ILLINOIS STATE
WATER SURVEY
PRAIRIE RESEARCH INSTITUTE

Report of Investigation 122

The Sediment Budget of the Illinois River: 1981-2015

Misganaw Demissie, Elias Getahun, and Laura Keefer

ILLINOIS

The Sediment Budget of the Illinois River: 1981-2015

by

Misganaw Demissie, Elias Getahun, and Laura Keefer
Surface Water Hydrology & Hydraulics Section

Illinois State Water Survey
Prairie Research Institute
University of Illinois at Urbana-Champaign
Champaign, IL

November 2016

The Sediment Budget of the Illinois River: 1981-2015

by
Misganaw Demissie, Elias Getahun, and Laura Keefer
Illinois State Water Survey

Executive Summary

Many major streams in Illinois flow into the Illinois River, which drains nearly half of the state. The Illinois Waterway, with its system of locks and dams, links Chicago and the Great Lakes to the Mississippi River and thereby to the Gulf of Mexico. This linkage has significant transportation and commercial values for the state and the nation. In addition, with its numerous backwater lakes, wetlands, and floodplain forests, the Illinois River valley is an important ecological resource by providing a significant habitat for fish, waterfowl, and other birds and animals.

The Illinois River's environment has been subject to many impacts associated with watershed development, including waste discharges from urban areas, water-level control for navigation, and sediment and chemical inflow from agricultural lands. Water quality of the river was severely degraded for several decades prior to the 1970s when environmental regulations were enacted to control pollutant discharges. Since then, the river water quality has gradually been improving. However, ongoing issues associated with erosion and sedimentation are recognized as primary environmental problems in the Illinois River valley. The main source of sediment to the Illinois River valley is soil erosion in the watershed land areas, streambanks, and bluffs. The contribution of watershed erosion to the sedimentation problem in the Illinois River valley can be quantified by analyzing the sediment yields of tributary streams that drain into the valley. The contribution of bank erosion along the Illinois River and bluff erosion along the Illinois River valley are much more difficult to quantify at present because of the lack of data.

Sediment yields from tributary streams of the Illinois River were calculated based on suspended sediment load data collected by the U.S. Geological Survey (USGS). The period of sediment data records used in the analysis ranges from 1 year to 34 years, with the majority of the gaging stations having 5 or more years of record. Sediment rating curves that relate daily sediment load to daily water discharge were developed for each sediment monitoring station based on existing data. An improved rating curve procedure that uses nonlinear regression has already been developed in a previous Illinois State Water Survey study, and this procedure minimizes the inherent underestimations of the linear regression-based sediment rating method. The resulting sediment rating curves were used to fill missing data gaps in those monitoring stations with observed sediment load data, allowing the computation of annual sediment loads at each of these stations. Subsequently, regional annual sediment load estimation equations were then developed using annual sediment loads and discharge data from the monitoring stations. The data points coalesced into four different annual sediment yield equations, which were then used to calculate annual sediment yields generated by tributary streams in the Illinois River basin. The sediment budget analysis was performed for a 35-year period from water year 1981 to 2015. Tributary streams of the Spoon and La Moine Rivers had the highest sediment yield rates. The main stems of the Spoon, La Moine, and Vermilion Rivers had the second highest sediment yield rates, followed by the Sangamon, Iroquois, and Des Plaines Rivers.

Sediment yield calculations allowed the construction of a quantitative sediment budget for the Illinois River valley. The regional sediment load estimation equations were used to calculate the sediment inflows into the Illinois River valley from tributary streams. The sediment outflow from the Illinois River valley was determined from data collected by the USGS at the Valley City and Florence monitoring stations. On average, an estimated 12.9 million tons of sediment were delivered annually to the Illinois River valley from 1981 to 2015, of which 5.2 million tons was the average annual sediment outflow from the Illinois River at Valley City during the same period. This resulted in an estimated average annual deposition of 7.7 million tons (i.e., 60 percent of the total sediment delivered to the valley) of sediment delivered from tributary streams to the Illinois River valley. The total amount of sediment deposited in the Illinois River valley may be even higher since the estimated amount does not include sediment loads generated by bank and bluff erosion along the main stem of the Illinois River.

Contents

List of Figures

List of Tables

The Sediment Budget of the Illinois River: 1981-2015

by
Misganaw Demissie, Elias Getahun, and Laura Keefer
Illinois State Water Survey

Introduction

The Illinois River is the most significant river in Illinois. The river drains nearly half of the state and has a drainage area of 28,906 square miles. Except for about a 4,000-square-mile area in Indiana and Wisconsin, the watershed is located in Illinois (see Figure 1). The watershed contains the drainage basins of several of the state's significant rivers such as the Sangamon, La Moine, Spoon, Mackinaw, Vermilion, Fox, Kankakee, and Des Plaines Rivers. Historically, the Illinois River has played a significant role in the development of the state’s commerce and transportation. It is the only waterway that links the Great Lakes to the Mississippi River, and thus to the Gulf of Mexico. In addition, with its numerous backwater lakes, wetlands, and floodplain forests, the Illinois River valley is an important ecological resource by providing a significant habitat for fish, waterfowl, and other birds and animals.

The Illinois River's environment has been subjected to many impacts associated with watershed development, including waste discharges from urban areas, water-level control for navigation, and sediment and chemical inflow from agricultural and urban watersheds. The river quality was severely degraded for several decades prior to the 1970s when environmental regulations were enacted to control pollutant discharges. Since then, the quality of the river has been improving gradually.

The most persistent and still unmanaged problem facing the Illinois River is sedimentation in the river channel and backwater lakes. Based on sedimentation data for Peoria Lake, which is located along the Illinois River, clearly the rate of sedimentation in the Peoria Pool was significantly higher from 1965 to 1985 than from 1903 to 1965 (Demissie and Bhowmik, 1986; Demissie, 1997). Of special concern are the main channel and backwater lakes along the Illinois River.

Erosion and sedimentation have long been recognized as the principal causes of most of the environmental and ecological problems in the Illinois River valley. The Illinois River Action Plan of the Illinois State Water Plan Task Force (1987) ranks soil erosion and siltation combined as the number-one priority problem. In their “Conference Summary and Suggestions for Action,” *Proceedings of the Governor's Conference on Management of the Illinois River System: The 1990s and Beyond*, Mathis and Stout (1987) state: “Most of the problems uppermost on the

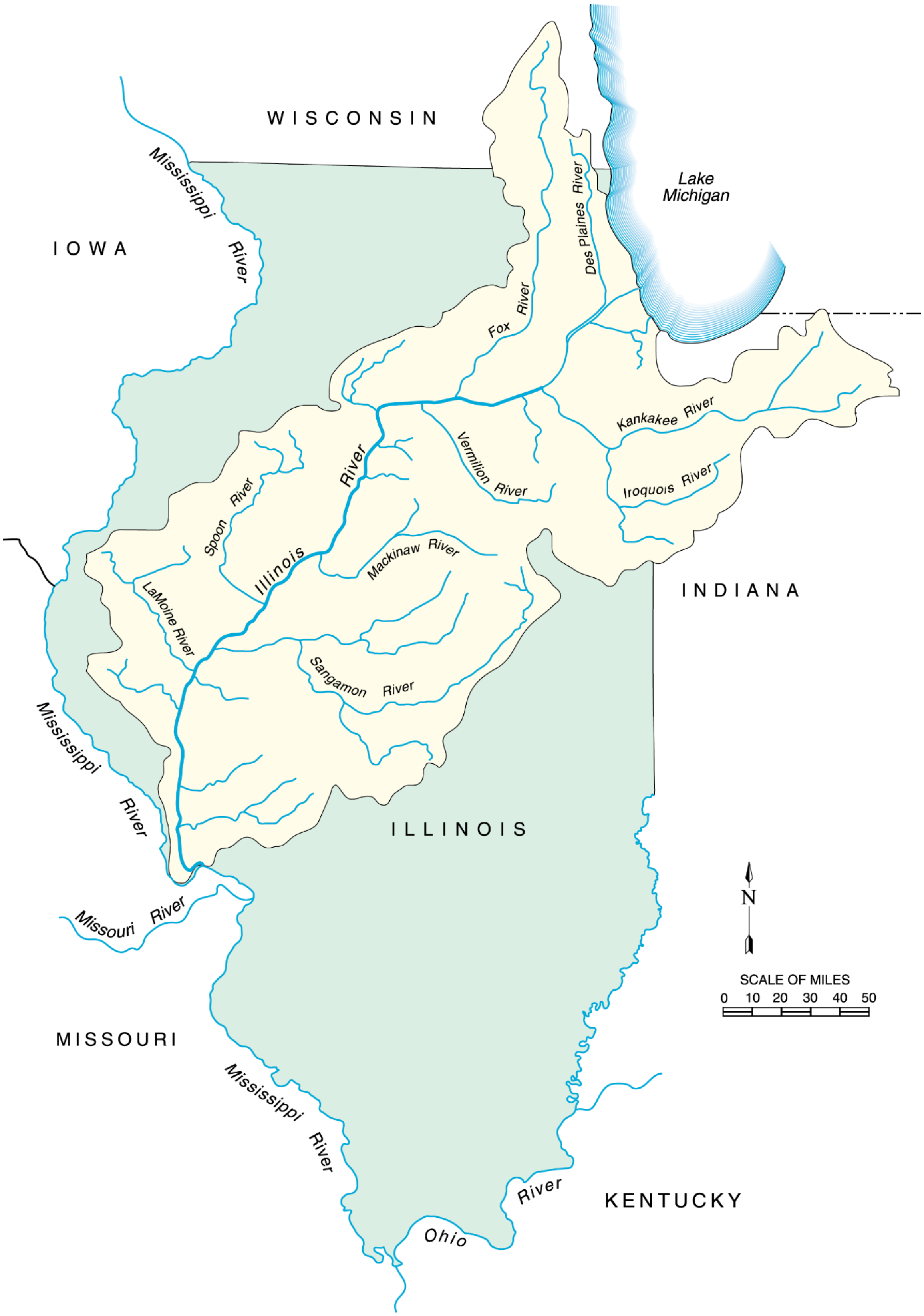

Figure 1. Location of the Illinois River basin

minds of participants included significant problems with soil erosion and siltation. All discussion groups recognized that soil erosion and siltation from land use practices threatened the Illinois River, its backwater lakes and associated biota." Many bottomland lakes along the river valley have already lost a large part of their capacity to sediment accumulation, and continue to do so at a very high rate. Several lakes in the valley have completely filled in with sediment, and others will follow in the near future. Even though it is repeatedly acknowledged that erosion combined with sedimentation is the main problem in the Illinois River valley, detailed studies on the issues are rare.

One study for the Peoria Lake segment of the Illinois River, completed by the Illinois State Water Survey (ISWS) (Demissie and Bhowmik, 1986), has resulted in tremendous public interest and a call for action to remedy the problems associated with erosion and sedimentation in the Illinois River valley. For the first time, the attention and efforts of local, state, and federal agencies have been focused on attainable erosion control and lake restoration projects. Findings and recommendations from the 1986 report have formed the basis of most projects and proposals for managing sedimentation in Peoria Lake.

A follow-up study analyzed the erosion and sedimentation problem for the entire Illinois River (Demissie et al., 1992; Demissie et al., 2004). The 1992 report provided important facts and numbers on erosion and sedimentation based on data available up to that time. It has been used as a basis for developing management alternatives in the Illinois River watershed and along the river valley. Several of the recommendations developed as part of the *Integrated Management Plan for the Illinois River Watershed* (State of Illinois, 1997) were based on the results of the study. Stream sediment data used for the 1992 report were collected by the U.S. Geological Survey (USGS) in 1981-1990 (Coupe et al., 1989; Fitzgerald et al., 1984, 1985, 1986, 1987, 1988; Richards et al., 1983, 1991; Sullivan et al., 1990; USGS, 1982).

Demissie et al. (1992) estimated the delivery of 13.8 million tons of sediment to the Illinois River valley annually for the period 1981-1990. The average annual sediment outflow at Valley City was calculated to be 5.6 million tons, resulting in an estimated 8.2 million tons of sediment deposition in the Illinois River valley annually. All suspended sediment data collected by the USGS since 1990 appear in the USGS Water Resources Data reports (Harris et al., 2002; La Tour et al., 1993, 1999, 2000, 2001; Richards et al., 1992; Wicker et al., 1995, 1996, 1997, 1998; Zuehls et al., 1994). The sediment budget analysis was further updated by including sediment data collected until 2000 (Demissie et al., 2004). The purpose of one of the major data collection efforts in 1994-1997 by the USGS was to develop a suspended sediment budget for the LaGrange Pool (Gaugush, 1999). This USGS study reported that suspended sediment discharges from the LaGrange Pool were significantly higher than that of Pool 13, whose drainage area is threefold. The suspended sediment loads per unit area contributed by the Illinois River and its tributaries in the area of the LaGrange Pool was much higher than the Mississippi River and its tributaries at Pool 13 (Guagush, 1999). The study also showed that the LaGrange Pool receives most of its sediment from the tributaries, not the main stem, whereas the reverse is true for Pool 13.

Since 2000, additional sediment data have become available for some of the USGS monitoring stations that were used to perform the sediment budget analysis in the past. This current report extended the sediment budget analysis to year 2015, using 15 more years of data. The average annual sediment delivery to the Illinois River valley in 1981-2015 was estimated to be 12.9 million tons. The average annual sediment outflow at Valley City for the same period was 5.2 million tons, indicating an estimated sediment deposition of 7.7 million tons in the Illinois River valley annually.

Acknowledgments

This report, which is an updated version of the 2004 report with the same title, was prepared as part of the authors' regular duties at the Illinois State Water Survey. Sangeetha Chandrasekaran has greatly contributed to this report by developing MATLAB codes necessary for extensive data processing and regression analyses. Lisa Sheppard edited the report and Sara Olson produced some of the illustrations.

Erosion and Sediment Yield

Sediment Data

The main task of this project was to collect and analyze sediment data from different sources so that reliable and consistent procedures could be developed to calculate sediment movement to and from the Illinois River valley. The most relevant data for this purpose are the sediment discharge data at gaging stations. All streamgaging stations with sediment discharge data within the Illinois River watershed were identified, and then the data were assembled in a consistent format for further analysis. Table 1 presents a summary of the available sediment discharge data, identifying the 44 gaging stations, their drainage area, and the river basin to which they belong. The table also provides information on the period of record and the type of sediment data collected at each station. Locations of the gaging stations are shown in Figure 2. Two types of sediment discharge data were available: mean daily sediment discharge from the USGS and instantaneous sediment discharge based on daily and weekly data collected by the ISWS and the U.S. Army Corps of Engineers (USACE). The period of record varied from a partial year to 34 years.

Even though the availability of these datasets is very good, several problems are associated with combining the different datasets. The first major problem is the inconsistency between datasets. The USGS-processed mean daily data can be used directly to calculate daily, monthly, or annual sediment yields. The ISWS and USACE data, however, are based primarily on instantaneous daily or weekly sediment samples and cannot be used directly to calculate daily, monthly, or annual sediment yields. The ISWS sediment data collection program initially was designed to be consistent with and the same as that of the USGS. The Illinois In-stream Benchmark Sediment Network was initiated in 1980 with 50 monitoring stations (Allgire and Demissie, 1995). However, program funding was drastically reduced after the first year and has been decreasing ever since (Allgire and Demissie, 1995). Decisions then were made to continue data collection on a weekly basis at 31 stations instead of discontinuing the program altogether or collecting data consistent with USGS data at only three or four stations. This decision enabled the ISWS to have a statewide, albeit sparse, coverage to monitor trends in sediment concentrations in Illinois streams. It is also possible to compute instantaneous sediment loads based on instantaneous sediment concentrations; however, these loads will not be consistent with the mean daily sediment load. Daily suspended sediment concentration data collected by the USACE have some gaps (Beckert, 2002). However, the data have not been processed to determine mean daily concentrations that can be used directly to compute daily average loads for comparison with the USGS data. Therefore, it would not be appropriate to mix the two datasets until a procedure is developed that can generate sediment load data from instantaneous weekly samples that are consistent with the mean daily sediment load determined from daily samples. Sediment concentration data are not collected only for the purposes of calculating sediment budgets but are also used to evaluate long-term trends in concentrations and sediment loads in streams and trends in watershed soil erosion.

Table 1. Suspended Sediment Monitoring Stations within the Illinois River Basin, 1981-2015

						Record type and frequency (Collecting Agency, Water Years)	
ISWS station code	*USGS station number*	*USGS station name*	*Drainage area (sq mi))*	*River basin*	*Period of record*	*Mean daily*	*Instantaneous daily or weekly*
107	05550000	Fox River at Algonquin	1403.0	FOX	1981-82		SWS 1981-82
108	05529000	Des Plaines River near Des Plaines	360.0	DES PLAINES	1981		SWS 1981
109	05532500	Des Plaines River at Riverside	630.0	DES PLAINES	1979-82, 2003-13	USGS 1979-82, 2003-13	
110	05551200	Ferson Creek near St. Charles	51.7	FOX	1981-82		SWS 1981-82
114	05551540	Fox River at Montgomery	1732.0	FOX	1981-83		SWS 1981-83
115	05539000	Hickory Creek at Joliet	107.0	DES PLAINES	1981		SWS 1981
116	05540500	DuPage River at Shorewood	324.0	DUPAGE	1981		SWS 1981
117	05552500	Fox River at Dayton	2642.0	FOX	1981, 2003-2009	USGS 2003-2009	SWS 1981
118	05556500	Big Bureau Creek at Princeton	196.0	BUREAU	1981-90		SWS 1981-90
122	05555300	Vermilion River near Lenore	1251.0	VERMILION	1981, 84-2000	USGS 1981	SWS 1984-2000
123	05542000	Mazon River near Coal City	455.0	MAZON	1981-2000		SWS 1981-2000
124	05527500	Kankakee River near Wilmington	5150.0	KANKAKEE	1978-2000	USGS 1978-82, 93-95	SWS 1983-2000
125	05520500	Kankakee River at Momence	2294.0	KANKAKEE	1978-2000	USGS 1978-81, 93-95	SWS 1982-85, 88-90, 93-2000
126	05568800	Indian Creek near Wyoming	62.7	SPOON	1981	USGS 1981	
130	05548105	Nippersink above Wonder Lake	84.5	FOX	1994-97	USGS 1994-97	
131	05548110	Nippersink below Wonder Lake	97.3	FOX	1994-97	USGS 1994-97	
227	05543500	Illinois River at Marseilles	8259.0	ILLINOIS	1975-82		
229	05569500	Spoon River at London Mills	1072.0	SPOON	1981-87, 94-2000		SWS 1981-87, 94-2000
230	05566500	East Branch Panther Creek at El Paso	30.5	MACKINAW	1981-82		SWS 1981-82
231	05554490	Vermilion River at McDowell	551.0	VERMILION	1981-82		SWS 1981-82
232	05526000	Iroquois River near Chebanse	2091.0	KANKAKEE	1978-83, 93-95	USGS 1978-81, 93-95	SWS 1982-83
233	05525000	Iroquois River at Iroquois	686.0	KANKAKEE	1978-82, 93-95	USGS 1978-80, 93-95	SWS 1981-82
234	05525500	Sugar Creek at Milford	446.0	KANKAKEE	1981-83		SWS 1981-83
235	05564400	Money Creek near Towanda	49.0	MACKINAW	1981		SWS 1981
236	05567510	Mackinaw River below Congerville	776.0	MACKINAW	1981-2000	USGS 1983-86	SWS 1981-82, COE 1987-2000
237	05568005	Mackinaw River below Green Valley	1092.0	MACKINAW	1981		SWS 1981
238	05570350	Big Creek at St. David	28.0	SPOON	1972-80	USGS 1972-80	
239	05570370	Big Creek near Bryant	41.2	SPOON	1972-86	USGS 1972-86	
240	05570380	Slug Run near Bryant	7.1	SPOON	1975-80	USGS 1975-80	
241	05570000	Spoon River at Seville	1636.0	SPOON	1981, 94-97, 2003-14	USGS 1981, 94-97, 2003-14	COE 1987-2000
242	05584500	La Moine River at Colmar	655.0	LA MOINE	1981-88, 93-2000		SWS 1981-88, 93-2000
244	05584685	Grindstone Creek near Birmingham	45.4	LA MOINE	1981	USGS 1981	
245	05585000	La Moine River at Ripley	1293.0	LA MOINE	1981, 83-90, 93-2000	USGS 1981, 94-97	SWS 1983-90, 93-2000
246	05583000	Sangamon River near Oakford	5093.0	SANGAMON	1981, 83-86, 94-97	USGS 1981, 83-86, 94-97	
247	05582000	Salt Creek near Greenview	1804.0	SANGAMON	1981-83		SWS 1981-83
248	05578500	Salt Creek near Rowell	335.0	SANGAMON	1981-83		SWS 1981-83
249	05572000	Sangamon River at Monticello	550.0	SANGAMON	1981-94		SWS 1981-96
252	05576500	Sangamon River at Riverton	2618.0	SANGAMON	1981-83, 87-2000		SWS 1981-83
253	05586100	Illinois River at Valley City	26743.0	ILLINOIS	1980-2011	USGS 1980-2011	
	05586300	Illinois River at Florence	26870.0	ILLINOIS	2011-14	USGS 2011-14	
254	05576022	South Fork Sangamon River below Rochester	870.0	SANGAMON	1981-82		SWS 1981-82
259	05587000	Macoupin Creek near Kane	868.0	MACOUPIN	1981		SWS 1981
260	05563800	Illinois River at Pekin	14585.0	ILLINOIS	1994-96	USGS 1994-1996	
261	05559600	Illinois River at Chillicothe	13543.0	ILLINOIS	1992-2000	USGS 1992-2000	
444	05584680	Grindstone Creek near Industry	35.5	LA MOINE	1981	USGS 1981	

Note: USGS – U.S. Geological Survey, SWS – State Water Survey; COE – U.S. Army Corps of Engineers.

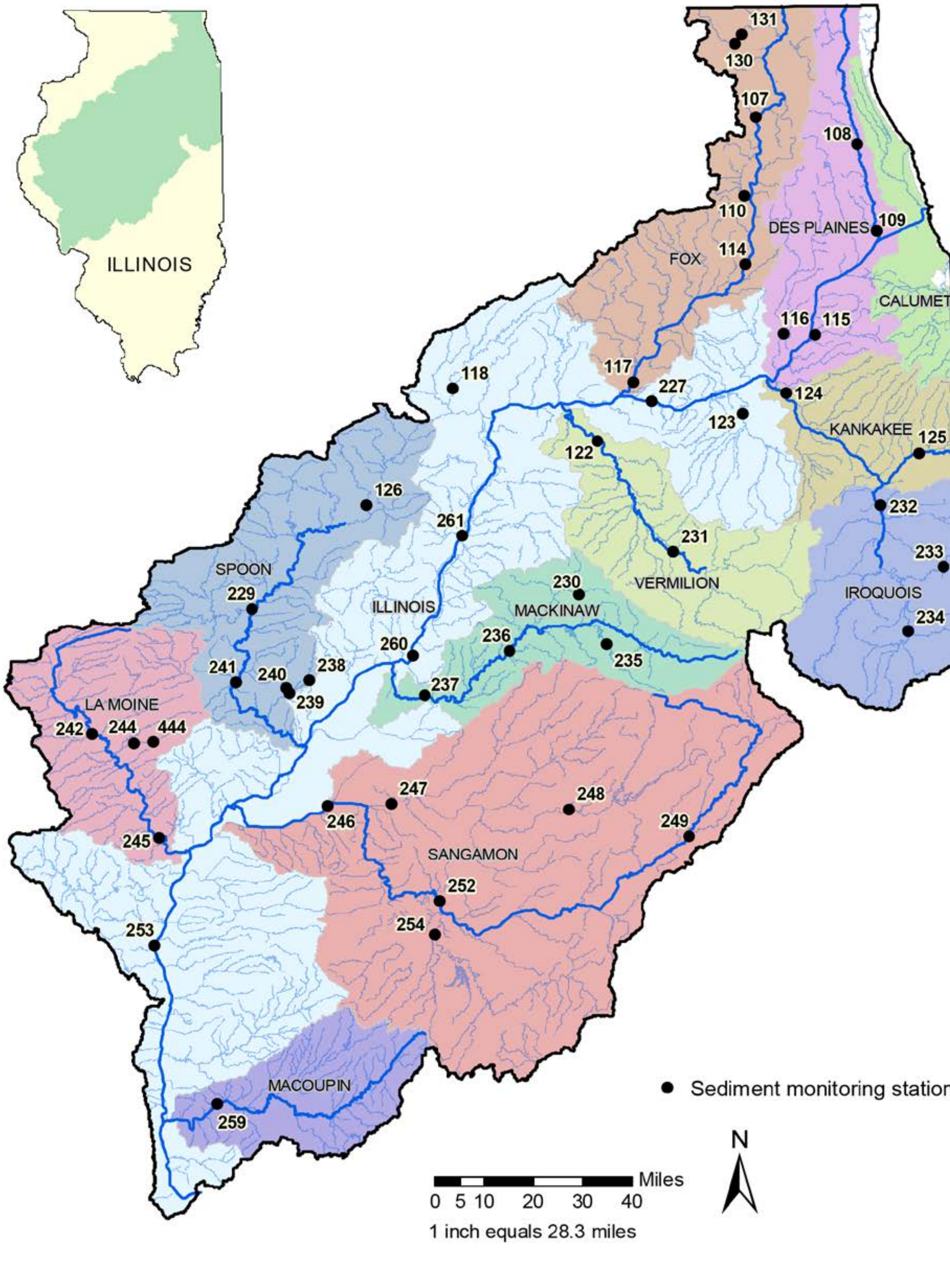

Figure 2. Locations of the available in-stream sediment data sites within the Illinois River watershed, 1981-2015

The ISWS is continuing its research effort to develop reliable procedures that would enable the use of instantaneous data to calculate periodic sediment yields consistent with USGS data. However, efforts to develop a reliable procedure have not yet been successful. Factors such as sampling frequency and the occurrence of flood events at different times complicate the problem. Furthermore, a sufficient number of concurrent mean daily and instantaneous data are not available. As a result, sediment yield calculations for the 1992 and 2004 reports and this report were based on the USGS mean daily sediment data.

The second problem was the duration of the record, which varies from a partial year to 34 years. In most cases, the record length is less than 10 years. Although it is difficult to develop long-term sediment budgets based on short-term records, procedures were developed in previous studies to overcome this problem and are used in this study.

The type of sediment analysis that can be conducted depends on the type and quality of available data. Good quality, long-term streamflow data are available for a large number of gaging stations in the Illinois River basin. These data are collected through the USGS cooperative streamgaging network. The sediment data are sporadic and of short duration; however, a combination of the two datasets has made the type of analysis described in this report possible. The collection of streamflow data continues as before, but collection of sediment data has been cut significantly by both the USGS and ISWS. Understanding of this major environmental and natural resource problem will not significantly improve in the near future without additional and sustained data collection. It is therefore very important that environmental and natural resources agencies in both the state and federal governments support the maintenance of the streamgaging network and the initiation of an expanded long-term sediment data collection program in Illinois.

Sediment Yield

A watershed’s sediment yield is the amount of sediment that eventually leaves a watershed and is available for deposition at other locations. In terms of sedimentation studies, sediment yield is one of the most important parameters that need to be determined to calculate the rate of sediment accumulation. Sediment yield is generally a small fraction of the total gross erosion in the watershed, which includes sheet, rill, gully, streambank, and streambed erosion. All soils eroded in a watershed are not transported and delivered to streams that drain out of the watershed. Depending on many physical factors, a certain percentage of eroded soils will be removed from one location for deposition at another location within the same watershed.

In the case of the Illinois River valley, it is important to determine how much sediment is delivered into the valley from different tributary streams to evaluate the magnitude and pattern of sedimentation in the river and backwater lakes. The procedures developed to calculate sediment yields of all tributary streams to the Illinois River can be found in Demissie et al. (2004).

Sediment Yield Calculations for the Illinois River Basin

As was done in the previous studies, the estimation of sediment yields for the Illinois River basin was based on suspended sediment load data available for the tributaries and main stem of the Illinois River. In this study, suspended sediment data from 17 stations were used to develop regional sediment yield equations that were eventually used to estimate sediment yields of ungaged streams and rivers. The Fox River at Dayton station is added to the list of stations used in the previous study because of new sediment data availability. In developing the regional sediment equations, the available suspended sediment data were carefully evaluated to obtain the sediment rating curves that relate suspended sediment loads with their corresponding streamflows for each of the 17 sediment monitoring stations. These rating curves were used to estimate daily sediment load and fill data gaps where there were only streamflow data. Sediment load rating curves tend to underestimate annual sediment yields (Ferguson, 1986; Walling and Webb, 1988), and a procedure that minimizes the underestimation was developed in previous work (Demissie et al., 2004; Crowder et al., 2007). This procedure was the basis for all annual sediment yield calculations in this report and is illustrated using analysis results for USGS 05552500 station (i.e., Fox River at Dayton). For this monitoring station, there were seven years of mean daily suspended sediment data available, and each year of data was separately analyzed to develop a sediment load equation of the form given in Equation 1

$$\log Q_s = a + b\,(\log Q_w)^c \qquad (1)$$

where Q_S is the daily sediment load in tons; Q_W is the daily mean water discharge in cubic feet per second (cfs); and *a*, *b*, and *c* are coefficients determined through a regression and optimization procedure. Seven sediment rating curves were obtained, as shown in Figures 3, resulting in varying regression equations. Table 2 shows the variation of the regression coefficients from year to year, which may be attributed to factors such as land cover, size of storm events, and its timing. The difference between rating curves for the different years is illustrated in Figure 4. In an attempt to obtain an optimum sediment rating curve for the monitoring station, the sediment data for all seven years were used in generating the regression equations, as illustrated in Figure 5.

The period of record curve (Figure 5) was compared to the individual year rating curves (Figure 4). As expected, the period of record curve tends to average out the year-to-year variation in sediment load estimates. For the purposes of long-term sediment budget analysis, it seems logical to use the sediment load equations derived from the period of record data. Therefore, similar equations for the period of record were developed for the 17 USGS stations used in this study. Analysis results for all stations are shown in Appendix A.

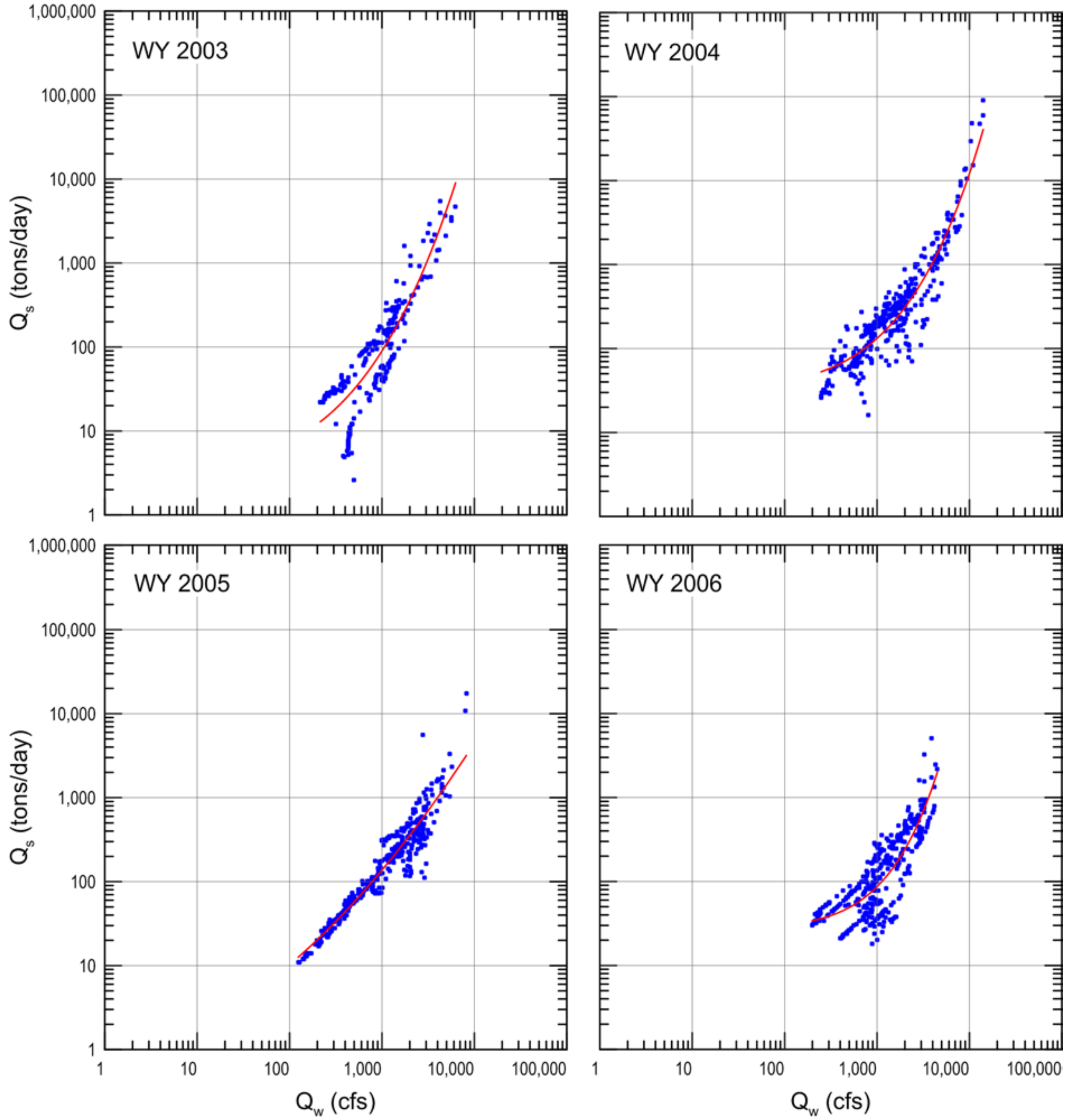

Figure 3. Yearly sediment load curves for Fox River at Dayton (05552500) (continued)

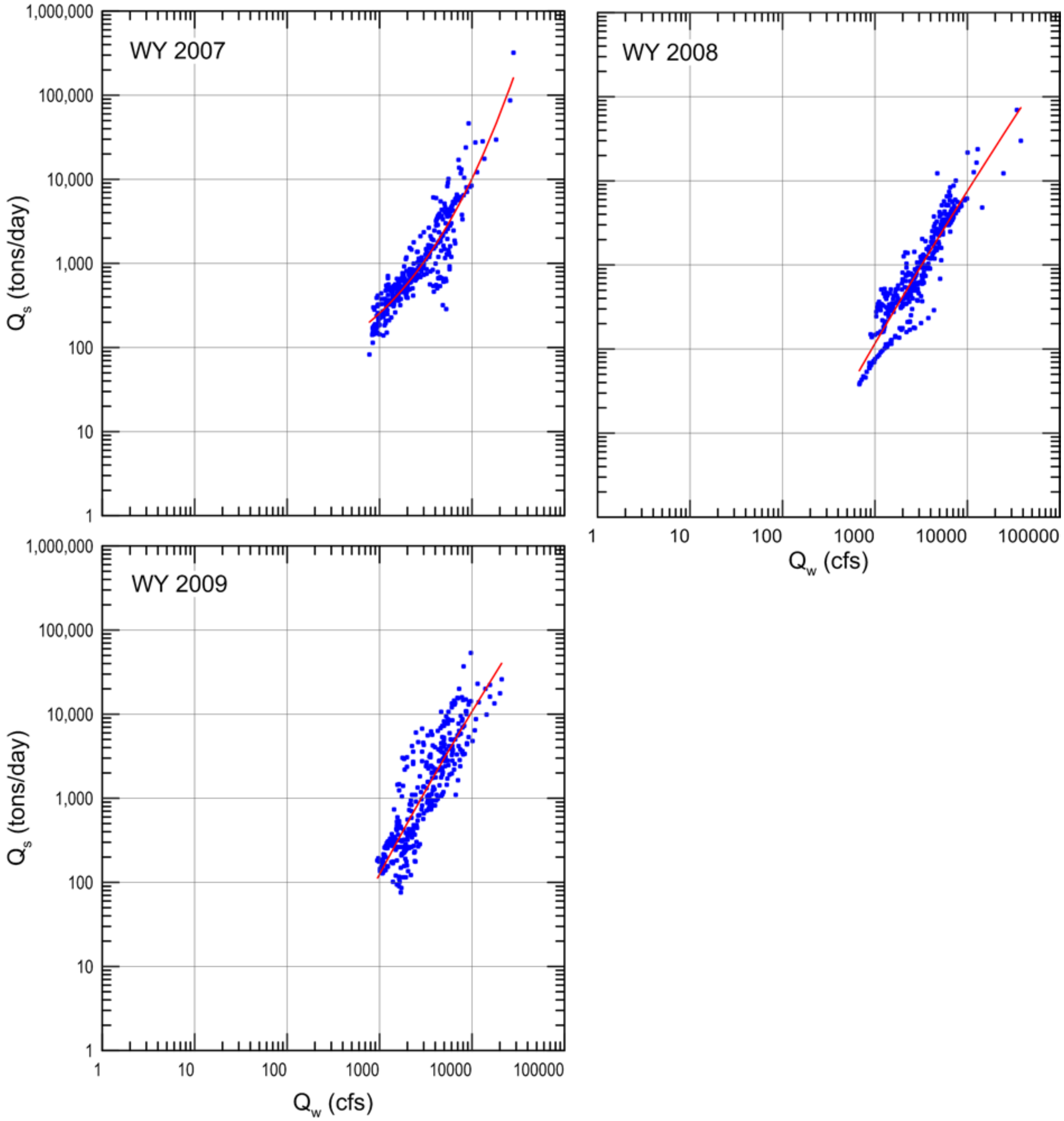

Figure 3. Yearly sediment load curves for Fox River at Dayton (05552500) (concluded)

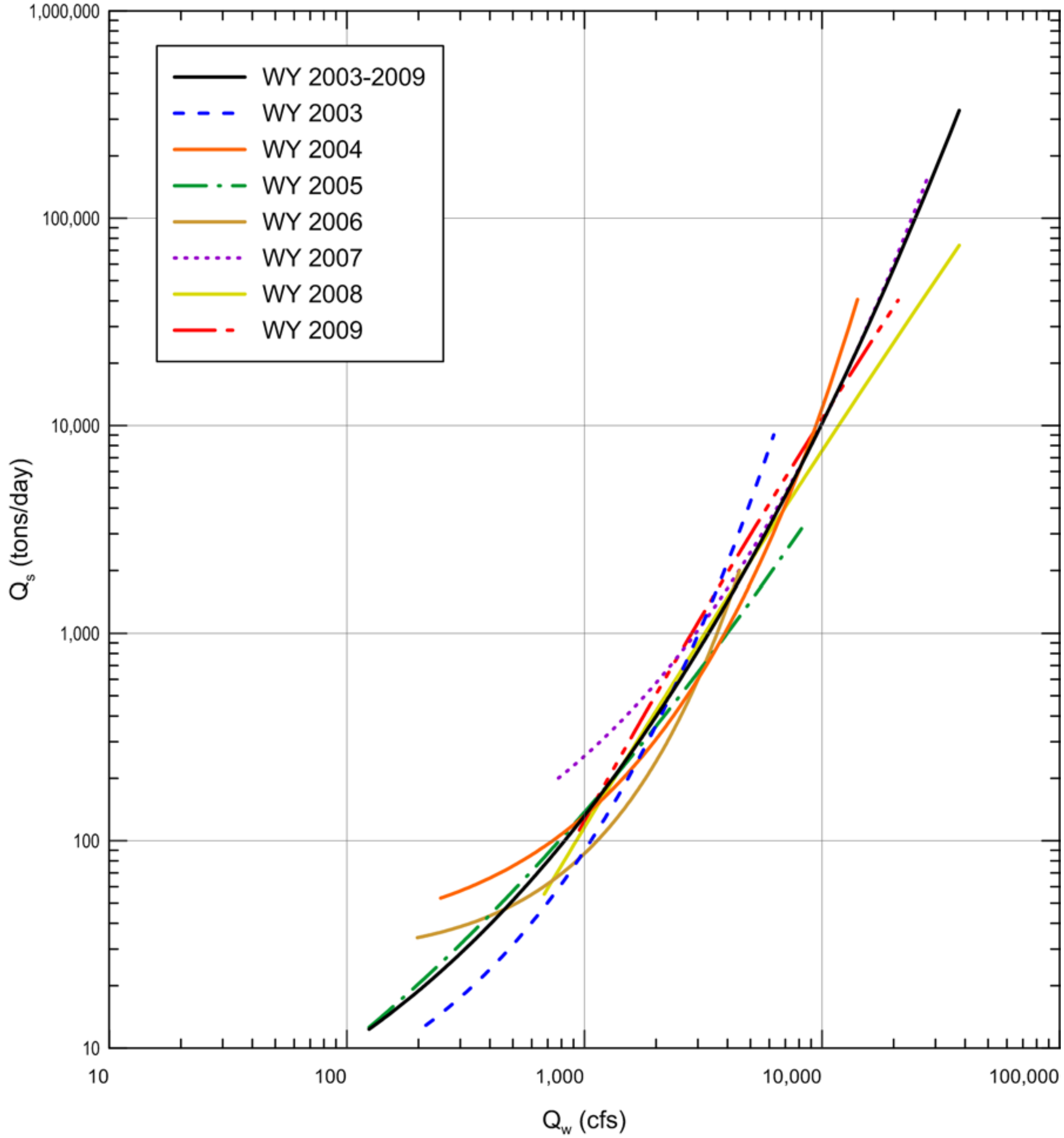

Figure 4. Comparison of yearly sediment load curves for Fox River at Dayton (05552500)

Table 2. Sediment Load Regression Coefficients for Fox River at Dayton

Water Year	*a*	*b*	*c*
2003	0.5942	0.0198	3.8
2004	1.5407	0.0021	5.1
2005	0.0218	0.2703	1.9
2006	1.4538	0.0003	6.8
2007	1.6061	0.0122	3.8
2008	-5.6847	3.4717	0.7
2009	-9.1766	6.1544	0.6
2003-2009	0.4295	0.0963	2.6

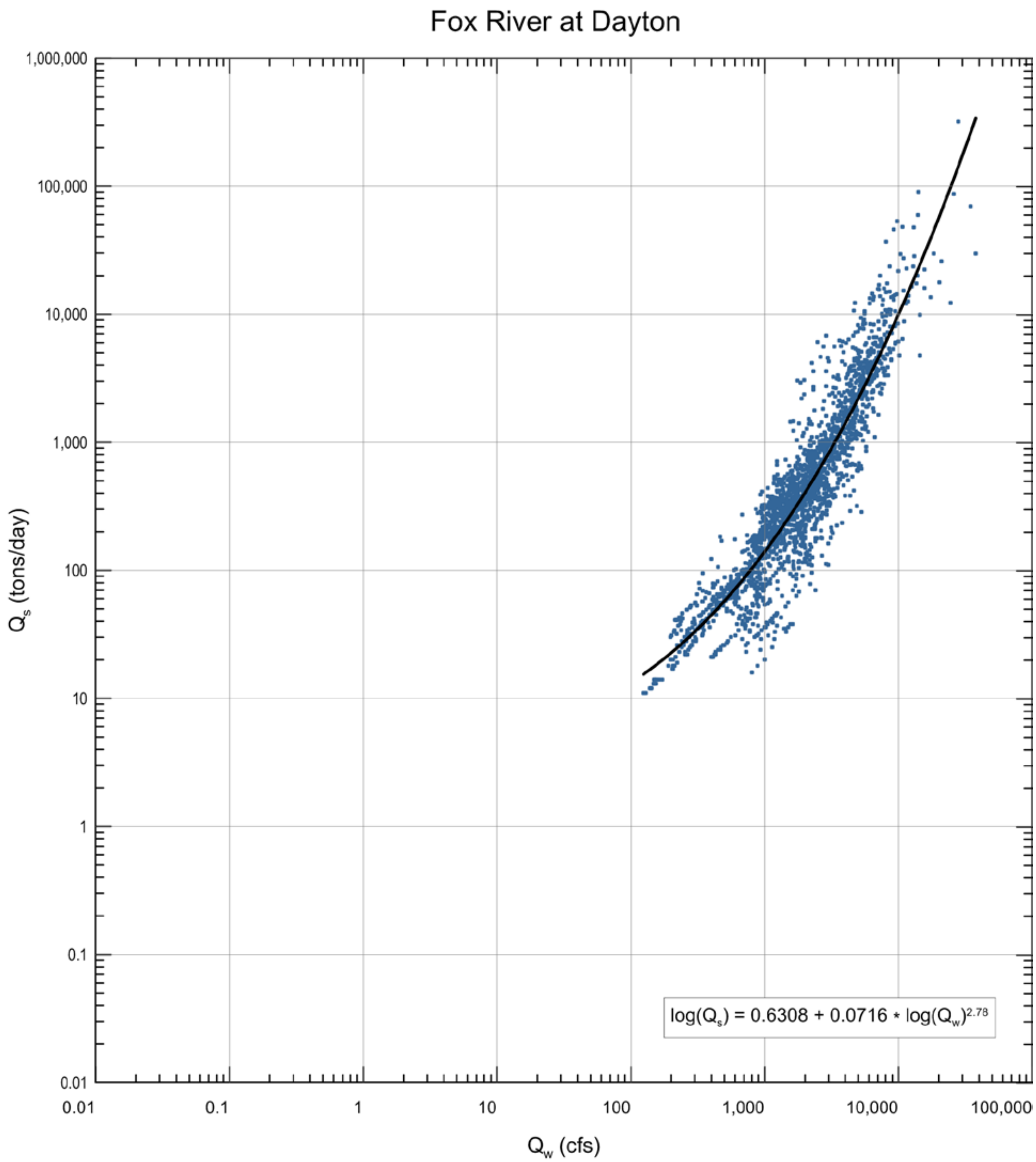

Figure 5. Comparison of multi-year sediment load curve to data points for Fox River at Dayton (05552500)

After developing the sediment load equations that relate the daily suspended sediment loads to the daily mean discharges, annual sediment loads were calculated. This was done by adding daily loads estimated using the daily water discharge records for all 17 sediment monitoring stations within the watershed for a 35-year period (1981-2015). Regional relationships were then developed between annual sediment loads (i.e., both measured and calculated) and annual water discharges of the 17 stations for estimating sediment loads from watersheds without sediment monitoring stations. As illustrated in Figure 6, these relationships were aggregated into four groups represented by the following equations:

$$\log(Q_s{}^A) = -3.52 + 1.97 \log(Q_w{}^A) \quad (2)$$

$$\log(Q_s{}^A) = -3.30 + 1.63 \log(Q_w{}^A) \quad (3)$$

$$\log(Q_s{}^A) = -5.10 + 1.79 \log(Q_w{}^A) \quad (4)$$

$$\log(Q_s{}^A) = -4.98 + 1.69 \log(Q_w{}^A) \quad (5)$$

where $Q_s{}^A$ and $Q_w{}^A$ are the annual sediment load and water discharge, respectively.

The group with the highest annual sediment yield rate, represented by Equation 2, includes mainly smaller tributary streams in the Spoon and La Moine River watersheds. The group with the second highest annual sediment yield rate, represented by Equation 3, includes the main stems of the Spoon, La Moine, Vermilion, and Mackinaw Rivers. The group with the third highest annual sediment yield rate represented by Equation 4 includes the Sangamon, Iroquois, Des Plaines, and Fox Rivers. The group with the least annual sediment yield rate, represented by Equation 5, includes stations on the Kankakee River. These four equations were then used to calculate annual sediment yields of tributary streams to the Illinois River.

Summaries of annual water discharge and sediment yield computations using Equations 2-5 for all tributary streams are presented in Tables 3 and 4, respectively, for the 35-year analysis period. The sediment yield estimates were then increased by 5 to 25 percent to account for the bed load.

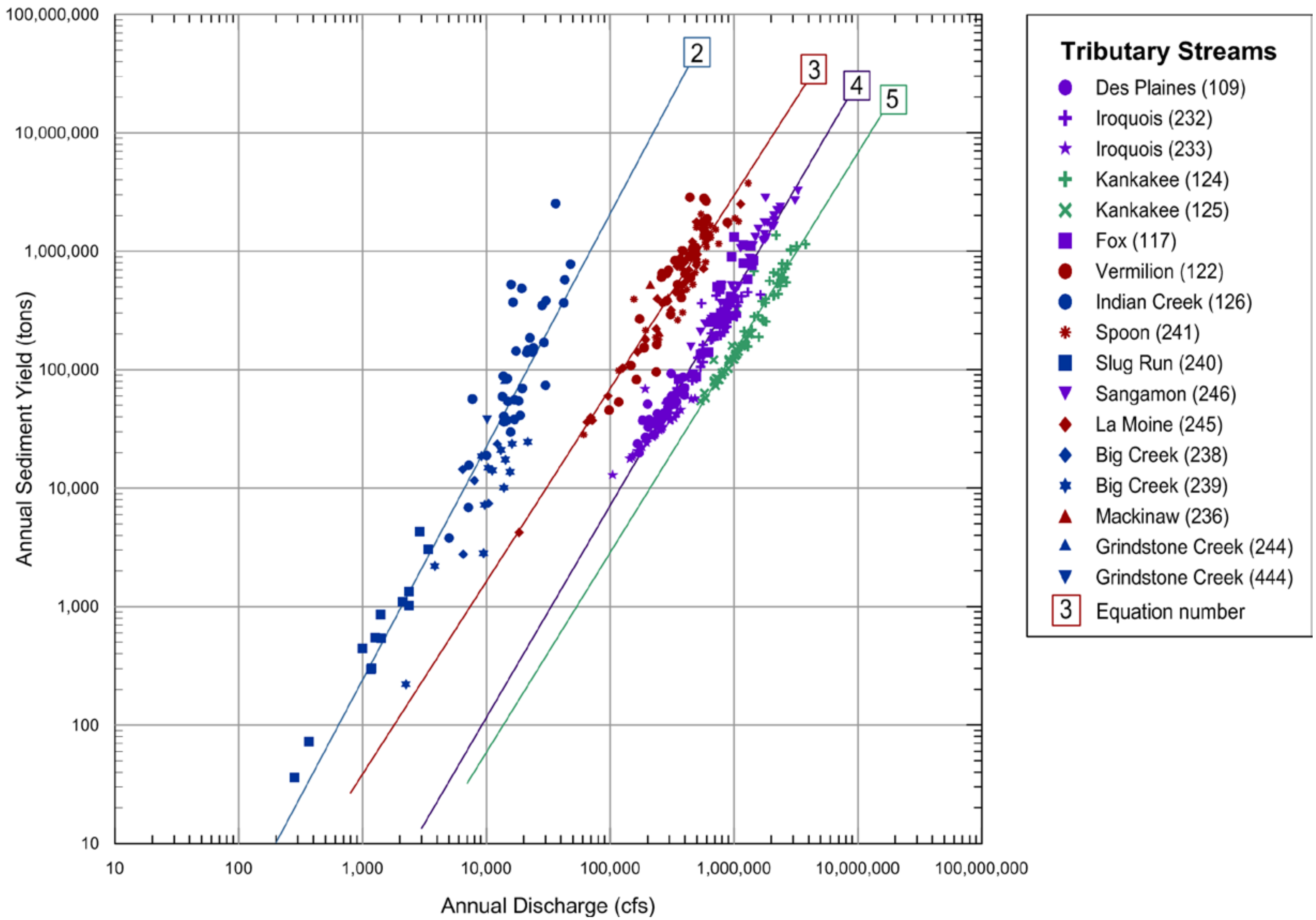

Figure 6. Annual sediment yield equations for tributary streams in the Illinois River valley

Table 3. Computed Annual Water Discharge of Tributary Streams in the Illinois River Basin, 1981-2015 (continued)

River/Stream	*Drainage Area (sq mi)*	*Annual water discharge (cfs-days * 1000)*											
		WY1981	*WY1982*	*WY1983*	*WY1984*	*WY1985*	*WY1986*	*WY1987*	*WY1988*	*WY1989*	*WY1990*	*WY1991*	*WY1992*
Des Plains River	2111	1846.6	1834.7	2086.4	1867.2	1855.8	2044.5	2043.5	1768.3	1626.6	1933.2	1990.5	1852.7
Kankakee River	5165	2205.1	2465.2	2443.5	2268.2	2100.5	2231.2	1739.2	1395.5	1829.2	2381.5	3200.8	1599.5
Mazon River	524	190.0	237.0	240.9	199.5	143.5	199.9	110.7	81.6	138.4	199.8	308.8	108.3
Fox River	2658	760.1	942.9	1189.3	834.2	774.0	988.6	888.0	756.9	469.8	771.4	843.4	629.9
Vermilion River	1331	463.4	616.8	609.7	429.5	277.3	469.6	313.4	199.2	184.3	509.0	606.3	249.8
Big Bureau Creek	536.8	170.6	213.4	217.8	126.6	151.9	177.9	126.1	149.6	27.0	188.5	197.4	111.0
Mackinaw River	1136	447.6	384.1	518.1	431.8	310.9	364.7	299.1	91.6	43.3	374.7	387.3	175.0
Spoon River	1855	615.1	732.3	733.6	498.9	563.2	545.7	460.2	264.1	69.3	560.8	526.4	399.6
Sangamon River	5418	1906.7	1898.5	2255.2	1873.0	1316.6	1680.4	1078.3	830.3	568.3	1512.9	1954.6	1152.7
La Moine River	1350	519.3	524.5	505.1	421.9	480.4	527.8	361.1	73.0	19.1	382.1	352.6	200.7
McKee Creek	444	170.8	172.5	166.1	138.7	158.0	173.6	118.8	24.0	6.3	125.7	116.0	66.0
Aux Sable Creek	187	67.8	84.6	86.0	71.2	51.2	71.3	39.5	29.1	49.4	71.3	110.2	38.7
Nettle Creek	53.2	19.3	24.1	24.5	20.3	14.6	20.3	11.2	8.3	14.1	20.3	31.3	11.0
Waupecan Creek	57.3	20.8	25.9	26.3	21.8	15.7	21.9	12.1	8.9	15.1	21.9	33.8	11.8
Bills Run	33.2	12.0	15.0	15.3	12.6	9.1	12.7	7.0	5.2	8.8	12.7	19.6	6.9
Hog Run	40	14.5	18.1	18.4	15.2	11.0	15.3	8.4	6.2	10.6	15.3	23.6	8.3
Covel Creek	74.1	26.9	33.5	34.1	28.2	20.3	28.3	15.7	11.5	19.6	28.3	43.7	15.3
Little Vermilion River	126	40.1	50.1	51.1	29.7	35.7	41.8	29.6	35.1	6.3	44.2	46.3	26.0
Cedar Creek	51.2	16.3	20.4	20.8	12.1	14.5	17.0	12.0	14.3	2.6	18.0	18.8	10.6
Spring Creek	92.1	29.3	36.6	37.4	21.7	26.1	30.5	21.6	25.7	4.6	32.3	33.9	19.0
Negro Creek	48.6	15.4	19.3	19.7	11.5	13.8	16.1	11.4	13.5	2.4	17.1	17.9	10.0
Allforks Creek	44.3	14.1	17.6	18.0	10.4	12.5	14.7	10.4	12.3	2.2	15.6	16.3	9.2
Sandy Creek	146	44.1	52.6	49.3	41.1	44.8	40.4	36.6	25.7	7.4	52.3	43.4	31.7
Crow Creek (west)	81.7	24.7	29.4	27.6	23.0	25.1	22.6	20.5	14.4	4.2	29.3	24.3	17.7
Strawn Creek	33.8	10.2	12.2	11.4	9.5	10.4	9.3	8.5	6.0	1.7	12.1	10.0	7.3
Crow Creek	130	39.2	46.8	43.9	36.6	39.9	35.9	32.6	22.9	6.6	46.5	38.6	28.2
Senachwine Creek	90	27.2	32.4	30.4	25.4	27.6	24.9	22.6	15.9	4.6	32.2	26.8	19.5
Snag Creek	99.1	29.9	35.7	33.4	27.9	30.4	27.4	24.9	17.5	5.1	35.5	29.5	21.5
Richland Creek	47	14.2	16.9	15.9	13.2	14.4	13.0	11.8	8.3	2.4	16.8	14.0	10.2
Farm Creek	61.3	24.2	20.7	28.0	23.3	16.8	19.7	16.1	4.9	3.3	28.3	29.2	13.2
Kickapoo Creek	306	92.3	110.2	103.2	86.2	93.9	84.6	76.8	53.9	15.6	109.6	91.0	66.5
Lost Creek	46.9	18.5	15.9	21.4	17.8	12.8	15.1	12.3	3.8	2.5	21.6	22.4	10.1
Lamarsh Creek	40.9	12.3	14.7	13.8	11.5	12.6	11.3	10.3	7.2	2.1	14.6	12.2	8.9
Copperas Creek	127	38.3	45.8	42.8	35.8	39.0	35.1	31.9	22.4	6.5	45.5	37.8	27.6
Spring Lake Slough	36.5	14.4	12.3	16.6	13.9	10.0	11.7	9.6	2.9	1.9	16.8	17.4	7.9
Buckheart Creek	39.1	11.8	14.1	13.2	11.0	12.0	10.8	9.8	6.9	2.0	14.0	11.6	8.5
Quiver Creek	261	102.8	88.3	119.0	99.2	71.4	83.8	68.7	21.0	13.9	120.4	124.5	56.3
Otter Creek	126	48.5	49.0	47.1	39.4	44.8	49.3	33.7	6.8	1.8	35.7	32.9	18.7
Sugar Creek	162	62.3	62.9	60.6	50.6	57.6	63.3	43.3	8.8	2.3	45.9	42.3	24.1
Little Creek	30.8	11.8	12.0	11.5	9.6	11.0	12.0	8.2	1.7	0.4	8.7	8.0	4.6
Indian Creek	286	105.7	77.2	120.1	85.1	50.4	77.5	57.1	41.5	13.2	73.3	111.5	39.5
Camp Creek	38.6	14.3	10.4	16.2	11.5	6.8	10.5	7.7	5.6	1.8	9.9	15.0	5.3
Coon Run Ditch	61.7	22.8	16.7	25.9	18.4	10.9	16.7	12.3	9.0	2.8	15.8	24.0	8.5
Mauvaise Terre Creek	178	65.8	48.0	74.8	53.0	31.4	48.2	35.5	25.8	8.2	45.6	69.4	24.6
	25765.2	10406.9	11191.5	12243.2	10087.5	9030.3	10416.8	8308.3	6137.2	5227.6	10066.8	11715.1	7172.5
Missing area	977.8	398.6	425.8	410.4	424.8	268.1	443.8	136.7	147.2	165.1	343.1	458.2	253.9
Total inflow	26743	10805.5	11617.4	12653.6	10512.3	9298.5	10860.7	8445.0	6284.4	5392.8	10409.8	12173.3	7426.5
Outflow at Valley City	26743	10194.6	11561.2	12497.6	10006.2	9178.4	9542.8	7729.2	5798.3	4415.8	9812.7	11458.1	6956.4
Percent difference		**-6**	**0**	**-1**	**-5**	**-1**	**-14**	**-9**	**-8**	**-22**	**-6**	**-6**	**-7**

Table 3. Computed Annual Water Discharge of Tributary Streams in the Illinois River Basin, 1981-2015 (continued)

	Drainage Area	*Annual water discharge (cfs-days * 1000)*											
River/Stream	*(sq mi)*	*WY1993*	*WY1994*	*WY1995*	*WY1996*	*WY1997*	*WY1998*	*WY1999*	*WY2000*	*WY2001*	*WY2002*	*WY2003*	*WY2004*
Des Plains River	2111	2356.1	1543.0	1759.8	1783.0	1663.9	1738.3	1752.3	1446.8	1561.3	1704.9	1194.6	1580.1
Kankakee River	5165	3801.4	2661.0	2090.6	1803.7	2447.1	2601.3	1557.9	1026.6	1469.8	2538.0	1215.3	1697.6
Mazon River	524	344.4	135.5	238.5	153.4	165.3	268.5	137.8	55.3	149.0	204.4	56.7	127.4
Fox River	2658	1446.7	652.7	815.2	1003.7	733.9	760.8	929.3	750.7	866.5	794.9	359.6	785.5
Vermilion River	1331	939.6	397.8	492.4	276.6	306.3	523.2	307.3	104.2	354.0	517.7	124.6	252.1
Big Bureau Creek	536.8	364.9	161.8	238.7	148.5	123.4	205.2	238.0	108.9	138.0	206.1	41.2	102.0
Mackinaw River	1136	909.3	321.9	415.9	160.5	163.9	439.2	318.7	59.1	249.4	406.0	141.8	205.8
Spoon River	1855	1480.7	435.7	726.6	420.4	428.7	856.2	664.8	279.3	670.3	629.0	175.8	314.1
Sangamon River	5418	3309.2	2470.4	1818.5	1205.4	844.2	2237.6	1471.8	478.7	1407.4	2378.9	729.4	1421.2
La Moine River	1350	934.5	323.1	589.6	411.7	274.0	518.9	395.1	132.2	359.1	511.0	100.5	247.0
McKee Creek	444	307.4	106.3	193.9	135.4	90.1	170.6	130.0	43.5	118.1	168.1	33.0	81.2
Aux Sable Creek	187	122.9	48.4	85.1	54.7	59.0	95.8	49.2	19.8	53.2	72.9	20.2	45.5
Nettle Creek	53.2	35.0	13.8	24.2	15.6	16.8	27.3	14.0	5.6	15.1	20.7	5.8	12.9
Waupecan Creek	57.3	37.7	14.8	26.1	16.8	18.1	29.4	15.1	6.1	16.3	22.3	6.2	13.9
Bills Run	33.2	21.8	8.6	15.1	9.7	10.5	17.0	8.7	3.5	9.4	12.9	3.6	8.1
Hog Run	40	26.3	10.3	18.2	11.7	12.6	20.5	10.5	4.2	11.4	15.6	4.3	9.7
Covel Creek	74.1	48.7	19.2	33.7	21.7	23.4	38.0	19.5	7.8	21.1	28.9	8.0	18.0
Little Vermilion River	126	85.7	38.0	56.0	34.8	29.0	48.2	55.9	25.6	32.4	48.4	9.7	23.9
Cedar Creek	51.2	34.8	15.4	22.8	14.2	11.8	19.6	22.7	10.4	13.2	19.7	3.9	9.7
Spring Creek	92.1	62.6	27.8	41.0	25.5	21.2	35.2	40.8	18.7	23.7	35.4	7.1	17.5
Negro Creek	48.6	33.0	14.7	21.6	13.4	11.2	18.6	21.5	9.9	12.5	18.7	3.7	9.2
Allforks Creek	44.3	30.1	13.4	19.7	12.3	10.2	16.9	19.6	9.0	11.4	17.0	3.4	8.4
Sandy Creek	146	109.6	31.8	53.3	30.0	30.6	63.0	54.9	22.7	48.4	42.9	13.4	24.5
Crow Creek (west)	81.7	61.3	17.8	29.8	16.8	17.1	35.3	30.7	12.7	27.1	24.0	7.5	13.7
Strawn Creek	33.8	25.4	7.4	12.3	6.9	7.1	14.6	12.7	5.3	11.2	9.9	3.1	5.7
Crow Creek	130	97.6	28.4	47.4	26.7	27.2	56.1	48.9	20.2	43.1	38.2	11.9	21.8
Senachwine Creek	90	67.6	19.6	32.8	18.5	18.8	38.8	33.8	14.0	29.8	26.4	8.3	15.1
Snag Creek	99.1	74.4	21.6	36.2	20.4	20.7	42.8	37.3	15.4	32.8	29.1	9.1	16.6
Richland Creek	47	35.3	10.3	17.1	9.7	9.8	20.3	17.7	7.3	15.6	13.8	4.3	7.9
Farm Creek	61.3	68.6	24.3	31.4	12.1	12.4	33.2	24.1	4.5	18.8	30.6	10.7	15.5
Kickapoo Creek	306	229.8	66.7	111.7	62.9	64.1	132.0	115.1	47.6	101.4	89.9	28.1	51.3
Lost Creek	46.9	52.5	18.6	24.0	9.3	9.5	25.4	18.4	3.4	14.4	23.4	8.2	11.9
Lamarsh Creek	40.9	30.7	8.9	14.9	8.4	8.6	17.6	15.4	6.4	13.6	12.0	3.8	6.9
Copperas Creek	127	95.4	27.7	46.3	26.1	26.6	54.8	47.8	19.7	42.1	37.3	11.7	21.3
Spring Lake Slough	36.5	40.9	14.5	18.7	7.2	7.4	19.7	14.3	2.7	11.2	18.2	6.4	9.2
Buckheart Creek	39.1	29.4	8.5	14.3	8.0	8.2	16.9	14.7	6.1	13.0	11.5	3.6	6.6
Quiver Creek	261	292.3	103.5	133.7	51.6	52.7	141.2	102.4	19.0	80.1	130.5	45.6	66.1
Otter Creek	126	87.2	30.2	55.0	38.4	25.6	48.4	36.9	12.3	33.5	47.7	9.4	23.1
Sugar Creek	162	112.1	38.8	70.8	49.4	32.9	62.3	47.4	15.9	43.1	61.3	12.1	29.6
Little Creek	30.8	21.3	7.4	13.5	9.4	6.3	11.8	9.0	3.0	8.2	11.7	2.3	5.6
Indian Creek	286	152.2	98.6	53.6	69.6	17.9	97.4	55.3	11.0	67.2	104.6	26.3	39.5
Camp Creek	38.6	20.5	13.3	7.2	9.4	2.4	13.1	7.5	1.5	9.1	14.1	3.6	5.3
Coon Run Ditch	61.7	32.8	21.3	11.6	15.0	3.9	21.0	11.9	2.4	14.5	22.6	5.7	8.5
Mauvaise Terre Creek	178	94.7	61.4	33.4	43.3	11.1	60.6	34.4	6.8	41.8	65.1	16.4	24.6
	25765.2	18564.7	10113.8	10612.3	8281.8	7885.0	11712.3	8971.4	4865.5	8282.5	11236.5	4499.9	7421.4
Missing area	977.8	689.5	432.7	326.9	200.8	280.5	474.0	230.3	78.5	229.1	460.0	199.4	408.9
Total inflow	26743	19254.2	10546.5	10939.3	8482.6	8165.5	12186.3	9201.7	4944.0	8511.6	11696.5	4699.2	7830.3
Outflow at Valley City	26743	17087.0	10890.1	10735.3	8032.9	7866.5	11363.5	8954.7	4870.2	8498.6	10510.5	4679.7	7455.8
Percent difference		*-13*	*3*	*-2*	*-6*	*-4*	*-7*	*-3*	*-2*	*0*	*-11*	*0*	*-5*

Table 3. Computed Annual Water Discharge of Tributary Streams in the Illinois River Basin, 1981-2015 (concluded)

	Drainage Area	*Annual water discharge (cfs-days * 1000)*											
River/Stream	*(sq mi)*	*WY2005*	*WY2006*	*WY2007*	*WY2008*	*WY2009*	*WY2010*	*WY2011*	*WY2012*	*WY2013*	*WY2014*	*WY2015*	*Average*
Des Plains River	2111	1417.7	1413.3	1967.3	1955.2	2107.2	1946.2	1799.1	1231.6	1573.9	1716.0	1736.9	1788.0
Kankakee River	5165	1943.2	1291.5	2367.9	2853.8	2696.5	2291.5	1793.7	1237.8	1680.1	2122.6	2883.9	2140.5
Mazon River	524	159.0	63.9	280.7	235.7	263.5	218.5	175.4	86.6	160.0	199.8	245.3	180.5
Fox River	2658	538.2	502.0	1189.5	1398.3	1380.2	1292.8	961.4	597.6	960.7	840.5	787.3	868.3
Vermilion River	1331	407.8	174.1	620.6	630.5	646.2	508.9	371.0	156.6	468.2	327.3	472.5	417.1
Big Bureau Creek	536.8	80.0	36.7	262.5	282.4	301.3	276.7	188.6	70.2	145.4	148.6	152.3	172.5
Mackinaw River	1136	378.4	131.1	412.6	471.2	534.2	585.7	317.6	93.4	397.8	250.3	480.1	337.8
Spoon River	1855	473.0	132.2	477.0	501.2	1152.7	1232.6	678.8	218.1	804.9	424.6	569.4	567.3
Sangamon River	5418	1969.8	692.9	1420.6	2524.4	2228.1	3508.2	1874.2	263.9	1582.6	1012.8	2127.2	1671.5
La Moine River	1350	399.4	68.0	173.8	365.6	638.8	1177.7	516.2	75.1	560.4	251.2	451.1	399.6
McKee Creek	444	131.3	22.3	57.2	120.3	210.1	387.3	169.8	24.7	184.3	82.6	148.4	131.4
Aux Sable Creek	187	56.7	22.8	100.2	84.1	94.0	78.0	62.6	30.9	57.1	71.3	87.6	64.4
Nettle Creek	53.2	16.1	6.5	28.5	23.9	26.8	22.2	17.8	8.8	16.2	20.3	24.9	18.3
Waupecan Creek	57.3	17.4	7.0	30.7	25.8	28.8	23.9	19.2	9.5	17.5	21.8	26.8	19.7
Bills Run	33.2	10.1	4.0	17.8	14.9	16.7	13.8	11.1	5.5	10.1	12.7	15.5	11.4
Hog Run	40	12.1	4.9	21.4	18.0	20.1	16.7	13.4	6.6	12.2	15.3	18.7	13.8
Covel Creek	74.1	22.5	9.0	39.7	33.3	37.3	30.9	24.8	12.3	22.6	28.3	34.7	25.5
Little Vermilion River	126	18.8	8.6	61.6	66.3	70.7	64.9	44.3	16.5	34.1	34.9	35.7	40.5
Cedar Creek	51.2	7.6	3.5	25.0	26.9	28.7	26.4	18.0	6.7	13.9	14.2	14.5	16.5
Spring Creek	92.1	13.7	6.3	45.0	48.4	51.7	47.5	32.4	12.0	24.9	25.5	26.1	29.6
Negro Creek	48.6	7.2	3.3	23.8	25.6	27.3	25.0	17.1	6.4	13.2	13.5	13.8	15.6
Allforks Creek	44.3	6.6	3.0	21.7	23.3	24.9	22.8	15.6	5.8	12.0	12.3	12.6	14.2
Sandy Creek	146	34.0	10.1	39.5	39.5	87.1	91.1	54.1	20.4	66.9	36.0	43.0	43.2
Crow Creek (west)	81.7	19.0	5.6	22.1	22.1	48.7	51.0	30.3	11.4	37.4	20.2	24.1	24.2
Strawn Creek	33.8	7.9	2.3	9.1	9.1	20.2	21.1	12.5	4.7	15.5	8.3	10.0	10.0
Crow Creek	130	30.3	9.0	35.2	35.2	77.5	81.2	48.1	18.2	59.6	32.1	38.3	38.5
Senachwine Creek	90	21.0	6.2	24.3	24.4	53.7	56.2	33.3	12.6	41.2	22.2	26.5	26.6
Snag Creek	99.1	23.1	6.8	26.8	26.8	59.1	61.9	36.7	13.9	45.4	24.4	29.2	29.3
Richland Creek	47	11.0	3.2	12.7	12.7	28.0	29.3	17.4	6.6	21.5	11.6	13.8	13.9
Farm Creek	61.3	28.6	9.9	31.2	35.6	40.3	44.2	24.0	7.0	30.0	18.9	36.2	23.5
Kickapoo Creek	306	71.3	21.1	82.8	82.8	182.5	191.0	113.3	42.8	140.2	75.5	90.1	90.5
Lost Creek	46.9	21.9	7.6	23.8	27.2	30.9	33.8	18.3	5.4	23.0	14.5	27.7	17.9
Lamarsh Creek	40.9	9.5	2.8	11.1	11.1	24.4	25.5	15.1	5.7	18.7	10.1	12.0	12.1
Copperas Creek	127	29.6	8.8	34.4	34.4	75.7	79.3	47.0	17.8	58.2	31.3	37.4	37.6
Spring Lake Slough	36.5	17.0	5.9	18.5	21.2	24.0	26.3	14.3	4.2	17.9	11.2	21.6	14.0
Buckheart Creek	39.1	9.1	2.7	10.6	10.6	23.3	24.4	14.5	5.5	17.9	9.6	11.5	11.6
Quiver Creek	261	121.6	42.1	132.6	151.4	171.7	188.3	102.1	30.0	127.9	80.4	154.3	99.9
Otter Creek	126	37.3	6.3	16.2	34.1	59.6	109.9	48.2	7.0	52.3	23.4	42.1	37.3
Sugar Creek	162	47.9	8.2	20.9	43.9	76.7	141.3	61.9	9.0	67.2	30.1	54.1	48.0
Little Creek	30.8	9.1	1.6	4.0	8.3	14.6	26.9	11.8	1.7	12.8	5.7	10.3	9.1
Indian Creek	286	71.4	21.9	46.2	85.0	79.9	174.6	103.8	17.8	81.3	39.9	97.6	70.8
Camp Creek	38.6	9.6	3.0	6.2	11.5	10.8	23.6	14.0	2.4	11.0	5.4	13.2	9.6
Coon Run Ditch	61.7	15.4	4.7	10.0	18.3	17.2	37.7	22.4	3.8	17.5	8.6	21.1	15.3
Mauvaise Terre Creek	178	44.4	13.6	28.7	52.9	49.8	108.7	64.6	11.1	50.6	24.8	60.8	44.1
	25765.2	8776.7	4810.6	10291.8	12527.2	13841.4	15425.5	10029.7	4435.6	9766.3	8190.5	11240.4	9670.8
Missing area	977.8	392.2	188.9	395.0	540.1	421.4	473.4	271.5	71.0	286.1	275.7	478.5	343.2
Total inflow	26743	9169.0	4999.6	10686.8	13067.3	14262.8	15898.9	10301.2	4506.5	10052.4	8466.2	11718.9	10014.1
Outflow at Valley City	26743	8492.5	5035.9	10727.1	12345.2	15147.4	15131.9	10660.7	4623.6	10063.9	9195.0	11467.5	9565.9
Percent difference		**-8**	**1**	**0**	**-6**	**6**	**-5**	**3**	**3**	**0**	**8**	**-2**	**-5**

Table 4. Computed Annual Sediment Yield from Tributary Streams in the Illinois River Basin, 1981-2015 (continued)

	Drainage Area	*Annual sediment yield (tons * 1000)*											
River/Stream	*(sq mi)*	*WY1981*	*WY1982*	*WY1983*	*WY1984*	*WY1985*	*WY1986*	*WY1987*	*WY1988*	*WY1989*	*WY1990*	*WY1991*	*WY1992*
Des Plains River	2111	145.6	153.9	199.9	156.2	160.2	160.5	178.9	114.9	99.0	169.6	181.8	138.5
Kankakee River	5165	1711.8	985.0	788.9	695.8	611.2	676.7	444.5	306.6	484.0	755.4	1244.0	385.9
Mazon River	524	228.0	326.9	335.7	247.0	144.4	247.7	94.6	57.5	136.1	247.6	502.9	91.3
Fox River	2658	297.9	438.3	664.2	352.0	307.8	477.1	393.6	295.7	125.9	305.9	359.0	212.8
Vermilion River	1331	1045.1	1484.8	1456.8	823.6	403.8	952.1	492.9	235.7	207.6	1085.8	1443.6	340.7
Big Bureau Creek	536.8	245.3	362.0	375.0	146.4	200.5	263.9	145.4	195.3	10.4	291.6	316.1	116.5
Mackinaw River	1136	960.6	749.0	1219.1	716.6	928.6	368.4	498.3	72.5	21.4	719.1	758.9	208.2
Spoon River	1855	2788.3	2141.9	2148.4	1146.7	1396.5	1326.9	1005.1	406.9	46.1	1387.1	1251.1	798.7
Sangamon River	5418	3593.7	1674.3	2278.9	2237.6	1402.0	1973.4	608.0	380.8	193.1	1115.0	1763.9	685.2
La Moine River	1350	2220.0	1243.9	1169.8	872.4	1077.9	1256.7	677.3	50.1	5.7	742.6	651.5	260.3
McKee Creek	444	528.5	538.5	501.6	357.4	456.3	544.9	266.9	13.7	1.2	296.8	255.2	89.1
Aux Sable Creek	187	260.0	400.5	413.3	286.2	150.4	287.1	90.6	50.0	140.1	287.0	671.4	86.9
Nettle Creek	53.2	81.8	126.3	130.4	90.0	47.1	90.3	28.2	15.5	43.8	90.3	212.6	27.1
Waupecan Creek	57.3	94.6	146.2	150.9	104.2	54.5	104.5	32.7	17.9	50.7	104.5	246.0	31.3
Bills Run	33.2	32.3	49.9	51.6	35.6	18.6	35.7	11.2	6.1	17.3	35.7	84.1	10.7
Hog Run	40	46.6	72.1	74.4	51.4	26.9	51.5	16.1	8.8	25.0	51.5	121.3	15.4
Covel Creek	74.1	50.6	78.0	80.5	55.7	29.3	55.9	17.6	9.7	27.3	55.9	130.8	16.9
Little Vermilion River	126	93.1	144.0	149.9	52.1	74.2	101.0	51.7	72.1	2.6	113.0	123.7	40.3
Cedar Creek	51.2	58.5	90.9	94.6	32.5	46.5	63.6	32.3	45.2	1.6	71.2	78.0	25.1
Spring Creek	92.1	59.9	92.7	96.5	33.4	47.7	65.0	33.2	46.3	1.7	72.7	79.6	25.8
Negro Creek	48.6	52.8	82.0	85.4	29.4	42.0	57.4	29.1	40.8	1.4	64.2	70.4	22.6
Allforks Creek	44.3	44.0	68.4	71.2	24.5	35.0	47.8	24.3	34.0	1.2	53.5	58.7	18.9
Sandy Creek	146	112.1	158.4	139.3	98.0	115.9	94.6	78.2	39.3	3.5	156.5	108.9	59.1
Crow Creek (west)	81.7	50.1	70.9	62.3	43.8	51.8	42.2	34.9	17.5	1.6	70.0	48.6	26.3
Strawn Creek	33.8	23.3	33.1	29.1	20.4	24.1	19.6	16.2	8.1	0.7	32.7	22.6	12.2
Crow Creek	130	89.4	126.3	111.1	78.2	92.4	75.4	62.4	31.4	2.8	124.8	86.8	47.1
Senachwine Creek	90	60.5	85.6	75.3	52.9	62.6	51.0	42.2	21.1	1.9	84.6	58.8	31.8
Snag Creek	99.1	62.4	88.2	77.6	54.6	64.5	52.6	43.5	21.9	2.0	87.2	60.6	32.8
Richland Creek	47	44.6	63.3	55.6	39.0	46.1	37.6	31.0	15.5	1.3	62.5	43.3	23.4
Farm Creek	61.3	64.0	47.4	85.3	59.7	31.3	42.8	29.0	2.9	1.3	87.3	93.2	19.6
Kickapoo Creek	306	475.2	672.1	591.1	415.5	491.3	400.8	331.4	166.4	14.9	663.9	461.6	250.1
Lost Creek	46.9	75.1	55.6	100.2	70.0	36.7	50.2	34.0	3.3	1.5	102.5	109.4	22.9
Lamarsh Creek	40.9	33.9	48.1	42.3	29.7	35.1	28.6	23.6	11.8	1.0	47.5	33.0	17.8
Copperas Creek	127	85.4	120.7	106.2	74.7	88.3	72.1	59.6	30.0	2.7	119.2	83.0	45.0
Spring Lake Slough	36.5	45.9	34.0	61.2	42.7	22.4	30.7	20.7	2.0	0.9	62.6	66.8	14.0
Buckheart Creek	39.1	31.1	44.0	38.7	27.1	32.1	26.2	21.6	10.8	0.9	43.5	30.2	16.3
Quiver Creek	261	586.6	435.2	780.8	546.8	287.9	393.1	266.9	26.6	11.9	798.7	852.1	180.6
Otter Creek	126	135.1	137.7	127.9	90.0	116.0	139.4	66.5	3.0	0.2	74.3	63.5	21.2
Sugar Creek	162	220.5	224.9	208.9	147.0	189.4	227.6	108.6	4.8	0.4	121.2	103.6	34.6
Little Creek	30.8	31.3	32.0	29.7	20.8	26.9	32.3	15.3	0.7	0.0	17.1	14.6	4.8
Indian Creek	286	619.2	335.0	795.2	405.0	145.7	337.8	185.6	99.8	10.7	302.9	686.7	90.5
Camp Creek	38.6	45.2	24.3	58.1	29.5	10.5	24.5	13.4	7.2	0.8	22.0	50.1	6.5
Coon Run Ditch	61.7	73.7	39.7	94.8	48.1	17.2	40.1	21.9	11.7	1.2	35.9	81.8	10.6
Mauvaise Terre Creek	178	245.2	132.8	314.8	160.5	57.8	133.9	73.6	39.6	4.3	120.0	271.9	35.9
	25765.2	17849.3	14458.8	16522.2	11100.4	9707.3	11561.1	6752.8	3051.5	1709.5	11352.9	14035.9	4651.2
Missing area	977.8	1584.0	1787.2	1670.4	1779.7	767.3	1928.3	225.7	257.9	317.8	1203.4	2044.1	694.9
Total inflow	26743	19433.2	16246.0	18192.6	12880.1	10474.6	13489.5	6978.5	3309.4	2027.3	12556.3	16080.0	5346.0
Outflow at Valley City	26743	7350.5	9018.6	5985.9	5217.3	5438.3	7881.9	4629.2	2059.6	1805.4	7052.2	10053.1	3726.9
Percent difference		**62**	**44**	**67**	**59**	**48**	**42**	**34**	**38**	**11**	**44**	**37**	**30**

Table 4. Computed Annual Sediment Yield from Tributary Streams in the Illinois River Basin, 1981-2015 (continued)

	Drainage Area	*Annual sediment yield (tons * 1000)*											
River/Stream	*(sq mi)*	*WY1993*	*WY1994*	*WY1995*	*WY1996*	*WY1997*	*WY1998*	*WY1999*	*WY2000*	*WY2001*	*WY2002*	*WY2003*	*WY2004*
Des Plains River	2111	228.8	98.5	129.6	141.4	124.9	134.1	147.2	100.4	111.4	137.3	67.2	127.3
Kankakee River	5165	1662.9	682.5	528.3	472.7	790.8	876.7	369.1	182.6	334.6	841.0	242.8	426.7
Mazon River	524	600.8	131.5	330.3	160.9	181.7	400.5	135.2	30.6	153.6	256.8	31.8	119.0
Fox River	2658	943.4	226.8	337.8	490.2	279.8	298.4	427.0	291.4	376.8	322.8	78.0	576.0
Vermilion River	1331	2946.6	726.9	1028.8	402.1	474.8	1135.4	477.4	82.0	601.1	1116.3	109.8	345.8
Big Bureau Creek	536.8	924.3	223.8	440.0	192.7	140.1	338.1	437.7	112.8	169.9	340.5	21.4	100.7
Mackinaw River	1136	3047.5	561.7	785.6	384.2	186.3	931.6	552.6	35.6	370.5	819.7	147.9	271.0
Spoon River	1855	6742.4	919.4	1882.5	1396.3	981.2	2763.1	1830.0	445.8	1854.7	1672.1	536.4	497.5
Sangamon River	5418	4528.5	2682.9	1572.5	1347.8	650.4	2247.1	1061.4	142.0	979.6	2507.6	301.9	996.9
La Moine River	1350	3186.3	565.1	888.0	999.6	453.8	1222.1	784.2	131.8	671.2	1192.3	84.3	364.8
McKee Creek	444	1604.6	216.7	671.4	341.4	159.2	527.6	316.1	41.0	264.2	512.8	24.7	131.1
Aux Sable Creek	187	831.1	134.4	405.5	171.2	198.1	510.9	139.0	23.5	161.9	299.8	24.6	119.3
Nettle Creek	53.2	263.6	42.0	127.9	53.7	62.1	161.5	43.5	7.2	50.7	94.4	7.6	37.2
Waupecan Creek	57.3	305.0	48.6	148.1	62.1	71.9	186.9	50.3	8.4	58.7	109.2	8.8	43.1
Bills Run	33.2	104.2	16.6	50.6	21.2	24.6	63.8	17.2	2.9	20.0	37.3	3.0	14.7
Hog Run	40	150.4	24.0	73.0	30.6	35.5	92.1	24.8	4.1	28.9	53.8	4.3	21.3
Covel Creek	74.1	161.9	26.2	79.0	33.3	38.6	99.5	27.1	4.6	31.5	58.4	4.8	23.2
Little Vermilion River	126	410.4	84.0	179.2	71.0	49.5	133.4	178.2	38.8	61.6	134.5	5.9	34.2
Cedar Creek	51.2	261.2	52.7	113.3	44.5	30.9	84.1	112.7	24.2	38.5	84.8	3.6	21.2
Spring Creek	92.1	264.6	54.0	115.4	45.6	31.8	85.9	114.7	24.9	39.6	86.6	3.8	21.9
Negro Creek	48.6	235.7	47.6	102.3	40.2	27.9	75.9	101.7	21.8	34.8	76.6	3.2	19.2
Allforks Creek	44.3	196.5	39.7	85.2	33.5	23.3	63.3	84.7	18.2	29.0	63.8	2.7	16.0
Sandy Creek	146	664.8	59.5	162.4	53.0	55.0	225.2	172.3	30.8	134.6	106.4	11.1	35.7
Crow Creek (west)	81.7	298.7	26.5	72.7	23.6	24.5	100.9	77.1	13.7	60.2	47.5	4.9	15.9
Strawn Creek	33.8	140.3	12.3	33.9	11.0	11.4	47.2	36.0	6.3	28.1	22.1	2.2	7.3
Crow Creek	130	529.8	47.5	129.5	42.3	43.9	179.6	137.3	24.6	107.3	84.8	8.8	28.5
Senachwine Creek	90	361.1	32.1	87.8	28.5	29.6	121.9	93.2	16.5	72.7	57.4	5.9	19.2
Snag Creek	99.1	371.1	33.1	90.5	29.5	30.6	125.5	96.0	17.1	74.9	59.2	6.1	19.8
Richland Creek	47	268.4	23.6	64.9	21.0	21.7	90.2	68.8	12.1	53.7	42.3	4.3	14.1
Farm Creek	61.3	498.1	64.8	107.2	16.5	17.2	119.3	63.6	2.3	39.3	102.2	13.0	26.9
Kickapoo Creek	306	2827.0	252.1	689.0	224.5	232.8	956.2	730.9	130.2	570.9	451.0	46.7	151.0
Lost Creek	46.9	587.0	76.0	125.9	19.3	20.1	140.2	74.6	2.7	46.0	120.1	15.2	31.5
Lamarsh Creek	40.9	204.2	17.9	49.3	15.9	16.5	68.6	52.4	9.2	40.8	32.2	3.3	10.7
Copperas Creek	127	506.2	45.4	123.7	40.4	41.9	171.6	131.2	23.5	102.6	81.1	8.4	27.2
Spring Lake Slough	36.5	358.4	46.4	76.9	11.8	12.3	85.6	45.5	1.7	28.1	73.3	9.3	19.2
Buckheart Creek	39.1	186.9	16.4	45.2	14.6	15.1	62.8	47.9	8.4	37.4	29.5	3.0	9.8
Quiver Creek	261	4528.3	593.7	979.7	152.6	158.8	1089.9	582.2	21.8	360.4	934.6	119.9	247.7
Otter Creek	126	425.2	53.6	173.0	85.9	38.9	134.8	79.3	9.4	65.8	130.9	5.5	31.7
Sugar Creek	162	694.9	87.4	282.6	140.2	63.4	220.2	129.4	15.3	107.4	213.7	9.0	51.8
Little Creek	30.8	99.6	12.3	40.2	19.8	8.9	31.3	18.3	2.1	15.2	30.4	1.2	7.3
Indian Creek	286	1263.2	540.2	164.3	273.6	19.4	527.7	175.0	7.5	255.3	606.9	41.1	90.6
Camp Creek	38.6	92.6	39.4	11.9	19.8	1.4	38.4	12.6	0.5	18.5	44.3	2.9	6.5
Coon Run Ditch	61.7	151.0	64.3	19.4	32.4	2.2	62.8	20.7	0.9	30.2	72.3	4.8	10.7
Mauvaise Terre Creek	178	499.8	213.9	65.2	108.5	7.7	209.0	69.4	3.0	101.2	240.3	16.3	36.0
	25765.2	45157.4	9964.1	13669.3	8321.1	5890.5	17240.6	10345.3	2134.2	8793.2	14400.8	2061.4	5227.3
Missing area	977.8	4331.6	1840.4	1102.1	453.1	832.9	2175.8	581.7	82.8	575.8	2058.9	447.3	1659.6
Total inflow	26743	49488.9	11804.6	14771.4	8774.2	6723.4	19416.4	10927.0	2217.0	9369.0	16459.7	2508.6	6887.0
Outflow at Valley City	26743	5464.2	5482.8	5560.6	5386.1	4096.0	4628.0	4415.2	2911.4	5130.1	7396.9	3162.2	4439.8
Percent difference		**89**	**54**	**62**	**39**	**39**	**76**	**60**	**-31**	**45**	**55**	**-26**	**36**

Table 4. Computed Annual Sediment Yield from Tributary Streams in the Illinois River Basin, 1981-2015 (concluded)

	Drainage Area	*Annual sediment yield (tons * 1000)*											
River/Stream	*(sq mi)*	*WY2005*	*WY2006*	*WY2007*	*WY2008*	*WY2009*	*WY2010*	*WY2011*	*WY2012*	*WY2013*	*WY2014*	*WY2015*	*Average*
Des Plains River	2111	100.5	94.5	180.1	198.1	192.1	168.5	146.2	98.3	171.3	137.0	128.0	143.5
Kankakee River	5165	536.0	269.0	748.1	1025.0	931.5	707.9	468.2	250.4	419.3	622.1	1043.4	672.0
Mazon River	524	170.6	38.7	430.7	324.0	388.5	286.3	200.3	63.5	172.4	247.5	345.8	224.6
Fox River	2658	149.1	96.4	1251.5	842.3	1232.6	771.2	453.8	193.7	453.2	356.8	317.3	428.5
Vermilion River	1331	756.7	189.2	1499.4	1538.9	1601.6	1085.3	648.7	159.3	947.8	528.9	962.0	838.2
Big Bureau Creek	536.8	66.4	17.5	519.2	589.8	660.8	569.3	291.9	53.1	185.8	193.0	201.4	270.2
Mackinaw River	1136	731.0	130.0	841.6	1044.6	1281.6	1488.9	549.3	74.8	792.8	372.8	1077.1	677.1
Spoon River	1855	643.3	134.4	822.2	817.1	2585.7	2435.2	1490.6	293.5	2076.4	1098.7	1095.5	1453.1
Sangamon River	5418	1788.6	275.4	996.1	2788.8	2230.1	5027.6	1636.1	48.9	1208.7	543.5	2052.5	1586.3
La Moine River	1350	798.0	44.6	205.8	691.1	1714.6	4643.6	1212.0	52.5	1385.3	374.9	973.2	939.1
McKee Creek	444	322.5	12.0	68.1	273.2	781.0	2488.9	522.6	14.5	610.0	135.3	405.5	408.4
Aux Sable Creek	187	183.7	31.1	557.5	396.2	492.6	341.6	222.5	56.2	185.9	286.8	428.4	266.4
Nettle Creek	53.2	57.6	9.6	176.3	125.0	155.6	107.6	69.9	17.4	58.3	90.3	135.2	83.9
Waupecan Creek	57.3	66.6	11.1	204.0	144.6	180.1	124.6	80.9	20.2	67.5	104.5	156.5	97.1
Bills Run	33.2	22.8	3.8	69.7	49.4	61.5	42.6	27.6	6.9	23.0	35.7	53.5	33.2
Hog Run	40	32.9	5.5	100.6	71.3	88.8	61.4	39.9	9.9	33.3	51.5	77.1	47.9
Covel Creek	74.1	35.8	6.0	108.6	77.1	95.9	66.5	43.3	10.9	36.2	55.8	83.4	51.9
Little Vermilion River	126	21.3	4.7	215.7	248.7	282.3	239.0	113.2	16.5	68.1	71.1	74.6	107.2
Cedar Creek	51.2	13.2	2.8	136.6	157.7	179.2	151.5	71.3	10.2	42.7	44.6	46.8	67.7
Spring Creek	92.1	13.7	3.0	138.9	160.2	181.9	154.0	72.8	10.6	43.8	45.7	47.9	69.0
Negro Creek	48.6	11.9	2.6	123.3	142.3	161.7	136.7	64.3	9.2	38.5	40.2	42.2	61.1
Allforks Creek	44.3	9.9	2.1	102.7	118.6	134.8	113.9	53.6	7.7	32.1	33.5	35.2	50.9
Sandy Creek	146	67.7	6.4	90.6	90.7	423.9	463.4	167.2	25.1	253.4	75.7	106.9	132.7
Crow Creek (west)	81.7	30.2	2.8	40.4	40.5	190.2	208.0	74.8	11.1	113.5	33.8	47.7	59.4
Strawn Creek	33.8	14.0	1.3	18.8	18.8	89.2	97.6	34.9	5.1	53.1	15.7	22.2	27.7
Crow Creek	130	54.0	5.1	72.2	72.3	337.9	369.4	133.3	20.0	202.0	60.4	85.2	105.8
Senachwine Creek	90	36.5	3.4	48.9	48.9	229.9	251.4	90.4	13.4	137.2	40.8	57.7	71.8
Snag Creek	99.1	37.7	3.5	50.4	50.5	236.4	258.5	93.1	13.9	141.2	42.1	59.5	73.9
Richland Creek	47	26.8	2.5	36.0	36.0	170.6	186.7	66.8	9.8	101.6	30.0	42.5	53.1
Farm Creek	61.3	89.0	11.1	105.5	136.9	175.2	210.0	63.1	5.7	98.2	39.5	142.1	77.5
Kickapoo Creek	306	286.9	26.8	383.9	384.4	1801.4	1969.7	709.3	105.9	1075.9	320.7	453.1	563.3
Lost Creek	46.9	104.6	13.0	124.0	161.0	206.1	247.0	74.0	6.7	115.3	46.3	167.0	91.0
Lamarsh Creek	40.9	20.4	1.9	27.4	27.4	129.8	142.0	50.8	7.5	77.3	22.8	32.4	40.4
Copperas Creek	127	51.6	4.9	69.0	69.1	322.8	352.9	127.4	19.1	193.0	57.7	81.4	101.1
Spring Lake Slough	36.5	63.8	7.9	75.7	98.3	125.8	150.8	45.2	4.1	70.4	28.3	102.0	55.6
Buckheart Creek	39.1	18.7	1.7	25.1	25.1	118.8	129.9	46.5	6.8	70.7	20.9	29.6	37.0
Quiver Creek	261	814.5	102.7	964.7	1250.5	1598.6	1914.2	578.1	53.0	897.9	363.1	1297.5	707.8
Otter Creek	126	80.9	2.6	16.0	68.1	202.3	668.2	133.5	3.1	156.7	32.8	102.6	105.0
Sugar Creek	162	132.1	4.2	26.1	111.2	330.4	1092.2	218.0	5.1	255.8	53.5	167.6	171.5
Little Creek	30.8	18.7	0.6	3.6	15.7	47.1	157.0	31.0	0.7	36.4	7.5	23.7	24.4
Indian Creek	286	287.4	28.7	122.9	403.9	358.6	1652.3	597.7	19.2	370.7	92.2	529.9	355.5
Camp Creek	38.6	20.8	2.0	8.8	29.4	26.1	121.3	43.6	1.4	26.9	6.6	38.6	25.9
Coon Run Ditch	61.7	34.1	3.3	14.5	48.0	42.6	197.8	71.2	2.2	44.0	10.8	63.0	42.3
Mauvaise Terre Creek	178	113.9	11.4	48.8	160.0	142.1	653.6	236.7	7.6	146.9	36.6	209.9	140.8
	25765.2	8936.3	1631.9	11870.0	15170.7	22920.2	32706.0	12165.5	1824.7	13690.4	6907.9	13644.7	11640.8
Missing area	977.8	1537.4	405.6	1557.4	2764.5	1753.6	2170.8	784.9	69.2	863.7	807.4	2213.2	1295.2
Total inflow	26743	10473.7	2037.5	13427.4	17935.3	24673.8	34876.9	12950.4	1893.9	14554.1	7715.2	15857.9	12935.9
Outflow at Valley City	26743	3710.1	2170.5	4118.9	6057.4	5908.2	8490.8	4362.2	1748.5	4937.5	5091.2	6090.9	5170.8
Percent difference		**65**	**-7**	**69**	**66**	**76**	**76**	**66**	**8**	**66**	**34**	**62**	**60**

Sediment Budget Estimate for the Illinois River Valley

The main purpose of collecting and analyzing all the sediment load data for the tributary streams is to develop a quantitative sediment budget for the Illinois River valley. By calculating the difference between the amount of sediment that flows into and out of the valley, it is possible to estimate the amount of sediment deposited in the valley. Because sediment inflow/outflow varies significantly from year to year, it is necessary to select a reasonable period of time to represent the long-term records of the Illinois River. After evaluating the USGS streamflow records for the Illinois River and the period during which most of the sediment data were collected, a 20-year period of analysis (1981-2000) was used in the previous study (Demissie et al., 2004). In this study, the analysis period was extended to 35 years by including 15 more years of data from 2001 to 2015. For the 35-year analysis period (i.e., 1981-2015), the sediment inflow from all tributary streams and the sediment outflow from the Illinois River were determined. The sediment load data from the Illinois River at Valley City augmented by the Illinois River at Florence was used as the sediment outflow data. The amount and percentage of sediment deposited in the Illinois River valley were calculated by determining the difference between the computed total inflow from tributary streams and outflow at Valley City. The total amount of annual sediment estimated to be deposited in the valley is presented in Table 5, including a percentage of the total sediment inflow.

The sediment budget estimate for the Illinois River valley indicates that the tributary streams delivered an average annual sediment load of 12.9 million tons in the period 1981-2015 to the Illinois River valley. The measured sediment load for the Illinois River at Valley City, which is 61.3 miles upstream of the junction of the Illinois River with the Mississippi River, averaged 5.2 million tons per year. This means that, on average, about 7.8 million tons or 60 percent of the sediment estimated to be delivered from tributary streams was deposited within the valley every year.

The total amount of sediment deposited in the valley may be even higher than the estimated amount as a result of additional deposition of sediment load generated from the river bank and bluff erosion along the main stem of the Illinois River. Insufficient data availability makes it difficult to provide reasonable estimates of the additional sediment deposition.

Figure 7a shows the variability and trends of total sediment inflow, outflow, and deposition in the Illinois River valley. Corresponding water discharges also are shown (Figure 7b). The major flux of sediment into the valley in 1993 was due to the major floods in Illinois and Upper Mississippi River basin in that year. The low-flow years of 1988, 1989, 2000, 2003, 2006, and 2012 resulted in the least amount of sediment inflows into the valley. The percentage of sediment deposited in the valley tends to follow the total inflow, with the highest percentage (89 percent) during a high inflow in 1993 and the lowest percentage (8 percent) during a low inflow in 2012. The very high sediment deposition rate in 1993 was caused primarily by the high floodwaters along the Mississippi River during the Great Mississippi Flood, which created a backwater effect on the Illinois River (Demissie, 1996). However, not all high sedimentation rates were due to Mississippi River backwater effects; other factors such as high flows from tributary streams would have increased sedimentation rates independent of Mississippi River backwaters.

Table 5. Sediment Budget Estimate for the Illinois River, 1981-2015

Water Year	*Total inflow from tributary streams (tons × 1000)*	*Outflow from Illinois River at Valley City (tons × 1000)*	*Deposition (tons × 1000)*	*Percent deposited*
WY1981	19,433	7,351	12,083	62
WY1982	16,246	9,019	7,227	44
WY1983	18,193	5,986	12,207	67
WY1984	12,880	5,217	7,663	59
WY1985	10,475	5,438	5,036	48
WY1986	13,489	7,882	5,608	42
WY1987	6,978	4,629	2,349	34
WY1988	3,309	2,060	1,250	38
WY1989	2,027	1,805	222	11
WY1990	12,556	7,052	5,504	44
WY1991	16,080	10,053	6,027	37
WY1992	5,346	3,727	1,619	30
WY1993	49,489	5,464	44,025	89
WY1994	11,805	5,483	6,322	54
WY1995	14,771	5,561	9,211	62
WY1996	8,774	5,386	3,388	39
WY1997	6,723	4,096	2,627	39
WY1998	19,416	4,628	14,788	76
WY1999	10,927	4,415	6,512	60
WY2000	2,217	2,911	-694	-31
WY2001	9,369	5,130	4,239	45
WY2002	16,460	7,397	9,063	55
WY2003	2,509	3,162	-654	-26
WY2004	6,887	4,440	2,447	36
WY2005	10,474	3,710	6,764	65
WY2006	2,038	2,170	-133	-7
WY2007	13,427	4,119	9,309	69
WY2008	17,935	6,057	11,878	66
WY2009	24,674	5,908	18,766	76
WY2010	34,877	8,491	26,386	76
WY2011	12,950	4,362	8,588	66
WY2012	1,894	1,748	145	8
WY2013	14,554	4,937	9,617	66
WY2014	7,715	5,091	2,624	34
WY2015	15,858	6,091	9,767	62
Average	**12,936**	**5,171**	**7,765**	**60**

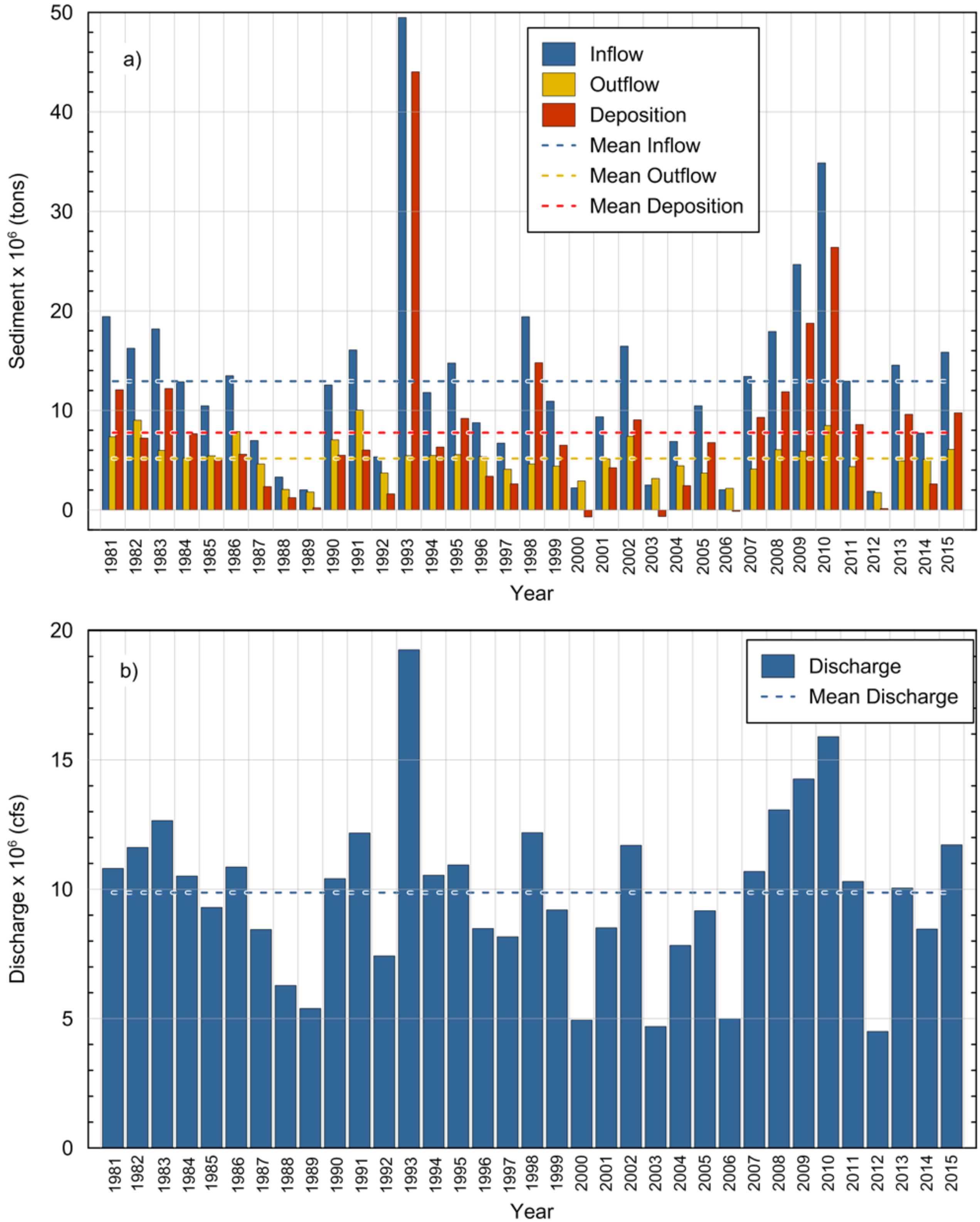

Figure 7. Variability and trends in the computed inflow, outflow, and deposition of sediment in the Illinois River valley, 1981-2015

Sediment estimates for Water Years 2000, 2003, and 2006 showed -31 percent, -26 percent, and -7 percent deposition, respectively, implying more sediment outflows than inflows. The total amount of sediment inflows in those years was 15 to 19 percent of the average annual sediment inflow since they were all low flow years. Thus, it is uncertain whether there was a real net scour of sediment from the Illinois River valley in Water Years 2000, 2003, and 2006.

The water and sediment budget estimates of the Illinois River are illustrated in Figures 8 and 9. The computed inflows of water and sediment from tributary streams are shown at the inlet points, and the width of the core represents either the water discharge or sediment load. No unexpected variation appears in the water budget (Figure 8). The discharge of the Illinois River increases gradually in the downstream direction, with the Kankakee and Sangamon Rivers being the major contributors. On the other hand, the computed sediment load in the Illinois River drastically increases both in the Peoria and LaGrange Pools (Figure 9). As shown in the figure, the main contributors of sediment inflow into the LaGrange Pool are Spoon, Sangamon, La Moine, and Mackinaw Rivers. The Spoon River delivers the most sediment per unit area (i.e., 3 tons/hectare) among the major tributaries to the Illinois River. The Vermilion and Kankakee Rivers contribute significant sediment into the Peoria and the Dresden Pools, respectively. In general, the lower Illinois River receives much more sediment than the upper Illinois River. It must be noted that Figure 9 is a cumulative sediment budget for the whole Illinois River valley. Sediment entrapment and thus deposition within each pool could not be calculated for each pool from available data. Therefore, sediment deposition within each pool is not quantified to represent its magnitude at each lock and dam location; instead, the estimated total sediment deposition within the valley is shown at the Illinois River at Valley City in Figure 9.

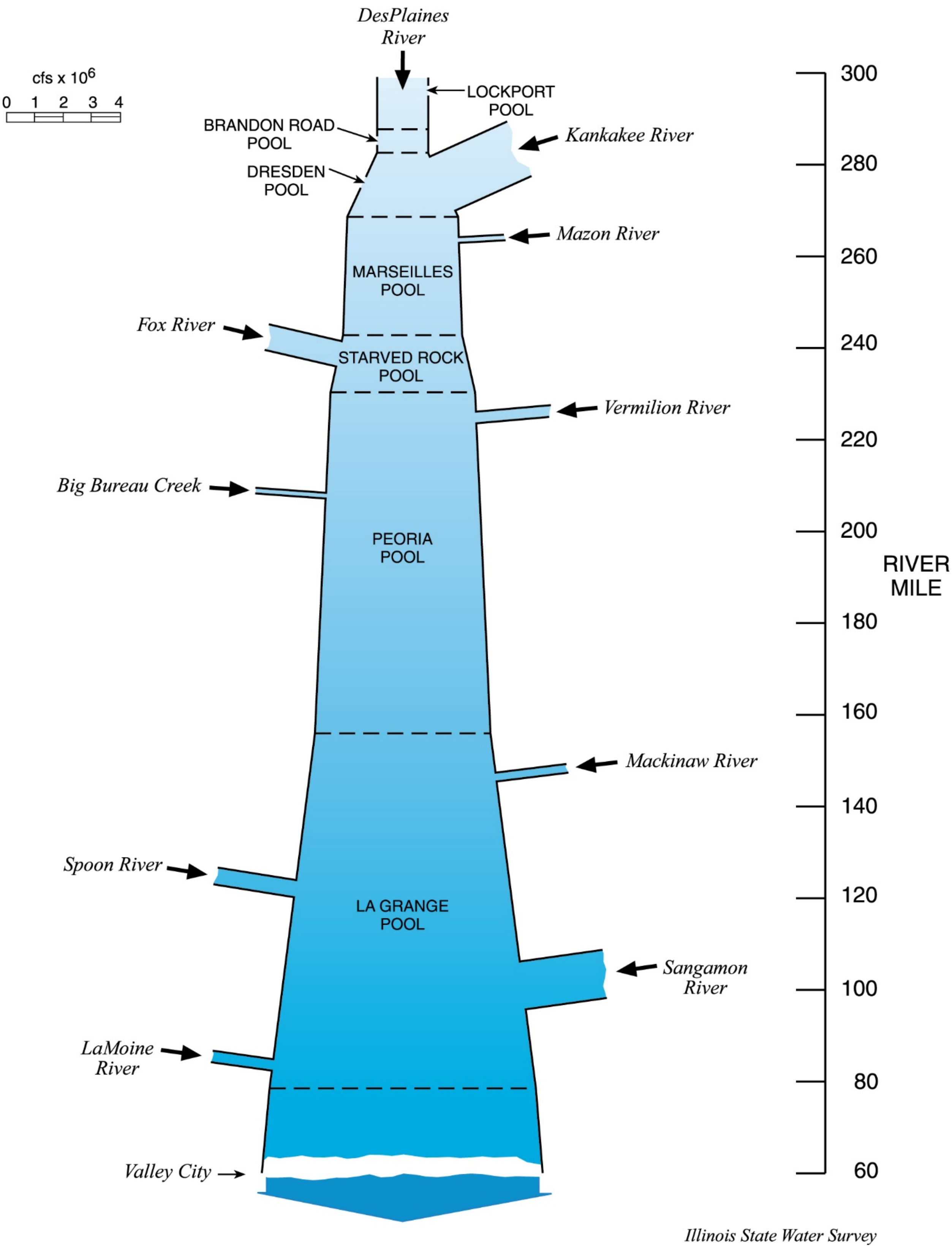

Figure 8. Water budget estimate for the Illinois River, 1981-2015

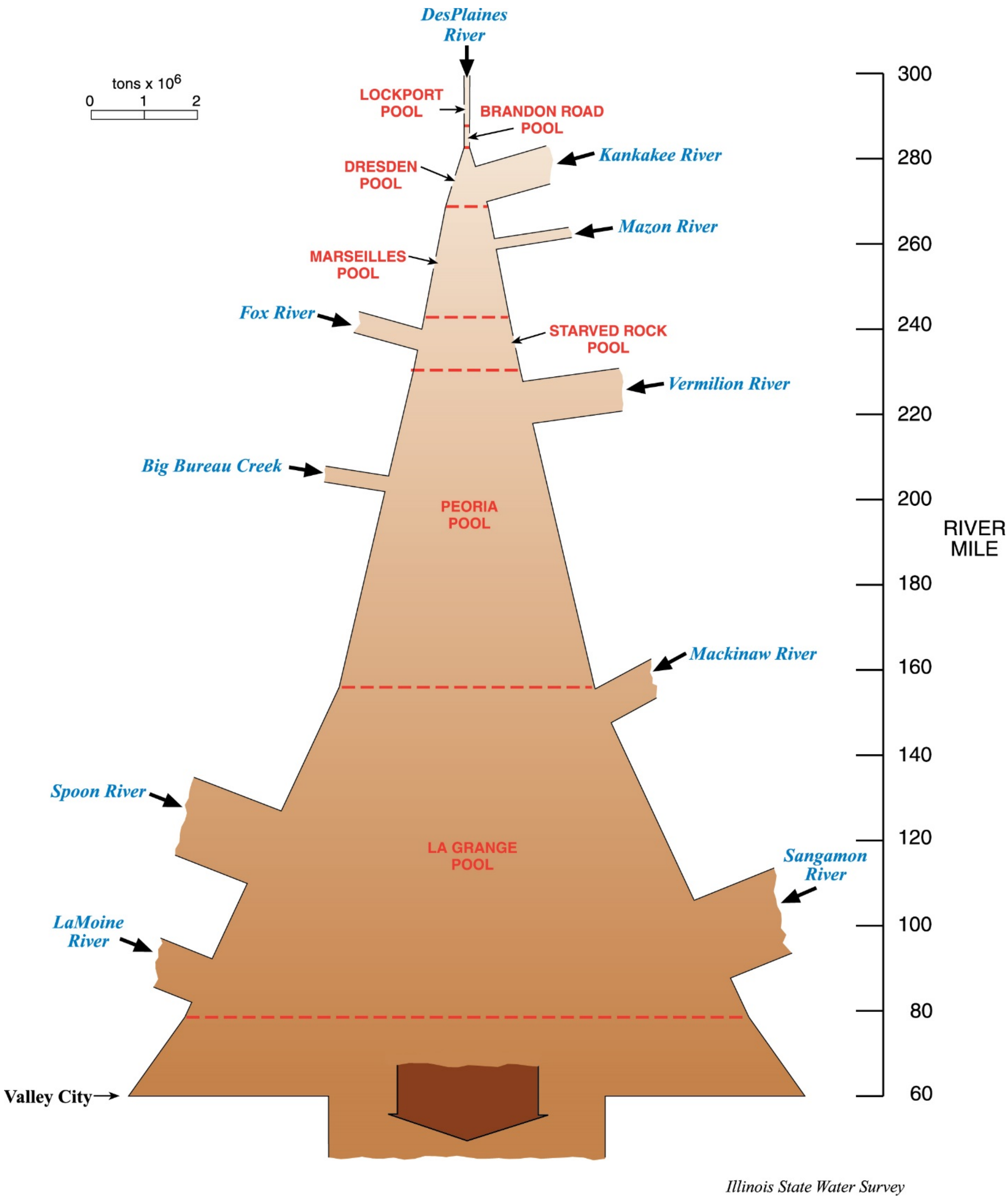

Figure 9. Sediment budget estimate for the Illinois River, 1981-2015

References

Allgire, R. L., and M. Demissie. 1995. *Benchmark Sediment Monitoring Program for Illinois Streams: Program Summary and Site Descriptions*. Illinois State Water Survey Circular 181, Champaign, IL.

Beckert, C. 2002. *Suspended Sediment Data for the Mackinaw River near Congerville and Sangamon River at Oakford*. Unpublished data. U.S. Army Corps of Engineers, Rock Island District, Rock Island, IL.

Coupe, R. H., P. D. Hayes, T. E. Richards, and R. L. Stahl. 1989. *Water Resources Data, Illinois, Water Year 1988, Volume 2, Illinois River Basin.* U.S. Geological Survey Water-Data Report IL-88-2, Urbana, IL.

Crowder, D.W., M. Demissie, and M. Markus. 2007. The Accuracy of sediment loads when log-transformation produces nonlinear sediment load-discharge relationships. *Journal of Hydrology* 336:250-268.

Demissie, M. 1996. *Impact of the 1993 Flood on Sedimentation and Sediment Quality in Backwater Lakes of Illinois*. Illinois State Water Survey Contract Report 593, Champaign, IL.

Demissie, M. 1997. "Patterns of Erosion and Sedimentation in the Illinois River Basin." *Proceedings of the 1997 Governor's Conference on the Management of the Illinois River System*, Peoria, IL, October 7-9, 1997, pp. 69-78.

Demissie, M., and N. G. Bhowmik. 1986. *Peoria Lake Sediment Investigation*. Illinois State Water Survey Contract Report 371, Champaign, IL.

Demissie, M., L. Keefer, and R. Xia. 1992. *Erosion and Sedimentation in the Illinois River Basin*. Illinois Department of Energy and Natural Resources Report ILENR/RE-WR-92/04, Springfield, IL.

Demissie, M., R. Xia., L. Keefer, and N. G. Bhowmik. 2004. *The Sediment Budget of the Illinois River*. Illinois State Water Survey, ISWS CR 2004-13, Champaign, IL.

Ferguson, R.I. 1986. River loads underestimated by rating curves. *Water Resources Research* 22(1):74-76.

Fitzgerald, K. K., P. D. Hayes, T. E. Richards, and R. L. Stahl. 1984. *Water Resources Data, Illinois, Water Year 1983, Volume 2, Illinois River Basin.* U.S. Geological Survey Water-Data Report IL-83-2, Urbana, IL.

Fitzgerald, K. K., P. D. Hayes, T. E. Richards, and R. L. Stahl. 1985. *Water Resources Data, Illinois, Water Year 1984, Volume 2, Illinois River Basin.* U.S. Geological Survey Water-Data Report IL-84-2, Urbana, IL.

Fitzgerald, K. K., P. D. Hayes, T. E. Richards, and R. L. Stahl. 1986. *Water Resources Data, Illinois, Water Year 1985, Volume 2, Illinois River Basin.* U.S. Geological Survey Water-Data Report IL-85-2, Urbana, IL.

Fitzgerald, K. K., P. D. Hayes, T. E. Richards, and R. L. Stahl. 1987. *Water Resources Data, Illinois, Water Year 1986, Volume 2, Illinois River Basin.* U.S. Geological Survey Water-Data Report IL-86-2, Urbana, IL.

Fitzgerald, K. K., P. D. Hayes, T. E. Richards, and R. L. Stahl. 1988. *Water Resources Data, Illinois, Water Year 1987, Volume 2, Illinois River Basin.* U.S. Geological Survey Water-Data Report IL-87-2, Urbana, IL.

Gaugush, R. F. 1999. *Suspended Sediment Budgets for Pool 13 and the La Grange Pool of the Upper Mississippi River System.* Project Status Report 99-11. U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, WI.

Harris, M. L., P. J. Draper, and D. L. Schrader. 2002. *Water Resources Data, Illinois Water Year 2001*. U.S. Geological Survey Water-Data Report IL-01, Urbana, IL.

Illinois Agricultural Statistics Service. 1988. *Illinois Agricultural Statistics - Annual Summary 1988 and 125 Year Summary*. Illinois Agricultural Statistics Service, Springfield, IL.

Illinois State Water Plan Task Force. 1987. *Illinois River Basin Action Plan*. Special Report No. 11, Illinois Division of Water Resources, Department of Transportation, Springfield, IL.

LaTour, J. K., J. M. Gioja, J .C. Maurer, and, T. L. Wicker. 2001. *Water Resources Data, Illinois Water Year 2000.* U.S. Geological Survey Water-Data Report IL-00, Urbana, IL.

LaTour, J. K., J. C. Maurer, T. L. Wicker, and J. M. Gioja. 1999. *Water Resources Data, Illinois Water Year 1998*. U.S. Geological Survey Water-Data Report IL-98, Urbana, IL.

LaTour, J. K., J. C. Maurer, T. L. Wicker, and J. M. Gioja. 2000. *Water Resources Data, Illinois Water Year 1999*. U.S. Geological Survey Water-Data Report IL-99, Urbana, IL.

LaTour, J.K., T.E. Richards, and R.H. Coupe. 1993. *Water Resources Data, Illinois, Water Year 1992, Volume 2, Illinois River Basin.* U.S. Geological Survey Water-Data Report IL-92-2.

Mathis, B., and G. E. Stout. 1987. "Conference Summary and Suggestions for Action." *Proceedings of the Governor's Conference on Management of the Illinois River System: The 1990s and Beyond*. Special Report No. 16, Water Resources Center, University of Illinois, Urbana, IL.

Richards, T. E., P. D. Hayes, R. L. Stahl, and K. K. Fitzgerald. 1983. *Water Resources Data, Illinois, Water Year 1982, Volume 2, Illinois River Basin.* U.S. Geological Survey Water-Data Report IL-82-2, Urbana, IL.

Richards, T. E., P. D. Hayes, and D. J. Sullivan. 1991. *Water Resources Data, Illinois, Water Year 1990, Volume 2, Illinois River Basin.* U.S. Geological Survey Water-Data Report IL-90-2, Urbana, IL.

Richards, T. E., P. D. Hayes, and D. J. Sullivan. 1992. *Water Resources Data, Illinois, Water Year 1991, Volume 2, Illinois River Basin.* U.S. Geological Survey Water-Data Report IL-90-2, Urbana, IL.

State of Illinois. 1997. *Integrated Management Plan for the Illinois River Watershed*. Technical Report of the Illinois River Strategy Team, Lt. Governor Bob Kustra, Chairman, Springfield, IL.

Sullivan, D. J., P. D. Hayes, T. E. Richards, and J. C. Maurer. 1990. *Water Resources Data, Illinois, Water Year 1989, Volume 2, Illinois River Basin.* U.S. Geological Survey Water-Data Report IL-89-2, Urbana, IL.

U.S. Geological Survey. 1982. *Water Resources Data, Illinois, Water Year 1981, Volume 2, Illinois River Basin*. U.S. Geological Survey Water-Data Report IL-81-2, Urbana, IL.

Walling, D. E., and B. W. Webb. 1988. "The Reliability of Rating Curve Estimates of Suspended Sediment Yield: Some Further Comments." *Sediment Budgets*, M.P. Bordas and D.E. Walling, editors, IAHS Publication No. 174, IAHS Press, Institute of Hydrology, Wallingford, Oxfordshire, UK.

Wicker, T. L., J. K. LaTour, and J. C. Mauer. 1996. *Water Resources Data, Illinois, Water Year 1995, Volume 2, Illinois River Basin.* U.S. Geological Survey Water-Data Report IL-95-2, Urbana, IL.

Wicker, T. L., J. K. LaTour, and J. C. Maurer. 1997. *Water Resources Data, Illinois, Water Year 1996, Volume 2, Illinois River Basin.* U.S. Geological Survey Water-Data Report IL-96-2, Urbana, IL.

Wicker T. L., J. K. LaTour, and J. C. Maurer. 1998. *Water Resources Data, Illinois, Water Year 1997, Volume 2, Illinois River Basin.* U.S. Geological Survey Water-Data Report IL-97-2, Urbana, IL.

Wicker, T. L., E. E. Zuehls, J. K. LaTour, and J. C. Maurer. 1995. *Water Resources Data, Illinois, Water Year 1994, Volume 2, Illinois River Basin*. U.S. Geological Survey Water-Data Report IL-94-2, Urbana, IL.

Zuehls, E. E., J. K. LaTour, and T. L. Wicker. 1994. *Water Resources Data, Illinois, Water Year 1993, Volume 2, Illinois River Basin.* U.S. Geological Survey Water-Data Report IL-93-2, Urbana, IL.

Appendix A. Results of Sediment Load Analysis

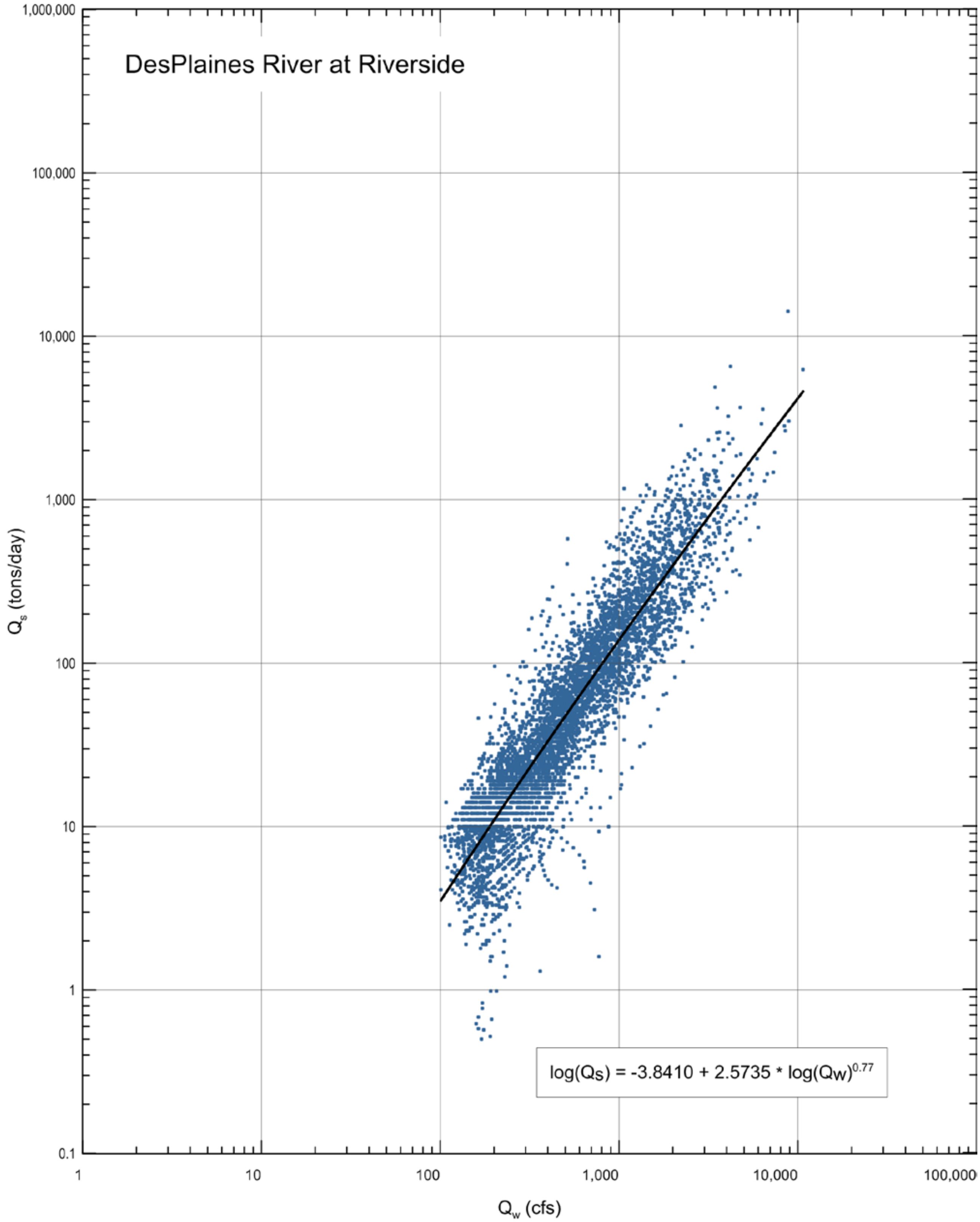

Figure A1. Comparison of multi-year sediment load curve with data for DesPlaines River at Riverside

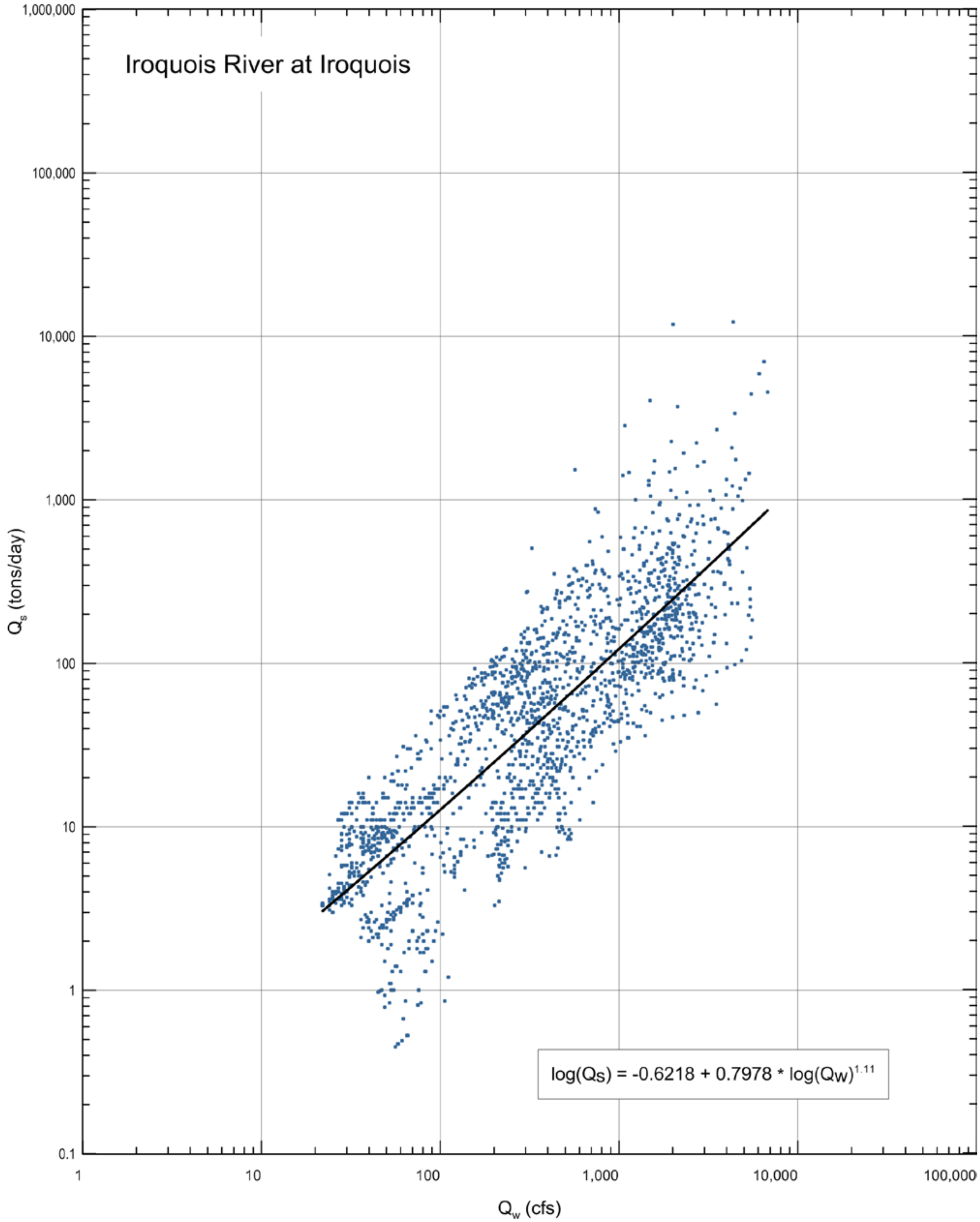

Figure A2. Comparison of multi-year sediment load curve with data for Iroquois River at Iroquois

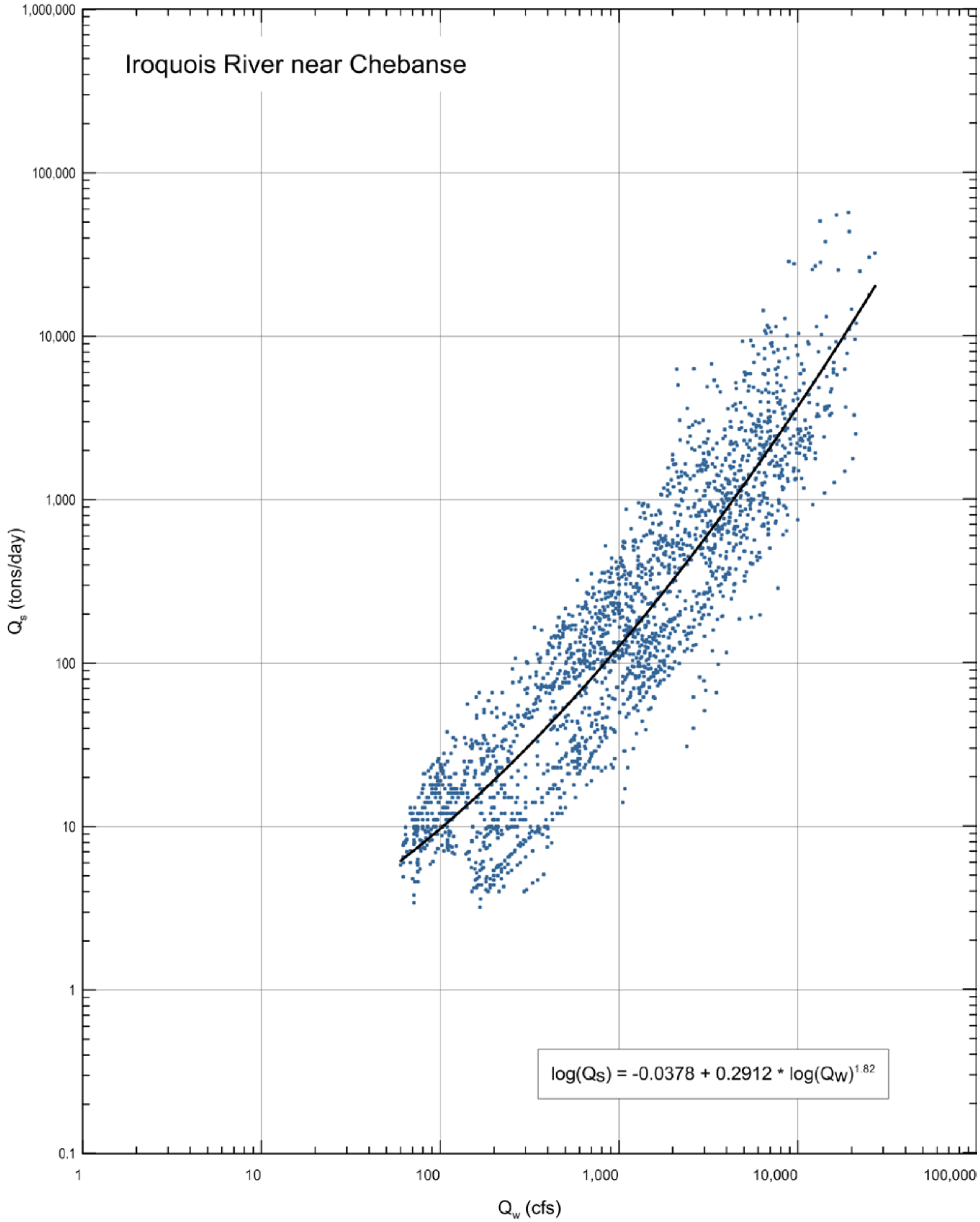

Figure A3. Comparison of multi-year sediment load curve with data for Iroquois River near Chebanse

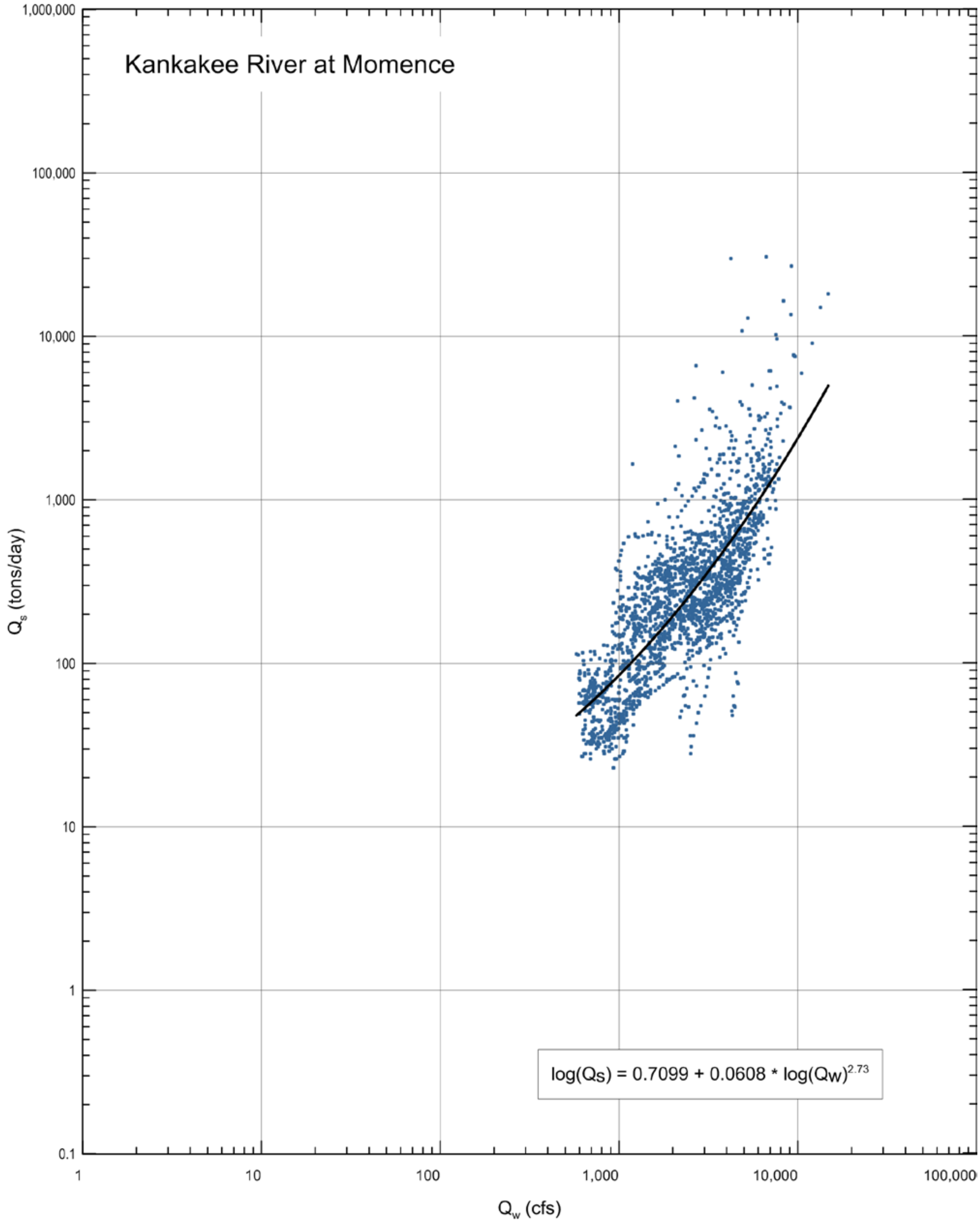

Figure A4. Comparison of multi-year sediment load curve with data
for Kankakee River at Momence

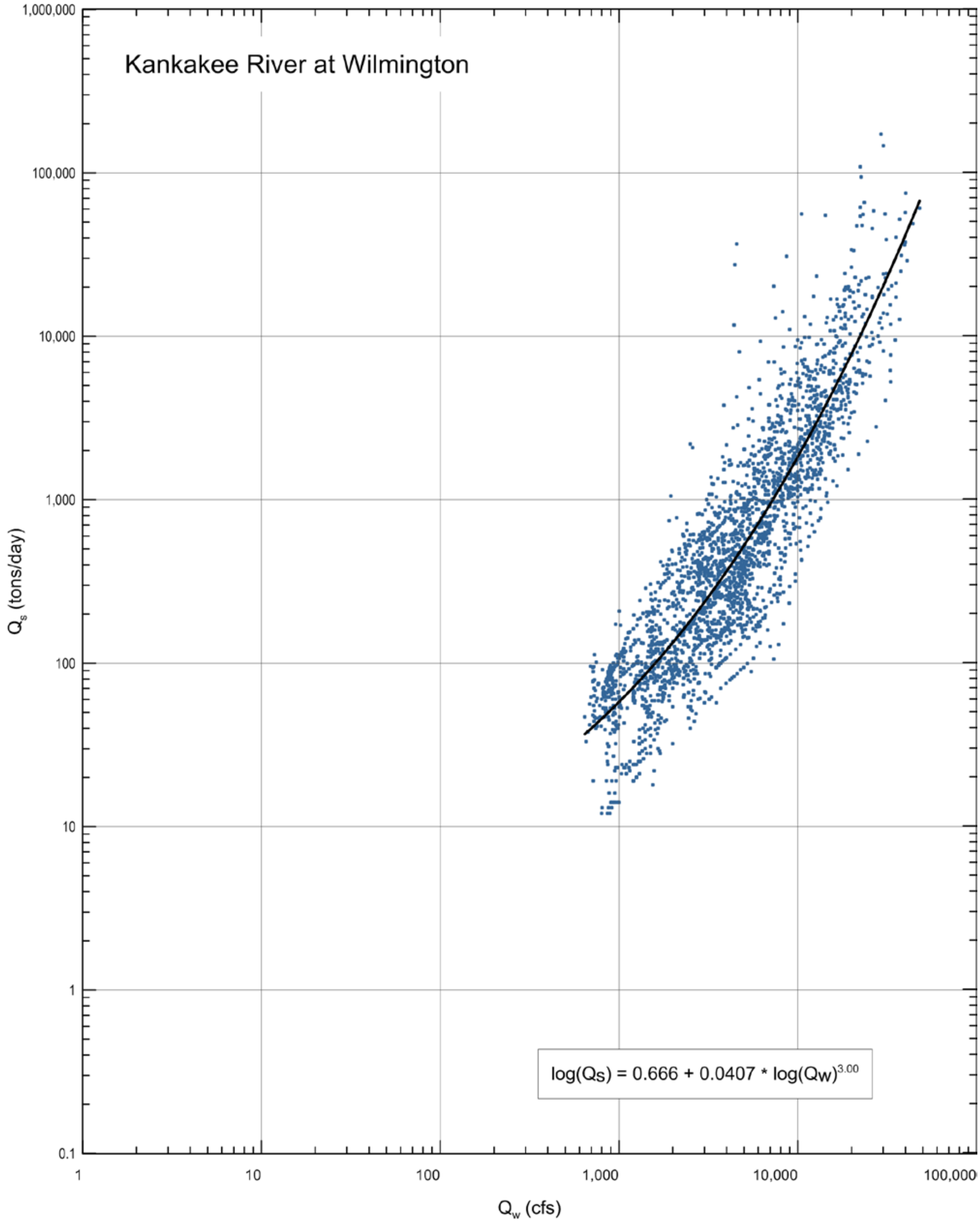

Figure A5. Comparison of multi-year sediment load curve with data for Kankakee River near Wilmington

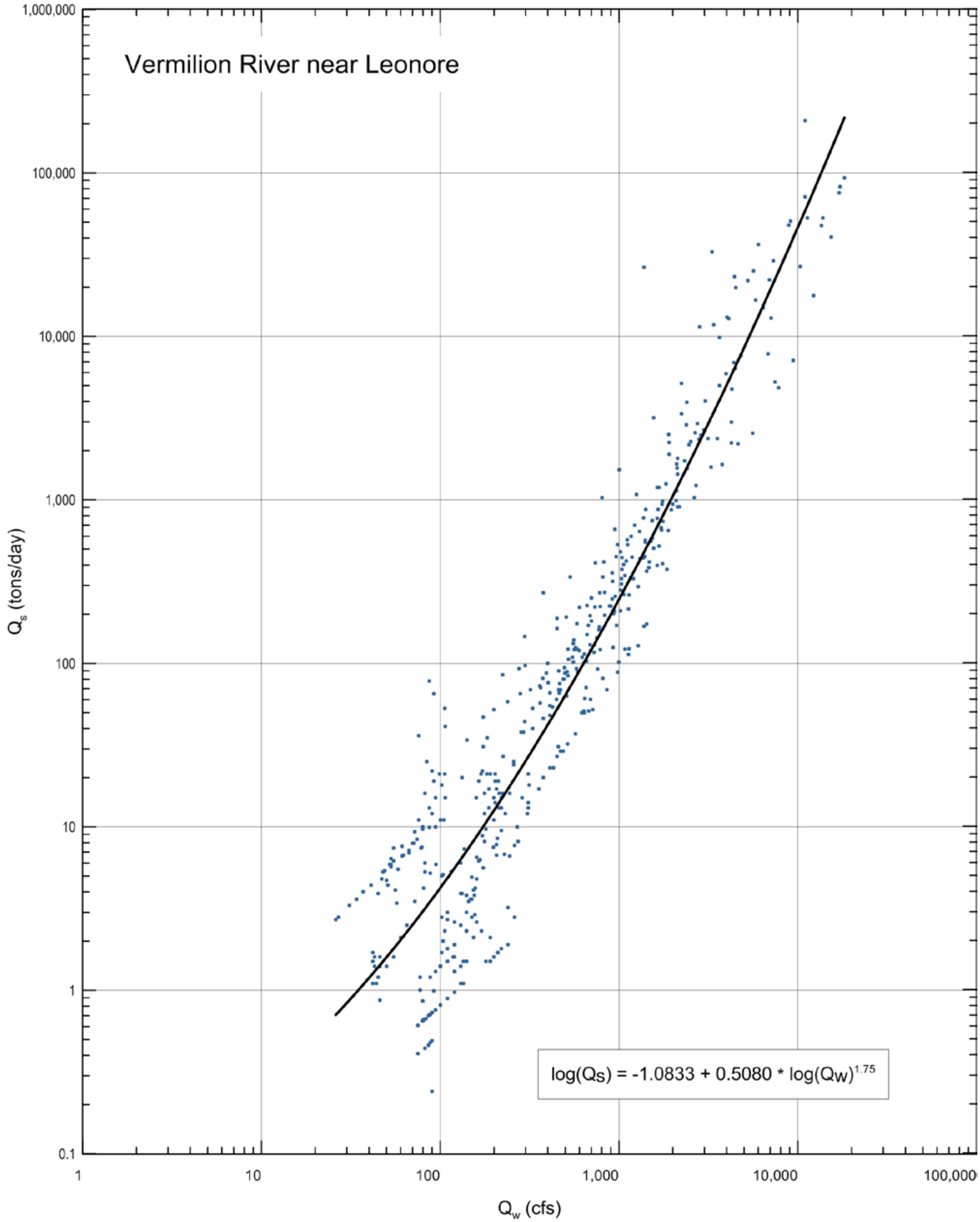

Figure A6. Comparison of multi-year sediment load curve with data for Vermilion River near Leonore

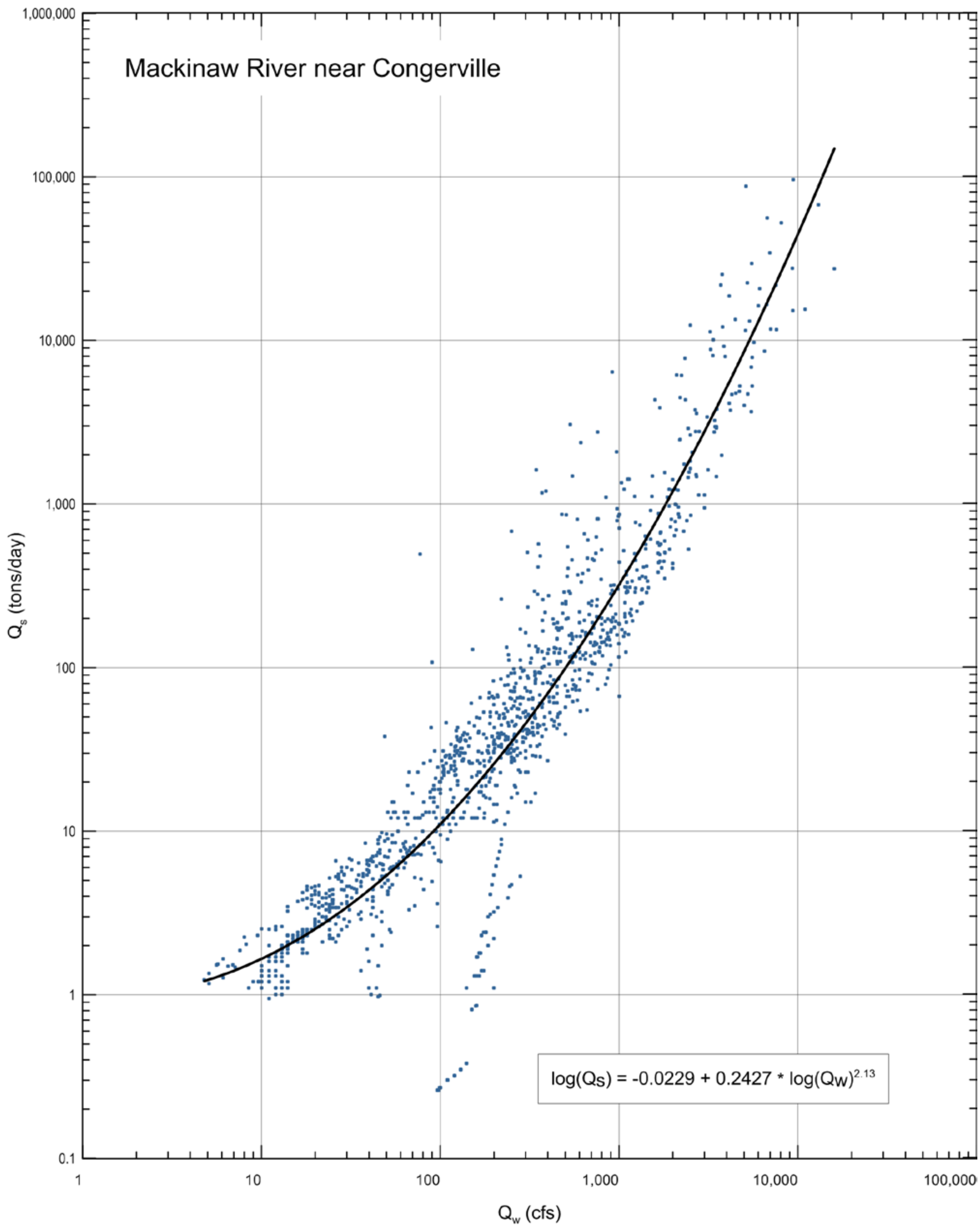

Figure A7. Comparison of multi-year sediment load curve with data
for Mackinaw River at Congerville

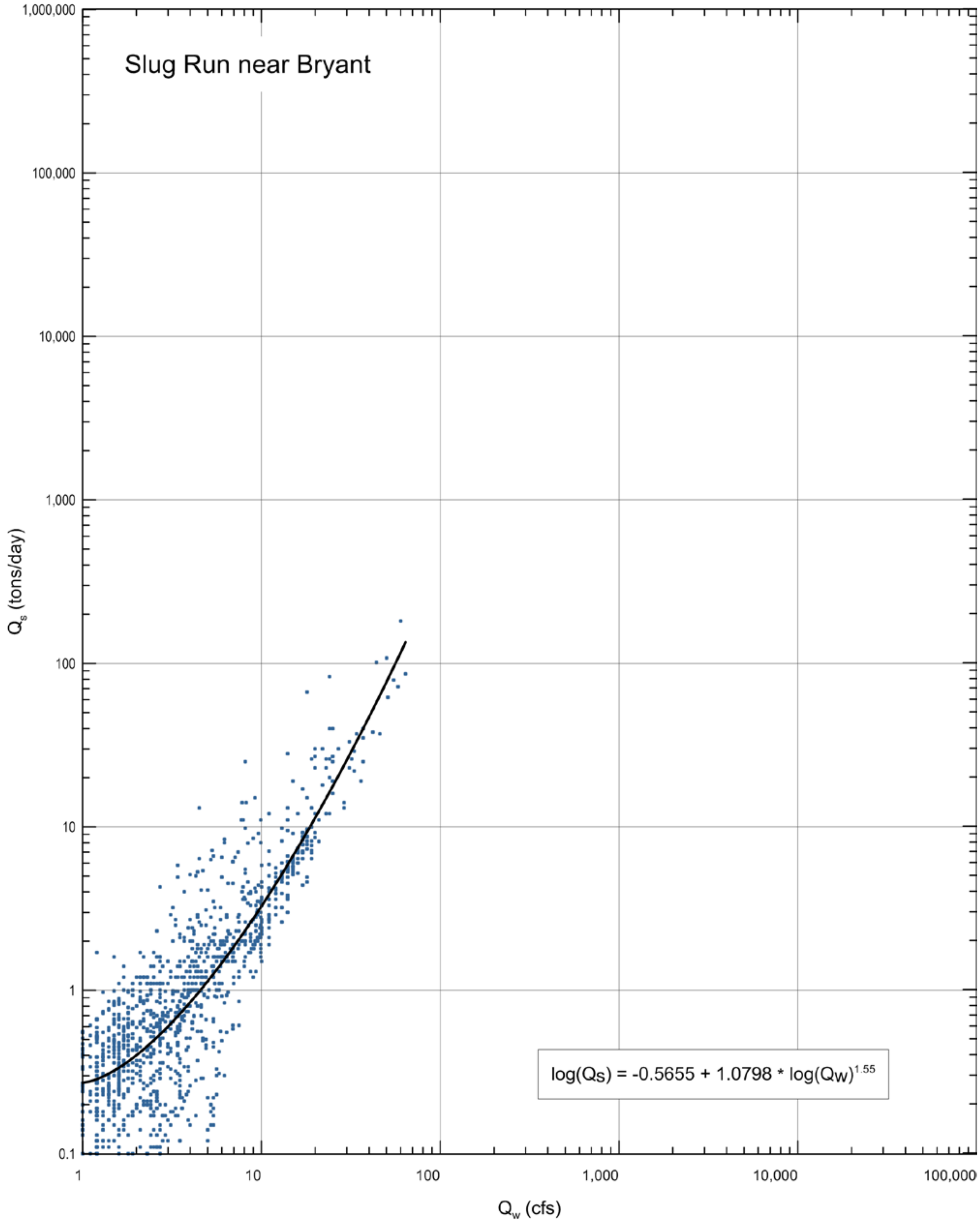

Figure A8. Comparison of multi-year sediment load curve with data for Slug Run near Bryant

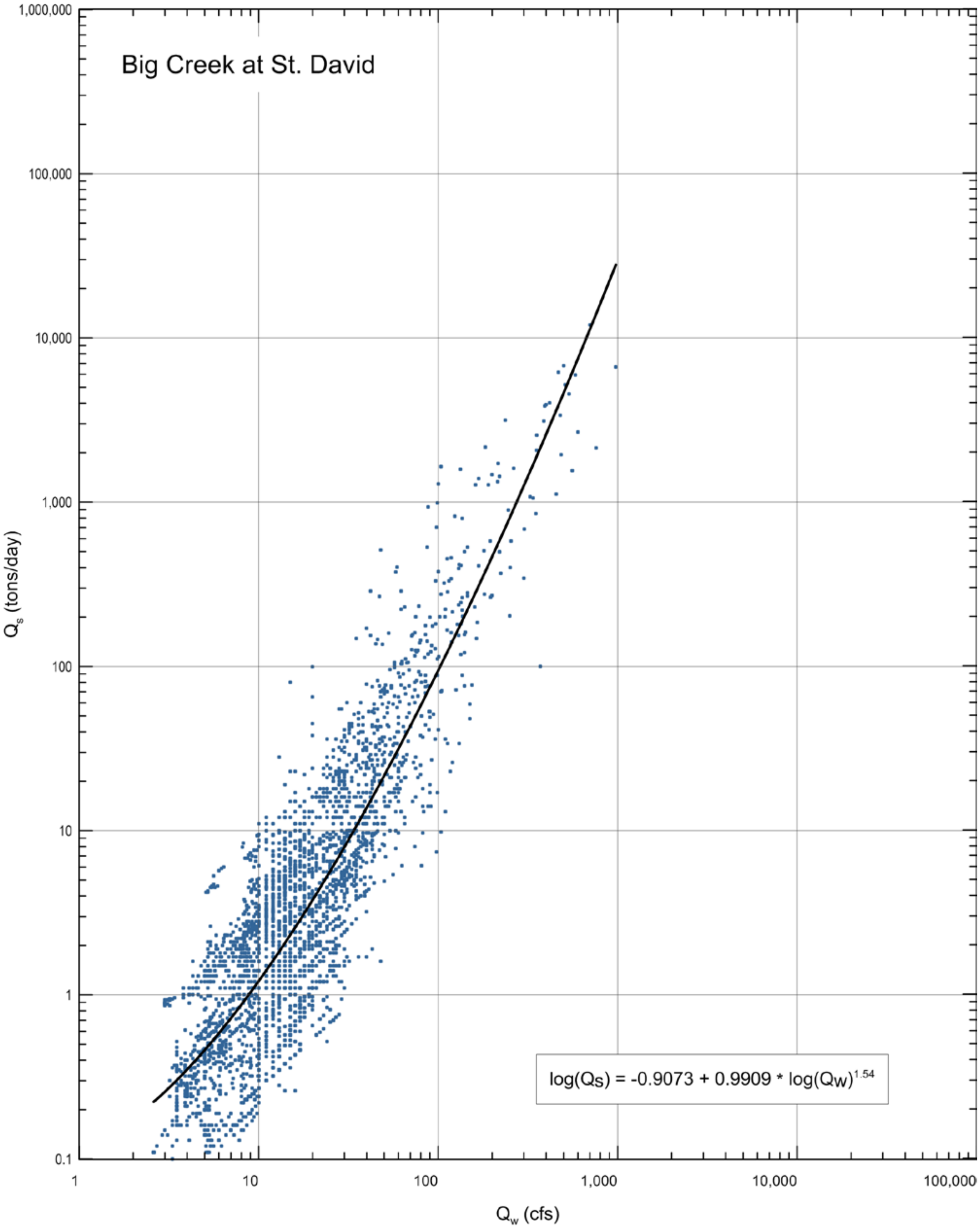

Figure A9. Comparison of multi-year sediment load curve with data
for Big Creek at St. David

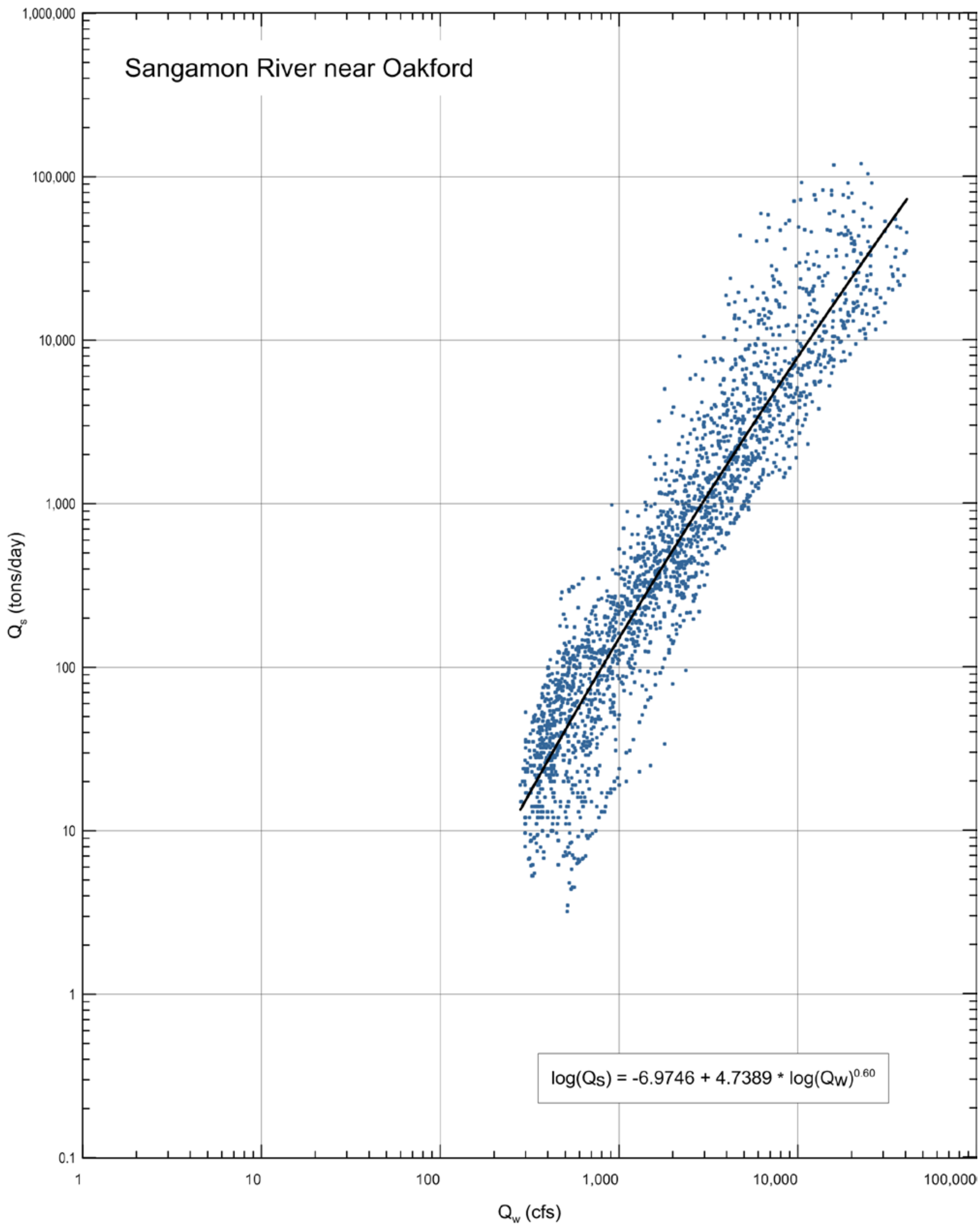

Figure A10. Comparison of multi-year sediment load curve with data for Sangamon River near Oakford

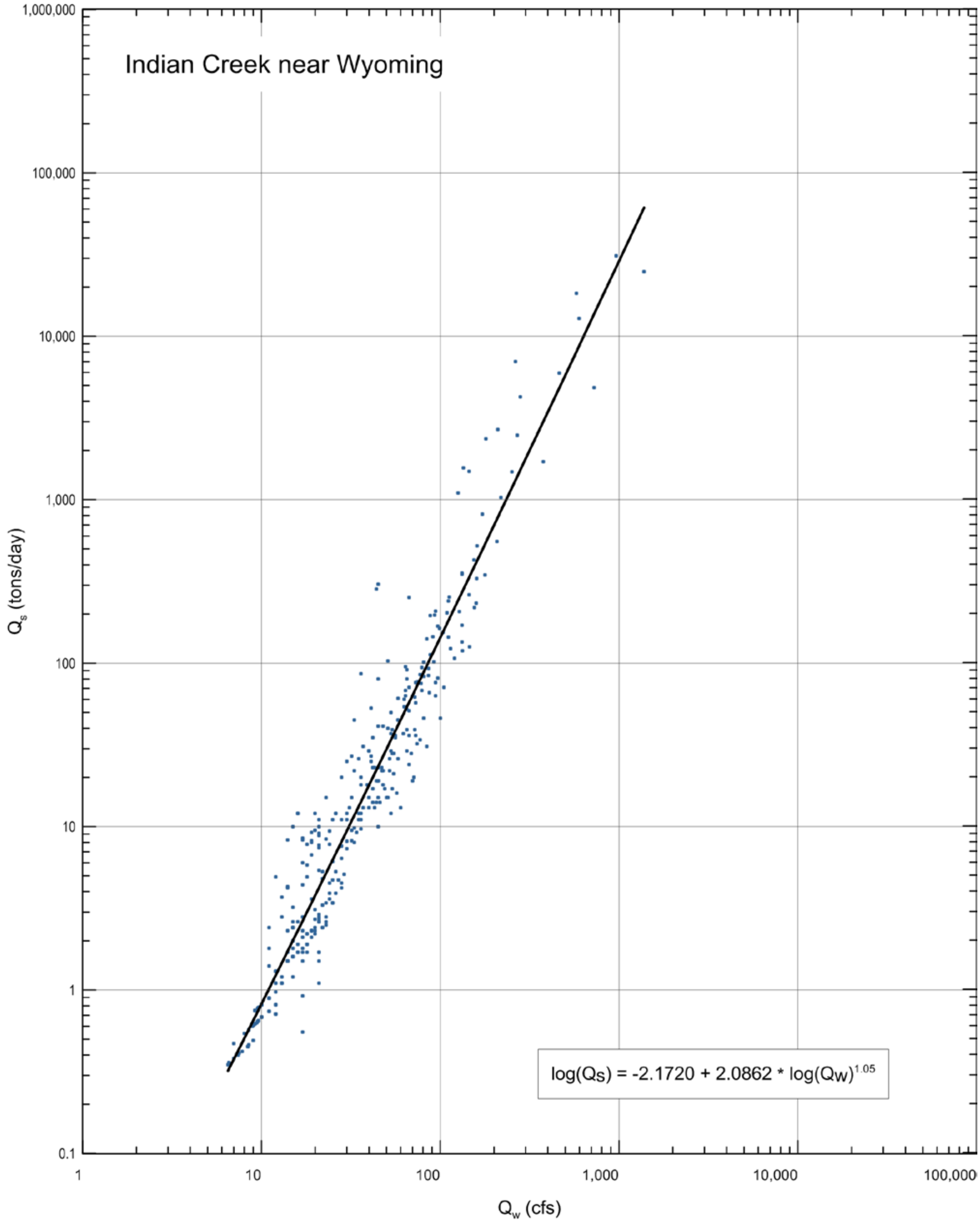

Figure A11. Comparison of multi-year sediment load curve with data for Indian Creek near Wyoming

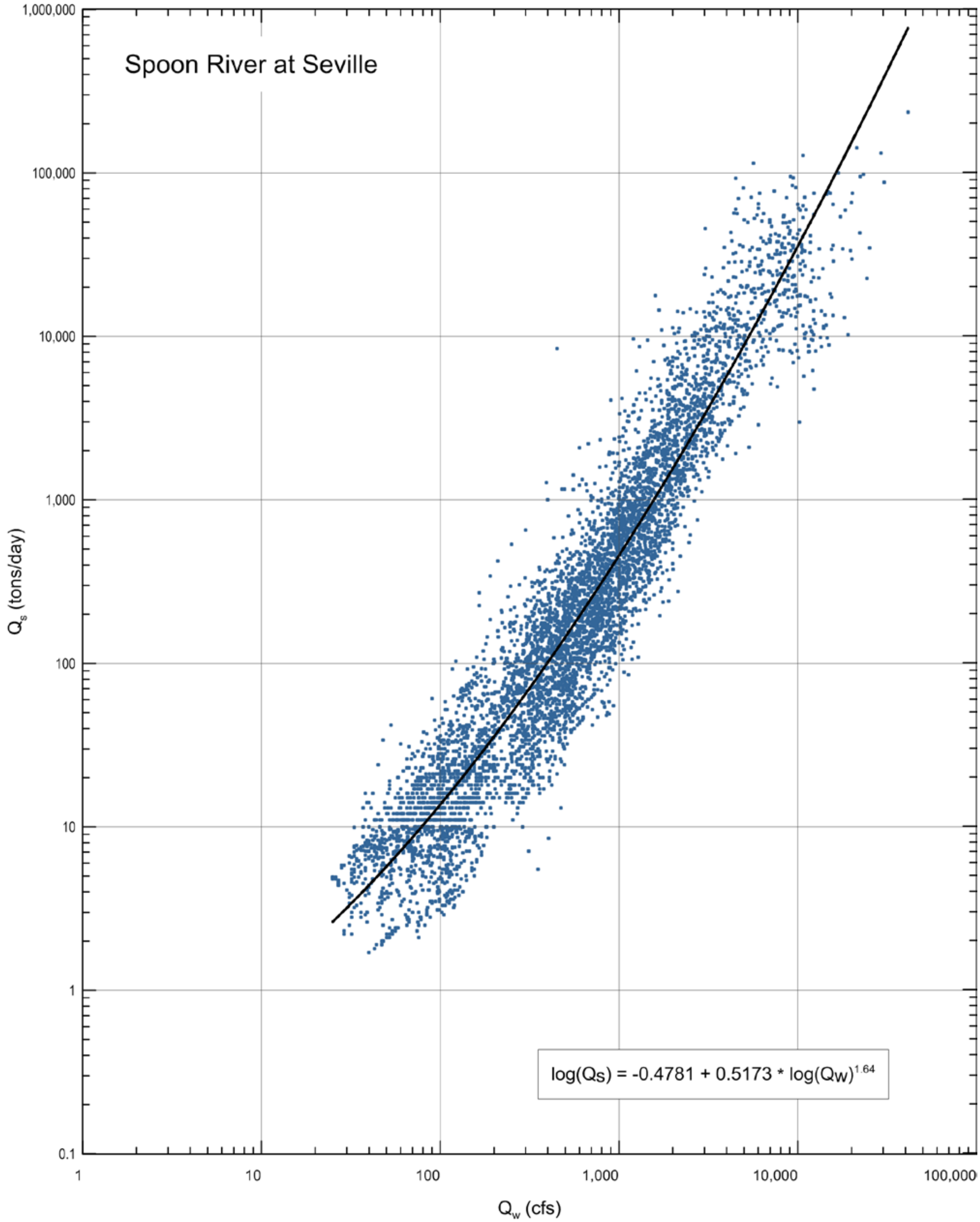

Figure A12. Comparison of multi-year sediment load curve with data for Spoon River at Seville

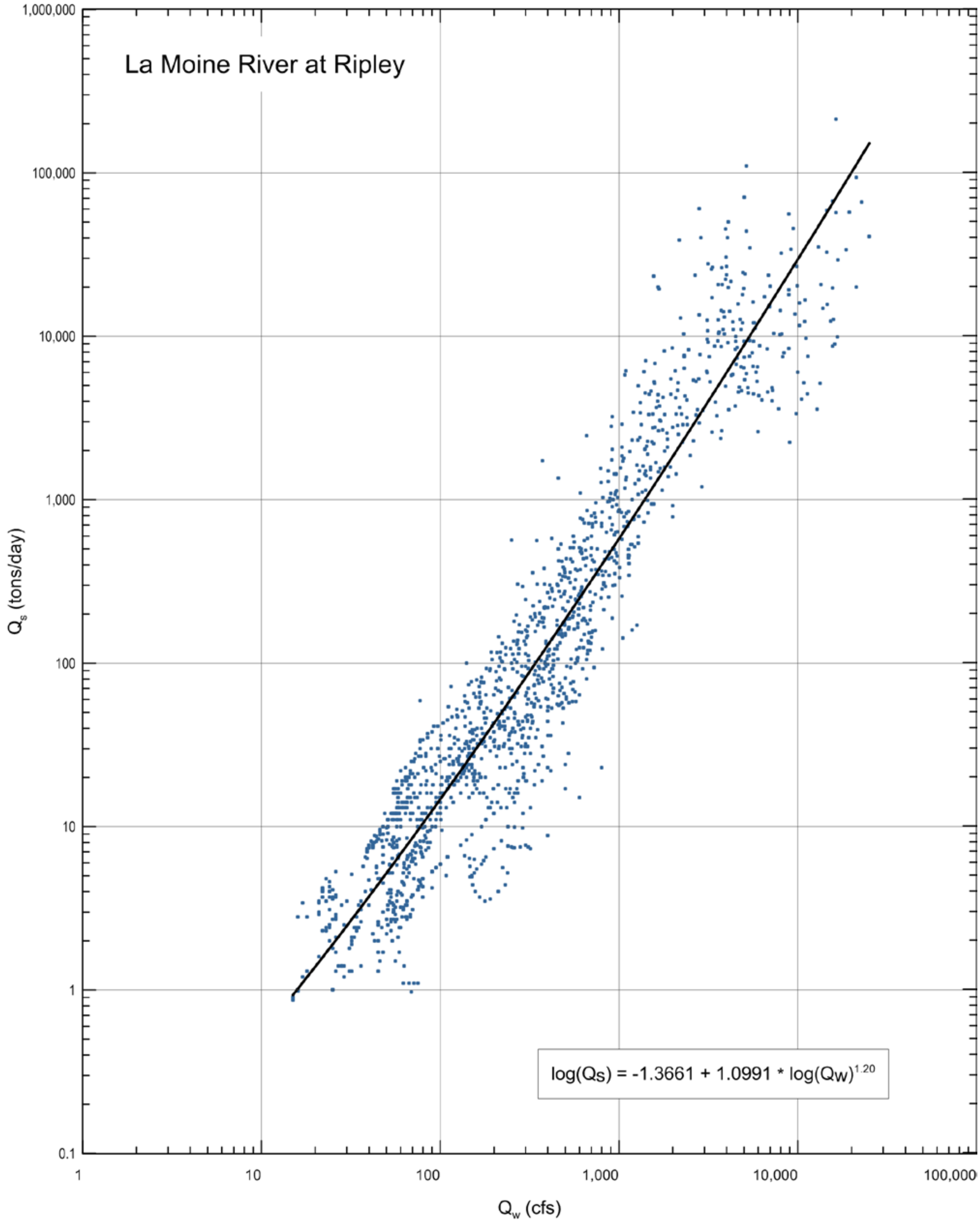

Figure A13. Comparison of multi-year sediment load curve with data for La Moine River at Ripley

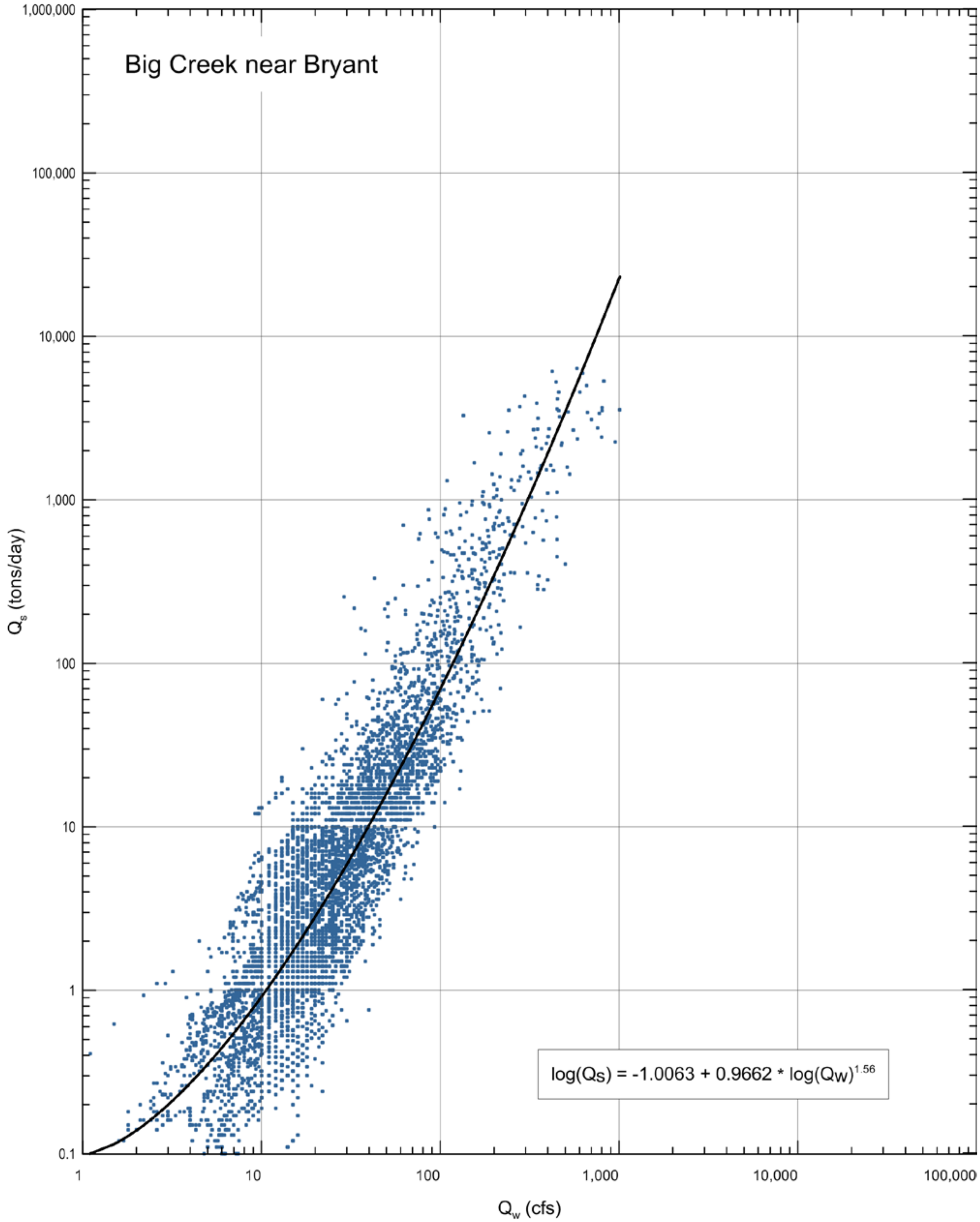

Figure A14. Comparison of multi-year sediment load curve with data for Big Creek near Bryant

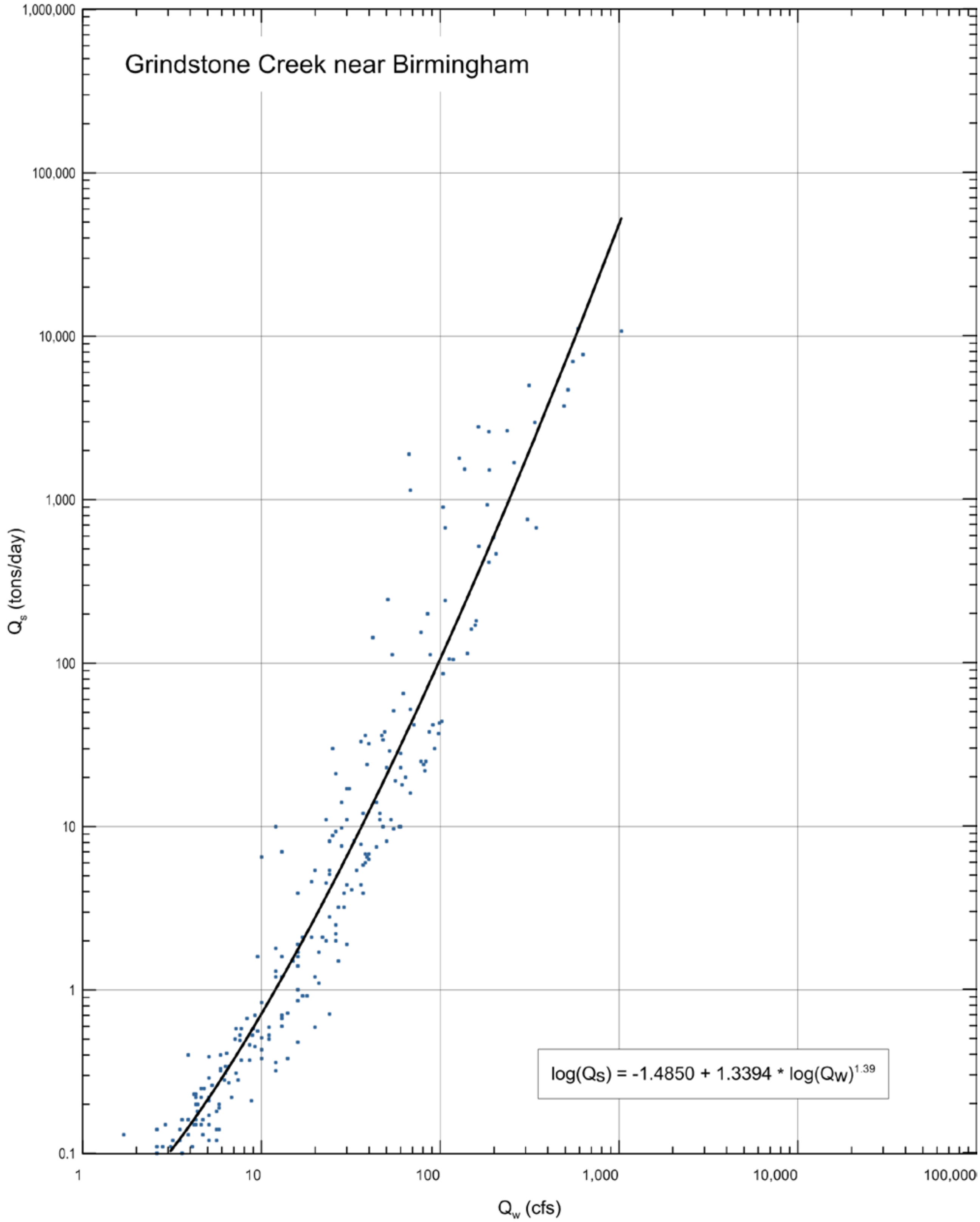

Figure A15. Comparison of multi-year sediment load curve with data
for Grindstone Creek near Birmingham

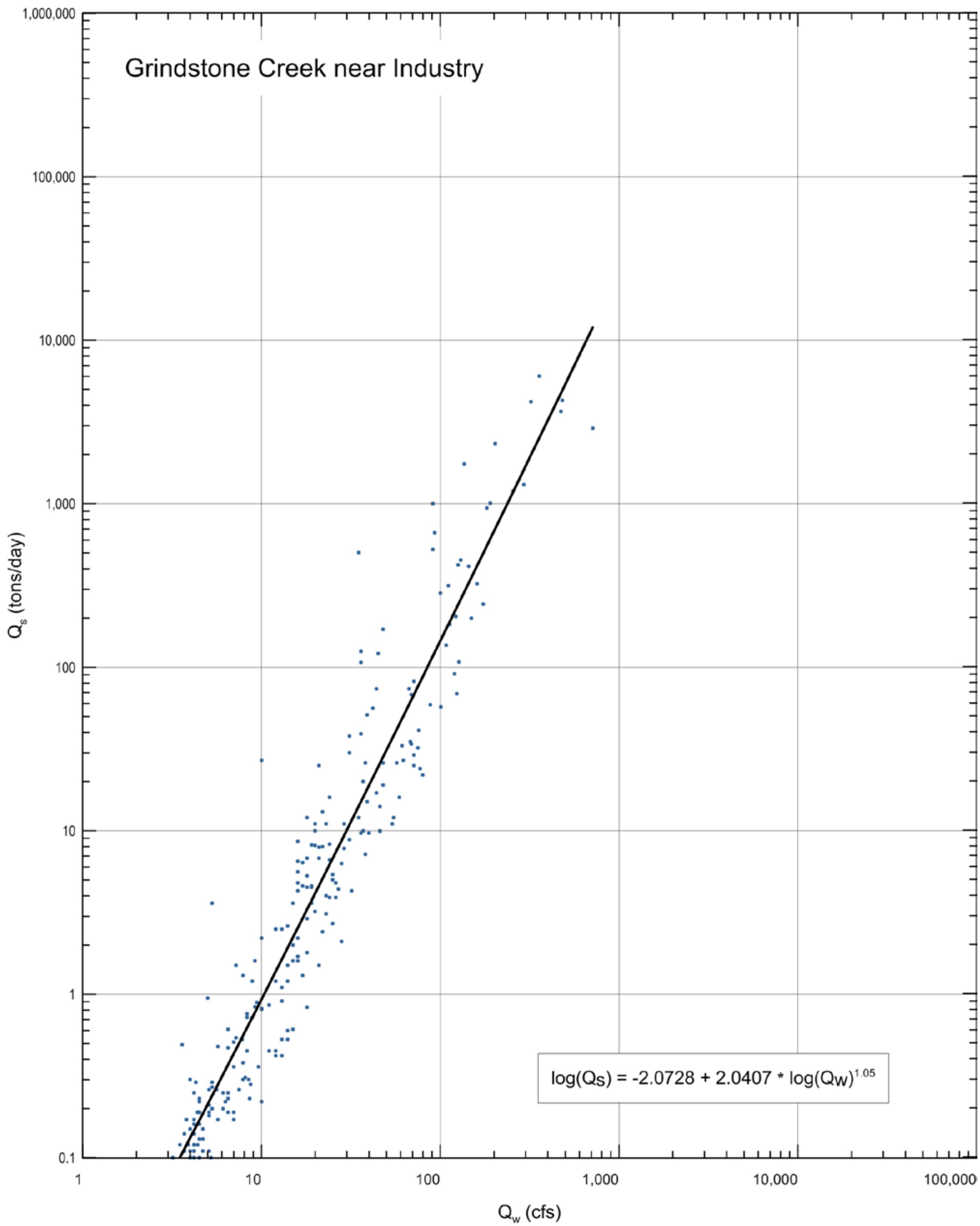

Figure A16. Comparison of multi-year sediment load curve with data
for Grindstone Creek near Industry

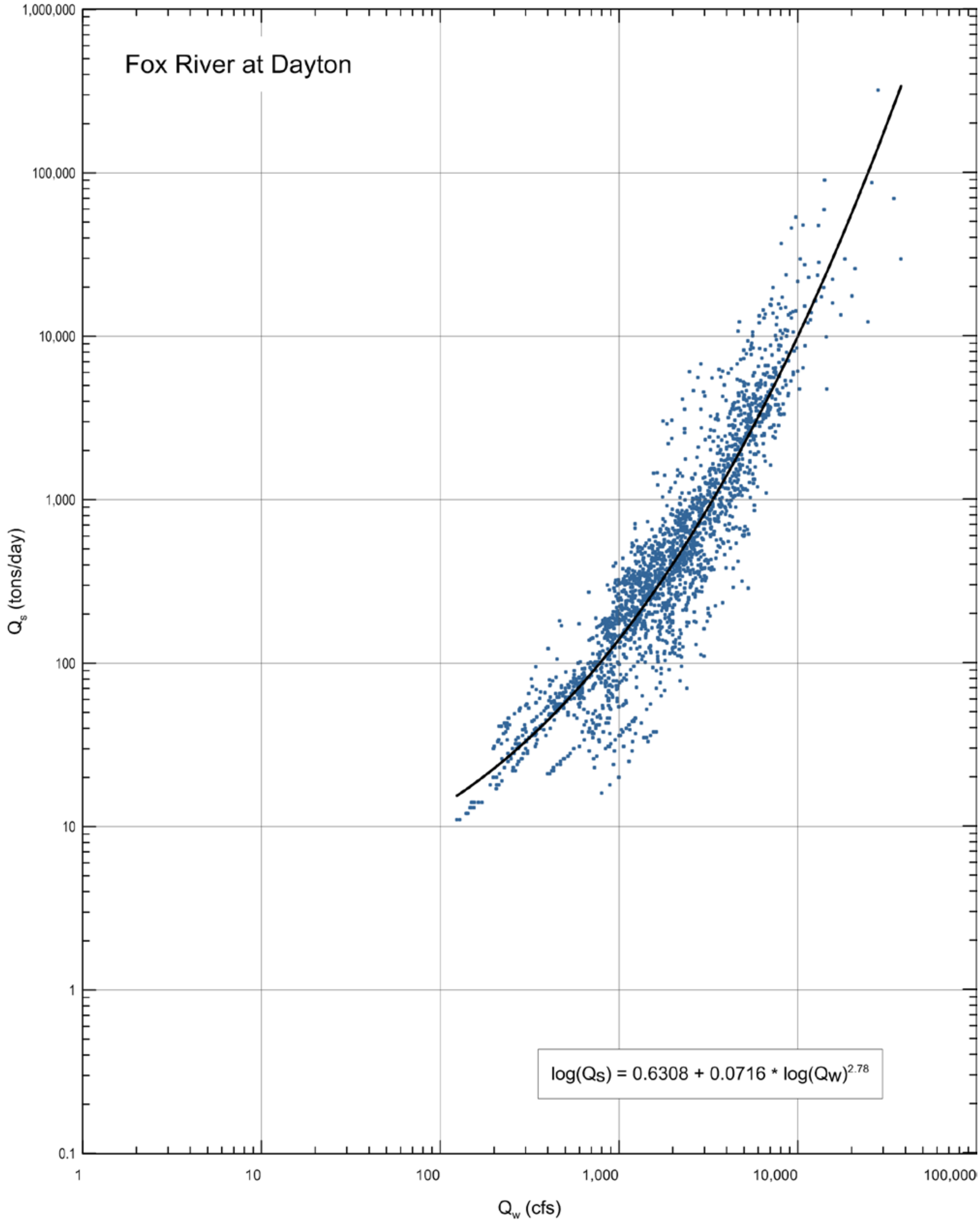

Figure A17. Comparison of multi-year sediment load curve with data for Fox River near Dayton