ELEPHANT BUTTE RESERVOIR

1988 Sedimentation Survey

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16. ABSTRACT

The 1988 sedimentation survey of Elephant Butte Reservoir documented the present storage-elevation relationship and loss of storage from sediment accumulation since the previous survey in 1980 as required by the Rio Grande Compact. Sonic depth recording equipment was interfaced with an automated, microwave positioning system to give continuous depth and sounding positions during the hydrographic survey. A total of 82 sediment range lines were resurveyed using end-point coordinates based on the New Mexico State Plane Central Zone System. The longitudinal and lateral distribution of the measured reservoir sedimentation are discussed. The Width Adjustment Method was used for revising contour areas and computing reservoir capacity.

As of February 1988, at a reservoir elevation of 4407, the capacity was 2,065,010 acre-feet and the surface area was 36,643 acres. Between the reservoir surveys of 1980 and 1988, 45,300 acre-feet of sediment have accumulated in Elephant Butte Reservoir. Since the reservoir's initial filling in 1915, 570,000 acre-feet of sediment have been trapped. The average annual rate of sediment accumulation since 1915 is 7,800 acre-feet and 5,660 acre-feet since 1980.

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ELEPHANT BUTTE RESERVOIR

1988 SEDIMENTATION SURVEY

by

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INTRODUCTION

Dam and Reservoir

Elephant Butte Dam, originally called Engle Dam, was one of the first major structures built by the Bureau of Reclamation after its formation in 1902. Construction of the dam began in 1908, but progress was delayed when difficulty was encountered in obtaining reservoir land. Construction of the dam resumed in 1912 and was completed in 1916, although water storage operations began in January 1915. Located about 125 miles north of El Paso, Texas, on the Rio Grande, the dam is part of the multipurpose Rio Grande Project that controls floods, generates power, and stores and delivers irrigation water.

The dam is a 301-foot-high concrete gravity structure that is 1,674 feet long and impounds 2,065,010 acre-feet of water. The spillway is an uncontrolled concrete ogee weir structure. A spillway channel below the dam was added in 1921 and modified in 1947. Service outlet deflectors were added in 1944. The general plan and sections for the dam and spillway are shown on figure 1.

In 1915, the surface area of Elephant Butte Reservoir was 40,064 acres and the capacity was 2,634,800 acre-feet at a spillway crest elevation[1] of 4407. The 1988 survey showed a surface area of 36,643 acres and a capacity of 2,065,010 acre-feet at the same reservoir elevation. This difference indicates a capacity loss of 569,790 acre-feet during the 73.1 years since the dam was built. An aerial photograph of the dam and lower reservoir is shown on figure 2.

The reservoir has a length of 41 miles and an average width of 1.39 miles. The average width was determined for the entire reservoir including the portion known as "The Narrows," which separates the upper and lower reservoir areas. An aerial photograph of The Narrows under high water conditions is included as figure 3. The reservoir elevation of about 4406 covered trees and vegetation in The Narrows portion and permitted easy access to the range lines for the hydrographic survey. Many of the trees in the upper reservoir were also inundated, as shown on figure 4. The last time the reservoir was at or near the spillway crest elevation was in 1942. The high reservoir elevation provided the desired overlap between land surveys and the 1988 hydrographic survey.

Drainage Area

The total drainage area above Elephant Butte Dam is 25,923 mi^2. A flood study completed in 1984, as part of the SEED (Safety Evaluation of Existing Dams) program for Elephant Butte Dam, computed a

[1] All elevations shown in the text were based on the original project datum; to adjust these elevations to mean sea level, add 43.3 feet.

contributing area of 12,023 mi^2. Subtracting the area of Elephant Butte Reservoir (57 mi^2) would result in a net contributing area of 11,966 mi^2. Sediment from the remaining area upstream is considered to be trapped by upstream dams including Jemez Canyon that closed in 1953 with a drainage area of 1,034 mi^2; Galisteo, closed in 1970 with a drainage area of 596 mi^2; and Cochiti, closed in 1973 with a drainage area of 11,960 mi^2. A noncontributing area of 310 mi^2 along the river channel between Albuquerque and Belen is assumed to sum to the total drainage area of 25,923 mi^2.

For the 1969 survey report, Galisteo and Cochiti Dams were not completed, but Abiquiu Dam, upstream from Cochiti, was closed in 1963 with a drainage area of 2,146 mi^2. Subtracting the noncontributing area of 310 mi^2, the reservoir area, and the drainage areas for Jemez and Abiquiu from the total results in a net contributing area of 22,376 mi^2.

For the 1957 survey report, only Jemez would have been completed and the net contributing area would be 24,552 mi^2. This value excludes the noncontributing area of 310 mi^2, the reservoir area of 57 mi^2, and the drainage area above Jemez Canyon Dam of 1,034 mi^2.

A map of the original drainage basin has been updated to show the noncontributing areas above the four upstream reservoirs, see figure 5.

SUMMARY AND CONCLUSIONS

The primary purpose of the 1988 survey was to gather data needed to compute the capacity of Elephant Butte Reservoir as required by the Rio Grande Compact. This report includes a discussion of the methods used to measure and study 73.1 years of reservoir sediment accumulations, and to briefly describe the field surveying procedures and equipment.

Standard land surveying methods were used to establish horizontal control points for the hydrographic survey. The survey used sonic depth recording equipment and an automated survey system with a line-of-sight electronic positioning unit. The system continuously recorded reservoir depths and horizontal distances from a fixed point as a boat was steered across the range line. Reservoir water surface elevations read on the gauge at the dam were used as control points in converting sonic depth measurements to true bottom elevations and to delineate the cross-sectional profiles.

The capacity of the reservoir from the 1988 survey was determined to be 2,065,010 acre-feet, with a surface area of 36,643 acres at a spillway crest elevation of 4407. The reservoir area and capacity tables were produced using the ACAP85 computer program that used measured contour surface areas and a least squares curve-fitting technique to compute both area and capacity at prescribed elevation increments.

A comprehensive summary of the reservoir sediment data from the 1988 survey is contained in table 1. The volume of sediments that have accumulated in the reservoir since the original survey is 569,790 acre-feet, indicating a loss in capacity of about 22 percent. This results in an average annual sediment accumulation of 7,795 acre-feet for the 73.1-year period from 1916 to 1988. At this rate of sediment accumulation, it will take about 13 years to lose 5 percent of the volume of Elephant Butte Reservoir. The Rio Grande Compact recommends a resurvey whenever a table of areas and capacities is in error by more than 5 percent. Therefore, the next sedimentation survey should be made in 2001.

RESERVOIR OPERATIONS

A plot of monthly inflows into the reservoir is shown on figure 6 for January 1916 through December 1988. The average annual inflow, based on 73.1 years of record, is 877,100 acre-feet. Reservoir stages at the end of each month from March 1915 through January 1988 are included on figure 6. The reservoir operation ranged from a minimum elevation of 4258.03 in 1954 to a maximum elevation of 4409.19 in 1942. An inflow-duration curve based on the monthly inflow discharge is shown on figure 7. Using the end-of-month reservoir pool elevation data, a stage-duration curve was derived and included as figure 8. Information from curves of this type is useful in making reservoir operation studies. Streamflow records of the gauging station at San Marcial, New Mexico, were used to represent the inflow for the period through water year 1951. Beginning with water year 1952, the combined streamflow records of the floodway and conveyance channel at San Marcial were used. However, these records did not reflect the total inflow because additional downstream tributaries to the reservoir, such as Monticello and Nogal Canyons, also contributed to the inflow.

DESCRIPTION OF BASIN

Topography of the drainage area is varied. In the extreme northern portion, it is mountainous and rugged. South of Santa Fe, New Mexico, the topography is less rugged, consisting of isolated mountains separated by desert plains and the Rio Grande Valley. The elevations of the drainage area also vary from 12,000 feet above mean sea level at the Continental Divide to 4,450 feet above mean sea level in the reservoir area.

The higher elevations are forested with pine and fir trees, and the slopes are sprinkled with cedars along the foothills. Natural cover of the plains consists chiefly of creosote bush, sagebrush, greasewood, cactus, and natural grasses. Thick stands of salt cedars, willows, and cottonwoods grow along the riverbanks above the reservoir.

The Rio Grande begins in the San Juan Mountains of Colorado and flows between the Conejos Mountains and La Garita Hills. The stream channel slopes are steep in the mountainous headwater regions. Most of the surface rock in these regions is igneous or metamorphic and not easily eroded. Just above the New Mexico State line, the river enters a deep canyon flowing through a stretch of low sediment contribution until it enters Espanola Valley near the confluence with the Rio Chama. Upon leaving the valley, the Rio Grande enters White Rock Canyon in the vicinity of Otowi Bridge. The unconsolidated sediments of the Santa Fe Formation (Miocene and Pliocene continental deposits) have been eroded to form the valley of the Rio Grande from the lower end of White Rock Canyon near Cochiti Diversion Dam to near San Acacia. The flood plains and terraces of the valley are composed of alluvium that is available for transport and contributes substantial quantities of sediment to the Rio Grande. From the mouth of the Rio Salado, just upstream from San Acacia, to the headwaters of Elephant Butte Reservoir, the Palomas Formation of the Quaternary period has been eroded to form the river valley. The major geologic formations of the Rio Grande Valley are of the Cenozoic era [1][2].

SURVEYS AND EQUIPMENT

Ten different surveys have been conducted, beginning in 1916. The 1925, 1935, 1940, and 1957 [2] surveys were run by the contour method, while the range method was used for the 1947, 1969 [3], 1974, 1980 [1], and 1988 surveys. Field work for the 1988 survey began in December 1987 and ended in September 1988. A layout of the reservoir sedimentation range system is shown on figure 9.

Surveying Methods

The field work consisted of locating the existing sedimentation range end markers and relocating those markers that had been lost or destroyed. To develop range end control for the 1988 survey, a traverse was surveyed from range lines 90 through 25 and tied into triangulation points at range 38 West (Nogal) and range 51A (Ark). State plane coordinates for the range line monuments were established based on the New Mexico central zone system [4]. Vertical control was established for range lines 26 through 90 where necessary. The above-water portions of the range lines from the range end to the water's edge that were profiled during the 1980 survey were used.

A hydrographic survey was run in February 1988, using sonic depth recording equipment to sound the underwater portion of 70 range lines. A depth recorder (fig. 10) was interfaced with an automated positioning system to give continuous reservoir depth and sounding position as the sounding boat (fig. 11) traversed each range line. A new mounting was developed for the boat-mounted T/R (transmitter/receiver) unit

[2] Numbers in brackets refer to entries in the Bibliography.

since the 1980 survey. The positioning system transmitted a line-of-sight, microwave signal to fixed shore stations (fig. 12), and converted the time of reply to range distances, which were then used to compute the coordinate position of the sounding boat. The controls required for the system included reservoir elevation, horizontal grid coordinates for all range ends and fixed shore stations, and the elevation of each shore station antenna. Upon activating the system, the boat was steered across a range line at a speed of about 5 feet per second. The system also gave directions to the boat operator for maintaining course. During each run, the depth and position data were recorded on magnetic tape (fig. 13) for later processing on an electronic computer. A graph plotter was used to track the boat and to give an immediate plot of each range profile (fig. 14). Auxiliary field equipment included radios for communication between shore and boat personnel and another boat to move equipment and personnel around the reservoir.

Procedures described by Blanton [5] were followed as closely as possible. The upper portion of the reservoir, sedimentation ranges 9 through 25, was surveyed under contract with the Albuquerque Office. The contractor used the range method to profile the range lines, and established horizonal and vertical control. Coordinates for the range end monuments were based on the New Mexico State Plane Central Zone System.

RESERVOIR SEDIMENT DISTRIBUTION

Longitudinal Distribution

The longitudinal profiles were plotted for the original, 1969, 1980, and 1988 reservoir conditions (fig. 15). Longitudinal profile data were also plotted in dimensionless form (fig. 16) for the original, 1980, and 1988 conditions relating percent of depth to percent of distance. Percent of depth was computed as the ratio of the thalweg depth at each range to the total depth. Thalweg depth was computed as the difference between the thalweg elevation (lowest point) at a range line and the lowest point on the profile (El. 4210). The total depth, 197 feet, was taken as the difference in lowest point on the profile (El. 4210) and the spillway crest elevation of 4407. Percent of distance was computed as the ratio of the distance between the dam and each range to the total distance (41.33 mi) measured between the dam and the point where the longitudinal profile intersected the thalweg elevation 4407 upstream. The graph on figure 16 indicates that between the 1915 and 1988 surveys, sediments had deposited longitudinally to the depths:

Interval distance above dam (miles)	Average depth of sediment (feet)
0-8	30
8-11	39
11-14	48
14-16	57
16-20	45
20-29	31
29-38	22
38-41	12

The greatest depths of longitudinal sediment deposits occurred between 14 and 16 miles above the dam. This reflects a morphological effect that The Narrows region (range lines 50 to 59) has on sediment deposition. The Narrows has an average width of 0.36 mile compared to an average width of 1.39 miles for the overall reservoir.

As a matter of further practical interest, a theoretical distribution of sediment within the reservoir was computed using the Empirical Area-Reduction Method [5]. It was assumed that the sediment inflow volume to be distributed would be 569,790 acre-feet, the volume measured by the 1988 survey. A plot of the depth-capacity relationship (fig. 17) using the original data indicated the reservoir to be type II. The "m" valve is the reciprocal of the slope used to classify reservoirs. An "m" of 2.92 falls in the type II range between 2.5 and 3.5 [6]. Results of the sediment distribution computations are listed in columns (8), (9), and (10) of table 2 for a type II reservoir. These computations predicted that the sediment would deposit to an elevation of 4260.3 for the inflow volume accumulated through 1988. This estimate compares favorably to the elevation of 4250 determined from the 1988 survey. The sediment distribution curves on figure 18 show how the actual distribution compares with the theoretical distribution of a type II reservoir. The curves show percentages of depth plotted against sediment deposited. The greatest differences between the actual and type II curves are in the 60- to 80-percent depths. The shape effect from The Narrows results in more sediment being deposited upstream, as evidenced from the lower than predicted elevation of sediment at the dam and the actual versus predicted sediment distribution curves.

In addition to classifying the reservoir for sediment distribution computations, the stage-duration curve (fig. 8) can be used to predict the delta formation of a reservoir [5, 6]. For delta computations, data from the curve are used to determine the pivot point (where topset and forset beds intersect). Using the 50-percent duration as a mean, the curve shows an end-of-month elevation stage of 4346. This indicates the pivot point occurs at about range 59, as seen in the longitudinal profile (fig. 15). For a sediment distribution study, the end-of-month stage of 4346 indicates the reservoir is operated with a normally moderate to considerable reservoir drawdown. This would classify the reservoir as a type II (flood plain-foothill) reservoir, as indicated by the depth-capacity curve (fig. 17).

Lateral Distribution

Ground profiles of the 82 reservoir sedimentation ranges are shown on figures 19 through 100. These profiles illustrate the general lateral distribution of sediments in the reservoir. Plots are from left to right looking upstream to be consistent with previous survey reports. It should be noted that range line 34 is located between ranges 22 and 23.

The original and 1988 profiles do not fully agree in the lateral direction for all ranges. The original profiles were transcribed from a 1915 topographic map with a contour interval of 10 feet. Thus, the point locations from the 1988 survey were more reliable than the location of points read from the 1915 topographic map. Also, it was necessary to estimate a portion near the end of some profiles to show how the original survey data connect with the 1988 data and to facilitate the reservoir area computations.

SEDIMENT ANALYSES

Sediment Accumulation

Sediments have accumulated in Elephant Butte Reservoir to a total volume of 569,790 acre-feet since the dam was constructed over 73 years ago. An average annual accumulation rate of 7,795 acre-feet was computed for the 73.1-year period. At this rate of sediment accumulation, it will take about 13 years to lose 5 percent of the volume of Elephant Butte Reservoir. The Rio Grande Compact recommends a resurvey whenever a table of areas and capacities is in error by more than 5 percent. Therefore, the next sedimentation survey should be conducted in 2001.

Measured sediment accumulations for the 1957, 1969, 1980, and 1988 sedimentation surveys were weighted by contributing drainage areas to compute an annual sediment yield rate. The net sediment accumulation rate from the contributing drainage area was 0.351 acre-foot per square mile per year for the 73.1-year period from time of filling to the 1988 sedimentation survey.

Reservoir Sedimentation Survey

A summary of the reservoir sediment data for the 1988 survey is contained in table 1. The data include a tabulation of incremental sediment inflow volume and sediment accumulation computed for the periods between the 1915, 1957, 1969, 1980, and 1988 surveys. Both types of data are valuable in practical and research studies.

RESERVOIR AREA AND CAPACITY

The 1988 reservoir surface areas were computed by the Width Adjustment Method described by Blanton [5]. Briefly, this method entails computing the 1988 contour areas between any two ranges by applying an adjustment factor to the 1915 contour area between the two ranges. The adjustment factor was determined to be the ratio of the new average width to the original average width for both the upstream and downstream ranges at a specified contour. Computations were facilitated by subdividing the reservoir into segments using the sedimentation range lines to delineate the limit of each segmental boundary. For any given contour elevation, the 1915 surface areas were multiplied by the adjustment factor to compute the 1988 surface area of each segment. The total surface area at a given contour elevation was computed as the summation of all segmental areas at that elevation.

The 1988 surface areas were used as control parameters for computing the reservoir capacities by electronic computer and the area-capacity program ACAP85. This program computes an area at 0.01- to 1-foot area increments by linear interpolation between basic data contours. The respective capacities and capacity equations are then obtained by integration of the area equations. The initial capacity equation is tested over successive intervals to ensure that equation fits within an allowable error term. The equation is used over the whole range that fits within the allowable error term. For the next interval, beginning where the initial allowable error term was exceeded, a new capacity equation is tested to fit until the error term is exceeded. Thus, the capacity curve is defined by a series of curves, each fitting a certain region of data within a specific elevation interval as constrained by the limiting error term. The final area equations are obtained by differentiation of the capacity equations, which are of second-order polynomial form:

$$y = a_1 + a_2 x + a_3 x^2$$

where:

y = capacity,

x = elevation above an elevation base,

a_1 = intercept, and

a_2 and a_3 = coefficients.

Results of the 1988 area and capacity computations are listed in columns (4) and (5) of table 2. Listed in columns (2) and (3) of this table are the original area and capacity values. A special set of area-capacity tables has been published separately for the 0.01-, 0.1-, and 1-foot elevation increments [7]. A description of the computations and coefficients output from the ACAP85 program is included with these tables. Both the original and 1988 area-capacity curves are plotted on figure 101. At spillway crest elevation 4407, the 1988 capacity is 2,065,010 acre-feet and the surface area is 36,643 acres.

During the course of the area and capacity computations, it was evident that the capacity had increased in some segments of the reservoir since the last complete survey in 1980. These gains in capacity were partly attributed to the effects of compaction of sediments in those segments. An additional factor influencing the increased capacities was the precision used to measure the profiles during the 1988 survey. The 1915 profiles were measured from the original topographic map using a contour interval of 10 feet. As a result, the apparent profile width changes indicated between the 1915 and 1988 surveys were, in many instances, due to inaccuracies in the original profile data.

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Table 1. — Reservoir sediment data summary.

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RESERVOIR SEDIMENT DATA SUMMARY

Elephant Butte
NAME OF RESERVOIR

57
DATA SHEET NO.

DAM	1. OWNER USBR Dept. of Interior	2. STREAM Rio Grande	3. STATE New Mexico
	4. SEC. 30 TWP. 13S RANGE 3W	5. NEAREST P. O. Truth or Consequences NM 4E	6. COUNTY Sierra
	7. LAT. 33° 09' 15" LONG 107° 11' 28"	8. TOP OF DAM ELEVATION 4,414[1]	9. SPILLWAY CREST ELEV. 4,407

RESERVOIR	10. STORAGE ALLOCATION	11. ELEVATION TOP OF POOL	12. ORIGINAL SURFACE AREA, ACRES	13. ORIGINAL CAPACITY, ACRE-FEET	14. GROSS STORAGE, ACRE-FEET	15. DATE STORAGE BEGAN
	a. FLOOD CONTROL					
	b. MULTIPLE USE [2]	4,407	40,064	2,631,585	2,634,800	Jan. 6, 1915
	c. POWER					16. DATE NORMAL OPER. BEGAN
	d. WATER SUPPLY					
	e. IRRIGATION					
	f. CONSERVATION					
	g. INACTIVE	4,231.5	420[3]	3,215	3,215	Feb. 1, 1915
	17. LENGTH OF RESERVOIR		41 MILES	AV. WIDTH OF RESERVOIR		1.39 MILES

WATERSHED			
	18. TOTAL DRAINAGE AREA 25,923 SQ. MI.		22. MEAN ANNUAL PRECIPITATION 15.1(8-22) INCHES
	19. NET SEDIMENT CONTRIBUTING AREA 11,966[4] SQ. MI.		23. MEAN ANNUAL RUNOFF .65 INCHES
	20. LENGTH 305 MILES	AV. WIDTH 85 MILES	24. MEAN ANNUAL RUNOFF 920,800(92)[5] AC.-FT.
	21. MAX. ELEV. 12,000	MIN. ELEV. 4,210	25. ANNUAL TEMP.: MEAN 52.3 RANGE 38.8-61.2

SURVEY DATA

26. DATE OF SURVEY	27. PERIOD YEARS	28. ACCL. YEARS	29. TYPE OF SURVEY	30. NO. OF RANGES OR CONTOUR INT.	31. SURFACE AREA, ACRES	32. CAPACITY, ACRE-FEET	33. C/I. RATIO, AC.-FT. PER AC.-FT.
Jan. 6, 1915			Contour (D)	10 ft (CI)	40,064	2,634,800	
Feb. 12, 1957[6]	–	42.1	Range (D)	73 (R) 10 ft (CI)	35,584	2,206,780	2.20
Apr. 1, 1969	12.1	54.2	Range (D)	60 (R)	36,569	2,137,219	2.31
Jan. 24, 1980	10.8	65.0	Range (D)	81 (R)	36,897	2,110,298	2.33
Feb. 17, 1988	8.1	73.1	Range (D)	82 (R)	36,643	2,065,010	2.24

26. DATE OF SURVEY	34. PERIOD ANNUAL PRECIPITATION	35. PERIOD WATER INFLOW, ACRE-FEET			36. WATER INFL. TO DATE, AC.-FT.	
		a. MEAN ANNUAL	b. MAX ANNUAL	c. PERIOD TOTAL	a. MEAN ANNUAL	b. TOTAL TO DATE
Jan. 6, 1915						
Feb. 12, 1957		926,137[7]	2,440,000	38,990,350[7]	926,137[7]	38,990,350[7]
Apr. 1, 1969		646,121[7]	1,391,000	7,818,070[7]	863,624[7]	46,808,420[7]
Jan. 24, 1980		710,204[7]	1,427,000	7,670,200[7]	838,133[7]	54,478,620[7]
Feb. 17, 1988		1,189,815[7]	1,732,000	9,637,500[7]	877,102[7]	64,116,120[7]

26. DATE OF SURVEY	37. PERIOD CAPACITY LOSS, ACRE-FEET			38. TOTAL SED. DEPOSITS TO DATE, ACRE-FEET		
	a. PERIOD TOTAL	b. AV. ANNUAL	c. PER SQ. MI.-YR.	a. TOTAL TO DATE	b. AV. ANNUAL	c. PER SQ. MI.-YR.
Jan. 6, 1915						
Feb. 12, 1957	[8]	–	–	428,020	10,167	0.393[9]
Apr. 1, 1969	69,561	5,749	0.257[9]	497,581	9,180	0.363[9]
Jan. 24, 1980	26,921	2,493	0.208[9]	524,502	8,069	0.337[9]
Feb. 17, 1988	45,288	5,591	0.480[9]	569,790	7,795	0.351[9]

26. DATE OF SURVEY	39. AV. DRY. WGT. LBS. PER CU. FT.	40. SED. DEP., TONS PER SQ. MI.-YR.		41. STORAGE LOSS, PCT.		42. SED. INFLOW, PPM.	
		a. PERIOD	b. TOTAL TO DATE	a. AV. ANN.	b. TOT. TO DATE	a. PERIOD	b. TOT. TO DATE
Jan. 6, 1915							
Feb. 12, 1957	60	–		0.386	16.2	–	–
Apr. 1, 1969	62	416[9]	490[9]	0.348	18.9	10,600[9]	10,562[9]
Jan. 24, 1980	62*	281[9]	455[9]	0.306	19.9	3,490[9]	9,566[9]
Feb. 17, 1988	62*	631[9]	474[9]	0.296	21.6	4,670[9]	8,830[9]

*assumed

Table 1. — Reservoir sediment data summary. - Continued

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RESERVOIR SEDIMENT DATA SUMMARY (Continued)

26. DATE OF SURVEY	43. DEPTH DESIGNATION RANGE IN FEET BELOW, AND ABOVE, CREST ELEVATION											
	193-175.5	175.5-167	167-147	147-127	127-107	107-87	87-67	67-47	47-27	27-11	11-CR	
	PERCENT OF TOTAL SEDIMENT LOCATED WITHIN DEPTH DESIGNATION											
Feb. 17, 1988	0.6	0.3	5.2	9.4	11.5	9.1	10.3	14.3	18.6	13.2	7.5[10]	

26. DATE OF SURVEY	44. REACH DESIGNATION PERCENT OF TOTAL ORIGINAL LENGTH OF RESERVOIR														
	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	-105	-110	-115	-120	-125
	PERCENT OF TOTAL SEDIMENT LOCATED WITHIN REACH DESIGNATION														

45. RANGE IN RESERVOIR OPERATION

WATER YEAR	MAX. ELEV.	MIN. ELEV.	INFLOW, AC.-FT.	WATER YEAR	MAX. ELEV.	MIN. ELEV.	INFLOW, AC.-FT.
1915[11]	4321.81		1,302,250	1930	4384.5	4372.27	930,000
1916	4346.85	4306.6	1,421,000	1931	4374.17	4349.74	418,000
1917	4353.8	4331.8	1,305,000	1932	4384.5	4351.75	1,440,000
1918	4337.0	4290.3	379,100	1933	4377.9	4365.02	717,000
1919	4358.8	4285.5	1,527,000	1934	4367.8	4325.0	298,300
1920	4393.87	4350.9	1,970,000	1935	4342.2	4322.8	917,600
1921	4392.5	4377.5	1,470,000	1936	4354.9	4331.83	872,900
1922	4389.5	4370.7	1,044,000	1937	4380.7	4333.87	1,597,000
1923	4377.4	4366.5	964,000	1938	4377.1	4365.6	1,004,000
1924	4395.8	4368.9	1,662,000	1939	4378.4	4351.2	615,700
1925	4382.1	4354.7	321,000	1940	4357.04	4323.2	333,100
1926	4378.1	4354.6	1,120,000	1941	4399.2	4324.3	2,440,000
1927	4373.95	4363.02	1,180,000	1942	4409.15	4397.0	2,322,000
1928	4379.10	4359.70	773,000	1943	4398.96	4380.82	441,600
1929	4374.8	4353.7	1,240,000	1944	4385.68	4369.16	982,500

46. ELEVATION-AREA-CAPACITY DATA

ELEVATION	AREA	CAPACITY	ELEVATION	AREA	CAPACITY	ELEVATION	AREA	CAPACITY
[1] 1915 Survey			1915 Survey					
4210	0	0	4320	11,894	490,800			
4220	98	490	4330	14,240	621,400			
4230	376	2,960	4340	16,595	775,600			
4240	671	4,660	4350	19,194	954,400			
4250	1,684	15,800	4360	22,563	1,162,100			
4260	3,157	39,700	4370	26,620	1,408,000			
4270	4,691	78,600	4380	30,191	1,692,800			
4280	6,145	132,800	4390	33,451	2,010,300			
4290	7,715	202,100	4400	37,328	2,363,900			
4300	8,923	285,400	4407	40,060	2,634,800			
4310	10,202	380,800	4410	41,283	2,756,600			

47. REMARKS AND REFERENCES

[1] All elevations are project datum. Add 43.3' to adjust to m.s.l.

[2] Irrigation and power.

[3] Estimated by interpolation.

[4] Represents loss of contributing area since closing of Jemez in 1953 (1,034 mi^2), Galisteo in 1970 (596 mi^2), Cochiti in 1973 (11,960 mi^2), noncontributing area (310 mi^2), and reservoir area (57 mi^2).

[5] Rio Grande at San Marcial.

[6] For intermediate survey. See data sheet 57-1 and 57-1a.

[7] Revised values from U.S. Geological Survey Water Supply Paper 1,732, totalled from item 45.

48. AGENCY MAKING SURVEY
49. AGENCY SUPPLYING DATA

50. DATE February 16, 1989

Table 1. — Reservoir sediment data summary. - Continued

7-2231a (12-88)
Bureau of Reclamation

RESERVOIR SEDIMENT DATA SUMMARY (Continued)

26. DATE OF SURVEY	43. DEPTH DESIGNATION RANGE IN FEET BELOW, AND ABOVE, CREST ELEVATION												
	PERCENT OF TOTAL SEDIMENT LOCATED WITHIN DEPTH DESIGNATION												

26. DATE OF SURVEY	44. REACH DESIGNATION PERCENT OF TOTAL ORIGINAL LENGTH OF RESERVOIR														
	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	-105	-110	-115	-120	-125
	PERCENT OF TOTAL SEDIMENT LOCATED WITHIN REACH DESIGNATION														

45. RANGE IN RESERVOIR OPERATION

WATER YEAR	MAX. ELEV.	MIN. ELEV.	INFLOW, AC.-FT.	WATER YEAR	MAX. ELEV.	MIN. ELEV.	INFLOW, AC.-FT.
1945	4385.60	4372.28	851,500	1960	4339.04	4322.40	563,400
1946	4375.66	4339.52	224,900	1961	4329.10	4301.99	437,700
1947	4339.36	4311.94	419,200	1962	4329.80	4304.38	748,100
1948	4349.22	4313.08	1,036,000	1963	4327.52	4282.07	405,500
1949	4351.3	4329.69	1,031,000	1964	4299.23	4275.51	164,200
1950	4346.01	4315.46	364,100	1965	4323.01	4277.46	821,700
1951	4315.79	4262.30	132,900	1966	4338.30	4311.03	725,340
1952	4324.59	4261.64	967,000	1967	4321.84	4293.03	391,600
1953	4220.49	4283.19	286,800	1968	4319.70	4295,09	646,230
1954	4297.30	4258.03	198,500	1969	4335.0	4308.77	787,600
1955	4295.46	4276.58	257,900	1970	4339.43	4303.02	729,200
1956	4304.40	4268.44	174,800	1971	4326.41	4271.19	413,100
1957	4337.12	4267.10	972,300	1972	4319.02	4279.67	427,900
1958	4373.34	4336.2	1,391,000	1973	4355.52	4319.22	1,309,000
1959	4362.8	4334.46	341,900	1974	4360.94	4321.20	451,400

46. ELEVATION-AREA-CAPACITY DATA

ELEVATION	AREA	CAPACITY	ELEVATION	AREA	CAPACITY	ELEVATION	AREA	CAPACITY

47. REMARKS AND REFERENCES

[8] Total storage showed gain of 9,180 acre-feet since 1947 survey.

[9] Adjusted for upstream dams reducing contributing drainage areas Abiquiu closed in 1963 (2,146 mi^2) and see footnote 4.

[10] Values sum to 100.0 percent of deposits (569,790 acre-feet) at crest El. 4407.

[11] From Jan. 1915 through Sept. 1915.

48. AGENCY MAKING SURVEY
49. AGENCY SUPPLYING DATA

50. DATE February 16, 1989

Table 1. — Reservoir sediment data summary. - Continued

7-2231a (12-88)
Bureau of Reclamation

RESERVOIR SEDIMENT DATA SUMMARY (Continued)

26. DATE OF SURVEY	43. DEPTH DESIGNATION RANGE IN FEET BELOW, AND ABOVE, CREST ELEVATION											
	PERCENT OF TOTAL SEDIMENT LOCATED WITHIN DEPTH DESIGNATION											

26. DATE OF SURVEY	44. REACH DESIGNATION PERCENT OF TOTAL ORIGINAL LENGTH OF RESERVOIR														
	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	-105	-110	-115	-120	-125
	PERCENT OF TOTAL SEDIMENT LOCATED WITHIN REACH DESIGNATION														

45. RANGE IN RESERVOIR OPERATION

WATER YEAR	MAX. ELEV.	MIN. ELEV.	INFLOW, AC.-FT.	WATER YEAR	MAX. ELEV.	MIN. ELEV.	INFLOW, AC.-FT.
1975	4345.91	4326.08	875,900				
1976	4353.05	4318.02	580,900				
1977	4325.18	4295.78	243,200				
1978	4314.70	4290.20	385,100				
1979	4364.95	4305.88	1,427,000				
1980	4380.48	4363.81	1,280,000				
1981	4378.14	4354.31	341,700				
1982	4364.69	4354.30	824,300				
1983	4383.60	4364.77	1,262,000				
1984	4392,31	4381.05	1,052,000				
1985	4404.35	4392.01	1,542,000				
1986	4407.21	4402.84	1,576,000				
1987	4406.60	4402.69	1,732,000				

46. ELEVATION-AREA-CAPACITY DATA

ELEVATION	AREA	CAPACITY	ELEVATION	AREA	CAPACITY	ELEVATION	AREA	CAPACITY
1980 Survey			1980 Survey					
4250	55	160	4350	14,872	652,300			
4260	971	5,293	4360	18,011	816,715			
4270	2,142	20,861	4370	20,994	1,011,742			
4280	2,660	44,873	4380	24,890	1,241,164			
4290	4,263	79,490	4390	28,697	1,509,096			
4300	6,205	131,833	4400	33,433	1,819,744			
4310	7,503	200,374	4407	36,643	2,065,010			
4320	9,535	285,562	4410	38,019	2,177,003			
4330	11,260	389,537						
4340	13,210	511,890						

47. REMARKS AND REFERENCES

48. AGENCY MAKING SURVEY
49. AGENCY SUPPLYING DATA

50. DATE February 16, 1989

Table 2. — Summary of 1988 survey results and sediment distribution computations.

(1) Elevation (feet)	(2) 1915 Area (acres)	(3) 1915 Capacity (acre-feet)	(4) 1988 Area (acres)	(5) 1988 Capacity (acre-feet)	(6) Measured sediment volume (acre-feet)	(7) Percent of measured sediment	(8) 1988 Computed capacity (acre-feet)	(9) Computed sediment volume (acre-feet)	(10) Percent of computed sediment
4407.0	40,060	2,634,800	36,643	2,065,010	569,790	100.0	2,065,010	569,790	100.0
4400.0	37,328	2,363,900	33,433	1,819,744	544,156	95.5	1,801,218	562,682	98.8
4390.0	33,451	2,010,300	28,697	1,509,096	501,204	88.0	1,471,938	538,362	94.5
4380.0	30,191	1,692,800	24,890	1,241,164	451,636	79.3	1,185,179	507,621	89.1
4370.0	26,620	1,408,000	20,994	1,011,742	396,258	69.5	935,176	472,824	83.0
4360.0	23,563	1,162,100	18,011	816,715	345,385	60.6	726,869	435,231	76.4
4350.0	19,194	954,400	14,872	652,300	302,100	53.0	558,700	395,700	69.4
4340.0	16,595	775,600	13,210	511,890	263,710	46.3	420,707	354.893	62.3
4330.0	14,240	621,400	11,260	389,537	231,863	40.7	308,041	313,359	55.0
4320.0	11,894	490,800	9,535	285,562	205,238	36.0	219,222	271,578	47.7
4310.0	10,202	380,800	7,503	200,374	180,426	31.7	150,811	229,989	40.4
4300.0	8,923	285,400	6,205	131,833	153,567	27.0	96,391	189,009	33.2
4290.0	7,715	202,100	4,263	79,490	122,610	21.5	53,056	149,044	26.2
4280.0	6,145	132,800	2,660	44,873	87,927	15.4	22,289	110,511	19.4
4270.0	4,691	78,600	2,142	20,861	57,739	10.1	4,692	73,908	13.0
4260.3	3,302	40,717	1,007	5,590	35,127	6.2	0	40,717	7.1
4260.0	3,257	39,700	971	5,293	34,407	6.0	0	39,700	7.0
4250.0	1,684	15,800	55	0	15,800	2.8	0	15,800	2.8
4240.0	671	4,660			4,660	0.8	0	4,660	0.8
4230.0	376	2,960			2,960	0.5	0	2,960	0.5
4220.0	98	490			490	0.1	0	490	0.1
4210.0	0	0			0	0.0	0	0	0.0

Explaination of columns:

(1) Elevation of reservoir water surface.
(2) Original reservoir surface area surveyed in 1915.
(3) Original reservoir capacity from 1915 survey
(4) Reservoir surface area surveyed in 1988.
(5) Reservoir capacity from 1988 survey.
(6) Measured sediment volume = collumn (3) minus column (5).
(7) Measured sediment expressed in percentage of total sediment (569,790 acre-feet).
(8) Computed 1988 reservoir capacity using Empirical Area-Reduction Method (Type II).
(9) Computed sediment volume for period from 1915 to 1988 = column (3) minus column (8).
(10) Computed sediment expressed in percentage of total sediment (569,790 acre-feet).

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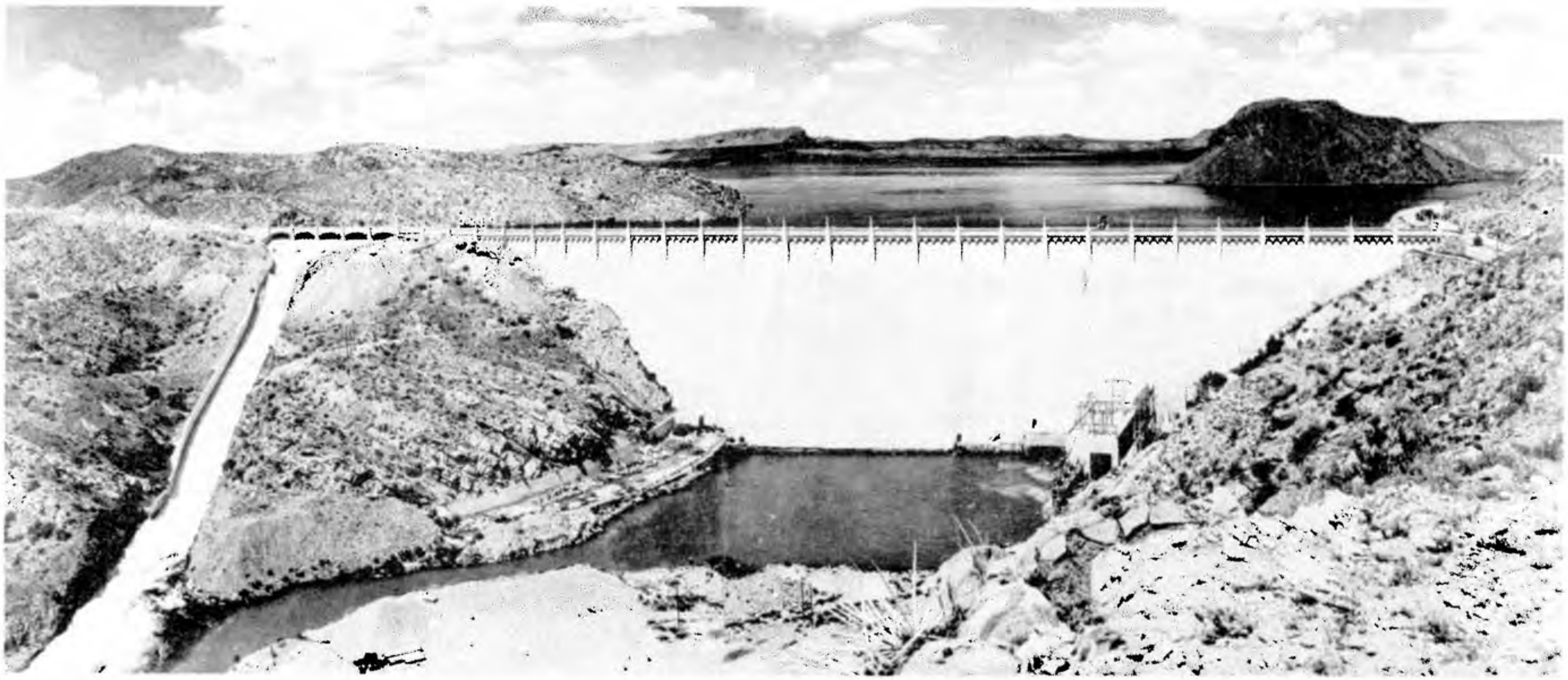


Figure 2. — Elephant Butte Dam and Reservoir.

Figure 3. — Aerial view of "The Narrows".

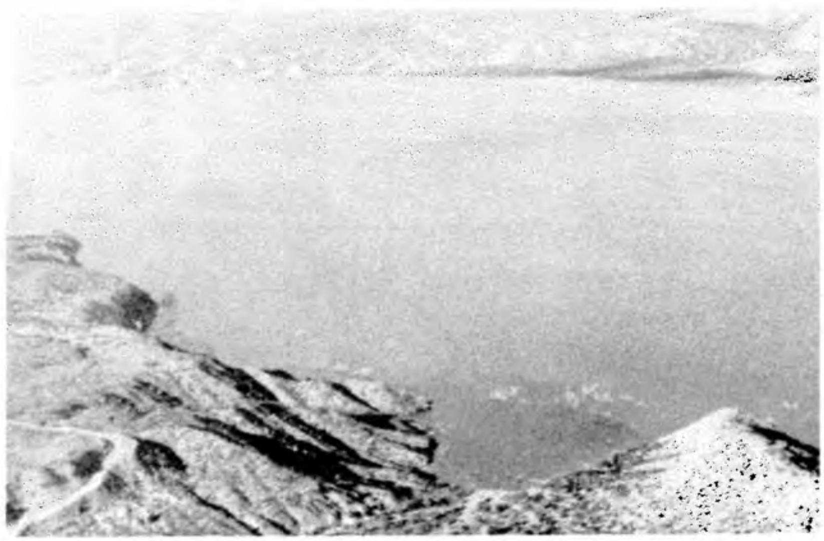


Figure 4. — Aerial view of upper reservoir.

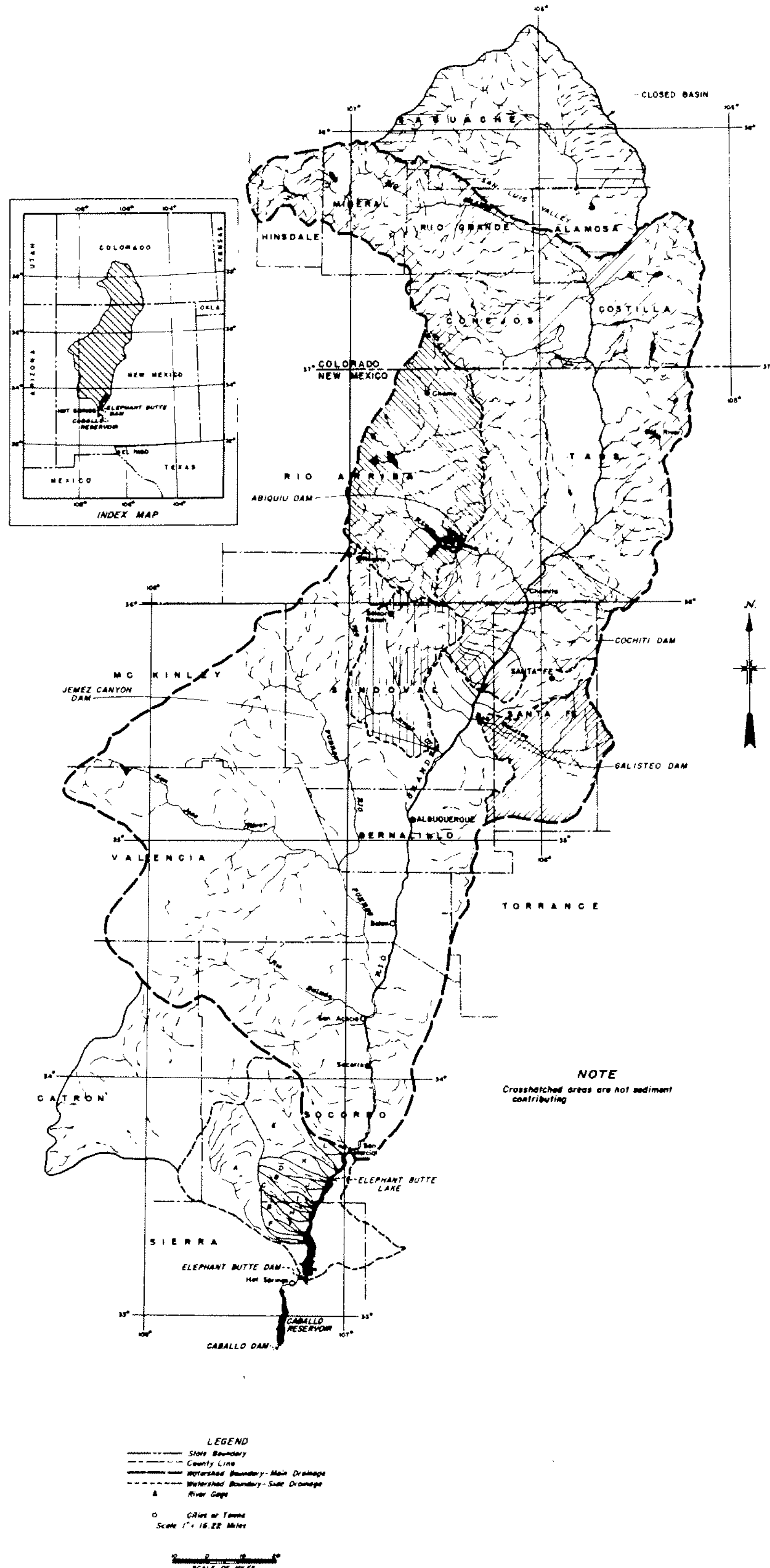


Figure 5. — Map of drainage area.

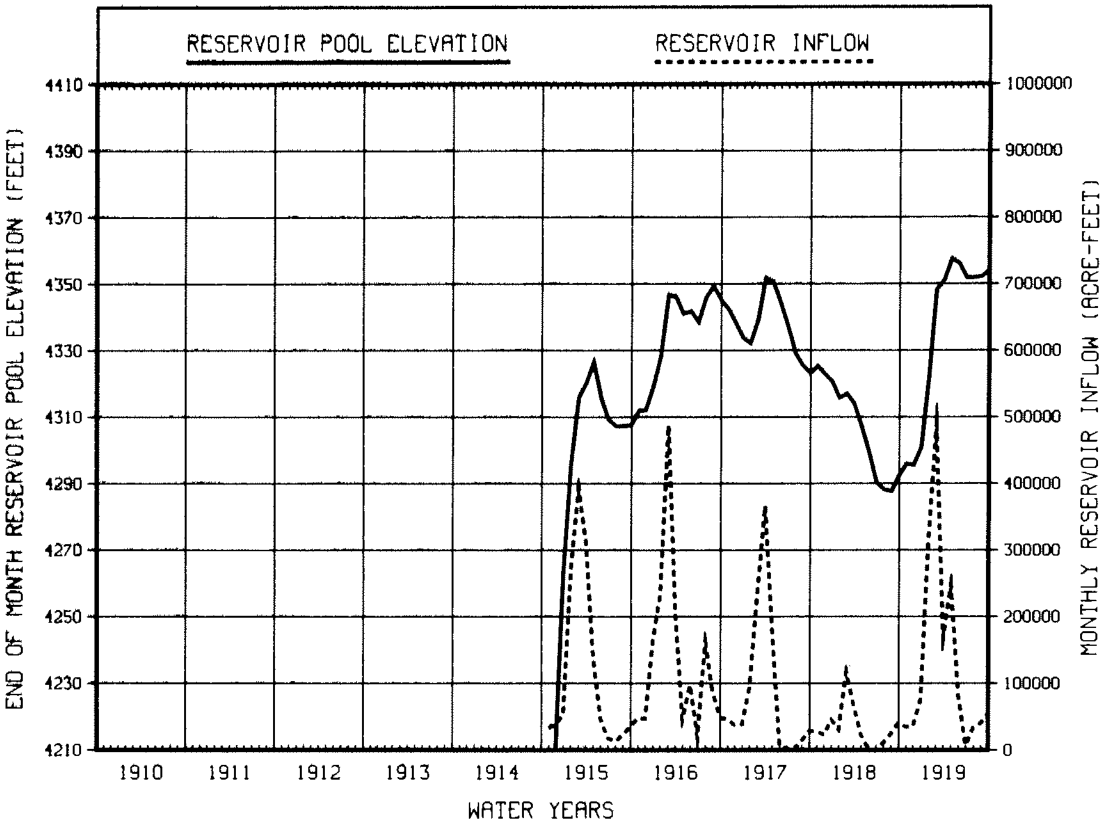


Figure 6. — Monthly inflows into reservoir with end-of-month pool elevations. (sheet 1 of 8)

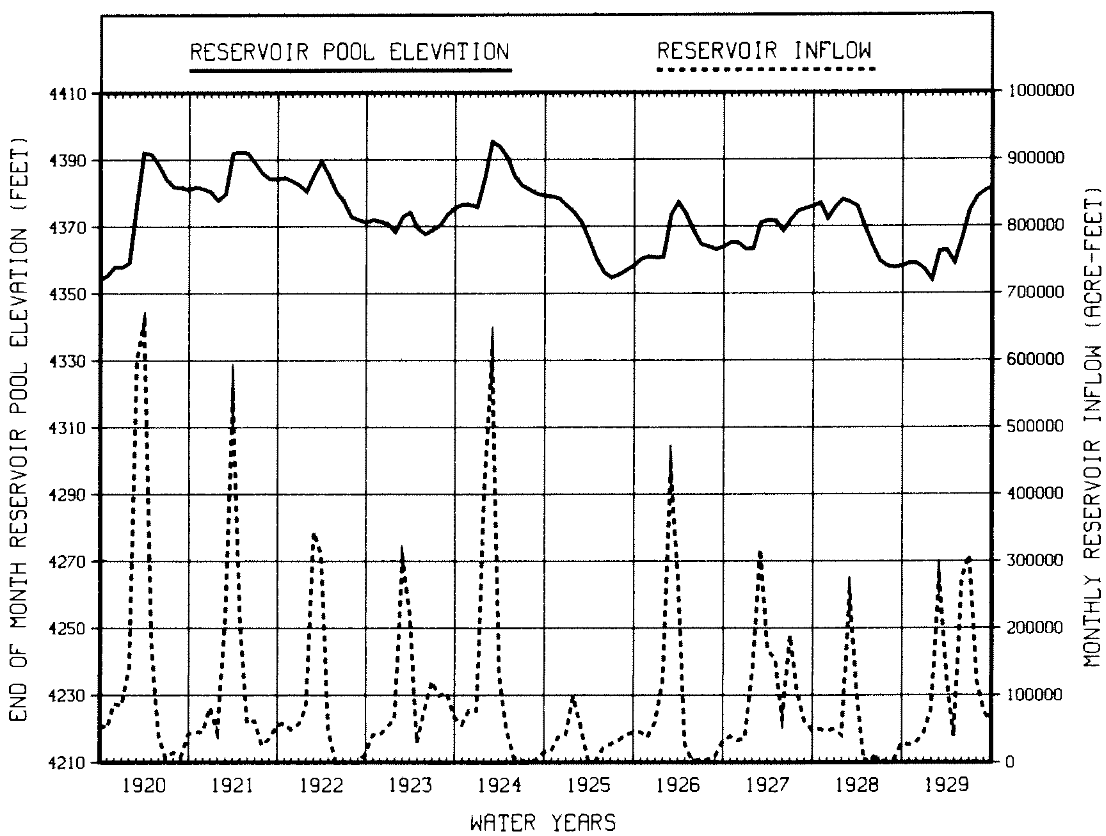


Figure 6. — Monthly inflows into reservoir with end-of-month pool elevations. (sheet 2 of 8)

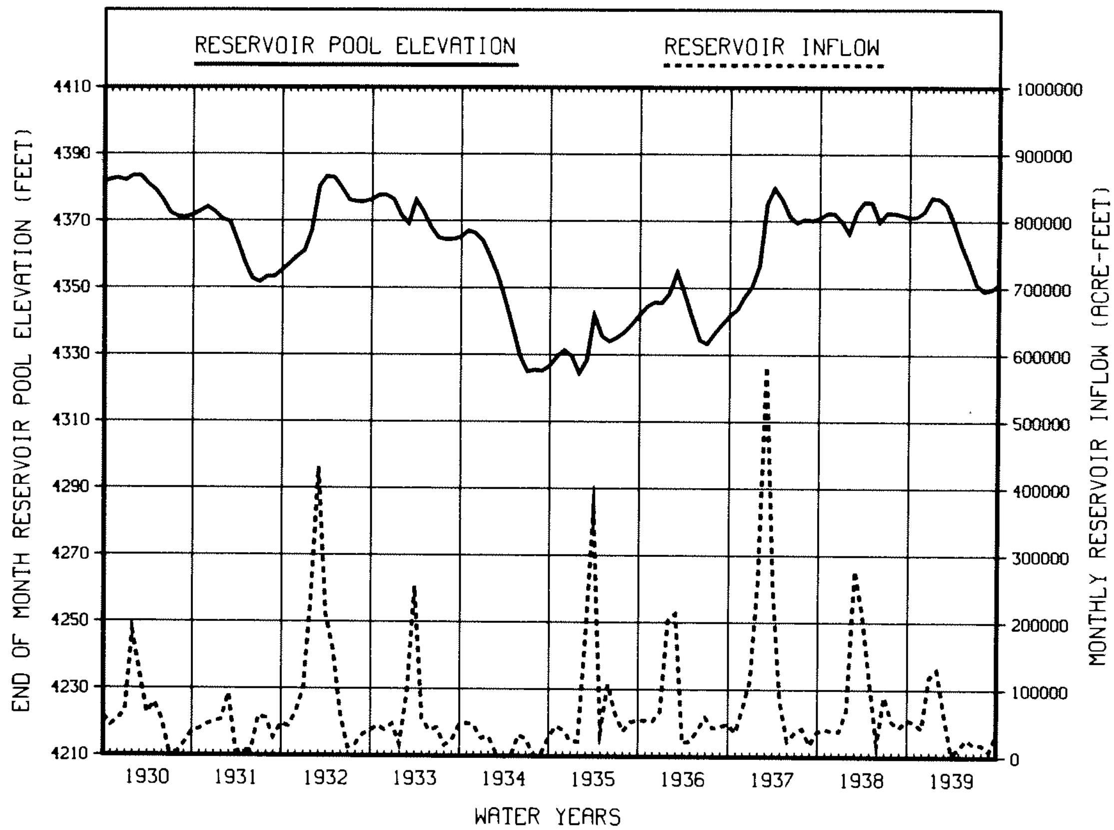


Figure 6. — Monthly inflows into reservoir with end-of-month pool elevations. (sheet 3 of 8)

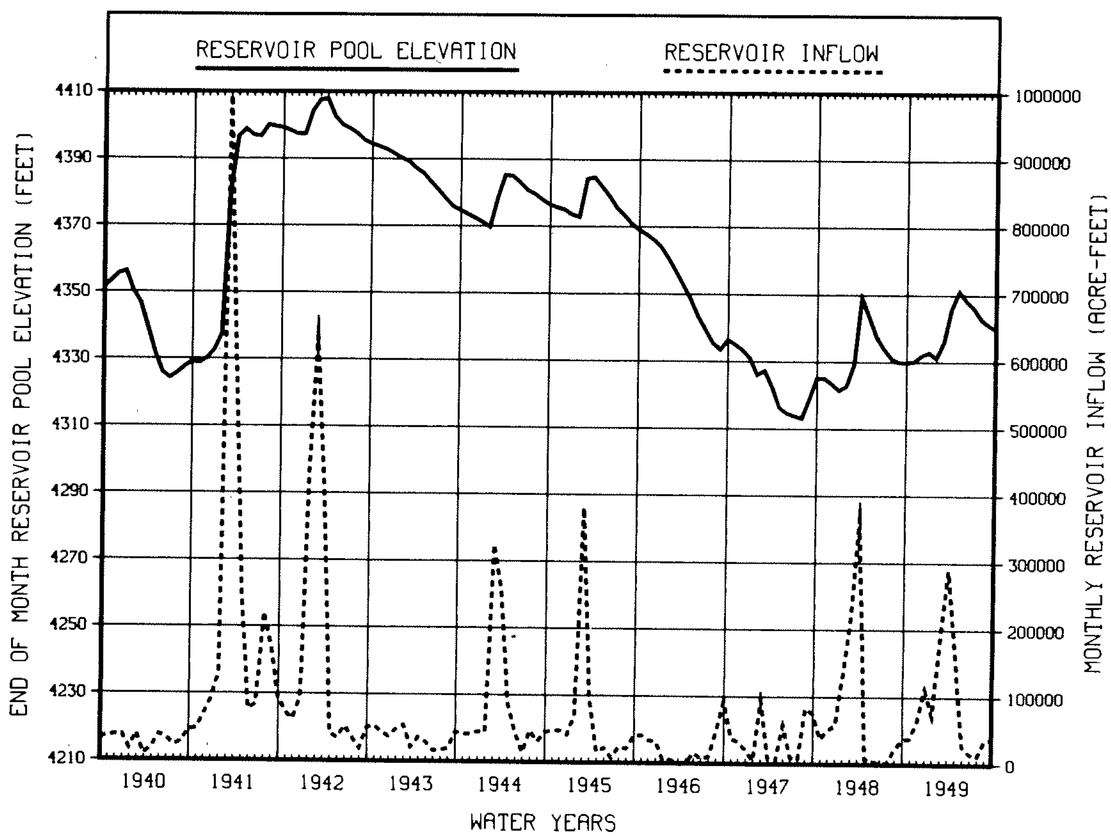


Figure 6. — Monthly inflows into reservoir with end-of-month pool elevations. (sheet 4 of 8)

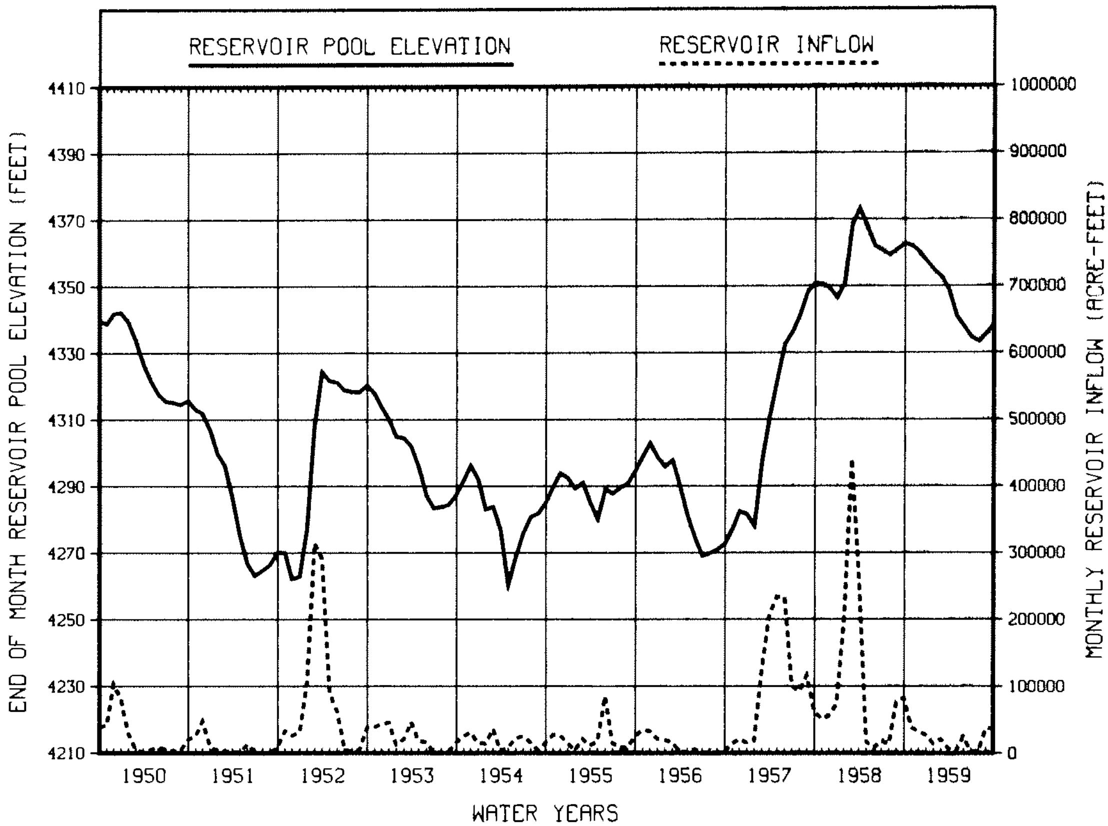


Figure 6. — Monthly inflows into reservoir with end-of-month pool elevations. (sheet 5 of 8)

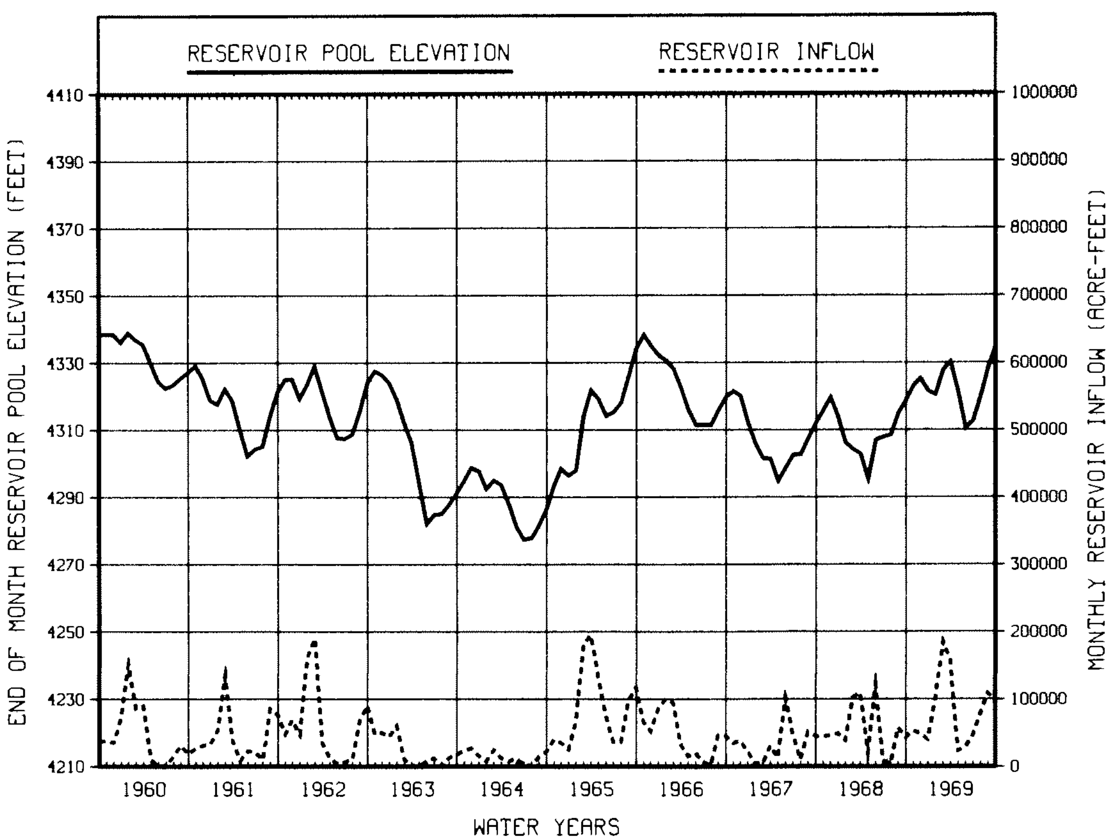


Figure 6. — Monthly inflows into reservoir with end-of-month pool elevations. (sheet 6 of 8)

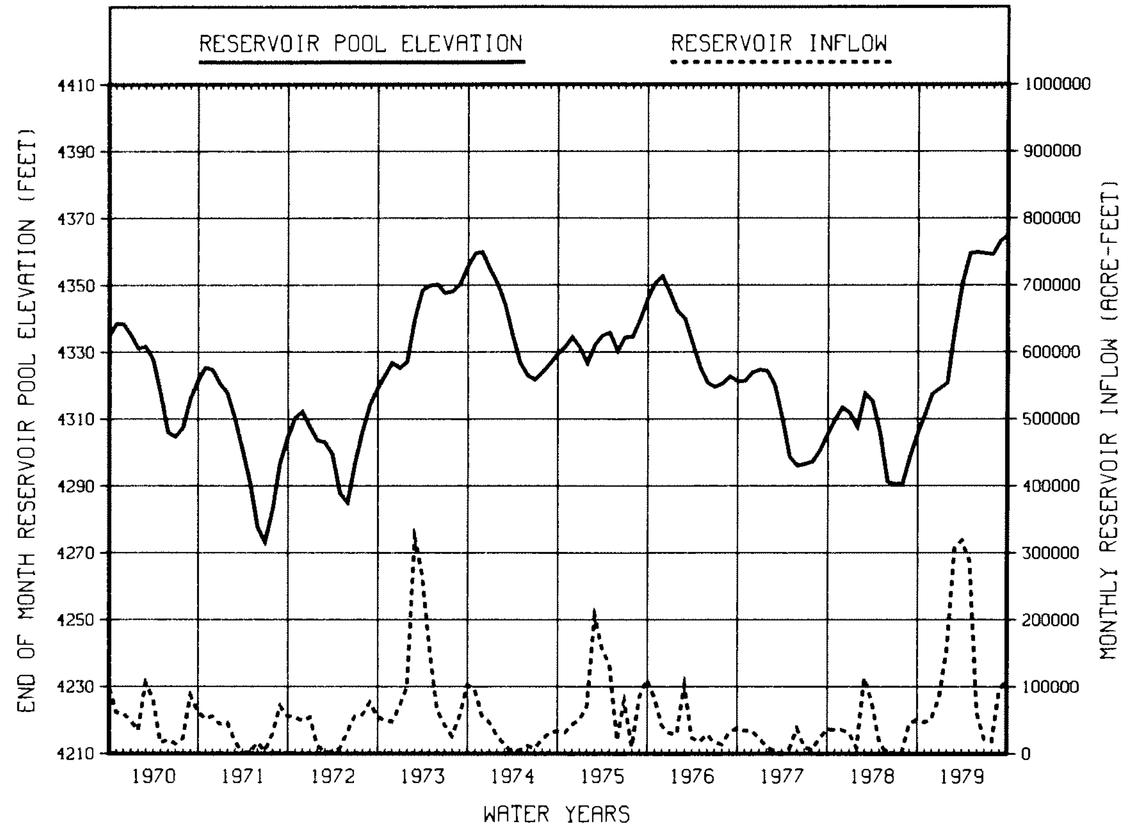


Figure 6. — Monthly inflows into reservoir with end-of-month pool elevations. (sheet 7 of 8)

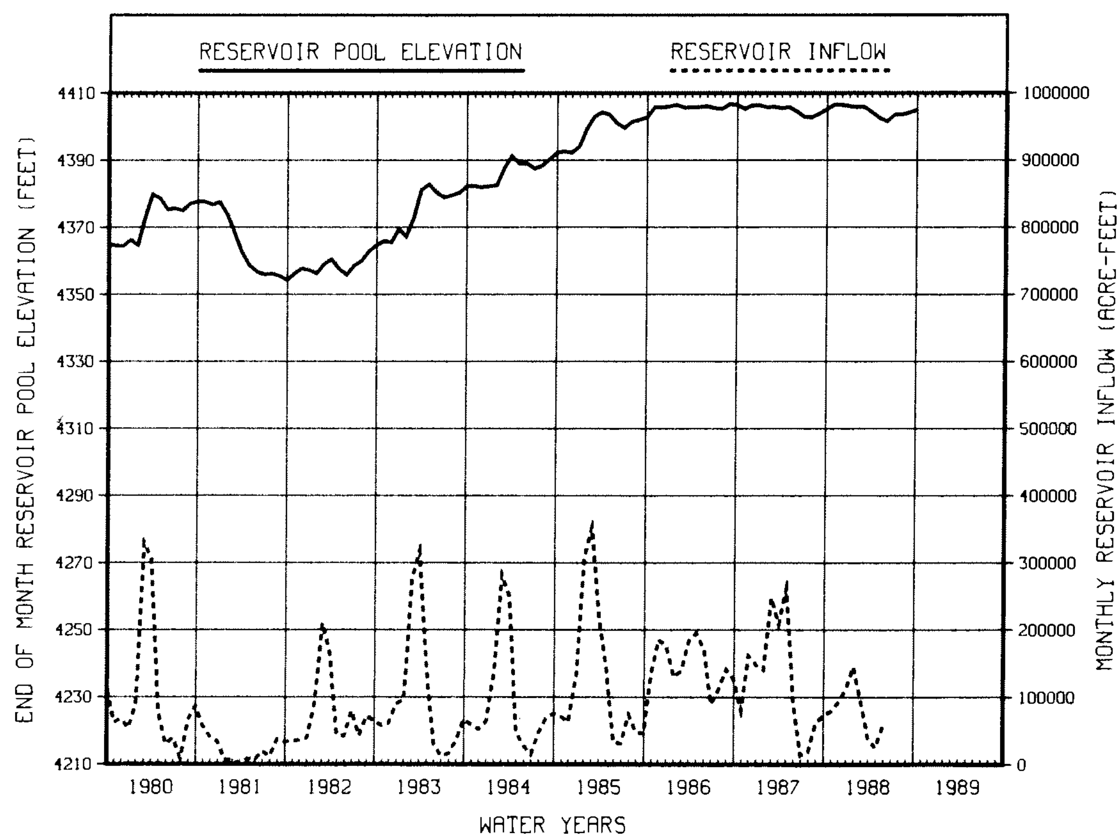


Figure 6. — Monthly inflows into reservoir with end-of-month pool elevations. (sheet 8 of 8)

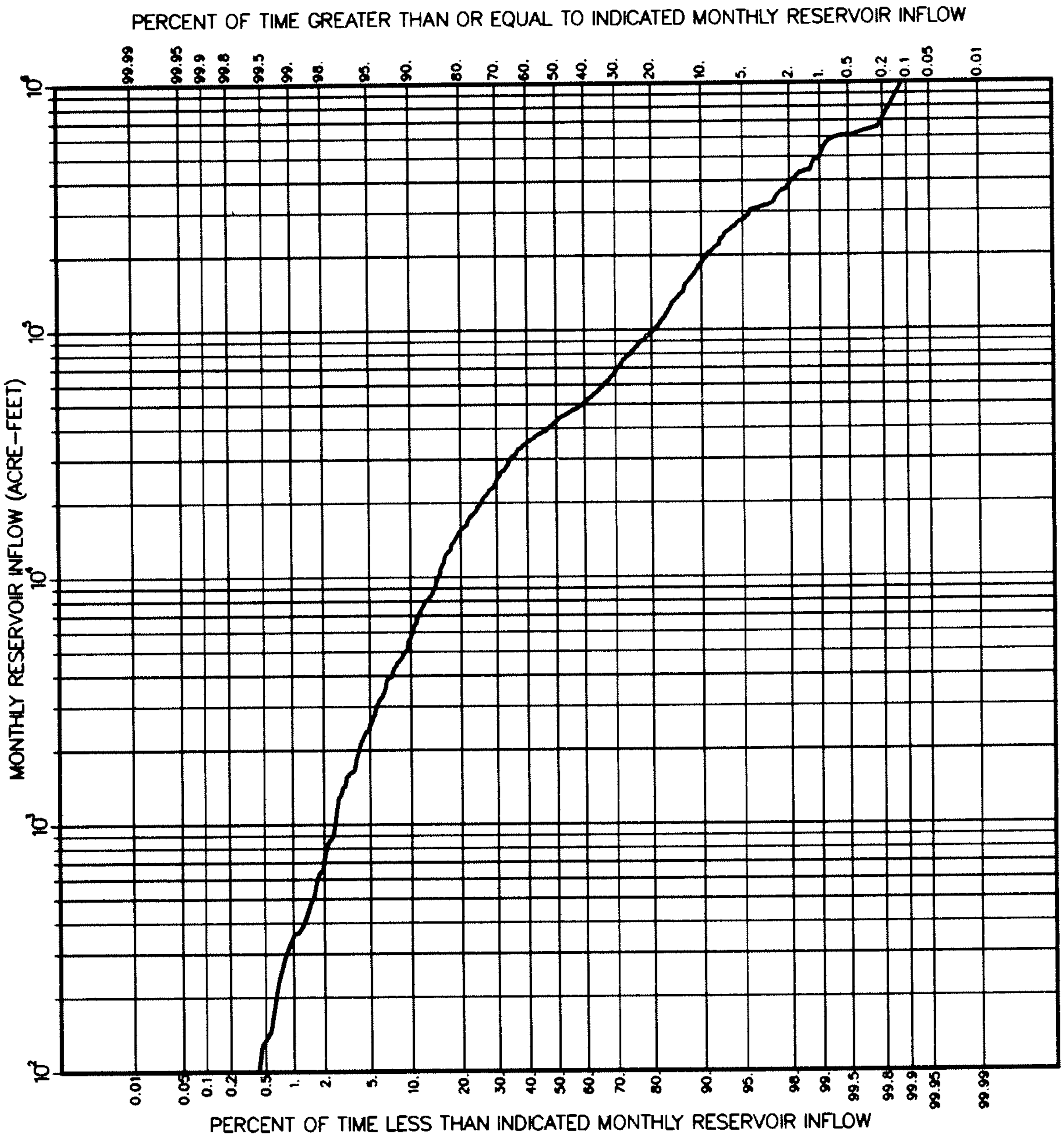


Figure 7. — Inflow-duration curve for monthly inflow discharges.

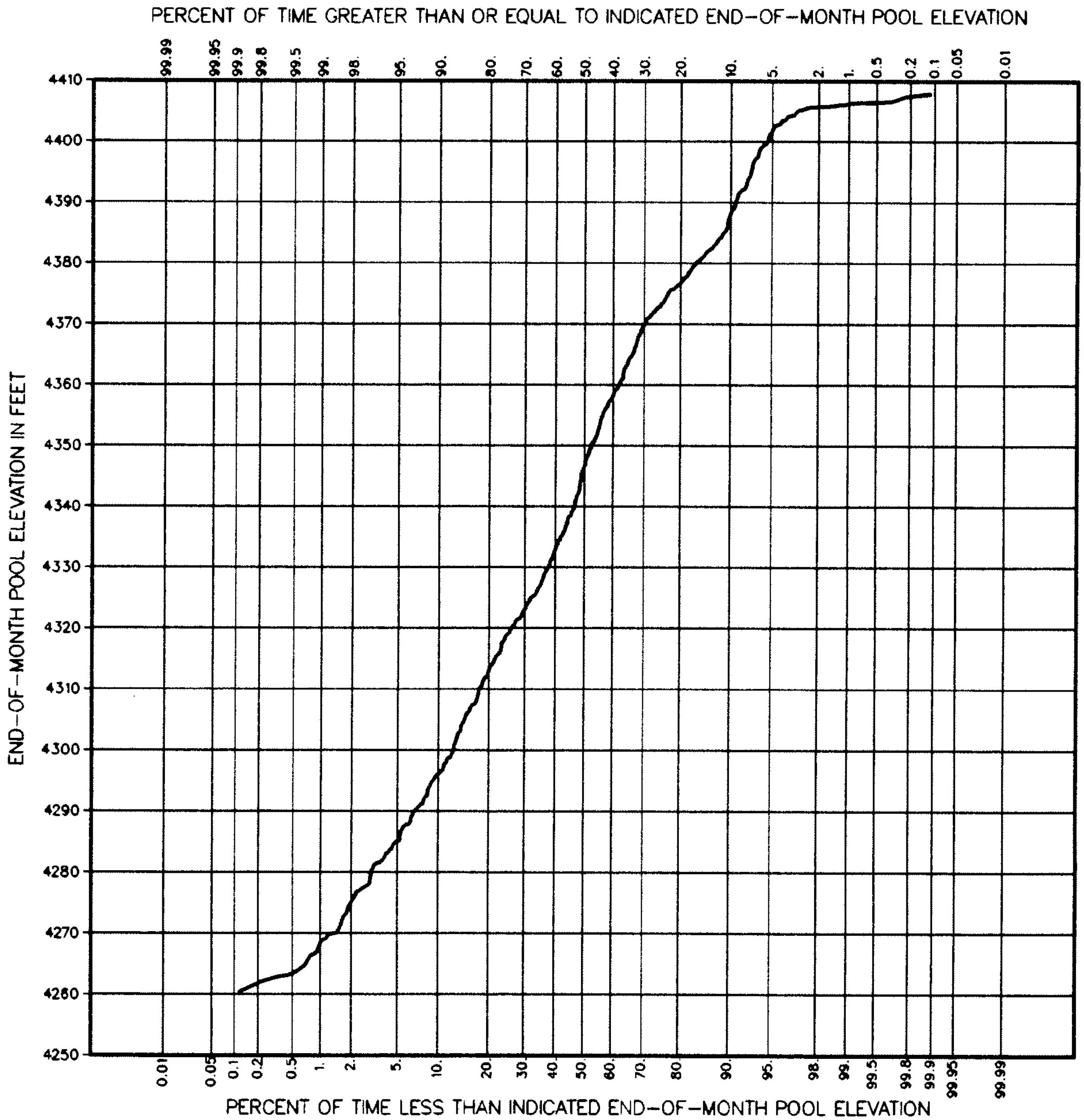


Figure 8. — Stage-duration curve for end-of-month reservoir elevations.

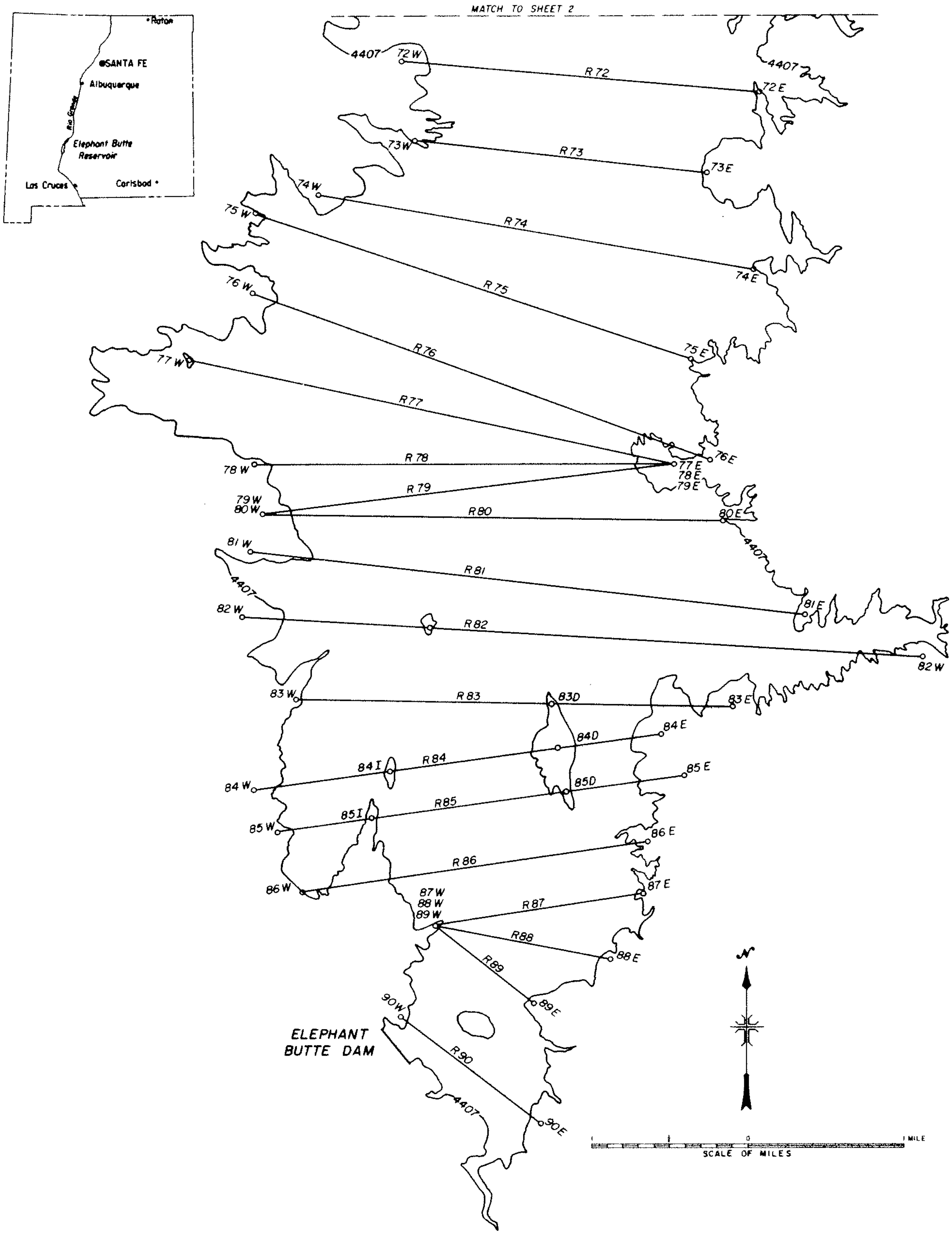


Figure 9. — Layout of reservoir sedimentation ranges. (sheet 1 of 5)

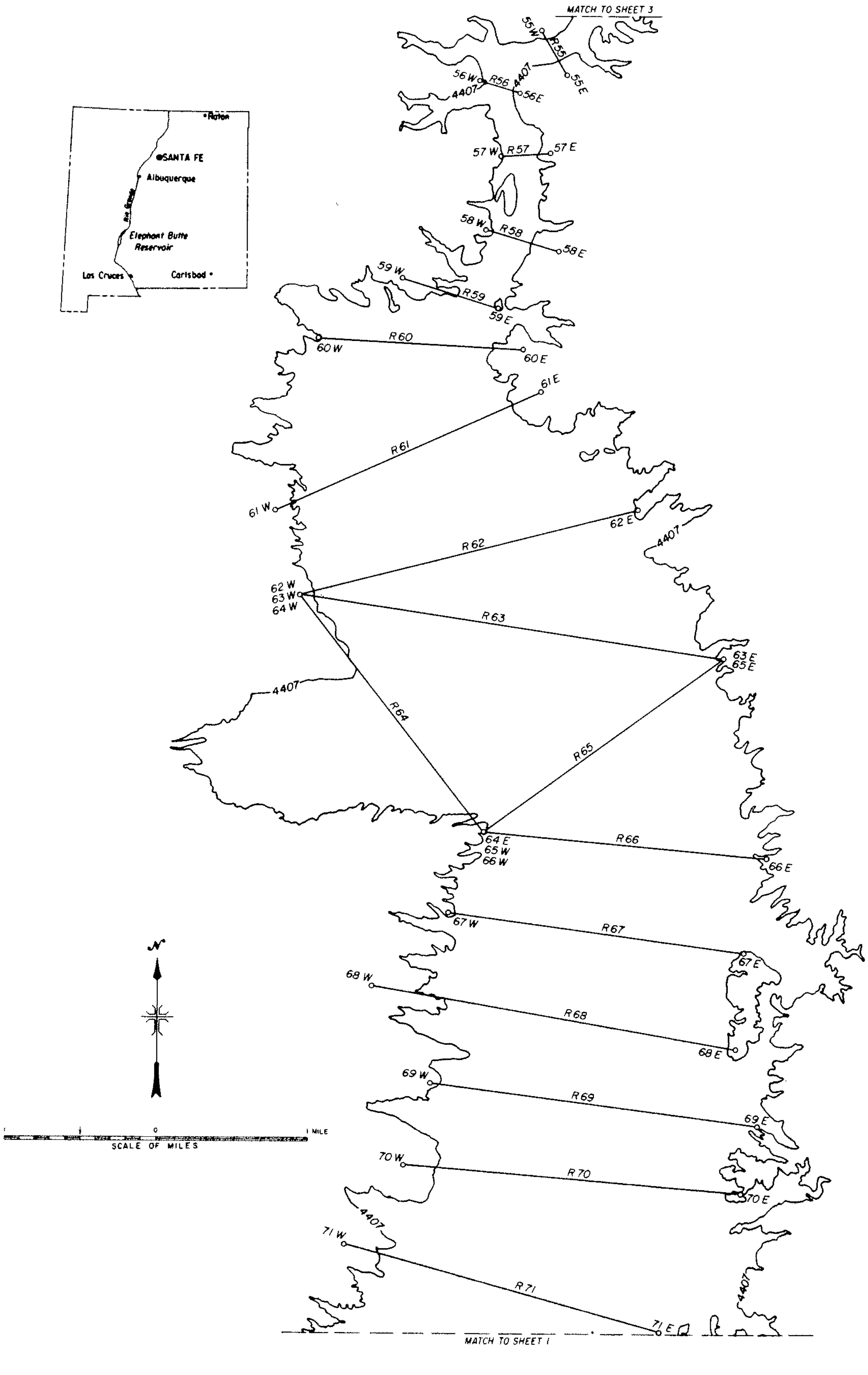


Figure 9. — Layout of reservoir sedimentation ranges. (sheet 2 of 5)

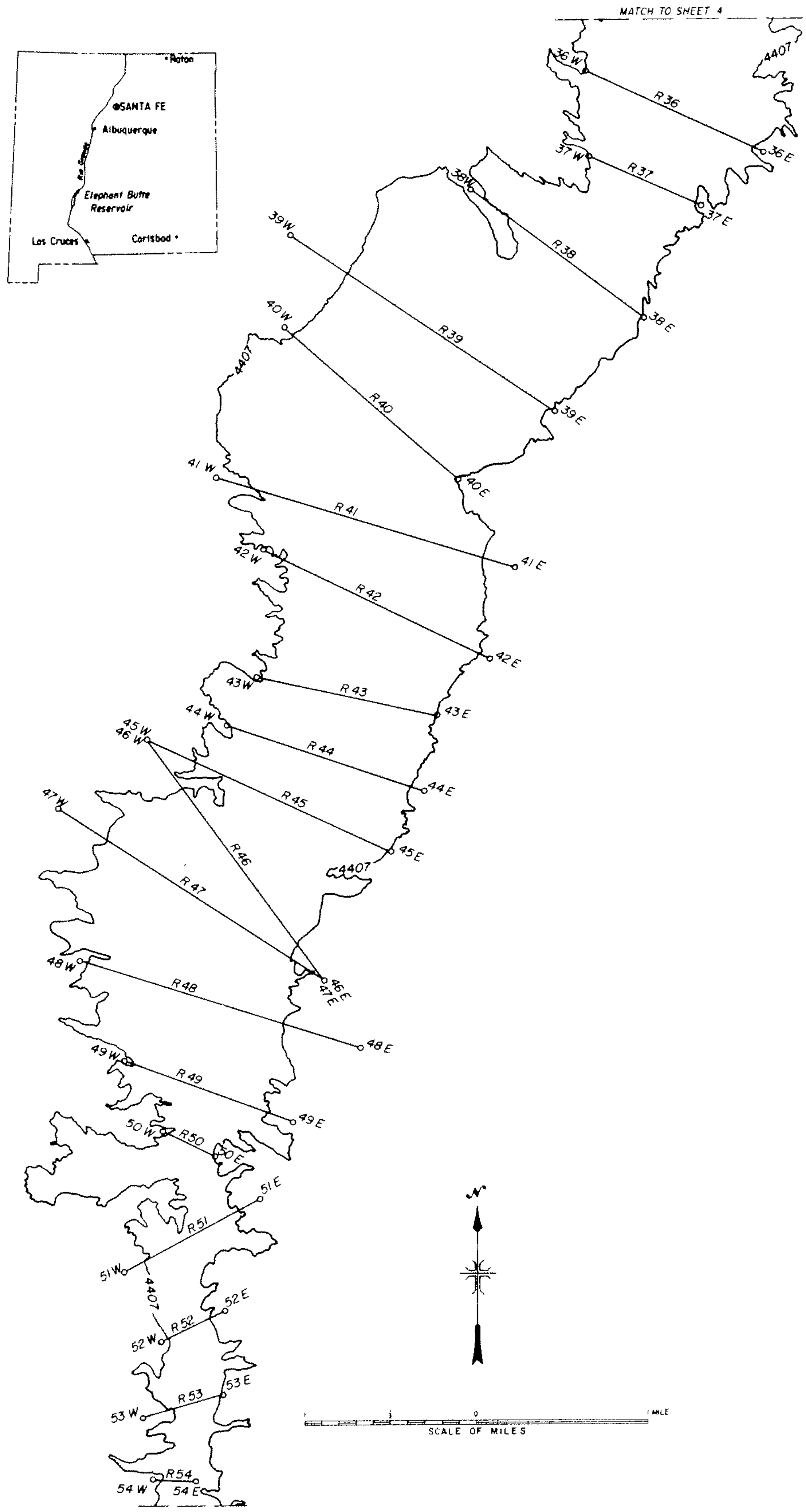


Figure 9. — Layout of reservoir sedimentation ranges. (sheet 3 of 5)

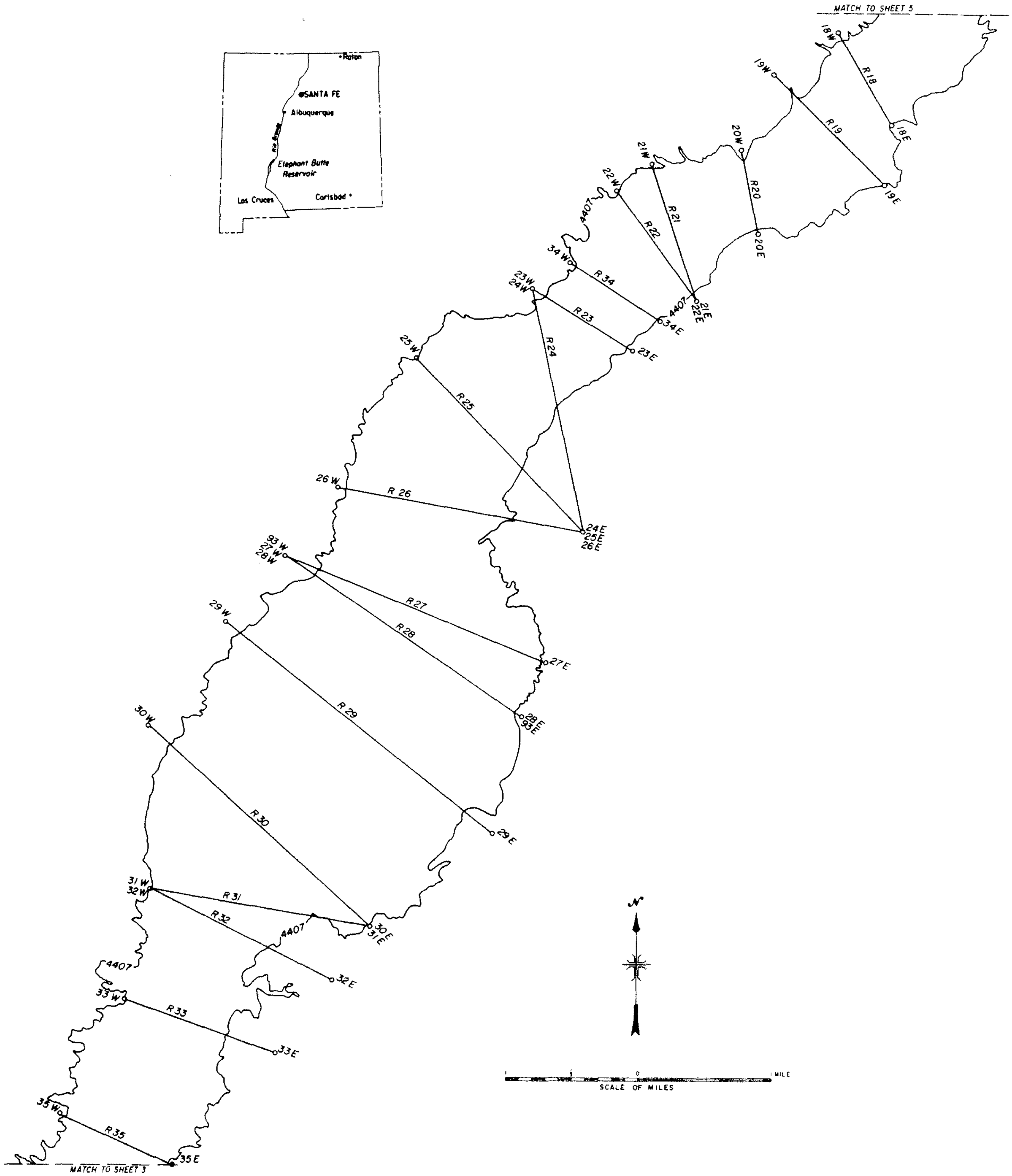


Figure 9. — Layout of reservoir sedimentation ranges. (sheet 4 of 5)

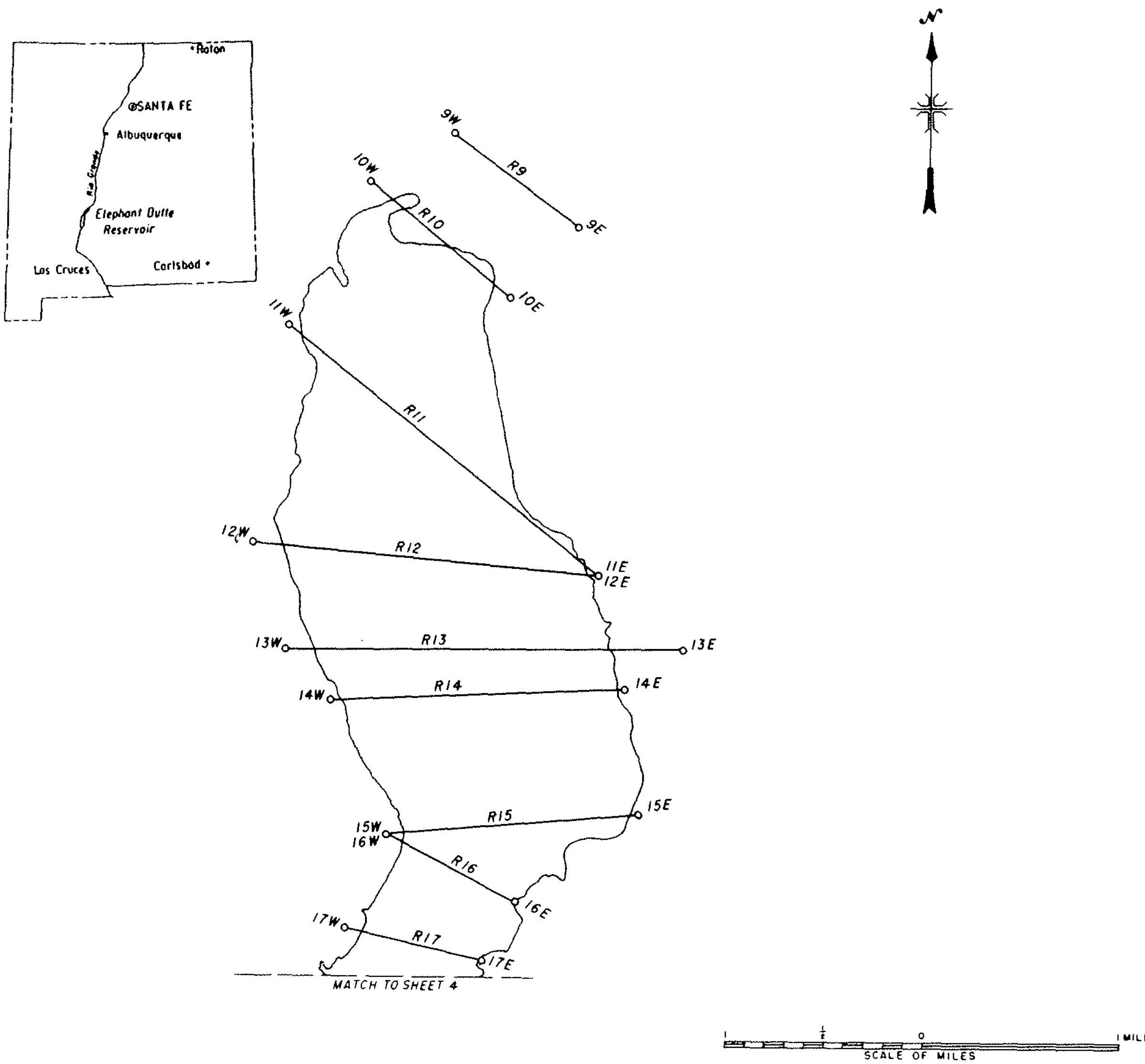


Figure 9. — Layout of reservoir sedimentation ranges. (sheet 5 of 5)

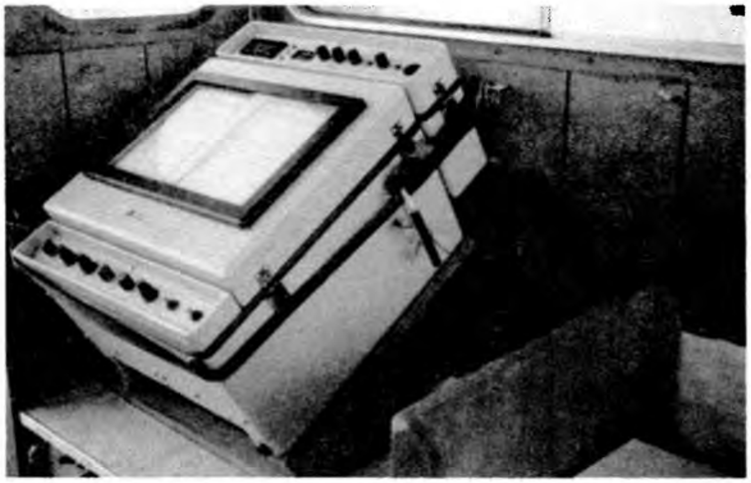


Figure 10. — Depth recorder (Fathometer).

Figure 11. — Survey sounding boat.

Figure 12. — Fixed shore station.

Figure 13. — Operator console and data tape recorder.

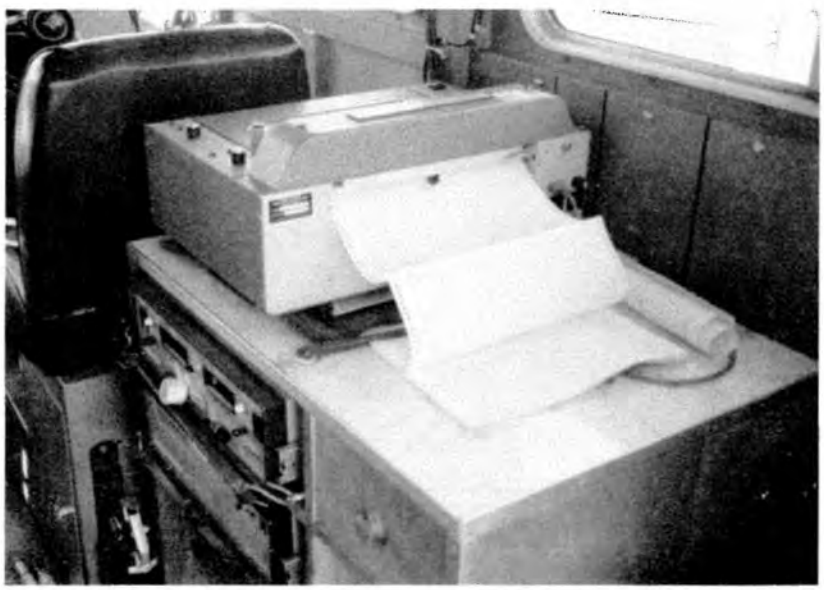


Figure 14. — Graph plotter with range console and data processor.

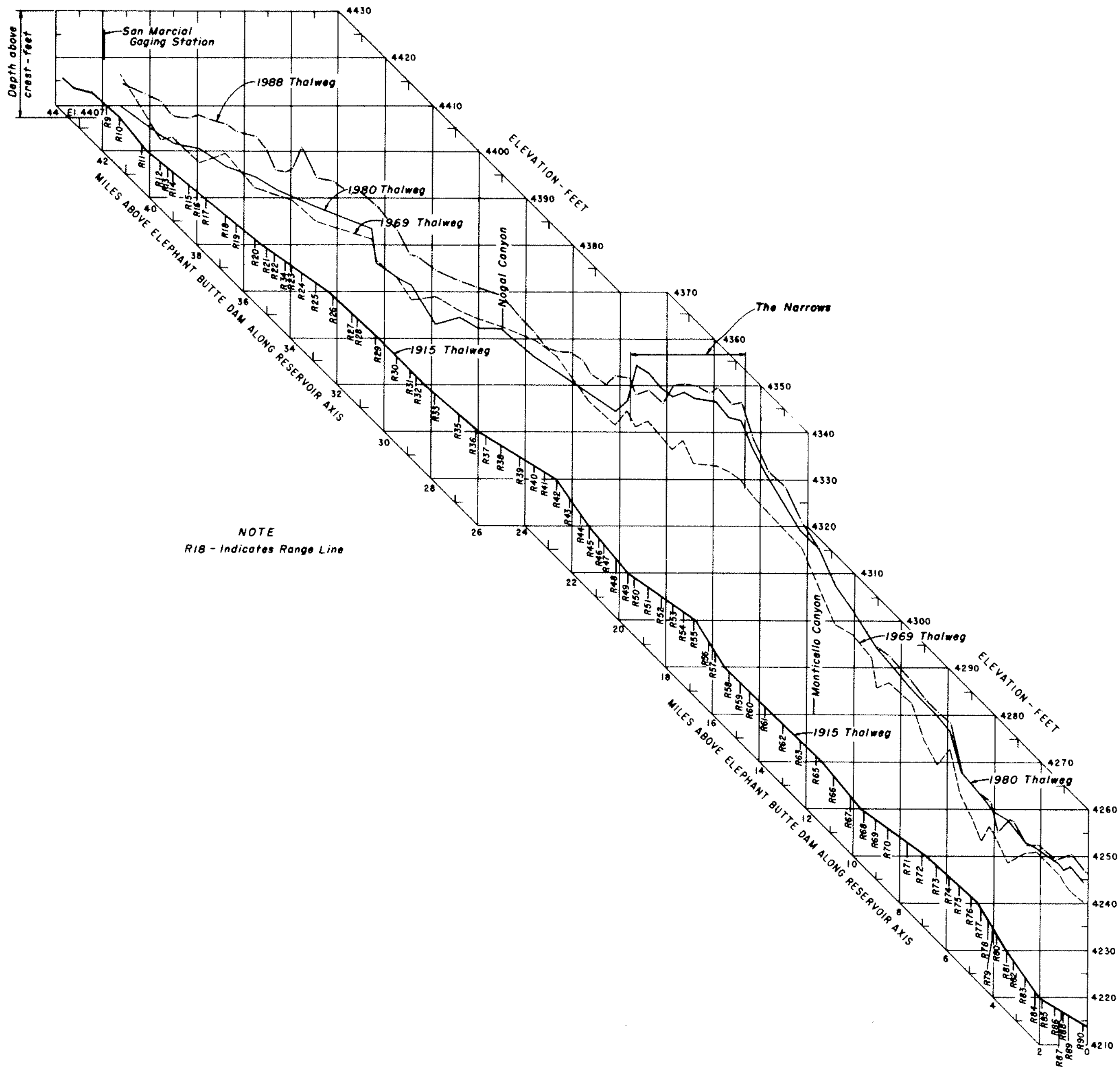


Figure 15. — Longitudinal profiles.

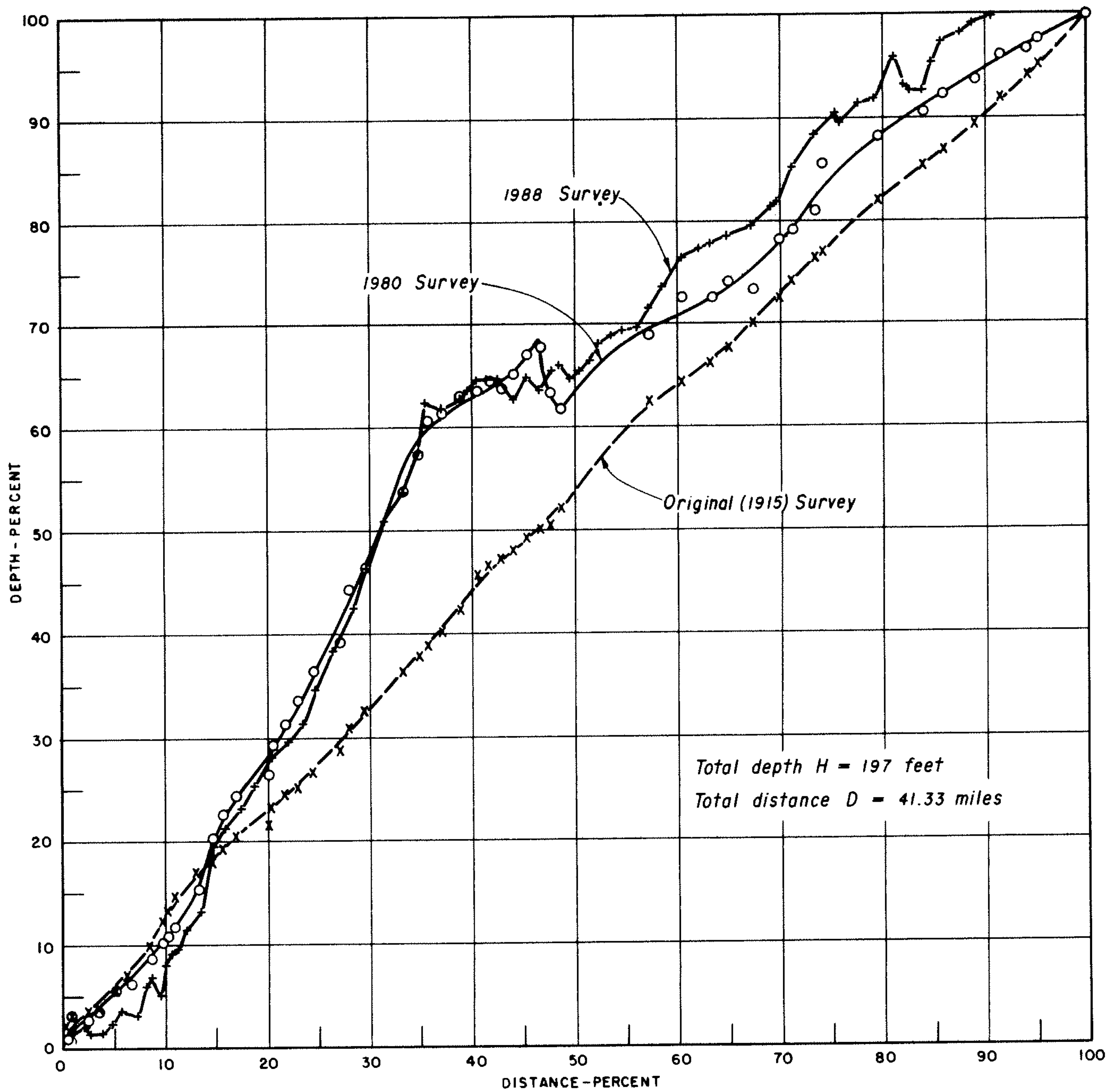


Figure 16. — Percent depth versus percent distance relationship for the Rio Grande above Elephant Butte Dam.

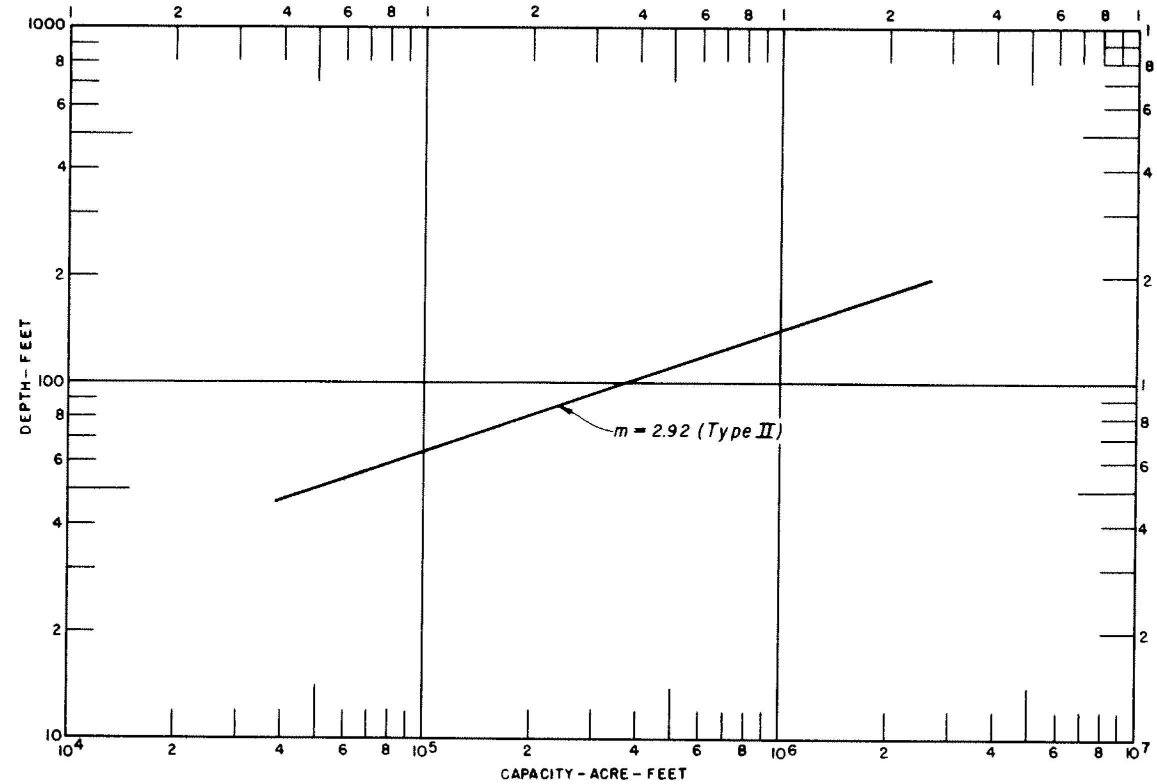


Figure 17. — Depth-capacity relationship for Elephant Butte Reservoir.

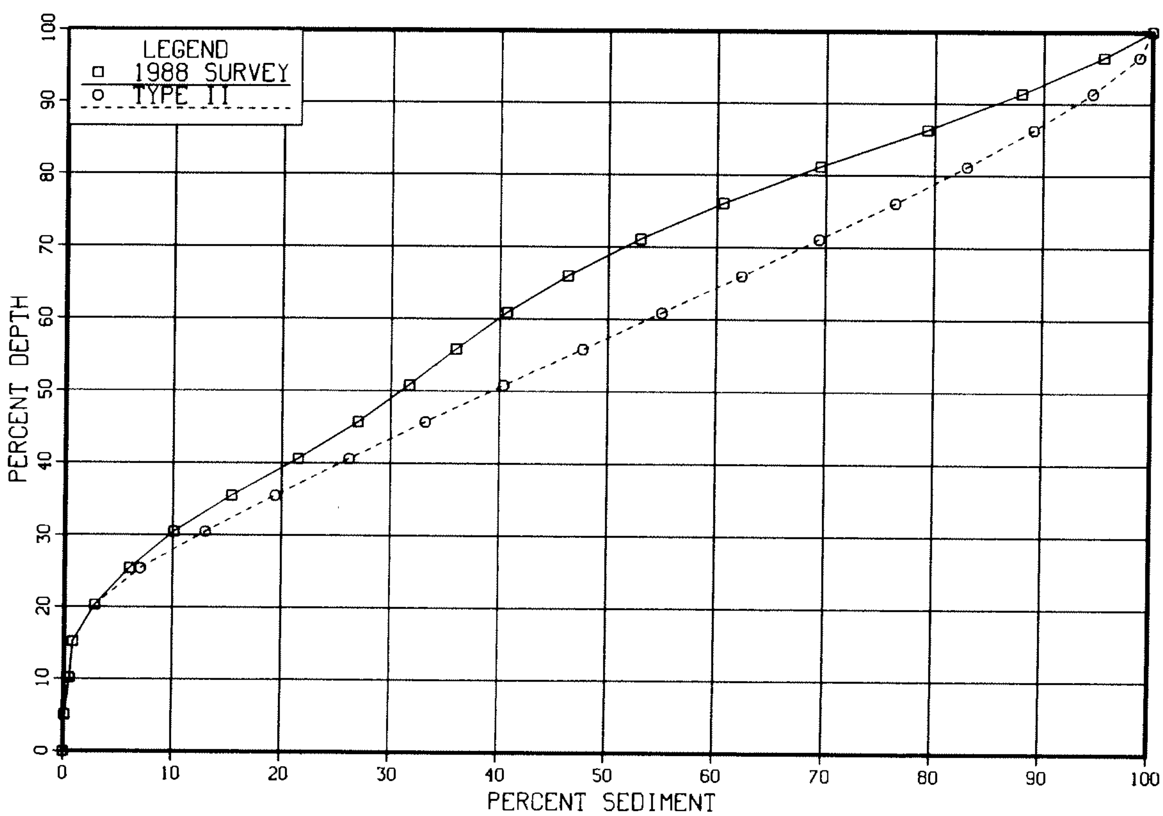


Figure 18. — Sediment distribution curves.

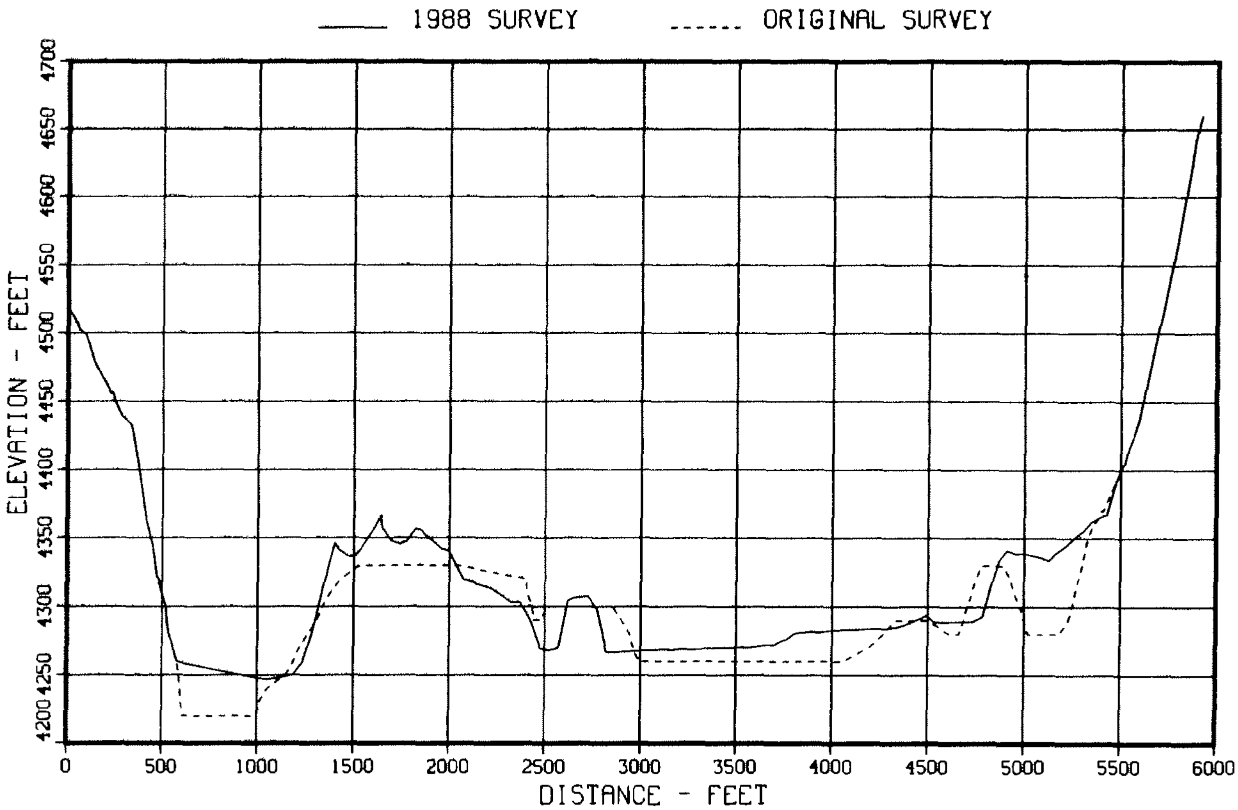


Figure 19. — Sedimentation range profiles for 1915 and 1988, range 90.

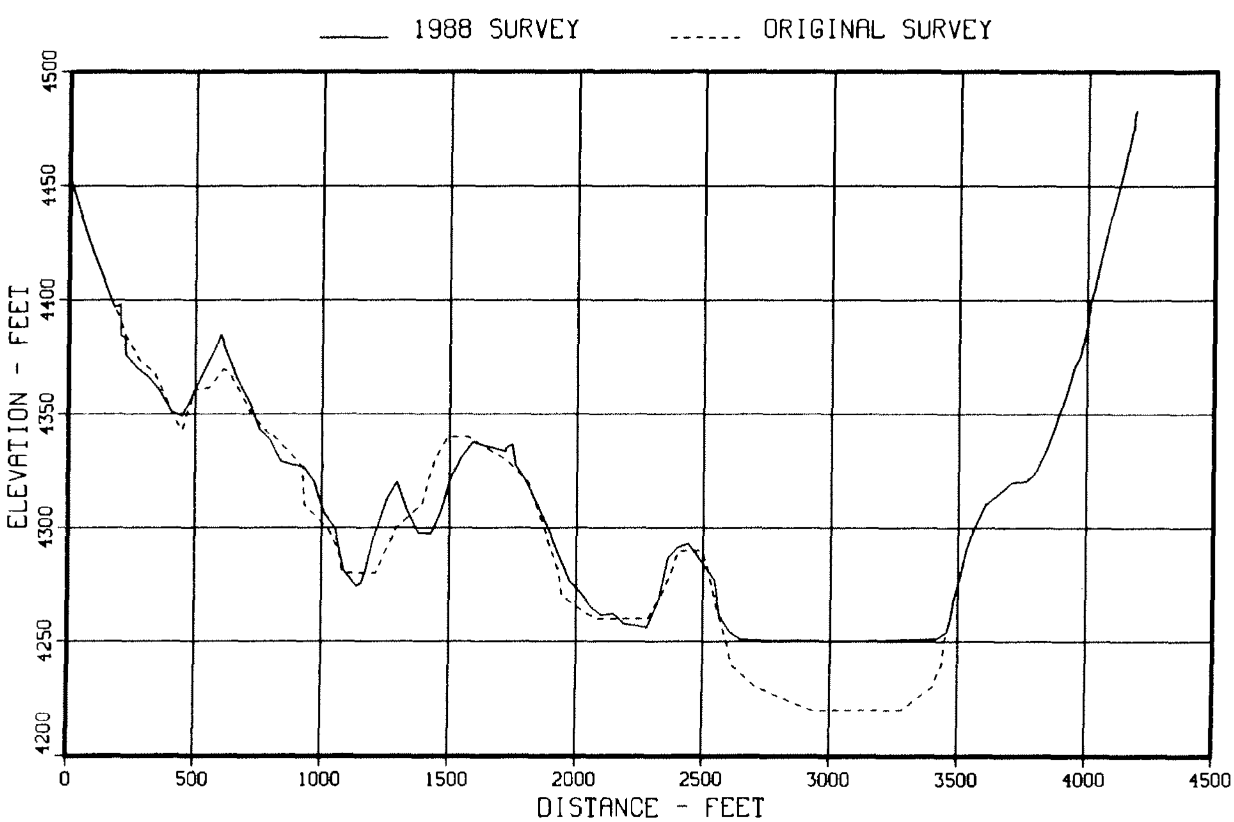


Figure 20. — Sedimentation range profiles for 1915 and 1988, range 89.

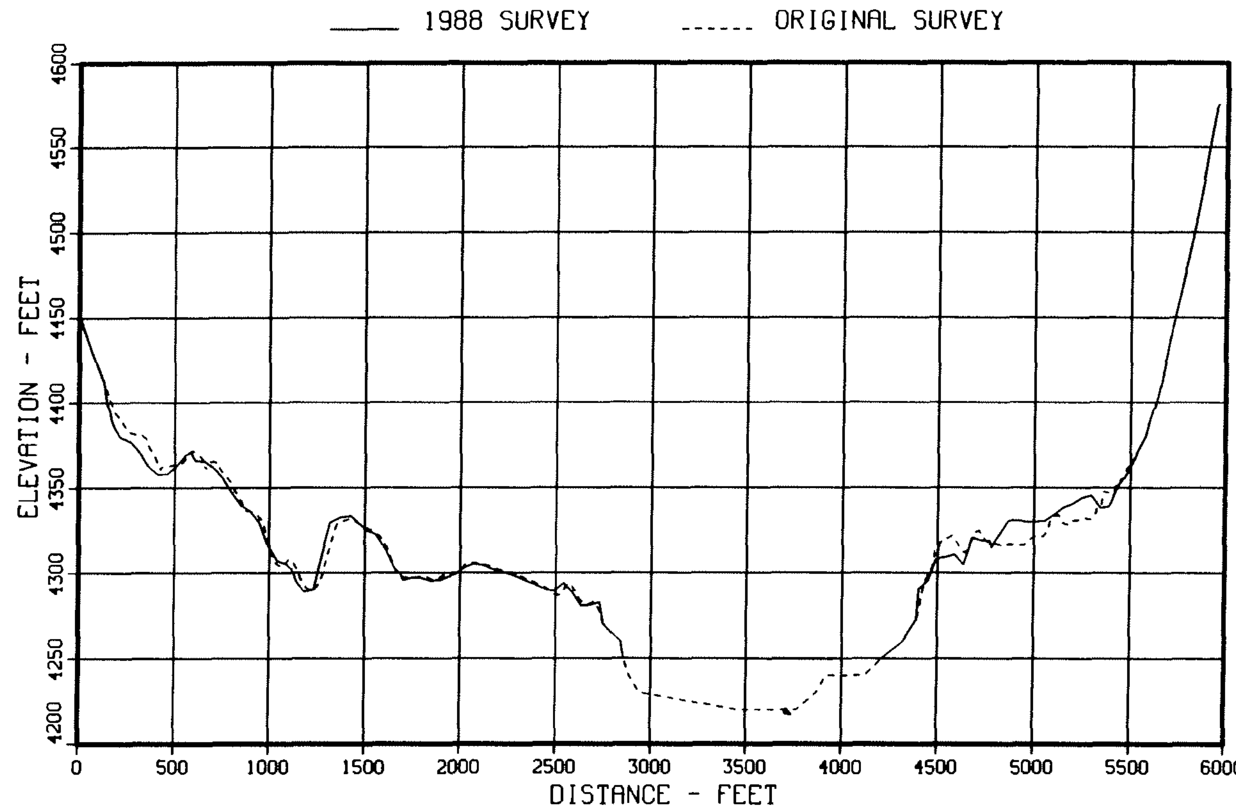


Figure 21. — Sedimentation range profiles for 1915 and 1988, range 88.

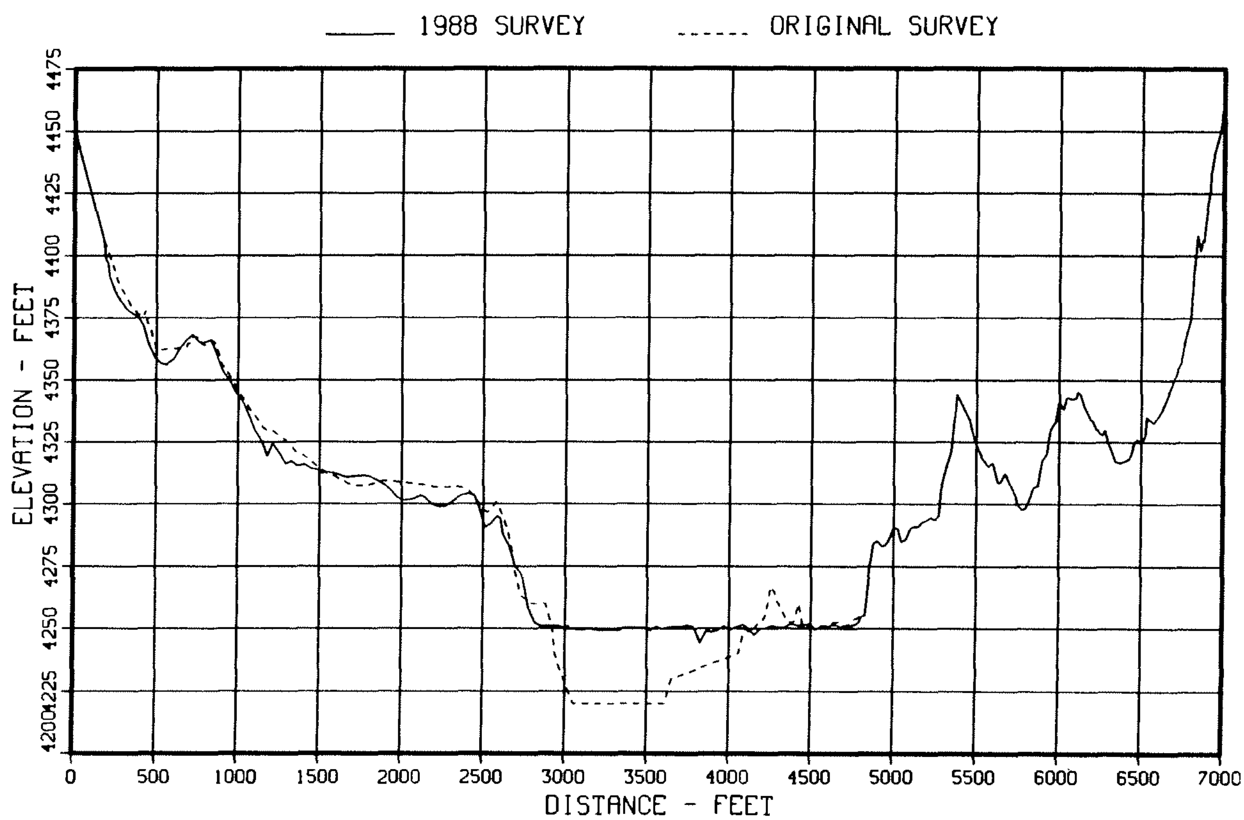


Figure 22. — Sedimentation range profiles for 1915 and 1988, range 87.

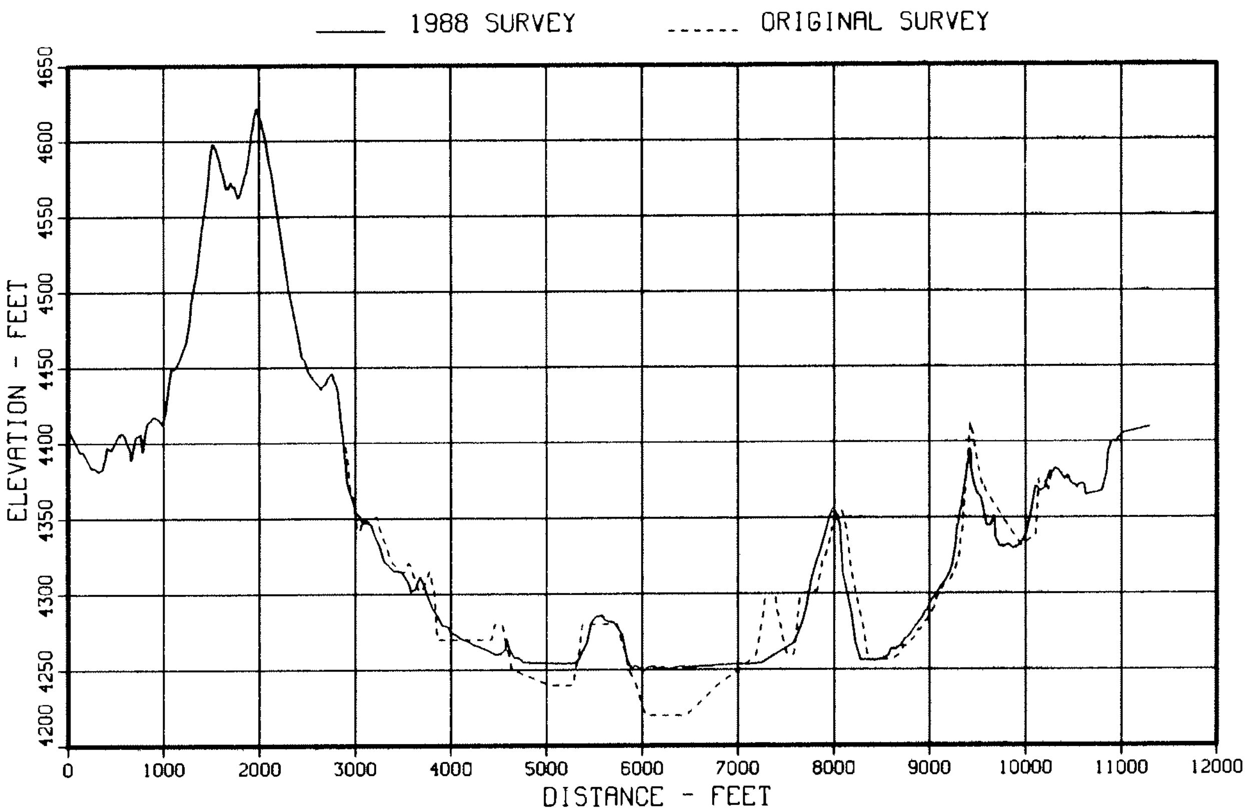


Figure 23. — Sedimentation range profiles for 1915 and 1988, range 86.

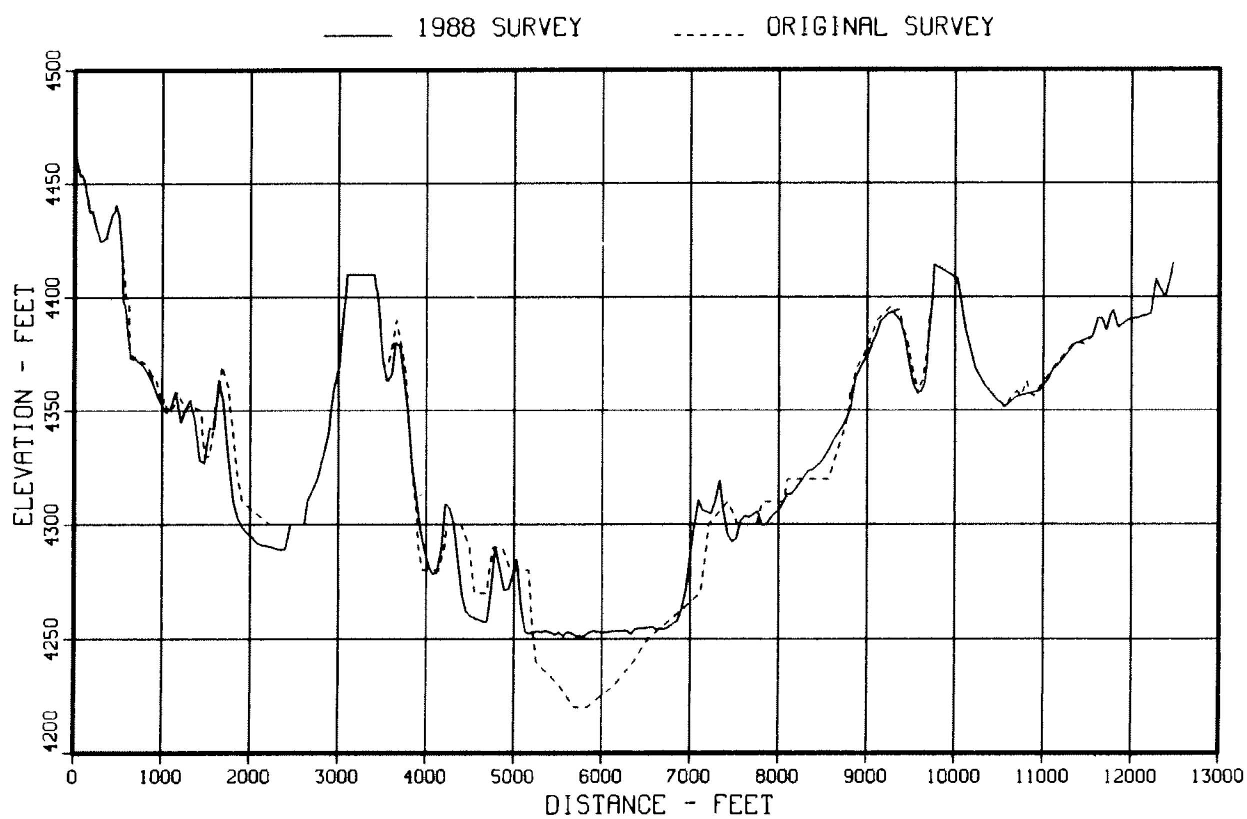


Figure 24. — Sedimentation range profiles for 1915 and 1988, range 85.

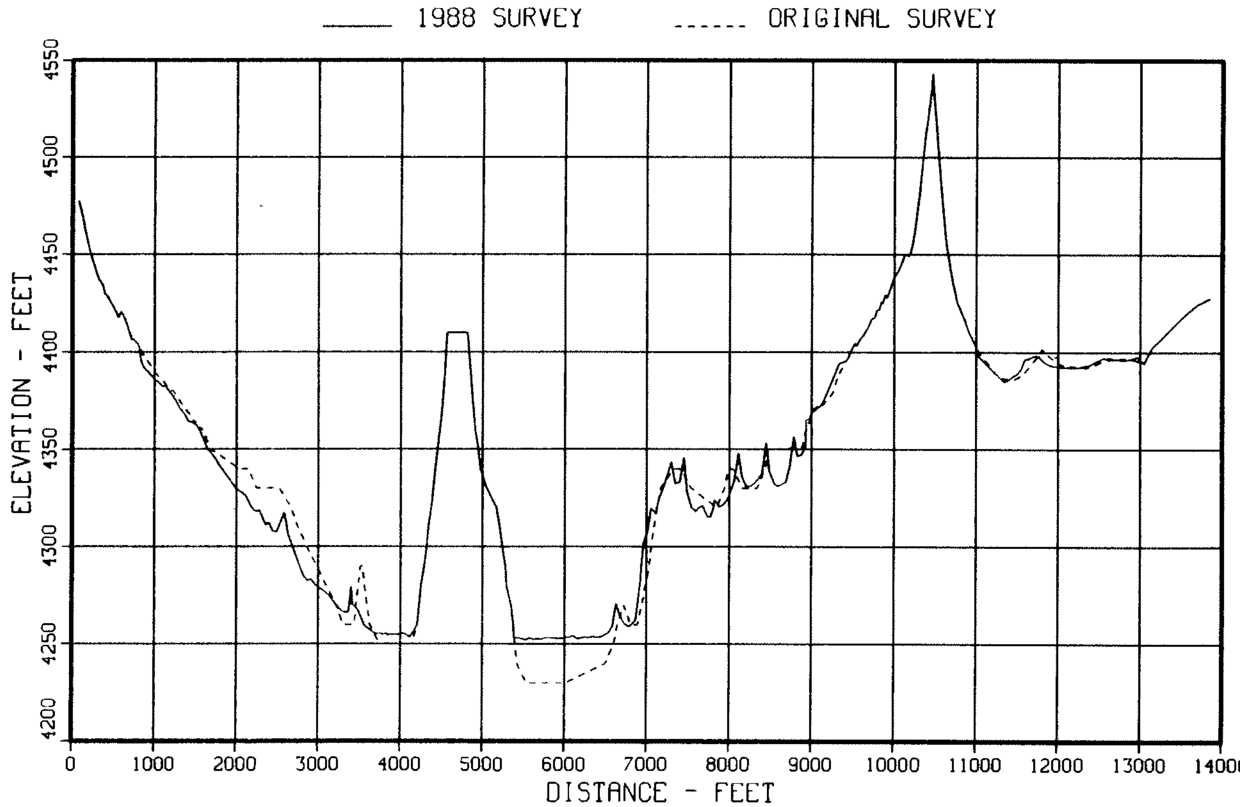


Figure 25. — Sedimentation range profiles for 1915 and 1988, range 84.

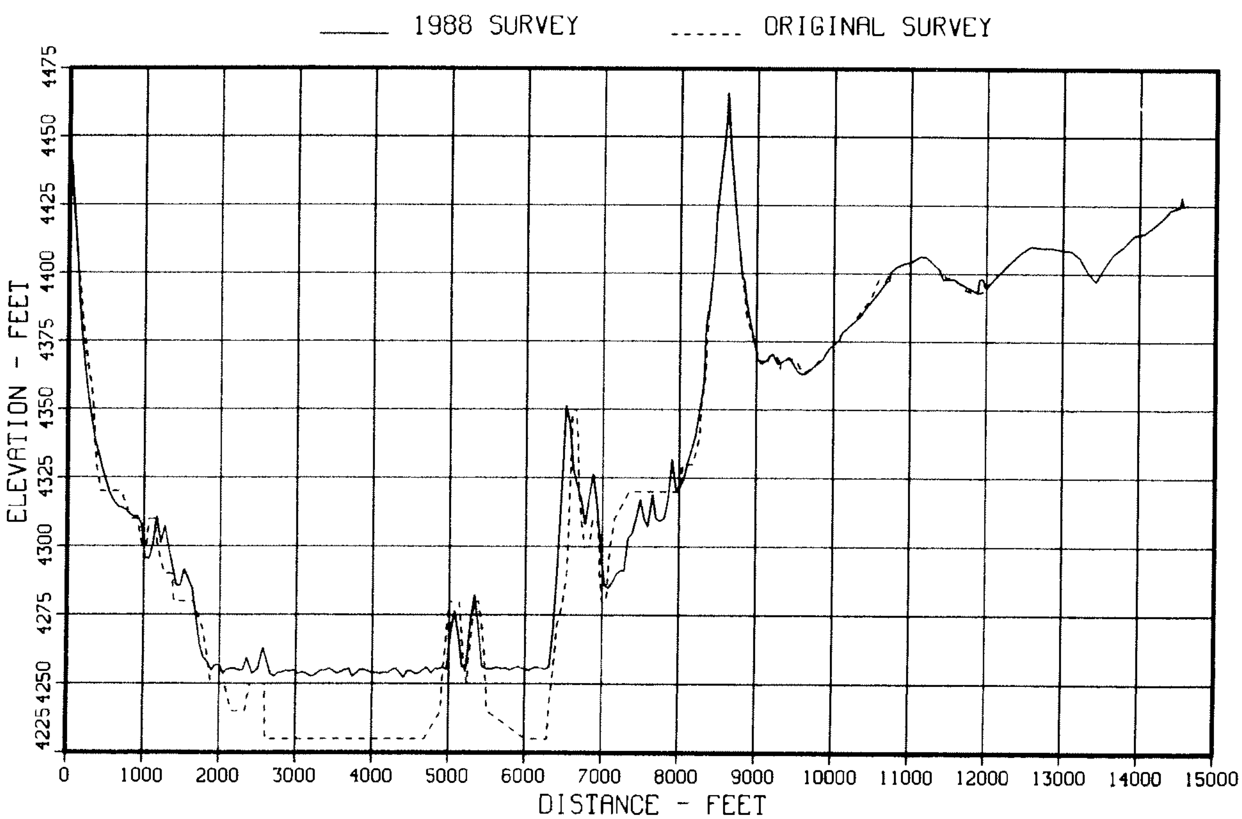


Figure 26. — Sedimentation range profiles for 1915 and 1988, range 83.

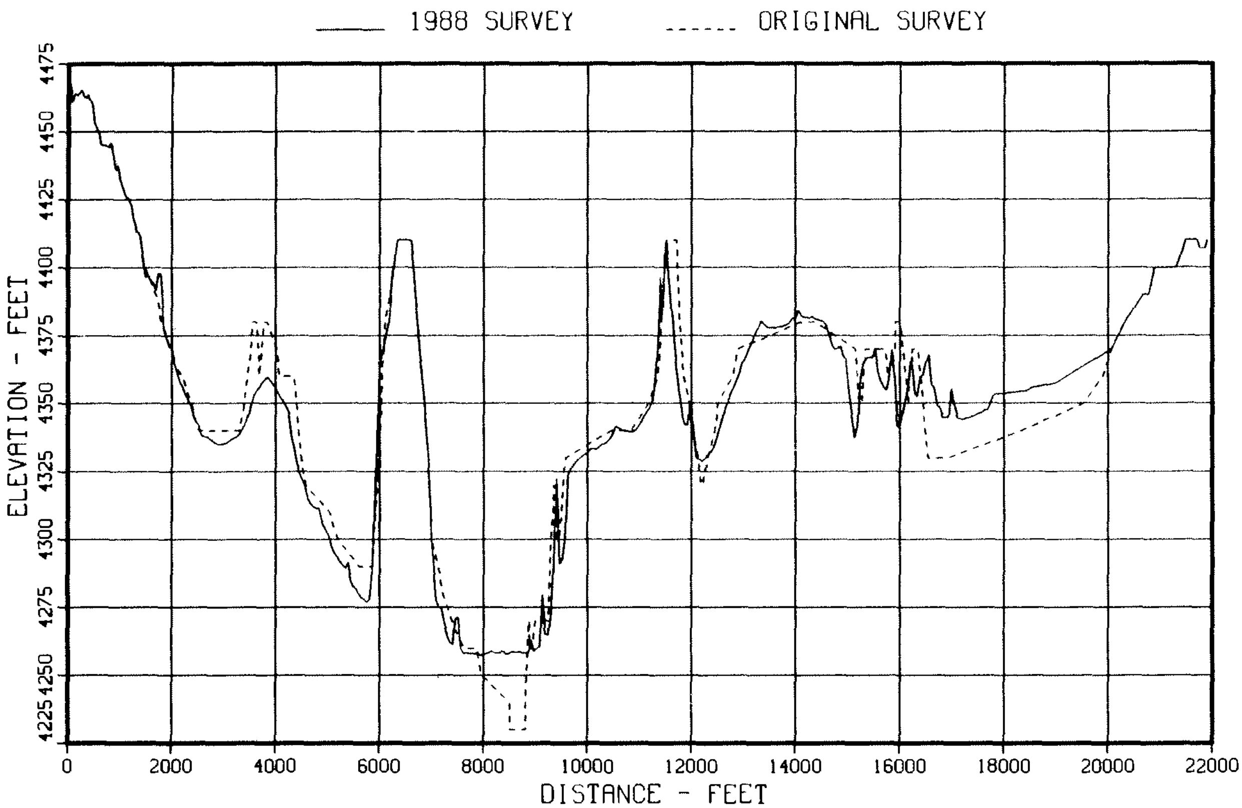


Figure 27. — Sedimentation range profiles for 1915 and 1988, range 82.

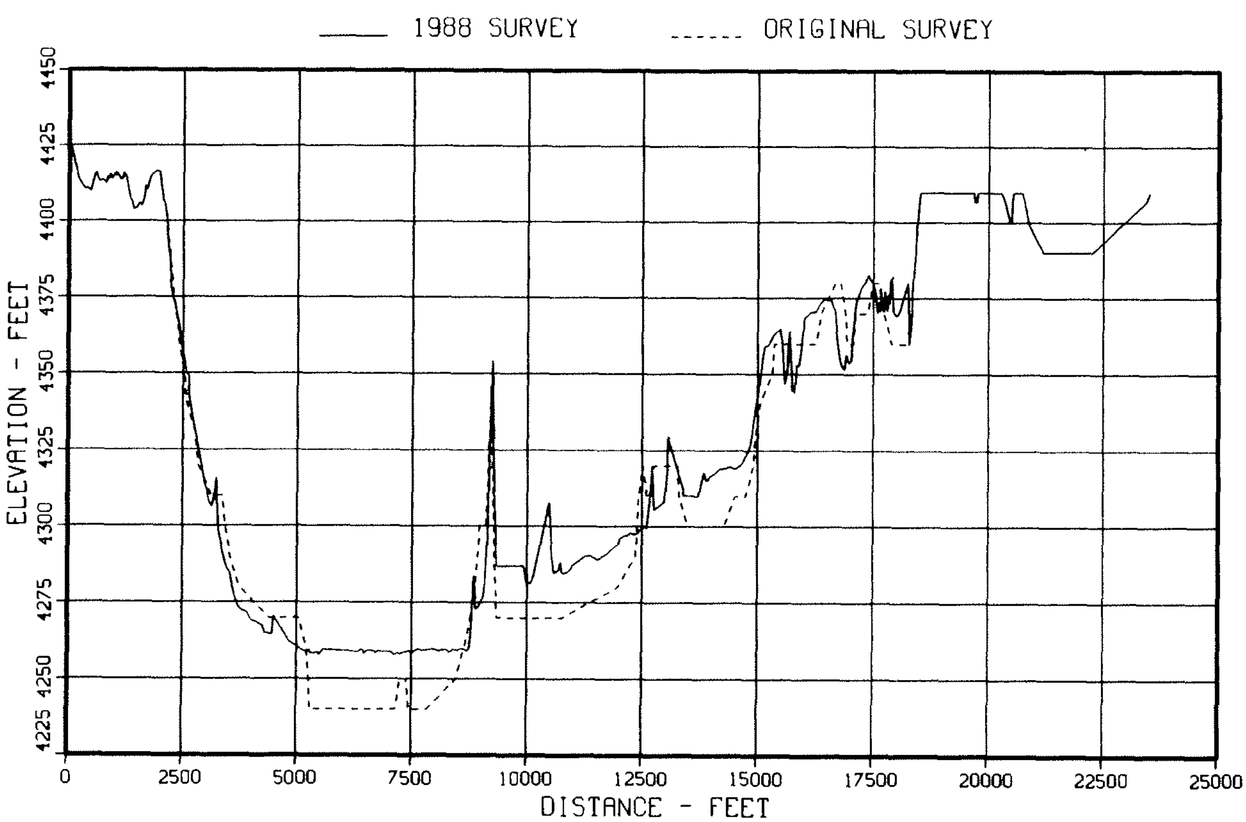


Figure 28. — Sedimentation range profiles for 1915 and 1988, range 81.

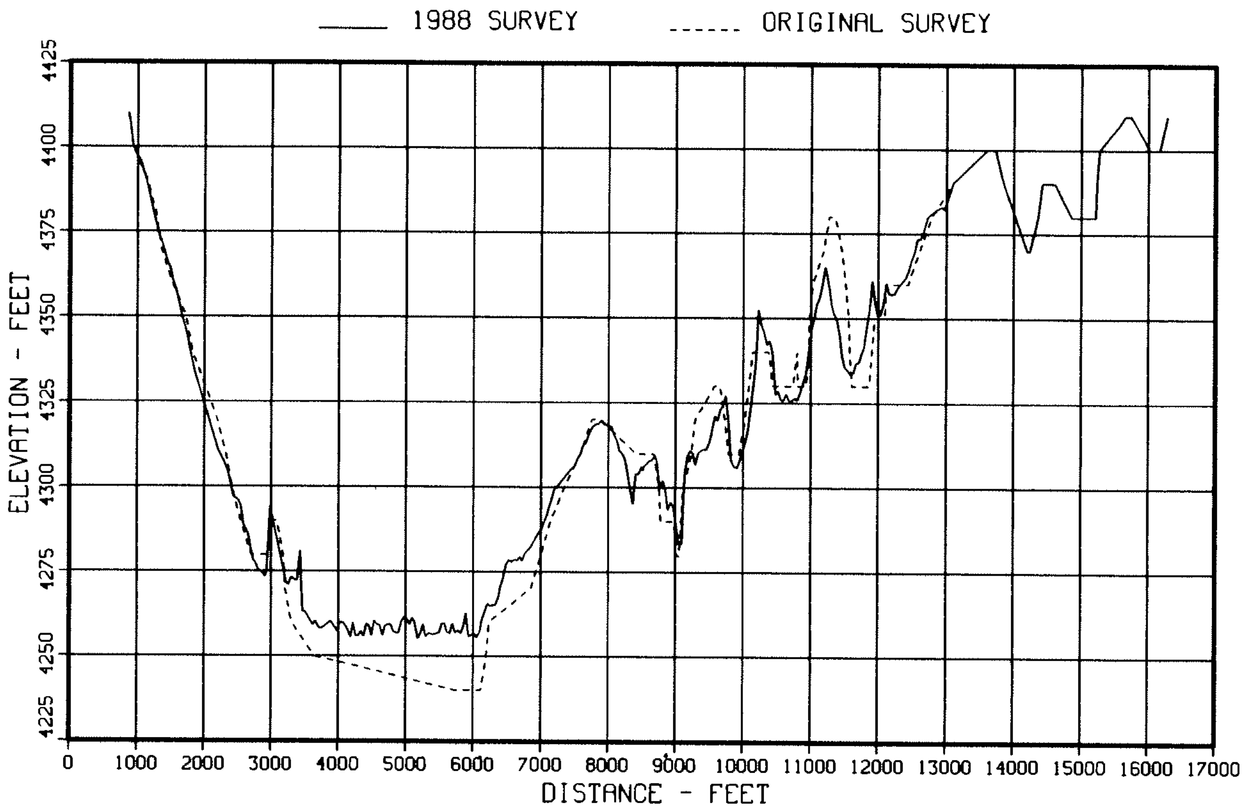


Figure 29. — Sedimentation range profiles for 1915 and 1988, range 80.

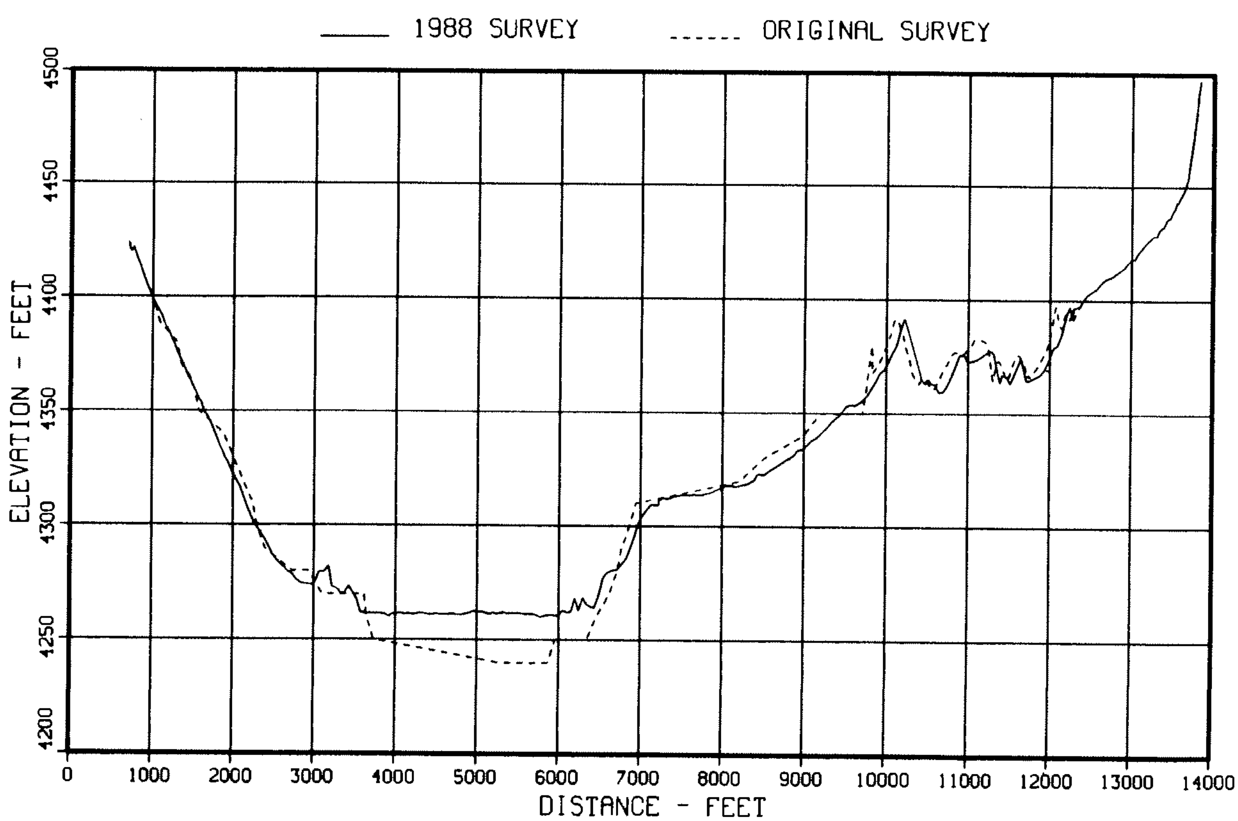


Figure 30. — Sedimentation range profiles for 1915 and 1988, range 79.

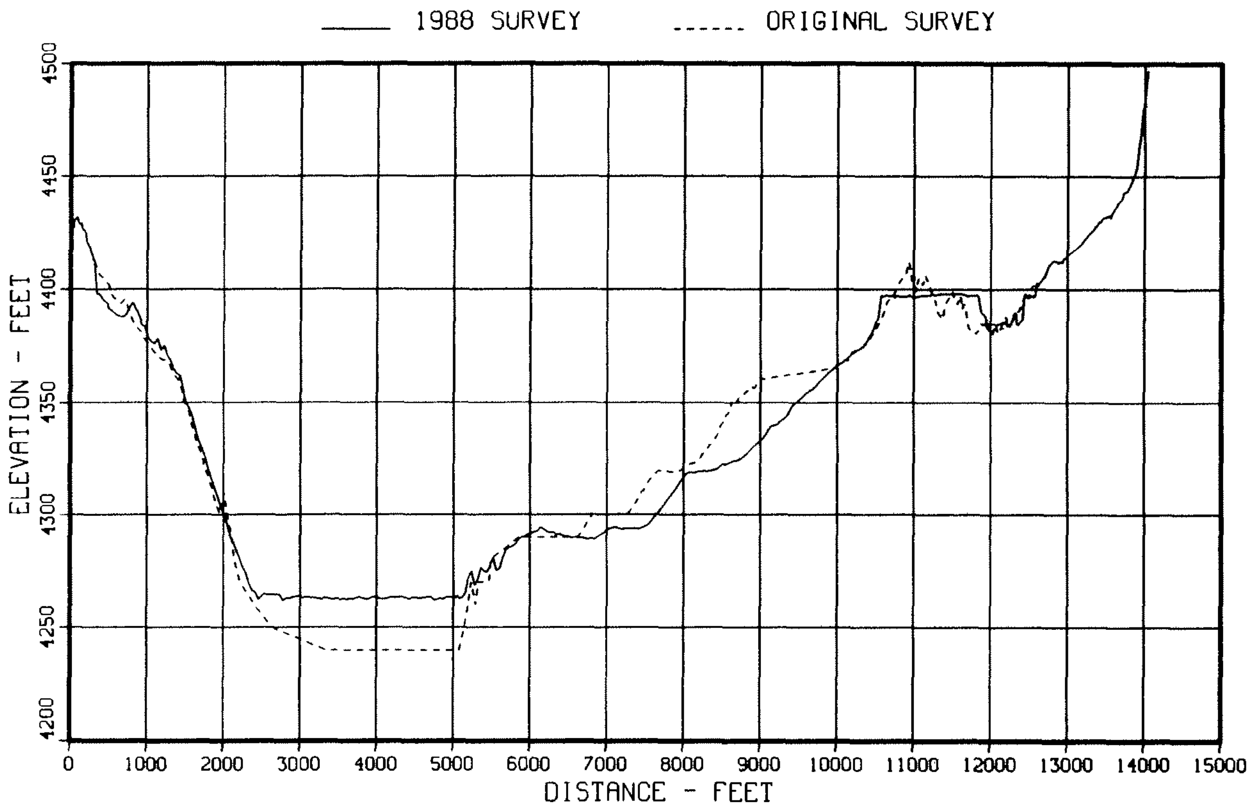


Figure 31. — Sedimentation range profiles for 1915 and 1988, range 78.

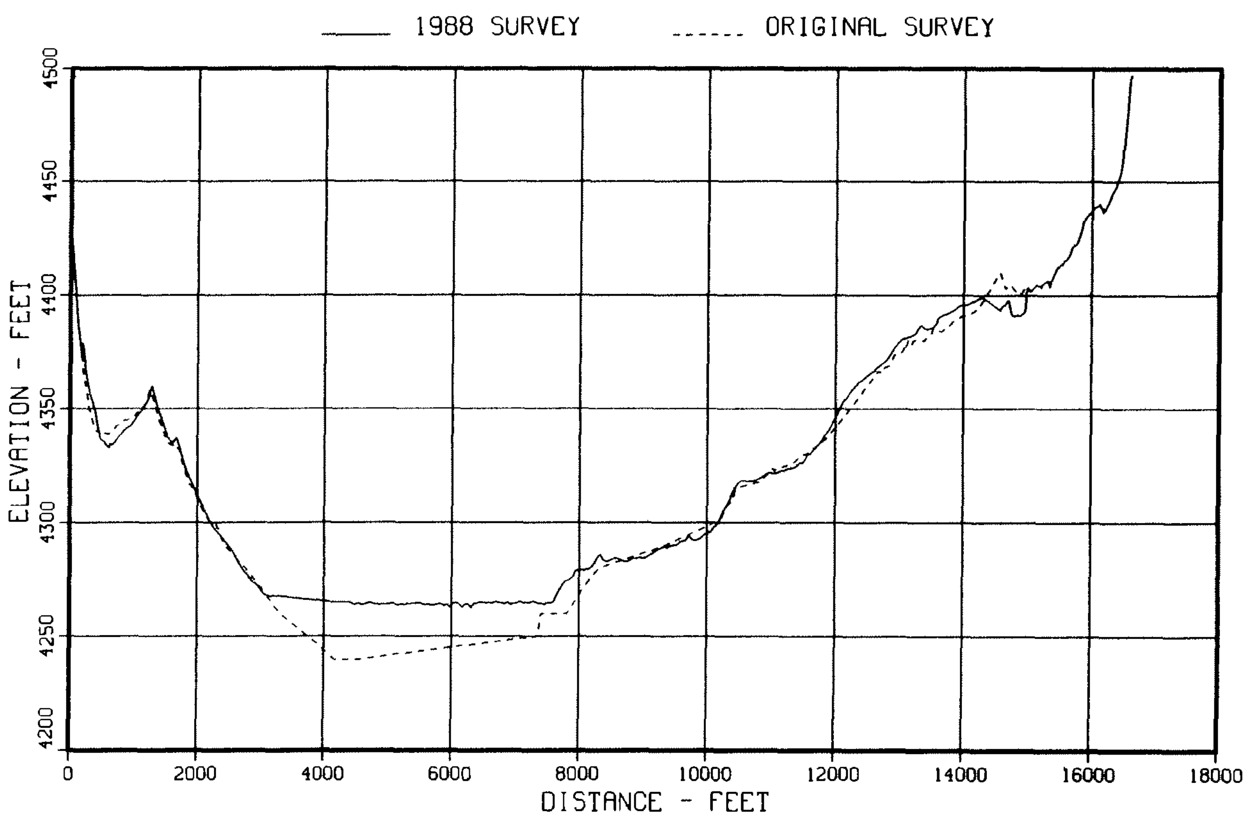


Figure 32. — Sedimentation range profiles for 1915 and 1988, range 77.

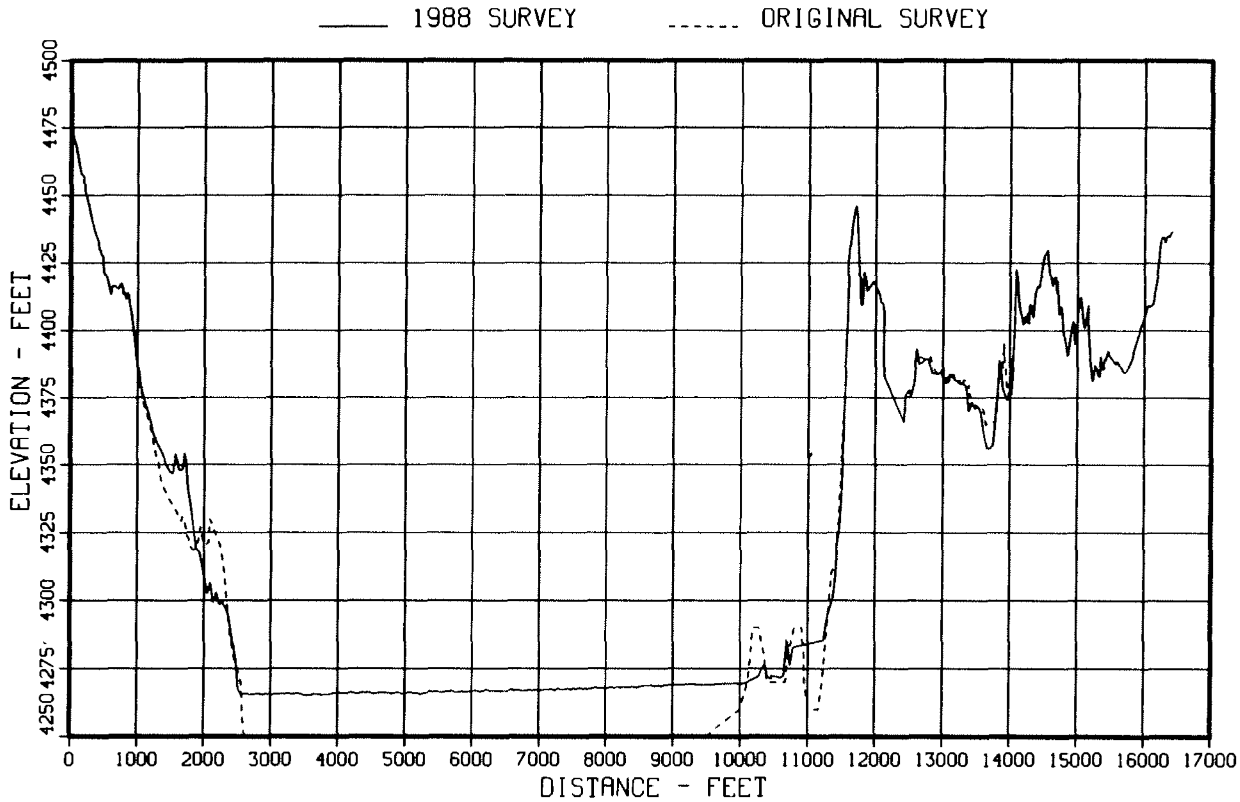


Figure 33. — Sedimentation range profiles for 1915 and 1988, range 76.

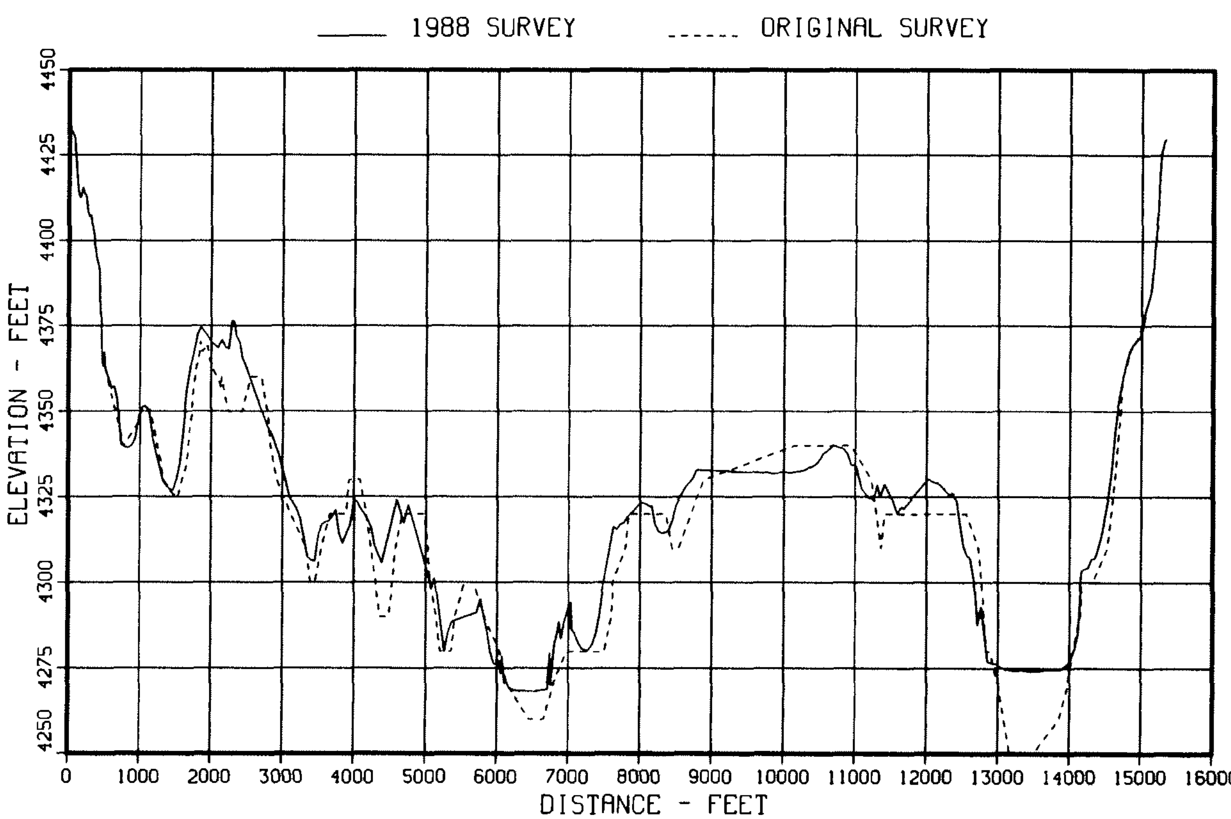


Figure 34. — Sedimentation range profiles for 1915 and 1988, range 75.

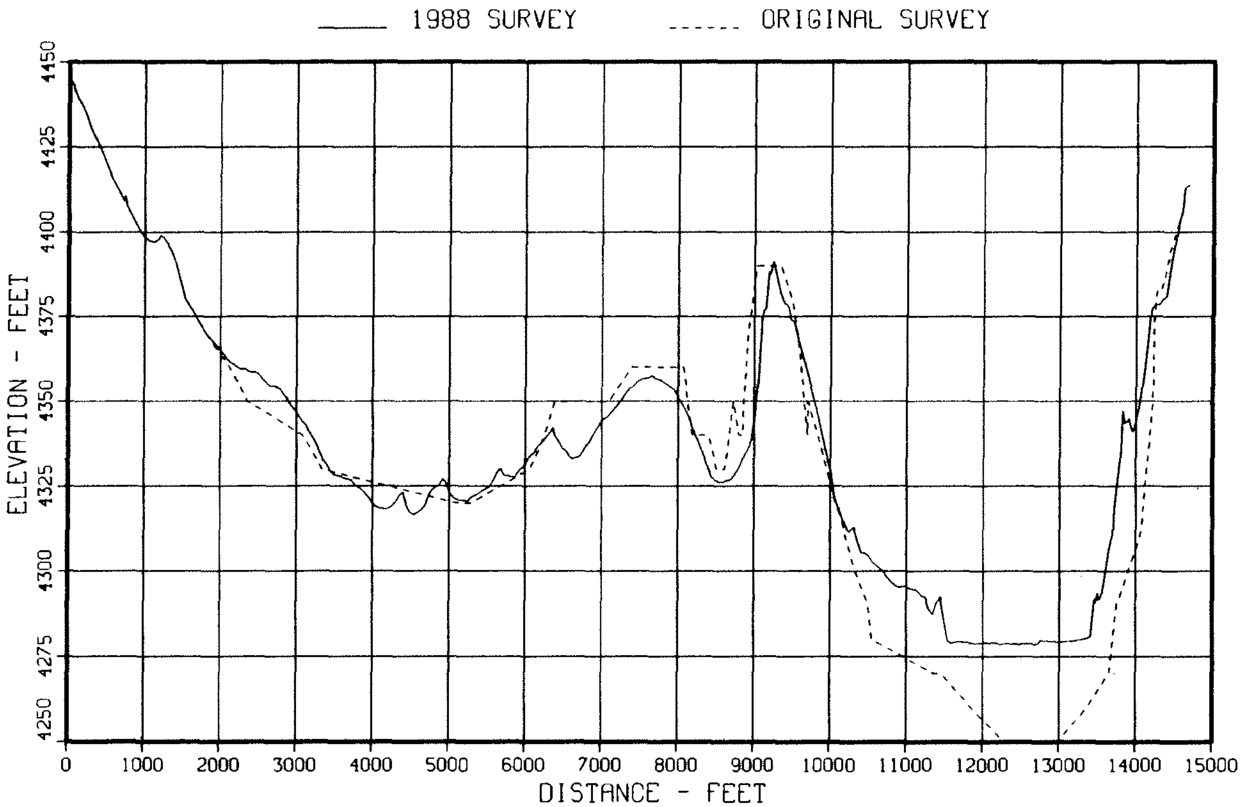


Figure 35. — Sedimentation range profiles for 1915 and 1988, range 74.

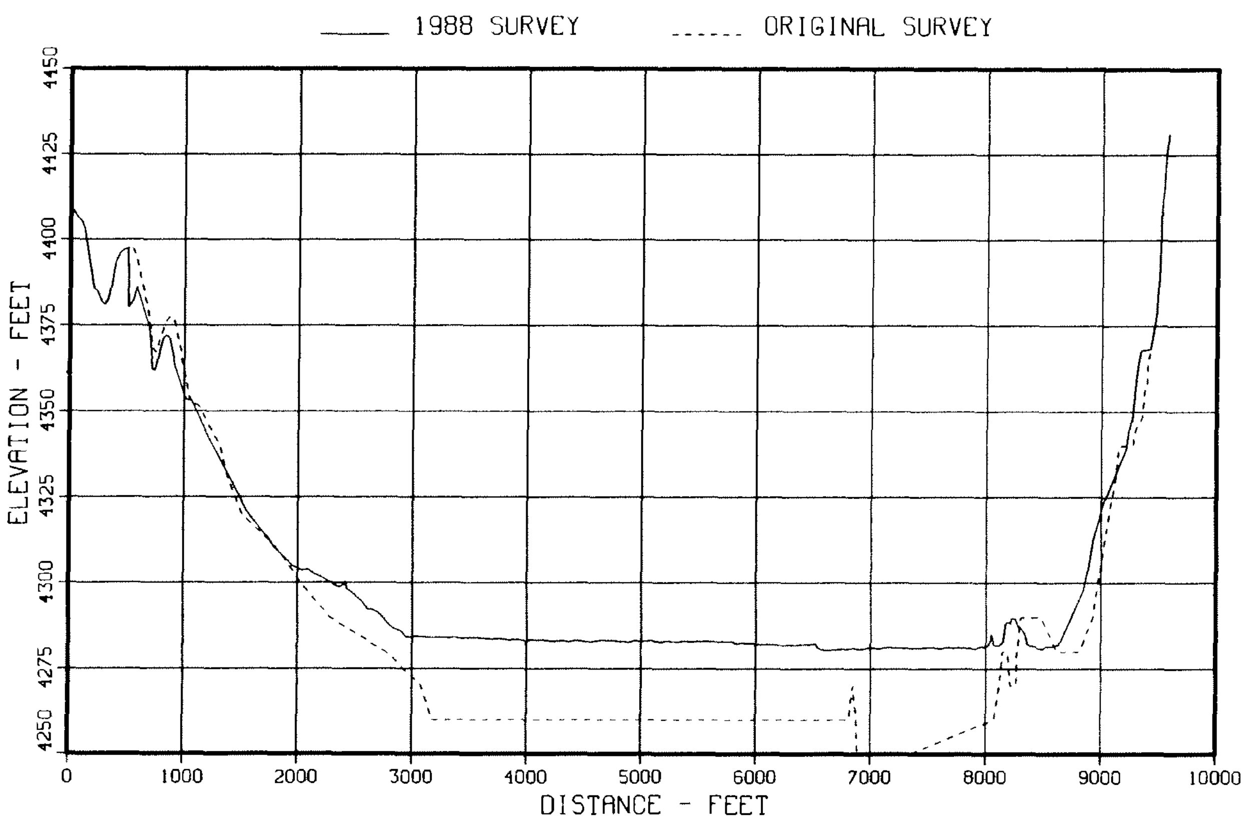


Figure 36. — Sedimentation range profiles for 1915 and 1988, range 73.

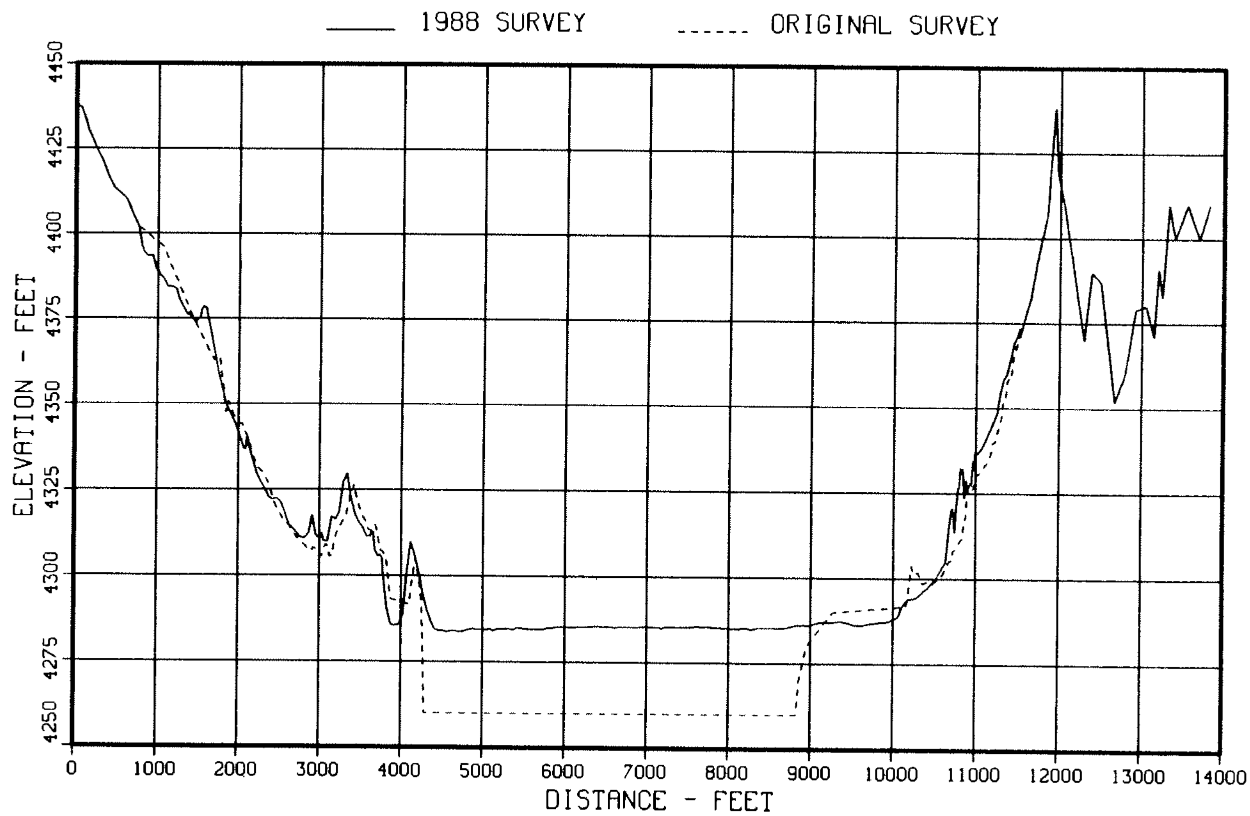


Figure 37. — Sedimentation range profiles for 1915 and 1988, range 72.

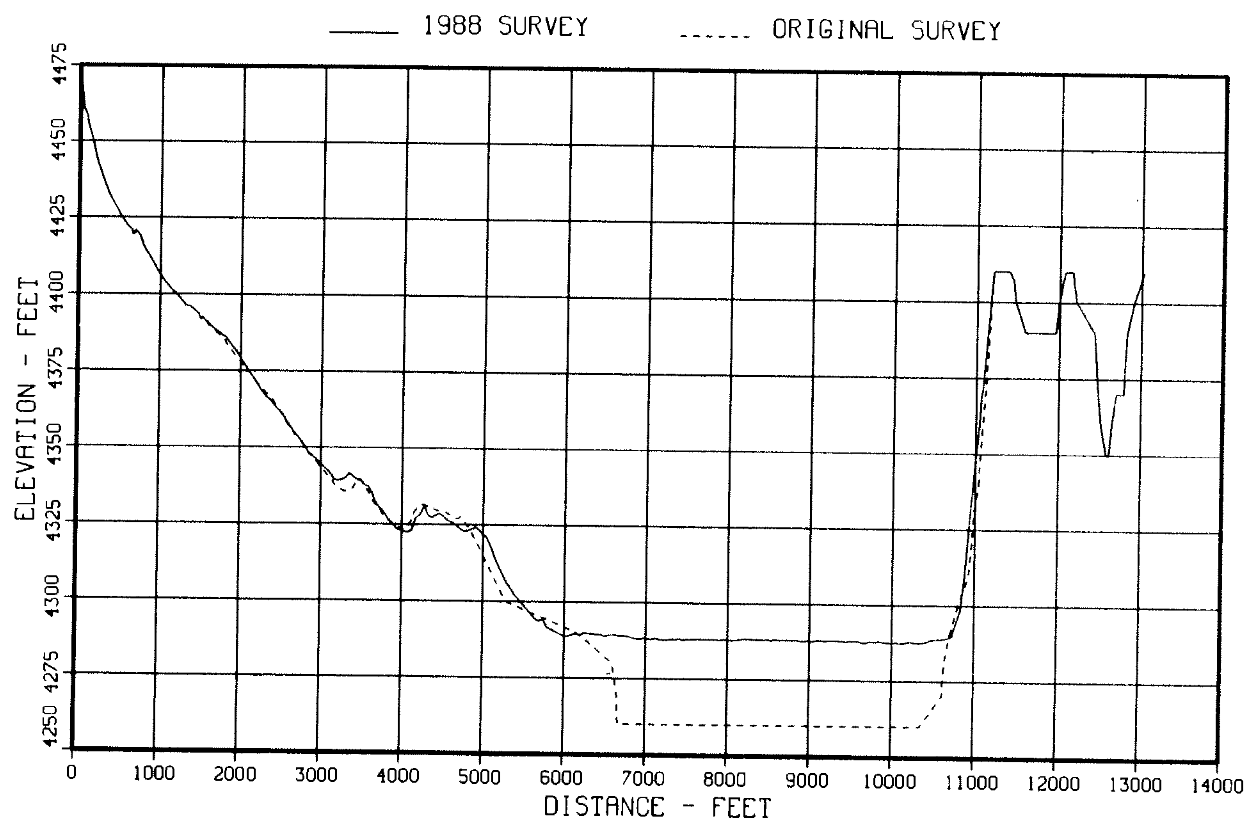


Figure 38. — Sedimentation range profiles for 1915 and 1988, range 71.

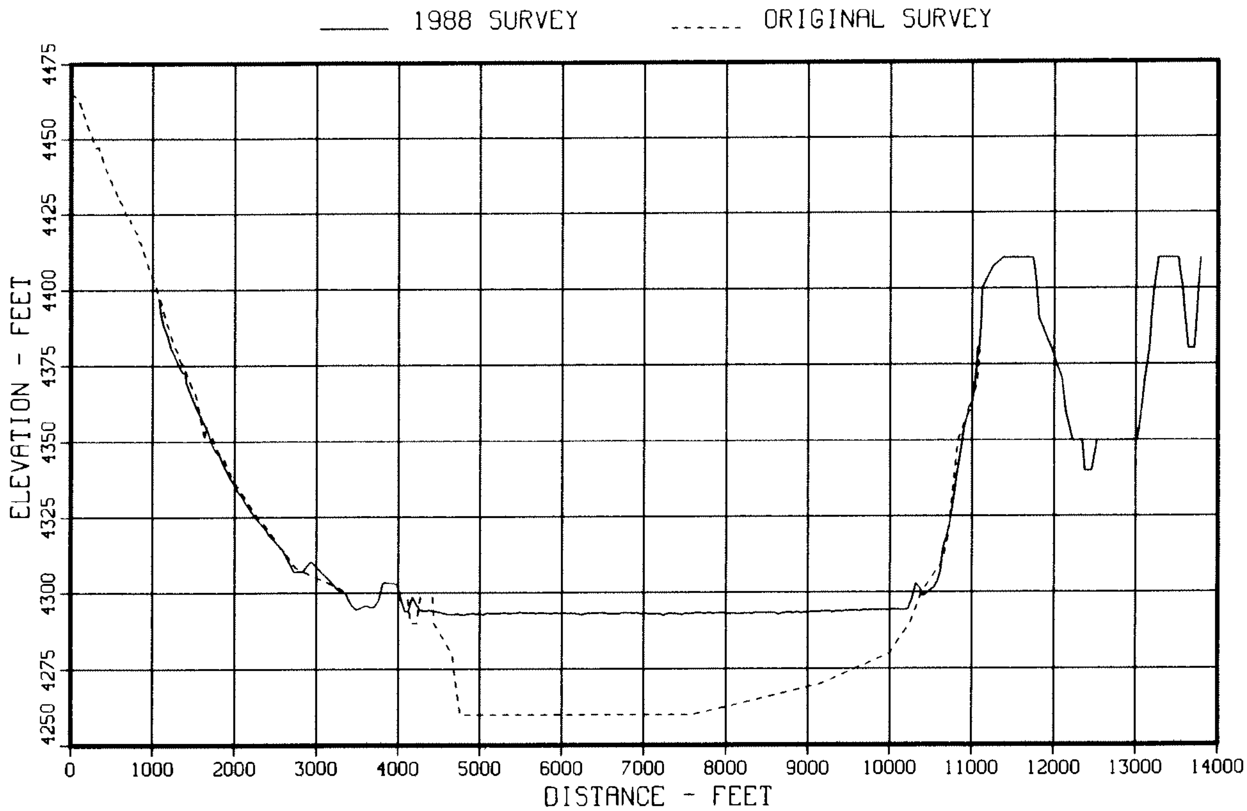


Figure 39. — Sedimentation range profiles for 1915 and 1988, range 70.

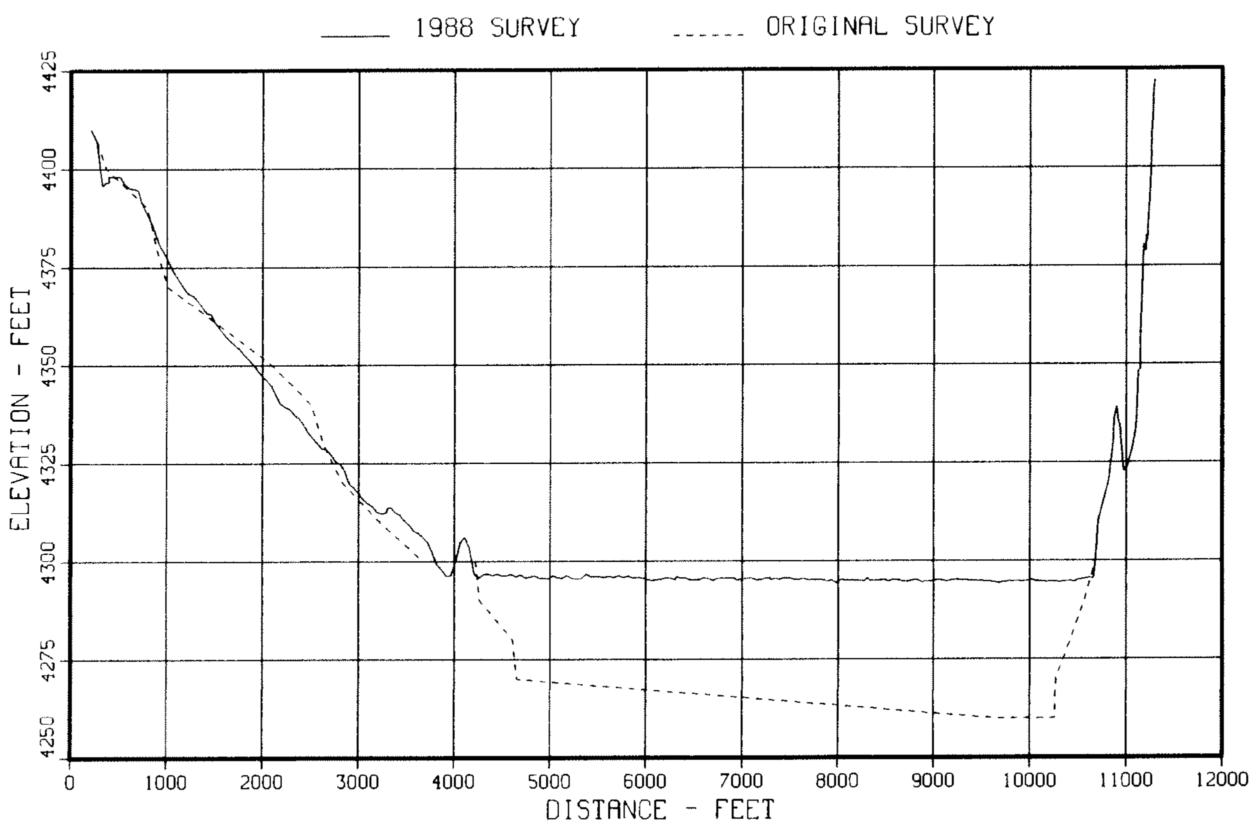


Figure 40. — Sedimentation range profiles for 1915 and 1988, range 69.

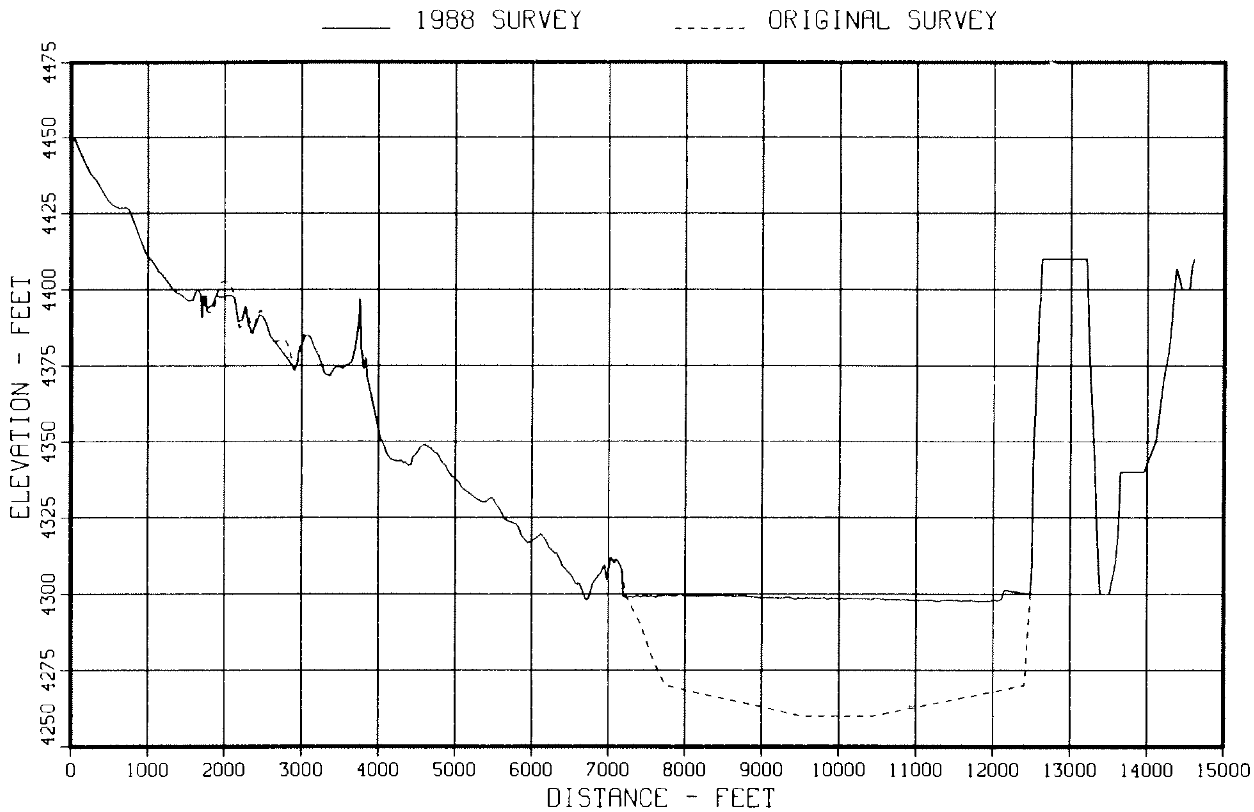


Figure 41. — Sedimentation range profiles for 1915 and 1988, range 68.

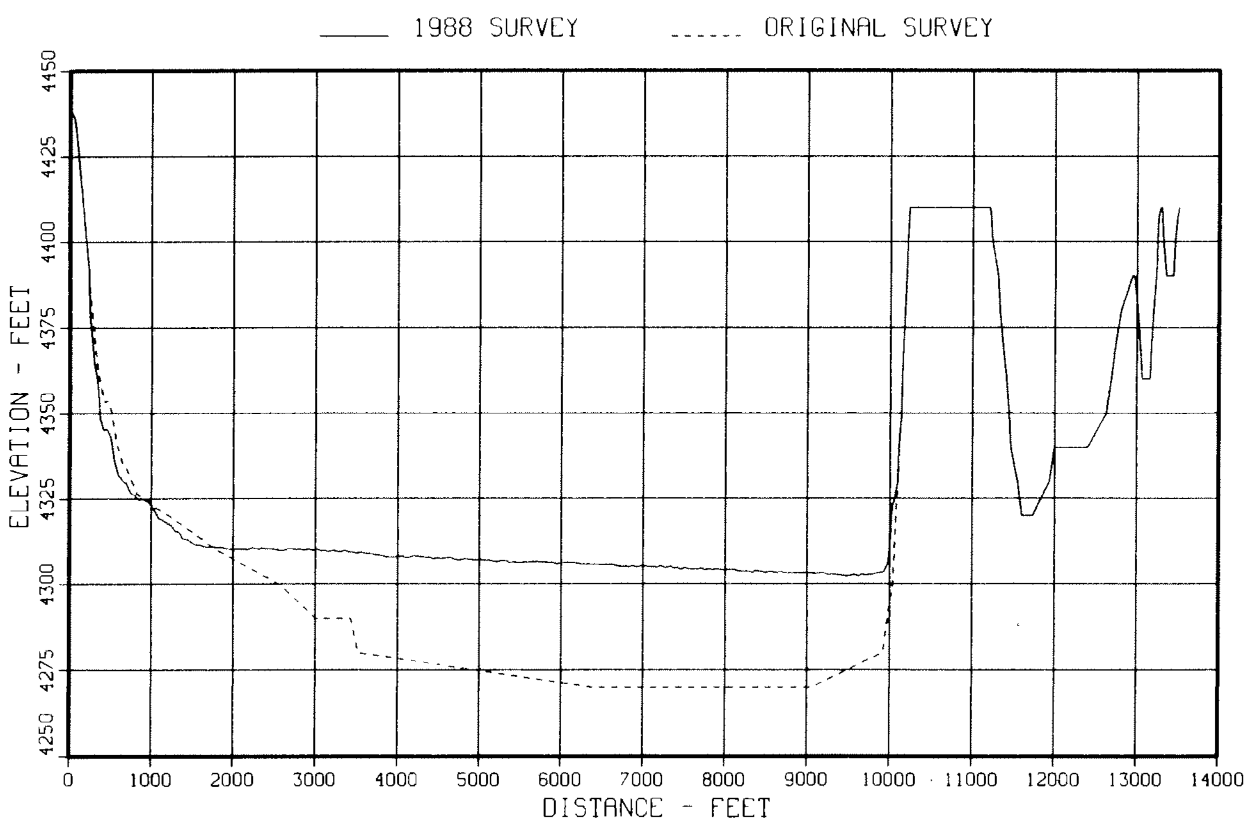


Figure 42. — Sedimentation range profiles for 1915 and 1988, range 67.

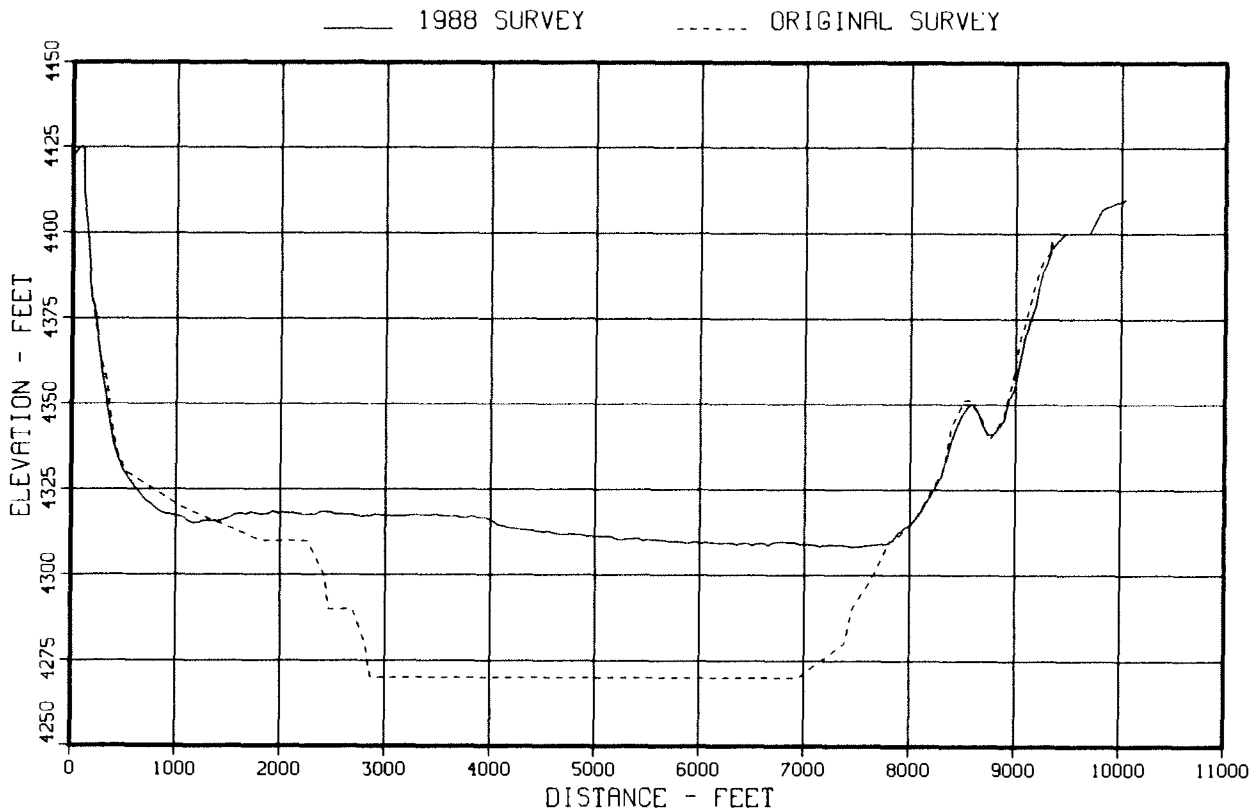


Figure 43. — Sedimentation range profiles for 1915 and 1988, range 66.

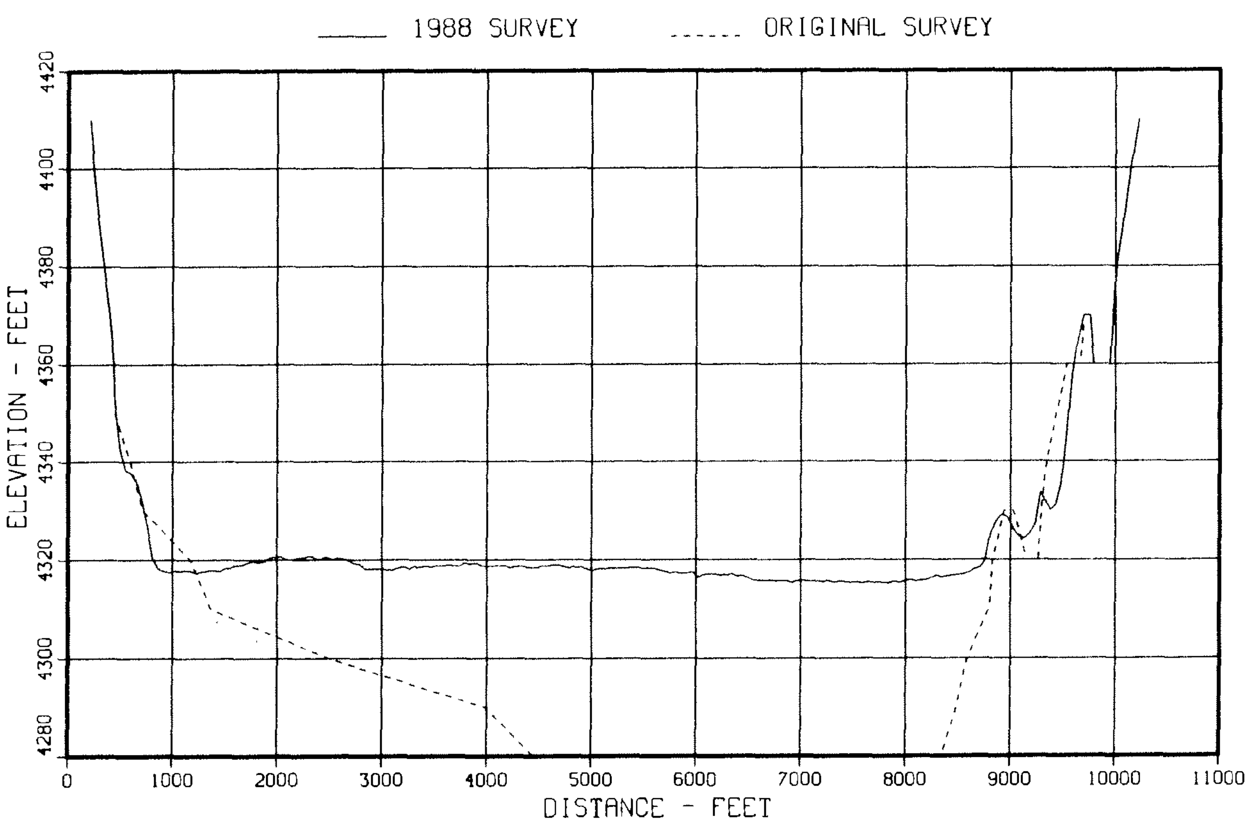


Figure 44. — Sedimentation range profiles for 1915 and 1988, range 65.

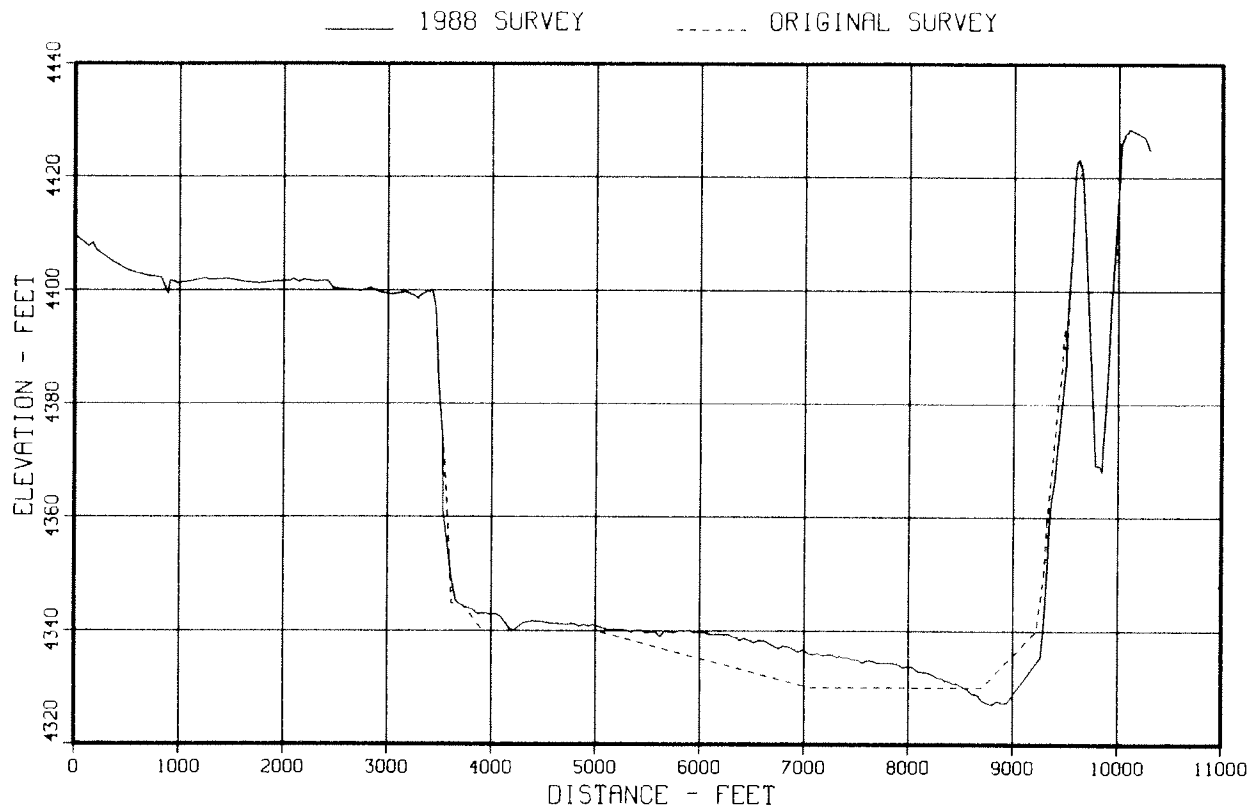


Figure 45. — Sedimentation range profiles for 1915 and 1988, range 64.

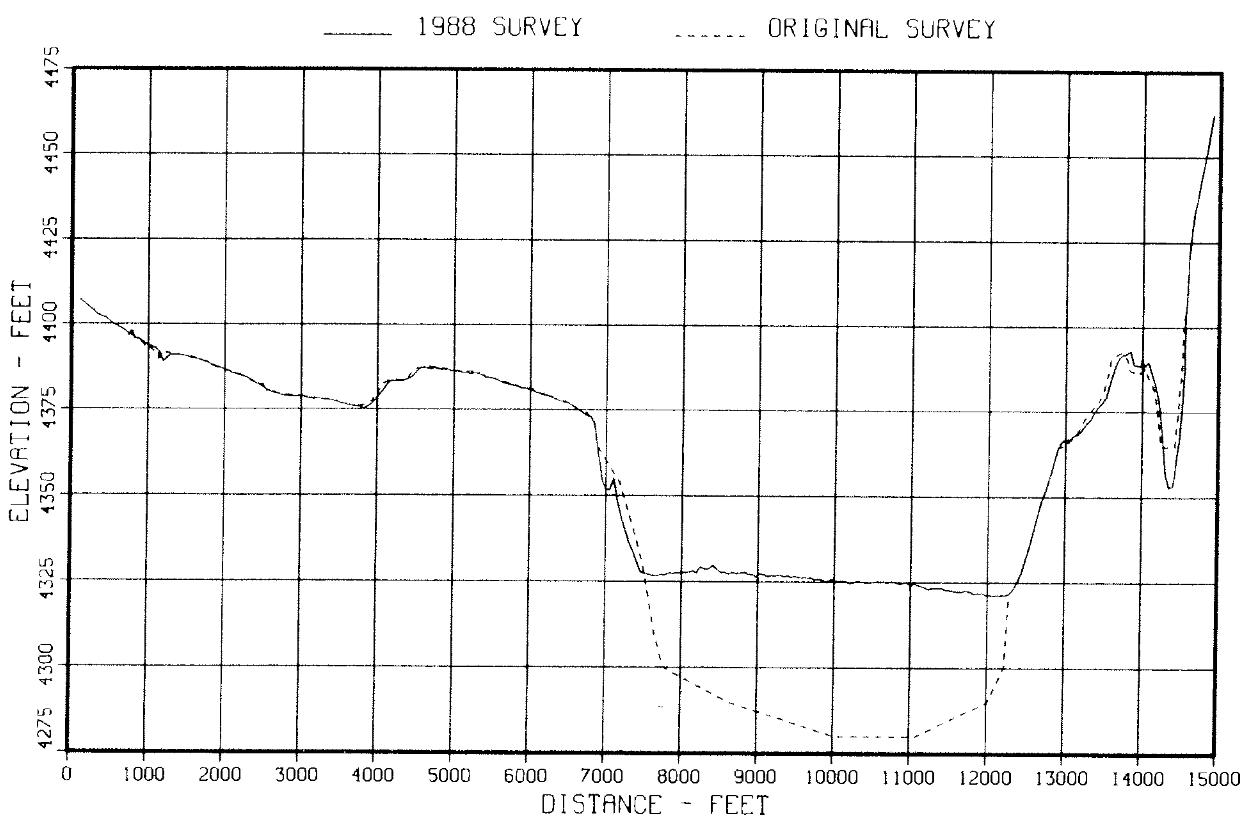


Figure 46. — Sedimentation range profiles for 1915 and 1988, range 63.

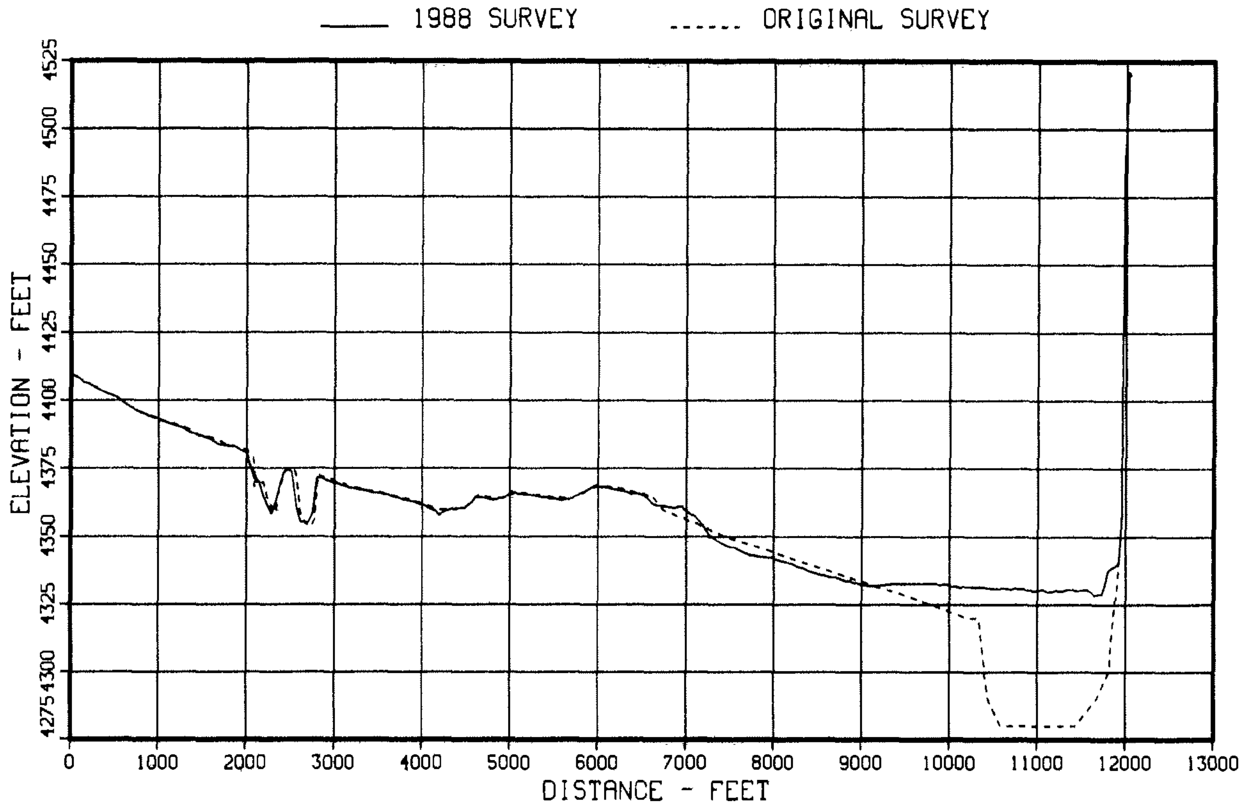


Figure 47. — Sedimentation range profiles for 1915 and 1988, range 62.

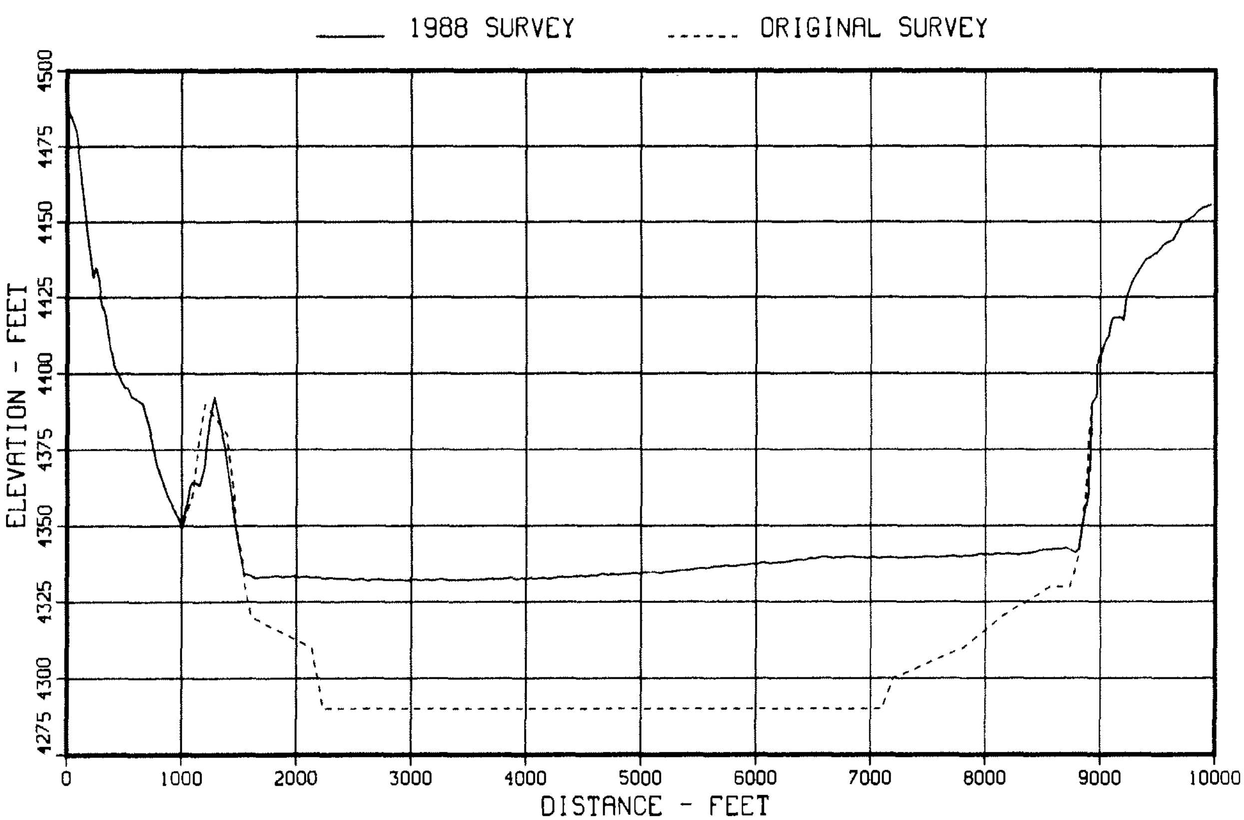


Figure 48. — Sedimentation range profiles for 1915 and 1988, range 61.

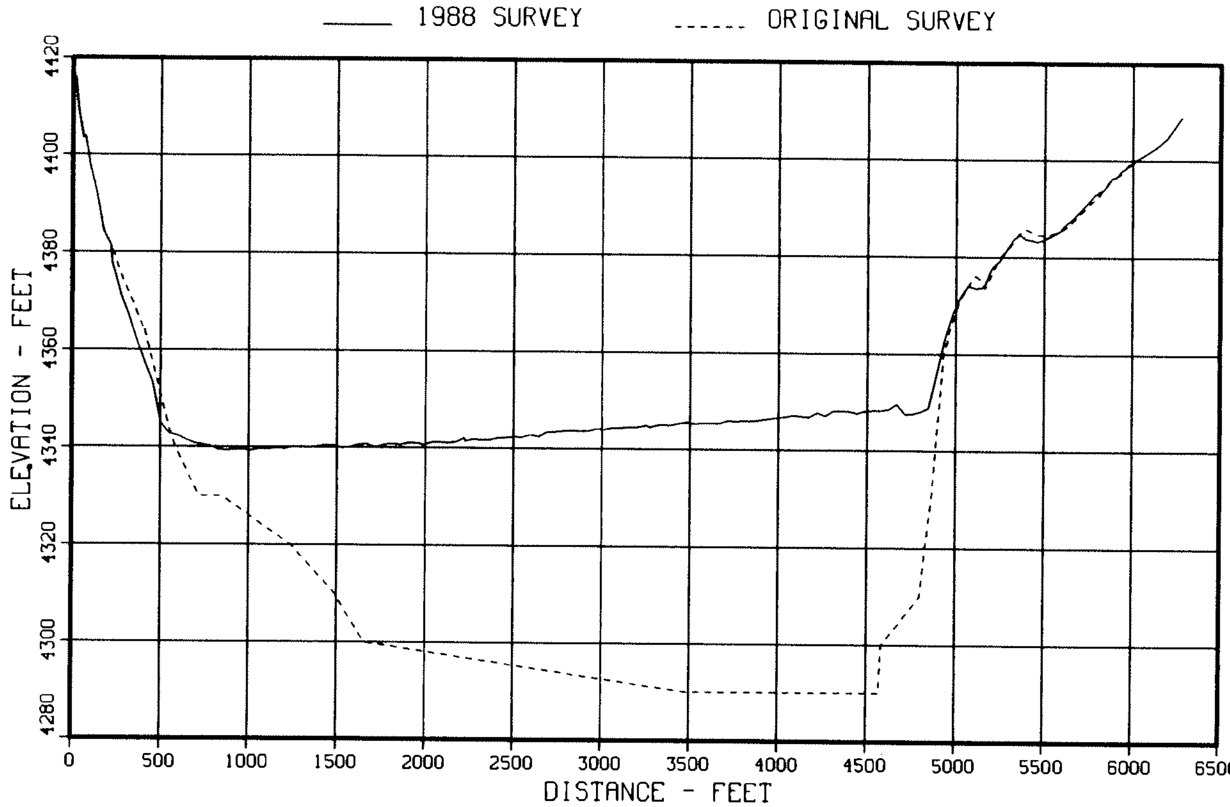


Figure 49. — Sedimentation range profiles for 1915 and 1988, range 60.

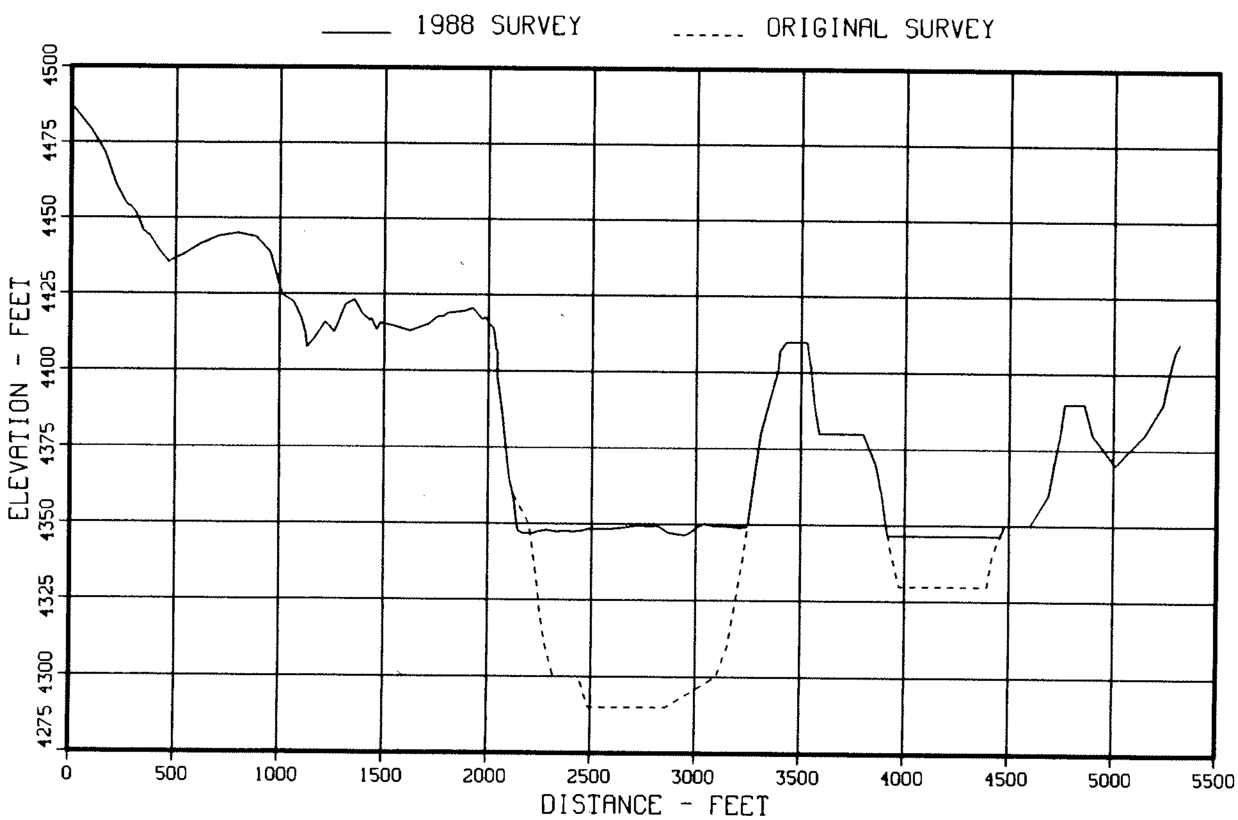


Figure 50. — Sedimentation range profiles for 1915 and 1988, range 59.

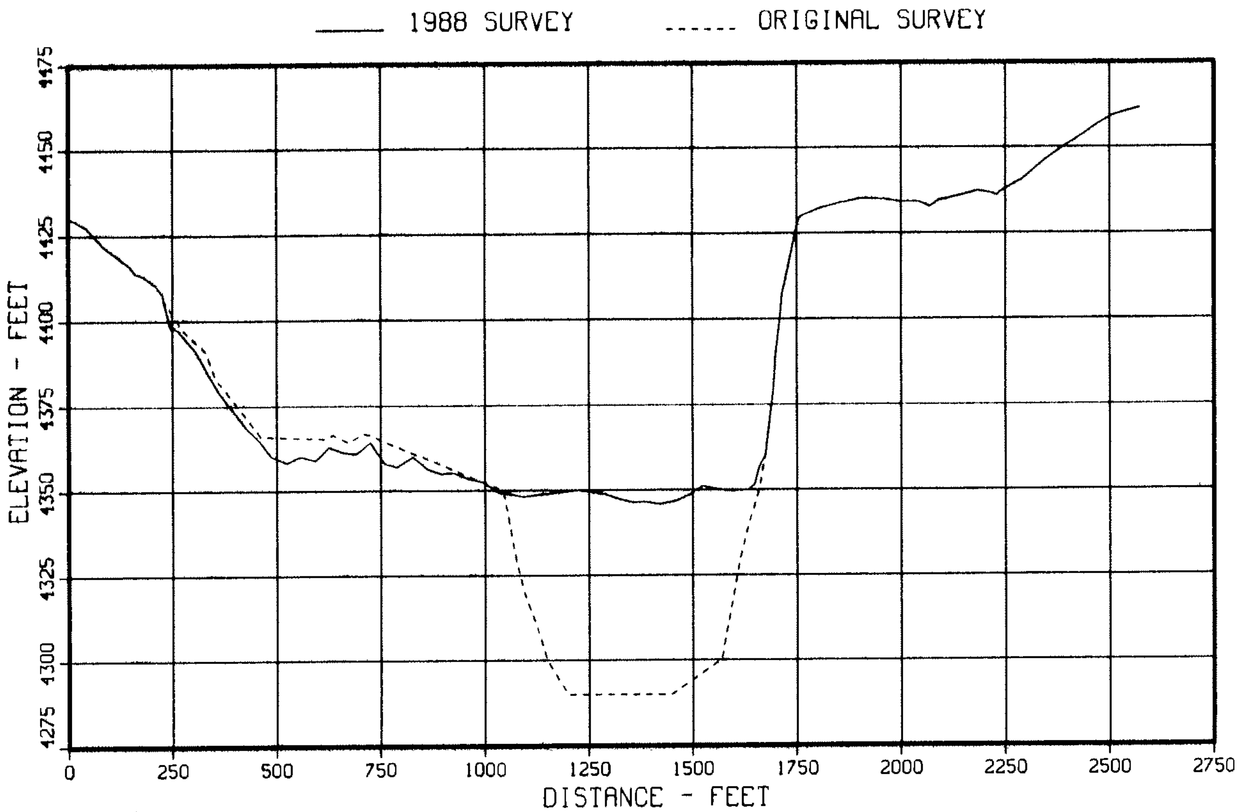


Figure 51. — Sedimentation range profiles for 1915 and 1988, range 58.

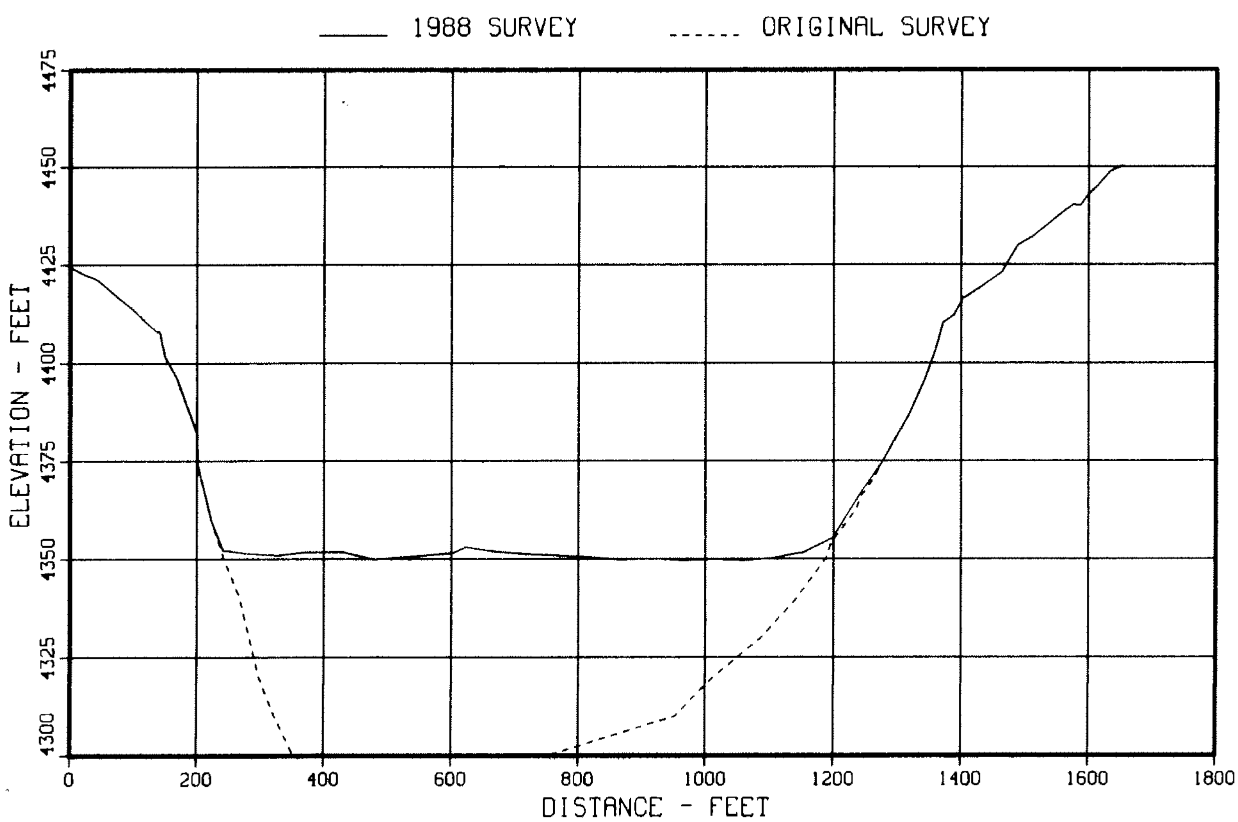


Figure 52. — Sedimentation range profiles for 1915 and 1988, range 57.

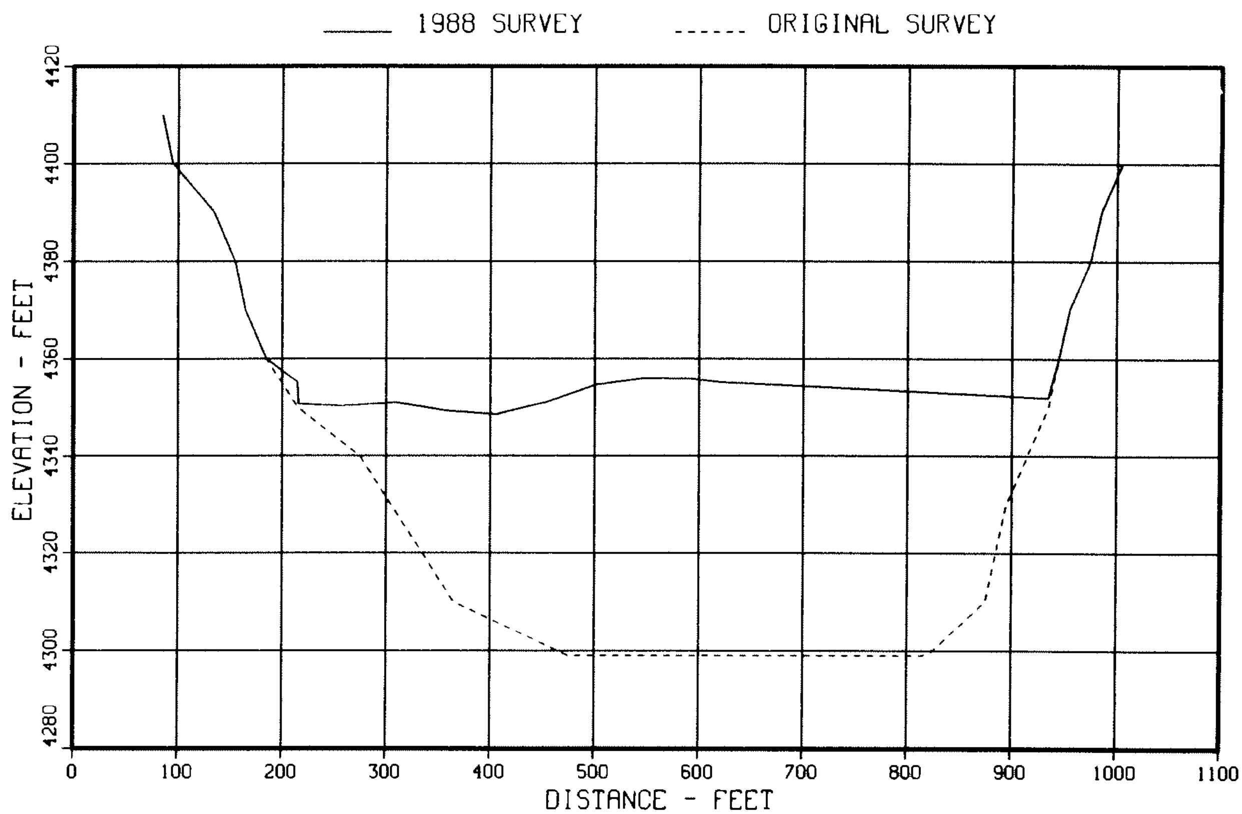


Figure 53. — Sedimentation range profiles for 1915 and 1988, range 56.

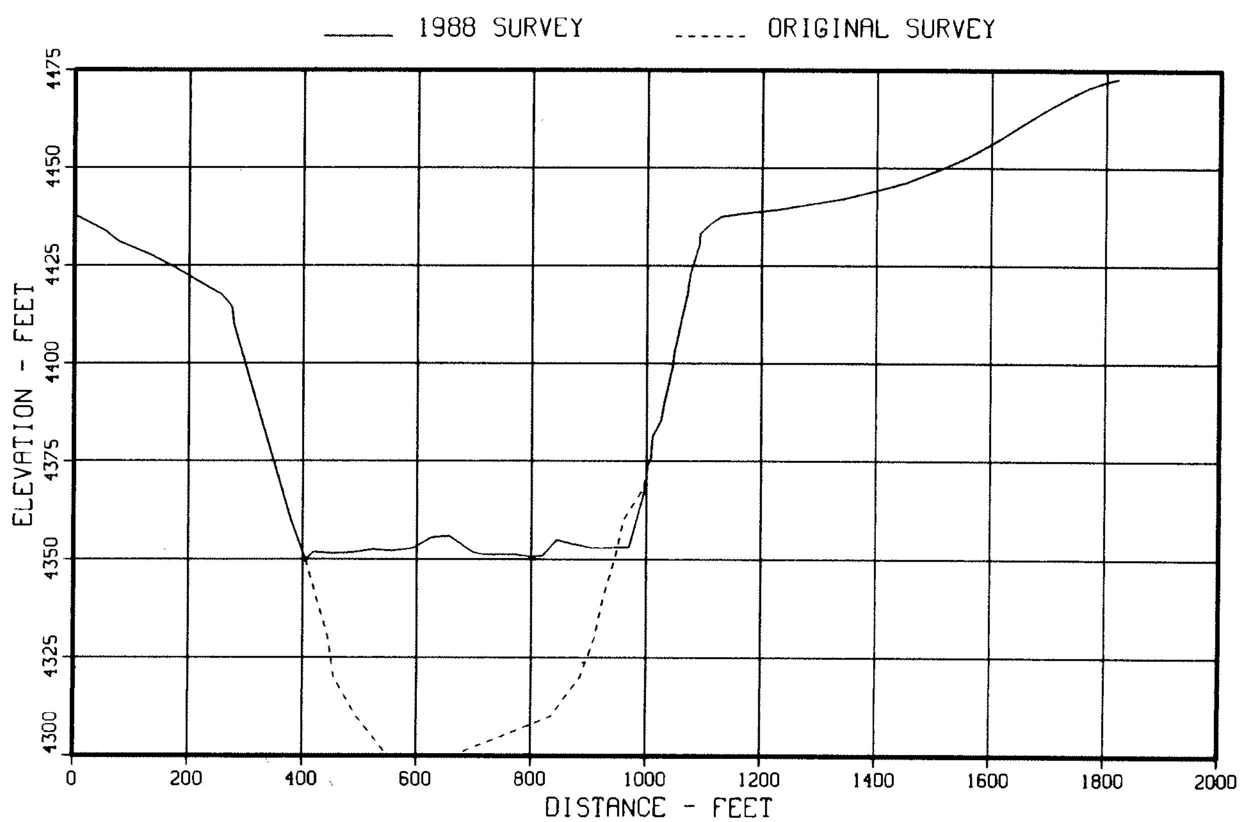


Figure 54. — Sedimentation range profiles for 1915 and 1988, range 55.

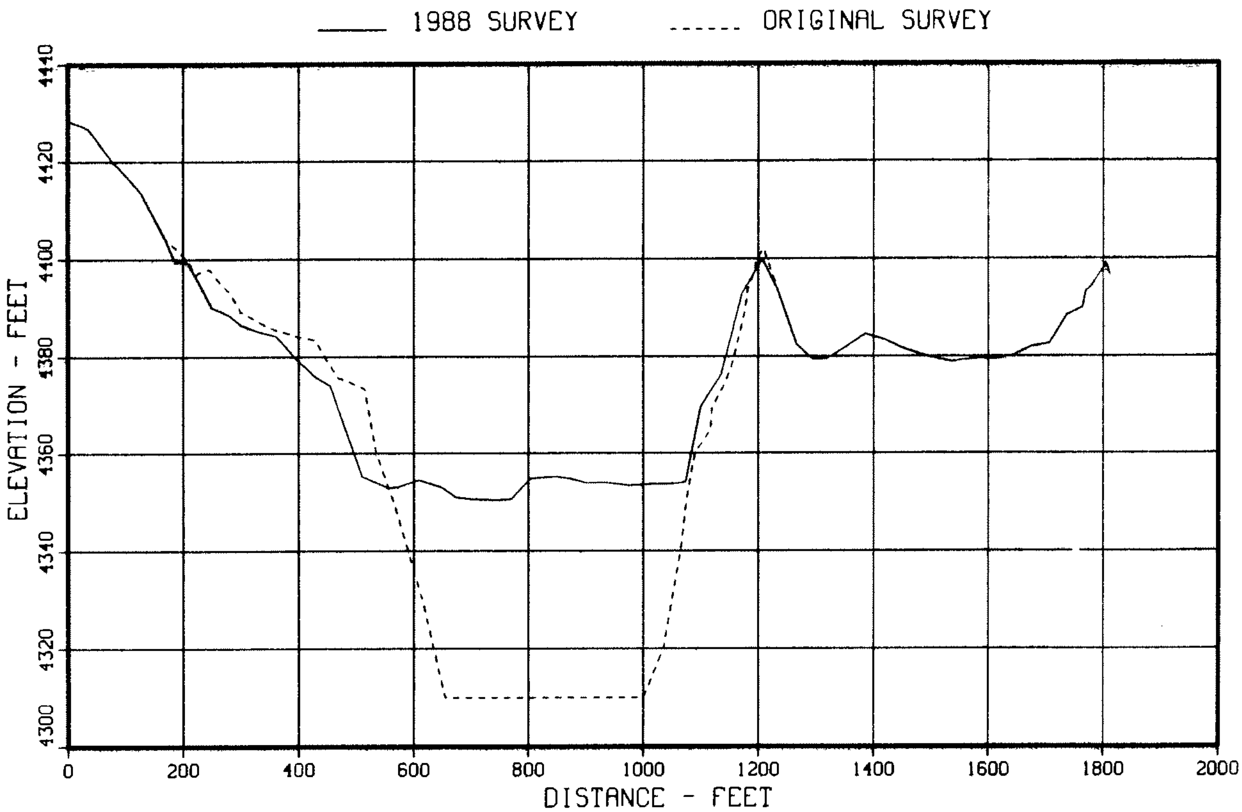


Figure 55. — Sedimentation range profiles for 1915 and 1988, range 54.

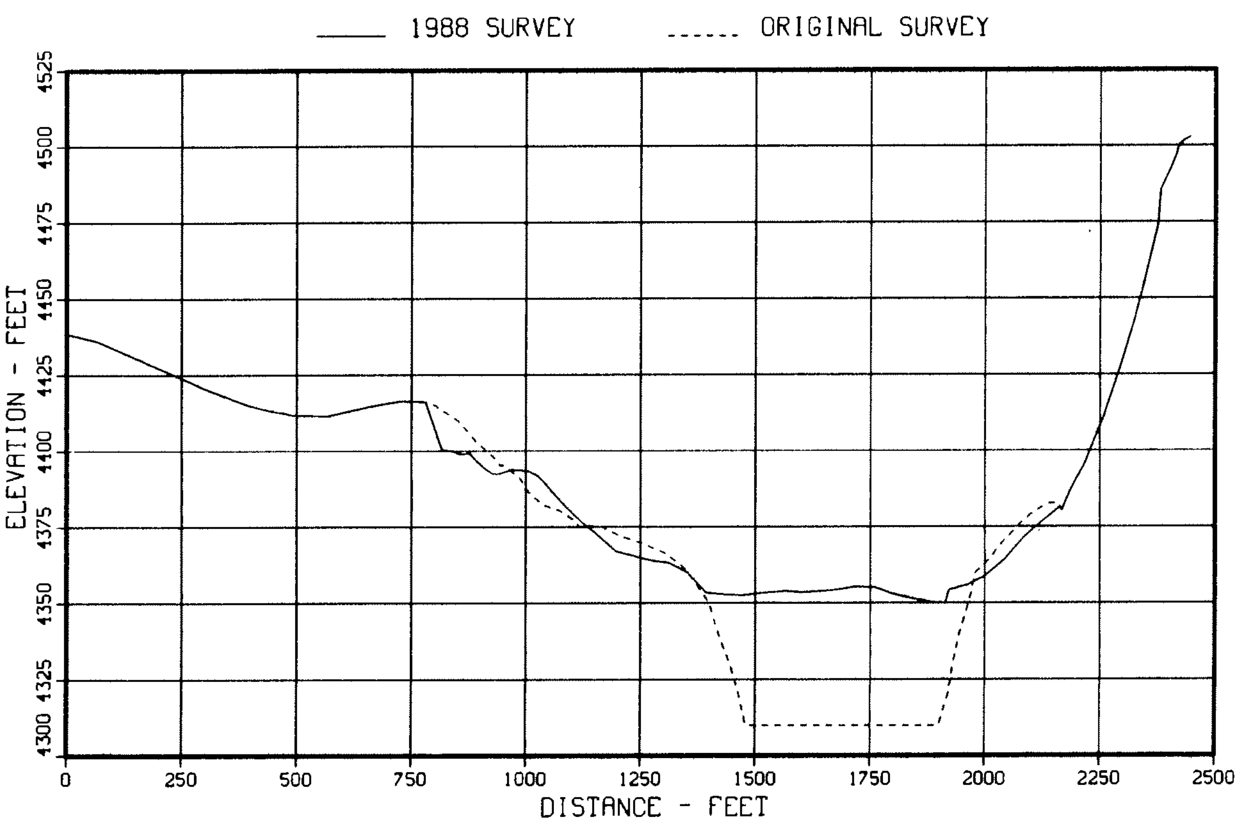


Figure 56. — Sedimentation range profiles for 1915 and 1988, range 53.

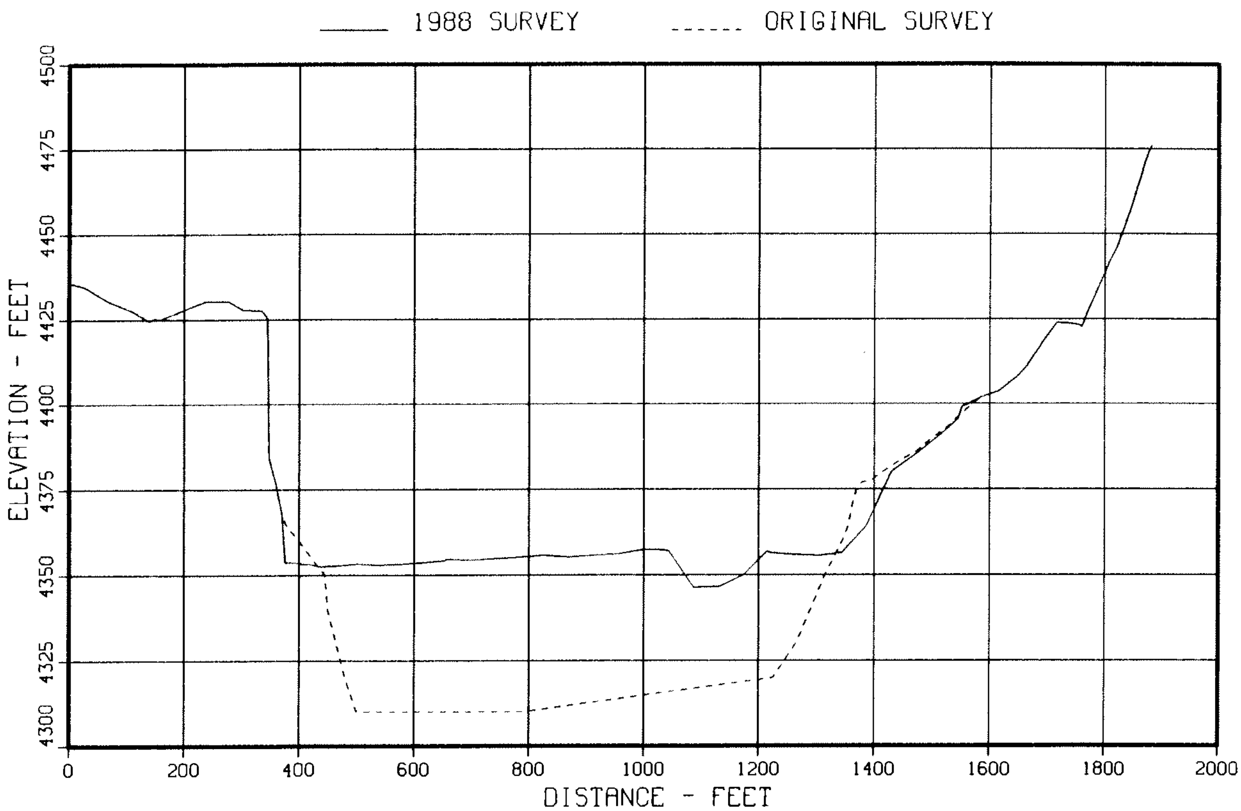


Figure 57. — Sedimentation range profiles for 1915 and 1988, range 52.

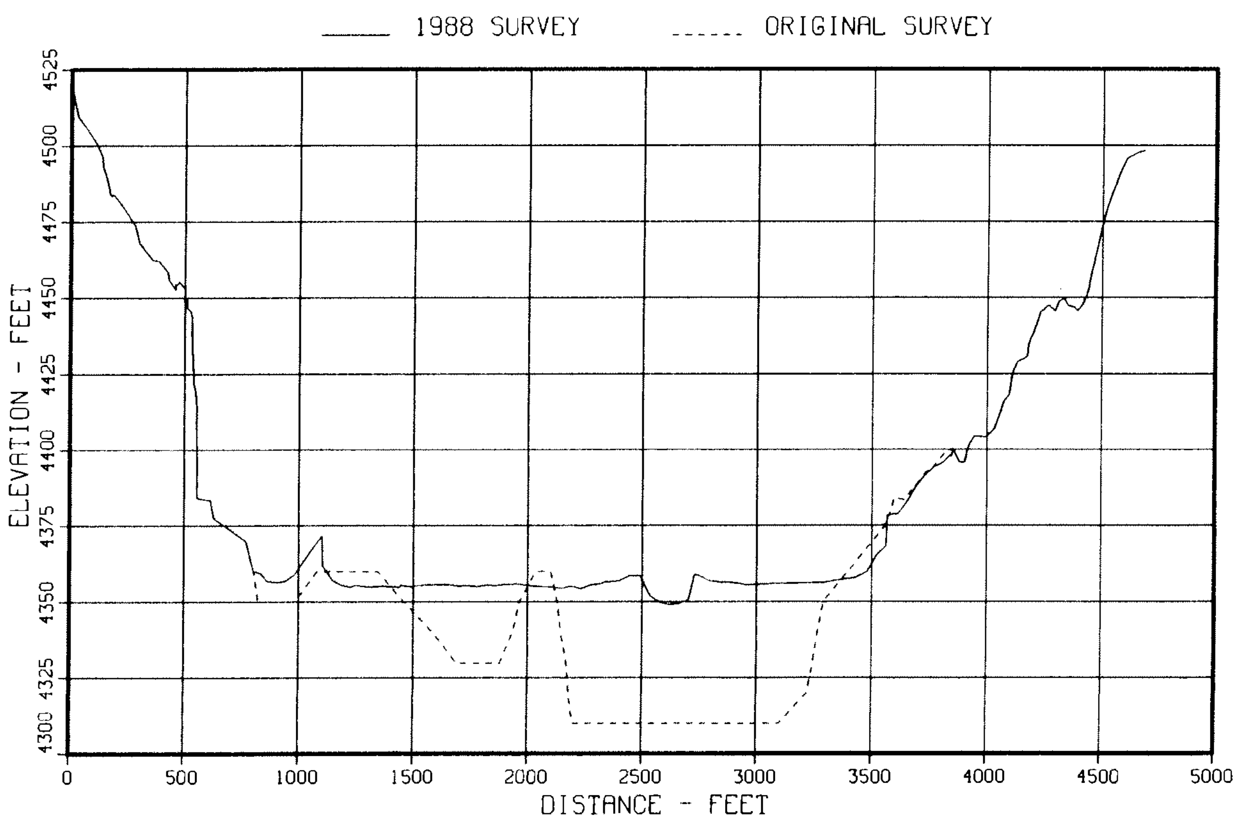


Figure 58. — Sedimentation range profiles for 1915 and 1988, range 51.

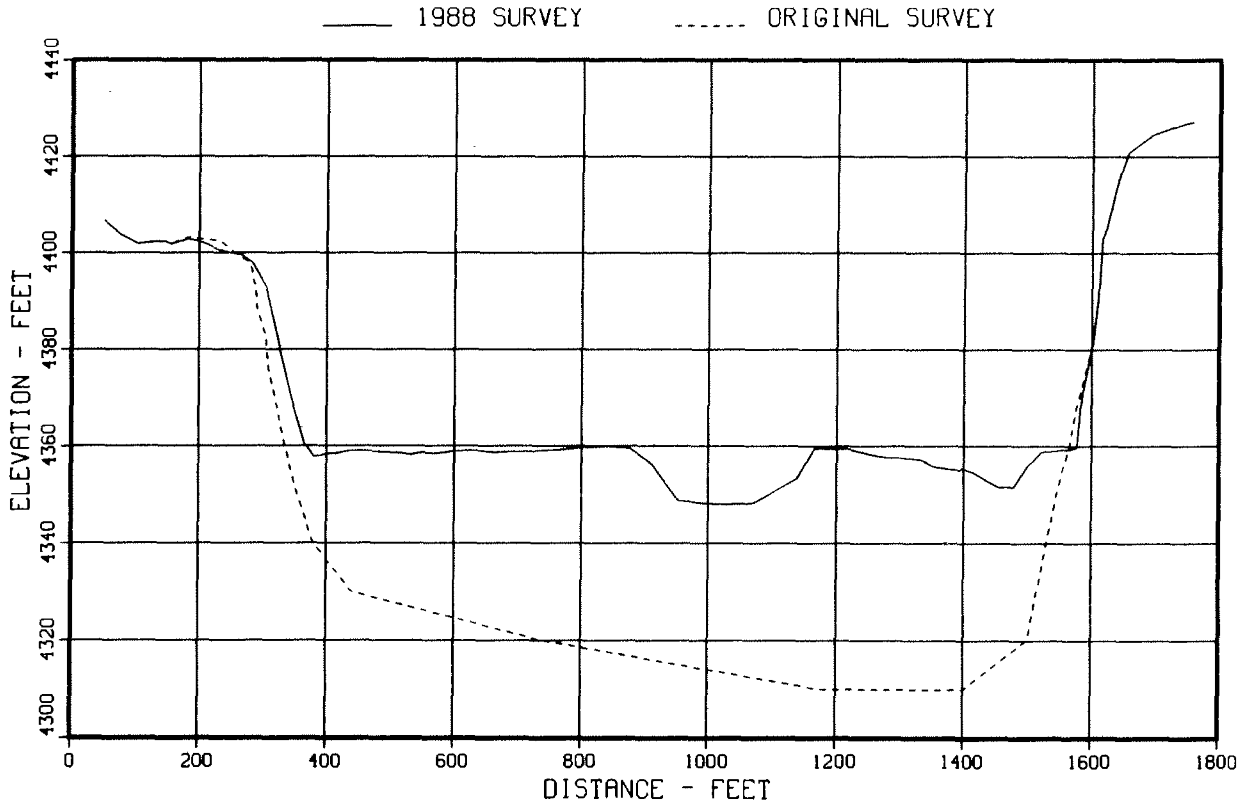


Figure 59. — Sedimentation range profiles for 1915 and 1988, range 50.

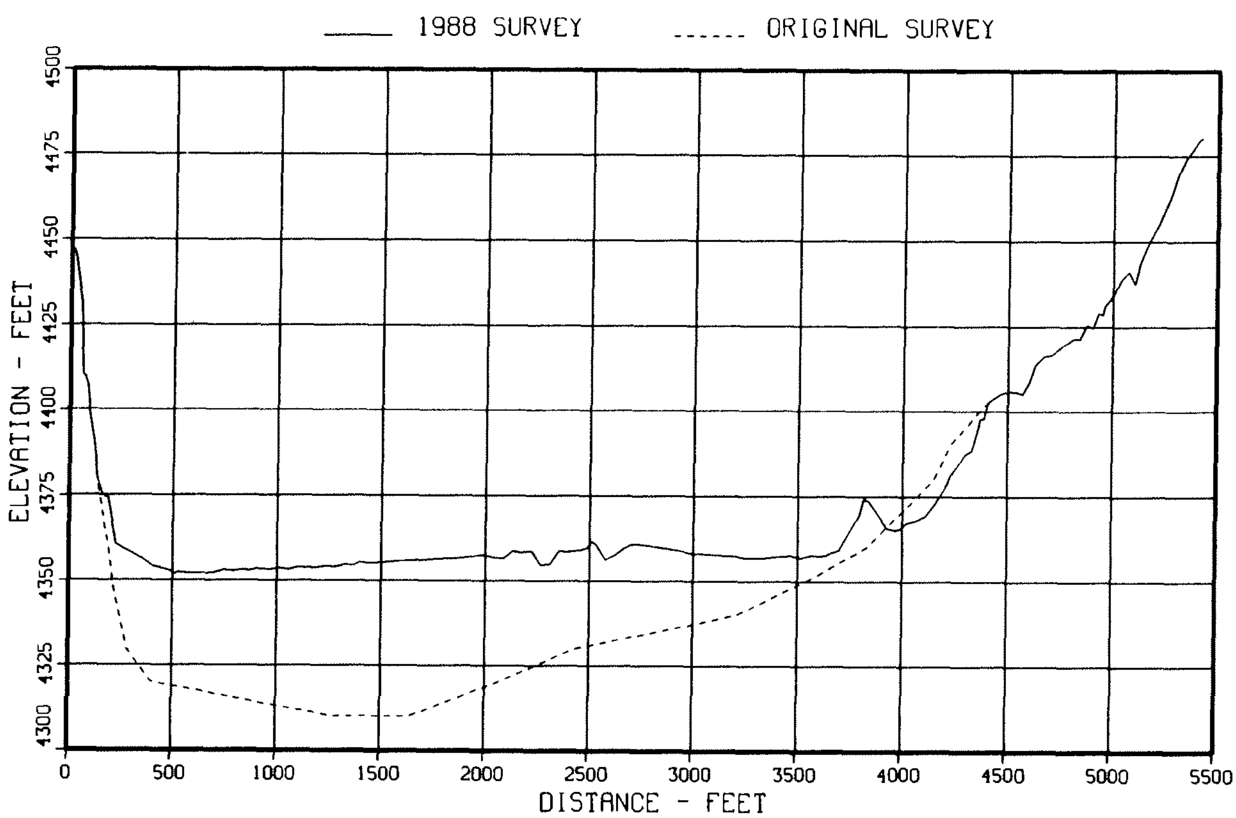


Figure 60. — Sedimentation range profiles for 1915 and 1988, range 49.

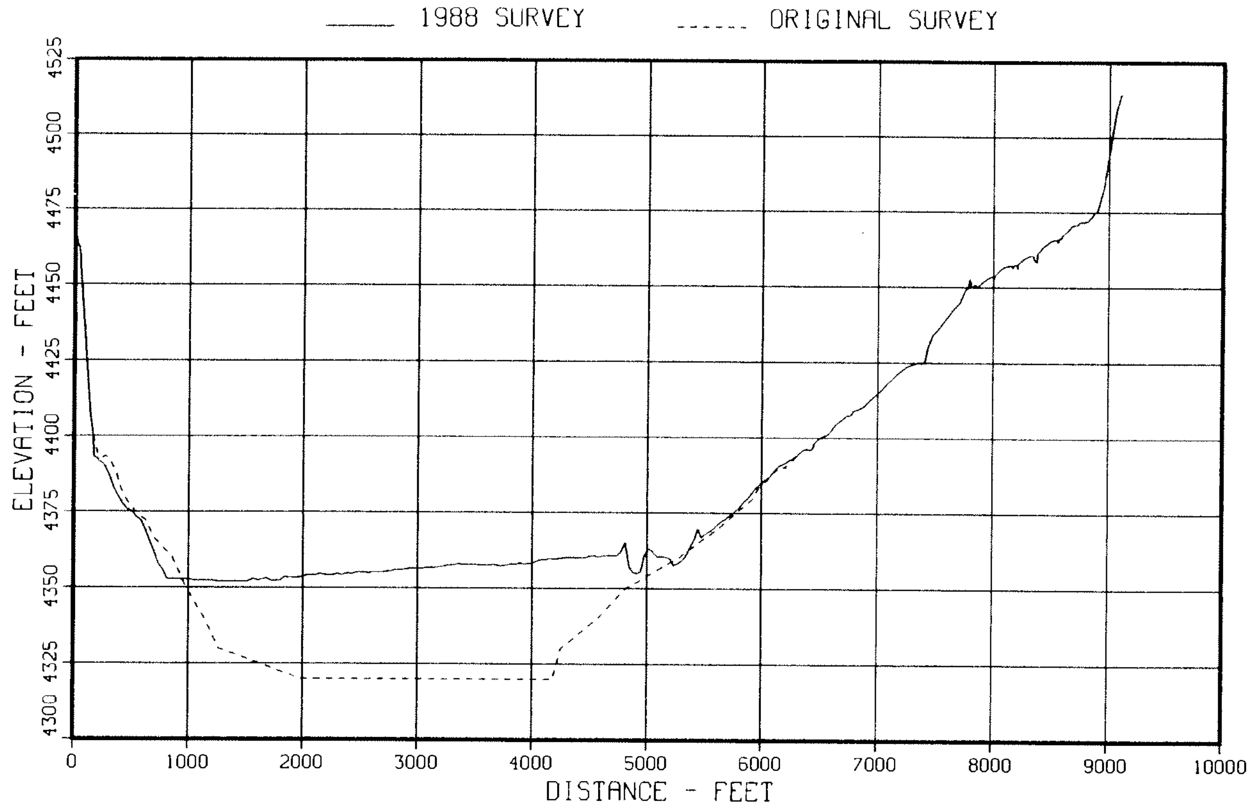


Figure 61. — Sedimentation range profiles for 1915 and 1988, range 48.

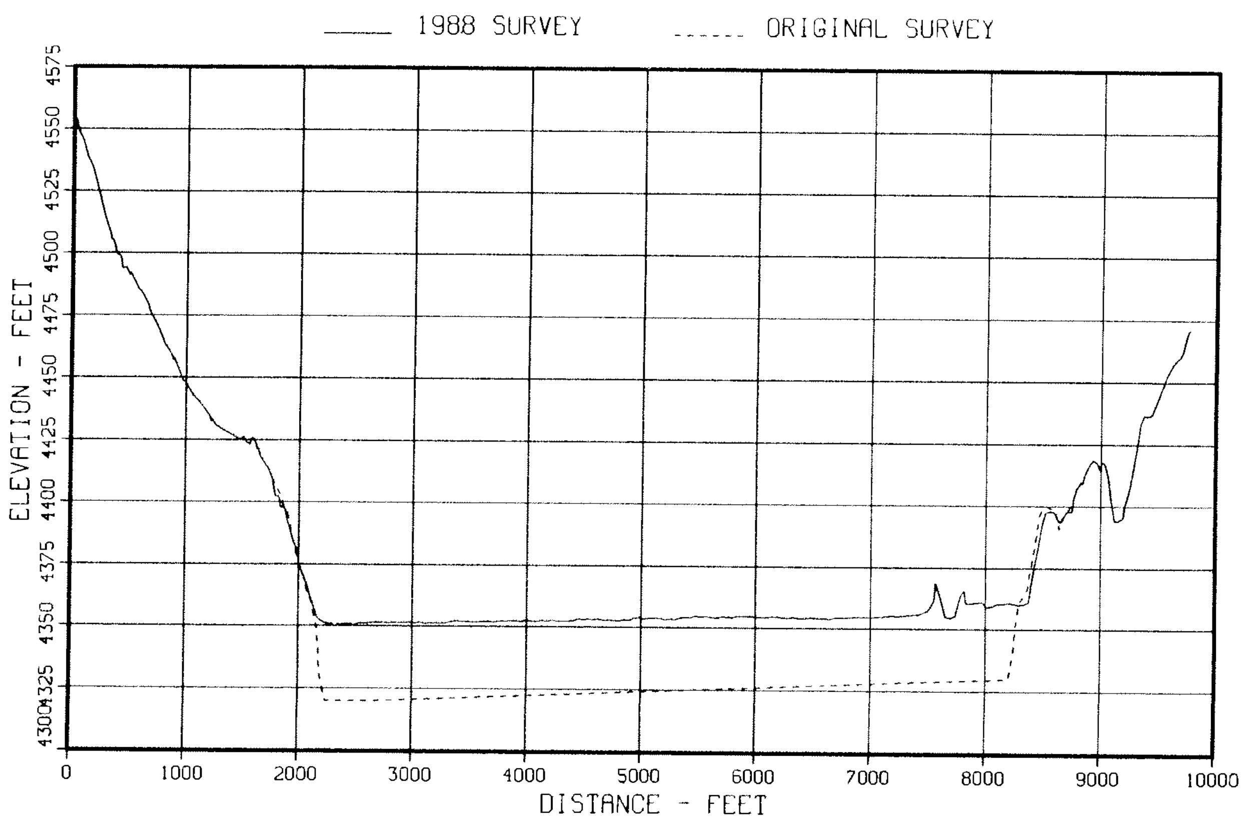


Figure 62. — Sedimentation range profiles for 1915 and 1988, range 47.

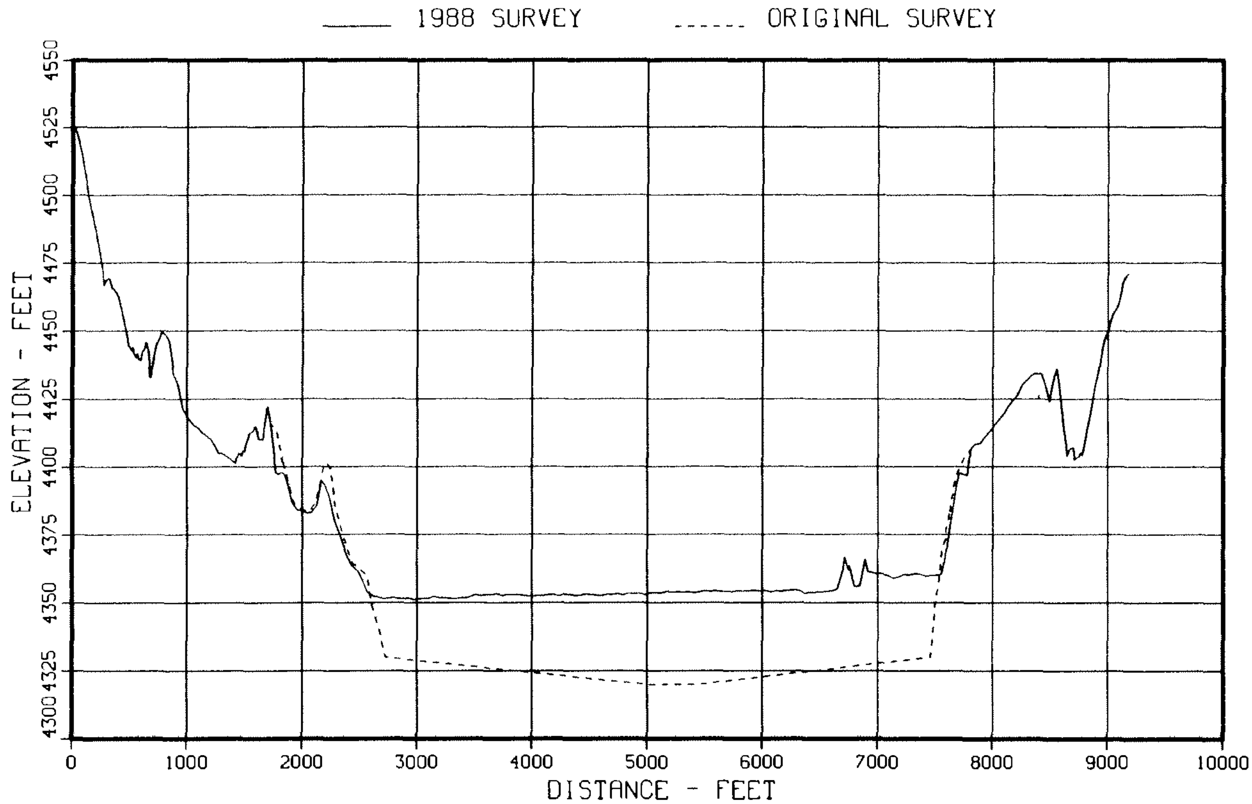


Figure 63. — Sedimentation range profiles for 1915 and 1988, range 46.

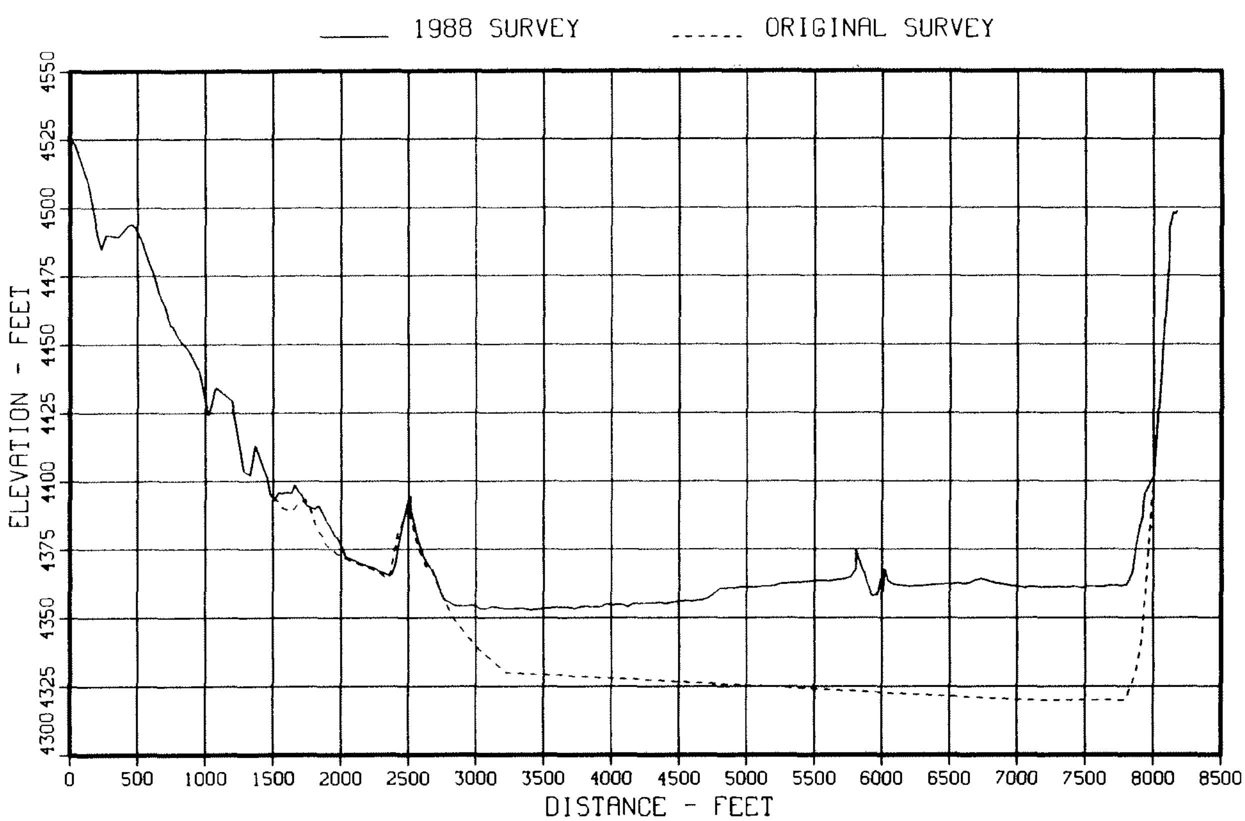


Figure 64. — Sedimentation range profiles for 1915 and 1988, range 45.

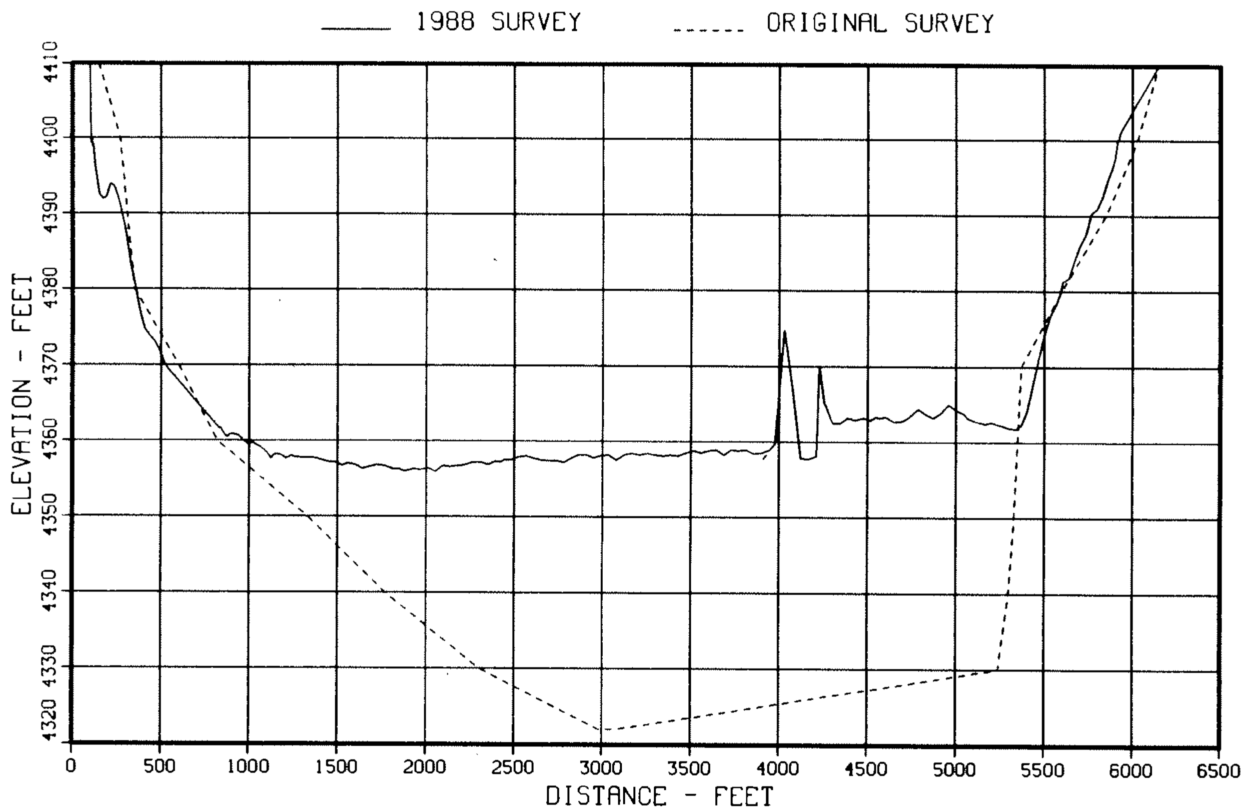


Figure 65. — Sedimentation range profiles for 1915 and 1988, range 44.

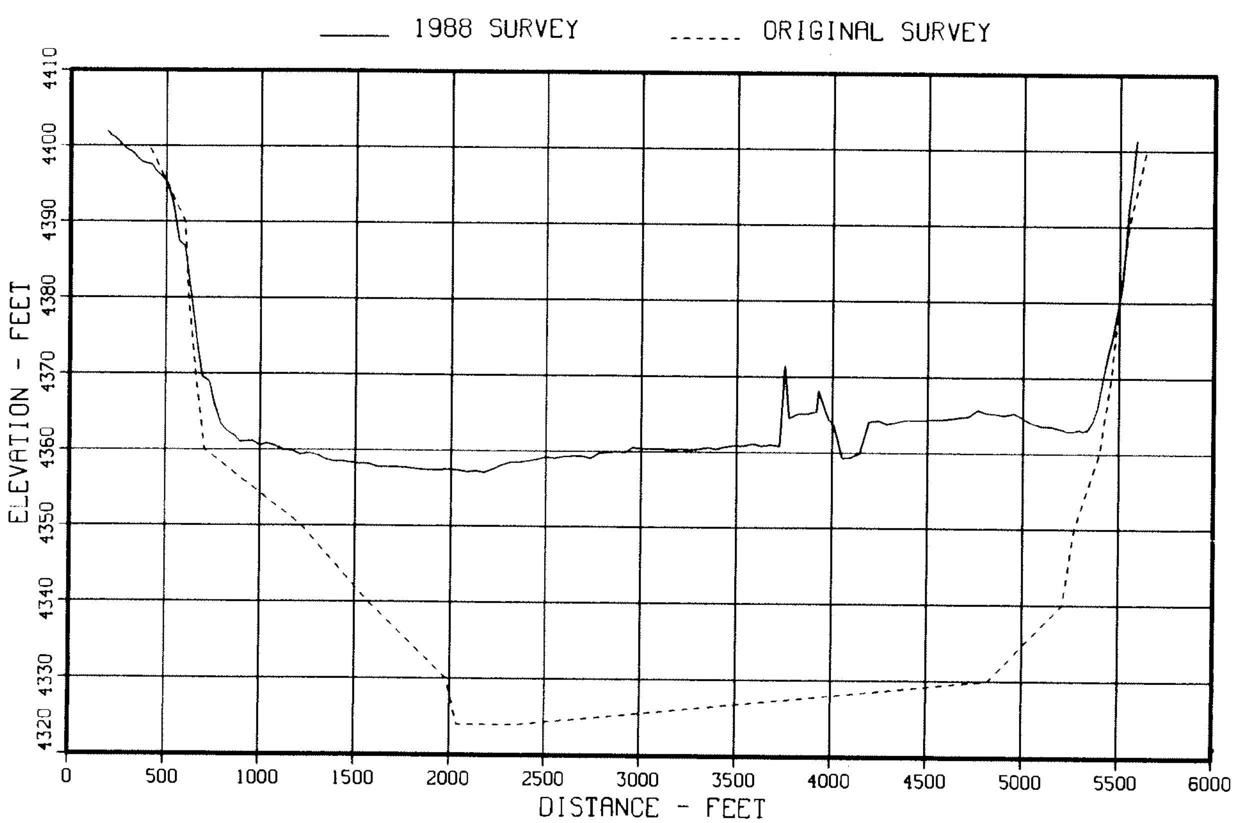


Figure 66. — Sedimentation range profiles for 1915 and 1988, range 43.

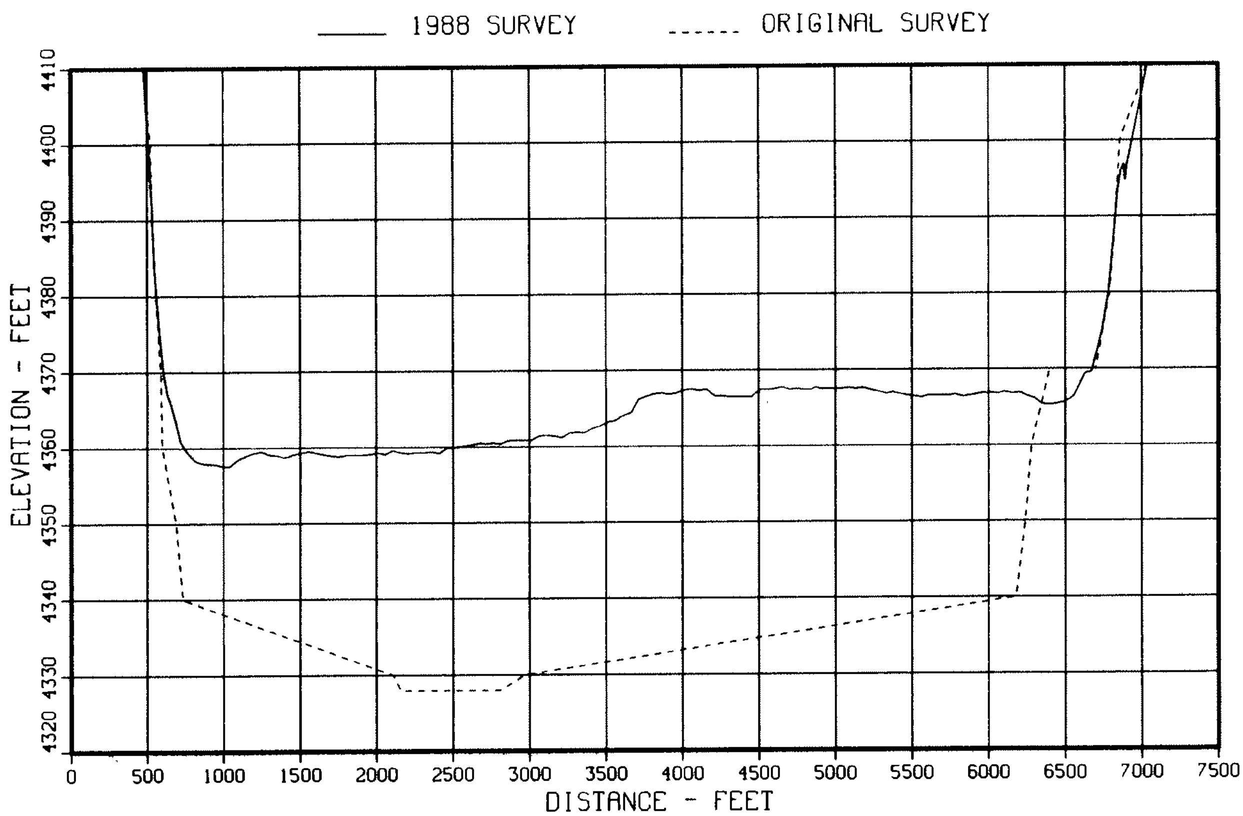


Figure 67. — Sedimentation range profiles for 1915 and 1988, range 42.

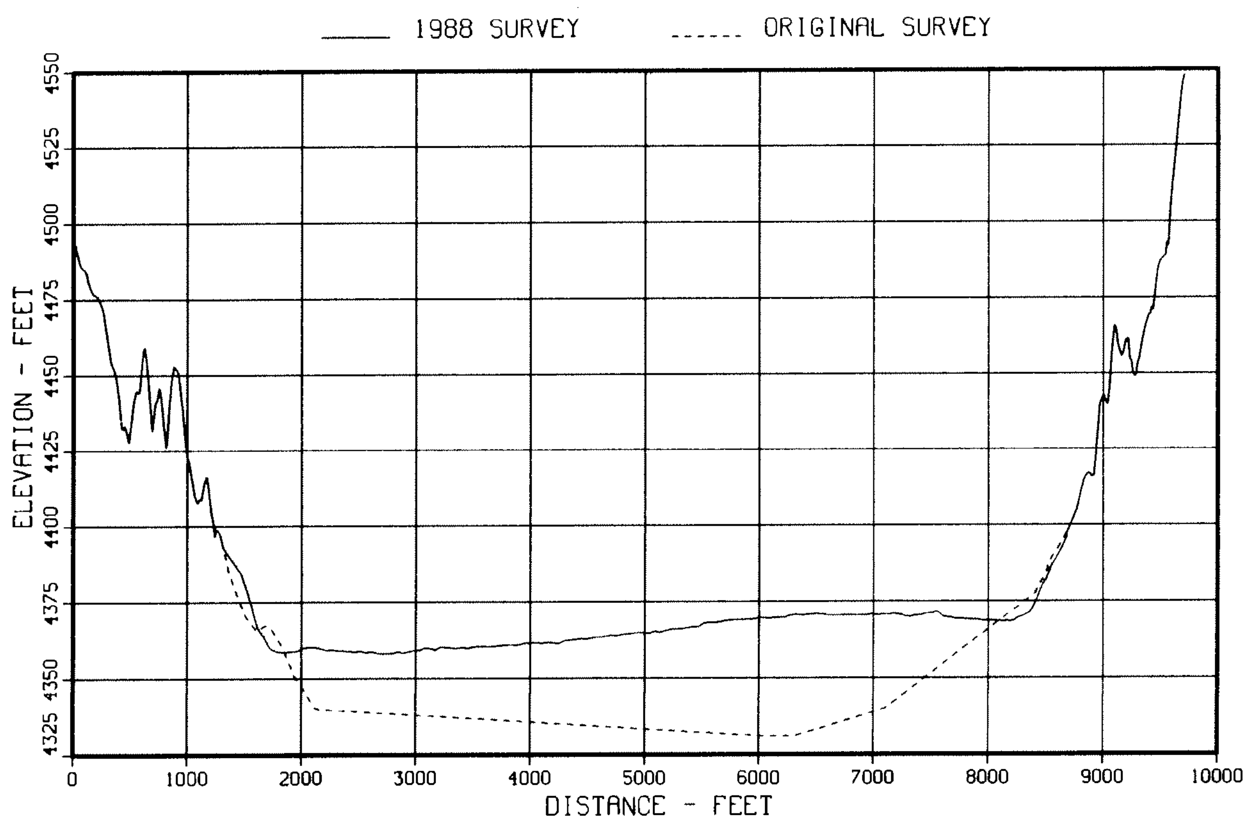


Figure 68. — Sedimentation range profiles for 1915 and 1988, range 41.

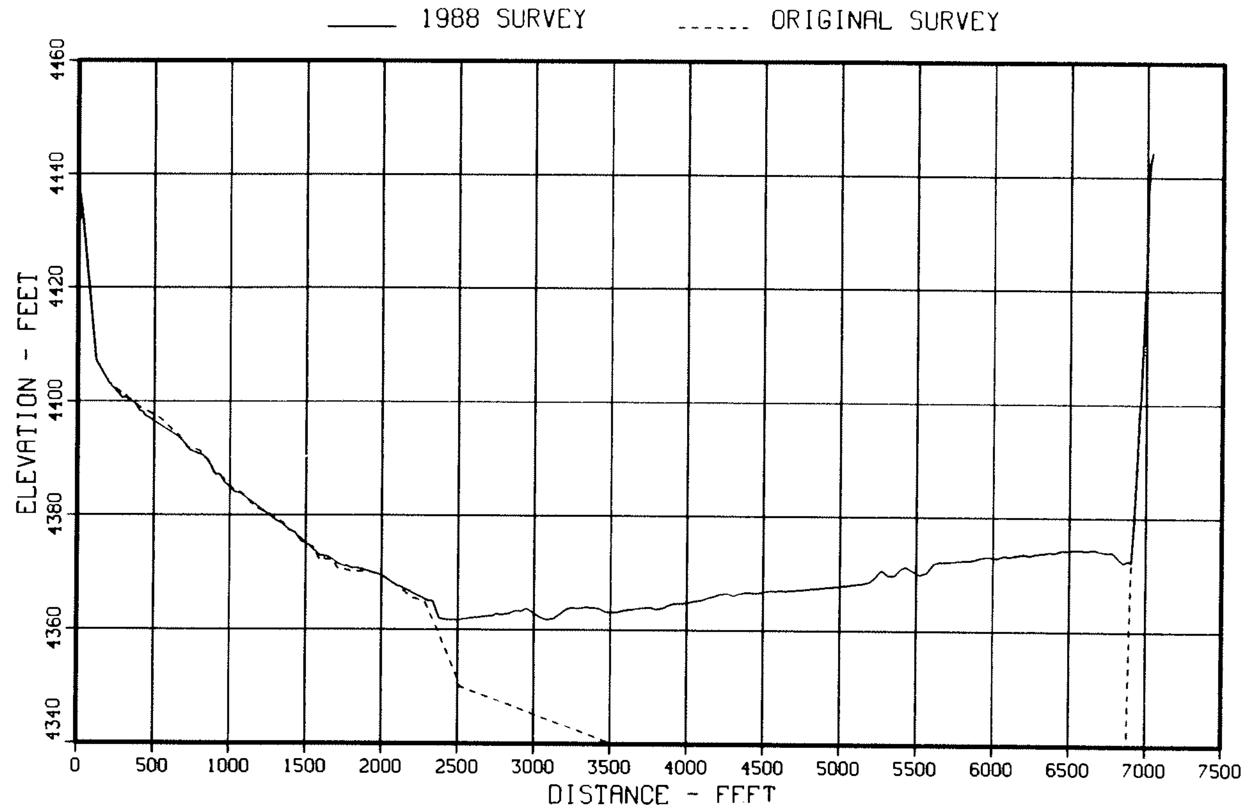


Figure 69. — Sedimentation range profiles for 1915 and 1988, range 40.

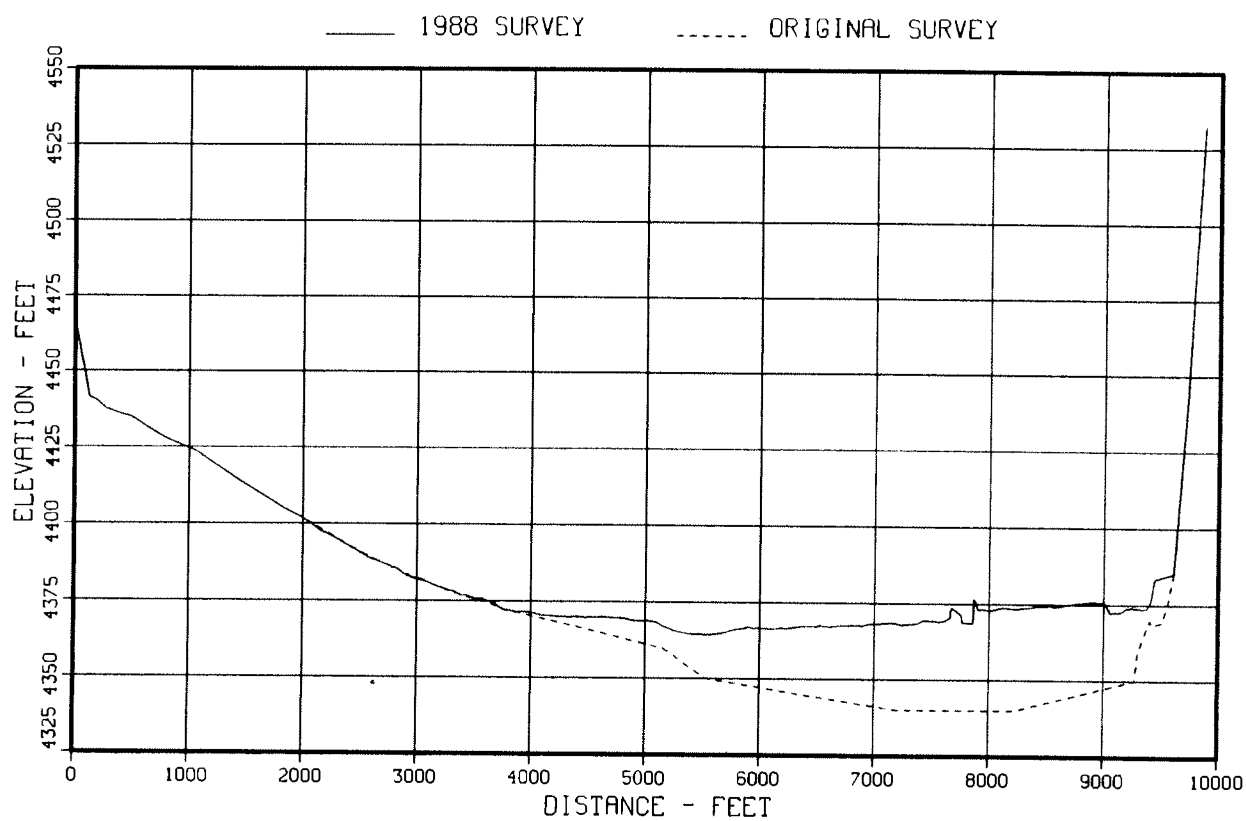


Figure 70. — Sedimentation range profiles for 1915 and 1988, range 39.

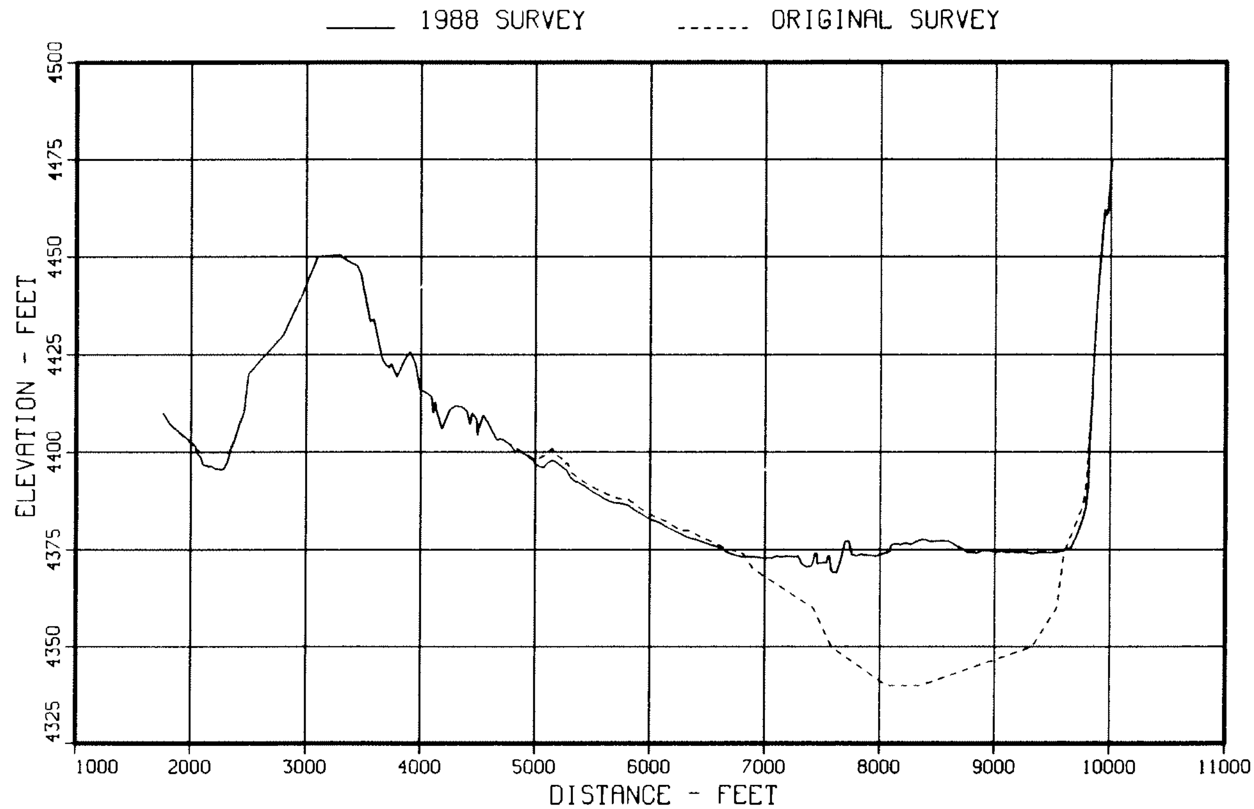


Figure 71. — Sedimentation range profiles for 1915 and 1988, range 38.

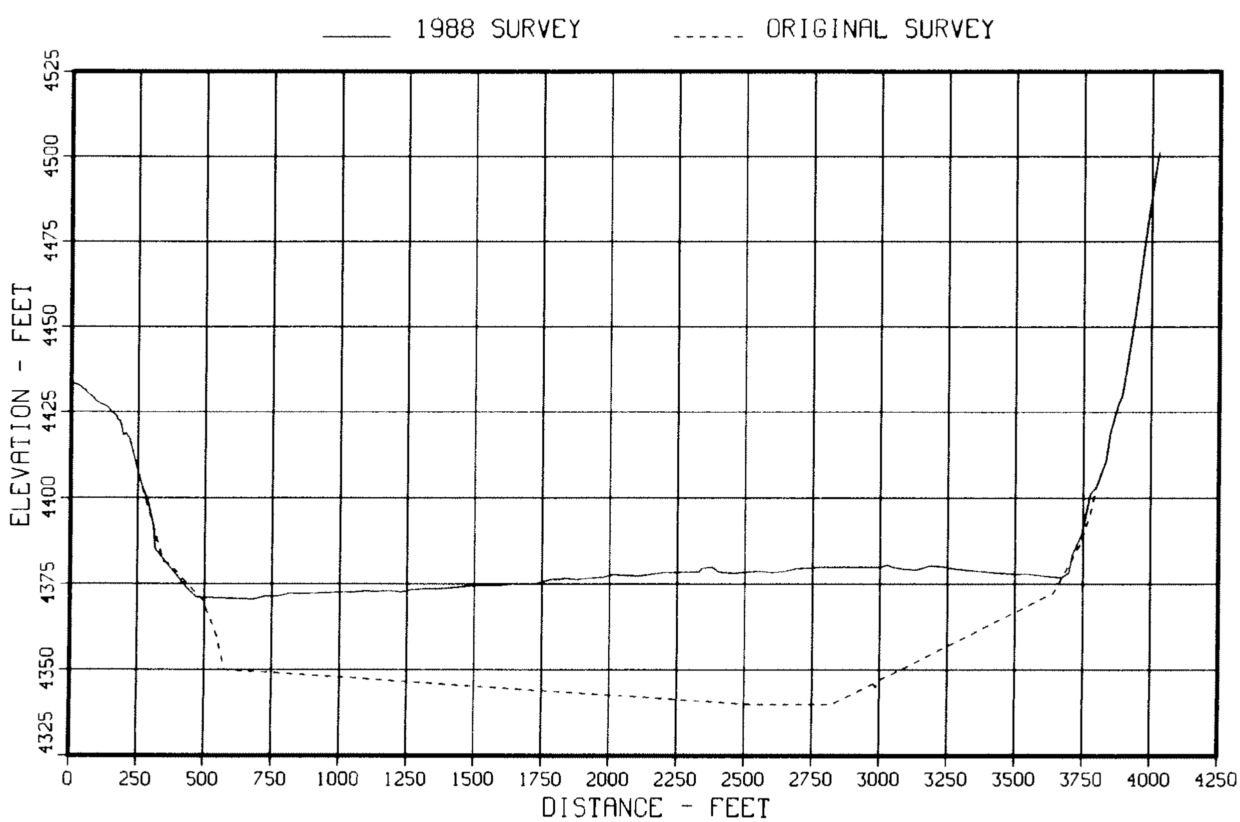


Figure 72. — Sedimentation range profiles for 1915 and 1988, range 37.

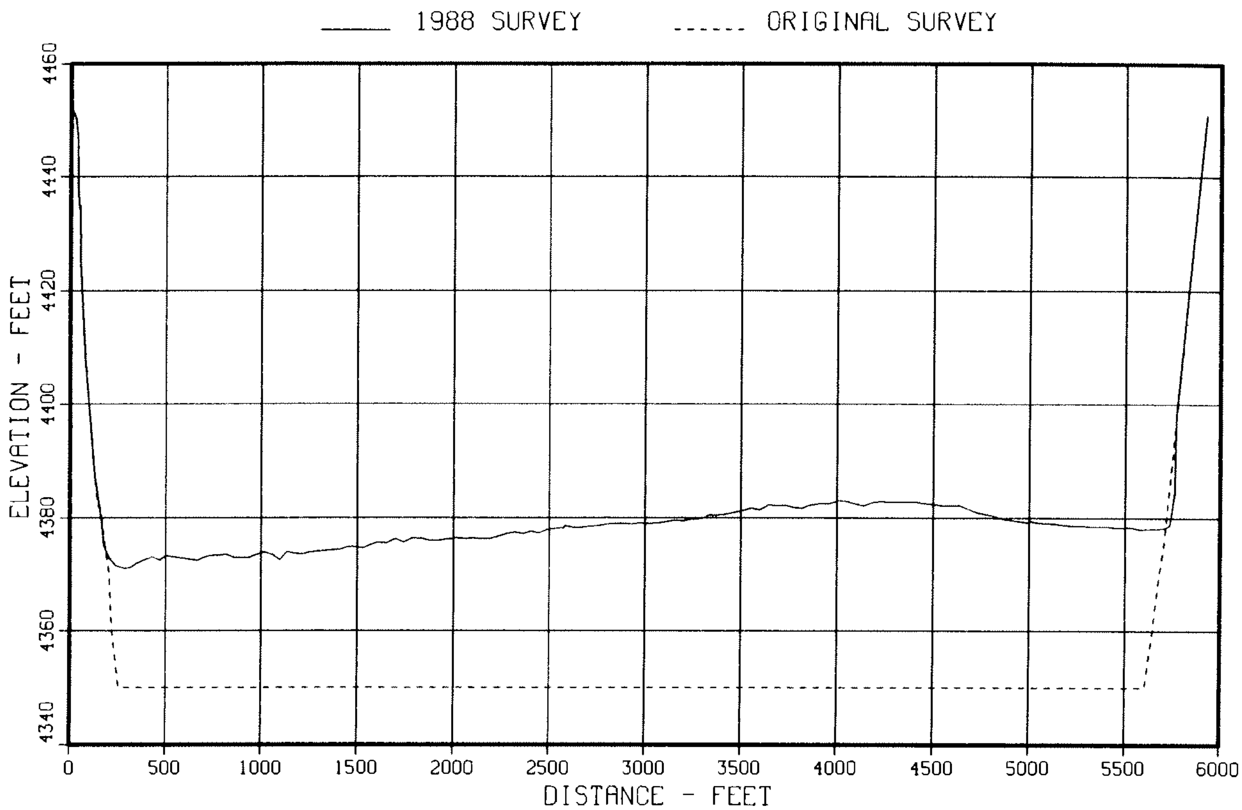


Figure 73. — Sedimentation range profiles for 1915 and 1988, range 36.

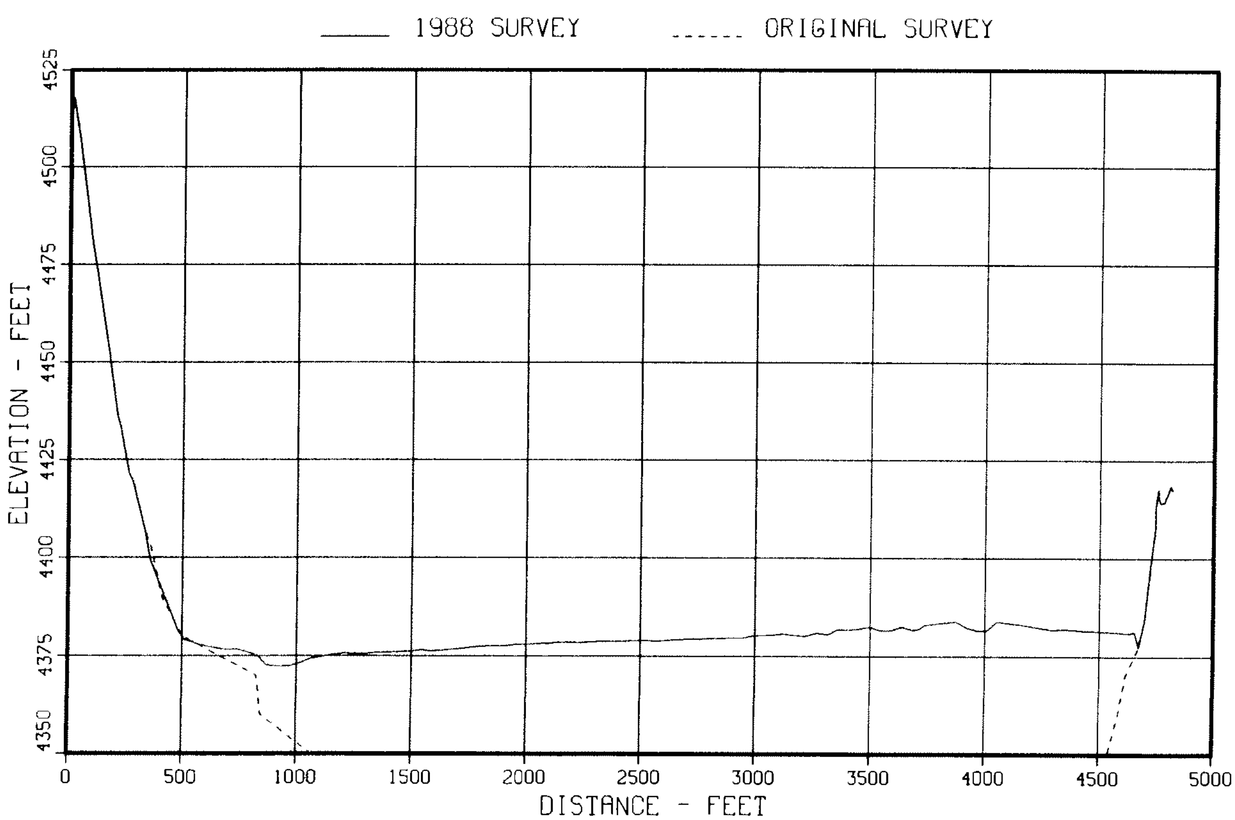


Figure 74. — Sedimentation range profiles for 1915 and 1988, range 35.

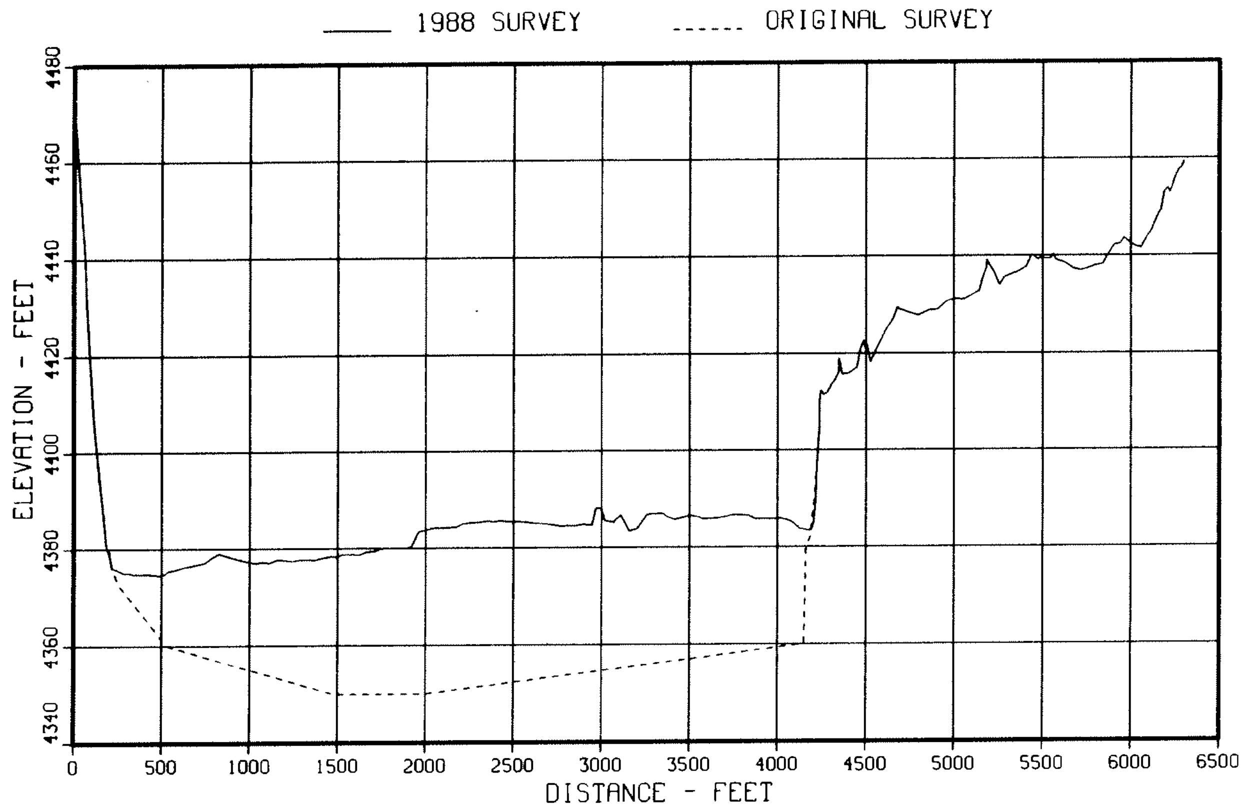


Figure 75. — Sedimentation range profiles for 1915 and 1988, range 33.

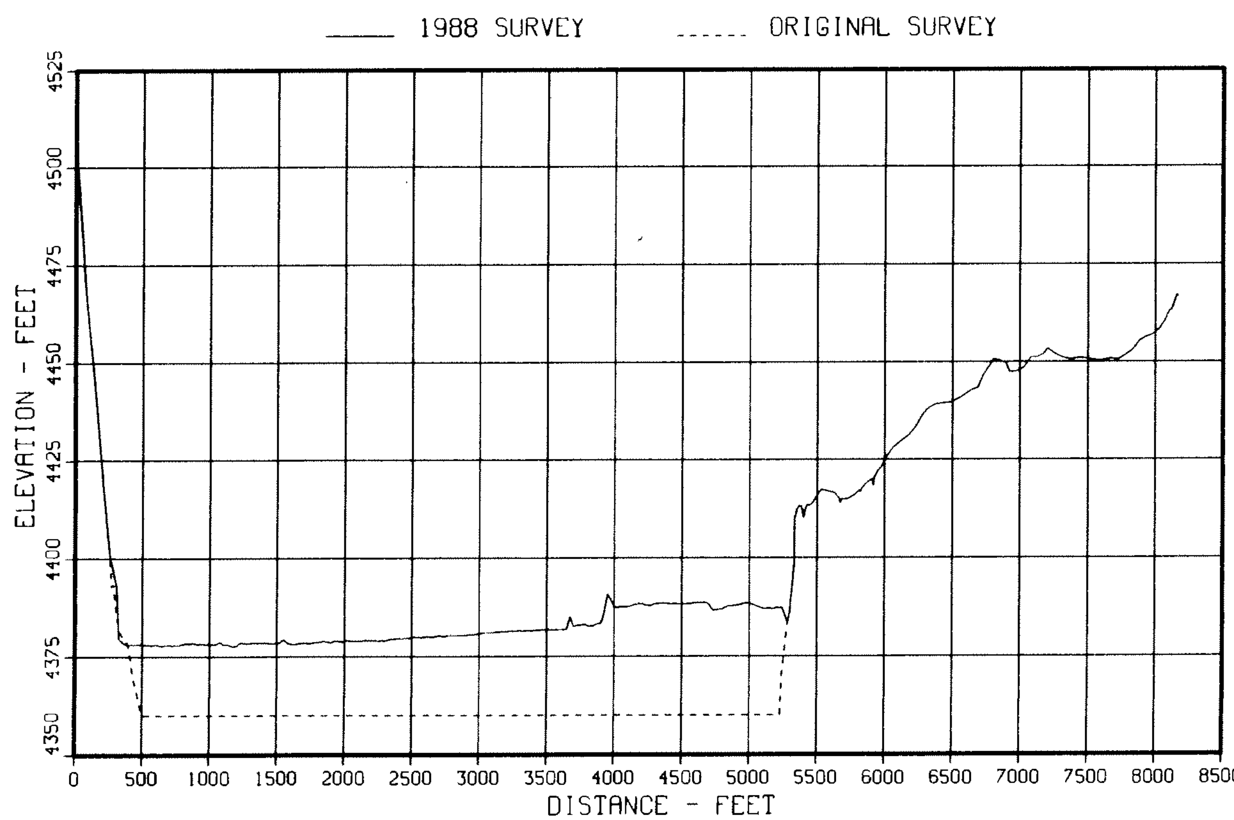


Figure 76. — Sedimentation range profiles for 1915 and 1988, range 32.

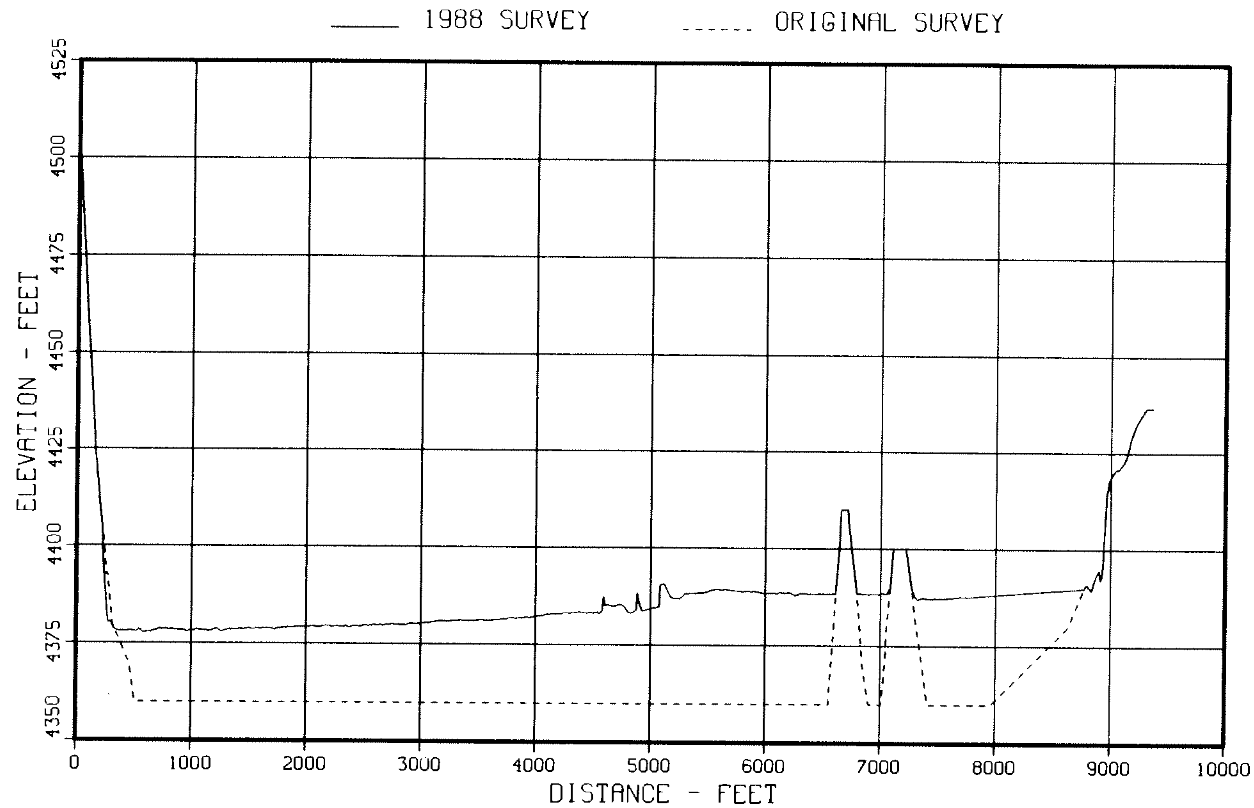


Figure 77. — Sedimentation range profiles for 1915 and 1988, range 31.

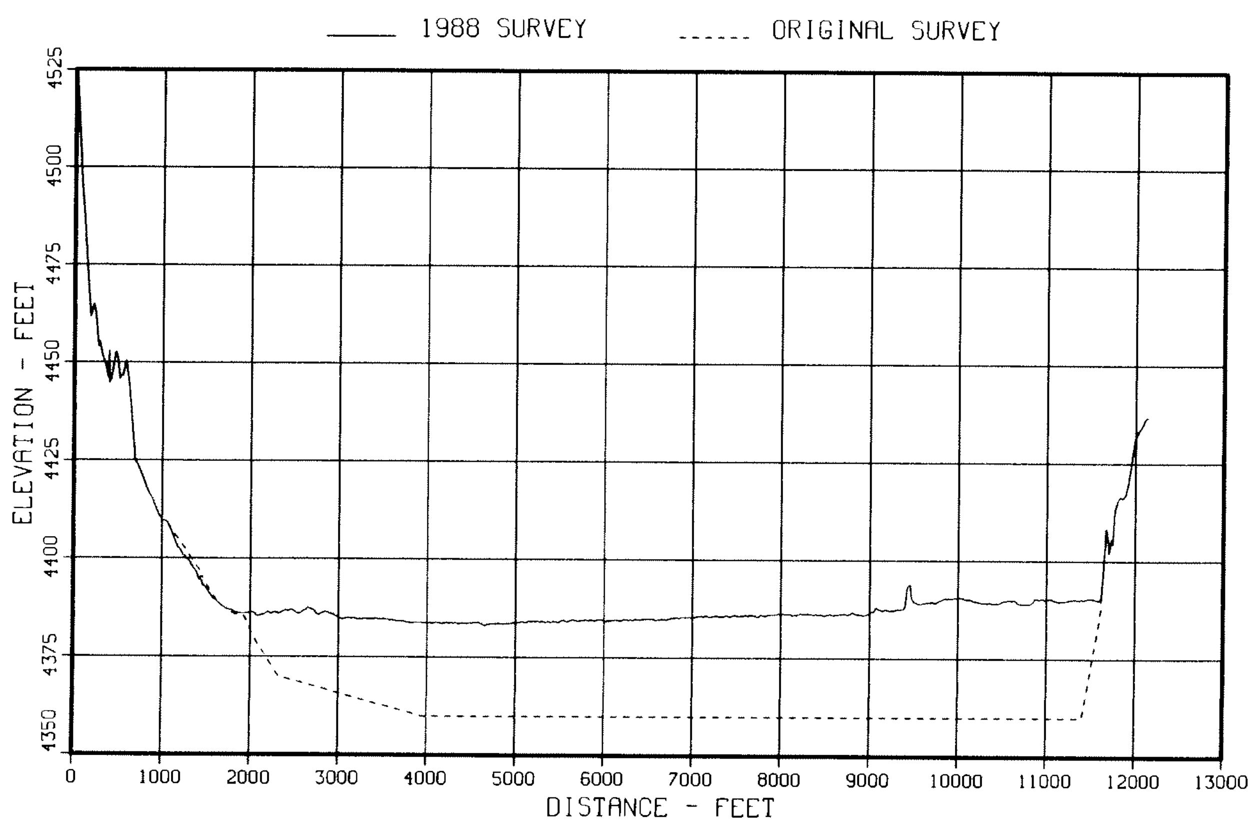


Figure 78. — Sedimentation range profiles for 1915 and 1988, range 30.

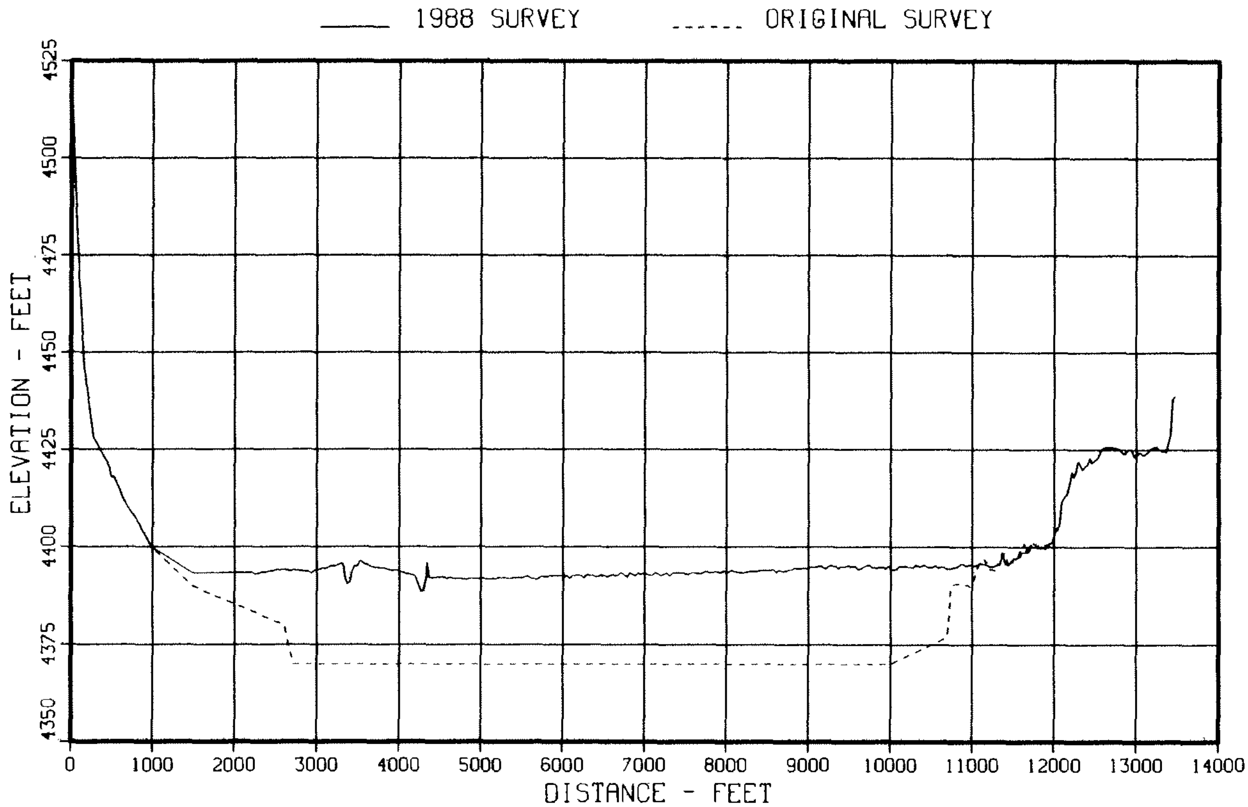


Figure 79. — Sedimentation range profiles for 1915 and 1988, range 29.

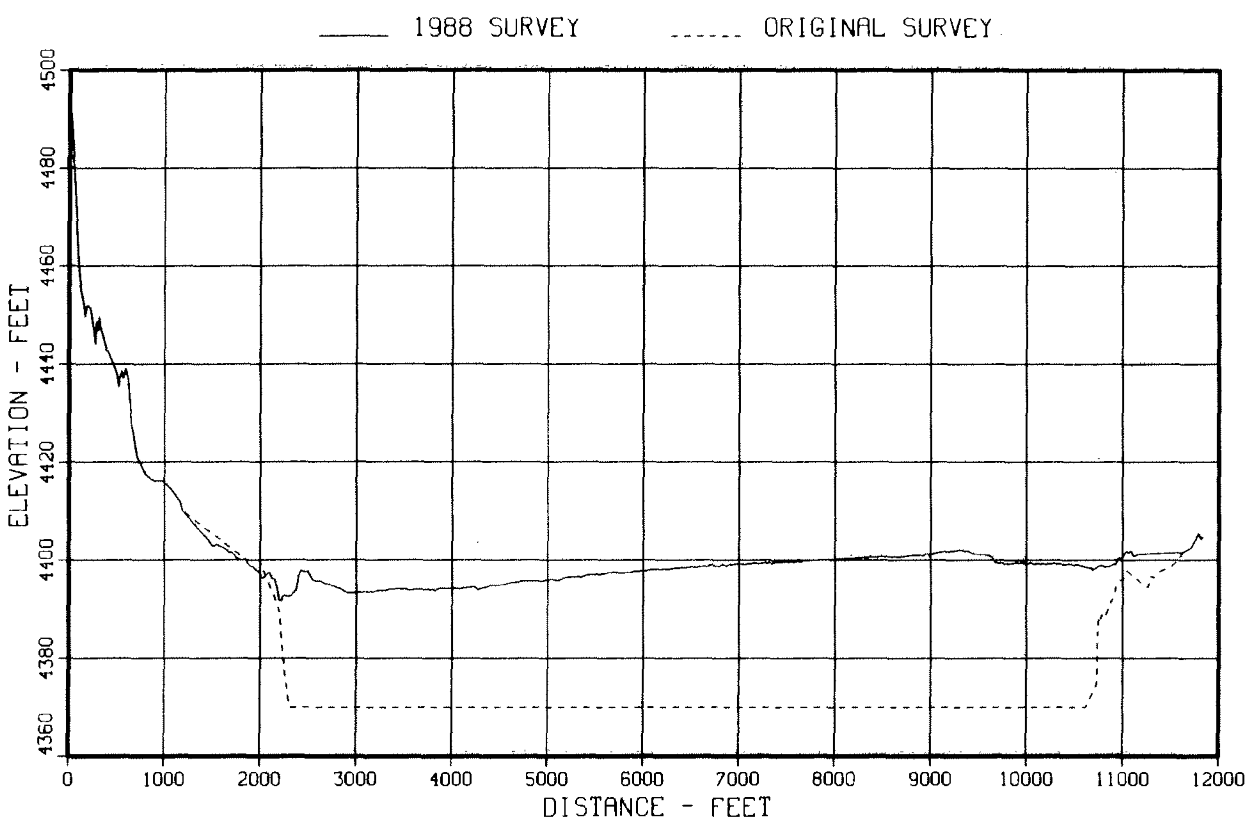


Figure 80. — Sedimentation range profiles for 1915 and 1988, range 28.

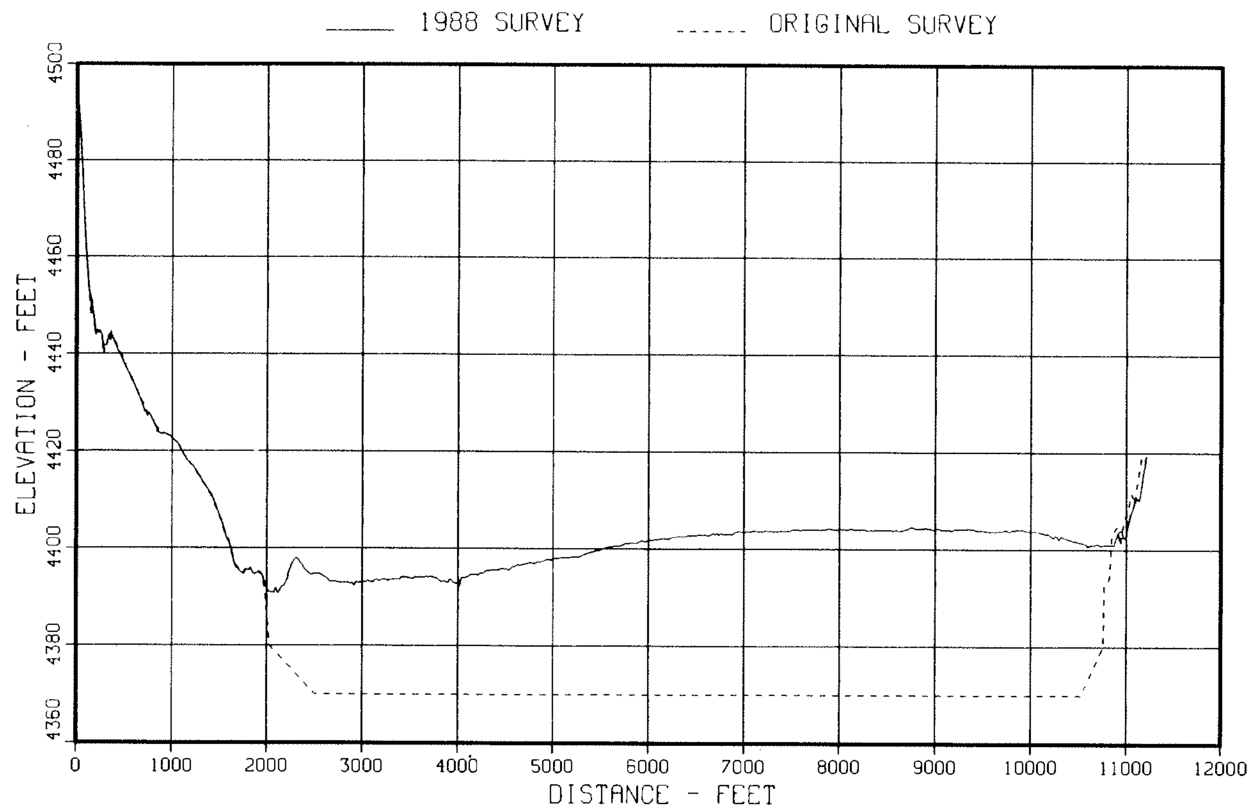


Figure 81. — Sedimentation range profiles for 1915 and 1988, range 27.

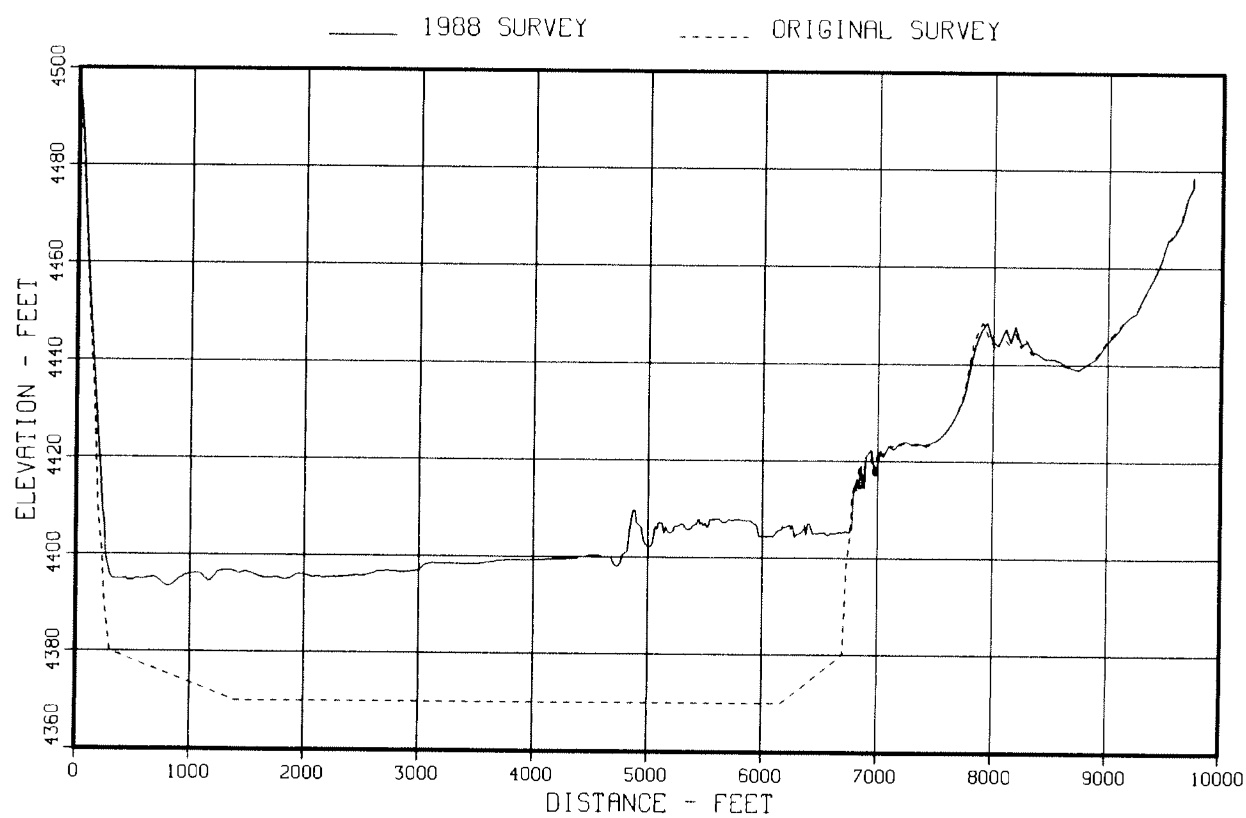


Figure 82. — Sedimentation range profiles for 1915 and 1988, range 26.

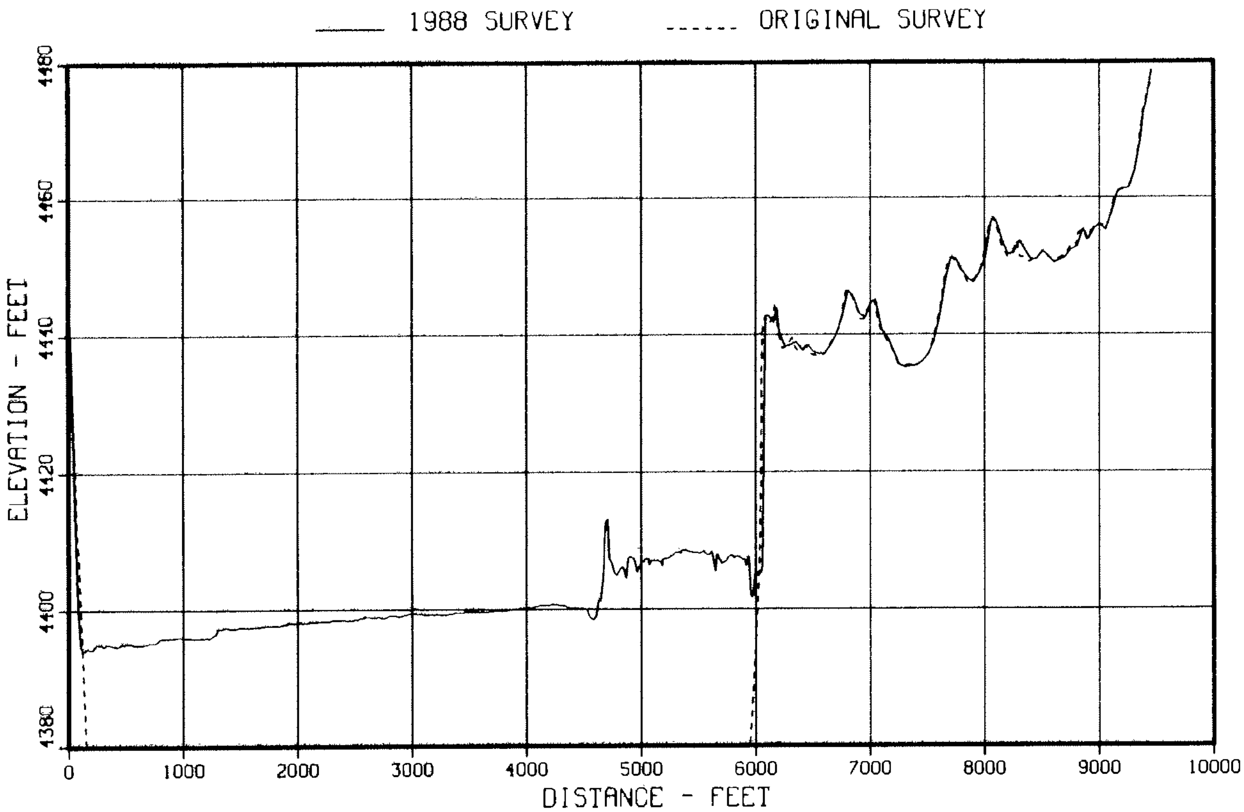


Figure 83. — Sedimentation range profiles for 1915 and 1988, range 25.

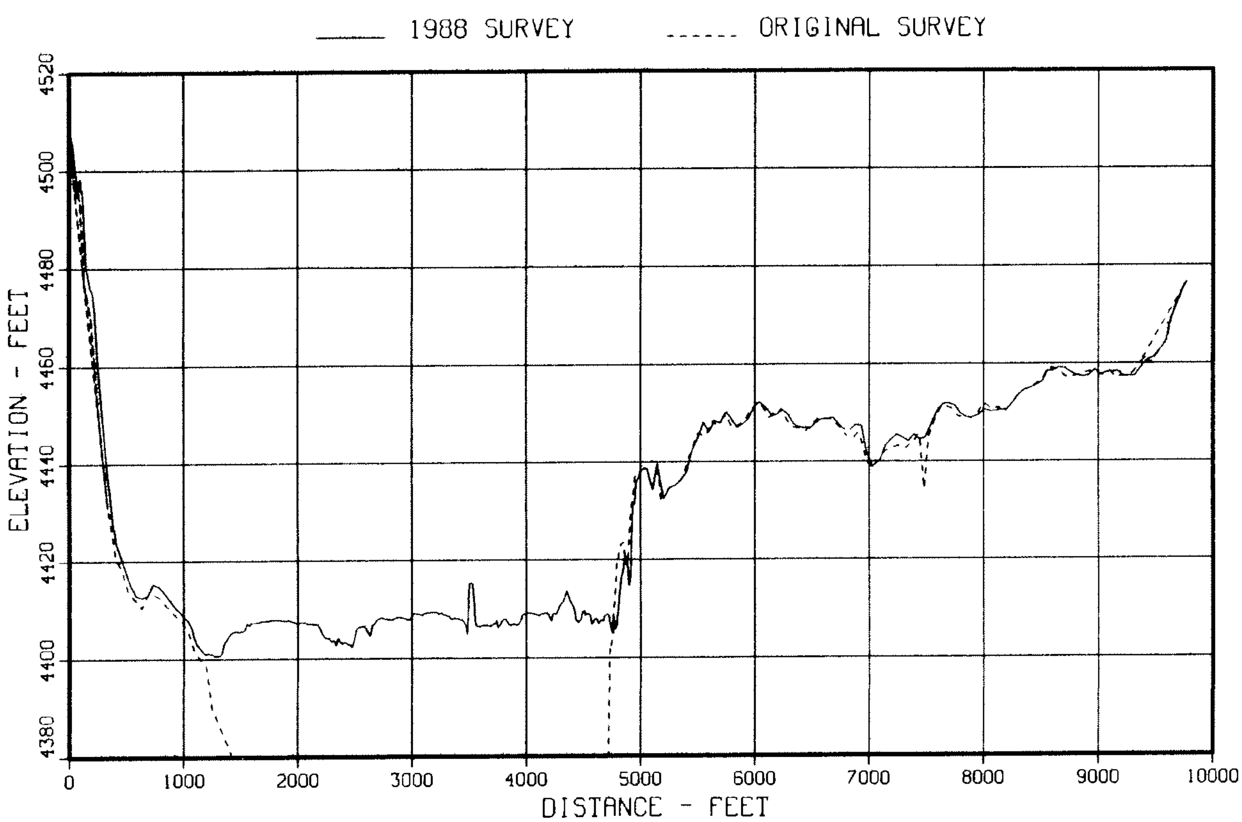


Figure 84. — Sedimentation range profiles for 1915 and 1988, range 24.

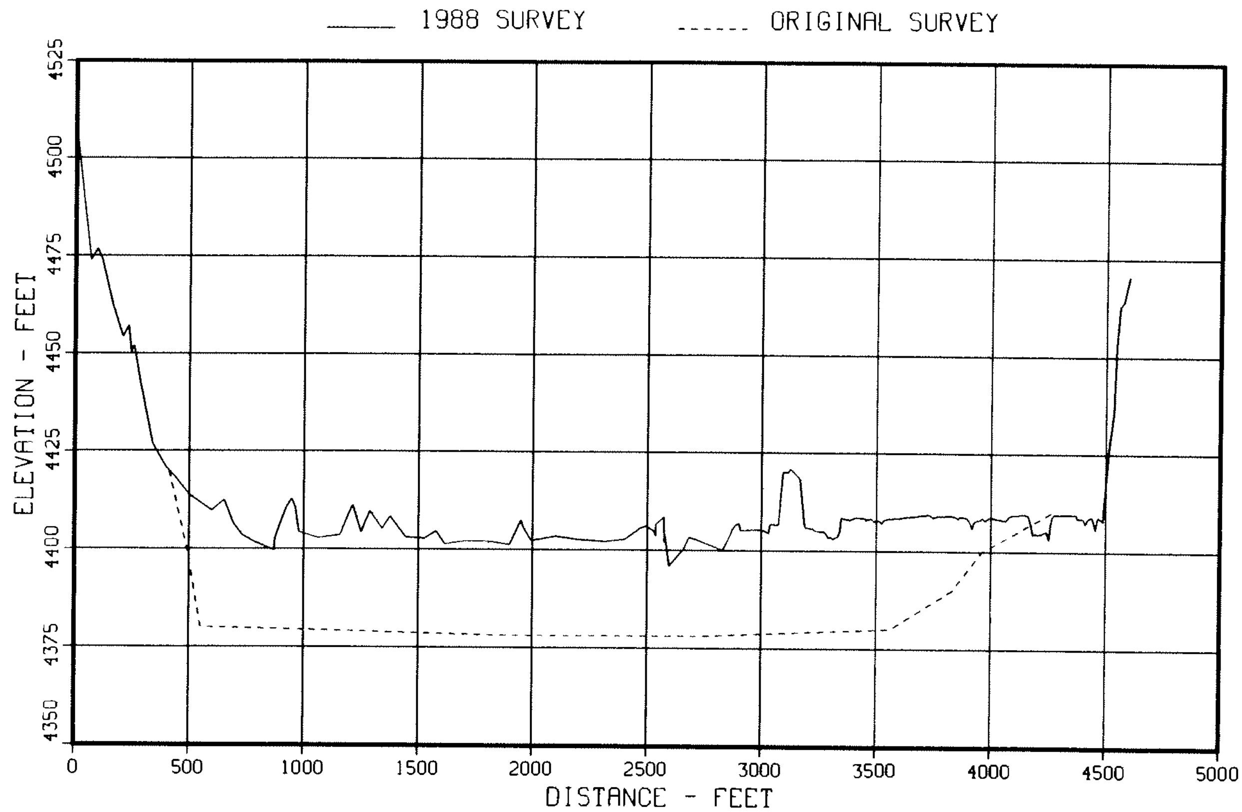


Figure 85. — Sedimentation range profiles for 1915 and 1988, range 23.

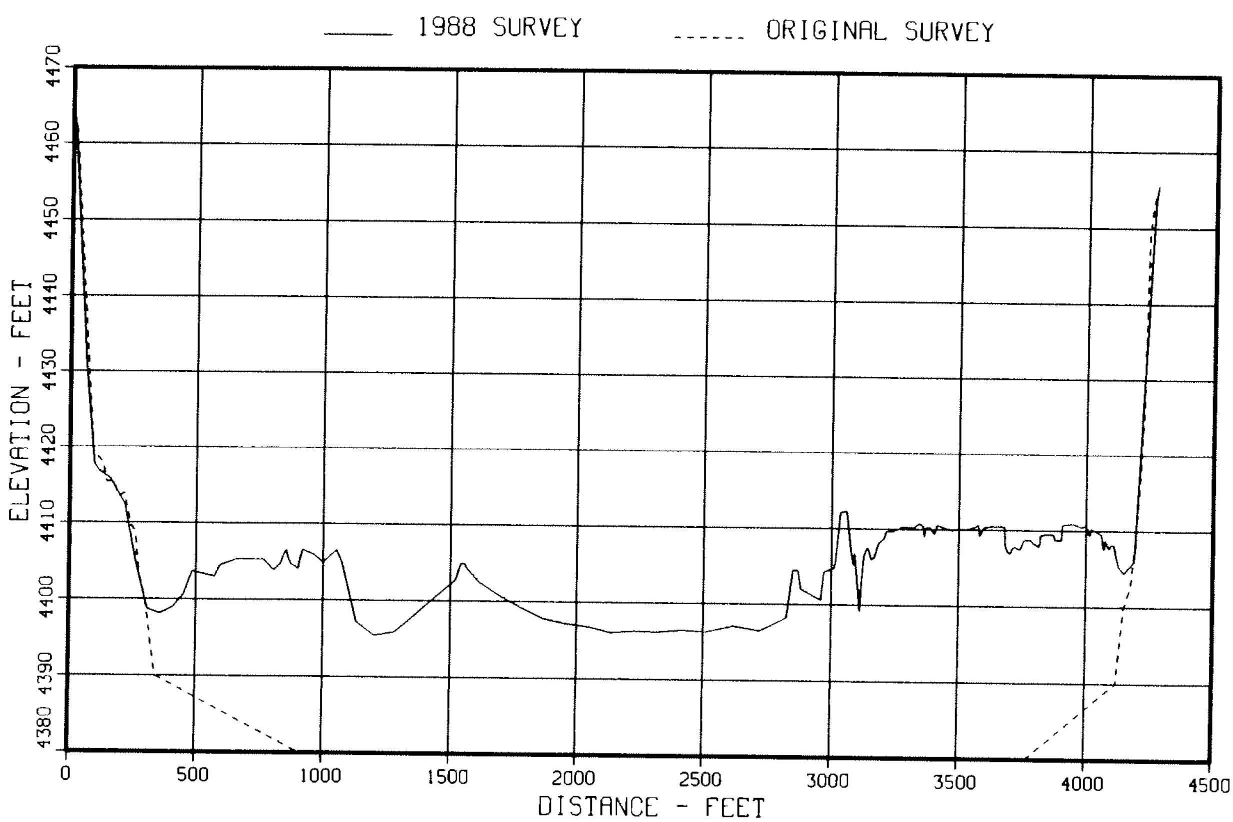


Figure 86. — Sedimentation range profiles for 1915 and 1988, range 34.

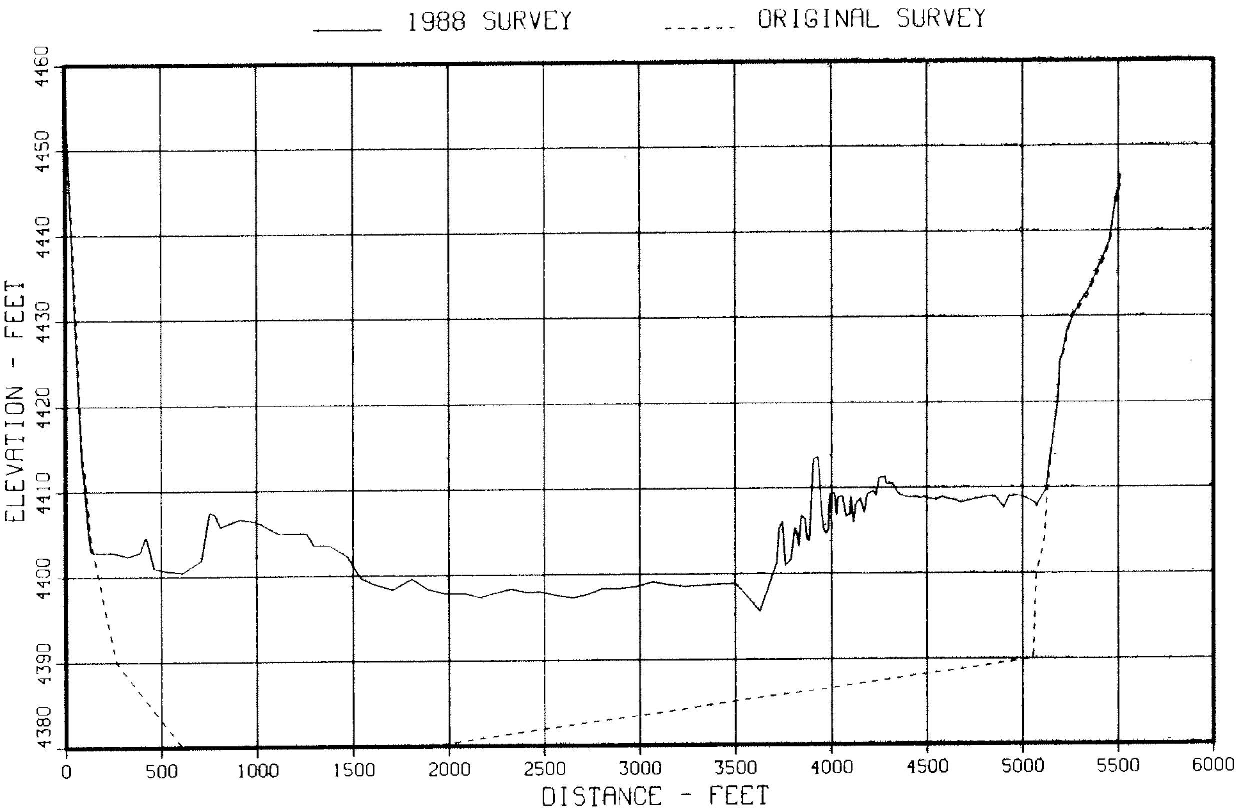


Figure 87. — Sedimentation range profiles for 1915 and 1988, range 22.

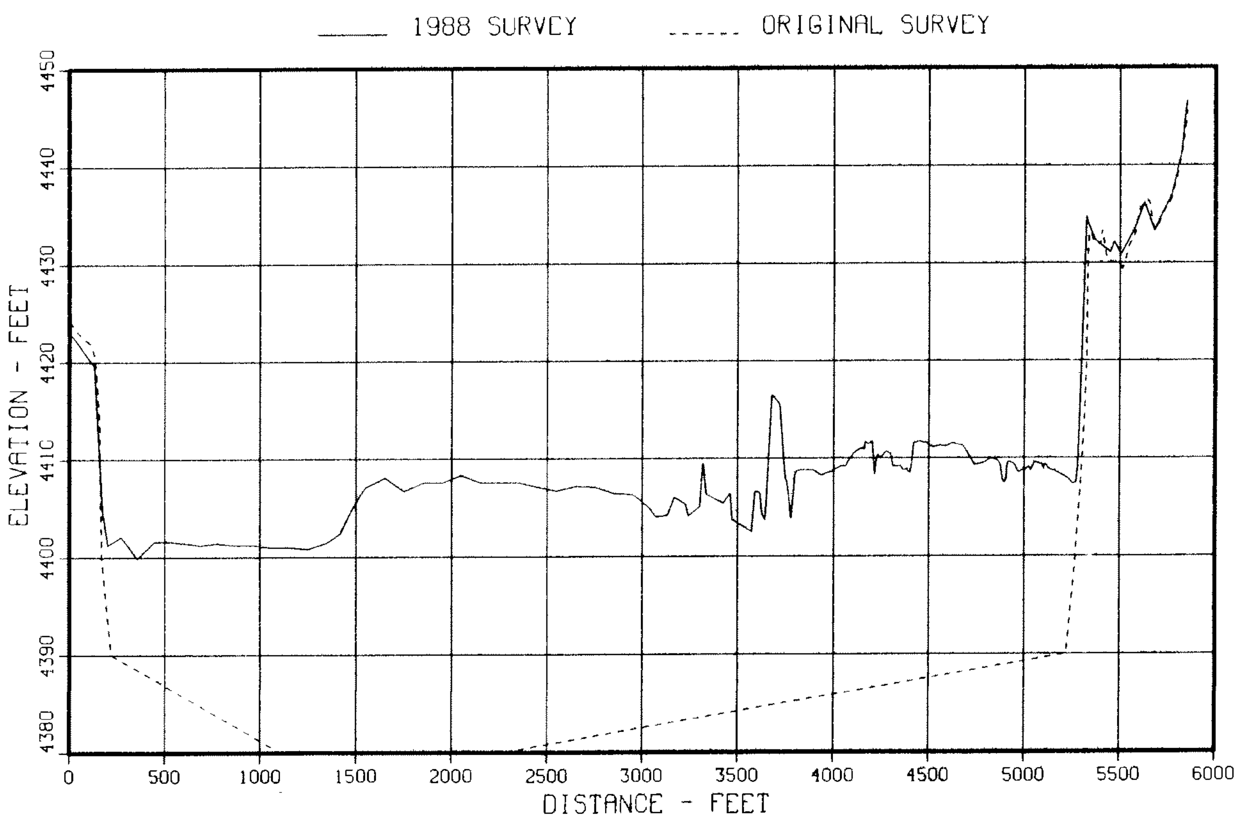


Figure 88. — Sedimentation range profiles for 1915 and 1988, range 21.

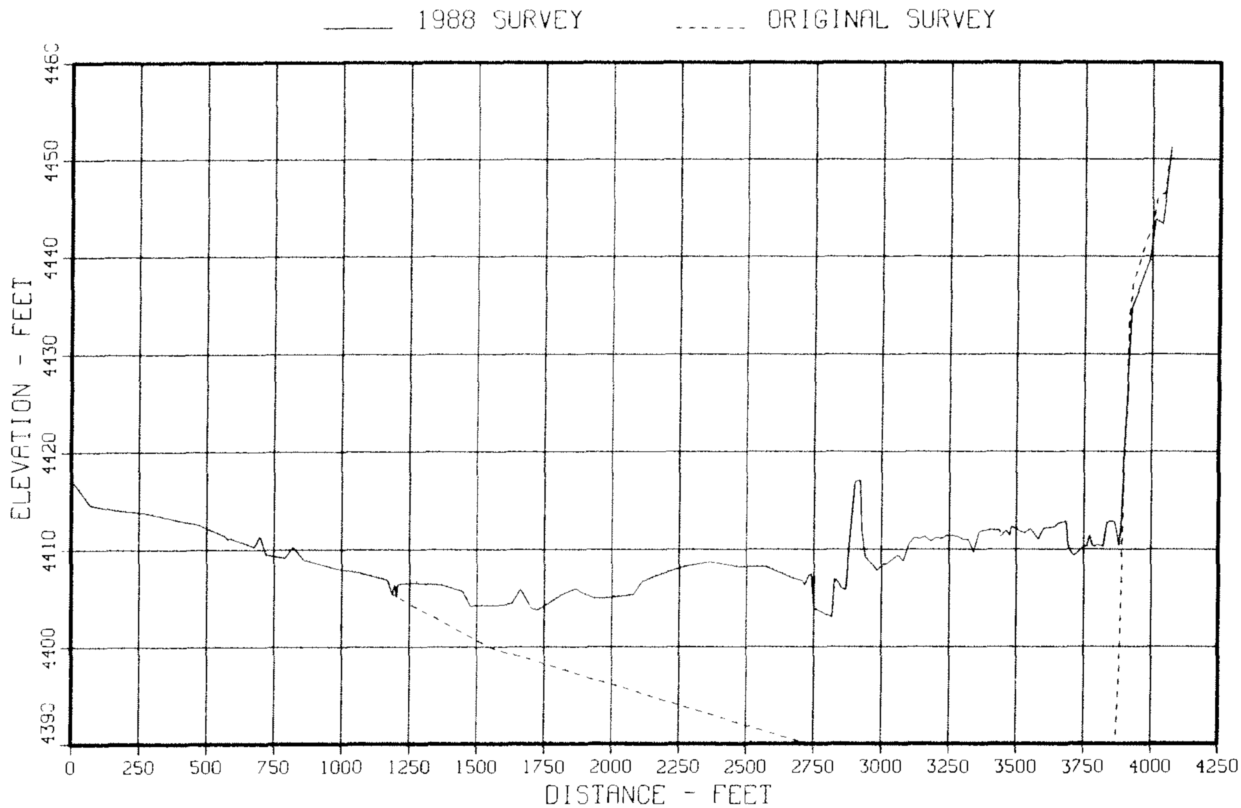


Figure 89. — Sedimentation range profiles for 1915 and 1988, range 20.

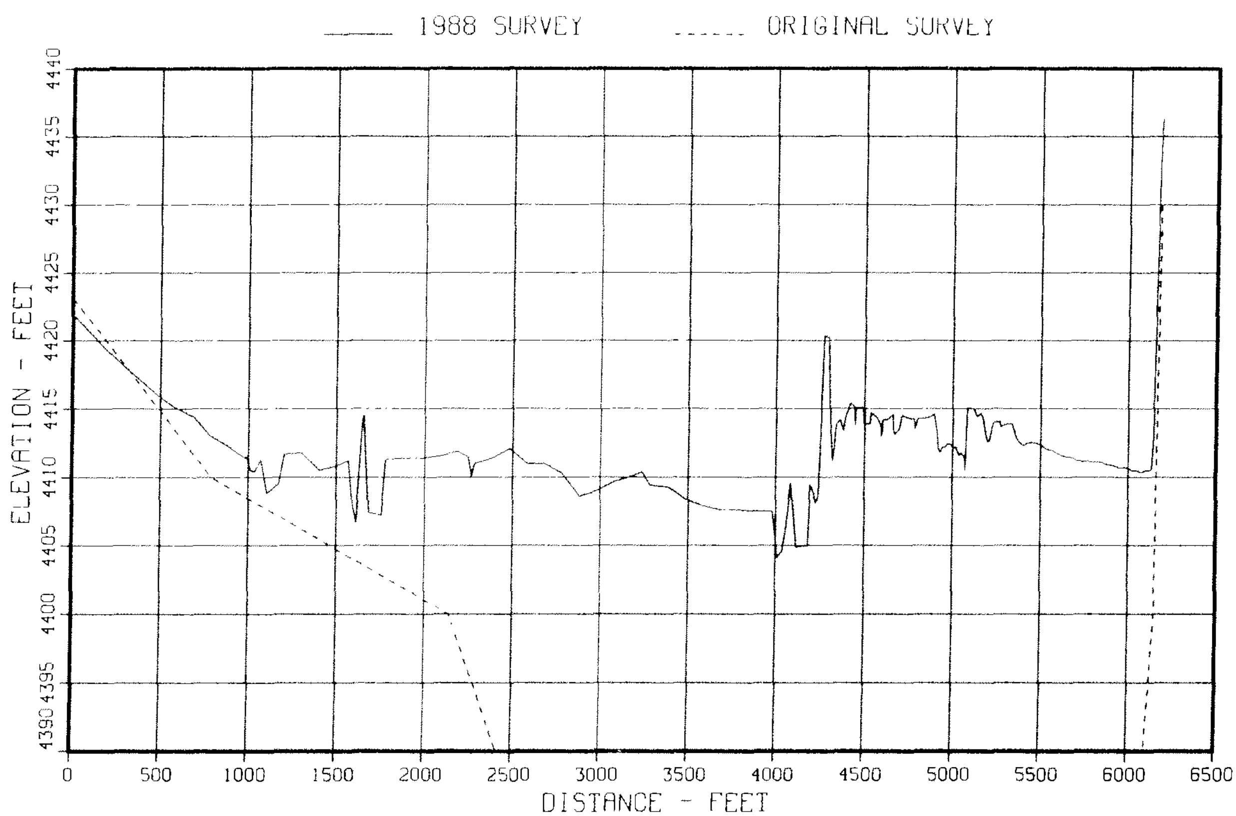


Figure 90. — Sedimentation range profiles for 1915 and 1988, range 19.

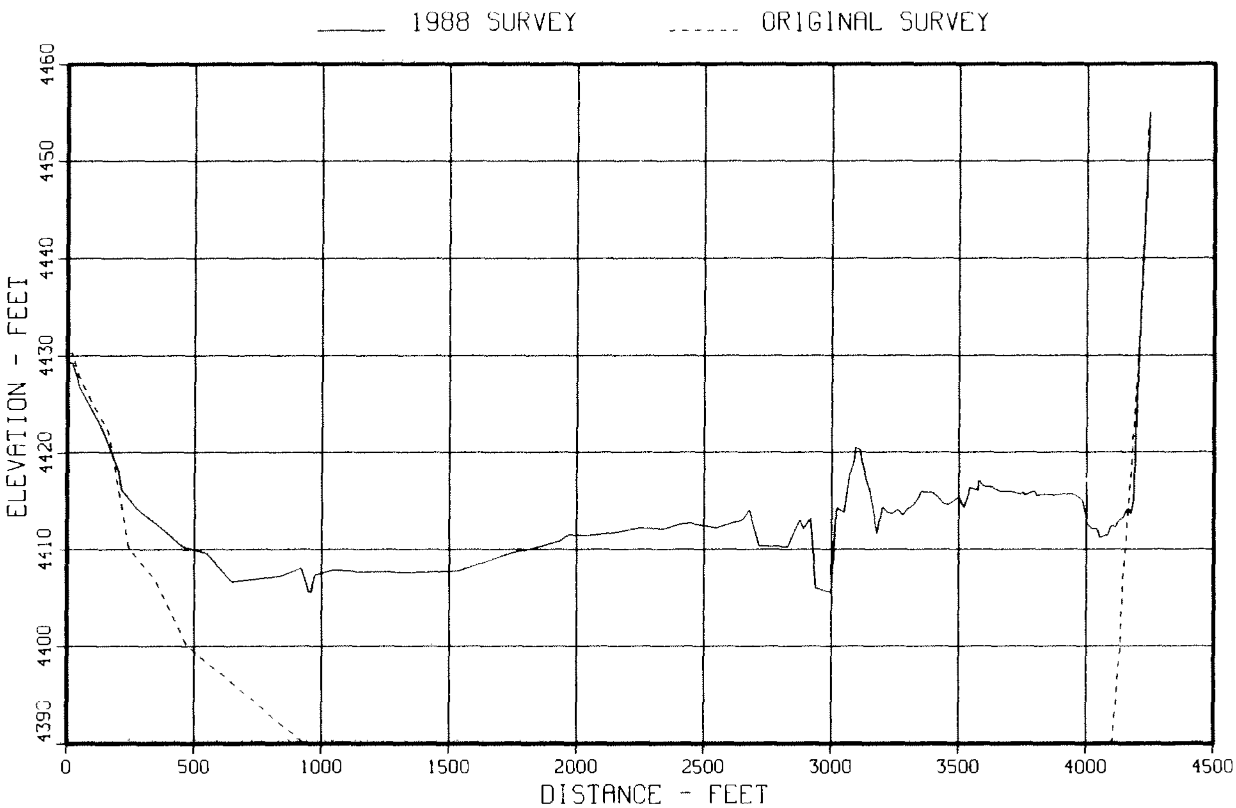


Figure 91. — Sedimentation range profiles for 1915 and 1988, range 18.

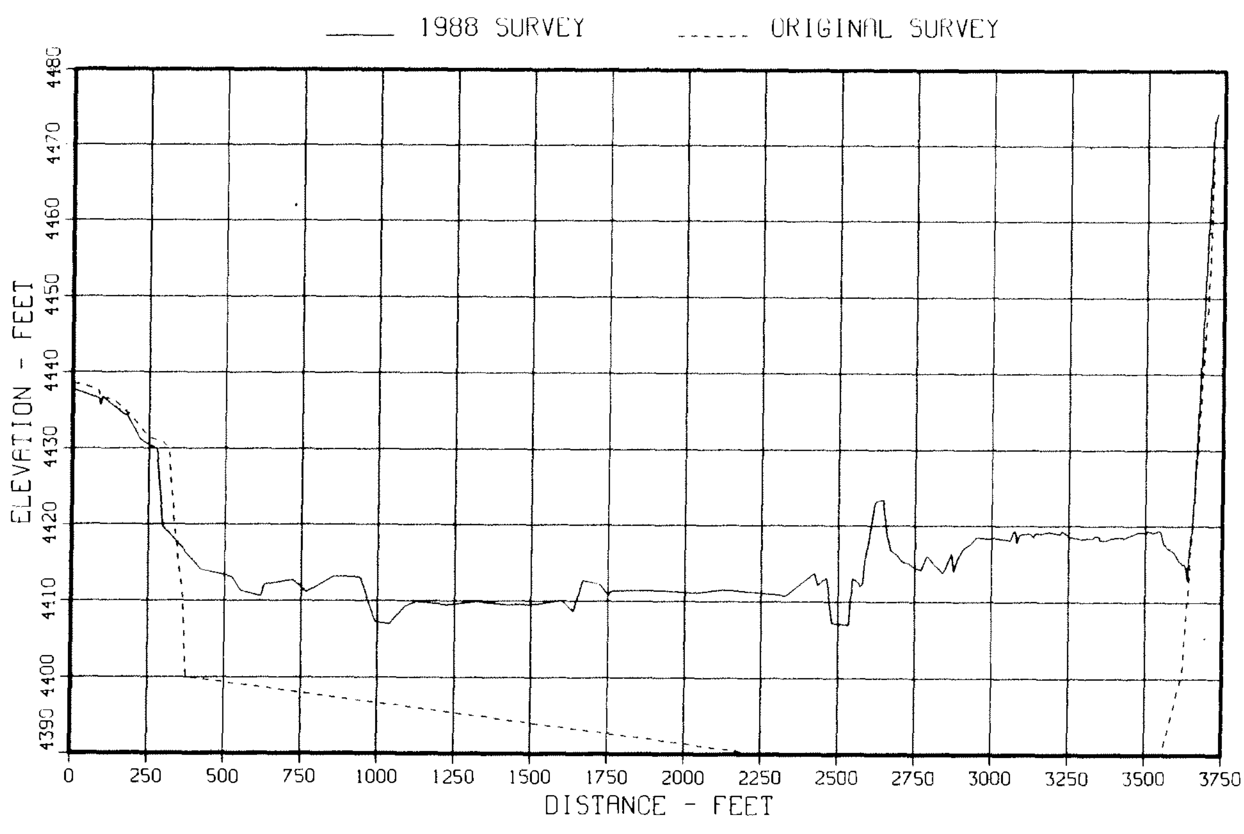


Figure 92. — Sedimentation range profiles for 1915 and 1988, range 17.

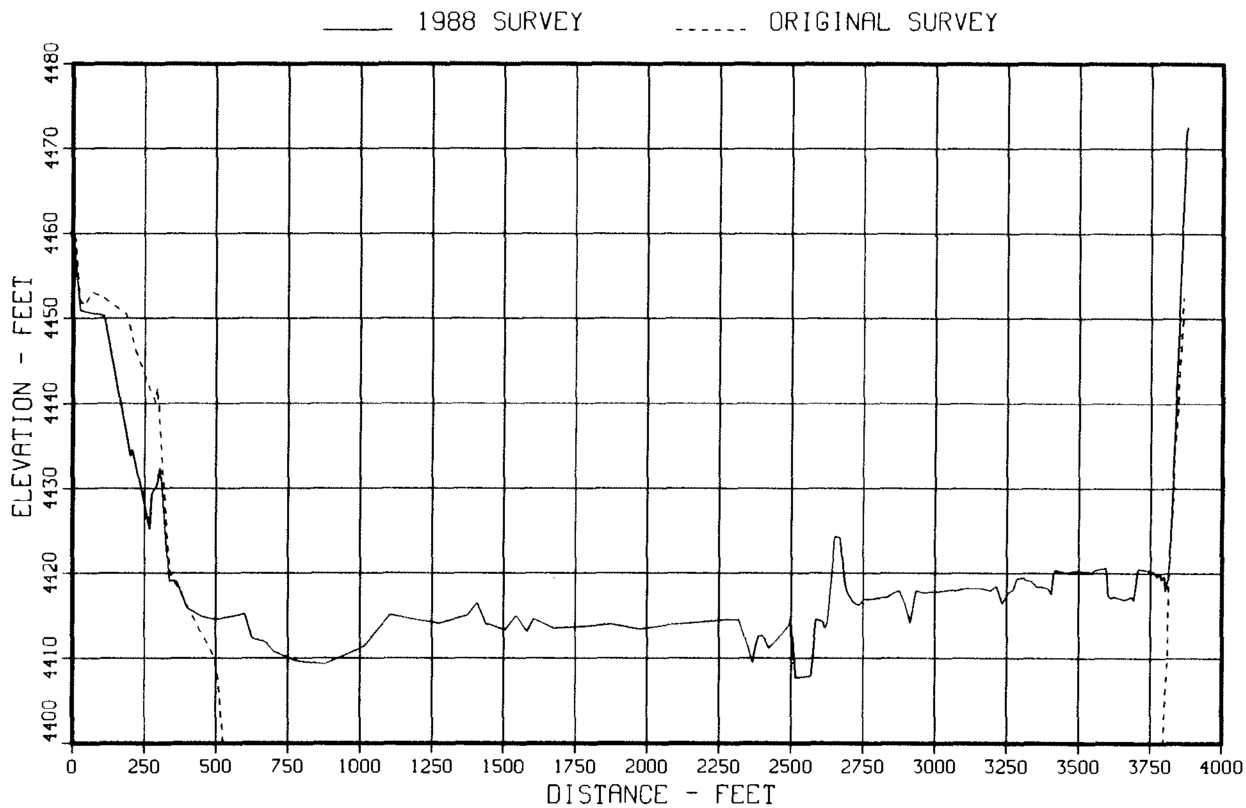


Figure 93. — Sedimentation range profiles for 1915 and 1988, range 16.

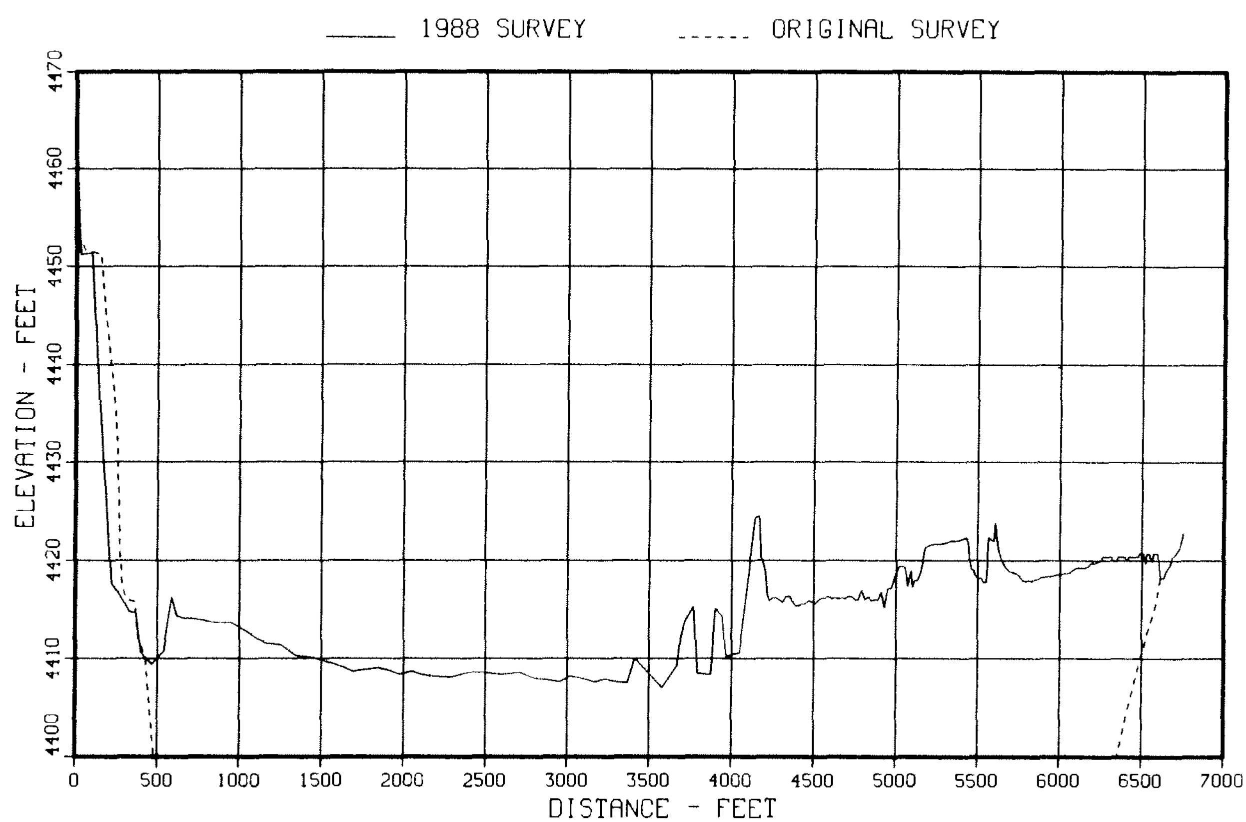


Figure 94. — Sedimentation range profiles for 1915 and 1988, range 15.

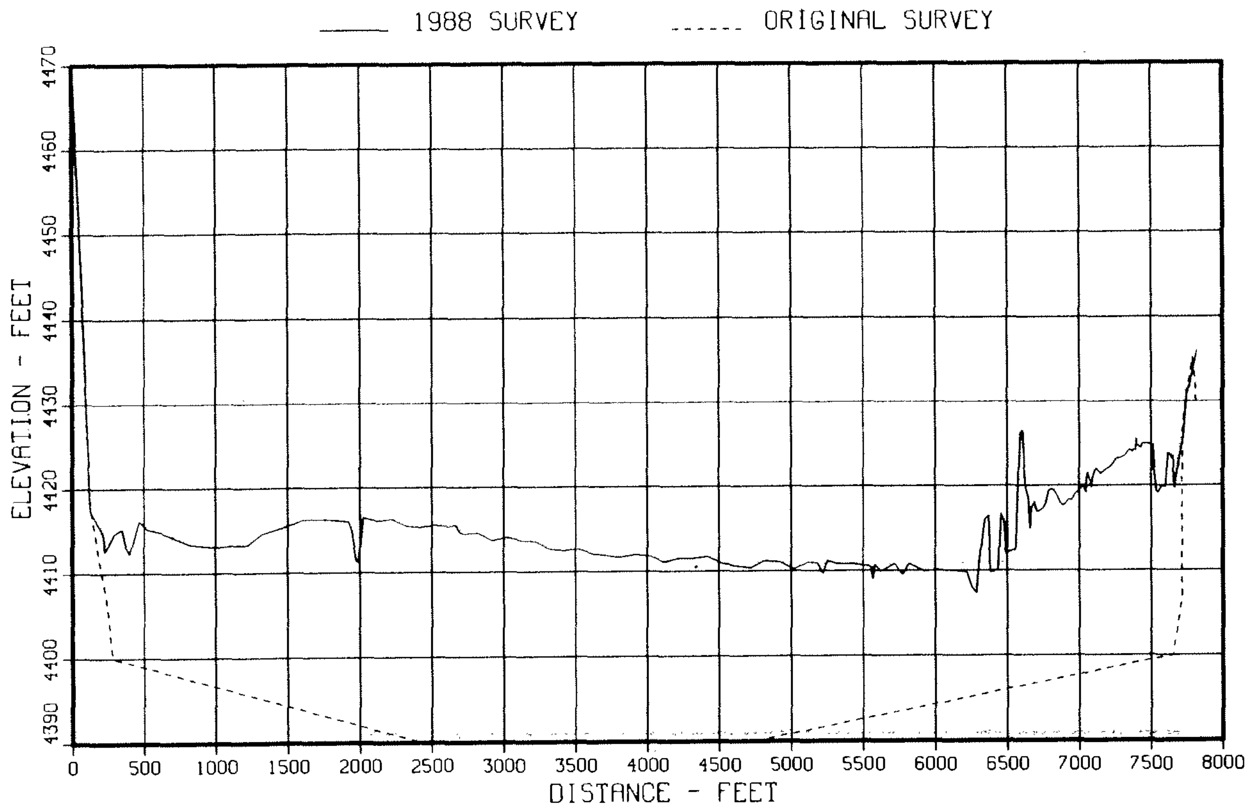


Figure 95. — Sedimentation range profiles for 1915 and 1988, range 14.

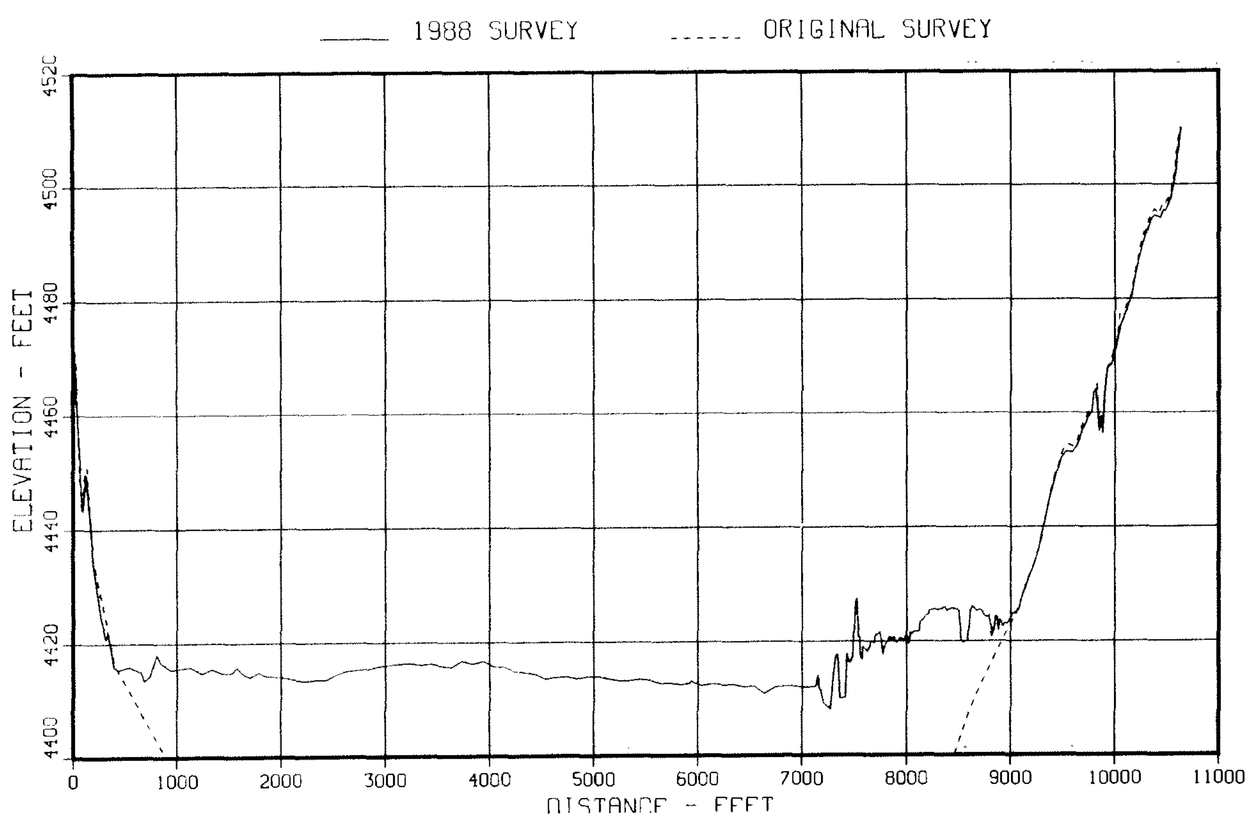


Figure 96. — Sedimentation range profiles for 1915 and 1988, range 13.

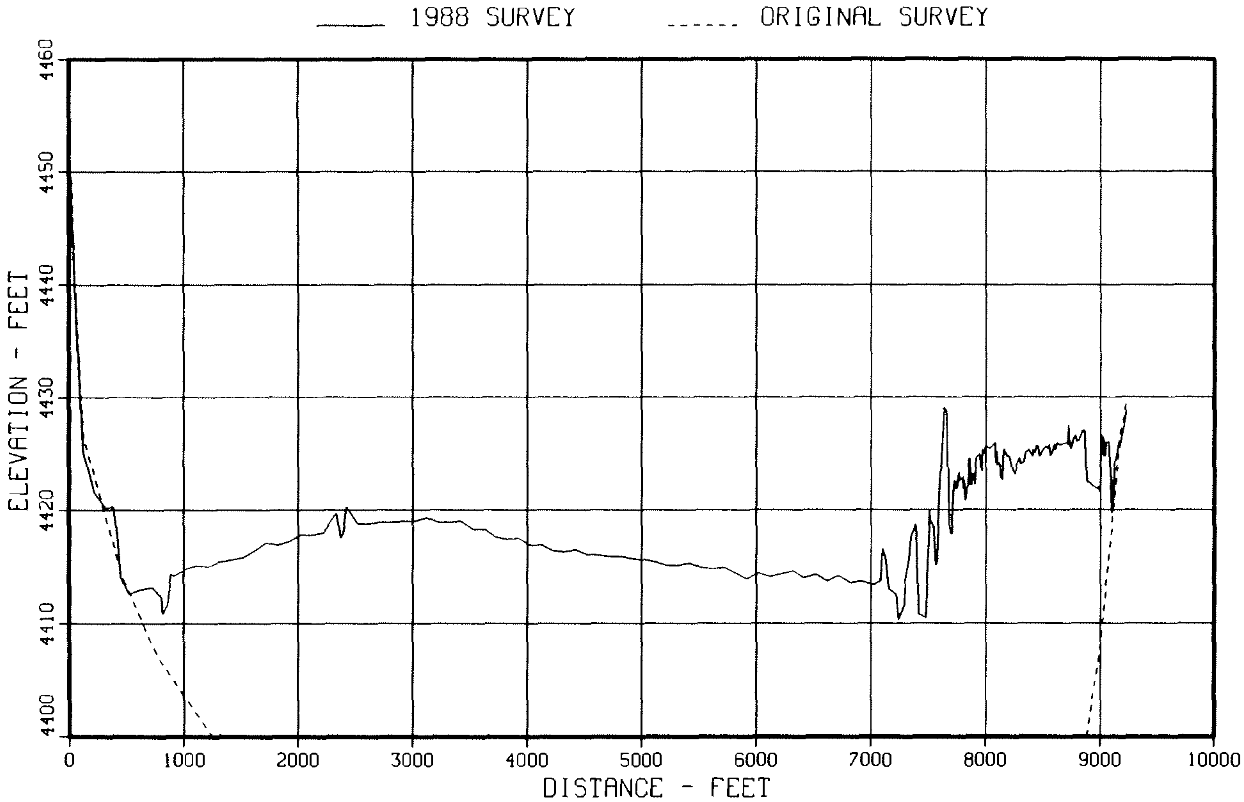


Figure 97. — Sedimentation range profiles for 1915 and 1988, range 12.

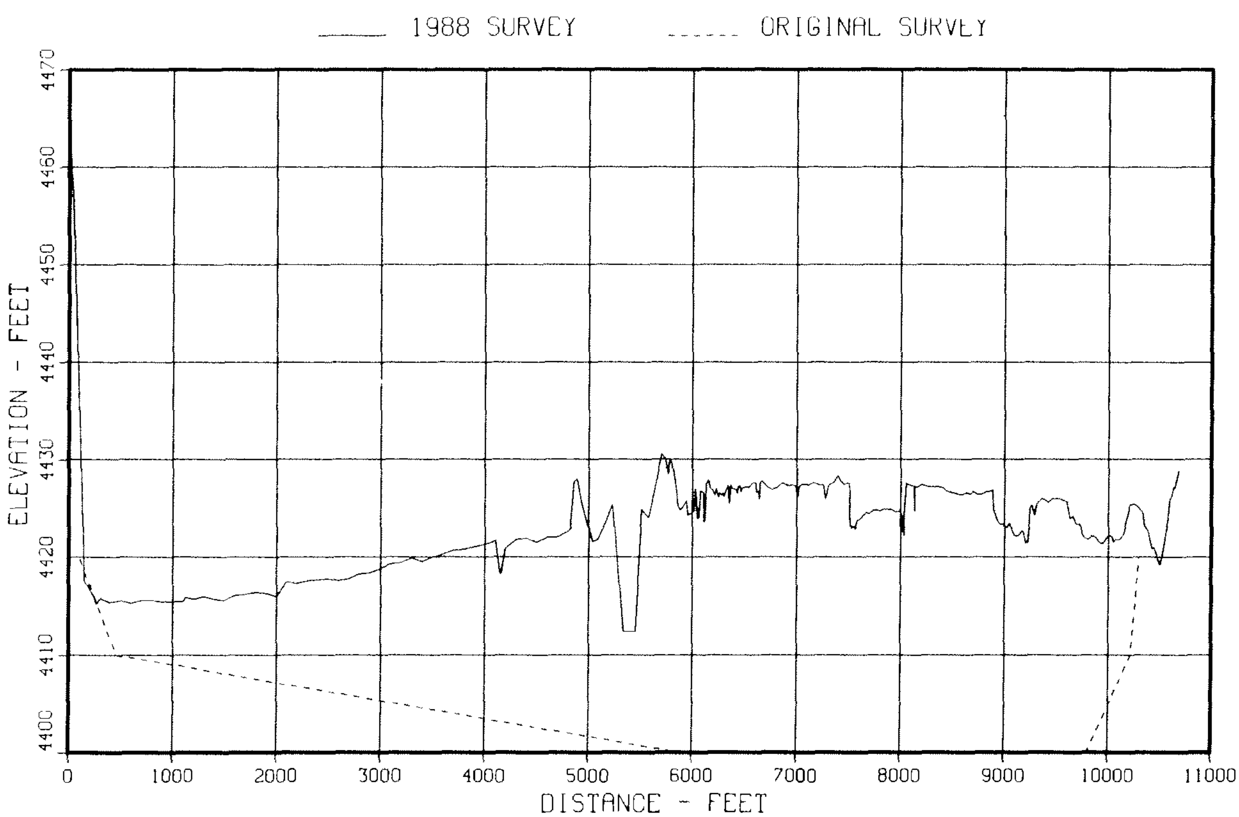


Figure 98. — Sedimentation range profiles for 1915 and 1988, range 11.

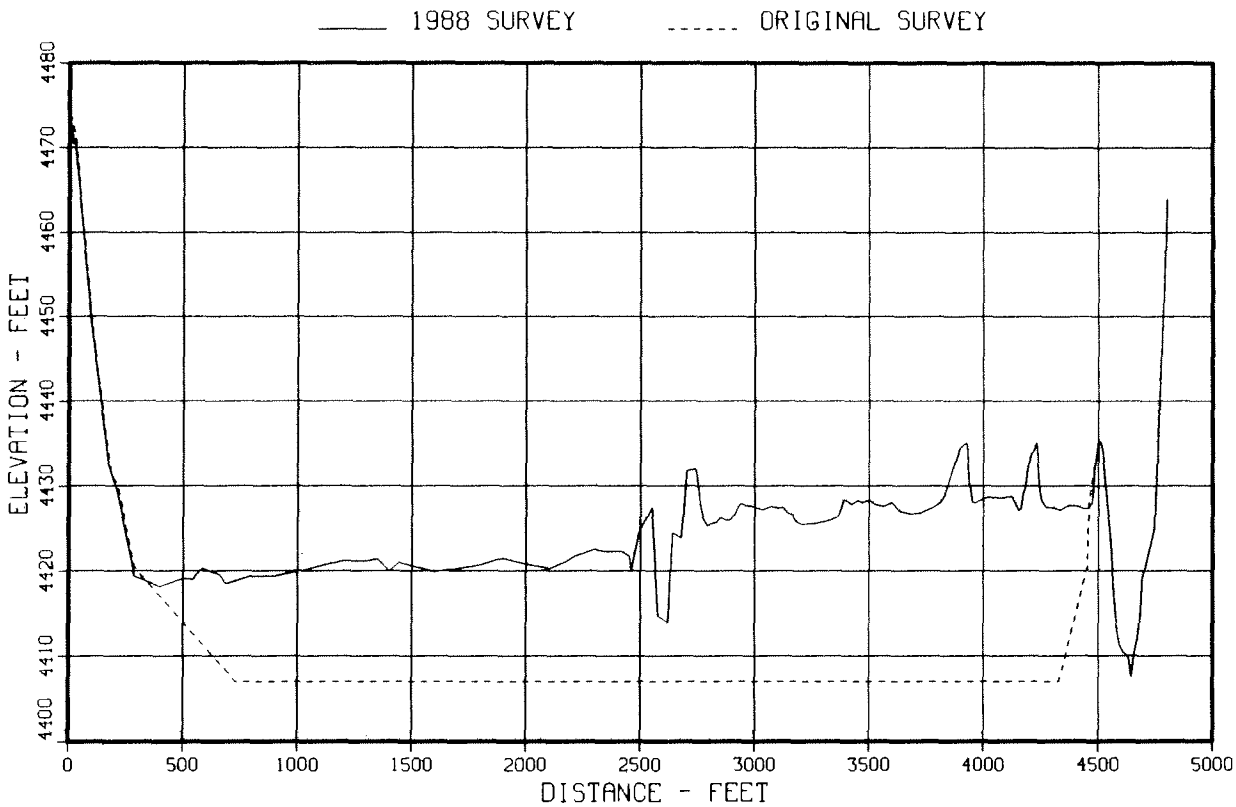


Figure 99. — Sedimentation range profiles for 1915 and 1988, range 10.

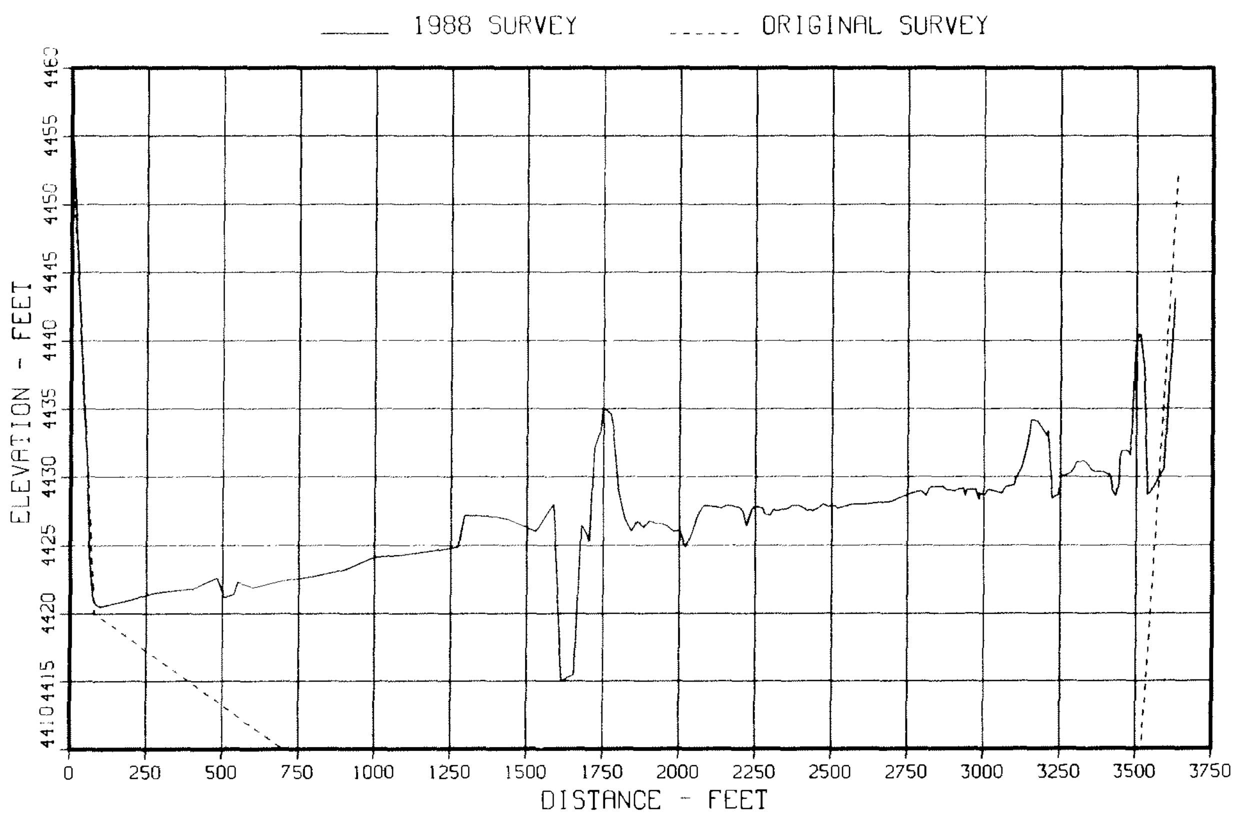
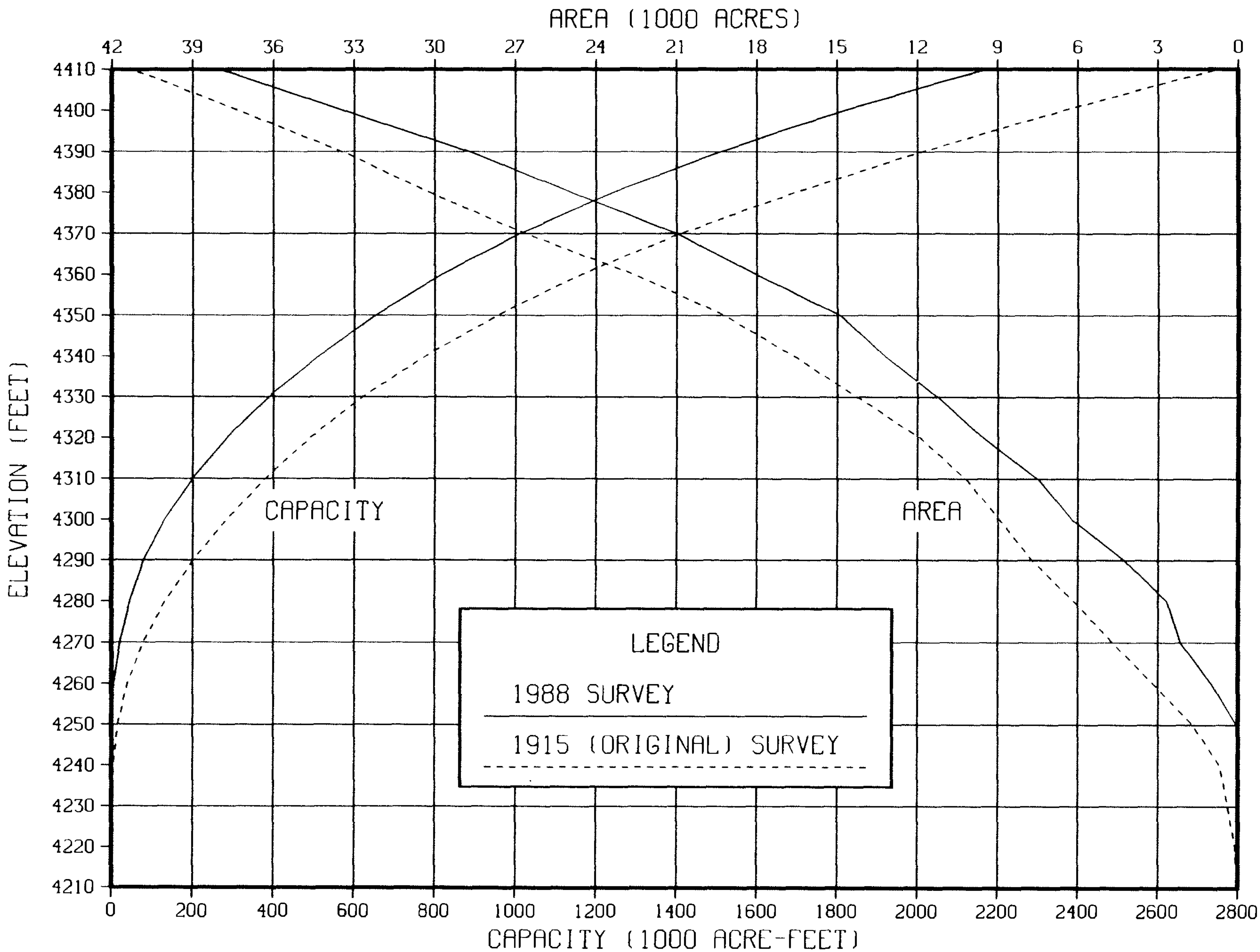


Figure 100. — Sedimentation range profiles for 1915 and 1988, range 9.



Note: Add 43.3 feet to adjust to mean sea level elevation.

Figure 101. — Area-capacity curves for Elephant Butte Reservoir.

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Mission of the Bureau of Reclamation

The Bureau of Reclamation of the U.S. Department of the Interior is responsible for the development and conservation of the Nation's water resources in the Western United States.

The Bureau's original purpose "to provide for the reclamation of arid and semiarid lands in the West" today covers a wide range of interrelated functions. These include providing municipal and industrial water supplies; hydroelectric power generation; irrigation water for agriculture; water quality improvement; flood control; river navigation; river regulation and control; fish and wildlife enhancement; outdoor recreation; and research on water-related design, construction, materials, atmospheric management, and wind and solar power.

Bureau programs most frequently are the result of close cooperation with the U.S. Congress, other Federal agencies, States, local governments, academic institutions, water-user organizations, and other concerned groups.

A free pamphlet is available from the Bureau entitled "Publications for Sale." It describes some of the technical publications currently available, their cost, and how to order them. The pamphlet can be obtained upon request from the Bureau of Reclamation, Attn D-7923A, P O Box 25007, Denver Federal Center, Denver CO 80225-0007.