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# **Sedimentation Survey of Lake Decatur's Big and Sand Creek Basins, Macon County, Illinois**

by  
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**Prepared for the  
City of Decatur**

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Illinois State Water Survey  
Watershed Science Section  
Champaign, Illinois

A Division of the Illinois Department of Natural Resources

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## Abstract

Sedimentation detracts from the use of any water-supply lake by reducing lake depth and volume, with a reduction of reserve water-supply capacity and possible burying of intake structures. Sedimentation of a reservoir is a natural process that can be accelerated or slowed by human activities in the watershed.

Lake Decatur is located in Macon County, northeast of Decatur, Illinois. The location of the dam is 39° 49' 28" north latitude and 88° 57' 30" west longitude in Section 22, T.16N., R.2W., Macon County, Illinois. The dam impounds the Sangamon River in the Sangamon River basin. The watershed is a portion of Hydrologic Unit 07130006 as defined by the U.S. Geological Survey. The lake was constructed in 1922 with a spillway level of 610 feet above mean sea level (feet-msl). In 1956, a set of hydraulic gates was installed on the original spillway to allow variable lake levels from 610 feet-msl to 615 feet-msl. The portions of the lake surveyed for the present study were the Big and Sand Creek basins. These basins are the two major tributary stream basins formed to the south (Sand Creek) and east (Big Creek) of the main body of the lake. They receive the flow of Sand, Big, and Long Creeks.

Lake Decatur has been surveyed to document sedimentation conditions nine times since 1930. Five of these survey efforts (1936, 1946, 1956, 1966, and 1983) were sufficiently detailed to be termed full lake sedimentation surveys. The survey discussed in detail in this report is not a full lake sedimentation survey. However, additional work included in the present study could be combined with the 2000 survey of Basin 6 of Lake Decatur to provide a complete baseline survey for future reference.

Sedimentation has reduced Big Creek basin capacity from 2,754 acre-feet (ac-ft) in 1922 to 1,512 ac-ft in 2001. The 2001 basin capacity was 54.9 percent of the 1922 potential basin capacity. For water-supply purposes, these volumes convert to capacities of 897 million gallons in 1922 and 493 million gallons in 2001. Sedimentation rate analyses indicate a decline in annual sediment deposition rates from 28 ac-ft (1922-1946) to 9.9 ac-ft annually (1983-2001). The long-term average annual deposition rate was 15.7 ac-ft (1922-2001).

Sedimentation has reduced the Sand Creek basin capacity from 610 acre-feet (ac-ft) in 1922 to 246 ac-ft in 2001. The 2001 basin capacity was 40.3 percent of the 1922 potential basin capacity. For water-supply purposes, these volumes convert to capacities of 199 million gallons in 1922 and 80 million gallons in 2001. Sedimentation rate analyses indicate a decline in annual sediment deposition rates from 8.4 ac-ft (1922-1946) to 2.3 ac-ft annually (1983-2001). The long-term average annual deposition rate was 4.6 ac-ft (1922-2001).

# **Sedimentation Survey of Lake Decatur's Big and Sand Creek Basins Macon County, Illinois**

## **Introduction**

The Illinois State Water Survey (ISWS) conducted a sedimentation survey of the Big and Sand Creek basins of Lake Decatur during fall 2001 and spring 2002 to provide information on storage and sedimentation conditions. The City of Decatur owns and operates Lake Decatur. The city withdraws water from the lake as the sole raw water source for direct distribution of finished water to the community.

Sedimentation detracts from the use of any water-supply lake by reducing depth and volume. As a result, there is a reduction of reserve water-supply capacity and possible burying of intake structures.

Sedimentation of a reservoir is a natural process that human activities in the watershed can either accelerate or slow. In general, sedimentation of a lake is presumed to be accelerated unintentionally as a secondary impact of other developments within the watershed. For example, construction and agricultural activities in a lake's watershed generally are presumed to increase sediment delivery to the lake due to increased exposure of soil material to erosive forces.

Reductions of the sedimentation rate in a lake due to human impacts almost always are the result of programs intentionally designed to reduce soil and streambank erosion, and they are often the result of implementing lake remediation programs. These programs may include, but are not limited to, implementation of watershed erosion control practices, streambank and lakeshore stabilization, stream energy dissipaters, and lake dredging.

Sedimentation of a reservoir is the final stage of a three-step sediment transport process. The three steps are watershed erosion by sheet, rill, gully, and/or streambank erosion; sediment transport in a defined stream system; and sediment deposition, in which stream energy is reduced such that the sediment no longer can be transported in suspension or as bed load. Sediment deposition can occur throughout the stream system.

Lake sedimentation occurs when sediment-laden water in a stream enters the reduced flow velocity regime of a lake. As water velocity is reduced, suspended sediment is deposited in patterns related to the size and fall velocity of each particle. During this process, soil particles are partially sorted by size along the longitudinal axis of the lake. Larger, heavier sand and coarse silt particles are deposited in the upper end of the lake; finer silts and clay particles tend to be carried further into the lake.

Several empirical methods have been developed for estimating sedimentation rates in Illinois (ISWS, 1967; Upper Mississippi River Basin Commission, 1970; Singh and Durgunoglu, 1990). These methods use regionalized relationships between watershed size and lake sedimentation rates. Within limits, they serve well as estimates. A more precise measure of the

sedimentation rate is provided by conducting a sedimentation survey of the reservoir, however. The sedimentation survey provides detailed information on distribution patterns within the lake and defines temporal changes in overall sedimentation rates.

## **Acknowledgments**

The project was funded by the City of Decatur. Keith Alexander, Director of Water Management was project manager.

Views expressed in this report are those of the author and do not necessarily reflect the views of the sponsor or the Illinois State Water Survey.

This project was conducted by the author as part of his regular duties at the Illinois State Water Survey under the administrative guidance of Derek Winstanley, Chief, and Mike Demissie, Head of the Watershed Science Section. Joshua Stevens assisted with the field data collection. Yi Han analyzed the sediment samples. H. Vernon Knapp and Yanqing Lian provided technical review. Eva Kingston edited the report. Linda Hascall reviewed the graphics.

## **Lake Information**

Lake Decatur (figure 1) is located in Macon County, east of Decatur, Illinois and was formed by an impoundment of the Sangamon River. The location of the dam is 39° 49' 28" north latitude and 88° 57' 30" west longitude in Section 22, T.16N., R.2W., Macon County, Illinois. The watershed is a portion of the Sangamon River basin and is located in Hydrologic Unit 07130006 as defined by the U.S. Geological Survey (USGS, 1974).

The lake was constructed in 1922 with a spillway level of 610 feet above mean sea level (feet-msl). In 1956, a set of hydraulic gates was installed on the original spillway to allow variable lake levels from 610 feet-msl to 615 feet-msl. The operating plan for these gates and the lake levels maintained have been revised several times since 1956. In 2002, the operating plan designated a winter target pool elevation of 612.5 feet National Geodetic Vertical Datum (NGVD) for the period December to April and a summer target pool elevation of 614.4 feet NGVD for the period May to November.

Fitzpatrick et al. (1987) present a more complete review of the history of the Decatur public water-supply system and the development of Lake Decatur.

The portions of the lake surveyed for the present study were the Big and Sand Creek basins. These two major tributary stream basins were formed to the south (Sand Creek) and east (Big Creek) of the main body of the lake. They receive the flow of Sand, Big, and Long Creeks

The direct watershed areas for these sections of the lake were determined by Fitzpatrick et al. (1987) as 45,430 acres for the Big Creek basin and 8,970 acres for the Sand Creek basin.

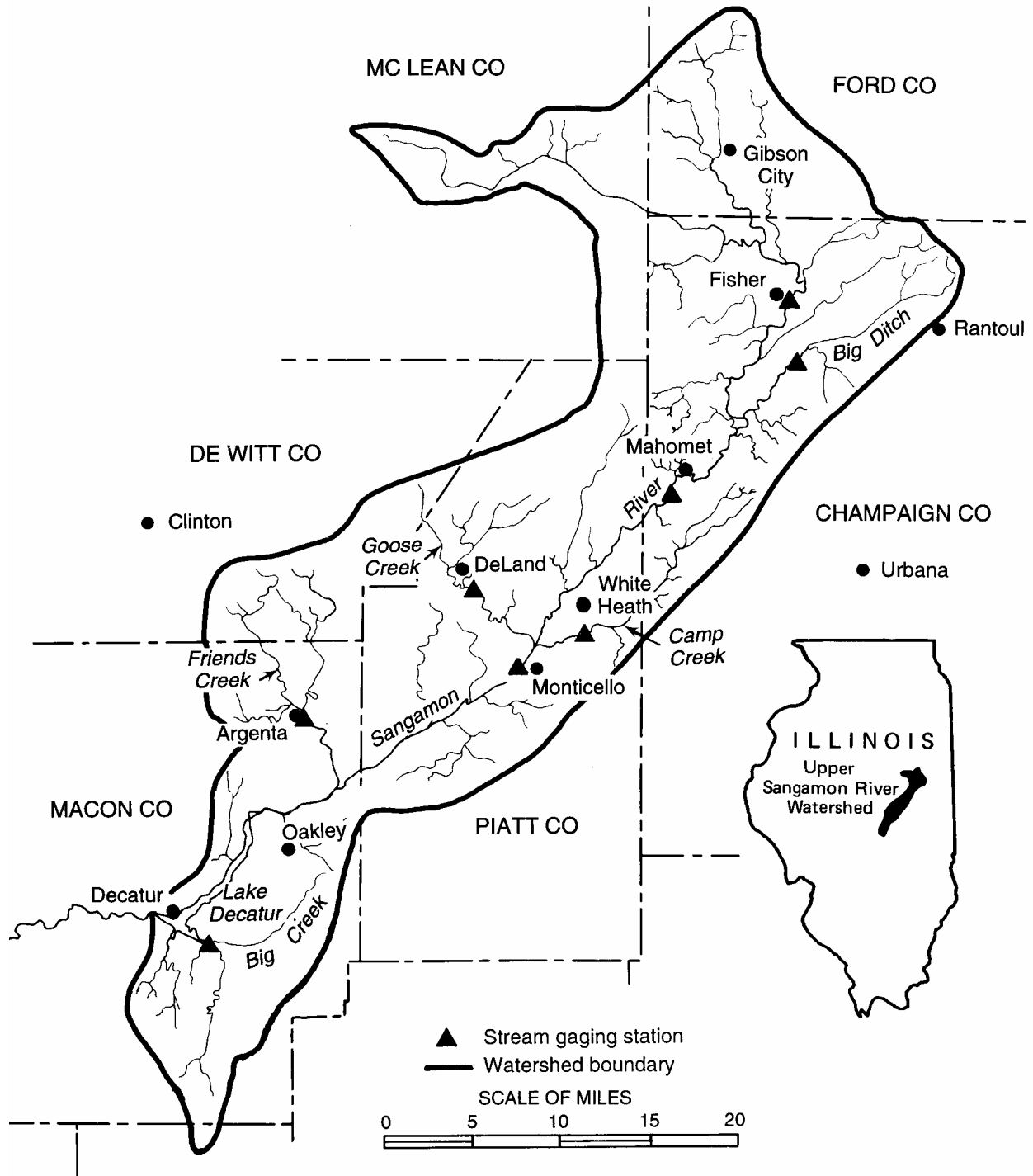


Figure 1. Location and watershed delineation of Lake Decatur



## Reservoir Sedimentation Records for Lake Decatur

Lake Decatur has been surveyed to document sedimentation conditions nine times since 1930. The plan for each of these surveys is shown (figure 2). Five of these surveys (1936, 1946, 1956, 1966, and 1983) were sufficiently detailed to be termed full lake sedimentation surveys. Survey types, year, and agency responsible were as follows:

<i>Survey type</i>	<i>Year</i>	<i>Agency</i>
Reconnaissance survey	1930	Macon County (F.L. Washburn, County Engineer)
Benchmark (initial) survey	1931	ISWS
Re-survey	1936	ISWS and Illinois Agricultural Experiment Station
Re-survey	1946	ISWS
Re-survey	1956	ISWS
Re-survey	1966	ISWS
Re-survey	1983	ISWS
Basin 6 re-survey	2000	ISWS
Big and Sand Creek Basins (Main Basins 1-5 Baseline)	2001-2002	ISWS

The present survey is not a full lake sedimentation survey. Detailed sedimentation analysis for this study was limited to the 12 transects in the work area as required by the study plan. Traditional survey lines in Basins 1-4 were surveyed as well as a new series of parallel cross sections. A series of cross sections was developed in Basin 5 (Faries Park Basin) based on the postdredging survey conducted in 1993 and 1994. Fitzpatrick et al. (1987) present detailed methodologies for the earlier surveys.

Prior to initiating the lake depth survey, all surviving monumentation established for previous surveys was recovered and located using a differentially corrected Leica 9600 System Geodetic Positioning System (GPS). When all previous monumentation for a range end was lost, relocation ties were used to determine the location of the range end, and a GPS position was determined.

The 2001 survey was conducted using an Odom Hydrographic Systems MK II fathometer for depth measurement and the differentially corrected GPS for horizontal control across the transect. When water depth was less than 3.0 feet, depth data were collected using a marked pole for depth measurement and the differentially corrected Leica 9600 GPS for horizontal control across the transect. All navigation and data logging functions were controlled using HYPACK hydrographic survey software. For navigation purposes, the GPS positions determined for the range ends were entered into the HYPACK system, which then provided guidance for positioning each line at pre-determined intervals. The GPS positions were differentially corrected using Radio Technical Commission for Maritime Services (RTCM) correction signals broadcast by the U.S. Coast Guard from St. Louis, Missouri.

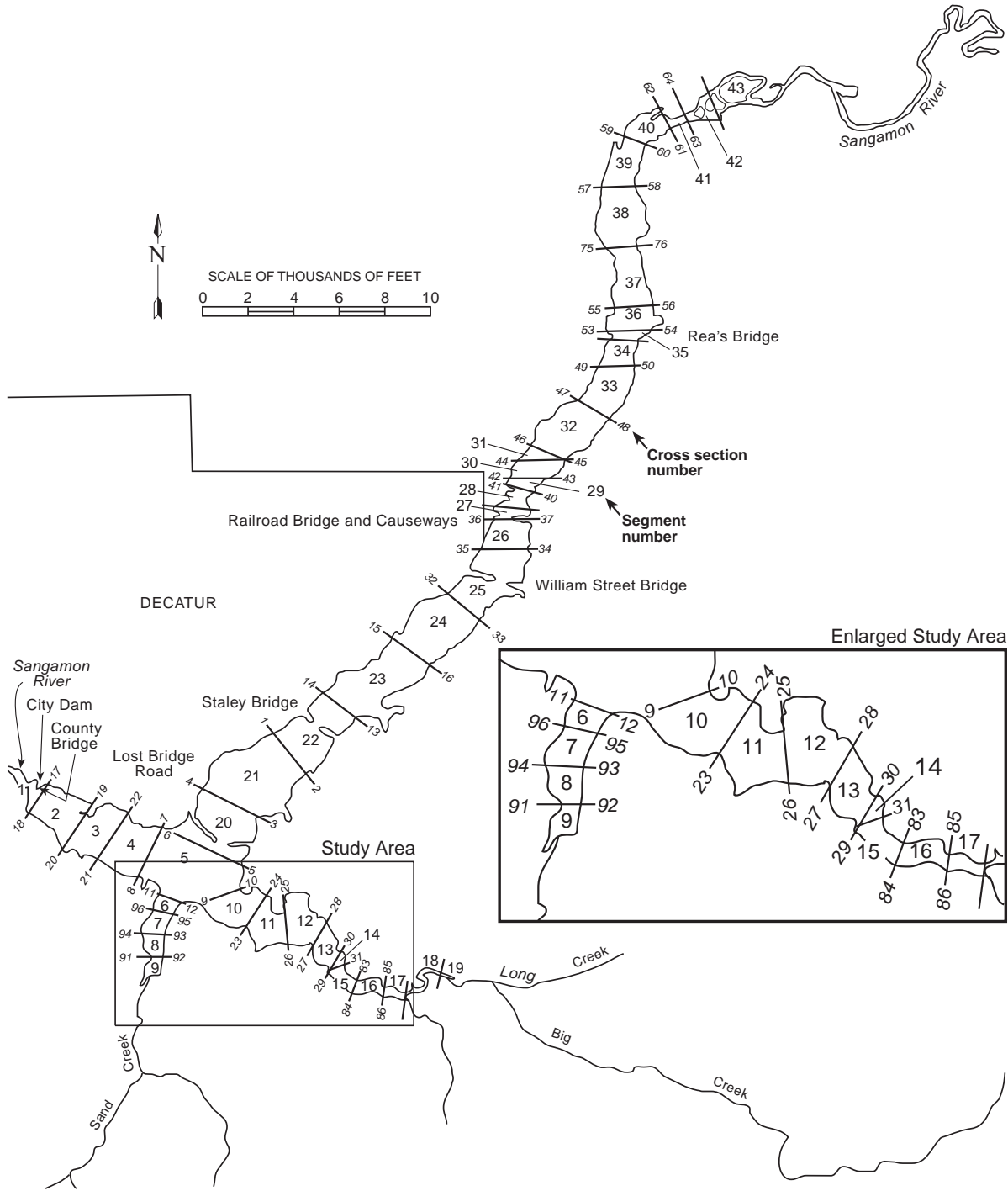


Figure 2. Survey plan for Lake Decatur, Big and Sand Creek basins

The fathometer was calibrated daily prior to initiating measurements. Calibration checks at the end of most work days showed daily variations of 0.1-0.2 feet in a profile at one-foot depth intervals. Manual water depth measurements were spaced at nominal 50-foot intervals along each transect line. The GPS position was recorded at each measuring point using the HYPACK software, and the measured water depth was manually entered into the record. For each cross section in the primary project area, three to five physical measurements of the water depth and sediment thickness were made with an aluminum sounding pole. All depth measurements were converted to bed elevations using a daily lake level obtained from the main water treatment plant.

Plots of all surveyed cross sections for Big and Sand Creek basins from 1936, 1946, 1956, 1966, 1983, and 2001 are presented in appendix I.

### **Volumes and Sedimentation Rates for Big and Sand Creek Basins**

Calculations of the lake capacities were made using the method described in the *National Engineering Handbook* of the U.S. Soil Conservation Service (USDA-SCS, 1968). This method can determine the original and present volume of each segment by using surface area of the lake segments, cross-sectional area and widths of their bounding segments, and a shape factor. These volumes are then summed to determine the total lake volume. The reference elevation used for the lake was the top of the spillway, 614.5 feet NGVD. This spillway elevation could not be maintained prior to the modifications made to the spillway in 1956, and the volumes listed are actually potential volumes that did not exist at that time. Table 1 presents the volume calculation results for the Big Creek basin for each survey. Table 2 presents the volume calculation results for the Sand Creek basin for each survey.

#### *Big Creek Basin*

Sedimentation has reduced the basin capacity from 2,754 acre-feet (ac-ft) in 1922 to 1,512 ac-ft in 2001. The 2001 basin capacity was 54.9 percent of the 1922 potential basin capacity. For water-supply purposes, these volumes convert to capacities of 897 million gallons in 1922 and 493 million gallons in 2001.

Sedimentation rates for Lake Decatur's Big Creek basin were analyzed in terms of deposition rates in the reservoir. Table 1 presents the sedimentation rates for Big Creek basin for all available sedimentation periods. These rates indicate that initial deposition rates of 28 ac-ft per year (1922-1946) dropped to 4.6 ac-ft per year (1946-1956). Since 1956, the sedimentation rate has been fairly stable and has been 9.9 ac-ft per year (1983-2001). The long-term average annual deposition rate was 15.7 ac-ft (1922-2001).

Table 3 presents capacity loss rates for the Big Creek basin. Capacity loss rates compare the rate of accumulation of sediment in the lake to the original reservoir capacity of the lake. The rate of capacity loss follows the volume loss rates presented in table 1 with initial high rates of 1.02 percent per year (1922-1946) to 0.17 percent per year (1946-1956). The most recent period (1983-2001) shows a loss rate of 0.36 percent per year, which is less than the long-term (1922-2001) rate of 0.57 percent per year.

**Table 1. Capacity and Capacity Loss Analysis for Big Creek Basin**

<i>Period</i>	<i>Big Creek basin capacity</i>	<i>Capacity loss for period</i>	<i>Cumulative capacity loss</i>	<i>Period annual capacity loss rate</i>	<i>Cumulative annual capacity loss rate</i>
<i>a) Analysis in units of ac-ft</i>					
1922	2,754				
1922-1936	2,362	392	392	28.0	28.0
1936-1946	2,080	282	674	28.2	28.1
1946-1956	2,034	46	720	4.6	21.2
1956-1966	1,918	116	836	11.6	19.0
1966-1983	1,690	228	1,064	13.4	17.4
1983-2001	1,512	178	1,242	9.9	15.7
<i>b) Analysis in units of million gallons</i>					
1922	897				
1922-1936	769	128	128	9.1	9.1
1936-1946	678	92	220	9.2	9.1
1946-1956	663	15	235	1.5	6.9
1956-1966	625	38	272	3.8	6.2
1966-1983	551	74	347	4.4	5.7
1983-2001	493	58	405	3.2	5.1

**Notes:**

Big Creek basin surface area was 332.8 acres in 2001.

Capacity shown is for the sedimentation survey conducted at the end of the period.

**Table 2. Capacity and Capacity Loss Analysis, Sand Creek Basin**

<i>Period</i>	<i>Sand Creek basin Capacity</i>	<i>Capacity loss for period</i>	<i>Cumulative capacity loss</i>	<i>Period annual capacity loss rate</i>	<i>Cumulative annual capacity loss rate</i>
<i>a) Analysis in units of ac-ft</i>					
1922	610				
1922-1936	500	110.4	110	7.9	7.9
1936-1946	409	90.7	201	9.1	8.4
1946-1956	399	10.2	211	1.0	6.2
1956-1966	360	38.6	250	3.9	5.7
1966-1983	287	72.8	323	4.3	5.3
1983-2001	246	41.5	364	2.3	4.6
<i>b) Analysis in units of million gallons</i>					
1922	199				
1922-1936	163	36.0	36.0	2.6	2.6
1936-1946	133	29.5	65.5	3.0	2.7
1946-1956	130	3.3	68.8	0.3	2.0
1956-1966	117	12.6	81.4	1.3	1.8
1966-1983	94	23.7	105.1	1.4	1.7
1983-2001	80	13.5	118.6	0.8	1.5

**Notes:**

Sand Creek basin surface area was 77.6 acres in 2001.

Capacity shown is for the sedimentation survey conducted at the end of the period.

**Table 3. Capacity Loss Rates (percent) Relative to Original Basin Capacity, Big Creek Basin**

<i>Period</i>	<i>Per period</i>	<i>Cumulative</i>	<i>Period annual loss</i>	<i>Cumulative annual loss</i>
1922-1936	14.2	14.2	1.02	1.02
1936-1946	10.2	24.5	1.02	1.02
1946-1956	1.7	26.1	0.17	0.77
1956-1966	4.2	30.3	0.42	0.69
1966-1983	8.3	38.6	0.49	0.63
1983-2001	6.5	45.1	0.36	0.57

**Table 4. Capacity Loss Rates (percent) Relative to Original Basin Capacity, Sand Creek Basin**

<i>Period</i>	<i>Per period</i>	<i>Cumulative</i>	<i>Period annual loss</i>	<i>Cumulative annual loss</i>
1922-1936	18.1	18.1	1.29	1.29
1936-1946	14.9	33.0	1.49	1.37
1946-1956	1.7	34.6	0.17	1.02
1956-1966	6.3	41.0	0.63	0.93
1966-1983	11.9	52.9	0.70	0.87
1983-2001	6.8	59.7	0.38	0.76

*Sand Creek Basin*

Sedimentation reduced basin capacity from 610 acre-feet (ac-ft) in 1922 to 246 ac-ft in 2002. The 2001 basin capacity was 40.3 percent of the 1922 potential basin capacity. For water-supply purposes, these volumes convert to capacities of 199 million gallons in 1922 and 80 million gallons in 2001.

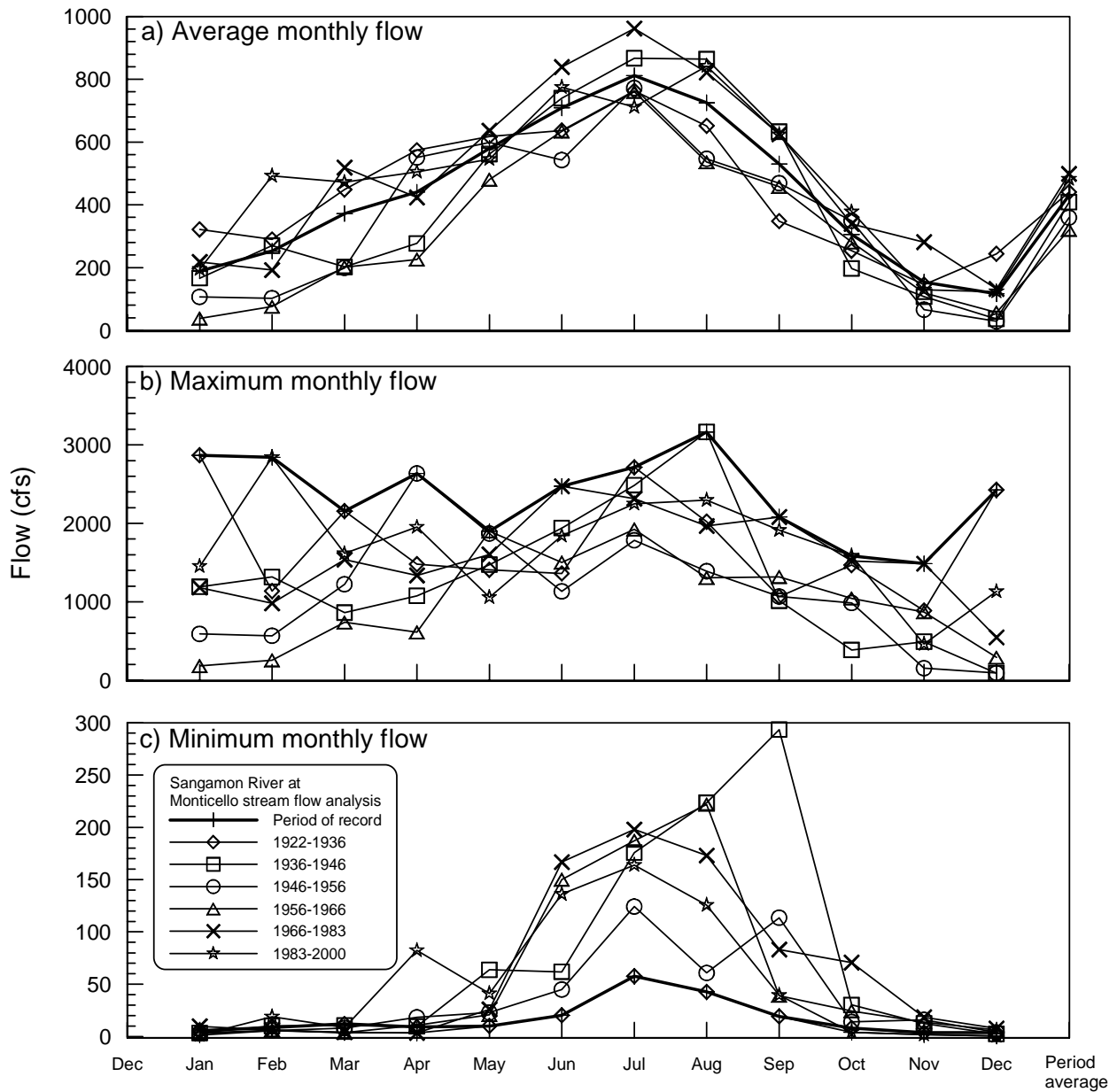
Sedimentation rates for Lake Decatur’s Sand Creek basin were analyzed in terms of deposition rates in the reservoir. Table 2 presents the sedimentation rates for Sand Creek basin for all available sedimentation periods. These rates indicate that initial deposition rates of 8.4 ac-ft per year (1922-1946) dropped to 1.0 ac-ft per year (1946-1956). The sedimentation rate has been stable in the 2.5 to 4.5 ac-ft per year range since the 1956 survey and has been 2.3 ac-feet per year (1983-2001). The long-term average annual deposition rate for 1922-2001 was 4.6 ac-ft.

Table 4 presents capacity loss rates for the Sand Creek basin. The capacity loss rates compare the rate of sediment accumulation in the lake to the original reservoir capacity. The rate of capacity loss follows the volume loss rates presented in table 2 with initial high rates of 1.37 percent per year (1922-1946) to 0.17 percent per year (1946-1956). The most recent period (1983-2001) shows a loss rate of 0.38 percent per year, considerably less than the long-term (1922-2001) rate of 0.76 percent per year.

**Factors Affecting Lake Sedimentation Rates**

Sedimentation rates in a lake can vary over time due to changes in either watershed or in-lake conditions. Changes in watershed conditions, such as altered precipitation patterns, land-use patterns, and streamflow variability, affect the sediment delivery rates to the lake. In-lake conditions that affect sedimentation rates involve the variation of trap efficiency (due to reduced storage capacity) and sediment consolidation.

Monthly streamflow statistics for the Sangamon River at Monticello are shown for the periods between each sedimentation survey from October 1921-September 1999 (figure 3). The



**Note:** Maximum and minimum lines and symbols for sub-periods are hidden when they are coincident with the period of record (heavier line) in the figure.

Figure 3. Comparison of a) average monthly flow, b) maximum monthly flow, and c) minimum monthly flow for the Sangamon River at Monticello for the six sedimentation periods and the full record of the Monticello station (1914-1999)

most important plots for analysis of lake sedimentation are the maximum and average monthly flows. High sediment transport rates are closely related to peak water discharge periods (Demissie et al., 1983; Bhowmik et al., 1993). The plots do not indicate any distinct differences in high and average flow characteristics for an individual sedimentation period.

Of interest for water-supply yield purposes are the generally lower minimum flows that occurred during the 1922-1936 and 1946-1956 periods. Low flow rates at the Monticello station for the early 1930s and the mid-1950s reflect the severe drought conditions that were prevalent for most Illinois streams during those time periods. The low volumetric sedimentation rates for the 1946-1956 period probably reflect the low sediment loading to the lake and sediment consolidation due to low lake levels during the 1950s drought period.

The trap efficiency (percentage portion of sediment captured by the reservoir) of each basin was determined using a predictive equation developed by Dendy (1974) based on the relationship between the annual capacity to inflow ratio and sediment-holding capacity. The trap efficiency of Big Creek basin was 81.2 percent in 1922, which means that 81.2 percent of all sediment entering from Big Creek and Long Creek was trapped in the basin. In general, as sediment accumulation reduces the volume of the lake basin, the holding time for water entering the lake is reduced so that there is less time for sediment to drop out of suspension, and the trap efficiency is reduced. The reduced capacity of Big Creek basin resulted in a trap efficiency of 72.5 percent in 2001.

The trap efficiency of the Sand Creek basin was 82.5 percent in 1922, which means that 82.5 percent of all sediment entering from Sand Creek was trapped in the lake basin. The reduced capacity of Sand Creek basin has resulted in a trap efficiency of 69.1 percent in 2001.

For each of these basins, sediments that are not trapped pass through to the main body of the lake and can be deposited there. Gradual consolidation of lake sediments affects the calculated sedimentation rate of the lake by reducing the volume of accumulated sediments. Sediments accumulate on the bottom of the lake in a very loose, fluid mass. These sediments are subject to compaction as they are covered by continued sedimentation or are exposed by occasional lake drawdown. This process reduces the volume of the sediments while increasing their weight per unit volume. Thus, the tonnage of the sediments accumulated during a period of time will not change, but the volume of the sediments may be reduced over time by up to 50 percent. This is also consistent with a reduced volumetric sedimentation rate over time. Consolidation of sediments has not been as apparent in the Big and Sand Creek basins as it was in the 2000 survey of Basin 6 of Lake Decatur (Bogner, 2001). The winter drawdown plan may not have as much impact on these two basins because they are slightly deeper than Basin 6.

## **Sediment Distribution**

The distribution of sediment in the Big Creek basin of the lake is shown (table 5). This table lists the average sediment thickness and mass distribution for the basin and for each lake calculation segment as shown in figure 2. Sediment thickness ranges from 1.5 to 4.5 feet. The distribution of sediment in the basin is reasonably uniform with the maximum depth of accumulation in segment 12 and the greatest mass per unit area in segment 14.

**Table 5. Sediment Distribution in Lake Decatur, Big Creek Basin**

<i>Segment from figure 2</i>	<i>1922 volume (ac-ft)</i>	<i>2001 volume (ac-ft)</i>	<i>2001 sediment accumulation (ac-ft)</i>	<i>2001 sediment weight (tons)</i>	<i>2001 sediment thickness (feet)</i>	<i>2001 sediment per segment acre (tons)</i>
10	762.2	500.3	261.9	172,649	3.8	2,486
11	661.4	363.0	298.4	228,902	4.5	3,471
12	619.4	287.3	332.1	265,348	4.6	3,653
13	304.5	139.2	165.3	164,789	4.0	3,967
14	34.9	16.1	18.8	24,595	3.5	4,555
15	117.1	59.6	57.5	75,161	3.0	3,927
16	113.6	64.5	49.1	69,643	2.5	3,573
17	140.8	82.3	58.5	95,331	1.5	2,432
Totals	2,754	1,512	1,242	1,096,416		
Averages					3.7	3,295

**Note:**

Averages are for all of Big Creek basin and are not column averages.

**Table 6. Sediment Distribution in Lake Decatur, Sand Creek Basin**

<i>Segment from figure 2</i>	<i>1922 volume (ac-ft)</i>	<i>2001 volume (ac-ft)</i>	<i>2001 sediment accumulation (ac-ft)</i>	<i>2001 sediment weight (tons)</i>	<i>2001 sediment thickness (feet)</i>	<i>2001 sediment per segment acre (tons)</i>
6	143.1	75.7	67.4	57,092	6.0	5,066
7	253.1	98.4	154.7	143,848	5.9	5,507
8	143.0	48.7	94.2	117,106	4.8	5,935
9	70.9	23.1	47.8	70,698	2.3	3,449
Totals	610	246	364	388,744		
Averages					4.7	5,008

**Note:**

Averages are for all of Sand Creek basin and are not column averages.

The distribution of sediment in the Sand Creek basin of the lake is shown (table 6). This table lists the average sediment thickness and mass distribution for the basin and for each lake calculation segment as shown in figure 2. Sediment thickness ranges from 2.3 to 6.0 feet. Sediment accumulation by mass is evenly distributed through most of the Sand Creek basin.

Density analyses of the sediment samples (appendix II) indicate that the unit weight of sediment in the upstream portions of both lake basins is greater than the unit weight of sediment in the downstream portions of the basin. In general, coarser sediments are expected to be deposited in the upstream portion of a lake where the entrainment velocity of the stream is reduced to the much slower velocities of a lake environment. These coarser sediments tend to be denser when settled and are subject to drying and higher compaction rates as a result of more frequent drawdown exposure in the shallow water environment. As the remaining sediment load of the stream is transported through the lake, increasingly finer particle sizes and decreasing unit weight are observed.

### **Sediment Particle Size Distribution**

A total of 12 lakebed sediment samples from the Big Creek basin and 6 samples from the Sand Creek basin were collected for particle size distribution analysis. Figure 4 and appendix III present the laboratory analyses for these samples. Figure 4A shows particle size distribution plots for samples collected from the Big Creek basin, and figure 4B shows plots for the Sand Creek basin. Both figures present data for samples collected from the top surface of the accumulated sediments (shown in black) and from core samples (shown in red) using the same plotting symbol as the corresponding surficial sample.

In these plots, a downward shift in the position of a line indicates an increase in the particle size of the materials. On a general basis, the surficial samples show the usual tendency for sediment particle size to decrease from upstream to downstream in the lake, a result of the natural sorting of suspended sediments in the lake environment. Coarse sediments are deposited as inflowing streamwater is first slowed upon entering the lake. As the water moves through the lake, suspended sediments become finer as the coarser sized fractions fall out of suspension.

Particle size distributions of figure 4 show the common tendency for sediments at any point in the lake to become more coarse with time. More recent, surficial sediments (shown in black) that have been deposited on top of older sediments (shown in red) are characteristically much more coarse. This observation is consistent with general trends in lake sediments. Surficial sediment, the most recently deposited sediment, tends to be coarser with time at a given point. This is due to the downlake shift in the initial depositional environment of the lake due to the loss of trap efficiency of the upper end of the lake. With time, the initial depositional zone in the lake will move further downlake because of water volume loss to sedimentation.

Depositional characteristics of the sediments in the Big Creek basin show some variation from these general trends. This is particularly true for the samples collected at the upper cross section, R86-R85. These variations are presumed to be due to shifts in the primary water flow paths in the upper reaches of the basin.





## Summary

The Illinois State Water Survey has conducted a sedimentation survey of the Big Creek and Sand Creek basins of Lake Decatur in Decatur, Illinois. The lake, originally constructed in 1922, is the raw water source for the Decatur public water-supply. Previous lake sedimentation surveys were conducted in 1936, 1946, 1956, 1966, 1983, and 2000. The operating elevation for the reservoir is 614.5 feet NGVD during the summer months and 612.5 feet NGVD for the winter months.

Sedimentation has reduced the capacity of the Big Creek basin from 2,754 ac-ft (897 million gallons) in 1922 to 1,512 ac-ft (493 million gallons) in 2001. Sediment accumulation rates in the basin have averaged 15.7 ac-ft per year from 1922 to 2001. Annual sedimentation rates for six separate periods, 1922-1936, 1936-1946, 1946-1956, 1956-1966, 1966-1983, and 1983-2001, were 28.0, 28.2, 4.6, 11.6, 13.4, and 9.9 ac-ft, respectively.

Sedimentation has reduced the capacity of the Sand Creek basin from 610 ac-ft (199 million gallons) in 1922 to 246 ac-ft (80.0 million gallons) in 2001. Sediment accumulation rates in the basin have averaged 4.6 ac-ft per year from 1922 to 2001. Annual sedimentation rates for six separate periods, 1922-1936, 1936-1946, 1946-1956, 1956-1966, 1966-1983, and 1983-2001, were 7.9, 9.1, 1.0, 3.9, 4.3, and 2.3 ac-ft, respectively.

The distribution of sediment in the eight calculation segments of the Big Creek basin of the lake results in average sediment thickness ranges from 1.5 to 4.5 feet. Average mass distributions in the Big Creek basin range from 2,432 to 4,555 tons per acre. Sedimentation by mass is evenly distributed through most of the basin.

The distribution of sediment in the four calculation segments of the Sand Creek basin of the lake results in average sediment ranges from 2.3 to 6.0 feet. Average mass distributions in the Sand Creek basin range from 3,449 to 5,935 tons per acre. Sediment accumulation by mass is evenly distributed through most of the Sand Creek basin.

Particle size distributions for the sediments of both basins show a common tendency for sediments that accumulate at any point in a lake to become coarser over time. More recent, surficial sediments that have been deposited on top of older sediments are characteristically much coarser. This observation is consistent with general trends in lake sediments. Surficial sediment, the most recently deposited sediment, tends to be coarser over time at a given point. This is due to the downlake shift in the initial depositional environment of the lake due to the loss of trap efficiency at the upper end of the lake. With time, the initial depositional zone in the lake will move further downlake because of water volume loss to sedimentation.

Depositional characteristics of the sediments in the Big Creek basin show some variation from this general trend. This is particularly true for the samples collected at the upper cross section, R86-R85. These variations are presumed to be due to shifts in the primary water flow paths in the upper reaches of the basin.



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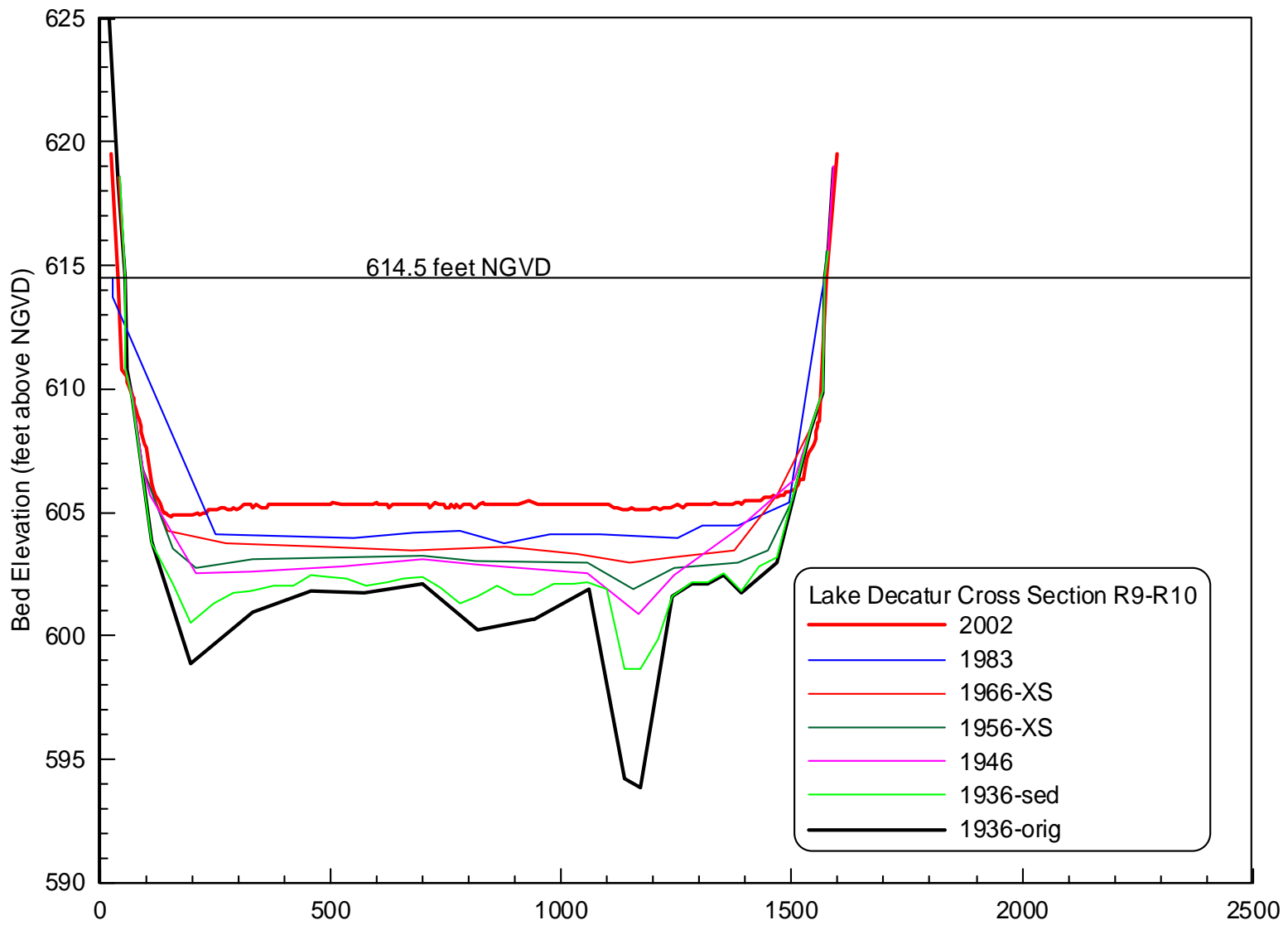
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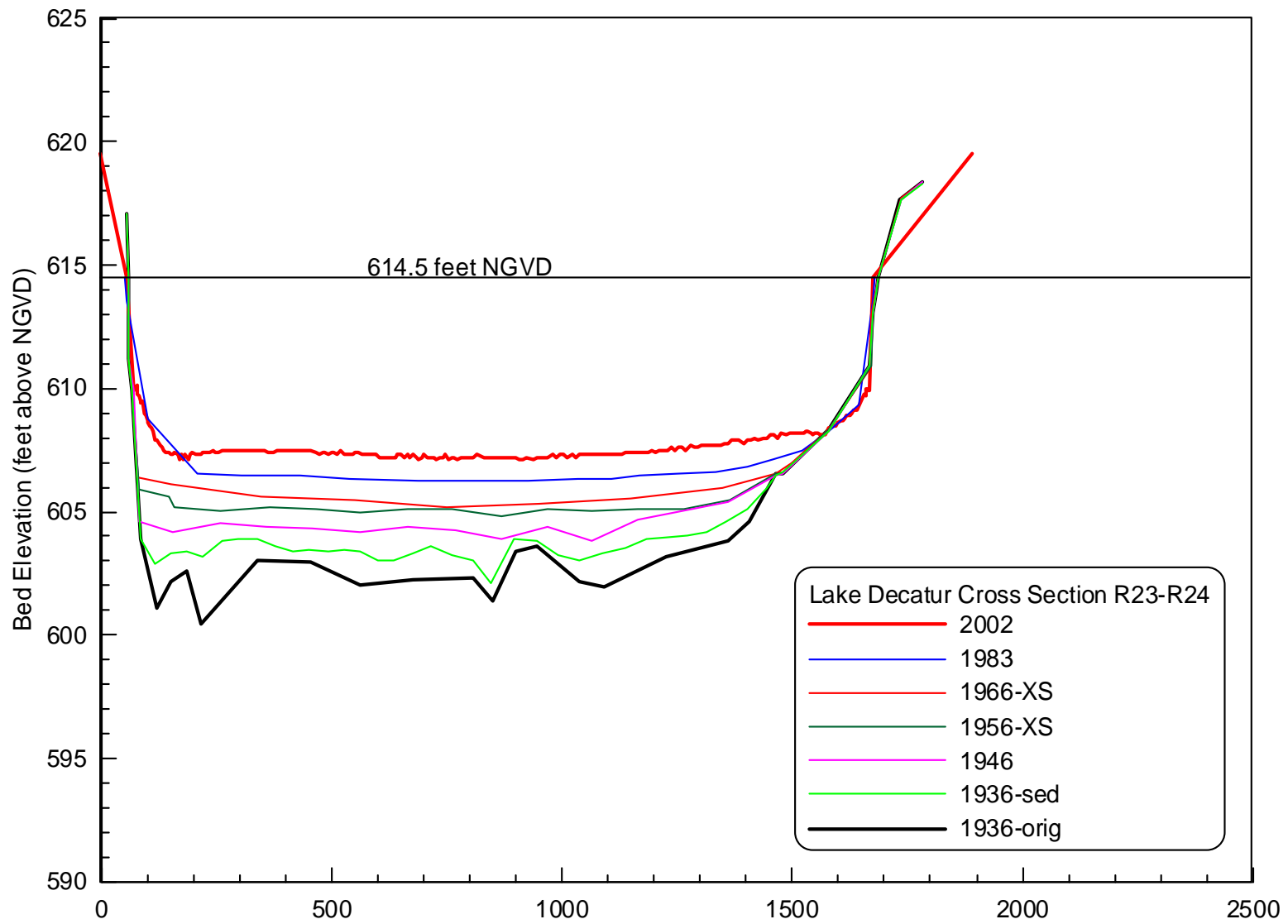
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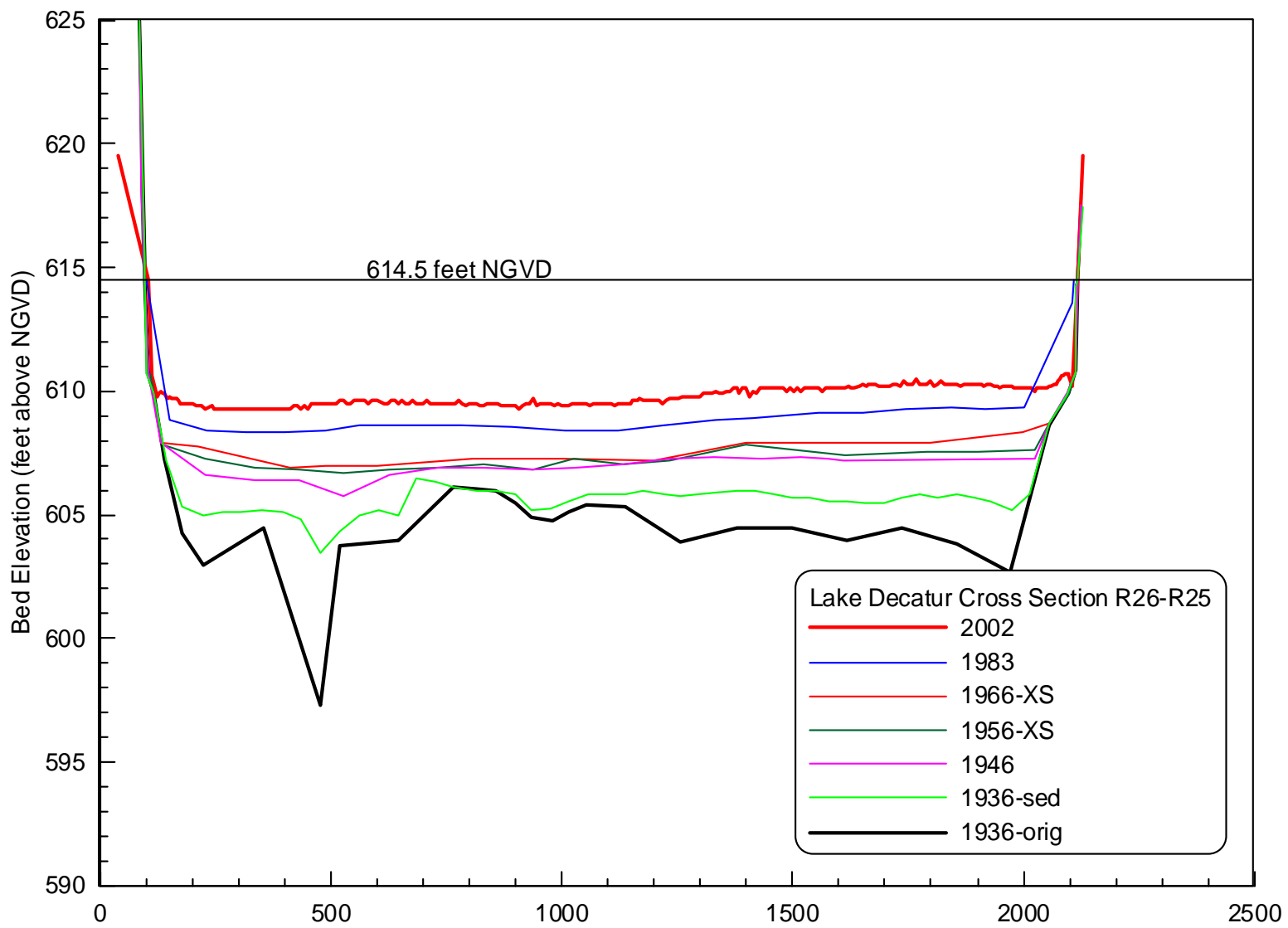
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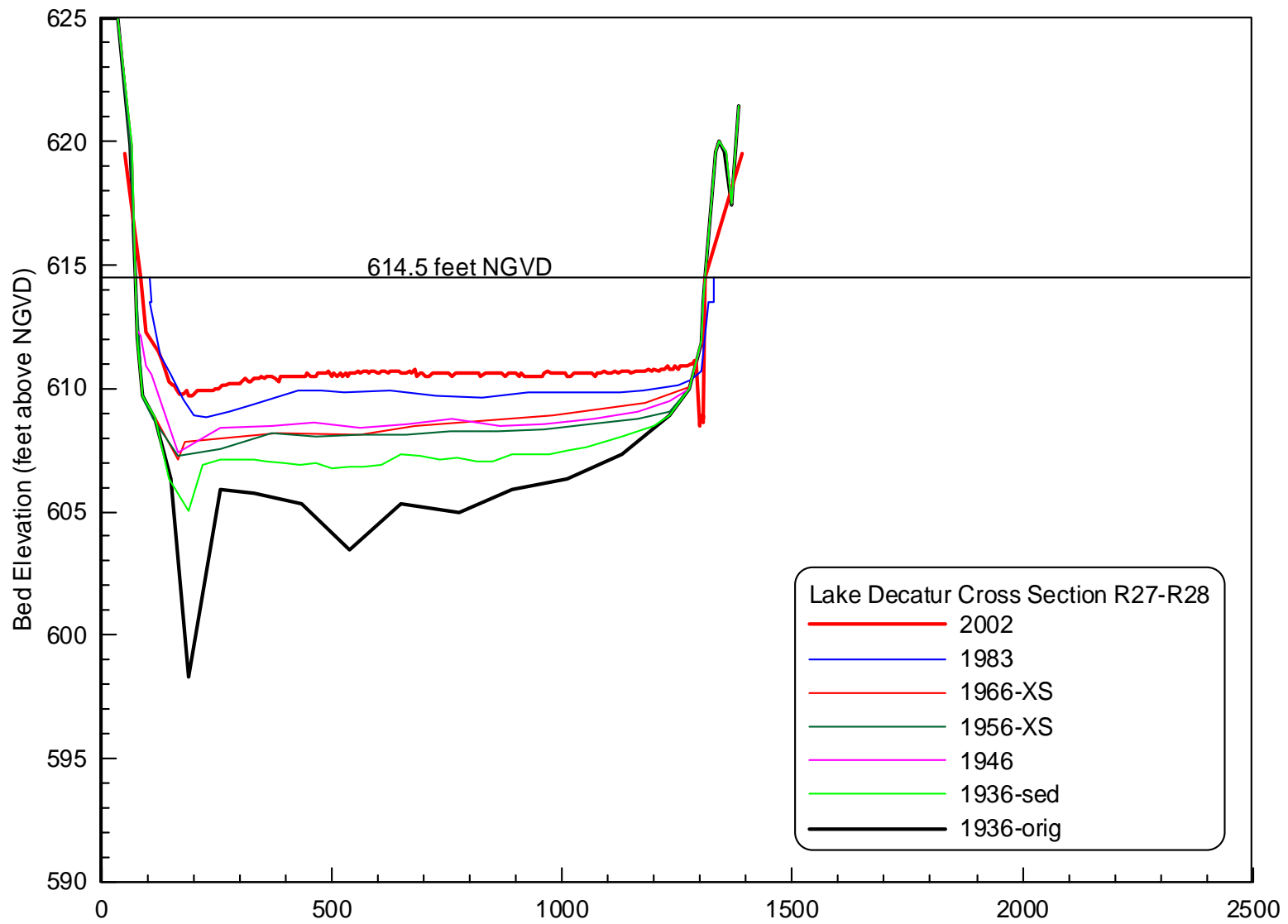
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**Appendix I. Cross-Section Plots  
of the Lake Decatur Big Creek  
and Sand Creek Basin Transects**

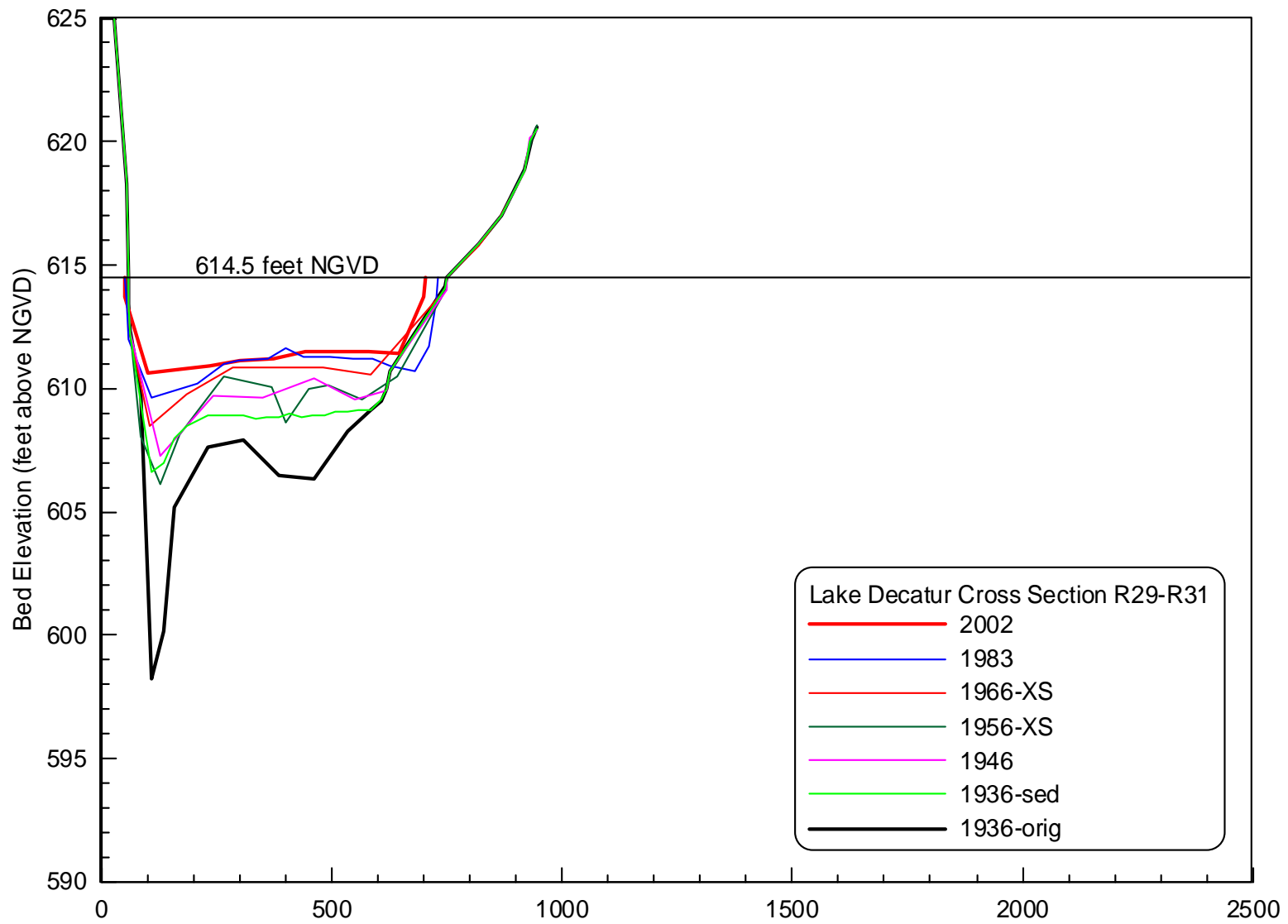


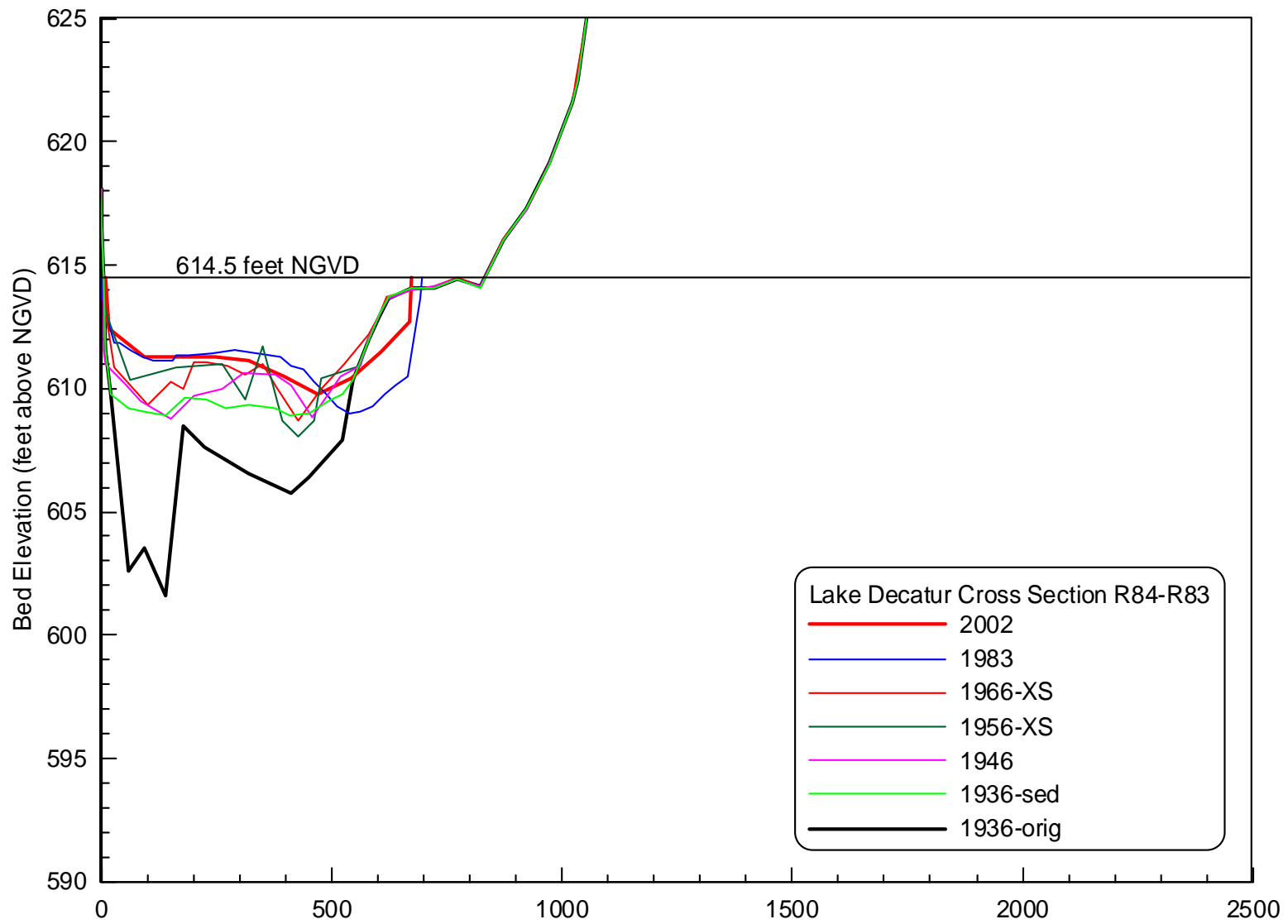


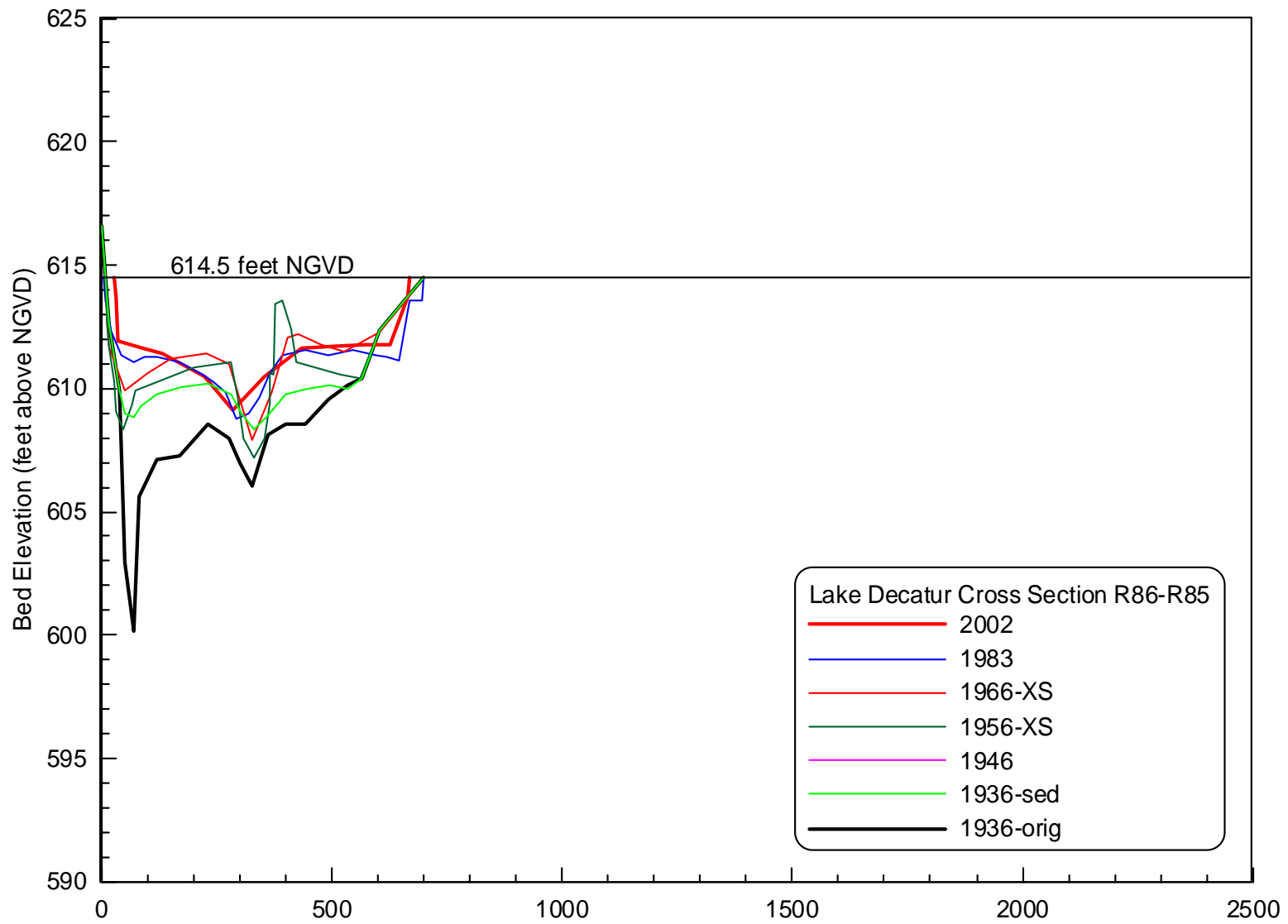


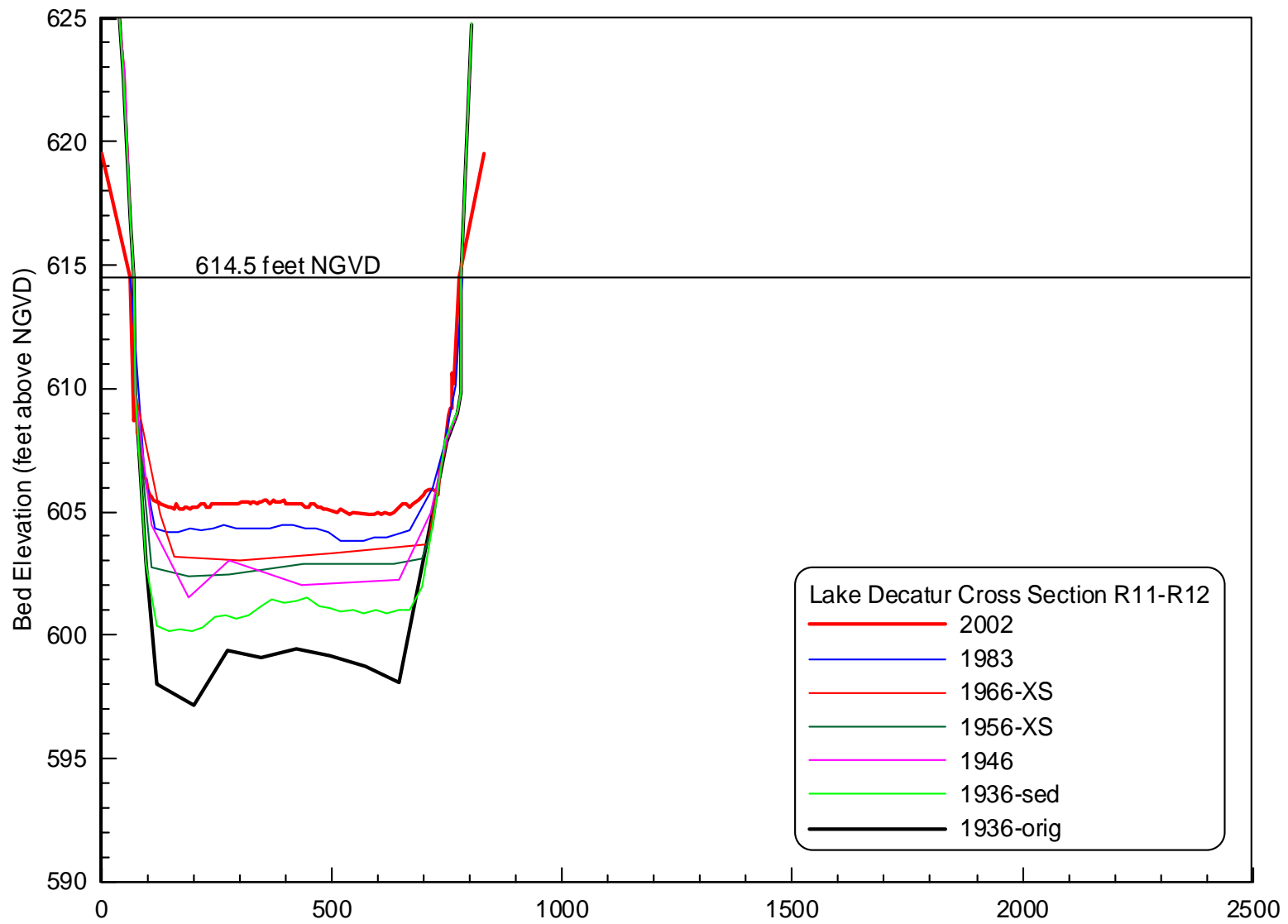


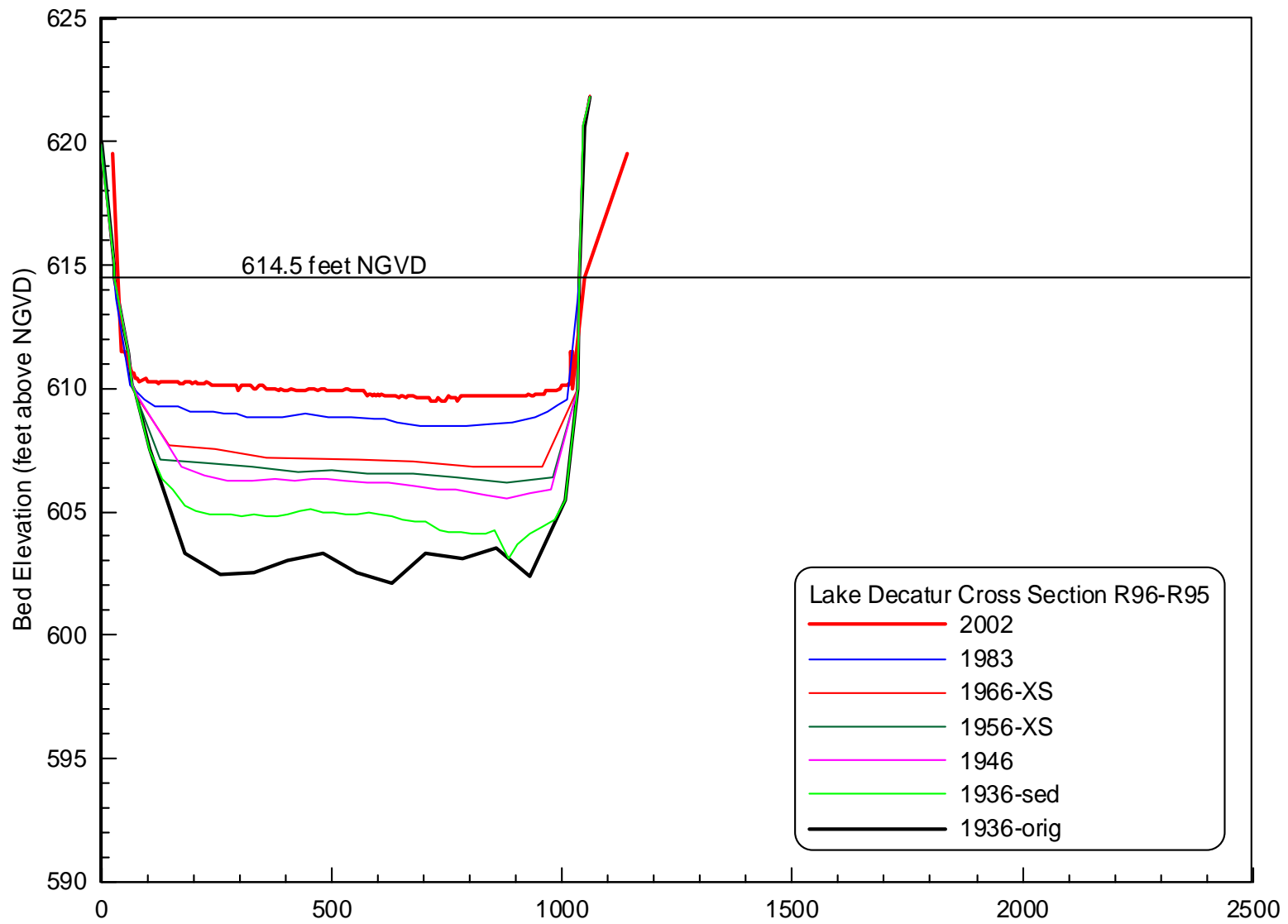


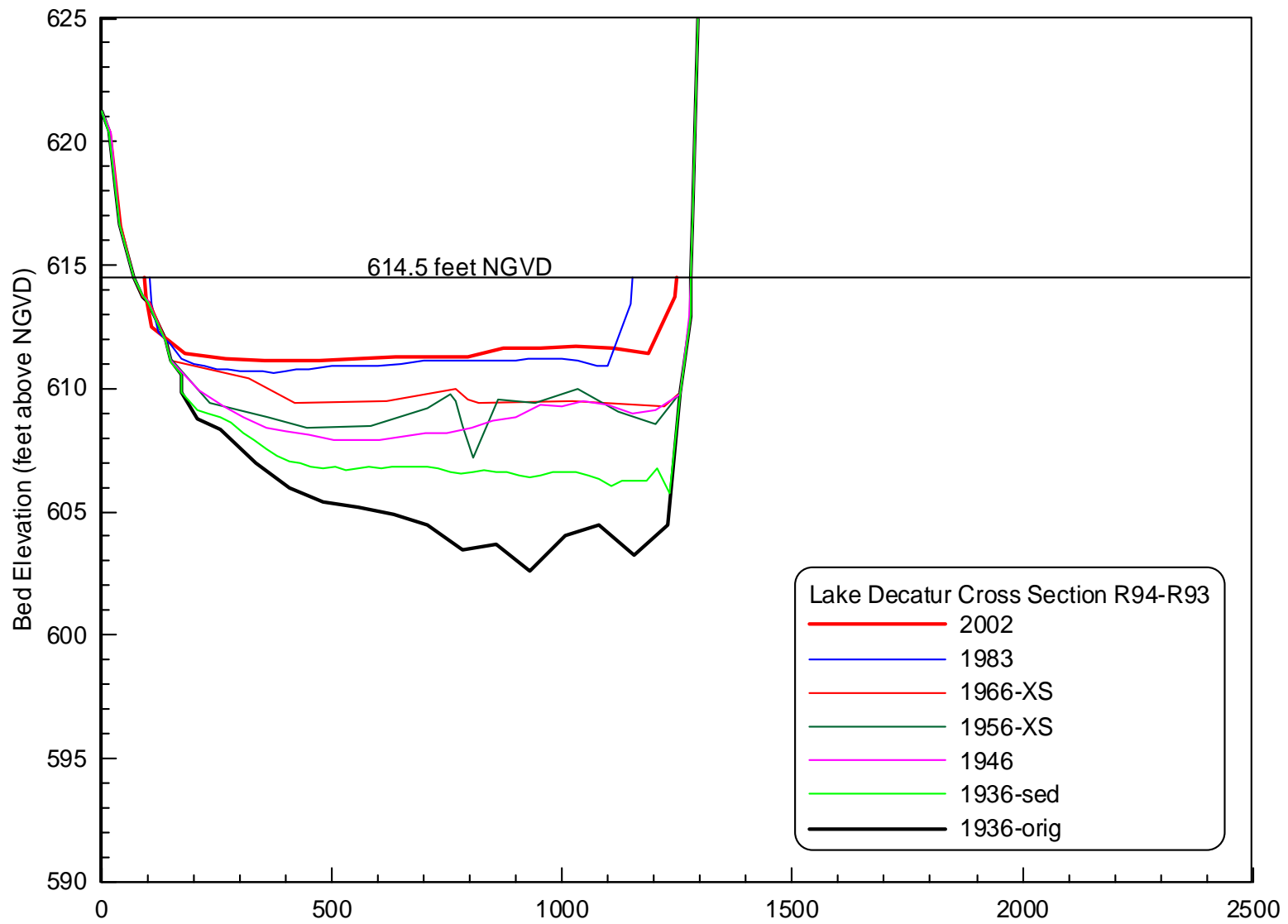


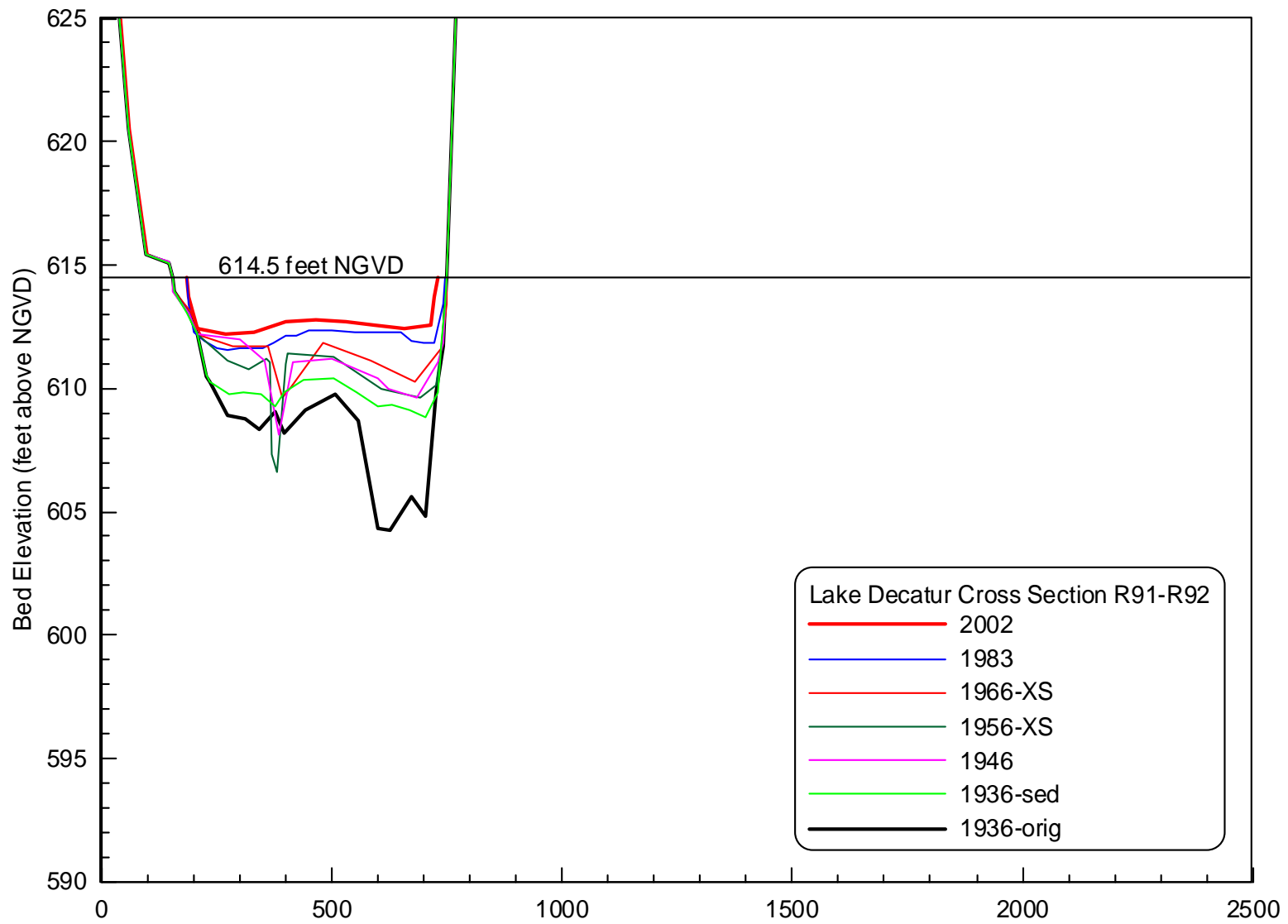












**Appendix II. Sediment Core Sample Unit Weight Results**

<i>Sample number</i>	<i>Location</i>	<i>Sediment layers</i>	<i>Unit weight (pounds per cubic foot)</i>
1	S11-12	Core 3-6	31.0
2	S11-12	Core 17-20	40.5
4	S96-95	Core 2-5	31.9
5	S96-95	Core 16-19	44.9
8	S94-03	Core 4-7	38.8
9	S94-93	Core 17-20	61.9
11	S91-92	Core 2-5	58.8
12	S91-92	Core 17-18	74.8
15	B9-10	Core 9-12	30.3
18	B23-24	Core 2-5	23.4
19	B23-24	Core 15-18	38.6
21	B26-25	Core 2-5	28.7
22	B26-25	Core 16-19	38.9
25	B27-28	Core 2-5	33.3
26	B27-28	Core 21-24	50.0

**Note:** All samples were collected at the transect midpoint

### Appendix III. Sediment Particle Size Distribution Sample Results

Sample number	Sample point	Depth below sediment surface	Silt and clay fractions						
			0.062	0.031	0.016	0.008	0.004	0.002	
PS3	S11-12	Surface	100.0	100.0	96.0	82.3	65.6	56.5	
PS6	S96-95	Surface	94.3	87.4	69.1	49.6	37.5	31.6	
PS7	S96-95	Core 19-20	100.0	100.0	92.2	76.1	63.6	54.5	
PS10	S94-93	Surface	95.4	89.3	68.2	46.1	32.6	31.4	
PS13	S91-92	Surface	92.4	80.2	47.0	32.3	25.1	22.1	
PS14	S91-92	Core 17-18	94.1	92.9	74.4	56.2	43.6	36.9	
PS16	B9-10	Surface	100.0	100.0	91.0	73.5	61.4	54.3	
PS17	B9-10	Core 13-15	100.0	99.8	97.1	86.8	73.4	63.2	
PS20	B23-24	Surface	100.0	99.0	88.0	70.4	58.1	50.9	
PS23	B26-25	Surface	98.7	92.4	71.4	53.4	42.3	37.5	
PS24	B26-25	Core 19-21	100.0	100.0	89.5	73.0	60.5	51.7	
PS27	B27-28	Surface	91.9	88.5	66.1	47.6	38.0	32.5	
PS30	B29-30	Surface		71.4	53.1	40.3	32.3	28.2	
PS31	B29-30	Core 17-19	96.5	91.1	66.4	42.9	31.1	26.7	
PS33	B84-83	Surface		80.9	60.2	42.2	32.8	28.0	
PS34	B84-83	Core 12-14	100.0	96.5	71.6	47.9	36.6	32.2	
PS36	B86-85	Core 0-3	98.2	98.4	82.1	56.3	41.6	35.1	
PS37	B86-85	Core 7-9		76.2	55.2	41.4	33.7	28.3	
			Coarse Fractions						
			0.710	0.5	0.25	0.18	0.125	0.09	0.063
PS30	B29-30	Surface	98.3	97.6	88.9	82.1	79.5	78.1	76.9
PS33	B84-83	Surface	99.8	99.7	98.2	95.5	91.2	89.3	87.5
PS37	B86-85	Core 7-9	99.9	99.8	97.9	93.7	89.6	86.1	83.7

**Notes:**

All samples were collected at the transect midpoint

Units for depth below sediment surface are in tenths of feet (12=1.2 foot)

Units for particle size are in percent finer than the given particle size (mm in column heading)



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