STREAMFLOW AND CROSS-SECTION DATA FOR THE TOMBIGBEE RIVER BETWEEN GAINESVILLE AND DEMOPOLIS LOCKS AND DAMS

By William L. Psinakis and Richard A. Gardner

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CONVERSION FACTORS

For use of readers who prefer to use metric (International System) units, conversion factors for inch-pound units used in this report are listed below:

Multiply inch-pound unit	By	To obtain metric unit
	Length	
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
acre-foot (acre-ft)	1,233	cubic meter (m^3)
	0.001233	cubic hectometer (hm^3)
	Flow	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)

Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)--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 of 1929."

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ABSTRACT

A review of records and historical research of floods indicate that the flood of April 15 through 18, 1979 was the highest recorded this century along the reach of the Tombigbee River that is now bounded upstream by Gainesville Lock and Dam and downstream by Demopolis Lock and Dam. The peak discharge at Epes was 247,000 cubic feet per second and 343,000 cubic feet per second at Demopolis Lock and Dam.

Limit curves have been developed for the tailwater section of Gainesville Dam. These limit curves, based on 105 computed discharges for four floods since April 1979, show a range in stage for a given discharge.

Data from hydrographic surveys that were made for more than 100 sedimentation ranges in 1971 are on file with the U.S. Army Corps of Engineers, Mobile District. Presently 42 sedimentation ranges are surveyed routinely between Gainesville Lock and Dam and Demopolis Lock and Dam. A comparison of these and other data may be made to identify possible changes that have occurred.

This report presents a data base of these and other hydrologic data collected along the reach of the Tombigbee River between Gainesville Lock and Dam and Demopolis Lock and Dam.

INTRODUCTION

The construction and operation of locks and dams along the Tombigbee River, channel alterations such as the cutoff canal at Rattlesnake Bend and the construction of the Tennessee-Tombigbee Waterway have resulted in changes to the streamflow characteristics and geometry of the Tombigbee River. It is important that these changes are documented in order to more efficiently utilize the resources of the Tombigbee River.

The purpose of this report is to present hydrologic data that have been collected over a period of decades, including discharge, velocity, stage, and channel geometry. The data base will include relations of stage and discharge, and relations of mean stream velocity of the main channel and total discharge.

The work includes compilation of hydrologic data collected from the study reach and application of computer techniques to generate graphical representations of some of the data.

River mileage used in this report is taken from U.S. Army Corps of Engineers Stream Mileage Tables and is referenced from mouth of the river.

Appreciation is expressed to the U.S. Army Corps of Engineers for their assistance.

DESCRIPTION OF STUDY REACH

The study reach is the Tombigbee River from the downstream side of the Gainesville Lock and Dam to and including the Demopolis Lock and Dam about 63 miles downstream. This reach of the river has a well defined meandering channel with a bendway cutoff canal located at Rattlesnake Bend near Demopolis (fig. 1). The river gradually widens downstream of Gainesville Lock and Dam as it flows into Demopolis Lake. The reach is characterized by moderate to steep-sloped banks and wide, flat, and mostly wooded flood plains, with scattered areas of the flood plains cultivated for agricultural use.

The streamflow characteristics and geometry of the study reach were affected by navigational project work including preparatory work and actual construction of Gainesville Lock and Dam, construction of Rattlesnake Bend cutoff canal, and channel improvement work. Table 1 lists the periods of project work and the approximate limits where navigation improvement work took place. The major tributaries to the Tombigbee River in the reach are the Noxubee and Black Warrior Rivers, and Brush, Factory, and Trussels Creeks (Nelson and Ming, 1983).

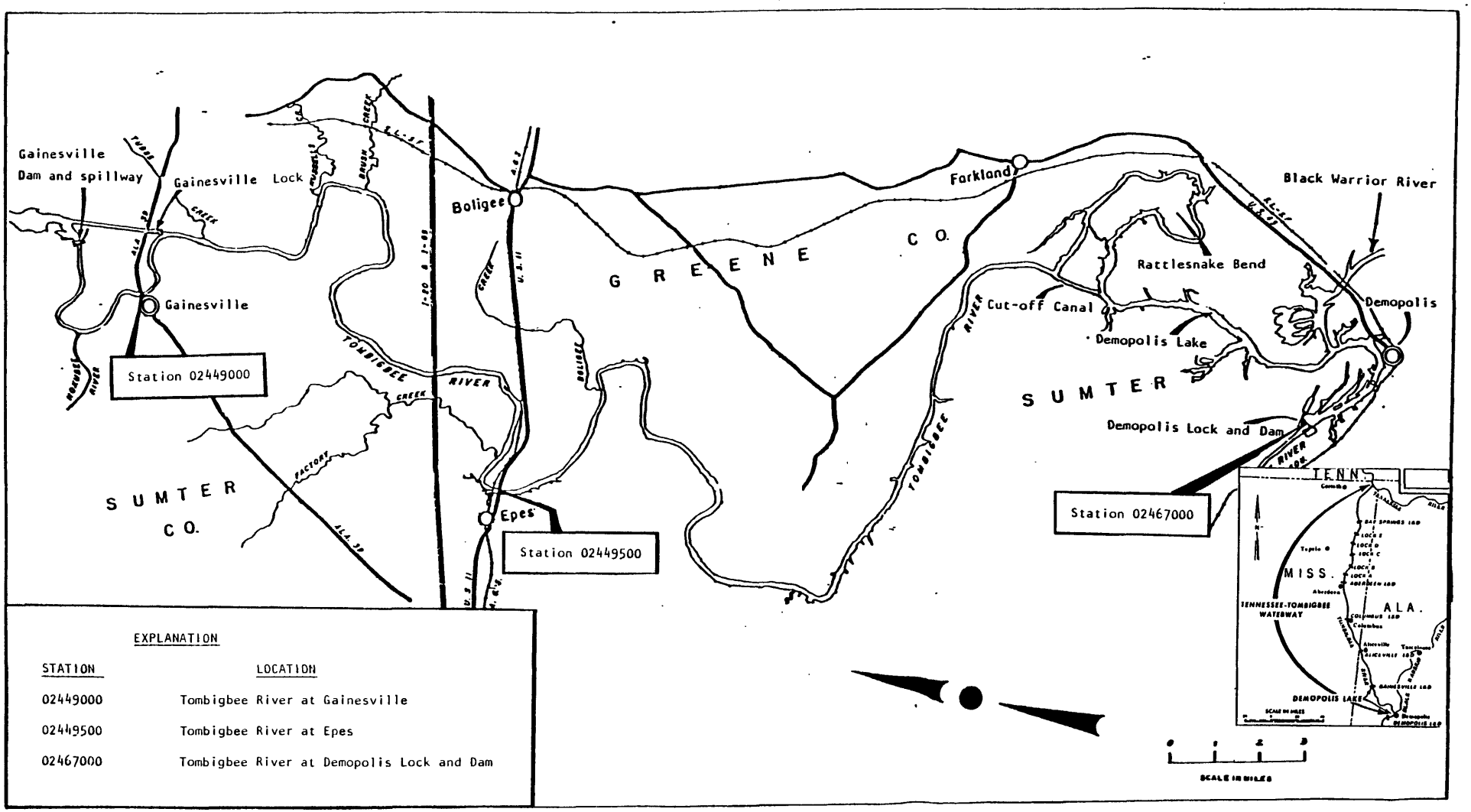

Figure 1.-Study reach

Table 1.--Chronology and location of construction and channel improvements in study reach

Construction of Gainesville Lock and Dam	
Construction began	Construction ended
November 1972	1978

Navigation Channel Improvement

Project name	Begin date	Completion date	Limits upstream river mile	Limits downstream river mile	Remarks
Rattlesnake Bend	5/75	6/76	191.0	181.0	
Demopolis	8/74	8/76	181.0	175.0	Black Warrior River upstream to Rattlesnake Bend.
			211.2	191.0	Upstream of Rattlesnake Bend.
	7/75	1/76	215.2	211.0	To U.S. Highway 11.
			224.6	215.4	Upstream of A.G.S. Railroad.
	7/75	10/76	224.6	233.0	

GAGING STATIONS

The three gaging stations located within the study reach are shown in figure 1.

Station 02449000 was established on the Tombigbee River at Gainesville at river mile 234.4 in October 1938. The datum of the gage is 63.29 feet above sea level. Gage height records collected at this site from 1937 to 1971 are contained in reports of the National Weather Service. Streamflow records are published for this station since 1939 in U.S. Geological Survey publications, and since 1961 in "Water Resources Data - Alabama" (annual report series). A water-stage recorder located 1.5 miles downstream of the station was used as a base gage for low water periods during the 1963 water year. Publication of daily mean discharge was discontinued at the end of the 1978 water year. This station has been operated as a flood hydrograph partial-record station since 1979.

Station 02449500 was established on the Tombigbee River at Epes (river mile 215.2) in January 1900. The station was operated as a nonrecording station during the following periods:

January 1900 to December 1901
November 1904 to August 1913.

The station was reestablished as a recording gaging station about 700 feet downstream of the original location in October 1939. Gage datum was 53.15 feet. This station served as the auxiliary gage to the base gage located at Gainesville, about 19.2 miles upstream.

Station 02467000 was operated by the National Weather Service from 1893 to 1928, and by the U.S. Geological Survey since 1928. The station was located on the Tombigbee River about 5 miles southeast of Coatopa at river mile 159.6 and gage datum was 29.30 feet during the period of operation from 1928 to 1955. In October 1955, following completion of the Demopolis Lock and Dam, the station was moved to the pool of Demopolis Lock and Dam about 2.5 miles west of Demopolis, at river mile 171.2. The datum of the gage is 56.00 feet. An auxiliary gage was operated at river mile 159.6 from 1956 to 1978.

Records have been published for this station since 1956 as "Tombigbee River at Demopolis Lock and Dam near Coatopa", and prior to 1956 as "Tombigbee River near Coatopa".

HISTORICAL FLOODS

A review of records and historical research indicate that the flood of 1979 was the highest flood of this century along the study reach. The flood produced a peak discharge of 261,000 cubic feet per second on April 15 at Gainesville, highest since 1818. One day later it produced a peak discharge of 247,000 cubic feet per second at Epes, highest since 1892. The flood produced a peak discharge of 343,000 cubic feet per second at Demopolis Lock and Dam on April 18, highest since 1818 (includes recorded floods that occurred at Tombigbee River near Coatopa).

Table 2 lists the annual peak discharges greater than 50,000 cubic feet per second at Gainesville. Figure 2 is a plot of these annual peak discharges versus annual peak stage.

Table 3 lists the annual peak discharges greater than 100,000 cubic feet per second at Demopolis Lock and Dam (includes recorded floods that occurred at Tombigbee River near Coatopa).

Table 2.--List of annual peak discharges greater than 50,000 cubic feet per second, corresponding gage height and peak gage height for Tombigbee River at Gainesville

Date	Peak discharge (cubic feet per second)	Gage height (feet above gage datum)	Peak gage height (feet above gage datum)	Date
00/00/1892	250,000	58.40		
03/07/39	53,500	44.32		
07/11/40	62,500	45.71	46.72	7/17/40
03/22/43	56,600	45.00	45.20	3/23/43
04/05/44	112,000	50.60		
03/01/45	64,000	46.80		
02/17/46	112,000	50.90		
01/26/47	60,400	45.40		
02/21/48	119,000	51.20		
01/11/49	168,000	53.90		
01/14/50	101,000	49.70	49.90	1/15/50
04/03/51	141,000	52.80	52.90	4/04/51
03/02/53	60,700	45.20	45.30	3/03/53
04/01/55	67,900	44.80		
04/07/56	55,200	39.73	40.15	4/16/56
02/10/57	63,800	43.21	43.35	2/11/57
11/27/57	76,500	46.40	46.73	11/29/57
03/11/60	60,200	42.14		
02/26/61	115,000	50.67	50.90	2/28/61
12/23/61	166,000	53.99	54.28	12/25/61
04/20/64	69,500	45.99		
02/19/65	78,400	47.34	47.39	2/20/65
02/17/66	51,700	40.04		
12/26/67	94,100	--		
04/22/69	96,000	49.39		
03/28/70	76,600	47.06		
03/06/71	83,300	48.01		
01/14/72	89,300	48.69		
03/23/73	172,000	54.21		
02/03/74	69,600	45.82		
03/21/75	108,000	--	50.43	3/22/75
04/02/76	81,000	42.66		
03/14/77	90,900	44.66		
05/16/78	82,300	40.20		
04/15/79	261,000	56.28		
03/25/80	117,000	48.17	48.20	3/26/80
04/02/81	52,100	35.73		
05/25/83	161,000	50.72	51.03	5/25/83
12/09/83	147,000	--	49.19	12/10/83
02/13/85	69,500	34.21		

Table 3.--List of annual peak discharges greater than 100,000 cubic feet per second, corresponding gage height and peak gage height for Tombigbee River at Demopolis Lock and Dam

Date	Peak discharge (cubic feet per second)	Gage height (feet above gage datum)[1]	Peak gage height (feet above gage datum)	Date
00/00/1897	126,000	59.20		
00/00/1899	172,000	63.70		
00/00/00	330,000	73.10		
00/00/02	250,000	68.90		
00/00/03	190,000	65.10		
00/00/05	130,000	59.80		
00/00/06	106,000	57.20		
00/00/08	101,000	56.50		
00/00/09	200,000	65.90		
00/00/12	144,000	61.20		
00/00/16	203,000	66.20		
00/00/19	115,000	58.10		
00/00/20	148,000	61.60		
00/00/22	100,000	56.50		
00/00/27	190,000	65.30		
00/00/28	144,000	61.20		
03/29/29	179,000	65.50		
11/22/29	164,000	--		
12/22/32	153,000	--		
02/29/32	124,000	--		
03/19/35	123,000	--		
02/12/36	145,000	--		
02/01/37	113,000	--		
04/14/38	158,000	--		
03/10/39	104,000	--		
07/21/40	100,000	--		
03/26/43	103,000	45.40		
04/07/44	140,000	48.70		

02/26/45	108,000	45.00		
02/20/46	169,000	50.10		
01/26/47	147,000	48.70		
02/23/48	156,000	49.10		
01/14/49	199,000	51.10		
01/18/50	117,000	45.90		
04/06/51	217,000	52.40		
03/03/53	101,000	44.00		
04/12/56	104,000	24.10		
02/09/57	102,000	24.00		
11/26/57	104,000	24.10		
03/09/60	104,000	24.07		
02/28/61	250,000	35.66		
12/25/61	202,000	31.95		
04/19/64	123,000	26.39		
02/18/65	109,000	24.72		
02/18/66	110,000	24.85		
12/28/67	115,000	25.39		
04/19/69	116,000	25.55		
03/27/70	145,000	25.96		
03/08/71	158,000	26.71		
01/15/72	161,000	26.82		
03/27/73	181,000	29.14		
01/01/74	136,000	25.51		
03/24/75	172,000	27.34		
04/05/76	166,000	27.03		
04/10/77	178,000	--	27.77	4/11/77
05/12/78	101,000	--	23.96	4/11/78
04/18/79	343,000	37.03		
03/27/80	200,000	30.26		
04/02/81	115,000	24.65		
04/24/82	145,000	25.02		
05/25/83	175,000	30.31		
12/09/83	184,000	28.84		
02/09/85	106,000	23.55		

[1] Gage datum prior to 1954 was 29.30 feet above sea level.
Gage datum since 1954 is 56.60 feet above sea level.

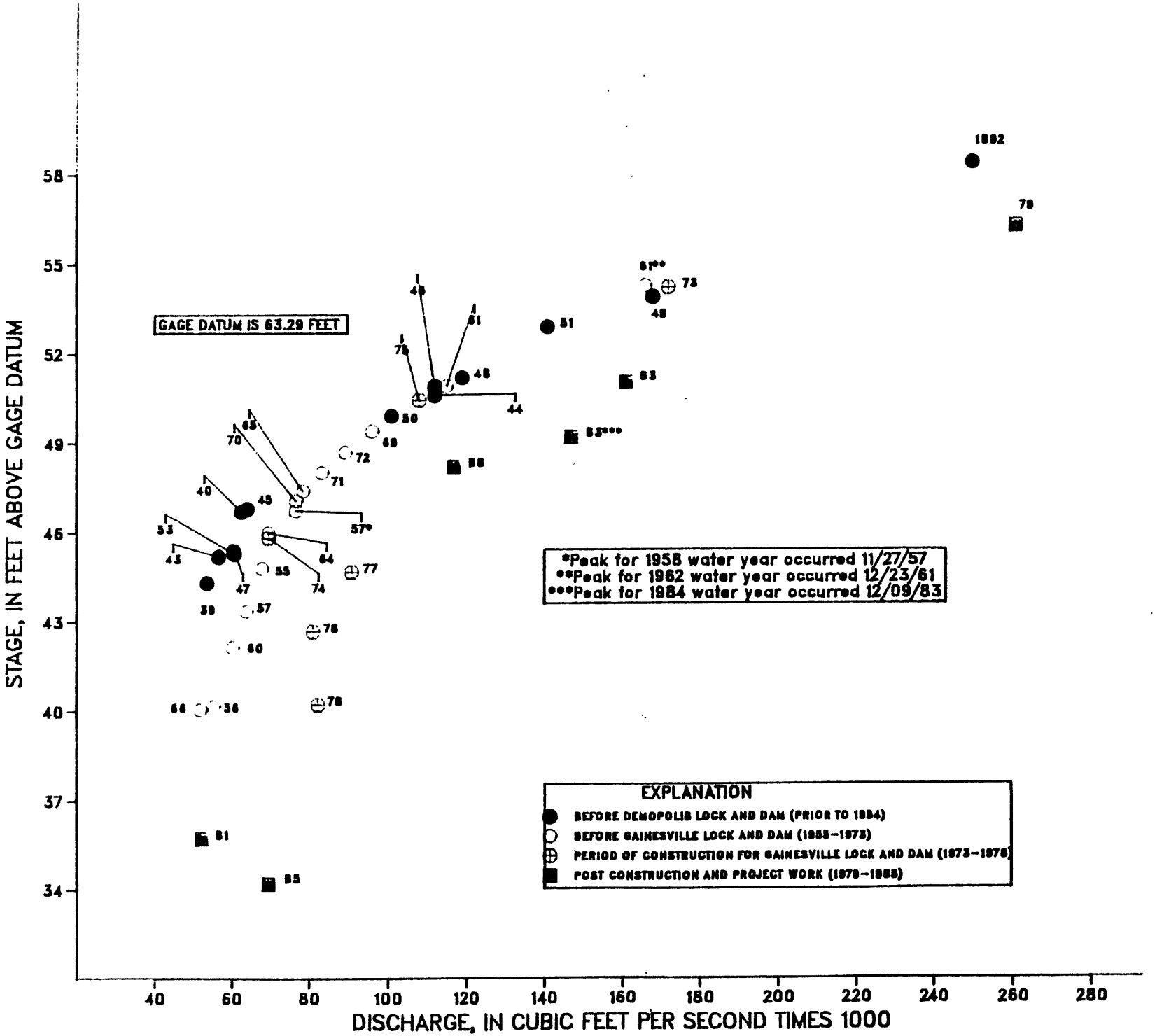

Figure 2.—Annual peak discharge versus peak stage for discharges greater than 50,000 cubic feet per second for Tombigbee River at Gainesville

FLOOD PROFILES

Flood profiles, defined by high-water mark elevations, were developed for the floods of 1948, 1973, 1979, and 1980. The elevation of the high-water marks was determined through field surveys. Maps showing the location and elevation of high-water marks are on file with the U.S. Geological Survey, Montgomery, Alabama. Figure 3 is a graph showing the profiles of the floods. The peak discharges at Gainesville during the floods and the dates of occurrence are shown in table 2.

LIMIT CURVES OF STAGE-DISCHARGE RELATIONS

Due to a lack of discharge measurements and backwater conditions that occur, a single stable stage-discharge relation cannot be developed for the Tombigbee River at Gainesville Dam (Ming and Nelson, 1983). Computed discharge versus stage was plotted for the tailwater of Gainesville Dam. The data were based on four floods since 1979. The scatter of the data points illustrate the effects of backwater conditions. Limit curves were drawn that envelope the plotted data showing the approximate range of stage for a given discharge. A graph showing the plotted data and limit curves is shown in figure 4. Additional information and details concerning the development of the limit curves are found in "Preliminary stage-discharge relations for Tombigbee River at Gainesville Dam, near Gainesville, Alabama" (Nelson and Ming, 1983).

Limit curves were also developed for the Tombigbee River below Gainesville Lock. Data used in the development of these curves included discharge measurements and a stage-discharge relation (rating) developed by the step backwater computer program. Additional information regarding the development of these curves are on file with the U.S. Geological Survey, Montgomery.

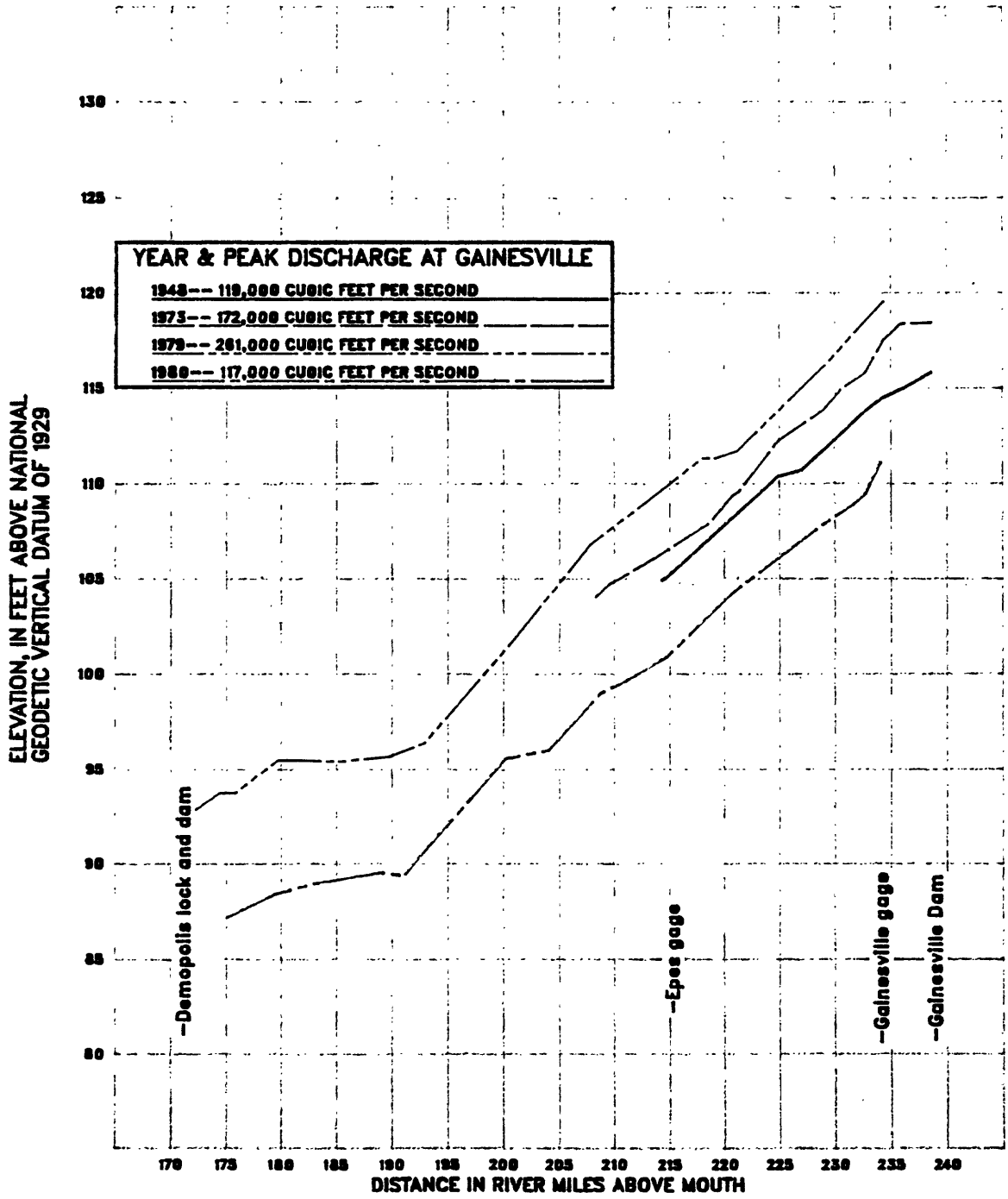

Figure 3.– Flood profiles of the study reach for the floods of 1948, 1973, 1979 and 1980

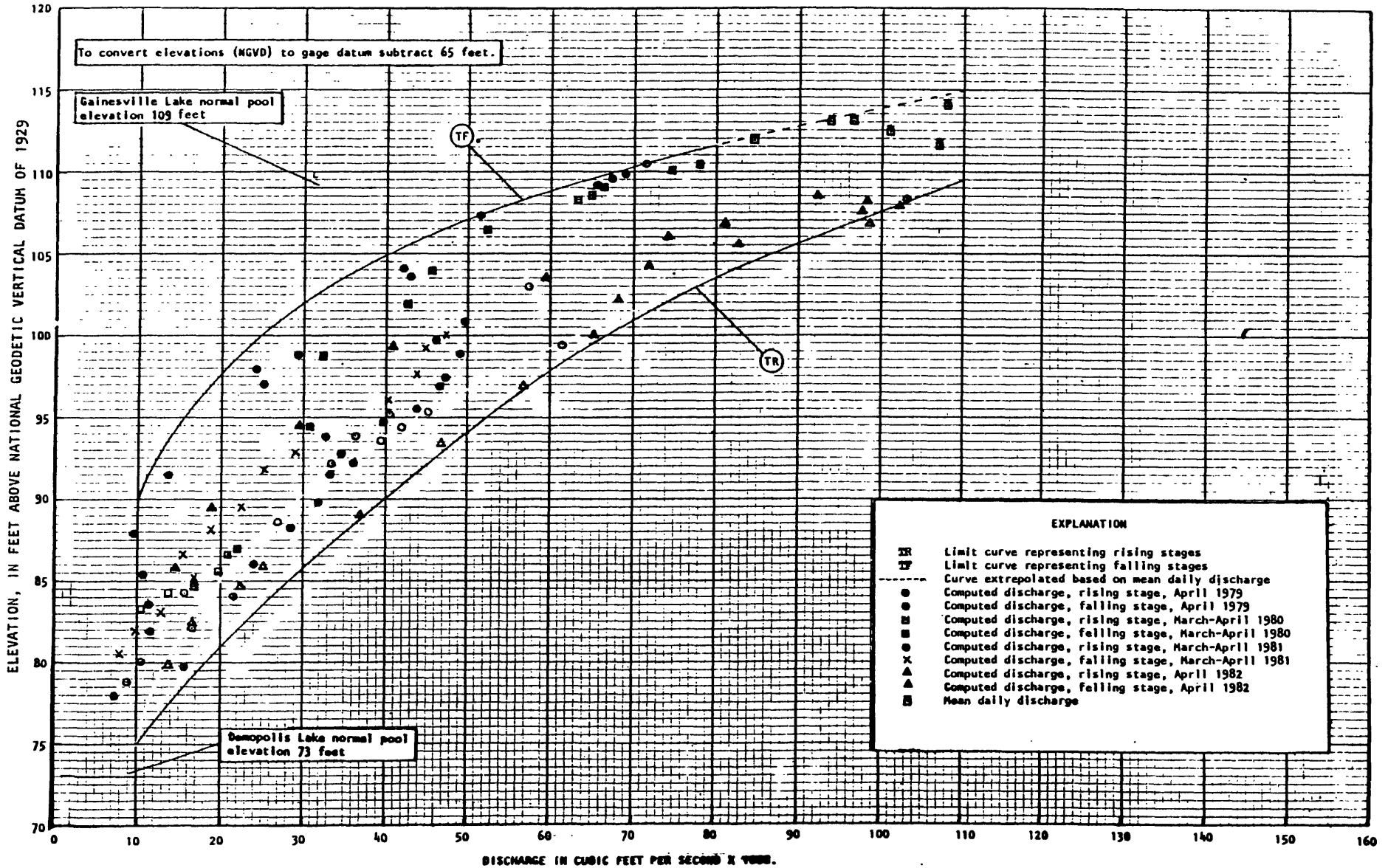

Figure 4.- Limit curves defining the ranges in stage for Tombigbee River at Gainesville Dam, tailwater.

SEDIMENTATION RANGES

In 1971, the U.S. Army Corps of Engineers surveyed more than 100 hydrographic ranges within the study reach. Cross-section data of the river channel were obtained from the surveyed ranges. Currently 42 ranges are surveyed routinely.

Cross-section data from six selected ranges were used to graphically represent the changes in the channel these ranges. The six ranges are listed in table 4. Plates were prepared showing the location of the ranges where the surveys took place in 1971. Since the ranges were not identified by the same alpha-numeric system as ranges are now, it was necessary to correlate the location of these ranges to the six selected ranges. This was done by locating a topographic feature on the Tombigbee River at a known river mile on the plates and measuring the distance upstream or downstream of this feature until the river mile on the plate matched the river mile of the selected alpha-numeric range. The closest range on the plate to the matching river mile was used. For convenience of the reader, the ranges in this report are identified by the alpha-numeric system.

In order to document changes in the channel that have occurred due to construction of the Rattlesnake Bend cutoff canal, Range 12CA (located just upstream of the cutoff canal) and Range 12CE (located just downstream of the canal) were selected. The four other ranges were selected to represent typical sections of the river. The location of the selected ranges are shown in figure 5.

Table 4.--Selected sedimentation ranges used for comparison of cross section data

Sedimentation range	Location (river miles above mouth)	Remarks
2C	231.5	
5C	221.2	
8C	208.8	
11C	196.7	
12CA	191.2	Downstream of Rattlesnake Bend cutoff canal
12CE	180.6	Upstream of Rattlesnake Bend cutoff canal

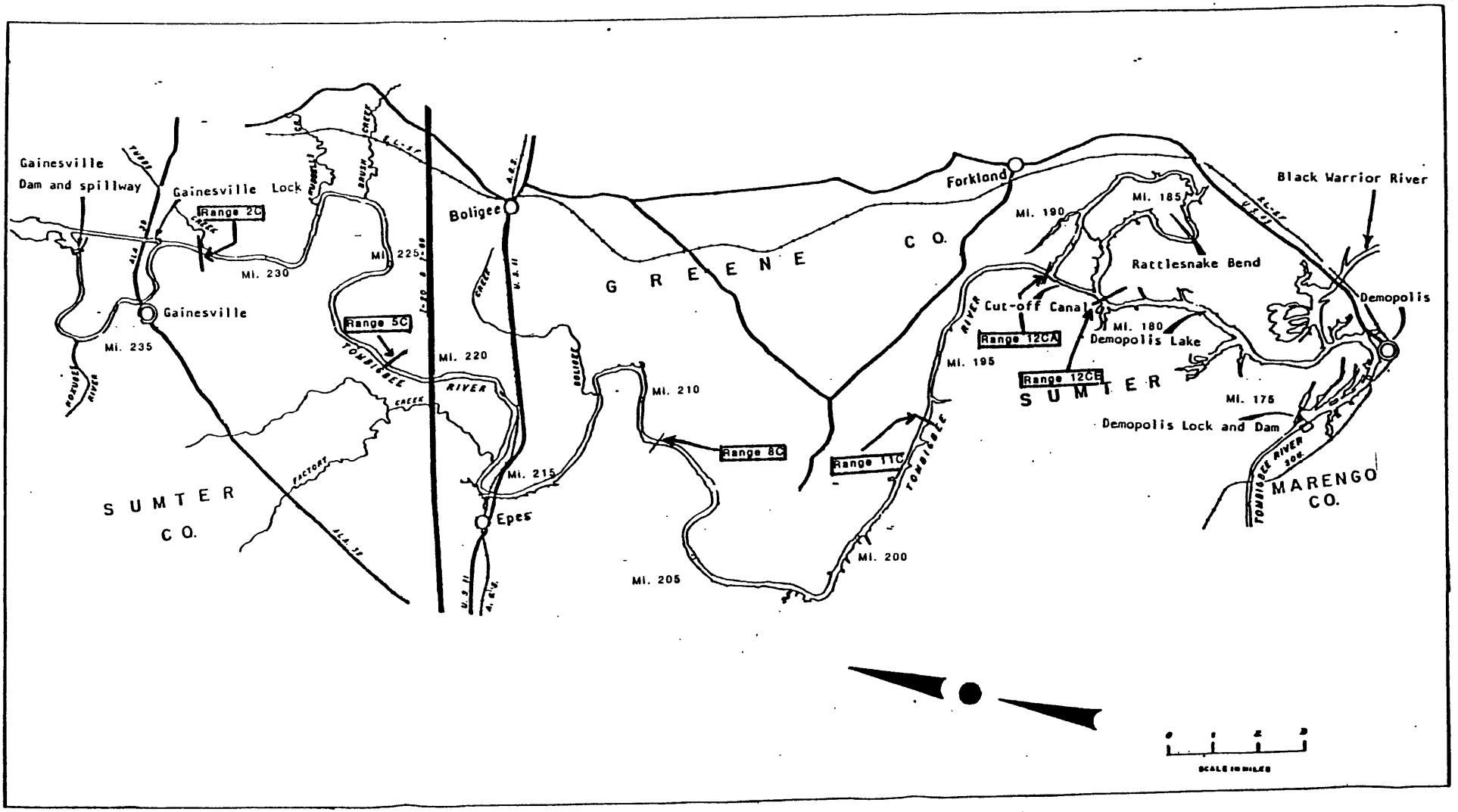

Figure 5.-Location of selected sedimentation ranges.

Table 5.--Data from discharge measurements made in vicinity of Rattlesnake Bend

Date	Discharge in cut (cubic feet per second)	Discharge in old bendway (cubic feet per second)	Discharge in channel above cut (cubic feet per second)
5/6/76	1990	2540	
9/8/76	2940	3280	
11/8/76	1420	1740	
3/22/77	40800	30800	
5/24/77	1120	Disregarded	
5/27/77	1660	1740	
5/28/77	Disregarded	Disregarded	
1/6/82	35800		56200
1/8/82	47100		80600
1/10/82	29700		50200
12/3/82	21800		37800
12/6/82	40000		72200
12/8/82	44700		78600
12/10/82	33100		65400
12/6/83	53700		93400
12/7/83	59700		105000
12/11/83	74500		121000
12/13/83	63100		110000
12/14/83	47500		78900

Cross-section data were available from surveys conducted in 1971 and annual surveys since 1977. Graphical representations of the cross-section data for the selected ranges are shown in figures 6 through 11. In some cases very little change was noted between some of the surveys, so in order to avoid unnecessary clutter, not all of the available surveys are represented in the graphs.

Additional comparison of cross-section data obtained from surveys conducted from 1977 to 1981 for selected ranges located in Rattlesnake Bend and in the cutoff canal are shown in "Environmental Impact Statement, Tennessee-Tombigbee Waterway, Alabama and Mississippi" (U.S. Army Corps of Engineers, 1981).

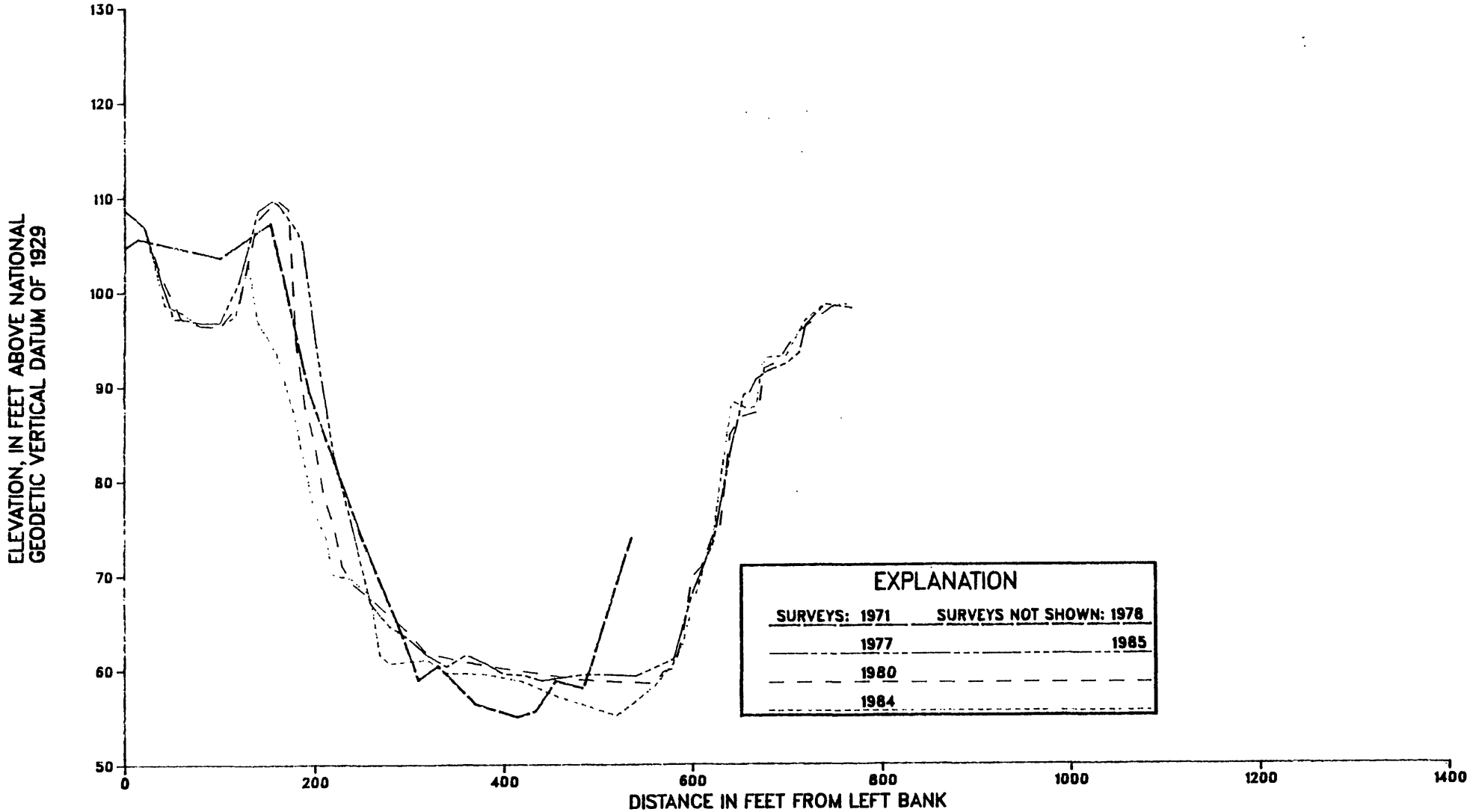

Figure 6.—Cross sections of sedimentation range 2C at river mile 231.5.

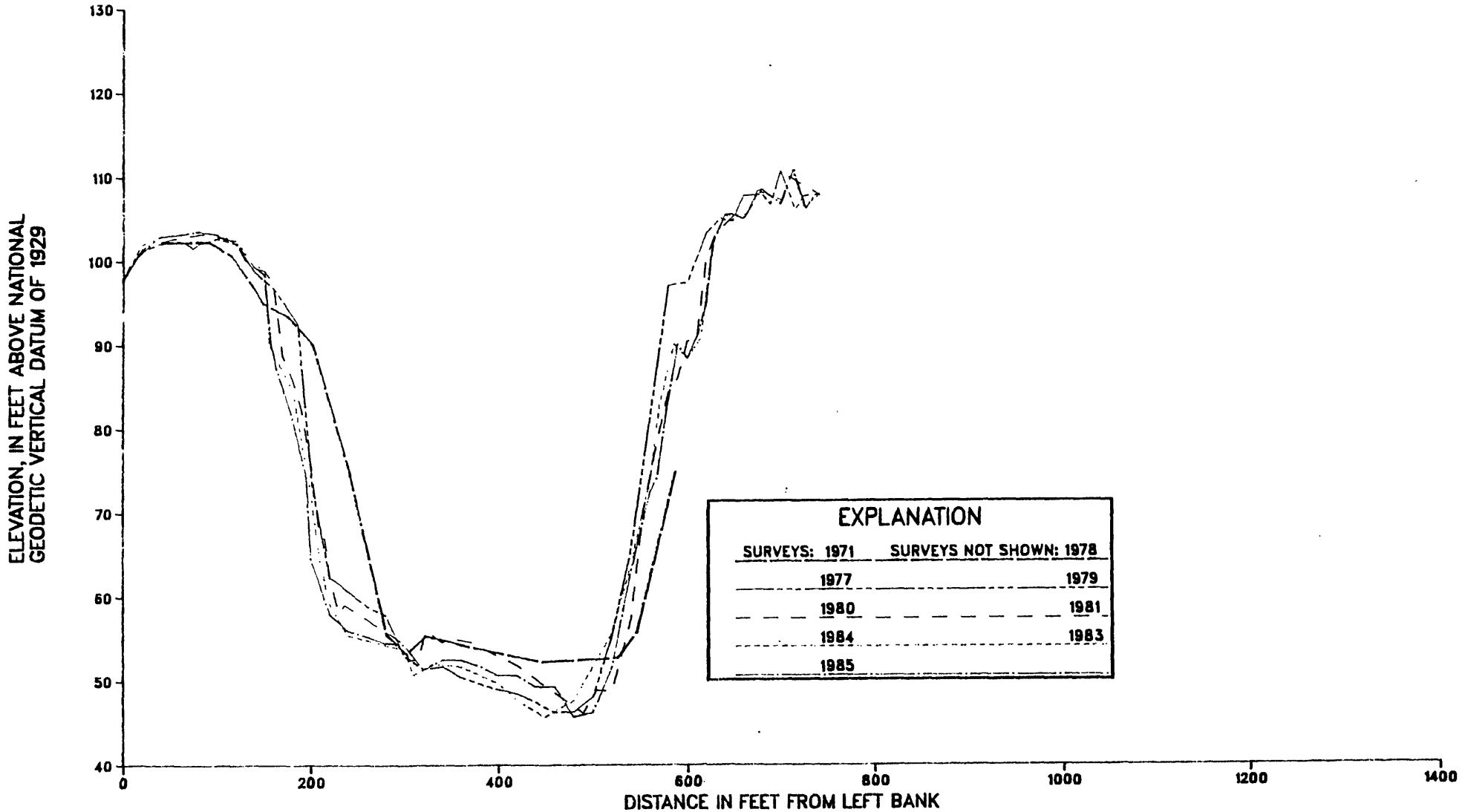

Figure 7.—Cross sections of sedimentation range 5C at river mile 221.2.

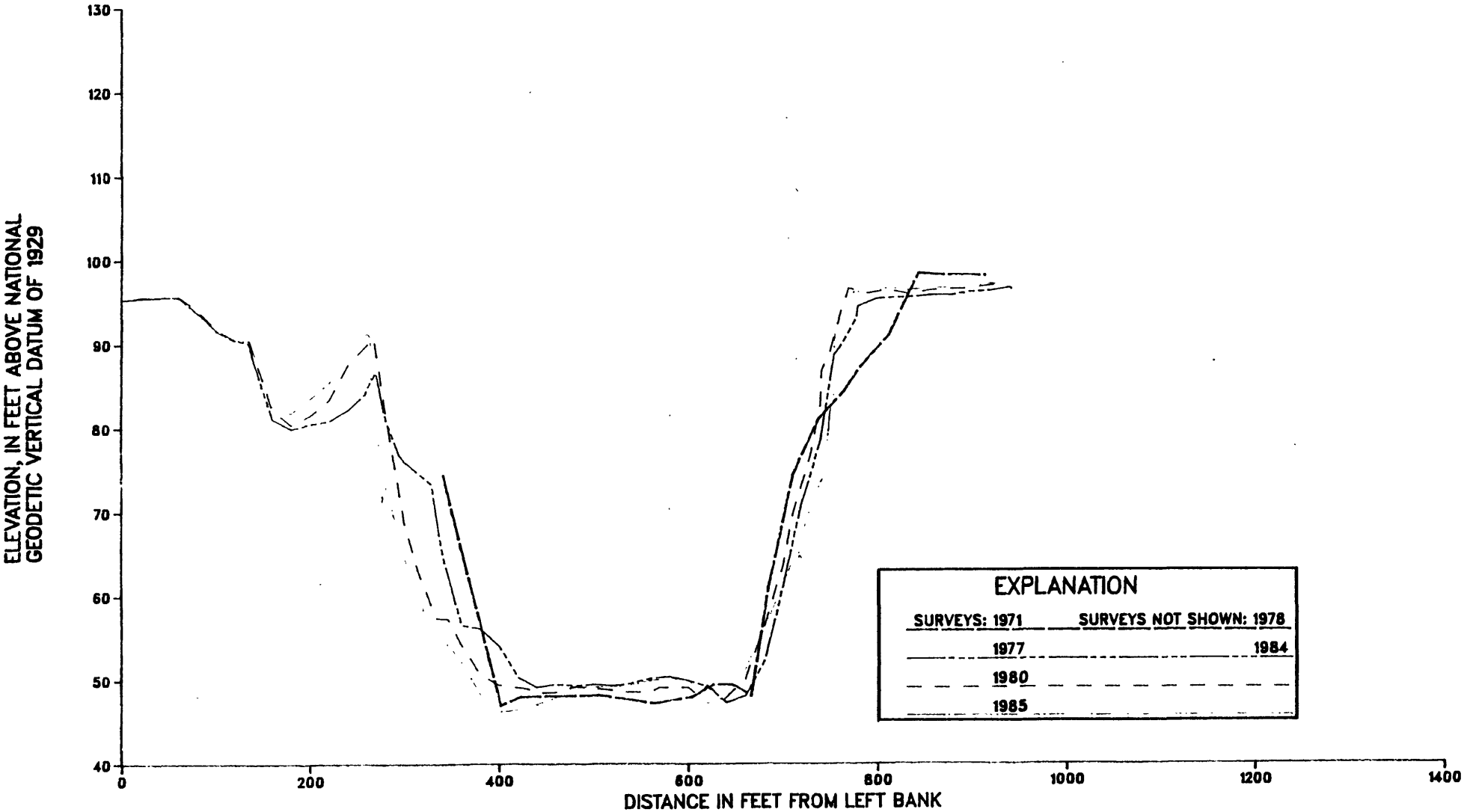

Figure 8.—Cross sections of sedimentation range 8C at river mile 208.8.

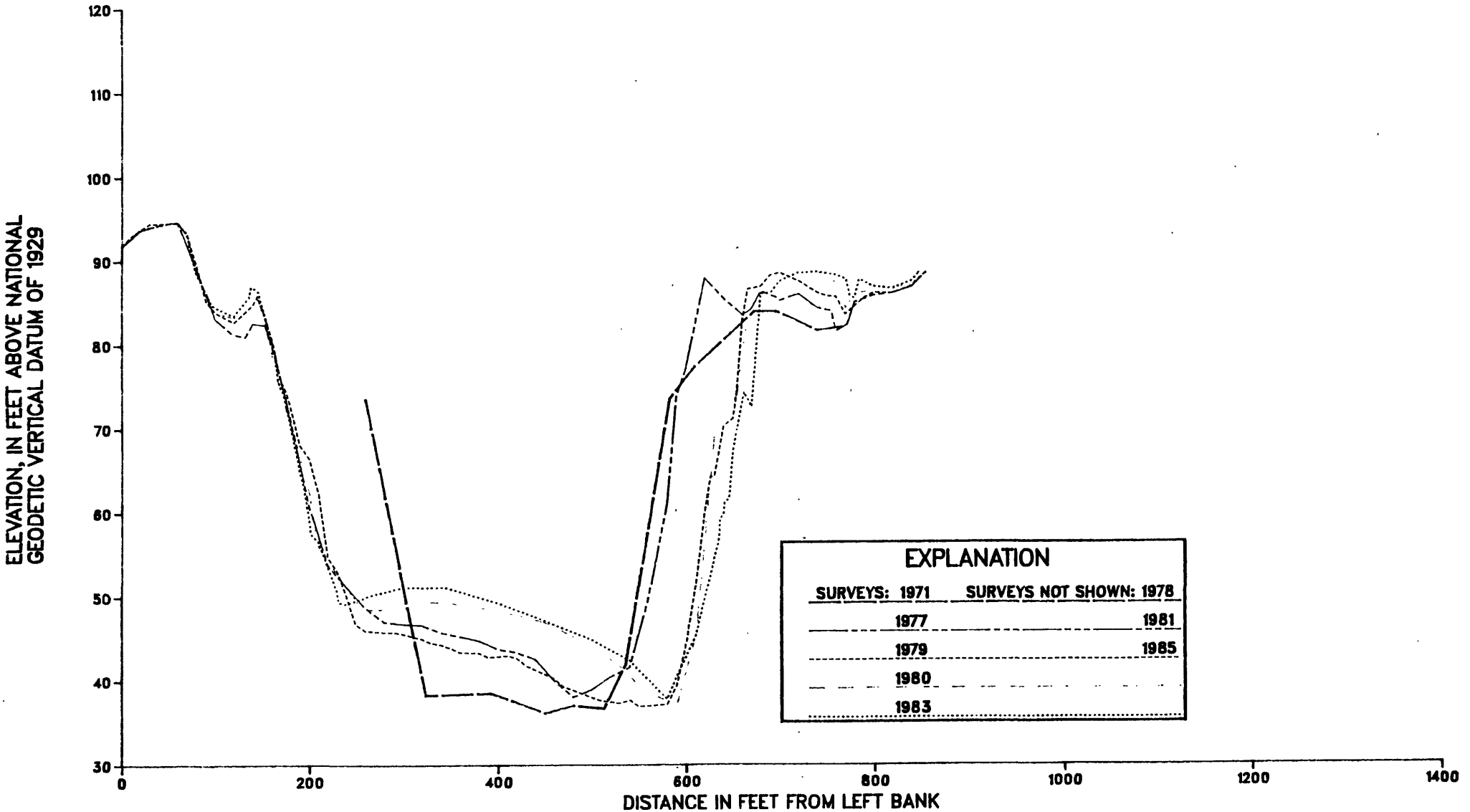

Figure 9.—Cross sections of sedimentation range 11C at river mile 196.7.

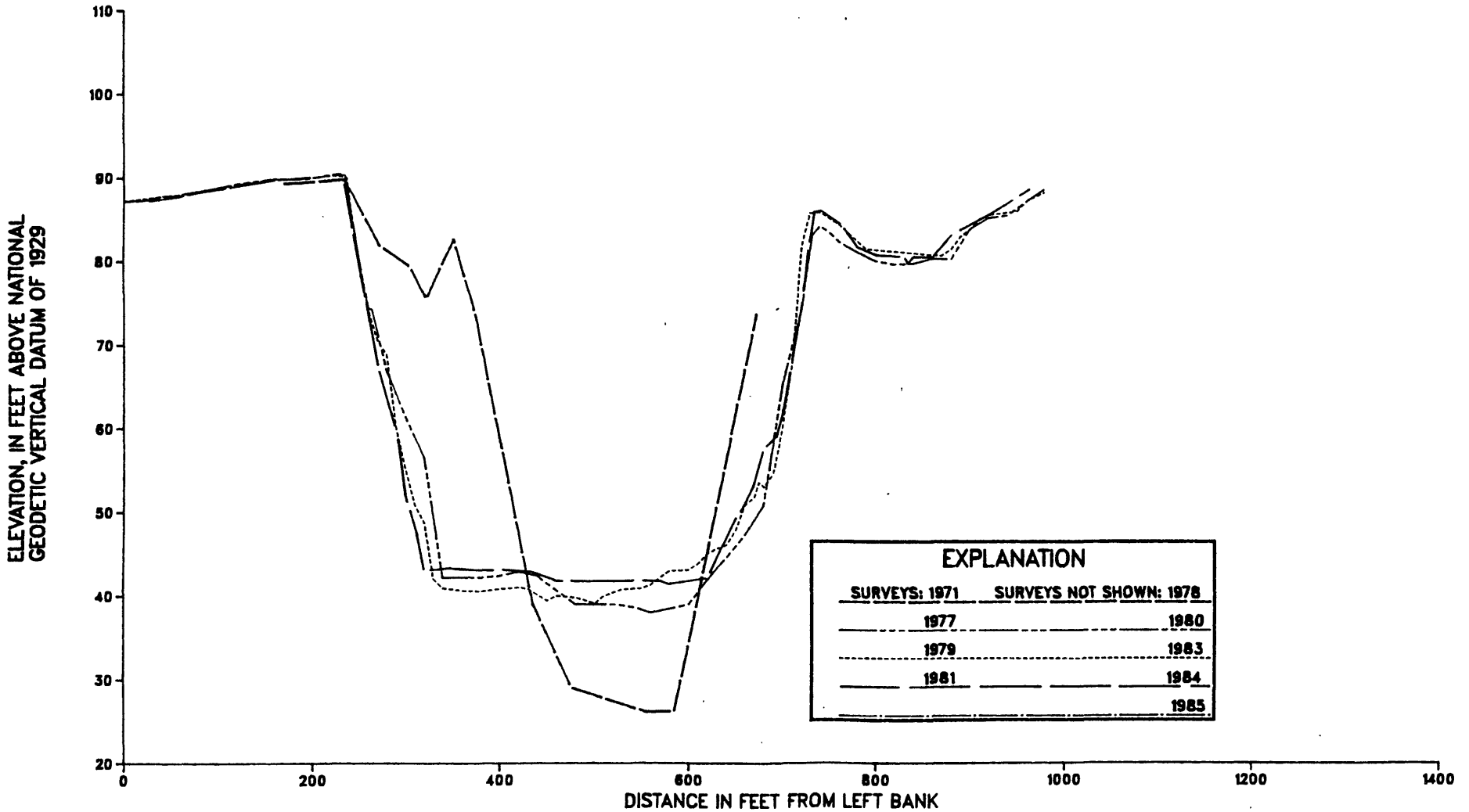

Figure 10.—Cross sections of sedimentation range 12CA at river mile 191.2.

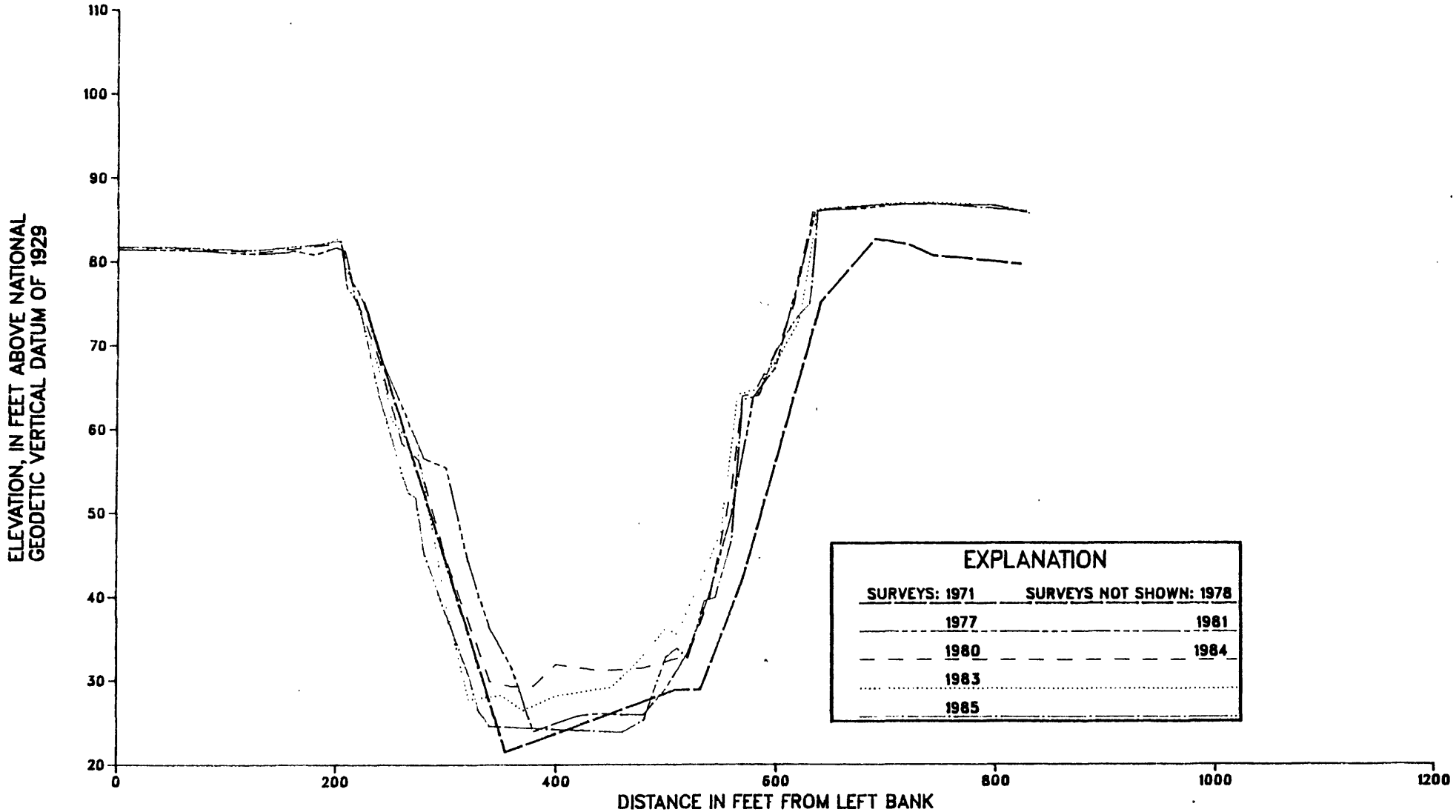

Figure 11.—Cross sections of sedimentation range 12CE at river mile 180.6.

DISCHARGE-VELOCITY RELATIONS AND FLOW DURATION ANALYSES

Relations of total discharge to mean velocity in the navigational channel, and flow durations were developed for the Tombigbee River at Gainesville and Epes. Mean velocity in the navigational channel was determined from discharge measurements and plotted against the total measured discharges. The data used for the Tombigbee River at Gainesville covered the period 1939 to 1979. The data used at Epes covered the periods 1906 to 1913 and 1939 to 1945. Mean curves were drawn through the plotted points. Curves drawn that envelope the plotted points define the limits of the plotted points. The curves for the Tombigbee River at Gainesville are shown in figure 12 and those for the Tombigbee River at Epes are shown in figure 13. Additional discharge-velocity relations for the Tombigbee River are on file at the U.S. Geological Survey, Montgomery.

The flow duration analyses were performed using data from the daily values file covering the same periods as those used to develop the discharge-velocity relations. The analyses were performed for different periods of the year. Bar graphs using the results of flow duration analyses for Gainesville and Epes are shown in figures 12 and 13, respectively. The percent of time when discharge exceeded a given amount can be determined from the graphs. Duration curves of daily flow for different periods of the year at Gainesville covering the period 1938 to 1980 are contained in "Compendium of Available Surface-Water Data in the Upper Tombigbee River Basin" (Gardner, 1982). This report also contains duration curves of daily flow for the Tombigbee River at Demopolis Lock and Dam covering the period 1928 to 1980.

ADDITIONAL DATA

The construction of the cutoff canal at Rattlesnake Bend was completed in 1976. Since completion, the U.S. Geological Survey has made 18 discharge Measurements in the vicinity of Rattlesnake Bend. The measurements were made in the cutoff canal, in the channel above the cutoff canal, and in the bendway channel. Data from these discharge measurements made are listed in table 5.

The environmental effects of the Rattlesnake Bend Cutoff Canal are discussed in "Draft Supplement to the Environmental Impact Statement, Volume 2: Appendices, Tennessee-Tombigbee Waterway, Alabama and Mississippi" (U.S. Army Corps of Engineers, 1981b).

Discharge measurements made at gaging stations within the study reach are on file at the U.S. Geological Survey, Tuscaloosa, Alabama.

Hydrologic data were collected in 1978 following the completion of Gainesville Lock and Dam, and during the filling of Gainesville Lake. Compilation of selected data and details concerning the collection of the data are found in "Hydrologic data collected at closure of Gainesville Lock and Dam, Tombigbee River near Gainesville, Alabama" (Ming and Sedberry, 1979).

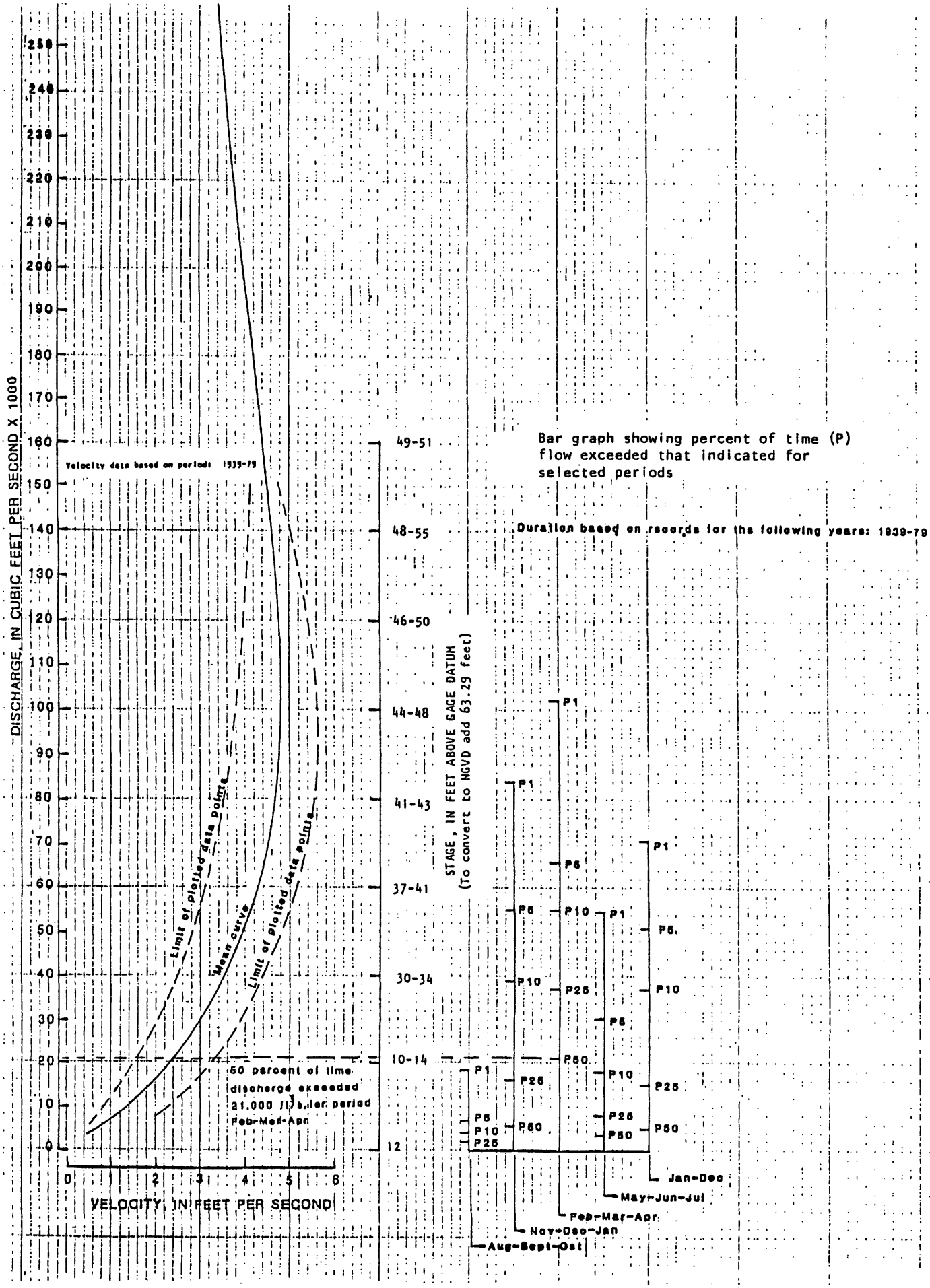

Figure 12.-Relation of mean channel velocity versus total discharge and flow durations for Tombigbee River at Gainesville.

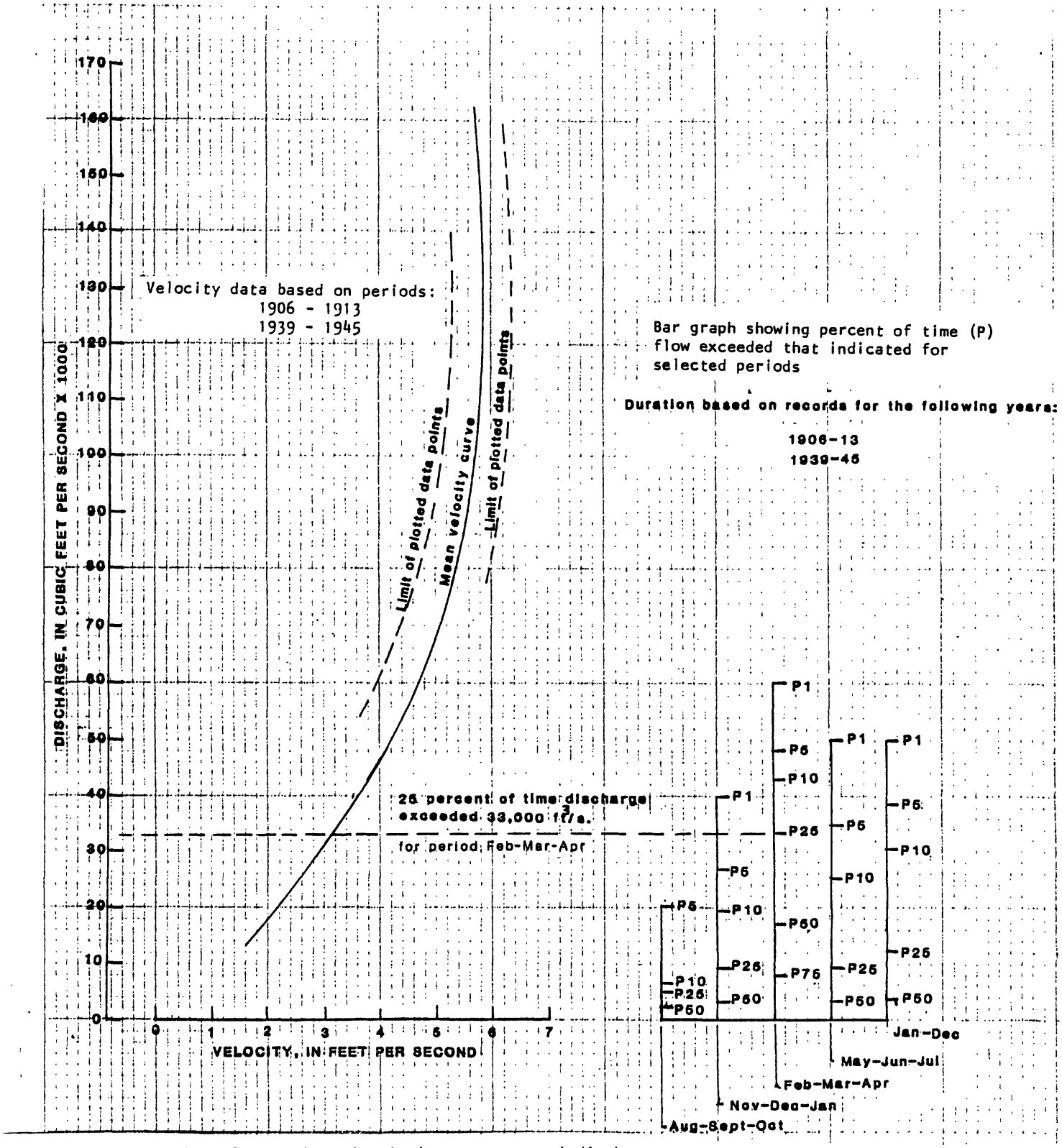

Figure 13.-Relation of mean channel velocity versus total discharge and flow durations for Tombigbee River at Epes.

CITED REFERENCES

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