Prepared in cooperation with the Beaver Water District

Constituent Concentrations, Loads, and Yields to Beaver Lake, Arkansas, Water Years 1999–2008

Scientific Investigations Report 2010–5181

U.S. Department of the Interior
U.S. Geological Survey

Front cover. War Eagle Creek near Hindsville, Arkansas. Photograph provided by Robert Morgan, Beaver Water District.

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U.S. Geological Survey, Reston, Virginia: 2010

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Suggested citation:
Bolyard, S.E., De Lanois, J.L., and Green, W.R., 2010, Constituent concentrations, loads, and yields to Beaver Lake, Arkansas, water years 1999–2008: U.S. Geological Survey Scientific Investigations Report 2010–5181, 43 p.

Acknowledgments

The U.S. Army Corps of Engineers supported the partial-flow streamflow monitoring at White River near Fayetteville and War Eagle Creek near Hindsville. The Arkansas Natural Resources Commission supported some of the water-quality monitoring at White River near Fayetteville.

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Conversion Factors

Multiply	By	To obtain
	Length	
kilomter (km)	0.6214	mile (mi)
meter (m)	3.281	foot (ft)
	Area	
square kilometer (km^2)	0.3861	square mile (mi^2)
	Volume	
cubic meter (m^3)	0.0008107	acre-foot (acre-ft)
	Flow rate	
cubit meter per second (m^3/s)	35.315	cubic foot per second (ft^3/s)
	Mass	
kilogram (kg)	2.250	pound avoirdupois (lb)
kilogram per day (kg/d)	2.205	pound per day (lb/d)
kilogram per year (kg/yr)	2.205	pound per years (lg/yr)
kilogram per year per square kilometer ($kg/yr/km^2$)	5.710	pound per year per square mile ($lb/yr/mi^2$)

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).)

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Altitude, as used in this report, refers to distance above the vertical datum.

Concentrations of chemical constituents in water are given either in milligrams per liter (mg/L) or micrograms per liter (µg/L).

Estimated concentration (“E” remark code)—Positive detections below the LRL are not censored. Detected analytes with concentrations between the LT-MDL and LRL are reported as estimated (“E” remark code). This is because a detection in this region should have a < 1 – percent probability of being a false positive (Childress and others, 1999). There are several circumstances that dictate this code; this is one of the most common.

Laboratory reporting level (LRL)—Generally equal to twice the yearly determined LT-MDL. The LRL controls false negative error. The probability of falsely reporting a non-detection for a sample that contained an analyte at a concentration equal to or greater than the LRL is predicted to be less than or equal to 1 percent. The value of the LRL will be reported with a “less than” remark code for samples in which the analyte was not detected. The National Water Quality Laboratory collects quality-control data from selected analytical methods on a continuing basis to determine long-term method detection levels (LT-MDL’s) and establish laboratory reporting levels (LRL’s). These values are re-evaluated annually based on the most current quality-control data and may, therefore, change (Childress and others, 1999).

Long-term method detection level (LT-MDL)—A detection level derived by determining the standard deviation of a minimum of 24 MDL spike sample measurements over an extended period of time. LT-MDL data are collected on a continuous basis to assess year-to-year variations in the LT-MDL. The LT-MDL controls false positive error. The chance of falsely reporting a concentration at or greater than the LT-MDL for a sample that did not contain the analyte is predicted to be less than or equal to 1 percent (Childress and others, 1999).

Method detection limit (MDL)—Minimum concentration of a substance that can be measured and reported with 99-percent confidence that the analyte concentration is greater than zero. It is determined from the analysis of a sample in a given matrix containing the analyte (U.S. Environmental Protection Agency, 1997). At the MDL concentration, the risk of a false positive is predicted to be less than or equal to 1 percent (Childress and others, 1999).

Minimum reporting level (MRL)—Smallest measured concentration of a constituent that may be reliably reported by using a given analytical method (Timme, 1995).

Water year (WY)—Is the period October 1 through September 30 designated by the calendar year in which it ends, for example, the 2008 water year runs from October 1, 2007 to September 30, 2008 (Rantz and others,1982).

Constituent Concentrations, Loads, and Yields to Beaver Lake, Arkansas, Water Years 1999–2008

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Abstract

Beaver Lake is a large, deep-storage reservoir used as a drinking-water supply and considered a primary watershed of concern in the State of Arkansas. As such, information is needed to assess water quality, especially nutrient enrichment, nutrient-algal relations, turbidity, and sediment issues within the reservoir system. Water-quality samples were collected at three main inflows to Beaver Lake: the White River near Fayetteville, Richland Creek at Goshen, and War Eagle Creek near Hindsville. Water-quality samples collected over the period represented different flow conditions (from low to high). Constituent concentrations, flow-weighted concentrations, loads, and yields from White River, Richland Creek, and War Eagle Creek to Beaver Lake for water years 1999–2008 were documented for this report. Constituents include total ammonia plus organic nitrogen, dissolved nitrite plus nitrate nitrogen, dissolved orthophosphorus (soluble reactive phosphorus), total phosphorus, total nitrogen, dissolved organic carbon, total organic carbon, and suspended sediment. Linear regression models developed by computer program S-LOADEST were used to estimate loads for each constituent for the 10-year period at each station. Constituent yields and flow-weighted concentrations for each of the three stations were calculated for the study.

Constituent concentrations and loads and yields varied with time and varied among the three tributaries contributing to Beaver Lake. These differences can result from differences in precipitation, land use, contributions of nutrients from point sources, and variations in basin size. Load and yield estimates varied yearly during the study period, water years 1999–2008, with the least nutrient and sediment load and yields generally occurring in water year 2006, and the greatest occurring in water year 2008, during a year with record amounts of precipitation. Flow-weighted concentrations of most constituents were greatest at War Eagle Creek near Hindsville than White River near Fayetteville and Richland Creek at Goshen. Loads and yields of most constituents were greater at the War Eagle Creek and White River stations than at the Richland Creek Station.

Introduction

Beaver Lake (fig. 1) is a large, deep-storage reservoir located in the White River Basin in northwestern Arkansas. The reservoir was completed in 1963 for the purposes of flood control, hydroelectric power, and water supply. Beaver Lake is the primary drinking-water supply for northwestern Arkansas. In addition, the reservoir is used for fish and wildlife habitat, and for recreation, and receives wastewater-treatment plant outflow. Because of the importance of Beaver Lake, it is considered a primary watershed of concern for the State of Arkansas. Information is needed to assess water quality, especially nutrient enrichment, nutrient-algal relations, turbidity, and sediment issues within the reservoir system.

The U.S. Geological Survey (USGS) along with the U.S. Army Corps of Engineers (USACE) has monitored streamflow into Beaver Lake since it was impounded in 1963, including a discontinued station at the White River, downstream from Beaver Dam in Table Rock Lake since 1909. In 1999, streamflow-gaging stations at White River near Fayetteville (USGS station number 07048600) and War Eagle Creek near Hindsville (USGS station number 07049000) were converted from partial-record stations (supported by the USACE) to continuous-record stations, and a new streamflow-gaging station was established on Richland Creek at Goshen (USGS station number 07048800), in cooperation with Beaver Water District. Also, periodic water-quality samples were collected at the White River near Fayetteville station in cooperation with Arkansas Soil and Water Conservation Commission, now Arkansas Natural Resources Commission. In 2001, USGS in cooperation with Beaver Water District modified the White River near Fayetteville water-quality sampling and initiated water-quality sampling at both the Richland Creek and War Eagle Creek stations. Water-quality sampling has continued at all three stations to present. Data collected by the USGS in cooperation with Beaver Water District from water years 1999 through 2008 are summarized in this report (appendix 1). A water year is the period October 1 through September 30 designated by the calendar year in which it ends. The USGS, in cooperation with Beaver Water District, used streamflow and

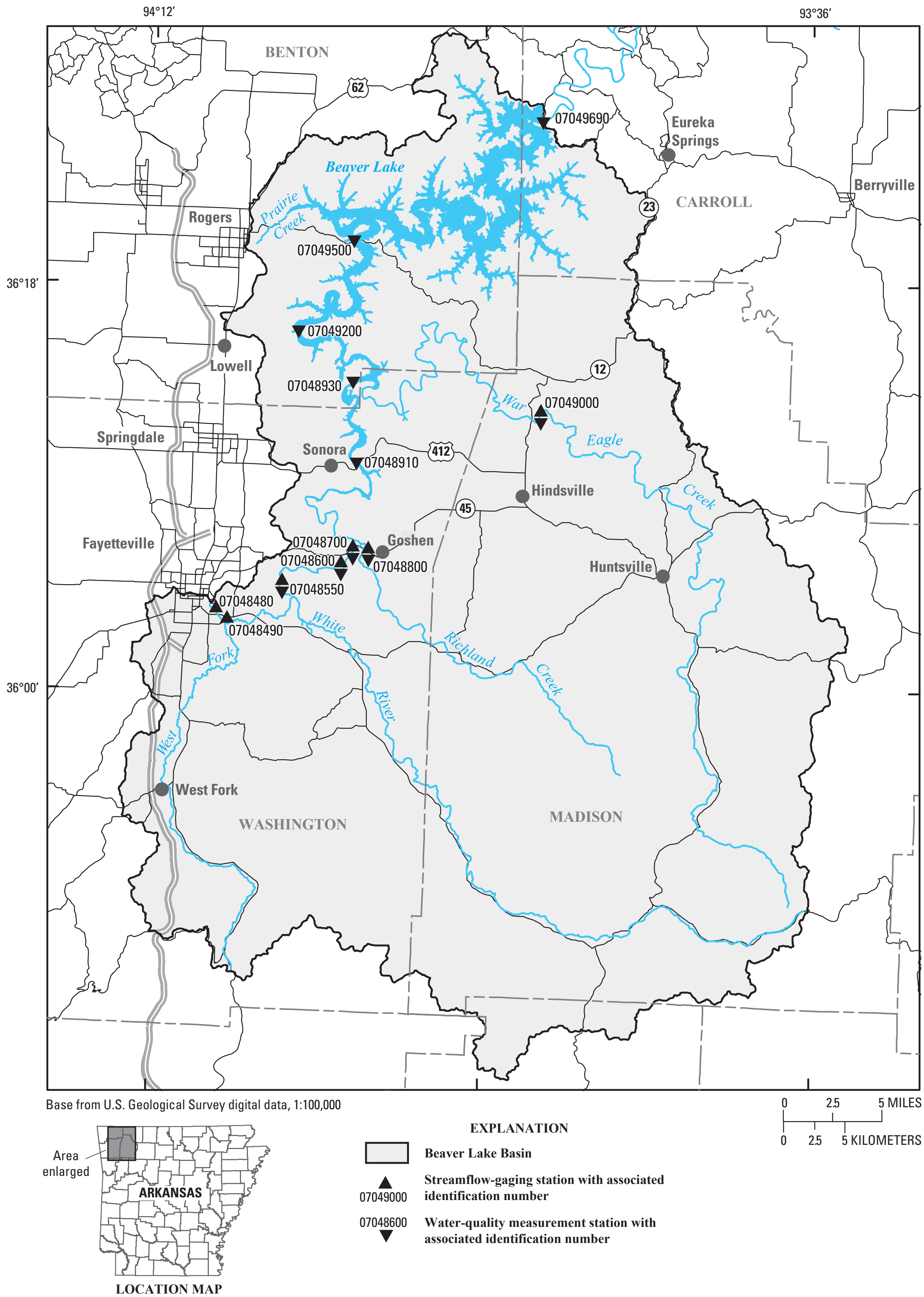

Figure 1. Beaver Lake Basin with streamflow and lake water-quality measurement sites (from Galloway and Green, 2006b).

water-quality data in a study to evaluate constituent concentrations and loads to Beaver Lake.

Study Area Description

Beaver Lake was impounded in 1963 on the White River, northeast of the city of Fayetteville, Arkansas, and in 1968, the reservoir reached conservation capacity (Haggard and Green, 2002). The conservation capacity of the reservoir is the storage capacity used for hydroelectric power, water supply, fish and wildlife, recreation, and water quality (U.S. Army Corps of Engineers, 1997). The basin has a drainage area of 3.087 km^2 at the Beaver Lake Dam. Beaver Lake contains 6,693 million m^3 (1,653,833 acre-ft) of water at the top of the current conservation pool (341.5 m above NAVD of 1988) at a surface area of 114 km^2 (Haggard and Green, 2002). The length of the reservoir is 80 km from the White River at the Highway 45 Bridge to the Beaver Lake Dam. The depth of the reservoir at the dam at conservation pool elevation is 60 m, and the average depth through the reservoir is 17 m (Haggard and Green, 2002).

Beaver Lake is affected by point and nonpoint sources of nutrients, sediment, and pathogens. The city of Fayetteville discharges about one-half of its treated sewage effluent into the White River immediately upstream from the backwater of the reservoir—however, the discharge is located downstream from the station where the sample was collected (USGS station 07048600). The city of West Fork discharges its treated sewage effluent into the West Fork of the White River, and the city of Huntsville discharges treated sewage effluent into a tributary of War Eagle Creek. Nutrients, sediment, pathogenic bacteria, and other constituents unrelated to municipal wastewater also can enter Beaver Lake through its tributaries and around its shoreline. The greatest increase in population in the State of Arkansas from 1990 to 2000 occurred in Benton, Washington, and Carroll Counties in northwestern Arkansas surrounding Beaver Lake where the population increased from approximately 239,000 to 335,000 (U.S. Census Bureau, 2009). The principal agricultural activity in the area is poultry production and secondarily, cattle production. As a result of all these factors, there is substantial concern about the current and future water quality of Beaver Lake.

The main inflows into Beaver Lake are the White River, Richland Creek, and War Eagle Creek (fig. 1). Several smaller tributaries also flow into the reservoir. The Basin has a drainage area of 2,968 km^2 upstream from Beaver Lake Dam. The White River is the largest tributary to Beaver Lake with a drainage area of 1,040 km^2 upstream from the streamflow-gaging station near Fayetteville (White River near Fayetteville, Arkansas, USGS station number 07048600), composing approximately 35 percent of the drainage area of Beaver Lake at the dam. War Eagle Creek is the second largest tributary to Beaver Lake with a drainage area of 681 km^2 at the streamflow-gaging station near Hindsville (War Eagle Creek near Hindsville, Arkansas, USGS station number 07049000), composing approximately 22 percent of the Beaver Lake Basin upstream from the dam. Richland Creek is another major tributary to Beaver Lake, with a drainage area of 357 km^2 upstream from the streamflow-gaging station at Goshen (Richland Creek at Goshen, Arkansas, USGS station number 07048800), composing approximately 12 percent of the drainage area of Beaver Lake upstream from the dam. Combined, these three tributaries (at the streamflow-gaging stations) represent approximately 69 percent of the total drainage area of Beaver Lake.

Purpose and Scope

The purpose of this report is to describe constituent concentrations, flow-weighted concentrations, loads, and yields to Beaver Lake for White River, Richland Creek, and War Eagle Creek for the study period, water years 1999–2008. Constituents include total ammonia plus organic nitrogen, dissolved nitrite plus nitrate nitrogen, total nitrogen, dissolved orthophosphorus (soluble reactive phosphorus), total phosphorus, dissolved organic carbon, total organic carbon, and suspended sediment.

Methods

Water-Quality Data Collection and Analysis

The USGS operates 7 continuous streamflow-gaging stations and 10 water-quality sampling stations in the Beaver Lake Basin in northwestern Arkansas (fig. 1). Three streamflow-gaging stations with water-quality sampling at the same stations were selected for use in this report: White River near Fayetteville, Arkansas (USGS station 07048600), Richland Creek at Goshen, Arkansas (USGS station 07048800), and War Eagle Creek near Hindsville, Arkansas (USGS station 07049000) (table 1, fig. 1). Stream gages were operated and streamflows were measured according to the methods described in Rantz and others (1982). Streamflow, in cubic feet per second, was computed every 15 minutes and averaged daily from 1999 through 2008 (and continues) at White River near Fayetteville, Richland Creek at Goshen, and War Eagle Creek near Hindsville, and was converted to cubic meters per second for this report (fig. 1, table 1). Water-quality samples, with corresponding instantaneous streamflows (streamflow at the time of sample collection), were collected during low-, moderate-, and high-flow conditions (fig. 2). The White River near Fayetteville water-quality sampling record began with bimonthly (occurring every 2 months) and high-flow event sampling from November 1999 through October 2000. Monthly and high-flow event samples were collected at the White River near Fayetteville beginning in January 2001 and at Richland Creek at Goshen and War Eagle Creek near

Table 1. Station information and streamflow statistics for continuous streamflow gaging stations used for water-quality monitoring in the Beaver Lake Basin, Arkansas.

[WY, water year; ddmmss, degrees, minutes, seconds in NGVD of 1929; km², square kilometer; m³/s, cubic meter per second]

Station name (number)	Period of record for station (WY)	Latitude (ddmmss)	Longitude (ddmmss)	Drainage area (km²)	Mean annual (WY) streamflow (m³/s)											Minimum and maximum daily mean streamflow for study period, 10/01/1998 – 09/30/2008 (m³/s)	
					1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Period of record	Minimum (date)	Maximum (date)
White River near Fayetteville (07048600)	1964–1994; 1999–2008	360423	940452	1,040	16.7	11.8	11.6	20.7	8.58	21.0	14.0	5.38	14.8	24.7	14.9	0.007 (09/18/2000)	1,340 (04/24/2004)
Richland Creek at Goshen (07048800)	1999–2008	360615	940027	357	5.75	2.94	2.64	5.61	2.14	6.65	4.33	1.64	3.68	14.6	4.98	0.003 (08/03/2006)	957 (04/10/2008)
War Eagle Creek near Hindsville (07049000)	1953–1970; 1999–2008	361200	935118	681	11.8	5.58	5.64	12.2	4.08	8.16	8.44	3.60	8.35	15.5	8.32	0.232 (10/11/2005)	767 (03/19/2008)

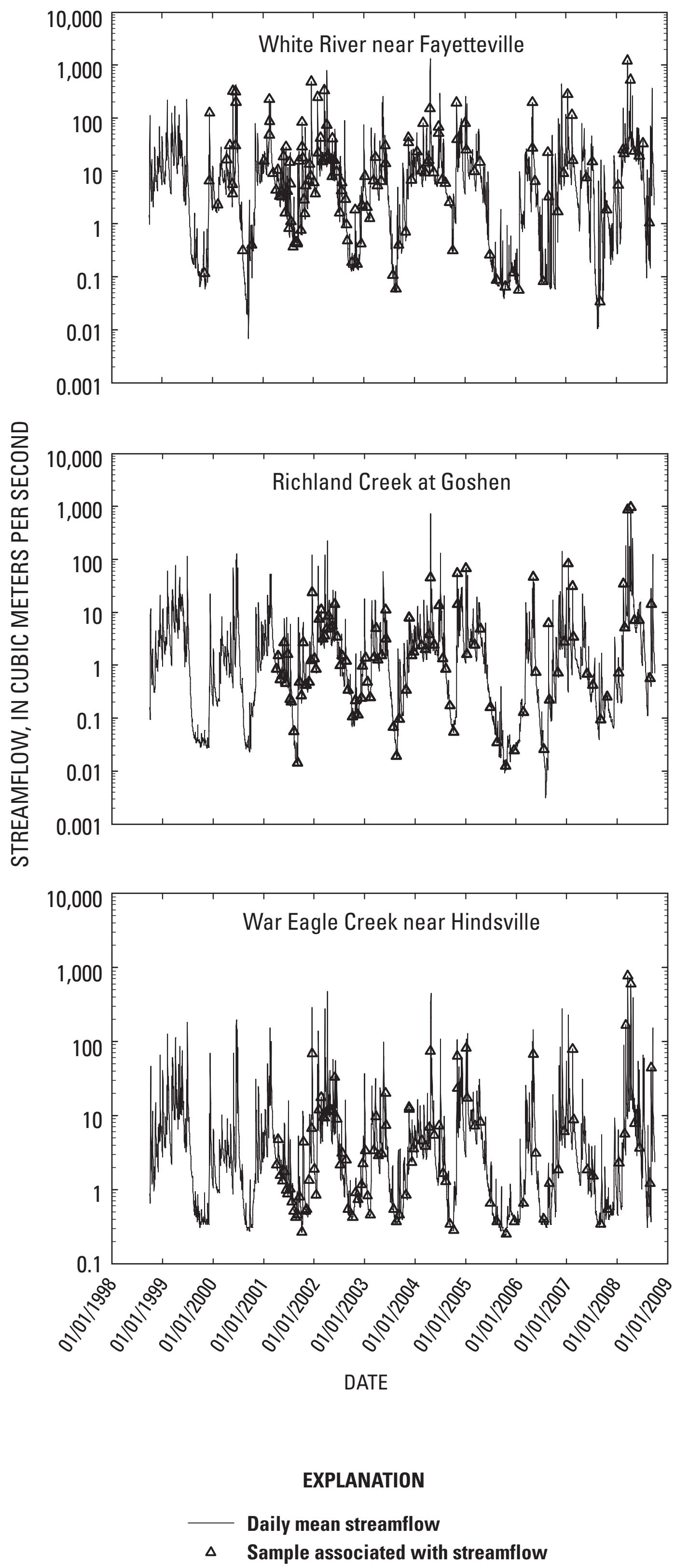

Figure 2. Streamflow hydrograph with sample points for White River near Fayetteville, Arkansas, Richland Creek at Goshen, Arkansas, and War Eagle Creek near Hindsville, Arkansas, for water years 1999–2008.

Hindsville beginning in April 2001. Samples were collected through November 2004. Bimonthly and high-flow event samples were collected at all three stations from January 2005 through September 2008. Representative water-quality samples were collected using equal-width increment methods (Edwards and Glysson, 1999).

The USGS National Water Quality Laboratory in Lakewood, Colorado, analyzed the water-quality samples for total ammonia plus organic nitrogen, dissolved nitrite plus nitrate, dissolved orthophosphorus, total phosphorus, total nitrogen (Fishman, 1993), dissolved organic carbon (Brenton and Arnett, 1993), and total organic carbon (Wershaw and others, 1987). Constituent concentrations were reported as uncensored values if they were greater than the laboratory reporting level (LRL). The LRL is set to reduce false positive error and is equal to twice the yearly determined long-term method detection level (LT-MDL). When the constituent was not detected, the LRL value was reported with a "less than" remark code and was considered a censored value. Estimated values with concentrations between the LT-MDL and the LRL are reported with an "E" remark code because of low confidence in the value (Childress and others, 1999). For the purposes of describing the mean and computing loads, censored values were converted to the LT-MDL value (with the "less than" remark code), if the LRL was reported at the time of the sample analysis, and "E" remark codes were removed. If the censored values were reported as less than the LT-MDL at the time of analysis, no alteration was made. The modified water-quality values with remark codes described above, which were used to determine the mean and loads, are found in the appendix (appendix 1).

Suspended-sediment samples were collected during low-, moderate-, and high-flow conditions. The USGS Missouri Water Science Center Sediment Laboratory in Rolla, Missouri, analyzed samples for suspended-sediment concentration following procedures established in Guy (1969).

Streamflow data measured from October 1998 through December 2008 are presented in this report. All streamflow data described are available on the web at *http://water.usgs.gov/ar/nwis.*

Constituent Load and Yield Estimation

Linear regression models developed by computer program S-LOADEST were used to estimate loads for each constituent for the 10–year period at each station (table 2). Data from all three tributaries generally appeared to fit the models. Load is the mass of a constituent transported past a selected point in a stream in a given amount of time, usually 1 year. The S-LOADEST program (TIBCO Software Inc., 2008) was used to estimate constituent loads by the rating-curve method (Cohn and others, 1989; Crawford, 1991) for the White River, Richland Creek, and War Eagle Creek stations. S-LOADEST estimates loads using mean daily streamflow, streamflow rating-curve parameters, several regression methods, and a ratio estimator. Because some of the constituent concentrations included in the S-LOADEST analyses were censored values, parameters were estimated by the adjusted maximum likelihood estimation (AMLE) method (Cohn, 1988; Cohn and others, 1992). In the absence of censored data, the method converts to the maximum likelihood estimation (MLE) method (Dempster and others, 1977; Wolynetz, 1979). Uncertainty in the estimated load was obtained using the method described by Likes (1980) and Gilroy and others (1990). The model (equation 1) used to calculate loads was based on the relation between the natural logarithms of L and Q:

$$ln(L) = b_0 + b_1\, ln(Q)$$

where

- ln is natural logarithm;
- L is constituent load, in kilograms per day (kg/d);
- b_0 is regression constant, dimensionless;
- b_1 is a regression coefficient, dimensionless;
- Q is daily mean streamflow, in cubic meters per second (m^3/s).

Estimated mean annual constituent loads and standard error of prediction (SEP) of the mean loads were calculated by S-LOADEST using all available data for each constituent for the 10-year period. The coefficient of determination (R^2) is the proportion of variability in the data set that is accounted for by the statistical model. For this report, an R^2 value of 0.90 or greater was considered a valid regression model. R^2 values less than 0.90, which demonstrates a positive relation, were not considered valid. Estimated residual variance is the maximum likelihood estimation variance corrected for the number of observations, number of censored observations, and number of parameters in the regression model.

The 95-percent confidence interval is the interval that has a 95-percent chance of containing the true regression line. In contrast, the 95-percent prediction interval is the interval in which you expect 95 percent of all data points to fall. A major factor determining the width of a confidence interval is the size of the sample used in the estimation procedure, with smaller samples having wider confidence intervals (Helsel and Hirsch, 2002).

Constituent yields for each of the three stations were calculated by dividing mean annual constituent load by the drainage area, in square kilometers (table 1). Flow-weighted concentrations for each of the three stations were calculated by dividing mean annual constituent loads by mean annual streamflow and multiplying by a conversion factor to adjust the units.

Linear regression was used to examine the relations between estimated daily loads and measured instantaneous loads, both reported in kilograms per day. Instantaneous load is calculated by multiplying streamflow, in cubic meters per second, constituent concentration, in milligrams per liter, and a conversion factor to convert to kilograms per day. The

Table 2. Regression models developed using constituent concentrations from water samples collected at water-quality stations at the White River near Fayetteville, Arkansas, water years 1999–2008, Richland Creek at Goshen, Arkansas, and War Eagle Creek near Hindsville, Arkansas, water years 2001–08.

[N, nitrogen; ln, natural logarithm; L, daily load in kilograms per day; Q, daily mean streamflow in cubic meter per second; P, phosphorus]

Station name (number)	Constituent (parameter code)	Number of observations	Number of censored observations[1]	Regression model	Estimated residual variance[2]	Coefficient of determination (R^2)
White River near Fayetteville (07048600)	Total ammonia + organic nitrogen, as N (00625)	146	28	ln(L) = 5.29 + 1.13*lnQ	0.936	0.87
	Dissolved nitrite + nitrate, as N (00631)	146	0	ln(L) = 5.42 + 1.15*lnQ	0.419	0.94
	Total nitrogen (00600)	118	0	ln(L) = 6.31 + 1.16*lnQ	0.146	0.98
	Dissolved orthophosphorus, as P (00671)	146	81	ln(L) = 1.03 + 1.38*lnQ	1.48	0.87
	Total phosphorus (00665)	146	37	ln(L) = 3.03 + 1.42*lnQ	1.19	0.90
	Dissolved organic carbon (00681)	104	0	ln(L) = 6.96 + 1.02*lnQ	0.321	0.94
	Total organic carbon (00680)	103	0	ln(L) = 7.13 + 1.09*lnQ	0.424	0.93
	Suspended sediment (80154)	146	0	ln(L) = 10.2 + 1.40*lnQ	0.674	0.94
Richland Creek at Goshen (07048800)	Total ammonia + organic nitrogen, as N (00625)	102	38	ln(L) = -3.61 + 1.05*lnQ	1.26	0.97
	Dissolved nitrite + nitrate, as N (00631)	102	2	ln(L) = -2.33 + 1.05*lnQ	1.51	0.96
	Total nitrogen (00600)	62	0	ln(L) = -0.771 + 1.04*lnQ	0.427	0.99
	Dissolved orthophosphorus, as P (00671)	102	60	ln(L) = -7.38 + 1.06*lnQ	2.24	0.94
	Total phosphorus (00665)	102	51	ln(L) = -6.58 + 1.11*lnQ	2.55	0.94
	Dissolved organic carbon (00681)	102	0	ln(L) = -0.959 + 1.03*lnQ	0.418	0.99
	Total organic carbon (00680)	102	0	ln(L) = -0.921 + 1.04*lnQ	0.476	0.99
	Suspended sediment (80154)	102	0	ln(L) = 1.04 + 1.10*lnQ	1.28	0.97

Table 2. Regression models developed using constituent concentrations from water samples collected at water-quality stations at the White River near Fayetteville, Arkansas, water years 1999–2008, Richland Creek at Goshen, Arkansas, and War Eagle Creek near Hindsville, Arkansas, water years 2001–08.—Contiinued

[N, nitrogen; ln, natural logarithm; L, daily load in kilograms per day; Q, daily mean streamflow in cubic meter per second; P, phosphorus]

Station name (number)	Constituent (parameter code)	Number of observations	Number of censored observations[1]	Regression model	Estimated residual variance[2]	Coefficient of determination (R^2)
War Eagle Creek near Hindsville (07049000)	Total ammonia + organic nitrogen, as N (00625)	100	36	$\ln(L) = 4.76 + 1.20{*}\ln Q$	0.959	0.82
	Dissolved nitrite + nitrate, as N (00631)	100	0	$\ln(L) = 6.52 + 0.997{*}\ln Q$	0.202	0.94
	Total nitrogen (00600)	64	0	$\ln(L) = 7.02 + 1.10{*}\ln Q$	0.111	0.98
	Dissolved orthophosphorus, as P (00671)	100	18	$\ln(L) = 2.58 + 1.12{*}\ln Q$	1.05	0.79
	Total phosphorus (00665)	100	11	$\ln(L) = 3.49 + 1.28{*}\ln Q$	0.613	0.89
	Dissolved organic carbon (00681)	100	0	$\ln(L) = 7.21 + 1.14{*}\ln Q$	0.336	0.92
	Total organic carbon (00680)	98	0	$\ln(L) = 7.36 + 1.19{*}\ln Q$	0.331	0.93
	Suspended sediment (80154)	100	1	$\ln(L) = 9.86 + 1.41{*}\ln Q$	1.02	0.86

[1]Censored observations are a result of an analysis value lower than the laboratory minimum reporting level.

[2]Estimated residual variance is the maximum likelihood estimation variance corrected for the number of observations, number of censored observations, and number of parameters in the regression model.

slope of the regression relates to how well the loading model estimates constituent loading. A line originating at zero with a slope of 1.0 would be the ideal relation.

Means, along with maxima, minima, and medians, were determined by an S-Plus software (TIBCO Software Inc., 2008) data summary statistics application applied to the data in appendix 1 (table 3).

Quality Assurance and Control

Field methods were conducted following procedures described in the USGS National Field Manual (U.S. Geological Survey, variously dated). Nutrient, total organic carbon, and dissolved organic carbon analyses were conducted at the USGS National Water Quality Laboratory in Denver, Colorado, following procedures described in Fishman (1993). SSC analyses were conducted at the USGS laboratory in Rolla, Missouri, following procedures described in Guy (1969). Field measurements, including water temperature, dissolved-oxygen concentration, pH, and specific conductance also were collected with each sample following protocols described in Wilde and Radke (1998).

To maintain proper quality assurance and control (QA/QC) of water-quality data, protocols for instrument calibration (Wilde and Radke, 1998) and equipment cleaning (Wilde and others, 1998) were followed. Associated blank and replicate water-quality samples also were collected by USGS personnel periodically. Results indicated that cleaning procedures were adequate in preventing cross-contamination of samples and that the laboratory results were reproducible. Results for QA/QC samples are available at the USGS National Water Information System webpage (*http://waterdata.usgs.gov/nwis*) and can be obtained through the USGS Arkansas Water Science Center in Little Rock, Arkansas.

Constituent Concentrations, Loads, and Yields for White River, a Tributary to Beaver Lake, near Fayetteville

Total Ammonia plus Organic Nitrogen

Total ammonia plus organic nitrogen concentrations for White River near Fayetteville ranged from less than 0.06 to 2.6 mg/L as N with a mean concentration of 0.48 mg/L as N (table 3). Concentrations tended to increase with increasing streamflow (fig. 3). Loads were estimated as a function of streamflow (R^2 = 0.87; table 2). These estimated loads then were compared to instantaneous measured load with a slope of 0.88 (fig. 4). For total ammonia plus organic nitrogen, the 10-year mean load was 294,000 kg/yr as N (table 4) and mean yield was 283 kg/yr/km^2 as N (table 5). Estimated mean annual flow-weighted concentration was 0.61 mg/L as N (table 6).

Dissolved Nitrite plus Nitrate Nitrogen

Dissolved nitrite plus nitrate concentrations for White River near Fayetteville ranged from 0.03 to 1.4 mg/L as N with a mean concentration of 0.44 mg/L as N (table 3). Concentrations tended to increase with increasing streamflow (fig. 3). Loads were estimated as a function of streamflow (R^2 = 0.94; table 2). These estimated loads were then compared to instantaneous measured load with a slope of 0.90 (fig. 4). For dissolved nitrate plus nitrite, the 10-year mean load was 273,000 kg/yr as N (table 4) and mean yield was 262 kg/yr/km^2 as N (table 5). Estimated mean annual flow-weighted concentration was 0.57 mg/L as N (table 6).

Total Nitrogen

Total nitrogen concentrations for White River near Fayetteville ranged from 0.31 to 3.0 mg/L with a mean concentration of 0.98 mg/L (table 3). Concentrations tended to increase with increasing streamflow (fig. 3). Loads were estimated as a function of streamflow (R^2 = 0.98; table 2). These estimated loads were then compared to instantaneous measured load with a slope of 0.94 (fig. 4). For total nitrogen, the 10-year mean load was 593,000 kg/yr (table 4) and mean yield was 570 kg/yr/km^2 (table 5). Estimated mean annual flow-weighted concentration was 1.23 mg/L (table 6).

Dissolved Orthophosphorus

Dissolved orthophosphorus concentrations for White River near Fayetteville ranged from less than 0.003 to 0.110 mg/L as P with a mean concentration of 0.015 mg/L as P (table 3). Concentrations tended to increase slightly with increasing streamflow (fig. 3). Loads were estimated as a function of streamflow (R^2 = 0.87; table 2). These estimated loads were then compared to instantaneous measured load with a slope of 1.09 (fig. 4). For dissolved orthophosphorus, the 10-year mean load was 10,300 kg/yr as P (table 4) and mean yield was 10 kg/yr/km^2 as P (table 5). Estimated mean annual flow-weighted concentration was 0.02 mg/L as P (table 6).

Total Phosphorus

Total phosphorus concentrations for White River near Fayetteville ranged from less than 0.010 to 0.600 mg/L with a mean concentration of 0.084 mg/L (table 3). Concentrations tended to increase with increasing streamflow (fig. 3). Loads were estimated as a function of streamflow (R^2 = 0.90; table 2). These estimated loads were then compared to instantaneous measured load with a slope of 0.96 (fig. 4). For total phosphorus, the 10-year mean load was 73,200 kg/yr (table 4)

Table 3. Summary statistics of constituent concentrations from water samples collected at water-quality stations for the White River near Fayetteville, Arkansas, water years 1999 – 2008, Richland Creek at Goshen, Arkansas, and War Eagle Creek near Hindsville, Arkansas, water years 2001-2008.

[mg/L, milligram per liter; N, nitrogen; P, phosphorus; <, less than the method detection level. All concentration data, including censored data, were used to calculate statistics]

		Constituent concentrations					
Station name (number)	Constituent (parameter code)	Minimum (mg/L)	Median (mg/L)	Mean (mg/L)	Maximum (mg/L)	Number of observations	Number of censored observations
White River near Fayetteville (07048600)	Total ammonia + organic nitrogen, as N (00625)	0.06	0.32	0.48	2.6	146	28
	Dissolved nitrite + nitrate, as N (00631)	0.03	0.37	0.44	1.4	146	0
	Total nitrogen (00600)	0.31	0.78	0.98	3.0	118	0
	Dissolved orthophosphorus, as P (00671)	<0.003	0.004	0.015	0.110	146	81
	Total phosphorus (00665)	<0.010	0.030	0.084	0.600	146	37
	Dissolved organic carbon (00681)	0.8	2.4	2.8	10.9	104	0
	Total organic carbon (00680)	0.7	2.7	3.6	19.5	103	0
	Suspended sediment (80154)	2	32	97	950	146	0
Richland Creek at Goshen (07048800)	Total ammonia + organic nitrogen, as N (00625)	<0.05	0.16	0.29	1.6	102	38
	Dissolved nitrite + nitrate, as N (00631)	0.01	0.825	0.850	3.9	102	2
	Total nitrogen (00600)	0.20	1.0	1.2	4.1	62	0
	Dissolved orthophosphorus, as P (00671)	<0.003	0.004	0.017	0.207	102	60
	Total phosphorus (00665)	0.007	0.009	0.044	0.440	102	51
	Dissolved organic carbon (00681)	0.6	1.7	2.56	25.4	102	0
	Total organic carbon (00680)	0.7	1.9	3.00	19.5	102	0
	Suspended sediment (80154)	1	22	58	1,050	102	0
War Eagle Creek near Hindsville (07049000)	Total ammonia + organic nitrogen, as N (00625)	<0.05	0.185	0.28	2.3	100	36
	Dissolved nitrite + nitrate, as N (00631)	0.257	1.12	1.16	2.36	100	0
	Total nitrogen (00600)	0.58	1.4	1.5	2.7	64	0
	Dissolved orthophosphorus, as P (00671)	<0.003	0.020	0.029	0.190	100	18
	Total phosphorus (00665)	0.018	0.040	0.064	0.460	100	11
	Dissolved organic carbon (00681)	0.7	1.6	2.6	29.8	100	0
	Total organic carbon (00680)	0.6	1.8	2.8	21.6	100	0
	Suspended sediment (80154)	<0.5	25	50	727	100	1

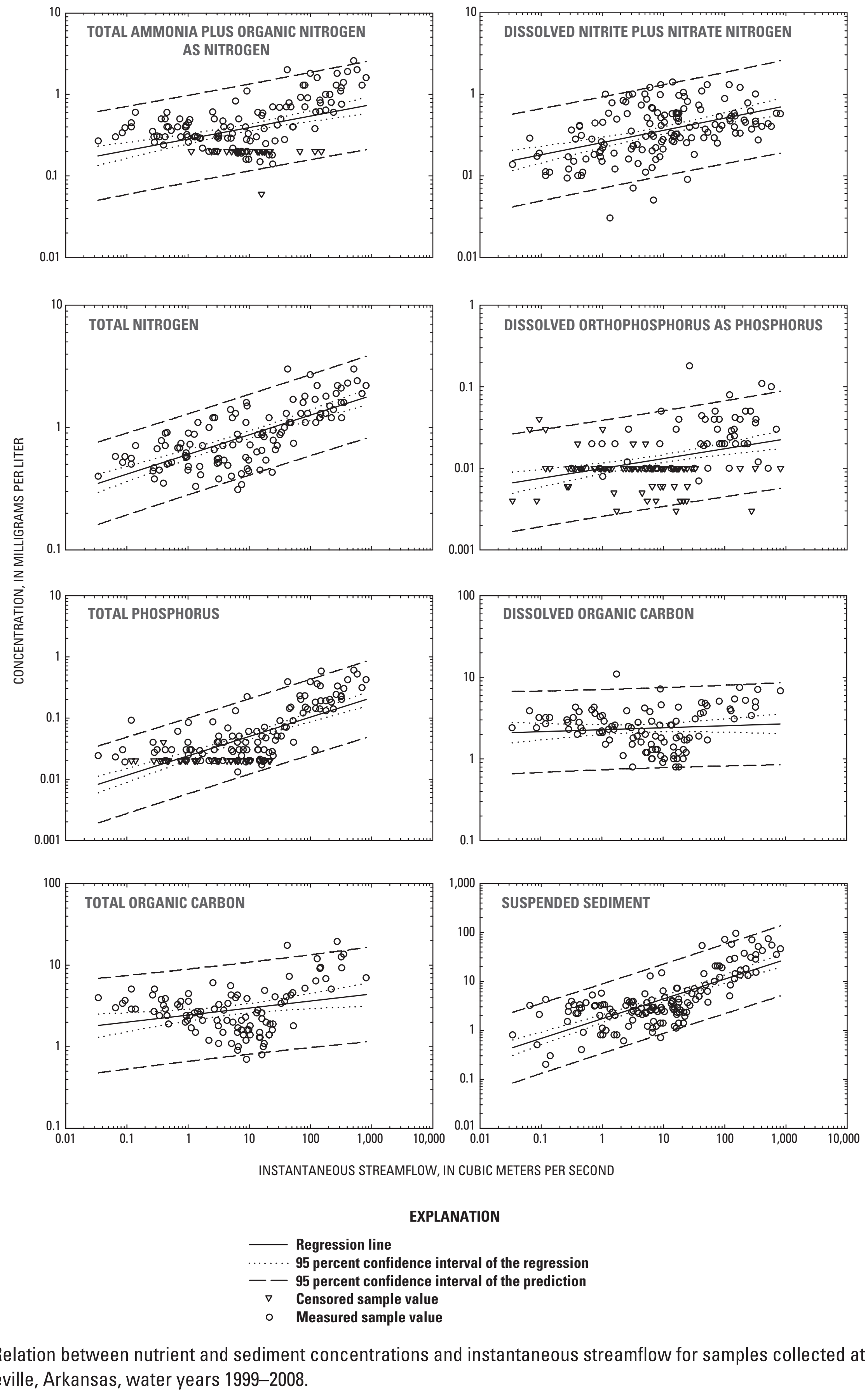

Figure 3. Relation between nutrient and sediment concentrations and instantaneous streamflow for samples collected at White River near Fayetteville, Arkansas, water years 1999–2008.

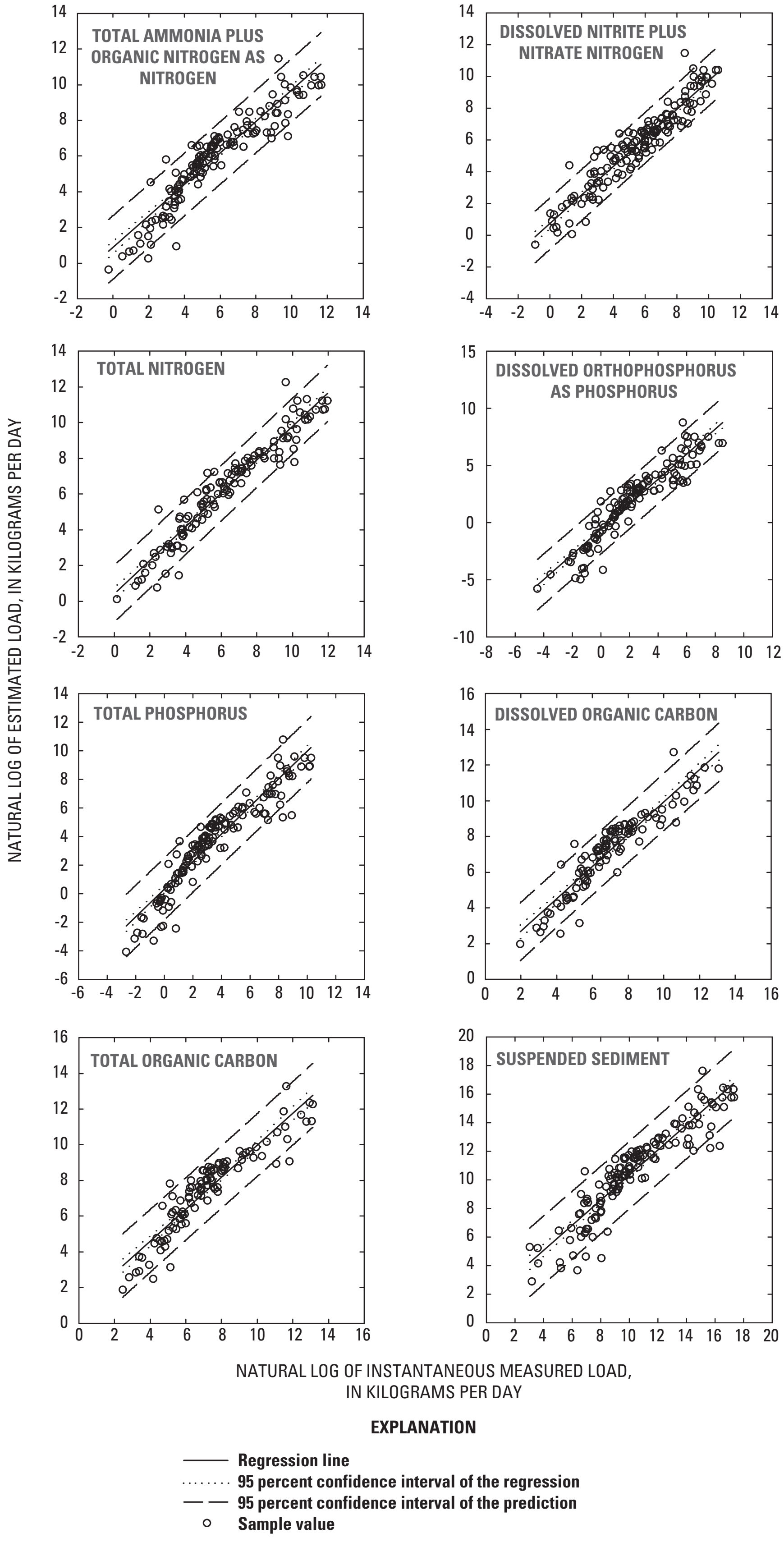

Figure 4. Relation between natural log of instantaneous measured load and natural log of estimated load for samples collected at White River near Fayetteville, Arkansas, water years 1999–2008.

Table 4. Estimated total annual constituent load from constituent concentrations in water samples collected at water-quality stations for the White River near Fayetteville, Arkansas, water years 1999–2008, Richland Creek at Goshen, Arkansas, and War Eagle Creek near Hindsville, Arkansas, water years 2001–08.

Constituent (parameter code)	Total annual load per water year (kilograms per year)												
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Minini-mum	Mean	Maximum
White River near Fayetteville (07048600)													
Total ammonia + organic nitrogen, as N (00625)	310,000	236,000	210,000	422,000	158,000	440,000	263,000	96,100	285,000	520,000	96,100	294,000	520,000
Dissolved nitrite + nitrate, as N (00631)	284,000	219,000	191,000	394,000	145,000	414,000	241,000	87,400	263,000	489,000	87,400	273,000	489,000
Total nitrogen (00600)	612,000	477,000	412,000	860,000	312,000	906,000	521,000	188,000	570,000	1,070,000	188,000	593,000	1,070,000
Dissolved orthophos-phorus, as P (00671)	9,000	8,400	5,930	15,800	4,700	18,300	7,960	2,680	9,250	20,800	2,680	10,300	20,800
Total phospho-rus (00665)	61,800	59,700	40,700	114,000	32,500	134,000	55,000	18,400	64,900	151,000	18,300	73,200	151,000
Dissolved or-ganic carbon (00681)	1,540,000	1,100,000	1,060,000	1,940,000	788,000	1,980,000	1,290,000	492,000	1,370,000	2,330,000	492,000	1,390,000	2,330,000
Total or-ganic carbon (00680)	2,150,000	1,590,000	1,470,000	2,830,000	1,100,000	2,930,000	1,810,000	674,000	1,950,000	3,460,000	674,000	2,000,000	3,460,000
Suspended sediment (80154)	58,300,000	55,800,000	38,400,000	106,000,000	30,600,000	125,000,000	51,800,000	17,400,000	60,800,000	141,000,000	17,400,000	68,500,000	141,000,000
Richland Creek at Goshen (07048800)													
Total ammonia + organic nitrogen, as N (00625)	61,900	32,400	27,700	61,700	22,400	76,800	46,500	17,500	39,700	176,000	17,500	56,300	176,000
Dissolved nitrite + nitrate, as N (00631)	253,000	133,000	113,000	252,000	91,700	314,000	190,000	71,700	162,000	723,000	71,700	230,000	723,000
Total nitrogen (00600)	242,000	126,000	109,000	240,000	88,100	296,000	182,000	68,600	155,000	672,000	68,600	218,000	672,000
Dissolved orthophos-phorus, as P (00671)	2,420	1,270	1,080	2,410	878	3,010	1,820	684	1,550	6,940	684	2,210	6,940
Total phospho-rus (00665)	9,660	5,190	4,200	9,880	3,400	13,000	7,280	2,710	6,240	31,300	2,710	9,290	31,300

Table 4. Estimated total annual constituent load from constituent concentrations in water samples collected at water-quality stations for the White River near Fayetteville, Arkansas, water years 1999–2008, Richland Creek at Goshen, Arkansas, and War Eagle Creek near Hindsville, Arkansas, water years 2001–08.—Continued

Constituent (parameter code)	Total annual load per water year (kilograms per year)												
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Minini-mum	Mean	Maximum
Dissolved organic carbon (00681)	484,000	251,000	219,000	478,000	177,000	584,000	365,000	137,000	310,000	1,310,000	137,000	432,000	1,310,000
Total organic carbon (00680)	586,000	306,000	263,000	583,000	213,000	721,000	441,000	166,000	376,000	1,650,000	166,000	530,000	1,650,000
Suspended sediment (80154)	10,200,000	5,460,000	4,430,000	10,400,000	3,580,000	13,700,000	7,610,000	2,850,000	6,570,000	32,900,000	2,850,000	9,770,000	32,900,000
War Eagle Creek near Hindsville (07049000)													
Total ammonia + organic nitrogen, as N (00625)	141,000	70,200	63,400	165,000	42,000	108,000	96,500	40,300	106,000	242,000	40,300	107,000	242,000
Dissolved nitrite + nitrate, as N (00631)	434,000	206,000	208,000	448,000	151,000	301,000	311,000	133,000	308,000	572,000	133,000	307,000	572,000
Total nitrogen (00600)	665,000	322,000	307,000	728,000	213,000	481,000	466,000	196,000	484,000	996,000	466,000	486,000	996,000
Dissolved orthophosphorus, as P (00671)	15,000	7,290	6,880	16,700	4,730	11,000	10,500	4,380	11,000	23,100	4,380	11,000	23,100
Total phosphorus (00665)	37,800	19,500	16,800	48,400	10,600	31,100	25,400	10,600	29,600	73,600	10,600	30,300	73,600
Dissolved organic carbon (00681)	1,120,000	547,000	509,000	1,260,000	346,000	828,000	774,000	324,000	825,000	1,780,000	324,000	831,000	1,780,000
Total organic carbon (00680)	1,380,000	688,000	622,000	1,620,000	412,000	1,060,000	946,000	395,000	1,040,000	2,370,000	395,000	959,000	2,370,000
Suspended sediment (80154)	33,500,000	18,400,000	14,600,000	47,300,000	8,620,000	31,500,000	21,800,000	9,250,000	28,400,000	80,800,000	8,620,000	29,400,000	80,800,000

Table 5. Estimated mean annual constituent loads and yield estimated from constituent concentrations in water samples collected at water-quality stations for the White River near Fayetteville, Arkansas, water years 1999–2008, Richland Creek at Goshen, Arkansas, and War Eagle Creek near Hindsville, Arkansas, water years 2001–08.

[km^2, square kilometer; kg/yr, kilograms per year; kg/yr/km^2, kilogram per year per square kilometer; SEP, standard error of prediction]

Station name (number)	Drainage area (km^2)	Constituent (parameter code)	Estimated mean annual	
			Total load[1] (+/- SEP) (kg/yr)	Total yield (kg/yr/km^2)
White River near Fayetteville (07048600)	1,040	Total ammonia + organic nitrogen, as N (00625)	294,000 (219)	283
		Dissolved nitrite + nitrate, as N (00631)	273,000 (124)	262
		Total nitrogen (00600)	593,000 (155)	570
		Dissolved orthophosphorus , as P (00671)	10,300 (16)	10
		Total phosphorus (00665)	73,200 (99)	70
		Dissolved organic carbon (00681)	1,390,000 (499)	1,340
		Total organic carbon (00680)	2,000,000 (913)	1,920
		Suspended sediment (80154)	68,500,000 (59,600)	65,900
Richland Creek at Goshen (07048800)	357	Total ammonia + organic nitrogen, as N (00625)	56,300 (63)	158
		Dissolved nitrite + nitrate, as N (00631)	230,000 (301)	644
		Total nitrogen (00600)	218,000 (120)	611
		Dissolved orthophosphorus, as P (00671)	2,210 (4)	6
		Total phosphorus (00665)	9,290 (24)	26
		Dissolved organic carbon (00681)	432,000 (218)	1,210
		Total organic carbon (00680)	530,000 (295)	1,480
		Suspended sediment (80154)	9,770,000 (12,000)	27,400
War Eagle Creek near Hindsville (07049000)	681	Total ammonia + organic nitrogen, as N (00625)	107,000 (103)	157
		Dissolved nitrite + nitrate, as N (00631)	307,000 (90)	451
		Total nitrogen (00600)	486,000 (125)	714
		Dissolved orthophosphorus , as P (00671)	11,000 (10)	16
		Total phosphorus (00665)	30,300 (23)	44
		Dissolved organic carbon (00681)	831,000 (385)	1,220
		Total organic carbon (00680)	959,000 (514)	1,410
		Suspended sediment (80154)	29,400,000 (36,800)	43,200

[1]Calculated by S-LOADEST and are statistics of all data in the 10-year period.

Table 6. Estimated mean annual constituent loads, mean annual streamflows, and mean flow-weighted constituent concentrations at water-quality stations for the White River near Fayetteville, Arkansas, water years 1999–2008, Richland Creek at Goshen, Arkansas, and War Eagle Creek near Hindsville, Arkansas, water years 2001–08.

[kg/yr, kilogram per year; ft^3/s, cubic foot per second; mg/L, milligram per liter; N, nitrogen; P, phosphorus]

Station name (number)	Constituent (parameter code)	Estimated mean annual Load (kg/yr)	Estimated mean annual Flow-weighted concentration (mg/L)
White River near Fayetteville (07048600)	Total ammonia + organic nitrogen, as N (00625)	294,000	0.61
	Dissolved nitrite + nitrate, as N (00631)	273,000	0.57
	Total nitrogen (00600)	593,000	1.23
	Dissolved orthophosphorus, as P (00671)	10,300	0.02
	Total phosphorus (00665)	73,200	0.15
	Dissolved organic carbon (00681)	1,390,000	2.94
	Total organic carbon (00680)	2,000,000	4.19
	Suspended sediment (80154)	68,500,000	136
Richland Creek at Goshen (07048800)	Total ammonia + organic nitrogen, as N (00625)	56,300	0.35
	Dissolved nitrite + nitrate, as N (00631)	230,000	1.42
	Total nitrogen (00600)	218,000	1.35
	Dissolved orthophosphorus, as P (00671)	2,210	0.014
	Total phosphorus (00665)	9,290	0.06
	Dissolved organic carbon (00681)	432,000	2.69
	Total organic carbon (00680)	530,000	3.28
	Suspended sediment (80154)	9,770,000	58.4
War Eagle Creek near Hindsville (07049000)	Total ammonia + organic nitrogen, as N (00625)	107,000	0.39
	Dissolved nitrite + nitrate, as N (00631)	307,000	1.17
	Total nitrogen (00600)	486,000	1.81
	Dissolved orthophosphorus, as P (00671)	11,000	0.04
	Total phosphorus (00665)	30,300	0.11
	Dissolved organic carbon (00681)	831,000	3.07
	Total organic carbon (00680)	959,000	3.84
	Suspended sediment (80154)	29,400,000	102

and mean yield was 70 kg/yr/km^2 (table 5). Estimated mean annual flow-weighted concentration was 0.15 mg/L (table 6).

Dissolved Organic Carbon

Dissolved organic carbon (DOC) concentrations for White River near Fayetteville ranged from 0.8 to 10.9 mg/L with a mean concentration of 2.8 mg/L (table 3). There was little relation between concentrations and streamflow (fig. 3). Loads were estimated as a function of streamflow (R2 = 0.94; table 2). These estimated loads were then compared to instantaneous measured load with a slope of 0.90 (fig. 4). For DOC, the 10-year mean load was 1,390,000 kg/yr (table 4) and mean yield was 1,340 kg/yr/km2 (table 5). Estimated mean annual flow-weighted concentration was 2.94 mg/L (table 6).

Total Organic Carbon

Total organic carbon (TOC) concentrations for White River near Fayetteville ranged from 0.7 to 19.5 mg/L with a mean concentration of 3.6 mg/L (table 3). There was a slight relation between concentration and streamflow (fig. 3). Loads were estimated as a function of streamflow (R2 = 0.93; table 2). These estimated loads were then compared to instantaneous measured load with a slope of 0.89 (fig. 4). For TOC, the 10-year mean load was 2,000,000 kg/yr (table 4) and mean yield was 1,920 kg/yr/km2 (table 5). Estimated mean annual flow-weighted concentration was 4.19 mg/L (table 6).

Suspended Sediment

Suspended sediment concentrations for White River near Fayetteville ranged from 2 to 950 mg/L with a mean concentration of 97 mg/L (table 3). Concentrations tended to increase with an increase in streamflow (fig. 3). Loads were estimated as a function of streamflow (R2 = 0.94; table 2). These estimated loads were then compared to instantaneous measured load with a slope of 0.88 (fig. 4). For suspended sediment, the 10-year mean load was 68,500,000 kg/yr (table 4) and mean yield was 65,900 kg/yr/km2 (table 5). Estimated mean annual flow-weighted concentration was 136 mg/L (table 6).

Constituent Concentrations, Loads, and Yields for Richland Creek, a Tributary to Beaver Lake, at Goshen

Total Ammonia plus Organic Nitrogen

Total ammonia plus organic nitrogen concentrations for Richland Creek at Goshen ranged from less than 0.05 to 1.6 mg/L as N with a mean concentration of 0.29 mg/L as N (table 3). Concentrations tended to increase with increasing streamflow (fig. 5). Loads were estimated as a function of streamflow (R^2 = 0.97; table 2). These estimated loads were then compared to instantaneous measured load with a slope of 0.79 (fig. 6). For total ammonia plus organic nitrogen as N, the 10-year mean load was 56,300 kg/yr as N (table 4) and mean yield was 158 kg/yr/km^2 as N (table 5). Estimated mean annual flow-weighted concentration was 0.35 mg/L as N (table 6).

Dissolved Nitrite plus Nitrate Nitrogen

Dissolved nitrite plus nitrate concentrations for Richland Creek at Goshen ranged from 0.01 (estimated) to 3.9 mg/L as N with a mean concentration of 0.850 mg/L as N (table 3). Concentrations tended to increase with increasing streamflow (fig. 5). Loads were estimated as a function of streamflow (R^2 = 0.96; table 2). These estimated loads were then compared to instantaneous measured load with a slope of 0.68 (fig. 6). For dissolved nitrite plus nitrate, the 10-year mean load was 230,000 kg/yr as N (table 4) and mean yield was 644 kg/yr/km^2 as N (table 5). Estimated mean annual flow-weighted concentration was 1.42 mg/L as N (table 6).

Total Nitrogen

Total nitrogen concentrations for Richland Creek at Goshen ranged from 0.20 to 4.1 mg/L with a mean concentration of 1.2 mg/L (table 3). Concentrations tended to increase with increasing streamflow (fig. 5). Loads were estimated as a function of streamflow (R^2 = 0.99; table 2). These estimated

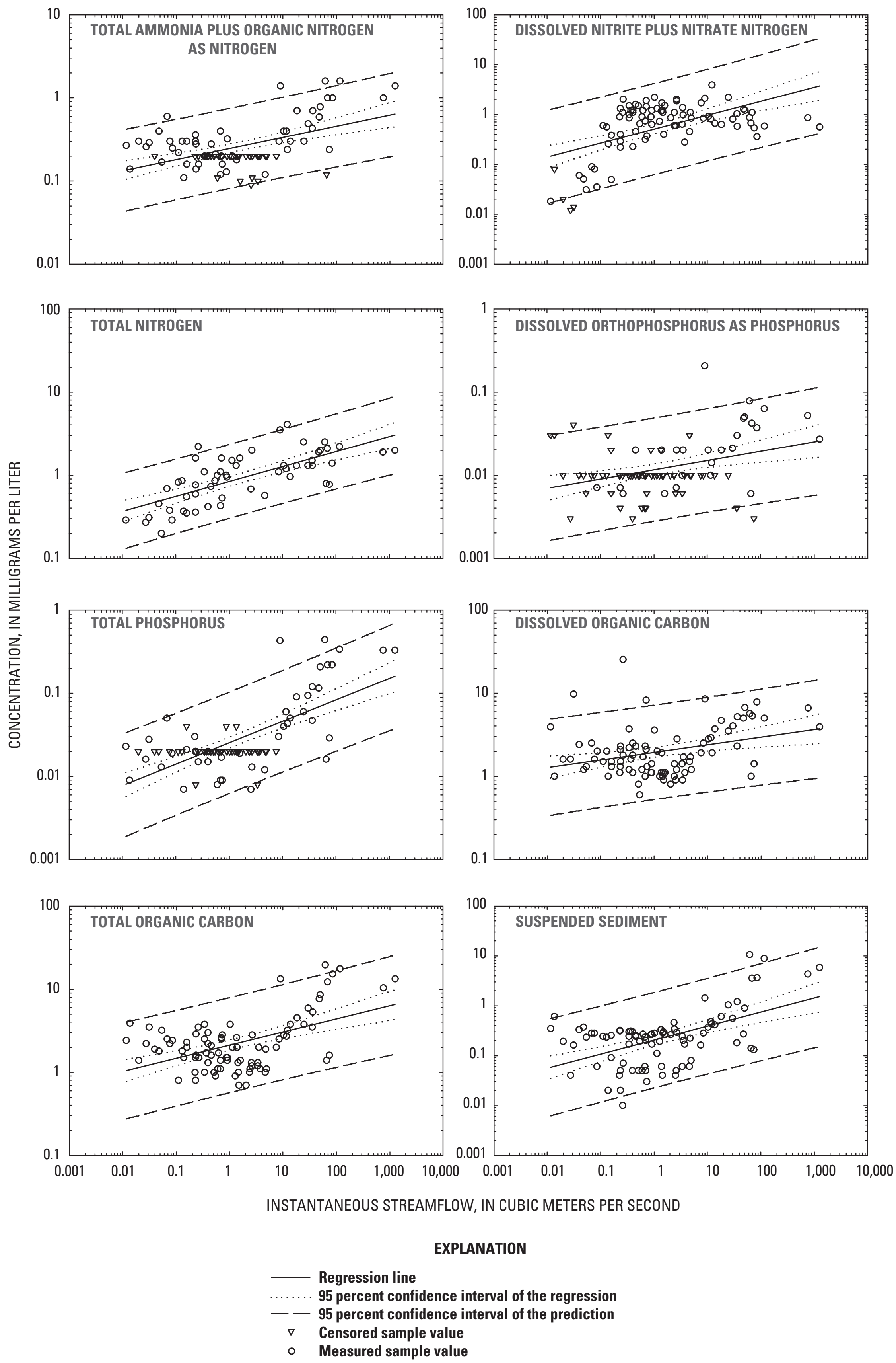

Figure 5. Relation between nutrient and sediment concentraitons and instantaneous streamflow for samples collected at Richland Creek at Goshen, Arkansas, water years 2001–08.

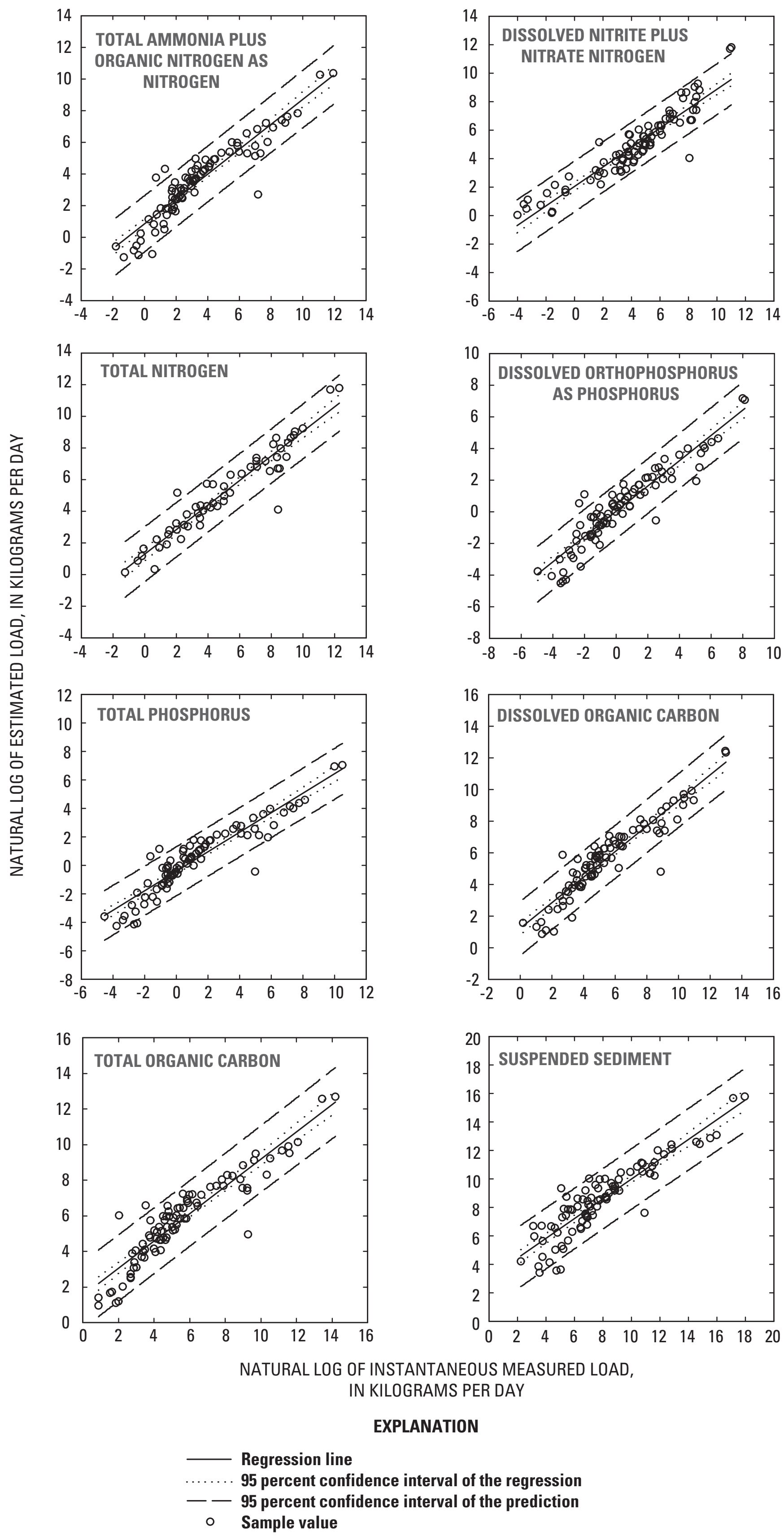

Figure 6. Relation between natural log of instantaneous measured load and natural log of estimated load for samples collected at Richland Creek at Goshen, Arkansas, water years 2001–08.

loads were then compared to instantaneous measured load with a slope of 0.78 (fig. 6). For total nitrogen, the 10-year mean load was 218,000 kg/yr (table 4) and mean yield was 611 kg/yr/km^2 (table 5). Estimated mean annual flow-weighted concentration was 1.35 mg/L (table 6).

Dissolved Orthophosphorus

Dissolved orthophosphorus concentrations for Richland Creek at Goshen ranged from less than 0.003 to 0.207 mg/L as P with a mean concentration of 0.017 mg/L as P (table 3). Concentrations tended to increase slightly with increasing streamflow (fig. 5). Loads were estimated as a function of streamflow (R^2 = 0.94; table 2). These estimated loads were then compared to instantaneous measured load with a slope of 0.80 (fig. 6). For dissolved orthophosphorus, the 10-year mean load was 2,210 kg/yr as P (table 4) and mean yield was 6 kg/yr/km^2 as P (table 5). Estimated mean annual flow-weighted concentration was 0.014 mg/L as P (table 6).

Total Phosphorus

Total phosphorus concentrations for Richland Creek at Goshen ranged from 0.007 to 0.440 mg/L with a mean concentration of 0.044 mg/L (table 3). Concentrations tended to increase with increasing streamflow (fig. 5). Loads were estimated as a function of streamflow (R^2 = 0.94; table 2). These estimated loads were then compared to instantaneous measured load with a slope of 0.68 (fig. 6). For total phosphorus, the 10-year mean load was 9,290 kg/yr (table 4) and mean yield was 26 kg/yr/km^2 (table 5). Estimated mean annual flow-weighted concentration was 0.06 mg/L (table 6).

Dissolved Organic Carbon

DOC concentrations for Richland Creek at Goshen ranged from 0.6 to 25.4 mg/L with a mean concentration of 2.56 mg/L (table 3). Concentrations tended to increase slightly with increases in stream streamflow (fig. 5). Loads were estimated as a function of streamflow (R^2 = 0.99; table 2). These estimated loads were then compared to instantaneous measured load with a slope of 0.81 (fig. 6). For DOC, the 10-year mean load was 432,000 kg/yr (table 4) and mean yield was 1,210 kg/yr/km^2 (table 5). Estimated mean annual flow-weighted concentration was 2.69 mg/L (table 6).

Total Organic Carbon

TOC concentrations for Richland Creek at Goshen ranged from 0.7 to 19.5 mg/L with a mean concentration of 3.00 mg/L (table 3). Concentrations tended to increase with increasing stream streamflow (fig. 5). Loads were estimated as a function of streamflow (R^2 = 0.99; table 2). These estimated loads were then compared to instantaneous measured load with a slope of 0.77 (fig. 6). For TOC, the 10-year mean load was 530,000 kg/yr (table 4) and mean yield was 1,480 kg/yr/km^2 (table 5). Estimated mean annual flow-weighted concentration was 3.28 mg/L (table 6).

Suspended Sediment

Suspended sediment concentrations for Richland Creek at Goshen ranged from 1 to 1,050 mg/L with a mean concentration of 58 mg/L (table 3). Concentrations tended to increase with increasing streamflow (fig. 5). Loads were estimated as a function of streamflow (R^2 = 0.97; table 2). These estimated loads were then compared to instantaneous measured load with a slope of 0.70 (fig. 6). For suspended sediment, the 10-year mean load was 9,770,000 kg/yr (table 4) and mean yield was 27,400 kg/yr/km^2 (table 5). Estimated mean annual flow-weighted concentration was 58.4 mg/L (table 6).

Constituent Concentrations, Loads, and Yields for War Eagle Creek, a Tributary to Beaver Lake, near Hindsville

Total Ammonia plus Organic Nitrogen

Total ammonia plus organic nitrogen concentrations for War Eagle Creek near Hindsville ranged from less than 0.05 to 2.3 mg/L as N with a mean concentration of 0.28 mg/L as N (table 3). Concentrations tended to increase with increasing streamflow (fig. 7). Loads were estimated as a function of streamflow (R^2 = 0.82; table 2). These estimated loads were then compared to instantaneous measured load with a slope of 0.93 (fig. 8). For total ammonia plus organic nitrogen, the 10-year mean load was 107,000 kg/yr as N (table 4) and mean yield was 157 kg/yr/km^2 as N (table 5). Estimated mean annual flow-weighted concentration was 0.39 mg/L as N (table 6).

Dissolved Nitrite plus Nitrate Nitrogen

Dissolved nitrite plus nitrate concentrations for War Eagle Creek near Hindsville ranged from 0.257 to 2.36 mg/L as N with a mean concentration of 1.16 mg/L as N (table 3). There was no relation between concentrations and changes in streamflow (fig. 7). Loads were estimated as a function of streamflow (R^2 = 0.94; table 2). These estimated loads were then compared to instantaneous measured load with a slope of 0.92 (fig. 8). For dissolved nitrate plus nitrite concentrations, the 10-year mean load was 307,000 kg/yr as N (table 4) and mean yield was 451 kg/yr/km^2 as N (table 5). Estimated mean annual flow-weighted concentration was 1.17 mg/L as N (table 6).

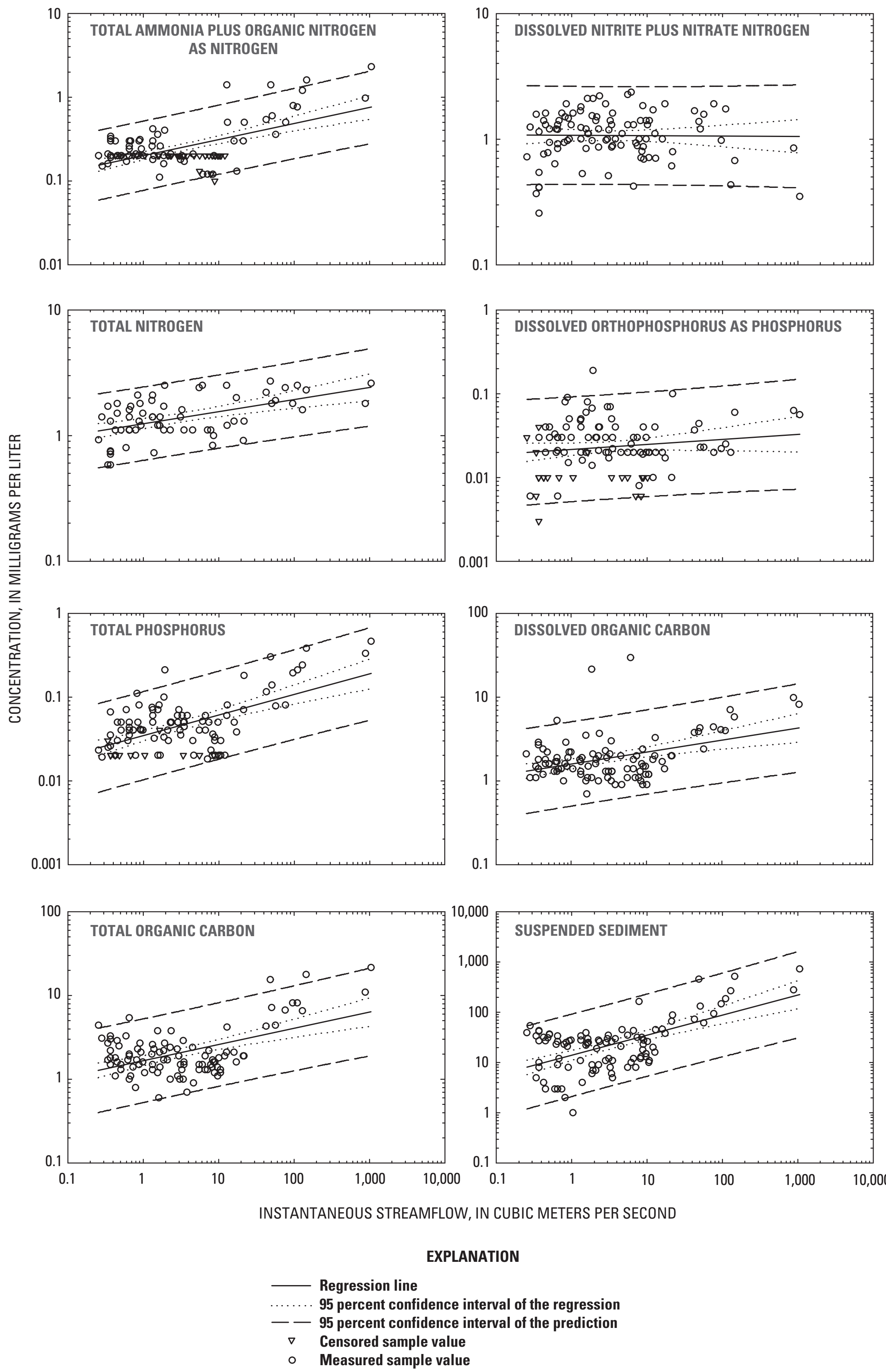

Figure 7. Relation between nutrient and sediment concentrations and instantaneous streamflow volume for samples collected at War Eagle Creek near Hindsville, Arkansas, water years 2001–08.

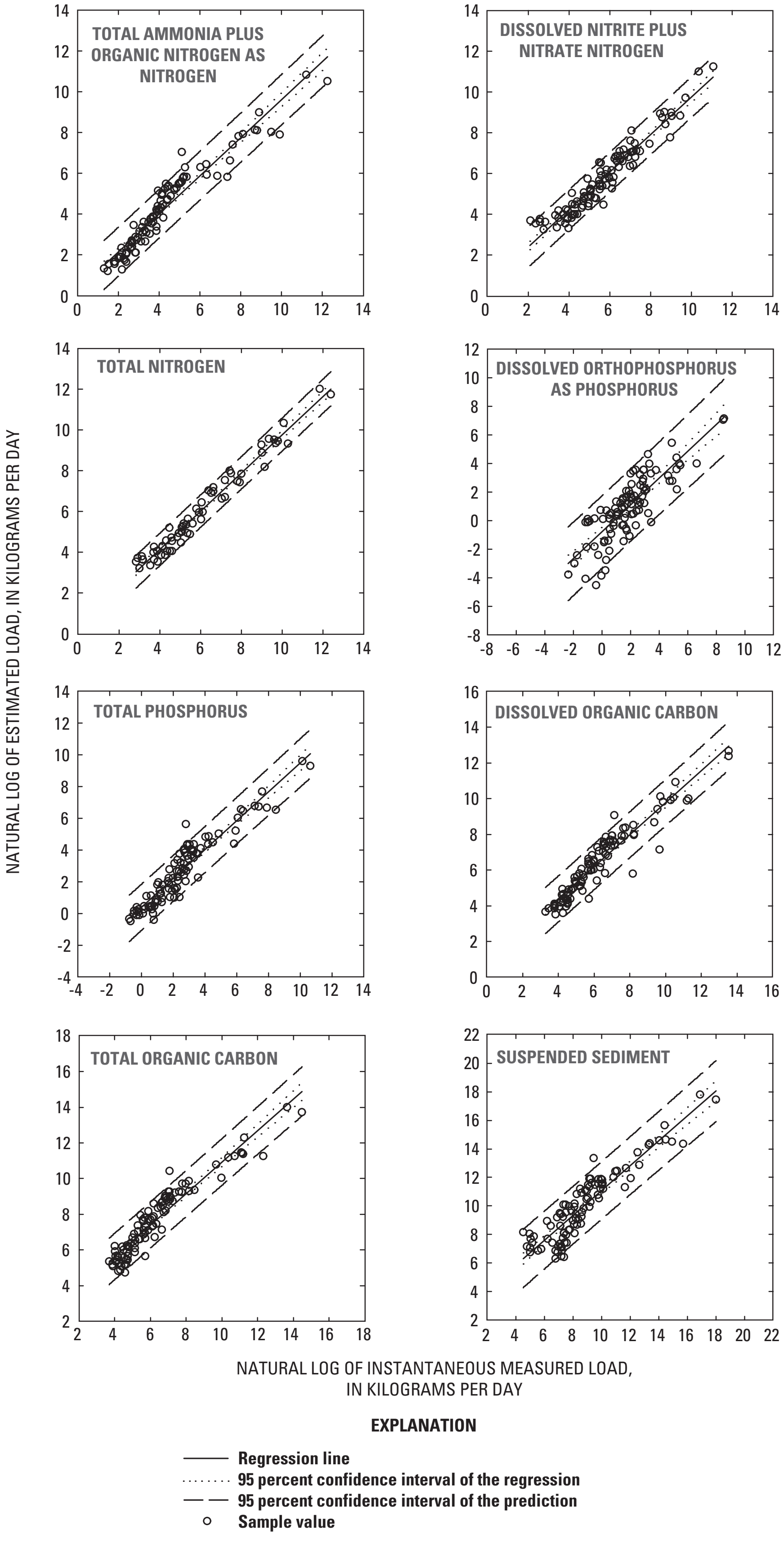

Figure 8. Relation between natural log of instantaneous measured load and natural log of estimated load for samples collected at War Eagle Creek near Hindsville, Arkansas, water years 2001–08.

Total Nitrogen

Total nitrogen concentrations for War Eagle Creek near Hindsville ranged from 0.58 to 2.7 mg/L with a mean concentration of 1.5 mg/L (table 3). Concentrations tended to increase slightly with increasing streamflow (fig. 7). Loads were estimated as a function of streamflow ($R^2 = 0.98$; table 2). These estimated loads were then compared to instantaneous measured load with a slope of 0.94 (fig. 8). For total nitrogen, the 10-year mean load was 486,000 kg/yr (table 4) and mean yield was 714 kg/yr/km^2 (table 5). Estimated mean annual flow-weighted concentration was 1.81 mg/L (table 6).

Dissolved Orthophosphorus

Dissolved orthophosphorus concentrations for War Eagle Creek near Hindsville ranged from less than 0.003 to 0.19 mg/L as P with a mean concentration of 0.029 mg/L as P (table 3). Concentrations tended to increase slightly with increasing streamflow (fig. 7). Loads were estimated as a function of streamflow ($R^2 = 0.79$; table 2). These estimated loads were then compared to instantaneous measured load with a slope of 0.94 (fig. 8). For dissolved orthophosphorus, the 10-year mean load was 11,000 kg/yr as P (table 4) and mean yield was 16 kg/yr/km^2 as P (table 5). Estimated mean annual flow-weighted concentration was 0.04 mg/L as P (table 6).

Total Phosphorus

Total phosphorus concentrations for War Eagle Creek near Hindsville ranged from 0.018 to 0.460 mg/L with a mean concentration of 0.064 mg/L (table 3). Concentrations tended to increase with increasing streamflow (fig. 7). Loads were estimated as a function of streamflow ($R^2 = 0.89$; table 2). These estimated loads were then compared to instantaneous measured load with a slope of 0.91 (fig. 8). For total phosphorus, the 10-year mean load was 30,300 kg/yr (table 4) and mean yield was 44 kg/yr/km^2 (table 5). Estimated mean annual flow-weighted concentration was 0.11 mg/L (table 6).

Dissolved Organic Carbon

DOC concentrations for War Eagle Creek near Hindsville ranged from 0.7 to 29.8 mg/L with a mean concentration of 2.6 mg/L (table 3). Concentrations tended to increase slightly with increases in streamflow (fig. 7). Loads were estimated as a function of streamflow ($R^2 = 0.92$; table 2). These estimated loads were then compared to instantaneous measured load with a slope of 0.90 (fig. 8). For DOC, the 10-year mean load was 831,000 kg/yr (table 4) and mean yield was 1,220 kg/yr/km^2 (table 5). Estimated mean annual flow-weighted concentration was 3.07 mg/L (table 6).

Total Organic Carbon

TOC concentrations for War Eagle Creek near Hindsville ranged from 0.6 to 21.6 mg/L with a mean concentration of 2.8 mg/L (table 3). Concentrations tended to increase with increasing streamflow (fig. 7). Loads were estimated as a function of streamflow ($R^2 = 0.93$; table 2). These estimated loads were then compared to instantaneous measured load with a slope of 0.88 (fig. 8). For TOC, the 10-year mean load was 959,000 kg/yr (table 4) and mean yield was 1,410 kg/yr/km^2 (table 5). Estimated mean annual flow-weighted concentration was 3.84 mg/L (table 6).

Suspended Sediment

Suspended sediment concentrations for War Eagle Creek near Hindsville ranged from less than 0.5 to 727 mg/L with a mean concentration of 50 mg/L (table 3). Concentrations tended to increase with increasing streamflow (fig. 7). Loads were estimated as a function of streamflow ($R^2 = 0.86$; table 2). These estimated loads were then compared to instantaneous measured load with a slope of 0.87 (fig. 8). For suspended sediment, the 10-year mean load was 29,400,000 kg/yr (table 4) and mean yield was 43,200 kg/yr/km^2 (table 5). Estimated mean annual flow-weighted concentration was 102 mg/L (table 6).

Tributary Water-Quality Comparison

Constituent concentrations, loads, and yields varied with time among the three tributaries contributing to Beaver Lake. These variations can result from differences in precipitation, land use, contributions of nutrients from point sources, and variations in basin size. Overall, for the 10-year period, constituent loads followed streamflow trends resulting from yearly weather changes. Generally, during wetter years, increased runoff contributed to an increase in streamflow. Fluctuation in load values followed the annual streamflow patterns (figs. 9–11). Load and yield estimates varied yearly during the study period, water years 1999–2008, with the least nutrient and sediment loads and yields generally occurring in water year 2006, and the greatest occurring in water year 2008, a year with extreme floods near Beaver Lake (Funkhouser and Eng, 2009).

Annual Flow-Weighted Concentrations

Flow-weighted concentrations of most constituents were greater at the War Eagle Creek station than at the White River and Richland Creek stations. Of the three stations, flow-weighted concentrations of total nitrogen, dissolved orthophosphorus as P, DOC, and suspended sediment were greatest at the War Eagle Creek station (figs. 12 and 13).

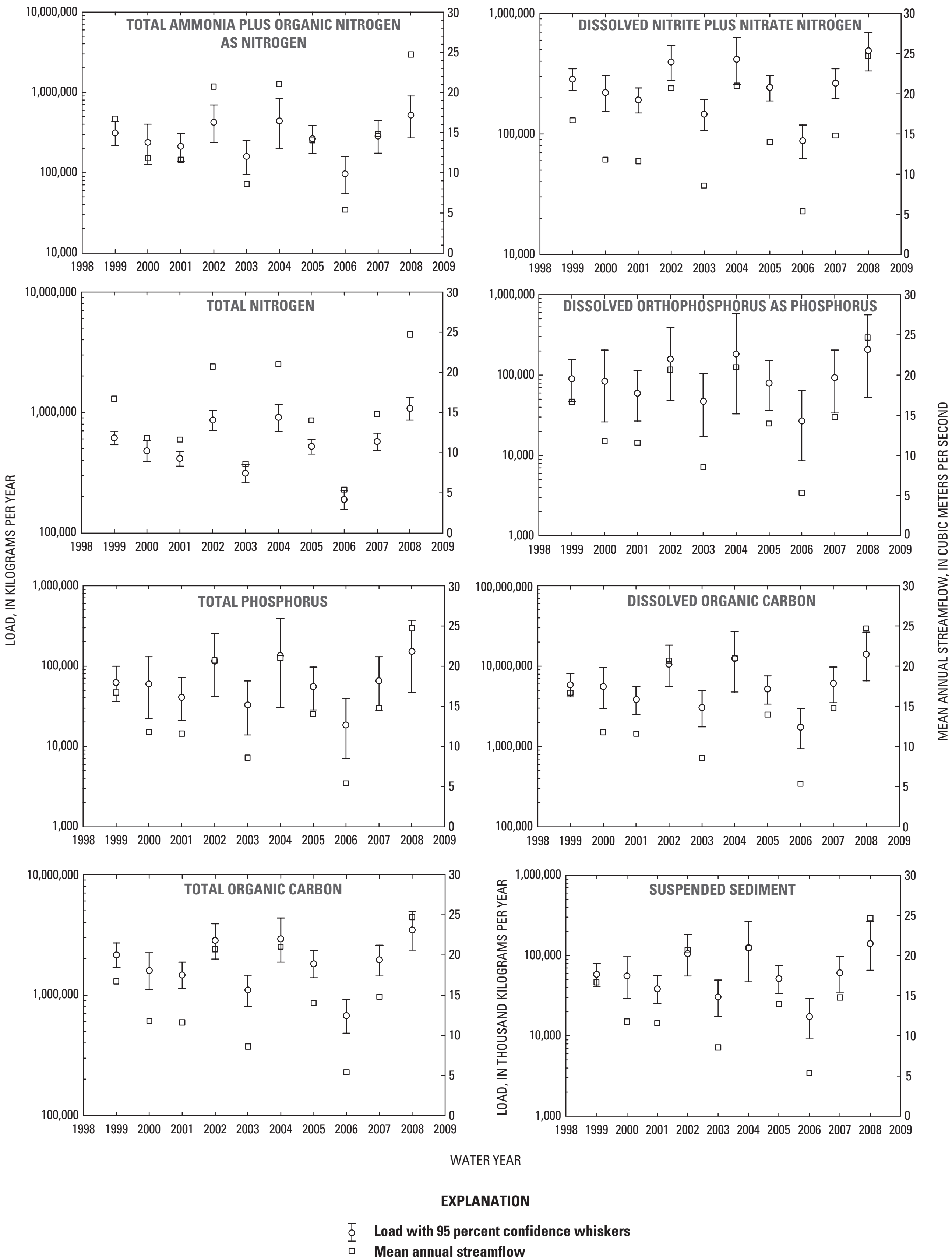

Figure 9. Time series of annual load and streamflow at White River near Fayetteville, Arkansas, water years 1999–2008.

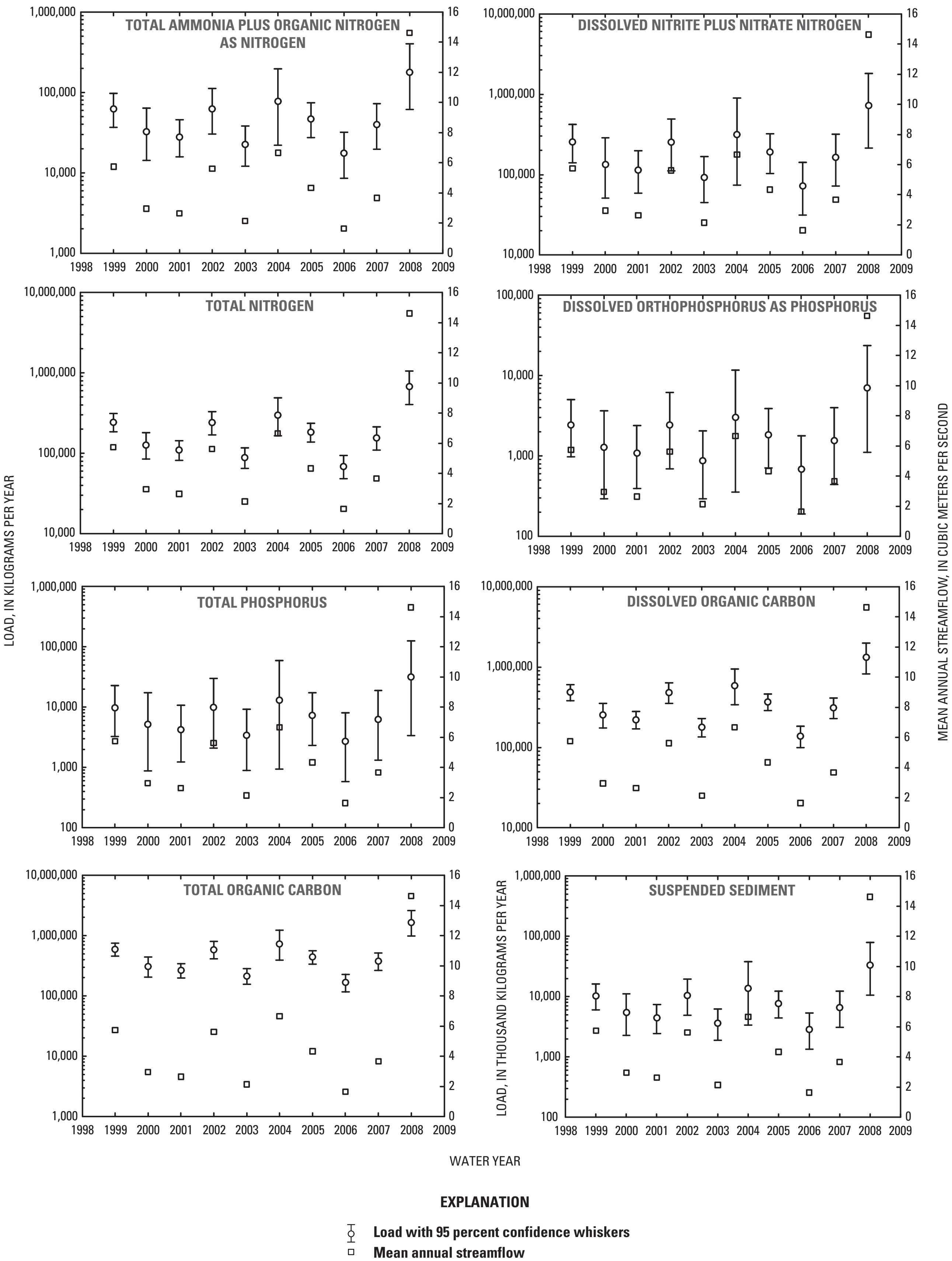

Figure 10. Time series of annual load and streamflow at Richland Creek at Goshen, Arkansas, water years 1999–2008.

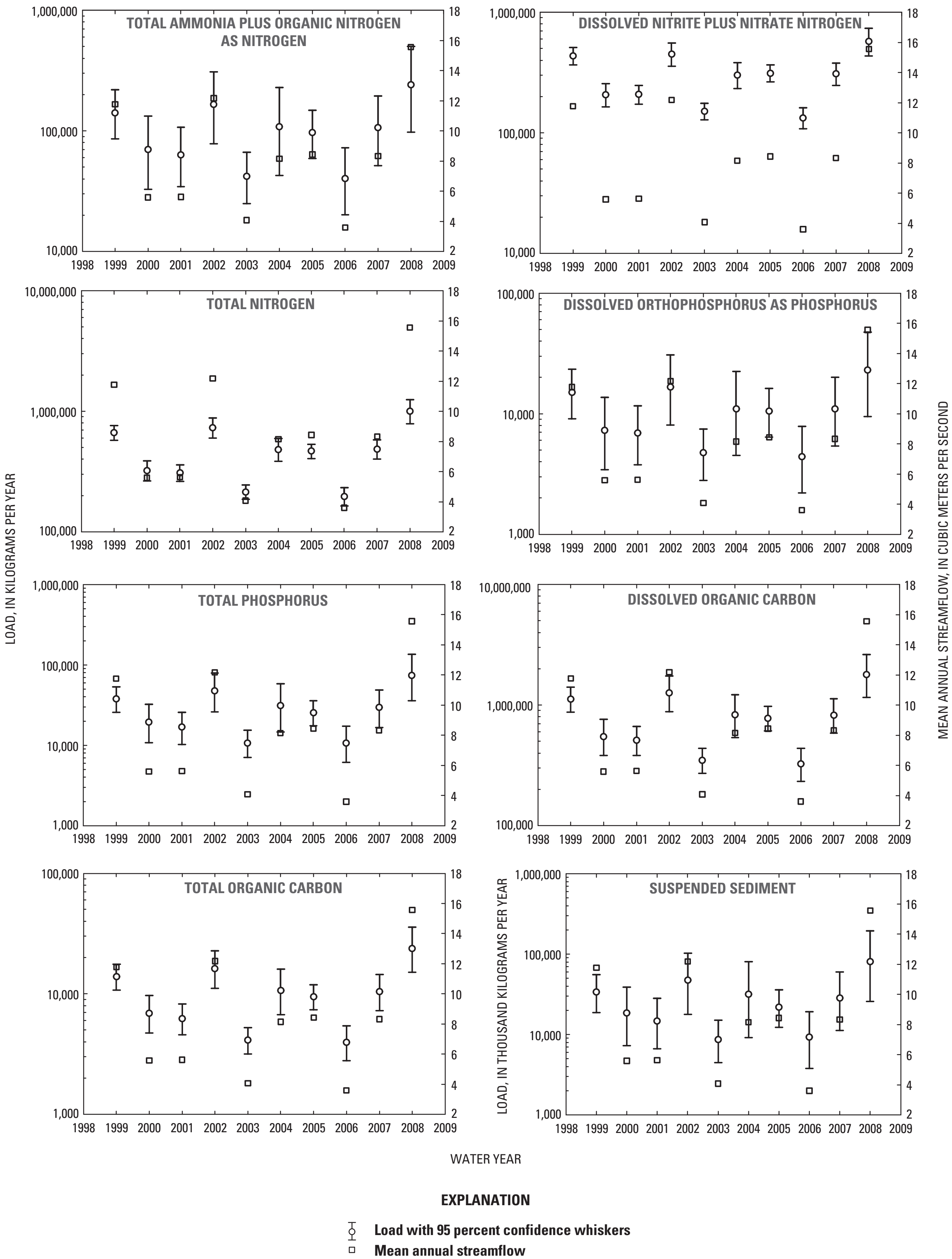

Figure 11. Time series of annual load and streamflow at War Eagle Creek near Hindsville, Arkansas, water years 1999–2008.

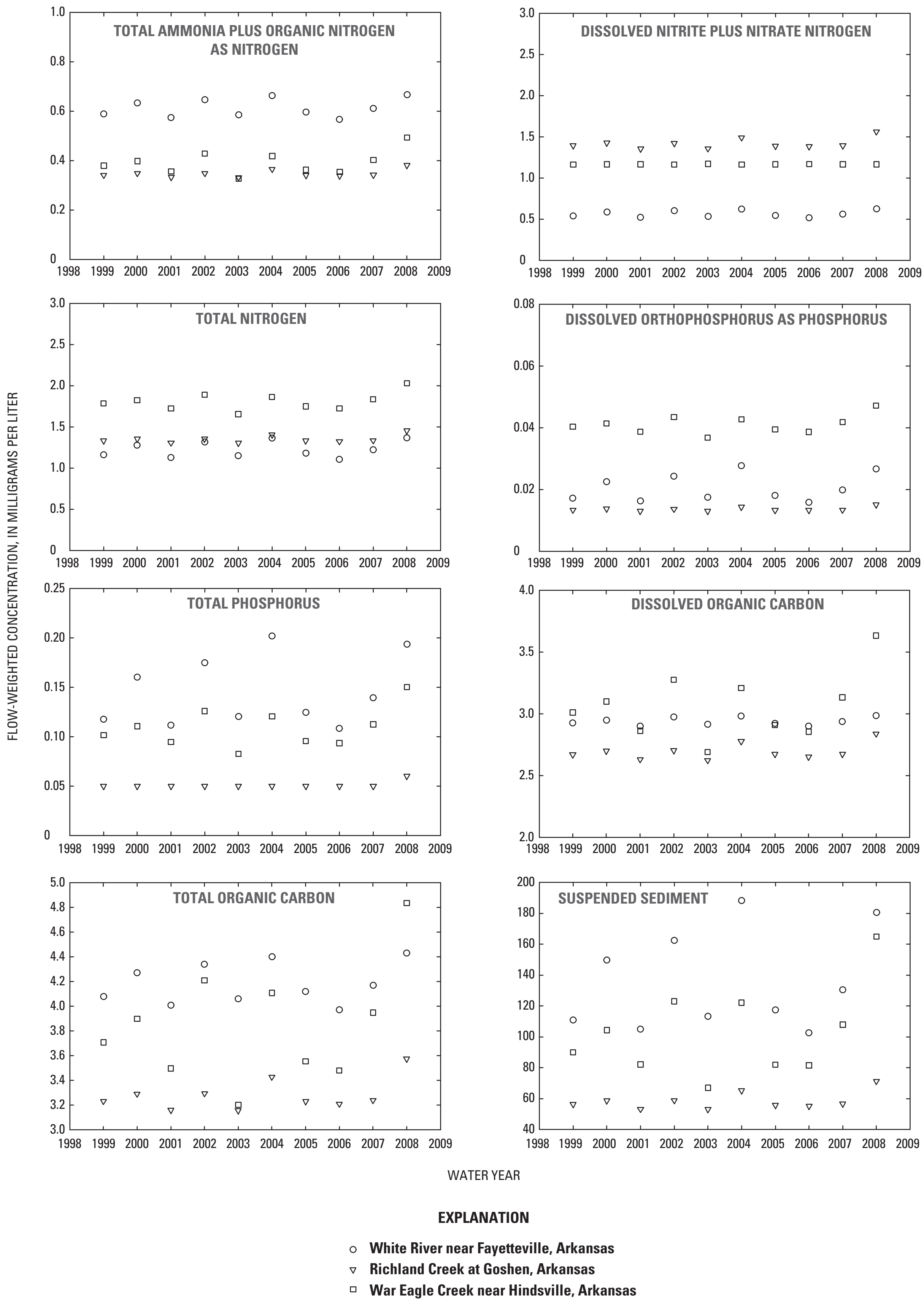

Figure 12. Time series of annual flow-weighted concentrations for nutrients, organic carbon, and sediment at White River near Fayetteville, Richland Creek at Goshen, and War Eagle Creek near Hindsville, Arkansas, water years 1999–2008.

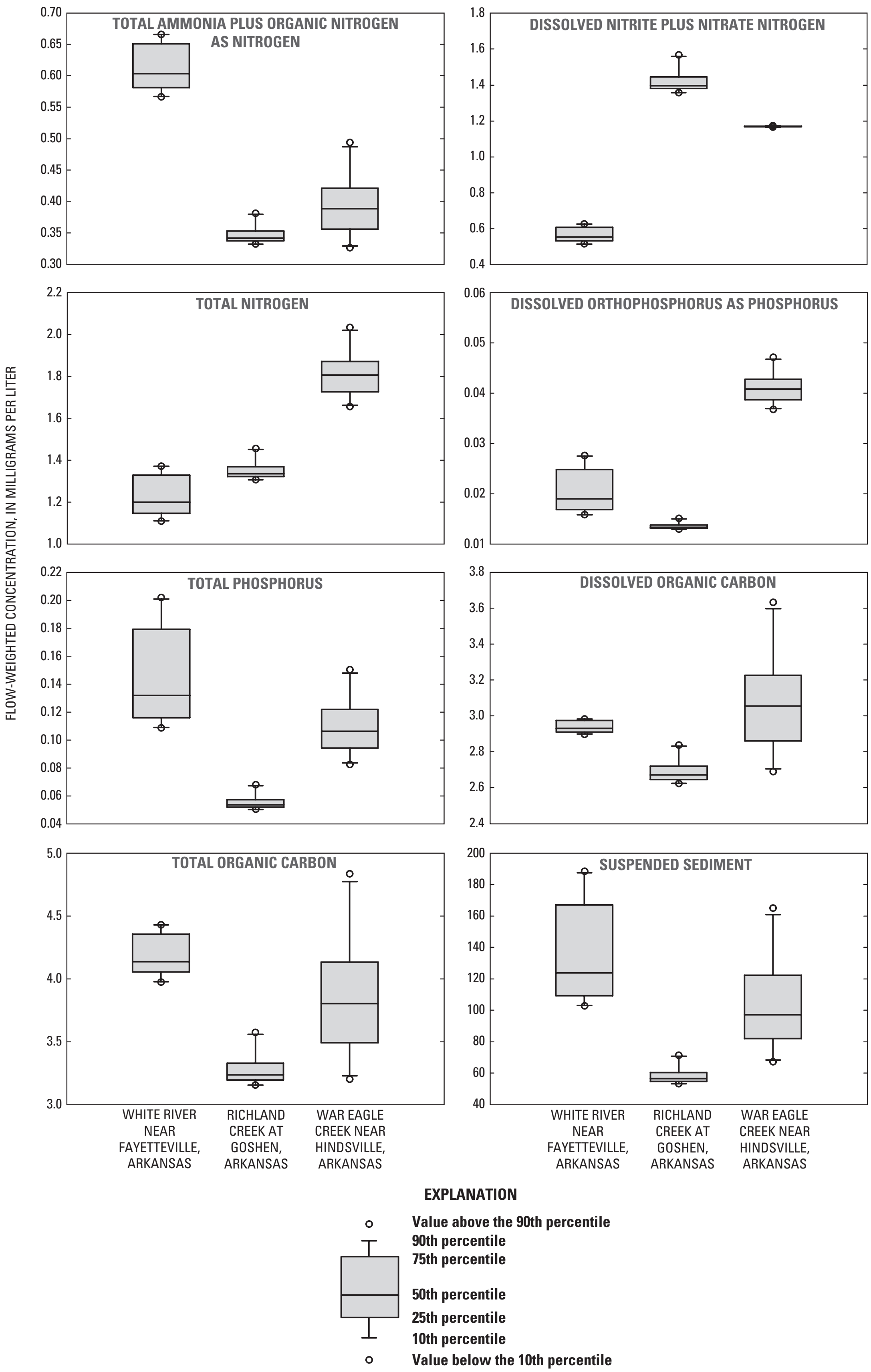

Figure 13. Distributions of annual nutrient, organic carbon, and sediment flow-weighted concentrations from water samples collected at White River near Fayetteville, Richland Creek at Goshen, and War Eagle Creek near Hindsville, Arkansas, water years 1999–2008.

Flow-weighted concentrations of total ammonia plus organic nitrogen, total phosphorus, and TOC were greatest at the White River station. Flow-weighted concentrations of dissolved nitrite plus nitrate were greatest at the Richland Creek station.

Annual Loads

Loads of most constituents were greatest at the War Eagle Creek and White River stations (fig. 14, table 4). Load amounts do not represent the contribution of the constituent for the entire basin but only that part upstream from the station where the samples were collected. Of the three stations, loads of dissolved nitrite plus nitrate and dissolved orthophosphorus were greatest at the War Eagle Creek station. Loads of total ammonia plus organic nitrogen, total nitrogen, total phosphorus, DOC, TOC, and suspended sediment were greatest at the White River station. Loads were least for all constituents at the Richland Creek station.

Annual Yields

Yields of most constituents were greatest at the War Eagle Creek and White River stations (fig. 15, table 5). Yield amounts do not represent the contribution of the constituent for the entire basin but only that part upstream from the station where the samples were collected. Of the three stations, yields of total nitrogen and dissolved orthophosphorus were greatest at the War Eagle Creek station. Yields of total ammonia plus organic nitrogen, total phosphorus, DOC, TOC, and suspended sediment were greatest at the White River station. Yields at Richland Creek were least for all constituents except dissolved nitrite plus nitrate, which were greatest at Richland Creek.

Summary

Beaver Lake is a large, deep-storage reservoir used as the primary drinking-water supply for northwestern Arkansas and a primary watershed of concern for the State of Arkansas. Because of increased population growth and varying land use, information is needed to assess water quality, especially nutrient enrichment and sediment issues within the reservoir system. In 1999, streamflow-gaging stations at White River near Fayetteville (USGS station 07048600) and War Eagle Creek near Hindsville (USGS station 07049000) were converted from partial-record stations (supported by the USACE) to continuous-record stations, and a new streamflow-gaging station was established on Richland Creek at Goshen (USGS station 07048800), in cooperation with Beaver Water District. Also, periodic water-quality samples were collected at the White River near Fayetteville station in cooperation with Arkansas Soil and Water Conservation Commission, now Arkansas Natural Resources Commission. In 2001, USGS in cooperation with Beaver Water District modified the White River near Fayetteville water-quality sampling and initiated water-quality sampling at both the Richland Creek and War Eagle Creek stations. Water-quality sampling has continued at all three stations to present. Water-quality samples collected during the study period represented different flow conditions (from low to high).

This report describes constituent loads, yields, and flow-weighted concentrations to Beaver Lake for White River, Richland Creek, and War Eagle Creek for the period 1999–2008 water years. Constituents include total ammonia plus organic nitrogen, dissolved nitrite plus nitrate nitrogen, total nitrogen, dissolved orthophosphorus (soluble reactive phosphorus), total phosphorus, dissolved organic carbon, total organic carbon, and suspended sediment.

The Beaver Lake study area comprises the lake with three main tributaries: White River, Richland Creek, and War Eagle Creek. Several smaller tributaries also flow into the reservoir. The basin has a drainage area of 2,968 km^2 upstream from Beaver Lake Dam. The White River is the largest tributary followed by War Eagle Creek and Richland Creek. Combined, these three tributaries represent approximately 69 percent of the total drainage area of Beaver Lake (measured upstream from the measured streamflow-gaging stations).

Estimated mean annual constituent loads and standard deviations of the mean loads were calculated by S-LOADEST using all available data for each constituent for the 10-year period. Constituent yields for each of the three stations were calculated by dividing mean annual constituent load by the drainage area, in square kilometers. Flow-weighted concentrations for each of the three stations were calculated by dividing mean annual constituent loads by mean annual streamflow and multiplying by a conversion factor to adjust the units.

Constituent concentrations, loads, and yields varied with time and varied among the three tributaries contributing to Beaver Lake. These variations can result from differences in precipitation, land use, contributions of nutrients from point sources, and variations in basin size. Load and yield estimates varied yearly during the study period, water years 1999–2008, with the least nutrient and sediment load and yields generally occurring in water year 2006, and the greatest occurring in water year 2008, during a year with record amounts of precipitation. Flow-weighted concentrations of most constituents were greatest at the War Eagle Creek station than at the White River and Richland Creek stations. Loads and yields of most constituents were greatest at the War Eagle Creek and White River stations than at the Richland Creek station.

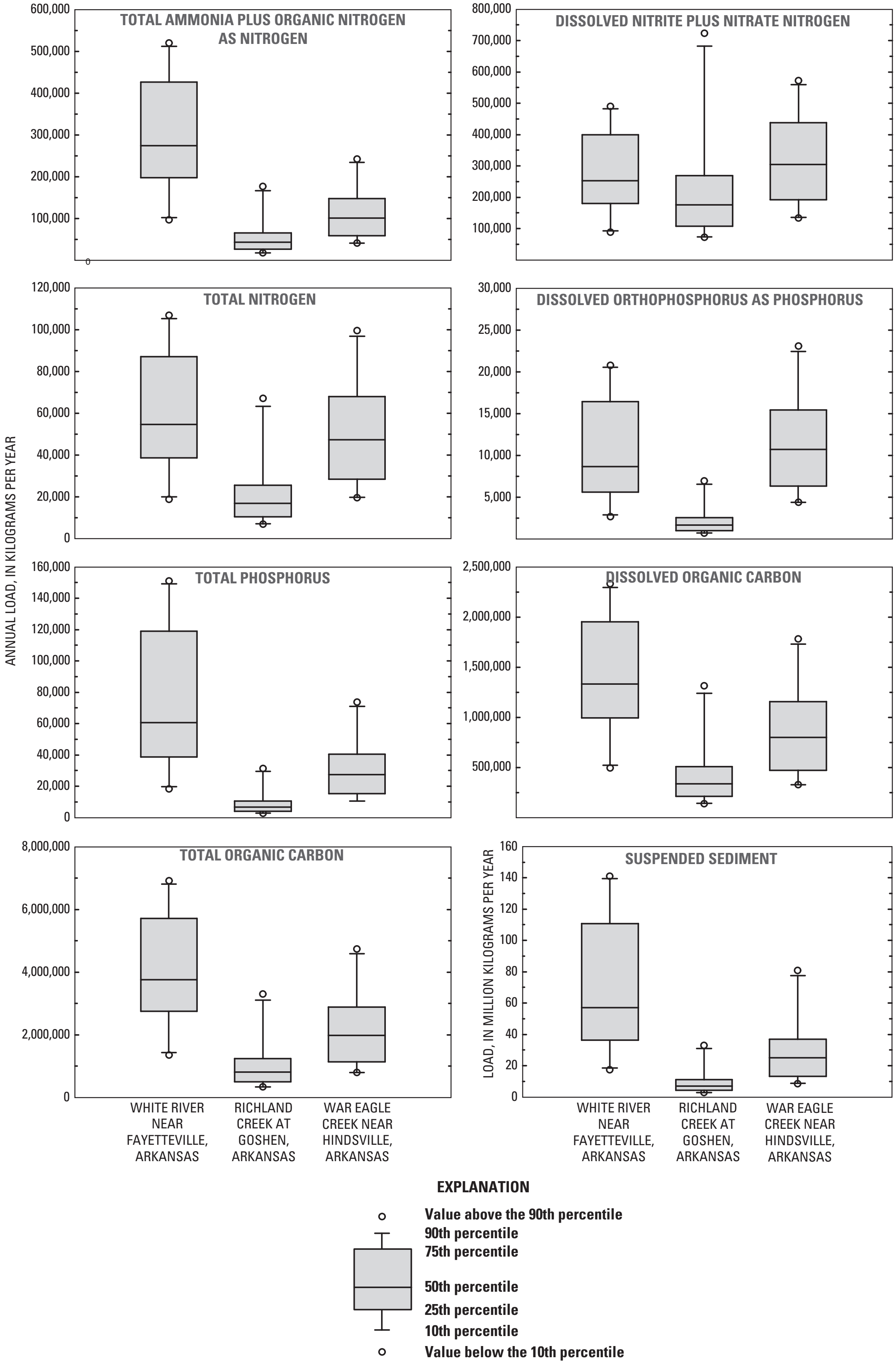

Figure 14. Distributions of annual nutrient, organic carbon, and sediment loads from water samples collected at White River near Fayetteville, Richland Creek at Goshen, and War Eagle Creek near Hindsville, Arkansas, water years 1999–2008.

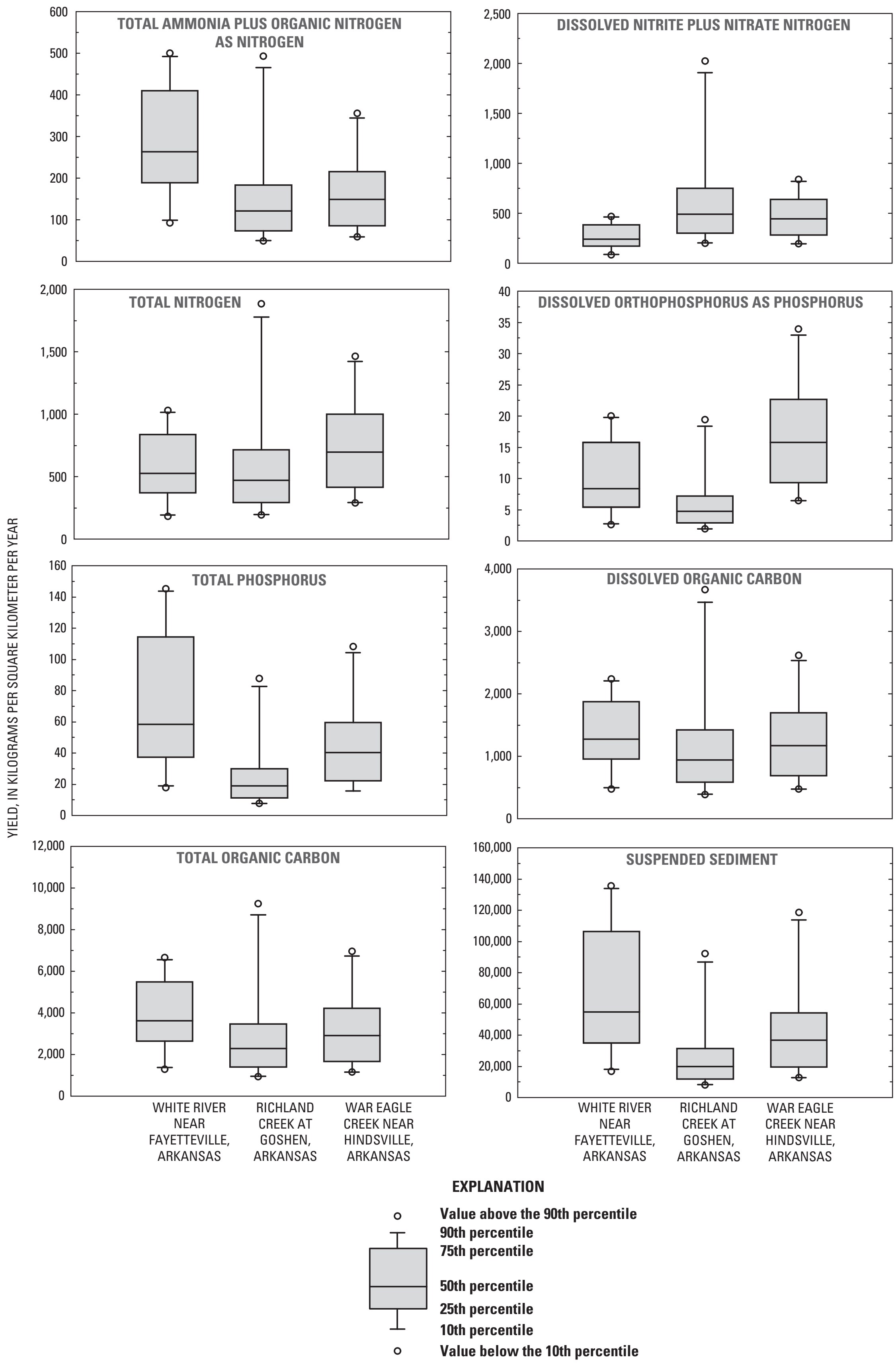

Figure 15. Distributions of annual nutrient, organic carbon, and sediment yields from water samples collected at White River near Fayetteville, Richland Creek at Goshen, and War Eagle Creek near Hindsville, Arkansas, water years 1999–2008.

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Appendix 1. Water-quality data results modified from NWIS data for White River near Fayetteville (07048600), Richland Creek at Goshen (07048800), and War Eagle Creek near Hindsville (07049000).

[Units are in milligrams per liter unless otherwise noted; m^3/s, cubic meter per second; five-digit numbers in parentheses are STORET parameter codes used for computer storage of data; N, nitrogen; p, phosphorus; <, less than; --, missing data. When laboratory reporting limit (LRL) values were originally reported, less than values were modified by dividing the LRL by 2 to get the long-term method detection level (LT–MDL) and the resulting LT–MDL value is reported below]

Date	Time	Instantaneous streamflow, in m^3/s (30209)	Total ammonia + organic, as N (00625)	Dissolved nitrite + nitrate, as N (00631)	Total nitrogen (00600)	Dissolved orthophosphorus, as P (00671)	Total phosphorus (00665)	Dissolved organic carbon (00681)	Total organic carbon (00680)	Suspended sediment (80154)
11/04/1999	1200	0.311	0.31	0.36	0.67	0.010	0.030	---	---	39
12/09/1999	1330	5.32	0.33	0.86	1.2	<0.010	0.050	---	---	36
12/12/1999	1715	180	0.64	1.2	1.8	<0.010	0.130	---	---	167
02/09/2000	945	2.44	<0.10	0.80	---	<0.010	<0.010	---	---	32
04/13/2000	1200	17.6	0.38	0.46	0.84	<0.010	0.030	---	---	43
05/07/2000	1700	28.9	0.42	0.29	0.71	<0.010	0.050	---	---	56
05/25/2000	1010	9.77	0.33	0.21	0.54	<0.010	0.060	---	---	63
05/26/2000	840	3.17	0.33	0.23	0.56	<0.010	0.050	---	---	39
05/27/2000	1500	512	2.6	0.43	3.0	0.010	0.600	---	---	738
06/14/2000	1900	69.7	0.92	0.42	1.3	0.050	0.200	---	---	206
06/14/2000	2240	90.0	0.91	0.41	1.3	0.020	0.140	---	---	189
06/17/2000	1315	408	1.9	0.40	2.3	0.110	0.420	---	---	421
06/17/2000	1745	583	2.0	0.40	2.4	0.100	0.520	---	---	542
06/18/2000	1140	143	0.62	0.58	1.2	0.030	0.140	---	---	111
08/08/2000	1030	0.538	0.36	0.16	0.52	0.010	0.030	---	---	36
10/12/2000	1330	0.963	0.32	0.26	0.58	<0.005	<0.010	---	---	57
01/08/2001	1100	14.2	<0.10	1.4	---	<0.005	0.030	---	---	28
02/14/2001	1930	100	1.8	0.88	2.7	0.020	0.390	---	---	712
02/15/2001	1315	317	1.1	1.0	2.1	<0.005	0.220	---	---	280
02/17/2001	715	119	0.38	1.3	1.7	0.010	0.030	---	---	50
03/13/2001	930	9.06	0.28	1.3	1.6	<0.005	<0.010	---	---	29
04/04/2001	1115	4.33	<0.10	0.73	---	<0.005	<0.010	1.6	2.1	28
04/17/2001	845	10.3	0.27	0.45	0.72	<0.005	0.020	1.6	1.8	24
05/01/2001	1130	3.17	0.29	0.23	0.52	<0.005	<0.010	0.8	1.1	25
05/15/2001	1330	3.74	0.47	0.24	0.71	<0.005	0.020	1.9	1.5	24
05/16/2001	1400	3.00	0.30	0.21	0.51	<0.005	<0.010	---	---	38
05/30/2001	1400	16.2	0.55	0.32	0.87	<0.005	0.050	2.9	2.6	72
05/30/2001	1430	16.7	0.59	0.32	0.91	<0.005	<0.010	---	---	72
06/12/2001	1315	1.61	0.29	0.12	0.41	0.020	0.020	2.6	2.7	20
06/15/2001	1015	31.7	0.69	0.18	0.87	0.010	0.090	---	---	70
06/26/2001	815	0.934	0.42	0.20	0.62	<0.005	0.030	3.3	2.4	32
07/09/2001	1345	0.736	0.50	0.18	0.68	<0.005	<0.010	4.3	3.1	31
07/13/2001	1400	24.5	0.70	0.09	0.79	<0.005	0.060	---	---	64
07/18/2001	900	6.00	0.83	0.43	1.3	0.010	0.130	---	---	127
07/23/2001	1100	1.08	0.49	0.24	0.73	<0.005	0.030	2.9	2.4	33
08/06/2001	1415	0.340	0.30	0.15	0.45	<0.005	<0.010	3.2	2.4	33

Appendix 1. Water-quality data results modified from NWIS data for White River near Fayetteville (07048600), Richland Creek at Goshen (07048800), and War Eagle Creek near Hindsville (07049000).—Continued

[Units are in milligrams per liter unless otherwise noted; m^3/s, cubic meter per second; five-digit numbers in parentheses are STORET parameter codes used for computer storage of data; N, nitrogen; p, phosphorus; <, less than; --, missing data. When laboratory reporting limit (LRL) values were originally reported, less than values were modified by dividing the LRL by 2 to get the long-term method detection level (LT–MDL) and the resulting LT–MDL value is reported below]

Date	Time	Instantaneous streamflow, in m^3/s (30209)	Total ammonia + organic, as N (00625)	Dissolved nitrite + nitrate, as N (00631)	Total nitrogen (00600)	Dissolved orthophosphorus, as P (00671)	Total phosphorus (00665)	Dissolved organic carbon (00681)	Total organic carbon (00680)	Suspended sediment (80154)
08/21/2001	1330	0.425	0.50	0.40	0.90	<0.005	0.030	3.8	3.9	33
09/04/2001	1100	0.453	0.60	0.31	0.91	<0.005	<0.010	---	---	28
09/05/2001	1215	0.368	0.50	0.28	0.78	<0.005	<0.010	4.3	3.8	22
09/17/2001	1230	9.26	1.1	0.41	1.5	0.050	0.220	4.6	3.9	148
10/01/2001	1250	0.765	0.30	0.44	0.74	<0.005	<0.010	3.6	3.6	32
10/10/2001	2320	151	<0.10	0.33	---	0.020	0.580	---	---	950
10/11/2001	355	120	<0.10	0.50	---	0.080	0.180	---	---	276
10/11/2001	1530	67.7	<0.10	0.29	---	0.040	0.230	---	---	99
10/15/2001	1400	17.8	<0.10	0.96	---	0.040	0.070	4.3	4.9	37
10/24/2001	1100	2.75	0.20	0.97	1.2	<0.005	0.020	---	---	37
10/29/2001	1315	1.44	0.30	0.78	1.1	<0.005	<0.010	2.5	2.7	23
11/07/2001	1530	4.98	0.40	1.0	1.4	0.010	<0.010	4.2	5.6	55
11/26/2001	1345	6.43	<0.10	0.32	---	<0.005	<0.010	2.9	4.3	26
12/04/2001	1030	13.7	<0.10	0.57	---	<0.005	0.030	---	---	38
12/10/2001	1400	7.99	<0.10	0.59	---	0.010	0.030	1.3	1.4	24
12/17/2001	415	816	1.6	0.57	2.2	<0.005	0.420	6.8	7.0	462
12/17/2001	745	699	1.3	0.58	1.9	0.030	0.310	---	---	349
12/17/2001	1745	239	0.60	0.78	1.4	0.020	0.140	---	---	130
01/03/2002	915	6.00	<0.10	1.2	---	<0.005	<0.010	3.8	4.0	25
01/14/2002	1230	3.11	<0.10	1.0	---	<0.005	<0.010	1.5	1.8	16
01/31/2002	1245	266	1.3	0.62	1.9	0.050	0.240	---	---	306
02/06/2002	1215	22.0	<0.10	0.93	---	<0.005	<0.010	1.7	1.9	19
02/20/2002	1145	40.5	0.70	0.64	1.3	0.020	0.070	3.6	4.1	63
03/05/2002	1400	16.2	<0.10	0.57	---	0.030	<0.010	1.8	2.2	21
03/07/2002	1000	16.5	<0.10	0.51	---	<0.005	<0.010	---	---	23
03/19/2002	745	221	0.80	0.45	1.2	0.050	0.180	5.2	5.1	179
04/02/2002	1630	17.9	<0.10	0.58	---	<0.005	<0.010	0.8	---	23
04/07/2002	2030	209	1.0	0.48	1.5	0.020	0.200	---	---	373
04/16/2002	1315	16.9	<0.10	0.58	---	<0.005	<0.010	1.0	1.0	29
04/30/2002	1400	14.8	<0.10	0.30	---	<0.005	0.020	1.0	1.5	30
05/13/2002	1745	13.8	0.60	0.27	0.87	<0.005	0.040	2.6	2.8	40
05/15/2002	1430	6.82	0.50	0.03	0.80	<0.005	0.050	---	---	29
05/17/2002	1300	76.2	1.3	0.25	1.6	0.030	0.120	---	---	206
05/29/2002	915	7.48	0.20	0.22	0.42	0.010	<0.010	1.9	1.6	26
06/17/2002	1815	8.78	0.40	0.17	0.57	0.020	0.040	2.6	2.3	14
07/08/2002	1115	0.991	0.30	0.15	0.45	0.020	0.040	2.2	2.1	11

Appendix 1. Water-quality data results modified from NWIS data for White River near Fayetteville (07048600), Richland Creek at Goshen (07048800), and War Eagle Creek near Hindsville (07049000).—Continued

[Units are in milligrams per liter unless otherwise noted; m^3/s, cubic meter per second; five-digit numbers in parentheses are STORET parameter codes used for computer storage of data; N, nitrogen; p, phosphorus; <, less than; --, missing data. When laboratory reporting limit (LRL) values were originally reported, less than values were modified by dividing the LRL by 2 to get the long-term method detection level (LT–MDL) and the resulting LT–MDL value is reported below]

Date	Time	Instantaneous streamflow, in m^3/s (30209)	Total ammonia + organic, as N (00625)	Dissolved nitrite + nitrate, as N (00631)	Total nitrogen (00600)	Dissolved orthophosphorus, as P (00671)	Total phosphorus (00665)	Dissolved organic carbon (00681)	Total organic carbon (00680)	Suspended sediment (80154)
07/22/2002	1600	3.88	0.40	0.14	0.54	<0.005	0.040	2.8	2.8	22
07/25/2002	800	6.82	<0.10	0.05	---	<0.005	0.030	---	---	15
08/21/2002	1450	3.00	0.20	0.35	0.55	<0.005	0.040	2.4	2.1	23
08/28/2002	1300	0.934	0.40	0.17	0.57	<0.005	0.020	---	---	8
09/03/2002	1430	0.481	0.40	0.11	0.51	<0.005	<0.010	2.2	1.9	9
10/08/2002	1130	0.119	0.40	0.10	0.50	<0.005	<0.010	3.2	2.9	2
10/29/2002	1545	0.680	0.40	0.28	0.68	0.020	0.060	4.0	3.3	52
11/13/2002	1010	0.139	0.60	0.11	0.71	<0.005	<0.010	3.2	2.9	3
12/11/2002	1445	0.453	0.40	0.10	0.50	<0.005	<0.010	2.4	2.4	4
12/18/2002	1230	2.69	0.50	0.16	0.66	0.030	0.030	2.5	2.9	12
01/07/2003	1330	1.13	<0.10	0.99	---	<0.005	0.030	1.5	1.7	10
01/22/2003	1000	2.21	0.20	0.83	1.0	<0.005	0.020	1.1	1.2	6
02/12/2003	1130	1.27	0.30	0.58	0.88	<0.005	<0.010	2.3	2.6	19
03/11/2003	1345	6.63	<0.10	0.67	---	<0.005	0.010	1.0	1.0	11
03/25/2003	1515	17.6	<0.10	0.50	---	<0.005	0.020	1.2	1.1	14
04/08/2003	1450	5.15	<0.10	0.30	---	<0.005	0.030	1.2	1.1	23
05/05/2003	1530	6.48	<0.10	0.20	---	<0.005	0.020	1.0	0.9	29
06/03/2003	30	48.1	0.70	0.37	1.1	0.040	0.150	4.8	4.3	84
06/05/2003	1445	13.3	0.30	0.33	0.63	0.010	0.060	2.6	2.6	35
07/29/2003	1615	1.33	0.30	0.03	0.33	<0.005	<0.010	1.7	1.5	27
08/20/2003	1300	0.278	0.30	0.17	0.47	<0.005	<0.010	2.8	2.7	24
09/09/2003	1330	0.425	0.30	0.41	0.71	<0.005	0.020	2.8	2.9	28
10/28/2003	1340	0.906	0.40	0.19	0.59	0.010	<0.010	2.1	2.0	20
11/18/2003	1115	53.0	0.40	0.34	0.74	0.010	0.040	1.7	1.8	37
11/19/2003	730	33.4	0.50	0.41	0.91	<0.005	0.050	3.1	3.4	42
12/09/2003	1345	6.40	0.20	0.68	0.88	<0.005	0.040	1.5	1.5	41
01/21/2004	1415	21.4	<0.10	0.66	---	<0.005	<0.010	1.3	1.4	23
02/18/2004	1345	10.4	<0.10	0.55	---	<0.005	<0.010	1.0	1.4	46
03/05/2004	1100	81.8	1.3	0.53	1.8	0.040	0.230	---	---	205
03/17/2004	1230	9.09	<0.10	0.51	---	<0.005	0.030	1.1	0.7	29
04/13/2004	1315	14.7	<0.10	0.26	---	<0.005	<0.010	1.4	1.3	26
04/22/2004	1415	178	1.0	0.33	1.3	0.040	0.190	7.5	6.8	134
05/19/2004	1245	9.29	0.20	0.26	0.46	<0.005	<0.010	1.8	1.6	26
06/22/2004	1420	82.1	0.70	0.37	1.1	0.020	0.150	5.1	5.2	120
06/23/2004	1015	51.8	0.40	1.3	1.7	0.020	0.090	4.5	4.6	62
07/21/2004	1130	5.10	0.29	0.11	0.40	<0.010	0.020	2.0	4.3	22

Appendix 1. Water-quality data results modified from NWIS data for White River near Fayetteville (07048600), Richland Creek at Goshen (07048800), and War Eagle Creek near Hindsville (07049000).—Continued

[Units are in milligrams per liter unless otherwise noted; m³/s, cubic meter per second; five-digit numbers in parentheses are STORET parameter codes used for computer storage of data; N, nitrogen; p, phosphorus; <, less than; --, missing data. When laboratory reporting limit (LRL) values were originally reported, less than values were modified by dividing the LRL by 2 to get the long-term method detection level (LT–MDL) and the resulting LT–MDL value is reported below]

Date	Time	Instantaneous streamflow, in m³/s (30209)	Total ammonia + organic, as N (00625)	Dissolved nitrite + nitrate, as N (00631)	Total nitrogen (00600)	Dissolved orthophosphorus, as P (00671)	Total phosphorus (00665)	Dissolved organic carbon (00681)	Total organic carbon (00680)	Suspended sediment (80154)
08/11/2004	1200	3.20	0.31	0.07	0.38	<0.010	0.040	1.8	3.3	32
09/09/2004	1400	0.396	0.24	0.10	0.35	<0.010	<0.020	2.0	3.2	22
10/05/2004	1215	0.283	0.26	0.12	0.38	<0.003	0.027	2.3	5.1	31
11/01/2004	1515	320	1.2	0.464	1.6	0.036	0.230	5.0	12.6	347
11/03/2004	1440	37.9	0.28	0.728	1.0	0.007	0.071	1.9	3.6	49
01/03/2005	1945	147	0.79	0.539	1.3	0.042	0.190	5.4	9.4	142
01/11/2005	1600	24.5	0.14	0.812	0.95	<0.003	0.024	1.7	1.9	36
03/08/2005	1500	9.80	0.16	0.275	0.44	<0.003	0.020	0.9	1.6	14
04/18/2005	1340	15.0	0.15	0.306	0.45	<0.003	0.021	1.1	1.3	12
06/29/2005	1515	0.266	0.35	0.093	0.44	<0.003	0.040	3.0	4.3	15
08/17/2005	1500	0.0934	0.39	0.187	0.58	<0.020	0.019	3.2	3.7	21
10/19/2005	1400	0.0651	0.30	0.288	0.58	<0.015	0.023	3.9	3.0	32
12/19/2005	1430	0.119	0.45	0.111	0.56	<0.015	0.091	2.7	5.1	42
02/23/2006	1540	1.02	0.26	0.220	0.48	<0.015	0.025	2.1	3.6	8
05/02/2006	1200	26.6	0.27	0.390	0.66	<0.090	0.043	1.8	4.1	32
05/04/2006	1415	276	1.8	0.369	2.2	0.003	0.330	3.4	19.5	695
05/23/2006	830	6.57	0.19	0.124	0.31	<0.003	0.013	1.3	1.7	9
07/19/2006	900	0.0850	0.34	0.172	0.52	0.004	0.030	2.4	3.4	5
08/23/2006	1330	42.2	2.0	1.08	3.0	0.044	0.390	4.9	17.5	533
08/29/2006	1600	2.55	0.61	0.572	1.2	0.012	0.086	3.9	6.1	40
11/01/2006	1215	1.73	0.22	0.489	0.71	0.003	0.026	10.9	2.1	8
12/13/2006	1230	8.92	0.16	0.974	1.1	<0.003	0.019	7.2	1.2	7
01/13/2007	1615	323	0.76	0.429	1.2	0.040	0.199	4.3	9.3	151
02/13/2007	1430	123	0.61	0.468	1.1	0.024	0.141	4.1	6.4	84
02/20/2007	1430	16.1	0.06	0.590	0.65	0.003	0.017	0.8	0.8	11
05/29/2007	1245	7.53	0.19	0.157	0.34	0.004	0.024	1.3	2.1	12
07/09/2007	1330	4.47	0.29	0.207	0.49	0.005	0.068	2.2	3.4	21
09/04/2007	1640	0.0340	0.27	0.136	0.40	0.004	0.024	2.4	4.0	8
10/22/2007	1023	1.56	0.29	0.188	0.48	0.005	0.029	2.3	2.5	8
01/14/2008	945	5.44	0.22	0.508	0.72	0.004	0.028	1.2	2.0	12
02/16/2008	2333	129	1.6	0.537	2.2	0.029	0.360	3.9	12	563
02/25/2008	1513	21.2	0.18	1.05	1.2	0.004	0.027	1.0	1.4	14
03/19/2008	1525	144	0.85	0.395	1.2	0.025	0.333	3.1	9.1	294
04/10/2008	1915	351	1.4	0.273	1.6	0.012	0.300	7.1	13.6	512
05/06/2008	940	23.8	0.18	0.252	0.43	0.004	0.028	1.2	1.6	23
06/13/2008	915	18.7	0.25	0.289	0.54	0.004	0.047	1.9	2.0	26

Appendix 1. Water-quality data results modified from NWIS data for White River near Fayetteville (07048600), Richland Creek at Goshen (07048800), and War Eagle Creek near Hindsville (07049000).—Continued

[Units are in milligrams per liter unless otherwise noted; m^3/s, cubic meter per second; five-digit numbers in parentheses are STORET parameter codes used for computer storage of data; N, nitrogen; p, phosphorus; <, less than; --, missing data. When laboratory reporting limit (LRL) values were originally reported, less than values were modified by dividing the LRL by 2 to get the long-term method detection level (LT–MDL) and the resulting LT–MDL value is reported below]

Date	Time	Instantaneous streamflow, in m^3/s (30209)	Total ammonia + organic, as N (00625)	Dissolved nitrite + nitrate, as N (00631)	Total nitrogen (00600)	Dissolved orthophosphorus, as P (00671)	Total phosphorus (00665)	Dissolved organic carbon (00681)	Total organic carbon (00680)	Suspended sediment (80154)
07/09/2008	1450	45.3	0.79	0.290	1.1	0.019	0.143	3.7	7.3	142
08/26/2008	1120	1.02	0.45	0.448	0.90	0.008	0.084	3.4	4.5	33
Richland Creek at Goshen (07048800)										
04/04/2001	1415	0.340	<0.10	1.5	---	<0.005	<0.010	2.2	2.5	17
04/17/2001	800	0.906	<0.10	1.2	---	<0.005	<0.010	1.1	1.4	17
05/01/2001	1000	0.538	0.21	0.65	0.86	<0.005	<0.010	0.6	0.9	19
05/15/2001	1210	0.680	0.40	0.74	1.1	<0.005	<0.010	2.3	1.1	23
05/30/2001	1130	0.906	0.32	0.63	0.95	<0.005	<0.010	1.4	1.5	27
06/12/2001	945	0.453	0.28	0.45	0.73	0.020	<0.010	2.3	1.6	24
06/26/2001	715	0.110	0.22	0.60	0.82	<0.005	<0.010	1.5	0.8	24
07/10/2001	1530	0.232	0.30	0.29	0.59	<0.005	<0.010	2.1	1.5	31
07/23/2001	1215	0.232	0.36	0.40	0.76	<0.005	0.020	1.3	0.8	32
08/07/2001	1125	0.0765	0.30	0.08	0.38	<0.005	<0.010	1.6	2.2	28
08/23/2001	1445	0.0481	0.40	0.05	0.45	<0.005	<0.010	1.2	1.8	37
09/05/2001	915	0.0396	<0.10	0.06	---	<0.005	<0.010	2.4	1.9	33
09/17/2001	1400	0.623	<0.10	1.2	---	0.010	<0.010	1.7	1.7	27
10/01/2001	1400	0.368	<0.10	1.2	---	<0.005	<0.010	1.6	1.7	31
10/15/2001	1500	2.66	<0.10	2.0	---	0.020	<0.010	2.8	2.8	29
10/29/2001	1430	0.453	<0.10	1.6	---	<0.005	<0.010	2.3	2.1	25
11/06/2001	1330	0.396	<0.10	1.2	---	<0.005	<0.010	2.5	3.0	30
11/26/2001	1510	0.340	<0.10	1.0	---	<0.005	<0.010	3.7	3.8	30
12/10/2001	1500	0.396	<0.10	1.1	---	<0.005	0.020	1.1	1.3	30
12/18/2001	930	24.6	0.30	2.2	2.5	<0.005	0.060	3.5	3.8	102
01/03/2002	1105	1.02	<0.10	2.2	---	<0.005	<0.010	3.6	3.8	28
01/14/2002	1400	0.708	<0.10	1.9	---	<0.005	<0.010	2.1	2.5	20
02/06/2002	1030	7.53	<0.10	1.7	---	<0.005	<0.010	1.9	2.0	16
02/20/2002	1300	10.4	0.40	0.91	1.3	0.020	0.040	2.8	2.8	37
03/05/2002	1510	3.51	<0.10	0.97	---	0.020	<0.010	1.7	2.0	20
03/18/2002	1630	0	<0.10	0.69	---	0.010	<0.010	1.3	1.3	7
04/02/2002	1515	0	0.20	1.1	1.3	<0.005	<0.010	0.8	2.0	15
04/15/2002	1615	0	<0.10	1.2	---	<0.005	<0.010	1.0	1.2	15
04/30/2002	1245	0	<0.10	0.68	---	0.020	<0.010	0.9	1.2	9
05/13/2002	1630	0	0.60	0.85	1.4	0.020	0.060	4.1	4.5	20
05/29/2002	815	0	<0.10	0.87	---	0.020	<0.010	2.0	1.9	12
06/17/2002	1645	0	<0.10	1.0	---	0.020	0.020	1.4	1.3	7
07/08/2002	1230	0	0.40	0.79	1.2	0.010	0.030	1.9	2.2	5

Appendix 1. Water-quality data results modified from NWIS data for White River near Fayetteville (07048600), Richland Creek at Goshen (07048800), and War Eagle Creek near Hindsville (07049000).—Continued

[Units are in milligrams per liter unless otherwise noted; m^3/s, cubic meter per second; five-digit numbers in parentheses are STORET parameter codes used for computer storage of data; N, nitrogen; p, phosphorus; <, less than; --, missing data. When laboratory reporting limit (LRL) values were originally reported, less than values were modified by dividing the LRL by 2 to get the long-term method detection level (LT–MDL) and the resulting LT–MDL value is reported below]

Date	Time	Instantaneous streamflow, in m^3/s (30209)	Total ammonia + organic, as N (00625)	Dissolved nitrite + nitrate, as N (00631)	Total nitrogen (00600)	Dissolved orthophosphorus, as P (00671)	Total phosphorus (00665)	Dissolved organic carbon (00681)	Total organic carbon (00680)	Suspended sediment (80154)
07/22/2002	1500	0	0.30	0.35	0.65	<0.005	0.030	2.5	2.3	7
08/20/2002	1440	0	0.30	0.85	1.1	<0.005	0.030	1.8	1.8	8
09/03/2002	1330	0	0.60	0.42	1.0	<0.005	<0.010	2.3	1.9	11
10/08/2002	930	0	<0.10	0.14	---	<0.005	<0.010	1.2	0.9	5
10/28/2002	1500	0	<0.10	0.10	---	<0.005	<0.010	1.5	1.1	3
11/13/2002	900	0	<0.10	0.11	---	<0.005	<0.010	1.5	1.2	3
12/11/2002	1300	0.227	<0.10	0.89	---	<0.005	0.030	1.1	1.0	4
12/18/2002	1400	1.13	0.20	1.3	1.5	<0.005	<0.010	2.0	2.0	11
01/08/2003	830	1.39	<0.10	1.7	---	0.020	<0.010	1.9	2.0	6
01/22/2003	1110	0.510	<0.10	1.5	---	<0.005	<0.010	0.8	1.0	5
02/12/2003	940	0.261	<0.10	1.1	---	<0.005	<0.010	1.8	3.5	1
03/12/2003	745	1.44	<0.10	1.2	---	<0.005	<0.010	1.0	1.3	4
03/25/2003	1415	4.96	<0.10	0.84	---	<0.005	<0.010	1.2	1.1	8
04/08/2003	1345	1.27	<0.10	0.72	---	<0.005	<0.010	1.0	0.9	19
05/05/2003	1430	1.50	<0.10	0.40	---	<0.005	<0.010	0.9	0.7	30
06/02/2003	2300	18.3	0.70	0.63	1.3	0.020	0.090	4.7	4.5	60
06/05/2003	1345	3.37	<0.10	0.64	---	0.010	<0.010	1.4	1.3	24
07/29/2003	1540	0.0680	0.60	0.09	0.69	<0.005	0.050	2.5	2.5	28
08/20/2003	1120	0.0198	0.30	0.01	---	<0.005	<0.010	1.6	1.4	19
09/09/2003	1235	0.130	0.30	0.56	0.86	<0.005	<0.010	2.0	1.8	23
10/28/2003	1200	0.340	0.20	0.85	1.1	<0.005	<0.010	1.2	1.0	24
11/18/2003	1215	11.6	0.40	0.81	1.2	0.010	0.060	2.9	2.7	48
11/19/2003	845	8.41	0.30	0.84	1.1	<0.005	0.030	2.5	2.5	28
12/09/2003	1130	1.47	<0.10	1.1	---	<0.005	<0.010	1.1	1.0	28
01/21/2004	1245	4.76	<0.10	1.1	---	<0.005	0.010	1.7	1.9	22
02/18/2004	1245	2.38	<0.10	1.1	---	<0.005	0.010	1.0	1.0	46
03/17/2004	1030	2.04	<0.10	0.86	---	<0.005	0.010	0.8	0.7	26
04/13/2004	1440	3.74	<0.10	0.28	---	<0.005	<0.010	1.1	1.1	17
04/22/2004	1715	36.0	0.70	0.58	1.3	0.030	0.120	5.2	5.3	119
05/19/2004	930	2.41	<0.10	0.60	---	<0.005	<0.010	1.4	1.1	34
06/23/2004	850	13.8	0.30	0.66	0.96	<0.005	0.050	3.7	3.8	41
07/21/2004	940	1.36	0.18	1.17	1.3	<0.010	<0.020	1.1	2.6	33
08/11/2004	1530	0.878	0.13	0.89	1.0	<0.010	<0.020	1.1	1.5	26
09/08/2004	1250	0.159	0.16	0.38	0.55	<0.010	<0.020	1.3	2.0	25
10/05/2004	1330	0.0538	0.17	0.031	0.20	<0.003	0.013	1.3	3.2	23
11/01/2004	1700	68.5	1.0	1.1	2.1	0.042	0.220	5.3	12.3	351

Appendix 1. Water-quality data results modified from NWIS data for White River near Fayetteville (07048600), Richland Creek at Goshen (07048800), and War Eagle Creek near Hindsville (07049000).—Continued

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Date	Time	Instantaneous streamflow, in m^3/s (30209)	Total ammonia + organic, as N (00625)	Dissolved nitrite + nitrate, as N (00631)	Total nitrogen (00600)	Dissolved orthophosphorus, as P (00671)	Total phosphorus (00665)	Dissolved organic carbon (00681)	Total organic carbon (00680)	Suspended sediment (80154)
11/03/2004	1315	12.1	0.24	3.9	4.1	0.014	0.043	1.9	3.2	43
01/04/2005	855	61.4	1.6	0.868	2.5	0.078	0.440	5.7	19.5	1050
01/11/2005	1400	1.59	0.10	1.51	1.6	0.006	0.019	1.1	1.4	26
03/07/2005	1330	2.55	0.09	0.592	0.68	<0.003	0.007	0.9	1.3	4
04/18/2005	1430	4.62	0.12	0.454	0.57	<0.015	0.012	1.5	1.0	6
06/28/2005	1445	0.159	0.30	0.049	0.35	<0.003	0.021	1.5	2.3	9
08/15/2005	1430	0.0311	0.29	0.014	0.31	<0.020	0.028	9.7	3.5	16
10/19/2005	1230	0.0116	0.27	0.018	0.29	<0.015	0.023	3.9	2.4	35
12/19/2005	1330	0.0136	0.14	0.040	---	<0.015	0.009	1.0	3.9	60
02/22/2006	1410	0.139	0.11	0.257	0.37	<0.015	0.007	1.0	1.5	2
05/04/2006	1700	84.4	1.0	0.356	1.4	0.037	0.220	7.8	15.3	363
05/23/2006	1230	0.736	0.16	0.369	0.53	<0.003	0.009	1.3	2.8	3
07/19/2006	815	0.0272	0.26	0.012	0.27	0.003	0.016	1.6	2.2	4
08/23/2006	1415	8.98	1.4	2.11	3.5	0.207	0.430	8.5	13.3	143
08/29/2006	1355	0.235	0.28	1.31	1.6	0.007	0.020	2.3	2.9	5
10/31/2006	1315	0.708	0.20	1.44	1.6	0.004	0.017	8.2	2.6	5
12/13/2006	1320	0.263	0.16	2.0	2.2	0.006	0.015	25.4	1.5	7
01/13/2007	1715	116	1.6	0.581	2.2	0.063	0.340	5.0	17.6	876
02/13/2007	1400	29.7	0.49	0.805	1.3	0.021	0.094	4.0	5.9	55
02/20/2007	1515	3.40	<0.05	1.36	---	0.006	0.008	0.9	1.2	6
05/29/2007	1400	0.680	0.12	0.313	0.43	0.004	0.009	1.0	1.4	6
07/09/2007	1500	0.396	0.20	0.226	0.42	0.003	0.015	1.8	2.2	5
09/04/2007	1600	0.0850	0.25	0.035	0.29	0.007	0.019	2.0	2.4	6
10/22/2007	1130	0.235	0.14	0.220	0.36	0.004	0.008	1.5	1.6	2
01/14/2008	1155	0.595	0.11	0.894	1.0	0.004	0.008	1.2	1.1	5
02/17/2008	1230	50.1	0.78	1.21	2.0	0.050	0.208	6.7	8.6	89
02/25/2008	1448	2.63	0.11	1.86	2.0	0.007	0.013	1.2	1.2	5
03/19/2008	1310	762	1.0	0.853	1.9	0.052	0.330	6.6	10.4	428
04/10/2008	1720	1270	1.4	0.559	2.0	0.027	0.330	3.9	13.3	582
05/06/2008	1040	65.4	0.12	0.669	0.79	0.006	0.016	1.0	1.4	14
06/09/2008	1010	74.8	0.24	0.531	0.77	0.003	0.029	1.4	1.6	13
08/26/2008	1042	35.7	0.43	1.03	1.5	0.004	0.047	2.3	3.5	18
09/04/2008	1300	47.3	0.59	1.27	1.9	0.048	0.116	5.0	7.6	27
War Eagle Creek near Hindsville (07049000)										
04/05/2001	830	2.15	<0.10	1.5	---	0.030	0.030	1.8	---	19
04/17/2001	1400	4.53	0.21	0.89	1.1	0.020	0.030	2.0	2.4	21

Appendix 1. Water-quality data results modified from NWIS data for White River near Fayetteville (07048600), Richland Creek at Goshen (07048800), and War Eagle Creek near Hindsville (07049000).—Continued

[Units are in milligrams per liter unless otherwise noted; m^3/s, cubic meter per second; five-digit numbers in parentheses are STORET parameter codes used for computer storage of data; N, nitrogen; p, phosphorus; <, less than; --, missing data. When laboratory reporting limit (LRL) values were originally reported, less than values were modified by dividing the LRL by 2 to get the long-term method detection level (LT–MDL) and the resulting LT–MDL value is reported below]

Date	Time	Instantaneous streamflow, in m^3/s (30209)	Total ammonia + organic, as N (00625)	Dissolved nitrite + nitrate, as N (00631)	Total nitrogen (00600)	Dissolved orthophosphorus, as P (00671)	Total phosphorus (00665)	Dissolved organic carbon (00681)	Total organic carbon (00680)	Suspended sediment (80154)
05/02/2001	745	1.56	0.36	0.84	1.2	0.020	0.020	1.0	1.2	22
05/16/2001	850	1.33	0.42	1.0	1.4	0.050	0.070	1.7	1.3	28
05/30/2001	800	1.67	0.26	1.1	1.4	0.030	0.020	1.5	1.4	25
06/12/2001	800	0.934	0.24	1.0	1.2	0.050	0.040	2.2	2.1	27
06/25/2001	1330	0.793	0.21	0.94	1.1	0.020	0.020	1.0	0.8	23
07/09/2001	1215	0.991	0.20	1.3	1.5	0.030	0.040	2.2	1.6	28
07/24/2001	1400	0.651	0.26	0.84	1.1	0.030	0.050	1.3	1.0	26
08/07/2001	615	0.425	0.30	0.76	1.1	<0.005	0.020	2.4	1.8	32
08/21/2001	1130	0.368	0.30	0.41	0.71	<0.005	<0.010	2.9	1.8	42
09/05/2001	730	0.481	<0.10	0.78	---	<0.005	<0.010	2.2	2.5	31
09/18/2001	930	0.850	0.20	1.9	2.1	0.040	0.050	2.9	2.3	25
10/04/2001	800	0.510	<0.10	1.2	---	0.040	0.050	1.6	1.5	36
10/16/2001	1530	3.40	<0.10	0.86	---	0.050	0.050	3.0	2.9	26
11/01/2001	730	0.623	<0.10	1.2	---	0.020	0.030	1.7	1.7	23
11/06/2001	1215	0.651	0.30	1.3	1.6	0.030	0.040	5.3	5.4	34
11/26/2001	1645	1.58	<0.10	1.2	---	0.060	0.070	3.5	3.8	39
12/13/2001	715	2.97	<0.10	1.0	---	0.070	0.070	1.9	1.9	30
12/18/2001	815	77.0	0.50	1.9	2.4	0.020	0.080	4.4	6.7	95
01/03/2002	1315	2.35	<0.10	2.2	---	0.040	0.050	3.7	3.8	26
01/16/2002	1530	1.61	<0.10	2.1	---	0.080	0.080	0.7	0.6	24
02/06/2002	930	12.1	<0.10	1.7	---	0.010	0.020	1.8	1.9	20
02/20/2002	1545	16.0	0.30	1.0	1.3	0.020	0.050	1.7	2.1	46
03/07/2002	1530	8.89	<0.10	0.87	---	0.040	0.030	2.4	---	23
03/18/2002	1530	8.61	0.20	0.80	1.0	<0.005	<0.010	1.6	1.6	32
04/02/2002	1400	10.1	<0.10	1.3	---	<0.005	0.020	0.9	1.8	26
04/16/2002	1100	10.7	<0.10	1.4	---	0.020	0.020	1.2	1.2	11
04/30/2002	1145	10.6	<0.10	0.71	---	0.020	0.030	1.2	1.3	10
05/13/2002	1500	12.8	1.4	1.1	2.5	0.040	0.060	2.0	2.1	16
05/29/2002	715	9.68	<0.10	1.4	---	0.030	<0.010	1.5	1.4	15
06/17/2002	1530	8.21	<0.10	1.4	---	0.020	0.020	1.3	1.4	12
07/08/2002	1345	2.10	<0.10	1.4	---	0.030	0.040	1.6	1.7	7
07/22/2002	1330	3.26	0.20	1.4	1.6	0.070	0.060	2.1	1.3	8
08/20/2002	1615	2.83	<0.10	1.9	---	0.030	0.060	2.3	2.3	11
09/03/2002	1230	0.680	0.30	1.4	1.7	<0.005	<0.010	1.4	1.1	12
10/08/2002	830	0.425	<0.10	1.4	---	<0.005	<0.010	1.2	1.1	4
10/28/2002	1350	1.05	<0.10	1.6	---	<0.005	<0.010	1.4	1.2	1

Appendix 1. Water-quality data results modified from NWIS data for White River near Fayetteville (07048600), Richland Creek at Goshen (07048800), and War Eagle Creek near Hindsville (07049000).—Continued

[Units are in milligrams per liter unless otherwise noted; m^3/s, cubic meter per second; five-digit numbers in parentheses are STORET parameter codes used for computer storage of data; N, nitrogen; p, phosphorus; <, less than; --, missing data. When laboratory reporting limit (LRL) values were originally reported, less than values were modified by dividing the LRL by 2 to get the long-term method detection level (LT–MDL) and the resulting LT–MDL value is reported below]

Date	Time	Instantaneous streamflow, in m^3/s (30209)	Total ammonia + organic, as N (00625)	Dissolved nitrite + nitrate, as N (00631)	Total nitrogen (00600)	Dissolved orthophosphorus, as P (00671)	Total phosphorus (00665)	Dissolved organic carbon (00681)	Total organic carbon (00680)	Suspended sediment (80154)
11/13/2002	800	0.736	<0.10	1.6	---	0.030	0.040	1.4	1.4	3
12/09/2002	1445	1.33	0.30	1.8	2.1	0.040	0.060	1.3	1.5	<0.5
12/19/2002	845	1.93	0.40	2.1	2.5	0.190	0.210	2.1	2.7	7
01/07/2003	1045	3.48	<0.10	1.6	---	0.030	0.050	1.3	1.5	5
01/22/2003	1245	0.821	<0.10	1.5	---	0.080	0.110	1.6	1.7	2
02/12/2003	830	0.453	0.20	1.3	1.5	0.040	0.050	1.8	2.9	3
03/11/2003	1220	3.40	<0.10	1.3	---	<0.005	<0.010	1.0	1.0	6
03/25/2003	1245	9.71	<0.10	1.0	---	0.020	0.050	1.2	1.1	13
04/09/2003	730	2.86	<0.10	0.98	---	0.020	0.050	1.3	1.1	25
05/05/2003	1300	3.06	<0.10	0.51	---	0.020	0.040	1.1	1.0	35
06/03/2003	745	21.3	0.30	0.61	0.91	0.010	0.070	2.0	1.9	66
06/05/2003	1215	7.39	<0.10	0.88	---	0.030	0.050	2.0	2.2	32
07/29/2003	1445	0.510	0.20	0.94	1.1	0.030	0.040	1.6	1.3	37
08/20/2003	1025	0.368	0.20	0.54	0.74	<0.005	0.010	1.8	1.5	27
09/09/2003	1130	0.453	0.20	1.6	1.8	0.020	0.030	1.6	1.6	27
10/28/2003	1100	0.878	0.30	0.97	1.3	0.090	0.080	1.5	1.5	21
11/18/2003	1655	21.8	0.50	0.79	1.3	0.100	0.180	2.0	1.9	89
11/19/2003	1115	13.0	0.50	0.70	1.2	0.020	0.080	3.3	4.2	45
12/09/2003	1000	2.29	<0.10	1.2	---	0.040	0.050	1.0	1.0	28
01/21/2004	1130	9.00	<0.10	0.69	---	<0.005	0.020	1.5	1.6	28
02/18/2004	1045	4.67	<0.10	1.1	---	<0.005	0.020	0.9	0.9	45
03/17/2004	930	3.82	<0.10	1.0	---	0.040	0.060	0.9	0.7	30
04/13/2004	1625	6.65	<0.10	0.42	---	0.020	0.040	1.4	1.3	12
04/22/2004	1800	129	1.2	0.43	1.6	0.020	0.240	7.1	6.6	267
05/19/2004	830	5.55	<0.10	1.3	---	<0.005	<0.010	1.4	1.3	35
06/23/2004	725	6.65	<0.10	1.3	---	0.030	0.060	1.8	1.9	43
07/21/2004	830	1.64	0.11	1.1	1.2	0.020	<0.020	1.1	2.1	30
08/11/2004	1400	1.33	0.18	1.23	1.4	0.020	0.050	1.2	2.6	34
09/08/2004	1100	0.340	0.16	1.57	1.7	<0.010	0.030	1.1	1.7	34
10/05/2004	1045	0.283	0.15	1.24	1.4	0.006	0.019	1.1	3.1	54
11/02/2004	1115	51.0	0.60	1.2	1.8	0.023	0.138	4.3	7.2	133
11/03/2004	925	56.9	0.36	1.57	1.9	0.023	0.078	2.4	4.4	61
01/04/2005	1230	48.7	1.4	1.38	2.7	0.044	0.300	3.9	15.5	454
01/11/2005	1250	17.3	0.13	1.91	2.0	0.017	0.038	1.4	1.6	38
03/08/2005	815	7.11	0.12	0.931	1.1	<0.003	0.018	1.1	1.3	8
04/19/2005	800	8.33	0.12	0.709	0.83	<0.003	0.036	1.0	1.7	13

Appendix 1. Water-quality data results modified from NWIS data for White River near Fayetteville (07048600), Richland Creek at Goshen (07048800), and War Eagle Creek near Hindsville (07049000).—Continued

[Units are in milligrams per liter unless otherwise noted; m^3/s, cubic meter per second; five-digit numbers in parentheses are STORET parameter codes used for computer storage of data; N, nitrogen; p, phosphorus; <, less than; --, missing data. When laboratory reporting limit (LRL) values were originally reported, less than values were modified by dividing the LRL by 2 to get the long-term method detection level (LT–MDL) and the resulting LT–MDL value is reported below]

Date	Time	Instantaneous streamflow, in m^3/s (30209)	Total ammonia + organic, as N (00625)	Dissolved nitrite + nitrate, as N (00631)	Total nitrogen (00600)	Dissolved orthophosphorus, as P (00671)	Total phosphorus (00665)	Dissolved organic carbon (00681)	Total organic carbon (00680)	Suspended sediment (80154)
06/28/2005	1330	0.651	0.24	0.914	1.1	0.006	0.043	1.7	1.9	9
08/15/2005	1330	0.368	0.34	0.414	0.75	<0.020	0.035	2.7	3.0	8
10/19/2005	1120	0.255	0.20	0.721	0.92	<0.015	0.023	2.1	4.4	39
12/19/2005	1200	0.368	0.19	1.14	1.3	0.030	0.066	1.4	3.3	43
02/22/2006	1200	0.595	0.17	0.631	0.80	0.033	0.070	1.3	3.3	3
05/04/2006	1900	146	1.6	0.673	2.3	0.060	0.380	5.8	17.8	517
05/23/2006	1100	3.11	0.18	1.18	1.4	0.017	0.035	1.3	1.5	12
07/19/2006	650	0.368	0.32	0.257	0.58	0.003	0.026	1.4	2.2	10
08/29/2006	1240	0.906	0.31	1.46	1.8	0.015	0.041	1.9	2.7	8
11/01/2006	1100	1.87	0.20	1.53	1.7	0.067	0.100	21.7	2.2	6
12/13/2006	1040	6.14	0.12	2.36	2.5	0.025	0.051	29.8	1.5	10
02/13/2007	1300	96.6	0.79	0.973	1.8	0.022	0.194	4.1	8.1	146
02/20/2007	1630	8.81	<0.05	1.84	---	0.019	0.033	0.9	1.2	18
05/30/2007	820	1.87	0.16	0.968	1.1	0.014	0.033	1.1	1.7	9
07/10/2007	1345	1.39	0.20	0.530	0.73	0.016	0.032	1.9	2.3	4
09/04/2007	1510	0.340	0.21	0.367	0.58	0.006	0.025	1.5	2.7	5
10/22/2007	1245	0.651	0.20	1.19	1.4	0.021	0.035	1.9	2.0	3
01/14/2008	1047	2.29	0.21	0.859	1.1	0.021	0.049	2.0	2.4	9
02/25/2008	1327	5.55	0.13	2.26	2.4	0.020	0.040	1.1	1.5	8
03/04/2008	1030	111	0.76	1.73	2.5	0.025	0.210	4.0	8.1	187
03/19/2008	1015	881	0.97	0.844	1.8	0.063	0.329	9.9	11.0	279
04/10/2008	1430	1060	2.3	0.347	2.6	0.056	0.460	8.2	21.6	727
05/06/2008	1140	7.84	0.12	0.999	1.1	0.008	0.023	1.1	1.5	164
06/09/2008	1110	3.48	0.17	0.886	1.1	0.022	0.044	1.3	1.6	11
08/26/2008	957	1.30	0.26	1.68	1.9	0.048	0.075	1.8	2.0	11
09/04/2008	1400	42.8	0.54	1.68	2.2	0.037	0.115	3.8	4.3	73

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