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The Arkansas Water Resources Center monitored water quality at seven sites in the Upper White River Basin during base flow conditions and storm events from July 1, 2009 through June 30, 2010. Water samples were collected manually with an alpha or Kemmerer style sampler and analyzed for nitrate-nitrogen (NO_3-N), sulfate (SO_4), chloride (Cl^-), soluble reactive phosphorus (SRP), total phosphorus (TP), dissolved ammonia (NH_3-N), total N (TN), total suspended solids (TSS), and turbidity. Physico-chemical parameters were measured in field including pH, conductivity, water temperature, and dissolved oxygen concentration. The selected sites were all at established discharge monitoring stations maintained by the US Geological Survey, and constituent loads were determined using regression models between constituent concentrations, discharge, and seasonal factors to estimate daily loads, which were then summed to produce monthly, seasonal and annual load estimates. The constituent loads and annual flow-weighted concentrations for the 2009 calendar year are summarized in the table below, using the data collected in this study. The regression models were applied throughout the calendar year discharge record to estimate constituent loads for individual sites.

Summary of calculated total loads (kg) for each parameter at the sampled sites in the Upper White River Basin for the period, January through December 2009.

Site	Cl^-	SO_4	NH_3-N	NO_3-N	SRP	TN	TP	TSS
Brush Creek	153,000	313,000	1,200	41,000	1,000	48,000	5,400	3,031,000
Richland Creek[A]	--	--	--	--	--	--	--	--
Town Branch	22,000	47,000	330	1,300	130	1,900	360	213,000
Town Branch Tributary	74,000	148,000	1,300	14,000	150	15,000	480	129,000
War Eagle Creek	1,947,000	2,610,000	37,000	501,000	17,400	582,000	78,000	37,803,000
West Fork White River	844,000	3,280,000	18,000	91,000	3,200	136,000	30,000	12,697,000
White River	2,024,000	6,815,000	71,000	313,000	12,000	442,000	98,000	35,851,000

Summary of calculated flow weighted concentrations (FWC, mg L^{-1}) for each parameter at the sampled sites in the Upper White River Basin for the period, January through December 2009.

Site	Cl^-	SO_4	NH_3-N	NO_3-N	SRP	TN	TP	TSS
Brush Creek	7.52	14.03	0.06	2.03	0.05	2.38	0.27	149
Richland Creek[A]	--	--	--	--	--	--	--	--
Town Branch	15.06	31.92	0.22	0.87	0.07	1.29	0.26	145
Town Branch Tributary	16.26	32.76	0.28	3.00	0.03	3.38	0.11	29
War Eagle Creek	4.31	5.77	0.08	1.11	0.04	1.29	0.17	84
West Fork White River	4.09	15.88	0.09	0.44	0.02	0.66	0.14	61
White River	2.84	9.55	0.10	0.44	0.02	0.62	0.14	50

[A] Adequate flow data to estimate loads is not yet available from the USGS. Loads will be estimated and this report amended as soon as the necessary data is made available.

ABBREVIATIONS: Chloride (Cl^-), Sulfate (SO_4), Ammonia-Nitrogen (NH_3-N), Nitrate-Nitrogen (NO_3-N), Soluble Reactive Phosphorus (SRP), Total Nitrogen (TN), Total Phosphorus (TP), Total Suspended Solids (TSS), Upper White River Basin (UWRB), Arkansas Water Resources Center (AWRC), Arkansas Natural Resources Commission (ANRC).

INTRODUCTION

The White River (HUC# 11010001) is one of three major inflows into Beaver Lake, the primary drinking water supply for northwest Arkansas. Over 350,000 Arkansans or approximately 1/8th of the State's population use Beaver Lake as the source of their drinking water. The lake is also a significant source of recreation and tourism in northwest Arkansas. Because of the value of Beaver Lake and its tributaries to the local economy, the Northwest Arkansas Council, a group of regional business persons, has made its protection a top priority. In response, the council contracted to have a watershed-based strategy completed to protect the use of Beaver Lake as the regional water supply (completed by TetraTech).

The Upper White River Basin (UWRB) is a 319 priority catchment of the Arkansas Natural Resources Commission (ANRC). Furthermore, three stream segments on tributaries to Beaver Lake and 1,500 acres of the Lake itself are currently listed on the ADEQ's 303(d) list as impaired (ADEQ, 2008). The identified causes of this impairment are sediment, dissolved oxygen, and total dissolved solids, where the sources of pollutants identified in the assessment were surface erosion and unknown. In addition to the identified impairment, the Upper White River Basin is identified by the ANRC as a nutrient surplus watershed (Act 1061 Ark. Code Ann. 15-20-1104).

The UWRB is a dominantly forested region that has traditionally been characterized by agricultural activity including pasture land, cattle grazing, and poultry operations. Over the past decade forest and pasture land has been converted to urban and suburban space, especially along the western part of the drainage area. Transport of sediment, organic matter, and nutrients from headwater streams to Beaver Lake influence the concentrations of organic carbon, nutrients and sediment in the raw water used by Beaver Water District and three other public water utilities. Beaver Water District is currently experiencing seasonal taste and odor problems related to the growth of cyanobacteria in the upper portion of Beaver Lake. The amount of organic carbon has been increasing over the last decade, raising concerns about disinfection byproducts rules established for drinking water by the U.S. Environmental Protection Agency.

The UWRB has at least fourteen current or completed section 319(h) projects addressing nutrients and sediment, and the United States Department of Agriculture (USDA) also conducts programs and projects within the basin. Planning for implementation of nonpoint source projects in the basin, and evaluation of their success or failure depends on the availability of comparable long term water quality data. Four of the seven selected sampling sites have continuous long term water quality and discharge data, whereas the other three sites have some historical water quality data but not continuous discharge. The selected sampling sites provide a comprehensive assessment of water quality in the Beaver Lake Watershed and its tributaries in the UWRB, and this report presents the annual loads and flow-weighted concentrations (FWC) of select constituents at these sites for the 2009 calendar year. Semi-annual loads from 1 January to 30 June 2010 are also presented for all sampled sites in the appendix.

STUDY SITE DESCRIPTIONS

The selected sites encompass the UWRB in Arkansas on the White River downstream from the confluence of its three forks and the other three major tributaries to Beaver Lake (i.e., Brush Creek, Richland Creek and War Eagle Creek). The selected sites are representative of various land uses within the Beaver Lake Watershed, including catchments that are pasture dominated (Brush Creek) and that are dominated by urban, residential, and industrial development (Town Branch and its tributary). Two of the sites, West Fork of the White River and White River near Fayetteville, are on stream segments identified as impaired by ADEQ. Three of the sites; Richland Creek, Town Branch and Town Branch Tributary; are on direct tributaries to those streams, or to the impaired segment of Beaver Lake. The other two sites represent more rural systems and are included to provide a better range of land uses. The sampled sites are described in more detail below.

Brush Creek at Highway 45 (USGS Station No. 07048890)

Brush Creek lies in the central portion of the UWRB and drains a 52 km^2 area. This site was sampled because of its agricultural influence where greater than 38% of the drainage area is pasture land use. The U.S. Geological Survey (USGS) began monitoring discharge at Brush Creek at Highway 45 (near Mayfield, Arkansas) in 2007. Average annual discharge at this site has ranged from 0.5 $m^3 s^{-1}$ (2009) to 1.0 $m^3 s^{-1}$ (2008).

Richland Creek at Highway 45 (USGS Station No. 07048800)

Richland Creek lies in the southern portion of the UWRB and drains a 357 km^2 area of mixed land uses that is generally forested (67%). The U.S. Geological Survey (USGS) began monitoring discharge at Richland Creek at Highway 45 (at Goshen, Arkansas) in 1998. Average annual discharge at this site has ranged from 1.6 $m^3 s^{-1}$ in 2006 to 15 $m^3 s^{-1}$ in 2008.

Town Branch at Fayetteville (USGS Station No. 07048480)

Town Branch lies in the southwestern portion of the UWRB and drains 2 km^2 of urbanized area in south Fayetteville, Arkansas. The U.S. Geological Survey (USGS) began monitoring discharge at Town Branch in 1996. Average annual discharge at this site has ranged from 0.03 $m^3 s^{-1}$ in 2003 to 0.1 $m^3 s^{-1}$ in 2008.

Town Branch Tributary (USGS Station No. 07048490)

Town Branch Tributary lies in the southwestern portion of the UWRB and drains 4 km^2 of urbanized area in south Fayetteville before flowing into Town Branch. The U.S. Geological Survey (USGS) began monitoring discharge at Town Branch Tributary at Highway 16 in 1996. Average annual discharge at this site has ranged from 0.04 $m^3 s^{-1}$ in 2000 to 0.1 $m^3 s^{-1}$ in 2004.

War Eagle Creek near Hindsville (USGS Station No. 07049000)

War Eagle Creek lies in the southern portion of the UWRB and drains a 681 km^2 area that is mixed land use with 28% pasture and 62% forest. War Eagle receives the treated wastewater effluent from the City of Huntsville, Arkansas. The U.S. Geological Survey (USGS) began monitoring discharge at War Eagle Creek near Hindsville, Arkansas in 1954. Over the past decade, average annual discharge at this site has ranged from 3.6 $ft^3 s^{-1}$ in 2006 to 15 $m^3 s^{-1}$ in 2008.

West Fork White River East of Fayetteville (USGS Station No. 07048550)

The West Fork White River lies in the southwestern portion of the UWRB and drains 319 km^2 of mixed forest, agriculture and urban land use. The U.S. Geological Survey (USGS) began monitoring discharge at West Fork White River East of Fayetteville, Arkansas in 2001. Average annual discharge at this site has ranged from 1.7 $m^3 s^{-1}$ in 2006 to 7.5 $3^3 s^{-1}$ in 2008.

White River near Fayetteville (USGS Station No. 07048600)

The White River lies in the southern portion of the UWRB and drains 1036 km^2 of predominantly forested and some agricultural land use. The U.S. Geological Survey (USGS) began monitoring discharge at White River near Fayetteville, Arkansas in 1964. This site is just upstream of the wastewater effluent discharge from the Paul Noland Facility in Fayetteville, AR. Over the past decade, average annual discharge at this site has ranged from 5 $m^3 s^{-1}$ in 2006 to 25 $m^3 s^{-1}$ in 2008.

METHODS

Sample Collection

Storm and base flow events in the UWRB were sampled from July 1, 2009 through June 30, 2010 at seven locations on selected streams, including West Fork of the White River, White River near Fayetteville, Richland Creek, Brush Creek, War Eagle Creek, Town Branch and a tributary to Town Branch. Water samples were collected using an alpha style horizontal sampler or a Kemmerer type vertical sampler near the vertical centroid of flow (i.e., middle of the channel where water is actively moving). Water samples were collected every 168 hours on average at each site where up to 25% of the collected samples represented storm event or surface runoff conditions following episodic rainfall events, including small and large storm events.

Physico-chemical parameters including pH, conductivity, temperature, and dissolved oxygen concentration were measured on site. All water samples were delivered to the Arkansas Water Resources Center Water Quality Laboratory (WQL) and analyzed for nitrate-nitrogen (NO_3-N), sulfate (SO_4), chloride (Cl), soluble reactive phosphate (SRP), total phosphorus (TP), dissolved ammonia (NH_3-N), total nitrogen (TN), total suspended solids (TSS), and turbidity. Duplicate samples were collected at a frequency of 10% throughout the duration of the project for quality assurance and quality control purposes. All water samples were analyzed following analytical procedures as outlined in the quality assurance project plan.

Load Determination and Mean Concentrations

Constituent loads (L) were calculated at each site using the constituent concentration data from the collected samples and average daily discharge data (Q_d) from the USGS from desired time periods. Daily measured loads were calculated by multiplying Q_d by a corresponding constituent concentration. The calculated loads were plotted as a function of Q_d then linear regression was used to develop an equation that describes daily constituent loads (L_d) at each site as a function of measured discharge. The basic log-log linear regression model for L_d can be expressed solely as a function of discharge:

$$\ln(L_d) = \beta_0 + \beta_1 \ln(Q_d) \quad (1)$$

where ln represents the natural logarithm function, β_o is a constant, β_1 is the coefficient for discharge and Q_d is the daily mean discharge (cfs). Regression models were also developed to consider seasonal influences:

$$\ln(L_d) = \beta_0 + \beta_1 \ln(Q_d) + \beta_2 \sin(2\pi T) + \beta_3 \cos(2\pi T) \quad (2)$$

where β_2 and β_3 are the coefficients for seasonal variation, and T is decimal time.

Log-log regression often results in bias when transforming the log values, where the values are often under-estimated. Therefore, a non-parametric bias correction factor (BCF; Helsel and Hirsh, 2002) was calculated and used when transforming the logarithmic results back to actual loads. BCF for natural logarithmic transformation is:

$$BCF = \frac{\sum e^{e_i}}{n} \qquad (3)$$

where n is the number of samples and e_i is the residual or difference between measured and estimated loads in natural log units. This factor was multiplied by the re-transformed value to account for any bias.

Daily loads often show two distinct relations with Q_d representing different flow regimes (e.g., base flow conditions and storm events). Thus, load estimation using regression models can be complex requiring the model developer to really get to know the data. This project evaluated whether all the data could be used to develop regression models, or whether the data needed to be split at some breakpoint separating the data into flow regimes. Then, separate regression models would be developed based on the breakpoint. The appropriate regression model (i.e., equation 1 or 2) was selected based upon the coefficient of determination (R^2), calculated BCFs, and visually observation of any breakpoints in the relations between L_d and Q_d. Season factors were included in the regression models (i.e., Equation 2) for all data or data representing the low flow regimes, when the regression coefficients were both significant and or when the regression model with seasonal factors explained an additional 5% of the variation in L_d. Whereas, only equation 1 was used with the data to represent the high flow regime or storm event conditions.

The selected regression was applied and then used to estimate L_d. The estimated loads were multiplied by the calculated BCF and summed into annual loads during the calendar year. The annual flow-weighted concentration (mg L^{-1}) was determined by dividing the total load (kg) by the annual discharge volume (m^3).

RESULTS

White River near Fayetteville

Physico-chemical parameters were measured on-site during this project period (i.e., from 1 July 2009 to 30 June 2010). Physico-chemical parameters varied seasonally and with episodic rainfall events; a summary of the parameters measured at White River near Fayetteville are provided in Table 1. The physico-chemical properties of the White River were within the expected range relative for a stream influenced by the mixed land uses (forest, pasture and urban) in its catchment. The physico-chemical properties are also influenced by the flow conditions and time of sample collection.

Discharge and constituent concentrations were variable throughout the year showing the effects of episodic rainfall events and seasonal influences. Average daily flow during 2009 at the White River near Fayetteville was 1,933,000 m^3, but was as great as 55,158,000 m^3 during storm events. Total annual discharge was 713,557,000 m^3. A total of 60 samples collected during the study period at White River were used in linear regression with flow to estimate

Table 1. Minimum, Maximum and geometric mean of physico-chemical parameters at the White River near Fayetteville from 1 July 2009 to 30 June 2010.

Parameter	Minimum	Maximum	Geometric Mean
pH	7.5	8.1	7.8
Conductivity (µS cm^{-1})	70	164	111
Dissolved Oxygen (mg L^{-1})	4.7	13.4	9.2
Temperature (^oC)	2.3	29.1	11.3

Table 2. Regression equation and statistics of linear regression model used to estimate constituent loads at White River near Fayetteville during calendar year 2009.

Parameter	Regression Equation	Flow Regime	R^2	P
NO_3-N	$\ln(L_d) = -0.80 + 1.10 \ln(Q_d)$	All	0.96	<0.001
SO_4	$\ln(L_d) = 4.11 + 0.86 \ln(Q_d)$	All	0.95	<0.001
Cl	$\ln(L_d) = 2.43 + 0.93 \ln(Q_d)$	All	0.97	<0.001
SRP	$\ln(L_d) = -6.99 + 1.43 \ln(Q_d) - 0.65\sin(2\pi T) - 0.95\cos(2\pi T)$	All	0.92	<0.001
TP	$\ln(L_d) = -4.61 + 1.42 \ln(Q_d) - 0.29\sin(2\pi T) - 1.15\cos(2\pi T)$	All	0.96	<0.001
TN	$\ln(L_d) = -0.39 + 1.10 \ln(Q_d)$	All	0.98	<0.001
NH_3-N	$\ln(L_d) = -3.50 + 1.23 \ln(Q_d) - 0.26\sin(2\pi T) - 1.11\cos(2\pi T)$	All	0.90	<0.001
TSS	$\ln(L_d) = 0.54 + 1.49 \ln(Q_d) - 0.35\sin(2\pi T) - 1.26\cos(2\pi T)$	All	0.93	<0.001

annual loads for 2009 (see Appendix 2). All constituents were sufficiently described by one equation for all flow regimes, and four constituents (i.e., SRP, TP, NH_3-N, and TSS) had seasonal factors included in the regression models. The amount of variation in the dependent variable explained by the selected linear regression models ranged from 90% to 98% for all equations ($P<0.001$). A summary of the regression equations used and statistical significance of the selected models is provided in Table 2.

The calculated BCFs ranged from 1.03 (TN) to 1.29 (SRP) for the selected parameters at White River near Fayetteville, and the BCF, total annual loads and FWC during 2009 are shown in Table 3. The White River had the greatest Cl, SO_4, NH_3-N and TP loads of all the monitored sites in the UWRB, because this site drains the largest catchment area within the UWRB. The loads measured from the White River near Fayetteville are influenced by Lake Sequoyah, since two of the White River Forks (Mainstem and Middle) flow into this reservoir. Lake Sequoyah may serve as a sink for N, P and TSS, as sedimentation, biological uptake, and biotransformation likely occur in this reservoir. Future monitoring efforts should consider evaluating the influence of this reservoir on nutrient and sediment dynamics in this catchment. The West Fork flows into the White River downstream from this reservoir.

Daily loads are shown in Figure 1, and these graphs show order of magnitude differences in L_d between constituents and flow regimes; L_d clearly shows the influence of episodic rainfall-runoff events on constituent transport in this relatively large river within the UWRB. Daily

Table 3. Bias correction factors (BCF), calculated annual loads (kg) and flow-weighted concentrations (FWC) for each constituent at White River near Fayetteville during 2009.

Parameter	BCF			Total Load	FWC
	All Flows	Low Flow	High Flow	(kg)	(mg L^{-1})
Cl	1.04	--	--	2,024,000	2.84
SO_4	1.06	--	--	6,815,000	9.55
NH_3-N	1.27	--	--	71,000	0.10
NO_3-N	1.07	--	--	313,000	0.44
SRP	1.29	--	--	12,000	0.02
TN	1.03	--	--	442,000	0.62
TP	1.13	--	--	98,000	0.14
TSS	1.24	--	--	35,851,000	50

Table 4. Summary of estimated monthly loads (kg) for each constituent at the White River near Fayetteville for Calendar Year 2009.

Month	Cl	SO_4	NH_3-N	NO_3-N	SRP	TN	TP	TSS
January	131,000	453,000	1,240	18,800	170	26,700	1,440	432,000
February	166,000	572,000	1,740	23,700	210	33,500	2,000	596,000
March	153,000	529,000	2,830	21,500	260	30,400	3,200	995,000
April	260,000	886,000	7,560	38,000	680	53,700	8,700	2,816,000
May	425,000	1,370,000	24,900	71,800	2,670	101,000	34,400	12,496,000
June	51,100	194,000	2,480	5,620	190	8,000	2,250	729,000
July	7,400	31,400	240	600	16	860	160	46,800
August	19,100	75,900	750	1,890	79	2,700	630	204,000
September	162,000	544,000	8,540	25,400	1,960	35,900	12,400	4,790,000
October	426,000	1,353,000	18,200	77,300	5,200	109,000	30,300	12,000,000
November	117,000	423,700	1,560	14,700	270	20,900	1,570	480,000
December	106,000	378,000	900	13,800	140	19,600	940	274,000

Daily loads were summed to produce monthly loads, which were also dependent upon the frequency and intensity of storm events. Higher loads were observed during the rainy seasons of spring and fall, and the highest loads observed during May and October. Loads were least during the dry, summer months of July and August. A summary of the monthly loads from CY 2009 are presented in Table 4. Semi-annual and monthly loads were also summed through June 2010 and are presented in Appendices 3 and 4, respectively.

Brush Creek at Highway 45

Physico-chemical parameters were measured on-site during this project period (i.e., from 1 July 2009 to 30 June 2010). Physico-chemical parameters varied seasonally and with episodic rainfall events; a summary of the parameters measured at Brush Creek are provided in Table 5. The pH was within the expected range (7.7-8.5), and conductivity ranged from 136 to 406 $\mu S\ cm^{-1}$ which is representative of streams with agricultural influences from the landscape. Dissolved oxygen concentrations were variable likely dependent on the time of sampling, as well as the flow conditions sampled. The water temperature was variable, reflecting the seasonal influence of the local climate.

Average daily flow during 2009 at Brush Creek was 55,000 m^3 and total annual discharge was 20,322,000 m^3. From the period July 1 to December 30, 2009, a total of 58 samples were collected at Brush Creek, analyzed, and used in linear regression with flow to estimate annual loads for 2009. Most parameters were adequately described by one equation for all flow regimes, while the other parameters (i.e., SRP, TP and TSS) required separate equations for low flow and high flow regimes. Three regression models included seasonal factors to estimate L_d for NO_3-N, NH_3-N and TSS. The amount of variation in the dependent variable explained by the selected linear regression equations

Table 5. Minimum, Maximum and geometric mean of physico-chemical parameters at Brush Creek from 1 July 2009 to 30 June 2010.

Parameter	Minimum	Maximum	Geometric Mean
pH	7.7	8.5	8.0
Conductivity ($\mu S\ cm^{-1}$)	136	406	310
Dissolved Oxygen ($mg\ L^{-1}$)	5.7	12.9	9.7
Temperature (^oC)	2.4	24.5	10.4

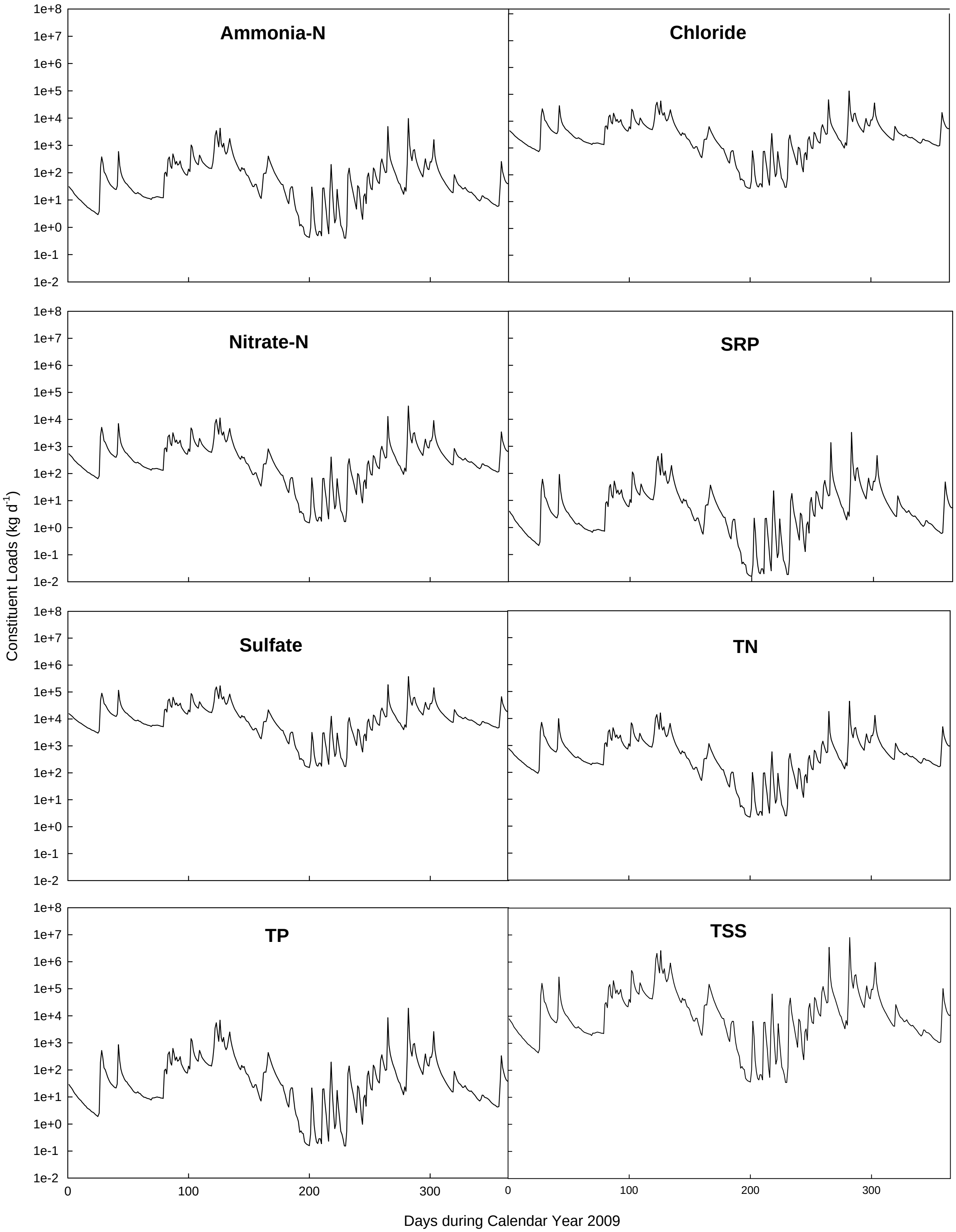

Figure 1. Daily constituent loads (kg d^{-1}) as a function of time (d) at the White River near Fayetteville during 2009.

Table 6. Regression equation and statistics of linear regression model used to estimate constituent loads at Brush Creek during calendar year 2009.

Parameter	Regression Equation	Flow Regime	R^2	P
NO_3-N	$\ln(L_d) = 1.77 + 0.91 \ln(Q_d) + 0.26\sin(2\pi T) + 0.41\cos(2\pi T)$	All	0.97	<0.001
SO_4	$\ln(L_d) = 3.64 + 0.99 \ln(Q_d)$	All	0.98	<0.001
Cl	$\ln(L_d) = 3.31 + 0.89 \ln(Q_d)$	All	0.98	<0.001
SRP	$\ln(L_d) = -3.02 + 0.92 \ln(Q_d)$	Low	0.94	<0.001
	$\ln(L_d) = -6.80 + 2.00 \ln(Q_d)$	High	0.79	0.003
TP	$\ln(L_d) = -2.52 + 0.92 \ln(Q_d)$	Low	0.94	<0.001
	$\ln(L_d) = -9.27 + 2.81 \ln(Q_d)$	High	0.87	<0.001
TN	$\ln(L_d) = 1.65 + 1.02 \ln(Q_d)$	All	0.97	<0.001
NH_3-N	$\ln(L_d) = -3.38 + 1.21 \ln(Q_d) - 0.21\sin(2\pi T) + 0.89\cos(2\pi T)$	All	0.87	<0.001
TSS	$\ln(L_d) = 1.52 + 1.05 \ln(Q_d) + 0.18\sin(2\pi T) - 0.65\cos(2\pi T)$	Low	0.75	<0.001
	$\ln(L_d) = -9.31 + 3.95 \ln(Q_d)$	High	0.85	0.001

ranged from 75% to 98% for all equations ($P \leq 0.003$). A summary of the regressions equation used and statistical significance of the selected model(s) is provided in Table 6.

Average daily flow during 2009 at Brush Creek was 55,000 m^3 and total annual discharge was 20,322,000 m^3. From the period July 1 to December 30, 2009, a total of 58 samples were collected at Brush Creek, analyzed, and used in linear regression with flow to estimate annual loads for 2009. Most parameters were adequately described by one equation for all flow regimes, while the other parameters (i.e., SRP, TP and TSS) required separate equations for low flow and high flow regimes. Three regression models included seasonal factors to estimate L_d for NO_3-N, NH_3-N and TSS. The amount of variation in the dependent variable explained by the selected linear regression equations ranged from 75% to 98% for all equations ($P \leq 0.003$). A summary of the regressions equation used and statistical significance of the selected model(s) is provided in Table 6.

The calculated BCFs ranged from 1.03 (Cl, TN and SO_4 for all flows) to 1.55 (TSS for high flow regime) for the selected parameters at Brush Creek, and the BCF, total loads and FWC for each parameter during 2009 are presented in Table 7. Brush Creek is the smallest of the four tributaries monitored that flow into Beaver Lake. The loads from Brush Creek were generally less than those from the larger catchment areas that are discussed within this report, whereas the FWCs concentrations were greater

Table 7. Bias correction factors (BCF), calculated annual loads (kg) and flow-weighted concentrations (FWC) for each constituent at Brush Creek at Highway 45 during 2009.

Parameter	BCF			Total Load	FWC
	All Flows	Low Flow	High Flow	(kg)	(mg L^{-1})
Cl	1.03	--	--	153,000	7.52
SO_4	1.03	--	--	313,000	14.03
NH_3-N	1.76	--	--	1,200	0.06
NO_3-N	1.05	--	--	41,000	2.03
SRP	--	1.07	1.24	1,000	0.05
TN	1.03	--	--	48,000	2.38
TP	--	1.09	1.26	5,400	0.27
TSS	--	1.28	1.55	3,031,000	149

Table 8. Summary of estimated monthly loads (kg) for each constituent at Brush Creek at Highway 45 for Calendar Year 2009.

Month	Cl	SO_4	NH_3-N	NO_3-N	SRP	TN	TP	TSS
January	8,890	18,000	31	3,370	56	3,630	213	53,400
February	19,100	38,500	62	7,130	75	7,610	263	77,800
March	19,600	39,600	100	6,390	84	7,260	278	70,300
April	22,700	46,500	170	6,290	100	7,620	425	157,800
May	33,000	72,000	440	7,520	330	10,000	2,320	1,570,000
June	6,460	11,800	70	1,100	13	1,400	22	4,000
July	1,600	2,530	13	220	3	265	5	697
August	3,000	4,920	24	420	6	501	10	1,210
September	2,610	4,270	14	416	5	466	9	677
October	24,360	53,500	220	5,060	280	6,280	1,840	1,090,000
November	5,950	10,400	18	1,460	12	1,500	20	1,030
December	5,700	10,100	12	1,840	12	1,810	22	1,320

for nutrients and TSS than that observed at the White River near Fayetteville. It is important to monitor this catchment area, because it represents a landscape that is composed of a majority of pasture land use. Brush Creek at Highway 45 represents constituent transport that is without the influence of effluent discharges.

Daily loads are shown in Figure 2, and these graphs show order of magnitude differences in L_d between constituents and flow regimes; L_d clearly shows the influence of episodic rainfall-runoff events on constituent transport in this relatively agricultural catchment within the UWRB. Daily loads were summed to produce monthly loads, which were also dependent upon the influence of episodic rainfall-runoff events. Higher loads were observed during the rainy seasons of spring and fall, and the highest loads observed during May. Loads were least during the dry, summer months of July, August and September. A summary of the monthly loads from CY 2009 are presented in Table 8. Semi-annual and monthly loads were also summed through June 2010 and are presented in Appendices 3 and 4, respectively.

Richland Creek at Highway 45

Physico-chemical parameters were measured on-site during this project period (i.e., from 1 July 2009 to 30 June 2010). Physico-chemical parameters varied seasonally and with episodic rainfall events; a summary of the parameters measured at Richland Creek are provided in Table 9. The pH was within the expected range (7.5-8.7) for streams with groundwater inflows from limestone geology. The conductivity ranged from 72 to 193 µS cm^{-1}, and it was representative of stream draining a predominantly forested catchment. Dissolved oxygen concentrations were variable likely dependent on upon the time of sampling, as well as the flow conditions sampled. The water temperature was variable, reflecting the seasonal influence of the local climate.

Table 9. Minimum, Maximum and geometric mean of physico-chemical parameters at Richland Creek at Highway 45 from 1 July 2009 to 30 June 2010.

Parameter	Minimum	Maximum	Geometric Mean
pH	7.5	8.7	7.8
Conductivity (µS cm^{-1})	72	193	123
Dissolved Oxygen (mg L^{-1})	6.1	13.8	9.3
Temperature (^{o}C)	2.6	28.4	11.3

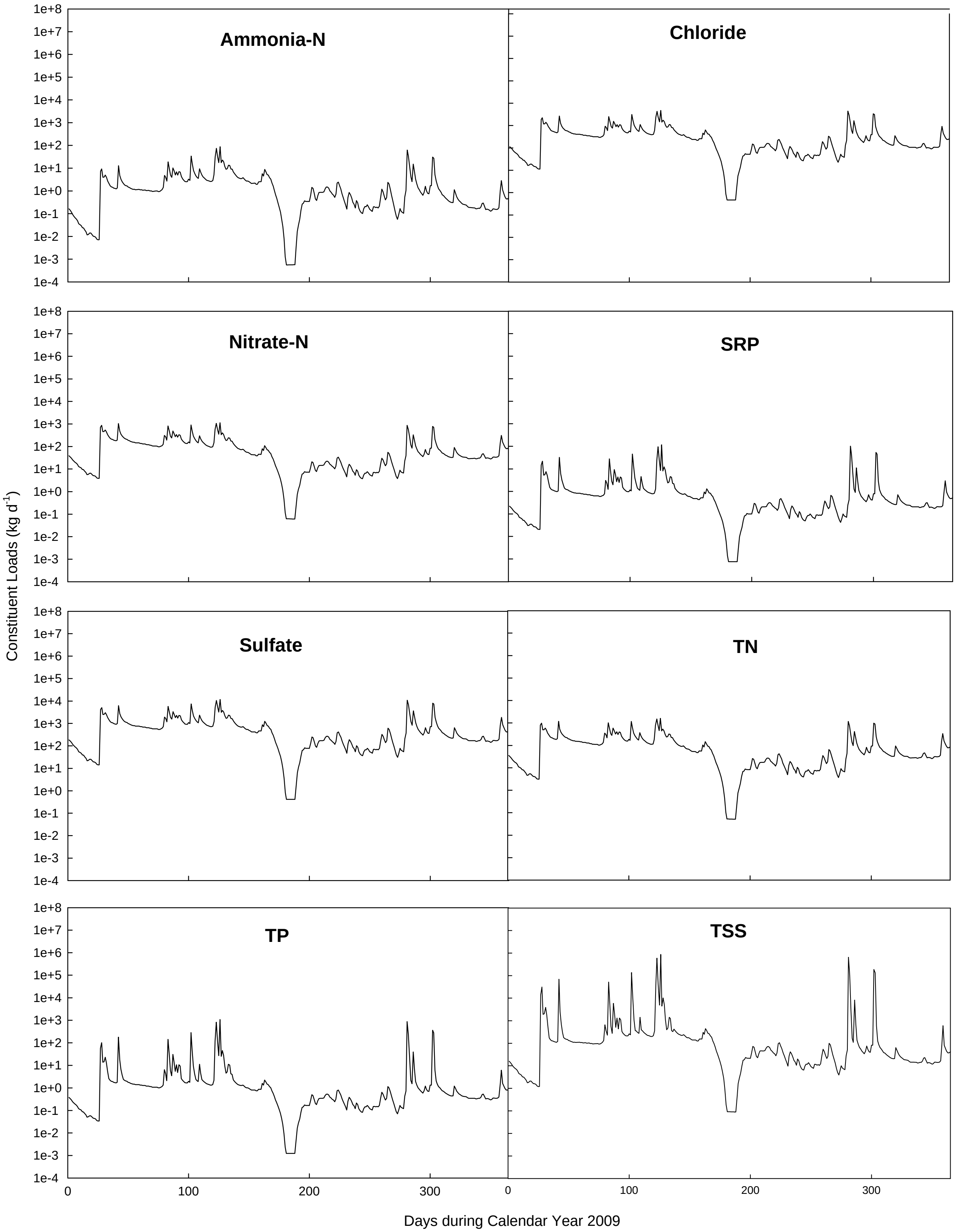

Figure 2. Daily constituent loads (kg d^{-1}) as a function of time (d) at Brush Creek at Highway 45 during 2009.

Table 10. Minimum, Maximum and geometric mean of physico-chemical parameters at the Town Branch at Fayetteville from 1 July 2009 to 30 June 2010.

Parameter	Minimum	Maximum	Geometric Mean
pH	7.8	8.4	8.0
Conductivity (µS cm^{-1})	76	703	475
Dissolved Oxygen (mg L^{-1})	4.9	12.2	9.1
Temperature (^oC)	2.0	25.9	10.0

The discharge data provided by the USGS was not complete for calendar year 2009, because the USGS has not revised the discharge record to address sporadic missing data. Thus, adequate flow data to develop regression models and estimate loads for this site, is not yet available from the USGS. Loads will be estimated, and this report will be updated when the data is made available.

Town Branch at Fayetteville

Physico-chemical parameters were measured on-site during this project period (i.e., from 1 July 2009 to 30 June 2010). Physico-chemical parameters varied seasonally and with episodic rainfall events, and a summary of the physico-chemical parameters at Town Branch at Fayetteville is provided in Table 10. Conductivity measured in Town Branch showed a wider range than the other sites monitored within the UWRB.

Average daily flow during 2009 at Town Branch was 4,000 m^3 and total annual discharge was 1,466,000 m^3. From the period July 1 to December 30, 2009, a total of 55 samples were collected at Town Branch, analyzed, and used in linear regression with flow to estimate annual loads for 2009. All parameters were sufficiently described by one equation for all flow regimes, and three constituents (i.e., Cl, SRP and TP) had regression models that included seasonal factors. The relation between L_d and Q_d did not suggest that separate regression models needed to be developed for low and high flow regimes. The amount of variation in the dependent variable explained by the selected linear regression models ranged from 71% to 88% for all equations (P<0.001). A summary of the regression equations used and statistical significance of the selected models is provided in Table 11.

The calculated BCFs ranged from 1.23 (Cl) to 4.14 (TSS) for the selected parameters at Town Branch at Fayetteville, and the BCF, total loads and FWC for each parameter during 2009 are presented in Table 12. This was the smallest catchment area monitored in this project, and it had the least constituent transport as measured by annual loads. However, FWCs at Town

Table 11. Regression equation and statistics of linear regression model used to estimate constituent loads at Town Branch during calendar year 2009.

Parameter	Regression Equation	Flow Regime	R^2	P
NO_3-N	$\ln(L_d) = 0.69 + 0.86 \ln(Q_d)$	All	0.83	<0.001
SO_4	$\ln(L_d) = 4.71 + 0.59 \ln(Q_d)$	All	0.71	<0.001
Cl	$\ln(L_d) = 3.67 + 0.75 \ln(Q_d) + 0.77\sin(2\pi T) + 0.36\cos(2\pi T)$	All	0.80	<0.001
SRP	$\ln(L_d) = -3.09 + 1.25 \ln(Q_d) - 0.83\sin(2\pi T) - 0.78\cos(2\pi T)$	All	0.85	<0.001
TP	$\ln(L_d) = -2.08 + 1.37 \ln(Q_d) - 0.30\sin(2\pi T) - 0.63\cos(2\pi T)$	All	0.87	<0.001
TN	$\ln(L_d) = 1.02 + 0.96 \ln(Q_d)$	All	0.88	<0.001
NH_3-N	$\ln(L_d) = -2.03 + 1.33 \ln(Q_d)$	All	0.79	<0.001
TSS	$\ln(L_d) = 2.36 + 1.78 \ln(Q_d)$	All	0.82	<0.001

Table 12. Bias correction factors (BCF), calculated annual loads (kg) and flow-weighted concentrations (FWC) for each constituent at Town Branch at Fayetteville during 2009.

Parameter	BCF			Total Load	FWC
	All Flows	Low Flow	High Flow	(kg)	(mg L^{-1})
Cl	1.23	--	--	22,000	15.06
SO_4	1.67	--	--	47,000	31.92
NH_3-N	1.94	--	--	330	0.22
NO_3-N	1.35	--	--	1,300	0.87
SRP	1.67	--	--	130	0.07
TN	1.24	--	--	1,900	1.29
TP	1.62	--	--	360	0.26
TSS	4.14	--	--	213,000	145

Branch at Fayetteville were generally similar to those measured at Brush Creek at Highway 45. This suggests that the delivery of nutrients and sediments were similar between this urban dominated catchment and the agricultural catchment (i.e., Brush Creek at Highway 45).

Daily loads are shown in Figure 3, and these graphs show order of magnitude differences in L_d between constituents and flow regimes; L_d clearly shows the influence of episodic rainfall-runoff events on constituent transport in this urban dominated catchment within the UWRB. The flashy nature of the hydrologic response of this stream is reflected in the display of L_d as a function of time. Daily loads were summed to produce monthly loads, which were also dependent upon influence of episodic rainfall-runoff events. Higher loads were observed during the rainy seasons of spring and fall, and the highest loads observed during May and October. Loads were least during summer and winter months. A summary of the monthly loads from CY 2009 are presented in Table 13. Semi-annual and monthly loads were also summed through June 2010 and are presented in Appendices 3 and 4.

Town Branch Tributary

Physico-chemical parameters were measured on-site during this project period (i.e., from 1 July 2009 to 30 June 2010), and these parameters varied seasonally and with episodic rainfall events. A summary of the physico-chemical parameters at Town Branch Tributary

Table 13. Summary of estimated monthly loads (kg) for each constituent at Town Branch at Fayetteville for Calendar Year 2009.

Month	Cl	SO_4	NH_3	NO_3-N	SRP	TN	TP	TSS
January	2,440	3,310	23	85	8	130	11	15,800
February	3,150	3,900	9	81	3	110	4	2,050
March	4,300	4,840	19	110	6	160	11	7,420
April	2,030	2,740	15	64	5	93	12	8,480
May	3,440	5,450	40	160	13	240	43	24,000
June	620	2,160	4	39	1	50	6	1,060
July	720	3,230	15	78	5	110	29	7,120
August	790	3,800	35	120	12	190	66	21,300
September	870	4,460	34	130	11	200	51	18,100
October	2,060	7,730	120	300	41	500	150	105,400
November	730	2,860	5	54	2	69	4	1,200
December	930	2,310	5	42	2	54	2	1,400

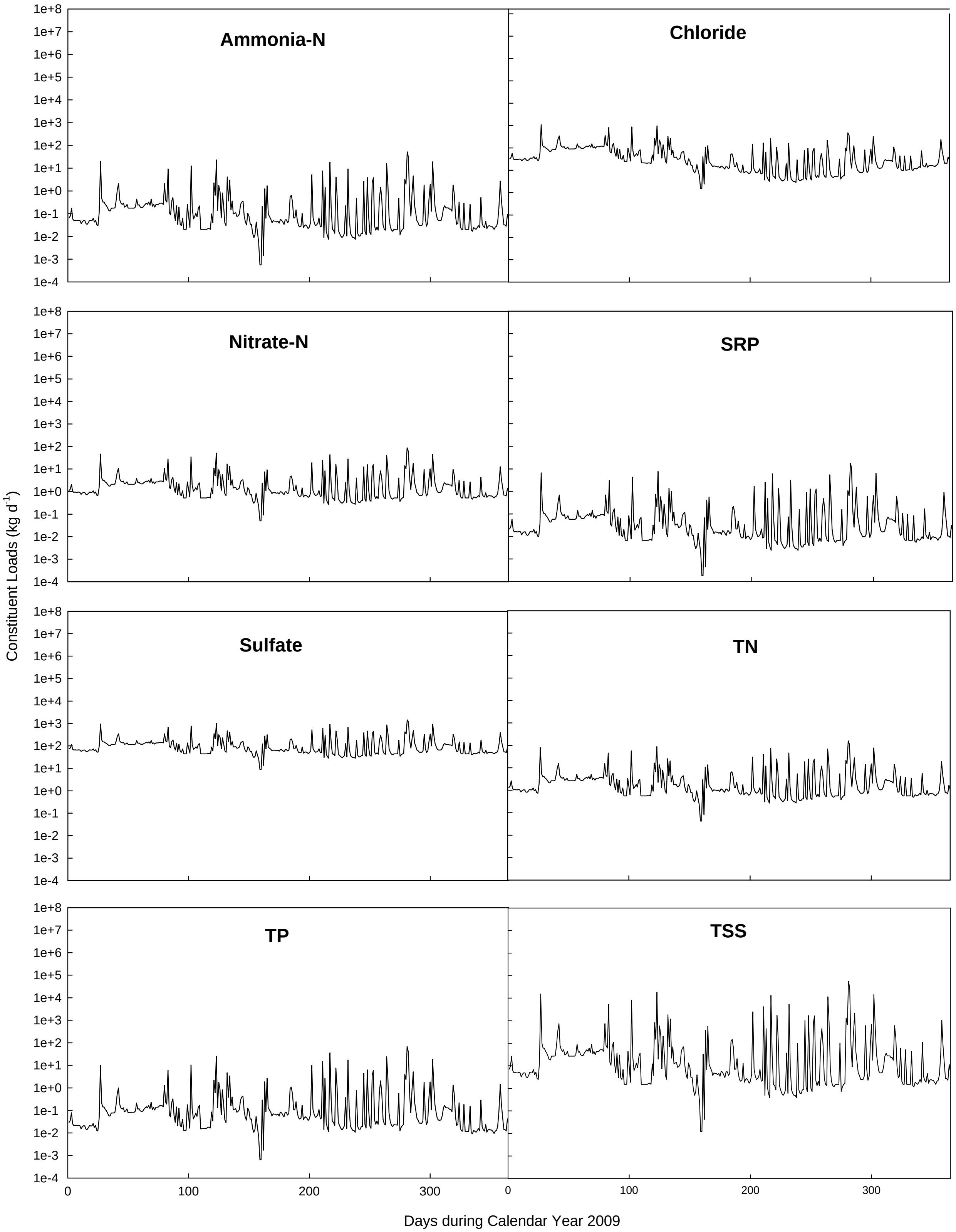

Figure 3. Daily constituent loads (kg d^{-1}) as a function of time (d) at Town Branch at Fayetteville during 2009.

Table 14. Minimum, Maximum and geometric mean of physico-chemical parameters at the Town Branch Tributary from 1 July 2009 to 30 June 2010.

Parameter	Minimum	Maximum	Geometric Mean
pH	7.8	8.3	8.2
Conductivity (µS cm^{-1})	96	614	476
Dissolved Oxygen (mg L^{-1})	5.9	15.0	9.9
Temperature (^oC)	2.4	20.3	8.7

is provided in Table 14. The physico-chemical properties of this tributary were relatively similar to that observed in Town Branch at Fayetteville, which would be expected as both catchments drain urban development on the southside of Fayetteville. However, the maximum water temperature was less at this site than Town Branch at Fayetteville, likely reflecting the influence of its riparian corridor and groundwater inflows within this catchment. These factors (i.e., riparian shading and groundwater inflows) would buffer the temperature effects of increased summer temperatures and urban development.

Average daily flow during 2009 at Town Branch Tributary was 12,000 m^3 and total annual discharge was 4,532,000 m^3. From the period July 1 to December 30, 2009, a total of 52 samples were collected at Town Branch Tributary, analyzed, and used in linear regression with flow to estimate annual loads for 2009. All parameters were adequately described by one equation for all flow regimes, and Cl, SRP, TP and TSS had significant seasonal influences that the other parameters did not. The amount of variation in the dependent variable explained by the selected linear regression equations ranged from 85% to 97% (P<0.001) for all equations. A summary of the regression equations is provided in Table 15.

The calculated BCFs ranged from 1.08 to 3.49 for the selected parameters at Town Branch Tributary, and the BCF, total loads and FWC for each parameter during 2009 are presented in Table 16. This site is a tributary flowing into Town Branch downstream from Town Branch at Fayetteville, and its catchment area is about twice the size (4 km^2) of the upstream site (2 km^2). However, the total discharge at this site was three times greater than that observed at Town Branch at Fayetteville. The constituent loads at this tributary were about three times greater for Cl, NH_3-N and SO_4, whereas the other constituents showed greater differences compared to Town Branch at Fayetteville. Interestingly, SRP and TP loads at this tributary only increased at most 1.3 times greater than that at the upstream site, while NO_3-N and TN

Table 15. Regression equation and statistics of linear regression model used to estimate constituent loads at Town Branch Tributary during calendar year 2009.

Parameter	Regression Equation	Flow Regime	R^2	P
NO_3-N	$\ln(L_d) = 2.19 + 0.88 \ln(Q_d)$	All	0.95	<0.001
SO_4	$\ln(L_d) = 4.53 + 0.89 \ln(Q_d)$	All	0.93	<0.001
Cl	$\ln(L_d) = 3.77 + 0.85 \ln(Q_d) + 0.39\sin(2\pi T) + 0.67\cos(2\pi T)$	All	0.94	<0.001
SRP	$\ln(L_d) = -2.77 + 1.03 \ln(Q_d) - 0.39\sin(2\pi T) - 0.75\cos(2\pi T)$	All	0.96	<0.001
TP	$\ln(L_d) = -2.14 + 1.17 \ln(Q_d) - 0.27\sin(2\pi T) - 1.12\cos(2\pi T)$	All	0.94	<0.001
TN	$\ln(L_d) = 2.28 + 0.91 \ln(Q_d)$	All	0.97	<0.001
NH_3-N	$\ln(L_d) = -1.63 + 1.29 \ln(Q_d)$	All	0.93	<0.001
TSS	$\ln(L_d) = 1.90 + 1.37 \ln(Q_d) - 0.003\sin(2\pi T) - 1.43\cos(2\pi T)$	All	0.85	<0.001

Table 16. Bias correction factors (BCF), calculated annual loads (kg) and flow-weighted concentrations (FWC) for each constituent at Town Branch Tributary during 2009.

Parameter	BCF			Total Load	FWC
	All Flows	Low Flow	High Flow	(kg)	(mg L^{-1})
Cl	1.18	--	--	74,000	16.26
SO_4	1.15	--	--	148,000	32.76
NH_3-N	1.50	--	--	1,300	0.28
NO_3-N	1.12	--	--	14,000	3.00
SRP	1.15	--	--	150	0.03
TN	1.08	--	--	15,000	3.38
TP	1.34	--	--	480	0.11
TSS	3.49	--	--	129,000	29

loads increased by almost an order of magnitude. The loads of TSS at this tributary were about 60% of what was observed at the upstream site, Town Branch at Fayetteville. This shows the variable nature in constituent transport from small urban catchments, and similar differences were observed in the FWCs between these two urban streams.

Daily loads are shown in Figure 4, and the flashy nature of the hydrologic response of this stream is reflected in the display of L_d as a function of time. Daily loads were summed to produce monthly loads, which were dependent upon flow regime and the influence of episodic rainfall-runoff events. At this site, monthly loads were variable for the different constituents over the year. A summary of the monthly loads from CY 2009 are presented in Table 17. Semi-annual loads and monthly loads were also summed through June 2010 and are presented in Appendices 3 and 4, respectively.

War Eagle Creek near Hindsville

Physico-chemical parameters were measured on-site during this project period (i.e., from 1 July 2009 to 30 June 2010), and these parameters varied seasonally and with episodic rainfall events. A summary of the physico-chemical parameters at War Eagle Creek is provided in Table 18. The measured values were within expected ranges for a stream that receives treated wastewater effluent from a relatively rural facility and drains a mixed land use catchment, which is mostly forested (62%).

Table 17. Summary of estimated monthly loads (kg) for each constituent at Town Branch Tributary for Calendar Year 2009.

Month	Cl	SO_4	NH_3	NO_3-N	SRP	TN	TP	TSS
January	7,100	7,780	70	710	3	800	8	1,960
February	5,530	5,940	46	550	2	610	6	1,620
March	4,190	5,830	34	540	3	590	9	2,680
April	4,830	8,580	50	790	6	870	20	6,560
May	6,140	15,700	110	1,440	17	1,610	70	26,100
June	1,370	5,060	25	470	7	510	29	9,190
July	1,280	6,020	35	560	12	610	45	12,800
August	1,090	5,380	41	490	12	550	44	12,400
September	2,420	9,770	82	900	17	1,000	53	12,190
October	11,590	33,040	410	3,000	44	3,470	130	30,900
November	12,800	25,660	200	2,350	21	2,650	47	8,350
December	15,330	19,700	180	1,800	10	2,040	22	4,490

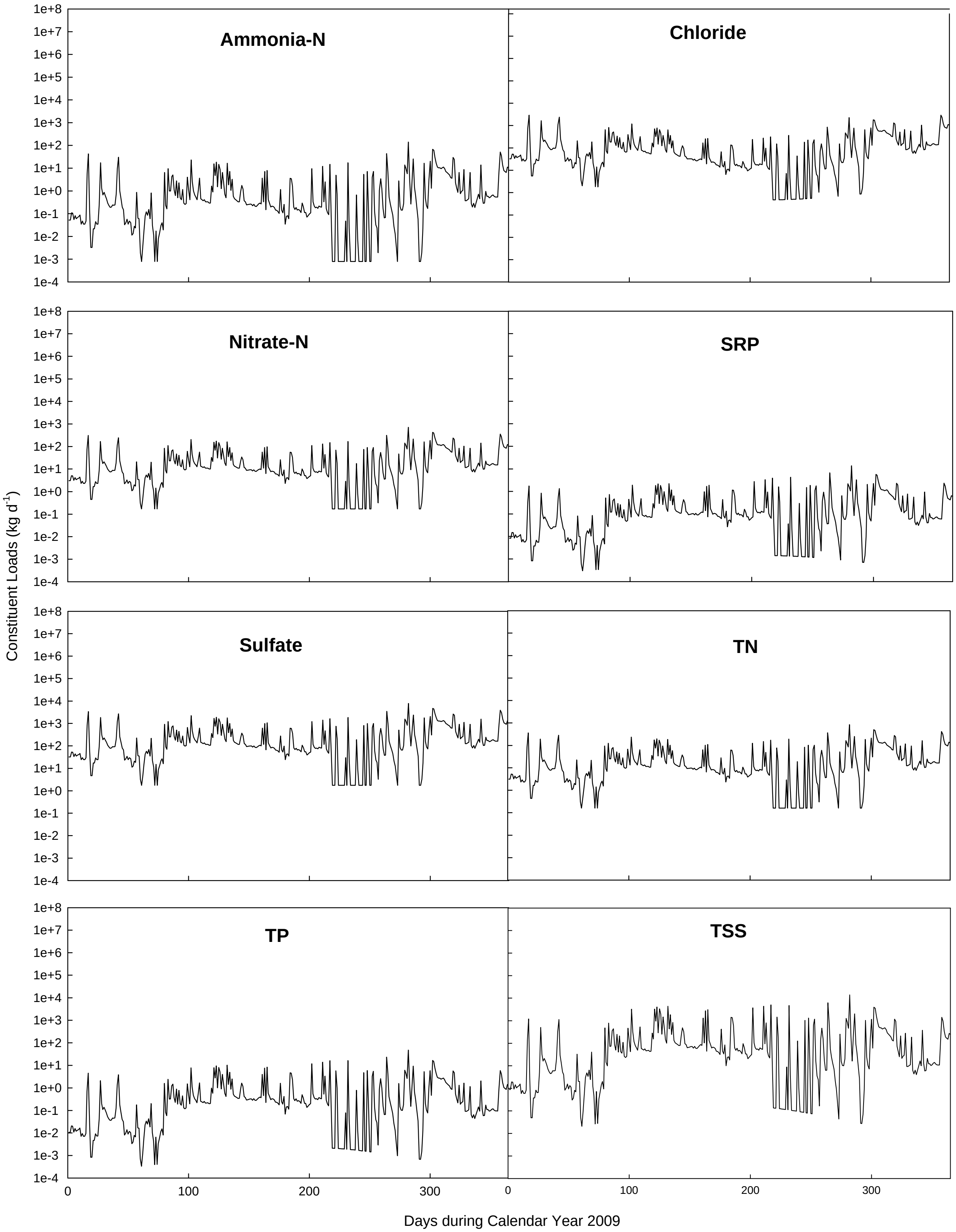

Figure 4. Daily constituent loads (kg d^{-1}) as a function of time (d) at Town Branch Tributary during 2009.

Table 18. Minimum, Maximum and geometric mean of physico-chemical parameters at the War Eagle Creek near Hindsville from 1 July 2009 to 30 June 2010.

Parameter	Minimum	Maximum	Geometric Mean
pH	7.7	8.1	7.9
Conductivity (µS cm^{-1})	79	270	168
Dissolved Oxygen (mg L^{-1})	6.5	13.7	9.16
Temperature (^oC)	1.5	26.9	10.8

Average daily flow during 2009 at War Eagle Creek was 1,224,000 m^3 and total annual discharge was 452,000,000 m^3. From the period July 1 to December 30, 2009, a total of 56 samples were collected at War Eagle Creek, analyzed, and used in linear regression with flow to estimate annual loads for 2009. All parameters were adequately described by one equation for all flow regimes, and SRP, TP, NH_3-N and TSS had significant seasonal influences while the other parameters did not include seasonal factors in the regression models. The amount of variation in the dependent variable explained by the selected linear regression equations ranged from 87% to 99% (P<0.001) for all equations. A summary of the regression equations used and statistical significance of the selected models is provided in Table 19.

The calculated BCFs ranged from 1.01 to 1.28 for the selected parameters at War Eagle Creek, and the BCF, total loads and FWC for each parameter during 2009 are presented in Table 20. War Eagle Creek near Hindsville exhibited the greatest NO_3-N, SRP and TSS loads of sites monitored in the UWRB, likely due to its catchment land use characteristics (mixed pasture and forest) and treated effluent influences. Albeit, the TSS load was 5% greater than that measured in the White River near Fayetteville. The similarity in TSS loads between War Eagle Creek and the White River despite differences in catchment area and total discharge is likely because of Lake Sequoyah, whereas the difference in NO_3-N and SRP would probably be related to the rural effluent discharge into a tributary of War Eagle Creek. The FWCs of these constituents were generally greater at War Eagle Creek compared to the White River, except for SO_4. Whereas, the smaller streams draining catchments that were primarily agricultural or urban had greater FWCs than did the War Eagle Creek near Hindsville.

Daily loads are shown in Figure 5, and War Eagle Creek near Hindsville exhibits a more stable hydrologic response like the other larger watershed monitored in the UWRB, especially when compared to the flashy urban streams in the Town Branch catchment. Daily loads were

Table 19. Regression equation and statistics of linear regression model used to estimate constituent loads at War Eagle Creek near Hindsville during calendar year 2009.

Parameter	Regression Equation	Flow Regime	R^2	P
NO_3-N	$\ln(L_d) = 1.51 + 0.92 \ln(Q_d)$	All	0.98	<0.001
SO_4	$\ln(L_d) = 2.97 + 0.95 \ln(Q_d)$	All	0.99	<0.001
Cl	$\ln(L_d) = 4.48 + 0.68 \ln(Q_d)$	All	0.92	<0.001
SRP	$\ln(L_d) = -6.48 + 1.52 \ln(Q_d) - 0.24\sin(2\pi T) - 0.37(2\pi T)$	All	0.93	<0.001
TP	$\ln(L_d) = -5.49 + 1.58 \ln(Q_d) - 0.38\sin(2\pi T) - 0.98(2\pi T)$	All	0.95	<0.001
TN	$\ln(L_d) = 1.43 + 0.96 \ln(Q_d)$	All	0.99	<0.001
NH_3-N	$\ln(L_d) = -4.64 + 1.36 \ln(Q_d) - 0.17\sin(2\pi T) - 0.96(2\pi T)$	All	0.87	<0.001
TSS	$\ln(L_d) = -1.59 + 1.84 \ln(Q_d) - 0.31\sin(2\pi T) – 1.33(2\pi T)$	All	0.96	<0.001

Table 20. Calculated annual loads (kg) and flow-weighted concentrations (FWC) for each constituent at War Eagle Creek near Hindsville during 2009.

Parameter	BCF			Total Load	FWC
	All Flows	Low Flow	High Flow	(kg)	(mg L^{-1})
Cl	1.06	--	--	1,947,000	4.31
SO_4	1.02	--	--	2,610,000	5.77
NH_3-N	1.28	--	--	37,000	0.08
NO_3-N	1.02	--	--	501,000	1.11
SRP	1.25	--	--	17,400	0.04
TN	1.01	--	--	582,000	1.29
TP	1.14	--	--	78,000	0.17
TSS	1.16	--	--	37,803,000	84

summed to produce monthly loads. At this site, loads were not as variable as those observed in smaller catchments in the watershed, but higher loads were still observed during spring and fall when local climate typically exhibits more rainfall events, and the highest loads were observed during the months of May and October. Loads were least during the drier, summer months of July and August. A summary of the monthly loads from CY 2009 are presented in Table 21. Semi-annual and monthly loads were also summed through June 2010 and are presented in Appendices 3 and 4, respectively.

West Fork White River East of Fayetteville

Physico-chemical parameters were measured on-site during this project period (i.e., from 1 July 2009 to 30 June 2010). Physico-chemical parameters varied seasonally and with episodic rainfall events; a summary of the parameters measured at West Fork White River east of Fayetteville is provided in Table 22. The physico-chemical properties of the West Fork White River were within the expected range where pH ranged from 7.50 to 8.2 and conductivity ranged from 85 to 242 which is typical for a stream draining catchment with

Table 21. Summary of estimated monthly loads (kg) for each constituent at War Eagle Creek near Hindsville for Calendar Year 2009.

Month	Cl	SO_4	NH_3-N	NO_3-N	SRP	TN	TP	TSS
January	127,000	158,000	740	30,600	580	35,200	1,290	386,000
February	169,000	202,000	850	39,500	540	44,900	1,230	323,000
March	186,000	244,000	2,080	47,100	940	54,300	3,090	1,130,000
April	258,000	340,000	3,650	65,800	1,330	75,700	5,150	1,950,000
May	360,000	604,000	14,800	113,700	5,270	135,400	27,930	16,200,000
June	114,000	113,000	1,900	22,600	410	25,100	2,650	978,000
July	37,400	22,200	180	4,700	28	4,860	170	34,000
August	23,200	11,400	58	2,500	10	2,480	52	8,000
September	98,600	111,000	1,550	21,700	690	24,700	3,460	1,220,000
October	310,400	537,000	10,000	100,500	7,030	121,000	31,680	15,300,000
November	149,200	156,000	690	30,900	400	35,000	1,140	222,000
December	115,000	110,000	300	22,000	190	24,000	410	69,900

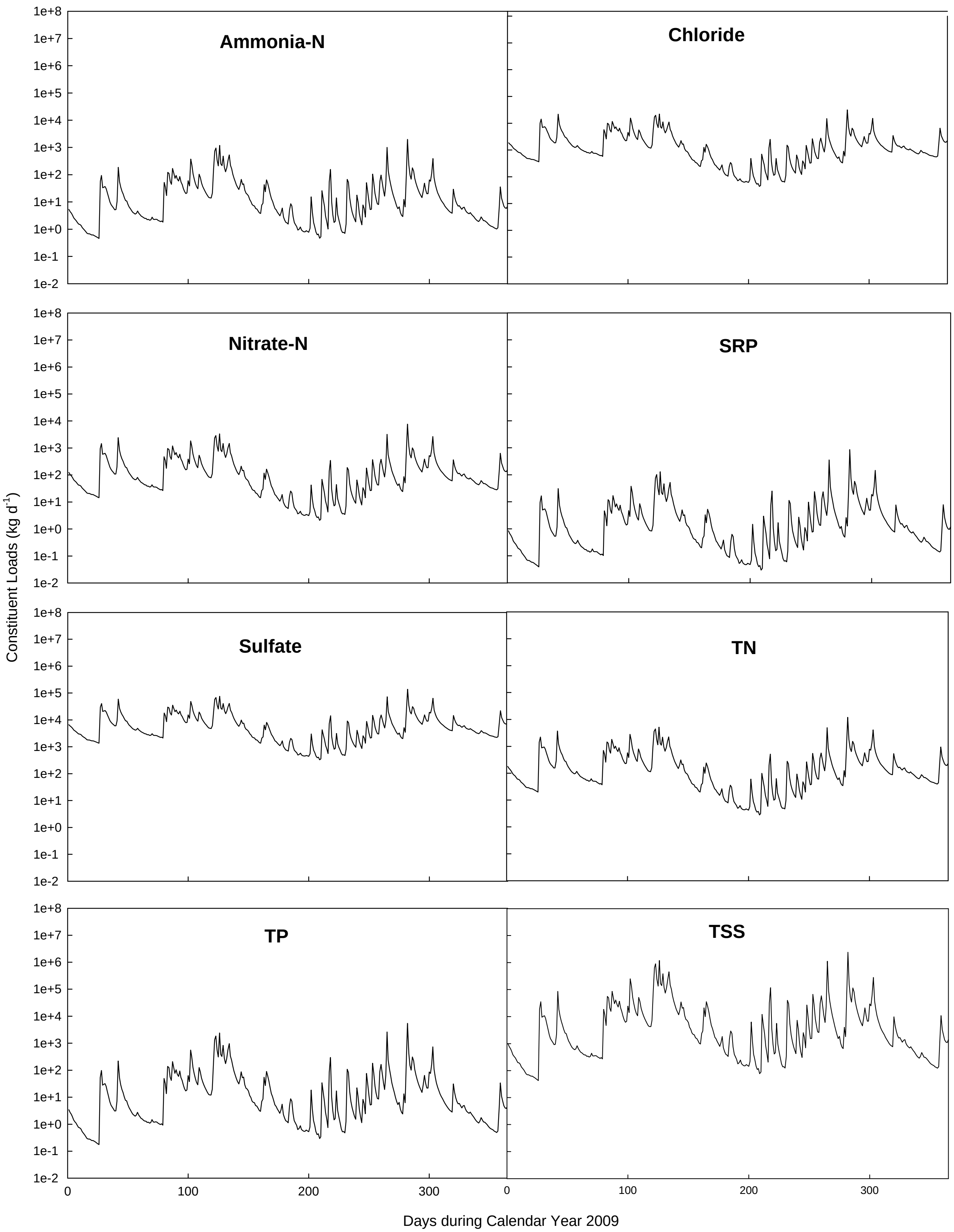

Figure 5. Daily constituent loads (kg d^{-1}) as a function of time (d) at War Eagle Creek near Hindsville during 2009.

Table 22. Minimum, maximum and geometric mean of physico-chemical parameters at the West Fork White River East of Fayetteville from 1 July 2009 to 30 June 2010.

Parameter	Minimum	Maximum	Geometric Mean
pH	7.50	8.2	7.8
Conductivity (µS cm^{-1})	85	242	169
Dissolved Oxygen (mg L^{-1})	4.9	14.2	9.0
Temperature (^oC)	0.5	29.2	10.1

mixed forest, agriculture and urban land uses with only a small effluent discharge in the headwaters. Dissolved oxygen concentrations and temperature were also variable likely due to sampling time and local climate.

Discharge and constituent concentrations were variable throughout the year showing the effects of episodic rainfall events and seasonal influences. Average daily flow during 2009 at the West Fork White River near Hindsville was 560,000 m^3, but was as great as 14,612,000 m^3 during storm events. Total annual discharge was 206,563,000 m^3 which is approximately 85% of that observed during 2008 (Nelson 2009a). A total of 59 samples collected during the study period at West Fork White River were used in linear regression with flow to estimate annual loads for 2009. All parameters were adequately described by one equation for all flow regimes, and five parameters (i.e., Cl, SRP, TP, NH_3-N, and TSS) had significant seasonal influences. The amount of variation in the dependent variable explained by the selected linear regression models ranged from 86% to 96% (P <0.001) for all equations. A summary of the regressions equations used and statistical significance of the selected models is provided in Table 23.

The calculated BCFs ranged from 1.04 (SO_4) to 1.38 (NH_3-N) for the selected parameters at the West Fork White River. Stream flow during 2009 was approximately 20% less than that observed in 2008 (Nelson, 2009a), and [as expected] the calculated loads at this site for calendar year 2009 were generally less than those observed in 2008 and decreased by as much as a third (TP; Nelson, 2009a). However, chloride loads increased by 9% during 2009. The difference in loads could reflect changes in the monitoring program where samples were collected more frequently throughout the sampling period, as well as changes in the load estimation technique. FWC decreased or remained constant for most parameters, except for Cl which increased from 3.18 to 4.09 mg L^{-1}. The BCF, total loads and FWC during 2009 are shown in Table 24.

Table 23. Regression equations and statistics of linear regression model used to estimate constituent loads at the West Fork White River East of Fayetteville during calendar year 2009.

Parameter	Regression Equation	Flow Regime	R^2	P
NO_3-N	$\ln(L_d) = -0.46 + 1.07 \ln(Q_d)$	All	0.93	<0.001
SO_4	$\ln(L_d) = 4.94 + 0.79 \ln(Q_d)$	All	0.95	<0.001
Cl	$\ln(L_d) = 3.14 + 0.87 \ln(Q_d) + 0.24\sin(2\pi T) + 0.21\cos(2\pi T)$	All	0.96	<0.001
SRP	$\ln(L_d) = 3.67 + 0.75 \ln(Q_d) + 0.77\sin(2\pi T) + 0.36\cos(2\pi T)$	All	0.90	<0.001
TP	$\ln(L_d) = -4.51 + 1.46 \ln(Q_d) - 0.43\sin(2\pi T) - 1.54\cos(2\pi T)$	All	0.92	<0.001
TN	$\ln(L_d) = -0.15 + 1.09 \ln(Q_d)$	All	0.96	<0.001
NH_3-N	$\ln(L_d) = -3.46 + 1.23 \ln(Q_d) - 0.20\sin(2\pi T) - 1.14\cos(2\pi T)$	All	0.86	<0.001
TSS	$\ln(L_d) = 0.82 + 1.55 \ln(Q_d) - 0.39\sin(2\pi T) - 1.69\cos(2\pi T)$	All	0.93	<0.001

Table 24. Calculated annual loads (kg) and flow-weighted concentrations (FWC) for each constituent at West Fork White River East of Fayetteville during 2009.

Parameter	BCF			Total Load	FWC
	All Flows	Low Flow	High Flow	(kg)	(mg L^{-1})
Cl	1.06	--	--	844,000	4.09
SO_4	1.04	--	--	3,280,000	15.88
NH_3-N	1.38	--	--	18,000	0.09
NO_3-N	1.10	--	--	91,000	0.44
SRP	1.29	--	--	3,200	0.02
TN	1.07	--	--	136,000	0.66
TP	1.24	--	--	30,000	0.14
TSS	1.26	--	--	12,697,000	61

Daily loads are presented in Figure 6, and this figure shows the order of magnitude difference between daily constituent loads and flow regimes at the West Fork White River. The daily constituent loads clearly show the influence of episodic storm events which re-suspend materials from within the fluvial channel and transport these materials from the landscape. Daily loads were summed to produce monthly loads, and higher loads were observed during spring and fall with the highest loads observed during the months of May and October. Loads were lesser during the drier summer months. A summary of the monthly loads from CY 2009 are presented in Table 25. Semi-annual and monthly loads were also summed through June 2010 and are presented in Appendices 3 and 4, respectively.

DISCUSSION

This project successfully estimated constituent loads in calendar year 2009 using water samples collected during this project period at seven sites in the UWRB. Historically, annual constituent loads have only been estimated at two sites in the UWRB. The West Fork White River has been monitored since 2003, but this catchment only represents approximately 6% of the UWRB. Annual constituent loads have also been estimated at the White River since 2003, but site location has switched between White River near Goshen (USGS Station No. 07048700) and White River near Fayetteville (USGS Station No. 07048600). Loads need to be consistently measured at both sites, as well as others throughout the basin, because estimating

Table 25. Summary of estimated monthly loads (kg) for each constituent at West Fork White River East of Fayetteville for Calendar Year 2009.

Month	Cl	SO_4	NH_3-N	NO_3-N	SRP	TN	TP	TSS
January	65,700	209,000	300	5,310	47	7,890	260	91,000
February	103,000	315,000	520	8,230	70	12,300	470	170,000
March	92,000	294,000	950	7,720	86	11,500	990	394,000
April	118,000	405,000	1,830	10,600	150	15,800	2,130	874,000
May	175,000	656,000	6,910	21,600	660	32,600	11,700	5,460,000
June	14,100	76,000	370	1,110	26	1,580	430	157,000
July	4,540	29,900	110	330	9	460	110	37,000
August	12,100	76,900	450	1,280	67	1,850	700	259,000
September	48,500	267,000	1,950	7,240	560	10,800	3,990	1,609,000
October	126,600	593,000	3,920	20,700	1,460	31,460	8,490	3,525,000
November	45,300	206,000	320	4,060	75	5,910	310	93,000
December	39,900	152,000	140	2,860	25	4,150	99	29,000

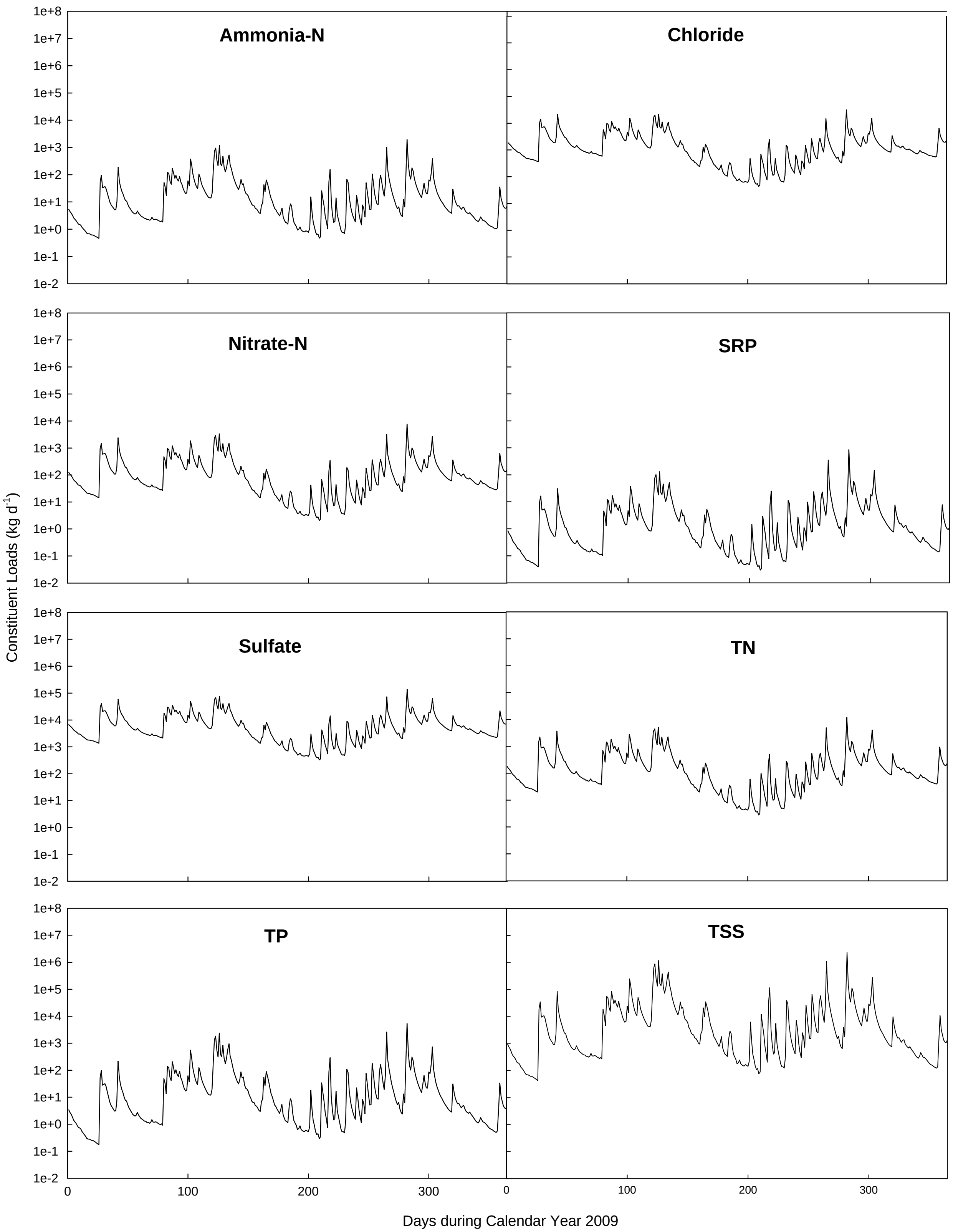

Figure 6. Daily constituent loads (kg d^{-1}) as a function of time (d) at West Fork White River during 2009.

annual loads at multiple sites in the watershed (i.e., UWRB) provides valuable loading information to support the development of future watershed models, as well as increases our understanding of this watershed system. There is no substitute for real data, which provides load estimates from streams draining catchments that vary in hydrologic response, effluent discharges and land use characteristics. Building at least a five year database following consistent sampling or monitoring protocol would allow for focus on trend analysis using flow adjusted concentrations or loads. Analyzing trends based on flow adjusted data, and not just making quantitative comparisons between year, is necessary to accurately determine trends in water quality, because loading is typically closely tied to hydrology (e.g., Massey et al., 2009a, Massey et al., 2009b).

The historical loads reported for the West Fork White River and White River were estimated using an autosampler approach. The 2009 annual loads, however, were estimated using regression models that were developed from a weekly monitoring program that specifically targeted storm events. This method of load estimation expanded the number of sites sampled and was less expensive; costs could be reduced further by decreasing the number of samples collected from approximately 57 (on average) to 46 samples per site per year which would still capture seasonal variability in those constituents where it is important, as well as allow for trend analysis. The historic method had the benefit of providing event based information that the current monitoring program does not, because autosamplers collected flow composite samples which represented the rising and falling limb of individual storm events. It is important to target storm events in weekly monitoring programs so that loads are accurately estimated when using regression models. While both load estimation methods have their advantages, ANRC should have confidence that switching monitoring programs provided data that is comparable to that collected with autosamplers.

When estimating constituent loads using statistical models, multiple factors including flow regimes and seasonal variations need to be considered so that the selected model best describes the relationship between load and discharge at a site. To estimate loads at select sites in UWRB during 2009, some constituents required different models for low and high flow (e.g., SRP and TP at Brush Creek), and some constituents required a seasonal component be included in the model (e.g., SRP, TP, NH_3-N, and TSS at War Eagle Creek). Most often, the model with the best statistics (e.g., lowest BCF and highest R^2 value) was chosen to represent daily loads in the selected stream, but it was critical that the data be closely investigated to determine the most appropriate regression model.

The loads observed at the selected sites in the UWRB during 2009 generally increased as catchment drainage area increased (Figure 7). War Eagle Creek did, however, exhibit higher TN and TSS loads then White River even though the White River drains an area 1.5 times the size of the War Eagle Creek catchment area. Higher loads at War Eagle Creek are likely a result of the influences from pastured area in the catchment and treated wastewater effluent from the City of Huntsville. TN, TP and TSS FWCs did not exhibit the same pattern of increasing concentration with increasing drainage area (Figure 8). In fact, the smaller urban-influenced catchments typically exhibited FWC that were higher than the larger streams. This is the first information available on urban nonpoint sources in the UWRB, and it highlights the need to maintain an expanded monitoring program that monitors multiple sites ranging in catchment size and land use.

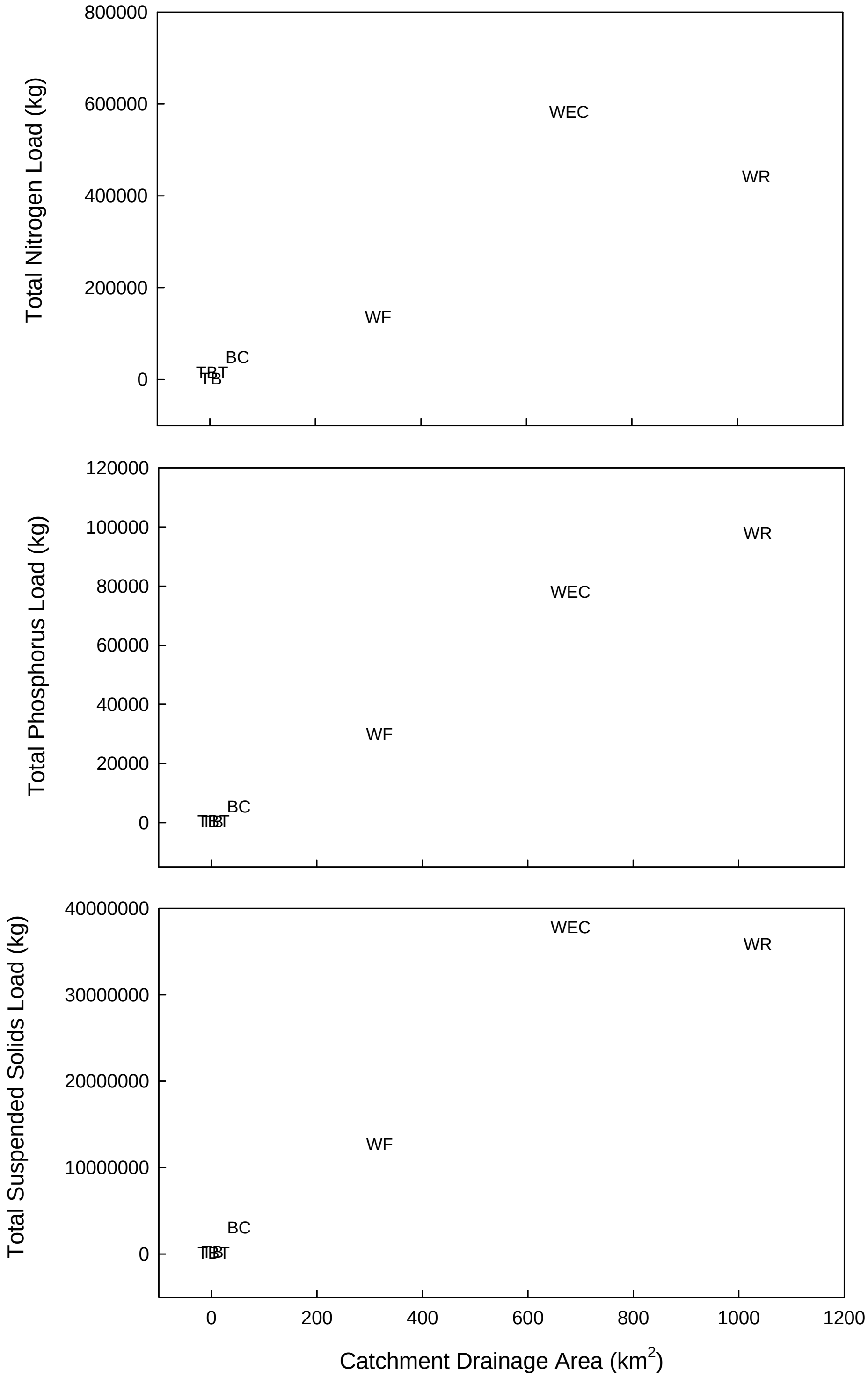

Figure 7. Total nitrogen, total phosphorus and total suspended solids load during CY 2009 as a function of catchment drainage area for Brush Creek at Highway 45 (BC), Town Branch at Fayetteville (TB), Town Branch Tributary (TBT), War Eagle Creek near Hindsville (WEC), West Fork White River East of Fayetteville (WFWR), and White River near Fayetteville (WR) in the Upper White River Basin.

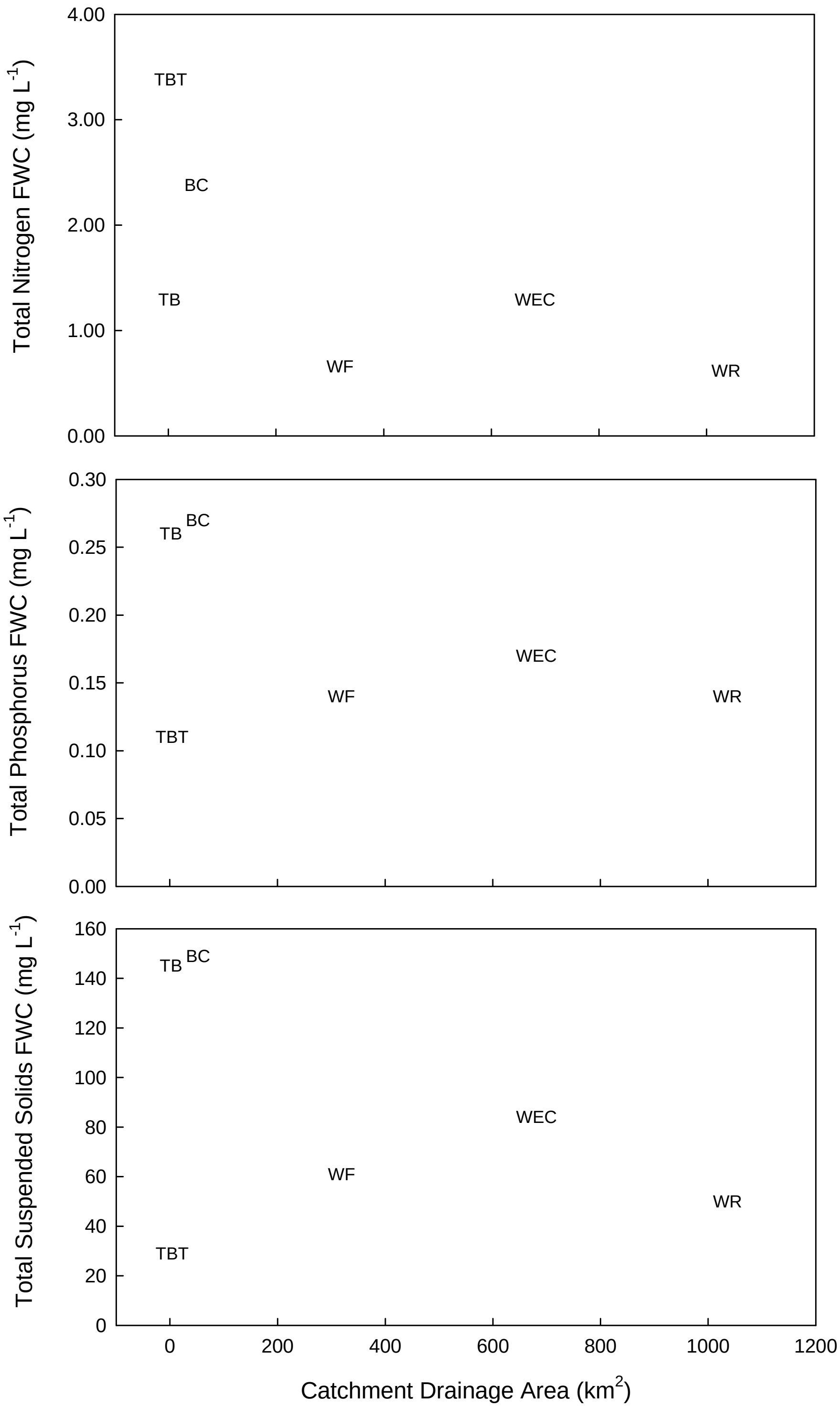

Figure 8. Total nitrogen, total phosphorus and total suspended solids flow weighted concentrations during CY 2009 as a function of catchment drainage area for Brush Creek at Highway 45 (BC), Town Branch at Fayetteville (TB), Town Branch Tributary (TBT), War Eagle Creek near Hindsville (WEC), West Fork White River East of Fayetteville (WFWR), and White River near Fayetteville (WR) in the Upper White River Basin.

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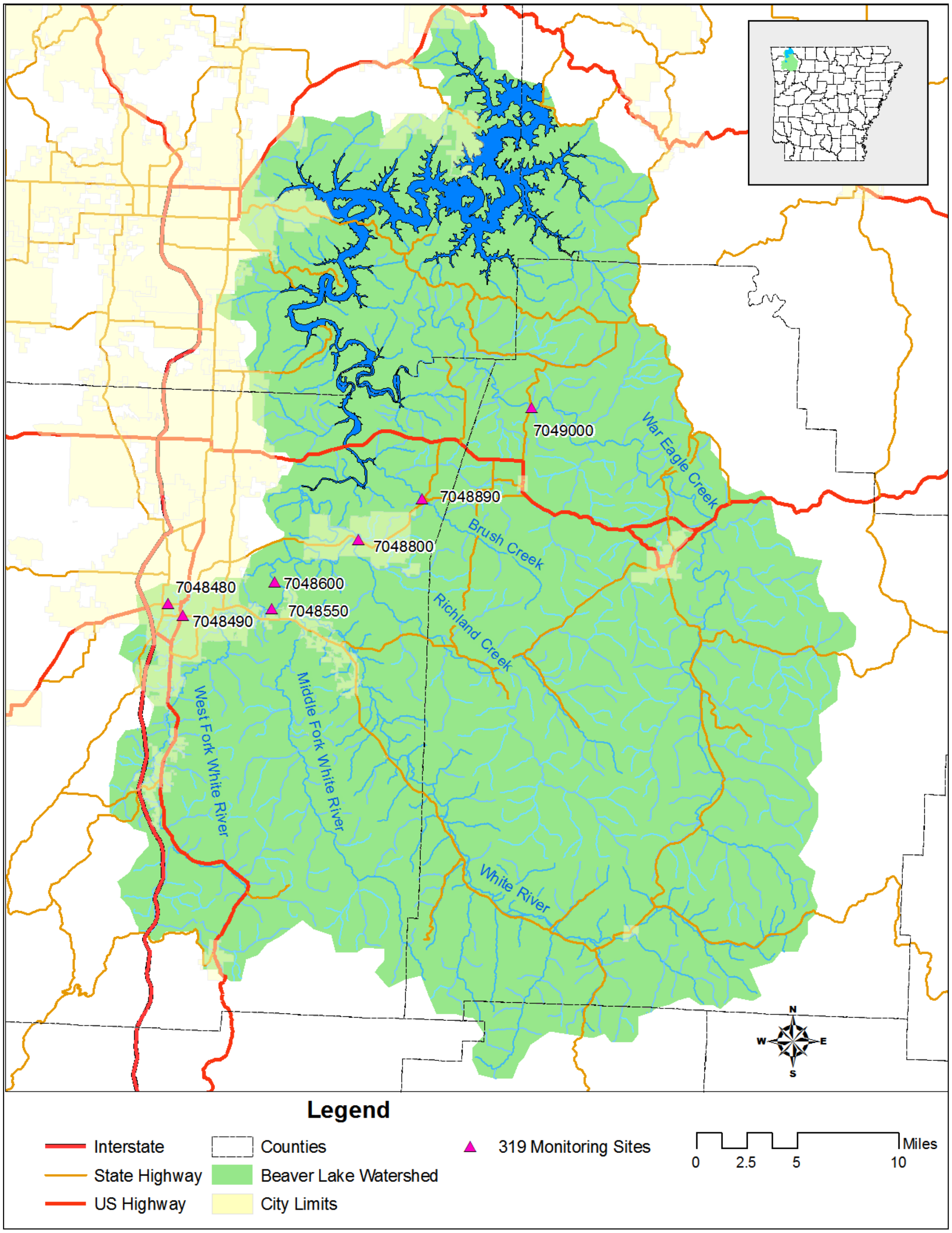
APPENDIX 1. Location of the study sampling stations and ADEQ monitoring sites in the White River Basin, northwest Arkansas.



Appendix 2. Sample collection record and constituent concentrations[A] measured at select sites within the Upper White River Basin from 1 July 2009 to 30 June 2010.

[A]All concentrations are reported ot three decimal places to provide raw data, except for TSS which is reported as a whole number; the practical quantitation limit of thes constituents are 0.90 mg L^{-1} NH_3-N, 0.16 mg L^{-1} Cl, 0.003 mg L^{-1} NO_3-N, 0.01 mg L^{-1} SRP, 0.02 mg L^{-1} SO_4, 0.05 mg L^{-1} TN, 0.02 mg L^{-1} TP, and 7 mg L^{-1} TSS.

2A. White River near Fayetteville

Date	Time	Collector	NH_3-N	Cl	NO_3-N	SRP	SO_4	TN	TP	TSS	Turbidity
08-Jul-09	11:30 AM	AWRC, W. Cash	0.06	3.152	0.233	0.002	15.008	0.34	0.030	5	9.3
15-Jul-09	8:50 AM	AWRC, W. Cash	0.05	2.903	0.152	0.007	8.808	0.31	0.034	5	9.0
22-Jul-09	9:30 AM	AWRC, W. Cash	0.11	5.649	0.310	0.005	20.013	0.44	0.054	14	18
29-Jul-09	9:00 AM	AWRC, W. Cash	0.04	3.244	0.259	0.004	14.112	0.42	0.030	6	8.6
05-Aug-09	7:30 AM	AWRC, W. Cash	0.08	4.830	0.412	0.008	22.325	0.56	0.030	5	7.3
12-Aug-09	8:15 AM	AWRC, W. Cash	0.13	3.920	0.462	0.006	17.548	0.69	0.074	23	31
19-Aug-09	8:35 AM	AWRC, W. Cash	0.24	4.335	0.218	0.004	19.052	0.45	0.054	13	17
20-Aug-09	3:35 PM	AWRC, W. Cash	0.08	5.557	0.345	0.011	33.067	0.68	0.236	120	126
26-Aug-09	9:45 AM	AWRC, W. Cash	0.02	3.179	0.264	0.003	15.341	0.50	0.052	12	17
02-Sep-09	10:15 AM	AWRC, W. Cash	0.10	3.338	0.159	0.004	27.166	0.39	0.058	14	18
05-Sep-09	1:15 PM	AWRC, W. Cash	0.06	3.501	0.213	0.007	26.577	0.47	0.028	61	62
09-Sep-09	9:00 AM	AWRC, W. Cash	0.08	3.020	0.212	0.007	12.730	0.45	0.060	18	26
09-Sep-09	10:15 AM	AWRC, W. Cash	0.06	4.754	0.441	0.013	30.297	0.66	0.104	45	50
16-Sep-09	9:00 AM	AWRC, W. Cash	0.16	2.649	0.132	0.014	10.683	0.38	0.068	23	19
17-Sep-09	7:00 AM	AWRC, W. Cash	0.10	2.872	0.219	0.011	12.719	0.43	0.074	24	28
22-Sep-09	12:35 PM	AWRC, W. Cash	0.41	1.402	0.564	0.031	4.981	0.97	0.528	200	337
29-Sep-09	10:15 AM	AWRC, W. Cash	0.05	2.761	0.741	0.004	12.198	0.88	0.050	10	18
07-Oct-09	9:15 AM	AWRC, W. Cash	0.05	2.887	0.513	0.011	16.734	0.68	0.064	15	25
09-Oct-09	2:15 PM	AWRC, W. Cash	0.16	1.192	0.456	0.078	4.061	0.84	0.424	151	233
14-Oct-09	9:45 AM	AWRC, W. Cash	0.15	2.027	0.462	0.026	7.306	0.69	0.110	22	52
21-Oct-09	9:15 AM	AWRC, W. Cash	0.05	2.377	0.554	0.004	10.383	0.68	0.032	5	18
28-Oct-09	10:00 AM	AWRC, W. Cash	0.02	2.509	0.331	0.015	9.125	0.47	0.044	10	24
04-Nov-09	10:00 AM	AWRC, W. Cash	0.03	2.193	0.468	0.008	8.065	0.50	0.020	8	17
11-Nov-09	10:00 AM	AWRC, W. Cash	0.03	2.391	0.341	0.001	9.584	0.37	0.026	7	12
18-Nov-09	9:45 AM	AWRC, W. Cash	0.04	2.633	0.325	0.005	9.932	0.48	0.046	7	18
24-Nov-09	9:45 AM	AWRC, W. Cash	0.01	2.514	0.267	0.005	10.492	0.37	0.028	6	13
02-Dec-09	9:10 AM	AWRC, W. Cash	0.01	2.535	0.212	0.001	10.727	0.28	0.022	6	9.8
09-Dec-09	10:15 AM	AWRC, W. Cash	0.01	3.003	0.235	0.002	11.726	0.28	0.012	5	10
16-Dec-09	8:45 AM	AWRC, W. Cash	0.01	2.750	0.244	0.003	10.708	0.29	0.010	5	8.9
22-Dec-09	9:15 AM	AWRC, W. Cash	0.01	2.690	0.206	0.001	10.692	0.26	0.020	5	8.5
31-Dec-09	9:30 AM	AWRC, W. Cash	0.01	3.385	0.502	0.005	9.862	0.53	0.024	3	13
06-Jan-10	9:30 AM	AWRC, W. Cash	0.01	3.390	0.473	0.006	10.170	0.48	0.020	4	9.6
13-Jan-10	10:00 AM	AWRC, W. Cash	0.02	3.604	0.495	0.001	11.028	0.56	0.018	6	9.2
20-Jan-10	9:30 AM	AWRC, W. Cash	0.01	3.961	0.376	0.001	12.434	0.45	0.016	3	6.2
27-Jan-10	9:45 AM	AWRC, W. Cash	0.12	3.209	0.571	0.001	9.040	0.65	0.014	5	17
04-Feb-10	9:30 AM	AWRC, W. Cash	0.05	6.460	0.533	0.002	13.590	0.64	0.038	5	16
11-Feb-10	9:15 AM	AWRC, W. Cash	0.05	4.432	0.636	0.005	9.966	0.62	0.018	2	12
17-Feb-10	9:15 AM	AWRC, W. Cash	0.03	5.151	0.617	0.003	11.976	0.60	0.018	3	8.6
24-Feb-10	2:30 PM	AWRC, W. Cash	0.01	3.439	0.523	0.002	9.260	0.56	0.024	4	17
03-Mar-10	9:30 AM	AWRC, W. Cash	0.01	3.224	0.479	0.004	9.984	0.51	0.010	4	9.8
10-Mar-10	9:15 AM	AWRC, W. Cash	0.02	3.898	0.426	0.008	11.988	0.52	0.018	8	13
17-Mar-10	9:45 AM	AWRC, W. Cash	0.01	3.361	0.364	0.001	10.952	0.49	0.038	8	12
23-Mar-10	12:10 PM	AWRC, W. Cash	0.16	3.955	0.526	0.025	8.815	0.79	0.134	34	68
31-Mar-10	9:45 AM	AWRC, W. Cash	0.03	2.795	0.519	0.001	8.308	0.58	0.030	10	17
07-Apr-10	10:00 AM	AWRC, W. Cash	0.05	2.547	0.392	0.002	7.498	0.37	0.040	12	21
14-Apr-10	9:30 AM	AWRC, W. Cash	0.07	2.685	0.293	0.001	8.720	0.42	0.026	8	13
21-Apr-10	9:15 AM	AWRC, W. Cash	0.03	2.857	0.235	0.001	10.427	0.34	0.018	7	7.5
24-Apr-10	5:15 PM	AWRC, W. Cash	0.07	3.795	0.248	0.001	16.215	0.42	0.120	50	49
28-Apr-10	9:30 AM	AWRC, W. Cash	0.08	2.911	0.604	0.002	10.261	0.46	0.036	10	15
05-May-10	9:30 AM	AWRC, W. Cash	0.09	2.847	0.295	0.006	9.551	0.52	0.068	15	31
12-May-10	9:30 AM	AWRC, W. Cash	0.44	2.987	0.237	0.001	9.268	0.44	0.112	38	82
13-May-10	10:45 PM	AWRC, W. Cash	0.17	3.242	0.240	0.009	11.845	0.56	0.190	109	107
14-May-10	4:00 PM	AWRC, W. Cash	0.12	5.002	0.551	0.021	18.122	0.79	0.520	338	322
15-May-10	12:15 PM	AWRC, W. Cash	0.08	2.822	0.303	0.033	7.210	0.71	0.238	86	118
15-May-10	6:45 PM	AWRC, W. Cash	0.06	1.776	0.252	0.048	5.013	0.87	0.809	152	494
17-May-10	9:30 AM	AWRC, W. Cash	0.05	1.819	0.346	0.018	5.697	0.59	0.146	44	77
26-May-10	9:15 AM	AWRC, W. Cash	0.08	2.345	0.377	0.009	7.648	0.58	0.084	23	42
09-Jun-10	9:30 AM	AWRC, W. Cash	0.08	2.813	0.195	0.008	12.307	0.34	0.048	11	14
16-Jun-10	9:15 AM	AWRC, W. Cash	0.08	3.054	0.258	0.004	10.116	0.39	0.046	10	14
24-Jun-10	7:15 AM	AWRC, W. Cash	0.06	2.791	0.131	0.009	10.912	0.28	0.050	4	7.0

2B. Brush Creek at Highway 45

Date	Time	Collector	NH_3-N	Cl	NO_3-N	SRP	SO_4	TN	TP	TSS	Turbidity
08-Jul-09	10:45 AM	AWRC, W. Cash	0.04	11.166	2.196	0.020	13.116	2.34	0.028	2.9	2.8
15-Jul-09	8:00 AM	AWRC, W. Cash	0.02	12.199	1.794	0.021	12.798	1.96	0.030	2.0	2.9
22-Jul-09	8:30 AM	AWRC, W. Cash	0.03	11.035	2.416	0.022	11.572	2.36	0.036	2.8	2.9
29-Jul-09	8:30 AM	AWRC, W. Cash	0.11	11.166	1.786	0.021	15.921	1.94	0.036	1.7	2.1
05-Aug-09	8:15 AM	AWRC, W. Cash	1.36	11.441	1.433	0.021	14.538	1.51	0.032	2.0	2.2
12-Aug-09	9:00 AM	AWRC, W. Cash	0.01	11.083	1.559	0.018	12.518	1.63	0.030	2.3	2.9
19-Aug-09	9:30 AM	AWRC, W. Cash	0.01	11.312	1.075	0.018	15.722	1.15	0.030	1.4	1.5
26-Aug-09	8:45 AM	AWRC, W. Cash	0.02	11.235	1.072	0.019	15.279	1.22	0.032	1.9	2.0
02-Sep-09	9:15 AM	AWRC, W. Cash	0.06	11.050	0.782	0.020	15.221	0.91	0.032	2.0	3.0
09-Sep-09	8:00 AM	AWRC, W. Cash	0.02	11.449	0.797	0.019	14.103	1.08	0.024	1.5	2.6
16-Sep-09	8:00 AM	AWRC, W. Cash	0.18	10.886	0.857	0.028	12.489	1.00	0.064	9.4	16.3
23-Sep-09	10:30 AM	AWRC, W. Cash	0.03	9.456	1.891	0.020	23.690	1.96	0.034	4.7	6.2
29-Sep-09	9:30 AM	AWRC, W. Cash	0.01	10.319	1.206	0.019	25.384	1.38	0.032	1.0	1.3
07-Oct-09	8:30 AM	AWRC, W. Cash	0.01	10.326	1.792	0.025	18.980	1.92	0.036	3.7	6.0
14-Oct-09	8:45 AM	AWRC, W. Cash	0.06	5.176	1.972	0.040	13.647	2.18	0.076	7.3	19.2
21-Oct-09	8:30 AM	AWRC, W. Cash	0.01	8.516	3.357	0.026	17.202	3.47	0.024	1.1	1.9
28-Oct-09	9:15 AM	AWRC, W. Cash	0.01	8.051	1.726	0.025	22.005	1.87	0.030	0.9	6.2
04-Nov-09	9:15 AM	AWRC, W. Cash	0.01	8.313	3.171	0.028	13.311	3.24	0.030	1.3	4.1
11-Nov-09	9:15 AM	AWRC, W. Cash	0.01	10.706	3.440	0.022	13.236	3.50	0.032	1.5	2.2
18-Nov-09	9:00 AM	AWRC, W. Cash	0.01	8.666	2.319	0.019	17.204	2.53	0.038	1.4	3.8
24-Nov-09	9:00 AM	AWRC, W. Cash	0.01	9.418	2.516	0.021	16.440	2.72	0.026	0.9	2.0
02-Dec-09	8:20 AM	AWRC, W. Cash	0.01	10.428	2.544	0.014	18.557	2.65	0.022	0.8	1.2
09-Dec-09	9:20 AM	AWRC, W. Cash	0.01	10.171	2.543	0.018	18.358	2.65	0.018	1.3	1.5
16-Dec-09	7:45 AM	AWRC, W. Cash	0.01	11.102	2.454	0.015	18.930	2.54	0.014	0.7	2.3
22-Dec-09	8:30 AM	AWRC, W. Cash	0.01	10.981	2.498	0.011	20.387	2.57	0.022	1.8	3.0
31-Dec-09	8:45 AM	AWRC, W. Cash	0.01	8.442	2.053	0.018	22.783	2.19	0.026	0.8	3.4
06-Jan-10	8:30 AM	AWRC, W. Cash	0.01	9.014	2.114	0.017	23.133	2.17	0.020	0.8	4.1
13-Jan-10	9:15 AM	AWRC, W. Cash	0.01	10.661	2.666	0.014	20.189	2.71	0.018	1.0	3.0
20-Jan-10	8:45 AM	AWRC, W. Cash	0.01	10.390	2.131	0.012	26.172	2.29	0.026	0.9	2.0
27-Jan-10	9:00 AM	AWRC, W. Cash	0.02	8.513	2.795	0.011	14.574	2.92	0.016	2.1	8.4
04-Feb-10	8:45 AM	AWRC, W. Cash	0.02	9.070	2.500	0.009	15.549	2.68	0.044	3.3	12.5
11-Feb-10	8:15 AM	AWRC, W. Cash	0.01	9.109	3.306	0.016	12.579	3.37	0.030	1.2	6.6
17-Feb-10	8:30 AM	AWRC, W. Cash	0.04	10.582	3.467	0.013	13.744	3.34	0.018	1.2	5.7
24-Feb-10	1:45 PM	AWRC, W. Cash	0.01	10.105	3.090	0.014	13.665	3.07	0.024	1.9	5.9
03-Mar-10	8:45 AM	AWRC, W. Cash	0.01	11.100	3.309	0.011	14.876	3.34	0.012	1.9	4.5
10-Mar-10	8:30 AM	AWRC, W. Cash	0.01	11.473	3.177	0.017	16.792	3.23	0.010	1.8	3.6
17-Mar-10	8:45 AM	AWRC, W. Cash	0.03	9.330	2.535	0.012	21.681	2.81	0.024	1.6	2.8
17-Mar-10	9:00 AM	AWRC, W. Cash	0.02	10.991	2.923	0.013	17.716	3.15	0.028	0.7	2.2
23-Mar-10	11:26 AM	AWRC, W. Cash	0.08	4.784	1.735	0.034	13.030	1.98	0.074	10.3	26.5
31-Mar-10	8:45 AM	AWRC, W. Cash	0.01	7.730	2.625	0.010	15.015	2.77	0.022	2.7	4.4
31-Mar-10	9:00 AM	AWRC, W. Cash	0.02	9.552	3.194	0.008	12.340	3.20	0.026	3.1	5.6
07-Apr-10	9:00 AM	AWRC, W. Cash	0.01	9.046	2.648	0.019	12.607	2.64	0.030	4.7	6.0
07-Apr-10	9:15 AM	AWRC, W. Cash	0.02	7.193	2.214	0.016	15.422	2.38	0.024	2.7	3.7
14-Apr-10	8:45 AM	AWRC, W. Cash	0.01	10.230	2.807	0.002	13.520	2.95	0.026	2.4	3.3
21-Apr-10	8:30 AM	AWRC, W. Cash	0.01	11.054	2.784	0.016	13.313	2.96	0.028	2.3	3.0
24-Apr-10	5:45 PM	AWRC, W. Cash	0.05	7.529	1.917	0.018	22.525	1.94	0.100	37.1	40.0
28-Apr-10	8:45 AM	AWRC, W. Cash	0.02	8.027	1.986	0.018	16.157	2.25	0.028	1.5	4.1
05-May-10	8:45 AM	AWRC, W. Cash	0.04	9.944	2.157	0.027	15.338	2.26	0.036	2.7	4.6
12-May-10	8:45 AM	AWRC, W. Cash	0.01	8.715	1.940	0.031	15.448	2.05	0.054	4.7	7.5
14-May-10	8:45 AM	AWRC, W. Cash	0.12	4.335	1.045	0.029	15.421	1.35	0.092	17.4	39.0
14-May-10	4:15 PM	AWRC, W. Cash	0.07	3.480	0.766	0.111	11.664	1.25	0.358	80.8	138
15-May-10	1:05 PM	AWRC, W. Cash	0.38	2.879	0.696	0.148	8.451	2.20	1.780	1463.7	767
15-May-10	1:15 PM	AWRC, W. Cash	0.20	2.884	0.657	0.225	8.278	2.36	2.188	2004.8	984
17-May-10	8:45 AM	AWRC, W. Cash	0.01	4.430	1.722	0.030	11.963	1.87	0.064	7.6	13.8
26-May-10	8:30 AM	AWRC, W. Cash	0.01	8.124	2.664	0.029	12.440	2.79	0.048	4.0	5.6
09-Jun-10	8:45 AM	AWRC, W. Cash	0.03	11.234	2.693	0.031	11.237	2.78	0.042	3.1	2.5
16-Jun-10	8:30 AM	AWRC, W. Cash	0.04	11.726	2.476	0.032	11.276	2.47	0.054	3.1	3.9
24-Jun-10	8:15 AM	AWRC, W. Cash	0.01	11.137	2.242	0.027	11.991	2.32	0.092	9.0	1.8

2C. Richland Creek

Date	Time	Collector	NH_3-N	Cl	NO_3-N	SRP	SO_4	TN	TP	TSS	Turbidity
08-Jul-09	11:00 AM	AWRC, W. Cash	0.04	5.13	0.18	0.00	9.26	0.41	0.04	6	7.10
15-Jul-09	8:15 AM	AWRC, W. Cash	0.02	5.08	0.15	0.00	8.94	0.30	0.03	7	9.90
22-Jul-09	8:45 AM	AWRC, W. Cash	0.03	7.22	0.17	0.00	11.54	0.34	0.06	7	7.10
29-Jul-09	8:45 AM	AWRC, W. Cash	0.03	5.78	0.19	0.00	10.72	0.34	0.03	7	8.80
05-Aug-09	8:00 AM	AWRC, W. Cash	0.04	5.93	0.40	0.00	9.73	0.49	0.02	5	4.70
12-Aug-09	8:45 AM	AWRC, W. Cash	0.03	4.12	1.31	0.01	11.35	1.46	0.04	8	13.60
19-Aug-09	9:15 AM	AWRC, W. Cash	0.06	4.06	1.29	0.01	10.27	1.43	0.06	13	18.60
26-Aug-09	9:00 AM	AWRC, W. Cash	0.02	3.89	0.63	0.00	10.22	0.80	0.04	8	9.30
02-Sep-09	9:30 AM	AWRC, W. Cash	0.05	4.04	0.26	0.00	9.97	0.43	0.03	4	6.20
09-Sep-09	8:15 AM	AWRC, W. Cash	0.00	4.51	0.70	0.01	11.82	0.81	0.01	7	9.80
16-Sep-09	8:15 AM	AWRC, W. Cash	0.03	3.91	0.56	0.01	10.62	0.66	0.02	6	7.10
17-Sep-09	7:45 AM	AWRC, W. Cash	0.04	3.37	0.64	0.01	10.10	0.85	0.08	24	39.20
22-Sep-09	1:10 PM	AWRC, W. Cash	0.25	2.38	0.97	0.03	6.13	1.22	0.19	69	118
29-Sep-09	9:45 AM	AWRC, W. Cash	0.02	4.08	1.23	0.01	9.15	1.38	0.02	2	3.30
07-Oct-09	8:45 AM	AWRC, W. Cash	0.00	4.98	1.04	0.01	17.09	1.15	0.03	2	3.00
14-Oct-09	9:00 AM	AWRC, W. Cash	0.05	2.97	1.07	0.02	7.16	1.29	0.07	12	29.20
21-Oct-09	8:45 AM	AWRC, W. Cash	0.00	4.05	1.36	0.01	8.92	1.51	0.01	2	4.80
28-Oct-09	9:30 AM	AWRC, W. Cash	0.02	3.87	0.58	0.01	9.99	0.71	0.03	3	13.80
04-Nov-09	9:30 AM	AWRC, W. Cash	0.01	3.57	1.09	0.01	7.71	1.26	0.02	1	7.40
11-Nov-09	9:30 AM	AWRC, W. Cash	0.01	3.79	0.89	0.01	8.66	0.96	0.02	2	3.00
18-Nov-09	9:15 AM	AWRC, W. Cash	0.01	3.91	0.61	0.01	10.43	0.77	0.03	2	9.50
24-Nov-09	9:15 AM	AWRC, W. Cash	0.03	3.73	0.58	0.01	10.11	0.69	0.02	1	3.60
02-Dec-09	8:35 AM	AWRC, W. Cash	0.00	4.23	0.55	0.00	11.34	0.63	0.01	2	2.40
09-Dec-09	9:30 AM	AWRC, W. Cash	0.00	4.25	0.63	0.01	12.14	0.70	0.00	0	2.20
16-Dec-09	8:00 AM	AWRC, W. Cash	0.00	4.61	0.56	0.00	13.95	0.64	0.00	2	3.00
22-Dec-09	8:45 AM	AWRC, W. Cash	0.00	4.43	0.54	0.00	13.24	0.61	0.01	2	2.40
31-Dec-09	8:55 AM	AWRC, W. Cash	0.00	4.39	0.83	0.01	12.41	0.93	0.02	1	6.50
06-Jan-10	8:45 AM	AWRC, W. Cash	0.00	4.44	0.79	0.01	12.31	0.86	0.01	1	6.70
13-Jan-10	9:30 AM	AWRC, W. Cash	0.00	4.58	0.81	0.00	12.06	0.88	0.01	1	2.00
20-Jan-10	9:00 AM	AWRC, W. Cash	0.02	5.33	0.67	0.00	15.39	0.80	0.01	1	2.80
27-Jan-10	9:15 AM	AWRC, W. Cash	0.01	4.43	1.04	0.00	10.78	1.16	0.00	2	9.80
04-Feb-10	9:00 AM	AWRC, W. Cash	0.02	5.17	0.97	0.00	12.27	1.15	0.03	4	13.80
11-Feb-10	8:30 AM	AWRC, W. Cash	0.02	4.11	1.23	0.01	9.39	1.35	0.02	1	9.60
17-Feb-10	8:45 AM	AWRC, W. Cash	0.04	4.34	1.12	0.01	10.24	1.22	0.02	1	7.70
24-Feb-10	2:00 PM	AWRC, W. Cash	0.00	4.14	0.97	0.01	10.20	1.13	0.02	1	8.80
03-Mar-10	9:00 AM	AWRC, W. Cash	0.00	4.29	1.03	0.01	10.81	1.11	0.00	1	5.40
10-Mar-10	8:45 AM	AWRC, W. Cash	0.01	4.61	0.96	0.01	12.08	1.05	0.00	2	4.80
17-Mar-10	9:15 AM	AWRC, W. Cash	0.01	4.39	0.80	0.00	12.58	0.96	0.01	3	3.90
23-Mar-10	11:42 AM	AWRC, W. Cash	0.10	3.40	0.88	0.02	8.28	1.14	0.09	15	37.40
31-Mar-10	9:15 AM	AWRC, W. Cash	0.00	3.62	0.98	0.00	8.46	1.26	0.02	5	9.90
07-Apr-10	9:30 AM	AWRC, W. Cash	0.02	3.45	0.73	0.01	8.67	0.83	0.03	5	9.20
14-Apr-10	9:00 AM	AWRC, W. Cash	0.00	3.66	0.71	0.00	9.02	0.85	0.01	3	5.70
21-Apr-10	8:45 AM	AWRC, W. Cash	0.00	3.81	0.66	0.00	9.79	0.79	0.01	2	4.10
28-Apr-10	9:00 AM	AWRC, W. Cash	0.04	4.03	0.59	0.00	13.35	0.77	0.01	2	4.50
05-May-10	9:00 AM	AWRC, W. Cash	0.08	4.06	0.59	0.00	13.06	0.73	0.02	4	6.40
12-May-10	9:00 AM	AWRC, W. Cash	0.10	4.35	0.75	0.00	15.65	0.95	0.04	8	12.20
13-May-10	11:15 PM	AWRC, W. Cash	0.13	2.95	0.50	0.07	11.01	1.16	0.68	315	378
14-May-10	4:30 PM	AWRC, W. Cash	0.06	3.33	0.57	0.06	10.96	1.06	0.31	100	127
15-May-10	1:00 PM	AWRC, W. Cash	0.15	2.54	0.44	0.06	6.58	0.94	0.45	280	210
15-May-10	5:45 PM	AWRC, W. Cash	0.27	1.70	0.38	0.06	4.22	0.95	0.71	395	393
17-May-10	9:00 AM	AWRC, W. Cash	0.00	2.73	0.78	0.01	6.72	0.95	0.07	13	27.00
26-May-10	8:45 AM	AWRC, W. Cash	0.02	3.44	0.93	0.02	8.43	1.16	0.06	7	17.10
09-Jun-10	9:00 AM	AWRC, W. Cash	0.00	4.12	0.86	0.01	9.45	0.99	0.03	3	4.00
16-Jun-10	8:45 AM	AWRC, W. Cash	0.02	4.12	0.71	0.01	9.15	0.81	0.02	4	3.00
24-Jun-10	8:00 AM	AWRC, W. Cash	0.11	4.16	0.44	0.01	8.96	0.56	0.02	10	2.40

2D. Town Branch at Fayetteville

Date	Time	Collector	NH_3-N	Cl	NO_3-N	SRP	SO_4	TN	TP	TSS	Turbidity
08-Jul-09	1:00 PM	AWRC, W. Cash	0.05	16.383	8.860	0.058	91.328	9.06	0.076	2	3.3
15-Jul-09	9:45 AM	AWRC, W. Cash	0.04	15.516	6.536	0.034	82.106	6.24	0.048	2	2.9
21-Jul-09	6:30 AM	AWRC, W. Cash	0.23	1.435	0.520	0.072	5.607	1.04	0.382	258	202
22-Jul-09	10:30 AM	AWRC, W. Cash	0.62	16.186	5.726	0.118	76.209	6.01	0.152	2	2.7
29-Jul-09	9:45 AM	AWRC, W. Cash	0.22	15.996	1.471	0.039	87.373	1.79	0.058	2	2.3
30-Jul-09	2:15 PM	AWRC, W. Cash	0.13	6.512	0.720	0.127	6.332	1.16	0.288	105	104
05-Aug-09	6:30 AM	AWRC, W. Cash	0.03	16.170	2.244	0.037	87.748	2.45	0.038	2	2.2
10-Aug-09	7:00 PM	AWRC, W. Cash	0.40	2.881	0.584	0.132	10.309	1.21	0.396	122	138
12-Aug-09	7:30 AM	AWRC, W. Cash	0.02	15.656	1.871	0.046	70.947	2.17	0.056	2	4.2
19-Aug-09	8:00 AM	AWRC, W. Cash	0.02	12.084	2.280	0.021	78.178	2.63	0.046	1	2.8
20-Aug-09	7:40 AM	AWRC, W. Cash	0.10	1.818	0.437	0.033	7.772	0.63	0.090	18	24.3
20-Aug-09	10:10 AM	AWRC, W. Cash	0.11	1.707	0.620	0.162	8.842	1.13	0.380	133	133
26-Aug-09	10:15 AM	AWRC, W. Cash	0.02	16.209	1.230	0.023	92.564	1.46	0.044	3	6.3
02-Sep-09	10:50 AM	AWRC, W. Cash	0.13	1.233	0.256	0.048	5.156	0.51	0.134	36	40.3
09-Sep-09	9:45 AM	AWRC, W. Cash	0.01	15.034	1.065	0.027	81.930	1.37	0.068	8	17.6
16-Sep-09	9:45 AM	AWRC, W. Cash	0.10	2.439	0.262	0.057	9.262	0.55	0.122	23	29.7
29-Sep-09	11:00 AM	AWRC, W. Cash	0.02	17.157	0.861	0.021	83.986	1.13	0.032	1	1.3
07-Oct-09	9:45 AM	AWRC, W. Cash	0.04	13.607	1.183	0.048	66.817	1.45	0.074	2	3.3
14-Oct-09	10:15 AM	AWRC, W. Cash	0.02	11.780	0.850	0.036	49.362	1.05	0.056	2	6.7
21-Oct-09	10:00 AM	AWRC, W. Cash	0.03	15.163	0.751	0.019	71.220	0.91	0.038	2	2.4
28-Oct-09	10:30 AM	AWRC, W. Cash	0.07	12.440	0.686	0.042	57.166	0.89	0.044	2	4.3
04-Nov-09	10:45 AM	AWRC, W. Cash	0.02	14.152	0.730	0.018	59.689	0.92	0.024	2	3.5
11-Nov-09	10:30 AM	AWRC, W. Cash	0.02	14.513	0.644	0.021	74.902	0.80	0.094	1	2.5
18-Nov-09	10:20 AM	AWRC, W. Cash	0.03	12.600	0.719	0.038	58.308	0.91	0.056	1	3.8
24-Nov-09	10:20 AM	AWRC, W. Cash	0.21	5.931	0.630	0.052	28.964	0.95	0.100	11	20.8
02-Dec-09	10:00 AM	AWRC, W. Cash	0.01	14.716	0.576	0.010	78.425	0.71	0.014	1	1.7
09-Dec-09	11:00 AM	AWRC, W. Cash	0.03	11.896	0.691	0.027	67.952	1.04	0.036	2	3.3
16-Dec-09	10:30 AM	AWRC, W. Cash	0.04	13.934	0.622	0.010	80.716	0.75	0.012	0	2.1
22-Dec-09	9:45 AM	AWRC, W. Cash	0.01	13.442	0.567	0.004	76.717	0.68	0.022	3	4.0
31-Dec-09	10:00 AM	AWRC, W. Cash	0.01	29.115	0.769	0.015	63.873	0.93	0.026	1	3.1
06-Jan-10	10:10 AM	AWRC, W. Cash	0.04	90.426	0.802	0.008	79.484	0.91	0.008	1	3.2
13-Jan-10	10:45 AM	AWRC, W. Cash	0.01	24.125	0.788	0.001	78.698	0.93	0.008	1	1.3
20-Jan-10	10:10 AM	AWRC, W. Cash	0.03	59.043	0.674	0.001	52.898	0.90	0.024	5	10.1
27-Jan-10	10:20 AM	AWRC, W. Cash	0.02	26.569	0.877	0.011	62.665	1.02	0.004	1	3.8
04-Feb-10	10:10 AM	AWRC, W. Cash	0.37	114.763	0.514	0.027	30.310	0.96	0.230	59	133
11-Feb-10	9:55 AM	AWRC, W. Cash	0.03	74.901	0.813	0.008	72.273	0.88	0.016	1	5.3
17-Feb-10	10:00 AM	AWRC, W. Cash	0.02	40.094	0.730	0.003	79.736	0.75	0.006	1	4.9
24-Feb-10	3:30 PM	AWRC, W. Cash	0.07	44.601	0.794	0.028	71.007	1.39	0.930	624	690
03-Mar-10	10:10 AM	AWRC, W. Cash	0.01	33.467	0.794	0.003	76.380	0.88	0.005	1	2.9
10-Mar-10	10:00 AM	AWRC, W. Cash	0.46	44.258	0.748	0.043	90.028	1.20	0.054	2	3.4
17-Mar-10	10:15 AM	AWRC, W. Cash	0.03	31.201	0.594	0.001	88.477	0.75	0.028	1	2.7
23-Mar-10	1:36 PM	AWRC, W. Cash	0.09	20.410	0.460	0.040	21.341	0.70	0.102	22	25.0
31-Mar-10	10:20 AM	AWRC, W. Cash	0.01	34.774	0.620	0.001	74.180	0.78	0.020	4	4.1
07-Apr-10	10:40 AM	AWRC, W. Cash	0.23	30.554	1.064	0.002	62.847	1.64	0.046	5	9.3
14-Apr-10	10:05 AM	AWRC, W. Cash	0.06	29.334	0.780	0.001	79.249	0.97	0.010	2	2.1
21-Apr-10	9:50 AM	AWRC, W. Cash	0.01	30.483	0.573	0.003	82.126	0.70	0.012	1	1.9
28-Apr-10	10:10 AM	AWRC, W. Cash	0.07	30.743	0.756	0.013	80.884	0.91	0.018	1	2.1
05-May-10	10:05 AM	AWRC, W. Cash	0.05	29.739	0.620	0.010	82.900	0.79	0.020	2	2.0
12-May-10	10:10 AM	AWRC, W. Cash	0.62	30.795	0.773	0.081	74.214	1.36	0.108	2	4.2
14-May-10	10:20 AM	AWRC, W. Cash	0.16	2.057	0.277	0.089	3.189	1.00	0.885	601	480
17-May-10	10:15 AM	AWRC, W. Cash	0.31	25.669	0.767	0.081	52.211	1.36	0.144	5	7.0
26-May-10	9:55 AM	AWRC, W. Cash	0.28	18.782	0.737	0.073	46.396	1.21	0.130	4	10.6
09-Jun-10	10:05 AM	AWRC, W. Cash	0.04	26.096	0.877	0.022	75.237	1.03	0.038	1	1.8
16-Jun-10	9:50 AM	AWRC, W. Cash	0.03	24.850	0.571	0.019	77.154	0.69	0.066	2	2.1
24-Jun-10	6:40 AM	AWRC, W. Cash	0.02	25.745	1.742	0.031	99.093	2.18	0.070	9	2.0

2E. Town Branch Tributary

Date	Time	Collector	NH_3-N	Cl	NO_3-N	SRP	SO_4	TN	TP	TSS	Turbidity
08-Jul-09	12:45 AM	AWRC, W. Cash	0.01	20.98	5.81	0.04	44.42	5.75	0.05	3	3.10
15-Jul-09	9:30 AM	AWRC, W. Cash	0.02	20.40	4.14	0.04	42.80	4.20	0.05	2	4.50
21-Jul-09	6:45 AM	AWRC, W. Cash	0.20	1.53	0.78	0.07	4.86	1.34	0.61	395	272
22-Jul-09	10:45 AM	AWRC, W. Cash	0.08	17.39	7.01	0.04	48.47	6.76	0.06	2	2.30
29-Jul-09	10:30 AM	AWRC, W. Cash	0.02	20.93	5.51	0.04	45.13	5.40	0.05	1	1.80
10-Aug-09	6:45 PM	AWRC, W. Cash	0.56	1.73	0.58	0.06	4.54	1.17	0.63	405	288
12-Aug-09	7:45 AM	AWRC, W. Cash	0.04	18.00	8.68	0.04	49.46	8.30	0.05	2	2.50
19-Aug-09	8:15 AM	AWRC, W. Cash	0.01	16.46	5.28	0.03	40.22	5.29	0.05	2	1.70
20-Aug-09	7:50 AM	AWRC, W. Cash	0.20	4.86	0.87	0.06	13.99	1.20	0.23	73	87.70
20-Aug-09	10:00 AM	AWRC, W. Cash	0.51	0.84	0.84	0.12	2.64	1.10	0.44	264	214
26-Aug-09	10:30 AM	AWRC, W. Cash	0.01	20.59	7.67	0.03	48.18	7.79	0.05	1	2.50
09-Sep-09	9:30 AM	AWRC, W. Cash	0.06	19.33	6.72	0.04	46.71	6.90	0.05	3	4.60
29-Sep-09	10:45 AM	AWRC, W. Cash	0.02	21.26	7.24	0.03	49.30	7.59	0.04	2	1.10
07-Oct-09	10:00 AM	AWRC, W. Cash	0.20	16.20	7.00	0.04	49.11	6.98	0.05	1	2.00
14-Oct-09	10:30 AM	AWRC, W. Cash	0.42	14.64	4.83	0.04	48.35	5.30	0.05	1	2.60
21-Oct-09	10:15 AM	AWRC, W. Cash	0.06	19.63	5.73	0.03	51.53	5.85	0.04	1	1.40
28-Oct-09	10:45 AM	AWRC, W. Cash	0.23	15.70	4.56	0.04	47.58	4.70	0.03	1	1.60
04-Nov-09	11:00 AM	AWRC, W. Cash	0.14	17.20	5.02	0.03	50.91	5.23	0.03	1	1.90
11-Nov-09	10:45 AM	AWRC, W. Cash	0.03	18.40	4.80	0.02	49.89	5.12	0.11	1	2.20
18-Nov-09	10:35 AM	AWRC, W. Cash	0.12	17.20	4.31	0.02	49.44	4.70	0.04	1	1.70
24-Nov-09	10:35 AM	AWRC, W. Cash	0.01	9.80	1.83	0.03	30.74	1.97	0.04	2	3.80
02-Dec-09	9:45 AM	AWRC, W. Cash	0.05	19.22	4.76	0.02	51.44	4.76	0.09	37	40.50
09-Dec-09	10:50 AM	AWRC, W. Cash	0.11	14.30	3.47	0.02	42.21	3.56	0.02	2	1.80
16-Dec-09	10:40 AM	AWRC, W. Cash	0.18	19.42	4.40	0.02	51.42	4.78	0.02	7	3.10
13-Jan-10	10:30 AM	AWRC, W. Cash	0.20	21.75	3.54	0.01	47.50	3.60	0.02	0	0.90
20-Jan-10	10:25 AM	AWRC, W. Cash	0.07	50.93	2.57	0.01	44.40	2.85	0.01	3	7.70
27-Jan-10	10:30 AM	AWRC, W. Cash	0.27	25.73	4.31	0.01	55.01	4.73	0.01	1	2.10
04-Feb-10	10:25 AM	AWRC, W. Cash	0.43	65.17	1.77	0.03	31.75	2.15	0.14	36	78.40
11-Feb-10	10:05 AM	AWRC, W. Cash	0.52	52.58	4.49	0.01	54.36	4.75	0.02	1	4.90
17-Feb-10	10:10 AM	AWRC, W. Cash	0.26	31.87	4.46	0.01	57.52	4.77	0.01	1	5.60
24-Feb-10	3:10 PM	AWRC, W. Cash	0.18	35.65	4.13	0.03	58.05	4.48	0.02	1	2.10
03-Mar-10	10:20 AM	AWRC, W. Cash	0.15	27.48	4.40	0.01	56.15	4.54	0.01	2	4.40
10-Mar-10	10:10 AM	AWRC, W. Cash	0.04	29.06	3.89	0.01	55.68	3.94	0.01	1	2.10
17-Mar-10	10:25 AM	AWRC, W. Cash	0.05	25.55	3.86	0.00	57.97	4.08	0.03	1	2.30
23-Mar-10	12:43 PM	AWRC, W. Cash	0.56	35.38	3.05	0.04	45.08	3.59	0.11	12	16.30
31-Mar-10	10:30 AM	AWRC, W. Cash	0.07	26.23	4.33	0.00	53.57	4.57	0.02	2	2.20
07-Apr-10	10:30 AM	AWRC, W. Cash	0.02	26.55	2.74	0.03	49.17	2.84	0.05	2	3.70
14-Apr-10	10:20 AM	AWRC, W. Cash	0.05	24.53	3.83	0.01	52.65	3.98	0.04	6	4.00
21-Apr-10	10:00 AM	AWRC, W. Cash	0.06	23.95	4.02	0.03	51.38	4.20	0.04	2	1.40
28-Apr-10	10:20 AM	AWRC, W. Cash	0.10	24.08	4.61	0.03	53.82	4.65	0.03	1	2.00
05-May-10	10:15 AM	AWRC, W. Cash	0.04	24.85	4.15	0.07	51.97	4.26	0.09	1	1.50
12-May-10	10:20 AM	AWRC, W. Cash	0.06	24.38	4.78	0.05	53.24	5.31	0.10	1	1.50
14-May-10	10:30 AM	AWRC, W. Cash	0.39	2.17	0.88	0.10	4.38	1.58	0.81	399	350
17-May-10	10:25 AM	AWRC, W. Cash	0.23	19.52	4.22	0.03	45.43	4.34	0.05	3	3.20
26-May-10	10:15 AM	AWRC, W. Cash	0.17	18.70	4.63	0.04	44.13	5.10	0.07	2	3.20
09-Jun-10	10:15 AM	AWRC, W. Cash	0.01	20.81	4.22	0.05	45.78	4.22	0.06	2	2.50
16-Jun-10	10:10 AM	AWRC, W. Cash	0.01	20.90	3.79	0.05	42.46	3.86	0.11	2	2.10
24-Jun-10	6:50 AM	AWRC, W. Cash	0.01	24.12	4.35	0.08	45.82	4.41	0.11	9	1.10

2F. War Eagle Creek near Hindsville

Date	Time	Collector	NH_3-N	Cl	NO_3-N	SRP	SO_4	TN	TP	TSS	Turbidity
08-Jul-09	10:30 AM	AWRC, W. Cash	0.02	9.762	1.652	0.009	4.692	1.87	0.020	6	6.3
15-Jul-09	7:30 AM	AWRC, W. Cash	0.02	13.686	1.562	0.006	5.088	1.74	0.024	4	6.2
22-Jul-09	8:00 AM	AWRC, W. Cash	0.04	12.736	2.004	0.008	5.476	2.05	0.032	7	5.8
29-Jul-09	8:00 AM	AWRC, W. Cash	0.11	11.779	1.643	0.006	5.701	1.86	0.042	7	8.7
05-Aug-09	8:45 AM	AWRC, W. Cash	0.05	12.905	1.410	0.005	5.541	1.64	0.032	6	5.5
12-Aug-09	11:00 AM	AWRC, W. Cash	0.04	13.557	1.470	0.003	5.977	1.58	0.030	6	7.7
19-Aug-09	9:45 AM	AWRC, W. Cash	0.02	19.044	1.330	0.002	8.122	1.47	0.040	6	8.6
26-Aug-09	8:30 AM	AWRC, W. Cash	0.01	15.920	1.157	0.001	6.114	1.39	0.034	6	6.8
02-Sep-09	9:00 AM	AWRC, W. Cash	0.04	19.270	1.206	0.002	6.655	0.91	0.034	5	7.4
09-Sep-09	7:30 AM	AWRC, W. Cash	0.01	35.427	1.220	0.005	10.250	1.46	0.024	8	10.7
16-Sep-09	7:30 AM	AWRC, W. Cash	0.16	11.991	1.133	0.035	5.986	1.27	0.032	6	5.4
17-Sep-09	8:15 AM	AWRC, W. Cash	0.04	16.319	1.102	0.083	9.199	1.31	0.164	34	33.6
22-Sep-09	1:30 PM	AWRC, W. Cash	0.31	1.932	0.494	0.030	3.298	0.96	0.460	189	306
29-Sep-09	9:00 AM	AWRC, W. Cash	0.02	6.272	1.455	0.014	6.828	1.58	0.034	4	5.9
07-Oct-09	8:00 AM	AWRC, W. Cash	0.02	8.307	1.404	0.011	6.767	1.60	0.024	5	5.0
09-Oct-09	11:30 AM	AWRC, W. Cash	0.18	2.135	1.108	0.093	3.635	1.37	0.858	346	540
14-Oct-09	8:30 AM	AWRC, W. Cash	0.14	3.220	1.043	0.033	4.897	1.34	0.126	42	58
21-Oct-09	8:00 AM	AWRC, W. Cash	0.01	6.394	1.738	0.018	6.366	1.84	0.030	5	8.7
28-Oct-09	8:45 AM	AWRC, W. Cash	0.01	4.918	0.880	0.025	7.022	1.00	0.038	10	12
30-Oct-09	9:00 AM	AWRC, W. Cash	0.05	3.078	0.796	0.030	5.021	1.18	0.405	232	184
04-Nov-09	9:00 AM	AWRC, W. Cash	0.03	4.429	1.442	0.016	5.644	1.53	0.026	5	10
11-Nov-09	9:00 AM	AWRC, W. Cash	0.01	5.738	1.477	0.010	6.166	1.51	0.026	3	4.5
18-Nov-09	8:45 AM	AWRC, W. Cash	0.01	4.574	0.864	0.011	6.249	1.01	0.034	4	9.8
24-Nov-09	8:45 AM	AWRC, W. Cash	0.01	5.093	1.041	0.013	6.131	1.15	0.022	2	4.4
02-Dec-09	8:00 AM	AWRC, W. Cash	0.01	5.280	0.992	0.006	6.237	1.09	0.020	2	3.4
09-Dec-09	9:00 AM	AWRC, W. Cash	0.01	6.494	1.196	0.007	6.417	1.29	0.010	2	2.6
16-Dec-09	7:30 AM	AWRC, W. Cash	0.01	7.033	1.098	0.009	7.052	1.19	0.006	2	3.8
22-Dec-09	8:15 AM	AWRC, W. Cash	0.01	7.509	1.214	0.002	7.207	1.30	0.014	1	3.2
31-Dec-09	8:15 AM	AWRC, W. Cash	0.01	4.156	0.944	0.010	6.268	1.03	0.024	3	9.4
06-Jan-10	8:15 AM	AWRC, W. Cash	0.01	5.103	1.032	0.010	6.948	1.05	0.014	2	6.6
13-Jan-10	8:45 AM	AWRC, W. Cash	0.01	6.255	1.231	0.009	6.988	1.29	0.020	2	3.9
20-Jan-10	8:30 AM	AWRC, W. Cash	0.03	8.120	1.082	0.003	8.069	1.21	0.020	3	4.8
27-Jan-10	8:30 AM	AWRC, W. Cash	0.03	4.916	1.276	0.008	6.382	1.35	0.016	5	14
04-Feb-10	8:15 AM	AWRC, W. Cash	0.05	6.009	1.213	0.012	7.623	1.36	0.044	7	12
11-Feb-10	8:00 AM	AWRC, W. Cash	0.02	4.767	1.490	0.010	6.066	1.56	0.022	4	9.5
17-Feb-10	8:15 AM	AWRC, W. Cash	0.01	5.400	1.424	0.016	6.483	1.37	0.026	3	9.0
24-Feb-10	1:15 PM	AWRC, W. Cash	0.01	4.716	1.218	0.011	6.109	1.25	0.028	4	13
03-Mar-10	8:30 AM	AWRC, W. Cash	0.01	5.998	1.422	0.011	6.594	1.46	0.008	3	5.6
10-Mar-10	8:15 AM	AWRC, W. Cash	0.01	5.907	1.365	0.009	6.955	1.44	0.008	5	5.8
17-Mar-10	8:30 AM	AWRC, W. Cash	0.03	5.818	1.174	0.006	7.130	1.36	0.026	4	4.9
23-Mar-10	11:03 AM	AWRC, W. Cash	0.15	3.390	1.031	0.024	5.073	1.33	0.156	88	97
31-Mar-10	8:30 AM	AWRC, W. Cash	0.01	4.632	1.270	0.006	5.665	1.38	0.034	10	14
07-Apr-10	8:45 AM	AWRC, W. Cash	0.02	4.699	2.634	0.015	5.510	1.04	0.040	10	14
14-Apr-10	8:30 AM	AWRC, W. Cash	0.01	5.463	1.035	0.001	5.725	1.18	0.020	6	7.5
21-Apr-10	8:00 AM	AWRC, W. Cash	0.01	6.558	1.238	0.008	5.932	1.41	0.018	4	4.1
28-Apr-10	8:30 AM	AWRC, W. Cash	0.06	5.512	1.254	0.003	6.752	1.44	0.014	4	5.1
05-May-10	8:30 AM	AWRC, W. Cash	0.06	5.888	1.127	0.005	7.153	1.32	0.028	6	5.7
12-May-10	8:15 AM	AWRC, W. Cash	0.08	5.924	1.293	0.012	7.290	1.57	0.056	13	17
14-May-10	9:15 AM	AWRC, W. Cash	0.14	6.530	1.211	0.037	8.301	1.49	0.140	41	51
14-May-10	8:15 PM	AWRC, W. Cash	0.07	3.970	1.311	0.042	6.362	1.66	0.252	118	111
15-May-10	1:30 PM	AWRC, W. Cash	0.09	3.401	0.964	0.031	5.520	1.32	0.228	100	113
17-May-10	8:30 AM	AWRC, W. Cash	0.08	2.909	0.995	0.014	4.902	1.17	0.076	27	36
26-May-10	8:00 AM	AWRC, W. Cash	0.01	4.390	1.120	0.018	5.797	1.23	0.080	37	33
09-Jun-10	8:30 AM	AWRC, W. Cash	0.05	9.028	1.626	0.015	5.634	1.71	0.034	6	5.4
16-Jun-10	8:15 AM	AWRC, W. Cash	0.04	12.065	1.607	0.014	6.153	1.66	0.046	6	5.7
24-Jun-10	8:45 AM	AWRC, W. Cash	0.07	11.946	1.591	0.009	5.614	1.73	0.070	1	5.3

2G. West Fork White River East of Fayetteville

Date	Time	Collector	NH_3-N	Cl	NO_3-N	SRP	SO_4	TN	TP	TSS	Turbidity
08-Jul-09	12:15 AM	AWRC, W. Cash	0.02	4.968	0.369	0.001	31.234	0.55	0.042	11	17
15-Jul-09	9:00 AM	AWRC, W. Cash	0.07	5.255	0.134	0.004	24.359	0.37	0.034	9	12
22-Jul-09	9:45 AM	AWRC, W. Cash	0.12	6.298	0.719	0.014	34.660	0.92	0.126	38	60
29-Jul-09	9:30 AM	AWRC, W. Cash	0.06	5.366	0.289	0.002	33.567	0.51	0.038	10	13
30-Jul-09	7:15 PM	AWRC, W. Cash	0.30	6.530	0.470	0.011	31.920	0.72	0.228	114	124
05-Aug-09	7:15 AM	AWRC, W. Cash	0.05	6.487	0.727	0.006	38.959	0.97	0.040	13	14
12-Aug-09	8:00 AM	AWRC, W. Cash	0.22	4.986	0.583	0.012	38.628	0.91	0.106	34	57
19-Aug-09	8:30 AM	AWRC, W. Cash	0.08	5.448	0.219	0.003	31.440	0.54	0.064	19	24
20-Aug-09	3:20 PM	AWRC, W. Cash	0.26	3.793	0.493	0.026	25.236	0.87	0.406	200	234
26-Aug-09	10:00 AM	AWRC, W. Cash	0.06	3.991	0.439	0.006	27.510	0.64	0.072	23	31
02-Sep-09	10:30 AM	AWRC, W. Cash	0.05	4.024	0.175	0.008	40.382	0.34	0.068	20	25
05-Sep-09	1:00 PM	AWRC, W. Cash	0.12	4.166	0.325	0.010	33.822	0.60	0.038	108	122
09-Sep-09	9:15 AM	AWRC, W. Cash	0.07	3.967	0.397	0.017	23.833	0.64	0.082	29	43
09-Sep-09	10:00 AM	AWRC, W. Cash	0.03	4.324	0.443	0.030	33.648	0.69	0.142	54	65
16-Sep-09	9:15 AM	AWRC, W. Cash	0.04	4.328	0.386	0.015	31.985	0.52	0.070	30	30
22-Sep-09	12:30 PM	AWRC, W. Cash	0.21	2.251	0.637	0.039	10.243	1.18	0.328	116	162
29-Sep-09	10:30 AM	AWRC, W. Cash	0.02	3.834	0.589	0.006	34.285	1.08	0.038	7	9.3
07-Oct-09	9:30 AM	AWRC, W. Cash	0.06	4.285	0.415	0.025	34.995	0.69	0.103	23	36
09-Oct-09	2:20 PM	AWRC, W. Cash	0.16	1.240	0.389	0.042	5.431	0.63	0.396	149	244
14-Oct-09	10:00 AM	AWRC, W. Cash	0.12	2.339	0.468	0.015	13.803	0.74	0.094	24	45
21-Oct-09	9:30 AM	AWRC, W. Cash	0.04	3.387	0.553	0.008	26.214	0.64	0.014	10	8.2
28-Oct-09	10:15 AM	AWRC, W. Cash	0.01	3.050	0.277	0.014	14.859	0.44	0.042	10	23
04-Nov-09	10:15 AM	AWRC, W. Cash	0.01	3.011	0.475	0.007	18.650	0.50	0.014	4	11
11-Nov-09	10:15 AM	AWRC, W. Cash	0.01	3.445	0.259	0.001	22.178	0.27	0.016	3	5.0
18-Nov-09	10:00 AM	AWRC, W. Cash	0.03	3.343	0.305	0.005	16.596	0.42	0.032	3	13
24-Nov-09	10:00 AM	AWRC, W. Cash	0.01	3.398	0.192	0.006	20.278	0.28	0.014	2	6.0
02-Dec-09	9:25 AM	AWRC, W. Cash	0.01	3.646	0.152	0.001	22.107	0.21	0.018	2	3.2
09-Dec-09	10:30 AM	AWRC, W. Cash	0.01	12.050	0.855	0.002	36.675	0.51	0.010	3	5.7
16-Dec-09	9:00 AM	AWRC, W. Cash	0.01	4.304	0.203	0.003	25.068	0.26	0.002	2	5.6
22-Dec-09	9:30 AM	AWRC, W. Cash	0.01	4.319	0.155	0.001	25.483	0.24	0.010	4	4.7
31-Dec-09	9:45 AM	AWRC, W. Cash	0.01	7.411	0.461	0.005	22.510	0.52	0.016	2	8.4
06-Jan-10	9:45 AM	AWRC, W. Cash	0.01	6.544	0.425	0.005	20.179	0.46	0.010	2	8.4
13-Jan-10	10:15 AM	AWRC, W. Cash	0.01	6.911	0.467	0.001	23.352	0.53	0.010	3	4.6
20-Jan-10	9:45 AM	AWRC, W. Cash	0.01	7.951	0.288	0.001	25.043	0.38	0.014	2	4.3
27-Jan-10	10:00 AM	AWRC, W. Cash	0.03	5.686	0.625	0.001	18.070	0.69	0.001	3	11
04-Feb-10	9:45 AM	AWRC, W. Cash	0.05	13.379	0.478	0.001	23.737	0.62	0.038	8	16
11-Feb-10	9:30 AM	AWRC, W. Cash	0.02	10.011	0.620	0.005	20.507	0.61	0.014	2	9.8
17-Feb-10	9:30 AM	AWRC, W. Cash	0.01	6.721	0.525	0.003	22.602	0.50	0.014	2	6.7
24-Feb-10	2:45 PM	AWRC, W. Cash	0.01	6.825	0.507	0.001	19.259	0.51	0.016	3	10
03-Mar-10	9:45 AM	AWRC, W. Cash	0.01	6.012	0.406	0.003	21.635	0.46	0.003	3	5.9
10-Mar-10	9:30 AM	AWRC, W. Cash	0.02	6.617	0.347	0.006	25.553	0.48	0.010	6	8.2
17-Mar-10	10:00 AM	AWRC, W. Cash	0.05	6.428	0.388	0.001	24.953	0.51	0.024	7	8.7
23-Mar-10	12:24 PM	AWRC, W. Cash	0.20	6.498	0.559	0.010	13.348	0.79	0.106	37	59
31-Mar-10	10:00 AM	AWRC, W. Cash	0.06	4.933	0.555	0.001	18.547	0.62	0.028	12	15
07-Apr-10	10:15 AM	AWRC, W. Cash	0.04	4.547	0.421	0.003	17.031	0.40	0.042	15	19
14-Apr-10	9:45 AM	AWRC, W. Cash	0.01	4.882	0.261	0.001	20.578	0.38	0.026	11	13
21-Apr-10	9:30 AM	AWRC, W. Cash	0.02	5.218	0.268	0.001	24.662	0.20	0.018	7	8.3
28-Apr-10	9:45 AM	AWRC, W. Cash	0.07	4.257	0.316	0.005	15.860	0.45	0.032	11	13
05-May-10	9:45 AM	AWRC, W. Cash	0.05	3.801	0.272	0.003	13.361	0.39	0.046	17	23
12-May-10	9:45 AM	AWRC, W. Cash	0.76	3.735	0.340	0.001	12.037	0.61	0.258	88	203
13-May-10	10:30 PM	AWRC, W. Cash	0.36	3.719	0.263	0.013	15.912	0.71	0.374	207	222
14-May-10	3:45 PM	AWRC, W. Cash	0.09	2.835	0.292	0.025	10.231	0.91	0.605	372	370
15-May-10	12:00 PM	AWRC, W. Cash	0.02	2.612	0.268	0.015	8.672	0.73	0.200	96	121
15-May-10	6:30 PM	AWRC, W. Cash	0.09	2.118	0.251	0.029	5.603	0.89	1.075	679	636
17-May-10	9:45 AM	AWRC, W. Cash	0.04	2.511	0.365	0.016	9.837	0.58	0.112	40	61
26-May-10	9:30 AM	AWRC, W. Cash	0.08	3.867	0.337	0.014	18.793	0.65	0.114	33	52
09-Jun-10	9:45 AM	AWRC, W. Cash	0.11	4.352	0.219	0.008	26.244	0.38	0.046	13	14
16-Jun-10	9:30 AM	AWRC, W. Cash	0.04	4.965	0.455	0.010	19.615	0.54	0.096	18	23
24-Jun-10	7:00 AM	AWRC, W. Cash	0.03	4.679	0.064	0.006	23.066	0.24	0.044	4	7.4

Appendix 3. Summary of estimated semi-annual loads and flow-weighted concentrations for each constituent at sites in the Upper White River Basin from 1 January through 30 June 2010; the data are provisional as the US Geological Survey has not finalized its discharge record for this period.

3A. Summary of calculated total loads (kg) for each parameter at the sampled sites in the Upper White River Basin for the period, January through June 2010.

Site	Cl^-	SO_4	NH_3-N	NO_3-N	SRP	TN	TP	TSS
Brush Creek	83,000	166,000	530	25,000	392	29,000	1,900	1,081,000
Richland Creek[A]	--	--	--	--	--	--	--	--
Town Branch	21,000	29,000	160	770	50	1,100	160	78,000
Town Branch Tributary	68,000	99,000	920	9,000	70	10,000	280	109,000
War Eagle Creek	897,000	1,067,000	11,000	208,000	4,000	237,000	17,000	7,816,000
West Fork White River	500,000	1,736,000	8,300	44,000	790	66,000	12,000	5,429,000
White River	957,000	3,296,000	29,000	138,000	3,000	195,000	37,000	12,910,000

3B. Summary of calculated flow weighted concentrations (FWC, mg L^{-1}) for each parameter at the sampled sites in the Upper White River Basin for the period, January through June 2010.

Site	Cl^-	SO_4	NH_3-N	NO_3-N	SRP	TN	TP	TSS
Brush Creek	7.68	15.43	0.05	2.35	0.04	2.67	0.18	100
Richland Creek[A]	--	--	--	--	--	--	--	--
Town Branch	24.50	33.27	0.19	0.90	0.06	1.31	0.18	91
Town Branch Tributary	21.96	31.94	0.30	2.92	0.02	3.31	0.09	35
War Eagle Creek	4.98	5.93	0.06	1.16	0.02	1.32	0.09	43
West Fork White River	4.85	16.81	0.08	0.43	0.01	0.64	0.12	523
White River	2.92	10.04	0.09	0.42	0.01	0.59	0.11	39

[A] Adequate flow data to estimate loads is not yet available from the USGS. Loads will be estimated and this report amended as soon as the necessary data is made available.

Appendix 4. Summary of estimated monthly loads (kg) for each constituent in the Upper White River Basin; the data are provisional as the US Geological Survey has not finalized its discharge record for this period.

4A. Summary of estimated monthly loads (kg) for each constituent at the White River near Fayetteville, Arkansas from 1 January 2010 to 30 June 2010.

Month	Cl	SO_4	NH_3-N	NO_3-N	SRP	TN	TP	TSS
January	135,000	480,000	1,040	17,427	125	125	125	125
February	192,000	666,000	1,890	26,659	210	210	210	210
March	199,000	680,000	3,800	29,238	374	374	374	374
April	110,000	395,000	2,300	13,846	175	175	175	175
May	291,000	955,000	19,100	47,344	2,055	2,055	2,055	2,055
June	30,700	121,000	1,180	3,041	76	76	76	76

4B. Summary of estimated monthly loads (kg) for each constituent at Brush Creek at Fayetteville, Arkansas from 1 January 2010 to 30 June 2010.

Month	Cl	SO_4	NH_3-N	NO_3-N	SRP	TN	TP	TSS
January	8,610	16,000	19	3,150	20	3,150	37	2,710
February	19,900	40,100	63	7,400	64	7,930	160	25,400
March	20,500	42,200	110	6,750	100	7,720	370	91,400
April	12,800	24,400	74	3,510	30	4,070	59	8,180
May	20,100	42,200	270	4,340	170	5,710	1,270	952,690
June	590	830	3	93	1	100	2	250

4C. Summary of estimated monthly loads (kg) for each constituent at Town Branch at Fayetteville, Arkansas from 1 January 2010 to 30 June 2010.

Month	Cl	SO_4	NH_3-N	NO_3-N	SRP	TN	TP	TSS
January	2,930	4,030	16	97	5	140	8	5,990
February	4,500	5,210	17	130	6	170	8	4,620
March	5,190	5,590	24	140	8	200	15	8,990
April	2,780	3,620	19	90	6	130	15	8,790
May	4,860	7,590	78	260	26	410	96	46,400
June	820	2,590	9	55	3	75	14	3,090

4D. Summary of estimated monthly loads (kg) for each constituent at Town Branch Tributary at Fayetteville, Arkansas from 1 January 2010 to 30 June 2010.

Month	Cl	SO_4	NH_3-N	NO_3-N	SRP	TN	TP	TSS
January	29,300	33,100	320	3,020	15	3,430	37	8,770
February	10,400	11,200	77	1,030	5	1,140	11	2,570
March	15,800	22,900	230	2,090	15	2,380	52	19,800
April	5,340	9,610	81	880	8	990	30	11,800
May	6,690	19,600	200	1,790	27	2,040	130	58,800
June	760	2,960	19	270	5	300	21	7,440

4E. Summary of estimated monthly loads (kg) for each constituent at War Eagle Creek near Hindsville, Arkansas from 1 January 2010 to 30 June 2010.

Month	Cl	SO_4	NH_3-N	NO_3-N	SRP	TN	TP	TSS
January	133,000	133,000	350	26,500	220	29,400	440	81,400
February	216,000	273,000	1,160	53,000	730	60,700	1,650	413,000
March	183,000	232,000	1,830	45,000	840	51,700	2,660	944,000
April	129,000	132,000	920	26,200	300	29,200	1,060	304,000
May	201,000	277,000	6,290	53,000	1,900	61,700	11,100	6,050,000
June	34,900	21,000	150	4,440	24	4,630	130	27,900

4F. Summary of estimated monthly loads (kg) for each constituent at West Fork White River, Arkansas from 1 January 2010 to 30 June 2010.

Month	Cl	SO_4	NH_3-N	NO_3-N	SRP	TN	TP	TSS
January	72,100	237,000	250	5,180	37	7,600	190	60,400
February	96,500	300,000	410	7,060	50	10,400	320	106,000
March	117,000	367,300	1,240	10,200	120	15,200	1,340	536,000
April	85,000	297,000	1,030	6,860	78	10,100	1,030	393,000
May	118,000	469,000	5,070	14,200	480	21,400	8,990	4,220,000
June	12,200	65,700	300	920	20	1,310	320	118,000