

FRESNO RESERVOIR

1978 SEDIMENTATION SURVEY



Department of the Interior



Bureau of Reclamation

FRESNO RESERVOIR

1978 Sedimentation Survey

Hydrology Branch
Division of Planning
Upper Missouri Regional Office

U.S. Department of the Interior
Bureau of Reclamation
Billings, Montana

May 1984

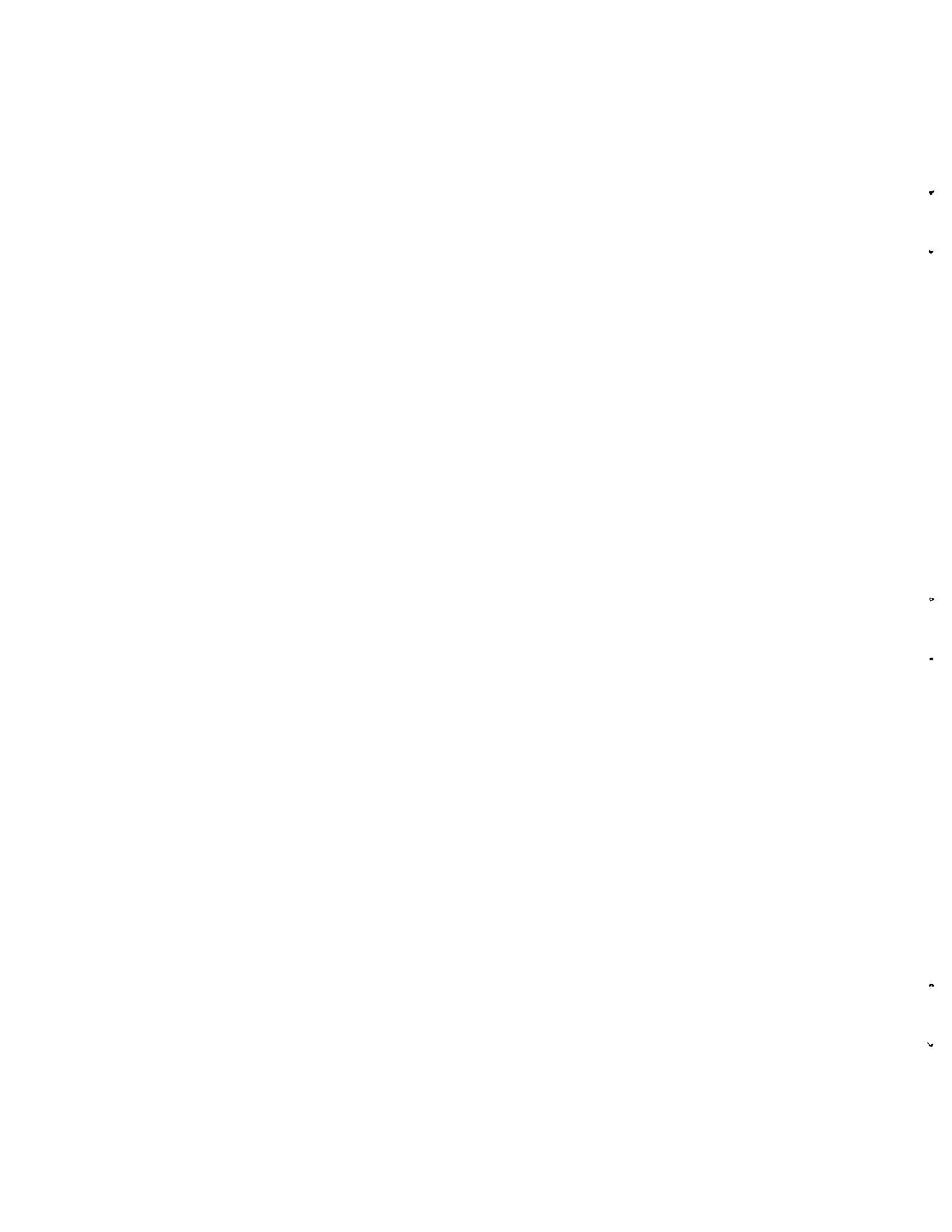


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INTRODUCTION

Fresno Dam and Reservoir is located on the Milk River about 13 miles upstream or west of Havre in north-central Montana. Construction by the Bureau of Reclamation was completed in 1939. The original surface area of Fresno Reservoir in 1939 was 5,760 acres and the capacity was 129,062 acre-feet at the water surface elevation of 2575.0 feet. The 1978 survey resulted in a surface area of 4,878 acres and a capacity of 103,397 acre-feet at the same water surface elevation. Fresno reservoir is the principal storage component of the 124,200-acre Milk River Project. Location of the project features is shown on the project map (Figure 1). Figure 2 shows plan and section views of Fresno Dam.

The drainage area above Fresno Dam is 3,766 square miles, of which 3,096 square miles is the net sediment contributing area. Elevations range from slightly more than 2,500 feet near the dam to about 10,000 feet on the western fringe, but only a very small part of the area is higher than 5,000 feet.

The Milk River rises in the mountains of Glacier National Park and flows northeasterly into Canada. It then flows easterly more than 200 miles through the Province of Alberta and recrosses the International Boundary in northwestern Hill County, Montana, where it travels a southeasterly course to Fresno Reservoir. Below Fresno, the Milk River flows easterly and empties into the Missouri River below Fort Peck Reservoir in northeastern Montana. The western fringe of the drainage is mountainous, but the major part of the area ranges from steeply to gently rolling topography. Through the irrigation season, the flow of the Milk River above Fresno is augmented by water from the St. Mary River which flows into the Milk River via the St. Mary Canal. The St. Mary River water is diverted at a point below Lake Sherburne, near the boundary of Glacier National Park, and flows through the St. Mary Canal to the headwaters of the North Fork of the Milk River.

Sedimentation has long been recognized as a serious problem in the Milk River. Indeed, the river was named for the opaque appearance of its water. Bank sloughing and channel alteration have been observed along the entire length. The specific amount of sediment accumulation in Fresno Reservoir had not been determined prior to this resurvey, but it was known to be significant.

In the years immediately preceding the resurvey two events occurred to bring attention to the sedimentation problem. One was the claim initiated by the Canadian government that the additional flow of St. Mary River water in the Milk River had caused widespread bank erosion and accompanying loss of valuable farm land and improvements. The other was complaints of boaters at Fresno Reservoir running aground on sand bars or islands, even in the lower or deeper parts of the reservoir. It therefore became apparent that a reservoir resurvey was needed at Fresno Reservoir.

Both 1976 and 1977 were low runoff years and Fresno Reservoir was drawn down to nearly empty in mid-July 1977. The extreme drawdown presented an excellent opportunity for aerial photography for a resurvey. A contract was issued and aerial photography was performed in October

1977. The underwater measurements were made in the spring of 1978. Both parts of the fieldwork are discussed elsewhere in this report. Because the survey was completed in 1978, it is henceforth referred to as the 1978 resurvey.

The 1978 sediment resurvey was the first since Fresno Dam was completed in 1939. This report has been written to document the field survey methods and computational procedures used to obtain the elevation-area-capacity curves and tables presented in this report. Comparison of these curves with the original elevation-area-capacity curves is made to show the effects of over 38 years of sedimentation in Fresno Reservoir. Because sediment ranges were not established when the dam and reservoir were completed and the topography used for the original area-capacity tables could not be located, the extent of analysis that could be performed was limited.

SURVEY METHODS

Aerial Survey

When the decision to conduct a reservoir resurvey was made during the irrigation season of 1977, a number of actions were initiated. The sediment ranges were located on 1:24,000 (7½-minute) quadrangle sheets by Regional and E&R Center personnel. Figure 3 is an index map for Figure 4 (sheets 1-4) that show the location of these sediment ranges. The sediment ranges were field located and control panels for aerial photography placed by surveyors from the Upper Missouri Projects Office. Horizontal and vertical control used for the sediment resurvey is shown in Table 1. A contract to conduct the aerial survey was awarded to Delta Aerial Surveys, Denver, Colorado.

The aerial photographs were taken in October 1977. Fieldwork to establish the horizontal and vertical coordinates of the control panels was continued in the winter and spring of 1978. After receiving the ground control data, the contractor measured the cross sections from the aerial photography. The data furnished by the contractor was in the form of punched cards which were ready for computation by automatic data processing.

Underwater Survey

The underwater portion of the reservoir resurvey was done by Bureau personnel in May and June 1978. Measurements of depth were made at Ranges 1 through 10, 40, 50, and 51. The remainder of the sediment ranges were either dry at the time of the aerial survey or were surveyed using conventional land surveying techniques.

The fieldwork for the underwater survey was performed in two sessions. In general, the first session was used to prepare for a smooth, efficient operation when the actual underwater measurements were made. This session was used to assemble and check out the equipment for the underwater measurements. The boat and Electronic Distance Measuring Device (EDMD) were operated for familiarization. The sediment range lines had been located and marked by field personnel prior to the aerial photography. Since these markers were located on the top of bluffs overlooking the reservoir, it was necessary to establish a point on line near the edge of the water for use as an instrument station when the underwater measurements were made.

The second session consisted of profiling the underwater portion of the sediment range lines. The water depths were measured with a boat-mounted depth sounding device that operates on the sonar principle. This instrument, supplied by the sedimentation section of the E&R Center, prints a continuous trace of depth as the boat travels across the water surface along the range line. A vertical line is drawn on the chart on command to mark distances, scales, etc. and handwritten notes may be entered on the chart to aid interpretation. Distances along the range line (offsets) were measured using an Electronic Distance Measuring Device (EDMD). The instrument used for the Fresno Reservoir resurvey was chosen because it could be operated in a dynamic or tracing mode

and also because it provided for voice communication between the stationary and mobile units, or, in this case, the shore station and the boat.

The procedure used in profiling the underwater portion of each line was as follows:

The stationary unit of the EDMD and a transit were located on the range line on the right bank and as close to the edge of water as practical. The flags set during the preliminary session were used for references. The distance along the range line (offset) to the edge of water was measured with a tape. The first few shallow underwater measurements were made by sounding with a level rod and the offset distances measured by tape from the reference flag. The boat containing the sounding gear and dynamic part of the EDMD was located on-line by transit and the EDMD and depth sounder turned on. With the electronic instruments functioning, the boat was set in motion and proceeded across the reservoir at a moderate rate. The boat was kept on-line by the transit operator communicating with the boat operator by voice through the EDMD. The EDMD operator on board the boat monitored the distance the boat traveled and informed the sounding operator to mark the chart at the appropriate points. When the boat reached the left bank, any needed shallow measurements were made by sounding with a rod and the distance to the left range marker measured by tape. This last distance measurement was made to check the distances read by the EDMD.

RESERVOIR AREA AND CAPACITY COMPUTATIONS

Data Preparation

As discussed previously, cross section data were obtained from two different sources, aerial photography and sonar readings, which were taken at different times. These data had to be combined to obtain complete cross sections. This combination of data was accomplished in the following manner.

At the time the aerial photography was done, October 1977, the water surface in Fresno Reservoir was at approximately 2547.0 feet. The following spring when the sonar readings were taken the water surface had risen to approximately 2570 feet. Because of this difference in water surface, offset and elevation data were obtained by both methods for approximately 23 vertical feet. This overlap of data offered a means to compare the data and insure that the data sets were indeed compatible. The cross section data taken by both methods were plotted to the same scale on separate sheets. Separate sheets were used because the field data were measured from different datums, or zero, for offsets and from opposite sides of the reservoir. The two plots for each range were superimposed or overlaid for comparison. In all cases, the slopes on both sides compared quite closely with only small variations in individual segments. The distances across the reservoir, as indicated by the two sets of data, varied slightly, generally 1 to 2 percent. These minor differences can be explained by the fact that the measurements may not have been taken on exactly the same line. It is also possible that the elevations determined from photographs taken when the soils were dry may differ slightly, due to shrink-swell factors, from those determined by sounding when the material was saturated. Since the differences were minor, the data were accepted. The data from the underwater survey were used to complete the cross sections at each sediment range.

Cross section data were provided between the sediment range lines at even 500-foot stations by the aerial survey contractor. The underwater portion of each intermediate cross section was completed graphically using the upstream and downstream ranges as a guide.

Plots of the complete sediment range cross sections are shown in Figures 5 through 52.

Elevation-Area-Capacity Computations from Cross Section Data

Cross section data were used to compute areas and volumes at 1-foot elevation increments. The computations were performed on a digital computer using Program 268, Elevation-Area-Capacity Tables, written by personnel of the Division of Data Processing, Mid-Pacific Region, Bureau of Reclamation, Sacramento, California. This program uses the double-end area method to compute the volume between two planes, the end areas being the horizontal areas of segmental water surfaces derived for particular increments of elevation. The area of the water surface between two cross sections at a given elevation is computed by calculating

the width of the water surface at the two stations (obtained from the cross section data) and multiplying the average of these widths by the distance between the two stations. Incremental volume is obtained by averaging the area at consecutive elevations and multiplying by the elevation increment (1 foot in this case). The areas and volumes between each set of cross sections along the centerline are accumulated to provide the complete table.

The cross section data for Fresno Reservoir included several sets of cross sections taken normal to the centerlines of several tributaries as well as the main reservoir and river.

Computation of Final Elevation-Area-Capacity Tables

The final elevation-area-capacity tables in 1-, 0.1-, and 0.01-foot elevation increments for Fresno Reservoir were generated using the Bureau of Reclamation computer program ACAP. The elevation-area data generated by Program 268 at 1-foot elevation increments were used as input to program ACAP. In ACAP, respective capacities and capacity equations are obtained by integration of the area equations defined by the input data. The initial capacity equation is tested over successive intervals to check whether it fits within an allowable error term. This one equation is used over the whole range that fits within this error term. At the next interval, a new capacity equation (integrated from the basic area equation over that interval) begins testing the fit until it too exceeds the error term. The capacity curve thus becomes a series of curves, or splines, each fitting a certain region of data. The final area equations are obtained by differentiation of the capacity equations. Capacity equations are of the form $y = a_1 + a_2x + a_3x^2$ where y is the capacity and x is the elevation above an elevation base. A sufficiently small error term was selected for this application such that the generated area and capacity values differed from the input calculated by Program 268 by less than 1 percent.

The final elevation-area values are shown in Tables 2 and 3 for 1- and 0.1-foot elevation increments, respectively. The elevation-capacity values are shown in Tables 4, and 5 for 1-, and 0.1-foot elevation increments, respectively. Areas and capacities were also computed at the 0.01-foot increments but are not included in this report. The area-capacity curves are shown on Figure 53.

SEDIMENTATION ANALYSES

Sedimentation Accumulation

Sediments have accumulated in Fresno Reservoir to a total volume of 25,665 acre-feet at elevation 2575.0 feet, top of spillway crest, since the dam was built over 38 years ago. An average annual accumulation rate of 663.2 acre-feet was computed for the period since closure (38.7 yrs). Sediments from the drainage area were deposited at a rate of 0.214 acre-foot per square mile per year.

The original elevation-area-capacity tables for Fresno Reservoir, dated 1953, are based on preconstruction (1934) data. The 1978 resurvey is the first evaluation of sediment accumulation in Fresno Reservoir. In several of the figures and tables that follow, useful comparison between the resurveyed and original reservoir is precluded by the lack of original survey data. In Figure 54 the original area-capacity curves are plotted against the 1978 resurvey curves. This plot is useful in visualizing the total loss in capacity at various elevations.

It should be noted that these sediment accumulation values are obtained from comparison with the original capacity tables. These original tables were based on areas planimetered from 5-foot interval contours. However, the original topographic maps could not be located and their accuracy or detail is unknown. Sediment samples were not taken at the time of the 1978 sediment resurvey. The absence of this data limits the conclusions that may be drawn from the available data.

There are only scattered sediment load data for the Milk River above Fresno Reservoir and accurate prediction of sediment yield is not possible. However, a memorandum from the Chief, Sedimentation Section to the Chief of the Hydrology Branch, E&R Center, dated February 21, 1968, Subject "Safety of Dams - Fresno Dam Tailwater - Milk River Project, Montana, Examination of Existing Structures" contains an estimate of 0.20 to 0.35 acre-feet per square mile annually, or approximately 550 to 1,000 acre-feet per year inflow to Fresno. The total sediment accumulation indicated in this study at elevation 2575.0 feet, spillway crest, is 25,665 acre-feet or about 663 acre-feet per year. At elevation 2580.0 feet, 0.65 feet above the maximum observed water surface, the rate is about 760 acre-feet per year. Both of these values are well within expected limits and give credence to the results.

Sediment Distribution

In Table 6, the results of the sediment distribution computations are summarized. These values show a significant sediment accumulation in the reservoir over the years, and show that a large part of the sediment is deposited in the active conservation pool (below elevation 2567.0 feet).

Figures 55 through 57 aid in describing the distribution of sediment within Fresno Reservoir. Figure 55 shows the depth-capacity relationship for Fresno Reservoir. Calculations indicate that a portion of the points fit the Type I (lake) range, a portion fit the Type II (floodplain-foothill) range, and a portion fit the Type III (hill) range. A plot of

the thalweg profile is shown on Figure 56. Without original profile data, no useful comparisons can be made. However, it appears from the data present in Table 6 that over 25 percent of the sediment has been deposited between elevations 2568.0 and 2574.0 feet (miles 10 and 12). Figure 57 shows a plot of percent depth versus percent sediment deposited. Data for the plot was taken from Table 6. The total depth was taken as the depth from the maximum observed water surface (approximately 2580.0 feet) to the streambed at the face of the dam, determined from the 1978 resurvey. As may be seen from Table 6, the sediment distribution is fairly uniform, with the greatest accumulation in the active conservation pool. The accumulation in the upper, or active, part of the reservoir is explained by observing the cross sections in this portion of the reservoir. Although the reservoir is narrow in relation to its length, the increase in cross sectional area in this region is sufficient to reduce inflow velocity and allow sediment deposition. The lower portion of the reservoir may be less impaired because of the high accumulation rate in the upper portion of the reservoir and may benefit from a slight flushing action near the outlet works.

Reservoir Sedimentation Summary

A summary of the reservoir sediment data for the 1978 survey is contained in Table 7. The data include a tabulation of incremental sediment inflow volume and sediment accumulation computed for the periods between 1939 (original) and the 1978 resurvey. These data and other information in the table are valuable for future surveys and other reservoir sediment investigations. The capacity of Fresno Reservoir at elevation 2575.0, the top of the joint use space, is 103,397 acre-feet. This is approximately 20 percent less (25,665 acre-feet) than the original capacity. The area at this elevation is 4,878 acres, a reduction of about 15 percent (897 acres) from the original area. Table 8, Reservoir Capacity Allocations, shows the allocations of the storage space in Fresno Reservoir as a result of the 1978 resurvey.

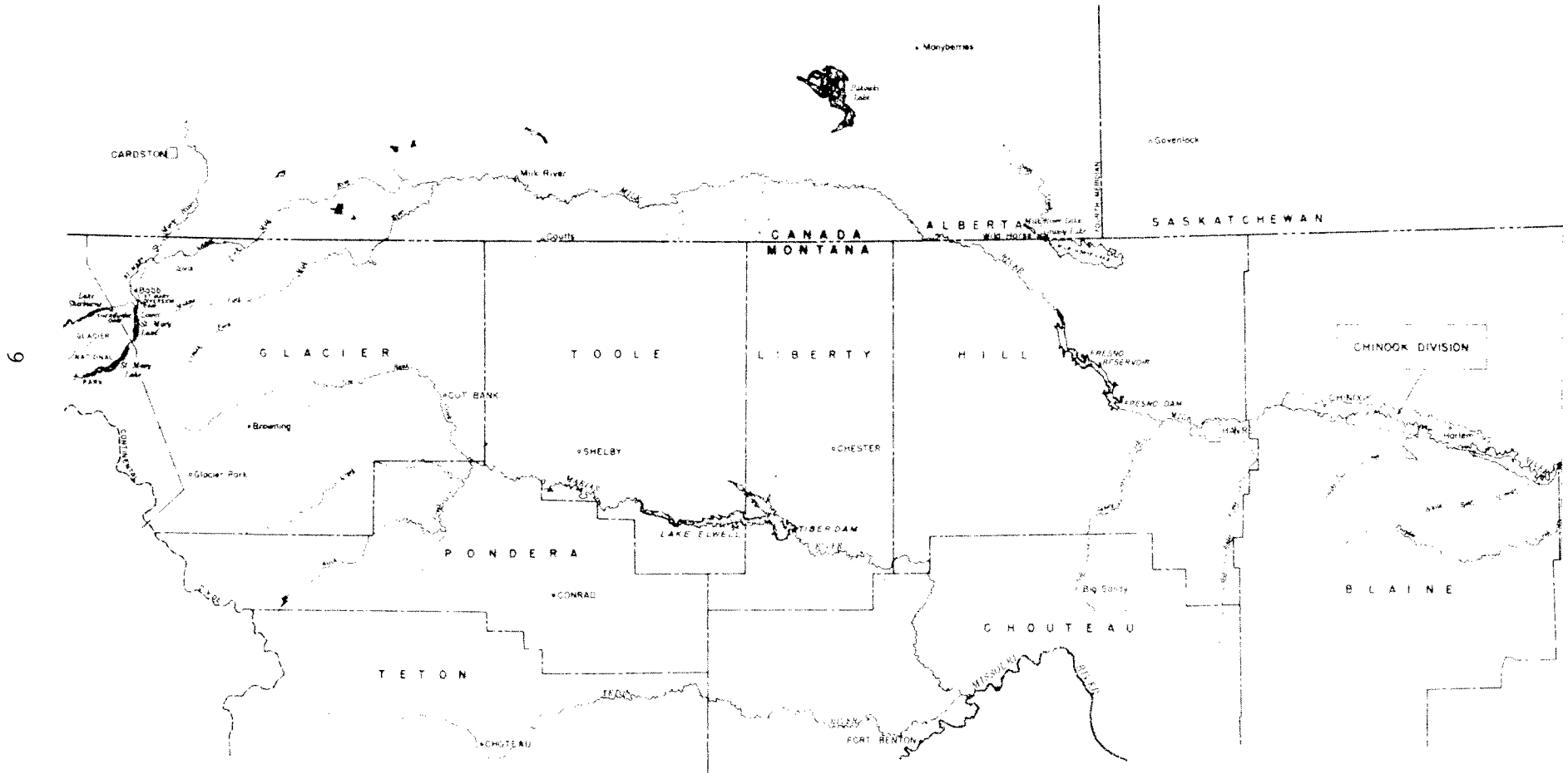


Figure 1 - Milk River Project Map

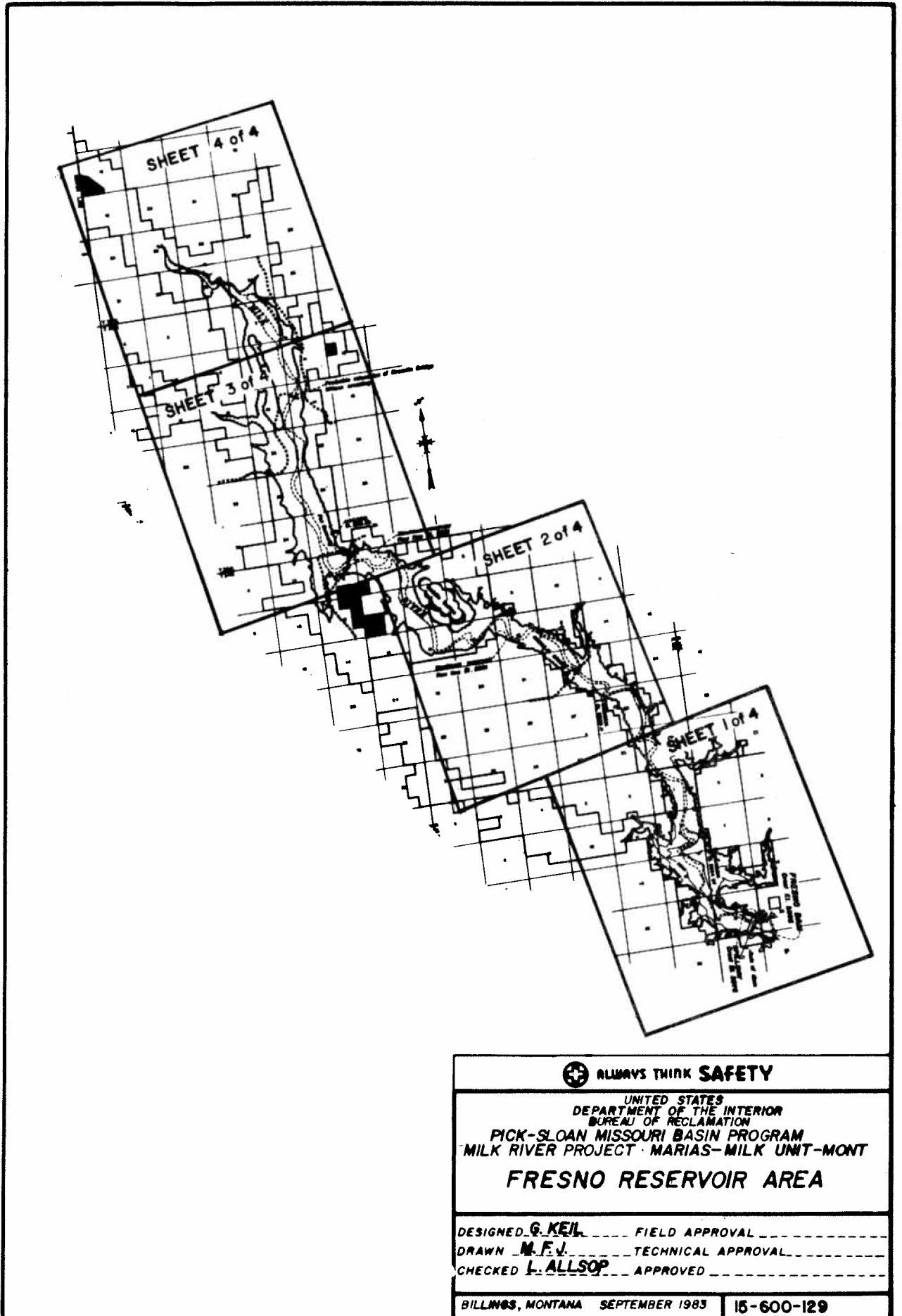


Figure 3 - Index Map

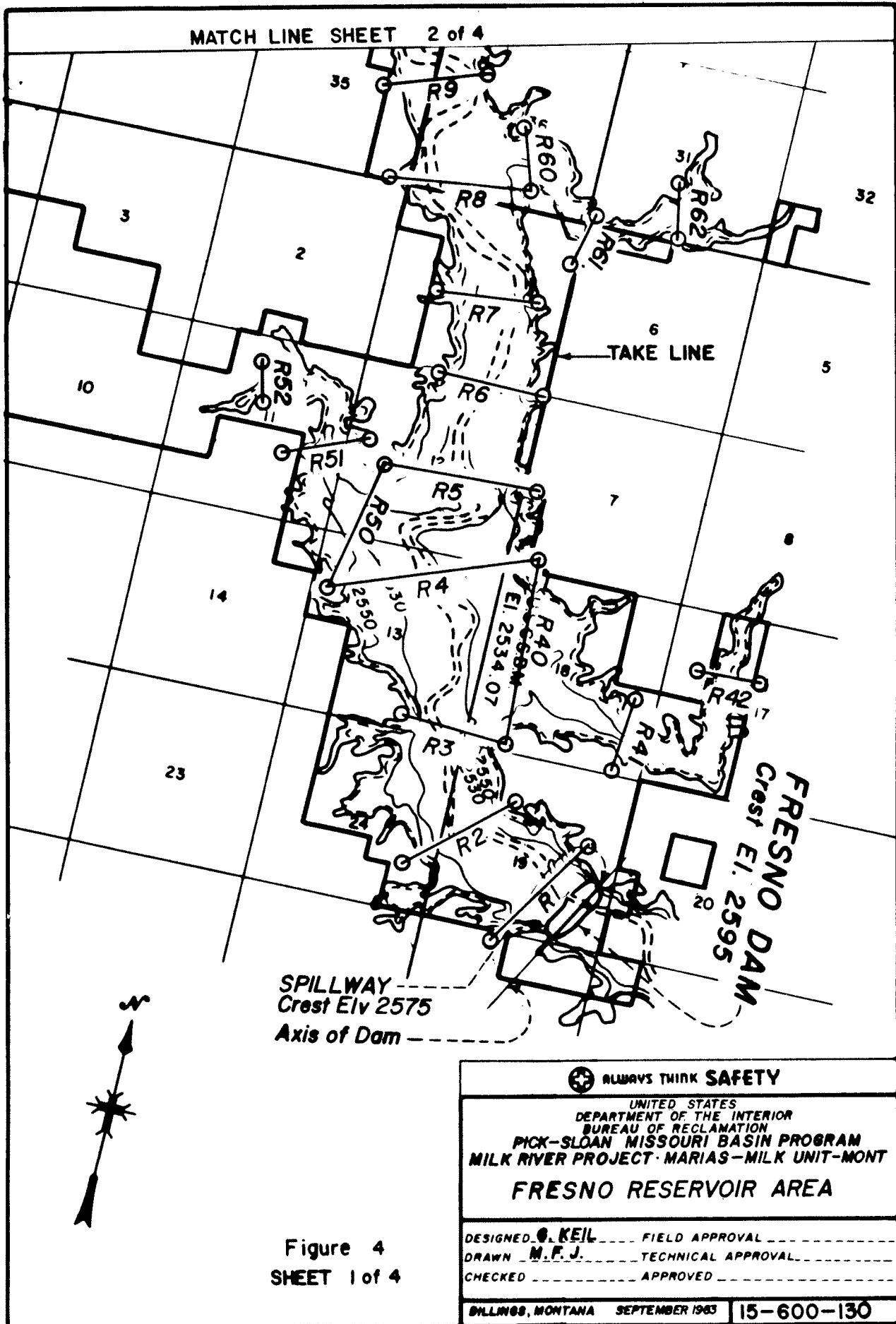


Figure 4 - Layout of Sediment Range System (Sheet 1 of 4)

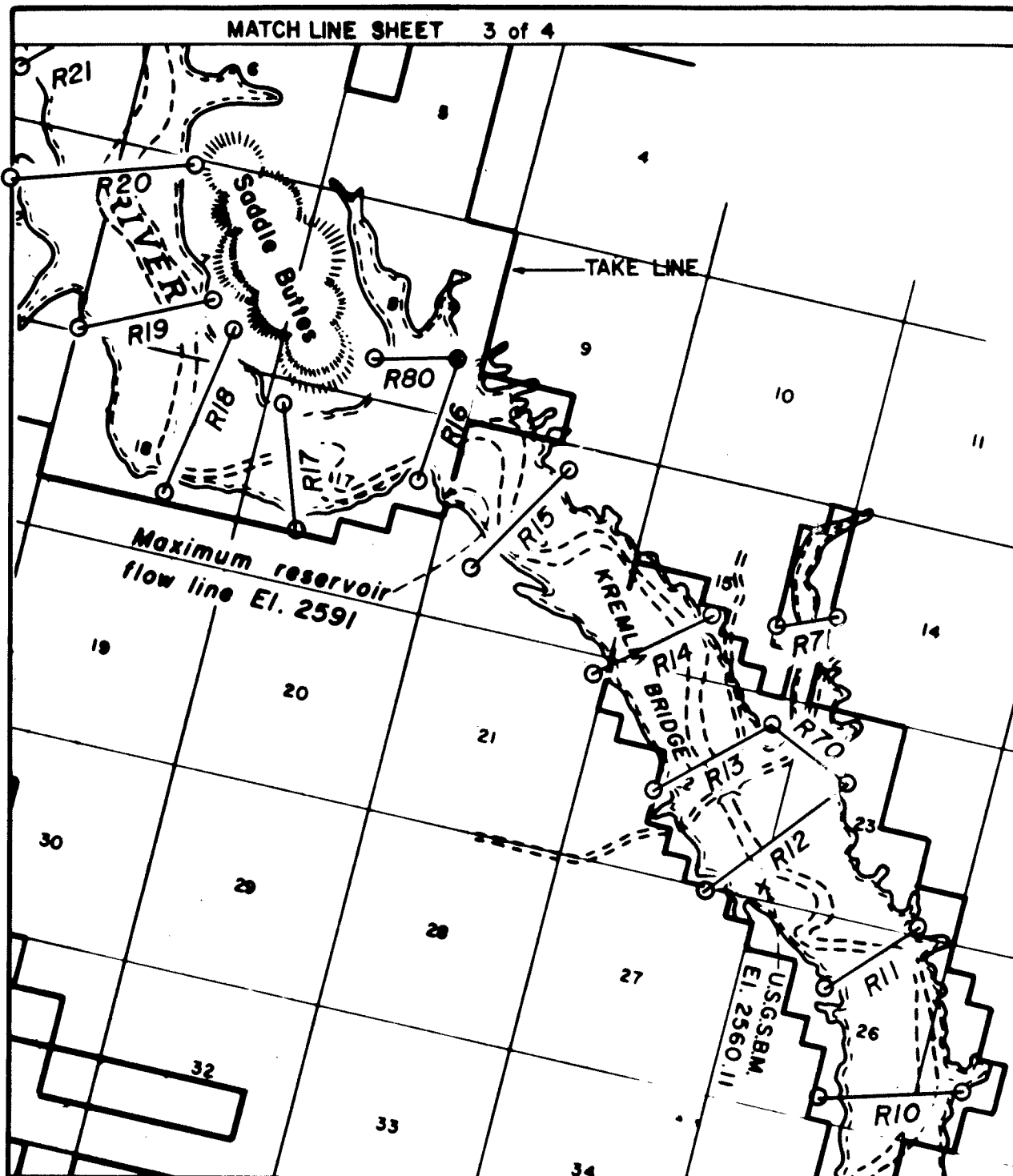


Figure 4
SHEET 2 of 4

ALWAYS THINK SAFETY

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DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
PICK-SLOAN MISSOURI BASIN PROGRAM
MILK RIVER PROJECT · MARIAS-MILK UNIT-MONT
FRESNO RESERVOIR AREA

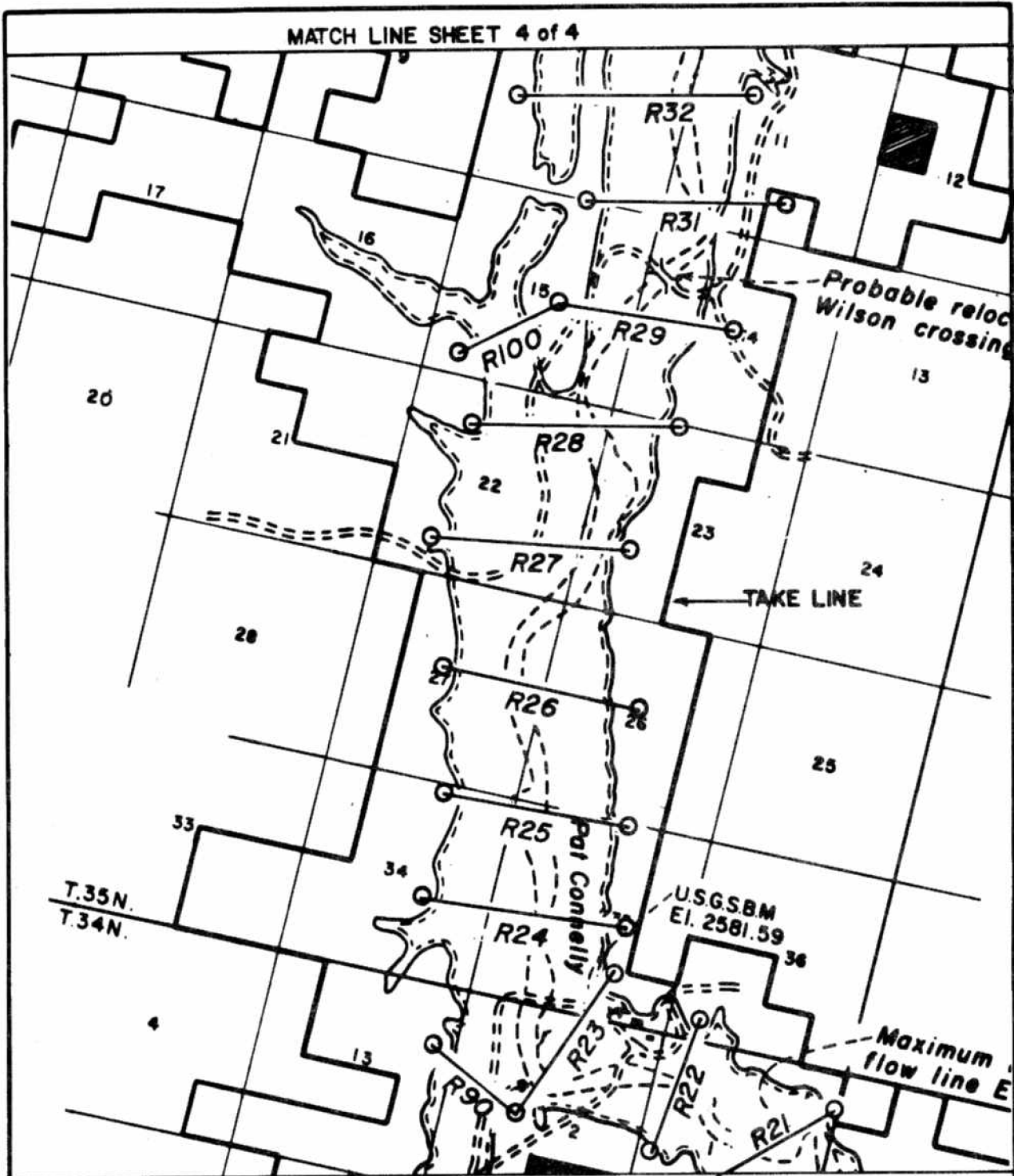
DESIGNED G. KEIL FIELD APPROVAL

DRAWN - M.F.J. TECHNICAL APPROVAL

CHECKED APPROVED

BILLINGS, MONTANA SEPTEMBER 1983 | 15-600-131

Figure 4 - Layout of Sediment Range System (Sheet 2 of 4)



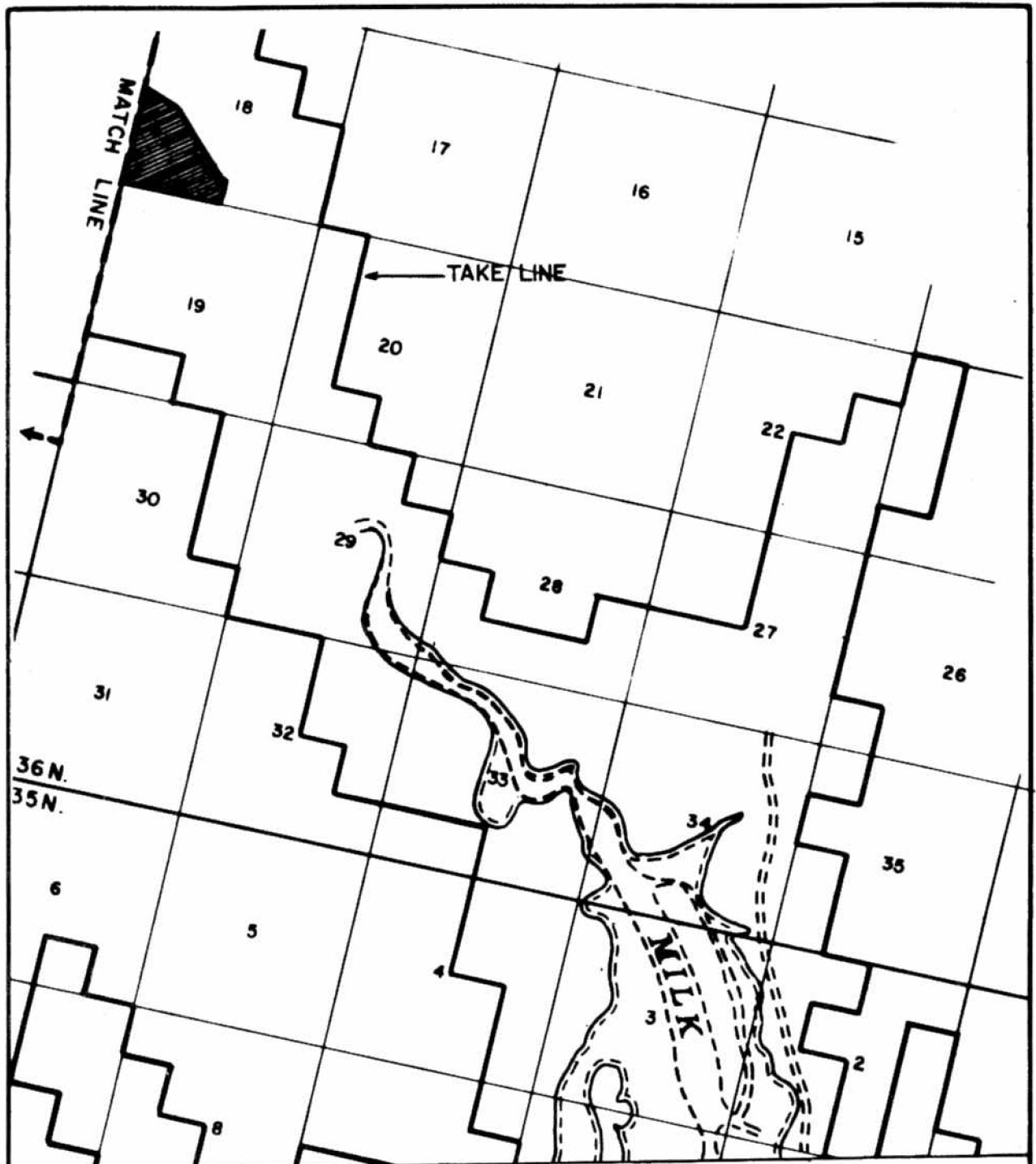
MATCH LINE SHEET 2 of 4



Figure 4
SHEET 3 of 4

ALWAYS THINK SAFETY	
UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION PICK-SLOAN MISSOURI BASIN PROGRAM MILK RIVER PROJECT · MARIAS-MILK UNIT-MONT	
FRESNO RESERVOIR AREA	
DESIGNED S. KEIL	FIELD APPROVAL _____
DRAWN M. F. J.	TECHNICAL APPROVAL _____
CHECKED _____	APPROVED _____
BILLINGS, MONTANA SEPTEMBER 1969 15-600-132	

Figure 4 - Layout of Sediment Range System (Sheet 3 of 4)



MATCH LINE SHEET 3 of 4



Figure 4
SHEET 4 of 4

 ALWAYS THINK SAFETY	
UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION PICK-SLOAN MISSOURI BASIN PROGRAM MILK RIVER PROJECT - MARIAS-MILK UNIT - MONT FRESNO RESERVOIR AREA	
DESIGNED G. KEIL	FIELD APPROVAL
DRAWN M.F.V.	TECHNICAL APPROVAL
CHECKED	APPROVED
BILLINGS, MONTANA SEPTEMBER 1983	
15-600-133	

Figure 4 - Layout of Sediment Range System (Sheet 4 of 4)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 1
GROUND PROFILE FOR SECTION 0

91

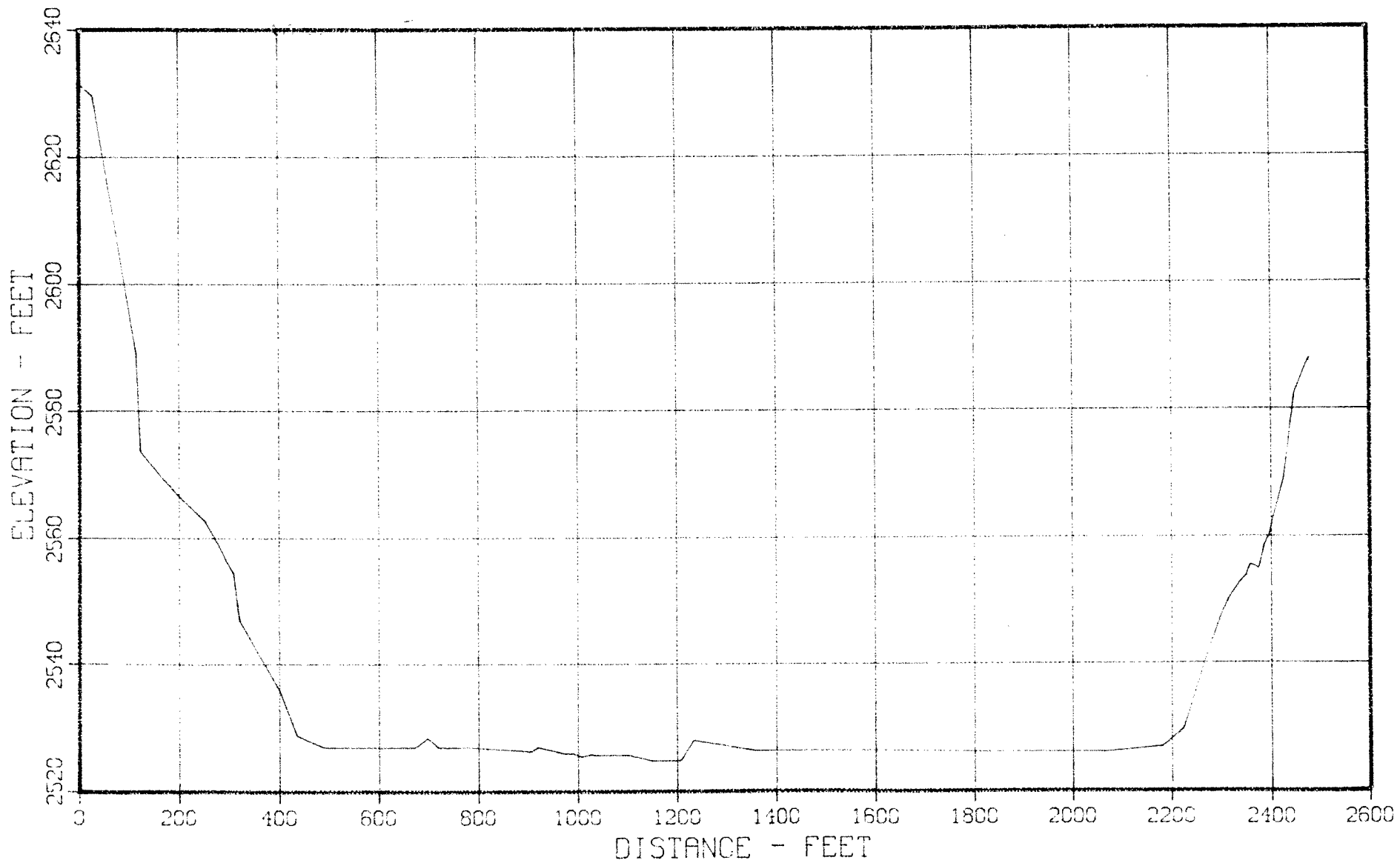


Figure 5 - Sediment Range Profile - Range 1 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 2
GROUND PROFILE FOR SECTION 3296

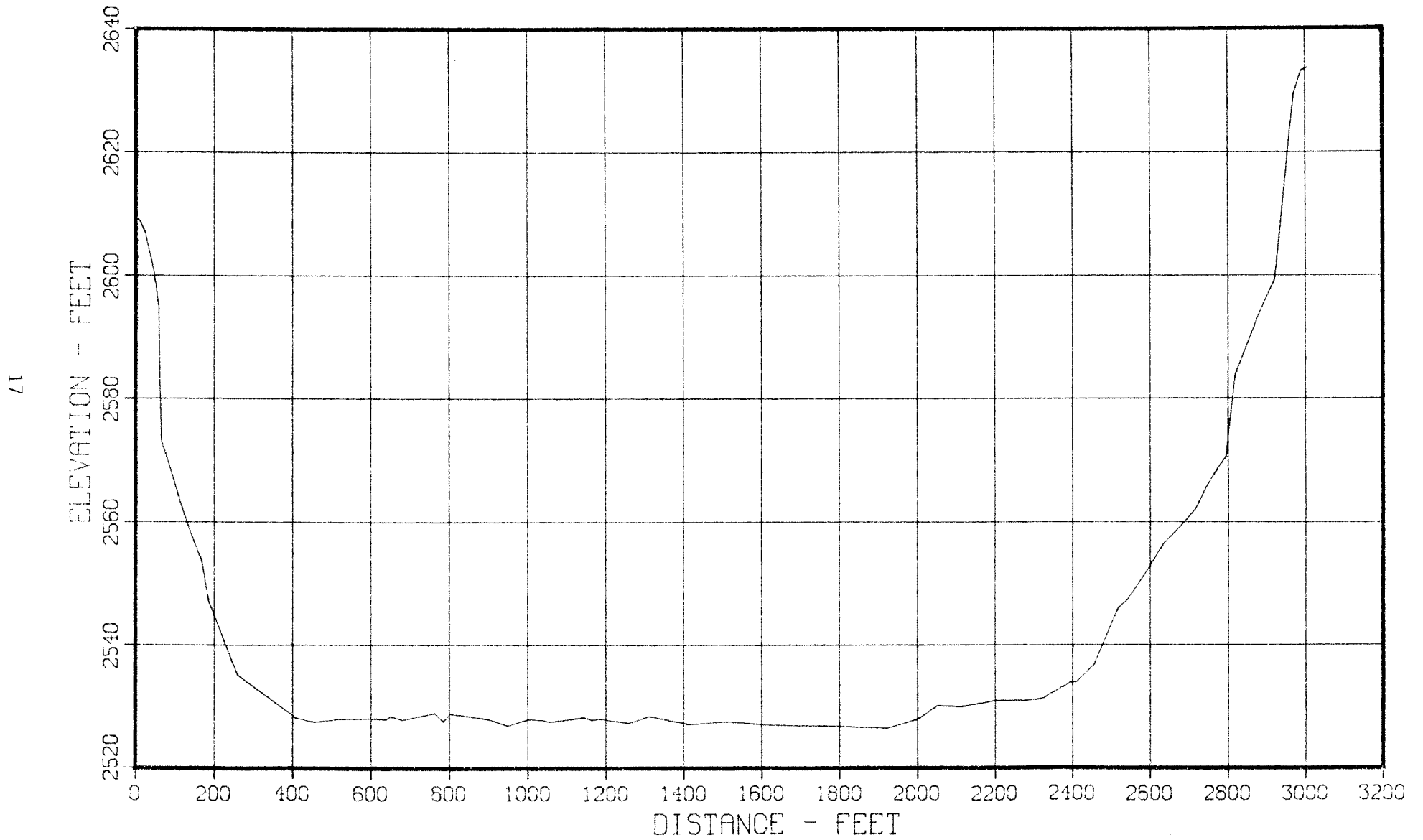


Figure 6 - Sediment Range Profile - Range 2 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 3
GROUND PROFILE FOR SECTION 6467

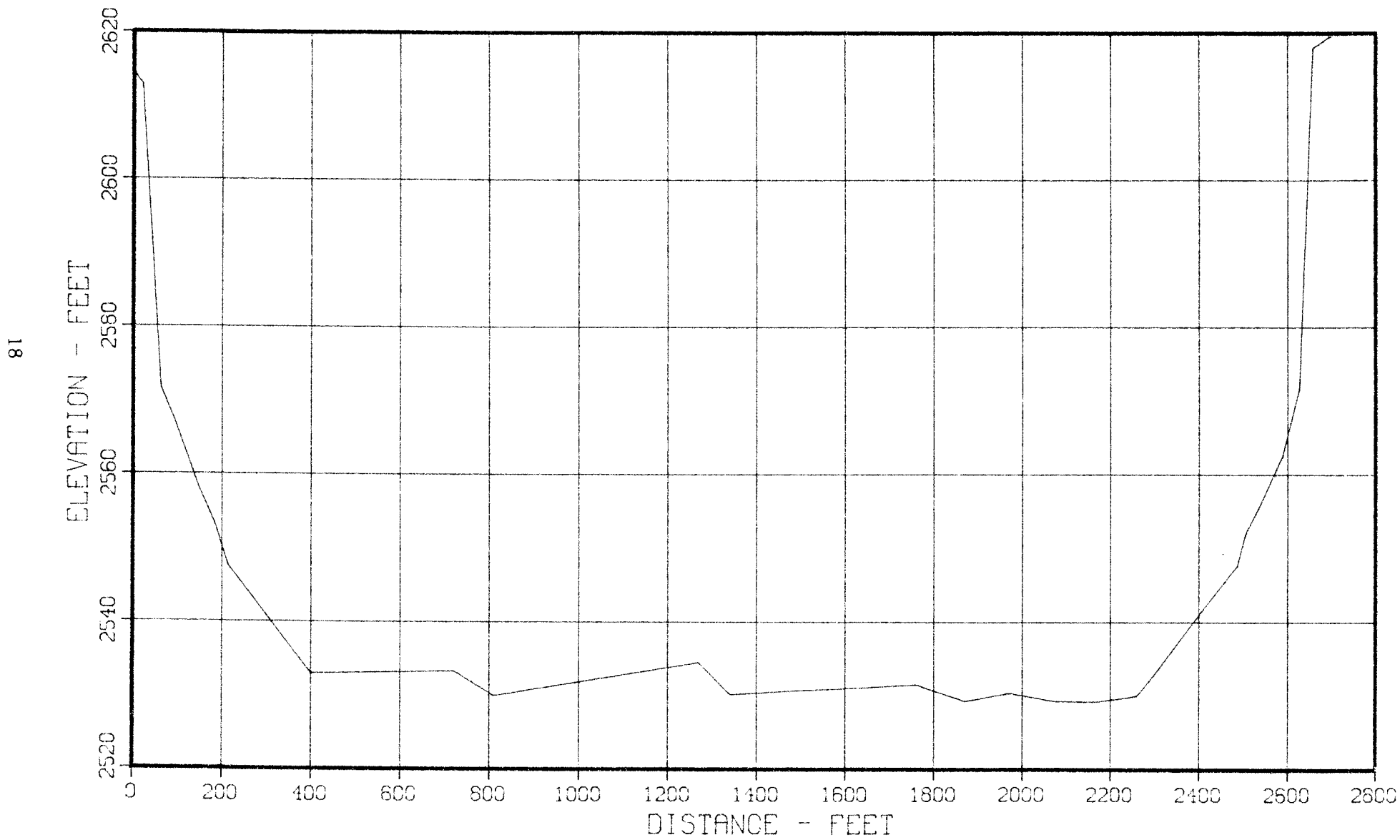


Figure 7 - Sediment Range Profile - Range 3 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 4
GROUND PROFILE FOR SECTION 10874

61

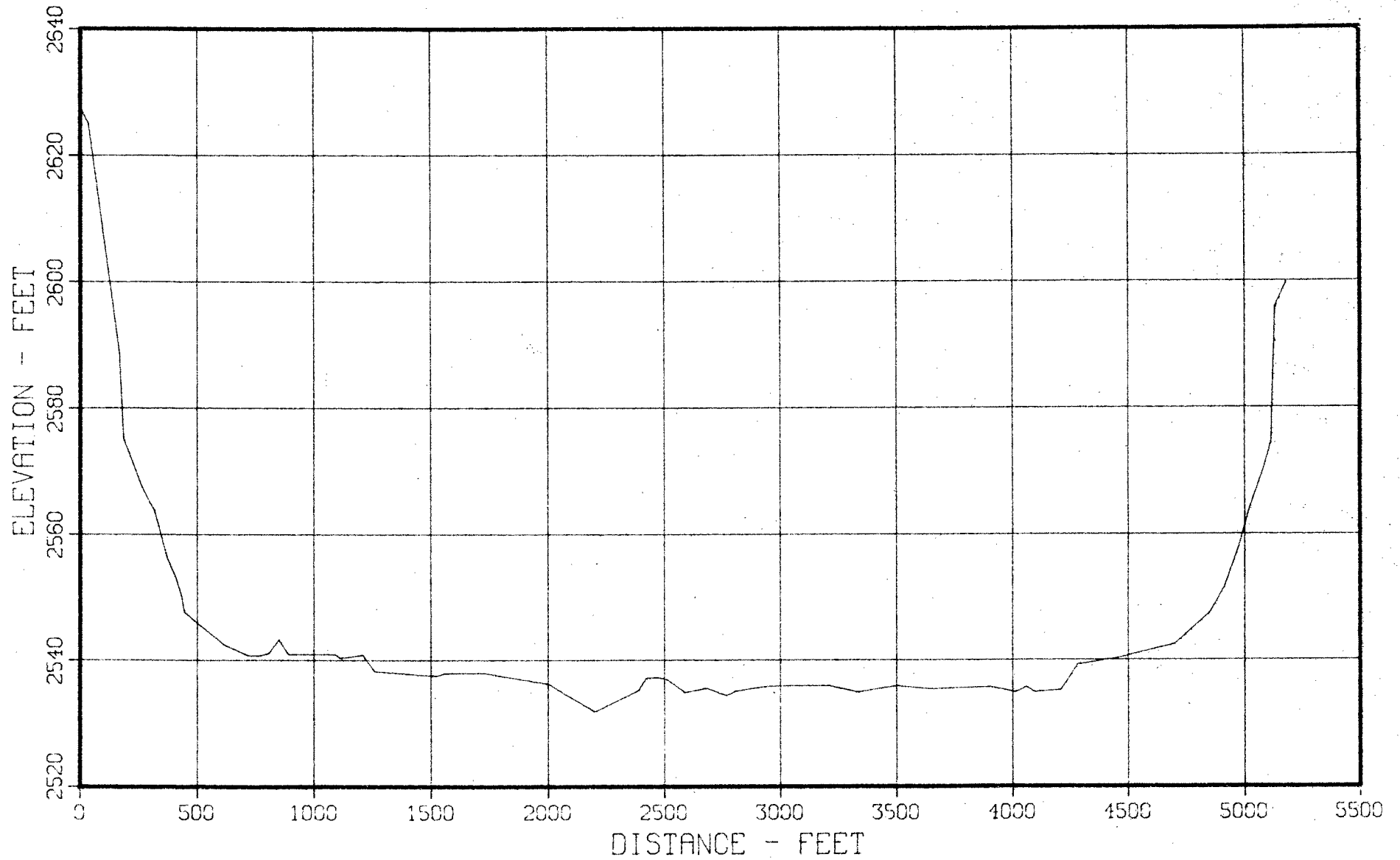


Figure 8 - Sediment Range Profile - Range 4 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 5
GROUND PROFILE FOR SECTION 14088

20

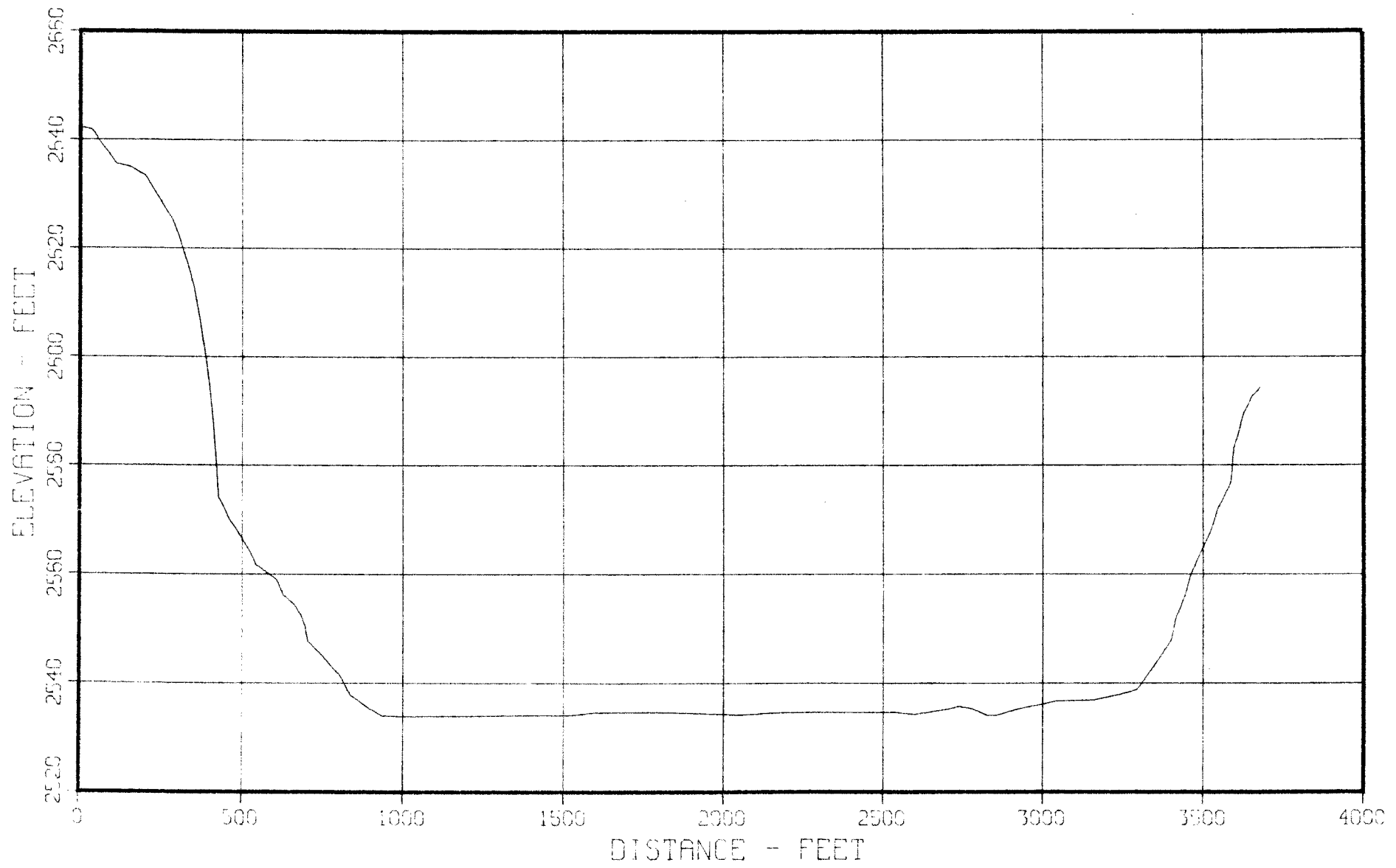


Figure 9 - Sediment Range Profile - Range 5 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 6
GROUND PROFILE FOR SECTION 16863

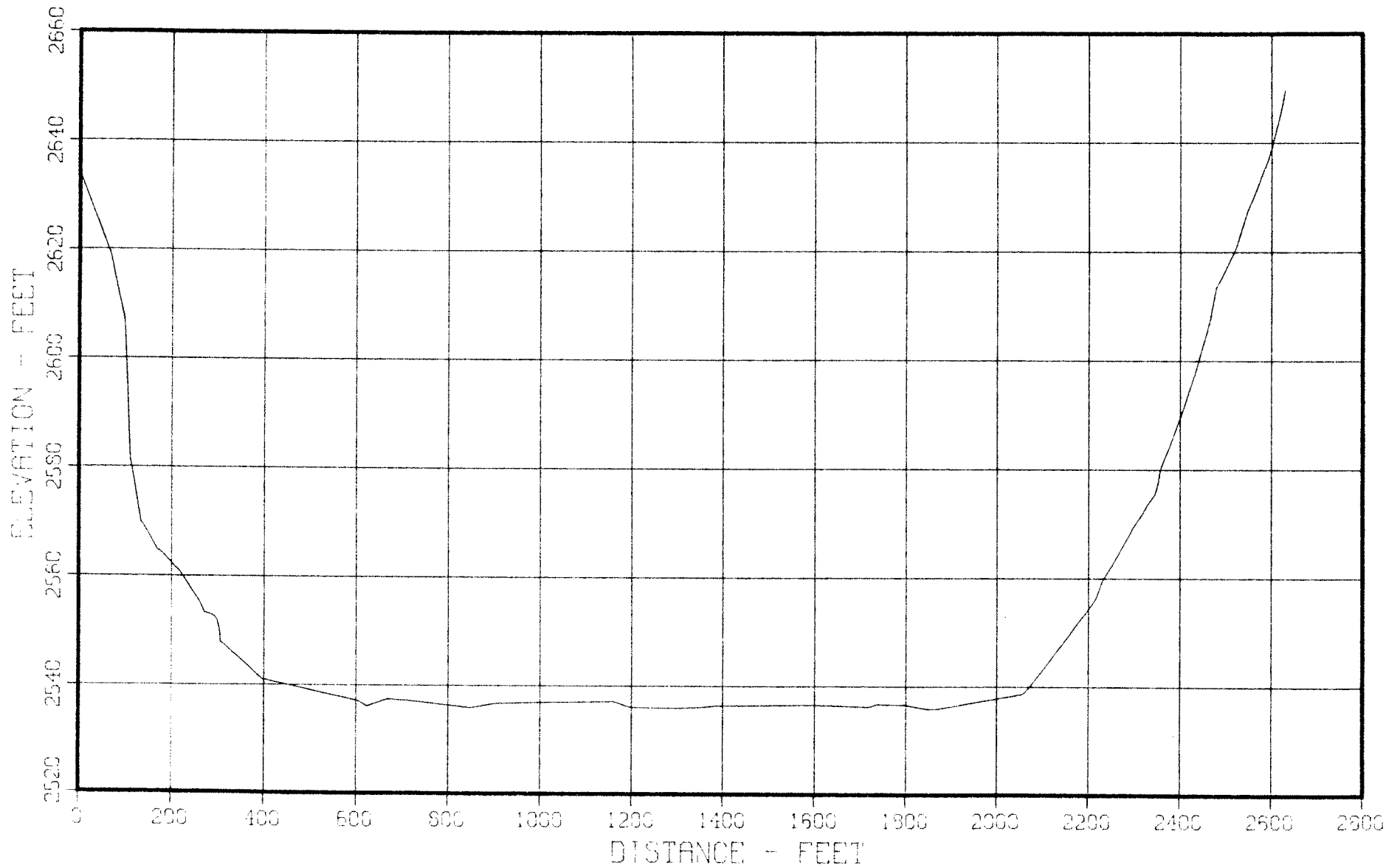


Figure 10 - Sediment Range Profile - Range 6 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 7
GROUND PROFILE FOR SECTION 19973

22

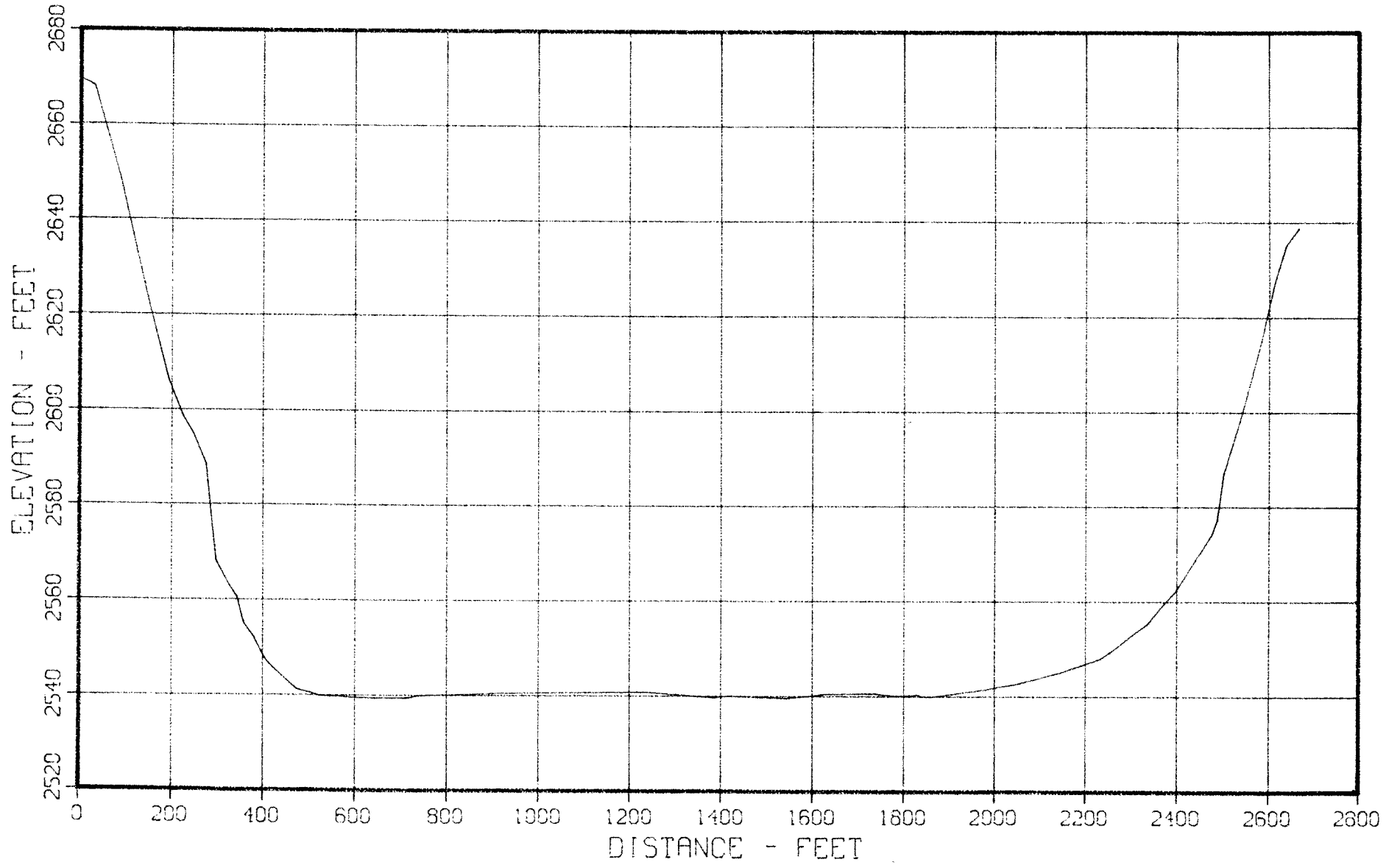


Figure 11 - Sediment Range Profile - Range 7 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 8
GROUND PROFILE FOR SECTION 227.35

23

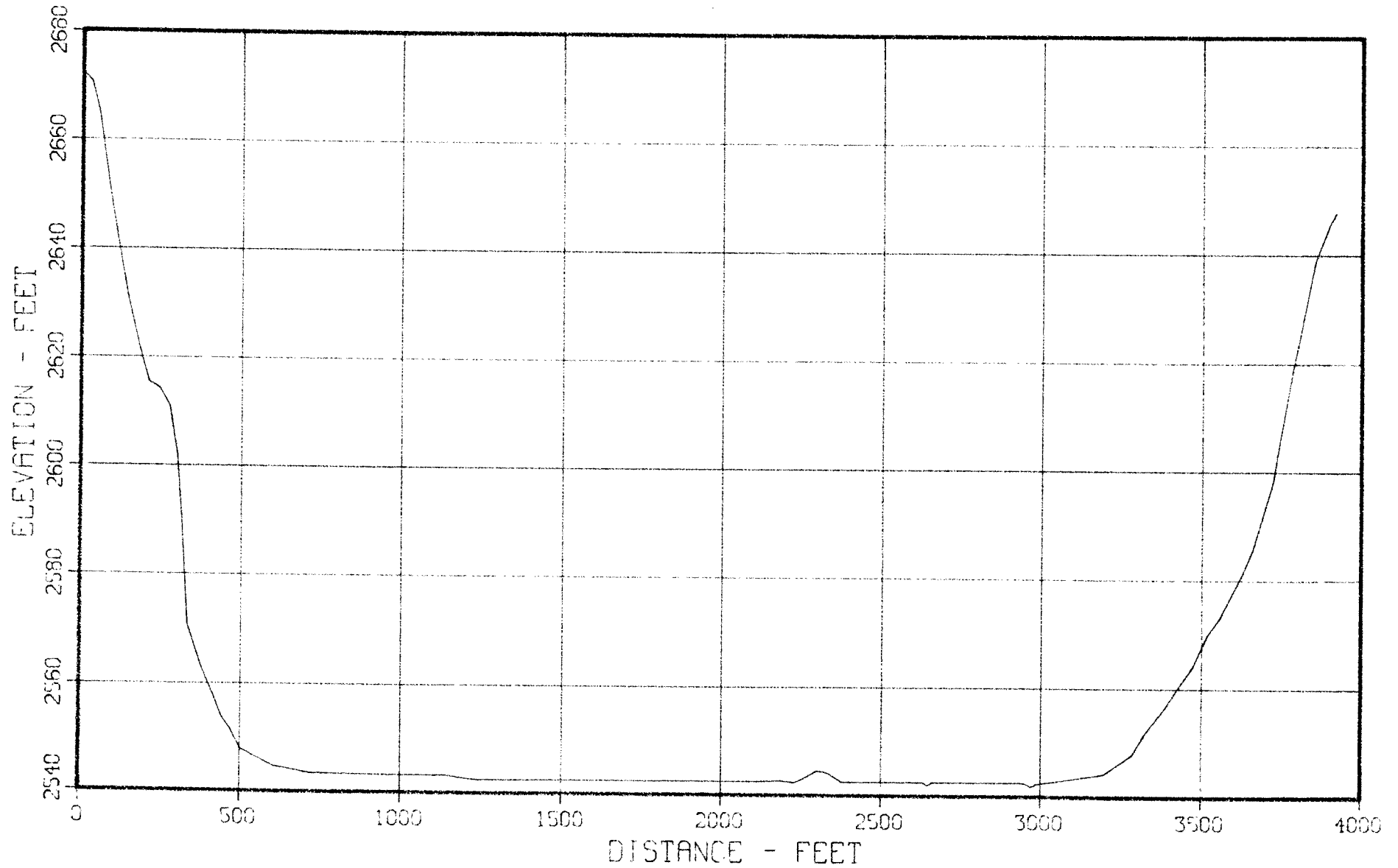


Figure 12 - Sediment Range Profile - Range 8 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 8A
GROUND PROFILE FOR SECTION 23719

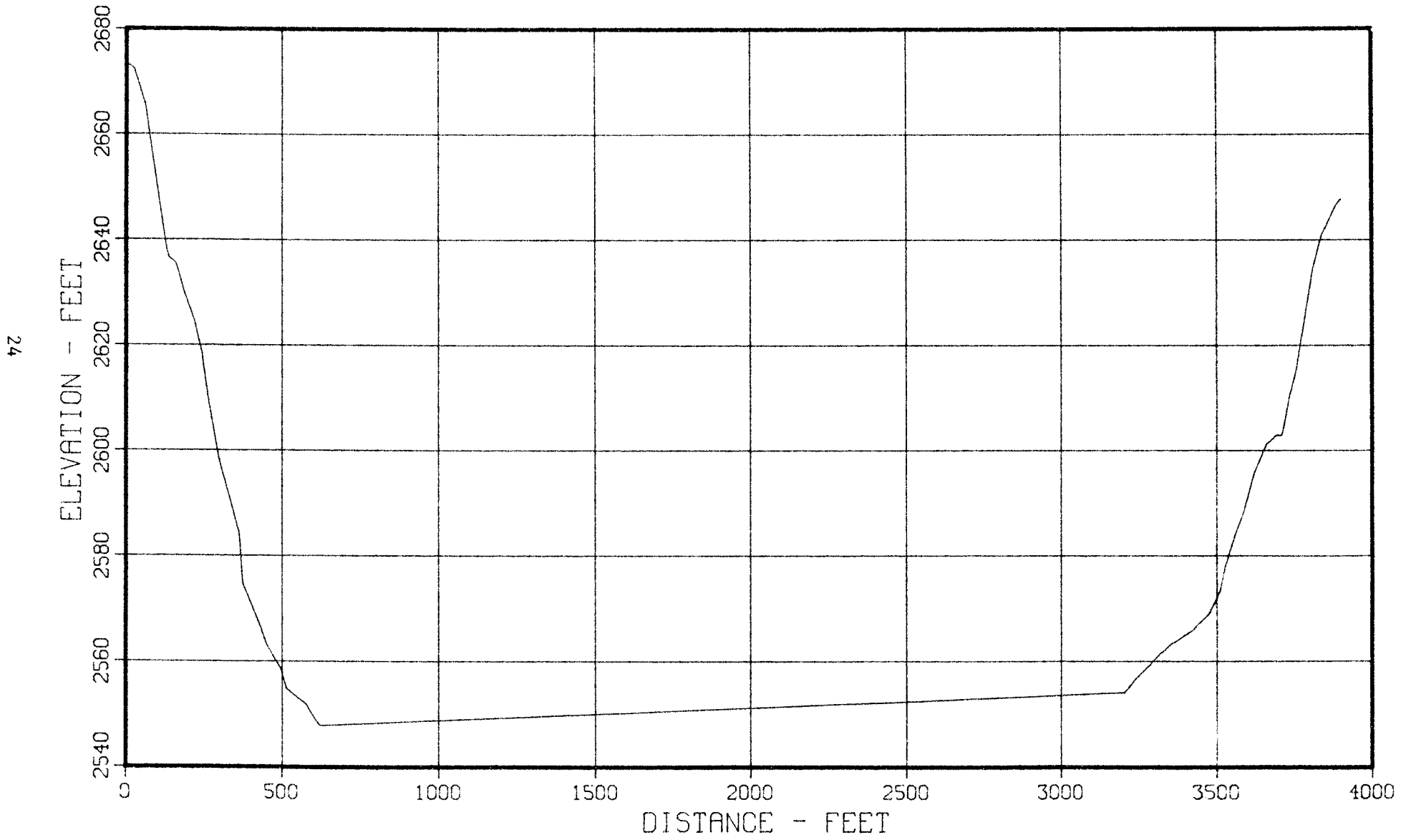


Figure 13 - Sediment Range Profile - Range 8A (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY.
RANGE 9
GROUND PROFILE FOR SECTION 25918

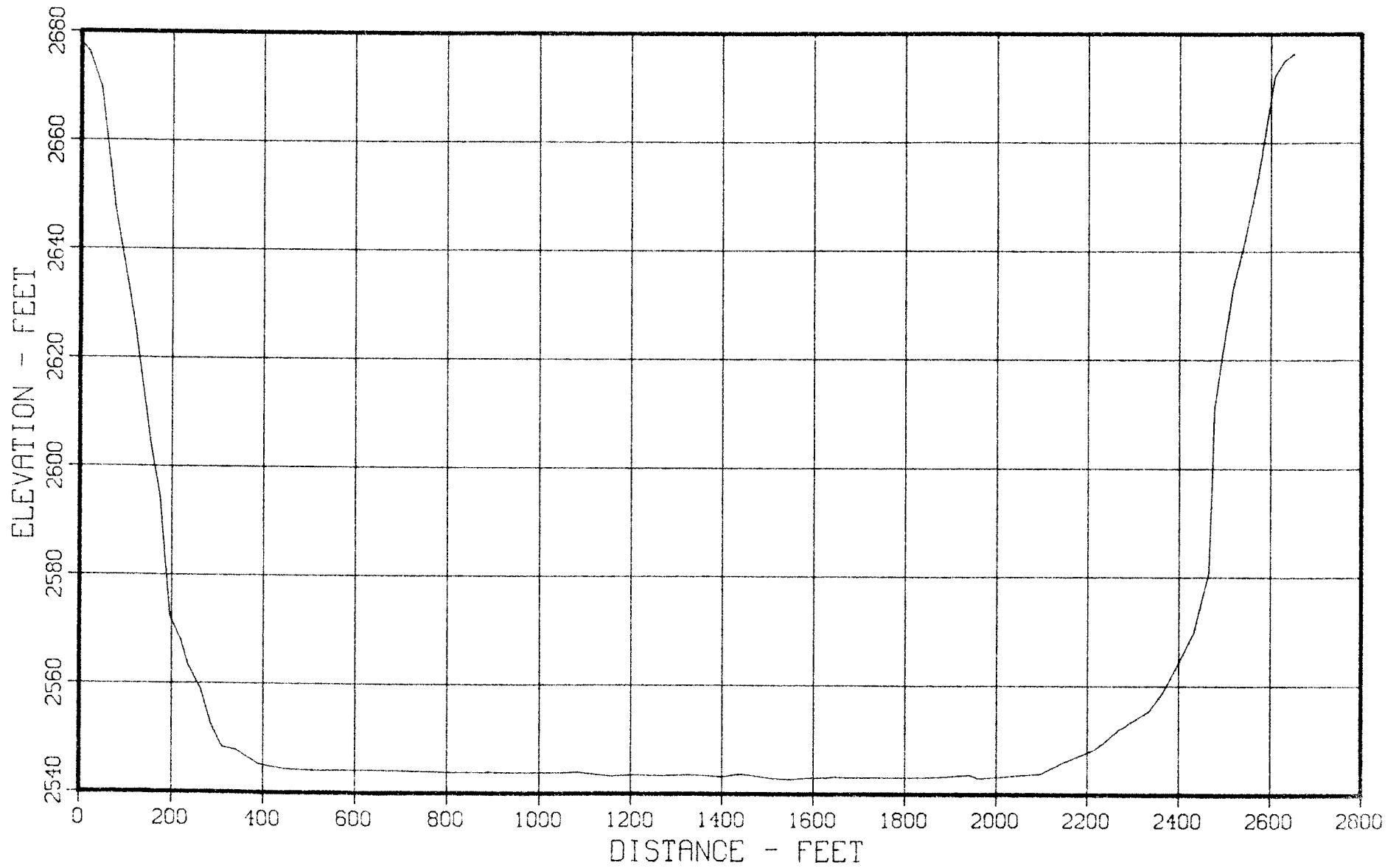


Figure 14 - Sediment Range Profile - Range 9 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 10
GROUND PROFILE FOR SECTION 29186

26

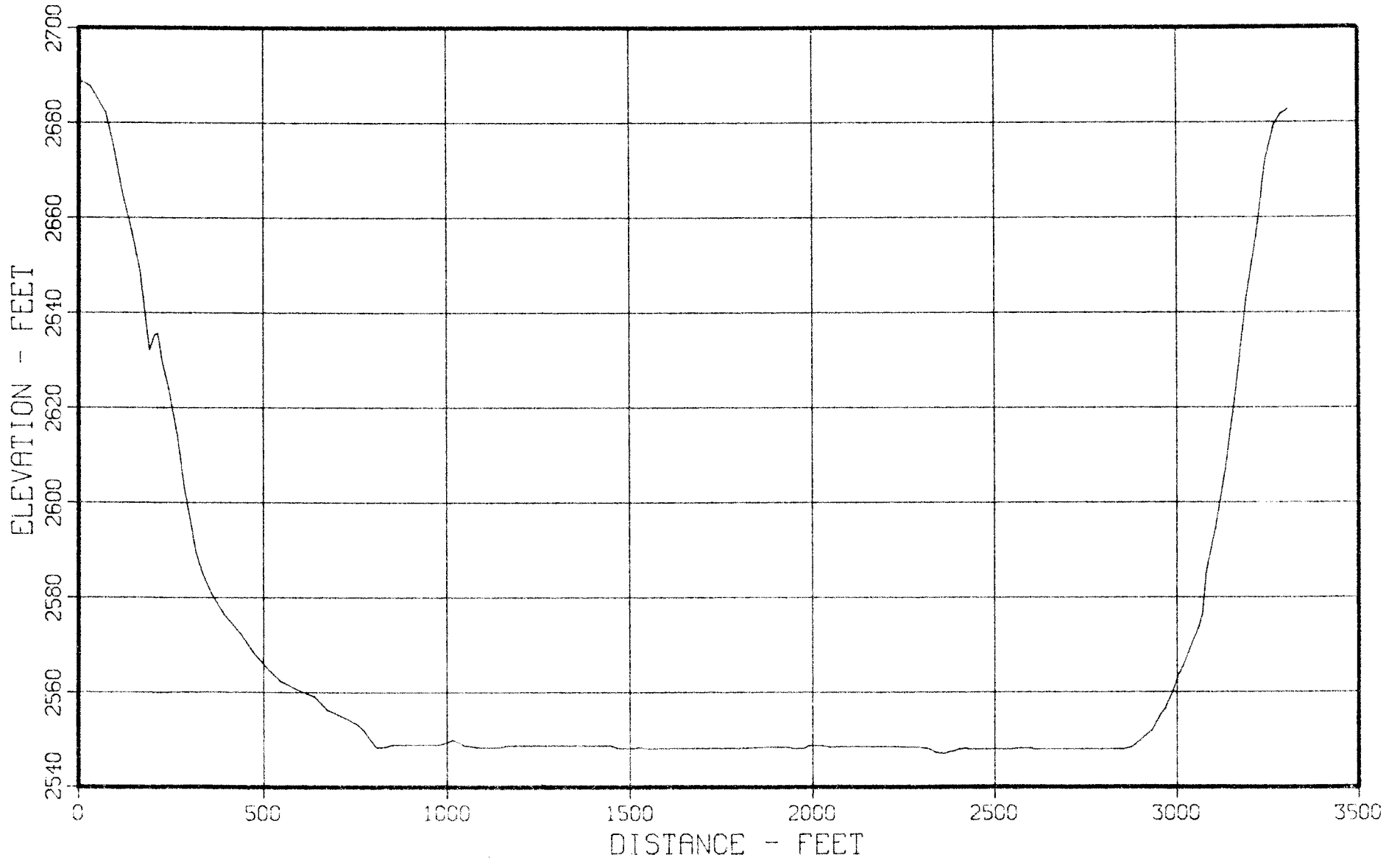


Figure 15 - Sediment Range Profile - Range 10 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 11
GROUND PROFILE FOR SECTION 32079

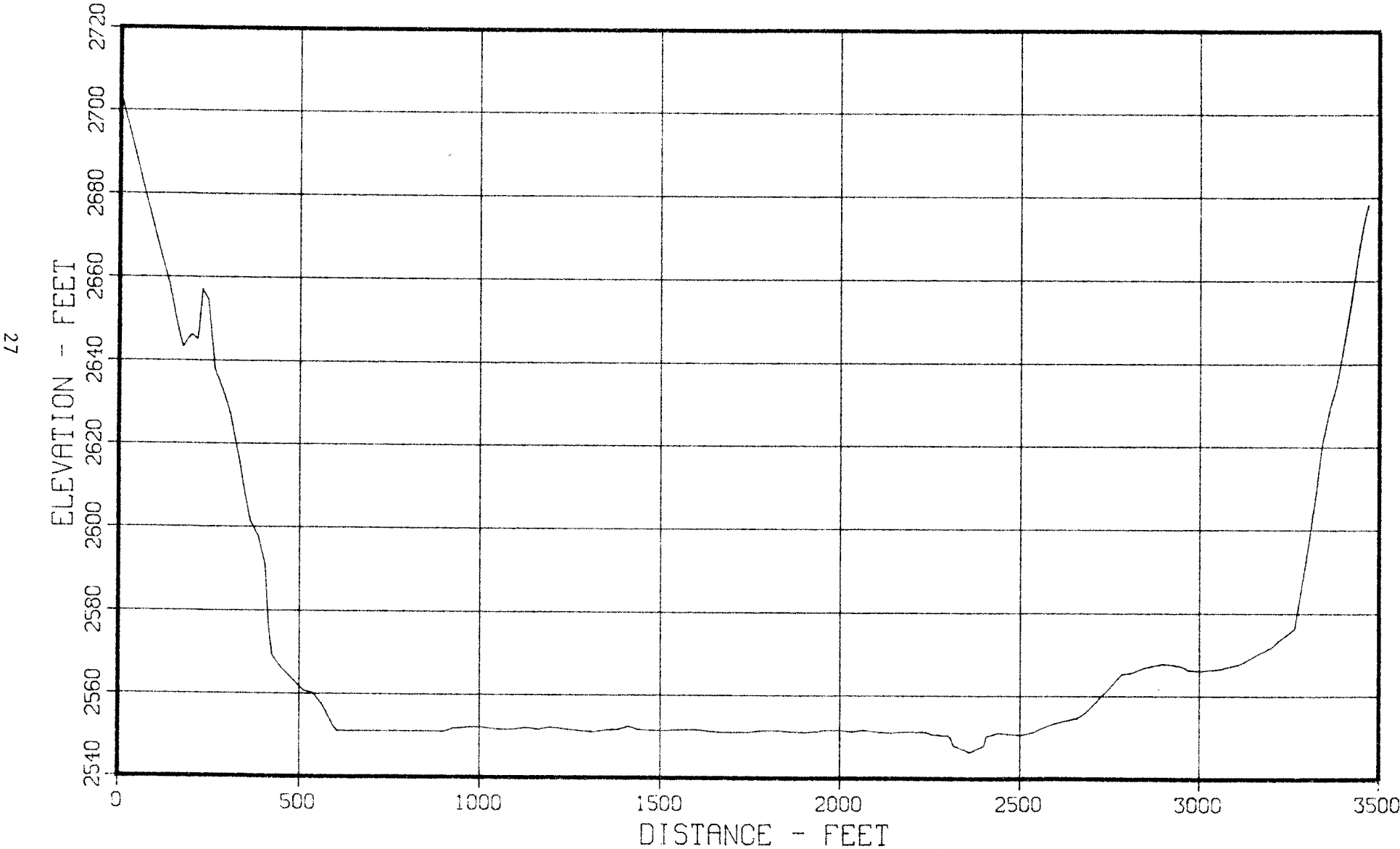


Figure 16 - Sediment Range Profile - Range 11 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 12
GROUND PROFILE FOR SECTION 36063

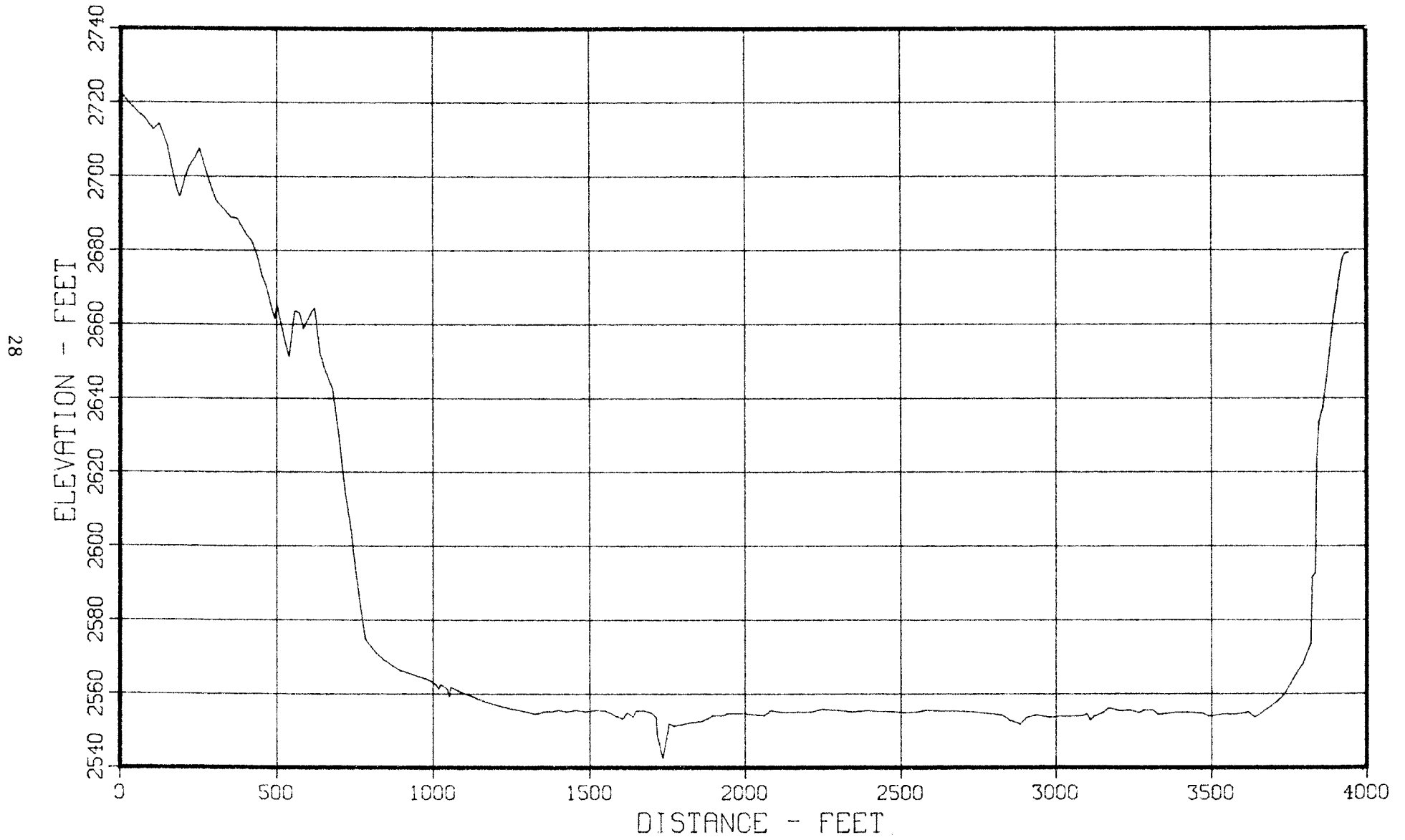


Figure 17 - Sediment Range Profile - Range 12 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 13
GROUND PROFILE FOR SECTION 39936

29

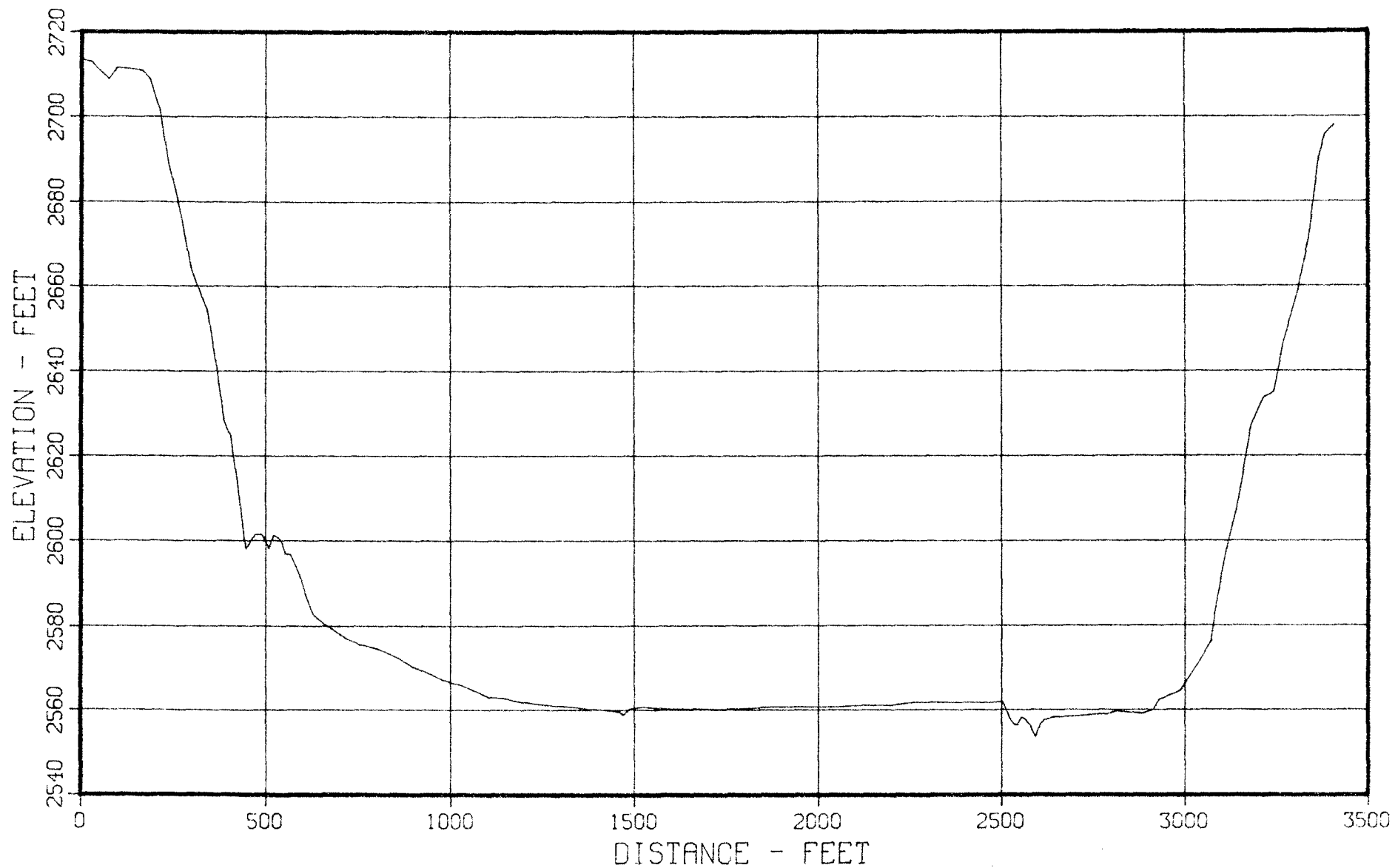


Figure 18 - Sediment Range Profile - Range 13 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 14
GROUND PROFILE FOR SECTION 43152

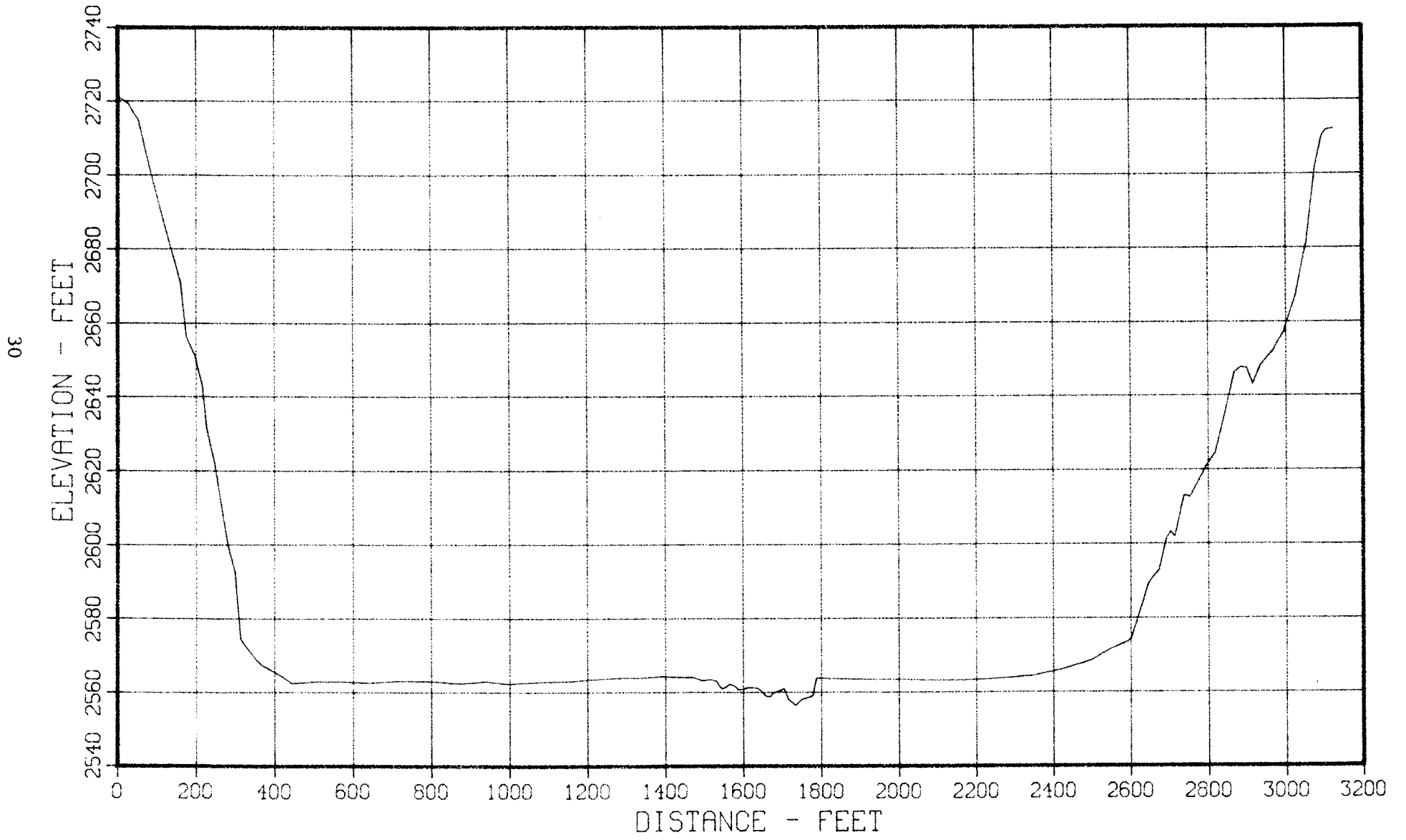


Figure 19 - Sediment Range Profile - Range 14 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 15
GROUND PROFILE FOR SECTION 47447

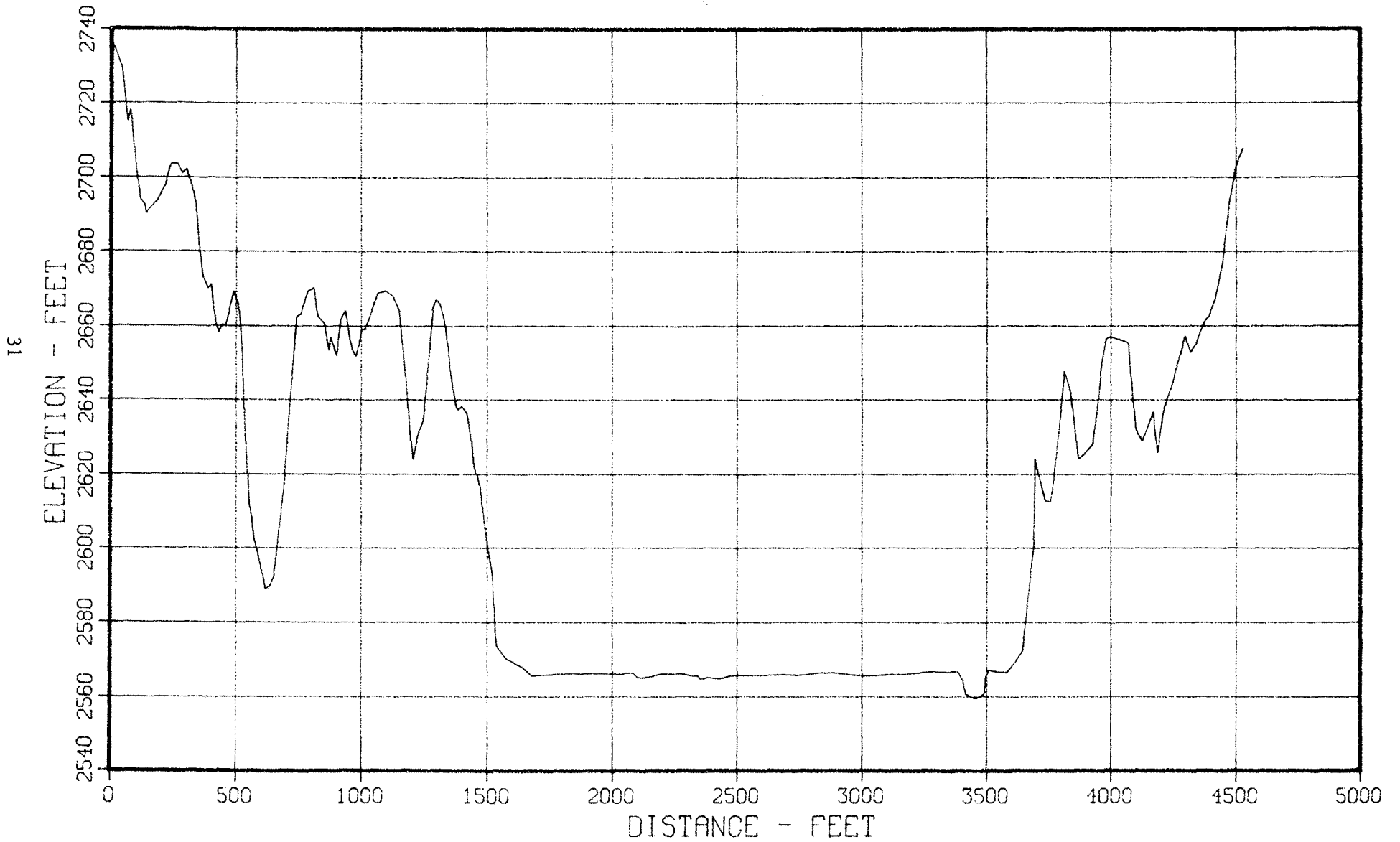


Figure 20 - Sediment Range Profile - Range 15 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 16
GROUND PROFILE FOR SECTION 51582

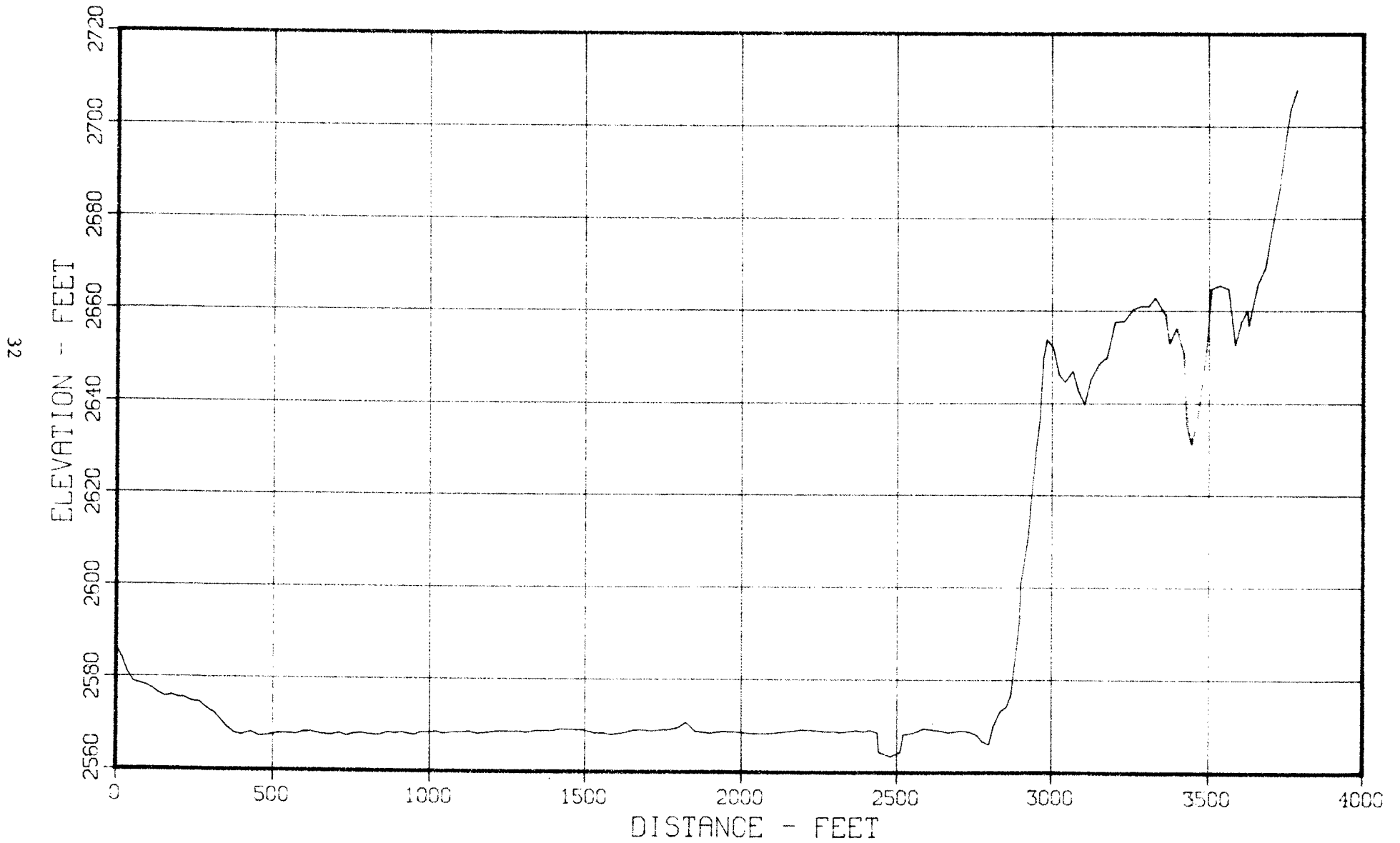


Figure 21 - Sediment Range Profile - Range 16 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 17
GROUND PROFILE FOR SECTION 55009

33

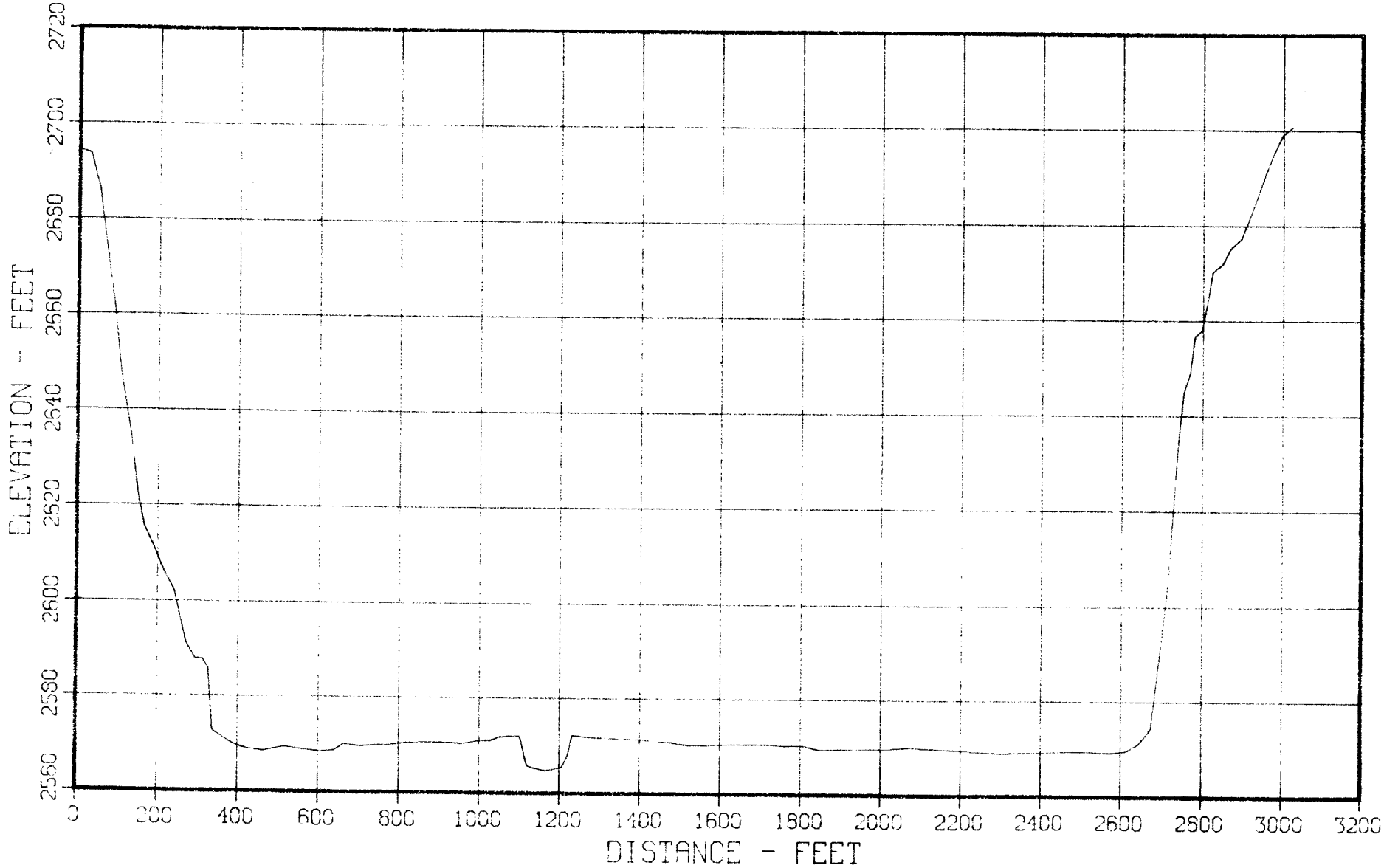


Figure 22 - Sediment Range Profile - Range 17 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 18
GROUND PROFILE FOR SECTION 57827

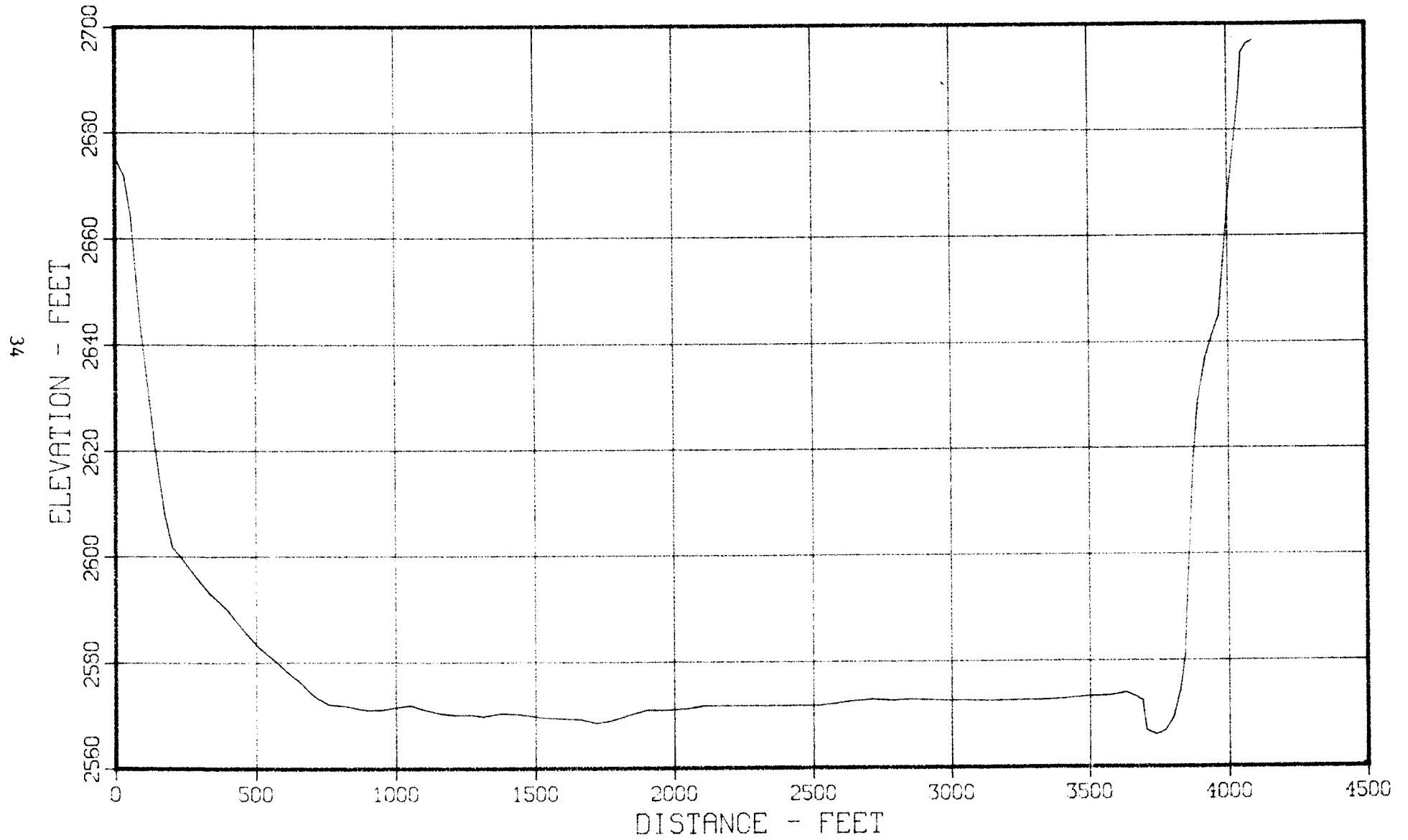


Figure 23 - Sediment Range Profile - Range 18 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 19
GROUND PROFILE FOR SECTION 61023

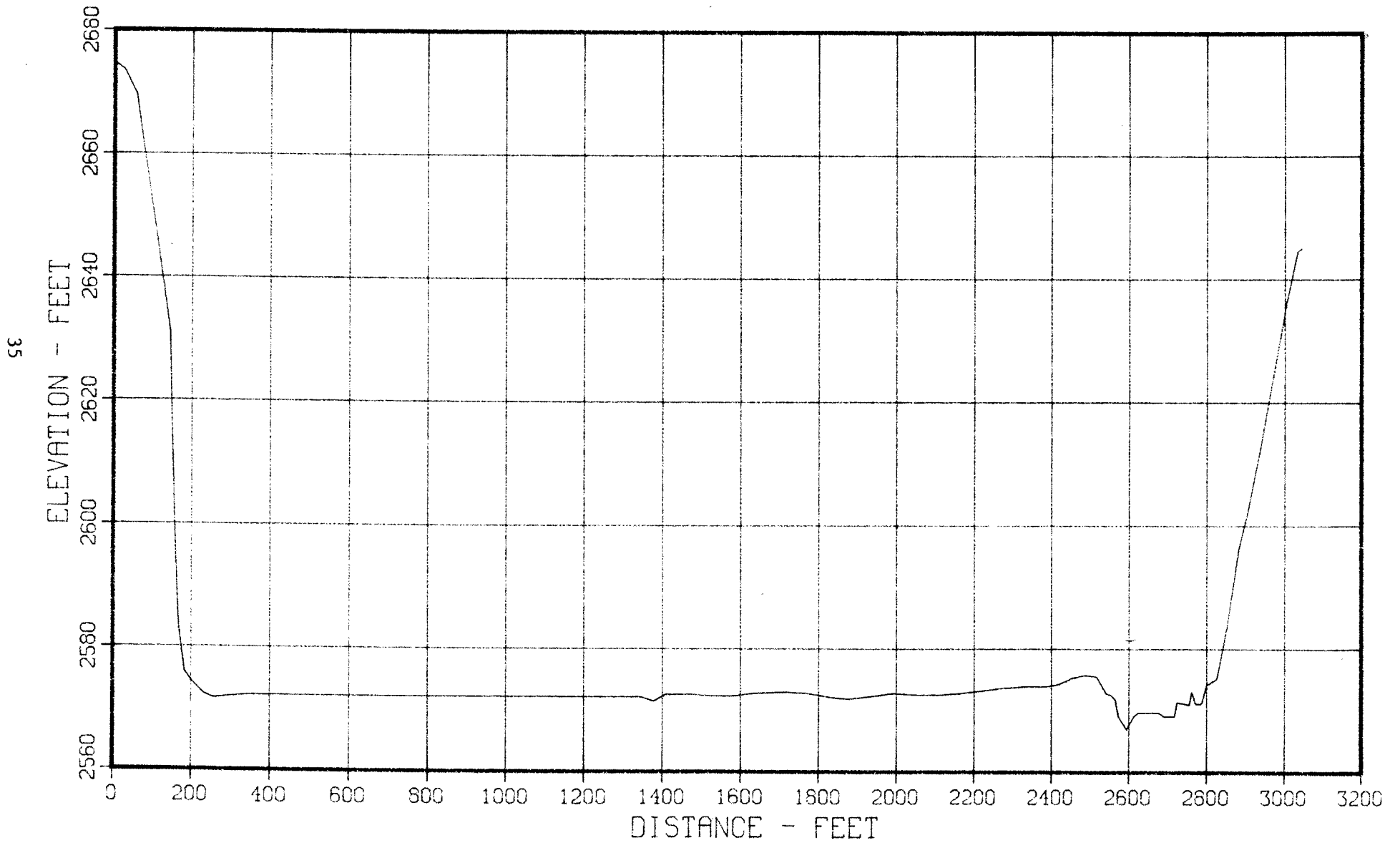


Figure 24 - Sediment Range Profile - Range 19 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 20
GROUND PROFILE FOR SECTION 64545

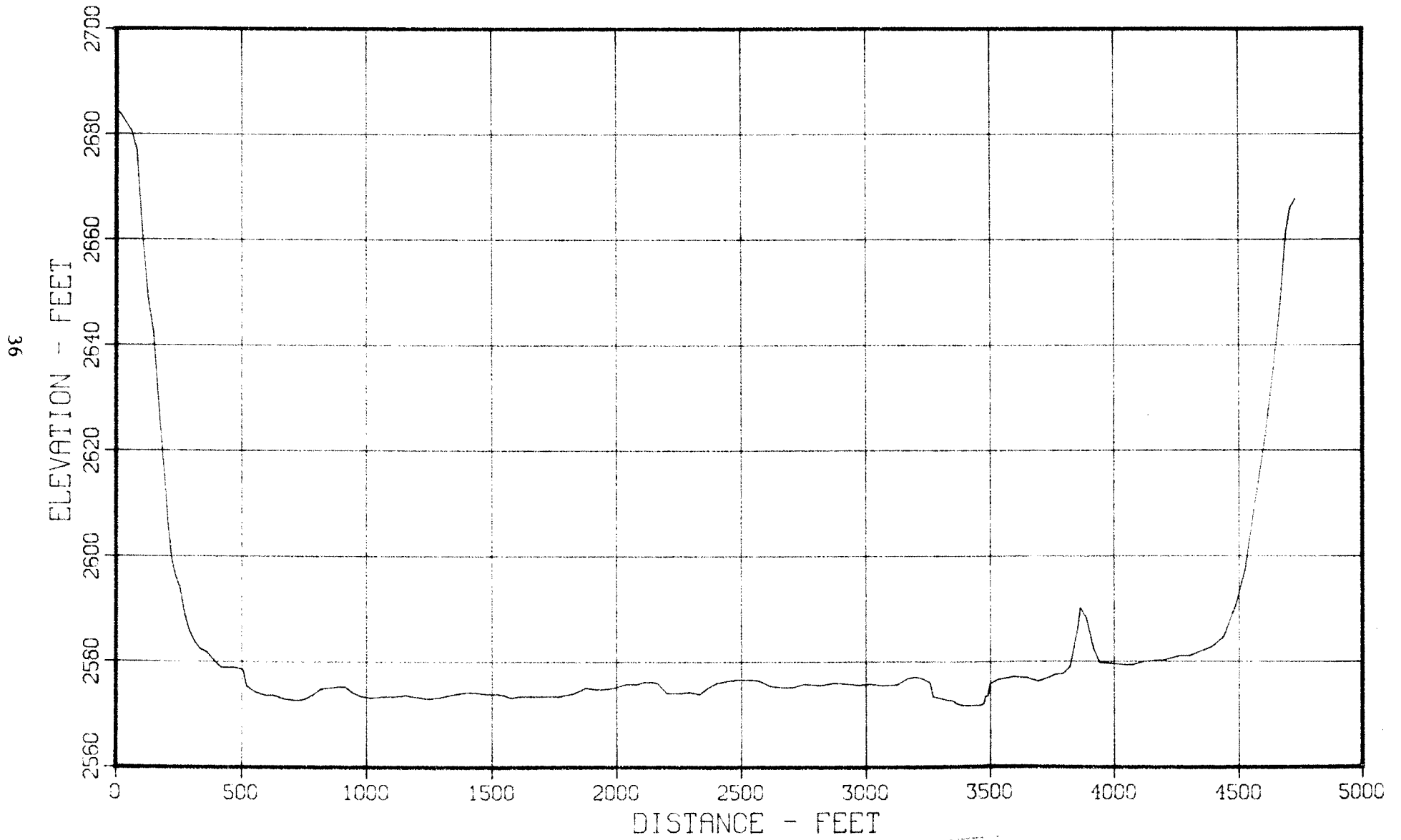


Figure 25 - Sediment Range Profile - Range 20 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 21
GROUND PROFILE FOR SECTION 69438

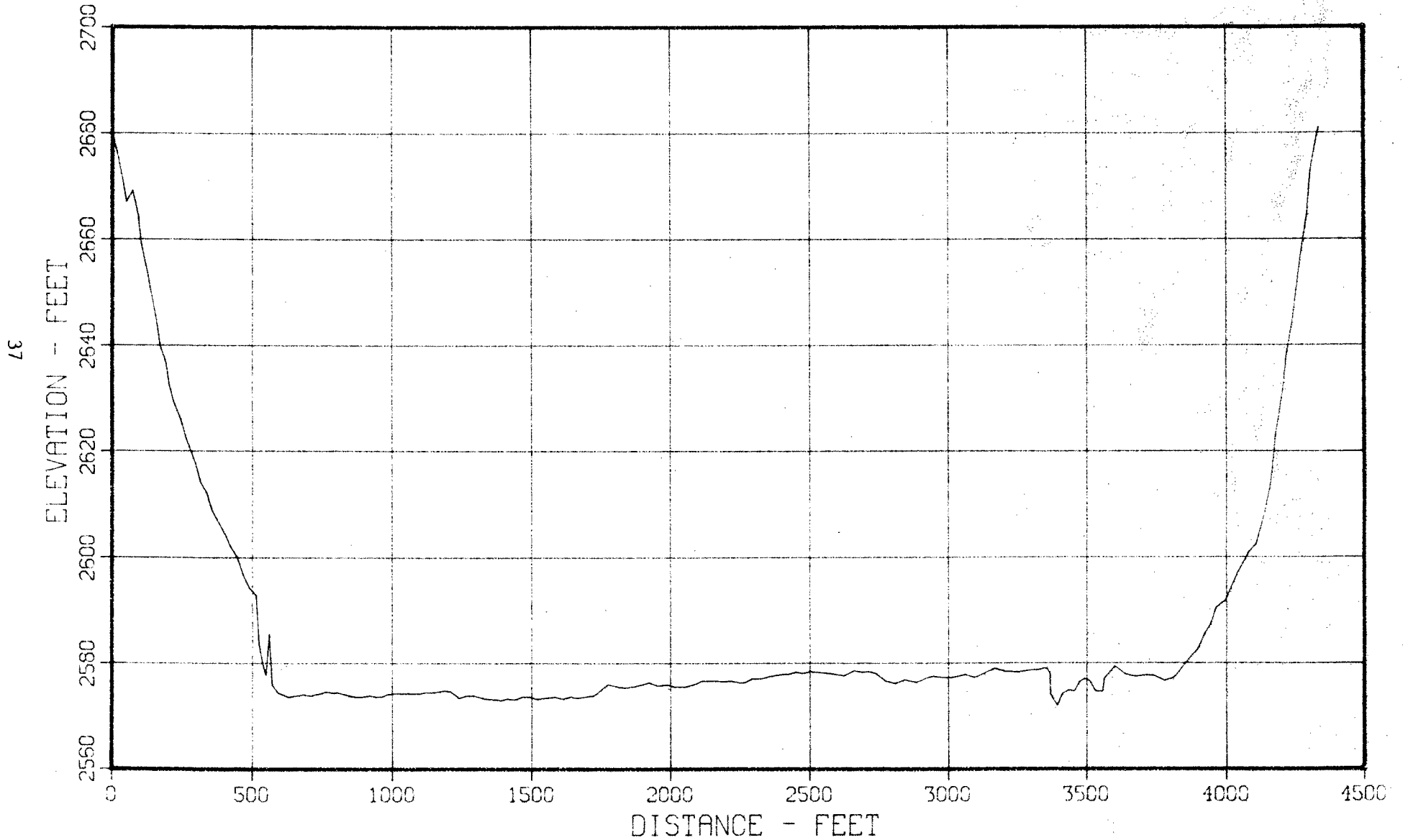


Figure 26 - Sediment Range Profile - Range 21 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 22
GROUND PROFILE FOR SECTION 71290

83

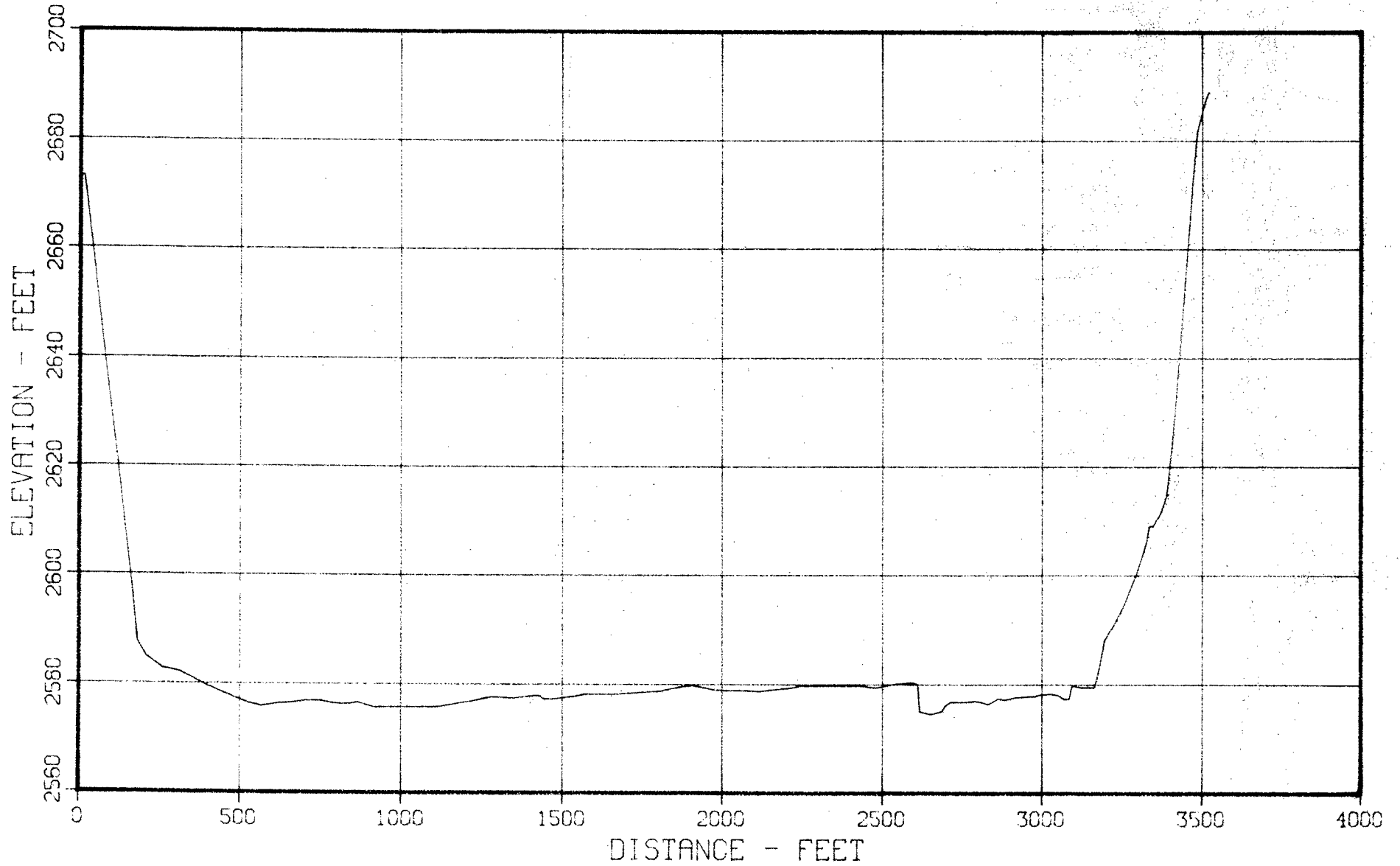


Figure 27 - Sediment Range Profile - Range 22 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 23
GROUND PROFILE FOR SECTION 75304

68

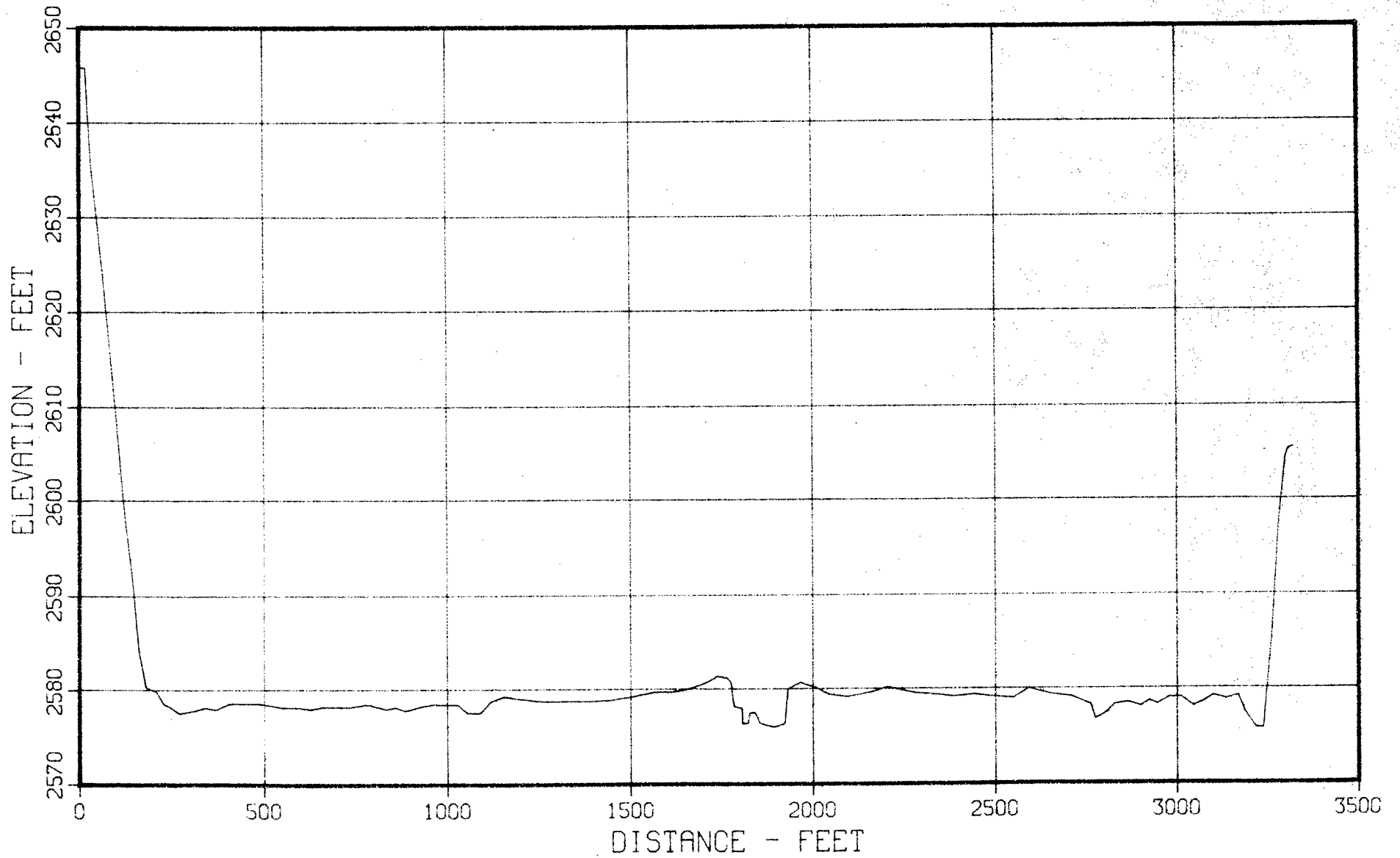


Figure 28 - Sediment Range Profile - Range 23 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 24
GROUND PROFILE FOR SECTION 78950

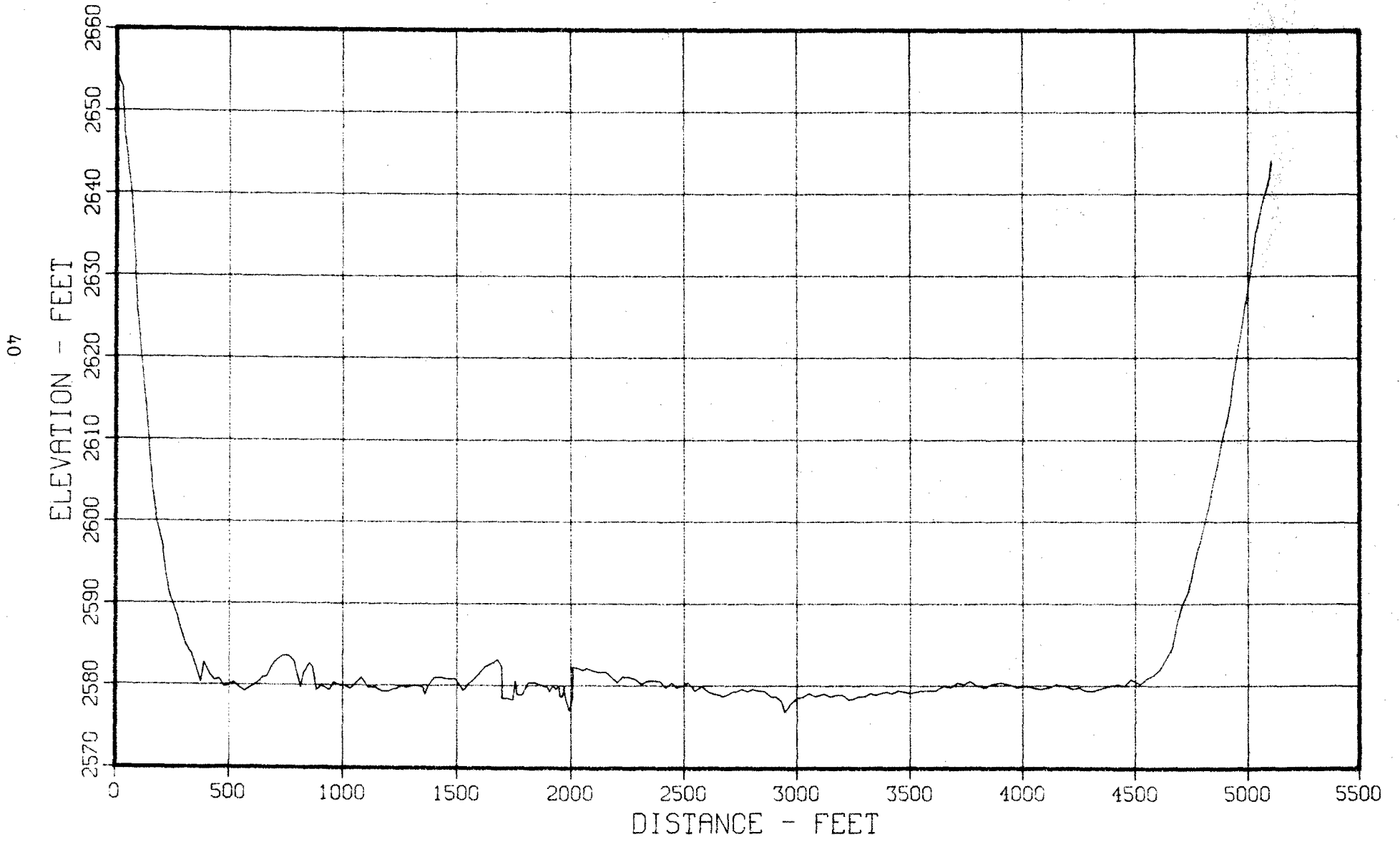


Figure 29 - Sediment Range Profile - Range 24 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 25
GROUND PROFILE FOR SECTION 82051

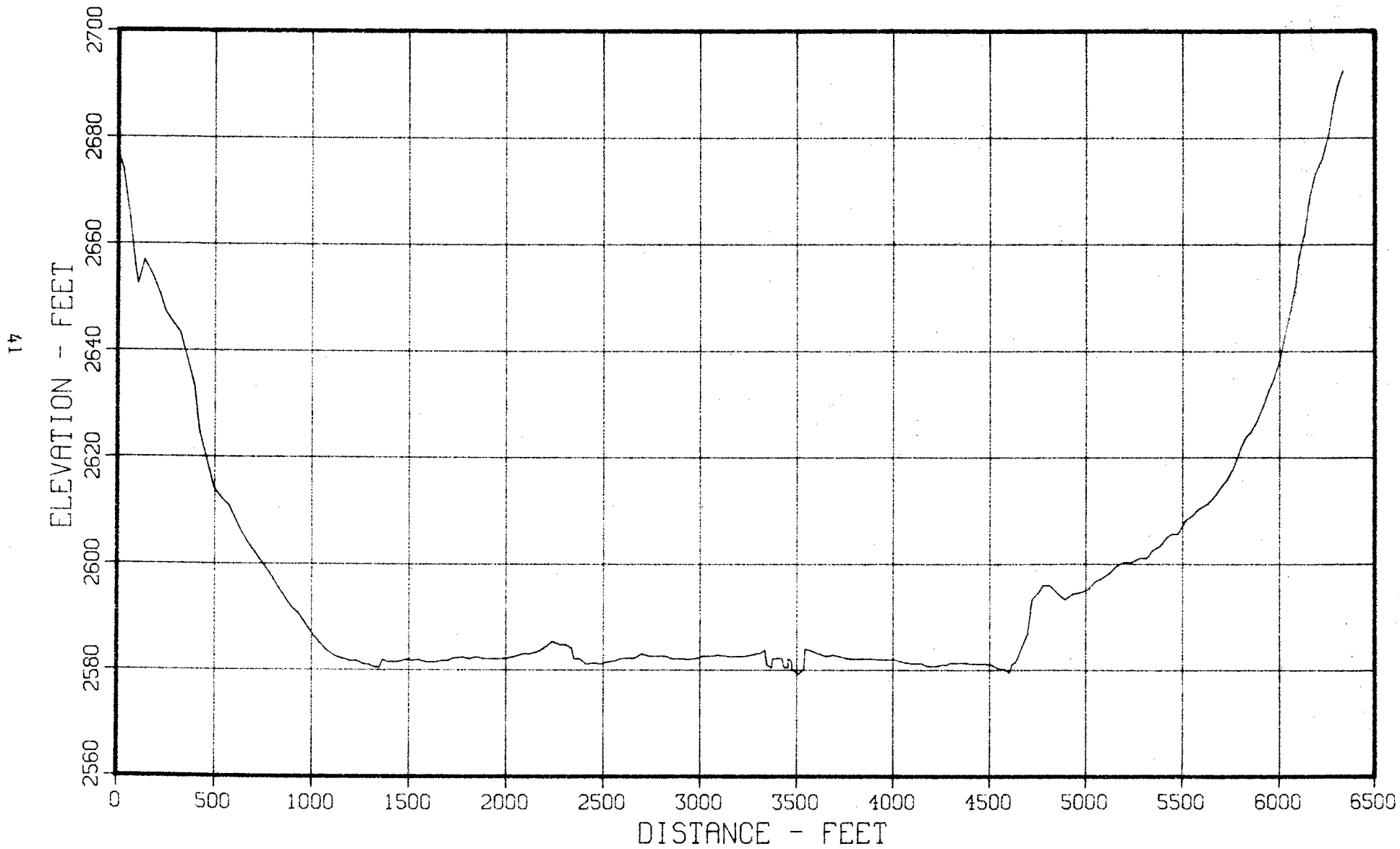


Figure 30 - Sediment Range Profile - Range 25 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 26
GROUND PROFILE FOR SECTION 85796

42

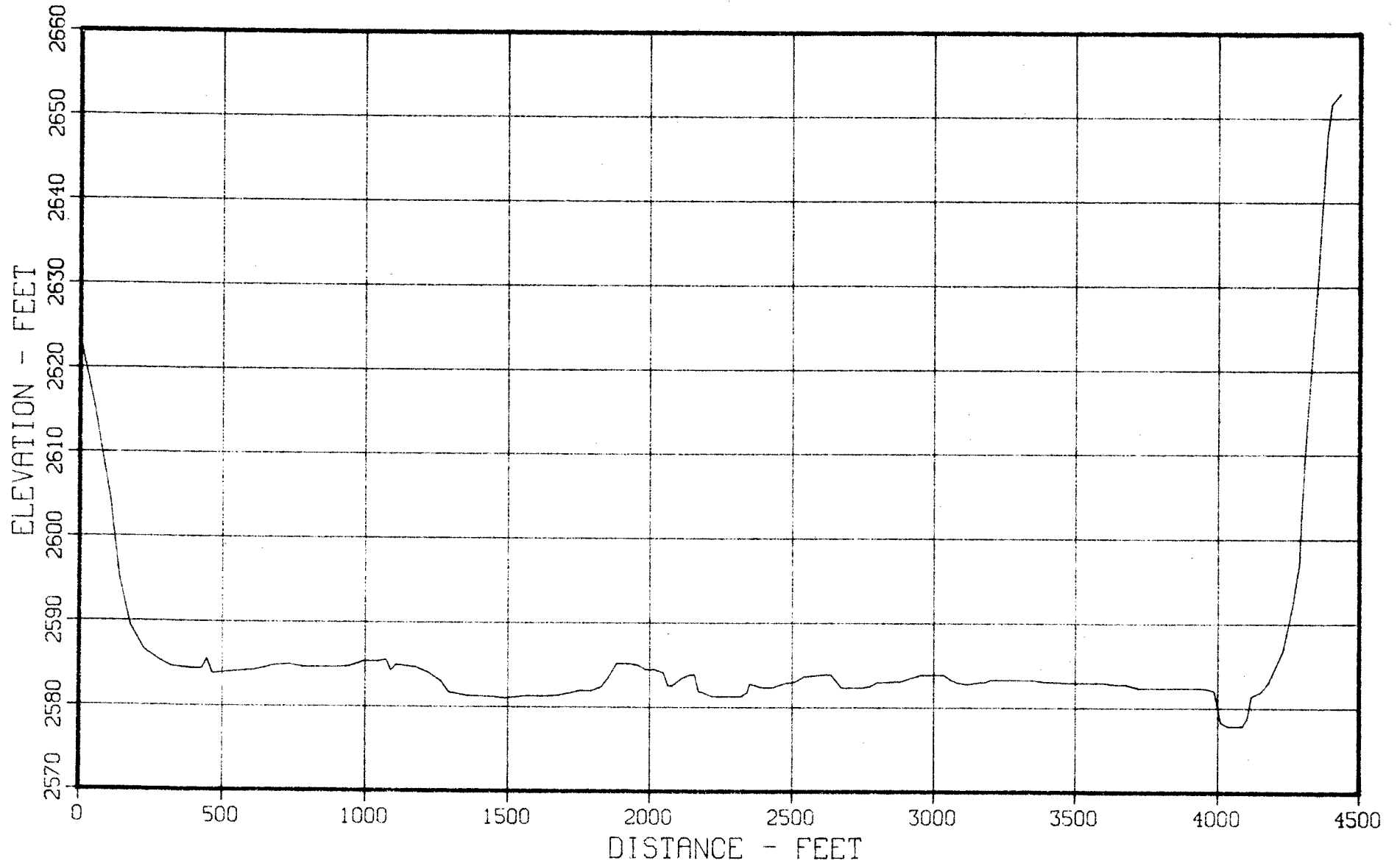


Figure 31 - Sediment Range Profile - Range 26 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 27
GROUND PROFILE FOR SECTION 88962

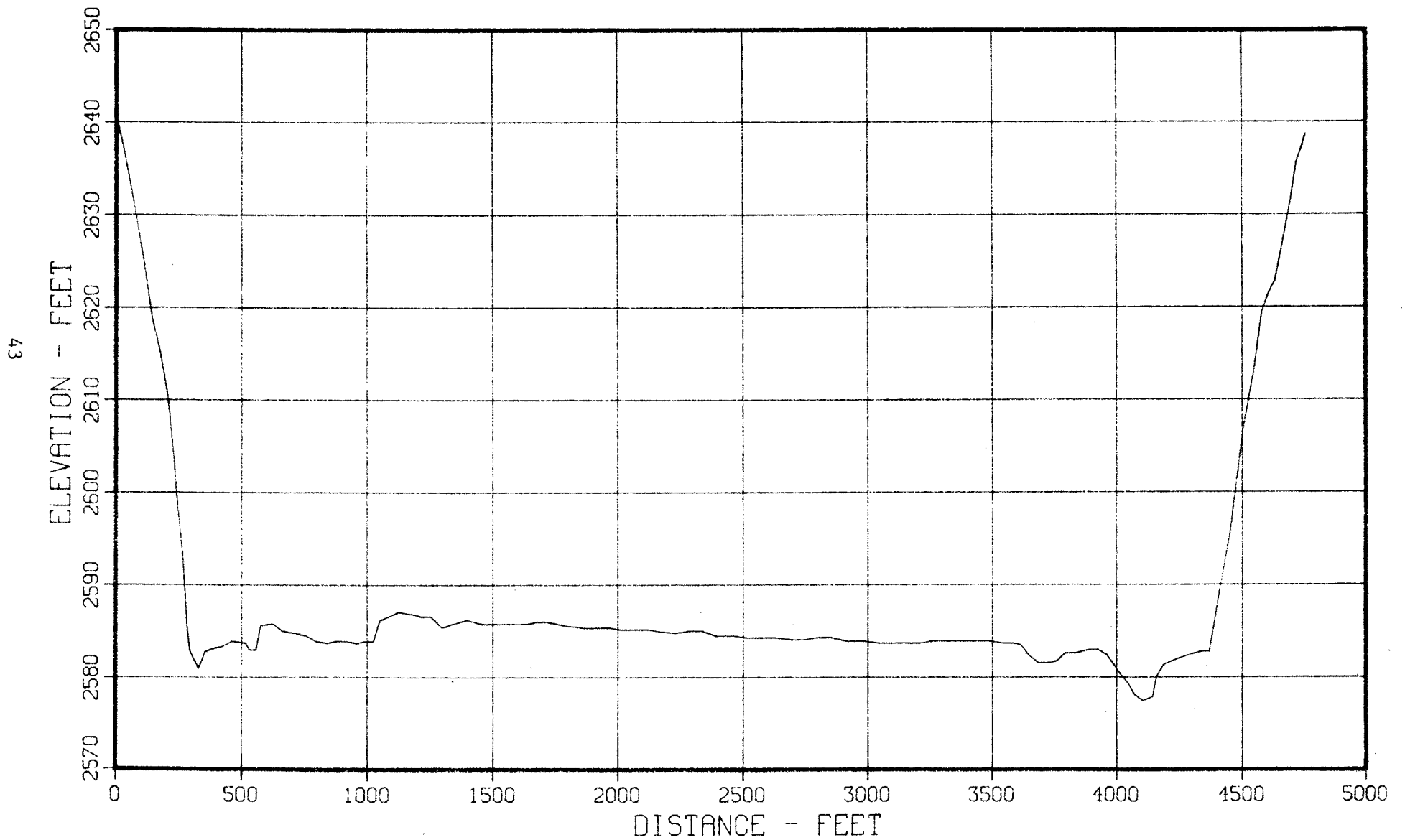


Figure 32 - Sediment Range Profile - Range 27 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 28
GROUND PROFILE FOR SECTION 92052

77

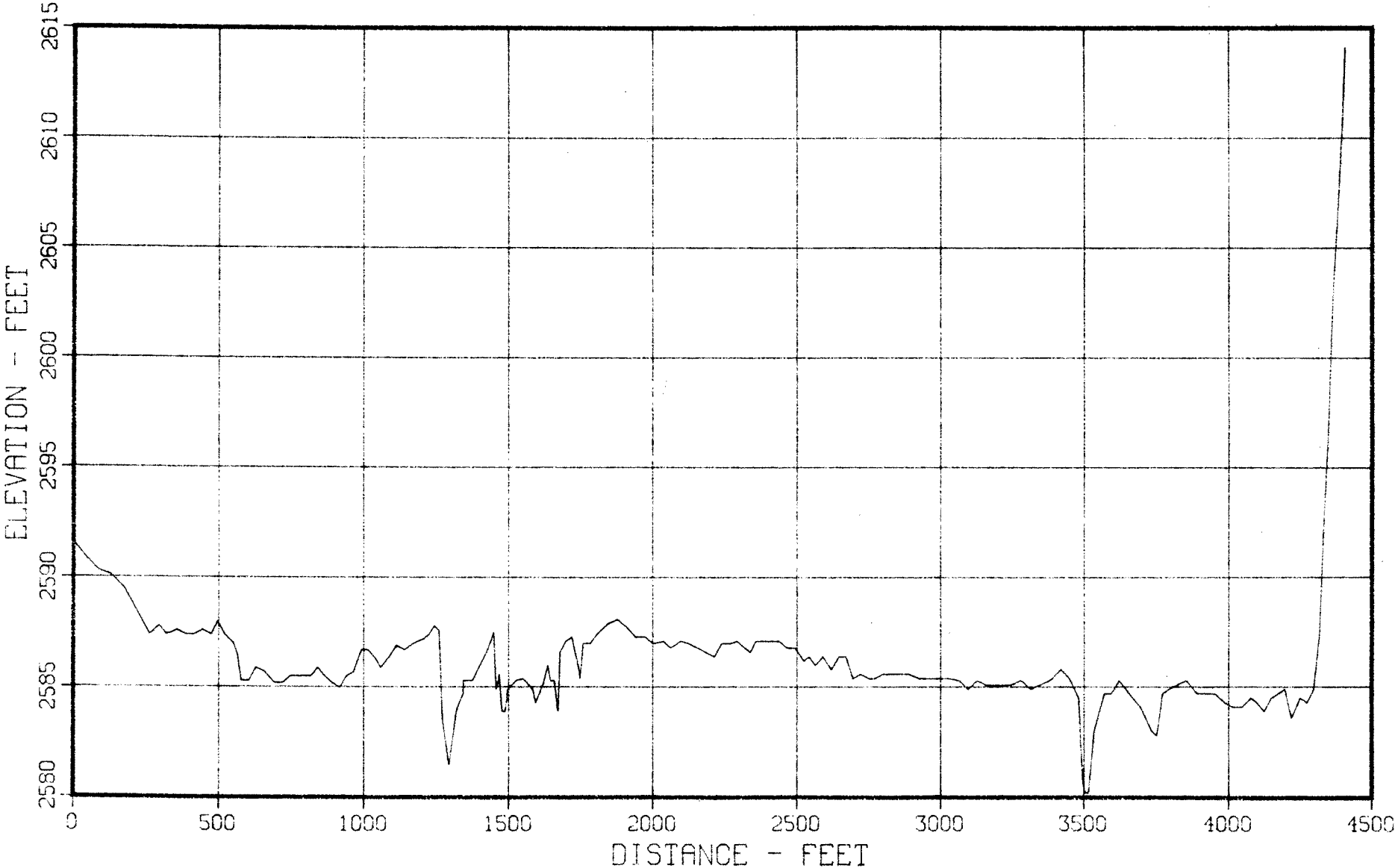


Figure 33 - Sediment Range Profile - Range 28 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 29
GROUND PROFILE FOR SECTION 95453

45

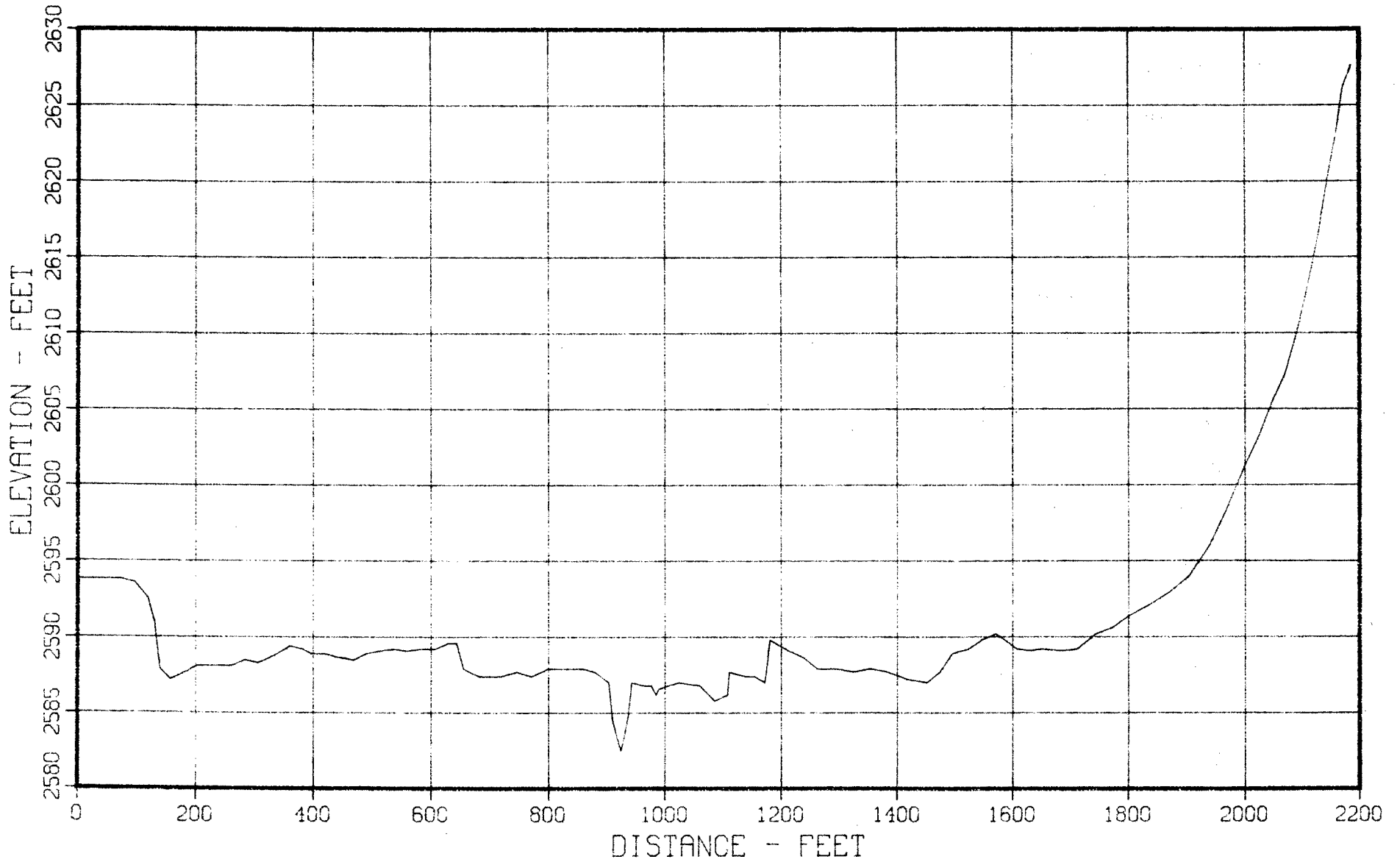


Figure 34 - Sediment Range Profile - Range 29 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 30
GROUND PROFILE FOR SECTION 98904

94

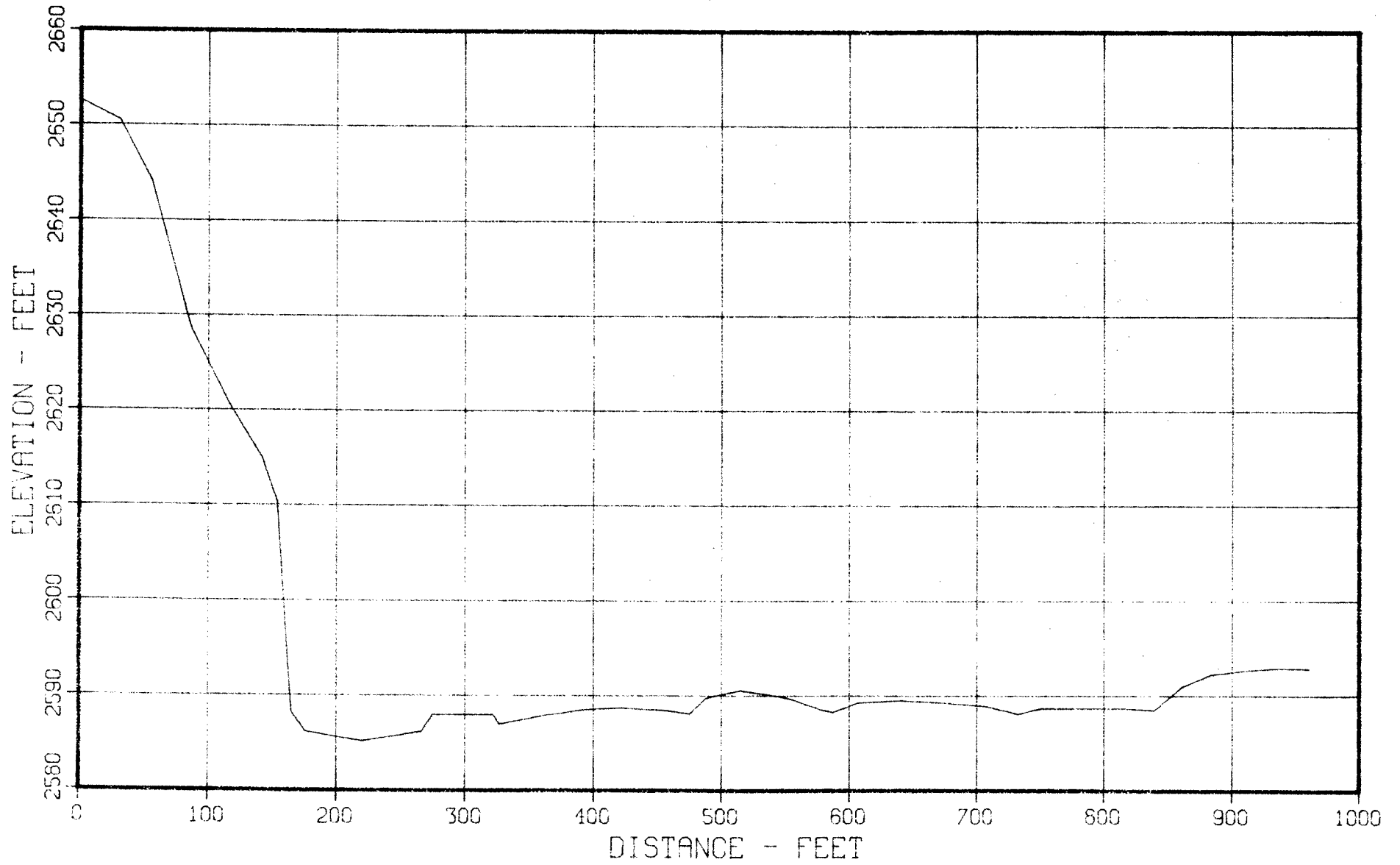
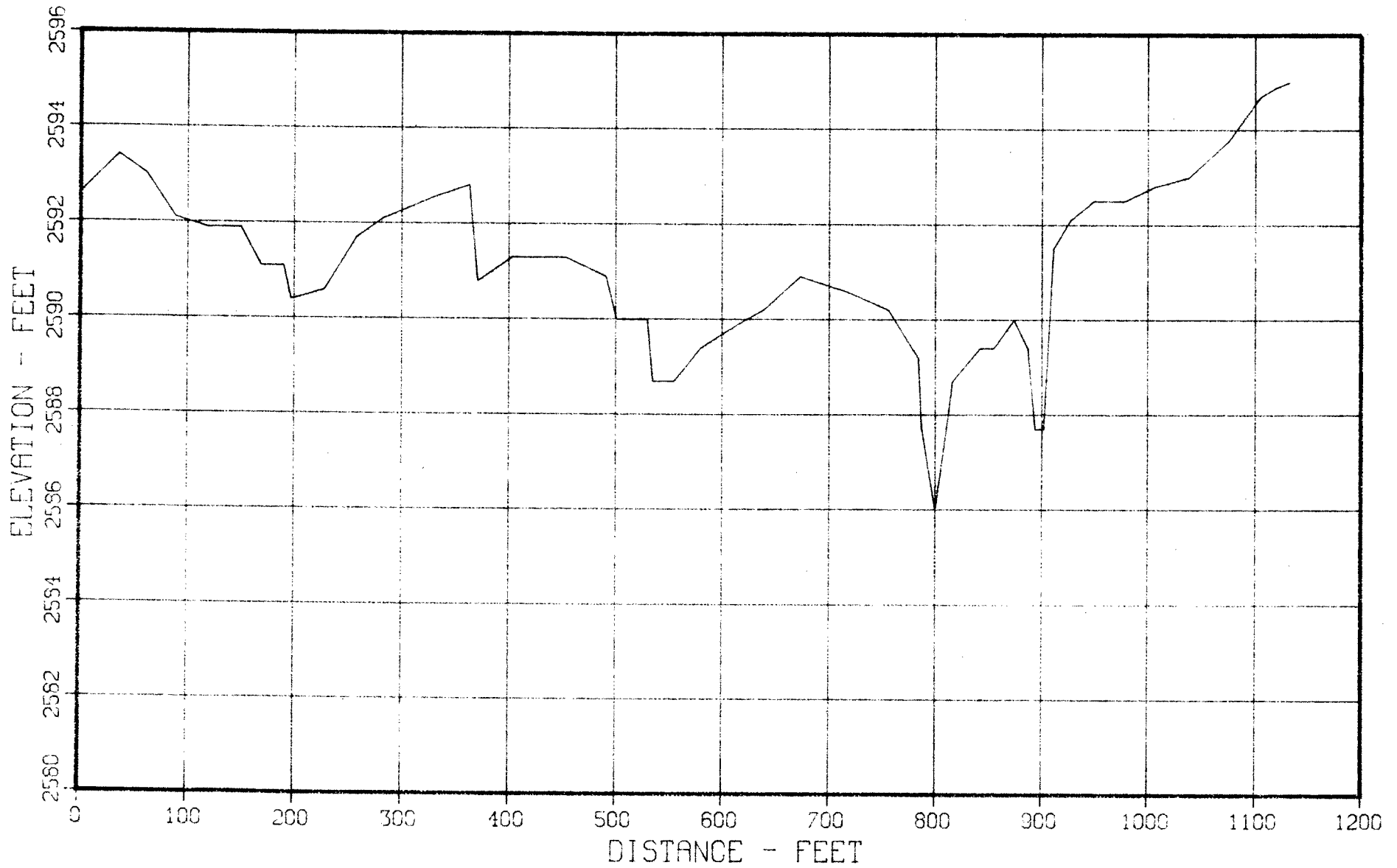


Figure 35 - Sediment Range Profile - Range 30 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 31
GROUND PROFILE FOR SECTION 102135



47

Figure 36 - Sediment Range Profile - Range 31 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 32
GROUND PROFILE FOR SECTION 106220

87

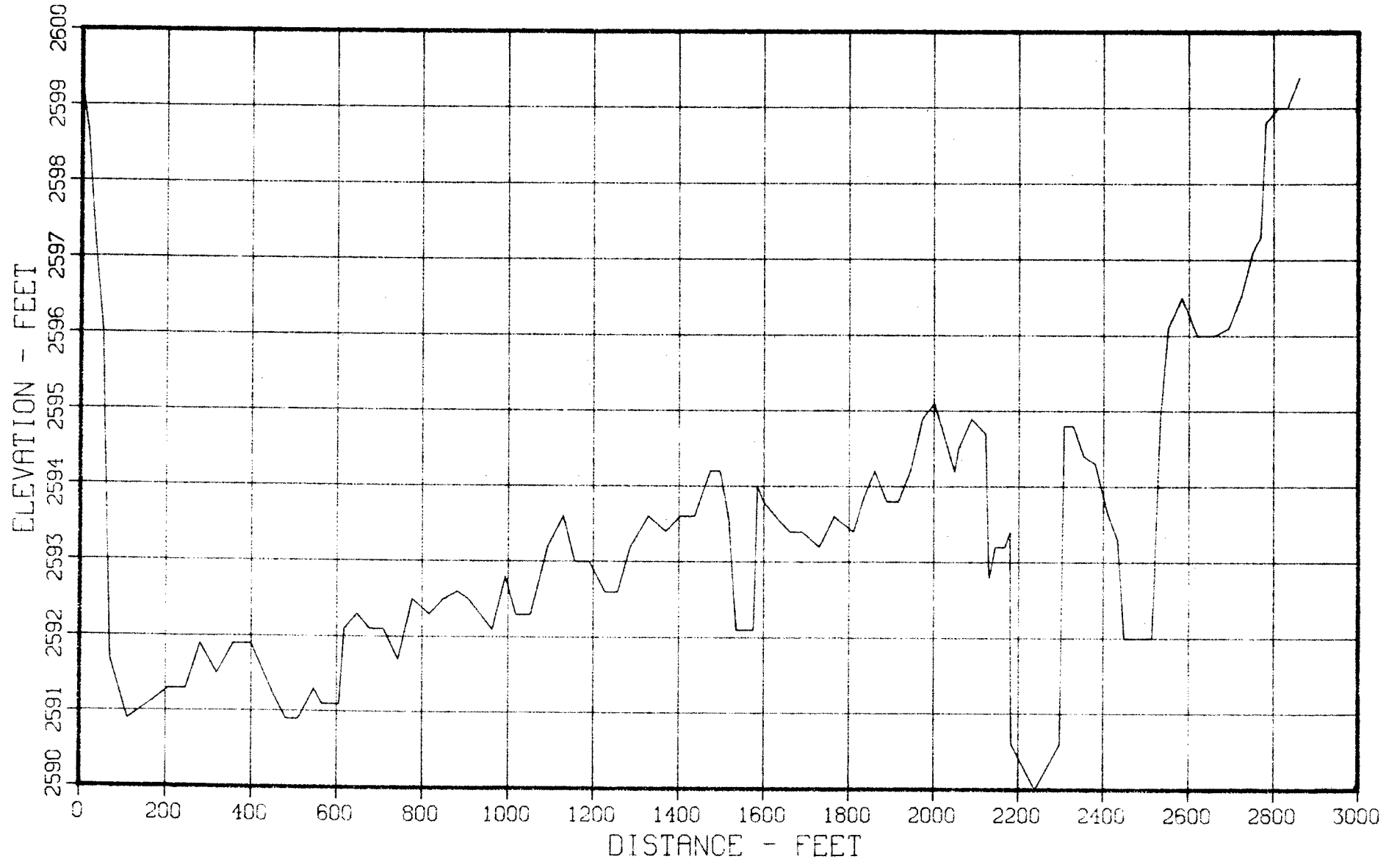


Figure 37 - Sediment Range Profile - Range 32 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 33
GROUND PROFILE FOR SECTION 111070

67

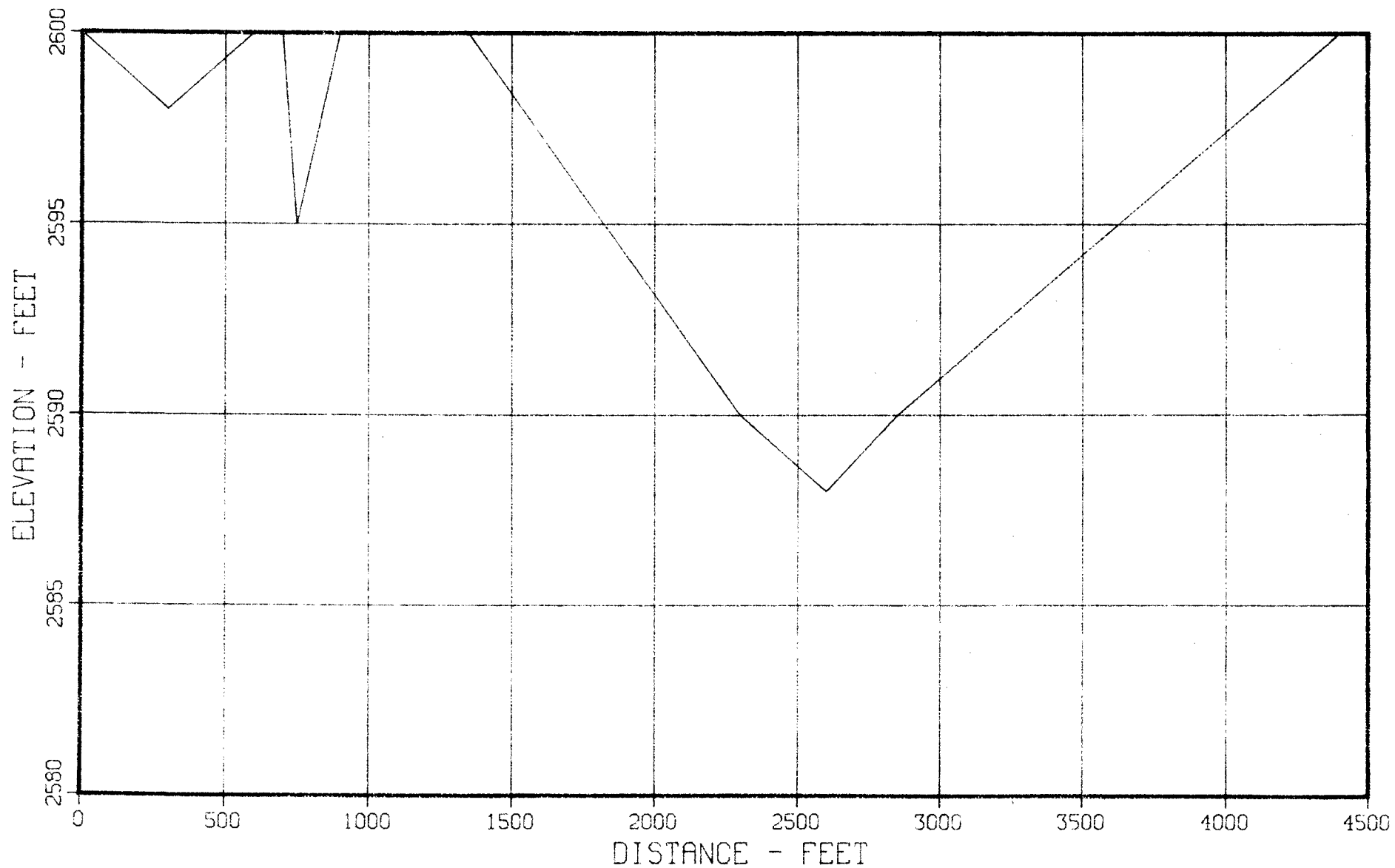


Figure 38 - Sediment Range Profile - Range 33 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 40
GROUND PROFILE FOR SECTION 0

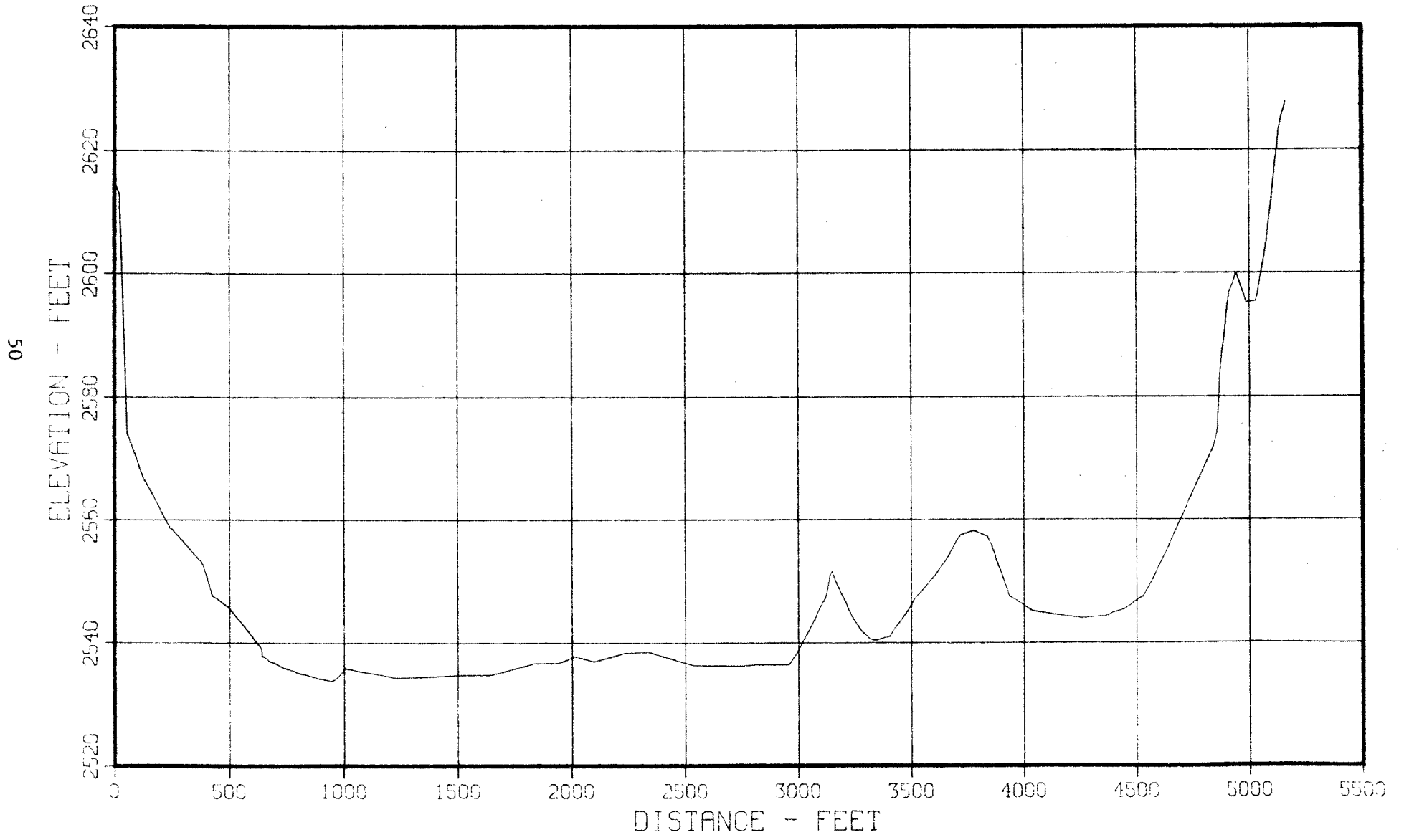


Figure 39 - Sediment Range Profile - Range 40 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 41
GROUND PROFILE FOR SECTION 3772

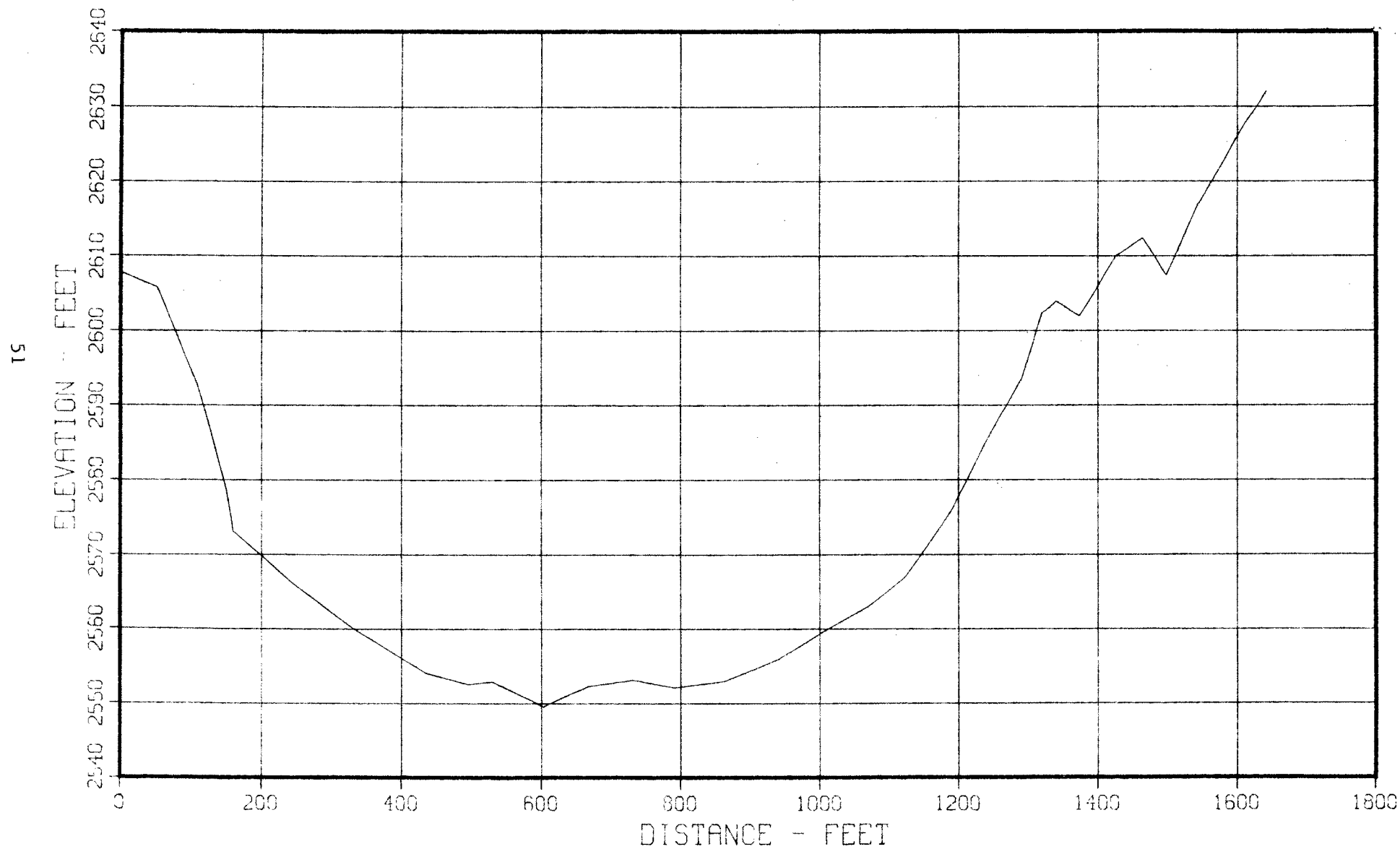


Figure 40 - Sediment Range Profile - Range 41 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 42
GROUND PROFILE FOR SECTION 0

52

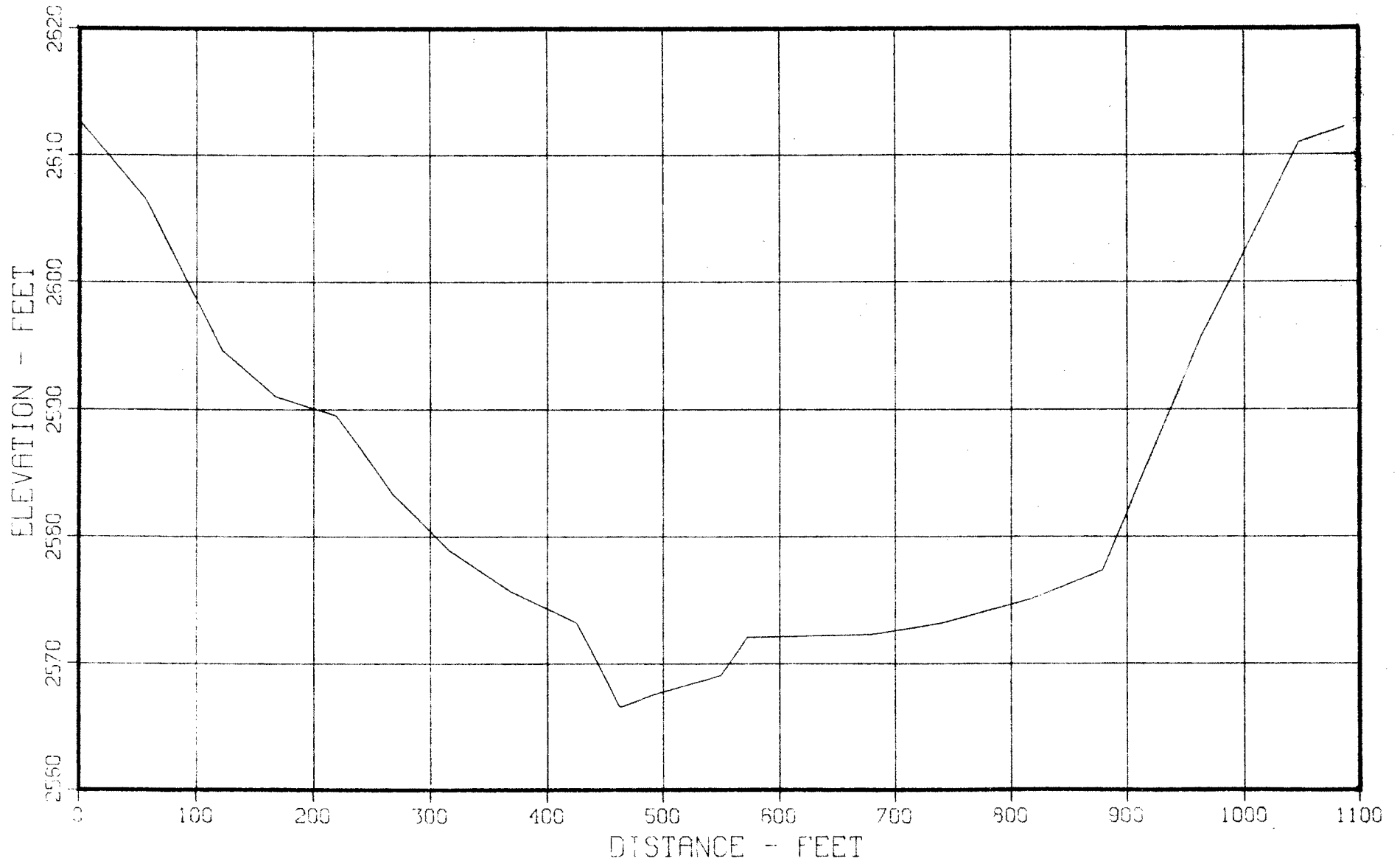


Figure 41 - Sediment Range Profile - Range 42 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 50
GROUND PROFILE FOR SECTION 0

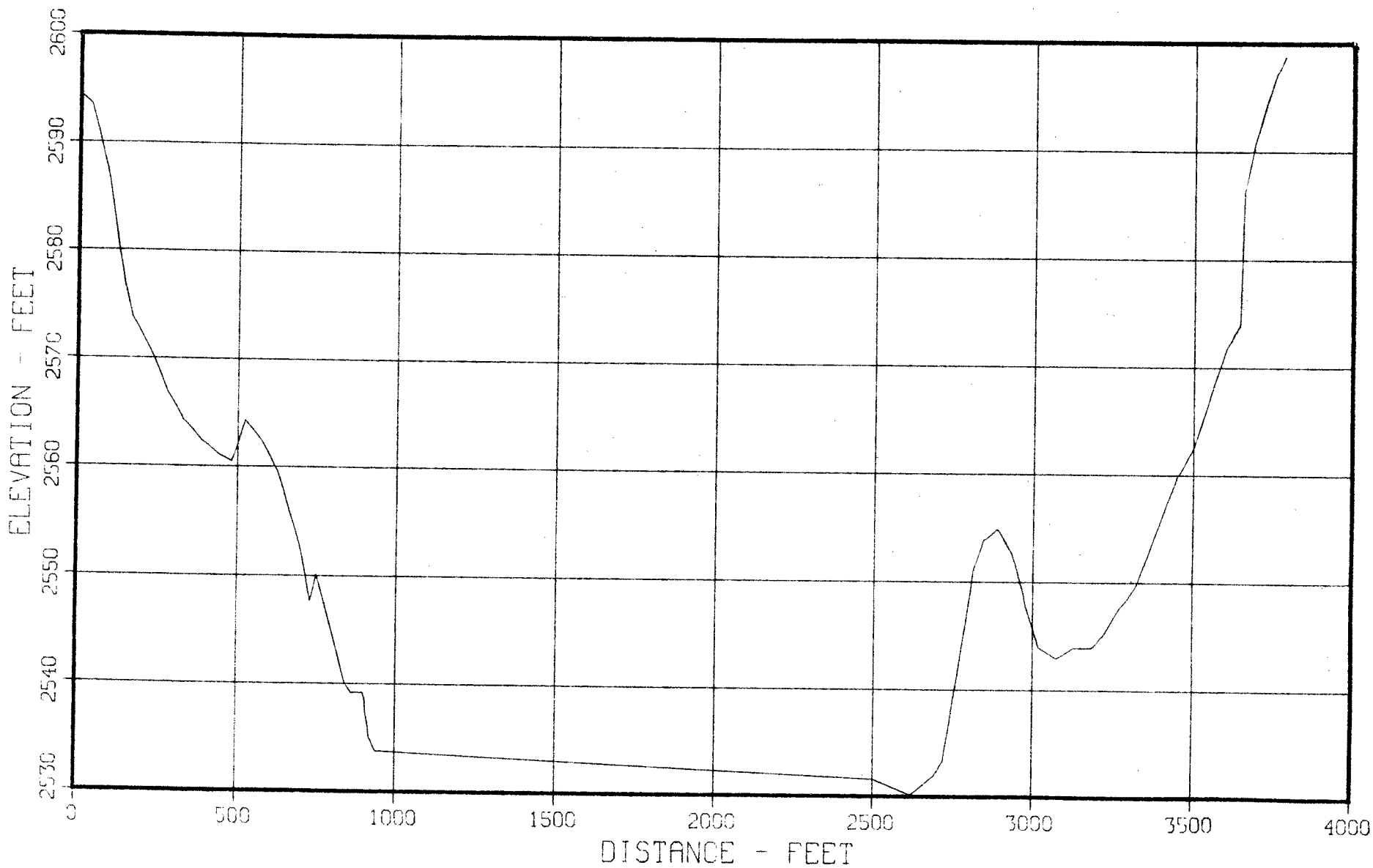


Figure 42 - Sediment Range Profile - Range 50 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 51
GROUND PROFILE FOR SECTION 2494

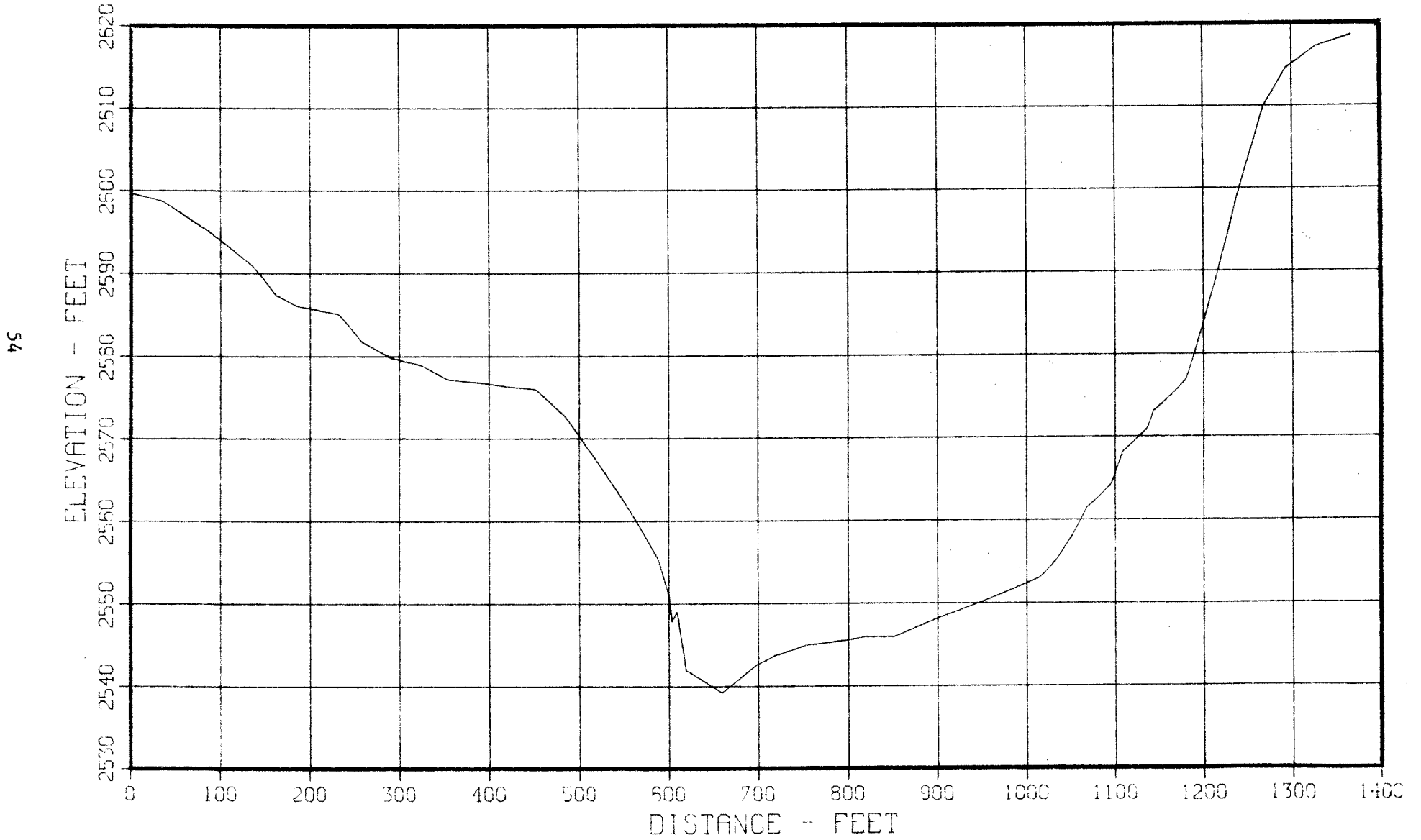


Figure 43 - Sediment Range Profile - Range 51 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 52
GROUND PROFILE FOR SECTION 5020

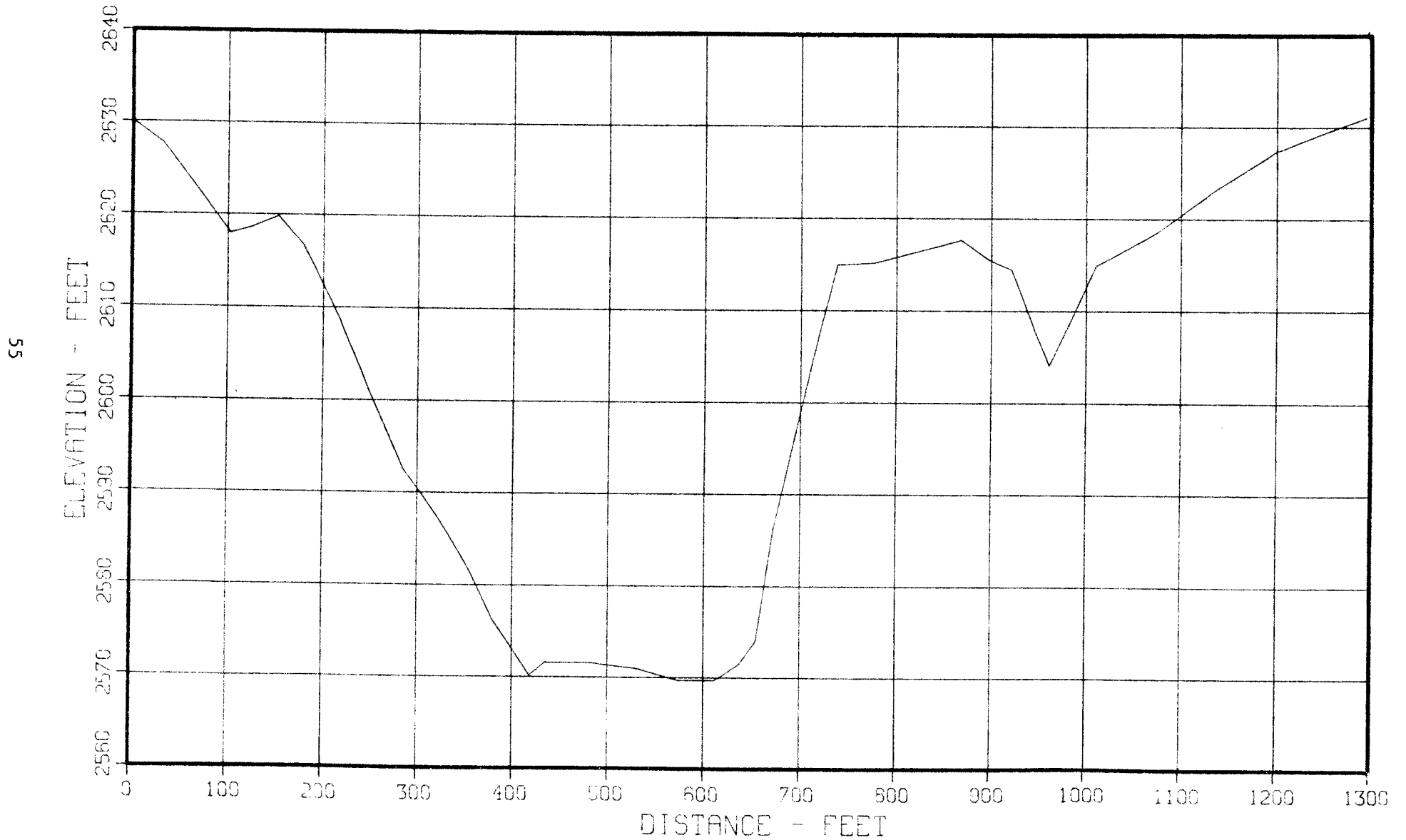


Figure 44 - Sediment Range Profile - Range 52 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 60
GROUND PROFILE FOR SECTION 0

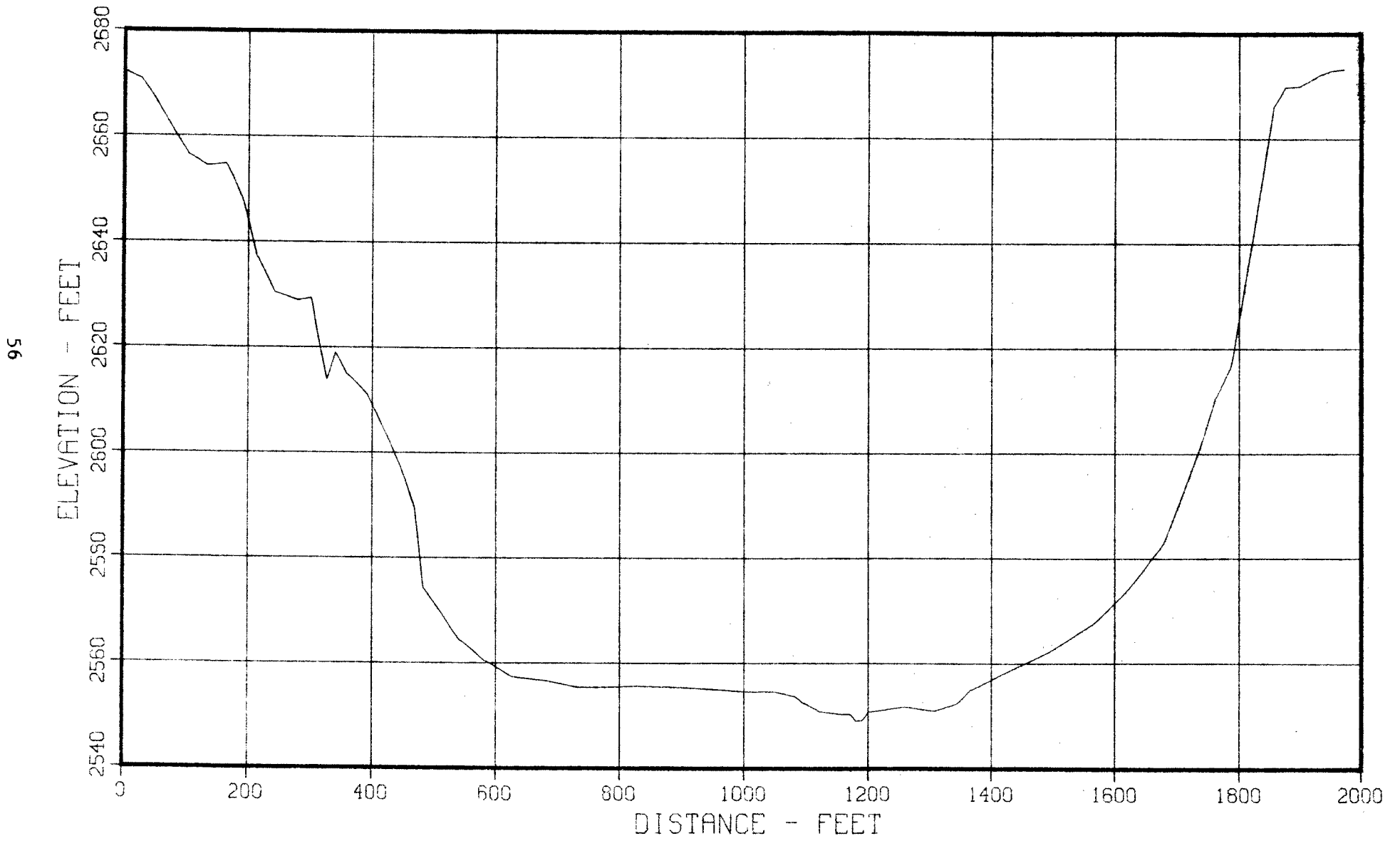


Figure 45 - Sediment Range Profile - Range 60 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 61
GROUND PROFILE FOR SECTION 2266

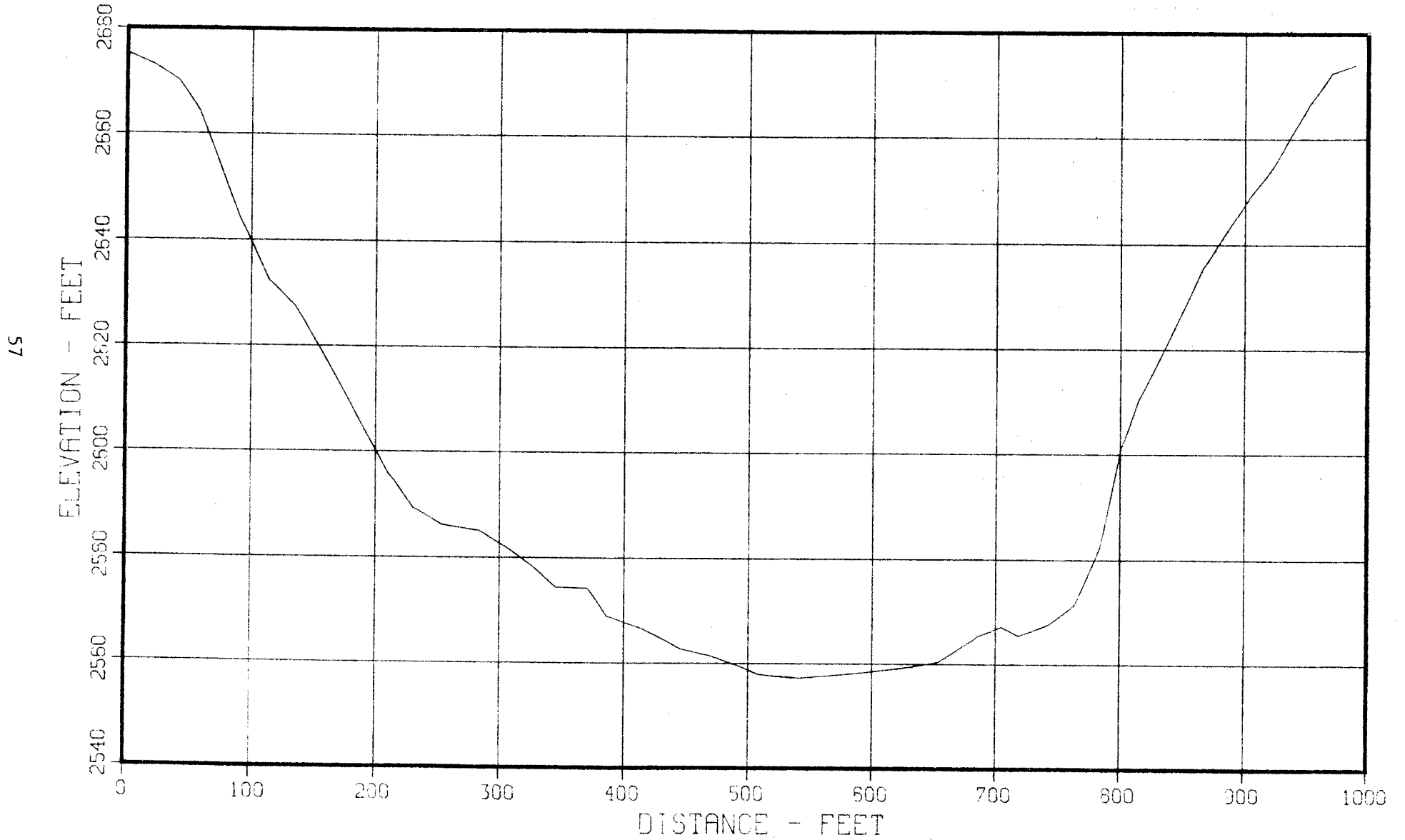


Figure 46 - Sediment Range Profile - Range 61 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 62
GROUND PROFILE FOR SECTION 5386

85

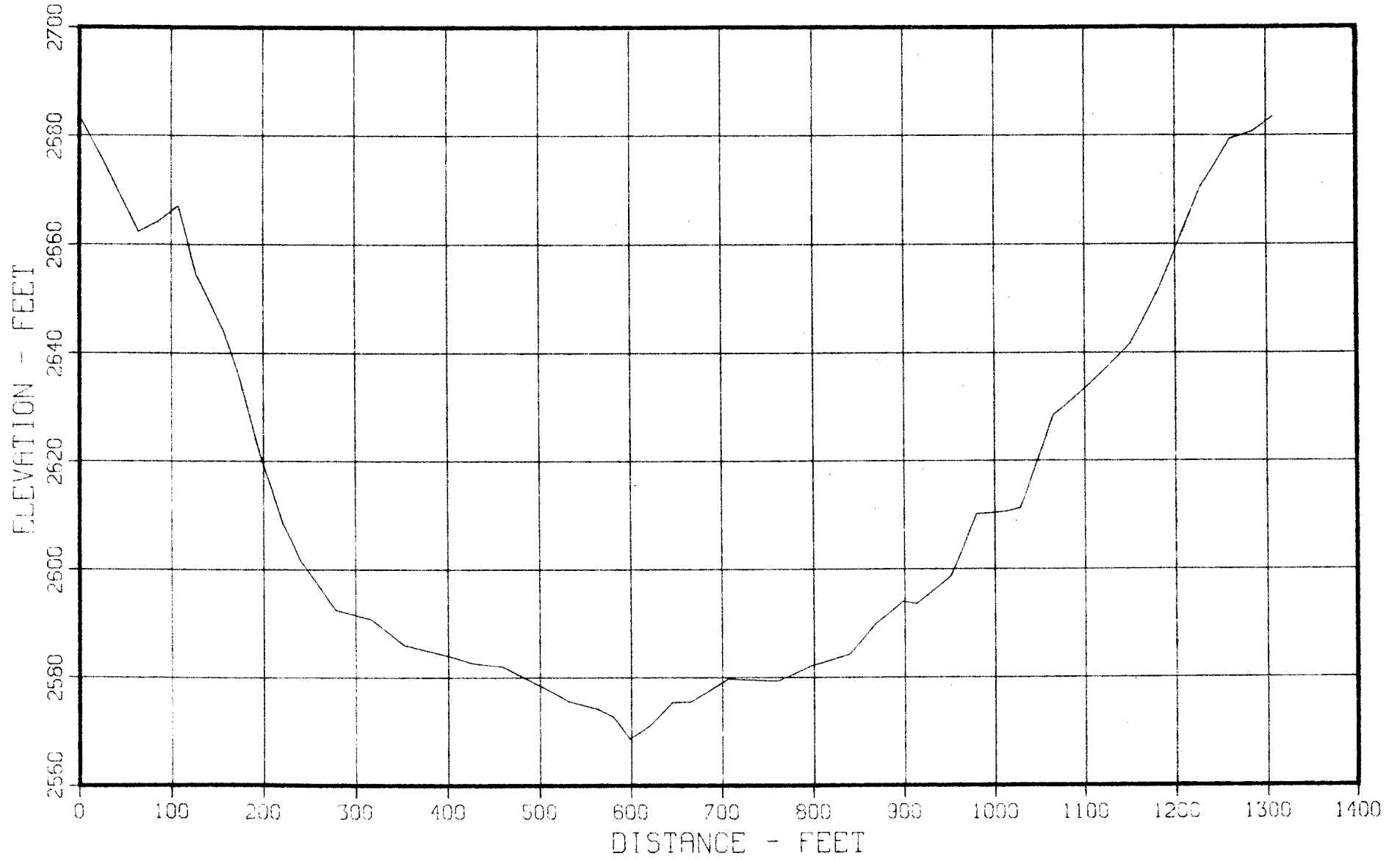


Figure 47 - Sediment Range Profile - Range 62 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 70
GROUND PROFILE FOR SECTION 0

65

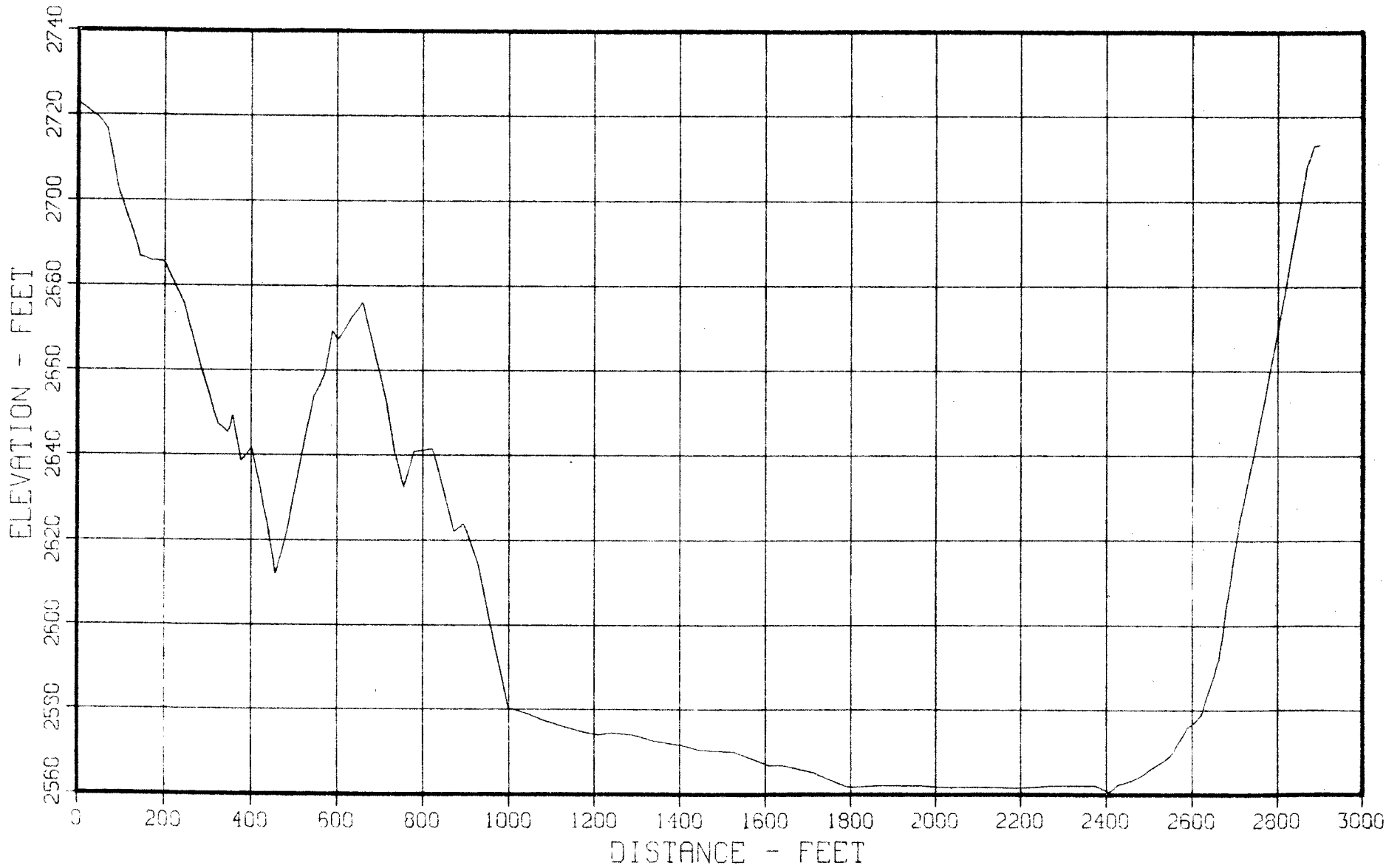


Figure 48 - Sediment Range Profile - Range 70 (1078)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 71
GROUND PROFILE FOR SECTION 3755

09

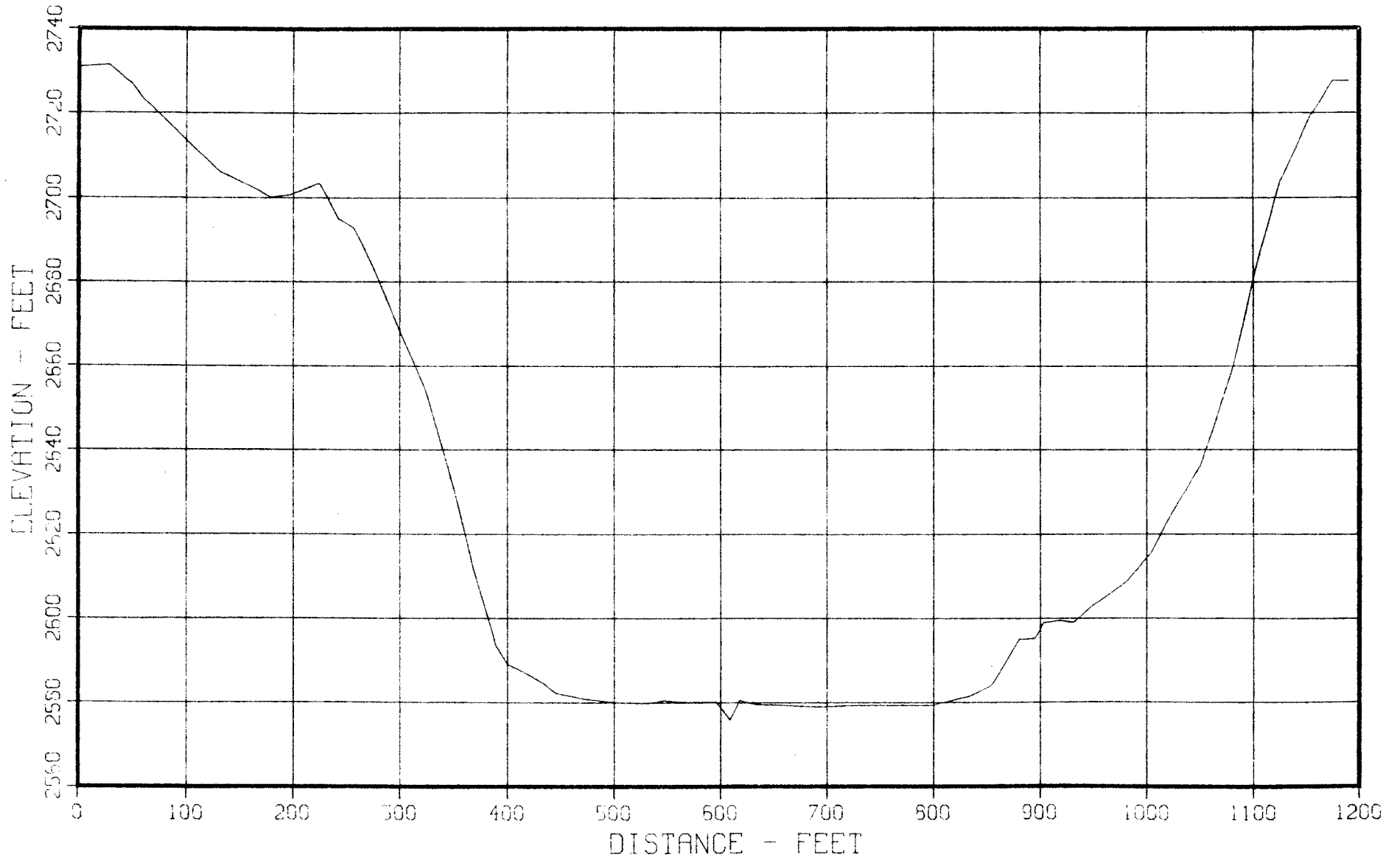


Figure 49 - Sediment Range Profile - Range 71 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 80
GROUND PROFILE FOR SECTION 0

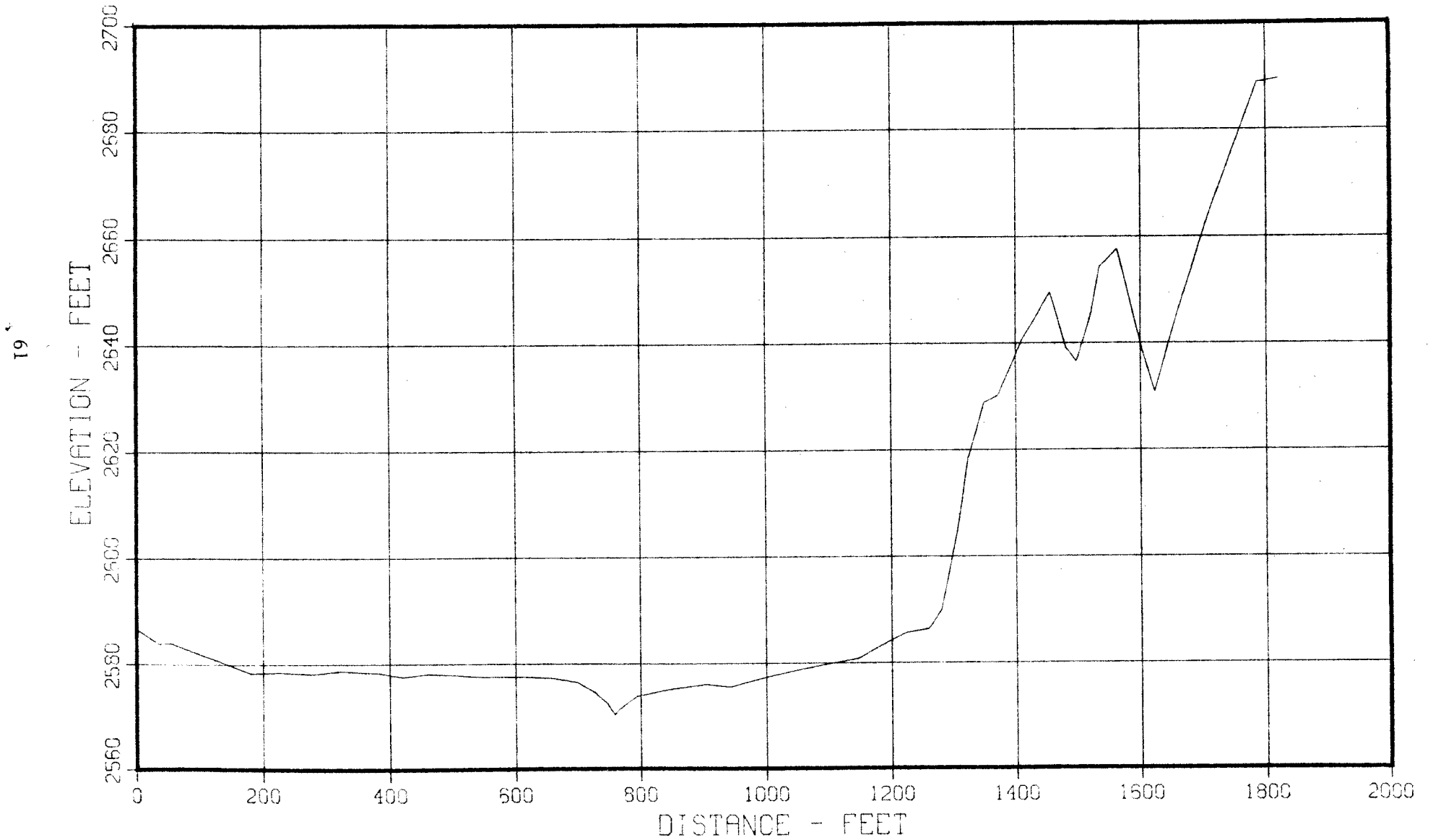


Figure 50 - Sediment Range Profile - Range 80 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 90
GROUND PROFILE FOR SECTION 0

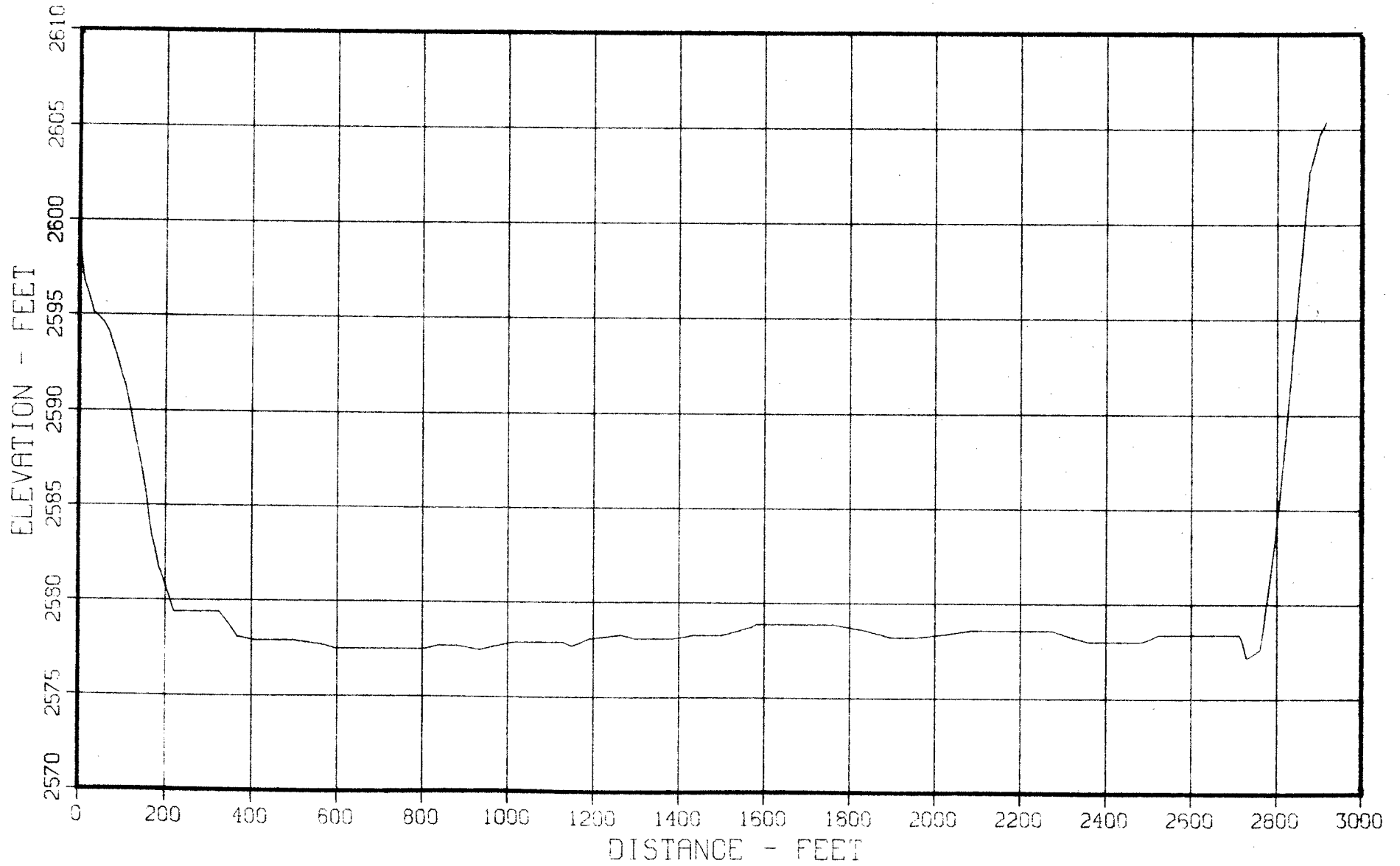


Figure 51 - Sediment Range Profile - Range 90 (1978)

FRESNO RESERVOIR SEDIMENT RESURVEY
RANGE 100
GROUND PROFILE FOR SECTION 0

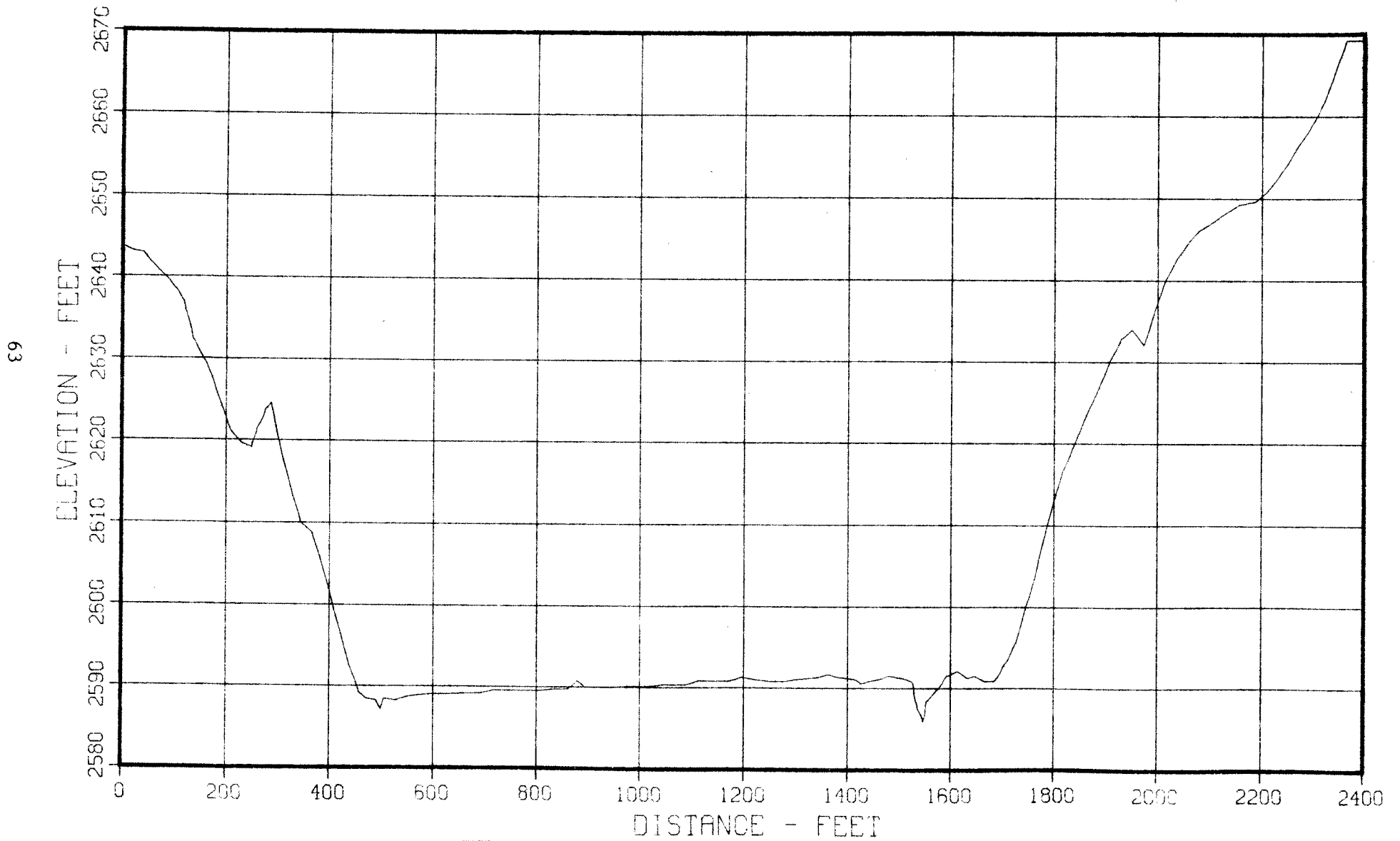


Figure 52 - Sediment Range Profile - Range 100 (1978)

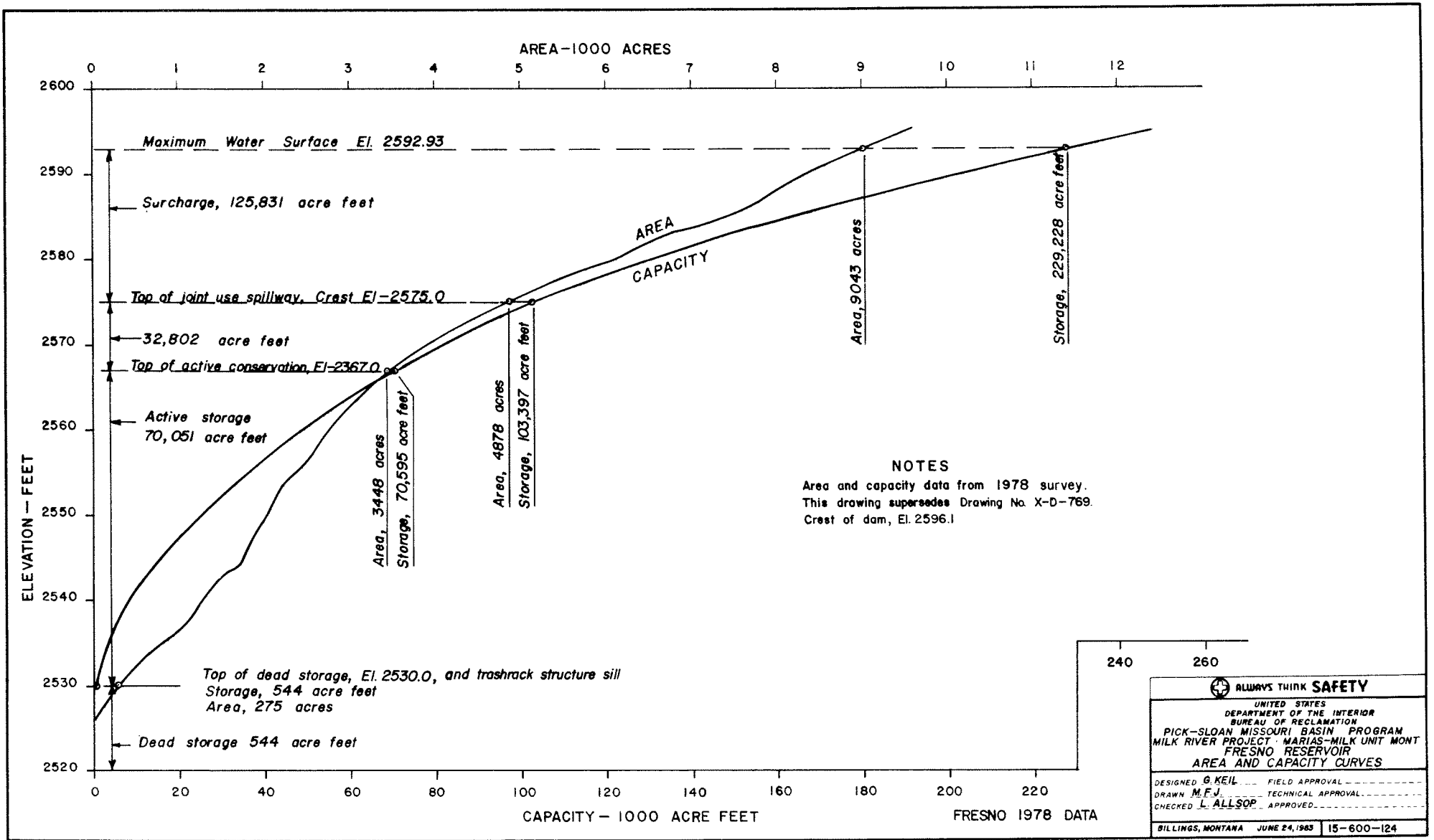


Figure 53 - Area and Capacity Curves

79

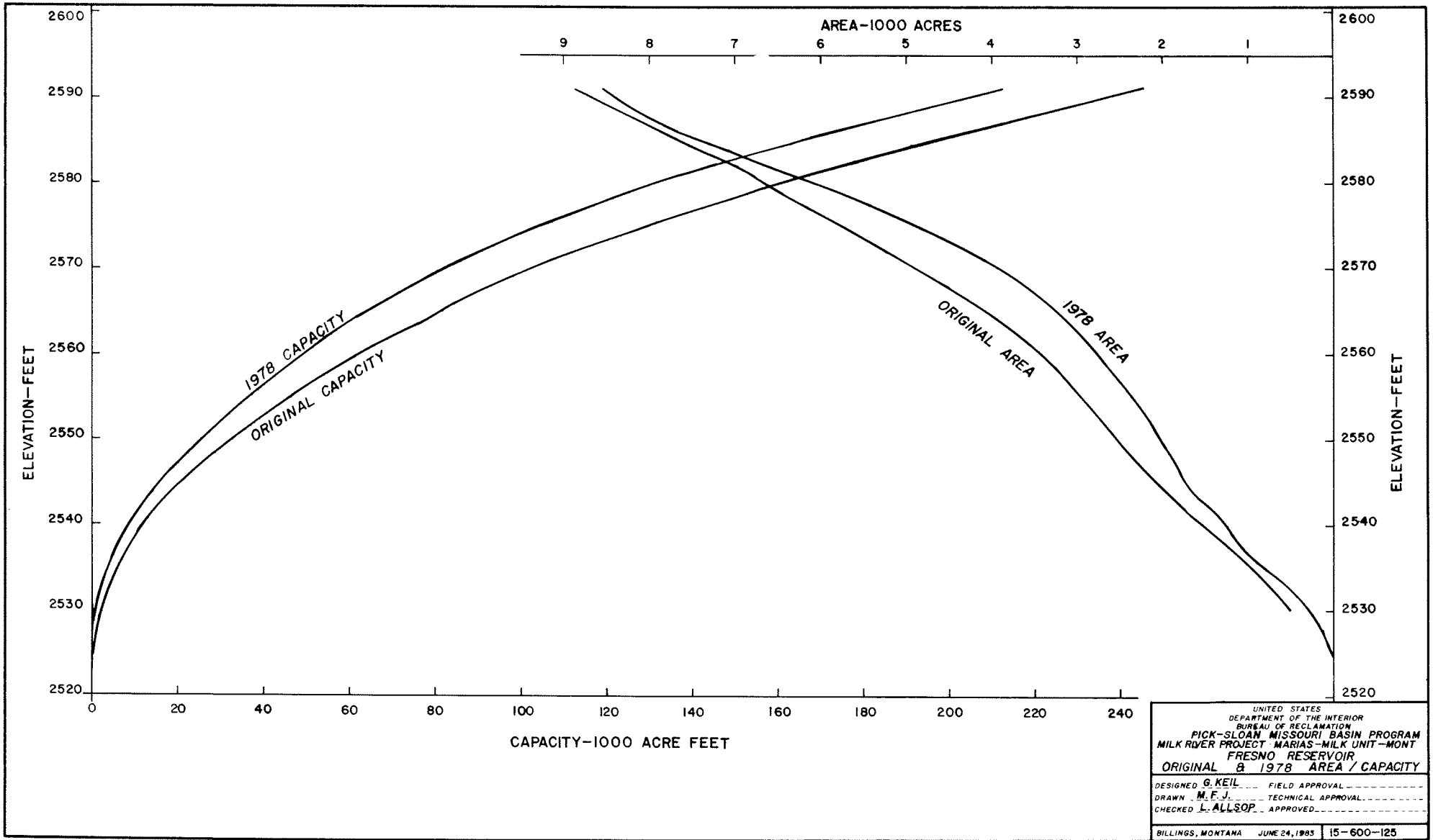


Figure 54 - Original and 1978 Area and Capacity Curves

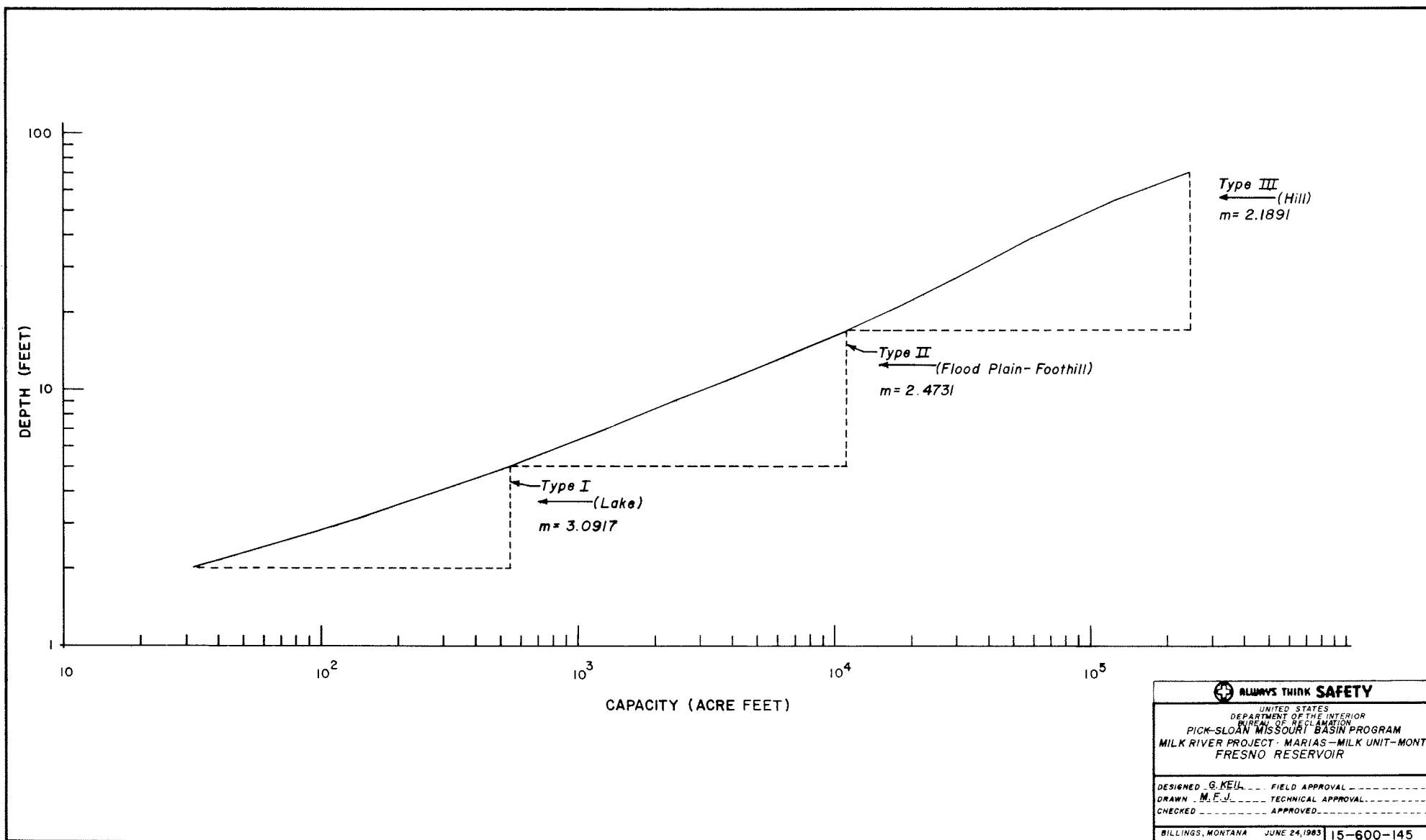
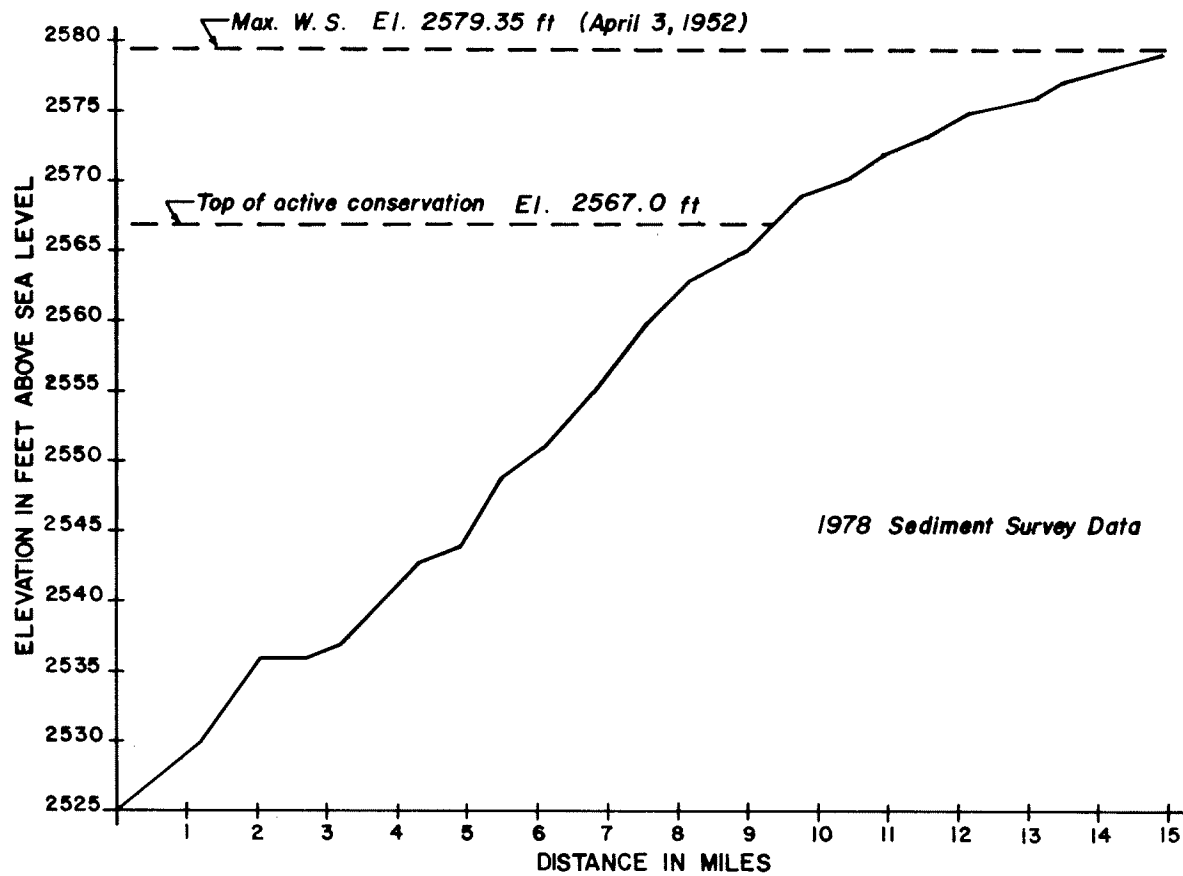


Figure 55 - Reservoir Depth - Capacity Relationship

ALWAYS THINK SAFETY	
UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION PICK-SLOAN MISSOURI BASIN PROGRAM MILK RIVER PROJECT - MARIAS - MILK UNIT - MONT FRESNO RESERVOIR	
DESIGNED <u>G. KELL</u>	FIELD APPROVAL -----
DRAWN <u>M. E. J.</u>	TECHNICAL APPROVAL -----
CHECKED -----	APPROVED -----
BILLINGS, MONTANA	JUNE 24, 1983 15-60Q-145



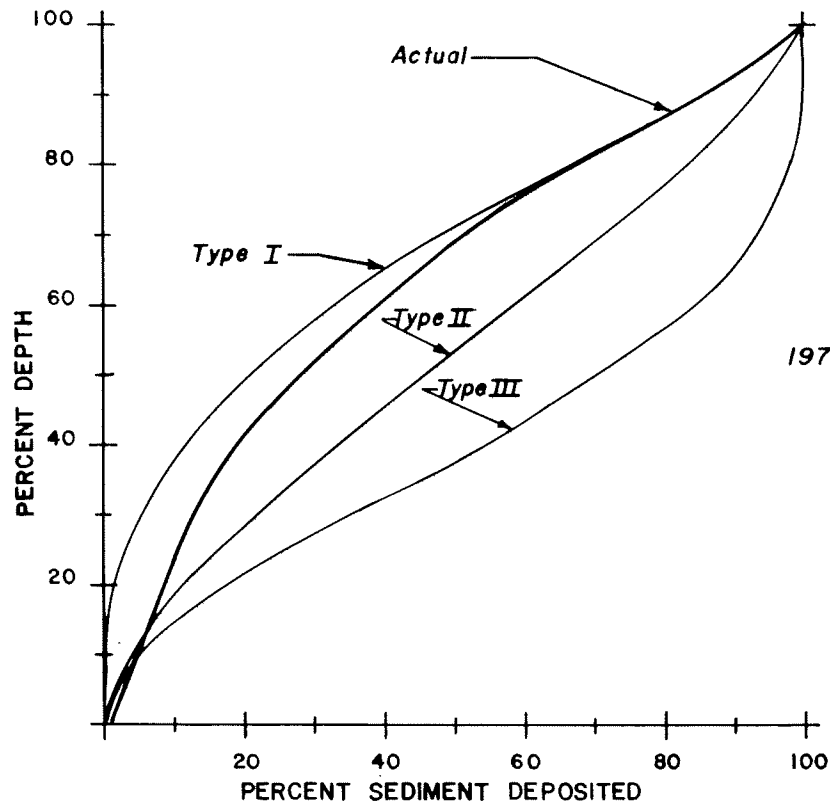
ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
PICK-SLOAN MISSOURI BASIN PROGRAM
MILK RIVER PROJECT - MARIAS-MILK UNIT-MONT
FRESNO RESERVOIR
CENTERLINE PROFILE

DESIGNED **G. KEIL** FIELD APPROVAL
 DRAWN **M.F.J.** TECHNICAL APPROVAL
 CHECKED **L. ALLSOP** APPROVED

BILLINGS, MONTANA JUNE 24, 1983 | 15-600-127

Figure 56 - Longitudinal Profiles



NOTES
 1978 Sediment Survey Data
 H= Total Depth= 54 Feet
 (El. 2580)
 Max Observed
 W.S. El. 2579.35
 (April 3, 1952)

3/27/84 600 <i>at</i>	ADD Type I, Type II, Type III
UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION PICK-SLOAN MISSOURI BASIN PROGRAM MILK RIVER PROJECT- MARIAS-MILK UNIT-MONT FRESNO RESERVOIR	
DESIGNED <u>G. KEIL</u>	FIELD APPROVAL
DRAWN <u>M. F. J.</u>	TECHNICAL APPROVAL
CHECKED <u>L. ALLSOP</u>	APPROVED
BILLINGS, MONTANA JUNE 24, 1983	15-600-128

Figure 57 - Sediment Disposition Curve

Table 1

HORIZONTAL AND VERTICAL CONTROL FOR
FRESNO RESERVOIR RESURVEY CONTRACT

<u>Range Point Number</u>	<u>Marker</u>	<u>Elevation</u>	<u>Northing</u>	<u>Easting</u>
R1R	Alum. Cap	2588.0	582,938.6	1,890,911.4
R1L	Alum. Cap	2631.5	585,204.8	1,891,913.3
R2R	3/4" Rebar	2633.6	584,240.0	1,887,173.2
R2L	3/4" Rebar	2609.6	586,184.8	1,889,466.0
R3R	Alum. Cap	2619.5	588,425.0	1,886,039.4
R3L (R40L)	Alum. Cap	2614.7	588,054.0	1,888,711.7
R4R (R50R)	Alum. Cap	2598.8	591,679.6	1,883,592.0
R4L (R40R)	Alum. Cap	2627.8	593,214.9	1,888,540.7
R5R (R50L)	Alum. Cap	2594.4	595,374.7	1,884,398.8
R5L	Alum. Cap	2642.3	595,940.6	1,888,034.1
R6R	Brass Cap	2649.9	598,435.1	1,884,828.7
R6L	Brass Cap	2633.9	598,428.2	1,887,459.8
R7R	3/4" Rebar	2638.8	600,999.1	1,884,385.5
R7L	3/4" Rebar	2669.6	601,995.8	1,886,857.8
R8R	Alum. Cap	2647.7	603,644.7	1,882,340.5
R8L (R60L)	Alum. Cap	2672.3	604,175.9	1,886,222.3
R9R	3/4" Rebar	2676.3	606,191.3	1,881,755.3
R9L	3/4" Rebar	2678.1	607,400.1	1,884,114.1
R10R	3/4" Rebar	2682.6	609,603.0	1,880,713.0
R10L	3/4" Rebar	2688.9	610,405.4	1,883,920.1
R11R	Brass Cap	2678.3	611,678.3	1,879,837.3
R11L	Brass Cap	2704.4	614,029.4	1,882,387.6
R12R	Alum. Cap	2679.2	613,939.3	1,877,675.2
R12L (R70L)	Alum. Cap	2722.9	617,423.9	1,879,521.3
R13R	Alum. Cap	2697.9	617,212.0	1,874,047.8
R13L (R70R)	Alum. Cap	2713.4	618,884.3	1,877,016.6
R14R	3/4" Rebar	2712.1	619,277.0	1,872,029.3
R14L	3/4" Rebar	2721.1	621,295.2	1,874,416.0
R15R	Brass Cap	2708.0	621,197.2	1,868,232.1
R15L	Brass Cap	2737.6	624,506.6	1,871,324.1
R16R	Alum. Cap	2707.9	622,622.0	1,866,096.9
R16L (R80L)	Alum. Cap	2586.7	626,401.1	1,865,884.9
R17R	3/4" Rebar	2700.7	621,707.6	1,863,700.9
R17L	3/4" Rebar	2694.4	624,290.2	1,862,130.7
R18R	Alum. Cap	2696.8	621,623.1	1,859,865.7
R18L	Alum. Cap	2675.6	625,671.7	1,860,481.7
R19R	3/4" Rebar	2645.0	625,242.9	1,856,708.7
R19L	3/4" Rebar	2674.7	626,779.2	1,859,335.0
R20R	Alum. Cap	2667.7	628,556.4	1,853,738.0
R20L	Alum. Cap	2684.8	629,330.4	1,858,404.4
R21R	Brass Cap	2681.0	632,006.6	1,852,849.4
R21L	Brass Cap	2680.5	635,066.8	1,855,924.1
R22R	3/4" Rebar	2688.9	632,655.5	1,851,521.0
R22L	3/4" Rebar	2673.5	635,431.5	1,853,688.7

Table 1
(continued)

HORIZONTAL AND VERTICAL CONTROL FOR
FRESNO RESERVOIR RESURVEY CONTRACT

<u>Range Point Number</u>	<u>Marker</u>	<u>Elevation</u>	<u>Northing</u>	<u>Easting</u>
R23R (R90R)	Alum. Cap	2605.5	633,572.0	1,847,783.0
R23L	Alum. Cap	2645.8	636,344.2	1,849,610.7
R24R	3/4" Rebar	2644.0	637,818.4	1,844,056.9
R24L	3/4" Rebar	2654.8	638,071.7	1,849,155.9
R25R	Brass Cap	2692.6	641,051.5	1,843,039.7
R25L	Brass Cap	2677.2	640,989.1	1,849,371.6
R26R	3/4" Rebar	2652.9	644,778.9	1,843,312.9
R26L	3/4" Rebar	2623.6	644,627.5	1,847,740.4
R27R	Alum. Cap	2638.7	647,487.0	1,842,459.4
R27L	Alum. Cap	2640.8	648,090.2	1,847,176.9
R28R	3/4" Rebar	2614.1	650,154.1	1,842,852.8
R28L	Alum. Cap	2591.6	651,599.3	1,847,015.9
R29R	Alum. Cap	2627.6	654,177.8	1,844,431.2
R29L	Alum. Cap	2593.8	654,274.6	1,846,615.3
R30R	Alum. Cap	2592.9	656,966.5	1,846,885.9
R30L	Alum. Cap	2652.6	657,379.1	1,847,753.2
R31R	Alum. Cap	2595.0	659,952.6	1,845,191.2
R31L	Alum. Cap	2592.6	660,048.4	1,846,319.4
R32R	Alum. Cap	2599.4	663,606.3	1,843,303.9
R32L	Alum. Cap	2599.3	664,283.4	1,846,083.3
R40R (R4L)	Alum. Cap	2627.8	593,214.9	1,888,540.7
R40L (R3L)	Alum. Cap	2614.7	588,054.0	1,888,711.7
R41R	3/4" Rebar	2632.0	590,222.0	1,892,301.6
R41L	3/4" Rebar	2607.8	588,594.4	1,892,084.3
R42R	3/4" Rebar	2612.2	590,078.8	1,894,256.8
R42L	3/4" Rebar	2612.7	590,084.0	1,895,345.6
R50R (R4R)	Alum. Cap	2598.8	591,679.6	1,883,592.0
R50L (R5R)	Alum. Cap	2594.4	595,374.7	1,884,398.8
R51R	3/4" Rebar	2618.6	594,978.3	1,881,633.4
R51L	3/4" Rebar	2599.7	595,615.7	1,882,843.8
R52R	3/4" Rebar	2631.1	596,238.5	1,880,355.1
R52L	3/4" Rebar	2630.1	597,522.5	1,880,185.3
R60R	Alum. Cap	2673.4	605,992.6	1,885,454.7
R60L (R8L)	Alum. Cap	2672.3	604,175.9	1,886,222.3
R61R	3/4" Rebar	2674.1	603,970.6	1,888,034.4
R61L	3/4" Rebar	2675.3	603,412.5	1,887,216.5
R62R	3/4" Rebar	2683.5	605,092.0	1,890,410.7
R62L	3/4" Rebar	2683.5	603,799.2	1,890,612.6
R70R (R13L)	Alum. Cap	2713.4	618,884.3	1,877,016.6
R70L (R12L)	Alum. Cap	2722.9	617,423.9	1,879,521.3
R71R	3/4" Rebar	2727.6	621,305.8	1,876,426.0
R71L	3/4" Rebar	2731.0	622,001.9	1,877,392.3
R80R	Alum. Cap	2689.5	626,367.5	1,864,063.7
R80L (R16L)	Alum. Cap	2586.7	626,401.1	1,865,884.9

Table 1
(continued)

HORIZONTAL AND VERTICAL CONTROL FOR
FRESNO RESERVOIR RESURVEY CONTRACT

<u>Range Point Number</u>	<u>Marker</u>	<u>Elevation</u>	<u>Northing</u>	<u>Easting</u>
R90R (R23R)	Alum. Cap	2605.5	633,572.0	1,847,783.0
R90L	Alum. Cap	2598.7	635,655.4	1,845,741.1
R100R	Alum. Cap	2664.7	652,626.3	1,841,317.6
R100L	Alum. Cap	2643.7	653,969.4	1,843,301.0

AERIAL PICTURE POINT ELEVATIONS

<u>Aerial Photo No.</u>	<u>Location</u>	<u>Elevation</u>
2338	Approx. 2000 feet south of $\frac{24}{25} \mid \frac{19}{30}$ T. 33 N., R. 13-14 E.	2657.79 2X2 Hub
2341	Approx. 900 feet SW of R14R	2707.98 2X2 Hub
?	Approx. 3200 feet West of R31R	2617.67
?	Approx. 700 feet West of R11L	2714.29 2X2 Hub

TABLE 2 - AREA IN ACRES - 1-FOOT INCREMENTS

FRESNO RESERVOIR

1978 RESURVEY

(ACAP) COMPUTED
03/21/84
11.11.24.

AREA TABLE IN ACRES		ELEVATION INCREMENT IS ONE FOOT								
ELEV. FEET	0	1	2	3	4	5	6	7	8	9
2520						1	8	48	132	218
2530	275	371	461	548	643	784	978	1074	1146	1200
2540	1254	1358	1432	1467	1714	1753	1787	1821	1872	1961
2550	2040	2083	2128	2173	2224	2357	2485	2542	2603	2663
2560	2752	2842	2932	3022	3131	3237	3343	3448	3592	3748
2570	3904	4059	4241	4434	4627	4878	5102	5325	5548	5855
2580	6130	6296	6509	6721	7115	7397	7679	7825	8006	8187
2590	8369	8550	8825	9059	9293	9527				

TABLE 3 - AREA IN ACRES - 0.10-FOOT INCREMENTS

FRESNO RESERVOIR

1978 RESURVEY

(ACAP) COMPUTED
03/21/84
11.12.31.

AREA TABLE IN ACRES		ELEVATION INCREMENT IS ONE TENTH FOOT								
ELEV. FEET	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
2524									1	1
2525	1	2	2	3	4	4	5	6	6	7
2526	8	12	16	20	24	28	32	36	40	44
2527	48	56	65	73	81	90	98	107	115	124
2528	132	141	149	158	166	175	184	192	201	209
2529	218	224	229	235	241	247	252	258	264	270
2530	275	285	294	304	314	323	333	342	352	361
2531	371	380	389	398	407	416	425	434	443	452
2532	461	470	479	487	496	505	513	522	531	540
2533	548	558	567	577	586	596	605	615	624	634
2534	643	657	671	685	700	714	728	742	756	770
2535	784	804	823	842	862	881	900	920	939	958
2536	978	987	997	1006	1016	1026	1035	1045	1054	1064
2537	1074	1081	1088	1095	1103	1110	1117	1124	1132	1139
2538	1146	1152	1157	1162	1168	1173	1179	1184	1189	1195
2539	1200	1206	1211	1216	1222	1227	1232	1238	1243	1249
2540	1254	1264	1275	1285	1295	1306	1316	1327	1337	1347
2541	1358	1365	1373	1380	1388	1395	1403	1410	1417	1425
2542	1432	1436	1439	1443	1446	1450	1453	1457	1460	1463
2543	1467	1492	1516	1541	1566	1591	1615	1640	1665	1689
2544	1714	1722	1725	1729	1732	1736	1739	1743	1746	1749
2545	1753	1756	1760	1763	1766	1770	1773	1777	1780	1784
2546	1787	1790	1794	1797	1801	1804	1808	1811	1814	1818
2547	1821	1825	1830	1835	1841	1846	1851	1857	1862	1867
2548	1872	1890	1898	1906	1914	1922	1930	1937	1945	1953
2549	1961	1969	1977	1985	1992	2000	2008	2016	2024	2032

TABLE 3 - CONTINUED

FRESNO RESERVOIR

1978 RESURVEY

(ACAP) COMPUTED

03/21/84

11.12.31.

AREA TABLE IN ACRES

ELEVATION INCREMENT IS ONE TENTH FOOT

ELEV. FEET	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
2550	2040	2043	2047	2052	2056	2061	2065	2070	2074	2079
2551	2083	2088	2092	2097	2101	2106	2110	2115	2119	2124
2552	2128	2133	2137	2142	2146	2151	2155	2160	2164	2169
2553	2173	2173	2177	2183	2189	2195	2201	2206	2212	2218
2554	2224	2241	2254	2267	2280	2293	2305	2318	2331	2344
2555	2357	2369	2382	2395	2408	2421	2433	2446	2459	2472
2556	2485	2488	2494	2500	2506	2512	2518	2524	2530	2536
2557	2542	2548	2554	2561	2567	2573	2579	2585	2591	2597
2558	2603	2609	2615	2621	2627	2633	2639	2645	2651	2657
2559	2663	2671	2680	2689	2698	2707	2716	2725	2734	2743
2560	2752	2761	2770	2779	2788	2797	2806	2815	2824	2833
2561	2842	2851	2860	2869	2878	2887	2896	2905	2914	2923
2562	2932	2941	2950	2959	2968	2977	2986	2995	3004	3013
2563	3022	3036	3046	3057	3067	3078	3089	3099	3110	3120
2564	3131	3141	3152	3163	3173	3184	3194	3205	3216	3226
2565	3237	3247	3258	3268	3279	3290	3300	3311	3321	3332
2566	3343	3353	3364	3374	3385	3395	3406	3417	3427	3438
2567	3448	3452	3467	3483	3498	3514	3530	3545	3561	3576
2568	3592	3607	3623	3639	3654	3670	3685	3701	3717	3732
2569	3748	3763	3779	3795	3810	3826	3841	3857	3872	3888
2570	3904	3919	3935	3950	3966	3982	3997	4013	4028	4044
2571	4059	4068	4087	4107	4126	4145	4164	4184	4203	4222
2572	4241	4261	4280	4299	4319	4338	4357	4376	4396	4415
2573	4434	4453	4473	4492	4511	4531	4550	4569	4588	4608
2574	4627	4677	4700	4722	4744	4767	4789	4811	4834	4856
2575	4878	4901	4923	4945	4968	4990	5012	5035	5057	5079
2576	5102	5124	5146	5169	5191	5213	5236	5258	5280	5303
2577	5325	5347	5370	5392	5414	5437	5459	5481	5504	5526
2578	5548	5608	5636	5663	5691	5718	5745	5773	5800	5828
2579	5855	5883	5910	5938	5965	5992	6020	6047	6075	6102

TABLE 3 - CONTINUED

FRESNO RESERVOIR

1978 RESURVEY

(ACAP) COMPUTED
03/21/84
11.12.31.

ELEV. FEET	AREA TABLE IN ACRES									
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
2580	6130	6130	6130	6148	6169	6190	6211	6233	6254	6275
2581	6296	6318	6339	6360	6381	6403	6424	6445	6466	6488
2582	6509	6530	6551	6573	6594	6615	6636	6658	6679	6700
2583	6721	6862	6890	6918	6946	6975	7003	7031	7059	7087
2584	7115	7144	7172	7200	7228	7256	7284	7313	7341	7369
2585	7397	7425	7453	7482	7510	7538	7566	7594	7622	7651
2586	7679	7679	7680	7698	7716	7734	7752	7770	7789	7807
2587	7825	7843	7861	7879	7897	7915	7934	7952	7970	7988
2588	8006	8024	8042	8061	8079	8097	8115	8133	8151	8169
2589	8187	8206	8224	8242	8260	8278	8296	8314	8332	8351
2590	8369	8387	8405	8423	8441	8459	8478	8496	8514	8532
2591	8550	8615	8638	8662	8685	8708	8732	8755	8779	8802
2592	8825	8849	8872	8895	8919	8942	8966	8989	9012	9036
2593	9059	9082	9106	9129	9153	9176	9199	9223	9246	9269
2594	9293	9316	9340	9363	9386	9410	9433	9456	9480	9503
2595	9527									

TABLE 4 - CAPACITY IN ACRE-FEET - 1-FOOT INCREMENTS

FRESNO RESERVOIR

1978 RESURVEY

(ACAP) COMPUTED
03/21/84
11.11.24.

CAPACITY TABLE IN ACRE FEET										
ELEVATION INCREMENT IS ONE FOOT										
ELEV. FEET	0	1	2	3	4	5	6	7	8	9
2520						0	4	32	122	297
2530	544	867	1283	1788	2383	3097	3978	5004	6114	7287
2540	8514	9820	11215	12664	14255	15990	17760	19564	21409	23329
2550	25329	27386	29492	31643	33835	36127	38548	41059	43632	46265
2560	48976	51773	54660	57637	60726	63910	67199	70595	74116	77786
2570	81612	85593	89752	94090	98620	103397	108387	113600	119037	124757
2580	130750	136945	143348	149963	156936	164193	171731	179460	187375	195472
2590	203750	212209	220919	229861	239037	248447				

TABLE 5 - CAPACITY TABLE IN ACRE-FEET - 0.10-FOOT INCREMENTS

FRESNO RESERVOIR

1978 RESURVEY

(ACAP) COMPUTED
03/21/84
11.12.31.

CAPACITY TABLE IN ACRE FEET											ELEVATION INCREMENT IS ONE TENTH FOOT										
ELEV. FEET	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9											
2524									0	0											
2525	0	0	0	1	1	1	2	2	3	4											
2526	4	5	7	9	11	13	16	20	23	28											
2527	32	37	43	50	58	67	76	86	97	109											
2528	122	136	150	166	182	199	217	236	255	276											
2529	297	319	342	365	389	413	438	464	490	517											
2530	544	572	601	631	662	693	726	760	795	830											
2531	867	904	943	982	1022	1064	1106	1149	1192	1237											
2532	1283	1329	1377	1425	1474	1524	1575	1627	1680	1733											
2533	1788	1843	1899	1956	2015	2074	2134	2195	2257	2320											
2534	2383	2448	2515	2583	2652	2723	2795	2868	2943	3019											
2535	3097	3176	3258	3341	3426	3513	3602	3693	3786	3881											
2536	3978	4076	4175	4276	4377	4479	4582	4686	4791	4897											
2537	5004	5111	5220	5329	5439	5550	5661	5773	5886	5999											
2538	6114	6228	6344	6460	6576	6693	6811	6929	7048	7167											
2539	7287	7407	7528	7649	7771	7894	8017	8140	8264	8389											
2540	8514	8640	8767	8895	9024	9154	9285	9417	9550	9684											
2541	9820	9956	10093	10230	10369	10508	10648	10788	10930	11072											
2542	11215	11358	11502	11646	11791	11935	12080	12226	12372	12518											
2543	12664	12812	12963	13116	13271	13429	13589	13752	13917	14085											
2544	14255	14426	14598	14771	14944	15118	15291	15465	15640	15815											
2545	15990	16165	16341	16517	16694	16870	17048	17225	17403	17581											
2546	17760	17938	18118	18297	18477	18657	18838	19019	19200	19382											
2547	19564	19745	19928	20111	20295	20480	20664	20850	21036	21222											
2548	21409	21596	21785	21976	22167	22358	22551	22744	22938	23133											
2549	23329	23526	23723	23921	24120	24319	24520	24721	24923	25126											

TABLE 5 - CONTINUED

FRESNO RESERVOIR

1978 RESURVEY

(ACAP) COMPUTED

03/21/84

11.12.31.

CAPACITY TABLE IN ACRE FEET										
ELEV. FEET	ELEVATION INCREMENT IS ONE TENTH FOOT									
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
2550	25329	25529	25734	25939	26144	26350	26557	26763	26970	27178
2551	27386	27595	27804	28013	28223	28434	28644	28856	29067	29279
2552	29492	29705	29919	30133	30347	30562	30777	30993	31209	31426
2553	31643	31857	32075	32293	32511	32731	32950	33171	33392	33613
2554	33835	34058	34283	34509	34736	34965	35195	35426	35658	35892
2555	36127	36363	36601	36840	37080	37321	37564	37808	38053	38300
2556	38548	38795	39044	39294	39544	39795	40047	40299	40552	40805
2557	41059	41313	41569	41824	42081	42338	42595	42853	43112	43372
2558	43632	43892	44153	44415	44678	44941	45204	45468	45733	45999
2559	46265	46536	46804	47072	47342	47612	47883	48155	48428	48702
2560	48976	49252	49528	49806	50084	50363	50644	50925	51207	51489
2561	51773	52058	52343	52630	52917	53205	53494	53784	54075	54367
2562	54660	54954	55248	55544	55840	56137	56435	56734	57034	57335
2563	57637	57951	58255	58560	58866	59173	59482	59791	60102	60413
2564	60726	61039	61354	61670	61987	62304	62623	62943	63264	63586
2565	63910	64234	64559	64885	65213	65541	65871	66201	66533	66865
2566	67199	67534	67870	68207	68545	68884	69224	69565	69907	70250
2567	70595	70947	71293	71640	71989	72340	72692	73046	73401	73758
2568	74116	74476	74838	75201	75566	75932	76300	76669	77040	77412
2569	77786	78162	78539	78918	79298	79680	80063	80448	80834	81222
2570	81612	82003	82396	82790	83186	83583	83982	84383	84785	85188
2571	85593	86012	86420	86830	87241	87655	88070	88488	88907	89328
2572	89752	90177	90604	91033	91464	91896	92331	92768	93207	93647
2573	94090	94534	94980	95428	95879	96331	96785	97241	97699	98158
2574	98620	99097	99566	100037	100510	100986	101464	101944	102426	102910
2575	103397	103886	104377	104871	105366	105864	106364	106867	107371	107878
2576	108387	108898	109412	109928	110446	110966	111488	112013	112540	113069
2577	113600	114134	114670	115208	115748	116291	116836	117383	117932	118483
2578	119037	119599	120161	120726	121294	121864	122437	123013	123592	124173
2579	124757	125344	125934	126526	127121	127719	128320	128923	129529	130138

TABLE 5 - CONTINUED

FRESNO RESERVOIR

1978 RESURVEY

(ACAP) COMPUTED
03/21/84
11.12.31.

CAPACITY TABLE IN ACRE FEET										
ELEVATION INCREMENT IS ONE TENTH FOOT										
ELEV. FEET	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
2580	130750	131364	131976	132590	133205	133823	134443	135066	135690	136316
2581	136945	137576	138209	138843	139481	140120	140761	141405	142050	142698
2582	143348	144000	144654	145310	145968	146629	147291	147956	148623	149292
2583	149963	150647	151334	152025	152718	153414	154113	154814	155519	156226
2584	156936	157649	158365	159084	159805	160529	161256	161986	162719	163454
2585	164193	164934	165678	166424	167174	167926	168682	169440	170200	170964
2586	171731	172491	173258	174027	174797	175570	176344	177120	177898	178678
2587	179460	180243	181028	181815	182604	183395	184187	184981	185777	186575
2588	187375	188177	188980	189785	190592	191401	192211	193024	193838	194654
2589	195472	196291	197113	197936	198761	199588	200417	201247	202080	202914
2590	203750	204588	205427	206269	207112	207957	208804	209652	210503	211355
2591	212209	213071	213934	214799	215666	216536	217408	218282	219159	220038
2592	220919	221803	222689	223577	224468	225361	226257	227154	228054	228957
2593	229861	230769	231678	232590	233504	234420	235339	236260	237183	238109
2594	239037	239968	240901	241836	242773	243713	244655	245600	246546	247496
2595	248447									

Table 6

SUMMARY OF 1978 SURVEY RESULTS AND
SEDIMENT DISTRIBUTION COMPUTATIONS

<u>Elevation</u> (feet)	<u>Original Capacity</u> (acre-feet)	<u>1977/1978 Capacity</u> (acre-feet)	<u>Measured Sediment Volume</u> (acre-feet)	<u>Percent of Measured Sediment</u>	<u>Incremental Percentage</u>	<u>Sediment Loss as % of Original Cap.</u>
*2580	160,162	130,750	29,412	100.0	4.3	18.4
2578	147,182	119,037	28,145	95.7	5.5	19.1
2576	134,922	108,387	26,535	90.2	2.9	19.7
**2575	129,062	103,397	25,665	87.3	3.1	19.9
2574	123,382	98,620	24,762	84.2	6.7	20.1
2572	112,562	89,752	22,810	77.5	6.6	20.3
2570	102,462	81,612	20,850	70.9	6.5	20.4
2568	93,072	74,116	18,956	64.4	6.1	20.4
2566	84,362	67,199	17,163	58.3	5.2	20.3
2564	76,332	60,726	15,606	53.1	5.0	20.4
2562	68,822	54,660	14,162	48.1	4.6	20.6
2560	61,762	48,976	12,786	43.5	4.4	20.7
2558	55,142	43,632	11,510	39.1	3.8	20.9
2556	48,922	38,548	10,374	35.3	3.8	21.2
2554	43,102	33,835	9,267	31.5	4.0	21.5
2552	37,592	29,492	8,100	27.5	3.6	21.6
2550	32,362	25,329	7,033	23.9	3.4	21.7
2548	27,432	21,409	6,023	20.5	3.1	22.0
2546	22,882	17,760	5,122	17.4	2.2	22.4
2544	18,722	14,255	4,467	15.2	2.3	23.9
2542	15,002	11,215	3,787	12.9	1.8	25.2
2540	11,772	8,514	3,258	11.1	1.4	27.7
2538	8,982	6,114	2,868	9.7	0.8	31.9
2536	6,602	3,978	2,624	8.9	1.3	39.8
2534	4,622	2,383	2,239	7.6	1.7	48.4
2532	3,022	1,283	1,739	5.9	1.4	57.5
2530	1,862	544	1,318	4.5	3.2	70.8
2525	377	0	377	1.3		100.0
2524.8	--	0			1.3	
2520	0		0	0.0		

* Maximum water surface for period of record is 2579.35.

**Spillway crest elevation 2575 feet.

Table 7 - Reservoir Sediment Data Summary

Fresno Reservoir

NAME OF RESERVOIR

DAM	1. OWNER Department of Int. USBR		2. STREAM Milk River		3. STATE Montana			
	4. SEC. 19 TWP. 33 N RANGE 14 E		5. NEAREST P.O. Havre, MT		6. COUNTY Hill			
	7. LAT. 48° 36' 30" LONG. 109° 56' 50"		8. TOP OF DAM ELEVATION 2596.1		9. SPILLWAY CREST ELEV. 2575.0			
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	2575.0	5757	40,430	129,062	Nov. 1939		
	c. POWER							
	d. WATER SUPPLY					16. DATE NORMAL OPER. BEGAN		
	e. IRRIGATION							
	f. CONSERVATION	2567.0	4374	86,770	88,632	Apr. 1943		
g. INACTIVE	2530.0	505	1,862	1,862				
WATERSHED	17. LENGTH OF RESERVOIR 15 MILES			AV. WIDTH OF RESERVOIR 0.5 MILES				
	18. TOTAL DRAINAGE AREA 3,766 SQ. MI.			22. MEAN ANNUAL PRECIPITATION 13 INCHES				
	19. NET SEDIMENT CONTRIBUTING AREA 3,096 SQ. MI.			23. MEAN ANNUAL RUNOFF 0.74 INCHES				
	20. LENGTH 269 MILES	AV. WIDTH 15.5 MILES		24. MEAN ANNUAL RUNOFF 149,000 1/ AC.-FT.				
	21. MAX. ELEV. 6,000 ft.	MIN. ELEV. 2500 ft.		25. ANNUAL TEMP.: MEAN 42 RANGE 56 to 109				
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.
	Nov. 1939	0	0	Contour	5 ft.	5757	129,062	0.87
	June 1978	38.7	38.7	Range	223	4878	103,397	0.69
	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		
	June 1978	11.7	271,160	389,100	10,575,256	271,160	10,575,256	
	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.-YEAR	a. TOTAL TO DATE	b. AV. ANNUAL	c. PER SQ. MI.-YEAR	
	June 1978	25,665 2/(32,912)	663.2 (850.4)	0.214 (0.275)	25,665 (32,912)	663.2 (850.4)	0.214 (0.275)	
	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	
June 1978	unknown	unknown	unknown	.51	19.89	unknown	unknown	

Table 7 - Continued

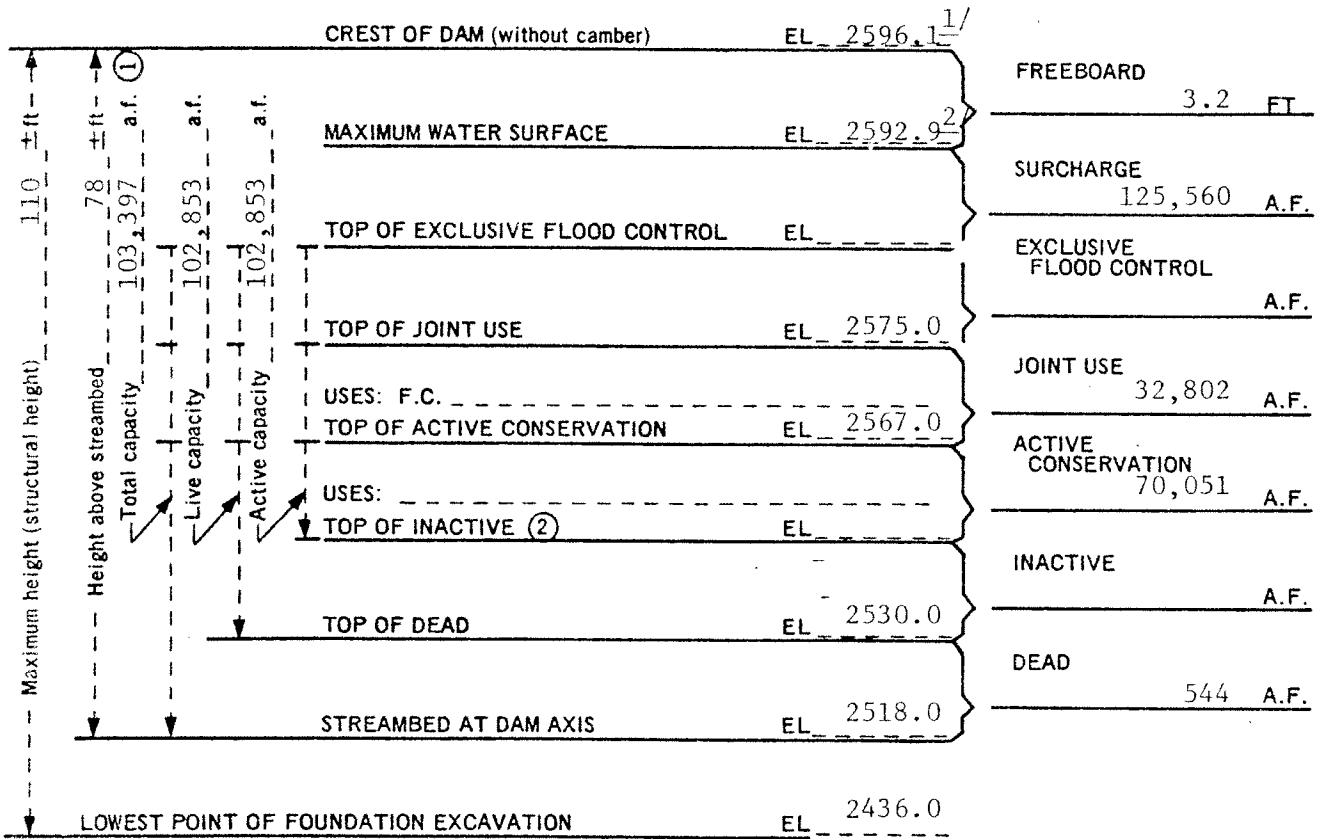
26. DATE OF SURVEY	43. DEPTH DESIGNATION RANGE IN FEET BELOW, AND ABOVE, CREST ELEVATION														
	PERCENT OF TOTAL SEDIMENT LOCATED WITHIN DEPTH DESIGNATION														
June 1978	12.7	16.4	15.2	12.2	10.1	9.5	7.6	5.2	2.9	3.8	3.2	1.3			
26. DATE OF SURVEY	44. REACH DESIGNATION PERCENT OF TOTAL 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.								
1940	2548.82	2531.23	175,183	1953	2576.35	2563.40	379,978								
1941	2549.45	2540.15	151,268	1954	2576.25	2564.35	256,849								
1942	2567.60	2541.95	265,057	1955	2576.35	2564.00	268,325								
1943	2573.50	2554.80	246,592	1956	2575.30	2561.90	249,223								
1944	2564.80	2554.30	128,876	1957	2575.75	2560.55	258,883								
1945	2564.05	2553.45	217,566	1958	2574.70	2549.70	296,020								
1946	2560.70	2554.95	229,973	1959	2576.35	2548.35	349,273								
1947	2576.60	2558.15	310,160	1960	2576.25	2553.85	308,256								
1948	2576.10	2563.10	297,150	1961	2558.20	2533.25	216,354								
1949	2564.10	2540.30	241,312	1962	2564.25	2542.20	252,996								
1950	2560.95	2538.30	263,032	1963	2562.15	2551.00	248,697								
1951	2575.90	2561.70	275,965	1964	2571.45	2552.25	272,861								
1952	2579.35	2557.00	320,657	1965	2577.90	2560.85	344,200								
46. ELEVATION-AREA-CAPACITY DATA															
ELEVATION	AREA	CAPACITY	ELEVATION	AREA	CAPACITY	ELEVATION	AREA	CAPACITY							
2595	9527	248447	2550	2040	25329										
2590	8369	203750	2545	1753	15990										
2585	7397	164193	2540	1254	8514										
2580	6130	130750	2535	784	3097										
2575	4878	103397	2530	275	544										
2570	3904	81612	2525	1	0										
2565	3237	63910	2520	0	0										
2560	2752	48976													
2555	2357	36127													
47. REMARKS AND REFERENCES															
<p>1/ 137,000 AF additional from St. Marys Canal</p> <p>2/ To elevation 2590.0</p>															
48. AGENCY MAKING SURVEY					50. DATE <u>April 1984</u>										
49. AGENCY SUPPLYING DATA															

Table 7 - 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.								
1966	2575.80	2569.25	272,000												
1967	2576.80	2560.50	389,100												
1968	2571.40	2561.95	285,700												
1969	2576.30	2565.00	331,500												
1970	2575.22	2561.38	221,300												
1971	2574.55	2543.21	248,000												
1972	2575.20	2552.15	361,600												
1973	2568.40	2543.35	177,300												
1974	2575.75	2540.10	274,040												
1975	2577.45	2564.75	319,400												
1976	2575.60	2559.50	286,500												
1977	2565.20	2540.55	115,600												
1978	2577.25	2543.75	318,600												
46. ELEVATION-AREA-CAPACITY DATA															
ELEVATION	AREA	CAPACITY	ELEVATION	AREA	CAPACITY	ELEVATION	AREA	CAPACITY							
47. REMARKS AND REFERENCES															
48. AGENCY MAKING SURVEY															
49. AGENCY SUPPLYING DATA															
50. DATE <u>April 1984</u>															

RESERVOIR CAPACITY ALLOCATIONS

TYPE OF DAM	Homogeneous Earthfill	REGION	UM	STATE	Montana
OPERATED BY	Bureau of Reclamation	Fresno			RESERVOIR
CREST LENGTH	2,070 FT; CREST WIDTH 22 FT	Fresno			DAM
VOLUME OF DAM	2,105,000 CU YD	Milk River			PROJECT
CONSTRUCTION PERIOD	1937-1939				DIVISION
STREAM	Milk River				UNIT
RES AREA	4,878 ACRES AT EL 2575	Operational			STATUS OF DAM
ORIGINATED BY:	APPROVED BY:				
(Initials)	(Code)	(Date)	(Initials)	(Code)	(Date)



- ① Includes _____ a.f. allowance for _____ year sediment deposition between streambed and El. _____, of which _____ a.f. is above El. _____
- ② Established by _____

REFERENCES AND COMMENTS:

1/ Crest profile survey, 1968

2/ Modpuls routing of revised 1967 IDF

Data from 1978 sediment resurvey
 Specifications No. 692
 Drawing No. 16-604-1 (Rev.)