SEDIMENTATION IN VERSAILLES LAKE, RIPLEY COUNTY, SOUTHEASTERN INDIANA, 1956-88

By Danny E. Renn and Leslie D. Arihood

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Multiply	By	To obtain
acre	0.4047	hectare
cubic foot (ft^3/s)	0.02832	cubic meter
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
inch (in.)	2.54	centimeter
mile (mi)	1.609	kilometer
square foot (ft^2)	0.09290	square meter
square mile (mi^2)	2.590	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.

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ABSTRACT

Sedimentation has affected the storage capacity and surface area of Versailles Lake. The lake was constructed by damming Laughery Creek in 1956. At the dam, the drainage area of Laughery Creek is 168 square miles. Locations where the largest amount of sediment has accumulated for the 32-year period 1956-88, are in the upper end of the lake where Laughery Creek enters and in the middle part of the lake; however, sediment has also accumulated in the rest of the lake. The surface area of the lake for 1956 was 10,400,000 square feet (239 acres) and for 1988 was 9,700,000 square feet (223 acres).

In 1956, the volume of water in Versailles Lake was 115,000,000 cubic feet; in 1988, the volume was 73,400,000 cubic feet. The amount of sediment accumulation in the lake during 1956-88 was 41,600,000 cubic feet. In 1988, the volume of water remaining in the lake was 63.8 percent of the 1956 volume; 36.2 percent of the 1956 lake volume had filled with sediment. The annual rate of sediment accumulation in the lake during 1956-88 was 1,300,000 cubic feet per year.

Potential decreases in the storage capacity of Versailles Lake for the 32-year period 1989-2020 were estimated. The percentage volume of water in the lake in 2020 is expected to be 28 percent of the 1956 volume; 72 percent of the lake is expected to be filled with sediment.

Physiographic data indicate no distinct source areas in the drainage basin of Laughery Creek that are contributing unusually large amounts of sediment to Versailles Lake.

INTRODUCTION

Versailles Lake is located in Versailles State Park, near the town of Versailles, in Ripley County, southeastern Indiana (fig. 1). The lake is used for recreation and is the sole source of water for the town of Versailles. The lake is managed by the Indiana Department of Natural Resources. Accumulation of sediment in the lake can decrease the storage capacity of the lake and can affect recreational use and water-supply availability. Therefore, information about the location, amount, annual rate of sediment accumulation, and the potential for future decreases in storage capacity 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.

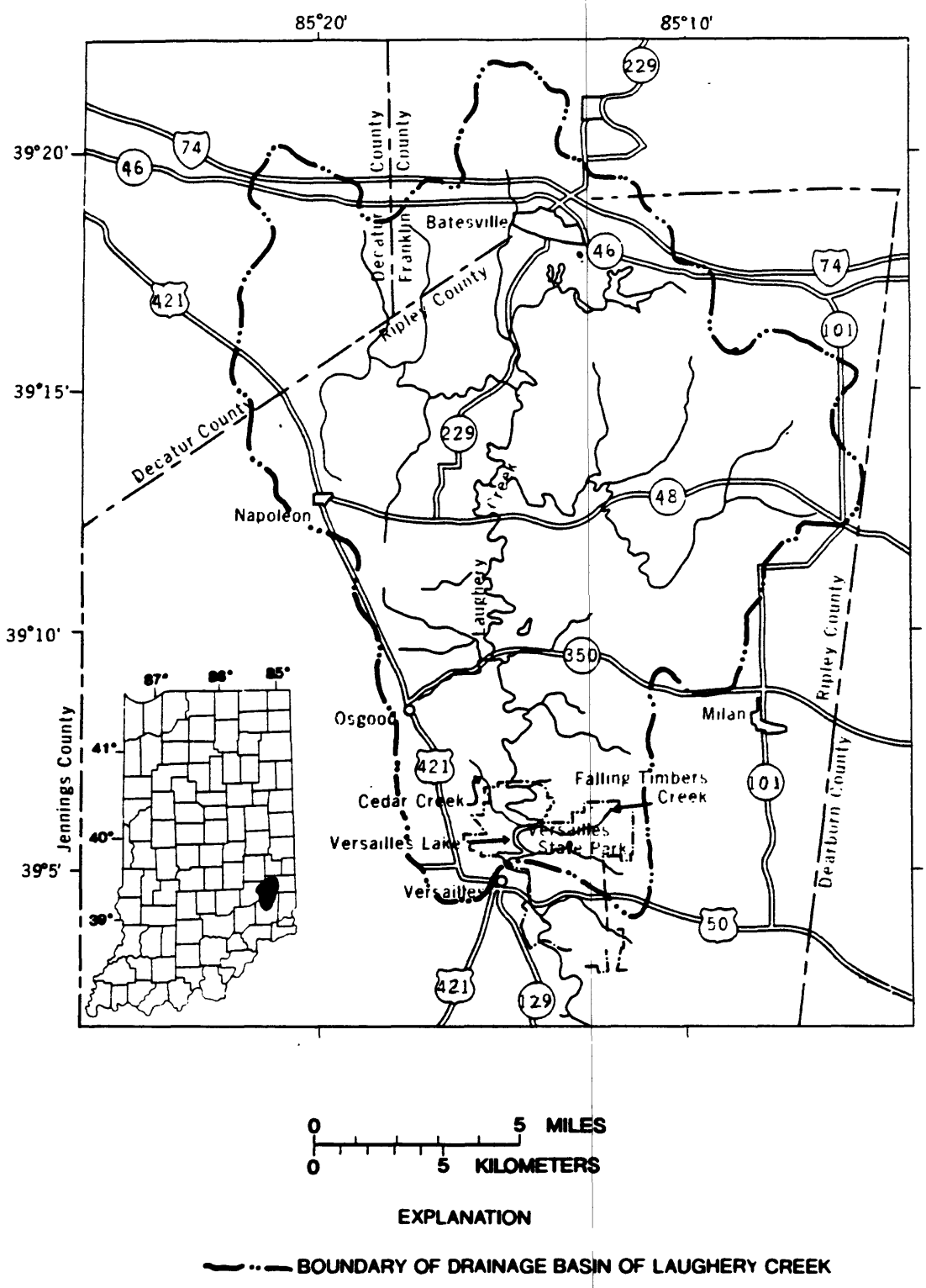


Figure 1.-- Location of Versailles Lake and drainage basin of Laughery Creek upstream from dam.

Purpose and Scope

This report presents (1) locations of sediment accumulation in Versailles Lake for the 32-year period 1956-88; (2) the amount and annual rate of sediment accumulation in the lake during 1956-88; and (3) estimated decreases in the storage capacity of the lake for the 32-year period 1989-2020. In addition, the report determines whether there are areas in the drainage basin of Laughery Creek that might be contributing unusually large amounts of sediment to the lake.

Width, depth, and surface-area data were used to locate areas of sediment accumulation in Versailles Lake during 1956-88. Depth-contour data were used to determine the amount and the annual rate of sediment accumulation in the lake during 1956-88. The amount and annual rate of sediment accumulation were used to estimate decreases in the storage capacity of the lake during 1989-2020. Physiographic data were used to identify locations in the drainage basin of Laughery Creek that might be contributing unusually large amounts of sediment to the lake.

Physical Setting

Versailles Lake was created by construction of an earthern dam across Laughery Creek. Construction of the dam was started in 1955 and completed in the summer of 1956 (Jay Johnson, Indiana Department of Natural Resources, oral commun., 1987). The water level of the lake is controlled by a concrete spillway with a movable gate. The height of the spillway is approximately 790 ft above sea level. Release of water through the gate is controlled by the personnel of Versailles State Park. Generally, water is not released (Ted Tapp, Property Manager, Versailles State Park, oral commun., 1988). Water levels for the lake (U.S. Geological Survey lake-level recording station 03276800) indicate that, except for periods of intensive rainfall, the lake level is generally at or near 790 ft above sea level. During periods of intensive rainfall, the level of the lake increases and decreases rapidly without any changes of the gate.

Versailles Lake receives drainage from Laughery Creek. Most of the drainage basin of Laughery Creek is in Ripley County, but parts are in southeastern Decatur County and southwestern Franklin County (fig. 1). At the dam, the drainage area of Laughery Creek is 168 mi^2. The length of Laughery Creek from where it enters the lake to where it becomes intermittent is 43.4 mi. Two small tributaries enter directly into the lake: Falling Timbers Creek from the east (drainage area of 6.00 mi^2) and Cedar Creek from the west (drainage area of 4.58 mi^2) (fig. 1).

Geology

The drainage basin of Laughery Creek upstream from the dam of Versailles Lake is underlain by sedimentary rocks, most of which are carbonates. The basin is primarily underlain by Ordovician limestones and shales (fig. 2) (Gray and others, 1972); however, the extreme western part of the basin is underlain by Silurian limestones, dolomites, and shales (fig. 2) (Gray and others, 1972).

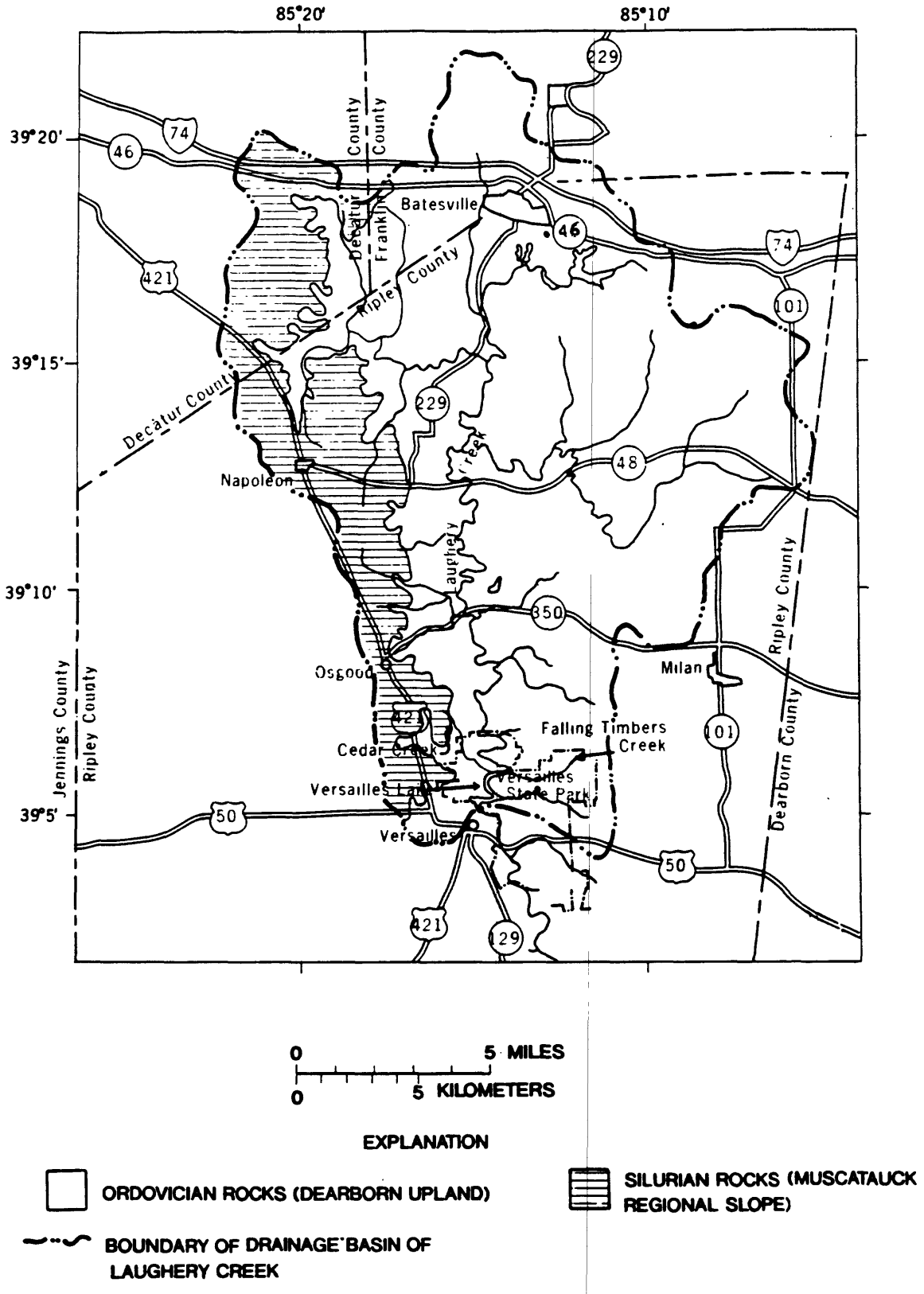


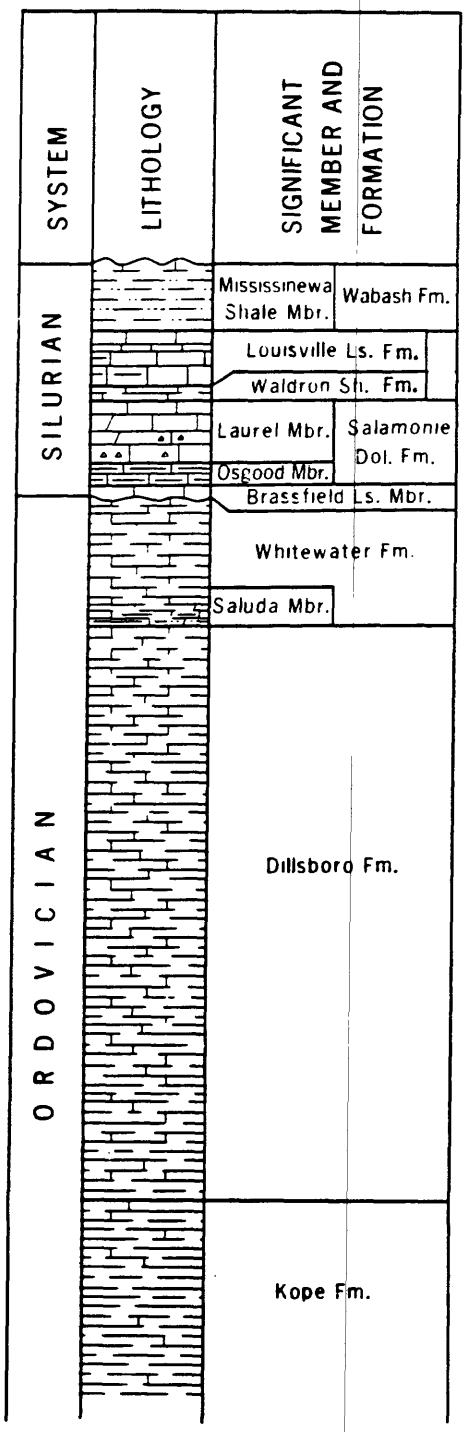
Figure 2.-- Location of Ordovician and Silurian rocks and the Dearborn Upland and Muscatauck Regional Slope in drainage basin of Laughery Creek (modified from Gray and others, 1972).

The Ordovician limestones and shales (fig.3) is virtually flat lying, whereas the Silurian bedrock slopes gently to the west. Two major Ordovician rock units are the Saluda Member of the Whitewater Formation and the Dillsboro Formation. The Saluda Member, which lies conformably above the Dillsboro Formation, is a gray, silty, dolomitic limestone. Its thickness ranges from approximately 50 ft in the lower part of the basin to 20 ft in the upper part of the basin. The Dillsboro Formation is composed of argillaceous, rubbly limestone and calcareous shale. It is about 400 ft thick in the basin. The Saluda Member is more resistant than the Dillsboro Formation; thus, it is a ridge-forming rock unit, whereas the Dillsboro Formation is a valley-forming rock unit. The bedrock is overlain by thin unconsolidated glacial-till deposits of Holocene age (Gray and others, 1972). The till is composed of clay- to gravel-size deposits and generally is present in the upland areas. The average thickness of the till is 20 ft, but in the northern part of the basin, the till can be as much as 50 ft thick. In parts of the basin, generally in the upland areas, the till is overlain by thin deposits of loess.

The drainage basin of Laughery Creek is in the Dearborn Upland and the Muscatatuck Regional Slope physiographic units (fig. 2) (Schneider, 1966, p. 41). The Dearborn Upland unit coincides with the Ordovician bedrock and the Muscatatuck Regional Slope unit coincides with the Silurian bedrock. Both physiographic units are dissected plateaus, and some parts are so dissected that the upland surfaces have been destroyed. Because of the difference in bedrock resistance, the topography of the drainage basin of Laughery Creek is characterized by nearly level uplands and entrenched valleys. The upland areas, the result of the resistant Saluda Member, are nearly equal in elevation at approximately 1,000 ft above sea level. The valleys, the result of the non-resistant Dillsboro Formation, range in shape from the U-shaped Laughery Creek valley to the V-shaped valleys of the tributaries.

Soils

The soils of the Laughery Creek drainage basin are grouped into three major soil associations (fig. 4)--Avonburg and Cobbsfork (Cobbsfork is termed Clermont in Decatur and Franklin Counties); Cincinnati, Hickory, and Rossmoyne; and Carmel, Eden, and Switzerland (Rogers, 1950, Shively, 1983, and McWilliams, 1985). The Avonburg and Cobbsfork soils are found on upland ridgetops that range from nearly level to gently sloping; these soils are poorly to somewhat poorly drained, are formed in loess and till, and are associated with agricultural areas. The Cincinnati, Hickory, and Rossmoyne soils are found on upland ridgetops and slopes that range from nearly level to steep; these soils are generally well drained, are formed in till, and are generally associated with agricultural areas. The Carmel, Eden, and Switzerland soils are found on slopes that range from steep to very steep; these soils are well drained, are formed in bedrock residuum, and are generally associated with forested areas. The erosion hazard for the Avonburg, Cobbsfork, Rossmoyne, and Switzerland soils is slight. The erosion hazard for the Cincinnati, Hickory, and Carmel soils ranges from slight to moderate. The erosion hazard for the Eden soils is moderate. The Switzerland soil has a moderate infiltration rate when thoroughly wet; thus, the runoff potential for this soil ranges from low to medium. The Avonburg, Cincinnati, Hickory, Rossmoyne, Carmel, and Eden soils have a slow infiltration rate when thoroughly wet; thus, the runoff potential for these soils ranges from medium to high. The Cobbsfork soil has a very slow infiltration rate when thoroughly wet; thus, the runoff potential for this soil is high.



EXPLANATION

Dol. Dolomite Ls. Limestone Sh. Shale

Fm. Formation Mbr. Member

Figure 3.-- Generalized geologic column showing names and positions of formations and significant members of the Ordovician and Silurian Systems in drainage basin of Laughery Creek (modified from Gray and others, 1972).

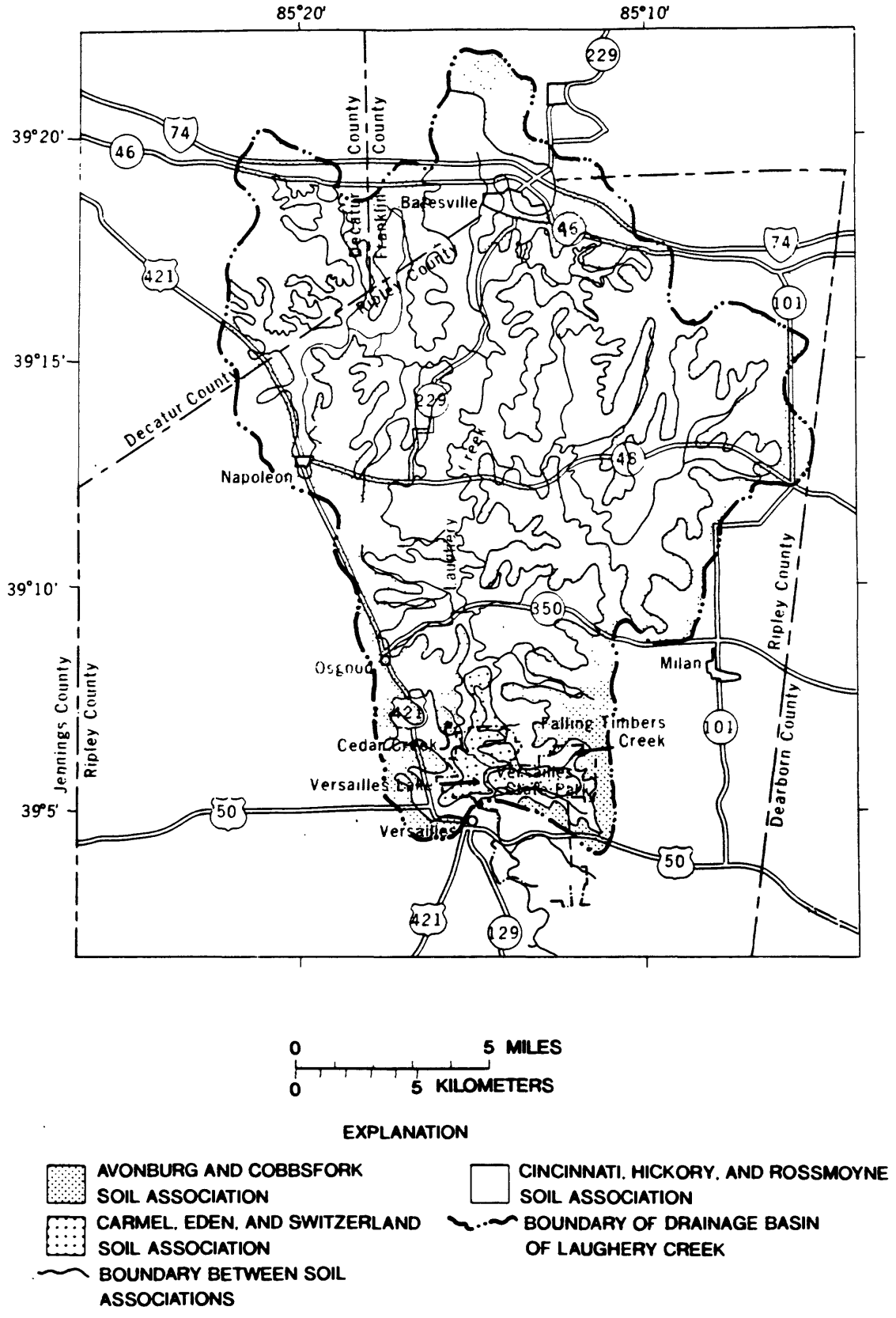


Figure 4.-- Location of major soil associations in drainage basin of Laughery Creek (modified from Rogers and others, 1950, Shively, 1983, and McWilliams, 1985).

Land Use

A grid network was overlain on aerial photographs taken in 1977 to categorize land use within the drainage basin of Laughery Creek. The predominant land use was determined at each of the 102 grid intersections and a land-use code was assigned (fig. 5). By this categorization, land use within the basin is 42 percent row crop, 30 percent forest, and 28 percent pasture. In general, agricultural areas, row crop and pasture, are in upland areas and forested areas are in valleys. The major crops in the basin are corn and soybeans, which are usually tilled conventionally. The same grid network that was used on the 1977 photographs was overlain on aerial photographs taken in 1961 to determine the change in land use over time. Comparisons between the 1961 and 1977 land uses indicate little or no change in land use during that period. Within the drainage basin of Laughery Creek are municipal point-source discharges at Batesville, Napoleon, and Osgood; industrial point-source discharges at Batesville and Napoleon; water-treatment point-source discharge at Batesville; one operating sanitary landfill; two closed sanitary landfills; six confined feedlots; and one crushed-stone quarry (State of Indiana, Water-quality-management planning maps, region 12).

Water Use and Availability

Two municipalities--Versailles and Milan--use Versailles Lake as a source of municipal water supply. Versailles uses the lake as its sole source of water supply, and Milan uses the lake as an auxiliary source to its main water supply. Water withdrawals in Versailles for 1975 were approximately 130,000 gal/d (Governor's Water Resource Study Commission 1980, p. 384); water withdrawals in 1987 were approximately 275,000 gal/d (Ernie Purvis, Versailles Water Department, oral commun., 1987). Water withdrawals for Milan are highly variable; withdrawals in 1987 were approximately 200,000 gal for the entire year (Donald Hamilton, Milan Water Department, oral commun., 1987).

Laughery Creek does not flow continuously. The 7-day, 10-year low flow[1], for Laughery Creek at Farmers Retreat (drainage area of 248 mi^2) is zero, even though the average flow for 33 years is 272 ft^3/s (Stewart, 1983, p. 29). A flow-duration curve for Laughery Creek at Farmers Retreat indicates a lack of ground-water contribution. The bedrock and glacial deposits are poor sources of ground water (Governor's Water Resource Study Commission 1980, p. 376).

METHODS OF INVESTIGATION

Compilation and Collection of Lake Data

Width, depth, surface-area, and depth-contour data for Versailles Lake for 1956 were obtained from a 1959 depth-contour map (Indiana Department of Conservation, 1959). A 1946 U.S. Geological Survey topographic map was modified to produce the 1959 map. Modifications made to the 1946 map were: 5-ft contour intervals were added between the 10-ft contours; contour intervals at the dam

[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).

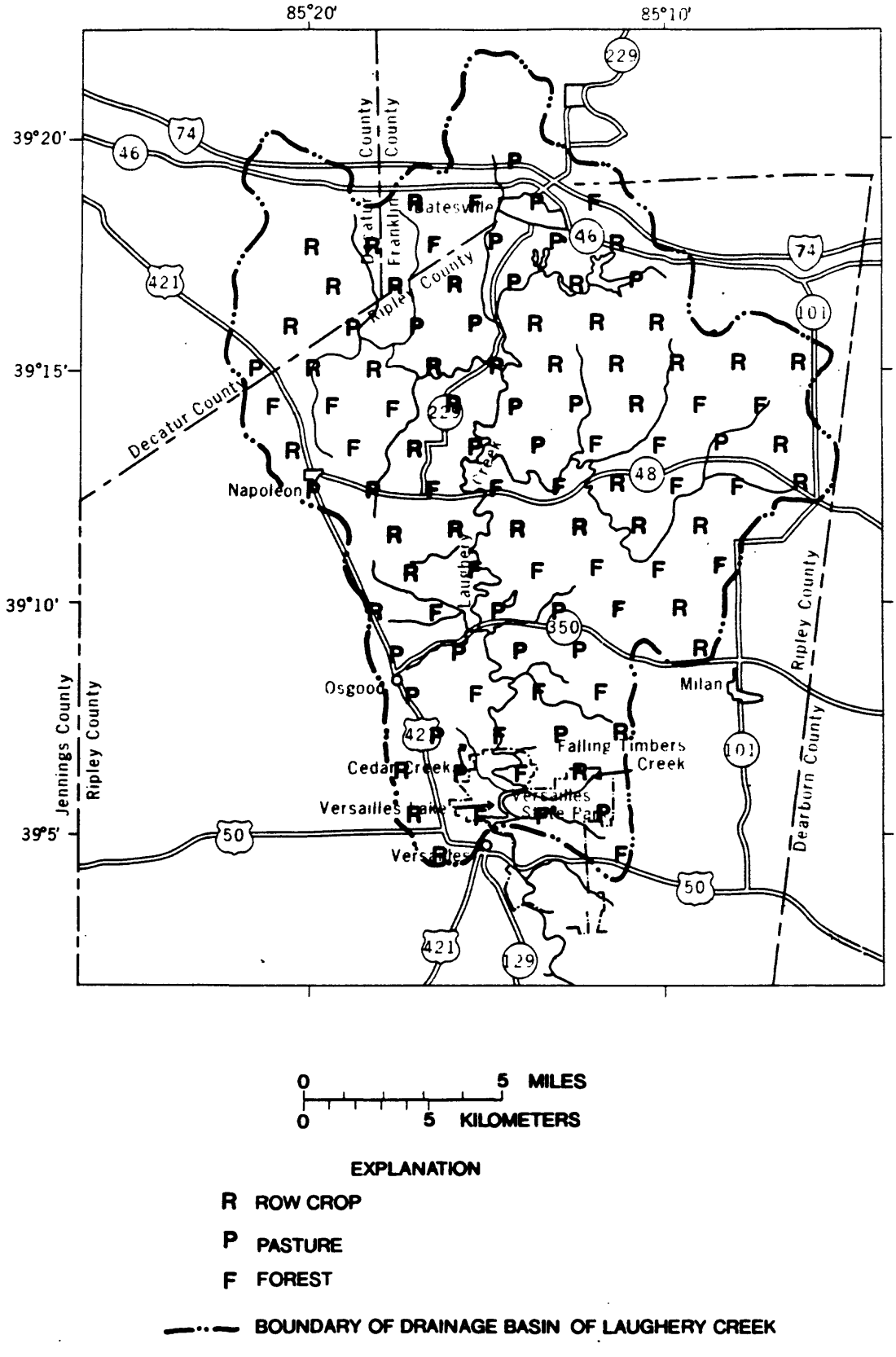


Figure 5.-- Land use in drainage basin of Laughery Creek.

were inferred; and the map scale of one inch equals 2,000 ft was changed to one inch equals 500 ft. Data for the 1946 map were collected in 1943. It was assumed that there had been little or no change in the topography between 1943 and 1956 when the Versailles Lake dam was constructed. Although the channel of Laughery Creek was delineated on the 1959 map, no depth values were noted for the channel. Depth values used for the sides of the channel were those of the nearest contour interval, and the values used for the center of the channel were determined by subtracting 5 ft from the nearest contour interval. The 1959 map provided width and depth data for 48 transects (A through VV; fig. 6). Along each transect, a depth value was determined for each contour interval and for the sides and center of the channel of Laughery Creek. For each depth value, a corresponding width value was determined by measuring the distance from the beginning of the transect to the location of the depth value. Values for the width data were to the nearest 1 ft, and values for the depth data were to the nearest 5 ft.

Width and depth data for Versailles Lake for 1982 were obtained from the Indiana Department of Natural Resources (Bob Wilkerson, Indiana Department of Natural Resources, written commun., 1987). These data were collected during May 1982 at seven transects (C, G, I, J, K, M, and N; fig. 6). Values for the width data were to the nearest 1 ft, and values for the depth data were to the nearest 0.1 ft.

Width and depth data were collected in Versailles Lake during December 1987 at 16 transects (A through P; fig. 6). Widths were measured with a small-diameter graduated steel cable, and depths were measured with a graduated steel tape. Along each transect, at various width intervals, generally 10 ft, a depth value was determined. Values for the width data were to the nearest 1 ft, and values for the depth data were to the nearest 0.1 ft.

Depth data were collected in Versailles Lake during June 1988 at 32 transects (Q through VV; fig. 6). A fathometer was used to measure depth. 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. The width data collected during December 1987 and a visual inspection of the shoreline of the lake made during June 1988 indicate that, with the exception of point bars having formed between transects B and C and at transects F and G (fig. 6), the shoreline had changed little from 1977 to 1988. The shoreline of the 1977 photograph was modified to include the changes, and then used to determine the transect widths and surface area for 1988. Along each transect, a depth value was determined for each 1 ft change in the bottom elevation of the lake. For each depth value, a corresponding width value was determined by measuring the distance from the beginning of the transect to the location of the depth value. Values for the width and depth data were to the nearest 1 ft. The width and depth data for 1987 (tables 1-5 in the "Supplemental Data" section at the end of the report) and the width and depth data for 1988 (tables 6-14 in the "Supplemental Data" section at the end of the report) were used to construct a 1988 depth-contour map (fig. 7) with 2-ft contour intervals.

Collection of Physiographic Data

Physiographic data were collected during August 1988 at 320 sites. Two hundred of the sites were located along roads and were approximately one-half mile apart; 120 of the sites were located whenever a road crossed a stream, regardless of the frequency of crossings. The data consisted of land use, land slope, slope length, farming practice, field-border width, stream-buffer width, and the presence of ephemeral gullies.

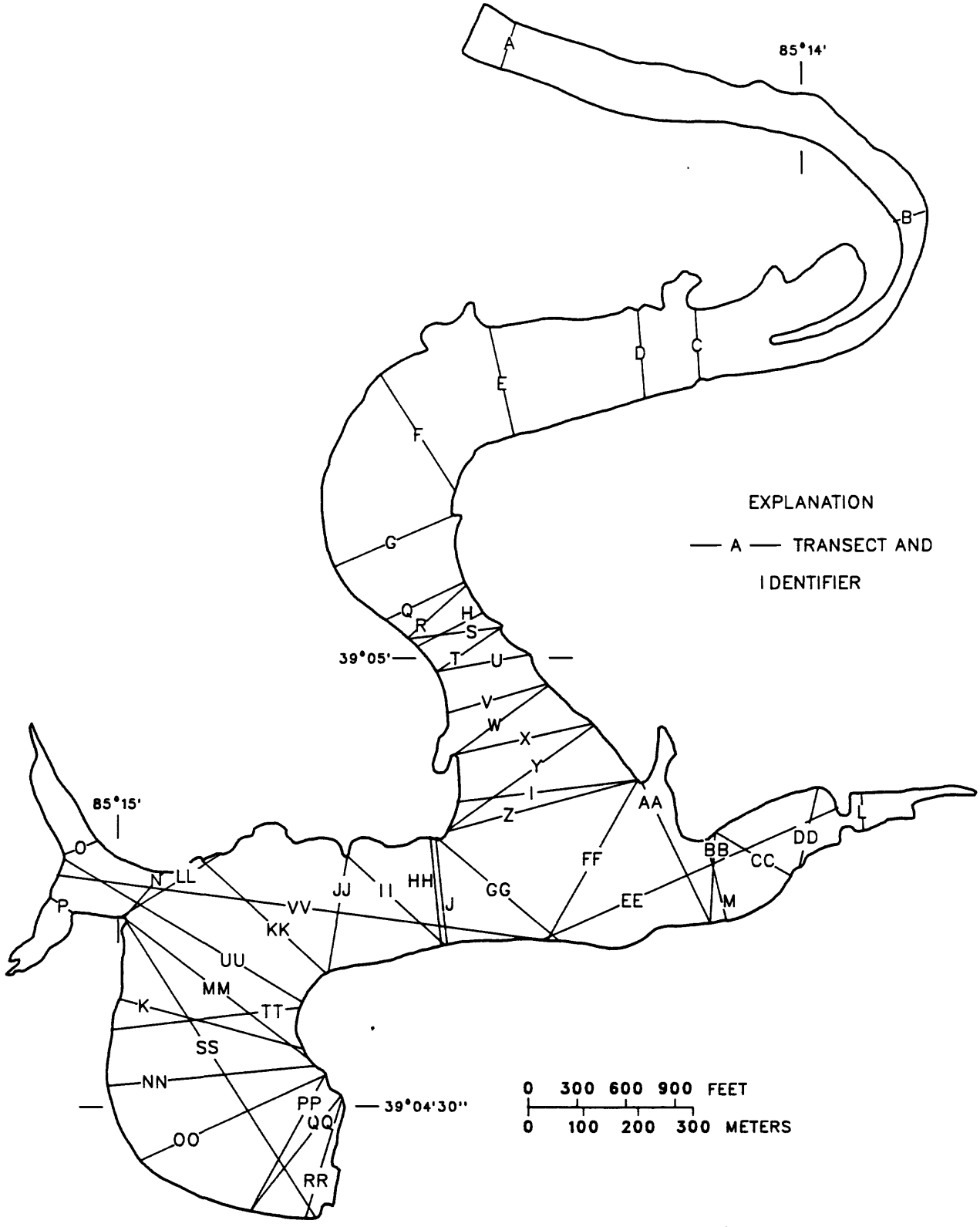


Figure 6.--Shoreline and location of transects, Versailles Lake.

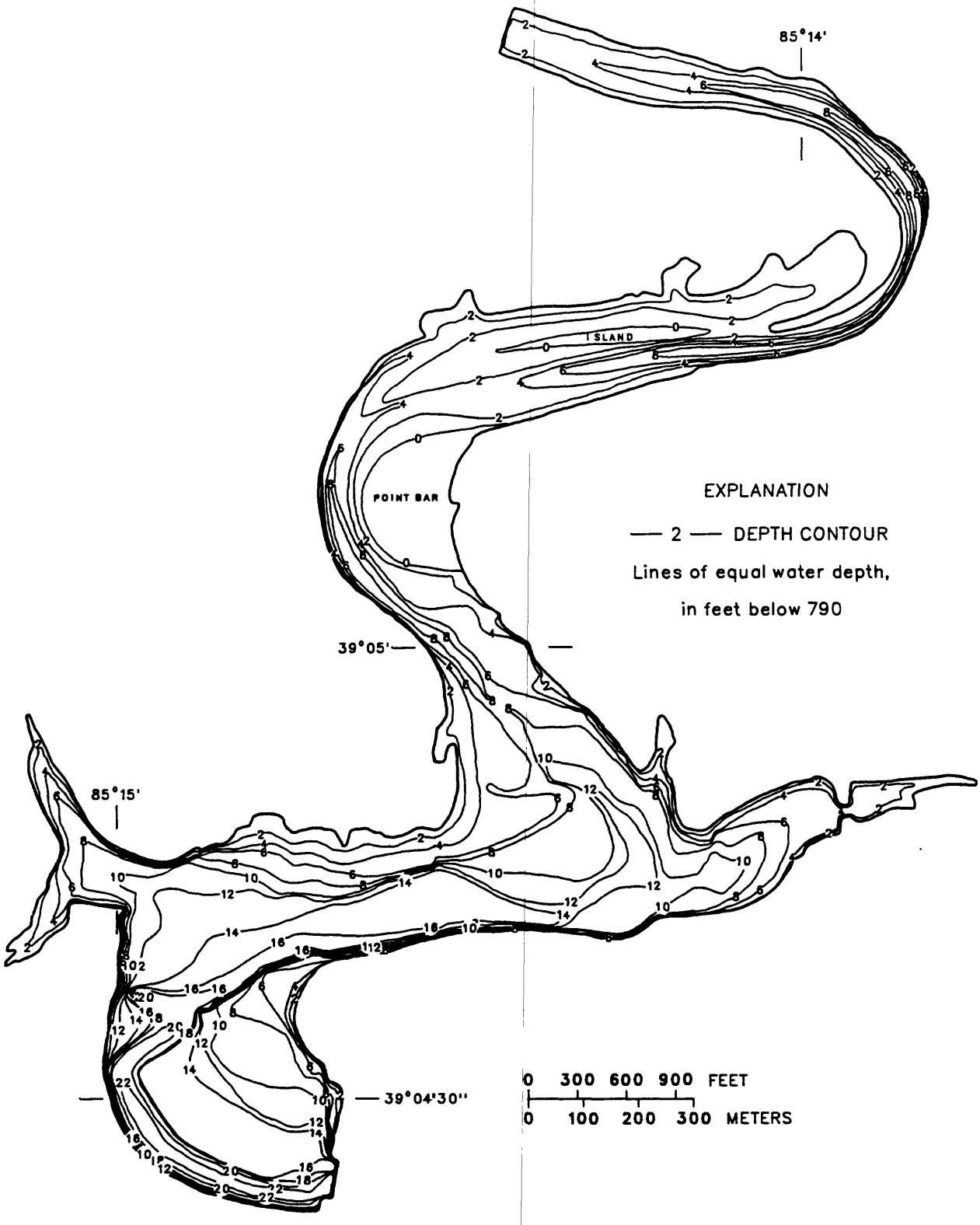


Figure 7.--Depth contours for Versailles Lake, 1988.

SEDIMENTATION IN VERSAILLES LAKE

Areas of sediment accumulation in Versailles Lake from 1956 through 1988 were identified by use of the width and depth data for 1956, 1982, 1987, and 1988 and the surface-area data for 1956 and 1988. The amount and the annual rate of sediment accumulation in the lake from 1956-88 was determined from the depth-contour data for 1956 and 1988.

Sediment Accumulation

Areas of Accumulated Sediment

Cross-sectional profiles for 48 transects, A through VV (figs. 8-23), were constructed by use of the width and depth data. These profiles show where sediment has accumulated. A water-surface datum of 790 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 15 (in the "Supplemental Data" section at the end of the report).

The area remaining was determined for 7 cross-sectional areas for 1956-82, 16 for 1956-87, 32 for 1956-88, and 7 for 1982-87. The area remaining, expressed as a percentage, was determined by dividing one cross-sectional area by another cross-sectional area times 100 (table 16 in the "Supplemental Data" section at the end of the report). Given transect A as an example, the 1987 cross-sectional area of 561 ft^2 divided by the 1956 cross-sectional area of 1,420 ft^2 times 100 equals 39.5; that is, 39.5 percent of the 1956 cross-sectional area remains in 1987. The percentage of change in remaining areas for all cross-sectional areas but one ranged from 14.2 percent (transect E) to 121 percent (transect LL). The change for transect RR was an anomalously high 350 percent. The increase in remaining areas for transects N, LL, and NN probably can be attributed to the fact that the depth values were rounded to the nearest 5 ft for 1956, to the nearest 0.1 ft for 1982 and 1987, and to the nearest 1 ft for 1988. The reason for the large percentage for transect RR can be attributed to the fact that the 1956 depths at the dam were inferred. The largest computed percentage changes in remaining areas, which represent locations where the largest amount of sediment has accumulated, are in the upper end of Versailles Lake where Laughery Creek enters and in the middle part of the lake. Although the largest amount of accumulated sediment was at the upper end and the middle part of the lake, sediment has also accumulated in the rest of the lake. The only significant amount of accumulated sediment for the two tributaries that enter the lake was at the mouth of Falling Timber Creek (transect L).

Sedimentation rates for the transects were determined for the periods 1956-82, 1956-87, 1956-88, and 1982-87 (table 17 in the "Supplemental Data" section at the end of the report). The rates were determined by subtracting one cross-sectional area from another cross-sectional area and then dividing by the number of years between data collection. Given transect A as an example, the 1956 cross sectional area of 1,420 ft^2 subtracted from the 1987 cross sectional area of 561 ft^2 equals 859 ft^2. This value divided by 31 years, (1987 minus 1956), results in an average sedimentation rate of 27.7 ft^2 per year; that is, 27.7 ft^2 of sediment per year was deposited in transect A during 1956-87. The negative values for transects N, LL, NN, and RR can be attributed to the increased cross-sectional area of these transects (table 16).

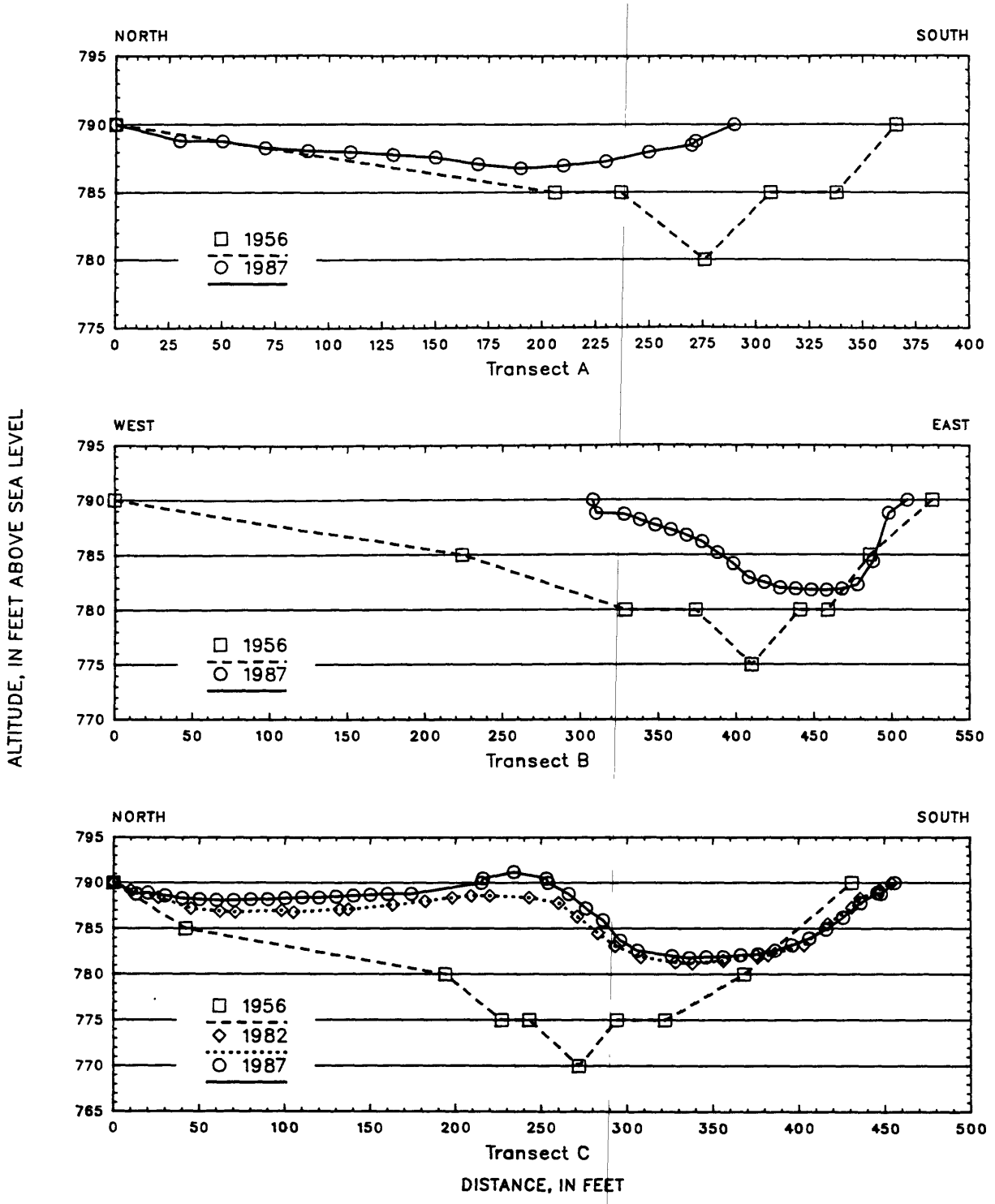


Figure 8.—— Cross sections for transects A, B, and C, Versailles Lake.

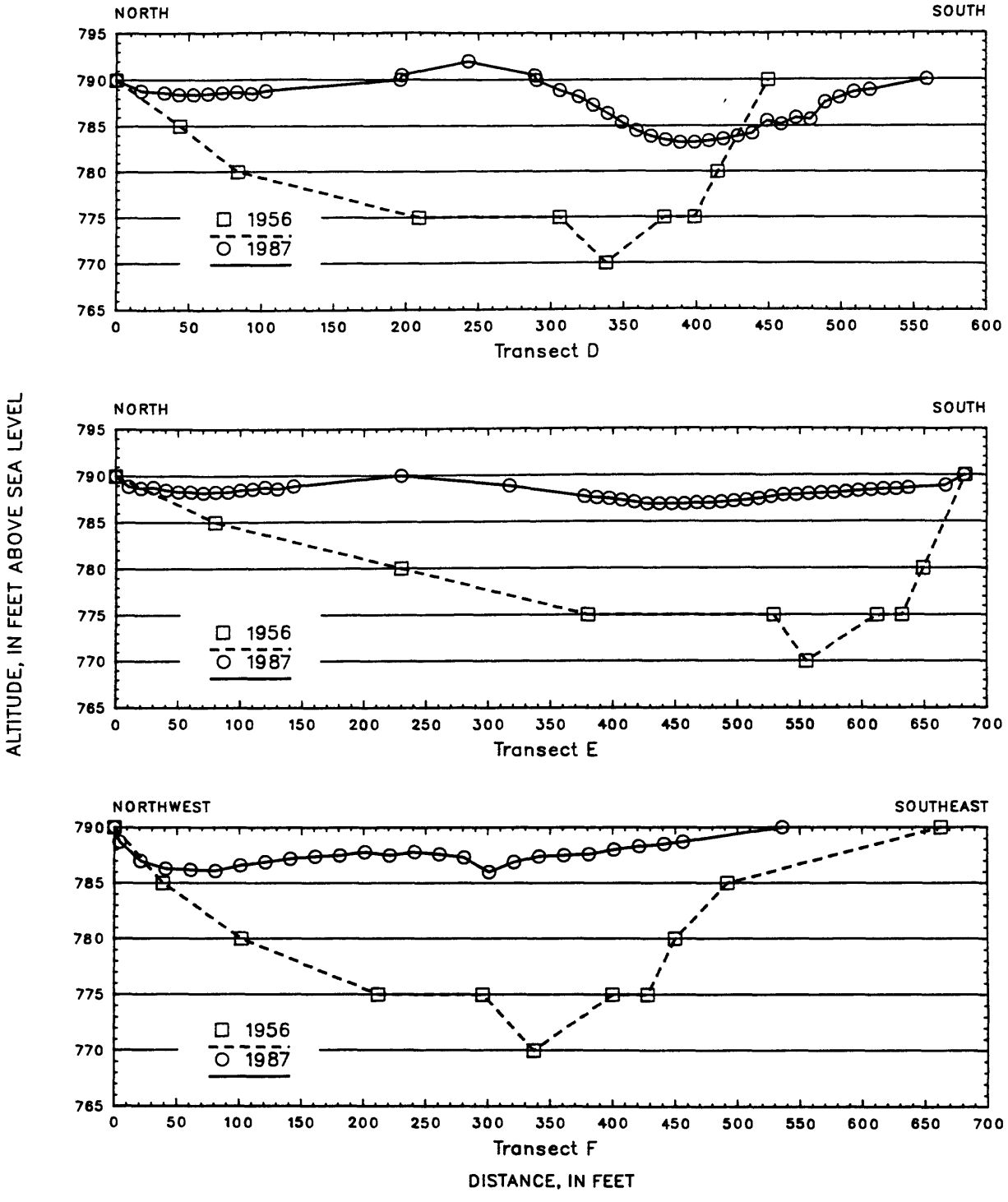


Figure 9.-- Cross sections for transects D, E, and F, Versailles Lake.

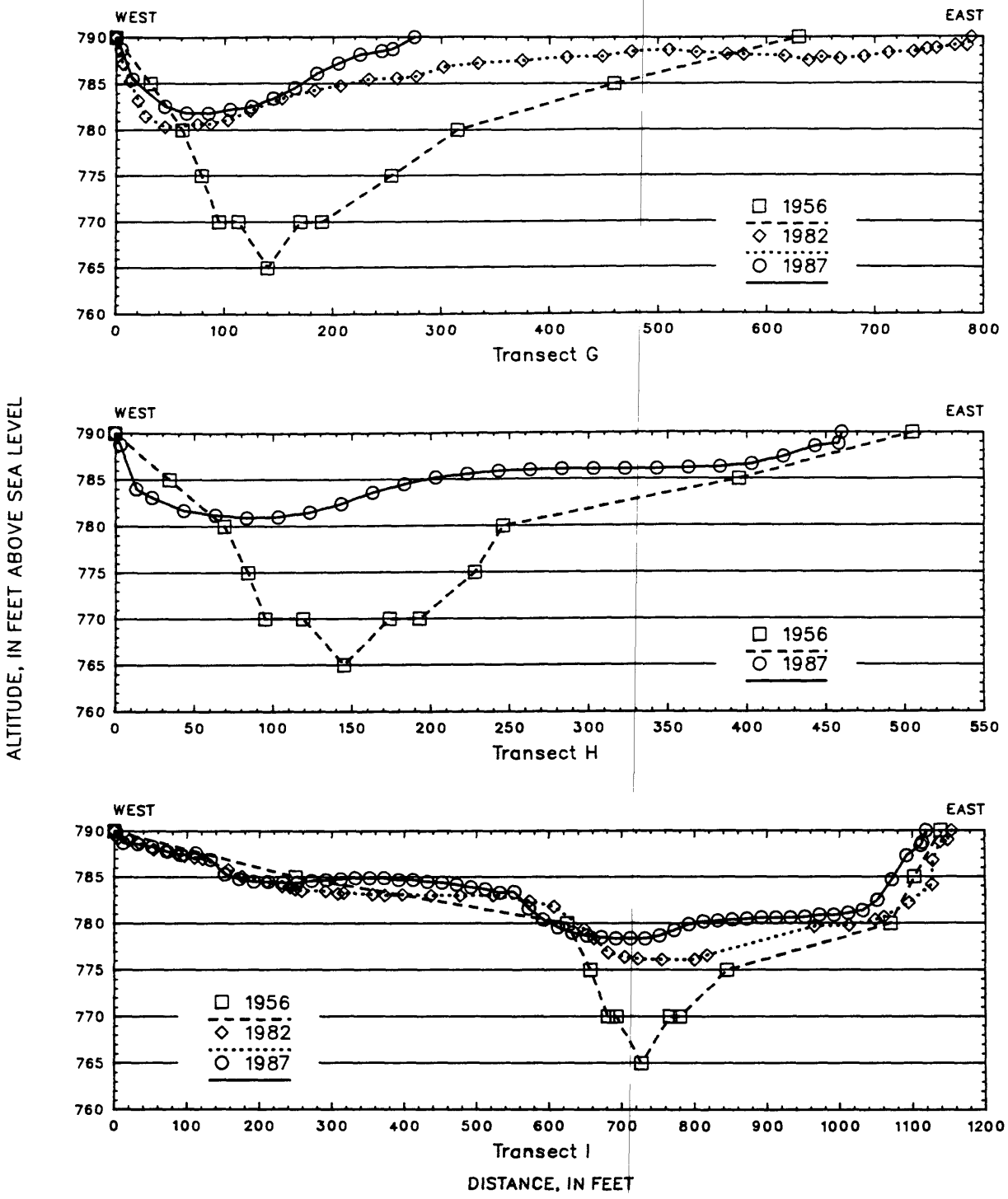


Figure 10.—— Cross sections for transects G, H, and I, Versailles Lake.

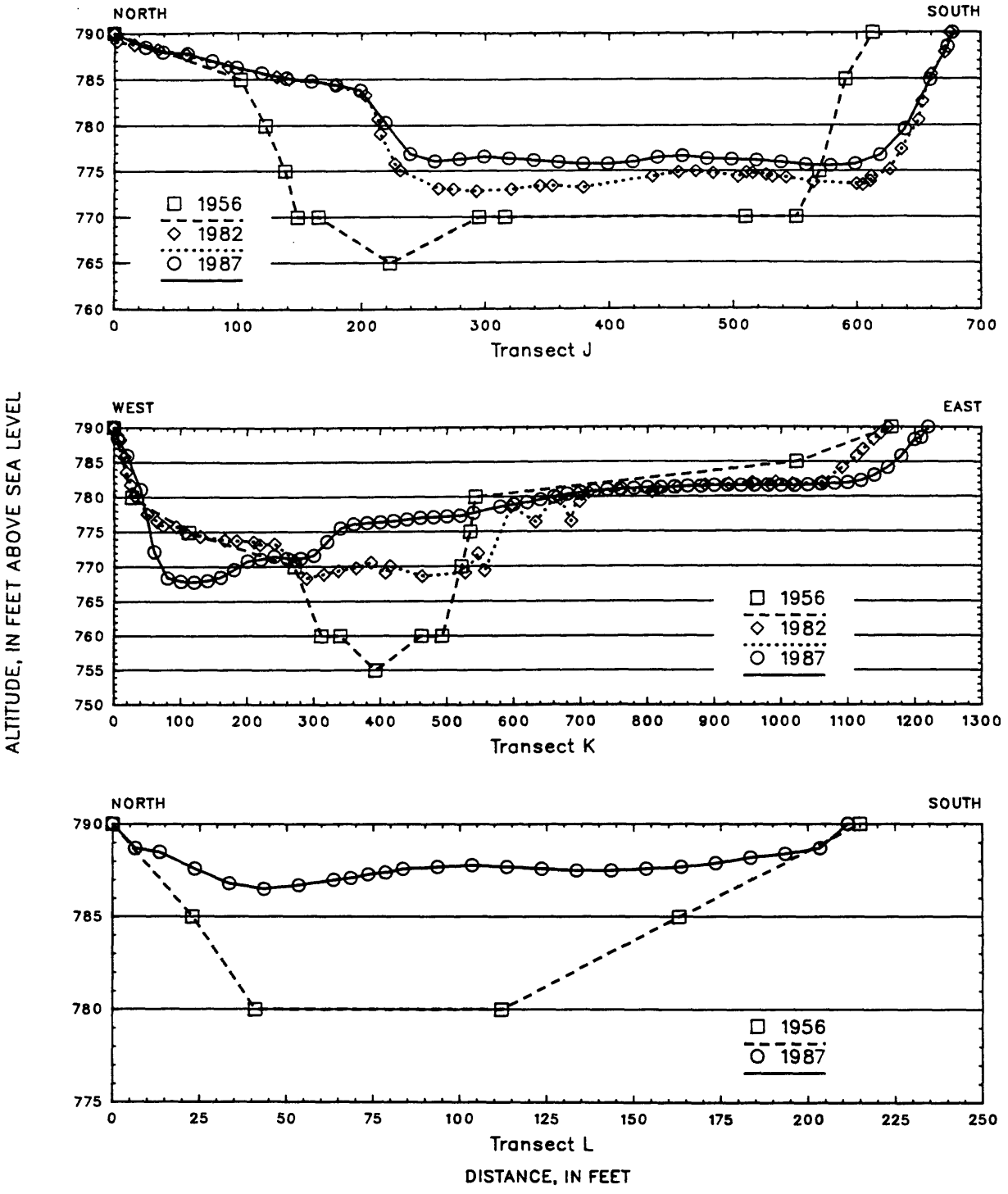


Figure 11.-- Cross sections for transects J, K, and L, Versailles Lake.

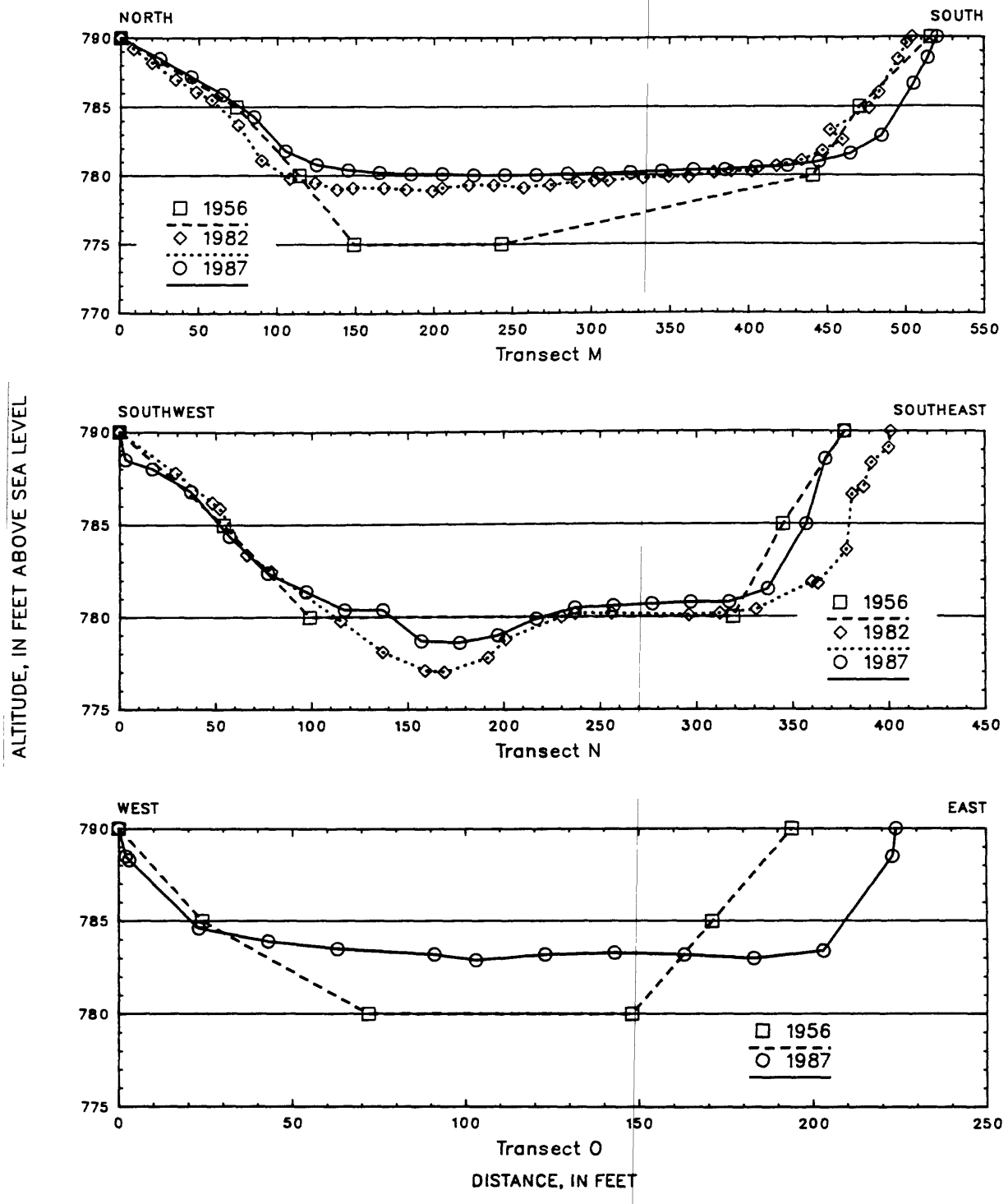


Figure 12.-- Cross sections for transects M, N, and O, Versailles Lake.

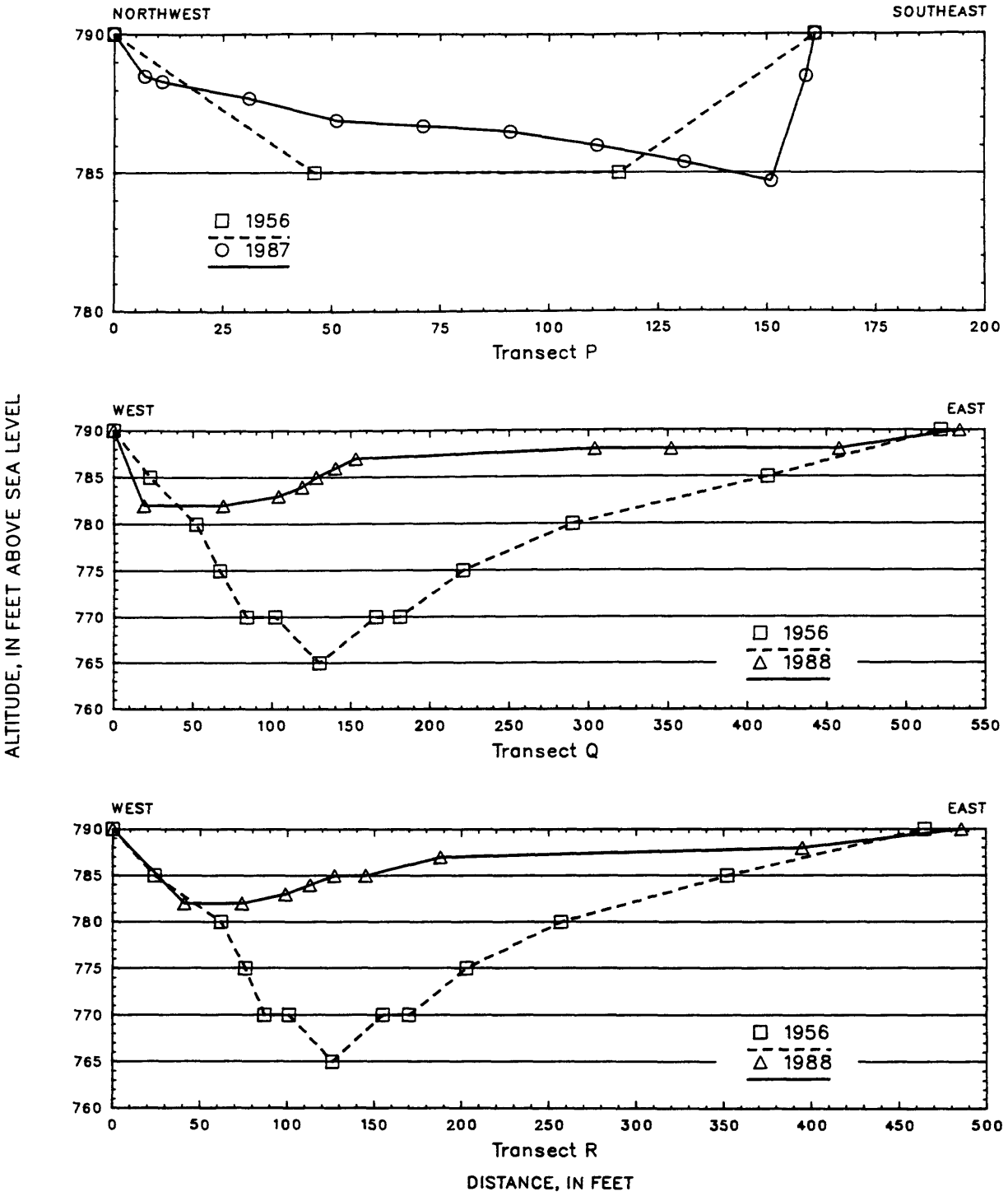


Figure 13.-- Cross sections for transects P, Q, and R, Versailles Lake.

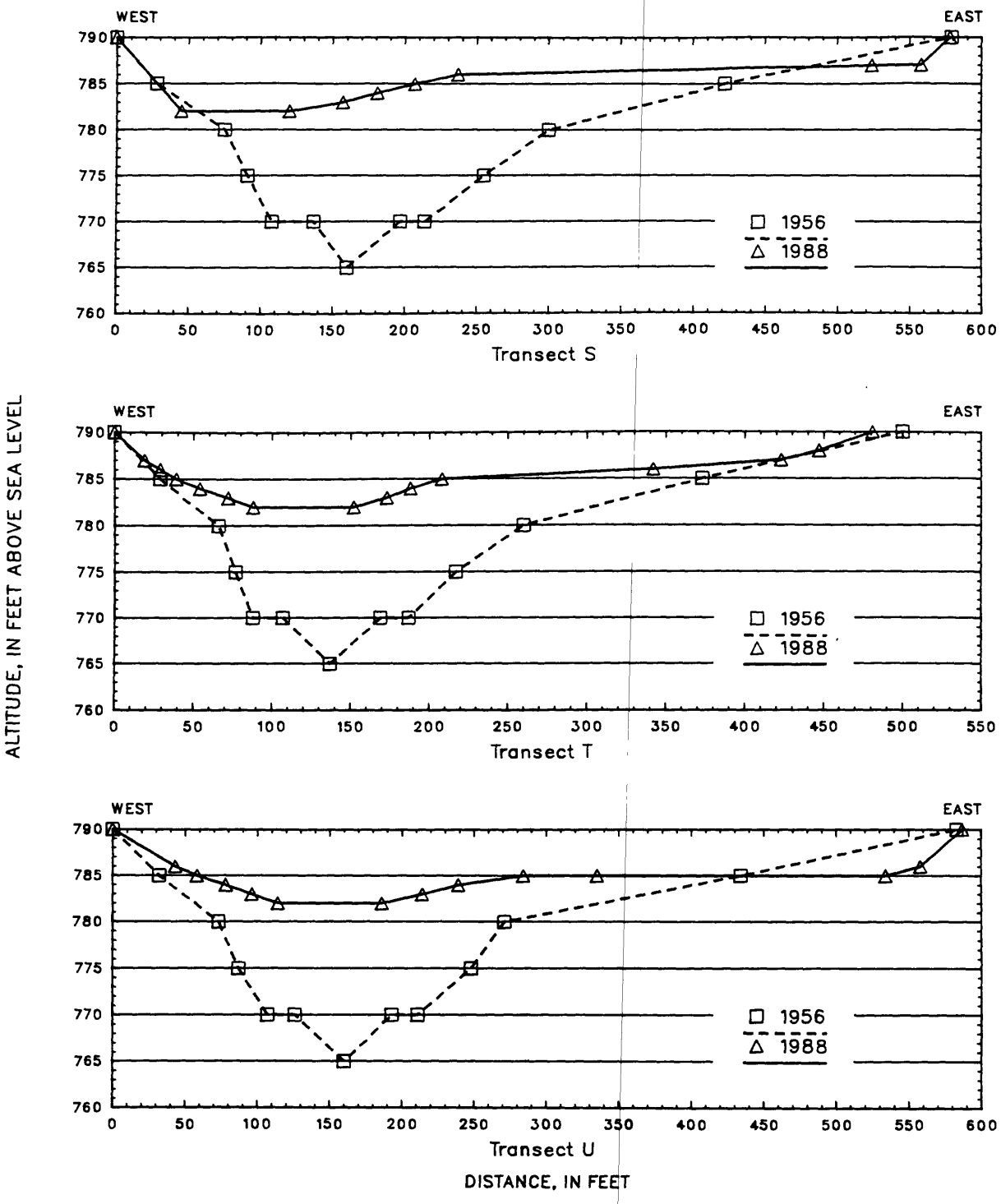


Figure 14.-- Cross sections for transects S, T, and U, Versailles Lake.

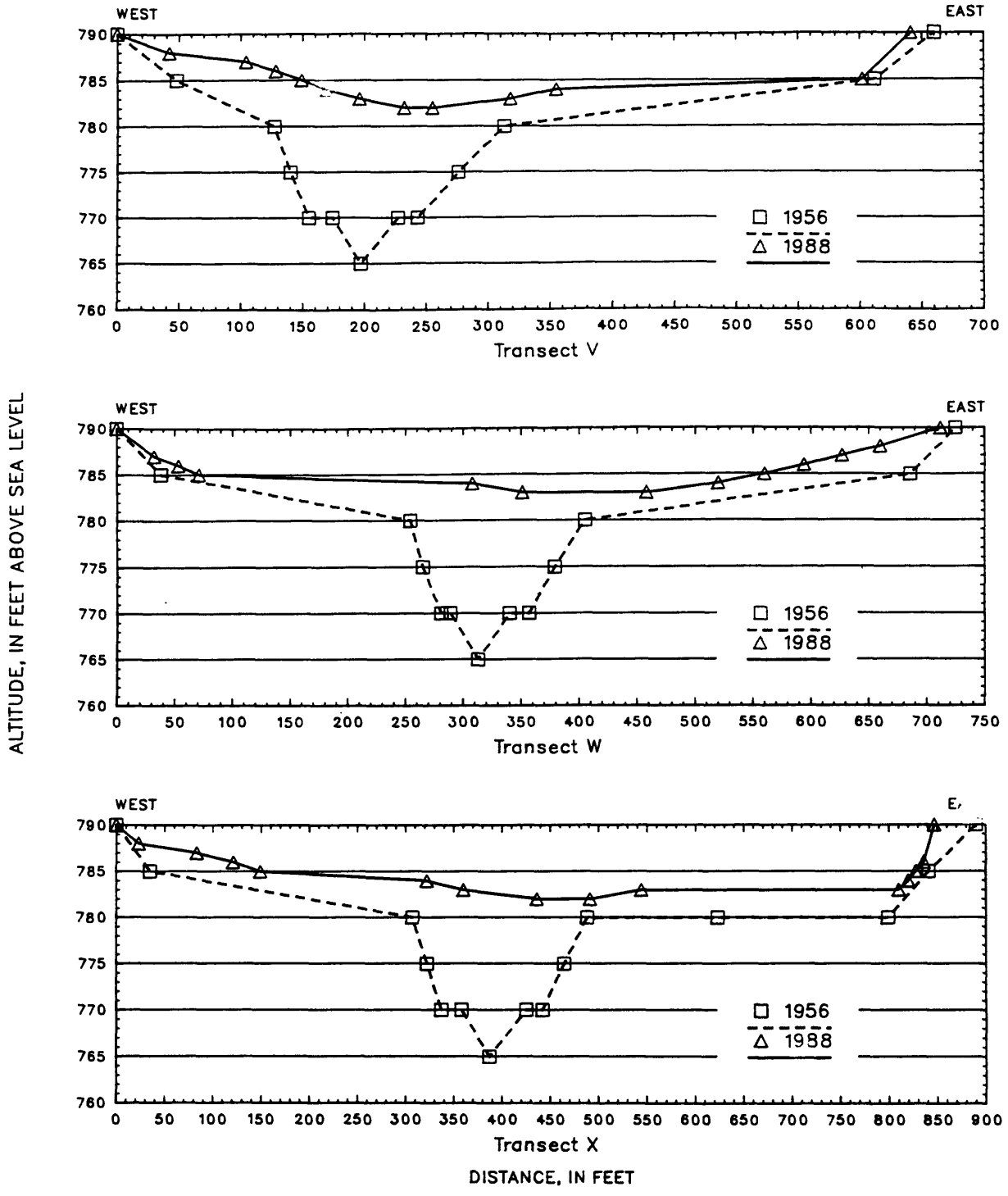


Figure 15.-- Cross sections for transects V, W, and X, Versailles Lake.

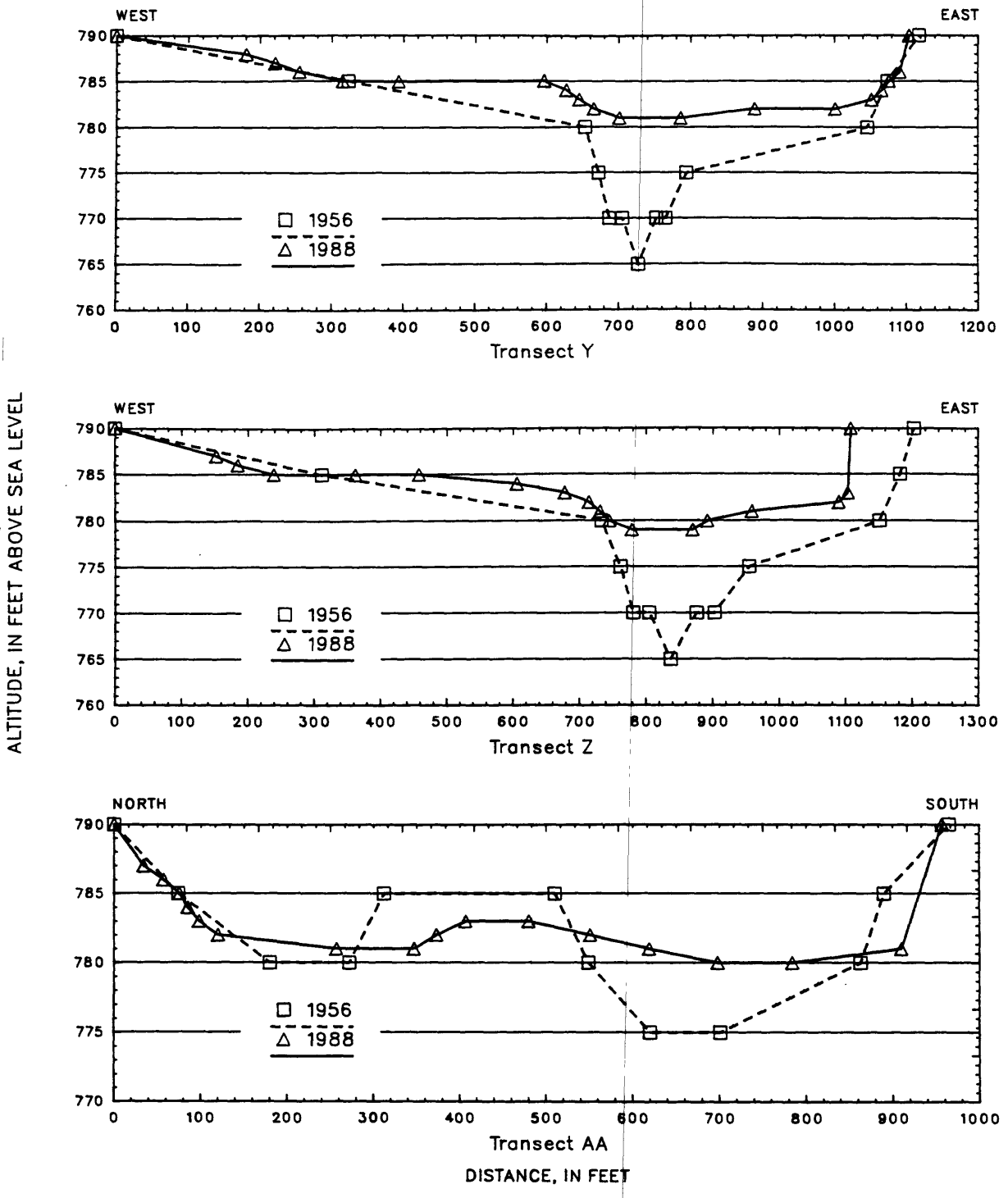


Figure 16.-- Cross sections for transects Y, Z, and AA, Versailles Lake.

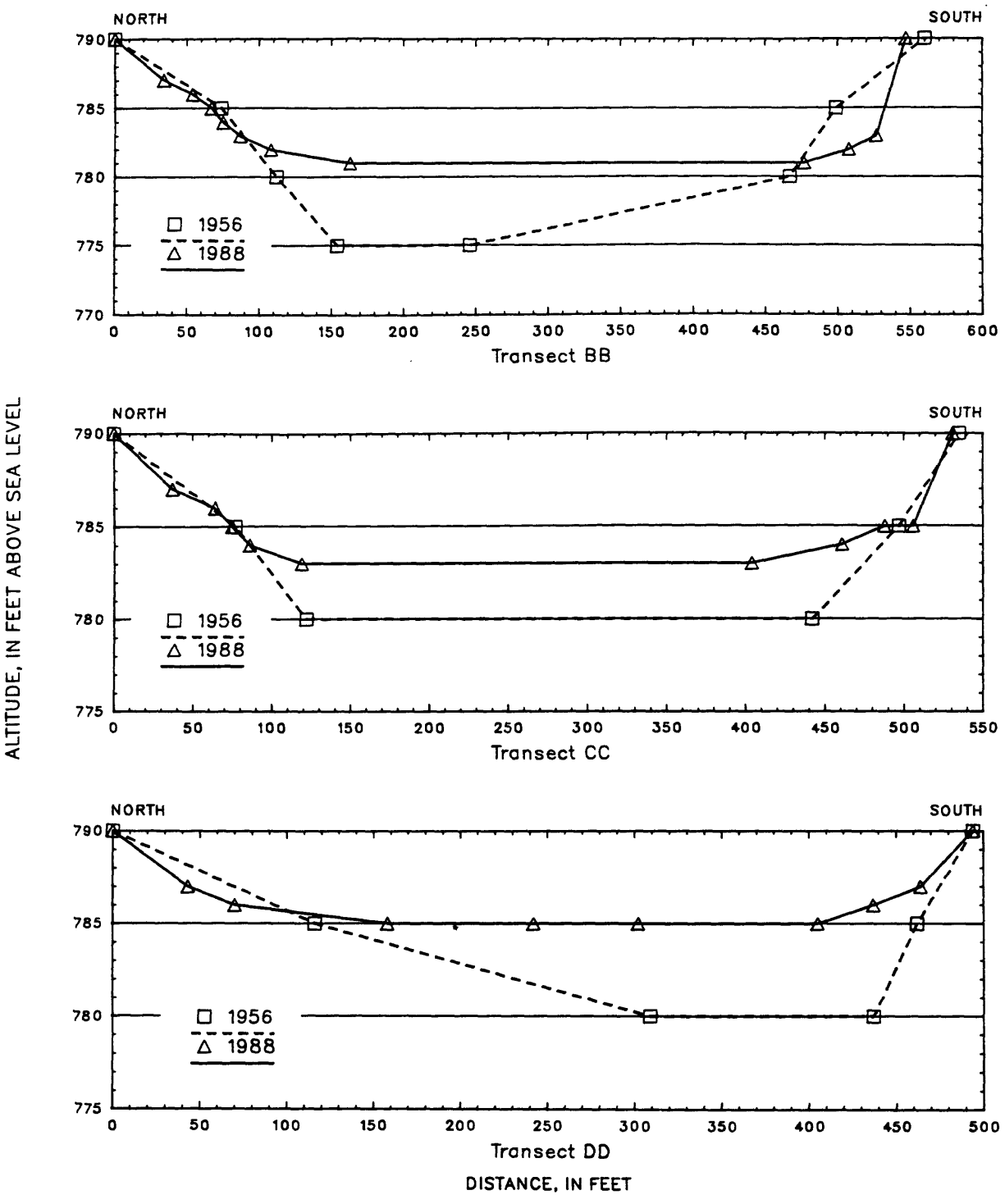


Figure 17.-- Cross sections for transects BB, CC, and DD, Versailles Lake.

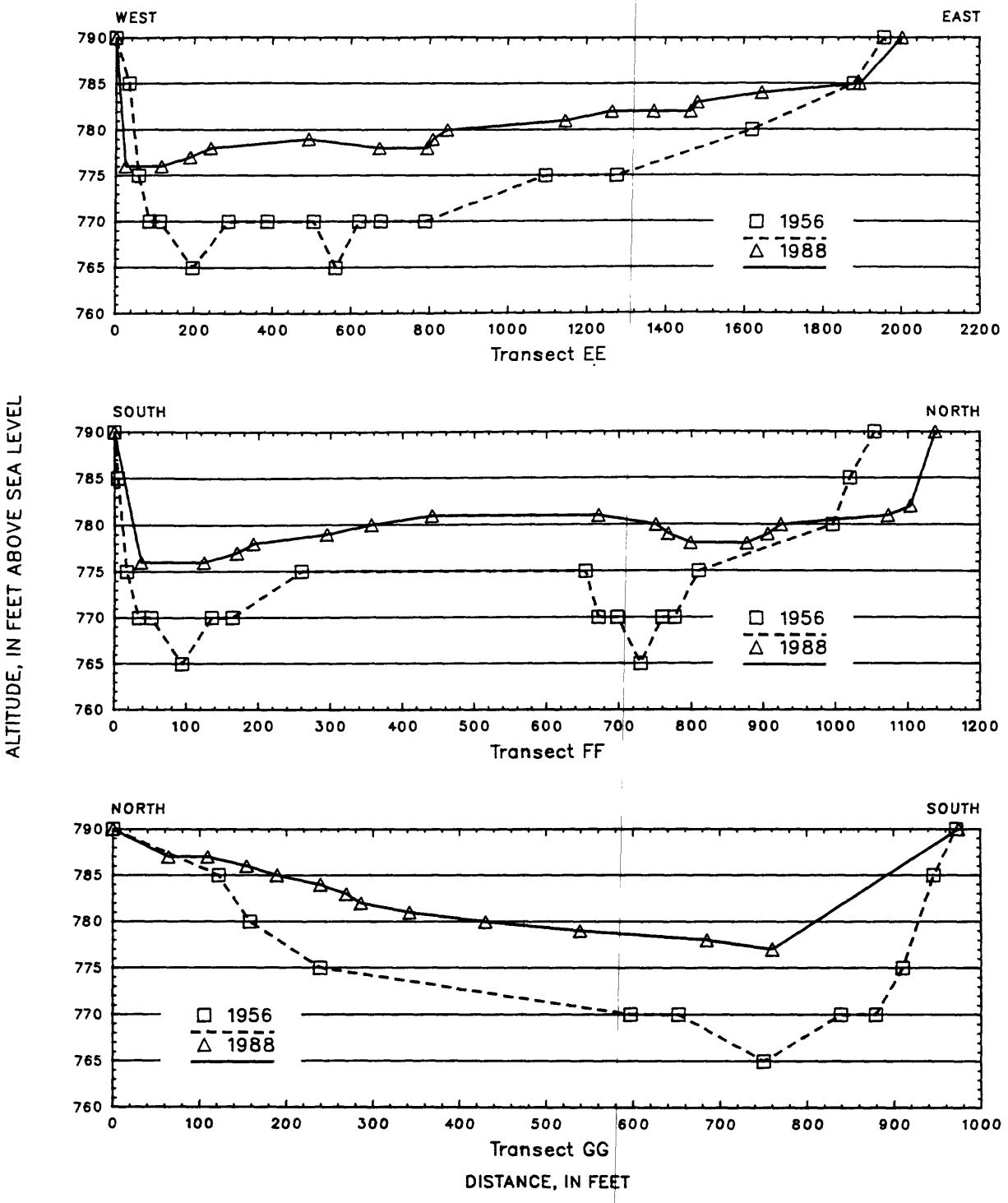


Figure 18.-- Cross sections for transects EE, FF, and GG, Versailles Lake.

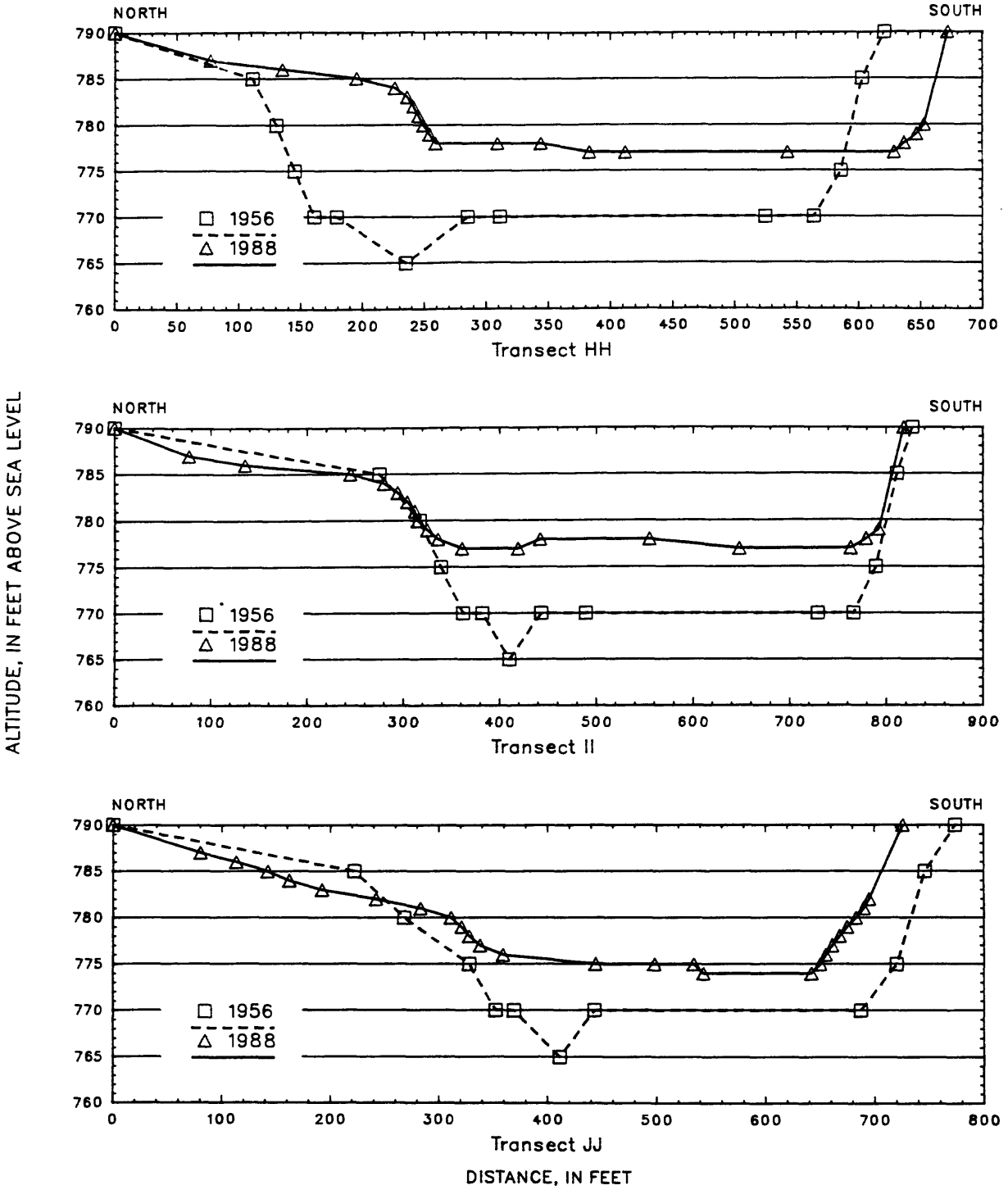


Figure 19.-- Cross sections for transects HH, II, and JJ, Versailles Lake.

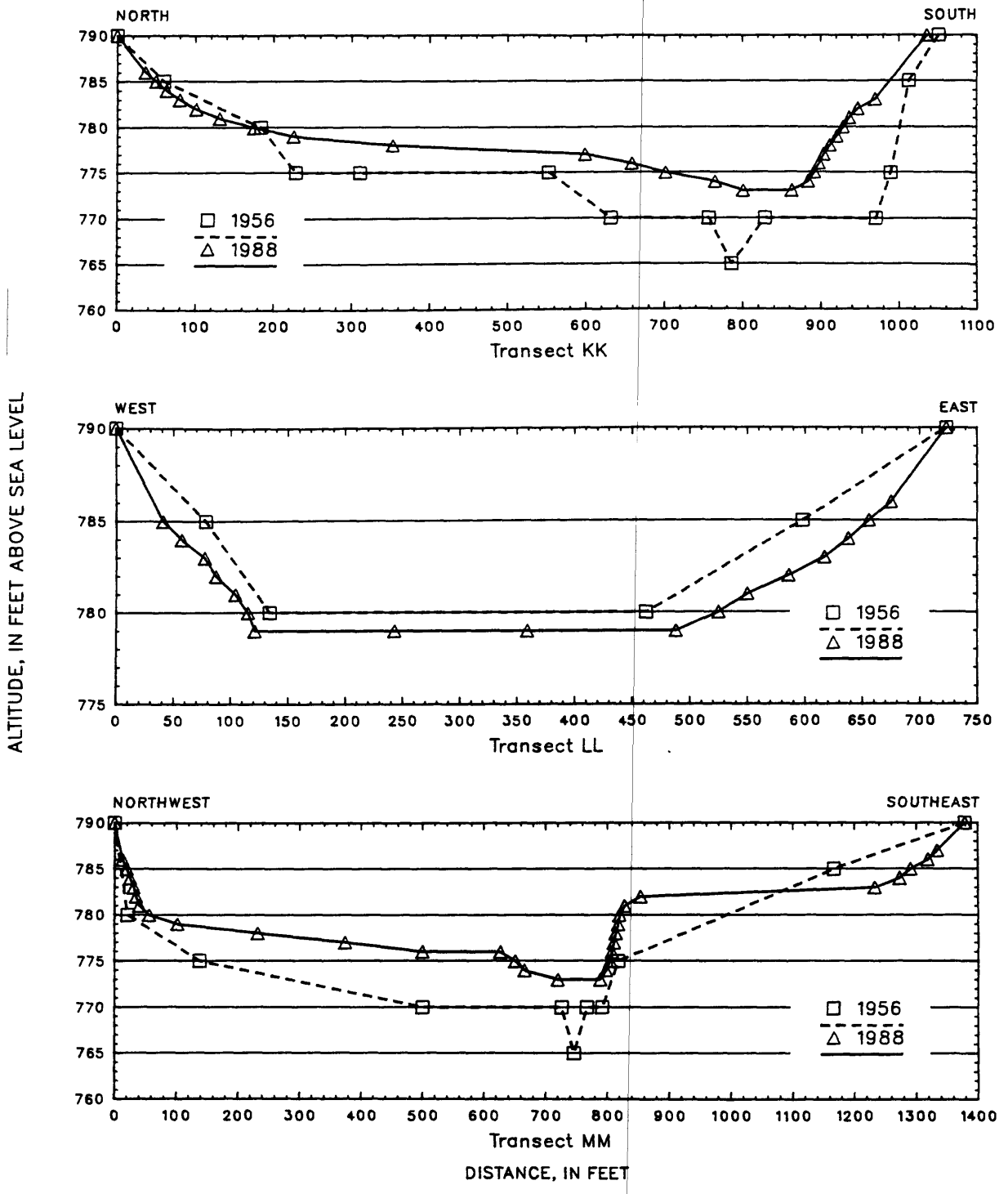


Figure 20.-- Cross sections for transects KK, LL, and MM, Versailles Lake.

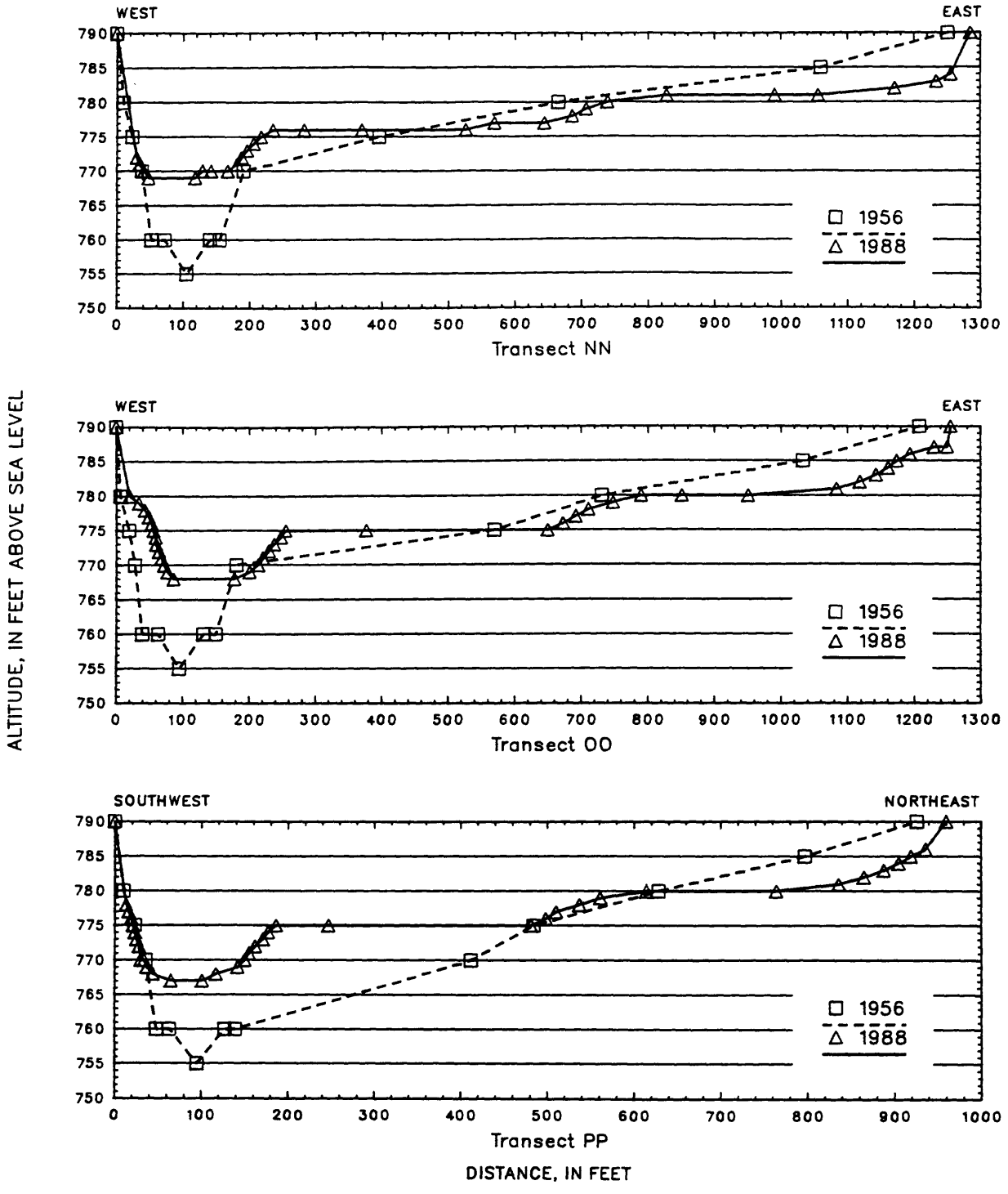


Figure 21.—— Cross sections for transects NN, OO, and PP, Versailles Lake.

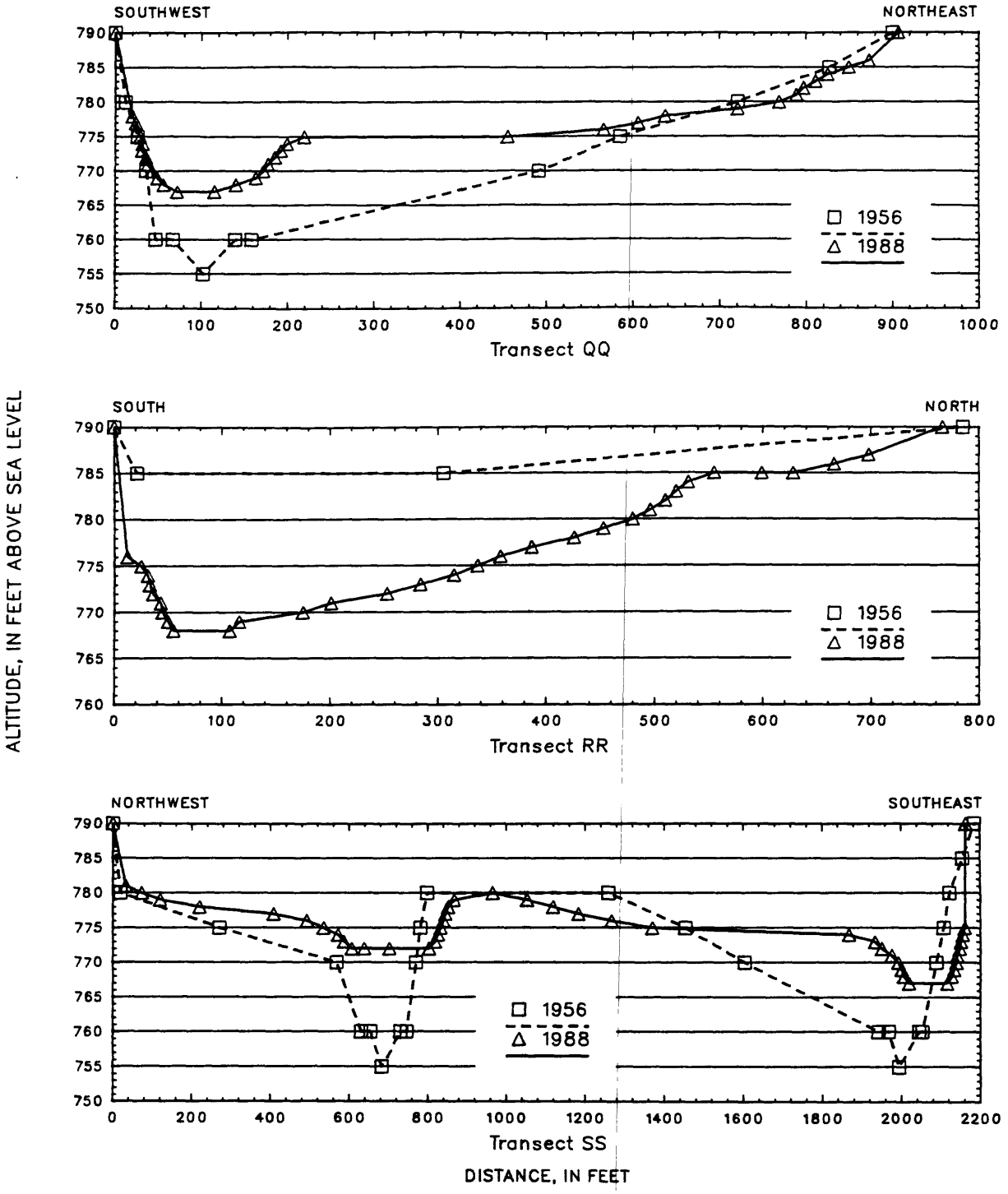


Figure 22.-- Cross sections for transects QQ, RR, and SS, Versailles Lake.

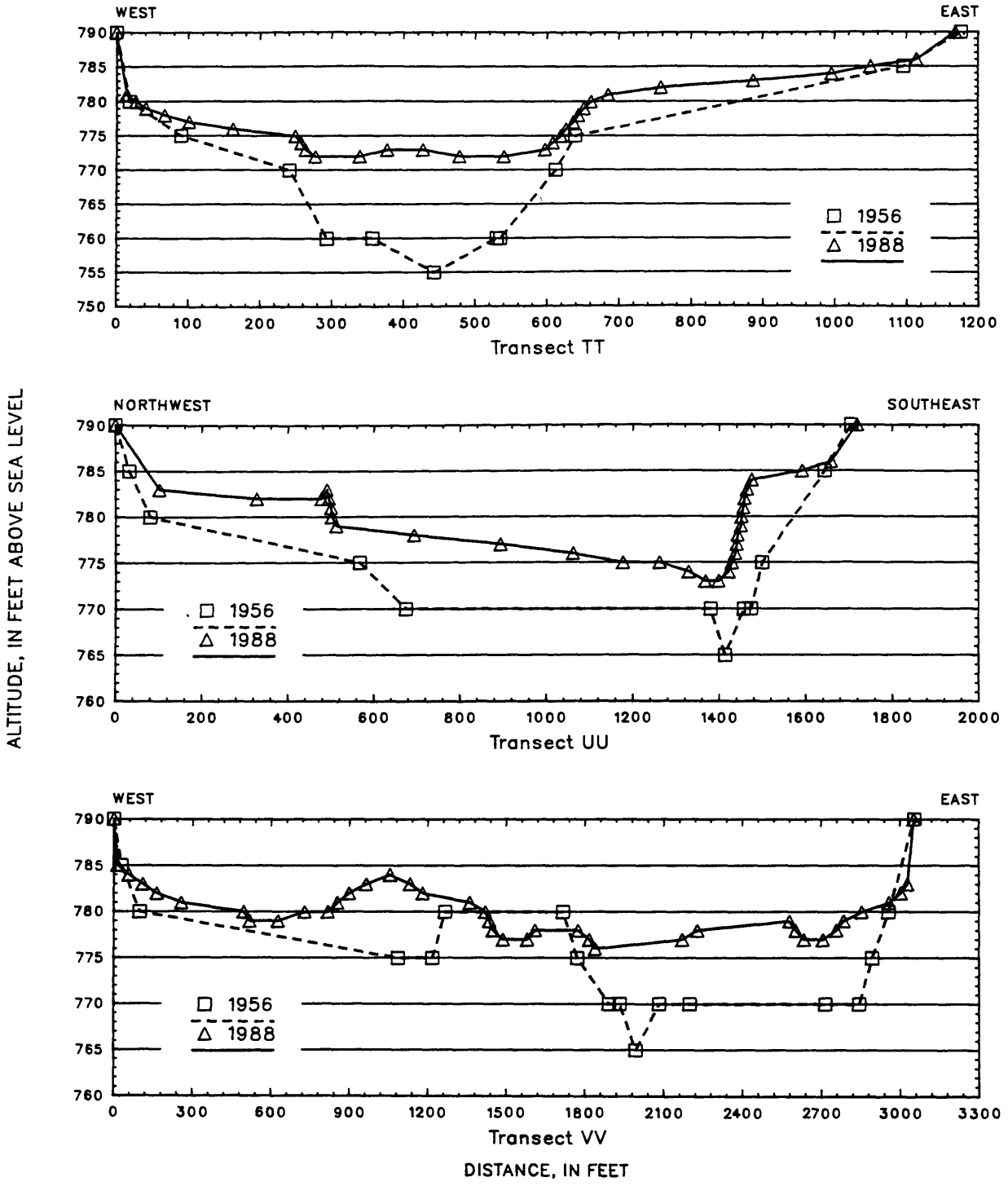


Figure 23.-- Cross sections for transects TT, UU, and VV, Versailles Lake.

A general trend in sedimentation rates was determined by a comparison of the rates for 1956-82 to the rates for 1982-87 for transects C, (at the upper end of Versailles Lake), G and I, (in the middle part of the lake), J and K, (at the lower end of the lake), and M (in one of the tributaries that enters the lake). Rates for 1982-87, when compared to rates for 1956-82, have decreased at transect C; greatly increased at G, I, J, and K; and slightly decreased at M. The decrease in rate at transect C probably can be attributed to the deposition of the maximum amount of sediment possible at C. The large increase in rates at transects G, I, J, and K probably can be attributed to the movement of sediment-deposition areas farther into the lake, not to an increase in the amount of sediment entering the lake from the Laughery Creek drainage basin. The small decrease in rate at transect M probably can be attributed to the small amount of sediment that the tributaries contribute to the lake.

The surface-area data for Versailles Lake for 1956 were obtained from the 1959 depth-contour map, and the data for 1988 were obtained from the modified 1977 aerial photograph. The surface area for 1956 was 10,400,000 ft^2 (239 acres) and for 1988 was 9,700,000 ft^2 (223 acres). The decrease in surface area from 1956 through 1988 was 700,000 ft^2 (16.1 acres). The annual rate of surface-area decrease for the 32-year period 1956-88 is 21,900 ft^2 per year (0.503 acre per year). The most substantial change in the shoreline occurred in the upper end of the lake between transects B and C, where a large hooked-shaped point bar has formed; at transects C, D, and E, where an island has formed; and at transects F and G, where a large point bar has formed.

Amount of Accumulated Sediment

The amount and the annual rate of sediment accumulation in Versailles Lake during 1956-88 and the volume of water in the lake in 1956 and 1988 were determined from the depth-contour data. The volume of water in the lake in 1988 was subtracted from the volume of water in 1956 to determine the amount of sediment that had accumulated in the lake during 1956-88 and to calculate the annual rate of sediment accumulation.

The areas encompassed by the contour lines of the 1959 and 1988 depth-contour maps were measured, multiplied by the labeled depth value, and then added to determine the volume of water in Versailles Lake in 1956 and 1988. The following example shows how volumes were computed for 1956.

1. In the upper end of the lake the area enclosed by the shoreline, the 5-ft contour line, and the channel of Laughery Creek 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. The area enclosed by the channel was subtracted from the area enclosed by the 5-ft contour line. The resulting value was multiplied by 5 ft (depth values used for the sides of the channel are those of the nearest contour interval) to find the volume from the 5-ft contour line to the channel.

4. The area enclosed by the channel was multiplied by 7.5 ft (7.5 ft is a value halfway between the 5-ft contour line and the bottom of the channel, 10 ft) to find the volume of the channel.

5. All the volumes computed in steps 2-4 were added to find the volume for the upper end of the lake.

6. The value for contours that had no greater value than themselves, was multiplied by the area enclosed by that contour. This same procedure was used for all contours. After these values were determined, they were added to give the volume of water in the lake in 1956.

In 1956, the volume of water in Versailles Lake was 115,000,000 ft^3; in 1988, the volume was 73,400,000 ft^3 (table 18 in the "Supplemental Data" section at the end of the report). In 1988, the volume of water remaining in the lake was 63.8 percent of the 1956 volume. The volume of water in the lake for 1988 was subtracted from the volume of water for 1956 to determine the amount of sediment that had accumulated in the lake during 1956-88, which was 41,600,000 ft^3. By 1988, 36.2 percent of the 1956 lake volume had filled with sediment.

The total amount of accumulated sediment (41,600,000 ft^3), was divided by 32 years to determine the annual rate of sediment accumulation in Versailles Lake. That annual rate is 1,300,000 ft^3 per year.

Potential for Future Decreases in Lake Storage Capacity Due to Accumulated Sediment

Potential decreases in the storage capacity of Versailles Lake for the 32-year period 1989-2020 were estimated from the amount of sediment accumulation in the lake during 1956-88 (41,600,000 ft^3) and the annual rate of sediment accumulation (1,300,000 ft^3 per year). During 1989-2020, the volume of water remaining in the lake is expected to decrease (table 19 in the "Supplemental Data" section at the end of the report) as the amount of sediment increases (table 20 in the "Supplemental Data" section at the end of the report). It was assumed the future rate of deposition would be held 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.

The volume of water in Versailles Lake was 115,000,000 ft^3 in 1956 and 73,400,000 ft^3 in 1988. In 1988, the volume of water remaining in the lake was 63.8 percent of the 1956 volume; 36.2 percent of the lake had filled with sediment. The percentage volume of water in the lake in 2020 is expected to be 28 percent of the 1956 volume; 72 percent of the lake is expected to be filled with sediment (fig. 24). At first, most of the new sediment will probably accumulate in the upper end and the middle part of the lake. Later, as these parts of the lake become filled with sediment, sediment will accumulate in the lower end of the lake.

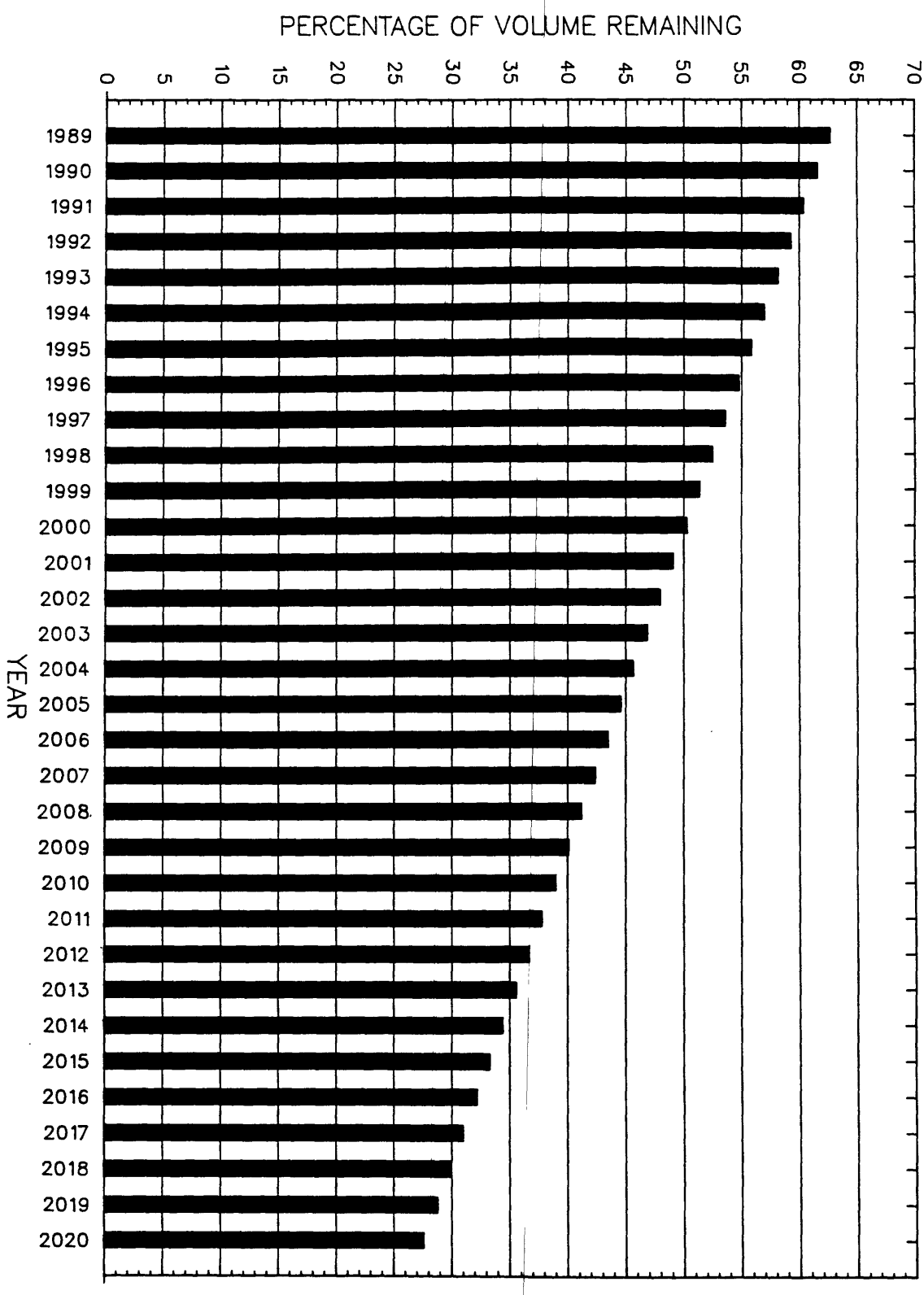


Figure 24.-- Estimated percentage of volume of water remaining in Versailles Lake, 1989-2020.

Sources of Sediment

The physiographic data were used to identify areas in the drainage basin of Laughery Creek that are contributing unusually large amounts of sediment to Versailles Lake. Land use, land slope, slope length, farming practice, field-border width, stream-buffer width, and the presence of ephemeral gullies at each site were assigned numerical values (table 21 in the "Supplemental Data" section at the end of the report) to create a "sedimentation-index number." For example, a site at which the land use was row crop (value of 1) on a severe slope (value of 2) was assigned an index number of 3. A site at which land use was pasture or forest was assigned a sedimentation-index number of zero regardless of other physiographic factors. The greater the sedimentation-index number, the greater the contribution of sediment from a site. For individual sites, the sedimentation-index number ranged from zero to 5. Between sites, the sedimentation-index numbers could vary greatly within short distances.

The drainage basin of Laughery Creek was divided into 15 subbasins to determine general trends in the sedimentation-index numbers. Each subbasin was of approximately equal area and had an approximately equal number of sites. The sedimentation-index numbers for sites within a subbasin were averaged to determine an average sedimentation-index number for each subbasin (table 22 in the "Supplemental Data" section at the end of the report). The sedimentation-index numbers for the subbasins ranged from 1.11 to 2.06, the mean was 1.51. Large or small sedimentation-index numbers were not found in any one area of the drainage basin; thus, there do not appear to be any distinct source areas in the drainage basin of Laughery Creek that are contributing unusually large amounts of sediment to Versailles Lake.

SUMMARY AND CONCLUSIONS

Areas of sediment accumulation in Versailles Lake for the 32-year period 1956-88 were identified by use of the transect width and depth data for 1956, 1982, 1987, and 1988 and surface-area data for 1956 and 1988. Cross-sectional profiles for 48 transects of the lake were constructed by use of the width and depth data. These profiles show where sediment has accumulated. The area remaining, expressed as a percentage, was determined for the 48 cross-sectional areas and sedimentation rates for 6 transects also were determined. The largest decreases and the largest computed percentage changes in cross-sectional areas, which represent locations where the largest amount of sediment has accumulated, are in the upper end of the lake where Laughery Creek enters and in the middle part of the lake; however, sediment has also accumulated in the rest of the lake. Sedimentation rates for the transects were determined for 1956-82, 1956-87, 1956-88, and 1982-87.

Sedimentation rates for six transects for 1956-82 and 1982-87 were compared to determine a general trend. Rates for 1982-87, when compared to rates for 1956-82, have decreased in the upper end of Versailles Lake, greatly increased in the middle part and lower end of the lake, and slightly decreased in one of the tributaries that enter the lake. The decrease in rate in the upper end of the lake probably can be attributed to the deposition of the maximum amount of sediment possible. The large increase in rates in the middle part and lower end of the lake probably can be attributed to the movement of sediment-deposition areas further into the lake, not to an increase in the amount

of sediment entering the lake from the Laughery Creek drainage basin. The small decrease in one of the tributaries probably can be attributed to the small amount of sediment that the tributaries contribute to the lake. The surface-area of the lake for 1956 was 10,400,000 ft^2 (239 acres) and for 1988 was 9,700,000 ft^2 (223 acres).

The amount and the annual rate of sediment accumulation in Versailles Lake from 1956-88 was determined from depth-contour data for 1956 and 1988. In 1956, the volume of water in the lake was 115,000,000 ft^3; in 1988, the volume was 73,400,000 ft^3. The amount of sediment accumulation in the lake during 1956-88 was 41,600,000 ft^3. In 1988, the volume of water remaining in the lake was 63.8 percent of the 1956 volume; 36.2 percent of the 1956 lake volume had filled with sediment. The annual rate of sediment accumulation in the lake during 1956-88 was 1,300,000 ft^3 per year.

Potential decreases in the storage capacity of Versailles Lake for the 32-year period 1989-2020 were estimated from the amount of sediment accumulation in the lake during 1956-88 and the annual rate of sediment accumulation. The percentage volume of water in the lake in 2020 is expected to be 28 percent of the 1956 volume; 72 percent of the lake is expected to be filled with sediment.

Physiographic data for 1988 were used to identify areas in the drainage basin of Laughery Creek that are contributing unusually large amounts of sediment to Versailles Lake. The data indicate no distinct source areas in the drainage basin that are contributing unusually large amount of sediment to the lake.

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(p. 37 follows)

SUPPLEMENTAL DATA

Tables 1-22

(p. 39 follows)

Table 1.--Width and depth data for transects A, B, and C, Versailles Lake, December 1987

Transect A		Transect B		Transect C			
Width[1] (feet)	Depth[2] (feet)	Width[3] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)
0	0.0	308	0.0	0	0.0	396	6.8
30	1.2	310	1.2	13	1.2	406	6.1
50	1.2	328	1.3	20	1.1	416	5.1
70	1.7	338	1.8	30	1.4	426	3.8
90	1.9	348	2.3	40	1.7	436	2.2
110	2.0	358	2.7	50	1.8	446	1.1
130	2.2	368	3.2	60	1.9	448	1.2
150	2.4	378	3.8	70	1.9	456	0.0
170	2.9	388	4.8	80	1.8		
190	3.2	398	5.8	90	1.8		
210	3.0	408	7.1	100	1.7		
230	2.7	418	7.5	110	1.6		
250	2.0	428	8.0	120	1.6		
270	1.5	438	8.1	130	1.5		
272	1.2	448	8.2	140	1.4		
290	0.0	458	8.2	150	1.3		
		468	8.1	160	1.2		
		478	7.7	174	1.2		
		488	5.6	215	0.0		
		498	1.2	216	-0.5		
		510	0.0	234	-1.2		
				253	-0.5		
				254	0.0		
				266	1.2		
				276	2.8		
				286	4.1		
				296	6.3		
				306	7.4		
				326	8.0		
				336	8.2		
				346	8.1		
				356	8.1		
				366	7.9		
				376	7.8		
				386	7.4		

[1]Measured from north to south.
[2]Depth below pool stage of 790 feet (above sea level).
[3]Measured from west to east.

Table 2.--Width and depth data for transects D, E, and F, Versailles Lake, December 1987

Transect D		Transect E				Transect F	
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	587	1.8	0	0.0
17	1.2	10	1.1	597	1.7	4	1.3
33	1.4	20	1.3	607	1.6	21	3.0
43	1.6	30	1.2	617	1.5	41	3.7
53	1.6	40	1.5	627	1.5	61	3.8
63	1.5	50	1.7	637	1.4	81	3.9
73	1.4	60	1.7	667	1.1	101	3.4
83	1.3	70	1.8	682	0.0	121	3.1
93	1.5	80	1.7			141	2.8
103	1.2	90	1.7			161	2.6
196	0.0	100	1.5			181	2.5
197	-0.5	110	1.4			201	2.2
243	-2.0	120	1.2			221	2.5
289	-0.5	130	1.4			241	2.2
290	0.0	143	1.1			261	2.4
306	1.1	230	0.0			281	2.7
319	1.8	317	1.1			301	4.0
329	2.7	377	2.3			321	3.1
339	3.6	387	2.4			341	2.6
349	4.6	397	2.5			361	2.5
359	5.5	407	2.7			381	2.4
369	6.1	417	2.9			401	2.0
379	6.5	427	3.1			421	1.7
399	6.8	447	3.1			456	1.3
409	6.6	457	3.1			536	0.0
429	6.1	477	3.0				
439	5.8	487	2.9				
449	4.4	497	2.8				
459	4.8	507	2.7				
469	4.1	517	2.5				
479	4.3	527	2.3				
489	2.4	537	2.1				
499	1.9	547	2.1				
520	1.1	567	1.9				
559	0.0	577	1.9				

[1]Measured from north to south.
[2]Depth below pool stage of 790 feet (above sea level).
[3]Measured from northwest to southeast.

Table 3.--Width and depth data for transects G, H, and I, Versailles Lake, December 1987

Transect G		Transect H		Transect I			
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	0.0	692	11.6
5	1.3	3	1.2	12	1.3	712	11.6
15	4.5	13	6.0	32	1.4	732	11.6
45	7.5	23	6.9	52	1.7	752	11.3
65	8.2	43	8.3	72	2.2	772	10.7
85	8.2	63	8.8	92	2.6	792	10.1
105	7.8	83	9.1	112	2.4	812	9.8
125	7.5	103	9.0	132	3.1	832	9.7
145	6.6	123	8.5	152	4.7	852	9.6
165	5.5	143	7.6	172	5.2	872	9.5
185	3.9	163	6.4	192	5.5	892	9.4
205	2.8	183	5.5	212	5.5	912	9.4
225	1.9	203	4.8	232	5.6	932	9.4
245	1.5	223	4.4	252	5.6	952	9.3
255	1.3	243	4.1	272	5.4	972	9.1
275	0.0	263	4.0	292	5.3	992	9.1
		283	3.9	312	5.2	1,012	8.9
		303	3.9	332	5.1	1,032	8.6
		323	3.9	352	5.1	1,052	7.5
		343	3.9	372	5.1	1,072	5.3
		363	3.8	392	5.3	1,092	2.7
		383	3.7	412	5.3	1,112	1.6
		403	3.4	432	5.5	1,114	1.3
		423	2.6	452	5.6	1,119	0.0
		443	1.5	472	5.8		
		458	1.2	492	6.1		
		460	0.0	512	6.3		
				532	6.7		
				552	6.6		
				572	8.4		
				592	9.6		
				612	10.4		
				632	11.0		
				652	11.3		
				672	11.5		

[1] Measured from west to east.
[2] Depth below pool stage of 790 feet (above sea level).

Table 4.--Width and depth data for transects J, K, and L, Versailles Lake, December 1987

Transect J		Transect K				Transect L	
Width[1] (feet)	Depth[2] (feet)	Width[3] (feet)	Depth[2] (feet)	Width[3] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)
0	0.0	0	0.0	700	9.4	0.0	0.0
25	1.5	6	1.5	720	9.2	6.5	1.3
39	2.0	20	4.0	740	9.0	13.5	1.5
59	2.2	40	8.9	760	8.9	23.5	2.4
79	3.0	60	17.8	780	8.8	33.5	3.2
99	3.7	80	21.6	800	8.7	43.5	3.5
119	4.3	100	22.1	820	8.7	53.5	3.3
139	4.9	120	22.2	840	8.6	63.5	3.0
159	5.2	140	22.0	860	8.5	68.5	2.9
179	5.6	160	21.5	880	8.5	73.5	2.7
199	6.2	180	20.4	900	8.4	78.5	2.6
219	9.7	200	19.2	920	8.4	83.5	2.4
239	13.1	220	18.9	940	8.4	93.5	2.3
259	13.9	240	18.5	960	8.4	103.5	2.2
279	13.7	260	18.8	980	8.4	113.5	2.3
299	13.4	280	18.8	1,000	8.4	123.5	2.4
319	13.6	300	18.4	1,020	8.4	133.5	2.5
339	13.8	320	16.4	1,040	8.3	143.5	2.5
359	14.0	340	14.5	1,060	8.2	153.5	2.4
379	14.2	360	13.9	1,080	8.1	163.5	2.3
399	14.2	380	13.7	1,100	8.0	173.5	2.1
419	14.0	400	13.6	1,120	7.7	183.5	1.8
439	13.5	420	13.4	1,140	6.9	193.5	1.6
459	13.3	440	13.2	1,160	5.8	203.5	1.3
479	13.6	460	13.0	1,180	4.2	211.5	0.0
499	13.7	480	12.9	1,200	1.8		
519	13.8	500	12.8	1,210	1.5		
539	14.0	520	12.7	1,220	0.0		
559	14.3	540	12.3				
579	14.4	580	11.4				
599	14.2	600	11.1				
619	13.2	620	10.8				
639	10.4	640	10.4				
659	5.1	660	10.0				
673	1.5	680	9.6				
677	0.0						

[1]Measured from north to south.
[2]Depth below pool stage of 790 feet (above sea level).
[3]Measured from west to east.

Table 5.--Width and depth data for transects M, N, O, and P, Versailles Lake, December 1987

Transect M		Transect N		Transect O		Transect P	
Width[1] (feet)	Depth[2] (feet)	Width[3] (feet)	Depth[2] (feet)	Width[4] (feet)	Depth[2] (feet)	Width[5] (feet)	Depth[2] (feet)
0	0.0	0	0.0	0.0	0.0	0	0.0
25	1.5	3	1.5	1.5	1.5	7	1.5
45	2.8	17	2.0	3.0	1.7	11	1.7
65	4.1	37	3.2	23.0	5.4	31	2.3
85	5.7	57	5.6	43.0	6.1	51	3.1
105	8.2	77	7.6	63.0	6.5	71	3.3
125	9.2	97	8.6	91.0	6.8	91	3.5
145	9.6	117	9.6	103.0	7.1	111	4.0
165	9.8	137	9.6	123.0	6.8	131	4.6
185	9.9	157	11.3	143.0	6.7	151	5.3
205	9.9	177	11.4	163.0	6.8	159	1.5
225	10.0	197	11.0	183.0	7.0	161	0.0
245	10.0	217	10.1	203.0	6.6		
265	10.0	237	9.5	223.0	1.5		
285	9.9	257	9.4	224.0	0.0		
305	9.9	277	9.3				
325	9.8	297	9.2				
345	9.7	317	9.2				
365	9.6	337	8.5				
385	9.6	357	5.0				
405	9.4	367	1.5				
425	9.3	377	0.0				
445	9.0						
465	8.4						
485	7.1						
505	3.4						
514	1.5						
520	0.0						

[1]Measured from north to south.
[2]Depth below pool stage of 790 feet (above sea level).
[3]Measured from southwest to northeast.
[4]Measured from west to east.
[5]Measured from northwest to southeast.

Table 6.--Width and depth data for transects Q, R, S, and T, Versailles Lake, June 1988

Transect Q		Transect R		Transect S		Transect T	
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
19	8	41	8	45	8	19	3
69	8	74	8	120	8	29	4
104	7	99	7	157	7	39	5
119	6	113	6	181	6	54	6
128	5	127	5	207	5	72	7
140	4	145	5	237	4	88	8
153	3	188	3	524	3	152	8
304	2	395	2	558	3	173	7
352	2	486	0	578	0	188	6
458	2					208	5
534	0					342	4
						423	3
						447	2
						481	0

[1]Measured from west to east.
[2]Depth below pool stage of 790 feet (above sea level).

Table 7.--Width and depth data for transects U, V, W, and X, Versailles Lake, June 1988

Transect U		Transect V		Transect W		Transect X	
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
43	4	42	2	32	3	23	2
58	5	104	3	53	4	83	3
78	6	128	4	71	5	121	4
96	7	149	5	308	6	149	5
114	8	169	6	351	7	322	6
186	8	196	7	458	7	360	7
214	7	232	8	520	6	436	8
239	6	255	8	560	5	491	8
284	5	318	7	594	4	544	7
335	5	355	6	627	3	810	7
534	5	602	5	660	2	820	6
558	4	641	0	712	0	828	5
587	0					836	4
						847	0

[1]Measured from west to east.
[2]Depth below pool stage of 790 feet (above sea level).

Table 8.--Width and depth data for transects Y, Z, AA, and BB, Versailles Lake, June 1988

Transect Y		Transect Z		Transect AA		Transect BB	
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
181	2	152	3	34	3	34	3
221	3	185	4	57	4	54	4
255	4	239	5	75	5	67	5
315	5	362	5	85	6	75	6
393	5	458	5	98	7	87	7
596	5	606	6	120	8	108	8
627	6	678	7	257	9	163	9
645	7	714	8	347	9	477	9
665	8	731	9	373	8	508	8
701	9	745	10	407	7	527	7
786	9	779	11	480	7	547	0
889	8	870	11	551	8		
1,001	8	892	10	619	9		
1,052	7	959	9	698	10		
1,066	6	1,090	8	784	10		
1,076	5	1,104	7	910	9		
1,091	4	1,108	0	957	0		
1,104	0						

[1]Measured from west to east.
[2]Depth below pool stage of 790 feet (above sea level).
[3]Measured from north to south.

Table 9.--Width and depth data for tansects CC, DD, EE, and FF, Versailles Lake, June 1988

Transect CC		Transect DD		Transect EE		Transect FF	
Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)	Width[3] (feet)	Depth[2] (feet)	Width[4] (feet)	Depth[2] (feet)
0	0	0	0	0	0	0	0
37	3	43	3	25	14	37	14
64	4	70	4	117	14	124	14
75	5	158	5	190	13	170	13
86	6	242	5	242	12	193	12
119	7	302	5	492	11	295	11
404	7	405	5	672	12	357	10
461	6	437	4	794	12	441	9
488	5	464	3	808	11	672	9
506	5	494	0	845	10	751	10
531	0			1,146	9	768	11
				1,265	8	799	12
				1,371	8	877	12
				1,465	8	906	11
				1,482	7	924	10
				1,646	6	1,073	9
				1,896	5	1,104	8
				2,003	0	1,138	0

[1]Measured from north to south.
[2]Depth below pool stage of 790 feet (above sea level).
[3]Measured from west to east.
[4]Measured from south to north.

Table 10.--Width and depth data for transects GG, HH, II, and JJ, Versailles Lake, June 1988

Transect GG		Transect HH		Transect II		Transect JJ	
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
64	3	77	3	77	3	80	3
109	3	135	4	135	4	113	4
154	4	195	5	245	5	142	5
189	5	226	6	280	6	162	6
239	6	236	7	294	7	192	7
269	7	241	8	304	8	242	8
286	8	245	9	312	9	283	9
342	9	249	10	315	10	311	10
430	10	254	11	325	11	321	11
539	11	259	12	336	12	328	12
685	12	309	12	361	13	338	13
760	13	344	12	419	13	359	14
975	0	383	13	442	12	444	15
		412	13	555	12	498	15
		543	13	648	13	534	15
		629	13	763	13	543	16
		637	12	779	12	642	16
		647	11	792	11	650	15
		653	10	818	0	655	14
		672	0			661	13
						668	12
						675	11
						683	10
						690	9
						695	8
						726	0

[1]Measured from north to south.
[2]Depth below pool stage of 790 feet (above sea level).

Table 11.--Width and depth data for transects KK, LL, MM, and NN, Versailles Lake, June 1988

Transect KK		Transect LL		Transect MM		Transect NN	
Width[1] (feet)	Depth[2] (feet)	Width[3] (feet)	Depth[2] (feet)	Width[4] (feet)	Depth[2] (feet)	Width[3] (feet)	Depth[2] (feet)
0	0	0	0	0	0	0	0
36	4	41	5	13	4	30	18
50	5	57	6	20	5	34	19
63	6	77	7	25	6	41	20
80	7	87	8	31	7	48	21
101	8	104	9	35	8	118	21
131	9	115	10	40	9	129	20
175	10	121	11	56	10	142	20
226	11	243	11	102	11	167	20
353	12	359	11	232	12	181	19
599	13	488	11	374	13	188	18
659	14	525	10	500	14	196	17
702	15	550	9	627	14	206	16
765	16	586	8	651	15	217	15
801	17	617	7	666	16	235	14
863	17	638	6	720	17	282	14
884	16	656	5	789	17	369	14
892	15	675	4	798	16	526	14
898	14	723	0	805	15	569	13
904	13			808	14	644	13
912	12			811	13	686	12
921	11			814	12	707	11
929	10			818	11	739	10
937	9			820	10	828	9
948	8			828	9	991	9
970	7			854	8	1,056	9
1,036	0			1,233	7	1,171	8
				1,273	6	1,234	7
				1,291	5	1,256	6
				1,319	4	1,285	0
				1,334	3		
				1,379	0		

[1]Measured from north to south.
[2]Depth below pool stage of 790 feet (above sea level).
[3]Measured from west to east.
[4]Measured from northwest to southeast.

Table 12.--Width and depth data for transects OO and PP, Versailles Lake, June 1988

Transect OO				Transect PP			
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	1,174	5	0	0	936	4
20	10	1,194	4	13	12	960	0
34	11	1,230	3	16	13		
43	12	1,250	3	19	14		
49	13	1,255	0	21	15		
53	14			23	16		
56	15			25	17		
59	16			28	18		
60	17			30	20		
64	18			34	20		
68	19			37	21		
72	20			44	22		
77	21			65	23		
86	22			101	23		
178	22			117	22		
201	21			142	21		
214	20			150	20		
221	19			155	19		
230	18			162	18		
238	17			171	17		
248	16			177	16		
255	15			186	15		
377	15			247	15		
650	15			481	15		
673	14			498	14		
692	13			510	13		
711	12			537	12		
748	11			561	11		
790	10			614	10		
851	10			764	10		
951	10			836	9		
1,084	9			865	8		
1,119	8			888	7		
1,143	7			905	6		
1,161	6			919	5		

[1]Measured from west to east.
[2]Depth below pool stage of 790 feet (above sea level).
[3]Measured from southwest to northeast.

Table 13.--Width and depth data for transects QQ, RR, and SS, Versailles Lake, June 1988

Transect QQ		Transect RR		Transect SS			
Width[1] (feet)	Depth[2] (feet)	Width[3] (feet)	Depth[2] (feet)	Width[4] (feet)	Depth[2] (feet)	Width[4] (feet)	Depth[2] (feet)
0	0	0	0	0	0	2,117	23
20	12	12	14	33	9	2,128	22
24	13	25	15	73	10	2,134	21
25	14	31	16	120	11	2,140	20
29	15	33	17	220	12	2,142	19
32	16	36	18	408	13	2,148	18
31	17	43	19	492	14	2,151	17
36	18	45	20	535	15	2,156	16
38	19	50	21	572	16	2,161	15
43	20	55	22	587	17	2,164	0
49	21	107	22	606	18		
56	22	116	21	638	18		
72	23	175	20	702	18		
115	23	201	19	803	18		
140	22	253	18	818	17		
163	21	284	17	826	16		
172	20	315	16	833	15		
177	19	337	15	839	14		
185	18	358	14	845	13		
192	17	387	13	852	12		
199	16	426	12	867	11		
219	15	453	11	965	10		
455	15	480	10	1,053	11		
566	14	496	9	1,119	12		
606	13	510	8	1,183	13		
637	12	520	7	1,267	14		
721	11	531	6	1,370	15		
769	10	555	5	1,869	16		
789	9	599	5	1,934	17		
797	8	628	5	1,951	18		
811	7	666	4	1,976	19		
825	6	698	3	1,993	20		
850	5	766	0	2,001	21		
873	4			2,007	22		
907	0			2,020	23		

[1]Measured from southwest to northeast.
[2]Depth below pool stage of 790 feet (above sea level).
[3]Measured from south to north.
[4]Measured from northwest to southeast.

Table 14.--Width and depth data for transects TT, UU, and VV, Versailles Lake, June 1988

Transect TT		Transect UU		Transect VV			
Width[1] (feet)	Depth[2] (feet)	Width[3] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)	Width[1] (feet)	Depth[2] (feet)
0	0	0	0	0	0	2,854	10
14	9	102	7	15	5	2,958	9
27	10	328	8	57	6	3,003	8
41	11	478	8	110	7	3,028	7
67	12	490	7	164	8	3,053	0
101	13	495	8	257	9		
162	14	500	9	495	10		
249	15	502	10	518	11		
257	16	513	11	626	11		
263	17	694	12	728	10		
277	18	894	13	817	10		
339	18	1,062	14	853	9		
377	17	1,178	15	899	8		
427	17	1,262	15	964	7		
478	18	1,329	16	1,055	6		
540	18	1,368	17	1,132	7		
597	17	1,399	17	1,181	8		
608	16	1,422	16	1,361	9		
619	15	1,430	15	1,420	10		
626	14	1,438	14	1,436	11		
636	13	1,441	13	1,449	12		
643	12	1,443	12	1,487	13		
651	11	1,451	11	1,580	13		
661	10	1,452	10	1,610	12		
685	9	1,456	9	1,774	12		
758	8	1,459	8	1,816	13		
887	7	1,465	7	1,839	14		
996	6	1,475	6	2,170	13		
1,050	5	1,592	5	2,228	12		
1,114	4	1,659	4	2,580	11		
1,168	0	1,719	0	2,603	12		
				2,634	13		
				2,706	13		
				2,758	12		
				2,786	11		

[1]Measured from west to east.
[2]Depth below pool stage of 790 feet (above sea level).
[3]Measured from northwest to southeast.

Table 15.--Cross-sectional areas for transects A through VV, Versailles Lake, 1956, 1982, 1987, and 1988

[Dashes (--) indicate no data]

Transect	Cross-section area (square feet)			
	1956	1982	1987	1988
A	1,420	--	561	--
B	3,120	--	974	--
C	4,100	1,790	1,390	--
			[1]31	
D	5,380	--	1,170	--
			[1]171	
E	7,590	--	1,080	--
F	6,460	--	1,280	--
G	6,240	2,890	1,380	--
H	5,060	--	2,400	--
I	10,700	9,280	7,750	--
J	9,780	7,830	6,810	--
K	15,800	15,100	14,400	--
L	1,410	--	485	--
M	5,130	4,290	4,120	--
N	2,950	3,380	3,000	--
O	1,410	--	1,350	--
P	577	--	529	--
Q	5,610	--	--	1,170
R	4,760	--	--	1,690
S	5,760	--	--	2,660
T	5,060	--	--	2,320
U	5,710	--	--	3,170
V	6,410	--	--	3,310
W	6,690	--	--	3,550
X	9,090	--	--	5,120
Y	9,450	--	--	5,980
Z	10,900	--	--	7,030
AA	8,000	--	--	7,620
BB	5,520	--	--	4,230
CC	4,240	--	--	3,140
DD	3,290	--	--	2,080
EE	30,100	--	--	18,400
FF	16,600	--	--	11,700
GG	14,900	--	--	7,610

Table 15.--Cross-sectional areas for transects A through VV, Versailles Lake, 1956, 1982, 1987, and 1988--Continued

[Dashes (--) indicate no data]

Transect	Cross-section area (square feet)			
	1956	1982	1987	1988
HH	9,810	--	--	6,110
II	10,600	--	--	7,370
JJ	9,870	--	--	7,340
KK	15,500	--	--	11,800
LL	5,230	--	--	6,320
MM	18,300	--	--	14,400
NN	15,400	--	--	15,500
OO	16,400	--	--	16,000
PP	15,000	--	--	12,600
QQ	16,900	--	--	12,500
RR	2,670	--	--	9,340
SS	38,100	--	--	31,600
TT	19,800	--	--	13,400
UU	26,700	--	--	17,700
VV	44,300	--	--	31,700

[1]Area of island.

Table 16.--Area remaining, expressed as a percentage, in cross-sectional areas, Versailles Lake 1956-82, 1956-87, 1956-88, and 1982-87

[Dashes (--) indicate no data]

Transect	Percentage			
	1956-82	1956-87	1956-88	1982-87
A	--	39.5	--	--
B	--	31.2	--	--
C	43.7	[1]33.9	--	[1]77.6
D	--	[1]21.8	--	--
E	--	14.2	--	--
F	--	19.8	--	--
G	46.3	22.1	--	47.8
H	--	47.4	--	--
I	86.7	72.4	--	83.5
J	80.1	69.6	--	87.0
K	95.6	91.1	--	95.4
L	--	34.4	--	--
M	83.6	80.3	--	96.0
N	116	102	--	88.7
O	--	95.7	--	--
P	--	91.7	--	--
Q	--	--	20.9	--
R	--	--	35.5	--
S	--	--	46.2	--
T	--	--	45.8	--
U	--	--	55.5	--
V	--	--	51.6	--
W	--	--	53.1	--
X	--	--	56.3	--
Y	--	--	63.3	--
Z	--	--	64.5	--
AA	--	--	95.2	--
BB	--	--	76.6	--
CC	--	--	74.1	--
DD	--	--	63.2	--
EE	--	--	61.1	--
FF	--	--	70.5	--

Table 16.--Area remaining, expressed as a percentage, in cross-sectional areas, Versailles Lake, 1956-82, 1956-87, 1956-88, and 1982-87--Continued

[Dashes (--) indicate no data]

Transect	Percentage			
	1956-82	1956-87	1956-88	1982-87
GG	--	--	51.1	--
HH	--	--	62.3	--
II	--	--	69.5	--
JJ	--	--	74.4	--
KK	--	--	76.1	--
LL	--	--	121	--
MM	--	--	78.7	--
NN	--	--	101	--
OO	--	--	97.6	--
PP	--	--	84.0	--
QQ	--	--	74.0	--
RR	--	--	350	--
SS	--	--	82.9	--
TT	--	--	67.7	--
UU	--	--	66.3	--
VV	--	--	71.6	

[1]Does not include area of island.

Table 17.--Sedimentation rates, Versailles Lake, 1956-82, 1956-87, 1956-88, and 1982-87

[Dashes (--) indicate no data]

Transect	Square feet			
	[1]1956-82	[2]1956-87	[3]1956-88	[4]1982-87
A	--	27.7	--	--
B	--	69.2	--	--
C	88.5	[5]87.7	--	[5]72.7
D	--	[5]136	--	--
E	--	210	--	--
F	--	167	--	--
G	129	157	--	275
H	--	85.8	--	--
I	54.6	95.2	--	278
J	75.0	95.8	--	185
K	26.9	45.2	--	127
L	--	29.8	--	--
M	32.3	32.6	--	30.9
N	[6]-16.5	[6]-1.61	--	69.1
O	--	1.94	--	--
P	--	1.55	--	--
Q	--	--	137	--
R	--	--	95.9	--
S	--	--	96.9	--
T	--	--	85.6	--
U	--	--	79.4	--
V	--	--	96.9	--
W	--	--	98.1	--
X	--	--	124	--
Y	--	--	108	--
Z	--	--	121	--
AA	--	--	11.9	--
BB	--	--	40.3	--
CC	--	--	34.4	--
DD	--	--	37.8	--
EE	--	--	366	--
FF	--	--	153	--
GG	--	--	228	--
HH	--	--	116	--
II	--	--	101	--
JJ	--	--	79.1	--
KK	--	--	116	--
LL	--	--	[6]-34.1	--
MM	--	--	122	--

Table 17.--Sedimentation rates, Versailles Lake, 1956-82, 1956-87, 1956-88, and 1982-87--Continued

[Dashes (--) indicate no data]

Transect	Square feet			
	[1]1956-82	[2]1956-87	[3]1956-88	[4]1982-87
NN	--	--	[6]-3.13	--
OO	--	--	12.5	--
PP	--	--	75.0	--
QQ	--	--	138	--
RR	--	--	[6]-208	--
SS	--	--	203	--
TT	--	--	200	--
UU	--	--	281	--
VV	--	--	394	--

[1]26 year period.
[2]31 year period.
[3]32 year period.
[4]5.5 year period.
[5]Does not include area of island.
[6]Data indicate an increase in cross-section area.

Table 18.--Volume of water in Versailles Lake, 1956 and 1988

Year	Volume of water			
	Cubic feet	Cubic yards	Acre-feet	Gallons
1956	115,000,000	4,260,000	2,640	860,000,000
1988	73,400,000	2,720,000	1,680	549,000,000

Table 19.--Estimated volume of water in Versailles Lake, 1989-2020

Year	Volume of water		
	Cubic feet	Cubic yards	Acre feet
1989	72,100,000	2,670,000	1,660
1990	70,800,000	2,620,000	1,620
1991	69,500,000	2,570,000	1,560
1992	68,200,000	2,520,000	1,570
1993	66,900,000	2,480,000	1,540
1994	65,600,000	2,430,000	1,510
1995	64,300,000	2,380,000	1,480
1996	62,000,000	2,300,000	1,420
1997	61,700,000	2,280,000	1,420
1998	60,400,000	2,240,000	1,390
1999	59,100,000	2,190,000	1,360
2000	57,800,000	2,140,000	1,330
2001	56,500,000	2,090,000	1,300
2002	55,200,000	2,040,000	1,270
2003	53,900,000	2,000,000	1,240
2004	52,600,000	1,950,000	1,210
2005	51,300,000	1,900,000	1,180
2006	50,000,000	1,850,000	1,150
2007	48,700,000	1,800,000	1,120
2008	47,400,000	1,760,000	1,090
2009	46,100,000	1,710,000	1,060
2010	44,800,000	1,660,000	1,030
2011	43,500,000	1,610,000	999
2012	42,200,000	1,560,000	969
2013	40,900,000	1,510,000	939
2014	39,600,000	1,470,000	909
2015	38,300,000	1,420,000	879
2016	37,000,000	1,370,000	849
2017	35,700,000	1,320,000	820
2018	34,400,000	1,270,000	790
2019	33,100,000	1,220,000	760
2020	31,800,000	1,180,000	730

Table 20.--Estimated amount of sediment in Versailles Lake, 1989-2020

Year	Volume of sediment		
	Cubic feet	Cubic yards	Acre feet
1989	42,900,000	1,590,000	985
1990	44,200,000	1,640,000	1,010
1991	45,500,000	1,680,000	1,040
1992	46,800,000	1,730,000	1,070
1993	48,100,000	1,780,000	1,100
1994	49,400,000	1,830,000	1,130
1995	50,700,000	1,880,000	1,160
1996	52,000,000	1,920,000	1,190
1997	53,300,000	1,970,000	1,220
1998	54,600,000	2,020,000	1,250
1999	55,900,000	2,070,000	1,280
2000	57,200,000	2,120,000	1,310
2001	58,500,000	2,170,000	1,340
2002	59,800,000	2,210,000	1,370
2003	61,100,000	2,260,000	1,400
2004	62,400,000	2,310,000	1,430
2005	63,700,000	2,360,000	1,460
2006	65,000,000	2,410,000	1,490
2007	66,300,000	2,460,000	1,520
2008	67,600,000	2,500,000	1,550
2009	68,900,000	2,550,000	1,580
2010	70,200,000	2,600,000	1,610
2011	71,500,000	2,650,000	1,640
2012	72,800,000	2,700,000	1,670
2013	74,100,000	2,740,000	1,700
2014	75,400,000	2,790,000	1,730
2015	76,700,000	2,840,000	1,760
2016	78,000,000	2,890,000	1,790
2017	79,300,000	2,940,000	1,82[illegible]
2018	80,600,000	2,980,000	1,850
2019	81,900,000	3,030,000	1,880
2020	83,200,000	3,080,000	1,910

Table 21.--Numerical values assigned for physiographic factors in drainage basin of Laughery Creek

Factor	Numerical value
Land use	1; row crop 0; pasture 0; forest
Land slope	2; severe 1; moderate 0; mild
Slope length[1]	1; greater than 100 feet 0; less than 100 feet
Farming practice	1; farm on slopes 1; fall tilling 1; poor pasture condition 0; no fall tilling 0; no till
Field-border width	1; less than 5 feet 0; greater than 5 feet
Stream-buffer width	1; less than 10 feet 0; greater than 10 feet
Presence of ephemeral gully	1; present 0; not present

[1]Degree of slope is defined relative to slopes within the basin.

Table 22.--Average sedimentation-index number for subbasins in drainage basin of Laughery Creek

Subbasin	Sedimentation-index number
1	1.11
2	1.38
3	1.71
4	1.25
5	1.39
6	1.76
7	1.28
8	1.43
9	1.81
10	1.32
11	1.45
12	1.82
13	1.38
14	1.50
15	2.06