SEDIMENTATION PROFILES IN LAKE TUSCALOOSA, ALABAMA, 2000

By Victor E. Stricklin

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Abstract

Lake Tuscaloosa, created in 1969 by the impoundment of North River, is the primary water supply for the cities of Tuscaloosa and Northport, Alabama, and surrounding areas. In 1982, 17 cross-sections were established in the principal tributaries of the lake, which include North River, Dry Creek, Turkey Creek, Binion Creek, Tierce Creek, Carroll Creek, and Brush Creek. These cross-sections were resurveyed in 1986 to determine the amount of sedimentation or scour occurring in the lake at these areas. In May 2000, 14 of the 17 cross-sections were located for resurveying to determine the amount of sedimentation or scour since 1986.

The maximum amount of sediment deposition determined from the 2000 survey occurred in the upper end of the Carroll Creek tributary at cross-section CC8 (3.0 feet). The maximum amount of scour occurred in the Turkey Creek tributary at cross-section TRC2 (7.0 feet). Of the 14 cross-sections, 6 indicated increased amounts of sediment deposition, 5 indicated scouring of bottom sediments, and 3 indicated little or no change.

INTRODUCTION

Lake Tuscaloosa (fig. 1), created in 1969 by the impoundment of North River, provides the primary water supply for the cities of Tuscaloosa and Northport and surrounding areas. The lake is also used for recreation and shoreline residential development. Land-use practices in the basin, such as coal mining, agriculture, timber harvesting, and residential development, have caused concerns about the possible changes in the rate of sedimentation in the lake. This report has been prepared by the U.S. Geological Survey in cooperation with the city of Tuscaloosa.

Purpose and Scope

The purpose of this report is to describe the amount of sedimentation or scour at selected sites in Lake Tuscaloosa. Cross-section comparisons in May 2000 were made at 14 locations on 7 principal tributaries previously measured in 1982 and 1986.

Previous Investigations

Previous investigations within the Lake Tuscaloosa basin include Kenner and others (1975), Hubbard (1975, 1976a, 1976b), Cole (1985a, 1985b), and Slack (1987, 1988). Seventeen cross-sections were established by Cole to compare sedimentation in 1982 to pre-impoundment conditions. Slack resurveyed the 17 cross-sections annually to determine sedimentation rates from 1982 to 1986.

Data-Collection Methods

Cross-sections were established in the lake in 1982 to determine the amount of sedimentation occurring at 17 locations in Lake Tuscaloosa. The cross-sections were surveyed and monumented so that they could be accurately relocated for future surveys. Cross-sections were selected on seven principal tributaries and located near points of inflow to the lake where streamflow velocity decreases and the greatest amount of sediment deposition should occur. For convenience of the reader each of the cross-sections are referenced to its contributing tributary.

Bottom profiles were recorded at each cross-section using a fathometer in 1982, 1986, and 2000. The fathometer produces a pen trace of the lake bottom through reflection of a sonic signal which provides a good method for comparison for the two previous surveys with the 2000 survey. The accuracy of this method is $\pm$1.0 feet.

DESCRIPTION OF THE STUDY AREA

Lake Tuscaloosa is located in north-central Tuscaloosa County, Alabama, and receives surface runoff from 423 square miles. The principal tributaries to Lake Tuscaloosa are North River, Binion Creek, Brush Creek, Carroll Creek, Dry Creek, Tierce Creek, and Turkey Creek. North River and Binion Creek provide up to approximately 85 percent of the inflow to the lake (Slack, 1987).

The study area has a subtropical climate characterized by warm, humid weather, with a mean annual temperature of 62°F (Frentz and Lynott, 1978) and mean annual precipitation of approximately 55 inches. Precipitation is mainly in the form of rain with little or no snowfall.

Approximately 75 percent of the land in the study area is forested (Slack, 1987). Some areas have been cleared for crop production and pasture land. It has been estimated that less than 5 percent of the total drainage area has been disturbed due to surface coal mining. Residential development near the lake has steadily increased since the lake was formed.

Relatively impermeable sandstone, shales, and siltstone from the Pottsville Formation of Pennsylvanian age underlies the entire study area. The Pottsville is mainly exposed in the north, northeastern part of the study area. Beds of coal and underclay are also present in parts of the formation. Ground water usually occurs in openings along joints, fractures, and bedding planes, and in coal seams.

The more permeable Coker Formation of Cretaceous age crops out in the southern and western parts of the study area. Although the upper 300 feet of the Coker Formation consists chiefly of clay (Metzger, 1965), the permeable sand and gravel beds in the lower 100 feet provide significant quantities of base flow to streams and are the principal source of water from wells in much of the Lake Tuscaloosa area (Cole, 1985a).

SEDIMENTATION

Sedimentation damages a reservoir if the decreased storage capacity prevents supplying the full service for which it was designed. Sufficient capacity must be maintained in domestic water-supply reservoirs to assure continuity of supply during periods of prolonged drought and to meet expected increases in water demand. If such reservoirs are built with capacities far in excess of reasonable requirements, the additional cost represents in effect prepaid insurance against loss by sedimentation. If the capacity is only equal to the reasonable requirements, any reduction by sedimentation represents a direct damage which involves both an accumulating loss of service value and a future replacement cost (Brown, 1950).

As tributaries enter Lake Tuscaloosa, there is a reduction of flow velocity and a corresponding reduction in transport capacity. This velocity reduction results in a progressive deposition of sediment load from coarsest near the point of inflow to finest toward the dam. As deposition in the lake continues, the resulting delta front will move progressively down into the lake. The greater the percentage of coarse sediments, the larger will be the volume and extent of the delta, and therefore, the larger the proportion of material deposited in the upper ends of the reservoir. However, large fluctuations in lake water levels, such as occurred during 2000, causes the formation of multiple delta fronts due to point of reduced velocity occurring farther down the tributary into the lake during periods of lower lake levels. As a consequence, the greatest thickness and often the greatest volume of sediment deposition can vary throughout the tributary as a result of variations of lake levels during the time of deposition.

Sediment movement and deposition in Lake Tuscaloosa is a continuing process. Sediment supply rates are influenced by physiography, soils, precipitation, and land use. Areas with steep slopes and soils with high erosion potential have rapid runoff and increased sediment yield. Areas with dense vegetation cover have reduced erosion rates. Logging, agriculture, construction, and activities associated with surface coal mining, such as removal of the vegetative cover, building and maintaining haul roads, and creation of spoil piles subject to weathering and erosion, can increase sediment yields and reduce reservoir storage capacity.

Bottom profiles were measured at 14 locations in Lake Tuscaloosa in 2000 and compared to 1986 profiles (figs. 2-15). The maximum sediment deposition and scour values reported in table 1 were calculated by assuming that profiles of troughs were the most accurate and that maximum change occurred in troughs. The reader is cautioned that the value was calculated for a single point in the cross section usually located in the main trough and does not necessarily represent changes in sedimentation within the entire cross section or upstream or downstream of the cross section. Because of the variability of boat speed and angle, uncertainty of water level at a given location, and inconsistency of measurement error, it is not possible to determine exactly how much deposition is occurring in the lake.

The greatest change occurred in Turkey Creek (TRC2) with 7.0 feet of scour (table 1). The greatest amount of fill occurred at Carroll Creek (CC8) with 3.0 feet of fill. Scour was indicated at five sites, fill at six sites, and three sites indicated little or no change since the previous survey. These changes show the dynamic processes of sedimentation in the lake.

Table 1.--Estimated maximum sediment depositions at Lake Tuscaloosa cross sections from 1969 to 1982, 1982 to 1986, and 1986 to 2000
[--, no change]

Lake cross section[a]	Contributing basin	Principal formation drained	Maximum sediment deposition (feet)		
			1969-82[b]	1982-86[c]	1986-2000
BC2	Binion Creek	Coker	2	1.0	1.5
BC5	Binion Creek	Coker	2	-1.8	1.5
BRC1	Brush Creek	Pottsville	3	3.5	-3.0
BRC4	Brush Creek	Pottsville	13	3.0	-3.5
BRC7	Brush Creek	Pottsville	20	-1.0	-3.5
CC2	Carroll Creek	Coker	3	.8	-2.0
CC5	Carroll Creek	Coker	<1	.0	--
CC8	Carroll Creek	Coker	4	-1.2	3.0
DC2	Dry Creek	Pottsville	2	.0	2.5
NR2	North River	Pottsville	8	-1.0	d
NR5	North River	Pottsville	11	-1.5	d
NR8	North River	Pottsville	8	-1.5	d
TC1	Tierce Creek	Pottsville	4	1.0	--
TC4	Tierce Creek	Pottsville	-2	-1.2	--
TC7	Tierce Creek	Pottsville	-2	-1.0	1.5
TRC2	Turkey Creek	Pottsville and Coker	7	-.1	-7.0
TRC5	Turkey Creek	Pottsville and Coker	15	.4	1.5

[a] Locations of cross sections are shown on figure 1.
[b] From Cole (1985a).
[c] From Slack and Pritchett (1988).
[d] Locations not resurveyed in 2000.

SUMMARY

Lake Tuscaloosa, created in 1969 by the impoundment of North River, is the primary water supply for the cities of Tuscaloosa and Northport, Alabama, and surrounding communities. Seventeen cross-sections were established by Cole (1985a) to determine amounts of sediment deposition to the lake since impoundment. Slack resurveyed these 17 cross-sections annually from 1982 to 1986 to determine a rate of sedimentation into Lake Tuscaloosa. In May 2000, 14 of the original 17 cross-sections were resurveyed to determine the amount of sediment deposition or scour at these points in the lake since 1986. Rates of sedimentation could not be determined accurately due to the amount of time since the last surveys, variability of boat speed and angle, uncertainty of water level at a given location, and measurement error.

It was determined that 6 of the 14 resurveyed cross-sections indicated increased amounts of sediment deposition with cross-section CC8 (Carroll Creek) showing an increase of 3.0 feet. The greatest amount of change occurred at cross-section TRC-2 (Turkey Creek) which indicated 7.0 feet of scour. Four additional cross-sections indicated scour since the previous survey. Three cross-sections in the lake indicated little or not change since the previous survey.

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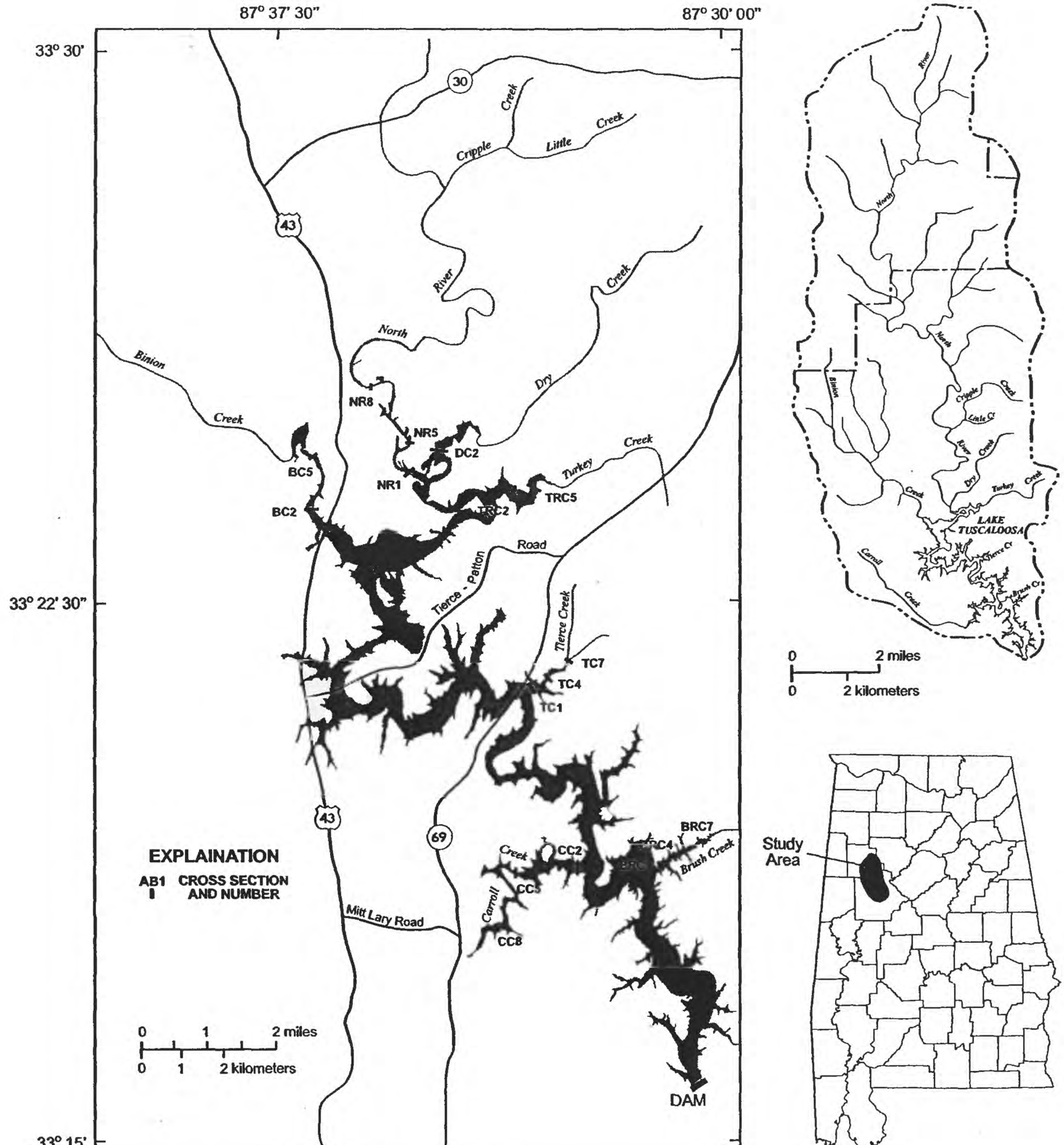

Figure 1.--Location of study area and lake cross sections

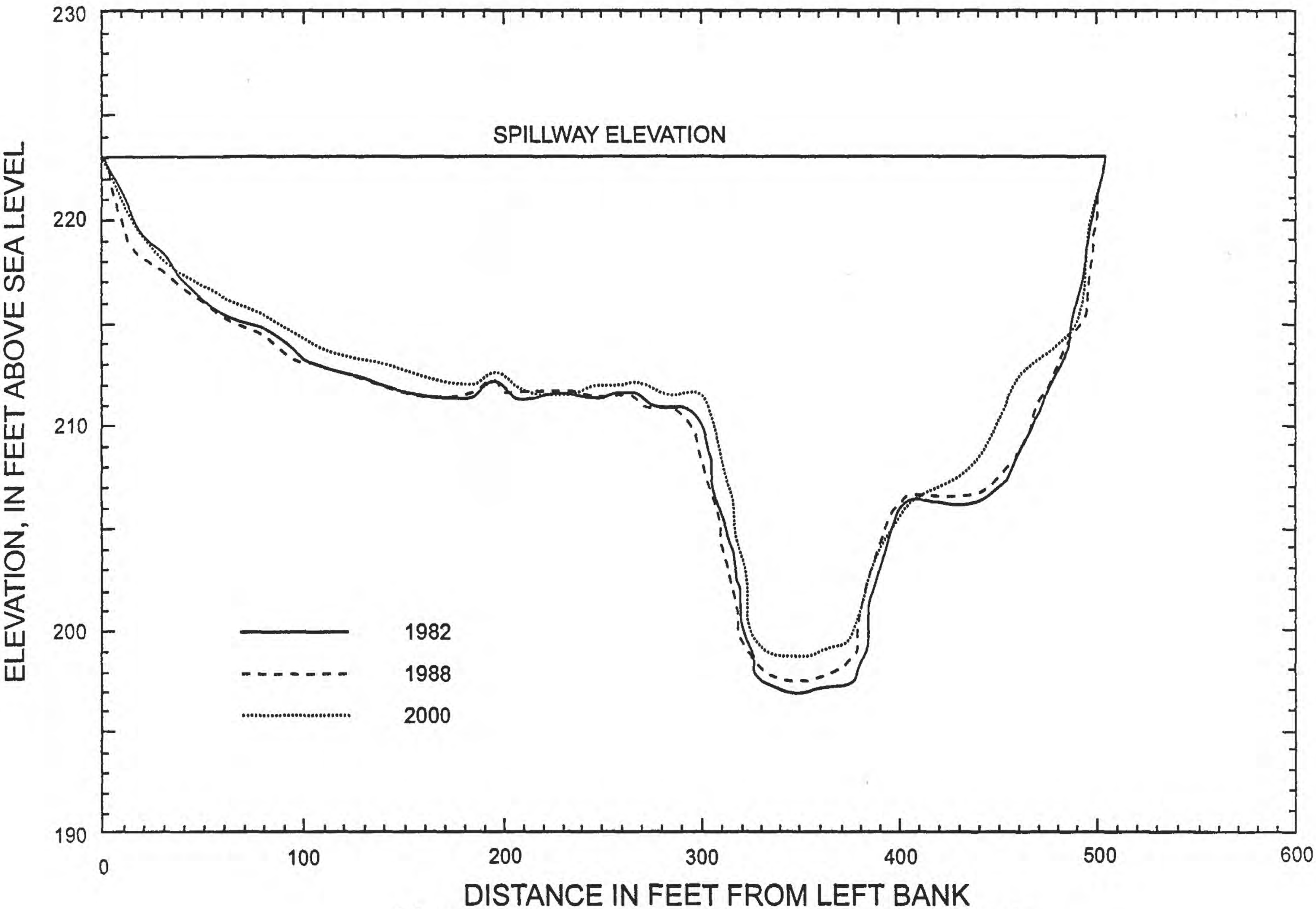

Figure 2.--Cross section BC2 in Binion Creek basin

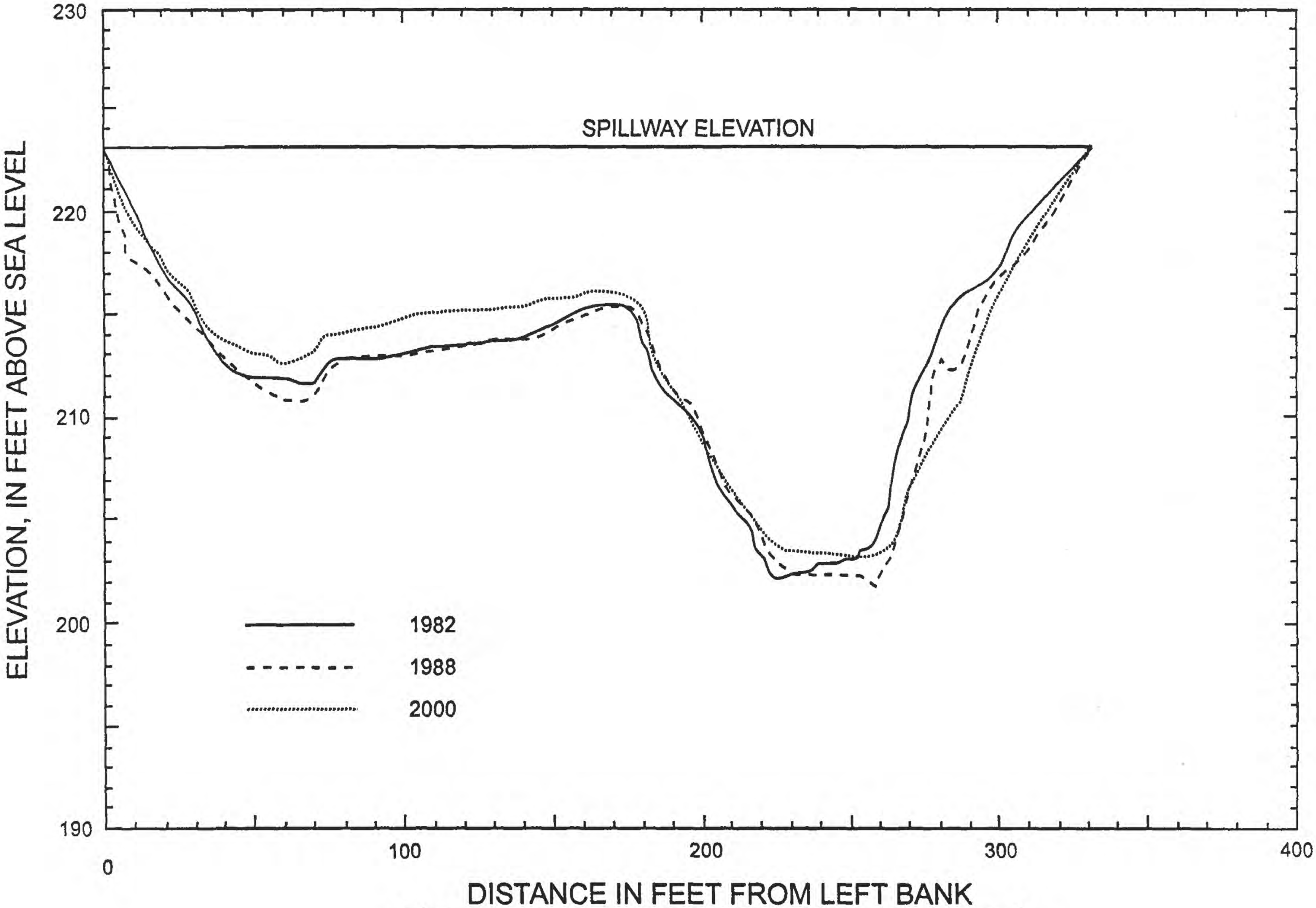

Figure 3.--Cross section BC5 in Binion Creek basin

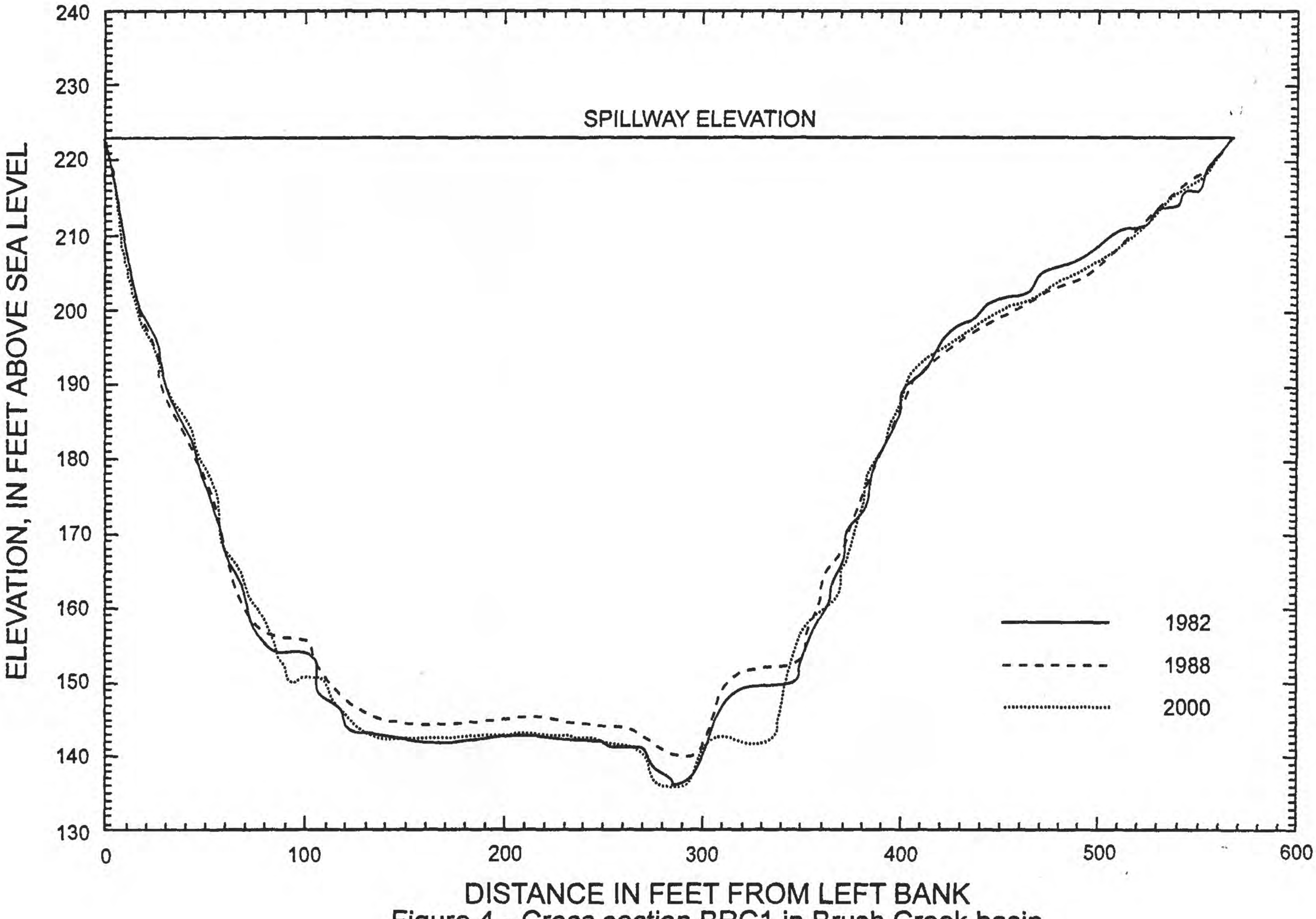

Figure 4.--Cross section BRC1 in Brush Creek basin

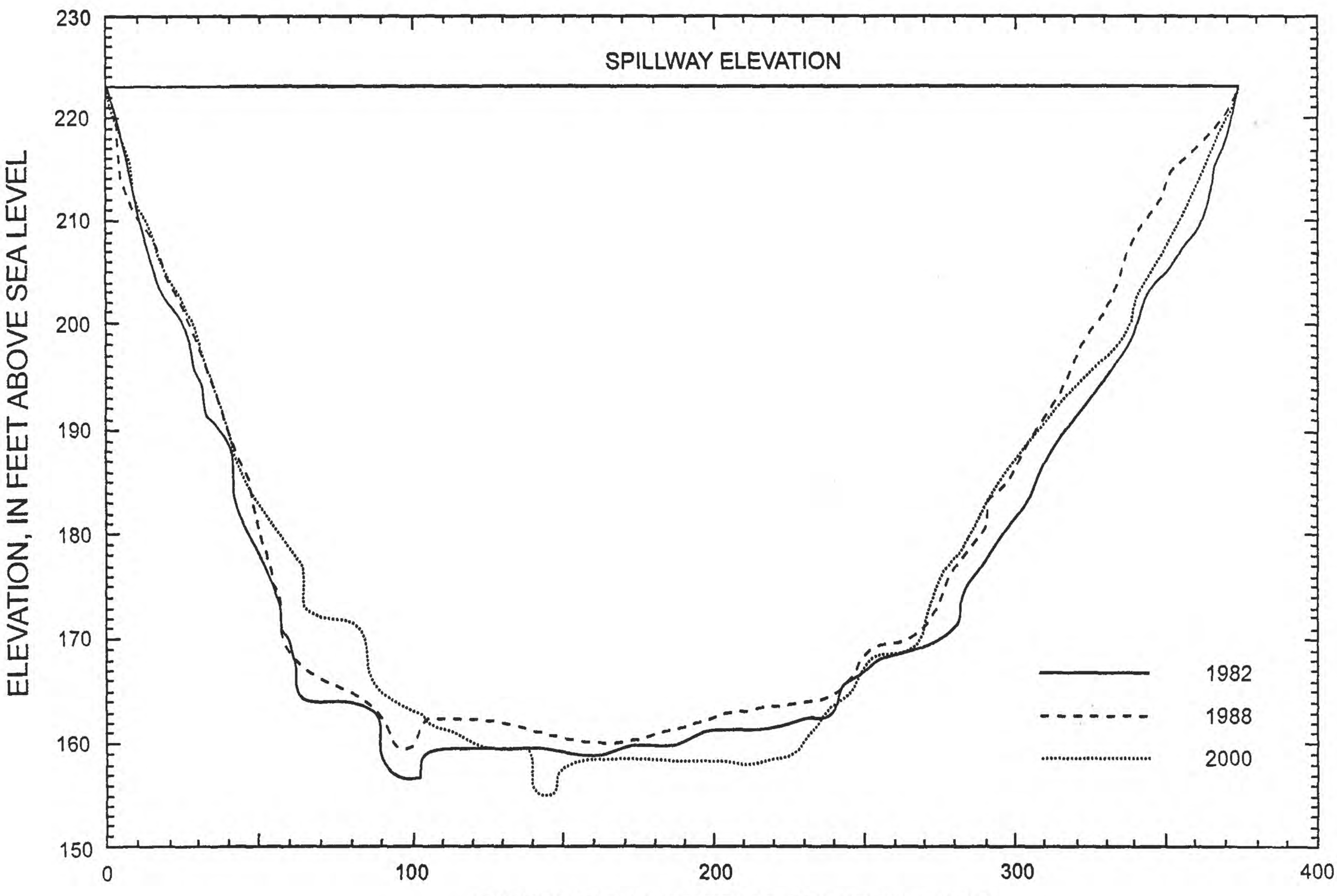

Figure 5.--Cross section BRC4 in Brush Creek basin

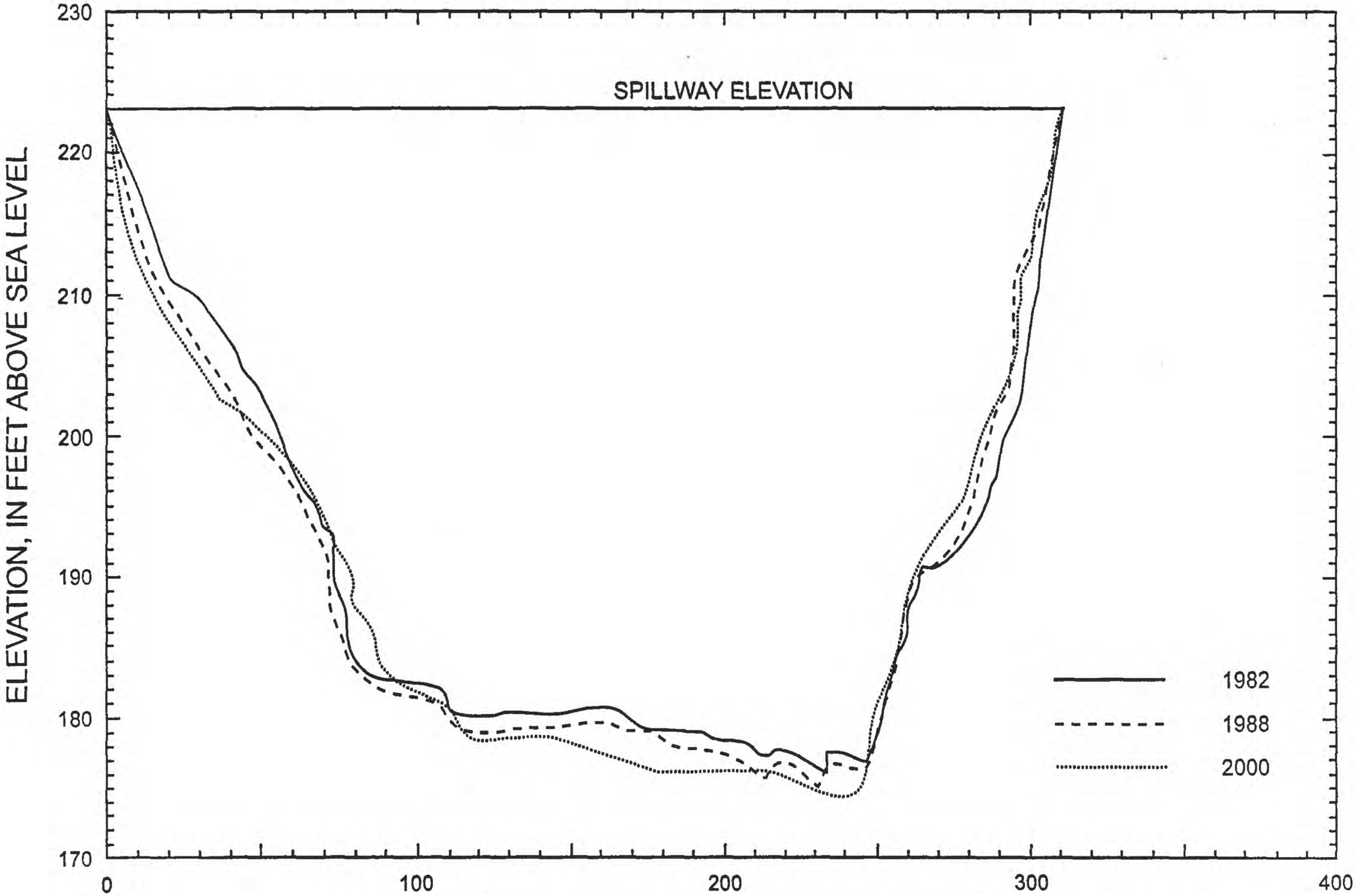

Figure 6.--Cross section BRC7 in Brush Creek basin

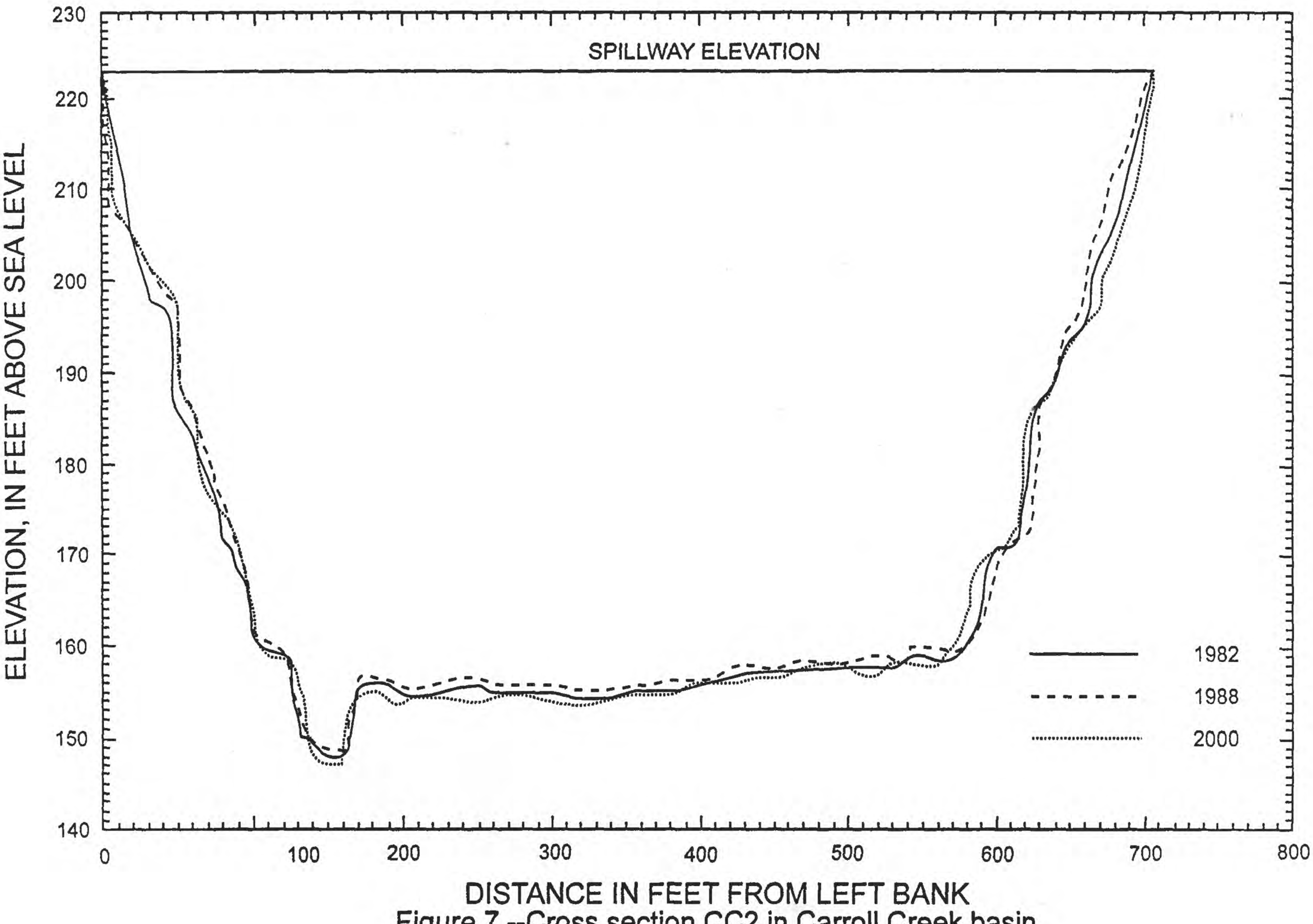

Figure 7.--Cross section CC2 in Carroll Creek basin

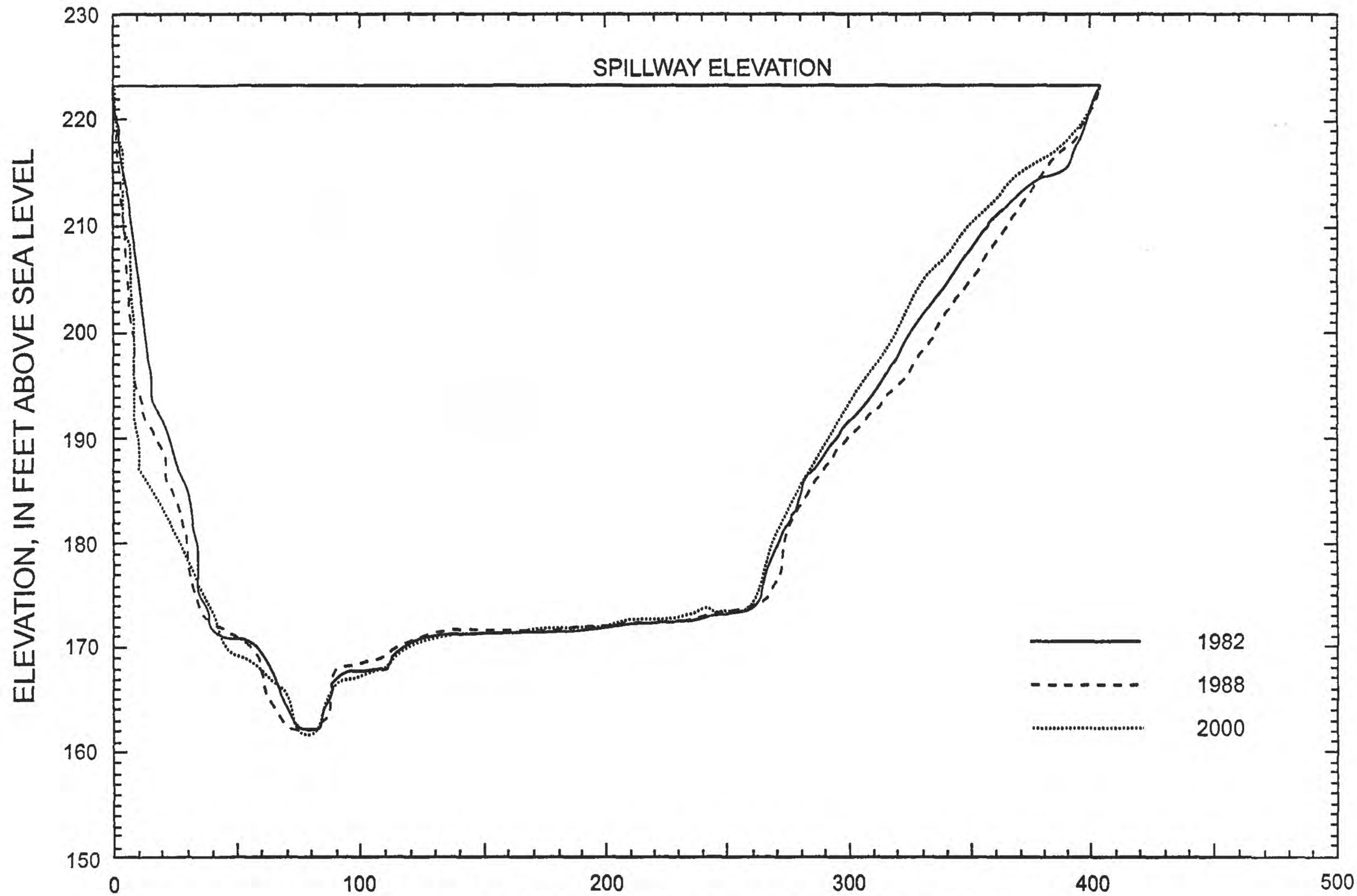

Figure 8.--Cross section CC5 in Carroll Creek basin

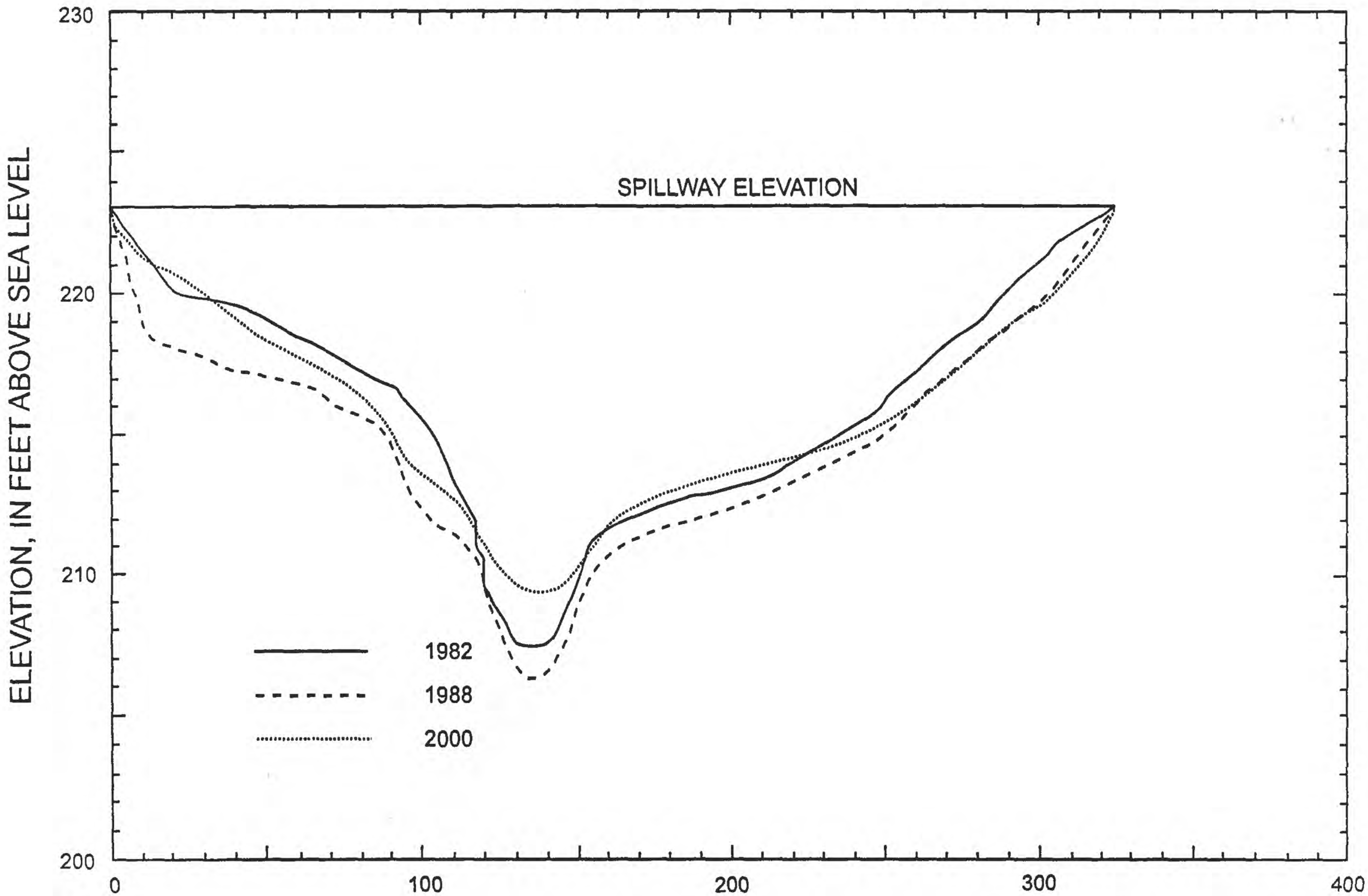

Figure 9.--Cross section CC8 in Carroll Creek basin

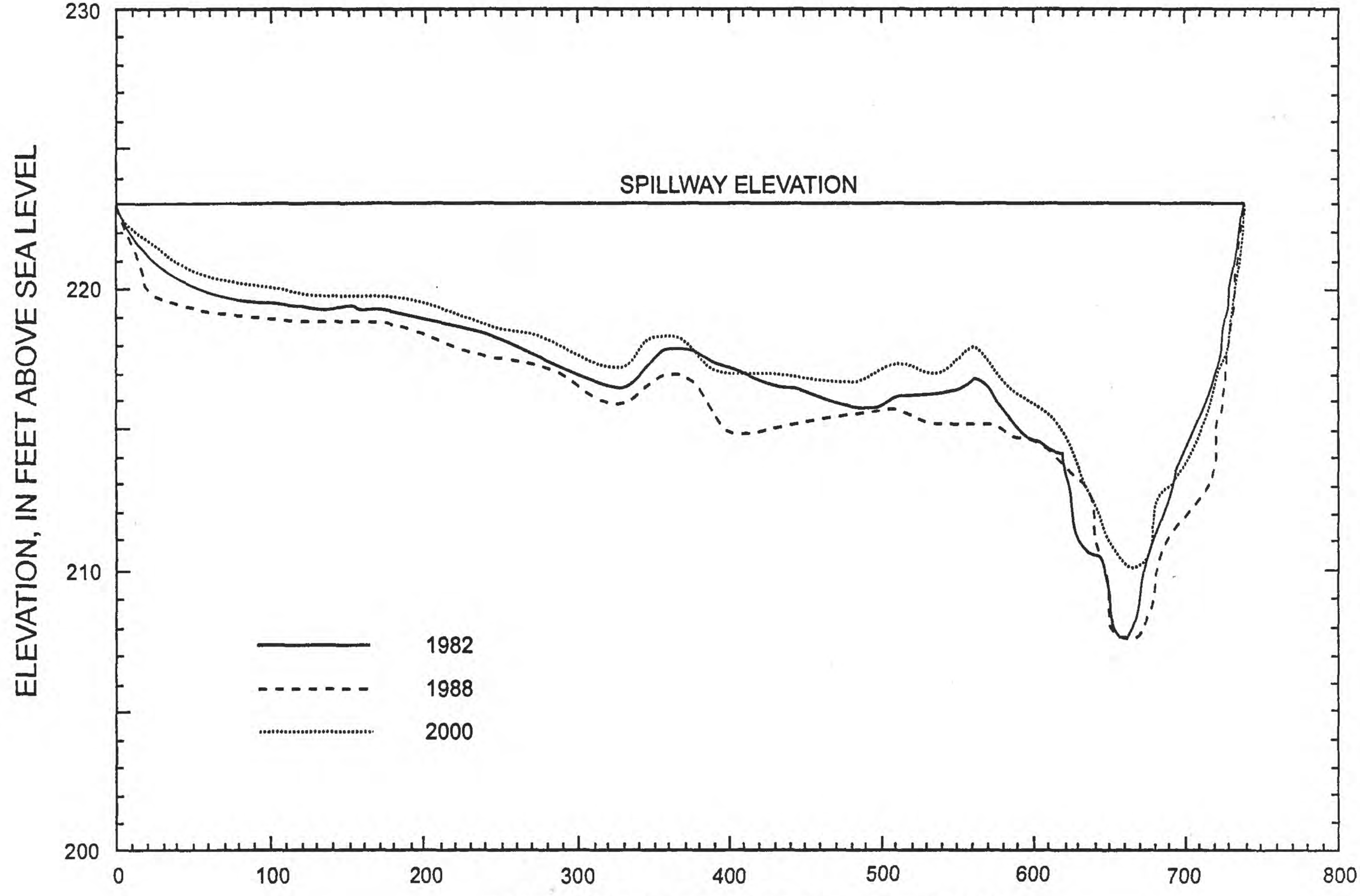

Figure 10.--Cross section DC2 in Dry Creek basin

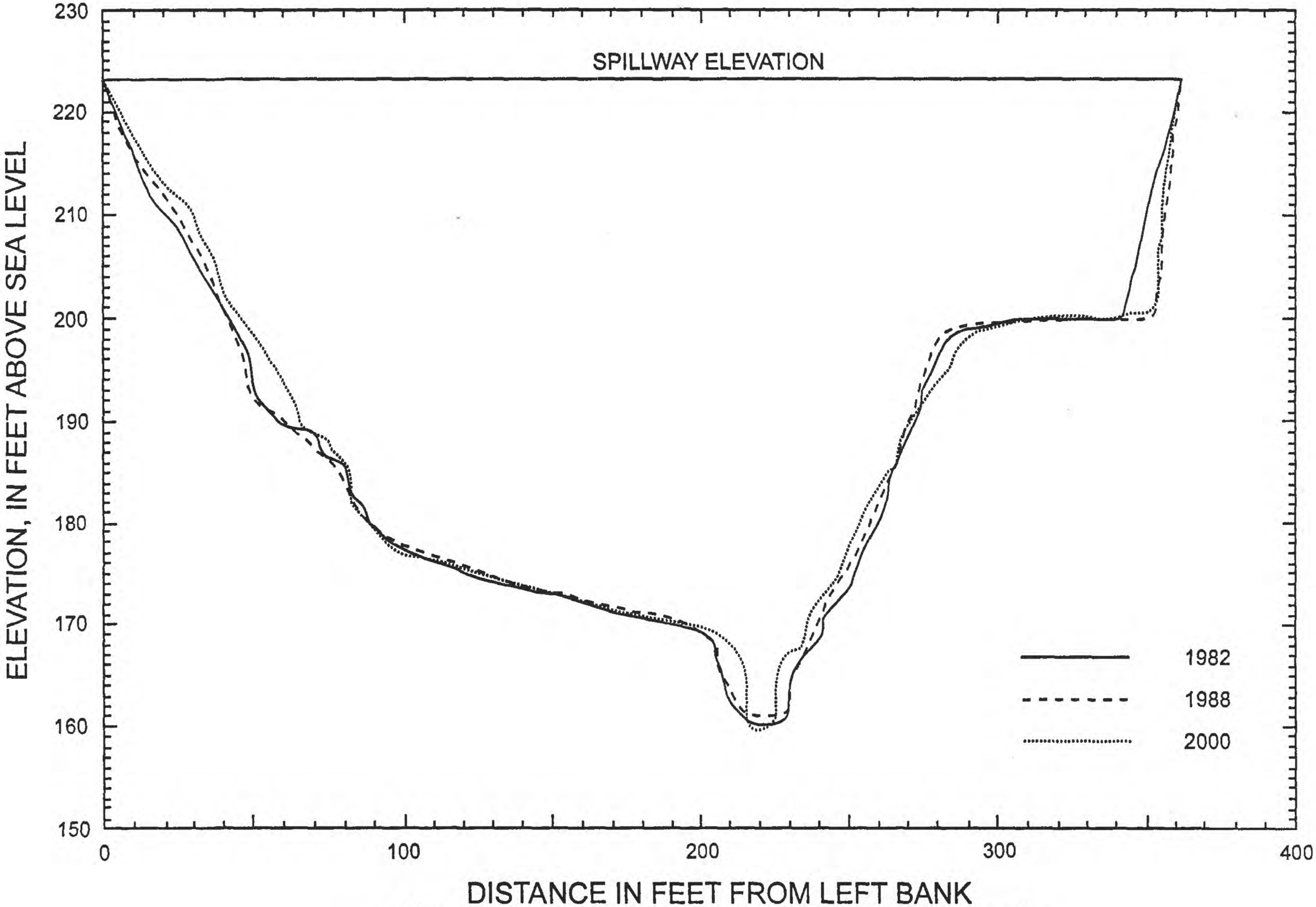

Figure 11.--Cross section TC1 in Tierce Creek basin

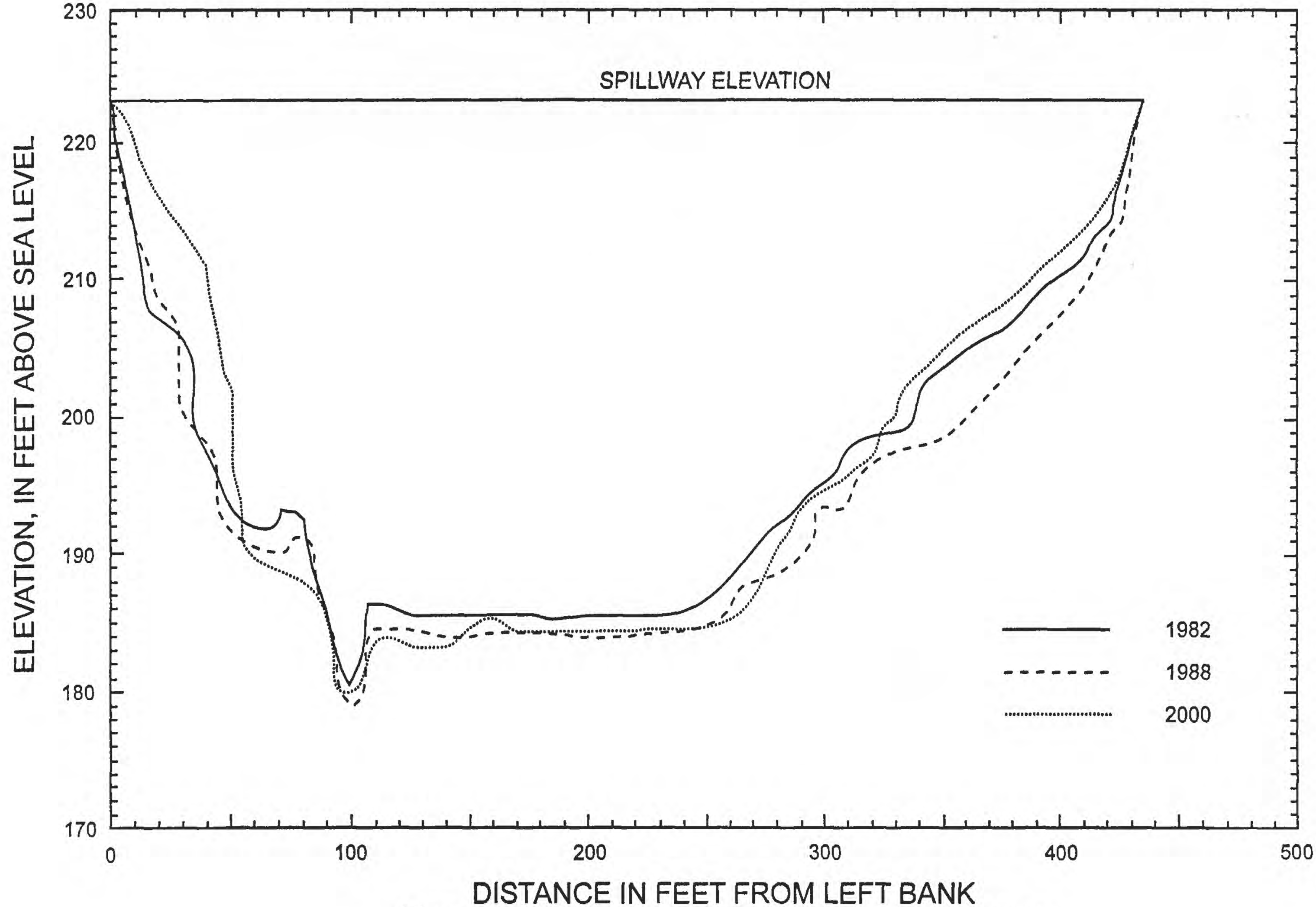

Figure 12.--Cross section TC4 in Tierce Creek basin

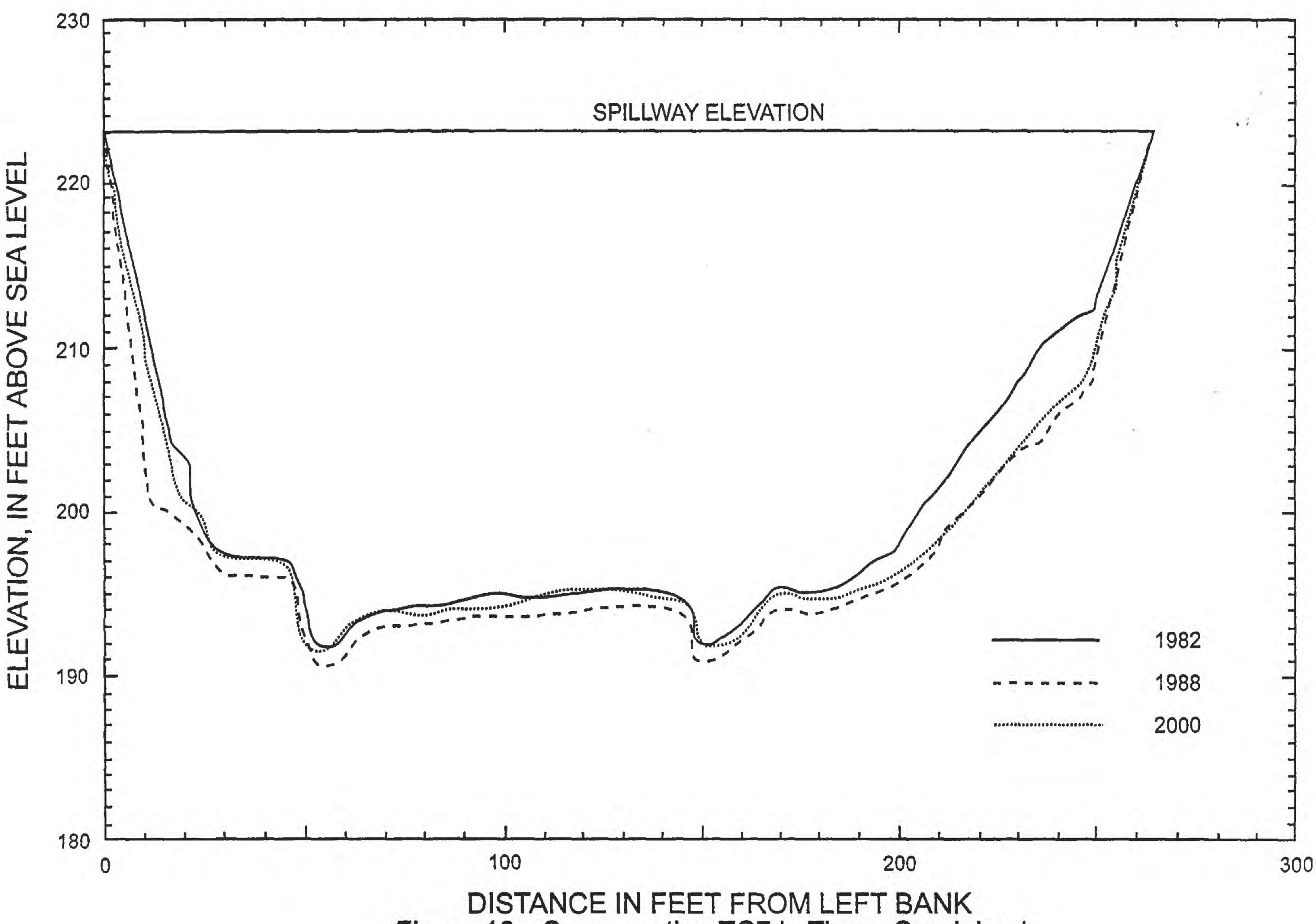

Figure 13.--Cross section TC7 in Tierce Creek basin

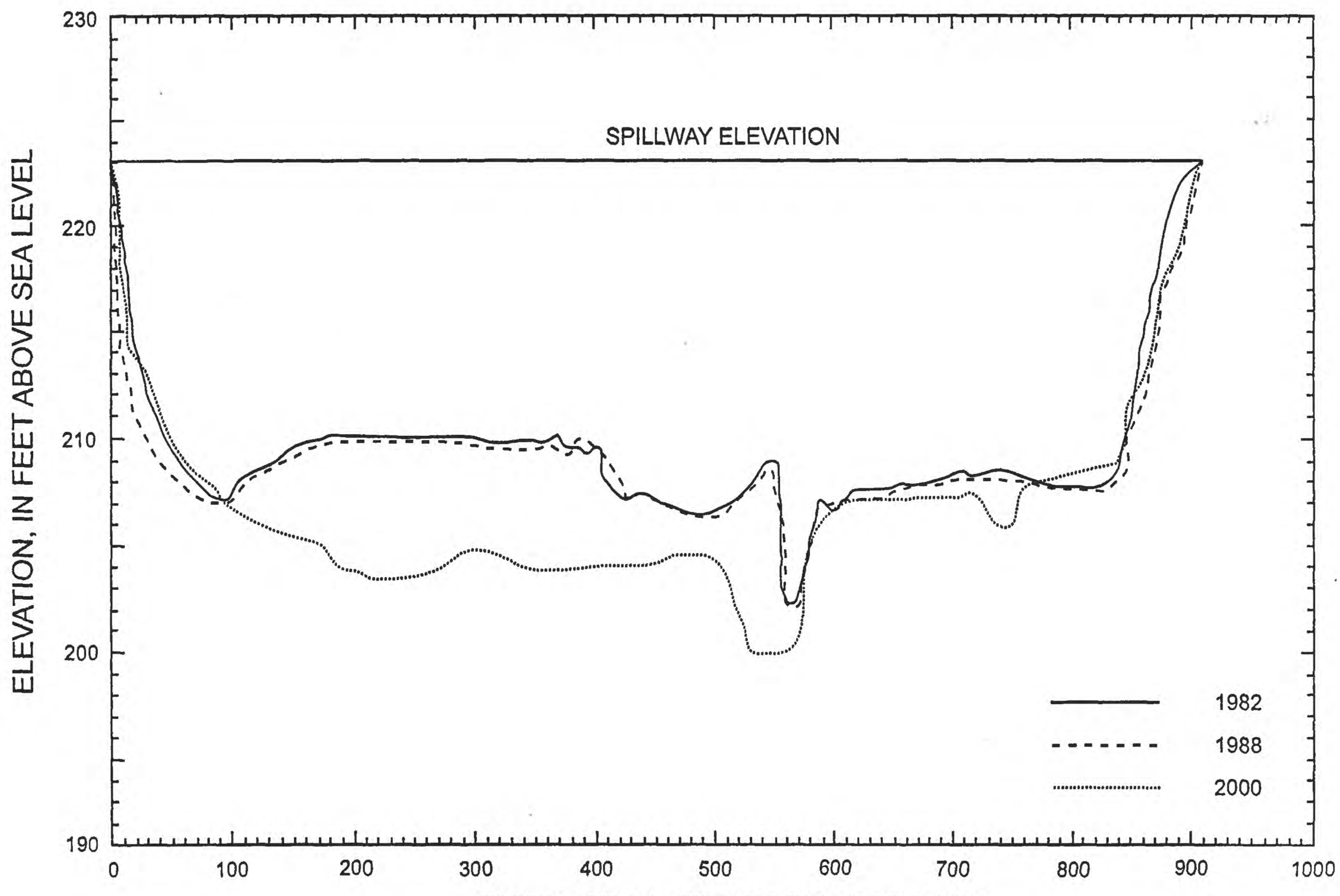

Figure 14.--Cross section TRC2 in Turkey Creek basin

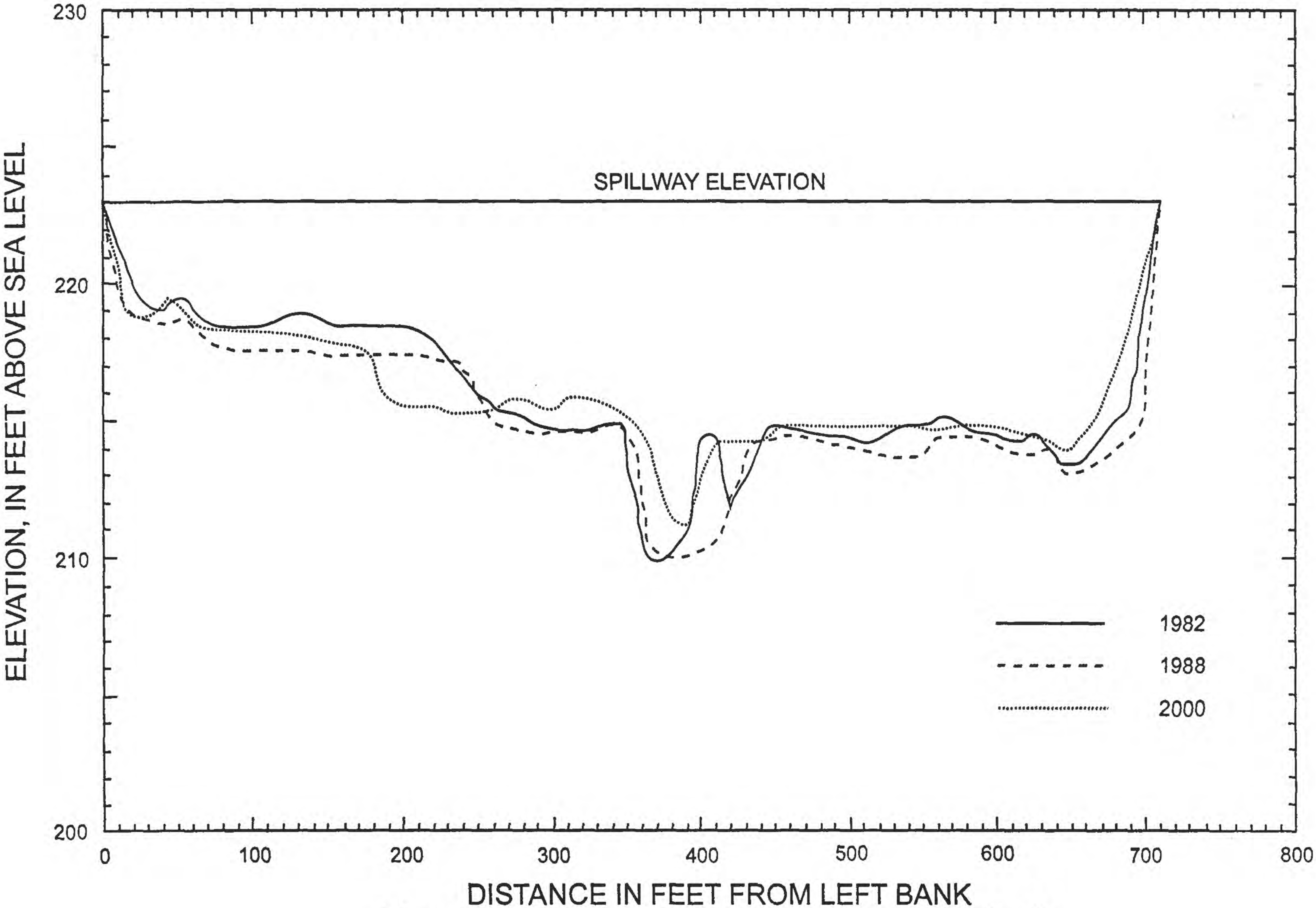

Figure 15.--Cross section TRC5 in Turkey Creek basin