SEDIMENTATION IN WHITEWATER LAKE, UNION COUNTY, EAST-CENTRAL INDIANA, 1959-88

By Danny E. Renn

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CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
acre	0.4047	hectare
acre-foot (acre-ft)	1.233	cubic meter
cubic foot (ft^3)	0.02832	cubic meter
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
cubic yard (yd^3)	0.7646	cubic meter
foot (ft)	0.3048	meter
gallon (gal)	3.785	liter
gallon per day (gal/d)	0.003785	cubic meter per day
gallon per minute (gal/min)	0.06309	liter per second
inch (in.)	2.54	centimeter
mile (mi)	1.609	kilometer
square foot (ft^2)	0.09290	square meter
square mile (mi^2)	2.59	square kilometer

Sea Level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929--a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

SEDIMENTATION IN WHITEWATER LAKE, UNION COUNTY, EAST-CENTRAL INDIANA, 1959-88

By **Danny E. Renn**

ABSTRACT

Sedimentation has had little effect on the storage capacity or surface area of Whitewater Lake. The lake was constructed by damming Silver Creek in 1949 and was dredged during 1978-81 and 1984-88. At the dam, the drainage area of Silver Creek is 19.2 square miles. Locations where the largest amount of sediment has accumulated for the 29-year period 1959-88 are in the upper part of the lake where Silver Creek enters. In general, except for the upper part of the lake, there has been little sediment accumulation in most of the lake. The surface area of the lake was 7,580,000 square feet (174 acres) in 1959 and 6,590,000 square feet (151 acres) in 1988.

In 1959, the volume of water in Whitewater Lake was 138,000,000 cubic feet; in 1988, the volume was 132,000,000 cubic feet. The amount of sediment that accumulated in the lake from 1959-88 was 6,000,000 cubic feet. In 1988, the volume of water remaining in the lake was 95.6 percent of the 1959 volume, and 4.4 percent of the 1959 lake volume had filled with sediment.

The total amount of sediment that accumulated in Whitewater Lake from 1959-88 (10,350,000 cubic feet) was determined by adding the amount of sediment that accumulated in the lake from 1959-88 (6,000,000 cubic feet) and the amount of sediment that was dredged from the lake during 1978-81 and 1984-88 (4,350,000 cubic feet). Thus, the annual rate of sediment accumulation in the lake from 1959-88 was 357,000 cubic feet per year.

Potential decreases in the storage capacity of Whitewater Lake based on whether dredging is continued or discontinued were estimated for the 29-year period 1989-2017. If dredging is continued, the potential for future decreases in the storage capacity of the lake is small. If dredging is discontinued, the volume of water in the lake in 2017 is estimated to be 88.2 percent of the 1959 volume; 11.8 percent of the 1959 volume of the lake would be filled with sediment.

INTRODUCTION

Whitewater Lake is located in Whitewater Memorial State Park, near the town of Liberty, in Union County, east-central Indiana (fig. 1). The lake is used for recreation and is managed by the Indiana Department of Natural Resources. The lake was created in 1949 and was dredged during 1978-81 and 1984-88.

Accumulation of sediment in Whitewater Lake can decrease its storage capacity and can affect recreational use. Therefore, information about the locations and amount of sediment accumulation, the total amount of sediment accumulation (determined by adding the amount of accumulated sediment and the amount of dredged sediment), the annual rate of sediment accumulation, and estimated decreases in

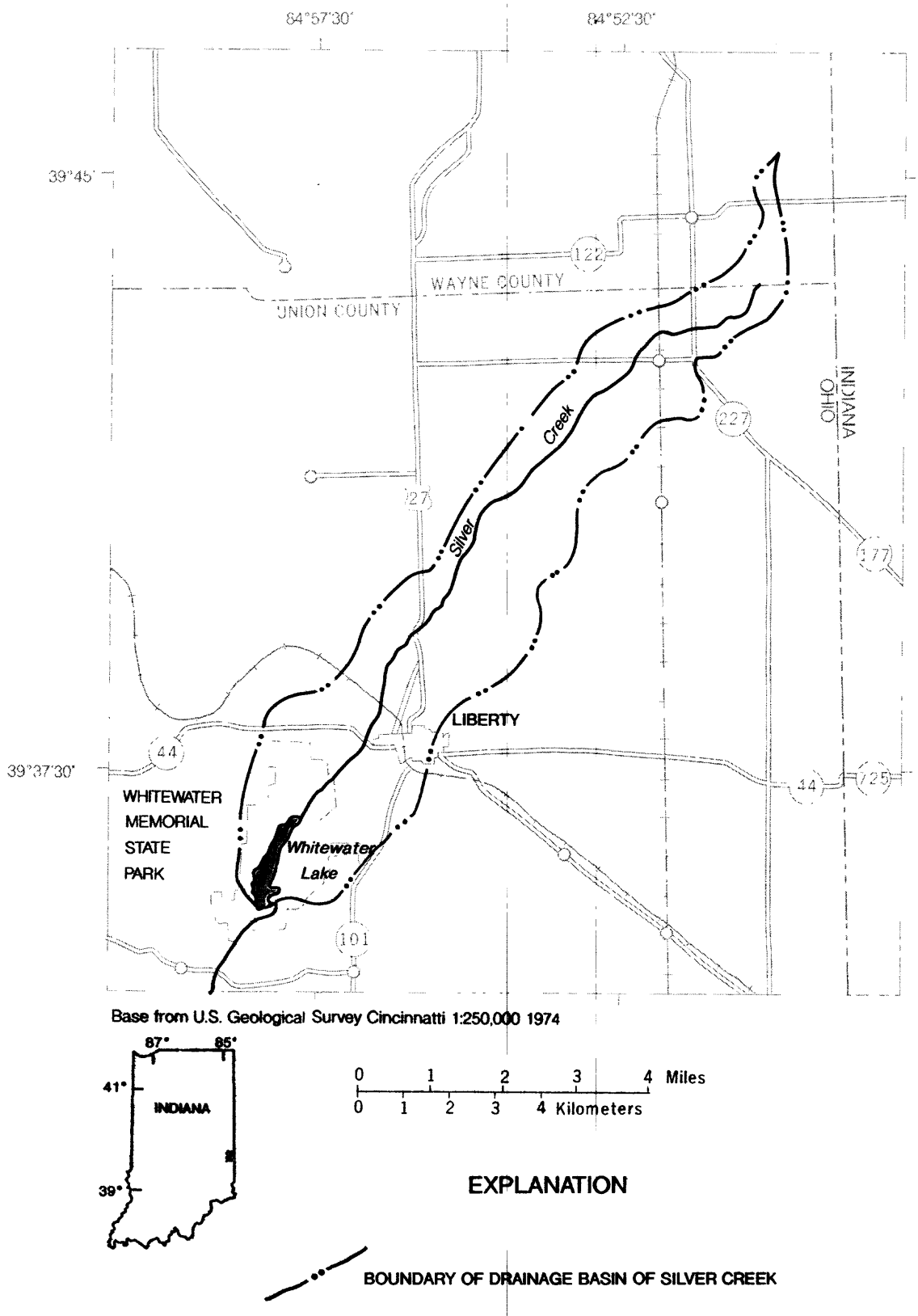


Figure 1.-- Location of Whitewater Lake and drainage basin of Silver Creek upstream of dam.

the storage capacity of the lake based on whether dredging is continued or discontinued is needed to effectively manage the resources of the lake. In 1987, the U.S. Geological Survey, in cooperation with the Indiana Department of Natural Resources, began a study to provide this information.

Purpose and Scope

This report presents information on (1) locations of sediment accumulation in Whitewater Lake for the 29-year period 1959-88; (2) the amount of sediment that accumulated in the lake from 1959-88; (3) the total amount of sediment that accumulated in the lake from 1959-88 (determined by adding the amount of sediment that accumulated in the lake and the amount of sediment that was dredged from the lake); (4) the annual rate of sediment that accumulated; and (5) estimated decreases in the storage capacity of the lake based on whether dredging is continued or discontinued for the 29-year period 1989-2017.

Width, depth, and surface-area data were used to locate areas of sediment accumulation in Whitewater Lake from 1959-88. Depth-contour data were used to determine the amount of sediment that accumulated in the lake from 1959-88. The amount of sediment that accumulated in the lake and the amount of sediment that was dredged from the lake were used to determine the total amount of sediment that accumulated in the lake from 1959-88 and the annual rate of sediment that accumulated. This information also was used to estimate decreases in the storage capacity of the lake based on whether dredging is continued or discontinued from 1989-2017.

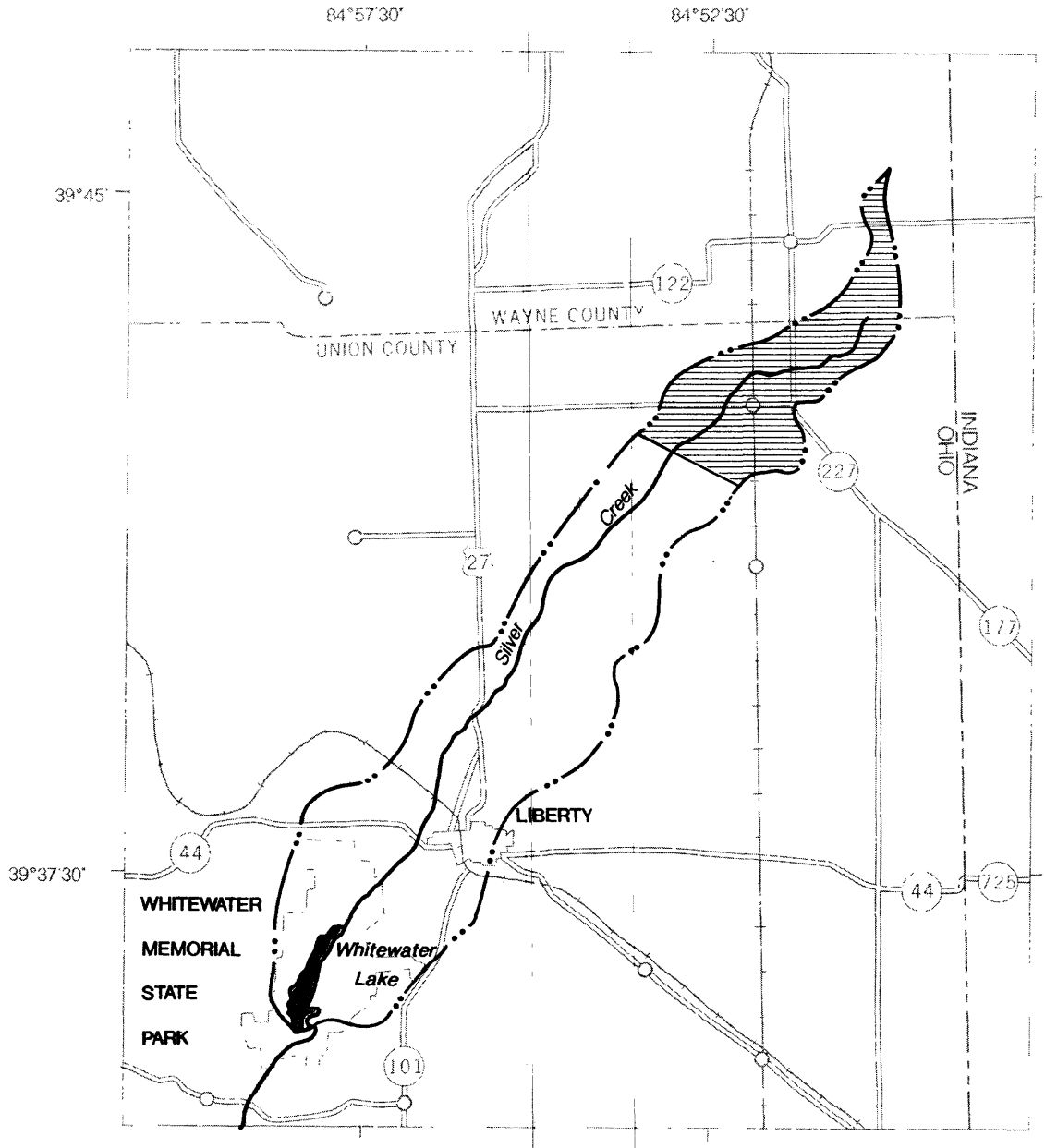
Physical Setting

Whitewater Lake was created by construction of an earthen dam across Silver Creek in 1949 (Jay Johnson, Indiana Department of Natural Resources, oral commun., 1987). The water level of the lake is controlled by a concrete spillway. The height of the spillway is approximately 821 ft above sea level. The lake receives drainage from Silver Creek. Most of the drainage basin of Silver Creek is in Union County, but the most upstream part is in southeastern Wayne County (fig. 1). At the dam, the drainage area of Silver Creek is 19.2 mi^2. The length of Silver Creek from where it enters the lake to where it becomes intermittent is 11.1 mi.

Geology

The drainage basin of Silver Creek upstream from the dam of Whitewater Lake is underlain primarily by limestones and shales of Ordovician age (fig. 2) (Gray and others, 1972); however, the extreme northeastern part of the basin is underlain by limestones, dolomites, and shales of Silurian age (fig. 2) (Gray and others, 1972). The Ordovician and Silurian bedrock have little, if any, slope. The bedrock is overlain by thick unconsolidated glacial-till deposits of Holocene age (Gray and others, 1972). The average thickness of the till is 50 ft in the lower part of the basin and 100 ft in the upper part of the basin (Indiana Department of Natural Resources, 1988, p. 12). The till is composed of clay- to gravel-size deposits that can contain sand and gravel lenses up to 10 ft thick (Indiana Department of Natural Resources, 1988, p. 15). In parts of the basin, generally in the upland areas, the till is overlain by thin deposits of loess.

The drainage basin of Silver Creek is in the Dearborn Upland physiographic unit (Schneider, 1966, p. 41). In the drainage basin, the channel of Silver Creek and its tributaries are entrenched with steep slopes rising to rolling uplands. This topography is characteristic of the Dearborn Upland unit. A distinctive feature of the drainage basin of Silver Creek is that the shape of the drainage basin is long, straight, and



EXPLANATION

ORDOVICIAN ROCKS

SILURIAN ROCKS

BOUNDARY OF DRAINAGE BASIN OF SILVER CREEK

Figure 2.-- Location of Ordovician and Silurian rocks in drainage basin of Silver Creek (modified from Gray and others, 1972).

narrow and the tributaries to Silver Creek are generally perpendicular to the main channel. In the upper part of the drainage basin, the maximum altitude of the land surface is approximately 1,140 ft above sea level; in the lower part, the maximum altitude is approximately 950 ft above sea level. The most upstream channel of Silver Creek has an altitude of approximately 1,130 ft above sea level; the most downstream channel has an altitude of approximately 750 ft above sea level.

Soils

The soils of the drainage basin of Silver Creek are grouped into five major soil associations (fig. 3): Fincastle and Crosby, Genesee and Eel, Russell and Hennepin, Russell and Miami, and Xenia and Celina (Alfred and others, 1960). The Fincastle and Crosby soils are nearly level, somewhat poorly drained, have a slow infiltration rate, a slow to medium runoff potential, and a slight to moderate erosion potential. The Genesee and Eel soils are located in flood plains, are nearly level, poorly drained, have a moderate infiltration rate, a ponded to slow runoff potential, and moderate to no erosion potential. The Russell and Hennepin and the Russell and Miami soils range from sloping to steep, are well drained, have a slow to moderate infiltration rate, a slow to very rapid runoff potential, and a moderate to very severe erosion potential. The Xenia and Celina soils range from nearly level to gently sloping, are moderately well drained, have a moderate infiltration rate, a slow to rapid runoff potential, and a slight to severe erosion potential. All soils are formed in loess and till.

Land Use

A visual inspection of the drainage basin of Silver Creek made during 1988 indicates that land use within the basin is primarily agricultural, including row crop and pasture, with some forest. Generally, the agricultural areas are located in upland areas and the forested areas are located along stream channels. The major crops in the basin are corn, soybeans, and winter wheat, which usually are tilled conventionally, and the major livestock raised are hogs, poultry, and beef cattle (Indiana Department of Natural Resources, 1988, p. 7). The town of Liberty is the only municipality in the basin and had a population of 1,840 in 1980. The basin includes a municipal point-source discharge at Liberty, one operating sanitary landfill, one closed sanitary landfill, two confined feedlots, and one salt-storage area (State of Indiana, Water-quality-management planning maps, region 9).

Water Use and Availability

Silver Creek does not flow continuously. The 7-day, 10-year low flow[1], for Silver Creek near Liberty (drainage area of 9.67 mi^2) is zero; the average flow for 1960-67 was 11.1 ft^3/s (Indiana Department of Natural Resources, 1988, p. 25). The average flow per square mile in the drainage basin of Silver Creek is 1.15 ft^3/s. The average flow per square mile in the drainage basin of the Whitewater River, in which Silver Creek is located, is 1.11 ft^3/s. The ground-water contribution in the drainage basin of the Whitewater River ranges from 43 to 67 percent, which indicates a good connection between the surface- and ground-water systems (Indiana Department of Natural Resources, 1988, p. 33).

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[1]7-day, 10-year low flow is the discharge at the 10-year recurrence interval taken from a frequency curve of annual values of the lowest mean discharge for 7 consecutive days (the 7-day flow).

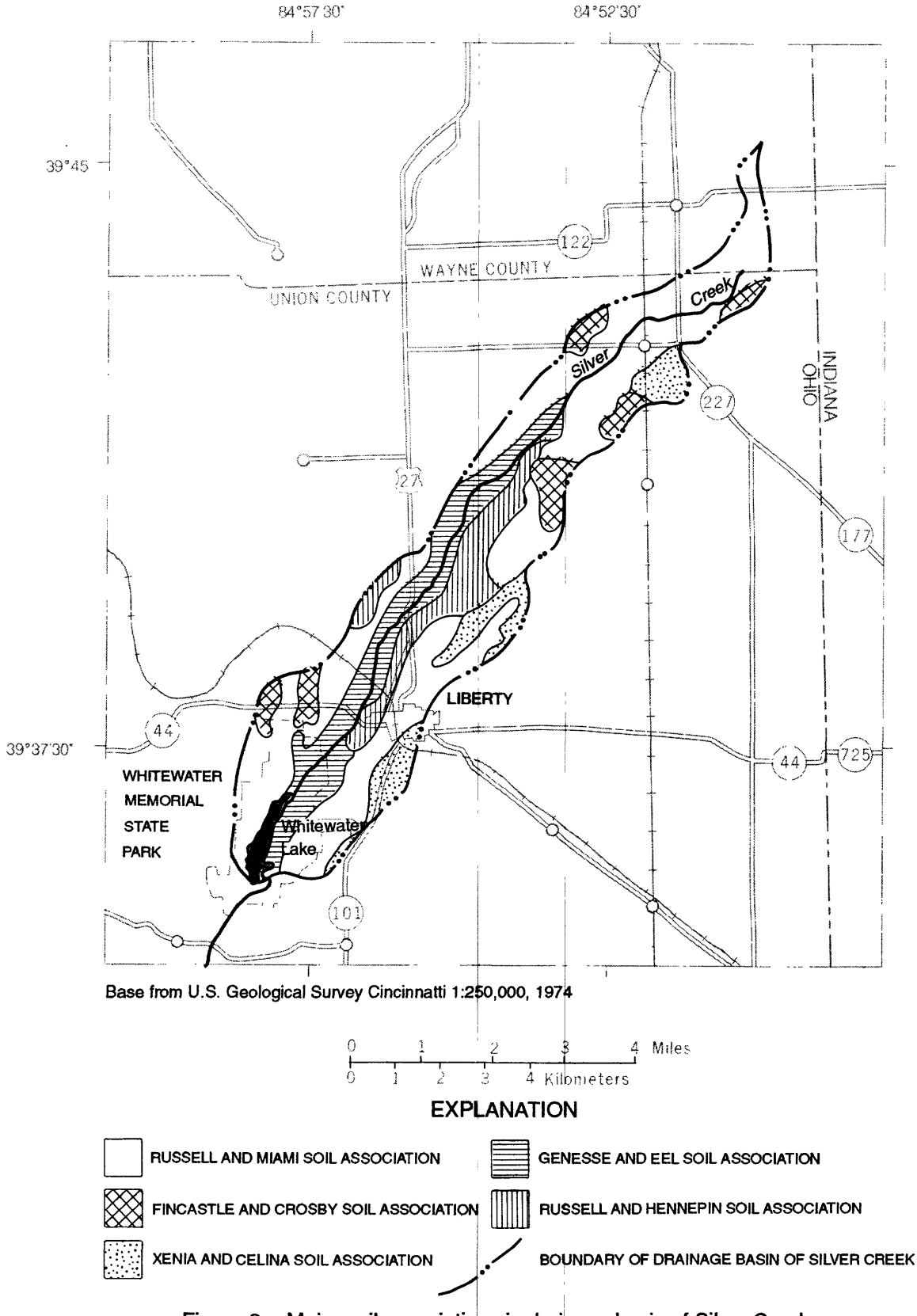


Figure 3.-- Major soil associations in drainage basin of Silver Creek (modified from Alfred and others, 1960).

Ground water is the sole source of water for domestic and agricultural use in the drainage basin of Silver Creek. Most wells are located in the unconsolidated glacial-till, but some wells are located in the Ordovician and Silurian bedrock. Production from wells located in the glacial-till ranges from 0 to 60 gal/min, with an average of 2 to 3 gal/min; production from wells located in the bedrock ranges from 0 to 50 gal/min, with an average of 2 to 8 gal/min; dry holes are common (Indiana Department of Natural Resources, 1988, pl. 3). The town of Liberty uses ground water as its sole source of municipal water supply. The wells for the town of Liberty are located in the drainage basin of the East Fork Whitewater River, outside the drainage basin of Silver Creek. In 1988, water withdrawals for the town were approximately 200,000 gal/d (Fielding Tipton, Liberty Water Department, oral commun., 1987).

METHODS OF INVESTIGATION

Width, depth, surface-area, and depth-contour data for Whitewater Lake for 1959 were obtained from a depth-contour map produced from data collected during the summer of 1959 (Indiana Department of Conservation, 1959). A revised map scale of 1 in. equals 375 ft was used to determine transect widths and lake surface-area. The original 1959 fathometer profiles were obtained to verify the locations of the depth contours. The 1959 map provided width and depth data for 52 transects (A through ZZ; fig. 4). Along each transect, a depth was determined for each contour interval and, for each depth, a corresponding width was determined by measuring the distance from the beginning of the transect to the location of the depth value. Widths were determined to the nearest 1 ft, and depths were determined to the nearest 5 ft. During data collection, the lake level was 821 ft above sea level.

Depth data were collected in Whitewater Lake during June 1988 at 52 transects (A through ZZ; fig. 4). During data collection, the lake level was 821 ft above sea level. A fathometer was used to measure depth; however, due to the ongoing dredging operation in the lake, data could not be collected in the area enclosed by transects OO, PP, QQ, and the eastern shoreline. A 1977 aerial photograph of the lake (Indiana Department of Highways, written commun., 1988) was used to determine transect widths and surface area for 1988. A visual inspection of the shoreline of the lake made during June 1988 indicates that, with the exception of a change in the shoreline in the upper part of the lake where Silver Creek enters, the shoreline had changed little from 1977 to 1988. Based on the visual inspection and available information, the lake level in the 1977 photograph was estimated to be 821 ft above sea level. The shoreline in the 1977 photograph was modified to include the change in the shoreline in the upper part of the lake and then used to determine the transect widths and surface area for 1988. Along each transect, a depth was determined for each 1 ft change in the bottom elevation of the lake. For each depth, a corresponding width was determined by measuring the distance from the beginning of the transect to the location of the depth value. Width and depth data were determined to the nearest 1 ft. The width and depth data for 1988 (tables 1-23 in the "Supplemental Data" section at the end of the report) were used to construct a 1988 depth-contour map (fig. 5) with 2-ft contour intervals.

The amount of sediment that was dredged from Whitewater Lake during 1978-81 and 1984-88 were obtained from the property manager of Whitewater Memorial State Park (Merl Gentry, Whitewater Memorial State Park, oral commun., 1988).

SEDIMENTATION IN WHITEWATER LAKE

Areas of sediment accumulation in Whitewater Lake from 1959-88 were identified by use of the transect width and depth data for 1959 and 1988 and the surface-area data for 1959 and 1988. The amount of sediment that accumulated in the lake from 1959-88 was determined from the depth-contour data for 1959 and 1988. The total amount of sediment that accumulated in the lake from 1959-88 was

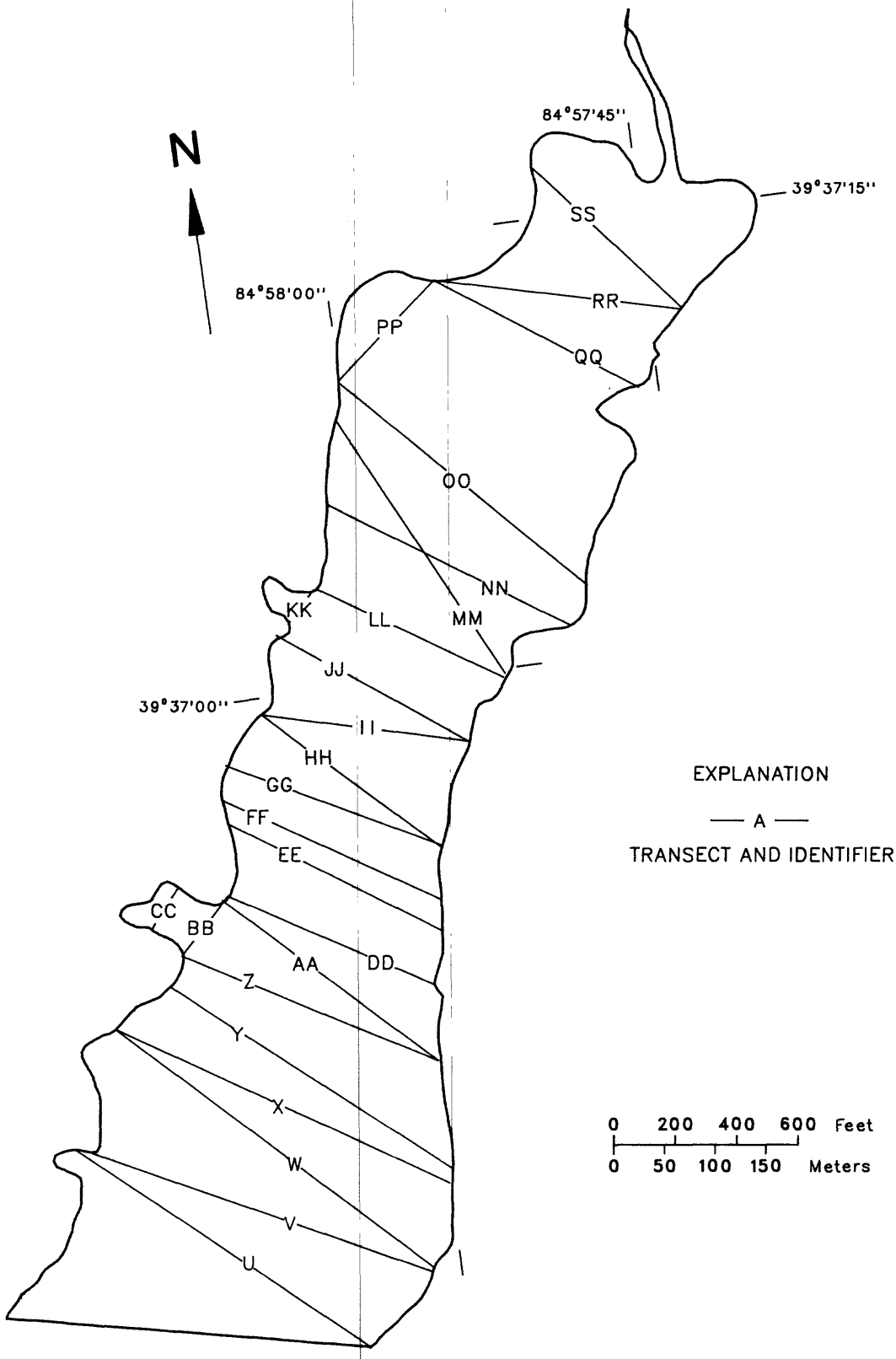


Figure 4a.——Shoreline and location of transects, northern part of Whitewater Lake.

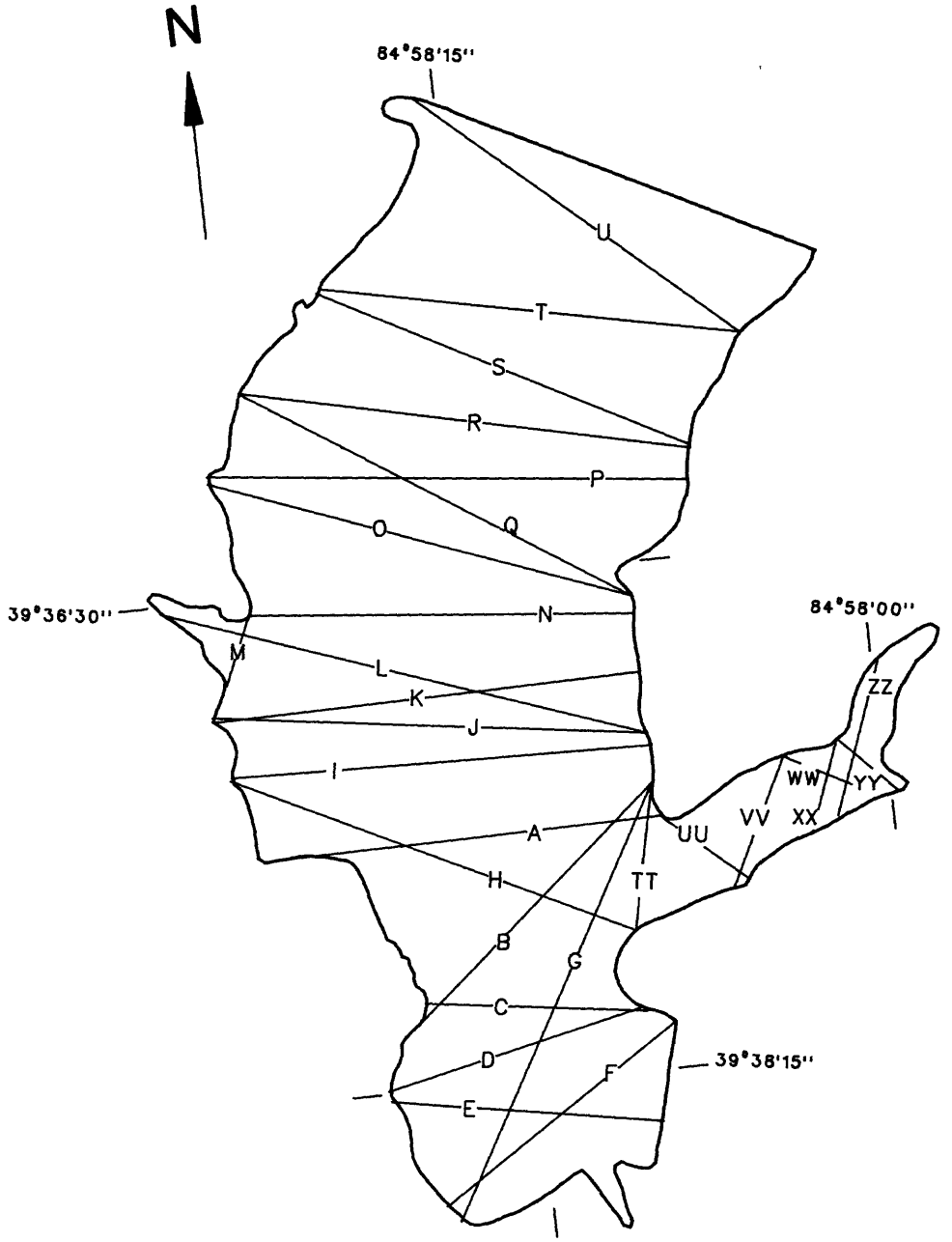
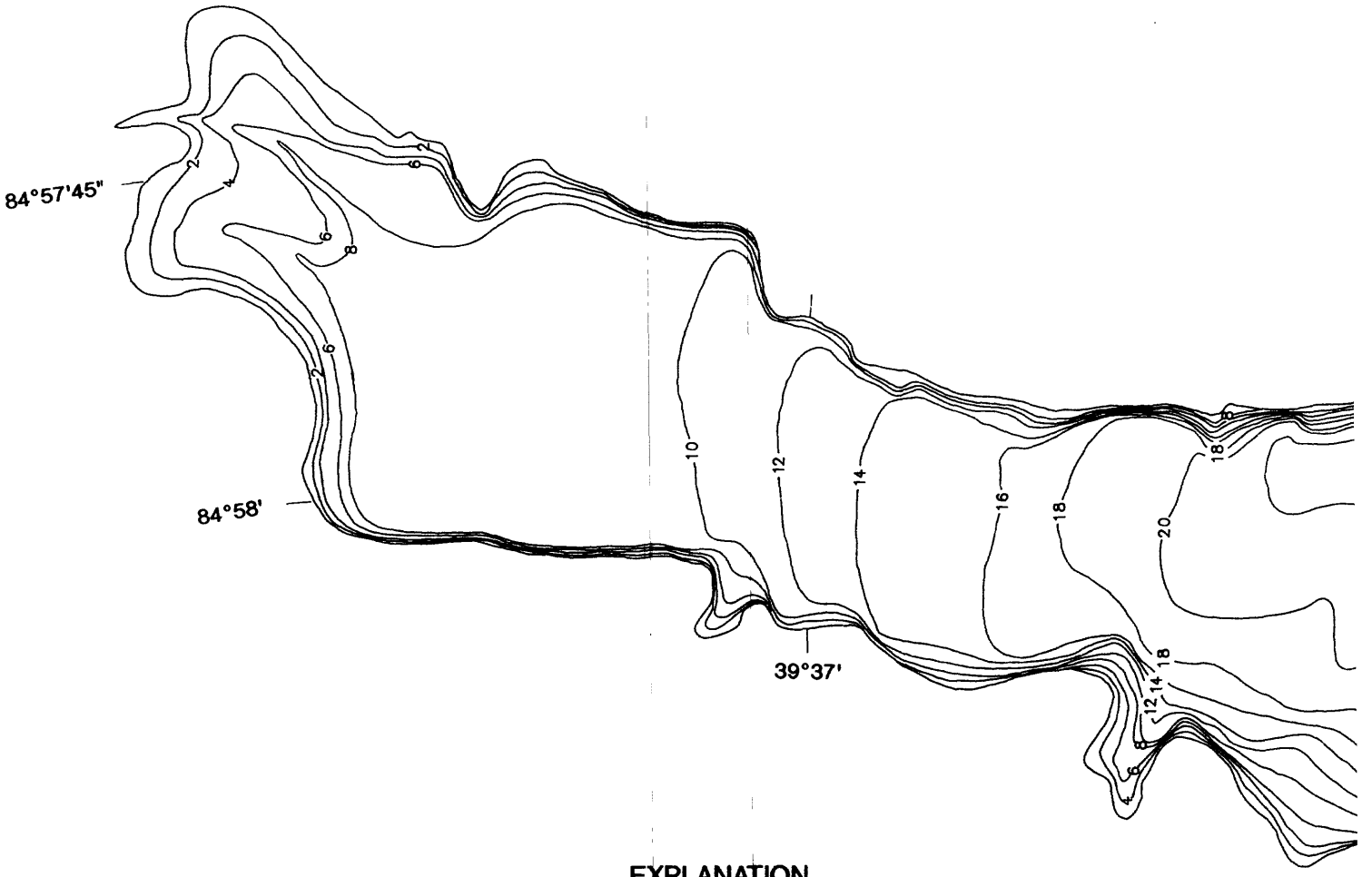


Figure 4b.——Shoreline and location of transects, southern part of Whitewater Lake.



EXPLANATION

-22-DEPTH CONTOUR--Lines of equal water depth,

in feet below 821

Figure 5a.--Depth contours for northern part of Whitewater Lake, 1988.

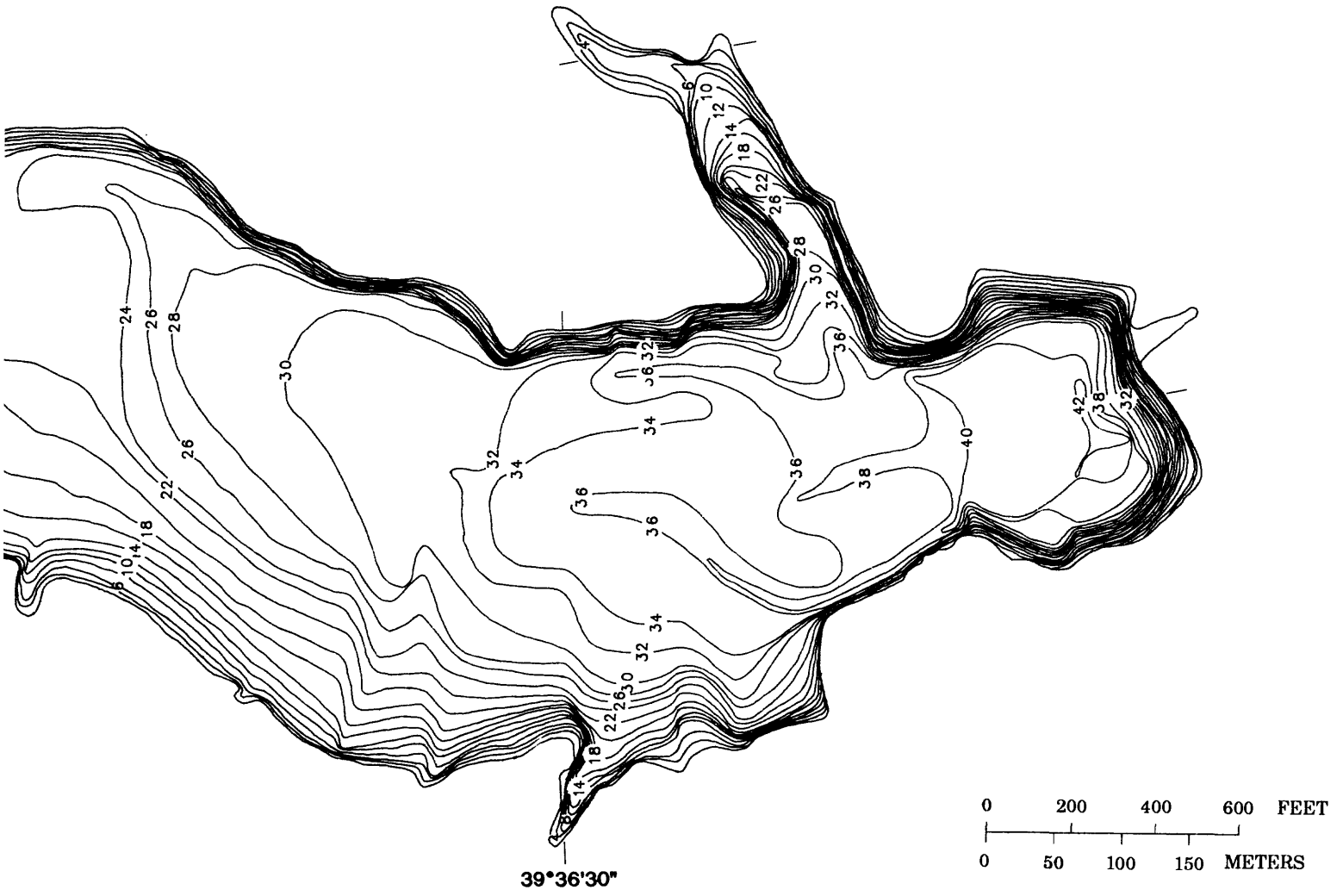


Figure 5b.--Depth contours for southern part of Whitewater Lake, 1988.

determined by adding the amount of sediment that accumulated in the lake from 1959-88 and the amount of sediment that was dredged from the lake during 1978-81 and 1984-88. The annual rate of sediment that accumulated in the lake was determined by dividing the total amount of accumulated sediment by 29 years.

Areas of Accumulated Sediment

Cross-sectional profiles for 52 transects, A through ZZ (figs. 6-23), were constructed by use of the transect width and depth data. These profiles show where sediment has accumulated. A water-surface datum of 821 ft was used for all cross sections. The area of each cross section was measured to determine the area remaining in the cross-sectional profiles. Areas for the cross sections are given in table 24 (in the "Supplemental Data" section at the end of the report).

The area remaining in the cross-sectional profiles were determined for the 52 transects. The area remaining, expressed as a percentage, was determined by dividing one cross-sectional area by another cross-sectional area times 100 (table 25 in the "Supplemental Data" section at the end of the report). Using transect B as an example, the 1988 cross-sectional area of 30,800 ft^2 divided by the 1959 cross-sectional area of 33,000 ft^2 times 100 equals 93.3--that is, 93.3 percent of the 1959 cross-sectional area remains in 1988. The area remaining in the cross-sectional profiles ranged from 72.2 percent (transect OO) to 125 percent (transect PP). The average area remaining in the cross-sectional profiles is 95.7 percent. Except for transects PP, QQ, RR, and SS, the increases and some of the decreases in cross-sectional areas probably can be attributed to the fact that the depth values were rounded to the nearest 5 ft for 1959 and to the nearest 1 ft for 1988. The increases in cross-sectional areas for transects PP, RR, and SS, and the small decrease in cross-sectional area for transect QQ, is a result of dredging. Dredging occurred in the upper part of the lake from slightly below where Silver Creek enters the lake to transect OO, with transects PP, QQ, RR, and SS having been dredged. In transects PP, RR, and SS, the dredging operation removed sediment below the 1959 contour level. The largest computed percent change in area remaining for the cross-sectional profiles, which represent locations where the largest amount of sediment has accumulated, are in the upper part of the lake where Silver Creek enters. In general, except for the upper part of the lake, there has been little sediment accumulation in most of the lake.

The surface-area data for Whitewater Lake for 1959 were obtained from the 1959 depth-contour map, and the data for 1988 were obtained from the modified 1977 aerial photograph. The surface area was 7,580,000 ft^2 (174 acres) in 1959 and 6,590,000 ft^2 (151 acres) in 1988. The decrease in surface area from 1959-88 was 990,000 ft^2 (22.7 acres). The annual rate of surface area decrease for the 29-year period 1959-88 is 34,100 ft^2 (0.78 acre) per year. In general, most of the change in the shoreline of the lake is a result of sedimentation in the upper part of the lake where Silver Creek enters.

Amount of Accumulated Sediment

The amount of sediment that accumulated in Whitewater Lake from 1959-88 and the volume of water in the lake in 1959 and 1988 were determined from the depth-contour data for 1959 and 1988. The volume of water in the lake in 1988 was subtracted from the volume of water in 1959 to determine the amount of sediment that accumulated in the lake from 1959-88. The areas encompassed by the contour lines of the 1959 and 1988 depth-contour maps were measured, multiplied by the depth value, and then added to determine the volume of water in Whitewater Lake in 1959 and 1988. The following example shows how volumes were computed for 1959.

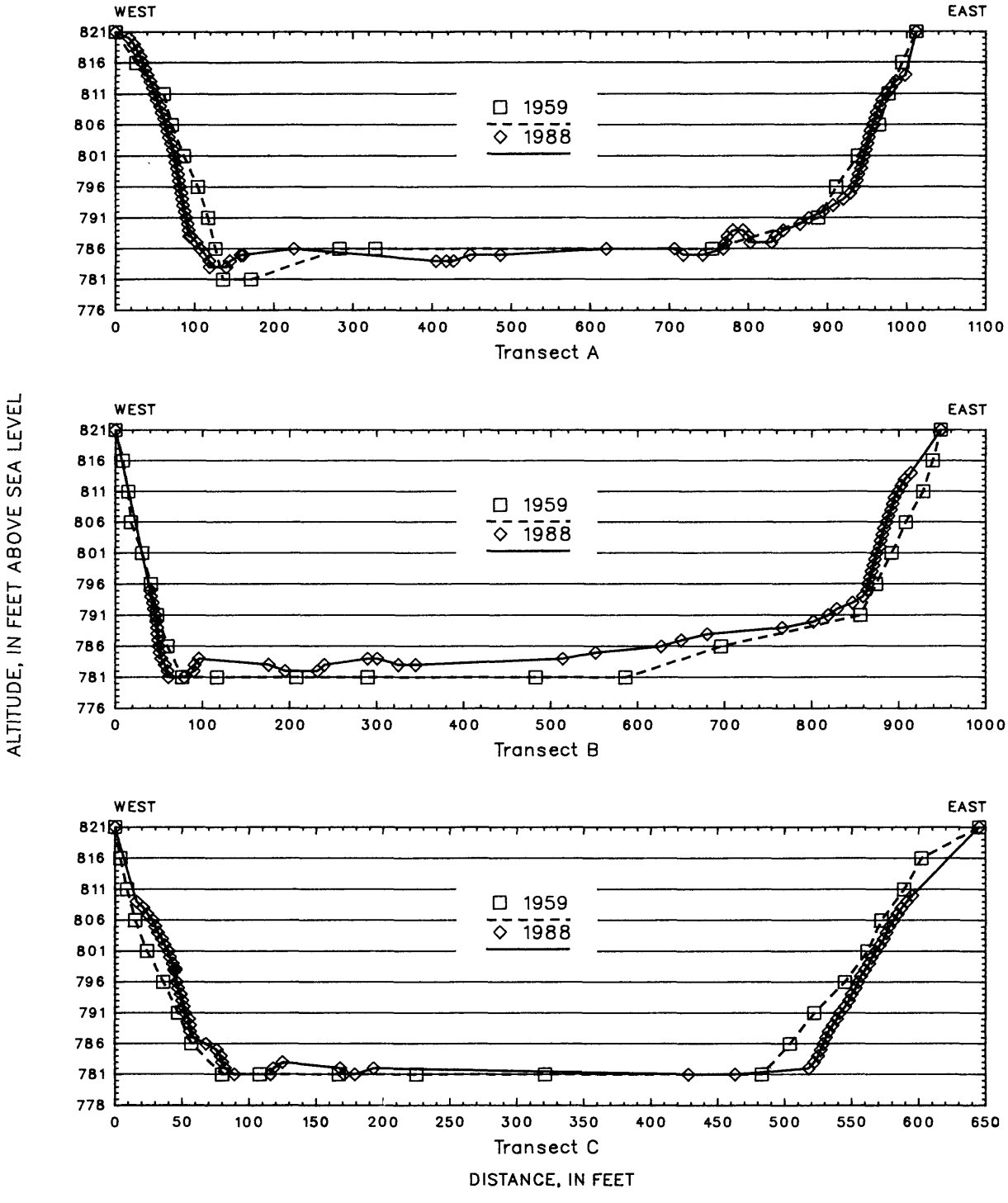


Figure 6.—— Cross sections for transects A, B, and C, Whitewater Lake.

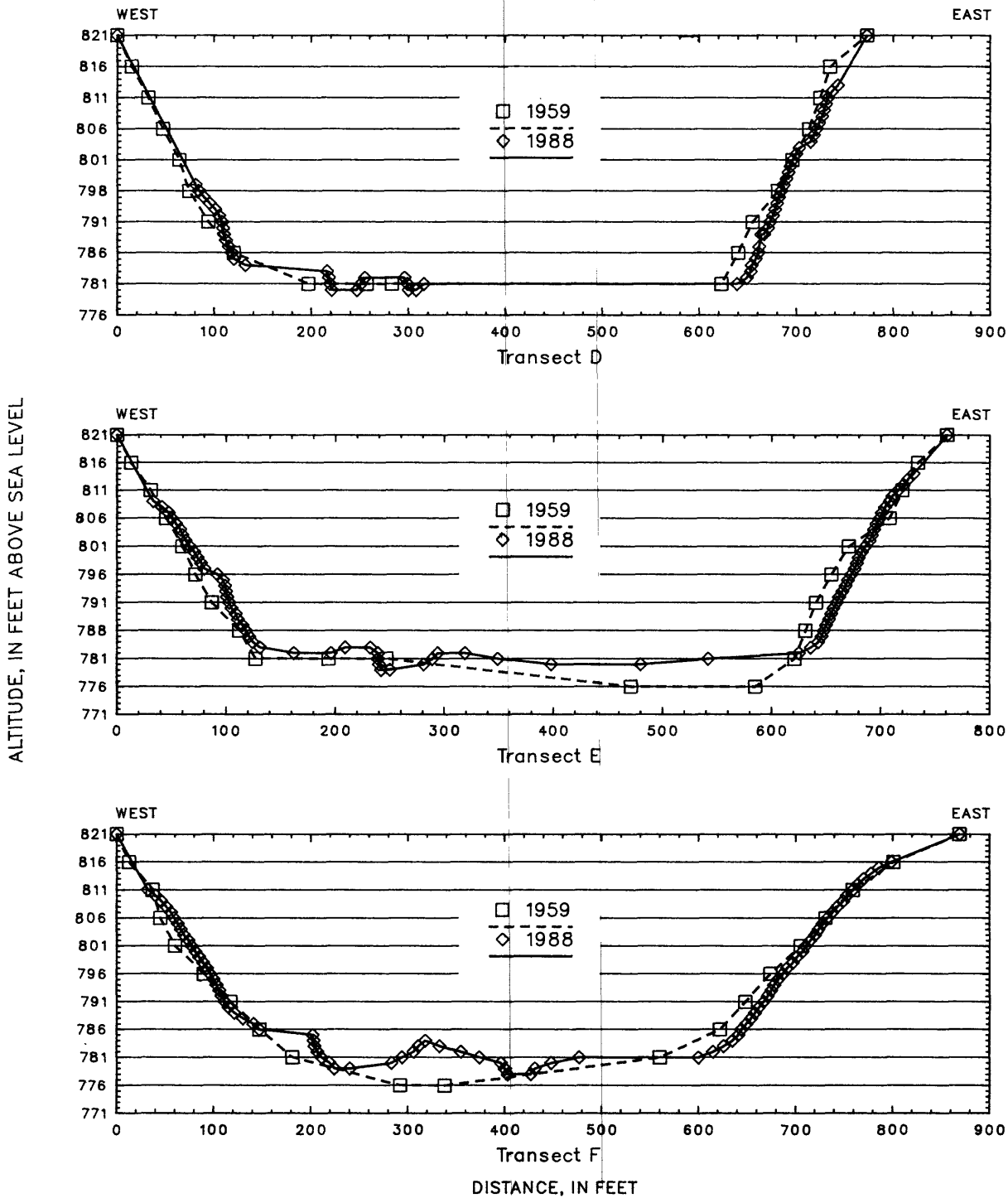


Figure 7.-- Cross sections for transects D, E, and F, Whitewater Lake.

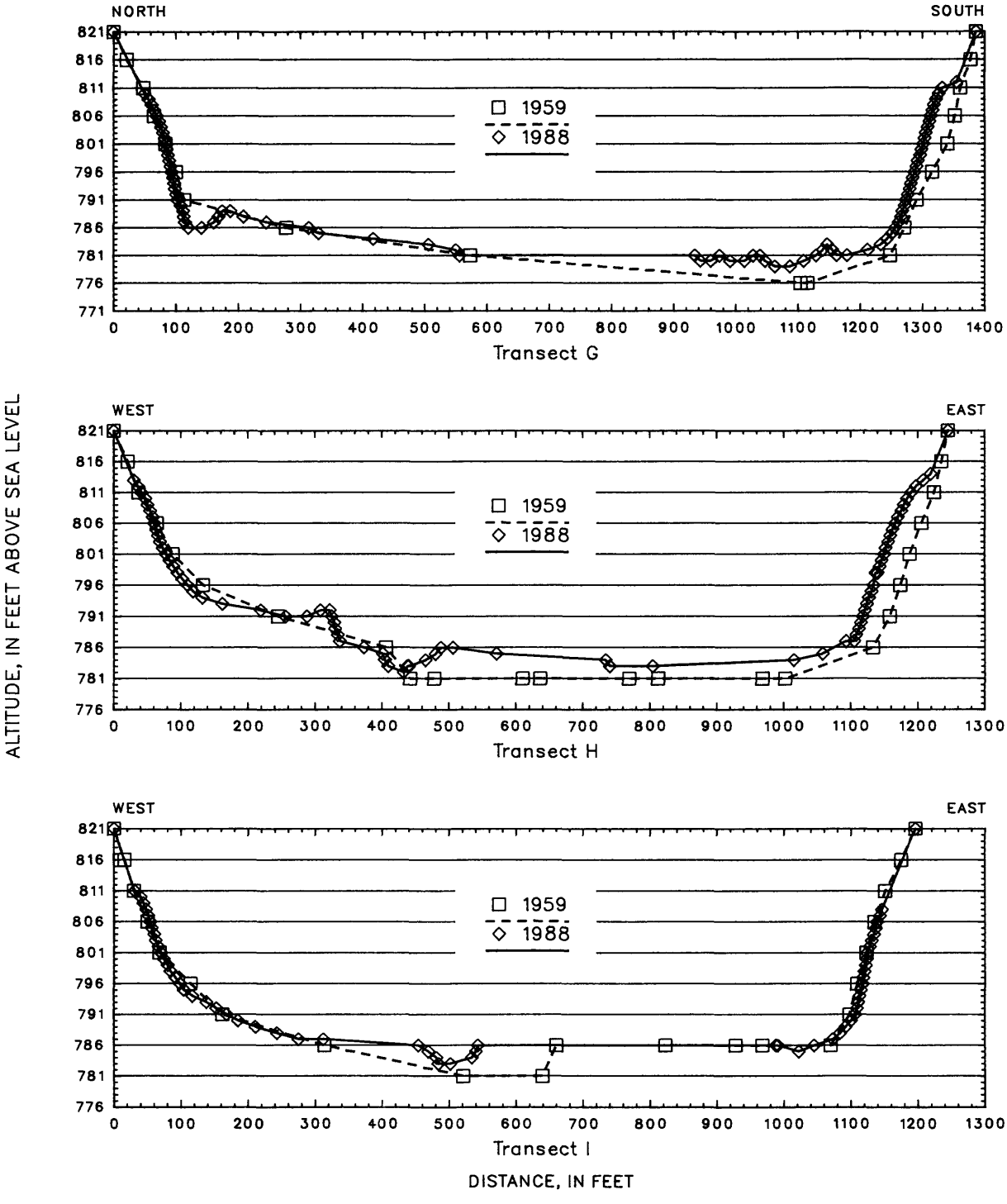


Figure 8.-- Cross sections for transects G, H, and I, Whitewater Lake.

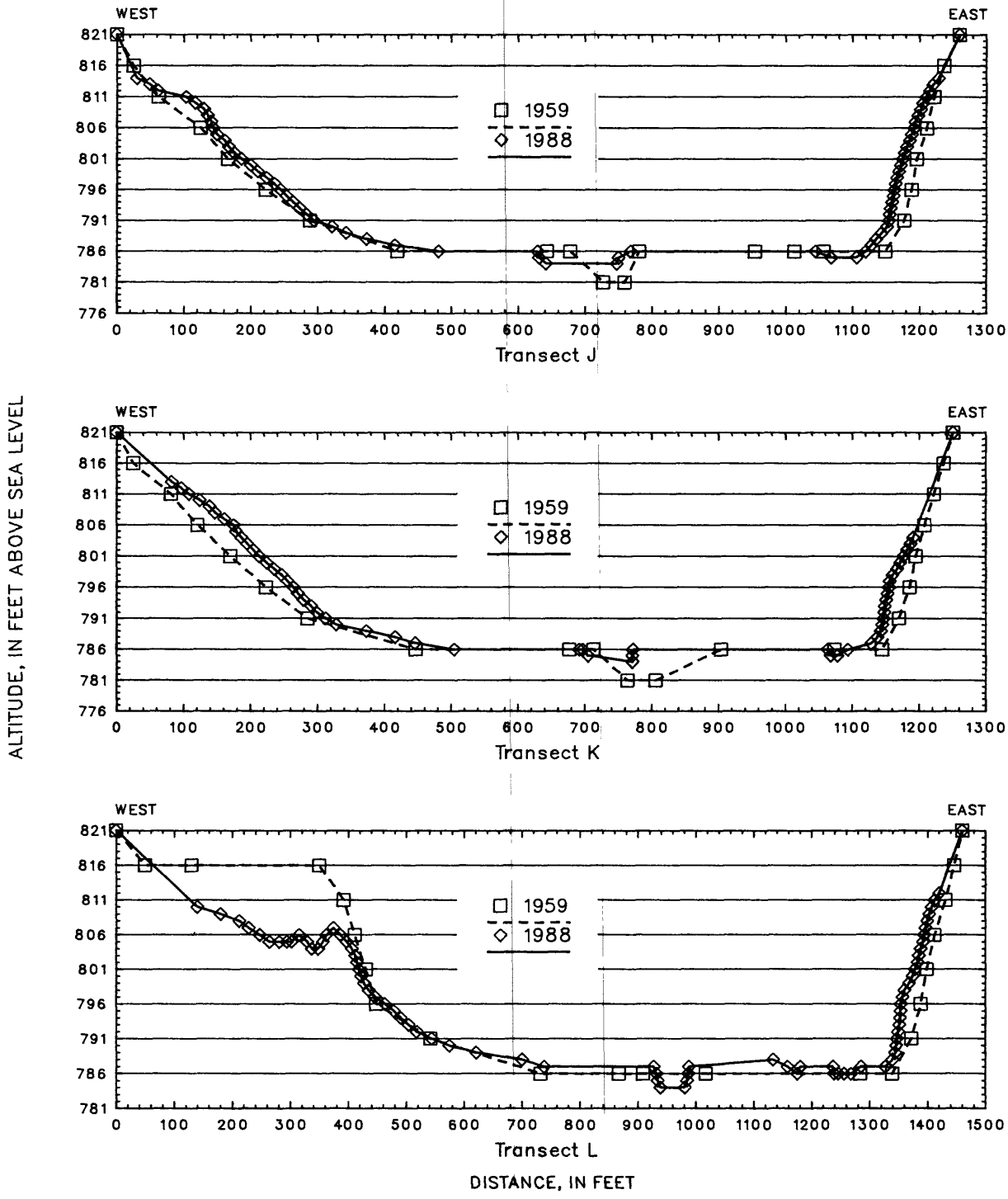


Figure 9.-- Cross sections for transects J, K, and L, Whitewater Lake.

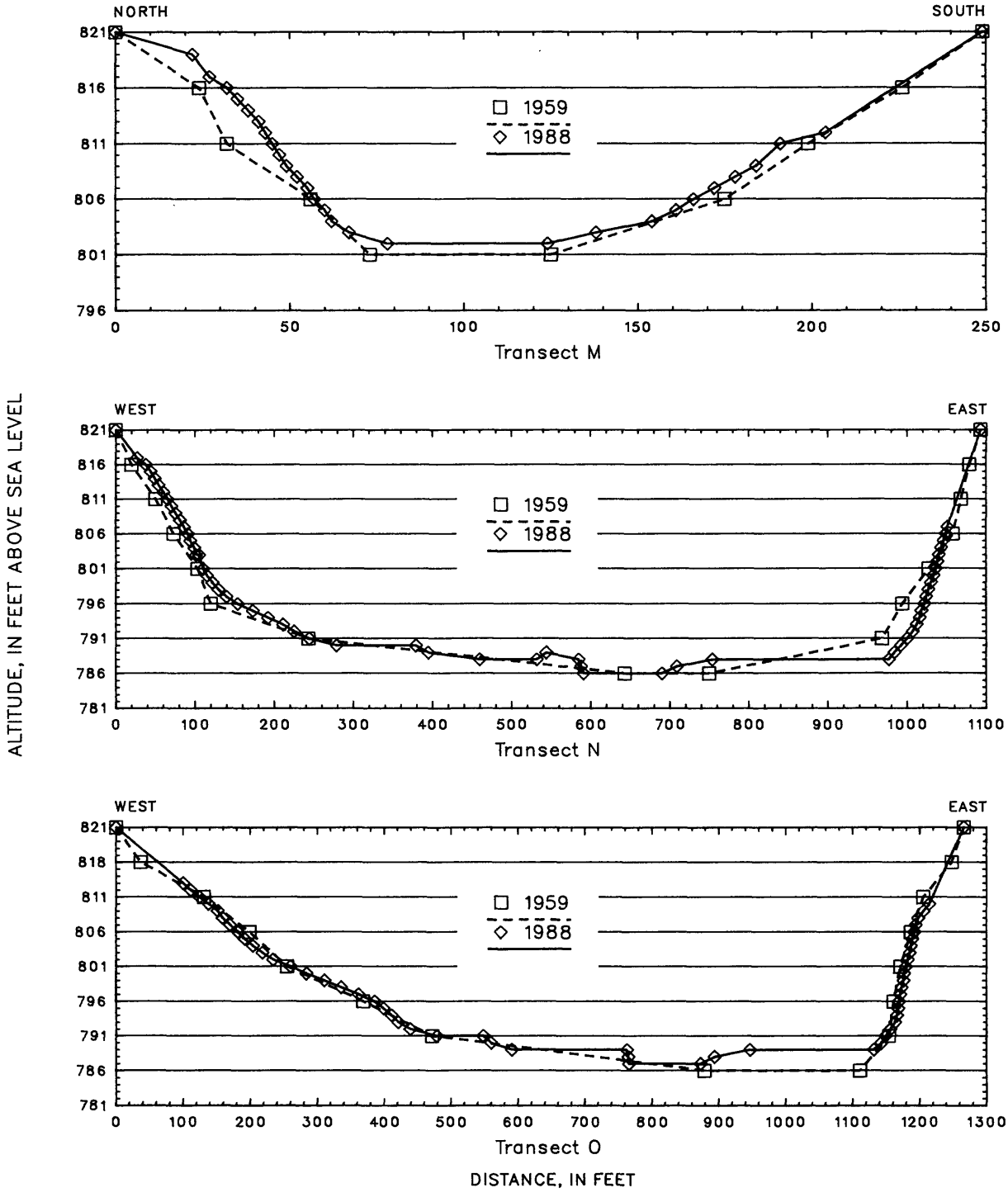


Figure 10.—— Cross sections for transects M, N, and O, Whitewater Lake.

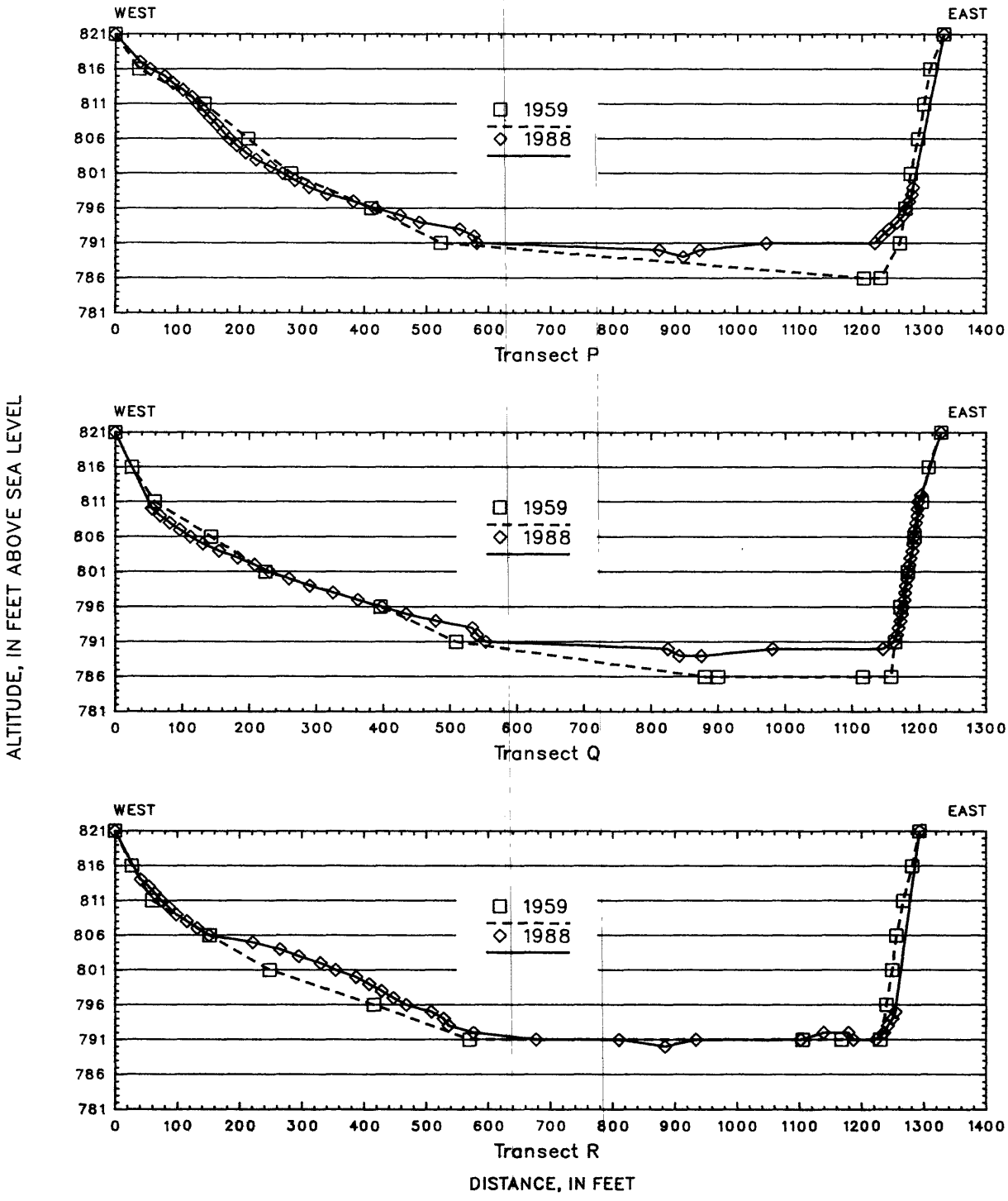


Figure 11.-- Cross sections for transects P, Q, and R, Whitewater Lake.

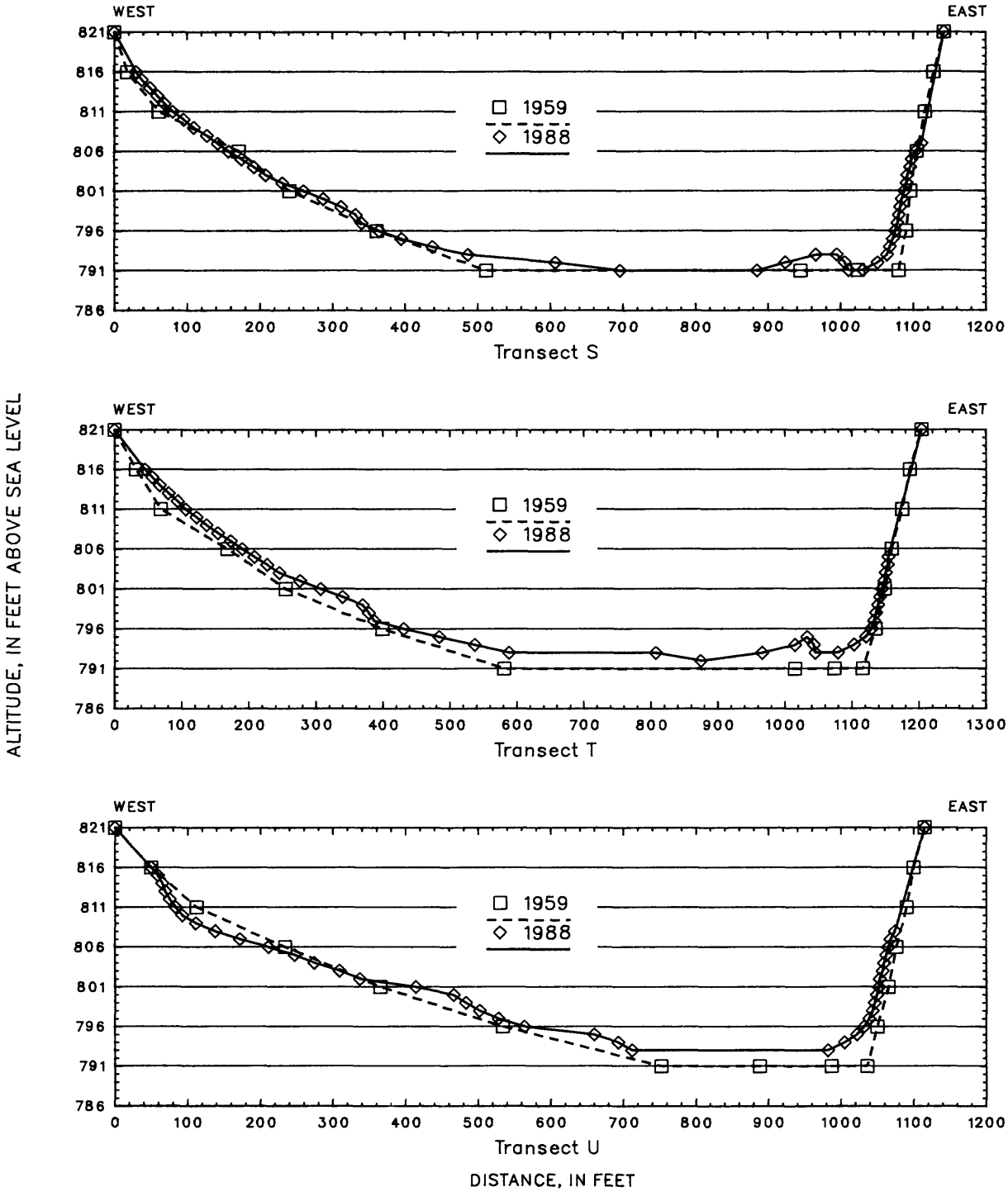


Figure 12.-- Cross sections for transects S, T, and U, Whitewater Lake.

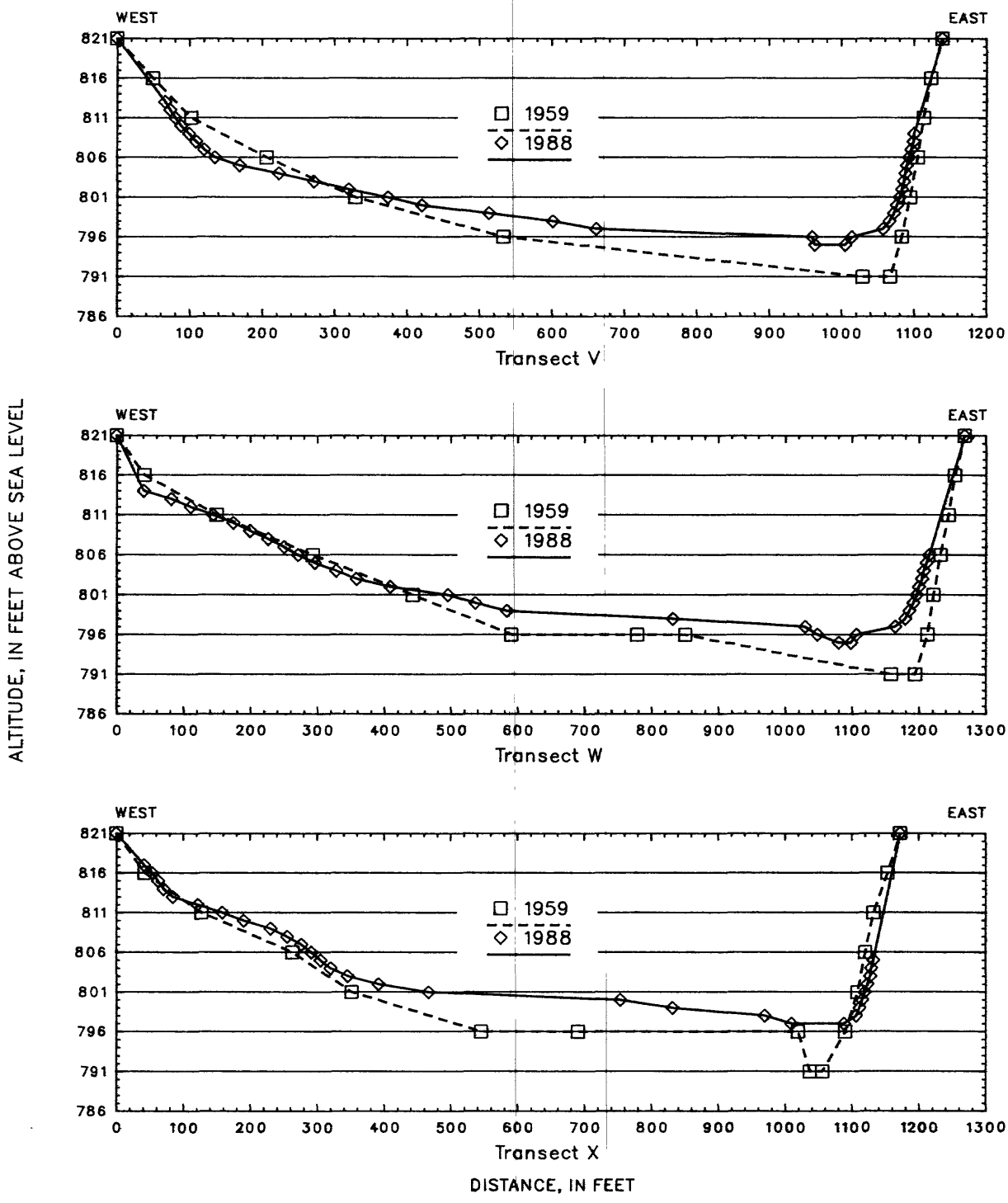


Figure 13.-- Cross sections for transects V, W, and X, Whitewater Lake.

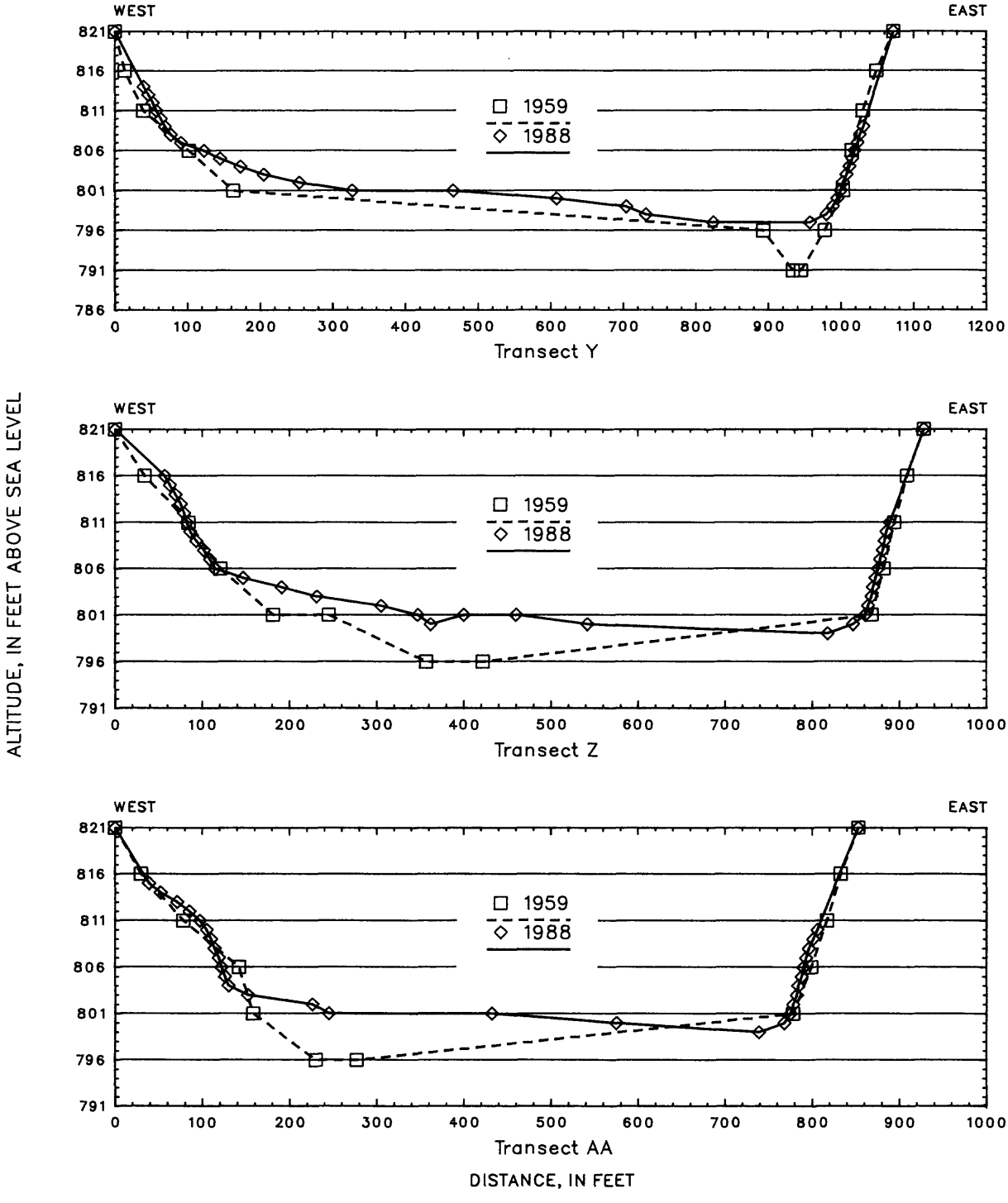


Figure 14.-- Cross sections for transects Y, Z, and AA, Whitewater Lake.

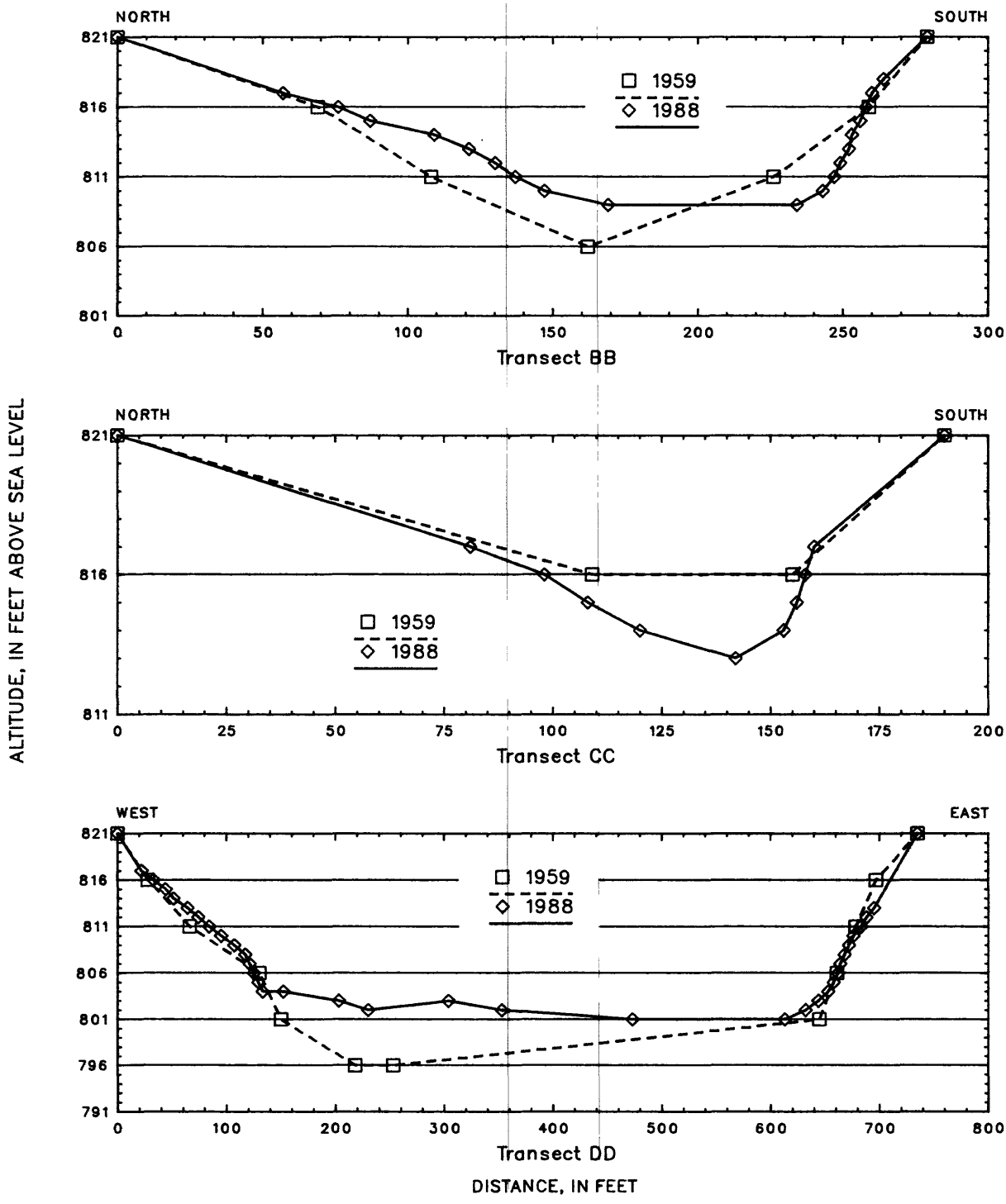


Figure 15.-- Cross sections for transects BB, CC, and DD, Whitewater Lake.

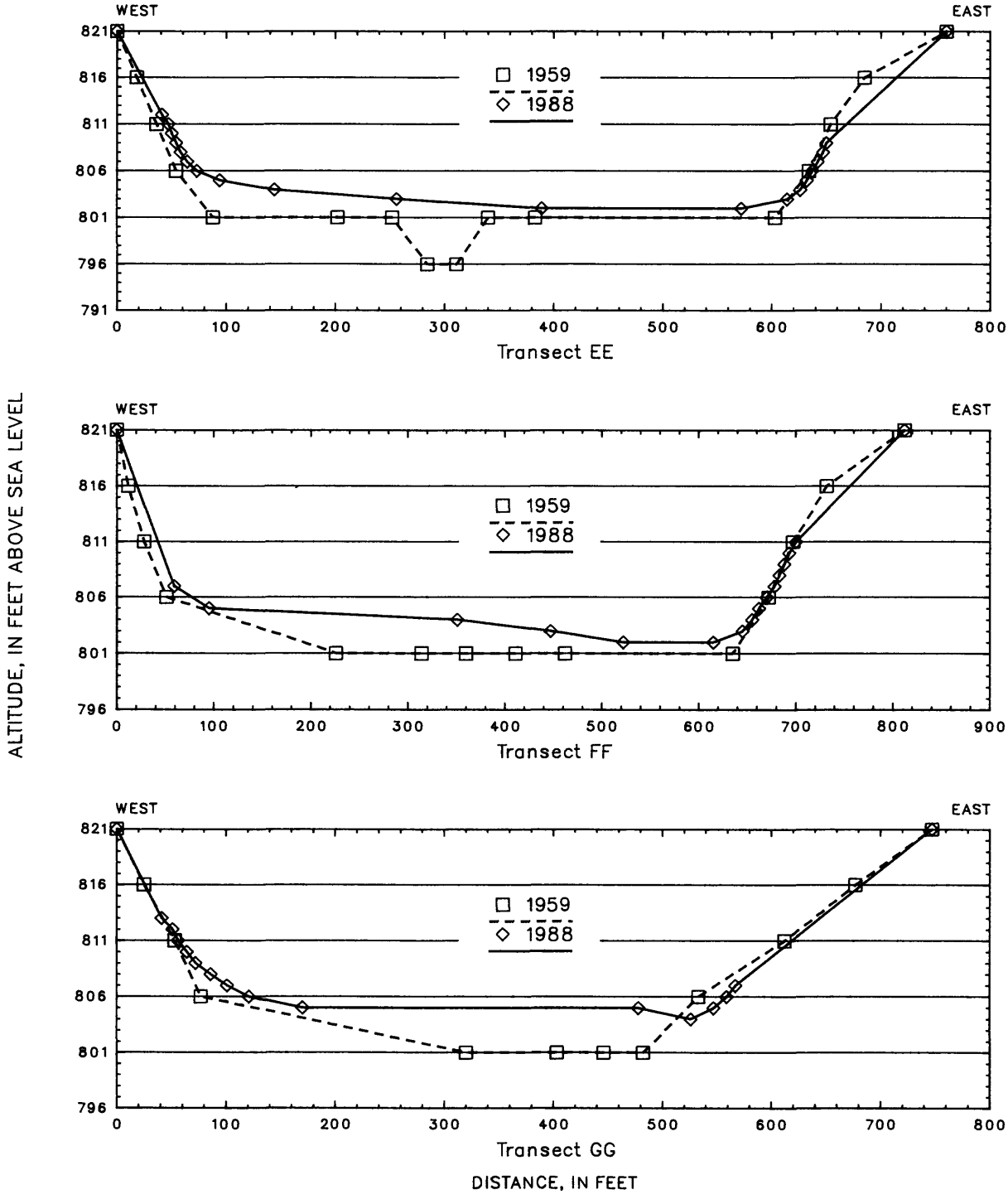


Figure 16.-- Cross sections for transects EE, FF, and GG, Whitewater Lake.

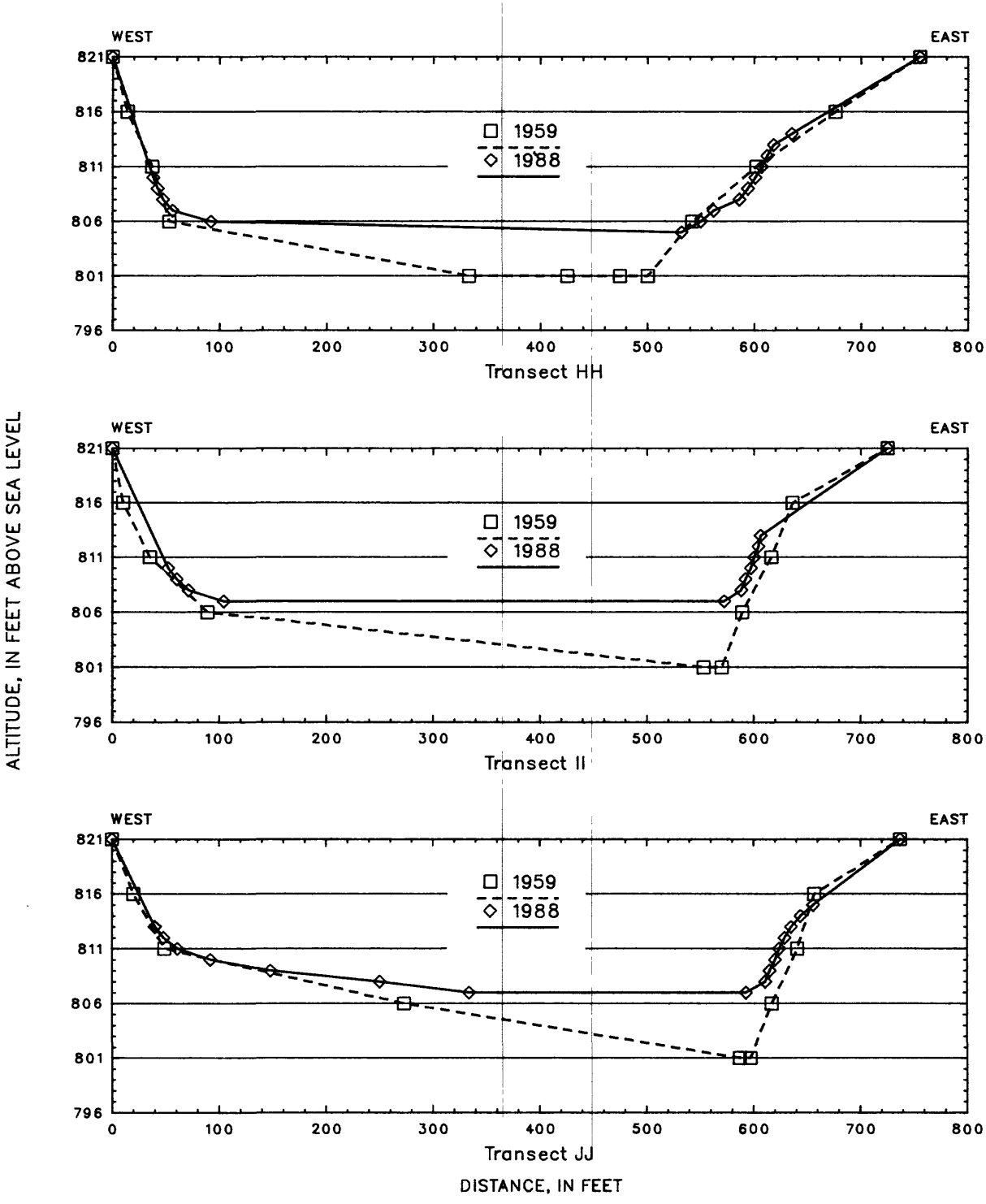


Figure 17.-- Cross sections for transects HH, II, and JJ, Whitewater Lake.

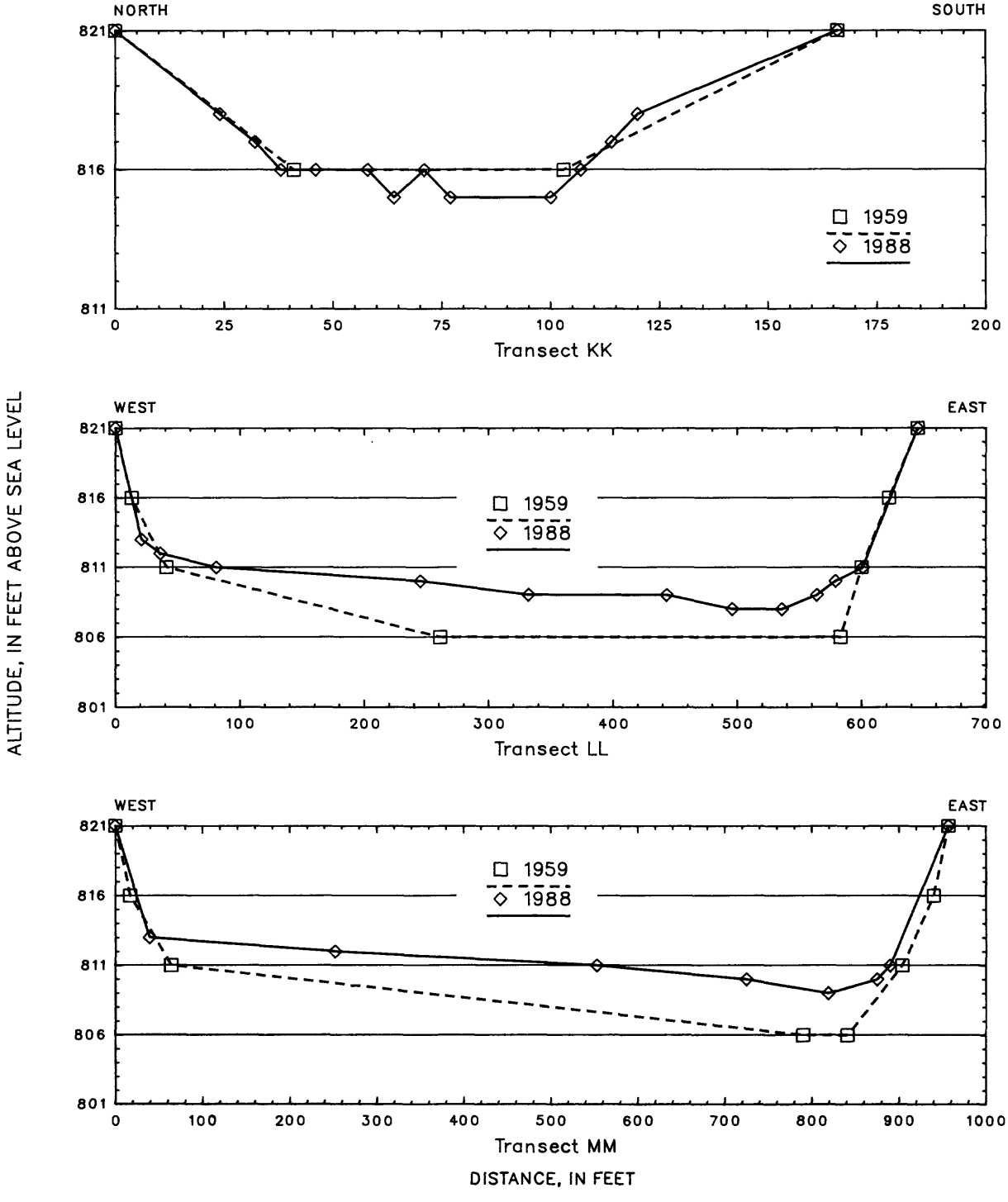


Figure 18.-- Cross sections for transects KK, LL, and MM, Whitewater Lake.

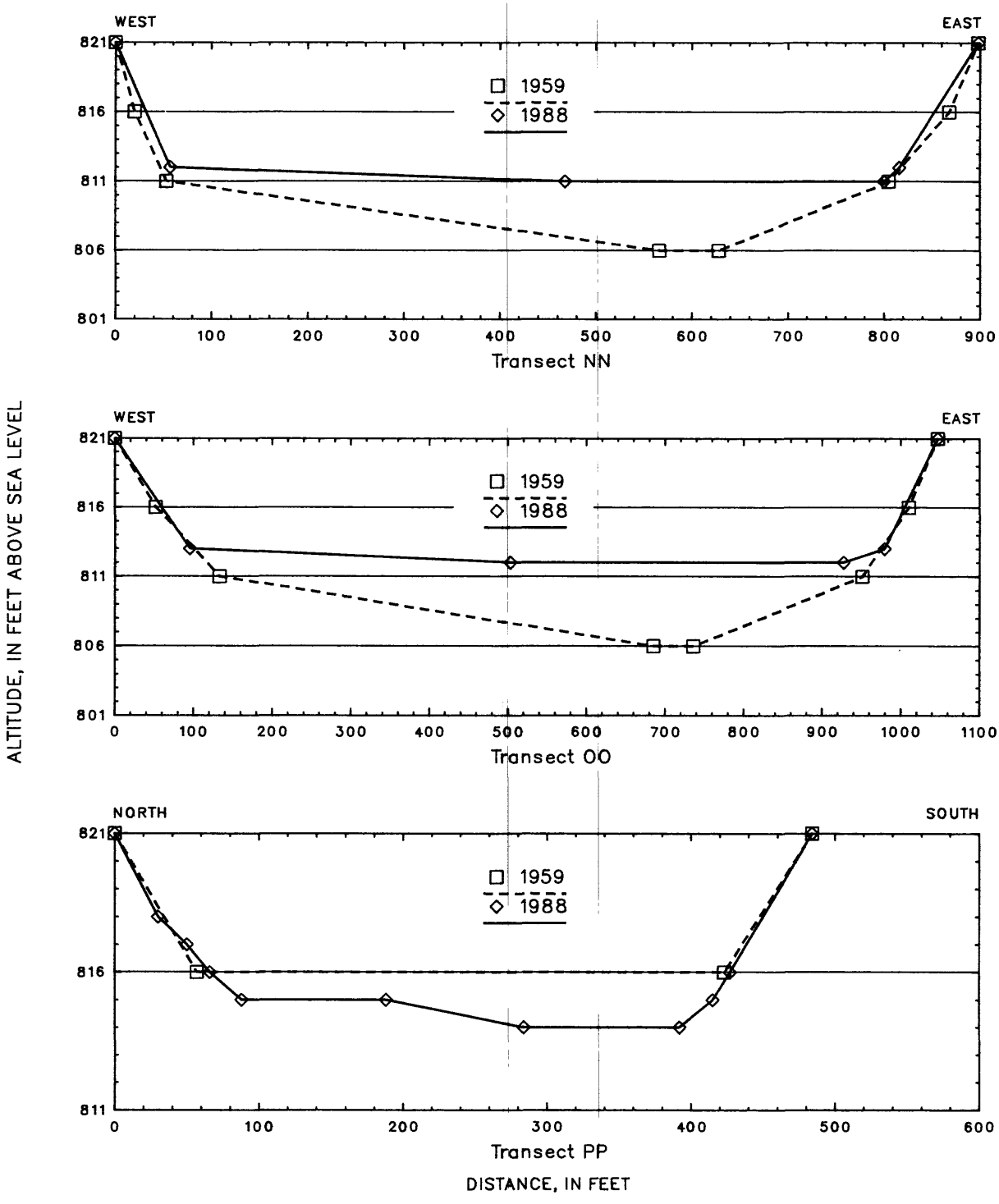


Figure 19.—— Cross sections for transects NN, OO, and PP, Whitewater Lake.

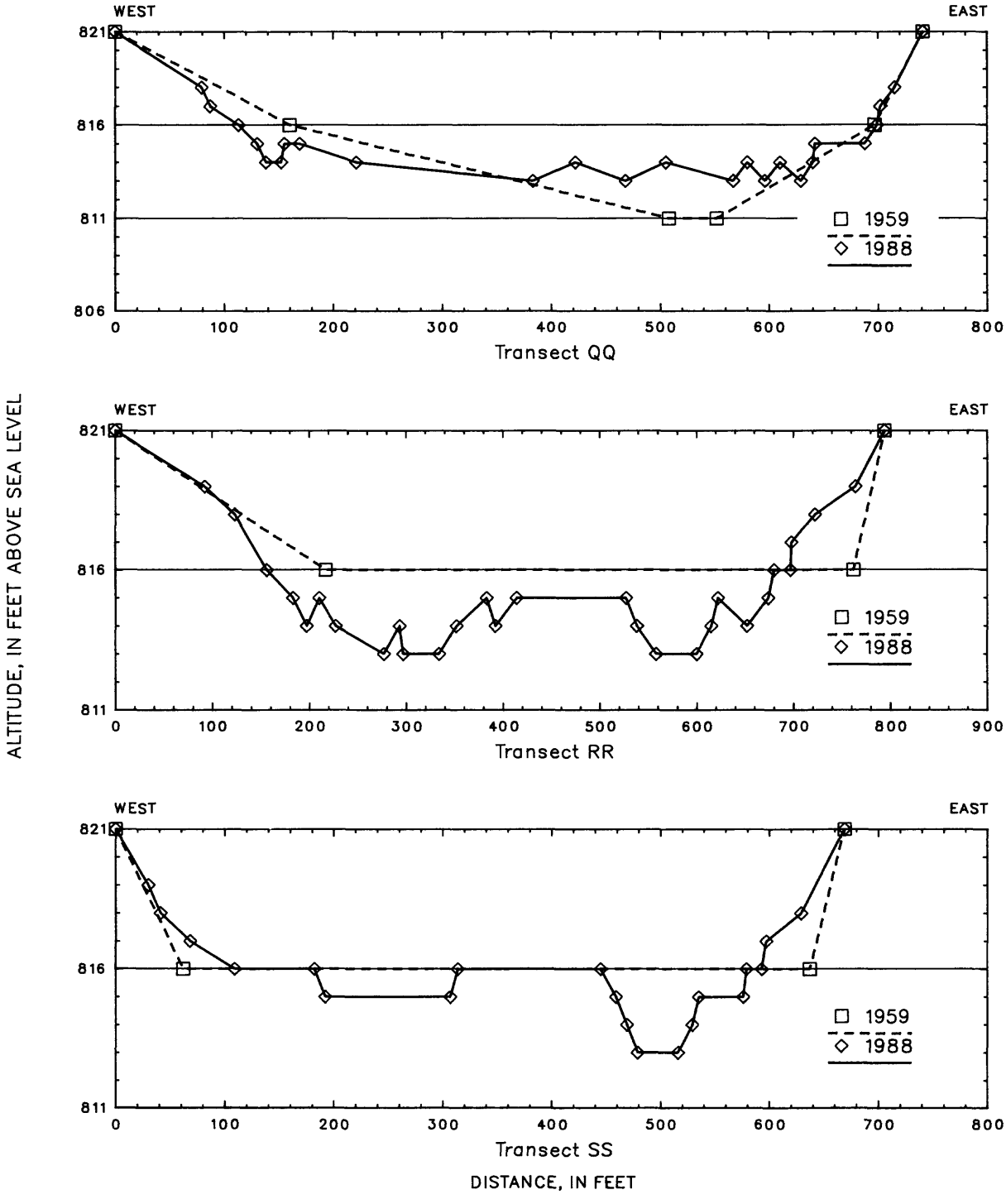


Figure 20.-- Cross sections for transects QQ, RR, and SS, Whitewater Lake.

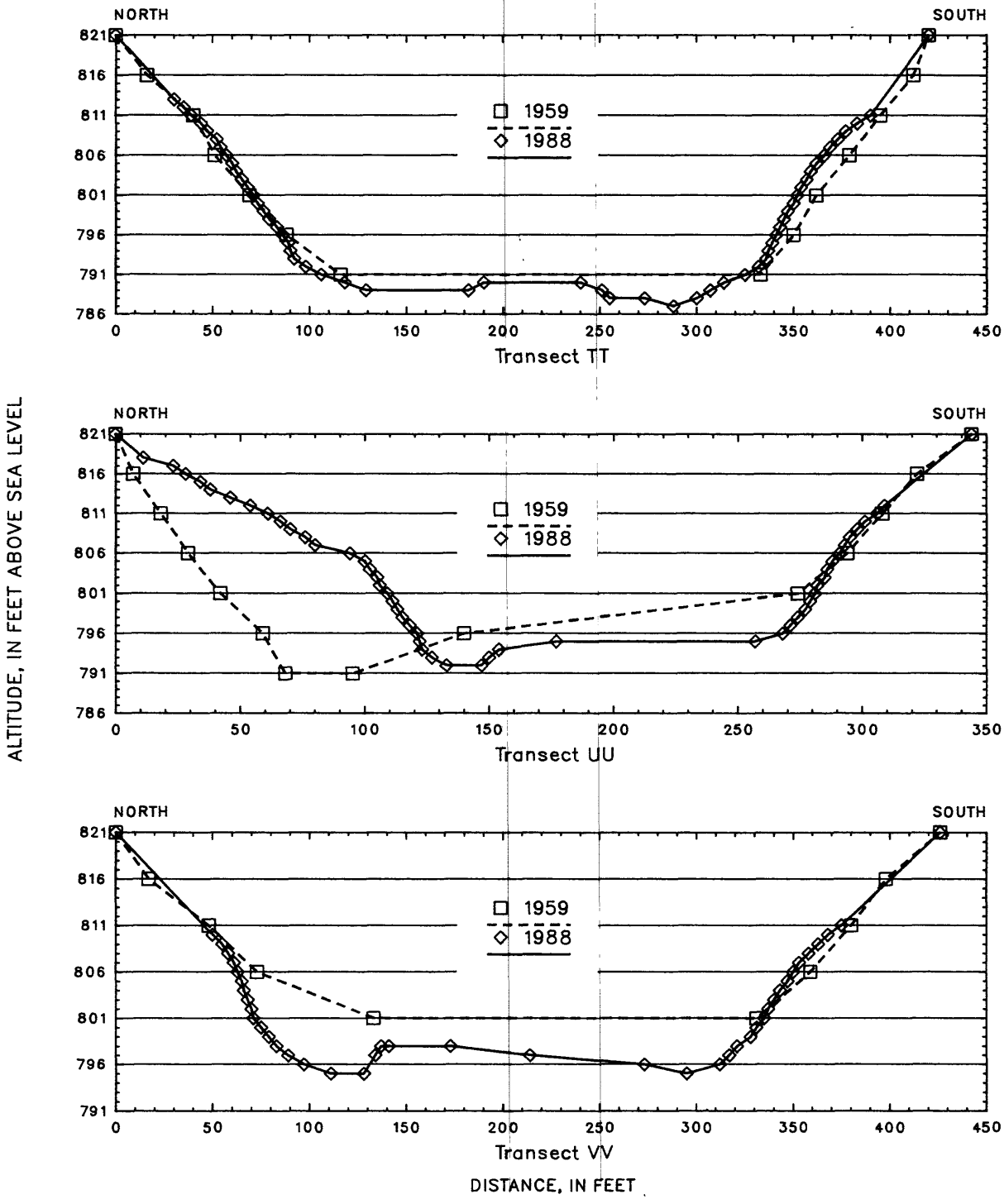


Figure 21.-- Cross sections for transects TT, UU, and VV, Whitewater Lake.

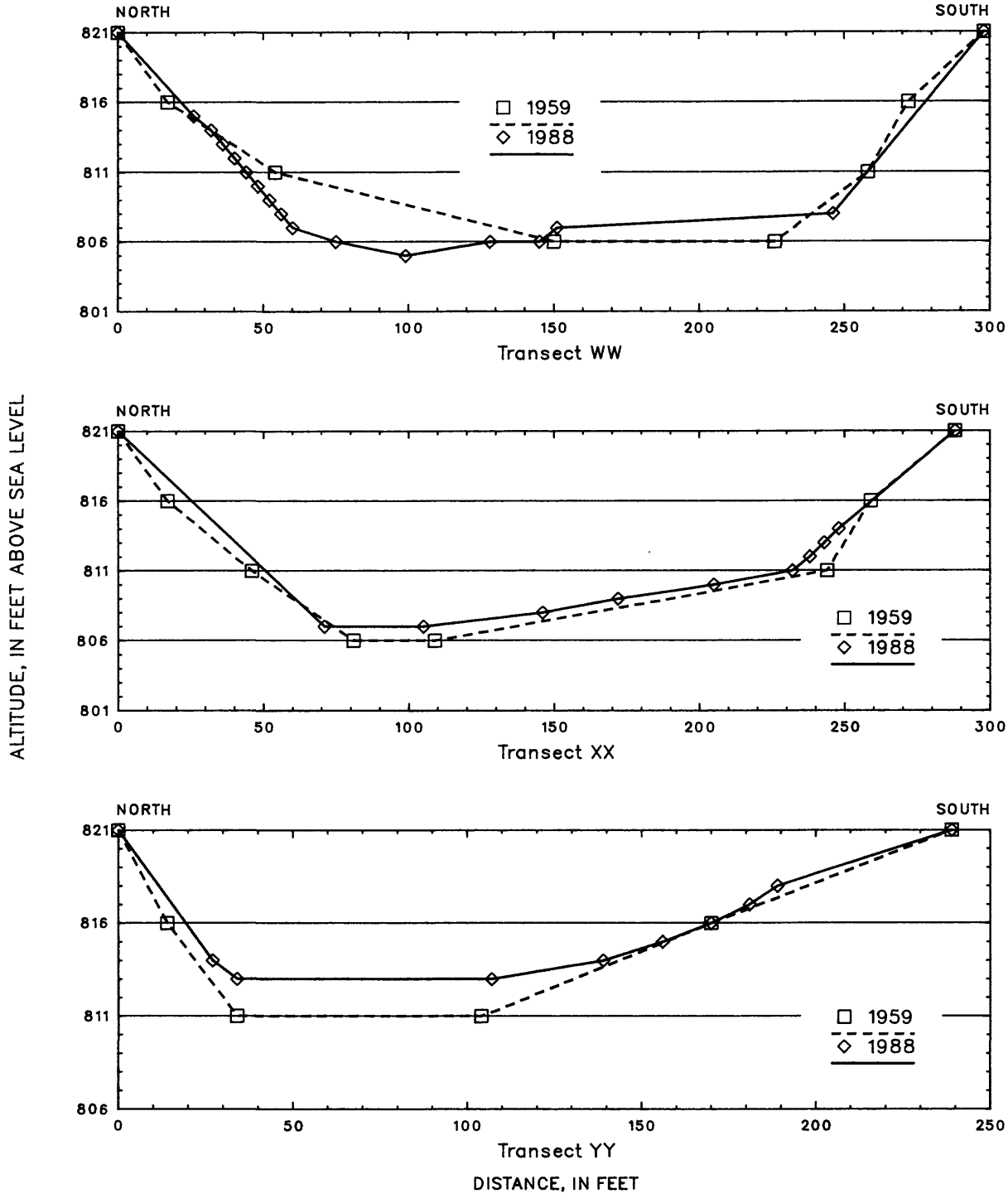


Figure 22.—— Cross sections for transects WW, XX, and YY, Whitewater Lake.

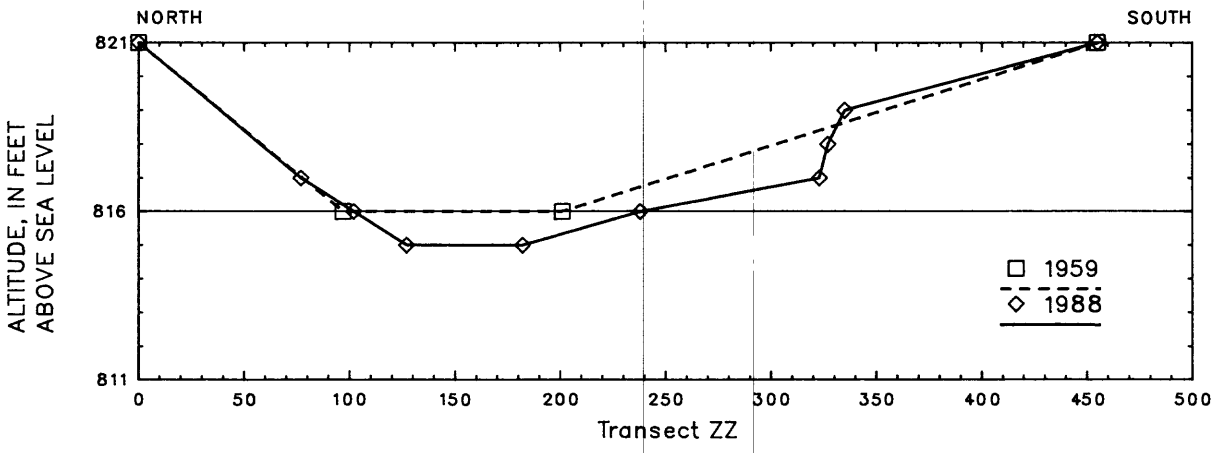


Figure 23.-- Cross-section for transect ZZ, Whitewater Lake.

1. The area enclosed by the shoreline and the 5-ft contour line were measured.

2. The area enclosed by the 5-ft contour line was subtracted from the area enclosed by the shoreline. The resulting value was multiplied by 2.5 ft (2.5 ft is a value halfway between zero, the shoreline, and the 5-ft contour line) to find the volume from the shoreline to the 5-ft contour line.

3. This same procedure was used for all contours. To determine the area enclosed by the deepest contour (42 ft) in the lake, the area enclosed by the contour was multiplied by 42.

4. All the volumes computed in steps 1-3 were added to give the volume of water in the lake in 1959.

In 1959, the volume of water in Whitewater Lake was 138,000,000 ft^3; in 1988, the volume was 132,000,000 ft^3. The volume of water in the lake for 1988 was subtracted from the volume of water for 1959 to determine the amount of sediment that accumulated in the lake from 1959-88, which was 6,000,000 ft^3. In 1988, the volume of water remaining in the lake was 95.6 percent of the 1959 volume, and 4.4 percent of the 1959 lake volume had filled with sediment.

The total amount of sediment that accumulated in Whitewater Lake from 1959-88 was determined by adding the amount of sediment that accumulated in the lake from 1959-88 (6,000,000 ft^3) and the amount of sediment that was dredged from the lake during 1978-81 and 1984-88 (4,350,000 ft^3). Even though the dredging operation removed sediment that was deposited before 1959 in transects PP, RR, and SS, the amount of sediment dredged from the lake was used in the calculation. The total amount of sediment that accumulated in the lake from 1959-88 is 10,350,000 ft^3. The total amount of sediment accumulation (10,350,000 ft^3) was divided by 29 years to determine the annual rate of sediment that accumulated in the lake from 1959-88. That annual rate is 357,000 ft^3 per year.

Potential for Future Decreases in Lake-Storage Capacity due to Accumulated Sediment

Potential decreases in the storage capacity of Whitewater Lake based on whether dredging is continued or discontinued were estimated for the 29-year period 1989-2017. It was assumed the future rate of deposition would be constant, that sediment compaction would be negligible, and the trap efficiency of the lake would not change. In using the assumptions about sediment compaction and trap efficiency, the potential decreases in storage capacity would be the maximum to occur.

Most of the sedimentation in Whitewater Lake is occurring in the upper part of the lake where the dredging operation is located. During 1978-81 and 1984-88, dredging removed sediment at an average rate of 483,000 ft^3 per year (4,350,000 ft^3 divided by 9 years). If the annual rate of sediment that accumulated in the lake during 1959-88 is 357,000 ft^3 per year, it is evident that if the dredging is continued the potential for future decreases in the storage capacity of the lake is small.

The potential decrease in the storage capacity of Whitewater Lake if the dredging is discontinued was estimated from the volume of water in the lake in 1959 (138,000,000 ft^3) and the annual rate of sediment that accumulated in the lake (357,000 ft^3). For the 29-year period 1989-2017, an estimated 10,350,000 ft^3 (357,000 ft^3 times 29 years) of sediment would accumulate in the lake if the dredging is discontinued. The volume of water in the lake in 2017 is estimated to be 88.2 percent of the 1959 volume; 11.8 percent of the lake is estimated to be filled with sediment. At first, most of the new sediment probably will accumulate in the upper end of the lake. Later, as this part of the lake became filled with sediment, sediment would accumulate in the middle and lower parts of the lake.

SUMMARY AND CONCLUSIONS

Areas of sediment accumulation in Whitewater Lake for the 29-year period 1959-88 were identified by use of the transect width and depth data for 1959 and 1988 and the surface-area data for 1959 and 1988. Cross-sectional profiles for 52 transects of the lake were constructed by use of the transect width and depth data. These profiles show where sediment has accumulated. The area remaining in the cross-sectional profiles, expressed as a percentage, was determined for the 52 transects. The largest computed percent change in area remaining for the cross-sectional profiles, which represent locations where the largest amount of sediment has accumulated, are in the upper part of the lake where Silver Creek enters. In general, except for the upper part of the lake, little sediment has accumulated in most of the lake. The surface area of the lake was 7,580,000 ft^2 (174 acres) in 1959 and 6,590,000 ft^2 (151 acres) in 1988.

The amount of sediment that accumulated in Whitewater Lake from 1959-88 was determined from the depth-contour data for 1959 and 1988. In 1959, the volume of water in the lake was 138,000,000 ft^3; in 1988, the volume was 132,000,000 ft^3. The amount of sediment that accumulated in the lake from 1959-88 was 6,000,000 ft^3. In 1988, the volume of water remaining in the lake was 95.6 percent of the 1959 volume, and 4.4 percent of the 1959 lake volume had filled with sediment.

The total amount of sediment that accumulated in Whitewater Lake from 1959-88 (10,350,000 ft^3) was determined by adding the amount of sediment that accumulated in the lake from 1959-88 (6,000,000 ft^3) and the amount of sediment that was dredged from the lake during 1978-81 and 1984-88 (4,350,000 ft^3). The annual rate of sediment that accumulated in the lake was determined by dividing the total amount of sediment by 29 years. The annual rate of sediment that accumulated in the lake from 1959-88 was 357,000 ft^3 per year.

Potential decreases in the storage capacity of Whitewater Lake based on whether dredging is continued or discontinued were estimated for the 29-year period 1989-2017. Most of the sedimentation in the lake is occurring in the upper part of the lake where the dredging operation is located. During 1978-81 and 1984-88, dredging removed sediment at an average rate of 483,000 ft^3 per year. If the annual rate of sediment that accumulated in the lake during 1959-88 is 357,000 ft^3 per year, it is evident that the potential for future decreases in the storage capacity of the lake is small if dredging is continued. The potential decrease in the storage capacity of the lake if dredging is discontinued was estimated from the volume of water in the lake in 1959 and the annual rate of sediment that accumulated in the lake. For the 29-year period 1989-2017, an estimated 10,350,000 ft^3 of sediment would accumulate in the lake if the dredging is discontinued. The volume of water in the lake in 2017 is estimated to be 88.2 percent of the 1959 volume; an estimated 11.8 percent of the lake would be filled with sediment.

REFERENCES CITED

Alfred, S.D., Ulrich, H.P., and Zachary, A.I., 1960, Soil survey of Fayette and Union Counties, Indiana: United States Department of Agriculture in cooperation with Purdue University Agricultural Experiment Station, 91 p.

Gray, H.H., Forsyth, J.L., Schneider, A.F., and Gooding, A.M., 1972, Regional geologic map no. 7, Cincinnati sheet, part B: Bloomington, Indiana Geological Survey, 1 sheet, scale 1:250,000.

Indiana Department of Conservation, 1959, Map of Whitewater Lake showing depth contours and surrounding conditions, Union County: Indianapolis, Division of Water Resources, 1 sheet, scale 1:500.

Indiana Department of Natural Resources, 1988, Water resource availability in the Whitewater River basin, Indiana: Indiana Department of Natural Resources, Division of Water, Water Resource Assessment 88-2, 126 p.

Indiana, State 208, Water quality management planning maps, region 9: Data from Indiana State Board of Health, Base from U.S. Geological Survey 1:250,000 quadrangle maps.

Schneider, A.F., 1966, Physiography, *in* Lindsay, A.A., ed., Natural features of Indiana--Symposium, 1966: Indianapolis, Indiana Academy of Science, p. 40-56.

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SUPPLEMENTAL DATA

(Tables 1-25)

Table 1.--Width and depth data for transect A, Whitewater Lake, June 1988

Transect A					
Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)
0	0	106	35	939	23
17	1	113	36	942	22
23	2	118	37	943	21
27	3	119	38	946	20
31	4	140	38	948	19
34	5	144	37	950	18
37	6	158	36	952	17
40	7	161	36	954	16
44	8	225	35	957	15
47	9	405	37	960	14
49	10	418	37	962	13
52	11	427	37	966	12
56	12	448	36	969	11
58	13	486	36	974	10
61	14	620	35	980	9
63	15	706	35	986	8
65	16	717	36	998	7
67	17	742	36	1,012	0
70	18	768	35		
72	19	771	34		
74	20	773	33		
75	21	780	32		
77	22	793	32		
79	23	800	33		
80	24	802	34		
81	25	829	34		
83	26	834	33		
84	27	844	32		
85	28	865	31		
87	29	876	30		
89	30	894	29		
91	31	907	28		
92	32	920	27		
93	33	929	26		
95	33	934	25		
102	34	937	24		

[1]Measured from north to south.
[2]Depth below pool stage of 821 feet (above sea level).

Table 2.--Width and depth data for transects B and C, Whitewater Lake, June 1988

Transect B				Transect C			
Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)
0	0	829	29	0	0	193	39
40	26	847	28	16	12	428	40
41	27	859	27	21	13	463	40
43	28	864	26	24	14	518	39
44	29	865	25	28	15	522	38
46	30	867	24	30	16	525	37
47	31	869	23	32	17	527	36
48	32	871	22	35	18	529	35
48	33	873	21	37	19	531	34
49	34	875	20	40	20	533	33
50	35	878	19	41	21	536	32
51	36	879	18	43	22	539	31
53	37	881	17	44	23	541	30
57	38	883	16	45	23	545	29
60	39	886	15	46	25	548	28
61	40	888	14	47	26	550	27
79	40	891	13	49	27	553	26
90	39	893	12	50	28	555	25
91	38	895	11	51	29	557	24
96	37	899	10	52	30	560	23
176	38	903	9	55	31	563	22
195	39	907	8	56	32	565	21
232	39	914	7	56	33	568	20
240	38	948	0	58	34	571	19
290	37			68	35	574	18
301	37			76	36	576	17
325	38			79	37	578	16
345	38			80	38	581	15
514	37			82	39	584	14
552	36			89	40	587	13
627	35			116	40	591	12
650	34			118	39	595	11
680	33			125	38	645	0
766	32			168	39		
802	31			171	40		
819	30			179	40		

[1]Measured from west to east.
[2]Depth below pool stage of 821 feet (above sea level).

Table 3.--Width and depth data for transect D, Whitewater Lake, June 1988

Transect D			
Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)
0	0	671	31
81	24	673	30
84	25	676	29
89	26	678	28
95	27	680	27
101	28	682	26
105	29	684	25
108	30	687	24
109	31	690	23
110	32	692	22
112	33	694	21
115	34	696	20
118	35	700	19
120	36	703	18
132	37	715	17
216	38	718	16
218	39	721	15
219	40	724	14
221	41	727	13
247	41	729	12
251	40	731	11
255	39	733	10
296	39	737	9
299	40	743	8
300	41	773	0
308	41		
316	40		
639	40		
649	39		
653	38		
654	37		
658	36		
661	35		
662	34		
664	32		
667	32		

[1]Measured from west to east.
[2]Depth below pool stage of 821 feet (above sea level).

Table 4.--Width and depth data for transect E, Whitewater Lake, June 1988

Transect E					
Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)
0	0	250	42	708	12
33	12	281	41	711	11
41	13	289	40	716	10
47	14	294	39	721	9
50	15	319	39	725	8
54	16	349	40	730	7
58	17	398	41	761	0
60	18	480	41		
63	19	542	40		
67	20	625	39		
71	21	636	38		
74	22	643	37		
77	23	646	36		
80	24	648	35		
92	25	650	34		
97	26	653	33		
99	27	655	32		
100	28	657	31		
101	29	660	30		
103	30	662	29		
105	31	665	28		
109	32	668	27		
111	33	670	26		
115	34	673	25		
118	35	676	24		
121	36	678	23		
124	37	680	22		
131	38	683	21		
162	39	686	20		
196	39	690	19		
209	38	692	18		
232	38	694	17		
239	39	696	16		
239	40	699	15		
240	41	701	14		
242	42	704	13		

[1]Measured from west to east.
[2]Depth below pool stage of 821 feet (above sea level).

Table 5.--Width and depth data for transect F, Whitewater Lake, June 1988

Transect F					
Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)
0	0	294	40	720	18
32	10	306	39	724	17
40	11	311	38	728	16
46	12	318	37	733	15
51	13	333	38	738	14
56	14	355	39	743	13
59	15	374	40	749	12
63	16	396	41	753	11
66	17	400	42	759	10
69	18	403	43	764	9
74	19	427	43	770	8
77	20	431	42	778	7
81	21	448	41	786	6
85	22	477	40	799	5
89	23	600	40	869	0
93	24	615	39		
96	25	626	38		
100	26	635	37		
103	27	641	36		
106	28	644	35		
108	29	649	34		
111	30	654	33		
115	31	658	32		
121	32	662	31		
130	33	667	30		
141	34	671	29		
147	35	675	28		
202	36	678	27		
203	37	682	26		
204	38	687	25		
207	39	691	24		
211	40	697	23		
219	41	701	22		
224	42	707	21		
240	42	710	20		
283	41	715	19		

[1]Measured from west to east.
[2]Depth below pool stage of 821 feet (above sea level).

Table 6.--Width and depth data for transect G, Whitewater Lake, June 1988

Transect G					
Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)
0	0	506	38	1,290	24
50	11	550	39	1,292	23
56	12	556	40	1,296	22
61	13	934	40	1,298	21
65	14	943	41	1,301	20
69	15	960	41	1,303	19
73	16	974	40	1,305	18
76	17	991	41	1,308	17
79	18	1,014	41	1,311	16
82	19	1,028	40	1,313	15
84	20	1,039	40	1,316	14
85	21	1,047	41	1,318	13
87	22	1,063	42	1,322	12
89	23	1,087	42	1,326	11
91	24	1,109	41	1,332	10
93	25	1,129	40	1,355	9
95	26	1,140	39	1,386	0
97	27	1,147	38		
98	28	1,155	39		
100	29	1,162	40		
102	30	1,179	40		
107	31	1,212	39		
111	32	1,233	38		
112	33	1,243	37		
114	34	1,251	36		
120	35	1,256	35		
141	35	1,261	34		
161	34	1,265	33		
168	33	1,267	32		
174	32	1,271	31		
187	32	1,273	30		
208	33	1,276	29		
245	34	1,279	28		
313	35	1,281	27		
329	36	1,284	26		
417	37	1,287	25		

[1]Measured from north to south.
[2]Depth below pool stage of 821 feet (above sea level).

Table 7.--Width and depth data for transect H, Whitewater Lake, June 1988

Transect H					
Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)
0	0	432	39	1,179	12
30	8	438	38	1,184	11
36	9	440	38	1,190	10
41	10	465	37	1,197	9
47	11	480	36	1,208	8
50	12	488	35	1,219	7
54	13	506	35	1,245	0
58	14	571	36		
60	15	734	37		
63	16	740	38		
66	17	804	38		
69	18	1,015	37		
73	19	1,058	36		
78	20	1,093	34		
83	21	1,105	34		
89	22	1,108	33		
95	23	1,112	32		
102	24	1,115	31		
110	25	1,118	30		
118	26	1,121	29		
132	27	1,124	28		
162	28	1,127	27		
219	29	1,131	26		
256	30	1,134	25		
288	30	1,137	23		
308	29	1,140	23		
322	29	1,143	22		
325	30	1,146	21		
329	31	1,150	20		
330	32	1,152	19		
334	33	1,156	18		
337	34	1,159	17		
373	35	1,162	16		
401	36	1,166	15		
404	37	1,170	14		
409	38	1,175	13		

[1]Measured from west to east.
[2]Depth below pool stage of 821 feet (above sea level).

Table 8.--Width and depth data for transects I and J, Whitewater Lake, June 1988

Transect I				Transect J			
Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)
0	0	991	35	0	0	1,045	35
31	10	1,022	36	30	7	1,068	36
40	11	1,045	35	49	8	1,106	36
44	12	1,073	34	61	9	1,120	35
48	13	1,084	33	103	10	1,128	34
51	14	1,092	32	117	11	1,135	33
54	15	1,100	31	130	12	1,143	32
56	16	1,106	30	136	13	1,151	31
60	17	1,109	29	141	14	1,154	30
62	18	1,111	28	144	15	1,155	29
66	19	1,113	27	149	16	1,157	28
70	20	1,115	26	161	17	1,159	27
74	21	1,117	25	167	18	1,161	26
80	22	1,118	24	175	19	1,162	25
84	23	1,120	23	186	20	1,164	24
91	24	1,122	22	200	21	1,166	23
98	25	1,123	21	210	22	1,169	22
104	26	1,124	20	223	23	1,172	21
117	27	1,128	19	235	24	1,175	20
138	28	1,131	18	244	25	1,178	19
153	29	1,134	17	253	26	1,181	18
168	30	1,137	16	263	27	1,185	17
185	31	1,139	15	273	28	1,188	16
211	32	1,143	14	283	29	1,192	15
243	33	1,146	13	294	30	1,194	14
275	34	1,196	0	321	31	1,198	13
312	34			342	32	1,202	12
454	35			373	33	1,205	11
469	36			415	34	1,210	10
481	37			481	35	1,215	9
484	38			629	35	1,220	8
502	38			631	36	1,229	7
534	37			641	37	1,260	0
540	36			747	37		
543	35			750	36		
988	35			768	35		

[1]Measured from west to east.
[2]Depth below pool stage of 821 feet (above sea level).

Table 9.--Width and depth data for transect K, Whitewater Lake, June 1988

Transect K			
Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)
0	0	1,068	36
82	8	1,078	36
96	9	1,094	35
108	10	1,129	34
124	11	1,138	33
139	12	1,143	32
147	13	1,145	31
161	14	1,147	30
175	15	1,148	29
178	16	1,149	28
186	17	1,151	27
195	18	1,153	26
204	19	1,155	25
213	20	1,156	24
224	21	1,160	23
235	22	1,167	22
246	23	1,172	21
255	24	1,177	20
264	25	1,182	19
271	26	1,187	18
279	27	1,191	17
291	28	1,251	0
299	29		
312	30		
328	31		
373	32		
416	33		
446	34		
505	35		
692	35		
697	35		
705	36		
771	37		
771	36		
772	35		
1,064	35		

[1]Measured from west to east.
[2]Depth below pool stage of 821 feet (above sea level).

Table 10.--Width and depth data for transects L and M, Whitewater Lake, June 1988

Transect L						Transect M	
Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)
0	0	738	34	1,388	17	0	0
140	11	927	34	1,392	16	22	2
180	12	932	35	1,394	15	27	4
212	13	934	36	1,396	14	32	5
228	14	939	37	1,399	13	35	6
247	15	981	37	1,403	12	38	7
264	16	985	36	1,407	11	41	8
281	16	987	35	1,412	10	43	9
294	16	988	34	1,420	9	45	10
302	16	1,133	33	1,460	0	47	11
315	15	1,158	34			49	12
329	16	1,175	35			52	13
337	17	1,180	34			55	14
348	17	1,237	34			57	15
356	16	1,239	35			60	16
362	15	1,246	35			62	17
374	14	1,256	35			67	18
386	15	1,268	35			78	19
397	16	1,285	34			124	19
406	17	1,327	34			138	18
412	18	1,339	33			154	17
415	19	1,344	32			161	16
418	20	1,346	31			166	15
422	21	1,347	30			172	14
427	22	1,349	29			178	13
435	23	1,351	28			184	12
446	24	1,352	27			191	10
463	25	1,353	26			204	9
478	26	1,354	25			249	0
490	27	1,357	24				
504	28	1,360	23				
518	29	1,368	22				
544	30	1,374	21				
575	31	1,378	20				
621	32	1,383	19				
700	33	1,385	18				

[1]Measured from west to east.
[2]Depth below pool stage of 821 feet (above sea level).
[3]Measured from north to south.

Table 11.--Width and depth data for transects N and O, Whitewater Lake, June 1988

Transect N				Transect O			
Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)
0	0	591	35	0	0	1,156	29
27	4	690	35	100	8	1,163	28
38	5	709	34	111	9	1,166	27
44	6	754	33	124	10	1,168	26
49	7	977	33	138	11	1,169	25
54	8	984	32	152	12	1,171	24
60	9	992	31	159	13	1,173	23
65	10	1,000	30	170	14	1,176	22
70	11	1,007	29	182	15	1,177	21
75	12	1,012	28	192	16	1,179	20
81	13	1,016	27	204	17	1,182	19
86	14	1,018	26	218	18	1,185	18
91	15	1,022	25	234	19	1,187	17
94	16	1,024	24	260	20	1,189	16
99	17	1,027	23	284	21	1,192	15
101	18	1,030	22	311	22	1,194	14
105	18	1,033	21	336	23	1,198	13
110	20	1,036	20	362	24	1,206	12
115	21	1,038	19	386	25	1,214	11
122	22	1,040	18	399	26	1,266	0
130	23	1,043	17	411	27		
140	24	1,046	16	421	28		
154	25	1,049	15	439	29		
173	26	1,051	14	479	30		
192	27	1,093	0	548	30		
211	28			560	31		
225	29			591	32		
244	30			763	32		
279	31			765	33		
379	31			766	34		
395	32			873	34		
460	33			894	33		
532	33			947	32		
544	32			1,132	32		
585	33			1,143	31		
588	34			1,149	30		

[1]Measured from west to east.
[2]Depth below pool stage of 821 feet (above sea level).

Table 12.--Width and depth data for transects P and Q, Whitewater Lake, June 1988

Transect P				Transect Q			
Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)
0	0	1,266	26	0	0	1,183	20
40	4	1,272	25	55	11	1,185	19
56	5	1,276	24	67	12	1,187	18
79	6	1,280	23	81	13	1,190	17
92	7	1,282	22	96	14	1,191	16
108	8	1,332	0	112	15	1,192	15
123	9			131	16	1,193	14
132	10			155	17	1,195	13
142	11			183	18	1,197	12
152	12			208	19	1,198	11
163	13			230	20	1,199	10
173	14			259	21	1,203	9
183	15			290	22	1,233	0
195	16			325	23		
209	17			362	24		
226	18			398	25		
249	19			434	26		
268	20			478	27		
288	21			533	28		
311	22			540	29		
340	23			553	30		
382	24			825	31		
417	25			842	32		
457	26			875	32		
488	27			981	31		
553	28			1,146	31		
576	29			1,162	30		
581	30			1,167	29		
874	31			1,169	28		
913	32			1,172	27		
939	31			1,174	26		
1,046	30			1,176	25		
1,221	30			1,178	24		
1,231	29			1,179	23		
1,243	28			1,180	22		
1,256	27			1,182	21		

[1]Measured from west to east.
[2]Depth below pool stage of 821 feet (above sea level).

Table 13.--Width and depth data for transects R and S, Whitewater Lake, June 1988

Transect R				Transect S			
Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)
0	0	1,254	26	0	0	1,068	27
41	7	1,293	0	30	5	1,072	26
54	8			38	6	1,075	25
64	9			49	7	1,078	24
74	10			59	8	1,080	23
87	11			69	9	1,082	22
98	12			80	10	1,084	21
115	13			95	11	1,088	20
132	14			109	12	1,091	19
151	15			127	13	1,092	18
221	16			142	14	1,096	17
265	17			157	15	1,098	16
295	18			175	16	1,103	15
330	19			192	17	1,111	14
354	20			208	18	1,142	0
387	21			231	19		
408	22			260	20		
428	23			287	21		
447	24			312	22		
468	25			332	23		
508	26			340	24		
528	27			364	25		
536	28			395	26		
576	29			438	27		
677	30			487	28		
810	30			607	29		
884	31			696	30		
934	30			885	30		
1,102	30			924	29		
1,139	29			966	28		
1,179	29			995	28		
1,187	30			1,006	29		
1,223	30			1,011	30		
1,236	29			1,031	30		
1,242	28			1,051	29		
1,249	27			1,064	28		

[1]Measured from west to east.
[2]Depth below pool stage of 821 feet (above sea level).

Table 14.--Width and depth data for transects T and U, Whitewater Lake, June 1988

Transect T				Transect U			
Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)
0	0	1,133	24	0	0	1,059	17
45	5	1,136	23	50	5	1,062	16
56	6	1,139	22	59	6	1,065	15
67	7	1,142	21	65	7	1,068	14
80	8	1,145	20	69	8	1,074	13
94	9	1,148	19	75	9	1,115	0
106	10	1,150	18	83	10		
122	11	1,153	17	92	11		
137	12	1,154	16	111	12		
154	13	1,204	0	138	13		
173	14			172	14		
190	15			211	15		
208	16			247	16		
227	17			274	17		
245	18			309	18		
276	19			337	19		
307	20			414	20		
340	21			466	21		
370	22			483	22		
379	23			502	23		
387	24			528	24		
431	25			564	25		
484	26			660	26		
537	27			693	27		
588	28			712	28		
807	28			982	28		
874	29			1,005	27		
966	28			1,022	26		
1,015	27			1,032	25		
1,033	26			1,039	24		
1,043	27			1,043	23		
1,045	28			1,046	22		
1,079	28			1,049	21		
1,103	27			1,052	20		
1,121	26			1,053	19		
1,129	25			1,057	18		

[1]Measured from west to east.
[2]Depth below pool stage of 821 feet (above sea level).

Table 15.--Width and depth data for transects V, W, X, and Y, Whitewater Lake, June 1988

Transect V		Transect W		Transect X		Transect Y	
Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)
0	0	0	0	0	0	0	0
66	8	40	7	41	4	40	7
73	9	81	8	53	5	46	8
80	10	110	9	62	6	52	9
88	11	144	10	70	7	57	10
99	12	174	11	84	8	63	11
109	13	199	12	121	9	69	12
120	14	226	13	158	10	77	13
135	15	250	14	190	11	91	14
169	16	271	15	230	12	123	15
223	17	296	16	255	13	145	16
271	18	328	17	276	14	173	17
319	19	358	18	291	15	205	18
373	20	408	19	305	16	254	19
420	21	495	20	320	17	327	20
513	22	536	21	345	18	466	20
601	23	583	22	391	19	608	21
661	24	831	23	466	20	704	22
959	25	1,029	24	753	21	731	23
963	26	1,048	25	831	22	824	24
1,005	26	1,080	26	969	23	957	24
1,014	25	1,098	26	1,009	24	980	23
1,057	24	1,106	25	1,088	24	989	22
1,066	23	1,164	24	1,106	23	995	21
1,072	22	1,179	23	1,111	22	1,000	20
1,076	21	1,185	22	1,115	21	1,003	19
1,080	20	1,191	21	1,119	20	1,008	18
1,083	19	1,196	20	1,123	19	1,012	17
1,086	18	1,199	19	1,127	18	1,016	16
1,088	17	1,204	18	1,129	17	1,019	15
1,090	16	1,207	17	1,132	16	1,023	14
1,093	15	1,211	16	1,172	0	1,026	13
1,096	14	1,215	15			1,031	12
1,099	13	1,268	0			1,072	0
1,100	12						
1,139	0						

[1]Measured from west to east.
[2]Depth below pool stage of 821 feet (above sea level).

Table 16.--Width and depth data for transects Z, AA, BB, and CC, Whitewater Lake, June 1988

Transect Z		Transect AA		Transect BB		Transect CC	
Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)	Width[3] (feet)	Depth[2] (feet)	Width[3] (feet)	Depth[2] (feet)
0	0	0	0	0	0	0	0
57	5	39	6	57	4	81	4
63	6	52	7	76	5	98	5
69	7	71	8	87	6	108	6
75	8	85	9	109	7	120	7
79	9	97	10	121	8	142	8
82	10	105	11	130	9	153	7
86	11	110	12	137	10	156	6
93	12	114	13	147	11	158	5
102	13	119	14	169	12	160	4
109	14	122	15	234	12	190	0
115	15	126	16	243	11		
147	16	130	17	247	10		
191	17	152	18	249	9		
231	18	226	19	252	8		
305	19	245	20	253	7		
347	20	432	20	256	6		
362	21	575	21	258	5		
400	20	739	22	260	4		
460	20	768	21	264	3		
542	21	775	20	279	0		
818	22	778	19				
847	21	782	18				
861	20	784	17				
864	19	788	16				
868	18	790	15				
870	17	793	14				
873	16	796	13				
876	15	801	12				
878	14	806	11				
881	13	853	0				
883	12						
885	11						
889	10						
928	0						

[1]Measured from west to east.
[2]Depth below pool stage of 821 feet (above sea level).
[3]Measured from north to south.

Table 17.--Width and depth data for transects DD, EE, FF, and GG, Whitewater Lake, June 1988

Transect DD		Transect EE		Transect FF		Transect GG	
Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)
0	0	0	0	0	0	0	0
22	4	41	9	59	14	41	8
33	5	47	10	95	16	51	9
44	6	50	11	351	17	56	10
51	7	54	12	447	18	64	11
64	8	58	13	522	19	72	12
74	9	64	14	615	19	86	13
84	10	73	15	645	18	101	14
95	11	94	16	655	17	121	15
107	12	144	17	662	16	170	16
117	13	256	18	670	15	478	16
121	14	389	19	678	14	526	17
125	15	572	19	683	13	547	16
129	16	614	18	688	12	559	15
133	17	626	17	693	11	567	14
152	17	632	16	700	10	747	0
203	18	637	15	812	0		
230	19	642	14				
304	18	647	13				
353	19	650	12				
473	20	760	0				
613	20						
632	19						
644	18						
653	17						
658	16						
662	15						
664	14						
668	13						
672	12						
676	11						
683	10						
688	9						
695	8						
735	0						

[1]Measured from west to east.
[2]Depth below pool stage of 821 feet (above sea level).

Table 18.--Width and depth data for transects HH, II, JJ, and KK, Whitewater Lake, June 1988

Transect HH		Transect II		Transect JJ		Transect KK	
Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)	Width[3] (feet)	Depth[2] (feet)
0	0	0	0	0	0	0	0
38	11	52	11	40	8	24	3
42	12	60	12	48	9	32	4
47	13	71	13	61	10	38	5
56	14	104	14	92	11	46	5
92	15	572	14	148	12	58	5
532	16	588	13	250	13	64	6
550	15	592	12	334	14	71	5
562	14	597	11	593	14	77	6
586	13	600	10	611	13	100	6
594	12	604	9	615	12	107	5
601	11	606	8	620	11	114	4
607	10	725	0	624	10	120	3
612	9			629	9	166	0
618	8			635	8		
635	7			644	7		
755	0			656	6		
				737	0		

[1]Measured from west to east.
[2]Depth below pool stage of 821 feet (above sea level).
[3]Measured from north to south.

Table 19.--Width and depth data for transects LL, MM, NN, and OO, Whitewater Lake, June 1988

Transect LL		Transect MM		Transect NN		Transect OO	
Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)
0	0	0	0	0	0	0	0
21	8	39	8	57	9	95	8
36	9	252	9	468	10	503	9
81	10	553	10	800	10	927	9
245	11	725	11	816	9	979	8
332	12	819	12	898	0	1,047	0
443	12	875	11				
496	13	890	10				
536	13	957	0				
564	12						
579	11						
601	10						
645	0						

[1]Measured from west to east.
[2]Depth below pool stage of 821 feet (above sea level).

Table 20.--Width and depth data for transects PP, QQ, RR, and SS, Whitewater Lake, June 1988

Transect PP		Transect QQ		Transect RR		Transect SS	
Width[1] (feet)	Depth[2] (feet)	Width[3] (feet)	Depth[2] (feet)	Width[3] (feet)	Depth[2] (feet)	Width[3] (feet)	Depth[2] (feet)
0	0	0	0	0	0	0	0
30	3	79	3	92	2	30	2
50	4	87	4	123	3	41	3
66	5	113	5	156	5	68	4
88	6	130	6	183	6	109	5
188	6	138	7	197	7	182	5
284	7	152	7	210	6	192	6
392	7	155	6	227	7	307	6
415	6	169	6	277	8	314	5
427	5	221	7	293	7	445	5
484	0	383	8	297	8	459	6
		422	7	334	8	469	7
		468	8	352	7	479	8
		505	7	383	6	516	8
		567	8	392	7	529	7
		580	7	414	6	535	6
		596	8	527	6	576	6
		610	7	538	7	579	5
		629	8	558	8	593	5
		640	7	600	8	597	4
		642	6	615	7	629	3
		688	6	622	6	669	0
		699	5	652	7		
		702	4	674	6		
		715	3	680	5		
		741	0	697	5		
				698	4		
				722	3		
				764	2		
				794	0		

[1]Measured from north to south.
[2]Depth below pool stage of 821 feet (above sea level).
[3]Measured from west to east.

Table 21.--Width and depth data for transects TT and UU, Whitewater Lake, June 1988

Transect TT				Transect UU			
Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)
0	0	325	30	0	0	277	22
30	8	332	29	11	3	279	21
35	9	336	28	23	4	281	20
39	10	337	27	28	5	282	19
44	11	339	26	34	6	285	18
47	12	341	25	38	7	286	17
52	13	343	24	46	8	288	16
54	14	345	23	54	9	291	15
57	15	347	22	61	10	293	14
60	16	350	21	66	11	295	13
62	17	352	20	70	12	298	12
65	18	354	19	76	13	301	11
68	19	357	18	80	14	306	10
71	20	359	17	94	15	309	9
73	21	362	16	100	16	344	0
76	22	366	15	102	17		
79	23	369	14	105	18		
83	24	373	13	106	19		
86	25	377	12	109	20		
89	26	383	11	111	21		
90	27	390	10	113	22		
92	28	420	0	115	23		
98	29			118	24		
106	30			121	25		
118	31			122	26		
129	32			123	27		
182	32			127	28		
190	31			133	29		
240	31			147	29		
251	32			150	28		
255	33			154	27		
273	33			177	26		
288	34			257	26		
300	33			268	25		
307	32			271	24		
314	31			274	23		

[1]Measured from north to south.
[2]Depth below pool stage of 821 feet (above sea level).

Table 22.--Width and depth data for transects VV, WW, and XX, Whitewater Lake, June 1988

Transect VV				Transect WW		Transect XX	
Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)
0	0	353	14	0	0	0	0
50	11	358	13	26	16	71	14
55	12	363	12	32	17	105	14
58	13	368	11	36	18	146	13
61	14	375	10	40	19	172	12
63	15	426	0	44	10	205	11
65	16			48	11	232	10
66	17			52	12	238	9
68	18			56	13	243	8
70	19			60	14	248	7
71	20			75	15	288	0
75	21			99	16		
79	22			128	15		
83	23			145	15		
89	24			151	14		
97	25			246	13		
111	26			298	0		
128	26						
134	24						
137	23						
141	23						
173	23						
214	24						
273	25						
295	26						
312	25						
317	24						
321	23						
328	22						
331	21						
335	20						
337	19						
340	18						
343	17						
347	16						
350	15						

[1]Measured from north to south.
[2]Depth below pool stage of 821 feet (above sea level).

Table 23.--Width and depth data for transects YY, and ZZ, Whitewater Lake, June 1988

Transect YY		Transect ZZ	
Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)
0	0	0	0
27	7	77	4
34	8	102	5
107	8	127	6
139	7	182	6
156	6	238	5
170	5	323	4
181	4	327	3
189	3	335	2
239	0	455	0

[1]Measured from north to south.
[2]Depth below pool stage of 821 feet (above sea level).

Table 24.--Cross-sectional areas for transects A through ZZ, Whitewater Lake, 1959 and 1988

Transect	Cross-sectional area (square feet) 1959	1988	Transect	Cross-sectional area (square feet) 1959	1988	Transect	Cross-sectional area (square feet) 1959	1988
A	30,600	31,200	S	27,700	26,900	KK	570	593
B	33,000	30,800	T	28,800	26,700	LL	8,260	6,850
C	21,000	21,200	U	23,900	22,800	MM	11,400	8,820
D	25,000	25,200	V	24,400	22,500	NN	10,400	8,000
E	26,100	24,900	W	25,900	23,500	OO	11,600	8,370
F	26,300	25,500	X	23,200	20,600	PP	2,120	2,650
G	49,900	47,600	Y	22,100	20,300	QQ	4,650	4,540
H	41,100	38,400	Z	18,000	16,300	RR	3,340	4,180
I	37,800	37,000	AA	16,300	14,800	SS	3,110	3,320
J	37,000	35,900	BB	2,240	2,050	TT	9,760	9,910
K	37,000	34,900	CC	590	719	UU	6,840	6,030
L	35,200	36,700	DD	13,400	11,600	VV	6,550	7,770
M	3,190	2,930	EE	12,800	11,600	WW	3,230	3,410
N	30,900	30,800	FF	13,100	11,900	XX	2,990	2,790
O	32,000	31,300	GG	10,600	9,540	YY	1,560	1,310
P	33,800	32,400	HH	10,900	9,450	ZZ	1,400	1,580
Q	32,700	30,900	II	10,400	8,400			
R	31,800	31,000	JJ	9,730	8,250			

Table 25.--Area remaining, expressed as a percentage, in cross-sectional areas, Whitewater Lake, 1959-88

Transect	Percentage	Transect	Percentage	Transect	Percentage
A	102	S	97.1	KK	104
B	93.3	T	92.7	LL	82.9
C	101	U	95.4	MM	77.4
D	101	V	92.2	NN	76.9
E	95.4	W	90.7	OO	72.2
F	97.0	X	88.8	PP	125
G	95.4	Y	91.9	QQ	97.6
H	93.4	Z	90.6	RR	125
I	97.9	AA	90.8	SS	107
J	97.0	BB	91.5	TT	102
K	94.3	CC	122	UU	88.2
L	104	DD	86.6	VV	119
M	91.8	EE	90.6	WW	106
N	99.7	FF	90.8	XX	93.3
O	97.8	GG	90.0	YY	84.0
P	95.9	HH	86.7	ZZ	113
Q	94.5	II	80.8		
R	97.5	JJ	84.8		

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