# STREAMFLOW AND CROSS-SECTION DATA FOR THE TOMBIGBEE RIVER BETWEEN ALICEVILLE AND GAINESVILLE 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 |
|---|---|---|
| foot (ft) | 0.3048 | meter (m) |
| mile (mi) | 1.609 | kilometer (km) |
| square mile ($mi^2$) | 2.590 | square kilometer ($km^2$) |
| acre-foot (acre-ft) | 1,233 | cubic meter ($m^3$) |
| | 0.001233 | cubic hectometer ($hm^3$) |
| 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."

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

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## ABSTRACT

A review of records and historical research of floods for the Tombigbee River near Cochrane, Alabama show that the flood of 1892 was the highest since 1818. In 1962 the U.S. Army Corps of Engineers estimated a peak discharge of 235,000 cubic feet per second for this flood. This estimated discharge is more than 40 percent greater than the next highest flood peak; that of 1973.

Limit curves have been developed for the tailwater of Aliceville Lock and Dam. These limit curves, based on 61 computed discharges and 24 discharge measurements, show the range in stage for a given discharge at this site. Similarly, limit curves developed for Gainesville Lock and Dam pool were developed based on 49 computed discharges and 10 mean daily discharges.

Data from hydrographic surveys that were made for more than 100 ranges in 1937 and 1971 are on file with the U.S. Army Corps of Engineers. Presently 49 sedimentation ranges between Aliceville Lock and Dam and Gainesville Lock and Dam are surveyed routinely. Comparison of these and other data may be made to identify changes occurring along this reach of the river as a result of natural and man-made causes.

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

## INTRODUCTION

The construction and operation of locks and dams along the Tombigbee River, channel alterations such as cutoff canals at Big Creek Bend and Cooks Bend which were completed in 1979, 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 resource of the Tombigbee River.

The purpose of this report is to present a data base of hydrologic data that have been collected over a period of decades for the study reach, 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 scope of 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 to 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 Aliceville Lock and Dam to and including the Gainesville Lock and Dam, located about 50 miles downstream (fig. 1). This reach of the river has a well defined meandering channel with several bendway cutoff canals. The river gradually widens downstream of Aliceville Lock and Dam as it flows into Gainesville Lake which is formed by the Gainesville Dam. The reach is characterized by moderate- to steep-sloped banks, and wide, flat, mostly wooded flood plains, with scattered areas of the flood plains cultivated for agricultural use. The streamflow characteristics of the river and geometry of the channel were affected by channel improvement work, and preparatory work for, and construction of, the locks and dams, and bendway cutoff canals. Table 1 lists the periods during which project work took place and the approximate geographic limits where navigation improvement work took place. Major tributaries in the reach are the Sipsey River and Beaver, Bogue Chitto, and Lubbub Creeks (Nelson and Ming, 1983).

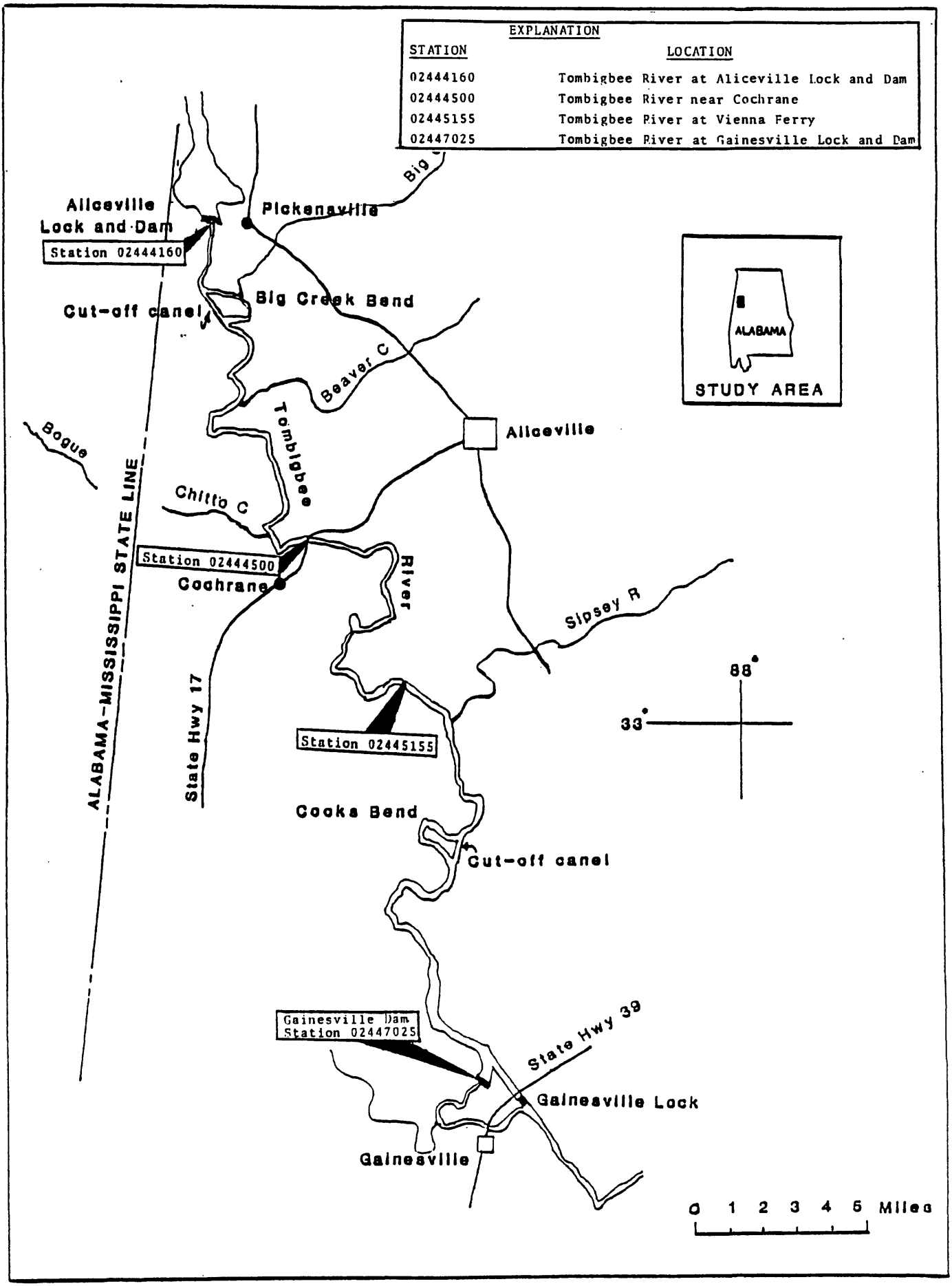


Figure 1.-Study reach

Table 1.--List of major navigational project activities in the study reach

| Project name | Begin date | Completion date | Limits upstream river mile | Limits downstream river mile | Remarks |
|---|---|---|---|---|---|
| Gainesville | 8/77 | 1/80 | 269.7 | 239.0 | |
| | 8/77 | 1/80 | 271.4 | 269.7 | Downstream of State Highway 17. |
| | 8/77 | 1/80 | 283.1 | 271.5 | Upstream of State Highway 17. |
| Additional work | 8/82 | 9/83 | 271.5 | 271.4 | In vicinity of State Highway 17. |
| Big Creek cutoff canal | 4/76 | 3/79 | 286.1 | 283.1 | |
| Aliceville | 1/80 | 4/82 | 317.3 | 286.1 | Upstream of Big Creek cutoff canal. |

## ALICEVILLE LOCK AND DAM

The Aliceville Lock and Dam is located on the Tombigbee River about 2 miles southwest of Pickensville at river mile 287.4 (fig. 1). Construction of the facility was completed in 1979. The lock is 110 feet wide and 600 feet long, with a lift capacity of 27 feet. The dam consists of a gate controlled spillway section with four 60-foot wide radial gates and a fixed-crest spillway that is 150 feet long. The elevation of the gated spillway is 111 feet above sea level and the elevation of the fixed crest spillway is 135.3 feet. The normal pool elevation of Aliceville Lake, which is formed by the dam, is 136 feet. Storage capacity of the lake at normal pool elevation is 60,400 acre-feet. The lock and dam is operated by the U.S. Army Corps of Engineers.

## GAINESVILLE LOCK AND DAM

The Gainesville Dam is located on the Tombigbee River about 2 miles northeast of Gainesville at river mile 238.8. Construction of the facility was completed in 1978. The lock is a separate facility located about 1.5 miles southeast of the dam at the end of an approach canal (fig. 1). The dam consists of a gate-controlled spillway section with five 50-foot wide radial gates and a fixed crest spillway that is 225 feet long. The elevation of the gate-controlled section is 75 feet and the elevation of the fixed-crest spillway section is 108.5 feet. The normal pool elevation of Gainesville Lake, which is formed by the dam, is 109 feet. Storage capacity of the lake at normal pool elevation is 45,290 acre-feet. The dam is operated by the U.S. Army Corps of Engineers.

Discharge coefficients were developed based on discharge measurements made at the dam. These coefficients are used in discharge equations to compute discharge for the various types of flow that occur at the dam. Relations between the coefficients and the heights of the tailwater, headwater, and gate openings are on file at the U.S. Geological Survey, Montgomery.

## GAGING STATIONS

Four gaging stations are located within the study reach. The location of each station is shown in figure 1.

Station 02444160 was established on the Tombigbee River at the Aliceville Lock and Dam about 2 miles southwest of Pickensville, at river mile 287.4 in October 1980. The datum of the gage is 100.00 feet. Streamflow records are published in "Water Resources Data - Alabama" (annual report series).

Station 02444500 was established on the Tombigbee River about 1.2 miles northeast of Cochrane, at river mile 271.4 in October 1938. The datum of the gage is 89.85 feet. Stage data obtained from this site from October 1909 to September 1924 are contained in reports by the National Weather Service. The U.S. Army Corps of Engineers maintained a gage at this site November 11 through November 30, 1936, and from 1938 to 1970 at the same datum. Streamflow records have been published for this station in U.S. Geological Survey publications since 1938, and in "Water Resources Data - Alabama" (annual report series) since 1961. Publication of daily mean discharge was discontinued in March 1978 when the station was converted to a flood hydrograph station. Publication of these data was discontinued at the end of the 1978 water year.

Station 02445155, Tombigbee River at Vienna Ferry, was established 12 miles downstream as the auxiliary gage for the station located near Cochrane. The datum of the gage is 82.09 feet. This gage has been operating since February 1940.

Station 02447025 was established on the Tombigbee River at the Gainesville Lock and Dam about 1.8 miles north of Gainesville at river mile 238.8 in March 1978. The datum of the gage is 65.00. Streamflow records are published in "Water Resources Data - Alabama" (annual report series).

## HISTORICAL FLOODS

Based on reports by the National Weather Service and historical research, the highest flood on the Tombigbee River near Cochrane occurred in April 1892. The discharge was estimated at 235,000[a] cubic feet per second by the U.S. Army Corps of Engineers in 1962 (Harold Doyal, U.S. Army Corps of Engineers, oral commun., 1987). The flood produced a peak stage of 50.2 feet gage datum. Table 2 lists annual peak discharges greater than 50,000 cubic feet per second and annual peak gage heights. Figure 2 is a plot of annual peak discharge versus annual peak stage. Data after 1979 are peak gage heights versus daily mean discharge at Aliceville Lock and Dam. Based on estimates made by the U.S. Army Corps of Engineers, the flood of 1892 also produced the highest discharge at the sites where Aliceville Dam and Gainesville Dam are now located. The flood produced a discharge of 235,000 cubic feet per second at the Aliceville Lock and Dam site and 266,000 cubic feet per second at the Gainesville Dam site.

## FLOOD PROFILES

Flood profiles, defined by high-water mark elevations, were developed for the floods of 1949, 1973, 1979, and 1980. The elevations of the high water marks were determined by field surveys. Maps showing the location and elevation of the high-water marks are on file at the U.S. Geological Survey, Montgomery, Alabama. Figure 3 is a graph showing the profiles of the floods. Table 2 lists the peak discharges and dates of occurrence near Cochrane for the floods of 1949, 1973, and 1979. The maximum daily mean discharge of 108,000 cubic feet per second occurred March 25 during the 1980 flood at Gainesville Lock and Dam.

[a] Previously published as 255,000 cubic feet per second in "Magnitude and frequency of floods in Alabama" (Olin, 1984).

Table 2.--Annual peak discharges greater than 50,000 cubic feet per second for Tombigbee River near Cochrane

| Water year | Date | Peak discharge (cubic feet per second) | Gage height (feet above gage datum) | Maximum gage height (feet above gage datum) | Date |
|---|---|---|---|---|---|
| 1892 | 4/ /92 | 235,000 | 50.20 | | |
| 1939 | 3/03/39 | — | 33.20 | | |
| 1940 | 7/08/40 | — | | 36.26 | 7/16/40 |
| 1941 | 3/11/41 | — | 22.24 | | |
| 1942 | 3/23/42 | — | 23.38 | | |
| 1943 | 3/18/43 | — | 27.70 | 33.50 | 3/23/43 |
| 1944 | 4/03/44 | 108,000 | 43.70 | | |
| 1945 | 3/10/45 | 54,800 | 36.40 | 37.70 | 2/28/45 |
| 1946 | 2/15/46 | 92,800 | 42.80 | 42.90 | 2/16/46 |
| 1947 | 1/09/47 | 52,700 | 35.50 | 36.40 | 1/11/47 |
| 1948 | 2/19/48 | 107,000 | 44.50 | | |
| 1949 | 1/09/49 | 163,000 | 46.90 | | |
| 1950 | 1/12/50 | 76,500 | 41.20 | 41.80 | 1/13/50 |
| 1951 | 4/02/51 | 124,000 | 45.00 | | |
| 1952 | 12/28/51 | — | 29.40 | 29.80 | 12/30/51 |
| 1953 | 2/28/53 | 52,000 | 36.97 | 37.17 | 3/01/53 |
| 1954 | 1/28/54 | — | 25.20 | | |
| 1955 | 3/29/55 | 77,000 | 40.00 | 40.80 | 3/29/55 |
| 1956 | 3/18/56 | — | | | |
| 1957 | 2/09/57 | 59,700 | 37.70 | | |
| 1958 | 11/25/57 | 69,200 | 40.00 | 40.20 | 11/26/57 |
| 1959 | 2/20/59 | — | 28.10 | | |
| 1960 | 3/09/60 | — | 33.19 | 33.80 | 3/10/60 |
| 1961 | 2/27/61 | 59,800 | 41.72 | | |
| 1962 | 12/22/61 | 122,000 | 45.78 | | |
| 1963 | 7/20/63 | — | 29.87 | | |
| 1964 | 4/18/64 | 50,600 | 37.93 | 38.14 | 4/19/64 |
| 1965 | 2/17/65 | 60,900 | 39.08 | 39.58 | 2/18/65 |
| 1966 | 5/02/66 | — | 31.96 | 32.35 | 2/19/66 |
| 1967 | 2/25/67 | — | | | |
| 1968 | 1/15/68 | 79,800 | 41.78 | 41.94 | 1/16/68 |
| 1969 | 4/20/69 | 66,000 | 41.45 | | |
| 1970 | 1/07/70 | 63,700 | 38.19 | 39.71 | 3/26/70 |
| 1971 | 3/03/71 | 60,300 | 39.76 | | |
| 1972 | 3/12/72 | 58,700 | 39.74 | | |
| 1973 | 3/21/73 | 166,000 | 47.37 | | |
| 1974 | 1/31/74 | 52,500 | | 37.47 | 2/01/74 |
| 1975 | 3/19/75 | 109,000 | | 43.10 | 3/20/75 |
| 1976 | 4/04/76 | — | 35.06 | | |
| 1977 | 3/12/77 | 69,000 | 39.55 | | |
| 1978 | 5/15/78 | 62,000 | 35.93 | | |
| 1979 | 4/13/79 | 106,200 | 43.22 | | |

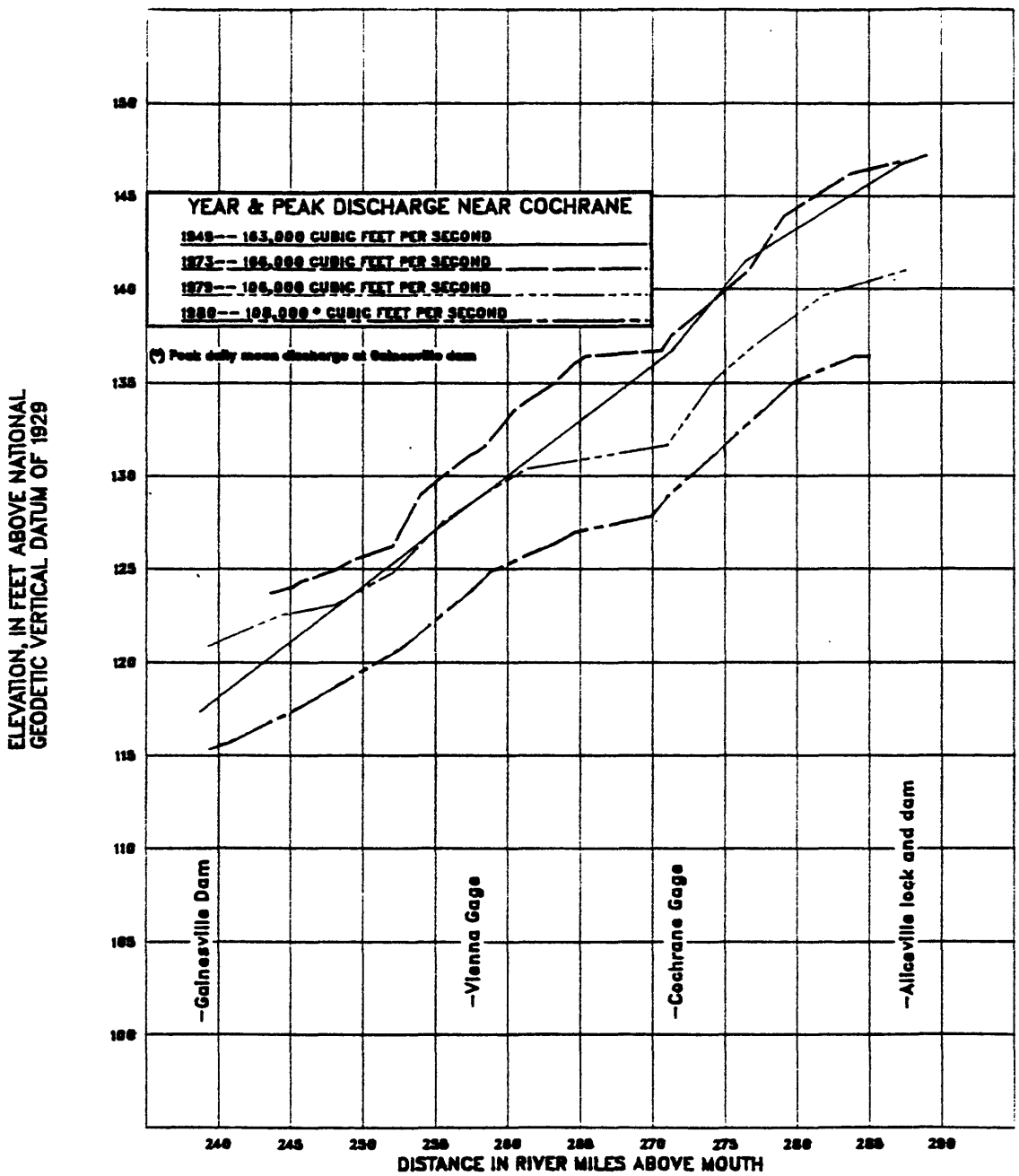


Figure 3.– Flood profiles of study reach for the floods of 1949, 1973, 1979 and 1980

## LIMIT CURVES OF STAGE-DISCHARGE RELATIONS

Due to backwater conditions, a single, stable stage-discharge relation cannot be developed for the Tombigbee River at Aliceville Lock and Dam. Preliminary limit curves were developed that define a range in stage for a given discharge. Discharge measurements and computed discharge were plotted versus stage, based on data collected from 1980 to May 1983, while navigation project was being done downstream to the Big Creek cutoff canal. Figure 4 is a graph of the plotted data and limit curves for the Aliceville Lock and Dam, tailwater. Details concerning the development of the limit curves are contained in "Preliminary Stage-Discharge Relations for the Tombigbee River at Aliceville Lock and Dam, near Pickensville, Alabama" (Nelson and Ming, 1983).

Following completion of the project work, additional data indicated a need to update the limit curves. Stage data and computed discharge for the period December 3 through 10, 1983 were used in development of the updated curves. Figure 5 is a graph showing the plot of stage versus computed discharge, and the updated limit curves for the Aliceville Lock and Dam, tailwater. Additional information concerning the update limit curves are contained in "Stage-Discharge Relations for Tombigbee River at Aliceville Lock and Dam, near Pickensville, Alabama--Updated 1985" (Nelson and Ming, 1986).

Limit curves were also developed for the Tombigbee River at Gainesville Dam using stage and computed discharge for the period 1979-82. Figure 6 is a graph showing the plotted data and limit curves for the Gainesville Dam, pool. Additional information is contained in "Preliminary Stage-Discharge Relations for the Tombigbee River at Gainesville Dam, near Gainesville, Alabama" (Nelson and Ming, 1983).

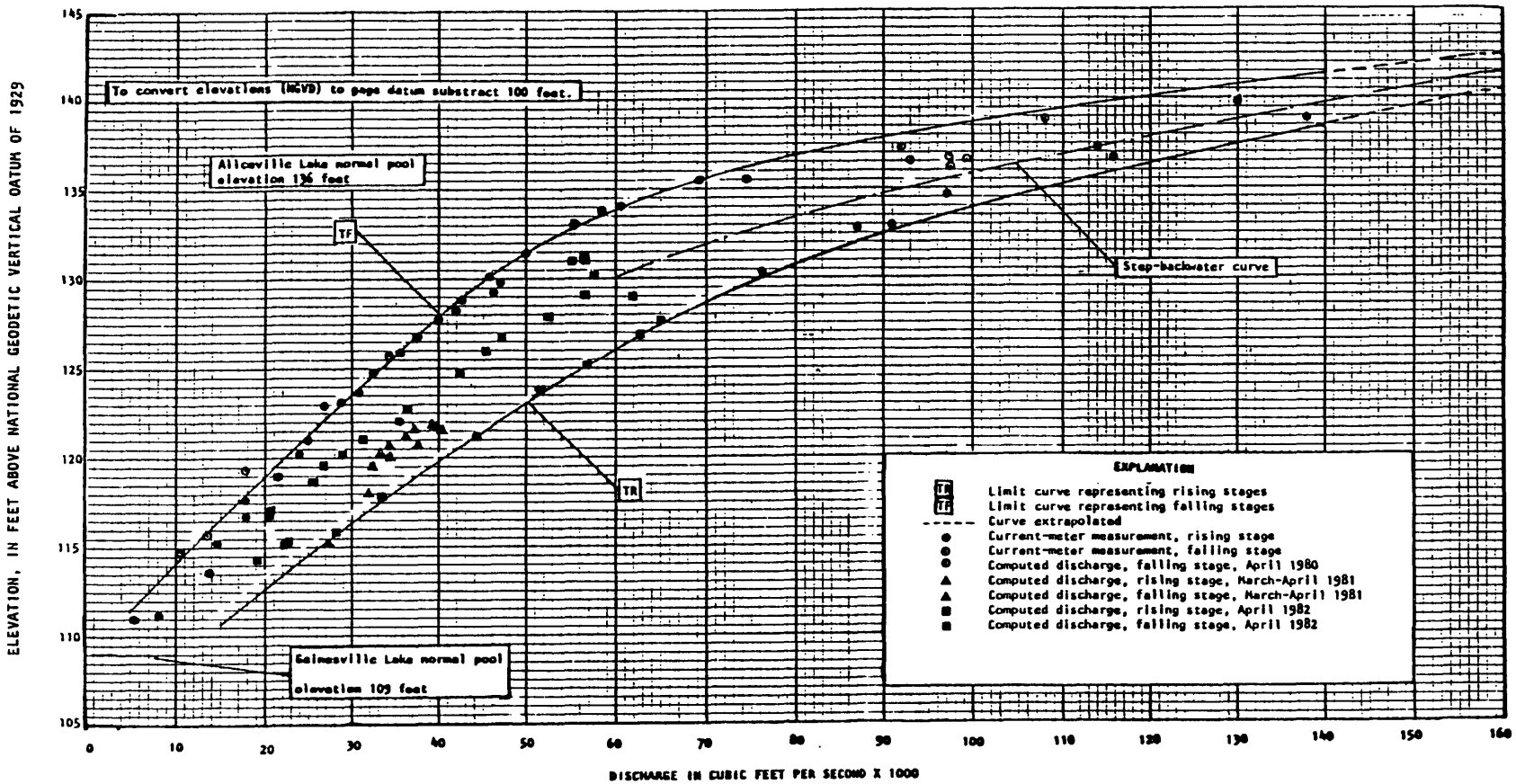


Figure 4.-Limit curves defining the ranges in stage for Tombigbee River at Aliceville Lock and Dam, tailwater.

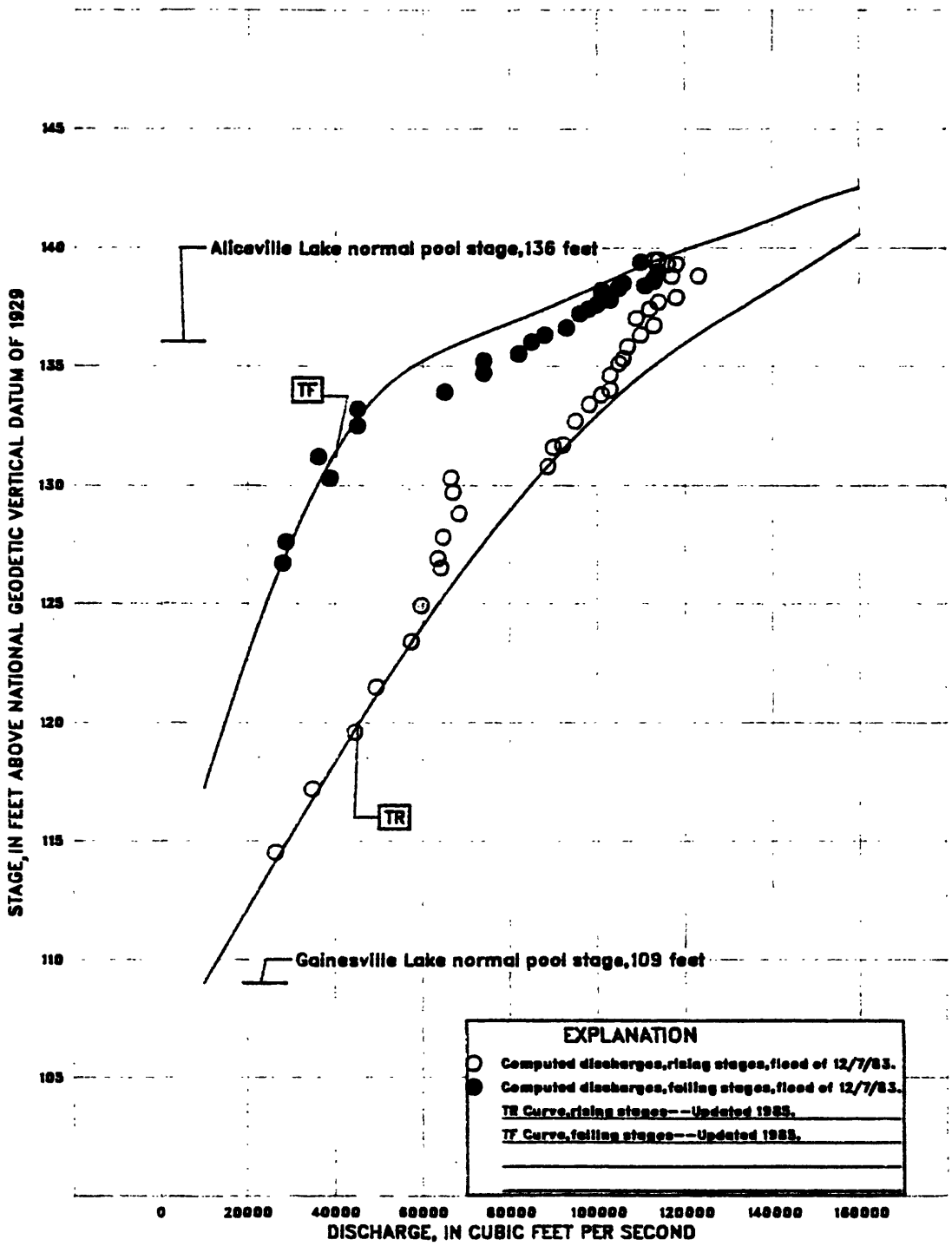


Figure 5.– Updated limit curves defining the ranges in stage for Tombigbee River at Alliceville Lock and Dam, tailwater.

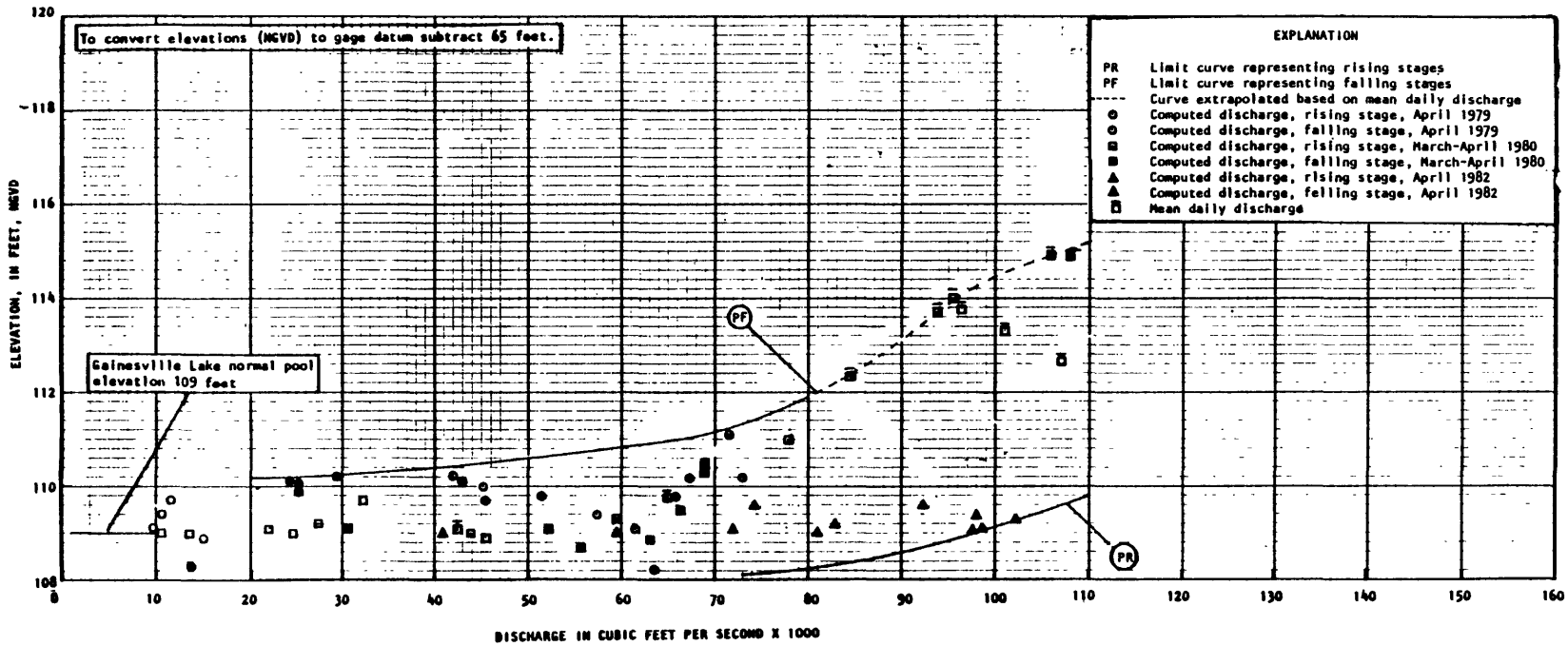


Figure 6.-Limit curves defining the ranges in stage for Tombigbee River at Gainesville Dam, pool.

## SEDIMENTATION RANGES

In 1937 and 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 49 sedimentation ranges are surveyed routinely.

The cross section data of six selected ranges were used to graphically represent the changes in the channel of the river at these ranges. The six ranges are listed in table 3 and shown in figure 7. Plates were prepared showing the location of the ranges where surveys took place in 1937 and 1971. Since these 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 location of the six selected ranges. This was done by locating a highway crossing or mouth of a creek or river entering the Tombigbee River at a known river mile on the plates and measuring the distance upstream or downstream of the point until the river mile location on the plate matched the river mile location of the alpha-numeric identified ranges. The closest range on the plate to the river mile location was used. For convenience of the reader, all ranges are identified by the alpha-numeric system in this report. In order to document changes in the channel associated with construction of the Big Creek cut-off canal, Range 16A (located just upstream of the canal) and Range 15A (located just downstream of the canal) were selected. Similarly, Ranges 4A and 4AG were at the Cooks Bend cutoff canal.

Table 3.--Selected sedimentation ranges used for comparison of cross section data

| Sedimentation range | Location (river miles above mouth) | Remarks |
|---|---|---|
| 2A | 241.3 | |
| 4A | 247.7 | Downstream of Cooks Bend cutoff canal |
| 4AG | 252.1 | Upstream of Cooks Bend cutoff canal |
| 9A | 264.3 | |
| 15A | 283.0 | Downstream of Big Creek cutoff canal |
| 16A | 286.7 | Upstream of Big Creek cutoff canal |

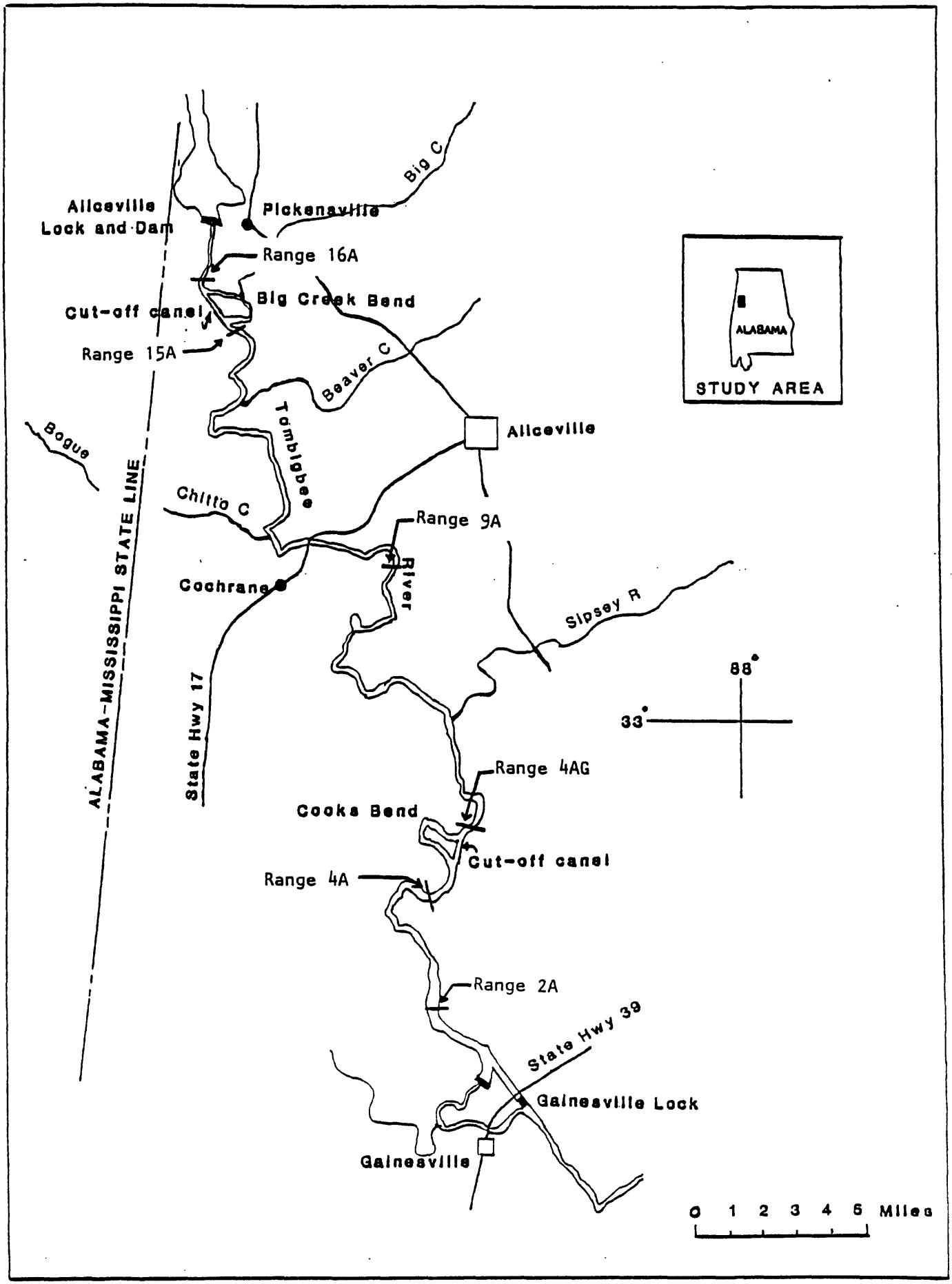


Figure 7.-Location of selected sedimentation ranges.

Cross section data were available from surveys conducted in 1937, 1971, and annual surveys since 1977. Graphical representations of the cross section data for the selected ranges are shown in figures 8 through 13. In some cases there was very little change 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 Big Creek Bend and Cooks Bend, and in the cutoff canals constructed at these bends are shown in "Environmental Impact Statement, Tennessee-Tombigbee Waterway, Alabama and Mississippi" (U.S. Army Corps of Engineers, 1981a).

## DISCHARGE-VELOCITY RELATION

A relation of total discharge to mean velocity in the navigational channel was developed for the Tombigbee River near Cochrane. Data taken from discharge measurements made at the site were used to define the discharge-velocity relation. Mean velocity in the navigational channel was determined from the discharge measurements and plotted against the total measured discharge. The data used covered the period 1939-77. A mean curve was drawn through the plotted points. Due to a scatter of the plotted data, limit curves were drawn that enveloped the data points. The curves are shown in figure 14.

Using data from the daily values file, flow duration analyses for the Tombigbee River near Cochrane were performed for different periods of the year. The period of record from which the data were obtained is 1939-77. Bar graphs using the results of a discharge duration analysis are also shown in figure 14. The percent of time when discharge exceeded a given amount can be determined from the graph. Duration curves of daily flows for the Tombigbee River near Cochrane for the period 1938-78 are contained in "Compendium of Available Surface Water Data in upper Tombigbee River basin" (Gardner, 1982). Additional discharge-velocity relations for the Tombigbee River are on file at the U.S. Geological Survey, Montgomery.

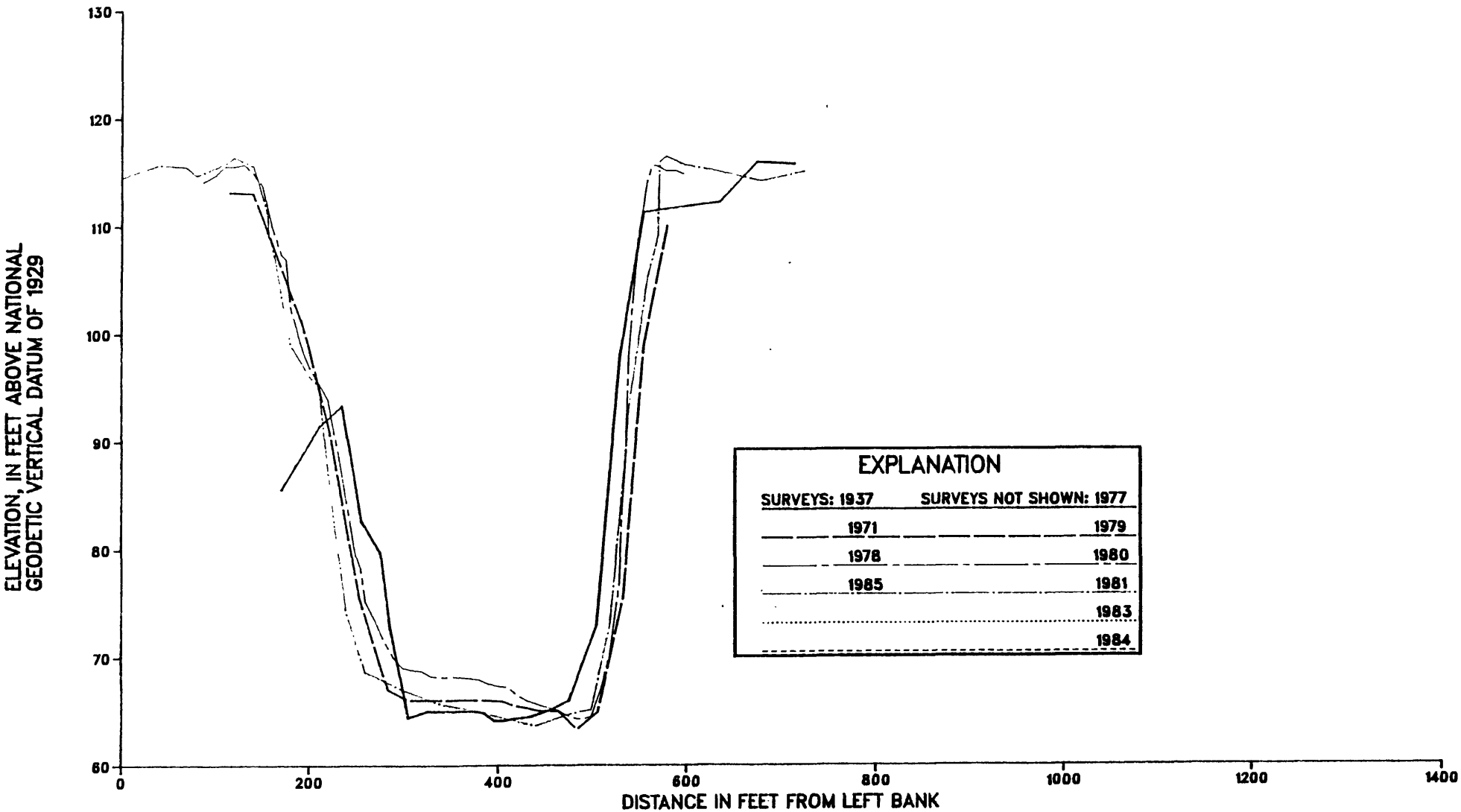


Figure 8. Cross sections of sedimentation range 2A at river mile 241.3.

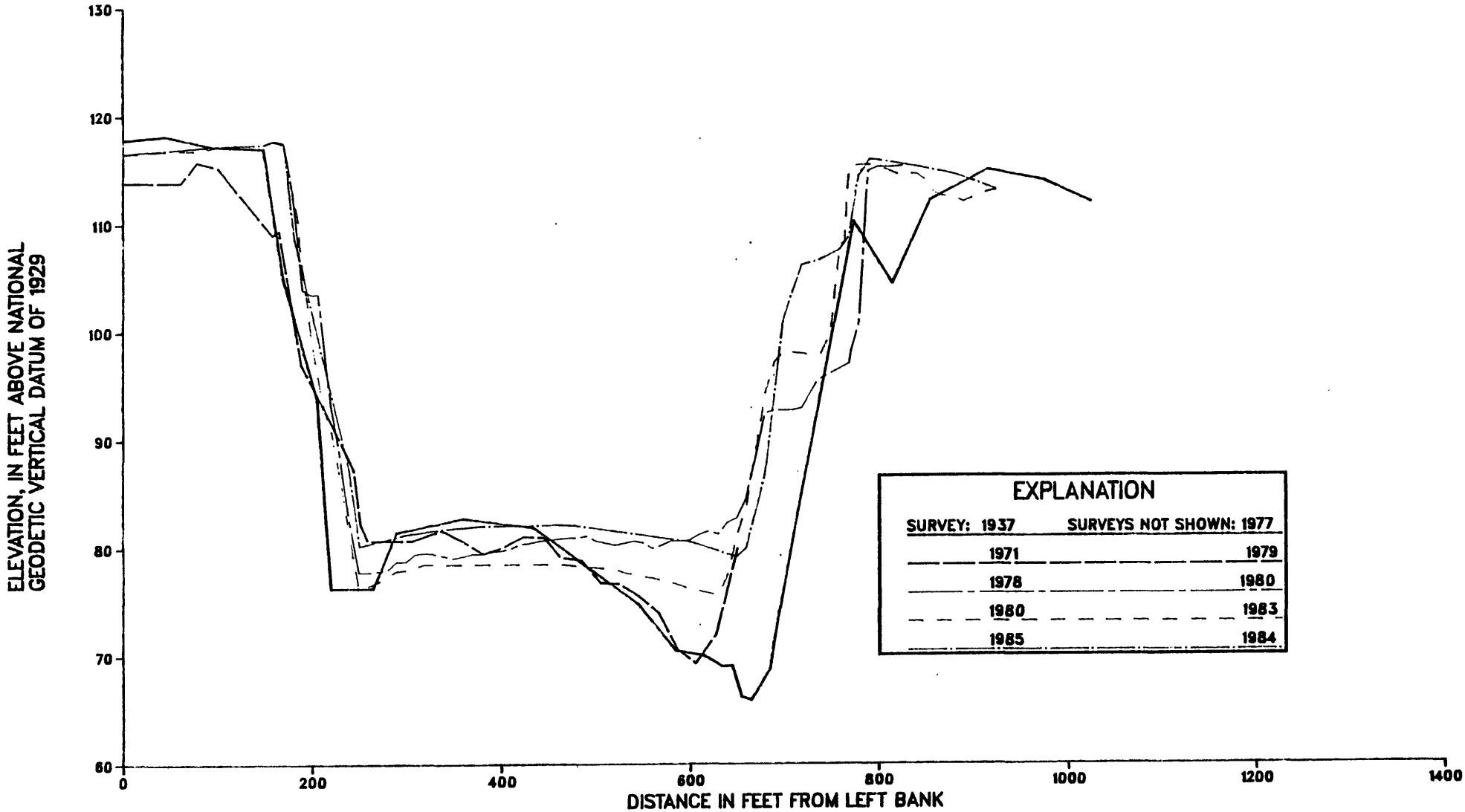


Figure 9. Cross sections of sedimention range 4A at river mile 247.7.

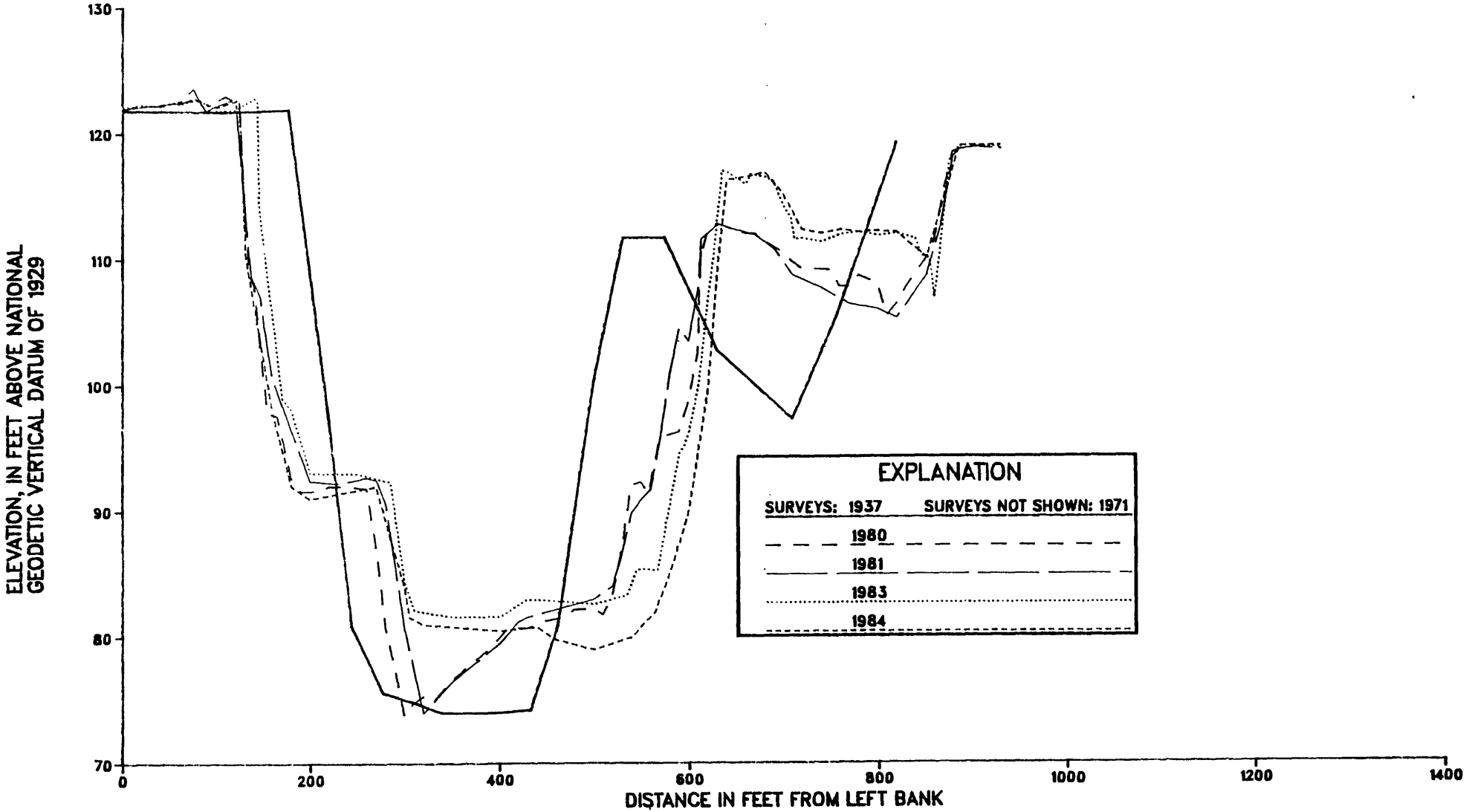


Figure 10. Cross sections of sedimentation range 4AG at river mile 252.1.

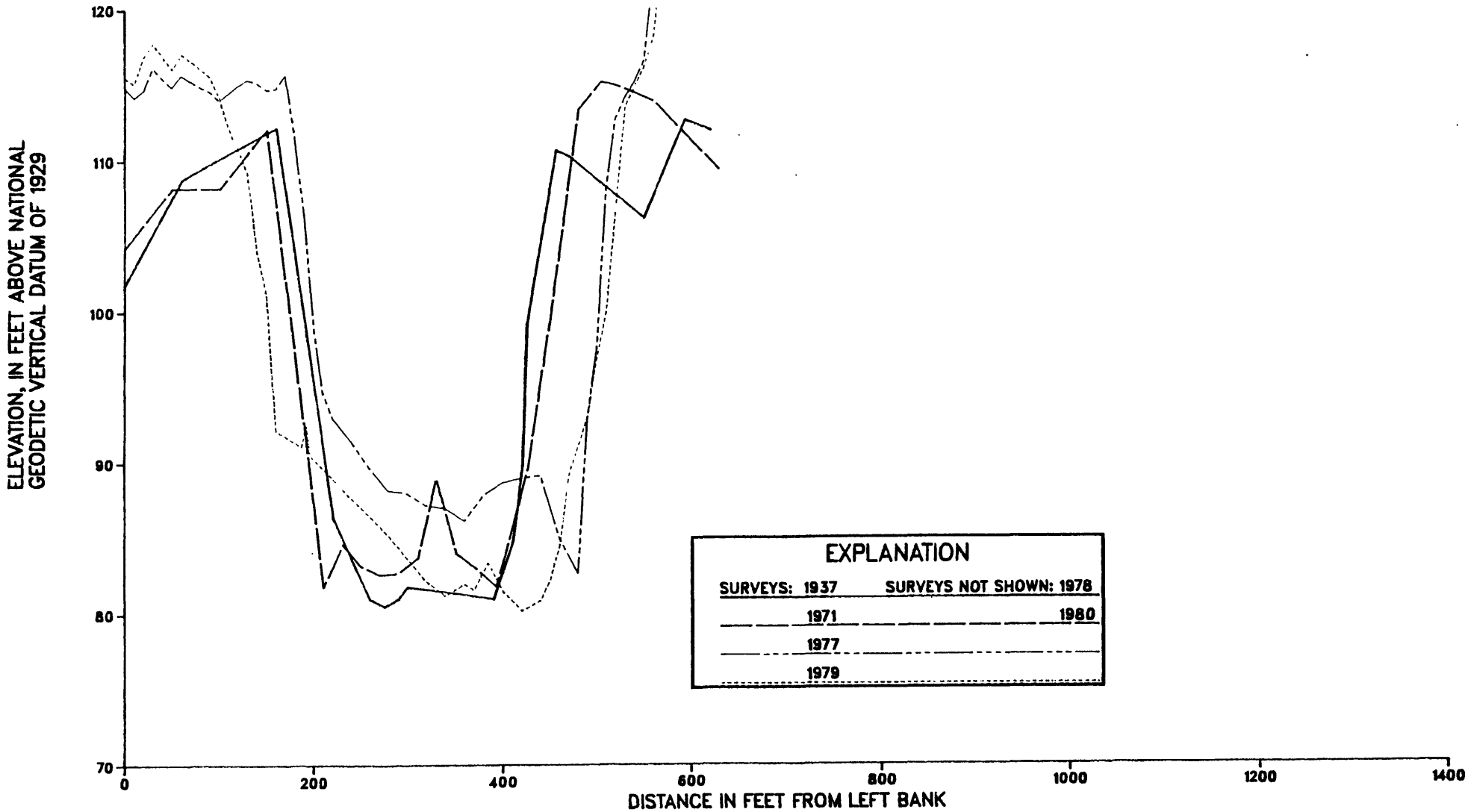


Figure 11. Cross sections of sedimentation range 9A at river mile 284.3.

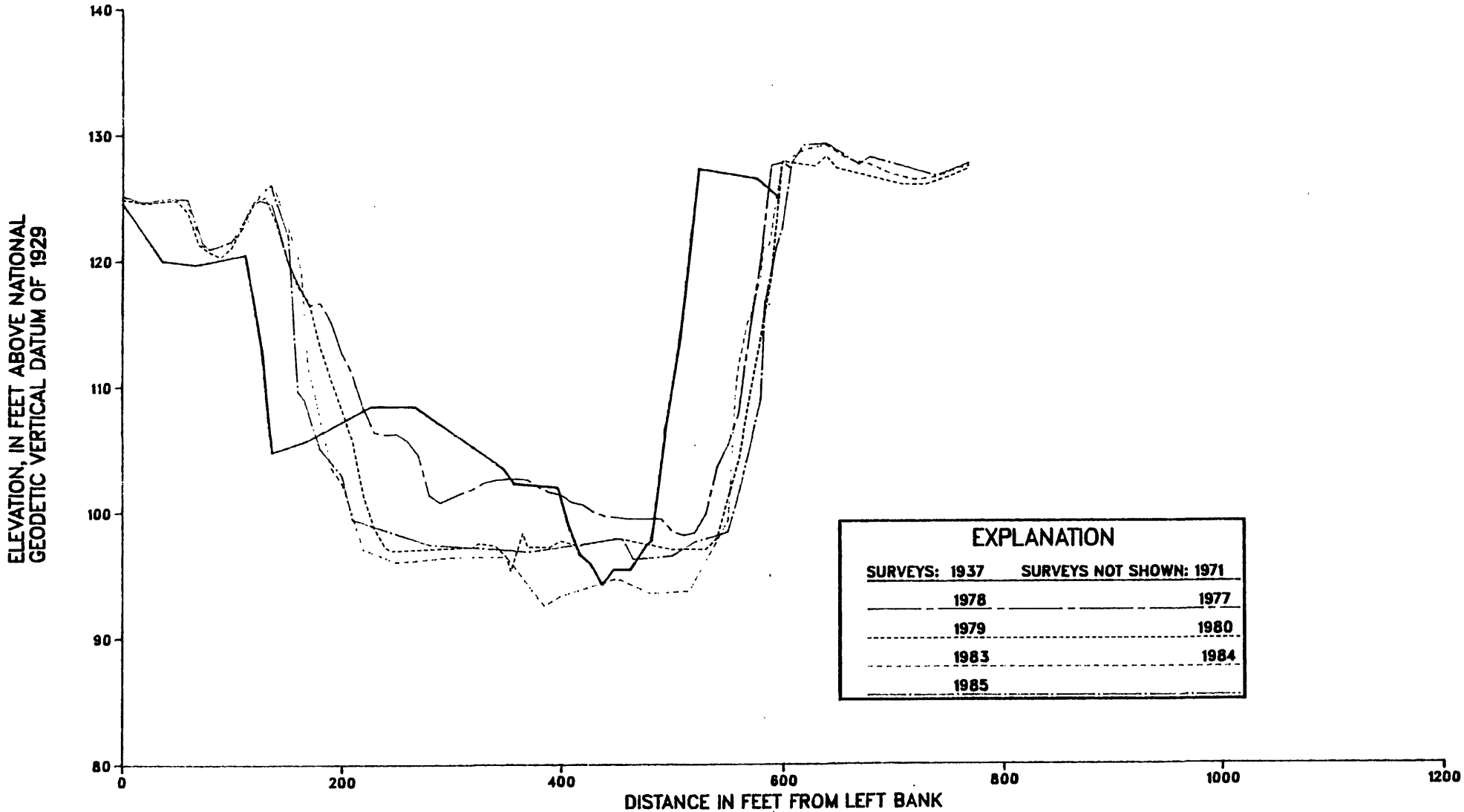


Figure 12. Cross sections of sedimentation range 15A at river mile 283.0.

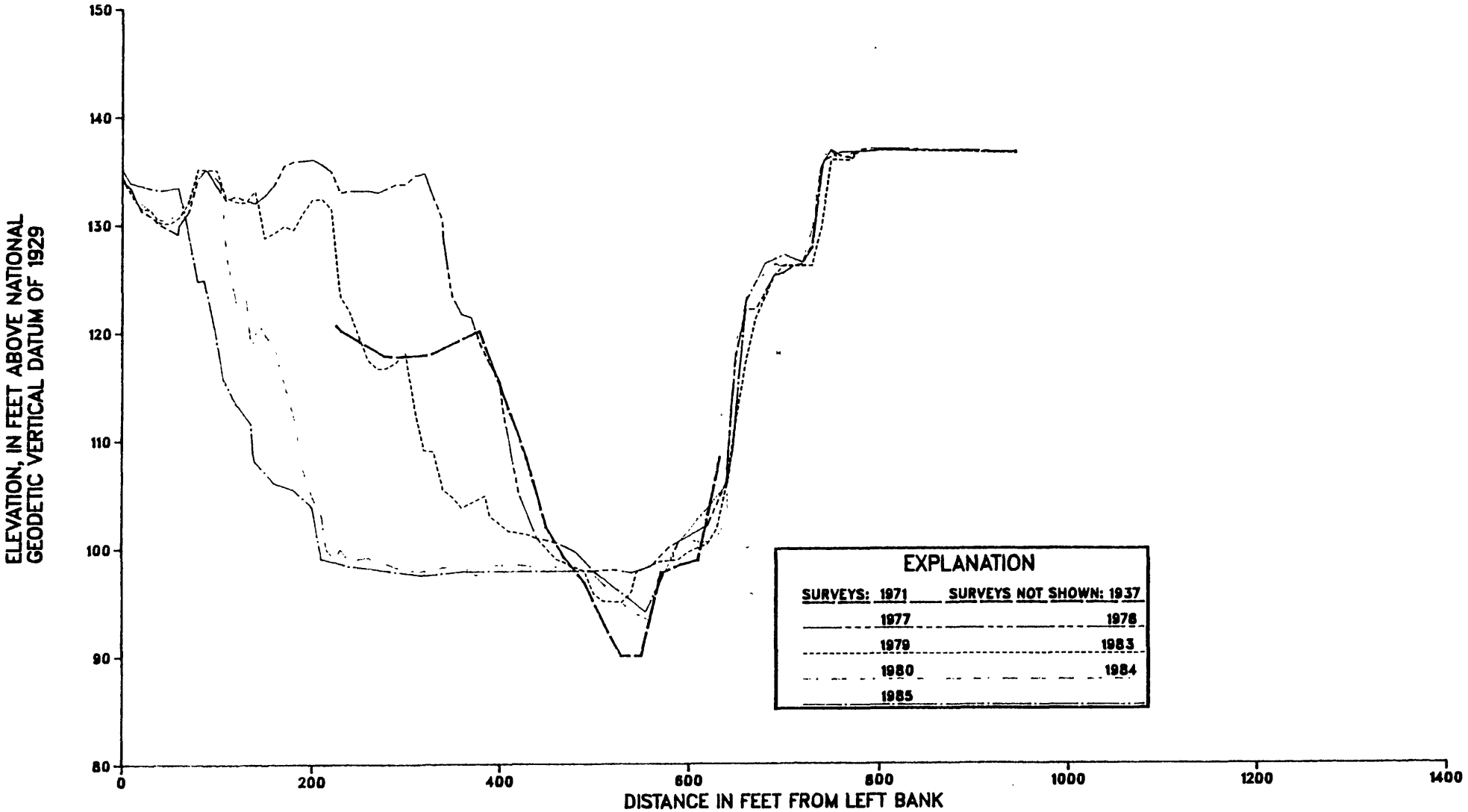


Figure 13. Cross sections of sedimentation range 16A at river mile 286.7.

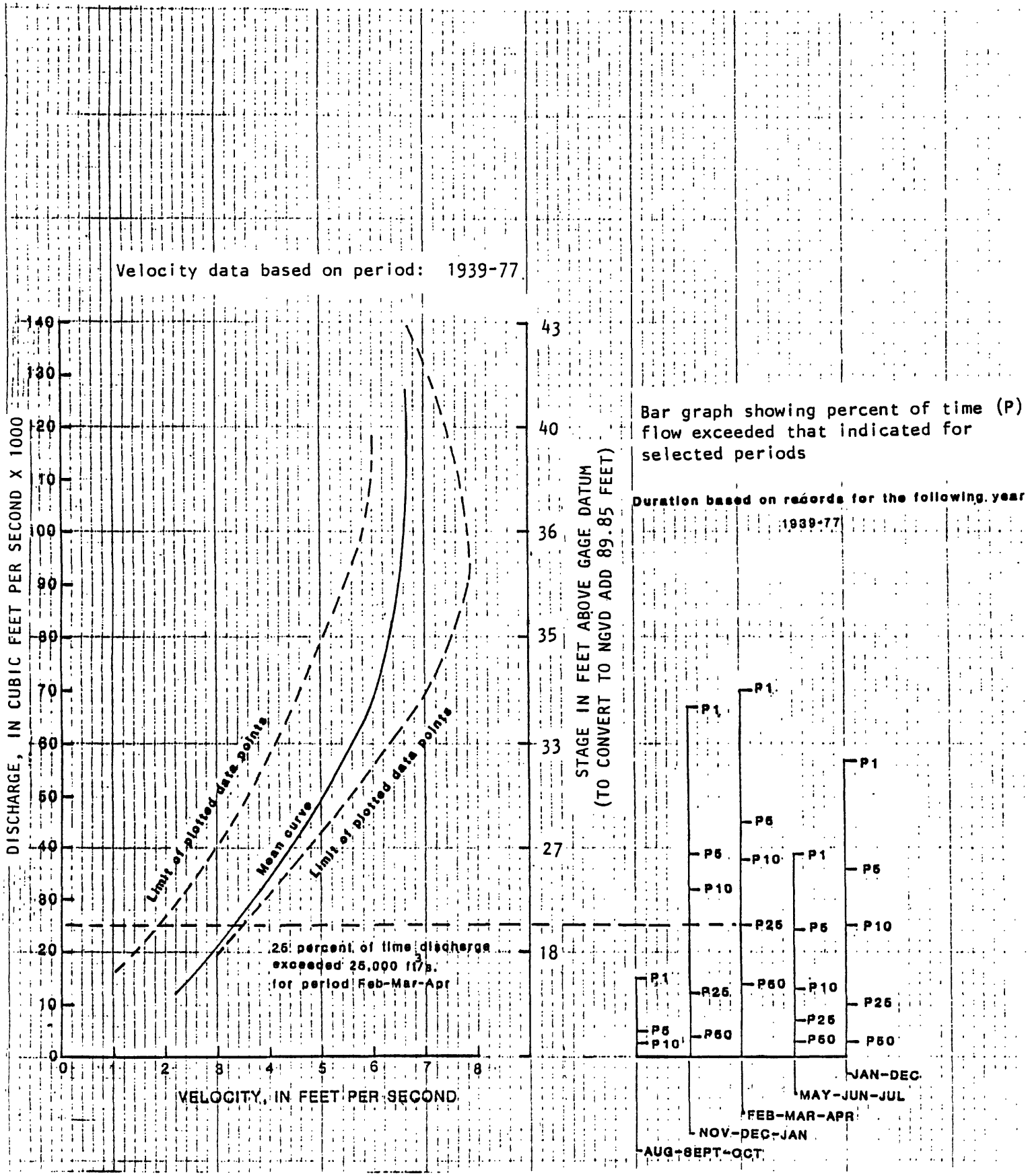


Figure 14. Relation of mean channel velocity versus total discharge and flow durations for Tombigbee River near Cochrane.

## ADDITIONAL DATA

The construction of two cutoff canals--one at Big Creek Bend and one at Cooks Bend--was completed in 1979. Since completion, the U.S. Geological Survey has made 24 discharge measurements in the vicinity of both canals. The measurements were made in the cutoff canal and in the channel above the cutoff canal. Two discharge measurements were made in Big Creek Bend in 1982. Data from the measurements made in the vicinity of Cooks Bend are listed in table 4, and data from the measurements made in the vicinity of Big Creek Bend are listed in table 5.

Discharge measurements made at the gaging station sites within the study reach are on file at the U.S. Geological Survey, Montgomery.

The environmental effects of the cutoff canals constructed along the Tennessee-Tombigbee Waterway 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).

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 included in "Hydrologic Data Collected at Closure of Gainesville Lock and Dam, Tombigbee River near Gainesville, Alabama" (Ming and Sedberry, 1980).

Table 4.--Data from discharge measurements made in vicinity of Cooks 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) |
|---|---|---|---|
| 1/5/82 | 26,000 | --- | 48,800 |
| 1/7/82 | 32,600 | --- | 66,400 |
| 1/9/82 | 27,400 | --- | 43,500 |
| 12/2/82 | 12,700 | --- | 33,900 |
| 12/5/82 | 26,100 | --- | 54,100 |
| 12/7/82 | 35,500 | --- | 75,400 |
| 12/9/82 | 30,200 | --- | 68,500 |
| 12/11/82 | 15,900 | --- | 31,500 |
| 5/4/84 | 31,400 | --- | 64,500 |
| 5/5/84 | 36,700 | --- | 70,600 |
| 5/6/84 | 32,200 | --- | 69,700 |
| 5/7/84 | 30,600 | --- | 59,700 |

Table 5.--Data from discharge measurements made in vicinity of Big Creek 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) |
|---|---|---|---|
| 4/21/82 | 61,600 | --- | --- |
| 4/22/82 | 58,100 | --- | --- |
| 4/23/82 | 51,400 | --- | 66,000 |
| 4/24/82 | 44,100 | --- | --- |
| 12/7/82 | --- | 11,000 | --- |
| 12/8/82 | --- | 8,300 | --- |
| 12/9/82 | 30,100 | --- | --- |
| 12/5/83 | 81,700 | --- | --- |
| 12/10/83 | 41,600 | --- | --- |
| 12/10/83 | 39,500 | --- | --- |
| 4/29/84 | 59,900 | --- | --- |
| 4/30/84 | 44,800 | --- | --- |

## CITED REFERENCES


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