CANE CREEK FLOOD-FLOW CHARACTERISTICS AT STATE ROUTE 30 NEAR SPENCER, TENNESSEE

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FACTORS FOR CONVERTING INCH-POUND UNITS TO INTERNATIONAL SYSTEM UNITS (SI)

The following factors may be used to convert the inch-pound units used herein to the International System of Units (SI):

Multiply	By	To obtain
feet (ft)	0.3048	meters (m)
miles (mi)	1.609	kilometers (km)
square miles (mi^2)	2.590	square kilometers (km^2)
cubic feet per second (ft^3/s)	0.02832	cubic meters per second (m^3/s)

National Geodetic Vertical Datum of 1929 (NGVD of 1929) is a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called "Mean Sea Level."

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ABSTRACT

The Tennessee Department of Transportation has constructed a new bridge and approaches on State Route 30 over Cane Creek near Spencer, Tennessee. The old bridge and its approaches were fairly low, permitting considerable flow over the road during floods. The new bridge is longer and its approaches are considerably higher, causing different flow conditions at the site. Analysis of the effects of the new bridge, as compared to the old bridge, on a flood of the magnitude of the May 27, 1973 flood is presented. The May 27, 1973 flood was greater than a 100-year flood. Analyses of the 50- and 100-year floods for the new bridge are also presented. Results of the study indicate that the new construction will increase the water-surface elevation by approximately 1 foot upstream from bridge for a flood equal to that of May 27, 1973.

INTRODUCTION

The Tennessee Department of Transportation has built a new bridge with new approaches over Cane Creek just upstream from the old bridge about 4 miles east of Spencer, Tennessee (fig. 1). The old bridge is to be removed. The new bridge, 17 feet longer than the old bridge, slopes upward from left to right (facing downstream) and the left (low) end is about 5 feet higher than the old bridge. The vehicular approaches to the new bridge consequently are higher than those to the old bridge (fig. 2). These changes in the physical conditions of the crossing alter the flood-flow characteristics at the site. The changes cause a larger percentage of a given discharge to flow through the bridge opening and a smaller percentage to flow over the road as compared to conditions existing prior to construction of the new bridge. For example, for a flood equal to the May 27, 1973 flood, 4 percent of the peak discharge would flow over the new road compared to 13 percent over the old road. The purpose of this report is to evaluate the relative hydraulic performance of the two bridges with respect to the flood of May 27, 1973, which was a major flood in the area. Computed data for the 50-year and 100-year floods at the site of the new bridge are also presented. The 50-year and 100-year floods are defined as the peak discharges which will be exceeded once, on the average, in 50 and 100 years, respectively, or stated another way, the peak discharge which has a 2 or a 1 percent chance, respectively, of being exceeded in any year.

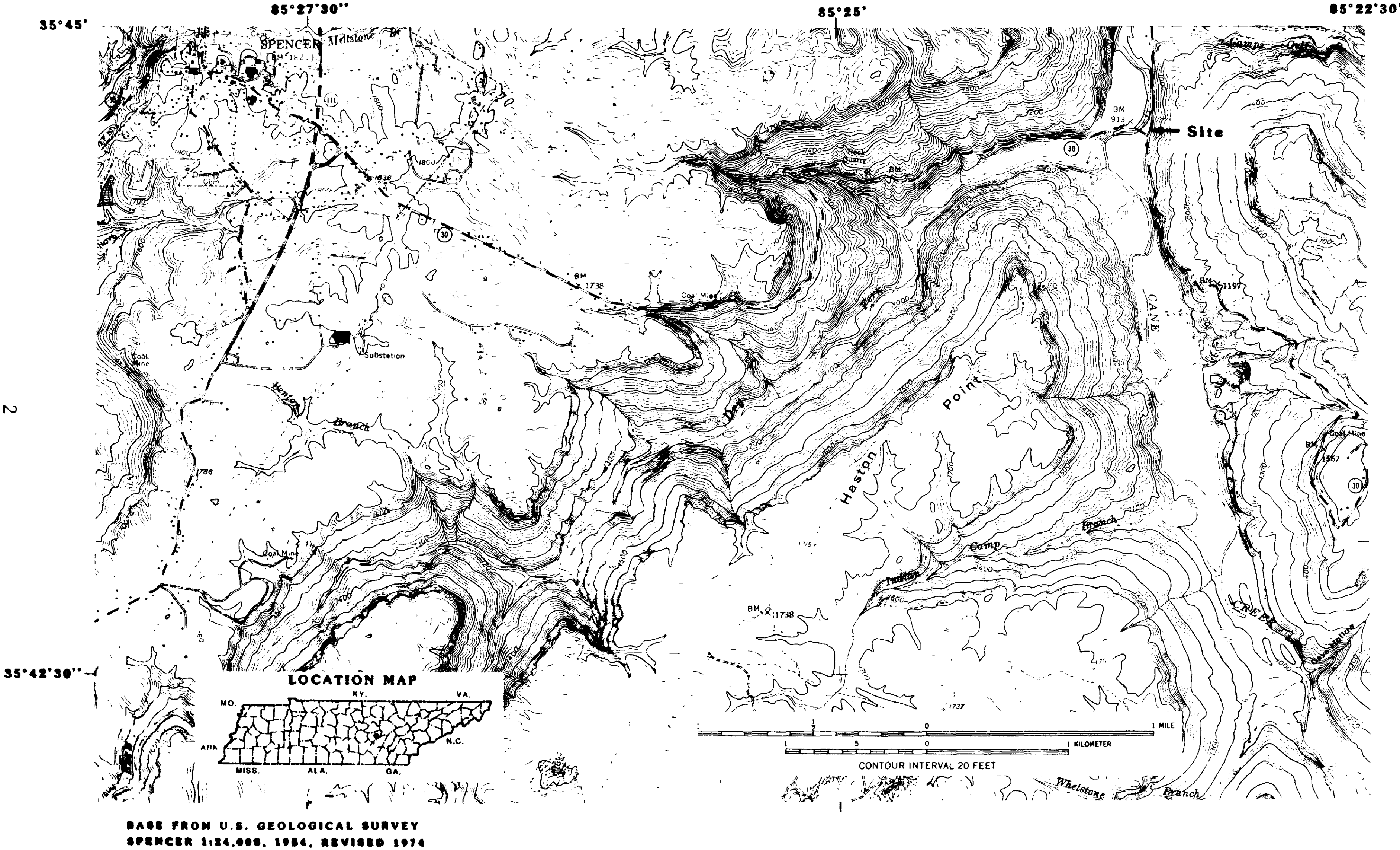

Figure 1.--Location of Cane Creek and new bridge site.

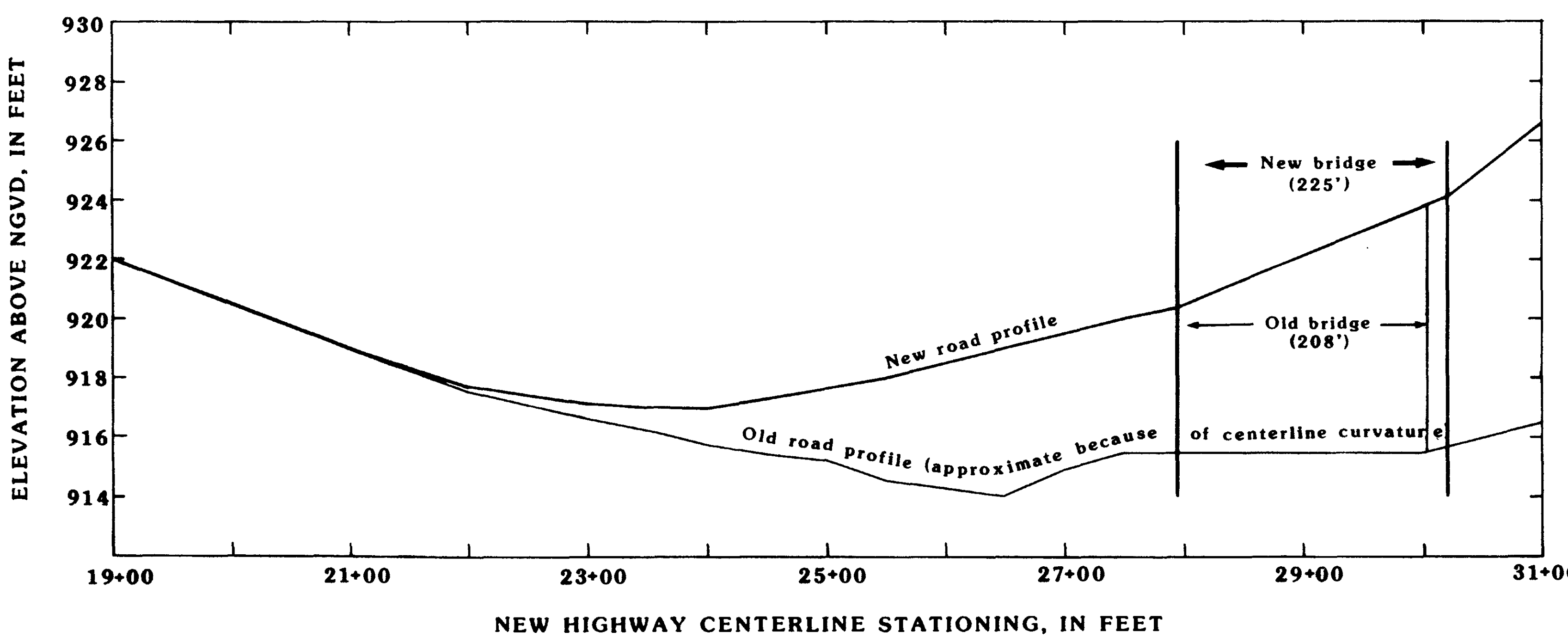

Figure 2.--Profiles of old and new road, State Route 30.

All elevations given in this report are referenced to Department of Transportation datum which is National Geodetic Vertical Datum of 1929.

This report has been prepared by the U.S. Geological Survey in cooperation with the Tennessee Department of Transportation.

SITE DESCRIPTION

The valley of Cane Creek at the site is about 1,200 feet wide and consists of a relatively small channel and a wide flood plain which is mostly wooded with some open fields (fig. 1). The channel bed is composed mostly of cobble stones. The drainage area of Cane Creek at the site is 134 square miles. Dry Fork, a tributary, enters Cane Creek on the left about 1,000 feet upstream from the bridge site. State Route 30 makes about a 90 degree turn at the point where it crosses Cane Creek (fig. 3). A house is located on the left flood plain about 750 feet upstream from the new bridge. The floor elevation of the house on Nov. 6, 1980, was 920.2 feet. The floor is assumed to have been at this elevation at the time of the May 27, 1973 flood. The floor elevation of the house on March 15, 1983, was 921.6 feet indicating that the house was raised by 1.4 feet after Nov. 6, 1980.

Principal data and data sources used in the preparation of this report are as follows:

1. High-water marks and estimated peak discharge for the flood of May 27, 1973 (old bridge conditions).

2. Plan and profile sheets for the old and new roadway and bridges, and valley cross sections and channel bed profile, furnished by the Department of Transportation.

3. Additional valley and bridge cross sections at the new bridge surveyed by personnel of the Geological Survey in March and April 1983.

4. High-water marks for the flood of April 5, 1983, surveyed by personnel of the Geological Survey on April 13, 1983.

5. Channel and valley roughness coefficients (Barnes, 1967) selected by personnel of the Geological Survey in March and April 1983.

6. Peak discharge data for streams in the surrounding area for the May 27, 1973 flood.

RESULTS OF STUDY

Past Floods

Systematic records of floods at this site are not available. However, the maximum flood in recent years occurred on May 27, 1973. The

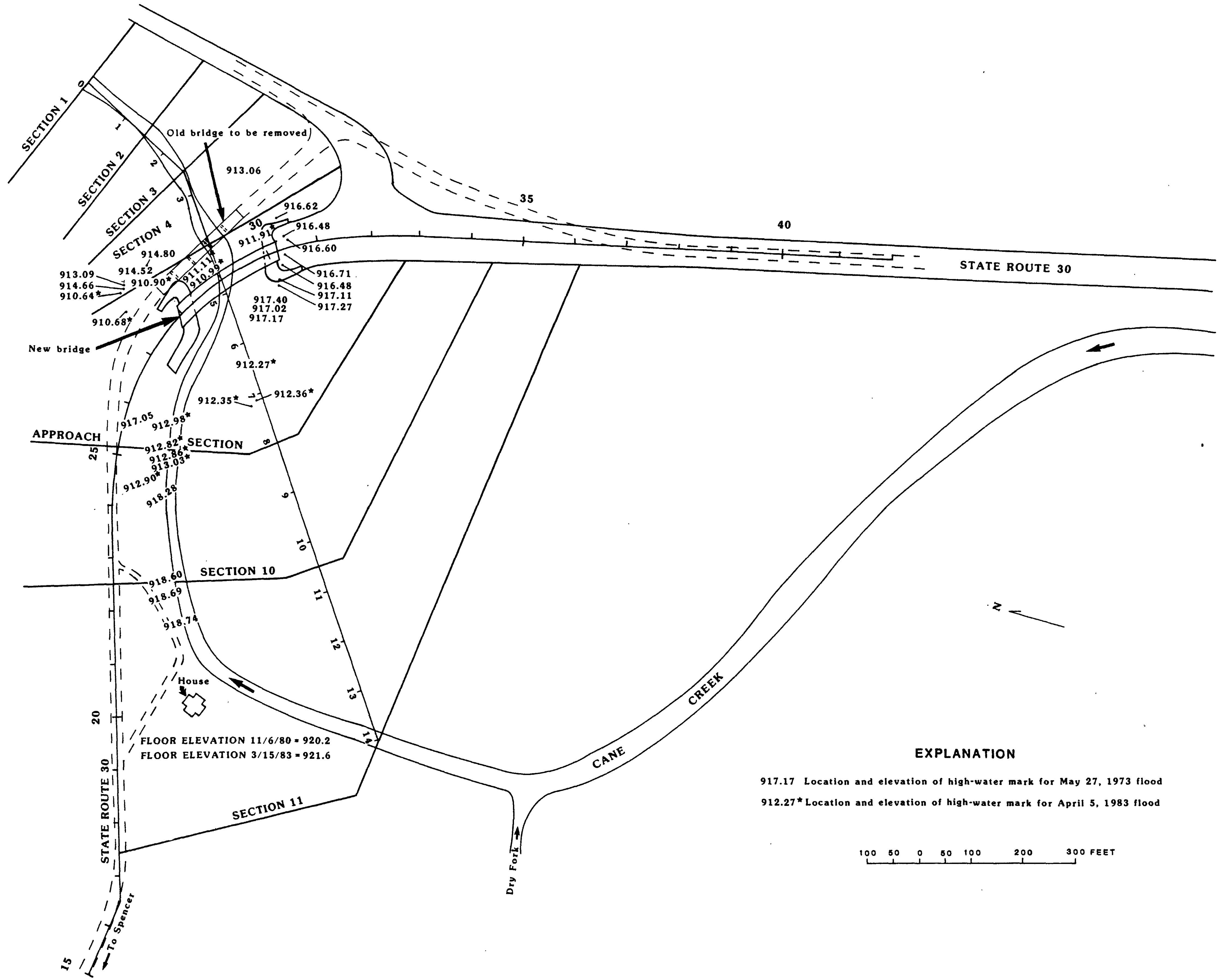

Figure 3.--Site layout and high-water marks for May 27, 1973 and the April 5, 1983 floods, Cane Creek at State Route 30, near Spencer, Tennessee.

peak discharge for the May 27, 1973 flood at this site is estimated to be 32,000 ft^3/s. This is about 1.4 times the 100-year flood computed from averaging the results of Area 1 and Area 2 regional relations by Randolph and Gamble (1976). The estimate of 32,000 ft^3/s is based on a correlation of peak discharge for this flood versus drainage area for 22 sites in the surrounding area. The flood of April 5, 1983, had an estimated discharge of about 6,000 ft^3/s--a magnitude that will be exceeded about once every two years on the average.

Several high-water marks were identified and flagged immediately after the 1973 flood and elevations were determined for these high-water marks on November 6, 1980, by personnel of the Geological Survey and the Department of Transportation. The approximate location and the elevation of these high-water marks are shown in figure 3. Also, elevations of several high-water marks for the flood of April 5, 1983, were surveyed by personnel of the Geological Survey on April 13, 1983, and they are shown in figure 3.

Water-Surface Profiles

Water-surface profiles for the May 27, 1973 flood (estimated discharge, 32,000 ft^3/s) have been computed, for conditions with the old and new bridges, by the standard-step method of backwater computation as described by Chow (1959) and Woodward and Posey (1941). Also, profiles for the 50-year and 100-year floods have been computed for conditions with the new bridge in place. The computations were performed with the U.S. Geological Survey's computer program E431 (Shearman, 1976) using roughness coefficients (Barnes, 1967) selected in the field. These roughness coefficients ranged from 0.050 to 0.060 for the main channel; 0.040 to 0.045 for the cleared overbank; and 0.075 to 0.080 for the wooded overbank. The computed profile with the new bridge in place is approximately 1 foot higher upstream from the bridge than the high-water marks of the May 27, 1973 flood (fig. 4). Details of the results of the computations and comparison with the May 27, 1973 flood at various locations are shown in table 1.

CONCLUSIONS

The computed water-surface profile for the new bridge conditions indicates that if a flood discharge of 32,000 ft^3/s were to occur today, the water-surface elevation would be higher than actually occurred on May 27, 1973 (old bridge conditions), upstream from the bridge as follows: approach section, 0.9 feet; section 10, 0.9 foot; house, 0.9 foot; and section 11, 0.7 foot. These differences are based on interpolation and extrapolation of elevations of high-water marks for the flood of May 27, 1973.

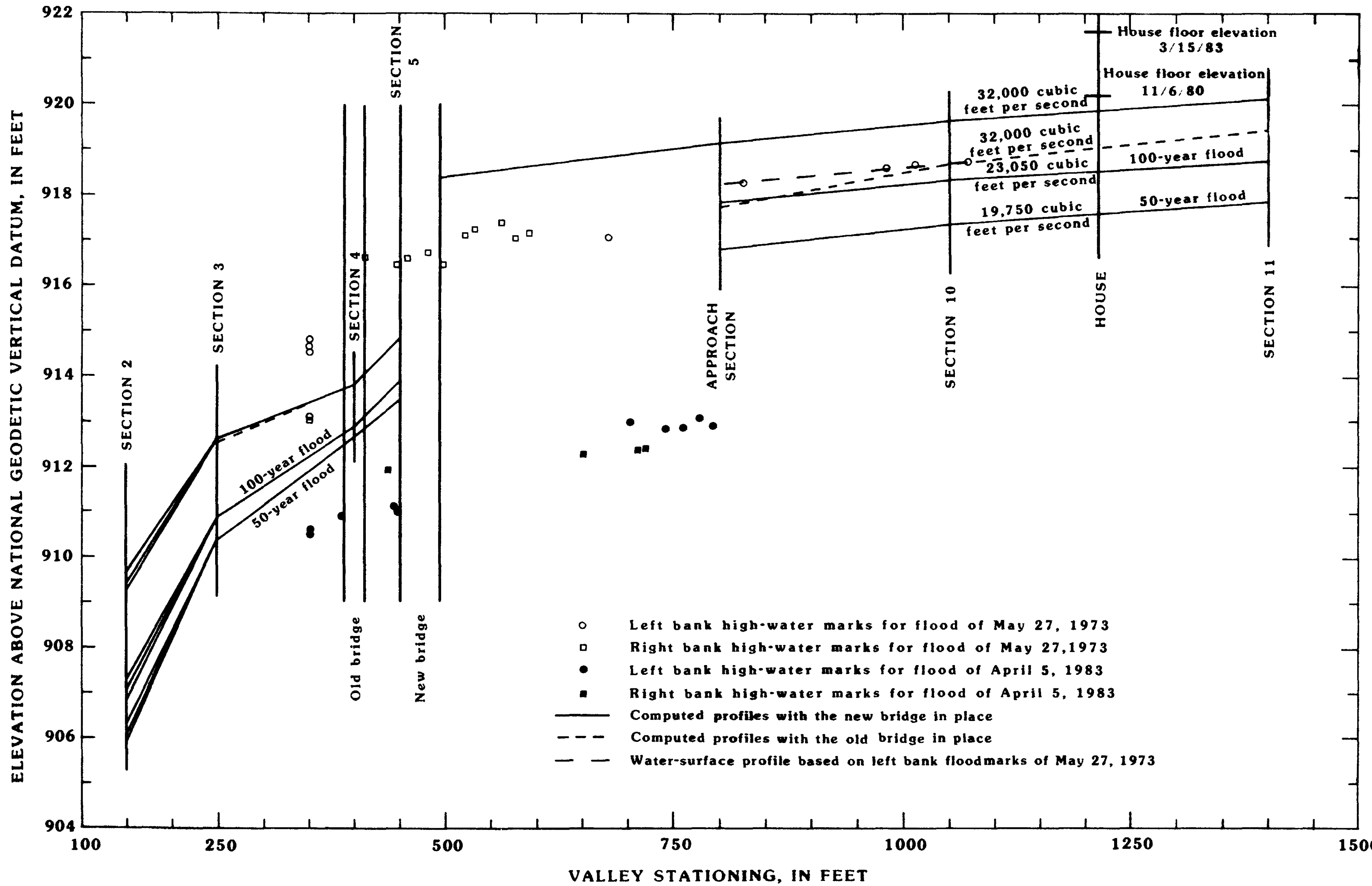

Figure 4.--Comparison of computed profiles for the new bridge with computed and actual profiles for the old bridge.

Table 1.--Comparison of computed water-surface profiles for the new bridge with computed and actual profiles for the old bridge

Location	50-year flood (19,750 ft^3/s) computed	100-year flood (23,050 ft^3/s) computed	May 27, 1973 flood (32,000 ft^3/s) computed	May 27, 1973 flood (32,000 ft^3/s) actual
	Elevation, in feet			
	With new bridge in place			
Section 3	910.4	910.9	912.6	--
Section 4	912.6	912.9	913.8	--
Section 5	913.4	913.9	914.8	--
Downstream side bridge.	913.4	913.9	914.8	--
Approach section.	916.8	917.8	919.1	--
Section 10	917.3	918.3	919.6	--
House	[a]917.6	[a]918.5	[a]919.9	--
Section 11	917.8	918.8	920.1	--
	With old bridge in place			
Section 3	--	--	912.5	--
Section 4	--	--	913.6	--
Downstream side bridge.	--	--	913.6	--
Approach section.	--	--	917.7	[b]918.2
Section 10	--	--	918.7	[b]918.7
House	--	--	[a]919.0	[b]919.0
Section 11	--	--	919.4	[b]919.4

[a] Interpolated from computed profile.
[b] From extrapolation of high-water marks of the May 27, 1973, flood.

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Woodward, S. M., and Posey, C. J., 1941, Hydraulics of steady flow in open channels: New York, John Wiley & Sons, Inc., 151 p.

SUPPLEMENTAL DATA FOR FLOOD OF MAY 27, 1973

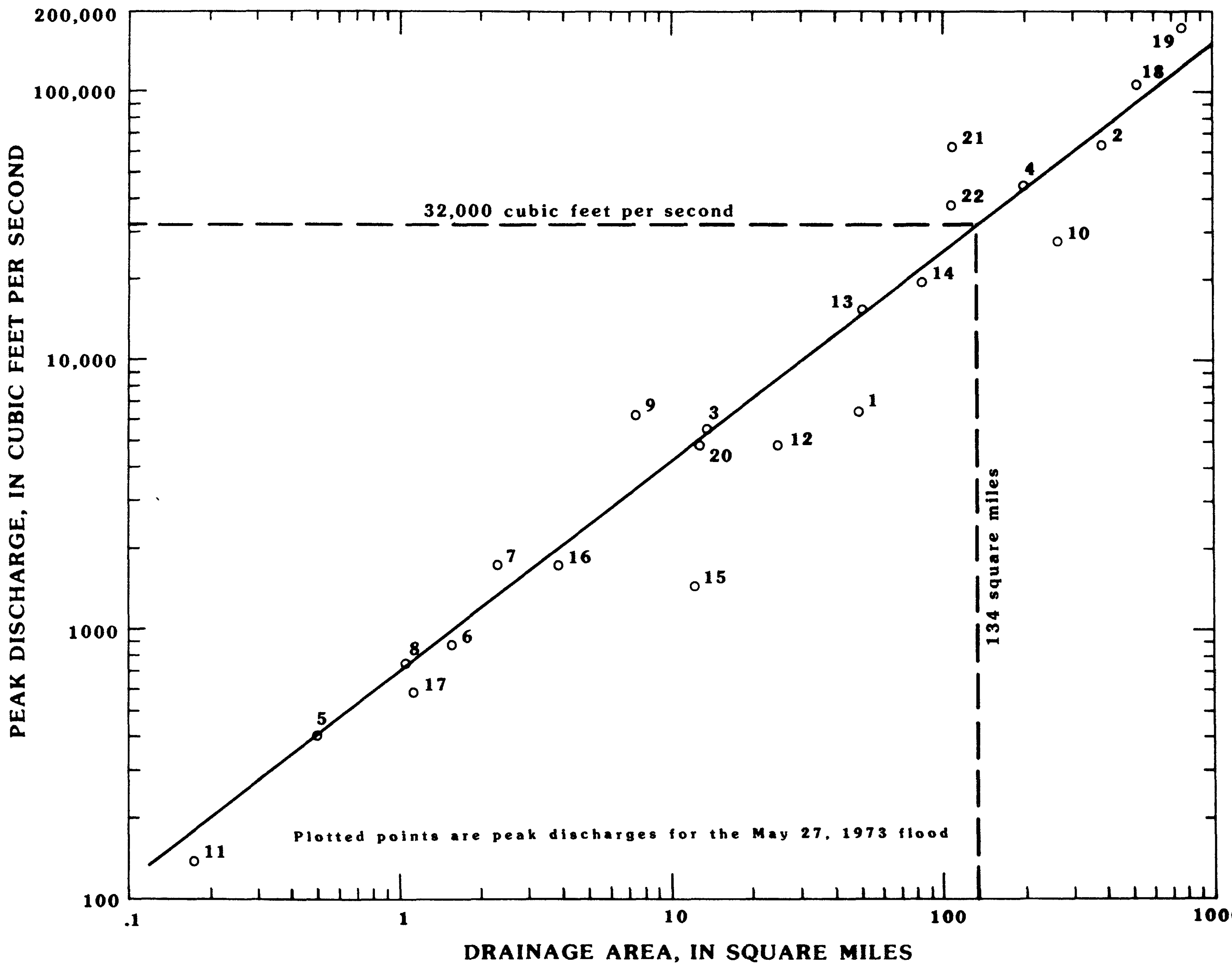

Figure 5.--Peak discharge versus drainage area for the May 27, 1973 flood on surrounding streams.

Table 2.--Drainage area and peak discharge for the May 27, 1973 flood on surrounding streams

[Note: The first two digits "03" of the station number have been omitted]

Plot No.	Station No.	Stream name and location	Contributing drainage area (mi^2)	Peak discharge (ft^3/s)
1	408200	Brimstone Creek near Robbins	48.7	6,540
2	408500	New River at New River	382	63,700
3	409000	White Oak Creek at Sunbright	13.5	5,560
4	414500	East Fork Obey River near Jamestown	196	44,800
5	417700	Mathews Branch tributary near Livingston	.49	405
6	418900	Raccoon Creek near Old Winesap	1.52	882
7	420360	Mud Creek tributary No. 2 near Summitville	2.28	1,760
8	420380	Mud Creek tributary near Summitville	1.03	746
9	420400	Mud Creek near Summitville	7.30	6,300
10	427500	East Fork Stones River near Lascassas	262	27,400
11	427830	Short Creek tributary near Christiana	.17	140
12	534000	Coal Creek at Lake City	24.5	4,810
13	--	Emory River near Wartburg (misc. site)	49.2	15,500
14	538500	Emory River near Wartburg	83.2	19,900
15	538600	Obed River at Crossville	12.0	1,470
16	538900	Self Creek near Big Lick	3.80	1,760
17	539100	Byrd Creek near Crossville	1.10	590
18	539800	Obed River near Lancing	518	105,000
19	540500	Emory River at Oakdale	764	171,000
20	541300	Bitter Creek near Oakdale	12.6	4,880
21	541500	Whites Creek near Glen Alice	108	62,500
22	596000	Duck River below Manchester	107	38,000