FLOODS
ON
FRENCH BROAD RIVER AND TRIBUTARIES
IN VICINITY OF
ROSMAN
NORTH CAROLINA

TENNESSEE VALLEY AUTHORITY
DIVISION OF WATER CONTROL PLANNING

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REPORT NO. 0-6878

(An Interim Report)

KNOXVILLE, TENNESSEE
APRIL 1971

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Tennessee Valley Authority
Division of Water Control Planning

FOREWORD

This interim report relates to the flood situation along French Broad River and its tributaries, East, Middle, North, and West Forks French Broad River in the vicinity of Rosman, North Carolina. It has been prepared at the request of the town of Rosman through the North Carolina Department of Water and Air Resources to aid (1) in the solution of local flood problems and (2) in the best utilization of land subject to overflow. Data assembled by TVA on rainfall, runoff, historical and current flood heights, and other technical information bearing upon the occurrence and magnitude of floods in localities throughout the region provide the basis for this report.

The report does not include plans for the solution of flood problems. Rather, it is intended to provide the basis for further study and planning on the part of Rosman in developing programs to minimize vulnerability to flood damages by controlling the type of use made of the flood plain through zoning and subdivision regulations.

TVA, in cooperation with state and local agencies, has prepared plans for comprehensive resource development of the French Broad River basin in North Carolina. The plan for water resource development includes three reservoirs which would provide a substantial degree of flood protection at Rosman. When flood control is provided upstream on the North, West, or East Forks of French Broad River, the flood information in this report will be revised to reflect the reduced hazard. Until such protective works are built, this flood information is appropriate for use in planning to minimize vulnerability to flood damages.

The report covers three significant phases of the Rosman flood problem. The first brings together a record of the largest known floods of the past on French Broad River and its four tributaries in the vicinity of Rosman. The second treats of Regional Floods. These are derived from consideration of the largest floods known to have occurred in the same general geographical region as the five streams and generally within 60 miles of Rosman. The third develops the Maximum Probable Floods for these streams. Floods of this magnitude on most streams are considerably larger than any that have occurred in the past. They are the floods of infrequent occurrence that are considered in planning protective works, the failure of which might be disastrous.

The report contains maps, profiles, and cross sections which indicate the extent of flooding that has been experienced and that might occur in the future in the vicinity of Rosman. This should be useful in planning future developments in the flood plains. Structures or building floor levels may be planned either high enough to avoid flood damage or at lower elevations with recognition of the chance and hazards of flooding that are being taken.

I.

SUMMARY

OF

FLOOD SITUATION

I.

SUMMARY OF FLOOD SITUATION

Rosman, North Carolina, is located in the headwaters of the French Broad River 35 miles south of Asheville. The river begins a little over one mile upstream from Rosman at the confluence of North and West Forks French Broad River, which have drainage areas of 37.4 and 29.4 square miles, respectively. One mile downstream from Rosman, Middle Fork French Broad River, with a drainage area of 5.7 square miles, and East Fork French Broad River, with a drainage area of 26.4 square miles, flow into the French Broad River.

This investigation covers French Broad River from its head at Mile 217.7 to the mouth of Catheys Creek at Mile 208.4[1]. East Fork French Broad River is covered from the mouth to the mouth of Upper Creek at Mile 4.4 and Middle Fork from the mouth to the mouth of Claypole Branch at Mile 2.0. North Fork French Broad River is covered from the mouth to Mile 2.1 and West Fork from the mouth to Mile 1.5.

Much of the residential, commercial, and industrial development of Rosman is located on the flood plains of French Broad River and its tributaries. Portions of this land have been inundated by floods of the past, and a substantially larger area is within reach of the greater floods of the future.

Records of streamflow on French Broad River have been maintained at Rosman by the U. S. Geological Survey since December 1935, and records were maintained by the Geological Survey at Calvert, 2.4 miles downstream from Rosman, from October 1924 to September 1955. No records of streamflow have been maintained on the four tributary streams in the vicinity of Rosman.

In compiling a record of the early floods on the streams, it has been necessary to interview residents along the streams who have knowledge of past floods and to conduct research in newspaper files and historical documents. From these investigations and from studies of possible future floods on the streams in

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1. The French Broad River from the mouth of Catheys Creek to Penrose bridge at Mile 186.9 was covered in a report issued in May 1964 entitled "Floods on French Broad & Davidson Rivers and King, Nicholson, & Tucker Creeks in Vicinity of Brevard, North Carolina."

the vicinity of Rosman, the flood situation, both past and future, has been developed. The following paragraphs summarize the significant findings with regard to the flood situation which are discussed in more detail in succeeding sections of the report.

* * *

THE GREATEST FLOOD known to have occurred in recent years on the streams in the vicinity of Rosman was on October 4, 1964. During such a flood there is considerable overflow with high velocities along the streams.

* * *

OTHER LARGE FLOODS on streams in the vicinity of Rosman occurred in June 1876, July 1916, August 1928, August 1940, and September 1964. A flood on October 11, 1970, was about the same height as the October 1964 flood on East and Middle Forks French Broad River, but it was lower on the other streams.

* * *

REGIONAL FLOODS on French Broad River and its tributaries in the vicinity of Rosman are based upon floods experienced on streams within 60 miles of the town, a number of which are larger than any known floods on the five streams. This indicates that greater floods than those experienced so far may reasonably be expected in the future. Based upon the magnitude of floods that have occurred on neighboring streams, a Regional Flood may occur on French Broad River that would be from 2 to 6 feet higher than the October 1964 flood, being about 3 feet higher in Rosman. On East Fork French Broad River, a Regional Flood would be 3 to 10 feet higher than the October 1964 flood, and on Middle Fork a Regional Flood would be 2 to 5 feet higher than the October 1964 flood. A Regional Flood on North Fork French Broad River would be 5 to 10 feet higher than the October 1964 flood, and a Regional Flood on West Fork would be 3 to 6 feet higher than the October 1964 flood.

* * *

MAXIMUM PROBABLE FLOOD determinations indicate that floods could occur on French Broad River that would exceed the October 1964 flood in the vicinity of Rosman by 6 to 15 feet. On East Fork French Broad River, the Maximum Probable Flood would be 8 to 19 feet higher than the October 1964 flood, averaging about 13 feet higher. The Maximum Probable Flood on Middle Fork would exceed

the October 1964 flood by 4 to 9 feet. On North Fork French Broad River, the Maximum Probable Flood would be 12 to 22 feet higher than the October 1964 flood, and on West Fork the Maximum Probable Flood would be 5 to 13 feet higher than the October 1964 flood.

* * *

FLOOD DAMAGES that would result from a recurrence of floods as large as that of 1964 on the streams in the vicinity of Rosman would be appreciable. More extensive damages would be caused along all five streams by the Regional and Maximum Probable Floods because of their greater depths and velocities.

* * *

MOST FREQUENT FLOOD OCCURRENCES on the streams in the vicinity of Rosman have been in the months of August and October; however, floods have occurred in every month of the year.

* * *

VELOCITIES OF WATER during the October 4, 1964, flood ranged up to 9 feet per second in the channel and 2 feet per second on the flood plain of French Broad River. Along East Fork French Broad River, velocities during the October 1964 flood were up to 12 feet per second in the channel and 2 feet per second on the flood plain. During the October 1964 flood on Middle Fork, channel and flood-plain velocities ranged up to 14 and 4 feet per second, respectively. On North and West Forks French Broad River, velocities in the channel during the October 1964 flood ranged up to 9 feet per second. Flood-plain velocities ranged up to 2 feet per second along both streams. During a Maximum Probable Flood, velocities in the channel would range up to 14 feet per second on French Broad River, 20 feet per second on East Fork French Broad River, 19 feet per second on Middle Fork, 20 feet per second on North Fork, and 14 feet per second on West Fork. On the flood plain velocities would range up to 5 feet per second on French Broad River and on East, North, and West Forks, and up to 6 feet per second on Middle Fork French Broad River. These high velocities would be extremely dangerous to life and property.

* * *

DURATION OF FLOODS is relatively short on all streams in the vicinity of Rosman. During the September 1964 flood, the French Broad River at Rosman

was above bankfull stage for 15 hours and had a maximum rate of rise of 3.9 feet per hour. The October 1964 flood was above bankfull stage for 22 hours and had a maximum rate of rise of 2.0 feet per hour. During a Maximum Probable Flood on French Broad River, the stream at Rosman would rise 19 feet in 12 hours with a maximum rate of rise of 3 feet per hour, remaining out of banks for about 9 hours. On East Fork French Broad River, the Maximum Probable Flood would rise 23 feet in 9 hours with a maximum rate of rise of 5 feet per hour, and the stream would remain out of banks for 7 hours. Middle Fork would rise 14 feet in 2 hours with a maximum rate of rise of 5 feet in 0.5 hour during a Maximum Probable Flood. It would remain out of banks for 2 hours. On North Fork the Maximum Probable Flood would rise 25 feet in 9 hours with a maximum rate of rise of 5 feet per hour, and the stream would remain out of banks for 6 hours. West Fork would rise 19 feet in 8 hours with a maximum rate of rise of 5 feet per hour during a Maximum Probable Flood. The stream would remain out of banks for 7 hours.

* * *

HAZARDOUS CONDITIONS would occur during large future floods as a result of the rapidly rising streams, high velocities, and deep flows.

* * *

FUTURE FLOOD HEIGHTS that would be reached if floods of the magnitude of the Regional and Maximum Probable occurred in the vicinity of Rosman are shown in Table 1. The table compares these flood crests with the crest of the October 4, 1964, flood at each location.

TABLE 1

RELATIVE FLOOD HEIGHTS

Flood	Location	Mile above Mouth	Estimated Peak Discharge cfs	Above October 1964 Flood feet
	French Broad River			
October 4, 1964	U.S. Highway 178 at Rosman	216.45	13,500	0.0
Regional	(USGS stream gage)		29,000	2.3
Maximum Probable			64,000	6.0
October 4, 1964	Bridge at Calvert	214.02	16,800	0.0
Regional	(former USGS stream gage)		36,000	3.5
Maximum Probable			73,000	8.1
	East Fork French Broad River			
October 4, 1964	Secondary Route 1107	2.73	7,000	0.0
Regional	(downstream side)		17,000	5.8
Maximum Probable			42,000	14.9
	Middle Fork French Broad River			
October 4, 1964	U.S. Highway 178	1.95	3,500	0.0
Regional	(upstream side)		7,500	3.6
Maximum Probable			18,000	5.7
	North Fork French Broad River			
October 4, 1964	U.S. Highway 64	0.02	7,200	0.0
Regional	(upstream side)		21,000	5.2
Maximum Probable			49,000	13.9
	West Fork French Broad River			
October 4, 1964	U.S. Highway 64	1.20	7,500	0.0
Regional	(downstream side)		18,000	4.8
Maximum Probable			45,000	10.7

II.

THE WATERSHED AND REGION

II.

THE WATERSHED AND REGION

Rosman, in Transylvania County, North Carolina, is located on the French Broad River 216 miles upstream from the mouth and 35 miles south of Asheville in the area where four streams which make up the headwater drainage system of the French Broad River converge. North Fork and West Fork French Broad River join a mile upstream from Rosman to form the French Broad River. Middle Fork and East Fork French Broad River join the main stream about one mile downstream from Rosman. From Rosman the river flows generally northeastward through Transylvania County, turns northward then northwestward to flow into Tennessee. At Knoxville it joins Holston River to form the Tennessee River. This section of the report includes a brief history of the region and descriptions of the streams and watersheds covered by this report.

Settlement

The land which now constitutes Transylvania County was considered to be Indian land until 1783 when it was declared open to settlement by the white men by Act of the North Carolina General Assembly. Buncombe County was formed in 1792, to include all the land in North Carolina west of the Blue Ridge. The land then became a part of Henderson County when that county was formed in 1838 and a portion became Jackson County when that county was formed in 1851. Transylvania County was organized in 1861, being formed from parts of Henderson and Jackson Counties. Brevard was made the county seat.

Rosman is at the site of an early Cherokee Indian village called Eastatoe. One of the early trade routes from the North Carolina mountains to the markets at Charleston, South Carolina, and Augusta, Georgia, followed the French Broad River to the site of Rosman, then crossed the Blue Ridge Divide at Eastatoe Gap, at the head of Middle Fork French Broad River.

Joseph S. Silversteen came to Transylvania County in 1902 to build and operate the Toxaway Tanning Company on the right bank of French Broad River at Mile 217. Two other industries were added later in this same vicinity, the Gloucester Lumber Company in 1911, and the Rosman Tanning Extract Company in 1913.

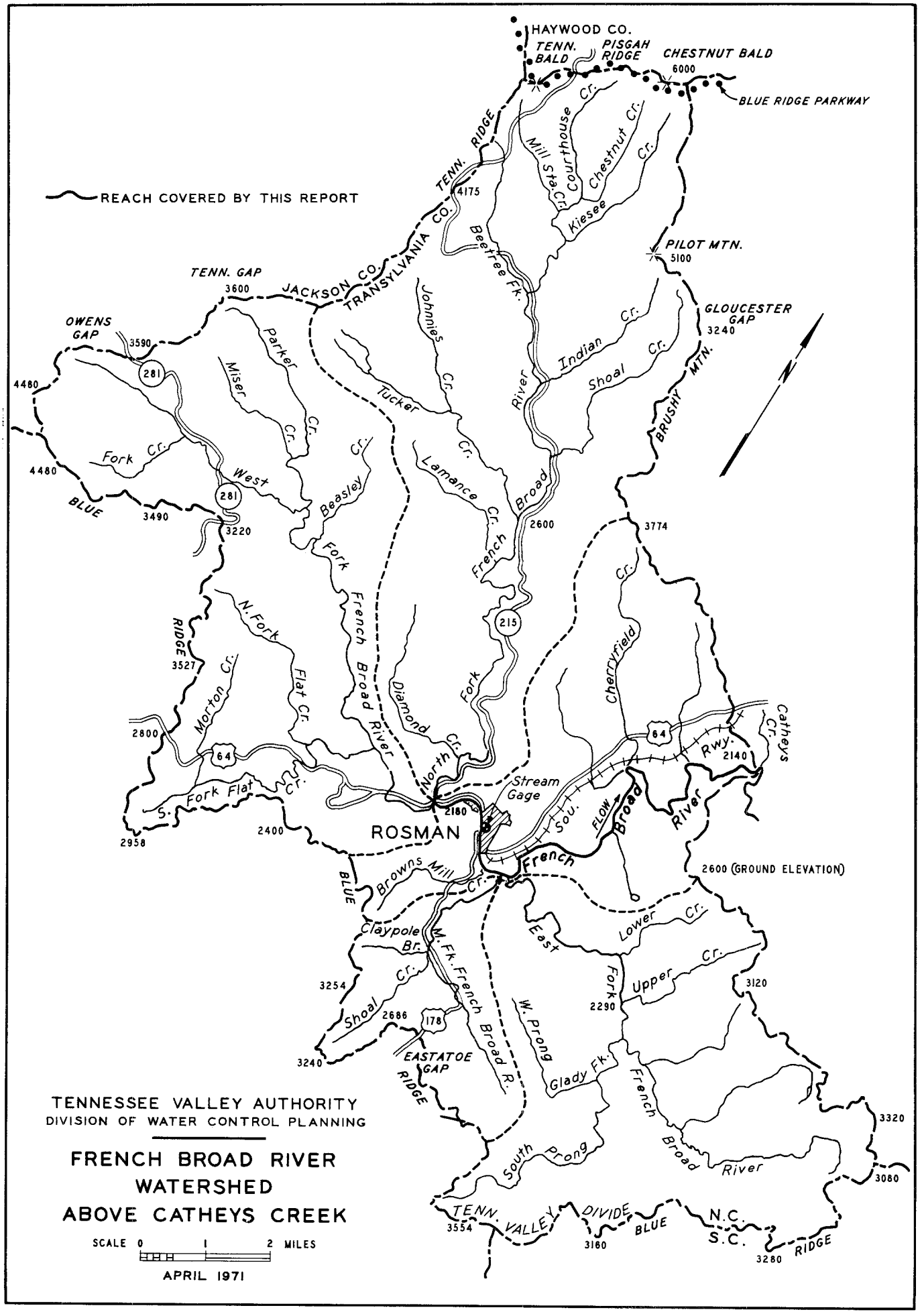
The community near the Silversteen enterprises was first incorporated in 1903, with the name of Eastatoe. A new incorporation was enacted in 1905 with the name Rosman, a word derived from the names of two men associated with Mr. Silversteen, Messrs. Rosenthal and Osmansky. In 1910 the population of Rosman was 145, and the population of Transylvania County was 7,191. The county has grown slowly but steadily, reaching a population of 18,571 in 1970. The population of Rosman has remained close to 500 since 1920.

The Hendersonville-Brevard Railroad, now the Toxaway Line of the Southern Railway, was completed to Brevard in 1894 and to Rosman in 1900. In 1903 the railroad was extended up West Fork French Broad River and Flat Creek to serve lumber operations and a resort hotel at Lake Toxaway, just outside the French Broad River watershed divide. The railroad now operates only as far as Rosman, and for some years there have been no lumber or tannery plants at Rosman. The economy of the area is now tied to other developments in Transylvania County, M-B Industries, American Thread Company, Olin Corporation, du Pont Company, and the NASA Data Acquisition Facility, the satellite tracking installation located 6 miles northwest of Rosman.

U. S. Highway 64 passes through Brevard and Rosman and crosses Transylvania County from east to west. U. S. Highway 178 follows the old trade route from Rosman through the Middle Fork basin into the Piedmont area of South Carolina. N. C. Highway 215 follows North Fork to provide access from Rosman to the Blue Ridge Parkway and the Canton-Waynesville area of Haywood County.

French Broad River and Its Valley

The French Broad River drains an area of 5,124 square miles in North Carolina and Tennessee. Above the mouth of Catheys Creek, the lower limit of this study, the watershed lies wholly within Transylvania County, North Carolina, and is roughly rectangular in shape, about 15 miles by 8 miles. The long dimension lies in a northwest-southeast direction perpendicular to the general course of the river. The four forks of French Broad River drain all but a small portion of the watershed. The North Fork originates at the north corner, West Fork at the west corner, Middle Fork along the southwest side, and East Fork along the southeast side. Plate 1 is a map of the 116-square-mile watershed above Catheys Creek. Pertinent drainage areas of French Broad River and its tributaries are given in Table 2.



TENNESSEE VALLEY AUTHORITY
DIVISION OF WATER CONTROL PLANNING

FRENCH BROAD RIVER WATERSHED ABOVE CATHEYS CREEK

SCALE 0 1 2 MILES

APRIL 1971

HD-1311

TABLE 2

DRAINAGE AREAS IN WATERSHED OF FRENCH BROAD RIVER

Stream	Location	Mile above Mouth	Drainage Area sq. mi.
French Broad River	Mouth	0	5124
	N. C. - Tenn. state line	102.03	1664
	Asheville (Pearson bridge)	145.75	945
	Above Catheys Creek (Lower limit of study)	208.45	116
	Former USGS stream gage at Calvert	214.02	103
	Above East Fork	215.43	75.3
	Above Middle Fork	215.54	69.6
	USGS stream gage at Rosman	216.45	67.9
	Head of river (Confluence North and West Forks)	217.74	66.8
Catheys Creek	Mouth	0	13.7
East Fork French Broad	Mouth	0	26.4
	N. C. Secondary Route 1107	2.73	23.0
	Below Upper Creek (Upper limit of study)	4.38	20.1
Middle Fork French Broad	Mouth	0	5.67
	U. S. Highway 178	1.95	4.57
	Below Claypole Branch (Upper limit of study)	2.00	4.57
North Fork French Broad	Mouth	0	37.4
	U. S. Highway 64	0.02	37.4
	Below Diamond Creek	1.03	37.0
	Upper limit of study	2.13	34.2
West Fork French Broad	Mouth	0	29.4
	U. S. Highway 64	1.20	27.2
	Upper limit of study	1.50	27.0

The watershed is bounded on the north by Pisgah Ridge, on the northwest by Tennessee Ridge, on the southwest and southeast by the Blue Ridge, and on the northeast by a less prominent ridge which follows Pilot, Three Forks, Kelley, Middle, and Quillen Mountains. Pisgah Ridge forms the line between Transylvania and Haywood Counties; drainage on the north side goes to the Pigeon River. Tennessee Ridge separates Transylvania County from Jackson County and the drainage of Tuckasegee River. The Blue Ridge is part of the divide between the

Tennessee Valley and the Atlantic Coast drainage; drainage to the south of the ridge goes to the Savannah and Saluda river systems. Elevations in the watershed range from a high of 6,000 feet at Chestnut Bald, at the north corner, to valley floor elevations of 2,185 feet at Rosman and 2,140 feet at the lower limit of the study. Forest cover averages 86 percent in Transylvania County. For the watershed above the mouth of Catheys Creek, the land in forest cover would exceed 90 percent of the drainage area.

The study covers French Broad River from its origin at the junction of West Fork and North Fork, Mile 217.74, to the mouth of Catheys Creek, Mile 208.45, a distance of 9.29 miles. The incorporated area of Rosman includes land on the right bank of the river from Mile 217.30 to Burnt Road, Mile 216.73, and the left bank from Mile 216.76, near the Southern Railway bridge, to Mile 216.13. Except for the short reach where the town includes both banks of the river near Burnt Road and the railroad bridge, the stream channel is part of the corporate limit of Rosman.

French Broad River is joined by Middle Fork at Mile 215.54 and by East Fork at Mile 215.43. Browns Mill Creek, which drains a small area on the right bank just upstream from Middle Fork, joins French Broad River at Mile 215.84. A number of other streams join the river below Rosman, but these also drain relatively small areas and have little effect upon floods on the main stream. The largest of these is Cherryfield Creek, which enters on the left bank of the river at Mile 212.11.

In the reach covered by this investigation, French Broad River falls from elevation 2,193 to 2,130 feet, an average rate of fall of 6.8 feet per mile. Upstream from the Rosman corporate limit, the flood plain is 400 to 1,000 feet wide. At the Southern Railway bridge the flood plain is 600 feet wide, then increases gradually to a width of 2,000 feet at the U. S. Highway 178 bridge and decreases again to about 800 feet at the lower corporate limit. From Rosman to the mouth of Catheys Creek, the river meanders through a broad flood plain which is 2,000 feet to 3,000 feet wide at most places. The narrowest place in this reach is 800 feet wide a short distance downstream from Calvert bridge. At Mile 209, where Bunker Hill rises from the left-bank flood plain, the effective overflow width is about 1,200 feet. One-half mile downstream near the mouth of Catheys Creek, the flood plain is nearly 4,000 feet wide.

East Fork French Broad River and Its Valley

East Fork French Broad River drains an area of 26.4 square miles. It has a watershed 5 miles long which varies in width from 6 miles at the upper end on the Blue Ridge divide to 3 miles at the lower end. East Fork has its head on the slopes of Quillen Mountain at the east corner of the basin at an elevation of 3,080 feet. The stream follows a generally westward course and joins French Broad River about one mile downstream from Rosman at River Mile 215.43 at a valley-floor elevation of 2,175 feet. The largest tributary, Glady Fork, heads up at Sassafras Mountain at the southern tip of the watershed and joins East Fork at Mile 4.97. Other tributary streams are relatively short and mostly follow courses which are perpendicular to the main stream.

The topography is relatively flat around the watershed rim in contrast to that usually found in mountainous areas. Along the Blue Ridge the elevations average around 3,000 feet and range from 2,820 feet at Sassafras Gap to 3,554 feet at Sassafras Mountain. On the southwest side of the basin Line Runner Ridge and Joshua Mountain, at elevations ranging from 2,800 feet to 3,200 feet, separate East Fork from the drainage of Middle Fork French Broad River. At the northeast divide the drainage of East Fork adjoins that of Little River and Carson Creek. Elevations are 3,000 to 3,200 feet between Middle Mountain and Jim Raines Mountain, about 2,900 feet at Kelley Mountain, and 2,600 feet at Walnut Gap at the north corner of the watershed. Along the northwest side of the basin the rim elevations drop off gradually to the flood plain at the mouth of East Fork. The watershed of East Fork is at least 90 percent in forest.

The investigation covers East Fork from the mouth to the confluence with Upper Creek, a distance of 4.38 miles. In the reach covered by the investigation East Fork falls from elevation 2,281 to 2,168 feet, an average fall of 26 feet per mile. The flood plain is 800 to 1,000 feet wide below Mile 1.0 and averages about 500 feet wide in the reach upstream from Mile 1.0. The flood plain varies in width from 200 feet at several locations to as much as 1,500 feet at the mouth of Lower Creek at Mile 3.6.

Table 2 lists drainage areas in the watershed of East Fork French Broad River, and the watershed is shown on Plate 1.

Middle Fork French Broad River and Its Valley

Middle Fork, the smallest of the four forks at the head of French Broad River, drains an area of 5.67 square miles which lies to the west of the East Fork watershed. The watershed is roughly fan-shaped, 3 miles long and 3 miles across. Middle Fork has its head at the southeast corner of the basin and flows northwestward, then northward to join French Broad River at Mile 215.54, 0.1 mile upstream from the mouth of East Fork. Shoal Creek rises at the southwest corner of the basin and flows northward. Claypole Branch heads at the west divide and follows a northeastward course. Both these tributaries enter Middle Fork on the left bank at Mile 2.00. Below Mile 2.0 the watershed is narrow and there are no tributaries of any size.

The Blue Ridge forms the southern and western boundaries for the Middle Fork watershed. Elevations along the ridge are mostly 3,000 to 3,200 feet and range from 2,686 feet at Eastatoe Gap to 3,370 feet at Indian Camp Mountain at the southeast corner. Line Runner Ridge and Joshua Mountain, which separate the Middle Fork and East Fork drainages, have elevations of 2,800 to 3,200 feet. At the mouth of Middle Fork the valley-floor elevation is 2,175 feet.

The investigation covers Middle Fork from the mouth to the confluence with Shoal Creek and Claypole Branch, a distance of 2.0 miles. In this reach the stream falls from elevation 2,270 to 2,170 feet, an average rate of fall of 50 feet per mile. The flood-plain widths vary from 200 to 800 feet and average about 500 feet for the study reach.

Table 2 lists pertinent drainage areas for the Middle Fork watershed, which is shown on Plate 1.

North Fork French Broad River and Its Valley

North Fork, draining an area of 37.4 square miles, is the largest of the four streams which make up the headwater drainage system of the French Broad River. The watershed has the shape of an elongated oval, 12 miles in length by $5\frac{1}{2}$ miles at the widest point. North Fork is formed by four streams, Mill Station, Courthouse, Chestnut, and Kiesee Creeks, which drain the steep slopes of Tennessee Bald and Devils Courthouse at the northern end of the watershed. The stream follows a southward course to its junction with West

Fork near Rosman. Beetree Fork and Tucker Creek drain sizable areas on the west side of the basin and enter North Fork on the right bank. Shoal Creek, heading up at Gloucester Gap, is the largest left-bank tributary.

The upper end of the watershed is bounded by Tennessee Ridge and Pisgah Ridge. Bracken Mountain and Glassmine Mountain separate the North Fork drainage from West Fork. The sharp ridge which forms the divide between North Fork and the watersheds of Davidson River and Catheys Creek to the east includes Shuck Ridge, Sassafras Knob, Pilot Mountain, Brushy Mountain, Big Mountain Ridge, and Double Springs Mountain.

On Pisgah Ridge, which is the Transylvania-Haywood county line, elevations range from 5,340 feet at Beech Gap to 6,000 feet at Chestnut Bald. Tennessee Bald, at the intersection with Tennessee Ridge, is 5,560 feet in elevation. Along Tennessee Ridge the crest elevations drop off to 4,175 feet at Pinhook Gap and 4,200 feet at Bald Rock, where the divide between West Fork and North Fork joins Tennessee Ridge. The divide at the east side of the basin is nearly 6,000 feet at the intersection with Pisgah Ridge, drops off to 3,240 feet at Gloucester Gap in a distance of 4 miles, continues at an average of 3,400 to 3,600 feet for another 4 miles, then drops off gradually to 2,400 feet at the lower end of the basin. About 95 percent of the watershed area is covered by forest. About 80 percent of the watershed area is within the boundaries of Pisgah National Forest, but there are private holdings scattered throughout the watershed.

The investigation covers North Fork from the mouth to Mile 2.13. Diamond Creek has its head at Pine Grove Gap on the southwest basin rim and enters North Fork on the right bank at Mile 1.07. North Fork falls from elevation 2,241 to 2,194 feet in the study reach, an average rate of fall of 22 feet per mile. The flood plain averages 500 feet in width, but widths vary from 200 feet to 800 feet. The widest section is in the vicinity of Mile 1.4.

The watershed of North Fork French Broad River is shown on Plate 1, and pertinent drainage areas are listed in Table 2.

West Fork French Broad River and Its Valley

West Fork drains an area of 29.4 square miles. The watershed is rectangular, 8 miles by 3 miles, with the longer axis lying northwest and southeast. The stream has its head at the west corner of the watershed near Owens

Gap and flows southeastward to where it joins North Fork to form the French Broad River about one mile upstream from Rosman. Parker Creek, which rises at Tennessee Gap near the north corner of the basin, is the principal tributary in the headwaters area. Flat Creek drains the southwest portion of the watershed and enters the right bank of West Fork at Mile 2.00.

Tennessee Ridge forms the northwestern boundary and the Blue Ridge the southwest and part of the southeastern boundaries of the watershed. A ridge which includes Bracken and Glassmine Mountains separates West Fork from the North Fork basin at the northeast. The topography in the basin and along the basin rim is more rugged than in the East Fork or Middle Fork basins. Elevations on the Blue Ridge are 2,400 to 2,900 feet along the southeastern side of the watershed. On the southwestern rim the elevations range from 2,800 feet near the southern corner to 3,527 feet at Rocky Mountain, 3 miles to the north, then are mostly 3,200 to 3,400 feet from Rocky Mountain to the western corner, where Panthertail and Shelton Pisgah Mountains reach 4,480 feet, the highest elevations in the watershed. On Tennessee Ridge elevations range from 3,590 feet at Owens Gap and Tennessee Gap to 4,200 feet or higher at Round Mountain, the Pinnacle, and Bald Rock. The divide between West Fork and North Fork is mostly 3,000 feet or higher except near the lower end of the watershed where it drops off to 2,600 and 2,400 feet. The watershed of West Fork is 90 percent or more in forest cover and about 50 percent in holdings of Pisgah National Forest.

The investigation covers West Fork French Broad River from the mouth to Mile 1.50. Three small streams, Frozen Creek, Woodruff Branch, and Schoolpath Branch, enter West Fork in this reach. West Fork falls from elevation 2,237 to 2,194 feet, an average fall of 29 feet per mile for the reach covered. The flood plain ranges from 300 to 1,000 feet in width, averaging 600 feet. The widest section is in the one-half-mile reach downstream from U. S. Highway 64. For some distance upstream from the study reach, West Fork is between high ridges with little or no flood plain.

Drainage areas in the West Fork watershed are listed in Table 2, and the watershed is shown on Plate 1.

III.

THE FLOOD PLAINS

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Along the streams covered by this report, there are many manmade features which may be affected by floods or which may have an effect upon the height of floodwaters. This section of the report discusses the industrial, commercial, and residential developments in the flood plains, the highways and railroads that parallel the streams or cross the flood plains, and the bridges spanning the streams.

1. FRENCH BROAD RIVER

Developments in the Flood Plain

Plate 7 shows the flood plain of French Broad River for the reach covered by this report. The principal residential and commercial developments of Rosman are on the 0.6-mile reach of the left-bank flood plain which is in the town's corporate limits. This reach is shown in greater detail on Plate 8. One large industry is on the flood plain downstream from Rosman. Except for these developments and the few places where highways or the railroad are in the flood plain, these lands are in agricultural use.

The Toxaway line of the Southern Railway has its present upstream terminus on the right-bank flood plain at Mile 217.3. A railroad loading and unloading area and a pulpwood storage yard occupy the right-bank flood plain from Mile 216.8 to 217.3. The railroad crosses the river at Mile 216.76 and is on the left-bank flood plain through Rosman. The line is at the edge of the left-bank flood plain from the lower corporate limit of Rosman at Mile 216.13 to Galloway Creek at Mile 214.3, for a short distance at Cherryfield Creek at Mile 212.0, and at Patterson Creek and Limekiln Branch at Mile 209.9 to 209.6. At other points the tracks are located back away from the flood plain. In the flood of October 1964, water was over the tracks in Rosman from Mile 216.5 to 216.1. A Regional Flood would be over the tracks in Rosman by as much as 7 feet and would overtop the tracks at the Patterson Creek crossing. During a Maximum Probable Flood, most of the tracks from the upper end downstream to Mile 214.6 would be under water. Depths of flooding would be up to 12 feet. The tracks would also be flooded at the Cherryfield Creek, Patterson Creek, and Limekiln Branch crossings.

U. S. Highway 64 is on the left bank of French Broad River from the confluence of West Fork and North Fork to the Southern Railway bridge, Mile 217.7 to 216.7. Through Rosman and downstream to Galloway Creek, Mile 214.5, the highway runs parallel to the railroad at the edge of the left-bank flood plain, but is on higher ground than the railroad. Downstream from Galloway Creek the highway is located far back from the flood plain. The flood of October 1964 was over the highway at a few places upstream from the Rosman development. A Regional Flood would reach depths of 5 feet at some sections of the highway upstream from Rosman and would be over the highway at the intersection with Burnt Road in Rosman. A Maximum Probable Flood would overtop most of the highway upstream from Rosman with depths of flooding up to 13 feet. In Rosman, water would be over the highway at the Burnt Road intersection and at two places near the lower end of town.

U. S. Highway 178 crosses the French Broad River flood plain in Rosman at Mile 216.45 and follows the right-bank flood plain downstream to Mile 215.9. The October 1964 flood overtopped the bridge and highway where it crosses the flood plain and was over much of the highway on the right bank. During a Regional or a Maximum Probable Flood, most of the highway from the intersection with U. S. Highway 64 in Rosman downstream to Mile 216 would be flooded by depths up to 5 feet and 10 feet, respectively.

Most of the secondary roads in the French Broad River flood plain covered by this study were flooded in October 1964. All would be impassable during a Regional or Maximum Probable Flood.

The American Thread Company began operations in 1965 at their plant which occupies land on the left-bank flood plain at Mile 214.3-214.4. The plant and office floors are at elevation 2,184. Galleries which provide drainage and carry utility lines in the plant are at elevation 2,182 feet. A water intake located on the riverbank at Mile 214.42 has pumps located at elevation 2,176.4 feet. These features at the plant are all above the height reached in the floods of July 1916 and October 1964 and are above the Regional Flood. A Maximum Probable Flood would reach an elevation of 2,180 feet at the plant.

The Rosman sewage treatment plant, built in 1968, is on the left bank of the river at Mile 215.92. The plant would be put out of operation by overflow of the digester tank at elevation 2,185 feet. This is about 2 feet above the height

reached at the point in the record flood of October 1964. A Regional Flood would overtop the tank by one foot, and a Maximum Probable Flood would be 6 feet over the tank.

In Rosman the businesses along U. S. Highway 64 are mostly above flood height, but the larger part of the town's development is located at lower elevations along Main Street and Eastatoe Street, which run parallel to the river, and Church Street, Depot Street, and U. S. Highway 178, which are at right angles to the river. In this area are a church, the post office, a small community building, and business and residential units. Automatic dialing equipment of the Citizens Telephone Company is in a building on Main Street at Mile 216.34. On the right bank along Burnt Road are a number of other businesses and residences. A Duke Power Company substation and voltage regulating station are on the right-bank flood plain near Burnt Road. The right-bank flood plain land from Mile 216.8 to 217.2, formerly occupied by the large sawmill of the Gloucester Lumber Company, is now used as a pulpwood storage and loading yard by U. S. Plywood-Champion Papers, Incorporated, serving their paper mill at Canton, North Carolina.

In the record flood of October 1964 at Rosman, there were 39 residence or apartment units flooded, also a church, a laundry, a restaurant, three grocery stores, and a recreation center. Another 20 homes or businesses were surrounded by the water. The Gloucester Lumber Company suffered the greatest damage when some lumber was washed away and a large amount had to be downgraded because of staining by the floodwaters. A Regional Flood would be up to 9 feet deep in the pulpwood storage yard, 4 feet deep at the substation, and 3 feet above the floor of telephone building. About 20 businesses and 60 residences, including mobile homes and apartment units, would be flooded. The average depth of flooding during a Regional Flood would be about 3 feet, but depths would range up to 7 feet.

In the immediate vicinity of Rosman, a Maximum Probable Flood on the French Broad River would be about 4.5 feet higher than the Regional Flood. An additional 20 residences and 5 businesses would be flooded, and water would surround other houses. As shown on Plate 8, most of Rosman between U. S. Highway 64 and the river would be under water.

In the study reach downstream from Rosman, there are very few buildings below the level of the Maximum Probable Flood.

Bridges across the Stream

One railroad bridge and five highway bridges cross French Broad River in the reach investigated. Table 3 lists pertinent elevations for these bridges and shows their relation to the crest of the flood of October 1964 and the Regional Flood. Plate 9 shows the relation of the floor and the underclearance at the bridges to the flood profiles. Figures 1 and 2 are photographs of some of the bridges.

TABLE 3

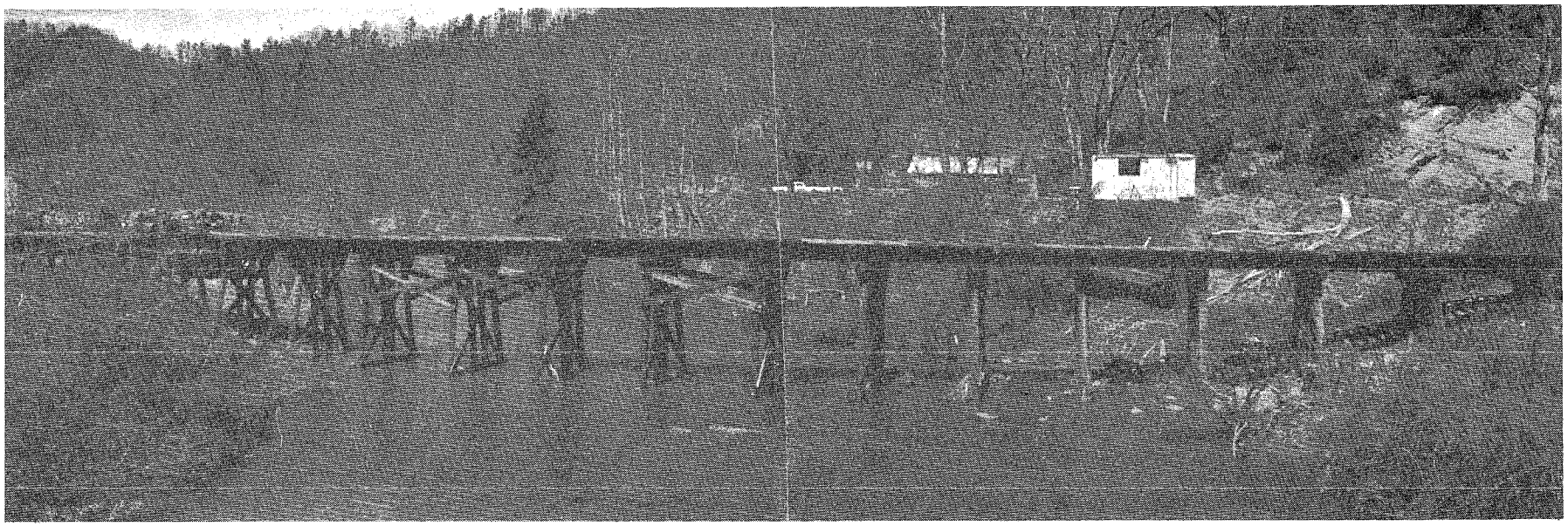
BRIDGES ACROSS FRENCH BROAD RIVER

Mile above Mouth	Identification	Low Water Elev. feet	Floor Elev. feet	Regional Flood Crest Elev. feet	October 1964 Flood Crest Elev. feet	Underclearance Elev. feet	Underclearance Above 1964 Flood feet	Underclearance Below 1964 Flood feet
208.94	Bunker Hill Road (Secondary Route 1127)	2133.6	2145.3	2151.8	2147.1	2143.0		4.1
212.82	Secondary Route 1109	2147.7	2160.2	2163.6	2160.5	2157.9		2.6
214.02	Calvert Road (Secondary Route 1129)	2155.8	2167.6	2169.9	2166.6	2165.0		1.6
216.45	U. S. Highway 178	2176.0	2188.1	2191.1	2188.8	2186.2		2.6
216.73	Burnt Road (Secondary Route 1135)	2179.7	2194.7	2197.2	2193.0	2192.2		0.8
216.76	Southern Railway	2179.9	2197.9*	2198.4	2194.3	2195.6	1.3	

*Top of rails.

The Southern Railway bridge in Rosman was not overtopped by the October 1964 flood; however, the flood on September 29 had washed out two timber bents leaving the tracks suspended in midstream. The bents had not been replaced when the second flood occurred, and the larger opening provided better flow conditions and less chance of debris blocking the channel. A Regional Flood would just overtop the rails, and a Maximum Probable Flood would be almost 5 feet above the rails.

The bridge on Burnt Road, which crosses the river in Rosman just downstream from the railroad bridge, and Calvert Road at Mile 214.02 were not overtopped during the October 1964 flood, but the right-bank approach at Burnt Road and both



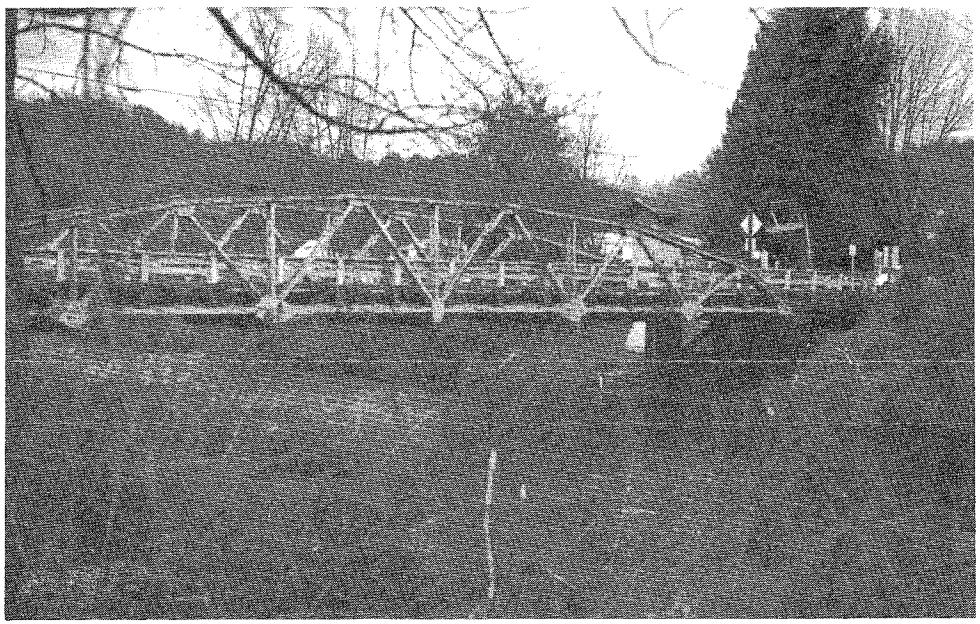


Figure 1.--FRENCH BROAD RIVER BRIDGES IN ROSMAN

Upper view is downstream side of Southern Railway bridge at Mile 216.76. Two bents in the trestle were washed out during the flood of September 1964. The lower view is downstream side of U. S. Highway 178 bridge at Mile 216.45. The U. S. Geological Survey stream gage can be seen on left bank above bridge (see Figure 8).

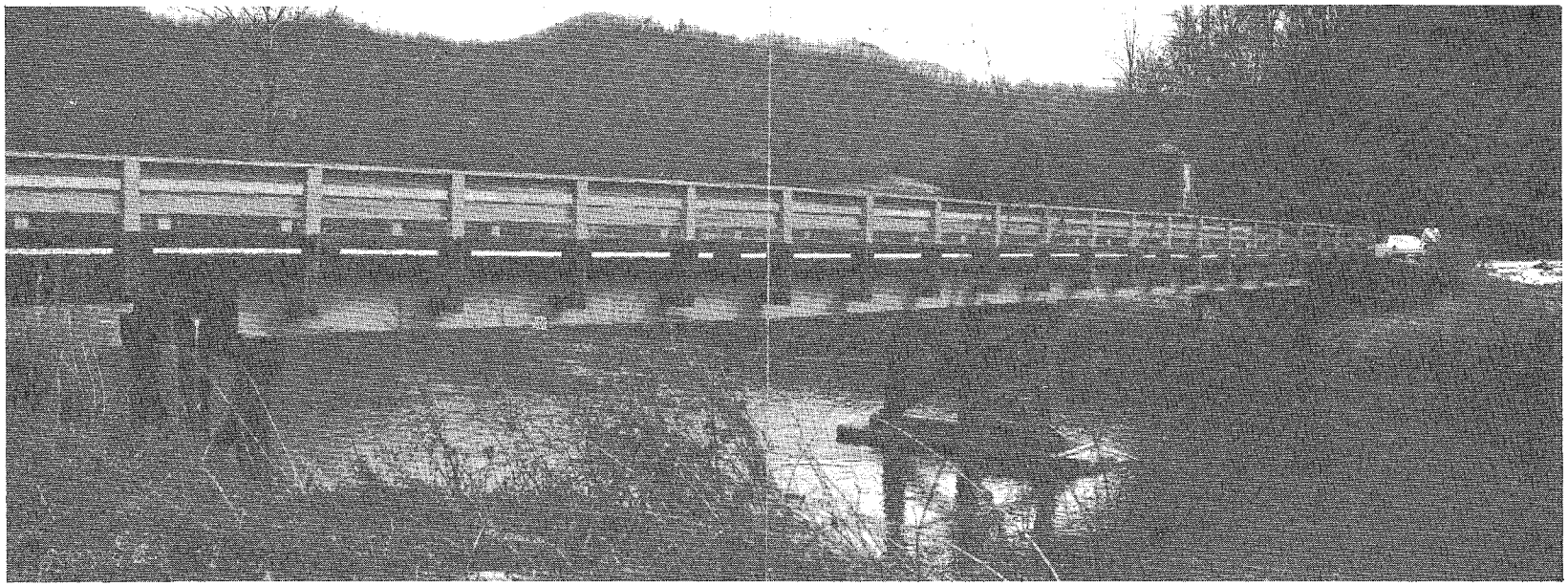


Figure 2.--FRENCH BROAD RIVER BRIDGES BELOW ROSMAN

Upper view is upstream side of bridge at Mile 214.02 carrying Secondary Route 1129. Concrete shelter at right is the site of the former U.S. Geological Survey stream gage at Calvert. Lower view is upstream side of Bunker Hill Road (Secondary Route 1127) bridge at Mile 208.94. The October 1964 flood was almost 2 feet over the bridge floor.

approaches at Calvert Road were flooded. The other three bridges, including that on U. S. Highway 178 in Rosman, were all overtopped during the October 1964 flood. A Regional Flood would overtop all the highway bridges by amounts ranging from 2.3 to 6.5 feet, and a Maximum Probable Flood would be 7 to 14 feet over the floors of the five highway bridges.

During the October 1964 flood, the railroad bridge and Burnt Road bridge together resulted in heading up of about 2 feet. Heading up would be about the same at those bridges during a Regional Flood and would decrease slightly during a Maximum Probable Flood. At the U. S. Highway 178 bridge, heading up of about one foot occurred during the October 1964 flood, but heading up would decrease during larger floods. At the other three highway bridges, there is no appreciable heading up during floods.

Obstructions to Flood Flow

The effect of obstructions due to bridges and their approach fills has been described in the previous section. With the exception of the bridges and some naturally restricted flood plains, there are no significant obstructions to flows in the French Broad River reach included in this study.

2. EAST FORK FRENCH BROAD RIVER

Developments in the Flood Plain

Plate 11 shows the flood plain of East Fork French Broad River for the reach covered. Except for the roads and bridges and a few residences, the land in the flood plain is used for agricultural purposes. East Fork Road, secondary route 1107, follows the stream connecting with Rosman to the northwest and the Cedar Mountain community to the east. The road crosses East Fork at three points in the study reach. During the flood of October 1964 the road was overtopped at many places, and there was heavy damage to the pavement, fills, and ditches.

Most of the farm buildings and houses in the reach investigated are above the level of the October 1964 flood; but several would be flooded by the Regional Flood, which would exceed the height of the 1964 flood by an average of 5 feet. A Maximum Probable Flood, averaging 13 feet higher than the October 1964 flood, would flood or surround nearly all of the buildings along East Fork.

Bridges across the Stream

Three highway bridges, one private road bridge, and one footbridge cross East Fork French Broad River in the reach investigated for this report. Table 4 lists pertinent elevations for these bridges and shows their relation to the crest of the flood of October 1964 and the Regional Flood. Plate 12 shows the relation of the floor and the underclearance at the bridges to the flood profiles. Figure 3 shows photographs of some of the bridges.

TABLE 4

BRIDGES ACROSS EAST FORK FRENCH BROAD RIVER

Mile above Mouth	Identification	Low Water Elev. feet	Floor Elev. feet	Regional Flood Crest Elev. feet	October 1964 Flood Crest Elev. feet	Underclearance Elev. feet	Above 1964 Flood feet	Below 1964 Flood feet
0.92	Secondary Route 1107	2177.9	2187.0	2190.8	2187.8	2184.4		3.4
1.76	Secondary Route 1107	2195.0	2208.7	2212.9	2205.8	2206.5	0.7	
2.73	Secondary Route 1107	2237.7	2247.9	2257.6	2247.4	2245.3		2.1
3.01	Footbridge	2250.2	2255.8	2264.0	2256.4	2255.6		0.8
3.92	Private road	2272.4	2282.5	2289.8	2285.0	2281.5		3.5

The floors of two of the bridges on Secondary Route 1107 at Mile 1.76 and Mile 2.73 are above the October 1964 flood level, but the other three bridges are below that flood level. A Regional Flood would overtop all of the bridges by depths ranging from 4 to 10 feet.

During the October 1964 flood, heading up due to the constrictions in the channel by the bridges and their approach fills was negligible except at the bridge at Mile 2.73. At this bridge the heading up amounted to almost 2 feet. During a Regional Flood, heading up would increase to 6 feet, but would still be negligible at the other bridges.

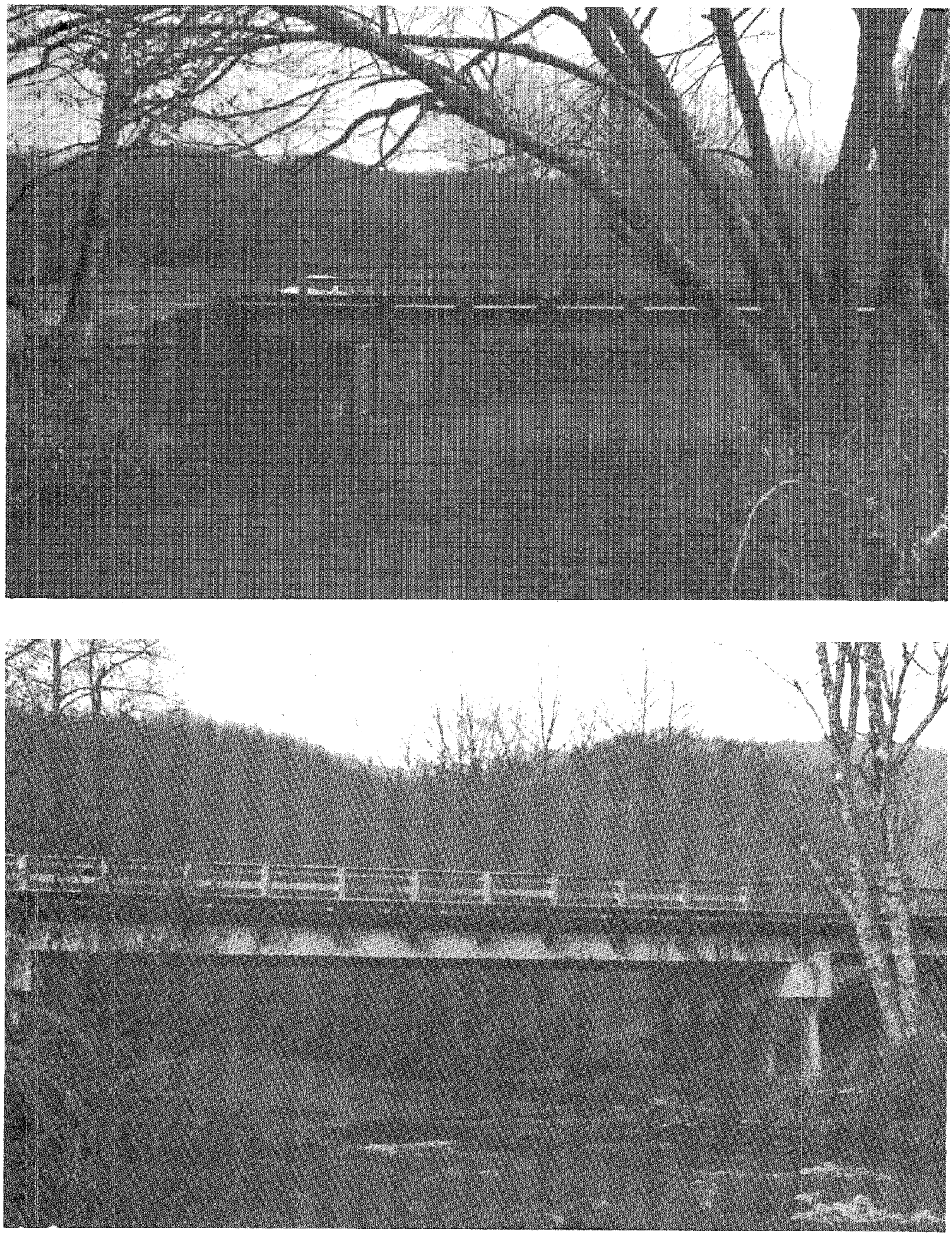


Figure 3.--BRIDGES ON EAST FORK FRENCH BROAD RIVER

Both bridges are on East Fork Road, Secondary Route 1107. Upper view shows downstream side of bridge at Mile 0.92, which was overtopped by the October 1964 flood. Lower view is downstream side of the bridge at Mile 1.76.

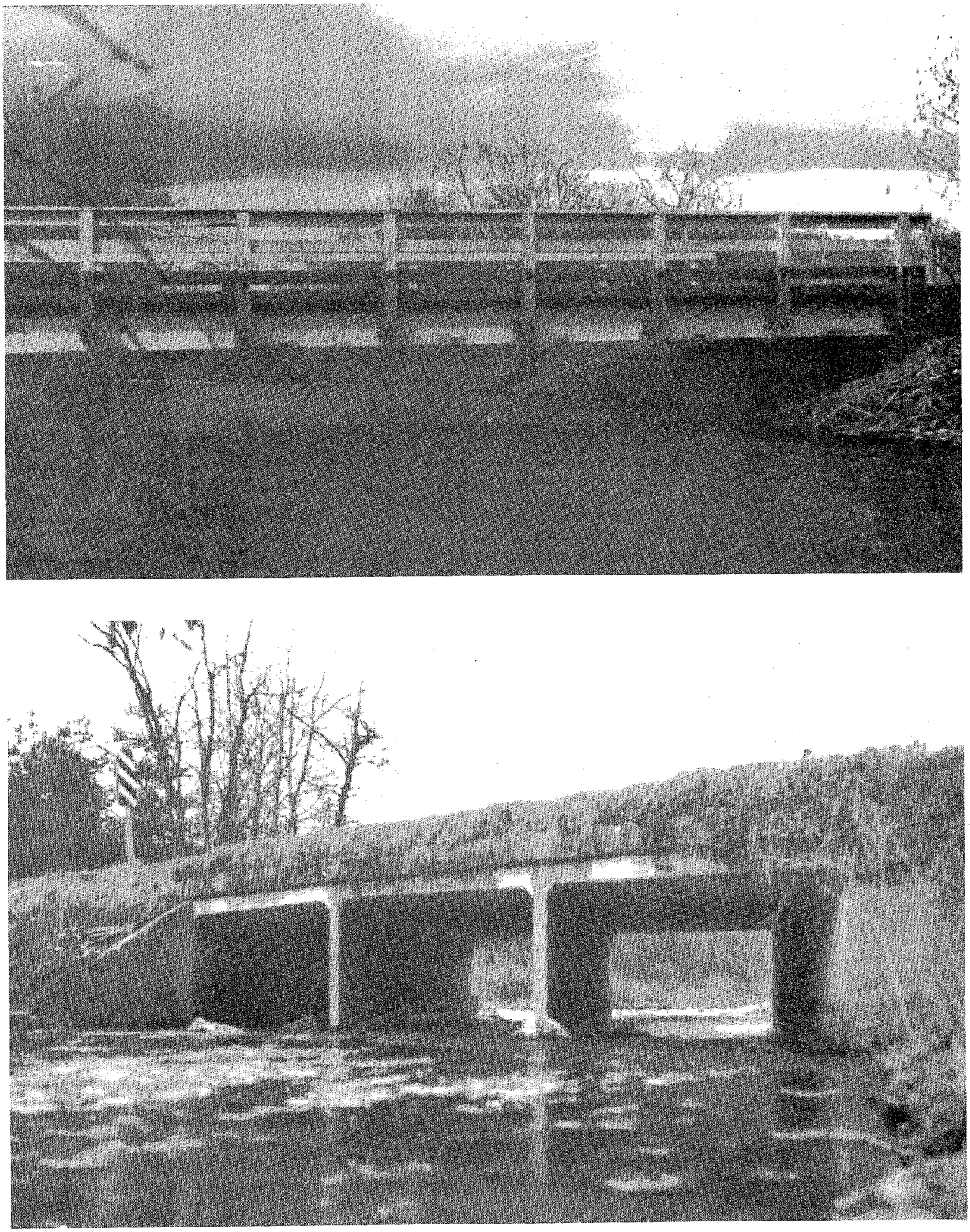


Figure 4.--BRIDGES ON MIDDLE FORK FRENCH BROAD RIVER

Upper view is upstream side of bridge on Secondary Route 1107 at Mile 0.24. The October 1964 flood was almost 2 feet higher than the bridge floor. Lower view is upstream side of the U. S. Highway 178 bridge at Mile 1.95. During the October 1964 flood, debris partially blocked the culvert and caused water to overflow the highway.

Obstructions to Flood Flow

The effect of obstructions due to the bridges and their approach fills has been described in the previous section. With the exception of the bridges and the naturally restricted flood plains in the vicinity of Miles 2.3 and 3.0, there are no significant obstructions to flows in the East Fork French Broad River reach included in this study.

3. MIDDLE FORK FRENCH BROAD RIVER

Developments in the Flood Plain

The Middle Fork flood plain is shown on Plate 7. Land in the flood plain is used mostly for agricultural purposes, but some homes are in the flood plain and there are roads subject to flooding.

U. S. Highway 178 crosses Middle Fork at Mile 1.95 near the upper end of the study reach and is on the left bank downstream to Mile 1.3. East Fork Road crosses the flood plain at Mile 0.2, and Secondary Route 1131 follows the stream from East Fork Road upstream to Mile 1.4 where it connects with U. S. Highway 178. During the October 1964 flood, the three highways were overtopped at the four flood-plain crossings in the reach. During a Regional Flood, which would average about 3 feet higher than the 1964 flood, longer sections of the roads would be flooded, and a Maximum Probable Flood would inundate several sections which parallel the stream.

Farm homes and buildings are generally back from the flood plain, but some residences have been located on the flood plain in recent years, and these are subject to flooding.

Bridges across the Stream

Four highway bridges cross Middle Fork French Broad River in the reach investigated for this report. Table 5 lists pertinent elevations for these bridges and shows their relation to the crest of the flood of October 1964 and the Regional Flood. Plate 9 shows the relation of the floor and the underclearance at the bridges to the flood profiles. Figure 4 shows photographs of some of the bridges.

TABLE 5

BRIDGES ACROSS MIDDLE FORK FRENCH BROAD RIVER

Mile above Mouth	Identification	Low Water Elev. feet	Floor Elev. feet	Regional Flood Crest Elev. feet	October 1964 Flood Crest Elev. feet	Underclearance Elev. feet	Above 1964 Flood feet	Below 1964 Flood feet
0.24	Secondary Route 1107	2175.5	2180.8	2186.4	2182.5	2178.6		3.9
0.82	Secondary Route 1131	2201.7	2209.0	2212.6	2208.3	2206.6		1.7
1.40	Secondary Route 1131	2228.0	2237.0	2239.6	2234.8	2234.6		0.2
1.95	U. S. Highway 178	2269.8	2278.1	2282.1	2278.5	2274.7		3.8

During the October 1964 flood, the bridges at Miles 0.24 and 1.95 were overtopped. At the lower bridge the left-bank abutment was undermined and that end of the bridge dropped a few inches, but the bridge was passable after the flood receded. Both abutments of the bridge at Mile 1.40 were undermined and that bridge was not passable following the flood. A Regional Flood would overtop all of the bridges by depths ranging from 2 to 5 feet.

All four of the bridges and their approach fills restrict flows to some extent so that heading up occurred during the October 1964 flood. The heading up ranged from 1.3 feet at Mile 0.24 to 4.2 feet at Mile 1.95. Debris blocked much of the opening at the latter bridge causing some of the rise above the bridge. During a Regional Flood, heading up of about 4 feet would occur at the bridges at Miles 0.82 and 1.95 and about 2 feet at Mile 1.40. Heading up at the bridge at Mile 0.24 would be negligible.

Obstructions to Flood Flow

The effect of obstructions due to the bridges and their approach fills has been described in the previous section. With the exception of the bridges, there are no significant obstructions to flows in the Middle Fork French Broad River reach included in this study.

4. NORTH FORK FRENCH BROAD RIVER

Developments in the Flood Plain

The flood plain of North Fork French Broad River for the reach covered is shown on Plate 11. Above Mile 1.85 the land is within the boundary of Pisgah National Forest. Below Mile 1.85 the land is in agricultural use or has been left idle.

N. C. Highway 215 follows the edge of the left-bank flood plain through the reach. U. S. Highway 64 crosses the flood plain at Mile 0.02, and Secondary Road 1322 crosses at Mile 1.10. During the October 1964 flood, water was a few inches deep over U. S. Highway 64 for a short reach on the left bank, but neither of the other roads was overtopped. A Regional Flood would be about 4 feet deep on U. S. Highway 64 and would overtop a short reach of Highway 215 upstream from the intersection with U. S. Highway 64. Secondary Road 1322 would be flooded to a depth of 8 feet. A Maximum Probable Flood would be about 8 feet higher than the Regional Flood, flooding longer sections of the roads at those locations and also a section of N. C. Highway 215 near the upper end of the reach.

A mobile type building on the left-bank flood plain at Mile 0.06 is operated as a drive-in restaurant. No other structures are presently on the flood plain of North Fork in the reach covered by this investigation.

Bridges across the Stream

Two highway bridges cross North Fork French Broad River in the reach covered by this report. Table 6 lists pertinent elevations for these bridges and shows their relation to the crest of the flood of October 1964 and the Regional Flood. Plate 12 shows the relation of the floor and the underclearance at the bridges to the flood profiles. Figure 5 shows photographs of the bridges.

Neither bridge was overtopped during the October 1964 flood, but a Regional Flood would overtop U. S. Highway 64 by 3.5 feet and Route 1322 by 7 feet. A Maximum Probable Flood would overtop the bridges by 12 and 14 feet, respectively.

U. S. Highway 64 bridge and its approach fills caused heading up of about one foot during the October 1964 flood, but during larger floods the heading up would not be important. At Secondary Route 1322, heading up of less than one foot occurred during the 1964 flood, and this would increase to 2.5 feet during a Regional Flood.

TABLE 6

BRIDGES ACROSS NORTH FORK FRENCH BROAD RIVER

Mile above Mouth	Identification	Low Water Elev. feet	Floor Elev. feet	Regional Flood Crest Elev. feet	October 1964 Flood Crest Elev. feet	Underclearance Elev. feet	Above 1964 Flood feet	Below 1964 Flood feet
0.02	U. S. Highway 64	2193.5	2210.5	2214.0	2208.8	2205.6		3.2
1.10	Secondary Route 1322	2214.0	2228.0	2235.4	2225.7	2225.4		0.3

Obstructions to Flood Flow

The effect of obstructions due to the bridges and their approach fills has been described in the previous section. With the exception of the bridges and the naturally restricted flood plains in the vicinity of Miles 0.7 and 1.2, there are no significant obstructions to flows in the North Fork French Broad River reach included in this study.

5. WEST FORK FRENCH BROAD RIVER

Developments in the Flood Plain

Plate 11 shows the flood plain of West Fork French Broad River for the reach covered. There are industrial buildings on the flood plain near Mile 1.0, and a few residences are in the flood plain nearer the mouth. Elsewhere in the study reach the valley land is in agricultural use. The railroad which formerly followed the stream through this reach has been abandoned, and the tracks and bridges have been removed.

U. S. Highway 64 crosses the stream and flood plain at Mile 1.20 and is on the left bank from that point to the mouth. Changes made to the highway some years ago included a relocation of the West Fork stream channel to eliminate a sharp bend at Mile 0.7 and a relocation of the road across the old streambed. During the October 1964 flood, West Fork sought to follow its old channel and cut out a portion of the highway at Mile 0.7. About 800 feet of the highway was flooded where it crosses the flood plain at Mile 1.20, when a mass of debris almost blocked the bridge opening. During a Regional Flood, about 1,400 feet of the highway would be flooded with depths up to 4 feet. Almost one-half mile of the highway would be under water during a Maximum Probable Flood. Secondary Route 1135 crosses the flood plain on a high bridge at Mile 0.05. The road is above the Regional Flood but about 2 feet below the Maximum Probable Flood.

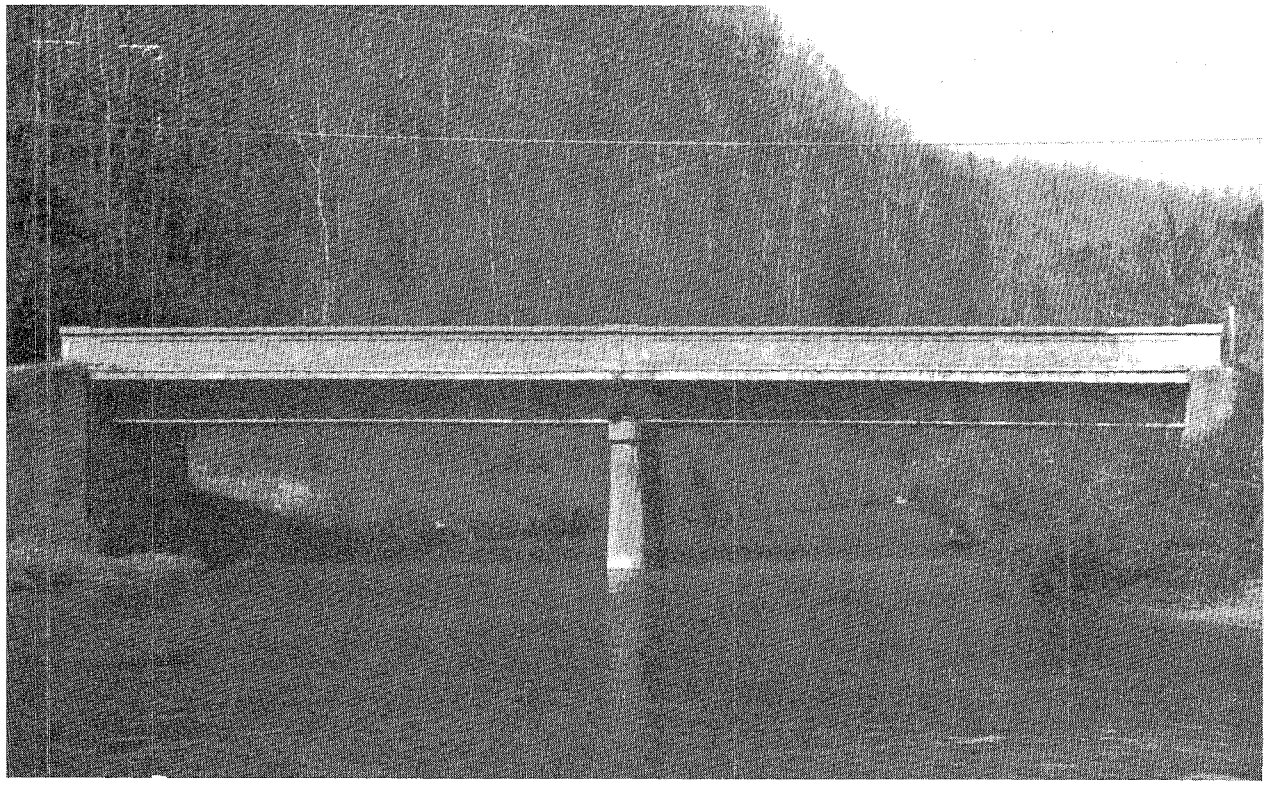


Figure 5.--BRIDGES ON NORTH FORK FRENCH BROAD RIVER

Upper view shows downstream side of the U. S. Highway 64 bridge at Mile 0.02. Lower view is downstream side of the bridge on Secondary Route 1322 at Mile 1.10. The October 1964 flood was above the underclearance level of both these bridges so that heading up occurred, but neither road was overtopped.

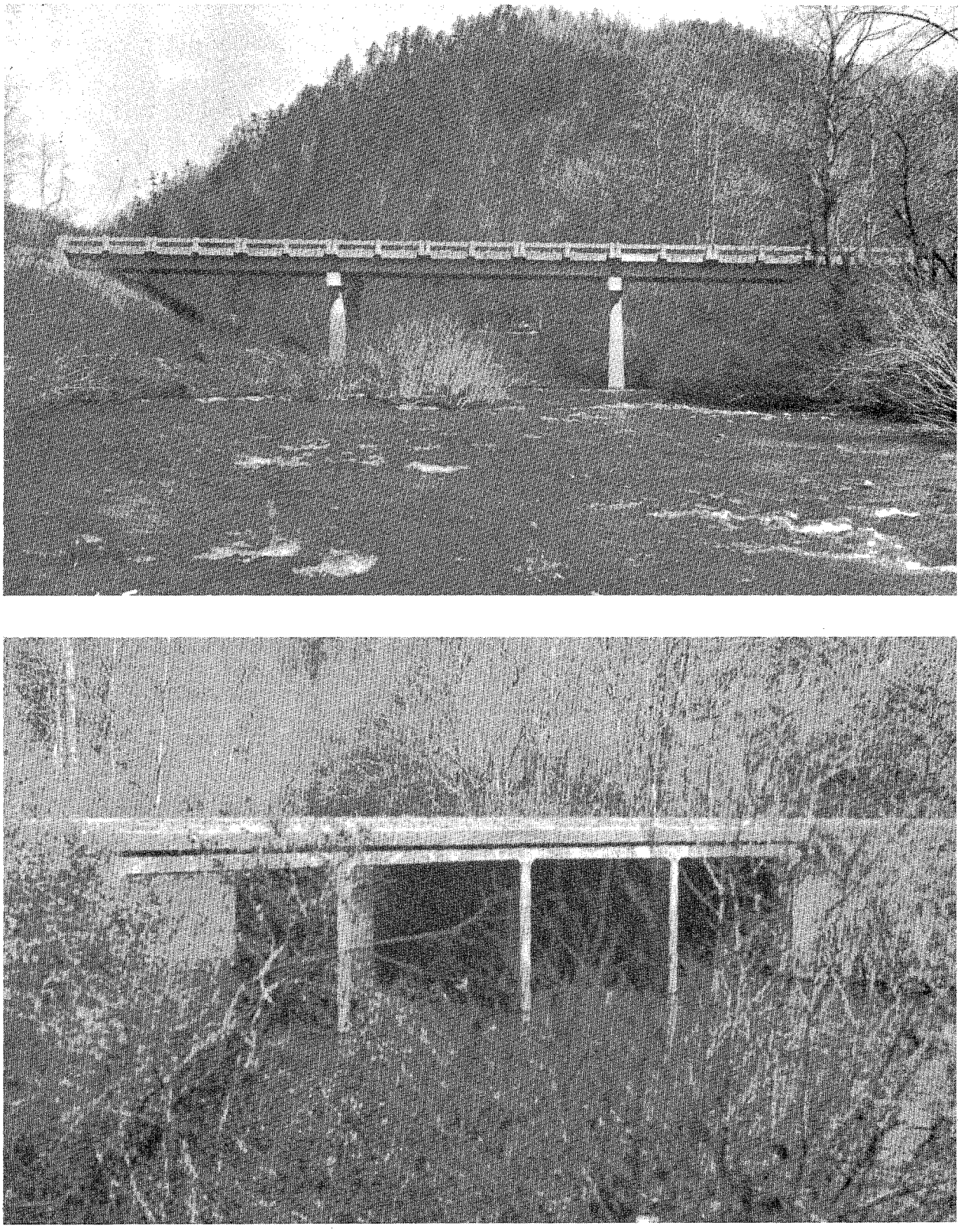


Figure 6.--BRIDGES ON WEST FORK FRENCH BROAD RIVER

Upper view is upstream side of the bridge on Secondary Route 1135 at Mile 0.05. Lower view shows downstream side of the U. S. Highway 64 bridge at Mile 1.20. During the October 1964 flood, debris almost blocked this bridge opening; water overflowed the bridge and several hundred feet of the highway (see Figure 10).

The Mitchell-Bissell Company, manufacturers of formed wire products, began operations in 1962 in a building on the left-bank flood plain at Mile 1.0. Now diversified and renamed M-B Industries, Incorporated, a Snyder Spring Company division has been added in a building erected just upstream and the Flame Spray Engineering division is operating in a building located on the north side of U. S. Highway 64 near the edge of the flood plain at Mile 0.80. The floor elevation in the Mitchell-Bissell division building is 2,229.3 feet, in the Snyder Spring Company building 2,232.2 feet, and in the Flame Spray Engineering building 2,237.3 feet. During the flood of October 1964, water overtopping U. S. Highway 64 flowed across the plant grounds and ripped up slabs of paving. The water was about one foot deep outside the building but only reached a depth of 3 inches in the building.

A Regional Flood would reach a depth of about 5 feet at the Mitchell-Bissell and Snyder Spring Company buildings. A Maximum Probable Flood would be about 7 feet higher. The floor of the Flame Spray Engineering building is slightly higher than the Maximum Probable Flood level.

Bridges across the Stream

Two highway bridges cross West Fork French Broad River in the reach investigated for this report. Table 7 lists pertinent elevations for these bridges and shows their relation to the crest of the flood of October 1964 and the Regional Flood. Plate 12 shows the relation of the floor and the underclearance at the bridges to the flood profiles. Figure 6 shows photographs of the bridges.

TABLE 7

BRIDGES ACROSS WEST FORK FRENCH BROAD RIVER

Mile above Mouth	Identification	Low Water Elev. feet	Floor Elev. feet	Regional Flood Crest Elev. feet	October 1964 Flood Crest Elev. feet	Underclearance Elev. feet	Above 1964 Flood feet	Below 1964 Flood feet
0.05	Secondary Route 1135	2194.1	2220.9	2214.0	2208.9	2217.6	8.7	
1.20	U. S. Highway 64	2227.3	2238.9	2243.4	2240.4	2236.3		4.1

As mentioned previously, debris partially blocked the opening at the U. S. Highway 64 bridge during the October 1964 flood, and the highway was overtopped to a depth of 1.5 feet. A Regional Flood would overtop the bridge by 4 feet, and a Maximum Probable Flood would be 7 feet over the bridge. The floor of the bridge on Secondary Route 1135 is above the Regional Flood, but 2 feet below the Maximum Probable Flood.

At the bridge on Secondary Route 1135, heading up is negligible during floods as great as the Regional Flood but would amount to about 3 feet during a Maximum Probable Flood on West Fork. At the U. S. Highway 64 bridge, heading up of 5 feet occurred during the October 1964 flood, mainly because of the blockage of the bridge opening. Heading up of about 4 feet would occur during a Regional Flood, but heading up would be negligible during a Maximum Probable Flood.

Obstructions to Flood Flow

The effect of obstructions due to the bridges and their approach fills has been described in the previous section. With the exception of the bridges, there are no significant obstructions to flows in the West Fork French Broad River reach included in this study.

IV.

PAST FLOODS

IV.

PAST FLOODS[1]

This section of the report is a history of floods which have occurred on the French Broad River and its major tributaries, East, Middle, North, and West Forks, in the vicinity of Rosman in Transylvania County, North Carolina. The portion of French Broad River considered extends from Mile 208.4 at the mouth of Catheys Creek to the head of the river at Mile 217.7 at the confluence of the West and North Forks. The investigation on the East Fork covers the reach from its mouth to the mouth of Upper Creek at Mile 4.4, and the Middle Fork is covered from its mouth to the mouth of Claypole Branch at Mile 2.0. The investigation on the West Fork covers the lower 1.5 miles of that stream, and the North Fork is covered from the mouth to Mile 2.1.

Records of stages and discharges have been maintained on the French Broad River at Rosman since December 1935, with an additional period of record from May 1907 to June 1909. At Calvert, 2.4 miles downstream from Rosman, records were maintained from October 1924 to September 1955. No records of stages and discharges have been maintained on any of the other four streams covered by this report.

Flood history investigations were made by TVA engineers during 1935 to 1937 to develop information along the French Broad River from Rosman through the reach covered by this report and downstream to the mouth of the river. Additional investigations have been made along the French Broad River following most of the major floods which have occurred since 1937. No investigations were made along the four tributary streams covered by this report until after the floods of September and October 1964. Investigations were made on all of the streams following the flood of October 1970.

This section of the report discusses separately the flood history of the five streams.

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1. Prepared by Hydraulic Data Branch.

1. FRENCH BROAD RIVER

The first stream gage on the French Broad River at Rosman was a staff gage installed by the U. S. Geological Survey on May 7, 1907. It was located about 500 feet downstream from the present site and continued in operation until June 30, 1909. On December 11, 1935, a wire-weight gage was installed by the U. S. Geological Survey on the bridge at the present site, and on July 6, 1937, it was replaced by a recording gage on the left bank 10 feet upstream from the bridge. Continuous records are available since the latter date.

At Calvert, 2.4 miles downstream from Rosman, the U. S. Geological Survey installed a staff gage upstream from the bridge on October 15, 1924. Observations were made on it until April 5, 1932, when it was replaced by a staff gage on the downstream side of the bridge. Three months later on July 5, 1932, a chain gage was installed on the upstream side of the bridge, and on May 17, 1934, a recording gage was placed in operation on the right bank 10 feet downstream from the bridge. Continuous records are available from that date until September 30, 1955, when the station was discontinued.

To supplement the records obtained at these gaging stations, local residents were interviewed for information on heights of floods. Newspaper files were searched, as were historical documents and records. Valuable data were obtained from reports of field investigations made by TVA engineers after important floods which have occurred since 1937. These records and investigations have developed a knowledge of floods on French Broad River covering the past 180 years.

Flood Stages and Discharges

Table 8 lists peak stages and discharges for the known floods exceeding bankfull stage of 8 feet at the U. S. Geological Survey gaging station on French Broad River at Rosman, North Carolina, or exceeding a stage of 7 feet at the U. S. Geological Survey gaging station on French Broad River at Calvert, North Carolina. Stages for the flood of July 16, 1916, at both stations are from high-water marks as are the Calvert stages shown for floods since 1955. Floods have generally occurred at both stations on the same dates, but the magnitude varies considerably because of the rainfall distribution during the flood-producing storms. The gage at Rosman measures the runoff from North and West Forks of French Broad River, while the gage at Calvert includes also the runoff from the East and Middle Forks. Because of the wide variations in rainfall and runoff over those watersheds, it is not possible to develop a good relation between peak stages or discharges at the Rosman and Calvert gaging stations.

TABLE 8

FLOOD CREST ELEVATIONS ABOVE BANKFULL STAGE

FRENCH BROAD RIVER AT CALVERT AND ROSMAN, NORTH CAROLINA

This table includes all known floods above bankfull stage of 7 feet at the U. S. Geological Survey gaging station at Calvert, Mile 214.02, or above bankfull stage of 8 feet at the U. S. Geological Survey gaging station at Rosman, Mile 216.45. Gage records were maintained at Calvert from 1924 to 1955, drainage area at the gage site is 103 square miles, and gage zero was 2,154.63 feet above mean sea level. At Rosman gage records began in 1935, drainage area at the gage is 67.9 square miles, and gage zero is 2,173.83 feet above mean sea level.

Date of Crest	Calvert			Rosman		
	Gage Heights		Peak	Gage Heights		Peak
	Stage	Elevation	Discharge	Stage	Elevation	Discharge
	feet	feet	cfs	feet	feet	cfs
July 16, 1916	13.5 (a)	2,168.1	18,000	13.9 (a)	2,187.7	11,000
December 8, 1924	8.1	2,162.7	4,490			
January 18, 1926	9.0	2,163.6	5,330			
August 15, 1928	13.0	2,167.6	16,100			
March 14, 1929	7.6	2,162.2	4,090			
September 26, 1929	8.6	2,163.2	4,730			
April 22, 1931	8.0	2,162.6	4,410			
October 17, 1932	11.6	2,166.2	11,200			
October 31, 1932	8.6	2,163.2	4,910			
May 5, 1933	10.0	2,164.6	6,910			
January 9, 1935	9.36	2,163.99	5,870			
November 13, 1935	7.67	2,162.30	4,170			
April 6, 1936	8.77	2,163.40	5,100	9.4	2,183.2	4,280
October 9, 1936	7.29	2,161.92	3,880	7.5	2,181.3	2,560
October 19, 1937	9.18	2,163.81	5,580	10.15	2,183.98	5,400
July 21, 1938	7.46	2,162.09	4,020	8.10	2,181.93	3,050
January 30, 1939	7.30	2,161.93	3,880	8.50	2,182.33	3,370
August 18, 1939	10.53	2,165.16	8,000	10.55	2,184.38	6,100
April 19, 1940	7.39	2,162.02	3,930	8.62	2,182.45	3,460
August 13, 1940	11.66	2,166.29	12,300	11.80	2,185.63	9,040
August 30, 1940	10.83	2,165.46	9,380	11.86	2,185.69	9,410
May 20, 1942	9.58	2,164.21	6,570	10.38	2,184.21	5,740
December 29, 1942	9.23	2,163.86	5,810	9.86	2,183.69	4,940
February 10, 1946	7.16	2,161.79	3,750	7.45	2,181.28	2,460
January 20, 1947	7.05	2,161.68	3,600	7.80	2,181.63	2,730

TABLE 8 (Continued)

Date of Crest	Calvert			Rosman		
	Gage Heights		Peak	Gage Heights		Peak
	Stage	Elevation	Discharge	Stage	Elevation	Discharge
	feet	feet	cfs	feet	feet	cfs
August 3, 1948	7.67	2,162.30	4,120	9.08	2,182.91	3,620
September 6, 1948	7.05	2,161.68	3,640	8.00	2,181.83	2,800
November 6, 1948	7.11	2,161.74	3,680	7.98	2,181.81	2,790
November 19, 1948	7.38	2,162.01	3,880	8.84	2,182.67	3,400
November 28, 1948	7.80	2,162.43	4,220	8.19	2,182.02	2,910
June 16, 1949	8.75	2,163.38	5,190	9.49	2,183.32	4,080
July 12, 1949	8.39	2,163.02	4,780	8.45	2,182.28	3,100
July 18, 1949	7.30	2,161.93	3,820	8.53	2,182.36	3,150
August 28, 1949	7.92	2,162.55	4,330	7.97	2,181.80	2,780
September 1, 1950	9.40	2,164.03	6,140	11.17	2,185.00	5,700
December 7, 1950	9.06	2,163.69	5,600	10.23	2,184.06	4,500
March 11, 1952	9.83	2,164.46	6,960	11.15	2,184.98	5,660
March 23, 1952	8.18	2,162.81	4,570	9.58	2,183.41	3,880
February 21, 1953	9.36	2,163.99	6,070	10.11	2,183.94	4,380
January 22, 1954	8.60	2,163.23	5,010	8.40	2,182.23	3,060
April 4, 1957				10.80	2,184.63	5,180
December 20, 1957				8.90	2,182.73	3,380
January 21, 1959				9.12	2,182.95	3,530
October 9, 1959				8.10	2,181.83	2,880
February 25, 1961				9.43	2,183.26	3,760
August 24, 1961	8.5 (a)	2,163.1	4,900	8.72	2,182.55	3,260
December 12, 1961				9.13	2,182.96	3,540
September 29, 1964	10.6 (a)	2,165.2	11,000	13.31	2,187.14	9,600
October 4, 1964	11.75 (a)	2,166.38	16,800	14.95	2,188.78	13,500
October 1, 1965				11.12	2,184.95	5,620
February 13, 1966				12.50	2,186.33	7,970
June 4, 1967				10.55	2,184.38	4,870
July 7, 1967				9.07	2,182.90	3,500
August 23, 1967				9.44	2,183.27	3,770
March 12, 1968				9.80	2,183.63	4,080
June 15, 1969				9.51	2,183.34	3,830
October 11, 1970	10.31 (a)	2,164.94	9,800	10.61	2,184.44	4,940

(a) Estimated from high-water mark.

Table 9 lists the highest ten floods in order of magnitude on the French Broad River at the Rosman gage.

TABLE 9

HIGHEST TEN FLOODS IN ORDER OF MAGNITUDE

FRENCH BROAD RIVER AT ROSMAN, NORTH CAROLINA

Order No.	Date of Crest	Gage Height	
		Stage feet	Elevation feet
1	October 4, 1964	14.95	2,188.78
2	July 16, 1916	13.9	2,187.7
3	September 29, 1964	13.31	2,187.14
4	February 13, 1966	12.50	2,186.33
5	August 30, 1940	11.86	2,185.69
6	August 13, 1940	11.80	2,185.63
7	September 1, 1950	11.17	2,185.00
8	March 11, 1952	11.15	2,184.98
9	October 1, 1965	11.12	2,184.95
10	April 4, 1957	10.80	2,184.63

TABLE 10

MONTHLY FLOOD DISTRIBUTION--FRENCH BROAD RIVER AT ROSMAN

Month	Number of Occurrences*	Month	Number of Occurrences*
January	6	July	4
February	4	August	8
March	4	September	4
April	4	October	8
May	2	November	4
June	3	December	5
		Total	56

*Number of occurrences during 46 years of record, October 1924 through December 1970.

Flood Occurrences

Plate 2 shows crest stages and months of occurrence of known floods which have exceeded bankfull stage of 8 feet on the French Broad River at the stream gage at Rosman. The months of occurrence of floods which exceeded bankfull stage of 7 feet at the stream gage at Calvert during the period from 1924 to 1935 are also shown. Table 10 shows the distribution of the 56 floods occurring during the period since gage records started at Calvert in 1924. The record shows that floods have occurred in every month of the year, the greatest number of floods occurring in the months of August and October.

Duration and Rate of Rise

Plate 3 shows the stage hydrographs on the French Broad River at Rosman for the floods of September 29 and October 4, 1964. During the September flood the river rose to its crest stage in 20 hours at an average rate of 0.6 foot per hour with a maximum rate of 3.9 feet per hour and remained above bankfull stage for 15 hours. In October the crest was reached in 14 hours at an average rate of rise of 0.8 foot per hour with a maximum rate of 2.0 feet per hour, and the river remained above bankfull stage for 22 hours.

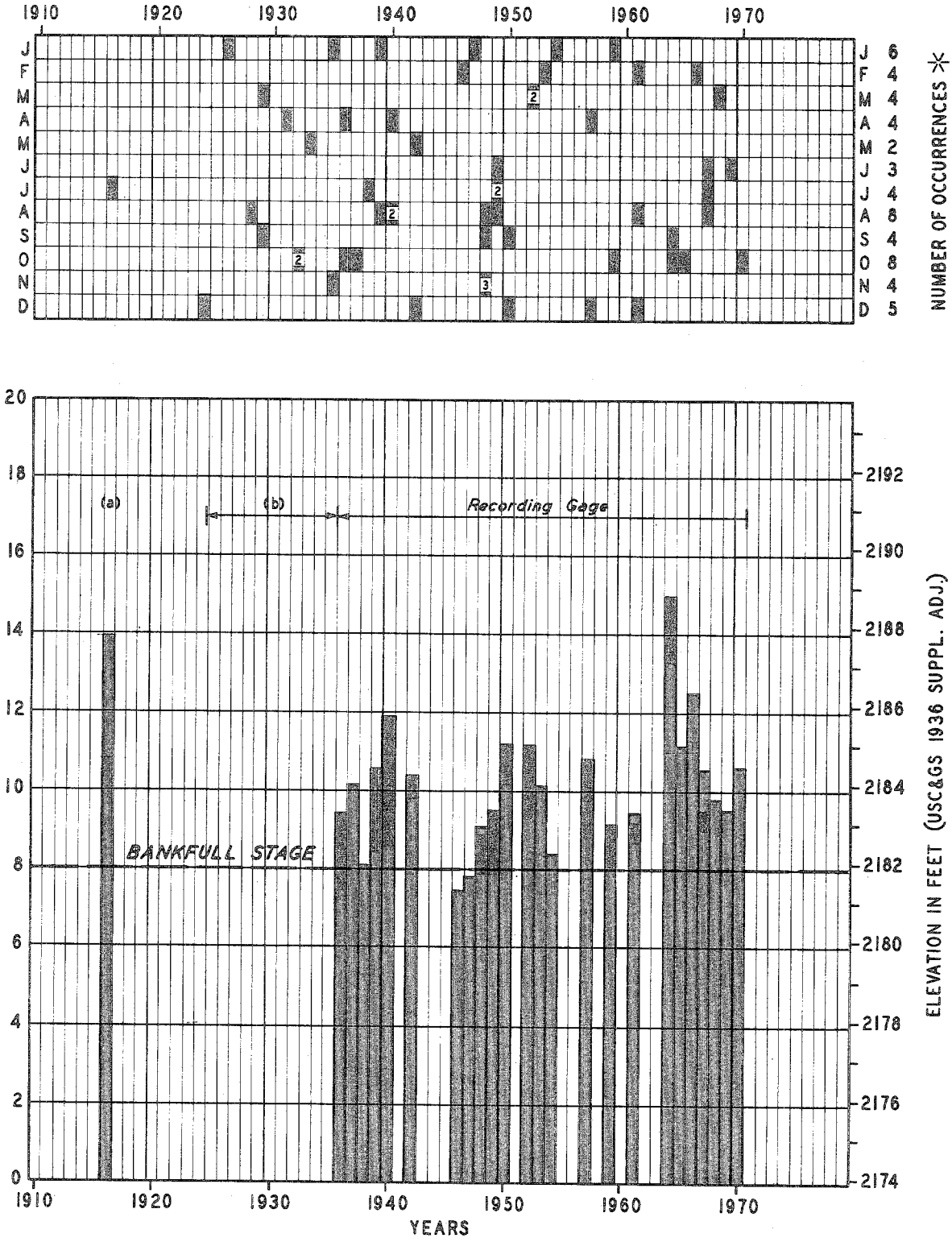
At the Calvert stream gage the duration of flooding is generally several hours greater than at Rosman, but the rate of rise is less.

Velocities

During the flood of October 1964, it is estimated that velocities in the channel of the French Broad River in the vicinity of Rosman ranged up to 9 feet per second. Overbank velocities ranged up to 2 feet per second. During larger floods velocities would be even greater in the channel, and in the overbank areas velocities would be high.

Flooded Areas, Flood Profiles, and Cross Sections

Plate 7 shows the approximate area along French Broad River in the vicinity of Rosman that was inundated by the flood of October 4, 1964, and that would be inundated by the Maximum Probable Flood. The actual limits of these overflow areas on the ground may vary somewhat from those shown on the map because the contour interval of the map does not permit precise plotting of the flooded area boundaries. The contour interval of Plate 7 is 40 feet.



✳ Number of occurrences during the period Oct. 1924 through Dec. 1970.

(a) Stage based upon high water mark.

(b) Bankfull stage of 7 feet exceeded at gage at Calvert, N.C.-Mile 214.02

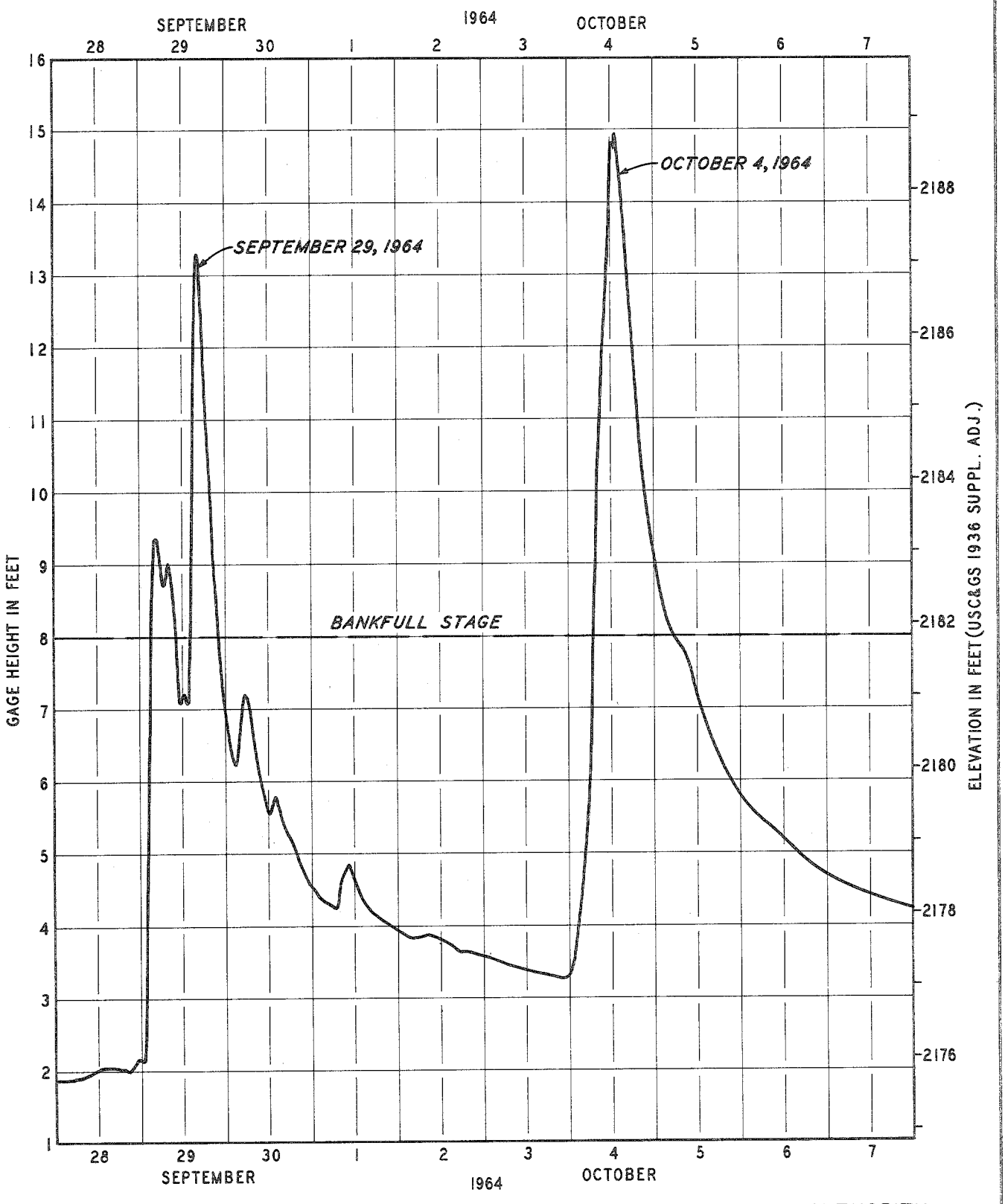
Stream gage at River Mile 216.45

TENNESSEE VALLEY AUTHORITY
DIVISION OF WATER CONTROL PLANNING

FLOODS ABOVE BANKFULL STAGE FRENCH BROAD RIVER AT ROSMAN, N. C.

APRIL 1971

PLATE 3



TENNESSEE VALLEY AUTHORITY
DIVISION OF WATER CONTROL PLANNING

Stream Gage at River Mile 216.45

STAGE HYDROGRAPH
FRENCH BROAD RIVER
AT
ROSMAN, N.C.

APRIL 1971

The overflow limits in the immediate area of Rosman are also shown on Plate 8, which is a section of a large-scale topographic map compiled by TVA in 1965. The map shows more detail than Plate 7, and the contour interval is 4 feet.

Plate 9 shows the high water profiles on French Broad River for the floods of October 4, 1964, and October 11, 1970. Also shown are the profiles for the Regional and Maximum Probable Floods discussed in Sections V and VI of this report.

Plate 10 shows typical cross sections of French Broad River in the reach investigated. The locations of the sections are shown on the map and profile, Plates 7 and 9. The cross sections show the elevation and extent of overflow of the October 4, 1964, flood and the Regional and Maximum Probable Floods.

Flood Descriptions

Following are descriptions of known large floods that have occurred on French Broad River and its tributaries in the vicinity of Rosman. These are based upon newspaper accounts, historical records, and investigations by TVA engineers.

Information is sparse on the very early floods on French Broad River and its tributaries in the vicinity of Rosman. A search of early Asheville newspapers gives hints of floods in the headwater reaches of French Broad River but no clue from which flood heights can be estimated in most cases. On the other hand, there are numerous references to floods and flood damages on the river in the immediate vicinity of Asheville. Experience in more recent floods indicates that damaging or near-damaging floods probably occurred on the headwater streams whenever there were overflows on the main river at Asheville, but that the effects close to Asheville crowded out the news from the headwater areas. It is probable also that floods have occurred in the vicinity of Rosman which were not mentioned in the early Asheville newspapers.

April 1791

Many large floods occurred in the early years of settlement in the Asheville vicinity. The earliest known of these floods occurred in April 1791. Since the country was only sparsely settled at the time, information on the flood is naturally meager but still sufficient to establish quite definitely that it was the greatest flood on Swannanoa River of which there is any knowledge and probably

one of the greatest on French Broad River. The weight of evidence indicates that on the Swannanoa River the flood exceeded the severe flood of July 1916 by as much as 5 feet. Since a flood in April is likely to be caused by general rains, it is reasonable to assume that the French Broad River was also unusually high at that time and that it may have been as high as in the flood of July 1916.

1796-1875

Historical reference is found to a flood on both French Broad River and Swannanoa River in August 1796. Another flood in 1810 was said to have been particularly high on the Swannanoa River.

The Asheville "Citizen" of July 27, 1916, quotes Mr. W. J. Alexander, a member of one of the first families to settle near Asheville, as saying that the first notable flood in his lifetime occurred in May 1845, when he was 15 years old. Flood history investigations in the adjoining Tuckasegee River basin have definitely established that a great flood occurred in May 1840, and it is probable that the French Broad flood occurred at that time, rather than in 1845.

Floods occurred in August 1850 and August 1852. According to the Asheville "News" of September 2, 1852, the 1852 flood on the French Broad River "was higher . . . than it has been for many years before, exceeding largely the great flood two years ago."

Great floods occurred throughout the upper half of the Tennessee Valley in March 1867. They were the largest floods ever known on the lower French Broad, Holston, and Little Tennessee Rivers and on the Tennessee River itself from Knoxville through Chattanooga. On the French Broad River at Newport, Tennessee, the flood exceeded by 1.0 to 1.5 feet the floods of 1902 and 1916. Although the storm was most severe in the lower part of the French Broad watershed, it undoubtedly produced a large flood also in the Rosman vicinity.

Intense rainfall produced a flood late in February 1875. The Asheville "Citizen" for March 4, 1875, reported that "the Swannanoa and French Broad Rivers rose so rapidly that persons residing along their banks had to abandon their houses and effects and flee for safety. In many domiciles the water was 3 and 4 feet deep."

June 17, 1876

This flood, often called the "June Freshet," is one of the great floods along the upper reaches of the French Broad River. At Asheville it ranked next below the July 1916 crest among floods of the past 170 or more years, and the same relation probably holds for the reach of the river near Rosman.

Mr. R. L. Gash, an attorney at Brevard and a member of one of the pioneer families of Transylvania County with an avid interest in its early history, was interviewed by TVA engineers in 1937. Mr. Gash stated that at the time of the 1916 flood the oldest residents of the area said the flood was the greatest they had seen or heard of and that the highest known previously was the "June Freshet" of 1876.

The Brevard "Sylvan Valley News" in an article printed on July 21, 1916, had the following to say about the relation of the July 1916 flood to the flood of June 1876:

> P. C. Surrette and E. B. Clayton of the Penrose section say they have high water marks made by the noted June Freshet of 1876 and that the water Sunday was 5 feet higher than at the destructive flood 40 years ago. . . .

May 1901, February 1902

On May 22, 1901, the French Broad River at Asheville rose to a stage of 11 feet and damaged railroads, industries, and other developments and disrupted the city's water supply. It is probable that there was a large flood on the upper reaches of the river also.

A flood occurred on February 28, 1902, that was the highest on the French Broad River at Asheville since June 1876. Evidently the flood was not quite so large in the Rosman vicinity. The "Sylvan Valley News" of March 7, 1902, stated:

> March came in the latter part of last week with a terrific rush and a heavy downpour of rainfall. As a result the various streams in the county were soon out of banks, some footlogs were removed from their resting places and some of the bridges had a narrow escape. Washouts along the railroads prevented trains from running either to Toxaway or Hendersonville from Friday until Tuesday following. Yet our people have not suffered as other sections have.

January 23, 1906

This was a large flood on the French Broad River above Asheville. The following account of the flood is from the "Sylvan Valley News" of January 26, 1906:

THE FLOOD

> Tuesday morning French Broad River was the highest recorded since the great June Freshet of 30 years ago and those who have been watching the high water marks made at that time tell us that it only lacks 3 or 4 inches of the record made in 1876.
>
> But in the present instance it rained. Roofs that were rainproof heretofore let in the water in sluices. The water was hurled into the river from the mountainsides with such force that it cut its way through the bottoms, taking all loose soil with it. It was simply a boiling, seething torrent from hill to hill and the damage done to farming lands is incalculable. . . .
>
> The iron abutment at the south end of Wilson's iron bridge was moved about 18 inches downstream . . . Island Ford bridge is reported all right but the approach to it is washed away. The Luther Hamilton mill dam on Little River is washed away; also the bridge across Little River at the mouth of Laurel Creek. . . .
>
> Our railroad suffered severely by washouts . . . A great amount of damage has been done which we will not hear about in time for this issue of the News.

August 31, 1910

The French Broad River at Asheville reached a stage in this flood which was equal to that of May 1901. There was a heavy loss to crops which were nearing maturity. The "Sylvan Valley News" of September 2, 1910, contained the following account:

> Rainfall from 6 o'clock Monday until 6 o'clock Tuesday a.m. (was) 1.80 inches. From Tuesday to Wednesday morning there was a fall of 5.70 inches according to the rain gage at Major Breese's. Some rain that -- and watercourses made a strenuous effort to prove it.

HIGH WATER

> The heavy rains have done much damage to growing crops and to property. The river is reported to be higher than for several years. Cornfields along the banks are inundated and the crop is seriously injured.

> The Southern Railway has been a heavy loser, trestles having been washed away, the track torn up, bridges injured, freight and passenger traffic suspended -- no trains for several days and no mail. . . .
>
> Many of the pupils of Brevard Institute could come no further than Hendersonville and thus were unable to be at the opening on Thursday.

July 16, 1916

This is one of the greatest floods of which there is definite record on the upper French Broad River and its tributaries. It resulted from a tropical hurricane storm that passed inland over Charleston, South Carolina, on July 14 and advanced northwestward across South Carolina. As it moved overland the storm lost much of its surface intensity but maintained its intensity and high moisture content in the upper levels. The presence of a high-pressure area over the northeastern states caused the storm to be directed against the highest portion of the Blue Ridge, which it was unable to cross because of insufficient energy.

The heaviest rainfall during the storm occurred along the Blue Ridge, particularly along the eastern boundary of the French Broad River basin upstream from Asheville. Altapass, North Carolina, located on the crest of the Blue Ridge 70 miles northeast of Rosman, recorded 23.7 inches of rainfall for the storm, 22.2 inches of this falling in 24 hours. Rainfall exceeded 12 inches at Rosman and was in excess of 15 inches in the headwaters of East Fork French Broad River. Rainfall amounts decreased rapidly to the north and west of the Blue Ridge, and Asheville received only 2.85 inches for the storm. Three persons lost their lives in one of the many landslides that resulted from the intense rain in Transylvania County.

General rains had fallen over the upper French Broad watershed a week earlier, putting the river and most of its tributaries out of banks. The streams had been receding only a few days when the great storm of July 15-16 hit. Streams rose rapidly and by early Sunday, July 16, overflow was widespread with severe damage to roads, railroads, crops, and other property.

Graphic accounts of the flood are contained in the files of newspapers at Brevard and Asheville. The rise that took place a week prior to the main flood overflowed wide areas and caused major damage, as evidenced from the following excerpts from the "Sylvan Valley News" of July 14, 1916:

TRANSYLVANIA GRIPPED BY WORST STORM SINCE JUNE FRESHET OF '76

THOUSANDS OF ACRES OF RIVER FARMS TRANSFORMED INTO VAST LAKES AND HUNDREDS OF BUSHELS OF RYE WASHED DOWNSTREAM WHILE CROPS STAND SEVERAL FEET UNDER WATER.

RAILROAD TRANSPORTATION SUSPENDED FOR THREE DAYS WITHOUT RAIL AND PASSENGER SERVICE: POWER PLANT OUT OF COMMISSION AND TOWN IN DARKNESS

Transylvania County is emerging from the most destructive overflow it has suffered since the noted June Freshet of 1876.

Rain began Friday and throughout Saturday, Sunday, and Monday there was almost a continual downpour, as a result of which the streams in this county overflowed and took in their sweep thousands of acres of land. . . .

The storm brought clearly to mind the frequently mentioned "June Freshet" of 1876 when the waters were said to have been higher and more destructive than they were during the present storm . . .

In the issue of July 21, 1916, the paper describes the even greater flood that occurred on July 16:

FLOOD DESTRUCTION IN FIVE STATES

LANDSLIDES AND HIGH WATERS DESTROY LIVES AND PROPERTY

TORRENTIAL RAINFALL OF SATURDAY NIGHT FOLLOWED ON SUNDAY MORNING BY LANDSLIDES AND UNPRECEDENTED HEIGHT IN RIVERS WHICH TOOK HEAVY TOLL IN LIVES, CROPS, AND OTHER PROPERTY, LEAVING DESTRUCTION IN THE DEATH-DEALING TRAIL OF THE FLOODS

JOHNNY HEATH, MRS. CALDWELL SENTELLE AND DAUGHTER KILLED IN LANDSLIDES

IT BEAT JUNE FRESHET OF '76

P. C. Surrette and E. B. Clayton of the Penrose section say they have high water marks made by the noted June Freshet of 1876 and that the water Sunday was 5 feet higher than at the destructive flood 40 years ago. They say the water was 7 feet higher than it was last week.

NEARLY 15 INCHES OF RAINFALL IN 48 HOURS

> The Weather Bureau station on the Institute grounds registered a fall of 14.7 inches from . . . Friday to the same hour Sunday afternoon, just a little over one foot.

ROADS AND BRIDGES DAMAGED SEVERAL HUNDRED THOUSAND DOLLARS

> In many places tons of earth and rock mixed with forests rest where once there were good roads. In other places the roads have been washed away.
>
> The majority of small bridges in the county were destroyed and many of the major bridges across the rivers have been wrecked.
>
> Island Ford Bridge is standing and the others between Rosman and Wilson Bridge went downstream. . . . Elm Bend bridge is standing. The bridge across the French Broad at Pisgah Forest was destroyed. Patton's bridge is said to have been washed from its foundation. Others along the river suffered greatly from being washed away.

ROSMAN SUFFERED FROM HIGH WATERS OF THE FLOOD

> The town of Rosman felt the effects of the storm. Waters raged there Sunday morning and grew deeper until they reached the first floors of some of the residences and stores.

Four high-water marks for the 1916 flood were obtained in Rosman. One at the upper end of town is higher than the flood of October 1964, but one mark near the stream gage and two marks in the lower end of town are about one foot lower than the October 1964 flood. The heavy rainfall over the watershed of East Fork French Broad River apparently resulted in a large flood on that stream in 1916, for high-water marks for the 1916 flood on French Broad River downstream from the mouth of East Fork to the lower limits of this study are higher than the October 1964 flood by amounts ranging up to 1.7 feet. Farther downstream on the French Broad River the 1916 flood exceeded the 1964 flood by 10 feet or more because of the large floods in 1916 on Mud Creek, Cane Creek, and Swannanoa River.

October 25 and 28, 1918

The "Brevard News" of Thursday, October 31, 1918, states:

Transylvania has again been subjected to a flood or freshet. It came last Thursday afternoon. The rain continued in a steady downpour through the night and Friday morning the French Broad was up 11 feet. The trestle near Rosman and a bridge near Penrose were washed away.

During the following four days the sky stayed the color of lead and we had a slow drizzling rain with an occasional shower.

Monday night the whole irrigating system was turned on in full force with thunder and lightning.

--- The rain continues and it has been impossible as yet to form an estimate of the damage done to the crops.

The Asheville "Citizen" of October 30, 1918, says:

BREVARD SECTION DELUGED

--- The railway is out of commission between Hendersonville and Brevard and from Rosman to Lake Toxaway, the latter link having been badly crippled last Saturday. Two trestles were washed away Tuesday morning and three last week.

August 15, 1928

This was a large flood on the upper French Broad River and its tributaries. On the main stream the flood was under the great flood of July 1916, 4.3 feet lower at the Blantyre stream gaging station, 0.5 foot lower at the Calvert gage, and about 1.5 feet lower at Rosman.

The "Brevard News" of August 23, 1928, includes the following account of the flood:

COUNTY RECOVERS FROM FLOOD EFFECT

INDUSTRIES, ROADS, FARMS SUFFER FROM EFFECT OF SWOLLEN STREAMS

COMMUNICATION CUT OFF FOR TWO DAYS

ROSMAN AND PISGAH FOREST GET BRUNT OF RAGING WATERS - BUSINESS GOING ON

Transylvania County is rapidly recovering from the effects of the flood of last week, when streams in the county left their banks, flooded the highways, covered acres of bottom land, washed bridges and trestles on logging roads away, and had the county isolated for two days.

> Wednesday of last week was the beginning of the flood conditions when the French Broad River flooded the streets of Rosman and by Thursday morning the high waters had reached a point but little under that which prevailed in the 1916 flood.
>
> Much damage was done to the crops in the county along the French Broad valley. . . . County commissioners Wednesday set aside $10,000 for the purpose of replacing bridges that were washed away during the floods last week and to repair roads. . . .
>
> FARMERS SUFFER GREAT LOSSES FROM FLOOD
>
> Farmers of Transylvania County have suffered great losses as a result of the high waters last week. Many farmers report total loss of their crops while others were more fortunate in having much of their crops growing on the uplands.

August 13 and August 30, 1940

Two large floods occurred in the upper French Broad River basin in August 1940. Coming at the height of the crop growing season, they caused heavy losses to farmers in the valley. The first flood was the higher of the two on the main stream and on most tributaries and generally the highest flood since August 1928.

The August 13 flood resulted from a tropical storm whose center moved inland at Savannah, Georgia, on August 11, then described a great circle to the west and north of the area, bringing heavy rains to much of the southeast.

At Beech Gap, at the head of North Fork, an unofficial rainfall catch was found which totaled 16.8 inches for the storm. At the Rosman stream gage the river crested at 10:30 a.m. on August 13 at 11.80 feet, less than one foot below the 1928 flood and 2.1 feet under the flood of July 1916. At the Calvert stream gage the crest stage was 1.3 feet lower than the 1928 flood.

French Broad River was not back within banks until early on August 16, so that water was over many fields the greater part of three days, with a resultant heavy loss to crops. Some 4800 acres of corn, hay, and truck crops were flooded in Transylvania County.

The rise on the French Broad River and its tributaries on August 30 followed rainfall originating in a purely local meteorological disturbance which was

confined to the North Carolina mountains. Rainfall amounts for the storm over the watershed affecting streams in the Rosman vicinity were quite uniform and generally close to 8 inches.

The French Broad River at Rosman was 0.1 foot higher than in the flood which occurred two weeks earlier, but through most of the reach covered by this investigation the river was not so high as in the mid-August flood. At the Calvert stream gage the river crested at 10.83 feet, 0.8 foot lower than on August 13. Some additional damage was done to crops by the second overflow. Bridges, bridge approaches, and roads, repaired after the first flood, were again damaged.

June, July, and August 1949

In the summer of 1949 floods occurred in June, July, and August which resulted in large losses throughout the upper French Broad River basin. The first flood occurred on June 16. Two separate floods occurred in July, on July 12 and 18. A fourth flood took place August 28. None of the floods was so high as the mid-August 1940 flood, but damage was much more severe because of the large increase in the acreage which had been planted to truck crops. Damage to these truck crops alone for the four floods amounted to $373,000 in Transylvania County and $942,000 for the watershed above Asheville. Investigations which were made by TVA engineers after the floods showed that the total of all damages resulting from the floods amounted to $486,000 for Transylvania County and $1,219,000 for the French Broad watershed above Asheville. Of the flood damages which occurred in Transylvania County, the losses along the reach of French Broad River covered by this investigation amounted to some $250,000 in truck crops and some $35,000 for other crops.

August 24, 1961

After their heavy losses in 1949, many truck crop planters said they were going to cut back their operations because of the high flood risks involved in the upper French Broad River basin. Overbank floods continued to occur on an average of about once per year, with stages equal to or exceeding those in 1949, but none of these took place during the growing season. This favorable flood-loss experience, plus continuing good market conditions, served to erase the memory of the early flood losses, and the planters began putting larger and larger acreages into truck crops and into gladioli for the commercial flower market. In the summer of 1961 the acreage which was planted in truck crops was nearly double the acreage

which was in the flood plain when the first of the 1949 floods occurred. The acreage of river-bottom land planted in gladioli was several times greater in 1961 than in 1949. The land in use for the usual farm crops of corn, hay, pasture, and small grains was also increased over 1949. Thus the stage was set for high losses when flood conditions developed late in August 1961.

At the Rosman and Calvert stream gages, the crest stage on August 24 was not so high as the largest 1949 flood, but farther downstream the crest was about 1.5 feet higher than any of the 1949 floods.

The flood caused damages amounting to $1,380,000 for the upper French Broad River basin, about 13 percent more than that which resulted from the four floods which occurred in the summer of 1949. In Transylvania County the damage to crops of all kinds totaled $532,000. The loss to regular farm crops was $35,000, to gladioli $32,000, and to truck crops $465,000, nearly double the total truck crop loss in 1949.

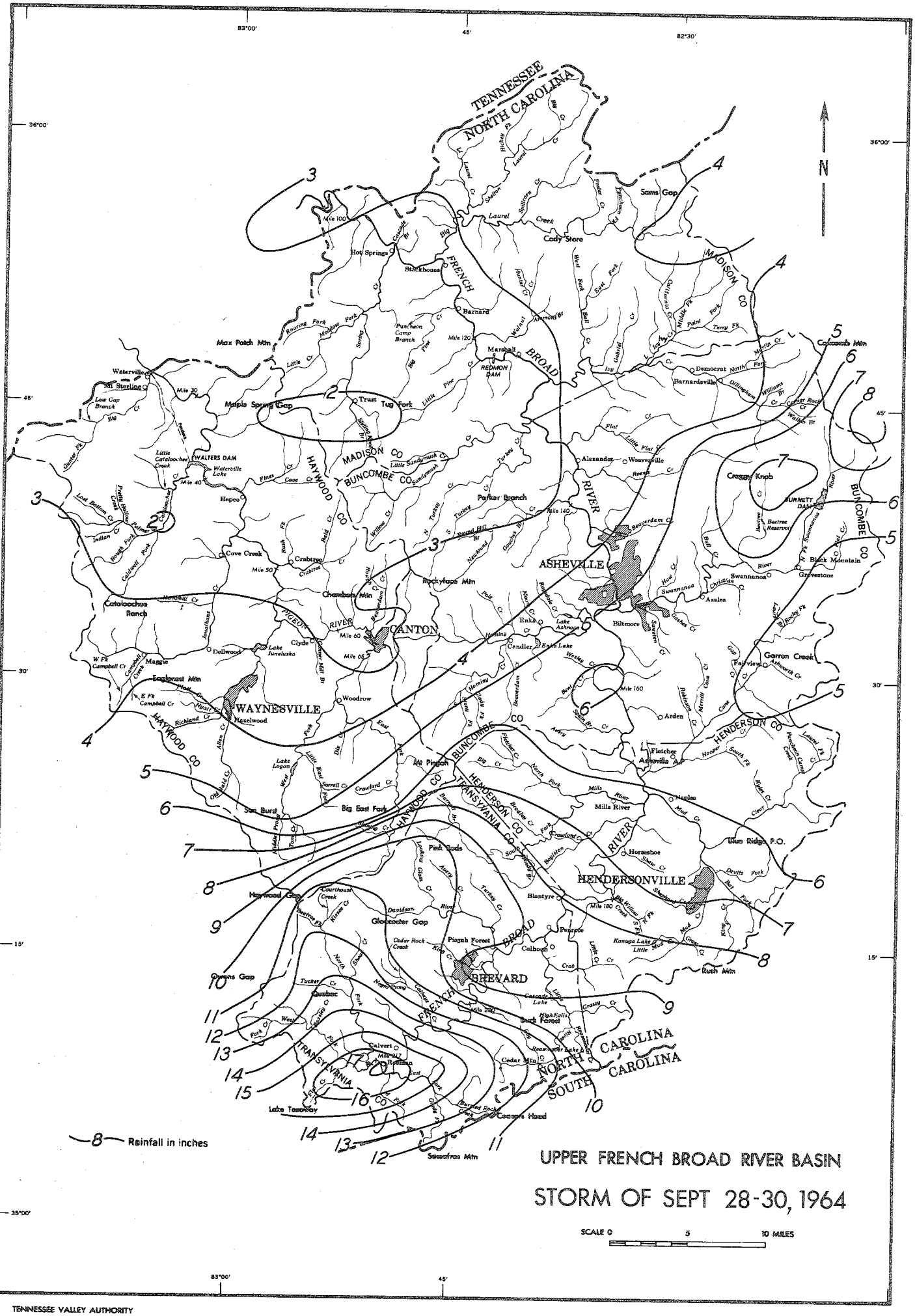
September 29 and October 4, 1964

Two storms in a period of seven days over the headwaters of the French Broad River produced floods which were the most damaging experienced in the upper portion of the river basin since July 1916.

The first storm, on September 28-30, coming after several weeks of dry weather, was most severe near Rosman, at the head of the river and over the forks of the French Broad River which converge near that community. The resulting flood at Rosman was only a little less severe than the record flood of July 1916. A large part of the town was overflowed with damage to homes, businesses, roads, and bridges. Downstream from Rosman the flood crest dropped off in relation to the great 1916 flood, but was still sufficient to cause wide overflow of agricultural lands in Transylvania and Henderson Counties. At and below Asheville the river remained within its banks.

Tributary streams fell rapidly after the first flood and were mostly near normal seasonal levels when the second storm hit on October 4-5; but in the reach of the French Broad River in Transylvania and Henderson Counties, where the river channel gradient is very flat, the stream was within its banks but still quite high. In this storm the rainfall was more widely distributed and, with conditions favorable for much higher runoff, the resulting flood was more severe and more widespread than that following the first storm.

PLATE 4



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The French Broad River this time exceeded the 1916 flood through most of Rosman and was within a foot or so of the 1916 flood crest height all along its course through Transylvania County. Through Henderson and Buncombe Counties, the flood crest dropped off in relation to the 1916 flood. At Asheville it was 12 feet under the 1916 crest height but a little above the height of the flood of August 30, 1940, the last serious flood to hit the city. The flood was serious on many of the tributaries as well as on the main stream.

The isohyetal map on Plate 4 shows the distribution of the rainfall over the upper French Broad River basin during the period September 28-30. This storm caused flood stages on most of the streams above Asheville and in addition thoroughly soaked the ground in advance of the equally intense storm of October 4-5. Several supplemental rainfall catches were obtained in the vicinity of Rosman following the storm of September 28-30. Acceptable catches ranged from 12 to 15 inches. These data were used to supplement rainfall station network records in developing the isohyetal map.

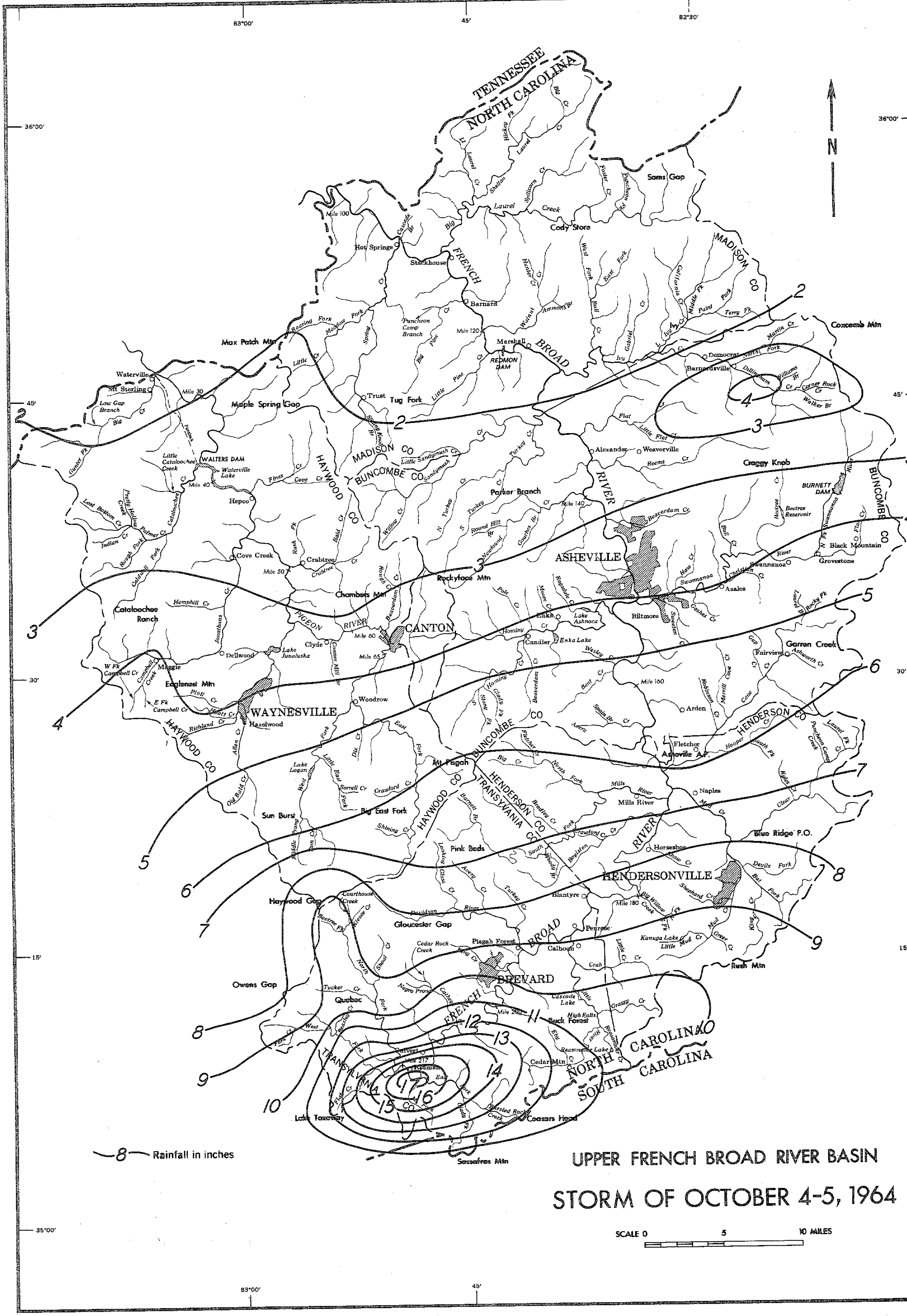
The heaviest precipitation occurred upstream from Brevard, where rainfall in excess of 10 inches was reported at several stations. The highest rainfall reported was 17.24 inches at Rosman. Downstream from Brevard the rainfall decreased gradually and averaged about 2 to 3 inches along the Tennessee-North Carolina state line. Heavy rains began to fall at all stations in the basin around 8 to 10 p.m. on September 28. In the period of some 60 hours up to observation time on the morning of October 1, the rainfall averaged 7.6 inches over the French Broad River basin above Asheville, an area of 945 square miles.

Light showers occurred between observation time on the morning of October 1 and the beginning of the intense storm of October 4-5. The average rainfall over the basin above Asheville during this $2\frac{1}{2}$-day period was 0.3 inch. These light showers served to keep the ground wet prior to the October 4-5 storm.

The isohyetal map on Plate 5 shows the rainfall distribution over the upper French Broad River basin for the storm of October 4-5. This storm produced crest stages higher than those resulting from the earlier storm of September 28-30.

The October 4-5 storm, like the storm of September 28-30, produced the heaviest rainfall over the area above Brevard. Several stations reported amounts in excess of 10 inches, the Rosman station again reporting the maximum storm total, 17.53 inches. The isohyetals for the September 28-30 and October 4-5 storms are

PLATE 5



UPPER FRENCH BROAD RIVER BASIN

STORM OF OCTOBER 4-5, 1964

TENNESSEE VALLEY AUTHORITY
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surprisingly similar in configuration. As with the September 28-30 storm, the rainfall during the October 4-5 storm decreased gradually downstream from Brevard and averaged about 1.5 inches along the Tennessee-North Carolina state line. Intense rain began to fall at all stations in the area at 11 or 12 p.m. on October 3, and up to observation time on October 5 an average of 7.2 inches had fallen over the basin above Asheville. The total rainfall at Rosman for the period September 28-October 5 was 35.4 inches which, as far as available known records are concerned, is an all-time maximum for an 8-day period in the Tennessee Valley.

During the night of September 28-29, rainfall which was near 4 inches caused a rise in the French Broad River at Rosman that crested about one foot over the bankfull stage in the early morning hours. The river had receded about 2 feet when an intense storm that dumped another 4 inches of rain in a short period of time caused a rise in the river which many of the residents of Rosman stated was the fastest they had ever seen. The river reached bankfull stage of 8 feet at 2 p.m. and was at its crest of 13.31 feet two hours later. With the peak stage just 0.6 foot lower than the great flood of July 1916, much of the town was flooded. The river fell almost as fast as it had risen, and the stream was back within its banks at Rosman before midnight.

Traffic was halted when water overflowed U. S. Highway 178 in Rosman and on the right-bank flood plain downstream from the town. Two bents were washed out at the Southern Railway trestle which crosses the river in Rosman, and water was over the tracks on the left bank in the lower part of town. Floodwaters flowed down the street which parallels the left bank of the river, entering 20 homes and businesses and surrounding some 37 other buildings. The water rose so rapidly that people had little time to move furniture or carpets out of the flood's reach or even to get automobiles out of the flood area. Depth of flooding in homes ranged up to 1.3 feet. The two homes with basements were flooded, with heavy damage to furnaces, utilities, and freezer-stored food.

At a number of buildings the flood damage was reduced by keeping doors tightly blocked against the flood. At a grocery store water was nearly a foot deep outside the store but was held to about half that depth on the inside. At a church parsonage and at one other home, tightly sealed doors kept water out although water rose above the floor levels outside. There was damage to gardens, lawns, and shrubbery, but losses of this kind were not great.

Red Cross and rescue squad personnel were on duty during the flood, using boats and high-wheeled vehicles to evacuate people and assist stranded motorists.

Above Rosman, on North and West Forks of French Broad River and on their tributaries, water was over secondary roads and flooded the narrow bottom lands. There was a minimum effect, however, upon traffic on U. S. Highway 64 and on the road connecting Rosman with the North Fork and Balsam Grove communities.

There was widespread overflow of the agricultural lands along French Broad River in Transylvania and Henderson Counties between Rosman and the head of Buck Shoals. Some farm crops had been gathered, but harvesting of grain corn and silage corn had just started to make progress when the overflow began. The truck crop operations also were mostly finished for the year, but there were a number of places where some of these high-value crops were still in the fields. Likewise, the picking of gladioli flowers was about completed for the season, and most of the flower producers had begun harvesting the flower bulbs when the heavy rains on September 28-29 stopped work in the fields. The overflow covered flowers still in the fields and bulbs still in the ground, and in a few instances washed away crated bulbs which were stacked in the field ready for hauling to storage houses.

All tributary streams had receded rapidly in the four days following the flood crest on September 29 and were not much above normal levels when the second storm began on Saturday, October 3. The French Broad River in its upper reaches was also back to near-normal stages, and the residents of Rosman had about recovered from the effect of the flood on Tuesday. Homes had been cleaned up, basements had been pumped out, and much of the damaged equipment had been repaired. Streets had been cleared and there was little evidence of the flood left when a hard rain began shortly before midnight. By noon on Sunday the rain at Rosman amounted to about 10 inches. Rain continued at a lesser rate until Monday morning. The river, at a 3-foot stage Saturday night, began a steady rise with the beginning of heavy rain. Bankfull stage of 8.00 feet was reached at 7:00 a.m. Sunday, and a crest of 14.95 feet occurred at 1:45 p.m. This was 1.6 feet higher than the first flood and one foot higher than the 1916 flood at the gage. The river remained above bankfull stage until 5:00 a.m. on Monday.

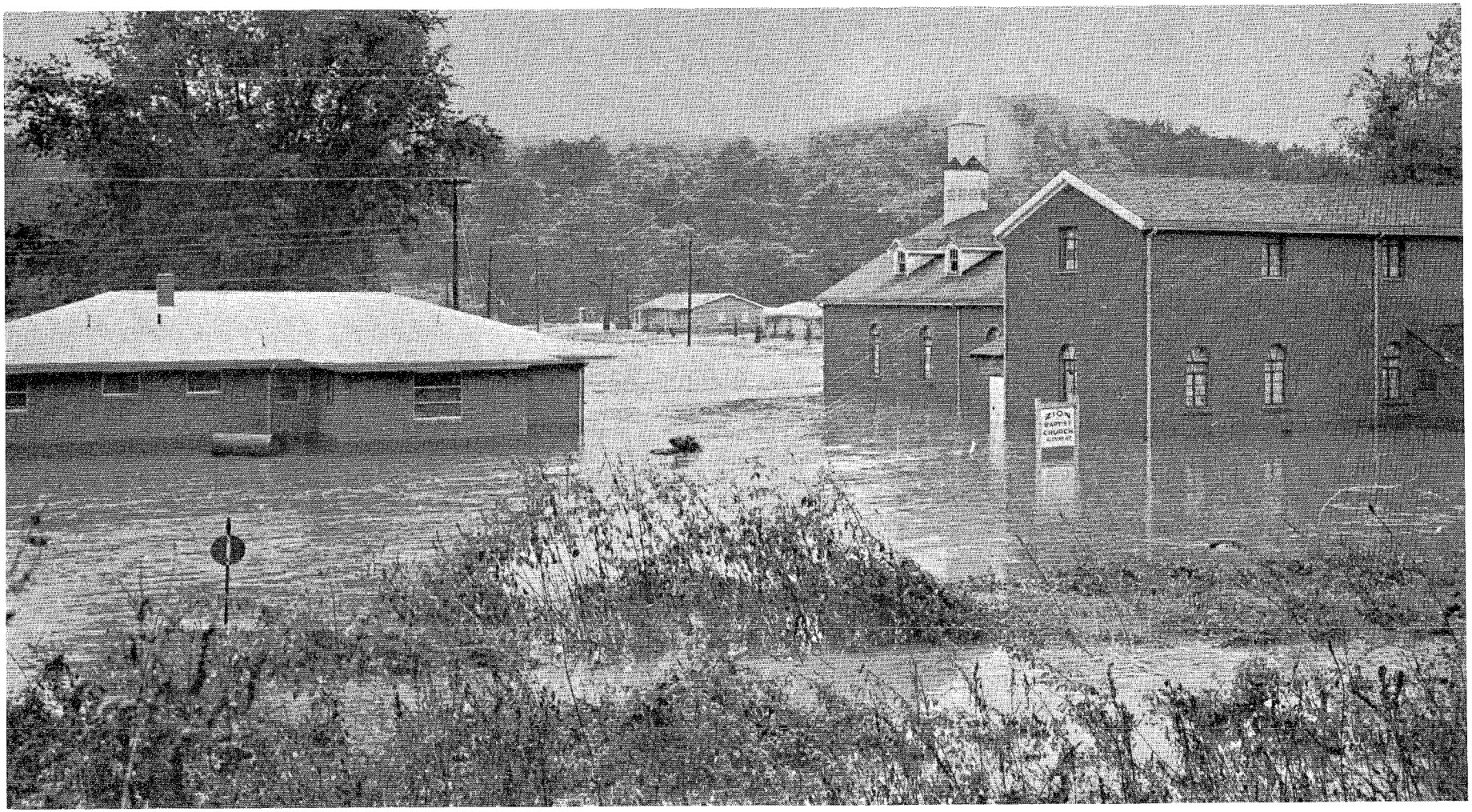

Figure 7.--FLOOD OF SEPTEMBER 29, 1964, ON FRENCH BROAD RIVER AT ROSMAN

Floodwaters invaded this area of brick buildings twice in a week. The high-water mark of September 29 can be seen on the bricks more than a foot above the current water level. Water was 0.3 foot deep on the lower floor of the church, but tight-fitting doors kept the water out of the adjoining parsonage. On October 4, water reached a depth of 1.5 feet in both buildings. In the background are two 2-unit apartment houses. The floor of the farther one, nearest to the river at Mile 216.3, was above the September flood but 0.3 foot below the October flood. The nearer apartment was flooded to depths of 0.8 foot in September and 2.2 feet in October.

(Photo by Asheville Citizen-Times)

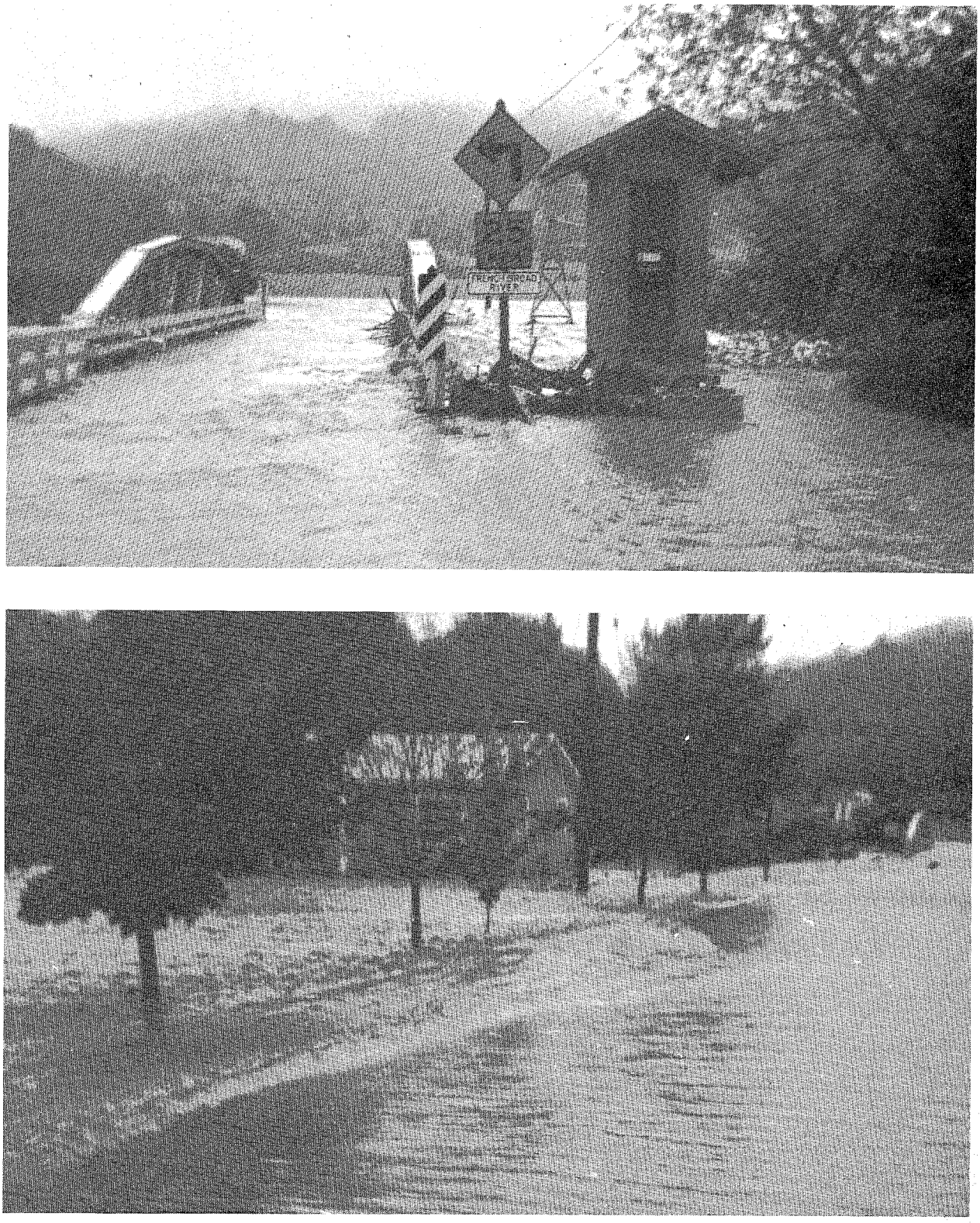

Figure 8.--OCTOBER 4, 1964, FLOOD ON U. S. HIGHWAY 178, ROSMAN

Upper view shows bridge over the French Broad River and the U. S. Geological Survey stream gage on upstream side of the bridge. The stage had fallen about 0.2 foot below crest when the picture was taken. Lower view is southwest along the highway on left bank, looking toward the bridge at right, a few minutes after the crest. The water had reached to approximately an inch below the floor of the house.

All the homes and businesses that had been flooded on the previous Tuesday were again flooded on Sunday, this time to greater depths. U. S. Highway 178 was flooded and made impassable for a greater distance. More of the Southern Railway tracks in the town were put under water, and two additional bents were damaged at the trestle in Rosman, although the suspended tracks did not wash out.

This time 37 homes or apartments and 2 mobile homes were flooded, with depths ranging up to 3.3 feet. A few people managed to raise furniture above flood levels, but many had heavy damage to furniture, clothing, books, carpets, and other personal items. Several families had worked hard following the first flood to clean and wax their hardwood floors and it appeared that there would be little permanent damage, but the second flood, with its greater depth and longer duration, caused extensive damage to all floors that were flooded. A church and its adjoining parsonage had heavy damage to floors and furnishings. There was additional damage to businesses affected in the first flood and appreciable damage at a restaurant and a grocery which had not been flooded before. The water surrounded, but did not enter, some 20 other homes and businesses. A large hole was scoured out at a street intersection in the lower part of town, and there was other damage to streets and driveways.

The greatest damage at Rosman occurred at the Gloucester Lumber Company, located on the right bank of the French Broad River in the upper end of town. Floodwaters poured through the plant area where thousands of board-feet of hardwood lumber was stacked. A large amount of lumber was washed away, and much of the remaining lumber was stained by the floodwaters and had to be down-graded. At a power substation downstream from the lumber firm, floodwaters did not reach the electrical equipment, but there was damage to the grounds and fence.

The rescue squads were again active in the flood area and worked long hours assisting the flood victims and directing traffic. The Red Cross and the Salvation Army assisted in providing shelter and giving aid to the affected families.

Upstream from Rosman the North and West Forks of the French Broad River rose to great heights, flooding highways and damaging bridges. Several slides occurred, blocking or partially blocking highways. One large

slide on the highway which follows North Fork blocked the road for several days, and residents of the Balsam Grove community and workers at the Rosman Data Acquisition Facility of NASA had to make long detours.

The Mitchell-Bissell Company, manufacturers of formed wire fabrications for the textile industry and located on West Fork French Broad River about one mile above its mouth, had water to a 3-inch depth in their building. Water outside the plant building rose one foot above floor level, and damage would have been much greater if water in the plant had reached that depth. Drift and debris partially blocked a concrete culvert which carries West Fork under U. S. Highway 64 just upstream from the plant, and floodwater poured over the highway over a length of 500 feet and flowed into the plant area. Downstream from the plant a section of the highway was undercut, and an underground telephone cable was broken. Farther downstream a small sawmill was flooded, and a building containing a grocery store and cafe was undermined and toppled into the river. Near the confluence of the West and North Forks, another small sawmill was damaged by the floodwater.

The October 4 floods were severe also on Middle Fork and East Fork of French Broad River. On Middle Fork a culvert under U. S. Highway 178 was partially blocked, and water flowed over the road. Traffic was affected by the washing and scour on secondary roads and by the washing out or damaging of bridges. Traffic between Rosman and the communities in the East Fork watershed was disrupted for most of a week when the East Fork Road was severely scoured by the high-velocity overflow.

Direct comparison of the floods of September and October with the large floods of the past is difficult for the tributaries in the headwater area near Rosman. This is due in part to a scarcity of information on past floods on streams and in part to changes which have been wrought by gravel removal operations or highway work along the streams. Both floods were large on the two forks above Rosman, North Fork and West Fork, where they may well have exceeded the large floods of 1940 and 1916. On Middle and East Forks, the October floods were much larger than the floods on September 29, but the relation to past floods is uncertain.

The floods of September and October 1964 probably rate as the most damaging in the upper French Broad River basin since 1916. Total damage from the floods was estimated to be in excess of $1,800,000, of which slightly more than one-third was agricultural loss. Highway damage in Transylvania County,

Figure 9.--OCTOBER 4, 1964, FLOOD ALONG SOUTHERN RAILWAY IN ROSMAN

The view is downstream along the tracks from U. S. Highway 178, about 500 feet from the left bank of the French Broad River. At the crest of the flood, which occurred about one-half hour earlier, water had been 1.2 feet deep at the front of the store.

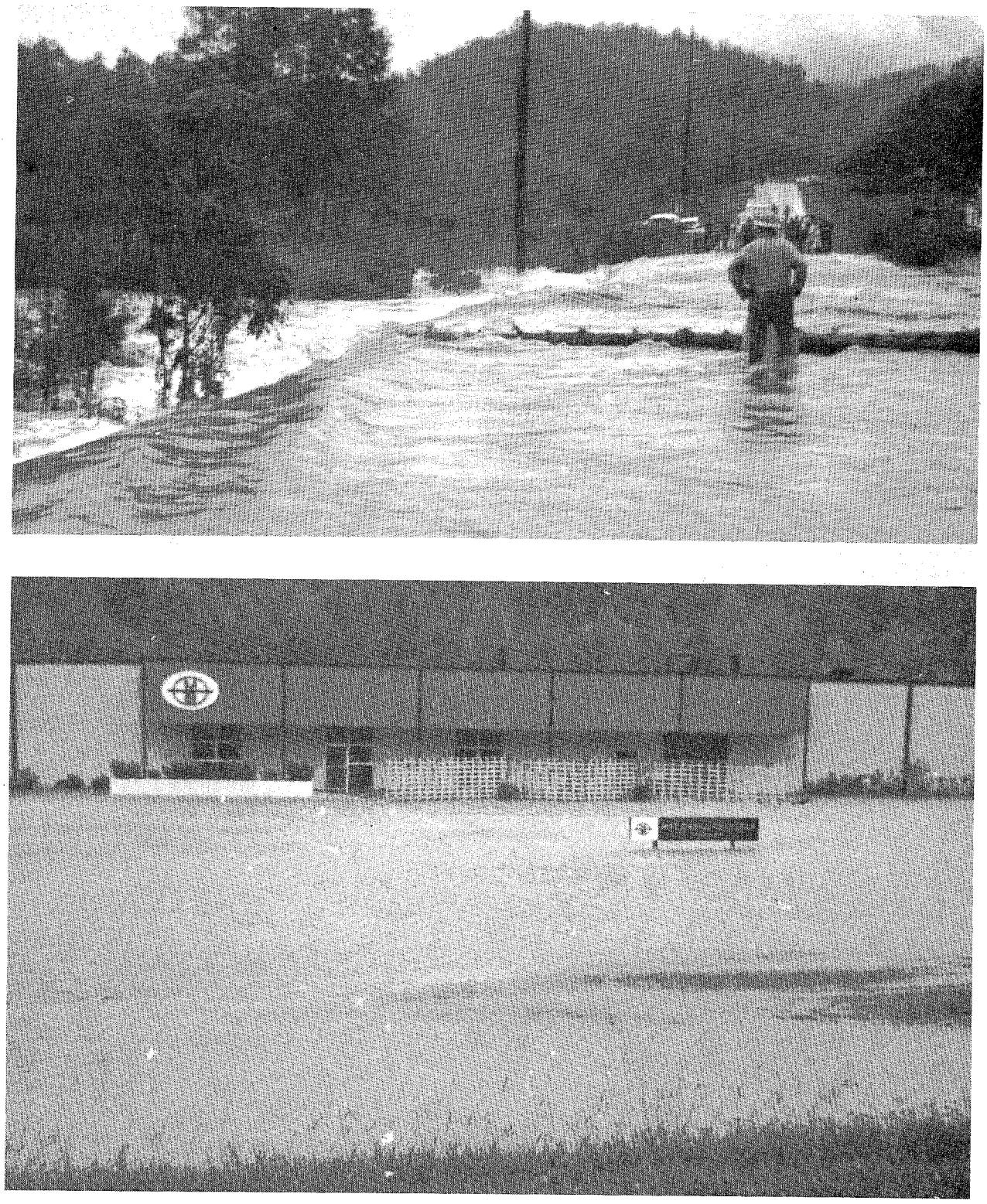

Figure 10.--OCTOBER 4, 1964, FLOOD ON WEST FORK FRENCH BROAD RIVER

Upper view is west along U. S. Highway 64 at the bridge. Flooding of the highway was due partially to a large amount of drift, which almost blocked the bridge opening and resulted in a heading up of more than 5 feet. Lower view is downstream from the highway just east of the bridge. The West Fork flows from right to left at the foot of the wooded slope about 300 feet behind the building. At the flood crest, water was about 1 foot deep outside the plant but only 3 inches deep inside.

including damage to bridges, exceeded $60,000. Industrial, commercial, residential, and other damage in the immediate vicinity of Rosman was estimated to be about $120,000.

Profiles for the flood of October 1964 are shown on Plates 9 and 12, and the areas inundated by that flood are shown on Plates 7, 8, and 11. Figures 7 to 10 are photographs taken in the vicinity of Rosman during the September and October floods.

February 13, 1966

Six to eight inches of rain falling on ground which was already saturated from rain and melting snow resulted in floods on French Broad River and its tributaries. At Rosman the river reached a crest of 12.50 feet at 9:00 a.m. on February 13, 2.45 feet lower than the crest stage on October 4, 1964. A number of houses were flooded to shallow depths, and many others had basements flooded or were surrounded by the water.

October 11, 1970

Intense thunderstorm activity on the night of October 10-11, 1970, produced floods on a number of streams in Transylvania County. At Rosman 7.60 inches of rain fell in a 3-hour period beginning at 10:00 p.m. on October 10, with 10.63 inches recorded for the 24-hour period ending at 8:00 a.m. on October 11.

Rainfall over the North and West Forks averaged about 6 inches, and only minor flooding occurred along those streams. On the French Broad River at Rosman, the river crested at a stage of 10.61, 4.3 feet lower than the October 1964 crest. Rainfall over the Middle and East Forks was considerably greater, with a high measurement of 14.3 inches in the Middle Fork watershed. The crest stage on these two streams was almost as high as that of October 1964, and at the former gage on French Broad River at Calvert located downstream from Middle and East Forks, the crest stage of 10.31 feet was just 1.4 feet lower than the October 1964 flood. Profiles for the flood were developed for the river reaches covered by this investigation and are shown on Plates 9 and 12.

The total damage from this flood was estimated to be about $60,000. The principal damage was to roads, bridges, and farm property, such as fences,

ditches, field roads, and land. The damage to crops was relatively light, far less than that experienced during several floods in the previous 10 years. This was due in part to crops having been largely harvested prior to the flood, but also because truck crop and flower producers have planted less in the lands subject to overflow to avoid losses such as they suffered in 1961, 1964, and 1967.

2. EAST AND MIDDLE FORKS FRENCH BROAD RIVER

Flood Records

Except for scattered discharge measurements, usually made during periods of low flow, there are no records of stages and discharges on either East or Middle Forks of French Broad River. Immediately after the floods of September and October 1964, TVA engineers made an investigation of the floods on the two streams; and in connection with this report, high-water marks were obtained after the flood of October 11, 1970, and detailed profiles were developed through the reaches included in the report.

Flood Occurrences

The investigation indicates that major floods have occurred with about the same frequency on East and Middle Forks as on French Broad River. The relative magnitude of floods is about the same on East and Middle Forks, but they are not the same as on French Broad River.

Duration and Rate of Rise

Streams such as East and Middle Forks of French Broad River with small watersheds and steep slopes experience floods that are characterized by very rapid rates of rise and short duration.

Velocities

Along East Fork French Broad River in the reach investigated, velocities in the channel during floods such as that of October 4, 1964, would range up to 12 feet per second, and in the overbank areas velocities would range up to 2 feet per second. Channel velocities along Middle Fork French Broad River during floods such as that of October 1964 would range up to 14 feet per second, and overbank velocities would range up to 4 feet per second. During larger floods on either stream, velocities would be greater.

Flooded Areas, Flood Profiles, and Cross Sections

Plate 7 shows the approximate area along Middle Fork and Plate 11 shows the approximate area along East Fork that was inundated by the flood of October 4, 1964, and that would be inundated by the Maximum Probable Flood. The actual limits of the overflow area on the ground may vary somewhat from that shown on the maps because the contour interval of the maps does not permit precise plotting of flooded area boundaries. The contour interval on Plates 7 and 11 is 40 feet.

Plate 9 shows the high water profiles on Middle Fork French Broad River for the floods of October 4, 1964, and October 11, 1970. Also shown are the profiles for the Regional and Maximum Probable Floods, which are discussed in Sections V and VI of this report. Plate 12 shows the profiles for the same floods on East Fork French Broad River.

Plate 10 shows typical cross sections of Middle Fork French Broad River, and Plate 13 shows typical cross sections of East Fork French Broad River, in the reaches investigated. The locations of the sections are shown on the maps, Plates 7 and 11, and the profiles, Plates 9 and 12. Each cross section shows the elevation and extent of overflow of the October 1964 flood and the Regional and Maximum Probable Floods.

Flood Descriptions

Descriptions of the large floods on East and Middle Forks French Broad River are included with the discussion of past floods on French Broad River.

3. NORTH AND WEST FORKS FRENCH BROAD RIVER

Flood Records

Records of stream stages and discharges have not been maintained on either North or West Fork French Broad River, and few references to floods on the two streams are found in newspaper accounts of floods in the vicinity of Rosman. High-water marks were located in the field immediately after the floods of September and October 1964, and detailed profiles were developed following the flood of October 11, 1970.

Flood Occurrences

The investigation indicates that major floods have occurred with about the same frequency on North and West Forks as on French Broad River. The relative magnitude of floods on North Fork is about the same as on West Fork, and on both streams the order of magnitude is about the same as on the French Broad River at Rosman. Because of variations in storm rainfall, the order of magnitude of floods on North and West Forks may vary considerably from the order of magnitude of floods on East and Middle Forks and on French Broad River downstream from the mouth of East Fork.

Duration and Rate of Rise

Streams such as North and West Forks French Broad River, like East and Middle Forks, experience floods that are characterized by rapid rates of rise and short duration.

Velocities

Along North Fork French Broad River in the reach investigated, velocities in the channel during floods such as that of October 1964 would range up to 9 feet per second, and in the overbank areas velocities would be as high as 2 feet per second. Velocities along West Fork French Broad River during a flood such as that of October 1964 would also range up to 9 feet per second in the channel and 2 feet per second in the overbank areas. During larger floods, velocities would be greater on both streams.

Flooded Areas, Flood Profiles, and Cross Sections

Plate 11 shows the approximate areas along North and West Forks that were inundated by the flood of October 4, 1964, and that would be inundated by the Maximum Probable Flood. The actual limits of the overflow area on the ground may vary somewhat from those shown on the map because the contour interval of the map does not permit precise plotting of the flooded area boundaries. The contour interval on Plate 11 is 40 feet.

Plate 12 shows the high water profiles on North and West Forks for the floods of October 4, 1964, and October 11, 1970. Also shown are the profiles for the Regional and Maximum Probable Floods, which are discussed in Sections V and VI of this report.

Plate 13 shows typical cross sections of North and West Forks French Broad River in the reaches investigated. The locations of the sections are shown on the map, Plate 11, and the profiles, Plate 12. Each cross section shows the elevation and extent of overflow of the October 1964 flood and the Regional and Maximum Probable Floods.

Flood Descriptions

Descriptions of the large floods on North and West Forks French Broad River are included with the discussion of past floods on French Broad River.

V.

REGIONAL FLOODS

V.

REGIONAL FLOODS[1]

This section of the report relates particularly to floods on streams whose watersheds are comparable with those of the upper French Broad River and its tributaries.

Large floods have been experienced in the past on streams in the general geographical and physiographical region of Rosman, North Carolina. Storms similar to those causing floods on neighboring streams could occur over the upper French Broad River watershed and cause similar floods. Floods of this size are designated as Regional Floods. It is therefore desirable, in connection with any determination of future floods which may occur on the upper French Broad River and its East Fork, Middle Fork, North Fork, and West Fork, to consider floods that have occurred in the region on watersheds with similar topography, watershed cover, and physical characteristics.

Maximum Known Floods in the Region

Storm rainfall over watersheds in the Southern Appalachian Mountains, including the upper French Broad River watershed, is influenced considerably by the topography of the region. This is true of the occasional tropical hurricanes as well as the large cyclonic storms more typical of the winter months. Moist air moving northward and westward from the Gulf and Atlantic Coasts is forced upward by the gradually sloping ground rising to the crest of the Tennessee Valley Divide. As a result, the easterly slopes of the Divide and the area immediately beyond the crest within the Valley are subject to heavy orographic rainfall. The distribution of this rainfall, however, is different over the watersheds to the east and south of the Tennessee Valley Divide than over the watersheds within the Valley. On the coastward slopes, the heavy precipitation that results when the moist air is lifted over the mountains is widespread, covering entire river basins. Within the Tennessee Valley, the heavy precipitation is confined largely to a narrow band along the top and immediately beyond the Divide. Within the French Broad River basin, additional heavy rains are induced by the mile-high Pisgah Ridge, which

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1. Prepared by Hydraulic Data Branch.

TABLE 11

MAXIMUM KNOWN FLOOD DISCHARGES ON STREAMS

IN THE REGION OF ROSMAN, NORTH CAROLINA

No.	Stream	Location	Drainage Area sq. mi.	Date	Peak Discharge Amount cfs	Peak Discharge Per Sq. Mi. cfs
1	Cane River	nr Sioux, N. C.	157	August 13, 1940	31,800	203
2	Tuckasegee River	at Tuckasegee, N. C.	143	August 30, 1940	40,800	285
3	Pigeon River	at Canton, N. C.	133	August 30, 1940	31,600	238
4	Swannanoa River	at Biltmore, N. C.	130	April 1791	40,000	308
5	Mud Creek	at Naples, N. C.	109	July 1916	40,000	367
6	French Broad River	at Calvert, N. C.	103	August 15, 1928	16,100	156
7	Sandymush Creek	nr Alexander, N. C.	79.5	August 30, 1940	20,000	252
8	French Broad River	at Rosman, N. C.	67.9	October 4, 1964	13,500	199
9	Cane Creek	nr Fletcher, N. C.	63.1	July 16, 1916	23,000	366
10	Clear Creek	nr Hendersonville, N. C.	44.6	July 16, 1916	20,600	462
11	Caney Fork	above Cowarts, N. C.	39.4	August 30, 1940	21,700	551
12	North Fork French Broad River	nr Rosman, N. C.	37.0	October 4, 1964	6,120	165
13	West Fork Pigeon River	at Lake Logan Dam, N. C.	32.8	August 30, 1940	14,900	454
14	Hominy Creek	above Candler, N. C.	28.9	August 30, 1940	12,400	429
15	North Fork Swannanoa River	nr Black Mountain, N. C.	23.8	June 16, 1949	16,500	693
16	Wolf Creek	nr Tuckasegee, N. C.	14.1	August 30, 1940	14,500	1,030
17	Middle Prong, West Fork Pigeon River	above Spruce, nr Waynesville, N. C.	8.4	August 30, 1940	16,400	1,950
18	Right Fork Swannanoa River	nr Black Mountain, N. C.	5.1	June 16, 1949	4,500	882
19	Pilkey Creek	nr Fontana Reservoir, N. C.	3.87	July 5, 1943	4,520	1,170
20	Holcomb Branch	nr Ivy, N. C.	2.41	June 2, 1937	3,400	1,400
21	Alum Cave Creek	nr mouth, Sevier Co., Tenn.	1.95	September 1, 1951	5,800	2,970

forms the western boundary of that basin. Because of the differences in the distribution of rainfall during large storms, floods occurring on watersheds lying to the south and east of the Tennessee Valley Divide have not been considered in the determination of Regional Floods on the upper French Broad and its tributaries.

Table 11 lists the maximum known floods experienced on watersheds comparable with those of the upper French Broad River and within about 60 miles of Rosman. Included in the list are floods caused by the storms of July 1916, August 1940, June 1949, and September-October 1964.

The storm of July 15-16, 1916, was the second of two tropical hurricanes that moved inland over the southeastern part of the United States during July 1916. The first hurricane dissipated over southern Alabama but brought sufficient rainfall to western North Carolina on July 8-10 to saturate the ground. The second hurricane that followed brought heavy rainfall along the Blue Ridge Mountain Divide between the Atlantic and Tennessee River drainage. At Altapass, North Carolina, about 37 miles northeast of Asheville, 22.2 inches of rainfall were recorded in a 24-hour period, the greatest 24-hour amount ever recorded within the Tennessee Valley. Devastating floods resulted on the upper French Broad River and its headwater tributaries from an estimated 16 to 18 inches of rain that fell on the watersheds of some tributaries.

In August 1940, two severe storms caused extensive flooding in the Rosman region. The first storm in mid-August originated as a tropical hurricane and dropped heavy rainfall along the eastern Tennessee Valley Divide from the Hiwassee River basin northeast to the Watauga River headwaters. High rainfall centers of 14 to 16 inches were experienced in the Tuckasegee River watershed. In the upper French Broad region, rainfall varied from 12 inches along the southern and western rims of the basin to about 10 inches along the eastern rim. Extensive flooding occurred throughout the area, but in the Rosman region, flood discharges were generally lower than those of July 1916. This same area was again deluged by heavy rains about two weeks later on August 29-30. Unlike the first storm, the second one resulted from thunderstorm activity rather than a hurricane and lasted approximately one day. The heaviest rain fell over the headwaters of the Tuckasegee River and averaged more than 10 inches on some of the tributaries. Record flooding occurred along the upper Tuckasegee River and its tributaries and in the Pigeon River watershed.

The June 14-16, 1949, storm was part of a widespread disturbance that produced floods of considerable magnitude throughout much of the southeastern part of the Tennessee Valley. Record or near-record flooding was experienced on the North Fork Swannanoa River at Black Mountain, North Carolina, where 8.50 inches of rainfall were recorded in 21 hours. Approximately 2.5 inches of rain had fallen during the two days prior to this intense burst of rainfall.

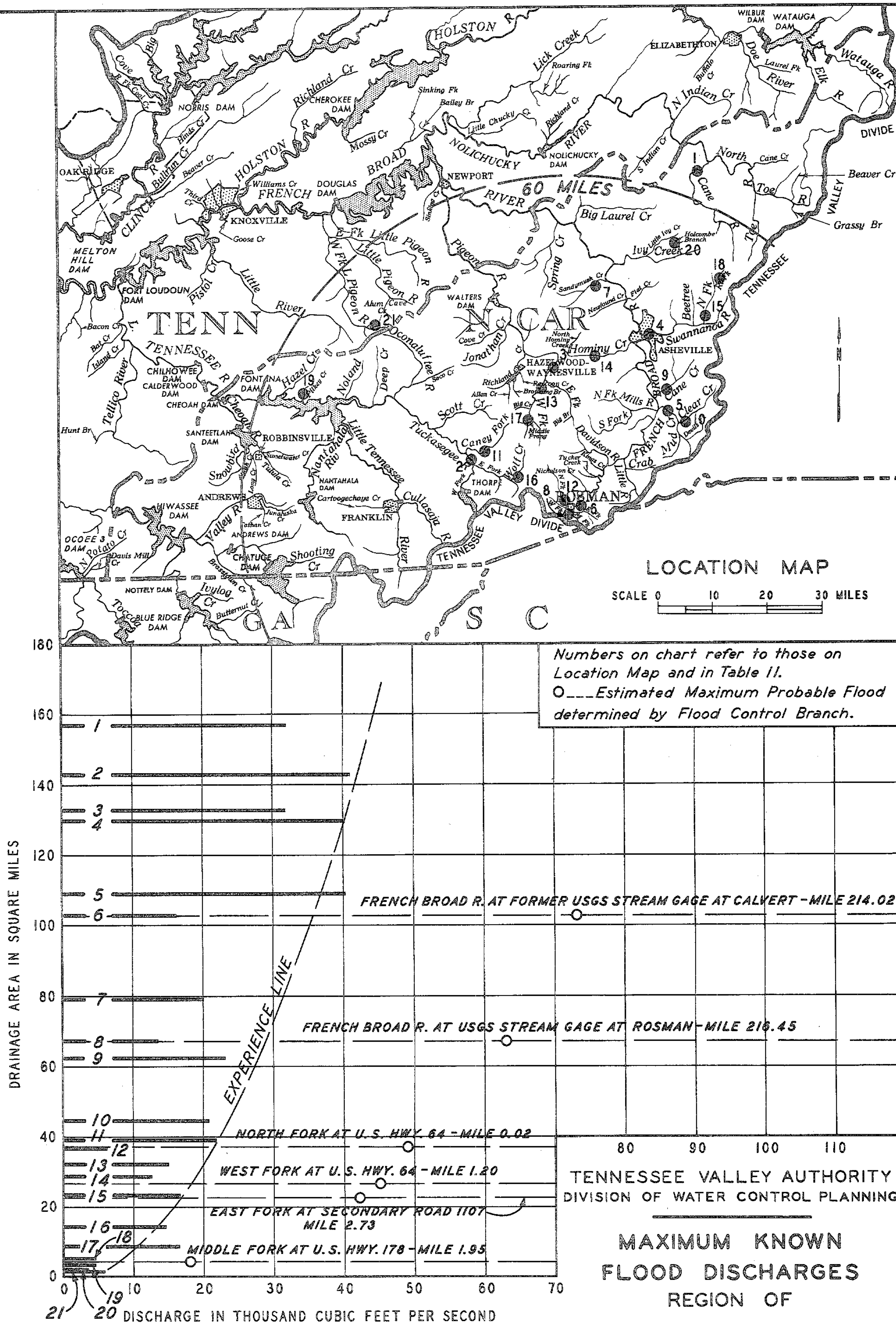
The most recent storms to produce widespread flooding in the Rosman region were the storms of September-October 1964. The first storm, that of September 28-30, brought general rains to the western North Carolina region. This storm produced only moderate flooding in the Little Tennessee and Hiwassee River basins, but in the headwaters of the French Broad River, flood stages approached those of the flood of July 1916. The maximum rainfall recorded during this storm was nearly 18 inches at Rosman. The second storm on October 4-5 was associated with the passage of a decadent hurricane which again brought heavy rainfall over the Blue Ridge Divide region of western North Carolina. Rosman was again the center of the heaviest rainfall, which again was nearly 18 inches. Record or near-record flooding was experienced on the headwaters of several streams along the Blue Ridge Divide, but the magnitude of the floods decreased rapidly as the streams traversed areas of decreasing rainfall. At Rosman and throughout most of Transylvania County, flood stages approached or exceeded those of the 1916 flood. Total rainfall at Rosman for the period September 28-October 5 was 35.4 inches, which is believed to be the maximum of record for an 8-day period in the Tennessee Valley.

All of the floods listed in Table 11 have occurred on watersheds in the region of Rosman that have similar physical characteristics. Floods of like magnitude, modified to take into account differences in drainage area characteristics, could occur in the future on the upper French Broad River and its tributaries.

Determination of Regional Floods

Plate 6 is a diagram of the discharges tabulated in Table 11 together with a map showing the locations of the discharge measurements.

The floods listed in Table 11 and shown on Plate 6 occurred from different types of storms. The July 1916 and mid-August 1940 floods resulted from decadent hurricanes, while both the late August 1940 and the June 1949 floods resulted from general thunderstorm activity with intense rainfall over a localized



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MAXIMUM KNOWN FLOOD DISCHARGES REGION OF ROSMAN, N.C.

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area. The October 1964 flood resulted from a hurricane. High stages were caused in part by the heavy rainfall from a general storm which occurred a week earlier. The upper French Broad River, along with the East Fork, Middle Fork, North Fork, and West Fork, is susceptible to flooding from each of these storm types.

With the exception of the April 1791 flood on the Swannanoa River, all of the floods listed in Table 11 have occurred within a 50-year period. This emphasizes that floods of this magnitude cannot be considered as rare events in the region and it must therefore be anticipated that such floods will occur again in the future.

TABLE 12

REGIONAL FLOOD PEAK DISCHARGES

Stream	Location	Mile above Mouth	Drainage Area sq. mi.	Discharge cfs
French Broad River	U.S. Hwy 178 at Rosman (USGS stream gage)	216.45	67.9	29,000
	Bridge at Calvert (former stream gage)	214.02	103	36,000
East Fork French Broad River	Secondary Route 1107	2.73	23.0	17,000
	Mouth	0.0	26.4	18,000
Middle Fork French Broad River	U.S. Hwy 178	1.95	4.57	7,500
	Mouth	0.0	5.67	8,300
North Fork French Broad River	Upper limit of study	2.00	34.2	20,000
	U.S. Hwy 64	0.02	37.4	21,000
West Fork French Broad River	U.S. Hwy 64	1.20	27.2	18,000
	Mouth	0.0	29.4	19,000

Based upon the maximum flood discharges experienced in the region, it is reasonable to expect future flood discharges on the upper French Broad River to be in the order of those listed in Table 12. For the purposes of this report, such floods are designated as Regional Floods.

The profiles of the Regional Floods on French Broad River and Middle Fork French Broad River are shown on Plate 9. Such a flood on French Broad River would be 2 to 6 feet higher than the October 4, 1964, flood, being about 3 feet higher in Rosman. A Regional Flood may occur on Middle Fork French Broad River in the reach investigated that would be from 2 to 5 feet higher than the October 1964 flood, averaging about 3 feet higher. The Regional Flood profile on East Fork French Broad River is shown on Plate 12. In the reach investigated on that stream, a Regional Flood may occur that would be 3 to 10 feet higher than the October 4, 1964, flood, averaging 5 feet higher. On North Fork French Broad River, a Regional Flood may occur that would average about 7 feet higher than the October 1964 flood, but which would range from 5 to 10 feet higher as shown on Plate 12. The profile of the Regional Flood on West Fork French Broad River is also shown on Plate 12. It would average about 4 feet higher than the profile for the flood of October 4, 1964, ranging from 3 to 6 feet higher. Figures 11 to 16 show the height that would be reached by the Regional Flood at several locations along the streams in the vicinity of Rosman.

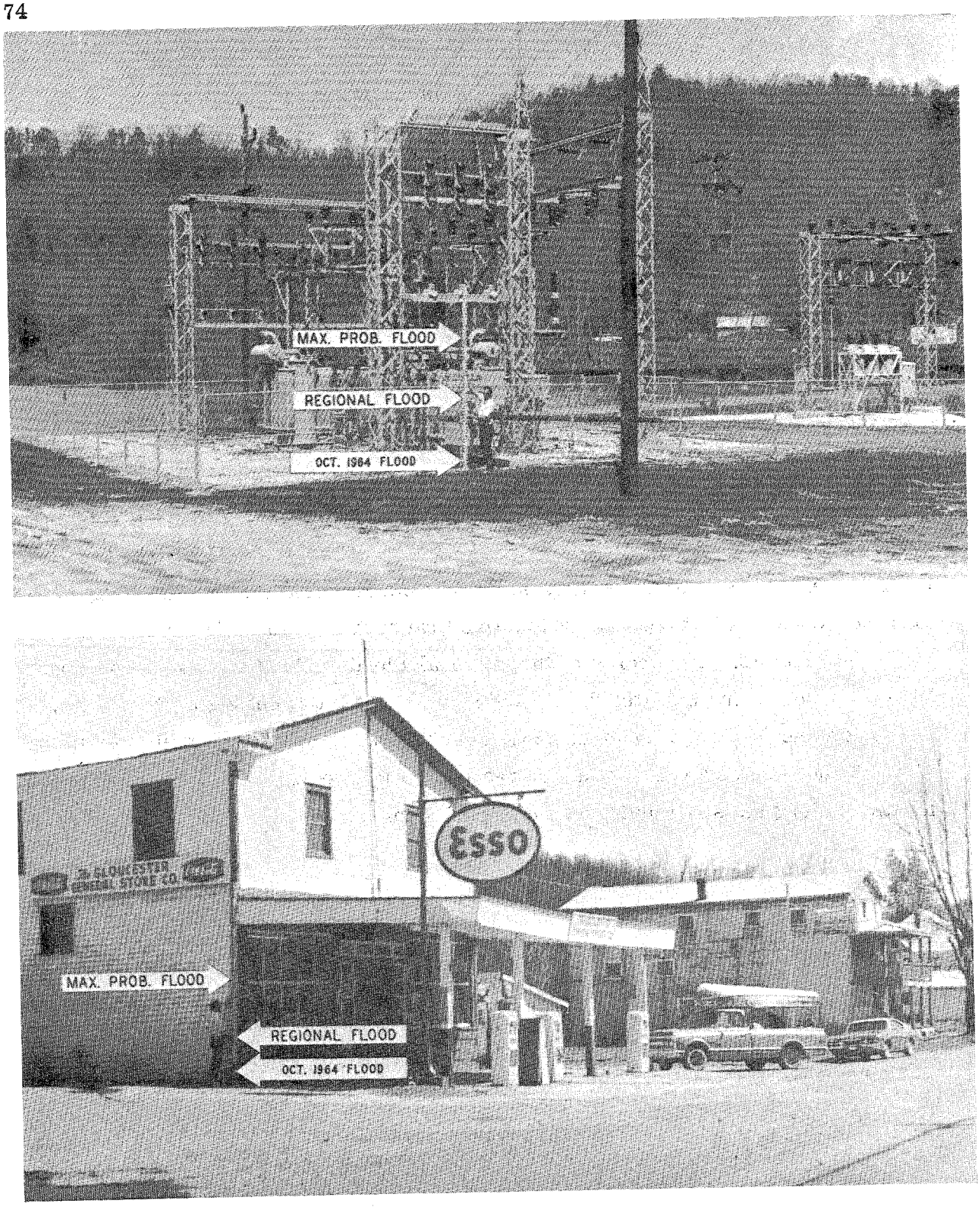

Figure 11.--FLOOD HEIGHTS AT UPPER END OF ROSMAN

Upper view shows Duke Power Company substation on right bank of the French Broad River at Mile 216.75, looking north toward the railway trestle. The October 1964 flood caused some land scour and fence damage at the station. Lower view is the Gloucester General Store on left bank at Mile 216.53. During October 1964, floodwater was about 2 feet deep in front of the store, but was 6 inches below the floor. Arrows show the heights of the October 1964 flood and the Regional and Maximum Probable Floods.

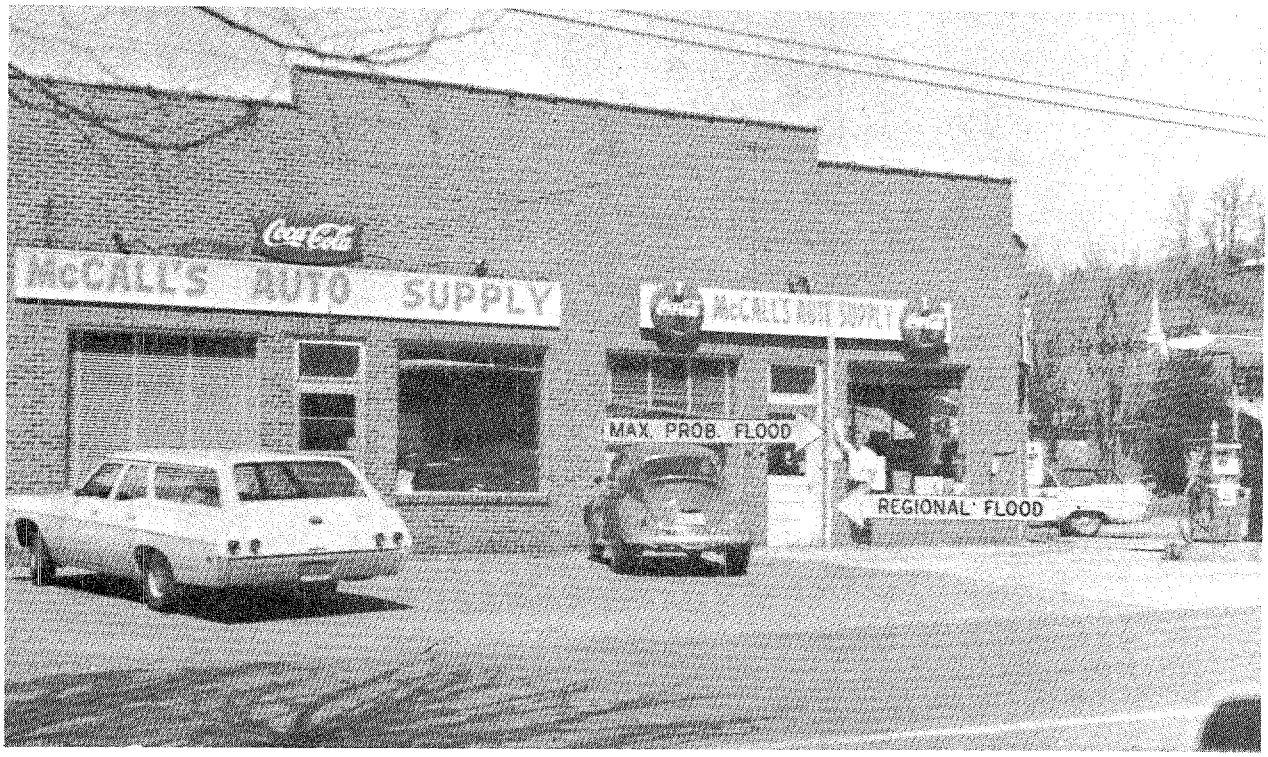

Figure 12.--FLOOD HEIGHTS ALONG U. S. HIGHWAY 178 IN ROSMAN

McCall's Auto Supply is on the upstream side of the highway. The October 1964 flood did not quite reach the building, but was about one-half foot below the floor level. The Rosman Self Service grocery store is on the downstream side of the highway, beside the Southern Railway track. A view of this store during the October 1964 flood is shown in Figure 9. Arrows show the October 1964, Regional, and Maximum Probable Flood heights.

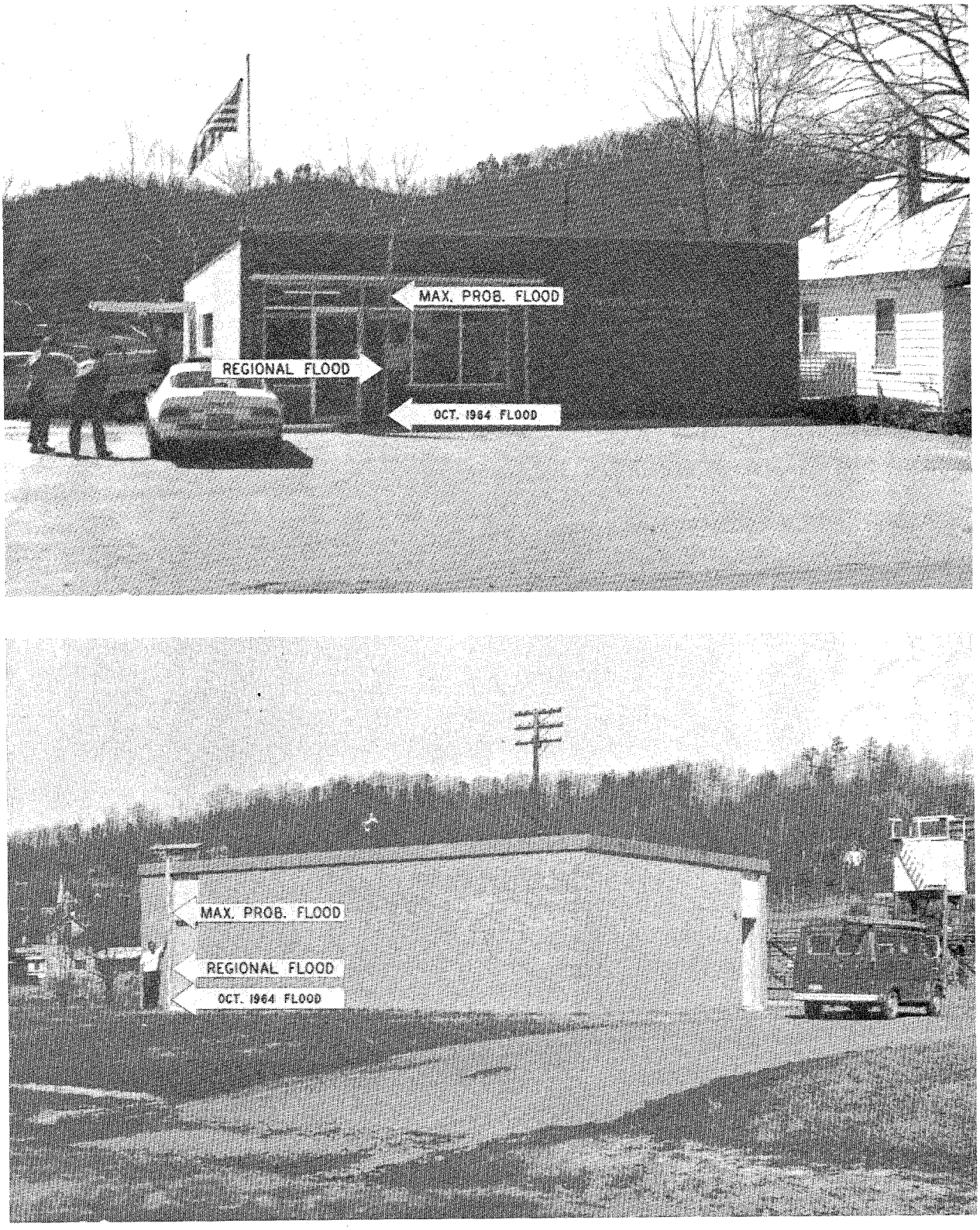

Figure 13.--FLOOD HEIGHTS ALONG MAIN STREET IN ROSMAN

Upper view shows post office on west side of street at Mile 216.42 of the French Broad River. Lower view is the Citizens Telephone Company automatic dialing exchange on east side of street at Mile 216.34. Both buildings have been constructed since the October 1964 flood. The heights of that flood and the Regional and Maximum Probable Floods are shown by arrows.

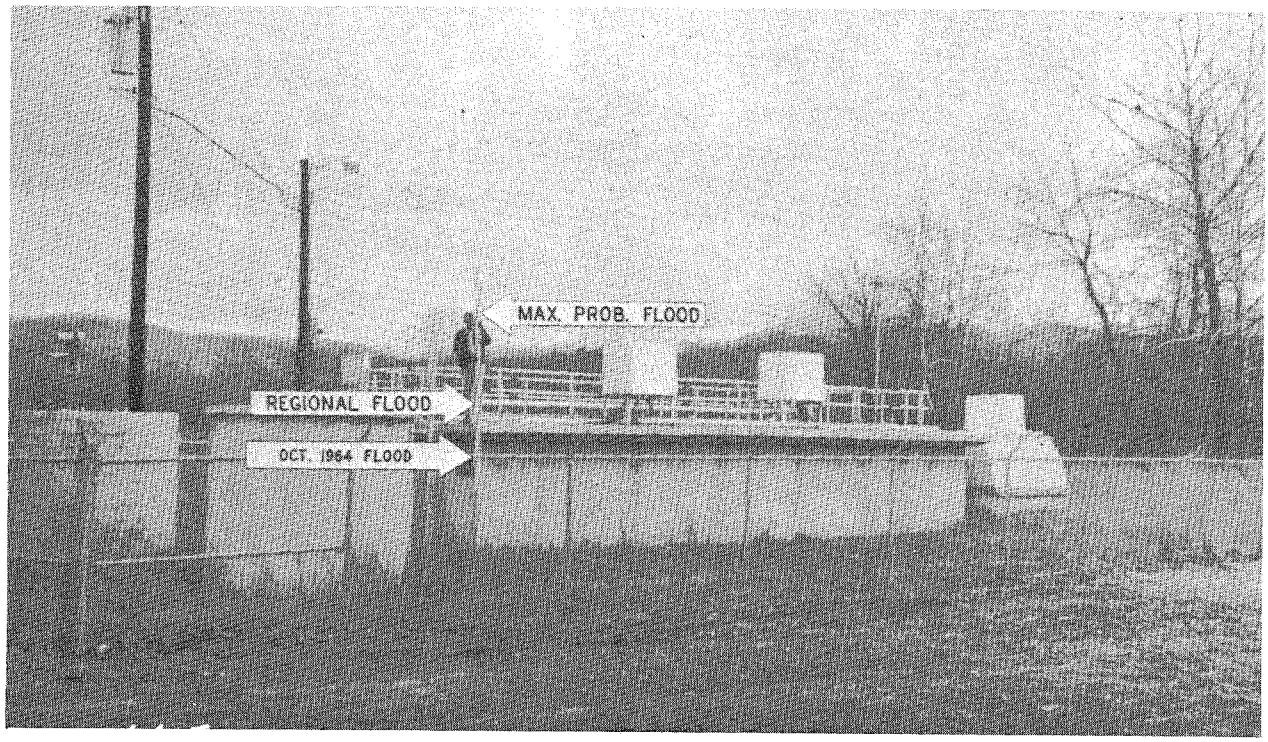

Figure 14.--FLOOD HEIGHTS AT LOWER END OF ROSMAN

The Zion Baptist Church is on Main Street at Mile 216.27 of the French Broad River. The floor slopes down from front to rear, and the lower portion was flooded by both the September and October 1964 floods (see Figure 7). Lower view shows the Rosman sewage treatment plant on left bank at Mile 215.92. Operation of the plant, which was built in 1968, would not be seriously affected until the concrete structures were overtopped, but the fence has been damaged by floods in 1969 and 1970. Arrows show the heights of the October 1964, Regional, and Maximum Probable Floods.

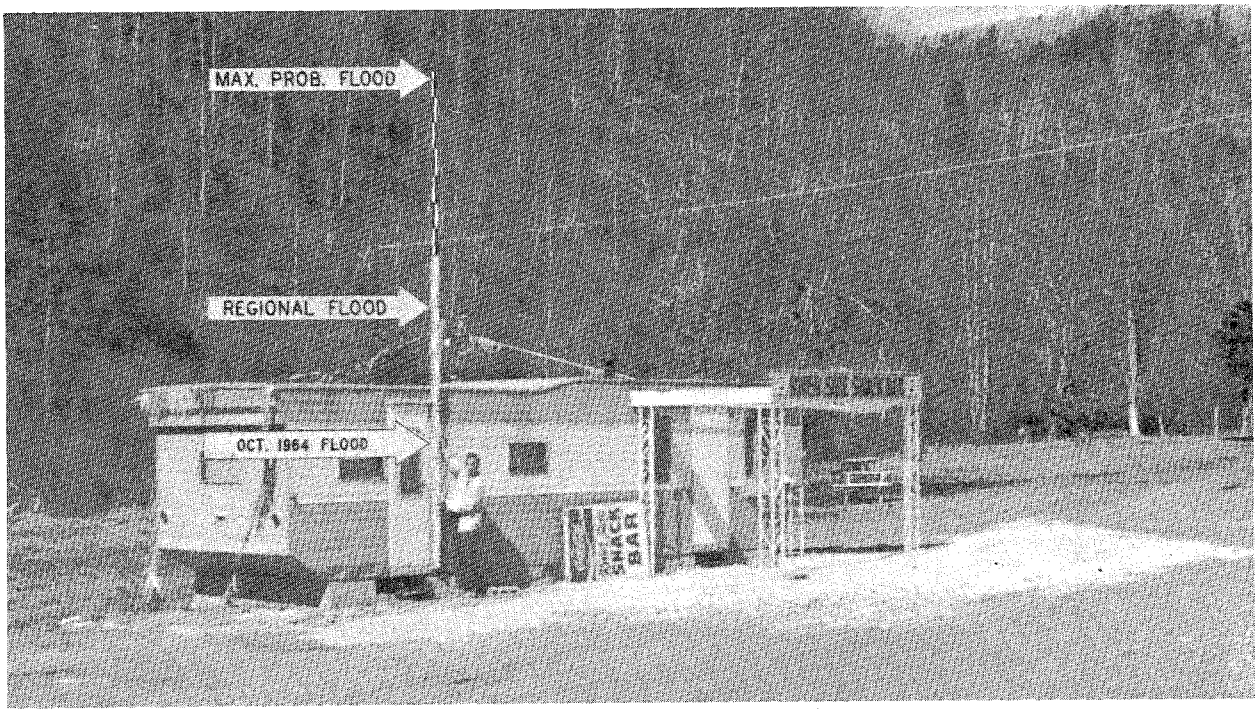

Figure 15.--FLOOD HEIGHTS ON NORTH FORK FRENCH BROAD RIVER

The River Side Snack Bar is on the left bank at Mile 0.06, upstream from U. S. Highway 64, but was not there at the time of the 1964 floods. Arrows show the October 1964, Regional, and Maximum Probable Flood heights.

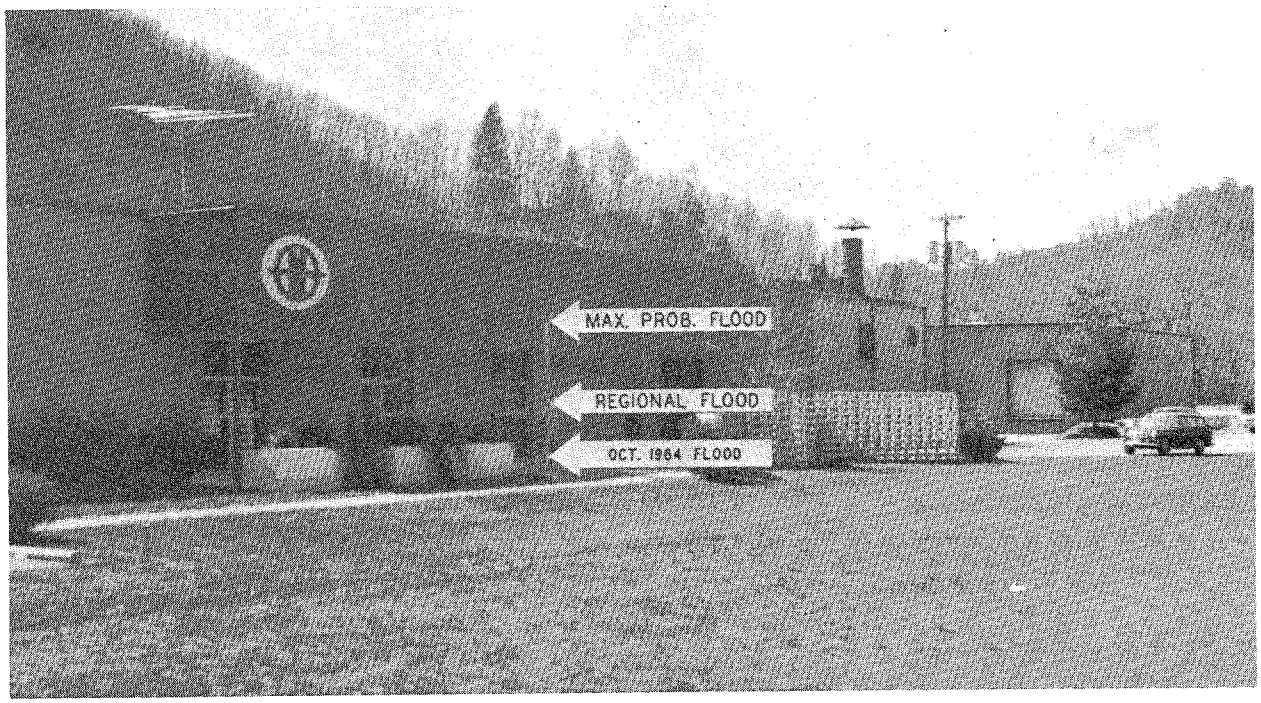

Figure 16.--FLOOD HEIGHTS ON WEST FORK FRENCH BROAD RIVER

The Mitchell-Bissell Division of M-B Industries is on the left bank at Mile 0.97. Figure 10 shows the building during the October 1964 flood. Arrows show heights of the October 1964, Regional, and Maximum Probable Floods.

VI.

MAXIMUM PROBABLE FLOODS

VI.

MAXIMUM PROBABLE FLOODS[1]

This section discusses Maximum Probable Floods on streams involved in this study and some of the hazards of great floods. Floods of the magnitude of the Maximum Probable are the kind considered in planning protective works, the failure of which might be disastrous. They represent reasonable upper limits of expected flooding.

Drainage areas of the streams involved in this study are as follows:

Stream	Mile above Mouth		Drainage Area	
	From	To	Downstream Limit	Upstream Limit
			sq. mi.	sq. mi.
French Broad River	208.45	217.74 (Head)	116	66.8
East Fork French Broad River	0	4.38	26.4	20.1
Middle Fork French Broad River	0	2.00	5.67	4.57
North Fork French Broad River	0	2.13	37.4	34.2
West Fork French Broad River	0	1.50	29.4	27.0

Extreme floods on these streams are most likely to result from either of two types of storms--intense periods of rainfall during winter storms of fairly long duration, or short-duration storms of the thunderstorm or hurricane type usually occurring during summer or early fall. Infiltration and other losses are generally low in winter and high in summer.

DETERMINATION OF FLOOD DISCHARGES

In determining the Maximum Probable Floods on the streams involved in this study, consideration was given to great storms and floods that have already

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1. Prepared by Flood Control Branch.

occurred on these watersheds and to those which have occurred elsewhere but could have occurred in this area. This procedure provides information about possible floods and storms additional to that which can be gained from the short-term local hydrologic records alone.

The maximum known flood on the French Broad River in the vicinity of Rosman occurred on October 4, 1964, with a peak discharge of 13,500 cubic feet per second at Rosman and 16,800 cubic feet per second at the former gage at Calvert, two miles downstream from Rosman. The next highest known flood occurred in July 1916. In Rosman it was about one foot lower than the 1964 flood, but downstream from the mouth of East Fork French Broad River at Mile 215.4, the 1916 flood exceeded the 1964 flood by 0.5 to 1.5 feet. The 1964 flood profile is well defined by flood marks.

The maximum known flood on the East, Middle, North, and West Forks of the French Broad River occurred in October 1964 with estimated peak discharges at their mouths of 7,000, 3,500, 7,200, and 7,500 cubic feet per second, respectively.

It is reasonable to expect that greater floods will occur on all of these streams.

Maximum Probable Storms

Observed storms are meteorologically transposable to the Rosman area from within a broad region extending generally from the Atlantic Ocean to the Appalachian Divide and from Florida through Pennsylvania. The moisture source for storms in this region is the warm, moist air flowing northward from the tropical Atlantic Ocean. In general the moisture potential for a given region decreases with its increased distance from the moisture source. Transposition of storms from within the broad region includes adjustments for the particular meteorological conditions to be expected in the Rosman area. Table 13 lists known rainfall depths for several large storms transposable to this area.

TABLE 13

SELECTED MAXIMUM OBSERVED STORMS TRANSPOSABLE

TO THE REGION OF ROSMAN, NORTH CAROLINA

Date	Location	Drainage Area sq. mi.	Rainfall Duration hours	Rainfall Depth inches
July 1916	North Carolina	20	6	7.8
		30	12	12.4
		70	12	12.1
		130	72	21.8
October 1941	Florida	20	6	12.2
		30	12	23.0
		70	12	21.3
		130	72	30.4
July 1960	Georgia	Point	3	12.5
June 1961	North Carolina	3.49	2.5	8.5

Storms for computing Maximum Probable Floods for Rosman were developed from storm data similar to that given in Table 13. The procedures used are reported in Hydrometeorological Report No. 45, "Probable Maximum and TVA Precipitation for Tennessee River Basins Up to 3000 Square Miles in Area and Durations to 72 Hours," which was prepared for TVA by the U. S. Weather Bureau and published in May 1969. The following rainstorms were adopted for computing the Maximum Probable Floods:

Location	Drainage Area sq. mi.	Rainfall Duration hours	Rainfall Depth inches
French Broad River			
Lower limit (Mile 208.45)	116	72	26.6
Upper limit (Mile 217.74)	66.8	12	20.5
East Fork French Broad River			
Mouth	26.4	12	23.0
Upper limit (Mile 4.38)	20.1	6	20.5
Middle Fork French Broad River			
Mouth	5.67	3	17.8
Upper limit (Mile 2.00)	4.57	3	17.8
North Fork French Broad River			
Mouth	37.4	12	21.8
Upper limit (Mile 2.13)	34.2	12	22.0
West Fork French Broad River			
Mouth	29.4	12	22.7
Upper limit (Mile 1.50)	27.0	12	22.9

From a meteorological standpoint, storms 1.6 times greater than these can occur.

Maximum Probable Flood Discharges

The peak discharges expected to result from an occurrence of the maximum probable storm were computed by using average runoff conditions. Table 14 lists the peak discharges at selected locations on the streams included in this study.

TABLE 14

MAXIMUM PROBABLE FLOOD PEAK DISCHARGES

Stream	Location	Mile above Mouth	Drainage Area sq. mi.	Discharge cfs
French Broad River	U.S. Hwy 178 at Rosman (USGS stream gage)	216.45	67.9	64,000
	Bridge at Calvert (former stream gage)	214.02	103	73,000
East Fork French Broad River	Secondary Route 1107	2.73	23.0	42,000
	Mouth	0.0	26.4	45,000
Middle Fork French Broad River	U.S. Hwy 178	1.95	4.57	18,000
	Mouth	0.0	5.67	20,000
North Fork French Broad River	Upper limit of study	2.00	34.2	47,000
	U.S. Hwy 64	0.02	37.4	49,000
West Fork French Broad River	U.S. Hwy 64	1.20	27.2	45,000
	Mouth	0.0	29.4	47,000

Maximum Recorded Floods

As a guide in determining their reasonableness, the computed Maximum Probable Floods were compared with maximum observed floods on other streams. Factors such as the meteorology of the region and flood-producing characteristics of the watershed were given consideration in determining whether peak discharges on other streams were comparable. Table 15 lists peak discharges for observed floods on several streams approximately the size of those discussed in this report, some of which equal or approach the adopted Maximum Probable Flood rates if allowance is made for the size of a watershed. For comparison, the discharges of the October 1964 flood on the French Broad River at Rosman and at the mouths of its East, Middle, North, and West Forks are listed.

TABLE 15

SELECTED MAXIMUM OBSERVED FLOODS

APPLICABLE TO ROSMAN, NORTH CAROLINA

Stream	Location	Drainage Area sq. mi.	Date	Peak Discharge Amount cfs	Peak Discharge Per Sq. Mi. cfs
Big Creek	Sunburst, N. C.	1.69	1940	12,400	7,340
N. F. Catawba R.	Asheford, N. C.	5.2	1940	15,000	2,880
W. F. Pigeon R.	Spruce, N. C.	12.2	1940	16,500	1,350
Steels Creek	Tablerock, N. C.	16	1940	24,000	1,500
Elk Creek	Banner Elk, N. C.	17.8	1940	22,000	1,200
Upper Creek	Tablerock, N. C.	20.2	1940	25,000	1,240
Cane Creek	Bakersville, N. C.	22	1901	29,500	1,340
N. F. Catawba R.	Woodlawn, N. C.	41.8	1940	55,000	1,320
Elkhorn Creek	Keystone, W. Va.	44	1901	60,000	1,360
Wilson Creek	Adako, N. C.	66	1940	99,000	1,500
Linville R.	Branch, N. C.	67	1940	39,500	590
French Broad R.	Rosman, N. C.	67.9	1964	13,500	199
E. F. French Broad R.	Rosman, N. C.	26.4	1964	7,000	265
M. F. French Broad R.	Rosman, N. C.	5.67	1964	3,500	617
N. F. French Broad R.	Rosman, N. C.	37.4	1964	7,200	192
W. F. French Broad R.	Rosman, N. C.	29.4	1964	7,500	170

Frequency

It is not possible to assign a probability of occurrence or frequency to the Maximum Probable Flood. The occurrence of such a flood would be a rare event; however, it could occur in any year.

Possible Larger Floods

Floods larger than the Maximum Probable are hydrologically possible; however, the combination of factors that would be necessary to produce such floods would seldom occur. The consideration of floods of this magnitude is of greater importance in some problems than in others but should not be overlooked in the study of any problem.

HAZARDS OF GREAT FLOODS

The amount and extent of damage caused by any flood depend in general on how much area is flooded, the height of flooding, the velocity of flow, the rate of rise, and the duration of flooding.

Areas and Heights of Flooding

The areas flooded by the Maximum Probable Flood and the flood of October 1964 are shown on Plates 7, 8, and 11. Depths of flow can be estimated from the crest profiles which are shown on Plates 9 and 12.

The profiles for the five streams were computed by using stream characteristics for selected reaches as determined from available observed flood profiles, topographic maps, and valley cross sections which were surveyed in 1970 and supplemented by some cross sections surveyed in 1964. The elevations shown on Plates 9 and 12 and the overflow area shown on Plates 7, 8, and 11 have been determined with an accuracy consistent with the purposes of this study and the accuracy of the basic data. More precision would require costly surveys not warranted by this study.

The profiles of the Maximum Probable Flood depend in part upon the degree of destruction or clogging of various bridges during the floods. Because it is impossible to forecast these events, it was assumed that all bridge structures would stand and that no clogging would occur.

The Maximum Probable Flood profile on the French Broad River is from about 6 to about 15 feet higher than the October 1964 flood profile, the maximum difference occurring at Mile 217.74.

The Maximum Probable Flood profile on East Fork is from about 8 to 19 feet higher and on Middle Fork is from about 4 to 9 feet higher than the October 1964 flood. The maximum differences occur at Mile 3.6 on East Fork and Mile 1.4 on Middle Fork. On North Fork the Maximum Probable Flood is from about 12 to 22 feet higher than the October 1964 flood, and on West Fork it is from about 5 to 13 feet higher. The greatest differences are at Mile 1.4 on North Fork and Mile 0.5 on West Fork.

Figures 11 to 16 on pages 74 to 78 show the height that would be reached by the Maximum Probable Flood at several locations along the streams included in this report.

Velocities, Rates of Rise, and Duration

Water velocities in the streams during a flood depend largely upon the size and shape of the cross section, the condition of the stream, and the bed slope, all of which vary on different streams and at different locations on the same stream.

During the Maximum Probable Flood, the range of velocities in the main channel and in the overflow plain of the five streams of this study would be as shown in Table 16.

TABLE 16

MAXIMUM PROBABLE FLOOD VELOCITIES

	Feet Per Second			
	Main Channel		Overflow Plain	
	From	To	From	To
French Broad River	4	14	2	5
East Fork French Broad River	11	20	2	5
Middle Fork French Broad River	10	19	2	6
North Fork French Broad River	10	20	2	5
West Fork French Broad River	11	14	2	5

The total rise above low water to the crest stage, the maximum rate of rise, and the duration above bankfull stage of the Maximum Probable Flood on each of these five streams would be as shown in Table 17.

These rapid rates and high stream velocities in combination with deep, long-duration flooding would create a hazardous situation in developed areas.

TABLE 17

MAXIMUM PROBABLE FLOODS--RATE OF RISE AND DURATION

Stream	Location	Total Rise above Low Water	Maximum Rate of Rise	Duration above Bankfull Stage
French Broad River	U. S. Highway 178, Mile 216.45 (stream gage at Rosman)	19 feet in 12 hours	3 feet in 1 hour	9 hours
East Fork French Broad River	Secondary Route 1107, Mile 2.73	23 feet in 9 hours	5 feet in 1 hour	7 hours
Middle Fork French Broad River	U. S. Highway 178, Mile 1.95	14 feet in 2 hours	5 feet in 0.5 hour	2 hours
North Fork French Broad River	U. S. Highway 64, Mile 0.02	25 feet in 9 hours	5 feet in 1 hour	6 hours
West Fork French Broad River	U. S. Highway 64, Mile 1.20	19 feet in 8 hours	5 feet in 1 hour	7 hours


LEGEND:
OVERFLOW LIMITS
OCTOBER 1964
MAXIMUM PROBABLE FLOOD
M-210 — MILES ABOVE MOUTH
24 CROSS SECTION
2177.8 — GROUND ELEVATION IN FEET (USC&GS 1936 SUPPL. ADJ.)
CONTOUR INTERVAL 40 FEET (DASH LINE 20 FEET)
The extent of overflow as shown is based upon contours, except at cross sections & known flood limits, & may not represent exact flood conditions on the ground.
BASE MAP IS A PORTION OF USGS - TVA TOPOGRAPHIC MAPS 185 NE DATED 1967 AND 185 SE DATED 1969 WITH MINOR REVISIONS.
ROSMAN
Corporate Limits
FRENCH BROAD RIVER
Middle Fork French Broad
E. Fk. French Broad R.
AREA COVERED BY PLATE 8
STREAM GAGE (1935-
STREAM GAGE (1924-1955)
AMERICAN THREAD CO.
Southern Rwy.
NATIONAL FOREST BOUNDARY
Morgan Mill Cr.
Cherryfield
Patterson
Limekiln Br.
Wilson Mill Cr.
Catheys Creek
Cantrell Cr.
Paxton Cr.
Kelley Br.
Graveyard Hill
Bunker Hill
Calvert
Cove Hollow
Browns Mill
SCS 308
SCS 309
SCS 310
SCS 311
SCS 312
SCS 313
SCS 314
SCS 315
SCS 316
SCS 317
SCS 348
SCS 349
M-217
M-216
M-215
M-214
M-213
M-212
M-211
M-210
M-209
M-208
M-1
FLOW
64
178
25
BM R 25 2179
2200
2400
2360
2600

TENNESSEE VALLEY AUTHORITY
DIVISION OF WATER CONTROL PLANNING

FLOODED AREAS
FRENCH BROAD RIVER AND
M. FORK FRENCH BROAD RIVER
IN VICINITY OF
ROSMAN, N.C.

SCALE 0 1000 2000 FEET

APRIL 1971

BASE MAP IS A PORTION OF TVA MAPS, G-MS-462P554-214 AND 217 DATED 1965 WITH MINOR REVISIONS.

TENNESSEE VALLEY AUTHORITY
DIVISION OF WATER CONTROL PLANNING

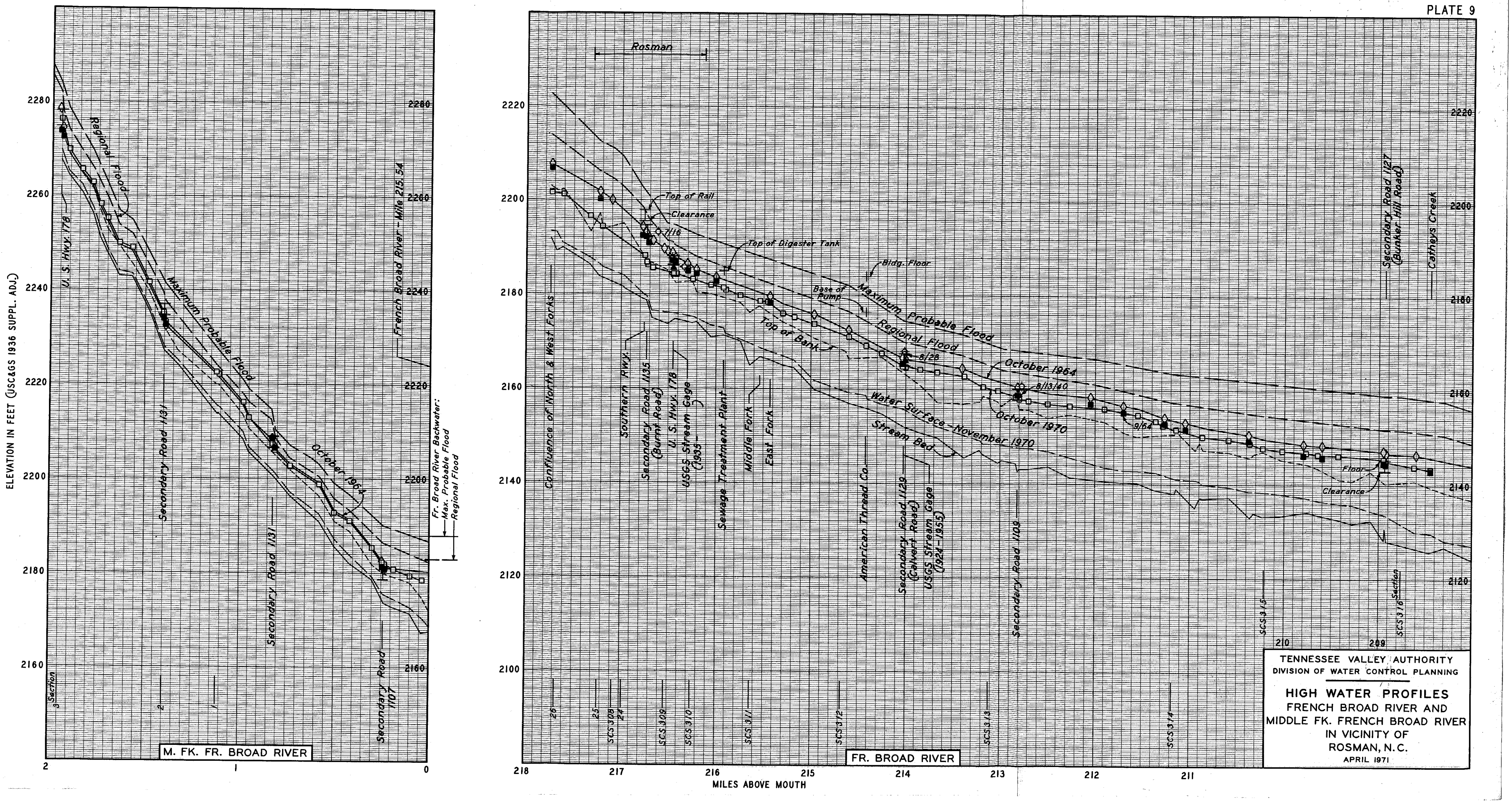
FLOODED AREAS
FRENCH BROAD RIVER
AT
ROSMAN, N.C.

SCALE 0 200 400 FEET

APRIL 1971

HD-1311

PLATE 9

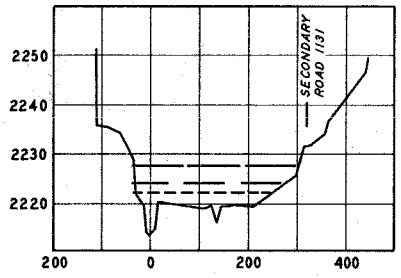


TENNESSEE VALLEY AUTHORITY
DIVISION OF WATER CONTROL PLANNING

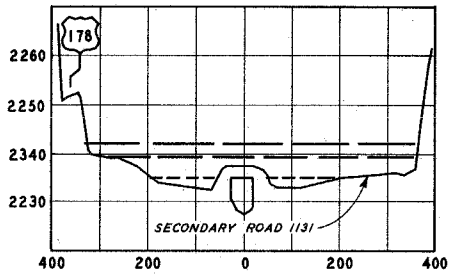
HIGH WATER PROFILES
FRENCH BROAD RIVER AND MIDDLE FK. FRENCH BROAD RIVER IN VICINITY OF ROSMAN, N.C.

APRIL 1971

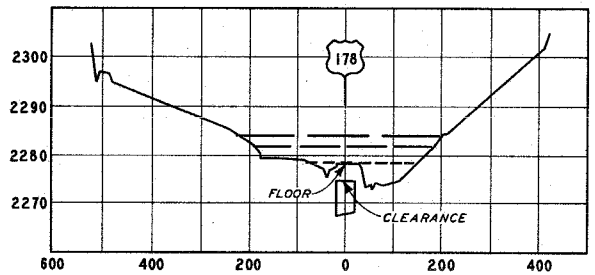
AD-1311



SECTION 1 - MILE 1.12



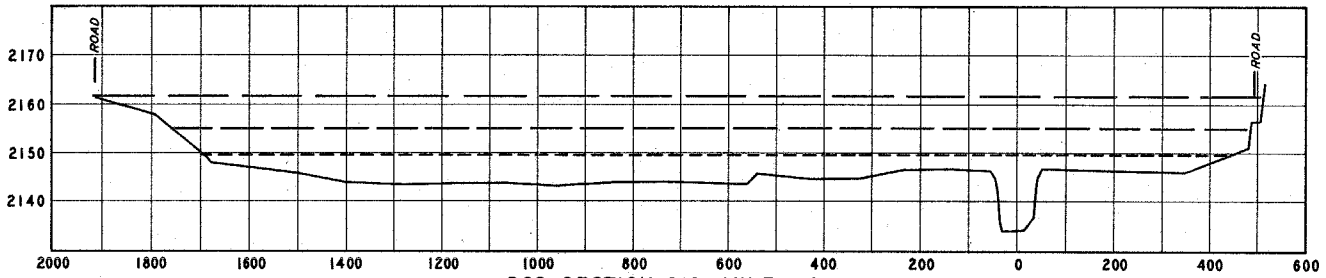
SECTION 2 - MILE 1.40



SECTION 3 - MILE 1.95

Sections taken looking downstream

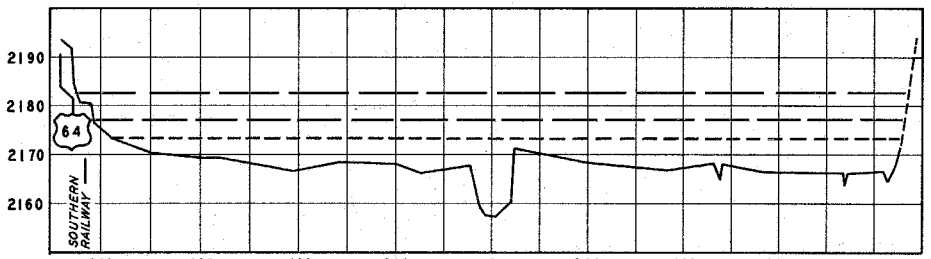
MIDDLE FORK FRENCH BROAD RIVER



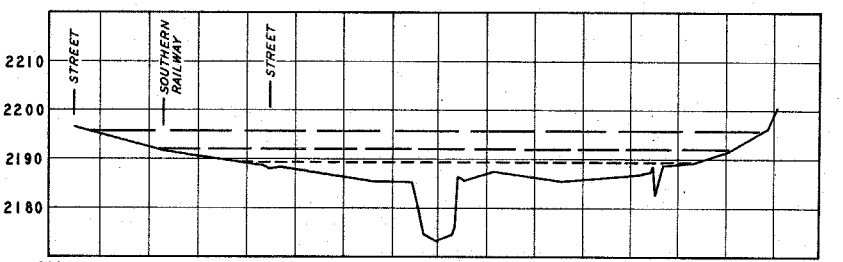
SCS SECTION 315 - MILE 210.21

LEGEND:

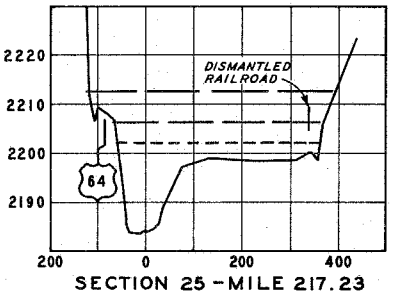
- Maximum Probabe Flood
- Regional Flood
- October 1964



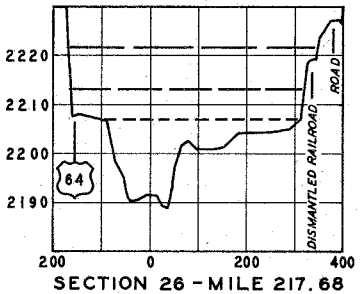
SCS SECTION 312 - MILE 214.68



SCS SECTION 309 - MILE 216.54



SECTION 25 - MILE 217.23



SECTION 26 - MILE 217.68

7 sections on French Broad River not shown

FRENCH BROAD RIVER

ELEVATION IN FEET (USC&GS 1936 SUPPL. ADJ.)

HORIZONTAL DISTANCE IN FEET

TENNESSEE VALLEY AUTHORITY
DIVISION OF WATER CONTROL PLANNING

CROSS SECTIONS

FRENCH BROAD RIVER AND MIDDLE FK. FRENCH BROAD RIVER IN VICINITY OF ROSMAN, N.C.

APRIL 1971

PLATE 10


BASE MAP IS A PORTION OF USGS-TVA TOPOGRAPHIC MAPS 185 NE DATED 1967 AND 185 SE DATED 1969 WITH MINOR REVISIONS.
LEGEND:
OVERFLOW LIMITS
OCTOBER 1964
MAXIMUM PROBABLE FLOOD
M-215 MILES ABOVE MOUTH
3 CROSS SECTION
2238.9 GROUND ELEVATION IN FEET (USC&GS 1936 SUPPL. ADJ.)
CONTOUR INTERVAL 40 FEET (DASH LINE 20 FEET)
The extent of overflow as shown is based upon contours, except at cross sections & known flood limits, & may not represent exact flood conditions on the ground.
ROSMAN
Corporate Limits
AMERICAN THREAD CO.
STREAM GAGE (1924-1955)
STREAM GAGE (1935)
AREA COVERED BY PLATE 8
M-B INDUSTRIES
WHITMIRE CEM
GILLESPIE CEM
Panther Mtn
Walker Mtn
Diamond Creek
Ash Cove
Gads Cove
Powelltown
Rainbow Lake
East Fork
Upper Cr.
M. Fk. French Broad R.
W. Fk. French Broad River
FRENCH BROAD RIVER
Southern Rwy.
SCS 347
SCS 346
BM LR 732 2260
BM LHT 1861 2291
BM LR 735 2186
BM LR 734 2245
BM C 86 2183
BM VHT 860 2180
FLOW

TENNESSEE VALLEY AUTHORITY
DIVISION OF WATER CONTROL PLANNING

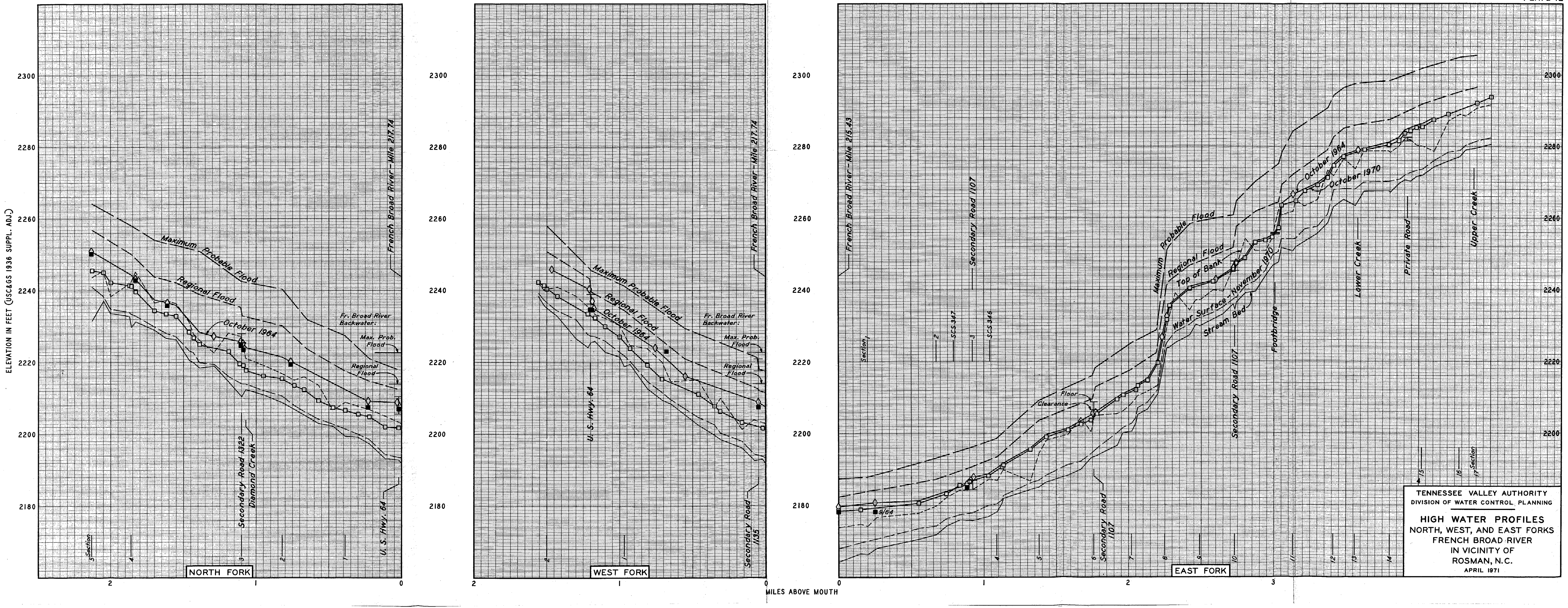
FLOODED AREAS
FRENCH BROAD RIVER AND NORTH, WEST, AND EAST FORKS IN VICINITY OF ROSMAN, N.C.

SCALE 0 1000 2000 FEET

APRIL 1971

HD-1311

PLATE 12

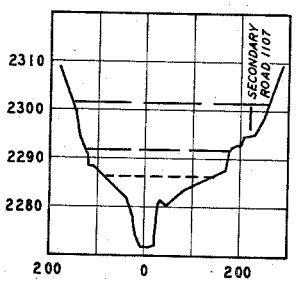


TENNESSEE VALLEY AUTHORITY
DIVISION OF WATER CONTROL PLANNING

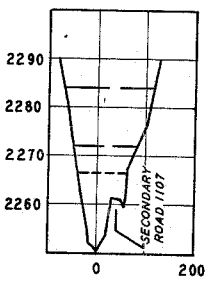
HIGH WATER PROFILES
NORTH, WEST, AND EAST FORKS
FRENCH BROAD RIVER
IN VICINITY OF
ROSMAN, N.C.

APRIL 1971

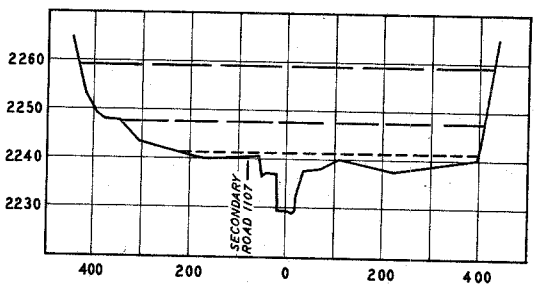
HD-1311



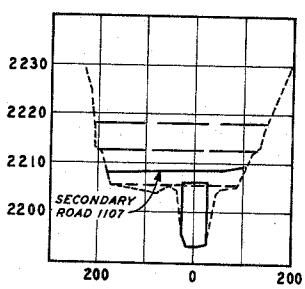
SECTION 15-MILE 4.02



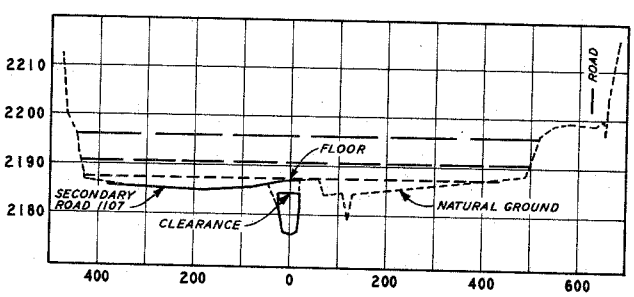
SECTION 11-MILE 3.13



SECTION 9-MILE 2.49



SECTION 6-MILE 1.76

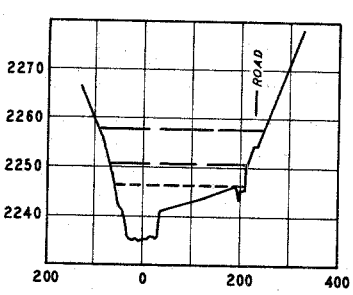


SECTION 3-MILE 0.92

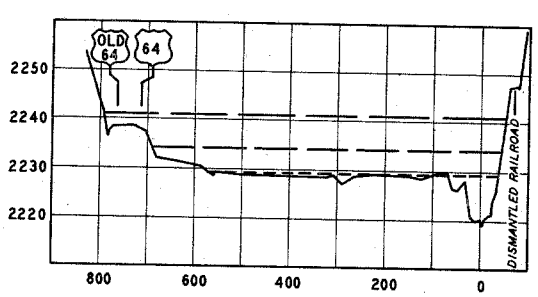
EAST FORK

14 sections not shown

ELEVATION IN FEET (USC&GS 1936 SUPPL. ADJ.)



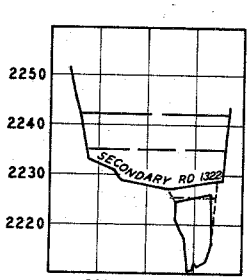
SECTION 2-MILE 1.50



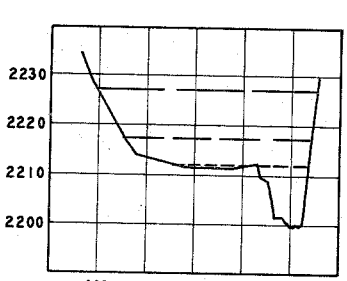
SECTION 1-MILE 0.97

Sections taken looking downstream

WEST FORK



SECTION 3-MILE 1.10



SECTION 1-MILE 0.39

NORTH FORK

3 sections not shown

LEGEND:

- Maximum Probable Flood
- Regional Flood
- October 1964

TENNESSEE VALLEY AUTHORITY
DIVISION OF WATER CONTROL PLANNING

CROSS SECTIONS

NORTH, WEST, AND EAST FORKS
FRENCH BROAD RIVER
IN VICINITY OF
ROSMAN, N.C.

APRIL 1971

HORIZONTAL DISTANCE IN FEET