DICKINSON DAM
EDWARD ARTHUR PATTERSON LAKE
1991 SEDIMENTATION SURVEY

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The Natural Resources Conservation Service surveyed Edward Arthur Patterson Lake in 1991. The field data were used for computing the storage-elevation relationship. The report describes the survey procedures used during the 1991 collection and provides data for future surveys.

As of 1991, at reservoir spillway crest elevation 2,420.0 (feet), the surface area was 1,194 acres with a total storage capacity of 8,612 acre-feet. Since the reservoir's initial filling in May 1950, 1,885 acre-feet of sediment have been trapped in Edward Arthur Patterson Lake. The average annual sediment accumulation rate is 46 acre-feet per year for the 41-year period of operation.

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DICKINSON DAM
EDWARD ARTHUR PATTERSON LAKE

1991 SEDIMENTATION SURVEY

by

Lori H. Lest

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Water Resources Services
Technical Service Center
Denver, Colorado

September 1995

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U.S. Department of the Interior
Mission Statement

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally-owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

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INTRODUCTION

Dickinson Dam and Reservoir (Edward Arthur Patterson Lake), part of the Dickinson Unit of the Pick-Sloan Missouri Basin, are located on the Heart River in Stark County, 1.5 miles west of Dickinson, North Dakota (fig. 1). The reservoir provides municipal water for Dickinson and downstream irrigators. The reservoir also provides flood control, recreational, and fish and wildlife benefits.

Dickinson Dam was constructed from March 1949 to March 1950. The earthfill dam contains 324,000 cubic yards of material with a structural height* of 62 feet and a crest length of 2,275 feet. The spillway crest elevation was 2,416.5, top of active conservation. Modifications to the dam, completed in 1982, raised the spillway crest 3.5 feet to elevation 2,420.0.

At the time of closure, May 1950, reservoir surface area at the spillway crest, elevation 2,416.5 feet, was about 862 acres with an active capacity of 6,952 acre-feet. Reservoir surface area at elevation 2,420.0 was about 1,194 acres with an active capacity of 10,497 acre-feet. These estimates were developed using Reclamation's ACAP92 (1992) program to determine the change in reservoir storage. These numbers differ from the original area-capacity tables.

The drainage area at Dickinson Dam is about 406 square miles. The basin averages 11 miles in width over the 36 miles upstream from Edward Arthur Patterson Lake.

SUMMARY AND CONCLUSIONS

This report presents the results of an investigation to monitor changes in Edward Arthur Patterson Lake after 41 years of reservoir sediment accumulation.

The NRCS (Natural Resources Conservation Service) State Office, formerly known as the Soil Conservation Service, surveyed the lake in 1991. Standard land surveying techniques were used to survey the lake.

The total storage capacity of the reservoir from the 1991 survey is estimated to be 8,612 acre-feet with a surface area of 1,194 at elevation 2,420.0.

DESCRIPTION OF THE BASIN

Dickinson Dam drainage basin is located in southwestern North Dakota. The area of the basin is 406 square miles. During the 1900s, much of this area was overgrazed. During the drought in the 1930s, stream erosion and channelization increased, but channels have become grass covered and the runoff potential has decreased. The basin is mostly gently rolling farm land with some interspersed pasture land.

Average annual precipitation is about 16 inches, and mean annual runoff is about 19,400 acre-feet. Temperatures range from -37 to 108 °F with a mean temperature of 42 °F.

* The definition of terms such as "structural height," "hydraulic height," etc., may be found in manuals such as Reclamation's *Design of Small Dams* and *Guide for Preparation of Standing Operating Procedures for Dams and Reservoirs*, or ASCE's *Nomenclature for Hydraulics*.

SURVEYS

Survey History

The original sediment ranges were located and surveyed by Reclamation; the survey was started September 1949 and completed in July 1950. In 1991, the reservoir sediment range lines were re-surveyed again by the NRCS.

Survey Methods and Equipment

The 1991 survey was conducted by personnel from the NRCS in Bismarck and their field office in Dickinson. According to the Dakotas Area Office, the NRCS used standard land surveying procedures to profile each range line. Depth readings were taken from a boat using a rod to probe the bottom. The original survey designated the right bank, looking downstream, as the 0+00 station, as did the NRCS survey. Figure 2 displays the surveyed range lines on the original contour map. Also, the original area-capacity curve and table are on the map. Table 3 has the coordinates of the end points for the range lines.

RESERVOIR AREA AND CAPACITY

Development of 1991 Contour Areas

The reservoir was subdivided into segments for sedimentation analysis and to better represent storage changes. The surveyed range lines were used to delineate the limit of each segmental boundary. The method used to compute the new reservoir volume caused by sediment inflow takes the segmented areas (area between the range lines) and determines where the sediment has filled in the original areas. This determination was done by comparing the plots of the original and 1991 range line cross-sections simultaneously. The comparison indicated the lateral distribution of the sediment at the different measured contour elevations. Where these plots indicate changes have occurred on the side slopes of the reservoir, a decision was made to determine whether the change was caused by actual deposition, erosion, or survey inaccuracies. No area adjustment was made if the measured change was judged to be caused by survey inaccuracy. The 1991 surface areas were developed by calculating the 1991 average bottom sediment elevation and comparing it to the original thalweg elevation at each range line. In each segment, the original surface area of each contour elevation that was below the 1991 average bottom sediment elevation was digitized and subtracted from the original area, resulting in the 1991 surface areas. The 1991 total reservoir surface area at a given contour is the original total area minus the summation of all segmental areas silted in at that elevation. The 1991 total area computation results are listed in column (2) of table 2.

The maximum elevation of the reservoir was 2,421.13 feet on June 9, 1982; therefore, no surface area change was assumed to occur above elevation 2,420.0. This assumption is illustrated by the cross-section plots of the range lines which show that the sediment did not accumulate above the spillway crest elevation of 2,420.0. Everything below elevation 2,398.0 has filled in with sediment. The original area-capacity table was done using 4-foot contour intervals from elevation 2,390.0 to 2,430.0 feet; therefore, the new table is consistent with the original.

1991 Revised Storage Capacity

The 1991 surface area and elevation relationships were used as control parameters to compute reservoir capacities by means of Reclamation's area-capacity computer program ACAP92 (Reclamation, 1992). The program computes surface areas for 0.01- to 1.0-foot area increments by linear interpolation between the given contour areas. 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 check whether it fits within an allowable error margin. This one equation is used over the whole range that fits within this error term. At the next interval beyond, 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, 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:

$$y = a + a_2x + a_3x^2$$

where:

y = capacity
x = elevation above a reference base
a = intercept
a_2 and a_3 = coefficients

The results of the 1991 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. To allow comparison of the original capacities with the 1991 capacities, the original capacity values have been revised by using the same curve fitting technique as was used for the 1991 area and capacity computation (ACAP92). Both the original and 1991 area and capacity curves are plotted on figure 3. Area and capacity tables have been published separately for the 0.01-, 0.10-, and 1-foot elevation increments (Reclamation, 1995). The 1991 survey determined that the reservoir has a total storage capacity of 8,612 acre-feet and a surface area of 1,194 acres at spillway crest elevation 2,420.0. The table on the following page contains the dead, inactive, and conservation capacities.

SEDIMENT ANALYSES

Sedimentation Accumulation

Total sediment volume that has accumulated in Edward Arthur Patterson Lake since May 1950 is 1,885 acre-feet at the spillway elevation of 2,420.0. The average annual sediment accumulation rate is 46 acre-feet per year for the 41-year period of operation. Over the contributing basin area, this rate equates to 0.11 acre-feet per square mile per year.

Sedimentation Summary

The results of the sediment data and volume computations for the 1991 survey are shown in tables 1 and 2. The data include a tabulation of incremental sediment inflow volume and sediment accumulation computed for the period between initial conditions and the 1991 resurvey. Table 1 includes information on the drainage basin, records of estimated inflow, reservoir operations, and reservoir storage.

Use	Water Surface Elevation (feet)	Capacity: (acre-feet)			Measured Sediment (acre-feet) (2)-(3)
		(1) Original Capacities after 1981 modification	(2) Original Capacities Computed by ACAP92	(3) 1991 Capacities Computed by ACAP92	
Dead Storage Capacity	2385.0 to 2404.0	1,040	1,049	356	693
Inactive Capacity	2404.0 to 2405.0	195	202	100	102
Conservation Storage Capacity	2405.0 to 2420.0	8,934	9,246	8,156	1,090

(1) Capacities after the 1981 structural modifications were taken from the Reservoir Capacity Allocations sheet, modified October 1, 1984.
(2) Original capacities computed using ACAP92.
(3) 1991 capacities computed using ACAP92 from the 1991 survey.

RESERVOIR SEDIMENT DISTRIBUTION

Longitudinal Distribution

The distribution of sediment throughout the length of the reservoir is illustrated in part by plots of the thalweg profiles representing the original and 1991 resurveyed profiles of the main channel (fig. 4). Field notes describing the location of the thalweg were not available for either survey. Therefore, the lowest elevation at each range line was used as the thalweg.

Lateral Distribution

The 41 range lines originally surveyed in 1950 were resurveyed in 1991. The original and the 1991 range cross-section data are plotted together to depict the changes that have occurred and to represent the general lateral distribution of sediment within the reservoir (figs. 5 to 45). Most of the sediment deposition is located within the historic river channel.

Depth Distribution

The computation of sediment distribution by elevation is given in section 43 of table 1. The entire volume of sediment is below the spillway crest, elevation 2,420.0. About 48 percent of the deposited sediment is found below the top of inactive pool, elevation 2,405.0 feet. The remaining 52 percent of the sediment is found between elevations 2,406.0 and 2,418.0 feet.

REFERENCES

American Society of Civil Engineers, *Nomenclature for Hydraulics*, ASCE Headquarters, New York, 1962.

Blanton, J.O. III, *Procedures for Monitoring Reservoir Sedimentation: Technical Guideline for Bureau of Reclamation*, Denver Office, Denver, CO, October 1982.

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Bureau of Reclamation, *Guide for Preparation of Standing Operating Procedures for Bureau of Reclamation Dams and Reservoirs*, U.S. Government Printing Office, Denver, CO, 1987a.

Bureau of Reclamation, *Design of Small Dams*, U.S. Government Printing Office, Denver, CO, 1987b.

Bureau of Reclamation, Technical Service Center, *Edward Arthur Patterson Lake Area and Capacity Tables, Dickinson Unit,* Great Plains Region, Denver, CO, July 1994.

RESERVOIR SEDIMENT
DATA SUMMARY

Dickinson
(Edward Arthur Patterson Lake)
NAME OF RESERVOIR

1
DATA SHEET NO.

DAM	1. OWNER Bureau of Reclamation		2. STREAM Heart River		3. STATE North Dakota	
	4. SEC 18 T 139 N R 96 W		5. NEAREST PO Dickinson, ND		6. COUNTY Stark	
	7. LAT 46° 52' LONG 102° 50'		8. TOP OF DAM 2,436.6[1]		9. SPILLWAY CREST 2,420.0[2]	
RESERVOIR	10. STORAGE ALLOCATION	11. ELEVATION TOP OF POOL	12. ORIGINAL SURFACE AREA, Ac	13. ORIGINAL CAPACITY, AF	14. GROSS STORAGE ACRE FEET	15. DATE STORAGE BEGAN
	a. FLOOD CONTROL	2430.6[3]	2,092[4]	16,708	27,205[5]	
	b. MULTIPLE USE					5/50
	c. POWER					
	d. WATER SUPPLY					16. DATE NORMAL OPERATION BEGAN
	e. IRRIGATION					
	f. CONSERVATION	2,420.0[2]	1,195[4]	9,246	10,497[5]	
	g. INACTIVE	2,405.0	216	1,251	1,251[5]	5/50
	17. LENGTH OF RESERVOIR 20.6 MILES[6]			AVG. WIDTH OF RESERVOIR 0.16 MILES		
BASIN	18. TOTAL DRAINAGE AREA 406 SQ. MI.[7]			22. MEAN ANNUAL PRECIPITATION 16.3 IN.[8]		
	19. NET SEDIMENT CONTRIBUTING AREA 406 SQ. MI.[7]			23. MEAN ANNUAL RUNOFF 1.1 IN.		
	20. LENGTH 36.0 MI.[7]	AV. WIDTH 11.3 MI.		24. MEAN ANNUAL RUNOFF 19,170 AC.-FT.[10]		
	21. MAX. ELEV. 3,000 FT.[7]	MIN. ELEV. 2,420 FT.[7]		25. ANNUAL TEMP. MEAN 42 °F RANGE -37 to 108 °F[8]		

SURVEY DATA	26. DATE OF SURVEY	27. PER. YRS.	28. ACCL. YRS.	29. TYPE OF SURVEY	30. NO. OF RANGES OR INTERVAL	31. SURFACE AREA, AC.	32. CAPACITY ACRE-FEET	33. C/I RATIO AF/AF
	1950	0	0	Contour(D)	4 ft.	1,194[4]	10,497[5]	0.54[9]
	1991	41.0	41.0	Range(D)	41	1,194	8,612	0.44[9]

26. DATE OF SURVEY	34. PERIOD ANNUAL PRECIP.	35. PERIOD WATER INFLOW, ACRE FEET			36. WATER INFLOW TO DATE, AF	
		a. MEAN ANN.	b. MAX. ANN.	c. TOTAL	a. MEAN ANN.	b. TOTAL
1991	16.3[8]	19,170[10]	66,625[10]	843,502[10]	19,170[10]	843,502[10]

26. DATE OF SURVEY	37. PERIOD CAPACITY LOSS, ACRE-FEET			38. TOTAL SEDIMENT DEPOSITS TO DATE, AF		
	a. TOTAL	b. AV. ANN.	c. /MI.^{2}-YR.	a. TOTAL	b. AV. ANNUAL	c. /MI.^{2}-YR.
1991	1,885	46.0	0.11	1,885	46.0	0.11

26. DATE OF SURVEY	39. AV. DRY WT. (#/FT^3)	40. SED. DEP. TONS/MI.^{2}-YR.		41. STORAGE LOSS, PCT.		42. SED. INFLOW, PPM	
		a. PERIOD	b. TOTAL TO DATE	a. AV. ANNUAL	b. TOTAL TO DATE	a. PER.	b. TOT.
1991	N/A			0.44	18.0		

Table 1. - Reservoir sediment data summary (page 1 of 2).

26. DATE OF SURVEY	43. DEPTH DESIGNATION RANGE IN FEET BELOW AND ABOVE CREST ELEVATION 2420									
	-40 to -36	-36 to -32	-32 to -28	-28 to -24	-20 to -16	-16 to -12	-12 to -8	-8 to -4	-4 to 0	0 to 4
	PERCENT OF TOTAL SEDIMENT LOCATED WITHIN DEPTH DESIGNATION									
1991	7	8	12	21	25	20	7	0	0	0

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	100-105	105-110	110-115	115-120	120-125
	PERCENT OF TOTAL SEDIMENT LOCATED WITHIN REACH DESIGNATION														

45. RANGE IN RESERVOIR OPERATION

WATER YEAR	MAX.	MIN.	INFLOW, AF	WATER YEAR	MAX.	MIN.	INFLOW, AF
1952	2419.2	2412.8	-667	1953	2417.2	2412.7	10,808
1954	2419.6	2411.8	27,896	1955	2418.2	2411.8	12,858
1956	2415.5	2411.8	2,436	1957	2419.3	2413.0	23,335
1958	2416.9	2413.7	5,650	1959	2418.5	2413.7	16,867
1960	2418.0	2413.4	11,284	1961	2414.4	2410.7	244
1962	2416.6	2410.4	3,752	1963	2417.1	2413.2	12,244
1964	2417.1	2412.9	6,610	1965	2418.2	2413.6	32,642
1966	2418.2	2415.1	18,166	1967	2418.2	2412.8	37,613
1968	2414.2	2412.7	1,654	1969	2418.3	2412.7	50,236
1970	2420.1	2414.2	42,520	1971	2418.0	2414.4	39,947
1972	2420.1	2415.9	61,780	1973	2418.1	2413.6	18,601
1974	2417.0	2413.1	4,094	1975	2418.5	2412.8	41,272
1976	2416.8	2412.8	8,124	1977	2417.4	2412.5	11,967
1978	2419.4	2414.8	66,625	1979	2417.9	2413.9	39,012
1980	2415.7	2411.4	985	1981	2416.8	2410.9	5,934
1982	**2421.0**	2414.9	55,353	1983	2420.9	2416.0	27,831
1984	2420.7	2416.0	17,862	1985	2418.6	2415.6	1,197
1986	2420.6	2415.6	44,959	1987	2420.8	2418.7	21,744
1988	2419.7	2413.8	-378	1989	2420.4	2413.3	2,827
1990	2416.5	2413.5	758	1991	2413.6	2409.3	-81
1992	2410.6	2408.0	-347	1993	2417.3	**2408.0**	4,870
1994	2420.5	2416.0	16,908	1995	unavailable	unavailable	35,510

46. ELEVATION - AREA - CAPACITY DATA FOR 1950 AND 1991[9]

ELEV.	AREA	CAP.	ELEV.	AREA	CAP.	ELEV.	AREA	CAP.	ELEV.	AREA	CAP.
1950 (Min. elev. 2,390.0')						1991 (Min. elev. 2,390.0')					
2390	17	19[5]	2418	979	8,323[5]	2390	0	0	2418	978	6,440
2394	39	131[5]	2420	1,194	10,497[5]	2394	0	0	2420	1,194	8,612
2398	63	335[5]	2422	1,410	13,101[5]	2398	28	56	2422	1,410	11,216
2402	133	727[5]	2426	1,775	19,471[5]	2402	51	214	2426	1,775	17,586
2406	244	1,481[5]	2430	2,092	27,205[5]	2406	130	576	2430	2,092	25,320
2410	432	2,833[5]				2410	309	1,454			
2414	667	5,031[5]				2414	603	3,278			

47. REMARKS AND REFERENCES

[1] Crest of dam after 1981 modifications to the crest of the dam and spillway.

[2] Top of active conservation as of 1981.

[3] Top of surcharge, maximum water surface elevation, as of 1981.

[4] Surface areas interpolated from original surface areas, 1950.

[5] Capacity values recomputed using original surface areas and current methods (ACAP92) for comparison with 1991 values to compute sediment deposition.

[6] Channel lengths at elevation 2430 feet: Main channel - 12.1 miles, Tributaries - 0.5, 1.1, 1.3, 2.8, 2.8 miles

[7] Probable Maximum Flood for Dickinson Dam, February 22, 1990, Reclamation.

[8] *Project Data Book*, Reclamation.

[9] Capacity/Inflow; inflow is from item no. 24.

[10] Calculated from the inflow data provided by the Dakotas Area Office, complete list of data in item 45.

48. AGENCY MAKING SURVEY Natural Resources Conservation Service State Office

49. AGENCY SUPPLYING DATA Bureau of Reclamation, Dakotas Area Office | DATE 9/95

Table 1. - Reservoir sediment data summary (page 2 of 2).

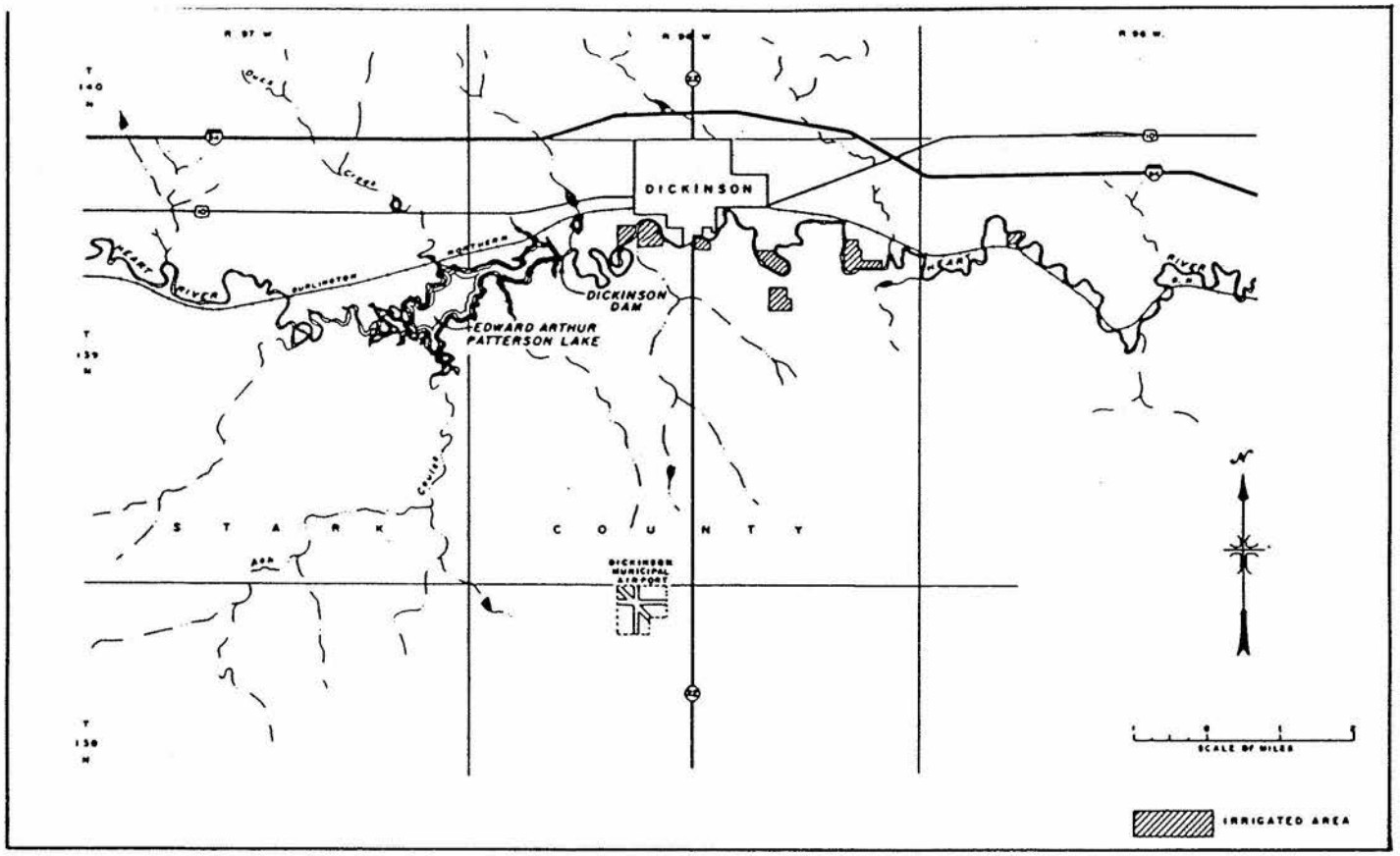
(1) Elevation (feet)	(2) Original Area (acres)	(3) Original Capacity (acre-feet)	(4) 1991 Area (acres)	(5) 1991 Capacity (acre-feet)	(6) Measured Sediment Volume (acre-feet)	(7) Percent Measured Sediment	(8) Percent Reservoir Depth
2430	2092	27205	2092	25320	1885	100	100
2426	1775	19471	1775	17586	1885	100	90
2422	1410	13101	1410	11216	1885	100	80
2420	1194	10497	1194	8612	1885	100	75
2418	979	8323	978	6440	1883	100	70
2414	667	5031	603	3278	1753	93	60
2410	432	2833	309	1454	1379	73	50
2406	244	1481	130	576	905	48	40
2402	133	727	51	214	513	27	30
2398	63	335	28	56	279	15	20
2394	39	131	0	0	131	7	10
2390	17	19	0	0	19	1	0

(1) Elevation of reservoir water surface.
(2) Original reservoir surface area from the 1950 survey.
(3) Original calculated reservoir capacity computed using ACAP92 from original measured surface areas.
(4) Reservoir surface area from 1991 survey.
(5) 1991 calculated reservoir capacity computed using ACAP92 from 1991 surface areas.
(6) Measured sediment volume = column (3) - column (5).
(7) Measured sediment expressed in percentage of total sediment (1885 acre-feet).
(8) Depth of reservoir expressed in percentage of total depth (40 feet).

Table 2. - Summary of 1993 survey results.

Range	Right Bank			Left Bank		
	State Plane North	State Plane East	Elevation (feet)	State Plane North	State Plane East	Elevation (feet)
R-1	20,832.3	48,357.2	2432.2	22,498.0	48,245.1	2434.7
R-2	20,720.5	47,924.4	2434.9	21,711.9	46,948.2	2436.1
R-3	19,405.5	47,465.7	2449.1	21,330.6	45,580.7	2436.8
R-4	19,745.7	44,550.5	2439.1	21,107.0	43,748.3	2436.0
R-5	18,182.0	43,629.1	2432.3	20,946.1	39,926.6	2436.9
R-6	16,404.0	41,729.2	2448.0	19,262.0	39,177.6	2420.2
R-7	14,018.6	39,122.1	2441.4	19,282.0	36,716.8	2431.7
R-8	14,031.9	37,109.2	2438.8	18,053.0	35,343.8	2429.2
R-9	17,396.5	34,885.5	2423.5	17,814.0	34,829.1	2430.9
R-10	14,023.6	33,621.4	2440.7	16,839.3	33,728.2	2435.2
R-11	16,981.9	32,204.5	2421.8	17,379.6	32,608.3	2438.4
R-12	16,981.9	32,204.5	2421.8	16,895.1	31,887.6	2427.9
R-13	16,328.0	32,931.4	2427.4	16,202.4	32,620.7	2422.8
R-14	15,359.9	32,833.6	2427.8	15,500.8	32,350.7	2419.6
R-15	15,500.8	32,350.7	2419.6	15,863.0	31,109.1	2427.9
R-16	16,257.6	31,943.6	2424.6	16,450.4	32,020.0	2428.3
R-17	16,127.1	31,267.6	2425.8	16,118.0	31,063.1	2428.2
R-18	14,930.2	31,378.9	2460.8	15,371.4	31,035.2	2428.0
R-19	16,085.9	30,345.0	2450.5	15,863.0	31,109.1	2427.9
R-20	16,313.3	30,766.5	2427.1	16,508.8	31,128.9	2429.3
R-21	16,085.9	30,345.0	2450.5	16,548.0	30,017.8	2428.8
R-22	17,097.2	29,960.8	2431.5	17,034.8	30,141.1	2432.6
R-23	17,971.4	30,484.0	2429.2	17,951.0	30,677.7	2432.1
R-24	18,457.2	30,283.1	2429.2	18,493.1	30,530.6	2441.6
R-25	18,396.4	29,554.0	2439.0	18,902.7	29,554.8	2432.6
R-26	18,811.6	29,012.1	2427.7	18,848.9	29,234.1	2433.3
R-27	19,302.8	28,815.2	2430.5	19,303.1	28,466.3	2432.9
R-28	19,303.4	28,183.5	2430.7	19,303.1	28,466.3	2432.9
R-29	17,438.9	25,173.5	2440.6	17,555.6	25,162.1	2438.0
R-40	20,715.5	49,768.5	2435.5	20,832.3	48,357.2	2432.2
R-50	22,168.2	47,355.2	2434.8	22,619.5	48,106.6	2433.2
R-51	23,556.6	45,412.9	2472.6	23,879.3	46,553.0	2454.9
R-60	19,431.0	45,486.2	2438.5	19,745.7	44,550.5	2439.1
R-61	18,131.8	46,269.0	2434.3	17,822.7	45,479.0	2435.4
R-62	16,976.1	46,725.2	2436.9	16,884.1	46,085.0	2434.5
R-70	21,583.7	39,369.1	2453.5	21,996.9	40,506.9	2444.2
R-71	23,145.2	39,427.4	2440.3	22,836.5	40,282.5	2471.8
R-80	15,640.6	41,342.9	2438.8	14,018.6	39,122.1	2441.4
R-81	14,114.8	42,383.2	2446.9	13,315.9	41,159.4	2432.5
R-82	12,609.6	41,046.7	2430.5	12,884.2	40,731.6	2434.3
R-83	11,312.8	41,707.8	2438.0	11,487.1	40,825.2	2434.7
R-84	16,315.7	32,485.8	2425.2	16,530.2	32,486.4	2426.4
R-85	16,289.0	32,635.8	2427.5	16,674.9	32,635.3	2424.6

Table 3. - Coordinates of the end points for the range lines.



Dickinson Unit

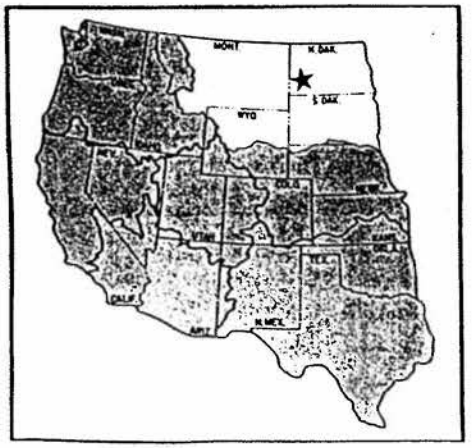


Figure 1. - Dickinson Dam and Edward Arthur Patterson Lake location map.

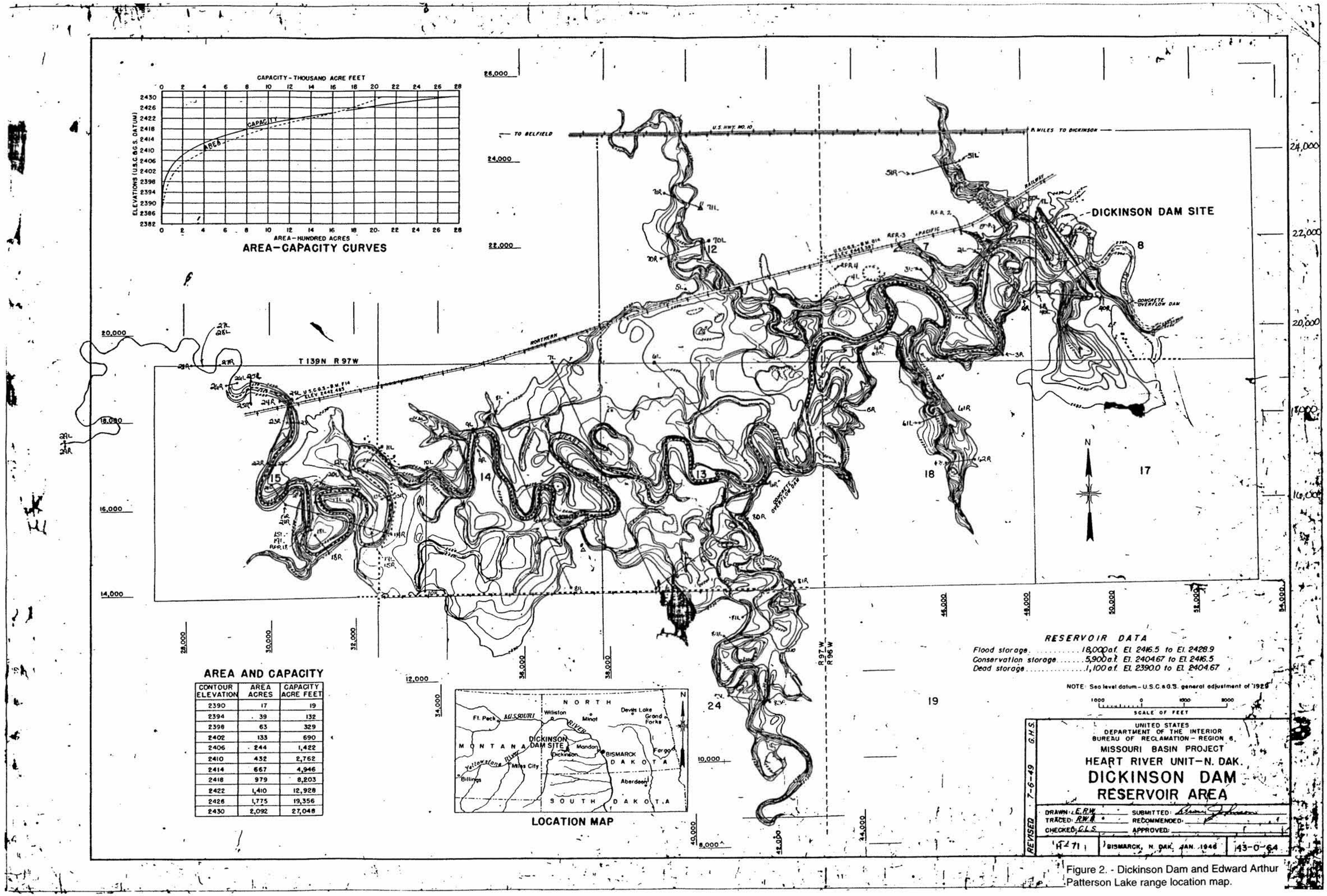


Figure 2. - Dickinson Dam and Edward Arthur Patterson Lake range location map.

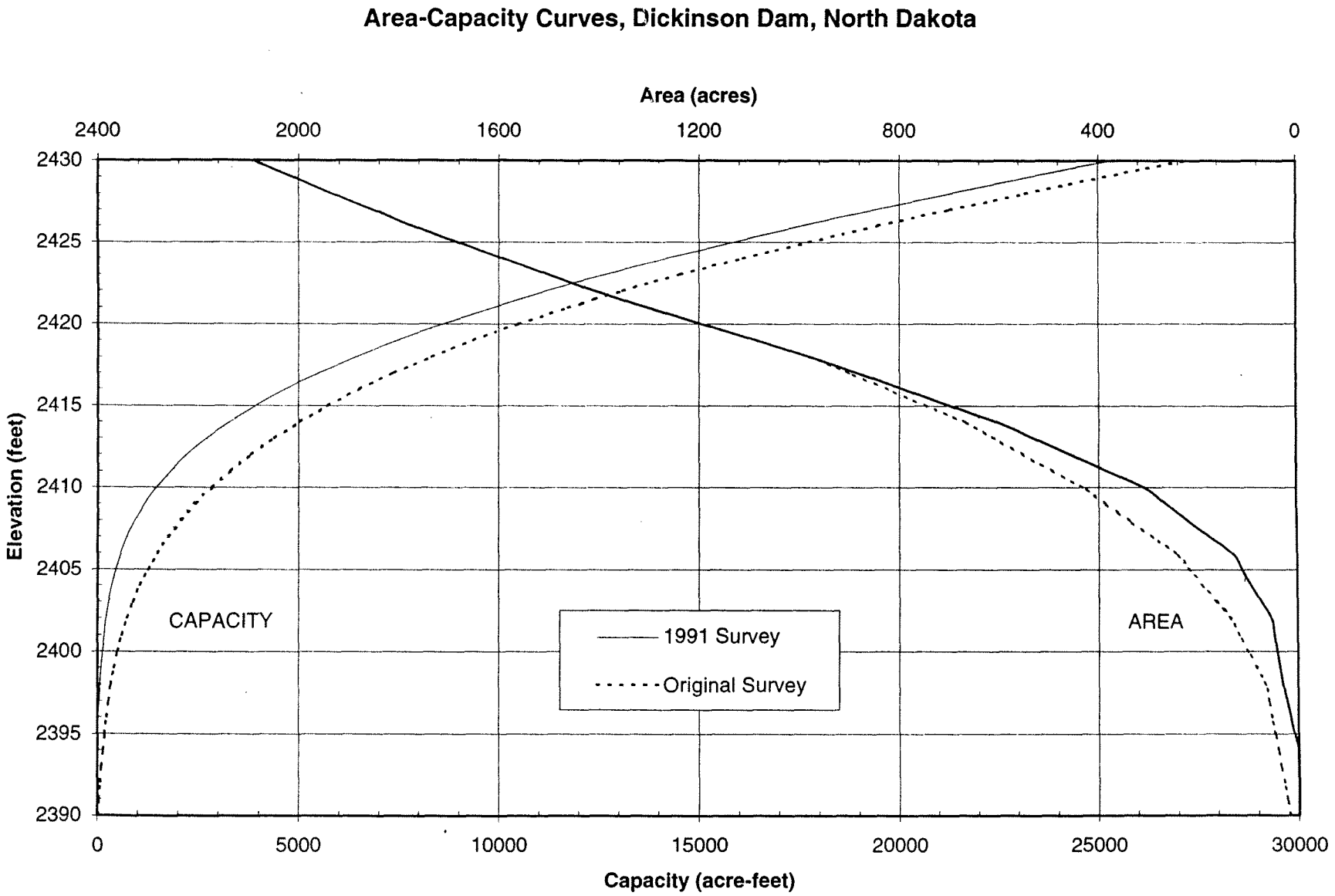


Figure 3. - Area and capacity curves for Dickinson Dam and Edward Arthur Patterson Lake.

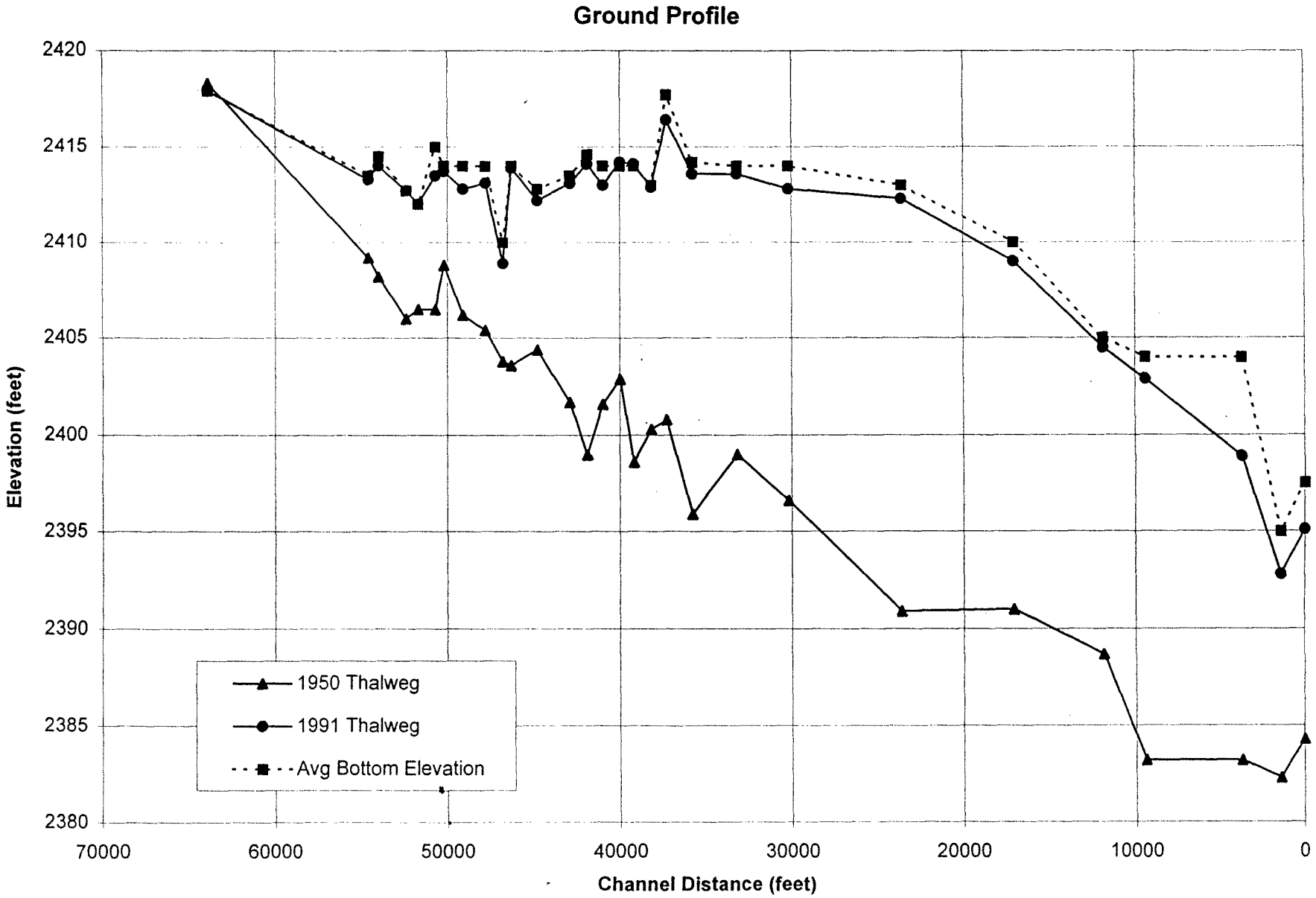


Figure 4. - Edward Arthur Patterson Lake, thalweg profiles.

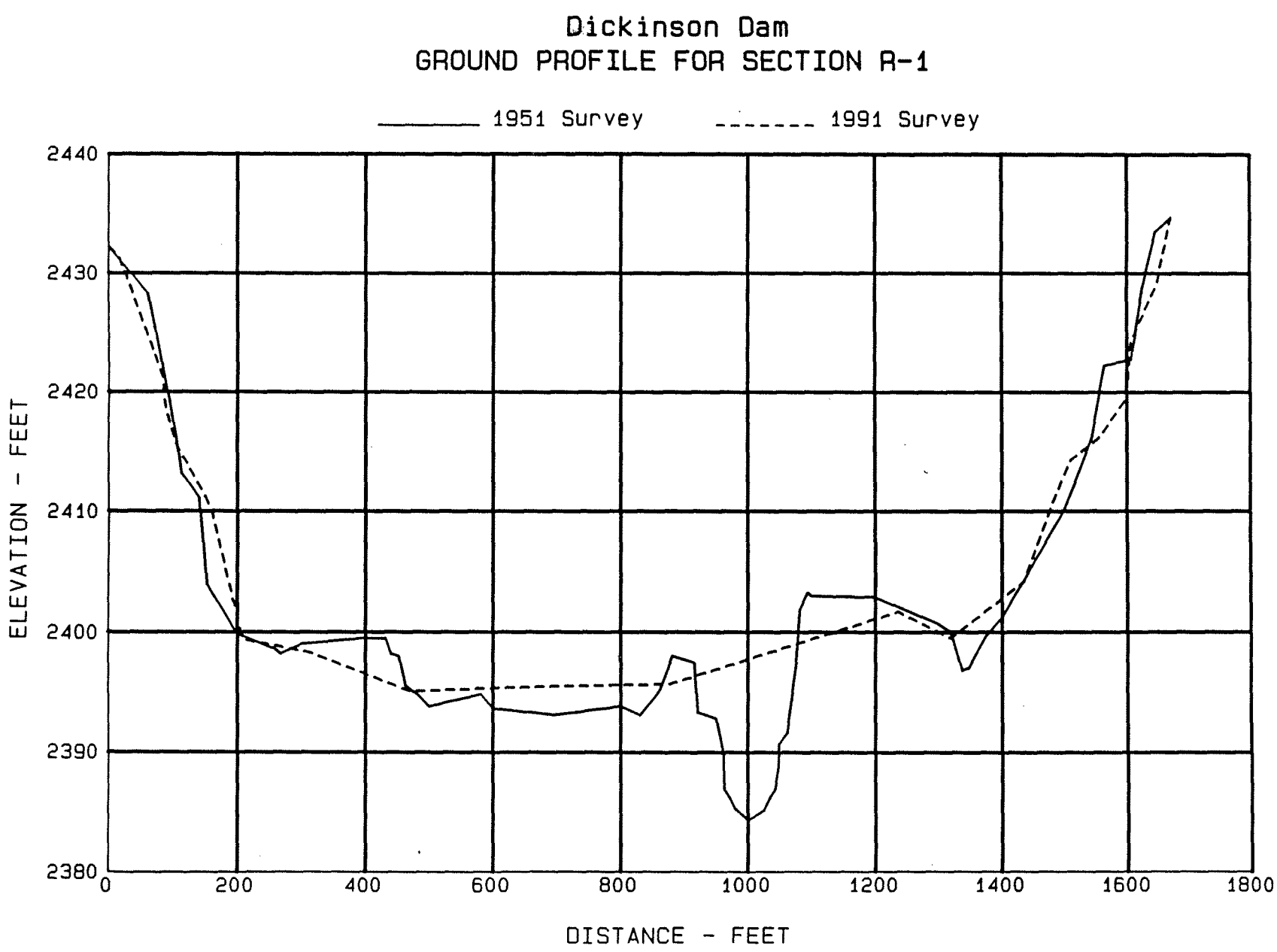


Figure 5. - Dickinson Dam ground profile for section R-1.

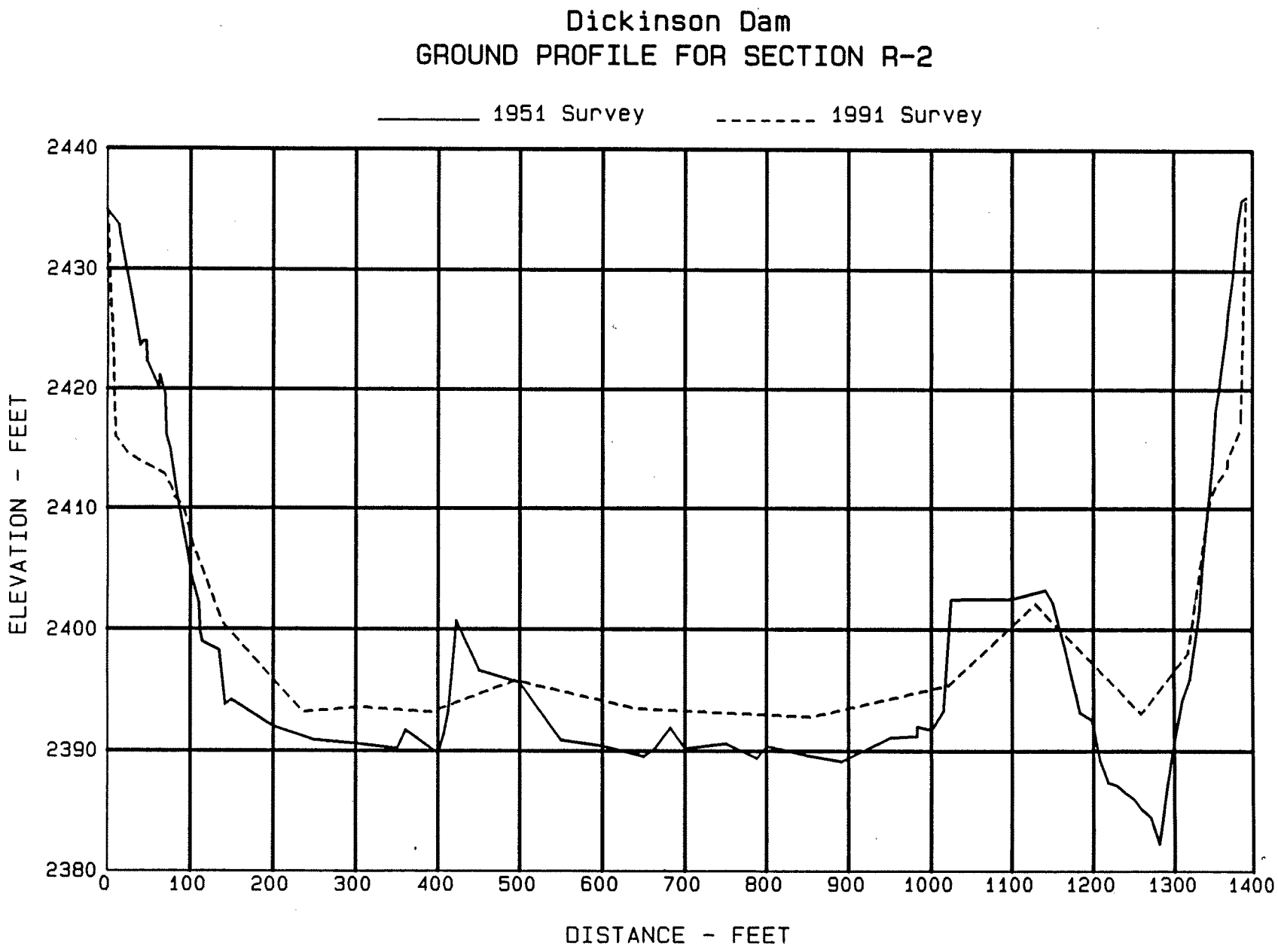


Figure 6. - Dickinson Dam ground profile for section R-2.

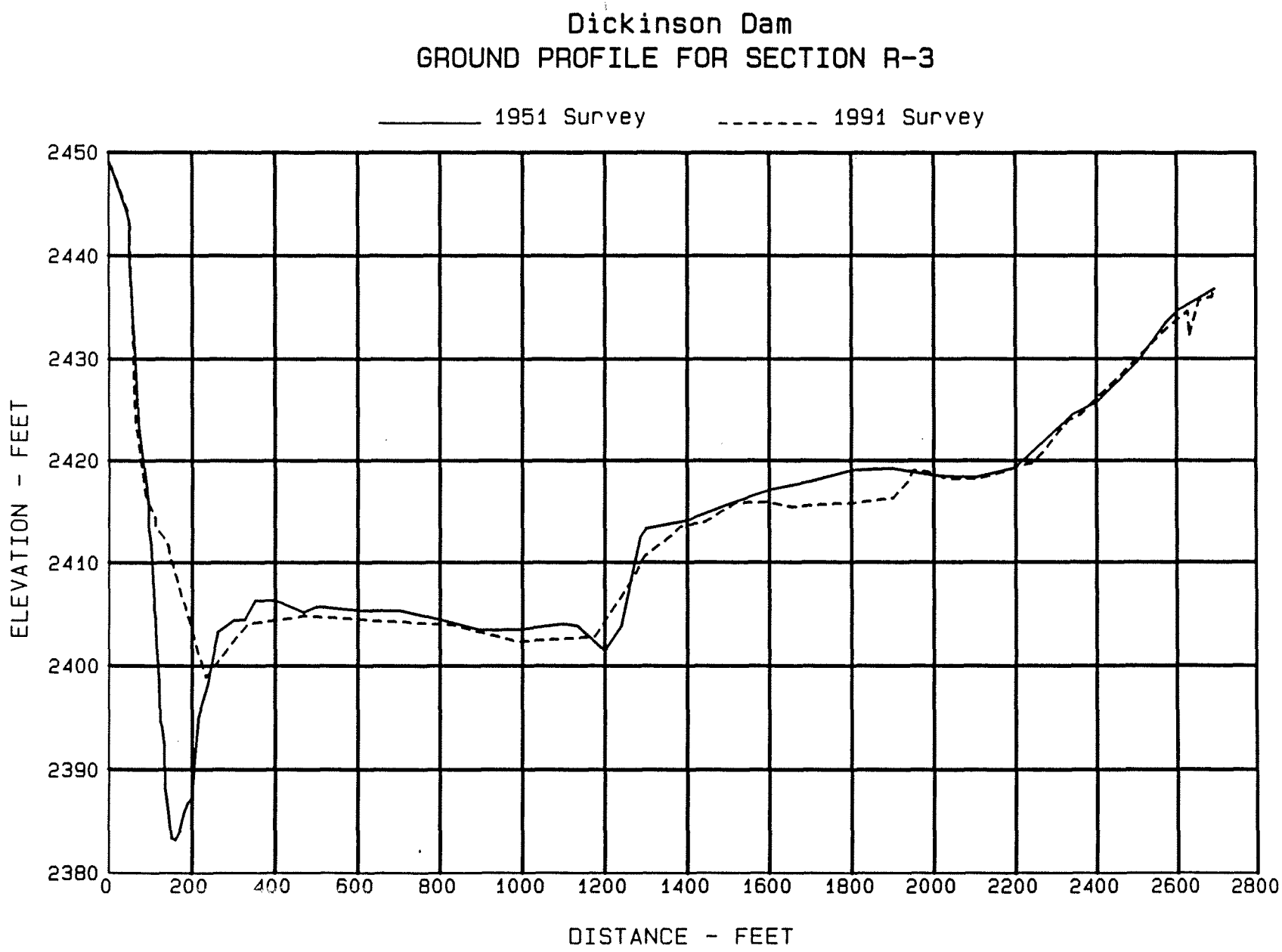


Figure 7. - Dickinson Dam ground profile for section R-3.

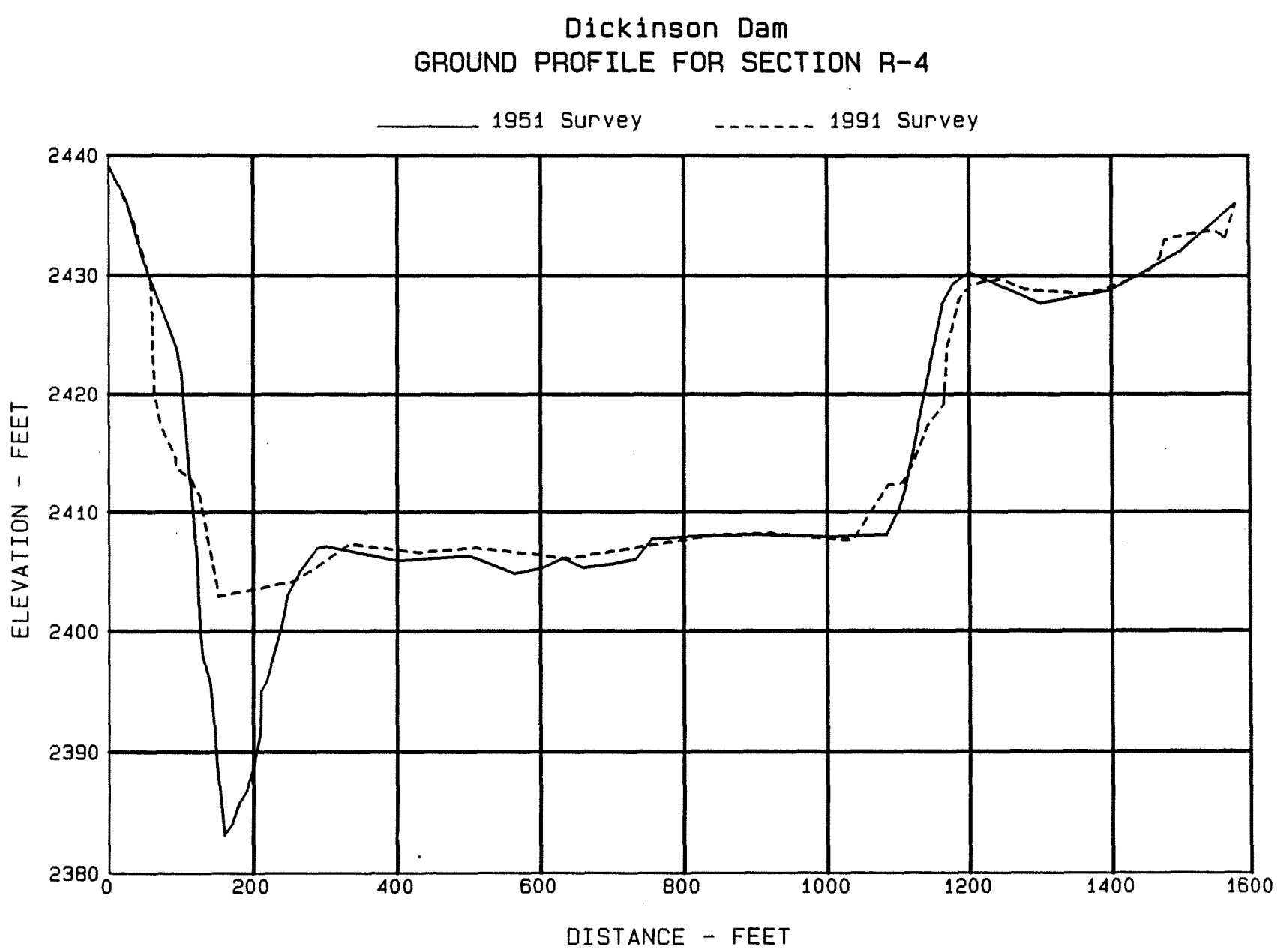


Figure 8. - Dickinson Dam ground profile for section R-4.

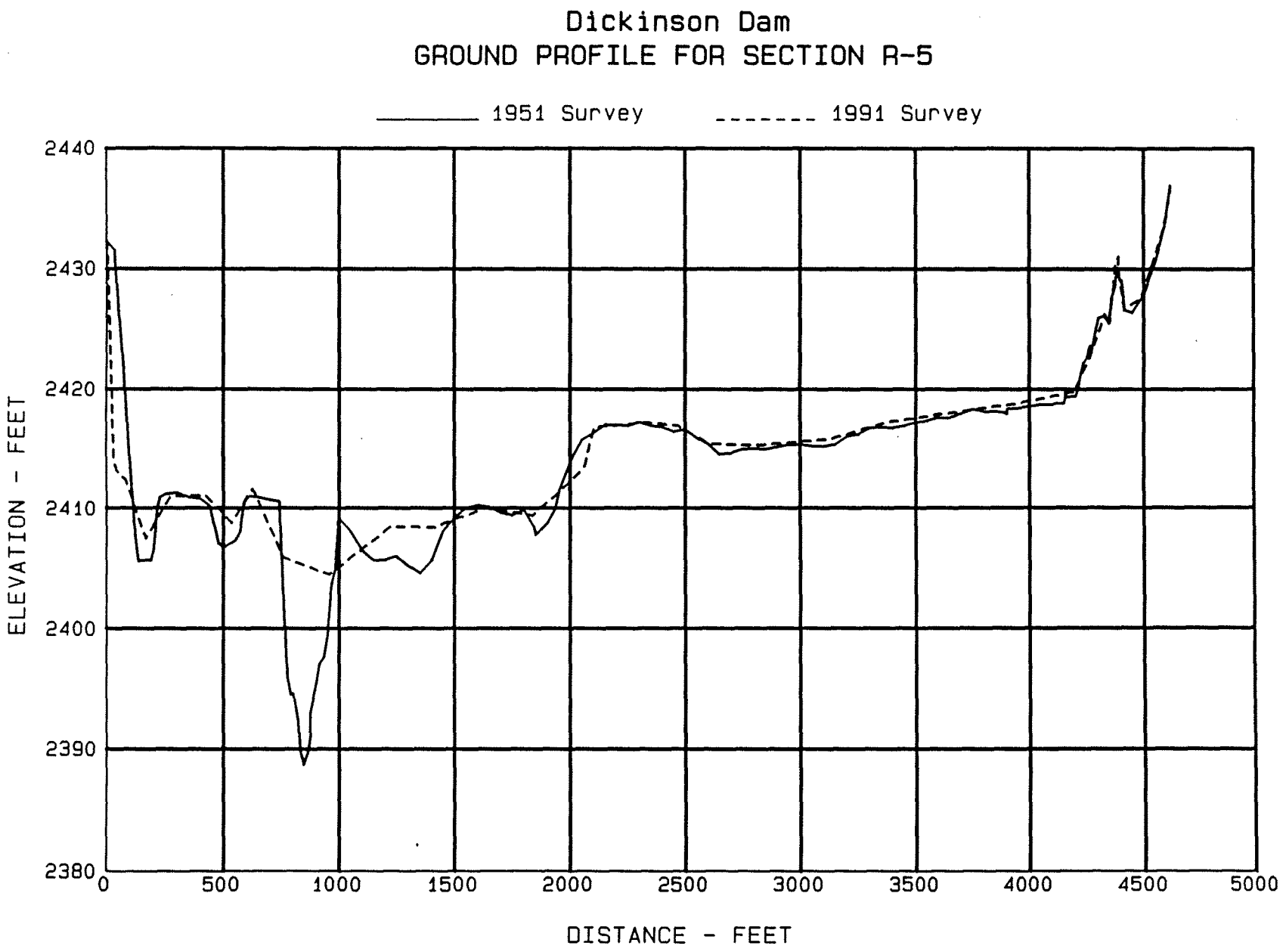


Figure 9. - Dickinson Dam ground profile for section R-5.

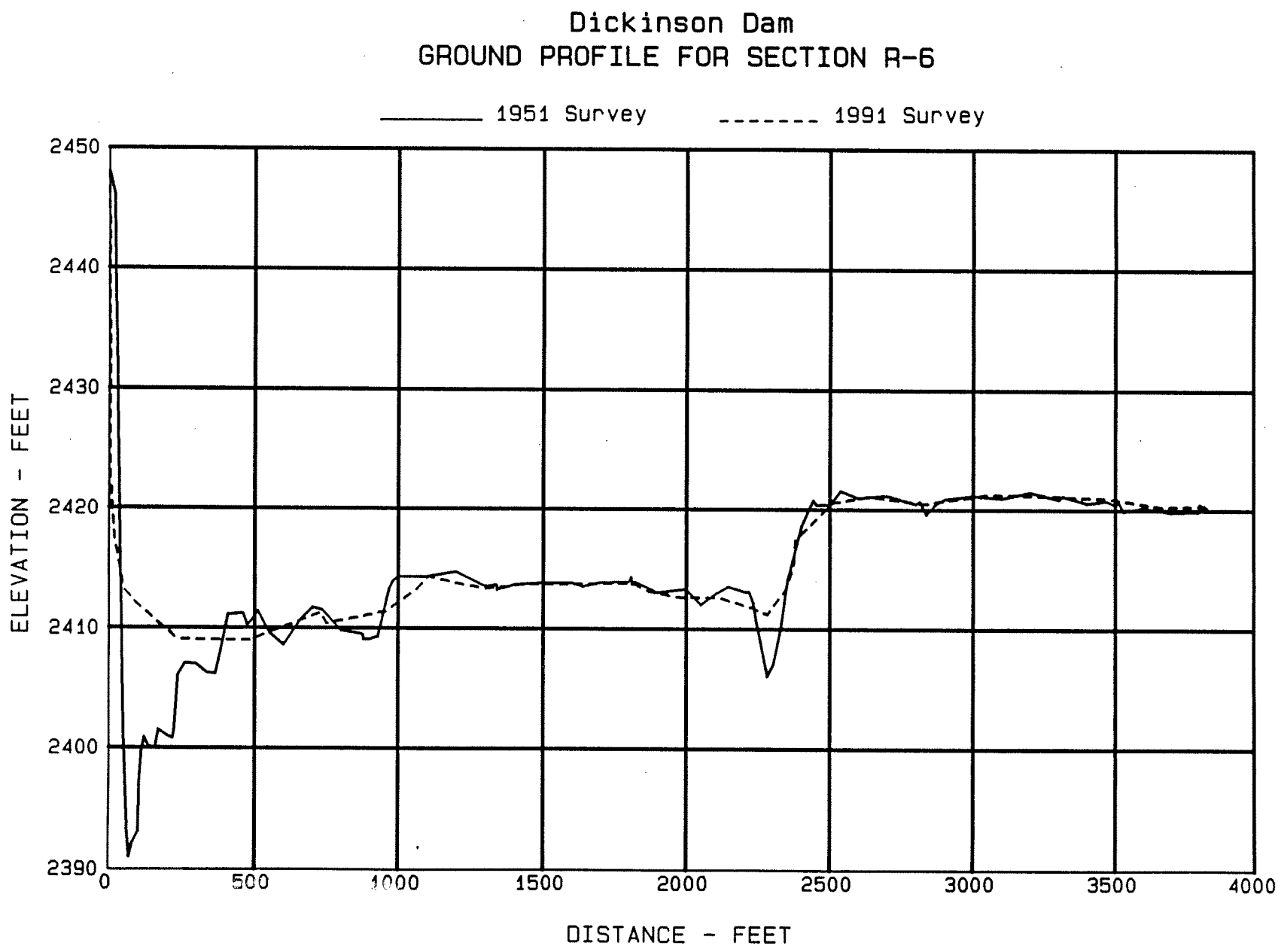


Figure 10. - Dickinson Dam ground profile for section R-6.

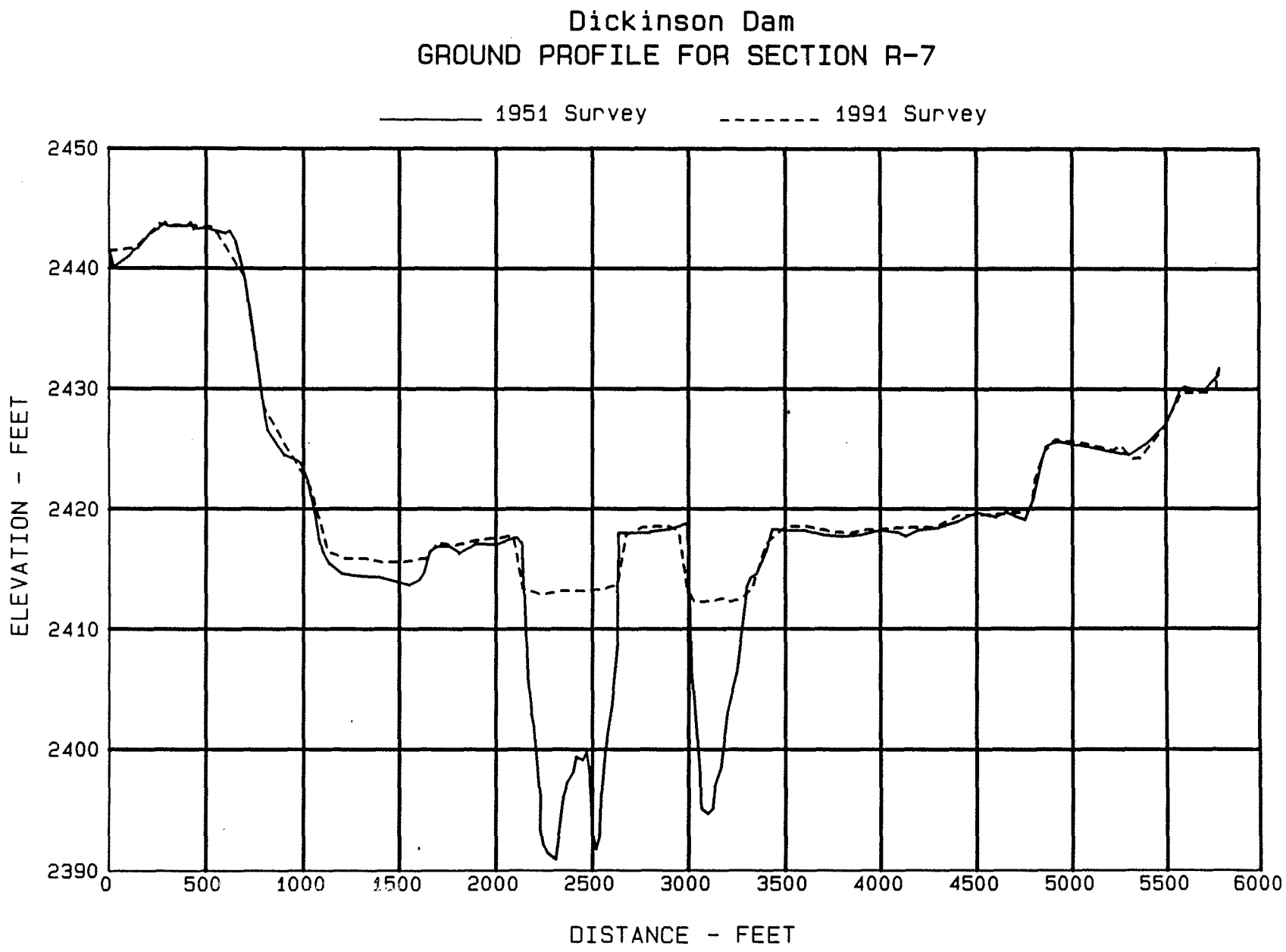


Figure 11. - Dickinson Dam ground profile for section R-7.

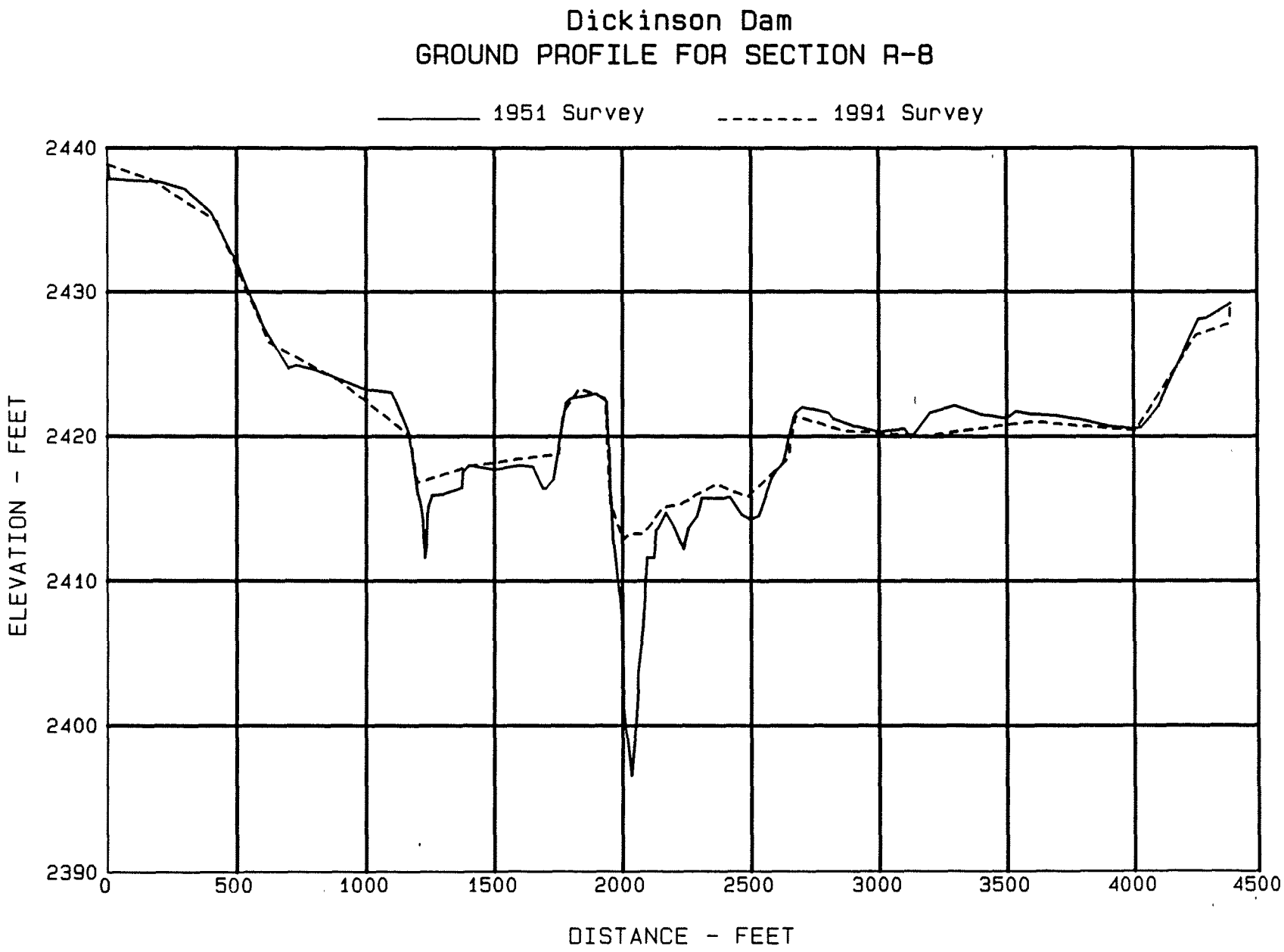


Figure 12. - Dickinson Dam ground profile for section R-8.

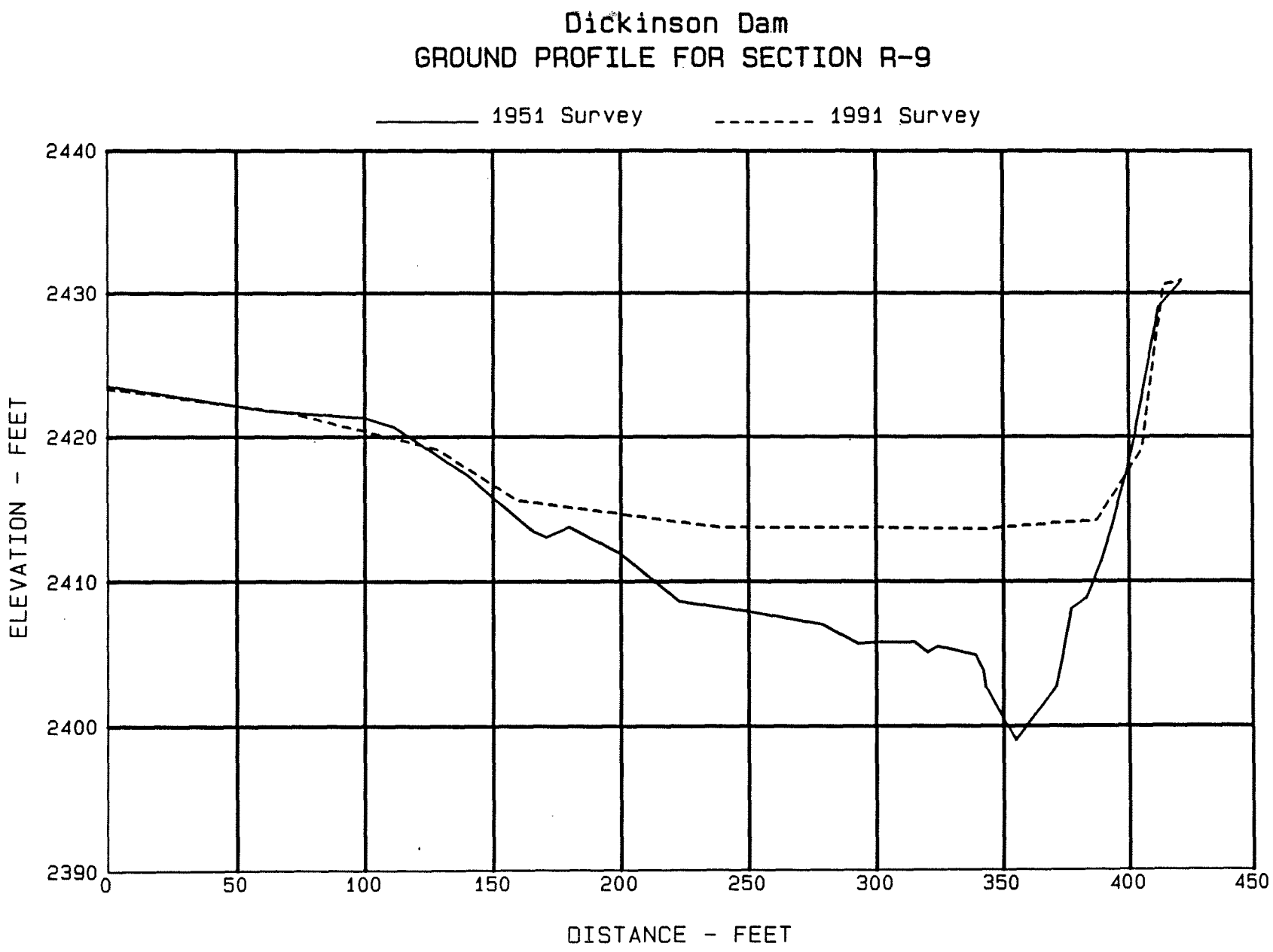


Figure 13. - Dickinson Dam ground profile for section R-9.

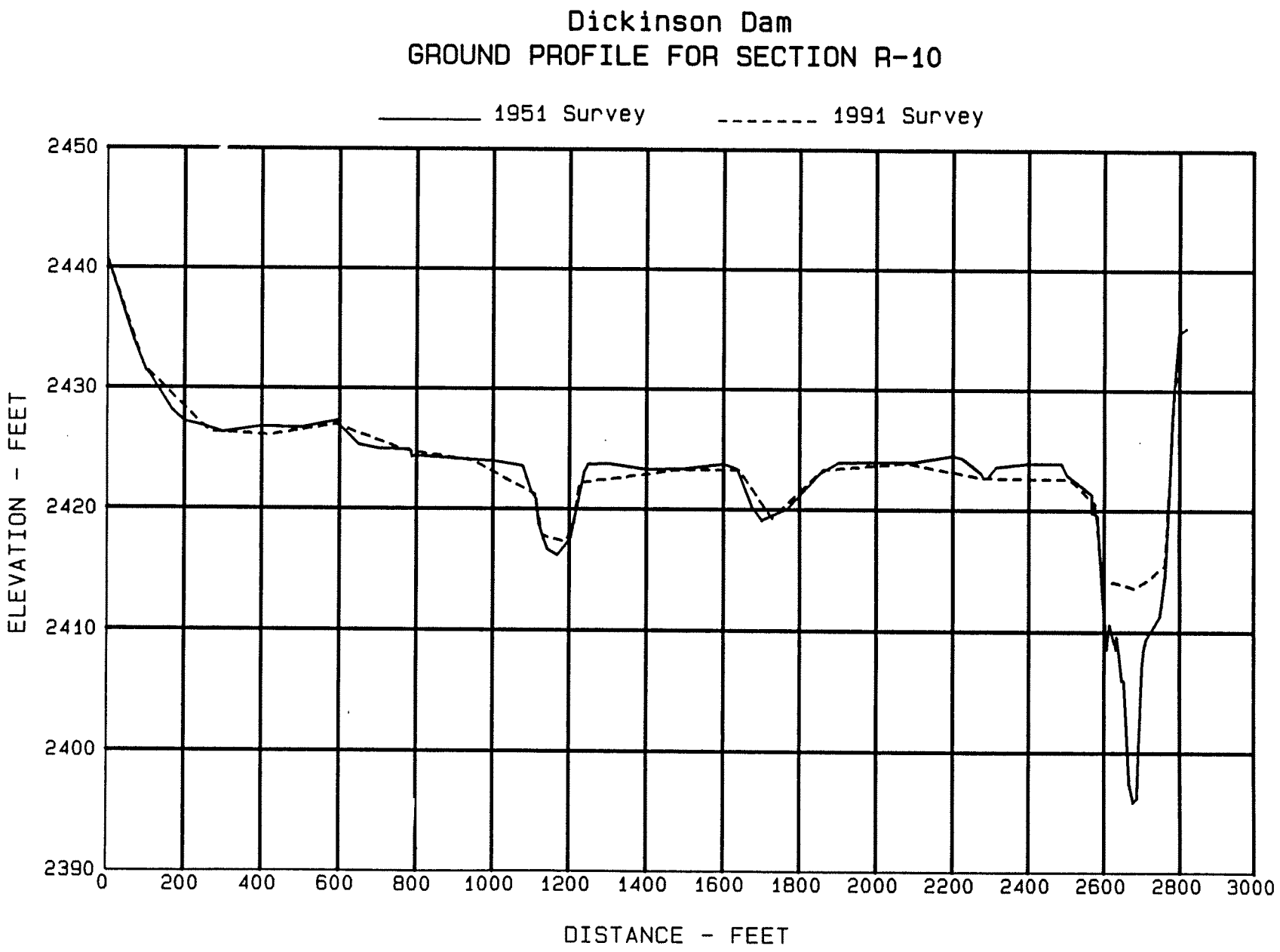


Figure 14. - Dickinson Dam ground profile for section R-10.

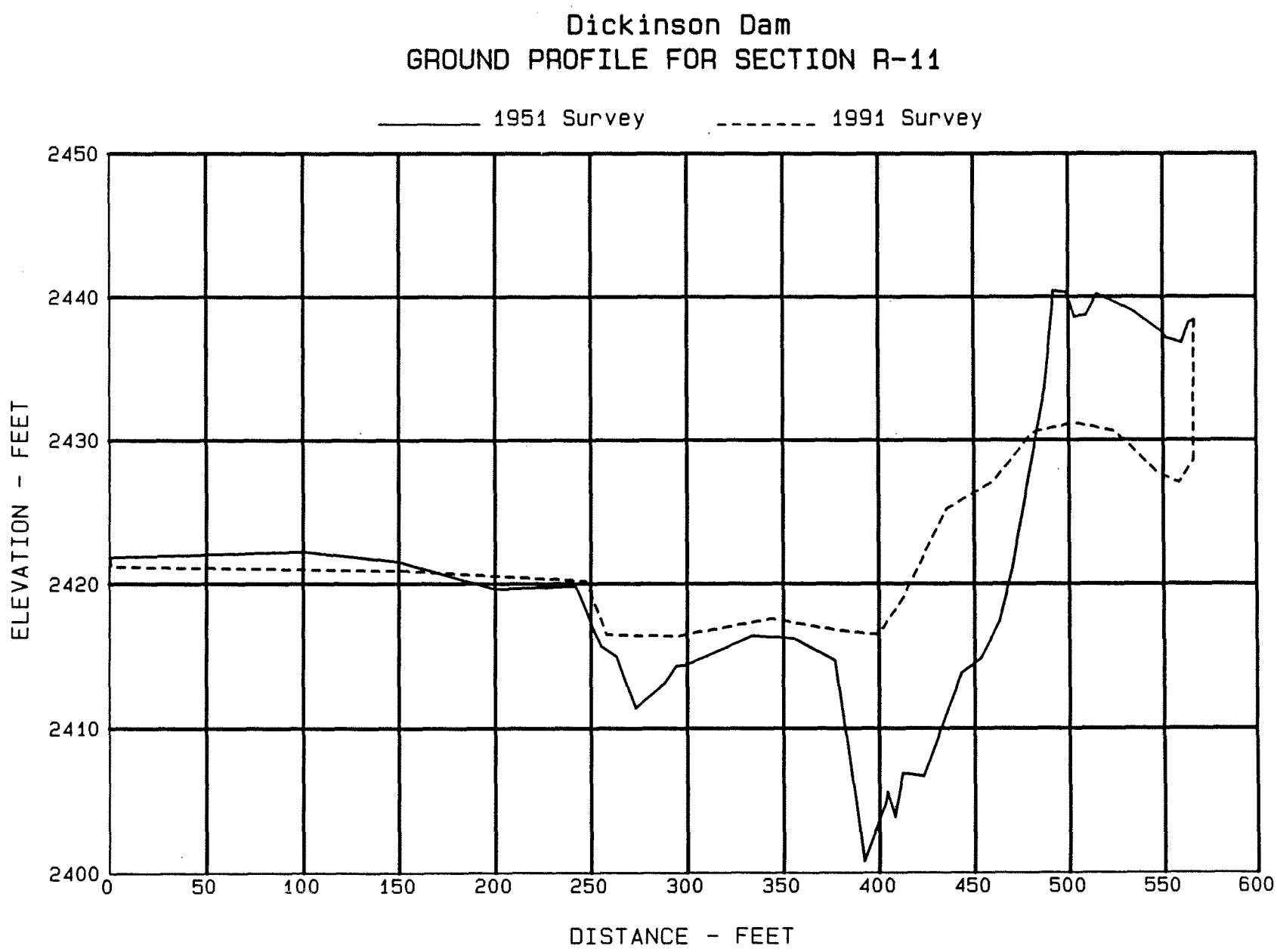


Figure 15. - Dickinson Dam ground profile for section R-11.

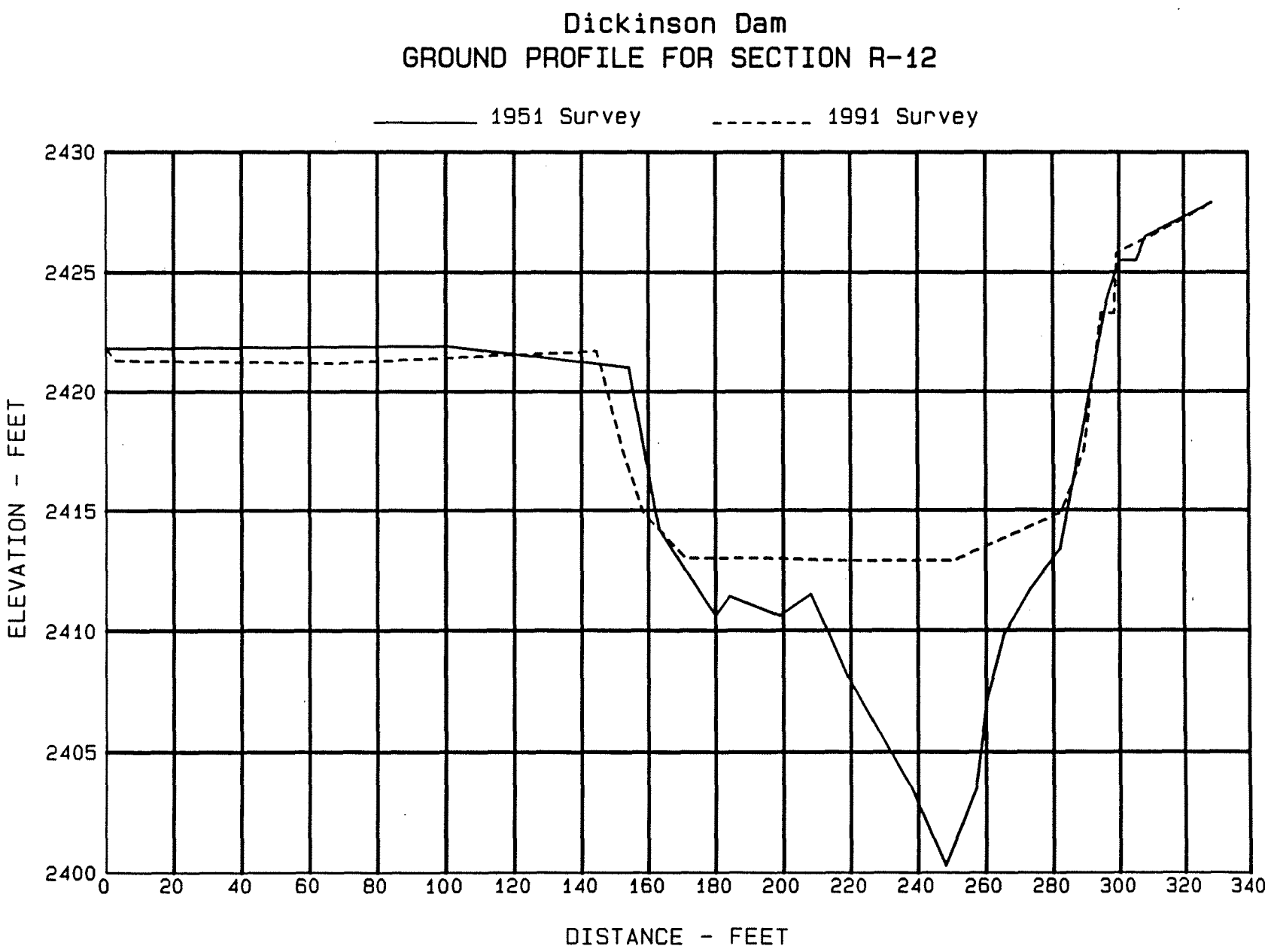


Figure 16. - Dickinson Dam ground profile for section R-12.

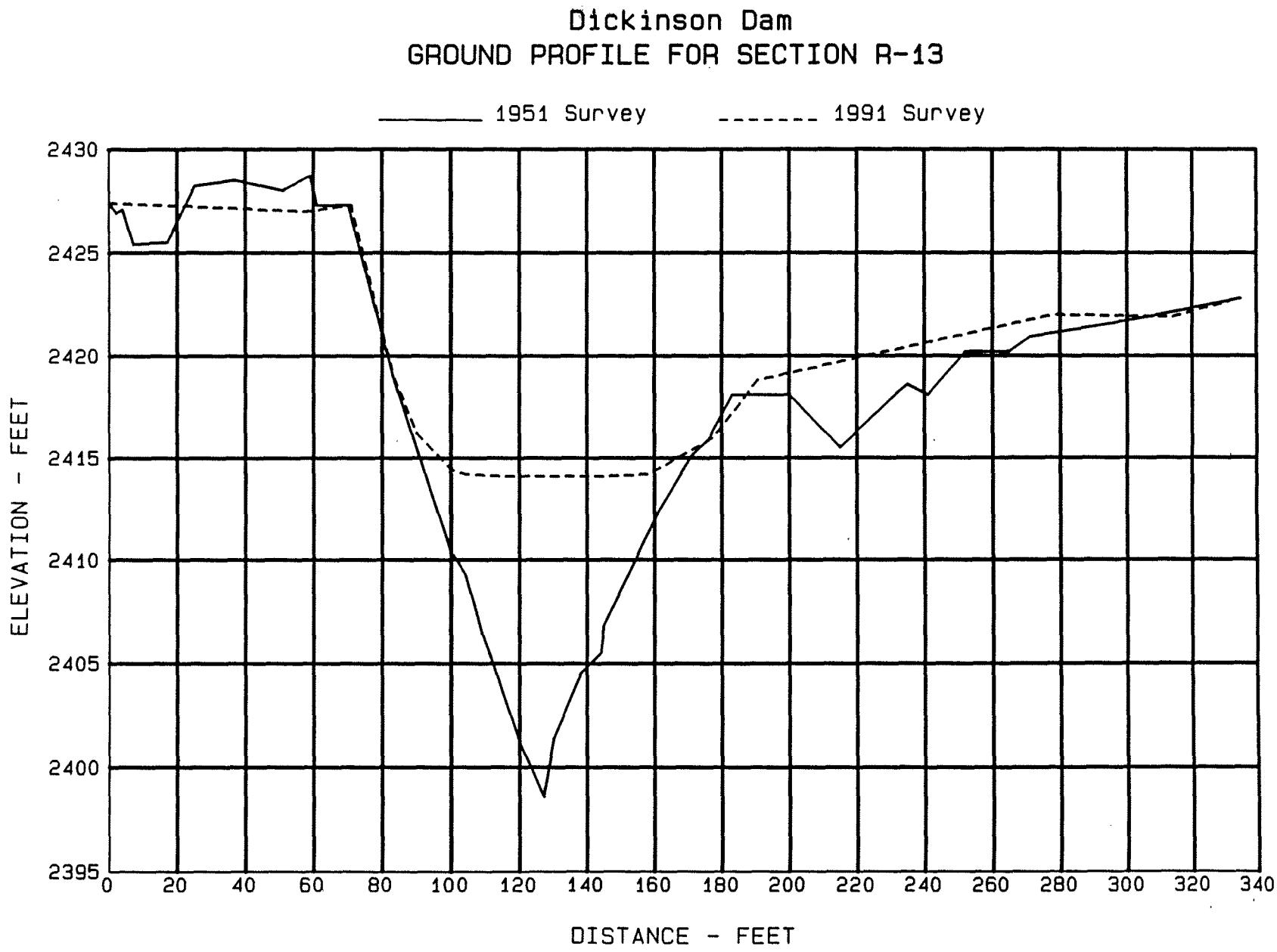


Figure 17. - Dickinson Dam ground profile for section R-13.

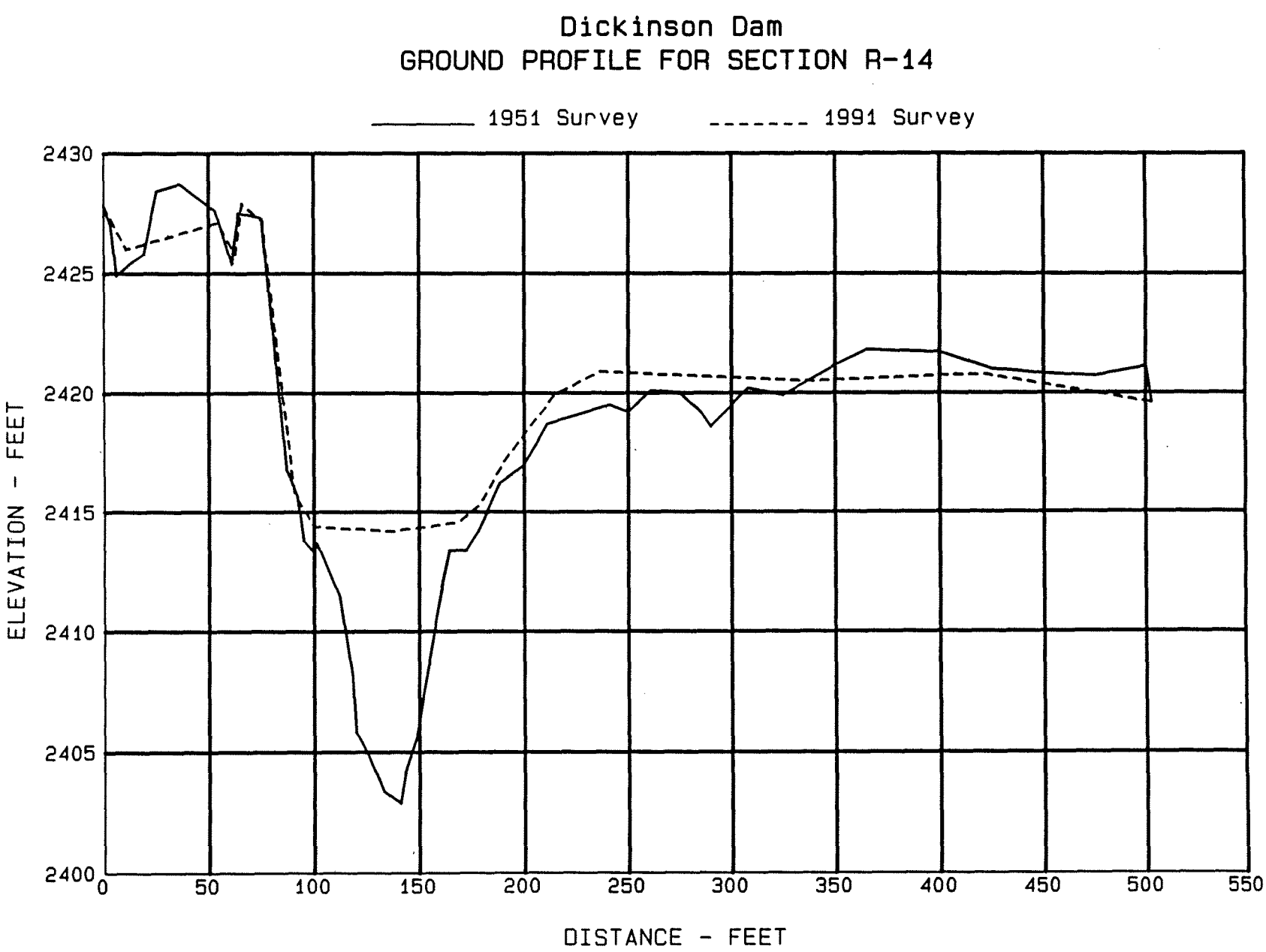


Figure 18. - Dickinson Dam ground profile for section R-14.

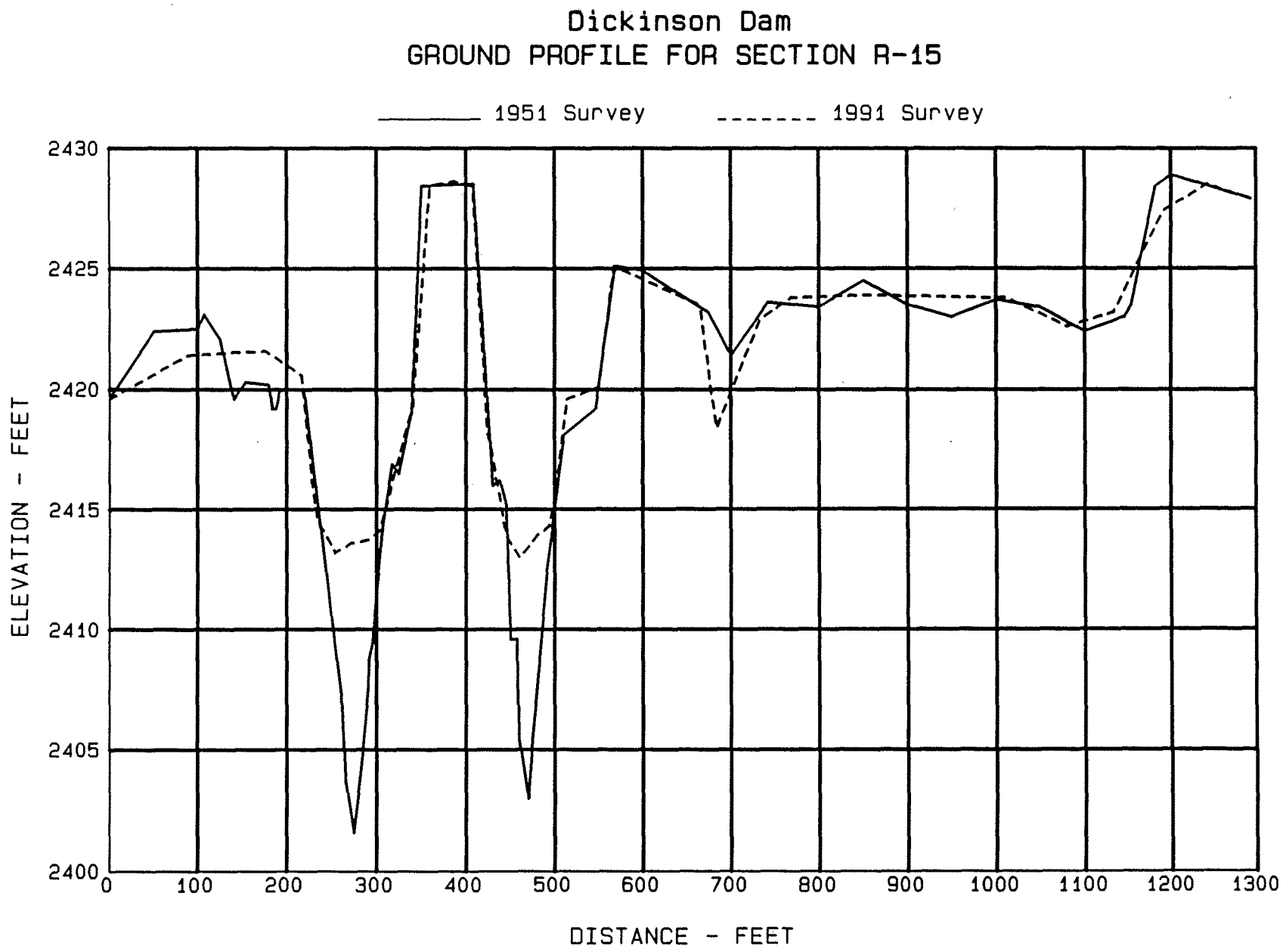


Figure 19. - Dickinson Dam ground profile for section R-15.

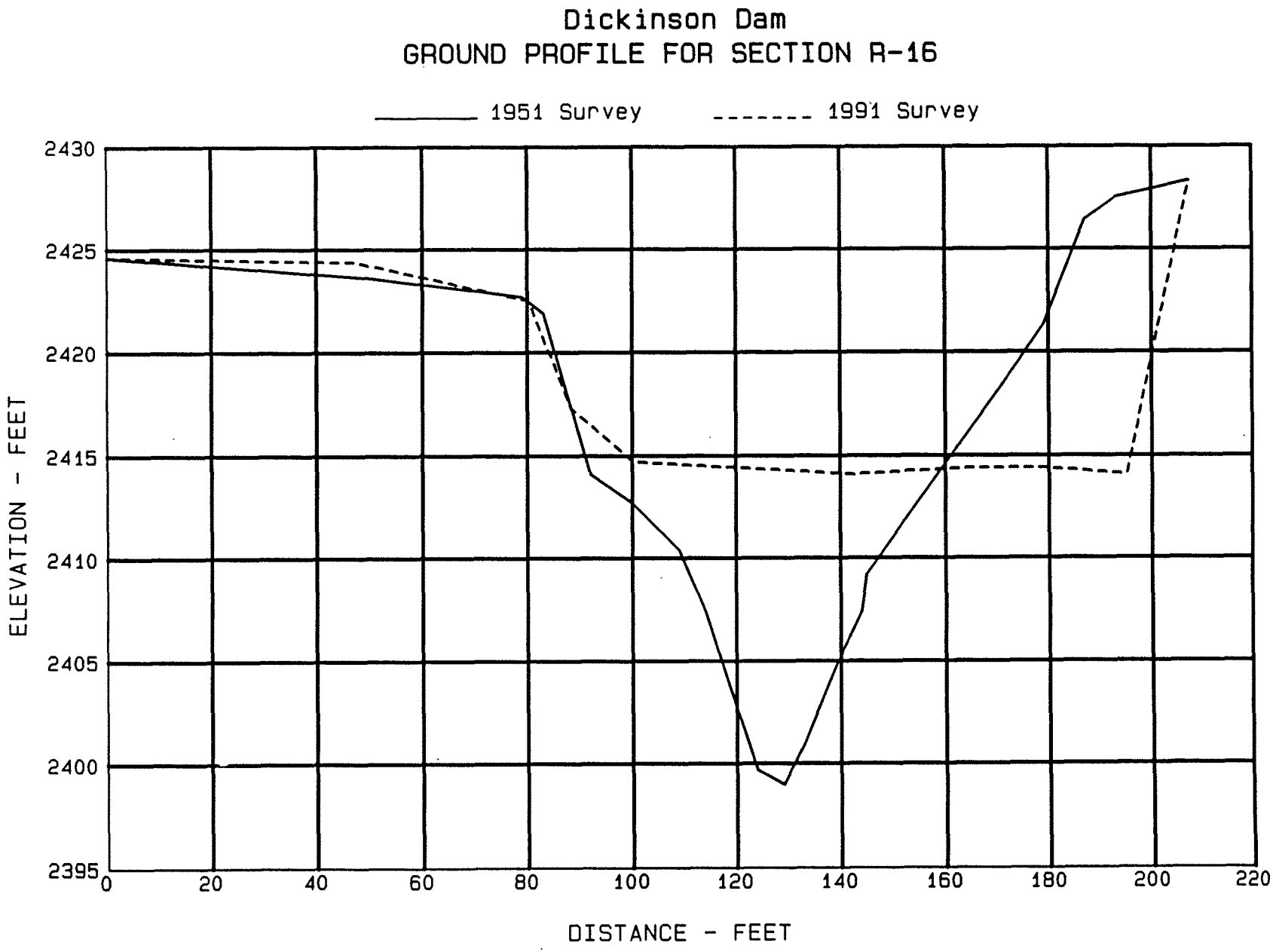


Figure 20. - Dickinson Dam ground profile for section R-16.

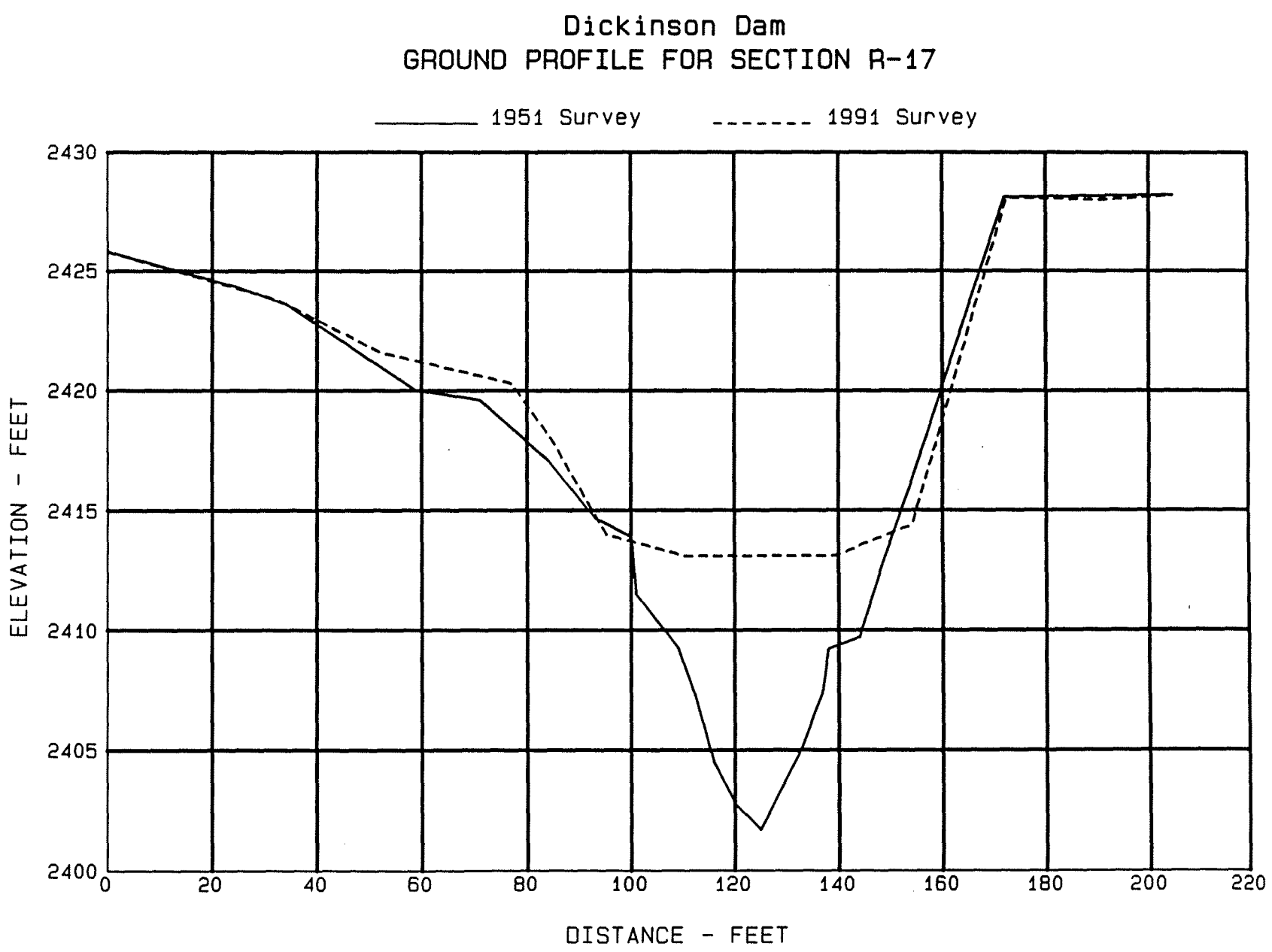


Figure 21. - Dickinson Dam ground profile for section R-17.

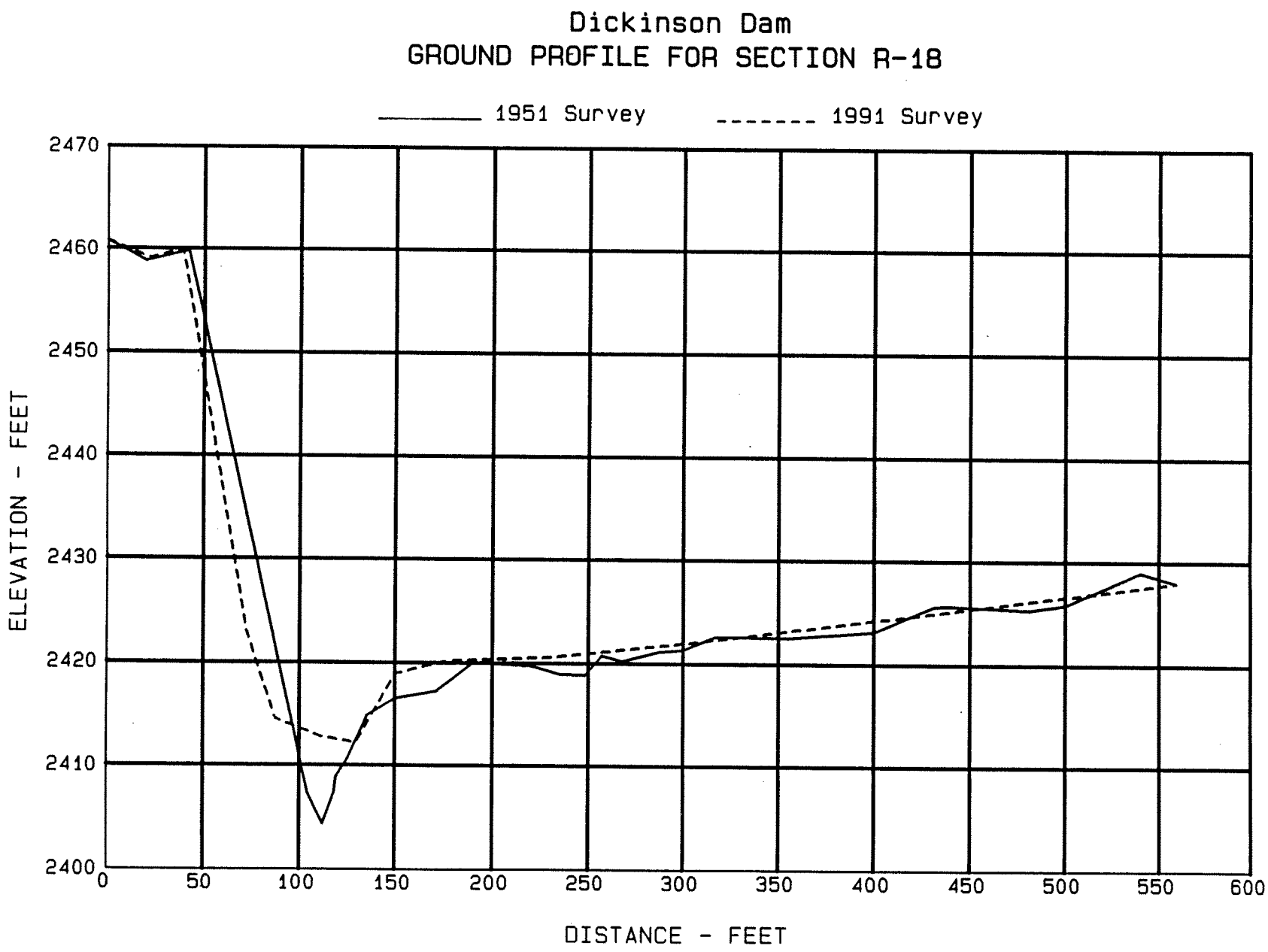


Figure 22. - Dickinson Dam ground profile for section R-18.

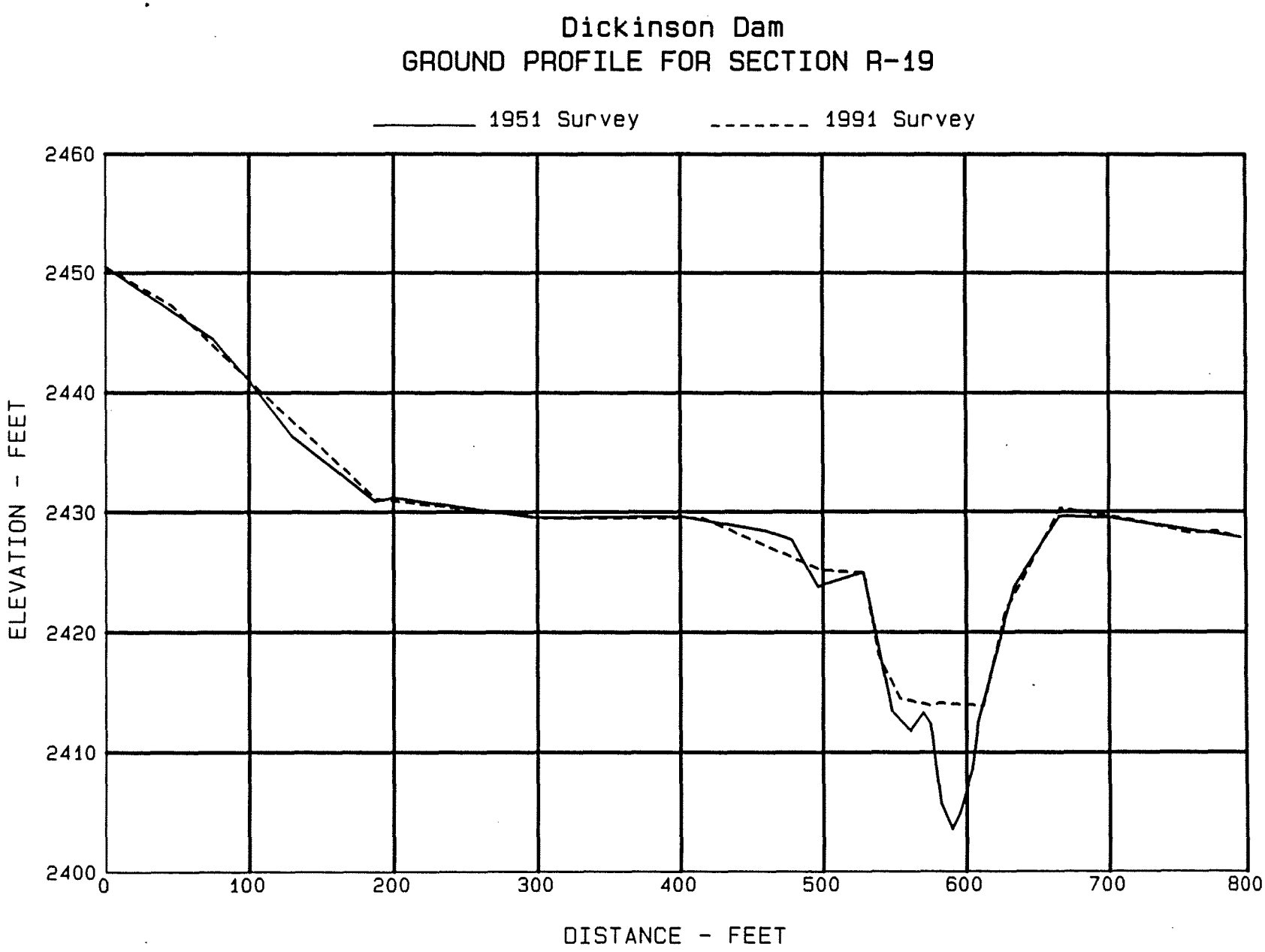


Figure 23. - Dickinson Dam ground profile for section R-19.

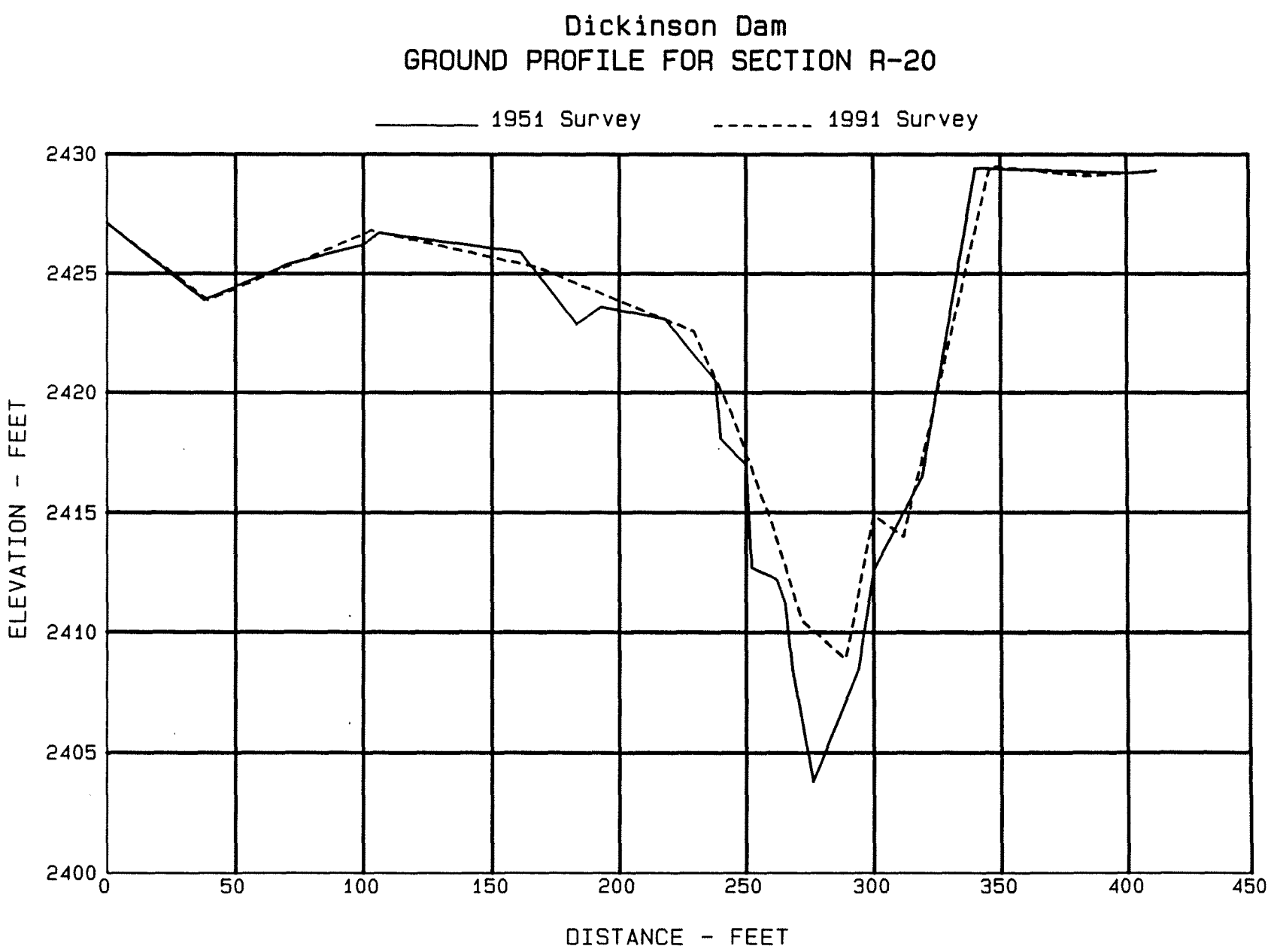


Figure 24. - Dickinson Dam ground profile for section R-20.

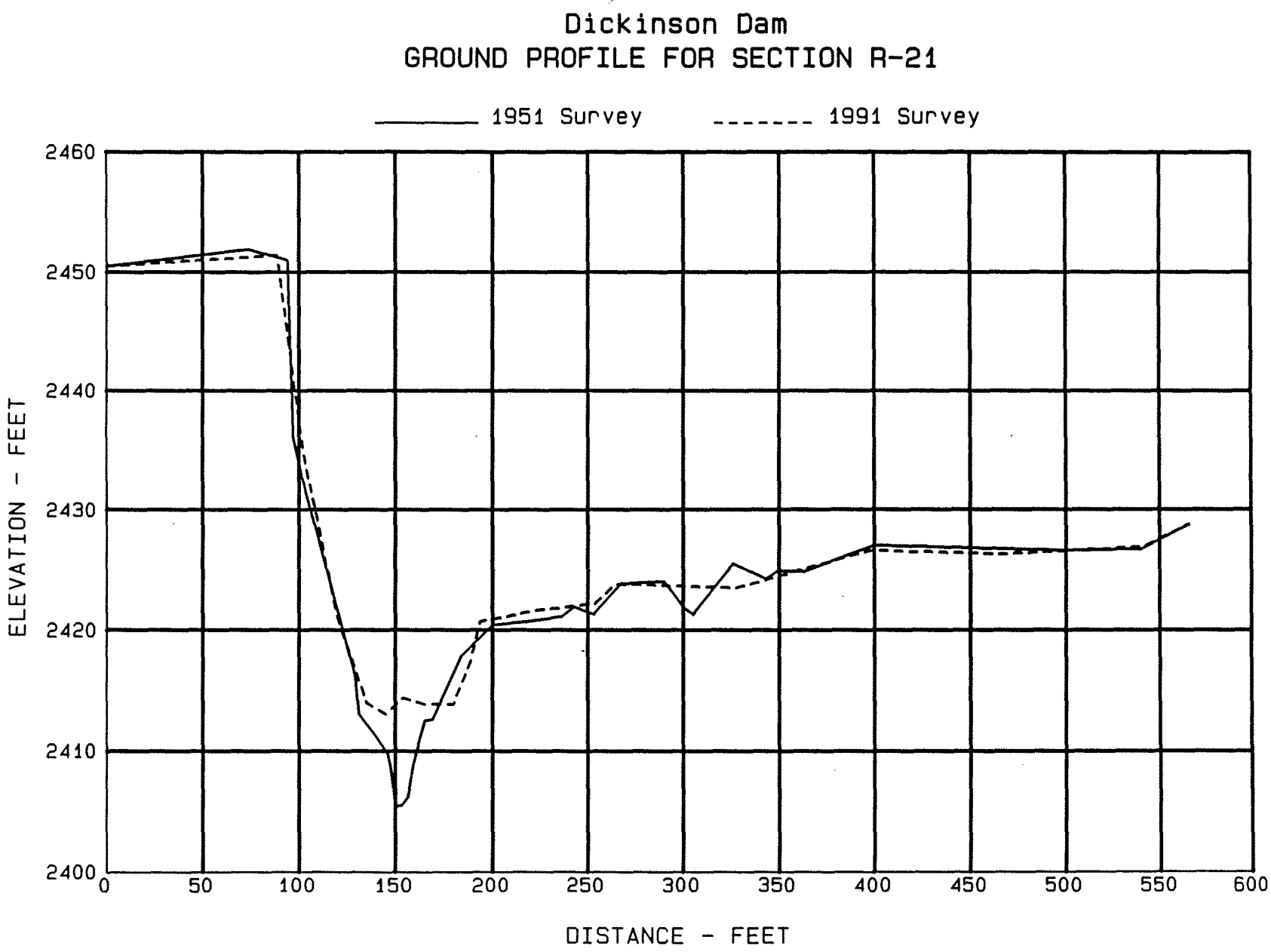


Figure 25. - Dickinson Dam ground profile for section R-21.

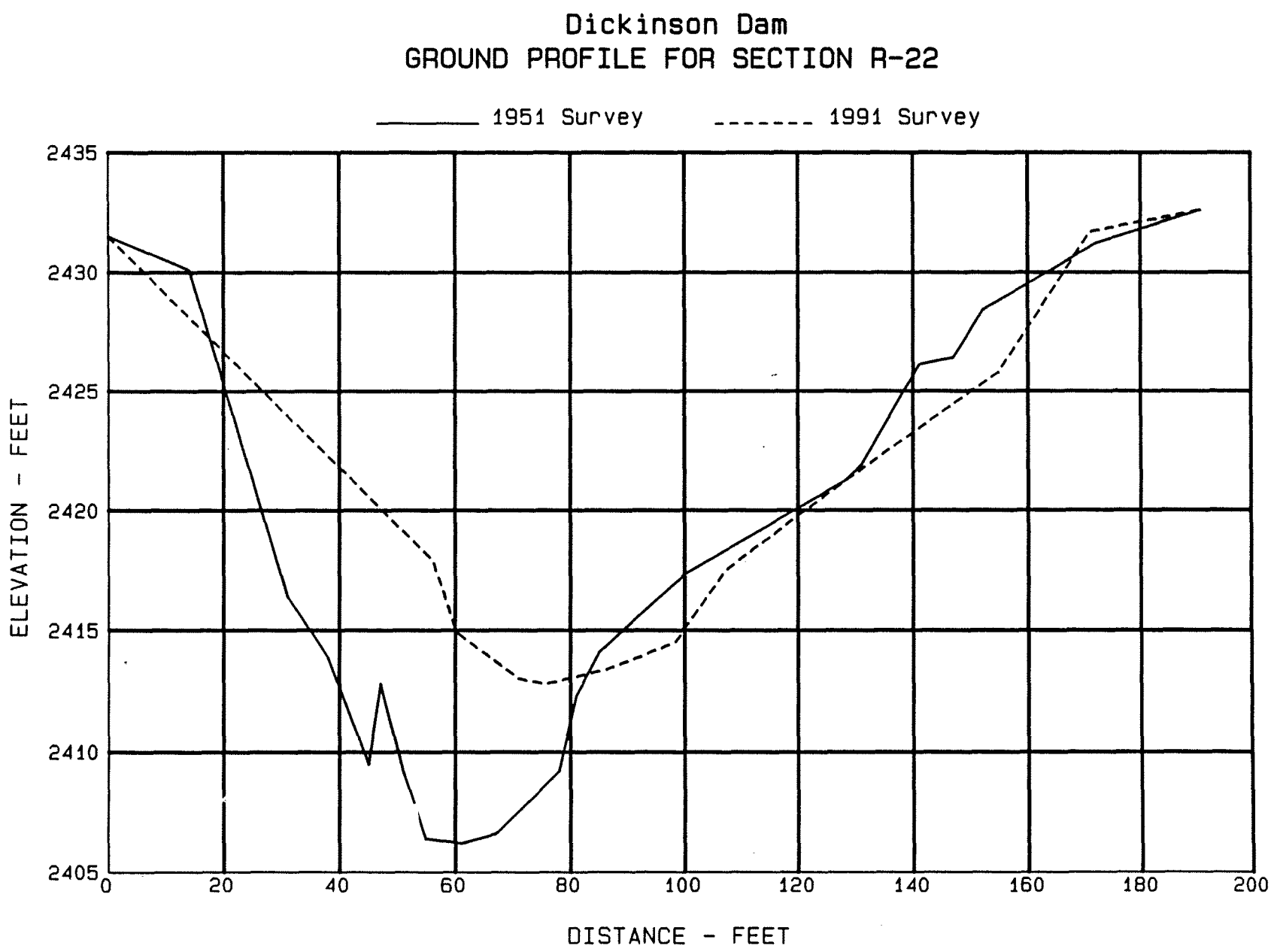


Figure 26. - Dickinson Dam ground profile for section R-22.

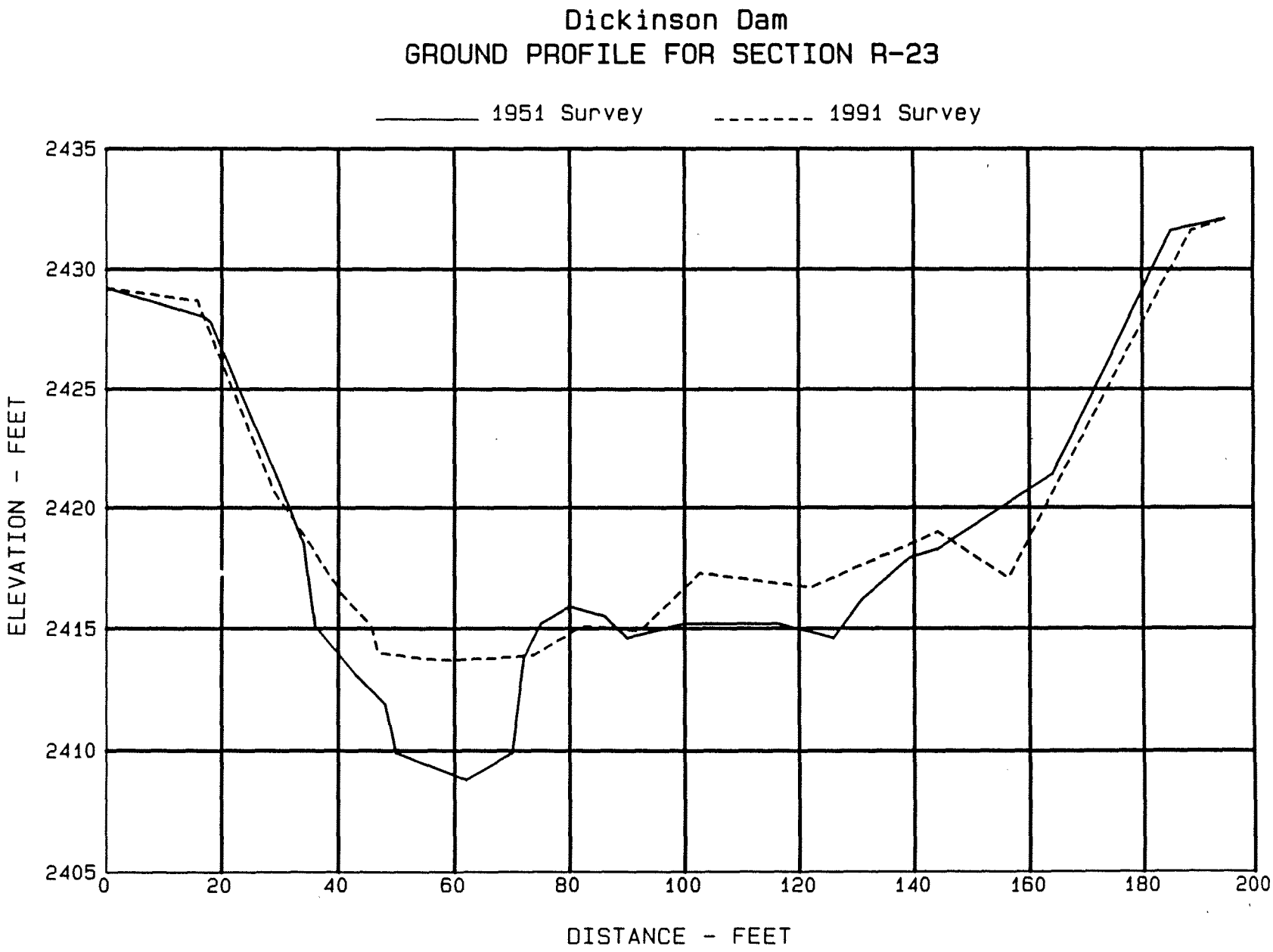


Figure 27. - Dickinson Dam ground profile for section R-23.

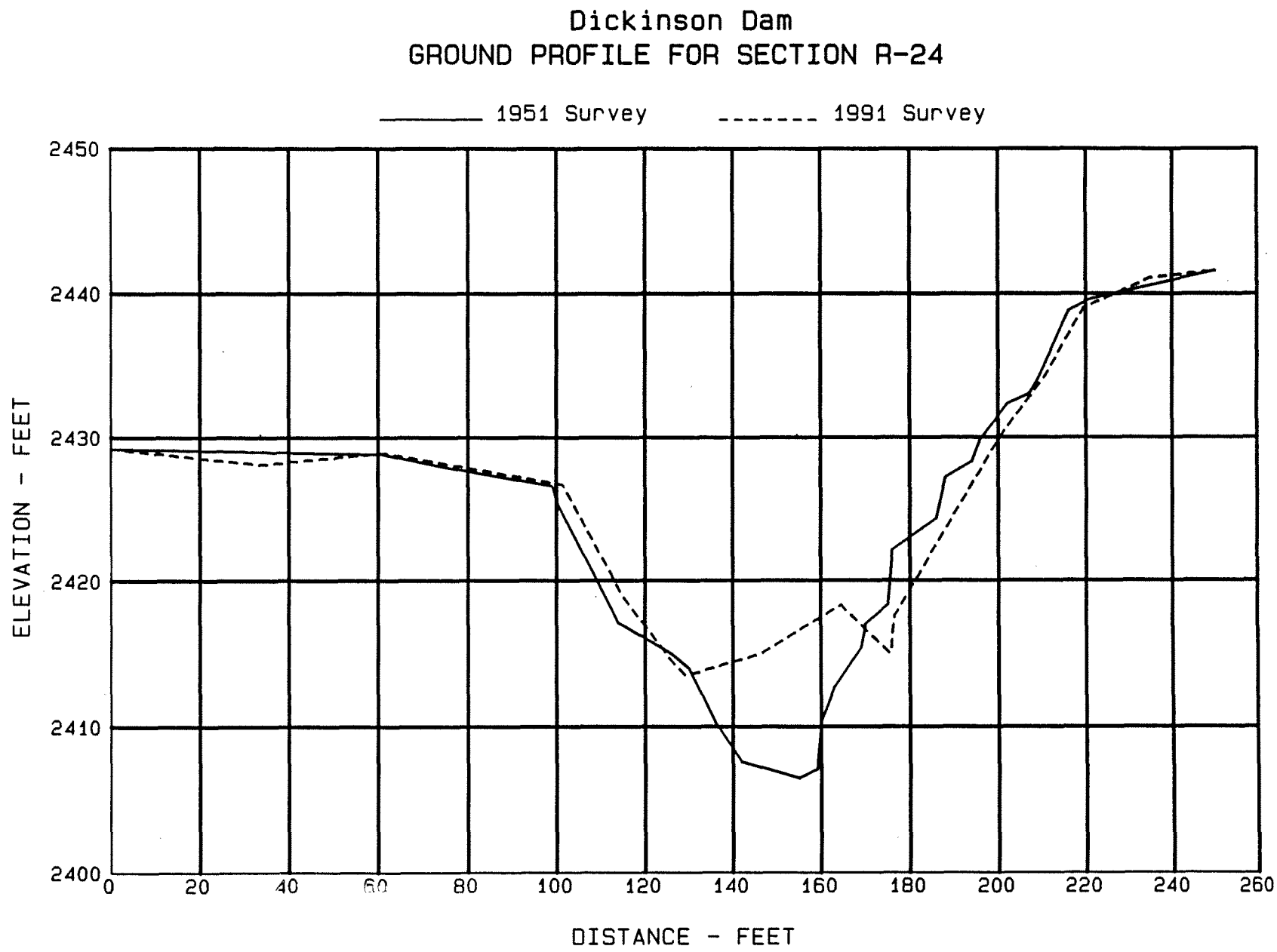


Figure 28. - Dickinson Dam ground profile for section R-24.

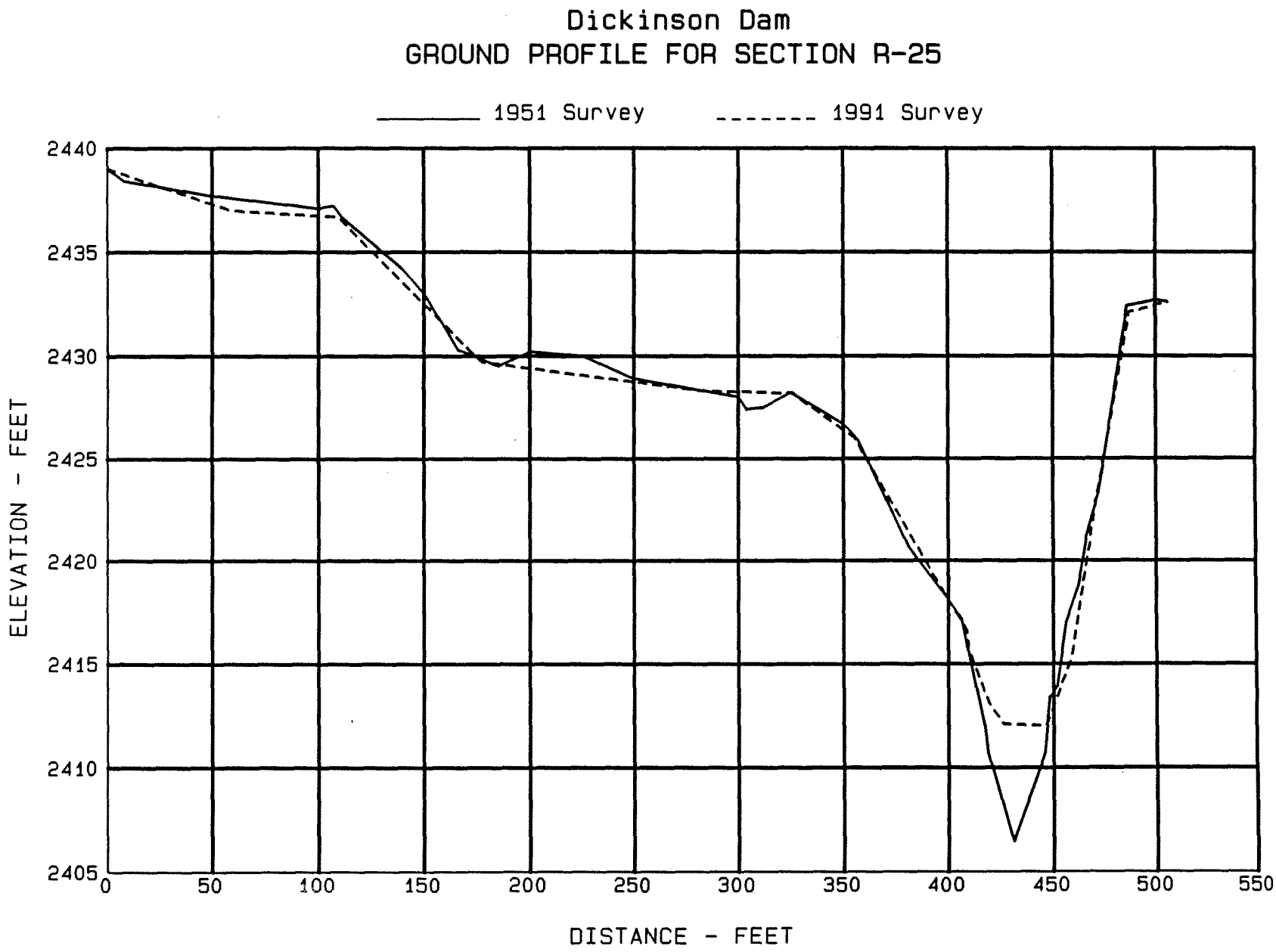


Figure 29. - Dickinson Dam ground profile for section R-25.

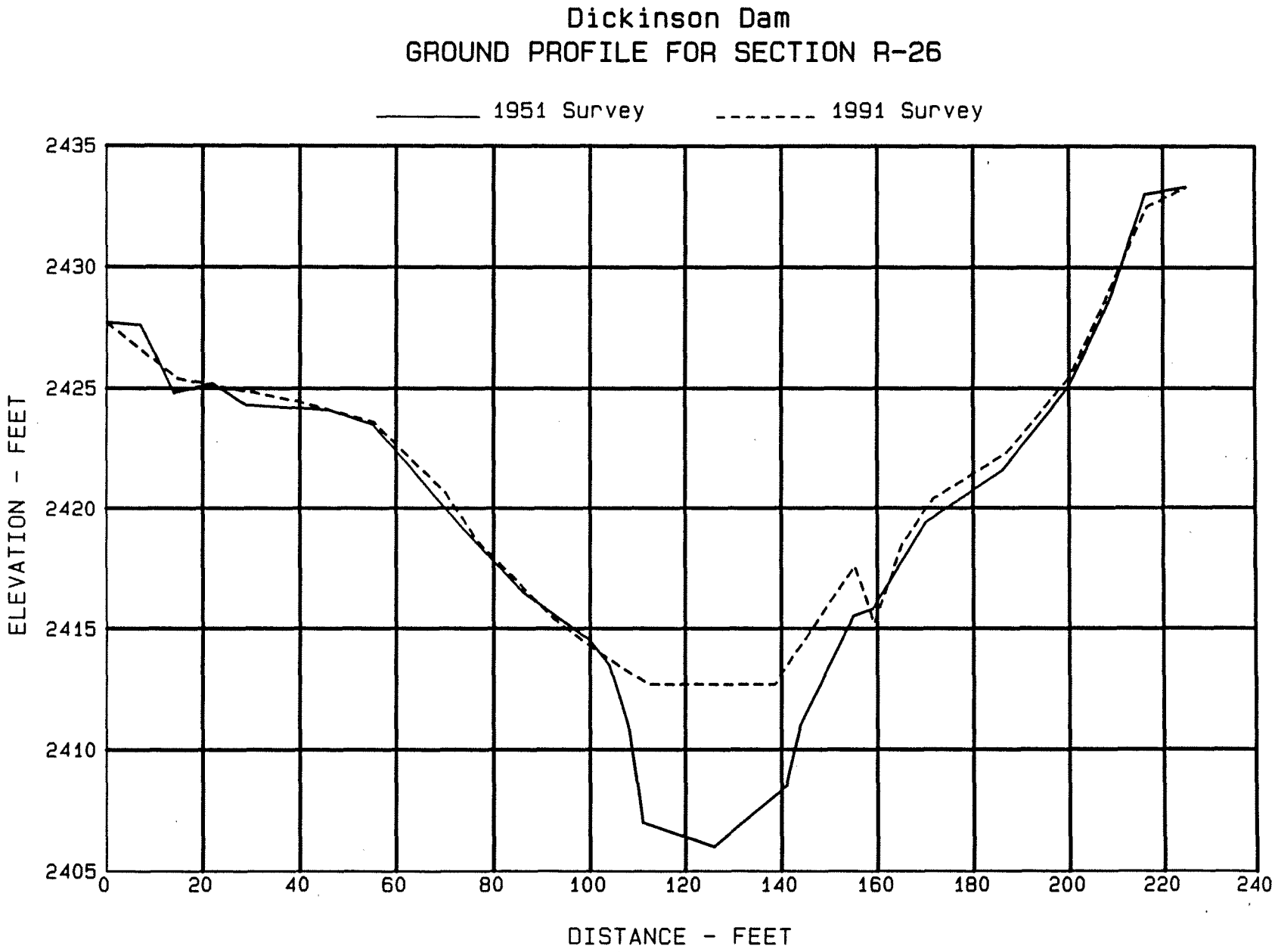


Figure 30. - Dickinson Dam ground profile for section R-26.

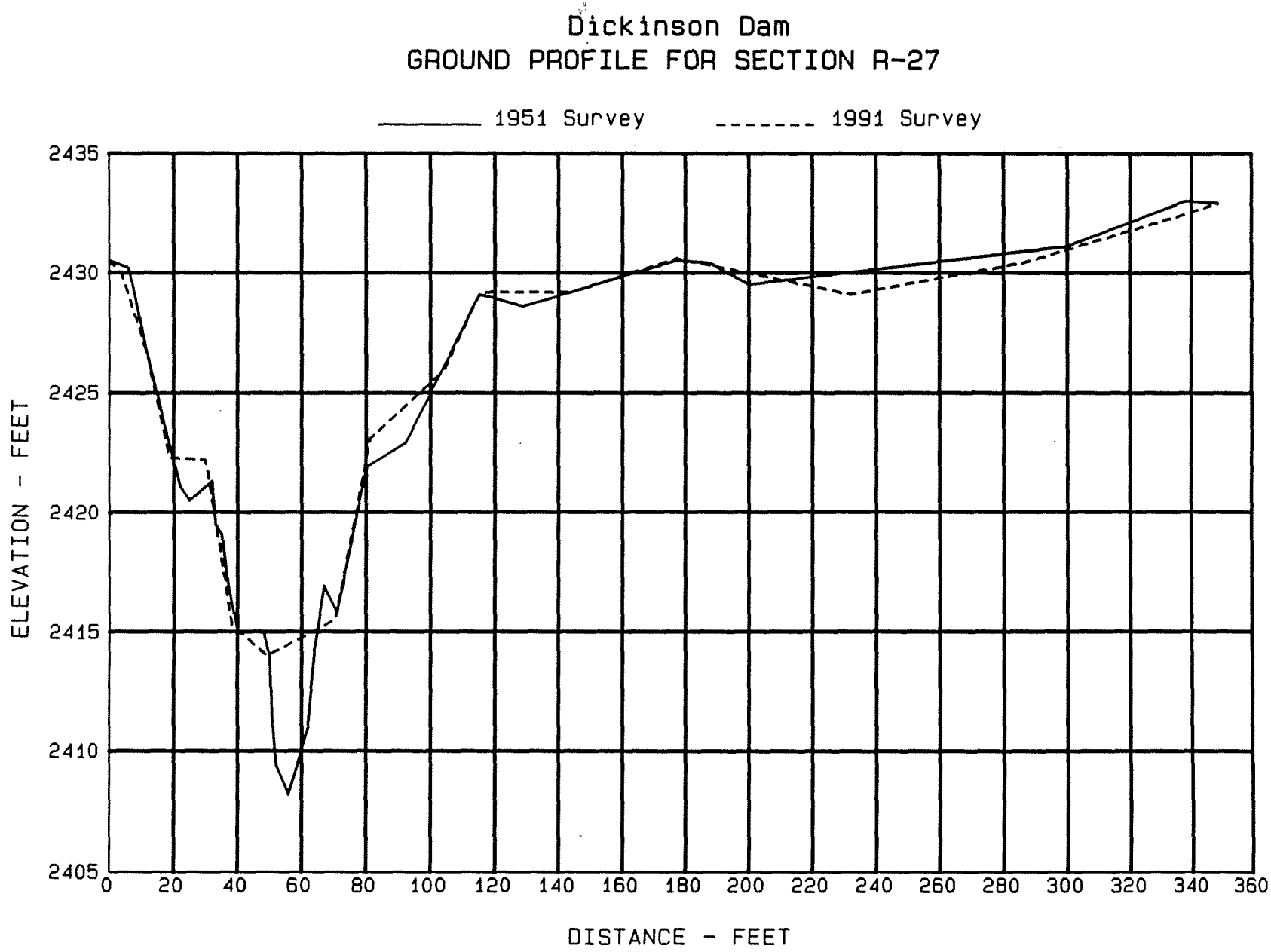


Figure 31. - Dickinson Dam ground profile for section R-27.

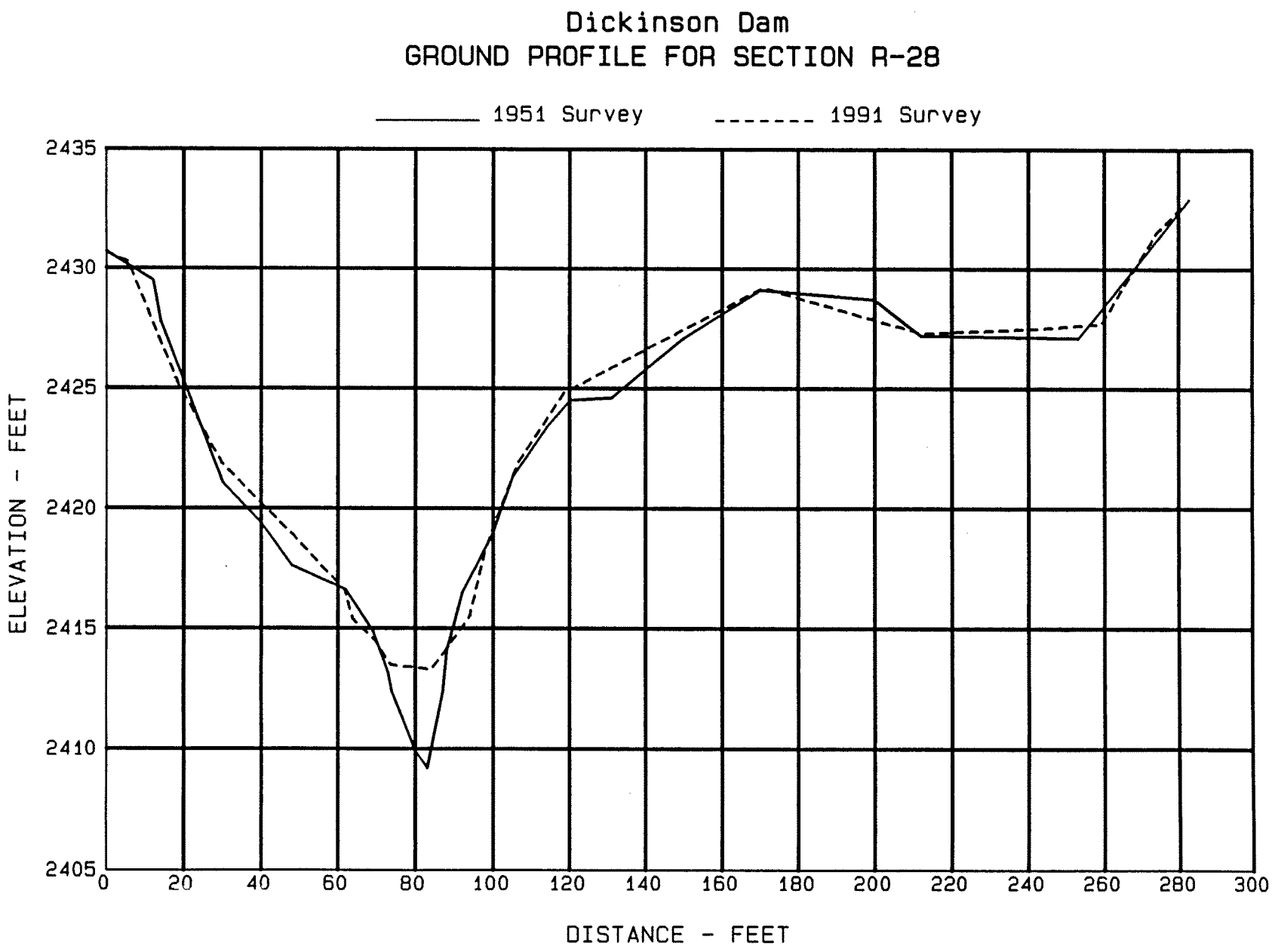


Figure 32. - Dickinson Dam ground profile for section R-28.

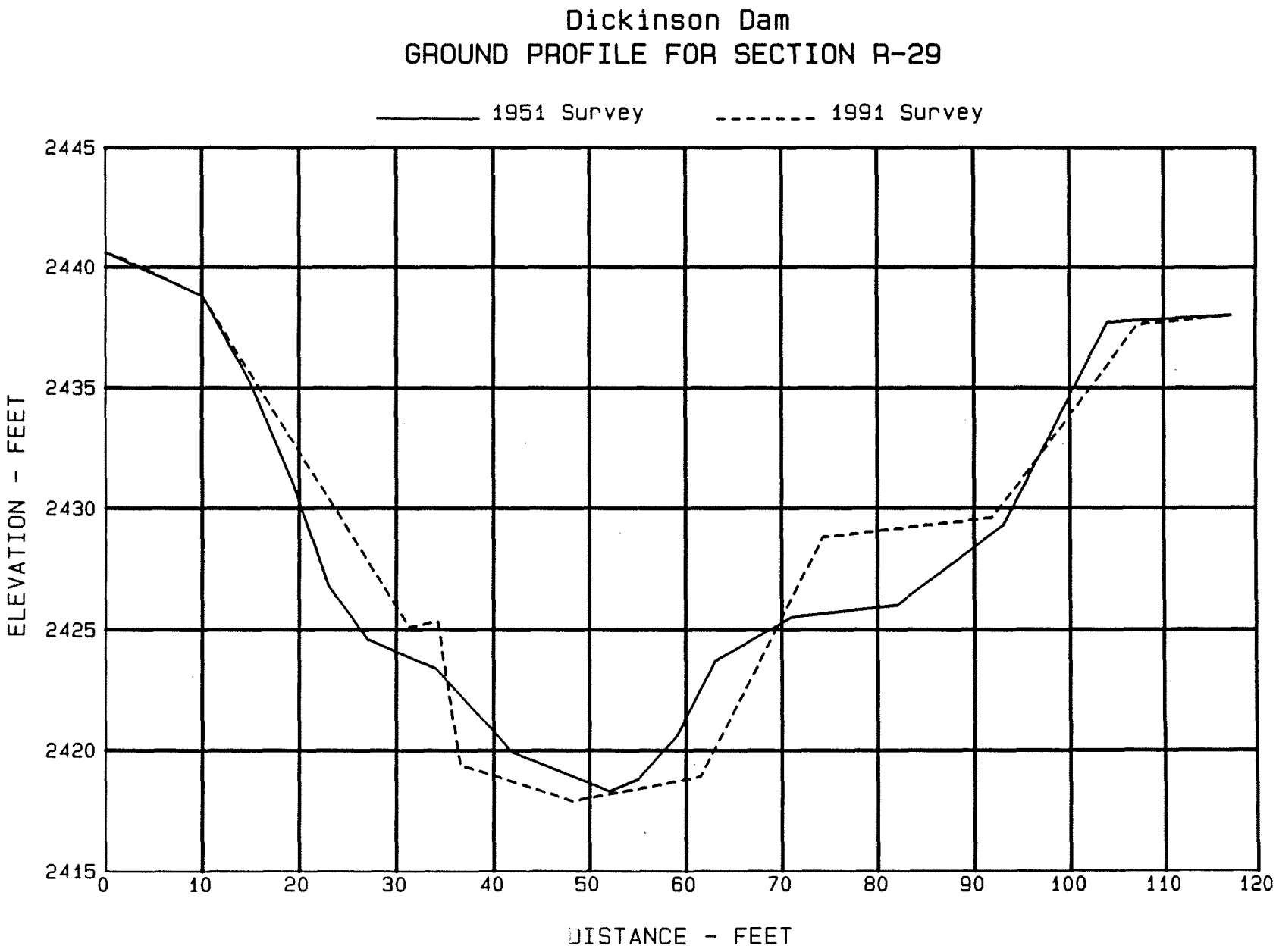


Figure 33. - Dickinson Dam ground profile for section R-29.

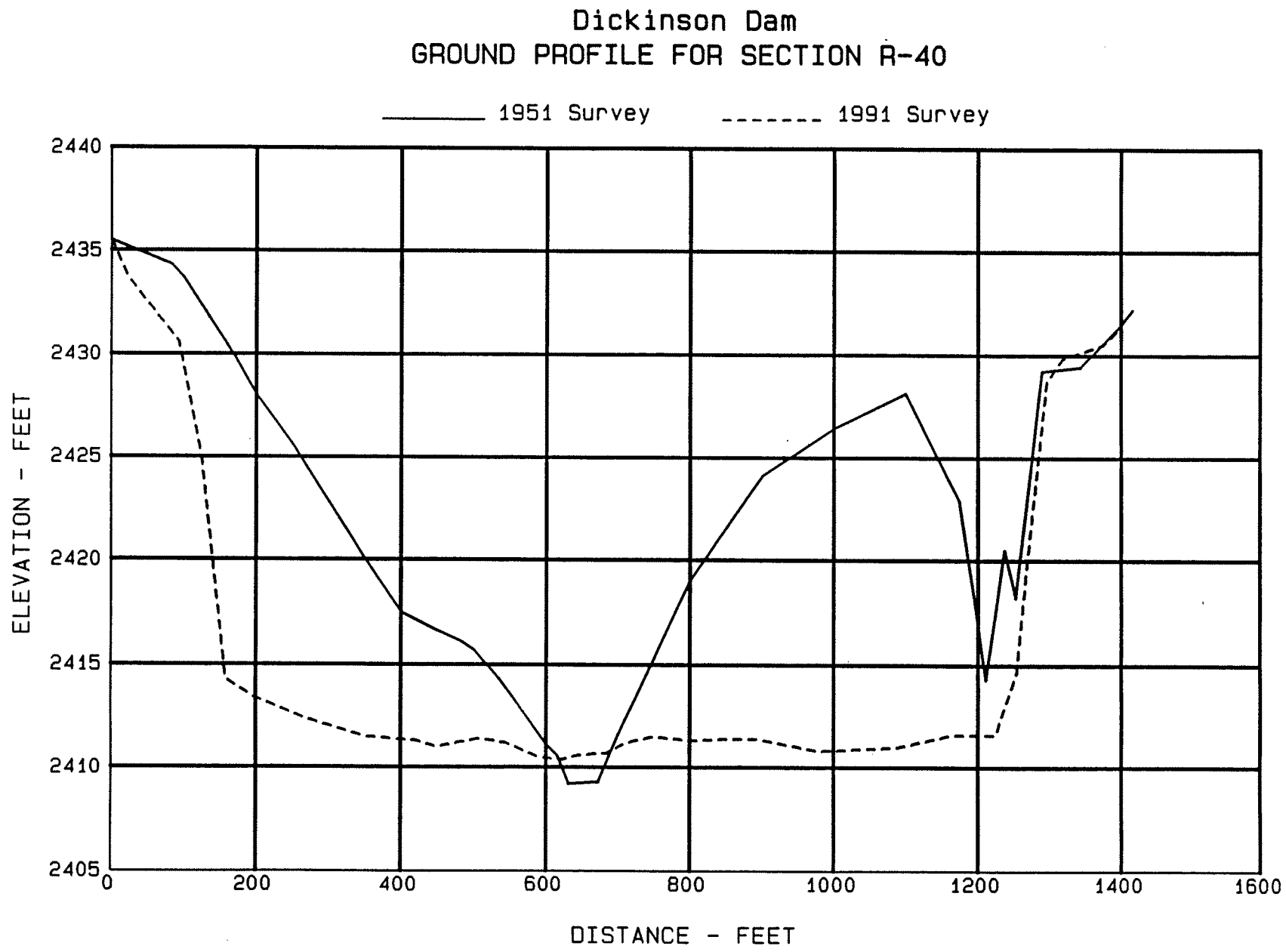


Figure 34. - Dickinson Dam ground profile for section R-40.

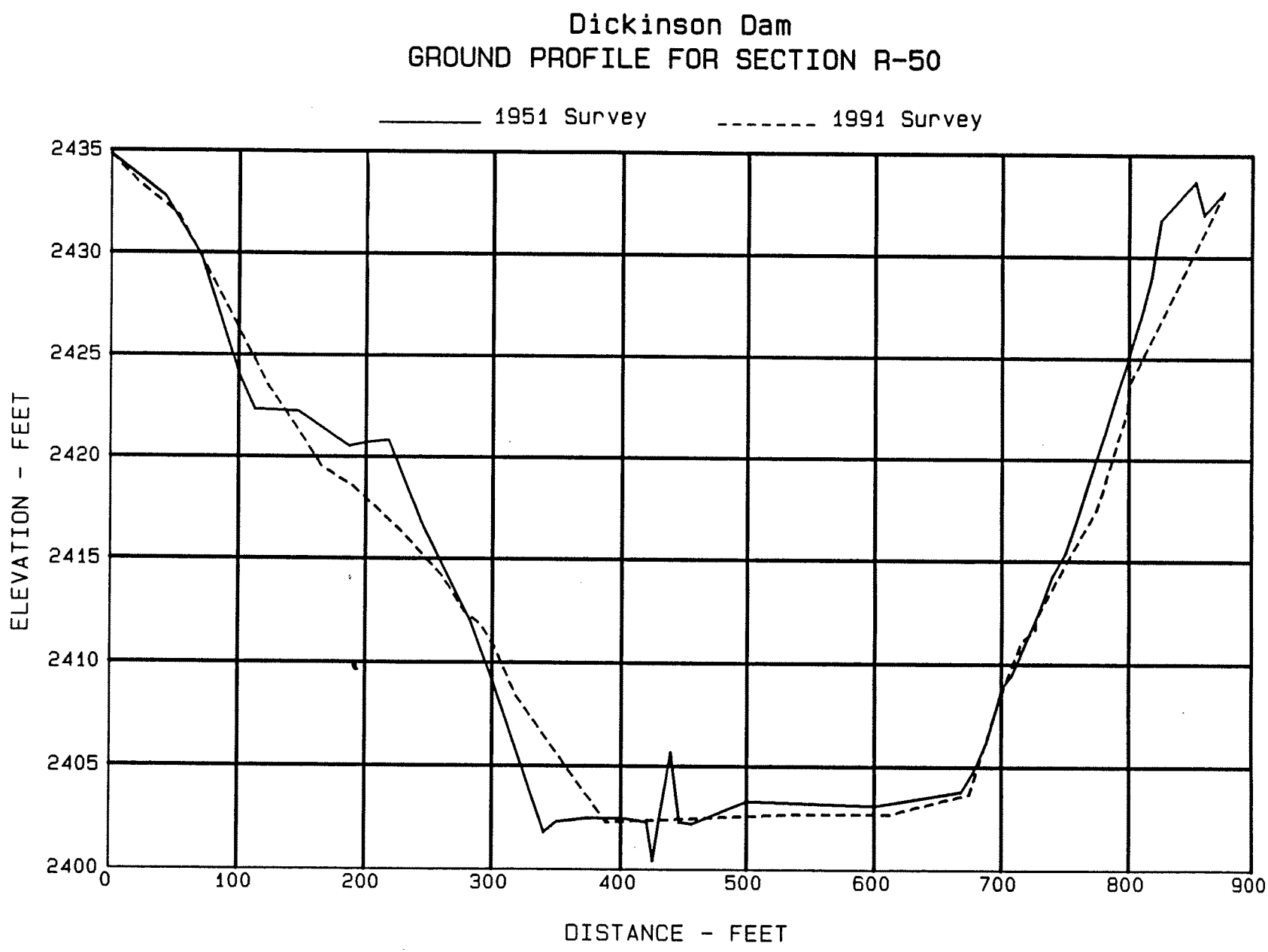


Figure 35. - Dickinson Dam ground profile for section R-50.

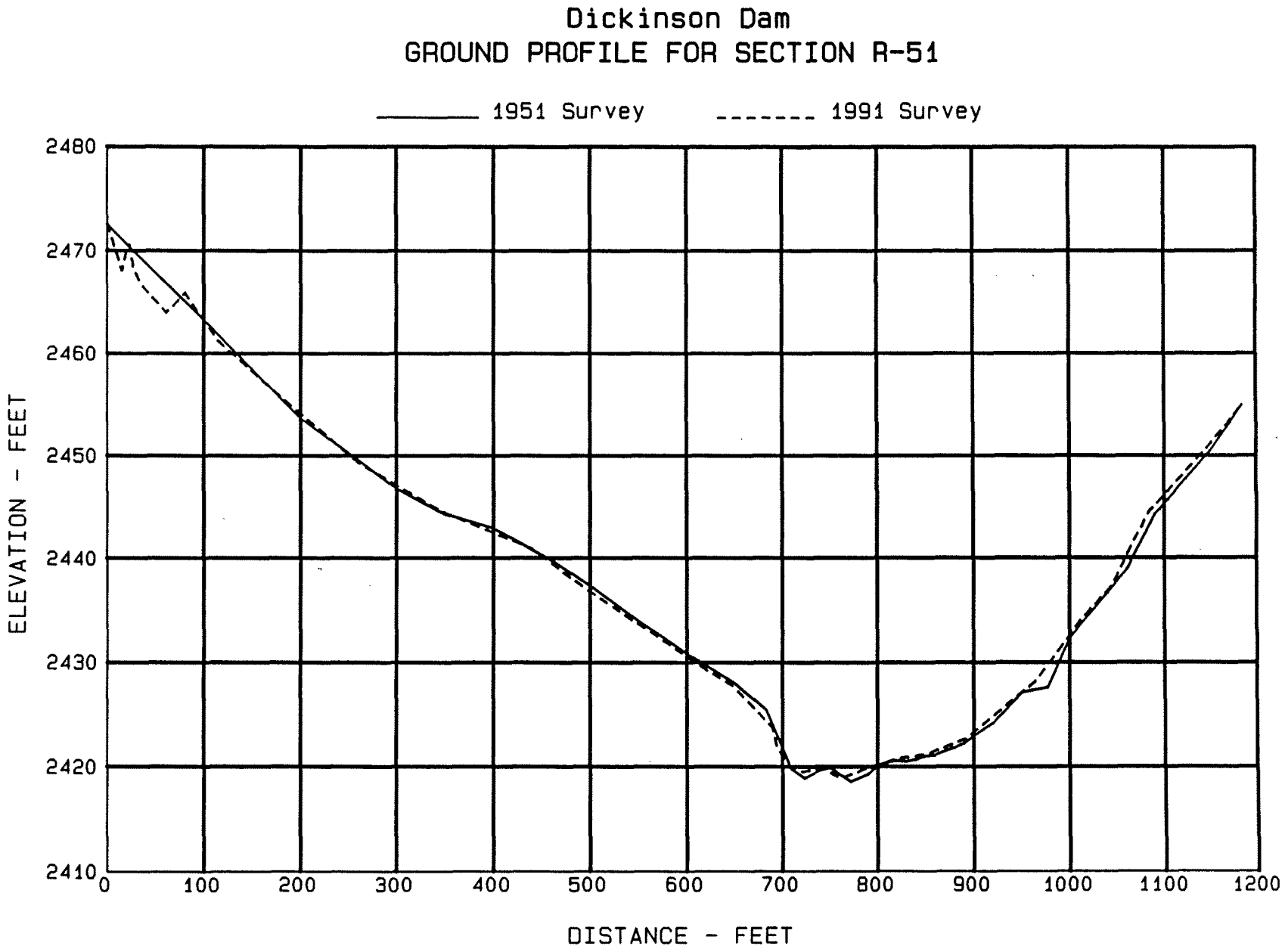


Figure 36. - Dickinson Dam ground profile for section R-51.

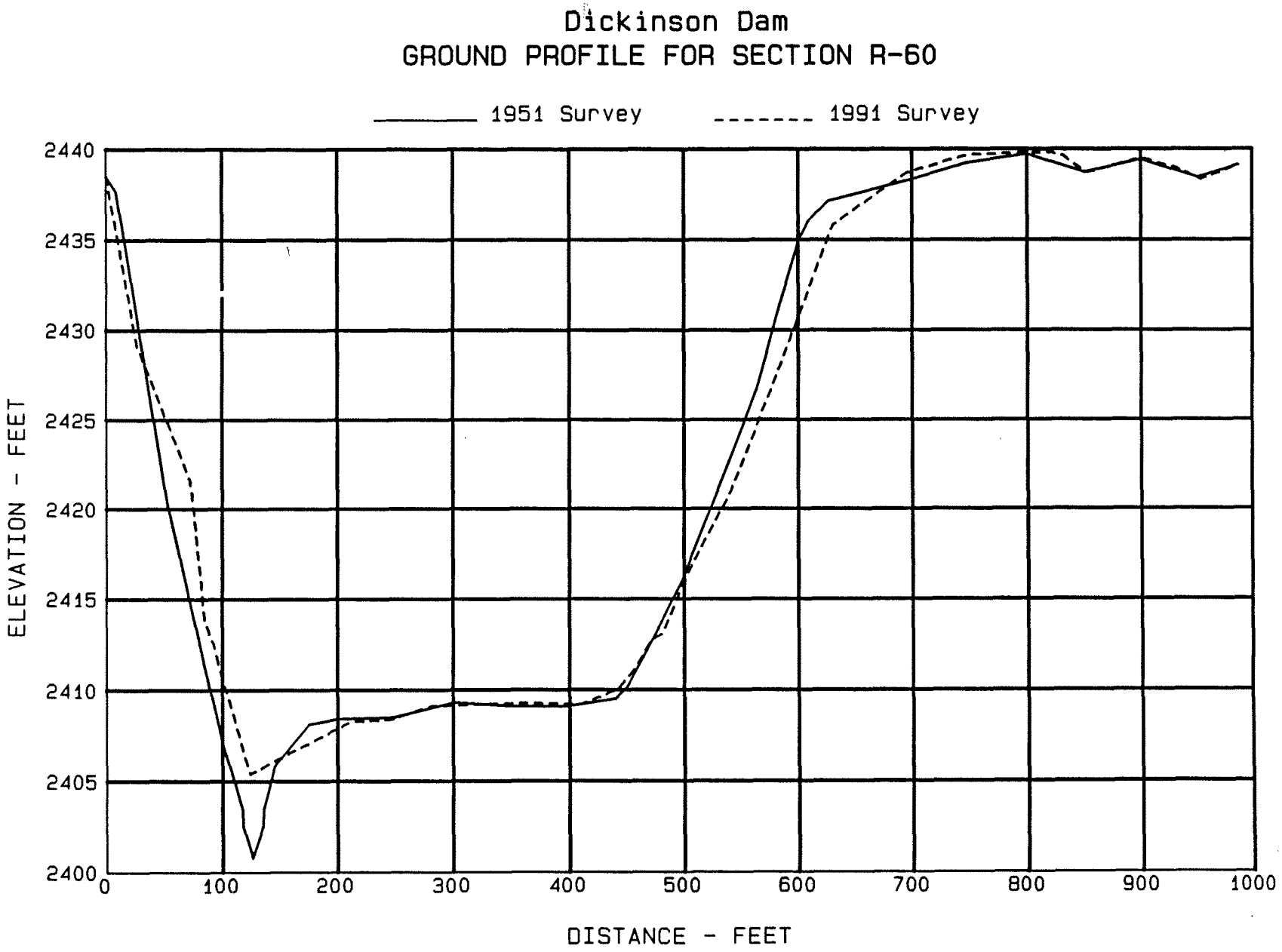


Figure 37. - Dickinson Dam ground profile for section R-60.

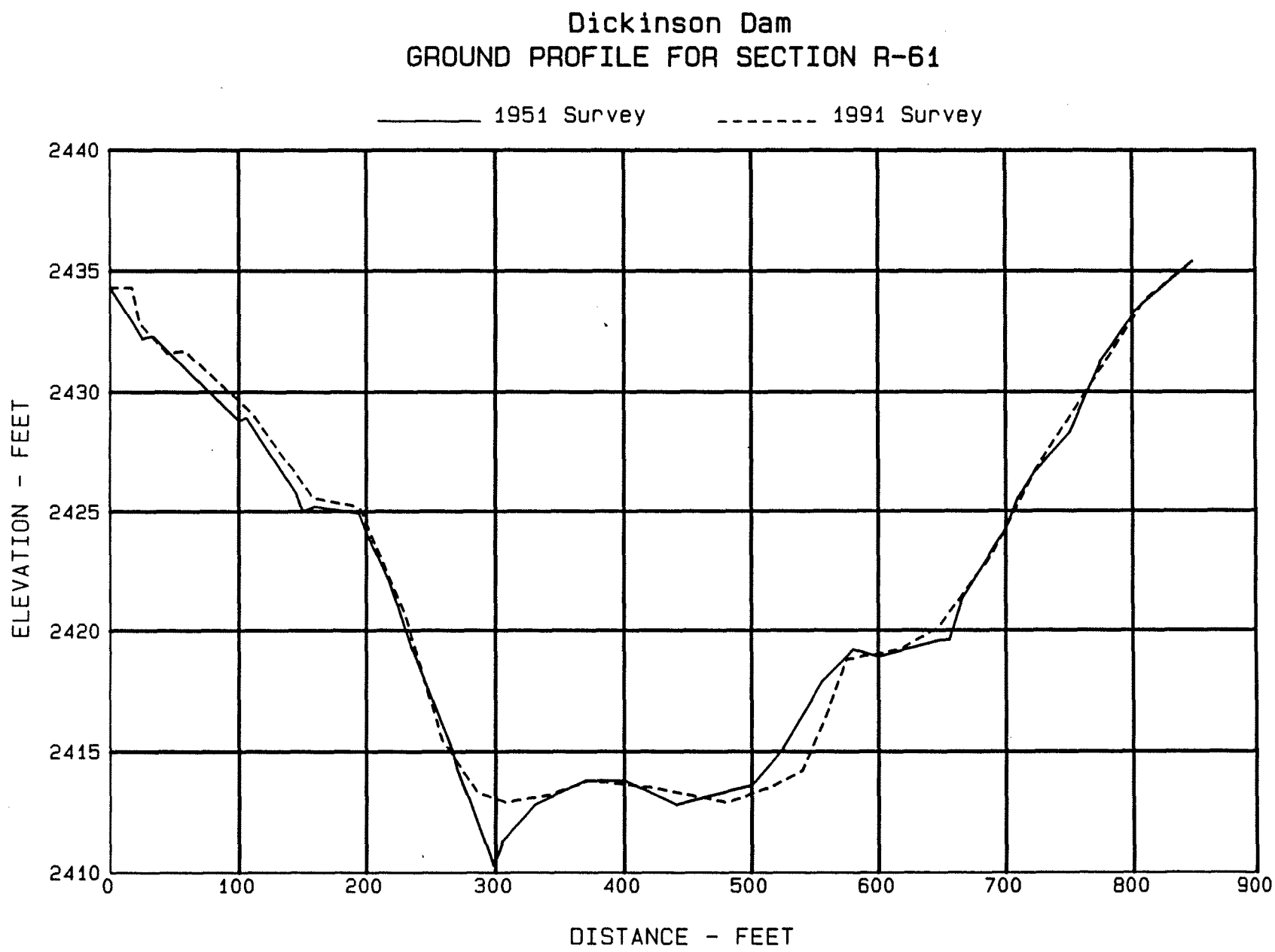


Figure 38. - Dickinson Dam ground profile for section R-61.

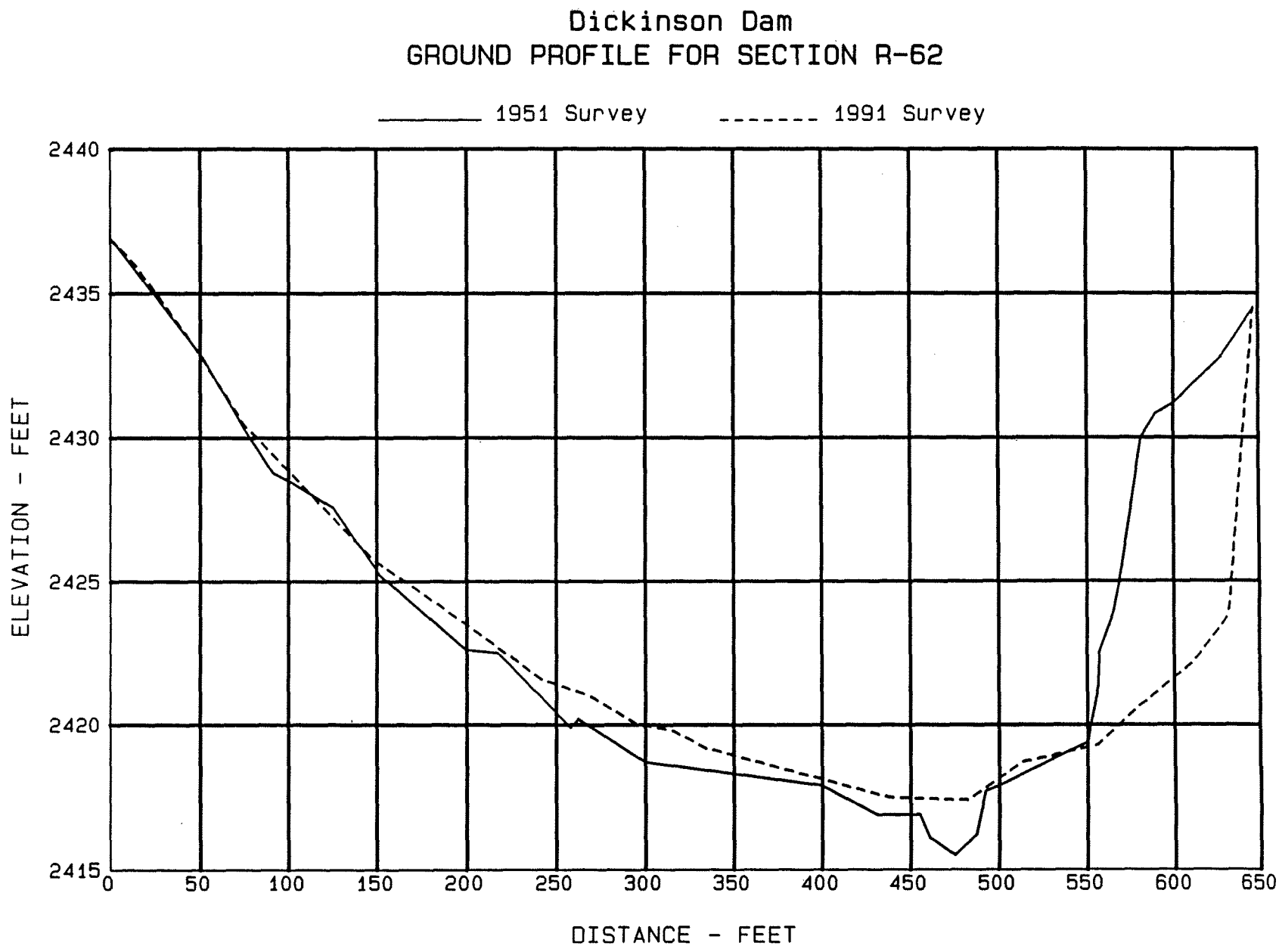


Figure 39. - Dickinson Dam ground profile for section R-62.

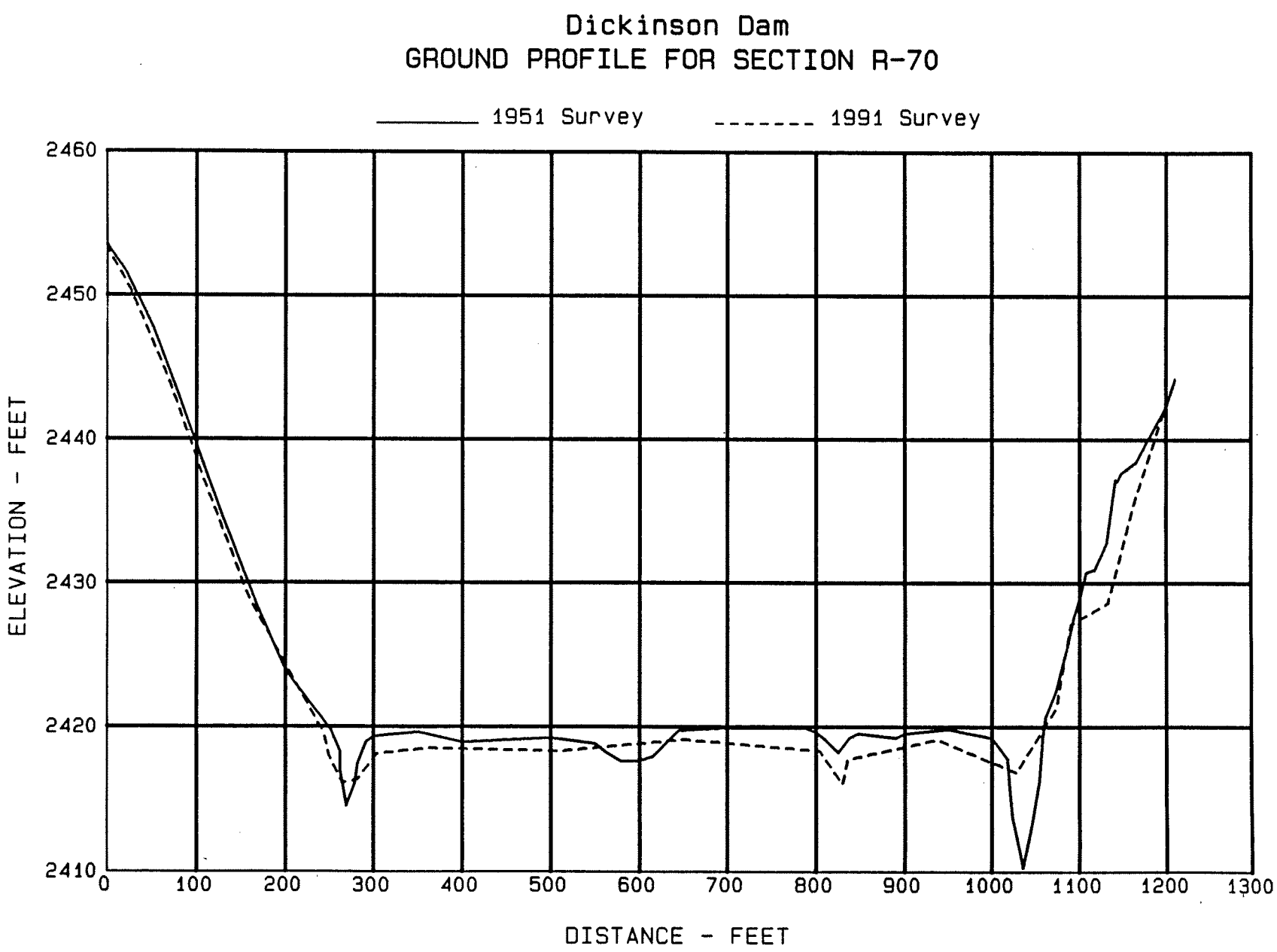


Figure 40. - Dickinson Dam ground profile for section R-70.

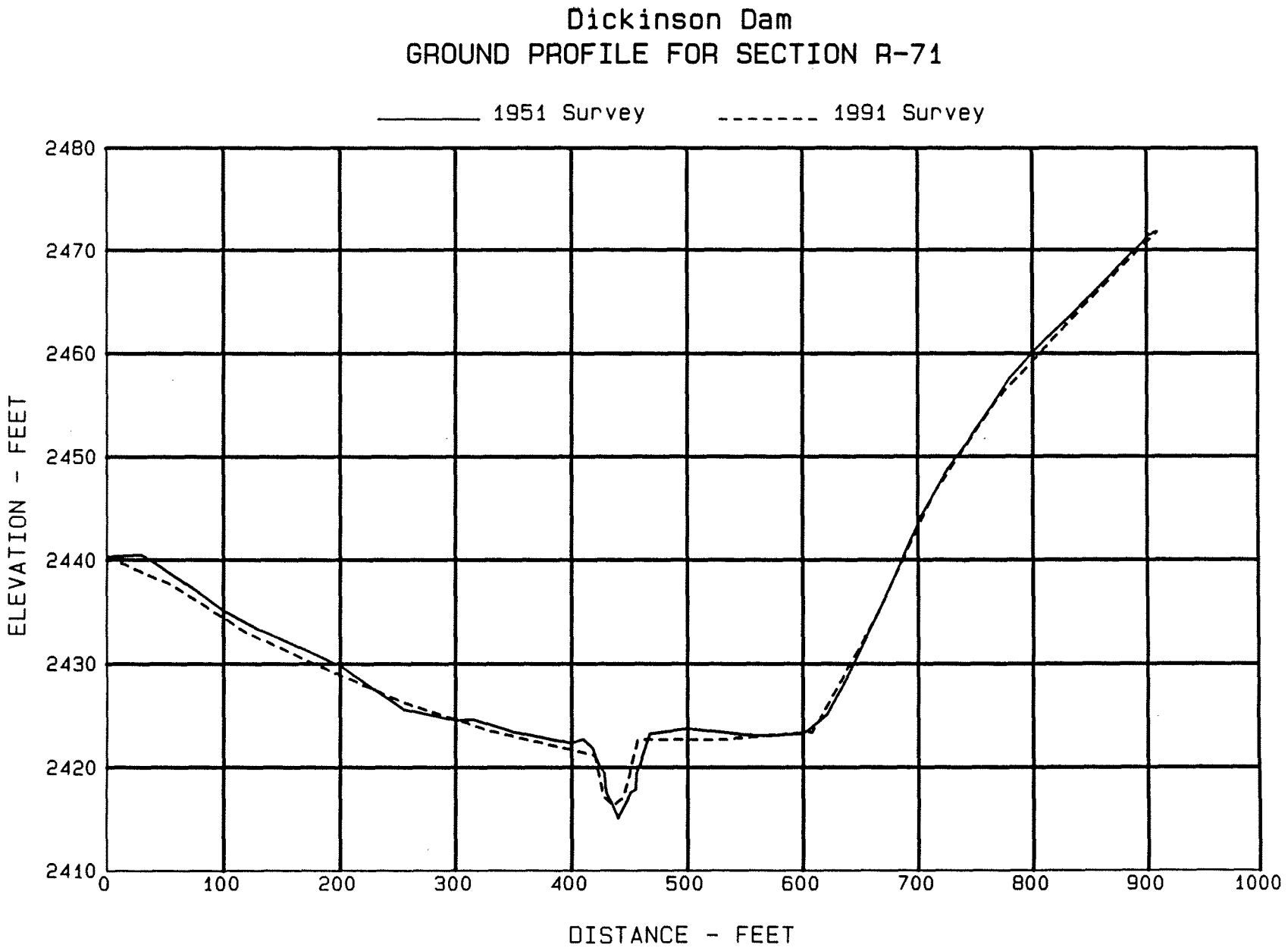


Figure 41. - Dickinson Dam ground profile for section R-71.

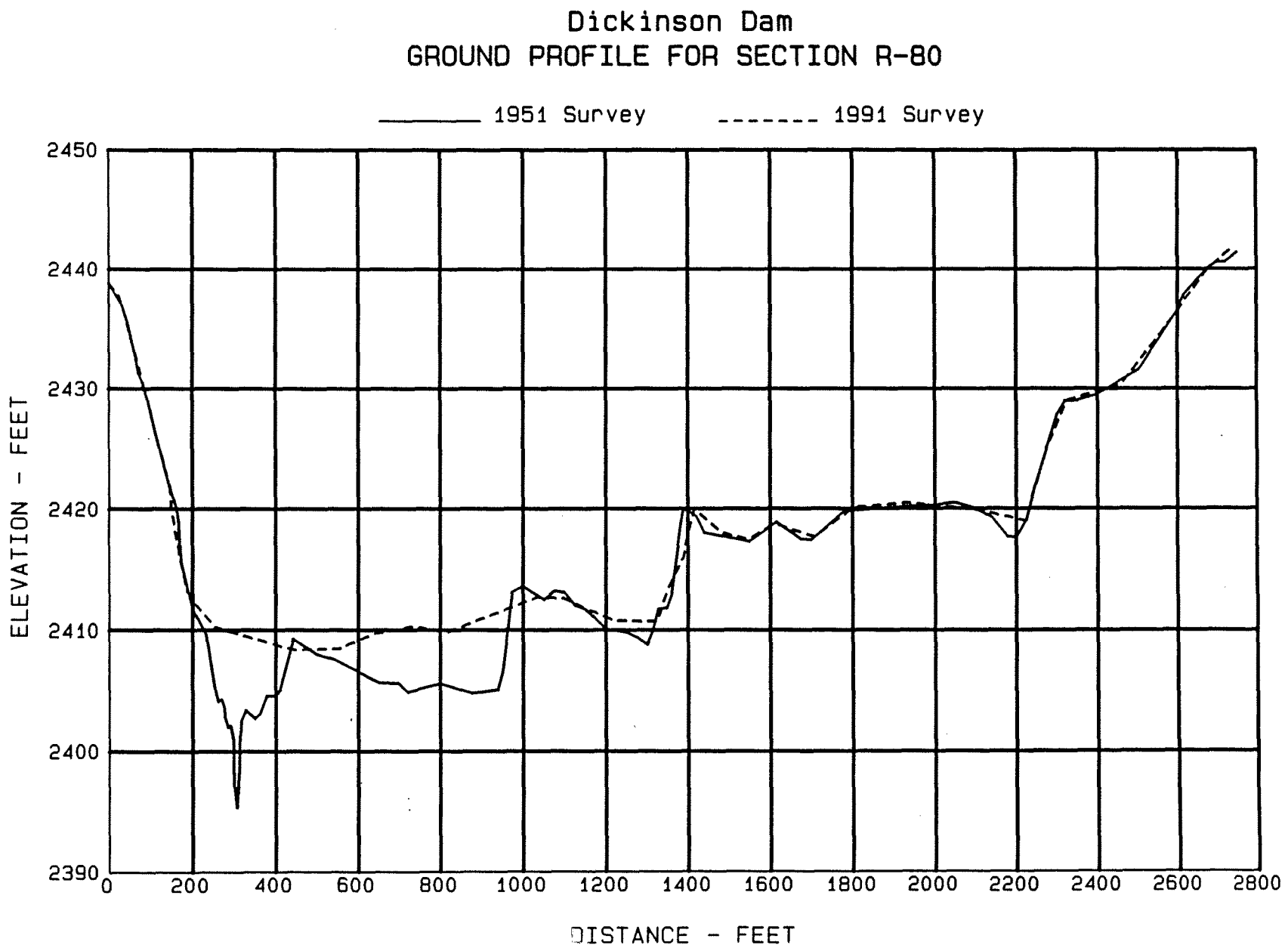


Figure 42. - Dickinson Dam ground profile for section R-80.

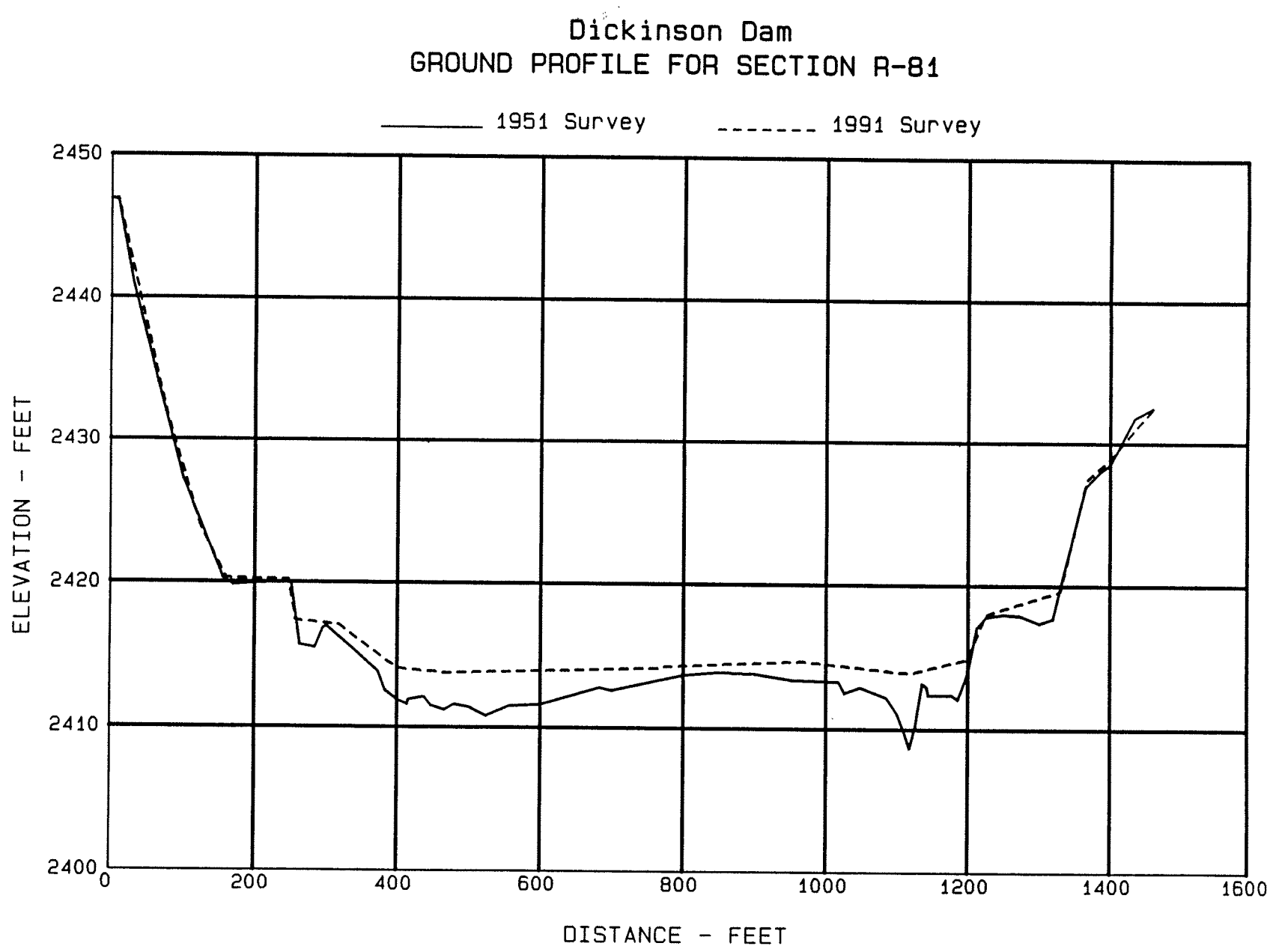


Figure 43. - Dickinson Dam ground profile for section R-81.

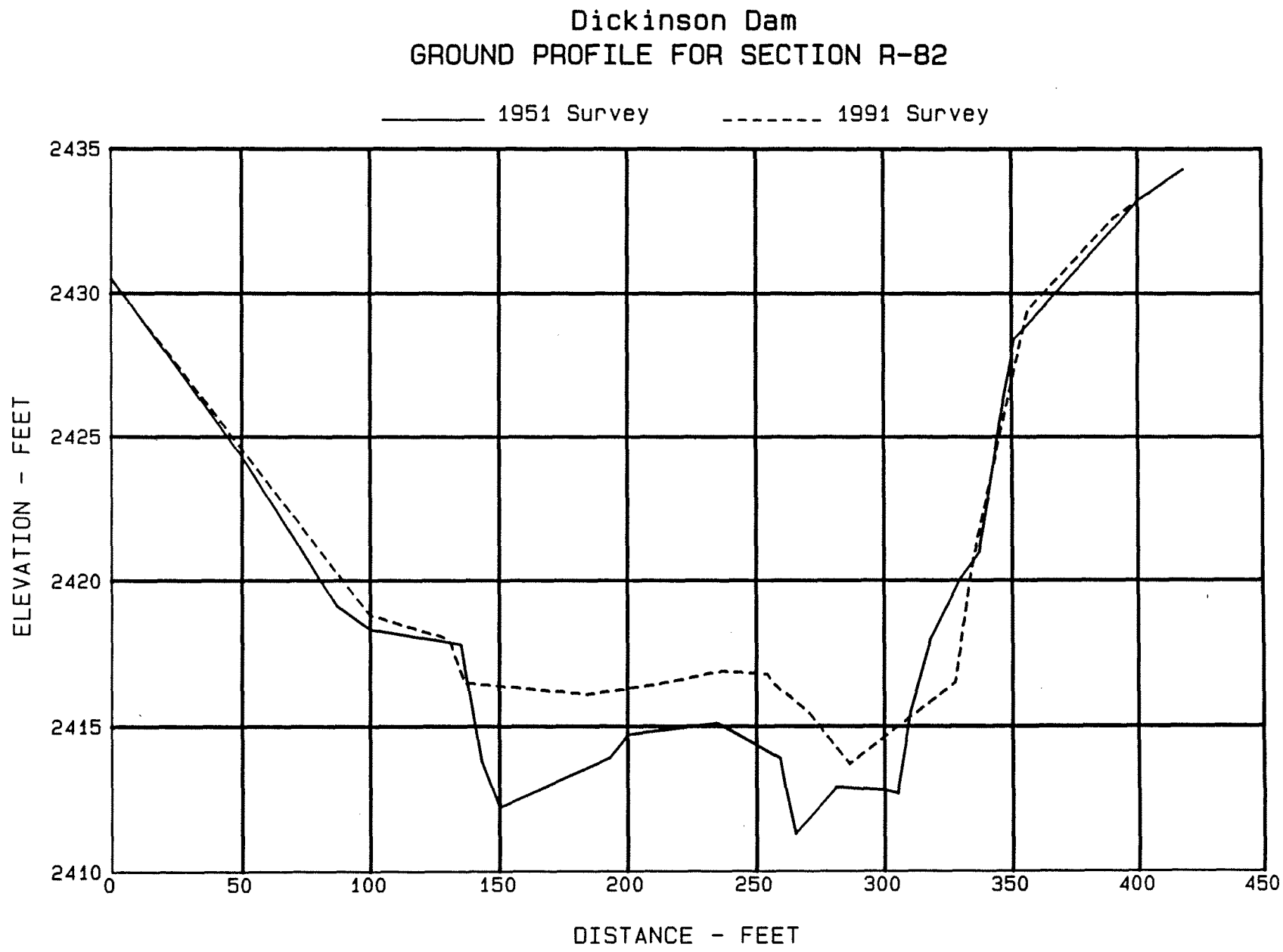


Figure 44. - Dickinson Dam ground profile for section R-82.

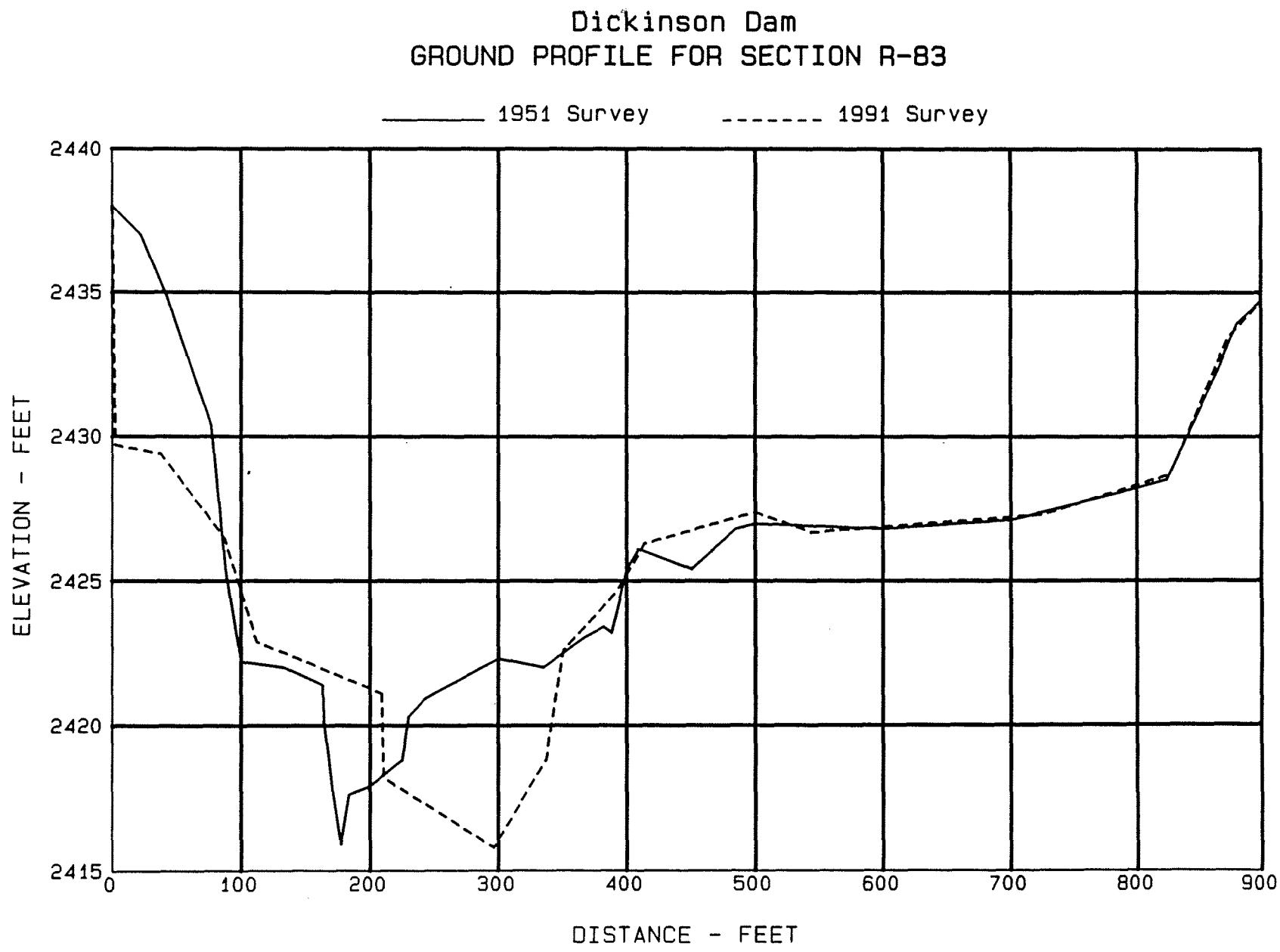


Figure 45. - Dickinson Dam ground profile for section R-83.

Mission

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American Public.