FLOOD OF SEPTEMBER 7-9, 1987, IN LEXINGTON AND RICHLAND COUNTIES IN THE VICINITY OF SAINT ANDREWS ROAD AND IRMO, SOUTH CAROLINA

By Wladmir B. Guimaraes

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 89-4077

Prepared in cooperation with

LEXINGTON COUNTY, RICHLAND COUNTY,

and the TOWN OF IRMO, SOUTH CAROLINA

Columbia, South Carolina

1989

DEPARTMENT OF THE INTERIOR

MANUEL LUJAN, JR., Secretary

U.S. GEOLOGICAL SURVEY

Dallas L. Peck, Director

For additional information
write to:

District Chief
U.S. Geological Survey, WRD
1835 Assembly Street
Suite 677A
Columbia, South Carolina 29201

Copies of this report may be
purchased from:

U.S. Geological Survey
Books and Open-File Reports
Federal Center, Bldg. 810
Box 25425
Denver, Colorado 80225

CONTENTS

ILLUSTRATIONS

(Plates in pocket at back of report)

TABLES

FLOOD OF SEPTEMBER 7-9, 1987, IN LEXINGTON AND RICHLAND COUNTIES IN THE VICINITY OF SAINT ANDREWS ROAD AND IRMO, SOUTH CAROLINA

By Wladmir B. Guimaraes

ABSTRACT

Localized heavy rainfall on September 7, 1987, in Lexington and Richland Counties, South Carolina, caused severe flooding in the basins of Kinley Creek, Rawls Creek, and Stoop Creek, in the vicinity of Saint Andrews Road and the town of Irmo, South Carolina. The flooding damaged homes, furnishings, and landscaping.

Rainfall, peak discharges, high-water elevations, and frequency relations of rainfall and discharge are tabulated and plotted for selected streams. The rain was most intense in the area along Rawls Creek, R-2 (tributary to Rawls Creek), Koon Branch (tributary to Rawls Creek), and the upper part of Kinley Creek. A rainfall of about 5.5 inches in 3 hours, which has a recurrence interval in excess of 100 years, was reported by local residents along these streams.

High-water marks are presented in this report for Stoop Creek, Kinley Creek, K-1 (tributary to Kinley Creek), K-2 (tributary to Kinley Creek), Unnamed tributary to Kinley Creek, Lowery Creek (tributary to Kinley Creek), Rawls Creek, R-2 (tributary to Rawls Creek), and Koon Branch (tributary to Rawls Creek).

Peak discharges at the most downstream sites on Rawls Creek and Koon Branch had recurrence intervals of 75 years and 60 years, respectively. Peak discharge recurrence intervals on Kinley Creek varied from 20 to 25 years north of the K-1 basin to less than 10 years at K-1. The Stoop Creek basin had a recurrence interval of 10 years.

INTRODUCTION

Intense rainfall of as much as 5.5 inches in a 3-hour period on September 7, 1987, resulted in flash floods on several small streams in Lexington and Richland Counties, South Carolina. The areas most affected by these flash floods were in Rawls Creek, Kinley Creek, and Stoop Creek basins north of the Saluda River and west of Interstate Highway 26 (plate 1). This area has undergone a rapid rate of development during the last two decades. Shopping centers, parking lots, restaurants, and other light commercial developments have been constructed along nearly all primary highways in the area. Many new residential subdivisions have also been constructed in the area. This development has resulted in a substantial increase in the amount of impervious area with a corresponding increase in the rate and volume of storm runoff in the basins. Storage provided by a small flood-detention pond and numerous small recreational ponds and reservoirs have partially offset the increase in runoff, but local residents report that flooding remains a problem in the area.

This report documents the flood of September 7-9, 1987, along reaches of Kinley Creek and four of its tributaries (Lowery Branch, and unnamed tributary, K-1 and K-2), Rawls Creek and two of its tributaries (Koon Branch and R-2), and Stoop Creek. This flood, referred to locally as the "Labor Day flood," damaged homes, furnishings, and landscaping in several residential areas and overtopped many roads and bridges (figs. 1 and 2). On one tributary to Kinley Creek (K-1), the flood of September 7, 1987, was exceeded 2 days later by another flood. In this report, the flood high-water marks, frequencies, and other flood data presented for the K-1 tributary are for the larger flood of September 9, 1987. This report, prepared in cooperation with Lexington and Richland Counties and the town of Irmo, South Carolina, includes the following data:

(1) The amount and distribution of rainfall;
(2) Location and elevation of high-water marks;
(3) Peak discharges at selected locations; and
(4) Recurrence intervals of peak discharges.

METHODS OF ANALYSIS

Rainfall data were collected by local residents, and at a recording rain gage operated by the U.S. Geological Survey. Rainfall data collected by local residents were verified where possible.

High-water marks were flagged at road crossings and at 1,000-ft intervals between road crossings along the streams within 17 days of the flood. Elevations of these high-water marks were determined by standard survey techniques using benchmarks established by the Federal Emergency Management Agency (FEMA), except at site 3 (Rawls Creek at Newberry Avenue), where elevations are referenced to an arbitrary datum. These benchmarks are described in appendix A. Determination of peak water-surface elevations was complicated by the fact that the quality of high-water marks was lessened by a rainstorm on September 9. Some marks were verified by interviews with residents.

Peak discharges for the September 7, 1987, flood at several sites were computed by using indirect methods of measurements that are based on elevations of floodmarks and geometry of channels, culverts, bridges, and highway embankments. The flow through culverts was determined by using U.S. Geological Survey program A526 (Mathai and others, undated), and methods developed by Bodhaine (1968). Flow over embankments was determined by step-backwater methodology using WSPRO, a step-backwater computer program developed by the U.S. Geological Survey for the Federal Highway Administration (Shearman and others, 1986). Peak flows were also computed at contracted openings (bridges), using methods developed by Matthai (1967), and at dams by methods described by Hulsing (1967).

Figure 1.--Flood damage at residence in Coldstream subdivision, September 7, 1987.

Figure 2.--Water flowing around residence in Coldstream subdivision, September 7, 1987.

Most computations were rated fair to poor, with fair indicating an error of less than 15 percent and poor indicating an error greater than 15 percent. These ratings were due primarily to the quality of high-water marks in the high-velocity areas downstream of the culverts and bridges. Computed peak discharges appear reasonable in that recurrence intervals for the peak discharge computations at adjacent sites are similar.

Peak discharges can be substantially reduced by upstream storage of floodwaters in lakes and detention ponds. Peak discharges computed at sites affected by storage were not adjusted to remove the effect of storage.

Flood-frequency relations for this study were computed and plotted for selected sites using equations developed by Whetstone (1982) and adjusted for urbanization using equations developed by Sauer and others (1983). Basin characteristics used in the flood frequency analysis include drainage area, streambed slope, percent impervious area, channel length, and basin development parameters. These data were obtained from U.S. Gelogical Survey 7.5 minute series topographic quadrangle maps of Irmo and Columbia North, Agricultural Stabilization and Conservation Service aerial photographs (1981), and field inspections.

Recurrence intervals of the computed peak discharges were determined from the plotted flood-frequency relation. Discharges affected by storage were not used to define flood-frequency relation.

FLOOD OF SEPTEMBER 7-9, 1987

Rainfall

Rainfall data were collected at one site equipped with a recording rain gage operated by the U.S. Geological Survey and at seven other sites where rainfall is monitored by residents. Reported rainfall totals exceeded 5 inches at four sites in the Rawls Creek basin but diminished to the south and east (fig. 3). Less than 1 inch of rainfall was recorded at the southernmost site (site H).

Rainfall totals for the September 7, 1987, flood were measured over a period of about 3 hours at all eight sites. Rainfall intensities of 5.4 and 5.5 inches in a 3-hour period were reported at sites A and B and 4.0 inches was reported for a 2-hour period at site D. Even greater rainfall intensities were reported at sites C and F, but the duration of the rainfall at these sites could not be verified.

Rainfall-frequency relations were developed for durations of 3 hours (fig. 4) and for 2 hours (fig. 5) using data from Hershfield, (1961) and the recurrence interval for rainfall intensities at all eight sites were determined (table 1). The recurrence intervals for rainfall intervals at Sites A, B, C, and F are in excess of 100 years. The 4 inches of rainfall in two hours reported at Site D has a recurrence interval of about 60 years. Recurrence intervals for rainfall intensities at Sites E, G, and H are 10 years or less.

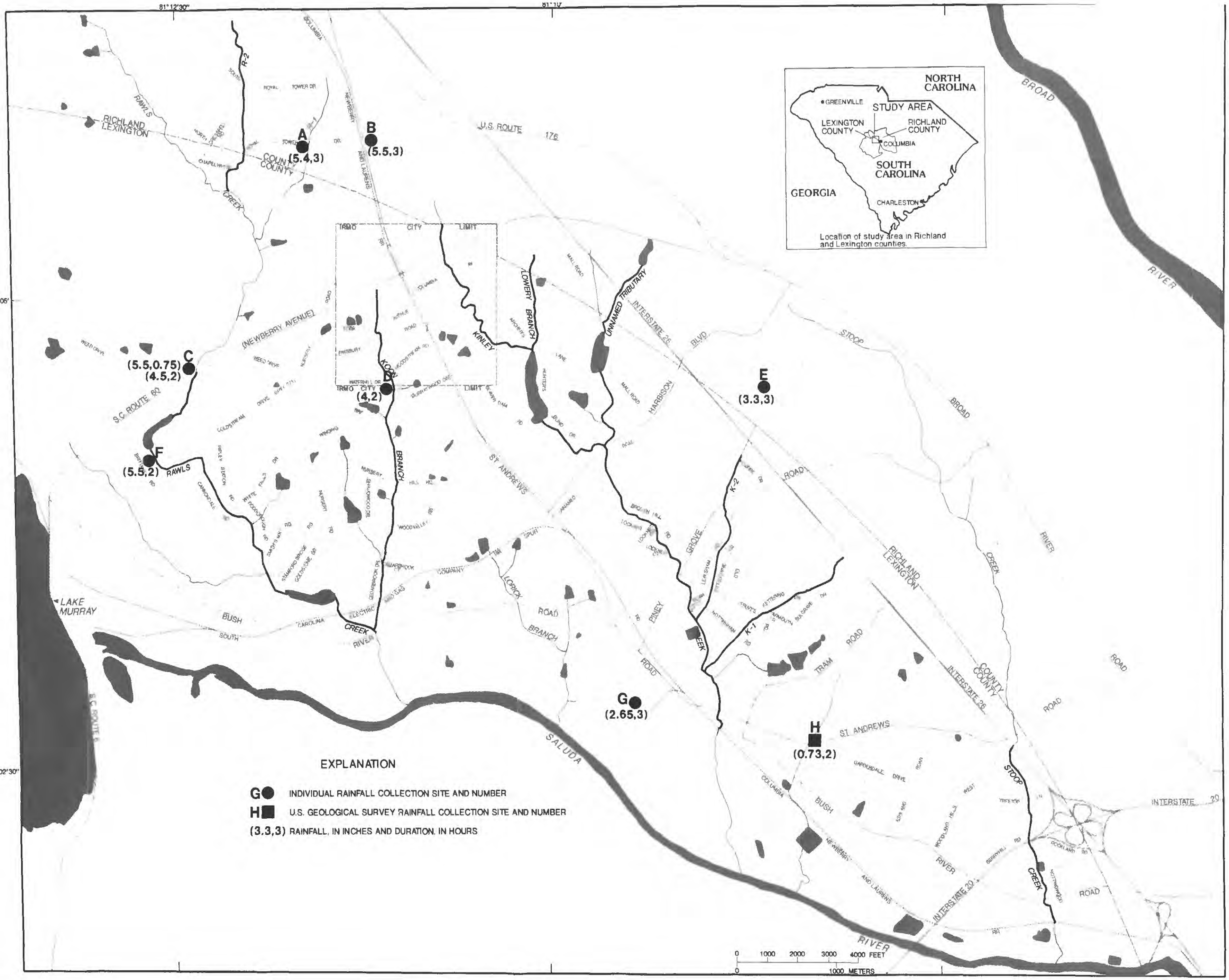

Figure 3.--Map showing rainfall amounts and duration at selected sites, September 7, 1987.

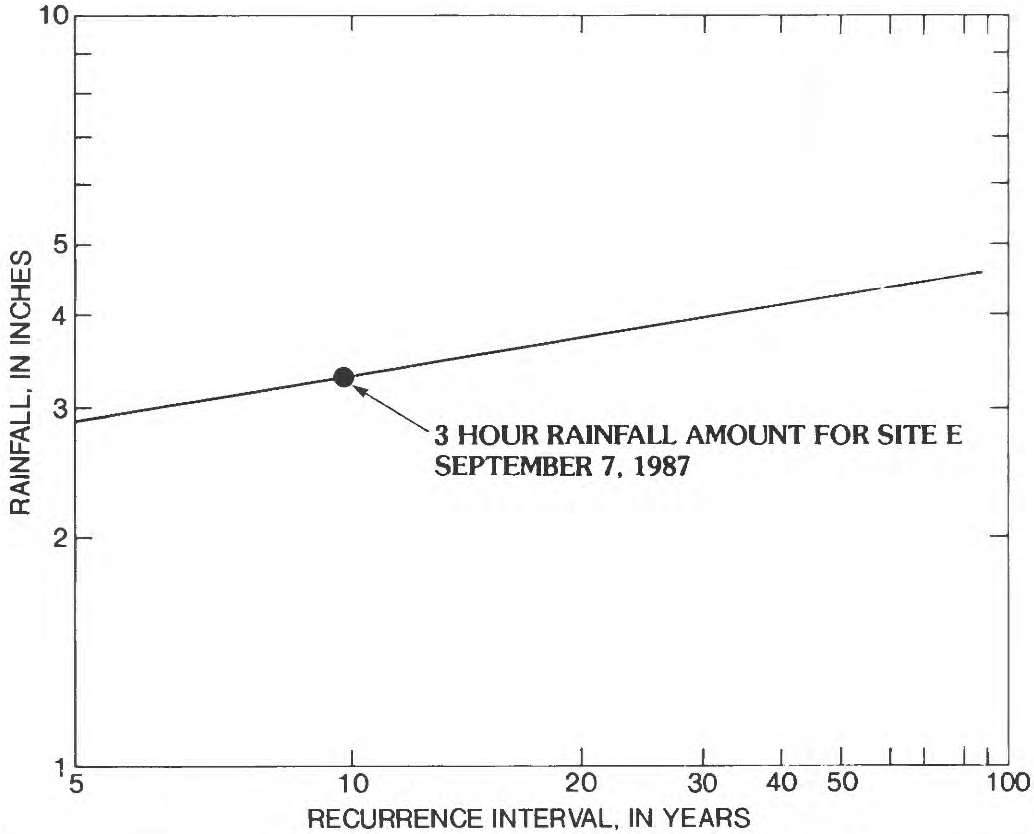

Figure 4.--Three-hour rainfall frequency relation for the Piedmont physiographic province of South Carolina.

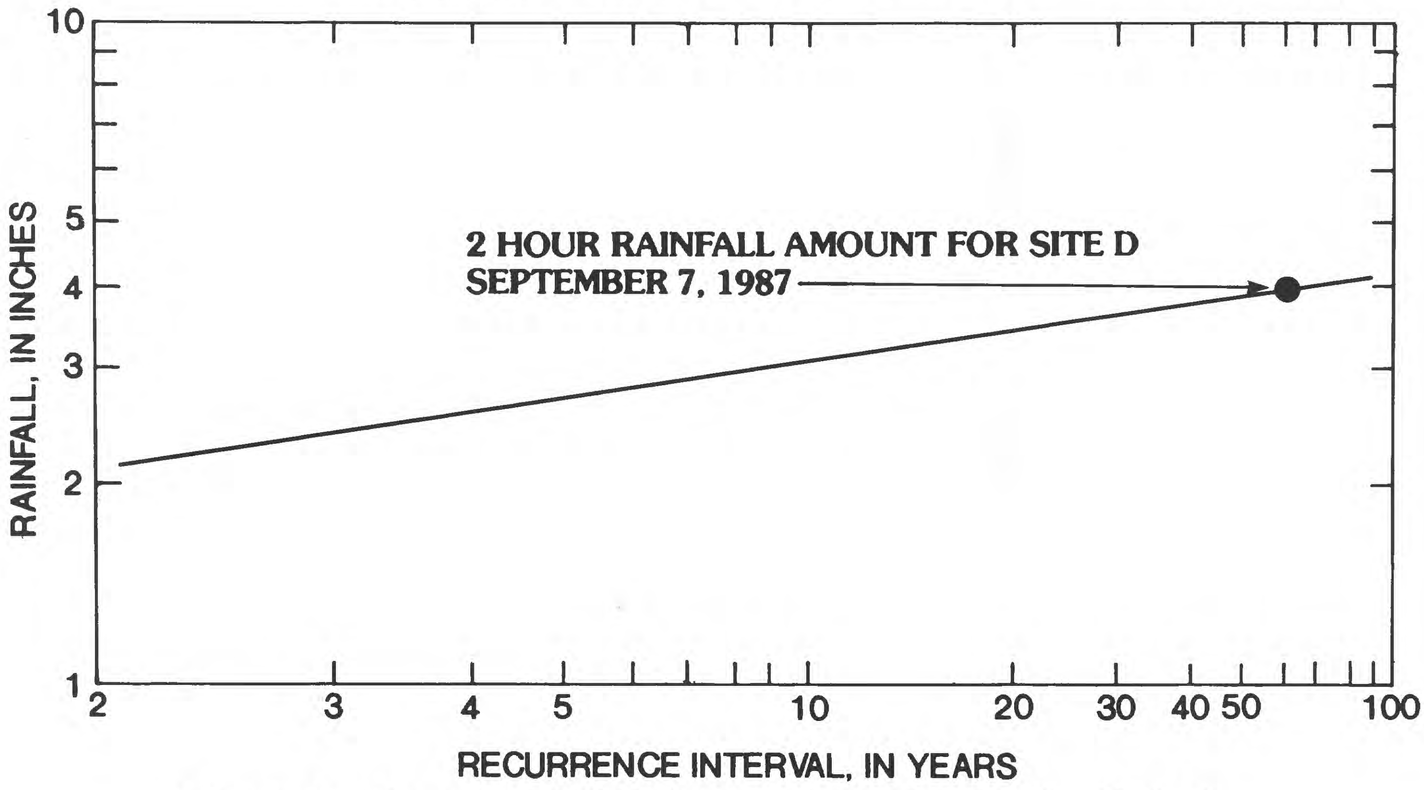

Figure 5.--Two-hour rainfall frequency relation for the Piedmont physiographic province of South Carolina.

Table 1.--Quanity, duration, and frequency of rainfall at selected rainfall reporting stations

Site number (figure 3)	Site location	Rainfall (inches)	Duration (hours)	Recurrence interval (years)
A	325 N. Royal Tower	5.4	3	>100
B	Friarsgate	5.5	3	>100
C	Rawls Creek near Hwy 60	5.5, 4.5	0.75, 2	>100, >100
D	Koon Branch at at Waterhill Drive	4.0	2	60
E	Near Harbison Boulevard East of I-26	3.3	≈ 3	10
F	Near Rawls Creek near Bush River Road	5.5	2	>100
G	Near Kinley Creek at St. Andrews Road	2.65	≈ 3	5
H	USGS Gaging Station (340240081081400)	0.73	2	<2

Peak Discharges

Peak disharges for the September 7, 1987, flood were computed for 16 sites shown on plate 1. The peak discharges ranged from 3,500 ft^3/s (cubic feet per second) on Rawls Creek at Site 5 (Nursery Road) to about 100 ft^3/s at the Unnamed Tributary to Kinley Creek at Site 13 (table 2). The peak discharges at sites affected by upstream storage in lakes and ponds have not been adjusted to remove the effects of storage. Peak discharges were unaffected by storage from lakes and detention ponds at the following sites: Site 11 (Lowery Creek at Columbia Avenue), Site 9 (Kinley Creek at Columbia Avenue), Site 18 (K-1 at Nottingham Drive), Site 16 (K-2 at Nottingham Drive), Site 6 (Koon Branch at South Carolina Electric and Gas Company railroad spur), Site 3 (Rawls Creek at Newberry Avenue), Site 1 (R-2 at South Royal Tower Drive), and Site 21 (Stoop Creek at Treetop Lane).

High-Water Mark Elevations

The elevation reached by floodwaters at a location is a function of the volume of water draining to the location, water-surface elevations downstream, and the carrying capacity or conveyance of the channel. Backwater from the Saluda River was not a factor in the area from the flood of September 7, 1987, because the rainfall was localized. Reduced channel conveyance did, however, contribute to the flooding at some locations along Koon Branch, Kinley Creek, and K-1 where channel obstructions caused ponding

Table 2.--Water-surface elevations and peak discharges at selected sites for the flood of September 7, 1987

[mi^2, square mile; ft^3/s, cubic foot per second]

Site number (plate 1)	Site location	Drainage area (mi^2)	Peak discharge (ft^3/s)	Headwater elevation (feet)	Tailwater elevation (feet)	Affected by upstream storage
1	R-2 at South Royal Tower Drive	0.92	686	317.99	316.59	No
3	Rawls Creek at Newberry Ave.	5.44	2,580	104.65	[1]102.05	No
4	Rawls Creek at Ripley Station Road	6.20	2,430	218.10	217.40	Yes
5	Rawls Creek at Nursery Road	8.32	3,500	200.46	[2,3]--	Yes
6	Koon Branch at SCEG spur RR	1.54	1,230	198.04	191.450	No
9	Kinley Creek at Columbia Ave.	.35	319	290.6	--	No
10	Kinley Creek at downstream crossing of Archers Lane	.49	209	279.8	[2]--	Yes
11	Lowery Creek at Columbia Ave.	1.49	416	274.48	[2]--	No
12	Kinley Creek at Beaver Dam	1.79	570	247.14	[2]--	Yes
13	Unnamed tributary to Kinley Creek at U.S. end of pond	.34	100	251.39	246.20	Yes
14	Unnamed tributary to Kinley Creek at outlet to pond on Archers Lane	.76	186	245.97	[2]--	Yes
15	Kinley Creek at Harbison Blvd.	3.05	1,020	224.55	223.25	Yes
16	K-2 at Nottingham Drive	1.43	939	198.48	197.48	No
[4]18	K-1 at Nottingham Drive	.39	250	203.80	200.80	No
19	Kinley Creek at Columbia, Newberry, Laurens RR	6.37	706	181.39	181.04	Yes
21	Stoop Creek at Treetop Lane	3.28	1,275	183.26	182.36	No

[1] Arbitrary datum used.
[2] Tailwater elevation not needed for indirect discharge computation.
[3] Storage effects were negligible because outflow capacity was large.
[4] Elevations and discharge on September 9, 1987.

or backwater conditions for some distance upstream. Culverts were obstructed on Koon Branch by debris at Waterhill Drive and Murraywood Drive causing water to flow over the embankments. Water also flowed over the road embankment at Fork Avenue and Finsbury Avenue, apparently because the culvert openings were too small to accommodate the flow. The culvert extends underneath high ground 150 feet downstream of Finsburry Avenue. Water flowing over Finsbury Avenue flooded property downstream as it made its way over the high ground to the stream below the culvert outlet. High-water marks could not be obtained for the reach between 8,180 feet and 9,900 feet; however, the flood appeared to be contained within the stream banks downstream of the culvert at Finsbury Avenue. According to residents, Kinley Creek experienced a temporary obstruction near Broken Hill Road when a fallen tree blocked flow and created ponding upstream. When the tree dislodged, ponded water was released and temporarily increased the flow downstream. Ponded conditions existed on K-1 at Old Friars Road where the culvert was 30 to 40 percent obstructed and water flowed over the road embankment.

The elevations reached by the floodwaters for the 16 sites where peak discharges were computed are presented in table 2. Peak water-surface elevations along all streams are presented in table 3. High-water marks are compared to the 100-year flood profile (FEMA) for the flood of September 7, 1987, in figures 6-14. Locations of stationing along the stream where the elevations of high-water marks were obtained and the benchmarks used in determining flood elevations are shown on plate 2. Benchmark elevations and descriptions are given in appendix A. These benchmarks may be useful for determining property elevations for comparison with the observed flood elevations.

Flood Frequency

The flood-frequency relations were computed for selected basins as part of this study. A flood-frequency relation is the relation of peak discharge to the probability of its occurrence in any one year. Recurrence interval (the reciprocal of the probability of occurrence) is the average time interval, in years, between which floods will equal or exceed the indicated magnitude. For example, a flood with a 100-year recurrence interval may be expected to be equaled or exceeded an average of once in 100 years. Stated another way, it is a flood that has a 1 percent probability of occurring in any given year. However, the occurrence of a flood of this magnitude in any given year does not reduce the probability of a flood of equal or greater magnitude occurring within the same year, or in consecutive years. When many years of flood-discharge data are available, flood-frequency relations are computed using annual maximum discharges and methods described in "Guidelines for Determining Flood Flow Frequency", Bulletin 17B of the U.S. Water Resources Council (1981). In the absence of long-term discharge records, as was the case in this study, flood-frequency relations can be computed from regional equations developed from data for nearby long-term discharge stations.

Discharges for selected recurrence intervals and the indirectly computed peak discharges for the flood of September 7, 1987, are given in table 4 for 10 indirect-measurement sites. Flood-frequency relations and the recurrence interval of peak discharge can be developed for each site

Table 3.--Peak water-surface elevations along streams, September 7 and 9, 1987
[dashes indicate no data]

Stream	Distance from confluence (feet)	High-water mark elevation (feet)
		Sept. 7, 1987
Stoop Creek	[1] 2,240	178.4
	[1] 2,420	179.1
	[1] 3,350	185.4
	[1] 4,400	188.2
	[1] 4,750	189.9
	[1] 5,900	194.8
	[1] 6,000	195.7
	[1] 7,200	203.2
	[1,4] 4,700	206.9
Kinley Creek	[1] 5,200	181.0
	[1] 5,300	181.4
	[1] 6,000	183.8
	[1] 6,850	186.4
	[1] 7,650	190.4
	[1] 8,450	191.8
	[1] 9,950	197.9
	[1] 10,700	200.2
	[1] 10,900	201.6
	[1] 12,330	209.7
	[1] 13,200	211.3
	[1] 14,400	214.2
	[1] 15,300	217.8
	[1] 16,550	223.2
	[1] 16,900	224.9
	[1] 17,600	228.6
	[1,4] 18,250	247.1
	[1] 21,250	253.5
	[1] 22,350	267.2
	[1] 22,450	277.4
	[1] 23,000	280.7
Kinley Creek	[1] 23,250	283.2
	[1] 23,350	284.3
	[1] 24,200	286.2
	[1] 24,300	290.6

Table 3.--Peak water-surface elevations along streams, September 7 and 9, 1987--Continued

[dashes indicate no data]

Stream	Distance from confluence (feet)	High-water mark elevation (feet)
		Sept. 7, 1987
Kinley Creek	[1,5]25,100	300.9
	[1,6]25,100	299.9
		Sept. 9, 1987
K-1	[2]300	190.3
	[2]1,550	200.8
	[2]1,650	203.8
	[2]2,700	217.0
	[2]3,000	219.0
	[2]3,200	223.5
	[2]3,800	227.7
	[2]4,000	232.9
	[2]5,200	249.8
	[2]5,500	256.3
		Sept. 7, 1987
K-2	[2]200	196.4
	[2]550	197.5
	[2]650	198.5
	[2]1,550	205.3
	[2]2,300	210.1
	[2]2,600	211.8
	[2]3,300	215.0
	[2]3,500	216.5
	[2,4]4,000	221.1
	[2]5,200	229.9
Lowery Creek	[2]200	249.8
	[2]300	251.8
	[2]1,000	253.6
	[2]2,850	267.7
	[2]3,050	274.5

Table 3.--Peak water-surface elevations along streams, September 7 and 9, 1987--Continued

[dashes indicate no data]

Stream	Distance from confluence (feet)	High-water mark elevation (feet)
		Sept. 7, 1987
Unnamed tributary to Kinley Creek	[2]2,450	233.2
	[2]2,800	235.8
	[2]3,150	246.0
	[2]3,900	246.2
	[2]4,050	251.4
	[2]5,600	263.4
Rawls Creek	[1]2,650	185.3
	[1]2,800	186.9
	[1]4,300	195.8
	[1]5,050	200.5
	[1]6,650	201.4
	[1]6,750	201.6
	[1]7,800	205.7
	[1]8,300	207.7
	[1]8,800	210.7
	[1]10,150	217.4
	[1]10,250	218.1
	[1]11,150	221.0
	[1]12,200	227.6
	[1]13,300	236.0
	[1]13,400	239 1
	[1]26,900	302.5
	[1]27,600	304.9
	[1,4]27,700	307.3
R-2	[3]900	299.9
	[3]2,000	304.5
	[3]2,100	306.9
	[3]3,250	316.6
	[3]3,350	318.0
Koon Branch	[3]860	192.0
	[3]960	198.0
	[3]1,660	198.9
	[3]2,580	206.9
	[3]3,040	211.0

Table 3.--Peak water-surface elevations along streams, September 7 and 9, 1987--Continued
[dashes indicate no data]

Stream	Distance from confluence (feet)	High-water mark elevation (feet)
		Sept. 7, 1987
Koon Branch	[3]3,700	214.2
	[3]4,000	217.9
	[3]4,820	223.1
	[3]4,920	223.9
	[3]5,900	234.8
	[3]6,340	---
	[3]7,040	249.7
	[3]7,500	253.6
	[3,4]8,180	261.3
	[3]9,900	279.1
	[3]10,100	283.4
	[3]10,600	291.5

[1]Distance from confluence with Saluda River.
[2]Distance from confluence with Kinley Creek.
[3]Distance from confluence with Rawls Creek.
[4]End of FEMA study
[5]West branch of Kinley Creek.
[6]East branch of Kinley Creek.

Table 4.--Computed discharges for the flood of September 7, 1987, and estimated discharges for various recurrence intervals

[mi^2, square mile; ft^3/s; cubic foot per second]

Site number (plate 1)	Location	Drainage area (mi^2)	Peak discharges for indicated recurrence interval (ft^3/s)					Computed discharge (ft^3/s)
			5 years	10 years	25 years	50 years	100 years	
1	R-2 at South Royal Tower Drive	0.92	355	479	631	790	934	686
3	Rawls Creek at Newberry Ave.	5.44	1,140	1,520	1,990	2,430	2,870	2,580
4	Rawls Creek at Ripley Station Road	6.20	1,270	1,680	2,180	2,660	3,140	2,430
5	Rawls Creek at Nursery Road	8.32	1,530	2,020	2,630	3,180	3,770	3,500
6	Koon Branch at SCEG' spur RR	1.54	543	715	922	1,140	1,340	1,230
9	Kinley Creek at Columbia Ave.	.35	189	254	331	418	494	319
11	Lowery Creek at Columbia Ave.	1.49	232	319	430	547	646	416
16	K-2 at Nottingham Drive	1.43	554	732	945	1,160	1,380	939
18	K-1 at Nottingham Drive	.39	226	301	391	490	580	[1]250
21	Stoop Creek at Treetop Lane	3.28	981	1,280	1,640	1,990	2,350	1,275

[1]Peak discharge for the September 9, 1987 flood.

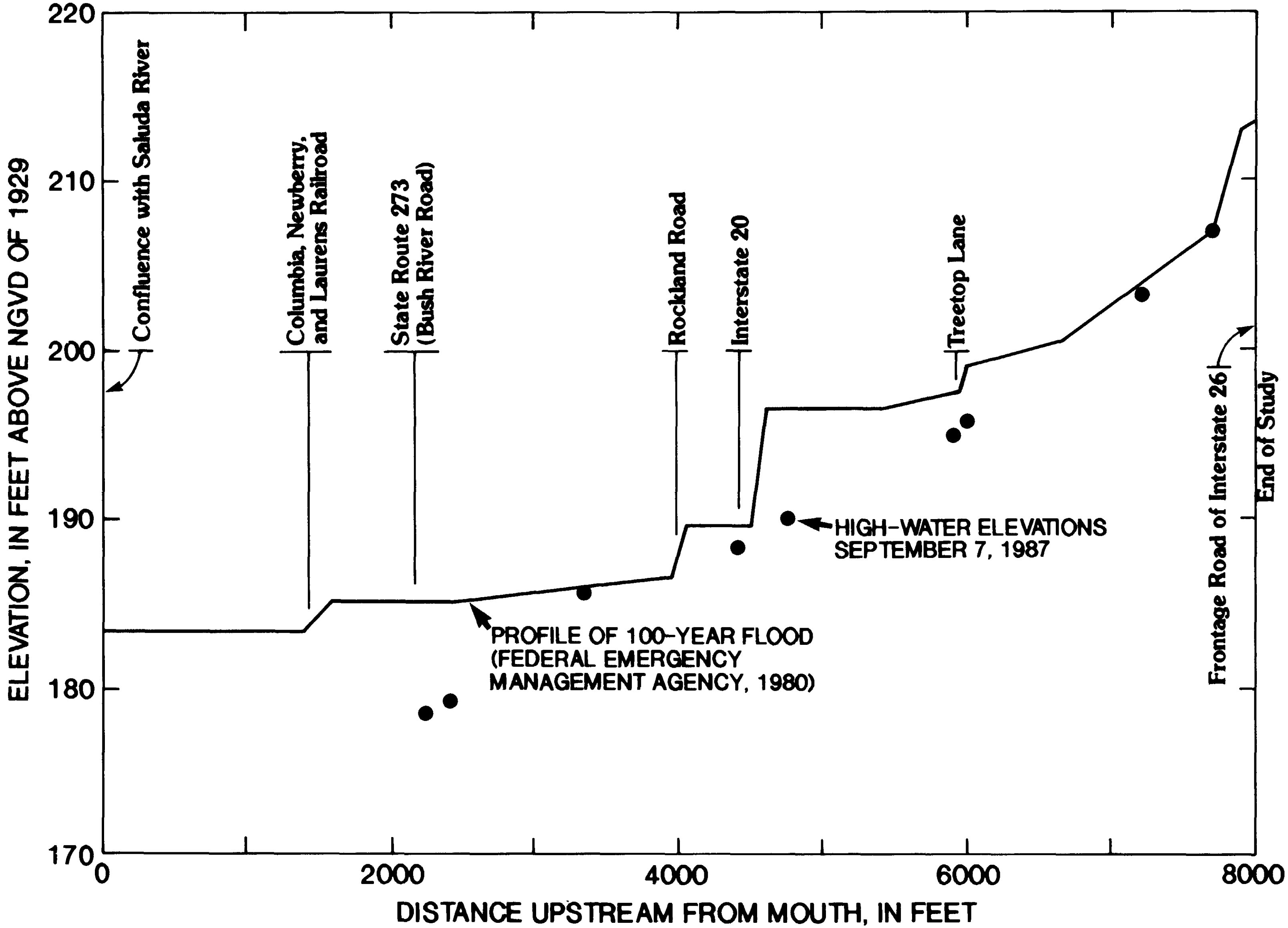

Figure 6.--High-water elevations for the flood of September 7, 1987, and the 100-year flood profile along Stoop Creek.

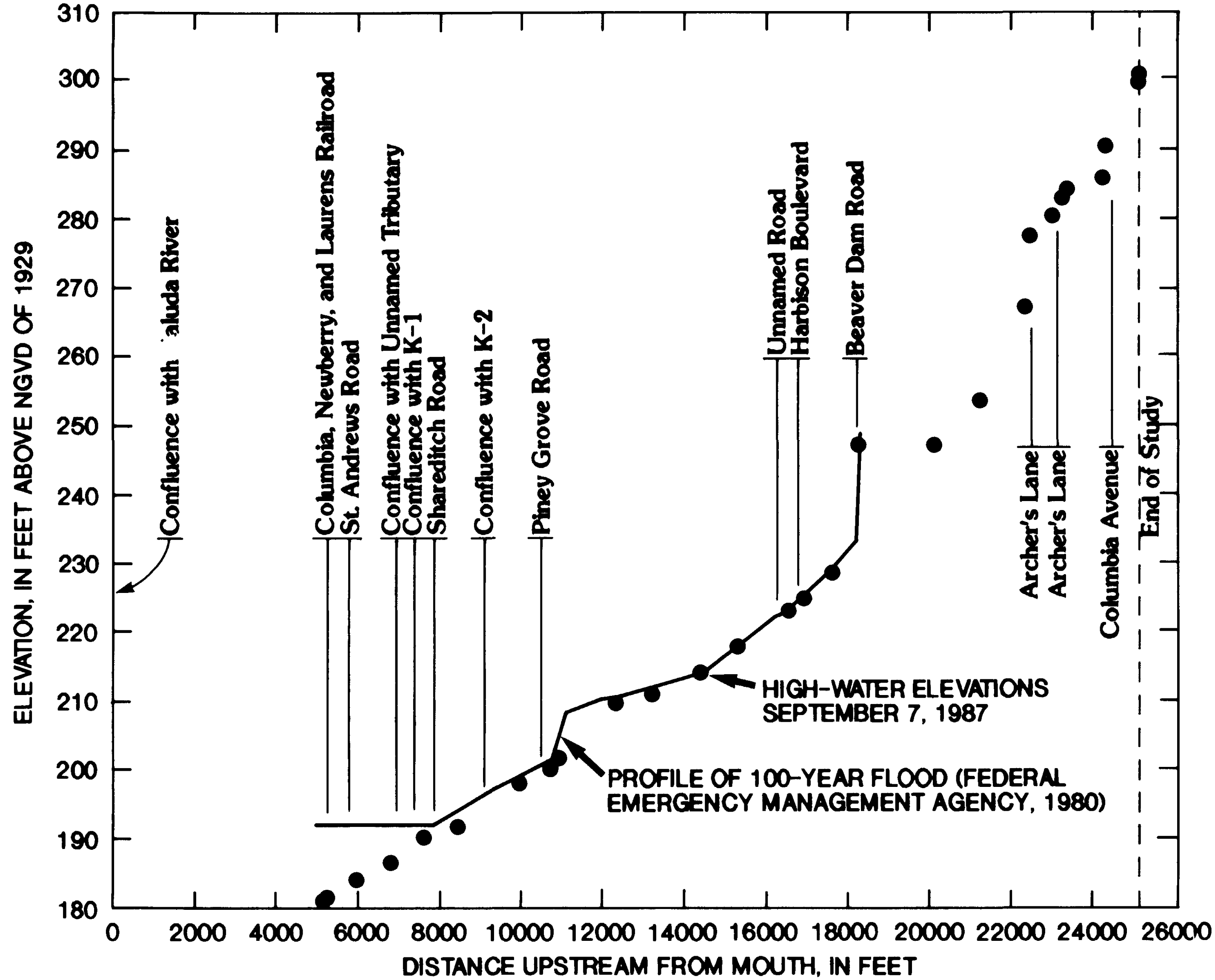

Figure 7.--High-water elevations for the flood of September 7, 1987, and the 100-year flood profile along Kinley Creek.

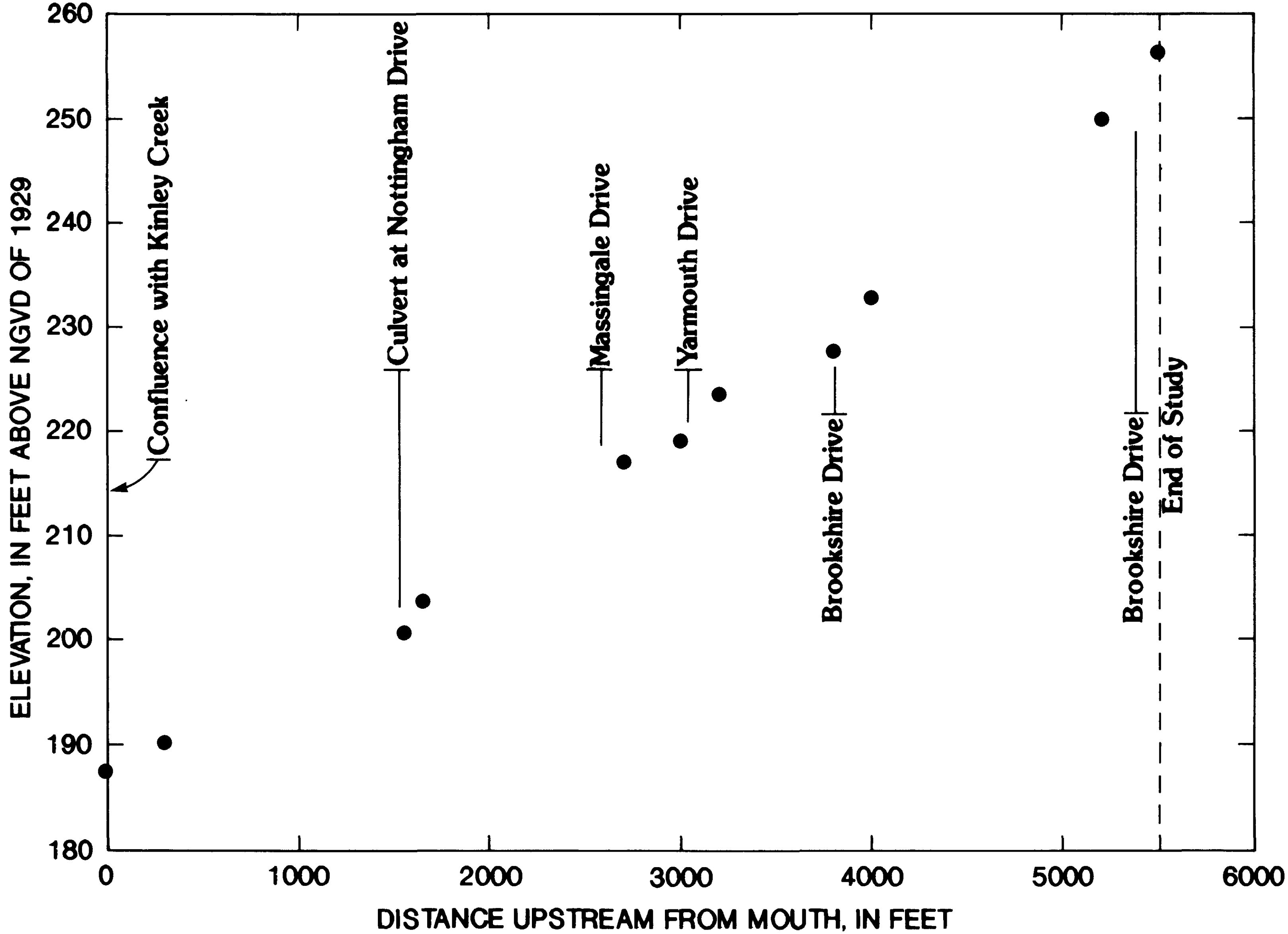

Figure 8.--High-water elevations for the flood of September 9, 1987, along K-1.

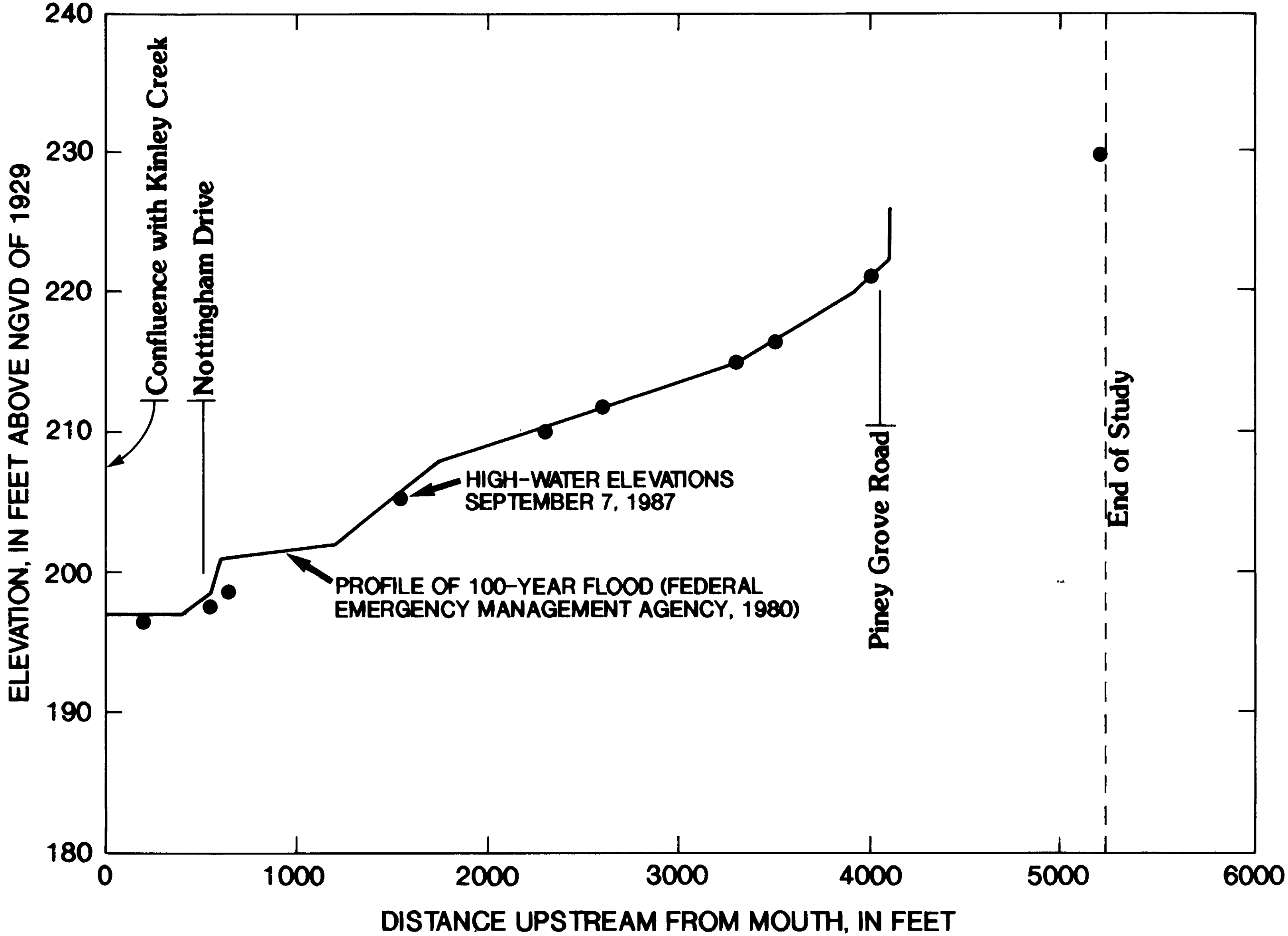

Figure 9.--High-water elevations for the flood of September 7, 1987, and the 100-year flood profile along K-2.

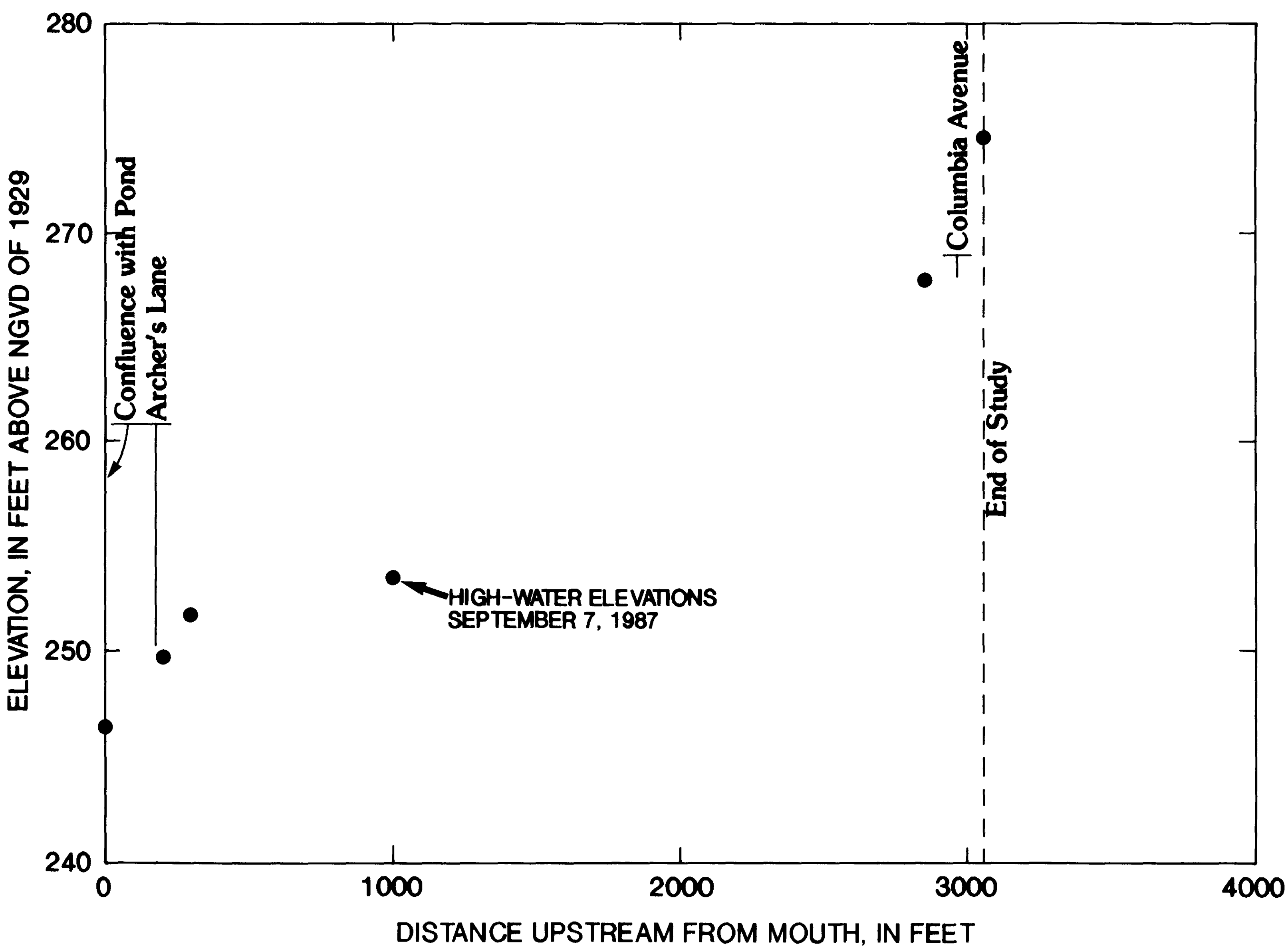

Figure 10.--High-water elevations for the flood of September 7, 1987, along Lowery Branch.

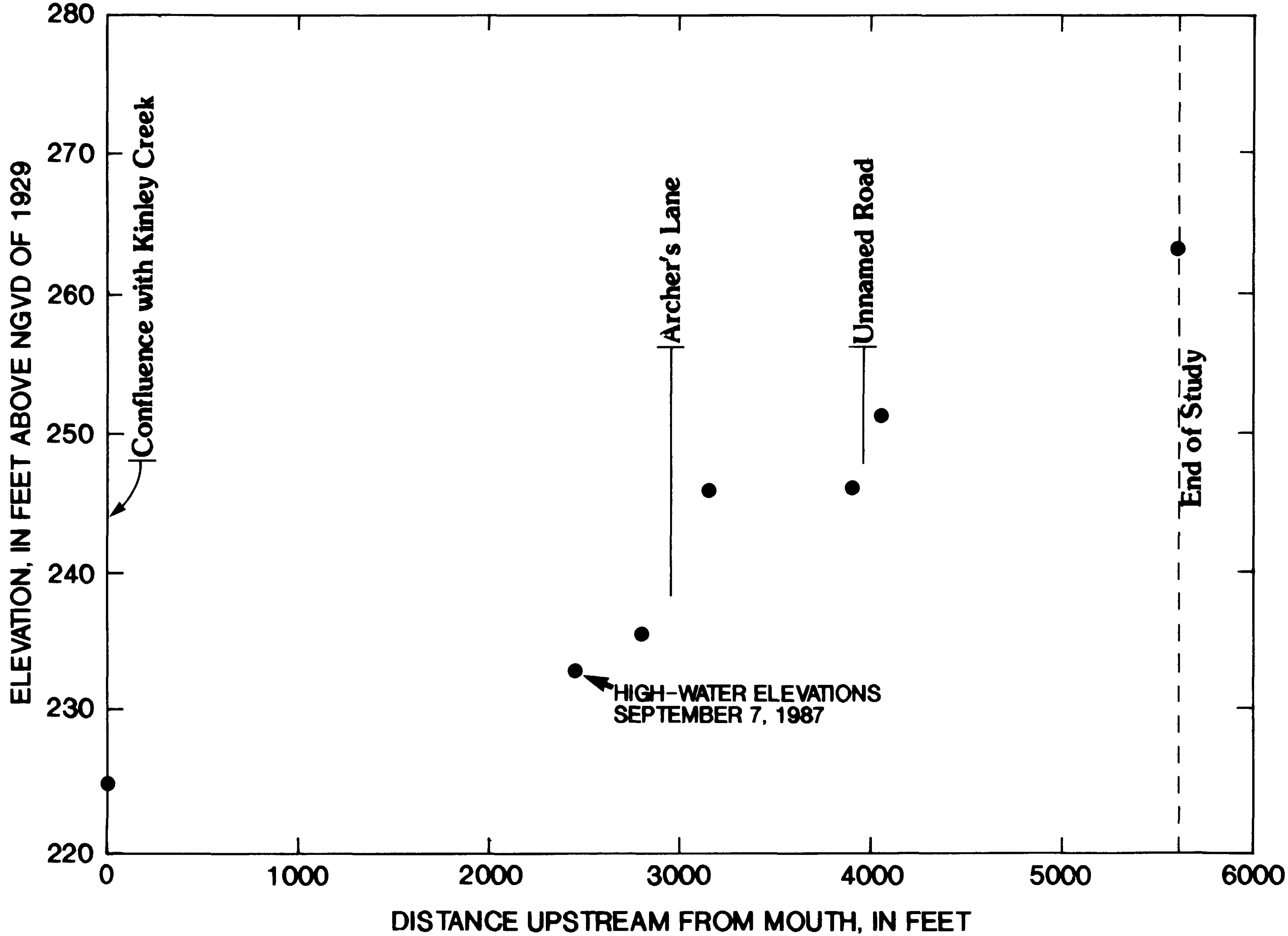

Figure 11.--High-water elevations for the flood of September 7, 1987, along Unnamed Tributary to Kinley Creek.

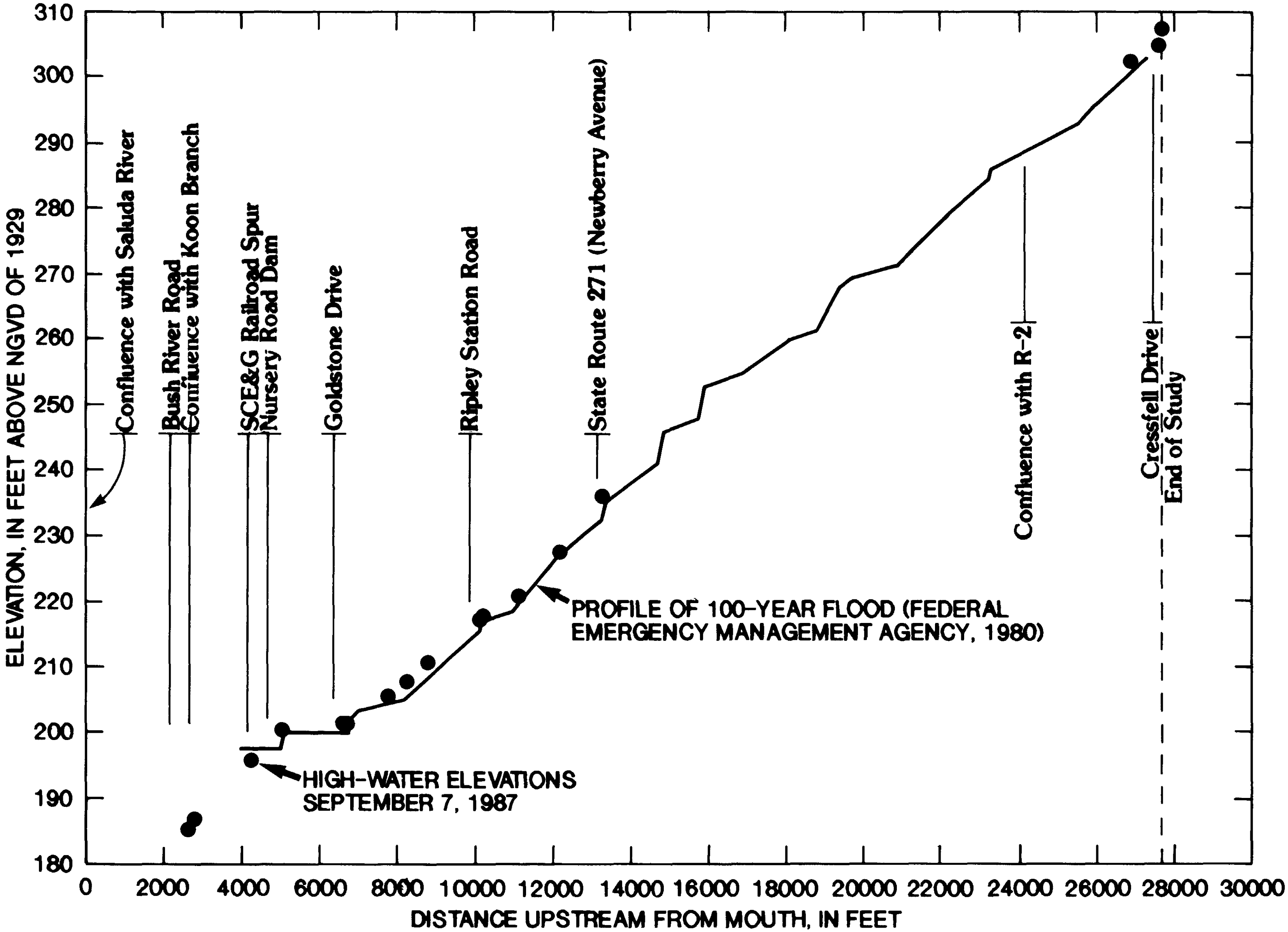

Figure 12.--High-water elevations for the flood of September 7, 1987, and the 100-year flood profile along Rawls Creek.

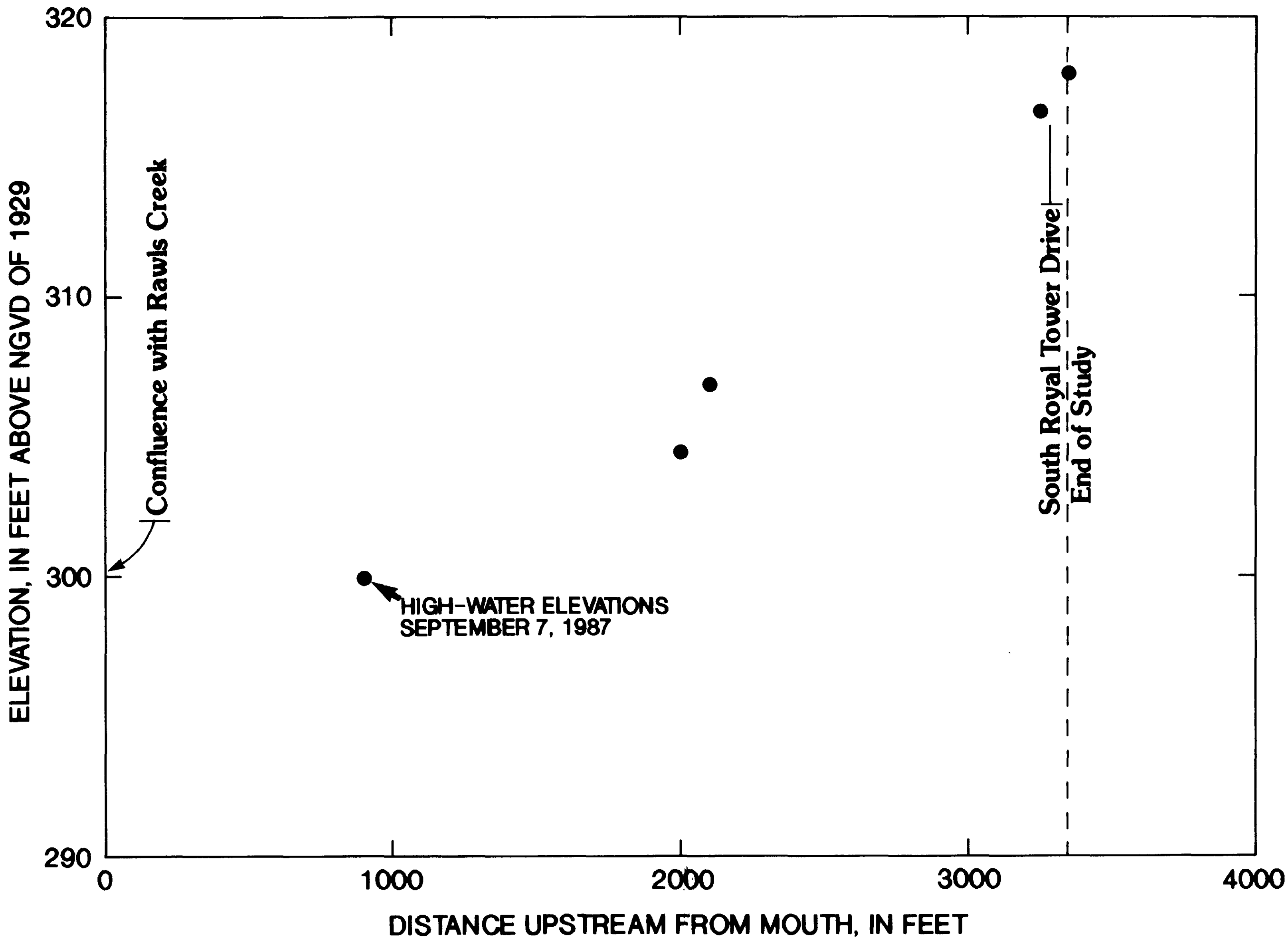

Figure 13.--High-water elevations for the flood of September 7, 1987, along R-2.

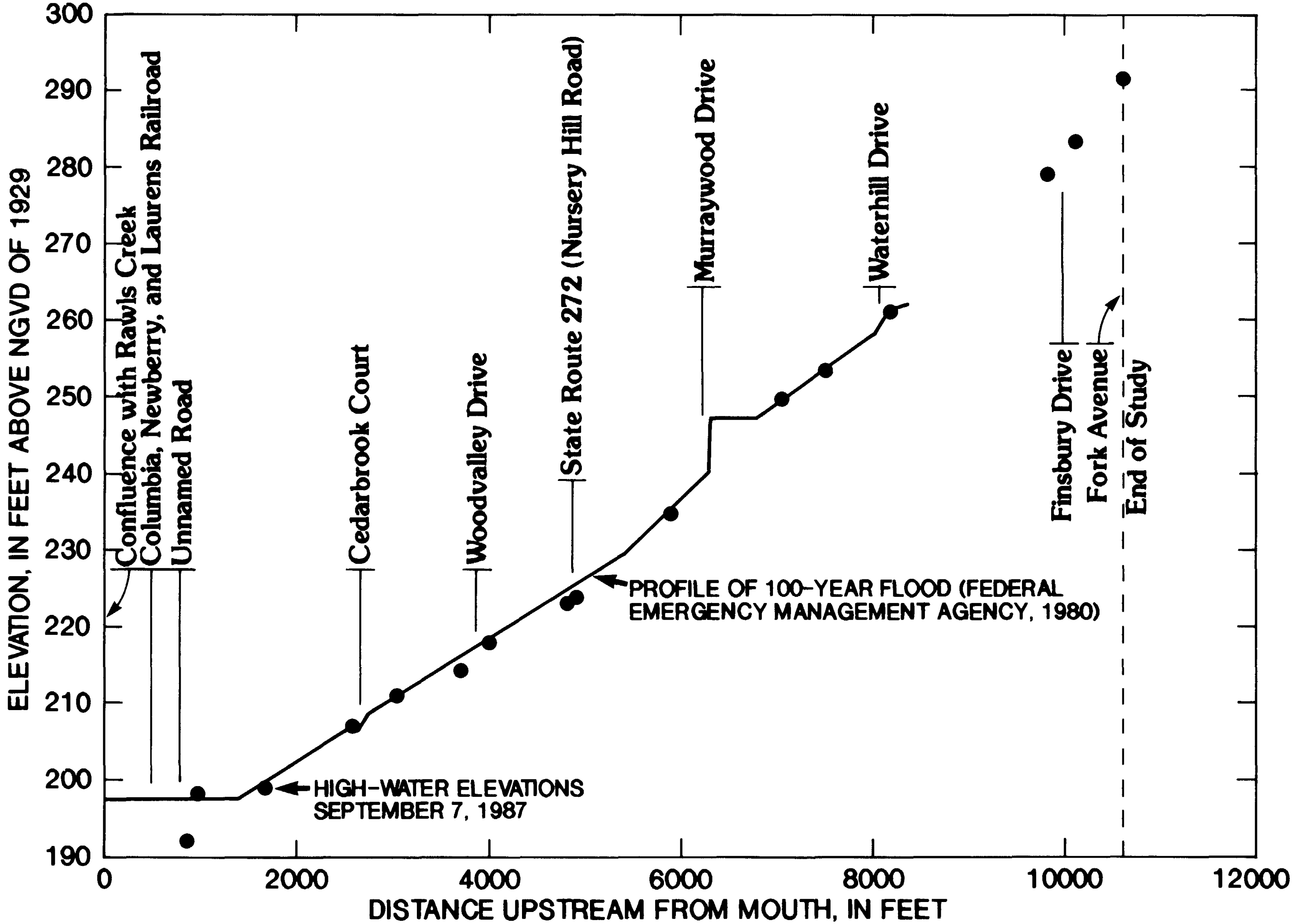

Figure 14.--High-water elevations for the flood of September 7, 1987, and the 100-year flood along Koon Branch.

from the data in table 4 for the September 7, 1987, flood. Flood frequency relations for sites on Rawls Creek, Koon Branch, and Kinley Creek are shown in figures 15, 16, and 17, respectively.

Recurrence intervals for computed peak discharges for the flood of September 7, 1987, are shown on figure 18. The recurrence interval was as large as 75 years for the most downstream site on Rawls Creek, and was 60 years at the most downstream site on nearby Koon Branch. Recurrence intervals varied from 20 to 25 years along Kinley Creek north of the basin divide of K-1 and K-2, but were 10 years or less at sites on K-1 and Stoop Creek.

Flood frequencies were determined for Rawls Creek at Newberry Avenue (Highway 60), Ripley Station Road, and at the Nursery Road dam to be 67 years, 40 years, and 75 years, respectively. The computed recurrence interval of 40 years for the site at Ripley Station Road may have been low because storage in a pond in the Coldstream Country Club could have affected the peak discharge.

The regionalized flood-frequency equations used to compute discharges of various recurrence intervals (table 4) were derived for free-flowing streams that are not affected by storage in upstream lakes or detention ponds. Therefore, the computed recurrence intervals for the September 7, 1987, flood do not reflect upstream storage and have not been adjusted for the small amount of storage afforded by the retention pond on Kinley Creek and the numerous small recreation ponds throughout the area.

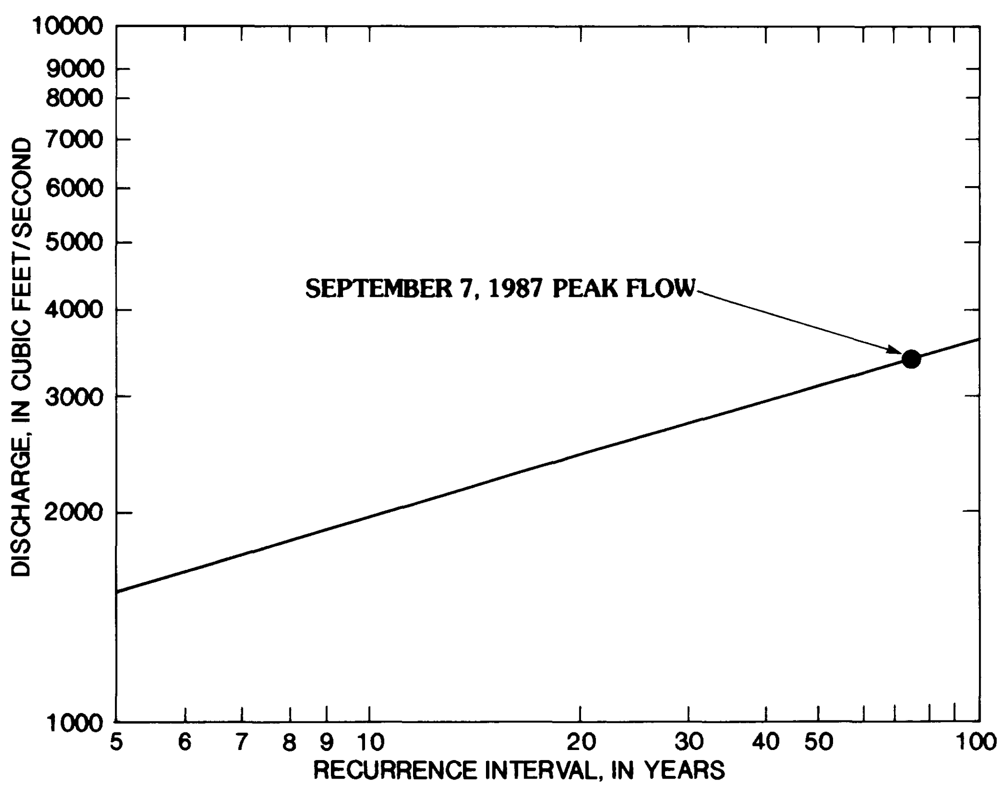

Figure 15.--Flood-frequency relation for Rawls Creek at Nursery Road.

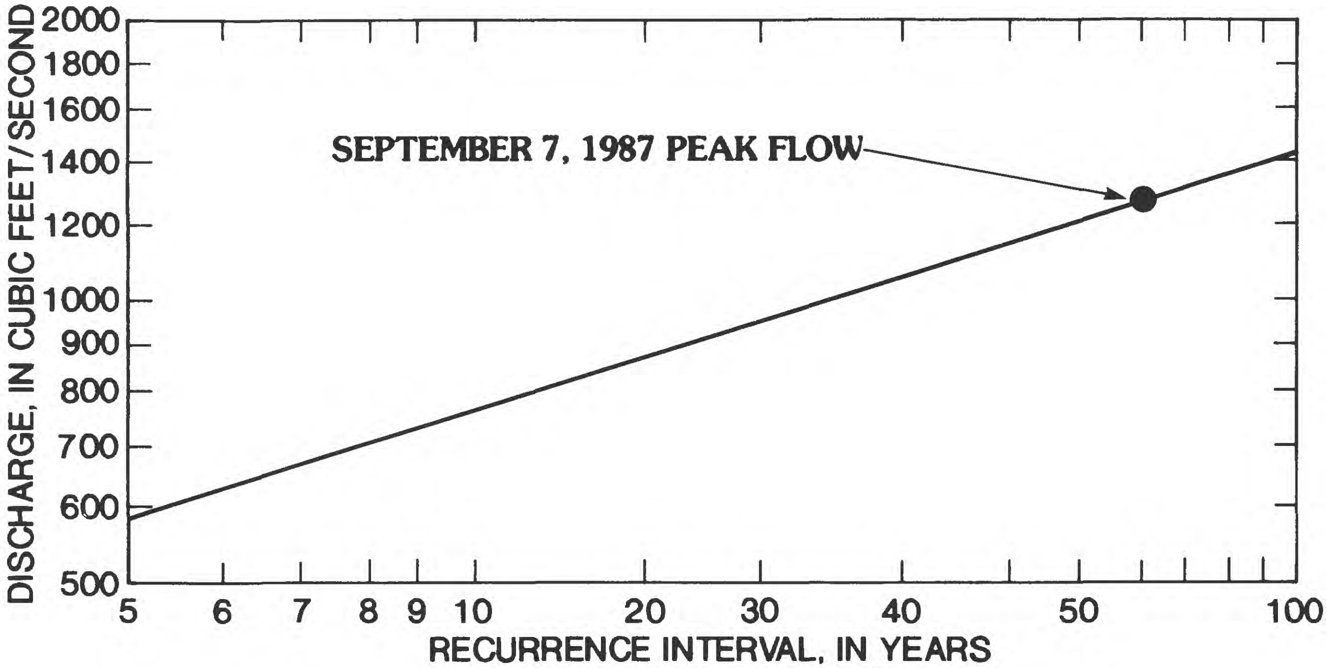

Figure 16.--Flood-frequency relation for Koon Branch at South Carolina Electric and Gas Railroad spur for the flood of September 7, 1987.

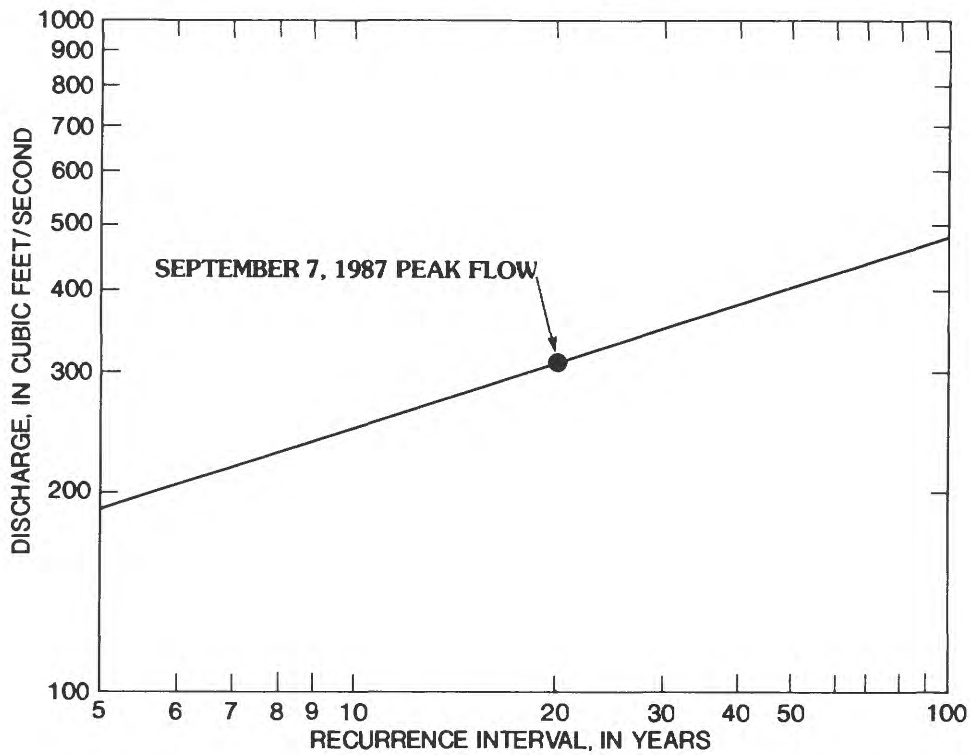

Figure 17. Flood-frequency relation for Kinley Creek at Columbia Avenue for the flood of September 7, 1987.

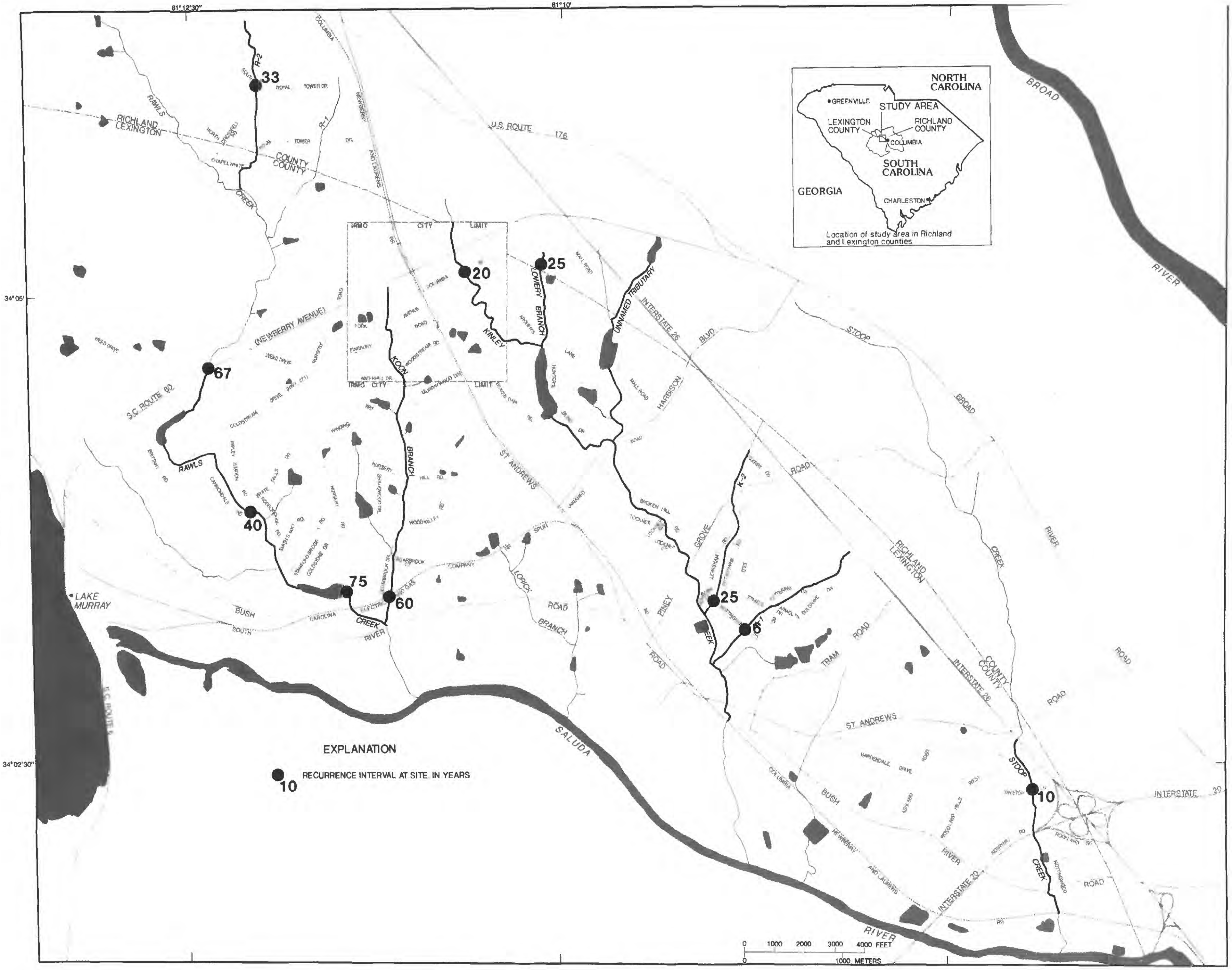

Figure 18.--Recurrence intervals for peak discharges at selected sites in Lexington and Richland Counties for the flood of September 7, 1987.

For comparison, discharges for selected recurrence intervals computed by the Federal Emergency Management Agency (FEMA) and the U.S. Geological Survey (USGS) are given for selected sites in table 5 and shown on plate 1. The FEMA flood-frequency data were determined in a 1980 study, which was conducted to prepare flood-insurance maps (Federal Emergency Management Agency, 1980), and were computed using urban flood-frequency equations developed by Putnam (1972) that were based on data for North Carolina. The USGS flood-frequency data were determined using rural flood-frequency equations developed by Whetstone (1982), and adjusted for urbanization using methods described by Sauer and others (1983). The equations by Whetstone (1982) are statewide, rural equations developed using data from South Carolina. These equations, used in conjunction with those by Sauer and others (1983) are currently the accepted method of determining urban flood-frequency relations for South Carolina streams where no local flood-frequency relations exist. Although the FEMA and USGS methods and results differed and basin characteristics probably have changed substantially during the period since the 1980 FEMA study, the statistical analyses showed that the USGS flood-frequency relation did not differ significantly from the FEMA flood-frequency relation at most sites.

Table 5.--Estimated peak discharges of the Federal Emergency Management Agency and the U.S. Geological Survey for the 10-, 50-, and 100-year floods at selected sites in Lexington and Richland Counties

Site number (plate 1)	Location	Study	Drainage area (square miles)	Peak discharge for indicated recurrence interval (cubic feet per second)		
				10 years	50 years	100 years
2	Tributary R-2 at mouth	FEMA[1]	1.20	820	1,340	1,580
		USGS[2]	1.22	628	1,010	1,200
7	Koon Branch at mouth	FEMA[1]	1.50	960	1,560	1,820
		USGS[2]	1.54	715	1,140	1,340
8	Rawls Creek at mouth	FEMA[1]	10.30	2,930	4,310	4,810
		USGS[2]	10.48	2,540	3,930	4,640
15	Kinley Creek above Harbison Blvd.	FEMA[1]	3.11	940	1,600	1,900
		USGS[2]	3.05	1,023	1,620	1,920
17	Kinley Creek above confluence W/K-2	FEMA[1]	5.49	1,410	2,420	2,830
		USGS[2]	5.47	1,546	2,420	2,860
20	Kinley Creek at mouth	FEMA[1]	7.00	2,280	3,440	3,880
		USGS[2]	6.89	1,730	2,700	3,200
22	Stoop Creek at mouth	FEMA[1]	3.90	1,540	2,420	2,790
		USGS[2]	3.92	1,410	2,190	2,590

[1] Federal Emergency Management Agency
[2] U.S. Geological Survey

SUMMARY

Rainfall totals of up to 5.5 inches in a 3-hour period on September 7, 1989, resulted in flash flooding in and around the town of Irmo, South Carolina. Rainfall intensities, reported by several local residents, had recurrence intervals in excess of 100 years. The intense rainfall resulted in a flash flood, referred to locally as the Labor Day flood, which overtopped streets and bridges and damaged residential property along streams in the area. The magnitude and frequency of flooding along Rawls Creek and two of its tributaries (R-2 and Koon Branch), Kinley Creek and three of its tributaries (K-2, Lowery Creek, and an unnamed tributary), and Stoop Creek are documented in this report for the flood of September 7, 1987. Also included in this report are flood data for a slightly larger flood of September 9, 1987, on another tributary to Kinley Creek (K-1).

High-water marks for the flood of September 7, 1987, are shown for eight stream reaches in the area. High-water marks are also shown for the flood of September 9, 1987, on K-1. Profiles for the 100-year flood developed by FEMA in a 1980 flood insurance mapping study are shown for comparison purposes for five of the stream reaches.

Peak discharges were computed at 16 sites in the area by using indirect measurement techniques. Peak discharges ranged from about 100 ft^3/s (cubic feet per second) at the site on a small unnamed Tributary to Kinley Creek to 3,500 ft^3/s at the Rawls Creek site at Nursery Road. Peak discharges at the most downstream sites on Rawls Creek and Koon Branch had recurrence intervals of 75 years, and 60 years, respectively. Peak discharges on Kinley Creek varied from 20 to 25 years north of K-1 basin to less than 10 years at K-1. The Stoop Creek basin had a recurrence interval of 10 years. Peak discharges for selected recurrence intervals computed by the U.S. Geological Survey and presented in this flood report agree reasonably well with those computed by FEMA in a 1980 study using different computational procedures.

REFERENCES

Agricultural Stabilization and Conservation Service, 1981, Aerial photographs, Lexington County, South Carolina: U.S. Department of Agriculture, State/County 45063, film roll 178, no. 22, 53, 54, 55, 92, 93, and 94, scale 1:333.

Bodhaine, G.L., 1968, Measurement of peak discharge at culverts by indirect methods: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. A3, 60 p.

Federal Emergency Management Agency, 1980, Flood insurance study, Unincorporated Areas, South Carolina, Lexington County: Federal Emergency Management Agency, Flood Insurance Study, 34 p.

Hershfield, D.M., 1961, Rainfall frequency atlas of the United States for durations from 30 minutes to 24 hours and return periods from 1 to 100 years: U.S. Weather Bureau Technical Paper No. 40, 115 p.

Hulsing, H., 1967, Measurement of peak discharge at dams by indirect methods: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. A5, p. 29.

Matthai, H.F., 1967, Measurement of peak discharge at width contractions by indirect methods: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. A4, 44 p.

Matthai, H.F., Stull, H.E., and Davidian, J., undated, Preparation of input data for automatic computation of stage-discharge relations at culverts: U.S. Geological Survey Techniques of Water-Resources Investigations, book 7, chap. C3, 25 p.

Putnam, A.L., 1972, Effect of urban development on floods in the Piedmont Province of North Carolina: U.S. Geological Survey, unnumbered Open-File Report, 87 p.

Sauer, V.B., Thomas, W.O., Jr., Stricker, V.A., and Wilson, K.V., 1983, Flood characteristics of urban watersheds in the United States: U.S. Geological Survey Water-Supply Paper 2207, 63 p.

Shearman, J.O., Kirby, W.H., Schneider, V.R., and Flippo, H.N., 1986, Bridge waterway analysis model/research report: U.S. Geological Survey and the Federal Highway Administration, Office of Research and Development, FHWA/RD-86-108, 112 p.

U.S. Water Resources Council, 1981, Guidelines for determining flood flow frequency: U.S. Water Resources Council Bulletin 17B, 183 p.

Whetstone, B.H., 1982, Techniques for estimating magnitude and frequency of floods in South Carolina: U.S. Geological Survey Water-Resources Investigations 82-1, 78 p.

APPENDIX A

LIST OF BENCHMARKS

APPENDIX A

BENCHMARKS

Number	Description	Elevation (feet above sea level)
BM 1	Chiseled square on northeast side of bridge at St. Andrews Road over Kinley Creek, established by U.S. Geological Survey.	189.49
BM 1A	Chiseled square on northwest abutment of the Columbia, Newberry, Laurens Railroad bridge over Kinley Creek, established by U.S. Geological Survey.	187.69
BM 2	Chiseled square on northeast side of Nottingham Drive on top of culvert, over K-1, established by U.S. Geological Survey.	205.20
BM 3	Chiseled square on curb next to mailbox of 407 Old Friars Road, established by U.S. Geological Survey.	215.82
BM 4	Chiseled square on a catch basin on the northeast side of Yarmouth Road over K-1, established by U.S. Geological Survey.	220.54
BM 5	Chiseled square on the southeast side of bridge of Piney Grove Road over Kinley Creek, established by U.S. Geological Survey.	205.15
BM 6	Chiseled square on a catch basin on the southwest side of Foxfire Drive, over K-2, established by U.S. Geological Survey.	231.32
BM 7	Chiseled square on a catch basin on the southwest side of Harbison Blvd. near Kinley Creek, established by U.S. Geological Survey.	225.95
BM 8	Chiseled square on a foot bridge over Kinley Creek, established by U.S. Geological Survey. The foot bridge is located between Quail Valley swimming pool and tennis courts.	229.13

APPENDIX A

BENCHMARKS

Number	Description	Elevation (feet above sea level)
BM 9	Chiseled square on south side of Archers Lane dam to pond over Unnamed tributary to Kinley Creek, established by U.S. Geological Survey.	259.56
BM 10	Chiseled square on north side of Columbia Avenue on top of RCP culvert over Lowery Creek, established by U.S. Geological Survey.	272.83
BM 11	Chiseled square on northwest abutment of dam on Nursery Road over Rawls Creek, established by U.S. Geological Survey.	205.46
BM 12	Chiseled square on catch basin in front of 501 Smith Market Road, near Rawls Creek, established by U.S. Geological Survey.	205.07
BM 13	Chiseled square on southwest curb of bridge in front of 200 Rodborough Drive, over an unnamed tributary to Rawls Creek, established by U.S. Geological Survey.	213.63
BM 14	Cniseled square on curb on the northwest side of bridge of Cedar Brook Court over Koon Branch, established by U.S. Geological Survey.	209.28
BM 15	Chiseled square on catch basin on the corner of Cedarbrook Drive, and Shadowood Drive, near Koon Branch established by U.S. Geological Survey.	208.82
BM 16	Chiseled square on the curb on the southwest side of bridge of Wood Valley Drive over Koon Branch, established by U.S. Geological Survey.	215.40
BM 17	Chiseled square on catch basin in front of 142 Cannondale Drive, near Rawls Creek, established by U.S. Geological Survey.	220.08
BM 18	Chiseled square on catch basin in front of 180 Cannondale Drive, near Rawls Creek, established by U.S. Geological Survey.	225.91

APPENDIX A

BENCHMARKS

Number	Description	Elevation (feet above sea level)
BM 19	Chiseled square on southwest side of bridge of Coldstream Drive over Rawls Creek, established by U.S. Geological Survey.	235.87
BM 20	Chiseled square on catch basin approximately 50 feet east of downstream side of North Royal Tower Drive bridge over R-2, established by U.S. Geological Survey.	309.45
BM 21	Chiseled square on southwest side of bridge on Bush River Road over Stoop Creek, established by U.S. Geological Survey.	184.76
BM 22	Chiseled square west of culvert approximately 7 feet north of manhole, 10 feet south of building on Berryhill Road at Village Tavern near Stoop Creek, established by U.S. Geological Survey.	188.11
BM 23	Chiseled square on curb on southwest side of bridge of Treetop Lane over Stoop Creek, established by U.S. Geological Survey.	197.24
BM 24	Chiseled square on curb in northwest corner of parking lot behind The Interstate Center on Berryhill Road, near Stoop Creek, established by U.S. Geological Survey.	203.92
BM 29	Chiseled square on north side of Finsbury Road between 218 and 212 Finsbury Road, near Koon Branch, established by U.S. Geological Survey.	279.57
BM 30	Chiseled square on north, upstream side of RCP culvert on Fork Avenue over Koon Branch, established by U.S. Geological Survey.	286.87
RMX 1	Chiseled square on southwest side of curb of the furthest upstream crossing of Kinley Creek and Archers Lane, established by U.S. Geological Survey.	293.53

APPENDIX A

BENCHMARKS

Number	Description	Elevation (feet above sea level)
RMX 3	Chiseled square on north side of Columbia Avenue on top of RCP culvert over Kinley Creek, established by U.S. Geological Survey.	288.92
RMX 4	Chiseled "x" on drop inlet approximately 65 feet west of northwest bridge corner of the furthest downstream crossing of Archers Lane over Kinley Creek, established by U.S. Geological Survey.	281.54
RMX 5	Chiseled "x" on head wall of outflow pipe from Murraywood subdivision northwest and approximately 50 feet upstream of culvert entrance, near Koon Branch, established by U.S. Geological Survey.	191.32
RMX 6	Chiseled square on catch basin on Cedar Brook Drive in front of 2024 Cedar Brook Drive and approximately 25 feet north of fire hydrant, near Koon Branch, established by U.S. Geological Survey.	201.27
RMX 7	Chiseled square in southeast corner of catch basin at the end of Winding Way, near Koon Branch, established by U.S. Geological Survey.	270.68
RM 2	Chiseled x cut in the top of a curb at the southeast corner of a bridge at the upstream crossing of South Royal Tower over tributary R-2, established by U.S. Army Corps of Engineers.	320.99
RM 6	Chiseled square in the top of a masonry box culvert on the north side of the Columbia, Newberry, and Laurens bridge over Stoop Creek, established by U.S. Army Corps of Engineers.	178.17

APPENDIX A

BENCHMARKS

Number	Description	Elevation (feet above sea level)
RM 7	Chiseled square in the top of a curb at the northeast corner of Rockland Road bridge over Stoop Creek, established by U.S. Army Corps of Engineers.	187.65
RM 17	Chiseled square cut in top of concrete base for traffic stop signal at the intersection of the Columbia, Newberry, and Laurens Railroad and St. Andrews Road, near Kinley Creek, established by U.S. Army Corps of Engineers.	197.79
RM 19	Chiseled square cut in top of concrete catch basin cover at east corner of the intersection of Pittsdowne Road and Nottingham Road, near K-2, established by U.S. Army Corps of Engineers.	201.45
RM 20	Railroad spike driven into South Carolina Electric and Gas Company power pole, #138358, approximately 2 feet above ground at the northeast corner of the intersection of Piney Grove Road and Nottingham Road, near Kinley Creek, established by U.S. Army Corps of Engineers.	210.15
RM 21	Chiseled square cut in top of curb on northeast side of Piney Grove Road bridge over tributary K-2, established by U.S. Army Corps of Engineers.	225.74
RM 23	Chiseled square cut in top of curb at northeast corner of Beaver Dam Road bridge over spillway at Lake Quail Valley, over Kinley Creek, established by U.S. Army Corps of Engineers.	251.64
RM 24	Chiseled square cut in top of curb at northeast corner of Bush River Road bridge over Rawls Creek, established by U.S. Army Corps of Engineers.	188.24

APPENDIX A

BENCHMARKS

Number	Description	Elevation (feet above sea level)
RM 26	Chiseled "x" cut in top of curb at east corner of Goldstone Drive bridge over Rawls Creek, established by U.S. Army Corps of Engineers.	207.41
RM 27	Chiseled square cut in top of concrete curb at northeast corner of Woodvalley Drive bridge over Koon Branch, established by U.S. Army Corps of Engineers.	215.35
RM 28	Chiseled square cut in top of concrete curb at northeast end of Nursery Hill Road bridge over Koon Branch, established by U.S. Army Corps of Engineers.	227.53
RM 30	Chiseled square cut in top of concrete gutter at northwest corner of the intersection of Woodstream Road and Water Hill Drive, near Koon Branch, established by U.S. Army Corps of Engineers.	266.68
RM 31	Chiseled "x" cut in top of curb at southwest end of Ripley Station Road bridge over Rawls Creek, established by U.S. Army Corps of Engineers.	216.80

Note: Bench marks established by the U.S. Army Corps of Engineers were established for FEMA.