DATA-COLLECTION METHODS AND DATA SUMMARY FOR VERIFICATION OF A ONE-DIMENSIONAL, UNSTEADY-FLOW MODEL OF THE FOX RIVER IN NORTHEASTERN ILLINOIS, OCTOBER–NOVEMBER 1990

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CONVERSION FACTORS, ABBREVIATED WATER-QUALITY UNITS, AND VERTICAL DATUM

Multiply	By	To obtain
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
square foot (ft^2)	0.09294	square meter
square mile (mi^2)	2.590	square kilometer
cubic foot per second (ft^3/s)	0.02832	cubic meter per second

Temperature in degrees Fahrenheit (°F) can be converted to degrees Celsius (°C) as follows:

$$°C = (5/9) \times (°F - 32)$$

Abbreviated water-quality units used in this report:

micrograms per liter (µg/L)
milliliters (mL)
milliliters per minute (mL/min)

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

Data-Collection Methods and Data Summary for Verification of a One-Dimensional, Unsteady-Flow Model of the Fox River in Northeastern Illinois, October–November 1990

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Abstract

Synoptic-study measurements of unsteady streamflow and dye concentrations were collected on a 49.4-mile reach of the Fox River in southeastern Wisconsin and northeastern Illinois in October and November 1990. The study area included the Fox River and its major tributaries from Wilmot, Wis., downstream to South Elgin, Ill. The measurements were obtained to verify a one-dimensional, unsteady-flow model of the river system.

Unsteady-flow conditions were created through operation of flow-control structures at Stratton Dam near McHenry, Ill. On November 1, 1990, dam gate openings were decreased to 0.1 foot. Openings remained at 0.1 foot until low flow was established throughout the reach. On November 5, the gate openings were increased to 2.5 feet. The change in gate openings created unsteady-flow conditions by allowing flow through the gates to increase from about 60-80 cubic feet per second to about 1,600 cubic feet per second.

During the study period, discharge was computed continuously from stage records with stage-discharge relations at 7 stations on the Fox River and its tributaries; discharge was measured at 15 additional stations in the basin. Stage was recorded continuously at 15 stations in the basin (11 stations on the Fox River and 4 stations on the Fox River tributaries); stage was measured periodically at 8 additional stations on the Fox River.

Fluorescent dye was injected continuously at Stratton Dam from November 2-8, 1990, during the unsteady flow to measure time- and space-integrated characteristics of the velocity flow field. Water samples were collected for fluorometric analysis at 18 sites downstream from the injection.

INTRODUCTION

Unsteady-flow models are a mathematical representation of physical laws affecting streamflow. The models can be applied to particular hydraulic and boundary conditions to simulate streamflow events. The models can simulate a wide range of flow conditions including flood flows, tidal flows, and regulated flows. Calibration and verification of these models using field data are needed to ensure the accuracy of the model results (Schaffranek, 1989). Extensive data sets are vital for calibration and verification of a model. The U.S. Geological Survey (USGS) in cooperation with the Illinois Department of Transportation, Division of Water Resources (DWR), and Du Page County, Department of Environmental Concerns (hereafter referred to as "Du Page County") completed a study in November 1990 to collect the data needed for the model.

This data set was collected to augment hydraulic data and data from USGS long-term continuous-record gaging stations for the Fox River in northeastern

Illinois. The hydraulic data, which includes the geometry of channel cross sections, estimates of Manning's roughness coefficients, and geometry of flow-control structures, were obtained from DWR. The long-term continuous-record stations are run independent of this synoptic study by the USGS and provide streamflow data that would normally be available for the study area.

The data presented in this report can be combined with the hydraulic and long-term continuous-record station data to test the one-dimensional, unsteady-flow model–Full EQuations Hydraulic Routing Model (FEQ) (D.D. Franz, Linsley, Kraeger and Associates; and C.S. Melching, U.S. Geological Survey, written commun., 1992). FEQ is based on a full dynamic wave formulation that accounts for non-uniform, unsteady, and inertia components of flow. This formulation is needed to accurately describe flow in low-gradient channels, flow into large reservoirs, highly unsteady dam-break flood waves, or reversing flows (Viessman and others, 1989, p. 253).

The Fox River in northeastern Illinois was chosen for a synoptic data collection because of the available hydraulic and continuous-record station data and the ability to control flow by operation of the sluice gates at Stratton Dam. Gate openings were decreased to 0.1 ft for November 1-4, 1990, to establish low flow throughout the study reach. Gate openings were increased to 2.5 ft on November 5. This rapid increase in gate openings caused an unsteady-flow transition to high-flow conditions.

Detailed data were collected on the Fox River and its tributaries during this unstable period and are presented in this report. Recorded streamflow data are provided on the diskette accompanying this report. The data from the event can be compared to flow-model simulations of the event to verify the accuracy of the application of FEQ to the Fox River.

Purpose and Scope

The purpose of this report is to document the data collected for the Fox River in northeastern Illinois during a synoptic study from October 31 through November 10, 1990. This report describes the study area, the methods for selecting sites for data collection, and the methods for collecting data. The report also serves to describe, summarize, and archive the synoptic data used for the verification of a one-dimensional, unsteady-flow model. The data are especially useful for verifying hysteresis in the stage-discharge relation, reverse flow, and flow through control structures as modeled by a one-dimensional, unsteady-flow model.

Description of the Study Area

The headwaters of the Fox River lie about 15 mi northwest of Milwaukee in Waukesha County, Wis. From its source, the river flows south to the Illinois-Wisconsin border and then south through the Chain O' Lakes. Just south of Aurora, Ill., the Fox River flows southwesterly and drains into the Illinois River near Ottawa, Ill. (Leighton and others, 1948). The Fox River drains approximately 2,658 mi^2 and is a major tributary to the Illinois River (fig. 1).

The total length of the Fox River is 185 mi with the reach of the Fox River studied beginning downstream from the dam at Wilmot, Wis., at river mile 114.8, and ending 49.4 mi downstream at river mile 67.2 in South Elgin, Ill. (Healy, 1979, p. 181-206).

The total fall of the river-bed elevation from source to mouth is 470 ft (U.S. Army Corps of Engineers, 1976, p. 2-8). The fall in the study reach is approximately 45 ft. The majority of the fall in the reach, approximately 30 ft, is in the 14.4-mi reach from Algonquin to South Elgin (fig. 2).

In the upper region of the basin, above the Chain O' Lakes, the Fox River is a slow, shallow, winding stream. Its width ranges from 50 to 200 ft with well defined banks. From the lakes to Algonquin, the river channel is poorly defined with low banks and wide flood plains. From Algonquin to South Elgin and downstream to Ottawa, the channel becomes straighter and the current more swift. The average width of the river varies from 300 to 400 ft in this reach (Leighton and others, 1948).

At Fox River at Algonquin, the annual mean flow for the 1991 water year was 1,038 ft^3/s. The November mean flow for water years 1916-91 is 775 ft^3/s (Richards and others, 1992, p. 247).

Climate in the study area is humid continental, with warm to hot summers and cold winters. The mean annual temperature in the basin is 50°F. Mean monthly temperatures vary from a minimum temperature of 25°F in January to a maximum of 75°F in July. Mean annual precipitation is approximately 35 in. (Wendland and others, 1992).

Streamflow for the study period was regulated through DWR operations of Stratton Dam, located at river mile 97.8 at gaging station Fox River near

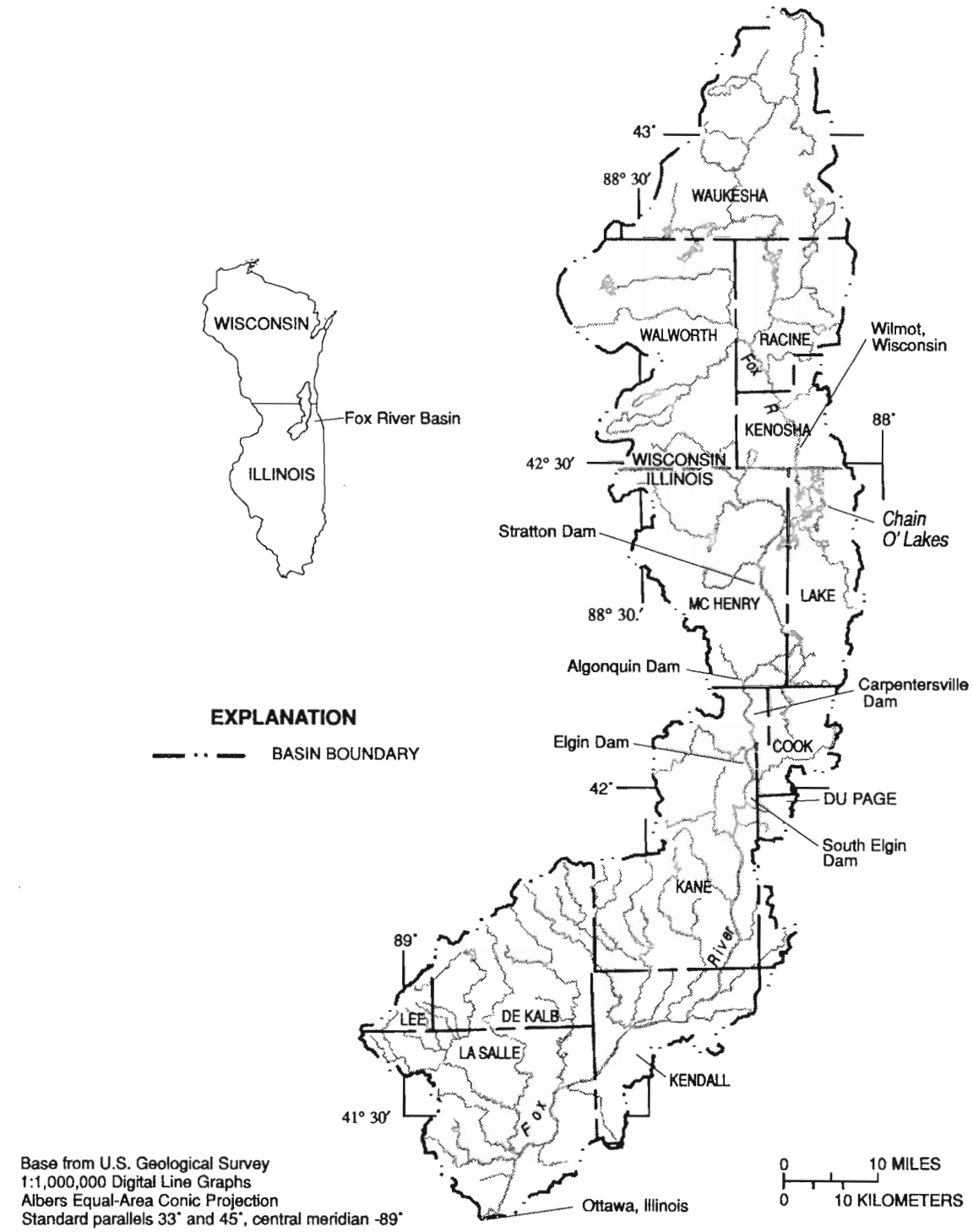

Figure 1. Fox River Basin in northeastern Illinois and southeastern Wisconsin.

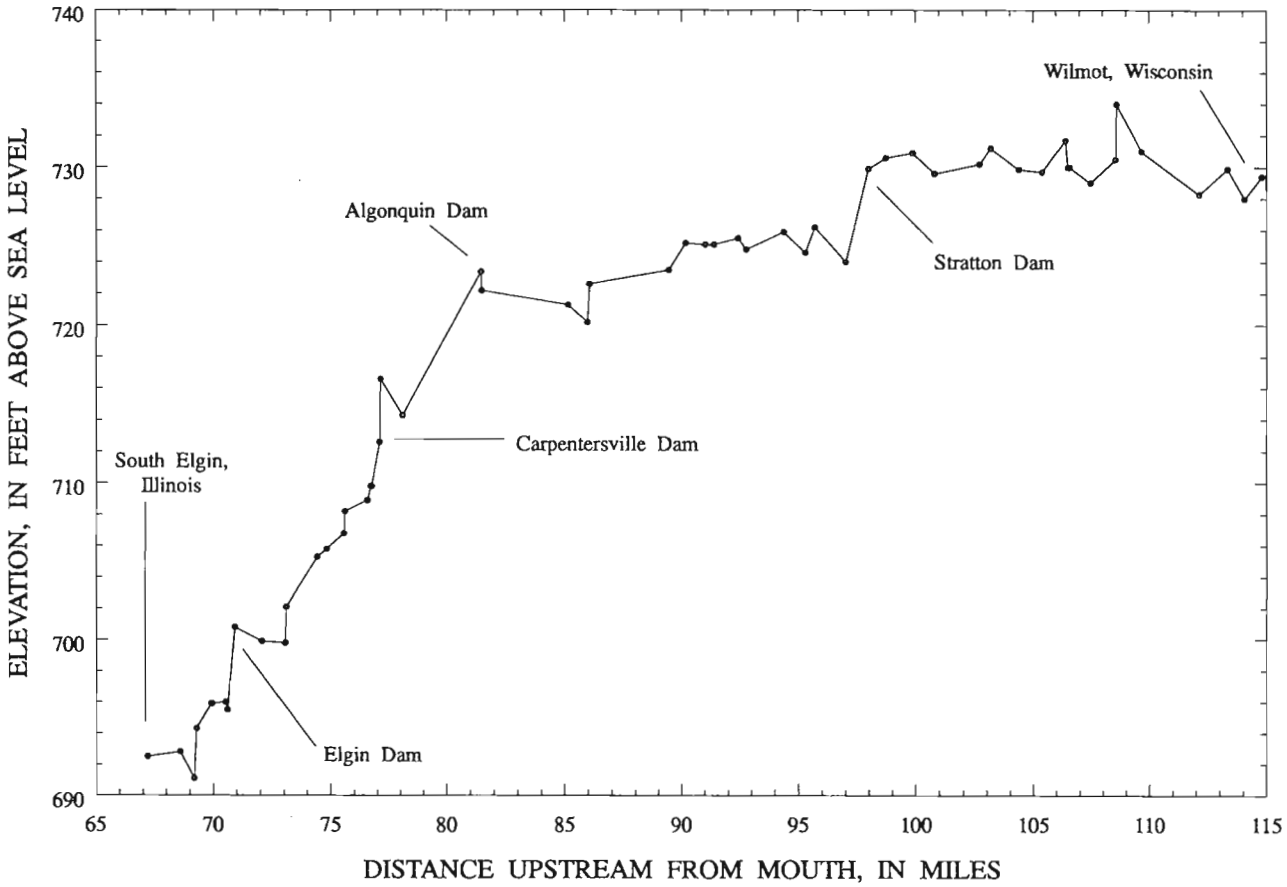

Figure 2. Bed-elevation profile for the Fox River from Wilmot, Wis., to South Elgin, Ill.

McHenry (fig. 1). The control structures at the dam consist of a navigation lock, five sluice gates, a fish ladder, and a spillway (fig. 3).

Each sluice gate is 13.75 ft wide and can be raised to create a maximum gate opening of 9.0 ft. The design of the gates allows flow under the gate. Flow does not go over the top of the gates (fig. 4). The sill on which the closed gates rest is at an elevation of 731.15 ft above sea level. From April through October, the gates are set to maintain a headwater-pool stage of 4.00 ft (737.0 ft above sea level). During November of each year, the sluice gates are gradually adjusted to lower the headwater-pool stage to 2.5 ft (735.5 ft above sea level). This lower headwater-pool stage allows storage for flood control during spring runoff (Fisk, 1988). During low flows, discharge measurements are made by wading downstream from the gates. During medium and high flows, boat discharge measurements are made upstream from the gates (fig. 3).

Acknowledgments

Personnel from DWR and Du Page County assisted with field reconnaissance and data collection. The Stratton Dam Lockmaster, Frank Novak, Jr., adjusted gate openings to produce the desired flow regimes. Their cooperation on this study is gratefully acknowledged.

DATA-COLLECTION DESIGN

An integrated design for the control of the gates at Stratton Dam, injection of the dye, and collection of all data were based on preliminary simulation of the Fox River using the FEQ model coupled with the Branched Lagrangian Transport Model (BLTM) (Jobson and Schoellhamer, 1987). The proposed release schedule for the dam was simulated with a partially calibrated FEQ model of the Fox River to estimate the timing of the low-flow recession, the time

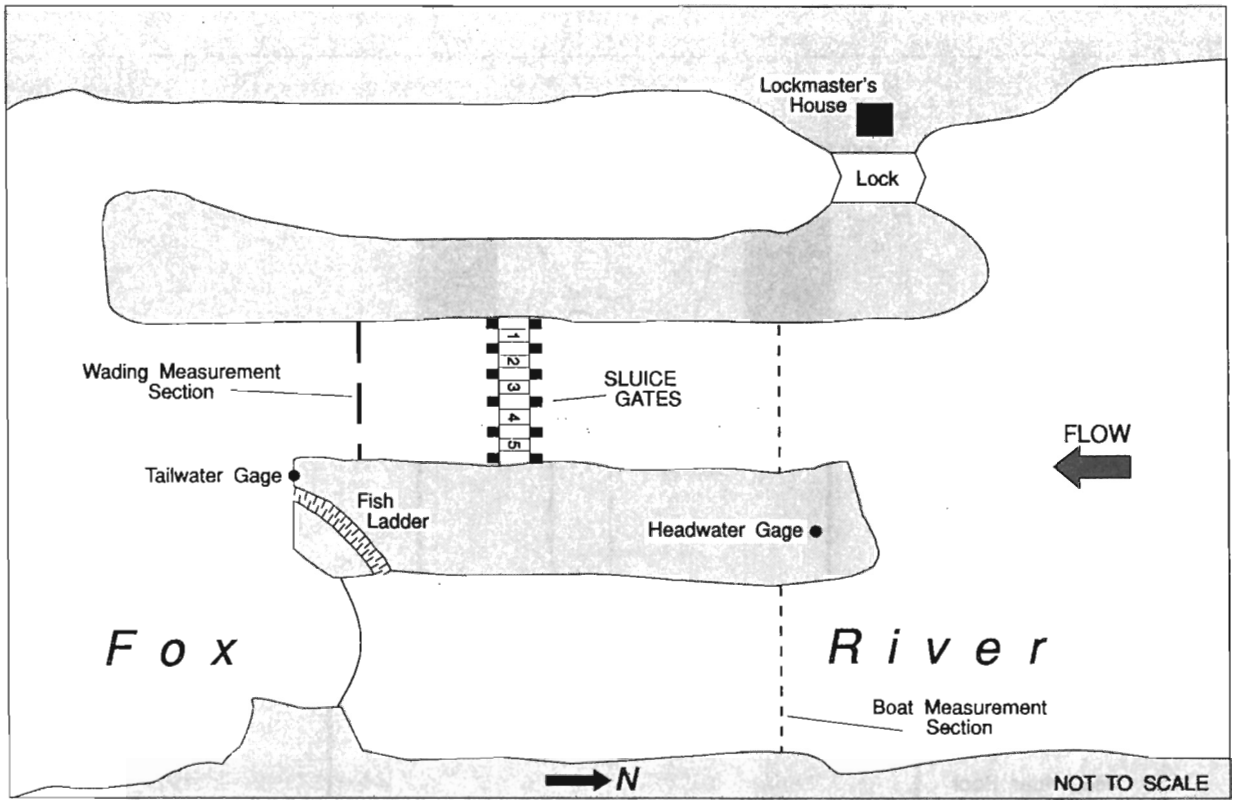

Figure 3. Locations of control structures at Stratton Dam at Fox River near McHenry, Ill. (from Fisk, 1988, p. 4).

for steady-state low flow to be established in the study reach, and the time for the high-flow wave to reach various locations. Transport modeling was used to indicate the amount of dye needed and the rate of dye injection at Stratton Dam for detectable concentrations at downstream sites and a maximum concentration of 10 µg/L at the intakes to the Elgin water-treatment facility (Kilpatrick and Wilson, 1989).

The simulated wave generated at Stratton Dam was analyzed to identify locations of reverse flow and hysteresis of the stage-discharge relation throughout the study reach. From the preliminary model simulation, a tentative schedule for the location and timing of measurements and samples during the synoptic study could be prepared. Based on the preliminary simulations, continuous-record stage gages were installed at four sites in the study reach. These stations, referred to as study stations, were Fox River near Cary, Fox River at Huntley Road at Carpentersville, a tailwater gage at Fox River at Algonquin, and a headwater and tailwater gage at the dam at Fox River at Lawrence Avenue at Elgin. The synoptic data from these stations can be used to assess the model analysis of hysteresis in the stage-discharge relation, backwater, and flow through control structures.

Detailed data were collected on the Fox River and its tributaries during this unsteady-flow period to allow for the evaluation of the FEQ analysis of unsteady flow, especially hysteresis in the stage-discharge relation, reverse flow, and flow through complex structures. Streamflow and dye data to describe the unsteady flow were collected at 36 sites in the study reach (table 1, fig. 5). Discharge measurements were made at several sites on the Fox River and its tributaries. Stage measurements, made manually or recorded continuously, were taken at several additional sites on the Fox River. Dye samples also were collected at various sites on the Fox River.

DATA-COLLLECTION METHODS AND DATA SUMMARY

Operations at Stratton Dam are primarily intended to enhance recreational opportunities and mitigate flood events on the Fox River. During this study, operations were modified to create flow conditions to

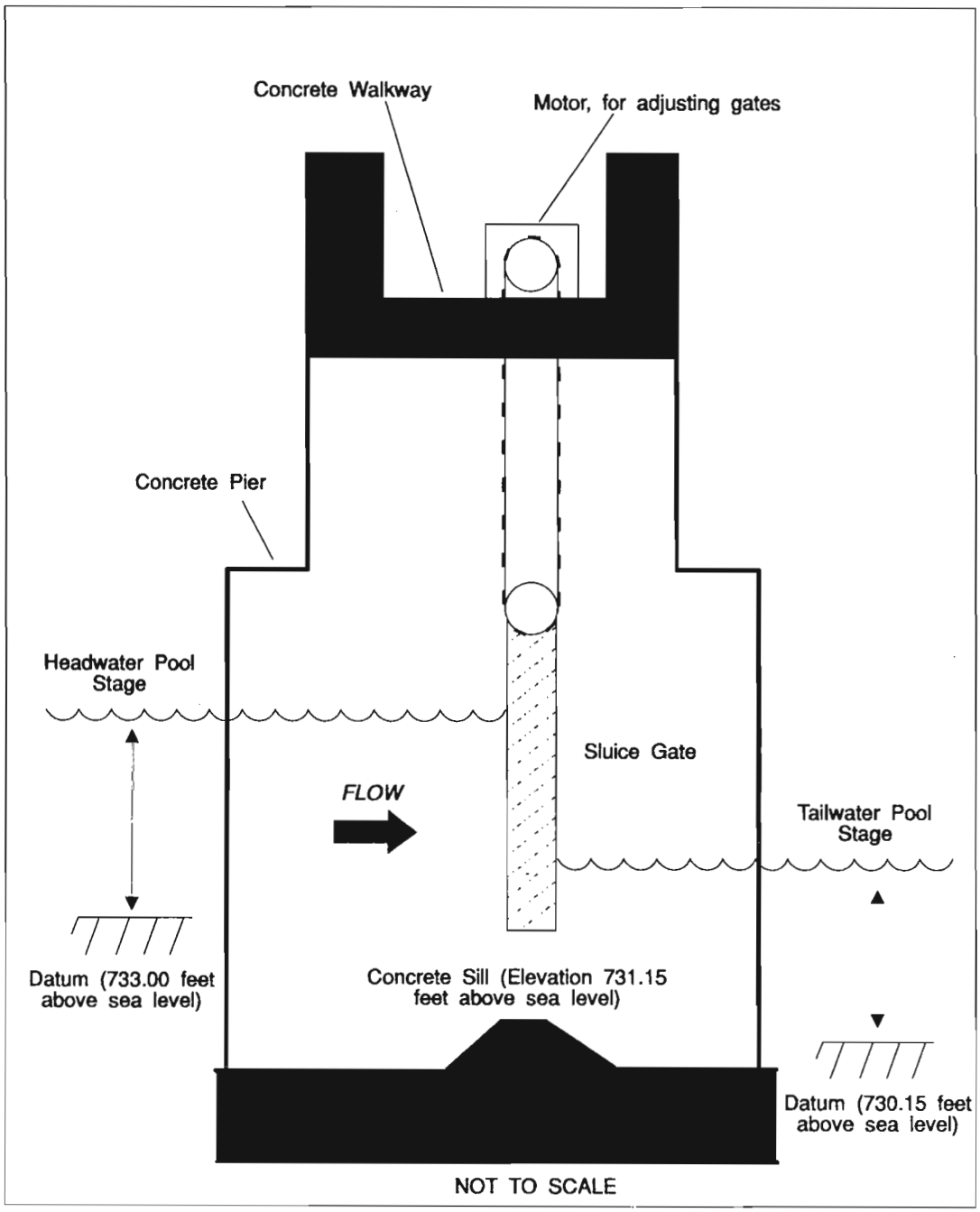

Figure 4. Cross section of sluice gate at Sratton Dam at Fox River near McHenry, Ill. (from Fisk, 1988, p. 7).

Table 1. Streamflow and dye data-collection sites for the Fox River, October-November 1990

[Map numbers refer to those in figure 5; --, not available]

Datum:

HW, Headwater datum; TW, Tailwater datum

Type and frequency of data collected:

CS, Continuous stage; PS - Periodic stage; CQM, Continuous discharge; PQM, Periodic discharge measurements; DYE, Dye sampling

Type of gage or sampling method:

SW, Stilling well sensor with electronic data logger; TD, Tape down from a known elevation; STF, Reading from a staff gage; QM, Current-meter discharge measurement; RAT, Rated discharge computed from stage-discharge relation; APS, Automatic pumping sampler; DB, Dye boat sampler; Grab, Grab samples

Map number	Station number	River mile above mouth	Station name and location	Datum (feet above sea level)	Type and frequency of data collected	Type of gage or sampling method
1	05546500	116.6	Fox River at Wilmot, Wis. Lat: 42°30′40″ Long: 88°10′45″	735.22	CS, CQM	SW, RAT
2	05547000	113.6	Channel Lake near Antioch, Ill. Lat: 42°28′20″ Long: 88°08′50″	733.00	CS	SW
3	05547500	108.0	Fox Lake near Lake Villa, Ill. Lat: 42°25′10″ Long: 88°07′35″	733.00	CS	SW
4	05547755	[1]107.5	Squaw Creek at Round Lake, Ill. Lat: 42°21′00″ Long: 88°05′13″	764.94	CS, CQM	SW, RAT
5	05548000	106.4	Nippersink Lake at Fox Lake, Ill. Lat: 42°24′10″ Long: 88°10′55″	733.00	CS	SW
6	05548280	[1]106.3	Nippersink Creek near Spring Grove, Ill. Lat: 42°26′37″ Long: 88°14′51″	746.00	CS, CQM	SW, RAT
7	05548500	103.0	Fox River at Johnsburg, Ill. Lat: 42°22′35″ Long: 88°14′15″	733.00	CS, PQM	SW, QM
8	05548528	[1]102.5	Dutch Creek at McCullom Lake, Ill. Lat: 42°22′19″ Long: 88°16′09″	--	PQM	QM
9	05549100	[1]100.3	Boone Creek at McHenry, Ill. Lat: 42°20′45″ Long: 88°16′48″	--	PQM	QM
10	05549500	97.8	Fox River near McHenry, Ill. Lat: 42°18′35″ Long: 88°15′05″	HW 733.00 TW 730.15	CS, PQM, DYE CS	SW, QM, GRAB SW
11	--	96.9	Fox River at Ferndale, Ill. Lat: 42°17′58″ Long: 88°14′34″	--	DYE	GRAB
12	--	96.6	Fox River at Holiday Hills, Ill. Lat: 42°17′43″ Long: 88°14′15″	--	DYE	GRAB
13	05549600	95.1	Fox River at Burtons Bridge, Ill. Lat: 42°16′44″ Long: 88°13′31″	[2]733.12	PS, PQM, DYE	TD, QM, APS
14	--	93.5	Fox River at river mile 93.5 at Burtons Bridge, Ill. Lat: 42°15′42″ Long: 88°13′05″	--	DYE	DB
15	--	92.8	Fox River at Fox River Valley Gardens, Ill. Lat: 42°15′00″ Long: 88°12′37″	[2]733.96	PS, PQM, DYE	TD, QM, GRAB
16	05549800	92.4	Fox River near Cary, Ill. Lat: 42°14′34″ Long: 88°12′48″	721.21	CS	SW
17	05549802	[1]92.4	Fox River Tributary at Rawson Bridge, Ill. Lat: 42°14′26″ Long: 88°13′05″	--	PQM	QM
18	05549815	89.5	Fox River at river mile 89.5 above Fox River Grove, Ill. Lat: 42°13′18″ Long: 88°10′37″	--	DYE	DB
19	05549850	[1]89.4	Flint Creek near Fox River Grove, Ill. Lat: 42°12′40″ Long: 88°10′23″	738.00	CS, CQM	SW, RAT
20	05549865	86.0	Fox River at Fox River Grove, Ill. Lat: 42°12′04″ Long: 88°13′30″	[2]752.63	PQM, DYE	QM, APS

Table 1. Streamflow and dye data-collection sites for the Fox River, October-November 1990—Continued

Map number	Station number	River mile above mouth	Station name and location	Datum (feet above sea level)	Type and frequency of data collected	Type of gage or sampling method
21	05549890	[1]85.3	Spring Creek at Fox River Grove, Ill. Lat: 42°11′14″ Long: 88°13′40″	--	PQM	QM
22	--	84.0	Fox River at Haegers Bend, Ill. Lat: 42°11′24″ Long: 88°15′44″	--	DYE	GRAB
23	05550000	81.6	Fox River at Algonquin, Ill. Lat: 42°09′59″ Long: 88°17′25″	HW 729.48 TW 721.98	CS, CQM, DYE CS	SW, RAT, GRAB SW
24	05550065	[1]81.6	Crystal Creek at Algonquin, Ill. Lat: 42°09′58″ Long: 88°17′30″	--	PQM	QM
25	05550070	77.2	Fox River at Carpentersville, Ill. Lat: 42°06′53″ Long: 88°17′33″	--	PQM, DYE	QM, GRAB
26	05550080	76.9	Fox River at Chicago NorthWestern Railroad Bridge at Carpentersville, Ill. Lat: 42°06′37″ Long: 88°17′26″	[2]723.39	PS	TD
27	05550090	76.7	Fox River at Huntley Road at Carpentersville, Ill. Lat: 42°06′30″ Long: 88°17′22″	700.00	CS, PQM, DYE	SW, QM, GRAB
28	05550100	76.1	Fox River at East Dundee, Ill. Lat: 42°06′07″ Long: 88°16′52″	[2]712.98	PS, DYE	TD, GRAB
29	05550120	75.2	Fox River at West Dundee, Ill. Lat: 42°05′16″ Long: 88°16′35″	700.07	PS, DYE	STF, GRAB
30	05550130	[1]74.6	Jelkes Creek at West Dundee, Ill. Lat: 42°04′56″ Long: 88°17′22″	--	PQM	QM
31	05550150	73.2	Fox River at I-90 at Elgin, Ill. Lat: 42°03′59″ Long: 88°16′17″	[2]729.11	PS, DYE	TD, GRAB
32	05550307	[1]72.2	Tyler Creek at State Route 31 at Elgin, Ill. Lat: 42°03′43″ Long: 88°17′33″	--	PQM	QM
33	05550310	71.0	Fox River at Lawrence Avenue at Elgin, Ill. Lat: 42°02′30″ Long: 88°17′22″	HW695.95 TW689.36	CS, PQM, DYE CS, PS	SW, QM, GRAB SW, STF
34	05550320	70.1	Fox River at Elgin, Ill. Lat: 42°01′47″ Long: 88°16′45″	[2]720.05	PS, DYE	TD, GRAB
35	05550500	[1]68.8	Poplar Creek at Elgin, Ill. Lat: 42°01′35″ Long: 88°15′20″	716.00	CS, CQM	SW, RAT
36	05551000	67.2	Fox River at South Elgin, Ill. Lat: 41°59′46″ Long: 88°17′43″	687.95	CS, CQM, DYE	SW, RAT, GRAB

[1]River miles indicate the location of the mouth of the tributary above the mouth of the Fox River.

[2]Elevation given is reference point elevation used for tape downs to water surface.

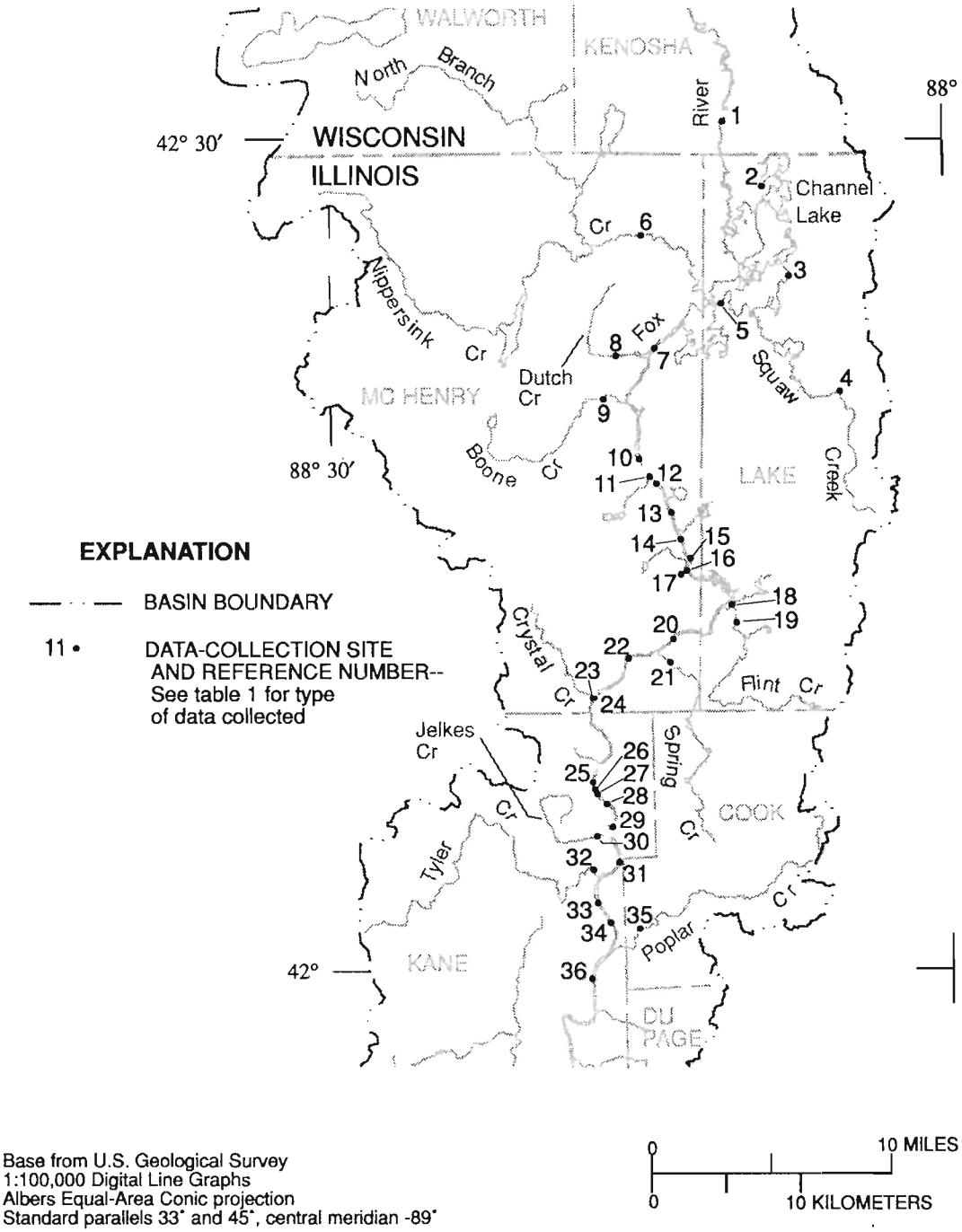

Figure 5. Locations of the streamflow and dye data-collection sites and tributary streams in the Fox River Basin.

test an unsteady-flow model yet minimize any adverse effect on area residents and boaters. Thus, Stratton Dam gate openings were decreased in the fall drawdown when low water levels are expected. The normally low levels also meant that when greater flows were allowed through the gates, flow remained within the banks of the river.

On November 1 at 1055 hours, the gate openings at Stratton Dam were decreased to 0.1 ft to reduce the flow through the gates to about 60-80 ft^3/s. A semi-constant rate dye injection began at 1432 hours on November 2, during the low-flow period, and continued through the high-flow period until 1400 hours on November 8. On November 5 at 1350 hours, after the low flow became established throughout the reach, the gate openings were increased to 2.5 ft. Increasing the openings created a peak flow of about 1,600 ft^3/s through the gates. Continuous stage and the flow measurements at Stratton Dam at Fox River near McHenry for the study period are shown in figure 6.

Detailed streamflow data were collected on the Fox River and its tributaries during the study in order to thoroughly describe flow characteristics. On October 31, 1990, crews began making discharge measurements on the Fox River and its tributaries. Streamflow was measured at nine stations on the Fox River and at seven stations on its tributaries. Intensive discharge measurements were made at Fox River at Johnsburg (map number 7) and Fox River near Cary (map number 16) where preliminary modeling indicated reverse flow or hysteresis of the stage-discharge relation. Data collected at these stations can be used to verify an unsteady-flow model analysis of reverse flow or hysteresis of the stage-discharge relation. At Fox River at Huntley Road at Carpentersville (map number 27), the detailed streamflow measurements can verify the unique stage-discharge relation developed in unsteady-flow model simulation.

Streamflow

Stage data were collected at 12 stream- and 3 lake-gaging stations in the Fox River Basin. Nine of

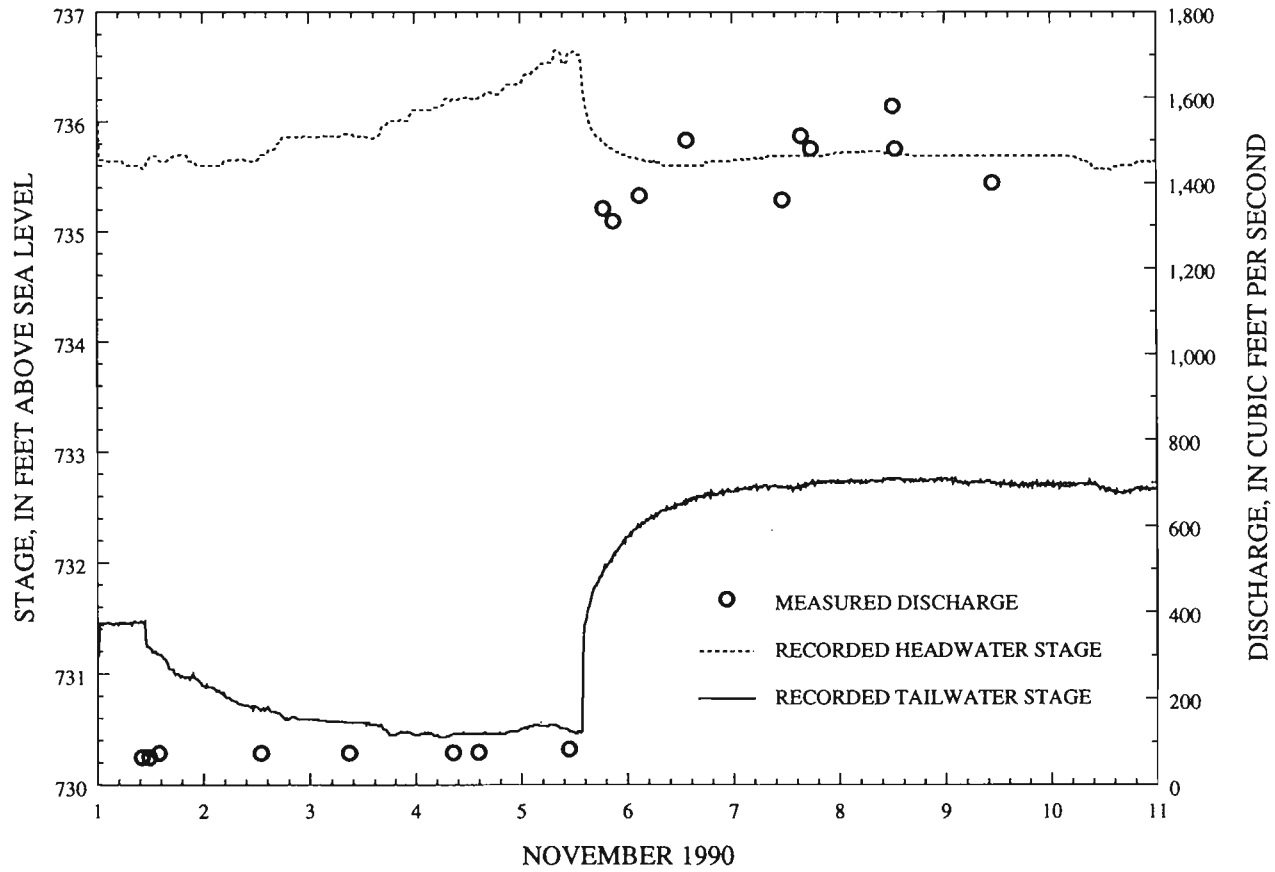

Figure 6. Measured discharge and recorded headwater and tailwater stages at Fox River near McHenry, Ill.

the stream-gaging stations are long-term continuous-record stations and three are study stations, with an additional study station tailwater gage at Fox River at Algonquin (map number 23). At the stream-gaging stations, stage measurements were obtained at 15-minute intervals; at lake-gaging stations, stage measurements were obtained at 1-hour intervals using automated sensors and recorders. Seven of the twelve stream-gaging stations have a rated stage-discharge relation. Crews made measurements of discharge using current meters at the three study stations periodically throughout the study. Recorded stage and discharge at all gaging stations for the study period are on the diskette accompanying this report.

Several other stations on the Fox River (table 3) and its tributaries (table 4) were measured periodically for discharge. Tape downs from reference points of known elevations and staff-gage readings were made for calculation of stage at eight additional stations as often as feasible (table 5) (tables at end of report).

Preliminary modeling indicated that reverse flow would occur at Fox River at Johnsburg (map number 7) just after the gate openings at Stratton Dam were decreased on November 1, 1990. Two crews made eight discharge measurements during a 5-hour period before, during, and after the gate openings were decreased to 0.1 ft in order to measure the reverse flow. The reduced and bidirectional flow velocities over a large cross-sectional area during the low-flow period were not favorable for measuring the flow using conventional current meters. Current meters were used, however, in an effort to obtain a minimal description of the flow. Discharge measurements and 15-minute interval stage data for Fox River at Johnsburg are shown in figure 7.

Preliminary model simulations indicated hysteresis in the stage-discharge relation at Fox River near Cary (map number 16). Crews made intensive discharge and stage measurements just upstream from this site at Fox River at Fox River Valley Gardens (map number 15) during the periods of varying flow in order to obtain a detailed description of the flow during the rising and falling limbs of the stage hydrograph. A series of 34 flow measurements were made at Fox River at Fox River Valley Gardens during the synoptic period (table 3). Again, the measurement conditions were poor. The discharge measurements and corresponding measured stages are shown consecutively in figure 8.

Twenty-three discharge measurements were made at Fox River at Huntley Road at Carpentersville (map number 27), where preliminary model simulations indicated a unique stage-discharge relation, during the synoptic study and are shown with recorded stage in figure 9. The measurements are shown consecutively, as were the measurements at Fox River at Fox River Valley Gardens (map number 15), in order to illustrate the unique stage-discharge relation despite unsteady flow.

The downstream boundary of the study reach is Fox River at South Elgin (map number 36). The recorded headwater and tailwater stages and rated discharge are shown in figure 10.

Dye-Injection Test

A dye study using a semiconstant-rate dye injection was combined with the unsteady-streamflow analysis to determine time- and space-integrated velocity flow fields and time of travel and travel transport rate of waterborne solutes in the study reach. An environmentally safe fluorescent dye, rhodamine WT20, was injected from two points at Stratton Dam. An initial slug of the dye, consisting of dye container rinse of unknown volume and concentration, was injected at Stratton Dam on November 2 at 1432 hours. The slug injection served only as an initial indicator of dye passage. The slug injection was immediately followed by a fairly constant-rate injection at the second and fourth sluice gates of the dam, to be continued throughout the study and ended with a final slug injection, again container rinse.

The dye, in a 20-percent solution (2×10^8 µg/L), was mixed with distilled water to make an injection solution with a concentration of 9.386×10^7 µg/L, determined using fluorometric laboratory techniques (Wilson and others, 1986). Two battery-operated, constant-rate, positive-displacement pumps withdrew dye at a combined rate of about 30 mL/min from the tank for injection to the stream. During periods when one of the pumps malfunctioned, the other pump rate was increased to keep the injection rate as constant as possible. Injection rate was measured volumetrically by noting the volume in the dye tank from which the pumps drew. The flow from each pump was also measured periodically by collecting the flow in a graduated cylinder over a 10-minute period. On November 6 at 0852 hours, both pumps were found stopped. An injection stop time was estimated based

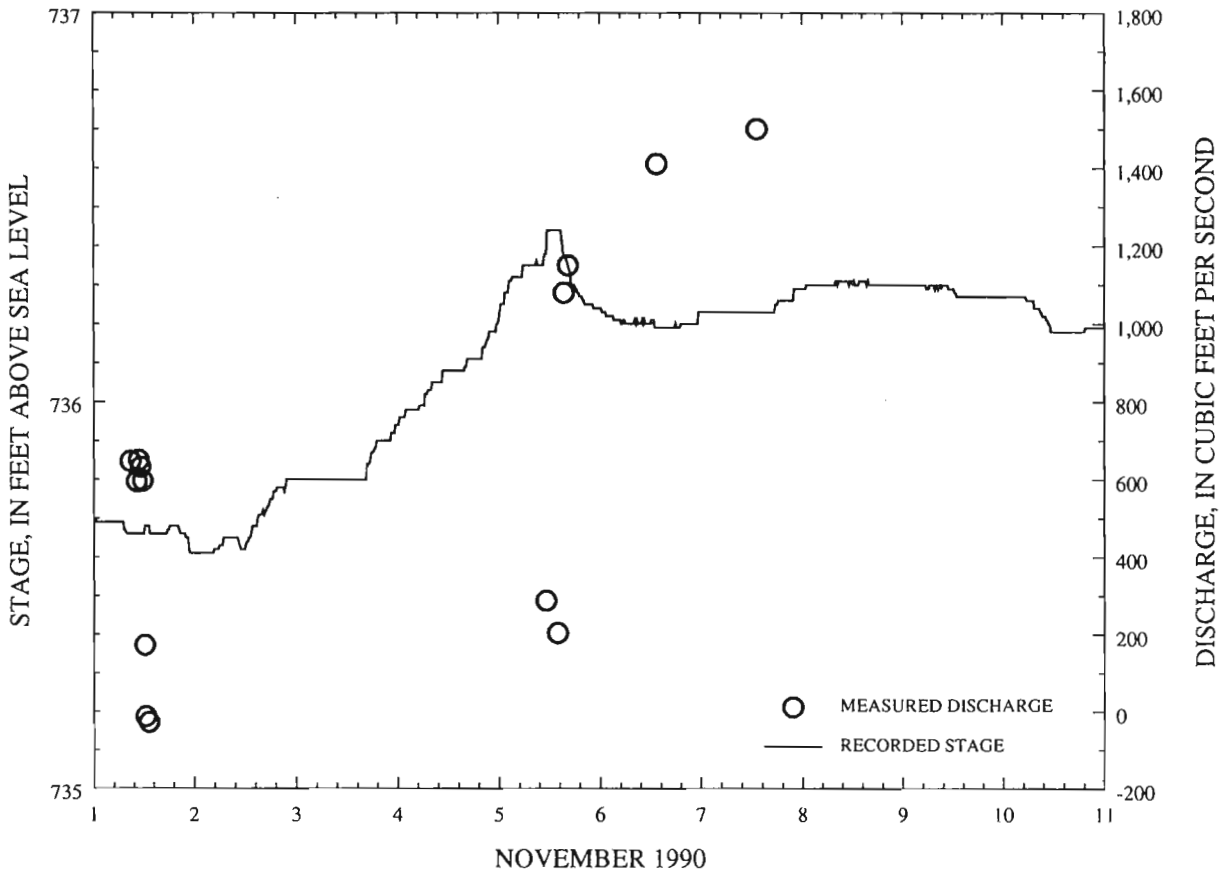

Figure 7. Measured discharge and recorded stage at Fox River at Johnsburg, Ill. (negative discharge indicates flow upstream).

on the last measured injection rate and the volume of dye remaining in the tank.

On November 4 at 1540 hours, more dye and distilled water were added to the tank resulting in a solution with a laboratory-determined concentration of 9.497×10^7 µg/L. On November 6, dye was added forming a solution with a concentration of 1.621×10^8 µg/L. The injection rates and concentrations for the synoptic period are in table 2.

Collection of water samples at 18 sites downstream from the dye injection, for concentration determination by fluorescence, generally began just before the initial dye injection and continued through November 10. The methods of collection used were grab sampling and two types of automated sampling.

Grab samples were collected by dipping a 40-mL glass sample bottle into the flow near the water surface. Where feasible, samples were collected at several points in a cross section. Collection across the cross section helped determine if mixing of the dye was complete. Grab samples were collected at 14

Table 2. Dye-injection time-series data for the Fox River, October-November 1990

[µg/L, micrograms per liter; mL/min, milliliters per minute; --, not available]

Date	Time (hours)	Concentration (µg/L)	Dye injection rate (mL/min)
11/02/90	1432	--	Slug injection
	1725	9.386×10^7	35
	2332	9.386×10^7	31
11/03/90	1105	9.386×10^7	31
	1535	9.386×10^7	31
	2343	9.386×10^7	28
11/04/90	0830	9.386×10^7	29
	1540	9.497×10^7	29
	2308	9.497×10^7	28
11/05/90	0732	9.497×10^7	30
	1608	9.497×10^7	31
	1824	9.497×10^7	0
11/06/90	0900	9.497×10^7	32
	1305	9.497×10^7	23
	1410	9.497×10^7	23
	1901	1.621×10^8	30
11/07/90	0854	1.621×10^8	32
	1737	1.621×10^8	31
	2344	1.621×10^8	32
11/08/90	1400	--	Slug injection

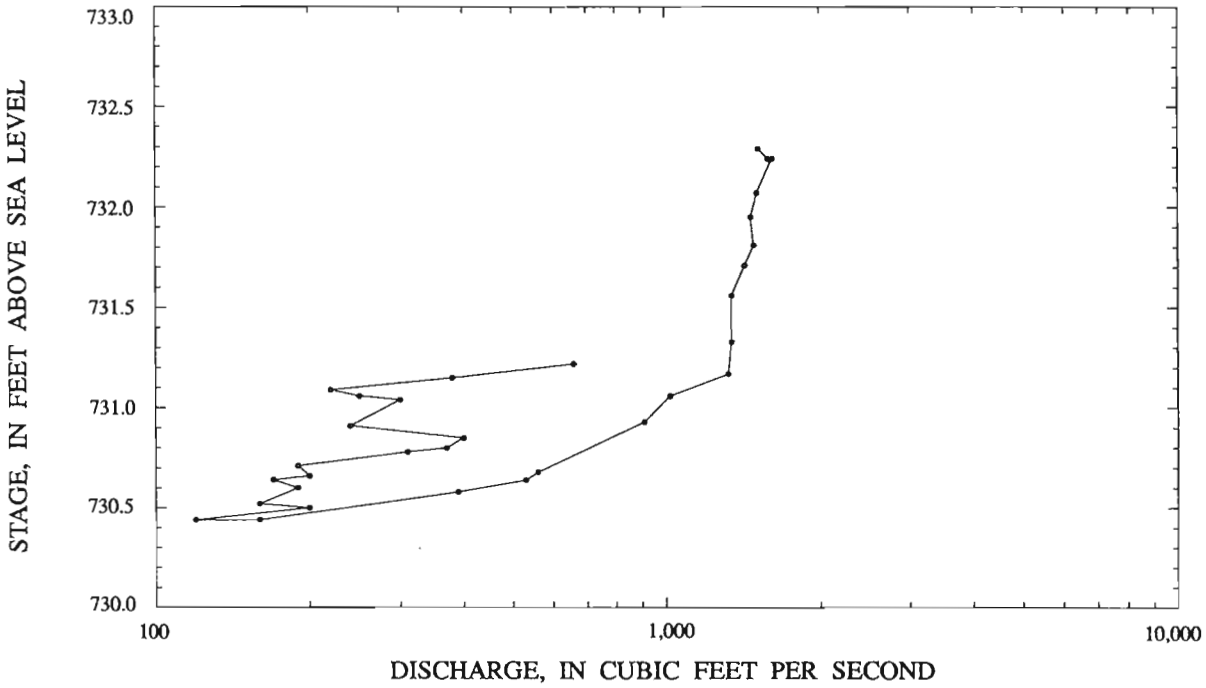

Figure 8. Measured stage-discharge relation at Fox River at Fox River Valley Gardens, Ill. (consecutive measurements are joined by line segments to illustrate the hysteresis effect).

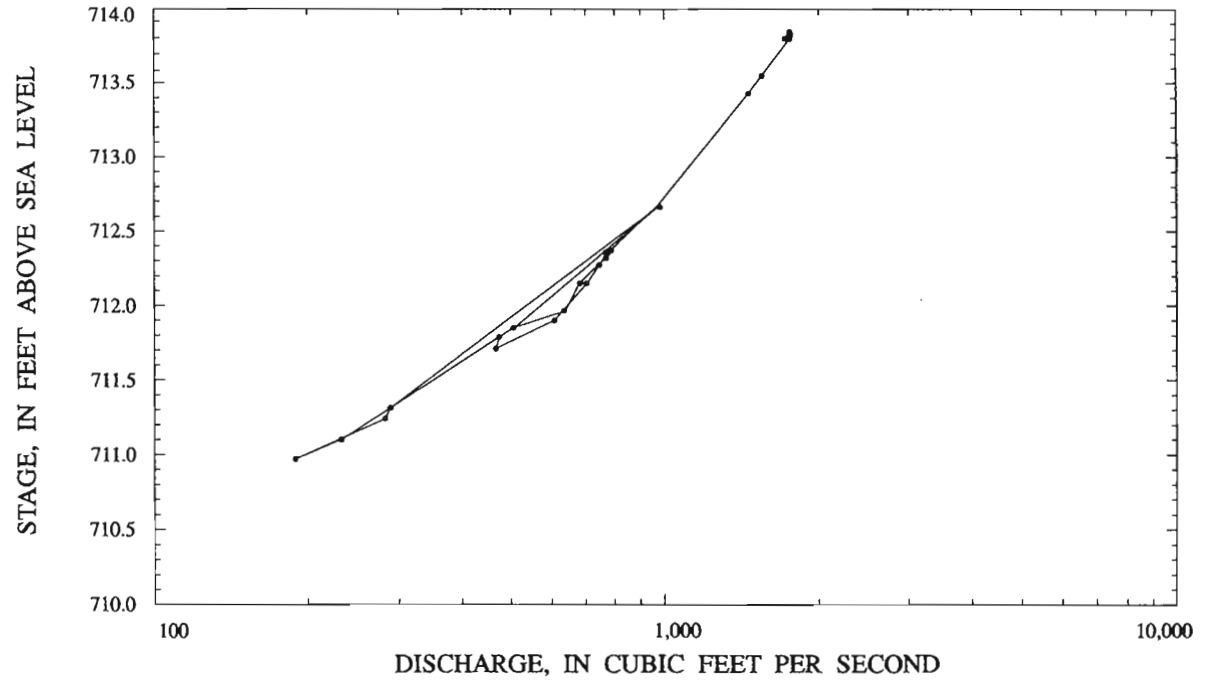

Figure 9. Measured stage-discharge relation at Fox River at Huntley Road at Carpentersville, Ill. (measurements consistent with a unique stage-discharge relation).

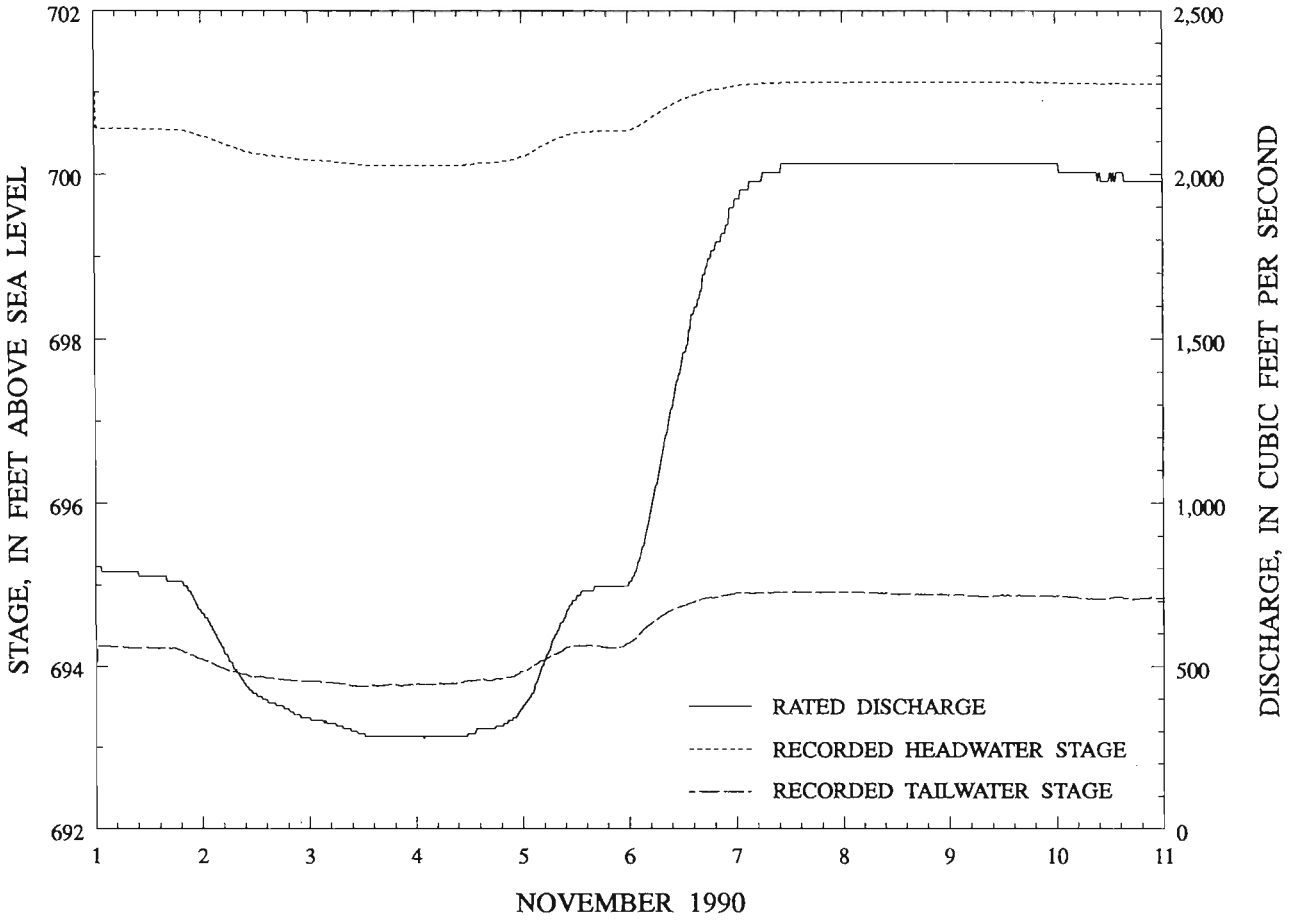

Figure 10. Rated discharge and recorded headwater and tailwater stages at Fox River at South Elgin, Ill.

sites within the reach at varying time intervals. At sites where crews were making discharge measurements, grab samples were collected as often as every 2 hours. Other grab dye sites had sample collection approximately twice per day.

Two sites, Fox River at Burtons Bridge (map number 13) and Fox River at Fox River Grove (map number 20) (fig. 5), were equipped with automatic pumping samplers. The sampler was placed on the streambank with the intake placed as near the center of flow as possible. A sample was collected approximately every 2 hours near the bed of the river. The automatic pumping samplers were serviced periodically by collecting stored samples and reloading the sampler with fresh collection bottles. The equipment was also checked for any malfunctions. The samples collected from November 5 at 1800 hours to November 6 at 2000 hours at Fox River at Fox River Grove were contaminated. The sampler was swamped, allowing for the samples to intermix and be diluted.

Dye boats were anchored near the center of flow at Fox River at river mile 93.5 at Burtons Bridge (map number 14) and Fox River at river mile 89.5 above Fox River Grove (map number 18). The boats used were spring-loaded automatic samplers (Kilpatrick and Wilson, 1982) that drew one sample from near the water surface approximately every 2.5 hours. The boats were serviced periodically throughout the synoptic study. On the afternoon of November 3 through the morning of November 5, the samples from the dye boat samplers were lost. Any measured dye samples during that period were manually collected. On November 6-7, the boat sampler at river mile 89.5 above Fox River Grove (map number 18) malfunctioned and samples were not collected.

The fluorescence of the samples was measured at the USGS laboratory in the District office in Urbana, Ill. Some samples were analyzed for fluorescence in the field as a rough check of data-collection activities. Samples suspected to be contaminated were discarded.

A Turner Designs model 10[1] fluorometer was used with a rhodamine WT accessory kit containing the lamps and filters necessary for analysis of dye concentration in stream samples. The fluorometer was calibrated with standards prepared from the concentrated dye (20-percent stock solution). Fluorescence was converted to dye concentration in micrograms per liter based on the prepared stock standards. Dye concentrations at selected sites are presented in table 6 (at end of report) and figures 11-18.

Concentrations of each injection solution were analyzed based on injection standards prepared from each solution. The injection standards were prepared in 0.5, 1, 2, 5, 10, 50, and 100 µg/L solutions and compared to the standards prepared from the concentrated dye solution.

DATA ARCHIVE

Files of unit-value stage and discharge data collected for this study are provided in a compressed format on a high-density diskette. The files were retrieved from the Automated Data Processing System (ADAPS), a State stream information data base maintained in the Illinois District of the USGS. The diskette can be read using an IBM compatible microcomputer running MS-DOS operating system. Individual compressed files reside together in a library file named DAT90.EXE. The decompressed files require approximately 7 megabytes of disk space. Table 7 (at end of report) shows the data files of the library and characteristics of each data file.

LHarc, version 1.13c (Yoshizaki, 1989), was used to compress the data files into a self-extracting library. The program and documentation may be obtained by copying 'LH113C.EXE' to any directory on the hard disk, typing 'LH113C', and pressing the enter key. The compression-decompression program is copyrighted by Haruyasu Yoshizaki. Permission to copy is granted freely provided that all copies contain the statement "copyrighted by Haruyasu Yoshizaki" (Mitten and Londquist, 1991).

The contents of DAT90.EXE can be extracted by copying DAT90.EXE to a subdirectory on the hard disk, typing 'DAT90' in that subdirectory, and pressing the enter key. The files will be decompressed into their original form according to the American International Standard Code for Information Interchange (ASCII).

[1]Use of brand and trade names in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

SUMMARY

Unsteady-flow data were collected on the Fox River in southeastern Wisconsin and northeastern Illinois for the period October 31-November 10, 1990. Stage and streamflow on a 49.4-mile study reach of the Fox River and its tributaries were measured during a controlled unsteady-flow period. Fluorescent dye was injected throughout the period, and water samples were collected downstream from the injection site.

Locations of new study gaging stations to augment long-term continuous-record gaging stations were established based on preliminary model simulation of the flow conditions expected during the synoptic study. Streamflow data were collected to investigate stage-discharge relations at the study stations and to verify a one-dimensional, unsteady-flow model. Stage was monitored continuously at 11 Fox River stations and 4 tributary stations. Eight stations on the Fox River had periodic stage measurements.

Discharge data were collected by either a current-meter measurement or, at continuous-record stations, indirectly by use of a stage-discharge relation. Discharge measurements were made at eight stations on the Fox River and seven stations on its tributaries.

Dye samples were collected at 18 sites on the Fox River; 14 grab-sample collection sites, 2 dye-boat collection sites, and 2 automatic-pumping-sampler collection sites. The samples were analyzed for fluorescence, and dye concentrations were calculated.

Continuous streamflow data during the synoptic study for gaging stations are provided on the diskette accompanying this report.

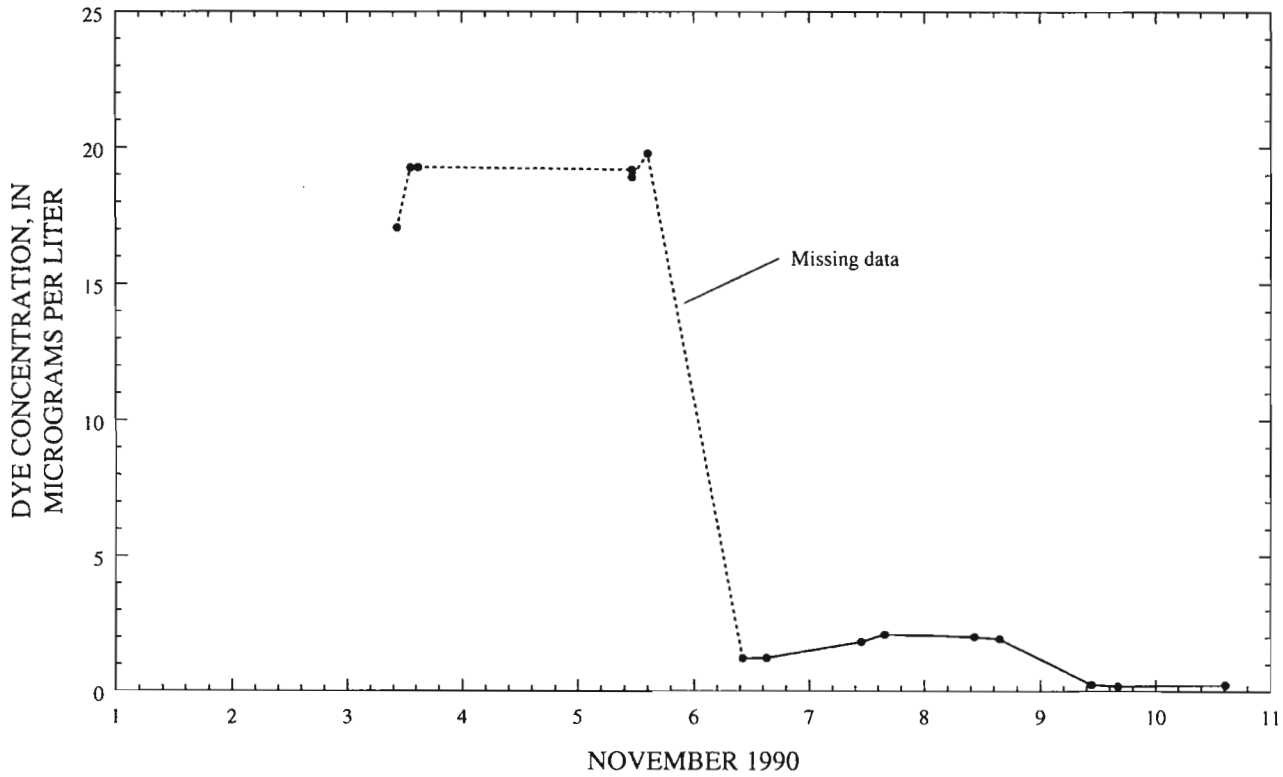

Figure 11. Observed dye concentrations at Fox River at Ferndale, Ill.

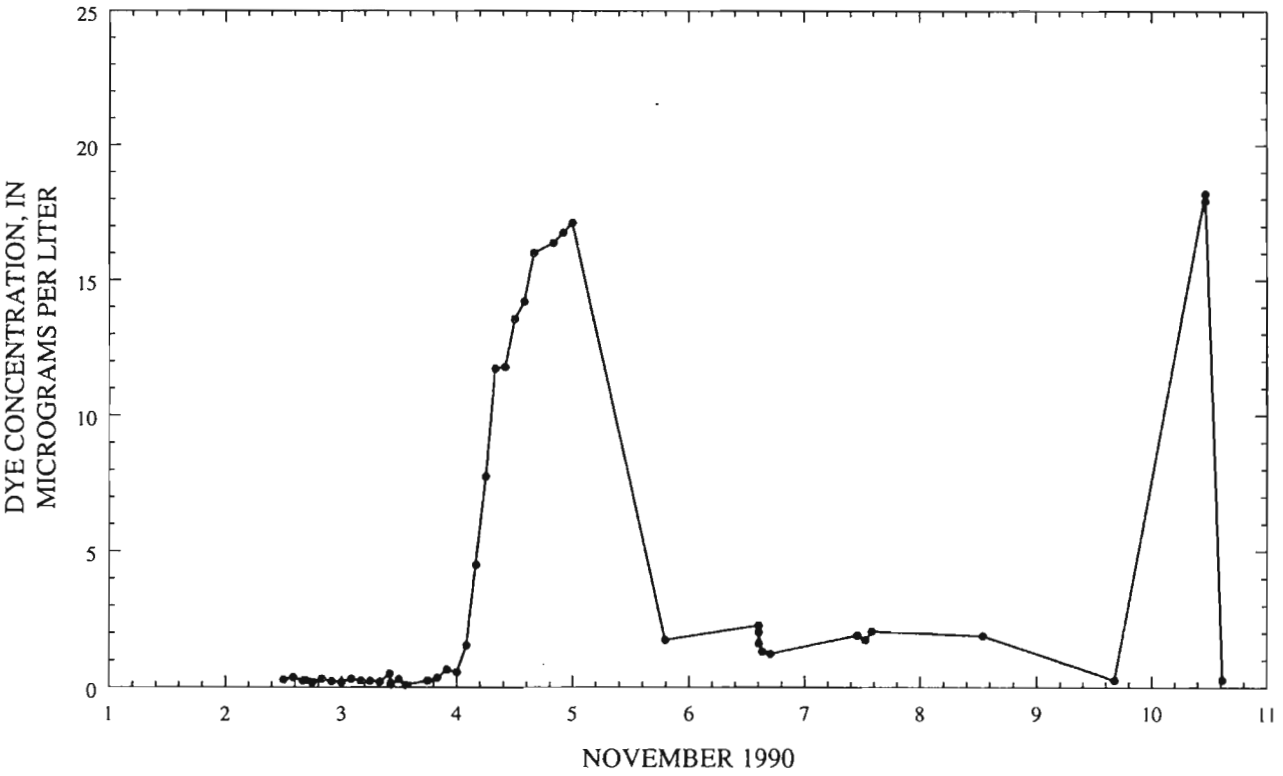

Figure 12. Observed dye concentrations at Fox River at Burtons Bridge, Ill.

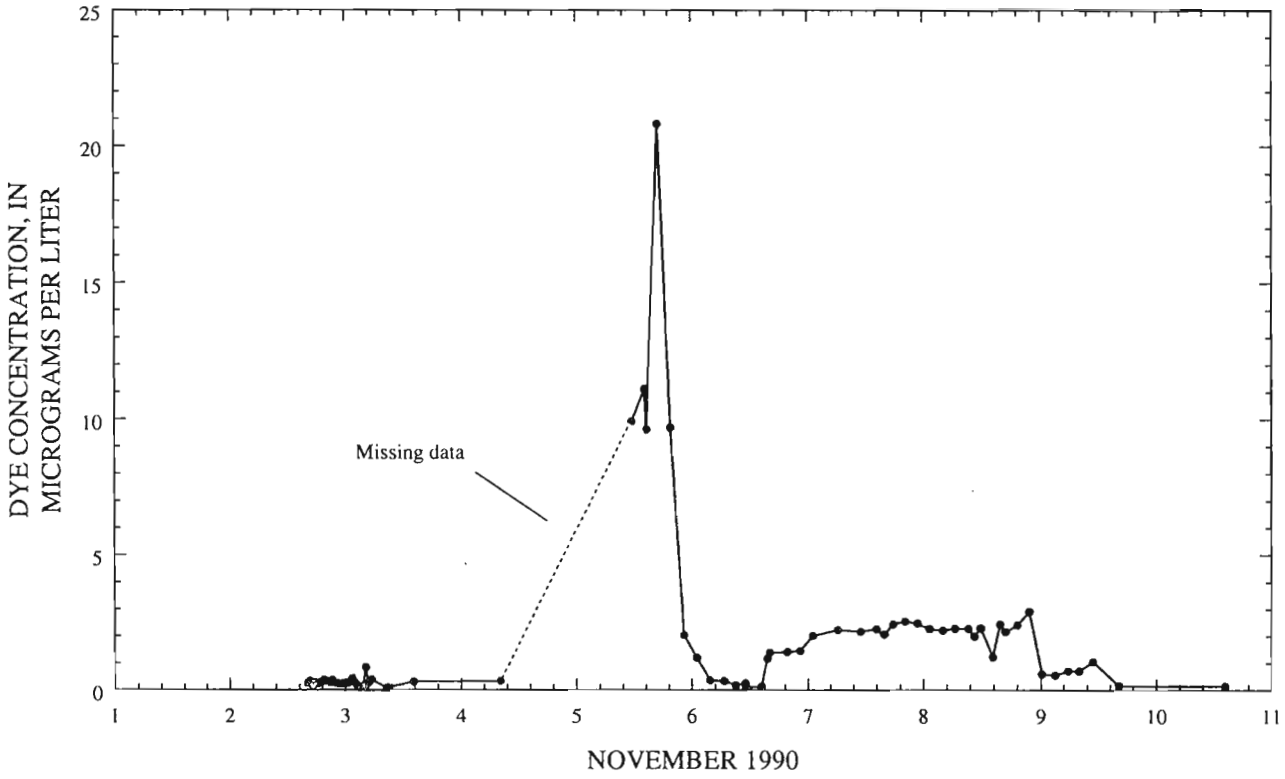

Figure 13. Observed dye concentrations at Fox River at river mile 93.5 at Burtons Bridge, Ill.

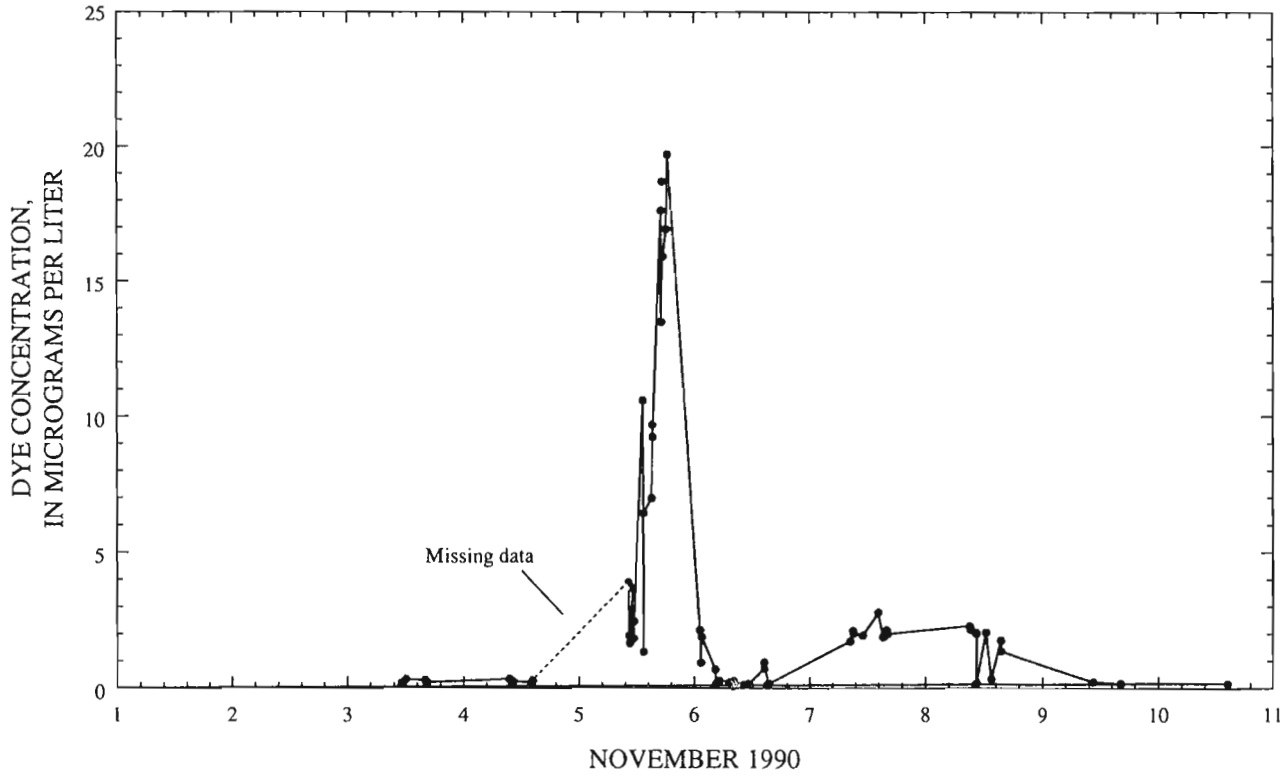

Figure 14. Observed dye concentrations at Fox River at Fox River Valley Gardens, Ill.

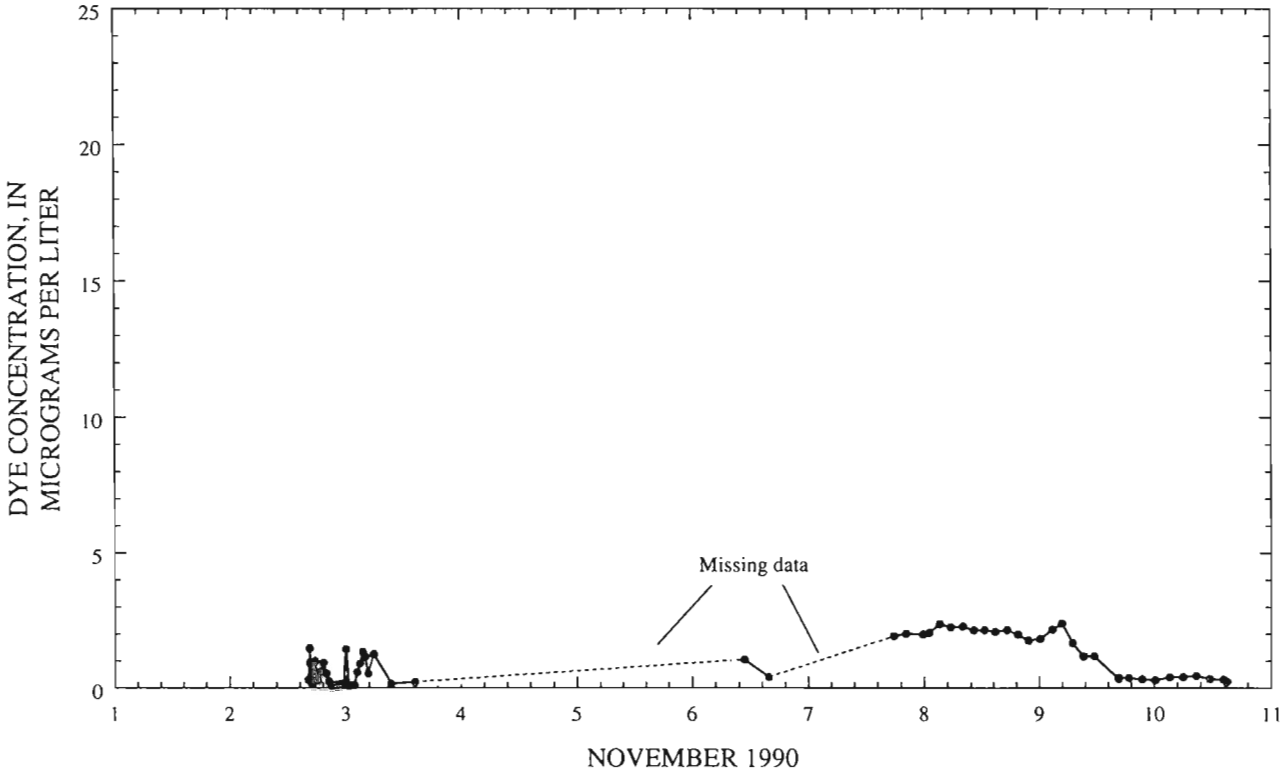

Figure 15. Observed dye concentrations at Fox River at river mile 89.5 above Fox River Grove, Ill.

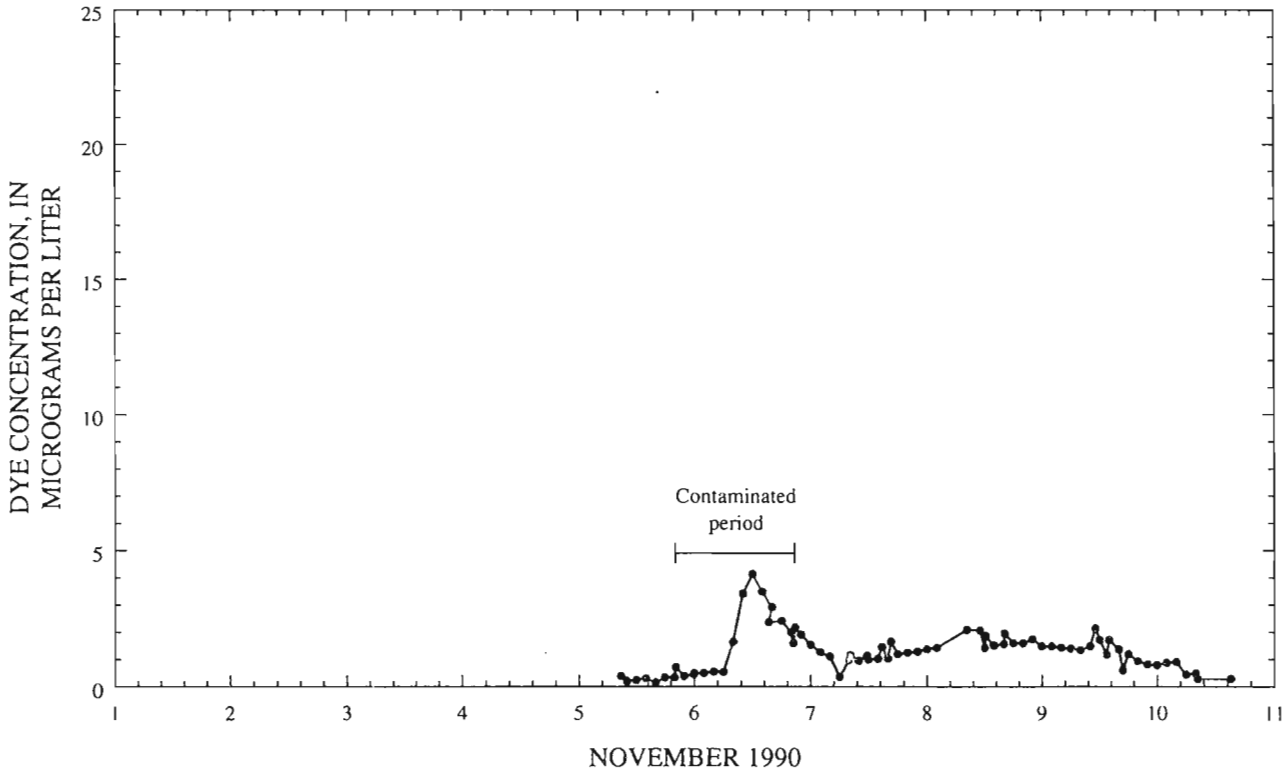

Figure 16. Observed dye concentrations at Fox River at Fox River Grove, Ill.

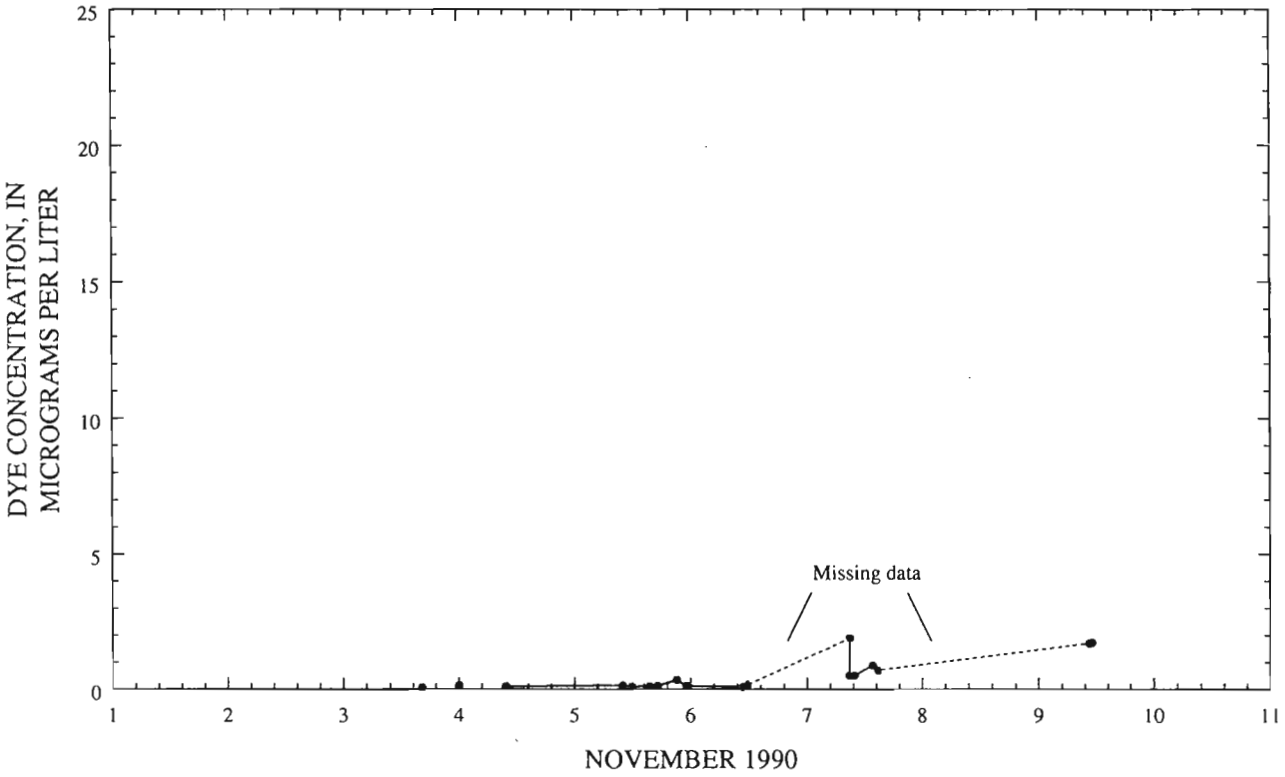

Figure 17. Observed dye concentrations at Fox River at Huntley Road at Carpentersville, Ill.

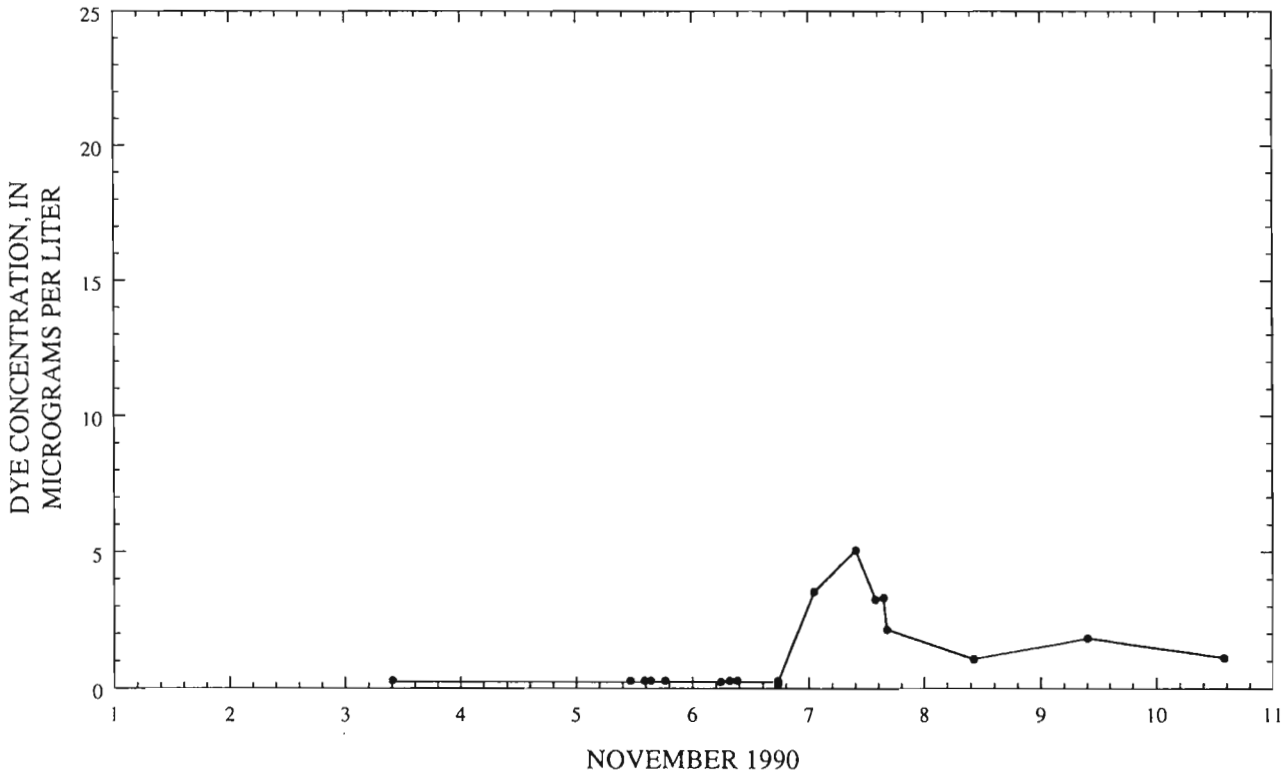

Figure 18. Observed dye concentrations at Fox River at Lawrence Avenue at Elgin, Ill.

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TABLES 3-7

Table 3. Summary of selected discharge measurements made on the Fox River
[ft^2, square feet; ft^3/s, cubic feet per second; --, no data available]

Station name and map number	Date	Start time (hours)	End time (hours)	Width (feet)	Cross-sectional area (ft^2)	Stage (feet above sea level)	Discharge (ft^3/s)
Fox River at Johnsburg, 7	11/01/90	0820	0905	435	1,240	735.71	647
		1000	1035	434	1,360	735.71	595
		1035	1100	434	1,340	735.70	650
		1100	1120	434	1,340	735.70	632
		1120	1145	434	1,350	735.70	597
		1135	1242	432	1,370	735.73	172
		1220	1251	434	1,370	735.73	-13
		--	1315	434	1,300	735.72	-28
	11/05/90	1155	1255	447	1,640	736.45	288
		1325	1440	447	1,640	736.44	204
		1455	1555	444	1,600	736.42	1,080
		1600	1700	443	1,570	736.37	1,150
	11/06/90	1250	1350	444	1,520	736.21	1,410
	11/07/90	1250	1350	445	1,600	736.24	1,500
Fox River near McHenry, 10	11/01/90	0936	1034	134	1,130	735.58 [1]731.46	636
		1137	1202	96.0	40.0	735.69 [1]731.26	64
		1350	1414	96.0	40.2	735.62 [1]731.20	74
	11/02/90	1243	1306	96.0	45.4	735.69 [1]730.73	74
	11/03/90	0825	0848	96.0	42.6	735.91 [1]730.59	74
	11/04/90	0815	0840	96.0	44.0	736.17 [1]730.51	75
		1355	1423	96.0	43.8	736.17 [1]730.50	77
	11/05/90	1024	1048	97.0	49.4	736.56 [1]730.55	83
		1812	1918	133	1,210	735.81 [1]731.96	1,340
		2035	2139	133	1,220	735.74 [1]732.08	1,310
	11/06/90	0230	0335	133	1,200	735.66 [1]732.34	1,370
		1300	1405	133	1,190	735.60 [1]732.55	1,500
	11/07/90	1049	1154	133	1,190	735.69 [1]732.68	1,370
		1430	1610	133	1,190	735.69 [1]732.69	1,510
		1640	1815	133	1,190	735.69 [1]732.71	1,480
	11/08/90	1200	1240	210	1,210	735.70 [1]732.76	1,560
		1202	1322	133	1,180	735.70 [1]732.76	1,480
	11/09/90	0947	1107	133	1,180	735.69 [1]732.72	1,470
Fox River at Burtons Bridge, 13	11/06/90	1040	1150	353	1,740	732.20	1,440
	11/07/90	1035	1135	339	1,810	732.40	1,550
Fox River at Fox River Valley Gardens, 15	11/01/90	0845	0930	334	1,430	731.22	657
		1000	1035	334	1,440	731.22	674
		1040	1120	334	1,430	731.22	659
		1130	1225	334	1,400	731.15	380
		1230	1310	333	1,390	731.09	232
		1330	1415	333	1,380	731.06	264
		1420	1505	333	1,370	731.04	297
		1655	1800	330	1,420	730.91	244
		1955	2120	332	1,360	730.85	416
		2300	2400	330	1,320	730.80	367

Table 3. Summary of selected discharge measurements made on the Fox River--Continued

Station name and map number	Date	Start time (hours)	End time (hours)	Width (feet)	Cross-sectional area (ft^2)	Stage (feet above sea level)	Discharge (ft^3/s)
Fox River at Fox River Valley Gardens, 15–Continued	11/02/90	0200	0318	330	1,260	730.78	309
		0455	0730	330	1,210	730.71	194
		0800	0916	329	1,270	730.66	201
		1100	1200	330	1,230	730.64	174
		1500	1605	330	1,200	730.60	189
	11/03/90	1115	1230	328	1,170	730.52	159
		1545	1700	328	1,160	730.50	205
	11/04/90	0940	1045	328	1,170	730.44	130
		1404	1505	328	1,150	730.44	155
	11/05/90	1115	1145	329	1,200	730.58	406
		1315	1350	329	1,210	730.64	535
		1400	1440	329	1,220	730.68	559
		1500	1535	329	1,280	730.93	921
		1545	1620	330	1,330	731.06	1,020
		1705	1810	330	1,390	731.17	1,320
		1820	1930	330	1,430	731.33	1,350
		2206	2306	332	1,510	731.56	1,340
	11/06/90	0110	0205	332	1,560	731.71	1,420
		0430	0530	330	1,620	731.81	1,480
		0730	0830	330	1,630	731.95	1,460
		1037	1138	338	1,730	732.07	1,500
	11/07/90	0840	0935	338	1,790	732.24	1,610
		1515	1615	338	1,760	732.24	1,580
	11/08/90	0855	0950	338	1,710	732.29	1,540
Fox River at Fox River Grove, 20	11/01/90	1420	1620	267	1,410	730.82	527
	11/06/90	1237	1343	262	1,550	731.54	1,430
	11/07/90	1015	1127	262	1,630	731.71	1,740
	11/08/90	0840	0950	263	1,610	731.72	1,750
Fox River at Carpentersville, 25	11/02/90	1030	1130	163	124	--	259
	11/03/90	1115	1155	180	113	--	187
Fox River at Huntley Road at Carpentersville, 27	10/31/90	1700	1805	185	444	712.37	788
	11/01/90	0810	0919	185	447	712.36	769
		1136	--	185	443	712.32	769
		1340	1435	185	436	712.28	741
		1557	1656	179	418	712.14	668
		1835	--	179	376	711.98	600
		2047	2128	178	348	711.85	505
	11/02/90	0850	0923	168	247	711.36	287
		1030	1105	162	250	711.28	282
	11/03/90	1136	1211	150	197	710.97	189
	11/04/90	0935	1010	163	227	711.10	232
	11/05/90	1040	1125	177	341	711.79	473
		1445	1522	176	333	711.71	466
		1955	2045	182	367	711.90	608
		2054	2152	184	407	712.15	704
		2158	2300	185	439	712.35	775
	11/06/90	0033	0130	188	498	712.68	974
		1140	1230	194	645	713.43	1,450
		1600	--	195	677	713.55	1,540
	11/07/90	0850	0932	193	729	713.80	1,750
		1340	1442	193	706	713.80	1,710
	11/08/90	0900	--	193	718	713.85	1,750
	11/09/90	1108	1200	194	726	713.83	1,760
Fox River at Lawrence Avenue at Elgin, 33	10/31/90	1550	1715	309	506	709.34	914
	11/01/90	0840	0950	245	573	709.33	802
		1555	1647	245	573	709.31	715
		1915	2005	243	538	709.29	650
		2200	2246	242	515	709.17	574
	11/02/90	0550	0630	232	579	708.99	377
		1230	1345	224	552	708.92	309
		1627	1730	224	539	708.92	272
	11/03/90	0850	0925	222	493	708.83	212

Table 3. Summary of selected discharge measurements made on the Fox River--Continued

Station name and map number	Date	Start time (hours)	End time (hours)	Width (feet)	Cross-sectional area (ft^2)	Stage (feet above sea level)	Discharge (ft^3/s)
Fox River at Lawrence Avenue at Elgin, 33–Continued	11/03/90	1400	1445	220	508	708.82	194
	11/04/90	0850	0950	223	509	708.85	242
		1115	1155	222	526	708.85	253
	11/05/90	1100	1137	256	543	709.20	720
		1537	1635	256	540	709.20	650
		1945	2030	244	527	709.18	642
		2210	2250	244	556	709.23	720
	11/06/90	0610	0700	254	691	709.64	1,270
		0905	1015	254	752	709.73	1,420
		1530	1630	255	796	709.73	1,590
	11/07/90	0830	0930	256	844	709.94	1,840
		1400	1455	256	850	709.94	1,870
	11/08/90	0905	1000	256	835	709.94	1,800
	11/09/90	0810	0930	260	850	709.93	1,910

[1]Tailwater stage.

Table 4. Summary of selected discharge measurements made on the Fox River tributaries
[ft^2, square feet; ft^3/s, cubic feet per second; --, no data available]

Station name and map number	Date	Start time (hours)	End time (hours)	Width (feet)	Cross-sectional area (ft^2)	Stage (feet above sea level)	Discharge (ft^3/s)
Dutch Creek at McCullom Lake, 8	11/04/90	1015	1024	11.5	9.9	--	2.7
Boone Creek at McHenry, 9	11/03/90	1407	1422	23.0	14.7	--	10
Fox River Tributary at Rawson Bridge, 17	11/03/90	1538	1552	7.6	3.2	--	1.7
Spring Creek at Fox River Grove, 21	11/05/90	1340	1400	18.5	24.1	--	15
	11/07/90	1157	1203	16.0	17.4	--	30
Crystal Creek at Algonquin, 24	10/31/90	1310	1340	19.4	14.1	--	15
	11/02/90	1320	1340	17.0	8.1	--	12
	11/04/90	1405	1441	21.7	16.0	--	28
	11/05/90	1347	1406	35.3	42.8	--	113
	11/06/90	1450	1520	27.0	69.2	--	50
	11/07/90	1545	1620	29.0	77.4	--	37
	11/08/90	1222	1240	16.2	10.5	--	34
	11/09/90	1230	1255	16.0	11.7	--	36
Jelkes Creek at West Dundee, 30	11/03/90	1535	1602	22.0	39.6	--	7.6
	11/04/90	1135	1150	16.0	16.4	--	6.8
	11/04/90	1215	1239	22.0	37.1	--	7.7
	11/04/90	1321	1337	12.2	5.5	--	6.8
	11/06/90	1420	1445	14.0	8.8	--	10
	11/07/90	1157	1215	13.0	7.1	--	7.8
Tyler Creek at State Route 31 at Elgin, 32	11/02/90	1205	1225	26.0	15.8	--	8.7
	11/03/90	1100	1125	16.4	9.6	--	6.2
	11/05/90	1300	1325	21.0	37.5	--	85
	11/06/90	1350	1405	19.5	33.0	--	89
	11/07/90	1110	1122	19.6	27.2	--	60
	11/08/90	1115	1125	19.5	27.6	--	45

Table 5. Summary of measured stages on the Fox River

[--, no data available]

Method of measurement:

a, Tape down from known elevation; b, Reading from staff gage.

Station name and map number	Date	Time (hours)	Stage (feet above sea level)	Method of measurement
Fox River at Burtons Bridge, 13	11/06/90	1040	732.18	a
		1150	732.20	a
	11/07/90	1035	732.39	a
		1140	732.39	a
	11/09/90	1450	732.39	a
Fox River at Fox River Valley Gardens, 15	11/01/90	0804	731.22	a
		0830	731.19	a
		0845	731.21	a
		0900	731.22	a
		1100	731.23	a
		1145	731.14	a
		1200	731.12	a
		1215	731.10	a
		1315	731.07	a
		1400	731.05	a
		1430	731.04	a
		1515	731.02	a
		1530	731.00	a
		1645	730.94	a
		1730	730.93	a
		1800	730.82	a
		1845	730.57	
		1940	730.86	a
		1955	730.85	a
		2030	730.82	a
		2045	730.84	a
		2120	730.85	a
		2300	730.82	a
		2345	730.78	a
	11/02/90	0200	730.81	a
		0215	730.77	a
		0230	730.76	a
		0500	730.75	a
		0600	730.71	a
		0630	730.70	a
		0645	730.69	a
		0700	730.68	a
		0730	730.67	a
		0800	730.66	a
		0830	730.67	a
		0845	730.66	a
		1050	730.65	a
		1120	730.64	a
		1135	730.65	a
		1205	730.64	a
		1450	730.61	a
		1500	730.62	a
		1530	730.61	a
		1545	730.60	a
	11/03/90	1115	730.53	a
		1230	730.51	a
		1540	730.50	a
		1610	730.49	a
		1655	730.50	a
	11/04/90	0945	730.44	a
		1030	730.45	a
		1045	730.44	a

Table 5. Summary of measured stages on the Fox River—Continued

Station name and map number	Date	Time (hours)	Stage (feet above sea level)	Method of measurement
Fox River at Fox River Valley Gardens, 15–Continued	11/04/90	1400	730.45	a
		1430	730.44	a
		1500	730.44	a
	11/05/90	1035	730.56	a
		1105	730.57	a
		1120	730.59	a
		1150	730.59	a
		1315	730.59	a
		1330	730.64	a
		1345	730.66	a
		1400	730.67	a
		1415	730.68	a
		1430	730.67	a
		1445	730.70	a
		1500	730.83	a
		1515	730.91	a
		1530	730.98	a
		1545	731.01	a
		1600	731.04	a
		1615	731.08	a
		1630	731.11	a
		1715	731.12	a
		1730	731.14	a
		1800	731.27	a
		1845	731.34	a
		1930	731.34	a
		2210	731.53	a
		2230	731.57	a
		2245	731.68	a
	11/06/90	0110	731.71	a
		0130	731.73	a
		0140	731.75	a
		0420	731.84	a
		0723	731.93	a
		0745	731.94	a
		0800	731.95	a
		0815	731.96	a
		0830	731.97	a
		1030	732.00	a
		1045	732.01	a
		1100	732.02	a
		1115	732.03	a
		1130	732.03	a
	11/07/90	0840	732.23	a
		0900	732.24	a
		0930	732.25	a
		1505	732.24	a
		1610	732.25	a
	11/08/90	0900	732.26	a
		0915	732.27	a
		1000	732.27	a
Fox River at Chicago NorthWestern Railroad Bridge at Carpentersville, 26	11/01/90	0930	712.88	a
		1248	712.87	a
		1447	712.84	a
		1712	712.74	a
		2002	712.66	a
		2150	712.61	a
	11/02/90	1012	712.40	a
		1125	712.42	a
	11/03/90	1235	712.24	a

Table 5. Summary of measured stages on the Fox River—Continued

Station name and map number	Date	Time (hours)	Stage (feet above sea level)	Method of measurement
Fox River at Chicago NorthWestern Railroad Bridge at Carpentersville, 26–Continued	11/04/90	1023	712.31	a
	11/05/90	1140	712.61	a
		1550	712.56	a
		2344	713.04	a
	11/06/90	0155	713.23	a
		1030	713.72	a
		1311	713.82	a
		1719	713.91	a
	11/07/90	0958	714.16	a
		1516	714.15	a
	11/08/90	1017	714.22	a
	11/09/90	1038	714.20	a
Fox River at East Dundee, 28	11/02/90	1645	710.56	a
	11/03/90	0930	710.45	a
	11/04/90	1050	710.52	a
		1621	710.43	a
	11/06/90	0019	711.78	b
		1006	712.52	b
		1336	712.62	b
		1759	712.74	b
	11/07/90	1020	712.97	b
		1320	712.95	b
		1535	712.96	b
	11/08/90	0836	713.03	b
		1035	713.02	b
	11/09/90	1030	713.00	b
Fox River at West Dundee, 29	11/02/90	0700	709.26	b
		1150	709.19	b
		1700	709.07	b
	11/03/90	0915	709.01	b
	11/04/90	1102	708.98	b
	11/05/90	1232	709.47	b
		1630	709.45	b
		2400	709.85	b
	11/06/90	0956	710.44	b
		1342	710.56	b
		1748	710.59	b
	11/07/90	1033	710.78	b
		1311	710.77	b
		1543	710.77	b
	11/08/90	1043	710.83	b
	11/09/90	1014	710.80	b
Fox River at I-90 at Elgin, 31	11/02/90	1155	708.96	a
		1721	708.88	a
	11/03/90	1350	708.72	a
	11/04/90	1301	708.84	a
	11/05/90	1652	709.19	a
	11/06/90	1130	709.78	a
		1245	709.75	a
	11/07/90	1137	710.11	a
Fox River at Lawrence Avenue at Elgin, 33	11/01/90	0800	701.17	b
		1525	701.15	b
		1825	701.09	b
		2140	700.95	b
	11/02/90	0514	700.62	b
		1150	700.47	b
		1829	700.34	b

Table 5. Summary of measured stages on the Fox River—Continued

Station name and map number	Date	Time (hours)	Stage (feet above sea level)	Method of measurement
Fox River at Lawrence Avenue at Elgin, 33–Continued	11/03/90	0807	700.23	b
		1313	700.21	b
	11/04/90	1014	700.25	b
	11/05/90	1015	701.00	b
		1726	700.95	b
		1915	700.93	b
		2058	700.99	b
		2305	701.11	b
	11/06/90	0725	701.85	b
		1720	702.25	b
	11/07/90	1020	702.46	b
		1545	702.45	b
	11/08/90	1040	702.49	b
Fox River at Elgin, 34	11/01/90	1005	700.64	a
		1722	700.64	a
		2310	700.64	a
	11/02/90	0710	700.33	a
		1245	700.25	a
		1400	700.17	a
		1810	700.17	a
	11/03/90	1145	700.11	a
		1520	700.09	a
	11/04/90	1223	700.11	a
		1515	700.13	a
	11/05/90	1200	700.60	a
		1715	700.50	a
		2045	700.56	a
	11/06/90	0715	701.08	a
		1700	701.37	a
	11/07/90	1000	701.51	a
		1520	701.52	a
	11/08/90	1025	701.52	a

Table 6. Dye concentrations for selected stations on the Fox River
[µg/L, micrograms per liter; --, not available]

Station name and map number	Date	Time (hours)	Concentration (µg/L)
Fox River near McHenry, 10	11/02/90	1425	0.37
		1430	.28
		1432	.19
		1438	33.4
		1441	43.6
		1445	40.8
		1545	.44
		1647	1.65
	11/03/90	0802	25.3
		0804	24.8
		1003	22.5
		1317	24.8
		1453	26.8
	11/05/90	1110	23.8
		1110	23.5
		1425	2.41
		1448	1.34
	11/06/90	1008	1.53
		1507	1.26
	11/07/90	1048	1.92
		1544	2.33
		1715	2.28
	11/08/90	1016	2.08
		1154	2.11
		1531	.43
		1705	1.37
	11/09/90	1035	1.73
		1221	.21
		1605	.23
	11/10/90	1438	.17
Fox River at Ferndale, 11	11/03/90	1028	17.0
		1320	19.2
		1457	19.3
	11/05/90	1114	19.2
		1114	18.9
		1427	19.8
	11/06/90	1011	1.22
		1509	1.23
	11/07/90	1051	1.83
		1548	2.10
	11/08/90	1021	2.02
		1537	1.94
	11/09/90	1040	.24
		1608	.19
	11/10/90	1440	.23
Fox River at Holiday Hills, 12	11/02/90	1600	.20
	11/03/90	0808	5.03
		1025	9.06
		1322	13.4
		1449	14.6
	11/05/90	1116	17.4
		1116	17.4
		1445	19.1
	11/06/90	1013	.34
		1428	18.3
		1511	1.26
	11/07/90	1053	1.71

Table 6. Dye concentrations for selected stations on the Fox River—Continued

Station name and map number	Date	Time (hours)	Concentration (µg/L)
Fox River at Holiday Hills, 12–Continued	11/07/90	1550	2.13
	11/08/90	1024	2.07
		1540	10.5
	11/09/90	1045	.47
		1609	.33
	11/10/90	1442	.23
Fox River at Burtons Bridge, 13	11/02/90	1200	.28
		1400	.37
		1600	.24
		1640	.26
		1800	.20
		2000	.31
		2200	.22
		2400	.19
	11/03/90	0200	.31
		0400	.25
		0600	.23
		0800	.20
		1000	.50
		1016	.16
		1018	.10
		1200	.29
		1326	.08
		1800	.24
		2000	.35
		2200	.64
		2400	.55
	11/04/90	0200	1.53
		0400	4.48
		0600	7.74
		0800	11.7
		1000	11.8
		1200	13.5
		1400	14.2
		1600	16.0
		2000	16.4
		2200	16.7
	11/04/90	2400	17.1
	11/05/90	1906	1.74
	11/06/90	1430	2.27
		1430	1.61
		1430	2.03
		1513	1.31
		1655	1.23
	11/07/90	1057	1.91
		1238	1.74
		1400	2.06
	11/08/90	1300	1.90
	11/09/90	1613	.27
	11/10/90	1121	18.2
		1121	17.9
		1444	.28
Fox River at river mile 93.5 at Burtons Bridge, 14	11/02/90	1605	.25
		1640	.33
		1715	.16
		1750	.28
		1825	.23
		1900	.31

Table 6. Dye concentrations for selected stations on the Fox River—Continued

Station name and map number	Date	Time (hours)	Concentration (µg/L)
Fox River at river mile 93.5 at Burtons Bridge, 14–Continued	11/02/90	1935	0.37
		2010	.32
		2045	.29
		2120	.37
		2155	.27
		2230	.25
		2305	.23
		2340	.25
	11/03/90	0015	.24
		0050	.28
		0125	.43
		0200	.28
		0235	.15
		0310	.14
		0345	.12
		0420	.84
		0455	.26
		0530	.38
		0843	.09
		1411	.31
	11/04/90	0811	.33
	11/05/90	1125	9.91
		1410	11.1
		1435	9.61
		1700	20.8
		1940	9.69
		2220	2.03
	11/06/90	0100	1.20
		0340	.36
		0640	.33
		0900	.18
		1100	.25
		1109	.10
		1420	.13
		1532	1.16
		1600	1.38
		1940	1.41
		2220	1.45
	11/07/90	0100	2.01
		0620	2.23
		1105	2.17
		1420	2.26
		1557	2.07
		1745	2.44
		2015	2.54
		2245	2.48
	11/08/90	0115	2.27
		0400	2.21
		0630	2.29
		0915	2.28
		1030	1.99
		1145	2.30
		1415	1.23
		1545	2.45
		1650	2.17
		1915	2.41
		2145	2.91
	11/09/90	0015	.60
		0300	.55
	11/09/90	0545	.71

Table 6. Dye concentrations for selected stations on the Fox River—Continued

Station name and map number	Date	Time (hours)	Concentration (µg/L)
Fox River at river mile 93.5 at Burtons Bridge, 14–Continued	11/09/90	0800	0.72
		1049	1.06
		1617	.16
	11/10/90	1448	.15
Fox River at Fox River Valley Gardens, 15	11/03/90	1120	.19
		1145	.19
		1210	.33
		1604	.31
		1625	.25
		1643	.23
	11/04/90	0951	.34
		1011	.23
		1031	.27
		1415	.21
		1433	.26
		1452	.30
	11/05/90	1023	3.90
		1042	1.95
		1054	1.67
		1122	3.67
		1134	1.83
		1141	2.47
		1323	10.6
		1340	1.35
		1340	6.43
		1510	6.99
		1527	9.70
		1530	9.24
		1708	17.6
		1718	13.5
		1736	18.7
		1751	15.9
		1825	16.9
		1850	19.7
	11/06/90	0118	2.13
		0138	.94
		0153	1.88
		0440	.69
		0455	.17
		0515	.29
		0740	.23
		0800	.07
		0815	.27
		1017	.12
		1110	.14
		1125	.16
		1445	.72
		1445	.72
		1445	.96
		1538	.17
	11/07/90	0851	1.73
		0906	2.12
		0921	2.02
		1110	1.95
		1430	2.79
		1528	1.89
		1543	1.90
		1600	2.14
		1615	2.01

Table 6. Dye concentrations for selected stations on the Fox River—Continued

Station name and map number	Date	Time (hours)	Concentration (µg/L)
Fox River at Fox River Valley Gardens, 15–Continued	11/08/90	0910	2.28
		0925	2.17
		0940	2.14
		1039	2.05
		1042	2.01
		1053	.19
		1240	2.05
		1350	.34
		1547	1.76
		1549	1.36
	11/09/90	1052	.24
		1627	.18
	11/10/90	1450	.18
Fox River at river mile 89.5 above Fox River Grove, 18	11/02/90	1607	.34
		1625	.98
		1625	1.45
		1700	.27
		1735	1.04
		1810	.39
		1845	.67
		1920	.98
		1955	.62
		2030	.33
		2105	.18
		2140	.22
		2215	.19
		2250	.24
		2325	.19
		2400	1.43
	11/03/90	0035	.17
		0110	.18
		0145	.18
		0220	.63
		0255	.92
		0330	1.32
		0405	1.15
		0440	.57
		0550	1.25
		0918	.20
		1428	.26
	11/06/90	1046	1.05
		1549	.36
	11/07/90	1745	1.82
		2015	1.90
		2345	1.87
	11/08/90	0100	1.93
		0315	2.23
		0530	2.12
		0800	2.15
		1015	2.01
		1230	2.01
		1445	1.96
		1715	2.01
		1930	1.85
		2145	1.63
	11/09/90	0015	1.68
		0245	2.01
		0445	2.23
		0700	1.52

Table 6. Dye concentrations for selected stations on the Fox River—Continued

Station name and map number	Date	Time (hours)	Concentration (µg/L)
Fox River at river mile 89.5 above Fox River Grove, 18–Continued	11/09/90	0915	1.02
		1130	1.02
		1635	.41
		1640	.49
		1845	.47
		2130	.42
	11/10/90	0015	.37
		0315	.47
		0600	.47
		0845	.49
		1130	.38
		1415	.35
		1457	.31
Fox River at Fox River Grove, 20	11/03/90	0451	3.25
	11/05/90	0845	.39
		1000	.20
		1200	.24
		1400	.30
		1600	.17
		1800	.34
		2000	.34
		2015	.72
		2200	.39
		2358	.46
		2400	.49
	11/06/90	0200	.50
		0400	.55
		0600	.54
		0800	1.65
		1000	3.41
		1200	4.13
		1400	3.48
		1520	2.60
		1520	2.37
		1520	2.34
		1600	2.92
		1601	2.22
		1800	2.41
		2000	1.99
		2026	1.60
		2045	2.18
		2200	1.91
		2400	1.54
	11/07/90	0200	1.27
		0400	1.11
		0600	.36
		0800	.98
		0817	1.16
		1000	.96
		1142	1.14
		1144	1.14
		1200	.99
		1400	1.02
		1445	1.46
		1600	1.03
		1635	1.66
		1800	1.20
		2000	1.26
		2200	1.29

Table 6. Dye concentrations for selected stations on the Fox River—Continued

Station name and map number	Date	Time (hours)	Concentration (µg/L)
Fox River at Fox River Grove, 20–Continued	11/07/90	2400	1.37
	11/08/90	0200	1.43
		0817	2.09
		1101	2.06
		1200	1.43
		1215	1.87
		1400	1.52
		1600	1.57
		1608	1.96
		1800	1.60
		2000	1.60
		2200	1.75
		2400	1.49
	11/09/90	0200	1.49
		0400	1.43
		0600	1.40
		0800	1.35
		1000	1.49
		1107	2.15
		1200	1.72
		1330	1.18
		1400	1.72
		1600	1.37
		1650	.60
		1800	1.20
		2000	.94
		2200	.83
		2400	.80
	11/10/90	0200	.88
		0400	.91
		0600	.45
		0800	.51
		0823	.29
		1237	.21
		1505	.29
Fox River at Haegers Bend, 22	11/04/90	1605	5.51
	11/07/90	1153	.89
		1640	1.07
	11/08/90	1107	1.79
		1612	2.13
	11/09/90	1113	1.76
		1656	1.60
	11/10/90	1510	.36
Fox River at Algonquin, 23	11/05/90	2035	.52
		2332	.43
	11/06/90	1555	3.69
		1555	3.54
		1555	3.69
		1614	3.20
	11/07/90	1117	.63
		1500	.92
	11/08/90	1200	1.85
Fox River at Carpentersville, 25	11/03/90	--	.09
	11/04/90	1037	.12
	11/05/90	1210	.09
		2137	.49
	11/06/90	1026	.09

Table 6. Dye concentrations for selected stations on the Fox River—Continued

Station name and map number	Date	Time (hours)	Concentration (µg/L)
Fox River at Carpentersville, 25–Continued	11/07/90	1013	1.68
	11/09/90	1047	1.74
Fox River at Huntley Road at Carpentersville, 27	11/03/90	1615	.15
		1617	.06
		1617	.07
		1618	.09
	11/04/90	0944	.10
		0950	.10
	11/05/90	0958	.15
		1152	.09
		1153	.10
		1535	.11
		1713	.13
		2110	.35
		2310	.13
	11/06/90	1050	.08
		1151	.17
	11/07/90	0850	1.89
		0850	1.73
		0850	.51
		0950	.51
		1336	.88
		1447	.69
	11/09/90	1031	1.70
		1108	1.73
	11/10/90	1213	.49
Fox River at East Dundee, 28	11/09/90	1031	1.70
Fox River at West Dundee, 29	11/05/90	1043	.49
	11/06/90	1645	.31
		1645	.45
		1645	.34
	11/07/90	1522	.84
	11/09/90	1020	1.66
Fox River at I-90 at Elgin, 31	11/04/90	1300	.23
	11/05/90	1652	.10
		2257	.50
	11/06/90	1715	.55
		1715	.41
		1715	.48
	11/07/90	1233	1.77
		1546	1.19
	11/08/90	1050	1.46
	11/09/90	0959	1.71
Fox River at Lawrence Avenue at Elgin, 33	11/03/90	0900	.08
		1410	.09
		1418	.08
		1425	.06
		2400	.08
	11/05/90	1150	.07
		1650	.11
		1940	.11
		2040	.09
		2225	.11
	11/06/90	0600	.06
		0845	.11

Table 6. Dye concentrations for selected stations on the Fox River—Continued

Station name and map number	Date	Time (hours)	Concentration (µg/L)
Fox River at Lawrence Avenue at Elgin, 33–Continued	11/06/90	1050	0.09
		1645	.14
		1730	.37
		1730	.25
		1730	.28
	11/07/90	0106	3.36
		0945	4.81
		1345	3.07
		1530	3.13
		1614	2.08
	11/08/90	1015	1.08
		1030	1.20
	11/09/90	0941	1.79
	11/10/90	1354	1.11
Fox River at Elgin, 34	11/09/90	0750	1.71
Fox River at South Elgin, 36	11/07/90	0127	4.46
		1230	1.56
		1650	4.03

Table 7. Summary of unit-value stage and discharge data files, size, and descriptions in library DAT90.EXE

File name	Size (bytes)	Description
ALGON.D90	124,803	Tailwater-stage unit-value data, 10/19/90-11/10/90 15-minute interval for station 05550000,map number 23
ALGON.Q90	349,493	Discharge unit-value data, 10/01/90-11/30/90 15-minute interval for station 05550000, map number 23
ALGON.U90	339,336	Headwater-stage unit-value data, 10/01/90-11/30/90 15-minute interval for station 05550000, map number 23
ANTIOCH.S90	85,744	Stage unit-value data, 10/01/90-11/30/90 60-minute interval for station 05547000, map number 2
ELG.D90	169,039	Tailwater-stageunit-value data, 10/31/90-11/30/90 15-minute interval for station 05550310, map number 33
ELG.U90	171,360	Headwater-stage unit-value data, 10/31/90-11/30/90 15-minute interval for station 05550310, map number 33
FLNTCK.Q90	351,012	Discharge unit-value data, 10/01/90-11/30/90 15-minute interval for station 05549850, map number 19
FLNTCK.S90	346,971	Stage unit-value data, 10/01/90-11/30/90 15-minute interval for station 05549850, map number 19
HUNT.S90	171,151	Stage unit-value data, 10/31/90-11/30/90 15-minute interval for station 05550090, map number 27
JOHNSBG.S90	339,267	Stage unit-value data, 10/01/90-11/30/90 60-minute interval for station 05548500, map number 7
LKVILLA.S90	85,647	Stage unit-value data, 10/01/90-11/30/90 60-minute interval for station 05547500, map number 3
MCHENRY.D90	337,900	Tailwater-stageunit-value data, 10/01/90-11/30/90 15-minute interval for station 05549500, map number 10
MCHENRY.U90	338,821	Headwater-stage unit-value data, 10/01/90-11/30/90 15-minute interval for station 05549500, map number 10
NIPCR.Q90	350,597	Discharge unit-value data, 10/01/90-11/30/90 15-minute interval for station 05548280, map number 6
NIPCR.S90	339,132	Stage unit-value data, 10/01/90-11/30/90 15-minute interval for station 05548280, map number 6
NIPLK.S90	84,880	Stage unit-value data, 10/01/90-11/30/90 60-minute interval for station 05548000, map number 5
POPCK.Q90	348,554	Discharge unit-value data, 10/01/90-11/30/90 15-minute interval for station 05550500, map number 35
POPCK.S90	338,292	Stage unit-value data, 10/01/90-11/30/90 15-minute interval for station 05550500, map number 35
RAWSON.S90	164,618	Stage unit-value data, 10/01/90-11/30/90 15-minute interval for station 05549800, map number 16
SELG.D90	339,282	Tailwater-stageunit-value data, 10/01/90-11/30/90 15-minute interval for station 05551000, map number 36
SELG.Q90	350,258	Discharge unit-value data, 10/01/90-11/30/90 15-minute interval for station 05551000, map number 36

Table 7. Summary of unit-value stage and discharge data files, size, and descriptions in library DAT90.EXE--Continued

File name	Size (bytes)	Description
SELG.U90	345,088	Headwater-stage unit-value data, 10/01/90/11/30/90 15-minute interval for station 05551000, map number 36
SQWCK.Q90	350,770	Discharge unit-value data, 10/01/90-11/30/90 15-minute interval for station 05547755, map number 4
SQWCK.S90	349,148	Stage unit-value data, 10/01/90-11/30/90 15-minute interval for station 05547755, map number 4
WILMOT.Q90	343,368	Stage unit-value data, 10/01/90-11/30/90 15-minute interval for station 05546500, map number 1
WILMOT.S90	339,491	Stage unit-value data, 10/01/90-11/30/90 15-minute interval for station 05546500, map number 1

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