

**FLOODS
ON
FRENCH BROAD
AND
SWANNANOA
RIVERS**

**VICINITY
OF
ASHEVILLE
NORTH
CAROLINA**

**TENNESSEE
VALLEY
AUTHORITY**

**DIVISION
OF
WATER
CONTROL
PLANNING**

TENNESSEE VALLEY AUTHORITY
DIVISION OF WATER CONTROL PLANNING

FLOODS
ON
FRENCH BROAD
AND
SWANNANOA RIVERS
IN VICINITY OF
ASHEVILLE, NORTH CAROLINA

REPORT NO. 0-5975

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FOREWORD

Tennessee Valley Authority
Division of Water Control Planning

FOREWORD

This report relates to the flood situation along the French Broad and Swannanoa Rivers in the vicinity of Asheville, North Carolina. It has been prepared at the request of the Asheville City Council through the North Carolina Department of Water Resources to aid (1) in the solution of local flood problems and (2) in the best utilization of lands subject to overflow. The report is based on work the TVA has been carrying on since its beginning in connection with its water resource operations throughout the Tennessee Valley. TVA has assembled information on rainfall, runoff, historical and current flood heights, and other technical data bearing on the occurrence and magnitude of floods in localities throughout the region which provide the basis for preparation of the report.

The report does not include plans for the solution of flood problems.¹ Rather, it is intended to provide the basis for further study and planning on the part of the City of Asheville in arriving at solutions to minimize vulnerability to flood damages. This might involve (1) the construction of flood protection works, (2) local planning programs to guide developments by controlling the type of use made of the flood plain through zoning and subdivision regulations, or (3) a combination of the two approaches.

The report covers three significant phases of the Asheville flood problem. The first brings together a record of the largest known floods of the past on the French Broad and Swannanoa Rivers. The second treats of Regional Floods. These are derived from consideration of the largest floods known to have occurred on streams of similar physical characteristics in the same general geographical region as that of the French Broad and Swannanoa Rivers and generally within 75 miles of Asheville. The third develops the Maximum Probable Floods for the French Broad

1. Following the August 1940 floods, at the request of the local people, TVA made an investigation of the flood situation in the Upper French Broad River watershed and developed plans to provide protection against floods. Included in these plans were measures to afford flood protection at Asheville. No action has been taken on the plans.

and Swannanoa Rivers. 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. Such floods are used by TVA in the design of the physical features of reservoirs, dams, powerhouses, and local flood protection works.

The report contains maps, profiles, and valley cross sections which indicate the extent of flooding that has been experienced and that might occur in the future in the Asheville vicinity.

In problems concerned with the control of developments in the flood plains of the French Broad and Swannanoa Rivers, and in reaching decisions on the magnitude of floods to consider for this purpose, appropriate consideration should be given to the possible future occurrence of floods of the magnitude of (1) those that have occurred in the past, (2) the Regional Floods derived from those that have occurred on streams of similar physical characteristics in the region of Asheville, and (3) the Maximum Probable Floods that it is estimated might occur.

This report should be useful in planning new developments in the flood plain. From the maps, profiles and cross sections, the depth of probable flooding by either recurrence of the largest known historical floods or by occurrence of the Regional or Maximum Probable Floods at any location may be ascertained. Having this information, floor levels for buildings 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.
RESUME
OF
FLOOD SITUATION

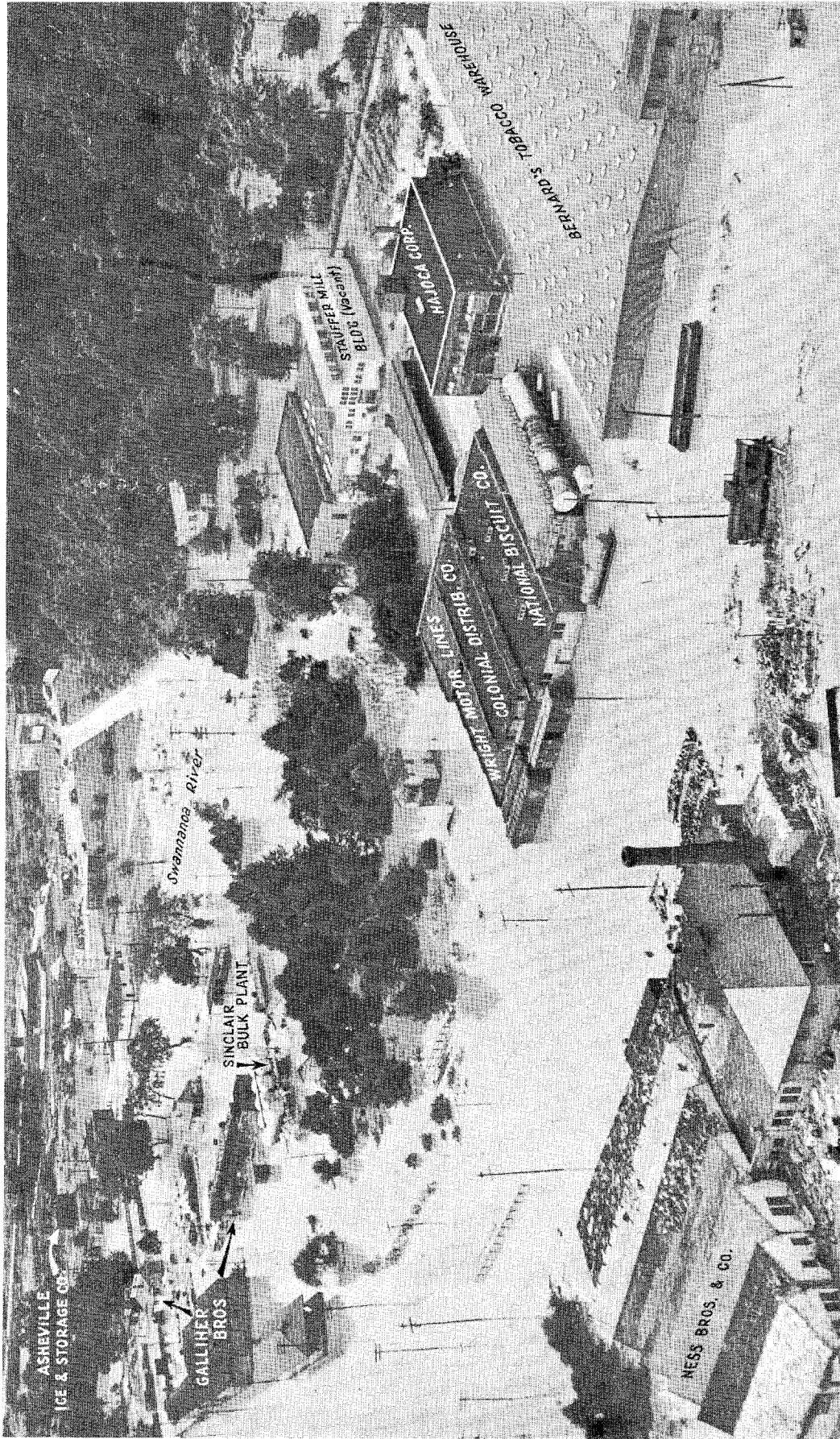


Figure 1. -- AUGUST 30, 1940, FLOOD AT BILTMORE

The Swannanoa River's normal channel is from right to left along the rows of telephone poles in the middle background. The Southern Railway right-of-way is in the foreground. The mid-August 1940 flood crest was 3 feet higher than the overflow shown in this view.

(Photo by Asheville Citizen)

Tennessee Valley Authority
Division of Water Control Planning

I.

RESUME OF FLOOD SITUATION

Asheville, North Carolina, is located on the French Broad River 148 miles above the mouth of the river and 46 miles above the Tennessee-North Carolina state line. Six miles of the course of the river, from Mile 145.3 to Mile 151.5, adjoin or are within the corporate limits of the city. The Swannanoa River, a tributary with a drainage area of 133 square miles, joins the French Broad River at Asheville. The lower 5.5 miles of its course are within the corporate limits. The portions of the rivers covered by this investigation are from Mile 142.2 to Mile 151.5 on the French Broad River and from the mouth to Mile 7.6 on the Swannanoa River. The total area of the French Broad watershed above the Asheville business district, including the Swannanoa River basin, is 937 square miles.

The flood plains of the French Broad and Swannanoa Rivers are highly developed through Asheville. Many industries, commercial establishments and residences are subject to flooding. The city has experienced overflows a number of times since it was incorporated 163 years ago, the largest of these being in July 1916. The most recent serious flooding was in August 1940 when two floods hit the western North Carolina area within less than three weeks.

Practically complete records of river stages and discharges are available on the French Broad River at Asheville since 1895. On the Swannanoa River records are essentially complete since 1920. In compiling a record of early floods on the two rivers, it has been necessary to interview residents along the two 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 French Broad and Swannanoa Rivers in the vicinity of Asheville, 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 this report.

THE GREATEST FLOOD in about 170 years on the French Broad River and the second greatest on the Swannanoa River in the Asheville vicinity occurred on July 16, 1916. The flood took six lives at Asheville, washed away homes, other buildings and four of the main river bridges in the city, and caused heavy damage to industries, business places, and the Southern Railway.

* * *

A GREAT FLOOD occurred on the Swannanoa and French Broad Rivers in April 1791, soon after settlement of the region began. The available evidence indicates that this was the greatest flood known on the Swannanoa River and that it exceeded the flood of July 1916 by about 5 feet. It is probable that an unusually high flood also occurred on the French Broad River and that it may have been of the magnitude of the flood in 1916.

* * *

OTHER BIG FLOODS on the French Broad River reaching within 5 and 8 feet, respectively, of the 1916 crest occurred in June 1876 and August 1852. The largest recent floods, in August 1928 and August 1940, were 10 to 11 feet lower than the 1916 flood. On the Swannanoa River, floods in August 1928 and August 1940 have come within two feet of the 1916 flood height on that stream.

* * *

EXTENSIVE DEVELOPMENTS in the flood plains of the French Broad and Swannanoa River would cause these great floods of the past to be higher if they occurred again. Land fills and buildings in the flood plain and the many bridges across the streams have seriously reduced flood flow capacity. On the French Broad River a flood of the same discharge as the 1916 flood would today be 3 to 4 feet higher between Pearson Bridge and West Asheville Viaduct than the actual flood elevation. On the Swannanoa River, a repetition of the 1916 flood would be up to 2.5 feet higher today at Biltmore and up to 15 feet higher upstream from the Recreation Park dam.

* * *

A REGIONAL FLOOD on the French Broad River at Asheville, based on floods experienced within 75 miles of the city, would have a peak discharge of the same magnitude as the flood of July 1916 but would be 1 to 4 feet higher in elevation over much of the reach because of recent flood plain developments. A Regional Flood on the Swannanoa River would be a little greater than that of 1791 and more than double

the magnitude of the 1916 flood. It would reach stages generally 3 to 11 feet higher than the actual 1916 crest. In the 1.5 miles above the Asheville Recreation Park the difference would be 11 to 23 feet because of the abandoned dam built after 1916. (See Figures 24 to 29.)

* * *

MAXIMUM PROBABLE FLOOD determinations indicate that floods could occur on the French Broad River in the Asheville vicinity 2 to 12 feet higher than the actual 1916 flood. A Maximum Probable Flood on the Swannanoa River would be 7 to 18 feet higher in stage than in 1916 below the recreation park. Figures 24 to 29 show the heights that would be reached by a Maximum Probable Flood at several locations along the two rivers.

* * *

BACKWATER from large floods on the French Broad River affects flood heights only on the lower one to two miles of the Swannanoa River. In July 1916 this backwater in the Swannanoa River was higher than the headwater flood from the mouth upstream to about Mile 1.5.

* * *

FLOOD DAMAGES that would result from a recurrence of floods as large as those of July 1916 on the French Broad and Swannanoa Rivers would be very great at Asheville. The 1916 flood on the two rivers inundated the then existing industrial and business development on the flood plains and caused damages exceeding two and one-half million dollars in the city. A recurrence of the 1916 flood under present conditions would cause much larger damages because of the higher stages caused by the obstructions and the greatly expanded use being made of the flood plains. The Regional and Maximum Probable Floods, with their great depths and high velocities, would cause even heavier damages.

* * *

MOST FREQUENT FLOOD OCCURRENCES on the French Broad and Swannanoa Rivers at Asheville have been in the late spring and summer and especially in August. Most of the higher floods have been summer floods resulting from very heavy hurricane rainfall or intense thunderstorms. However, floods occur also in the fall and winter and large floods may come on either stream at any time.

* * *

CHARACTERISTICS OF THE WATERSHED above Asheville are such that in most large floods the peak stage occurs on the French Broad River at Asheville close to the time of the peak on Swannanoa River. This effect is due largely to the natural storage of flood waters resulting from the flat channel slope and wide flood plain of the French Broad River upstream from Asheville.

* * *

FLOOD PROTECTION investigations made by TVA soon after the 1940 floods indicated that a balanced plan of flood protection could be provided which would protect the Swannanoa and French Broad River flood plains at Asheville from frequent and damaging floods, in addition to affording a high degree of protection to a large area of agricultural land upstream from Asheville. The plan included levees along the right bank of the French Broad River at Asheville. To date the works included in the plans have not been built.

* * *

VELOCITIES OF WATER during the July 1916 flood ranged up to 15 feet per second in the channel of the French Broad River in the Asheville vicinity and up to 6 feet per second on the flood plain. Along the Swannanoa River the channel velocities in 1916 ranged up to 18 feet per second and the flood plain velocities up to 8 feet per second. During a Maximum Probable Flood, velocities on the French Broad River would range up to 18 feet per second in the channel and up to 8 feet per second over the flood plain. The corresponding velocities on the Swannanoa River would be 22 and 11 feet per second.

* * *

DURATION OF FLOODS is relatively short on both rivers at Asheville. On the French Broad River, the mid-August 1940 flood was above bankfull stage for 49 hours and the late August 1940 flood was above banks for 29 hours. On the Swannanoa River the period above bankfull stage for the same two floods was 14 hours and 12 hours, respectively. The average rate of rise during the larger of the 1940 floods on each stream was in the order of 0.5 to 0.6 foot per hour. During the 1916 flood on the French Broad River the average rate of rise was 0.6 foot per hour but the maximum rise in a single hour was 4.8 feet. Floods of the magnitude of the Maximum Probable Flood on the French Broad River would rise about 28 feet from low water to the crest stage in 19 hours, with a maximum rate of rise of about 2.5 feet per hour. On the Swannanoa River the corresponding figures would be 33 feet

from low water to crest stage in about 14 hours with a maximum rate of 3 feet per hour.

* * *

EXTREMELY HAZARDOUS CONDITIONS would occur during large future floods on the two rivers in the Asheville vicinity. Practically all of the flood plain areas would be submerged with depths up to 25 or more feet along the French Broad River and the Swannanoa River during a Maximum Probable Flood. Some buildings would be submerged. High velocities would sweep many buildings away. The lives of those occupying homes and other structures would be endangered.

* * *

FUTURE FLOOD HEIGHTS that would be reached if floods of the magnitudes of the Regional and Maximum Probable occurred on the French Broad and the Swannanoa Rivers are shown in Table 1. This table compares these future flood crests under present conditions with the actual crest of the 1916 flood on both of these streams and with the crest of the 1916 flood if it were to be repeated under present conditions.

TABLE 1
RELATIVE FLOOD HEIGHTS
AT ASHEVILLE

<u>Flood</u>	<u>Location</u>	<u>Mile</u>	<u>Estimated Peak Discharge cfs</u>	<u>Above Actual 1916 Flood feet</u>
<u>French Broad River</u>				
1916, actual	Smith Bridge	147.33	110,000	0
Regional ^(a)	(downstream side)		110,000	2.7
Maximum Probable			154,000	11.4
<u>Swannanoa River</u>				
1916, actual	Biltmore	1.56	23,000	0
1916, present conditions			23,000	2.3
1791, actual			40,000	5(b)
Regional			53,000	7.7
Maximum Probable			96,000	13.3

(a) The discharge of the Regional Flood on the French Broad River is the same as the actual 1916 flood. However, the Regional Flood would be up to 4 feet higher than the 1916 flood because of present developments and land fills on the flood plain.

(b) Estimated from historical information.

II.

PAST FLOODS

Tennessee Valley Authority
Division of Water Control Planning
Hydraulic Data Branch

II.

PAST FLOODS

This section of the report is a history of floods which have occurred on the French Broad River and its tributary Swannanoa River in the vicinity of Asheville, Buncombe County, North Carolina. The portion of the French Broad River considered extends from the upper corporate limit of Asheville at the mouth of Hominy Creek, river Mile 151.5, to the mouth of Beaverdam Creek, 3.1 miles downstream from the lower corporate limit, at Mile 142.2, a distance of 9.3 river miles. The investigations on Swannanoa River cover 7.6 miles of the stream from U. S. Highway 70 at Azalea to the mouth. The lower 5.5 miles of the Swannanoa River are within the Asheville corporate limits.

The French Broad River enters Asheville from the south, flows eastward 2-1/2 miles to the confluence with Swannanoa River, then generally northward through Asheville and the industrial and residential communities of Woodfin, Craggy, and Elk Mountain. Swannanoa River enters the city from the east and follows a meandering course westward to its confluence with French Broad River. The main business district of Asheville is on high ground east of the French Broad River and north of the Swannanoa River. However, there is also a sizable commercial and industrial development on the Swannanoa River flood plain at Biltmore and extensive industrial and commercial developments are located on both banks along the lower four miles of Swannanoa River and on the right bank of French Broad River from the confluence with Swannanoa River to the lower end of the reach studied.

Records of river stages and discharges are essentially complete for the French Broad River at Asheville since September 1895, when a river gaging station was established by the U. S. Geological Survey. The U. S. Weather Bureau maintained records of flood stages on the French Broad River from March 1903 to November 1958. For the Swannanoa River, stage and discharge records are practically complete since October 1920 when the Geological Survey started a gaging station at Biltmore. Flood history investigations made by TVA Hydraulic Data

Branch engineers along the French Broad River in 1937 and along the Swannanoa River in 1941 developed information on floods prior to the beginning of stream gage records. Field investigations have been made by engineers of the Hydraulic Data Branch immediately following all the significant floods on the French Broad and Swannanoa Rivers in the last 25 years. Extensive investigations were made in the Asheville vicinity after the floods of August 13-14 and August 30, 1940. Local residents have been interviewed. Newspaper files and historical sources have been searched. From these sources it has been possible to develop a history of known floods on the French Broad and Swannanoa Rivers at Asheville covering the past 170 years.

This section of the report discusses separately the flood history of each of the two rivers.

1. FRENCH BROAD RIVER

FRENCH BROAD RIVER VALLEY

Settlement

Buncombe County was formed in 1792 from a part of Burke and Rutherford Counties and originally included all of the land in North Carolina lying west of the Blue Ridge. This land had been Cherokee Indian land until 1783 when the North Carolina General Assembly declared it open to the white man. The county seat, first called Morristown, was renamed Asheville in 1795 for Governor Samuel Ashe and was incorporated in 1797.

The routes along the Swannanoa and French Broad Rivers were important arteries of travel to and from the east and south, respectively, from the earliest settlement of the area. A toll road, the Buncombe Turnpike, was built with state aid in 1827. The Asheville-Greenville Plank Road, chartered in 1851, improved access to the area from the south. Rail service came to Asheville from the east in 1880 and from the south in 1886.

The 1950 census lists a population of 124,403 for Buncombe County and 53,000 for Asheville. In 1960 Asheville extended its corporate limits to increase its geographic area by about one-third. The Preliminary Reports of the 1960 Census of

Population, issued by the Bureau of the Census, gives present population of 58,747 for Asheville and 127,367 for Buncombe County.

The Stream and Its Valley

The French Broad River watershed covers an area of 5,124 square miles in North Carolina and Tennessee. The drainage area above Asheville, shown on Plate 1, is 50 miles long and has an average width of about 20 miles. The river originates on the western and northern slopes of the Blue Ridge which divides the Tennessee River drainage from that flowing toward the Atlantic Ocean. The watershed above Asheville lies entirely within the heavily forested Appalachian Mountain physiographic sub-region. Forest cover averages 85 percent in Transylvania County and 62 percent in the watershed portions of Henderson and Buncombe Counties. For the three counties together the land in forest cover amounts to 68 percent of the watershed.

The French Broad River begins at Rosman, North Carolina, 35 miles southwest of Asheville, where four tributaries converge. These four streams drop steeply from the watershed rim, where elevations range from 3000 feet to as much as 6000 feet. From Rosman to Asheville the river follows a meandering course through a broad flood plain with a channel slope of about 3 feet per mile, much flatter than is usual for a mountain stream. The wide bottoms in this reach provide substantial natural storage of flood waters which has an important bearing on the timing and height of flood peaks.

In the Asheville vicinity the principal tributary, in addition to the Swannanoa River which will be discussed later, is Hominy Creek, which joins the French Broad River at the upper corporate limit of Asheville, draining an area of 104 square miles lying just to the southwest of the city. The stream heads at the west against the low divide near Canton and at the south against the slopes of Mount Pisgah, where the elevation reaches 5721 feet. Heavy rainfall over the fan-shaped drainage area of Hominy Creek concentrates runoff rapidly, producing floods which can affect the flood situation through Asheville. A number of smaller tributaries join the French Broad River in the Asheville vicinity. These include Town Branch, Reed Creek, and Beaverdam Creek, entering French Broad River on the right bank at Mile 148.1, Mile 145.3, and Mile 142.2, respectively, and Mill Creek, which joins the river on the left bank at Mile 146.8.

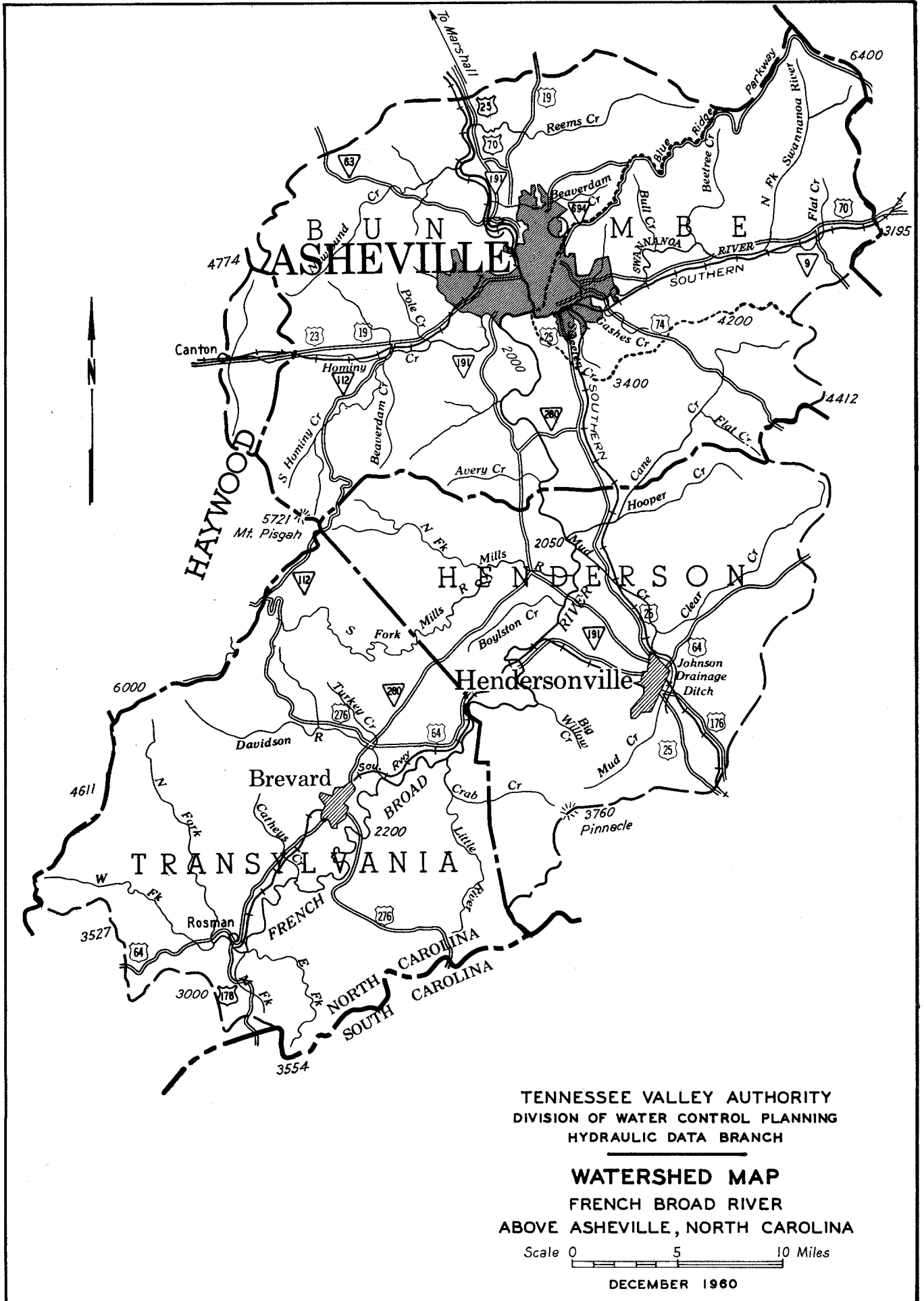
From Rosman downstream to Long Shoals, about 15 miles above Asheville, the French Broad River falls 2.5 feet per mile. Through Long Shoals and to the mouth of Hominy Creek the rate of fall is 5.5 feet per mile. Over the reach covered by this investigation, the river falls from elevation 1973 feet at Hominy Creek to elevation 1917 at the base of Craggy Dam, or about 6.0 feet per mile.

Pertinent drainage areas of the French Broad River and its tributaries in the vicinity of Asheville are given in Table 2.

TABLE 2
DRAINAGE AREAS IN WATERSHED
OF FRENCH BROAD RIVER

<u>Stream</u>	<u>Location</u>	<u>Mile Above Mouth</u>	<u>Drainage Area sq. mi.</u>
French Broad River	Above Hominy Creek	151.5	695
	Below Hominy Creek	151.5	799
	Above Swannanoa River	149.0	801
	Below Swannanoa River	149.0	934
	Smith Bridge	147.3	937
	Pearson Bridge	145.8	945
	Below Beaverdam Creek	142.2	966
Hominy Creek	Mouth	0.0	104
Swannanoa River	Mouth	0.0	133
Beaverdam Creek	Mouth	0.0	12.4

Because of the character of the French Broad watershed above Asheville, the peak of major rises occurs at Asheville well ahead of the peak in the very flat reach of the river above Asheville. In floods resulting from rains which are general over the watershed, the flood flow from Swannanoa River and Hominy Creek largely determines the time of peak and to a considerable extent the amount of peak discharge which occurs on the French Broad River at Asheville. On the other hand, in storms which are heavier in the French Broad River headwaters, the flow from that part of the watershed may determine the time of the peak at Asheville.



TENNESSEE VALLEY AUTHORITY
 DIVISION OF WATER CONTROL PLANNING
 HYDRAULIC DATA BRANCH

WATERSHED MAP
FRENCH BROAD RIVER
ABOVE ASHEVILLE, NORTH CAROLINA

Scale 0 5 10 Miles

DECEMBER 1960

ASF -1311

The corporate limits of Asheville lie on the left bank of the French Broad River from the mouth of Mill Creek, Mile 146.83, to the mouth of Hominy Creek, Mile 151.50, and on the right bank from near the mouth of Reed Creek, Mile 145.29, to Swannanoa River, Mile 149.01. The corporate limits lie on the left side of the Swannanoa River through Biltmore and the Koon Development, Mile 1.4 to 3.2, and in the vicinity of the old Asheville Recreation Park, Mile 4.7 to 5.5. The right bank of the Swannanoa River is within the corporate limits from the mouth to Mile 5.5. Property of the Biltmore Estate lies along the left bank of the Swannanoa River from Mile 1.4 to the mouth and along the right bank of the French Broad River from Swannanoa River upstream.

The flood plain of the French Broad River in the reach investigated varies in width from a few hundred feet up to about 1500 feet. On the left bank the flood plain is narrow except above Carrier Bridge, Mile 149.0 to 150.5, where the width is 200 to 800 feet, and between the West Asheville Viaduct and Smith Bridge, where it is about 600 feet wide. From the upper corporate limit at Swannanoa River the right bank flood plain of French Broad River widens to 1200 feet then reduces to about 800 feet in width at Town Branch. Between Town Branch and Pearson Bridge the right bank flood plain is generally 300 to 700 feet in width and from Pearson Bridge through Woodfin it is 300 to 600 feet wide. Below Woodfin the flood plain narrows to a negligible width, widens to about 400 feet at Craggy, narrows again and then widens to about 500 feet at Elk Mountain. Above the mouth of Swannanoa River there are two wide bottoms on the property of Biltmore Estate, one opposite Hominy Creek which is 1500 feet wide and one above Swannanoa River which is 700 to 1000 feet in width.

Developments in the Flood Plain

Plates 10 and 11 and Figures 2 to 5 and 7 to 10 show the highly developed flood plain of the French Broad River through Asheville. Within the area which would be overflowed in a very large flood, there are at present 140 active industrial and business firms and 61 occupied dwelling units. Some 29 commercial buildings are vacant. Table 3 identifies the industries and commercial establishments in the flood plain, gives the pertinent floor elevation for each and shows the elevation of the actual flood crest for the flood of July 1916, and for the Regional and Maximum Probable Floods under present conditions at each location. The tabulation lists 105 firms that would be subject to overflow in a flood of the height of the actual July 1916 flood. Some 33 of these firms were in the flood plain at the time of the floods

TABLE 3

FLOOD PLAIN STRUCTURES

FRENCH BROAD RIVER IN VICINITY OF ASHEVILLE, N. C.

Map Ref. No.	Identification	River Mile	Bank	Floor Elev.	Flood Elevations		
					1916 Actual	Regional (a)	Maximum Probable
<u>Hominy Creek to Carrier Bridge</u>							
	Bell, Sand Company	150.35	L	1982.4	1997.4	1998.3	2004.4
	Owens' Airfield	150.10-150.20	L	1977.5-1981.3	1996.8-1997.0	1997.7-1997.9	2004.0-2004.2
	Dr. J. E. Owens, Dentist	150.15	L	1981.8	1997.0	1997.9	2004.2
	Asheville Motor Speedway	149.98-150.10	L	1978.6	1996.6-1996.8	1997.5-1997.7	2003.9-2004.0
	Harris' Sand Company	149.92	L	1982.3	1996.4	1997.4	2003.9
	Amboy Drive-Inn	149.62	L	1980.6	1995.7	1996.8	2003.5
	Hy-Rocket Service Station	149.57	L	1982.0	1995.6	1996.7	2003.5
	Amoco Bulk Plant	149.50	L	1978.5	1995.5	1996.6	2003.4
<u>Carrier Bridge to West Asheville Viaduct</u>							
166	Southern Railway, car repair building	148.98	R	1991.6	1994.3	1995.4	2002.7
167	Standard Milling Company	148.58	R	1977.2-1979.6	1992.2	1993.8	2001.4
168	Days Warehouse	148.30-148.55	R	1978.7-1978.9	1990.8-1992.0	1992.3-1993.6	2000.3-2001.2
169	Ryder Truck Rentals	148.44	R	1977.5	1991.5	1993.1	2000.8
170	Ness Brothers Company	148.26-148.40	R	1978.7-1979.5	1990.8-1991.2	1992.2-1992.8	2000.2-2000.7
171	Champion Paper & Fibre Co., storage	148.40	R	1979.6	1991.2	1992.8	2000.7
172	Days Stock Yard Cafe	148.25	R	1978.7	1990.8	1992.2	2000.2
173	Days Stock Yard	148.25	R	1977.2	1990.8	1992.2	2000.2
174	Days Warehouse, vacant	148.24	R	1978.9	1990.8	1992.2	2000.2
175	Southern Railway Pullman Office	148.23	R	1986.5	1990.8	1992.1	2000.2
176	Southern Railway Sawmill	148.22	R	1981.4	1990.7	1992.1	2000.2
177	Days Tobacco Warehouse	148.07-148.22	R	1974.7-1976.0	1990.5-1990.7	1991.7-1992.1	1999.9-2000.2
178	Southern Railway Boiler Room	148.20	R	1990.7	1990.7	1992.1	2000.2
179	Southern Railway Yard Office	148.13	R	1983.3	1990.6	1991.9	2000.1
180	Southern Railway, Asheville Passenger Station	148.08	R	1985.7	1990.5	1991.8	1999.9
181	U. S. Post Office - Glenrock Station	148.08	R	1983.3	1990.5	1991.8	1999.9
182	Rea Auto Supply Storage	148.08	R	1982.5	1990.5	1991.8	1999.9
183	Southern Shoe Shop	148.08	R	1983.2	1990.5	1991.8	1999.9
184	Thatcher Furnace Company	148.08	R	1983.5	1990.5	1991.8	1999.9
185	Vacant	148.08	R	1983.5	1990.5	1991.8	1999.9
186	Vacant	148.08	R	1987.2	1990.5	1991.8	1999.9
187	Wilkins Mortuary	148.08	R	1987.4	1990.5	1991.8	1999.9
188	Vacant	148.08	R	1990.7	1990.5	1991.8	1999.9
189	Blue Plate Foods Warehouse	148.08	R	1988.8	1990.5	1991.8	1999.9
190	Southern Tool & Die Company	148.08	R	1988.6	1990.5	1991.8	1999.9
191	Vacant	148.08	R	1989.2	1990.5	1991.8	1999.9
192	Railway Express Garage	148.08	R	1989.2	1990.5	1991.8	1999.9
193	Seal Buick Company Body Shop	148.08	R	1991.2	1990.5	1991.8	1999.9
194	Rose 5 & 10 Cent Store Warehouse	148.08	R	1997.2	1990.5	1991.8	1999.9
195	Biltmore Foods Warehouse	148.08	R	1997.9	1990.5	1991.8	1999.9
196	Allen Birchette Funeral Home	148.08	R	2002.7	1990.5	1991.8	1999.9
197	Auto Repair Shop	148.08	R	1997.4	1990.5	1991.8	1999.9
198	Cut Rate Market	148.08	R	1997.6	1990.5	1991.8	1999.9
199	Fair Grocery	148.08	R	1996.3	1990.5	1991.8	1999.9
200	C. P. Grocery	148.08	R	1988.7	1990.5	1991.8	1999.9
201	Vacant	148.08	R	1988.7	1990.5	1991.8	1999.9
202	James Keys Hotel	148.08	R	1988.5	1990.5	1991.8	1999.9
203	Phillips 66 Service	148.08	R	1988.8	1990.5	1991.8	1999.9
204	Rea Auto Supply	148.08	R	1985.3	1990.5	1991.8	1999.9
205	OK Cash Store	148.08	R	1983.4	1990.5	1991.8	1999.9
206	(Nantahala Hotel	148.08	R	1982.2	1990.5	1991.8	1999.9
	(Asheville ABC Store	148.08	R	1982.2	1990.5	1991.8	1999.9
207	Service Cleaners	148.08	R	1982.4	1990.5	1991.8	1999.9
208	Artex Manufacturing Company	148.08	R	1982.6-1982.9	1990.5	1991.8	1999.9
209	(Glen Rock Hotel	148.08	R	1982.9	1990.5	1991.8	1999.9
	(Ansel Refrigeration Company	148.08	R	1982.9	1990.5	1991.8	1999.9
	(Vacant	148.08	R	1982.9	1990.5	1991.8	1999.9
	(Atlantic Cafe	148.08	R	1982.9	1990.5	1991.8	1999.9
	(Vacant	148.08	R	1982.9	1990.5	1991.8	1999.9
	(Chandler's Barber Shop	148.08	R	1982.9	1990.5	1991.8	1999.9
210	Used Appliance Shop	148.08	R	1982.9	1990.5	1991.8	1999.9
211	Speedy Grill	148.08	R	1983.3	1990.5	1991.8	1999.9
212	Irving Ness Company	148.08	R	1981.8-1987.4	1990.5	1991.8	1999.9
213	Irving Ness Company	148.08	R	1986.7	1990.5	1991.8	1999.9
214	Armour & Company	148.08	R	1987.5	1990.5	1991.8	1999.9
215	Kelly Fruit Company	148.07	R	1991.0	1990.5	1991.7	1999.9
216	Evans Poultry House	148.07	R	2009.4	1990.5	1991.7	1999.9
217	Vacant	148.07	R	1991.8	1990.5	1991.7	1999.9
218	Irving Ness Company	148.06	R	1992.3	1990.5	1991.6	1999.8
219	Vacant	148.06	R	1976.3	1990.4	1991.6	1999.8
220	Vacant	148.05	R	1976.3	1990.4	1991.6	1999.8
221	Asheville Waste Paper Company	148.05	R	1993.6	1990.4	1991.6	1999.8
222	Smith Brokerage Company	148.05	R	1993.6	1990.4	1991.6	1999.8
223	Sands & Company Grocery	148.05	R	1995.4	1990.4	1991.6	1999.8
224	Vacant	148.04	R	1977.4	1990.4	1991.6	1999.7
225	Asheville Livestock Yards	147.97-148.04	R	1975.5	1990.1-1990.4	1991.3-1991.6	1999.4-1999.7
226	Ness Brothers Company	148.04	R	1996.4	1990.4	1991.6	1999.7
227	Vacant	148.03	R	1995.4	1990.3	1991.5	1999.7
228	Vacant	148.02	R	1995.5	1990.3	1991.5	1999.7
229	Service Station, Vacant	148.02	R	1998.2	1990.3	1991.5	1999.7
230	Ness Brothers Company	148.01	R	2008.6	1990.3	1991.5	1999.6

TABLE 3 (Continued)

FLOOD PLAIN STRUCTURES

FRENCH BROAD RIVER IN VICINITY OF ASHEVILLE, N. C.

Map Ref. No.	Identification	River Mile	Bank	Floor Elev.	Flood Elevations		
					1916 Actual	Regional (a)	Maximum Probable
<u>Carrier Bridge to West Asheville Viaduct (Continued)</u>							
231	Vacant	148.00	R	1997.0	1990.2	1991.4	1999.5
232	Vacant	148.00	R	1996.9	1990.2	1991.4	1999.5
233	Busters Body Shop	147.97-147.99	R	1995.6	1990.1-1990.2	1991.3-1991.4	1999.4-1999.5
234	Highland Distributing Company	147.98	R	1995.8	1990.2	1991.4	1999.5
235	Asheville Stock Yard Office	147.98	R	1974.7	1990.2	1991.4	1999.5
236	Stock Yard Cafe	147.98	R	1975.4	1990.2	1991.4	1999.5
237	Kahn Company	147.95-147.98	R	1970.4-1979.8	1990.0-1990.2	1991.2-1991.4	1999.3-1999.5
238	Vacant	147.97	R	1995.2	1990.1	1991.3	1999.4
239	Vacant	147.97	R	1993.0	1990.1	1991.3	1999.4
240	PYA Distributing Company	147.95-147.97	R	1995.6	1990.0-1990.1	1991.2-1991.3	1999.3-1999.4
241	Southern Railway, Vacant	147.93-147.97	R	1987.2	1989.8-1990.1	1991.2-1991.3	1999.2-1999.4
242	Chas. M. Britt, brokers	147.94-147.96	R	1991.9	1989.9-1990.0	1991.2-1991.3	1999.2-1999.4
243	Trading Post	147.93	R	1972.4	1989.9	1991.2	1999.2
244	Citizens Fuel Company	147.93	R	1975.8	1989.9	1991.2	1999.2
245	Asheville Topsoil Company	147.91	R	1973.2	1989.7	1991.1	1999.2
246	Texaco Oil Bulk Plant	147.87-147.90	R	1975.7	1989.4-1989.6	1991.1	1999.1-1999.2
247	Pure Oil Bulk Plant	147.84-147.87	R	1994.8	1989.2-1989.4	1991.0-1991.1	1999.1
248	Post Machinery Company	147.81-147.83	R	1971.2-1975.1	1989.0-1989.1	1991.0	1999.1
249	Denison Manufacturing Company	147.81	R	1974.5-1978.3	1989.0	1991.0	1999.1
250	Ballards Truck Stop Cafe	147.80	R	1976.6	1988.9	1991.0	1999.1
251	Ned Wheeler Brokerage Company	147.80	R	1986.5	1988.9	1991.0	1999.1
252	Bailey Brokerage Company	147.80	R	1992.4	1988.9	1991.0	1999.1
253	Public Ser. Co. of N.C., gas plant	147.78	R	1976.8	1988.8	1991.0	1999.0
254	Robertson & Baker Garage	147.76-147.78	R	1974.9-1976.1	1988.6-1988.8	1990.9-1991.0	1999.0
255	Warehouse - Bailey Brokerage Company	147.78	R	1988.3	1988.8	1991.0	1999.0
256	Dave Steel Company	147.72-147.78	R	1990.4-1993.6	1988.0-1988.8	1990.8-1991.0	1999.0
257	Ashe. Blue Gem Coal Company	147.75	R	1986.1-1991.0	1988.6	1990.9	1999.0
253a	Public Service Company of N. C.	147.72-147.74	R	1980.4	1988.0-1988.6	1990.8-1990.9	1999.0
258	Vacant	147.72	R	1993.0	1988.0	1990.8	1999.0
259	Carolina P & L Company substation	147.72	R	1975.5	1988.0	1990.8	1999.0
260	Farmers Federation, Warehouse	147.68-147.72	R	1999.6-2002.8	1987.5-1988.0	1990.8	1999.0
261	Farmers Federation	147.66-147.68	R	1988.5	1987.2-1987.5	1990.1-1990.8	1998.5-1999.0
<u>West Asheville Viaduct to Smith Bridge</u>							
262	Pearce-Young & Angle, warehouse	147.62	R	1986.7	1987.0	1990.1	1998.1
263	Asheville Ice & Storage Company	147.55-147.62	R	1977.3-1981.6	1986.7-1987.0	1990.0	1998.0-1998.1
264	Tidewater Supply Company	147.58	R	1986.9	1986.8	1990.0	1998.0
265	Leemon Dist. Company (under construction)	147.54	R	1976.0±	1986.7	1990.0	1998.0
266	Main Auto Parts	147.47-147.51	L	1973.9-1975.2	1986.3-1986.4	1989.9	1998.0
267	Beacon Blanket Company warehouse	147.37-147.50	R	1970.3-1978.3	1985.8-1986.4	1989.8-1989.9	1997.9-1998.0
268	All-Aluminum Company	147.46	R	1973.6	1986.2	1989.9	1998.0
269	Dixie Tobacco Warehouse No. 1	147.35-147.46	L	1978.9-1979.8	1985.7-1986.2	1989.8-1989.9	1997.9-1998.0
270	Clyde Eby, Incorporated	147.44	R	1973.1	1986.1	1989.9	1998.0
271	W. N. C. Livestock Market	147.37-147.41	L	1977.6	1985.8-1986.0	1989.8	1997.9
272	Beacon Blanket Company Warehouse	147.37-147.40	R	1973.7	1985.8-1985.9	1989.8	1997.9
273	Earl Chesterfield Mills	147.33-147.39	R	1987.3-1996.8	1985.7-1985.9	1989.8	1997.9
274	(Farmers Supply Company Warehouse)	147.39	L	1979.3	1985.9	1989.8	1997.9
	(Farmers Supply Company Warehouse)	147.36	L	1979.0	1985.8	1989.8	1997.9
275	W N C Livestock Market, office	147.36	L	1977.1	1985.8	1989.8	1997.9
276	Farmers Livestock Supply Company	147.34	L	1975.4	1985.7	1989.7	1997.9
277	L & M Cafe	147.34	L	1975.4	1985.7	1989.7	1997.9
278	Vacant	147.34	R	1971.8	1985.7	1989.7	1997.9
279	Bonitz Insulating Company	147.34	R	1981.7	1985.7	1989.7	1997.9
280	Earl Chesterfield Mills, office	147.34	R	1977.2-1987.3	1985.7	1989.7	1997.9
<u>Smith Bridge to Southern Railway Bridge</u>							
281	Vacant	147.32	R	1990.9	1985.6	1989.2	1997.6
282	Vacant	147.32	R	1987.0	1985.6	1989.2	1997.6
283	J. M. Westall Company	147.25-147.32	R	1975.1-1986.1	1985.3-1985.6	1987.9-1989.2	1996.7-1997.6
284	Farmers Truck Stop Cafe	147.32	R	1980.5	1985.6	1989.2	1997.6
285	Bryan Packing Company	147.31	L	1981.1-1981.5	1985.6	1988.1	1996.9
286	Buncombe Company school bus garage	147.28	L	1975.0	1985.4	1988.0	1996.8
287	Vacant	147.28	R	1987.0	1985.4	1988.0	1996.8
288	Southern Fuel Company	147.21	R	1973.1	1985.0	1987.7	1996.5
289	Concrete Specialty Company	147.20	R	1971.9	1985.0	1987.6	1996.5
290	Hunter Funeral Supply Company	147.20	R	1973.9	1985.0	1987.6	1996.5
<u>Southern Railway Bridge to Pearson Bridge</u>							
	Post Machinery Company, foundry	146.90	R	1980.5	1980.3	1983.3	1989.9
	Edaco Used Auto Parts	146.88	R	1977.1	1980.2	1983.2	1989.8
	Tates Auto Parts	146.75	R	1974.0-1979.2	1979.4	1982.7	1989.4
	Asheville Incinerator Building, Vacant	146.72	R	1986.7	1979.1	1982.5	1989.3
	Fritchey's Auto Parts	146.68	R	1973.6	1978.9	1982.3	1989.1
	Chucks Auto Parts	146.56	R	1969.7-1971.1	1978.1	1981.7	1988.6
	Davis-Fowler Salvage	146.53	R	1968.8-1970.2	1978.0	1981.6	1988.5
	Sky City Truck Stop	146.42	R	1970.6	1977.3	1981.0	1987.9
	Ford's Auto Parts	146.39	R	1967.9	1977.1	1980.8	1987.7
	Adams & Hill Warehouse & Farmers Market	146.28-146.36	R	1968.1-1969.6	1976.5-1976.9	1980.2-1980.7	1987.2-1987.6
	Farmers Market	146.23-146.26	R	1969.4	1976.1-1976.4	1979.9-1980.1	1987.0-1987.1
	Asheville Used Auto Parts	146.18	R	1969.4	1975.9	1979.7	1986.7

TABLE 3 (Concluded)

FLOOD PLAIN STRUCTURES

FRENCH BROAD RIVER IN VICINITY OF ASHEVILLE, N. C.

Map Ref. No.	Identification	River Mile	Bank	Floor Elev.	Flood Elevations		
					1916 Actual	Regional (a)	Maximum Probable
<u>Pearson Bridge through Woodfin</u>							
	McChee Construction Company	145.74	R	1967.5	1973.2	1975.1	1981.2
	Plemmons Truck Stop	145.56	R	1959.3-1963.4	1971.6	1972.6	1977.5
	Riverside Motor Company	145.54	R	1961.5-1963.4	1971.5	1972.5	1977.4
	Tates Battery Company	145.50	R	1958.6	1971.1	1972.1	1977.0
	Asheville By-Products Company	145.46	R	1958.4-1959.8	1970.8	1971.9	1976.8
	Reynolds Storage Company warehouse	145.40	R	1968.8	1970.2	1971.4	1976.3
	Mutual Dist. Company, warehouse	145.38	R	1969.2	1970.1	1971.3	1976.2
	Planters Tobacco Warehouse No. 2	145.32-145.37	R	1967.6-1970.4	1969.6-1970.1	1970.9-1971.3	1975.8-1976.1
	Carlton Products Company, storage	145.36	R	1957.6-1968.7	1970.0	1971.2	1976.0
	Vacant	145.34	R	1955.0	1969.8	1971.0	1975.9
	Vacant	145.34	R	1966.7	1969.8	1971.0	1975.9
	Mutt & Jeff Produce	145.33	R	1965.8	1969.7	1971.0	1975.9
	Superior Coal Company	145.27	R	1968.2	1969.3	1970.5	1975.5
	Superior Lumber Company	145.19-145.22	R	1961.4-1965.5	1968.5-1968.7	1970.0-1970.2	1974.9-1975.1
	Williams Feed Store, warehouse	145.18	R	1964.4	1968.4	1969.9	1974.8
	Hicks Corporation	144.95-145.10	R	1958.9-1962.6	1966.6-1967.8	1968.3-1969.4	1973.2-1974.3
	Deweese Barber Shop	145.00	R	1970.2	1967.0	1968.7	1973.6
	Ayers Esso Service	144.97	R	1969.8	1966.8	1968.4	1973.4
	Honeycutt Grocery	144.96	R	1971.7	1966.7	1968.3	1973.3
	Carlton Products Company	144.80-144.83	R	1955.7-1970.7	1965.4-1965.6	1967.1-1967.4	1972.1-1972.3
	Young Brothers Grocery	144.83	R	1969.4	1965.6	1967.4	1972.3
	Ramsey's Grocery	144.83	R	1968.4	1965.6	1967.4	1972.3
	Woodfin Coffee Shop	144.82	R	1968.1	1965.5	1967.3	1972.2
	DeBord's Restaurant	144.82	R	1967.7	1965.5	1967.3	1972.2
	Carolina Bus Sales	144.81	R	1957.9	1965.5	1967.2	1972.1
	Vacant	144.81	R	1969.1	1965.5	1967.2	1972.1
	Phillips 66 Service	144.80	R	1969.1	1965.4	1967.1	1972.1
	Lodenberg & Son Shop	144.79	R	1970.9	1965.4	1967.1	1972.0
	Gordon Furniture Company	144.64-144.78	R	1954.8-1959.2	1964.1-1965.3	1965.8-1967.0	1970.8-1971.9
	Porter Music Company	144.75	R	1971.8	1965.0	1966.7	1971.7
	Griffin Grocery	144.74	R	1970.3	1964.9	1966.7	1971.6
	Vacant	144.63	R	1972.5	1964.1	1965.7	1970.7
	Crouch Grocery	144.62	R	1970.2	1964.0	1965.5	1970.6
	Pender Fox Stand	144.62	R	1969.9	1964.0	1965.5	1970.6
	Trailer Court Store	144.52	R	1952.9	1963.0	1964.6	1969.5
	Woodfin Trailer Court	144.40-144.52	R	1951.9	1961.9-1963.0	1963.4-1964.6	1968.2-1969.5
	Woodfin Coal & Oil Company	144.50	R	1957.1-1959.7	1962.8	1964.5	1969.4
<u>Woodfin to Craggy Dam</u>							
	N. C. State Highway Bridge Department	143.70-143.80	R	1948.6-1967.7	1955.5-1956.4	1955.7-1956.9	1960.2-1961.3
	Farmers Federation	143.26	R	1949.3	1951.9	1951.1	1955.4
	Farmers Federation Warehouse	143.20	R	1949.4-1950.6	1951.4	1950.5	1954.7
	Farmers Federation Warehouse	143.17	R	1949.6	1951.3	1950.2	1954.5
	Waynes Grocery & Service Station	143.12	R	1967.0	1950.9	1949.7	1953.9
	Craggy Milling Company	143.12	L	1950.4-1954.3	1950.9	1949.7	1953.9
	Southern Railway - Craggy Station	143.09	L	1947.5-1949.3	1950.7	1949.4	1953.5
	Burlington Mills	142.30-142.48	R	1937.8-1946.8	1942.2-1944.1	1942.4-1943.8	1945.2-1946.9
	C P & L Company Steam Plant	142.24	R	1938.4-1952.5	1941.7	1942.0	1944.7

(a) The Regional Flood peak discharge is the same as that of July 1916. Higher elevations than those actually occurring in 1916 result from present developments and land fills in the flood plain.

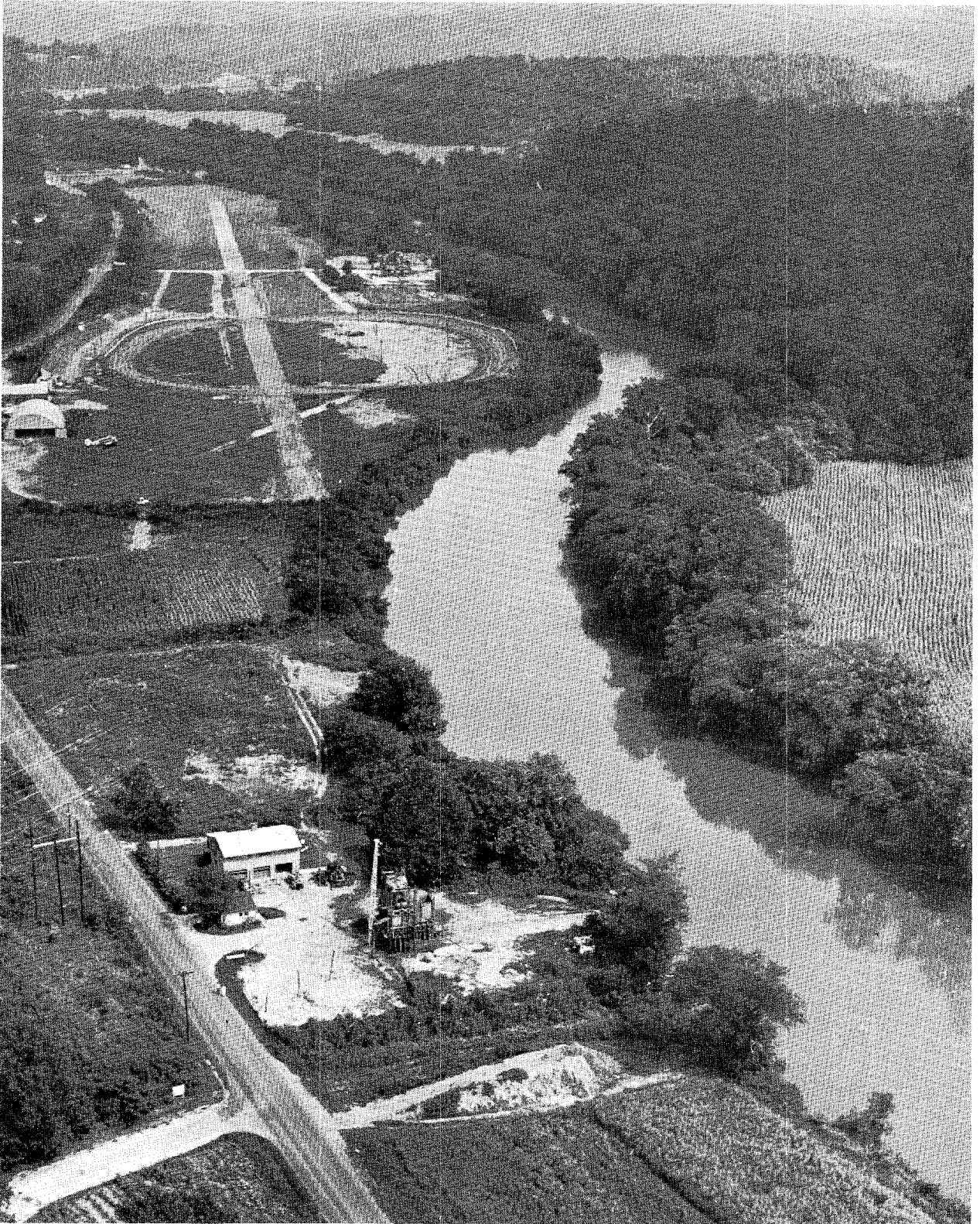


Figure 2. --FLOOD PLAINS ABOVE CARRIER BRIDGE

Aerial view of French Broad River and flood plains, looking downstream from about Mile 150.6. Bell Sand Company is in the left foreground. Owen's Airfield and an auto racetrack are near the center of the picture.

(Photo by H. Malcolm Gamble, Asheville Citizen-Times)

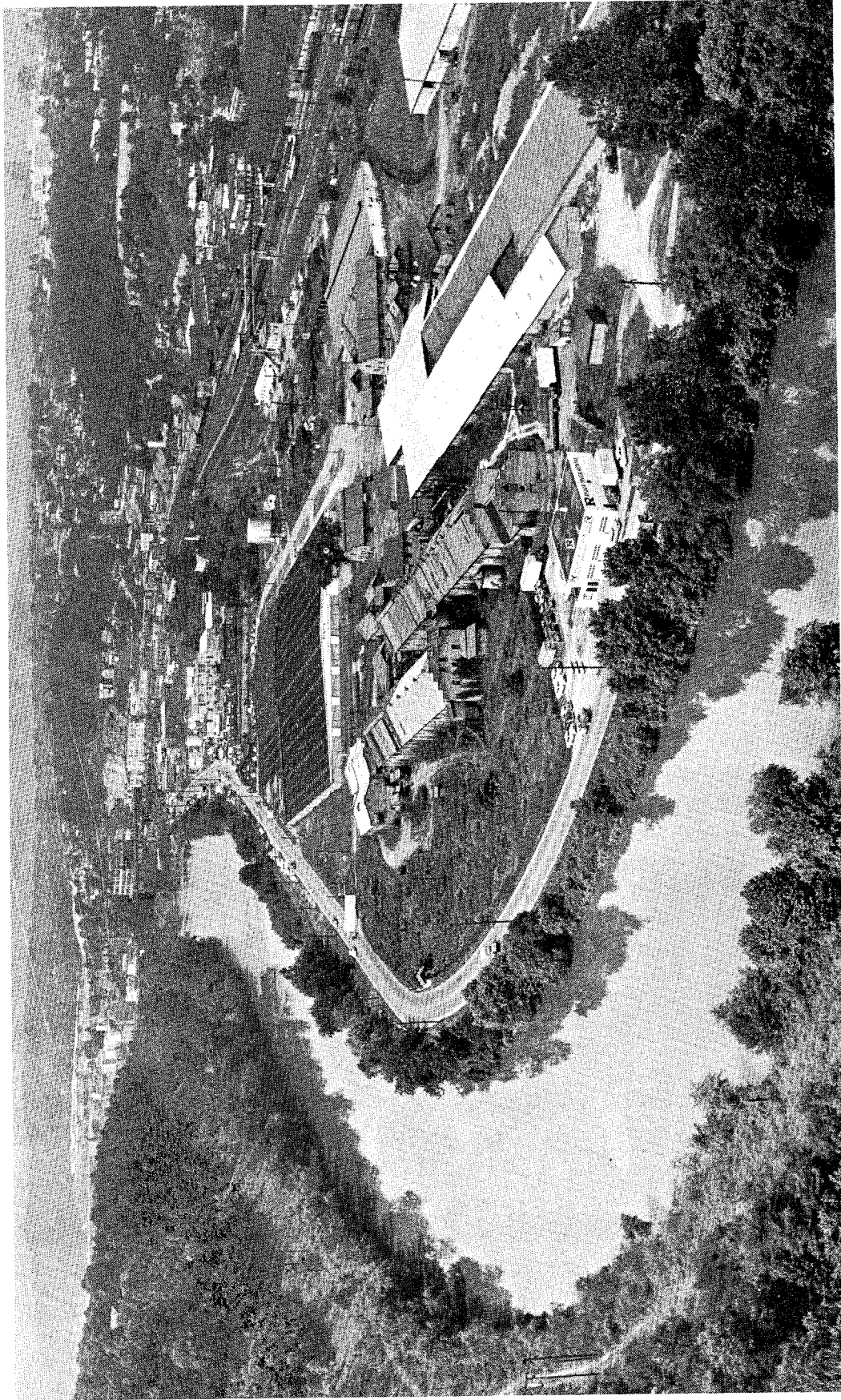


Figure 3. --DEVELOPMENTS JUST BELOW CARRIER BRIDGE

This view, looking down the French Broad River from about Mile 148.7, shows the upper end of the heavy flood plain development along the right side of the river. Ness Brothers occupies the old Hans Rees Tannery buildings. Day's large tobacco warehouse is new since 1940.

(Photo by H. Malcolm Gamble, Asheville Citizen-Times)

of August 1940. Very few of the 50 or more firms that were there at the time of the 1916 flood are still occupying the flood plain. A number of firms which have passed through floods of the past are operating today under different ownership.

There has been a notable increase in the development of the flood plain since the large floods in August 1940. A number of the larger industries and commercial developments have sold out or closed down for various reasons, but others have moved in, most particularly in recent years, to make use of the available buildings or building sites and to be near the transportation facilities. Opening of the Asheville truck route along the river has brought in many service businesses. The raised level land made available by the City's sanitary landfill system along the river has been inviting to developers.

The industrial development along the French Broad River is concentrated where railroad service is available and where the widest bottom lands are found, between Carrier Bridge and the Southern Railway bridge and in the Woodfin section. Commercial developments are most numerous in the section on Depot and Southside Streets near the Southern Railway passenger station, around Smith Bridge, and along the truck route between Carrier Bridge and Woodfin.

The Southern Railway takes up most of the right bank flood plain near Carrier Bridge where their engine and car service shops are located. The Asheville switch yards center at this point, extending upstream along the Swannanoa River and downstream along the French Broad River to beyond Town Creek, a distance of about a mile. The Asheville passenger station is at the north side of the yards at Town Creek. Main line tracks extend from the yards down the right bank and cross the river on the double-track bridge which angles across the stream a mile below the station. At Murphy Junction, which is at the left bank end of the bridge, the Murphy Line of the railroad turns west from the main line. The main line tracks follow the left bank of the river through Craggy toward Marshall and Hot Springs. A spur track which leaves the main line at the bridge follows the right bank between the river and the truck route to serve developments as far downstream as the Elk Mountain section.

There are nineteen developments which are classed as industries in the French Broad flood plain. These include a furniture factory, a cotton mill, 4 feed processing mills, 2 meat packing plants, a charcoal packing plant, two steel fabricators, a plastic pipe manufacturer, a rug factory, a rag salvage company, two

machinery firms, a battery manufacturing firm, and two sand and gravel plants. Developments which are classed as commercial include 13 food distributors, 9 auto parts firms, three bulk oil plants, four building supply firms, five fuel suppliers, three feed stores, six service stations, four garages, ten eating places, 13 grocery stores, a farmers' produce market, three stockyards, four tobacco sales warehouses, a commercial flying field and a motor speedway.

There are 42 residences or other dwelling units on the flood plain in the vicinity of the railway depot. Other homes in the flood plain include 7 at Woodfin, 8 between Woodfin and Craggy Dam, and 4 at scattered locations.

Highway planning studies are now under way to decide the routes for the Interstate System in the Asheville area, as well as interconnecting primary highways and urban access highways. It is likely that the next few years will see many changes in highways in the area, some of which will affect flood plain development along the French Broad River, perhaps to a marked degree.

Sanitary sewage is discharged into the French Broad River from 27 outfall sewers in the Asheville reach. Four Asheville sewers discharge into Hominy Creek which joins French Broad River at the upper corporate limit. An engineering study and report on the sewage problem for the metropolitan area of Asheville, issued in 1952, recommends the construction of a sewage treatment plant to be located on the right bank of French Broad River near Craggy with a system of intercepting sewers to bring the sewage to the plant. A smaller plant upstream from Asheville would treat the waste from the area south of the city. The plan proposes a 27-inch intercepting sewer along Hominy Creek and a 33-inch line along the left bank of French Broad River from Hominy Creek to Carrier bridge and crossing the river at that point. A main collecting sewer would take the discharge from this line and from the Swannanoa Sewer District line and follow the right bank to the treatment plant, intercepting all the lines which now empty into the river on that side. A West Asheville intercepting sewer would be built on the left bank from near the West Asheville viaduct to Mill Creek where it would cross the river and join the main line, and another intercepting sewer would run upstream from Beaverdam Creek to the treatment plant.

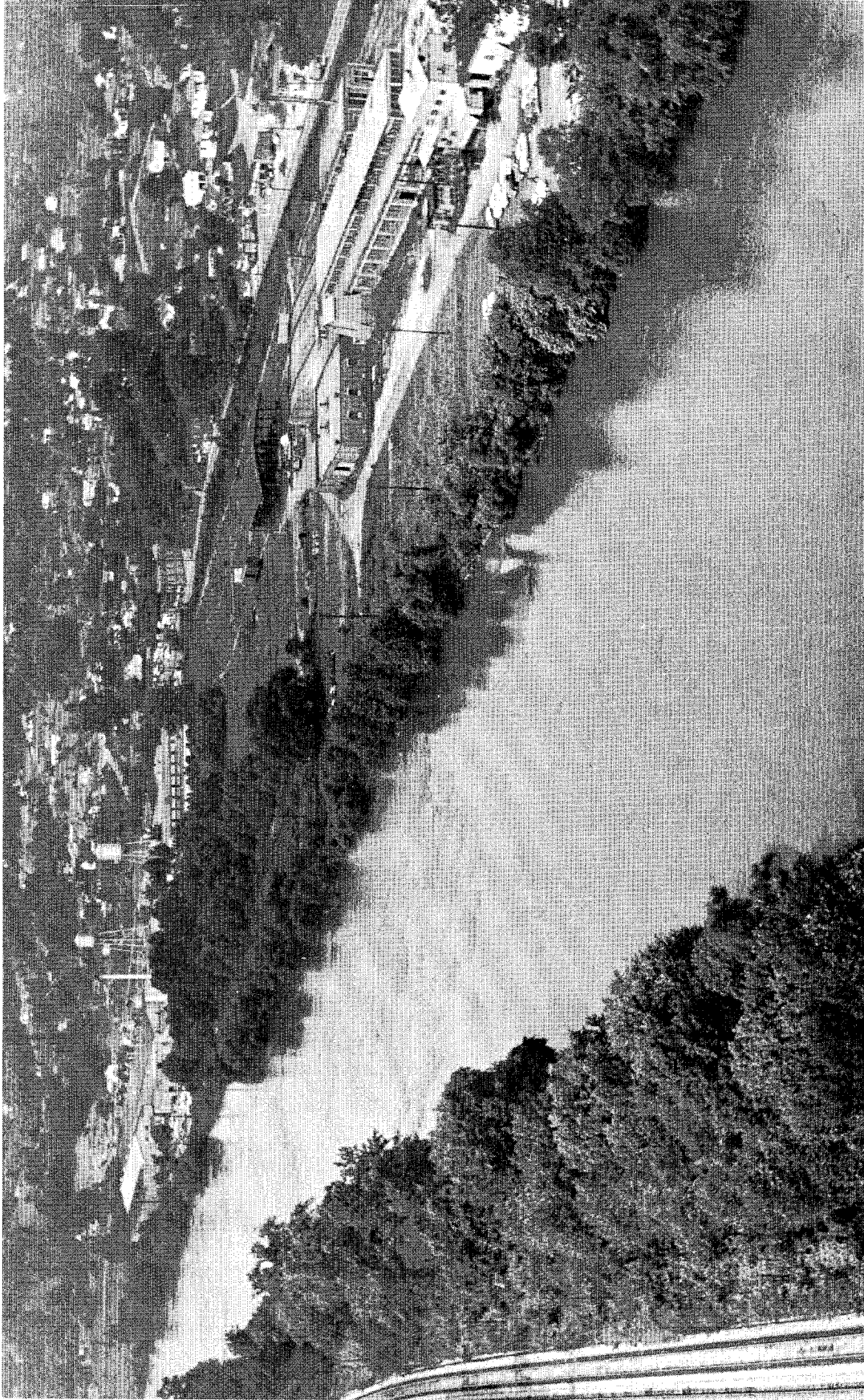


Figure 4. --WOODFIN MANUFACTURING DISTRICT

This view is downstream from about Mile 145. 3. The Hicks Corporation plant at the lower right was formerly the National Casket Company. (Photo by H. Malcolm Gamble, Asheville Citizen-Times)

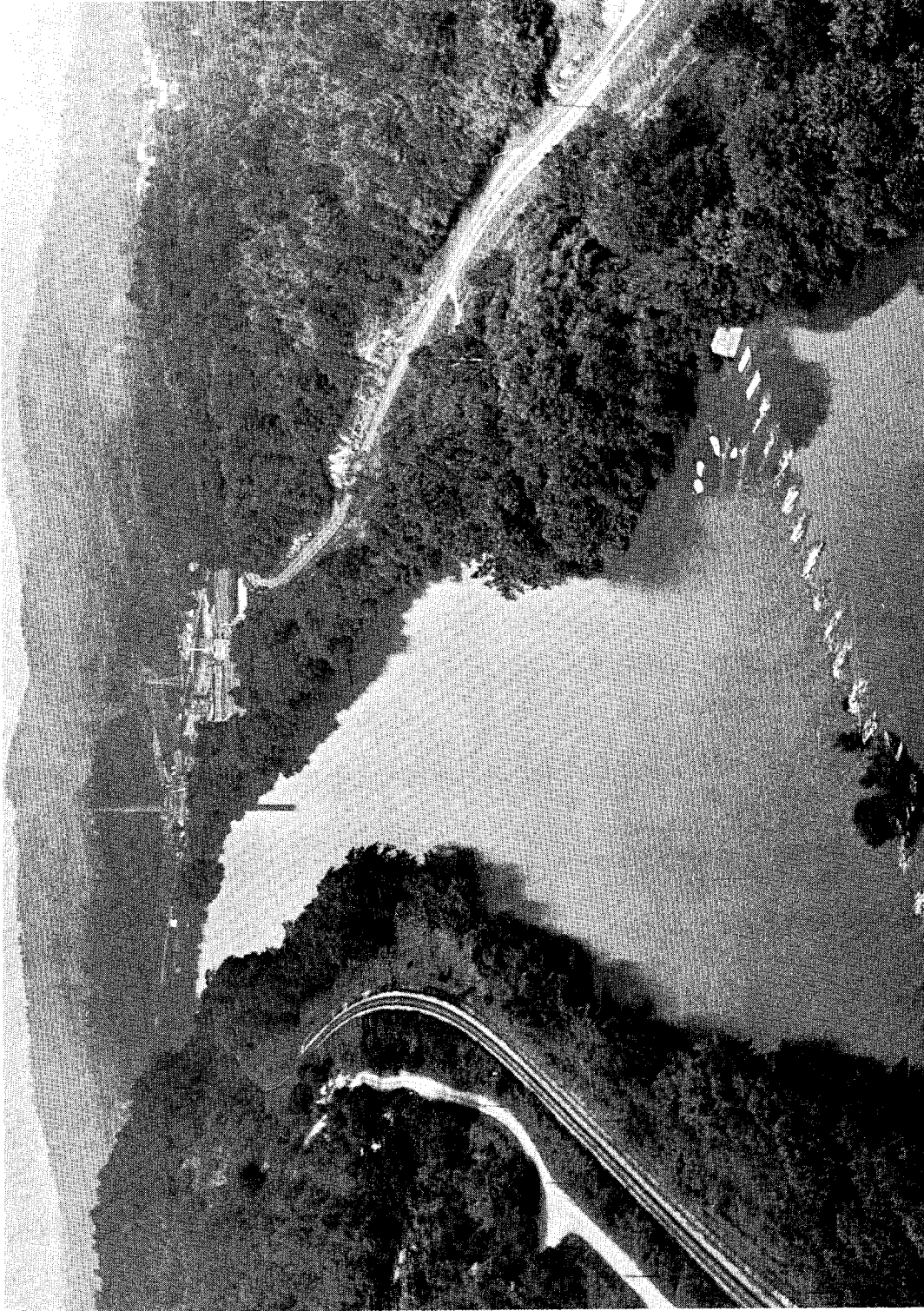


Figure 5. --FLOOD PLAIN BELOW CRAGGY BRIDGE

The river in this view is in backwater from Craggy Dam. The remains of the old Southern Railway bridge at Mile 143.0 are in the foreground.

(Photo by H. Malcolm Gamble, Asheville Citizen-Times)

Bridges Across the Stream

Six highway bridges and one railroad bridge cross French Broad River in the reach investigated. Table 4 lists pertinent elevations for these bridges and shows the relation to the actual crest of the July, 1916 flood on the river. Figures 6 to 9 are photographs of the bridges.

TABLE 4
BRIDGES ACROSS FRENCH BROAD RIVER
IN VICINITY OF ASHEVILLE, NORTH CAROLINA

<u>Mile Above Mouth</u>	<u>Identification</u>	<u>Low Water Elev. feet</u>	<u>Floor Elev. feet</u>	<u>Actual 1916 Flood Crest feet</u>	<u>Underclearance</u>		
					<u>Elev. feet</u>	<u>Above Flood feet</u>	<u>Below Flood feet</u>
143.08	Craggy	1931.3	1972.7	1950.6	1969.5	18.9	
145.75	Pearson	1951.7	1976.4	1973.4	1975.1	1.7	
147.08	Southern Railway	1961.2	1990.6	1984.3	1980.6		3.7
147.23	Smoky Park	1961.7	2054.4	1985.1		high	
147.33	Smith	1962.6	1988.0	1985.5	1985.5		0.0
147.66	West Asheville	1963.0	2014.3	1987.2	2007.3	20.1	
148.98	Carrier	1967.0	1994.7	1994.4	1991.3		3.1

Of the bridges over the French Broad River, three highway bridges have high clearances and have little effect on flood flows. These are the West Asheville Viaduct, the four-lane Smoky Park bridge completed in 1950 and the bridge at Craggy. The railroad bridge and the remaining three highway bridges are low enough to present some obstruction to flood flows.

Carrier Bridge, Figure 6, which crosses the French Broad River just below the mouth of Swannanoa River, is a concrete and steel structure completed in 1951. It replaced a steel truss bridge which in turn was built to replace the one destroyed there by the flood of July 1916. The floor of the present bridge is just above the elevation reached by the actual 1916 flood, but it would be overtopped in a recurrence of that flood since there is now somewhat less opening under the bridge

and flow capacity has been altered on the right bank by approach fills and other changes.

Smith Bridge, Figure 8, is a seven-span concrete arch bridge built after the steel truss bridge at the site was lost in 1916. The floor is at elevation 1983.2 feet at the ends of the bridge and rises to 1988 feet at the center. The actual 1916 flood crest was at elevation 1985.5, 2.3 feet higher than the ends of the present bridge. However, a recurrence of that flood would flow over the bridge floor.

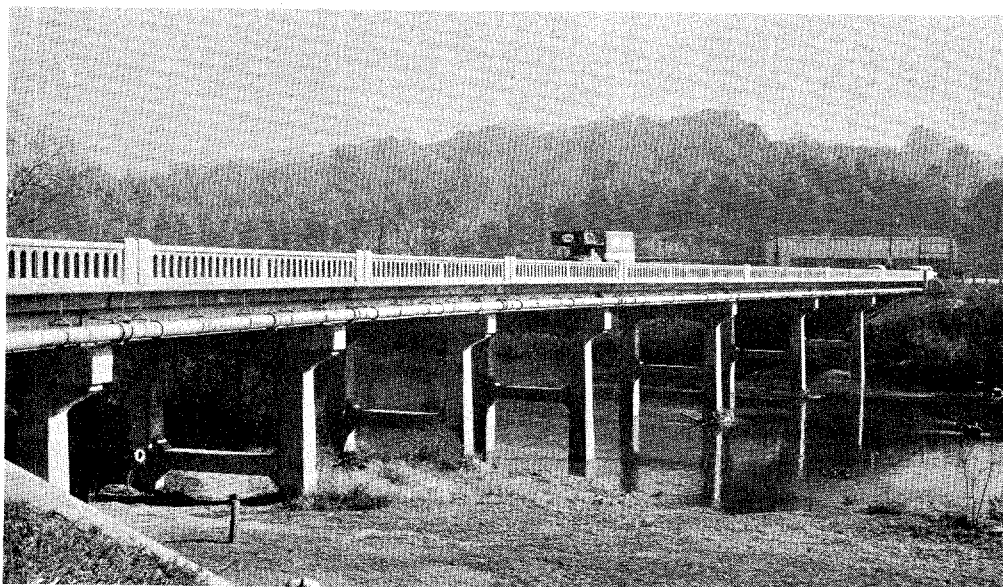
The Southern Railway bridge, Figure 8, is of heavy concrete construction with 22 openings each 30 feet wide. It is built at an angle of about 45 degrees to the flow line of the stream with the left end farthest downstream. In the 1916 flood, debris piled high against the upstream side of the bridge but it withstood the flood without damage. Flood waters headed up about 2.4 feet at the bridge but lacked about 6 feet of reaching track level.

Pearson Bridge, Figure 9, is a concrete arch bridge of five spans built after the 1916 flood to replace the steel truss bridge which was washed out at the time. Like Smith Bridge, the floor of this structure is five feet higher at the center than at the ends. The 1916 flood crest was two feet higher than the roadway at the ends of the bridge and considerably higher than the right bank approach to the bridge. However, because of the land fill on the right bank upstream, a recurrence of the 1916 flood would be 3.7 feet higher than the actual flood just above the bridge.

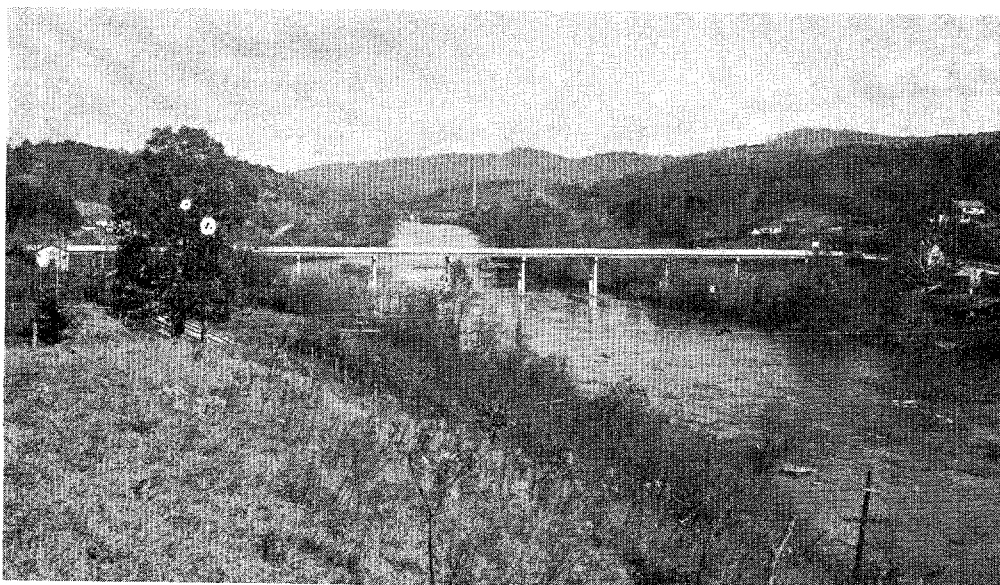
The West Asheville Viaduct, Figure 7, was the only highway bridge left on the French Broad River in the Asheville vicinity after the flood of July 1916. The bridge has two concrete arch spans and has its floor at elevation 2014.3 feet, 27 feet higher than the actual 1916 flood crest.

The Smoky Park bridge, Figure 8, crosses the river at Mile 147.23 between Smith Bridge and the Southern Railway bridge. It has four lanes, carries U. S. Highways 19 and 23 and State Highway 191, and handles heavy local traffic to and from downtown Asheville. The Asheville Expressway, to be opened to traffic in late 1960, will connect with the right end of the bridge. The bridge spans the river between high bluffs, and floor and underclearance elevations are both well above flood danger.

Also a high bridge is the one at Craggy, Mile 143.08, shown in Figure 6. The bridge washed out by the 1916 flood was replaced by a high level concrete arch



Carrier Bridge, Mile 148.98, looking downstream. This structure, built in 1951, replaces a steel truss bridge. An earlier bridge was destroyed by the July 1916 flood. A recurrence of the 1916 flood would overtop the floor of the present bridge.



Craggy Bridge, Mile 143.08, looking downstream. Rebuilt in 1954, the underclearance is 19 feet above the level of the 1916 flood which washed out an earlier bridge.

Figure 6. --CARRIER AND CRAGGY BRIDGES ACROSS
FRENCH BROAD RIVER

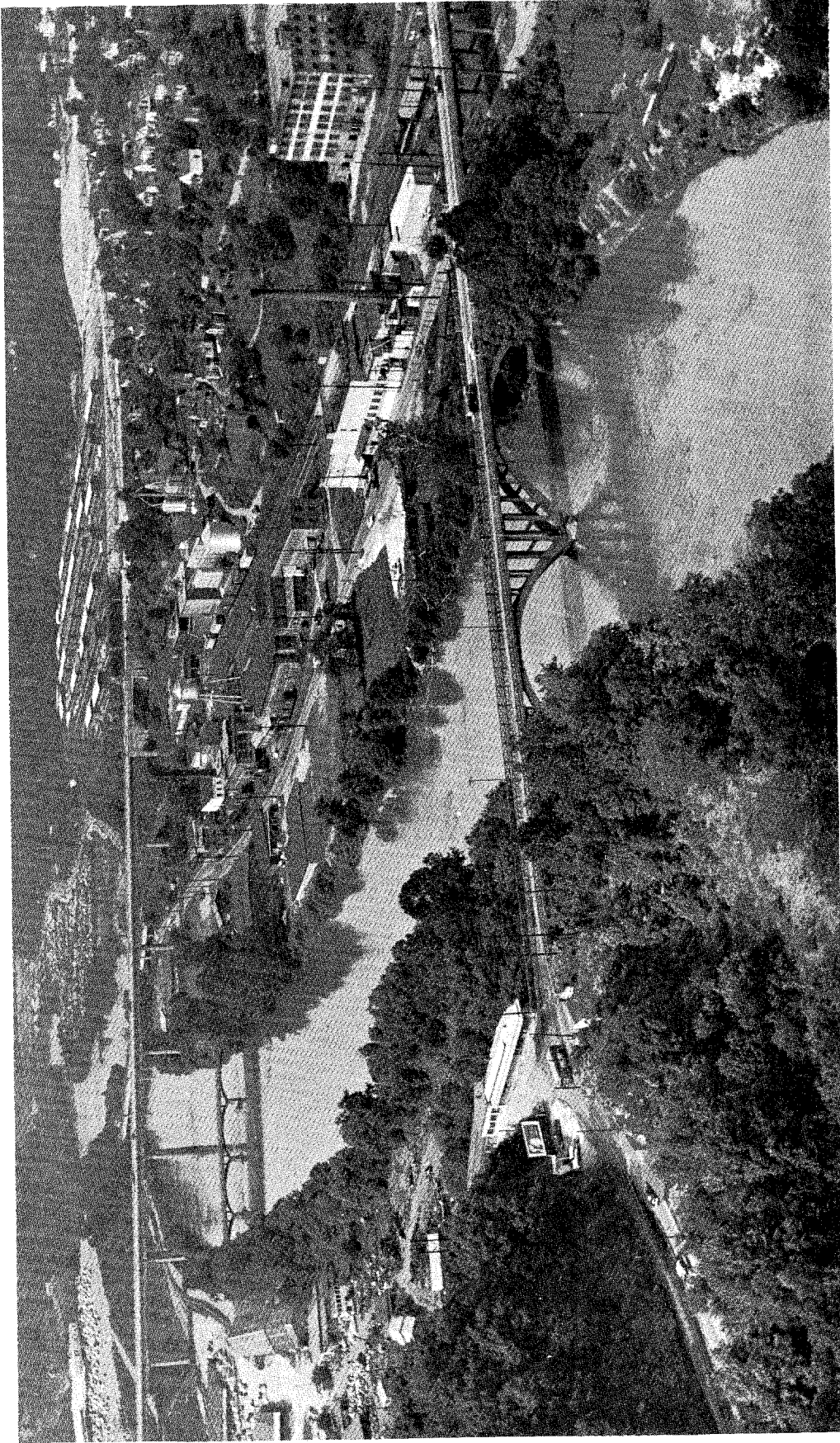


Figure 7. --WEST ASHEVILLE VIADUCT AND FLOOD PLAIN DEVELOPMENT

The viaduct, in the foreground, is at Mile 147.66. It was the only street bridge left at Asheville after the 1916 flood. A recurrence of the 1916 flood would be 24 feet under the bridge floor, but it would flood all of the buildings downstream from the bridge on the right bank riverward from the Earl Chesterfield Mills.

(Photo by H. Malcolm Gamble, Asheville Citizen-Times)

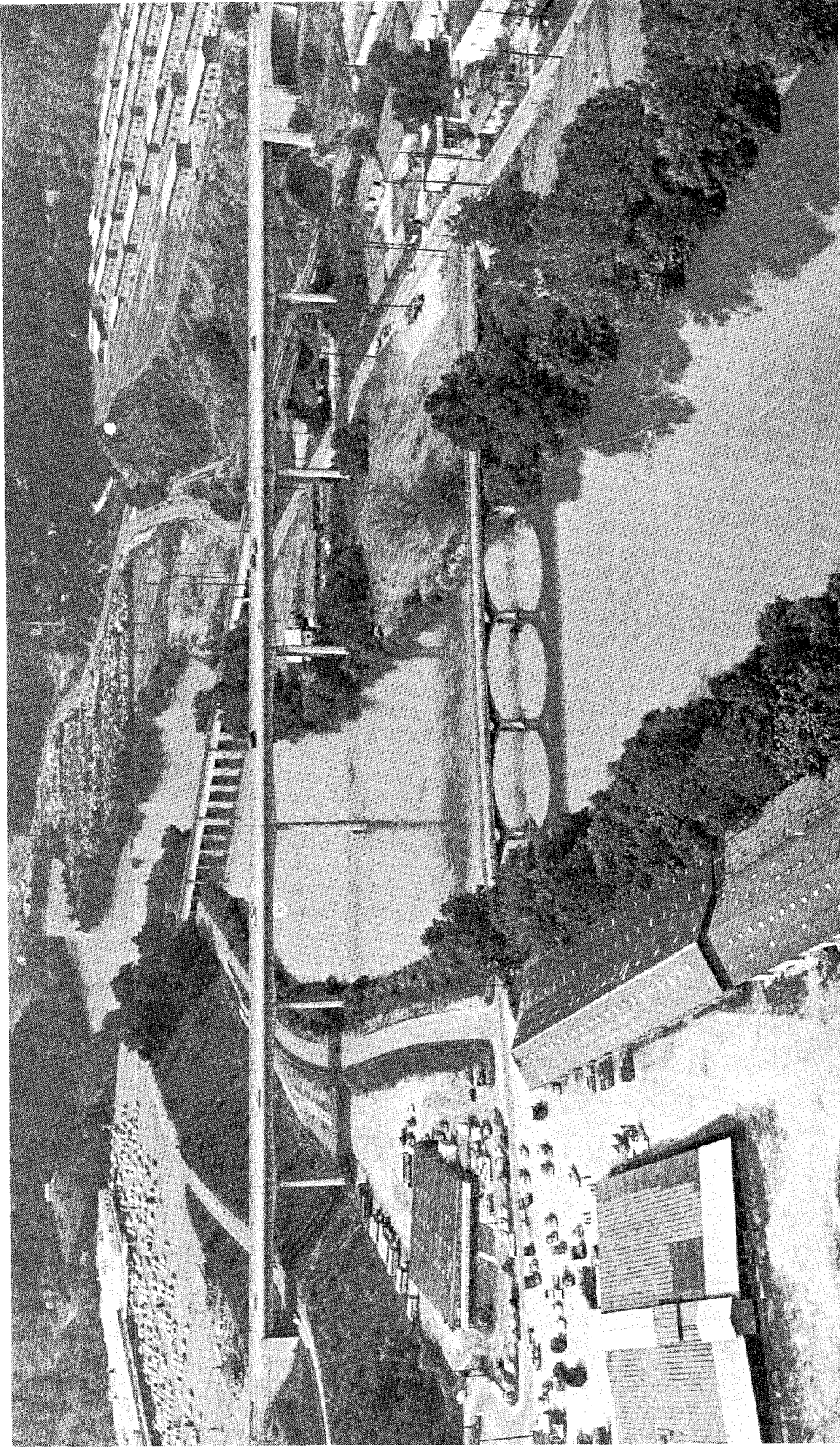


Figure 8. --SMITH, SMOKY PARK, AND SOUTHERN RAILWAY BRIDGES

Smith Bridge, Mile 147.33, was built after the 1916 flood to replace a washed-out steel bridge. It would be overtopped by a recurrence of the flood. Downstream at Mile 147.23, Smoky Park Bridge is new and is well above flood danger. The Southern Railway bridge, Mile 147.08, caught heavy drift during the 1916 flood but was not damaged.

(Photo by H. Malcolm Gamble, Asheville Citizen-Times)



Figure 9. --PEARSON BRIDGE AND LAND FILL

This bridge at Mile 145.75 is another which was built in 1916 to replace a washed-out steel bridge. Because of the high sanitary fill on the right bank just upstream from the bridge, a recurrence of the 1916 flood would be 3 to 4 feet higher in the foreground than the actual flood.

(Photo by H. Malcolm Gamble, Asheville Citizen-Times)

bridge. A narrow roadway on this bridge made it necessary to replace it in 1954 with the present 12-span steel and concrete bridge. The underclearance at this bridge is some 18.9 feet above the height of the actual 1916 flood.

Prior to 1957 there was a low railroad trestle crossing French Broad River at Mile 143.0, just below the Craggy highway bridge, which provided service to railroad customers on the right bank. It was removed when additional trackage was installed on the right bank of the river to provide a continuous spur line from the main line tracks to Elk Mountain. Figure 5 shows the remains of the old bridge piers.

Obstructions to Flood Flows

The extensive business, industrial, and residential developments in the Asheville flood plain substantially obstruct flood flows in the French Broad River. Fills on the flood plain reduce the flood capacity and in a number of places encroach on the river channel. The effect on flood flows by the bridges across the river has been discussed previously.

Since 1944 Asheville has used the land-fill method for disposal of its garbage, the area for disposal until 1960 being the right bank flood plain of French Broad River between the Southern Railway bridge and Pearson Bridge, Figures 9 and 10. This method has materially reduced the cost of garbage disposal for the city, and some 40 acres of land which was formerly idle because of the danger of frequent flooding has been made available for lease and development by commercial enterprises. The operation has altered conditions on the right bank from a point just above the railroad bridge to Pearson Bridge. On the left bank, grading for the Westgate Shopping Center and for a road between Smith Bridge and the railroad bridge, Figure 8, has reduced the overbank area and encroached on the river channel. Improvements to the truck route by-pass on the right bank of the river have resulted in considerable filling between Carrier bridge and Town Branch.

During the summer of 1960 the city discontinued the land fill on the right bank and opened up a new area on the left bank of the river between the West Asheville Viaduct, Mile 147.66, and Carrier Bridge, Mile 148.98.

These flood plain fills and the numerous buildings which occupy the flood plain, together with the bridges across the river, would seriously obstruct the flow of water in the French Broad River and cause floods to be substantially higher than

was previously the case. The greatest effect of this obstruction of the floodway would occur in the reach from Pearson Bridge, Mile 145.75, upstream to Town Branch, Mile 148.08. At Mile 146.02, for example, the actual July 1916 peak discharge occupied a width of 1130 feet and flowed 15 to 18 feet deep on the right bank flood plain. Today this width has been reduced over 300 feet by a high fill. As a result of this and other obstructions, a recurrence of the 1916 flood would have to rise 3.8 feet higher at this point to compensate for the loss of floodway. Similar filling on the right bank, together with the obstruction of Pearson Bridge, would cause the 1916 flood under present conditions to be 3 to 4 feet higher than the actual flood from Pearson Bridge to the Southern Railway bridge.

Above the railway bridge, a recurrence of the 1916 flood would be nearly 3 feet higher than the actual flood up to Smith Bridge. Just above Smith Bridge, a repetition of the 1916 flood discharge would result in stages 4 feet higher than the actual flood. From Smith Bridge the effect of the obstructions on flood height would decrease gradually to 1.5 feet at Town Branch and about 1 foot at Carrier Bridge.

Craggy Dam

The masonry dam on French Broad River at Mile 142.1, just below the mouth of Beaverdam Creek, was built in 1904 by Captain W. T. Weaver, who produced power at the site for the Asheville street railways and the growing electric distribution systems of the city. During the flood of July 1916 a large section of the dam was washed out and the powerhouse below was severely damaged. In 1923 the dam, the hydro plant, and a steam plant which had been built just above the dam were acquired by the Electric Bond and Share Company. In 1926 these properties became a part of the system of the Carolina Power and Light Company which operates the plants today.

The dam is approximately 700 feet long, averages 13 feet high, and its axis is at an angle of approximately 45 degrees to the flow line of the stream. A headgate structure at the right end of the dam controls flow into the flume which extends about 2600 feet down the right bank to the powerhouse. The crest of the dam is at an average elevation of 1929.7 feet. With flashboards in place the effective crest is at 1930.6 feet, at which elevation backwater extends upstream 0.8 mile to just below Craggy bridge. The effect of the dam on flood heights is confined to the short reach between the dam and Craggy.

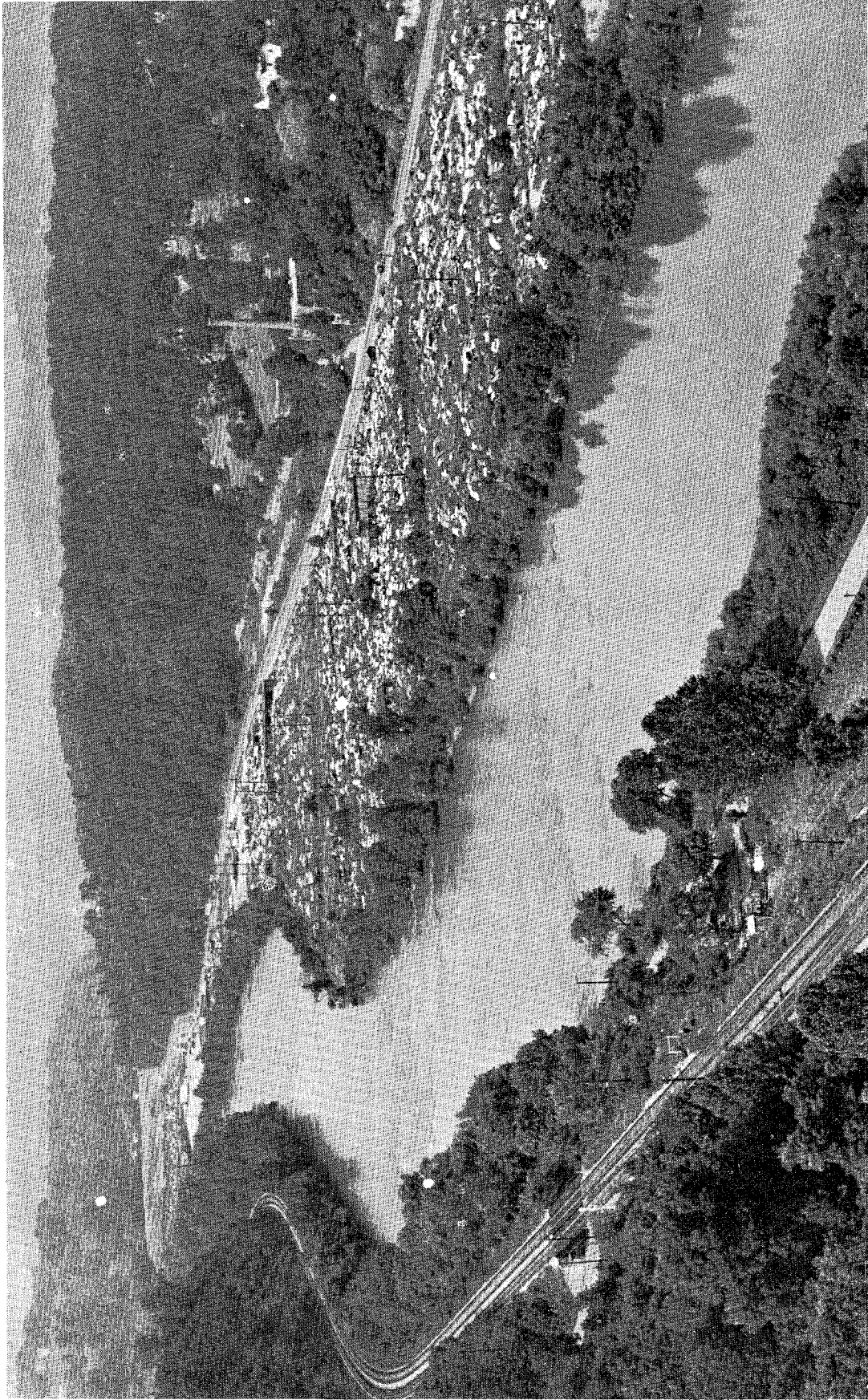


Figure 10. --LAND FILL AREA BELOW SOUTHERN RAILWAY BRIDGE

Looking downstream from about Mile 147.0, this aerial view shows part of the right-bank flood plain that has been used for disposal of garbage.

(Photo by H. Malcolm Gamble, Asheville Citizen-Times)

Flood Protection Study

Following the floods of August 1940, at the request of a committee of citizens, industrialists, and agriculturists of western North Carolina, TVA made an investigation of the flood situation in the Upper French Broad River watershed and developed plans to provide protection against floods. Included in the study was consideration of the flood problem at Asheville, including Biltmore. The results of a preliminary study were presented in Report No. 0-3075, "Flood Control for Upper French Broad River and Tributaries," dated August 1942. In June 1949, after more extensive investigations, TVA developed more detailed plans.

The studies showed the feasibility of a balanced plan for flood control of the Upper French Broad River basin which would protect the French Broad and Swannanoa River flood plains at Asheville from damaging floods and also provide a considerable degree of flood protection for the agricultural land upstream from Asheville.

These plans were presented to and discussed with the people of the region in a series of meetings. To date the works included in the plans have not been built.

FLOOD SITUATION

Flood Records

Records of river stages on the French Broad River are practically continuous for the past 65 years at gages located at Pearson and Smith Bridges. The U. S. Geological Survey established a wire-weight gage on Pearson Bridge at Asheville on September 2, 1895, and operated it until December 31, 1901. The station was re-established by the Geological Survey as a chain gage on the present Pearson Bridge on October 1, 1922. Twice daily observations of river stages were made until August 9, 1930, when a recording stream gage was installed at the site. Continuous records of stream stage and discharge are available since that date.

The U. S. Weather Bureau established a staff gage at Smith Bridge, 1.6 miles upstream from Pearson Bridge, on March 19, 1903. On November 1, 1904, the Geological Survey began observing a chain gage on the same bridge. The flood of July 1916 washed away Smith Bridge and both of the gages. River stages were

observed at a temporary staff gage just above the site of the present Smith Bridge from January 1, 1917, to November 22, 1917, and after that date at a staff gage located on a bridge pier. Observations were discontinued at this gage by the Geological Survey on September 30, 1922, when their station was transferred to Pearson Bridge. The gage continued to serve the Weather Bureau until August 22, 1934, when they replaced it with a gage on the right bank. On November 30, 1958, the Weather Bureau abandoned their gage at Smith Bridge and began using observations at the U. S. Geological Survey gaging station at Pearson Bridge.

For flood data on the French Broad River prior to the gage records, local residents were interviewed for information on dates and heights of floods. Files of the Asheville "Citizen" and "Times" and historical documents have been searched. Reports of investigations made by the Hydraulic Data Branch during the last 25 years have yielded valuable data. Chief among these were the reports prepared after the floods of August 1940 and in connection with the flood protection studies made shortly thereafter.

Flood Stages and Discharges

Peak stages and discharges are given in Table 5 for known floods exceeding the bankfull stage of 8 feet at the Pearson Bridge gage. For the period September 1895 to December 1901 and October 1922 to date the peak stages shown are those observed at the gage. For the period March 1903 to July 1916 and January 1917 to October 1922, peak stage observations made at the Smith Bridge gage have been adjusted to the Pearson Bridge site. Stages for floods prior to 1895 and for the periods when gage observations were suspended are from high water marks, newspaper or historical accounts, or from interviews.

Based on these estimates of the heights of the large floods prior to 1895, the highest known floods on the French Broad River at Asheville were those listed in Table 6.

The table does not include the flood of April 1791 which undoubtedly would be ranked among the top ten floods.

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 Asheville.

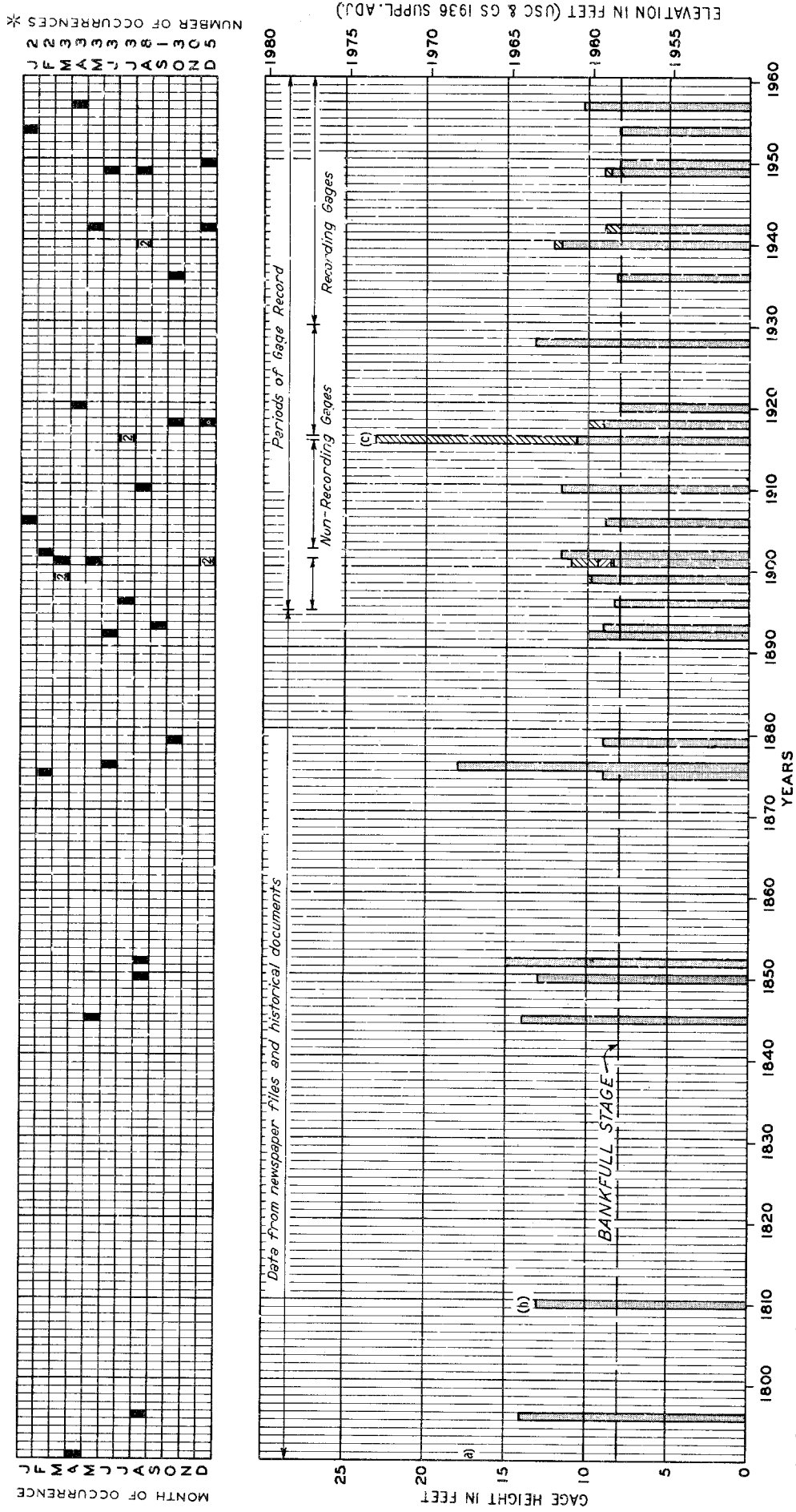
TABLE 5
FRENCH BROAD RIVER AT ASHEVILLE, NORTH CAROLINA
FLOOD CREST ELEVATIONS AND DISCHARGES ABOVE BANKFULL STAGE
1791-1960

This table includes all known floods above bankfull stage of 8 feet at the U. S. Geological Survey and U. S. Weather Bureau gaging station located just downstream from Pearson Bridge, River Mile 145.75. Drainage area is 945 square miles.

<u>Date of Crest</u>	<u>Gage Heights</u>		<u>Peak Discharge</u>	
	<u>Stage</u> feet	<u>Elevation</u> feet	<u>Amount</u> cfs	<u>Per Sq. Mi.</u> cfs
April 1791	(a)			
August 1796	14	1964		
	13	1963		
May 1845	14	1964		
August 1850	13	1963		
August 1852	15	1965		
February 1875	9	1959		
June 17, 1876	18	1968		
October 17, 1879	9	1959		
June 1892	10	1960		
September 13, 1893	9	1959		
July 8, 1896	8.3	1958.6	19,500	21
March 15, 1899	10.0	1960.3	26,500	28
March 19, 1899	9.8	1960.0	25,600	27
March 26, 1901	8.4	1958.7	19,900	21
May 22, 1901	11	1961	31,000	33
December 16, 1901	8.5	1958.8	20,300	21
December 29, 1901	9.4	1959.7	24,000	25
February 28, 1902	11.6	1961.9	33,900	36
January 23, 1906	8.9	1959.2	21,900	23
August 31, 1910	11.6	1961.9	33,900	36
July 10, 1916	10.7	1961.0	29,600	31
July 16, 1916	23.1	1973.4	110,000	116
October 30, 1918	9.0	1959.3	22,300	24
December 23, 1918	10.0	1960.3	26,500	28
April 2, 1920	8.0	1958.3	18,400	19
August 16, 1928	13.27	1963.6	42,700	45
October 16, 1936	8.20	1958.5	19,200	20
August 14, 1940	11.65	1961.9	31,800	34
August 30, 1940	12.15	1962.4	34,800	37
May 21, 1942	8.93	1959.2	20,900	22
December 30, 1942	8.10	1958.4	18,000	19
June 17, 1949	9.00	1959.3	20,100	21
August 28, 1949	8.55	1958.8	18,500	20
December 7, 1950	8.03	1958.3	16,400	17
January 23, 1954	8.07	1958.4	16,500	17
April 5, 1957	10.30	1960.3	24,200	26

(a) Stage unknown, but height may have been of the order of that of July 16, 1916.

ASF-1311

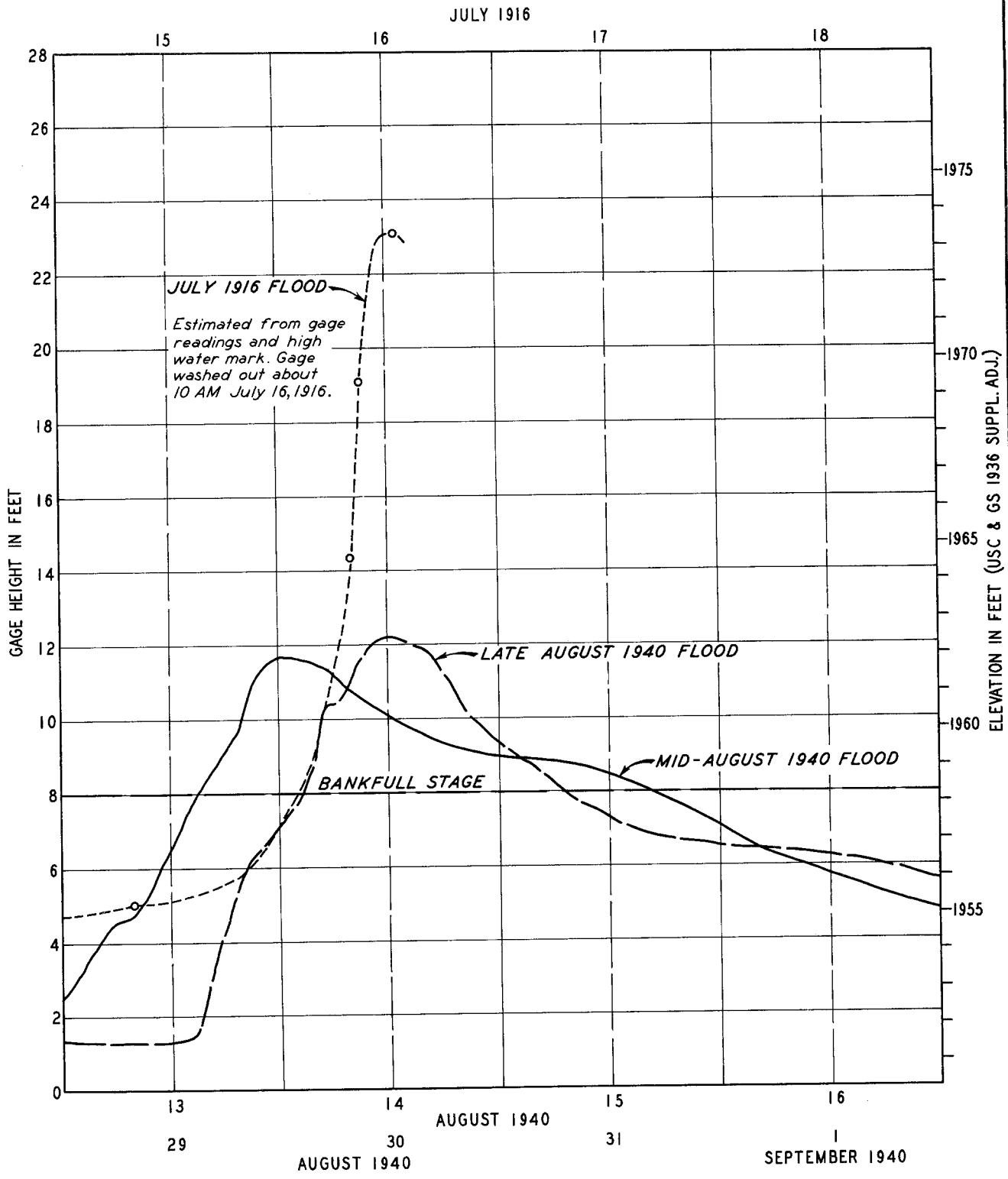


TENNESSEE VALLEY AUTHORITY
 DIVISION OF WATER CONTROL PLANNING
 HYDRAULIC DATA BRANCH

**FLOODS ABOVE
 BANKFULL STAGE**
 FRENCH BROAD RIVER
 AT ASHEVILLE, NORTH CAROLINA
 DECEMBER 1960

(a) Stage unknown in 1791.
 (b) Month unknown.
 (c) Stage based on high water marks.
 All stages referred to Gaging
 Station at Pearson Bridge
 River Mile 145.75

* Number of occurrences during 169 years
 1791 - 1960 excluding 1810 flood.



Gage at Mile 145.75

TENNESSEE VALLEY AUTHORITY
 DIVISION OF WATER CONTROL PLANNING
 HYDRAULIC DATA BRANCH

STAGE HYDROGRAPHS
 FLOODS OF JULY 1916 AND AUGUST 1940
 ON FRENCH BROAD RIVER
 AT ASHEVILLE, NORTH CAROLINA
 DECEMBER 1960

TABLE 6
HIGHEST KNOWN FLOODS IN ORDER OF MAGNITUDE
FRENCH BROAD RIVER AT ASHEVILLE

<u>Order No.</u>	<u>Date of Crest</u>	<u>Gage Height at Pearson Bridge</u>	
		<u>Stage feet</u>	<u>Elevation feet</u>
1	July 16, 1916	23. 1	1973. 4
2	June 17, 1876	18	1968
3	August 1852	15	1965
4	August 1796	14	1964
5	May 1845	14	1964
6	August 16, 1928	13. 27	1963. 6
7	1810	13	1963
8	August 1850	13	1963
9	August 30, 1940	12. 15	1962. 4
10	August 14, 1940	11. 65	1961. 9

The tabulation below shows the monthly distribution of 36 of the 37 known floods occurring in the period since 1791. The month of occurrence of the flood in 1810 is not known.

<u>Month</u>	<u>Number of Occurrences</u>	<u>Month</u>	<u>Number of Occurrences</u>
January	2	July	3
February	2	August	8
March	3	September	1
April	3	October	3
May	3	November	0
June	3	December	5

36

This record shows that floods above a stage of 8 feet have occurred in every month except November. Eight of the ten highest known floods have occurred in the summer months June through August when the headwater region of the French Broad watershed is subject to heavy rains resulting from either tropical hurricane storms or intense thunderstorms.

Rate of Rise and Velocities During Floods

Plate 3 shows stage hydrographs at the Pearson Bridge gage for the two large floods in August 1940 and for the rising portion of the record flood of July 1916. During the 1916 flood the French Broad River rose from a stage of 5 feet on July 15 to the crest of 23.1 feet on July 16 in 29 hours, at an average rate of rise of 0.6 foot per hour. The maximum rate of rise indicated by the special observed readings was 4.8 feet between 8 and 9 a. m. on July 16. The crest occurred at about 1 p. m.

During the late 1940 flood the rate of rise was slightly lower than in 1916. The river rose from a stage of 1.4 feet on August 29 to the crest of 12.15 feet on August 30 at an average rate of 0.5 foot per hour.

Average velocities in the channel of the French Broad River during the 1916 flood were in the order of 4 to 15 feet per second. In the flood plain, velocities ranged up to 6 feet per second. During larger floods velocities in both channel and overbank areas would be even greater.

Flooded Area, Flood Profiles, and Cross Sections

Plate 10 shows the approximate area along the French Broad River in the Asheville vicinity that was inundated by the 1916 flood on the river. Plate 11 shows at an enlarged scale the approximate 1916 flooded area between Carrier and Smith Bridges which is the most highly developed portion of the flood plain. The actual limits of these overflow areas on the ground may vary somewhat from those shown on the maps because the contour interval of the maps does not permit precise plotting of the flooded area boundaries. The contour interval on Plate 10 is 20 feet. The contour interval of the North Carolina State Highway Department maps upon which Plate 11 is based is 5 feet. The latter maps were used wherever available in defining the flooded area.

Plate 12 shows high water profiles on the French Broad River for the floods of July 1916, August 1928, and late August 1940. High water marks are shown for the mid-August 1940 flood. Plate 12 also shows a profile for the Regional Flood which is the 1916 flood as it would be under present conditions of development along the river and of the Maximum Probable Flood. These two floods are discussed in Sections III and IV, respectively.

Plate 13 shows typical cross sections of the French Broad River valley in the Asheville vicinity. The location of the cross sections is shown on the map and profile, Plates 10 and 12. Each cross section shows the elevation and extent of overflow of the actual flood of 1916 and of the Regional and Maximum Probable Floods. The Regional Flood elevation is the same as the 1916 flood would be under present conditions. A number of cross sections, the locations of which are shown on the map and profiles, are not reproduced but are available from the Hydraulic Data Branch of TVA to anyone who has need for them.

FLOOD DESCRIPTIONS

Following are descriptions of known large floods that have occurred on the French Broad and Swannanoa Rivers in the Asheville vicinity. These are based on newspaper accounts, historical records, and investigations by Hydraulic Data Branch engineers.

April 1791

Flood history research carried on in connection with the study of flood control for the Upper French Broad River and its tributaries showed that 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 meagre 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.

In an article printed in the Asheville "Citizen" on July 27, 1916, information on the flood is credited to Mr. W. J. Alexander, a member of one of the first families to settle in the Swannanoa River valley. Mr. Alexander, who was born in 1830, was told by his grandfather of a flood in April 1791 on Swannanoa River which apparently was fully as large as the great flood of July 1916, if not larger. Mr. W. O. Riddick, who owned the Azalea Woodworking Company plant at Azalea, stated that at the time of the 1916 flood a number of the older residents of the valley talked to him about another flood 125 years before, which they described as being at least as high as the 1916 flood and several thought it was four to six feet higher.

The weight of evidence indicates that there was such a great flood in 1791 and that it probably reached a height five feet above the 1916 flood on Swannanoa River. Since a flood in April is likely to be caused by general rains, it is reasonable to assume that the French Broad River at Asheville was also unusually high at this 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 rivers in August 1796. Another flood in 1810 was said to have been particularly high on the Swannanoa River.

The Asheville "Citizen" article of July 27, 1916, previously mentioned, quotes Mr. W. J. Alexander as saying that the first notable flood in his lifetime occurred in May 1845, when he was 15 years old. Mr. Joe Cheeseborough, who was born in 1873 and who lived nearly all his life on Swannanoa River just above Biltmore, recalled that an old Negro slave who was born in 1798 told him about this flood as "spreading from hill to hill" on the Swannanoa River. Mr. Cheeseborough believed that the 1845 flood was about like the 1916 flood at his home.

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 in many years before, exceeding largely the great flood two years ago. Even the sweet Swannanoa got high and played some wild pranks, among other things, carrying off the bridge at Mr. Patton's, two miles from here. "

The flood of March 1867 was the greatest known on the French Broad River at Newport, exceeding 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 at Asheville.

Intense rainfall caused a flood late in February 1875 which was probably more noteworthy on the Swannanoa than on the French Broad River. The "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. On Swannanoa River, where the flood was less severe than on French Broad River, the crest height was about the same as for the August 30, 1940, flood. The Signal Service weather observer describes the flood at Asheville as follows:

The most prominent feature of this month was the large freshet on the 15th, 16th, and 17th. The height of the French Broad River in this and adjacent counties was higher than it is remembered by the oldest inhabitants. . . . The river was highest on the 17th noon, after having risen steadily the two days previous. . . . The oldest persons in the county cannot remember such a height of the French Broad, and several of them stated the river to have been 2 feet higher than ever before. . . . The Swannanoa did not reach the height attained in the spring 1875.

May 1901, December 1901, and February 1902

Three floods damaged Asheville in a period of ten months shortly after the turn of the century. On May 22, 1901, the French Broad River rose to a stage of 11 feet and damaged railroads, industries and other developments which had sprung up along the water front. Homes and stores were flooded in Biltmore, and Asheville's water supply, obtained then from a pumping plant on Swannanoa River, was disrupted for several days when the plant was flooded and water lines were washed out.

On December 30, 1901, the Swannanoa River was very nearly as high as in the May flood, again putting water in homes and stores in the Biltmore area.

The flood on February 28, 1902, was not as high as either the May or December floods on Swannanoa River but on the French Broad River at Asheville it was 0.6 foot higher than in May and the highest since the flood of 1876. The tributaries joining the river below Asheville contributed heavily to the flood. Marshall, 20 miles below Asheville, had one of the greatest floods of its history at this time.

July 16, 1916

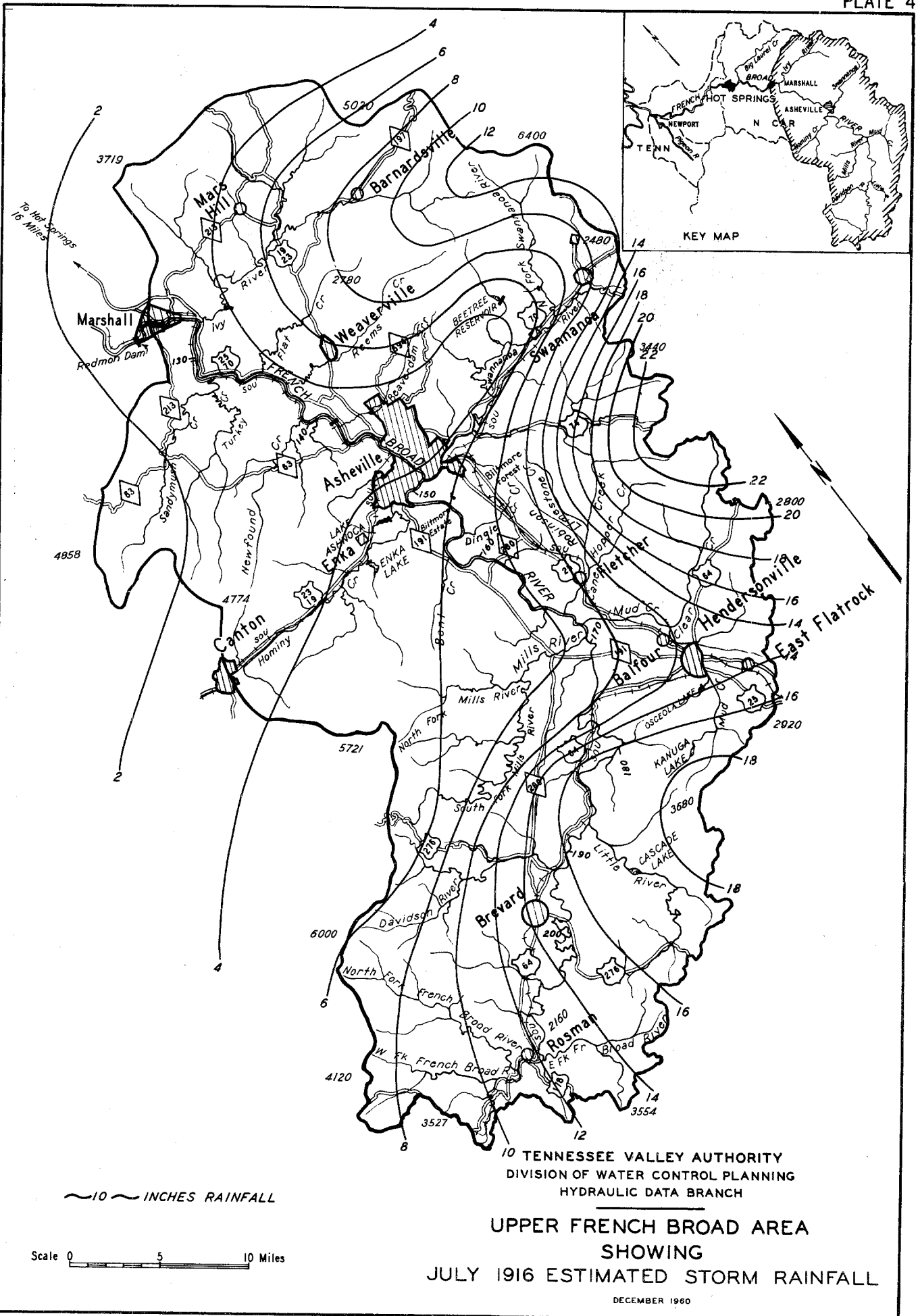
This is the greatest flood of which there is definite record on the Swannanoa River and on the North Carolina portion of the French Broad River. It

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 Swannanoa and French Broad River basins upstream from Asheville. Plate 4 shows the estimated rainfall distribution over the watershed above Marshall. Altapass, North Carolina, on the Blue Ridge 37 miles northeast of Asheville, recorded 23.7 inches for the storm, with 22.2 inches of this falling in 24 hours. As the map shows, rainfall amounts decreased rapidly to the north and west of the Blue Ridge and Asheville received only 2.85 inches for the storm.

General rains which had fallen over the area a week earlier had put both the French Broad and Swannanoa Rivers out of their banks in Asheville on July 10, with considerable damage along both streams. The rivers had been receding for only a few days from this flood when the great storm of July 15-16 raised the French Broad River to the highest flood of record at Asheville. The French Broad River reached a stage of 23.1 feet on the gage at Pearson bridge, five feet higher than the flood of June 17, 1876, and ten feet higher than any flood which has occurred in the 44 years since 1916. High water marks in Biltmore show a peak stage of 20.7 feet at the Swannanoa stream gage, higher than any flood since 1791.

Graphic accounts of the flood at Asheville are contained in the files of the Asheville newspapers (See Figure 11) and in a book published by the Southern Railway, "The Floods of July 1916." Some of the pictures shown in Figures 12 and 13 are taken from the latter source. The railway suffered heavy damage at many points on its system. At Asheville water stood 4.8 feet deep in the depot and damage to trackage and equipment was large. Especially hard hit by the flood were the firms along the French Broad River and on the Swannanoa River from Azalea to Biltmore, where much lumber was carried away. In Biltmore, commercial damage was heavy. Four main river bridges were lost, four houses were washed away, and 50 houses badly damaged along the French Broad River. Ten houses in the depot section and



~ 10 ~ INCHES RAINFALL

Scale 0 5 10 Miles

10 TENNESSEE VALLEY AUTHORITY
 DIVISION OF WATER CONTROL PLANNING
 HYDRAULIC DATA BRANCH

**UPPER FRENCH BROAD AREA
 SHOWING
 JULY 1916 ESTIMATED STORM RAINFALL**

DECEMBER 1960

ASF-1311

THE ASHEVILLE TIMES

VOLUME NO. 21 184

ASHEVILLE, N. C., MONDAY AFTERNOON, JULY 16, 1916

PRICE FIVE CENTS

Towns and Villages Wrecked By Floods

Eleven Lives Reported Lost--Marshall, Alexander, and Craggy Swept Away--Biltmore Submerged--Asheville River Front Damage Enormous--Loss In Buncombe Estimated At \$3,000,000.

RELIEF WORKERS MEET FOR CONFERENCE AT ASHEVILLE AUDITORIUM

Emergency meeting of the citizens of Asheville with the purpose of discussing the flood situation and appointing a relief committee was held at the Asheville Auditorium this morning.

Mr. Harkins stated that practically all the industries on the French Broad river were entirely crippled and 1200 men are now without work or means of support. Fifty families have lost their homes and every cent of property they own.

A few prominent citizens then made brief speeches urging the necessity for haste in appointing committees and organizing the relief work.

Governor Craig spoke feelingly of the great sorrow of the state and his belief in the ultimate triumph of Asheville and her citizens over a horrible calamity. He said further that a vast amount of praise was due the municipal departments for their prompt and efficient action in helping the flood victims and preventing further disaster.

Several ministers, including Dr. Waller and Father Marion, told of the horrors of the disaster and what had already been done to mitigate suffering.

Seventy-five families destitute by the catastrophe were quartered in the high school building. Chairman Thomas J. Harkins and his relief committee called together by Mayor Rankin quickly raised \$2000, food and bedding was provided for the homeless. All the charitable organizations joined in the work and action was prompt and effective.

ADMIRAL ELDRIDGE DEAD

Norfolk, Va., July 17--Rear Admiral Chas. Henry Eldridge, retired U. S. N., died at his residence here yesterday after a long illness. He was 75 years old and served on the Gulf and Atlantic squadrons during the war between the states. He was native of Dedham, Mass.

The Asheville Power and Light company stated today that they were unable to say when the light and power service would be restored.

With flood waters subsiding, Asheville is today carrying out relief work and taking count of the loss of life and property from the storm. Along the river fronts in the Swannanoa and French broad valleys industrial plants have been submerged and wrecked. The damage in Asheville is estimated at \$1,000,000; in Buncombe county the loss will add close to two million to this sum.

From the outside towns and communities come reports of death and havoc to property. In Marshall 53 houses are reported washed away in the narrow valley where the town lies. Two lives are said to be lost and two people are missing.

Five hundred excursionists from Knoxville and points west are marooned at Marshall. All bridges near that town except the railway structures.

The French Broad river at Alexander swept away all of the village on the west side of the stream except the Southern Railway station. The postoffice, a store and two dwelling houses went down in the swirling currents.

The damage at Biltmore is frightful.

Without warning at 4 o'clock Sunday morning the Swannanoa river overflowed the village. Men plunged into the stream carrying their wives and children. Horses turned loose plunged madly through the flooded streets in the darkness. In an hour the water was 15 feet deep in the streets. Four lives were lost.

All hydraulic plants located on the French Broad river are under water and it probably will be days before gas or electric power can be generated. One hundred and fifty feet of the stone dam at the Weaver power plant, four miles from the city was washed away. The steam generator is not available at this place and the company is planning to establish a line to the Ivy plant beyond Alexander.

Dr. I. A. Harris, from Jupiter, brought reports of light rains in that section and it is believed that north Buncombe did not suffer to any great extent from the tempests and cloudbursts that swept other sections.

Every bridge on the French Broad river for miles except the concrete structures, have been carried off. The concrete is standing firm, pressed against by tons of debris which includes thousands of feet of lumber.

EYE WITNESSES TELL OF TRAGEDIES AT HOME OF CAPTAIN J. C. LIPE

KNOWN DEAD.
JOHN C. LIPE, Biltmore.
CHARLOTTE WALKER, Biltmore.
MARION WALKER, Biltmore.
Mabel Foster, Biltmore.
WALTER TREXLER, Asheville.
LUTHER FRAZER, Negro, Asheville.

UNCONFIRMED LIST.
WALTER LIPE, Asheville.

The principal interest centered from an early hour in the morning until late afternoon about the Lipe house at Biltmore where Captain Lipe, and the nurses, the Misses Walker and Miss Foster, lost their lives.

P. A. Miller, mayor of South Biltmore, was an eye-witness to the entire scene, and described it to a Times representative.

"My little boy woke me about 6 o'clock," he said, "saying that the river was up and Captain Lipe's family in danger. I went right out there. Captain Lipe was up in a tree near his house, holding his youngest daughter, Miss Kathleen Lipe, above him. Miss Charlotte Walker, and Miss Foster, nurses from Biltmore hospital, and Miss Marion Walker, Miss Walker's sister, were standing at the foot of the tree in water up to their necks. They were holding to the tree and at times tried to climb up into it.

"Everyone of the Lipe family, and the nurses, had once got out of the house at 6 o'clock in the morning in water up to their ankles. They did not believe the water would rise any more, and went back after their belongings. The water caught them so suddenly that they could not get away.

"One by one the victims gave way, let go their hold and sank immediately. A young one was swimming to the last of the young ladies with a rope when she turned loose and sank. Captain Lipe was the last to turn loose. He had been in that cold water for six or eight hours, with the river lashing his back and beating him against the tree. When he gave way and fell into the water, he was seen to go ten feet, to sink, come up, go under again and was never seen any more.

Tied to Tree.
He left his daughter, Miss Kathleen, still clinging to the tree. She looked like that some two hours when a young man swam to her and went up the tree. Another young man swam out and took her a rope. They tied her to the tree, well above the water level, and she was able to turn loose. He was under her at all times, before they got a boat to her. We had phoned to Skyland in the morning for a boat, and young Frady brought it to Biltmore in a wagon. Raymond Flemmons, Mrs. Vanderbilt's chauffeur, and Will Donnanhoe who works at the

CONTINUED ON PAGE TWO

CONTINUED ON PAGE 3

Figure 11

20 in Biltmore were badly flooded. Damages caused by the flood on the French Broad River at Asheville were nearly two million dollars. Damages for the Swannanoa River basin were about \$600,000 of which the larger part occurred in the reach at Asheville.

August 16, 1928

At Asheville this flood was about 10 feet under the 1916 flood height on French Broad River but on Swannanoa River it was within about two feet of the 1916 flood and about the same as the flood of August 13, 1940. Although the total damage along the Swannanoa River was only about one-fourth of that in 1916, the industrial loss was nearly as great because of the influx of new industries in the 12 years after the 1916 flood. Along the French Broad River a number of large industries which were heavily damaged in 1916 were no longer in business in 1928 and as a result of this and the lower crest stage the damage in this flood was far below that in 1916. Figure 14 shows views during this flood.

August 13-14 and August 30, 1940

Two large floods occurred in the upper French Broad River basin in August 1940. The first, on August 13 and 14, 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. Rainfall amounts above Asheville were moderate in the valley but as much as 12 inches on the basin rim. In the Swannanoa basin amounts ranged from five inches at Asheville to 15 inches on North Fork watershed and 16 inches on upper Bull Creek. Plate 5 shows the distribution of rainfall during this storm.

The rise on the French Broad River at Asheville was not severe, the crest on August 14 being about 11.5 feet under that of July 1916. Banks were overtopped and some ten firms were affected to varying degrees. Runoff was very heavy in the Swannanoa River basin and the flood was serious in the Biltmore area. Overtopping of banks began about 1:30 p. m. on August 13 and at the crest stage of 19.0 feet at 7:30 p. m., water was 1 to 4 feet deep through the Biltmore business section and 2 to 8 feet deep through the industrial section along the river. A total of 73 firms were affected by the Swannanoa flood, two houses were washed away and 36 houses were flooded, 21 in the Biltmore section.



Figure 12. --JULY 1916 FLOOD AT ASHEVILLE

The upper view shows the French Broad River between Smith Bridge, in the foreground, and West Asheville Viaduct. Smith Bridge was washed out later during the flood. The flooded area on the right is now occupied by a Buncombe County garage, tobacco warehouse, livestock market, auto parts firm, and a supply company. The lower view is on Depot Street. The white building on the right is the Southern Railway station.

(Southern Railway photos)

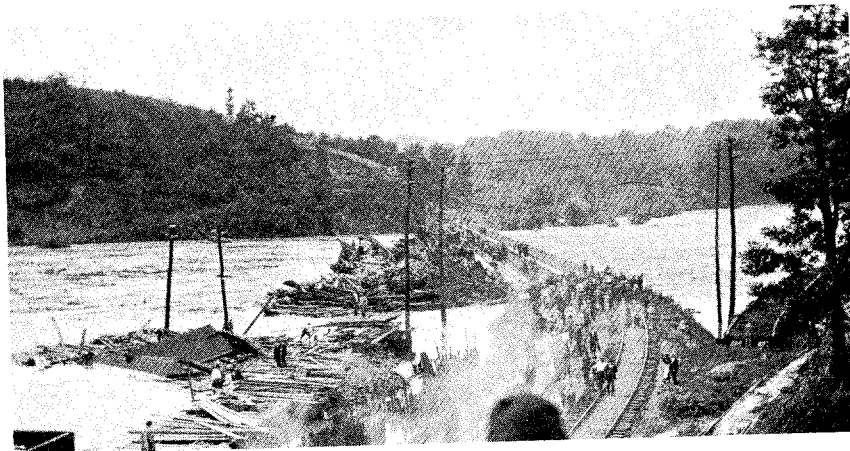


Figure 13. --MANY ASHEVILLE BUILDINGS CARRIED AWAY BY 1916 FLOOD

These three views show the debris of many frame buildings washed away and smashed by the flood. The upper view is at the Southern Coal Company yards; the middle picture is at the Texaco oil yard; the lower view is at the Southern Railway bridge, Mile 147.08.

(Photos by Southern Railway and Charles Waddell)

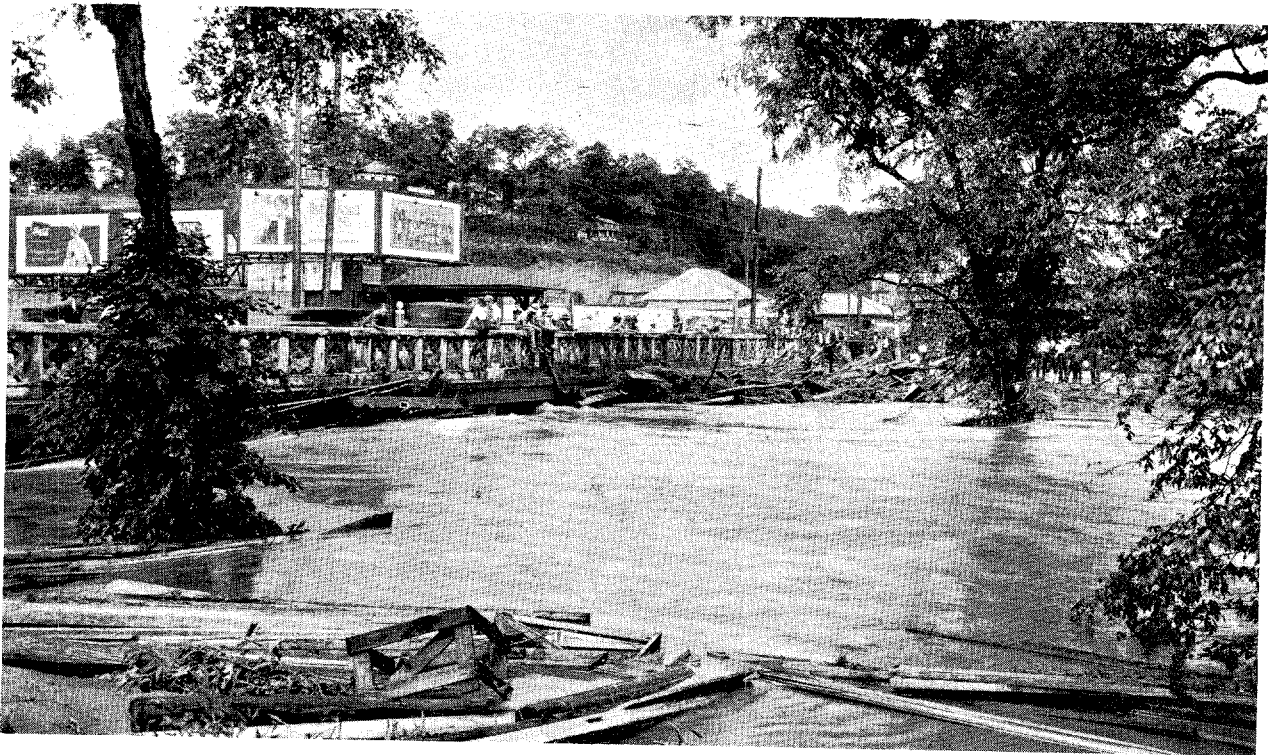
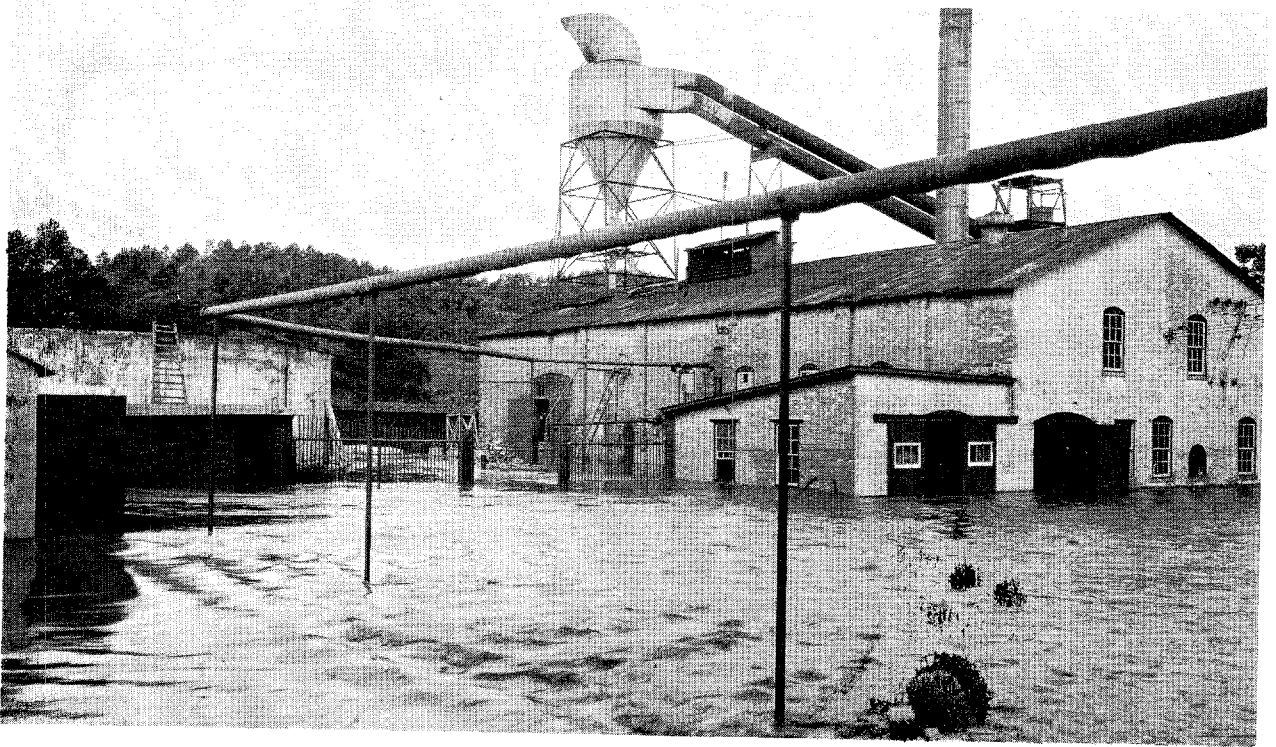


Figure 14. --AUGUST 1928 FLOOD

The upper view shows flooding by the French Broad River at the Carolina Wood Products Company near Mile 144. 8. The buildings at this plant were later occupied by the Alden Corporation and now by the Gordon Furniture Company and the Carlon Products Company. The lower view is the upstream side of the Biltmore Avenue bridge near the crest of the Swannanoa River flood.

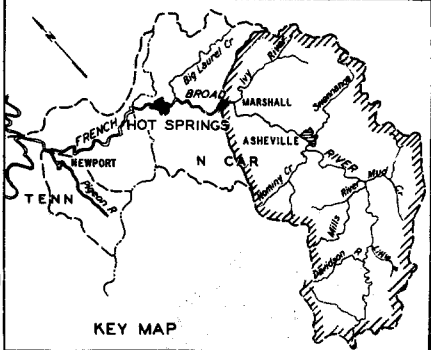
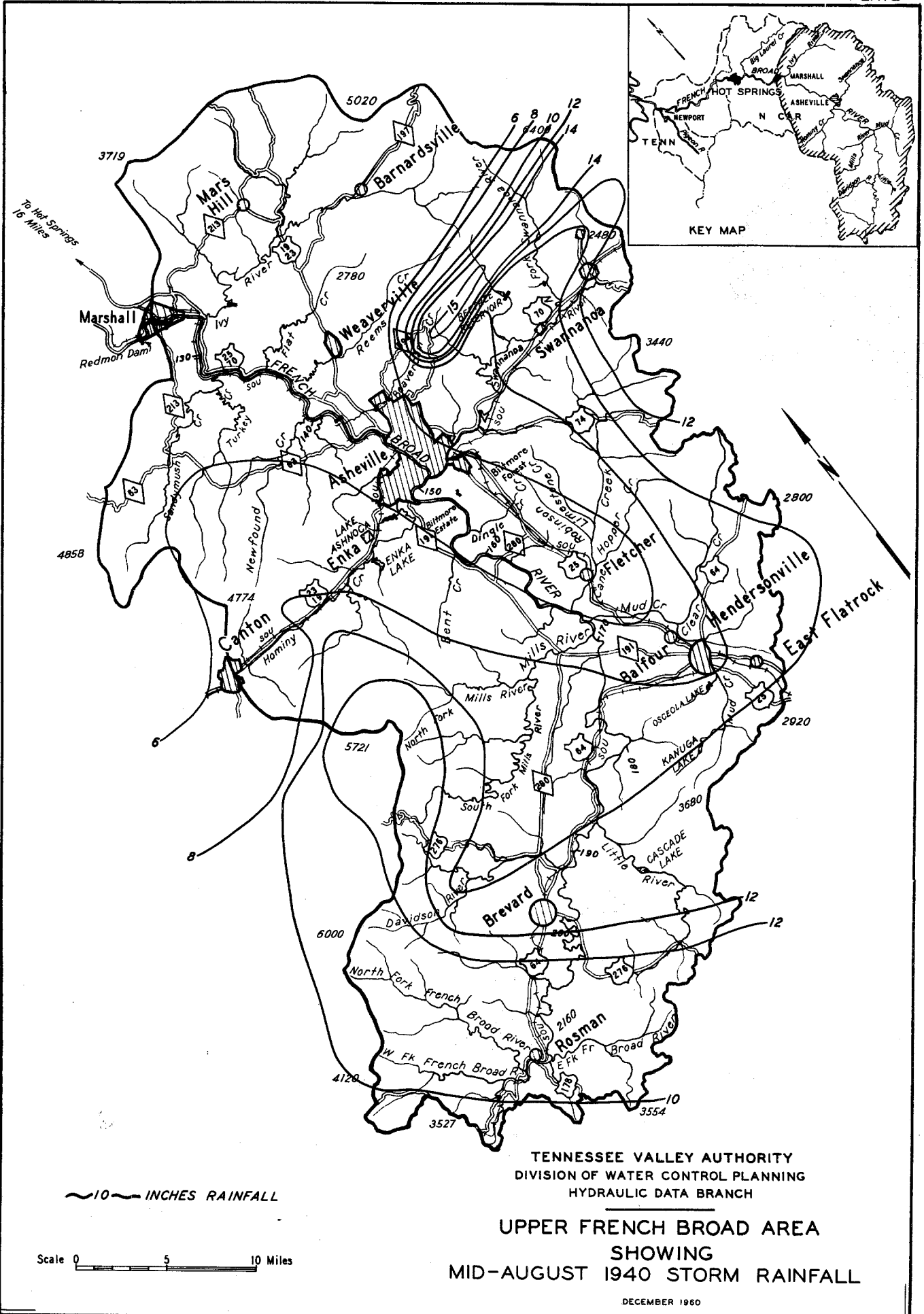
(Photos by Asheville Photo Service and E. L. Fisher)



Figure 15. --ASHEVILLE WATERFRONT ON AUGUST 30, 1940

This view is downstream from about Mile 148 toward the West Asheville Viaduct. Buildings shown are: No. 2a, Hildebrand Machine Company; No. 3a, Asheville Livestock Yards; No. 4a, S. Sternberg Company, now the Kahn Company; No. 6, the Texas Company; No. 7, Post Machinery Company; No. 41, the Carolina Coal and Ice Company.

(Photo by Asheville Citizen)

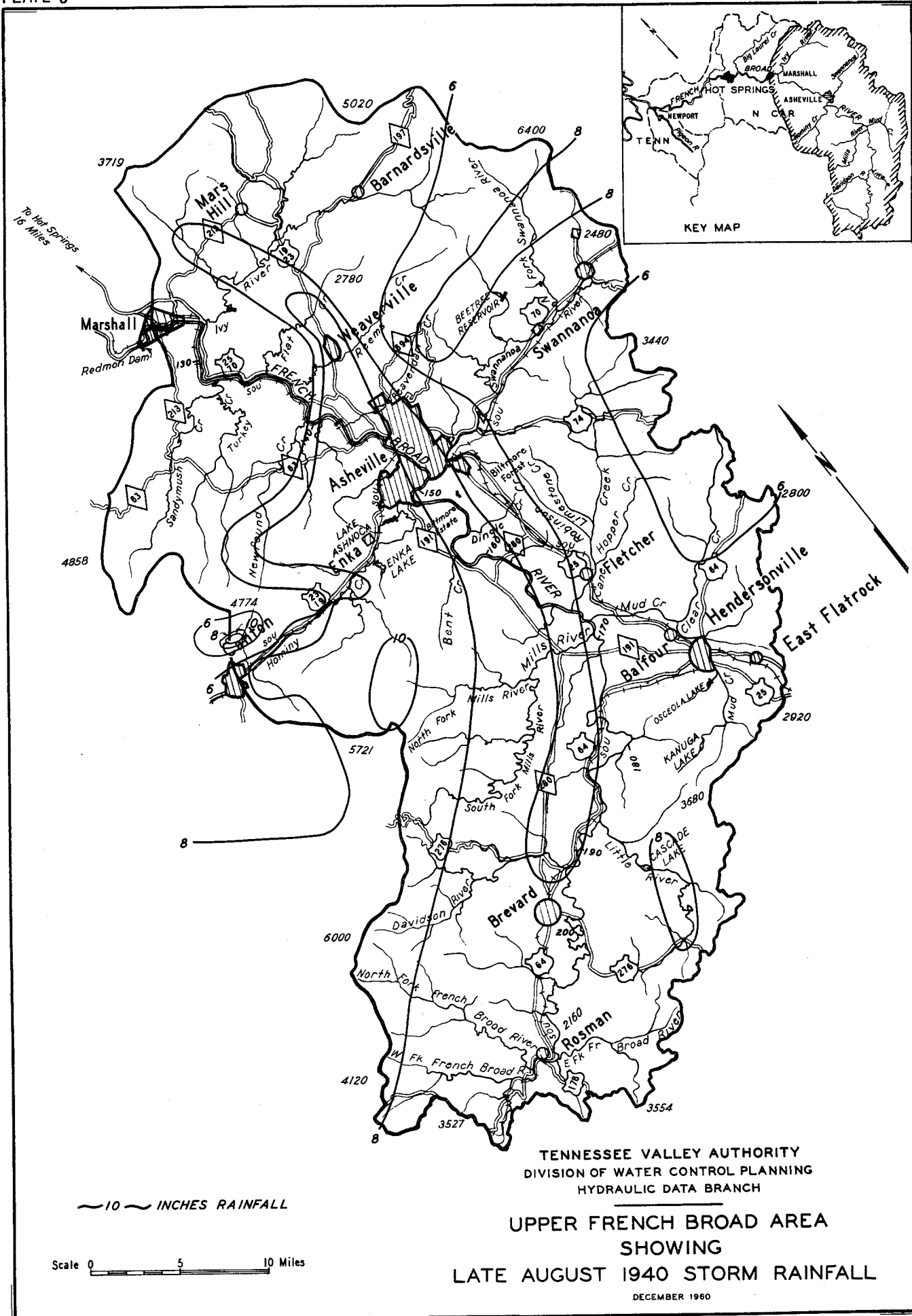


TENNESSEE VALLEY AUTHORITY
 DIVISION OF WATER CONTROL PLANNING
 HYDRAULIC DATA BRANCH

**UPPER FRENCH BROAD AREA
 SHOWING
 MID-AUGUST 1940 STORM RAINFALL**

DECEMBER 1960

ASF-1311



The rise of the two rivers on August 30 followed rainfall originating in a purely local meteorological disturbance which was confined to the North Carolina mountains. The rainfall distribution map, Plate 6, shows that amounts were uniformly between 6 and 8 inches over the watershed above Asheville. In the Swannanoa River basin rainfall was quite general, ranging from 6.8 inches near Asheville to 8.5 inches at North Fork.

On the French Broad River the crest stage was 0.5 foot higher than on August 14 and damage was essentially a repetition of that in the earlier flood. Figure 15 shows the Asheville waterfront during the flood. Swannanoa River was 3.7 feet lower at Biltmore than in the August 13 flood and damage was moderate, amounting in most cases to reflooding of goods which were already damaged from the first flood. The frontispiece, Figure 1, shows the overflow at Biltmore.

More complete descriptions of these storms and the floods through Asheville was given in the TVA report "Floods of August 1940 in Tennessee River Basin."

2. SWANNANOA RIVER

SWANNANOA RIVER VALLEY

The Stream and Its Valley

The Swannanoa River drains a rugged mountain area of 133 square miles lying east of Asheville. The river basin, shown on Plate 1, is about 17 miles long and 7 to 10 miles wide. Elevations along the Blue Ridge at the east of the basin and the Swannanoa Mountains at the south range generally from 3000 feet to 4000 feet, but in the Craggy Mountains and the Black Mountains along the north and northeast sides of the basin, where the principal tributaries of Swannanoa River rise, elevations range from 5000 feet to more than 6000 feet. Streams drop steeply from the ridges to the valley floor, where the elevation ranges from about 2350 feet at the town of Black Mountain to 2000 feet in Biltmore. The largest tributary is North Fork Swannanoa River, draining 31.8 square miles and heading in the northeast corner of the basin. Beetree Creek and Bull Creek, which lie to the west of North Fork, are the next largest tributaries.

Channel slopes on Swannanoa River are more nearly typical of mountain streams in general than are those on the French Broad River above Asheville. From the mouth of North Fork Swannanoa River, west of Black Mountain, to the mouth of Beetree Creek, 12 miles from Asheville, the fall is 23 feet per mile. From Beetree Creek to Azalea the rate of fall is 15.6 feet per mile. From U. S. Highway 70 at Azalea to the mouth, which is the reach covered by this investigation, the river falls from elevation 2044 to elevation 1965, or 10.5 feet per mile. Over the lower five miles of this reach, where the most significant developments are found, the fall is about 9 feet per mile.

Streams joining the Swannanoa River on the right bank in the reach under investigation are Grassy Branch at Azalea, Haw Creek at Mile 2.9, and Ross Creek at Mile 2.2. Left bank tributaries are Christian Creek at Azalea, Gashes Creek at Mile 4.4, and Sweeten Creek in Biltmore. All these streams drain relatively small areas and are subject to local flooding but have an insignificant effect on the main streams.

Pertinent drainage areas of the Swannanoa River and its tributaries in the vicinity of Asheville are listed in Table 7.

TABLE 7
DRAINAGE AREAS IN WATERSHED
OF SWANNANOA RIVER

<u>Stream</u>	<u>Location</u>	<u>Mile Above Mouth</u>	<u>Drainage Area sq. mi.</u>
Swannanoa River	Azalea	7.40	102
	Biltmore stream gage	1.56	130
	Mouth	0.0	133
Sweeten Creek	Mouth	0.0	5.78
Haw Creek	Mouth	0.0	4.73
Gashes Creek	Mouth	0.0	6.15

Except for a reach near the Asheville Recreation Park the flood plain on Swannanoa River is wide, with bottoms from 600 feet to 1000 feet or more in width occurring first on one bank then on the other as the stream meanders through the

valley. Such bottoms are found on both banks of the stream near Azalea and on the left bank above the abandoned recreation park dam. In the valley below the dam where the important industrial and commercial developments are located, broad bottoms occur on the right bank extending from Mile 4.9 to 3.6, from Mile 3.3 to 2.9, from Mile 2.6 to 2.2 and from Mile 1.5 to the mouth. Broad bottoms on the left bank are found from Mile 3.8 to 3.1, Mile 3.0 to 2.6, Mile 2.3 to 1.4 and from Mile 1.0 to the mouth, the latter on property of the Biltmore Estate. The flood plain widths on the right bank range up to 1000 feet at Mile 4.5, near the Municipal Golf Course, and at Mile 1.2, below Biltmore. On the left bank the flood plain is 1200 feet wide at the Sayles Bleacheries plant, Mile 3.5, 1500 feet wide in Biltmore at Mile 1.6, and about 2000 feet wide on the Biltmore Estate near the mouth of the stream.

Backwater from the 1916, 1928, and 1940 floods on the French Broad River would have extended 2-1/2 to 3-1/2 miles up the Swannanoa River if there were no corresponding floods on the latter stream. However, major floods reach their maximum height on these two streams at about the same time so that the net effect of the French Broad River backwater is felt only in the lower one to two miles. In July 1916 backwater in the Swannanoa River was higher than the headwater flood from the mouth upstream to about Mile 1.5.

Developments in the Flood Plain

Plates 14 and 15 show the extent of development on the flood plain of the Swannanoa River in the Asheville vicinity, and Figures 16 to 21 picture some of the flood plain area. Within the area which would be overflowed in a very large flood, there are now about 190 active firms and 76 dwellings. Table 8 identifies these industries and commercial establishments, gives the pertinent floor elevation for each, and lists the flood crest elevation at each place for the July 1916 flood, the Regional Flood, and the Maximum Probable Flood. The tabulation shows that the low floor levels of 126 firms would be subject to overflow in a flood the height of the actual 1916 flood. The Regional and Maximum Probable Floods would reach the floors of 174 and 189 firms, respectively. Some 45 of the firms which were affected by the 1940 floods are still in the flood plain. Four of these have changed ownership, two have changed locations and one other has changed both ownership and location.

TABLE 8

FLOOD PLAIN STRUCTURES

SWANNANOA RIVER IN VICINITY OF ASHEVILLE

Map Ref. No.	Identification	River Mile	Bank	Floor Elev.	Flood Elevations		Maximum Probable
					1916 Actual ^(a)	Regional	
<u>Azalea to Cheeseborough Bridge</u>							
	Brigman Garage	7.60	L	2060.4	2064.1		
	Brigman Grocery	7.59	L	2072.5	2064.0		
	Azalea Church	7.57	R	2063.3-2072.7	2063.7	2071.4	2078.6
	Baldwin Grocery	7.18	R	2064.3	2056.9	2066.4	2073.2
	Venus Restaurant	7.15	R	2064.3	2056.4	2065.9	2072.6
	Southern Railway Station	7.00	L	2053.1	2054.2	2063.9	2070.5
	Boling Chair Company	6.90	L	2045.6-2056.8	2053.5	2063.4	2069.8
	Gravel Plant	6.13	R	2042.0	2045.8	2060.1	2066.1
	Dance Hall-Asheville Recreation Park	5.24	L	2053.2	2034.6	2057.2	2061.6
	Golf Course-Asheville Recreation Park	5.16	L	2034.5	2033.6	2056.8	2061.0
	Filter Plant-Asheville Recreation Park	5.02	L	2025.3	2031.5	2038.3	2046.1
	Asheville Municipal Golf Course	4.1-4.9	R	2047.4-2051.2	2020.7-2030.1	2025.2-2034.6	2033.4-2040.4
	Cat & Fiddle Restaurant	4.37	R	2023.5	2023.9	2028.2	2034.8
	Bordens Ice Cream	4.37	L	2029.5	2023.9	2028.2	2034.8
	BF & WNC Transportation Company	4.37	L	2031.4	2023.9	2028.2	2034.8
	Fredrickson Trucking Company	4.37	L	2033.7	2023.9	2028.2	2034.8
	Pilot Freight Carriers, Inc.	4.37	L	2033.0	2023.9	2028.2	2034.8
	Shell Service Station	4.33	R	2021.9	2023.4	2027.8	2034.4
	Hensley Produce	4.21	R	2020.9	2022.0	2026.9	2033.9
	Big Apple Drive-Inn	4.18	R	2021.2	2021.7	2026.8	2033.8
	Appalachian Milling Company	3.97	R	2015.3-2018.3	2019.1	2025.2	2032.6
	Anz Construction Company	3.94	R	2015.7	2018.7	2025.1	2032.4
	Bowlings Produce	3.87	R	2012.8	2017.8	2024.5	2031.8
	Bowman Transportation, Inc.	3.84	R	2015.2	2017.5	2024.4	2031.6
	Sayles Biltmore Bleacheries	3.3-3.8	L	2011.7-2014.6	2011.2-2017.0	2018.4-2024.0	2026.5-2031.3
	Akers Motor Lines	3.75	R	2010.2-2013.6	2016.4	2023.7	2030.9
	Skyline Construction Company	3.70	R	2009.2	2015.7	2023.3	2030.6
	McLean Trucking Company	3.64	R	2013.4	2015.0	2022.9	2030.0
	Tomato House Produce	3.61	R	2007.4	2014.6	2022.8	2029.8
	Silver Slipper Drive-Inn	3.56	R	2005.0	2014.0	2022.3	2029.4
	Ledbetter Produce	3.33	R	2004.6	2011.5	2018.6	2026.7
	Ledbetter Motor Court	3.30	R	2005.4	2011.2	2018.4	2026.5
	Pepsi-Cola Bottling Plant	3.30	R	2010.3	2011.2	2018.4	2026.5
	Tweedle-Bee Drive-Inn	3.28	R	2008.4	2011.1	2018.3	2026.4
	Patio Restaurant	3.26	R	2007.9	2010.8	2018.1	2026.3
	Dean & Kellett Trailer Sales	3.25	R	2006.4	2010.7	2018.1	2026.3
	Jones Esso Service	3.23	R	2007.8	2010.6	2018.0	2026.2
	Wilson Amoco Service	3.22	R	2007.3	2010.5	2018.0	2026.2
	Jones Miniature Golf	3.22	R	2006.4	2010.5	2018.0	2026.2
	Waldensien Bakery Whse.	3.20	R	2009.8-2009.9	2010.2	2017.8	2026.1
	Matthews Gulf Service	3.17	R	2007.1	2010.0	2017.7	2026.0
<u>Cheeseborough Bridge to Stoner Road^(b)</u>							
1	Pig & Whistle Drive-Inn	3.13	R	2006.5	2009.6	2017.4	2025.9
2	Dreamland Theater-tickets	3.13	R	2004.5	2009.6	2017.4	2025.9
3	Dreamland Theater-projection	3.00	R	2003.0	2008.5	2016.6	2025.1
4	Three Mountaineers, Inc.	2.97	L	2008.7	2008.2	2016.5	2024.9
5	Southern Fiber Products Company	2.95	L	2009.8	2008.0	2016.4	2024.8
6	Farmers Supply Company	2.95	L	2009.6	2008.0	2016.4	2024.8
7	Maynards Fish Bait	2.92	R	2002.6	2007.8	2016.1	2024.6
8	Maynards Garage	2.90	R	2000.9	2007.6	2016.0	2024.6
9	Anderson Trucking Company, garage	2.86	L	2006.7	2007.3	2015.8	2024.4
10	Wright Motor Lines, garage	2.85	L	2007.0	2007.2	2015.7	2024.3
11	A&P Stores Warehouse	2.82	L	2005.4	2006.9	2015.6	2024.1
12	Hennis Freight Lines, office	2.82	L	2008.0	2006.9	2015.6	2024.1
13	Blue Ridge Trucking Company	2.80	L	2008.0	2006.8	2015.4	2024.0
14	G&H Transit Company, office	2.77	L	2004.4-2008.1	2006.5	2015.3	2023.8
15	Wagon Wheel Cafe	2.75	R	2008.2	2006.3	2015.1	2023.7
16	Associated Transport, Inc.	2.75	L	2008.9	2006.3	2015.1	2023.7
17	Asheville Mach. & Foundry Company	2.74	L	2004.8-2007.7	2006.3	2015.1	2023.7
18	Engineering Assoc., Inc.	2.72	L	2005.8	2006.1	2014.9	2023.5
19	Concrete Products Company	2.71	L	2004.3-2004.8	2006.0	2014.8	2023.4
20	Suburban Rulane Company	2.70	L	2007.6	2005.9	2014.8	2023.4
21	Hobby Shop	2.69	L	2005.1	2005.8	2014.7	2023.3
22	Skyway Distributing Company	2.68	L	2006.4-2006.8	2005.7	2014.7	2023.2
23	Bernard-Walker Tobacco Whse. #3	2.68	L	2005.6	2005.7	2014.7	2023.2
24	Hotpoint Company, whse.	2.67	L	2008.1	2005.6	2014.6	2023.1
25	Glendale Manufacturing Company	2.67	L	2008.2	2005.6	2014.6	2023.1
26	Lloyd's Drive-Inn	2.67	R	2004.5	2005.6	2014.6	2023.1
27	Britt & Tilson Glass Company	2.66	R	2003.7	2005.5	2014.6	2023.1
28	Banana Dist. Company	2.65	L	2008.3	2005.4	2014.2	2022.9
29	Chas. Westall Company	2.65	L	2009.4	2005.4	2014.2	2022.9
30	Biltmore Wheat Hearts Company	2.65	L	2010.3	2005.4	2014.2	2022.9
31	Renfro Dist. Company	2.65	L	2013.4	2005.4	2014.2	2022.9
32	Walls & Reagan Oil Company	2.65	L	2020.1	2005.4	2014.2	2022.9
33	Atlantic Oil Bulk Plant	2.65	L	2021.9	2005.4	2014.2	2022.9
34	White Scrap Salvage	2.65	L	2022.4	2005.4	2014.2	2022.9
35	Statesville Flour Mill, whse.	2.64	L	2005.0	2005.3	2014.1	2022.8

TABLE 8 (continued)

FLOOD PLAIN STRUCTURES

SWANNANOVA RIVER IN VICINITY OF ASHEVILLE

Map Ref. No.	Identification	River Mile	Bank	Floor Elev.	Flood Elevations		
					1916 Actual ^(a)	Regional	Maximum Probable
<u>Cheeseborough Bridge to Stoner Road^(b) (continued)</u>							
36	Johnson-Chandley Lumber Company	2.63	L	2000.7-2006.3	2005.2	2014.0	2022.8
37	Asheville Citizen-Times Company whse.	2.63	L	2005.7	2005.2	2014.0	2022.8
38	Great Southern Trucking Company	2.57	R	2009.2	2004.8	2013.7	2022.5
39	Quaker Oats Company, whse.	2.57	L	2006.8-2011.7	2004.8	2013.7	2022.5
40	W. R. Candler Trucking Company	2.54	R	2010.0	2004.6	2013.6	2022.4
41	Yellow Door Cafe	2.51	R	2006.5	2004.3	2013.4	2022.0
42	Carolina Trucking Company	2.48	R	2003.9	2004.1	2013.2	2022.0
43	Vacant	2.39	R	2002.3	2003.3	2012.1	2020.4
44	Southern Tile Company	2.28	R	1999.0	2002.4	2010.9	2018.6
45	Hardwood Corp. of America	2.25	L	2004.3-2006.0	2002.1	2010.6	2018.1
46	Williams-Brownell Company	2.10-2.22	L	1998.4-2001.7	2000.7-2001.8	2008.8-2010.1	2015.6-2017.5
47	Gold Dot Foods	2.18	R	2003.0	2001.5	2009.7	2016.9
48	Vacant	2.03	L	1996.0	2000.1	2008.2	2014.9
49	Wood Mosaic Corp. Mill	2.03	L	1999.9	2000.1	2008.2	2014.9
<u>Stoner Road to McDowell Street Viaduct</u>							
50	Planters Tobacco whse.	1.92-2.02	R	1997.2-1998.0	1999.4-2000.0	2007.2-2008.1	2014.0-2014.8
51	Wood Mosaic Corp. office	1.98	L	2000.3	1999.8	2007.8	2014.6
52	Dayco Foam Products Company	1.92	L	2002.3-2003.0	1999.4	2007.2	2014.0
53	Davidson-Pearsall, Inc.	1.86	L	1993.2	1999.1	2007.0	2013.5
54,55	Asheville Mica Corp.	1.86	L	1993.1-1993.2	1999.1	2007.0	2013.5
56	North State Materials Company	1.86	L	1995.9-2000.3	1999.1	2007.0	2013.5
57	Ed Atkinson Lumber Company	1.86	L	2001.0-2001.8	1999.1	2007.0	2013.5
58	General Plumbing Products Company	1.86	L	2000.1-2004.6	1999.1	2007.0	2013.5
59	Smoky Mountain Distributors	1.86	L	2001.7-2002.4	1999.1	2007.0	2013.5
60	(Shell Oil Company, bulk plant Adoa Corp.)	1.86	L	2004.0	1999.1	2007.0	2013.5
	(N. C. Equipment Company)	1.86	L	2004.2	1999.1	2007.0	2013.5
	(Smo-ko Service Station)	1.86	L	2001.6-2006.0	1999.1	2007.0	2013.5
	(Champion Heating Company)	1.86	L	2007.8	1999.1	2007.0	2013.5
	(Southern Bakery Company)	1.86	L	2008.3	1999.1	2007.0	2013.5
	(Asheville Tree Service)	1.86	L	2008.5	1999.1	2007.0	2013.5
	(Vacant)	1.86	L	2009.1	1999.1	2007.0	2013.5
	(Bruce's Drive-Inn)	1.86	L	2010.1	1999.1	2007.0	2013.5
	(Overnite Transportation Company)	1.86	L	2011.2	1999.1	2007.0	2013.5
	(Public Service Company Substation)	1.86	L	2029.3	1999.1	2007.0	2013.5
	(Sears, Roebuck & Company, whse.)	1.86	L	2013.8	1999.1	2007.0	2013.5
	(Sullivan Hardware Company of N. C.)	1.86	L	2019.8	1999.1	2007.0	2013.5
	(Consolidated Hide & Metal Company)	1.86	L	2020.6	1999.1	2007.0	2013.5
	(Dance Freight Lines, Inc.)	1.86	L	2018.7-2022.2	1999.1	2007.0	2013.5
	(White Truck Company)	1.86	L	2023.6	1999.1	2007.0	2013.5
	(R. Gumpert, Inc.)	1.86	L	2021.5	1999.1	2007.0	2013.5
		1.86	L	2022.8-2024.1	1999.1	2007.0	2013.5
61	Carolina Tractor & Equip. Company	1.85	L	1996.6-1998.1	1999.0	2006.9	2013.5
62	Bernard-Walker Tobacco whse. #2	1.83	L	1995.6	1998.9	2006.9	2013.4
63	Silverman Company	1.80-1.83	R	1990.2-1992.1	1998.7-1998.9	2006.8-2006.9	2013.2-2013.4
64	Gulf Oil Company bulk plant	1.82	L	1998.1	1998.8	2006.8	2013.3
65	Biltmore Coal & Lumber Company	1.82	L	1997.3	1998.8	2006.8	2013.3
66	Whitakers Gulf Service	1.82	L	1996.7	1998.8	2006.8	2013.3
67	Biltmore Fuel Company	1.82	L	1998.6	1998.8	2006.8	2013.3
68	Biltmore Cleaners	1.82	L	1997.7	1998.8	2006.8	2013.3
69	Simpson Bros. Milling Company	1.82	L	2001.2	1998.8	2006.8	2013.3
70	Bryson Bus Lines	1.82	L	2001.6	1998.8	2006.8	2013.3
71	N. C. State Highway Department	1.82	L	2003.5-2009.6	1998.8	2006.8	2013.3
72	(Seven-Up Bottling Company)	1.82	L	2005.7	1998.8	2006.8	2013.3
	(Engr. Assoc., Inc., shop)	1.82	L	2015.1	1998.8	2006.8	2013.3
	(Mack Truck Sales)	1.82	L	2014.0-2017.7	1998.8	2006.8	2013.3
	(Asheville Contracting Company)	1.82	L	2012.6-2015.3	1998.8	2006.8	2013.3
	(Blue Ridge Structures Company)	1.82	L	2015.9	1998.8	2006.8	2013.3
73	Slosman Corp.	1.81	L	1996.3	1998.8	2006.8	2013.2
74	Vacant	1.81	L	1994.3	1998.8	2006.8	2013.2
75	Newman Wholesale, Inc.	1.80	L	1995.2	1998.7	2006.8	2013.2
76	Piedmont Paper Company	1.80	L	1994.6	1998.7	2006.8	2013.2
77	Vacant	1.78	L	1993.6	1998.6	2006.7	2013.1
78	Champion Paper & Fibre Company, whse.	1.71-1.78	L	1990.3	1998.1-1998.6	2006.4-2006.7	2012.6-2013.1
79	S. W. Harrington, Inc.	1.77	L	1994.6-1994.9	1998.5	2006.7	2013.1
80	Cope Trucking Company, terminal	1.77	L	1994.0	1998.5	2006.7	2013.1
81	Price Piping Company	1.76	L	1993.4	1998.5	2006.6	2013.0
82	Tri-Co. Service Station	1.75	L	1992.6	1998.4	2006.5	2012.9
83	Clarks Garage	1.74	L	1991.8	1998.3	2006.5	2012.8
84	FCX Feed Store	1.74	L	1992.5	1998.3	2006.5	2012.8
85	Cope Trucking Company, garage	1.72	R	1991.6	1998.3	2006.5	2012.7
86	Morrison Furniture	1.71	L	1993.0	1998.2	2006.4	2012.6
87	Tuxedo Feeds, whse.	1.71	L	1994.1	1998.2	2006.4	2012.6
88	Asheville ABC Store	1.70	L	1993.1	1998.1	2006.4	2012.6
89	Sinclair Oil Bulk Plant	1.70	L	1994.9	1998.1	2006.4	2012.6
90	Lowe's Asheville Hardware, storage	1.70	L	1991.1	1998.1	2006.4	2012.6
91	Hajoca Corp.	1.62-1.70	R	1997.9	1997.6-1998.1	2006.1-2006.4	2012.0-2012.6
92	Blue Moon Bar	1.69	L	1993.8	1998.1	2006.4	2012.6
93	Plaza Barber Shop	1.69	L	1993.8	1998.1	2006.4	2012.6
94	Econ-O-Wash Laundry	1.69	L	1993.8	1998.1	2006.4	2012.6
95	Vacant	1.69	L	1993.8	1998.1	2006.4	2012.6
96	W & S Life Bldg., Vacant	1.68	L	2007.6	1998.0	2006.4	2012.5
97	Biltmore Plaza Offices	1.68	L	1997.1	1998.0	2006.4	2012.5
98	Biltmore Freight Station, Southern Railway	1.67	L	1995.9	1997.9	2006.3	2012.4
99	Biltmore Passenger Station, Southern Railway	1.67	L	1994.0	1997.9	2006.3	2012.4
100	Lowe's Asheville Hardware	1.59-1.67	L	1991.8-1995.8	1997.5-1997.9	2006.0-2006.3	2011.8-2012.4

TABLE 8 (concluded)

FLOOD PLAIN STRUCTURES

SWANNANOVA RIVER IN VICINITY OF ASHEVILLE

Map Ref. No.	Identification	River Mile	Bank	Floor Elev.	Flood Elevations		
					1916 Actual ^(a)	Regional	Maximum Probable
<u>Stoner Road to McDowell Street Viaduct (continued)</u>							
101	Cooper D. Cass Company	1.67	L	1996.1	1997.9	2006.3	2012.4
102	Pilot Life Insurance Company	1.67	L	1996.1	1997.9	2006.3	2012.4
103	Biltmore Drug Store	1.66	L	1995.1	1997.8	2006.2	2012.3
104	Biltmore Bakery	1.66	L	1995.7	1997.8	2006.2	2012.3
105	Kenilworth Garden Center	1.66	L	1995.7	1997.8	2006.2	2012.3
106	Vacant	1.66	L	1996.7	1997.8	2006.2	2012.3
107	Wachovia Bank & Trust Company	1.66	L	1997.4	1997.8	2006.2	2012.3
108	Money-Worth Real Estate	1.65	L	1993.7	1997.8	2006.2	2012.2
109	Biltmore Estate Office	1.65	L	1996.7	1997.8	2006.2	2012.2
110	Lisenbee Jewelry	1.65	L	1994.1	1997.8	2006.2	2012.2
111	Book Mart	1.65	L	1994.1	1997.8	2006.2	2012.2
112	Plaza Cafe	1.65	L	1994.6	1997.8	2006.2	2012.2
113	Biltmore Shoe Repair	1.64	L	1995.0	1997.8	2006.2	2012.2
114	Hot Shot Cafe	1.62	L	1993.0	1997.6	2006.1	2012.0
115	Aiken's Pharmacy	1.62	L	1993.0	1997.6	2006.1	2012.0
116	Gate City Auto Supply	1.62	L	1994.5	1997.6	2006.1	2012.0
117	Biltmore Fire Station	1.62	L	1993.1	1997.6	2006.1	2012.0
118	Fulgham Garage	1.62	R	1996.4	1997.6	2006.1	2012.0
119	Smile Oil Company	1.60	R	2000.2	1997.5	2006.1	2011.9
120	Crown Service Station	1.60	R	1994.1	1997.5	2006.1	2011.9
121	Casa Loma Bar	1.60	R	1992.7	1997.5	2006.1	2011.9
122	Biltmore Barber Shop	1.60	L	1992.8	1997.5	2006.1	2011.9
123	Tuxedo Feeds	1.60	L	1992.8-1993.4	1997.5	2006.1	2011.9
124	Biltmore Hardware	1.60	L	1993.2	1997.5	2006.1	2011.9
125	Biltmore Texaco Service	1.60	L	1993.7	1997.5	2006.1	2011.9
126	Pauls Drive-Inn	1.60	L	1993.2	1997.5	2006.1	2011.9
127	Dillingham Shell Service	1.60	L	1994.6	1997.5	2006.1	2011.9
128	Trentham Food Store	1.60	L	1995.5	1997.5	2006.1	2011.9
129	All Souls Church	1.60	L	2002.1-2002.4	1997.5	2006.1	2011.9
130	Allison-Erwin Company	1.57	R	1998.4	1997.4	2005.4	2011.1
131	Orkin Exterminators	1.57	R	2001.5	1997.4	2005.4	2011.1
132	Spur Service Station	1.57	R	1993.4	1997.4	2005.4	2011.1
133	Amoco Service & Bulk Station	1.57	R	1993.1	1997.4	2005.4	2011.1
134	Phillips 66 Service	1.57	R	1991.8	1997.4	2005.4	2011.1
135	Quality Coal Company	1.57	L	1992.6	1997.4	2005.4	2011.1
136	Thomas & Howard Whol. Groc.	1.55-1.57	L	1993.1-1994.5	1997.3-1997.4	2005.2-2005.4	2010.6-2011.1
137	Biltmore Variety Store	1.57	L	1993.2	1997.4	2005.4	2011.1
138	(Toledo Scales Shigley Drug Store	1.57	L	1993.0	1997.4	2005.4	2011.1
139	Bon Ton Cleaners	1.57	L	1993.4	1997.4	2005.4	2011.1
140	Stevens Esso Service	1.57	L	1996.7	1997.4	2005.4	2011.1
141	Three-Point Hardware	1.57	L	1994.9	1997.4	2005.4	2011.1
142	First Union National Bank	1.57	L	1998.8	1997.4	2005.4	2011.1
143	Post Office	1.57	L	1998.8	1997.4	2005.4	2011.1
144	A&P Store	1.57	L	1999.1	1997.4	2005.4	2011.1
145	Tandy's Gulf Service	1.57	L	2000.6	1997.4	2005.4	2011.1
146	Asheville Steel & Salvage Company	1.54-1.56	R	2004.9-2010.8	1997.1-1997.3	2005.0-2005.3	2010.3-2010.8
147	Swift & Company	1.54-1.56	R	2000.7-2005.0	1997.1-1997.3	2005.0-2005.3	2010.3-2010.8
148	Plaza Motor Court	1.55	R	2007.3	1997.3	2005.2	2010.8
149	Biltmore Iron & Metal Company	1.50-1.55	L	1995.4	1996.9-1997.3	2000.9-2005.2	2006.6-2010.6
150	Ken's Signs	1.50	L	1994.5	1996.9	2000.9	2006.6
151	Crest Furniture Company	1.50	L	1994.3	1996.9	2000.9	2006.6
152	Dayco Corp., whse.	1.50	R	2008.0	1996.9	2000.9	2006.6
153	American Suppliers, Inc.	1.50	R	2003.0	1996.9	2000.9	2006.6
154	Suds Center Laundry	1.50	L	1992.7	1996.9	2000.9	2006.6
155	Biltmore Sinclair Service	1.50	L	1994.2	1996.9	2000.9	2006.6
<u>McDowell Street Viaduct to Mouth</u>							
156	Southern Railway Freight Depot	1.25-1.45	R	1999.5-2000.0	1995.7-1996.6	1998.0-2000.5	2003.7-2006.1
157	Community Coal & Lumber Company	1.32-1.42	R	2007.6	1995.9-1996.4	1998.8-2000.0	2004.4-2005.6
158	Crane Company	1.36	R	2017.0	1996.1	1999.3	2005.0
159	Asheville Concrete Materials Company	1.00-1.15	R	1992.1-1993.6	1994.8-1995.4	1995.4-1996.8	2002.7
160	Southern Railway train crew bldg.	0.73	R	1991.3	1994.8	1995.4	2002.7
161	Southern Railway stock pens	0.46-0.52	R	1983.4-1985.6	1994.6	1995.4	2002.7
162	Shulimson Bros., Inc.	0.35-0.40	R	1981.3	1994.6	1995.4	2002.7
163	Shulimson Auto Parts	0.18	R	1980.4	1994.5	1995.4	2002.7
164	Champion Paper & Fibre Company, whse.	0.05-0.13	R	1988.3	1994.4-1994.5	1995.4	2002.7
165	Southern Railway-car shops	0.02-0.06	R	1987.5-1988.3	1994.3-1994.4	1995.4	2002.7

(a) The July 1916 flood if it recurred under present conditions of development in the flood plain would be up to 2.5 feet higher than the actual flood from Mile 1.51 to 3.00, up to 4 feet higher from Mile 3.53 to 3.95, and up to 15 feet higher from Mile 5.12 to 7.60.

(b) Buildings on the left bank from Mile 2.97 to Mile 2.57 are in the Koon Development.

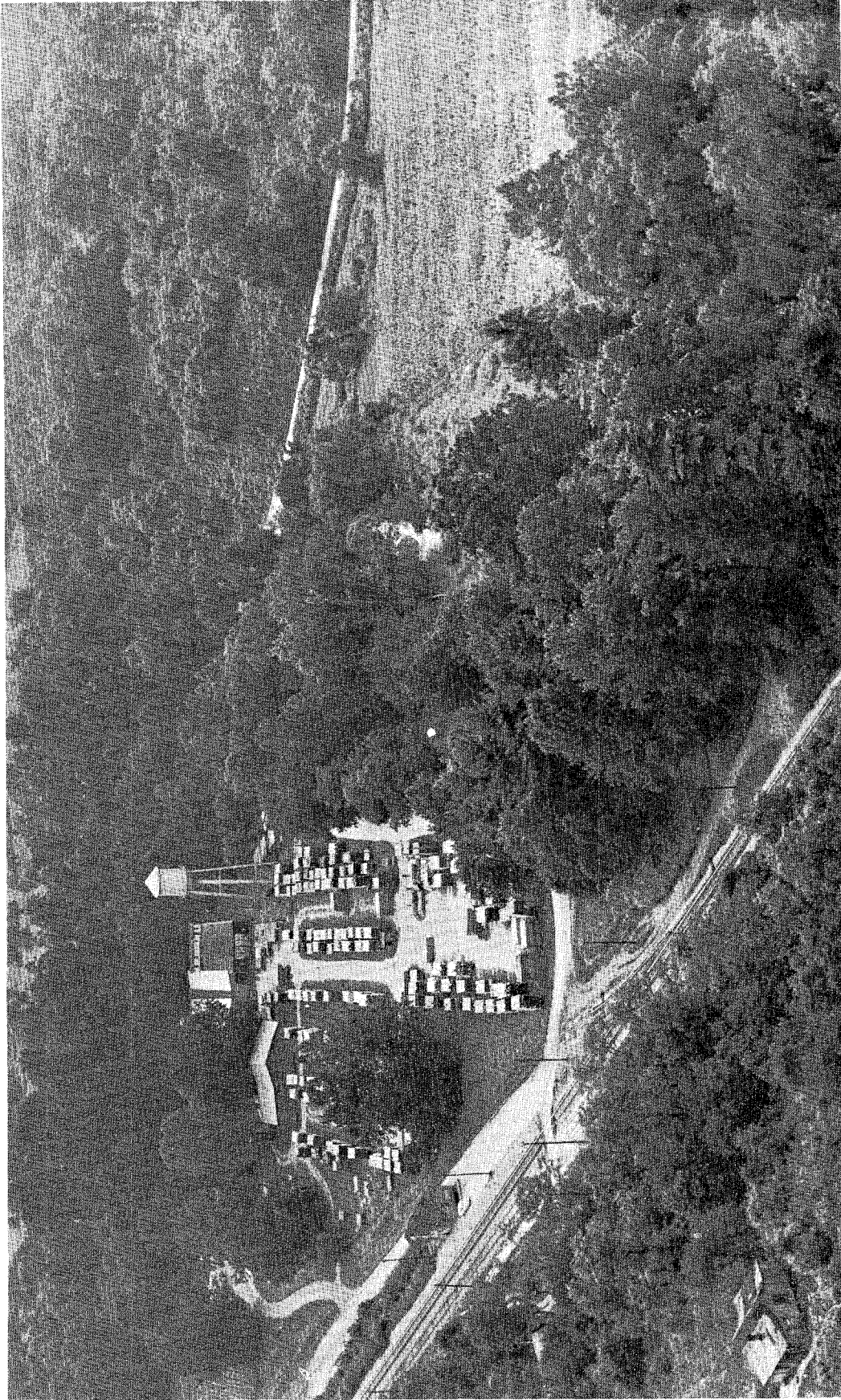


Figure 16. --BOLING CHAIR COMPANY AT AZALEA

This aerial view is looking down the Swannanoa River valley from about Mile 7. 2. Most of the area around the Boling Chair Company and the Southern Railway Company's Azalea station was flooded in July 1916.

(Photo by H. Malcolm Gamble, Asheville Citizen-Times)

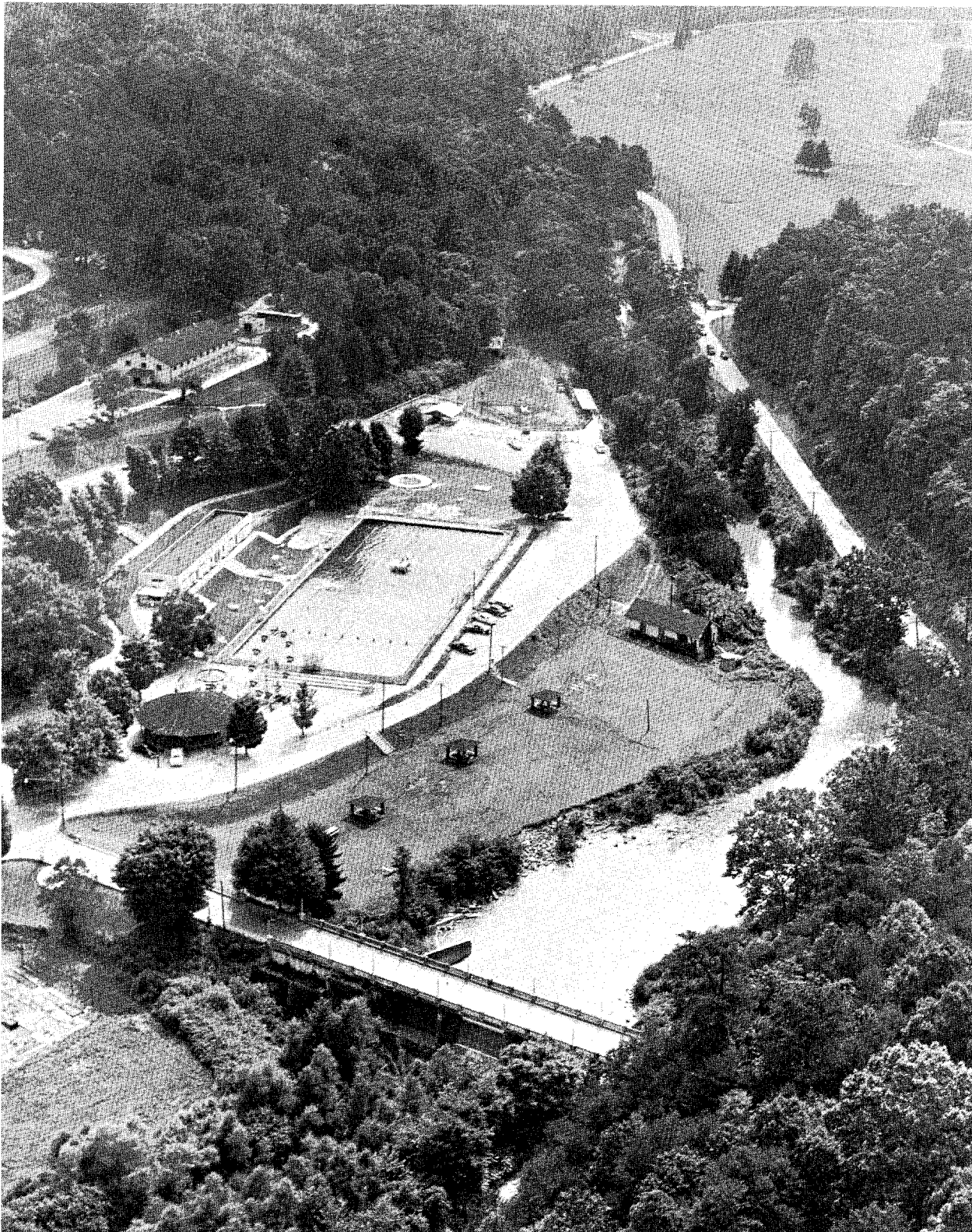


Figure 17. --ASHEVILLE RECREATION PARK

Looking downstream from Mile 5.2, this view shows the development at the Asheville Recreation Park. The abandoned dam is in the foreground. The July 1916 flood was 6 to 8 feet deep over the playground on the left side of the river.

(Photo by H. Malcolm Gamble, Asheville Citizen-Times)

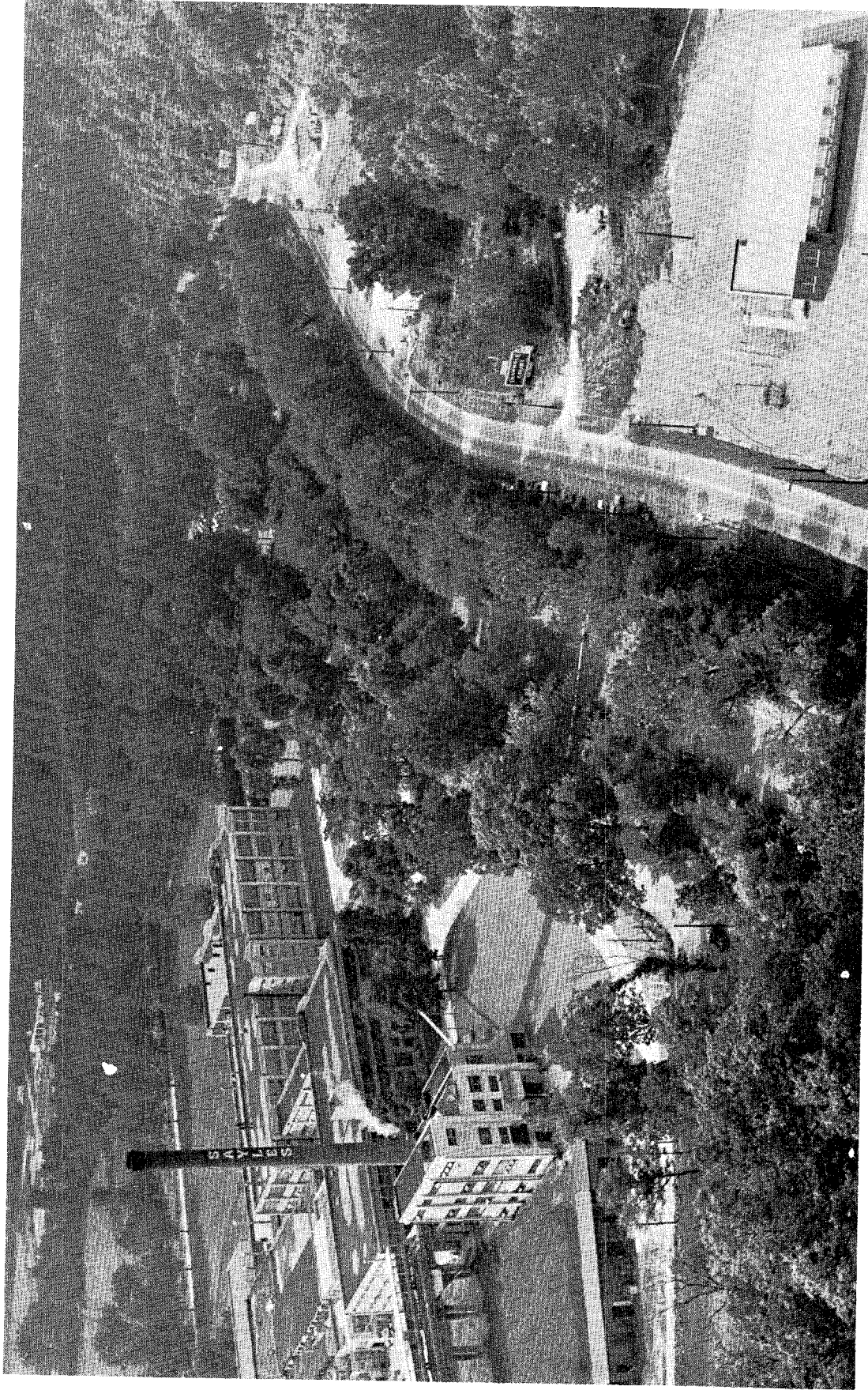


Figure 18. --SAYLES BILTMORE BLEACHERIES

This aerial view is downstream from Mile 3. 9. The Sayles plant is in the flood plain on the left.
(Photo by H. Malcolm Gamble, Asheville Citizen-Times)

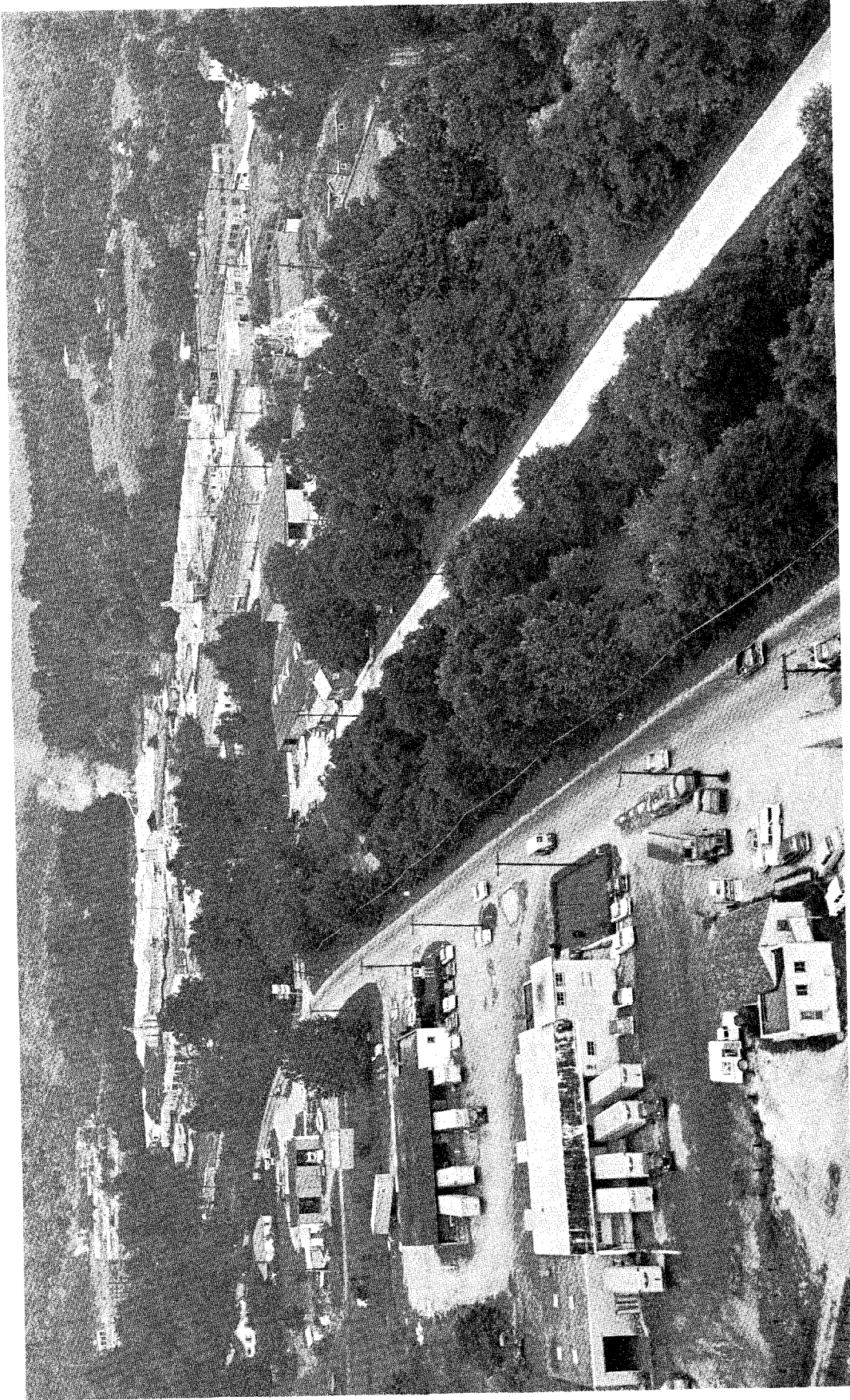


Figure 19. --KOOON DEVELOPMENT

This portion of the flood plain, looking upstream from Mile 2.5, is heavily developed by industry in the Koon Development, upper right, and by trucking firms along the highway on the left. Practically all of the developed area was flooded to shallow depths in July 1916. (Photo by H. Malcolm Gamble, Asheville Citizen-Times)

The development of the Swannanoa River flood plain has been rapid in the 20 years since the last severe floods. A number of firms moved from the area after suffering heavy losses in 1940, but in the intervening years other firms have taken their place and many more have moved into the area. This change is particularly noticeable in the Koon Development, along Sweeten Creek and along the truck route which follows the right bank of the river.

There are 26 developments which are classed as industrial in the Swannanoa River flood plain. These include a large cloth bleaching and processing plant, 3 furniture factories, a manufacturer of wood novelties, a garment factory, a concrete products plant, a ready-mix concrete plant, 2 wood dimension stock plants, a machinery firm, 2 bottling plants, 4 construction firms and various warehouse facilities for other industries.

The commercial developments include 14 motor freight terminals, 19 building materials firms, 13 food distributors, 7 feed distributors, 5 truck and equipment sales firms, 3 tobacco sales warehouses, 6 bulk oil plants, 16 service stations, 16 eating places, a large drive-in theater, 2 motor courts, 2 branch banks, a post office substation and 2 churches. There are 49 retail stores or other business places concentrated in the Biltmore business district alone. The motor freight terminals are all new in the flood plain since 1940 and are concentrated along the truck route and the access highways which connect with it. Figure 19 shows some of these terminals.

There are 36 houses in the flood plain in the Biltmore section, most of which were flooded or surrounded by water in 1940. There are 10 dwellings in the Koon Development, 14 between there and the U. S. Highway 74 bridge, 11 between the bridge and Azalea, and 5 more at scattered locations.

U. S. Highway 25 crosses the Swannanoa River at McDowell Street Viaduct, passes on the west side of the Biltmore business district on All Souls Crescent to Hendersonville Road. Alternate Route 25A leaves Highway 25 at McDowell and Lodge Streets, passes eastward through the business district on Lodge and Brook Streets and leaves the flood plain on Sweeten Creek Road. The Asheville truck route follows the right bank of Swannanoa River from its confluence with French Broad River via Meadow Road to Biltmore Avenue, then by Bryson Street and Swannanoa Road to river Mile 5.0, near the old Asheville Recreation Park, where it turns north to join U. S. Highway 70. U. S. Highway 74 follows

Swannanoa Road from Mile 3.2 to Mile 4.35, where it crosses the river to follow Gashes Creek to the southeast. U. S. Highway 70 crosses the flood plain at Azalea.

From the shop and car repair area near the confluence of the Swannanoa and French Broad Rivers, the switching yards of the Southern Railway extend up the right bank flood plain of the Swannanoa River, reducing to a six-track width at the Meadow Road overpass and widening to ten tracks near the freight depot below McDowell Street Viaduct, Figure 21. Three tracks cross Swannanoa River on the twin bridges at Mile 1.51, just below Biltmore. At the Biltmore passenger station the line to Spartanburg, called the A & S Line, turns south to leave the flood plain by way of the Sweeten Creek valley. The Salisbury Line continues up Swannanoa River at the edge of the flood plain to the Koon Development, then turns to higher ground south of the river. The line returns to the left bank flood plain at Mile 5.9, below Azalea, and continues eastward from Azalea by way of Christian Creek. In the shop area a large part of the old locomotive roundhouse has been made into a warehouse and is under lease to the Champion Paper and Fibre Company for paper and pulp storage. This firm leases other warehouse space farther downstream along the French Broad River and also in Biltmore and in the Koon Development.

Future changes in highways, now under consideration, can be expected to have an effect on developments in the flood plain of the Swannanoa River.

There is no sewage treatment plant on the Swannanoa River in the reach investigated. One 8-inch sewer line discharges into Swannanoa River at the mouth of Ram Branch, Mile 0.7. The sewer system of the Swannanoa Water and Sewer District, which extends to the head of the watershed at Ridgecrest and Montreat, collects the sanitary and industrial waste from practically the whole of the Swannanoa River basin and discharges it into the French Broad River from a 36-inch line at Carrier Bridge. The main line of this system crosses from the left to the right bank of Swannanoa River at Azalea and follows the right bank to the mouth, collecting enroute the sewage from lateral lines which serve the area north of the river. A second collecting line which follows the left bank of the river from U. S. Highway 74 bridge through Biltmore collects the waste from the south side of the river and crosses the river at Mile 1.5 where it connects to the main line on the right bank. The proposed plans for treatment of the sewage in the Asheville area include extensive repairs to the Swannanoa District sewer lines and connection to the main collecting sewer on the right bank of the French Broad River.

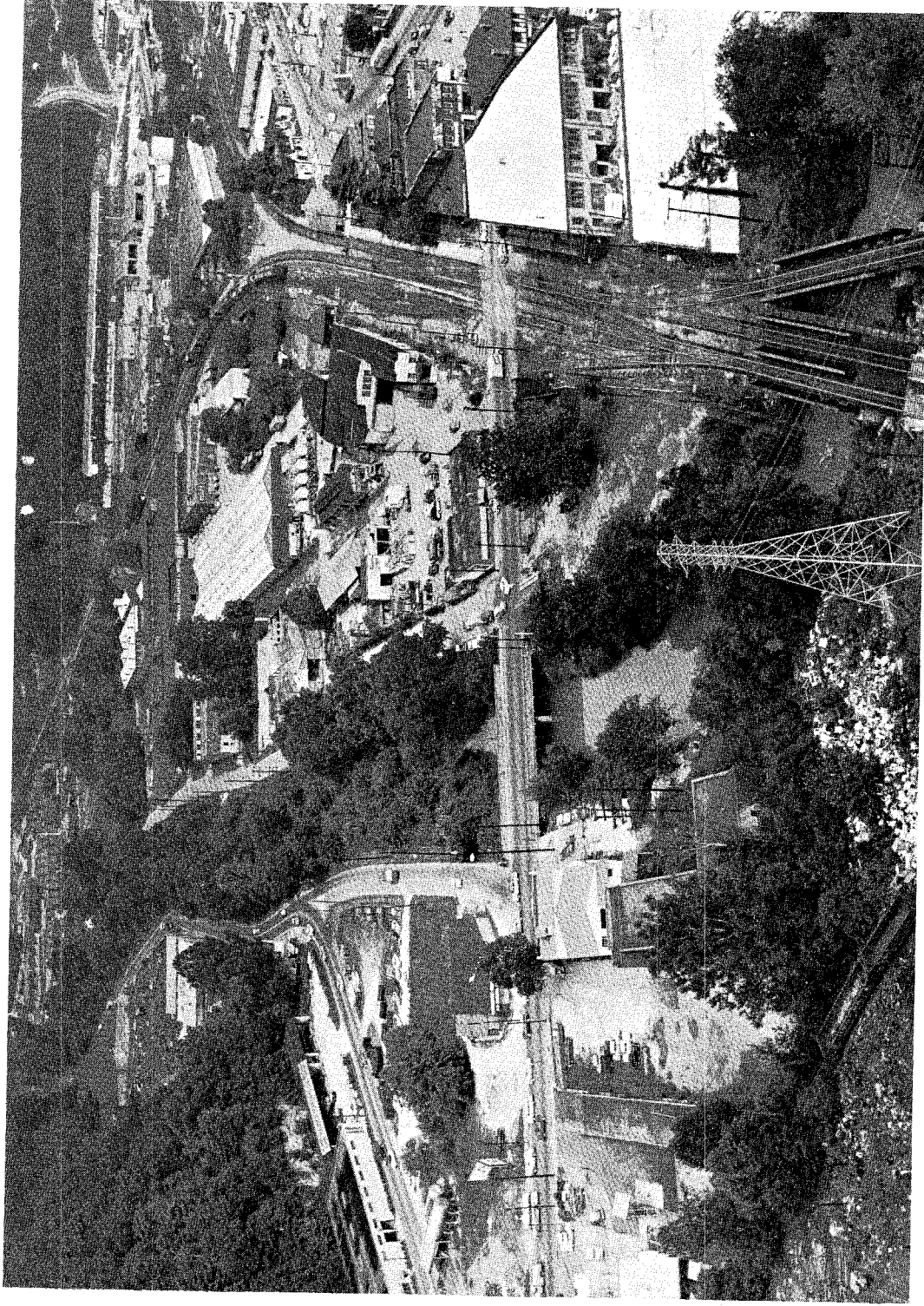


Figure 20. --BILTMORE INDUSTRIAL AND COMMERCIAL DEVELOPMENT

This view of Biltmore is upstream from Mile 1.5. The Southern Railway and Biltmore Avenue bridges are in the foreground. All of the flood plain seen here was under water in July 1916.

(Photo by H. Malcolm Gamble, Asheville Citizen-Times)

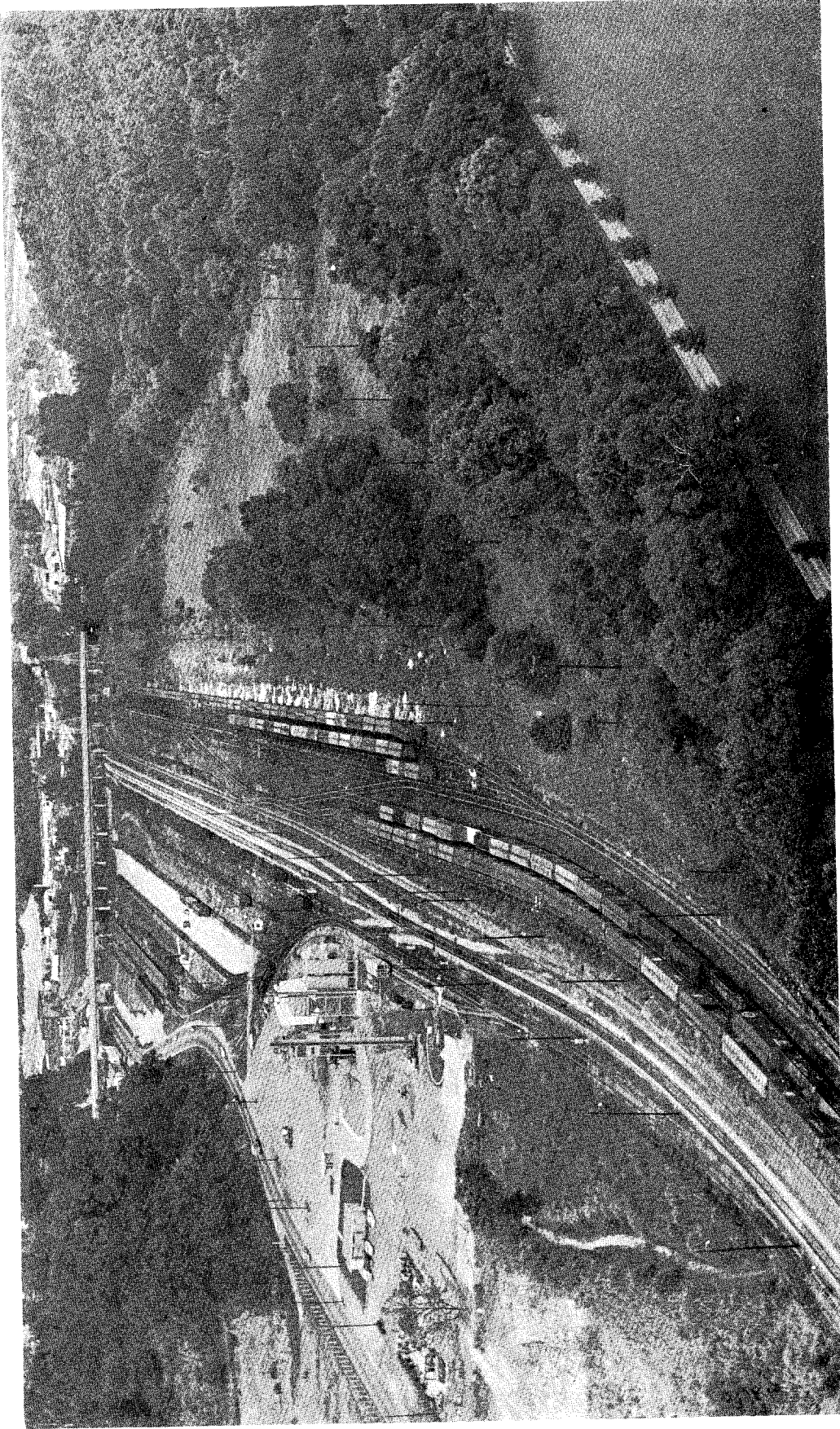


Figure 21. --SOUTHERN RAILWAY YARDS

The Swannanoa River flows along the road at the right of this view, looking upstream from Mile 0.8 toward the McDowell Street Viaduct. Ground level at the Asheville Concrete Materials Company plant has been raised, but the plant is still below 1916 flood levels.

(Photo by H. Malcolm Gamble, Asheville Citizen-Times)

Asheville gets its water supply from two city-owned watersheds in the Swannanoa River basin, one on North Fork and one on Beetree Creek. Pipelines carry the water from a reservoir at each watershed to two distribution reservoirs located on Beaucatcher Mountain within the city.

Bridges Across the Stream

Swannanoa River is crossed by one double railroad bridge and by eleven bridges which carry streets, roads, or private drives. Figures 22 and 23 show 11 of these bridges. Of the eight bridges along the lower five miles of the stream, all but one were overtopped in the flood of August 13, 1940. At that bridge, the McDowell Street Viaduct, the main spans are above flood danger but the approach at the Biltmore side is overflowed in large floods, cutting off access to Asheville from the south. The bridge across the Asheville Recreation Park Dam passed the 1940 flood but would be overtopped in a recurrence of the 1916 flood. Only the U. S. Highway 70 bridge at Azalea and the McDowell Street Viaduct would pass floods such as that of July 1916 without being overtopped.

Table 9 lists pertinent elevations for the twelve bridges across the Swannanoa River and shows the relation to the crest of the actual July 1916 flood.

At Mile 7.58, the U. S. Highway 70 bridge, built in 1936 and known also as Gudger Bridge, carries three-lane traffic between Asheville and the towns of Swannanoa and Black Mountain as well as through traffic to central and eastern North Carolina. It is a concrete structure, crossing the river at a point where the overflow section is narrow, requiring only short approach spans. The bridge floor is at elevation 2070.2 feet. The underclearance is at elevation 2066.4, 2.6 feet above the July 1916 flood crest elevation and four feet above the crest of the flood of August 13, 1940. There was an iron bridge here in 1916 which was washed out by the flood in that year.

The Azalea bridge at Mile 6.97 is of concrete construction with floor level at the top of bank elevation of the stream. Large floods overflow both approaches and the bridge. The flood of August 13, 1940, was 1.7 feet over the bridge floor and 5.1 feet higher than the bridge underclearance elevation. The 1916 flood washed out an iron bridge at this location.

The bridge at Mile 6.50 is a steel girder structure which carries secondary road traffic. The August 13, 1940, flood was 1.2 feet over the floor.

TABLE 9

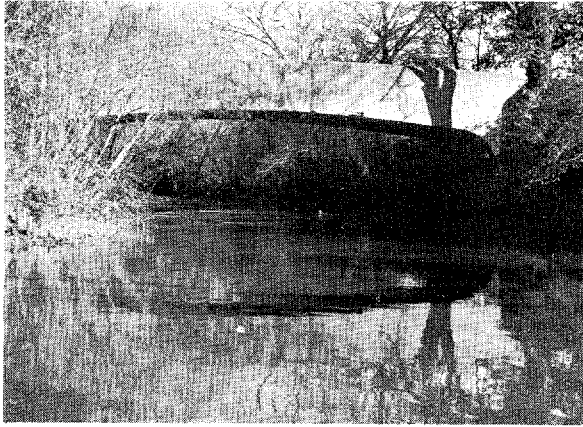
BRIDGES ACROSS SWANNANOA RIVER
IN VICINITY OF ASHEVILLE, NORTH CAROLINA

Mile Above Mouth	Identification	Low Water Elev. feet	Floor Elev. feet	Actual 1916 Flood Crest feet	Underclearance	
					Elev. feet	Above Flood feet
0.68	Biltmore Estate	1968.5	1987.2	1994.8	1983.9	10.9
1.47	McDowell Street	1976.8		1996.8	2009.7	12.9
1.51	Southern Railway	1977.0	1994.3 ^(a)	1997.1	1990.3	6.8 ^(b)
1.58	Biltmore Avenue	1978.4	1993.2	1997.4	1989.3	8.1 ^(b)
2.66	Glendale Avenue	1987.4	2000.9	2005.5	1999.3	6.2 ^(b)
3.12	Cheeseborough	1992.9	2007.5	2009.5	2006.5	3.0
3.53	Sayles	1996.8	2010.9	2013.6	2008.6	5.0 ^(b)
4.35	U. S. Highway 74	2004.3	2020.8	2023.6	2016.8	6.8
5.12	Recreation Park	2020.5	2046.2	2033.2	2042.7	9.5 ^(c)
6.50	Secondary road	2032.1	2048.8	2050.4	2047.1	3.3 ^(b)
6.97	Azalea	2035.7	2051.4	2054.0	2048.0	6.0 ^(b)
7.58	U. S. Highway 70	2044.0	2070.2	2063.8	2066.4	2.6

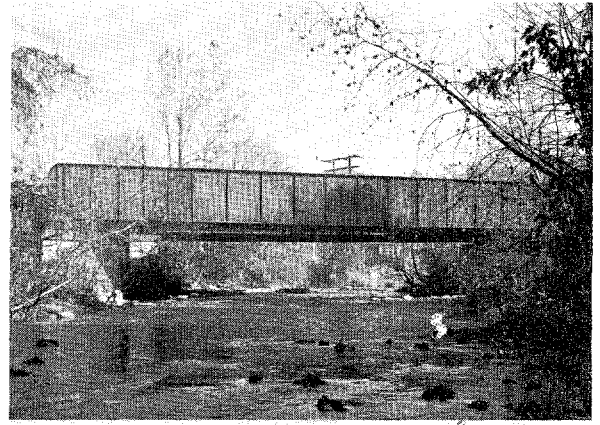
(a) Top of rail. The top of the steel girders is at elevation 1999.5.

(b) 1916 flood levels would be up to 4 feet higher under present conditions at these locations.

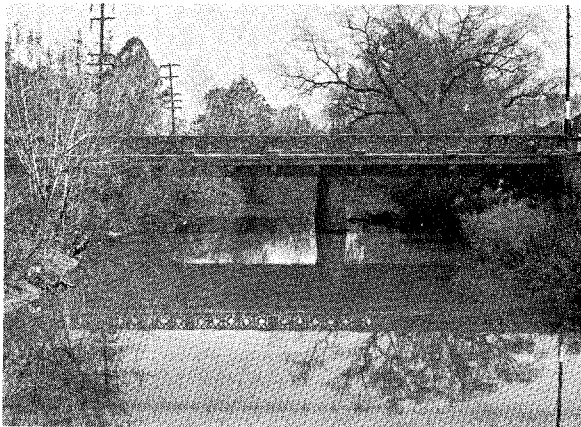
(c) 1916 flood level would be 15 or more feet higher under present conditions and would be about 2 feet over the bridge floor.



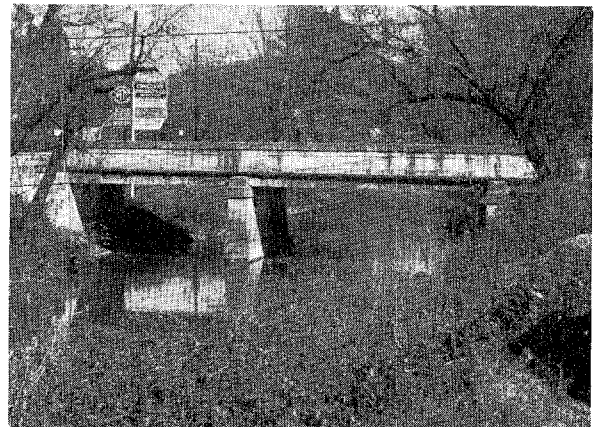
Biltmore Estate bridge, Mile 0.68,
downstream side



Southern Railway bridges, Mile 1.51,
downstream side



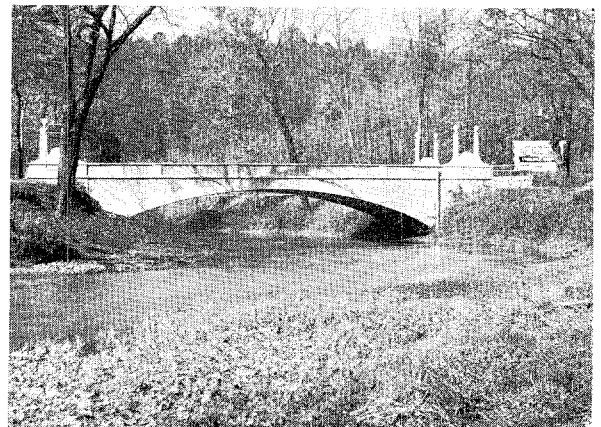
Biltmore Avenue bridge, Mile 1.58,
downstream side



Glendale Avenue bridge, Mile 2.66,
downstream side



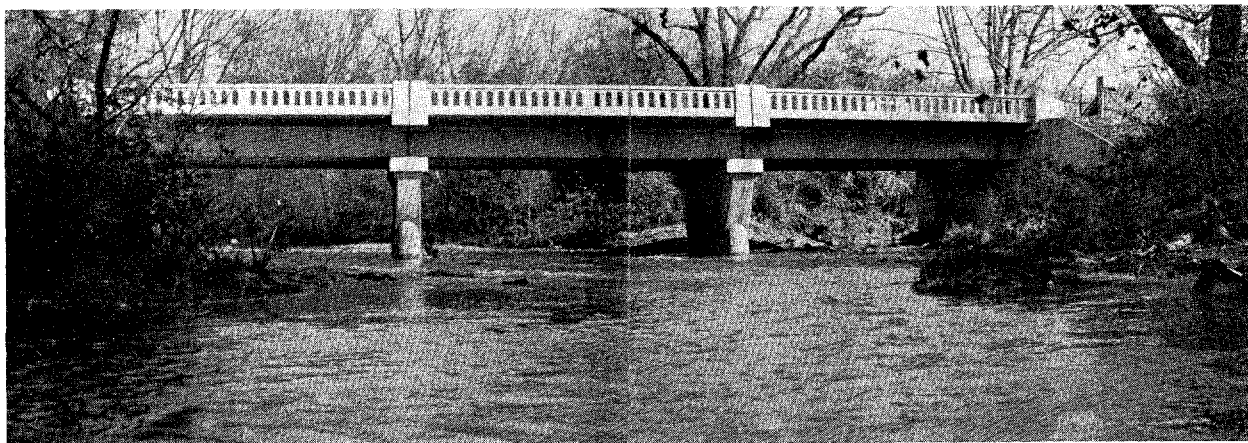
Cheeseborough Bridge, Mile 3.12,
downstream side



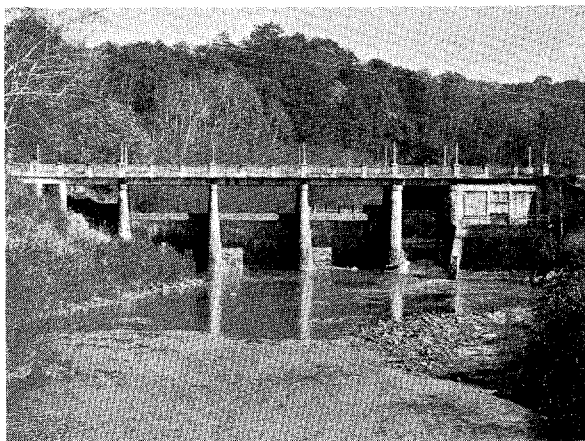
Sayles Bridge, Mile 3.53,
upstream side

Figure 22. --SWANNANOVA RIVER BRIDGES, MILES 0 TO 4

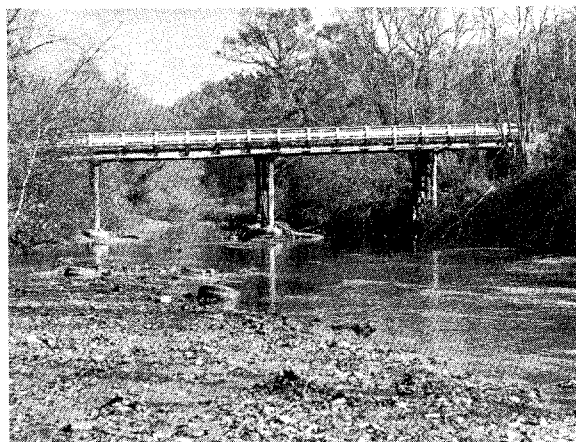
All six of these bridges would be overtopped by a recurrence of the July 1916 flood. The high McDowell Street Viaduct, Mile 1.47, is shown in Figure 21.



U. S. Highway 74 bridge, Mile 4.35, upstream side



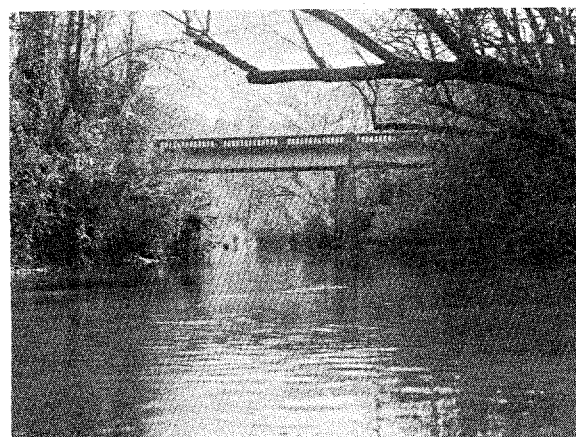
Asheville Recreation Park dam and bridge, Mile 5.12



Secondary road bridge, Mile 6.50, downstream side



Azalea Bridge, Mile 6.97, downstream side



U. S. Highway 70 bridge, Mile 7.58, upstream side

Figure 23. --SWANNANOVA RIVER BRIDGES, MILES 4 TO 7.6

A recurrence of the July 1916 flood would overtop all of these bridges except that on U. S. Highway 70.

The bridge crossing Asheville Recreation Park Dam (both dam and bridge were built in 1925) is a concrete structure that carries traffic to the park and to a few houses beyond the park. Water reached just above the underclearance elevation of the bridge in the August 13, 1940, flood. With the obstruction to flow provided by the dam and the bridge approaches, a recurrence of the flood of July 1916 would overtop the bridge floor by about 2 feet.

The U. S. Highway 74 bridge at Mile 4.35, built after 1916, carries traffic to the Gashes Creek area, to Bat Cave, Chimney Rock, and the other cities southeast of Asheville. The bridge is concrete with its underclearance about 12 feet above the low water elevation of the stream. In the flood of August 13, 1940, water was 1.4 feet over the bridge floor and broad overflow occurred at the right end of the bridge. In 1955 a new, wider roadway was put on the bridge.

Access to the Sayles-Biltmore Bleacheries plant and to the plant village nearby is provided by the low concrete arch bridge at Mile 3.53 which was completed in 1926. On August 13, 1940, water at the bridge reached elevation 2014.6 feet, 3.7 feet over the high point of the bridge floor and six feet over the right bank approach to the bridge. The Sayles Bridge would cause a heading up of about 4 feet during a recurrence of the 1916 flood peak discharge. A 6-inch gas pipeline crosses the river at the Sayles plant at Mile 3.73. Underclearance elevation is 2020.1 feet.

A light steel truss bridge at Mile 3.12 provides access to a private residence on the left bank. Water was about 0.5 foot over the bridge floor in the flood of August 13, 1940. A timber bridge here was washed out in 1916.

The Glendale Avenue bridge at Mile 2.66 carries traffic to the numerous industrial and commercial firms located in the Koon Development on the left bank at that point. The bridge is of concrete with high solid guard rails which provide considerable obstruction to flood flows. In the flood of August 13, 1940, water headed up two feet at the bridge and stood 4.5 feet over the floor.

The Biltmore Avenue bridge, built before 1916, carries the larger part of the traffic between Biltmore and downtown Asheville. The underclearance at the bridge is about ten feet above the low water level and the floor is four feet higher. In the August 13, 1940, flood, water was 3.2 feet over the bridge floor. The actual flood of July 1916 was one foot higher at this point than the 1940 flood, but it would be 2.9 feet higher if it were to recur under the present conditions of development.

The Southern Railway has two bridges 0.07 mile downstream from the Biltmore Avenue bridge which together carry three tracks across Swannanoa River. These are shown in Figure 23. A bridge was here in 1916, and the new bridges were built in 1917. The bridges have heavy steel girders which put a solid obstruction across the stream about nine feet in height. In the flood of July 1916 water was 6.8 feet above the underclearance elevation of the bridge girders and was over the railway tracks. Should the 1916 flood recur, the crest level would be more than 2 feet higher.

The McDowell Street Viaduct spans Swannanoa River and the freight yards of the Southern Railway which are on the right bank flood plain. Over most of its length the bridge is well above the elevation of past floods, but it dips down to flood plain level at the Lodge Street intersection at the left end of the bridge. In the flood of August 13, 1940, water was 3-1/2 feet deep in this intersection. The bridge was built after the 1916 flood.

The bridge at Mile 0.68 is a low concrete arch structure used as an access to Biltmore Dairy Farms. Water was higher than the bridge underclearance elevation in 1940, and in the flood of July 1916 flood backwater from French Broad River was eight feet higher than the elevation of the bridge floor.

Obstructions to Flood Flows

In addition to the bridges across the river, the numerous buildings in the flood plain of the Swannanoa River are a serious obstruction to flood flows. From Mile 2.9 at the upper end of the Koon Development to Mile 1.5 at Biltmore, buildings almost completely block the floodway on both sides of the river. Accompanying the construction of these buildings has been a good deal of filling of low areas. Since 1940, grading and filling have been carried out on the right bank near the railroad freight yards, Mile 0.8 to 1.0, above the Biltmore Avenue bridge, and between Miles 3.6 and 4.0, opposite the Sayles plant. There has been some filling on the left bank at Mile 2.2.

The effect of these obstructions on the height of the 1916 flood if it should occur again is shown on Plate 12. At Biltmore, the increase in height over the actual 1916 flood would range up to 2.5 feet. Higher elevations would occur from the Southern Railway bridges upstream to Cheeseborough Bridge. At Sayles Bridge, the obstruction of the bridge and the fills at the plant would cause a

recurrence of the 1916 flood to be as much as 4 feet higher for approximately one-half mile upstream.

Of significance, also, is the heavy growth of trees and other vegetation that lines both banks of the Swannanoa River. This growth appears to be denser now than it was at the time of the 1940 floods. It would have some effect in obstructing the flow and increasing the height of large floods, especially those occurring in the summer.

Asheville Recreation Park Dam

The Asheville Recreation Park Dam, located at Mile 5.12 on Swannanoa River, was completed in 1925. The dam is concrete, 26 feet high at the spillway, and has a bridge and roadway on top. The lake above the dam was called Lake Craig and for some years was one of the attractions at the city park. Silt deposits filled the lake and made it useless, however, and it has been drained and abandoned. Since 1952 a large gate at the left end of the spillway has been kept open. Land formerly in the lake is now farmed and was recently returned to the former owners under the conditions by which it was donated to the city when the dam was built. The dam remains in place and continues to have a serious effect on the height of floods on the Swannanoa River. A recurrence of the July 1916 flood discharge would result in a stage 15 feet higher than the actual flood just above the dam and flood heights would be greater for two or more miles upstream from the dam.

FLOOD SITUATION

Flood Records

Records of river stages and discharges on the Swannanoa River in the reach investigated cover 32 of the last 40 years. The U. S. Geological Survey made observations on a staff gage on Swannanoa River at the Biltmore Avenue bridge from December 1, 1920, to September 30, 1926. Since May 8, 1934, continuous records of streamflow are available from a recording stream gage 100 feet downstream from the bridge. The Geological Survey made observations on a staff gage at Azalea from August 1946 through September 1947 and at Swannanoa, 8 miles upstream from Azalea, from May 1907 to June 1909 and January 1926 to December 1931.

Data on floods on the river prior to December 1920 have been obtained from interviews with local residents who witnessed or had knowledge of the floods, from Asheville newspaper files, and from a search of historical records and documents. Reports of investigations made by engineers of the Hydraulic Data Branch since 1935 have supplied valuable information on the large floods of recent years.

Flood Stages and Discharges

Table 10 lists peak stages and discharges for known floods exceeding bankfull stage at the Geological Survey gage in Biltmore. Bankfull stage is 12 feet. For floods in the period 1920-1926 and from 1934 to date the flood crest stages are those observed at the gage. Stages for floods occurring prior to these periods are from high water marks or are estimated from newspaper and historical accounts or from interviews with local residents.

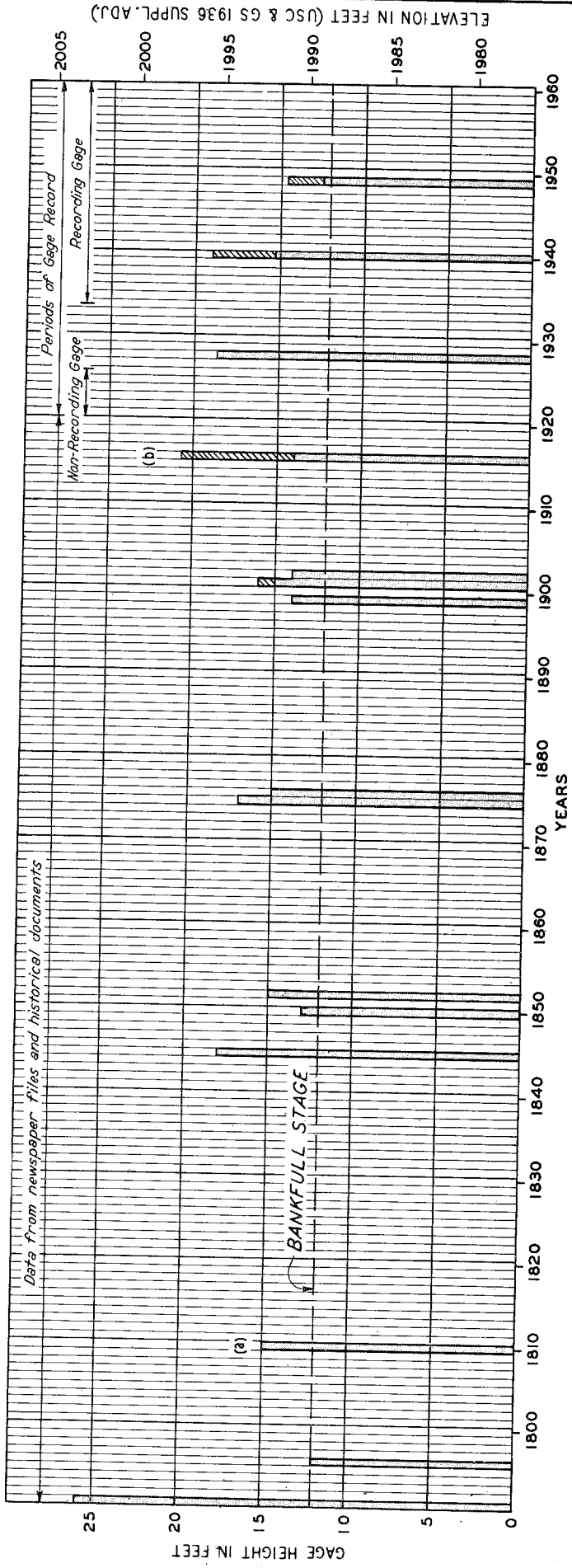
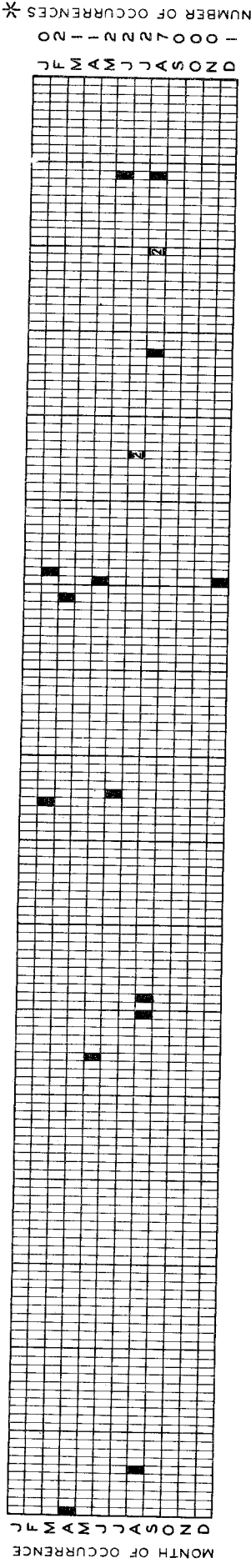
Based on these estimates of the heights of the early floods, the highest 8 floods on the Swannanoa River at Biltmore were those listed in Table 11.

Flood Occurrences

Plate 7 shows crest stages and months of occurrence of known floods exceeding bankfull stage of 12 feet on the Swannanoa River at the Biltmore gaging station. The tabulation below shows the monthly distribution of 18 of the 19 known floods occurring in the period since 1791. No month of occurrence is available for the flood in 1810.

<u>Month</u>	<u>Number of Occurrences</u>	<u>Month</u>	<u>Number of Occurrences</u>
January	0	July	2
February	2	August	7
March	1	September	0
April	1	October	0
May	2	November	0
June	2	December	<u>1</u>
			18

A longer period of record would probably show floods occurring in every month of the year. However, the most frequent occurrence of large floods of record has been in the spring and summer months. August is the outstanding month.

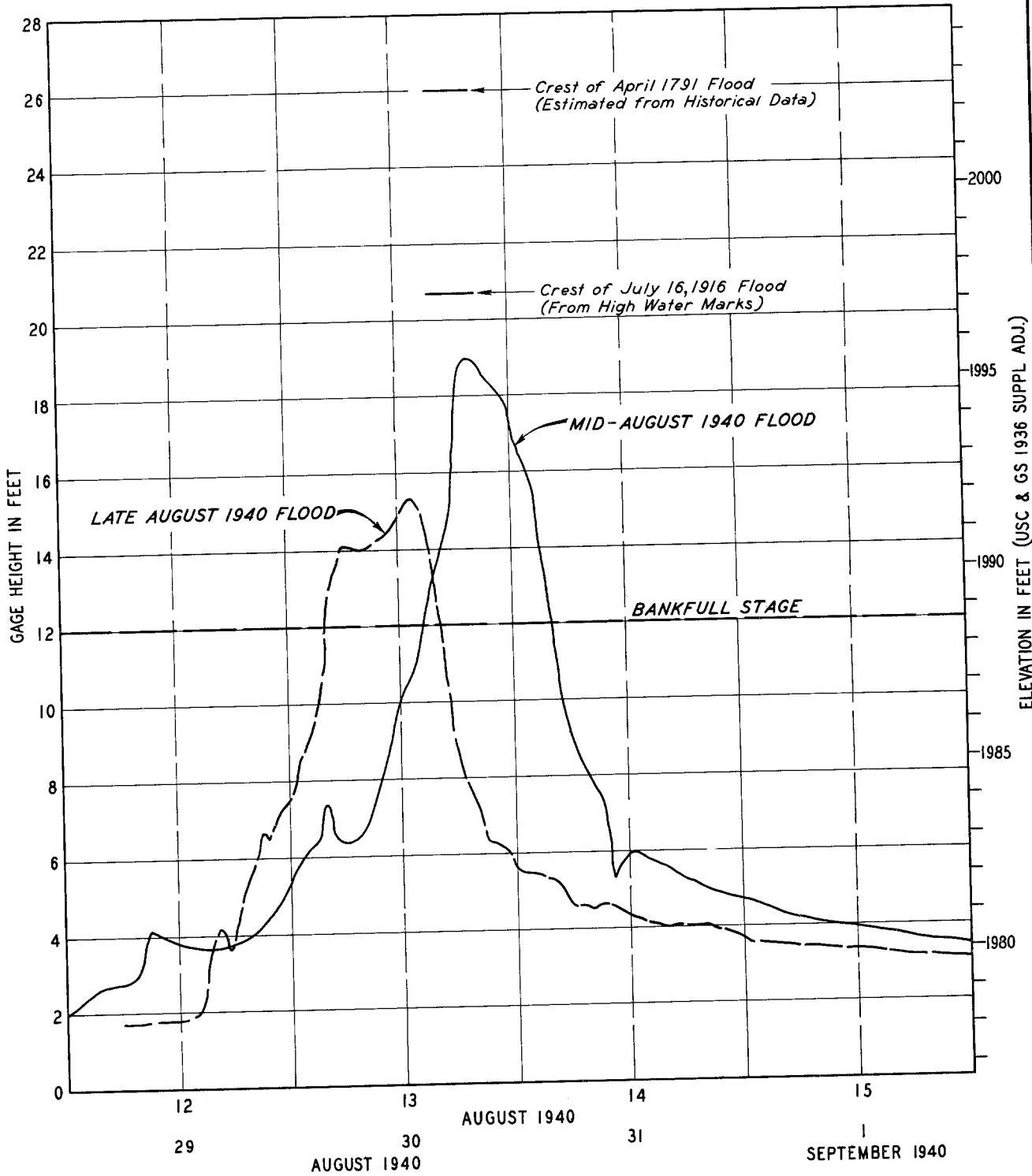


TENNESSEE VALLEY AUTHORITY
 DIVISION OF WATER CONTROL PLANNING
 HYDRAULIC DATA BRANCH

**FLOODS ABOVE
 BANKFULL STAGE**
 SWANNANOVA RIVER
 AT BILTMORE, NORTH CAROLINA

DECEMBER 1960

(a) Month unknown.
 (b) Stage based on high water marks.
 All stages referred to
 U.S. Geological Survey gage
 at River Mile 1.56
 * Number of occurrences during 169 years,
 1791-1960, excluding 1810 flood.



Gage at Mile 1.56

TENNESSEE VALLEY AUTHORITY
DIVISION OF WATER CONTROL PLANNING
HYDRAULIC DATA BRANCH

STAGE HYDROGRAPHS
FLOODS OF MID AND LATE AUGUST 1940
SWANNANOA RIVER
AT BILTMORE, NORTH CAROLINA
DECEMBER 1960

TABLE 10

SWANNANOA RIVER AT BILTMORE, NORTH CAROLINAFLOOD CREST ELEVATIONS AND DISCHARGES ABOVE BANKFULL STAGE

1791-1960

This table includes all known floods above bankfull stage of 12 feet at the U. S. Geological Survey gaging station, River Mile 1.56, just downstream from the Biltmore Avenue bridge. Drainage area is 130 square miles.

<u>Date of Crest</u>		<u>Gage Heights</u>		<u>Peak Discharge</u>	
		<u>Stage</u> feet	<u>Elevation</u> feet	<u>Amount</u> cfs	<u>Per Sq. Mile</u> cfs
April	1791	26	2003	40,000	308
August	1796	15	1992	10,600	82
	1810	15	1992	10,600	82
May	1845	18	1995	16,400	126
August	1850	13	1990	7,300	56
August	1852	15	1992	10,600	82
February	1875	17	1994	14,400	111
June	17, 1876	15	1992	10,600	82
March	19, 1899	14	1991	8,800	68
May	21, 1901	16	1993	12,400	96
December	30, 1901	15	1992	10,600	82
February	28, 1902	14	1991	8,800	68
July	10, 1916	14	1991	8,800	68
July	16, 1916	20.7	1997.3	23,000	177
August	16, 1928	18.7	1995.3	17,800	137
August	13, 1940	19.00	1995.58	18,400	142
August	30, 1940	15.34	1991.88	11,200	86
June	16, 1949	14.65	1991.23	9,930	76
August	28, 1949	12.56	1989.14	6,760	52

TABLE 11
HIGHEST KNOWN FLOODS IN ORDER OF MAGNITUDE
SWANNANOA RIVER AT BILTMORE

Order No.	Date of Crest		Gage Height	
			Stage feet	Elevation feet
1	April	1791	26	2003
2	July	16, 1916	20.7	1997.3
3	August	13, 1940	19	1995.6
4	August	16, 1928	18.7	1995.3
5	May	1845	18	1995
6	February	1875	17	1994
7	May	21, 1901	16	1993
8*	August	30, 1940	15.34	1991.9

* Five other floods in the period prior to gage records are estimated to have been of about the magnitude of that of August 30, 1940.

Rate of Rise and Velocities During Floods

Plate 8 shows stage hydrographs at the Biltmore gaging station for the two large floods in August 1940. Also shown is the crest stage of the July 1916 flood and the estimated crest stage of the April 1791 flood. During the August 13, 1940, flood the Swannanoa River rose from a stage of 4.0 feet on August 12 to the crest of 19.00 feet on August 13 in 24 hours, at an average rate of rise of 0.6 foot per hour. The maximum rate of rise in an hour was 2.4 feet between 5 and 6 p. m. on August 13, just 1-1/2 hours before the crest occurring at 7:30 p. m.

Average velocities in the channel of the Swannanoa River during the July 1916 flood were in the order of 4 to 18 feet per second. In the flood plain, velocities ranged up to 8 feet per second. During the 1791 and larger floods, velocities in both channel and overbank areas would be even greater.

Flooded Area, Flood Profiles, and Cross Sections

Plate 14 shows the approximate area along Swannanoa River that was inundated by the 1916 flood. Plate 15 shows at an enlarged scale the 1916 flooded

area in the highly developed reach between the Koon Development and the mouth of the river. The actual limits of these overflow areas on the ground may vary somewhat from those shown on the maps because the contour interval of the maps does not permit precise plotting of the flooded area boundaries. The contour intervals on Plate 14 are 20 feet and 40 feet. Plate 15 is based on maps prepared by the North Carolina State Highway Department which have a contour interval of 5 feet. The latter maps were used wherever available in defining the flooded area.

Plate 12 shows high water profiles on the Swannanoa River for the floods of July 1916, August 13, 1940, and August 30, 1940, and high water marks for the August 16, 1928, flood. Plate 12 also shows profiles of the 1916 flood under present conditions, and the Regional and Maximum Probable Floods which are discussed in Sections III and IV, respectively.

Plate 16 shows typical cross sections of the Swannanoa River valley in the reach studied. The location of the cross sections is shown on the profile and map, Plates 12 and 14. Each cross section shows the elevation and extent of overflow of the actual flood of July 1916, the 1916 flood under present conditions, and the Regional and Maximum Probable Floods. A number of cross sections, the locations of which are shown on the map and profiles, are not reproduced but are available from the Hydraulic Data Branch of TVA to anyone who has need for them.

FLOOD DESCRIPTIONS

Descriptions of large floods on the Swannanoa River are included with the discussion of past floods on the French Broad River.

III.

REGIONAL FLOODS

Tennessee Valley Authority
Division of Water Control Planning
Hydraulic Data Branch

III

REGIONAL FLOODS

Large floods have been experienced in the past on streams in the general geographical and physiographical region of Asheville, North Carolina. Heavy storms similar to those that caused these floods could occur over the French Broad River and Swannanoa River watersheds. In this event, floods would result on these two streams comparable in magnitude to those that did occur on the neighboring streams. Floods of this magnitude are designated as Regional Floods. It is therefore desirable in connection with any determination of future floods that may occur on either the French Broad River or the Swannanoa River, to consider floods that have occurred in the Asheville region on watersheds whose topography, watershed cover, and physical characteristics are similar to those of the two rivers.

Maximum Known Regional Floods

The distribution of storm rainfall over the French Broad River basin above Asheville and over the watersheds to the south and east is influenced considerably by the topography of the region. This is true of the summer tropical hurricane storms such as those in July 15-16, 1916, and August 13-14, 1940, as well as the cyclonic storms 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 south and east slopes of the Divide and the area immediately beyond the crest within the Valley are subject to heavy orographic rainfall. However, the distribution of this mountain-induced rainfall is different over the watersheds to the south and east of the Tennessee Valley than over the watersheds of the French Broad, Little Tennessee, and Hiwassee Rivers inside the Valley. On the coastward slopes the heavy precipitation, resulting when the moist air is lifted by the mountains, is generally widespread, covering whole river basins, whereas in the Tennessee Valley watersheds the heavier amounts are confined largely to a relatively narrow band along the top and immediately beyond the Divide. Within the French Broad River basin, additional heavy rain is induced by

the mile-high Pisgah Ridge which 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 French Broad and Swannanoa Rivers.

Table 12 lists the maximum known floods experienced on watersheds west of the Tennessee Valley boundary and within 75 miles of Asheville. The selection of watersheds has further been restricted to those whose headwaters lie in the Appalachian Mountain region, eliminating those to the west and northwest that lie entirely within the Great Valley beyond this region.

The largest known floods of the past in the Asheville region have generally resulted from the storms of May 1901, July 1916, or mid-August 1940. The storm of May 18-21, 1901, was one of the most severe known in the upper eastern portion of the Valley, particularly on the Nolichucky and Watauga River basins. Approximately 8 inches of rain fell in a 24-hour period on ground that had been saturated from previous rains. The numerous "waterspouts" and landslides that were reported in news accounts attest to the intensity of the rainfall. The resulting flood became known as the "May Tide" on the Nolichucky River.

The storm of July 15-16, 1916, was the second of two tropical hurricanes that moved inland over the southeastern part of the country during July 1916. The first hurricane, although it was dissipated over southern Alabama, 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. A maximum rainfall of 22.2 inches in a 24-hour period was recorded at Altapass, about 37 miles northeast of Asheville. Particularly devastating floods resulted on the upper French Broad River and its headwater tributaries from an estimated maximum of 16 to 18 inches of rain that fell on the watersheds of some of these tributaries. A description of this great storm and the resulting flood is contained in Section II.

The storm of mid-August 1940, like that of July 1916, originated as a tropical hurricane. The path of the storm center approximated a large "U" with the base along the Blue Ridge Mountains, one arm extending to Savannah, Georgia, and the other along the Virginia-North Carolina state line to the coast. Heavy rainfall was experienced along the eastern Tennessee Valley Divide from the Hiwassee River

TABLE 12

MAXIMUM KNOWN FLOOD DISCHARGES

ON STREAMS IN ASHEVILLE, NORTH CAROLINA, REGION

Map Reference No.	Stream	Location	Drainage Area sq. mi.	Date	Peak Discharge	
					Amount cfs	Per Sq. Mi. cfs
1	Little Tennessee River	at Fontana Dam, N. C.	1571	Mar.	129,000	82
2	French Broad River	at Marshall, N. C.	1332	July 16, 1916	115,000	86
3	Nolichucky River	at Nolichucky Dam, Tenn.	1183	Jan. 23, 1906	75,000	63
4	Nolichucky River	nr Greeneville, Tenn.	1141	May 22, 1901	110,000	96
5	French Broad River	at Asheville, N. C.	945	July 16, 1916	110,000	116
6	Nolichucky River	at Embreeville, Tenn.	305	May 22, 1901	120,000	149
7	French Broad River	at Bent Creek, N. C.	676	July 15, 1916	105,000	155
8	Tuckasegee River	at Bryson City, N. C.	655	May 1840	90,000	137
9	Watauga River	at Butler, Tenn.	427	Aug. 13, 1940	71,500	167
10	Tuckasegee River	at Dillsboro, N. C.	347	May 1840	53,000	153
11	French Broad River	at Blantyre, N. C.	296	July 16, 1916	50,700	171
12	N. Toe River	at Toecane, N. C.	233	Aug. 13, 1940	51,000	219
13	Tuckasegee River	at East Laport, N. C.	200	Aug. 30, 1940	45,000	225
14	Watauga River	at Stump Knob, Tenn.	171	Aug. 13, 1940	50,000	292
15	Cane River	nr Sioux, N. C.	157	Aug. 13, 1940	31,300	203
16	Swannanoa River	at Biltmore, N. C.	130	Apr. 1791	40,000	308
17	N. Toe River	at Altapass, N. C.	104	July 1916	30,800	296
18	Watauga River	nr Sugar Grove, N. C.	90.8	Aug. 13, 1940	50,800	559
19	S. Toe River	at Newdale, N. C.	60.8	Jan. 1927	33,000	543
20	Watauga River	nr Valle Crucis, N. C.	33.1	Aug. 13, 1940	38,000	1150
21	Cane Creek	ab Bakersville, N. C.	22.0	May 19-20, 1901	30,500	1390

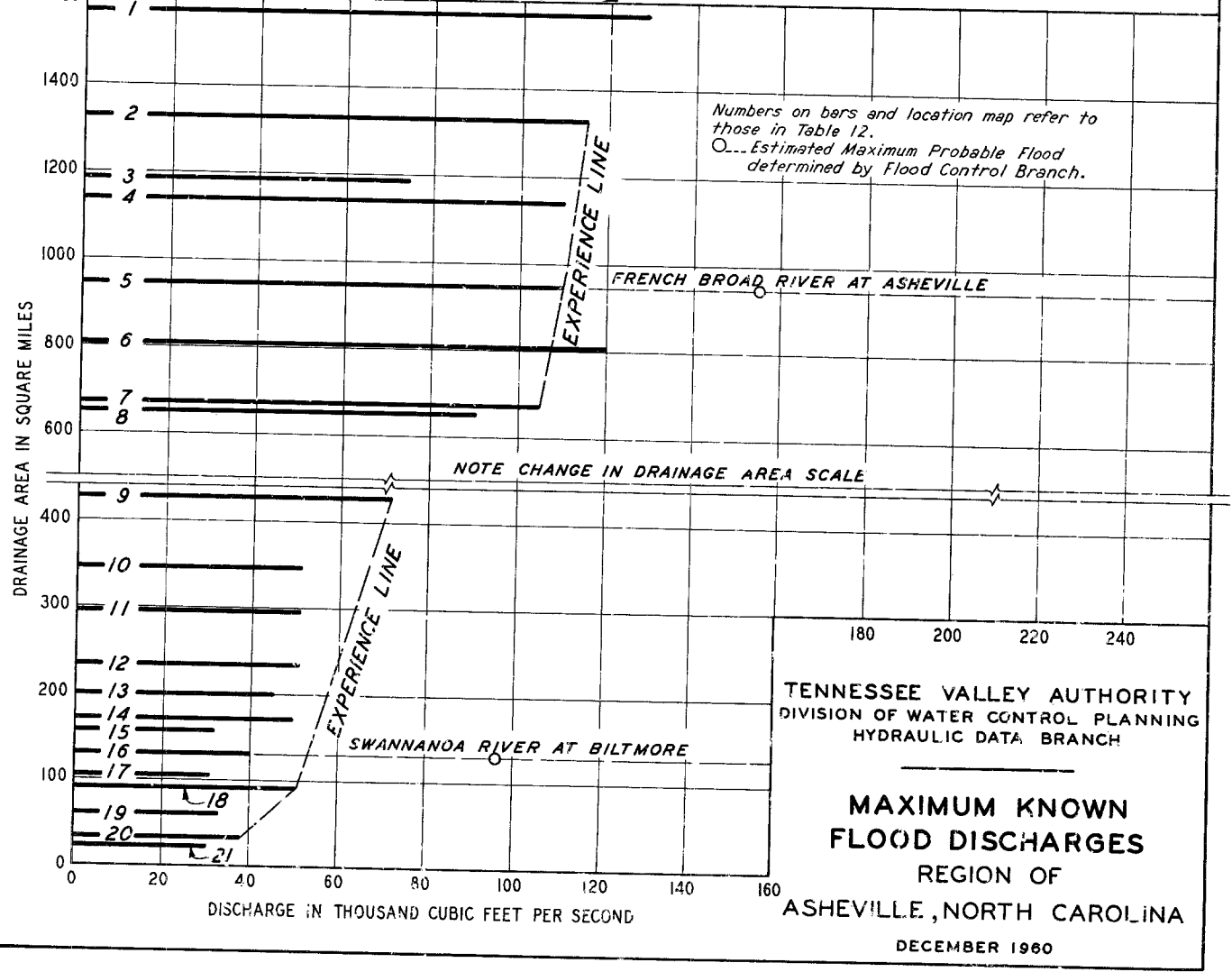
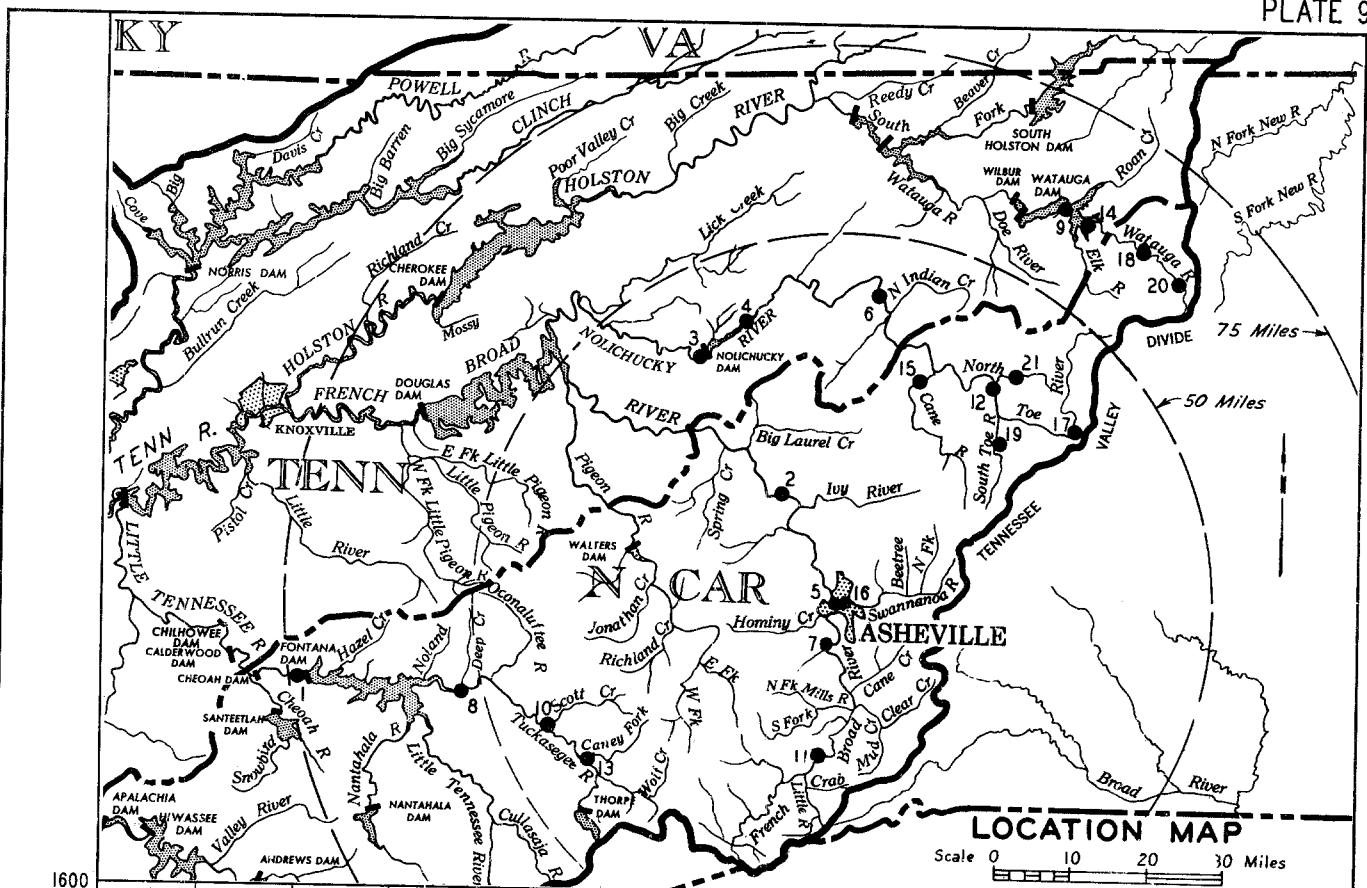
basin northeast to the Watauga River headwaters. Centers of high rainfall reaching 14 to 16 inches were experienced in the watersheds of the Tuckasegee River, some tributaries of the Nolichucky River and the Watauga River. The upper French Broad region was bounded along its rim by about 12 inches of rain to the south and west and about 10 inches to the east. A description of this storm and flood is also contained in Section II.

All of the floods listed in Table 12 have occurred in a meteorologically homogeneous region on watersheds whose physical characteristics are comparable to those of the upper French Broad River watershed. This indicates that floods of like magnitude, modified to take into account differences in drainage area characteristics, may occur in the future on the upper French Broad River and the Swannanoa River. However, the effect of an important characteristic of the upper French Broad River valley in modifying flood discharges must be taken into account. As has been described in Section II of this report, the broad flood plain and unusually flat slope of the 70-mile reach of French Broad River between Rosman and Asheville provide substantial natural storage of flood waters. This storage has a significant effect on the timing and crest discharge of floods on the French Broad River at Asheville.

French Broad and Swannanoa Rivers vs. Regional Flood Discharges

Plate 9 includes a diagram of the discharges tabulated in Table 12 and also a map showing the locations of the discharge measurements. Plate 9 shows that the record 1916 flood on the French Broad River was exceeded by the 1867 flood on the Little Tennessee River at Fontana Dam and the 1901 flood on the Nolichucky River at Embreeville; while the largest known flood on the Swannanoa River, that of 1791, was exceeded by floods in mid-August 1940 on several watersheds.

The 1916 storm in western North Carolina ranks as one of the most severe known in the vicinity of Asheville. In studies of the 1916 storm it has been found that the resulting flood on many watersheds has determined the magnitude of a Regional Flood. Since this is the case, it is logical to consider that the peak discharge of this flood should be used as the Regional Flood at Asheville. The discharge of the 1916 flood at Asheville is less than that observed on either the Little Tennessee River or the Nolichucky River. However, although the watersheds of both of these streams are comparable to that of the French Broad River above Asheville, there is a significant difference in the stream valleys themselves. The large natural storage available in the French Broad valley upstream from Asheville acts to reduce



ASF - 1311

the flood peak discharge at Asheville. Because of this storage it would be expected that the discharge of the Regional Flood at Asheville would be less than might be expected from the Little Tennessee and Nolichucky Rivers where there is no unusual natural storage.

The largest known flood on the Swannanoa River was not of the magnitude of a Regional Flood. Plate 9 shows that the estimated discharge of the 1791 flood on the Swannanoa River has been exceeded in magnitude by the mid-August 1940 flood on the Watauga River and several headwater tributaries of the Nolichucky River. The stream valleys of these watersheds are comparable to that of the Swannanoa River. Using the criteria of the maximum known floods experienced in the Asheville region, it would be reasonable to expect future floods on the Swannanoa River in the order of 53,000 cubic feet per second at Biltmore. A flood of this magnitude is designated as the Regional Flood on this river.

TABLE 13
REGIONAL FLOOD PEAK DISCHARGES

<u>Stream</u>	<u>Location</u>	<u>Mile Above Mouth</u>	<u>Drainage Area sq. mi.</u>	<u>Peak Discharge cfs</u>
French Broad River	at Pearson Bridge, Asheville	145.8	945	110,000
Swannanoa River	at Azalea	7.40	102	51,000
Swannanoa River	at Biltmore	1.56	130	53,000

The profiles of the Regional Floods on the French Broad River and the Swannanoa River are shown on Plate 12. Figures 24 to 26 show the heights that would be reached by the Regional and Maximum Probable Floods at various locations along the French Broad River. Figures 27 to 29 show similar views along the Swannanoa River.

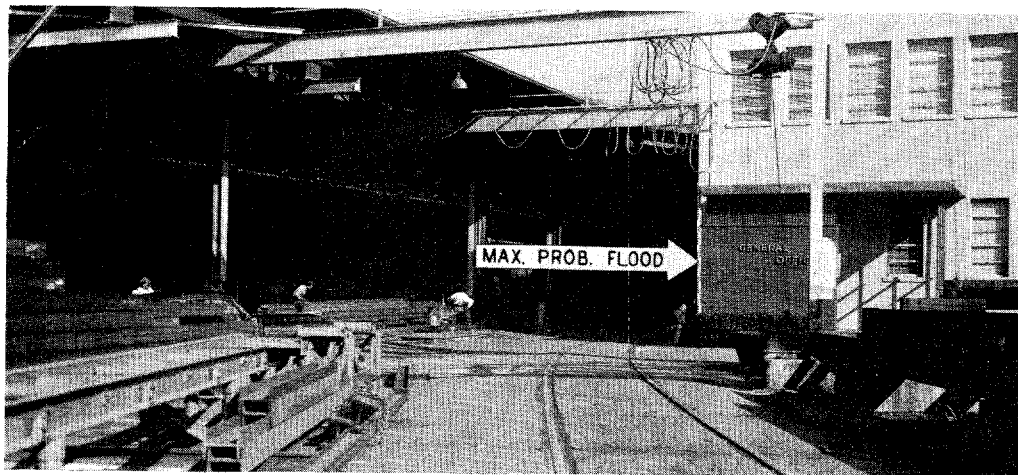
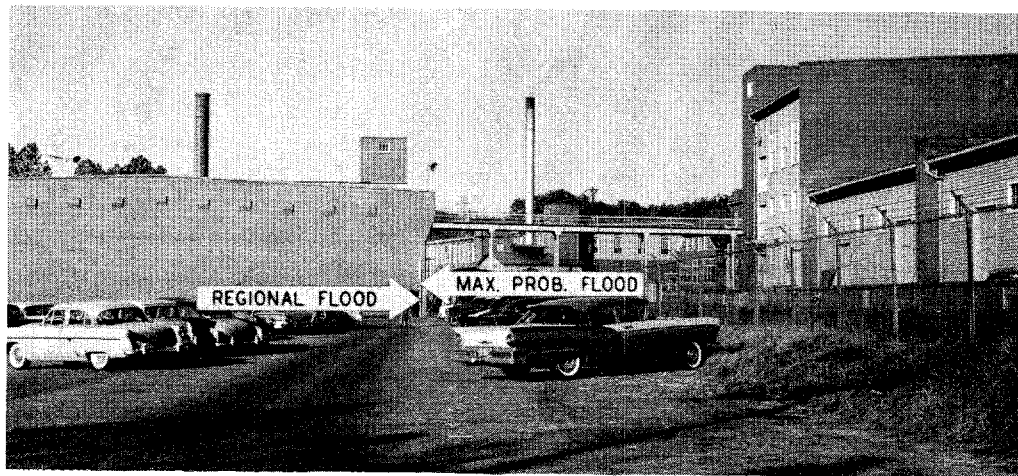


Figure 24. --ASHEVILLE INDUSTRIES ON FRENCH BROAD RIVER FLOOD PLAIN

The upper view is the Hicks Corporation plant on the right bank of the French Broad River at Mile 145. The middle view shows the Burlington Mills plant 2.5 miles farther downstream. The lower view shows the Dave Steel Company at Mile 147.78. This is Building No. 256 shown on Plate 11. Arrows show the heights of the Regional and Maximum Probable Floods at each location.

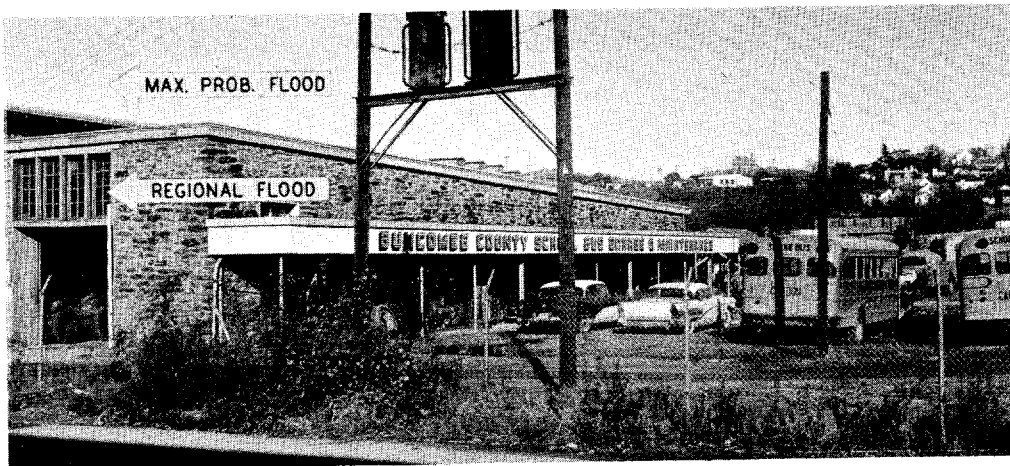


Figure 25. --SOUTHERN RAILWAY DEPOTS
AND SCHOOL BUS GARAGE

The upper view shows the Asheville station of the Southern Railway at Mile 148.08, Building No. 180 on Plate 11. The Craggy depot in the middle view is on the left bank 5 miles downstream, just above the Craggy Bridge. The lower view shows the Buncombe County school bus garage, Building No. 286, on the left bank at Mile 147.28. Arrows show the heights of the Regional and Maximum Probable Floods at these places.



Figure 26. --ASHEVILLE FLOOD PLAIN DEVELOPMENTS

The Bryan Packing Company in the upper view is Building No. 285 at Mile 147.31. Day's Tobacco Warehouse, Mile 148.22, is shown as Building No. 177 on Plate 11. The lower view shows Farmer's Market, located on the new land fill on the right bank at Mile 146.23. Arrows show the heights of the Regional and Maximum Probable Floods at the three locations.

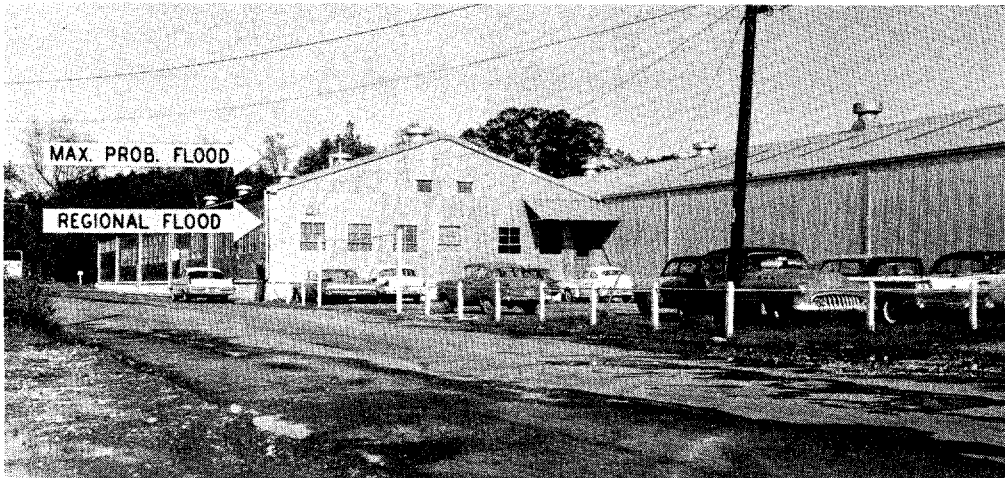


Figure 27. --INDUSTRIES ON SWANNANOA RIVER FLOOD PLAIN

Three Mountaineers, Inc., in the upper view is in the Koon Development, Building No. 4 on Plate 15. The middle view is the Pepsi-Cola Bottling Company at Mile 3.30 on the right side of the river. Silverman Company in the lower view is on the right side of the river, Mile 1.80, Building No. 63 on Plate 15. Arrows show the heights of the Regional and Maximum Probable Floods.

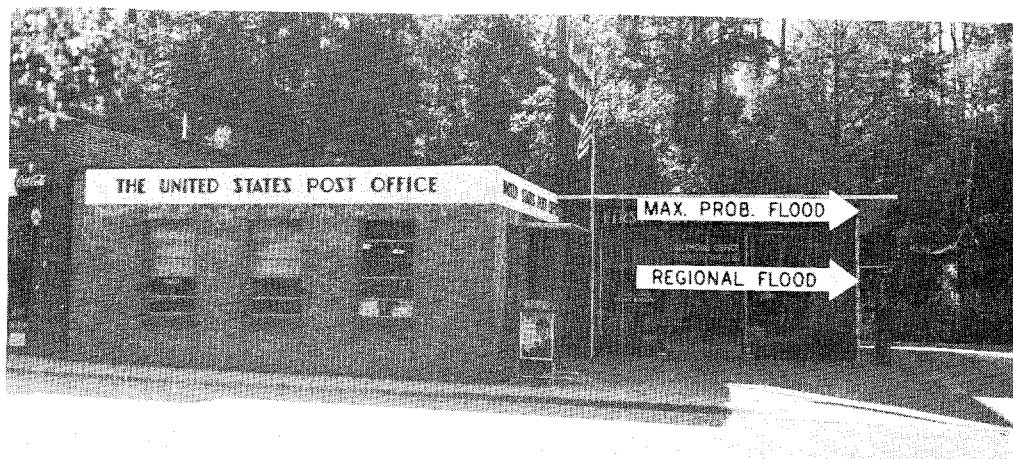
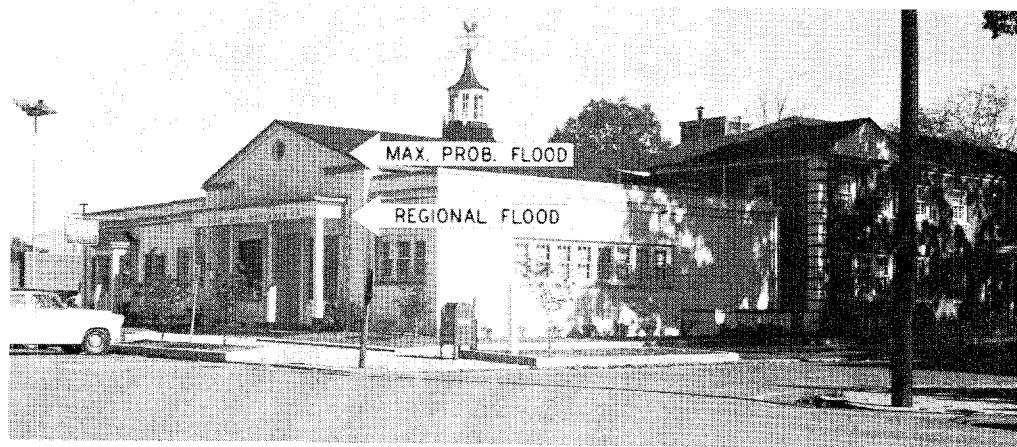


Figure 28. --OFFICE BUILDING, POST OFFICE, AND STORES
IN BILTMORE

Building No. 102, in the upper view, is the Pilot Life Insurance Company office building on Biltmore Plaza. In the middle view is the Biltmore Branch of the Asheville Post Office and the Biltmore office of the First Union National Bank, Buildings Nos. 143 and 142, respectively, on Plate 15. The lower view, east along Brook Street, shows Buildings Nos. 115, 114, 108, and the Biltmore railway depot in the background. Arrows show the heights of the Regional and Maximum Probable Floods at each location.

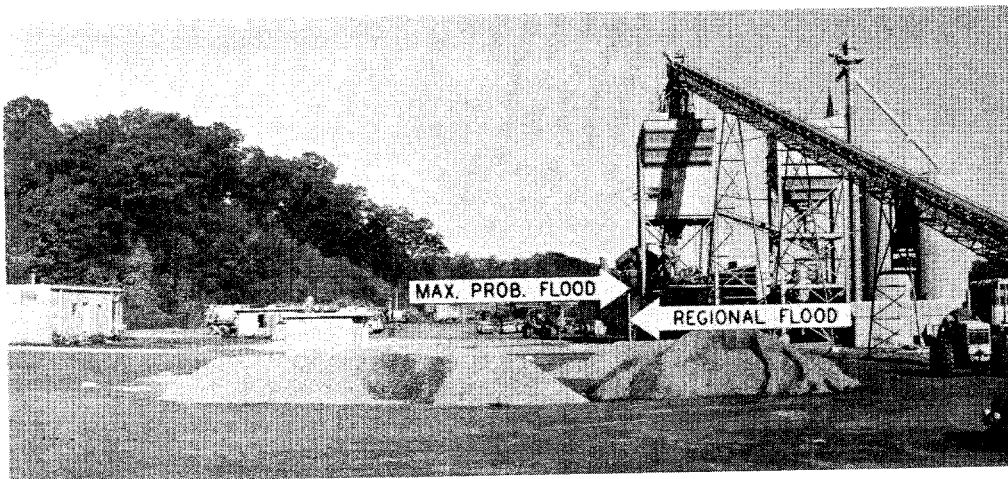


Figure 29. --BUILDERS' SUPPLY FIRMS ALONG SWANNANOA RIVER

Building No. 61, Carolina Tractor and Equipment Company at Biltmore, is in the upper view. The Hajoca Corporation, distributors of plumbing supplies, is Building No. 91 on Plate 15 and is located just above Biltmore Avenue on the right side of the river. The lower view shows part of the Asheville Concrete Materials Company plant, Building No. 159, on the right-bank flood plain near Mile 1.0. Arrows show the heights of the Regional and Maximum Probable Floods.

IV.

MAXIMUM PROBABLE FLOODS

Tennessee Valley Authority
Division of Water Control Planning
Flood Control Branch

IV

MAXIMUM PROBABLE FLOODS

The preceding sections have told about the floods that have occurred and about the Regional Floods on the French Broad and Swannanoa Rivers near Asheville, North Carolina. This section discusses the Maximum Probable Floods that may reasonably be expected. Floods of these magnitudes are of the kind considered in planning the construction and operation of protective works, the failure of which might be disastrous.

The French Broad River drains 945 square miles at the U. S. Geological Survey stream gage at Pearson Bridge near the lower limit of the present study. The Swannanoa River drains 133 square miles at its mouth. Extreme floods on these streams may 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 cloudburst or hurricane type usually occurring in the summer. Infiltration and other losses are generally low in winter and generally high in summer.

DETERMINATION OF MAXIMUM PROBABLE FLOODS

In determining the Maximum Probable Floods on the French Broad and Swannanoa Rivers, consideration was given to great storms and floods that have already occurred on these watersheds and to those which have occurred elsewhere but could have occurred on these areas. This procedure provides information about possible flood and storm occurrences 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 Asheville occurred in July 1916 with a discharge of about 110,000 cubic feet per second. On the Swannanoa River the maximum known flood occurred in April 1791 with a discharge of about 40,000 cubic feet per second. It is reasonable to expect that greater floods than those of the known past will occur on both streams.

Observed Storms

Observed storms are meteorologically transposable to the French Broad and Swannanoa River watersheds 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 distance from the moisture source. When transferring storms within the broad region to the French Broad and Swannanoa River watersheds, appropriate adjustments were made for differences in this moisture potential. The mountains surrounding these watersheds have a marked influence on the storm patterns, and allowance also was made for this influence.

Table 14 lists known rainfall depths for several large storms transposable to these watersheds.

TABLE 14

SELECTED MAXIMUM OBSERVED STORMS

<u>Date</u>	<u>Location</u>	<u>Rainfall Depth, Inches</u>	
		<u>133 Square Miles, 8-Hour Duration</u>	<u>945 Square Miles, 12-Hour Duration</u>
July 1916	North Carolina	8.7	10.5
August 1939	New Jersey	11.6	11.5
September 1940	New Jersey	17.6	10.5
October 1941	Florida	13.8	13.1

On the basis of these and other data, as adjusted for conditions in the watersheds, a rainstorm of 13.8 inches in 12 hours was adopted for computing the French Broad River Maximum Probable Flood and 16.6 inches in 8 hours for the Swannanoa River Maximum Probable Flood.

Storms greater than these can occur. Storms considered to be the greatest from a meteorological standpoint would be approximately 50 percent greater than that adopted for both the French Broad and Swannanoa River Maximum Probable Floods.

Observed Floods

Factors such as the meteorology of the region and flood-producing characteristics of the watersheds were given consideration in determining whether peak discharges on other streams are applicable to the French Broad and Swannanoa Rivers. In addition to the floods listed in Table 12 of section III, Table 15 lists peak discharges for observed floods on several streams approximately the size of the French Broad and Swannanoa Rivers. For comparison, the discharge of the highest known flood on each stream at Asheville is listed.

TABLE 15
SELECTED MAXIMUM OBSERVED FLOODS
IN VICINITY OF ASHEVILLE, NORTH CAROLINA

<u>Stream</u>	<u>Location</u>	<u>Drainage Area</u> sq. mi.	<u>Date</u>	<u>Peak Discharge</u>	
				<u>CFS</u>	<u>CFS Per Sq. Mi.</u>
Wilson Creek	Adako, N. C.	66	1940	99,000	1,500
Warrior Fork	Morganton, N. C.	80.5	1940	38,000	470
Watauga River	Watauga Co., N. C.	93.5	1940	37,000	396
Mud Creek	Naples, N. C.	109	1916	40,000	367
Catawba River	Marion, N. C.	170	1940	71,000	418
N. F. Catawba R.	Dam, Bridgewater, N. C.	380	1940	141,760	373
Yadkin River	Wilkesboro, N. C.	493	1940	160,000	325
Broad River	Boiling Springs, N. C.	864	1928	73,300	85
James River	Lick Run, Va.	1,369	1877	120,000	88
S. Br. Potomac R.	Springfield, W. Va.	1,471	1877	140,000	95
Catawba River	Catawba, N. C.	1,535	1940	177,000	115
Swannanoa River	Biltmore, N. C.	130	1791	40,000	308
French Broad R.	Asheville, N. C.	945	1916	110,000	116

Maximum Probable Flood Discharges

From consideration of the flood discharges in Tables 12 and 15 and of the transposition to the French Broad and Swannanoa River areas of outstanding storms, the peak discharge of the French Broad River Maximum Probable Flood was determined to be 154,000 cubic feet per second at Pearson Bridge and throughout the reach below the Swannanoa River, and 115,000 cubic feet per second above that tributary. The Swannanoa River Maximum Probable Flood was determined to be 96,000 cubic feet per second at Biltmore.

These flood rates were computed from the adopted storm using the unit hydrograph technique. The peak rate for the French Broad River is about 1.4 times the greatest known flood and for the Swannanoa River about 2.4 times the greatest known.

Frequency

The frequency of a flood of the magnitude of the Maximum Probable is not susceptible of definite determination. Such a flood would occur on the average only at rather long intervals of time, but it could occur in any year.

Possible Larger Floods

Floods larger than any of those discussed are hydrologically possible. However, the combination of factors that would be necessary to produce such floods would occur at rare intervals. The consideration of floods of this magnitude is of greater importance in some problems than in others and should not be overlooked in the study of any problem. Such floods, because of their extreme rarity and uncertainty of occurrence on a given watershed, need be given greatest consideration where dependence is placed on protective works, the failure of which would cause loss of life or destruction of valuable property.

FLOOD HEIGHTS AND VELOCITIES

Flood Crest Profiles and Overflow Areas

The crest profiles computed for the Maximum Probable Floods on the French Broad and Swannanoa Rivers in the vicinity of Asheville are shown on Plate 12. These profiles were computed using stream characteristics for selected reaches as determined from observed flood profiles, topographic maps, and valley cross sections. The cross sections for a portion of the French Broad River below the Swannanoa River and on the Swannanoa River below the Asheville Recreation Park were surveyed in 1941 and 1942. The remaining sections were surveyed in 1960 at which time the older sections were reviewed and altered to reflect 1960 conditions. The overflow areas that would be covered by the Maximum Probable Floods are shown on Plates 10 and 14.

The French Broad River Maximum Probable Flood profile is from 2 to 12 feet above elevations experienced in the 1916 flood. The greatest difference occurs in the vicinity of the Southern Railway bridge and Smith Bridge and is the result of heading-up caused by the bridge structures. The Swannanoa River Maximum Probable Flood profile is from 7 to 18 feet above the 1916 flood in the portion of the stream below the recreation park. It is from 16 to 19 feet above the August 13, 1940, flood in the portion of the river above the park. The Maximum Probable Flood profiles on Plate 12 are for present-day conditions.

It is impossible to foretell the destructive effect of velocities (see Velocities and Rates of Rise) on bridges over the streams, the dams, and structures bordering the streams. In computing the profile of the Maximum Probable Floods, there was no choice but to assume the survival of all structures.

The elevations shown on Plate 12 and the overflow areas shown on Plates 10 and 14 have been determined as accurately as possible consistent with the basic data, but actual elevations may vary from those shown on the maps. To determine elevations and flooded area limits more accurately would require costly surveys.

Velocities and Rates of Rise

During the Maximum Probable Flood on the French Broad River velocities in the main channel would range from about 5 to 18 feet per second, the highest velocity occurring immediately above Craggy Dam where silting has reduced the cross-sectional area of the stream. Higher rates under bridges or over Craggy Dam may be experienced. In the overflow area velocities would range from about 1 to 8 feet per second.

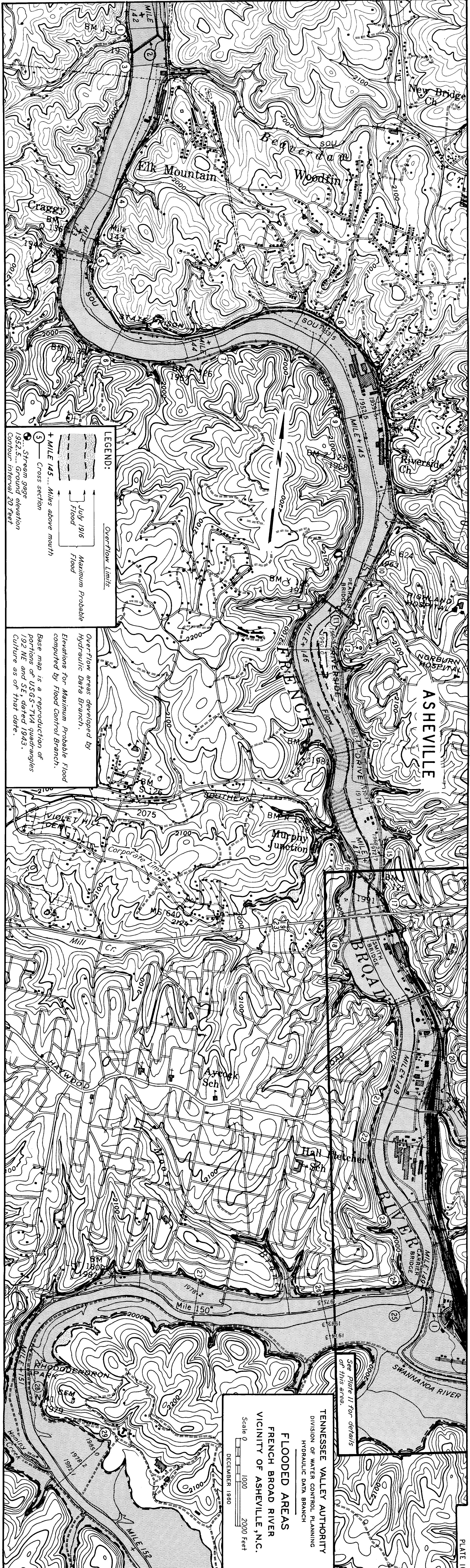
The Maximum Probable Flood on the French Broad River would rise about 28 feet above low water to its crest stage in about 19 hours. The maximum rate of rise would be about 2.5 feet in 1 hour.

During the Maximum Probable Flood on the Swannanoa River, velocities in the main channel would range from about 4 to 22 feet per second, the highest velocity occurring at the Asheville Recreation Park where the total stream cross section is smaller than at any other place within the limits of the study. Higher rates under bridges or over the abandoned dam at the park may be experienced. In

the overflow area, velocities would range up to 11 feet per second with the highest velocity occurring in the highway paralleling the stream at about Mile 2.

The Maximum Probable Flood on the Swannanoa River would rise about 33 feet above low water to its crest stage in about 14 hours. The maximum rate of rise would be about 3 feet in 1 hour.

These high velocities and rapid rates of rise in combination with deep flooding would create an extremely hazardous situation, especially on the narrow, highly developed flood plain along both streams.



LEGEND:

Over-flow Limits

July 1916 Flood

Maximum Probable Flood

+ MILE 145... Miles above mouth

③ — Cross section

⊕ — Stream gage

1952.5... Ground elevation

Contour Interval 20 feet

Over-flow areas developed by Hydraulic Data Branch.

Elevations for Maximum Probable Flood computed by Flood Control Branch.

Base map is a reproduction of portions of USGS-TVA quadrangles 192 NE and SE, dated 1943. Culture as of that date.

See Plate 11 for details of this area.

TENNESSEE VALLEY AUTHORITY

DIVISION OF WATER CONTROL PLANNING

HYDRAULIC DATA BRANCH

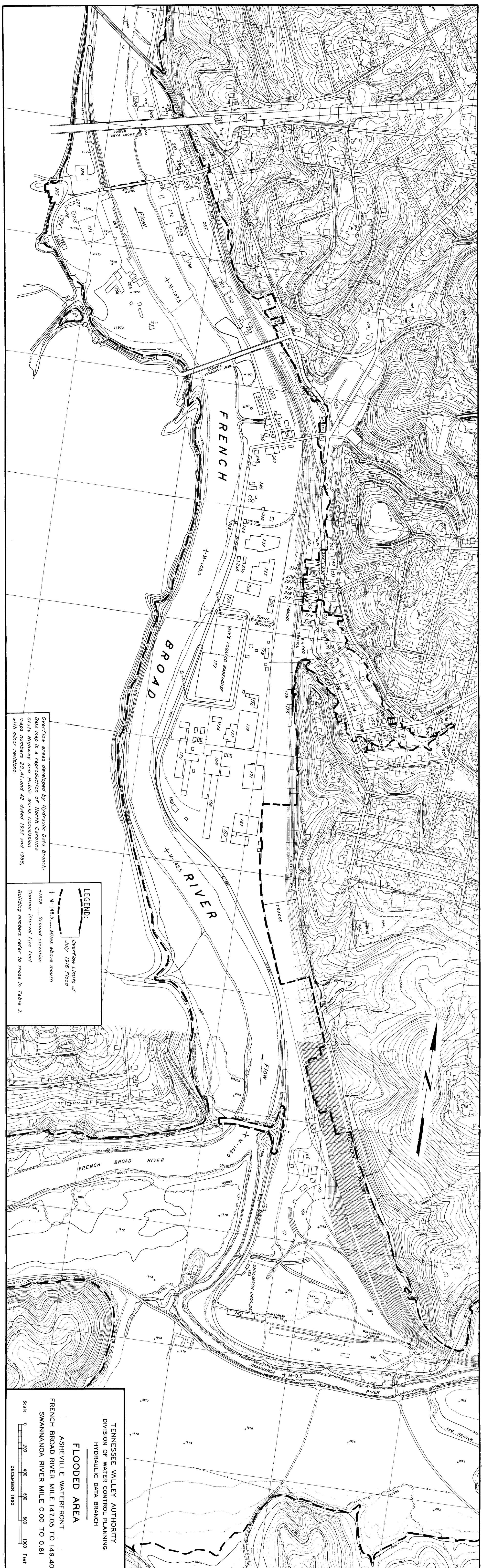
FLOODED AREAS

FRENCH BROAD RIVER

VICINITY OF ASHEVILLE, N.C.

Scale 0 1000 2000 Feet

DECEMBER 1960



Overflow areas developed by Hydraulic Data Branch.
 Base map is a reproduction of North Carolina
 State Highway and Public Works Commission
 maps numbers 20, 41, and 42 dated 1957 and 1958,
 with minor revisions.

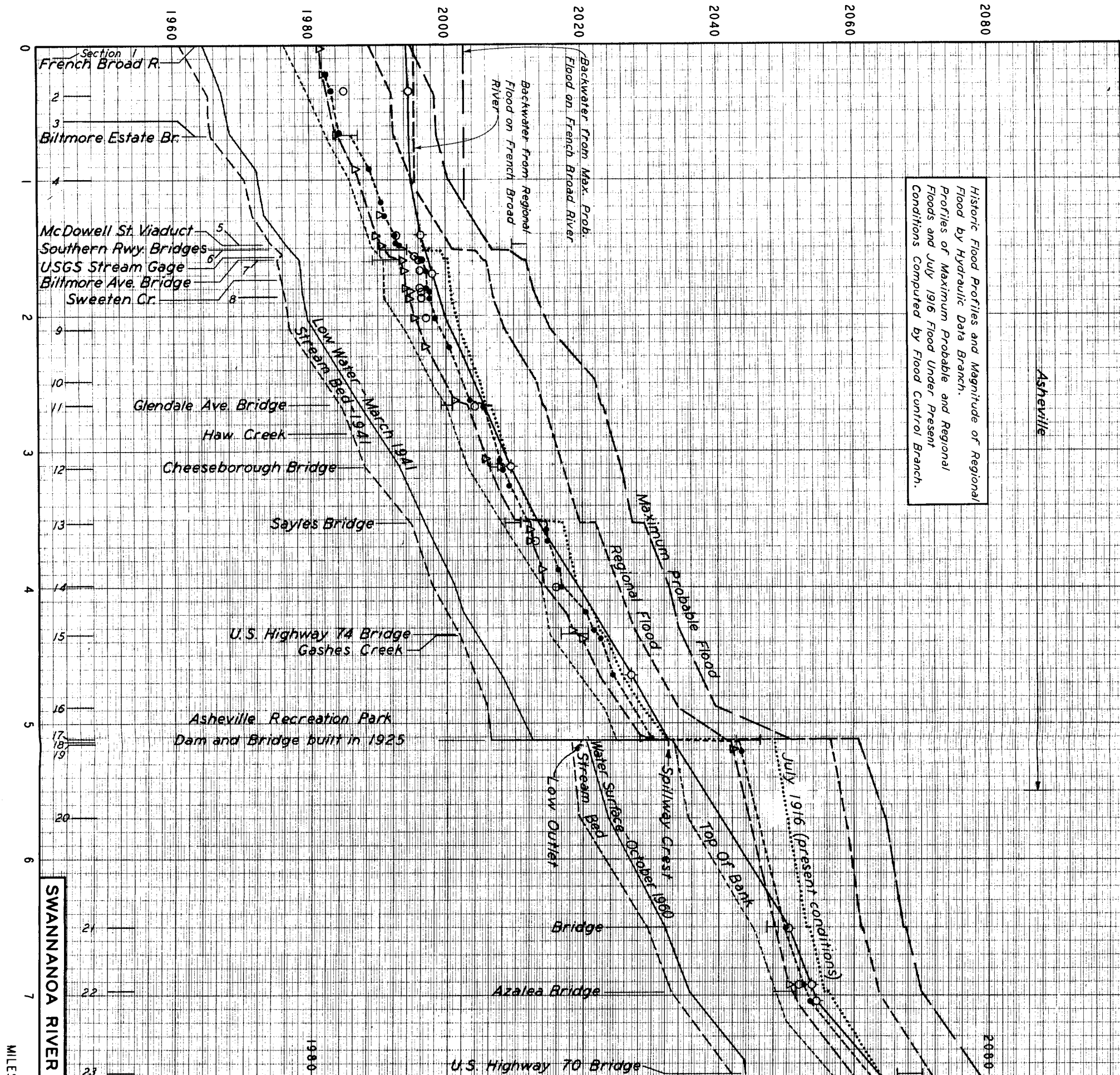
LEGEND:
 - - - - - Overflow Limits of July 1916 Flood
 + M-148.5... Miles above mouth
 +1978 Ground elevation
 Contour interval five feet
 Building numbers refer to those in Table 3.

TENNESSEE VALLEY AUTHORITY
 DIVISION OF WATER CONTROL PLANNING
 HYDRAULIC DATA BRANCH

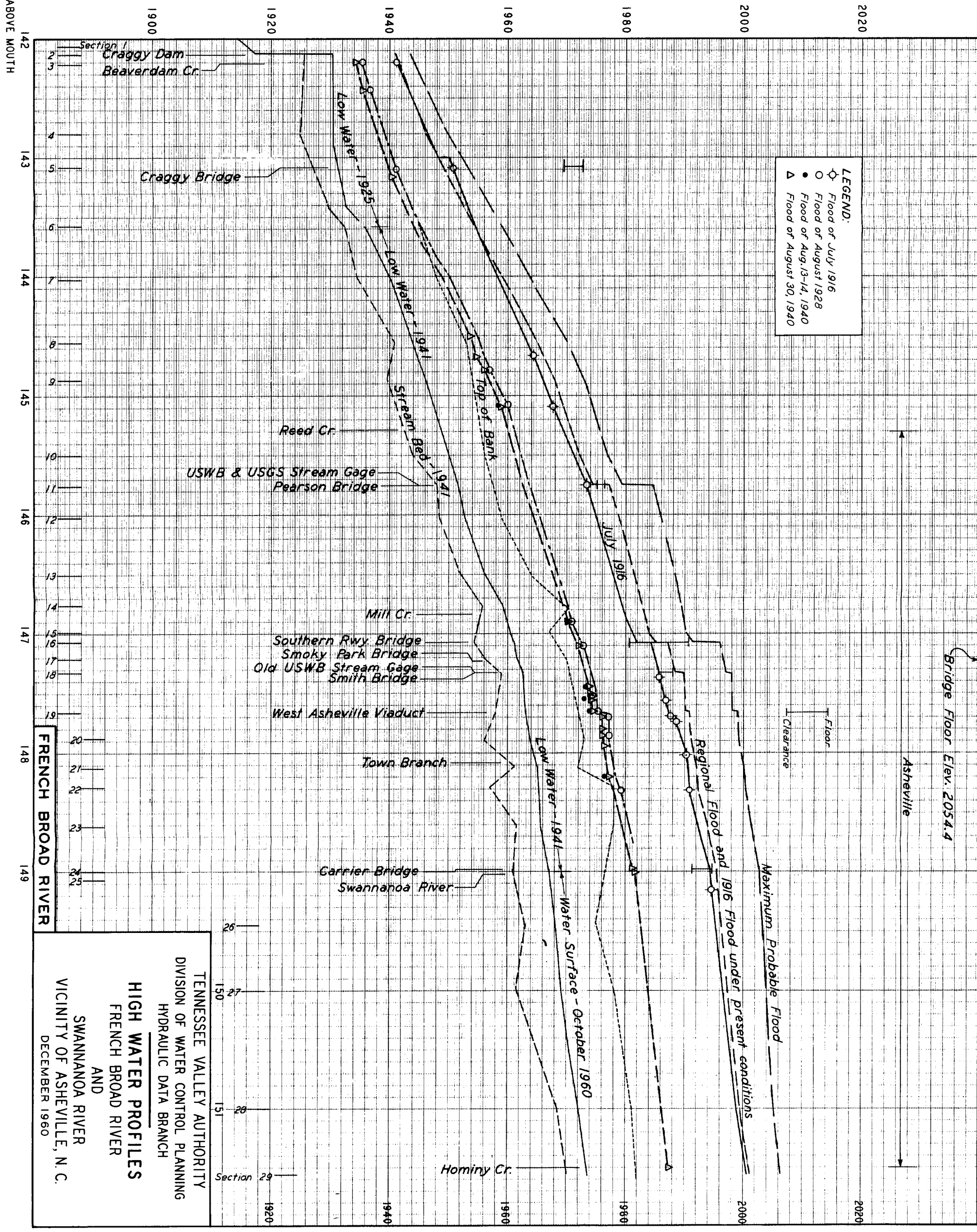
FLOODED AREA
 ASHEVILLE WATERFRONT
 FRENCH BROAD RIVER MILE 147.05 TO 149.40
 SWANNANOA RIVER MILE 0.00 TO 0.81

Scale 0 200 400 600 800 1000 Feet
 DECEMBER 1980

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

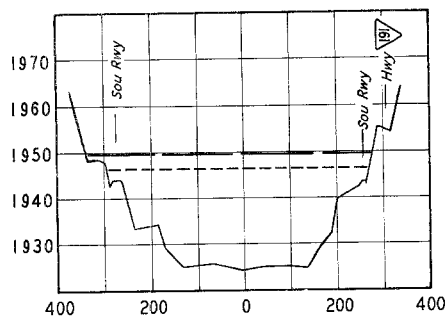


Historic Flood Profiles and Magnitude of Regional Flood by Hydraulic Data Branch. Profiles of Maximum Probable and Regional Floods and July 1916 Flood Under Present Conditions Computed by Flood Control Branch.

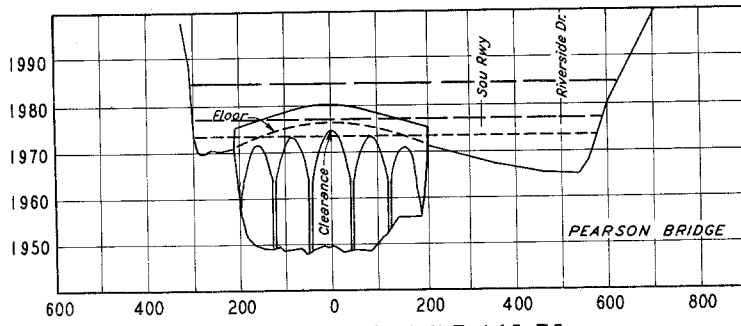


LEGEND:
 ○ Flood of July 1916
 ● Flood of August 1928
 ● Flood of Aug. 13-14, 1940
 ▲ Flood of August 30, 1940

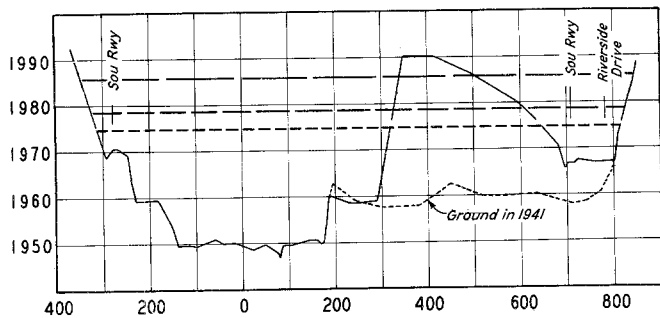
TENNESSEE VALLEY AUTHORITY
 DIVISION OF WATER CONTROL PLANNING
 HYDRAULIC DATA BRANCH
HIGH WATER PROFILES
 FRENCH BROAD RIVER
 AND
 SWANNANOA RIVER
 VICINITY OF ASHEVILLE, N. C.
 DECEMBER 1960



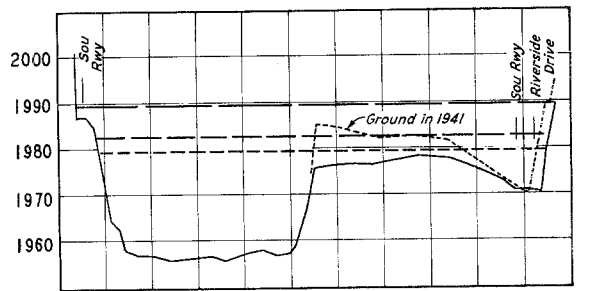
SECTION 4 - MILE 142.80



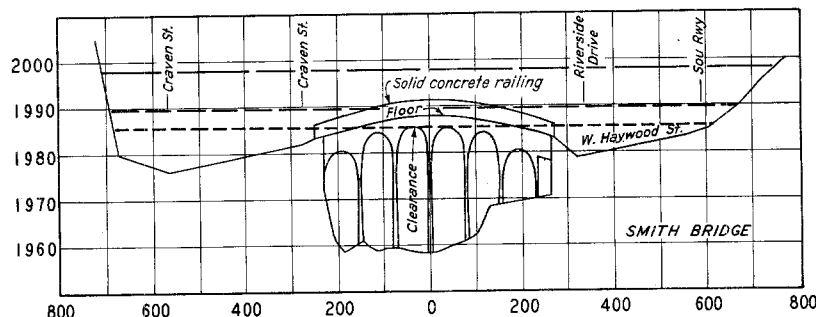
SECTION 11 - MILE 145.75



SECTION 12 - MILE 146.02



SECTION 14 - MILE 146.76

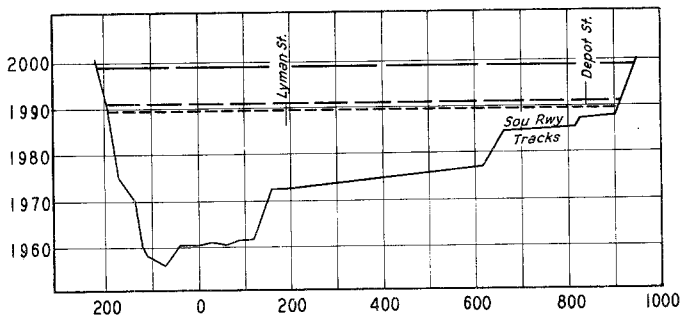


SECTION 18 - MILE 147.33

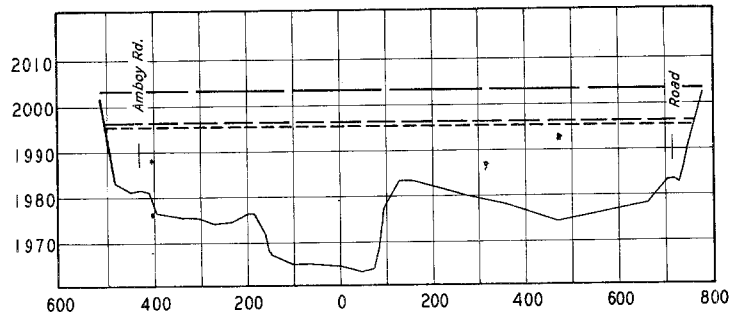
LEGEND:

- Maximum Probable Flood
- - - - - Regional Flood and July 1916 Flood, Present Conditions
- - - - - July 1916 Flood, Actual

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



SECTION 20 - MILE 147.88



SECTION 26 - MILE 149.45

HORIZONTAL DISTANCE IN FEET

Sections taken looking downstream.

22 sections not shown.

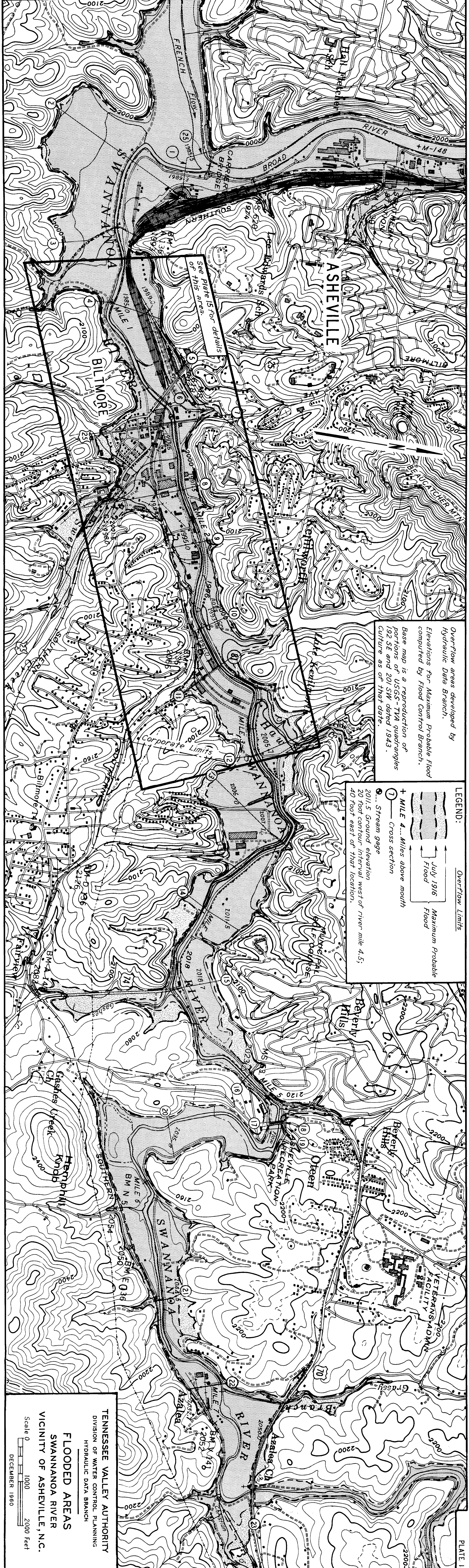
Elevations of Maximum Probable and Regional Floods computed by Flood Control Branch.

Sections 11, 18 and 20 by Maps and Surveys Branch.

Sections 4, 12, 14 and 26 and July 1916 Flood by Hydraulic Data Branch.

TENNESSEE VALLEY AUTHORITY
DIVISION OF WATER CONTROL PLANNING
HYDRAULIC DATA BRANCH

VALLEY CROSS SECTIONS
FRENCH BROAD RIVER
VICINITY OF
ASHEVILLE, NORTH CAROLINA
DECEMBER 1960



Overflow areas developed by Hydraulic Data Branch. Elevations for Maximum Probable Flood computed by Flood Control Branch. Base map is a reproduction of portions of USGS-TVA quadrangles 192 SE and 201 SW dated 1943. Culture as of that date.

LEGEND:

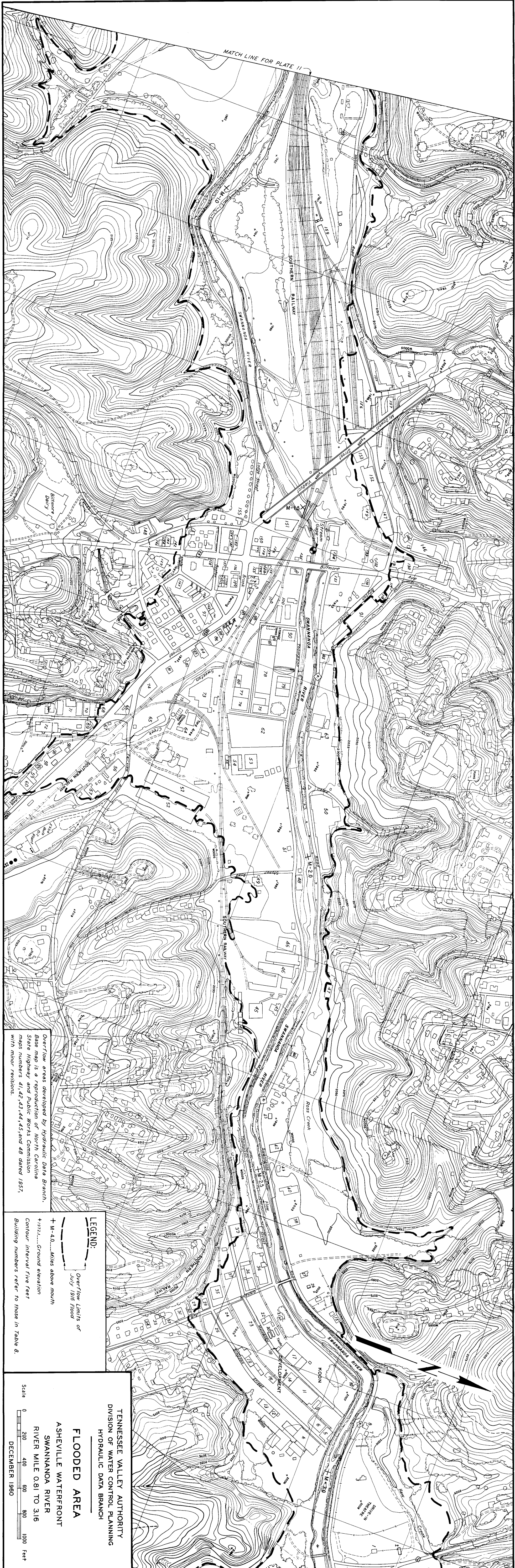
- Overflow Limits
- July 1916 Flood
- Maximum Probable Flood
- + MILE 4... Miles above mouth
- (7) Cross section
- Stream gage
- 2011.5 Ground elevation 20 foot contour Interval west of river mile 4.5; 40 foot east of that location.

TENNESSEE VALLEY AUTHORITY
 DIVISION OF WATER CONTROL PLANNING
 HYDRAULIC DATA BRANCH

FLOODED AREAS
 SWANNANOA RIVER
 VICINITY OF ASHEVILLE, N.C.

Scale 0 1000 2000 Feet
 DECEMBER 1960

MATCH LINE FOR PLATE 11



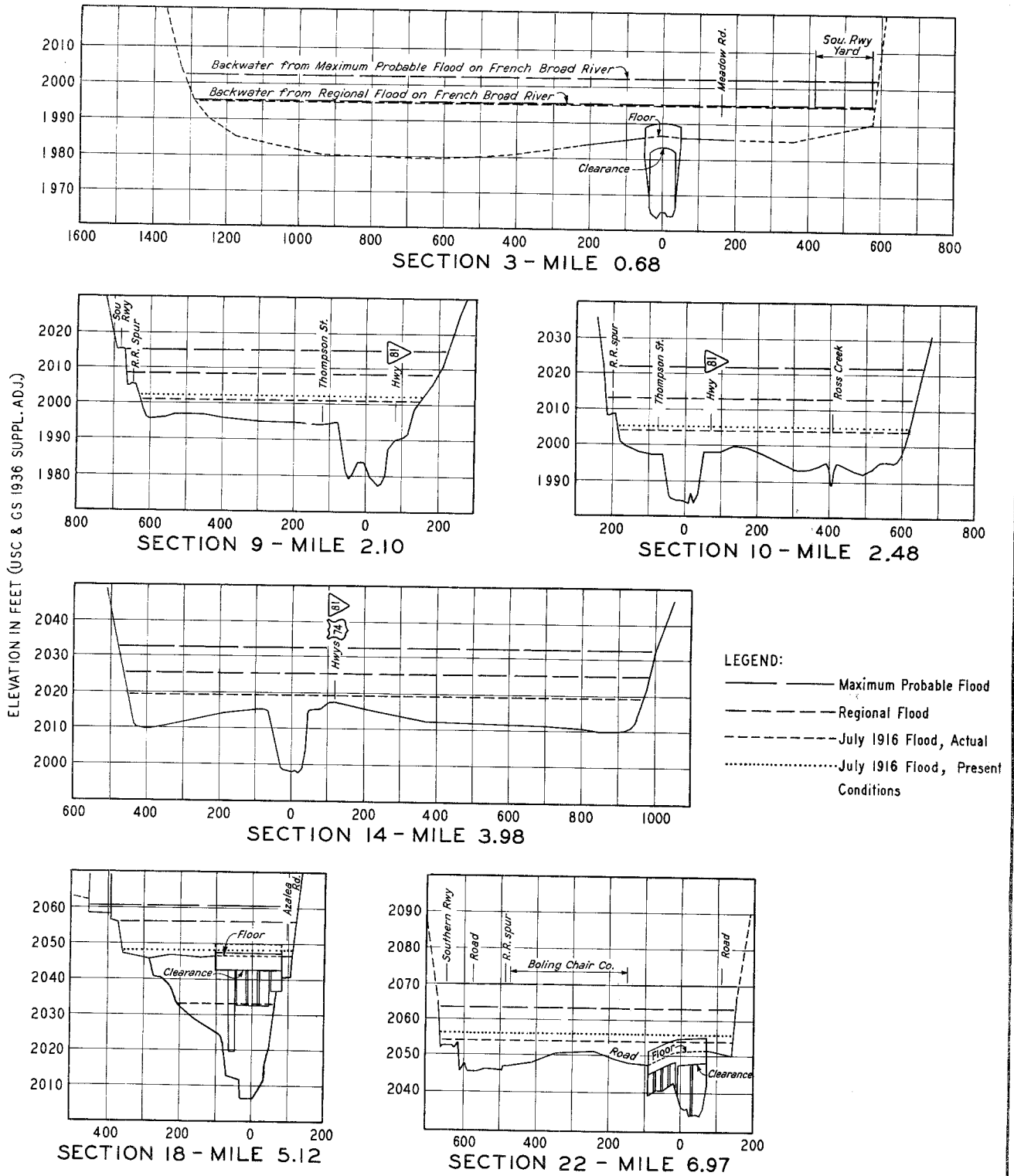
Over-flood areas developed by Hydraulic Data Branch. Base map is a reproduction of North Carolina State Highway and Public Works Commission maps numbers 41, 42, 43, 44, 45, and 48 dated 1957, with minor revisions.

LEGEND:
 - - - - - Overflood Limits of July 1916 Flood
 + M-4.0... Miles above mouth
 +1972... Ground elevation
 Contour interval five feet
 Building numbers refer to those in Table 8.

TENNESSEE VALLEY AUTHORITY
 DIVISION OF WATER CONTROL PLANNING
 HYDRAULIC DATA BRANCH

FLOODED AREA
 ASHEVILLE WATERFRONT
 SWANNANOA RIVER
 RIVER MILE 0.81 TO 3.16
 DECEMBER 1960

Scale 0 200 400 800 1000 Feet



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

LEGEND:
 ——— Maximum Probable Flood
 - - - Regional Flood
 - - - July 1916 Flood, Actual
 ····· July 1916 Flood, Present Conditions

Sections taken looking downstream.
 17 sections not shown.
 Elevations of Maximum Probable, Regional Flood,
 and July 1916 Flood Under Present Conditions
 Computed by Flood Control Branch.
 Sections 3 9 10 and 14 by Maps and Surveys Branch.
 Sections 18 and 22 and July 1916 Flood Elevations
 by Hydraulic Data Branch.

TENNESSEE VALLEY AUTHORITY
 DIVISION OF WATER CONTROL PLANNING
 HYDRAULIC DATA BRANCH

VALLEY CROSS SECTIONS
 SWANNANOVA RIVER
 VICINITY OF
 ASHEVILLE, NORTH CAROLINA
 DECEMBER 1960

HORIZONTAL DISTANCE IN FEET

ASF-1316