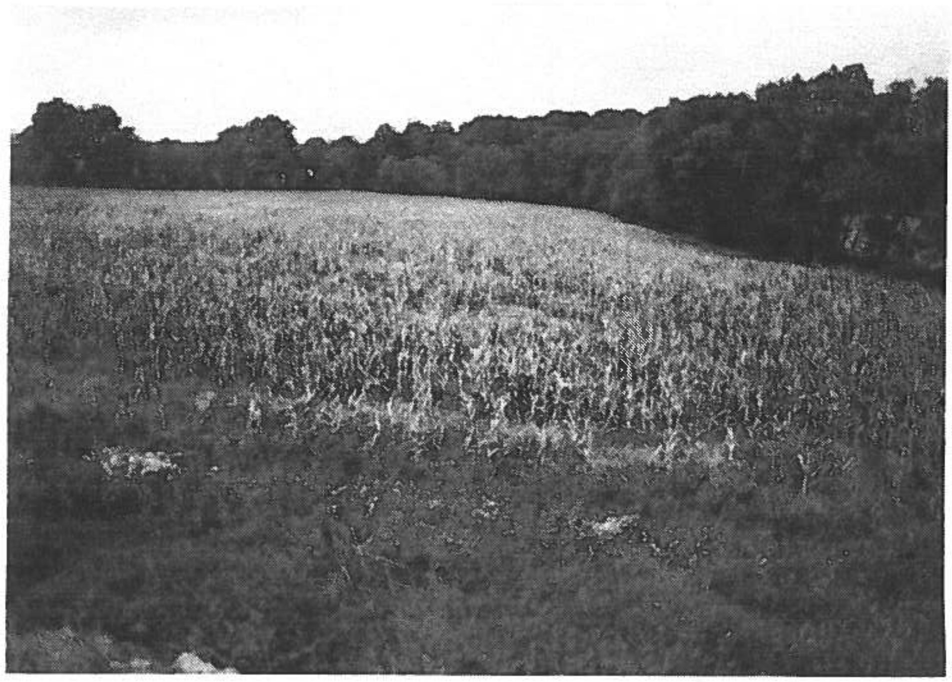
The covered bridge on Utica Road is of historical value. Though the approaches to this bridge will be inundated by the 25 year flood the structure itself is perched above the 100 year flood.



View of some of the many fish hatchery ponds found in the Fishing Creek watershed. Most of these are privately owned. The woodline in the background of this photo is actually the left bank (looking downstream) of Fishing Creek. Though some (relatively few) of these embankments are expected to be overtopped by the 100 year flood, resulting in a loss of the enclosed fish, the structures themselves should see only minor damage due to the shallow depths and low velocities anticipated in this vicinity. Since these are dugout ponds there is no hazard potential should failure occur.

Typical of the many cabins found in the upper Fishing Creek Watershed. Some of these are expected to sustain damage during the 100 year flood.

One of the many houses on Bethel Road situated along the path of diverted flow from the Mountaindale Bridge area. Due to a lack of adequate topographic mapping in this area, floodplain delineation was not performed. Flooding of the houses in this area, from the 100 year storm, is expected to be largely a foot or less above the first floor elevation.



Agricultural land use within the floodplain dominates the landscape from the Bethel Road crossing downstream. This photo was taken looking upstream from Devilbiss Road. Fishing Creek flows through the woodline in the background.

APPENDIX E: INVESTIGATIONS AND ANALYSIS

INVESTIGATIONS AND ANALYSIS

HYDROLOGY

The storm runoff for the Fishing Creek Watershed was calculated using the SCS TR-20 computer program (reference 2). The procedures used are explained in NEH-4 (reference 3). Variables considered in this methodology are drainage areas, runoff curve numbers, times of concentration, reach routing tables, structure properties, and rainfall. Explanations of these variables, with numerical data tabulated by subwatershed follows.

Drainage Areas (DA) - Drainage area is the measurement of the size of a subwatershed in acres or square miles. The Fishing Creek watershed was delineated on the U.S.G.S. quadrangle maps (reference 4). Area was calculated by use of a grid dot system. The Fishing Creek watershed was divided into nine subwatersheds which are shown in Appendix E1.

Time of Concentration (Tc) - Time of Concentration (Tc) is described as the longest time of flow from a watershed boundary to the lower end of the sub-watershed. The flow path naturally consists of a combination of overland (sheet), swale (shallow concentrated), and channel flows. In developed areas, closed systems such as storm drains and culverts may replace the entire natural system.

Tc flow paths were delineated and measured on the quadrangle map for all types of flow. Actual limitations of the flow paths were determined by a combination of field inspection, slopes, vegetative cover type, and experience. These flowpaths are shown in Figure E1.

Overland or sheet flow is described as flow over plane surfaces. A mean flow depth of .002' for paved areas to .02' for vegetated areas is applicable. Times were calculated using the Manning-Kinematic formula as described in SCS Technical Note, Hydrology No. N4 (reference 5). This methodology uses a combination of surface roughness, slope, rainfall, and flow length to determine Tc for the overland segment. Surface roughness was determined through field investigations for existing conditions. Slope was calculated from topographic maps. Rainfall was obtained from Technical Paper-40 (reference 6) for the 100-year event. Flow length was determined from field inspection, steepness of slopes, and experience.

Swale or shallow concentrated flow occurs in depressions or low areas during storms, but is otherwise absent. If a defined channel exists, the reach should not be considered a swale flow area. Velocity for swale areas was calculated using Figure 1 in reference 5.

Channel flows occur where a defined channel is evident, such as ditches, streams, or structural drainageways. Channels may be defined in specific terms of top width, depth, cross-sectional area, perimeter, slope, and surface roughness. Flow velocities are then calculated by use of Manning's Equation, HEC-2, or other acceptable methods. Velocities were calculated by applying Manning's equation to field measured channel sections. Tc is calculated by dividing the flow length by the computed velocity.

Total Tc for each subwatershed is calculated by adding the times for all of the flow paths. Results are listed in the TR20 input data (Figure E4).

Runoff Curve Numbers (RCN) - Runoff Curve Number is described as the runoff potential of a combination of soil and cover (land use) when the soil is not frozen. The higher the RCN, the higher the runoff from a given amount of rainfall. RCN's were calculated by using a combination of data from the SCS Soil Survey for Frederick County (reference 7), quadrangle maps, field observations, and local zoning maps (reference 8).

Soil types can be used as an indicator of the permeability of the ground surface and the water infiltration rates of the subsoils. The SCS has grouped all soil types into four hydrologic groups (HSG's) based on their permeability and infiltration as follows:

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

Group B - Soils having moderate infiltration rate when thoroughly saturated 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 saturated and consisting chiefly of soils having 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 when thoroughly saturated and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a clay pan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission.

The layout of HSG's in the watershed are shown in Figure E2.

Land use is an indicator of the cover condition of the ground surface throughout the watershed. Industrial land use implies a large amount of impervious area, therefore high runoff. "Open" land use (woods, parks, meadow, etc.) implies an absence of impervious areas, therefore lower runoff. The general land use cate-gories used in the Fishing Creek model were: forest, open, one-acre lots, and water for the extensive area covered by fish ponds.

Present and ultimate land use were considered to be the same for the purpose of this study. There is little variance between existing land use (forested/agricul-tural) and existing zoning (one-acre lots/conservation-five acre min.) with respect to RCN's. Present land use was determined from a combination of topographic maps and field observations (flood plain map, Appendix A). Ultimate land use was considered to be development to maximum density in accordance with existing zoning (Figure 3). The actual RCN's used and other relevant hydrologic data is shown in the TR20 input data (Figure E4).

Soil groups were delineated on soil maps from the SCS Soil Survey of Frederick County (reference 7).

Land use and soil groups were combined to calculate a weighted percentage for each subwatershed. Using these calculated values and the appropriate general RCN (from the table below), weighted RCN's were calculated. Results are listed in the table below.

GENERAL RUNOFF CURVE NUMBERS
existing conditions

Land Use	Hydrologic Soil Group B	C	D
Forest	55	70	77
Open Space	71	80	84
One-Acre Lots	68	80	85
Water	100	100	100

Rainfall - Rainfall data were obtained from TP-40 for the 2, 10, 25, 50 and 100-year, 24-hour events. This information is based upon analysis of rainfall gages within a region. Rainfall amounts were reduced by an areal distribution factor. Rainfall amounts used for this study are 3.15" (2-year), 4.9" (10-year), 5.4" (25-year), 6.15" (50-year) and 6.95" (100-year).

There are no recording rainfall gages in the Fishing Creek watershed. A recording gage is located in the Catoctin Mountain Park area near the northern boundary of the watershed. Therefore actual storm data are likely applicable for Fishing Creek with reference to distribution and amounts.

Antecedent Moisture Condition (AMC) - Antecedent moisture condition is the representation of the amount of moisture in the soil at the beginning of the rainfall event. AMC II is applied to all design storms. Modeling of actual events should reflect the AMC for that specific storm, a critical step when attempting to calibrate hydrologic models.

Rating Table - A rating table relates water surface elevation to discharge (cfs), and cross-sectional area (sq.ft.) for a range of discharges. These tables are used in the TR-20 model for routing a calculated runoff through a reach. This accounts for travel time and reduction of peak discharge due to available flood storage within the reach.

Rating tables for this study were developed by inputting various discharges into the HEC-2 computer model (see Hydraulics). The output was reviewed and values for discharge, elevation, and cross-sectional area were selected for use.

<u>Structures</u> - The TR-20 model can route a hydrograph through any structure which stores water, such as a dam or roadway embankment, given a storage versus discharge relationship (structure table). Only one structure within the Fishing Creek watershed has sufficient storage capacity to reduce peak flows; namely, the Fishing Creek Dam located 5000' upstream of Mountaindale Road. The structure table was developed using available topography to determine storage. Additional stage/storage/discharge information was obtained from the WRA Dam Safety Division.

<u>Special Investigations</u> - Certain unforeseen problems occurred during the hydrologic analysis which required additional time. One problem resulted from flood flows leaving the channel in the Mountaindale Road area and flowing through the adjacent subwatershed. This diverted flow rejoined the main stream near Bethel Road. A second obstacle encountered was the need for additional surveys/field investigations to develop data for reach routing tables.

The diverted flow required the development of data for the DIVERT routine contained in TR-20. This data consist of percentage of flow, related portion of drainage, and routing tables for the area where the flow splits. Also, this data had to be consistent with the data produced by the hydraulic model, HEC-2 (refer to Hydraulics).

The surveys/field investigation consisted of surveying cross-sections and vertical control, obtaining n values, and determining actual flow paths.

<u>Calibration</u> - Ideally, the results of hydrologic models should be compared with data gathered from actual flood events. This is usually accomplished using data recorded by stream and rainfall gages located within the study watershed. A stream flow gage is located just upstream of the reservoir but its data was found to be questionable.

An alternative method for calibration is to compare the watershed in question with known events in similar watersheds. Comparison watersheds must be similar in all aspects, including size, shape, land use, geography, etc. The only gaged watershed that is sufficiently similar is Hunting Creek, which is adjacent to Fishing Creek. Considering variance in model variables, the results of the Fishing Creek model agree favorably with the Hunting Creek data.

HYDRAULICS

Water surface profiles were computed using the HEC-2 computer program (reference 10). The program uses a procedure referred to as the Standard Step Method which balances energy between cross-sections, accounting for energy losses in the process. The losses considered are friction losses, transition losses, and losses at structures. The procedures are explained in Volume 6 of Hydrologic Engineering Methods for Water Resources Development (reference 11).

The HEC-2 program requires input of certain basic data: stream cross-sections; bridge/culvert geometry; roughness coefficients; and discharges. Explanation of the variables follow and the results are tabulated in Appendix B.

Cross-Section Data - Cross-sections are located where changes in hydraulic properties occur, such as slope, structures, roughness, and constrictions or expansions. The distance between sections is normally less than 1000'. Greater distances are used in rural areas where accuracy is less important. Closer spacing is necessary in developed or developing areas. Section locations along Fishing Creek are shown on the maps in Figure 8. Cross-sections were field surveyed by the Water Resources Administration or measured from topographic maps. All elevations are based on the National Geodetic Vertical Datum of 1929 (NGVD).

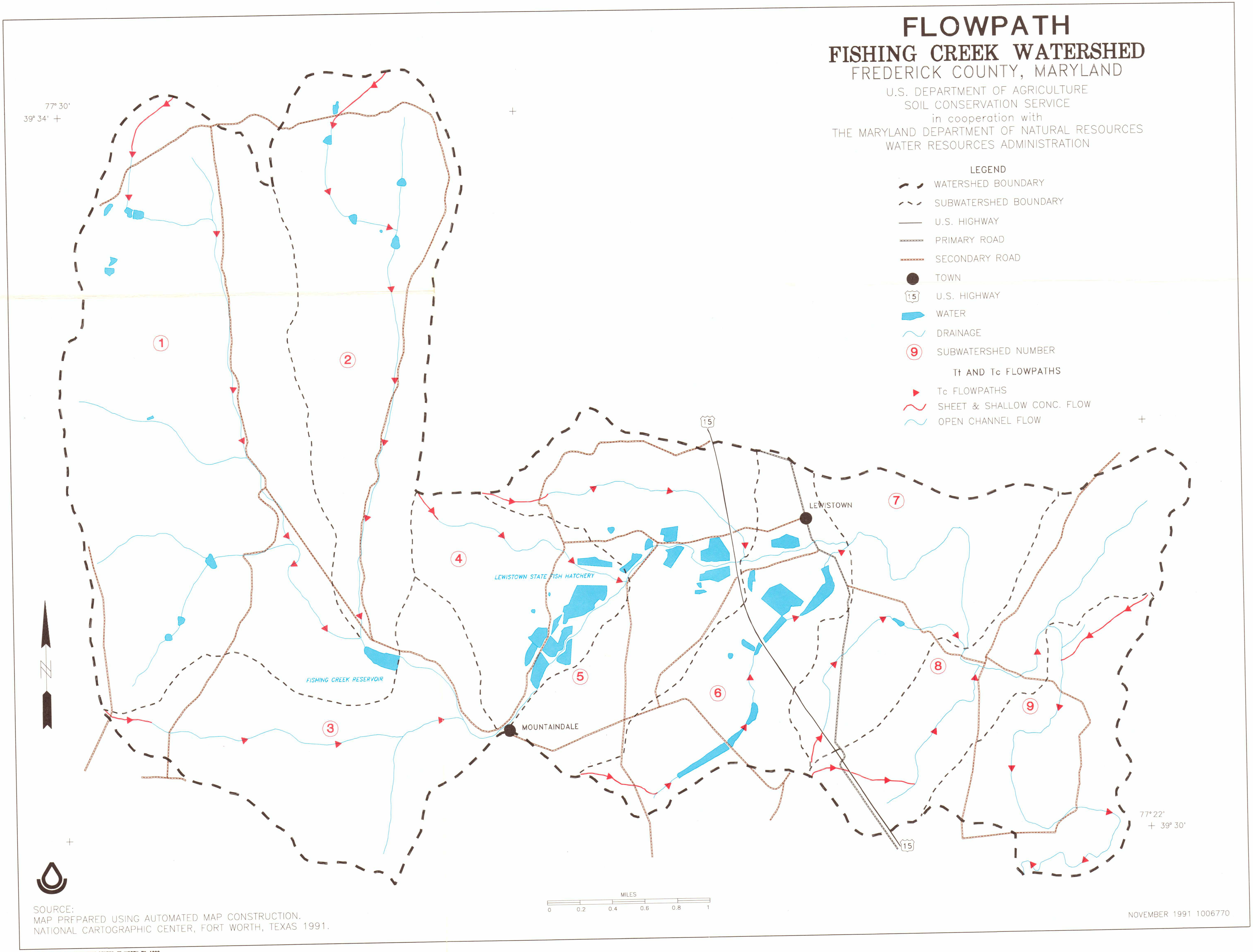
Bridges - All of the stream crossings in the detailed study portion of watershed are bridges. Data for the crossings were gathered through field surveys and observation.

Manning's "n" Values - Manning's "n" Values were used to determine friction losses through stream reaches. The values were determined by field observation throughout the Fishing Creek watershed. The basis for the selection is explained in NEH-5 (reference 13), Water Supply Paper 1849 (reference 14), and FHWA-TS-84-204 (reference 15).

Discharges - Discharges were obtained from the TR-20 results for the 2, 10, 25, 50, and 100-year events. These values were input in the HEC-2 model to develop final water surface profiles. Only the 2, 10 and 100-year profiles are shown in Appendix A. All of the profiles are tabulated in Appendix B.

Special Investigations - The diverted flow situation mentioned under hydrology in this section required extensive modeling corrections and modifications. The additional analysis consisted of: split flow modeling which calculates the amount of flow lost from the main flow; overflow channel surveying and modeling to establish rating tables and flood elevations for the lost flow; and divided flow modeling from Mountaindale Road to Bethel Road as a result of the diverted flow. Four additional hydraulic models were developed for the final analysis.

Calibration - Calibration of the HEC-2 model normally involves matching observed versus computed water surface elevations for known discharges. The discharges for actual events for Fishing Creek are available from existing gage records. Upon reviewing the data from the gage, it was determined to be questionable. The large variance from storm to storm could not be accounted for when comparing the stage/discharge to recorded rainfall. Corrections and/or re-evaluation of the gage was outside the scope of the study. Also, the absence of reliable high water marks throughout the watershed made calibration by this means impractical.

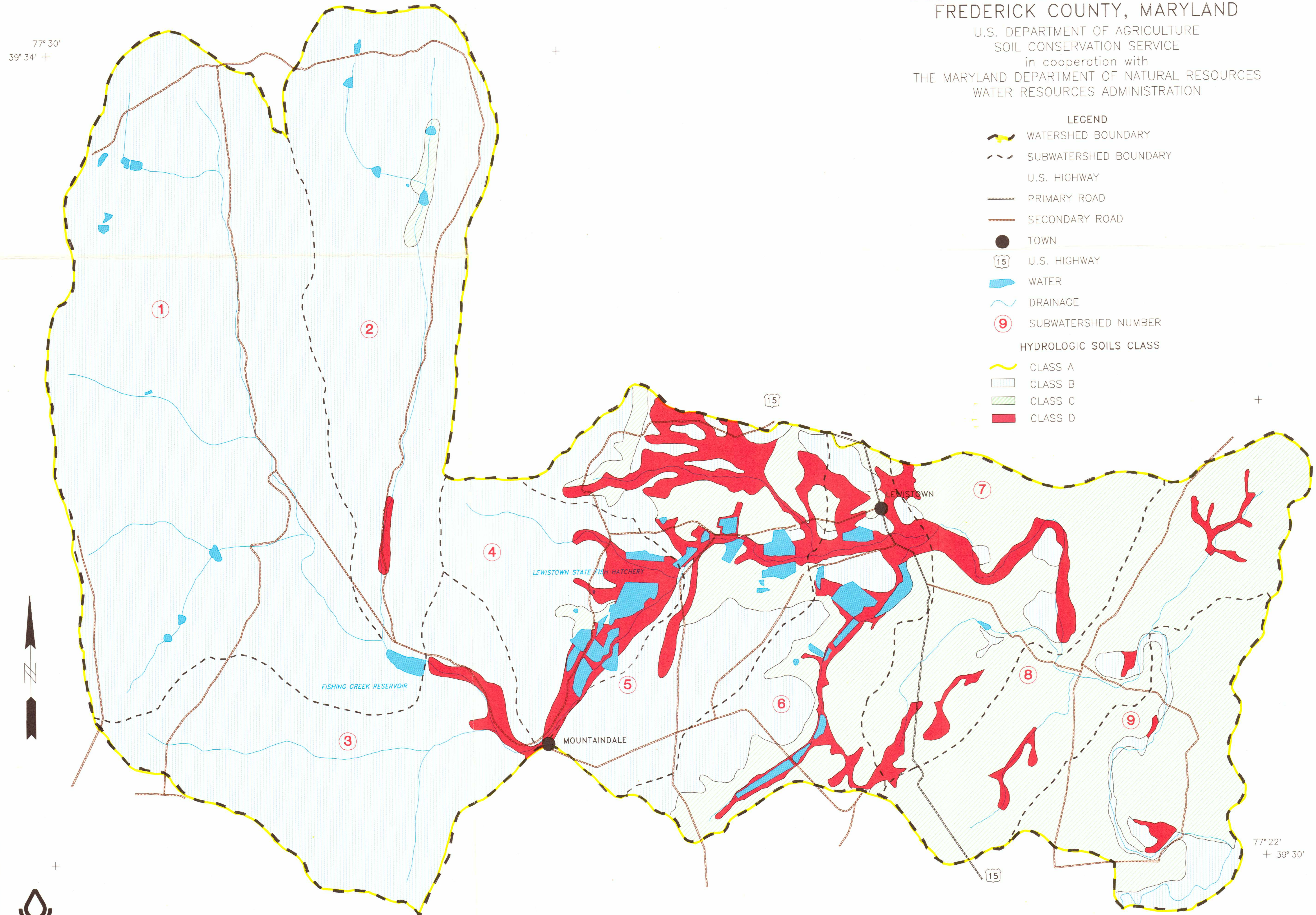


USDA-SCS-NATIONAL CARTOGRAPHIC CENTER, FT. WORTH, TX.-1992

FIGURE

HYDROLOGIC SOILS
FISHING CREEK WATERSHED
FREDERICK COUNTY, MARYLAND

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
in cooperation with
THE MARYLAND DEPARTMENT OF NATURAL RESOURCES
WATER RESOURCES ADMINISTRATION

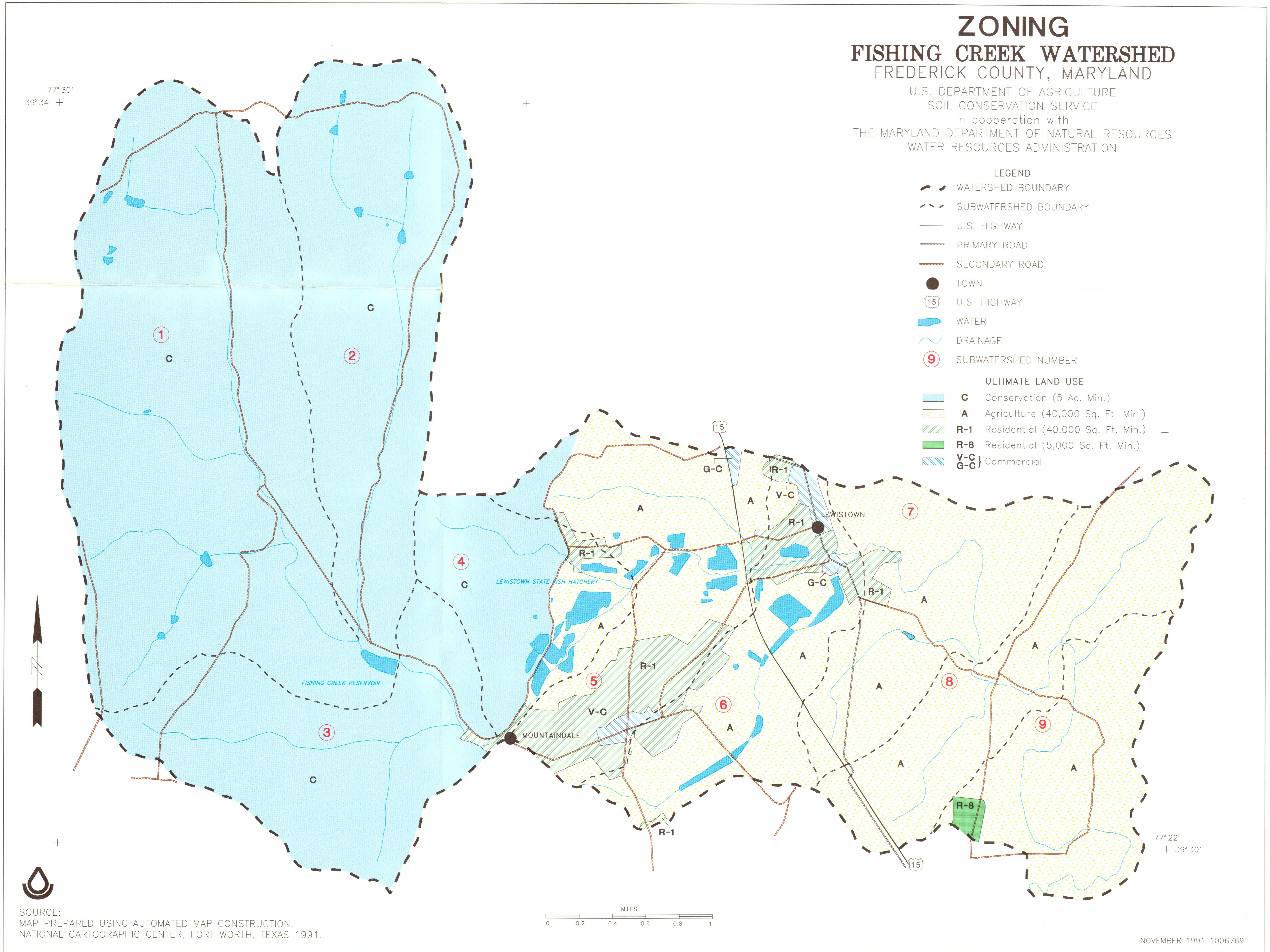


SOURCE:
MAP PREPARED USING AUTOMATED MAP CONSTRUCTION.
NATIONAL CARTOGRAPHIC CENTER, FORT WORTH, TEXAS 1991.

NOVEMBER 1991 1006768

USDA-SCS-NATIONAL CARTOGRAPHIC CENTER, FT. WORTH, TX.-1992

FIGURE E2



USDA-SCS-NATIONAL CARTOGRAPHIC CENTER, FT. WORTH, TX.-1992

FIGURE E3

```
JOB TR20             ECON     FULLPRINT          SUMMARY    NOPLOTS
TITLE 001    FISHING CREEK - FREDRICK CO.
TITLE        2 - 100 YEAR EVENTS EXISTING CONDITIONS
 3 STRUCT       01
 8                        713.          0.          0.
 8                        714.          200.        11.
 8                        716.          1000.       34.
 8                        718.          2300.       60.
 8                        720.          4000.       87.
 8                        722.          6000.       115.
 8                        724.          8100.       145.
 8                        726.          10350.      176.
 8                        728.          12800.      210.
 8                        730.          16000.      245.
 9 ENDTBL
 3 STRUCT       02
 8                        269.          0.          0.
 8                        274.63        900.        5.9
 8                        275.69        1221.       16.8
 8                        276.53        1500.       24.8
 8                        277.6         2000.       40.0
 8                        278.52        2500.       73.0
 8                        279.35        3000.       99.0
 8                        280.12        3500.       119.0
 8                        280.83        4000.       148.0
 8                        281.49        4500.       173.0
 8                        282.12        5005.       201.0
 9 ENDTBL
 2 XSECTN    003          1.0
 8                        642.          0.          0.
 8                        644.55        200.        48.
 8                        648.44        1455.       227.
 8                        649.17        1985.       301.
 8                        649.67        2925.       430.
 8                        650.33        4020.       574.
 9 ENDTBL
 2 XSECTN    041          1.0
 8                        512.4         0.          0.
 8                        514.17        100.        42.
 8                        514.70        189.        82.
 8                        515.38        393.        176.
 8                        515.54        460.        204.
 8                        516.14        800.        336.
 8                        516.53        1128.       433.
 8                        516.98        1629.       557.
 8                        517.30        2020.       652.
 8                        517.70        2600.       787.
 9 ENDTBL
 2 XSECTN    004          1.0
 8                        552.20        0.0         0.0
 8                        553.82        239.        94.
 8                        557.01        1615.       296.
 8                        557.79        2198.       357.
 8                        558.53        2932.       440.
 8                        559.09        3635.       533.
 9 ENDTBL
 2 XSECTN    005          1.0
 8                        383.7         0.          0.
 8                        387.75        500.        131.
 8                        388.46        797.        204.
 8                        389.86        2092.       654.
 8                        390.23        2562.       849.
 8                        390.78        3330.       1123.
 8                        391.45        4409.       1431.
```

FIGURE E4

```
9 ENDTBL
2 XSECTN    006               1.0
8                             378.        0.         0.
8                             382.34      500.       239.
8                             383.12      830.       368.
8                             384.72      2163.      889.
8                             385.        2650.      1073.
8                             385.62      3446.      1343.
8                             386.37      4581.      1671.
9 ENDTBL
2 XSECTN    007               1.0
8                             330.70      0.         0.
8                             335.87      600.       163.
8                             336.75      885.       226.
8                             339.16      2297.      609.
8                             339.68      2819.      756.
8                             340.49      4002.      1073.
8                             341.02      5501.      1437.
9 ENDTBL
2 XSECTN    008               1.0
8                             327.80      0.         0.
8                             332.14      700.       114.
8                             332.83      1030.      289.
8                             334.69      2350.      580.
8                             335.19      2857.      691.
8                             336.11      3868.      843.
8                             337.79      5255.      1125.
9 ENDTBL
2 XSECTN    009               1.0
8                             289.5       0.         0.
8                             295.21      1000.      280.
8                             296.47      1408.      378.
8                             299.07      2918.      807.
8                             299.61      3369.      1055.
8                             300.39      4050.      1316.
8                             301.78      5510.      1744.
9 ENDTBL
6 RUNOFF 1 001          5 4.8         55.        1.19        1     1   1
6 RUNOFF 1 002          6 2.67        56.        1.06        1     1   1
6 ADDHYD 4 002    5 6 7                                        1     1   1
6 RESVOR 2      01 7    5 713.                                 1     1   1
6 REACH  3 003    5     6 4560.                                1     1   1
6 RUNOFF 1 003          5 1.99        56.        .645          1     1   1
6 ADDHYD 4 003    5 6 7                                        1     1   1
6 DIVERT 6 003    7 4 1 1841.         .418       31.           1  1  1   1
6 REACH  3 004    4     6 7000.                                1  1  1   1
6 REACH  3 041    1     4 6200.                                1  1  1   1
6 RUNOFF 1 004          5 1.12        69.        .34           1     1   1
6 ADDHYD 4 004    6 5 7                                        1     1   1
6 ADDHYD 4 041    4 7 6                                        1     1   1
6 REACH  3 005    6     5 4900.                                1     1   1
6 RUNOFF 1 005          6 1.92        75.        1.17          1     1   1
6 ADDHYD 4 005    5 6 7                                        1     1   1
6 REACH  3 006    7     5 3850.                                1     1   1
6 RUNOFF 1 006          6 1.46        80.        2.93          1     1   1
6 ADDHYD 4 006    5 6 7                                        1     1   1
6 REACH  3 007    7     5 10100.                               1     1   1
6 RUNOFF 1 007          6 1.54        79.        1.            1     1   1
6 ADDHYD 4 007    5 6 7                                        1     1   1
6 REACH  3 008    7     5 5000.                                1     1   1
6 RUNOFF 1 008          6 1.59        79.        1.21          1     1   1
6 ADDHYD 4 008    5 6 7                                        1     1   1
6 REACH  3 009    7     5 7635.                                1     1   1
6 RUNOFF 1 009          6 1.14        76.        1.06          1     1   1
6 ADDHYD 4 009    5 6 7                                        1     1   1
6 RESVOR 2      02 7    5 269.0                                1     1   1
```

```
 6 REACH  3 009    5    6 2000.                                                  1      1    1
   ENDATA
 7 LIST
 7 INCREM 6               .1
 7 COMPUT 7 001        02 0.0          3.15          1.0           2 2   01   01
   ENDCMP 1
 7 ALTER  3
 6 DIVERT 6 003    7 4 1 1233.          .759          31.           1 1   1    1
 7 COMPUT 7 001        02 0.0          4.9           1.0           2 2   01   02
   ENDCMP 1
 7 ALTER  3
 6 DIVERT 6 003    7 4 1 1419.          .645          31.           1 1   1    1
 7 COMPUT 7 001        02 0.0          5.4           1.0           2 2   01   03
   ENDCMP 1
 7 ALTER  3
 6 DIVERT 6 003    7 4 1 1475.          .46           31.           1 1   1    1
 7 COMPUT 7 001        02 0.0          6.15          1.0           2 2   01   04
   ENDCMP 1
 7 ALTER  3
 6 DIVERT 6 003    7 4 1 1551.          .352          31.           1 1   1    1
 7 COMPUT 7 001        02 0.0          6.95          1.0           2 2   01   05
   ENDCMP 1
   ENDJOB 2
   PEAKS       4      5      4A    11.0974B     11.2064C     11.636
   PEAKS       6      7      6A    14.4626B     14.857
   PEAKS       7      8      7A    16.181
   PEAKS       8      9      8A    17.638
   ENDJOB 2
```