FLOODS
ON
NORTH TOE RIVER
AND
BEAVER & GRASSY CREEKS

IN VICINITY OF

SPRUCE PINE
NORTH CAROLINA

TENNESSEE VALLEY AUTHORITY
DIVISION OF WATER CONTROL PLANNING

FLOODS ON NORTH TOE RIVER AND BEAVER & GRASSY CREEKS—SPRUCE PINE, N. C.

TENNESSEE VALLEY AUTHORITY
KNOXVILLE. TENNESSEE

November 26, 1963

Colonel Harry E. Brown, Director
State of North Carolina Department
of Water Resources
Post Office Box 9392
Raleigh, North Carolina

Dear Colonel Brown:

In response to the request of the Town of Spruce Pine, North Carolina, through the North Carolina Department of Water Resources, TVA has prepared the report Floods on North Toe River and Beaver & Grassy Creeks in Vicinity of Spruce Pine, North Carolina. The purpose of this report is to provide basic information on floods that have occurred or may occur which would be helpful in the state and local programs of city planning and development at Spruce Pine. We are furnishing you copies of the report for distribution to the appropriate state and city agencies and individuals.

Also, copies of the report are being furnished interested Federal agencies for their information and use.

Sincerely,

TENNESSEE VALLEY AUTHORITY

Reed A. Elliot, Director
Division of Water Control
Planning

TENNESSEE VALLEY AUTHORITY
DIVISION OF WATER CONTROL PLANNING

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REPORT NO. 0-6372

KNOXVILLE, TENNESSEE
OCTOBER 1963

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FOREWORD

Tennessee Valley Authority
Division of Water Control Planning

FOREWORD

This report relates to the flood situation along North Toe River and Beaver and Grassy Creeks in the vicinity of Spruce Pine, North Carolina. It has been prepared at the request of the Mayor and Board of Aldermen of the Town of Spruce Pine 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 land subject to overflow. The report is based upon work 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 upon the occurrence and magnitude of floods in localities throughout the region which provide the basis for preparation of this report.

The report does not include plans for the solution of flood problems. Rather, it is intended to provide the basis for further study and planning on the part of the Town of Spruce Pine 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 Spruce Pine flood problem. The first brings together a record of the largest known floods of the past on North Toe River and Beaver and Grassy Creeks. 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 North Toe River and Beaver and Grassy Creeks and generally within 60 miles of Spruce Pine. The third develops the Maximum Probable Floods for North Toe River, Beaver Creek, and Grassy Creek. 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 physical features of reservoirs, dams, powerhouses, and some kinds of local flood protection works.

In problems concerned with the control of developments in the flood plains of North Toe River, Beaver Creek, and Grassy Creek, 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, and (3) the Maximum Probable Floods.

The report contains maps, profiles, and cross sections which indicate the extent of flooding that has been experienced and that might occur in the future in the vicinity of Spruce Pine. This should be useful in planning new developments in the flood plains. From the maps, profiles, and cross sections, the depth of probable flooding by either recurrence of the largest known floods or by occurrence of the Regional or Maximum Probable Floods at any location may be ascertained. By 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

I.

RESUME OF FLOOD SITUATION

Spruce Pine, North Carolina, is located on the North Toe River 31 miles above Huntdale, North Carolina, where North Toe River and Cane River join to form the Nolichucky River. Nolichucky River is a principal tributary of the French Broad River. Beaver Creek and Grassy Creek, tributaries with drainage areas of 5 and 11 square miles, respectively, join the North Toe River within the corporate limits of Spruce Pine. The Spruce Pine corporate limits extend for 4.14 miles along North Toe River, from Mile 29.75 to Mile 33.44 and Mile 34.08 to Mile 34.53, from the mouth to Mile 1.80 along Beaver Creek, and from the mouth to Mile 0.24 along Grassy Creek.

This investigation covers the North Toe River from Mile 29.2 to Mile 35.0, Beaver Creek from the mouth to Mile 1.33, and Grassy Creek from the mouth to Mile 2.59. The total drainage area of North Toe River above the lower limit of the reach studied is 134 square miles.

The principal business and residential development of Spruce Pine is on high ground on both sides of the river, but there are important industrial and commercial developments on land along North Toe River and Beaver Creek. Portions of this land have been inundated by floods of the past and a substantially greater area is within reach of the greater floods of the future.

Records of river stages and discharges were maintained continuously from 1934 to 1957 on the North Toe River in the vicinity of Spruce Pine. Intermittent records go back to 1907 when a staff gage was installed near the present site of the U. S. Highway 19E bridge. There are no records of streamflow on Beaver Creek or Grassy Creek. In compiling a record of the early floods on the three streams, it has been necessary to interview residents along the streams who have knowledge of past floods and to conduct research in newspaper files and historical documents. From these investigations and from studies of possible future floods on North Toe River, Beaver Creek, and Grassy Creek in the vicinity of Spruce Pine, 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 known to have occurred in this century on the North Toe River and Grassy Creek at Spruce Pine, and one of the greatest on Beaver Creek, occurred on July 16, 1916. There was considerable overflow and high velocities along the streams, but there was little development in the flood plains at that time.

* * *

ANOTHER GREAT FLOOD in May 1901 was the second highest flood on North Toe River in the memory of the oldest residents. The flood was one to two feet lower than that of the 1916 flood at Spruce Pine. Below Spruce Pine the flood exceeded the 1916 flood. This was also a great flood on Beaver Creek and Grassy Creek.

* * *

OTHER LARGE FLOODS on North Toe River occurred on August 13, 1940, August 24, 1961, and March 12-13, 1963. The flood of August 13, 1940, was the highest of these, reaching within 3 feet of the 1916 flood at the gage at Altapass, above Spruce Pine, and within 7 to 8 feet in downtown Spruce Pine. The recent floods of August 1961 and March 1963 were within 3 feet and 5 feet, respectively, of the mid-August 1940 flood at the Altapass stream gage. The 1940 and 1961 floods were also large floods on Beaver Creek and Grassy Creek.

* * *

REGIONAL FLOODS on North Toe River, Beaver Creek, and Grassy Creek in the vicinity of Spruce Pine are based upon floods experienced on streams within 60 miles of the community, a number of which are larger than any known floods on the three streams. This indicates that greater floods than those experienced so far may reasonably be expected in the future. Based upon the magnitude of floods that have occurred on neighboring streams, a Regional Flood may occur on North Toe River that would be generally 2 feet higher than the July 1916 flood. On Beaver Creek a Regional Flood would be about 10 feet higher than the August 1961 flood. On Grassy Creek a Regional Flood would reach stages averaging 8 feet higher than the August 1961 flood crest.

* * *

MAXIMUM PROBABLE FLOOD determinations indicate that floods could occur on North Toe River in the vicinity of Spruce Pine about 12 feet higher than the 1916 flood crest. Maximum Probable Floods on Beaver Creek and Grassy Creek would be about 13 feet and 11 feet, respectively, higher than the August 1961 flood.

* * *

FLOOD DAMAGES that would result from a recurrence of a flood as large as that of July 1916 on North Toe River, Beaver Creek, and Grassy Creek would be considerably greater than at the time of the actual flood because of the development now on the flood plains of the three streams. The Regional and Maximum Probable Floods, with their greater depths and velocities, would cause extensive damages.

* * *

MOST FREQUENT FLOOD OCCURRENCES on North Toe River, Beaver Creek, and Grassy Creek in the vicinity of Spruce Pine have been in the spring and summer, especially in the month of August. Most of the higher floods have been summer floods resulting from very heavy hurricane rainfall or intense thunderstorms. However, floods also occur in the fall and winter months, and large floods may occur at any time.

* * *

VELOCITIES OF WATER during the July 1916 flood ranged up to 22 feet per second in the channel of the North Toe River in the Spruce Pine vicinity and up to 7 feet per second on the flood plain. Along Beaver Creek and Grassy Creek, velocities during the August 1961 flood were up to 10 and 9 feet per second, respectively, in the channel, and up to 4 and 3 feet per second on the flood plain. During a Maximum Probable Flood, velocities in the channel would range up to 30 feet per second on North Toe River, up to 20 feet per second on Beaver Creek, and up to 18 feet per second on Grassy Creek. On the flood plain the corresponding figures would be 11, 7, and 5 feet per second.

* * *

DURATION OF FLOODS is relatively short on all streams in the vicinity of Spruce Pine. During the flood of July 1916 the North Toe River at Altapass remained above bankfull stage for 20 hours and had a maximum rate of rise of 5 feet per hour. During a Maximum Probable Flood on North Toe River, the stream would rise 38 feet in 12 hours with a maximum rate of rise of 6 feet per hour, remaining out of banks for about 36 hours. On Beaver Creek the Maximum Probable Flood would rise 17 feet in 1.5 hours with a maximum rate of rise of 14 feet in one hour, remaining out of banks for 4 hours. On Grassy Creek the rise would amount to 21 feet in 2 hours with a maximum rate of 14 feet in one hour, and the stream would remain out of banks for 6 hours.

* * *

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

* * *

FUTURE FLOOD HEIGHTS that would be reached if floods of the magnitude of the Regional and Maximum Probable occurred in the vicinity of Spruce Pine are shown in Table 1. The table compares these flood crests with the crest of a historical flood at each location.

TABLE 1

RELATIVE FLOOD HEIGHTS

IN VICINITY OF SPRUCE PINE

Flood	Location	Mile above Mouth	Estimated Peak Discharge cfs	Above 1916 or 1961 Flood feet
	North Toe River			
July 16, 1916	U. S. Highway 19E (downstream side)	31.45	45,000	0
Regional			57,000	1.6
Maximum Probable			103,000	11.5
	Beaver Creek			
August 24, 1961	U. S. Highway 19E (downstream side)	1.00	1,800	0
Regional			13,300	9.9
Maximum Probable			19,900	12.8
	Grassy Creek			
August 24, 1961	Carter Ridge Road (upstream side)	0.97	3,700	0
Regional			19,300	8.2
Maximum Probable			27,500	11.3

II.

PAST FLOODS

II.

PAST FLOODS[1]

This section of the report is a history of floods which have occurred on the North Toe River and its tributaries, Beaver Creek and Grassy Creek, in the vicinity of Spruce Pine, in Mitchell County, North Carolina. The portion of North Toe River considered extends from Mile 29.2, 0.5 mile below the lower corporate limit of Spruce Pine, to the Altapass Highway bridge at Mile 35.04, 0.5 mile above the upper corporate limit, a distance of 5.8 river miles. The investigation on Beaver Creek covers the 1.33 miles from its confluence with North Toe River to the mouth of Hanging Rock Branch. Grassy Creek is covered from the mouth to Mile 2.59, at the mouth of East Fork. Beaver Creek joins North Toe River at Mile 31.89, in the Spruce Pine business district. Grassy Creek joins North Toe River south of the principal development of Spruce Pine, at Mile 32.82. The study reaches are all in Mitchell County and the drainage areas of Beaver Creek and Grassy Creek are wholly within the county. About one-tenth of the drainage area of North Toe River above Spruce Pine lies in Mitchell County and the remainder is in Avery County, North Carolina.

The North Toe River flows generally northwestward in the reach covered by this report. Beaver Creek flows southward, then southwestward to the river. Grassy Creek flows generally northward to its confluence with North Toe River. Narrow bottom lands are found along Grassy Creek and the lower portion of Beaver Creek. North Toe River follows a narrow valley between close-set hills in its course through Spruce Pine.

The residential developments and the larger part of the business development of Spruce Pine are on high ground above flood danger, but there are important commercial and industrial developments on the narrow flood plain of North Toe River along the Clinchfield Railroad and the highways which follow the stream. The newer business and commercial developments of the town are along U. S. Highway 19E, which follows the right bank of Beaver Creek northeast of the central business district. Use of the flood-plain lands along Grassy Creek is principally agricultural but there are developments springing up on the flood plain along North Carolina Highway 226.

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1. Prepared by Hydraulic Data Branch.

The first records of river stage and discharge in the vicinity of Spruce Pine date from 1907, when the U. S. Geological Survey installed a staff gage on North Toe River near the present U. S. Highway 19E bridge. Sizable gaps exist in the early streamflow records, but they are continuous for the North Toe River during the period from May 1934 to December 1957, first at a recording gage installed near the upper corporate limit of Spruce Pine, and later at a recording gage located 1.5 miles upstream at Altapass. No records of stage or discharge have been maintained on Beaver or Grassy Creek.

Flood history investigations which were made by TVA engineers in the period 1935 to 1937 developed information on the North Toe River through Spruce Pine and downstream to the mouth. Investigations were made following the floods of August 1940, September 1959, August 1961, and March 1963 on North Toe River. Local residents have been interviewed. Field investigations have been made to supplement the early data and to develop in detail the flood profile for the largest recent flood on Beaver and Grassy Creeks, that of August 1961. A search has been made of newspaper files and historical documents. From these sources it has been possible to develop a history of the known floods on North Toe River, Beaver Creek, and Grassy Creek covering the past 62 years or more.

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

1. NORTH TOE RIVER VALLEY

Settlement

The land which now constitutes Mitchell County was made a part of Burke County by an act of the North Carolina General Assembly in 1777. Prior to that the land was hunting territory for the Cherokee Indians, but there is no evidence that they had established any permanent settlements in the area. In 1833 it was part of the section which was broken off from Burke County to form Yancey County. Mitchell County was formed from a part of Yancey County in 1861. In 1911 parts of Mitchell, Watauga, and Caldwell counties were taken to form Avery County, leaving the boundaries of Mitchell County as they are known today. The county took its name from Dr. Elisha Mitchell, the university professor and historian who died in an accident while exploring the mountain peak

which lies just south of the county. The peak is the highest point in the eastern United States, and also bears his name.

There were white settlers in the vicinity of Spruce Pine while it was still Indian territory. Land grants at the site are dated as early as 1778. Among the first settlers were Arch Cathey, Samuel Bright, William Lavendar, and Isaac English. Isaac English built the English Inn to serve the travelers who used the routes through the area. Mrs. English was the first postmistress and is credited with naming the town for a spruce pine tree which stood in the yard of the inn. The tree and the inn are still to be found today on English Street, where the inn now serves as a residence.

The Clinchfield Railroad, first called the South and Western, then later the Carolina, Clinchfield and Ohio, came to Spruce Pine in 1903. The principal commodity handled by the railroad is coal, which it transports from the Virginia and West Virginia fields to the industrial centers in South Carolina and the seaport at Charleston. The railroad has had a sizable effect upon the development of the mining industry of the area, the dominant factor in the present economy of Spruce Pine.

Mining of mica in the Spruce Pine area was begun shortly after the Civil War. Originally all of the production was in the form of sheet mica. It became important in the manufacture of condensers and insulators by the electrical industry, and at one time its production was the principal industry of the area. Today, little is produced because of competition from areas outside of United States; however, the production of ground mica continues to be important. It was first produced in 1906, and is used in the manufacture of roofing, rubber, and paints. Practically all of the U. S. producers of chinaware obtain their clay from the kaolin which is mined and processed in the Spruce Pine area, and about 70 percent of the feldspar used for glazing ceramic ware is mined in the vicinity of Spruce Pine.

Spruce Pine is served by modern highways which link it to the Piedmont section of North Carolina to the east, the metropolitan area of Asheville to the southwest, and the tri-cities area of Johnson City, Kingsport, and Bristol to the north. The Blue Ridge Parkway follows the North Toe River basin divide for a distance of 37 miles. One of the Parkway access points is at Gillespie Gap, about 5 miles south of Spruce Pine, at the intersection with North Carolina Highway 226.

Figure 1.--SPRUCE PINE SOON AFTER COMPLETION OF RAILROAD

This view of the settlement was taken in 1905, soon after the Clinchfield Railroad was built. The photograph appeared in the Tri-County News, Spruce Pine, on January 21, 1960. Landmarks identified include the Phillips Hotel at upper left, a livery stable in center background, the L. A. Berry store and post office with white roof at center, and the Berry home beyond the piles of crossties. The picture was taken from a point near the present U. S. Highway 19E bridge.

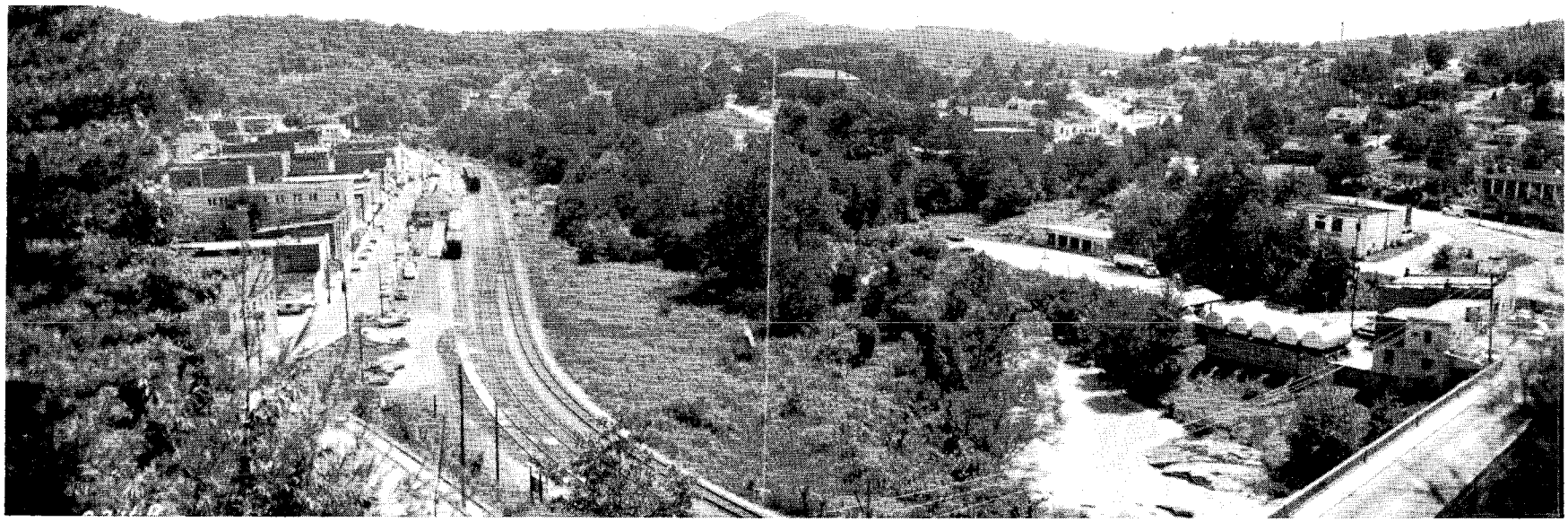


Figure 2.--NORTH TOE RIVER VALLEY AT SPRUCE PINE IN AUGUST 1963

The view is upstream from a vantage point near that used for the picture in Figure 1. The highway bridge can be seen at lower right corner, and the business development along Locust Avenue is at left.

Tourists are now visiting the Spruce Pine area in increasing numbers and are having an important effect upon the area's economy.

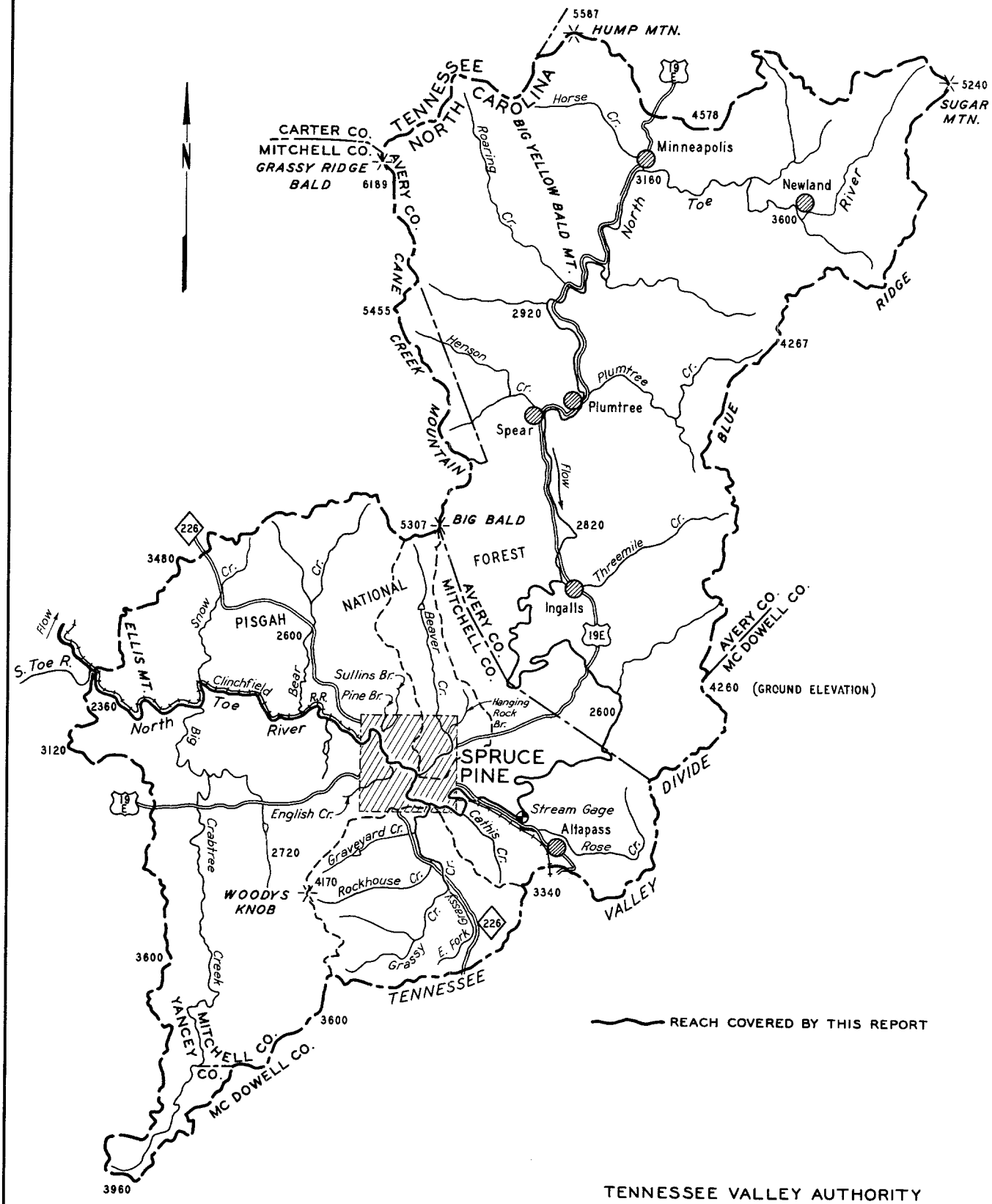
Spruce Pine was incorporated by an act of the North Carolina General Assembly on February 5, 1907. According to the 1960 census report the population of Spruce Pine is 2504 persons and that of Mitchell County is 13,906 persons. Figures 1 and 2 are photographs of the Town of Spruce Pine made in 1905 and in 1963, respectively.

The Stream and Its Valley

The North Toe River, the largest tributary of the Nolichucky River, drains an area of 442 square miles, all of which lies in North Carolina. The North Toe River watershed above the mouth of the South Toe River, with a drainage area of 183 square miles, is shown on Plate 1.

The drainage area above the lower limit of the Spruce Pine study comprises rugged mountain land lying in Mitchell and Avery Counties. Its shape is roughly rectangular, 20 miles in length and 5 to 10 miles in width. North Toe River has its head near Newland, North Carolina, at the northeast corner of the watershed, and flows generally southward to Spruce Pine where it turns to flow northwestward to its confluence with Cane River at Huntdale forming the Nolichucky River. From the extreme headwaters to the mouth of South Toe River, numerous small streams rise along the basin rim and flow generally at right angles to the main stream. Upstream from Spruce Pine, the largest of these are Roaring Creek and Plumtree Creek, with drainage areas of approximately 11 and 8 square miles, respectively. Two small tributaries flow into the river in the vicinity of Spruce Pine. Beaver Creek heads in a narrow valley north of the town, flows southward, then southwestward through a part of the business district to enter North Toe River near the center of Spruce Pine. Grassy Creek has its head at the Blue Ridge, along the southern rim of the watershed, and flows northward to join North Toe River near the upper corporate limit of Spruce Pine. Beaver Creek and Grassy Creek will be discussed in later sections of the report.

Other tributaries which enter North Toe River in the Spruce Pine vicinity are small and have relatively little effect upon the flood situation. English Creek drains a residential area along U. S. Highway 19E southwest of the business district and enters the river on the left bank at Mile 31.27. Sullins Branch joins North Toe River on the right bank at Mile 30.37. Cathis Creek



TENNESSEE VALLEY AUTHORITY
DIVISION OF WATER CONTROL PLANNING

UPPER NORTH TOE RIVER WATERSHED

SCALE 0 1 2 3 4 MILES

OCTOBER 1963

drains an agricultural area which adjoins the Grassy Creek drainage on the east and enters North Toe River on the left bank at Mile 33.59. Pertinent drainage areas of North Toe River and its tributaries in the vicinity of Spruce Pine are given in Table 2.

Heading in a narrow valley between the state line ridge and the Blue Ridge, North Toe River follows a course generally southward and parallel to the Blue Ridge, flowing through the towns of Minneapolis, Plumtree, Spear, and Ingalls in Avery County. The river enters Mitchell County at a point about four air-line miles east of Spruce Pine. Elevations along the Blue Ridge are generally between 3000 and 4000 feet, although the highest point is Sugar Mountain in the northeast corner of the basin at elevation 5240 feet. Along the northern and western rim of the watershed, elevations are generally over 4000 feet. High points are at Hump Mountain north of Minneapolis, 5587 feet, and Grassy Ridge Bald on the state line at the northwest corner of the watershed, 6189 feet. Elevations on the valley floor range from 3600 feet at Newland to 2600 feet at the Avery-Mitchell county line and 2500 feet in Spruce Pine. In its course through Avery County, North Toe River follows a winding course with relatively wide bottoms alternating with narrow, almost gorge-like reaches. From the county line through Spruce Pine and downstream to the mouth of the river at Huntdale, the course is also winding, but the valley is consistently narrow.

In the reach of North Toe River covered by the investigation, from Mile 35.04 to Mile 29.2, the stream channel falls from elevation 2540 feet to elevation 2467 feet, an average rate of fall of 12.6 feet per mile. The over-all width of the flood plain varies from about 200 feet to 600 feet. The portion of this occupied by the stream channel ranges from 50 to 100 feet. At the upper end of the study reach, near the Altapass Highway bridge, the flood plain is 500 feet wide. Through the "S" bend, which starts just below the bridge, and downstream to the mouth of Beaver Creek the flood plain is generally 200 to 300 feet wide. At Mile 31.70, at the athletic field near the Harris Elementary School, the flood plain is 600 feet wide. Elsewhere in the reach occupied by the Spruce Pine business development, the width is about 400 feet. From the business district to the lower end of the study reach the flood plain is generally 300 to 400 feet wide.

TABLE 2

DRAINAGE AREAS IN WATERSHED OF NORTH TOE RIVER

Stream	Location	Mile above Mouth	Drainage Area sq. mi.
North Toe River	Mouth	0.0	442
	Above South Toe River	21.5	183
	Lower limit of study	29.20	134
	U. S. Highway 19E	31.45	130
	Upper limit of study (Altapass Highway bridge)	35.04	110
	Former USGS stream gage at Altapass	35.97	104
Beaver Creek	Mouth	0.0	5.34
Grassy Creek	Mouth	0.0	11.4

The corporate limits of Spruce Pine form a square two miles on a side, with the sides oriented in a north-south and east-west direction. The river makes a pronounced "S" bend near the southeast corner of the corporate limits, so that in its course through the community the stream enters the corporate limits at Mile 34.53, leaves it at Mile 34.08, then enters it again at Mile 33.44. The river crosses the lower corporate limit at Mile 29.75, so that a total of 4.14 miles of its course is within the Spruce Pine corporate limits. The principal business and residential sections are on high ground, but some industrial and commercial developments are subject to flooding.

Developments in the Flood Plain

Plate 5 shows the flood plain of the North Toe River for the reach covered by this report. Figures 3 and 4 show views of the flood plain in Spruce Pine. Except for the land in the immediate Spruce Pine area, little use is made of the narrow flood plain other than for railroad and highway locations.

The Clinchfield Railroad follows the northeast, or right-bank, flood plain from the lower end of the study reach through the principal business district

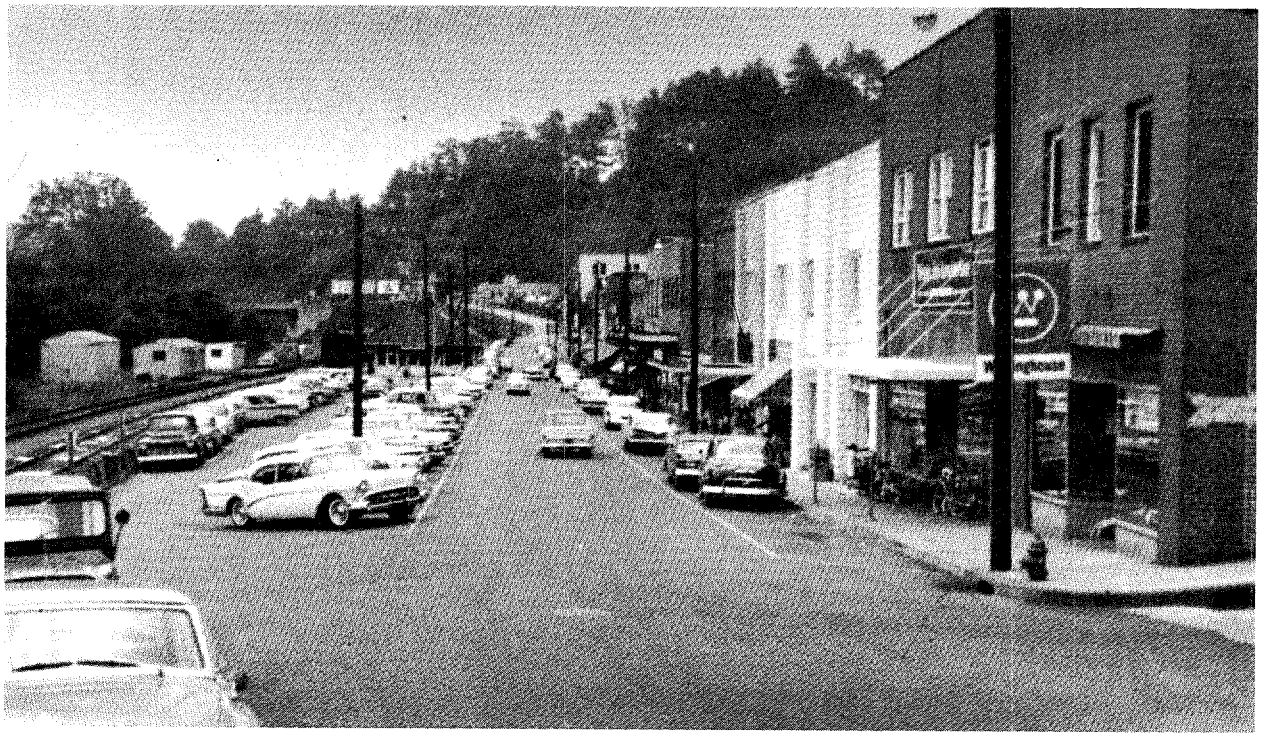


Figure 3.--BUSINESS DISTRICT AT SPRUCE PINE

View west along Locust Avenue from intersection of Topaz Street. North Toe River is out of the picture at left.

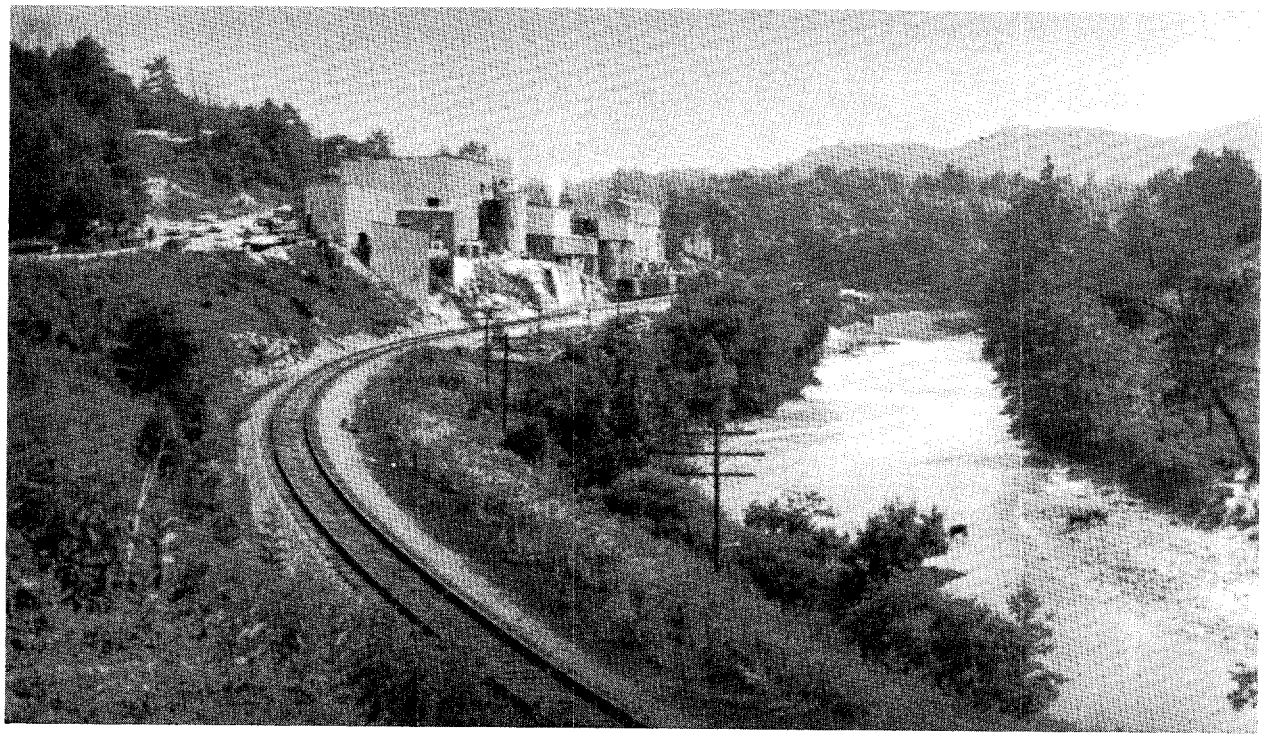


Figure 4.--INDUSTRIAL DEVELOPMENT ON NORTH TOE RIVER

International Minerals and Chemical Corporation buildings on right bank at Mile 30.7, about a mile downstream from center of Spruce Pine.

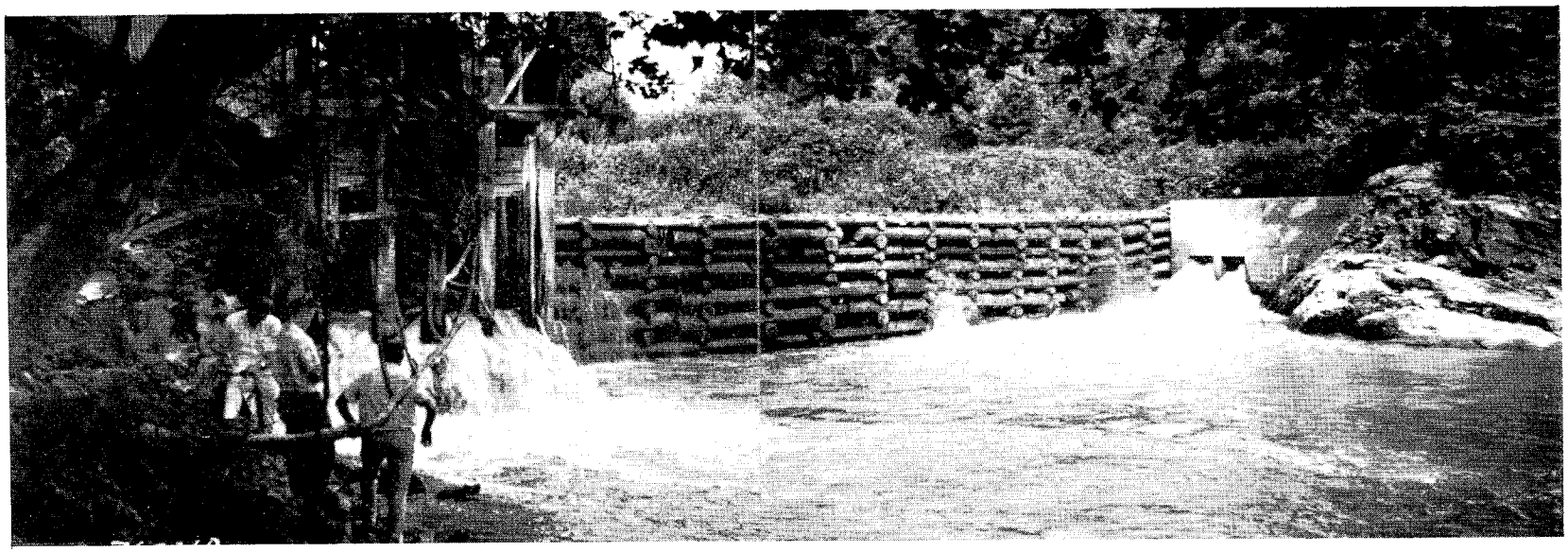


Figure 5.--DAM ON NORTH TOE RIVER, MILE 34.47, AT SPRUCE PINE

This timber crib dam was originally built to provide a source of water for mineral washing operations. Owned by the English Mica Corporation, the dam has not been maintained for a number of years. The concrete section at left end of dam (right of picture) is set at a right angle to the timber crib section.

of Spruce Pine to Mile 32.9. The railroad leaves the river at this point to pass through a gap, and it then follows the river again between Miles 34.24 and 33.86, at the middle of the "S" bend reach. It crosses the stream on a high bridge at the latter point, passes through a second gap, and returns to the river on the left-bank flood plain at Mile 34.9, near the upper end of the study reach. The railroad leaves the North Toe River basin by way of the Rose Creek valley and a tunnel through the crest of the Blue Ridge at Altapass, four miles southeast of Spruce Pine.

From Mile 31.7, near the depot, downstream to the lower end of the reach the tracks are as much as 3 feet below the level of the 1916 flood. The Regional Flood would cover the tracks in that reach to an average depth of 5 feet. During a Maximum Probable Flood water would cover the tracks upstream another half mile, and depths of flooding would range up to 19 feet.

U. S. Highway 19E follows the left-bank flood plain, from Mile 31.16 to Mile 31.45, crosses the river at that point, then follows the right side of the river above the flood plain to Mile 31.8, where it leaves the river to follow Beaver Creek. In the short section along the river downstream from the bridge the highway is near the same level as the railroad on the opposite bank, and it would be flooded in a similar manner by major floods. The route provides access from Spruce Pine to Burnsville and Asheville to the west and southwest, and the communities of the upper East Tennessee area to the north. N. C. Highway 226 goes through Bakersville and also connects with highways in the East Tennessee areas. To the south it connects with the Blue Ridge Parkway and main east-west highways at Marion. It follows the right bank of the river from Mile 30.2 to 31.45, crosses the river with U. S. Highway 19E, and proceeds south by way of the Grassy Creek basin. The Altapass Highway crosses North Toe River at Mile 35.04, follows the left bank upstream out of the study reach, and follows the right bank downstream to Mile 34.25. In the business district Locust Avenue is in the flood plain.

Industrial developments are found along the railroad on the right bank of the North Toe River near the upper corporate limit, at the mouth of Beaver Creek, and near the lower corporate limit. Business and commercial developments are on the right bank between Beaver Creek and the U. S. Highway 19E bridge and at scattered points between the bridge and Sullins Branch, and on the left bank above and below the U. S. Highway 19E bridge.

A small plant on the right-bank flood plain just below the Altapass Highway bridge, at Mile 34.87, manufactures concrete block, drain tile, and other products. The floor of the plant is at elevation 2550.9 feet and a residence at the site has its floor at elevation 2555.7 feet. Water was one foot over the plant floor in the flood of August 1961. At that location the 1916 flood reached an elevation of 2555, and the Regional and Maximum Probable Floods would reach elevations of 2569 and 2581, respectively.

A plant and dam of the English Mica Company, at Mile 34.47, has not been operated for some years. Figure 5 is a view of the dam, which is still in relatively good repair. The crest elevation is about 2542 feet and the lowest mill floor is at 2547.6 feet. In August 1961, flood water just upstream from the dam was one foot higher than the mill floor. The Regional Flood would be 17 feet higher than the 1961 flood and the Maximum Probable Flood would be another 11 feet higher. The firm has a larger plant installation, also out of operation at this time, located on the right bank just above the mouth of Grassy Creek. The dam and turbine located at Mile 32.97 was in operation at the time of the July 1916 flood and originally produced power for the plant operation. Only a small part of the dam is in place today and the plant buildings are now used only for warehousing. The 1916 flood was under the main building but did not get into the mill proper. The Regional and Maximum Probable Floods would be 2 and 12 feet higher, respectively, than the 1916 flood at that point.

Two newer plant installations just downstream from the old English Mica plant are located between the tracks of the Clinchfield Railroad and the Altapass Highway and are above any flood danger. One, the Feldspar Corporation, has its materials storage, ore processing, and railroad car loading facilities located at Mile 32.9. It has a water-supply dam on Grassy Creek 0.3 mile above the mouth, with a pipeline to carry water to the plant site. A waste treatment works, being built at the plant, is on the river side of the railroad, but is still well above flood heights. All the facilities of the Diamond Mica Corporation located at Mile 32.8 are above the railroad grade and above flood levels.

Storage and car loading facilities of the Harris Clay Company are at the side of the railroad at Mile 31.84, just below the mouth of Beaver Creek. Floor levels are above the elevation of the known floods and the Regional Flood but would be below a Maximum Probable Flood. The main operations of the firm are located northeast of Spruce Pine.

Harris Elementary School is on high ground above flood danger but an athletic field is on the left-bank flood plain at Mile 31.70. A flood as great as that of 1916 would cover the field.

The oldest business developments in Spruce Pine are those located along the street which parallels the railroad in the vicinity of the Clinchfield Railroad station. First called Lower Street and more recently known as Locust Avenue, the street is still a center of the business activity of the town. Included are eight clothing or dry goods stores, two variety stores, two furniture stores, two radio shops, a grocery, a restaurant, an auto supply store, two beauty shops, a barber shop, a jewelery store, a florist, a photography shop, a shoe repair shop, an insurance office, a loan office, a drugstore, a theater, and a newspaper office. Floor levels of these buildings vary from elevation 2517.1 to 2527.5 feet. The record flood of July 1916 reached an elevation near 2520 in the vicinity of the railroad station, flooding several of the lower buildings then in use to depths near 2 feet. A Regional Flood would be about 2 feet higher than the 1916 flood, and a Maximum Probable Flood would put water over the floor of all these buildings with depths up to 19 feet. Figures 2 and 3 are views which show the development along Locust Avenue.

On the left bank, developments which are in the vicinity of the U. S. Highway 19E bridge are mostly above flood danger. Downstream along U. S. Highway 19E, a lumber yard, an oil bulk plant, an explosives supply, an appliance store, and a service station would be affected by a flood of the magnitude of that of July 1916. The floor levels are generally about 4 feet below the 1916 flood, 6 feet below the Regional Flood, and 16 feet below the Maximum Probable Flood.

On the right bank, along the railroad and N. C. Highway 226, about Mile 31.1, are several warehouse buildings, a repair shop, and a funeral home. The floor of the latter is 2 feet above the Regional Flood height and 8 feet below the Maximum Probable Flood.

The plant of the International Minerals and Chemical Corporation occupies the steep land on the right bank, between the railroad and N. C. Highway 226 at Mile 30.66. A pumphouse at the riverbank has a floor level of 2506.2, and car loading facilities at the railroad at elevation 2514.6 are within the reach of floods on North Toe River. Water was over the railroad tracks at this site in the 1916 flood, reaching an elevation of 2513. A Regional Flood would reach an elevation of 2516, and a Maximum Probable Flood would be 10 feet higher. Figure 4 is a view of the plant.

The Lawson-United Feldspar plant, on the right bank at Mile 29.25, has all its principal buildings well above the known floods on North Toe River. Car loading is done at an elevated side track, also above the floods of record.

Spruce Pine obtains its water supply from two town-owned watersheds, one at the head of Beaver Creek, $3\frac{1}{2}$ miles north of the community, and one on Graveyard Creek, a tributary of Grassy Creek, 2 miles to the south. These watersheds provide a gravity supply for the town. Most of the ore processing firms have their own water-supply systems, usually a storage and diversion dam on one of the tributary streams.

A town-owned sewerage system now discharges wastes untreated into North Toe River. A number of residences and businesses discharge untreated wastes to the river or to Beaver Creek. The town is currently moving to meet the sewage treatment standards which have been set for North Toe River by the North Carolina Stream Sanitation Commission. An engineering firm is making studies for a collection system and treatment plant for this purpose, and grants totaling $431,000 have been approved under the accelerated public works program which will enable the town to improve both the water-supply and sewerage systems.

Bridges across the Stream

Two highway bridges, one railroad bridge, and three footbridges cross North Toe River in the vicinity of Spruce Pine. Table 3 lists pertinent elevations for these bridges and shows their relation to the crest of the flood of July 1916 and the Regional Flood. Plate 6 shows the relation of the floor and underclearance at the bridges to the flood profiles for the reach. Figures 6 and 7 are photographs of the bridges.

The U. S. Highway 19E bridge at Mile 31.5 carries all the local and through traffic that crosses North Toe River at Spruce Pine. This is a concrete bridge, completed in 1922, which replaced the original bridge, a steel truss structure that was located 200 feet upstream. A high concrete arch spans the river channel. A girder span on the right bank crosses the tracks of the Clinchfield Railroad. A matching approach section provides some floodway opening on the left bank. Solid abutments block portions of the flood plain at each end of the bridge. The roadway and underclearance of the bridge are above the elevation of the highest known floods at the site and also of the Regional Flood. During a Maximum Probable

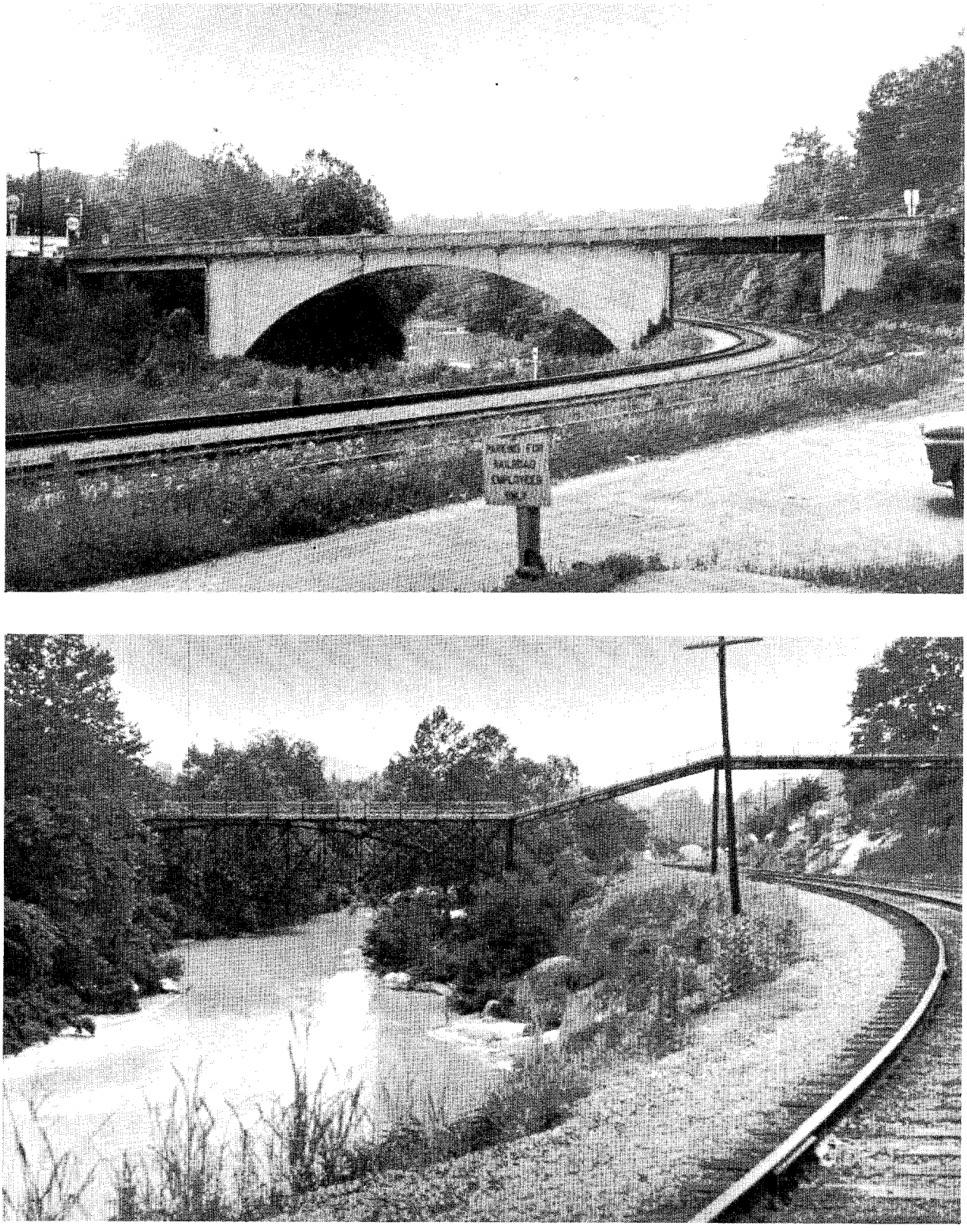


Figure 6.--NORTH TOE RIVER BRIDGES AT SPRUCE PINE

Upper view shows the upstream side of the U. S. Highway 19E bridge over the river at Mile 31.45. The bridge was built in 1922. Lower view is the upstream side of the steel footbridge, at Mile 31.78, which serves the Harris Elementary School and athletic field located on left bank.

Figure 7.--NORTH TOE RIVER BRIDGES ABOVE SPRUCE PINE

The Clinchfield Railroad bridge at Mile 33.86 is seen from left bank in the upper view. The lower picture shows the bridge on the highway leading to Altapass, viewed from right bank at Mile 35.04; the bridge was built in 1916.

TABLE 3

BRIDGES ACROSS NORTH TOE RIVER

Mile above Mouth	Identification	Low Water Elev. feet	Floor Elev. feet	Regional Flood Crest Elev. feet	July 1916 Flood Crest Elev. feet	Underclearance Elev. feet	Above 1916 Flood feet	Below 1916 Flood feet
31.45	U. S. Highway 19E	2493.2	2539.1	2520.9	2518.8	2533.5	14.7	
31.78	Pedestrian bridge	2498.3	2535.9	2523.8	2522.7	2522.1		0.6
32.89	Footbridge	2508.6	2523.4	2534.2	2532.2	2522.6		9.6
33.86	Clinchfield R.R.	2525.3	2579.8	2552.5	2546.0	2570.8	24.8	
34.22	Footbridge	2528.4	2531.6	2557.0	2549.6	2530.6		19.0
35.04	Altapass Highway	2541.6	2559.2	2572.0	2556.3	2557.7	1.4	

Flood, heading up of about 5 feet would cause the floodwaters to rise above the underclearance. There would be little heading up during floods as great as a Regional Flood.

A pedestrian bridge at Mile 31.78 provides access from Locust Street on the right bank to the Harris Elementary School on the left bank of North Toe River. The river-channel span is a steel deck truss. Two steel girder spans to the right of the channel cross the stream bank and the railroad. On the left bank a steel girder and pier section extends for 240 feet across the flood plain. The underclearance of the main span is below the elevation of the 1916 flood, but the floor level of the bridge is above the level of all floods except the Maximum Probable Flood. Heading up is negligible at the bridge.

A suspension-type footbridge at Mile 32.89 provides access from the plant of the Feldspar Corporation to their water-supply dam on Grassy Creek. A low-water bridge nearby, which had been used for access to a mining area on the left bank, has not been used for a number of years and is in poor condition. It has little or no effect upon flood heights. Both bridges would probably be washed out during a major flood.

The Clinchfield Railroad crosses North Toe River on a high bridge at Mile 33.86. The bridge consists of two heavy steel girder spans, concrete abutments, and a concrete center pier. The underclearance of the bridge is some 45 feet above

the normal water level, high enough to pass a Maximum Probable Flood, although heading up of about 3 feet would occur.

A log footbridge at Mile 34.22 provides access to the houses which are encircled by the upper part of the prominent "S" bend which North Toe River makes in this reach. The bridge is only a few feet above the water and would be carried away in any sizable flood.

The Altapass Highway bridge at Mile 35.04, built in 1916, is a steel truss structure with a short approach span at each end. A fill on the left bank varies in height from 2 to 10 feet over its length of 400 feet. Access to the bridge is affected when water overflows the left-bank approach fill at elevation 2557.8 feet. The maximum heading up during great floods would be less than 2 feet.

Dams across North Toe River

Three low dams have affected some of the floods of the past in the reach of North Toe River which is covered by this investigation. None of the dams is in use at this time, and at two of the sites only a part of the structure remains.

The Harris Electric Company built a concrete dam at Mile 29.69 prior to the July 1916 flood. Electric power was sold to customers in Spruce Pine and used at the Harris Clay Company plant just below the dam. The dam and powerhouse have not been used for many years and a 30-foot section of the dam, adjacent to the powerhouse site on the left bank, has been removed. The portion of the dam which remains, between the right bank and a large rock at mid-channel, is about 90 feet long and 10 feet high. Normal flow of the stream is carried by the open section at the left end of the dam. The dam would have a negligible effect upon the heights of floods of the magnitude of a Regional or Maximum Probable Flood.

The English Mica Company built a timber crib dam across North Toe River at Mile 32.97, just above the mouth of Grassy Creek, prior to the flood of July 1916. Another dam of similar construction was built at Mile 34.47 in 1938. The first dam has not been maintained for some time and has now largely disintegrated and been carried away; however, the restriction at the site would still cause major floods to head up about 4 feet. The upper dam is also no longer used, but is still relatively intact. It averages about 8 feet in height and is 120 feet long. Normal flow of the stream passes through two outlets which have been left open at the left end of the dam. With the headwater at the crest of the dam, backwater extends

upstream to Mile 35.25, a distance of 0.8 mile. The dam would cause a heading up of 7 feet in the Regional Flood profile, and 5 feet in the Maximum Probable Flood profile.

Obstructions to Flood Flow

The effect of obstructions due to the bridges and their approach fills and to the dams has been described in the previous sections. There have been some changes in the flood plain due to grading or filling at the site of developments in Spruce Pine and these will slightly affect future flood heights.

FLOOD SITUATION

Flood Records

Records of river stage and discharge were maintained continuously on North Toe River in the vicinity of Spruce Pine from 1934 to 1957. Intermittent records go back to June 19, 1907, when a staff gage was installed by the U. S. Geological Survey at a footbridge which was located near the site of the present U. S. Highway 19E bridge in Spruce Pine. Observations were discontinued at this gage June 30, 1908. Records were obtained from April 21, 1920, to October 9, 1920, at a staff gage at the first highway bridge over the river at Spruce Pine, located about 200 feet above the present bridge, and from August 21, 1921, to December 18, 1924, at a chain gage on the bridge. A staff gage one-half mile downstream from the bridge was used for observations from December 19, 1924, to September 30, 1926.

On May 8, 1934, records of streamflow began at a recording stream gage at Mile 34.54, just above the upper corporate limit of Spruce Pine. The station was discontinued in September 1938 when records were affected by backwater from the English Mica Company dam. Records began at a new recording gage site near Altapass, just above the mouth of Rose Creek, at Mile 35.97 on October 1, 1938, and were continued until December 31, 1957.

To supplement the record obtained at these gaging stations, local residents were interviewed for information on dates and heights of floods. Files of the Spruce Pine newspapers were searched, as were historical documents and

records. Valuable data were obtained from reports of field investigations made by TVA engineers after the important floods which have occurred in the last 28 years. These records and investigations have developed a knowledge of floods on North Toe River covering the past 62 years or more.

Flood Stages and Discharges

Table 4 lists peak stages and discharges for the known floods exceeding bankfull stage of 10 feet at the Geological Survey gaging station on North Toe River at Altapass. For floods since 1938 the flood crest stages are those observed at the gage. Stages for floods occurring prior to 1938 are from high water marks or are estimated from newspaper and historical accounts or from interviews with local residents.

Flood Occurrences

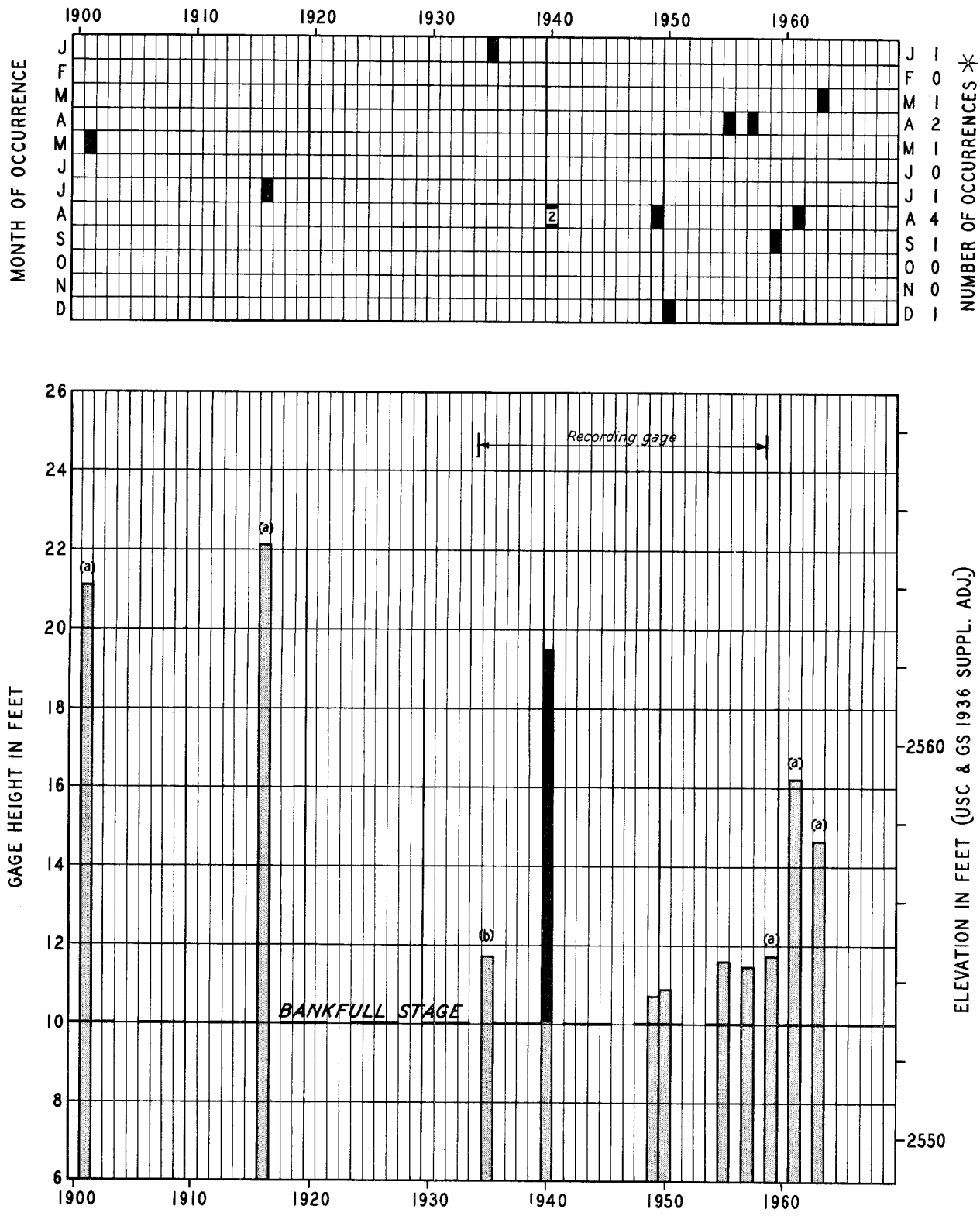
Plate 2 shows crest stages and months of occurrence of known floods since 1900 which have exceeded the bankfull stage of 10 feet on the North Toe River at the Altapass stream gage. Table 5 shows the monthly distribution of the 17 known floods occurring since 1791. The record shows that floods have occurred most frequently in the spring and summer months with the largest number of floods in August. A longer period of record would probably show floods occurring in every month of the year.

Duration and Rate of Rise

Plate 3 shows the stage hydrograph on North Toe River for the flood of August 13, 1940, at the stream gage at Altapass. During that flood the river rose to its crest stage in 17 hours at an average rate of 0.9 foot per hour with a maximum rate of over 4 feet per hour, and remained above bankfull stage 13 hours. Upon the basis of these figures and those computed for the Regional Flood, it is estimated that the 1916 flood rose at a maximum rate of 5 feet per hour and remained above bankfull stage for 20 hours.

Velocities

During the July 16, 1916, flood it is estimated that velocities in the channel of North Toe River in the vicinity of Spruce Pine ranged up to 22 feet per



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(a) Stage based on high water mark.

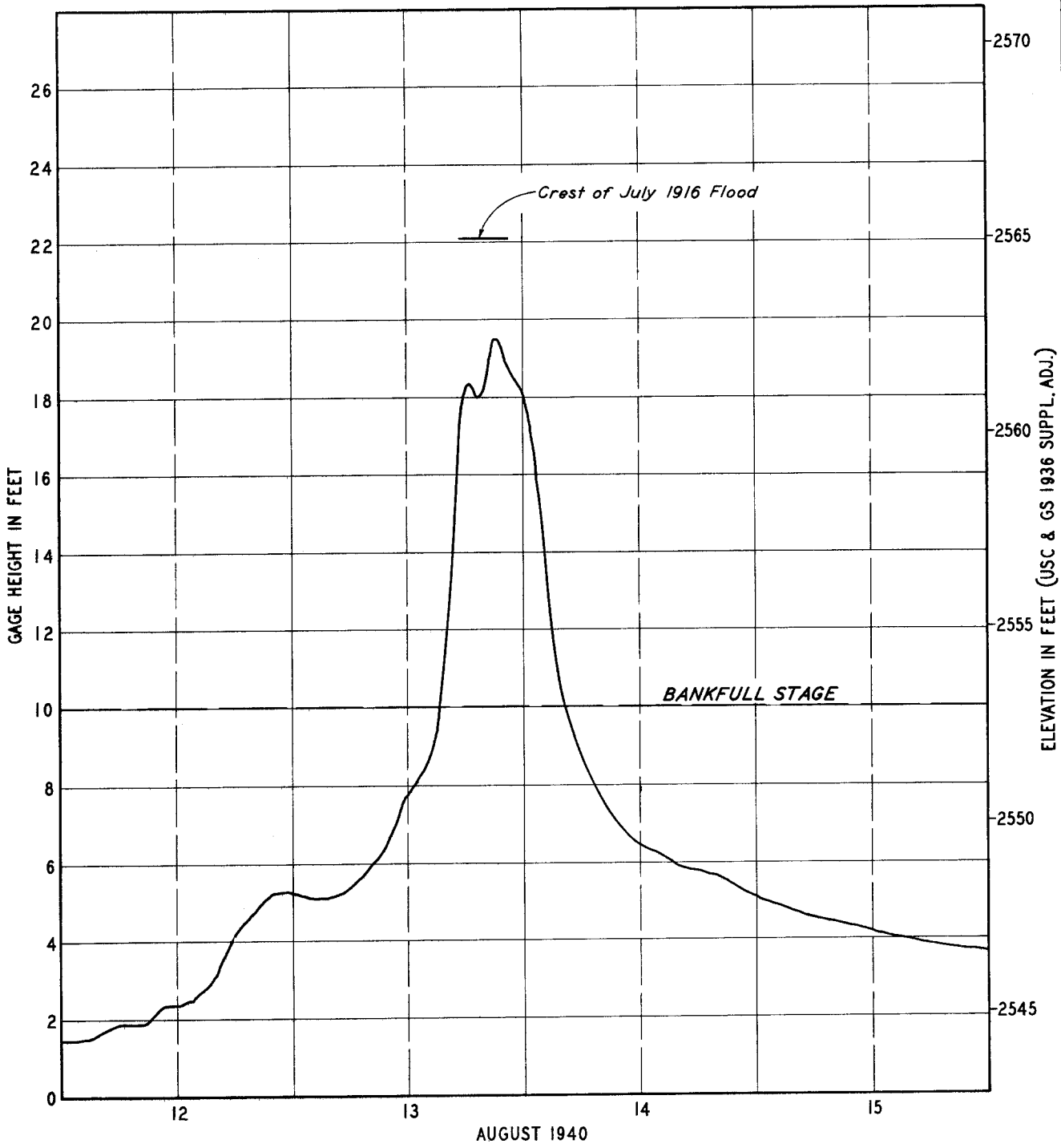
(b) Stage based on gage at different site and datum.

✳ Number of occurrences during period May 1901 to September 1963.

FLOODS ABOVE BANKFULL STAGE
NORTH TOE RIVER AT ALTAPASS, N.C.

OCTOBER 1963

PLATE 3



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Gage at River Mile 36.0

STAGE HYDROGRAPH

FLOOD OF MID-AUGUST 1940
NORTH TOE RIVER
AT ALTAPASS, N. C.
OCTOBER 1963

TABLE 4

NORTH TOE RIVER AT ALTAPASS, NORTH CAROLINA

FLOOD CREST ELEVATIONS AND DISCHARGES ABOVE BANKFULL STAGE

1791-1963

This table includes all known floods above bankfull stage of 10 feet at the U. S. Geological Survey gaging station at Altapass, Mile 36.0. Drainage area is 104 square miles.

Date of Crest	Gage Heights		Peak Discharge	
	Stage feet	Elevation feet	Amount cfs	Per Sq. Mile cfs
April 1791	(a)			
September 1824	(a)			
March 1867	(a)			
February 1875	(a)			
March 1899	(a)			
May 21, 1901	21.1(b)	2564.0	27,000	260
July 16, 1916	22.1(b)	2565.0	30,800	296
January 9, 1935	11.75(c)	-	4,450	40
August 13, 1940	19.5	2562.4	22,200	213
August 30, 1940	10.07	2552.98	6,620	64
August 28, 1949	10.70	2553.61	4,760	46
December 7, 1950	10.91	2553.82	4,970	48
April 14, 1955	11.60	2554.51	5,710	55
April 5, 1957	11.45	2554.36	5,340	51
September 30, 1959	11.70(d)	2554.61	5,700	55
August 24, 1961	16.22(d)	2559.13	13,100	126
March 12-13, 1963	14.67(d)	2557.58	10,100	97

(a) Stage unknown--Flood history investigations indicate that floods occurred at this time.
(b) Estimated from high-water marks.
(c) At gage 1.5 miles downstream (different datum).
(d) From silt lines in gage well.

Note: The 1901 and 1916 flood stages have been previously published as 23 feet and 24 feet, respectively. Recent investigations indicate that these stages are too high, and that the stages listed above are more nearly correct.

TABLE 5

MONTHLY FLOOD DISTRIBUTION

NORTH TOE RIVER AT ALTAPASS, N. C.

Month	Number of Occurrences	Month	Number of Occurrences
January	1	July	1
February	1	August	4
March	3	September	2
April	3	October	0
May	1	November	0
June	0	December	1
		Total	17

second, and overbank velocities ranged up to 7 feet per second. During larger floods, velocities would be even greater.

Flooded Areas, Flood Profiles, and Cross Sections

Plate 5 shows the approximate areas along the North Toe River in the vicinity of Spruce Pine that would be inundated by the flood of July 1916 under present conditions, and by the Maximum Probable Flood. The actual limits of these overflow areas on the ground may vary somewhat from those shown on the map because the contour interval of the map does not permit precise plotting of the flooded area boundaries. The contour interval of Plate 5 is 40 feet.

Plate 6 shows high water profiles for the floods of July 1916, September 30, 1959, and August 24, 1961. Also shown is the profile of the 1916 flood under present conditions above the dam at Mile 34.47, and the profiles for the Regional and Maximum Probable Floods discussed in Sections III and IV of this report.

Plate 9 shows typical cross sections of North Toe River in the reach investigated. The locations of the sections are shown on the map and profiles, Plates 5 and 6. The cross sections show the elevation and extent of overflow of the July 1916 flood and the Regional and Maximum Probable Floods.

FLOOD DESCRIPTIONS

Following are descriptions of known large floods that have occurred in the vicinity of Spruce Pine. These are based upon newspaper accounts, historical records, and investigations by TVA engineers.

Early Floods

Information is sparse on the very early floods on North Toe River and its tributaries in the vicinity of Spruce Pine. There was relatively little bottom land along the North Toe River to attract the first settlers, who were looking primarily for land that could be adapted to the raising of crops. Those who settled near the river had little reason to take note of the floods that occurred, hence little specific information on floods was passed along to later generations.

From newspaper accounts and other records it is known that a number of great floods occurred in the upper half of the Tennessee Valley and that there were severe floods on some streams whose watersheds were not far from that of North Toe River. It is probable that there were large floods on North Toe River at the same times.

April 1791

On the Swannanoa River, 25 miles southwest of Spruce Pine, a flood in April 1791 was the greatest of which there is any knowledge. The weight of evidence indicates that on that stream it exceeded the severe flood of July 1916 by as much as five feet. With such a great flood in a similar nearby watershed it is very probable that a large flood occurred in the vicinity of Spruce Pine at that time.

Other historical references are found of large floods on the Swannanoa River and French Broad River in the vicinity of Asheville in August 1796, sometime in 1810, and in May 1845. These floods were not so great as that in 1791, and there may or may not have been floods in the vicinity of Spruce Pine at those times.

September 1824

At the time of the May 1901 flood, Colonel William Bayliss, one of the early settlers then living on the Nolichucky River near Embreeville, Tennessee,

52 miles downstream from Spruce Pine, stated that a flood in 1824 was about the same height as the 1901 flood at that point. "The Knoxville Register" of Friday, October 8, 1824, gives the following account of the flood:

> "The accounts from the counties bordering on Nolichucky River are truly melancholy. The Greeneville Economist says the surface of the river was literally covered with property swept from owners. Trees were constantly prostrated by the force of the current. Almost every mill from the source to the mouth of the river was washed away or materially injured. After the water had fallen the body of a man that had been drowned was found in a drift some distance below Jonesboro. . . . . The river is said to have been 15 feet higher than it was ever known to be by the oldest inhabitants living on its borders."

No further information was found on the flood, but it was no doubt a large flood in the Spruce Pine vicinity.

1867-1899

Great floods occurred throughout the upper half of the Tennessee Valley in March 1867. They were the largest floods ever known on the lower Holston, French Broad, and Little Tennessee Rivers and on the Tennessee River itself from Knoxville through Chattanooga.

In February 1875 the Tennessee River at Knoxville had the second highest known flood in its history. The Asheville "Citizen" for March 4, 1875, in reporting on the flood in that vicinity, stated that "the Swannanoa and French Broad Rivers rose so rapidly that persons residing along their banks had to abandon their homes and flee for safety. In many domiciles the water was 3 or 4 feet deep."

The Jonesboro, Tennessee, "Herald and Tribune" of March 4, 1875, reported that "the damage caused by the late freshets which have continued for the last nine days has been the principal topic with all. . . . The bridge over the Nola Chucky at the Red Banks was badly damaged, and will require several hundred dollars to repair it."

A flood on June 17, 1876, was one of the great floods on the upper French Broad River. The flood was less severe on the Swannanoa River.

Floods were general throughout the upper Tennessee Valley during the latter half of March 1899. The Jonesboro "Herald and Tribune" of April 5, 1899, stated that "Chucky is still above its usual condition, having been thus for two weeks. Not since 1867 has it been so high as the recent tide."

Since the floods in 1867, 1875, and 1899 were general over the eastern part of the valley, and since there are definite references to floods on the Nolichucky River, it is probable that floods occurred in the vicinity of Spruce Pine in those years.

May 21, 1901

This is the earliest flood for which definite information could be obtained in the Spruce Pine vicinity. Severe flooding occurred at this time on most of the streams in western North Carolina, particularly those which headed on the eastern and western slopes of the Blue Ridge. On North Toe River from Boonford, 8 miles downstream from Spruce Pine, to the mouth, and along the length of the Nolichucky River this flood exceeded any others which are known.

The heaviest part of the storm appears to have occurred over Mitchell County. The watershed of Cane Creek, 7 miles north of Spruce Pine, was especially hard hit. Cane Creek, with a drainage area of 30.6 square miles, heads against the ridge which forms the northern boundary of the Beaver Creek watershed and the western boundary of the upper North Toe River watershed. The stream flows westward through Bakersville, the seat of Mitchell County, to join the North Toe River at Mile 14.0, 17 miles downstream from Spruce Pine.

The "Engineering News" of August 7, 1902, gives a report of an investigation of the flood on Cane Creek. The account states that at Bakersville, with about 22 square miles of drainage area contributing, the stream rose 11.5 feet above normal low water, about twice the height of any previous flood. The peak discharge was computed at around 30,000 cubic feet per second, or 1340 cubic feet per second per square mile of drainage area. Two persons lost their lives, and 12 homes, a church, and a mill were swept away.

At an official rain gaging station at Marion, 16 miles south of Spruce Pine and 24 miles south of Bakersville, 7.25 inches was reported for a 24-hour period. An unofficial record at Cranberry, 17 miles north of Spruce Pine and 14 miles northeast of Bakersville, gave 8 inches of rain in 12 hours. There were no records of the rainfall in Mitchell County, but the many slides and so-called waterspouts found in the Cane Creek watershed attested to the very heavy precipitation in that area.

The Erwin, Tennessee, "Magnet" of May 29, 1901, stated that "news has reached here of the appalling situation in the back mountain counties of Carter, Johnson, and Unicoi (Tennessee) and Mitchell County, North Carolina. . . . . One hundred homes in Mitchell County are gone. From 500 to 700 people are without food and clothing."

The Clinchfield Railroad had been completed only as far upstream on the Nolichucky River as Unaka Springs, in Tennessee, and there was little or no development along the North Toe River in Spruce Pine in 1901.

Testimony of older residents indicates that the flood was also severe on Beaver Creek and Grassy Creek. Mr. T. S. Greenlee, who observed this and later floods on Grassy Creek, stated that it was not so high as the 1916 flood there, but that water covered all the bottom land and there was very heavy damage to the land by washing and scouring. Mrs. M. L. Swann saw the flood on Beaver Creek and says she believes the flood was the highest ever known there.

July 16, 1916

This was the highest flood known in this century on North Toe River and on Grassy Creek and one of the highest on Beaver Creek. 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, the highest amount for the entire storm area being reported from Altapass, 4 miles southeast of Spruce Pine. There were two rain gages at Altapass located about one mile apart, one on the east slope and one on the west slope of the Blue Ridge. The east-slope gage recorded 23.7 inches during the storm period. The west-slope rain gage record showed 22.2 inches for the 24-hour period ending at 2 p.m. on July 16. Rainfall amounts decreased rapidly to the west of the Blue Ridge. Forty miles west of Altapass the total fall was less than one inch. At Asheville 2.85 inches fell during the storm period. General rains had fallen over the area a week earlier, putting most of the streams out of their banks. The streams had been receding only a few days from this rise when the great storm of July 15-16 hit.

Water was several feet deep over the tracks of the Clinchfield Railroad in Spruce Pine. Stores and buildings were flooded in the business development that had sprung up along what is now Locust Street in the period following the coming of the railroad. A house located between the railroad and the river, occupied by the railroad section foreman and his family, was flooded and heavily damaged.

The hydroelectric plant of the Harris Electric Company had been built only a few years earlier at Mile 29.69, just below the lower corporate limit of Spruce Pine. Generators located at the left end of the dam supplied power to customers in the Spruce Pine area and to the plant of the Harris Clay Company, then located just downstream from the dam. The powerhouse was flooded and the generators so badly damaged that they had to be sent back to the factory for repairs.

The Clinchfield Railroad had severe losses in the flood. The track was almost completely wrecked from Spruce Pine downstream to Unaka Springs, near Erwin, Tennessee. Tracks were in some places thrown to the opposite bank or carried several hundred feet downstream. Fills were badly washed. On the slopes of the Blue Ridge south of Altapass there were even more costly losses, with many large slides and washouts. It was August 23, 1916, before service was fully restored through Spruce Pine. Consideration was given by the railroad to raising the track grade along North Toe River to an elevation above the 1916 flood crest, but the idea was abandoned as too costly. In the years since 1916 the grade of the roadbed has been raised somewhat so that it is now generally about 1 to 2 feet higher than it was before the 1916 flood.

The 1916 flood exceeded the flood of May 1901 by about one foot near the site of the Altapass stream gage and by more than one foot in the Spruce Pine business district, according to the older residents who were interviewed by TVA engineers in 1937.

High water marks for the 1916 flood indicate that Cathis Creek, Grassy Creek, and Beaver Creek must have contributed extremely high flows to the North Toe flood in that reach so that the peak discharge at Spruce Pine approached that of the Regional Flood. At Altapass the 1916 flood was about three feet higher than the mid-August 1940 flood but would be several feet below a Regional Flood, but at Spruce Pine the 1916 flood was 8 feet higher than the mid-August 1940 flood and 2 feet below a Regional Flood. Downstream from Spruce Pine tributary inflows were lower because of the lighter rainfall west of the Blue Ridge, and the profile of the 1916 flood falls off in relation to the 1901 flood and the Regional Flood profiles.

On Grassy Creek the flood was the highest known, in the opinion of Mr. T. S. Greenlee. The relation of the 1916 flood to the other large floods on Beaver Creek is not known, but it undoubtedly was a serious flood on that stream also.

August 13, 1940

Two large floods affected the mountain headwaters of the Tennessee Valley in August 1940, but the first of these, on August 13, was the only one of consequence in the Spruce Pine vicinity. This flood resulted from a tropical storm, as did the flood of July 1916. In this case the storm center moved inland at Savannah, Georgia, on August 11, then described a large circle to the west and north, bringing heavy rains to much of the southeast. For the Tennessee Valley, the heaviest rainfall occurred along the crest of the Blue Ridge and the adjacent area on the northwest slope. At Mount Mitchell, 15 miles southwest of Spruce Pine, 14.33 inches was recorded for the storm. Rainfall exceeded 10 inches all along the crest of the Blue Ridge from Spruce Pine north to Newland, at the head of North Toe River. From the Blue Ridge, amounts decreased westward to 5.06 inches at Bakersville and 4.69 inches at Tipton Hill.

Streams began rising early Tuesday morning August 13. The crest occurred at Plumtree at 5 p.m., at the Altapass stream gage at 9:30 p.m., and at Spruce Pine at 10 p.m.

In the order of magnitude the flood ranks next below the 1916 and 1901 floods on North Toe River at Spruce Pine. The flood crest was 2.6 feet below a high water mark of the 1916 flood at the Altapass stream gage. At the Clinchfield Railroad station in Spruce Pine the difference was 7.4 feet. Flood waters did not enter the Spruce Pine business district. The tracks of the railroad were not overflowed at Spruce Pine or elsewhere along the North Toe River, but there were numerous slides and damage to fills. About one mile of the track was washed out along the Nolichucky River and there was heavy damage on the slope of the Blue Ridge south of Altapass. The railroad was out of service until August 19. Telephone service was disrupted to the area for about 24 hours, and commercial and farm property and crops were damaged above the study reach.

On Beaver Creek the flood was next highest to the 1901 flood, according to Mrs. M. L. Swann. On Grassy Creek the flood was about equal to the 1901 flood

as recalled by Mr. T. S. Greenlee. The damage was not extensive on either stream, according to the accounts of the flood in the Spruce Pine "Tri-County News".

August 30, 1940

At the Altapass stream gage this flood was 9.4 feet lower than the mid-August flood. At the railroad station in Spruce Pine the difference was about 4 feet.

September 30, 1959

This was a minor flood on North Toe River, only slightly higher than the August 30, 1940, flood and about equal to several other floods in the period since 1940. There was no overflow of consequence in the Spruce Pine vicinity.

August 24, 1961

This was the highest flood since August 13, 1940, in the vicinity of Spruce Pine. At the Altapass stream gage the flood was 3.3 feet lower than the mid-August 1940 flood and in Spruce Pine it was about 6 feet lower than that flood.

The North Toe River had little overflow, but on Beaver Creek and Grassy Creek the flooding was more serious.

Along Beaver Creek basements were flooded and several of the lightly built foot bridges and private bridges were washed out or damaged. The bridge at Ward Street, Mile 0.42, was carried away and at the state-maintained bridge at Gulf Street, Mile 0.06, one of the abutments was undermined. Water overflowed the trailer court at Mile 0.8, but did not reach the floors of the trailers. Bottom lands were overflowed along Grassy Creek and the flood waters came close to overflowing N. C. Highway 226 at the Grassy Creek Baptist Church.

March 12-13, 1963

This flood was 1.5 feet lower than the August 1961 flood on North Toe River at the Altapass stream gage. Beaver Creek and Grassy Creek were not out of their banks during this rise.

2. BEAVER CREEK VALLEY

The Stream and Its Valley

Beaver Creek drains a long, narrow, ruggedly mountainous area of 5.34 square miles which lies to the north of Spruce Pine and is wholly within Mitchell County. The watershed, shown on Plate 1, is rectangular in shape, 5 miles in length and about one mile wide over the greater part of its length. Steep ridges bound the heavily wooded upper half of the watershed with Wolfden Ridge, The Lookoff, Bailey Meadows, and Little Bald on the right or west side, and Dogwood Flats, Hickory Flats, and Big Bald on the left or east side. Elevations around the upper basin rim range from about 3600 feet up to 5307 feet at Big Bald at the upper tip of the watershed. Along the lower half of the watershed the bounding ridges range in elevation between 2800 and 3600 feet.

Beaver Creek rises in Wiggins Cove, on the slopes of Little Bald and Big Bald Mountains, at a valley floor elevation of about 4000 feet. The stream drops 1000 feet in the first two miles of its course. Beaver Creek flows generally southward from the head to its confluence with Biggerstaff Branch in Spruce Pine, where it turns southwestward for one mile to join the North Toe River at Mile 31.89. The lower 1.80 miles of the stream channel is within the corporate limits of Spruce Pine. Hanging Rock Branch, the largest tributary of Beaver Creek, enters on the left bank at Mile 1.33.

This investigation covers Beaver Creek from its confluence with Hanging Rock Branch to the mouth. In this reach the stream channel falls from an elevation of 2604 feet to elevation 2499 feet with an average slope of 79 feet per mile. This is about twice that of Grassy Creek and six times that of the North Toe River at Spruce Pine. The flood-plain width varies from about 150 feet at the upper end of the reach to about 500 feet at Mile 0.30. From the mouth of Biggerstaff Branch, Mile 1.01, downstream to Mile 0.5, where the greatest development is found, the flood plain is generally about 300 feet wide. From Mile 0.5 to the mouth the width is about 300 feet to 500 feet.

Pertinent drainage areas of Beaver Creek are given in Table 6.

TABLE 6

DRAINAGE AREAS IN WATERSHED OF BEAVER CREEK

Stream	Location	Mile above Mouth	Drainage Area sq. mi.
Beaver Creek	Mouth	0.0	5.34
	U. S. Highway 19E	1.00	4.76
	Upper limit of study (below mouth of Hanging Rock Branch)	1.33	4.30

Developments on the Flood Plain

Plate 5 shows the flood plain of Beaver Creek for the reach covered by this investigation. The relatively small amount of land in the flood plain that is not used for residential or commercial developments is idle.

The Clinchfield Railroad crosses Beaver Creek on a high fill just above the confluence with North Toe River, at Mile 0.03.

U. S. Highway 19E follows the right-bank flood plain of Beaver Creek from Mile 0.40 to Mile 1.00, where it crosses the stream to leave the watershed by way of Biggerstaff Branch. The lowest sections of the highway were two feet above the 1961 flood, but would be up to 8 feet under a Regional Flood and 11 feet under a Maximum Probable Flood.

Beaver Creek Road follows the right bank from the junction with U. S. Highway 19E at Mile 1.00 through the upper end of the study reach out of the corporate limits of Spruce Pine. It would be flooded up to 10 feet deep by a Regional Flood and 12 feet deep by a Maximum Probable Flood. A number of streets cross the flood plain and creek; Hanging Rock Road at Mile 1.29, Cabin Road at Mile 1.07, Ward Street at Mile 0.42, Gulf Street at Mile 0.06, and Altapass Highway at Mile 0.04.

A woodworking shop is on the left bank at Cabin Road. A small planing mill is on the right bank above U. S. Highway 19E. A grocery store at the upstream side of U. S. Highway 19E at Beaver Creek Road has a basement at flood plain level. The floors are 7 feet above the 1961 flood, but 5 feet below the Regional Flood and 7 feet below the Maximum Probable Flood.

An oil bulk plant is just downstream from the U. S. Highway 19E crossing, at Mile 0.96. The low point in the plant area is at a pump base, at elevation 2582.7 feet. The warehouse floor is at elevation 2589.5 feet. The 1961, Regional, and Maximum Probable Flood elevations at that point are 2580.7, 2590.7, and 2593.5, respectively.

A trailer court occupies low ground between the creek and U. S. Highway 19E between Mile 0.85 and Mile 0.79. The 1961 flood was one foot deep in the court. A Regional Flood would be ten feet deep and a Maximum Probable Flood would be almost three feet higher.

Business developments have taken up practically all of the Beaver Creek flood plain along U. S. Highway 19E in the reach from Mile 0.76 to Mile 0.60. The stream channel has been relocated and overbank flow conditions have been affected by grading and filling at the building sites. Now located in this reach are two automobile sales agencies, an auto frame shop, a tire recapping shop, two service stations, a department store, a super market, and a grocery store. The floor levels of these buildings are near that of the highway. The restrictive effect of the buildings and the filling in the area would tend to increase the height of a flood such as that of July 1916, should it recur under present conditions, and serious flooding would result. The 1961 flood lacked only a few inches from reaching one service station, but was two or more feet below the floors of the other buildings. A Regional Flood would be 8 feet deep in the service station and 2 to 6 feet deep in the others. A Maximum Probable Flood would be over 2 feet higher. Figure 8 shows this development.

A machine shop at Mile 0.55 would be affected by any overbank flood. The floor is 2 feet above the 1961 flood, but 9 feet below the Regional Flood and over 11 feet below the Maximum Probable Flood. A lumber and building materials firm on the right bank at Mile 0.14 has a warehouse floor at elevation 2523.7 feet. Regional and Maximum Probable Flood elevations would be near 2537 and 2539, respectively. An oil bulk plant on the left bank at Mile 0.10 is located above the flood plain.

Several residences are at low enough elevations to be affected by large floods on Beaver Creek.

For a number of years there was a small concrete dam at Mile 0.44 on Beaver Creek, just above the Ward Street bridge. At the original crest elevation water was backed up about 750 feet, to Mile 0.59. The section of the dam at the

stream channel has been removed, but the remains of the dam would still cause heading up during large floods if it remained in place.

Bridges across Beaver Creek

Six highway bridges, three private road bridges, one railroad bridge, and three footbridges cross Beaver Creek in the 1.33 miles covered by this investigation. Table 7 lists pertinent elevations for the bridges and shows their relation to the flood of August 1961. Plate 7 shows the relation of the floor and underclearance at the bridges to the flood profiles for the reach. Figures 9 to 13 are photographs of the bridges.

The Clinchfield Railroad crosses Beaver Creek at an arch-type concrete culvert just above the confluence of the creek with North Toe River. The culvert, shown in Figure 9, is 24 feet wide and 11 feet high at the center of the opening. A fill blocks the flood plain to a height of some 25 feet above the stream bed. Flooding of the tracks begins on the right bank about elevation 2526 feet.

Less than 100 feet upstream from the railroad culvert, the Altapass Highway crosses Beaver Creek on an almost identical structure. A relatively low approach fill crosses the flood plain at this point. Just above this bridge, Gulf Street crosses on a steel girder, wood floor bridge. The underclearance of this bridge is slightly lower than that at either of the two culverts downstream, but the net opening under the bridge is somewhat greater than at the culverts.

The bridge at Ward Street is a log and wood structure. Approach fills block the narrow flood plain up to heights of 6 feet.

Private bridges at Miles 0.55 and 0.66, which serve residences on the left bank, have steel girders and wood floors. Fills for the highway and the business developments along the highway block the right-bank flood plain.

U. S. Highway 19E crosses Beaver Creek at a three-opening concrete box culvert at Mile 1.00. A fill across the flood plain, 450 feet wide at this point, has an average height of about 10 feet. Overflow at the bridge begins when water overtops the highway at elevation 2592.9 feet.

The Cabin Road bridge at Mile 1.07 originally carried U. S. Highway 19E traffic before the route was relocated downstream. This is a concrete girder structure of one span, with approach fills across the narrow flood plain. Use of the

TABLE 7

BRIDGES ACROSS BEAVER CREEK

Mile above Mouth	Identification	Low Water Elev. feet	Floor Elev. feet	Regional Flood Crest Elev. feet	Aug. 24, 1961 Flood Crest Elev. feet	Underclearance Elev. feet	Above Flood feet	Below Flood feet
0.03	Clinchfield R.R.	2503.8	2527.6	2535.6	2511.4	2514.6	3.2	
0.04	Altapass Highway	2504.7	2517.3	2535.6	2512.0	2513.7	1.7	
0.06	Gulf Street	2505.6	2514.1	2535.6	2512.9	2512.2		0.7
0.17	Footbridge	2510.3	2513.8	2538.3	2517.1	2513.2		3.9
0.42	Ward Street	2533.6	2539.2	2549.2	2538.6	2538.0		0.6
0.55	Private road	2541.7	2551.7	2561.2	2549.9	2550.2	0.3	
0.66	Private road	2552.6	2561.2	2569.8	2561.1	2560.1		1.0
0.76	Footbridge	2558.6	2563.2	2574.2	2565.1	2562.2		2.9
1.00	U.S. Highway 19E	2577.4	2593.2	2601.0	2588.0	2587.2		0.8
1.07	Cabin Road	2584.9	2596.7	2604.2	2589.6	2594.0	4.4	
1.16	Private road	2589.3	2596.7	2607.0	2593.9	2595.5	1.6	
1.25	Footbridge	2596.6	2604.0	2612.9	2600.5	2602.7	2.2	
1.29	Hanging Rock Rd.	2599.3	2609.0	2618.9	2605.2	2607.6	2.4	

bridge is affected when water overflows the road at the left side of the flood plain, at elevation 2596.2 feet.

A private bridge at Mile 1.16, a log girder, wood floor type, is built at top-of-bank elevation, and would be carried away in any overbank flood.

The bridge at Hanging Rock Road, Mile 1.29, is a steel girder, wood floor structure with a fill on the narrow left-bank flood plain. Use of the bridge is affected when water overflows Beaver Creek Road at the right end of the bridge, at elevation 2607.4 feet.

Footbridges at Miles 0.17, 0.76, and 1.25 are all lightly built types made of logs and are set at top-of-bank elevation. A large flood would wash them away.

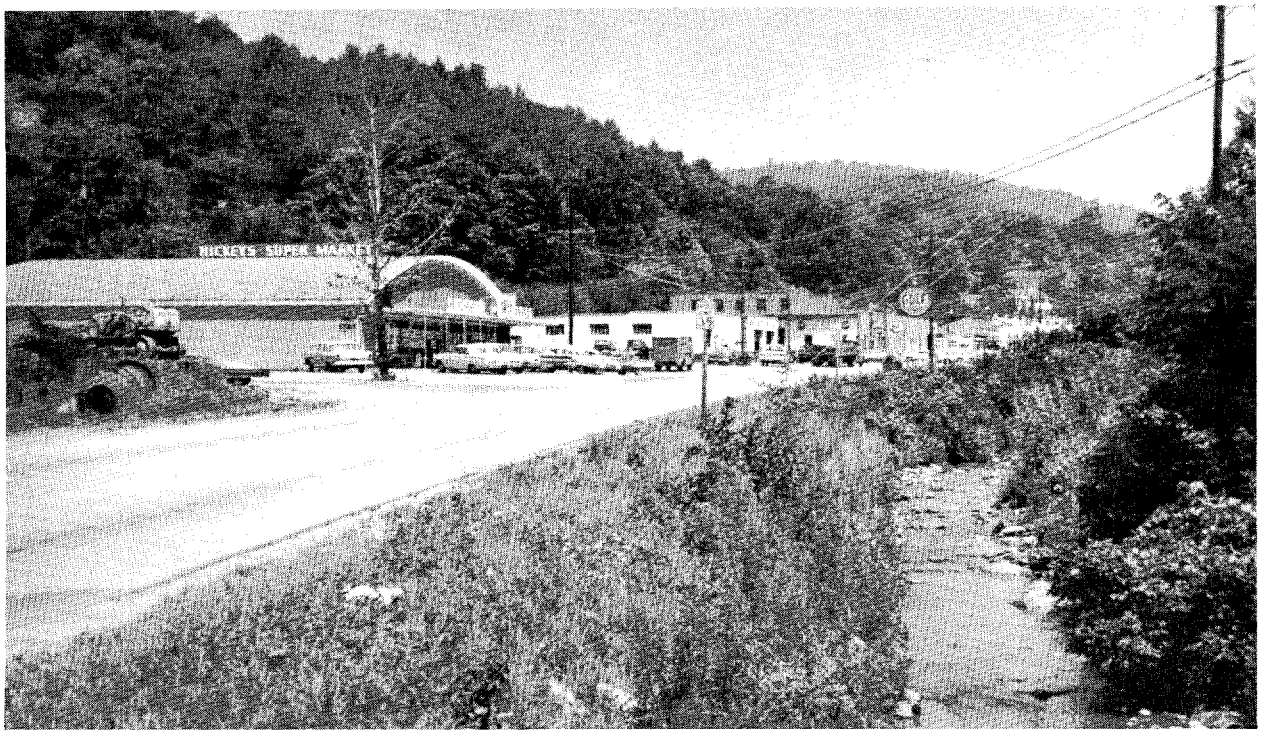

Figure 8.--COMMERCIAL DEVELOPMENT ON BEAVER CREEK

View upstream along creek channel and U. S. Highway 19E from Mile 0.6.

Figure 9.--CLINCHFIELD RAILROAD CULVERT OVER BEAVER CREEK

This view of upstream side of the culvert shows the small opening which, with the railroad fill, controls the flow in the lower reaches of the creek. The creek mouth is just below the culvert.

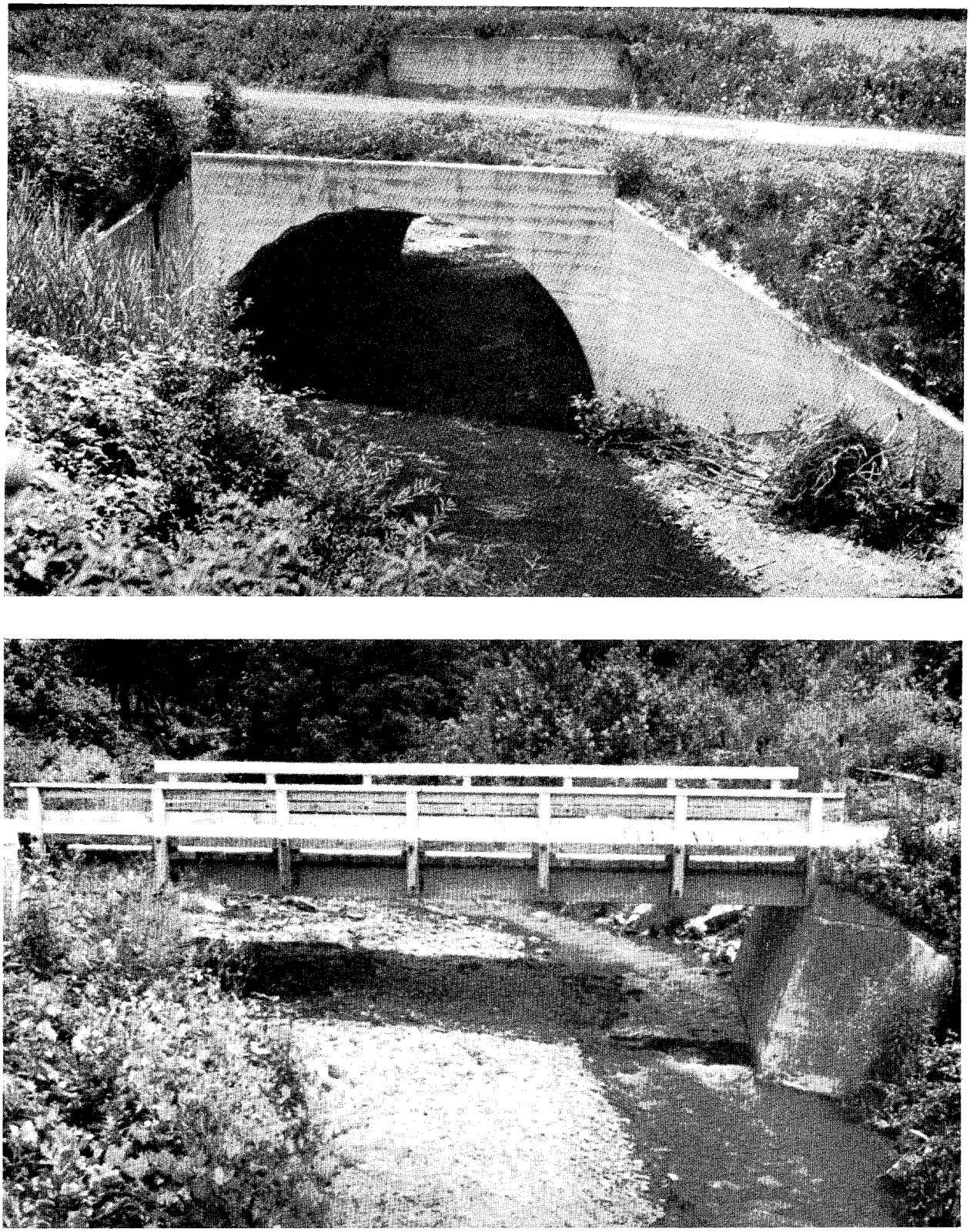

Figure 10.--HIGHWAY BRIDGES NEAR MOUTH OF BEAVER CREEK

Upper view is the Altapass Highway bridge at Mile 0.04, upstream side. The headwall of the railroad culvert in Figure 9 can be seen in background. These two culvert openings are the same size. Lower view shows the Gulf Street bridge, downstream side, at Mile 0.06.

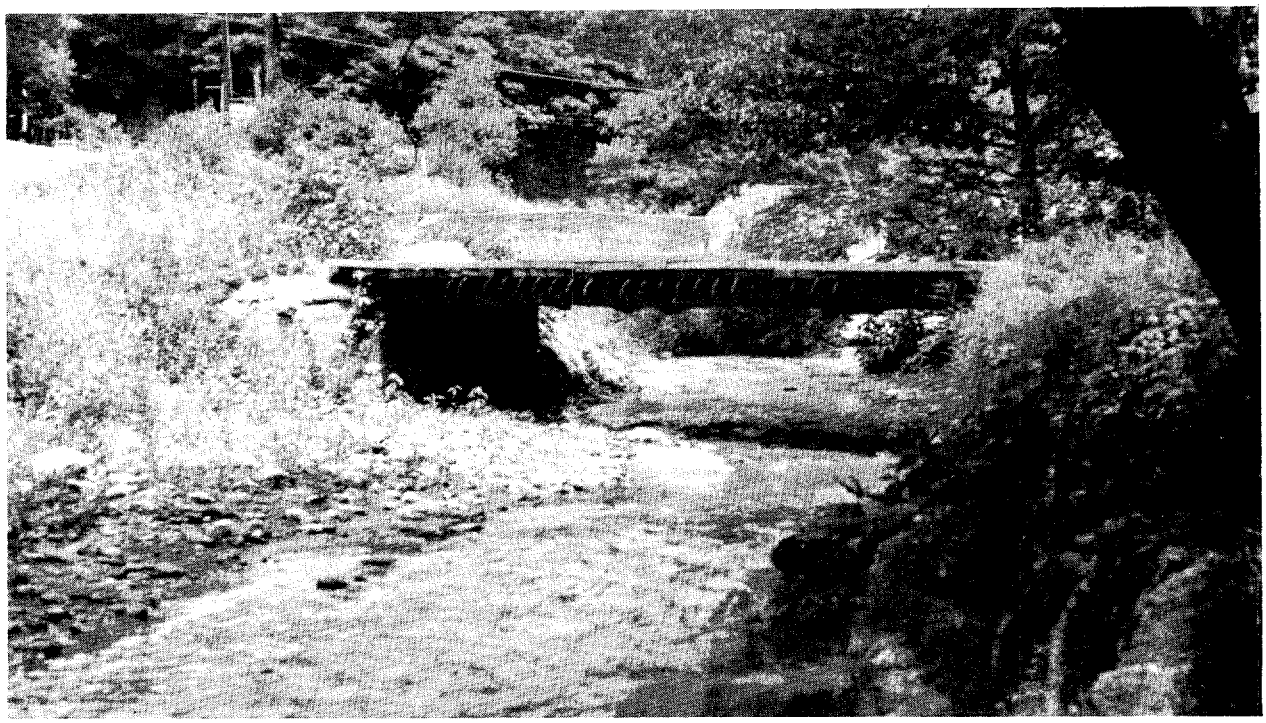

Figure 11.--WARD STREET BRIDGE OVER BEAVER CREEK

View upstream toward log and plank bridge at Mile 0.42. In the background is an old concrete dam of which a section at the channel is gone; the remainder is broken and would probably be washed out by a large flood.

Figure 12.--U. S. HIGHWAY 19E BRIDGE OVER BEAVER CREEK

This 3-opening box culvert at Mile 1.00, seen from upstream, accumulates debris which remains to obstruct the waterway for subsequent high flows.

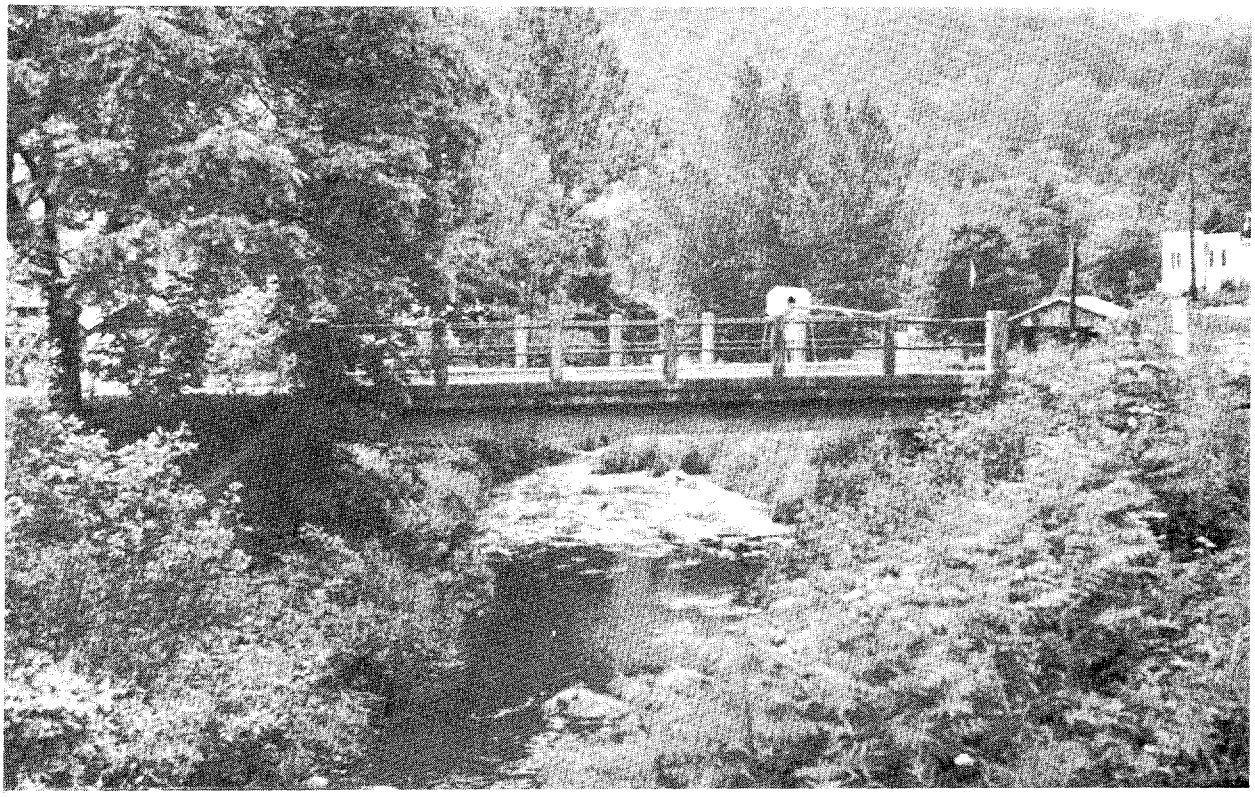

Figure 13.--MINOR BRIDGES ON BEAVER CREEK ABOVE SPRUCE PINE

Upper view shows the upstream face of Cabin Road bridge at Mile 1.07. This concrete bridge was built in 1921. Lower view is the downstream side of Hanging Rock Road bridge at Mile 1.27.

During the August 1961 flood heading up at the bridges was negligible except at the U. S. Highway 19E bridge where the constricted opening raised the flood crest about three feet. During a Regional Flood slight heading up would occur at the Ward Street bridge and at the private road bridge at Mile 0.55. Heading up at Cabin Road and Hanging Rock Road would be near three feet, and at U. S. Highway 19E heading up of almost six feet would occur. During a Maximum Probable Flood the effect of the bridges would be about the same or slightly less than during a Regional Flood.

Obstructions to Flood Flow

The effect of the obstructions due to the bridges and their approach fills and to the buildings and the grading and filling along the Beaver Creek flood plain have been described in the previous sections. The net effect of these changes would be to make a major flood, such as that of July 1916, higher than it would be under natural or undisturbed conditions.

FLOOD SITUATION

Flood Records

There are no records of stream stages or discharges available for Beaver Creek. Information on floods was obtained from interviews with the local residents and from a search of newspaper files and historical records. TVA engineers were able to obtain detailed information in the field to establish the flood profiles for the floods of August 24, 1961, and March 12-13, 1963.

Flood Occurrences

The investigation indicates that major floods have occurred at about the same frequency on Beaver Creek as on North Toe River.

Duration and Rate of Rise

Small, steep, mountainous watersheds, such as that of Beaver Creek, produce floods that are characterized by very rapid rates of rise and short duration. A flood such as that of August 1961 would rise 4 feet in one hour and would remain out of banks for 4 hours.

Velocities

Along Beaver Creek in the reach investigated, velocities in the channel during floods such as that of 1961 would range up to 10 feet per second, and in the overbank areas velocities would be as high as 4 feet per second. During larger floods, velocities would be greater.

Flooded Areas, Flood Profiles, and Cross Sections

Plate 5 shows the approximate area along Beaver Creek that was inundated by the flood of August 1961 and that would be inundated by the Maximum Probable Flood. The actual limits of the overflow area on the ground may vary somewhat from that shown on the map because the contour interval of the map does not permit precise plotting of the flooded area boundaries. The contour interval on Plate 5 is 40 feet.

Plate 7 shows the high water profile on Beaver Creek for the flood of August 1961. Also shown are the profiles for the Regional and Maximum Probable Floods, which are discussed in Sections III and IV of this report.

Plate 9 shows typical cross sections of Beaver Creek in the reach investigated. The locations of the sections are shown on the map, Plate 5, and the profile, Plate 7. Each cross section shows the elevation and extent of overflow of the 1961 flood and the Regional and Maximum Probable Floods.

FLOOD DESCRIPTIONS

Descriptions of the large floods on Beaver Creek are included with the discussion of past floods on North Toe River.

3. GRASSY CREEK VALLEY

The Stream and Its Valley

Grassy Creek drains an area of 11.4 square miles which lies wholly within Mitchell County. The watershed, shown on Plate 1, is fan-shaped, $3\frac{1}{2}$ miles long by 4 miles at the widest point. It is bounded on the south by the Blue Ridge, on the east by Carter Ridge, and on the west by Rich Knob, Woodys Knob, and

Chalk Mountain. Elevations around the basin rim range from 2800 to 3800 feet on the Blue Ridge, from 2800 to 3200 feet along Carter Ridge, and on the west from 3000 up to 4170 feet at Woodys Knob, the highest point in the watershed.

Two principal streams make up the headwater drainage system, Grassy Creek and East Fork. East Fork heads up at Gillespie Gap, on the Blue Ridge, and flows northward. Grassy Creek is formed at McCall Gap, in the southwest corner of the basin, and flows northeastward to its confluence with East Fork near Grassy Creek Baptist Church, near the middle of the basin. Grassy Creek flows generally northward from its confluence with East Fork to its mouth in the North Toe River in Spruce Pine. The lower 0.24 mile of the stream channel is within the corporate limits of Spruce Pine.

Between the confluence with East Fork and the mouth, the reach covered by this investigation, the stream channel falls from elevation 2608 feet to elevation 2508 feet, a fall of 100 feet in 2.59 miles with an average slope of 39 feet per mile. Over the lower 0.8 mile, where the stream follows a narrow wooded valley, the rate of fall is 56 feet per mile. Above Mile 1.0 the stream flows through broad bottom lands, with a channel slope of about 31 feet per mile.

Rockhouse Creek and Graveyard Creek join Grassy Creek in the study reach, both on the left bank. Rockhouse Creek rises on the steep slopes of Woodys Knob and enters the stream at Mile 1.65. Graveyard Creek rises between Woodys Knob and Chalk Mountain, at the northwest corner of the basin, and joins Grassy Creek at Mile 0.95.

Flood-plain widths vary from about 100 to more than 1000 feet. At the upper end of the study reach, Mile 2.59, the flood plain is about 800 feet wide and narrows to about 300 feet at Grassy Creek Baptist Church, Mile 2.23. From here to about Mile 1, the flood-plain width varies from 500 to more than 1000 feet, the widest place being near the confluence of Rockhouse Creek. From Mile 1 to the mouth, the stream flows through a gorge with widths of about 100 feet.

Pertinent drainage areas of Grassy Creek are given in Table 8.

Developments on the Flood Plain

Plate 5 shows the flood plain of Grassy Creek for the reach covered by this investigation. The flood-plain land below Mile 0.8 is largely wooded. Above Mile 0.8 the flood-plain land is used mostly for agriculture.

TABLE 8

DRAINAGE AREAS IN WATERSHED OF GRASSY CREEK

Stream	Location	Mile above Mouth	Drainage Area sq. mi.
Grassy Creek	Mouth	0.0	11.4
	Carter Ridge Road	0.97	9.50
	Upper limit of study (below mouth of East Fork)	2.59	6.20

The Blue Ridge Parkway follows the crest of the Blue Ridge where it forms the upper basin divide of the Grassy Creek watershed. The route is bringing increased tourist travel to the area. North Carolina Highway 226 passes in a north-south direction through the Grassy Creek watershed. At Gillespie Gap, where the highway crosses the Blue Ridge, it provides access to the Blue Ridge Parkway. From Gillespie Gap, Highway 226 follows East Fork to the confluence with Grassy Creek, crosses from the right bank to the left bank of Grassy Creek at Grassy Creek Baptist Church, then follows the left bank to a point near the Spruce Pine corporate limits. Through the reach the highway is two or more feet higher than the 1961 flood except at the bridge and immediately above; however, a Regional Flood would cover the highway with depths up to 8 feet, and a Maximum Probable Flood would reach depths up to 12 feet.

Carter Ridge Road crosses the flood plain and stream at Mile 0.97, providing access from N. C. Highway 226 to a garment manufacturing plant and a developing residential area on Carter Ridge. The plant of the Spruce Pine Manufacturing Company is on high ground opposite Mile 1.4, but access to the plant would be limited during large floods.

A number of developments along North Carolina Highway 226 provide services for local residents and the tourists of the area. These include a store and service station at Mile 2.18, a gem shop at Mile 2.15, and a woodworking shop at Mile 2.10. All of these are 2 to 5 feet above the 1961 flood but 3 to 6 feet below the Regional Flood, and 6 to 9 feet below the Maximum Probable Flood. A chair manufacturing shop on the left bank at Mile 1.57 is high enough to be above flood danger.

The Spruce Pine Golf Course occupies the rolling ground at the west side of N. C. Highway 226 in the reach from Mile 1.5 to Mile 0.9. Most of the development is out of the flood plain of Grassy Creek and not subject to flooding to any important extent.

A recent development is the Pine Valley Bowling Lanes, on the left-bank flood plain just above Carter Ridge Road, at Mile 1.05. The building is between the highway and creek, on ground which has been filled to the elevation of N. C. Highway 226. The floor is at elevation 2576.8 feet, 5.6 feet above the height reached by the flood of August 1961, but 2 feet and 5 feet, respectively, below the Regional Flood and the Maximum Probable Flood. The building is shown in Figure 14.

A concrete dam at Mile 0.30, owned by the Feldspar Corporation, supplies water for their plant on North Toe River near the mouth of Grassy Creek. The dam is 11 feet high and 95 feet long. Backwater from the dam extends upstream to Mile 0.47, about 900 feet. A 10-inch pipeline carries water from the dam to the plant site. During the 1963 flood there was a 7-foot drop in the water surface at the dam, but its effect diminishes with increases in flow so that during a Regional Flood there would be a drop of only 3 feet. Figure 15 is a view of the dam.

Two residences on the left bank near Mile 2 are within the reach of large floods on Grassy Creek. The Regional and Maximum Probable Floods would flood them to depths of more than 6 and 9 feet, respectively. The other residences in the reach are on higher ground out of the flood plain. Grassy Creek Baptist Church is also out of flood danger.

Bridges across Grassy Creek

Two highway bridges cross Grassy Creek in the reach covered by this investigation. Table 9 lists pertinent elevations for these bridges and shows their relation to the flood of August 1961. Plate 8 shows the relation of the floor and underclearance at the bridges to the flood profiles for the reach. Figure 16 shows photographs of the bridges.

The Carter Ridge Road bridge at Mile 0.97 is a one-span, steel girder, wood floor structure. Approach fills which range from 5 to 9 feet in height block all the right-bank flood plain, and the left-bank flood plain between N. C. Highway 226 and the stream. Use of the bridge is affected when water overflows the right end at elevation 2568.6 feet. The bridge was overtopped during the 1961 flood, but heading up is negligible during floods.

TABLE 9

BRIDGES ACROSS GRASSY CREEK

Mile above Mouth	Identification	Low Water Elev. feet	Floor Elev. feet	Regional Flood Crest Elev. feet	Aug. 24, 1961 Flood Crest Elev. feet	Underclearance Elev. feet	Above 1961 Flood feet	Below 1961 Flood feet
0.97	Carter Ridge Road	2559.0	2568.7	2577.4	2569.2	2566.2		3.0
2.23	N. C. Highway 226	2595.6	2607.2	2615.0	2606.9	2600.9		6.0

North Carolina Highway 226 crosses Grassy Creek on a three-opening box culvert at Mile 2.23. The highway fill, 4 to 6 feet high at this point, crosses the flood plain at an angle. Water will overflow the right edge of the highway at elevation 2606.6 feet. A Regional Flood would overtop the bridge by 8 feet, and heading up of about 2 feet would occur during large floods.

Obstructions to Flood Flow

The effect of the obstructions due to the bridges and their approach fills has been described in the previous section. The effect of the dam in the undeveloped lower reach of the stream has also been described.

North Carolina Highway 226 is on fill practically the full length of its route along the Grassy Creek flood plain, and the bowling lane development at Mile 1.05 is on filled land. Such restrictions of the flood plain can be expected to affect flood heights on Grassy Creek to some degree.

FLOOD SITUATION

Flood Records

There are no records of stream stages or discharges available for Grassy Creek. Information was obtained from interviews with local residents and from a search of newspaper files and historical records. TVA engineers were able to obtain detailed information in the field to establish the flood crest profiles for the floods of August 24, 1961, and March 12-13, 1963.

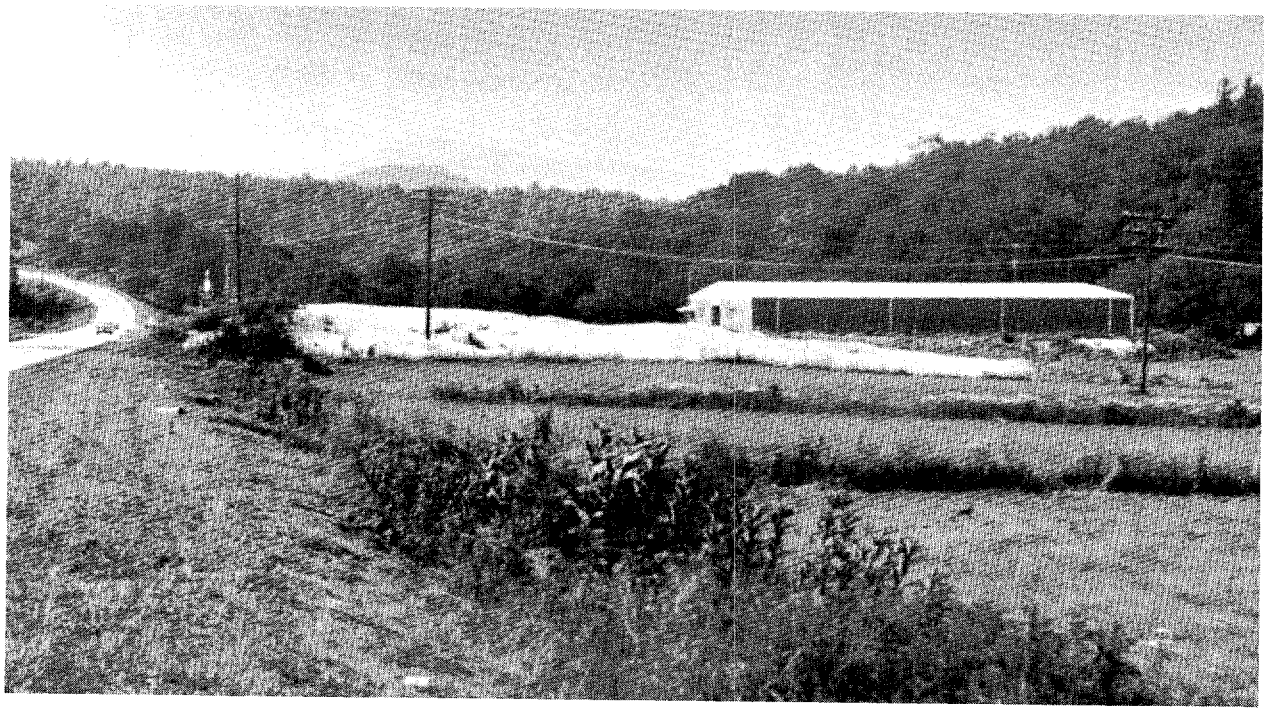

Figure 14.--BOWLING ALLEY IN GRASSY CREEK FLOOD PLAIN

This building is built on a fill near left bank of Grassy Creek. The view is downstream along North Carolina Highway 226.

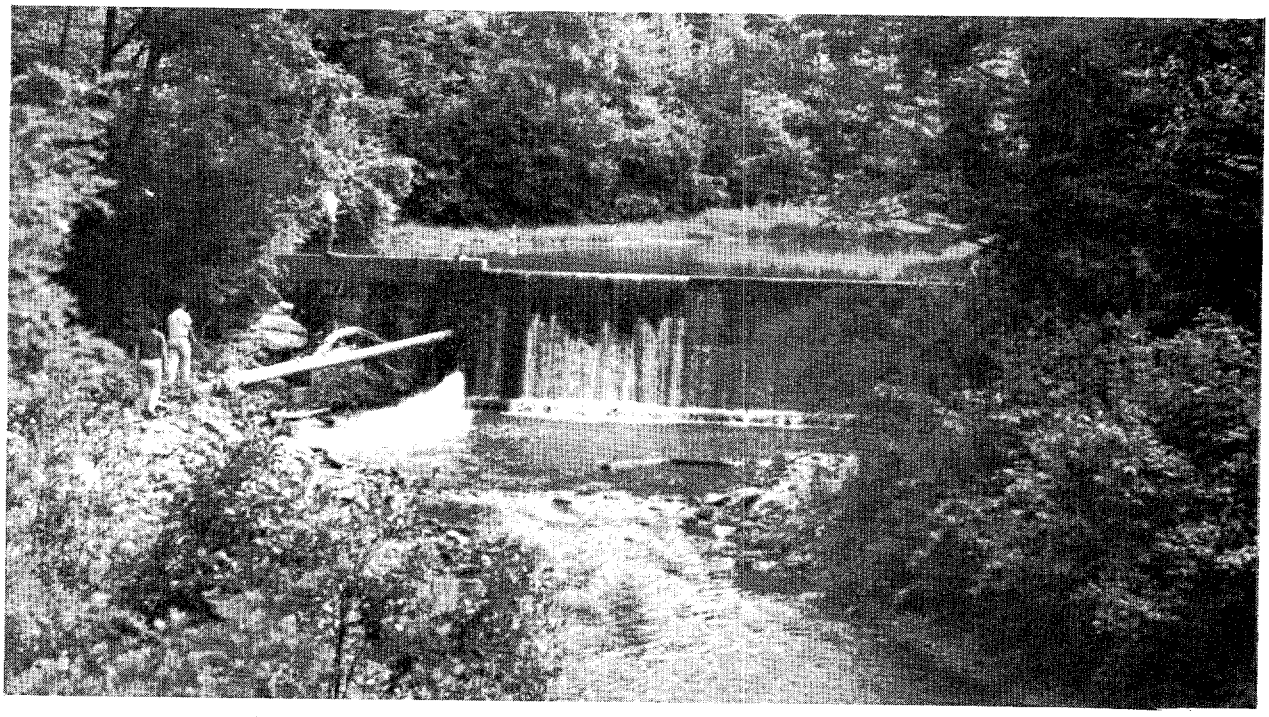

Figure 15.--GRASSY CREEK DAM AT MILE 0.30

This concrete dam is owned by the Feldspar Corporation. The reservoir is a source of clear water for mineral processing. A 10-inch pipe from the reservoir carries water to the plant located on the right bank of the North Toe River near the mouth of Grassy Creek.

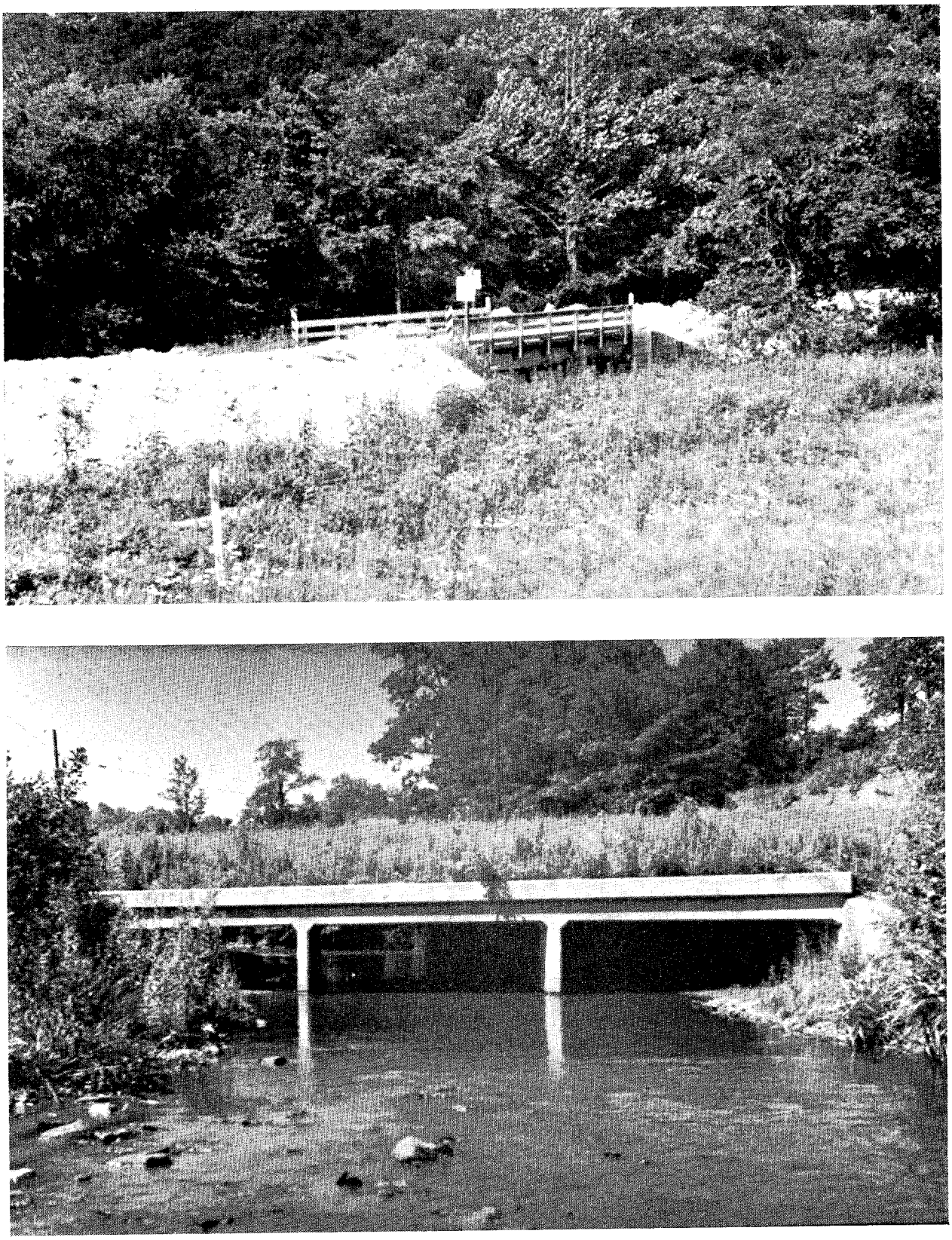

Figure 16.--GRASSY CREEK BRIDGES

Upper view shows the bridge on Carter Ridge Road over Grassy Creek at Mile 0.97, as seen from left bank toward the northwest. Lower view is the downstream side of the North Carolina Highway 226 bridge at Mile 2.23.

Flood Occurrences

The investigation indicates that major floods on Grassy Creek occur at about the same frequency as those on North Toe River.

Duration and Rate of Rise

Small mountainous watersheds such as that of Grassy Creek produce floods that are characterized by very rapid rates of rise and short duration. A flood such as that of August 1961 would rise 4 feet in one hour and remain out of banks for 5 hours.

Velocities

Along Grassy Creek in the reach investigated, velocities in the channel during floods such as that of 1961 would range up to 9 feet per second, and in the overbank areas velocities would be as high as 3 feet per second. During larger floods, velocities would be greater.

Flooded Areas, Flood Profiles, and Cross Sections

Plate 5 shows the approximate area along Grassy Creek that was inundated by the flood of August 24, 1961, and that would be inundated by the Maximum Probable Flood. The actual limit of the overflow area on the ground may vary somewhat from that shown on the map because the contour interval of the map does not permit precise plotting of the flooded area boundaries. The contour interval on Plate 5 is 40 feet.

Plate 8 shows high water profiles on Grassy Creek for the floods of August 1961 and March 12-13, 1963. Also shown are the profiles for the Regional and Maximum Probable Floods, which are discussed in Sections III and IV of this report.

Plate 9 shows typical cross sections of Grassy Creek in the reach investigated. The locations of the sections are shown on the map, Plate 5, and the profile, Plate 8. Each cross section shows the elevation and extent of overflow of the 1961 flood and the Regional and Maximum Probable Floods.

FLOOD DESCRIPTIONS

Descriptions of the large floods on Grassy Creek are included with the discussion of past floods on North Toe River.

III.

REGIONAL FLOODS

III.

REGIONAL FLOODS[1]

This section of the report relates particularly to floods on streams whose watersheds are comparable with those of North Toe River and Beaver and Grassy Creeks.

Large floods have been experienced in the past on streams in the general geographical and physiographical region of Spruce Pine, North Carolina. Heavy storms similar to those that caused these floods could occur over the watersheds of the North Toe River and its tributaries. In this event, floods would result on these streams comparable in magnitude with those that were experienced on neighboring streams. Floods of this size are designated as Regional Floods. It is therefore desirable, in connection with any determination of future floods that may occur on North Toe River and Beaver and Grassy Creeks, to consider floods that have occurred in the region on watersheds whose topography, watershed cover, and physical characteristics are similar to those of these three streams.

Maximum Known Floods in the Region

Storm rainfall over the watersheds in the southern Appalachian Mountains, including the North Toe River watershed, is influenced considerably by the topography of the region. This is true of the occasional tropical hurricane as well as the large cyclonic storms more typical of the winter months. Moist air moving northward and westward from the Gulf and Atlantic Coasts is forced upward by the gradually sloping ground rising to the crest of the Blue Ridge Mountains which form the Appalachian Divide. In the vicinity of Spruce Pine the Blue Ridge is also the Tennessee Valley Divide. As a result, the easterly slopes of the Blue Ridge and the area immediately west of the crest within the Tennessee Valley are subject to heavy orographic rainfall. On the coastward slopes this heavy precipitation is generally widespread and covers entire river basins, while on the western slopes the heavy precipitation is confined largely to a narrow band along the top and immediately beyond the crest. Characteristically, the rainfall diminishes on the downstream slopes west of the Divide, although occasionally tongues or cells of heavy rainfall have been experienced for considerable distances within the Valley.

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1. Prepared by Hydraulic Data Branch.

Table 10 lists the maximum known floods experienced on watersheds comparable with those of North Toe River and its tributaries and within about 60 miles of Spruce Pine. Because of the distribution of rainfall during heavy storms, the region considered in determining a Regional Flood on the North Toe River watershed was limited to those streams whose headwaters lie west of the Blue Ridge divide. Streams on the eastward slopes of the Blue Ridge Mountains and flowing into the Atlantic Ocean have not been included. Many severe storms have been experienced over watersheds in the Spruce Pine region. The storms of May 1901 and June 1924, and the hurricanes of July 1916 and mid-August 1940, are some of the largest that have occurred since the turn of the century.

The storm of May 18-21, 1901, caused particularly destructive floods in the Watauga and Nolichucky River basins. During this storm an estimated 8 inches of rain fell in a 24-hour period on ground that was saturated from previous rains. The numerous "waterspouts" and landslides that were reported in the news accounts attest to the intensity of the rainfall. In the Cane Creek watershed near Bakersville, North Carolina, as many as 17 landslides were counted on the side of a single hill. This flood on the Nolichucky River became known as the "May Tide."

The storm of June 13, 1924, was a severe local storm which produced intensive damage to a small area in Carter County, Tennessee. The greatest force of the storm covered an oval area of about 50 square miles. At Cardens Bluff, Tennessee, near the present site of Watauga Dam, rainfall measured almost 15 inches in an eight-hour period, 12 inches of this falling within $3\frac{1}{2}$ hours. Because of the small area covered by the storm only minor flooding occurred on the Watauga and Doe Rivers. Unfortunately, no discharges on the smaller tributaries are available because the steep slopes and large quantities of debris prevented making any discharge estimates. On one ravine with a catchment area of only about 15 acres two houses were demolished and nine of the occupants drowned. One occupant who escaped with severe injuries stated that a wall of water, rock, and earth 8 to 10 feet high crashed into these houses without warning, totally wrecking them.

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 brought sufficient rainfall to western North Carolina on July 8-10 to saturate the ground. The second hurricane brought extremely heavy rainfall

TABLE 10

MAXIMUM KNOWN FLOOD DISCHARGES ON STREAMS

IN THE REGION OF SPRUCE PINE, NORTH CAROLINA

No.	Stream	Location	Drainage Area sq. mi.	Date	Peak Discharge Amount cfs	Peak Discharge Per Sq. Mi. cfs
1	South Fork New River	nr Crumpler, N. C.	325	July 15, 1916	46,000	141
2	French Broad River	at Blantyre, N. C.	296	July 16, 1916	50,700	171
3	North Fork New River	nr Crumpler, N. C.	277	August 14, 1940	73,000	264
4	North Toe River	at Toecane, N. C.	233	August 13, 1940	51,000	219
5	South Fork New River	nr Jefferson, N. C.	207	August 14, 1940	52,800	255
6	Watauga River	at Stump Knob, Tenn.	171	August 13, 1940	50,000	292
7	Cane River	nr Sioux, N. C.	157	August 13, 1940	31,800	203
8	Doe River	at Elizabethton, Tenn.	137	May 21, 1901	39,000	285
9	Swannanoa River	at Biltmore, N. C.	130	April 1791	40,000	308
10	North Toe River	at Spruce Pine, N. C.	130	July 1916	45,000	346
11	North Toe River	at Altapass, N. C.	104	July 1916	30,800	296
12	Watauga River	nr Sugar Grove, N. C.	90.8	August 13, 1940	50,800	559
13	South Toe River	at Newdale, N. C.	60.8	January 1927	33,000	543
14	Watauga River	nr Sugar Grove, N. C.	55.1	August 13, 1940	41,000	744
15	Watauga River	nr Valle Crucis, N. C.	33.1	August 13, 1940	38,000	1150
16	Cane Creek	ab Bakersville, N. C.	22.0	May 19-20, 1901	30,500	1390
17	Elk River	nr Banner Elk, N. C.	17.8	August 13, 1940	22,000	1240
18	West Fork Pigeon River	nr Waynesville, N. C.	12.2	August 30, 1940	16,500	1350
19	Dutch Creek	at Valle Crucis, N. C.	10.6	August 13, 1940	16,000	1510
20	North Hominy Creek	nr Canton, N. C.	7.8	August 30, 1940	5,000	641
21	Dutch Creek	nr Valle Crucis, N. C.	2.42	August 13, 1940	9,200	3800
22	Crab Orchard Creek	nr Boone, N. C.	2.1	August 13, 1940	6,000	2860

along the Blue Ridge Mountain divide between the Atlantic and Tennessee River drainage. At nearby Altapass, North Carolina, rainfall totaling 22.2 inches was recorded in a 24-hour period. This storm caused extensive flooding in the upper French Broad River basin and produced record floods on the North Toe River.

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 basin northeast to the Watauga headwaters. The highest flood of record was experienced on many streams in the region as a result of the rainfall, which exceeded 14 inches in some areas in the Watauga and Nolichucky River basins.

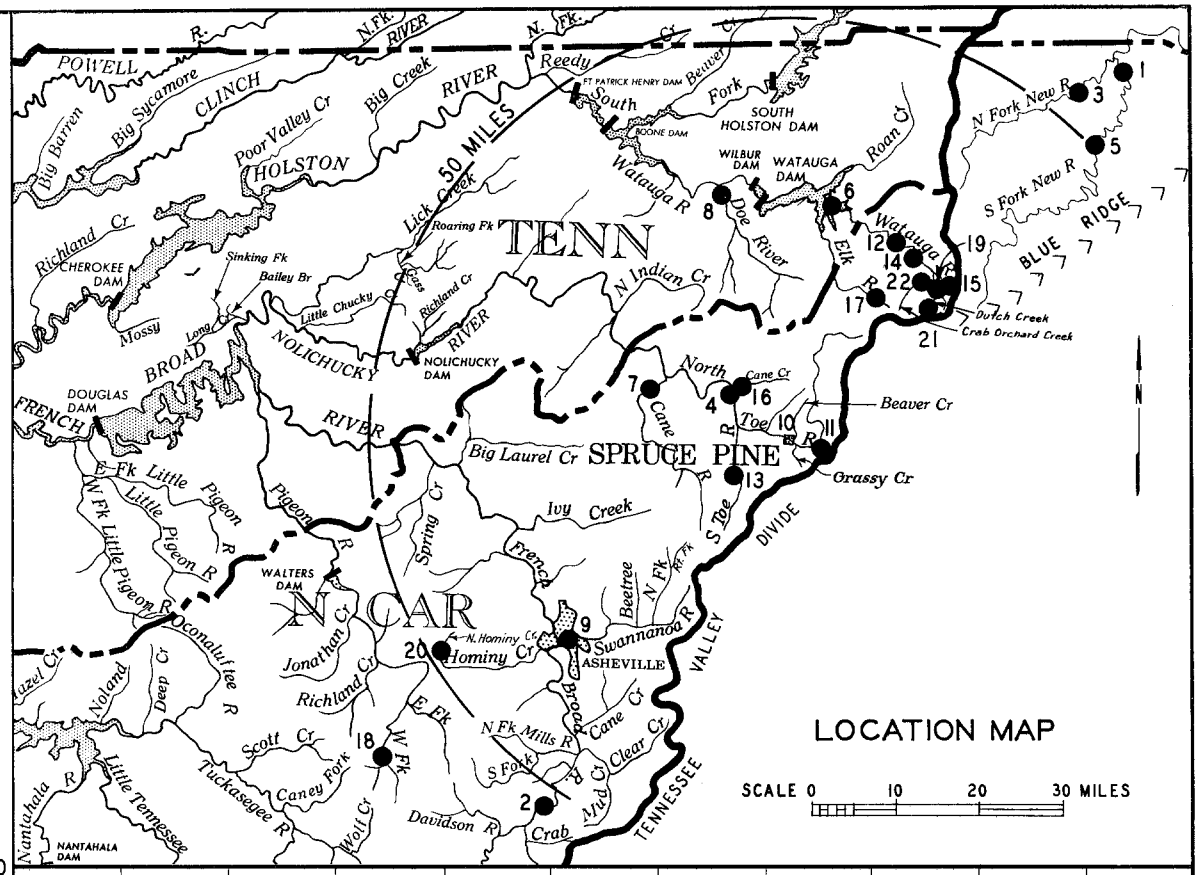
All of the floods listed in Table 10 have occurred on watersheds in the region of Spruce Pine that are similar in physical characteristics. This indicates that floods of like magnitude, modified to take into account differences in drainage area characteristics, could occur in the future on North Toe River and Beaver and Grassy Creeks.

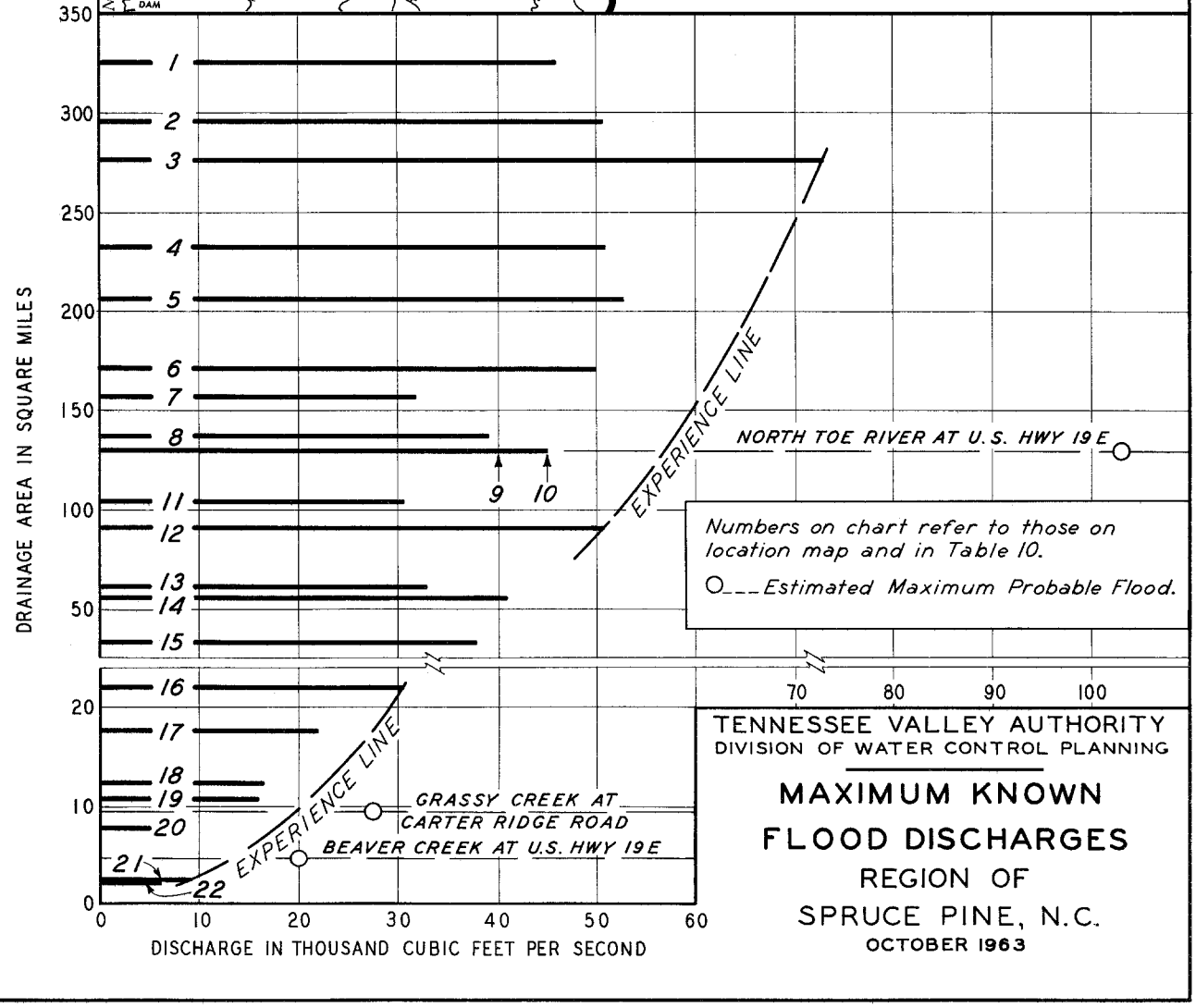
Determination of Regional Floods

Plate 4 is a diagram of the discharges tabulated in Table 10, together with a map showing the locations of the discharge measurements. The largest floods have occurred on those watersheds with headwaters on the Blue Ridge divide that lie in the narrow band or spillover area that is subject to heavy orographic precipitation. Above Spruce Pine, the North Toe River basin lies in this area and would be as susceptible to heavy rainfall as any of the watersheds in this region.

Most of the floods listed in Table 10 were caused by the tropical hurricanes of either July 1916 or mid-August 1940. However, record floods can result from other storms. Examples of these were the storm of May 1901 which was general over the eastern Tennessee Valley and the storm of June 1924 and late August 1940 which occurred over small localized areas.

With the exception of the flood of 1791 on the Swannanoa River, all of the floods listed in Table 10 are comparatively recent, having occurred in this century. This emphasizes that floods of these magnitudes cannot be considered





TENNESSEE VALLEY AUTHORITY
DIVISION OF WATER CONTROL PLANNING

MAXIMUM KNOWN FLOOD DISCHARGES REGION OF SPRUCE PINE, N.C.

OCTOBER 1963

as rare events in this region and, therefore, it must be anticipated that such floods will occur again in the future.

Both the hurricanes of July 1916 and mid-August 1940 produced widespread and extensive flooding on streams whose headwaters occur on the eastern slopes of the Blue Ridge. While these streams are not considered in the Spruce Pine region because of differences in rainfall characteristics over the watersheds, it is well to be aware of the magnitude of some of the discharges that have been experienced. Wilson Creek near Adako, North Carolina, whose headwaters form on the eastward slope of Grandfather Mountain, experienced severe flooding from both the 1916 and the 1940 storms. On August 13, 1940, a discharge of 99,000 cubic feet per second was experienced from drainage areas of only 66 square miles. Other watersheds that experienced unusually high peak discharges during this storm include the North Fork Catawba River near Woodlawn, North Carolina, with 55,000 cubic feet per second from 41.8 square miles, and Elk Creek at Elkville, North Carolina, in the Yadkin River Basin, where 70,000 cubic feet per second occurred on 50 square miles. These peak discharges probably resulted from a cell of very intense rainfall centered over the watershed following a period of prolonged rainfall. This is not an uncommon occurrence on the eastern slopes of the Blue Ridge Divide during a hurricane-originated storm, but it is less likely to occur west of the Divide because of the orographic distribution of rainfall. If such an event were to occur over the North Toe River Basin above Spruce Pine it would produce a flood more in the order of a Maximum Probable Flood, which is discussed in a subsequent section of this report.

Based upon the maximum flood discharges experienced in the region, it is reasonable to expect future flood discharges on North Toe River and Beaver and Grassy Creeks to be in the order of those given in Table 11. For the purposes of this report, floods of these magnitudes are designated as Regional Floods.

A Regional Flood may occur on North Toe River in the reach investigated that would be from about one to fourteen feet higher than the 1916 flood, but about two feet higher in the reach through the greater part of Spruce Pine. On Beaver Creek a Regional Flood may occur about 9 to 21 feet higher than the August 1961 flood, being about 10 feet higher over most of the reach. A Regional Flood may occur on Grassy Creek about 6 to 13 feet higher than the 1961 flood, being about 8 feet higher over most of the reach.

TABLE 11

REGIONAL FLOOD PEAK DISCHARGES

Stream	Location	Mile above Mouth	Drainage Area sq. mi.	Discharge cfs
North Toe River	U. S. Highway 19E	31.45	130	57,000
Beaver Creek	Mouth	0	5.34	14,000
	U. S. Highway 19E	1.00	4.76	13,300
Grassy Creek	Mouth	0	11.4	22,000
	Carter Ridge Road	0.97	9.50	19,300

The profile of the Regional Flood on North Toe River is shown on Plate 6. Plates 7 and 8 show the Regional Flood profiles on Beaver Creek and Grassy Creek. Figures 17 to 24 show the height that would be reached by the Regional Flood at several locations in the vicinity of Spruce Pine.

Figure 17.--FLOOD HEIGHTS BELOW SPRUCE PINE

Spruce Pine Wholesale Company, at Mile 31.18 on North Toe River, is shown in upper view. Lower picture is the Tri-County News building at Mile 31.53, near the lower end of Locust Avenue. Arrows show the heights of the July 1916 flood and the Regional Flood. The Maximum Probable Flood would be respectively 10 and 14 feet higher than the Regional Flood in the two views.

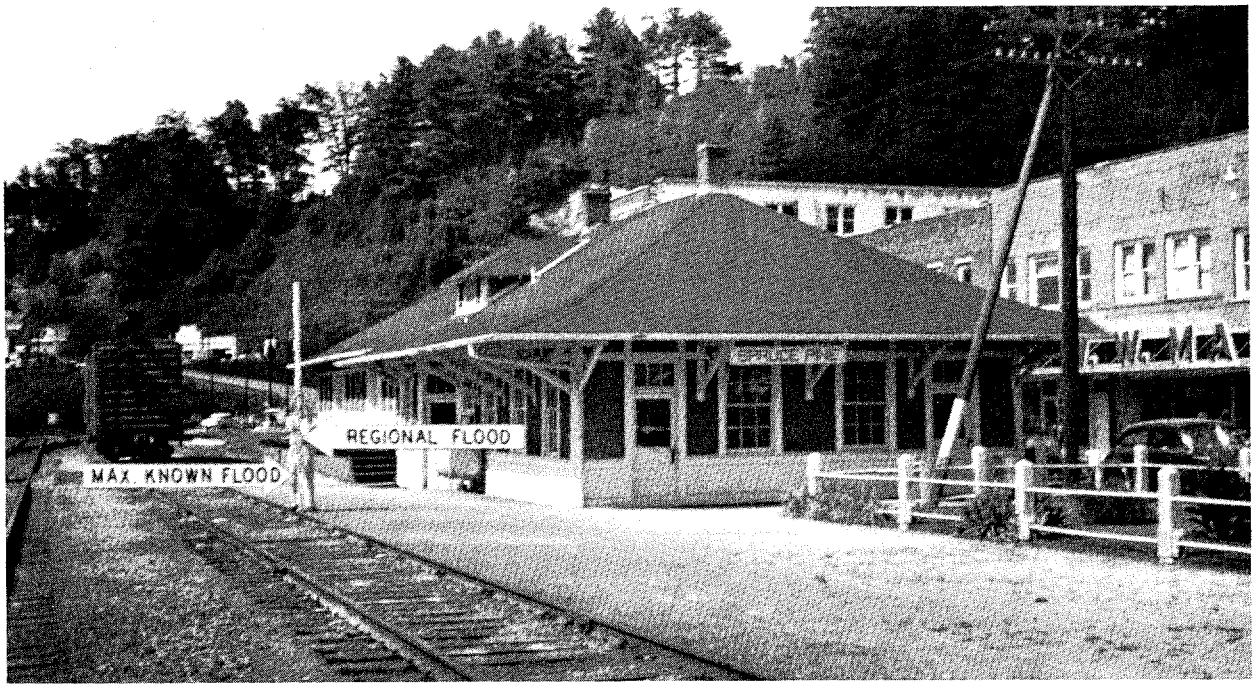


Figure 18.--FLOOD HEIGHTS AT CLINCHFIELD RAILROAD STATION

The depot is at Mile 31.59, and the river is some 200 feet (to left) of the tracks. Arrows show heights of the 1916 and Regional Floods; the Maximum Probable Flood would exceed the Regional Flood by 14 feet.

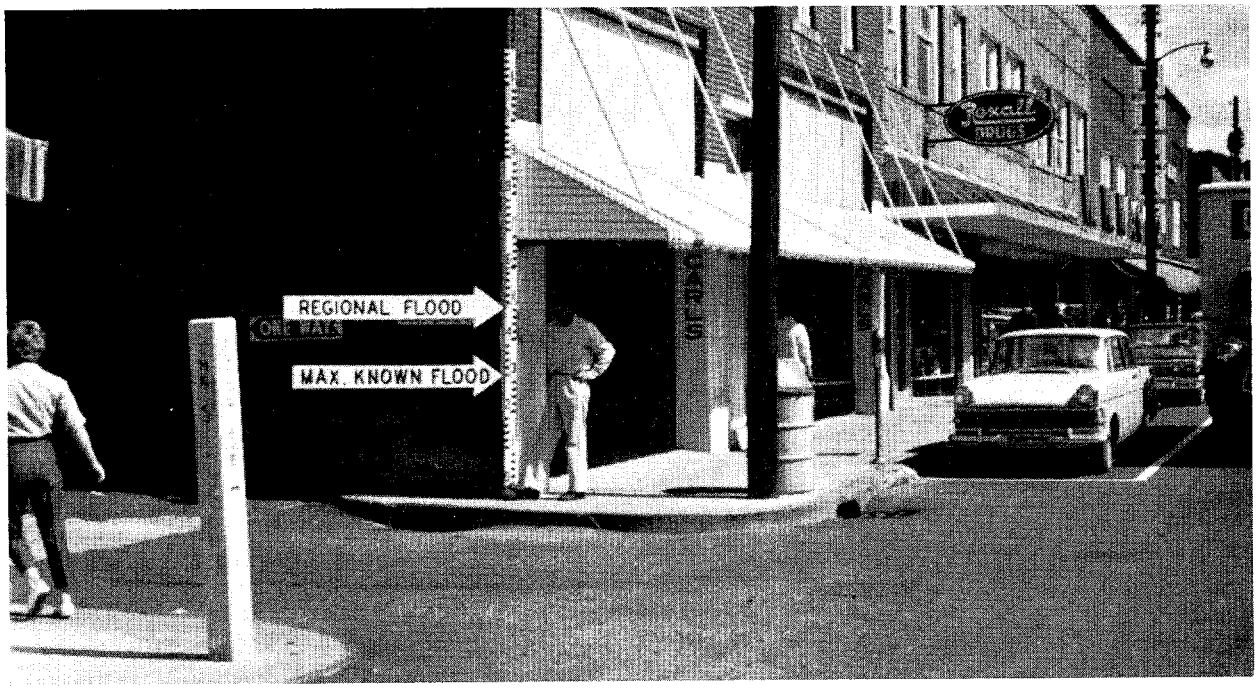


Figure 19.--FLOOD HEIGHTS AT LINK STREET

Carl's Department Store stands on the site of the Peterson Drug Store, which was affected by the 1916 flood. The floor elevation has been changed. Arrows show the 1916 and Regional Flood heights; the Maximum Probable Flood would be 14 feet higher than the Regional Flood.

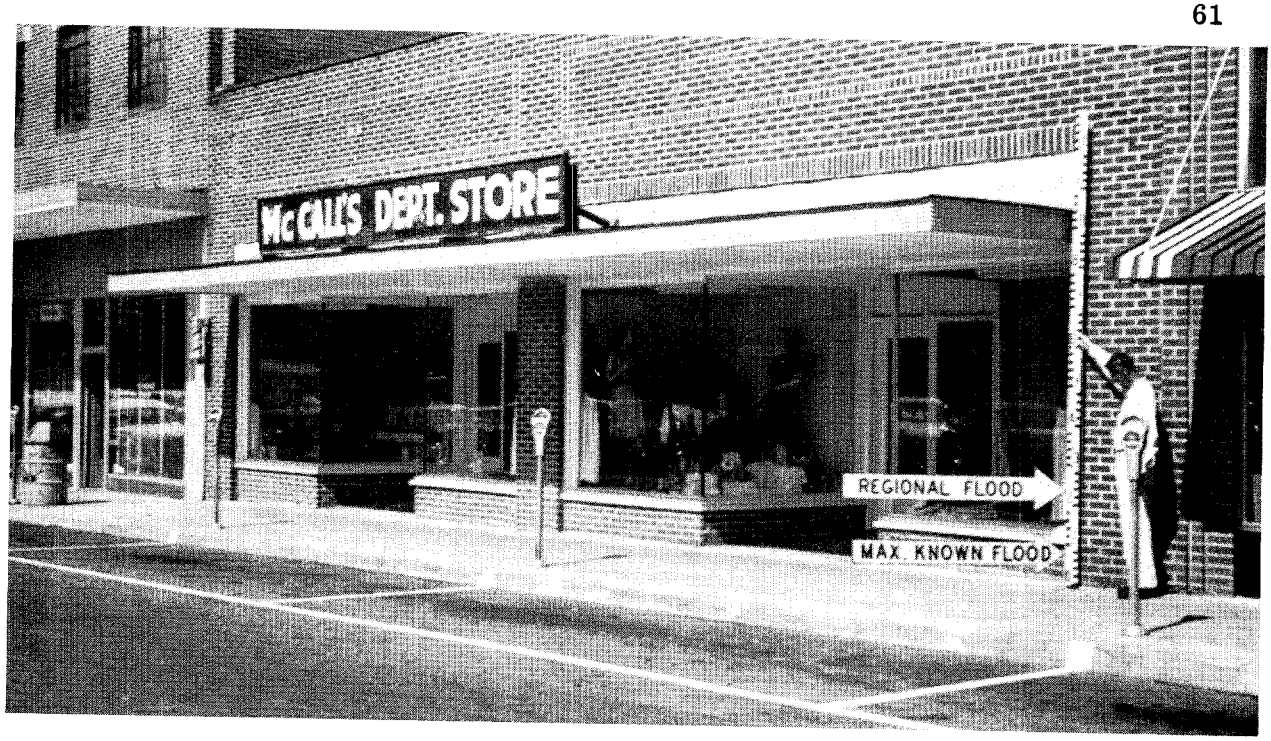


Figure 20.--FLOOD HEIGHTS ALONG LOCUST AVENUE

Arrows show the July 1916 and Regional Flood heights at McCall's Department Store, on Locust Avenue a block upstream from the depot, opposite Mile 31.66 on the river. The Maximum Probable Flood would be $13\frac{1}{2}$ feet higher than the Regional Flood.

Figure 21.--FLOOD HEIGHTS ABOVE SPRUCE PINE

This concrete block factory is on the North Toe River at Mile 34.87, about 3 miles upstream from the center of town. Arrows show the July 1916 and Regional Flood heights. The Maximum Probable Flood would exceed the Regional Flood by 12 feet. The 1916 flood under present conditions would be $6\frac{1}{2}$ feet higher than it actually was.

Figure 22.--FLOOD HEIGHTS ALONG BEAVER CREEK

Upper view shows Hickey's Super Market on U. S. Highway 19E, opposite Mile 0.61 on Beaver Creek. Lower view is the salesroom of the Maryland Motor Company at Mile 0.69. Arrows show heights of the Regional and Maximum Probable Floods.

Figure 23.--RETAIL AND WHOLESALE OUTLETS SUBJECT TO FLOOD

Upper view is the Barksdale service station opposite Mile 0.72 on Beaver Creek. Lower view shows the pump and storage tank area of D. O. Blevins' Sons at Mile 0.96, near the U. S. Highway 19E crossing. Arrows show Regional and Maximum Probable Flood heights.

Figure 24.--FLOOD HEIGHTS ALONG GRASSY CREEK

Upper view shows the Pine Valley Lanes on North Carolina Highway 226, at Mile 1.05 on Grassy Creek. Lower view is Lee's Mineral and Gem Shop on the same highway in the community of Grassy Creek, Mile 2.15. Arrows show the Regional and Maximum Probable Flood heights.

IV.

MAXIMUM PROBABLE FLOODS

IV.

MAXIMUM PROBABLE FLOODS[1]

This section discusses the Maximum Probable Floods on the North Toe River and Beaver and Grassy Creeks in the vicinity of Spruce Pine, North Carolina, and some of the hazards of great floods. Floods of the magnitude of the Maximum Probable Floods are the kind considered in planning construction and operation of protective works, the failure of which might be disastrous. They represent reasonable upper limits of expected flooding.

Drainage areas at the upper and lower limits, respectively, of the study are 110 and 134 square miles on the North Toe River, 4.3 and 5.3 square miles on Beaver Creek, and 6.2 and 11.4 square miles on Grassy Creek.

Extreme floods on these streams are most likely to result from either of two types of storms--intense periods of rainfall during winter storms of fairly long duration, or short-duration storms of the cloudburst or hurricane type usually occurring during summer or early fall. 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 North Toe River and Beaver and Grassy Creeks in the vicinity of Spruce Pine, 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 in this area. This procedure provides information about possible floods and storms additional to that which can be gained from the short-term local hydrologic records alone.

The maximum known flood on the North Toe River in the vicinity of Spruce Pine occurred on July 16, 1916. The peak discharge is estimated to have been 30,800 cubic feet per second at the former Altapass gage site, Mile 36.0, near the upstream limit of the study.

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1. Prepared by Flood Control Branch.

The large floods on Beaver and Grassy Creeks occurred on August 24, 1961. The peak discharge near the mouth of each stream is estimated to have been 1,900 and 4,000 cfs, respectively. The indications are that the 1916 flood was greater than the 1961 flood on each stream, but flood marks adequate to determine a profile were not found.

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

Observed Storms

Observed storms are meteorologically transposable to the Spruce Pine area from within a broad region extending generally from the Atlantic Ocean to the Appalachian Divide and from Florida through Pennsylvania. The moisture source for storms in this region is the warm, moist air flowing northward from the tropical Atlantic Ocean. In general, the moisture potential for a given region decreases with its increased distance from the moisture source. Transposition of storms from within the broad region includes adjustments for the particular meteorological conditions to be expected at Spruce Pine. Table 12 lists known rainfall depths for several large storms transposable to this area.

TABLE 12

SELECTED MAXIMUM OBSERVED STORMS TRANSPOSABLE TO THE REGION OF SPRUCE PINE, NORTH CAROLINA

Date	Location	Area	Rainfall	
			Duration	Depth
		sq. mi.	hours	inches
July 1916	North Carolina	100	6	7.2
		130	8	8.6
July 1938	North Carolina	4.0	1	6.0
August 1939	New Jersey	100	6	9.0
		130	8	11.6
September 1940	New Jersey	100	6	17.1
		130	8	17.6
July 1960	Georgia	Point	3	12.5
June 1961	North Carolina	3.49	2.5	8.5

Upon the basis of these and other data, as adjusted for conditions at Spruce Pine, the following rainstorms were adopted for computing the Maximum Probable Floods.

Location	Drainage Area sq. mi.	Rainfall Duration hours	Rainfall Depth inches
North Toe River			
Former Altapass gage	104	4	12.2
Lower limit	134	8	16.0
Beaver Creek			
Upper limit	4.3	1	8.9
Mouth	5.3	1	8.7
Grassy Creek			
Upper limit	6.2	1	8.5
Mouth	11.4	2	11.3

From a meteorological standpoint, storms as much as 50 percent greater than these can occur.

Observed Floods

Factors such as the meteorology of the region and flood-producing characteristics of the watershed were given consideration in determining whether peak discharges on other streams are applicable. Tables 10 and 13 list peak discharges for observed floods on streams of approximately the size of those discussed in this report. For comparison the discharge of the maximum known flood on each stream included in this study is listed.

TABLE 13

SELECTED MAXIMUM OBSERVED FLOODS

Stream	Location	Drainage Area sq. mi.	Date	Peak Discharge Amount cfs	Peak Discharge Per Sq. Mile cfs
Big Creek	Sunburst, N. C.	1.32	1940	12,900	9,800
Big Creek	Sunburst, N. C.	1.69	1940	12,400	7,340
N. F. Catawba R.	Asheford, N. C.	5.2	1940	15,000	2,900
Pigeon River	Spruce, N. C.	8.4	1940	16,400	1,950
Steels Creek	Tablerock, N. C.	16	1940	24,000	1,500
Stony Fork	Hendrix, N. C.	27.1	1940	37,000	1,370
N. F. Catawba R.	Woodlawn, N. C.	41.8	1940	55,000	1,320
Elk Creek	Elkville, N. C.	50	1940	70,000	1,400
Wilson Creek	Adako, N. C.	66	1940	99,000	1,500
Catawba River	Marion, N. C.	170	1940	71,000	418
North Toe River	Altapass, N. C.	104	1916	30,800	296
	U. S. Highway 19E at Spruce Pine	130	1916	45,000	346
Beaver Creek	Spruce Pine, N. C.	5.3	1961	1,900	358
	U. S. Highway 19E at Spruce Pine	4.8	1961	1,800	375
Grassy Creek	Spruce Pine, N. C.	11.4	1961	4,000	351
	Carter Ridge Road at Spruce Pine	9.5	1961	3,700	390

Maximum Probable Flood Discharge

From consideration of the flood discharges in Table 13 and of the transposition to the Spruce Pine area of outstanding storms, the peak discharge of the Maximum Probable Flood at selected locations was determined to be as follows:

Stream	Location	Drainage Area sq. mi.	Peak Discharge cfs
North Toe River	Former Altapass gage	104	100,000
	U. S. Highway 19E	130	103,000
	Lower limit	134	103,000
Beaver Creek	Upper limit	4.30	18,500
	U. S. Highway 19E	4.76	19,900
	Lower limit	5.34	22,000
Grassy Creek	Upper limit	6.20	25,000
	Carter Ridge Road	9.50	27,500
	Lower limit	11.4	30,000

The adopted discharges, while considerably greater than any known past floods on these streams, are well supported by observed floods which have occurred in similar nearby watersheds.

Frequency

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

Possible Larger Floods

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

HAZARDS OF GREAT FLOODS

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

Areas and Heights of Flooding

The areas flooded by the Maximum Probable and maximum known floods are shown on Plate 5. Depths of flow can be estimated from the crest profiles which are shown on Plates 6, 7, and 8.

Profiles were computed by using stream characteristics for selected reaches as determined from observed flood profiles, topographic maps, and cross sections which were surveyed in 1963. The elevations shown on Plates 6, 7, and 8 and the overflow areas shown on Plate 4 have been determined with an accuracy consistent with the purposes of this study and the accuracy of the basic data. More precision would require costly surveys not warranted by this study.

The profiles of the Maximum Probable Floods depend in part upon the degree of destruction or clogging of various bridges during the floods. Because it is impossible to forecast these events, it was assumed that all bridge structures would stand and that no clogging would occur. However, because of the poor condition of the mill houses located adjacent to the small dams on the North Toe River at Miles 32.97 and 34.47, it was assumed that these two buildings would be destroyed during the Maximum Probable and Regional Floods.

The Maximum Probable Flood profile on the North Toe River is from about 11 to 27 feet higher than elevations experienced in the July 1916 flood, and about 12 feet higher in the reach through Spruce Pine. The maximum difference occurs at the Altapass Highway bridge, Mile 35.04, and is partially the result of heading up at the dam, Mile 34.47, which was constructed in 1938.

The Maximum Probable Flood profile on Beaver Creek is from about 9 to 24 feet higher than the August 24, 1961, flood and about 13 feet higher over most of the reach. The maximum difference occurs near the mouth and is the result of heading up at the Clinchfield Railroad bridge, Mile 0.03.

On Grassy Creek the Maximum Probable Flood profile is from 9 to 18 feet higher than elevations experienced on August 24, 1961, and about 11 feet higher over most of the reach. The maximum difference occurs 0.1 mile below the small dam located at Mile 0.3.

The captions with Figures 17 to 21 indicate the height that would be reached by the Maximum Probable Flood at several locations along the North Toe River in the vicinity of Spruce Pine. Figures 22 to 24 show the height that would be reached by the Maximum Probable Floods along Beaver and Grassy Creeks.

Velocities, Rates of Rise, and Duration

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

During the Maximum Probable Flood, velocities in the main channel of the North Toe River and Beaver and Grassy Creeks would range as high as 30, 20, and 18 feet per second, respectively. In the overflow areas, velocities would range from less than 2 to about 11 feet per second, from about 2 to 7 feet per

second, and from less than 2 to about 5 feet per second on the North Toe River and Beaver and Grassy Creeks, respectively.

The Maximum Probable Flood on the North Toe River at the footbridge, Mile 31.78, would rise about 38 feet above low water to its crest stage in about 12 hours with a maximum rate of rise of about 6 feet in 1 hour.

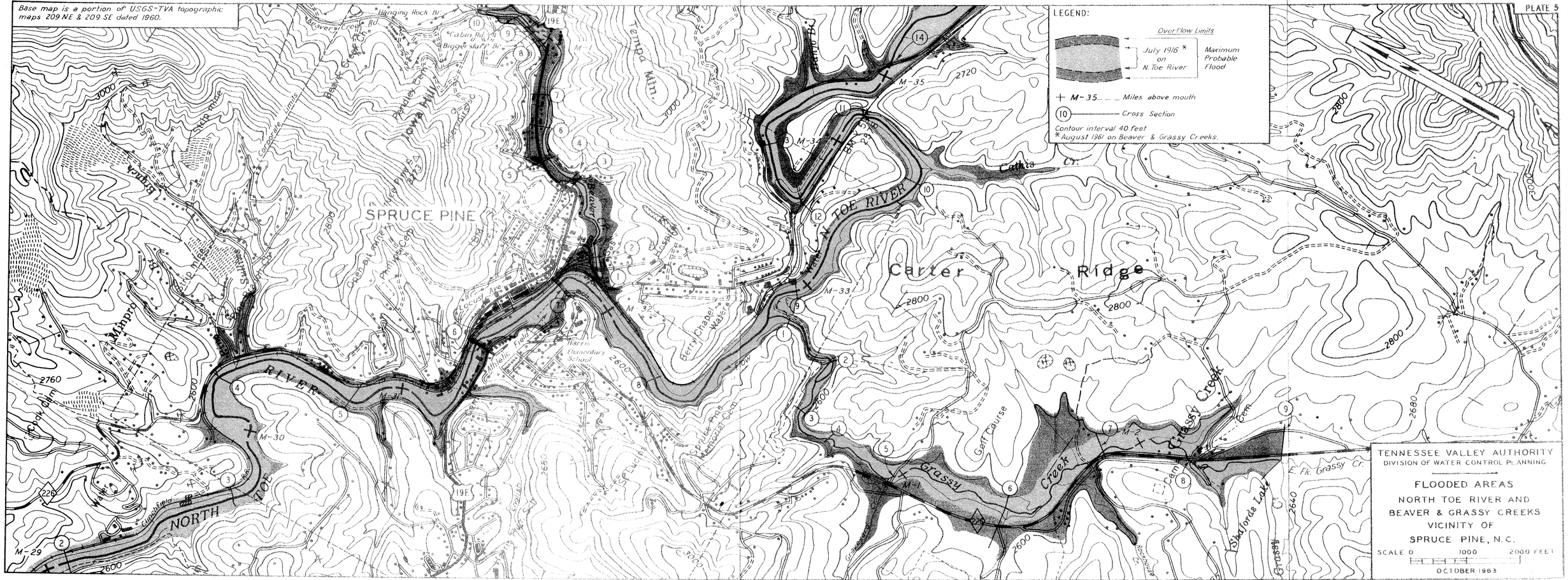
On Beaver Creek on the downstream side of the Ward Street bridge at Mile 0.42 the rise would be about 17 feet above low water to its crest stage in about 1.5 hours with a maximum rate of rise of about 14 feet in 1 hour.

On Grassy Creek below the Carter Ridge Road bridge, Mile 0.97, the rise would be about 21 feet above low water to its crest stage in about 2 hours with a maximum rate of rise of about 14 feet in 1 hour.

In the vicinity of Spruce Pine the Maximum Probable Flood on the North Toe River and Beaver and Grassy Creeks would exceed bankfull stage for approximately 36, 4, and 6 hours, respectively.

These rapid rates of rise and high stream velocities in combination with deep flooding would create a hazardous situation in developed areas.

Base map is a portion of USGS-TVA topographic maps 209 NE & 209 SE dated 1960.



NOTE:
Entire reach has steep banks and narrow flood plains. Top of bank shown only in the business district.

Spruce Pine

Spruce Pine

Top of Rail

Clearance

Floor

Clearance

Maximum Probable Flood

Regional Flood July 1916

July 1916 (Present conditions)

August 1961

September 1959

July 1963

Water Surface

Stream Bed

X 1901

August 13, 1940 △

March 12 - 13, 1963

Top of Bank

Crest

Harris Dam (Constructed prior to 1916, now partially destroyed)

Sullins Branch

English Creek

U.S. Highway 19E

N.C. Highway 226

Fourbridge

Beaver Creek

Grassy Creek

Fourbridge Dam (Constructed prior to 1916, now partially destroyed)

Cane Creek

Chinquapin Rd.

Fourbridge

Dam (Constructed 1956)

Former Stream Course

Altapass Highway

Section 2

Section 11

2580

2560

2540

2520

2500

2480

2460

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

29

30

31

32

33

34

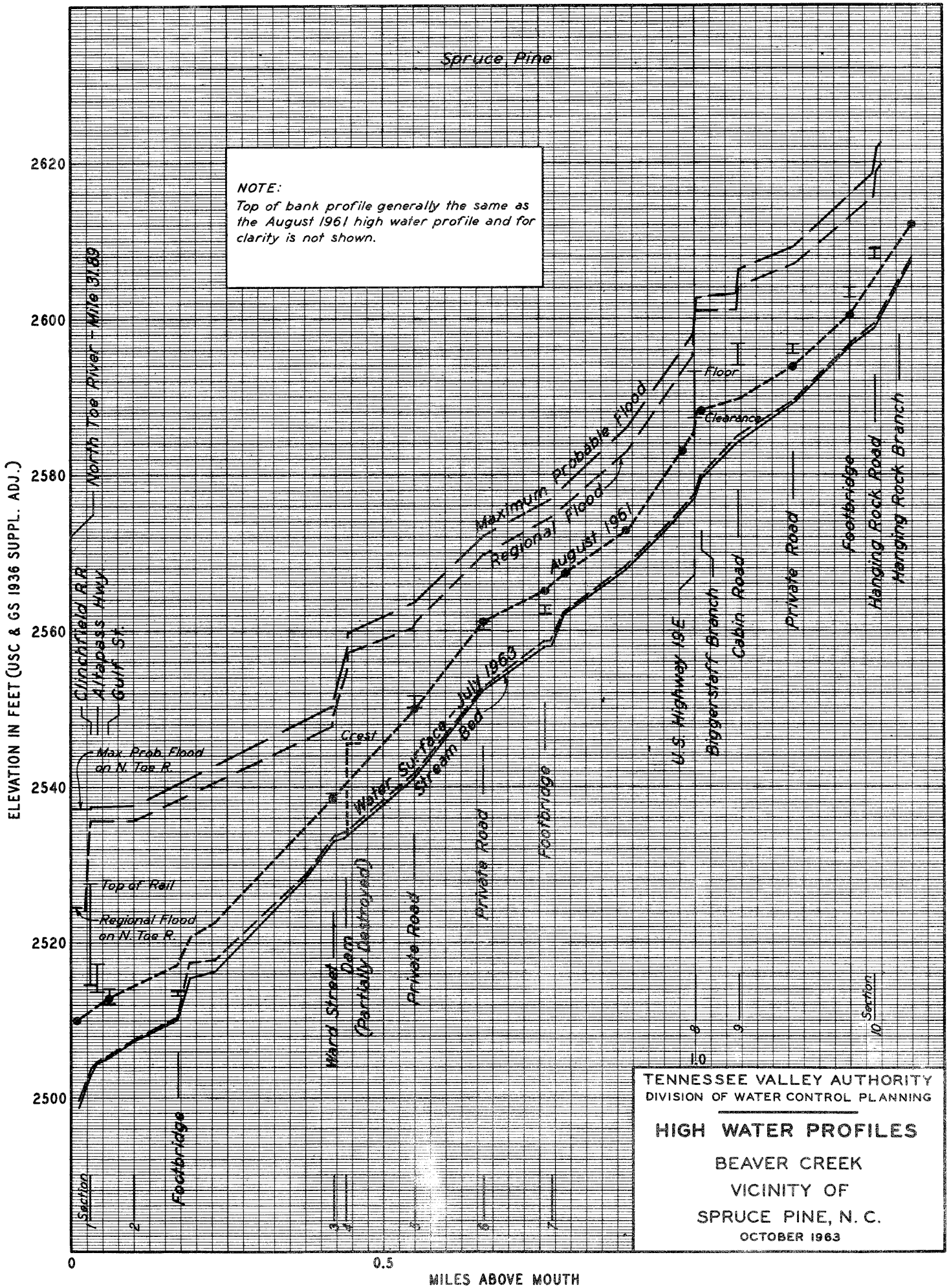
35

MILES ABOVE MOUTH

TENNESSEE VALLEY AUTHORITY
DIVISION OF WATER CONTROL PLANNING

HIGH WATER PROFILES
NORTH TOE RIVER
VICINITY OF
SPRUCE PINE, N. C.
OCTOBER 1963

PLATE 7



TENNESSEE VALLEY AUTHORITY
DIVISION OF WATER CONTROL PLANNING

HIGH WATER PROFILES

BEAVER CREEK
VICINITY OF
SPRUCE PINE, N. C.

OCTOBER 1963

HD - 1311

ELEVATION IN FEET (USC & GS 1936 SUPPL ADJ)

2500 2520 2540 2560 2580 2600 2620

0 0.5 1.0 1.5 2.0

MILES ABOVE MOUTH

Spruce Pine

North Toe River - Mile 32.82

Maximum Probable Flood on North Toe River

Regional Flood on N. Toe R.

Section 1

Dam

Crest

2

3

4

Graveyard Creek

Carter Ridge Road

5

August 1961

March 12, 1963

Water Surface - July 1963

Stream Bed

Maximum Probable Flood

Regional Flood

6

Rockhouse Creek

7

Floor Clearance

N. C. Highway 226

8

East Fork Grassy Creek

Section 9

NOTE:
Top of bank profile generally the same as the March 12, 1963 high water profile and for clarity is not shown.

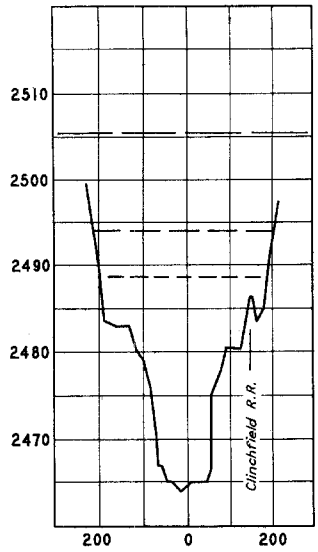
TENNESSEE VALLEY AUTHORITY
DIVISION OF WATER CONTROL PLANNING

HIGH WATER PROFILES

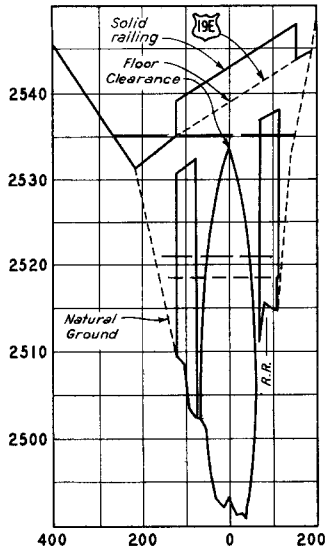
GRASSY CREEK
VICINITY OF
SPRUCE PINE, N. C.

OCTOBER 1963

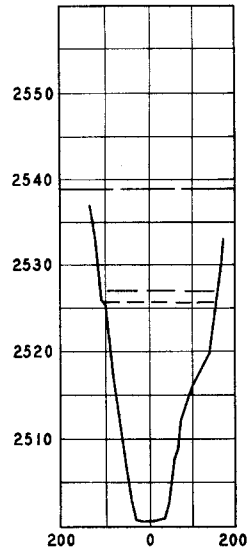
PLATE 8



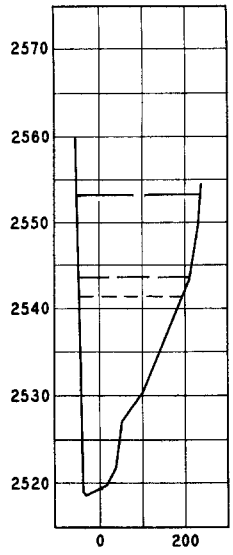
SECTION 2 - MILE 29.08



SECTION 6 - MILE 31.45



SECTION 8 - MILE 32.27

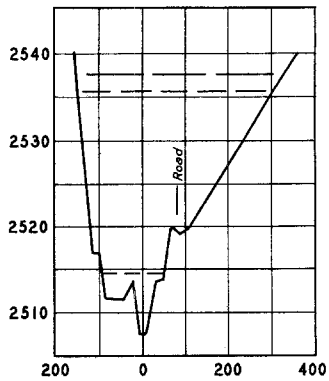


SECTION 10 - MILE 33.53

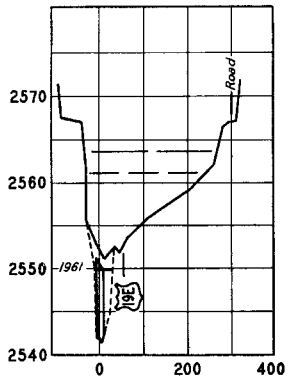
10 sections not shown.

NORTH TOE RIVER

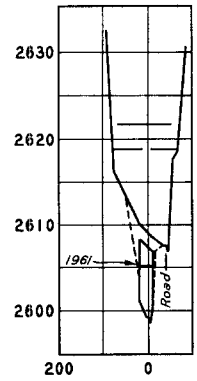
ELEVATION IN FEET (USC & GS 1938 SUPPL. ADJ.)



SECTION 2 - MILE 0.10



SECTION 5 - MILE 0.55



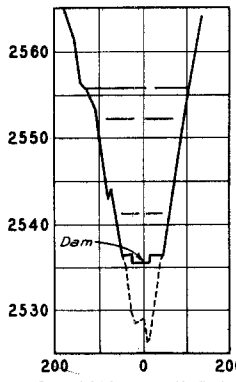
SECTION 10 - MILE 1.29

LEGEND:

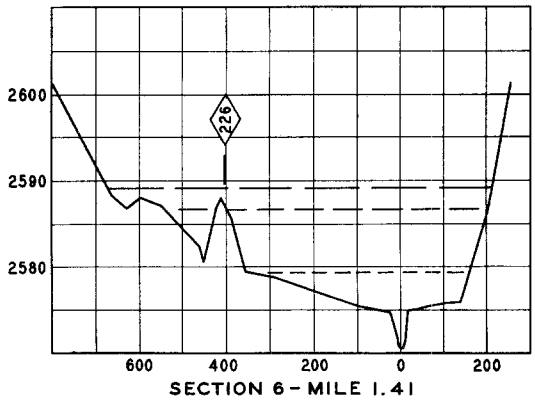
- Maximum Probable Flood
- Regional Flood
- July 1916 on North Toe River
- August 1961 on Beaver and Grassy Creeks

7 sections not shown.

BEAVER CREEK



SECTION 2 - MILE 0.30



SECTION 6 - MILE 1.41

7 sections not shown.

Sections taken looking downstream.

HORIZONTAL DISTANCE IN FEET

GRASSY CREEK

TENNESSEE VALLEY AUTHORITY
DIVISION OF WATER CONTROL PLANNING

CROSS SECTIONS

NORTH TOE RIVER AND
BEAVER & GRASSY CREEKS
VICINITY OF
SPRUCE PINE, N. C.

OCTOBER 1963