States
Department of
Agriculture

Soil
Conservation
Service

Richmond,
Virginia

FLOOD PLAIN MANAGEMENT

A Study Of Upper North River

Augusta County, Virginia

September 1984

The cover shows a 1983 photo of Natural Chimneys which are located in Natural Chimneys Regional Park. The park provides recreation facilities and unique sightseeing for the public. The area is subject to flooding.
(see photo Map 2)

W-WR2-F1.1

FOREWORD

The Soil Conservation Service, U.S. Department of Agriculture, prepared the information in this flood plain management report. Officials of the Virginia State Water Control Board, the Headwaters Soil and Water Conservation District, and Augusta County cooperated in compiling the report. Augusta County funds covered the cost of printing and finishing the report.

The flood hazard and land use information should serve as a technical base for flood plain management programs. State and local governments, as well as the public, will benefit from knowledge of flood information on Upper North River. A program to minimize future flood damages can be developed from this information. Describing the legal aspects and methods of conducting management programs is not within the scope of this report. However, some general recommendations are included.

We thank the many people who contributed information for the study. We also thank the landowners who gave permission for field surveys.

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INTRODUCTION

The purpose of the flood plain management study is to define the flood plain and identify potential flood losses. The report serves as the basis to develop a flood plain management program for North River. Use of this information and compliance with regulations pertaining to flood plain use can minimize loss of life and property damage from future floods. Section 1315.6 of the Virginia Uniform Statewide Building Code sets certain requirements for construction in flood plains. (Ref. 1).

Involved Organizations and Responsibilities

The Headwaters Soil and Water Conservation District (District) and the Augusta County Board of Supervisors (County) applied for a flood plain management study of Upper North River. The State Water Control Board (Board) received the application and requested the Soil Conservation Service (SCS) to conduct this study. SCS prepared a plan of study describing the study area, location, scope, responsibilities, estimated costs, funding arrangements, and tentative schedules. This plan of study approved on June 20, 1980 was reviewed by the District, County and Board.

SCS had responsibility for implementing the technical phases of the study, preparing maps and drawings and printing portions of the report. The County provided available information on the study area and obtained permission for field surveys. The County also paid all expenses in connection with printing and finishing. The County and District will hold public meetings and provide necessary publicity to implement a flood plain management program. The Board and SCS will provide assistance to assure prompt and effective use of the study findings.

Authorities

The Soil Conservation Service (SCS) of the U.S. Department of Agriculture participated in this study under the following authorities:

- Section 6, Public Law 83-566, as amended;
- Federal level Recommendation 3, A Unified National Program for Flood Plain Management, Water Resources Council, September 1979;
- Executive Order 11988, January 25, 1978;
- U. S. Department of Agriculture Secretary's Memorandum 1606 and 1607, November 7, 1966.

State statutes and directives of the Governor of Virginia authorize Board, District, and County involvement in flood plain management surveys and related studies. This study was performed in accordance with a Joint Coordination Agreement for Flood Plain Management between the State Water Control Board and the Soil Conservation Service, dated January 1979.

DESCRIPTION OF STUDY AREA

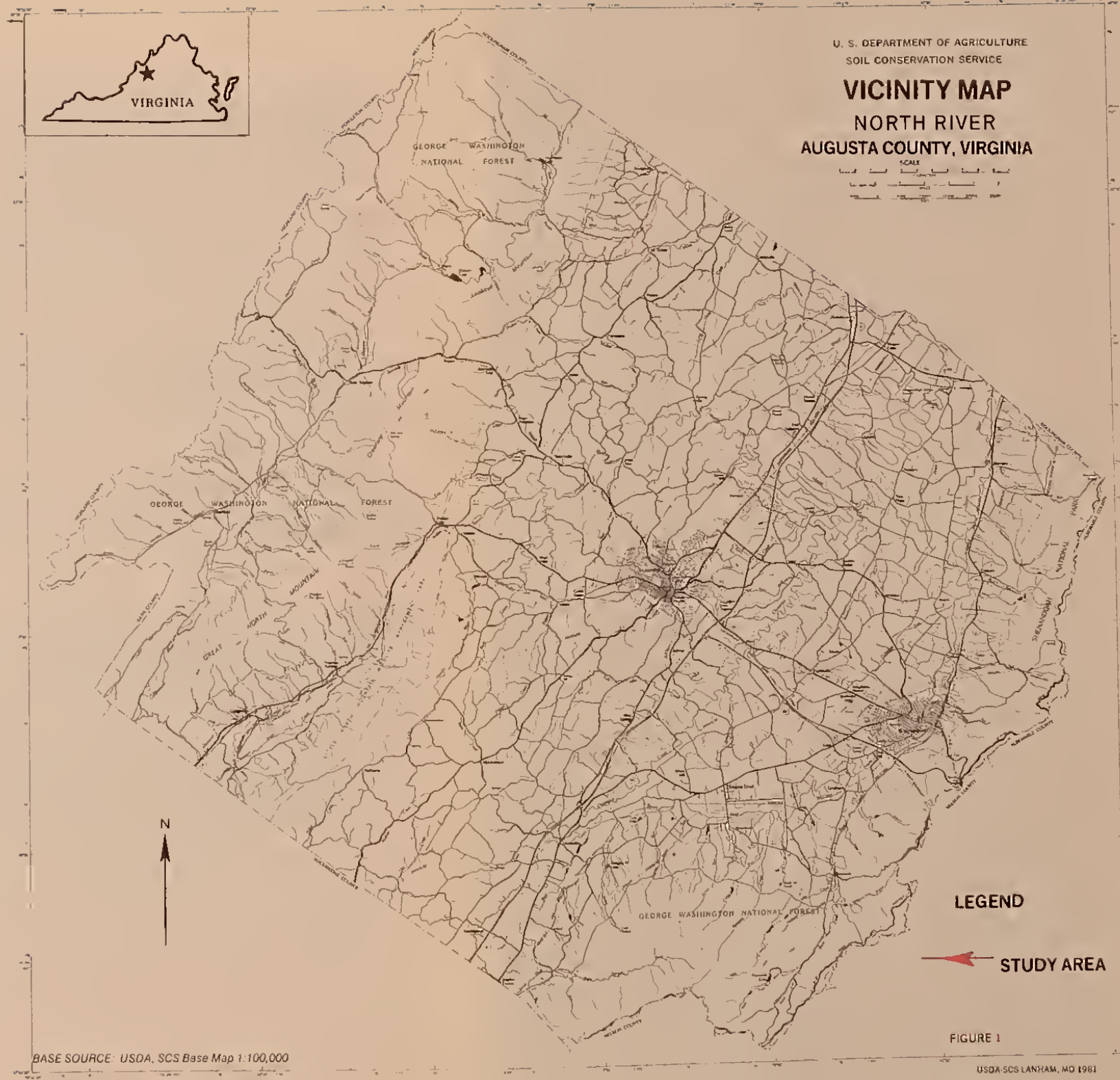
Upstream Drainage Area

The Upper North River drainage area comprises 101.24 square miles above the Augusta-Rockingham County line (figure 1). The Upper North River is a subbasin of the Potomac River Basin which is in the Mid-Atlantic Region as designated by the Water Resources Council. The USGS Hydrologic Unit code number in the area is 02070005.

The watershed is in the Northern Applachian Ridges and Valleys physiographic province. Soils are formed primarily in alluvial or colluvial material. Monongahela-Allegheny-Unison are the predominant soil series for open land. 1/ Upper areas of the watershed are predominately Drall-Hazleton - Leetonia and Lehew - Hazleton associations. Land use is about 10 percent pasture and hayland, 84 percent woodland, and 6 percent cropland and miscellaneous. Woodland in upper reaches is in the Federally owned George Washington National Forest.

Normal annual precipitation is 40 inches, including 25 inches of snowfall which equals about 2 inches of rainfall. Average January temperature is 35 degrees F and the average for July is 74 degrees F. Average growing season is 160 days.

1/ Soil Survey data is available at the SCS Augusta County Field Office, Staunton, Virginia.


VIRGINIA
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
VICINITY MAP
NORTH RIVER
AUGUSTA COUNTY, VIRGINIA
SCALE
GEORGE WASHINGTON NATIONAL FOREST
GEORGE WASHINGTON NATIONAL FOREST
GREAT NORTH MOUNTAIN
GEORGE WASHINGTON NATIONAL FOREST
SHENANDOAH NATIONAL PARK
N
LEGEND
STUDY AREA
BASE SOURCE: USDA, SCS Base Map 1:100,000
FIGURE 1
USDA-SCS LANHAM, MD 1981

Flood Plains

State Route 730 parallels North River through the study area. Other roads such as 731, 758, 764, 763, and 718 cross this flood plain. The predominate land use in this flood plain is cropland and idleland with heavy shrub and tree growth along the river. In addition, land use in this flood plain consists of pasture, medium and light brush, and meadow. Roads, buildings and dwellings take up a small percentage of land.

A total of approximately 7.5 stream miles were studied from Girl Scout Camp May Flather near Stokesville down to the Augusta-Rockingham County line (see Figure 1).

Natural and Beneficial Values

Upper North River is classified as a mountainous zone, cool cobbly-boulder substrate stream characterized by wide flood plains, moderate slopes, and rapid runoff of floodwaters. Large springs are present in the stream and in adjacent tributaries, especially in the lower sections of the study area. The upper end dries up, except for pools, for varying periods during most years.

The river through the study area is primarily a smallmouth and rock bass stream. However, it does contain localized sections of cold water where the springs occur. In these areas some escaped stocked trout (mostly from Mossy Creek in Rockingham County) flourish and reproduce. These scattered areas have significant recreation value. The rest of the stream is used moderately for recreation, including dipping for spring sucker runs and smallmouth bass fishing.

FLOOD HISTORY

The most damaging flood of record occurred in June 1949. In 1950 it was reported that damages exceeded $2,000,000 along with three deaths in the Town of Bridgewater. (Ref. 2). Damages included property loss (homes, furniture and livestock), farm loss (crops, fences, and land), road and highway damage, Rural Electrification Administration (distribution lines and telephone lines) damages, and damages in Bridgewater. It should be noted that the 1949 flood exceeded the 100-year frequency flood event.

Bulletin 10 (Ref. 2) in 1950 projected the 1949 flood to be about a 75-year flood. Data published by U.S.Geological Survey in 1978 show the 1949 storm at the North River gage near Stokesville would exceed the 100-year event. (Ref. 4). Many other storms have occurred but none as large as the 1949 flood.

FLOOD POTENTIAL

Present Conditions

Large Floods. Extreme floods would inundate about 2500 acres of primarily agricultural land (see table below). Extensive damage would be done to the land, crops, fences, farm roads, dwellings, buildings, and machinery. Damage to dwellings and businesses would occur mostly along the main stream of North River. Velocities would average about 3.5 feet per second and exceed 4.5 feet per second in some reaches. Out-of-bank stages would average about 2.6 feet for the 100-year storm to 3.4 feet for the 500-year storm. Duration of flooding would seldom exceed 20 hours except during storms of intense and prolonged rainfall.

In a situation of varying rainfall patterns a large rain could occur below the existing dams, sites 10, 76 and 77. (Ref. 3). In this case no protection would be given by the dams. (See section on Existing Programs for further explanation of the dams).

Flood Hazard Areas. The acres tabulated below are used primarily for pasture and other agricultural uses. Only about two percent is devoted to roads, farmsteads and similar uses.

	Acres by Flood Frequency		Buildings in 100-year flood plain			
Stream	100-year	500-year	Dwellings	Barns	Sheds	Churches
North River	1148	2503	35	6	22	2

Flood Plain Management Exhibits. The technical data needed for establishing a flood plain management program is in the appendix. Also the appendix outlines a procedure for determining the flood elevations at any particular location.

Flood plain photomaps show the area covered by the 100-and 500-year floods. Where only one line is shown, there is no difference in the boundary of the two flood areas. These photomaps should be used to determine approximate flood elevations.

Flood profile plates provide elevations of the 100-and 500-year floods at any location along the length of the streams. The elevations and discharges of the 10-, 25-, 50-, 100-and 500-year flood at each surveyed cross section are given in Table A-1. Sample cross sections illustrate how the flood areas were located on the photomaps.

Also included in the appendix is a list of benchmark elevations and locations, a glossary of terms and a list of references. The basic data is on file in the office of the USDA, Soil Conservation Service, 400 North Eighth Street, Federal Building, Richmond, Virginia 23240.

Figure 2. Approximately 200 feet south of Natural Chimneys at base of Sun Dial.

Figure 3. Looking north across state route 730 approximately 700 feet below the junction of State routes 730 and 718 at Stokesville.

Limitations on Use of Data. The flood elevations given in this report should be considered as minimum elevations. During floods, uprooted trees and other debris may collect on bridges and culverts and clog the channels. Such obstructions increase the depth and extent of flooding. The analysis was made without showing the effects of potential obstructions. Also, extremely rare events such as dam failure and climatic changes were not analyzed.

Future Conditions

The hydrologic conditions in the upstream areas are expected to improve as foresters and others continue to apply good management and conservation practices. This improvement is expected to reduce runoff approximately to the extent that additional development will increase runoff. Therefore, the flood hazard and damage potential is not expected to change significantly in the next 10 to 15 years.

FLOOD PLAIN MANAGEMENT

Existing Programs

In 1960 the Upper North River Public Law - 534 Work Plan was prepared by the Shenandoah Valley Soil Conservation District. (Ref. 3). Measures within the plan provided Land treatment, flood prevention, channel improvement, recreation, and Municipal and Industrial Water Supply. All three dams (sites 10, 76, and 77) proposed in the plan have been installed above this floodplain management study area. Proposed channel improvement has not been installed. On figure 1, site 10 on Skidmore Fork is west of the delineated floodplain; site 76 on North River is southwest of the delineated area and upstream of Staunton Dam; and site 77 on Little River is north of the delineated area.

Summary of Completed Structures

Dam Site #	Name	Class 1/	Total Flood Storage (Ac/Ft)	Date Construction Completed
10	Todd Lake	B	688	5-13-63
76	Elkhorn Lake	C	7020	11-5-65
77	Hearthstone	C	2768	10-28-66

1/ Hazard

Augusta County has previously enacted the usual ordinances relating to zoning, subdivisions, sanitation utilities and similar developments. None of the ordinances provide specifically for regulation in the use and management of flood prone areas, but to come under the regular Flood Insurance Program will require adoption of such regulations by localities. Also, a commitment to such constraints are now a prerequisite for federal funding under certain national programs.

The 1981 Edition of the Virginia Statewide Building Code (Ref. 1) requires restrictions on new construction and floodproofing of existing structures below the 100-year flood elevation. Data in this report can be used to comply with this section of the code. The bibliography lists several references (7-10) that discuss flood plain regulation and floodproofing measures. Augusta County has adopted these restrictions.

The Virginia Erosion and Sediment Control Handbook was adopted in 1974 and subsequently revised in 1980. (Ref. 5). The handbook includes mandatory criteria for control of runoff and sediment, and for prompt revegetation of sites disturbed by earth-moving operations.

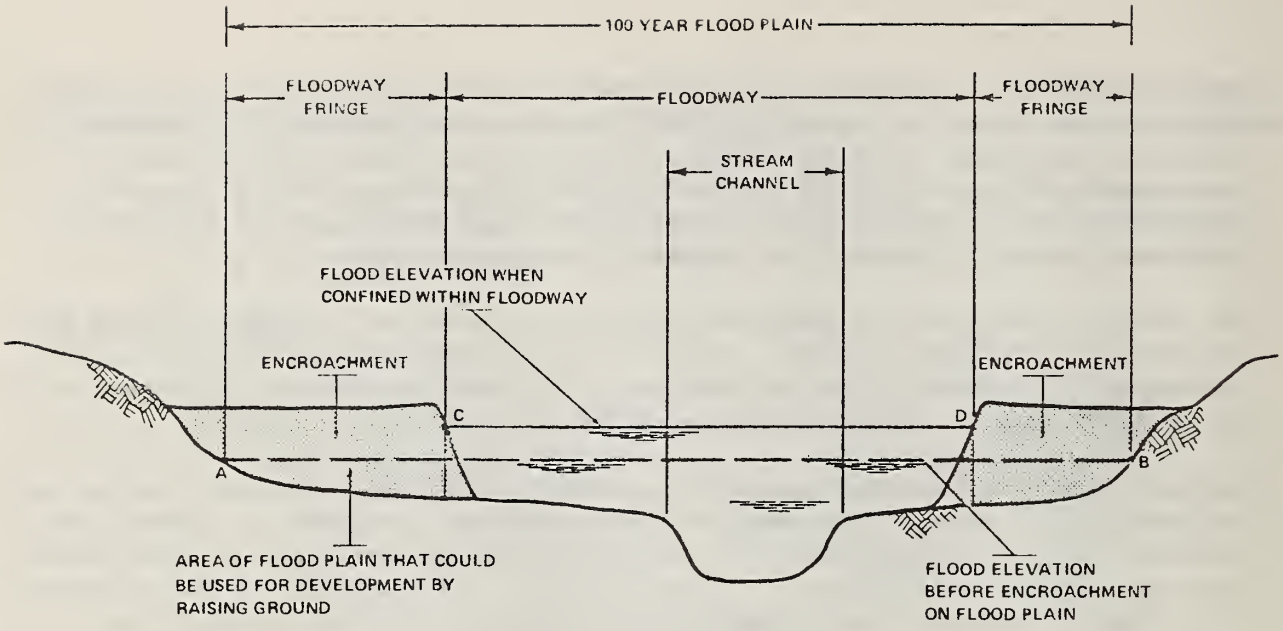
Augusta County has participated in the National Flood Insurance Program since the early 1970's under the emergency program and is working to come under the regular Flood Insurance Program. Participating communities are required to regulate use and development of flood plains. The program is administered by the Federal Emergency Management Agency (FEMA). In those communities participating in the FEMA program, owners and occupiers of all buildings and mobile homes in the community are eligible to obtain subsidized flood insurance coverage.

Floodways

Any construction activity that raises the elevation of the flood plain will restrict flow and increase flood heights. One part of flood plain management is balancing the benefits of flood plain development with the increased flood hazard. The floodway concept divides the 100-year flood area into a floodway and a floodway fringe. The floodway fringe is the portion of the flood plain that can be obstructed without increasing the water-surface elevation of the 100-year flood more than one foot or creating hazardous depths or velocities in the floodway. The floodway is the remaining portion of the channel and the flood plain (figure 4).

A preliminary analysis was made for a floodway on Upper North River. Values in Upper North River would exceed the criteria for hazardous conditions 1/. This confirms results of other studies that floodways should not be recommended by SCS on these flood plains.

1/ A hazardous condition is considered to exist if: the depth in feet times the velocity in feet per second exceeds seven; or the depth exceeds three feet, or the velocity exceeds 12 feet per second.



LINE A - B IS THE FLOOD ELEVATION BEFORE ENCROACHMENT
LINE C - D IS THE FLOOD ELEVATION AFTER ENCROACHMENT

FIGURE 4. FLOODWAY SCHEMATIC

Recommendations

It is recommended by this report that local sponsors will use the report and other such studies in the county to develop and implement a comprehensive flood plain management program. It is specifically recommended that the sponsors:

--review and update local ordinances relating to flood plains as a sound basis for the program; in particular, include restrictions on use and occupancy of flood plains as required by state legislation;

--carry out public information activities stressing the need for and the community benefits of the program;

--emphasize the importance of proper land use and conservation treatment in reducing flood hazards;

--encourage owners and occupants of buildings and mobile homes within and adjacent to the delineated flood hazard areas to carry flood insurance on the structures and contents; and

--determine what assistance is available and implement the restoration of riparian vegetation along the study streams.

Another recommendation that should be considered is a limited snagging and spot debris clean out of the channel from Camp May Flather down to the County line. This should be done in a manner that reduces environmental impacts and maintains aquatic habitat. An environmental assessment, interagency consultation, and possible permits may be needed before any work can be considered.

Evaluation of Potential

The recommendations above indicate the potential opportunities to reduce or minimize the impacts of future floods. The primary opportunities have to do with avoiding or regulating occupancy and modification of the flood plains. The Statewide Building Code and the Erosion and Sediment Control Ordinance provide useful tools to implement these opportunities. One prohibits or restricts further development in the flood plain (Ref. 1); the other (Ref. 5) provides for control of runoff and sediment from upstream development which might increase the flood hazard.

Public support can be enhanced through public information activities which stress the specific and community benefits of the flood plain management program. This will also afford the opportunity to emphasize the continuing importance of proper land use and conservation treatment throughout the community.

AFTERWORD

This flood plain management study is an aid to persons living in flood prone areas. If your home is within the flood plain, the following information should serve as a guide for dealing with floods.

Being well informed is your best protection. It is extremely important to know where to go in the event of a flood. Remember that roads are often built in valleys where floodwaters will most likely go. You should reach higher ground, and it may be easier and safer to do this on foot, rather than by car.

The major causes of floods are melting snows and rainfall. Listen to weather reports and be aware of the chance of flooding. Never ignore a flood warning. Listen for emergency instructions and follow instructions given.

If it is necessary for you to evacuate your home, do so quickly and cautiously. Follow evacuation instructions that are given. Do not try to take all of your belongings with you. Take necessary personal items such as eyeglasses or medicines, flashlights, a small supply of canned food, a can opener, and several blankets.

If you are traveling by car you may encounter these hazards:

washed-out road or bridge
undermined roadway
landslides
fallen rocks
downed powerlines
floating debris

Watch for these hazards carefully.

If it is not necessary to evacuate your home, there are precautions you should proceed with.

Fill large containers with water and after doing so shut off the main water valve to protect the clean water already in your water system. Be certain to shut off your water heater since no water will be going to it.

As long as electric service is available it may be used safely unless the main circuits are flooded. In such a case you will reduce the risk of electrical shock and short circuits if you turn the power off. Do not touch the switch if you are wet or standing in water. Unless you detect a gas leak, you may continue to use gas systems.

Be aware that floods often produce fire hazards. Watch for broken or leaking gas or oil lines, flooded electrical circuits, flooded furnaces and other appliances, and inflammable or explosive materials which may come from upstream.

Anchor or move inside any belongings such as trash cans, toys, lawnmowers, etc. They may become hazards to people downstream if they are washed away.

Move livestock to high, open ground and if possible keep them from drinking flood water or eating feed soaked with flood water.

The following items could help improve your chances of survival if a flood occurs:

- portable radio and spare batteries
- first aid kit
- flashlights and spare batteries
- foods which require little or no cooking and no refrigeration
- blankets
- rope
- hand tools
- drinking water

Precautions taken to reduce losses from flooding are called floodproofing.

The basement walls of your home are probably not built to withstand the additional pressures of water-soaked soils. You will have less damage if you allow flood waters to come in. When you receive a flood warning, remove articles from basement and open a basement window. Fuse boxes and other equipment should not be located in the basement.

Floodproofing for homes with adequately reinforced basement walls could include: sealing cracks in walls and floors with hydraulic cement, installation of a sump pump with a reliable power source, placing heavy screens over windows to prevent breakage from floating objects, and placing valves on main drain lines to prevent backup of water.

It is important to remember that floodproofing can help reduce damages, it does not make it safe to remain in your home during a flood.

After a flood, reenter buildings with caution. Watch for fire hazards and falling debris. Do not use appliances until they have been checked for damage. Do not use any food or water which may be contaminated.

Normal home insurance does not cover flooding. Ask your insurance agent about federally subsidized flood insurance. Not all agents handle flood insurance and you may have to contact several of them.

Many people are hurt or killed during or after a flood by their own carelessness. Know before hand what to do if a flood occurs. Your local Civil Defense Agency can help you with any questions you may have.

APPENDIX

This appendix provides the data needed to use this report.

The Flood Plain Area Photomaps can be used for decisions where precise elevations are not required; for example, a brief check of the appropriate photomap may indicate that a proposed building site is obviously in or out of the flood plain.

Following the photomaps are flood profiles and benchmark data. These two exhibits can be used with the photomaps to determine flood elevations at any point along the streams in the study area as follows:

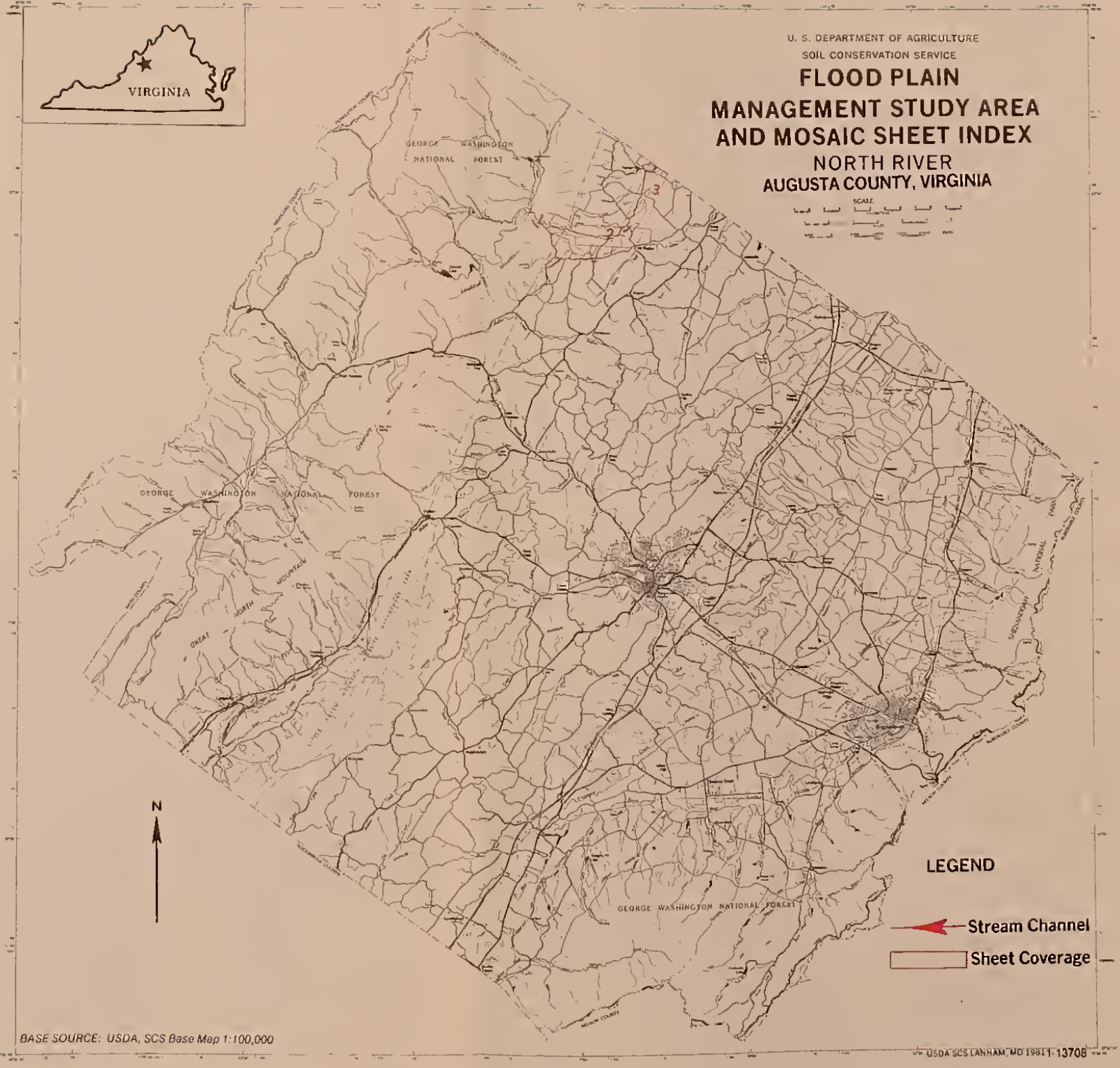
1. On the appropriate photomap find the point on the stream where the proposed building is to be located; then scale the distance along the stream to the nearest cross section.

2. On the appropriate flood profile sheet, scale the distance determined in Step 1 from the cross section back to the original stream location, and read the elevation of the desired flood frequency line.

3. Transfer the elevation determined in Step 2 to the ground from the nearest established benchmark.

   If the point on the ground is at one of the surveyed cross sections, the elevation can be read directly from Table A-1.

Typical cross sections following the profile plates illustrate the procedure used for placing flood elevations on Flood Plain Area Photomaps. The photomaps are based on semicontrolled aerial mosaics and the dimensions of the photomaps are not identical to those on the cross sections.


VIRGINIA
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
FLOOD PLAIN
MANAGEMENT STUDY AREA
AND MOSAIC SHEET INDEX
NORTH RIVER
AUGUSTA COUNTY, VIRGINIA
SCALE
GEORGE WASHINGTON NATIONAL FOREST
GEORGE WASHINGTON NATIONAL FOREST
GEORGE WASHINGTON NATIONAL FOREST
N
LEGEND
Stream Channel
Sheet Coverage
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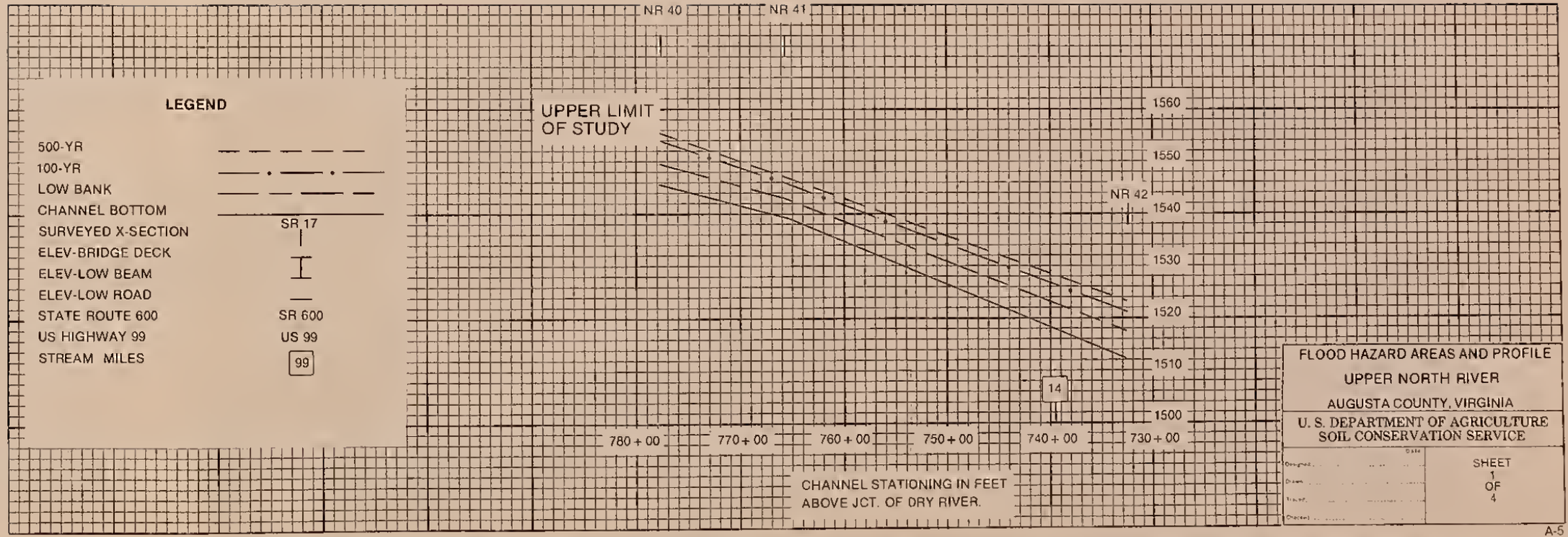
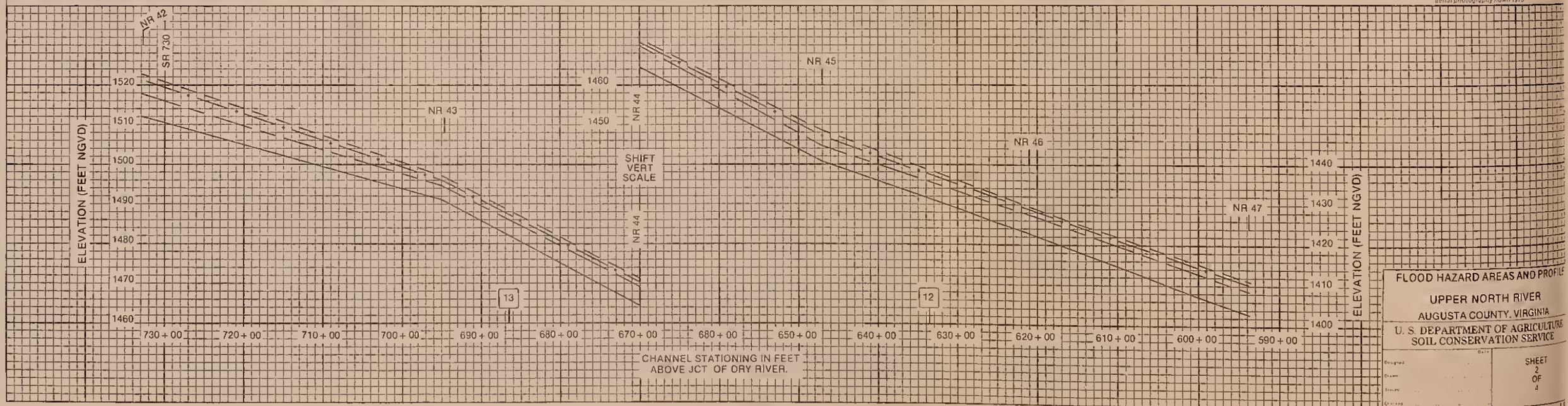
USDA SCS LANHAM, MD 1981 - 13708


LEGEND
500-YR
100-YR
LOW BANK
CHANNEL BOTTOM
SURVEYED X-SECTION
SR 17
ELEV-BRIDGE DECK
ELEV-LOW BEAM
ELEV-LOW ROAD
STATE ROUTE 600
SR 600
US HIGHWAY 99
US 99
STREAM MILES
99
NR 40
NR 41
NR 42
UPPER LIMIT OF STUDY
1560
1550
1540
1530
1520
1510
1500
14
780 + 00
770 + 00
760 + 00
750 + 00
740 + 00
730 + 00
CHANNEL STATIONING IN FEET ABOVE JCT. OF DRY RIVER.
FLOOD HAZARD AREAS AND PROFILE
UPPER NORTH RIVER
AUGUSTA COUNTY, VIRGINIA
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
SHEET 1 OF 4



FLOOD HAZARD AREAS AND PROFILE

UPPER NORTH RIVER

AUGUSTA COUNTY, VIRGINIA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

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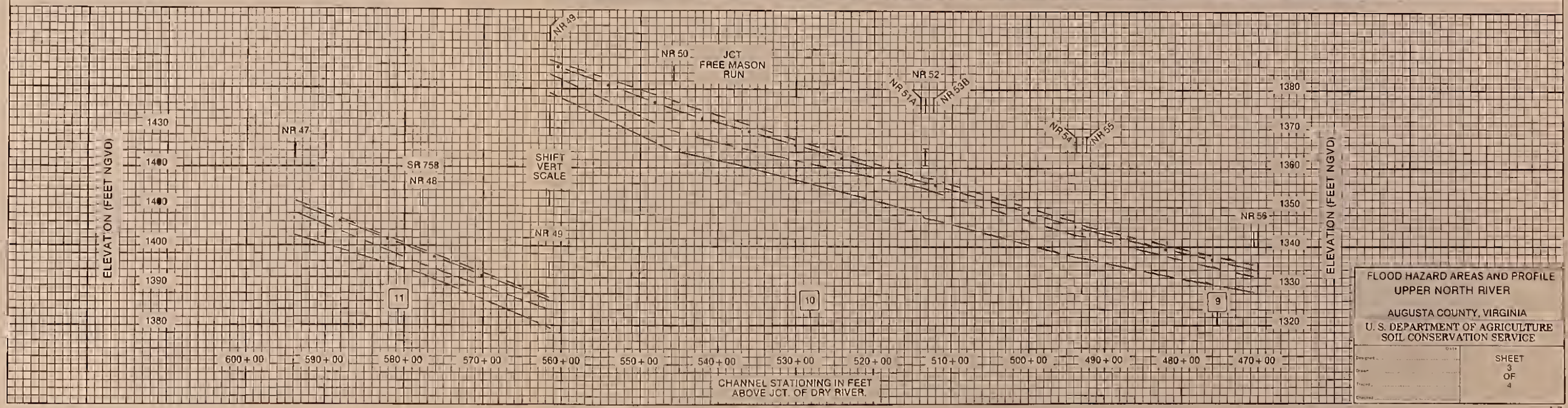
PHOTO SHEET 2



FLOOD HAZARD AREAS AND PROFILE
UPPER NORTH RIVER

AUGUSTA COUNTY, VIRGINIA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	SHEET 3 OF 4
Drawn	
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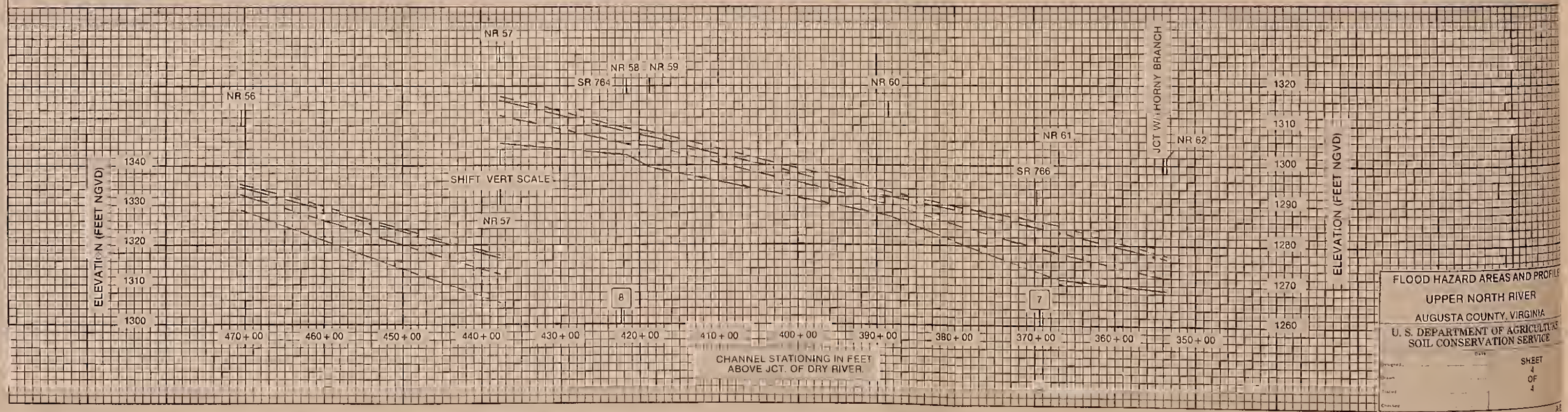
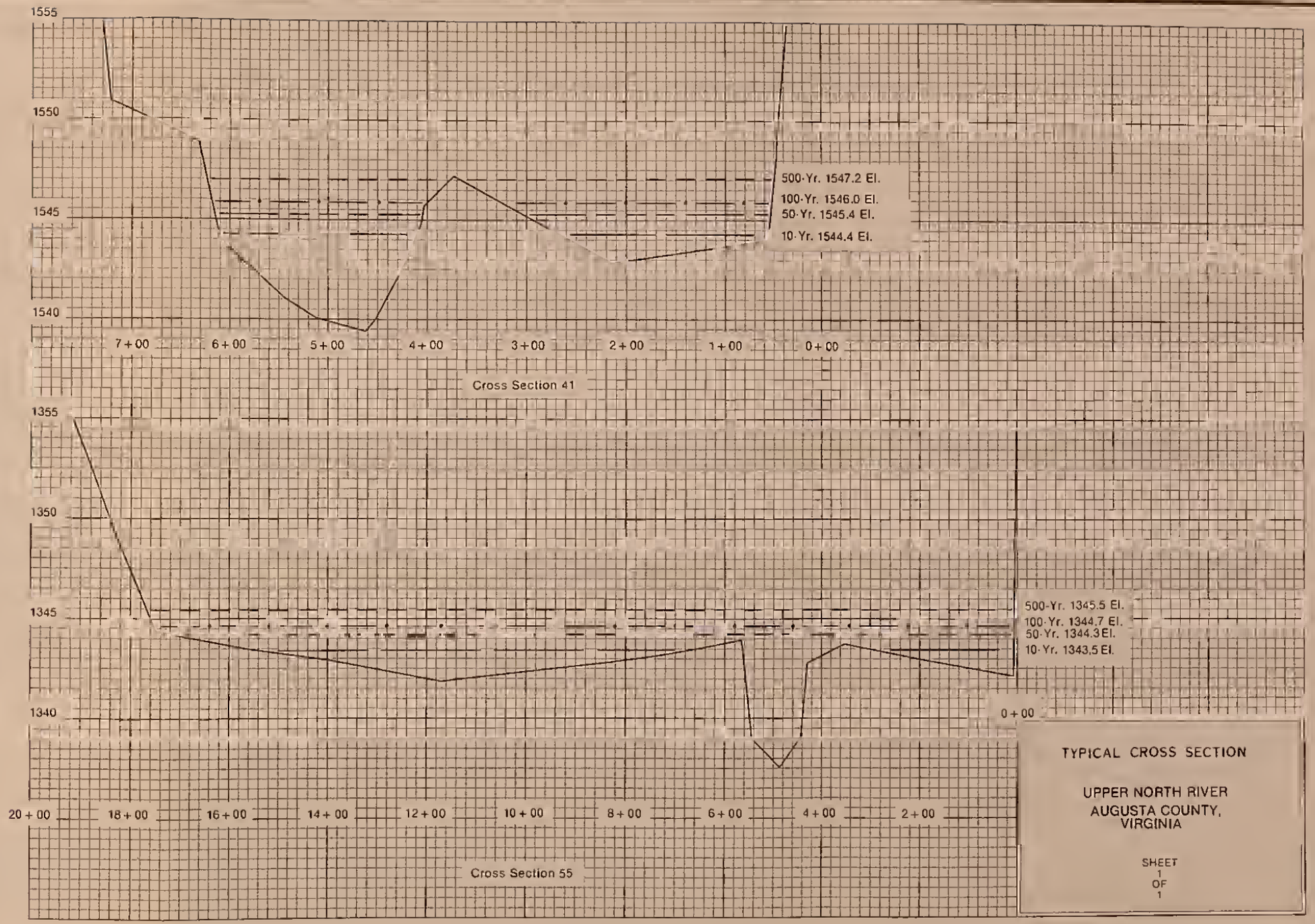
Checked	


SCALE 1:9 600
2000 1000 0 2000 Feet
600 400 200 0 600 Meters
SOURCE: Semi-controlled mosaic prepared from USDA-SCS aerial photography flown 1976
STATE ROUTE 730
NR 57
NR 60
NR 61
STATE ROUTE
MATCH LINE SHEET #2
PHOTO SHEET 3


NR 57
NR 58
NR 59
SR 764
NR 56
NR 60
NR 61
NR 62
SR 766
JCT W. HORNY BRANCH
SHIFT VERT SCALE
NR 57
ELEVATION (FEET NGVD)
1340
1330
1320
1310
1300
1320
1310
1300
1290
1280
1270
1260
470+00
460+00
450+00
440+00
430+00
420+00
410+00
400+00
390+00
380+00
370+00
360+00
350+00
CHANNEL STATIONING IN FEET ABOVE JCT. OF DRY RIVER.
FLOOD HAZARD AREAS AND PROFILE
UPPER NORTH RIVER
AUGUSTA COUNTY, VIRGINIA
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
SHEET 4 OF 4



TYPICAL CROSS SECTION

UPPER NORTH RIVER
AUGUSTA COUNTY,
VIRGINIA

SHEET
1
OF
1

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Table A-1 Frequency-discharge-elevations at cross sections Upper North River, Augusta County, Virginia

X-Sec.	Station	Photo Map No.	Profile Sheet No.	DA (sq mi)	10-year Disch. (cfs)	10-year Elev. (ft)	25-year Disch. (cfs)	25-year Elev. (ft)	50-year Disch. (cfs)	50-year Elev. (ft)	100-year Disch. (cfs)	100-year Elev. (ft)	500-year Disch. (cfs)	500-year Elev. (ft)
Upper North River Upper Limit of Study														
NR40	778 + 00		1	68.10	2500	1551.4	3600	1552.4	4600	1553.0	6000	1553.9	10080	1555.5
NR41	765 + 90		1	68.23	2500	1544.4	3600	1545.0	4600	1545.4	6000	1546.0	10080	1547.2
NR42	732 + 60	1	1&2	69.02	2600	1518.3	3800	1519.3	4800	1520.3	6200	1521.2	10400	1522.7
NR43	694 + 70	1	2	69.81	2600	1494.7	3800	1495.1	4800	1495.4	6200	1495.8	10400	1496.7
NR44	670 + 00	1	2	70.61	2600	1469.9	3800	1470.4	4900	1470.6	6300	1470.9	10600	1471.6
NR45	647 + 00	1	2	71.41	2700	1446.3	3900	1447.0	4900	1447.3	6400	1447.6	10800	1448.3
NR46	621 + 00	1	2	72.20	2700	1428.2	3900	1428.5	5000	1428.9	6500	1429.1	10900	1429.7
NR47	593 + 90	1	2&3	72.83	2800	1408.9	4000	1409.4	5100	1409.6	6600	1410.1	12000	1411.0
NR48	577 + 80	2	3	73.13	2800	1397.1	4000	1397.5	5100	1398.0	6600	1398.3	12000	1399.2
NR49	561 + 40	2	3	73.45	2800	1385.3	4000	1385.8	5100	1386.0	6600	1386.5	12000	1387.1
NR50	545 + 60	2	3	81.24	3700	1373.1	5400	1374.0	6800	1374.5	8800	1375.2	15000	1376.9
JCT	538 + 00	2	3	Freemason Run		1367.2		1368.0		1369.5		1370.5		1372.1
NR51A	514 + 00	2	3	81.75	3700	1355.5	5400	1356.3	6900	1356.8	8900	1357.3	15000	1358.4
NR52	513 + 20	2	3	81.78	State Route-731		Low Road	1355.0	Low	Steel	1360.6	Bridge	Deck	1365.2
NR53B	512 + 20	2	3	81.82	3700	1354.4	5400	1355.1	6900	1355.6	8900	1356.0	15000	1357.1
NR54	493 + 80	2	3	82.11	3700	1344.3	5400	1344.8	6900	1345.1	8900	1345.5	15000	1346.4
NR55	492 + 20	2	3	82.12	3700	1343.5	5400	1344.1	6900	1344.3	8900	1344.7	15000	1345.5
NR56	470 + 50	3	3&4	82.80	3800	1333.8	5500	1334.3	6900	1334.4	9000	1334.8	15100	1335.4
NR57	437 + 70	3	4	84.28	3800	1314.6	5600	1315.7	7000	1316.1	9100	1316.6	15300	1317.3
NR58	421 + 70	3	4	85.77	3900	1307.7	5600	1308.1	7100	1308.3	9200	1308.6	15500	1309.6
NR59	418 + 80	3	4	85.81	3900	1306.2	5600	1306.8	7100	1307.1	9200	1307.6	15500	1308.6
NR60	388 + 50	3	4	86.30	3900	1291.1	5700	1291.5	7200	1291.9	9300	1292.3	15600	1293.0
NR61	367 + 00	3	4	86.66	5300	1281.3	7700	1282.1	9700	1282.7	12600	1283.4	21200	1284.6
JCT	354 + 00	3	4	Thorny Branch		1275.1		1275.6		1276.0		1276.5		1277.5
NR62	353 + 50	3	4	101.24	5300	1274.9	7700	1275.4	9700	1275.8	12600	1276.2	21200	1277.1

Table A-2 Reference Mark Descriptions and Elevations, Upper North River Augusta County, Virginia

B.M. No.	Photo Map No.	Description, Location and Elevation in Feet (NGVD)
U-101	1	USC&GS - Located at the Junction of State Route 730 and 718 at Stokesville, 20 feet north of centerline of State Route 730 and approximately 100 feet west of a steel bridge over Upper North River. A standard disk stamped "U-101-1935" is set in the top of a concrete post. Elev - 1527.24
1002	2	SCS TBM - A square is chiseled in the end post on the upstream northwest end of the bridge over Upper North River at Natural Chimneys or Towers School on State Route 731. Elev - 1365.99
17	3	SCS TBM - A square is chiseled on the upstream northwest corner of a bridge over Thorny Branch 150 feet south of the Sangersville service station on State Route 730. Elev - 1288.43
2000	3	SCS TBM - A square is chiseled on the upstream south corner of concrete base of swinging foot bridge over North River approximately 250 feet from the centerline of State Route 766, square is located on the west end of foot bridge. Elev - 1279.86

TECHNICAL PROCEDURES

Approximately 7.5 miles of differential levels to establish vertical control and 23 cross sections were surveyed for this study. Surveys are referenced to National Geodetic Vertical Datum (NGVD) of 1929. Reference mark Descriptions and Elevations are listed in Table A-2 and shown on appropriate photomaps.

The peak discharge-frequency relations of stream gages in the vicinity were determined by the U. S. Geological Survey office in Richmond, Virginia, using a log-Pearson Type III analysis (per Water Resources Council Bulletin 17B, (Ref. 8). These discharges were correlated with TR-20 routings (Ref. 9) within the watersheds and used to determine peak discharge-frequency relations for the surveyed cross sections. The resultant data agrees with observed high water marks along North River.

Analyses of the hydraulic characteristics of streams were carried out using the SCS computer program WSP-2 (Ref. 10). Cross section data for the streams and structural geometry of bridges and culverts were obtained by transit surveys. From stage-discharge curves, elevations and flood boundaries could be determined at the cross sections. Straight line interpolations of the elevations were used for flood profiles between cross sections. Flood boundaries between cross sections were drawn on topographic maps using contour lines as a guide. These lines were transposed to the photomaps and checked in the field.

Glossary of Terms

backwater. High water caused by downstream obstruction or restriction, or by high stage on an intersecting stream.

BM. Benchmark of established elevation.

cfs. Cubic feet per second - a unit of discharge that is equal to the flow of one cubic foot per second past a given point.

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

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 - shown only if lower than elev.-bridge deck at a particular road section.

flood. An 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.

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

flood peak or peak discharge. Highest discharge attained during a flood.

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

flood profile or profile. A plotted or imaginary line defining the highest water surface elevations along a stream during a particular flood.

flood prone area. See flood plain.

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

floodway. The portion of the stream channel and flood plain that must be kept free of encroachment to prevent flood stages more than 1 foot higher than natural conditions.

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

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

NGVD. National Geodetic Vertical Datum of 1929.

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

profile. See flood profile.

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

state-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.

TBM. Temporary benchmark.

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

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