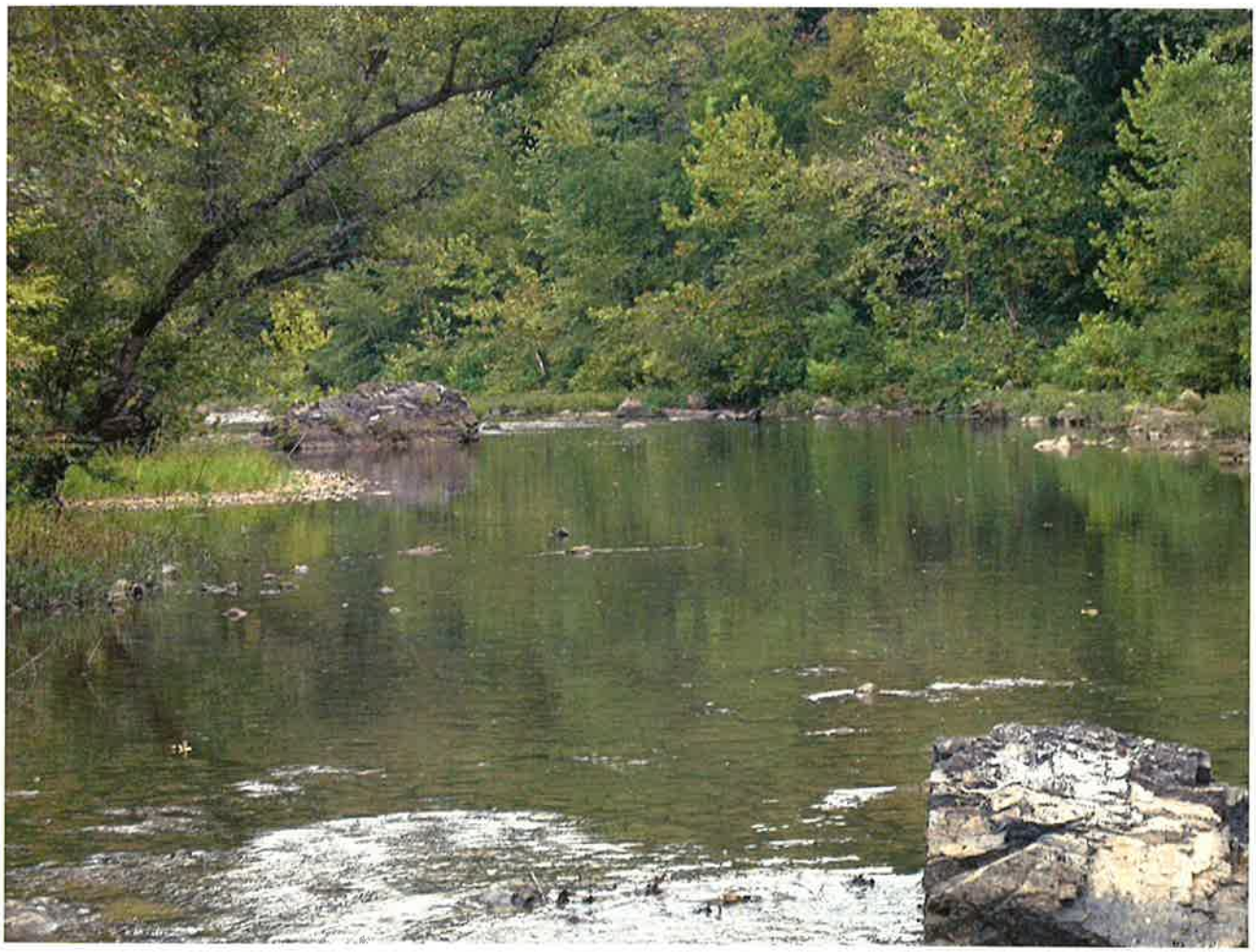
PHYSICAL, CHEMICAL AND BIOLOGICAL

ASSESSMENT OF THE

STRAWBERRY RIVER WATERSHED

Fulton, Izard, Sharp, and Lawrence Counties, Arkansas



ARKANSAS DEPARTMENT OF ENVIRONMENTAL QUALITY
Water Division

December 2003
WQ-03-12-01

WATER DIVISION, PLANNING SECTION

Mr. Martin Maner, P.E. is currently the Chief, and Mr. Steve Drown is the Assistant Chief of the Water Division, Both are involved with many of the activities of the Water Quality Planning Branch. The Water Quality Planning Branch consists of seven biologists/ecologists and two geologists. This branch deals with a variety of issues related to surface and ground water. Among the numerous activities is the management of the State Ambient Water Quality Monitoring Network for both surface and subsurface waters. Included in the network is routine monitoring as well as intensive, special investigations of watersheds and/or aquifers. The data generated from these activities are used to prepare the biennial "Water Quality Inventory Report (305B)" and the "List of Impaired Waterbodies, (303(d) list)", and to develop Total Maximum Daily Loads (TMDLs) for impaired water bodies. The data are also used to develop water quality standards and criteria for designated use assessment.

The staff continues to develop and/or enhance ecoregion-based, biological assessment criteria for both fish and macroinvertebrates. The staff additionally is active in the development and updating of water quality standards and technical review and administration of the National Pollutant Discharge Elimination System Permits Biomonitoring Program. Ground-water issues of concern in recent years have included the investigation of pesticides in ground water, potential impacts from confined animal operations, and saltwater intrusion in southeastern Arkansas. Various staff members represent the Department on numerous Federal, State, local, and watershed-based advisory boards and technical support groups.

Current staff includes:

Martin Maner, P.E., Chief, Water Division
Steve Drown, Assistant Chief, Water Division
Bill Keith, Technical Support Manager
Bob Singleton, Program Support Manager
Jim Wise, Program Section Manager
Kevin Dorman, Water Quality Specialist
Chris Davidson, Water Quality Specialist
Sarah Clem, Ecologist
Erica Shelby, Ecologist
Tim Kresse, Professional Geologist
John Fazio, Senior Geologist

To learn more about the Water Division and other divisions of the Arkansas Department of Environmental Quality, and to view a list of publications by the Planning Branch of the Water Division, visit www.adeq.state.ar.us, or call at (501) 682-0660.

Table of Contents

PHYSICAL, CHEMICAL AND BIOLOGICAL ASSESSMENT OF THE STRAWBERRY RIVER WATERSHED

Table of Contents (cont.)

Table of Contents (cont.)

List of Tables

List of Figures

List of Figures (cont.)

List of Figures (cont.)

List of Appendices

INTRODUCTION

The Strawberry River originates south of Salem in Fulton County, Arkansas. It flows through four counties and enters the Black River southeast of the City of Strawberry in Lawrence County. Most of the watershed is in the Ozark Highlands ecoregion with a transition to the Delta ecoregion occurring in the lower portion of the watershed mainly in southeast Lawrence County.

There are approximately 500,000 acres in the Strawberry River watershed. Land use activities in the watershed have been estimated to be 65% - 75% silviculture, 20%-30% agriculture, and less than 2% urban. Silviculture activities are limited to small, privately-owned parcels of land; much of which is being converted to pasture. Agriculture activities include confined animal operations, dairies, cattle production, and row-crop. The majority of the dairies are located between Salem and Horseshoe Bend in the headwaters of the watershed. Most of the poultry houses are located south and east of Horseshoe Bend in the lower section of the watershed. Pasture for cattle grazing and hay production is scattered throughout the watershed. The row-crop agriculture is confined to the lower watershed, mainly in Lawrence County. Recreation - mainly hunting, fishing and canoeing - occurs throughout the watershed. In addition, there are several state and federally listed "endangered species" and/or "species of concern" occurring in the Strawberry River, including the Strawberry River Darter, the Pink Mucket, Snuffbox, Curtis's Pearly Mussel, Slippershell, Scaleshell, Western Fanshell and the Rabbits Foot mussel (Harris, 1997). The river also host one of the most diverse fish faunas in the state with over 100 species of fish being recorded from the river (Robinson & Buchanan, 1992).

Arkansas' 2000 Water Quality Inventory Report (305(b)) identified 211.6 stream miles in the watershed, of which 113 were assessed using monitoring data. This report identified four stream segments, 40.4 stream miles, as only partially supporting the aquatic life use due to excessive silt caused by agriculture activities. One of those segments, 20.4 stream miles, was not supporting the primary contact recreation use due to excessive bacteria caused by agriculture activities.

The designated uses for the Strawberry River include: 1) Extraordinary Resource Waters; 2) Natural and Scenic Waterway; 3) Ecologically Sensitive Waterway; 3) Primary Contact Recreation; 4) Secondary Contact Recreation; 5) Domestic, Industrial and Agricultural Water Supply; and 6) Seasonal and Perennial Ozark Highlands Ecoregion Fisheries and Delta Ecoregion Fisheries.

The Strawberry River is an important water body resource to the state from both a water quality and aesthetic recreational aspect. The watershed is listed as a top priority for restoration and protection by the Arkansas Soil and Water Conservation Commission and the USDA Natural Resources Conservation Service. It is listed as a Priority One watershed by the Unified Watershed Assessment Task Force, and is a top priority for TMDL development. Addressing the nonpoint source pollution issues and developing physical, chemical and biological data is an ongoing activity of ADEQ.

GOALS AND OBJECTIVES

The main objective of this survey was to assess the waters of the Strawberry River watershed (USGS HUC 11010012) by identifying areas of water quality impairment, the causes and sources of the impairments, and to delineate impairments by subbasin in order to better facilitate corrective actions.

The goals of this survey were:

1) Develop environmental indicators and set attainment goals to assess the effectiveness of best management practices
2) Identify the environmental measurements needed to determine and establish the mechanisms of impairment remediation

ASSESSMENT SURVEY WORK PLAN

This three year assessment of the Strawberry River utilized five major activities: 1) a watershed land use survey; 2) a synoptic water quality, macroinvertebrate and fish community survey; 3) a ground water quality assessment; 4) a stream bank, riparian zone habitat survey; and 5) an intensive water quality, macroinvertebrate and fish community survey of North Big Creek.

The sample stations are listed in Table 1. The stations were located at the base of the major subbasins, along the main stem of the river, and at other strategic points to determine background conditions and loadings from nonpoint pollution sources, see Figure WQ-1 on page 30. Macroinvertebrate (Figure M-1 on page 80) and fish (Figure F-1 on page 88) communities were sampled at selected stations to obtain a representative data base throughout the watershed. Storm flow grab samples were collected from all of the sites to determine nonpoint source inputs. Water quality parameter analyses, Table 2, included the routine water quality indicators, pesticides from those sites located within the row-crop agriculture area of the watershed, metals, and fecal coliform bacteria. In addition, USGS flow gauging stations were established at several sites in order to determine storm water pollutant loads.

Ground-water samples were collected from irrigation and domestic wells and springs in the areas of the watershed that lacked sufficient data to determine current ground-water conditions. Water quality parameters analyzed included the routine ground-water quality indicators, pesticides, and metals. Well logs were obtained whenever possible to determine well characteristics.

Table 1: STRAWBERRY RIVER MONITORING STATIONS								
SITE ID	WATER BODY (stream segment)	County	WS	Samples				Latitude Longitude
	LOCATION (Sec., Twnshp, Rnge)			W	M	F	O	
WHI0143A	Strawberry River (011)	Fulton	39	X	X		X	36 16 23.68N 91 54 24.59W
	at Ar. Hwy. 9 bridge, 4.0 m. N. of Oxford (Sec 26, T19N, R9W)							
UWSBR01	Strawberry River (011)	Fulton	85	X	X	X	X	36 14 00.24N 91 48 59.66W
	south of Ar. Hwy. 354 W. of Horseshoe Bend (Sec 11, T18N, R8W)							
WHI0143E	Little Strawberry River (010)	Fulton	27	X	X		X	36 15 55.11N 91 46 56.76W
	at Co. Rd. bridge W. of Ar. Hwy 289 at Morriston (Sec 36, T19N, R8W)							
WHI143H	Little Strawberry River (010)	Izard	40	X	X	X	X	36 14 01.90N 91 47 23.51W
	at Ar. Hwy 354 bridge, 1.5 mi. E. of Wiseman (Sec 12, T18N, R8W)							
WHI143B	Strawberry River (009)	Izard	155	X	X	1	X	36 10 41.89N 91 44 21.94W
	Ar. Hwy 56 bridge 1.8 mi. E. of Ar. Hwy. 289 (Sec 33, T18N, R7W)							
UWSBR02	Strawberry River (009)	Sharp	217	X	X	2	X	36 05 55.42N 91 36 31.33W
	at US Hwy. 167 2.5 mi. N. of Ar. Hwy. 56 (Sec. 27, T17N, R6W)							
WHI0143L	Piney Fork Creek (012)	Izard	39	X	X	X	X	36 04 24.71N 91 44 05.33W
	at Co. Rd. west of Zion (Sec. 3, T16N, R7W)							
WHI0143M	Piney Fork Creek (012)	Sharp	99	X	X	X	X	36 04 49.52N 91 36 39.03W
	at US Hwy. 167 1.5 mi. N. of Ar. Hwy. 56 (Sec. 34, T17N, R6W)							
WHI0143I*	North Big Creek (007)	Sharp	20	X	X	X	X	36 13 21.30N 91 34 50.01W
	at Ar. Hwy 354, 1.4 mi. E. of US Hwy. 167 (Sec 12, T18N, R6W)							
UWNBC01	North Big Creek (007)	Sharp	75	X	X	X	X	36 08 17.34N 91 30 11.85W
	Co. Rd. off Ar. Hwy. 354 SE of Center (Sec 10, T17N, R5W)							
WHI0143P	Strawberry River (006)	Sharp	473	X	X		X	36 06 37.22N 91 26 58.59W
	Ar. Hwy 58, 3 mi. N. of Ar. Hwy. 58 (Sec 19 T17N R4W)							
WHI0143N	Mill Creek (016)	Sharp	23	X	X	X	X	36 07 12.65N 91 24 13.02W
	Strawberry River Rd. S. of Sitka (Sec 16, T17N, R4W)							
WHI024	Strawberry River (006)	Lawrence	539	X	X	3	X	36 01 39.67N 91 19 31.03W
	at Ar. Hwy. 115 N. of Strawberry (Sec 17, T16N, R3W)							

Table 1: STRAWBERRY RIVER MONITORING STATIONS (cont.)								
SITE ID	WATER BODY (RF1 str seg)	County	WS	Samples				Latitude Longitude
	LOCATION (Sec., Twnshp, Rnge)			W	M	F	O	
WHI0143K	South Big Creek (013)	Sharp	27	X	X	X	X	36 00 49.42N 91 29 28.62W
	Ar. Hwy. 58, 1.0 mi. N. of Ar. Hwy. 115 (Sec 23, T16N, R5W)							
WHI0143J	South Big Creek (013)	Lawrence	69	X	X	X	X	36 01 12.12N 91 20 09.88W
	Ar. Hwy. 117, 0.2 mi. S. of Ar. Hwy. 115, (Sec. 20, T16N, R3W)							
WHI0143S	Cooper Creek (003)	Lawrence	46	X	X	X	X	36 02 01.08N 91 18 26.08W
	Co. Rd. bridge, 0.8 mi. E. of Ar. Hwy. 115, (Sec 16, T16N, R3W)							
UWRDC01	Reed's Creek (014)	Lawrence	35	X	X	X	X	35 58 57.28N 91 20 12.68W
	Ar. Hwy 117, 2.8 mi. S. of Ar. Hwy. 115 (Sec 32, T16N, R3W)							
UWSBR03	Strawberry River (002)	Lawrence	755	X			X	35 55 06.11N 91 12 51.70W
	Ar. Hwy. 361 2.2 mi. E. of Ar. Hwy. 25 (Sec 30, T15N, R2W)							
WHI0143Q	Caney Creek (015)	Lawrence	16	X	X	X	X	35 54 24.12N 91 17 25.76W
	Ar. Hwy. 25 1.0 mi. S. of Saffell, (Sec 27, T15N, R3W)							
WHI0143R	Caney Creek (015)	Lawrence	20	X	X	X	X	35 54 45.46N 91 15 02.18W
	Co. Rd. 346, 1.0 mi. S. of Ar. Hwy. 361, (Sec 25, T15N, R3W)							

1- Fish sample collected at Dry Bone Road west of Evening Shade (Sec 18, T17N, R6W).
2- Fish sample collected at Baker's Ford east of Evening Shade (Sec 32, T17N, R5W).
3- Fish sample collected at Ar. Hwy 25 northeast of Strawberry (Sec 35, T16N, R3W).
* North Big Creek was sampled at four locations as part of the intensive survey below the Ash Flat WWTP.

W - Water Sample Site
M - Macroinvertebrate Sample Site
F - Fish Community Sample Site
O - Diurnal Dissolved Oxygen Sample Site
Co. Rd. - County Road
RF1 - River Reach One
str seg - stream segment
WS - Watershed (mi^2)
Sec. - Section Number
Tnsp. - Township
Rng. - Range

Table 2 - Water Quality Parameters

In-Situ & Lab Analyses	Metals, Dissolved	Pesticides		
pH	Aluminum	Alachlor	Endosulfan-Sulfate	
Dissolved Oxygen	Barium	Aldrin	Endrin	Simazine
Temperature	Beryllium	Ametryn	Fluchloralin	Technical
Flow	Boron	Atraton	Fonofos	Chlordane
Ammonia Nitrogen	Cadmium	Atrazine	Hexazinone	Terbuthlazine
Nitrate-Nitrite Nitrogen	Calcium	BHC-*	Malathion	Terbutryn
Total Phosphorus	Chromium	Chlorpyrifos	Methoxychlor	Trifluralin
Ortho-Phosphorus	Cobalt	Cyanazine	Methyl-parathion	
Chlorides	Copper	Cyprazine	Metolachlor	
Sulfates	Iron	p-p-DDD	Metribuzin	
Total Dissolved Solids	Lead	p-p-DDE	Molinate	
Total Suspended Solids	Manganese	p-p-DDT	PCB	
Total Hardness	Nickel	Diazinon	Pendimethalin	
Turbidity	Potassium	Dieldrin	Prometon	
Total Organic Carbon	Sodium	Dipropetryn	Prometryn	
Biochemical Oxygen Demand	Vanadium	Endosulfan-I	Propachlor	
Fecal Coliform	Zinc	Endosulfan-II	Propazine	

WATER QUALITY STANDARDS

Table 3 outlines the water quality standards that are applicable to the Strawberry River. Because the river traverses from the Ozark Highlands ecoregion into the Delta ecoregion, different sets of standards and assessment criteria must be applied. In addition, two sets of standards are utilized in the Delta ecoregion depending on the degree of alteration of the natural channel.

Specific numeric standards for temperature, pH, in stream minimum dissolved oxygen concentration based on watershed size, minerals, and in stream turbidity dependent on flow are established. Specific numeric criteria for fecal coliform bacteria concentrations are also established. Narrative criteria exist for taste, odor, color and other aesthetics characteristics. A narrative criteria addressing nutrients based of excessive algae growth states that "Materials stimulating algal growth shall not be present in concentrations sufficient to cause objectionable algal densities or other nuisance aquatic vegetation" (ADEQ, 2002). In addition, algae growth in a waterbody can not be sufficient to cause other numeric criteria not to be attained, such as the dissolved oxygen minimum standard.

ASSESSMENT CRITERIA

In order to make a monitored assessment of "non-support" for a stream segment, the data must include at least twelve monthly samples or be supplemented with additional data such as aquatic life community data. However, an assessment of "support" can be made with less than twelve monthly samples, but not less than six bimonthly samples which are supplemented by other information, such as visual knowledge of the waterbody and its watershed (ADEQ Assessment Methodology, 2002).

Table 3 - Water Quality Standards*

Ozark Highlands Ecoregion

Dissolved Oxygen (mg/L)	Primary	Critical
< 10 sq. mi. watershed	6	2
10 - 500 sq. mi. watershed	6	5
> 500 sq. mi. watershed	6	6

Chlorides	20 mg/L
Sulfates	30 mg/L
Total Dissolved Solids	270 mg/L

Temperature (C) 29

Turbidity	
base flow	10 NTU
all flows	17 NTU

Delta Ecoregion

Dissolved Oxygen (mg/L)	Primary	Critical*
< 10 sq. mil. Watershed	5	2
10 - 100 sq. mi. watershed	5	3
> 100 sq. mi. watershed	5	5

Chlorides	30 mg/L
Sulfates	30 mg/L
Total Dissolved Solids	270 mg/L

Temperature (C) 30

Turbidity	Least Altered	Channel Altered
base flow	45 NTU	75 NTU
all flows	84 NTU	100 NTU

*Critical Season standards apply when water temperatures reach 22 (C), usually between May and September.

Bacteria Extraordinary Resource Waters - At no time shall the fecal coliform content exceed a geometric mean of 200/100 ml in any size watershed.

Primary Contact Waters - Between April 1 and September 30, the fecal coliform content shall not exceed a geometric mean of 200/100 ml nor shall more than 10 percent of the total samples during any 30-day period exceed 400/100 ml. During the remainder of the calendar year, these criteria may be exceeded, but at no time shall the fecal coliform content exceed the level necessary to support secondary contact recreation.

Secondary Contact Waters - The fecal coliform content shall not exceed a geometric mean of 1000/100 ml, nor equal or exceed 2000/100 ml in more than 10 percent of the samples taken in any 30-day period.

Dissolved Metals – Dissolved metals standards are based on ecoregion hardness values.

* State of Arkansas Pollution Control and Ecology Commission, Regulation No. 2, October 28, 1998

The percent exceedance criteria as listed in Table 4 are calculated using the total number of sampling visits, even if no sample is taken due to the absence of sufficient water. The number of data points exceeding the criteria which are necessary for a "non-support" decision will be calculated and rounded up to the nearest whole number, e.g. 25% of 38 points = 9.5, then 10 exceedances equal 25%. For determination of "non-support" of primary contact use, four or more samples are required during the primary contact season, April 1 to September 30.

An evaluated assessment can be made for adjacent stream segments or in similar watersheds to monitored waters if there is reason to believe that the segments are similar with respect to the potential cause and magnitude of impairment. Unless documentation suggest otherwise, an evaluated assessment of "support of a designated use" can be made in the absence of data, utilizing existing data from adjacent and similar watersheds, and by having a general knowledge of the waterbody and watershed conditions. However, an assessment of "nonsupport" cannot be made under these conditions.

Table 4 – Designated Use Assessment Criteria

Parameter	Support	Non-Support
Temperature	≤ 10%	> 10%
Dissolved Oxygen	≤ 10%	> 10%
pH	≤ 10%	> 10%
CL/SO_4/TDS	≤ 50%	> 10%
Fecal Coliform		
Pri. Contact	≤ 25%	> 10%
Sec. Contact	≤ 25%	> 10%
Turbidity		
Base flow	≤ 25%	> 25%
All flows	≤ 15%	> 15%

HISTORICAL WATER QUALITY DATA

WHI0024

Water quality data has been collected from the Strawberry River at Arkansas Highway 115 south of Smithville, Arkansas (WHI024) in Lawrence County for over 20 years. Data from this site from 1992 to 2001 (Table 5) indicate that turbidity levels exceeded the Ozark Highlands Ecoregion water quality standards of 10 NTU and/or 17 NTU, whichever is applicable, (Table 3) in 22% of the samples collected. Turbidity levels ranged from 0.51 NTU to 230 NTU with a mean value of 16.75 NTU. Total suspended solids (TSS) concentrations ranged from 0.50 mg/L to 334 mg/L with a mean concentration of 29.20 mg/L. However, trends for these two parameters over the ten year period indicate a reduction in the overall turbidity and TSS concentrations, Figure 2. The turbidity values are especially important because the trend in the monthly means over the past ten years has decreased from 28 NTU in 1992 to 6 NTU in 2001. This same trend is apparent in the TSS concentrations with values of 45 mg/L in 1992 but only 15 mg/L in 2001. In addition, this trend is

Table 5 – WHI0024: Historical Water Quality Data (1992-2001)

Parameter	Mean	No. of Samples	Maximum	Minimum	% Samples Exceeding Standard
Dissolved Oxygen mg/L	8.52	100	14.00	2.90	0.0
pH	8.00	111	8.35	6.65	0.0
Temperature (C)	17.67	115	32.00	2.00	5.2
NO_2+NO_3-N mg/L	0.15	119	0.81	0.01	
Total Phosphorus mg/L	0.05	116	0.34	0.01	
Total Hardness mg/L	190.32	86	239.00	62.00	
Chloride mg/L	2.96	119	5.15	0.06	
Sulfate mg/L	6.25	120	42.20	0.50	<1.0
Total Dissolved Solids mg/L	198.39	120	246.00	134.00	
Total Suspended Solids mg/L	29.20	118	334.00	0.50	
Turbidity NTU	16.75	118	230.00	0.51	22
Fecal Coliform col/100 mL		15	5500	46	20

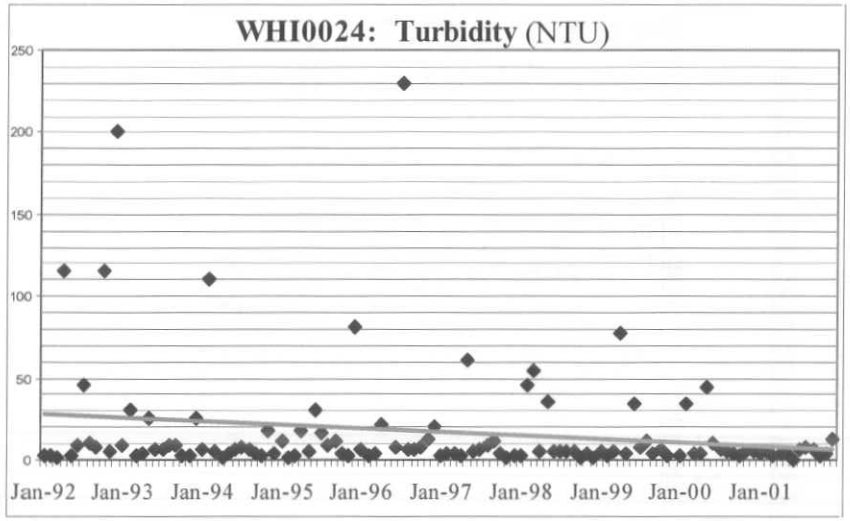
also apparent in the total phosphorus concentrations for the same time period. This is probably a reflection of the decreasing TSS values. However, the nitrate + nitrite nitrogen trend is relatively unchanged over the same ten year period, but the greatest peak concentrations have occurred within the last two years. Perhaps some of the reduction in turbidity, TSS, and total phosphorus can be attributed to the lack of rainfall that occurred between 1998 and 2000, thus reducing storm flow runoff. In addition, the storms that did occur were lower intensity storms, perhaps allowing more soil retention of the storm water and thus reducing runoff into the streams.

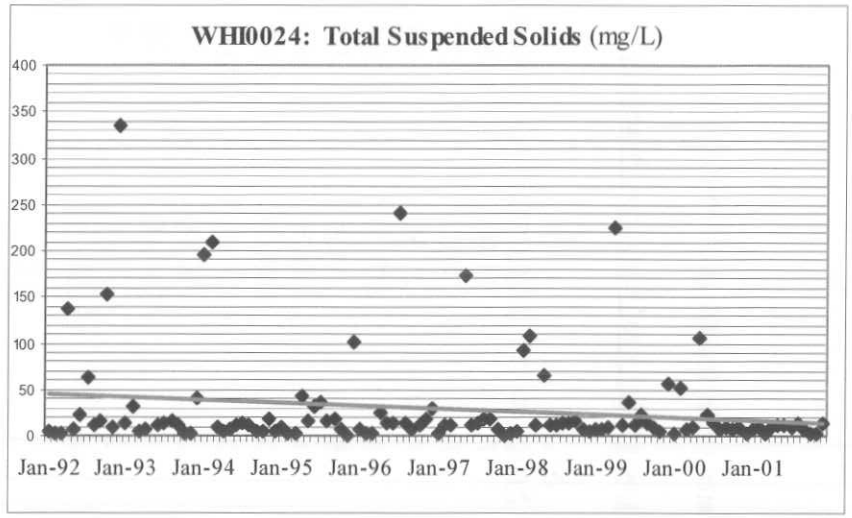
Bimonthly Stations

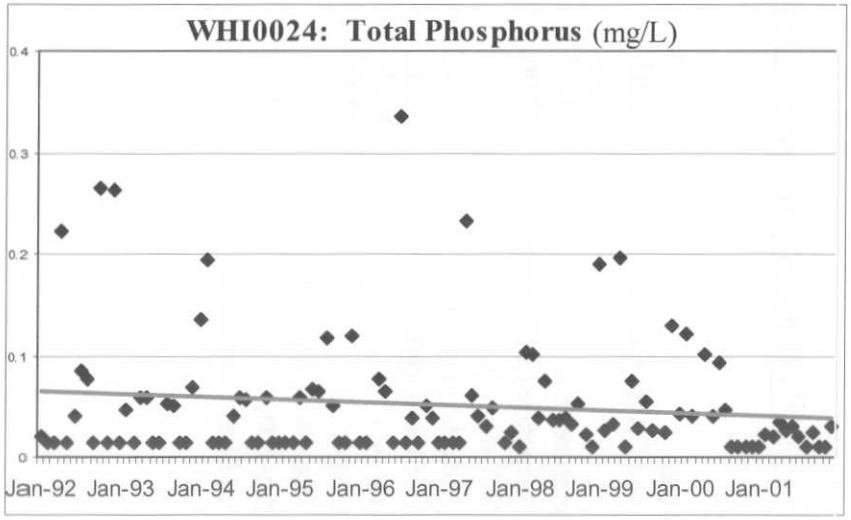
Five additional water quality sites were established as part of the ADRQ 1996 "Un-assessed Waters Survey" and have continued to be sampled as part of the ADEQ "Roving Water Quality Monitoring Network". Initially, these sites were sampled nine times between 1996 and 1998. There were three sites located on the main stem of the river, UWSBR01, UWSBR02, and UWSBR03, and two sites located on two tributaries; Reeds Creek, UWRDC01, and North Big Creek, UWNBC01. Location data for these sites are in Table 1 and Figure WQ-1 is a map showing the location of these sites. The data collected from these sites during that survey are summarized in Table 6.

Over 33% of the samples collected from UWSBR01, Strawberry River near Wiseman, had turbidity values greater than 17 NTU. They ranged from 2.6 to 74.0 NTU with a mean of 23 NTU. The majority of the land use above this site consists of dairy operations and pasture land. In contrast, none of the samples collected from UWSBR02, Strawberry River near Evening Shade, had turbidity values greater than 17 NTU. The maximum value at this site was 15 NTU; the minimum value was

Figure 1: Historical Water Quality Trends







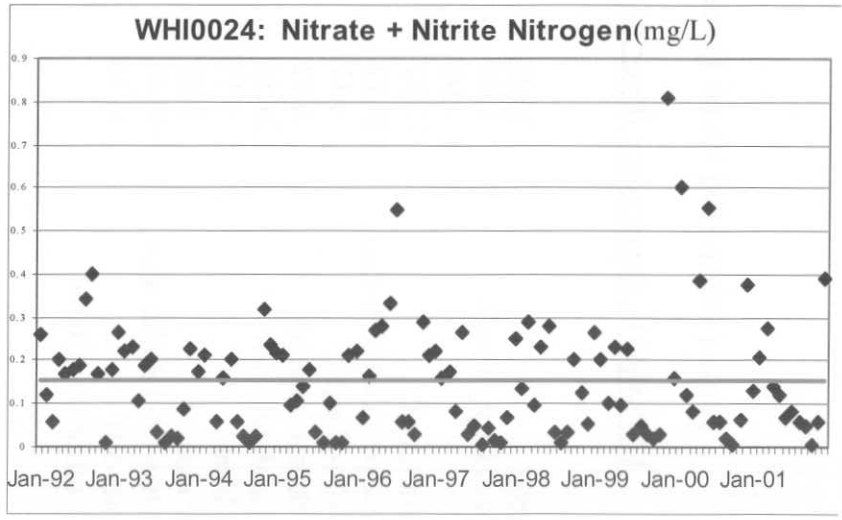


Table 6 - Historical Water Quality Data collected from 1994 to 1996

UWSBR01 - Strawberry River at Arkansas Highway 354 near Wiseman

Parameter	Mean	No. of Samples	Maximum	Minimum
Dissolved Oxygen mg/L	8.39	7	11.00	6.60
pH	7.91	7	8.65	7.38
Temperature (C)	17.17	7	25.50	6.60
Total Suspended Solids mg/L	26.22	9	122.00	1.00
NO_2+NO_3-N mg/L	0.17	8	0.30	0.07
Total Phosphorus mg/L	0.12	4	0.21	0.03
Total Hardness mg/L	128.56	9	168.00	68.00
Chloride mg/L	3.17	9	4.00	2.00
Sulfate mg/L	6.23	9	10.60	2.70
Total Dissolved Solids mg/L	139.45	9	163.00	114.00
Turbidity NTU	23.16	9	74.00	2.60
Fecal Coliform col/100 ml		9	>3500	31

UWSBR02 - Strawberry River at US. Highway 65 near Evening Shade

Parameter	Mean	No. of Samples	Maximum	Minimum
Dissolved Oxygen mg/L	5.03	8	7.50	2.60
pH	7.12	8	7.70	6.73
Temperature (C)	21.89	9	29.00	10.00
Total Suspended Solids mg/L	22.66	9	79.00	3.50
NO_2+NO_3-N mg/L	0.19	9	0.14	<0.05
Total Phosphorus mg/L	0.27	9	0.41	0.08
Total Hardness mg/L	62.01	9	153.00	22.00
Chloride mg/L	18.09	9	53.11	4.69
Sulfate mg/L	11.02	9	15.90	5.00
Total Dissolved Solids mg/L	161.33	9	253.00	121.00
Turbidity NTU	5.16	9	15.00	2.70
Fecal Coliform col/100 ml		9	2450	43

Table 6 - Historical Water Quality Data collected from 1994 to 1996 (cont.)

UWSBR03 - Strawberry River at Arkansas Highway 361 near Saffell

Parameter	Mean	No. of Samples	Maximum	Minimum
Dissolved Oxygen mg/L	8.68	6	11.40	7.00
pH	8.35	6	9.02	7.94
Temperature (C)	17.77	7	25.50	7.60
Total Suspended Solids mg/L	21.63	8	43.00	11.00
NO_2+NO_3-N mg/L	0.32	8	1.57	0.05
Total Phosphorus mg/L	0.07	5	0.14	0.04
Total Hardness mg/L	196.00	8	228.00	165.00
Chloride mg/L	3.35	8	4.00	3.00
Sulfate mg/L	4.86	9	7.20	1.30
Total Dissolved Solids mg/L	196.75	8	208.00	177.00
Turbidity NTU	12.26	8	25.00	5.00
Fecal Coliform col/100 ml		9	>600	108

UWNBC01 - North Big Creek off Arkansas Highway 354 near Center

Parameter	Mean	No. of Samples	Maximum	Minimum
Dissolved Oxygen mg/L	10.73	7	13.00	9.00
pH	8.49	7	9.15	8.17
Temperature (C)	21.40	6	30.00	8.10
Total Suspended Solids mg/L	6.00	6	15.00	3.00
NO_2+NO_3-N mg/L	0.15	7	0.29	0.03
Total Phosphorus mg/L	0.05	3	0.05	0.04
Total Hardness mg/L	224.33	9	249.00	177.00
Chloride mg/L	3.28	9	4.00	0.39
Sulfate mg/L	5.81	7	8.40	2.70
Total Dissolved Solids mg/L	221.61	9	246.00	177.00
Turbidity NTU	4.81	9	18.00	0.60
Fecal Coliform col/100 ml		9	>6000	6

Table 6 - Historical Water Quality Data collected from 1994 to 1996 (cont.)

UWRDC01 - Reeds Creek at Highway 117 near Strawberry

Parameter	Mean	No. of Samples	Maximum	Minimum
Dissolved Oxygen mg/L	9.70	6	11.60	8.50
pH	8.35	6	8.92	7.78
Temperature (C)	16.70	7	21.00	8.90
Total Suspended Solids mg/L	8.94	8	28.00	7.78
NO_2+NO_3-N mg/L	0.34	8	0.55	0.22
Total Phosphorus mg/L	0.08	3	0.15	0.03
Total Hardness mg/L	174.38	8	206.00	120.00
Chloride mg/L	3.16	8	199.00	147.00
Sulfate mg/L	4.30	9	8.2	1.30
Total Dissolved Solids mg/L	194.94	8	34.00	1.80
Turbidity NTU	7.95	8	34.00	1.80
Fecal Coliform col/100 ml		8	>6000	34

2.7 NTU; and the mean was 5.6 NTU. Turbidity values at the lowest watershed site, UWSBR03, Strawberry River near Saffell ranged from 5 to 25 NTU with a mean of 12 NTU. Over 11% of the samples collected from this site had turbidity values greater than 10 NTU, the Ozark Highlands ecoregion standard, but none exceeded the Delta Ecoregion turbidity standard of 84 NTU. In addition to the main stem, sites were established on two tributaries in the watershed; North Big Creek (UWNBC01) and Reeds Creek (UWRDC01). The turbidity values from North Big Creek ranged from <1 to 18 NTU with a mean of 5 NTU. Two samples, 22 % of the total collected, exceeded 10 NTU. Likewise, only two samples from Reeds Creek exceeded 10 NTU with turbidity values ranging from <1 to 34 NTU with a mean of 8 NTU.

The aquatic life use water quality criteria for turbidity for Ozark Highlands ecoregion streams states that no more than 10% of the samples can exceed the ecoregion water quality standard. Since the turbidity values from the main stem sites routinely exceeded these criteria, the water body segments associated with those sampling stations were listed as not fully supporting the aquatic life use. The tributaries were not listed because the sampling period was over a three year period.

Fecal coliform bacteria samples were collected from the Roving Network sites on nine occasions between 1994 and 1997. The upper Strawberry River site, UWSBR01, had 4 samples that exceeded the water quality standard for primary contact recreation. Concentrations ranged from 31 to greater than 3500 col/100 ml. Since more than 25% of the samples exceeded the use assessment criteria, this segment was listed as not supporting the primary contact recreation use.

The remaining five sites had fecal coliform samples that exceeded the standard, but all were assessed as supporting the primary contact recreation use. The lower main stem site, UWSBR03, had concentrations ranging from 108 to greater than 600 col/100 ml. Only one sample exceeded the standard during the swimming season. The site at North Big Creek had samples ranging from 6 to greater than 6000 col/100 ml. It had two samples exceed the standard during the swimming season. Likewise, Reeds Creek only had two samples exceed the standard during the swimming season and had concentrations ranging from 34 to greater than 6000 col/100 ml.

The greatest concentrations from all of the sites occurred during one storm event during early March. These concentrations were associated with large storm events resulting in heavy run-off and elevated turbidity and total suspended solids concentrations. Thus it is difficult to accurately determine if the bacteria is commonly occurring soil bacteria, or bacteria from warm blooded animals or other anthropogenic sources.

This page intentionally left blank

WATERSHED CHARACTERISTICS

LOCATION

The Strawberry River originates south of Salem in Fulton County, Arkansas. It flows through Fulton, Izard, Sharp and Lawrence counties and enters the Black River southeast of the City of Strawberry. The watershed lies in the Ozark Highlands ecoregion, but the lowest section is located in the Delta ecoregion. The tributaries in the lower section of the watershed, mainly in southeast Sharp and Lawrence counties, take on more lowland or transitional stream characteristics.

LAND USE

There are approximately 792 square miles in the Strawberry river watershed. Watershed land use activities have been estimated to be 65% - 75% silviculture, 20%-30% agriculture, and less than 2% urban, Figure L-1, (ESRI ARCVIEW 8.0). Silviculture activities are limited to small parcels of privately owned land, some of which are being converted to pasture. Most of the wooded land is in private ownership. There are two large tracks of land owned by The Nature Conservancy east of Evening Shade. This land is mostly in forest, but some is pasture and is leased to local cattlemen for hay fields and cattle grazing. It is all managed for wildlife enhancement.

Agriculture activities include confined animal operations, dairies, cattle production, and row-crop. The majority of the dairies are located between Salem and Horseshoe Bend in the headwaters of the watershed, stream segments 009 and 010. There are 22 dairies located in and around the watershed, eight of which are located in the upper Strawberry River drainage in Fulton and Izard Counties. Figure CAO-1 identifies the location of the dairies and Appendix CAO-1 outlines information about each dairy. Most of the dairies have less than 100 head of cattle and use a dry stack waste system. Two dairies have liquid animal-waste systems and have active permits. All of the dairies have active permits from the Arkansas Health Department and active farm management plans.

There are 276 poultry houses on 97 farms in the watershed with most located south of Horseshoe Bend in the lower section of the basin. Figure CAO-1 identifies the location of each of the operations and Appendix CAO-1 outlines pertinent information about each poultry operation.

The main stem of the Strawberry River from its headwaters near Salem and Oxford, to the mouth of Piney Fork Creek just west of Evening Shade, stream segments 009, 010, and 011, has nine poultry houses on three farms. This section of the watershed contains 228 mi^2 and has a low poultry operation to land mass ratio. However this section contains the majority of the dairy operations in the basin. Thus, agricultural land use accounts for a fair amount of the overall land use in this area of the basin.

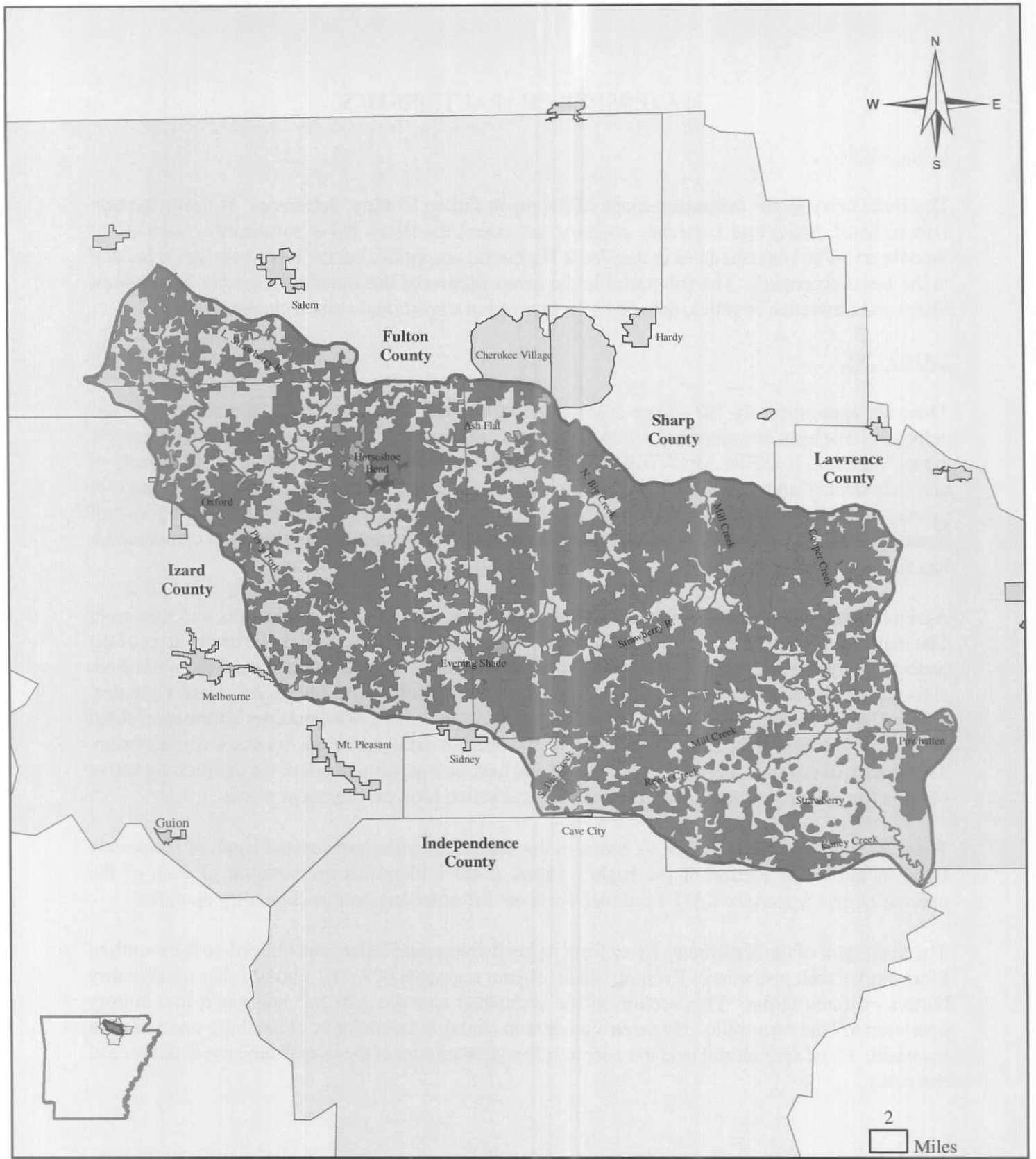


Figure L-1
Land Use
Strawberry River Watershed

Arkansas Department of
Environmental Quality
Water Division - Planning Section

Legend

- Watershed Boundary
- Cities
- Counties
- Streams
- Pasture and Cropland
- Forest Land
- Urban/Residential/Commercial

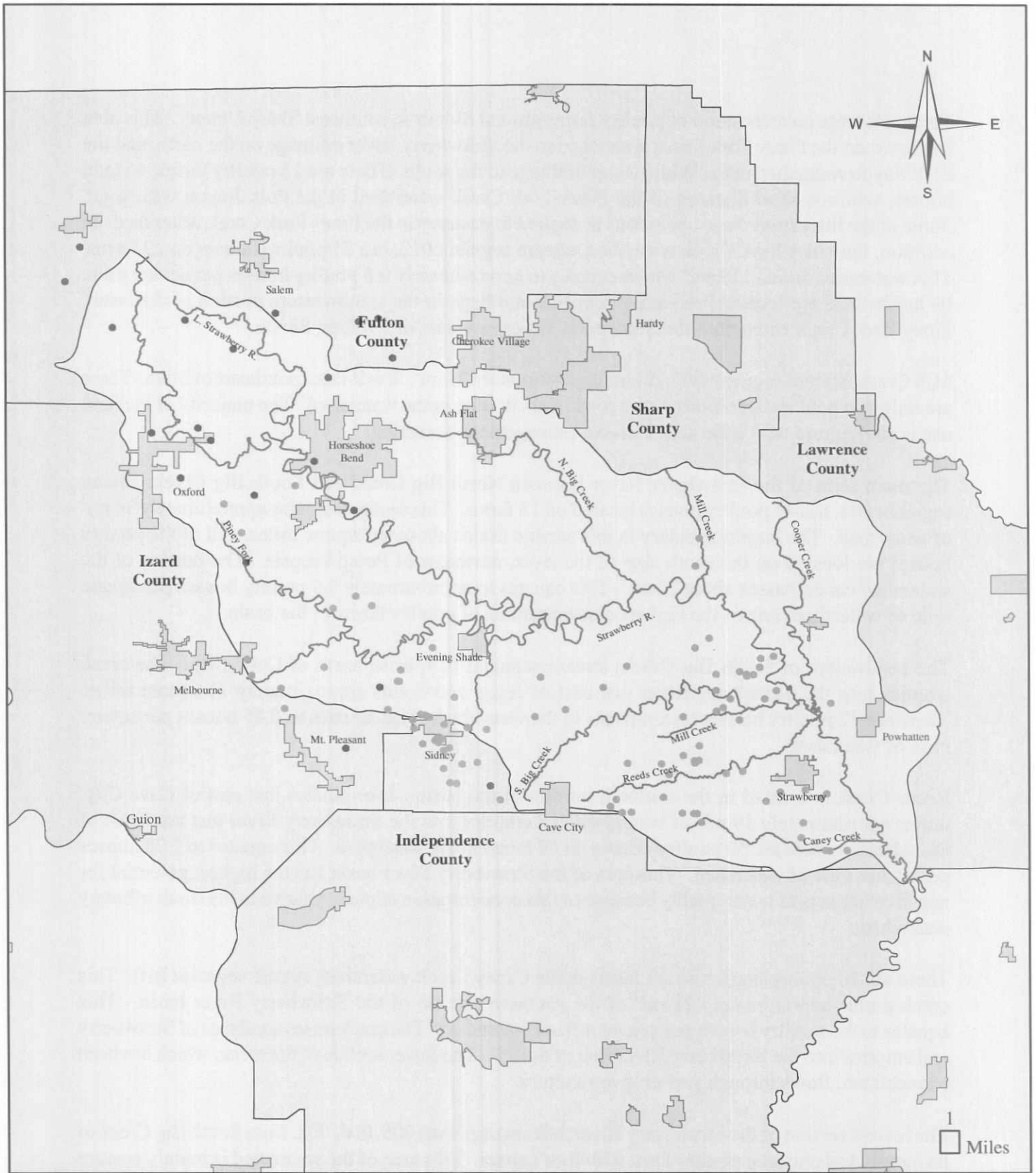


Figure CAO-1
Confined Animal Operations
Strawberry River Watershed

Arkansas Department of
Environmental Quality
Water Division - Planning Section

Legend

- Streams
- Chicken Houses
- Dairy Farms
- Arkansas_Cities

There is a large concentration of poultry farms around Sidney in southeast Sharp County. This area lies between the Piney Fork Creek watershed in the Strawberry River drainage on the north, and the Polk Bayou watershed in the White River drainage to the south. There are 15 poultry farms, 45 total houses, within a short distance of the Piney Fork Creek watershed in the Polk Bayou watershed. Some of the litter from these operations is applied to pastures in the Piney Fork Creek watershed. In addition, the Piney Fork Creek watershed, stream segment 012, has 55 poultry houses on 22 farms. This watershed drains 119 mi^2 which equates to approximately 0.8 poultry houses per square mile. Its headwaters are located between Violet Hill and Sage in the southwestern portion of the basin. Piney Fork Creek enters into the Strawberry River just west of Evening Shade.

Mill Creek, stream segment 007, drains approximately 23 mi^2. It is located southeast of Sitka. There are only two poultry operations with a total of six houses in the watershed. The majority of the land use is silviculture with little active timber management occurring.

The main stem of the Strawberry River between North Big Creek and South Big Creek, stream segment 006, has 41 poultry houses located on 13 farms. This section contains approximately 34 mi^2 of watershed. The largest tributary in this section drains about ten square miles. All of the poultry houses are located on the south side of the river, northeast of Poughkeepsie. The portion of the watershed encompasses about 22 mi^2. This equates to approximately 1.9 poultry houses per square mile of watershed, one of the highest concentrations of poultry farms in the basin.

The headwaters of South Big Creek, stream segment 013, arise north of Cave City. The creek empties into the Strawberry River just east of Jesup and drains approximately 71 square miles. There are 32 poultry houses on ten farms in the watershed. This equates to 0.45 houses per square mile of watershed.

Reeds Creek is located in the southern portion of the basin. It originates just east of Cave City, drains approximately 39 mi^2 of watershed and empties into the Strawberry River just northeast of Strawberry. There are 50 poultry houses on 19 farms in the watershed. This equates to 1.28 houses per square mile of watershed. This area of the Strawberry River basin has the highest potential for negative impacts to water quality because of this concentration of poultry farms in the small tributary watersheds.

There are 16 poultry houses on six farms in the Caney Creek watershed, stream segment 016. This creek drains approximately 21 mi^2 of the southern portion of the Strawberry River basin. This equates to 0.8 poultry houses per square mile of watershed. The creek arises southeast of Strawberry and empties into the Strawberry River east of Saffell. The lower section of the creek, which has been channelized, flows through row crop agriculture.

The lowest section of the Strawberry River, stream segments 005, 004, 002, from South Big Creek to its mouth, has only one poultry farm with four houses. This area of the watershed is mainly pasture land and row crop agriculture.

GEOLOGY

The Strawberry River watershed lies almost entirely within the Salem Plateau section of the Ozark Plateaus physiographic province. Lower and Middle Ordovician rocks are exposed at the surface within the watershed boundaries and extend out of the study area to the west and north of the watershed. Sparse erosional remnants of Mississippian rocks cap the hills along the southern watershed divide and form the boundary between the Salem and Springfield Plateaus to the south. Thin exposures of Cretaceous rocks are present in the southeastern and extreme northeastern portions of the watershed. Pleistocene deposits extend into the lower reaches of the Strawberry River and Caney Creek valleys and are truncated at their confluence by unconsolidated Holocene sediments of the Mississippi alluvial plain. Small remnants of Tertiary gravels are scattered on hilltops throughout the watershed (Figure GEO-1) (Haley et al., 1993).

The geology of the Ozark Plateaus Province consists of flat-lying to gently-dipping sedimentary rocks of Cambrian through Pennsylvanian age. The foundation on which these rocks were deposited are crystalline rocks of Precambrian age which crop out in southeastern Missouri and form the St. Francois Mountains (Adamski et al., 1995). The relationship between the strata and the Precambrian rocks records a dynamic configuration between land and shallow interior seas throughout much of this time interval. Numerous unconformities in the stratigraphic section account for most of the discontinuities in the distribution of the formations. These unconformities increase in number from south to north. The regional distribution and thicknesses of the formations, combined with regional structure, indicate that the Ozark region had been differentially uplifted along the general location of its present axis prior to deposition of Mississippian sediments (McKnight, 1935).

Thick deposits of mainly calcareous sediments were deposited during the Cambrian and Lower Ordovician. Uplifts near the end of Late Cambrian time and throughout Early Ordovician time resulted in extensive fracturing, jointing, and faulting of the competent carbonate rocks. Diagenetic processes involving the mixing of freshwater and seawater resulted in the conversion of limestone to dolostone. Uplift at the end of the Early Ordovician caused deep and pervasive erosion of the exposed landmass and development of an extensive karst surface now observable as paleokarst. Advancing seas during the Middle Ordovician resulted in widespread deposition of sand and calcareous sediments, which constitute the sedimentary rocks attributed to this period of inundation (Imes & Emmett, 1994). Collectively, the Lower and Middle Ordovician rocks represent the vast majority of strata represented at the surface in the Strawberry River watershed.

Geologic quadrangle maps, areal geology superimposed on 7.5 and 15 minute topographic maps, were used to examine the spatial distribution and position of stratigraphic units and structural features within the Strawberry River watershed. In addition, they were used to determine the thicknesses of rock units penetrated by wells sampled for this study. These unpublished maps were constructed by E.E. Glick, USGS, from 1971 through 1974.

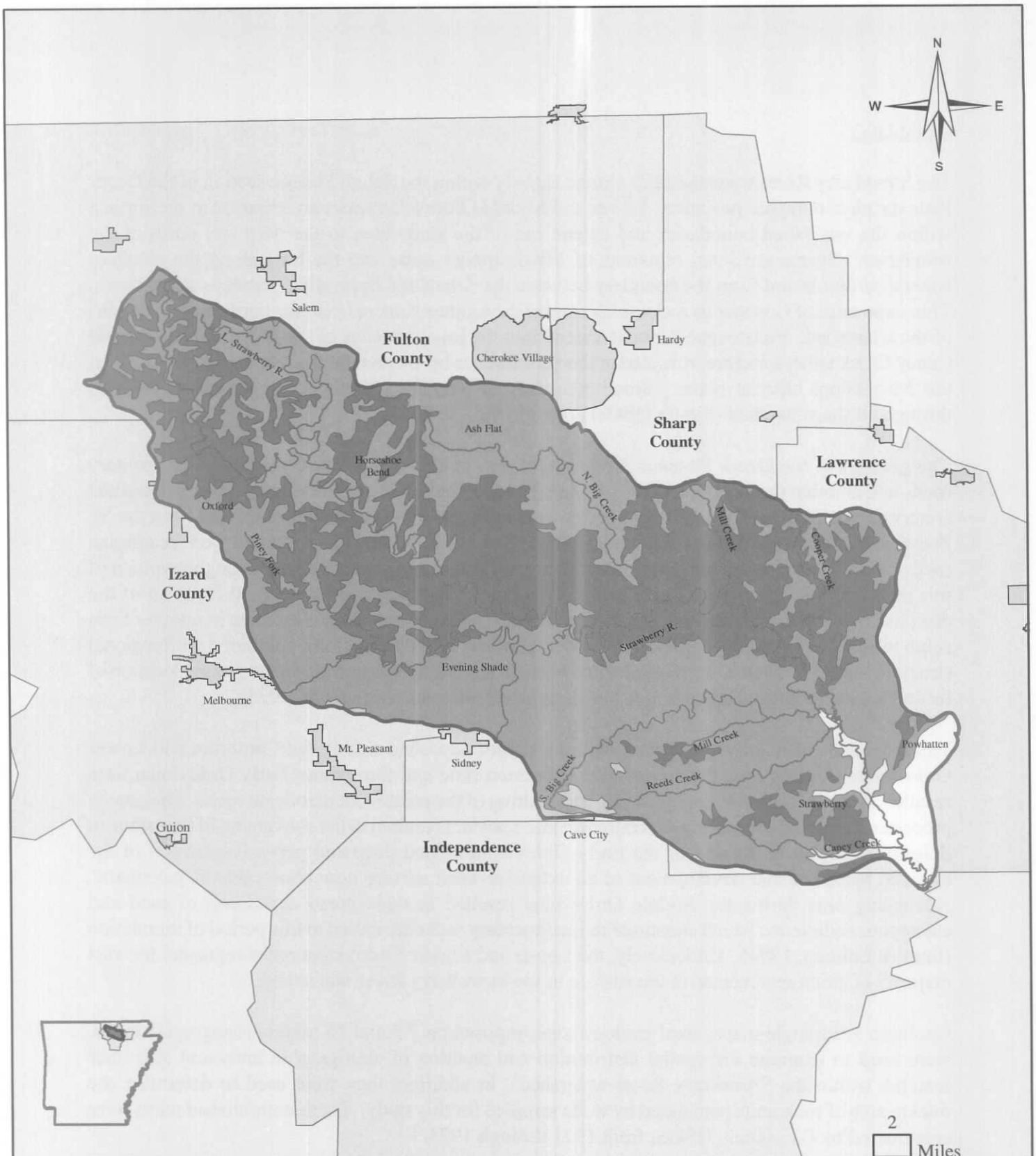


Figure GEO-1
Watershed Geology
Strawberry River Watershed

Arkansas Department of
Environmental Quality
Water Division - Planning Section

Legend

- Watershed Boundary
- Cities
- Counties
- Streams
- Qso - Alluvial deposits
- Qat - Alluvium and terrace deposits
- Kr - Cretaceous rocks
- Mb - Boone Formation
- Ocj - Cason Shale and Joachim Dolomite
- Ose - St. Peter Sandstone & Everton Formation
- Op - Powell Dolomite
- Ksc - Sand and clay
- Ocjc - Cotter and Jefferson City Dolomites

Regional dip of the rock units is to the south into Arkansas, generally resulting in progressively younger rock formations exposed at the surface as one traverses south. Greater degree of uplift and erosion to the north contributed to overall thickening of the units to the south (Imes & Emmett, 1994). Within the eastern portion and along the southeastern boundary of the Strawberry River watershed, the rocks are normally faulted, resulting in increased dips in the vicinity of the faults (Glick, 1972b,d,g; Glick, 1973a,b).

The majority of domestic wells sampled for the study penetrate Lower and Middle Ordovician formations in ascending order from oldest to youngest; the Jefferson City Dolomite, Cotter Dolomite, Powell Dolomite, Everton Formation, and St. Peter Formation (Table GEO-1), all of which crop out at the surface in the watershed. In the southeast portion of the watershed, three wells penetrate thin intervals of exposed Cretaceous rocks that unconformably overlie rocks of the Everton Formation, and likely are completed in the Everton. Two public supply wells penetrate the Roubidoux and Gasconade Formations (Prior et al., 1999), which are present only in the subsurface in Arkansas. Four irrigation wells are completed in Quaternary deposits of the Mississippi alluvial plain.

The Gasconade Formation unconformably overlies the Upper Cambrian Eminence Formation in northern Arkansas. The Gasconade consists of a well-defined basal sandstone member, the Gunter Sandstone, and overlying upper and lower medium-crystalline, light brownish-gray dolostone units. Chert is present in both dolostone units and may constitute more than 50 percent of the lower unit. The Gunter Sandstone member is a fine- to coarse-grained sandstone, which may be dolomitic. The thickness of the Gasconade Formation ranges from 300 to 600 feet in northern Arkansas (Prior et al., 1999; Adamski et al., 1995).

The Roubidoux Formation unconformably overlies the Gasconade (Prior et al., 1999) and consists of sandstones, dolostones, and sandy to cherty dolostones. The sandstones are loosely- to well-cemented. The dolostones are light gray to brown and are finely- to coarsely-crystalline. The dolostones may contain several distinct sandstone bodies. Thickness ranges from 100 to 450 feet (Adamski et al., 1995; Imes & Emmett, 1994).

The Jefferson City Dolomite rests unconformably upon the Roubidoux Formation in northern Arkansas and consists of light- to dark-tan, fine-grained, crystalline dolostone and considerable chert with some rare thin beds of sandstone, shale, and oolitic dolostone. The lower contact is not exposed in Arkansas. Few fossils are present in the formation. The Jefferson City Dolomite has not been successfully differentiated from the Cotter Formation in Arkansas (McFarland, 1998). Formation thickness averages about 200 feet (Adamski et al., 1995).

The Cotter Dolomite is composed of dolostone of predominantly two types: a fine-grained argillaceous, earthly-textured, relatively soft, white to buff or gray dolostone referred to as "cotton rock", and a more massive, medium-grained, gray dolostone that weathers to a hackly surface texture and becomes dark upon weathering. The formation contains concentrically-banded chert nodules, some minor beds of green shale, and occasional thin, interbedded sandstones. Fossils are rare, but include cephalopods, gastropods, and *Cryptozoan*, a reef-building algae. Although not differentiated from the Jefferson City Formation in Arkansas, the contact is considered disconformable. Thickness ranges from 340 to 500 feet (McFarland, 1998).

Table GEO-1. Stratigraphic column with descriptions of lithologic and geohydrologic properties of the Ozark aquifer and adjacent confining units within Arkansas (after Schrader, 2001).

ERA	PERIOD	GEOLOGIC UNIT	GEOHYDROLOGIC UNIT	LITHOLOGY	THICKNESS (feet)	GEOHYDROLOGY
Paleozoic	Devonian	Chattanooga Shale	Ozark confining unit	Shale unit that crops out in a narrow band that outlines the Ozark aquifer and is missing where the Ozark aquifer is exposed at the surface.	0 - 200	Unit is relatively impermeable because of large shale content.
		Clifty Limestone	Ozark aquifer	Chert with lenses of limestone, dolomite, and cherty sandstone.	0 - 250	The residual cherty rubble, weathered from cherty limestone and sandstone of the unit, may yield 2 to 5 gallons per minute (gpm)
		Penters Chert				
	Silurian	Lafferty Limestone		Limestone, dolomite, sandstone, and minor amounts of shale.	0 - 2,000	The limestones and dolomites commonly yield 5 to 10 gpm from solution channels, bedding planes, and fractures. Similar yields may be obtained from the sandstone where it is porous or fractured. These units contain many springs. Yields from springs and some wells may exceed 50 gpm.
		St. Clair Limestone				
		Brassfield Limestone				
	Ordovician	Cason Shale				
		Fernvale Limestone				
		Kimmswick Limestone				
		Plattin Limestone				
		Joachim Dolomite				
		St. Peter Sandstone				
		Everton Formation				
		Smithville Formation		Dolomite, dolomitic limestone, and minor amounts of sandstone and shale.	100 - 1000	The solution channels and fractures in the dolomite and dolomitic limestone commonly yield 5 to 10 gpm. Wells that tap large solution channels may yield more than 50 gpm, but large yields are uncommon. These units yield water to several large springs.
		Powell Dolomite				
		Cotter Dolomite				
		Jefferson City Dolomite				
		Roubidoux Formation		Sandstone and sandy dolomite. Not exposed in Arkansas.	100 - 250	Yields up to 450 gpm may be obtained from some wells, but yields are highly variable and generally average less than 150 gpm.
		Gasconade Dolomite		Dolomite, sandy dolomite, and sandstone. Not exposed in Arkansas.	350 - 650	The most productive water-bearing part of this unit is the Van Buren Formation. Wells that tap this formation commonly yield 150 to 300 gpm and may yield as much as 500 gpm.
		Van Buren Formation				
	Cambrian	Eminence Dolomite				
		Potosi Dolomite				
		Doe Run Dolomite	St. Francois confining unit	Shale and shaley dolomite, siltstone, and limestone conglomerate. Shales present both as distinct beds and disseminated throughout dolomite matrix. Not exposed in Arkansas.	0 - 750	Permeability is minimal to moderate. Unit is more permeable where transected by fault and fracture zones.
		Derby Dolomite				
		Davis Formation				

The Powell Dolomite is generally a fine-grained, light-gray to greenish-gray, limy, argillaceous dolostone with thin beds of shale, sandstone, sandy dolostone, and occasional chert. In the lower half of the formation, a dark, massive ledge with abundant drusy quartz has been located in many places. Although not known to contain many fossils, the Powell contains cephalopods, gastropods and trilobites. The lower contact with the Cotter Dolomite is considered disconformable. According to McFarland (1998), the maximum thickness is approximately 215 feet. However, a local, apparent thickness of at least 260 feet (dip ≈ 50 ft/mi) was measured from the Poughkeepsie geologic quadrangle map (Glick, 1972d), and a local, apparent thickness of 320 feet (dip ≈ 100 ft/mi) was measured from the Sitka geologic quadrangle map (Glick, 1971e). In the northwestern portion of the study area, the Powell thins dramatically to a 20- to 30-foot thick belt. In most of the area covered by the Salem geologic quadrangle map, the Everton Formation lies directly upon the Cotter Dolomite (Glick, 1972f).

The Everton Formation displays considerable variability in lithologic character from one place to another. This unit is composed of mixtures of dolostone, sandstone and limestone and, in limited areas, has traces of conglomerate, shale and chert. The limestones are light-gray to brownish-gray and are generally dolomitic and sandy. The dolostones are light- to dark-gray and are generally limy and sandy. The Everton includes thick members of friable sandstone dominating local sections in some areas. These sands commonly consist of white, well-rounded, frosted, medium-sized grains and are almost indistinguishable from the overlying St. Peter Sandstone, where sandstones of both formations are in contact. Bedding is thin to massive throughout the Everton Formation. Lithologies commonly grade laterally into one another along the bedding. Fossils are uncommon; however, ostracods, cephalopods, gastropods, bivalves, trilobites and bryozoans have been noted within the formation. The lower contact with the Powell is unconformable, and numerous disconformities occur within the formation. Thickness ranges from about 300 to 650 feet in Arkansas (McFarland, 1998). The Everton and St. Peter Formations are not differentiated on the geologic quadrangle maps covering the watershed extent, except where residual thicknesses of Everton cap hilltops, and the overlying St. Peter is not present.

The St. Peter Sandstone is generally a massive-bedded, friable, white sandstone with minor beds of shale, limestone, and dolostone. The sands are frosted, well-rounded, fine- to medium-sized grains. The cement is commonly calcite, often with single crystals incorporating hundreds to thousands of sand grains. The unit is a frequent bluff-former. Cross-bedding and ripple marks are rare. No body fossils are known from the formation in Arkansas, but a few trace fossils have been reported. The base of the St. Peter Sandstone is unconformable, often with several feet of relief. The formation ranges from a feather edge to as much as 175 feet thick (McFarland, 1998).

The Joachim Dolomite Formation upward through the Kimmswick Limestone Formation comprise the remainder of the Paleozoic strata represented in the watershed. These formations are of limited areal extent and are not penetrated by any of the wells sampled for this study. They are composed of limestones, dolomites, and minor amounts of sandstone and shale (McFarland, 1998). Cumulative thickness in the watershed is 100 feet or less (Glick, 1971d; Glick 1972b,c).

Three wells penetrate thin intervals of Upper Cretaceous rocks in the southeastern portion of the watershed. These rocks consist of black, shaley clay and gravel, and unconformably overlie the Everton Formation in this area (Glick, 1973b). Fossils present in this sequence suggest a possible correlation with the Ozan Formation. This sequence has not been assigned to a specific stratigraphic unit (McFarland, 1998).

Four shallow wells penetrate unconsolidated Holocene alluvium near the extreme southeastern boundary of the watershed. The lower portion of the sediments consists of coarse sands and gravels, and the upper portion is made up of fine to medium sands. Almost everywhere the sequence fines upward, but not in a uniform manner. The sequence is confined where the fine-grained top stratum is thin and continuous, but is an otherwise open hydrologic system. The alluvial deposits have a nominal thickness of approximately 125 feet (Kresse & Fazio, 2002).

Appendix GEO-1 lists estimated penetrated thicknesses of formations for most of the wells sampled for the present study. Considerable variability in formation thicknesses exists within the watershed according to 7.5 and 15 minute geologic quadrangle maps (Glick, 1971a-e; Glick, 1972a-g; Glick, 1973a,b; Glick, 1974) coincident with the watershed extent. USGS- and author-constructed structural contours enabled the determination of elevations of formation contacts where upper- or lower-formation contacts of interest were not mapped at the surface in the well vicinity. Areally-mapped contact elevations were traced to the well along a line parallel to the strike of the rock units to reduce overestimating or underestimating penetrated thicknesses. Penetrated thicknesses equal total formation thickness only where a given well intersects upper and lower contacts along its length. Formation thicknesses are apparent, as local variability in dips were not calculated for determination of true formation thicknesses. Well location coordinates were recorded in the field using a hand-held Trimble Geo*Explorer II* global positioning system. Locations were differentially corrected in Pathfinder and exported to and plotted in ArcMap on 7.5 minute topographic quadrangle map coverages. Mapped contacts were transposed from the geologic worksheets to larger-scale, ArcMap topographic coverages to better evaluate contact elevations. Well depths were subtracted from well elevations to determine well-bottom elevations. Local variability in strata dips, interpolation of contact elevations, the scale at which the contacts were originally plotted, and topographic contour intervals are all factors contributing to a margin-of-error of +/- 20 feet or greater for local formation penetrated thicknesses and/or formation thicknesses.

POINT SOURCE DISCHARGES

There are six point source discharges in the Strawberry River watershed. Figure PS-1 identifies the location of each of the discharges. Table PS-1 lists these dischargers, their locations, receiving streams, discharge limits and design flows.

The largest discharger is the City of Ash Flat. It discharges into the headwaters of North Big Creek, southeast of Ash Flat, one-half mile upstream of the Arkansas Highway 354 Bridge. During the study, the design flow for the facility was 0.09 million gallons per day (mgd), approximately 0.14 cubic feet per second (cfs). However, the facility was undergoing improvements and expansion to upgrade the treatment and increase the design flow to 0.15 mgd, approximately 0.23 cfs. The treatment consisted of an activated sludge system, clarifier, sand filter and chlorine disinfection.

During the survey, the Ash Flat treatment facility discharge was usually 90% to 100% of the stream flow at the highway bridge during the critical season. Water samples were collected from the facility's effluent ditch on a quarterly basis.

The Western Lawrence Waste Water Treatment District receives waste water from the cities of Strawberry and Lynn. The facility is located west of the Strawberry River and north of Arkansas Highway 25 in Lawrence County approximately two miles north of Strawberry. The effluent ditch enters the Strawberry River just upstream of the Arkansas Highway 25 Bridge. It is a primary treatment facility with a two cell settling pond and a polishing pond, followed by sand filters and chlorine disinfection. It has a design flow of 0.143 mgd, or approximately 0.22 cfs. The Strawberry River at Arkansas Highway 25 bridge has an average critical season flow of approximately 118 cfs. The treatment facility discharge is less than 0.2% of the average critical season flow. Thus, the effluent from the facility is probably having little to no effect on the Strawberry River.

The City of Oxford has a primary treatment system consisting of anaerobic digestion followed by a sand filter and chlorine disinfection. The facility is located southeast of Oxford. It discharges into Sandy Branch which enters the Strawberry River downstream of the Arkansas Highway 354 Bridge, east of Oxford. The design flow is 0.093 mgd, or approximately 0.014 cfs. During the critical season, this facility usually does not have a discharge due to excessive evaporation.

Horseshoe Bend, located in northeast Izard County, operates two waste treatment facilities. The north plant is located east of Arkansas Highway 289. It discharges into Hubble Branch which flows into the Little Strawberry River north of Wiseman. This facility has a design flow of 0.06 mgd, or approximately 0.009 cfs. The treatment consists of an activated sludge system, followed by a clarifier and chlorine disinfection.

The White Oak plant is located east of Arkansas Highway 354 and discharges into an unnamed tributary of the Strawberry River north of Franklin. This facility has a design flow of 0.20 mgd, or approximately 0.29 cfs. Treatment consists of an activated sludge system followed by a clarifier, aerobic sludge digestion, and chlorine disinfection.

The Allegheny Waste Water Treatment Facility treats waste from the Cherokee Village Hospital. The system consists of an extended-aeration activated sludge package plant followed by clarification, dosing tanks, intermittent sand filtration and chlorine disinfection. It is a very small system with a design flow of 0.05 mgd, but usually discharges less than 0.03 mgd. Because of this, it is unlikely that the treated water is having any effect on either the receiving stream or North Big Creek.

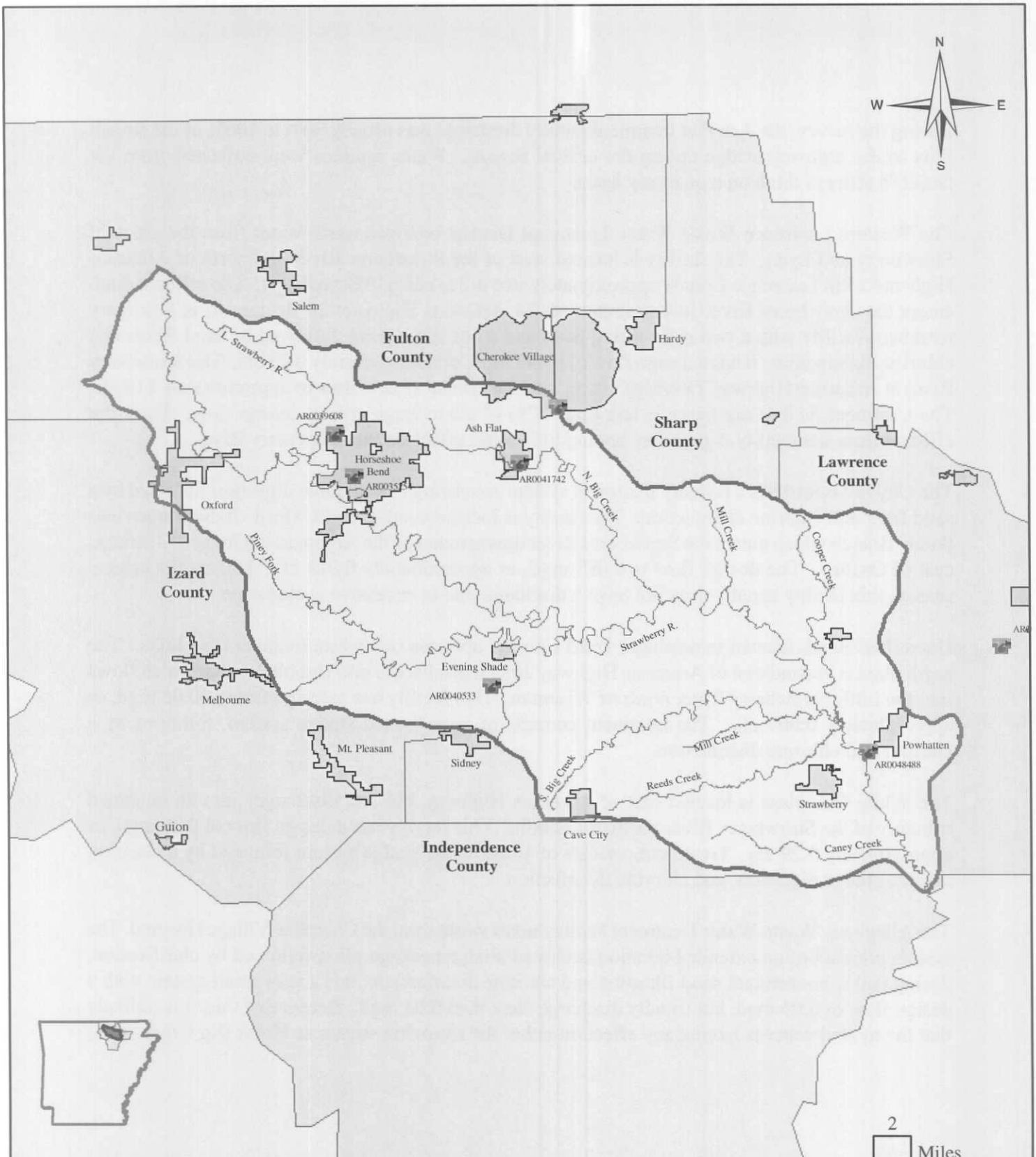


Figure PS-1
NPDES Locations,
Strawberry River Watershed

Arkansas Department of
Environmental Quality
Water Division - Planning Section

Legend

- Strawberry River Watershed
- Cities
- Counties
- Streams
- NPDES

Table PS-1: Point Source Discharges

Permit No.	Facility Name	Latitude	Longitude	County
	Receiving Waters - Location of Discharge			**Discharge Limits**
AR0035254	Horseshoe Bend, White Oak	36·12·35	-91·45·25	Izard
	Discharges to an unnamed tributary of Strawberry River below White Oak Lake in southern Horseshoe Bend, (Sec 20, T18N, R7W)			25/30/5/6 summer 25/30/10/6 winter 0.20 mgd
AR0038326	Allegheny WWTF	36 15 40	-91 33 45	Sharp
	Cherokee Village Hospital discharge to Worthington Creek to North Big Creek (Sec 31, T19N, R5W).			15/20/5 summer 20/20/12 winter 0.05 mgd
AR0039608	Horseshoe Bend, Hubble Creek	36 14 35	-91 46 30	Izard
	Discharges to Hubble Creek, a tributary to the Little Strawberry River, in northern Horseshoe Bend, (Sec 6, T18N, R7W).			25/30/5/6 summer 25/30/10/6 winter 0.06 mgd
AR0041742	Ash Flat, City of	36·12·50	-91·35·51	Sharp
	Discharge to North Big Creek upstream of Arkansas Highway 354, southeast of Ash Flat, (Sec 14, T18N, R6W).			10/15/5/5 summer 10/15/8/5 winter 0.150 mgd
AR0048488	Western Lawrence WWT Dist	35·59·12	-91·16·29	Lawrence
	Waste water treatment facility for the Cities of Strawberry and Lynn. Discharges to an unnamed tributary of the Strawberry River off Arkansas Highway 25 northeast of Strawberry, (Sec 34, T16N, R3W).			10/15/5 summer 10/15/10 winter 0.143 mgd
AR0049701	Oxford, City of	36·12·51	-91·55·01	Fulton
	Discharge to Sandy Creek, Strawberry River tributary. Facility is located southeast of Oxford, (Sec 14, T18N, R9W)			15/20/5 summer 15/20/10 winter 0.093 mgd

This page intentionally left blank.

WATER QUALITY ASSESSMENT

SAMPLE EVENT OVERVIEWS

Sixteen water quality sampling events were completed from March 2001 to June 2003. The sampling events targeted seasonal storm-flow and low-flow events. Figure WQ-1 is a map identifying the water quality sampling locations. The water quality data collected during this survey are located in Appendices WQ-1, water quality data, and WQ-2, metals data.

The spring, summer and fall of 2001 produced no significant storm flow events. Fewer storms of less than average rainfall occurred throughout the year. Five sampling events were completed during the first part of the survey, all of which represent seasonal low-flow events.

In December, 2001, a series of large storm events occurred. Eight inches of rain fell over a four day period in early December. However, this storm event produced little runoff. In late December, another more intense storm produced another eight inch rainfall during a 36-hour period. In stream flow in the River went from 200 cfs to 22,000 cfs within six hours. Unfortunately, samples could not be collected from this storm flow event. The extensive flooding during this storm event prevented travel throughout much of the northeast portion of the state.

After the storms in December, little to no rainfall occurred until late January. A winter low-flow event was collected during the third week of January. The following night, a two inch rainfall event occurred and samples were collected from this run-off event. The peak flow in the main stem of the river was sampled at the WHI0143P sample site.

The next significant storm event occurred in March 2002. Flow in the river increased from less than 200 cfs to greater than 5000 cfs. The peak flow was sampled at the UWSBR03 sample site. A similar storm occurred a month later in April. Peak flow from this event was sampled in the tributaries. During late April, a less intense storm event occurred with flows increasing from 300 cfs to 1300 cfs.

Rainfall was minimal during the summer of 2002, except for an isolated storm event in August. The majority of rain fell in the smaller tributary watersheds between WHI0143B and WHI0143P. Flows in North Big Creek and Piney Fork Creek were not affected by the rainfall. However, flows at WHI0143P increased from a normal summertime low flow of about 50 cfs to greater than 1250 cfs. The peak flow was sampled at WHI0143P.

The next significant runoff event occurred in December 2002. Stream flow increased from less than 200 cfs to greater than 3100 cfs at UWSBR03. Several inches of rain fell intermittently over a six day period. Peak flow was sampled at UWSBR03.

The winter and spring of 2003 was unusually dry. The watershed received only ten inches of precipitation during the first six month of the year. Most of the rainfall events produced less than a quarter of an inch of rain and resulted in no significant runoff.

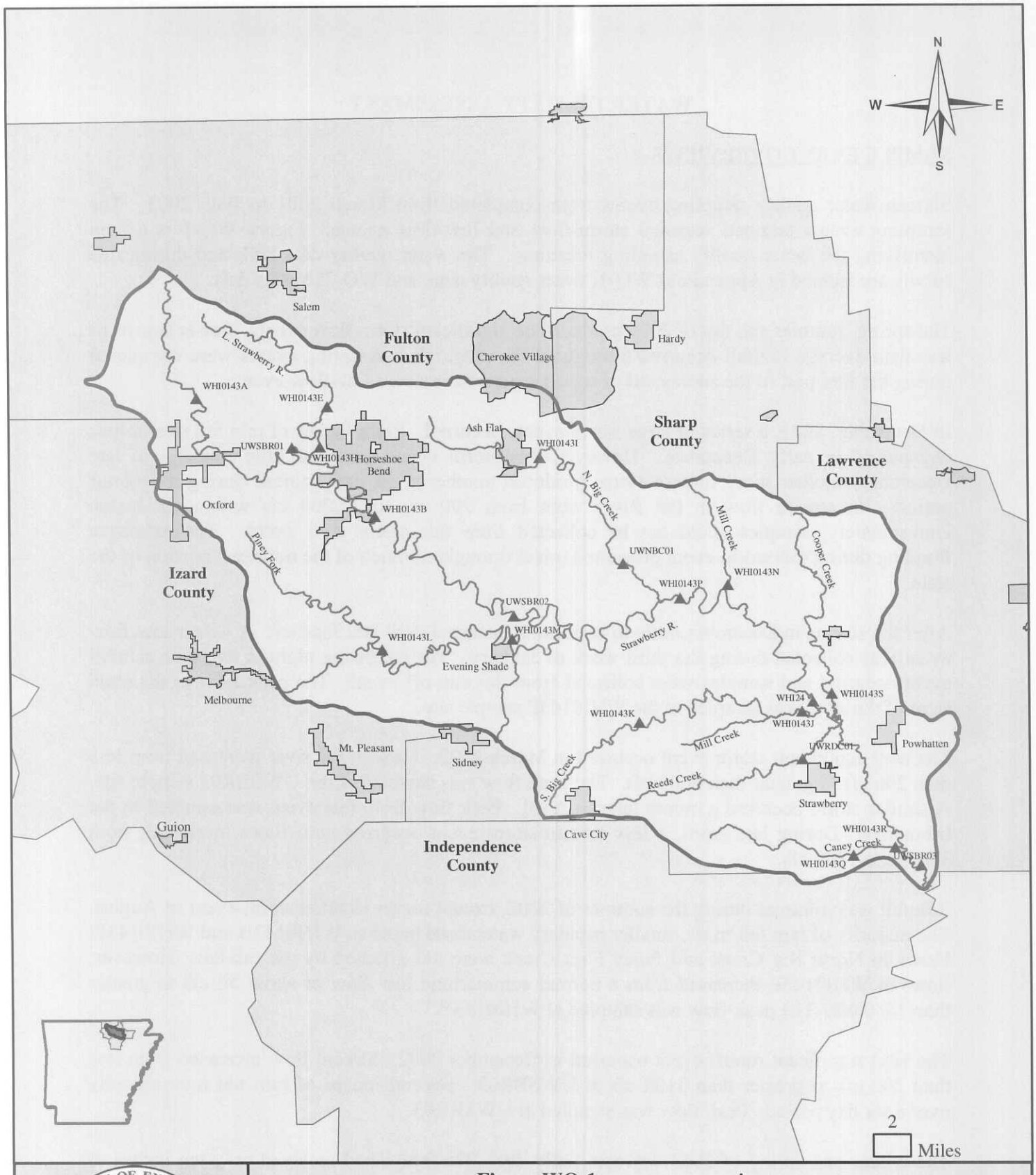


Figure WQ-1
Water Quality Sampling Locations
Strawberry River Watershed

Arkansas Department of
Environmental Quality
Water Division - Planning Section

Legend

- Watershed Boundary
- Cities
- Counties
- Streams
- ▲ Water Quality Stations

WATER CHEMISTRY DATA

Base flow conditions usually existed during September and January. During these months, especially during September, flows in the headwater streams were reduced to either standing pools or dry conditions. Low flow conditions in the main stem of the river ranged from less than 5 cfs at the upper site, WHI0143A, to 50 cfs in the mid-section of the river, UWSBR02, to generally no less that 130 cfs at UWSBR03. The peak flow during the survey, approximately 22,500 cfs, occurred in March 2002. The historical peak flow for the river occurred during the flood of December 1982. The river peaked at approximately 158,000 cfs (USGS, Stream flow statistics). On average, the river has an annual peak flow of less than 40,000 cfs.

Dissolved Oxygen

The greatest dissolved oxygen fluctuation recorded during the survey, 2.94 mg/L to 17.4 mg/L, was at the upper Little Strawberry River site, WHI0143A. The majority of the dissolved oxygen concentrations were between 5.0 mg/L and 10.0 mg/L. Three of the lowest values recorded during the survey occurred during the November 2001 sampling event at small tributary sites. The dissolved oxygen standard for the watershed ranges from 2.0 mg/L to 6 mg/L during the critical season, depending on watershed size, and is 6.0 mg/L during the rest of the season (Table 4 – Water Quality Standards and Criteria). There were only 10 dissolved oxygen grab sample readings recorded during the survey below 6.0 mg/L. Eight different sites had dissolved oxygen readings below 6.0 mg/L. Each reading occurred at one of the smaller tributary sites during seasonal low-flow conditions.

Turbidity and Total Suspended Solids

Turbidity values ranged from <1.0 NTU to 360 NTU. The assessment criteria for turbidity states that if more than 15% of the samples collected exceed either 17 NTU for Ozark Highland Streams, 84 NTU for Least-Altered Delta Streams, or 100 NTU for Channel-Altered Delta Streams, Table 4, then the water body is assessed as not attaining designated uses. Five sites, WHI0143A, UWSBR01, WHI0143H, WHI0143B, and UWSBR02, exceeded the criteria for designated use attainment for turbidity (Figure WQ-2) during the survey. Seven additional sites, WHI0143E, WHI0143L, WHI0143M, WHI0143I, UWNBC01, WHI0143P, and UWSBR03, had several exceedences of significant magnitude to warrant concern. All but one of these sites was in the upper portion of the watershed.

Overall, there is a decrease in both frequency of exceedence and peak magnitude of turbidity values from the headwaters to the mouth of the river. Figure WQ-2. However, in the main stem of the river there is a definite increase in turbidity in a downstream direction in both the peak and median values, Figure WQ-3. The main stem site at Arkansas Highway 58 near Poughkeepsie, WHI0143P, shows a significant decrease in peak turbidity, but not a decrease in the median turbidity value. This site is downstream of the confluence of North Big Creek, which had some of the lowest peak and median turbidity values of all of the tributary sites during the survey; and thus perhaps influenced the turbidity values at WHI0143P.

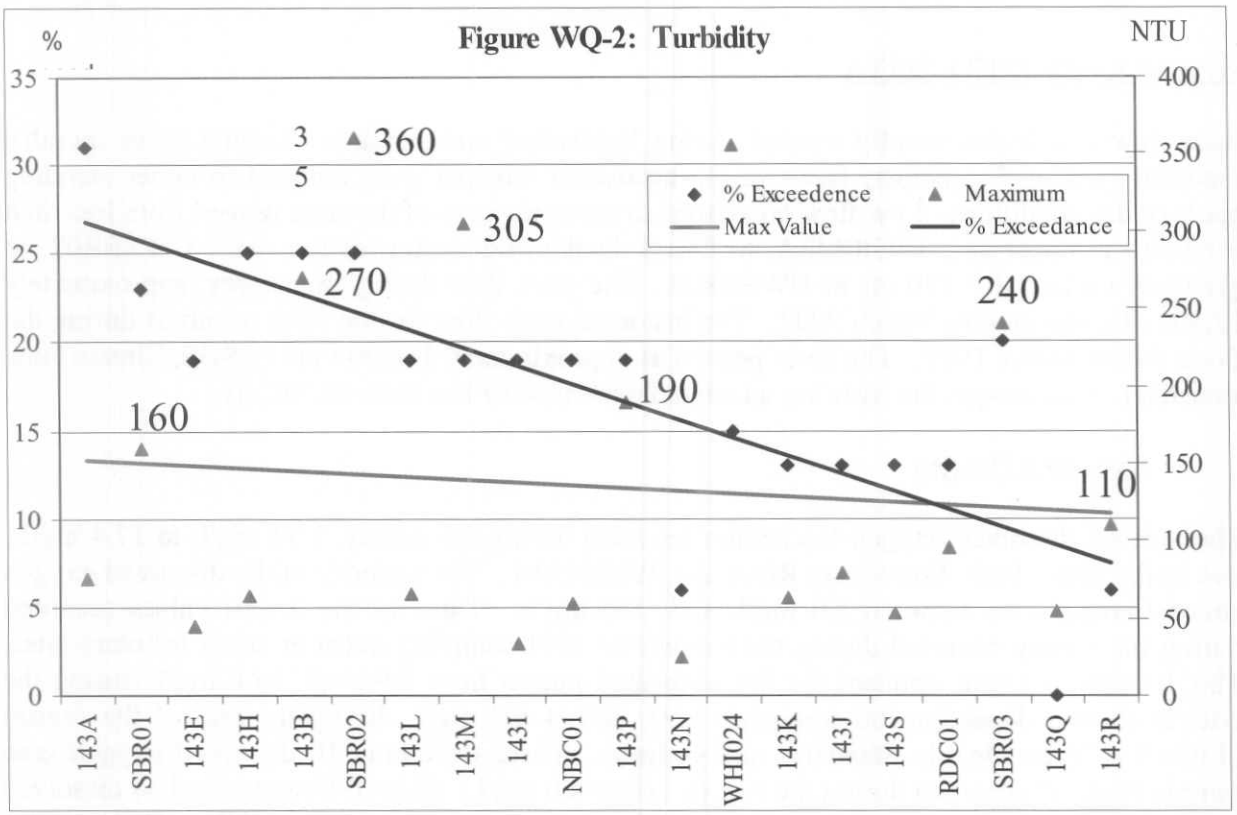


Figure WQ-2: Turbidity
%
NTU
35
30
25
20
15
10
5
0
400
350
300
250
200
150
100
50
0
3
5
360
305
270
240
190
160
110
% Exceedence
Maximum
Max Value
% Exceedance
143A
SBR01
143E
143H
143B
SBR02
143L
143M
143I
NBC01
143P
143N
WHI024
143K
143J
143S
RDC01
SBR03
143Q
143R

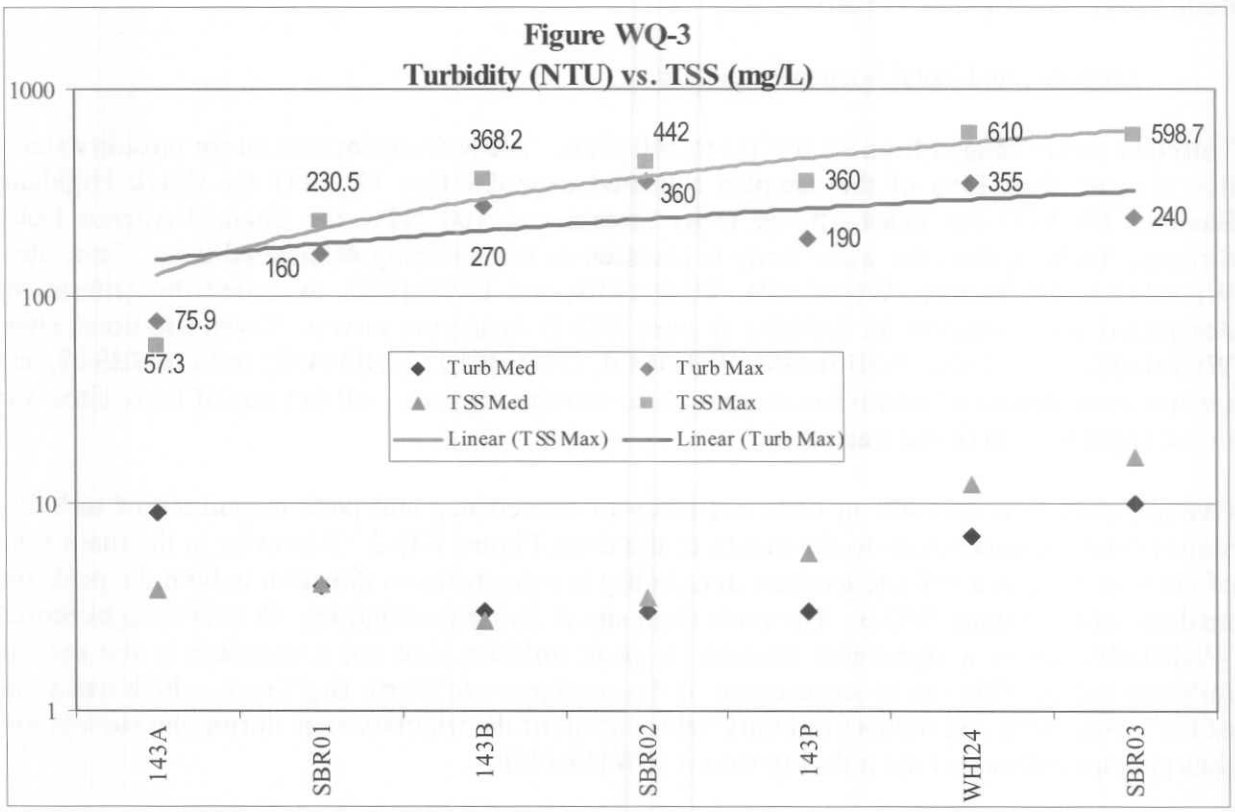


Figure WQ-3
Turbidity (NTU) vs. TSS (mg/L)
1000
100
10
1
368.2
442
610
598.7
230.5
360
360
355
240
160
270
190
75.9
57.3
Turb Med
Turb Max
TSS Med
TSS Max
Linear (TSS Max)
Linear (Turb Max)
143A
SBR01
143B
SBR02
143P
WHI24
SBR03

All but one peak turbidity value occurred during the January 24, 2002 storm event. Samples were collected prior to this storm event on January 22, 2002, a winter low-flow event. Turbidity values during this event were less than 5 NTU. However, two days later during the storm event turbidity values ranged from 25 NTU to 360 NTU. This storm event produced flows above bank full at many locations with a peak flow of approximately 6700 cfs at WHI024.

Total suspended solids (TSS) concentrations ranged from <1.0 mg/L to 610 mg/L. Most of the peak concentrations occurred during the January 24, 2002 storm event. Similar to the turbidity trends, the TSS concentrations trend increased in a downstream direction. There also was a slight increasing trend in the maximum TSS concentrations in a downstream direction. The lowest main stem site, Strawberry River near Saffell, UWSBR03, had the highest median TSS value of 16.8 mg/L. The lowest two main stem sites had the highest peak concentrations during the survey, both were approximately 600 mg/L.

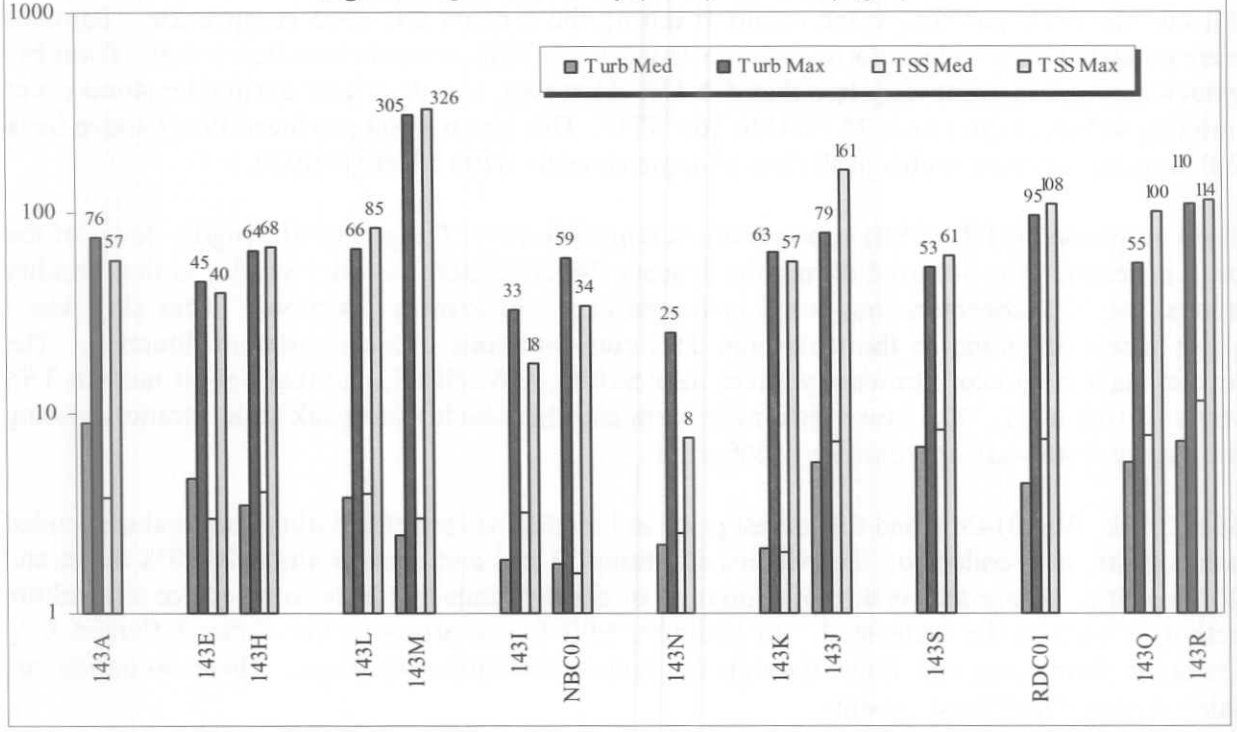
Mill Creek, WHI0143N, had the lowest peak and median values of turbidity and total suspended solids of all sites collected. The watershed drains 23 mi^2 and is approximately 80% forest and 20% pasture. There also is a limited amount of county roads and little to no active silviculture activities with in the watershed. In addition, Mill Creek arises in the Cotter/Jefferson City Dolomite formations and flows through the Powell Dolomite formation. These dolomites are fairly compact and resist erosion.

North Big Creek and the Little Strawberry River arise and flow through the Powell Dolomite formation. The peak turbidity and TSS values of these streams were usually less than 70 NTU and 70 mg/L, respectively (Figure WQ-4). In contrast, the peak TSS and turbidity values of the tributaries in the southern portion of the watershed, Piney Creek (WHI0143L & M), South Big Creek (WHI0143J), and Reeds Creek (RDC01) were noticeably higher, ranging from 100 mg/L to over 300 mg/L. These tributaries arise and flow through the St. Peter Sandstone and Everton formation. These formations are highly erodible, loosely compacted sandstones. It is apparent that the soils found throughout the watershed have an impact on the water quality in the river and its tributaries during storm events. In addition, land uses differ somewhat between the northern and southern tributaries. Land use in the northern tributaries is mainly dairy and cattle production with limited active silviculture. However, the land use in the southern tributaries is mostly poultry production and cattle grazing facilities with some active silviculture.

Chlorides, Sulfates and Total Dissolved Solids

Chloride concentrations ranged from a low near 1.0 mg/L at several sites, to a maximum of 22.90 mg/L at WHI0143I, the site downstream from the Ash Flat waste water treatment facility. Chloride concentrations at this site were normally less than 7.0 mg/L; but on three occasions the concentrations were greater than 19.0 mg/L. The median chloride value at all of the sites during the survey was less than 5.0 mg/L.

Figure WQ-4: Turbidity (NTU) vs. TSS (mg/L)

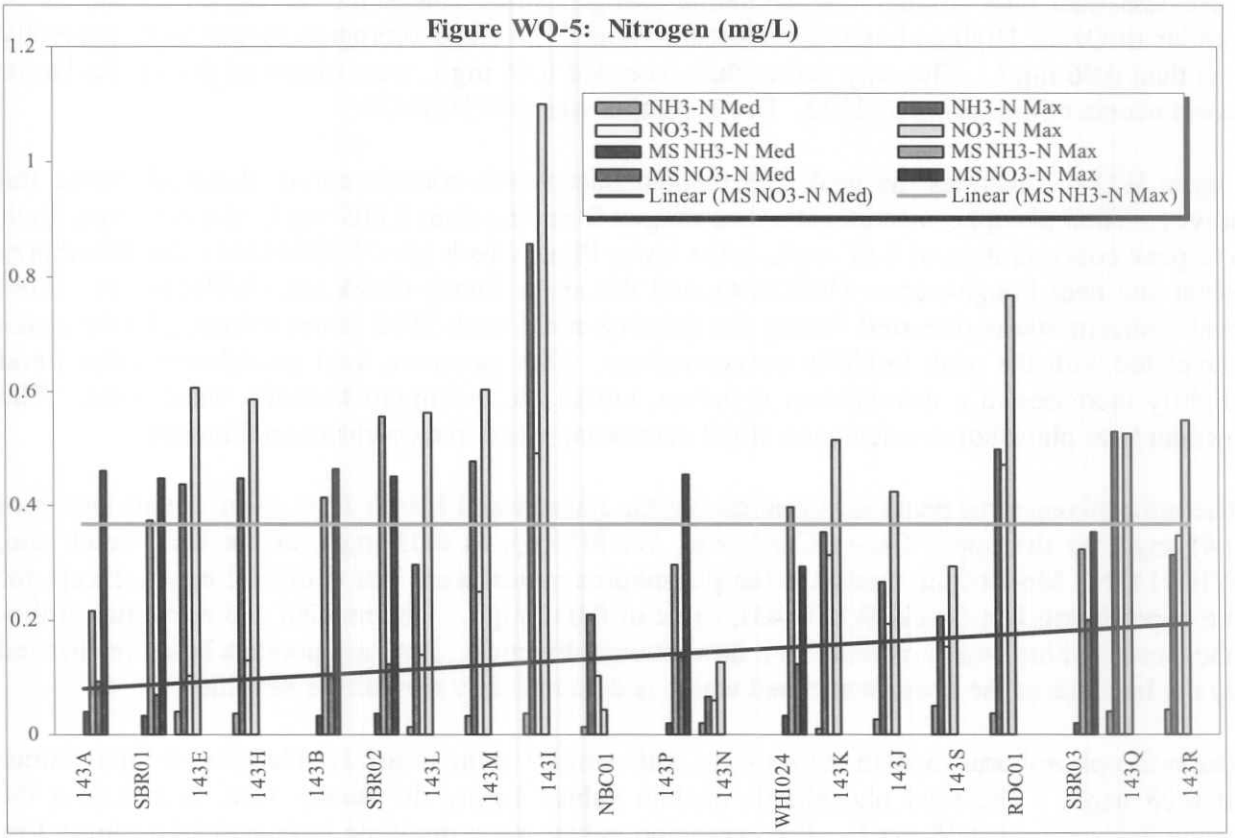


Total dissolved solids (TDS) concentrations ranged from less than 100 mg/L to 281 mg/L during the survey. Mill Creek, WHI0143N, had the highest median TDS value of 257 mg/L of all sites. The North Big Creek sites median TDS values were both near 248 mg/L, both of which are influence by the Ash Flat WWTP. All of the other sites had median TDS values at or below 205 mg/L. This is probably a direct reflection of the geologic formation, the Cotter and Jefferson City Dolomite, of the watersheds. During the larger storm events, the TDS values decreased in these systems, thus suggesting that the ground water influence in these systems plays an important roll in their TDS concentrations.

Nutrients

Figure WQ-5 illustrates the peak and median ammonia-nitrogen and nitrate+nitrite-nitrogen concentrations measured during the survey. The highest peaks, 1.10 mg/L of nitrate+nitrite-nitrogen (nitrogen) and 0.8 mg/L of ammonia-nitrogen, occurred at the site on North Big Creek below the Ash Flat waste water treatment facility, WHI0143I. However, the lower North Big Creek site had some of the lowest nitrogen concentrations measured during the survey with most values less than 0.2 mg/L. The lowest peak nitrogen value of 0.6 mg/L and lowest median nitrogen value of 0.13 mg/L were observed at Mill Creek, WHI0143N. Both of these watersheds, North Big Creek and Mill Creek have a very limited number of confined animal and cattle grazing operations, and a large percentage of silviculture land use.

Figure WQ-5: Nitrogen (mg/L)



Note: MS is main stem sites. The trend line is for main stem sites only.

Reed's Creek, UWRDC01, had the second highest peak nitrogen value of 0.77 mg/L, a median nitrogen value of 0.47 mg/L, and the highest maximum ammonia-nitrogen values of 0.50 mg/L, of all of the sites sampled, Figure WQ-5. This tributary also has one of the highest confined animal feeding operation concentrations within the watershed and a very high percentage of pasture land use. It was also observed that this tributary had a very high percentage of canopy cover throughout its length, thus limiting light penetration and possibly limiting the assimilation of these nutrients.

Figure WQ-5 illustrates that there is an increase in the median nitrate+nitrite-nitrogen concentration in a downstream direction. The peak concentrations seem to decrease somewhat at the two lowest main stem sites, from 0.45 mg/L to 0.35 mg/L, while remaining about the same at the other five main stem sites. In contrast, the median nitrate+nitrite-nitrogen values continue to increase from approximately 0.10 mg/L to 0.20 mg/L. However, these values are significantly lower than average median value of 0.85 mg/L of the Ozark Highlands ecoregion reference streams.

The Strawberry River north of Evening Shade, UWSBR02, had the highest ammonia-nitrogen concentration of 0.55 mg/L of all the main stem sites, Figure WQ-5. Trend analysis indicates that the main stem sites peak and median ammonia-nitrogen concentrations remain stable or slightly decrease in a downstream direction. Median concentrations from the main stem sites

were less than 0.04 mg/L. The ammonia-nitrogen values measured during the survey were similar to Ozark Highland ecoregion stream values. Average ecoregion values were generally less than 0.06 mg/L. The only values that exceeded 0.06 mg/L were observed during the larger storm events of the spring of 2002. The exception was at WHI0143I.

Figure WQ-6 illustrates the peak and median phosphorus concentrations observed during the survey. Total phosphorus concentrations ranged from less than 0.005 mg/L, the detection limit, to a peak concentration of 0.52 mg/L at the lower Piney Creek site (WHI0143M), the Strawberry River site near Poughkeepsie (WHI024), and the upper Caney Creek site (WHI0143Q). Most peak concentrations occurred during the January and March 2002 storm events. These peaks correlated with the peak turbidity concentrations. The maximum total phosphorus value trend slightly increases in a downstream direction, unlike the maximum turbidity value trend. The median total phosphorus value has a slight decreasing trend in a downstream direction.

The ortho-phosphorus peaks occurred during the January and March 2002 storm events and from 0.41 mg/L at the upper Caney Creek site, WHI0143Q, to 0.03 mg/L at the Mill Creek site, WHI0143N. Most of the median ortho-phosphorus values were less than 0.02 mg/L, except for the upper North Big Creek, WHI0143I, value of 0.031 mg/L. The median and maximum ortho-phosphorus value trends increase in a downstream direction. Both are perhaps being influenced by the land use of the lower watershed which is dominated by agriculture activities.

The ortho-phosphorus median values were quite similar to the Ozark Highlands ecoregion values of 0.03 mg/L. The total phosphorus median values during the survey were higher than the ecoregion value of 0.05 mg/L. The ecoregion values are a one-time grab sample during a low flow event. Most of the low-flow events during the survey had total phosphorus values at or less than 0.05 mg/l.

Fecal Coliform Bacteria

Fecal coliform bacteria samples were collected on 25 occasions from all sites. Eight samples were collected during both the 2001 and 2002 primary contact recreation (swimming) season. On a couple of occasions there was no water present at a few sites, thus these sites will have fewer samples. Assessment criteria states that if more than 25% of the samples collected during the swimming season exceed either the primary or secondary contact recreation standard, Table 4, then the swimming use is assessed as impaired.

Bacteria concentrations ranged from less than 4 col/100ml to greater than 2664 col/100ml. The intent of this survey was to determine designated use attainment and not to quantify maximum bacteria concentrations; thus a three milliliter dilution was used as the smallest dilution. Four sample sites had more than 25% of the samples collected during the 2001 swimming season exceed the standard, Figure WQ-7. The upper Strawberry River site, WHI0143E, had over 40% of the samples collected during the swimming season exceed the standard; Mill Creek, WHI0143N, and the lower South Big Creek site, WHI0143J, had almost 40% exceedence, and Cooper's Creek, WHI0143S, had a 50% exceedence. Four other sites, the Strawberry River near Wiseman, UWSBR01, the lower Little Strawberry River, WHI0143H, Reed's Creek, UWRDC01, and the lower Caney Creek site, WHI0143R, had a 25% exceedence rate.

Figure WQ-6: Phosphorus (mg/L)

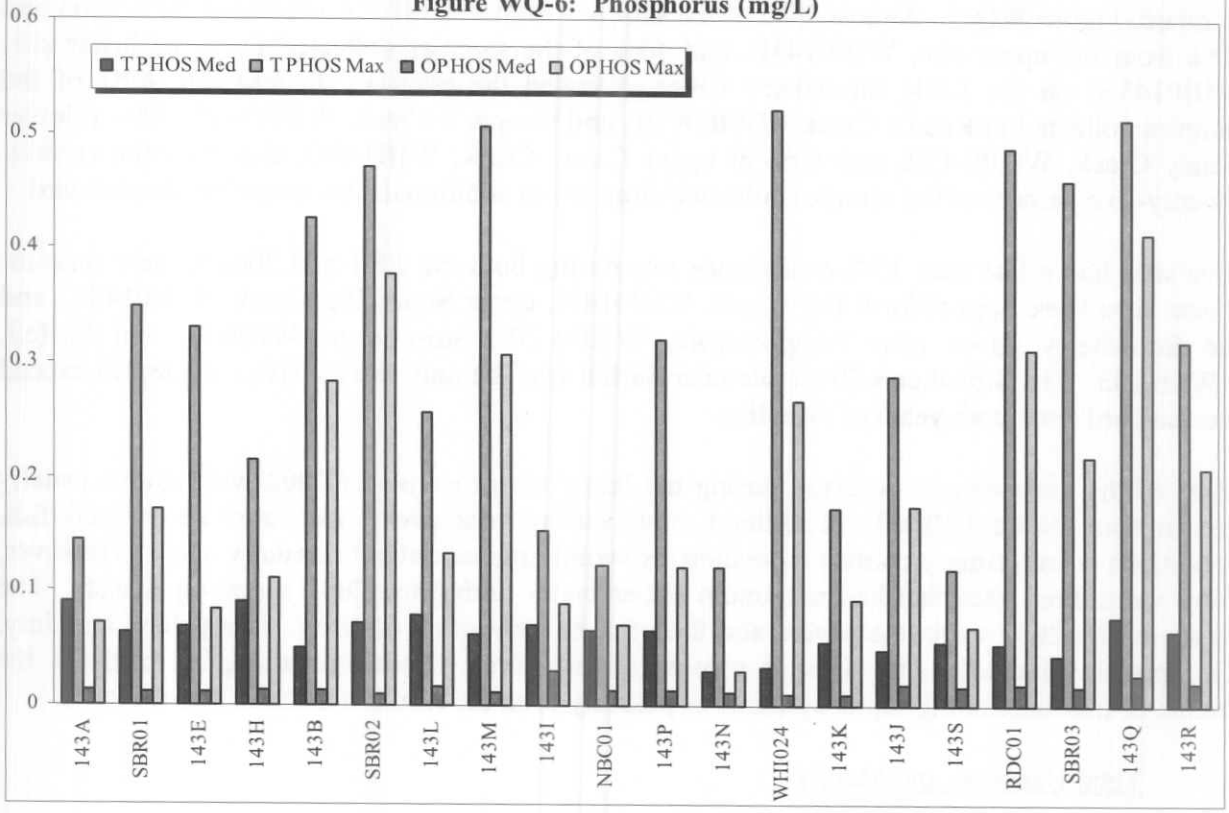
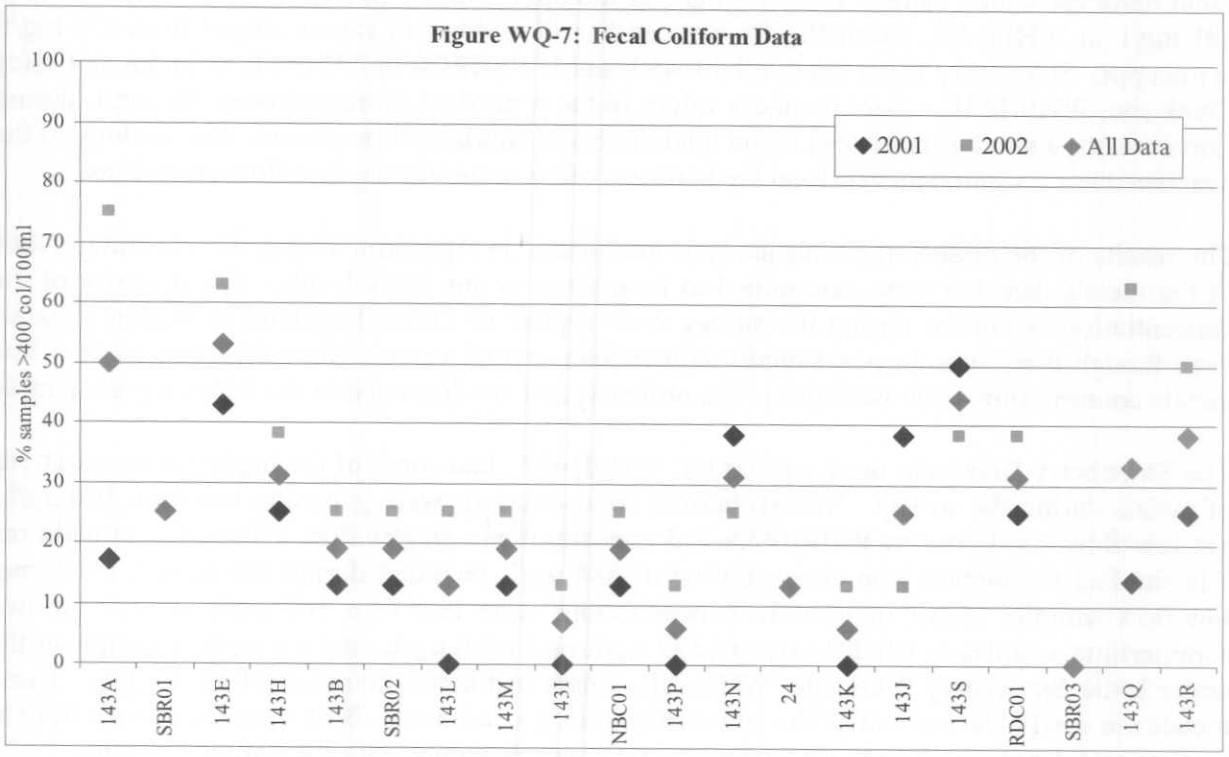


Figure WQ-7: Fecal Coliform Data



The 2002 bacteria data indicates a different result. Seven sites had concentrations exceed the standard, Figure WQ-7. Almost 75% of the samples from WHI0143A exceeded the criteria and 60% from the upper site, WHI0143E, and 40% of the samples collected from the lower site, WHI0143H, on the Little Strawberry River exceeded the criteria. In addition, 40% of the samples collected at Reed's Creek, UWRDC01, and Cooper's Creek, WHI0143S, 50% at lower Caney Creek, WHI0143R, and 60% at upper Caney Creek, WHI143Q, exceeded the criteria. Twenty-five percent of the samples collected from seven additional sites exceeded the standard.

Five sites had a less than 15% exceedence rate during both the 2001 and 2002 sample seasons. These sites were upper North Big Creek, WHI0143I, upper South Big Creek, WHI0143K, and the Strawberry River near Poughkeepsie, WHI0143P, Strawberry, WHI024, and Saffell, UWSBR03. The Strawberry River site near Saffell was the only site to have no samples exceed the standard from both years of sampling.

Most of the exceedences occurred during the larger storm events of 2002 with counts usually greater than 2664 col/100ml. In addition, flows during those events were at or above bank full, conditions when primary contact recreation, or swimming, would not normally occur. However, there were three sites that had maximum exceedences during the 2001 sampling season. The flows during 2001 were less severe and the peak concentration occurred during June and July. This possibly indicates that there is a more direct source of contamination, i.e. cattle in the stream or malfunctioning septic systems, or possibly even the result of isolated storm events.

Total Hardness and Metals

Total hardness values ranged from 30 mg/L at the upper Strawberry River site, WHI0143A, to 291 mg/L at WHI0143I, North Big Creek near Ash Flat. Median values ranged from 151 mg/L at the upper Strawberry River sites, WHI0143A and UWSBR01, to 272 mg/L at the lower Caney Creek site, WHI0143R. Total hardness values in the watershed decreased over 100 mg/L during storm events, a similar trend seen in the total dissolved solids concentrations. The geology of the watershed has a significant effect on the hardness of the water during low-flow conditions.

The results of the dissolved metals analysis are located in Appendix WQ-2, Metals Data. None of the metals detected were determined to be present in any toxic levels. The majority of the concentrations recorded during the survey were typical of Ozark Highland ecoregion streams, even though there was an occasionally higher than normal value. However, there were a few metals concentrations that were out of the ordinary, and are discussed in the following paragraph.

The Strawberry River site north of Oxford, WHI0143A, had some of the highest concentrations of metals during the survey. Normal barium concentrations were generally less than 100 µg/L, but low-flow conditions at WHI0143A had concentrations greater than 300 µg/L. In addition, this site had the highest iron concentration of 884 µg/L recorded during the survey, a summer low-flow sample. Most manganese concentrations were less than 100 µg/L, except for two summertime samples at WHI0143A of 1639 µg/L and 1410 µg/L, and a low-flow sample at the upper Little Strawberry River site, WHI143E, which had a concentration of 3230 µg/L. These metals are easily leached out of the soil during anoxic conditions. Both sites experience little to no flow and depressed diurnal dissolved oxygen concentration during the summer months.

72-Hour Dissolved Oxygen Profiles

Dissolved oxygen (DO), pH and temperature profiles were recorded for 72-hour periods during July and August at the following sites: WHI0143A, UWSBR01, WHI0143E, WHI0143H, WHI0143B, UWSBR02, WHI0143L, WHI0143M, WHI0143I, WHI0143N, WHI024, WHI0143K, WHI0143J, WHI0143S, UWRDC01, UWSBR03, WHI0143Q, WHI0143R, upstream of Ash Flat WWTP and North Big Creek at North Big Creek Road. Sampling years may vary for some sites, but sites were always profiled during minimum flow periods. Figures WQ-8 thru WQ-31 illustrate the data.

Three DO standards apply during the critical season to the Strawberry River: 1) Ozark Highlands ecoregion 10 to 100 mi^2 standard is 5 mg/L; 2) Ozark Highlands ecoregion >100 mi^2 watershed standard is 6 mg/L; and 3) Delta ecoregion >100 mi^2 watershed standard is 5 mg/L. The first standard applies to WHI0143A and UWSBR01. The second standard applies to WHI0143B, UWSBR02 and WHI024. The third standard applies to UWSBR03.

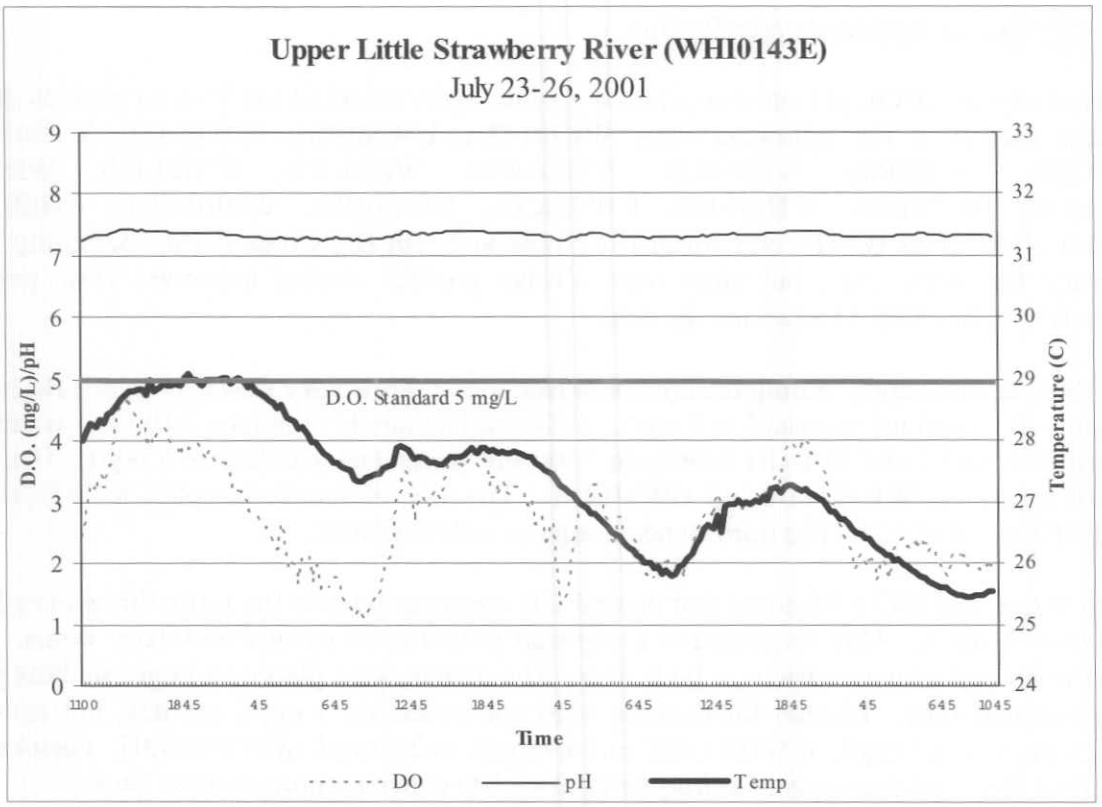
Figures WQ-8 and WQ-9 illustrate that diurnal DO concentrations in the Little Strawberry River drop below 5 mg/L. This watershed is comprised primarily of pasture and dairy farms. Tree canopy is limited or non-existent at both sites. The meters were placed in large, shallow pools during minimal flow. Diurnal fluctuations were not excessive, 3 mg/L per day, but extremes were 4.6 mg/L to 1.1 mg/L at WHI0143E and 6.9 mg/L to 2.5 mg/L at WHI0143H. Factors such as minimal flow and decomposition may be limiting DO concentrations at these sites.

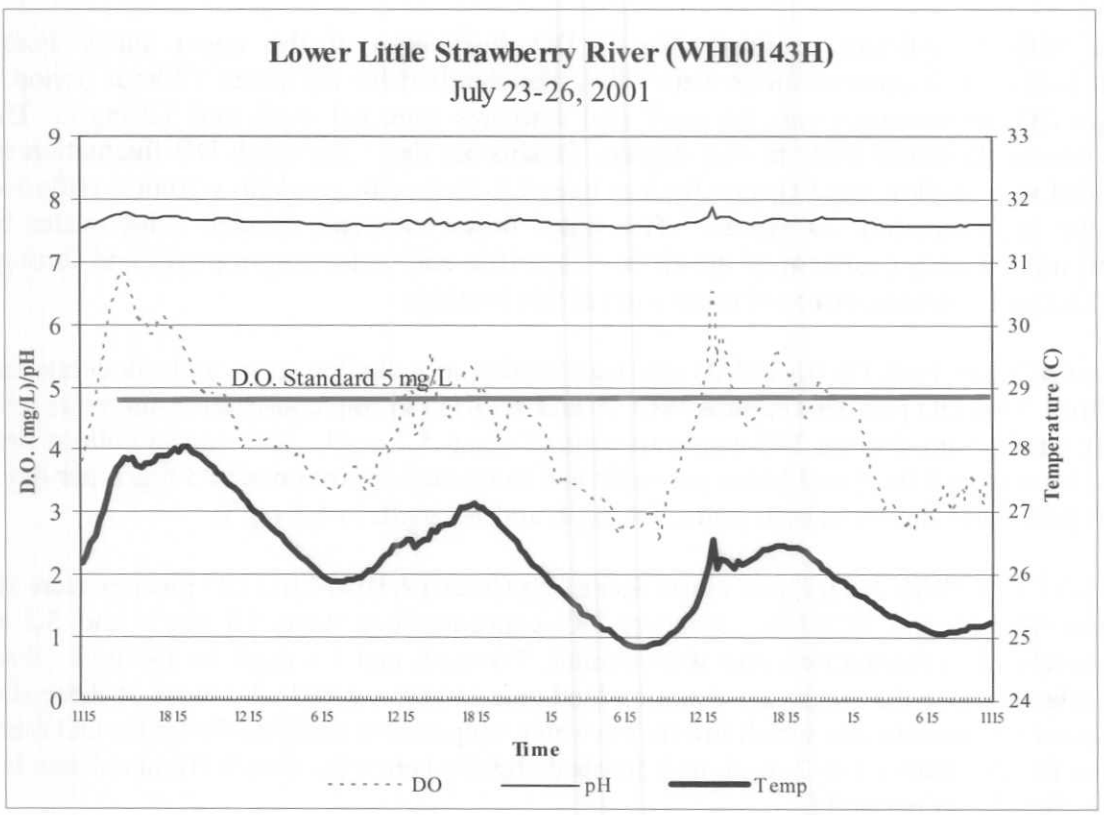
Figure WQ-10 indicates minimal diurnal DO fluctuation at the upper Piney Fork site (WHI0143L). DO concentrations were above the standard for the entire 72-hour period. The average DO concentration was 5.6 mg/L and extremes were 6.4 mg/L and 5.2 mg/L. Diurnal temperatures fluctuated three to four degrees Celsius per day. The small DO fluctuation can be attributed to a shallow pool (generally less than 1.5 feet) with good flow from a riffle located upstream approximately 30 meters. The water flows over and through a low-water bridge located immediately upstream of the riffle. The riffle and water pouring over and through the bridge act as a constant source of re-aeration at this location.

The lower Piney Fork (WHI0143M) site was located in a shallow pool with moderate canopy and flow. Two DO profiles (Figures WQ-11 and WQ-12) during consecutive summers revealed similar results with average DO concentrations of about 5.7 mg/L. DO concentrations dropped below the standard for 4 to 8 hours per night and fluctuated approximately 3 mg/L per day. DO fluctuations were similar in both years, 7.4 mg/L and 7.9 mg/L to 4.3 mg/L.

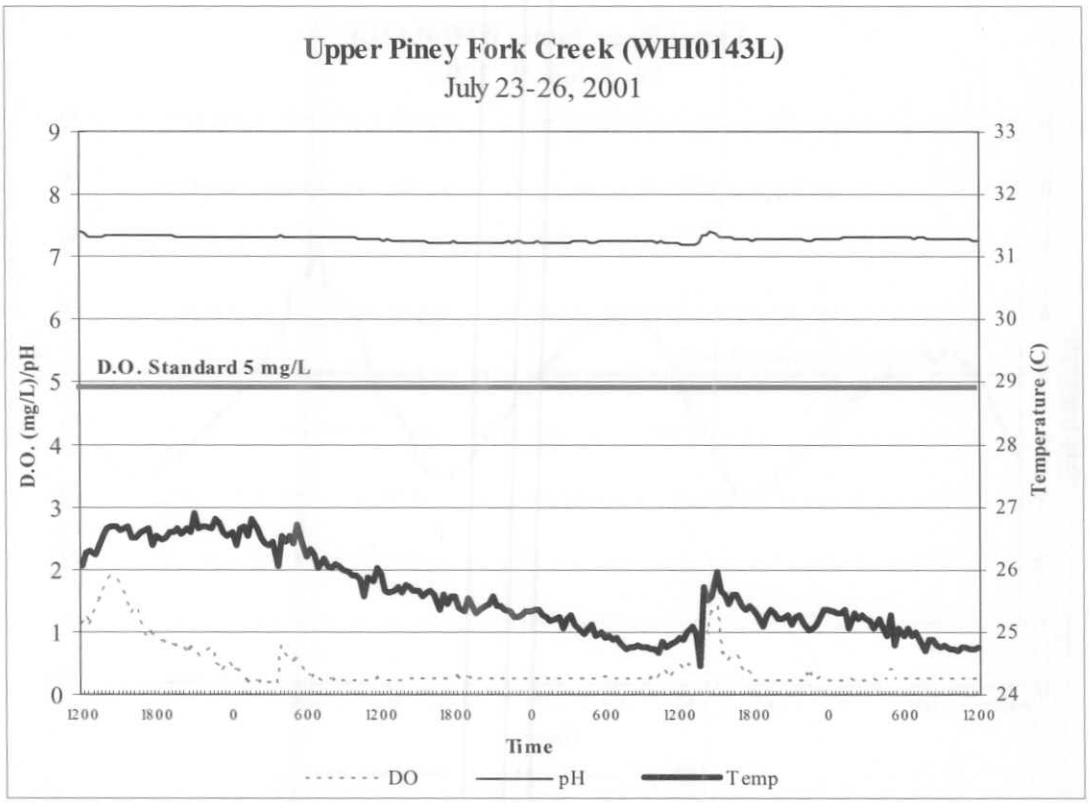
The Mill Creek (WHI0143N) and upper South Big Creek (WHI0143K) DO profiles were similar (Figures WQ-13 and WQ-14). Average DO concentrations were 5.5 mg/L and 5.3 mg/L, respectively. DO fluctuations also were similar, 7.0 mg/L and 7.2 mg/L to 4.4 mg/L. Pastures and cattle access to the creeks are common land uses in both watersheds. Both of these sites are influenced by groundwater which lowers the water temperature allowing for better DO retention. Diurnal DO fluctuated 1 to 2 mg/L and dropped slightly below the Ozark Highland standard for four to eight hours per night.

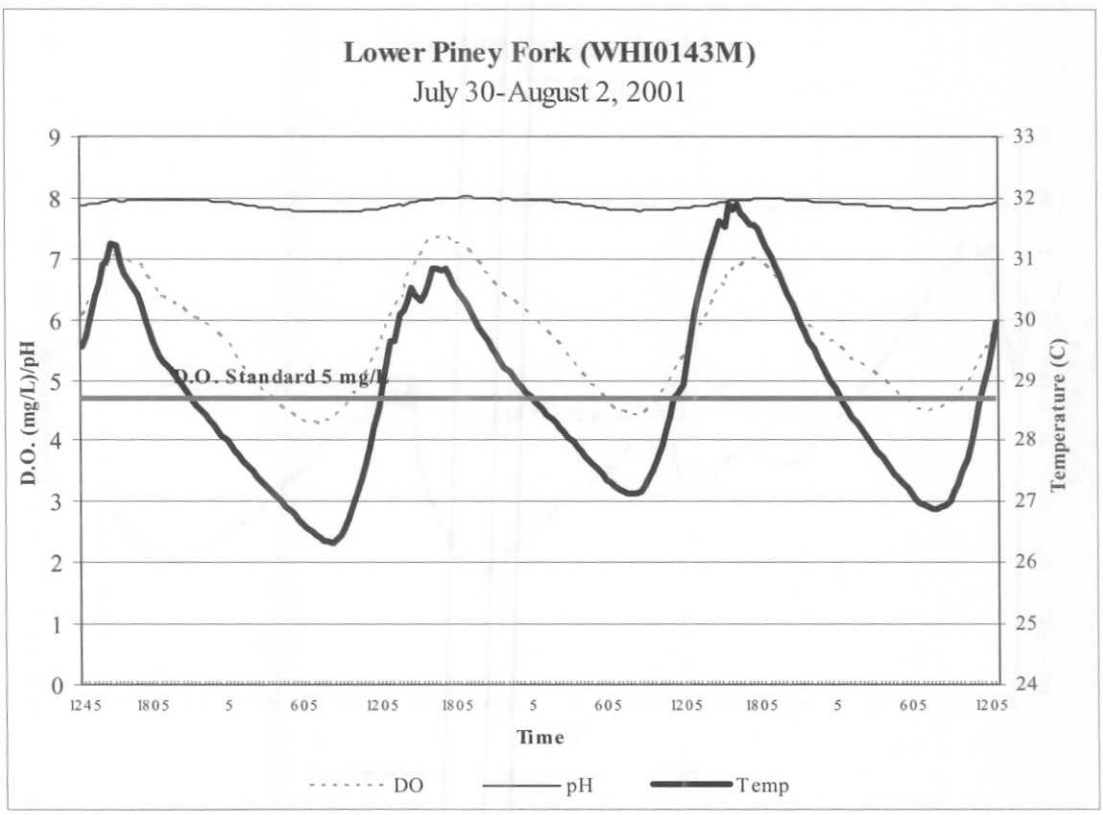
Figures WQ-8 and WQ-9



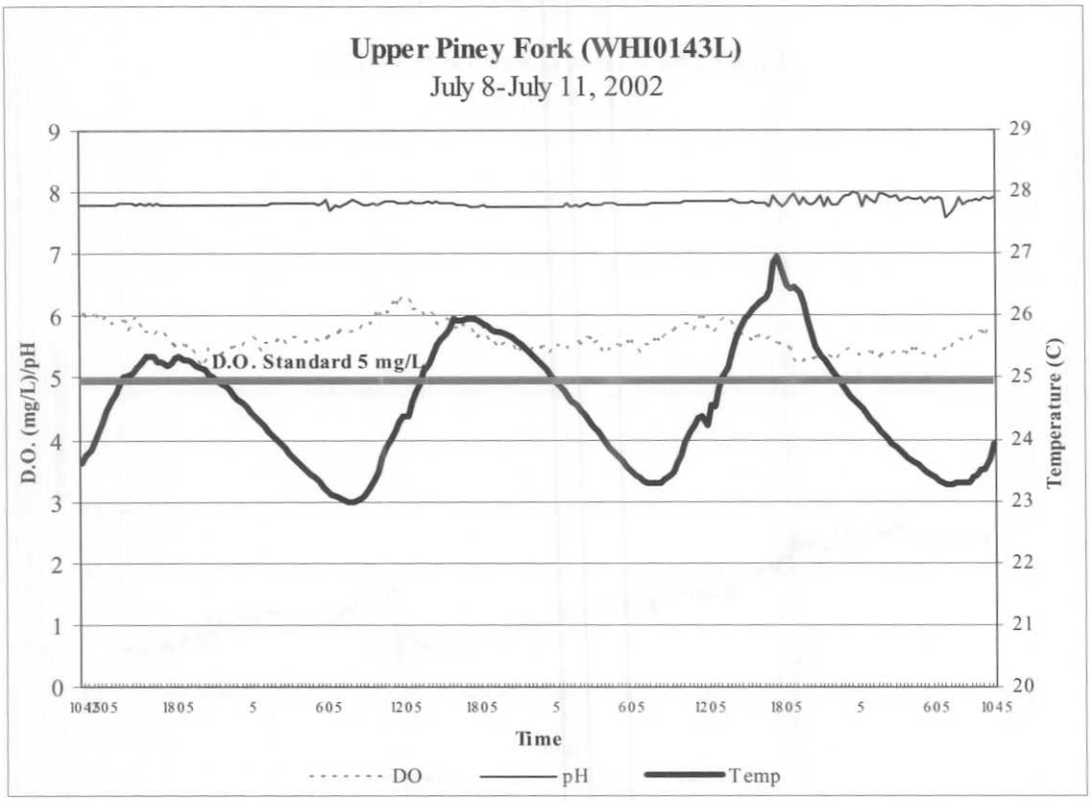


Figures WQ-10 and WQ-11





Figures WQ-12 and WQ-13



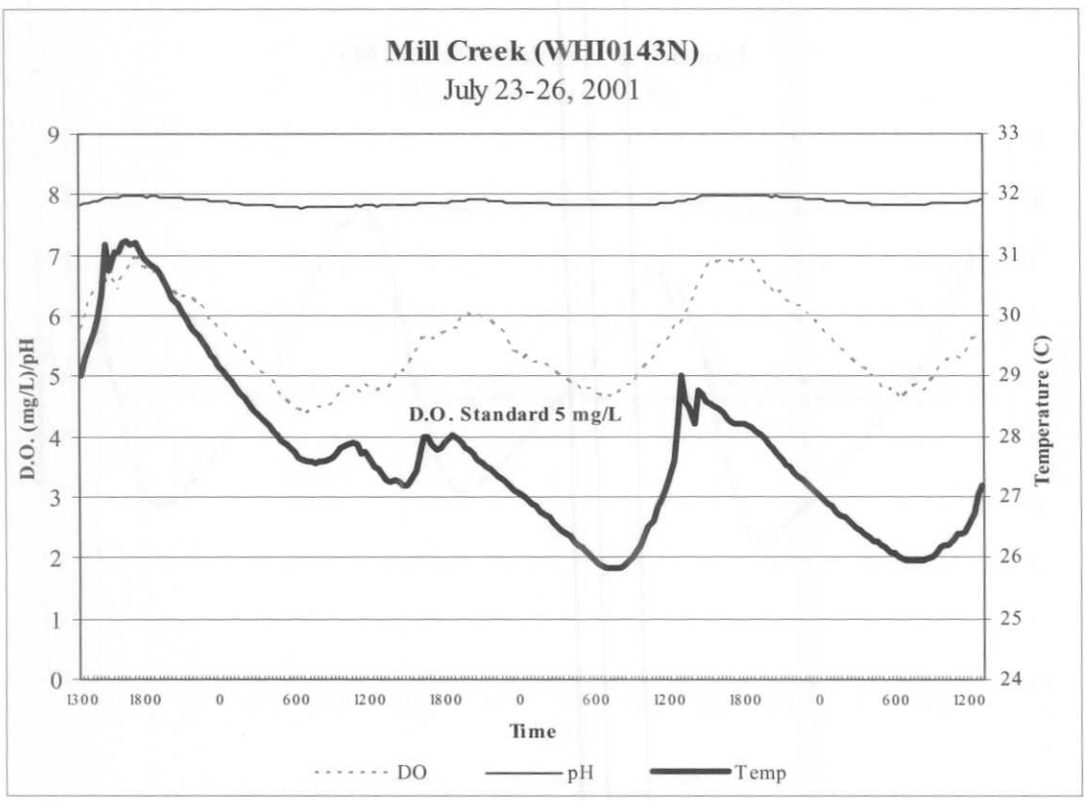
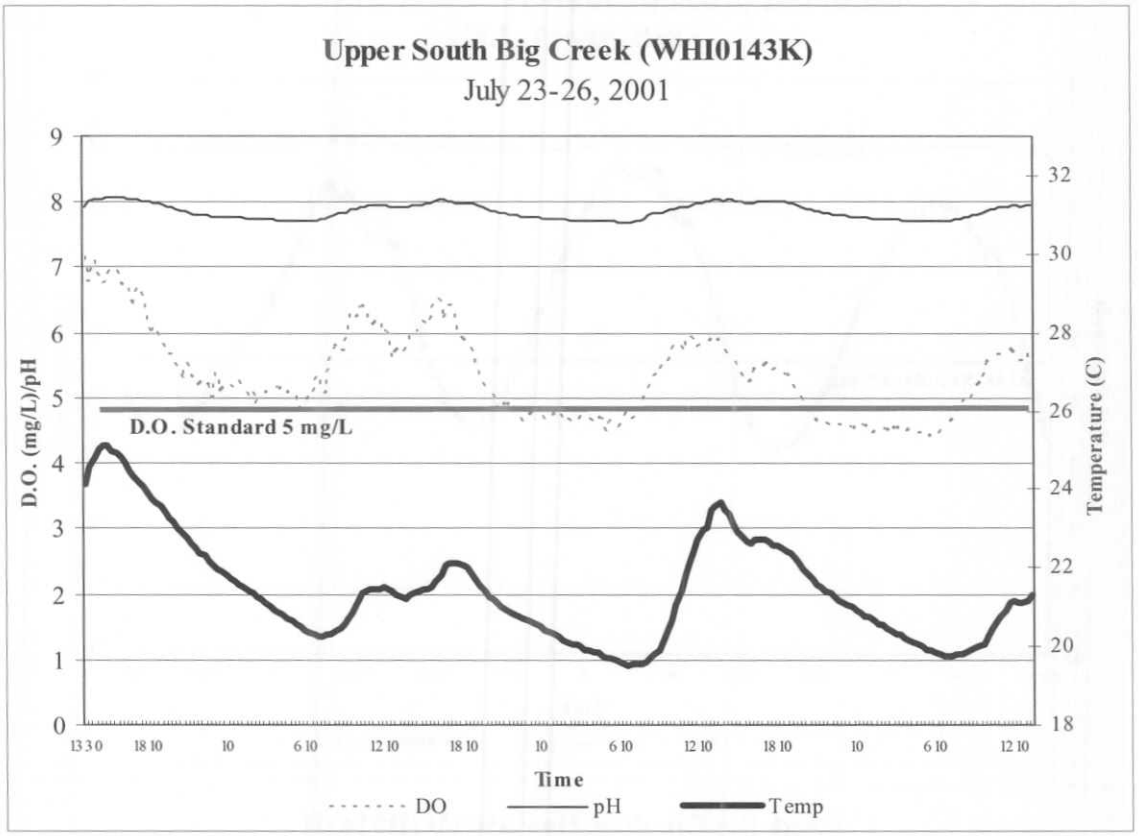


Figure WQ-14

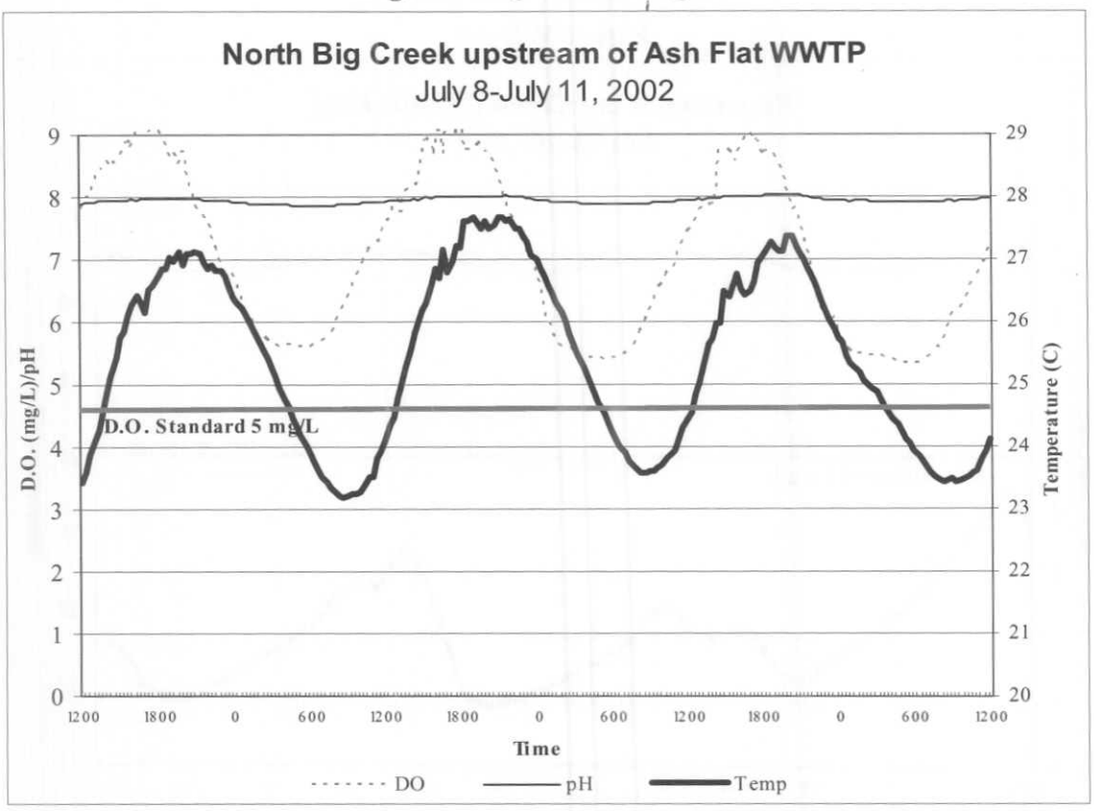


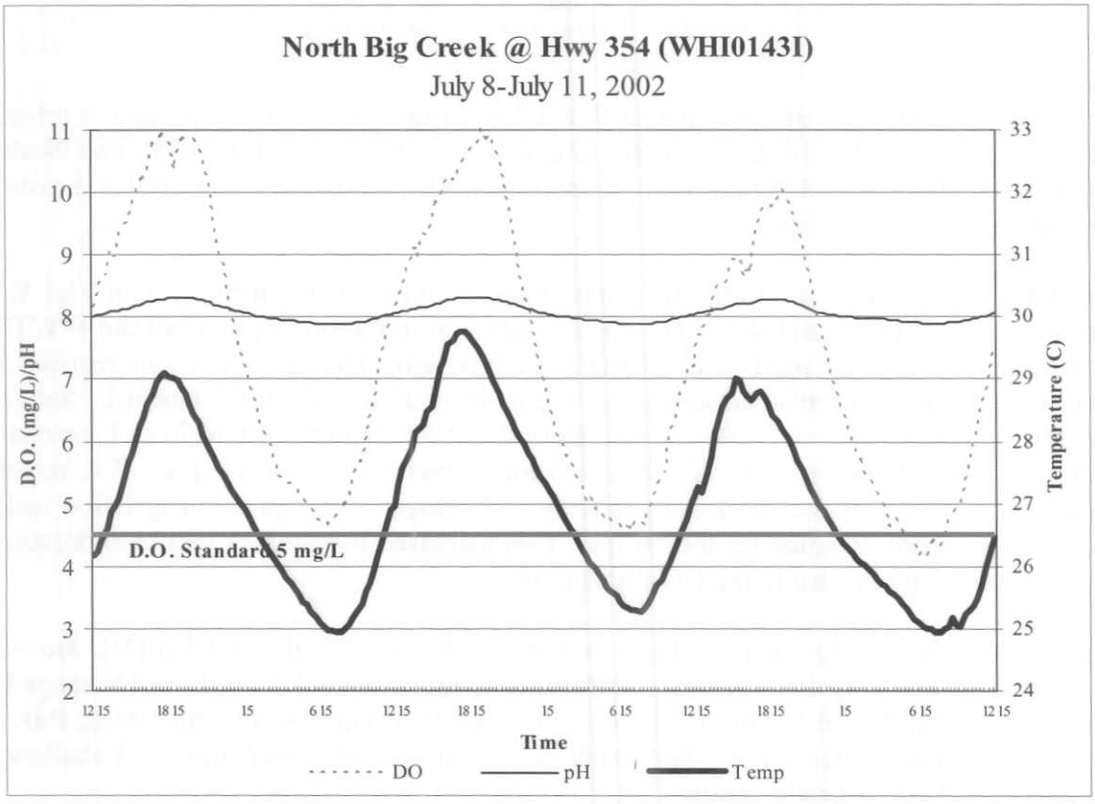
North Big Creek upstream of the Ash Flat WWTP is influenced by cattle access and urban run-off from Ash Flat. WHI0143I, North Big Creek below the Ash Flat WWTP, and North Big Creek at North Big Creek Road are located approximately one and two river miles downstream of the Ash Flat WWTP, respectively.

Three DO profiles from the North Big Creek sites displayed the effects of Ash Flat WWTP (Figures WQ-15, WQ-16, and WQ-17). The average concentration upstream of the WWTP was 7.0 mg/L compared to 7.4 mg/L and 6.7 mg/L downstream. DO concentrations reached 115% saturation upstream and remained above the Ozark Highlands ecoregion standard. Saturations downstream reached 130% to 140% and had diurnal DO fluctuations of 6 to 7 mg/L compared to 4 mg/L upstream. However, the DO concentrations never fell below 4 mg/L. The meter was deployed downstream of the Arkansas Highway 354 bridge. The riparian vegetation had been cleared and the creek widened for the bridge. This increased light penetration and duration and was probably the main factor in the DO fluctuations.

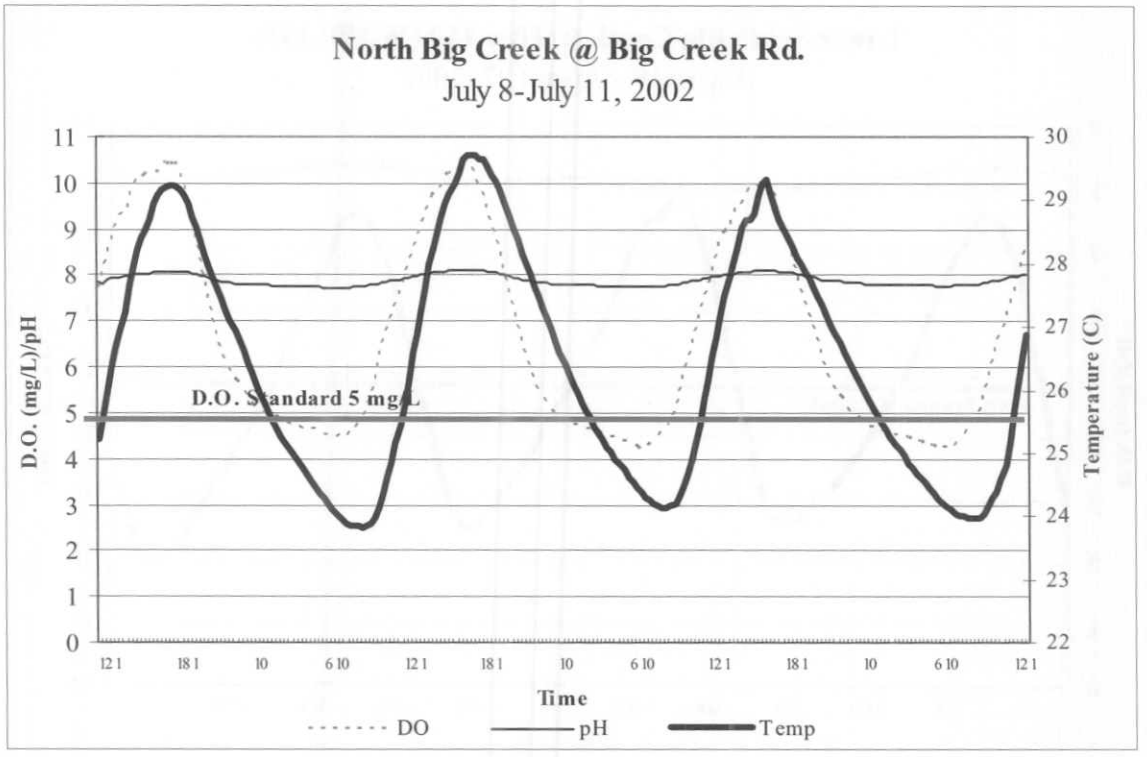
The 2001 and 2002 DO profiles from lower South Big Creek (WHI0143J) are similar (Figures WQ-18 and WQ-19). Average DO concentrations were 7.2 mg/L. DOs ranged from 9.0 mg/L to 6.0 mg/L and 8.6 mg/L to 6.4 mg/L. As with upper South Big Creek, this site is influenced by groundwater flows. The lower water temperature, good flow and shallow clear water maintained the DO concentration.

Figures WQ-15 and WQ-16





Figures WQ-17 and WQ-18



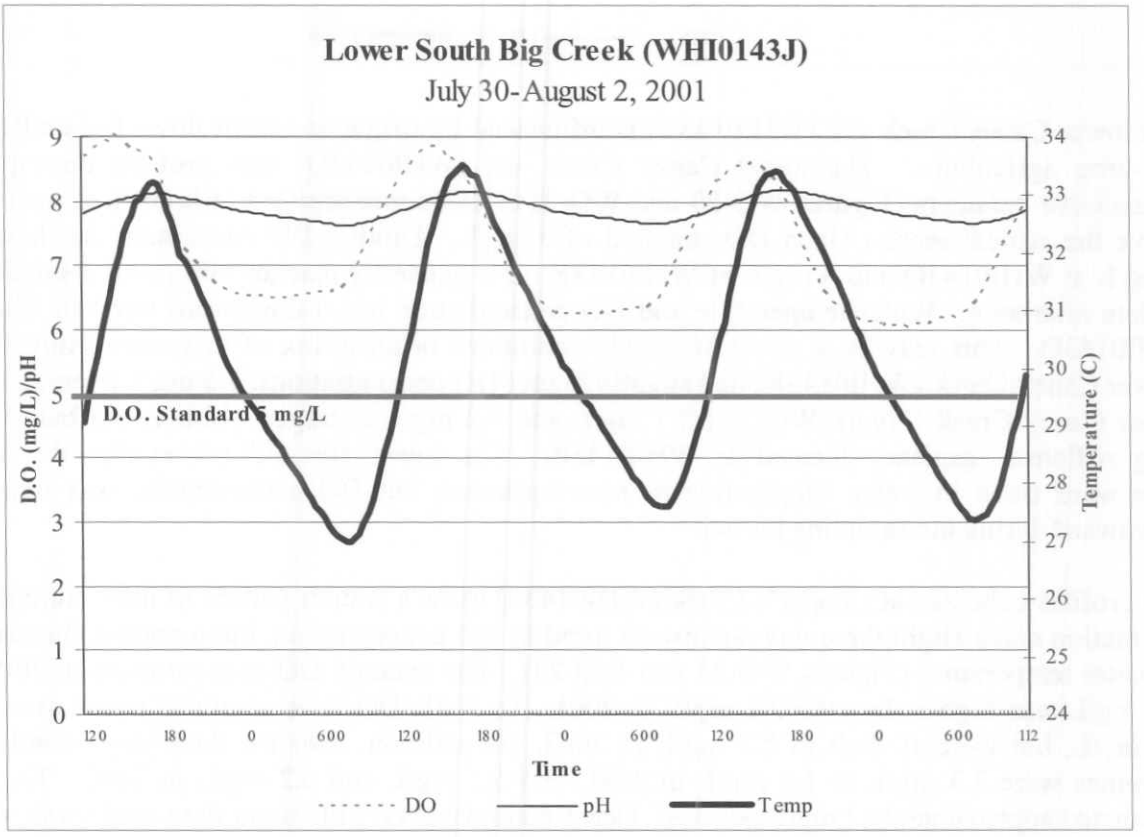
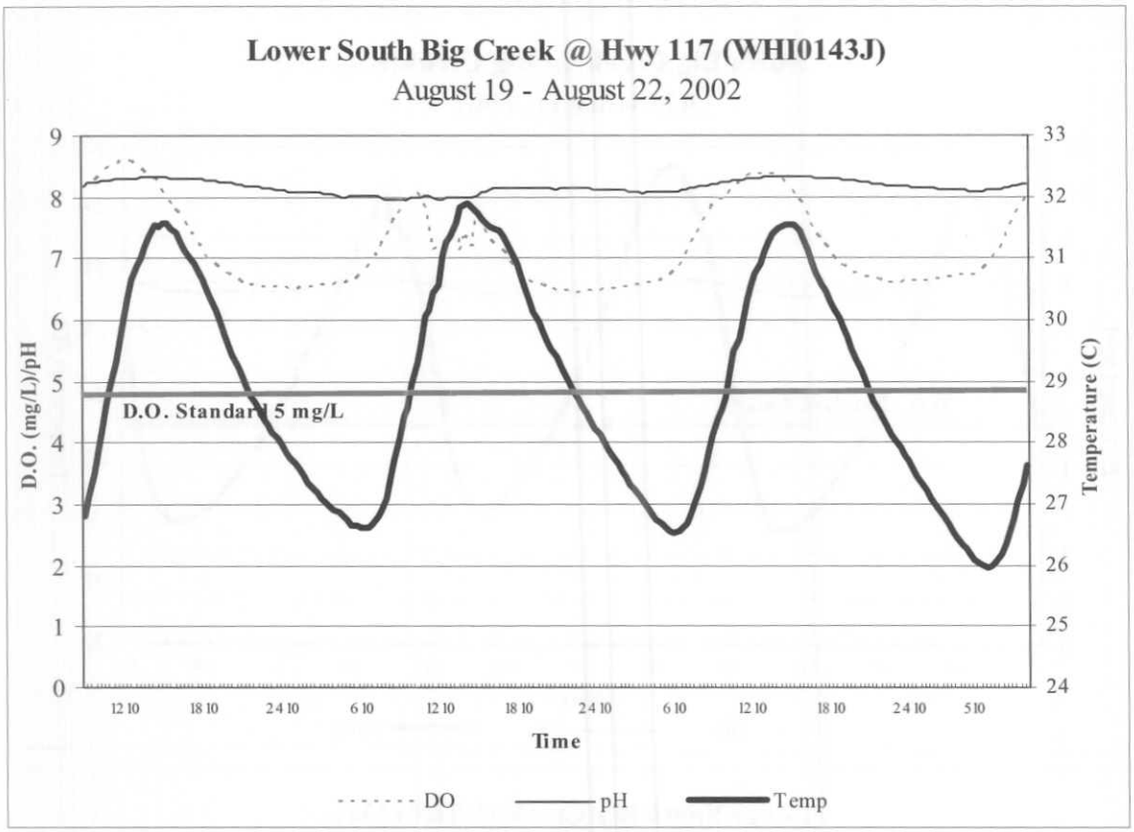


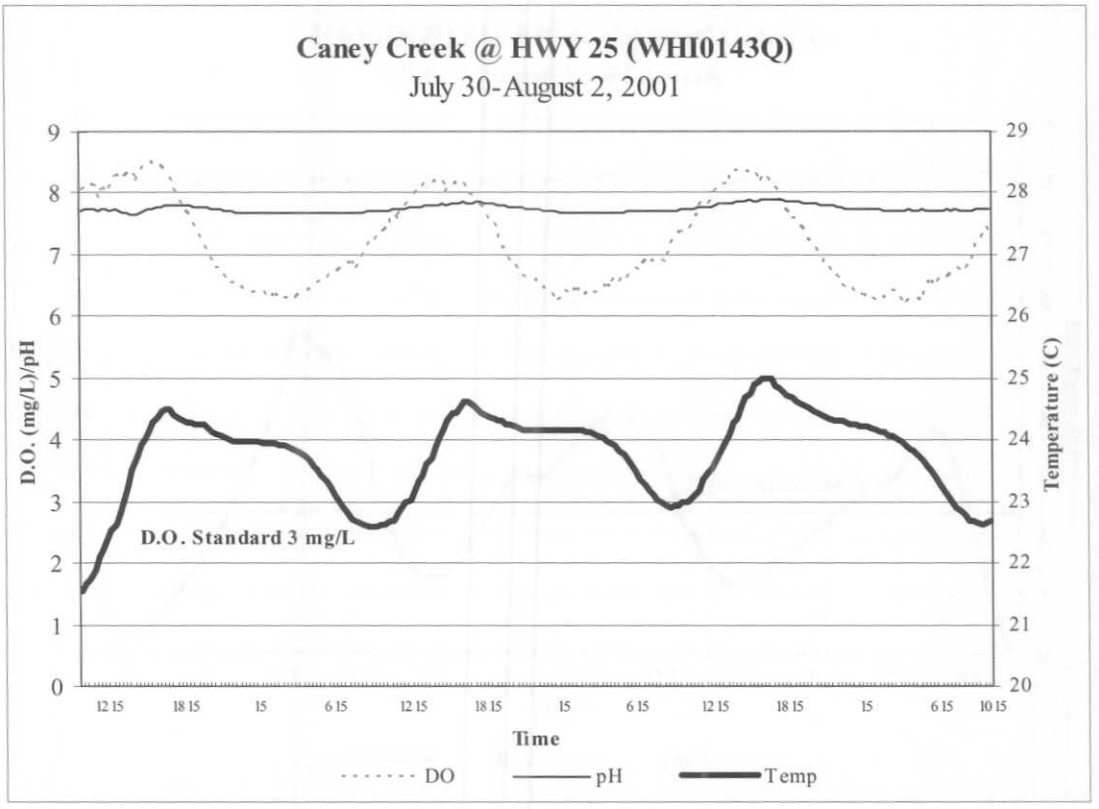
Figure WQ-19

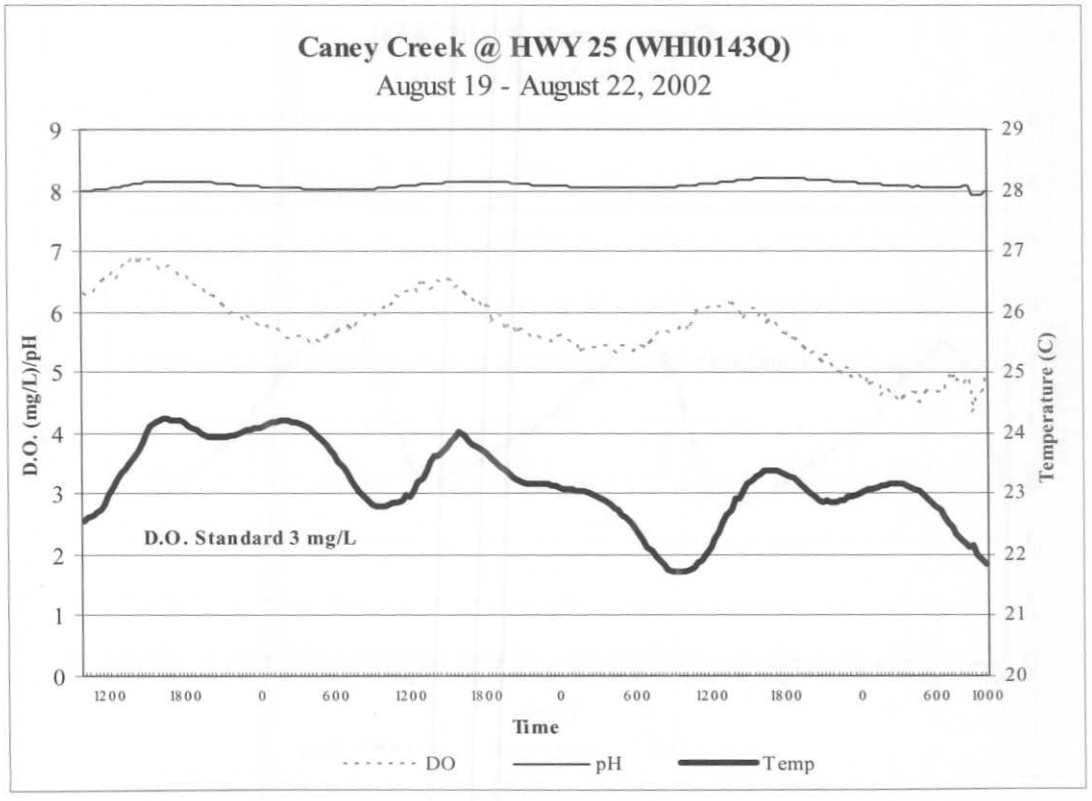


The lower Caney Creek site (WHI0143R) is influenced by irrigation return flows from adjacent row-crop agriculture. The upper Caney Creek site (WHI0143Q) was profiled during two consecutive summers (Figures WQ-20 and WQ-21). DO concentrations at both sites remained above the critical season Delta DO standard of 3 mg/L. Diurnal DO concentrations fluctuate 2 mg/L at WHI0143Q and 3 mg/L at WHI0143R. DO generally reaches 100 percent saturation by late afternoon. Water temperature and DO concentration had a downward trend in 2002 at WHI0143Q. This may be a result of cloudy conditions or an influx of irrigation return flow. Lower Caney Creek (WHI0143R) had slightly higher DO concentrations, 7.5 mg/L average, than upper Caney Creek (Figure WQ-22), 5.7 mg/L and 7.2 mg/L averages. This is attributed to a long riffle/run sequence located at WHI0143R. The lower site did not exhibit the same downward trend in water temperature as seen upstream, but DO concentration was trending downward during the sampling period.

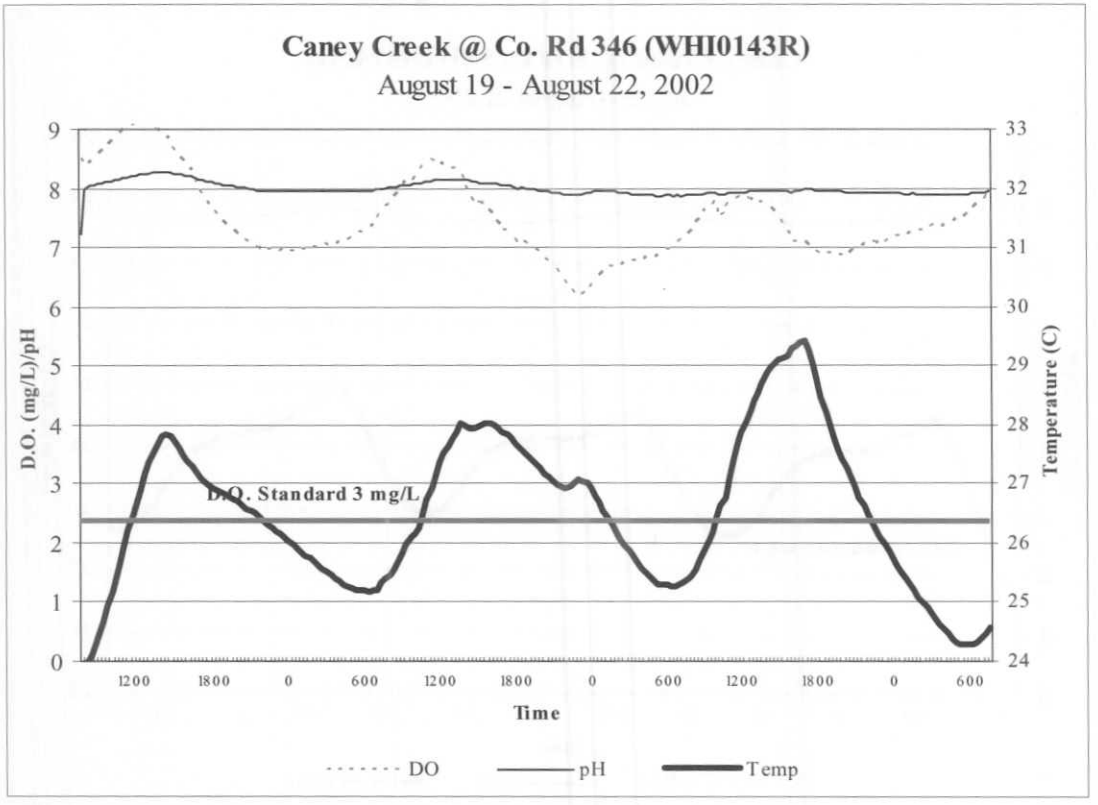
DO profiles collected at Cooper's Creek (WHI0143S) show a similar pattern of little diurnal DO fluctuation and a slight three day downward trend in DO concentration, but a normal fluctuation in water temperature (Figures WQ-23 and WQ-24). The average DO concentration in 2002 of 4.9 mg/L was higher than the 2.1 mg/L in 2001. In 2001, DO concentrations never exceeded 3.4 mg/L, but were as high as 5.7 mg/L in 2002. In addition, over the three day period, DO extremes were 3.3 mg/L to 1.1 mg/L in 2001, and 5.7 mg/L and 4.2 mg/L in 2002. The DO fluctuated approximately 1 mg/L per day. Dense canopy cover, little to no flow, and warm water temperatures are probably limiting the DO in this creek.

Figures WQ-20 and WQ-21





Figures WQ-22 and WQ-23



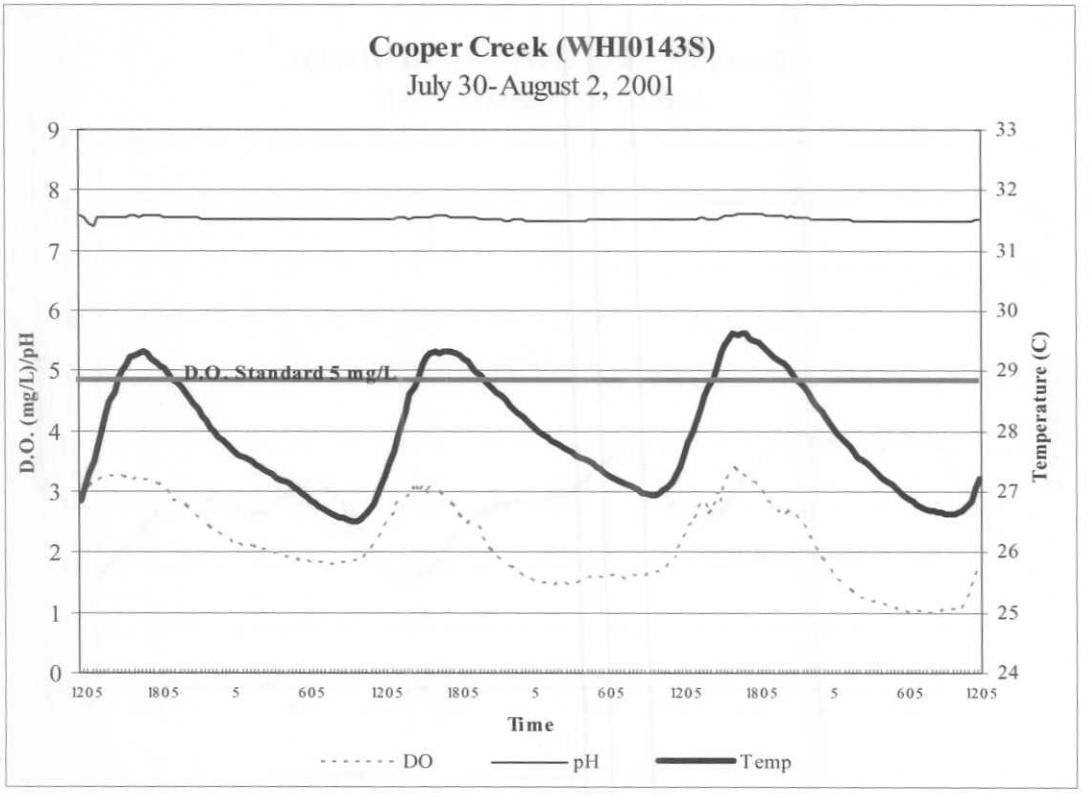
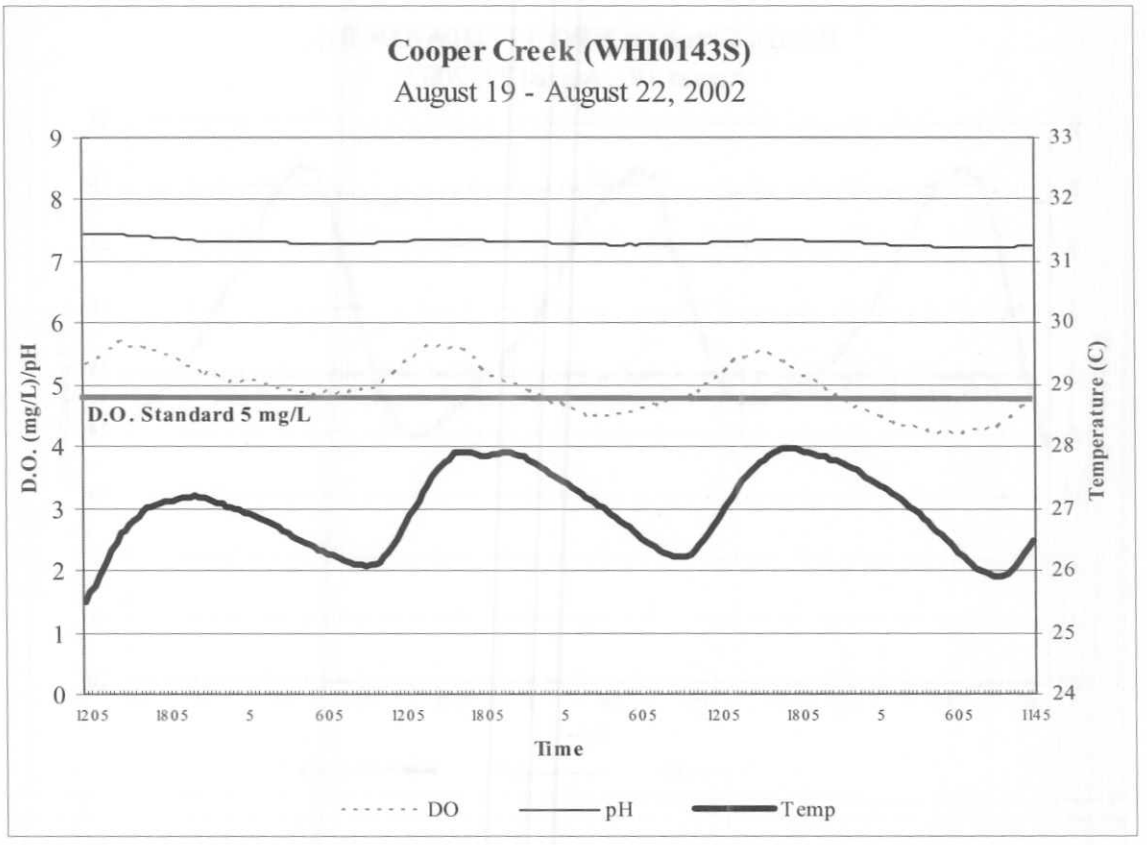


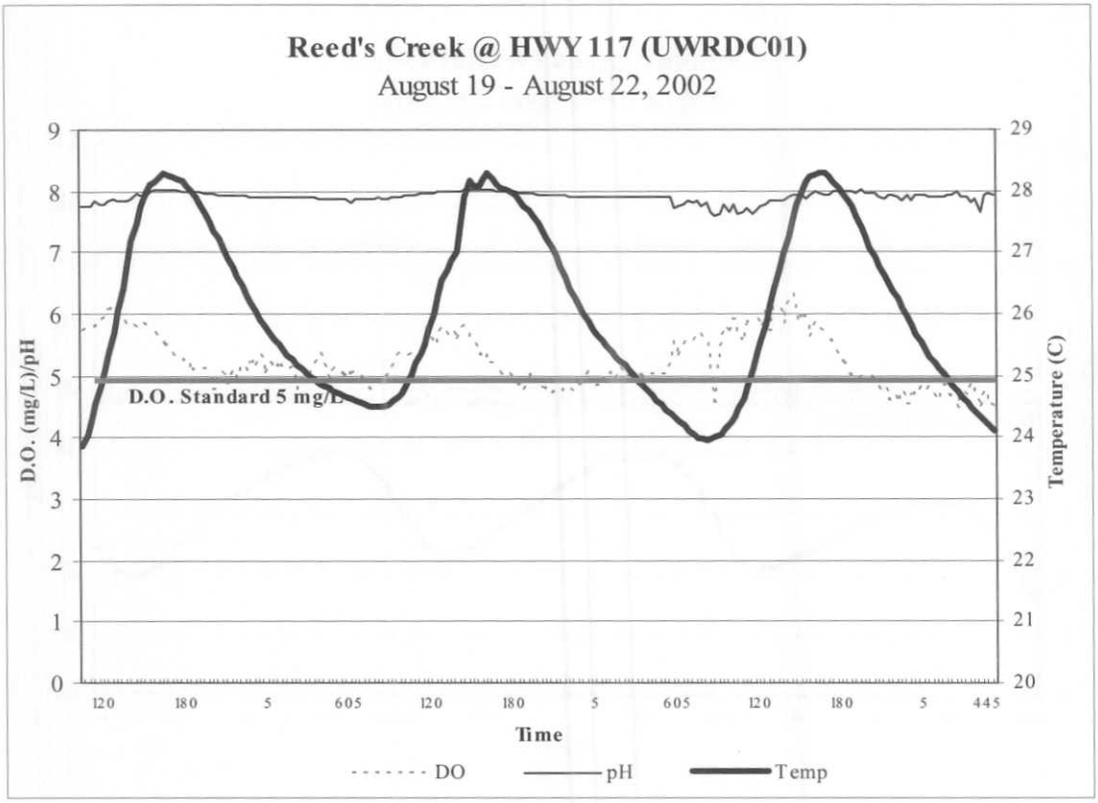
Figure WQ-24



Reed's Creek (UWRDC01) DO profile shows little diurnal DO fluctuation, but water temperature fluctuated 4°C each day (Figure WQ-25). Average DO concentration was 5.2 mg/L. DO extremes ranged from 4.5 mg/L to 6.3 mg/L. This site is influenced by groundwater flows and typically has steady flows throughout the year. The meter was placed in a shallow pool that was susceptible to rapid warming during the day.

WHI0143A and UWSBR01 generally have minimal to no flow during late summer. DO profiles from each of these sites show the effects of reduced flow on DO concentrations (Figures WQ-26 and WQ-27). DO concentrations at both sites were below the standard for all or the majority of the 72-hour sample period. Average DO concentrations at WHI0143A and UWSBR01 were similar, 3.0 mg/L and 3.1 mg/L respectively. DO lows were similar, 1.6 mg/L and 2.0 mg/L respectively, but the peak DO of 6.2 mg/L at WHI0143A was 2.3 mg/L higher than the peak at UWSBR01. DO concentration and water temperature show downward trends during the sampling period. There was little DO fluctuation at UWSBR01. This may be attributed to a dense canopy, reducing photosynthetic activity.

Figures WQ-25 and WQ-26



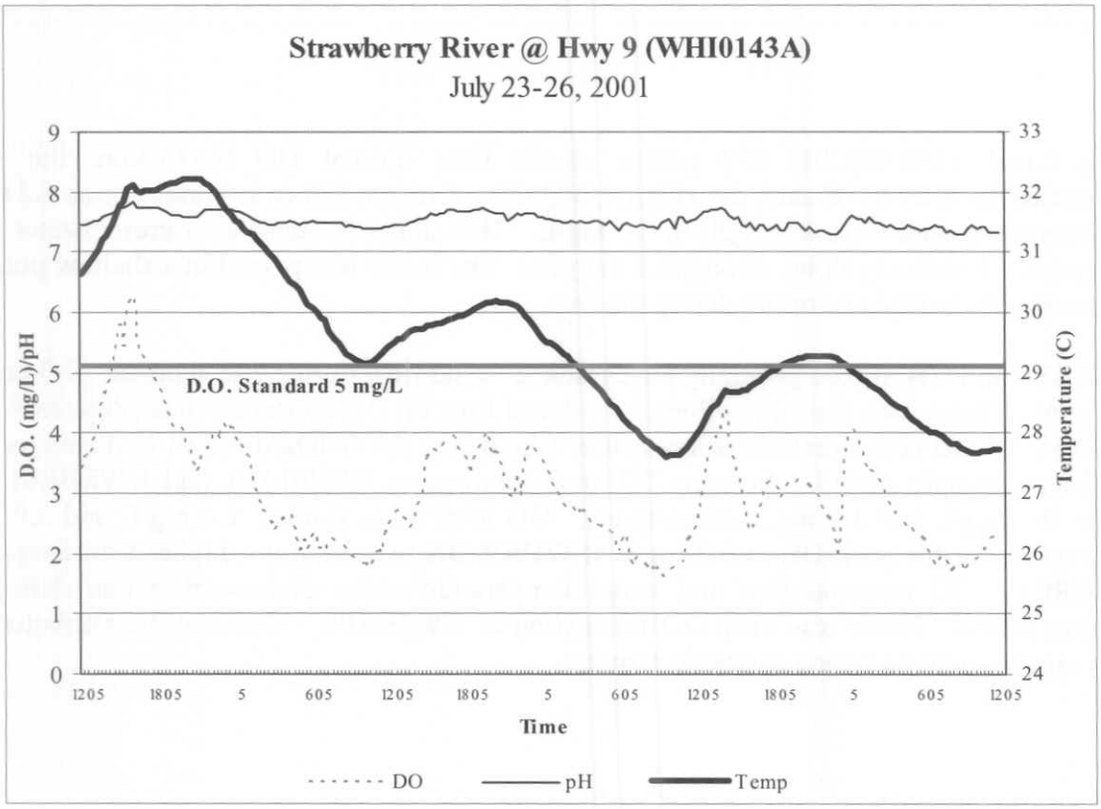
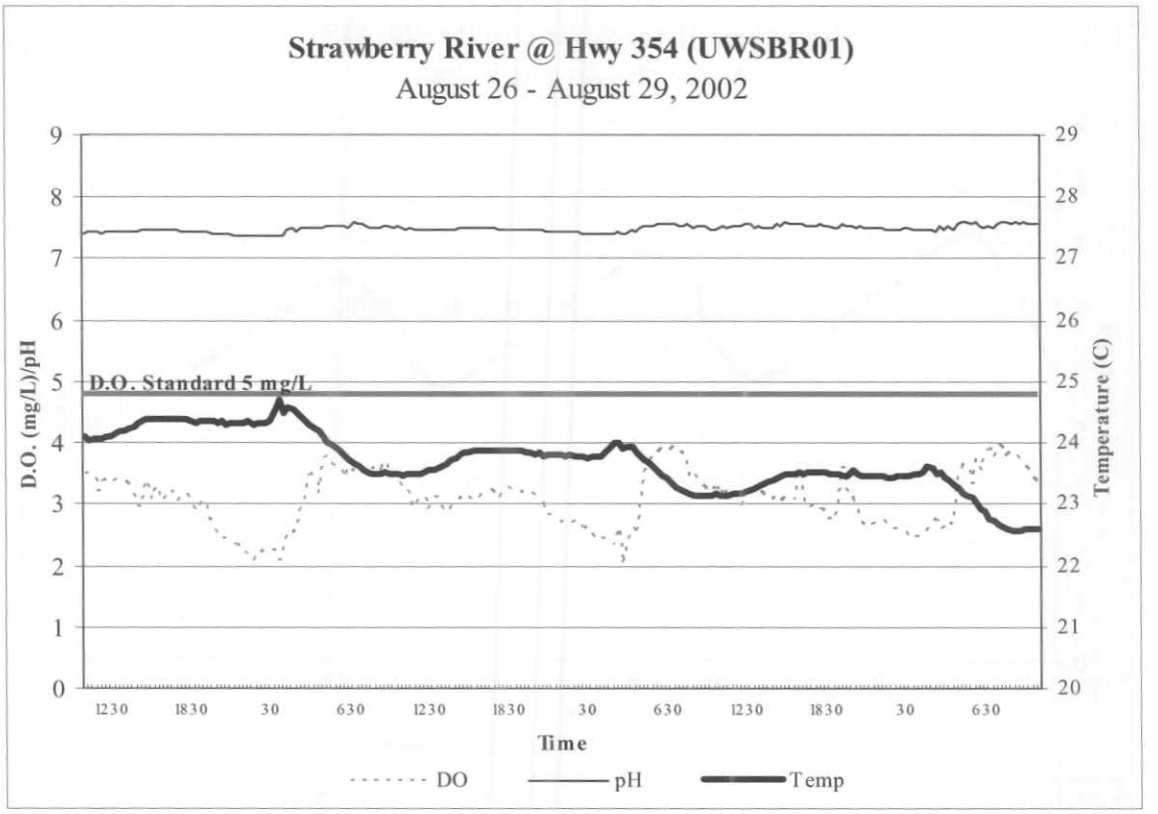


Figure WQ-27

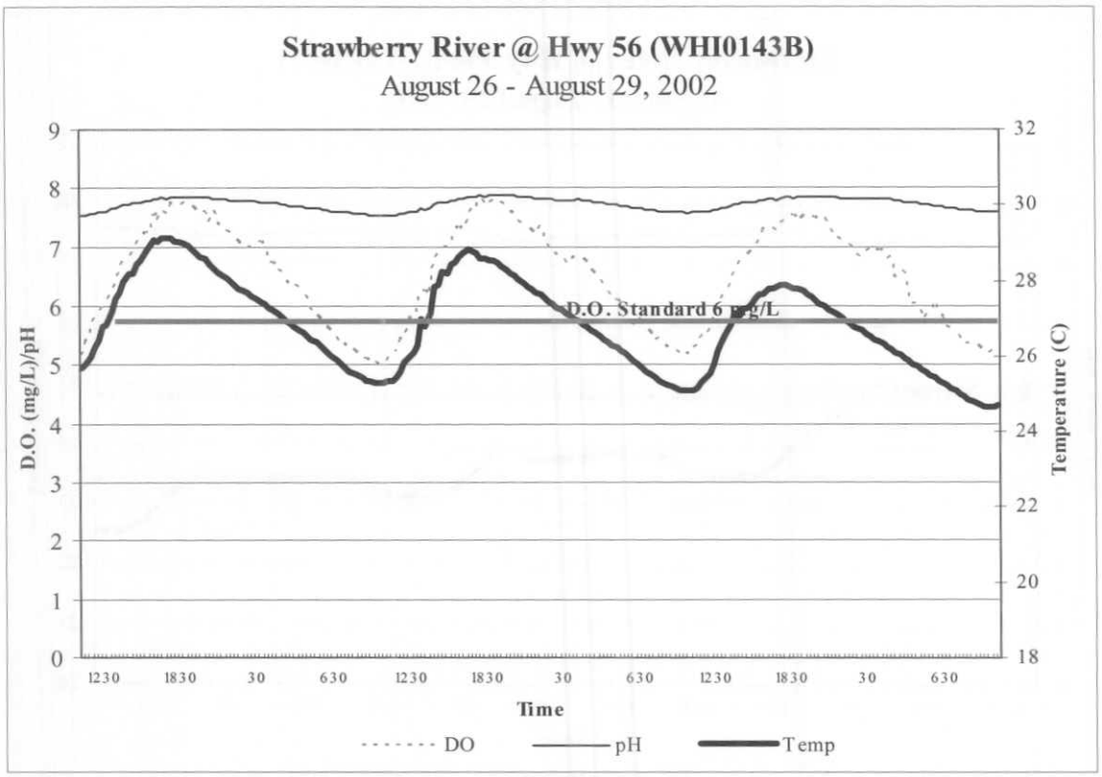


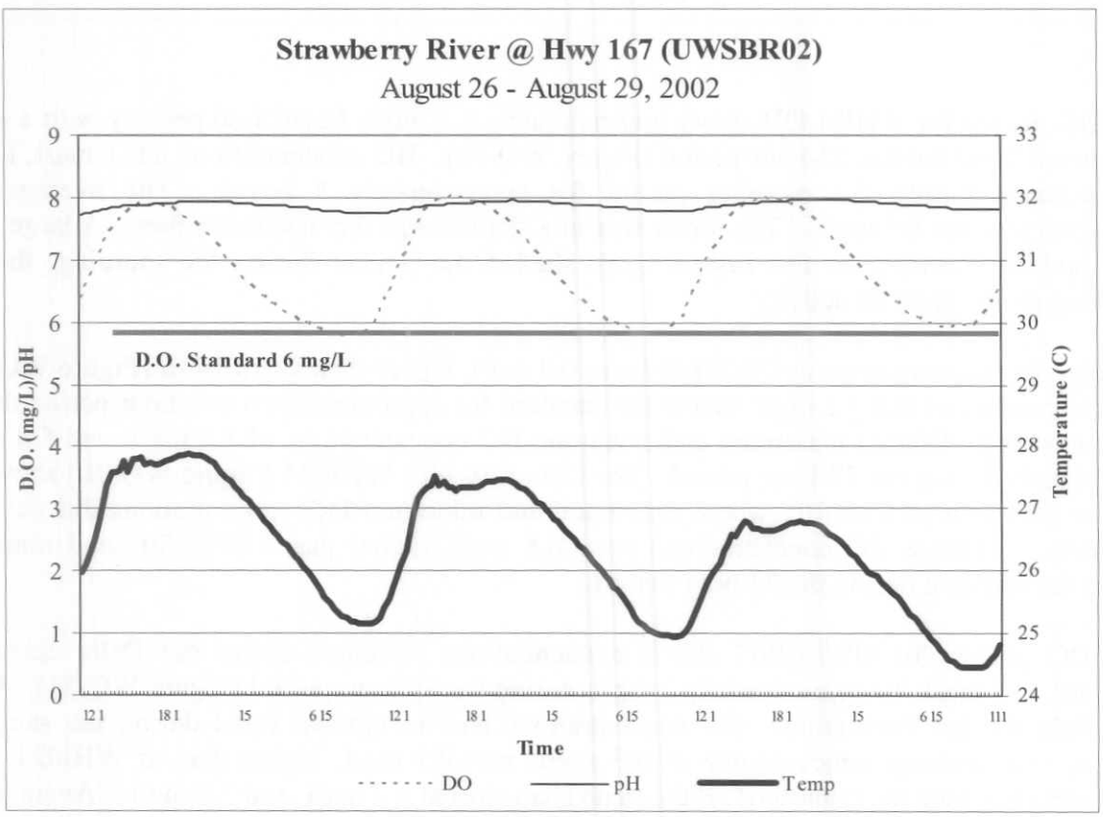
The DO profile for WHI0143B shows approximately a 3 mg/L fluctuation per day with a slight downward trend for the 72-hour period (Figure WQ-28). DO concentrations fell 1 mg/L below the standard during the morning period for approximately 8 hours. The average DO concentration was 6.5 mg/L. The meter was in a shallow run that had some flow. A large bluff and moderate canopy on the eastern bank shaded the stream during the morning, thereby reducing photosynthesis activity.

Average DO concentration at UWSBR02 was 0.4 mg/L higher than WHI0143B (Figure WQ-29). DO concentrations fell 0.2 mg/L below the standard for approximately a two-hour period during early morning. Diurnal maximum and minimum DO concentrations of 8.0 mg/L and 5.8 mg/L were steady during the 72-hour period. The DO profile for WHI024 (Figure WQ-30) showed a similar pattern to UWSBR02 where maximum and minimum DO concentrations did not vary diurnally. Average DO concentrations were 0.6 mg/L higher than UWSBR02 and remained above the standard during the 72-hour period.

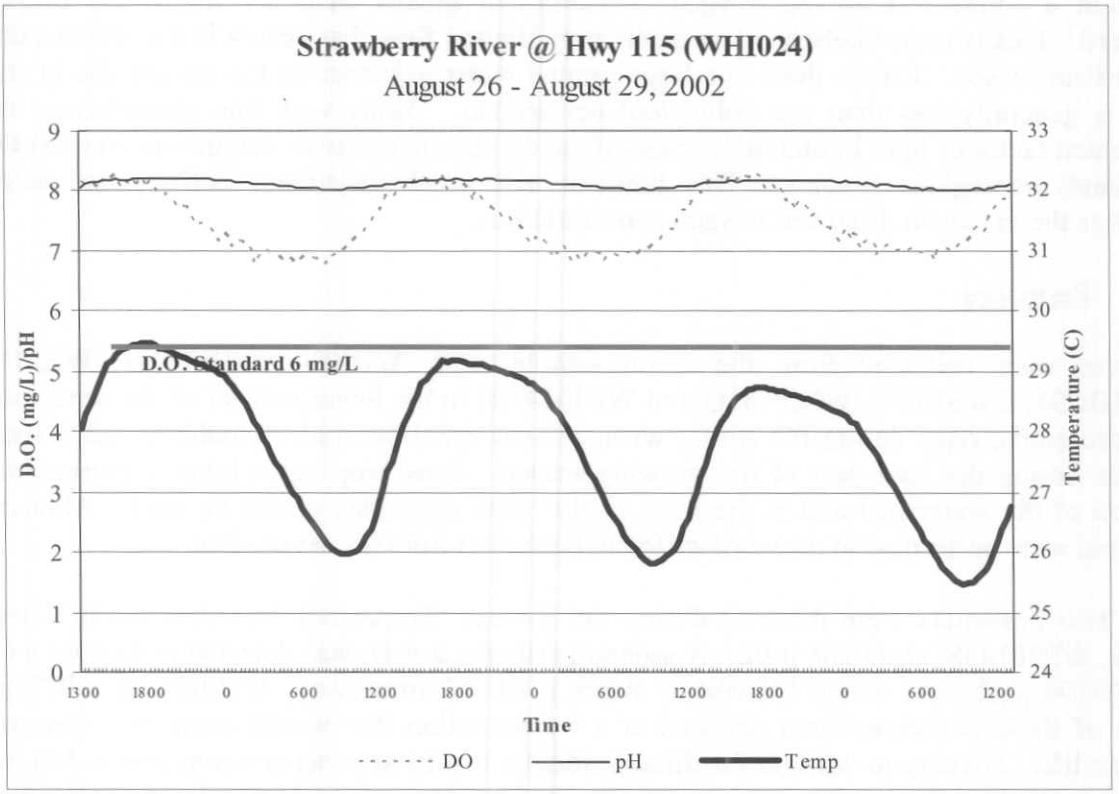
The DO profile for UWSBR03 shows concentrations remained above the Delta ecoregion standard of 5 mg/L by approximately 3 mg/L during the 72-hour period (Figure WQ-31). There was little diurnal fluctuation. DO concentrations had an upward trend during the sampling period. The average concentration of 8.3 mg/L was 0.8 mg/L higher than at WHI024. DO extremes also were the highest of all the main stem sites at 9.7 mg/L and 7.5 mg/L. Average DO concentrations generally increased toward the downstream sites.

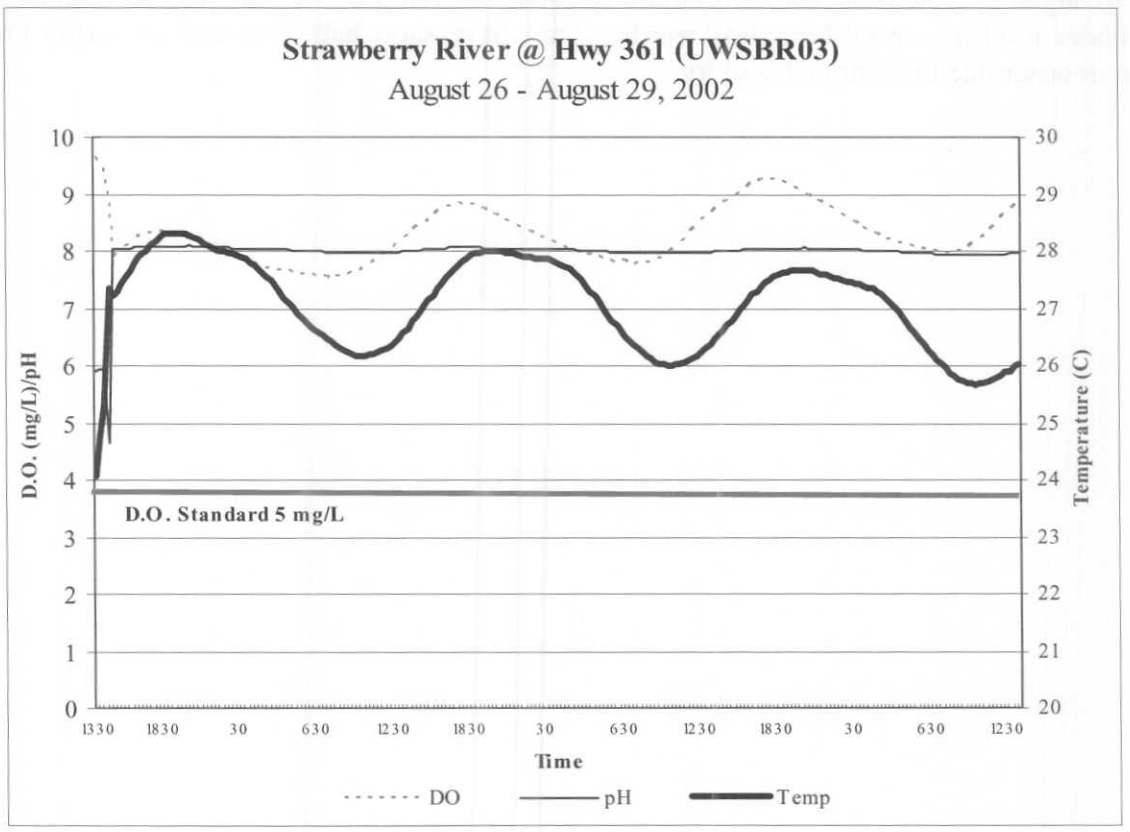
Figures WQ-28 and WQ-29





Figures WQ-30 and WQ-31





Ozark Highlands ecoregion streams with watersheds of less than 100 mi^2 routinely fail to maintain a summer dissolved oxygen concentration greater than 5.9 mg/L, the ecoregion standard. This is most likely because of the very limited flow that occurs in the streams during the critical season. Unless there is a large ground water influence in the stream, the in stream flow is generally less than one cubic foot per second. Along with this characteristic is the associated factor of light limitation because of the dense canopy cover that occurs on most Ozark Highlands ecoregions streams. This limits in stream photosynthetic activity and helps to suppress the in stream dissolved oxygen concentrations.

Pesticides

Samples were collected from the seven sample sites (WHI024, WHI0143J, WHI0143S, UWRDC01, UWSBR03, WHI0143Q and WHI0143R) in the lower section of the watershed on two occasions; once during the spring when pre-emergent pesticides would be used, and one sample during the later part of the growing season. Row crop agriculture is present in this portion of the watershed and is the most likely place pesticides would be used. Almost 850 analyses were performed to detect 61 different pesticides from the seven sites.

Only two pesticides were detected during the survey. Propachlor was detected in Cooper's Creek, WHI0143S, at 0.0266 µg/L. A second pesticide, 2-4-D, was detected in Cooper's Creek at 0.07194 µg/L and in the Strawberry River north of Strawberry, WHI024, at 0.0771µg/L. None of these pesticides were detected at a concentration that would cause any concern for aquatic life. Toxicity to wildlife for these pesticides begins at concentrations above 300 mg/kg and to aquatic organisms at concentrations above 100 mg/L. Both of the pesticides are herbicides used to control broadleaf weeds. They have short half lives and are easily broken down in water due to microbial activity.

GROUND-WATER QUALITY ASSESSMENT

BACKGROUND

Ground water has been an integral part of the growth of communities in the Strawberry River watershed since the early 1800's. Residents within the study area recall childhood memories of Sunday (and special event) gatherings around major springs in Calamine (Harry Howard, resident, personal communication) and Wiseman (Bobby Bookout, resident, personal communication) in the early 1900's. The perennial springs furnished ample amounts of water for drinking, cooking and cleaning at these events, and water was hauled throughout the year from the springs for domestic use by many of the early settlers in the area. The Wiseman town spring was used by residents to refrigerate their milk and other perishables prior to modern refrigeration techniques. The spring also supported a small cannery, a grist mill, and served as a water source for many residents when dug cisterns went dry. The town of Evening Shade clearly illustrates the importance of many of the larger springs in the area since the early and later part of the 1800's. In 1817, a cabin, grist mill and sawmill were erected by a Captain James Thompson in a tributary fed by a large spring. The immense popularity of the mill fueled early growth in the region, and Captain Thompson petitioned for a post office, listing as the name of the town, Evening Shade. Further growth resulted in the establishment of a store on a spot near Plum Spring, which became the focal point of all activity in the area. Plum Spring eventually grew into what is now the town of Evening Shade, and a rock structure that houses Plum Spring sits in the present-day town square (Sandra Taylor McCall, Evening Shade City Hall, written communication).

The importance of ground water to residents in the study area through present time is underscored by a review of water use from 1960 through 2000 (Table GW-1). Ground water has accounted for 99% of all drinking-water use from both domestic and municipal supplies from 1960 until 2000 for Fulton, Izard, Lawrence and Sharp counties. Minor use of surface water is evident only in Lawrence County, where water is extracted from the Strawberry River for municipal supply. Domestic wells accounted for most of the ground water produced during 1960, with 0.87 million gallons per day (mgd) from rural domestic wells versus 0.72 mgd from municipal-supply wells for the four-county area. Production from domestic wells continued to increase through 1985, although overshadowed by municipal-well production after 1965, and began to decline in every county except for Fulton County beginning in 1990. A review of the data from the four-county area reveals that domestic-supply wells accounted for approximately 30%-55% of the total ground water used from 1960 to 1985. Domestic-well use fell to 25% in 1990, 16% in 1995, and 12% in 2000, with the growth of municipal-supply systems. The decrease in the use of domestic wells is evident especially in Sharp and Lawrence counties, where the production from domestic wells was 0.47 mgd and 0.67 mgd, respectively, in 1985; 0.14 mgd and 0.36 mgd in 1990; and finally dropping to 0.08 mgd and 0.04 mgd in 1995, and 0.0 mgd and 0.01 mgd in 2000. Fulton County is the only county in the four-county study area, where production from domestic wells outweighed municipal-supply production in most years. The total production from domestic wells in 1995 was 0.63 mgd versus 0.41 mgd from municipal-supply systems, although production from municipal-supply systems was slightly greater than that from domestic wells in 2000.

Table GW-1. Public-supply and domestic-well water use in million gallons per day for the four-county study area.

	Fulton			Izard			Lawrence			Sharp		
	Public Supply [10]		Dom.	Public Supply		Dom.	Public Supply		Dom.	Public Supply		Dom.
Year	Surface	Ground		Surface	Ground		Surface	Ground		Surface	Ground	
1960 [1]	0	0.09	0.17	0	0.14	0.18	0.02	0.39	0.38	0	0.10	0.16
1965 [2]	0	0.12	0.20	0	0.11	0.20	0.02	0.71	0.41	0	0.14	0.16
1970 [3]	0	0.16	0.36	0	0.17	0.33	0.04	0.86	0.53	0	1.03	0.17
1975 [4]	0	0.29	0.45	0	0.64	0.37	0.09	1.20	0.56	0	1.10	0.11
1980 [5]	0	0.38	0.47	0	1.22	0.41	0.05	1.28	0.62	0	1.56	0.39
1985 [6]	0	0.34	0.52	0	0.86	0.43	0.05	1.43	0.67	0	1.42	0.47
1990 [7]	0	0.67	0.58	0	0.99	0.40	0.06	1.43	0.36	0	1.40	0.14
1995 [8]	0	0.41	0.63	0	2.05	0.32	0.08	1.52	0.04	0	1.48	0.08
2000 [9]	0	0.84	0.61	0	1.84	0.21	0.00	0.94	0.01	0	1.54	0

[1] Stephens and Halberg (1961); [2] Halberg and Stephens (1966); [3] Halberg (1972); [4] Halberg (1977); [5] Holland and Ludwig (1981); [6] Holland (1987); [7] Holland (1993); [8] Holland (1999); [9] Holland (USGS, written communication, 2003); [10] All values in million gallons per day – public supply includes surface and ground water, and domestic (Dom.) represents rural, domestic-well use.

The purpose of the ground-water assessment for this report was three-fold: to evaluate the potential impact of nonpoint sources on ground-water quality, to document general ground-water chemistry and water quality throughout the study area, and to review and compare trends in ground-water quality over time to other sources of data from the study area. In order to accomplish this goal, ground-water samples were collected from 53 wells and 9 springs, for a total of 62 ground-water sampling sites. Appendix GW-1 contains the complete ground-water quality analyses.

HYDROGEOLOGY

Except for a small outcrop of alluvial sediments in the southeastern portion of the watershed, which serves as irrigation supply for row-crop agriculture in the study area, ground water is extracted entirely from the Ozark aquifer, which serves as the dominant source of ground water in the Ozarks of northern Arkansas and southern Missouri. The Ozark aquifer is a thick sequence of water-bearing rock, ranging in age from the Late Cambrian to Middle Devonian. The formations comprising the Ozark aquifer are mainly dolostone, limestone and sandstone, ranging upward to 4000 feet in thickness (Imes and Emmett, 1994). Average thicknesses of the aquifer throughout most of the Salem Plateau range from approximately 1,500 – 2,000 feet (Imes and Emmett, 1994; Adamski et al., 1995). In the study area, only Ordovician-aged rocks of the Ozark aquifer are exposed at the surface and are represented by the sequence of rocks from the Jefferson City Dolomite to the St. Peter Sandstone (See Table GEO-1). These formations serve as the source of ground water for almost all of the domestic wells in the study area. Most municipal-supply wells extract water from deeper and more productive subsurface units, including the Roubidoux Formation and the Gasconade Dolomite. Depths to the top of the Roubidoux Formation and total depths of municipal wells in the study area range from approximately 400 feet and 1,500 feet, respectively, in the northwestern part of the watershed, to approximately 1,500 feet and 2,700 feet, respectively, in the southeastern portion of the watershed (Prior, et al., 1999). The greater depth for the municipal wells is rewarded by yields that range upward to greater than 600 gallons per minute (gpm) (Schrader, 2001; Prior et al.,

1999). These yields stand in stark contrast to well yields calculated from driller's logs for 100 shallow wells (< 300 feet) in the watershed, which ranged from 1 – 60 gpm, with a mean of 16 gpm. Lamonds (1972) similarly cites common yields of 5 – 10 gpm with some yields that may exceed 50 gpm for those formations above the Roubidoux Formation in the Ozark aquifer.

Ground-water recharge to the Ozark aquifer occurs through direct infiltration of precipitation through thin soils, near-surface fractures, and sinkholes, and through losing stream segments (Harvey, 1980; Imes and Emmett, 1994). Primary porosity and permeability are low for most of the rock units forming the Ozark aquifer. Secondary porosity and permeability results from fracturing and dissolution, resulting in extremely heterogeneous values that vary widely, even on a local scale (Adamski et al., 1995). In some formations, sandstone is present in massive, clean, well-sorted bodies and is relatively permeable, where it is not cemented (Imes and Emmett, 1994). Ground-water flow directions are well established in the Ozark aquifer in northeastern Arkansas, including flow across the study area, and trend in a southeastward direction toward the Mississippi River Basin (Lamonds, 1972; Harvey, 1980; Imes and Emmett, 1994; Schrader, 2001). Potentiometric surface maps have not been constructed for individual units within the Ozark aquifer; however, Imes and Emmett (1994) state that because most wells are open to at least several hundred feet of the aquifer and that the variation of head with depth is not large in comparison to the variation of head laterally in the aquifer, potentiometric maps for the Ozark aquifer are probably a good representation of the lateral head distribution in the aquifer.

In the watershed, water levels range from slightly greater than 700 feet above mean sea level (amsl) in the northwestern portion of the watershed to less than 300 feet (amsl) in Lawrence County in the southeastern portion of the watershed. In general, the flow mimics and is controlled by topography, especially where the unconfined portion of the aquifer intersects the land surface, resulting in springs and perennial streams (Lamonds, 1972; Imes and Emmett, 1994; Schrader, 2001). Because the topography of the Ozark Plateaus in eastern Arkansas was influenced strongly by the Ozark Dome in Missouri, difficulties arise in assessing the amount of influence by stratigraphic versus topographic controls on flow in such a large aquifer system. Although the contours of the upper potentiometric surface of the Ozark aquifer have been shown to mimic topography, Imes and Emmett (1994) state that water in the deeper portion of the aquifer discharges into the alluvial sediments within a few miles of the Ozark Escarpment, and some of this water ultimately may discharge into the Mississippi River. Both Imes and Emmett (1994) and Lamonds (1972) discuss confining conditions in the Roubidoux Formation and Gasconade Dolomite, and Lamonds (1972) states that some wells completed in the Roubidoux and lower formations flowed under artesian conditions. Prior et al. (1999) mapped water levels in the Roubidoux Formation and Gunter Sandstone member of the Gasconade Formation and noted that the potentiometric surface follows the regional dip of rock units toward the south and southeast in the vicinity of the study area. As such, there would appear to be major differences between the deeper units versus rock formations above the Roubidoux. However, Harvey (1980) cited turbidity in deeply-cased (1000 feet) municipal wells during storm events as evidence of the deep circulation, rapid infiltration, and well-defined connections to upper formations. In any case, potentiometric surface maps for the Roubidoux and lower rock units (Prior et al., 1999; Lamonds, 1972) show similar flow directions to the Ozark aquifer as a whole.

Galloway (USGS, Little Rock, written communication) constructed a water-level map for an approximate 120 square-mile area in the vicinity of Evening Shade (Sharp County) and demonstrated that water-level contours generally follow land-surface topography and indicate

discharge into local streams including the Strawberry River and the Piney Fork. From this information, and the regional reports cited above for the Ozark aquifer system, water levels throughout the watershed study area can be assumed to be strongly influenced by local topography, and act as base flow for the Strawberry River and its major tributaries.

METHODOLOGY

Ground-water quality in the Strawberry River watershed was assessed by the sampling of domestic, irrigation and municipal wells, in addition to nine perennial springs in the study area. Because the overall project objective was to assess potential water-quality impacts from nonpoint pollution sources, shallow wells of less than 600 feet were the primary focus of the sampling program. However, two municipal wells approximately 2,000 feet in depth were sampled in order to describe water chemistry and quality in the Lower Ordovician Roubidoux Formation in the watershed. The shallow wells sampled for this report include 47 wells completed in the Ozark aquifer, which is comprised of rocks dominantly of Ordovician age, and four irrigation wells completed within a small portion of Quaternary-age alluvial sediments, which overlie the bedrock in the southeastern portion of the watershed.

Figure GW-1 shows the locations of the wells and springs sampled for this study. Although a uniform random distribution of sampling locations was one of the objectives of the study, the absence of operational wells as a result of residents converting to municipal-supply systems, combined with the distribution of residents over some sparsely populated areas, resulted in a patchy network of wells and springs. However, the distribution of sampling locations is sufficiently random to adequately represent water-quality variation as influenced by both geology and land use within the watershed.

The wells and springs were sampled during August and September, 2002. All wells were sampled as near to the wellhead as possible through available faucets and other outlets. Most wells had been in use during the day of sampling; however, all wells were allowed to run for a minimum of ten minutes until field-measured parameters had stabilized prior to sampling. All samples were collected in approved containers for the selected parameters. Samples were filtered through disposable 0.45 µm pore-sized membranes in the field for analysis of dissolved metals and preserved with nitric acid to a pH of 2.0. All other samples were unfiltered, stored on ice, and delivered to the Arkansas Department of Environmental Quality (ADEQ) laboratory under chain-of-custody requirements. All samples were analyzed for major and minor cations and anions, nutrients, trace metals, and total dissolved solids. Analysis for pH, conductance and temperature were performed in the field at the time of sampling with an Orion^{tm} multifunction portable meter. Because 18 of the resulting samples contained NO_3-N concentrations equal to or greater than 1.0 mg/L, these wells were resampled and analyzed for fecal coliform and *E. coli* bacteria. Because each of the well locations had onsite septic systems, 18 samples additionally were forwarded to the USGS laboratory in Denver, Colorado, for analysis by method Schedule 1433 wastewater scan. This method includes analysis for approximately 62 compounds, which include, among others, various estrogen metabolites, fecal indicators, detergent metabolites, other detergent-related compounds, caffeine, cholesterol, and compounds used in the perfume and fragrance industry. Because the occurrence of elevated nitrogen species and bacterial contamination can occur from several sources, including animal waste and septic systems, the analysis provided an additional tool in determining the source of contamination.

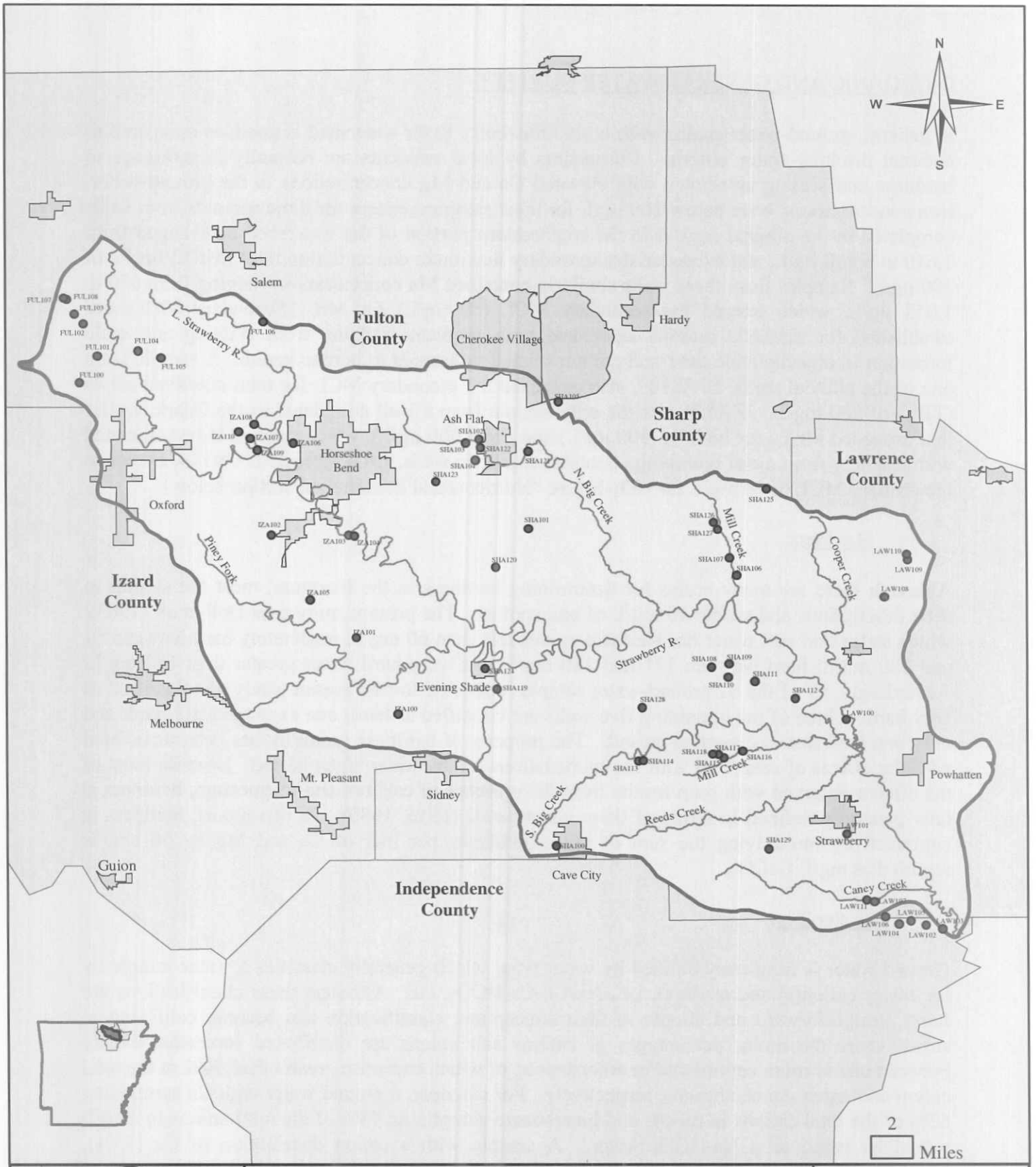


Figure GW-1
Ground Water Sampling Locations,
Strawberry River Watershed

Arkansas Department of
Environmental Quality
Water Division - Planning Section

Legend

- Wells
- Strawberry River Watershed
- Cities
- Counties
- Streams

INORGANIC AND GENERAL WATER QUALITY

In general, ground-water quality within the Strawberry River watershed is good, as compared to national drinking-water criteria. Complaints by local residents are normally in reference to hardness and scaling associated with elevated Ca and Mg concentrations in the ground water. Iron concentrations were below 100 µg/L for most samples, except for three samples from wells completed in the alluvial aquifer in the southeastern portion of the watershed that ranged from 2,610 to 6,830 µg/L, and exceeded the secondary maximum concentration limit (MCL) for Fe of 300 µg/L. Samples from these wells similarly contained Mn concentrations ranging from 650 to 1,053 µg/L, which exceed the secondary MCL (50 µg/L) for Mn. Secondary MCLs are established for aesthetic reasons associated with problems ranging from staining and scale formation to objectionable taste and are not related to hazards to human health. A sample from one of the alluvial wells, LAW103, also exceeded the secondary MCL for total dissolved solids (TDS) of 500 mg/L. IZA104 was the only sample from a well completed in the Ozark aquifer that exceeded MCLs for both Fe (300 µg/L) and Zn (5,000 µg/L), which appears to be associated with leaching from metal plumbing. Samples from two wells, LAW109 and LAW110, exceeded the primary MCL of 10 mg/L for NO_3-N (see "Nutrients and Bacteria" in section below).

Hardness

Although there are many scales for determining hardness in the literature, most are similar in their descriptions and within 10 mg/L of one another. The present study uses Doll et al. (1963), which states that soft water has hardness values less than 60 mg/L; moderately hard between 61 and 120 mg/L; hard between 121 and 180 mg/L; and very hard water greater than 180 mg/L. Accordingly, 57 of the 62 ground-water samples collected for the present study are classified as very hard. Three of the remaining five wells are classified as hard; one as moderately hard; and only one well that is classified as soft. The property of hardness primarily has been associated with the effects of soap, and with the encrustations left by water when heated. Because most of the effects observed with soap results from the presence of calcium and magnesium, hardness is now generally defined in terms of these constituents (Hem, 1989). In this report, hardness is computed by multiplying the sum of milliequivalents per liter of Ca and Mg by 50 and is reported as mg/L $CaCO_3$.

Water Type

Ground water is frequently defined by water type, which generally classifies a water sample by the major cation(s) and anion(s); i.e., Na-Cl, Ca-HCO_3, etc. Although these classifications are fairly straightforward and simple in their conception, classification can become confusing in cases where the molar percentages of cations and anions are distributed somewhat evenly between one or more cations and/or anions, none of which comprise greater than 50% of the total cation and anion concentrations, respectively. For example, a ground water with Ca comprising 62% of the total cations in meq/L and bicarbonate comprising 94% of the total anions in meq/L would be typed as a Ca-HCO_3 water. A sample with a cation distribution of Ca (35%), Mg (25%), and Na (30%), and bicarbonate as the dominant (> 50%) anion, the water would be defined by the dominant constituents as possibly a Ca,Na-HCO_3 or even a Ca,Na,Mg-HCO_3 water type.

Imes and Emmett (1994) show a range of water types for the Ozark aquifer throughout the Salem Plateau. For the area encompassing the watershed, Imes and Emmett (1994) show an approximate even split between a Ca-HCO_3 and a Na-Cl water type. However, analyses from 62 sampling sites for the present study and 28 sites sampled for the Hardy monitoring area (ADEQ, unpublished data) in Fulton and Sharp counties (dominantly north of the Strawberry River watershed area) reveal no Na-Cl water types. Prior et al. (1999) describes the water chemistry in the Roubidoux Formation and Gunter Sandstone as a "magnesium-bicarbonate type with generally low chloride." However, a review of the 46 wells that contain chemical analyses in Prior (1999) revealed that Mg was the dominant cation in only 6 of the 46 wells, and usually by only a few hundredths of a meq/L, whereas Ca was the dominant cation in 40 of the 46 samples. Galloway (USGS, Little Rock, written comm.) discusses the chemistry of the Evening Shade area and states that "wells and springs in the study area demonstrate a calcium-bicarbonate type water typical of the Ozark aquifer." Harvey (1980) states that Ca/Mg ratios in water from the Ozark Plateau region are close to one for dolomite aquifers and range from 1-10 for limestone aquifers, and additionally cites ratios for Ordovician dolomite aquifers that increase to 2-3 in the Springfield Plateau area as a result of leakage from the overlying limestone formations.

Water analyses for 58 samples from the Ozark aquifer for the present report reveal that Ca exceeds 50% of the total cations (meq/L) in 46 of the 58 samples, with Mg as the dominant cation in the remaining 12 samples. The mean percentage for Ca is 51.6% and highest value is 56.8%, whereas Mg percentages rarely drop below 44% and average 45.4%. These figures reveal only slight increases of Ca relative to Mg in the Ozark aquifer. Hem (1989) states that water in which no one cation or anion constitutes as much as 50 percent of the totals should be recognized as a mixed type and identified by the important cations and anions. Because the "50%" boundary has been adopted by most ground-water scientists, then the dominant water type in the watershed in most cases can be defined accurately as a Ca-HCO_3 type water. However, 7 of 11 samples from the Boone Formation (limestone) in the Omaha monitoring area in northwest Arkansas (Springfield Plateau) reveal Ca percentages greater than 90%, with a mean of 88%, and Mg percentages all under 10%, with a mean value of 4.9% (Huetter et al., 1997). These percentages stand in stark contrast to the close distribution between Ca and Mg concentrations for the Ozark aquifer in the study area, which results from the dominance of dolomite in the strata. Ca/Mg ratios calculated for this report range from 1.0 to 1.4 with a mean of 1.1; whereas, ratios from the 11 Boone Formation samples range from 10 to 41 with a mean of 24. Referring to ground water from each of these geologic regimes as a Ca-HCO_3 water type negates the large difference between the Ca/Mg ratios and resulting water chemistry as influenced by the rock type. The authors believe that ground water from the Ozark aquifer is more appropriately termed a Ca,Mg-HCO_3 water type, and recommend that the nomenclature be changed to reflect the differences in water from the limestone of the Springfield Plateau and the dolomite of the Salem Plateau in cases where Mg exceeds 40% or more of the total cations.

Figure GW-2 presents a Piper diagram of the data from the study, which depicts the distribution of the major cations and anions for each sample. The "cations" triangle reveals that most samples plot near the midpoint between the %Ca and %Mg endpoints, and provides a visual representation of the water type. Samples that deviate from the general cluster toward the %Na+K endpoint are represented by alluvial wells (squares) which are higher in both Na and Cl (see section below), and Ozark aquifer samples which contain higher salts and nutrients dominantly as a result of impacts from septic system effluent (see section "Nutrients and Bacteria").

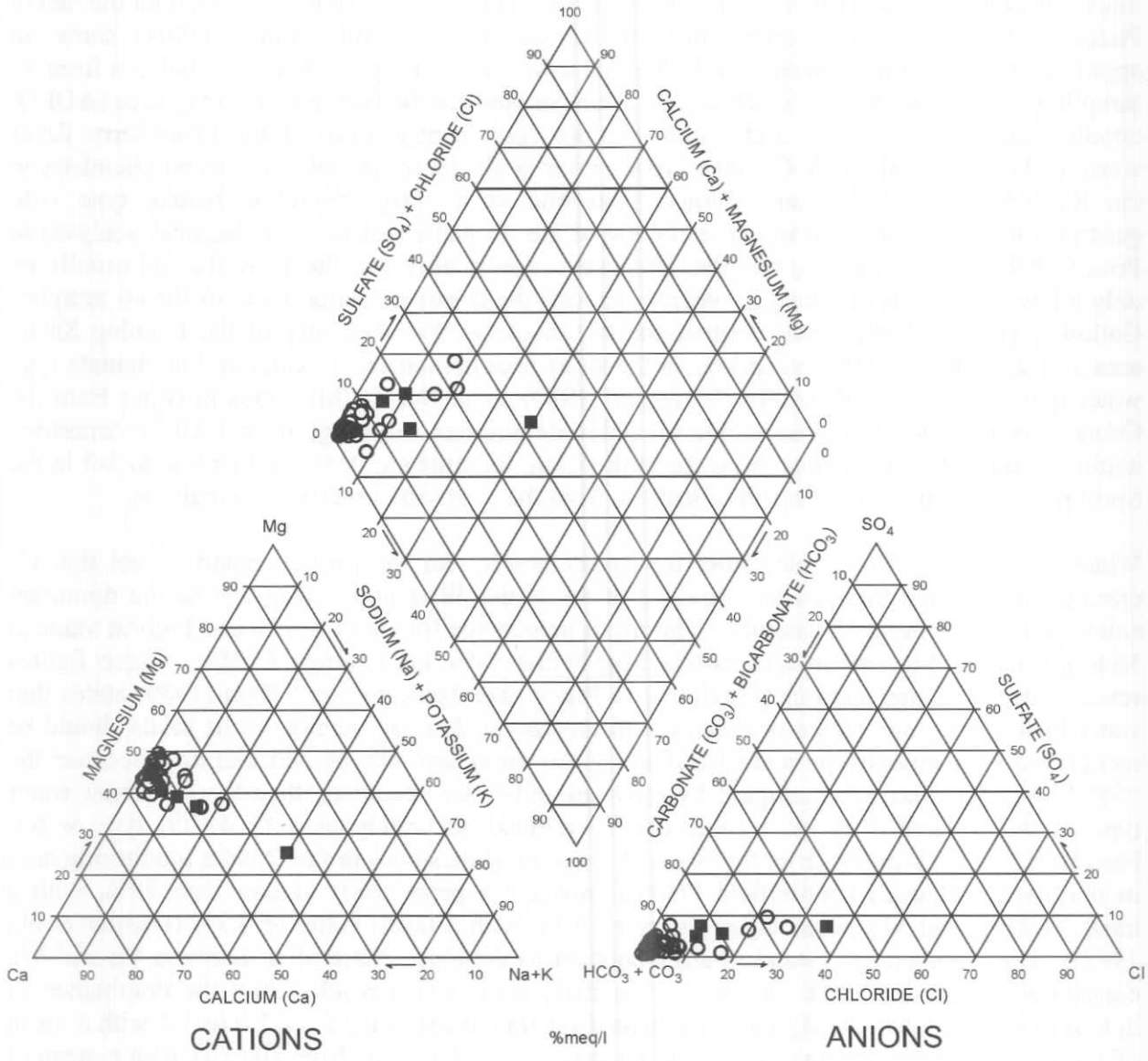


Figure GW-2. Piper diagram showing distribution of cations and anions in ground-water samples taken from Strawberry River watershed study area. Alluvial-aquifer samples are represented by squares; Ozark-aquifer samples are represented by circles for wells and triangles (hidden) for springs.

INFLUENCE OF ROCK TYPE ON WATER CHEMISTRY

Comparison of Water Chemistry in Exposed Ordovician Formations

The relationship of rock type to water chemistry was evaluated for the three major groups of Ordovician formations outcropping in the watershed. Problems often arise when attempting to define the water-producing formation for a well that penetrates more than one formation. Some investigators tend to use the lowest formation in these situations; however, drillers frequently advance borings to greater depths to obtain better yields, and merely obtain additional storage in cases where water is not encountered below the original producing zone. Because only the regolith is cased in most domestic wells, water can be produced from many zones, resulting in the physical mixing of water from one or more formations. Appendix GEO-1 lists the formations penetrated by the wells sampled for the present study, and demonstrates the difficulty in assigning the water-producing zone to a particular formation.

As a cursory review of the differences in water chemistry and quality across the watershed, each well was assigned to a specific formation based on its position on the Geologic Map of Arkansas (Haley et al., 1993). In cases where a well was near to or located on a formation boundary, and/or intercepted less than 20 feet of the upper formation, the well was assigned to the lower formation. Table GW-2 lists the minimum, maximum, mean and median concentrations for selected water-quality parameters for each of the three geologic designations as assigned by the Geologic Map of Arkansas: the St. Peter and Everton Formations (Ose), the Powell Dolomite (Op), and the Cotter and Jefferson City Dolomites (Ocjc).

Because some differences in concentrations can occur simply through the distribution of data with a wide range of concentrations, a *z*-test was performed to investigate the statistical significance of the perceived differences. A *z*-test is a statistical test that evaluates the differences between the means of two sample populations using calculated variances for each set, and was chosen because of the distribution of the sample concentrations. Results of the *z*-test are provided in Appendix GW-2. Because a difference in the mean concentrations can be the result of one or more wells with unusually high or low concentrations (outliers) relative to the rest of the data set, median concentrations were reviewed to verify trends in the mean concentrations.

One apparent trend noted in a review of Table GW-2 is the increase in Ca, Mg, HCO_3, and TDS concentrations from the Ose to the Ocjc. Because Ca, Mg, and HCO_3 concentrations are controlled by dissolution of the carbonate rock and serve as the dominant ions contributing to the TDS concentration in each well, a review of TDS concentrations is adequate for describing all four parameters. The three formations identified Table GW-2 are listed in order of their outcropping position from the southernmost formations (Ose) to the northernmost formations (Ocjc), and, as such, TDS concentrations increase from the south to the north in the watershed. Increases in TDS are the combined result of the solubility of the rock type (including cementing material), the pH of the infiltrating water, the presence of organic carbon, and the residence time of the ground water along the flow path from recharge to discharge areas. As such, the rock mineralogy combined with the hydraulic conductivity, as controlled by the size and abundance of fractures and bedding-plane openings, contribute to the overall TDS concentration along the flow path. However, there is scant literature available for reviewing either the mineralogy or hydrology of the Ozark aquifer in the study area, and only future research can validate the importance of and the controls on the increasing TDS concentrations from south to north.

Table GW-2. Comparison of water chemistry in the three groupings of Ordovician formations outcropping in the Strawberry River watershed study area.

	Ose [1]				Op [2]				Ocjc [3]			
	Min.	Max	Mean	Med.	Min.	Max	Mean	Med.	Min.	Max	Mean	Med.
Ca [4]	29.1	62.3	46.4	46.4	4.6	101	57.0	57.8	44.5	89.4	63.6	61.2
Mg	12.4	33.8	23.0	22.5	2.2	57.9	31.4	31.9	25.2	47.6	34.6	36.0
Na	0.9	3.6	1.8	1.4	1.2	21.9	3.6	2.1	0.7	6.0	2.0	1.6
Cl	1.6	8.4	3.3	2.3	1.8	35.3	6.9	3.5	1.6	33	6.1	3.8
HCO_3	144	338	257	252	13	559	303	302	242	451	345	355
SO_4	1.7	9.9	4.8	4.3	1.2	21.2	7.7	6.7	1.7	19.6	7.3	6.9
NO_3-N	0.11	2.73	0.81	0.48	0.02	14.0	1.88	0.51	0.02	3.81	0.83	0.53
TDS	142	144	216	212	57	465	278	291	222	414	301	309
Ca/Mg	1.12	1.42	1.24	1.2	0.96	1.27	1.10	1.08	0.98	1.28	1.11	1.11

[1] Ose = St. Peter and Everton Formations
[2] Op = Powell Dolomite
[3] Ocjc = Cotter and Jefferson City Dolomites
[4] Concentrations in mg/L; Ca/Mg ratios are calculated using equivalent concentrations of calcium and magnesium.

A review of the data from the Hardy monitoring area to the north of the watershed (ADEQ, unpublished data) reveals a mean TDS of 323 mg/L, which appears to validate the increasing TDS concentration to the north. A review of the *z*-test results reveals statistically-significant differences in TDS concentrations for both Op and Ocjc versus Ose, but not for Op versus Ocjc.

Statistically-significant differences additionally are noted for Ca/Mg ratios between both Op and Ocjc versus Ose. The differences in Ca/Mg ratios are evident from a review of Table GW-2. The minimum ratio of 1.12 for the Ose is slightly higher than the mean and median ratios for both the Op and Ocjc. A review of the data from the Hardy monitoring area (ADEQ, unpublished data), which is situated entirely within the Ocjc on the Geologic Map of Arkansas, reveals a Ca/Mg ratio of 1.08, which is similar to the mean values for the Op and Ocjc listed in Table GW-2. The higher Ca/Mg ratios for the Ose probably results from the higher content of calcite in the St. Peter Sandstone. McKnight (1935) states that the sand grains of the lowest member of the St. Peter Sandstone are cemented by calcite, and that the middle sandstone member is very limy with interstitial lime that tends to segregate into definite crystalline growths. Although sections of the St. Peter contain massive dolomite, sandy dolomite and dolomitic sandstone, the higher percentage of limestone in the Ose versus the Op and Ocjc contributes to the higher Ca/Mg ratios in the Ose. Figure GW-3 reveals the general trend for ranges of Ca/Mg ratios as plotted on a geologic map of the watershed.

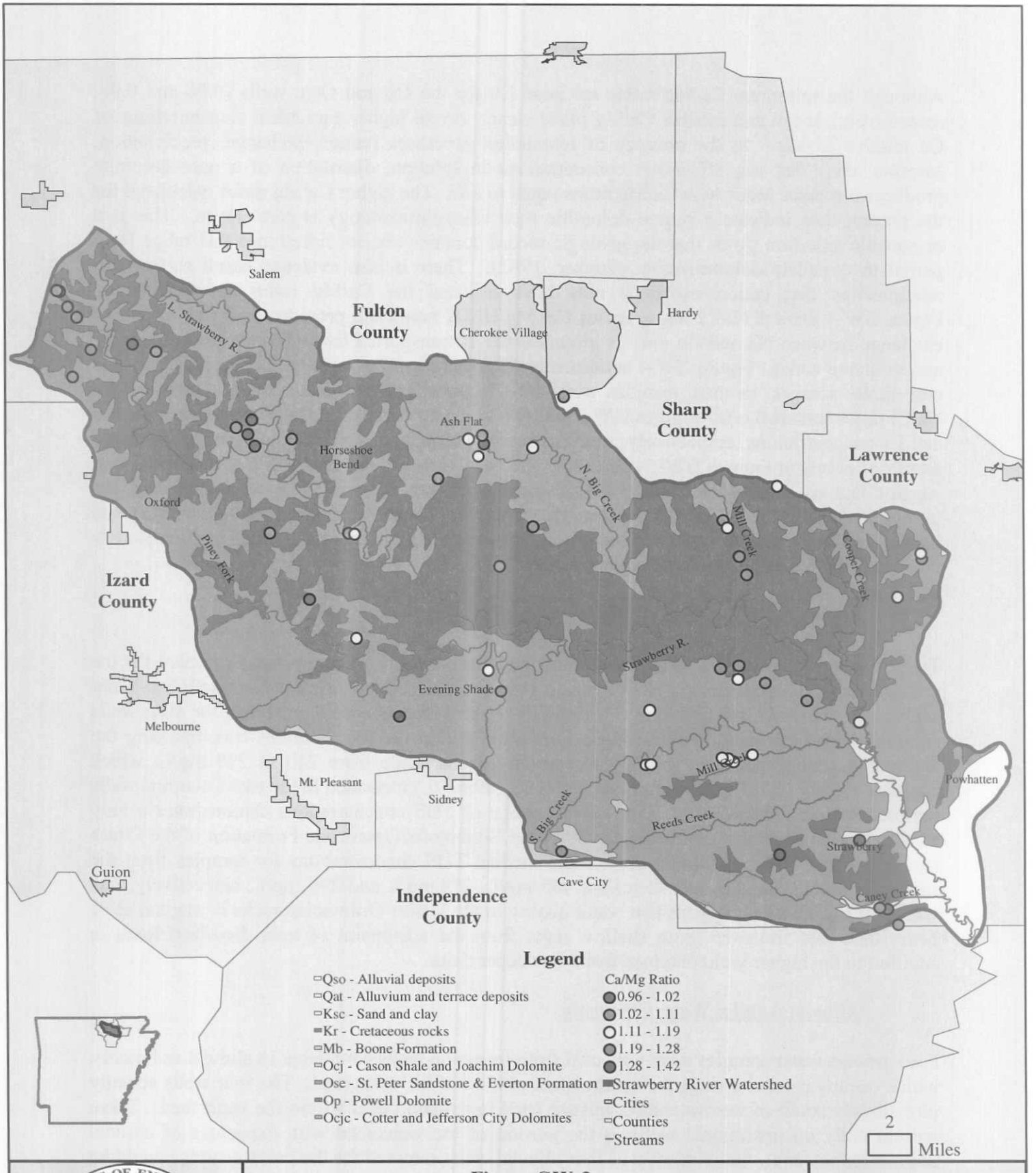


Figure GW-3
Calcium-Magnesium Molar Ratios, Strawberry River Watershed

Arkansas Department of Environmental Quality
Water Division - Planning Section

N
W
E
S

Although the minimum Ca/Mg ratios are near 1.0 for the Op and Ocjc wells (0.96 and 0.98, respectively), mean and median Ca/Mg ratios clearly reveal higher equivalent concentrations of Ca relative to Mg. In the absence of retardation processes (cation exchange, precipitation, sorption, etc.) that can affect ion concentrations in solution, dissolution of a pure dolomite produces a ground water with Ca/Mg ratios equal to one. The higher Ca/Mg ratios calculated for the present data indicate a source dolomitic rock whose mineralogy is part calcite. This is a reasonable assertion given that the geologic record contains ancient limestones that range from partial to complete dolomitization (Tucker, 1982). There is also evidence based on ion-pair relationships that cation exchange may have affected the Ca/Mg ratios in some areas. Figure GW-4 depicts Na/Cl ratios versus $Ca+Mg/HCO_3$ ratios and provides evidence for cation exchange between Na and Ca ions as ground water is transported through both the unsaturated and saturated zones. Figure GW-4 additionally demonstrates an association between excess salts and nitrate sources, as most samples with NO_3-N concentrations greater than 1.0 mg/L have Na/Cl ratios less than one. Figures GW-5 and GW-6 reveal correlations between increases in Na and Cl concentrations, respectively, to increases in Ca/Mg ratios. Although there is abundant scatter of points in Figures GW-5 and GW-6, the general trends in Figures GW-4 through GW-6 suggest that as sources of Na and Cl are introduced into the aquifer system (including the unsaturated zone), some of the Na may be replacing Ca at exchange sites (i.e., clays) and increasing the Ca concentrations in the ground water at the expense of Na, while simultaneously increasing the Ca/Mg ratio in the ground water.

Roubidoux/Gasconade Formation Water Chemistry

Two deep wells completed in the Roubidoux and Gasconade Formations were sampled for the present study. These wells are 1850 feet and 1900 feet in depth and are used as municipal-water supply for the town of Calamine. Prior (1999) provides chemical analyses for five wells completed in the Roubidoux/Gasconade Formation within the four counties encompassing the study area. Concentrations of TDS for the five wells range from 240 to 298 mg/L, which compare closely to TDS concentrations (249 and 259 mg/L) measured in the two Calamine wells sampled for the present study. The narrow range of TDS concentrations demonstrates a very consistent chemistry for ground water within the Roubidoux/Gasconade Formation of the Ozark aquifer system. The maximum, mean, and median TDS concentrations for samples from the shallower units (Ose, Op, and Ocjc) are 465 mg/L, 278 mg/L and 290 mg/L, respectively. As such, this information suggests that water quality in the Lower Ordovician rocks is as good as or better than that from the more shallow units from the standpoint of total dissolved load, in addition to the higher yield obtained from the deeper units.

Alluvial Aquifer Water Chemistry

Four ground-water samples were collected from irrigation wells completed in alluvial sediments, which occupy a small area in the southeastern portion of the watershed. The four wells actually plot slightly south of the watershed, but are used to irrigate fields within the watershed. There are currently no operational wells in the portion of the watershed with exposures of alluvial sediments; however, the proximity of four alluvial wells sampled for the present study should be highly representative of alluvial ground-water quality in this area. Table GW-3 compares sample analyses from the alluvial wells to samples from the Ozark aquifer. Mean and median concentrations of TDS are higher for alluvial aquifer samples than for the Ozark aquifer samples.

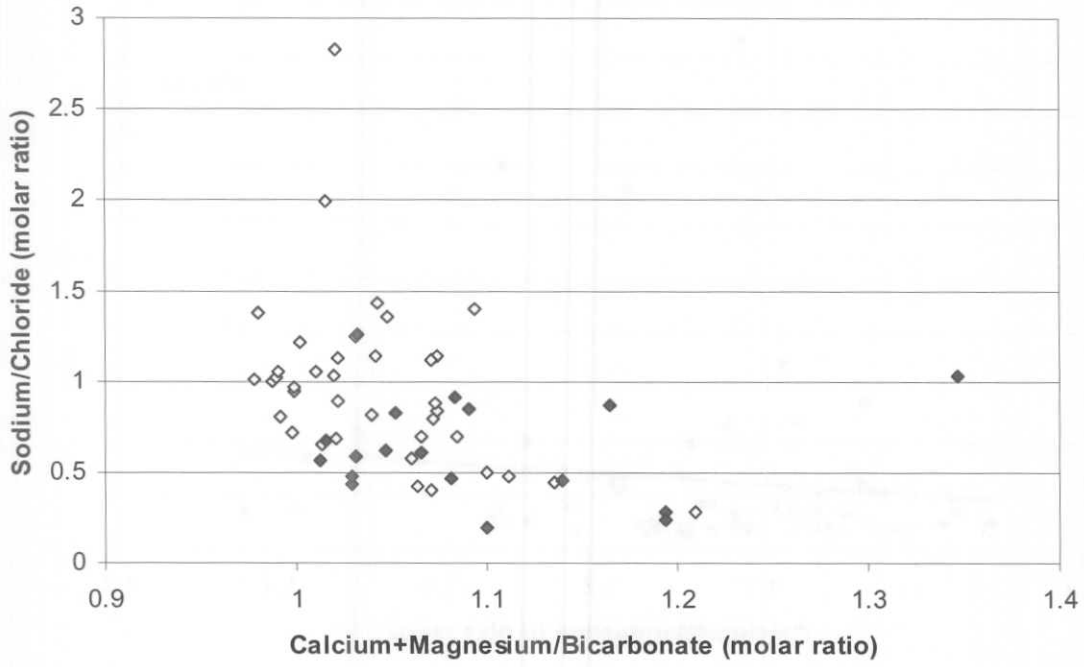


Figure GW-4. A graph of sodium/chloride ratios versus calcium+magnesium/bicarbonate ratios. Darkened data points represent samples with nitrate-N concentrations greater than or equal to 1.0 mg/L.

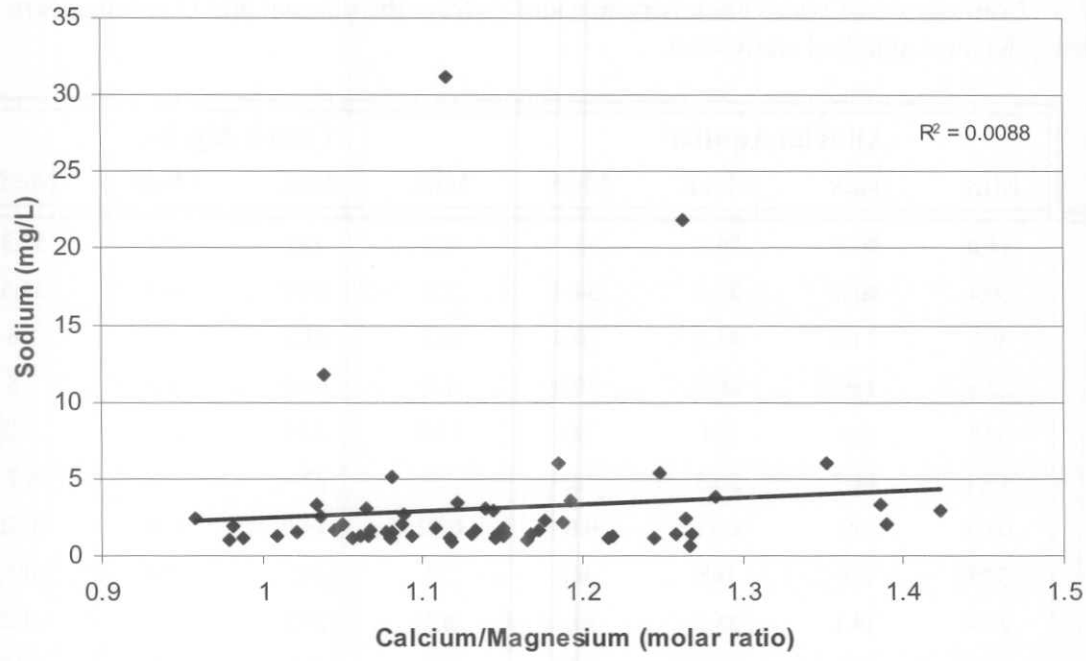


Figure GW-5. A graph of sodium concentrations versus calcium/magnesium ratios. Goodness of fit represented by R^2 value.

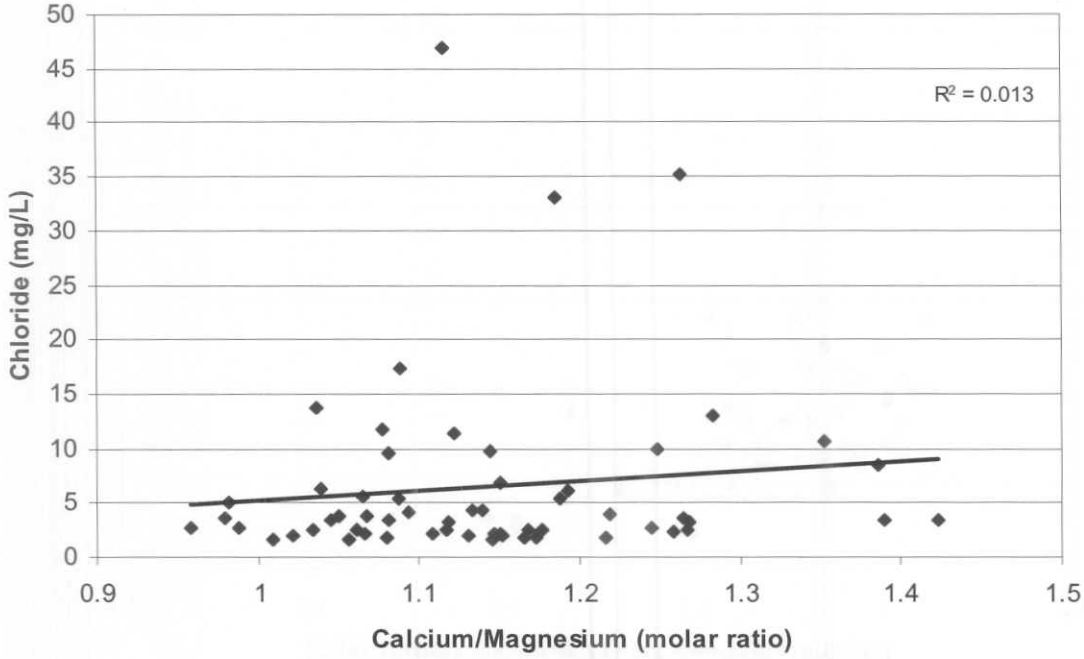


Figure GW-6. A graph of chloride concentrations versus calcium/magnesium ratios. Goodness of fit represented by R^2 value.

Table GW-3. Comparison of water chemistry in samples from the alluvial and Ozark aquifers in the Strawberry River watershed study area.

	Alluvial Aquifer				Ozark Aquifer			
	Min.	Max	Mean	Med.	Min.	Max	Mean	Med.
Ca [1]	64.0	90.7	75.2	73.1	4.6	101	57.6	57.3
Mg	30.4	40.8	35.0	34.4	2.2	57.9	30.9	31.5
Na	9.2	116	41.5	20.5	0.7	31.2	3.1	1.6
Cl	22.6	159	60.4	30.0	1.6	46.9	6.5	7.5
HCO_3	310	439	368	362	13.4	559	310	302
SO_4	15.4	44.7	26.3	22.6	1.2	27.4	7.4	6.7
NO_3-N	0.02	0.41	0.13	0.05	0.02	14.0	1.39	0.52
TDS	335	709	368	362	57	465	278	283
SiO_2	23.4	29.1	25.3	24.4	8.5	20.8	11.7	11.2
pH	7.02	7.56	7.29	7.30	5.9	8.3	7.57	7.57

[1] All parameter concentrations in mg/L, except for pH values, which are in standard pH units.

The maximum TDS concentration of 709 mg/L for the alluvial aquifer samples is similar to the maximum of 746 mg/L cited in Kresse and Fazio (2002) for 118 alluvial aquifer samples collected in the Bayou Bartholomew watershed in southeastern Arkansas. Mean and median concentrations of Na, Cl, and SO_4 are similarly elevated in the alluvial samples relative to the Ozark aquifer samples. Imes and Emmett (1994) state that discharge of poor-quality water from the lower portion of the Ozark aquifer within a few miles of the Ozark Escarpment can account for elevated salt content and TDS in the alluvial aquifer. Kresse and Fazio (2002) cited mixing of poor-quality water as the reason for increased Na, Cl and SO_4 concentrations in the alluvial aquifer in southeastern Arkansas. Their report additionally noted that increases in Na, Cl and SO_4 concentrations correlated to decreases in pH, %Ca (of total cations) and % HCO_3 (of total anions) at an approximate TDS concentration of 350 mg/L along a flow path defined by increasing TDS concentrations.

Mean and median NO_3-N concentrations for the alluvial aquifer samples (0.13 mg/L and 0.05 mg/L, respectively) were ten-fold lower than mean and median concentrations for the Ozark aquifer (1.39 mg/L and 0.52 mg/L, respectively) (Table GW-3). Kresse and Fazio (2003) identified reducing conditions in the alluvial aquifer of the Bayou Bartholomew watershed in southeastern Arkansas and attributed low NO_3-N concentrations (mean and median NO_3-N concentrations of 0.06 mg/L and 0.02 mg/L, respectively) in the alluvial aquifer to denitrification within the reducing zone.

NUTRIENTS AND BACTERIA

One of the primary objectives of the study was to evaluate impacts to ground-water quality from nonpoint sources of contamination, which consist dominantly of confined-animal operations. Most NH_3-N and ortho-P concentrations were nondetect at 0.005 mg/L. As such, only NO_3-N concentrations were considered as a first indication of anthropogenic impacts to ground-water quality. Because of the six-hour holding time, fecal coliform and *E. coli* bacteria were not analyzed during the August, 2002 sampling events, and a sampling event for bacteria analysis was planned for all wells exceeding 1.0 mg/L NO_3-N. Sixteen of the 58 total samples (26%) collected during August, 2002, contained NO_3-N concentrations greater than 1.0 mg/L. Because NO_3-N concentrations in two other wells were near the arbitrary limit of 1.0 mg/L (0.91 mg/L and 0.96 mg/L), these wells were also included in a sampling event on September 16, 2002. All samples were transported to the ADEQ Little Rock office and plated for fecal coliform and *E. coli* analysis within six hours of the collection time. Only one sample revealed any bacterial colonies, which was from a small, open pool of water in Evening Shade fed by an underground spring. Because the water was vulnerable to surface sources of contamination, the presence of bacteria is probably the result of the pool becoming contaminated at the surface. This theory is further supported by the fact that three wells, two of which were greater than 6.0 mg/L NO_3-N and one which exceeded 12.0 mg/L, revealed no bacterial colonies. During this re-sampling event, four samples were collected from new sites for complete chemical analysis. One of the new samples was from the well of a resident next door of the household whose well water contained 12.9 mg/L NO_3-N. This new sample contained 14.0 mg/L NO_3-N, and analysis of the sample for fecal coliform and *E. coli* bacteria revealed no colonies, similar to the other samples.

Adamski (1997) conducted a review of nutrients and pesticides in ground water of the Ozark Plateaus in Arkansas, Kansas, Missouri and Oklahoma as part of the USGS National Water-Quality Assessment Program. In establishing background concentrations for NO_3-N, he used 25

samples from relatively pristine sites (forest cover greater than or equal to 90 percent) and calculated the 90th percentile concentration for NO_3-N as 0.98 mg/L. However, because domestic wells, in addition to springs, were sampled for the study, impacts from septic systems cannot be discounted as a potential source of nitrogen to the wells, regardless of land use in the vicinity of the wells. As such, the nitrogen content of ground water in pristine areas may be significantly lower in areas void of input from septic systems. Adamski (1997) listed 45 of 98 samples (45.9%) collected for the random-unit survey in the Ozark Plateaus as containing NO_3-N concentrations that exceeded the background of 0.98 mg/L. For the present study, 17 of 58 samples (29.3%) collected from the Ozark aquifer were greater than 0.98 mg/L NO_3-N. The higher percentage for the data from Adamski (1997) appears to result from the inclusion of samples from both the Springfield Plateau and Salem Plateau aquifer systems. Agricultural land use is much greater in the Springfield Plateau area, and median NO_3-N concentrations in springs (2.6 mg/L) and wells (1.0 mg/L) in the Springfield Plateau aquifer were much greater than those from springs ($\approx$ 0.4 mg/L) and wells ($\approx$ 0.6 mg/L) in the Ozark aquifer (Adamski, 1997), which compared closely to median values for springs (0.47 mg/L) and wells (0.63 mg/L) in the Ozark aquifer for the present study. Adamski (1997) additionally noted that although springs in the Springfield Plateau aquifer contained significantly higher NO_3-N concentrations than wells, no significant difference was noted between springs and wells in the Ozark aquifer. Similarly, no significant difference in NO_3-N concentrations was noted between springs and wells for the present study.

The identification of the source(s) of nitrate contamination is complicated by the poor knowledge of the contribution from multiple sources including animal-waste lagoons, land application of solid and liquid animal waste, fertilizers, bat guano and septic-tank effluent. Several sources have linked elevated NO_3-N concentrations in ground waters of northern Arkansas to the explosive growth of the poultry industry in the area, although most of these studies acknowledge the complications in identifying either the specific source and/or the contribution from the various sources (Steele and McCalister, 1990; Smith and Steele, 1990; Austin and Steele, 1990; Steele and Adamski, 1987; Peterson et al., 2002, Davis et al., 2000). Steele and Adamski (1987) and Steele and McCalister (1990) compared wells and springs in a watershed with extensive pastureland to a watershed with forest cover as the dominant land use, and found statistically higher concentrations of NO_3-N in the watershed with extensive pasture use. Although septic systems were acknowledged as a potential source of contamination, Steele and McCalister (1990) cited figures that revealed a greater amount of nitrogen from poultry production than other sources, and listed waste from poultry production as the major source.

Adamski (1997) noted that NO_3-N concentrations in samples from wells and springs were positively correlated to percent agricultural land use around each sample site (within a mile), and negatively correlated to percent forest cover around each site (Figure GW-7). Because of the large area encompassed by the study and the quality of land coverage in the mid 1990's, all land that was not labeled as forest was considered agricultural land. Although septic systems are possible contamination sources for the domestic wells, regardless of the land use, the trends in Figure GW-7 can be interpreted as representing the additional nutrient input contributed by the application of animal waste. However, the upper boundary in Figures GW-7a and GW-7b reveals elevated (>5 mg/L) NO_3-N concentrations regardless of the percent land use, and the lower boundary appears to drive the trend. This phenomenon strongly suggests that septic-tank effluent is a major contribution to the total nutrient input, especially for ground water supplying domestic wells.

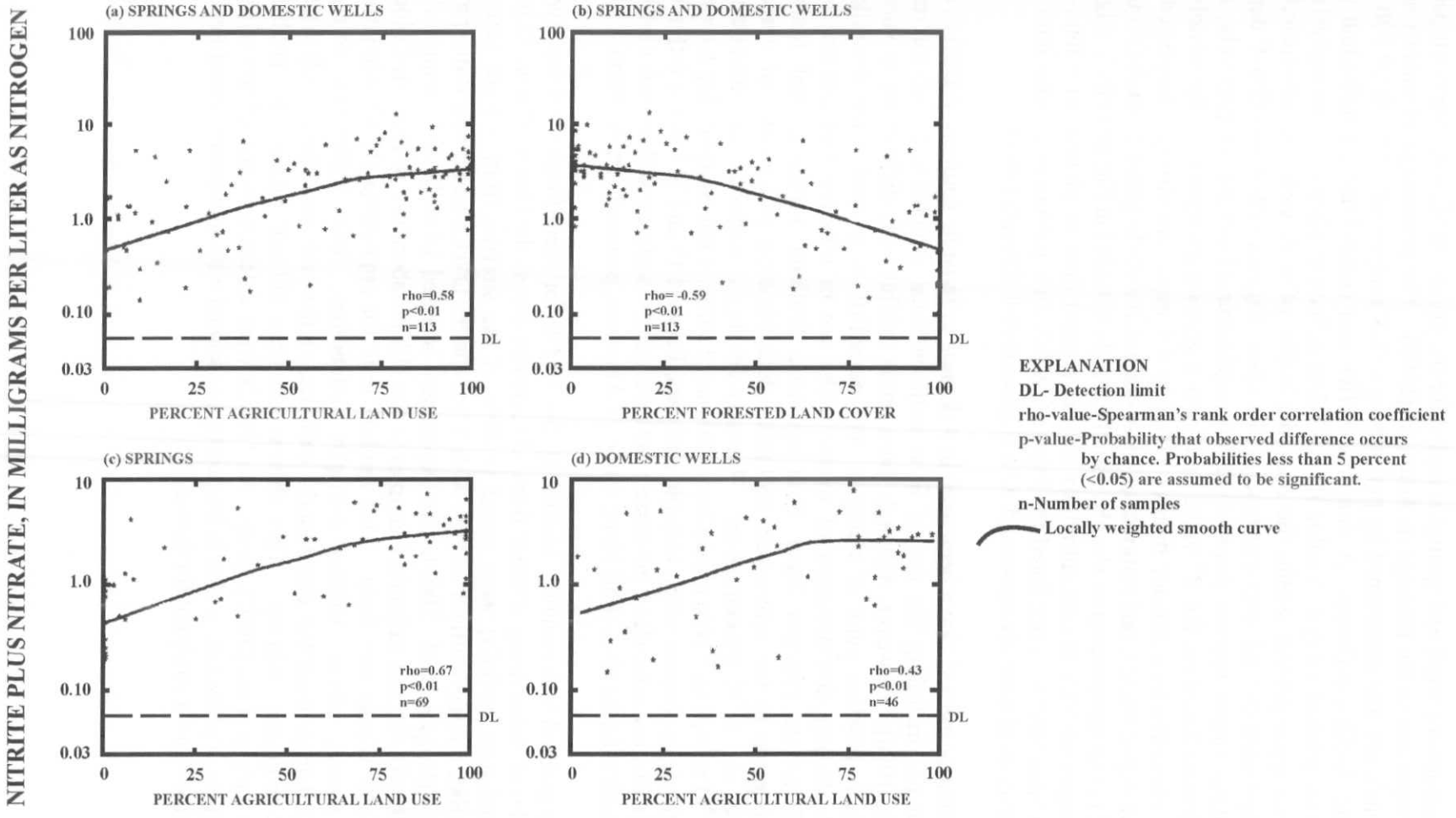


Figure GW-7. Relation of nitrite plus nitrate concentrations to agricultural land use and forested land cover for ground-water samples from (a) springs and domestic wells, (b) springs and domestic wells, (c) springs, and (d) domestic wells (from Adamski, 1997).

Nitrate-N concentrations for wells and springs sampled for the present study also were compared to land use for comparison to the findings in Adamski (1997). The percentage of various land uses surrounding each site was determined by performing a GIS analysis of CAST GAP 100 Ha land use data using ArcGIS software. A one-mile buffer was created around individual site locations, which were plotted using a Trimble III GPS data collection platform. An analysis of the various land-use types present within the one-mile buffer of each well was conducted to determine the composition of land uses surrounding the sites. Figures GW-8 and GW-9 depict NO_3-N concentrations versus percent forest cover and agricultural land use, respectively, and reveal poor correlations based on the R^2 value and from a general inspection of the trendline. However, NO_3-N concentrations greater than or equal to 6.0 mg/L are strongly suspected of contamination from septic wastes, and removal of these outliers results in general trends (Figures GW-10 and GW-11) that compare more closely with the trends revealed in Figure GW-7. Figure GW-12 depicts ranges of NO_3-N concentrations for the present data as plotted on a land-use map. Although several land uses are listed for Figure GW-12, only pasture and forest land use were used for the statistical analysis associated with Figures GW-8 through GW-11.

Over the years, different methods have been used in Arkansas to separate sources of nutrient and bacteria contamination including the use of fecal coliform/fecal streptococci bacteria ratios (Leidy and Morris, 1990). However, although these ratios exhibit wide differences in various waste sources, their different rates of transport and mortality in ground water complicate interpretation and ultimate determination of source. The use of nitrogen isotopes has been employed to differentiate nitrogen input from synthetic fertilizer versus animal manure. Unfortunately, processes in the subsurface, including denitrification and mixing of nitrogen sources, can affect the $\delta^{15}N$ concentration. Recently-developed methods for simultaneous determination of ^{18}O as well as ^{15}N in nitrate have eliminated some of the complicating factors in determination of nitrogen sources using isotopic analyses, because O and N behave differently when subjected to various subsurface processes: however, such analyses still do not proffer a definitive identification for all sites (Phil Hays, Univ. of Arkansas, personal communication).

A new laboratory method was recently created by the USGS for identification of wastewater contaminants, and was tested using samples from 139 streams across the United States. Organic wastewater contaminants (OWCs) were found in 80% of the streams from a wide range of residential, industrial, and agricultural origins with 82 of the 95 OWCs being found during the course of the study (Kolpin, et al., 2002). The Department selected 18 wells and springs which exceeded 1.0 mg/L NO_3-N, and submitted samples to the USGS laboratory in Denver, Colorado for a Schedule 1433 Wastewater Scan. This method tests for approximately 67 compounds, which include, among others, various estrogen metabolites, fecal indicators, detergent metabolites, other detergent-related compounds, caffeine, cholesterol, and compounds used in the perfume and fragrance industry. This abbreviated scan did not include the antibiotics measured for the Kolpin et al. (2002) study. No OWCs were detected in any of the samples, except for a detection of phthalate, which is frequently associated with laboratory contamination. Table GW-4 lists the OWCs analyzed for this report.

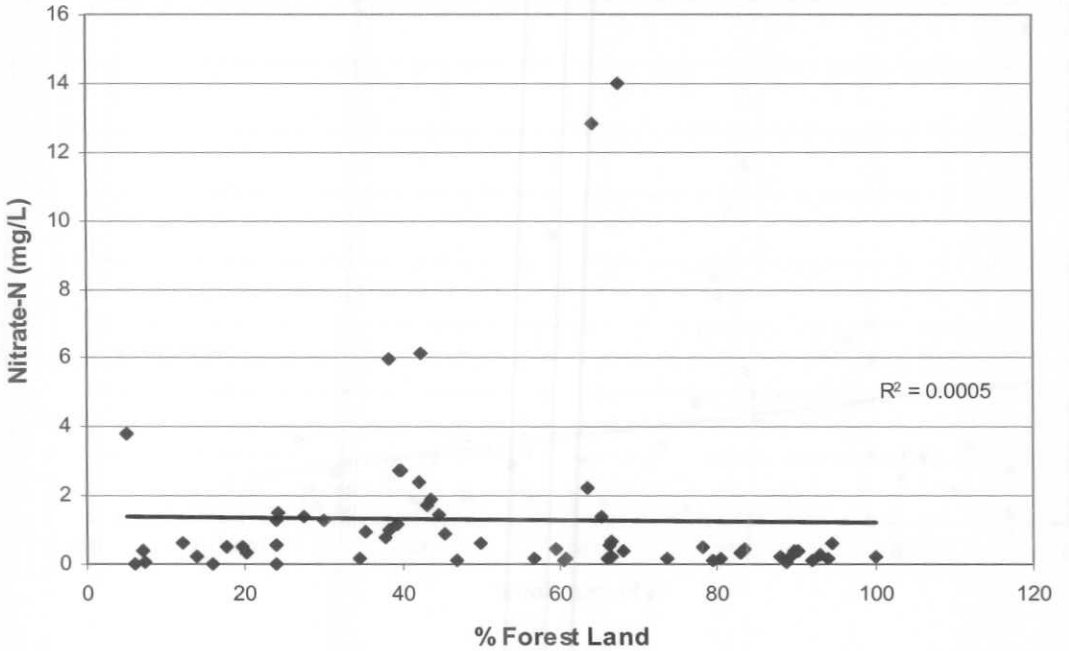


Figure GW-8. A graph of NO_3-N concentrations versus percent forest land cover for study area. Goodness of fit represented by R^2 value.

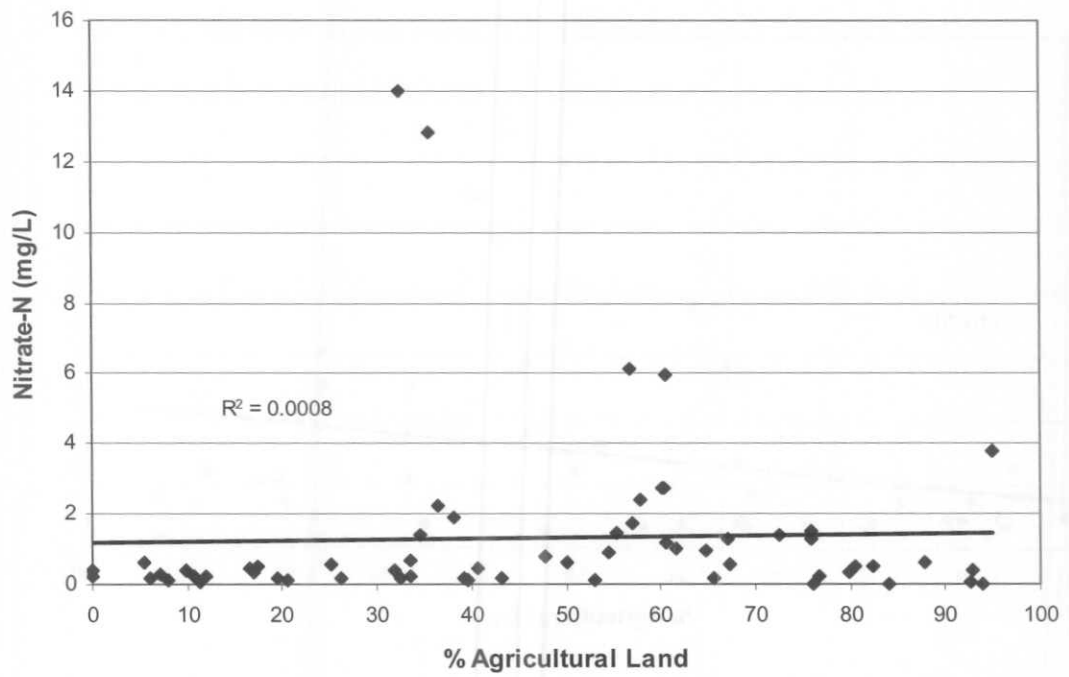


Figure GW-9. A graph of NO_3-N concentrations versus percent agricultural land use for study area. Goodness of fit represented by R^2 value.

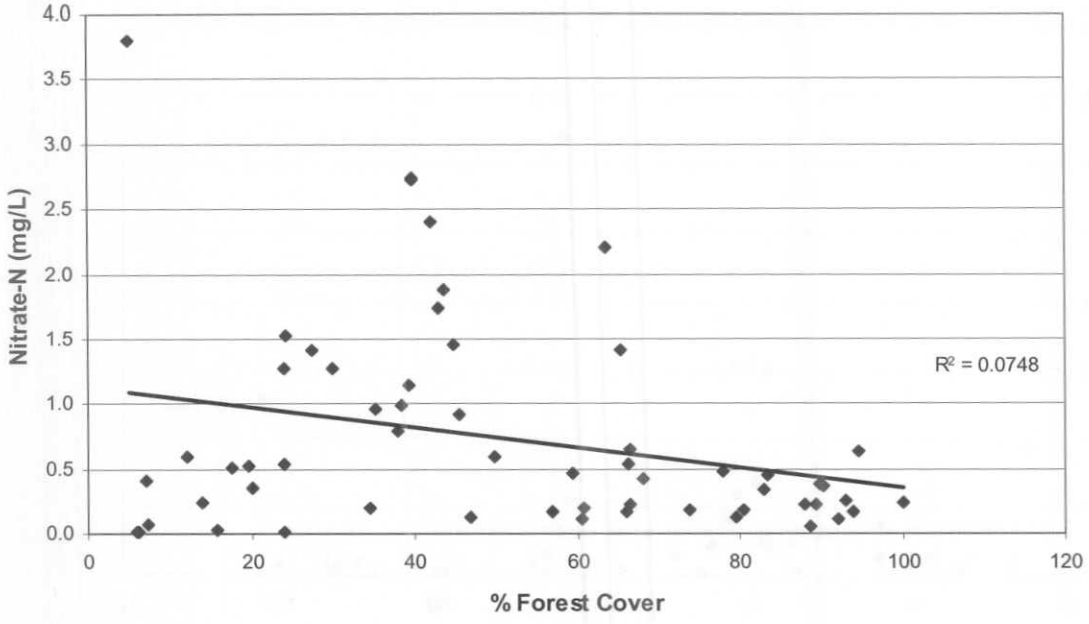


Figure GW-10. A graph of NO_3-N concentrations versus percent forest land cover. NO_3-N concentrations greater than 6.0 mg/L (four data points) have been removed. Goodness of fit represented by R^2 value.

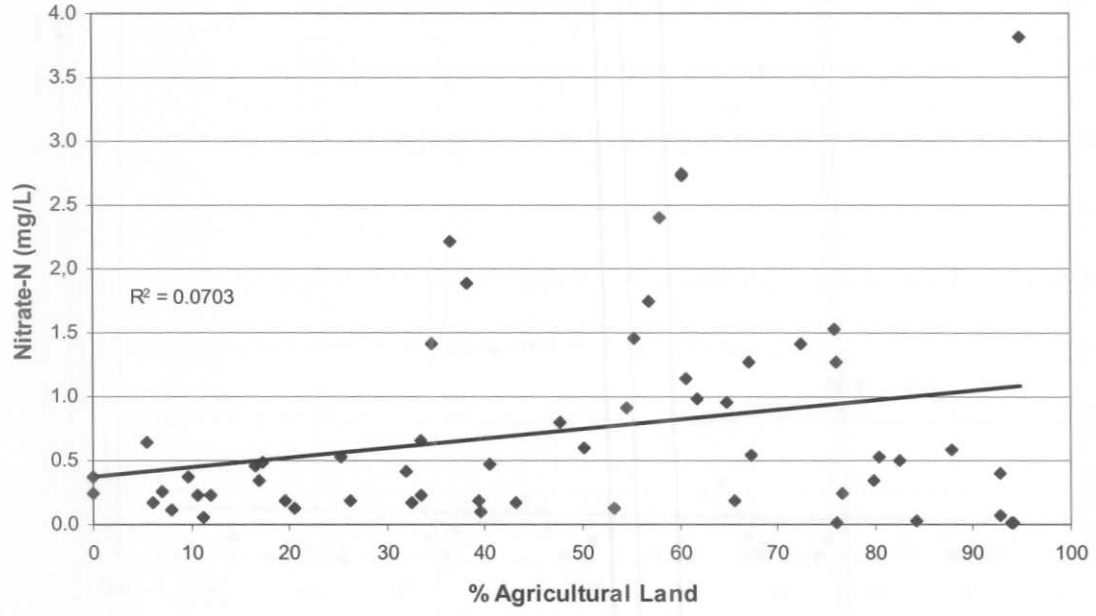


Figure GW-11. A graph of NO_3-N concentrations versus percent agricultural land use. NO_3-N concentrations greater than 6.0 mg/L have been removed. Goodness of fit represented by R^2 value.

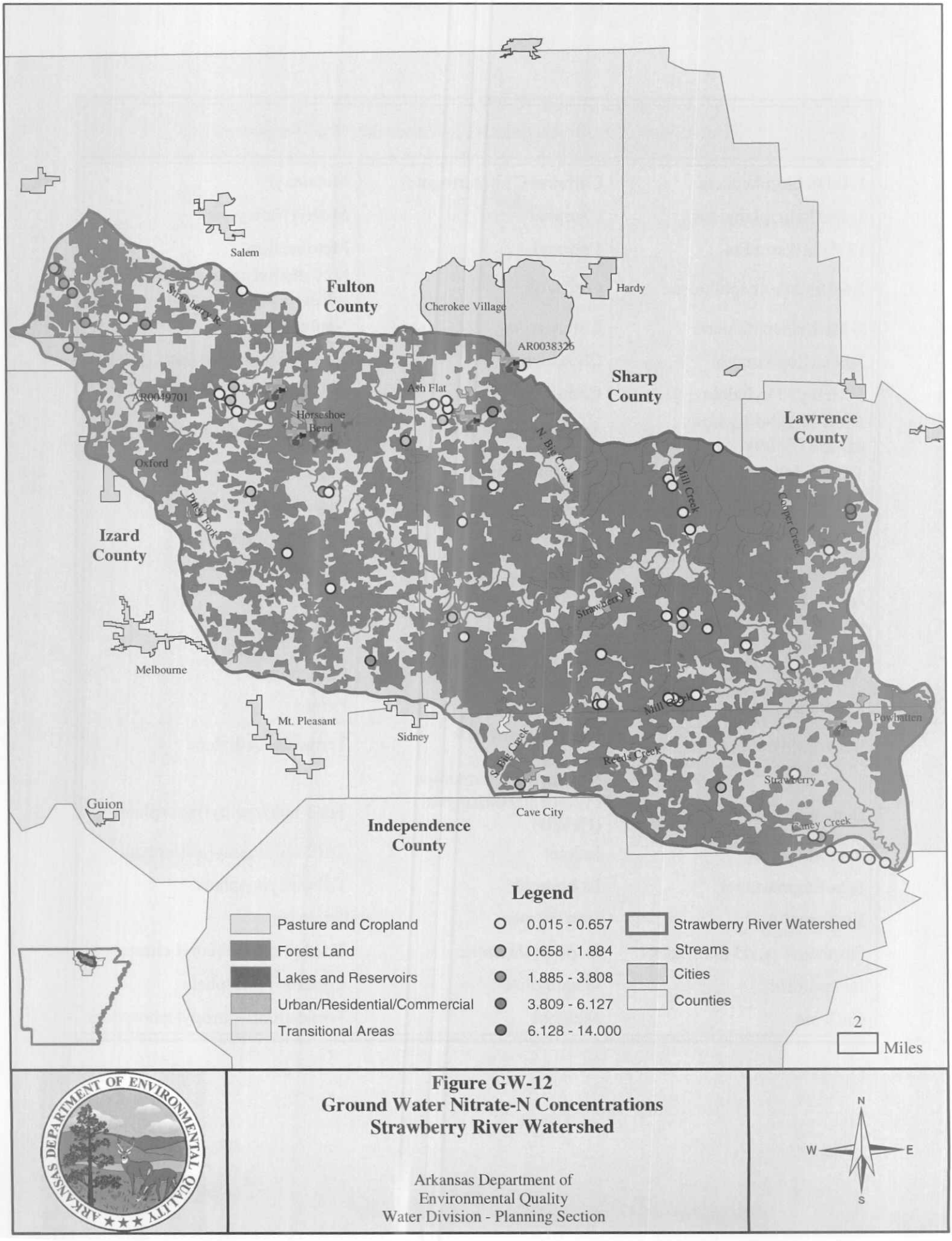


Figure GW-12
Ground Water Nitrate-N Concentrations
Strawberry River Watershed

Arkansas Department of
Environmental Quality
Water Division - Planning Section

N
W
E
S

Table GW-4. USGS Schedule 1433 Wastewater Scan Parameters		
1,4–Dichlorobenzene	Caffeine-C13 (surrogate)	Metalaxyl
1–Methylnaphthalene	Camphor	Methyl Salicylate
17–beta-Estradiol	Carbaryl	Metolachlor
2,6-Dimethylnaphthalene	Carbazole	N,N-diethyl-meta-toluamide (DEET)
2-Methylnaphthalene	Chlorpyrifos	Naphthalene
3-beta-Coprostanol	Cholesterol	Nonylphenol, diethoxy- (total)
3-Methyl-1H-indole	Cotinine	Octylphenol, diethoxy-
3-tert-Butyl-4-hydroxy anisole (BHA)	d-Limonene	Octylphenol, monoethoxy-
4-Cumylphenol	Decafluorobiphenyl	p-Cresol
4-n-Octylphenol	Diazinon	Para-Nonylphenol (total)
5-Methyl-1H-benzotriazole	Dichlorvos	Pentachlorophenol
Acetophenone	Equilenin	Phenanthrene
Acetyl hexamethyl tetrahydronaphthalene (AHTN)	Estrone	Phenol
Anthracene	Ethynyl estradiol	Prometon
Anthraquinone	Fluoranthene	Pyrene
Benzo[a]pyrene	Fluoranthene, d10 (surrogate)	Tetrachloroethylene
Benzophenone	Hexadydrohexamethyl-cyclopentabenzopyran (HHCB)	Tri(2-butoxyethyl)phosphate
beta-Sitosterol	Indole	Tri(2-chloroethyl)phosphate
beta-Stigmastanol	Isoborneol	Tributyl phosphate
Bisphenol A	Isophorone	Triclosan
Bisphenol A, d3 (surrogate)	Isopropylbenzene	Triethyl citrate (ethyl citrate)
Bromoform	Isoquinoline	Triphenyl phosphate
Caffeine	Menthol	Tris(dichlorisopropyl)phosphate

Sampling locations were also selected near confined animal operations in the watershed. A total of six wells were sampled that supplied water to chicken houses; two wells were sampled that supplied water to dairy facilities; and one sample was taken from a spring located in a field used as a pasture for cattle. Mean and median NO_3-N concentrations for these nine samples were 1.5 mg/L and 0.6 mg/L, respectively, as compared to 1.3 mg/L and 0.5 mg/L, respectively, for all samples. As such, there was no significant difference between samples collected next to animal facilities versus random locations within the watershed. The two samples which contained NO_3-N concentrations greater than 12.0 mg/L were in the northeast portion of the watershed. Although one owner raises dogs in a pasture behind his house, there are no confined animal operations in the area. The elevated NO_3-N concentrations strongly suggest contamination from onsite septic systems, but there is no definitive evidence for the source at the present time, and the Schedule 1433 Wastewater Scan analyses provided no additional information. Plans are underway to conduct a series of dye tests in both households, using two different dyes during concurrent time frames. Information gained from the dye traces will assist the residents in protecting their drinking water source.

This page intentionally left blank

AQUATIC MACROINVERTEBRATE COMMUNITY

The aquatic macroinvertebrate community was surveyed during 2001 to 2003 at the stations listed in Table M-1. Figure M-1 depicts aquatic macroinvertebrate sampling sites. Data presented in this section may be accessed via the ADEQ website, http://www.adeq.state.ar.us/water/data_edas/edas.asp.

Table M-1. Location data for aquatic macroinvertebrate sampling in the Strawberry River watershed, Arkansas, 2001 – 2003.

Station ID	Stream Name	Latitude	Longitude	Riffle/Pool #	County
WHI0143A	Strawberry River	36.275408	-91.907167	1	Fulton
WHI0143A	Strawberry River	36.277261	-91.907811	2	Fulton
UWSBR01	Strawberry River	36.230953	-91.811075	1	Izard
UWSBR01	Strawberry River	36.228650	-91.811875	2	Izard
WHI0143E	Little Strawberry River	36.267325	-91.780181	1	Izard
UWSBR01	Strawberry River	36.267672	-91.779867	2	Izard
WHI0143H	Little Strawberry River	36.237222	-91.790767	1	Izard
WHI0143H	Little Strawberry River	36.236036	-91.790022	2	Izard
WHI0143B	Strawberry River	36.174567	-91.739017	1	Izard
WHI0143B	Strawberry River	36.170706	-91.742628	2	Izard
WHI0143L	Piney Fork	36.073128	-91.732944	1	Izard
WHI0143B	Strawberry River	36.073011	-91.731978	2	Izard
WHI0143M	Piney Fork	36.080714	-91.610125	1	Sharp
WHI0143M	Piney Fork	36.080619	-91.610422	2	Sharp
UWSBR02	Strawberry River	36.098161	-91.608381	1	Sharp
UWSBR02	Strawberry River	36.101502	-91.609930	1	Sharp
UWSBR02	Strawberry River	36.101947	-91.610508	2	Sharp
NBC-STP	North Big Creek	36.213753	-91.601100	1	Sharp
WHI0143I	North Big Creek	36.222147	-91.580525	1	Sharp
WHI0143I	North Big Creek	36.220047	-91.581378	2	Sharp
D/S of 143I	North Big Creek	36.205830	-91.549416	1	Sharp
D/S of 143I	North Big Creek	36.206805	-91.549919	2	Sharp
UWNBC01	North Big Creek	36.137689	-91.508650	1	Sharp
UWNBC01	North Big Creek	36.137989	-91.509458	2	Sharp
WHI0143N	Mill Creek	36.121364	-91.402397	1	Sharp
WHI0143N	Mill Creek	36.123389	-91.401986	2	Sharp
WHI0143P	Strawberry River	36.107553	-91.446519	1	Sharp
WHI0143K	South Big Creek	36.011964	-91.491447	1	Sharp
WHI0143K	South Big Creek	36.010975	-91.492239	2	Sharp
WHI024	Strawberry River	36.026456	-91.323936	1	Lawrence
WHI0143S	Cooper Creek	36.032772	-91.305747	1	Lawrence
WHI0143J	South Big Creek	36.020047	-91.337603	1	Lawrence
UWRDC01	Reed's Creek	35.982561	-91.337106	1	Lawrence
WHI0143R	Caney Creek	35.906778	-91.291683	1	Lawrence
WHI0143Q	Caney Creek	35.905397	-91.261164	1	Lawrence

Note: Latitudes and Longitudes for aquatic macroinvertebrate samples are different than those for water quality and fish community samples that are recorded at bridges

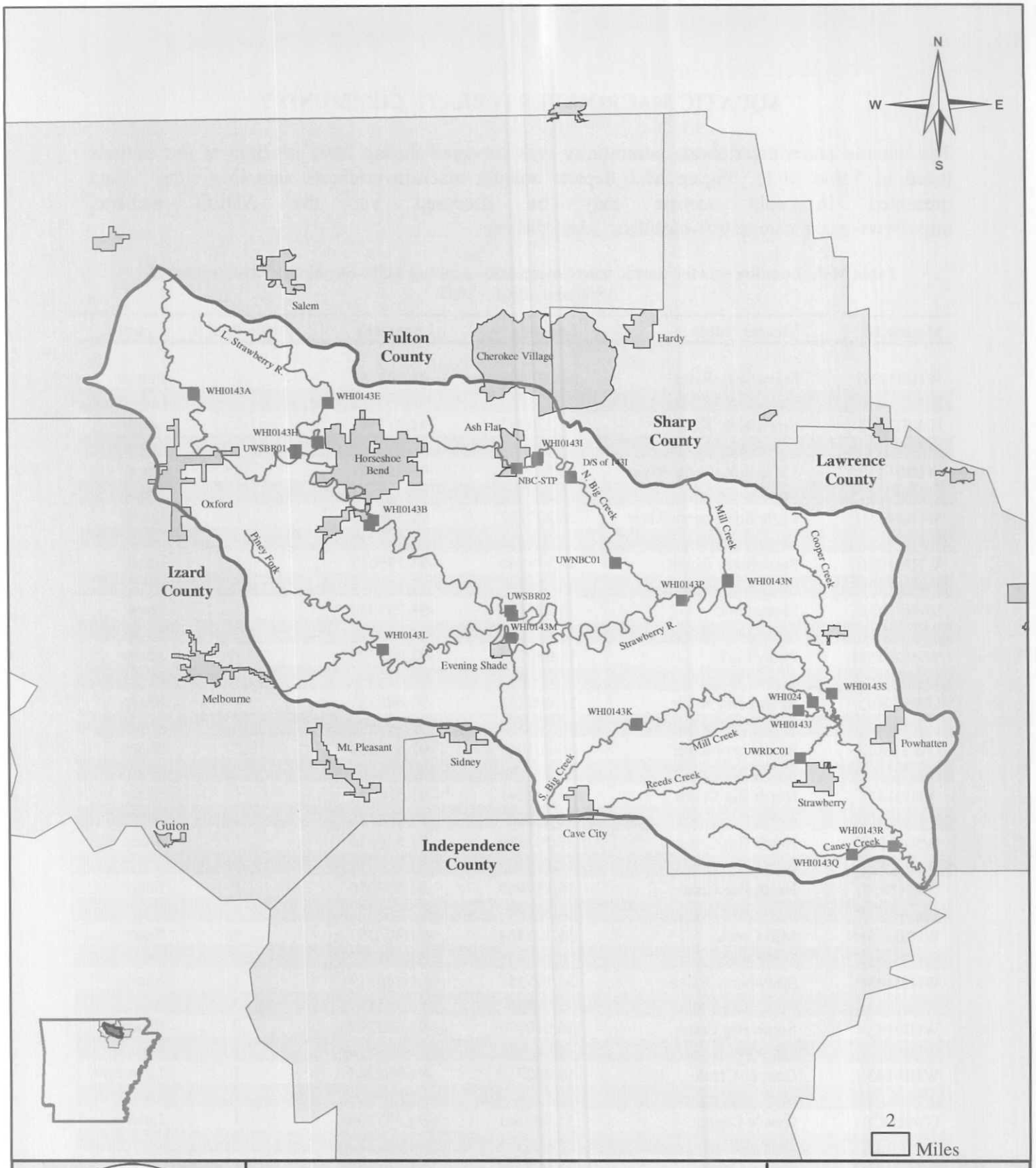


Figure M-1
Macroinvertebrate Sampling Sites
Strawberry River Watershed

Arkansas Department of
Environmental Quality
Water Division - Planning Section

Legend

- Watershed Boundary
- Cities
- Counties
- Streams

METHODOLOGY

A Turtox® D-frame dip net with shroud (800-900 multifilament) was used to collect samples. The samples were cleaned of larger debris in the field before preservation, preserved in 70% ethanol and labeled with the appropriate identifying information. Samples were collected during fall 2001, spring 2002, fall 2002 and spring 2003. Fall sampling periods for aquatic macroinvertebrates is defined by ADEQ as September 15 to October 31. The spring sampling period is defined as April 1 to June 15. Insufficient flow prevented collections from occurring at some sites during fall sampling periods.

Aquatic macroinvertebrates were collected using the traveling kick method in Ozark Highland streams. The net was placed downstream while the substrate was disturbed upstream. A five-minute kick sample was taken along diagonal transects enabling all microhabitats present to be sampled. Two riffles were sampled per station.

In Delta streams (WHI0143R, WHI0143Q, WHI0143J, WHI0143S, UWRDC01), aquatic macroinvertebrates were sampled in bank margins, woody debris/snags and submerged macrophytes. These habitats generally have the highest taxa richness and balance of pollution-sensitive organisms in lowland streams. These habitats were sampled proportional to their abundance within a 50-m reach. Organisms were collected by aggressively disturbing the target habitat for a distance of 1-m followed by 3 to 4 cleaning sweeps to collect dislodged organisms. Twenty 1-m collections were composited in a bucket, picked of large debris, preserved and labeled. Each sweep covers 0.3 m^2 of substrate (net width = 0.3 m x 1 m length of pass); therefore the total composite sample was taken from approximately 6 m^2 (Maxted et al. 2000; Barbour et al. 1996).

A subsample of approximately 100 organisms was picked in the laboratory. A 4-inch diameter metal ring was randomly tossed into the tray and organisms within the ring removed for the subsample. Subsampling continued until a minimum of 95 organisms was removed. The sample may exceed 100 organisms, but should not be less than 95 (ADEQ, 2003). Subsamples were identified to the proposed minimum levels for taxonomic resolution.

Taxonomic Level	Groups
Genus	Plecoptera, Ephemeroptera, Odonata, Trichoptera, Megaloptera, Neuroptera, Lepidoptera, Coleoptera, Hemiptera, Diptera (in part), Crustacea (in part), Mollusca (in part)
Family	Diptera (in part), Mollusca (in part)
Sub-family	Crustacea (in part)
Order	Other non-insect groups

PHYSICAL HABITAT ASSESSMENT

A two-tier approach was employed for all streams. This approach employs more quantitative data collection, which allows for a higher level of precision when comparing sites. Physical habitat data was used to calculate metrics on the following attributes: wetted width and mean channel depth; bank characteristics; substrate mean diameter, embeddedness; substrate stability; in-channel cover; channel habitat types; and riparian vegetation structure, complexity and disturbance. The close connectivity of various parameters should impact multiple metrics if habitat alteration is occurring.

Tier one is an observational (qualitative) approach to assessing various habitat parameters which assigns a numeric score (0-20) to each parameter (EPA 1999; Appendix FS). Scores are separated into four broad categories/conditions consisting of poor, 0-5; marginal, 6-10; sub-optimal, 11-15; and optimal, 16-20. Habitat parameters assessed in all streams are epifaunal substrate/available cover, sediment deposition, channel flow status, channel alteration, bank stability, vegetative protection and riparian vegetative zone width. Channel sinuosity, pool variability and pool substrate characterization is assessed in Delta streams. Frequency of riffles (or bends), velocity/depth regime and embeddedness is assessed in Ozark Highland streams.

Tier two combines both a qualitative (visual estimates) and quantitative (in-stream measurements) approach to developing a habitat profile for each sample reach based on eight broad categories. These categories include measurements/estimates of the in-channel cover, substrate, canopy cover, large woody debris within bankfull width, flow and visual riparian and human influence estimates.

- *Ozark Highland* - Physical habitat characterization includes conducting a pebble count in each of two riffles once per year.

- *Delta* - Physical habitat characterization will include a 50-m reach of stream. Presence/absence and quantity of undercut banks, woody debris, substrate particle size and submerged macrophytes may be highly variable in these streams. Each of these habitat types will be estimated to reduce variation and increase precision in these regions.

A two-person team conducted all of the assessments. This method reduced bias and subjectivity between assessors. No physical habitat activities were conducted in the stream until all biological collection was completed. Any deviations from the previously mentioned methods were noted in the project field notebook. All information was recorded in the field on appropriate data forms. A photograph was taken at each site.

COMMUNITY EVALUATION METHOD

Spring aquatic macroinvertebrate communities in small watersheds (≤ 40 mi^2) were evaluated by comparing the community structure at each site to the community structure of least-disturbed, Ozark Highland and Delta ecoregion reference streams of similar watershed sizes. ADEQ (in prep.) developed an Aquatic Macroinvertebrate Index for Small Watersheds in Arkansas

(AMISW). The AMISW uses a stream classification system based on the principle that streams reflect the character of the lands they drain and therefore data may be extrapolated regionally. The AMISW uses a suite of six metrics that have been proven responsive to independent (but imprecise) measures of disturbance. These metrics are normalized by assigning one of four scores (0, 2, 4 or 6) to each metric based on scoring thresholds used to calculate the AMISW (Table M-2). An ordinal rating scale for the AMISW is based on quadrisection of ranges assigning a rating of very poor, poor, good or very good (Table M-3). One score thus simplifies management because a single index value is used to determine whether action is needed.

Table M-2 Scoring thresholds used to calculate the Arkansas Macroinvertebrate Index - Small Watersheds (AMISW) for bioregions. The 95th percentile statistic was used to derive the 4 scoring thresholds (DeShon 1995).

	Reference Site Statistics					Scoring Thresholds			
	Min	5%	50%	95%	Max	6	4	2	0
Arkansas Bioregion 1									
Total Taxa Richness	11	13	19	24	25	>20	17-20	13-16	<13
EPT Index	5	5	8	13	15	>10	8-10	5-7	<5
% Dominant Taxa	13	15	28	47	53	<25	25-34	35-44	>44
% Diptera	0	1	8	36	54	<15	15-29	30-43	>43
Hilsenhoff Biotic Index	3.1	3.3	4.6	5.6	5.9	<4.0	4.0-4.6	4.7-5.3	>5.3
% Collectors	21	22	39	59	59	<32	32-41	42-51	>51
Arkansas Bioregion 3									
Total Taxa Richness	8	10	19	24	26	>19	15-19	10-14	<10
EPT Index	0	0	1	4	4	-a	≥3	2	<2
% Dominant Taxa	15	18	32	73	88	<36	36-53	54-71	>71
% Diptera	0	0	10	39	66	<18	18-34	35-51	>51
Hilsenhoff Biotic Index	5.4	5.5	6.3	7.2	7.5	<6.0	6.0-6.4	6.5-6.9	>6.9
% Collectors	9	11	34	91	96	<33	33-54	55-76	>76

a = Considered a weak metric for discrimination and given only three scoring criteria
Arkansas Bioregion 1 represents the Ozark Highlands, Ouachita and Boston mountains
Arkansas Bioregion 3 represents the lowland streams of the Delta, Typical Gulf Coastal Plain and Arkansas River Valley

Table M-3. Ordinal rating scale of the AMISW for all bioregions on quadrisection of scoring ranges. The gray areas of the range denote scores that may warrant placement into the next highest rating category but require replication to support judgment of rating category.

Very Poor	*Poor*	**Good**	*Very Good*
Bioregion 1			
1 2 3 4 5 6 7 8 9	*10 11 12 13 14 15 16 17 18*	**19 20 21 22 23 24 25 26 27**	*28 29 30 31 32 33 34 35 36*
Bioregion 3			
1 2 3 4 5 6 7 8 9	*10 11 12 13 14 15 16 17*	**18 19 20 21 22 23 24 25 26**	*27 28 29 30 31 32 33 34*

The AMISW was developed for the spring sampling period only because use of the AMISW for evaluating streams during the fall sampling period is not appropriate. The smaller watersheds do not have sufficient flow to permit sampling in the fall and therefore were not sampled. Best professional judgment and knowledge of expected metric values will be used to determine impacts in small watershed streams sampled during the fall.

RESULTS

Fall 2001

Sites with sufficient flow were sampled September 17 – 20, 2001. Habitat was suboptimal for all sites except UWSBR01, WHI0143N-B, WHI0143J, WHI0143S and WHI0143R. Substrate particle size generally was larger in Ozark Highland tributaries compared to main stem Strawberry River sites. Delta tributaries had substrates comprised of sand, clay and silts and therefore pebble counts were not conducted. Mean velocities were generally greater at main stem sites in the lower watershed and sites with spring-water influxes. Other channel characteristics, such as mean depth, canopy and wetted width, were variable (Appendix M-1a).

Forty taxa were identified from six main stem Strawberry River sites (Appendices M-2a; M-3a). Taxa richness ranged from 14 at UWSBR02-A to 23 at WHI0143B-B. Dominant or co-dominant taxa included *Stenonema* (3), *Stenelmis* (3) *Cheumatopsyche* (1) and Chironomidae (1). Mean tolerance value for dominant and co-dominant taxa was 4.8. EPT richness and composition was dominated by Ephemeroptera (mayflies) taxa. Plecopterans (stoneflies) were either absent or an insignificant component of the EPT metrics. EPT richness ranged from 5 at UWSBR02-A to 10 at WHI0143B-B and WHI024 ($\bar{x}$ = 8). EPT richness was 25 to 37 percent lower (based on means) at UWSBR01-A and UWSBR02-A, respectively, compared to other main stem sites. EPT composition however was greater relative to EPT richness for these two sites. UWSBR01-A and UWSBR02-A also had the fewest number (2) of sensitive taxa. Hilsenhoff Biotic Indices (HBI) generally was higher in upstream reaches. The exception was UWSBR02-A which had the lowest HBI (3.65) and no tolerant taxa (HBI > 7.0). *Stenonema* was the dominant taxon (50.6%) at UWSBR02-A, accounting for the lower HBI. The dominant taxon at UWSBR01-A was *Cheumatopsyche*.

Forty taxa were identified from seven Ozark Highlands tributary sites sampled(Appendices M-2a; M-3a). Taxa richness was comparable to main stem sites, ranging from 16 at WHI0143M-A to 22 at WHI0143K-A. Dominant taxa included *Stenelmis*, *Stenelmis* A, *Stenonema*, *Cheumatopsycyhe*, *Isonychia,* and *Simulium*. The mean tolerance value for dominant taxa was 4.3. Mean EPT richness was slightly lower (6.4) than observed in main stem sites. EPT richness was 29 to 43 percent lower at WHI0143K-B and WHI0143M-A, respectively, compared to other Ozark Highland tributaries. The absence of trichopterans (caddisflies) at WHI0143M-A accounted for most of the reduction in EPT richness. Number of sensitive taxa was variable, ranging from 2 at UWNBC01-B to 8 at WHI0143K-A. HBIs generally were in the upper 3 to lower 4 ranges, with the exceptions being UWNBC01-A and B (4.94 and 5.00, respectively).

Sixty-eight taxa were identified from five Strawberry River tributary sites located in the Delta (Appendices M-2a; M-3a). Taxa richness ranged from 21 at WHI0143S to 34 at WHI0143R. Dominant taxa included *Corbicula*, *Calopteryx*, Chironomidae, and *Gammarus*. EPT richness ranged from 2 to 6, which was higher than typical Delta streams. EPT composition was lower (<11%) than Ozark Highland tributary sites. HBI values ranged from 6.4 to 6.9. These communities were primarily comprised of collectors, 46%, and predators, 34%. *Corbicula* dominated WHI0143J.

Spring 2002

Sites were sampled between May 6 – 8 and June 24 - 26, 2002. Habitat was suboptimal for all sites except WHI0143A-A, WHI024, WHI0143J and WHI0143Q which received a marginal rating. Pebble counts were not performed during the spring sampling period. Velocities ranged from 0.51 to 1.82 feet per second (ft/s) in main stem sites, 0.37 to 2.17 ft/s in Ozark Highland tributary sites and 0.07 to 0.86 ft/s in Delta tributary sites. Depth was variable, but generally was 6 to 8 inches. Percent canopy and wetted width also were variable (Appendix M-1b).

Fifty taxa were identified from ten main stem Strawberry River sites (Appendices M-2b; M-3b). Taxa richness ranged from 12 at UWSBR01-A to 23 at WHI0143B-B and generally increased at sites lower in the watershed. Dominant taxa included *Baetis*, *Perlesta*, *Simulium*, *Cheumatopsyche,* and *Stenonema*. The mean tolerance value for dominant taxa was 4.4. EPT richness was variable ranging from 6 at WHI0143A-A to 12 at UWSBR02-B. Trichopterans comprised a smaller portion (< 7%) of the community at WHI0143A and UWSBR01 compared to downstream sites. Plecopterans were more prevalent at these two sites (> 15%) than downstream sites (< 2%). Mean sensitive taxa richness (3) was lowest at these two stations. HBI scores were similar at all sites (4.2 to 4.5) except WHI0143B (5.6). *Cheumatopsyche*, a tolerant caddisfly, was dominant at WHI0143B contributing to a higher HBI and percent collectors compared to other main stem sites.

Seventy-three taxa were identified from 19 Strawberry River tributary sites located in the Ozark Highlands (Appendices M-2b; M-3b). Taxa richness ranged from 9 at WHI0143L-B to 27 at NBC DS Hwy 354-B. Taxa richness generally was higher at sites with watershed area greater than 50 mi^2 or with a substantial spring-water influence. Dominant taxa included Chironomidae, *Perlesta*, *Stenonema*, *Cheumatopsyche*, *Simulium,* and *Lirceus*. *Lirceus*, a pollution tolerant taxon, comprised 25% of the community at WHI0143I, whereas it generally was absent or comprised less than 2% of other tributary communities. The mean tolerance value for dominant taxa was 5.8. Mean EPT richness was similar at all stations ranging from 8 to 12. Percent dominant taxon was less than 35% for all sites except WHI0143N-A and B (63.9 and 73.0%, respectively). These two sites also had the highest percentage (70.4 and 77.0%, respectively) of dipterans (comprised primarily of Chironomidae). HBI scores overall were much higher than observed in fall 2001. Collectors dominated the trophic feeding groups at all sites.

Seventy-one taxa were identified from five sites located in the Delta (Appendices M-2b; M-3b). Taxa richness ranged from 20 at WHI0143R to 31 at UWRDC01 and WHI0143S. Dominant taxa included Chironomidae, *Chimarra,* and *Gammarus*. Mean tolerance value for dominant taxa was 5.9. EPT richness ranged from 2 at WHI0143Q to 8 at WHI0143J and WHI0143S. Plecopterans were absent at all sites except WHI0143J, which had one taxon that comprised 1% of the total community. Percent dominant taxon (45.9%) and Diptera (51.0%) was highest at WHI0143J. High EPT richness at WHI0143J and WHI0143S resulted in these two sites having the lowest HBI or most sensitive communities. Caney Creek sites (WHI0143Q and WHI0143R) were the least sensitive. Percent collectors were high (44.9 to 71.2%) for all sites compared to reference stream data.

AMISW scores and ratings for samples collected during spring 2002 are presented in Table M-4. Sites receiving poor or very poor ratings (WHI0143H-B, WHI0143N-A and B) indicate aquatic macroinvertebrate communities where the community structure has deviated from expected conditions based on bioregion reference sites. Numerous sites (WHI0143H-A, WHI0143K-A and B, WHI0143L-B, NBC WWTP, WHI0143I-A, NBC DS HWY354-A) received ratings of poor/good. These require more data before assigning a rating of poor or good. Delta tributary streams supported exceptional aquatic macroinvertebrate communities based on AMISW scores.

Table M-4. AMISW scores and rating for aquatic macroinvertebrate samples collected from sites in the Strawberry River watershed (small watersheds < 40 mi^2) during spring 2002.

Station ID	Taxa Richness	EPT Index	% Dominant Taxa	% Diptera	HBI	% Collectors	Total Score	Rating
Mainstem Sites								
WHI0143A-A	2	2	4	4	4	4	20	Good
WHI0143A-B	2	4	0	6	4	4	20	Good
OH Tributaries								
WHI0143E-A	4	4	2	6	6	2	24	Good
WHI0143E-B	2	4	4	4	4	4	22	Good
WHI0143H-A	2	2	6	4	4	0	18	Poor/Good
WHI0143H-B	2	4	2	0	2	0	10	Poor
WHI0143N - A	4	4	0	0	0	0	8	Very Poor
WHI0143N - B	2	4	0	0	0	0	6	Very Poor
WHI0143K - A	6	4	2	4	2	0	18	Poor/Good
WHI0143K - B	6	4	0	6	2	0	18	Poor/Good
WHI0143L-A	2	4	4	4	4	4	22	Good
WHI0143L-B	0	2	2	6	4	2	16	Poor/Good
NBC WWTP	6	6	4	2	0	0	18	Poor/Good
WHI0143I-A	6	4	4	2	0	0	16	Poor/Good
WHI0143I-B	6	6	4	4	0	0	20	Good
NBC DS HWY354 - A	6	4	2	4	2	0	18	Poor/Good
NBC DS HWY354 - B	6	6	4	4	2	0	22	Good
Delta Tributaries								
UWRDC01	6	4	6	4	6	2	28	Very Good
WHI0143S	6	4	6	4	6	4	30	Very Good
WHI0143Q	6	2	6	6	4	2	26	Good/Very Good
WHI0143R	6	4	6	4	4	2	26	Good/Very Good

Fall 2002

Sites were sampled between October 14 – 16 and October 28 – 29, 2002. Habitat was suboptimal for all sites except WHI024, WHI0143N-B, WHI0143J, WHI0143R and WHI0143Q which received a marginal rating. Pebble counts were similar to counts performed during fall 2001, although slight variations were recorded. Velocities ranged from 0.53 to 1.32 ft/s in main stem sites, 0.06 to 0.86 ft/s in Ozark Highland tributary sites and 0.04 to 0.42 ft/s in Delta tributary sites. Depth was variable, but generally was 4 to 6 inches. Percent canopy and wetted width also were variable (Appendix M-1c).

Thirty-three taxa were identified from six main stem Strawberry River sites (Appendices M-2c; M-3c). Taxa richness ranged from 14 at WHI0143B-A to 21 at WHI0143P. Dominant or co-dominant taxa included *Stenonema,* and *Tricorythodes*. Both taxa have intermediate tolerance values, 3.3 and 5.4, respectively. Ephemeroptera comprised $\geq$ 61% of these communities. Plecopterans were either absent or an insignificant component of the EPT metrics. Number of sensitive taxa was similar at all sites (4 or 5) except WHI0143B. HBI scores ranged from 4.1 at UWSBR02-B to 4.9 at WHI024. Percent collectors were high (73%) at WHI024 compared to other main stem sites.

Fifty-four taxa were identified from ten Strawberry River tributary sites located in the Ozark Highlands (Appendices M-2c; M-3c). Taxa richness ranged from 14 at WHI0143M-B to 23 at WHI0143K-A. Dominant taxa included *Stenonema*, *Tricorythodes*, *Optioservus*, *Isonychia*, Chironomidae, and *Cheumatopsyche*. The mean tolerance value for dominant taxa was 4.1. The greatest number of sensitive taxa (8) occurred at WHI0143K. UWNBC01 had the fewest number of sensitive taxa (3) and the greatest percentage of tolerant taxa of 12.9%. Plecopterans were absent from all sites except WHI0143N-A (0.6%). Ephemeroptera was the dominant group at all sites, but composition was variable (34.9 to 80.4%). Percent Chironomidae was 29% at WHI0143N and 13% at WHI0143M-B. Mean HBI scores ranged from 3.8 at WHI0143K to 4.7 at WHI0143L.

Sixty taxa were identified from five Strawberry River tributary sites located in the Delta (Appendices M-2c; M-3c). Taxa richness ranged from 21 at WHI0143Q and WHI0143R to 27 at WHI0143S. Dominant taxa included Chironomidae and *Lirceus*. Sowbugs (Isopoda) dominated WHI0143Q and WHI0143R. Mean tolerance value for dominant taxon was 6.8. Number of EPT generally was greater than expected for deltaic streams (range: 2 to 7). Number of EPT was lowest at WHI0143S. The Delta communities were dominated, 64% of community, by collectors which were higher than expected at WHI0143Q and WHI0143R.

Spring 2003

Sites were sampled between April 21 – 23 and May 12 - 13, 2003. Habitat was suboptimal for all sites except UWSBR01-A, NBC WWTP and WHI0143R which received a marginal rating. Pebble counts were not performed during the spring sampling period. Velocities ranged from 0.48 to 2.85 ft/s in main stem sites, 0.25 to 1.16 ft/s in Ozark Highland tributary sites and 0.18 to 1.13 ft/s in Delta tributary sites. Depth was variable, but generally was 4 to 10 inches. Percent canopy and wetted width also were variable (Appendix M-1d).

Fifty-Nine taxa were identified from nine main stem Strawberry River sites (Appendices M-2d; M-3d). Taxa richness ranged from 15 at WHI0143A-B to 27 at WHI0143B-A and WHI0143P. Dominant taxa included Chironomidae, *Perlesta*, *Tricorythodes,* and *Stenelmis*. The mean tolerance value for dominant taxa was 5.3. EPT richness was variable ranging from 7 at WHI0143A-B to 17 at UWSBR01-B. Plecopterans were more prevalent, 29% of the community, at the upper two sites than downstream sites, <15% of the community. Mean sensitive taxa richness of five was lowest at WHI0143A. Mean HBI scores ranged from 4.2 at UWSBR01 to 5.3 at WHI0143A. Percent collectors accounted >51% of the community at WHI0143A-B and WHI0143B.

Seventy-four taxa were identified from 18 Strawberry River tributary sites located in the Ozark Highlands (Appendices M-2d; M-3d). Taxa richness ranged from 17 at WHI0143E-A to 32 at WHI0143H-A. Dominant taxa included *Cheumatopsyche*, *Leucrocuta*, *Perlesta*, *Stenonema*, *Serratella*, *Tricorythodes,* and Viviparidae. Percent dominant taxon of 45% was greatest at WHI0143I. Ephemeroptera and Plecoptera comprised the majority of the Percent EPT metric. One exception where Trichoptera comprised more of the EPT metric than Plecoptera was at WHI0143K. This site also had the greatest number of Trichoptera. Sowbugs (Isopoda) were present only at the upper North Big Creek sites. Mean HBI scores ranged from 2.9 at WHI0143E to 4.5 at WHI0143H. WHI0143H had the second greatest number of sensitive taxa, but had the greatest percent of tolerant taxa. Composition of functional feeding groups was more evenly distributed than observed in previous samples. Three communities, UWNBC01-A, WHI0143K-B and WHI0143M-A, were comprised of >51% percent collectors.

Fifty-eight taxa were identified from five Strawberry River tributary sites located in the Delta (Appendices M-2d; M-3d). Taxa richness ranged from 19 at WHI0143R to 31 at WHI0143J. Dominant or co-dominant taxa included Chironomidae, *Gammarus,* and Pleuroceridae. Number of EPT taxa generally was higher (range: 2 to 9) than expected for deltaic streams. WHI0143Q and WHI0143R had the fewest EPT taxa. Percent dominant taxon, percent collectors and HBI was highest at these two sites.

WHI0143A-B was the only site to receive an AMISW rating below good (Table M-5). Aquatic macroinvertebrate communities that received low AMISW ratings during spring 2002 showed considerable improvement during spring 2003. This turn around at sites scoring poorly during 2002 is not currently understood, but may indicate low persistence (community structure exhibits considerable changes between years; see discussion for more details).

DISCUSSION

Temporal Persistence: Seasonal and Inter-Annual Variability

Figure M-2 illustrates the similarity of habitat scores during the course of this study in the main stem Strawberry River and its Ozark Highland tributaries. While exceptions exist, the riffle habitats in the Strawberry River watershed scored in the suboptimal category annually and seasonally with minimal variations. Figure M-3 illustrates that pool habitat in the Delta tributaries was similar (suboptimal) annually and seasonally, although slightly lower (more likely to be rated marginal) in the fall sampling periods.

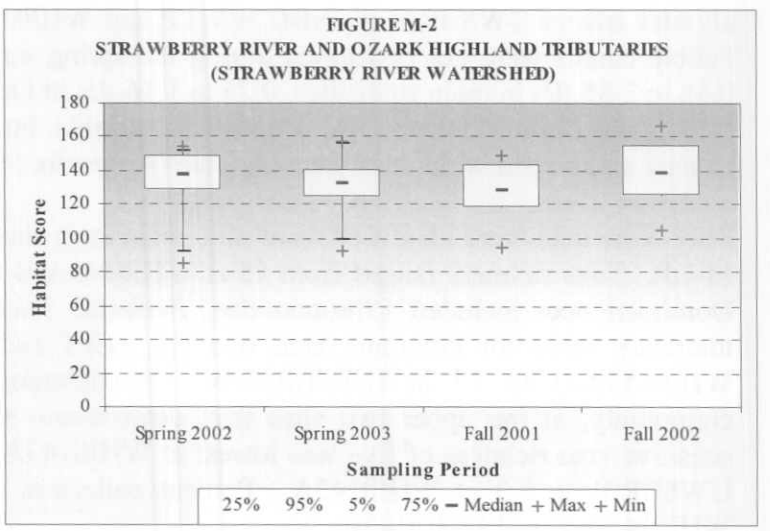
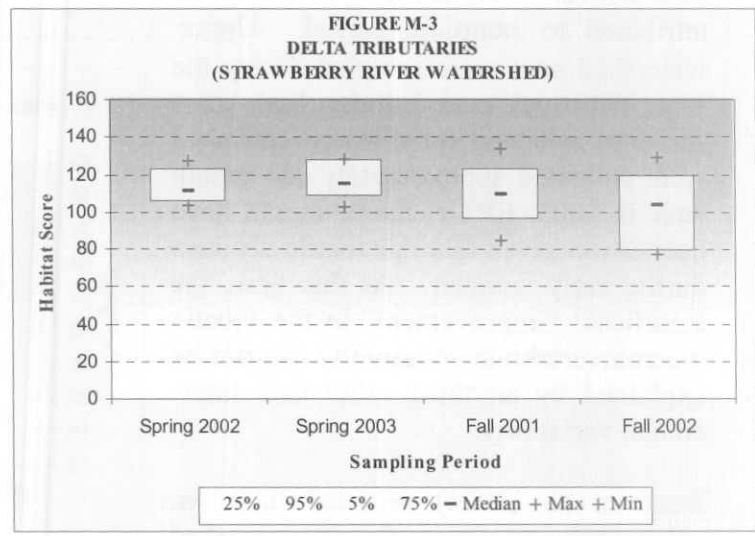


Table M-5. AMISW scores and rating for aquatic macroinvertebrate samples collected from sites in the Strawberry River watershed (small watersheds < 40 mi^2) during spring 2003.

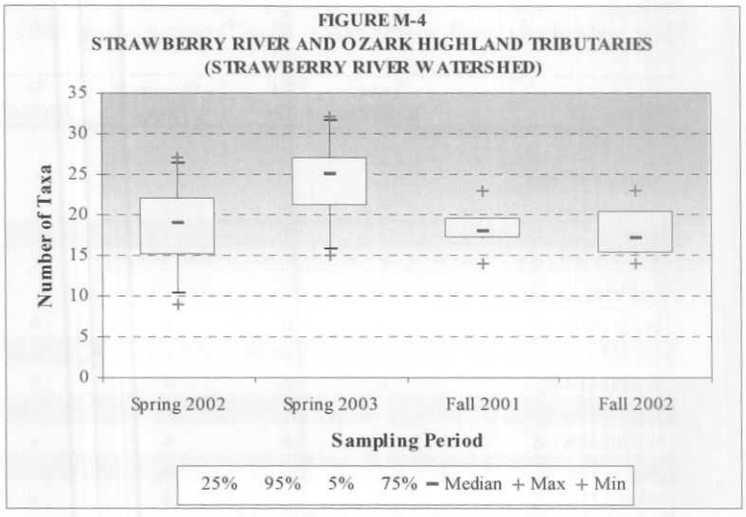
Station ID	Taxa Richness	EPT Index	% Dominant Taxa	% Diptera	HBI	% Collectors	Total Score	Rating
Mainstem Sites								
WHI0143A-A	4	4	2	6	2	6	24	Good
WHI0143A-B	2	2	4	2	0	0	10	Poor
OH Tributaries								
WHI0143E-A	4	6	2	6	6	6	30	Very Good
WHI0143E-B	6	6	4	6	6	6	34	Very Good
WHI0143H-A	6	6	4	6	2	4	28	Very Good
WHI0143H-B	6	6	4	6	4	6	32	Very Good
WHI0143N - A	6	6	4	4	4	4	28	Very Good
WHI0143N - B	6	6	4	4	4	2	26	Good/Very Good
WHI0143K - A	4	6	6	6	6	2	30	Very Good
WHI0143K - B	6	6	4	6	4	0	26	Good/Very Good
WHI0143L-A	6	4	6	6	6	4	32	Very Good
NBC WWTP	6	6	4	6	4	4	30	Very Good
WHI0143I-A	6	6	0	6	2	6	26	Good/Very Good
WHI0143I-B	6	6	2	6	4	4	28	Very Good
NBC DS HWY354 - A	6	6	4	6	6	4	32	Very Good
NBC DS HWY354 - B	6	6	6	6	6	4	34	Very Good
Delta Tributaries								
UWRDC01	6	4	6	6	4	4	30	Very Good
WHI0143S	6	4	6	4	4	2	26	Good/Very Good
WHI0143Q	6	2	4	6	2	0	20	Good
WHI0143R	4	4	6	6	2	0	22	Good

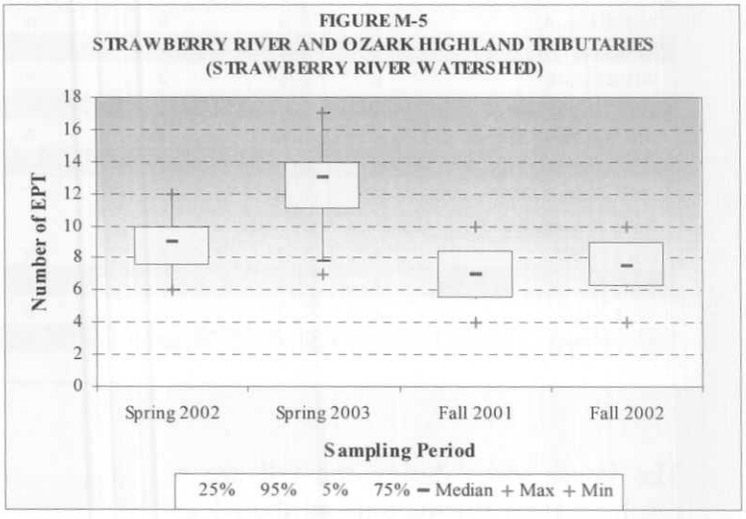
The lower score during the fall are a result of flow fluctuations attributed to both water removal for irrigation purposes and weather, and thus a reduction in optimal habitats.

AMISW metrics were improved for the Ozark Highlands sites between the springs of 2002 and 2003. Metrics that showed the greatest improvement included taxa richness, EPT richness, percent Diptera and percent collectors (Figures M-4; M-5; M-7 and M-9). Box and whiskers plots for percent dominant taxa (Figure M-6) and HBI (Figure M-8) slightly overlapped with spring 2002, but did improve during 2003.



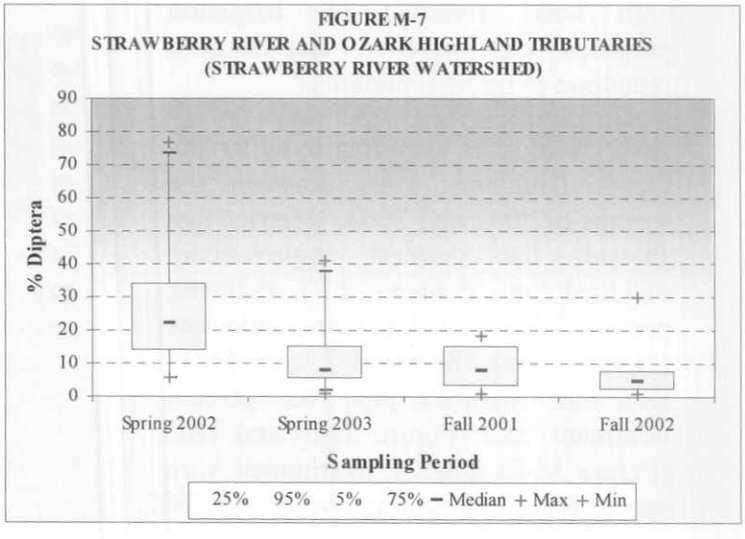
The total number of taxa collected (all sites) was similar, but the taxa richness per site generally was greater in 2003 (Figure M-4). This change also was evident by examining dominant taxa during each spring. During spring 2002, taxa that are more tolerant of perturbation (tolerance values greater than 6) were dominant at 15 main stem and tributary sites located in the Ozark Highlands. Whereas, the more tolerant taxa dominated 3 main stem and tributary sites during spring 2003. Similarly, improvements in other metrics such as EPT richness and HBI values may be an indication an improvement in biological integrity.





Without more detailed investigations, it is difficult to assess whether the observed variations between the springs of 2002 and 2003 are because of improving conditions, low persistence leading to high inter-annual variability, or perhaps simply because of the differences in the annual rainfall and runoff.

Inter-annual variability was not attributed to sampling period. Upper watershed sites were sampled during the same two week period during both years and sites collected in the lower watershed were collected approximately one month later in 2003. EPT richness should have been lower given that this metric declines during early summer. At this time, the significant "improvement" in the aquatic macroinvertebrate community can not be explained by anything other than inter-annual variability.



Bunn et al. (1986) reported that two ephemeral streams showed marked variation over time with no obvious pattern or trends among sites, and no

causal explanation. Another example of low persistence similar to what was observed in the Strawberry River watershed occurs when there is low temporal persistence in response to inter-annual variation in environmental conditions, and trends among sites are similar. Low persistence in the aquatic macroinvertebrate community makes it extremely difficult to predict when observed changes in patterns are a consequence of changes to ecological health. It is also important to note that temporal variation may be a result of several important biological processes, including competition, predation and recruitment. Changes in patterns (abundance, richness, species composition) do not always equate to changes in ecological integrity (Bunn and Davies 2000).

Inter-annual variability was minimal between fall samples in the Ozark Highlands. Fall taxa richness was similar, although community structure differed, to spring 2002 during both sampling years (Figure M-4). Temporal variation related to seasonal changes were evident in all metrics, but significant variations were observed in EPT richness. It is important to note that while fall metrics generally were more similar (except taxa and EPT richness) to spring 2003 than 2002, seasonal variability occurred between spring and fall samples in each year. While some site specific exceptions existed, seasonal variability when viewed as a whole (Strawberry River and its Ozark Highland tributaries) primarily existed in the presence or absence of taxa or in taxa composition and to a lesser extent as metric variability.

FIGURE M-9
STRAWBERRY RIVER AND OZARK HIGHLAND TRIBUTARIES
(STRAWBERRY RIVER WATERSHED)

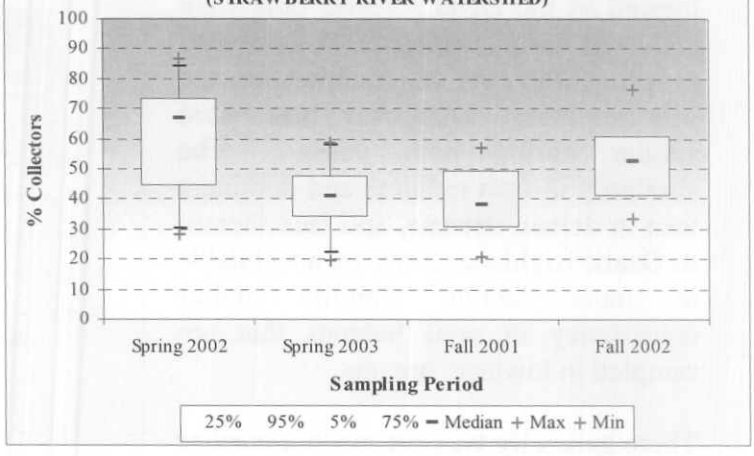


FIGURE M-6
STRAWBERRY RIVER AND OZARK HIGHLAND TRIBUTARIES
(STRAWBERRY RIVER WATERSHED)

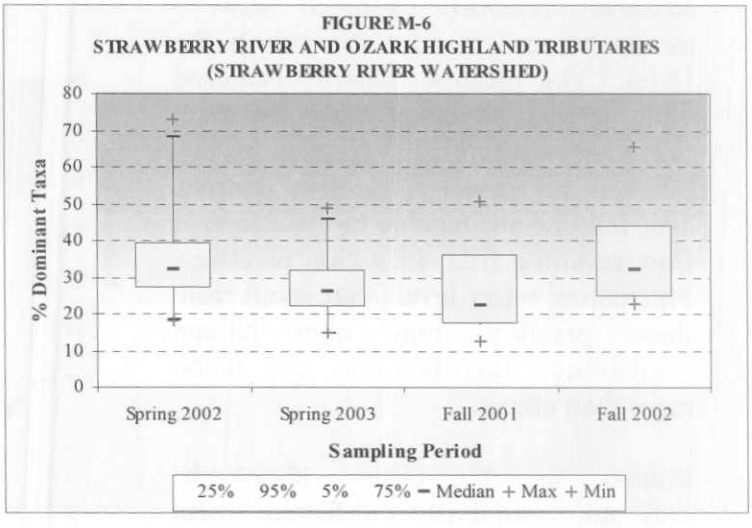


FIGURE M-8
STRAWBERRY RIVER AND OZARK HIGHLAND TRIBUTARIES
(STRAWBERRY RIVER WATERSHED)

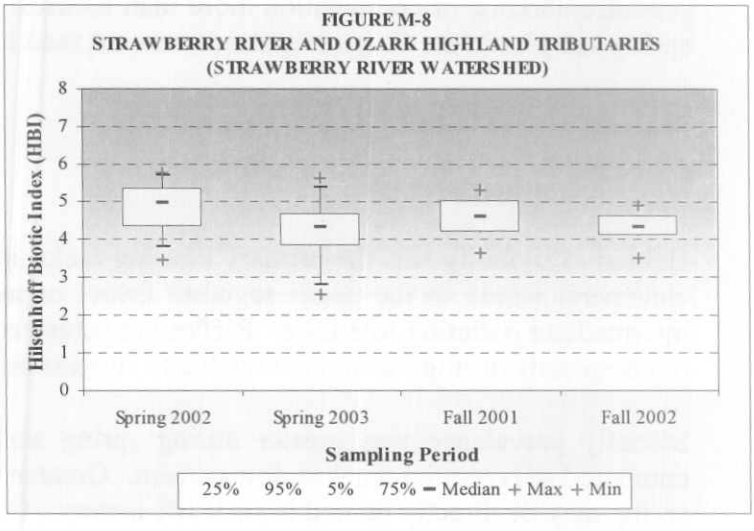
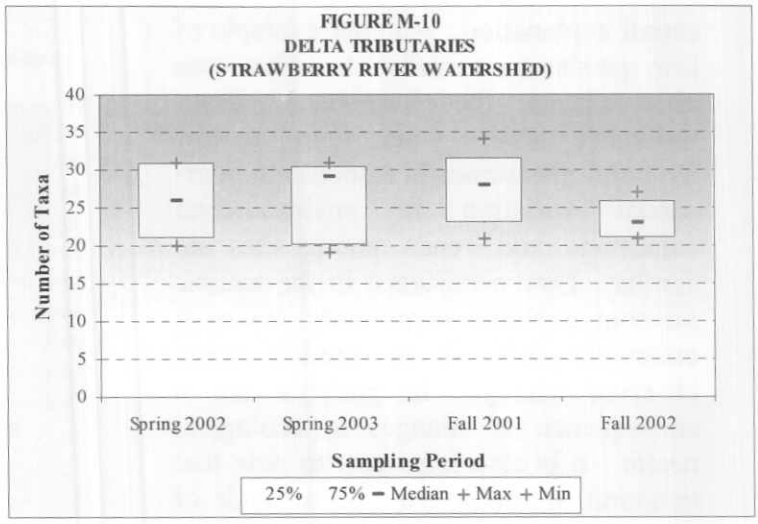
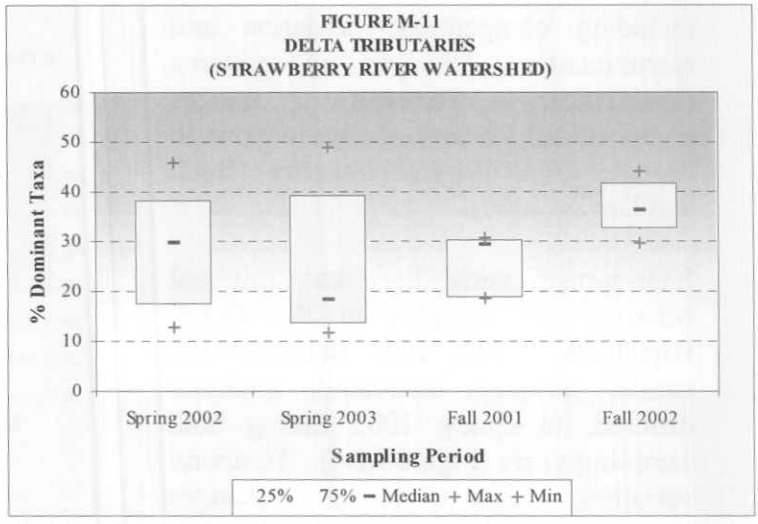


Figure M-10 illustrates that spring taxa richness was similar for tributary sites located in the Delta. Fewer taxa were collected during spring 2003 compared to spring 2002, but taxa richness per site was similar. Dominant taxa were similar during both years. The similarity in taxa richness and dominant taxa in deltaic streams, and lack thereof in Ozark Highlands, may be attributable to more habitat stability and/or consistency in pool habitats that are sampled in lowland streams.



There generally was not much annual or seasonal variability observed between metric values for sites located in the Delta. The greatest disparity occurred with percent dominant taxon between fall 2002 and fall 2003 (Figure M-11), but was not observed in other metrics. This may be attributable to variations in flow resulting from irrigation practices. Fluctuating water levels that result from these practices may alter habitat availability, thus favoring one taxon more than others.



Similar to the Ozark Highlands, seasonal variability affected taxa presence/absence or composition more than metrics. Inter-annual variability that occurred with spring samples in the Ozark Highlands was not seen in the Delta streams.

SITE AND WATERSHED EVALUATION

Strawberry River

Habitat availability was the primary limiting factor in the reaches upstream of UWSBR01. The ephemeral nature in the upper segment favors organisms with relatively short life cycles and intermediate pollution tolerance. Riffles are subjected to either being reduced to a trickling flow or completely drying out and are unable to support numerous taxa, EPT and sensitive taxa.

Stonefly prevalence was greater during spring sampling periods in the intermittent reaches compared to perennial reaches downstream. Greater abundance of stoneflies in this reach during spring may be directly related to their life history. Certain stonefly species inhabiting ephemeral habitats that are subjected to extremes in temperature often arrest embryonic development for

3-6 months and hatching is delayed until environmental conditions are more favorable. It is not known, because of the level of taxonomic resolution (genus), whether taxa collected during this assessment exhibit this trait.

WHI0143A was the only main stem Strawberry River site with a watershed area that fit criteria for use with the AMISW. The aquatic macroinvertebrate community rated good during both spring periods, with one exception WHI0143A-B in 2003. The poor rating during spring 2003 was attributed to a disturbance that caused channel scouring and altered the velocity regime and substrate.

The aquatic macroinvertebrate community composition at WHI0143B appeared to be slightly shifted towards scrapers because of organic enrichment from adjacent pastures and unrestricted cattle access. In stream habitat was comprised of cobble with numerous interstices that possibly provided the most suitable habitat when compared to other main stem sites. This abundance of microhabitats favored greater taxa richness. *Cheumatopsyche*, a caddisfly, was the dominant species during spring 2002. The lowest number of sensitive taxa in fall 2002 occurred at this site. Percent collectors was greater during the spring sampling period than typically observed in the other streams of the survey.

The aquatic macroinvertebrate community at UWSBR02 appeared to be limited, reduced taxa and EPT richness, in fall 2001. This was attributed to poor site selection (i.e. downstream of a bridge) rather than water quality or habitat impairment. High water events during the winter of 2001/2002 scoured the riffle converting it to a run rather than riffle. Subsequent sampling was moved approximately ½ mile upstream of the bridge and included two riffles. Acceptable metrics were observed at UWSBR02 during subsequent sampling periods.

Aquatic macroinvertebrate community metrics at WHI0143P and WHI024 did not indicate any major shifts in community structure that may be indicative of a perturbation. Eroding stream banks appear to be the greatest threat to reaches downstream of UWSBR01. Reaches upstream of UWSBR01 had the lowest frequency of eroding stream banks (Stream Bank Survey Section). The erosion of stream banks alter habitat by converting riffles to runs or scour pools or vice versus and thus can cause shifts in the macroinvertebrate community.

Ozark Highland Tributaries

All of the sites in the Strawberry River watershed located in the Ozark Highlands ecoregion were supporting an Ozark Highlands ecoregion macroinvertebrate community. There were, however, some sites that had a slight shift in the community. These shifts were most likely caused by sedimentation, increased periphyton production resulting from numerous factors (i.e., reduced canopy cover and/or reduced flows), or the destruction of in stream habitat.

Habitat availability (i.e. suitable flow) was a limiting factor in Ozark Highland tributaries with watershed areas <50 mi^2 and no substantial ground water influx. Lack of measurable flow inhibited sampling at these sites during the fall period. There were no apparent differences in community structure observed in spring metrics that could be attributed to disparities in flow between perennial and ephemeral sites.

Percent collectors generally were high at all of the Ozark Highland tributaries sites. Percent collectors did show signs of improvement in spring 2003 at all sites except UWNBC01, WHI0143K and WHI0143M. WHI0143K was affected by unrestricted cattle access and nutrient input from adjacent pastures. *Cheumatopsyche*, a pollution tolerant taxon, was dominant during spring 2002. This site also had a high HBI and percent dominant taxa. However, these impacts were only evident during spring 2002. For example, WHI0143K had the most sensitive community in fall 2002. This may be attributed to the lower than normal rainfall resulting in very low-flows during the spring of 2002.

WHI0143M was not scored using the AMISW because of its watershed area. Dipteran composition, primarily chironomidae, was elevated along with HBI and percent collectors. Numerous chicken houses and cattle farms are present in the Piney Fork watershed and likely contributed to these elevated metrics. As seen in the other Ozark Highland tributaries during spring 2003, metrics were much improved except percent collectors which remained high.

Numerous stressors (i.e. Ash Flat WWTP, unrestricted cattle access, run-off from pastures, eroding stream banks, and lower than normal spring-time flows) existed in the North Big Creek watershed during the survey. The most obvious of these was the impact from the Ash Flat WWTP. Isopod composition increases with increasing perturbation. This occurred at WHI0143I in spring 2002 and to a lesser extent in spring 2003. WHI0143I showed signs of improvement regarding biological metric values during 2003, but still had a high percentage of dominant taxon. The upper section of North Big Creek was the only site with isopods present. The impact appears to be restricted to a 2 to 3 mile reach downstream of the effluent since the site located 2 miles downstream of WHI0143I showed signs of recovery. Impacts from other stressors such as increased nutrients from pasture runoff, eroding streambanks and cattle access was less evident, but may account for UWNBC01 having the fewest sensitive taxa and more tolerant taxa in both fall periods. The North Big Creek site upstream of the WWTP was located next to a pasture with unrestricted cattle access and had a high number of chironomids during spring 2002.

Impacts from unrestricted cattle access were evident at Mill Creek (WHI0143N) throughout the study. Chironomidae dominated the community in Mill Creek during spring and fall 2002. During the fall of 2001, tolerant taxa composition was elevated and fewer sensitive taxa were present. However, AMISW ratings reflected a significant improvement in the aquatic macroinvertebrate community during spring 2003. Numerous factors could be contributing to the community health at this site, including direct cattle access to this reach, habitat destruction and lack of in-stream flow during early spring.

The aquatic macroinvertebrate community metrics at WHI0143H exhibited signs of a shift in the community to more collectors. However, the community at WHI0143E did not display this same characteristic. HBI, percent collectors, and Diptera were elevated at WHI0143H, similar to other tributary sites in the watershed. The spring 2003 data indicates improving conditions, although this site had a high percentage of tolerant taxa. Numerous conditions couold be contributing to the shift in the community at WHI0143H, including lower than normal spring-time flows and the destruction of in stream habitat and riparian zones.

Delta Tributaries

Delta tributaries consistently rated high compared to other least-impacted reference sites located in the Delta. The close proximity of these sites to the Ozark Highlands likely skewed the results more towards the high rating. These communities were more representative of a transitional community than a Delta community. Caney Creek scored lower than the other Delta tributaries. This creek had more irrigation influences that resulted in more fluctuation of water levels and thus habitat availability was often in flux. In addition, the creek was channelized to reduce flooding, thus altering the normal substrate and in stream habitat in the stream.

SUMMARY AND RECOMMENDATIONS

A summary of the aquatic macroinvertebrate community in the Strawberry River is below:

1. All of the sites sampled in the Strawberry River and its tributaries are fully supporting either an Ozark Highlands ecoregion or Delta ecoregion macroinvertebrate community. However, there are some areas in the watershed that indicate a shift in the community because of one or more stressors.

2. Unrestricted cattle access, eroding stream banks adjacent to pastures without riparian buffer strips and non-point source runoff from pastures, un-surfaced county roads, and confined animal operations were the primary threats to the aquatic macroinvertebrate community structure in the Strawberry River watershed. The greatest threat from eroding stream banks and un-surfaced county roads (sedimentation) is loss of habitat and food availability.

3. Altered community structure at WHI0143B appears to be a result of increased periphyton production, sedimentation, and loss of in stream habitat from pasture runoff, unrestricted cattle access, and eroding stream banks.

4. Non-point source impacts and lower than normal spring-time flows altered the community structure in Mill Creek (WHI0143N), North Big Creek (UWNBC01), lower Piney Fork (WHI0143M), upper South Big Creek (WHI0143K) and lower Little Strawberry River (WHI0143H). Impacts were greater during 2002 than 2003.

5. A 3-mile reach of North Big Creek below Ash Flat's WWTP effluent was impacted during 2002 and to a lesser extent during 2003. This was the only point source impact in the watershed but is typical of headwater streams in the Ozark Highlands ecoregion that are downstream of municipal wastewater treatment facilities.

6. Delta tributaries consistently rated high compared to least-disturbed reference sites. Communities inhabiting these streams were more indicative of transitional communities.

7. Fluctuation of water levels because of irrigation practices causes habitat availability to fluctuate in the Caney Creek watershed.

This page intentionally left blank.

FISH COMMUNITY

Fish community surveys were conducted at the stations listed below. Figure F-1 depicts the sites where fish community collections were made. Data presented in this section may be accessed via the ADEQ website, http://www.adeq.state.ar.us/water/data_edas/edas.asp.

STATION LOCATION

UWSBR01 - Strawberry River near Wiseman
WHI0143H - Little Strawberry River near Horseshoe Bend
Dry Fork Rd - Strawberry River west of Evening Shade
WHI0143L - Piney Fork Creek near Zion
WHI0143M - Piney Fork Creek near Evening Shade
TNC - Strawberry River near Evening Shade on The Strawberry River Preserve owned by The Nature Conservancy
WHI0143IA - North Big Creek near Ash Flat, above the waste water treatment facility
WHI0143I - North Big Creek near Ash Flat, below the waste water treatment facility
WHI0143IB - North Big Creek near Ash Flat at Treasure Hill road
UWNBC01 - North Big Creek near Center
WHI0143N - Mill Creek near Sitka
Perkins - Strawberry River near Smithville
WHI0143K - South Big Creek near Poughkeepsie
WHI0143J - South Big Creek near Jesup
WHI0143S - Cooper Creek near Smithville
UWRDC01 - Reeds Creek near Strawberry
Hwy 25 - Strawberry River near Strawberry
WHI0143Q - Caney Creek near Saffel
WHI0143R - Caney Creek ditch near Saffell

METHODOLOGY

A Smith-Root model 15-B backpack electrofishing device with pulsed DC current was used. The device was used in the shallow pools while wading upstream and dipping the stunned fishes from the water with dip nets. The riffles were collected by posting a twenty foot seine near the toe of the riffle and while working the electrofisher in a downstream direction through the riffle, the bottom substrate was disrupted and the fish were herded into the seine or washed in by the current. In addition, a barge electrofishing unit with pulsed DC current was used to collect fish from the main stem of the river at Barnes Ford, Perkins, and Hwy 25 sample sites.

Fish species of all types were collected from all available habitat within the sample area until a fully representative sample of the species in the area was thought to be obtained. Larger specimens were field identified and released. The smaller specimens and those needing further identification were preserved in a ten percent formalin solution and returned to the lab.

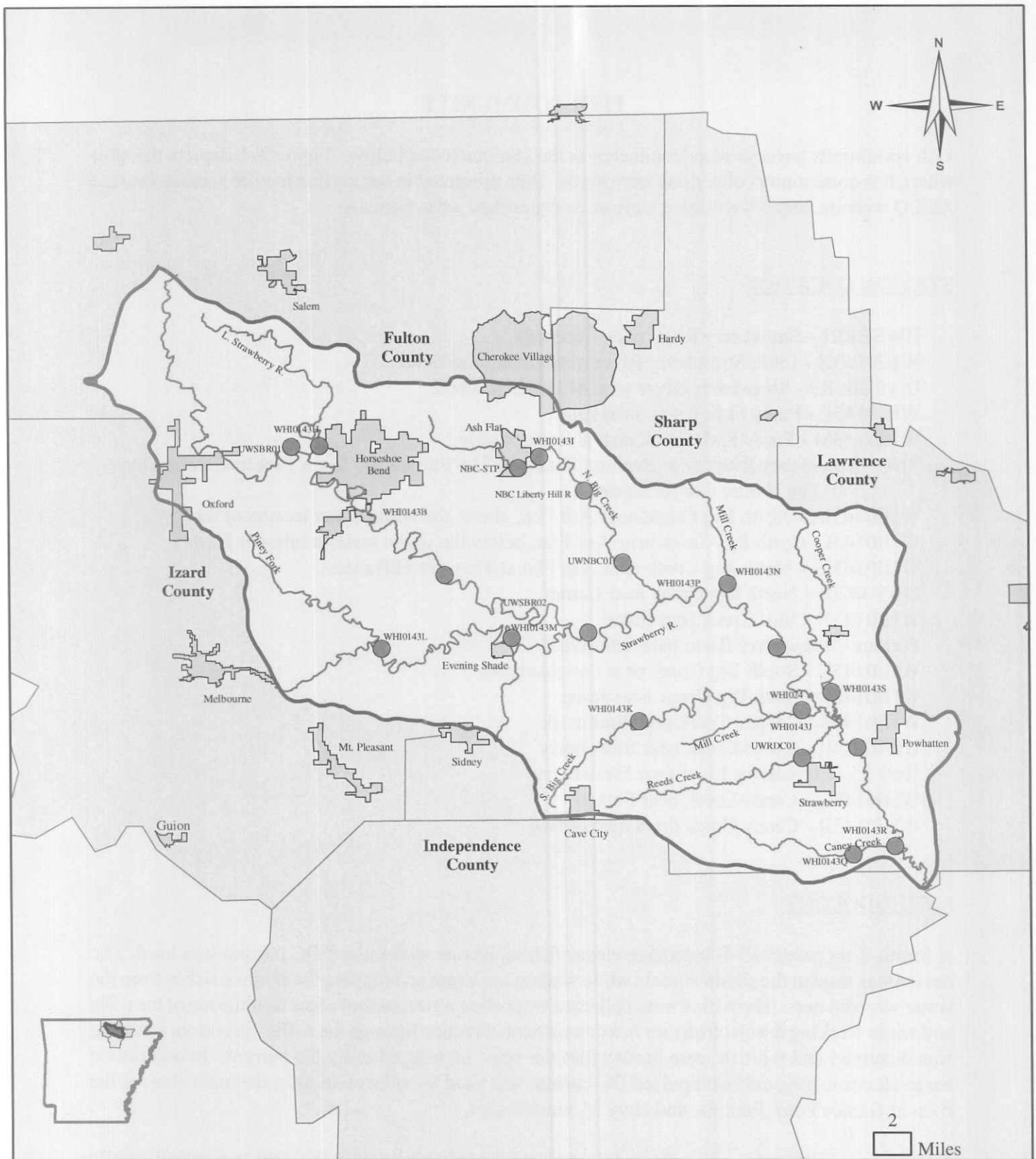


Figure F-1
Fish Sampling Locations,
Strawberry River Watershed

Arkansas Department of
Environmental Quality
Water Division - Planning Section

Legend

- Watershed Boundary
- Cities
- Counties
- Streams

HABITAT EVALUATION

Habitat evaluations were performed at all sites and were comprised of five parameters each consisting of three to seven variables. These parameters included: 1) habitat type; 2) habitat quantity; 3) quantity of substrate type based on fish use; 4) quantity of in stream cover; and 5) sediment on substrate. Each parameter for substrate type and in stream cover was given a score depending on its abundance. The scores given to the substrate parameters were multiplied by a factor to adjust these scores based on how they relate to fish habitat quality. Habitat type length, depth and width measurements were estimated for each habitat type and recorded in feet. The sediment on substrate parameter was scored according to the degree of embededness.

A total score for each habitat type was calculated by summing the scores for the substrate type, in stream cover and sediment on substrate. The scores from similar habitat types were averaged for each sampling station. The lengths of each habitat type were also summed. The total habitat type lengths were divided by 100 and multiplied by the average habitat type score. This score is the Ichthyofauna Habitat Index (IHI). Appendix F-1 outlines the habitat types and the in stream habitat ratings at each site.

FISH COMMUNITY EVALUATION METHOD

The fish communities were evaluated by directly comparing the community structures at each site to the fish communities of least-disturbed, Ozark Highlands, Least Disturbed Delta, and Channel-Altered Delta ecoregion reference streams of similar watershed sizes. A fish community structure index (CSI) was calculated using these parameters based on ecoregion reference stream data to generate the scoring criteria (Table F-1). Seventeen different parameters were compared between each of the communities and the reference streams.

The final determination of support is derived by utilizing all of the indices, the overall fish community, and the habitat and stream characteristics. Best professional judgement is also used in those unique situations when the metrics can not properly delineate the status of the fish communities based on the data collected.

Reference stream data from the Ozark Highlands ecoregion was used to determine fish community support from most of the sites. However, there were several sites, Cooper Creek, lower South Big Creek, Reeds Creek, and the Hwy 25 Strawberry River site that were located in the transition zone between two ecoregion types. These locations were more similar to a lowland stream with characteristics of both the Ozark Highlands ecoregion and the Least Disturbed Delta ecoregion. In addition, the Caney Creek Sites were more typical of Channel-Altered Delta ecoregion sites.

TABLE F-1 – Fish Community Biocriteria

Least Disturbed Ozark Highlands Ecoregion Reference Streams

Metric (% community, except Diversity Index)	SCORE		
	5	3	1
Cyprinidae	40 - 65	32-39 or 65 - 73	<32 or >73
Ictaluridae	>3[1]	1 - 3[1]	<1 or >3[1]
Centrarchidae	2 - 10[2]	<2 or 10 - 15[2]	>15[2]
Percidae	>10	5-10	<5
Sensitive Individuals	>40	40 - 30	<30
Primary TFL	<37	37 - 42	>42
Key Individuals	>25	25 - 15	<15
Diversity Index	>2.83	2.83 - 2.43	<2.43
No. of Species	>(wtrshd*0.034)+16.45	(wtrshd*0.034)+16.45 to (wtrshd*0.034)+12.26	<(wtrshd*0.034)+12.26

1 – no more that 3% bullheads 2 – no more than 2% Green sunfish

Channel Altered Delta Ecoregion Reference Streams

Metric (% community, except Diversity Index)	SCORE		
	4	2	0
Cyprinidae	10 - 26	2 - 10 or 26 - 34	<2 or >34
Ictaluridae	6 - 40	3 -6 or 40 -50[3]	<3 or >50[3]
Centrarchidae	6 – 40[4]	3 - 6 or 40 – 50[4]	<3 or >50[4] or >30% Green Sunfish
Percidae	>0.1	0.1 -0.05	<0.05
Sensitive Individuals	N/A	N/A	N/A
Primary TFL	<20	20 - 30	>30
Key Individuals	>25	10 - 25	<10
Diversity Index	>2.51	2.51 - 2.30	<2.30

3 – no more than 3% bullheads 4 – no more than 30% Green sunfish

The Community Structure Index is determined by the sum of the scores for each metric for each fish community. The relative scores were developed from average values from data collected from least disturbed ecoregion reference streams. The different scores are based on one and two standard deviation units from the average.

RESULTS

Fish community samples from the smaller watershed sites were collected in late spring to early summer. The larger main stem sites were collected in late summer and early fall. There were 86 species collected during this survey. There were 30 species of fish collected at SBR01 and at WHI0143H, 39 at Dry Fork Road, 31 at WHI0143L, 29 and WHI0143M, 39 at the TNC site, 22 at WHI0143IA, 21 at WHI0143I, 28 at WHI0143IB, 22 at NBC01, 28 at WHI0143N, 53 at the Perkins site, 22 at WHI0143K, 43 at WHI0143J, 20 at WHI0143S, 33 at RDC01, 55 at HWY 25, 22 at WHI0143Q and 38 at WHI0143R. Table F-2 depicts the community structure from each site as percent community composition of each family and the Community Structure Index parameters; sensitive species, Key species, primary trophic level species, the diversity index (Shannon-Wiener, log base 10), and the catch per unit effort (in minutes). Key Individuals are "Fishes which are normally dominant species within the important groups such as fish families or trophic feeding levels" (ADPC&E, 1998). The habitat evaluation for each site is located in Appendix F-1. A complete species list per station is located in Appendix F-2. The different community structure metrics discussed below are depicted in Figures F-2 thru F-6.

The fish community at the Little Strawberry River site, (WHI0143H), was dominated by stonerollers. This species accounted for more than 27% of the community. More than 43% of the community was comprised of cyprinids. The sunfish family accounted for 21% of the community with almost 16% of the community being longear sunfish. There were seven darter species collected comprising more than 26% of the community. The rainbow darter accounted for almost 22% of the community. Because of the large stoneroller population at this site, primary feeders made up 34% of the community. Over 37% of the community was comprised of Sensitive Individuals, and almost 28% of the community was comprised of Key Individuals. The diversity index was 3.37, and the catch per unit of effort was 14.50 fish per minute. Five pool habitats, one riffle, and four run habitats were sampled, totaling approximately 1500 feet of stream. The substrates varied from mostly a gravel/rubble in the riffle, to more bedrock and gravel/sand in the pools and runs. In stream cover was abundant in the pools and deeper runs, and aquatic vegetation was abundant in the riffle. Overall, the in stream habitat was excellent.

Two collections were made on Piney Fork Creek; one in the headwaters near Zion (WHI0143L), and one near Evening Shade (WHI0143M). The headwaters site was dominated by the stoneroller, accounting for more than 32% of the community. The longear sunfish comprised 23% of the community and the rainbow darter comprised 13% of the community. Ten species of cyprinids were collected accounting for almost half of the community. More than 35% of the community was primary feeders and 28% of the community was Sensitive Individuals. Key Individuals made up only 15% of the community. The diversity index was 3.3 and the catch per unit effort was 19.92 fish per minute. Four pools, three riffles and four run habitats were collected totaling approximately 2040 feet of stream. The substrates varied from a rubble/gravel/sand in the riffles to a bedrock/boulder/gravel in the runs and pools. In stream cover was very abundant in the pools and runs, but somewhat lacking in the riffles. Overall, the in stream cover was excellent.

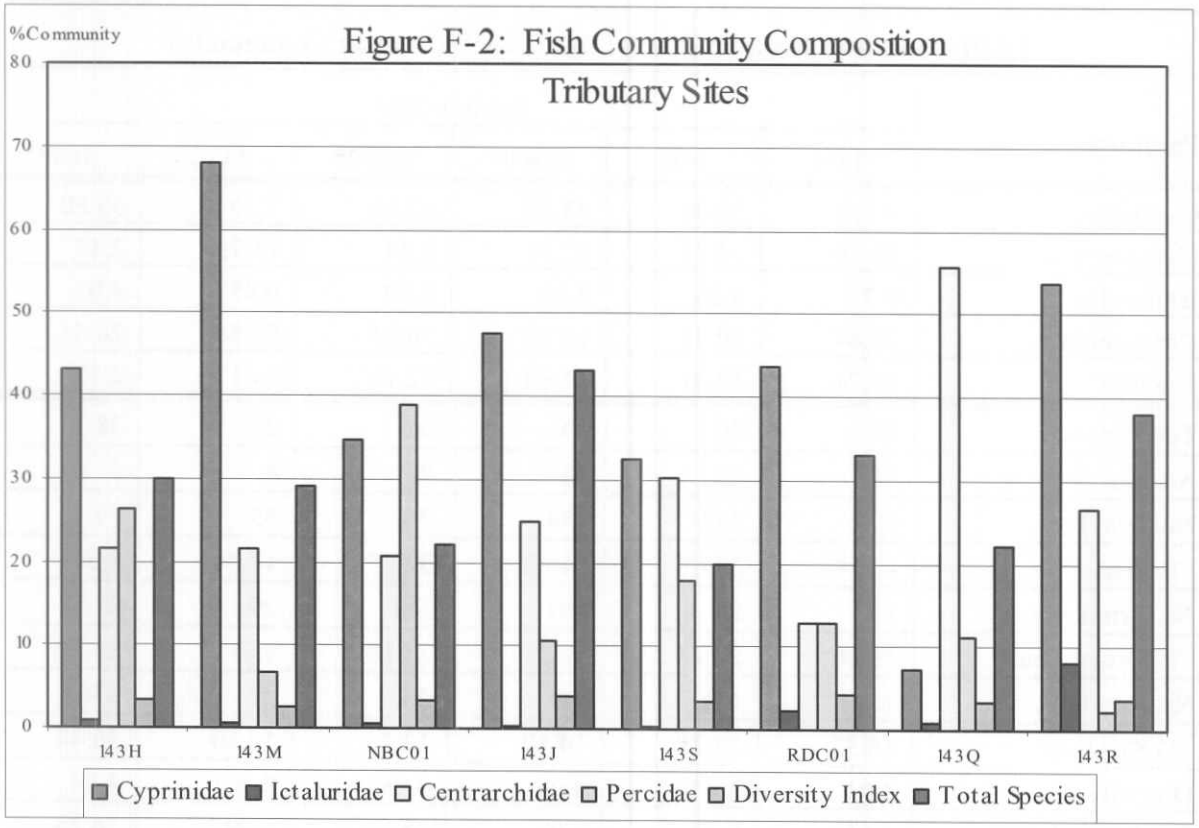
TABLE F-2 -- COMMUNITY STRUCTURE (Percent Community)							
Parameter	Sample Site						
	SBR01	143H	Dry Fork	143L	143M	TNC	143IA
Cyprinidae	28.51	43.12	42.81	47.48	68.03	42.25	54.38
Catostomidae	6.16	4.91	1.06	3.64	0.58	2.62	0.75
Ictaluridae	0.63	0.87	3.22	0.85	0.48	12.17	1.12
Centrarchidae	30.16	21.66	8.54	28.38	21.47	17.36	18.38
Percidae	32.06	26.28	43.52	15.95	6.63	24.95	20.99
Total Species	30	30	39	31	29	39	22
No. Sen. Species	12	13	22	14	17	22	9
No. Sen. Inds.	660	387	2094	467	1290	1211	437
% Sens. Inds.	41.90	37.25	67.50	28.32	68.40	66.10	40.76
No. Primary Inds	306	355	702	585	159	307	412
% Primary Inds	19.43	34.17	22.63	35.48	8.43	16.76	38.43
No. Key Inds.	489	288	1277	251	132	380	295
% Key Inds.	31.05	27.72	41.17	15.22	7.00	20.74	27.52
Diversity Index	3.26	3.37	3.48	3.30	2.40	4.11	3.06
Catch/Unit Effort	25.29	14.50	42.30	19.92	27.87	40.20	17.78

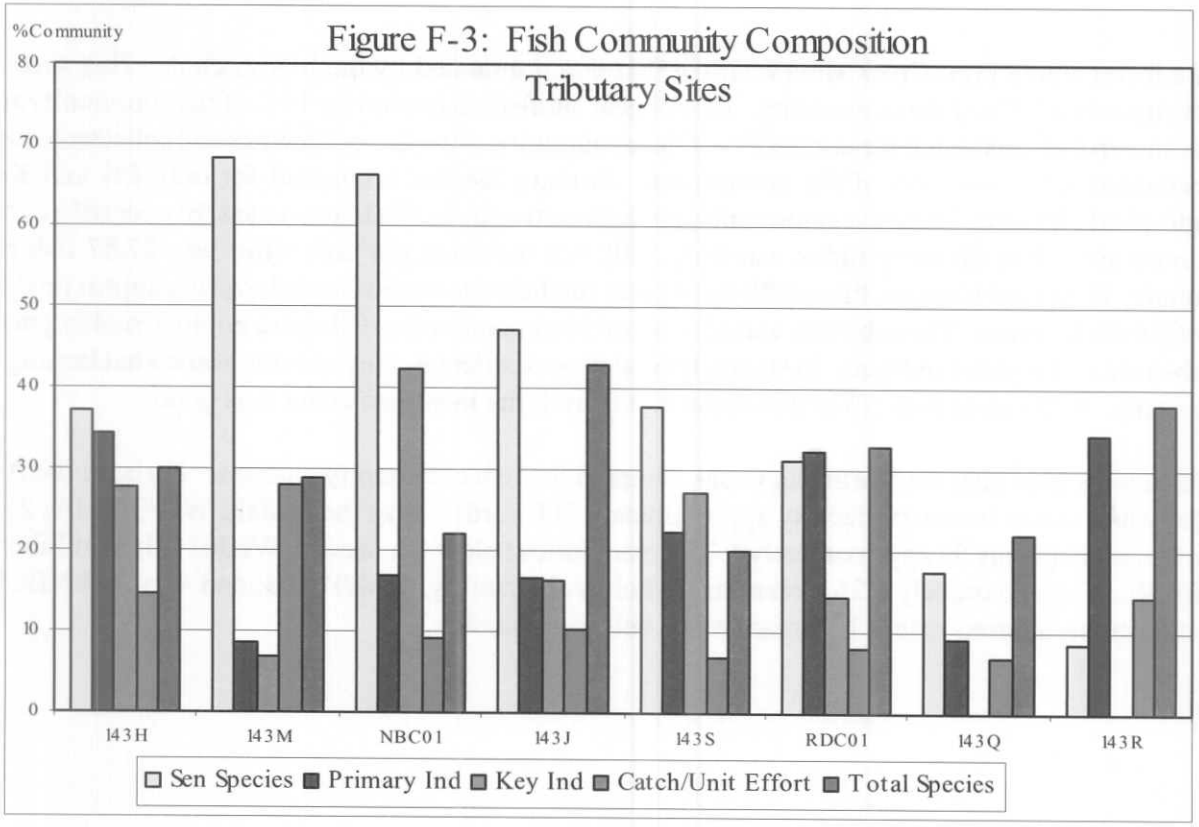
Parameter	Sample Site					
	143I	143IB	NBC01	143N	Perkins	143K
Cyprinidae	72.90	46.17	34.78	69.09	48.38	56.23
Catostomidae	1.55	5.04	2.74	0.44	3.92	1.47
Ictaluridae	2.44	0.31	0.64	0.44	4.90	0.98
Centrarchidae	9.93	27.49	20.77	16.67	15.28	6.38
Percidae	12.94	18.99	38.97	9.10	25.92	30.42
Total Species	21	28	22	28	53	22
No. Sen. Species	10	16	16	17	23	15
No. Sen. Inds.	366	438	411	672	1253	517
% Sens. Inds.	29.78	45.96	66.18	29.55	45.48	50.74
No. Primary Inds	711	254	104	1120	888	407
% Primary Inds	57.85	26.65	16.75	49.25	32.23	39.94
No. Key Inds.	346	315	263	490	330	365
% Key Inds.	28.15	33.05	42.35	21.55	11.98	35.82
Diversity Index	2.15	3.43	3.45	2.99	3.89	2.91
Catch/Unit Effort	19.58	15.89	9.25	35.32	30.71	14.63

TABLE F-2 -- COMMUNITY STRUCTURE (Percent Community)						
Parameter	Sample Site					
	143J	143S	RDC01	Hwy 25	143Q	143R
Cyprinidae	47.57	32.46	43.68	63.16	7.30	53.80
Catostomidae	10.49	14.22	12.31	3.84	11.75	2.17
Ictaluridae	0.37	0.24	2.19	5.99	0.95	8.03
Centrarchidae	24.84	30.33	12.98	10.15	55.56	26.46
Percidae	10.74	18.01	12.98	12.16	11.11	2.17
Total Species	43	20	33	55	22	38
No. Sen. Species	21	11	13	25	4	8
No. Sen. Inds.	378	159	184	706	55	79
% Sens. Inds.	47.19	37.68	31.03	32.27	17.46	8.57
No. Primary Inds	133	94	191	551	29	316
% Primary Inds	16.60	22.27	32.21	25.18	9.21	34.27
No. Key Inds.	131	115	84	40	57	336
% Key Inds.	16.35	27.25	14.17	1.83	18.10	36.44
Diversity Index	4.04	3.47	4.06	4.25	3.42	3.64
Catch/Unit Effort	10.42	6.77	8.08	28.58	6.99	14.25

The lower Piney Fork Creek site (WHI0143M) was dominated by the bigeye chub. This species accounted for 53% of the community. The longear sunfish accounted for 19% of the community and the stoneroller accounted for almost 8% of the community. Five darter species were collected which accounted for almost 7% of the community. Primary feeders accounted for only 8% and Key Individuals for only 7% of the community, while Sensitive Individuals accounted for over 68% of the community. The diversity index was only 2.40, but the catch per unit effort was 27.87 fish per minute. Four pool habitats, three riffles and three run habitats were sampled totaling approximately 1460 feet of stream. The substrate varied from rubble/gravel in the riffles to a boulder/rubble/gravel substrate in the pools and runs. In stream habitat was excellent in the pools but somewhat lacking in the runs. Riffle in stream cover was limited. Overall, the in stream cover was good.

There were four sites on North Big Creek sampled for fish community analysis: 1) above the Ash Flat waste water treatment facility approximately 200 yards above the outfall, WHI0143IA; 2) at Arkansas Highway 58 approximately 1.75 stream miles below the facility, WHI0143I; 3) at Liberty Hill Road approximately 6.25 stream miles below the facility, WHI0143B; and 4) at UWNBC01 near Center, approximately 12 stream miles below the facility.


%Community
Figure F-2: Fish Community Composition
Tributary Sites
80
70
60
50
40
30
20
10
0
143H
143M
NBC01
143J
143S
RDC01
143Q
143R
Cyprinidae
Ictaluridae
Centrarchidae
Percidae
Diversity Index
Total Species


%Community
Figure F-3: Fish Community Composition
Tributary Sites
80
70
60
50
40
30
20
10
0
143H
143M
NBC01
143J
143S
RDC01
143Q
143R
Sen Species
Primary Ind
Key Ind
Catch/Unit Effort
Total Species

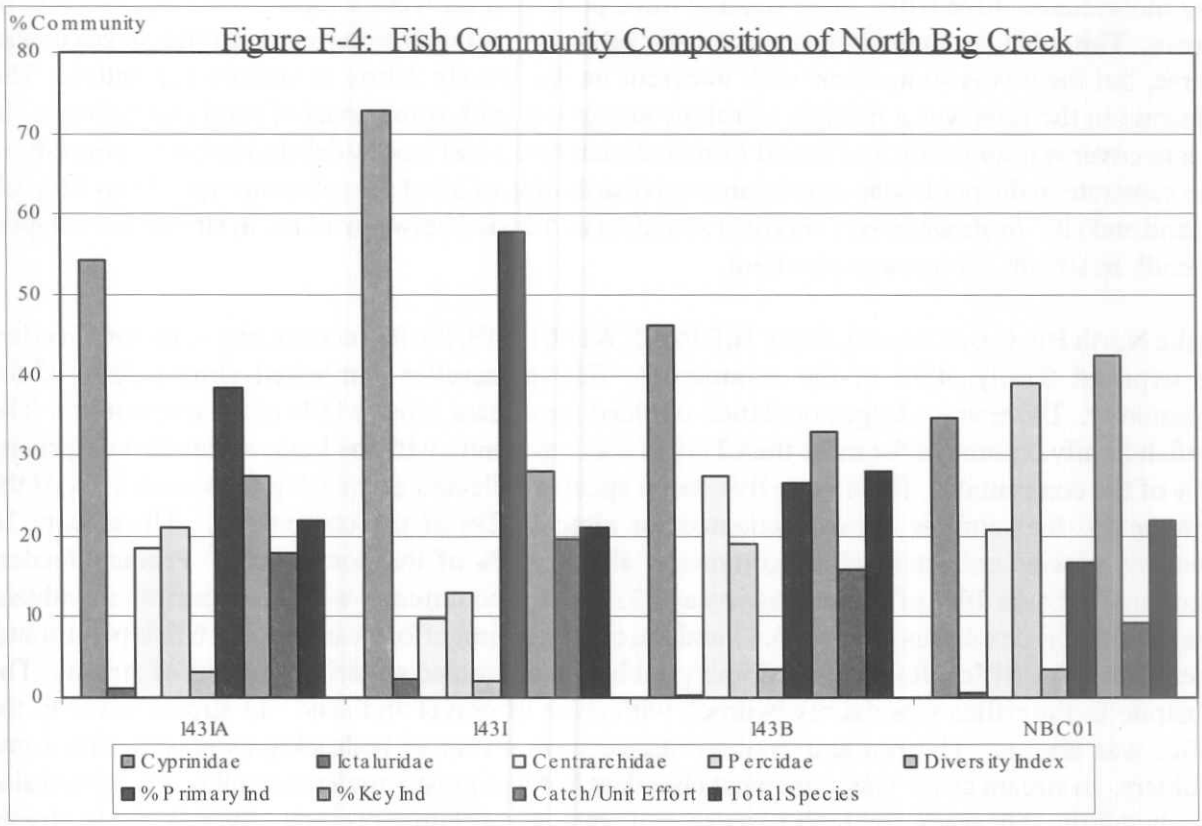


Figure F-4: Fish Community Composition of North Big Creek

The site above the Ash Flat waste water treatment facility, WHI0143IA, was dominated by the cyprinids, 54% of the community, with the stoneroller accounting for more than 34% of the overall community. The darter family accounted for 21% of the community with the rainbow darter comprising almost 16% of the community. The sunfishes comprised more than 18% of the community with the longear accounting for almost 15% of the community. Over 38% of the community was primary feeders, and 27% were Key species. Nine sensitive species were collected accounting for almost 41% of the community. The diversity index was 3.06 and the catch per unit effort was over 17 fish per minute. Four riffle, four run and three pool habitats were sampled covering almost 1000 feet of stream. The substrate in the riffles was mainly bedrock with areas of gravel. In stream cover was limited to some undercut banks and aquatic vegetation. Most of the substrate in the runs and pools was also bedrock, but there were some stretches of rubble/gravel with some boulders. In stream cover was more abundant ranging from just a little aquatic vegetation, to an abundant mixture of undercut banks, root wads and woody debris, and aquatic and hanging vegetation. Overall, the in stream habitat was excellent.

The fish community in the North Big Creek at the Arkansas Highway 54 bridge, WHI0143I, was dominated by the stoneroller, which accounted for more than 57% of the community. The cyprinid family accounted for almost 73% of the overall community. The darter family comprised almost 13% of the community with the rainbow darter accounting for almost 12% of the community. Sunfishes comprised almost 10% of the community with the longear sunfish making up most of the sunfish community. There were 10 sensitive species collected which was almost 30% of the community. Almost 58% of the community was primary feeders and 28% of the community was

Key Individuals. Five riffle, three run and three pool habitats were sampled covering 640 feet of stream. The substrate in the riffles was mostly rubble/gravel with some sand. In stream cover was sparse, but there was some areas with undercut banks, woody debris or aquatic vegetation. The substrate in the runs was a mixture of rubble and gravel with some areas of sand and bedrock. In stream cover was abundant and varied from undercut banks and woody debris, to aquatic vegetation. The substrate in the pools was usually an even distribution of all of the substrate types from bedrock to sand and silt. In stream cover was also abundant and varied between all the in stream cover types. Overall, in stream habitat was excellent.

At the North Big Creek site at Liberty Hill Road, WHI0143IB, the fish community was dominated by the cyprinid family, 46% of the community. The stoneroller comprised almost 25% of the community. There was a large population of bleeding shiners, almost 15% of the community. The sunfish family accounted for more than 27% of the community with the longear sunfish comprising 19% of the community. There were five darter species collected accounting for almost 19% of the community; the rainbow darter accounted for almost 12% of the community. There were 16 sensitive species collected which comprised almost 46% of the community. Primary feeders accounted for over 26% of the community and 33% of the community were Key species Individuals. The diversity index at this site was 3.43 and the catch per unit effort was almost 16 fish per minute. There were two riffles, four runs and four pool habitats sampled covering 915 feet of stream. The substrate in the riffles was mainly bedrock with areas of gravel and sand. In stream cover in the riffles was absent. The run and pool substrates were a mix of bedrock/gravel/sand with some boulders. In stream cover was somewhat abundant but was mostly undercut banks. There was also woody debris, root wads and both hanging and aquatic vegetation present. Overall, the in stream cover was excellent.

The darter family dominated the fish community at the lower North Big Creek site near Center, UWNBC01, comprising almost 39% of the community. The rainbow darter was the dominant species accounting for more than 18% of the community. The cyprinids accounted for almost 35% of the community with the stoneroller accounting for 16% and the bleeding shiner accounting for almost 15% of the community. The sunfish family accounted for 21% of the community with the longear sunfish accounting for almost 14%. More than 66% of the specimens collected were Sensitive Individuals. More than 42% of the community was Key Individuals and primary feeders accounted for more than 16% of the community. The diversity index was 3.45 and the catch per unit effort was 9.25 fish per minute. Seven riffle, eight run, and four pool habitats were sampled covering 1300 feet of stream. Most of the substrate in the riffles was comprised of rubble/gravel; there was some areas of bedrock also present. In stream cover in the riffles was very sparse, consisting primarily of aquatic vegetation. The run and pool substrates was mainly rubble and gravel, but has some areas of bedrock and sand/silt. In stream cover was moderate to abundant and consisted of root wads, woody debris, hanging vegetation and undercut banks. Overall, the in stream cover was excellent.

The cyprinid family dominated the fish community in Mill Creek (WHI0143N) accounting for 69% of the community. The stoneroller comprised 41% of the community. The bleeding shiner accounted for almost 15% and the longear sunfish accounted for 13% of the community. There were five darter species collected which accounted for 9% of the community. Almost half of the community was primary feeders, 30% were Sensitive Individuals and 22% were Key Individuals. The diversity index was 2.99 and the catch per unit effort was over 35 fish per minute. Two pools

three riffles and four runs were sampled totaling approximately 1355 feet of stream. Substrates in the riffles were mainly rubble/gravel with some bedrock. The pools generally had a variety of substrates from bedrock to sand/silt. The substrate in the runs was boulder/gravel with some bedrock. In stream cover in the pools was excellent, good in the runs, but only consisted of some aquatic vegetation in the riffles. Overall, the in stream habitat was good.

More than 56% of the fish community at the South Big Creek site at Highway 58 (WHI0143K) was comprised of Cyprinids. The stoneroller accounted for almost 40 percent of the community. There was also a large population of bleeding shiners which accounted for 12% of the community. Five darter species were collected which comprised more than 30% of the community. The rainbow darter accounted for 20% of the community. The sunfish family comprised less than 7% of the community. Four pool habitats, six riffles and six run habitats were sampled totaling approximately 1350 feet of stream sampled. Substrate in the riffles was mainly rubble/gravel, but there was some bedrock and sand present. The substrate in the pools and runs was mainly bedrock, but there were some areas with boulders and rubble/gravel/sand features. In stream cover in the pools and runs was abundant, and good in the riffles. Overall, the in stream habitat was excellent.

The lower South Big Creek site at Highway 58 (WHI0143J) was dominated by the cyprinid family. There were 14 cyprinid species collected accounting for 47% of the community. The telescope shiner and the stoneroller were the dominant cyprinid species and the longear sunfish was the dominant sunfish. Each of these species accounted for at least 15% of the community. The primary feeding group Individuals comprised less that 17% of the community while Sensitive Individuals accounted for over 17% of the community. Key Individuals accounted for over 16% of the community. The diversity index was 4.04 and the catch per unit of effort was 10.42 fish per minute. There were seven darter species collected which accounted for a little more than 10% of the community. Four pool habitats, three riffles, and four run habitats were sampled extending almost 710 feet. The substrate in the riffles consisted of rubble and gravel. The substrate in the lower three runs was dominated by sand, but the upstream run substrate was mainly rubble and gravel. The substrate in the lower two pools was mainly sand which shifted to a more gravel substrate and then a bedrock dominated substrate in the upstream pools. In stream cover in the runs and pools was excellent, but lacking in the riffles and in the upper most pool. Overall, the in stream habitat was excellent.

The sunfish family and the cyprinids co-dominated the Cooper Creek site (WHI0143S), each comprising more than 30% of the community. The stoneroller and the longear sunfish were the dominant species. There were 7 darter species collected which accounted for 18% of the community. The primary feeder group Individuals accounted for more than 22% of the community, Sensitive Individuals for 37%, and Key Individuals for 27% of the community. The diversity index was 3.47 and the catch per unit effort was 6.77 fish per minute. Four pool habitats, five riffles, and six run habitats were sampled covering 755 feet of stream. The substrate in the riffles varied from a gravel/sand to a bedrock/sand. The run substrates varied from a boulder/rubble to a bedrock/gravel. Two of the pools had bedrock/sand/silt substrates and the other had more of a boulder/rubble substrate. In stream cover in the riffles was good, consisting mainly of woody debris. The in stream cover in the runs and pools was excellent. Overall, the in stream cover was excellent.

The Reed's Creek site on Highway 25 (UWRDC01) was dominated by the cyprinid family which the stoneroller accounted for almost 26% of the community. The sunfish, sucker and darter families each accounted for over 12% of the community with the northern hogsucker being the next most abundant species. Over 32% of the community was primary feeders, 31% were Sensitive Individuals, and 14% were Key Individuals. The diversity index was 4.06 and the catch per unit of effort was 8.08 fish per minute. One pool habitat and five runs were sampled covering 1500 feet of stream. The substrate in the pool was mostly sand with some areas of gravel and the in stream cover was diverse and abundant. The runs were distinguished by the changes in substrates and in stream cover. The substrates varied from mostly sand, to sand/gravel, to a sand/rubble/boulder composition. In stream cover in the runs was either limited to moderate amounts of woody debris, or moderate to abundant amounts of a variety of cover. Overall, in stream habitat was excellent.

The centrarchid family dominated the fish community fish in Caney Creek at Highway 25 (WHI0143Q), accounting for more than 55% of the community. The bluegill sunfish was the dominant species accounting for 30% of the community. The green sunfish accounting for 18% of the community. The sucker family and the darter family comprised 11% of the community each. There were only three cyprinids collected from this site. Less than 10% of the community was primary feeders and Key Individuals, and more than 17% were sensitive species. The diversity index was 3.42, and the catch per unit of effort was 6.99 fish per minute. Four pools, one riffle, and four run habitats were collected covering approximately 1220 feet of stream. The substrate in the riffle was mainly hardpan clay with some silt. Woody debris was abundant on the substrate helping to create a riffle. In stream cover in the runs and pools was moderate, consisting mostly of undercut banks and woody debris. Overall, the in stream cover was good.

The cyprinid family dominated the Caney Creek site community on County Road 346 east of Saffel, (WHI0143R), comprising 54% of the community. The majority of the family was comprised of silvery minnows, stonerollers, and blacktail shiners. The sunfish family accounted for 26% of the community with the green sunfish accounting for more than 17%. There was a noticeable population of channel catfish, 7% of the community, at the site. Four pool habitats, two riffles, and seven runs were collected covering 1115 feet of stream. Substrates in the riffle areas were mainly hardpan clay with some gravel and sand. Run substrate varied between hardpan clay with gravel and sand, to a gravel/sand composite. The substrate in the pools was sand/silt with sections of exposed hardpan clay. In stream habitat in the riffles was abundant in the form of woody debris. The runs and pools both had abundant and varied in stream habitat. Overall, the in stream habitat was excellent.

The sunfishes, cyprinids, and darters comprised more than 90% of the community at the Strawberry River site near Wiseman, (UWSBR01), 30%, 28.5%, and 32% of the community, respectively. The rainbow darter dominated the community accounting for almost 29% of the community. The longear sunfish made up 25% of the community and less than 13% of the community was comprised of stonerollers. Less than 19% of the community was primary feeders; almost 42% were Sensitive Individuals, and 31% were Key Individuals. The diversity index was 3.26 and the catch per unit effort was 25.29 fish per minute. Four pool habitats, three riffles, and five runs were sampled extending 890 feet of stream. Substrate in the riffles was gravel. Substrate in the pools and runs

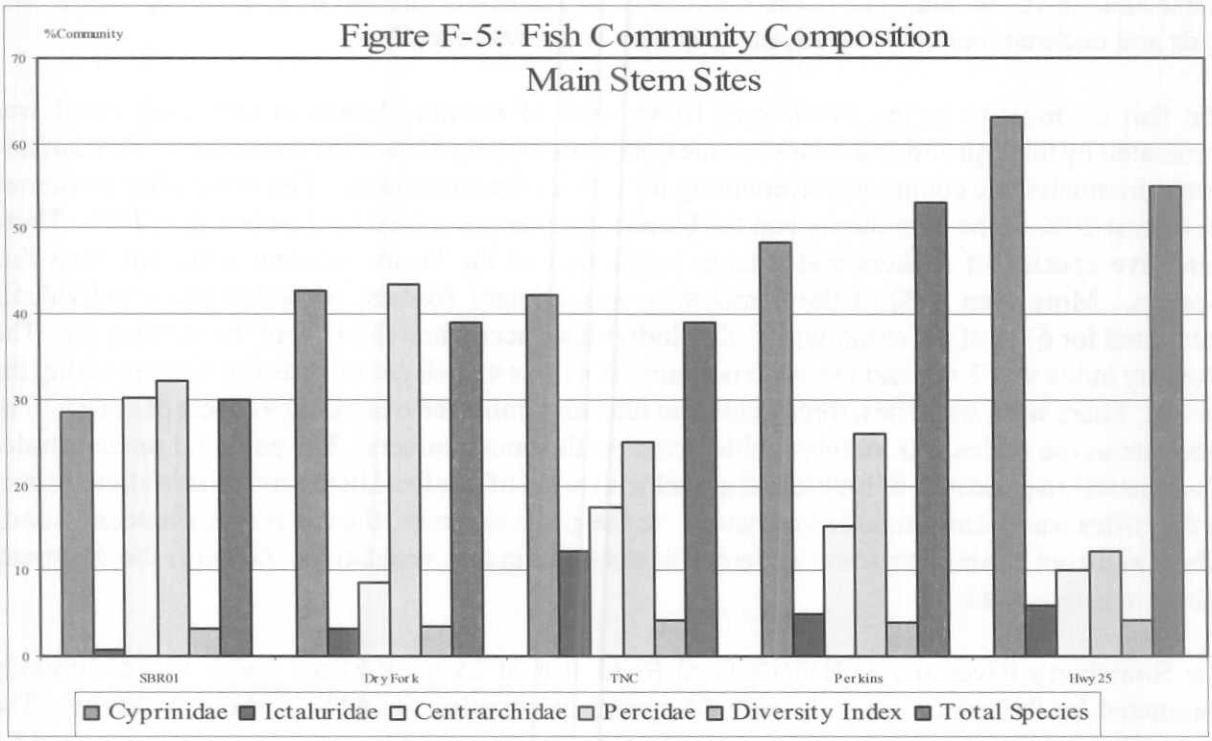


Figure F-5: Fish Community Composition
Main Stem Sites

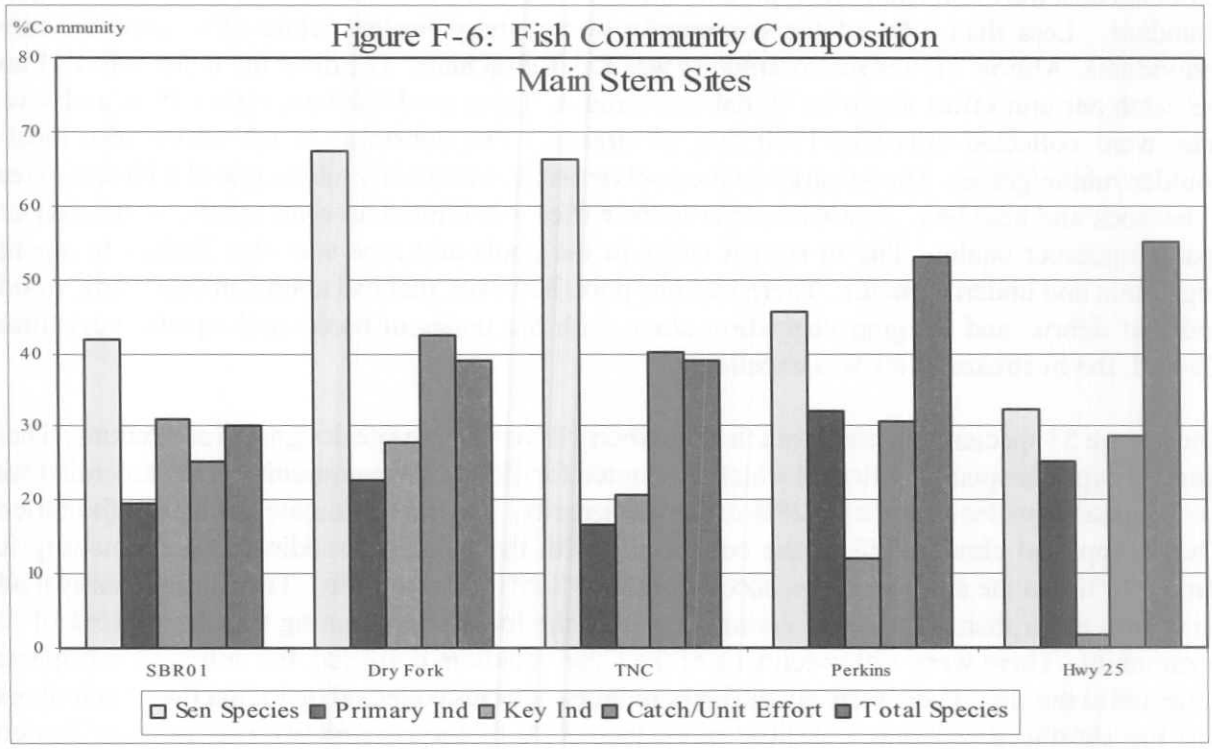


Figure F-6: Fish Community Composition
Main Stem Sites

was generally rubble/grave/sand with some boulders. In stream cover in the riffles was limited to sparse aquatic vegetation. The pools and runs had abundant in stream cover in woody debris, root wads and undercut banks. Overall, the in stream cover was excellent.

The fish community in the Strawberry River west of Evening Shade at Dry Fork Road was dominated by the cyprinid and darter families, each comprising 43% of the community. The rainbow darter dominated the community accounting for 29% of the community. The stoneroller accounted for almost 20% of the community and the bleeding shiner accounted for just less than 10%. There were five species of suckers and a large population of the Ozark madtom collected from this location. More than 22% of the community was primary feeders, while Sensitive Individuals accounted for 67% of the community. Key Individuals accounted for 41% of the community. The diversity index was 3.48, and the catch per unit effort was 42 fish per minute, the highest during the survey. There were six riffles, three pools and four runs collected extending 910 feet of stream. The substrate in the riffles was mainly rubble/gravel with some boulders. The pool and run substrates was generally a good mix of rubble and gravel with areas of sand and boulders. The in stream cover in the riffles was mainly aquatic vegetation. In the pools and runs, the cover was abundant woody debris and root wads with some undercut banks and aquatic vegetation. Overall, the in stream habitat was excellent.

The Strawberry River site at Baker's Ford Road east of Evening Shade had a fish community dominated by the minnow family with 14 species accounting for 42% of the community. The stoneroller and the bleeding shiner were the dominant cyprinids. The longear sunfish accounted for almost 14% of the community and the Ozark madtom comprised 11% of the community. Eight darter species were collected accounting for almost 25% of the community, four of which were quite abundant. Less than 17% of the community was primary feeders while 66% were Sensitive Individuals. Almost 21% of the community was Key Individuals. The diversity index was 4.11 and the catch per unit effort was over 40 fish per minute. Three pool habitats, eight riffles, and seven runs were collected covering 1700 feet of stream. The substrate in the riffles was mostly boulder/rubble/gravel. The substrate in the pools and runs was mainly rubble/gravel with some areas of bedrock and boulders. In stream cover in the riffles was limited to some aquatic vegetation and sparse undercut banks. The in stream cover in the pools and runs was also limited to aquatic vegetation and undercut banks. There was one pool, however, that had abundant root wads, woody and leaf debris, and hanging vegetation along with the undercut banks and aquatic vegetation. Overall, the in stream cover was excellent.

There were 53 species collected from the Strawberry River sample site designated as "Perkins. There were 15 cyprinid species collected which accounted for 48% of the community. The stoneroller was the dominant species comprising 28% of the community. The next dominate family was the darters. They comprised almost 26% of the community with the Arkansas saddle darter accounting for almost 11% and the rainbow darter accounting for 8% of the community. The sunfish family made up a little more than 15% of the community with the longear accounting for almost 10% of the community. There were 120 specimens of the Ozark madtom collected, the only madtom species collected at the site. There were six different redhorse species collected including the river redhorse and the shorthead redhorse. A little more than 32% of the community was primary feeders. Sensitive Individuals accounted for over 48% of the community and Key Individuals comprised almost 12% of the community. The diversity index was 3.89 and the catch per unit effort was 30.71

fish per minute. Two riffles, two pools, and two runs were sampled at this site covering 720 feet of stream. The substrate in the riffles was rubble and gravel. In stream cover was limited to very sparse aquatic vegetation. The substrate in the runs was mainly rubble/gravel with some sand and a few boulders. In stream cover in the runs and pools was very diverse and abundant. Overall, the in stream habitat was rated and excellent.

The furthest downstream sample site on the Strawberry River was at the Arkansas Highway 25 bridge. There were 55 species collected form this site. More than 63% of the community was cyprinids with 12 species collected. The blacktail shiner was the dominate minnow. The darter family accounted for 12% of the community. There were 15 darter species collected including the crystal darter and the walleye. More than 10% of the community was comprised of sunfishes with the longear sunfish accounting for almost 7% of the community. Seven sucker species were collected including the silver redhorse and the shorthead redhorse. Three different catfishes were collected with the Ozark madtom accounting for 5% of the community. More than 25% of the community was primary feeders while Key Individuals accounted for less than 2% of the community. There were 25 sensitive species collected accounting for 32% of the community. The diversity index was 4.25 and the catch per unit effort was 28 fish per minute. There were five pool habitats and six run habitats sampled covering 1530 feet of stream. The substrate in the runs was mainly gravel and sand. In stream cover was limited to woody debris, undercut banks and root wads. The substrate in the pools was mainly sand with some gravel and silt. In stream cover was mainly undercut banks, woody debris, root wads, and aquatic and hanging vegetation. Overall, the in stream habitat was rated as excellent.

DISCUSSION

Watershed Fish Assemblage

Fishes were collected from 19 sites in the Strawberry River watershed. Because several of the sites were located in transition zones between two ecoregions, a straight-forward assessment of use support was impractical. Therefore, the communities were not only assessed using the outlined assessment methodology above, but professional judgement was employed to fully assess the communities.

There were 86 species collected from the 19 fish community sites. Robison and Buchanan, 1992, report 93 species of fish as occurring in the watershed. This is probably not an exact number taking into account those species with records as only occurring pre-1960, those species that may occasionally frequent the lower portion of the river from the main stem of the Black River, and those species with un-substantiated records. The goal of this project was not to determine the complete species list from the river, but to determine the assemblages of the watershed fish communities However, there were a few species that were not collected, or were only collected in minimal numbers, that may be of concern. Likewise, there were a few species that were collected that have had limited to no previous records of occurrence in the Strawberry River that may be of some interest.

The cyprinids (minnows and shiners), centrarchids (sunfishes), and the percids (darters) comprised more than 93% of all fishes collected. There were 22 species of cyprinids collected during the

survey which represented over half of the fishes collected. Almost 25% of all fishes collected were stonerollers. The bleeding shiner and the bigeye chub were the next most abundant cyprinids each representing approximately six percent of all fishes collected. There were 20 species of darters collected collected representing over 21% of all fishes collected. The rainbow darter was the most abundant darter collected representing almost 12% of all fishes collected. The centrarchids accounted for over 18% of all fishes collected with the longear sunfish accounting for almost 13% of all fishes collected.

Perhaps the most significant species not to be collected was *Erimystax x-punctata*, the gravel chub. This species has numerous historical records as occurring in the river. Robison (1992) reports that this species is "...rather intolerant of siltation." This may suggest that the excessive turbidity that is found in the river from time to time may be having a detrimental effect on the gravel chub population. On the other hand, this survey collected numerous specimens of the streamline chub, *Erimystax harryi*, from several different locations. The only other record seems to be one specimen collected by Robinson in 1992 in North Big Creek at Highway 354 near Center (USFS DATABASE). Robison (1992) reports that this species is "...very intolerant of turbidity and siltation." It is unclear why the streamline chub was collected and the gravel chub was not. The historical records may actually be streamline chubs and not gravel chubs, and were collected and identified prior to the streamline chub being elevated to species status by Harris.

Other probable first time fish records for the Strawberry River are three additional redhorse species. Several specimens of the silver redhorse, *Moxostoma anisurum*, the river redhorse, *Moxostoma carinatum,* and the shorthead redhorse, *Moxostoma macrolepidotum*, were collected from several locations in the watershed. According to Robison (1992) only ten specimens of the silver redhorse, collected at only two locations, have been previously recorded in the state. Both sites were in the White River drainage. Three specimens of the silver redhorse were collected at the Arkansas Highway 25 site northeast of Strawberry, Arkansas during this survey. The shorthead redhorse has only sporadic distributional records, none of which are from the Strawberry River. There were 22 total specimens colleted from two sites on the main stem of the lower river during this survey. In addition, there are no current records of the river redhorse occurring in the Black River and its tributaries. This survey collected 13 specimens from four locations in the watershed. Three on the main stem of the river from just east of Evening Shade to the Arkansas Highway 25 site, and one specimen was collected from South Big Creek at the Highway 117 site near Jesup. Robison (1992) suggest that the sporadic records for these redhorse species is because of the lack of large river sampling.

The spotted sunfish, *Lepomis puntactus,* was collected from five locations in the lower portion of the watershed. Previous records of this species occurring in the White River drainage basin are from the Spring River and the Black River (Robison, 1992). Likewise, the mud darter, *Etheostoma asprigene*, had only been recorded from the Eleven Point and Current Rivers previous to this study. There were 42 mud darter specimens collected from two tributary sites, Reeds Creek and the upper Caney Creek, in the lower watershed during this survey. These records help to substantiate the presence of these species in the White River Drainage.

Three additional darter species of significance that were collected during this survey were the crystal darter, *Crystallaria asprella*, the cypress darter, *Etheostoma proeliare*, and the slenderhead darter, *Percina phoxocephala*. The crystal darter has only been collected in low numbers from the main

stem of the Strawberry River at the Arkansas Highway 115 bridge prior to this survey. One specimen was collected from the Arkansas Highway 25 bridge site during this survey. Although this species does not occur in great numbers, there seems to be a viable population in the watershed.

The slenderhead darter, on the other hand, has only been reported from the river on one occasion. Two specimens were collected from the river at Arkansas Highway 115 in 1974 (Robison, 1992). This species has also been recorded as occurring in other White River tributaries in and around the Batesville, Arkansas area. One specimen was collected on the main stem of the river at Arkansas Highway 25 during this survey. Robinson notes that Bruce Thompson believes this is probably an undescribed species similar to the Percina species of the Ouachita River (Robison, 1992).

No records of the cypress darter, *Etheostoma proeliare*, occurring in the Strawberry River appear to exist. However, it has been recorded from the Spring River and several White River tributaries. This survey collected one specimen from the upper Caney Creek site at Arkansas Highway 25 south of Saffel, Arkansas. The habitat in this tributary is more characteristic of the Delta ecoregion than the Ozark Highlands, which is typical habitat for the cypress darter.

Two mooneye specimens, *Hiodon tergisus*, were collected from the main stem of the Strawberry River in the lower part of the watershed. One specimen was collected just east of the Sharp County line in Lawrence County, Perkin's site, and the other at Arkansas Highway 25 in Lawrence County. The collection of these two specimens is significant because Robinson (1992) notes that the mooneye "...has declined in numbers in many parts of its range and is not common today in Arkansas."

Individual Site Fish Assemblages

All sites were supporting either an Ozark Highlands ecoregion fishery or a Channel Altered Delta ecoregion fishery, Table F-3. There were some oddities in a few of the communities, as is displayed by a couple of the individual metric scores in Table F-3, and in Appendix 10.

One example of this is the composition of the fish community at the lower Piney Fork Creek site. The overall score for the site was "generally supporting". This score was affected by the abnormally large number of bigeye chubs collected; almost 54% of the community. These chubs were nearly all the same size, somewhat small, possibly indicating the same year class and a recent hatch of the species. As is evident from other samples within the watershed, the bigeye chub generally comprises less than five percent of the total community. Reducing the chub population in this collection to five percent would raise the samples overall score enough for it to be scored as "fully supporting".

The upper Piney Fork Creek site was scored as "generally supporting". This site had a large percentage of stonerollers and longear sunfish which helped to lower its score slightly. This is somewhat typical of Ozark Highland fish communities from small headwater streams. These streams typically have a large percentage of shallow pools with very shallow riffles and run habitats. This habitat is better suited for sunfishes and minnows and tends to limit the darter and madtom populations. This is possibly one reason for the slightly reduced index score from this site.

TABLE F-3 -- FISH COMMUNITY STRUCTURE INDEX							
Parameter	Sample Site (Ozark Highlands Ecoregion)						
	SBR01	143H	Dry Fork	143L	143M	TNC	143IA
Cyprinidae	1	5	5	5	3	5	5
Ictaluridae	1	1	5	1	1	5	3
Centrarchidae	1	1	5	1	1	1	3
Percidae	5	5	5	5	3	5	5
% Sens. Inds.	5	3	5	3	5	5	5
% Primary Inds	5	5	5	5	5	5	3
% Key Inds.	5	5	5	3	1	3	5
# Species	5	5	5	5	5	5	5
Diversity Index	5	5	5	5	1	5	5
Total Score	33	35	45	33	25	39	39
Support Degree	GS	GS	FS	GS	GS	FS	FS

Parameter	Sample Site (Ozark Highlands Ecoregion)					
	143I	143IB	NBC01	143N	Perkins	143K
Cyprinidae	3	5	3	3	5	5
Ictaluridae	3	1	1	1	5	1
Centrarchidae	5	1	1	1	1	5
Percidae	5	5	5	3	5	5
% Sens. Inds.	3	5	5	3	5	5
% Primary Inds	1	5	5	1	5	3
% Key Inds.	5	5	5	3	1	5
# Species	5	5	5	5	5	5
Diversity Index	1	5	5	5	5	5
Total Score	31	37	35	25	37	39
Support Degree	GS	FS	GS	GS	FS	FS

TABLE F-3 -- FISH COMMUNITY STRUCTURE INDEX						
Parameter	Sample Site (Ozark Highlands Ecoregion)				Sample Site (Channel Altered Delta)	
	143J	143S	RDC01	Hwy 25	143Q	143R
Cyprinidae	5	3	5	5	2	0
Ictaluridae	1	1	3	5	0	4
Centrarchidae	1	1	3	5	2	4
Percidae	5	5	5	5	4	4
% Sens. Inds.	5	3	3	3	0	0
% Primary Inds	5	5	5	5	4	0
% Key Inds.	3	5	1	1	2	4
No. of Species	5	5	5	5		
Diversity Index	5	5	5	5	4	4
Total Score	35	33	35	39	18	25
Support Degree	GS	GS	GS	FS	GS	GS

Degree of Support Criteria		
Support	Ozark Highlands	Channel Altered Delta*
Fully	37 - 45	27 – 35
Generally	25 - 36	18 – 26
Impaired	24 - 12	9 – 17
Not Supporting	11 - 0	0 - 8

The Delta ecoregion does not have a value for sensitive species or No. of Species

The "Support" ranking is based on a 0 to 35 scale.

A similar situation in the fish community structure index occurred at the Little Strawberry River site. This site had a large population of stonerollers and longear sunfish. But unlike the Piney Fork Creek sites, it had a much larger darter population. The abundance of the sunfishes and lack of madtoms at this site caused the score to be listed as generally supporting. Once again, the nature of the smaller Ozark Highland streams to have extremely low flow during the late summer months causes there to be a lack of certain riffle species, thus affecting the index score.

Four fish community sample sites were located in North Big Creek to determine if the Ash Flat WWTP was influencing the fish community in the stream. One site was located above the effluent (WHI0143IA); one approximately one stream mile below the effluent (WHI0143I); one

approximately six stream miles below the effluent (WHI0143IB); and one approximately 14 stream miles below the effluent (USNBC01). The index scores for each of the sites were either generally or fully supporting. Similarity indices based on percent community structure and community species structure (ODUM) at WHI0143IA and WHI0143I were 74.60 and 79.07, respectively. Likewise, these same indices between WHI0143I and WHI0143IB were 71.66 and 69.39, respectively. This indicates that the communities at these sites are very similar both in community structure and in the species present at each site.

There were some slight differences between the communities that are worth noting. The community below the discharge (WHI0143I) had a greater percentage of primary feeders than any of the other three communities. In addition, WHI0143I had a lower percentage of Sensitive Individuals, fewer sunfishes and darters, a greater abundance of minnows, and a lower diversity index than the other communities. There was a shift in the abundance of several species in the WHI0143I community. The stoneroller and yellow bullhead populations had a noticeable increase in numbers, and the bigeye chub, shadow bass and longear sunfish all had a noticeable decrease in numbers. This type of community structure is typical of fish populations in the Ozark Highlands that are located below WWTPs, but doesn't necessarily indicate that there are impairments in the fishery use.

Mill Creek had a community index score of 25, one of the lowest during the survey, but is still listed as generally supporting. It scored lower in the Cyprinidae, Percidae, % Primary Feeders and % Key Individuals categories as compared to the other tributary sites. It did score ones in the Ictaluridea and Centrarchidae categories just as the other tributary sites scored. The habitat at this site was indicating the beginnings of a transition between the Ozark Highlands ecoregion stream to a stream more characteristic of a low-land stream. The in stream habitat rating at this site was good as compared to excellent at the other tributary sites. This is possibly one reason for the lower index score at this site.

South Big Creek is probably the most unique tributary in the watershed. The flow in its headwaters is dominated by ground water due to the numerous springs in the area. It flows through the Ozark Highlands ecoregion and then quickly drops off into an area that resembles the Arkansas River Valley ecoregion. This makes both of fish community sample sites on the tributary slightly atypical as compared to the ecoregion reference stream data. Even though the sample sites had atypical ecoregion characteristics, the upper South Big Creek site, WHI0143K, had a 39 index score, fully supporting. This site also lost points in the Ictaluridae and Centrarchidae categories. This has been typical of almost all of the Strawberry River sample sites. The madtom and sunfish abundances in the River's tributaries are not the same as in other Ozark Highland Streams.

The lower South Big Creek site, WHI0143J, scored as "generally supporting". The habitat at this site went from a high gradient, bedrock step-pool habitat to a low gradient, gravel bottom, shallow run-pool habitat, and the transitioned to a low-land type stream with a sand substrate. This variety of habitat gave the sample site a unique fish community composition, supporting fish species typical of several ecoregions. The site still lacked madtoms, and had a higher percentage of sunfishes similar to the other tributary sites in the watershed. The variety of habitat and species rich community at this site produced a diversity index above four. Generally, diversity indices are between 3.50 and 3.75 for fish communities in this ecoregion.

The habitat in Cooper Creek was very similar to the lower South Big Creek sites; step-pool bedrock to low-gradient riffles, runs and pools. It also lies in the transition zone between two ecoregions. The fish community at this site scored as generally supporting. The presence of the spotted sunfish and the dusky and blackside darters indicates a transition into a more low-land type stream. This site also had a lack of madtoms and an abundance of sunfishes, typical of the watershed tributaries, both of which lowered the biotic score as compared to the Ozark Highland ecoregion criteria.

Reed's Creek originates in the same geologic area as South Big Creek, but the ground water influence is not as apparent in the creek. Habitat characteristics are more similar to a low-land type stream than an Ozark Highland ecoregion stream. However, the fish community was scored as "generally supporting" for Ozark Highland Streams. This creek also scored lower in the percent ictalurid and centrarchid categories like the other tributaries in the watershed. It also only scored a one in the Key Individual category for Ozark Highland streams. Key Individuals are those species that are most common in a particular ecoregion. This indicates that the overall family composition is very typical of Ozark Highland streams, but the species composition is more typical of an low-land stream. This variety in habitat produced a species rich community with a diversity index above four, similar to that of South Big Creek.

Caney Creek was sampled at two locations. The WHI0143Q site was in a channelized stretch of the creek with a watershed land use dominated by confined animal operations and pasture land. The other site, WHI0143R, was further downstream in a channelized stretch with land use of row crop agriculture on either side of the creek. The fish communities at both sites were compared to Ozark Highland ecoregion streams, and Channel-Altered Delta ecoregion streams. The sites were listed as "impaired" when compared to Ozark Highland ecoregion criteria, and listed as "generally supporting" when compared to Channel-Altered Delta ecoregion criteria. Both sites had very diverse communities, but were both lacking sensitive species populations. It is obvious that the fish communities at both sites have been affected by the channelization and loss of in-stream habitat. However, both sites are maintaining a viable and diverse fish community, characteristic of a typical Channel Altered Delta ecoregion community.

The uppermost main stem site on the Strawberry River had a fish community similar to that of the tributary sites. It was scored as "generally supporting", but scored low in the cyprinid, ictalurid, and centrarchid categories, and high in all of the other categories. The dominant species at the site was the rainbow darter, a sensitive species, comprising nearly 29% of the total community. In all, Sensitive Individuals accounted for nearly 42% of the community. Similar to the tributaries, in stream flow at this site is limited to generally less than one cfs during the summer months. This site is supporting a typical Ozark Highland ecoregion stream fish community.

The transition from an Ozark Highland ecoregion stream to a Delta ecoregion stream is somewhat evident when examining the fish community structure of the four lower main stem sites. Each of the four sites scored as "fully supporting" an Ozark Highland ecoregion fishery. Each of these sites supported a large number of species and specimens. The HWY25 site had the highest diversity index of 4.25 during the survey, and the site at Dry Fork had the highest catch per unit effort during the survey of more than 42 specimens per minute sampled. Several species were collected from these locations that were not sampled at the tributary sites, including the silver, shorthead, and river redhorses, the bowfin, the crystal darter and the walleye.

Even though each of the main stem sites is supporting a healthy fishery, there are a few trends in the data that are interesting. Probably the most noticeable is the decline in the percent community of Ozark Highland ecoregion Key Individuals from upstream to downstream. Almost 41% of the community at the Dry Fork site were Ozark Highland Key Individuals. Only 21% of the community at the TNC site, 12% at the Perkins site, and only 2% of the community at the HWY25 site were Key Individuals. This is possibly indicating a transition between the two ecoregions. There was also a decline in the number of Sensitive Individuals and darter specimens from upstream to downstream, but an increase in the number of minnows and overall number of species collected. This is likely due to the transition of the habitat from a riffle-run-pool characteristic to a more low-land,, big river habitat of deeper runs and pools and fewer, swifter riffles.

The tributaries of the watershed, excluding South Big Creek because it is ground water influenced, each demonstrated a similar fish community structure that was somewhat different than the average fish community structure of the Ozark Highland ecoregion reference streams. For the most part, the minnow and the catfish populations, mainly madtoms, were less abundant in the Strawberry River tributaries as compared to the ecoregion reference streams, Table F-3. In contrast, the sunfish and darter populations at each of the sites were considerably larger than those of the ecoregion reference sites. These differences were significant enough to cause a decrease in the Cyprinidae, Ictaluridae and Centrarchidae metric scores at most of the sites. This also caused many of the sites to be scored as "generally supporting" instead of possibly fully supporting. Most sites scored the maximum points possible in the other metric categories with their numbers being either well above or below the scoring criteria for the metric. An example of this is the average percent community composition of the tributary sites is 0.89% and the ecoregion criteria is greater than 3% community structure. Another example is the percent community of primary individuals. The watershed sites had an average community structure of less than 28% and the ecoregion criteria is less than 42%. In addition to these two parameters, the diversity indices at each of the sites was much higher than the criteria; an average index of 3.325 for the watershed sites and an ecoregion criteria of greater than 2.77. Taking these factors into account, each of the watershed sites that were listed as "generally supporting" should probably be listed as "fully supporting" a Strawberry River watershed, Ozark Highland ecoregion fishery.

TABLE F-4 - Fish Community Comparison Between Least Disturbed Ozark Highlands Ecoregion Reference Streams and Strawberry River Tributary Sites

Metric (% community, except Diversity Index)	Ozark Highland Ecoregion Reference Streams	Strawberry River Tributary Sites
Cyprinidae	40 – 65	47.10
Ictaluridae	>3[1]	0.77
Centrarchidae	2 - 10[2]	21.36
Percidae	>10	20.11
Sensitive Individuals	>40	43.82
Primary TFL	<37	27.45
Key Individuals	>25	23.15
Diversity Index	>2.83	3.325

1 – no more that 3% bullheads2 – no more than 2% Green sunfish

STREAMBANK SURVEY

A stream bank stability survey was conducted throughout the watershed by visually identifying stream banks that were unstable. A float trip on the main stem of the Strawberry River, on North Big Creek, and Piney Fork Creek, combined with a watershed reconnaissance survey was used to locate the unstable stream banks. One hundred ninety stream banks, approximately 18.71 miles of stream bank, within the watershed were identified as unstable. There were 151 areas on the main stem identified as unstable; 29 on North Big Creek from near Center, Ar. to its mouth; 4 on Piney Fork Creek from the U.S. Highway 67 Bridge to its mouth; and 5 on South Big Creek from below the Ar. Highway 25 Bridge to its mouth. This is by no means a comprehensive survey of all the unstable stream banks in the watershed. These are only the stream banks that were identified during float trips when the river and its tributaries were assessable and by accessing the stream banks across private property.

The unstable stream banks are depicted in Figure SB-1. Appendix SB-1 lists the stream banks, briefly outlines some of the key characteristics of each, and gives the general location of each.

INTENSIVE STREAMBANK SURVEY

The stream bank located below Baker's Ford east of Evening Shade, SH22 was chosen for a more in-depth survey. Three transects across the channel were established to help determine the degree of annual stream bank erosion. Transect pins were set at each end of the transect. In addition, a pin (set pin) was set on top of the stream bank at a distance far enough back from the face so as not to be lost to erosion during storm events. A temporary bench mark (TBM) was established with an arbitrary height of 100. Stream bed cross-sectional elevations, relative to the TBM, were measured along each transect. Elevations were measured to the nearest 0.01 feet with a SOKKIA SET5F Total Station and a 25 foot target rod. Three additional pins (erosion pins), three feet in length, were driven into the face of the bank at the transect site to help determine the amount of erosion during storm events. The total length of the stream bank was measured in addition to the distance between the corner pins on opposite sides of the stream.

At each transect, the cross-sectional area (ft^2) of stream bank loss was calculated for the study period. The cross-sectional area lost was multiplied by the distance (ft) along the bank associated with each transect and expressed as cubic feet (ft^3) of bank lost. The total cubic feet of bank lost was then converted to cubic yards.

The study reach is approximately 425 feet in length. The first transect was located approximately 70 feet from the upstream point of bank instability. There was 146.1 feet between transects one and two, and 92.5 feet between transects two and three. It is 116.4 feet from the last transect to the downstream portion of the bank that was determined to be stable.

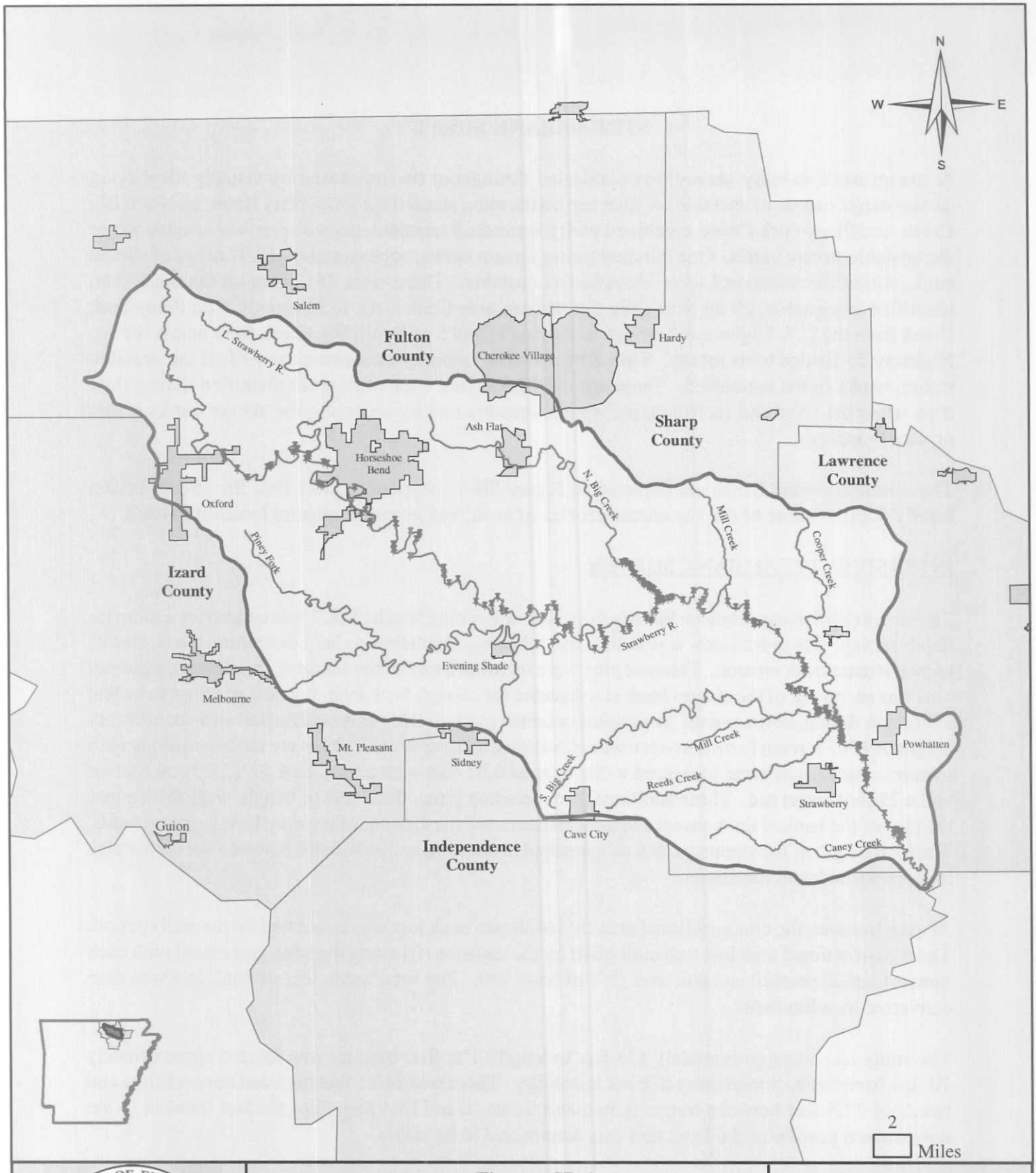


Figure SB-1
Eroding Streambank Locations
Strawberry River Watershed

Arkansas Department of
Environmental Quality
Water Division - Planning Section

Legend

- Watershed Boundary
- Cities
- Counties
- Streams

The bank erosion potential for this bank was determined to be very high. This rating was determined by using Rosgen's Stream Bank Erosion Potential method (Rosgen Applied Fluvial Geomorphology). Numerous factors are used to determine this ranking including bank height, root depth, root density, bank angle, bank material, soil stratification and surface area protection. The soils throughout the stream bank were sand/silt/clay with little to no gravel or cobble. This whole structure is over bedrock which is exposed in the thalweg. There was no root or surface area protection along the bank and the bank height was generally more than twice the bank full depth. This stream bank erodes in 40 to 50 foot sections instead of eroding uniformly along the entire length of the bank. This apparently is caused by eddies which form along the bank.

Transect 1 had an approximately 20 foot distance from the thalweg to the top of the bank. The upper five feet had a 79° vertical face. It sloped off at a 32° angle for the next 11.5 feet for a linear distance of 18 feet. Then there was a one foot vertical face present at the water surface. From here, the banks sloped at a 10° angle for approximately 15 linear feet to the thalweg (Figure SB-2). The total transect distance from the river-left transect pin to the river-right transect pin was 282 feet. The distance from the right transect pin to the toe of the left bank decreased by approximately one foot during the survey. Additionally, approximately 40 square feet of soil was added to the bank across the transect area on the left bank. However, the upper four feet of bank eroded approximately one foot during the survey. Bank pins were installed approximately 10 feet downstream of transect one in a portion of the bank where a bulge approximately 5 feet wide and 30 feet long was present. During 2002, this bulge fell and all of the bank pins were lost. As a result of the eddy, much of the soil was deposited slightly upstream of the bulge across the transect explaining the aggradation of the stream bank at this point.

In 2001, the top of the bank at Transect 2 (Figure SB-3) had a vertical face of approximately five feet. The bank then sloped at a 62° angle for about nine feet. The bank then flattened out to a 6° slope for another nine feet before sloping for approximately 23 feet at a 15° slope into the thalweg. The upper section of the bank lost two linear feet during the survey. In 2003, the upper 16 feet of bank was at a 63° angle. The next 16 feet was at a 42° slope which met the bedrock in the stream. It was another 16 feet with little to no slope to the thalweg point that existed in 2001. The total soil loss at the point was approximately 62 square feet. The actively eroding area of the stream bank at this point was estimated to be 65 feet. Using this number, over 4000 cubic feet (150 cubic yards) was lost during the two year survey. This area of stream bank seems to have fallen in during 2001 and then was eroded away in 2002 and 2003.

The lower transect in 2001 had about a five foot vertical face before sloping away at a 49° slope for approximately 17 feet. It had a one foot vertical drop at the waters surface and then sloped at approximately 7° for about 26 feet to the thalweg (Figure SB-4). In 2003, the bank had a six foot vertical slope before sloping off at approximately 29° for almost 21 linear bank feet. A short three foot bank section then slopes at a 45° angle into the water. The bank then slopes at a 10° angle for the next 15 feet to the thalweg. This transect was located in an area of the bank that sloughed off during the winter of 2002. Unlike the upper section, all of the material was eroded away during the year. The top six feet of the bank lost 6.6 feet. The length of the stream bank that was eroding around this transect was estimated to be 54 feet. The total soil lost at this transect over the study period was approximately 5200 square feet (192 cubic yards).

Figure SB-2

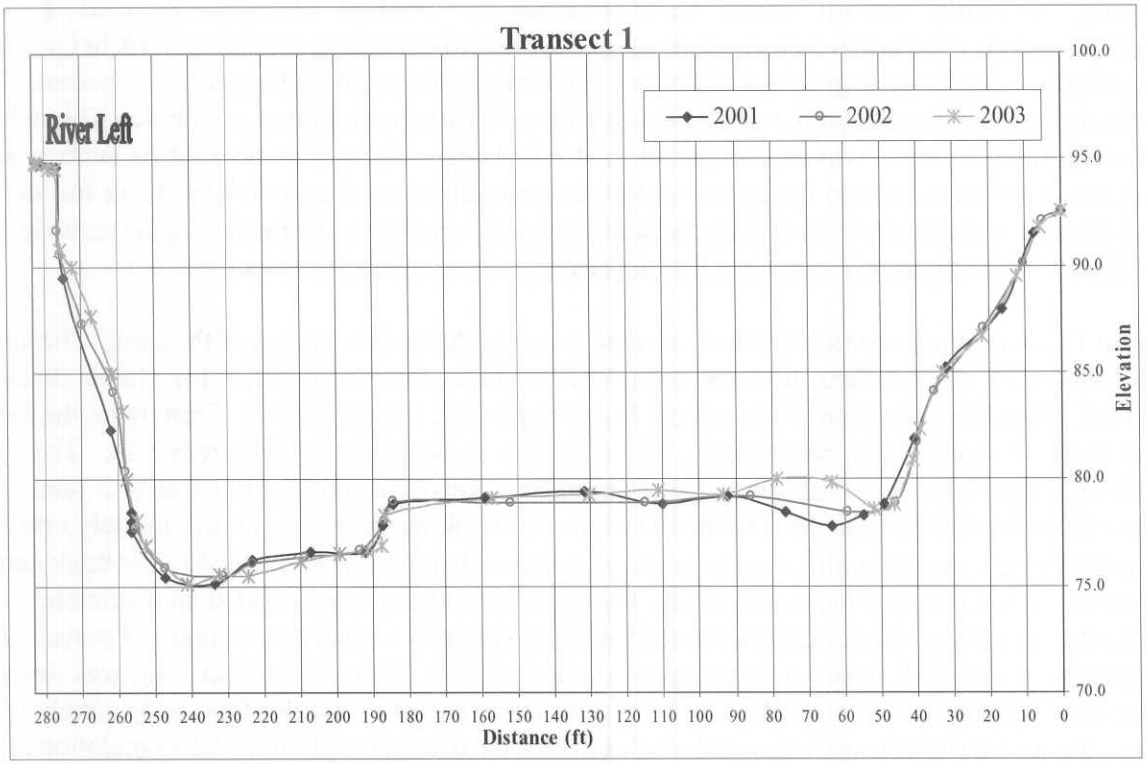
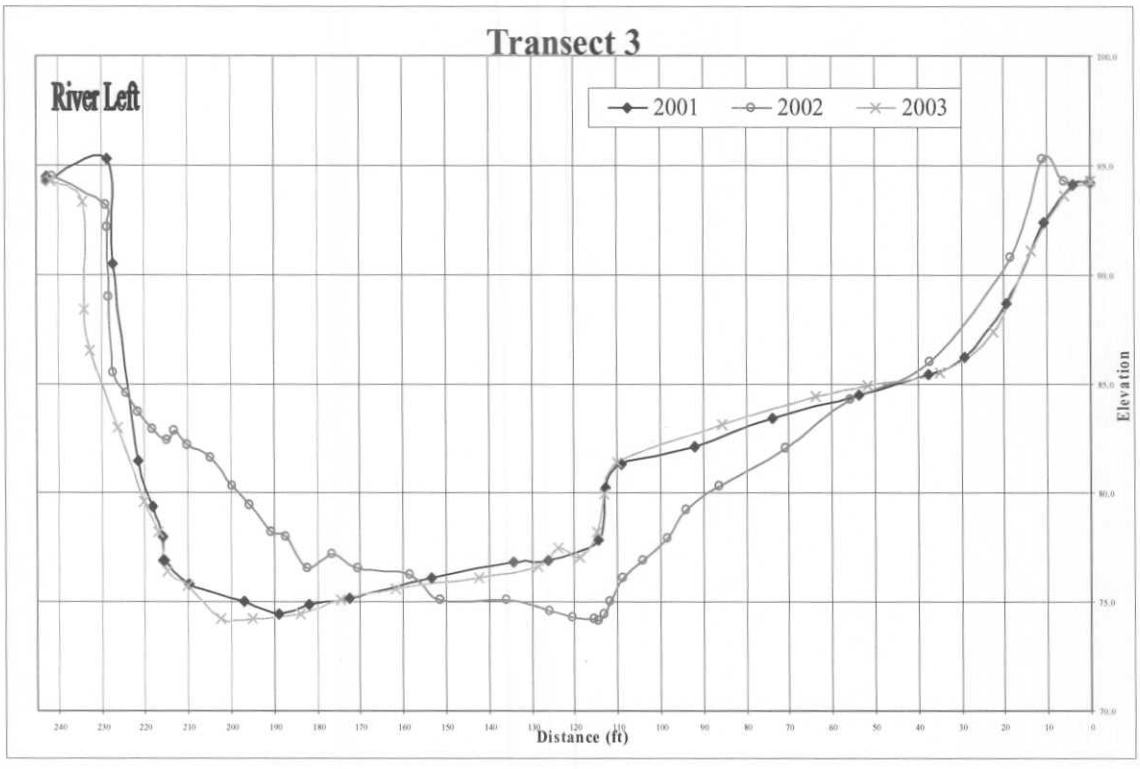


Figure SB-3

Figure SB-4



Extrapolating the total soil loss from this stream bank to the other banks in the Strawberry River, it is estimated that 64.980 cubic yards of soil is lost annually from stream bank erosion in the Strawberry River. This estimation is in no way to be considered the exact amount of soil that is lost in the watershed from stream bank erosion. It is a conservative estimation based on the data gathered from one stream bank over a two year period. Dozens of factors influence stream bank erosion on a watershed basis that were not considered in this estimation.

This page intentionally left blank.

CONCLUSIONS

A three year survey of the Strawberry River watershed resulted in the collection of numerous water quality, aquatic macroinvertebrate, and fish community samples as well as a comprehensive land use survey. Listed below are the main conclusions derived from this assessment. Tables C-1 and C-2 list the stream segments that indicated an impairment, their causes and possible sources.

1) Historical water quality data from the Department's Ambient and Roving Water Monitoring Networks indicated that there were occasionally very high values of in-stream turbidity. The Department's Water Quality Inventory Reports (305(B)), 1996, 1998, and 2000, listed several stream segments as impaired because of these high turbidity levels.

2) Historical water quality data from the Department's Roving Water Quality Monitoring Network indicated that there were occasionally high values of fecal coliform bacteria which exceeded the in-stream Ozark Highlands Ecoregion standard. The Department's 1998 and 2000, 305(B) reports listed several stream segments in the watershed as not maintaining the primary contact recreation use.

3) Historical water quality data at WHI0024, the Strawberry River near Poughkeepsie, for turbidity, total suspended solids, total phosphorus, and nitrate + nitrite nitrogen over the past ten years indicates a trend of decreasing concentrations.

4) In stream flow in the smaller tributaries in the watershed was reduced to generally less than one cubic foot per second during the latter parts of the summer and early fall. South Big Creek and Reed's Creek maintained a higher flow during the summer and fall months because of ground water inputs. Caney Creek generally maintained a higher flow during the summer and early fall because of irrigation return flow from adjacent crop land.

5) Land use in the upper portion of the watershed, upper Strawberry River and Little Strawberry River, was mainly dairies, pasture for cattle grazing, and forest with some light silviculture activities. One urban area, Horseshoe Bend is also located in this portion of the watershed. Land use in the northeast portion of the watershed was mainly silviculture with a few scattered poultry houses and small urban areas. The land use in the tributaries entering the main stem of the river from the south was mainly forested with some light silviculture activity. However, this area has numerous poultry houses and pasture area for cattle grazing. Row crop agriculture with a few poultry houses dominates the land use in the lowest section of the watershed near Saffell.

6) There are 22 dairies located in the watershed, all of which are located in the northern portion of the watershed upstream of Horseshoe Bend. There are 276 poultry houses on 97 farms in the watershed. The majority of these houses are located in the southern portion of the watershed between Melbourne and Strawberry.

7) There are six point source dischargers in the watershed. Each has a design flow of less than 0.3 mgd, or less than 0.5 cfs. The most significant of the dischargers is the City of Ash Flat which discharges into the headwaters of North Big Creek.

8) Dissolved oxygen data obtained during the grab sampling events indicates that concentrations fall below the Ozark Highlands ecoregion standard mainly at those sites that have minimal to no flow during the low-flow seasons. These sites were mainly the smaller tributaries and the headwater sites of the Strawberry River that do not have a significant ground water influence.

9) Turbidity values ranged from less than 1.0 NTU to 360 NTU. Five sites exceeded the assessment criteria for turbidity during the survey, WHI143A, UWSBR01, WHI0143H, WHI0143B, and UWSBR02. All of these sites were in the upper portion of the watershed. There is a distinct decrease in magnitude and frequency of occurrence in turbidity concentrations in the tributaries from the headwaters to the mouth. Main stem turbidity concentrations increase in a downstream concentration.

10) The highest concentrations of ammonia-nitrogen and nitrate-nitrite nitrogen occurred below the Ash Flat Waste Water Treatment facility. The lowest peak values for nitrogen occurred at the lower North Big Creek and Mill Creek sites. The Strawberry River near Evening Shade, UWSBR02, had the highest ammonia-nitrogen concentration of 0.55 mg/L of the main stem sites. Ammonia nitrogen values during the survey were quite similar to the ammonia nitrogen values of the Ozark Highlands ecoregion reference streams.

11) Reed's Creek had the second highest peak nitrogen value and the highest ammonia-nitrogen value of all sites. There is a high concentration of confined animal operations in the watershed.

12) There is an increase in the median nitrogen values in a downstream direction from all sites as well as in the main stem sites. The median nitrogen concentrations were four times lower than the median nitrogen concentrations from the Ozark Highlands ecoregion reference streams.

13) The peak total phosphorus concentration during the survey was 0.52 mg/L at the Strawberry River near Poughkeepsie, WHI024, Piney Creek near Evening Shade, WHI0143M, and the lower Caney Creek site, WHI0143Q. Median total phosphorus values decrease in a downstream direction and were slightly higher than the median values from the Ozark Highlands ecoregion reference streams. .

14) The peak ortho-phosphorus value of 0.41 mg/L occurred at the upper Caney Creek site, WHI0143R. The highest median ortho-phosphorus value occurred at the North Big Creek site, WHI0143I, below the Ash Flat Waste Water Treatment facility. Median ortho-phosphorus values increase in a downstream direction. The median ortho-phosphorus values during the survey were similar to the median values from the Ozark Highlands ecoregion reference streams.

15) Four sample sites, the upper Little Strawberry River, WHI0143E, Mill Creek, WHI0143N, lower South Big Creek, WHI0143J, and Cooper's Creek, WHI0143S, exceeded the criteria for fecal coliform bacteria concentration during the 2001 primary contact recreation season. Seven sites exceeded the criteria during the 2002 primary contact recreation season: upper Strawberry River, WHI0143A; both sites on the Little Strawberry River, WHI0143E and WHI0143H; Reed's Creek, UWRDC01; Cooper's Creek, WHI0143S; and both Caney Creek sites, WHI0143R and WHI0143Q. Most of the exceedences occurred during the larger storm events when flows were at or above bank full; typically not a condition when primary contact recreation takes place.

16) Most diurnal dissolved oxygen data indicate that concentrations fall below the 5.0 mg/L Ozark Highlands ecoregion standard on a routine basis. This is most likely occurring because of a lack of in stream flow during the critical season. Diurnal dissolved oxygen concentrations at the larger sites typically remain above the standard.

17) Ground water has accounted for 99% of all of the drinking-water use from 1960 to 2000 in Fulton, Izard, Sharp, and Lawrence counties. The majority of the water is extracted form the Ozark aquifer which is composed of Ordovician-age rocks. Some ground water is extracted from a small portion of the alluvial sediments in the row-crop agriculture portion of the watershed.

18) Nine springs and 51 wells were sampled during this survey. Eighteen wells were re-sampled for additional analysis including bacteria screening and Schedule 1433 Wastewater Scan by the USGS laboratory in Denver, Colorado.

19) Overall, ground water quality in the watershed is good as compared to national drinking water criteria. Hardness, resulting from high concentrations of calcium and magnesium, poses a problem for some domestic and municipal water supplies

20) Seventeen wells had nitrate-nitrogen values greater the 1.0 mg/L, two of which had a concentration greater than 6.0 mg/L and two others were greater than 12.0 mg/L. Septic tank effluent is probably the major contributor of the nitrogen at these sites. Confined animal operations and land application of liter is probably contributing as well.

21) The main stem of the Strawberry River generally supported a typical aquatic macroinvertebrate community indicative of the Ozark Highlands ecoregion. The only main stem site to indicate some alteration was the site south of Horseshoe Bend, WHI0143B. This site demonstrates characteristics of being altered by periphyton growth, sedimentation, and habitat destruction. Direct cattle access, reduction in riparian cover and the buffer zone are all suspected to be the cause of the problems at this site.

22) Periphyton growth, direct cattle access, habitat destruction and sedimentation seem to be altering the community at five tributary sites; Mill Creek, WHI0143N; lower North Big Creek, UWNBC01; lower Piney Fork Creek, WHI0143M; upper South Big Creek, WHI0143K, and lower Little Strawberry River, WHI0143H.

23) The area of North Big Creek below the Ash Flat Waste Water Treatment facility indicates a slight shift in the aquatic communities because of the influence of the discharge. However, the communities structure less than three stream miles below the discharge are typical of an Ozark Highland ecoregion community.

24) The macroinvertebrate communities in the Delta tributaries consistently rated high as compared to the least-disturbed ecoregion reference streams. This is most likely because these streams are in a transition between two ecoregions.

25) The fish communities throughout the watershed were determined to be either generally supporting or fully supporting either an Ozark Highlands or Channel Altered Delta ecoregion fisheries community.

26) Perhaps the most significant species not to be collect during this survey was the gravel chub, *Erimystax x-punctata*. However, possible first time records include the silver redhorse, *Moxostoma anisurum*, the river redhorse, *Moxostoma carinatum*, the shorthead redhorse, *Moxostoma macrolepidotum*, the red spotted sunfish, *Lepomis miniatus*, and the mud darter, *Etheostoma asprigene.* In addition, two additional darter species with limited White River drainage records were collected to better substantiate their presence in the Strawberry River. They were the slenderhead darter, *Percina phoxocephala*, and the cypress darter, *Etheostoma proeliare.*

27) Most of the fish communities in the transition zone between the Ozark Highlands ecoregion and the Delta Ecoregion were scored as only generally supporting instead of fully supporting. This is because the current assessment tools are not equipped to take into account the multiple influences fish communities received in such areas.

28) The tributaries of the watershed that are located in the Ozark Highlands ecoregion all demonstrated slight differences from the communities of the least-disturbed Ozark Highlands ecoregion communities. These differences included a significantly lower percent community composition of cyprinids and catfishes, a greater percent community composition of sunfishes and darters, and a diversity index that was more than one standard deviation higher than typical ecoregion communities.

29) There were 190 stream bank totaling 18.71 miles in the watershed identified as being unstable. There were 151 sites identified on the main stem of the Strawberry River, 29 on North Big Creek, four on Piney Fork Creek, and five sites on South Big Creek.

30) The stream bank surveyed east of Evening Shade demonstrated that this stream bank does not erode along the entire length of the exposed surface at an equal rate, but erodes in sections along the bank. Total soil loss at the site was estimated to be 192 cubic yards annually.

Table C-1 – List of Waters Impaired by Turbidity

Stream Name	Hydrologic Unit Code	Reach	Station Name	Impaired Use	Cause
Strawberry River	11010012	-011	WHI0143A, UWSBR01	Aquatic Life	Turbidity
Little Strawberry	11010012	-010	WHI0143E, WHI0143H	Aquatic Life	Turbidity
Strawberry River	11010012	-009	WHI0143B, UWSBR02	Aquatic Life	Turbidity
Strawberry River	11010012	-008	UWSBR02	Aquatic Life	Turbidity
Strawberry River	11010012	-006	WHI0024	Aquatic Life	Turbidity
Strawberry River	11010012	-005	WHI0024	Aquatic Life	Turbidity
Strawberry River	11010012	-004	WHI0024	Aquatic Life	Turbidity
Probable Sources: unpaved county roads; eroding stream banks, un-improved pastures					

Table C-2 – List of Waters Impaired by Bacteria

Stream Name	Hydrologic Unit Code	Reach	Station Name	Impaired Use	Cause
Strawberry River	11010012	-011	WHI0143A, UWSBR01	Primary Contact	Bacteria
Little Strawberry	11010012	-010	WHI0143E, WHI0143H	Primary Contact	Bacteria
Strawberry River	11010012	-009	WHI0143B, UWSBR02	Primary Contact	Bacteria
Strawberry River	11010012	-008	UWSBR02	Primary Contact	Bacteria
Mill Creek	11010012	-016	WHI0143N	Primary Contact	Bacteria
Cooper Creek	11010012	-003	WHI0143S	Primary Contact	Bacteria
Reed's Creek	11010012	-014	UWRDC01	Primary Contact	Bacteria
Caney Creek	11010012	-015	WHI0143Q, WHI0143R	Primary Contact	Bacteria
Probable Sources: storm water runoff from adjacent pastures and confined animal operations					

This page intentionally left blank.

RECOMMENDATIONS

Turbidity concentrations in the watershed need to be reduced to protect the Rivers' aquatic life designated use. Nutrient concentrations where cattle have direct access to the river and where runoff from pastures can enter directly into the river need to be reduced. In addition, fecal coliform bacteria concentrations in the watershed need to be reduced to protect the River's primary contact recreation designate use.

Best management practices to control sediment and reduce turbidity concentrations need to be developed for the upper portion of the watershed and in Piney Fork Creek, South Big Creek, and Reed's Creek. Practices addressing runoff from county roads, pasture, row crop agriculture, silviculture activities, and construction activities should be implemented. In addition, a watershed plan to address the numerous eroding stream banks needs to be developed and implemented.

Best management practices to reduce nutrient rich runoff from entering the Strawberry River and its tributaries should be implemented. These practices should be targeted in the upper portion of the watershed as well as in South Big Creek, Reed's Creek, Piney Fork Creek, Mill Creek, and the areas adjacent to the river in Izard and Sharp counties. Best management practices to control pasture runoff, cattle access, and to reduce the runoff of chicken litter from the time it is removed from the house to the time it is spread on the pasture need to be implemented.

Fecal coliform bacteria in the watershed need to be reduced to protect the primary contact recreation use in the watershed. Best management practices to reduce runoff from pastures need to be implemented. In addition, proper operation and maintenance of the dairy farms and proper storage and application of chicken litter needs to be attained.

Developing an overall watershed restoration action strategy plan for the Strawberry River watershed should also be accomplished. This plan should outline the problems of the watershed and list the tools needed to correct the problems. It should also have a time line for implementation of the plan and the responsibilities of the individual entities involved in the plan.

This page intentionally left blank.

REFERENCES

Adamski, J. C. 1997. Nutrients and Pesticides in Ground Water of the Ozark Plateaus in Arknasas, Kansas, Missouri, and Oklahoma. U.S. Geologic Survey, Water Resources Investigations Report 96-4313, Little Rock, AR. 28p.

Adamski, J. C., Peterson, J. C., Freiwald, D. A. and Davis, J. V. 1995. Environmental and Hydrologic setting of the Ozark Plateaus Study Unit, Arkansas Kansas, Missouri, and Oklahoma. U.S. Geologic Survey, Water-Resources Investigation Report 94-4022, Little Rock, AR. 69p.

Arkansas Department of Pollution Control and Ecology, 1987. Physical, Chemical, and Biological Characteristics of Least-Disturbed Reference Streams in Arkansas' Ecoregions. Volume II, Data Analysis. 148 pp.

----------1998. Water Quality Inventory Report. 376 pp.

----------2000. Water Quality Inventory Report. 376 pp.

----------October, 2002. Regulation No. 2, As Amended. Regulation Establishing Water Quality Standards for Surface Waters of the State of Arkansas.

----------2003. Comparison of 100-organism vs. 300-organism sub-sampling for use with ADEQ's aquatic macroinvertebrate methodology. Unpubl. Report WQ03-02-01. Arkansas Department of Environmental Quality. Little Rock, Arkansas.

---------In Preparation. Assessment framework for Arkansas' small watersheds using aquatic macroinvertebrates. Arkansas Department of Environmental Quality. Little Rock, Arkansas.

Arkansas Geologic Commission, 1998. Stratographic Summary of Arkansas. Extracted with minor revisions from Arkansas Geologic Commission Information Circular Number 36. Compiled by John D. McFarland.

Armour, C.L., D.A. Duff and W. Elmore. 1991. The effects of livestock grazing on riparian and streamecosystems. Fisheries (*Bethesda*). 16:7-11.

Austin, A. Y. and Steele, K. F. 1990. Nitrate Contamination of Ground Water in Northern Madison County, Arkansas. Arkansas Water Resources Center Misc. Pub. No. 74, Fayetteville, AR. 58p.

Barbour, M.T., J. Gerritsen, G.E. Griffith, R. Frydenborg, E. M^{c}Carron, J.S. White, and M.L. Bastian. 1996. A famework for biological criteria for Florida streams using benthic macroinvertebrates. J.N. Am. Benthol. Soc. 15(2):185-211.

Barbour, M.T., Gerritsen, J., Snyder, B.D., Stribling, J.B., 1999. Rapid Bioassessment Protocols for Use In Streams and Wadable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish. 2nd Edition. EPA 841-B-99-002.

Bunn, S.E. and P.M. Davies. 2000. Biological processes in running waters and their implications for the assessment of ecological integrity. *Hydrobiologia*. 422/423:61-70.

Bunn, S.E., D.H. Edward and N.R. Loneragan. 1986. Spatial and temporal variation in the macroinvertebrate fauna of streams of the northern Jarrah Forest, Western Australia: community structure. *Freshwater Biology*. 16:67-92.

Davis, R. K., Brahana J. V. and Johnson, J. S. 2000. Ground Water in Northwest Madison Arkansas: Minimizing Nutrient Contamination from Non-Point Sources in Karst Terrane. Arkansas Water Resources Center MSC-288, Fayetteville, AR. 69p.

DeShon, J.E. 1995. Development and application of the invertebrate community index (ICI). Pages 217-244 in W. S. Davis and T. P. Simon (editors). Biological assessment and criteria: tools for water resource planning and decision making. Lewis Publishers, Boca Raton, Florida.

Doll, W.L., Meyer, G. and Archer, R.J. 1963. Water Resources of West Virginia: West Virginia Department of Natural Resources, Division of Water Resources. 134 p.

ESRI, ArkView 8.0. 2001. GIS mapping technologies. 380 New York Street, Redlands, CA.

Glick, E.E., 1971a, Geologic map of the Ash Flat quadrangle: Arkansas Geological Commission Open-File Report, Little Rock, Arkansas, scale 1:24,000.

---------- 1971b, Geologic map of the Evening Shade quadrangle: Arkansas Geological Commission Open-File Report, Little Rock, Arkansas, scale 1:24,000.

---------- 1971c, Geologic map of the Myron quadrangle: Arkansas Geological Commission Open-File Report, Little Rock, Arkansas, scale 1:24,000.

---------- 1971d, Geologic map of the Sidney quadrangle: Arkansas Geological Commission Open-File Report, Little Rock, Arkansas, scale 1:24,000.

---------- 1971e, Geologic map of the Sitka quadrangle: Arkansas Geological Commission Open-File Report, Little Rock, Arkansas, scale 1:24,000.

---------- 1972a, Geologic map of the Agnos quadrangle: Arkansas Geological Commission Open-File Report, Little Rock, Arkansas, scale 1:24,000.

---------- 1972b, Geologic map of the Cave City quadrangle: Arkansas Geological Commission Open-File Report, Little Rock, Arkansas, scale 1:24,000.

---------- 1972c, Geologic map of the Melbourne quadrangle: Arkansas Geological Commission Open-File Report, Little Rock, Arkansas, scale 1:62,500.

---------- 1972d, Geologic map of the Poughkeepsie quadrangle: Arkansas Geological Commission Open-File Report, Little Rock, Arkansas, scale 1:24,000.

---------- 1972e, Geologic map of the Ravenden quadrangle: Arkansas Geological Commission Open-File Report, Little Rock, Arkansas, scale 1:24,000.

---------- 1972f, Geologic map of the Salem quadrangle: Arkansas Geological Commission Open-File Report, Little Rock, Arkansas, scale 1:62,500.

---------- 1972g, Geologic map of the Smithville quadrangle: Arkansas Geological Commission Open-File Report, Little Rock, Arkansas, scale 1:24,000.

---------- 1973a, Geologic map of the Grange quadrangle: Arkansas Geological Commission Open-File Report, Little Rock, Arkansas, scale 1:24,000.

---------- 1973b, Geologic map of the Strawberry quadrangle: Arkansas Geological Commission Open-File Report, Little Rock, Arkansas, scale 1:24,000.

---------- 1974, Geologic map of the Stuart quadrangle: Arkansas Geological Commission Open-File Report, Little Rock, Arkansas, scale 1:24,000.

Halberg, H. N. 1977. Use of Water in Arkansas, 1975. Arkansas Geologic Commission, Water Resources Summary Number 9, Little Rock, AR. 28P.

---------- 1972. Use of Water in Arkansas, 1970. Arkansas Geologic Commission, Water Resources Summary Number 7, Little Rock, AR. 17P.

Halberg, H. N., Stephens, J. W. 1966. Use of Water in Arkansas, 1965. Arkansas Geologic Commission, Water Resources Summary Number 5, Little Rock, AR. 12P.

Haley, B. R., Glick, E. E., Bush, W. V., Clardy, B. F., Stone, C. G. Woodward, M. B., and Zachry, D. L., 1993. Geologic Map of Arkansas and Associated Geologic Quad Maps. U. S. Geologic Survey and the Arkansas Geologic Commission, Little Rock, AR.

Harvey, E. J. 1980. Ground Water in the Springfield Plateaus of Southern Missouri and Northern Arkansas. U.S. Geologic Survey, Water-Resources Investigations 80-101. Rolla, MO. 66p.

Henley, W.F., M.A. Patterson, R.J. Neves and A.D. Lemly. 2000. Effects of sedimentation and turbidity on lotic food webs; a concise review for natural resource managers. *Review in Fisheries Science.* 8(2):125-139.

Hem, J.D. 1989. Study and Interpretation of the Chemical Characteristics of Natural Water. U.S. Geological Survey, Water-Supply Paper 2254, Third Edition. 263 p.

Holland, T.W. 1999. Water Use in Arkansas, 1995. U.S. Geological Survey, Open-File Report 99-188. One page map report.

---------- 1993. Use of Water in Arkansas, 1990. U.S. Geological Survey, Open-File Report 93-48. One page pamphlet report.

---------- 1987. Use of Water in Arkansas, 1985. Arkansas Geological Commission, Water Resources Summary Number 16, Little Rock, AR. 25p.

Holland, T.W., and Ludwig, A.H. 1981. Use of Water in Arkansas, 1980. Arkansas Geological Commission, Water Resources Summary Number 14, Little Rock, AR. 30p.

Huetter, T.A., Van Schaik, E.J., and Kresse, T.M. 1997. Report on the Third Sampling of the Omaha Monitoring Area. Arkansas Department of Pollution Control and Ecology WQ97-06-03. Little Rock, AR. 44p.

Imes, J.L. and Emmett, L.F. 1994. Geohydrology of the Ozark Plateaus Aquifer System in Parts of Missouri, Arkansas, Oklahoma and Kansas. U.S. Geologic Survey, Professional Paper 1414-D, 127p.

Koplin, D.W., Furlong, E.T., Meyer, M.T., Thurman, E.M., Zaugg, S.D., Barber, L.B. and Buxton, H.T. 2002. Pharmaceuticals, Hormones, and Other Organic Wastewater Contaminants in U. S. Streams, 1999-2000: A National Reconnaissance, Eviron. Sci. Technol., Vol 36, No. 6, 1202-1211.

Kresse, T.M. and Fazio, J.A. 2003. Occurrence of Arsenic in Ground Waters of Arkansas and Implications for Source ad Release Mechanisms. Arkansas Department of Environmental Quality, Water Quality Report WQ03-03-01, Little Rock, AR. 35p.

---------- 2002. Pesticides, Water Quality and Geochemical Evolution of Ground Water in the Alluvial Aquifer, Bayou Bartholomew Watershed, Arkansas. Arkanssas Department of Environmental Quality, Water Quality Report WQ02-05-01, Little Rock, AR. 111p.

Kresse, T.M., Van Schaik, E.J., Wise, J. and Huetter, T. 1997. Occurrence of Pesticides in Alluvial Aquifer of Eastern Arkansas. Arkansas Department of Pollution Control and Ecology, Water Quality Report WQ97-10-1, Little Rock, AR. 39 p.

Lamonds, A. G., 1972. Water-Resources Reconnaissance of the Ozark Plateaus Province, Northern Arkansas. U.S. Geologic Survey, Hydrologic Investigations Atlas HA-383.

Leidy, V.A. and Morris, E.E. 1990. Hydrogeology and Quality of Ground Water in the Boone Formation and Cotter Dolomite in Karst Terrain of Northwestern Boone County, Arkansas. U.S. Geological Survey, Water-Resources Investigations Report 90-4066, Little Rock, AR. 57p.

Maxted, J.R., M.T. Barbour, J. Gerritsen, V. Poretti, N. Primrose, A. Silvia, D. Penrose and R. Renfrow. 2000. Assessment framework for mid-atlantic coastal plain streams using benthic macroinvertebrates. J.N. Am. Benthol. Soc. 19(1):128-144.

Meister, R.T. 1996. Farm Chemicals Handbook '96. Meister Publishing Company, Willoughby, OH. Section C, Pesticide Dictionary, 417 p.

McFarland, J.D., 1998, Stratigraphic summary of Arkansas: Arkansas Geological Commission Information Circular 36, Little Rock, Arkansas, 39 p.

McKnight, E.T. 1935. Zinc and Lead Deposits of Northern Arkansas. U.S. Geologic Survey, Bulletin 853. 311p.

Peterson, E.W., Davis, R.K., Brahana, J.V. and Orndorff, H.A. 2002. Movement of Nitrate Through Regolith Covered Karst Terrane, Northwest Arkansas. Journal of Hydrology, 256 (2002) p. 35-47. Elsevier Science B.V.

Plafkin, J.L., M.T. Barbour, K.D. Porter, S.K. Gross and R.M. Hughes. 1989. Rapid bioassessment protocols for use in streams and rivers. Benthic macroinvertebrates and fish. EPA/444/4-89/001, Office of Water Regulations and Standards, U.S.E.P.A., Washington, DC. 162 pp.

Prior, W.L., Howard, J.M., McFarland, J.D., and Hill, S.S. 1999. Roubidoux Formation and Gunter Sandstone Member of the Gasconade Fromation, Major Aquifers in Northern Arkansa. Arkansas Geologic Commission, Water Resources Circular No. 17, Little Rock, AR. 45 p.

Rosgen, D. and H. L. Silvey. 1996. Applied River Morphology. Wildland Hydrology.

Robinson, H. W., Buchanan, T. M. 1992. Fishes Of Arkansas. The University of Arkansas Press, Fayetteville, Arkansas. 536 pp.

Schrader, T. P. 2001. Potentiometric Surface of the Ozark Aquifer in Northern Arkansas, 2001. U.S. Geologic Survey, Water-Resources Investigations Report 01-4233, Little Rock, AR. 11 p.

Smith, C.R. and Steele, K.F. 1990. Nitrate Contamination of Ground Water in Benton County, Arkansas. Arkansas Water Resources Center, Misc. Pub. No. 73, Fayetteville, AR. 48 p.

Steele, K.F. and McCalister, W.K. 1990. Nitrate Contamination of Ground Water from Limestone and Dolomite Aquifers in the Northeastern Washington County Area, Arkansas. Arkansas Water Resources Center Misc. Pub. No. 88, Fayetteville, AR. 33 p.

Steele, K.F. and Adamski, J.C. 1987. Landuse Effects on Ground-Water Quality in Carbonate Terrain. Arkansas Water Resources Center Pub. No. 129, Fayetteville, AR. 71 p.

Stephens, J.W. and Halberg, H.N. 1961. Use of Water in Arksnsas, 1960. Arkansas Geologic Commission, Special Ground-Water Report Number 4, Little Rock, AR. 8 p.

Tucker, M.E. 1982. Sedimentary Petrology, An Introduction. John Wiley and Sons, Inc., New York, 252 p.

United States Department of Agriculture, Cooperative Extension Service. 1996. *EXTOXNET.* Internet Pesticide Information Project of Cornell, Michigan State, Oregon State and University of California Universities. http://ace.ace.orst.edu/info/extoxnet/pips/ghindex.html

Wauchope, R.D. 1988. *Pesticides Properties Data Base. Version 1.0,* USDA SCS/ARS, Tifton, Georgia.

APPENDIX CAO-1

List of confined animal operations in the Strawberry River watershed, Arkansas.
2001 - 2003

List of dairies in the Strawberry River watershed, Arkasas.
2001 - 2003

ID	County	Cows	Lat (DD)	Long (DD)	STR	HUC	Reach	Tributary	Main Creek	Location
1	Fulton	<100	36.364589	-91.981553	Sec 30, T20N, R9W	11010006	-011	Big Creek	Norfork Lake	2.0 mi. S. of Viola, 0.5 mi. E. of Hwy 223
2	Fulton	<100	36.315544	-91.957160	Sec 16, T19N, R9W	11010012	-011t	Unnamed	Upper Strawberry River	3.1 mi. E. of Hwy 223 south of Hwy 395, @ Byron
3	Fulton	<100	36.325278	-91.803611	Sec 10, T19N, R8W	11010012	-010t	Unnamed	Little Strawberry River	2.5 miles south of Hwy 62 on Twin Silo Rd
4	Fulton	<100	36.301378	-91.845483	Sec 16, T19N, R8W	11010012	-010t	Raney Branch	Little Strawberry	S. of Wheeling Rd. 1.3 mi. E of Hwy 9 at Wheeling
5	Fulton	>100	36.279903	-91.753652	Sec 29, T19N, R7W	11010012	-010t	Hubble Branch	Little Strawberry	1.25 mi. S. of Glencoe on Hwy 289
6	Fulton	<100	36.276067	-91.747869	Sec 29, T19N, R7W	11010012	-010t	Hubble Branch	Little Strawberry	1.5 mi. S. of Glencoe on Hwy 289
7	Fulton	<100	36.290000	-91.694167	Sec 23, T19N, R7W	11010010	-017	Lick Creek	South Fork Spring River	1 mile N. of Hwy. 62 at Agnos
8	Fulton	<100	36.318056	-91.725278	Sec 10, T19N, R7W	11010012	-017	Lick Creek	South Fork Spring River	2.25 miles N. of Hwy. 62 at Glencoe
9	Fulton	<100	36.320278	-91.706944	Sec 11, T19N, R7W	11010012	-017	Lick Creek	South Fork Spring River	1 mile east of Heart N. of Hwy 62
10	Izard	<100	36.228056	-91.866389	Sec 8, T18N, R8W	11010012	-011	Unnamed	Upper Strawberry River	South of Hwy. 354, 4miles E. of Oxford
11	Izard	<100	36.173333	-91.732778	Sec 33, T18N, R7W	11010012	-011	Unnamed	Upper Strawberry River	South of Hwy. 56, 2 miles E. of Franklin
12	Izard	<100	36.233028	-91.924269	Sec 11, T18N, R9W	11010012	-011	Unnamed	Upper Strawberry River	1.0 mi. N. of Hwy. 354 on Hwy 9, N. of Oxford
13	Izard	<100	36.235444	-91.879422	Sec 7, T18N, R8W	11010012	-011	Unnamed	Upper Strawberry River	0.5 mi. N. of Hwy 354, 3.0 mi. E. of Hwy 9 near Oxfor
14	Izard	<100	36.197186	-91.898408	Sec 25, T18N, R9W	11010012	-011t	Sandy Creek	Upper Strawberry River	1.75 mi. E. of Hwy 9 on Co. Rd. 2.0 mi. S. of Hwy 354
15	Izard	>100	36.187928	-91.824278	Sec 27, T18N, R8W	11010012	-011t	Unnamed	Upper Strawberry River	2.0 mi. N. on Co. Rd. off Hwy 56 N. of Violet Hill
16	Izard	<100	36.058889	-91.835278	Sec 10, T17N, R8W	11010004	-012	Piney Fork	Strawberry River	End of Co. Rd. 1.5 miles S. of Violet Hill
17	Izard	>100	35.989722	-91.744722	Sec 33, T16N, R7W	11010004	-003	Poke Bayou	White River	2 miles S. of Hwy 58 near Mount Pleasant
18	Sharp	<100	35.958715	-91.609253	Sec 10, T15N, R6W	11010004	-003	Poke Bayou	White River	1874 west of Cave City

List of poultry farms in the Strawberry River watershed, Arkansas.
2001 - 2003

ID	County	Houses	Lat (DD)	Long (DD)	STR	HUC	Reach	Tributary	Main Creek	Location
48	Sharp	4	36.126524	-91.412875	Sec 16, T17N, R4W	11010012	-016	Mill Creek	Mill Creek	Mill Creek Road
49	Sharp	2	36.147992	-91.408644	Sec 4, T17N, R4W	11010012	-016	Mill Creek	Mill Creek	Mill Creek Road
50	Lawrence	4	35.905425	-91.296633	Sec 34, T15N, R3W	11010012	-015	Caney Creek	Caney Creek	West of Hwy 25 south of Strawberry
51	Lawrence	4	35.905074	-91.292994	Sec 34, T15N, R3W	11010012	-015	Caney Creek	Caney Creek	West of Hwy 25 south of Strawberry
52	Lawrence	2	35.905200	-91.276511	Sec 35, T15N, R3W	11010012	-015	Caney Creek	Caney Creek	East of Hwy 25, south of Strawberry
54	Lawrence	3	35.927025	-91.317026	Sec 21, T15N, R3W	11010012	-015	Caney Creek	Caney Creek	On Co. Rd. 333, south of Strawberry
57	Lawrence	2	35.915493	-91.319270	Sec 28, T15N, R3W	11010012	-015	Caney Creek	Caney Creek	On Co. Rd. 333, south of Strawberry
75	Sharp	1	35.928835	-91.412059	Sec 21, T15N, R4W	11010012	-015	Caney Creek	Caney Creek	S. of Hwy 230 on Co. Rd. E. of Aetna
76	Sharp	3	35.935516	-91.416308	Sec 16, T15N, R4W	11010012	-014	Reeds Creek	Reeds Creek	N. of Hwy 230 1.75 E. of Aetna
77	Sharp	7	35.935553	-91.419011	Sec 16, T15N, R4W	11010012	-014	Reeds Creek	Reeds Creek	S. of Hwy 230 1.75 E. of Aetna
78	Sharp	5	35.936143	-91.429904	Sec 17, T15N, R4W	11010012	-014	Reeds Creek	Reeds Creek	Hwy 230 1.0 mi. E. of Aetna
79	Sharp	2	35.937448	-91.477320	Sec 13, T15N, R5W	11010012	-014	Reeds Creek	Reeds Creek	Hwy 230 4 mi. E. of Cave City
80	Sharp	3	35.937125	-91.486405	Sec 14, T15N, R5W	11010012	-014	Reeds Creek	Reeds Creek	Grange Rd. 3.0 mi. E. of Cave City
81	Sharp	3	35.947521	-91.491638	Sec 14, T15N, R5W	11010012	-014	Reeds Creek	Reeds Creek	Grange Rd. 3.0 mi. E. of Cave City
82	Sharp	3	35.942165	-91.497026	Sec 14, T15N, R5W	11010012	-014	Reeds Creek	Reeds Creek	Hwy 230, 2.5 mi. E. of Cave City
83	Sharp	2	35.975148	-91.480275	Sec 2, T15N, R5W	11010012	-014	Reeds Creek	Reeds Creek	S. Fairview Rd N. of Hwy 230
87	Sharp	2	35.987789	-91.412820	Sec 6, T15N, R4W	11010012	-014	Reeds Creek	Reeds Creek	Grange Rd. W. of Grange
88	Sharp	1	35.987837	-91.412793	Sec 33, T16N, R4W	11010012	-014	Reeds Creek	Reeds Creek	Calamine Rd NE of Grange
89	Sharp	2	35.980516	-91.427655	Sec 32, T16N, R4W	11010012	-014	Reeds Creek	Reeds Creek	Co. Rd. NW of Grange
90	Sharp	3	35.974336	-91.448566	Sec 6, T15N, R4W	11010012	-014	Reeds Creek	Reeds Creek	Grange Rd. W. of Gramge
91	Sharp	2	35.976415	-91.417423	Sec 4, T15N, R4W	11010012	-014	Reeds Creek	Reeds Creek	Calamine Rd. W. of Grange
92	Sharp	2	35.966097	-91.441413	Sec 8, T15N, R4W	11010012	-014	Reeds Creek	Reeds Creek	Aetna Rd. N. of Aetna
93	Sharp	2	35.976750	-91.413249	Sec 4, T15N, R4W	11010012	-014	Reeds Creek	Reeds Creek	Calamine Rd. W. of Grange
94	Sharp	2	35.966240	-91.387927	Sec 2, T15N, R4W	11010012	-014	Reeds Creek	Reeds Creek	Calamine Rd. N. of Ark 230
95	Sharp	2	35.967712	-91.372504	Sec 12, T15N, R4W	11010012	-014	Reeds Creek	Reeds Creek	Co. Rd. N. of Hwy 230 W. of Strawberry
97	Sharp	2	35.948405	-91.447075	Sec 18, T15N, R4W	11010012	-014	Reeds Creek	Reeds Creek	Aetna Rd. N. of Aetna
98	Sharp	2	35.974626	-91.417024	Sec 4, T15N, R4W	11010012	-014	Reeds Creek	Reeds Creek	Grange Rd. S. of Grange
46	Sharp	6	36.034083	-91.501502	Sec 15, T16N, R5W	11010012	-013	South Big Creek	South Big Creek	
47	Sharp	3	36.049975	-91.478949	Sec 12, T16N R5W	11010012	-013	South Big Creek	South Big Creek	Hwy 58, 2 mi. S. of Poughkeepsie
58	Sharp	5	36.007194	-91.374726	Sec 26, T16N, R4W	11010012	-013	South Big Creek	South Big Creek	
59	Sharp	3	36.010276	-91.427360	Sec 21, T16N, R4W	11010012	-013	South Big Creek	South Big Creek	On Hwy. 115, west of Calamine
60	Sharp	3	36.014449	-91.395602	Sec 22, T16N, R4W	11010012	-013	South Big Creek	South Big Creek	On Hwy 115, east of Calamine

List of poultry farms in the Strawberry River watershed, Arkansas.
2001 - 2003

ID	County	Houses	Lat (DD)	Long (DD)	STR	HUC	Reach	Tributary	Main Creek	Location
61	Sharp	3	36.023732	-91.382690	Sec 23, T16N, R4W	11010012	-013	South Big Creek	South Big Creek	Off Hwy. 115, east of Calamine
69	Sharp	2	36.042784	-91.395794	Sec 10, T16N, R4W	11010012	-013	South Big Creek	South Big Creek	Off Nelsonville Road North of Calamine
84	Lawrence	4	36.029693	-91.339367	Sec 17, T16N, R3W	11010012	-013	South Big Creek	South Big Creek	Hwy 115 near Hwy 25 intc
85	Lawrence	2	36.023333	-91.350620	Sec 19, T16N, R3W	11010012	-013	South Big Creek	South Big Creek	Hwy 115 west of Hwy 25 intc
86	Sharp	1	36.017051	-91.389297	Sec 22, T16N, R4W	11010012	-013	South Big Creek	South Big Creek	Hwy 115 NE of Calamine
3	Izard	3	36.046596	-91.831938	Sec 10, T16N, R8W	11010012	-012	Caney Creek	Piney Fork Creek	N. side Hwy 69, 1.0 mi. W. of Sage
4	Izard	4	36.059092	-91.835754	Sec 3, T16N, R8W	11010012	-012	Caney Creek	Piney Fork Creek	Izard County Fair Grounds Road
5	Izard	4	36.156903	-91.838815	Sec 3, T17N, R8W	11010012	-012	Little Piney Creek	Piney Fork Creek	S. of Hwy 56 in Violet Hill
7	Sharp	3	36.006985	-91.651644	Sec 29, T16N, R6W	11010012	-012	Piney Fork Creek	Piney Fork Creek	Brown St. 688
8	Sharp	2	36.004295	-91.630076	Sec 28, T16D, R6W	11010012	-012	Piney Fork Creek	Piney Fork Creek	Brown St.
9	Sharp	1	36.002906	-91.612121	Sec 27, T16N, R6W	11010012	-012	Piney Fork Creek	Piney Fork Creek	
25	Sharp	1	36.027987	-91.641800	Sec 20, T16N, R6W	11010012	-012	Piney Fork		Box 611 Northeast of Sydney
26	Sharp	4	36.066442	-91.661467	Sec 6, T16N, R6W	11010012	-012	Piney Fork		
28	Izard	5	36.036297	-91.804566	Sec 13, T16N, R8W	11010012	-012	Piney Fork	Piney Fork	Sage, L. of Sage
29	Izard	3	36.052478	-91.763589	Sec 8, T16N, R7W	11010012	-012	Piney Fork	Piney Fork	1mile N of Boone town
30	Izard	2	36.049390	-91.691829	Sec 12, T16N, R7W	11010012	-012	Piney Fork	Piney Fork	off Needmore Rd.
31	Izard	2	36.040813	-91.693308	Sec 13, T16N, R7W	11010012	-012	Piney Fork	Piney Fork	off Needmore Rd.
32	Izard	2	36.040606	-91.694944	Sec 13, T16N, R7W	11010012	-012	Piney Fork	Piney Fork	off Needmore Rd.
33	Izard	2	36.019027	-91.704485	Sec 23, T16N, R7W	11010012	-012	Piney Fork	Piney Fork	highway 58 box 239
34	Sharp	2	36.010920	-91.681334	Sec 30, T16N, R6W	11010012	-012	Piney Fork	Piney Fork	
35	Sharp	2	36.014929	-91.673385	Sec 30, T16N, R6W	11010012	-012	Piney Fork	Piney Fork	Sidney Ar,
36	Sharp	1	36.014206	-91.669237	Sec 30, T16N, R6W	11010012	-012	Piney Fork	Piney Fork	
37	Sharp	2	36.012977	-91.666032	Sec 30, T16N, R6W	11010012	-012	Piney Fork	Piney Fork	Birdcreek Rd.
38	Sharp	2	36.012979	-91.665225	Sec 29, T16N, R6W	11010012	-012	Piney Fork	Piney Fork	Box 184 Birdcreek Rd. Sidney
39	Izard	2	36.020961	-91.801153	Sec 24, T16N, R8W	11010012	-012	Piney Fork	Piney Fork	Hc89 Box 526, off highway 58
40	Sharp	2	36.004394	-91.679924	Sec 30, T16N, R6W	11010012	-012	Piney Fork	Piney Fork	Shrew Cemetry rd. S. of Sidney
41	Izard	4	36.097740	-91.754199	Sec 29, T17N, R7W	11010012	-012	Piney Fork	Piney Fork	Hwy289 NE of Zion
1	Izard	2	36.178992	-91.854808	Sec 33, T18N, R8W	11010012	-011	Unnamed	Strawberry River	1.75 mi. N. on Co. Rd. N. of Violet Hill
2	Izard	2	36.192692	-91.787792	Sec 25, T18N, R8W	11010012	-009	Unnamed	Strawberry River	1.5 mi. N. of Hwy 56, N. of Franklin
6	Izard	5	36.106906	-91.732786	Sec 22, T17N, R7W	11010012	-009	Bear Creek	Strawberry River	Co. Rd. 67, 3.2 mi. N. of Zion
43	Sharp	2	36.012124	-91.566148	Sec 19, T16N, R5W	11010012	-006	Strawberry River	Strawberry River	West Red Barn Road
44	Sharp	2	36.017166	-91.537282	Sec 18, T16N, R5W	11010012	-006	Strawberry River	Strawberry River	East Red Barn Road

List of poultry farms in the Strawberry River watershed, Arkansas.
2001 - 2003

ID	County	Houses	Lat (DD)	Long (DD)	STR	HUC	Reach	Tributary	Main Creek	Location
45	Sharp	2	36.042698	-91.560262	Sec 18, T16N, R5W	11010012	-006	Strawberry River	Strawberry River	East Red Barn Road
62	Sharp	3	36.041258	-91.366655	Sec 12, T16N R4W	11010012	-006	Strawberry River	Strawberry River	Off Bruce Road NE of Calamine
63	Sharp	4	36.042476	-91.367243	Sec 12, T16N R4W	11010012	-006	Strawberry River	Strawberry River	Off Bruce Road NE of Calamine
64	Sharp	6	36.042232	-91.360432	Sec 12, T16N R4W	11010012	-006	Strawberry River	Strawberry River	Off Bruce Road NE of Calamine
65	Sharp	3	36.047924	-91.354773	Sec 12, T16N R4W	11010012	-006	Strawberry River	Strawberry River	Off Bruce Road NE of Calamine
66	Sharp	4	36.054566	-91.353728	Sec 1, T16N, R4W	11010012	-006	Strawberry River	Strawberry River	Off Marvin Road NE of Calamine
67	Lawrence	4	36.056054	-91.341623	Sec 6, T16N, R3W	11010012	-006	Strawberry River	Strawberry River	Off Bruce Road NE of Calamine
68	Sharp	3	36.044612	-91.373376	Sec 11, T16N, R4W	11010012	-006	Strawberry River	Strawberry River	Off Marvin Road NE of Calamine
70	Sharp	2	36.070655	-91.401179	Sec 34, T17N, R4W	11010012	-006	Strawberry River	Strawberry River	Off Push Road east of Nelsonville
71	Sharp	3	36.030439	-91.395757	Sec 1, T16N, R4W	11010012	-006	Strawberry River	Strawberry River	Off Push Road east of Nelsonville
72	Sharp	3	36.063486	-91.414704	Sec 4, T17N, R4W	11010012	-006	Strawberry River	Strawberry River	Off Nelsonville Road East of Nelsonville
42	Izard	2	35.992451	-91.672241	Sec 31, T16N, R6W	11010004	-003	Poke Bayou	Poke Bayou	St. Paul Road south of Sidney
11	Sharp	2	35.994704	-91.657565	Sec 32, T16N, R6W	11010004	-003	Poke Bayou		Mt. Carmel Rd.
12	Sharp	2	35.993230	-91.657137	Sec 32, T16N, R6W	11010004	-003	Poke Bayou		Mt. Carmel Rd.
13	Sharp	1	35.987033	-91.652584	Sec 32, T16N, R6W	11010004	-003	Poke Bayou		225 Mt. Carmel Rd.
14	Sharp	4	35.977603	-91.621185	Sec 3, T15N, R6W	11010004	-003	Poke Bayou		Brickel Spring Rd.
15	Sharp	8	35.973198	-91.652810	Sec 8, T15N, R6W	11010004	-003	Poke Bayou		Mt. Carmel Rd.
16	Sharp	2	35.962152	-91.647211	Sec 8, T15N, R6W	11010004	-003	Poke Bayou		West Center St.2333
18	Sharp	2	35.961569	-91.641231	Sec 9, T15N, R6W	11010004	-003	Poke Bayou		West Center St.
19	Sharp	2	35.948409	-91.600205	Sec14, T15N, R6W	11010004	-003	Poke Bayou		
20	Sharp	4	35.996300	-91.653853	Sec 32, T16N, R6W	11010004	-003	Poke Bayou		
21	Sharp	8	35.988944	-91.647325	Sec 32, T16N, R6W	11010004	-003	Poke Bayou		6mi. South of Hamlet Spring Rd.
22	Sharp	3	35.994856	-91.660492	Sec 31, T16N, R6W	11010004	-003	Poke Bayou		Mt. Carmel Cemetery Ln.
23	Sharp	2	35.996844	-91.658053	Sec 32, T16N, R6W	11010004	-003	Poke Bayou		Mt.Carmel Rd.
24	Sharp	1	35.976242	-91.635508	Sec 4, T15N, R6W	11010004	-003	Poke Bayou		Hamlet Spring Rd.303
27	Izard	2	36.099305	-91.717879	Sec 26, T15N, R7W	11010004	-003	Poke Bayou		Rt1 Box 115
96	Lawrence	4	36.018854	-91.288848	Sec 22, T16N, R3W	11010012	-003	Cooper Creek	Cooper Creek	Co. Rd. 2 mi. W. of Lynn
53	Lawrence	4	35.952593	-91.314270	Sec 9, T15N, R3W	11010012	-002	Strawberry - Bank	Strawberry - Bank	East of Hwy 25, south of Strawberry
55	Lawrence	4	35.951002	-91.337986	Sec 7, T15N, R3W	11010012	-002	Unnamed	trib - Strawberry	On Co. Rd. 333, southeast of Strawberry
56	Lawrence	2	35.944332	-91.351467	Sec 18, T15N, R3W	11010012	-002	Unnamed	trib - Strawberry	On Co. Rd. 333, southeast of Strawberry
73	Lawrence	4	35.949178	-91.294421	Sec 15, T15N, R3W	11010012	-002	Strawberry River	Strawberry River	Co. Rd. 350
74	Lawrence	4	35.945968	-91.300099	Sec 15, T15N, R3W	11010012	-002	Strawberry River	Strawberry River	off Hwy 25 2.0 mi. S. of Hwy 230

APPENDIX GEO-1

Well and Spring Geologic Data, Strawberry River watershed, Arkansas.
2001 – 2003

Appendix GEO-1
Well and Spring Geologic Data

Site Number	Well/Spring	Surface Elevation	Well Depth	Well Bottom Elevation	Surface Geology	Surface Geology Lower Contact Elevation	Qal Penetrated Thickness	K Penetrated Thickness	Ospe Penetrated Thickness	Oe Penetrated Thickness	Opw Penetrated Thickness	Oc Penetrated Thickness	Ojc Penetrated Thickness	Quadrangle Map
FUL100	well	882	400	482	Oe	790				92	100	208		Salem - 15 minute
FUL101	well	745	280	465	Opw	720					25	255		Salem - 15 minute
FUL102	well	825	134	691	Opw	800					25	109		Salem - 15 minute
FUL103	well	900	142	758	Opw	800					100	42		Salem - 15 minute
FUL104	well	775	207	568	Opw	720					55	152		Salem - 15 minute
FUL105	well	830	175	655	Opw	800					30	145		Salem - 15 minute
FUL106	well	885	260	625	Oc	(Upper) 900						260		Salem - 15 minute
FUL107	spring	900	N/A	N/A	Opw	N/A								Salem - 15 minute
FUL108	well	900	284	616	Opw	860					40	244		Salem - 15 minute
IZA100	well	595	150	445	Ospe	300			150					Sidney - 7.5 minute
IZA101	well	645	147	498	Opw	(Upper) 710					147			Sidney - 7.5 minute
IZA102	well	805	105	700	Oe	780				25	80			Melbourne - 15 minute
IZA103	well	530	70	460	Opw	525					5	65		Myron - 7.5 minute
IZA104	well	555	600	-45	Opw	525					30	400	170	Myron - 7.5 minute
IZA105	well	765	230	535	Oe	710				55	175			Melbourne - 15 minute
IZA106	well	705	unk.	unk.	Oc	unk.								Melbourne - 15 minute
IZA107	spring	590	N/A	N/A	Oc	N/A								Melbourne - 15 minute
IZA108	well	690	263	427	Opw	680					10	253		Melbourne - 15 minute
IZA109	well	665	unk.	unk.	Oc	unk.								Melbourne - 15 minute
IZA110	well	665	107	558	Oc	(Upper) 680						107		Melbourne - 15 minute
LAW100	well	305	unk.	unk.	Oe	250								Smithville - 7.5 minute
LAW101	well	285	188	97	Oe	-150				188				Strawberry - 7.5 minute
LAW102	well	235	65	170	Qal	unk.	65							Alicia - 15 minute
LAW103	well	235	75	160	Qal	unk.	75							Alicia - 15 minute
LAW104	well	240	53	187	Qal	unk.	53							Strawberry - 7.5 minute
LAW105	well	234	57	177	Qal	unk.	57							Strawberry - 7.5 minute
LAW106	well	318	600	-282	K	250		68		>250	?	?		Strawberry - 7.5 minute
LAW107	well	280	400	-120	K	260		20		>260	?	?		Strawberry - 7.5 minute
LAW108	well	455	200	255	Opw	315					140	60		Smithville - 7.5 minute
LAW109	well	605	300	305	Oe	550				55	200	45		Ravenden - 7.5 minute
LAW110	well	605	80	525	Oe	560				45	35			Ravenden - 7.5 minute
LAW111	well	265	145	120	K	260		5		140				Strawberry - 7.5 minute
SHA100	well	720	188	532	Ospe	(Upper) 740			188					Cave City - 7.5 minute
SHA101	well	665	218	447	Opw	640					25	193		Ash Flat - 7.5 minute
SHA102	well	620	180	440	Oc	370						180		Ash Flat - 7.5 minute

Appendix GEO-1
Well and Spring Geologic Data

Site Number	Well/Spring	Surface Elevation	Well Depth	Well Bottom Elevation	Surface Geology	Surface Geology Lower Contact Elevation	Qal Penetrated Thickness	K Penetrated Thickness	Ospe Penetrated Thickness	Oe Penetrated Thickness	Opw Penetrated Thickness	Oc Penetrated Thickness	Ojc Penetrated Thickness	Quadrangle Map
SHA103	well	625	203	422	Oc	370						203		Myron - 7.5 minute
SHA104	well	640	220	420	Oc	330						220		Ash Flat - 7.5 minute
SHA105	well	710	165	545	Oc	450						165		Stuart - 7.5 minute
SHA106	well	385	173	212	Opw	300					85	88		Sitka - 7.5 minute
SHA107	well	385	293	92	Opw	355					30	263		Sitka - 7.5 minute
SHA108	well	505	150	355	Opw	300					150			Poughkeepsie - 7.5 minute
SHA109	well	445	188	257	Opw	220					188			Poughkeepsie - 7.5 minute
SHA110	well	530	unk.	unk.	Oe	440								Poughkeepsie - 7.5 minute
SHA111	well	475	134	341	Oe	355				120	14			Poughkeepsie - 7.5 minute
SHA112	well	320	278	42	Oe	225				95	183			Smithville - 7.5 minute
SHA113	well	470	70	400	Oe	unk.				70				Poughkeepsie - 7.5 minute
SHA114	spring	485	N/A	N/A	Oe	N/A								Poughkeepsie - 7.5 minute
SHA115	spring	360	N/A	N/A	Oe	N/A								Sitka - 7.5 minute
SHA116	spring	315	N/A	N/A	Oe	N/A								Poughkeepsie - 7.5 minute
SHA117	well	395	1900	-1505	Oe	unk.								Poughkeepsie - 7.5 minute
SHA118	well	460	1850	-1390	Oe	unk.								Poughkeepsie - 7.5 minute
SHA119	spring	438	N/A	N/A	Oe	N/A								Evening Shade - 7.5 minute
SHA120	well	660	308	352	Opw	460					200	108		Ash Flat - 7.5 minute
SHA121	well	575	288	287	Oc	270						288		Ash Flat - 7.5 minute
SHA122	well	620	293	327	Oc	345						275	18	Ash Flat - 7.5 minute
SHA123	well	710	263	447	Opw	705					5	258		Myron - 7.5 minute
SHA124	spring	460	N/A	N/A	Oe	N/A								Evening Shade - 7.5 minute
SHA125	well	725	218	507	Opw	540					185	33		Sitka - 7.5 minute
SHA126	well	465	158	307	Opw	450					15	143		Sitka - 7.5 minute
SHA127	spring	415	N/A	N/A	Oc	N/A								Sitka - 7.5 minute
SHA128	spring	455	N/A	N/A	Oe	N/A								Sitka - 7.5 minute
SHA129	well	415	115	300	K/Oe contac	300				115				Grange - 7.5 minute

Stratigraphic Units

Qal - Quaternary alluvium
K - Cretaceous rocks
Ospe - St. Peter Sandstone and Everton Formation (undifferentiated)
Oe - Everton Formation
Opw - Powell Dolomite
Oc - Cotter Dolomite
Ojc - Jefferson City Dolomite

APPENDIX WQ-1

Water quality data collected from the Strawberry River watershed, Arkansas.
2001 - 2003

Appendix WQ-1
Water quality data collected from the Strawberry River watershed, Arkansas.
2001 - 2003

Flow (cfs) — Station Number (WHI****)

Date	143A	SBR01	143E	143H	143B	SBR02	143L	143M	143I	NBC01	143P	143N	WHI024	143K	143J	143S	RDC01	SBR03	143Q	143R	WWTP
01/03/19	6.5	12.6	6.8	1.2	207.0	232.0	20.8	40.0	8.6	35.0	367.0	15.3	480.0	18.3	43.9	31.8	34.6	343.0	13.4	15.5	
01/05/01	1.4	6.7	<1.0	0.7	26.6	27.9	5.0	20.0	2.2	14.8	83.2	4.9	80.0	8.9	21.7	6.0		206.0	4.7	8.6	
01/06/19	<1.0	3.1	<1.0	0.2	17.2	15.1	0.8	13.0	0.3	14.8	46.2	0.5	22.4	7.5	18.0	7.5	12.8	168.0	2.6	5.1	0.17
01/08/27	0.0	6.1	0.0	0.1	26.6	27.4	0.4	3.0	0.0	7.8		0.1	5.7	3.9	12.9	<1.0	84.6	135.0	2.2	2.8	0.19
01/11/06	0.0	7.6	0.0	0.2	11.3	12.1	0.4	65.0	0.3	8.9	59.6	12.0	38.3	5.3	24.5	10.5	28.9	171.0	4.2	10.0	0.26
02/01/22	2.2	6.9	2.6	2.1	26.6	45.9	12.8	31.0	5.3	13.0	6690.0	10.9	240.0	7.3	61.7	16.6	23.4	281.0	8.1	10.6	1.05
02/01/24	156.7	610.0	153.4	300.0	2780.0	5530.0	UM	475.0	92.0	25.6	4430.0	71.0	4580.0					7420.0	44.8	154.5	
02/03/12		459.0		243.0	1100.0	2320.0		535.0	79.4	269.0	1330.0	50.4	3380.0	104.3				7590.0			
02/04/08		1130.0		458.0	2150.0	1420.0		450.0		265.0	248.0	32.7	759.0		237.0	105.5		2150.0		35.8	
02/04/29		9.1		11.6	65.9	91.5		60.0		313.0	149.0	14.1	666.0		64.7		36.8	814.0			0.76
02/06/17	9.2	7.3	7.7	8.0	49.2		34.1	26.0	12.7	73.4	49.1	7.9		12.1	43.9	47.5	18.3	346.0	9.8	9.2	1.14
02/08/26		2.9		2.3	9.6	13.7		7.0		35.0	56.5	0.1	51.1				35.3	187.0			0.28
02/12/03	6.4	15.3	<1.0		26.6		0.5	10.0	0.3	10.0	1250.0	14.1	260.0	2.0		1.5	79.2	171.0	1.4	2.8	0.22
03/02/24	0.7	170.0	0.3		460.0	623.0	0.6	11.0	0.0	9.6	220.0	30.4	1280.0	6.4		1.9		3140.0	3.3	4.3	0.27
03/03/19							UM	150.0	40.6			10.9	327.0	53.2			55.0	309.0	41.4	153.0	
03/06/18			10.0				12.7		10.9	46.0				17.2	9.3	27.1	36.8	244.0	18.4	25.6	

Dissolved Oxygen (mg/L) — Station Number (WHI****)

Date	143A	SBR01	143E	143H	143B	SBR02	143L	143M	143I	NBC01	143P	143N	WHI024	143K	143J	143S	RDC01	SBR03	143Q	143R	WWTP
01/03/19	11.0	12.0	10.6	12.2	11.7	11.2	11.4	11.7	12.0	12.3	10.5	12.1	10.3	10.9	10.1	10.0	10.5	10.1	10.2	10.8	
01/05/01	7.6	6.1	7.5	6.9	7.0	6.8	5.4	7.4	15.9	10.9	8.4	8.5	8.2	9.7	8.5	6.3	8.2	7.5	8.3	8.3	
01/06/19	7.0	6.4	4.2	5.6	6.3	6.8	6.9	8.1	9.0	8.8	7.2	6.3	8.0	9.6	8.5	5.9	8.4	7.1	8.1	8.3	7.5
01/08/27	em	em	em	em	em	em	em	em	em	em	em	em	em	em	em	em	em	em	em	em	em
01/11/06	7.2	3.1	2.9	4.5	7.7	8.1	6.2	5.7	10.1	11.1	8.6	7.1	8.7	6.8	9.3	7.5	9.4	8.4	7.3	7.7	8.8
02/01/22	12.0	12.3	11.9	12.0	11.0	12.0	12.1	11.5	14.7	13.7	12.3	12.7	12.6	12.0	12.3	11.8	11.8	11.9	11.5	11.5	9.9
02/01/24	10.3	10.3	10.7	11.1	9.9	9.5	9.6	9.8	10.2	10.4	10.8	11.0	9.7	10.3	9.6	10.6	9.6	9.6	9.7	9.2	
02/03/12	8.0	8.5	9.4	10.0	8.6	10.8	10.5	10.8	11.4	11.2	10.5	10.2	10.0	11.3	10.9	10.7	10.8	10.1	11.0	10.2	
02/04/08	10.8	10.7	10.7	10.9	10.0	9.2	9.8	9.1	10.5	10.9	10.4	11.1	10.3	10.1	10.1	9.5	10.2	10.2	9.0	9.5	
02/04/29	8.5	9.9	11.0	12.9	11.3	10.7	11.0	10.0	9.1	11.5	8.9	11.0	9.9	11.5	10.1	10.5	9.8	9.1	7.1	8.1	9.3
02/06/17	7.1	8.0	8.4	9.1	8.9	9.4	7.6	10.8	9.5	9.0	7.0	7.0	6.8	8.1	7.1	5.9	7.2	6.2	7.0	8.4	7.5
02/08/26	7.8	7.9	9.7	9.2	10.4	8.9	7.8	8.0	5.3	10.4	10.1	14.1	10.7	13.6	11.5	7.1	11.1	9.2	11.2	9.2	10.6
02/12/03	15.6	15.6	17.4	18.0	16.2	16.2	14.3	17.3	11.0	14.2	10.5	8.4	9.1	8.0	10.1	10.2	10.5	7.9	8.5	8.0	7.7
03/02/24	12.5	12.3	12.2	12.4	12.5	12.4	12.3	12.7	11.0	11.4	10.5	11.6	11.2	11.0	11.4	11.5	11.6	11.6	11.4	11.5	7.1
03/03/19	9.2	9.7	10.4	11.2	10.5	11.0	10.1	11.7	14.3	12.2	10.5	11.8	10.3	11.3	10.1	9.5	10.6	9.4	9.5	10.0	
03/06/18	5.8	6.7	6.8	8.0	7.4	8.5	8.7	8.9	9.2	10.3	7.1	8.2		9.3	8.6	6.3	8.6	7.0	8.1	8.1	

Appendix WQ-1
Water quality data collected from the Strawberry River watershed, Arkansas.
2001 - 2003

Temperature (Degrees C) — Station Number (WHI****)

Date	143A	SBR01	143E	143H	143B	SBR02	143L	143M	143I	NBC01	143P	143N	WHI024	143K	143J	143S	RDC01	SBR03	143Q	143R	WWTP
01/03/19	10.3	10.3	10.9	11.3	10.7	10.8	10.5	10.0	10.7	11.1	11.0	9.9	10.8	11.4	10.4	10.0	10.2	10.5	10.1	9.7	
01/05/01	22.3	21.4	21.2	18.5	21.4	20.2	18.3	19.3	23.3	25.4	22.3	21.0	22.8	19.8	21.2	20.3	18.2	21.7	17.0	18.3	
01/06/19	28.0	25.5	26.0	26.0	27.5	27.0	24.5	26.5	27.0	24.5	27.5	25.2	28.6	21.2	28.6	26.1	25.2	28.4	22.1	25.2	25.0
01/08/27	26.2	26.0	25.0	27.1	27.5	25.5	28.0	27.5	27.8	29.2	27.4	25.9	28.2	19.8	28.2	25.2	25.0	27.9	22.3	25.6	27.1
01/11/06	12.2	13.4	12.9	13.2	13.9	14.0	12.2	13.9	14.2	15.0	14.7	13.0	13.8	14.5	13.4	13.4	12.4	14.5	13.6	12.6	16.8
02/01/22	5.0	4.0	5.0	6.0	6.0	6.9	6.5	6.0	7.0	7.4	5.9	5.3	5.5	9.7	5.9	4.5	6.4	5.5	6.9	6.4	8.8
02/01/24	9.5	10.0	9.5	9.5	10.5	10.8	10.7	11.1	9.8	10.0	11.3	9.2	11.7	10.3	11.3	9.1	11.6	11.5	9.3	10.2	
02/03/12	6.7	6.6	7.6	7.7	7.2	7.7	8.2	7.6	9.5	9.2	11.5	9.1	7.7	8.0	7.4	8.3	7.7	7.8	8.1	7.7	
02/04/08	11.7	11.0	11.6	11.9	11.5	13.1	12.3	12.8	14.0	13.5	13.6	13.8	13.4	7.5	13.1	13.4	13.2	13.4	14.3	13.8	
02/04/29	17.5	17.7	16.7	16.6	18.7	19.9	17.3	20.1	18.0	20.5	19.5	18.7	19.5	18.0	19.5	18.5	17.0	19.5	15.0	16.5	19.0
02/06/17	20.8	21.5	19.9	18.7	22.8	23.9	19.1	21.6	26.3	21.2	27.7	27.0	28.9	23.7	27.1	26.7	23.0	24.3	20.0	23.0	23.2
02/08/26	26.9	25.7	25.5	24.7	23.7	25.2	24.0	23.1	24.2	24.4	27.1	28.9	28.3	23.1	29.2	25.6	25.7	25.0	21.7	24.7	22.4
02/12/03	5.9	5.7	5.8	6.3	6.4	6.2	5.8	5.8	7.1	6.4	6.5	7.0	6.3	7.0	6.0	6.5	6.0	7.5	8.5	8.0	10.1
03/02/24	3.2	4.0	5.2	5.0	5.2	5.8	5.6	5.9	7.4	6.9	6.1	6.5	6.2	6.4	5.9	6.3	6.8	6.3	6.1	5.3	7.4
03/03/19	13.7	14.5	14.5	13.7	15.1	16.2	14.6	15.6	15.2	15.8	15.9	15.8	15.8	15.2	15.9	15.3	15.3	15.7	14.6	16.1	
03/06/18	23.3	22.9	23.2	20.5	24.0	24.2	20.9	22.7	22.9	25.9	24.5	23.1		20.8	23.9	23.7	20.7	24.3	20.4	21.6	

pH (Standard Units) — Station Number (WHI****)

Date	143A	SBR01	143E	143H	143B	SBR02	143L	143M	143I	NBC01	143P	143N	WHI024	143K	143J	143S	RDC01	SBR03	143Q	143R	WWTP
01/03/19	7.99	8.48	8.56	8.52	8.24	8.23	8.56	8.57	8.13	8.12	8.35	8.13	7.98	8.55	8.21	8.23	8.41	8.25	8.00	8.30	
01/05/01	7.71	7.77	7.93	7.66	7.96	8.02	7.79	8.17	8.42	8.05	7.91	8.10	7.89	8.01	7.57	8.01	7.95	7.50	7.43	7.80	
01/06/19	7.33	7.94	7.25	7.89	7.92	8.10	7.80	8.21	8.17	7.84	7.71	7.57	7.70	7.76	7.77	7.33	7.74	7.58	7.55	7.75	7.82
01/08/27	6.94	7.61	7.84	8.01	8.06	7.32	7.94	7.93	8.35	8.43	8.16	7.83	8.10	8.21	8.22	7.55	8.16	8.09	8.05	8.02	7.93
01/11/06	6.84	6.84	7.21	7.24	6.99	7.56	6.91	7.03	8.14	8.32	8.14	8.27	8.14	7.58	8.14	7.87	8.10	8.24	7.97	7.95	7.18
02/01/22	7.35	7.77	7.70	7.80	7.70	8.06	7.58	7.98	8.47	8.59	8.52	8.55	8.60	8.30	8.41	8.59	8.27	8.35	8.04	8.18	7.09
02/01/24	7.15	7.43	7.09	6.85	7.38	7.52	6.84	7.69	7.96	8.00	8.06	8.21	8.17	7.93	7.97	8.10	7.44	7.86	6.78	7.01	
02/03/12	7.47	7.67	7.73	7.75	7.73	7.71	7.83	7.83	8.01	8.16	7.96	8.20	8.14	8.00	7.70	8.10	7.81	8.05	7.71	7.60	
02/04/08	7.24	7.36	7.62	7.65	7.77	8.21	7.77	8.10	7.77	7.84	7.84	8.23	8.03	7.53	7.79	8.13	6.92	7.74	7.25	7.21	
02/04/29	7.38	7.87	7.99	8.04	7.93	8.36	8.48	8.75	8.30	7.33	8.27	8.44	8.40	8.14	8.24	8.17	7.91	8.25	7.59	7.79	7.65
02/06/17	7.73	7.97	7.99	7.88	8.04	8.39	7.97	8.44	6.54	6.59	6.86	6.58	8.26	8.31	8.15	7.19	8.00	8.16	7.96	7.89	7.61
02/08/26	7.92	8.02	8.05	8.14	7.93	8.37	7.76	8.32	7.95	8.33	8.18	8.40	8.28	8.11	8.36	7.75	8.21	8.12	8.05	8.09	7.40
02/12/03	7.78	7.86	8.13	8.02	8.04	8.28	7.74	8.12	em	em	em	em	8.25	8.00	8.20	8.90	7.90	7.92	8.01	7.69	em
03/02/24	6.78	7.03	7.04	7.40	7.46	7.94	7.50	7.78	8.45	8.40	7.75	7.82	7.71	7.57	7.73	7.40	7.46	7.60	7.80	7.30	7.42
03/03/19	7.58	7.73	7.79	7.79	7.86	8.06	7.89	8.04	8.80	7.60	7.47	7.40	7.89	7.72	7.98	7.74	7.52	7.97	7.72	7.50	
03/06/18	7.22	7.66	7.62	7.67	8.10	em	7.98	6.98	8.34	8.56	8.30	8.35		8.39	8.40	8.06	8.25	8.29	8.08	8.31	

Appendix WQ-1
Water quality data collected from the Strawberry River watershed, Arkansas.
2001 - 2003

Turbidity (NTUs) — Station Number (WHI****)

Date	143A	SBR01	143E	143H	143B	SBR02	143L	143M	143I	NBC01	143P	143N	WHI024	143K	143J	143S	RDC01	SBR03	143Q	143R	WWTP
01/03/19	3.9	3.5	1.1	1.3	3.2	1.8	1.4	1.2	1.3	0.6	1.8	0.9	2.6	1.3	2.3	4.9	3.1	4.2	5.2	16.0	
01/05/01	3.7	2.4	1.9	2.0	2.6	2.1	3.0	1.8	1.3	1.1	2.1	0.9	4.2	1.2	3.0	4.7	3.5	6.1	4.7	5.1	
01/06/19	11.0	4.2	2.2	3.6	3.1	3.8	2.4	2.7	1.5	1.8	3.1	1.9	7.8	1.6	5.5	8.1	4.9	17.0	6.8	7.1	4.3
01/08/27	11.0	12.0	5.2	4.8	3.6	4.2	9.2	2.8	2.2	2.0	4.0	3.2	7.6	2.6	3.6	6.5	3.9	9.8	3.8	5.5	5.2
01/11/06	4.5	3.4	4.9	2.2	2.4	1.3	3.0	1.8	4.2	1.0	1.4	1.0	3.0	1.3	3.3	2.6	2.4	5.8	3.6	4.3	2.7
02/01/22	0.5	6.2	1.0	1.5	3.1	2.2	1.6	2.0	1.5	0.6	1.2	0.8	1.7	1.4	3.4	4.7	3.1	3.5	5.0	4.7	2.6
02/01/24	60.0	160.0	45.0	64.0	270.0	360.0	66.0	305.0	355.0	59.0	190.0	25.0	33.0	63.0	79.0	53.0	95.0	240.0	55.0	110.0	
02/03/12	31.0	63.0	26.0	33.0	85.0	70.0	35.0	68.0	18.0	25.0	65.0	14.0	76.0	19.0	53.0	28.0	44.0	81.0	35.0	49.0	
02/04/08	40.0	104.0	41.0	55.0	65.0	31.0	58.0	24.0	24.0	21.0	2.6	6.0	10.0	5.5	13.0	14.0	8.9	7.3	20.0	15.0	
02/04/29	5.3	3.0	1.1	1.9	2.3	1.5	1.5	1.7	0.7	0.8	1.7	0.6	12.0	1.9	4.4	3.8	3.2	7.2	3.8	7.4	4.6
02/06/17	9.8	3.8	4.6	2.7	3.2	2.5	2.5	2.1	1.5	11.0	3.7	2.9	7.2	2.4	6.2	6.0	5.2	12.0	5.4	14.0	3.3
02/08/26	3.4	5.2	2.4	3.2	2.8	2.4	4.4	2.2	1.0	1.2	4.0	0.8	7.2	1.8	5.8	7.0	3.6	11.4	5.8	6.6	
02/12/03	8.1	2.5	5.2	3.9	3.7	1.9	3.3	0.4	1.5	1.6	2.4	2.5	2.4	1.5	2.3	6.6	1.4		2.0	4.2	
03/02/24	17.8	20.0	11.1	17.8	17.9	26.2	11.9	16.1	6.5	6.5	31.3	4.6		9.8	12.1	16.9	12.6	62.6	15.2	34.3	
03/03/19	75.9		6.7	5.6	7.1	3.3	4.8	3.0	2.5	1.7	4.8	3.5	7.8	2.5	6.0	8.3	5.2	12.3	21.2	23.8	
03/06/18	4.5		3.0	3.4	3.6	2.9	5.9	5.9	3.6	1.8	9.1	1.8		2.3	6.8	9.0	8.6	9.5	5.9	6.4	

Total Suspended Solids (mg/L) — Station Number (WHI****)

Date	143A	SBR01	143E	143H	143B	SBR02	143L	143M	143I	NBC01	143P	143N	WHI024	143K	143J	143S	RDC01	SBR03	143Q	143R	WWTP
01/03/19	1	1.3	<1	<1	1.5	<1	<1	<1	1.5	<1	1.8	2	3.3	<1	<1	6.3	1.5	6	3	16.8	
01/05/01	3.8	4.7	4	3.8	8.8	6.5	4.2	3.5	17	1.7	3.8	1	11.2	1.8	6.5	10.7	7	13.3	7.7	8.5	
01/06/19	3.25	6.25	1.5	5.5	2.75	3.5	1.75	1.25	<1.0	2	2.5	2.5	17.25	1.25	10.75	11.25	7.25	30.5	10.25	9.5	4.5
01/08/27	6	16	2.8	4.7	4.5	3	9	1.3	7.7	1.5	6	4.3	13.5	3.8	4.5	3.5	6	16.8	3	8.2	4.7
01/11/06	2.3	2.5	<1	2	1.3	<1	2.3	1.3	<1	<1	1	1.8	3.8	<1	3	1	<1	8	1.3	2.7	3.8
02/01/22	3.8	1.8	<1	1.3	1.8	<1	<1	1.3	1.3	1	<1	<1	1.8	1	4	2.3	1	4	4	8	6.2
02/01/24	40.5	230.5	22.3	49	368.2	442	61	326	17.5	34	360	6.5	610	57	161	61	108	598.7	100	113.5	
02/03/12	17.5	70.8	9.5	13	119	105	24.5	104	6	8	84.8	2.3	155.5	7.5	68.8	27.8	44.3	156.8	50	35.8	
02/04/08	57.3	225.5	40	68	174	81.5	84.5	54	12.3	11.3	65	3.2	20.8	2.3	17.3	19.8	27	11.3	19	15.3	
02/04/29	4.75	2.75	4	4.25	5.25	3.25	1.75	3	2.25	<1	7.75	6.25	41.25	1.25	6.5	7.75	5.75	15.5	4.75	12.5	9.75
02/06/17	5.5	2.7	3.2	<1	2	1.7	1.8	1	<1	1.5	4.8	1.8	10.5	2.2	8.2	8.2	7.5	20.3	6.8	32.3	6.5
02/08/26	1.3	3.5	2	3.2	1.5	3.2	4.2	2	<1	<1	<1.0	7.5	8.8	2.5	7	<1.0	8.5	23.8	3.7	5.7	
02/12/03	1.5	<1	1	2.5	1.8	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1		<1	1	
03/02/24	1	10.8	<1	16	9	12.8	2	6	1.7	1.5	16.5	<1		1.3	8.8	8.5	9.8	65.2	9.7	13.3	
03/03/19	35		1.5	1	1.3	<1	2	<1	1.3	<1	2.8	<1	7.7	<1	3.5	3.8	1.5	14.2	10.2	18.2	
03/06/18	2		2.3	2.5	2.7	3.2	4	3.3	3.2	1.5	5.7	<1		1.3	7.5	8.2	8	22	8	10.3	

Appendix WQ-1
Water quality data collected from the Strawberry River watershed, Arkansas.
2001 - 2003

Chlorides (mg/L) — Station Number (WHI****)

Date	143A	SBR01	143E	143H	143B	SBR02	143L	143M	143I	NBC01	143P	143N	WHI024	143K	143J	143S	RDC01	SBR03	143Q	143R	WWTP
01/03/19	5.83	5.47	6.13	6.93	5.9	5.37	5.28	5.27	8.45	5.19	5.47	4.32	5.15	4.13	4.38	4.72	5.02	5.33	5.48	5.42	
01/05/01	4.12	4.17	4.3	5.18	4.7	4.23	3.86	4.15	9.32	3.83	3.42	3.05	3.47	2.45	2.95	4.17	3.39	3.65	3.77	3.83	
01/06/19	4.01	3.34	4.25	5.3	6.24	3.26	3.43	3.49	19.81	3.15	2.85	3.09	2.66	2.32	2.44	3.3	3.05	3.12	3.77	3.73	113
01/08/27	4.6	3.1	3.85	6.76	4.97	3	3.25	3.91	19.78	2.83	2.31	2.44	2.51	2.09	2.24	4.23	2.84	3.1	3.48	3.55	117
01/11/06	4.95	3.73	6.85	11.87	5.58	3.78	4.09	4.35	26	3.66	3.23	3.39	3.25	3.77	3.34	4.19	3.55	3.58	3.79	4.07	82.8
02/01/22	4.3	4.45	4.95	5.84	4.42	4.15	4.15	4.02	7.59	3.85	3.54	2.83	3.44	2.6	2.87	3.05	3.3	3.63	3.85	3.7	78.04
02/01/24	2.08	1.63	2.51	2.27	1.85	1.78	2.56	2.18	2.75	1.82	1.98	1.31	2.02	2.91	1.77	2.08	2.62	2.5	2.06	2.25	
02/03/12	1.83	1.51	2.2	2.18	1.82	2.2	2.15	2.25	3.44	2.03	1.85	1.24	2.02	1.89	1.6	1.97	1.96	1.84	1.84	2.04	
02/04/08	1.05	1.27	2.93	2.88	3.18	2.61	2.81	2.7	2.96	3.02	2.89	2.45	2.96	2.95	2.85	3.11	3.42	2.88	5.14	3.3	
02/04/29	3.01	3.24	3.91	4.25	3.58	3.43	2.97	3.19	5.68	3.64	3.16	2.83	3.15	2.38	2.62	2.99	3.1	3.28	3.51	3.71	66.51
02/06/17	3.07	3.29	3.48	4.41	3.53	3.38	3.17	3.39	6.7	3.78	3.03	2.86	3.2	2.15	2.38	3.02	3.07	3.35	3.78	3.85	71.2
02/08/26	3.58	3.13	4.64	5.39	3.58	3.33	3.04	3.77	3.04	3.26	2.75	2.66	2.74	2.12	2.29	3.46	2.89	3.3	3.98	3.72	
02/12/03	4.33	3.88	4.31	6.93	4.9	3.37	3.48	3.78	22.9	2.66	2.49	2.84	2.63	2.41	2.29	3.76	2.9		3.4	3.49	
03/02/24	3.30	3.33	3.93	4.02	3.43	3.26	4.65	3.99	5.42	3.62	3.33	2.38		3.28	3.03	2.76	3.43	3.15	3.12	3.26	
03/03/19	3.44		4.08	4.17	4.17	80.2	4.07	4.6	6.4	3.82	3.48	2.72	3.53	2.53	2.97	3.58	3.38	3.66	5.89	5.49	
03/06/18	3.78		4.02	4.36	3.73	3.54	3.16	2.96	7.8	3.5	2.85	2.83		2.52	2.69	3.17	3.35	3.43	3.39	3.41	

Sulfates (mg/L) — Station Number (WHI****)

Date	143A	SBR01	143E	143H	143B	SBR02	143L	143M	143I	NBC01	143P	143N	WHI024	143K	143J	143S	RDC01	SBR03	143Q	143R	WWTP
01/03/19	6.72	6.98	5.42	6.11	6.99	7.55	7.66	6.37	6.7	7.42	7.69	9.22	7.88	5.92	7.07	7.37	6.59	7.71	6.87	7.06	
01/05/01	4	4.46	3.77	4.24	4.72	5.45	4.84	4.52	6.09	5.85	4.82	6.39	5.1	3.52	4.11	4.75	3.97	4.96	4.04	4.1	
01/06/19	1.74	3.01	3	3.37	3.9	4.42	3.5	3.04	5.34	4.87	3.85	5.17	3.87	2.88	3.42	3.47	3.16	3.81	3.67	3.64	32.07
01/08/27	1.65	3.79	2.77	2.81	4.16	4.49	3.3	2.56	4.93	5.25	4.06	5.6	4.2	3.36	3.29	2.93	3.42	4.06	3.66	3.64	29.77
01/11/06	2.59	2.7	3.89	4.27	4.61	5.08	5.55	3.16	10.17	7.14	5.14	6.41	5.14	3.13	4.84	3.7	4.37	4.64	3.15	3.11	31.23
02/01/22	6.38	6.63	5.08	5.94	6.04	6.79	6.37	5.69	5.99	6.18	5.79	6.37	5.94	3.7	4.84	4.87	4.32	5.68	4.55	4.34	27.91
02/01/24	3.92	3.71	3.97	4.01	4.69	5.26	5.14	5.68	4.1	4	4.93	4.32	5.03	4.64	3.98	4.1	4.18	5.86	4.37	4.12	
02/03/12	3.57	3.43	3.36	3.52	3.41	3.95	4.33	4.01	4.18	4.04	4.03	4.3	3.98	3.88	3.67	4.16	3.83	4.02	4.32	3.92	
02/04/08	1.69	1.82	3.55	4.94	4.28	5.15	4.73	4.38	5.29	4.82	4.96	5.43	5.09	3.57	4.78	4.85	4.61	5.05	5.2	4.62	
02/04/29	3.35	3.69	3.27	3.67	4.04	4.64	3.76	3.74	4.25	4.55	4.18	4.98	4.33	3.29	3.64	3.89	3.62	4.34	3.67	3.78	33.53
02/06/17	2.68	3.24	2.83	3.65	3.68	4.38	3.71	3.52	4.47	4.49	3.92	5.05	4.11	2.79	3.12	3.43	3.37	4.2	3.53	3.53	34.19
02/08/26	2.4	2.79	2.9	3.28	2.4	3.98	3.12	2.78	3.12	4.87	3.73	5.13	3.84	2.93	2.96	2.99	3.04	3.77	3.21	3.34	
02/12/03	4.51	4.19	4.99	5.29	5.2	6.02	4.32	4.26	11.1	7.01	5.07	7.42	5.21	3.61	3.99	4.91	3.82		3.95	3.93	
03/02/24	5.77	6.27	5.37	5.86	6.23	6.82	8.3	7.31	6.74	6.74	6.8	7.07		6.32	6.85	6.37	6.63	6.65	6.47	6.71	
03/03/19			3.96	5.19	5.19	20.3	5.82	5.94	5.61	5.83	5.47	6.48	5.74	4.19	4.91	5.47	4.53	5.46	5.63	6.44	
03/06/18	3.43		3.9	3.98	4.48	5.04	5.39	5.14	5.27	5.26	5.26	5.68		3.67	4.05	4.23	4.26	4.71	4.03	4.06	

Appendix WQ-1
Water quality data collected from the Strawberry River watershed, Arkansas.
2001 - 2003

Total Dissolved Solids (mg/L) — Station Number (WHI****)

Date	143A	SBR01	143E	143H	143B	SBR02	143L	143M	143I	NBC01	143P	143N	WHI024	143K	143J	143S	RDC01	SBR03	143Q	143R	WWTP
01/03/19	138.5	156.5	151	162.5	172	202	186	191.5	244	248	211.5	261	220.5	161	202.5	183.5	191.5	212.5	189.5	182.5	
01/05/01	158	178	179	184	209	228	196	223	246	264	229.5	276	229.5	185	211	219	203	220.5	206	214.5	
01/06/19	155	187	193	213	227	217	195	193	252	255	205	254	205	191	194	181	198	195	209	205	588
01/08/27	137	173	156.5	202	212.5	210	196.5	193.5	243.5	233	197.5	244.5	197.5	204.5	193	241	191.5	198.5	219.5	219.5	597
01/11/06	122.5	181.5	216	242	227	244	225	215.5	276.5	281.5	226	271.5	224.5	216	224.5	178.5	205	218	213	207	514.5
02/01/22	134	160	309	174	167	209	185	202	249	257	208	268	217	173	201	189	181	217	184	184	493
02/01/24	99	114	94	104	141	185	125	161	131	140	165	135	187	129	140	124	139	184	98	124	
02/03/12	80	98.5	88	98.5	107.5	125	115.5	116	142.5	145.5	132.5	153	143	108	119.5	130	118	144.5	108.5	105.5	
02/04/08	70.5	99	78.5	91.5	120	162.5	113	144	131	166	186.5	220	188	167.5	178	168	161.5	181	161	150	
02/04/29	139	159	159	183	187	209	186	200	258	272	222	280	229	184	216	205	198	223	212	205	541
02/06/17	138	164.5	174	189	187.5	208	199.5	207	260.5	262	224.5	274	230	195.5	208.5	208	204.5	222	215	216	542.5
02/08/26	149	149	190	200	187	209	197	203	257	245	204	254	204	189	184	185	190	200	208	210	
02/12/03	162	203	200	218	244	260	208	224	256	279	225	279	234	189	206	246	190		209	213	
03/02/24	94	110	102	114	118	135	151	153	177	183	159	185		129	154	130	148	149	130	123	
03/03/19	122		141	150	165	198	178	195	231	229	207	246	211	158	191	185	168	188	202	179	
03/06/18	149		177	186	172	202	197	176	249	249	182	269		164	204	216	195	210	184	185	

Total Organic Carbon (mg/L) — Station Number (WHI****)

Date	143A	SBR01	143E	143H	143B	SBR02	143L	143M	143I	NBC01	143P	143N	WHI024	143K	143J	143S	RDC01	SBR03	143Q	143R	WWTP
01/03/19	1.94	2.17	1.46	1.56	2.12	1.6	1.43	1.4	1.56	1.32	1.46	1.33	1.46	1.55	1.81	2.79	1.33	1.8	2.48	3.21	
01/05/01	2.63	2.59	1.98	1.9	2.27	2.44	2.01	2.09	1.96	1.78	1.78	1.76	1.94	1.55	1.73	2.71	1.65	1.79	1.85	1.85	
01/06/19	3	2.6	2.1	2.2	2.3	2.3	1.7	2.8	2.6	2.3	2.2	1.9	2.6	1.4	2.9	3.8	1.8	3.2	2	2.3	9.3
01/08/27	3.047	3.349	3.326	3.228	2.571	2.629	2.261	4.154	2.323	2.018	1.441	1.402	1.606	<1.0	1.444	3.67	1.172	1.569	1.037	1.464	6.283
01/11/06	3.171	4.507	3.142	3.164	2.469	2.565	1.593	3.799	1.583	1.535	1.724	1.597	2.536	2.234	2.058	4.007	1.403	2.642	2.004	3.218	5.947
02/01/22	1.596	1.739	<1.0	<1.0	1.376	1.339	1.194	1.022	1.154	<1.0	1.093	<1.0	1.144	<1.0	1.217	2.308	1.033	1.31	2.033	2.044	7.627
02/01/24	9.58	10.63	7.25	8.4	10.05	10.62	7.21	4.73	7.23	8.2	8.19	6.67	8.34	6.4	8.03	6.4	10.23	6.28	7.45	9.5	
02/03/12	6.4	7.6	5.7	6.4	7.6	6.2	5.8	6.5	5.4	5.3	5.9	4.3	5.7	5.2	7.4	5.1	7.4	6.2	11.3	8.2	
02/04/08	7.487	7.972	7.32	8.435	5.86	2.903	6.847	2.594	7.414	4.091	2.164	1.836	1.793	2.656	3.742	4.881	2.407	1.779	6.701	3.045	
02/04/29	1.9	2	1.3	1.3	1.64	1.49	1.52	1.29	1.41	1.7	1.41	1.27	1.36	1.41	1.62	2.52	1.3	1.6	1.64	1.91	8.55
02/06/17	2.044	1.964	1.292	1.001	1.988	1.664	1.309	1.549	1.195	1.33	1.478	1.315	1.629	1.286	2.058	2.975	1.426	1.87	1.336	1.443	7.179
02/08/26	1.9	3.11	1.51	<1.0	2.05	1.53	1.03	1.86	1.04	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.08	<1.0	1.91	1.71	<1.0	
02/12/03	1.98	2.29	1.23	1.39	1.88	1.6	0.911	2.08	1.02	1.58	1.07	0.842	1.24	0.61	1.06	2.44	1.49		1.22	1.38	
03/02/24	3.93	4.69	3	3.47	4.23	4.52	3.26	3.61	2.38	2.64	4.5	2.65		3.26	3.99	485	2.84	5.3	5.02	5.72	
03/03/19	7.1		2.39	2.04	2.66	2.14	2.55	2.05	2.22	1.86	1.9	2.13	2.44	1.86	2.67	4.85	2.86	1.9	8.81	6.31	
03/06/18	1.86		1.35	1.09	3.09	1.73	1.95	2.92	1.37	1.48	2.74	1.43		1.28	1.48	2.62	1.54	1.68	2.19	2.26	

Appendix WQ-1
Water quality data collected from the Strawberry River watershed, Arkansas.
2001 - 2003

Biochemical Oxygen Demand (mg/L) — Station Number (WHI****)

Date	143A	SBR01	143E	143H	143B	SBR02	143L	143M	143I	NBC01	143P	143N	WHI024	143K	143J	143S	RDC01	SBR03	143Q	143R	WWTP
01/03/19	0.01	0.10	0.20	0.23	0.23	0.06	0.08	0.02	0.06	0.44	0.11	0.05	1.28	0.34	0.06	0.43	0.23	0.13	0.60	0.31	
01/05/01	0.86	0.90	1.04	0.90	0.86	0.90	0.73	0.79	1.87	0.75	0.58	0.60	0.53	0.40	0.61	1.08	0.49	0.55	0.56	0.56	
01/06/19	0.60	0.64	0.80	0.72	0.51	0.56	0.45	0.49	1.10	0.31	0.57	0.69	0.74	0.23	0.63	0.70	0.35	0.86	0.42	0.47	
01/08/27	1.30	1.10	0.98	0.76	0.44	0.43	0.98	1.00	2.37	0.50	0.46	0.28	0.47	0.14	0.30	0.94	0.27	0.54	0.17	0.45	1.1
01/11/06	0.45	1.34	0.60	0.82	0.60	0.61	0.68	1.19	0.43	0.45	0.53	0.17	0.57	0.96	0.67	0.90	0.56	0.92	0.83	1.87	0.69
02/01/22	0.75	0.74	0.63	0.49	0.71	0.63	0.76	0.53	0.10	0.07	0.29	0.56	0.00	0.03	0.01	0.30	0.13	0.10	0.05	0.23	1.87
02/01/24	2.11	3.10	1.68	2.05	4.10	4.65	2.10	5.13	1.75	1.80	3.61	0.71	4.08	2.50	2.62	1.97	4.94	3.35	2.27	3.45	
02/03/12	0.78	1.14	0.77	1.10	1.65	1.53	1.16	1.92	0.92	0.57	1.64	0.24	1.59	0.76	1.71	1.01	1.59	1.59	1.16	1.66	
02/04/08	1.11	2.36	1.45	2.03	1.96	0.48	1.95	0.51	1.44	0.48	0.22	0.03	0.25	0.24	1.15	1.13	0.44	0.19	1.84	1.05	
02/04/29	0.62	0.37	0.50	0.67	0.83	0.44	0.49	0.36	0.67	0.42	0.33	0.42	0.47	0.34	0.57	0.90	0.37	0.52	0.37	0.71	2.92
02/06/17	1.13	0.67	0.54	0.48	0.69	0.31	0.53	0.54	0.32	0.56	0.10	0.42	0.55	0.06	0.54	0.83	0.35	0.67	0.61	1.00	1.27
02/08/26	0.75	0.89	1.04	1.12	1.33	0.72	0.89	0.77	0.69	0.64	0.71	0.74	0.84	0.68	0.72	0.90	0.71	1.23	0.77	0.72	
02/12/03	0.76	0.42	0.38	0.56	1.22	0.42	0.56	0.49	0.38		0.10		0.13			0.44	0.15		0.17	0.26	
03/02/24	0.99	1.08	0.67	0.84	1.00	0.73	0.72	1.49	0.56	0.73	1.02	0.48		0.61	0.77	1.08	0.70	1.80	1.09	1.51	
03/03/19	3.31		0.67	0.44	0.50	1.02	0.50	0.24	0.47	0.31	0.47	0.19	0.84	0.47	1.00	1.18	0.77	0.44	2.56	2.27	
03/06/18	0.72		0.51	0.42	0.74	0.30	0.32	0.42	0.58	0.60	0.90	0.65		0.37	0.51	0.64	0.53	0.44	0.62	0.59	

Ammonia Nitrogen, NH3-N — Station Number (WHI****)

Date	143A	SBR01	143E	143H	143B	SBR02	143L	143M	143I	NBC01	143P	143N	WHI024	143K	143J	143S	RDC01	SBR03	143Q	143R	WWTP
01/03/19	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.042	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.012	0.005	
01/05/01	0.020	0.020	0.020	0.020	0.010	0.020	0.010	0.040	<0.005	<0.005	<0.005	<0.005	0.100	<0.005	0.030	0.090	0.050	0.020	0.120	0.050	
01/06/19	0.065	0.014	0.039	0.080	0.012	<0.005	0.014	0.022	<0.005	0.010	<0.005	0.013	<0.005	0.010	0.025	0.048	0.017	0.016	0.018	0.020	0.028
01/08/27	0.065	0.006	0.041	0.008	<0.005	<0.005	0.049	0.010	<0.005	<0.005	0.012	0.017	<0.005	0.008	0.010	0.068	<0.005	0.021	0.020	0.044	0.025
01/11/06	<0.005	<0.005	0.034	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.014	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
02/01/22	0.216	0.375	0.438	0.449	0.277	0.333	0.298	0.478	0.856	0.210	0.296	0.044	0.307	0.355	0.269	0.207	0.497	0.325	0.377	0.314	13.490
02/01/24	0.112	0.259	0.089	0.114	0.413	0.554	0.111	0.420	0.061	0.070	0.120	0.030	0.398	0.114	0.156	0.132	0.443	0.299	0.096	0.196	
02/03/12	0.020	0.046	<0.005	0.029	0.055	0.040	<0.005	0.048	0.026	0.011	0.033	0.007	0.032	0.029	0.052	0.022	0.127	0.039	0.029	0.063	
02/04/08	0.091	0.265	0.094	0.163	0.232	<0.005	0.215	0.029	0.064	0.017	0.017	<0.005	0.026	0.007	0.105	0.107	0.145	0.013	0.529	0.059	
02/04/29	0.010	0.010	<0.005	0.010	0.010	0.010	0.010	<0.005	0.010	<0.005	<0.005	0.020	0.010	0.010	0.020	0.010	0.030	0.020	0.040	0.050	0.060
02/06/17	0.014	0.010	0.007	0.007	0.005	<0.005	0.006	<0.005	0.009	0.005	<0.005	<0.005	<0.005	<0.005	0.014	0.013	0.007	0.019	0.019	0.021	0.014
02/08/26	0.014	0.049	0.009	0.043	<0.005	0.032	0.012	0.024	0.037	0.035	0.021	<0.005	0.011	<0.005	0.027	0.050	0.016	0.027	0.030	0.021	
02/12/03	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.014	0.006	<.005	<0.005	<0.005	0.009	0.005	<0.005	0.012		<0.005	0.010	
03/02/24	<0.005	0.037	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005		<0.005	<0.005	<0.005	0.036	0.042	0.060	0.034	
03/03/19	<0.005		<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.340	<0.005	
03/06/18	0.041		<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.068		<0.005	<0.005	0.043	<0.005	<0.005	<0.005	<0.005	

Appendix WQ-1
Water quality data collected from the Strawberry River watershed, Arkansas.
2001 - 2003

Nitrate + Nitrite Nitrogen, NO3 + NO2 (mg/L) — Station Number (WHI****)

Date	143A	SBR01	143E	143H	143B	SBR02	143L	143M	143I	NBC01	143P	143N	WHI024	143K	143J	143S	RDC01	SBR03	143Q	143R	WWTP
01/03/19	0.185	0.161	0.305	0.256	0.172	0.264	0.247	0.511	0.690	0.183	0.278	0.053	0.273	0.306	0.253	0.140	0.621	0.278	0.393	0.348	
01/05/01	0.010	0.050	0.020	0.070	0.020	0.070	0.060	0.230	0.290	0.050	0.110	0.020	0.120	0.320	0.200	0.170	0.540	0.200	0.450	0.480	
01/06/19	0.043	0.054	0.054	0.097	0.051	0.079	0.178	0.142	0.042	0.065	0.087	0.100	0.045	0.357	0.199	0.170	0.525	0.166	0.524	0.460	24.920
01/08/27	0.039	0.040	0.065	0.033	0.035	0.041	0.053	0.034	0.021	0.029	0.030	0.089	0.029	0.367	0.113	0.129	0.343	0.073	0.368	0.338	27.760
01/11/06	0.030	0.034	0.030	0.030	0.105	0.035	0.054	0.033	0.766	0.066	0.080	0.060	0.040	0.242	0.192	0.041	0.240	0.078	0.231	0.109	14.898
02/01/22	0.072	0.037	0.044	0.013	<0.005	0.030	<0.005	0.045	0.030	0.009	0.011	0.041	0.008	0.006	0.032	0.037	0.070	0.015	0.069	0.054	0.077
02/01/24	0.375	0.323	0.527	0.428	0.313	0.280	0.322	0.302	0.451	0.270	0.270	0.100	0.278	0.367	0.238	0.166	0.470	0.285	0.222	0.200	
02/03/12	0.286	0.236	0.343	0.299	0.235	0.271	0.230	0.256	0.457	0.229	0.253	0.077	0.239	0.254	0.232	0.110	0.408	0.221	0.194	0.206	
02/04/08	0.237	0.448	0.316	0.458	0.405	0.236	0.450	0.409	0.414	0.440	0.296	0.090	0.294	0.444	0.278	0.294	0.507	0.274	0.507	0.349	
02/04/29	0.130	0.120	0.090	0.100	0.100	0.160	0.140	0.270	0.410	0.160	0.210	0.040	0.200	0.270	0.200	0.140	0.470	0.220	0.380	0.360	16.800
02/06/17	0.100	0.101	0.115	0.182	0.068	0.121	0.141	0.160	0.577	0.117	0.138	0.057	0.125	0.289	0.167	0.187	0.476	0.190	0.451	0.458	24.470
02/08/26	0.035	0.070	0.057	0.094	0.039	0.044	0.072	0.037	0.526	0.051	0.074	0.051	0.041	0.335	0.115	0.184	0.392	0.134	0.306	0.375	
02/12/03	0.011	0.015	0.002	0.030	<0.005	<0.005	0.043	<0.005	1.100	0.102	0.113	0.009	<0.005	0.355	0.149	0.011	0.332		0.042	0.199	
03/02/24	0.460	0.483	0.604	0.584	0.466	0.450	0.561	0.601	0.832	0.424	0.455	0.128		0.515	0.426	0.202	0.767	0.354	0.298	0.292	
03/03/19	0.162		0.156	0.162	0.114	0.141	0.105	0.250	0.605	0.105	0.136	0.063	0.115	0.211	0.189	0.117	0.465	0.143	0.369	0.549	
03/06/18	0.084		0.149	0.168	0.095	0.125	0.191	0.283	0.900	0.070	0.211	0.071		0.228	0.171	0.201	0.494	0.234	0.381	0.365	

Total Phosphorus (mg/L) — Station Number (WHI****)

Date	143A	SBR01	143E	143H	143B	SBR02	143L	143M	143I	NBC01	143P	143N	WHI024	143K	143J	143S	RDC01	SBR03	143Q	143R	WWTP
01/03/19	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.040	<0.020	<0.020	<0.020	0.020	<0.020	<0.020	<0.020	<0.020	0.020	<0.020	0.050	
01/05/01	<0.020	0.045	<0.020	<0.020	0.023	<0.020	<0.020	0.020	0.089	<0.020	0.030	0.032	0.026	<0.020	0.021	0.040	0.030	0.044	0.034	0.050	
01/06/19	<0.020	0.020	0.020	0.020	0.020	0.020	<0.020	0.020	0.040	<0.020	0.030	<0.020	0.030	0.020	0.030	0.060	0.030	0.060	0.040	0.060	5.040
01/08/27	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	3.738
01/11/06	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.031	3.305
02/01/22	<0.020	<0.020	0.028	<0.020	0.033	<0.020	0.027	<0.020	0.106	<0.020	0.026	0.021	<0.020	<0.020	<0.020	<0.020	0.020	0.041	<0.020	<0.020	3.264
02/01/24	0.122	0.282	0.112	0.167	0.425	0.471	0.165	0.506	0.107	0.123	0.320	<0.020	0.521	0.173	0.289	0.114	0.487	0.460	0.189	0.318	
02/03/12	0.060	0.110	0.070	0.090	0.160	0.150	0.090	0.160	0.120	0.070	0.140	0.020	0.160	0.070	0.180	0.060	0.200	0.170	0.100	0.170	
02/04/08	0.144	0.349	0.123	0.215	0.254	0.082	0.256	0.074	0.143	0.039	0.066	<0.020	0.038	0.032	0.092	0.086	0.133	0.024	0.513	0.072	
02/04/29	<0.020	0.030	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.030	<0.020	0.030	0.040	0.040	<0.020	0.020	0.030	0.020	0.020	<0.020	0.030	3.700
02/06/17	0.021	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.047	<0.020	<0.020	<0.020	0.020	<0.020	0.026	0.033	0.032	0.036	0.025	0.044	4.168
02/08/26	<0.020	0.022	0.021	<0.020	0.024	<0.020	<0.020	<0.020	0.072	<0.020	<0.020	<0.020	0.025	<0.020	0.025	0.052	0.027	0.052	0.042	0.030	
02/12/03	0.068	0.081	0.067	0.064	0.064	0.062	0.068	0.062	0.069	0.061	0.070	0.062	0.060	0.071	0.074	0.066	0.061		0.077	0.071	
03/02/24	0.038	0.057	0.039	0.049	0.050	0.052	0.034	0.042	0.043	0.030	0.052	0.030		0.040	0.056	0.045	0.063	0.100	0.060	0.094	
03/03/19	0.112		0.330	<0.020	0.046	0.032	0.037	0.051	0.050	<0.020	0.131	0.030	0.055	0.036	0.042	0.047	0.054	0.043	0.281	0.099	
03/06/18	0.143		0.155	0.109	0.104	0.112	0.108	0.117	0.152	0.107	0.116	0.120		0.109	0.113	0.119	0.120	0.120	0.115	0.112	

Appendix WQ-1
Water quality data collected from the Strawberry River watershed, Arkansas.
2001 - 2003

Ortho-Phosphorus (mg/L) — Station Number (WHI****)

Date	143A	SBR01	143E	143H	143B	SBR02	143L	143M	143I	NBC01	143P	143N	WHI024	143K	143J	143S	RDC01	SBR03	143Q	143R	WWTP
01/03/19	<0.005	<0.005	<0.005	<0.005	0.005	<0.005	<0.005	0.005	0.031	<0.005	<0.005	0.005	<0.005	<0.005	<0.005	<0.005	0.005	0.007	0.010	0.013	
01/05/01	<0.005	<0.005	0.010	<0.005	<0.005	0.010	<0.005	0.010	0.020	<0.005	<0.005	<0.005	0.040	0.010	<0.005	0.010	0.010	0.010	0.030	0.020	
01/06/19	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	4.348
01/08/27	0.008	0.006	0.006	0.006	0.005	0.005	0.006	0.006	0.014	0.007	0.009	0.009	0.008	0.011	0.007	0.018	0.014	0.012	0.023	0.028	3.675
01/11/06	0.005	0.012	0.017	0.010	0.012	0.012	0.016	0.011	0.029	0.016	0.013	0.020	0.015	0.018	0.020	0.018	0.019	0.022	0.032	0.041	3.518
02/01/22	<0.005	<0.005	<0.005	<0.005	<0.005	0.006	<0.005	0.005	0.046	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	2.990
02/01/24	0.072	0.171	0.084	0.110	0.283	0.377	0.110	0.307	0.070	0.070	0.120	0.030	0.266	0.093	0.175	0.068	0.312	0.218	0.109	0.208	
02/03/12	0.018	0.031	0.036	0.048	0.048	0.048	0.037	0.050	0.085	0.036	0.043	0.006	0.032	0.028	0.061	0.011	0.101	0.046	0.033	0.080	
02/04/08	0.066	0.120	0.053	0.087	0.080	0.006	0.132	0.012	0.059	0.009	0.020	<0.005	0.006	0.008	0.024	0.028	0.079	0.006	0.412	0.021	
02/04/29	0.010	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.010	<0.005	<0.005	<0.005	0.010	<0.005	0.010	<0.005	0.010	0.010	0.010	0.020	3.460
02/06/17	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.042	<0.005	<0.005	<0.005	<0.005	0.005	<0.005	0.008	0.018	0.007	0.016	0.019	3.900
02/08/26	0.006	0.007	0.006	0.007	0.005	0.008	0.005	0.006	0.058	0.007	0.007	0.006	0.007	0.007	0.008	0.025	0.015	0.022	0.032	0.020	
02/12/03	0.027	0.011	0.011	0.010	0.010	0.011	0.013	0.011	0.022	0.013	0.011	0.014	0.006	0.013	0.011	0.015	0.013		0.012	0.016	
03/02/24	0.006	0.019	0.009	0.018	0.015	<0.005	<0.005	0.015	0.024	<0.005	0.013	<0.005		0.009	0.023	0.006	0.031	0.025	0.018	0.041	
03/03/19	0.021		<0.005	<0.005	<0.005	<0.005	0.006	0.007	0.240	<0.005	0.028	<0.005	0.016	0.010	<0.005	0.007	0.021	<0.005	0.230	0.031	
03/06/18	0.013		0.012	0.014	0.015	0.016	0.018	0.021	0.088	0.014	0.015	0.014		0.013	0.016	0.021	0.026	0.023	0.020	0.009	

Total Hardness (mg/L). — Station Number (WHI****)

Date	143A	SBR01	143E	143H	143B	SBR02	143L	143M	143I	NBC01	143P	143N	WHI024	143K	143J	143S	RDC01	SBR03	143Q	143R	WWTP
01/03/19	112	139	134	145	154	188	169	182	231	238	202	251	208	143	185	160	172	196	158	148	
01/05/01	143	165	167	176	187	220	189	203	230	252	222	271	221	175	198	208	183	216	194	192	
01/06/19	138	179	181	200	216	219	183	194	222	249	199	255	202	183	189	169	192	187	201	194	274
01/08/27	118	164	145	191	197	208	181	182	208	232	192	233	184	192	172	220	177	187	209	209	248
01/11/06	112	162	196	221	214	240	210	219	240	280	226	284	221	197	221	164	186	200	199	183	270
02/01/22	132	158	169	171	178	217	190	200	248	269	220	283	224	175	198	182	180	215	187	188	286
02/01/24	36	43	53	50	40	46	78	55	90	90	94	113	101	87	89	89	66	120	63	47	
02/03/12	38	49	53	57	55	81	82	71	112	118	95	138	106	78	81	104	78	109	75	54	
02/04/08	30	49	40	48	91	150	76	135	100	150	193	221	193	162	167	148	151	186	132	144	
02/04/29	111	145	152	166	168	190	168	184	248	263	209	283	218	162	198	193	185	203	184	186	286
02/06/17									249	254	212	278	216	180	198	192	192	210	204	202	269
02/08/26	144	144	188	198	185	215	204	203	241	263	206	258	209	198	181	170	182	196	194	206	
02/12/03	153	202	199	216	242	268	208	233	230	291	230	288	233	191	203	238	187		210	206	
03/02/24	63	84	93	84	92	113	134	137	158	165	129	177		113	136	108	132	113	111	88	
03/03/19	96		142	154	158	193	176	189	224	233	211	251	212	159	189	182	175	206	166	170	
03/06/18	151		175	184	176	205	195	181	246	254	184	275		170	211	215	196	212	182	181	

APPENDIX WQ-2

Dissolved metals data collected from the Strawberry River watershed, Arkansas.
2001 - 2003

Appendix WQ-2
Metals

Aluminum (ug/L) — Station Number (WHI****)

Date	143A	SBR01	143E	143H	143B	SBR02	143L	143M	143I	NBC01	143P	143N	WHI024	143K	143J	143S	RDC01	SBR03	143Q	143R	WWTP
01/03/19	<127	<127	<127	<127	137	136	148	129	155	158	151	177	142	<127	136	137	142	152	<127	<127	
01/05/01	<127	<127	<127	<127	<127	<127	<127	<127	<127	<127	<127	<127	<127	<127	<127	<127	<127	<127	<127	<127	
01/06/19	<127	<127	<127	<127	<127	<127	<127	<127	<127	<127	<127	<127	<127	<127	<127	<127	<127	<127	<127	<127	<127
01/08/27	<127	165	<127	186	198	156	173	146	158	185	171	169	146	172	163	182	172	137	197	182	233
01/11/06	133	165	197	253	229	237	245	191	223	262	197	271	225	222	260	194	227	235	242	238	307
02/01/22	139	161	174	168	190	219	209	212	242	251	241	292	223	199	236	210	225	226	232	229	298
02/01/24																					
02/03/12	139	156	131	139	154	172	153	170	141	141	<127	144	127	<127	133	148	155	458	150	148	
02/04/08	135	145	142	153	<127	203	148	167	162	210	206	239	219	186	218	193	185	199	170	172	
02/04/29	<127	<127	<127	<127	<127	<127	<127	<127	<127	<127	<127	<127	<127	<127	<127	<127	<127	<127	<127	<127	<127
02/06/17	<127	136	136	140	154	157	158	177	196	197	186	224	193	180	195	193	218	206	223	217	213
02/08/26	163	154	193	208	202	231	226	211	254	243	208	221	205	210	181	172	203	202	217	254	
02/12/03	164	212	230	226	251	282	258	236	187	279	250	294	251	212	235	265	233		240	237	
03/02/24	163	135	<127	<127	<127	<127	<127	<127	<127	<127	170	<127	<127	<127	<127	<127	<127	293	<127	193	
03/03/19	319		127	130	144	157	150	161	168	193	155	196		137	164	180	146	163	225	191	
03/06/18	131		143	157	160	174	166	151	190	194	206	218		154	198	185	179	177	182	181	

Barium (ug/L) — Station Number (WHI****)

Date	143A	SBR01	143E	143H	143B	SBR02	143L	143M	143I	NBC01	143P	143N	WHI024	143K	143J	143S	RDC01	SBR03	143Q	143R	WWTP
01/03/19	51.8	48.7	33.3	32.4	42.5	38.2	37.6	38.8	32.8	29.6	32.5	24.2	34.1	24.4	28.0	33.8	29.5	34.0	31.1	31.8	
01/05/01	98.3	83.2	49.6	59.2	56.4	48.0	39.0	49.5	40.2	36.0	37.6	30.9	40.0	18.2	26.1	43.8	26.1	39.9	28.0	31.4	
01/06/19	266.3	80.2	74.5	70.3	67.1	54.6	52.7	46.2	49.4	39.9	36.8	34.1	38.3	22.9	32.1	48.3	29.1	42.2	37.7	40.9	10.1
01/08/27	320.0	92.2	65.9	71.5	53.3	55.6	86.7	56.2	42.8	30.4	32.5	33.8	39.9	16.2	26.8	66.9	28.5	39.6	36.3	46.4	9.5
01/11/06	176.0	81.6	441.0	84.6	49.0	47.4	49.4	62.8	45.8	35.5	32.0	29.6	33.2	24.7	29.4	42.0	26.9	35.1	36.4	39.6	10.3
02/01/22	68.1	61.3	40.0	36.9	44.9	38.3	39.5	40.5	32.7	30.1	34.2	26.6	33.7	24.1	29.1	35.2	29.1	33.2	32.3	34.8	12.4
02/01/24																					
02/03/12	23.9	28.4	22.6	21.9	25.8	25.7	26.8	24.7	23.2	19.1	20.5	14.6	22.0	21.4	19.8	26.0	24.4	27.6	25.5	24.1	
02/04/08	23.5	32.2	21.0	21.7	34.7	33.2	28.0	35.8	23.9	25.7	30.6	24.1	34.9	27.3	30.8	34.3	30.6	34.0	34.8	31.9	
02/04/29	39.0	49.7	40.4	38.6	44.3	39.2	38.3	34.6	36.0	32.8	35.6	27.0	33.4	23.3	27.1	39.9	27.5	35.3	28.5	35.2	13.0
02/06/17	58.1	60.9	51.9	47.8	50.0	44.4	46.0	46.9	40.8	36.2	37.7	30.3	40.5	23.1	29.2	44.6	29.1	40.7	31.9	35.6	12.3
02/08/26	105.0	65.8	72.2	61.5	54.7	40.0	48.1	52.3	48.1	38.7	35.7	32.2	40.8	18.5	26.5	48.9	25.6	39.2	39.1	32.6	
02/12/03	105.0	66.9	54.1	48.3	39.2	41.9	33.6	44.3	33.5	31.5	28.7	26.3	29.1	15.7	21.2	40.8	23.4		29.1	31.9	
03/02/24	25.9	25.2	22.6	23.2	29.4	22.2	32.5	33.2	22.4	18.4	19.9	14.1		21.5	18.4	24.2	21.8	20.2	22.0	23.1	
03/03/19	42.8		38.0	39.0	43.9	39.5	40.9	41.3	34.5	31.3	34.2	26.7		25.1	29.9	40.8	31.3	36.6	39.7	39.9	
03/06/18	84.3		57.4	49.9	49.1	45.9	49.3	46.2	44.1	35.9	37.8	32.3		28.3	32.8	51.4	35.3	41.3	34.9	37.5	

Appendix WQ-2
Metals

Beryllium (ug/L)

Date	143A	SBR01	143E	143H	143B	SBR02	143L	143M	143I	NBC01	143P	143N	WHI024	143K	143J	143S	RDC01	SBR03	143Q	143R	WWTP
	Station Number (WHI****)																				
01/03/19	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	
01/05/01	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	
01/06/19	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11
01/08/27	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11
01/11/06	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11
02/01/22	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11
02/01/24																					
02/03/12	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	
02/04/08	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	
02/04/29	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11
02/06/17	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11
02/08/26	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	
02/12/03	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	
03/02/24	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	
03/03/19	<0.11		<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	0.12	<0.11	<0.11		<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	
03/06/18	<0.11		<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11		<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	

Boron (ug/L)

Date	143A	SBR01	143E	143H	143B	SBR02	143L	143M	143I	NBC01	143P	143N	WHI024	143K	143J	143S	RDC01	SBR03	143Q	143R	WWTP
	Station Number (WHI****)																				
01/03/19	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	4.7	<4.5	<4.5	<4.5	<4.5	<4.5	4.6	<4.5	<4.5	<4.5	4.6	5.0	
01/05/01	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	7.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	
01/06/19	7.7	7.1	8.7	7.3	8.4	6.9	7.2	5.0	25.1	7.5	7.0	6.0	6.8	<4.5	7.2	8.2	5.6	7.0	7.4	7.2	173.8
01/08/27	12.0	6.1	4.9	6.8	7.0	5.1	<4.5	<4.5	15.2	<4.5	<4.5	5.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	111.0
01/11/06	14.4	9.6	7.2	10.9	7.5	<4.5	<4.5	<4.5	21.1	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	5.3	<4.5	<4.5	<4.5	<4.5	165.0
02/01/22	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	171.0
02/01/24																					
02/03/12	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	5.7	<4.5	<4.5	<4.5	<4.5	<4.5	
02/04/08	8.7	6.6	5.9	5.9	<4.5	<4.5	<4.5	<4.5	5.2	<4.5	<4.5	<4.5	<4.5	<4.5	7.1	6.3	<4.5	<4.5	8.8	6.5	
02/04/29	<4.5	<4.5	<4.5	<4.5	<4.5	5.7	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	160.2
02/06/17	5.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	6.5	<4.5	218.0
02/08/26	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	11.5	<4.5	<4.5	<4.5	<4.5	<4.5	5.4	8.8	<4.5	<4.5	<4.5	<4.5	
02/12/03	<4.5	4.7	<4.5	4.8	4.7	<4.5	<4.5	<4.5	12.4	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	4.7	<4.5	<4.5	5.6	8.3	
03/02/24	6.3	5.7	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	
03/03/19	4.7		<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5		<4.5	<4.5	<4.5	<4.5	<4.5	4.9	4.6	
03/06/18	6.9		12.0	9.6	7.8	8.4	9.6	9.0	10.0	6.9	8.7	8.6		5.6	4.5	7.8	7.6	7.2	9.2	9.5	

Appendix WQ-2
Metals

Cadmium (ug/L)	Station Number (WHI****)																			
Date	143A	SBR01	143E	143H	143B	SBR02	143L	143M	143I	NBC01	143P	143N	WHI024	143K	143J	143S	RDC01	SBR03	143Q	143R	WWTP
01/03/19	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	
01/05/01	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	0.26	<0.14	0.15	<0.14	<0.14	<0.14	<0.14	
01/06/19	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	0.22
01/08/27	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14
01/11/06	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14
02/01/22	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	0.22
02/01/24																					
02/03/12	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	
02/04/08	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	
02/04/29	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14
02/06/17	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14
02/08/26	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	1.24	<0.14	0.61	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	
02/12/03	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	
03/02/24	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	
03/03/19	<0.14		<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14		<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	
03/06/18	<0.14		<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14		<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	

Calcium (ug/L)	Station Number (WHI****)																			
Date	143A	SBR01	143E	143H	143B	SBR02	143L	143M	143I	NBC01	143P	143N	WHI024	143K	143J	143S	RDC01	SBR03	143Q	143R	WWTP
01/03/19	22.9	28.6	27.5	29.2	31.2	39.2	35.7	38.9	47.2	47.5	41.3	51.9	43.0	32.0	38.8	34.8	37.9	41.0	36.0	34.1	
01/05/01	29.0	33.2	33.2	33.9	36.4	44.4	39.9	41.6	42.7	45.7	45.3	53.2	45.0	38.8	42.1	45.0	41.6	45.1	44.1	43.6	
01/06/19	27.9	36.1	36.6	39.8	42.5	42.4	38.0	41.7	39.4	48.2	39.3	50.9	41.0	40.5	40.6	35.8	43.8	39.4	46.2	44.4	56.4
01/08/27	24.5	33.8	28.0	32.7	36.5	39.5	35.8	32.7	38.6	40.9	37.5	41.7	32.2	41.8	31.0	42.4	38.2	36.0	47.4	46.9	47.7
01/11/06	23.6	33.6	40.7	41.6	42.9	50.0	45.5	43.9	43.8	55.6	48.3	62.6	45.3	43.8	47.8	35.7	40.7	40.2	44.9	40.5	56.5
02/01/22	26.5	32.2	34.4	34.3	35.6	45.2	39.1	42.4	50.4	54.6	44.0	58.2	46.8	37.8	41.2	39.8	39.4	45.2	42.4	43.4	58.8
02/01/24																					
02/03/12	7.4	9.6	10.6	11.4	11.3	16.4	16.9	14.7	23.1	24.7	20.7	30.1	22.8	18.4	17.8	22.4	18.1	23.2	16.4	11.8	
02/04/08	6.1	9.9	8.2	10.0	19.1	30.6	16.1	28.5	20.8	30.9	41.8	46.3	41.0	35.8	36.0	32.5	34.7	41.4	29.1	33.1	
02/04/29	23.9	31.4	32.7	34.5	34.8	39.3	37.1	41.7	53.5	56.4	45.4	62.4	48.8	36.4	45.1	44.5	43.9	44.0	42.5	44.1	59.8
02/06/17	25.4	32.0	33.0	35.9	36.9	40.2	40.4	41.3	50.1	50.3	43.5	56.1	44.8	39.4	42.2	41.2	43.3	44.2	45.9	45.3	54.2
02/08/26	28.8	28.2	37.5	39.2	36.4	40.4	43.5	38.8	44.4	48.9	39.7	49.5	40.6	41.4	36.5	35.7	40.9	39.4	44.1	46.9	
02/12/03	30.3	39.7	39.3	43.0	49.1	54.3	44.6	48.1	41.4	57.8	46.7	58.3	48.0	41.9	43.2	51.7	42.0		48.4	47.2	
03/02/24	12.0	16.2	18.3	16.8	18.4	23.1	28.2	28.7	32.9	33.8	26.7	37.0		25.4	29.7	23.9	29.6	23.7	24.8	19.7	
03/03/19	18.8		28.7	29.9	30.6	37.8	36.5	37.6	44.0	43.6	42.4	50.0		35.2	38.5	37.9	38.9	43.0	35.7	37.6	
03/06/18	30.6		36.0	37.9	35.5	41.7	41.6	38.8	49.7	49.5	38.7	54.8		38.3	45.6	46.9	45.5	45.4	41.7	41.2	

Appendix WQ-2
Metals

Chromium (ug/L)	Station Number (WHI****)																			
Date	143A	SBR01	143E	143H	143B	SBR02	143L	143M	143I	NBC01	143P	143N	WHI024	143K	143J	143S	RDC01	SBR03	143Q	143R	WWTP
01/03/19	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	
01/05/01	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	
01/06/19	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
01/08/27	0.6	0.6	0.8	0.9	0.8	0.7	0.7	0.7	0.8	0.7	0.7	0.5	0.8	0.6	0.6	0.6	0.5	0.7	1.0	0.6	0.7
01/11/06	<0.4	0.6	0.6	0.9	0.9	1.0	0.7	0.8	0.9	0.5	<0.4	<0.4	0.5	0.4	0.4	<0.4	<0.4	<0.4	<0.4	<0.4	0.5
02/01/22	0.6	<0.4	0.9	0.6	0.8	0.5	0.7	0.7	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
02/01/24																					
02/03/12	0.8	0.9	0.7	0.7	0.6	1.1	1.1	0.8	0.5	0.5	0.8	<0.4	0.4	0.6	0.6	0.6	0.8	1.1	0.7	0.8	
02/04/08	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	
02/04/29	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
02/06/17	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
02/08/26	0.8	0.8	0.9	1.1	1.0	1.1	1.2	1.3	1.8	1.1	1.2	1.0	0.7	1.0	1.2	0.7	1.0	1.2	0.9	1.1	
02/12/03	1.0	0.9	0.8	0.9	1.0	0.9	0.7	0.8	1.1	0.8	0.9	0.8	0.5	0.6	0.9	0.9	0.7	<0.4	0.5	0.7	
03/02/24	<0.4	<0.4	<0.4	0.44	<0.4	<0.4	0.43	<0.4	0.72	<0.4	0.74	<0.4	<0.4	<0.4	<0.4	0.45	<0.4	<0.4	<0.4	<0.4	
03/03/19	0.43		<0.4	0.41	<0.4	<0.4	<0.4	<0.4	0.55	0.59	0.85	0.66		0.68	0.74	0.65	0.63	0.71	0.53	0.6	
03/06/18	<0.4		<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4		<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	

Cobalt (ug/L)	Station Number (WHI****)																			
Date	143A	SBR01	143E	143H	143B	SBR02	143L	143M	143I	NBC01	143P	143N	WHI024	143K	143J	143S	RDC01	SBR03	143Q	143R	WWTP
01/03/19	0.79	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	
01/05/01	0.68	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	
01/06/19	2.42	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.77	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
01/08/27	1.4	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.69	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
01/11/06	<0.50	<0.50	1.9	<0.50	<0.50	<0.50	<0.50	<0.50	0.69	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
02/01/22	1.08	0.56	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
02/01/24																					
02/03/12	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	
02/04/08	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	
02/04/29	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	
02/06/17	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
02/08/26	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	
02/12/03	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.60	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	
03/02/24	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	
03/03/19	<0.50		<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50		<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	
03/06/18	<0.50		<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50		<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	

Appendix WQ-2
Metals

Copper (ug/L) — Station Number (WHI****)

Date	143A	SBR01	143E	143H	143B	SBR02	143L	143M	143I	NBC01	143P	143N	WHI024	143K	143J	143S	RDC01	SBR03	143Q	143R	WWTP
01/03/19	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	
01/05/01	0.50	0.83	<0.50	<0.50	0.69	<0.50	<0.50	<0.50	0.63	<0.50	<0.50	<0.50	<0.50	7.19	<0.50	1.70	<0.50	<0.50	<0.50	<0.50	
01/06/19	<0.50	<0.50	<0.50	<0.50	<0.50	0.67	<0.50	0.53	0.57	<0.50	<0.50	0.58	<0.50	<0.50	<0.50	0.92	<0.50	0.51	<0.50	1.07	12.05
01/08/27	<0.50	0.77	0.55	0.94	0.57	<0.50	0.69	0.54	0.93	<0.50	1.01	<0.50	0.78	<0.50	<0.50	0.81	1.90	0.50	<0.50	<0.50	7.31
01/11/06	<0.50	<0.50	<0.50	<0.50	2.57	1.23	<0.50	<0.50	1.21	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	6.76
02/01/22	1.27	<0.50	0.51	0.50	<0.50	<0.50	0.73	<0.50	0.55	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.70	<0.50	<0.50	<0.50	<0.50	5.46
02/01/24																					
02/03/12	0.76	1.01	0.60	0.67	0.87	0.67	0.81	1.06	<0.50	<0.50	0.58	<0.50	0.61	0.56	0.91	<0.50	1.58	1.08	1.13	1.39	
02/04/08	0.99	1.28	0.92	1.10	0.79	0.79	1.43	0.74	0.86	<0.50	<0.50	<0.50	<0.50	<0.50	8.10	0.71	1.32	<0.50	1.53	<0.50	
02/04/29	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.78	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	9.39
02/06/17	0.77	<0.50	<0.50	0.89	<0.50	1.89	<0.50	0.66	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	8.43
02/08/26	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	6.16	<0.50	3.06	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	
02/12/03	<0.50	0.68	<0.50	<0.50	0.59	0.56	0.78	<0.50	1.71	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	1.08	0.64	<0.50	<0.50	<0.50	
03/02/24	<0.50	<0.50	<0.50	<0.50	0.61	3.86	1.19	1.20	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.57	1.04	<0.50	<0.50	<0.50	0.59	
03/03/19	<0.50		<0.50	<0.50	<0.50	<0.50	0.85	<0.50	1.68	<0.50	<0.50	<0.50		<0.50	<0.50	<0.50	<0.50	<0.50	0.98	0.81	
03/06/18	<0.50		<0.50	0.59	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50		<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	

Iron (ug/L) — Station Number (WHI****)

Date	143A	SBR01	143E	143H	143B	SBR02	143L	143M	143I	NBC01	143P	143N	WHI024	143K	143J	143S	RDC01	SBR03	143Q	143R	WWTP
01/03/19	109.0	114.0	26.1	24.3	45.1	39.9	37.2	43.5	33.0	33.8	41.7	39.7	46.5	57.4	65.8	62.4	51.8	45.9	53.9	54.6	
01/05/01	116.0	54.0	47.3	42.9	44.4	49.9	43.2	42.9	43.9	52.7	44.5	47.0	39.4	53.1	72.0	93.2	71.0	39.2	47.5	44.1	
01/06/19	884.0	43.9	47.9	48.5	43.6	40.5	34.6	39.9	46.0	53.2	37.9	44.7	35.9	41.0	43.5	60.5	40.4	32.7	40.9	41.0	127.0
01/08/27	99.4	27.4	45.4	28.1	36.7	36.7	21.4	35.6	54.5	48.4	30.8	35.8	28.2	40.9	42.3	72.3	54.3	26.8	28.6	30.8	113.0
01/11/06	18.9	84.4	149.0	50.7	51.3	52.4	48.0	43.1	32.9	43.0	43.2	38.9	46.0	63.3	61.3	120.0	57.3	59.5	58.0	208.0	100.0
02/01/22	200.0	55.3	31.7	26.0	35.2	38.8	41.3	38.3	34.9	38.4	42.3	39.9	43.1	38.6	57.1	60.9	59.3	50.7	48.0	54.0	87.8
02/01/24																					
02/03/12	91.5	128.0	73.9	92.6	135.0	105.0	75.3	120.0	93.3	78.1	87.3	78.6	94.5	92.4	112.0	87.8	149.0	286.0	126.0	170.0	
02/04/08	136.0	167.0	133.0	162.0	110.0	83.7	124.0	65.0	98.6	94.6	73.5	76.5	65.0	79.9	87.9	95.5	73.1	68.3	125.0	82.8	
02/04/29	74.3	117.0	73.6	67.3	79.8	86.1	86.2	75.9	96.6	102.0	89.5	102.0	83.9	93.4	89.8	107.0	90.9	87.7	87.7	101.0	157.0
02/06/17	97.0	88.3	85.9	77.3	75.6	94.3	92.5	96.9	95.0	103.0	82.2	109.0	97.1	80.5	80.7	124.0	79.6	74.6	66.1	85.6	195.0
02/08/26	308.0	68.7	63.6	65.8	71.4	70.8	61.9	71.5	72.7	85.6	76.5	58.3	68.0	25.4	67.2	132.0	73.5	71.0	67.7	63.2	
02/12/03	128.0	48.7	42.8	46.5	55.4	61.0	46.4	55.1	56.3	64.4	48.8	57.9	56.0	39.5	52.1	99.7	41.2		45.4	47.7	
03/02/24	174.0	132.0	61.9	61.1	104.0	97.3	67.0	72.3	68.6	52.5	120.0	50.6		61.9	84.0	116.0	84.3	181.0	119.0	209.0	
03/03/19	185.0		67.5	62.0	66.6	72.8	68.1	72.1	76.8	78.1	72.0	82.0		68.4	83.2	101.0	74.6	78.9	169.0	161.0	
03/06/18	72.8		67.1	72.0	62.9	74.2	69.3	71.7	88.4	93.8	102.0	102.0		67.5	83.3	103.0	71.8	78.0	79.4	82.2	

Appendix WQ-2
Metals

Lead (ug/L)	Station Number (WHI****)																			
Date	143A	SBR01	143E	143H	143B	SBR02	143L	143M	143I	NBC01	143P	143N	WHI024	143K	143J	143S	RDC01	SBR03	143Q	143R	WWTP
01/03/19	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	
01/05/01	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	1.79	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	
01/06/19	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
01/08/27	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
01/11/06	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
02/01/22	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	1.09
02/01/24																					
02/03/12	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	0.5	<0.4	<0.4	
02/04/08	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	0.5	<0.4	1.42	<0.4	<0.4	<0.4	
02/04/29	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	1.19
02/06/17	<0.4	<0.4	<0.4	<0.4	<0.4	0.44	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
02/08/26	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	0.94	<0.4	0.66	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	
02/12/03	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	
03/02/24	QA	QA	QA	QA	QA	QA	QA	QA	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	
03/03/19	<0.4		<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4		<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	
03/06/18	<0.4		<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4		<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	

Magnesium (ug/L)	Station Number (WHI****)																			
Date	143A	SBR01	143E	143H	143B	SBR02	143L	143M	143I	NBC01	143P	143N	WHI024	143K	143J	143S	RDC01	SBR03	143Q	143R	WWTP
01/03/19	13.2	16.5	15.9	17.6	18.5	22	19.4	20.7	27.5	29.1	24	29.4	24.5	15.4	21.3	17.7	18.7	22.7	16.5	15.3	
01/05/01	17.1	19.9	20.5	22.1	23.4	26.5	21.8	24.2	30.1	33.4	26.4	33.6	26.3	18.9	22.5	23.2	19.2	25.2	20.3	20.2	
01/06/19	16.7	21.6	21.9	24.5	26.6	27.5	21.3	21.7	30.1	31.2	24.4	31.2	24.3	19.8	21.4	19.2	20	21.6	20.8	20.2	32.3
01/08/27	13.7	19.3	18.2	26.6	25.6	26.6	22.2	24.3	27.1	31.5	23.8	31.4	25.2	21.4	23	27.7	19.9	23.6	22.1	22.3	31.4
01/11/06	13	19	22.9	28.4	25.9	28	23.5	26.5	31.7	34.2	25.7	31	26.2	21.3	24.6	18.1	20.5	24.3	21	20	31.4
02/01/22	16.1	18.8	20.1	20.8	21.7	25.4	22.4	22.9	29.7	32.2	26.7	33.5	26	19.6	23.1	20	19.8	24.7	19.6	19.3	33.9
02/01/24																					
02/03/12	4.8	6.2	6.5	6.9	6.6	9.8	9.7	8.3	13.3	13.7	10.6	15.2	12	7.8	8.8	11.7	8.1	12.4	8.2	6	
02/04/08	3.7	6	4.7	5.6	10.5	17.8	8.6	15.4	11.7	17.7	21.4	25.7	21.9	17.6	18.8	16.3	15.5	20	14.3	14.9	
02/04/29	12.4	16.1	17	19.3	19.6	22.3	18.3	19.3	27.9	29.7	23.3	30.8	23.4	17.3	20.8	19.9	18.4	22.6	19	18.5	33.2
02/06/17	15.1	18.6	19.3	21.1	21.6	23.9	22.3	23.4	30	31.3	25.2	33.6	25.4	19.7	22.5	21.7	20.3	24.1	21.7	21.5	32.4
02/08/26	21.7	17.9	22.9	24.2	22.9	27.6	23.2	25.8	31.6	34.2	25.9	32.6	26.1	21.4	21.8	19.6	19.3	23.7	20.4	21.5	
02/12/03	18.8	25.1	24.5	26.4	29.1	32.1	23.4	27.3	30.7	35.6	27.5	34.7	27.5	21	23	26.5	20		21.7	21.4	
03/02/24	7.91	10.6	11.4	10.3	11.3	13.4	15.5	15.8	18.4	19.5	15.1	20.6		11.9	14.9	11.7	14	13	11.8	9.51	
03/03/19	11.9		17.2	19.3	19.9	24	21.2	23.1	27.6	30.1	25.6	30.6		17.3	22.6	21.1	18.8	24	18.7	18.6	
03/06/18	18		20.7	21.8	21.1	24.5	22.2	20.4	29.5	31.6	21.1	33.6		18	23.6	23.8	20.1	23.9	19	18.9	

Appendix WQ-2
Metals

Manganese (ug/L) — Station Number (WHI****)

Date	143A	SBR01	143E	143H	143B	SBR02	143L	143M	143I	NBC01	143P	143N	WHI024	143K	143J	143S	RDC01	SBR03	143Q	143R	WWTP
01/03/19	240.0	105.0	26.5	15.6	24.5	11.8	29.5	17.6	6.4	4.4	14.8	5.0	21.1	17.6	59.9	58.4	70.1	34.2	102.0	91.0	
01/05/01	321.1	93.5	69.9	98.0	45.6	28.6	58.3	19.0	10.9	8.5	18.4	13.0	17.5	14.4	41.8	90.1	65.3	19.6	89.5	57.0	
01/06/19	1639.0	93.2	122.4	93.2	29.8	22.1	32.9	56.5	39.5	8.5	13.3	18.0	23.5	20.7	52.2	92.0	42.1	23.5	102.6	77.0	1.8
01/08/27	1410.0	91.9	114.0	3.6	20.0	14.6	15.9	105.0	61.7	3.6	5.8	9.3	13.0	12.2	35.6	390.0	27.7	13.7	100.0	67.7	<.5
01/11/06	3.7	222.0	3230.0	52.3	19.4	16.2	68.7	20.2	2.1	1.8	10.7	4.6	20.5	35.2	72.2	42.8	64.1	38.0	99.8	269.0	1.4
02/01/22	362.0	223.0	22.3	23.5	32.5	16.1	33.5	19.3	3.7	4.4	12.3	5.4	23.8	30.8	78.6	62.0	86.7	43.9	108.0	126.0	18.8
02/01/24																					
02/03/12	31.0	28.8	10.9	11.7	15.9	7.9	16.7	10.0	8.1	4.0	4.8	2.9	8.4	21.0	16.7	10.7	26.9	38.4	34.8	49.9	
02/04/08	32.0	46.8	16.1	14.8	22.2	14.4	18.7	12.7	8.9	7.0	15.5	4.3	26.6	87.3	60.1	58.8	67.4	45.5	101.0	114.0	
02/04/29	102.0	34.8	27.5	18.5	20.6	12.0	19.2	9.7	3.0	9.4	14.9	5.3	16.9	22.4	49.3	53.4	64.1	87.5	79.9	176.8	<.5
02/06/17	105.0	36.7	37.9	24.6	16.8	19.3	38.9	12.9	8.8	10.5	16.7	5.1	16.4	17.7	42.0	65.7	50.8	60.1	79.3	59.0	1.6
02/08/26	217.0	114.0	50.9	39.3	46.0	29.2	30.5	35.0	26.3	8.5	11.3	8.6	19.5	9.7	19.4	130.0	31.5	29.1	51.3	57.9	
02/12/03	177.0	22.3	21.7	17.1	9.3	10.1	17.4	2.4	1.8	1.2	7.3	1.3	22.0	4.1	28.1	44.3	31.9		50.0	23.6	
03/02/24	81.7	47.1	13.9	17.0	18.7	8.8	19.1	11.3	7.5	2.8	7.2	2.3		15.4	24.2	29.7	48.6	10.0	60.2	44.0	
03/03/19	134.0		47.3	29.7	36.0	20.8	51.0	22.3	9.8	6.4	25.4	7.3		20.9	52.9	88.6	76.9	41.5	134.0	117.0	
03/06/18	328.0		90.3	37.2	25.1	14.6	56.5	20.8	15.9	8.2	17.4	8.1		16.6	55.8	100.0	62.0	23.0	76.1	35.2	

Nickel (ug/L) — Station Number (WHI****)

Date	143A	SBR01	143E	143H	143B	SBR02	143L	143M	143I	NBC01	143P	143N	WHI024	143K	143J	143S	RDC01	SBR03	143Q	143R	WWTP
01/03/19	QA	QA	QA	QA	QA	QA	QA	QA	QA	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	
01/05/01	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	2.74	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	
01/06/19	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	3.74
01/08/27	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	3.42
01/11/06	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	7.57	<2.0	<2.0	<2.0	<2.0	<2.0	2.73
02/01/22	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	?2.86
02/01/24																					
02/03/12	3.18	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	
02/04/08	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	
02/04/29	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	2.14	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	4.54
02/06/17	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	3.66
02/08/26	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	2.64	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	
02/12/03	<2.0	<2.0	<2.0	<2.0	<2.0	2.1	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	
03/02/24	<2.0	<2.0	<2.0	<2.0	<2.0	2.14	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	
03/03/19	<2.0		<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0		<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	
03/06/18	<2.0		<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0		<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	

Appendix WQ-2
Metals

Potassium (ug/L) — Station Number (WHI****)

Date	143A	SBR01	143E	143H	143B	SBR02	143L	143M	143I	NBC01	143P	143N	WHI024	143K	143J	143S	RDC01	SBR03	143Q	143R	WWTP
01/03/19	1.10	1.00	0.60	0.90	1.50	1.00	1.20	1.20	1.30	1.40	0.50	<0.46	<0.46	<0.46	<0.46	0.50	0.60	1.30	0.60	<0.46	
01/05/01	9.40	3.30	1.70	2.00	2.00	2.10	4.10	1.70	2.70	1.70	1.50	1.40	1.60	1.20	1.30	1.80	1.40	1.80	1.60	1.60	
01/06/19	2.00	1.25	0.71	1.20	1.01	<0.46	1.00	<0.46	1.11	0.92	<0.46	0.68	0.46	<0.46	0.59	<0.46	<0.46	<0.46	<0.46	<0.46	15.60
01/08/27	2.20	3.10	2.80	3.30	2.40	2.30	1.50	2.40	2.60	1.50	2.00	1.70	0.80	<0.46	0.50	2.80	0.60	0.60	0.70	0.80	14.70
01/11/06	5.30	4.70	3.80	4.40	2.80	2.60	1.50	3.10	3.00	0.90	2.20	2.20	1.40	1.70	0.90	2.40	<0.46	1.10	0.60	0.80	14.40
02/01/22	<0.46	<0.46	1.30	1.40	1.30	2.30	0.90	0.80	<0.46	<0.46	<0.46	<0.46	<0.46	<0.46	<0.46	<0.46	<0.46	0.80	<0.46	<0.46	13.10
02/01/24																					
02/03/12	2.60	2.30	2.20	2.30	2.30	2.00	2.20	2.20	2.00	1.40	1.20	0.60	1.30	1.30	1.80	1.30	2.60	1.90	2.10	2.60	
02/04/08	2.40	2.50	2.00	2.30	2.20	1.30	2.40	1.20	2.20	1.40	1.20	0.80	1.20	1.10	1.70	1.90	1.80	1.40	3.00	1.40	
02/04/29	<0.46	1.10	0.90	0.70	0.60	2.00	<0.46	<0.46	<0.46	<0.46	<0.46	<0.46	<0.46	<0.46	<0.46	<0.46	<0.46	<0.46	<0.46	<0.46	14.10
02/06/17	1.90	1.50	1.20	1.80	1.00	0.60	<0.46	<0.46	1.00	0.90	1.10	1.10	1.30	1.00	1.30	1.50	1.20	1.70	1.30	1.40	14.30
02/08/26	1.90	2.50	2.30	1.80	2.30	1.70	1.10	1.40	1.90	1.10	1.10	<0.46	1.00			1.37	0.60	1.40	1.30	0.70	
02/12/03	2.24	2.21	1.23	1.43	1.48	1.40	1.08	1.32	1.95	0.90	0.88	0.70	0.95	0.72	0.57		0.80		0.79	1.01	
03/02/24	2.51	2.00	1.96	2.26	2.95	2.69	2.26	2.19	2.12	1.34	2.68	1.64		2.00	1.81	2.33	2.15	2.75	2.37	3.02	
03/03/19	1.41		0.76	0.92	0.76	0.67	<0.46	<0.46	0.51	<0.46	0.49	<0.46		<0.46	0.56	1.04	0.82	0.80	3.08	1.94	
03/06/18	1.87		2.25	2.03	1.67	1.79	1.79	2.12	2.07	1.59	2.21	1.72		1.19	1.20	1.57	1.53	1.65	1.30	1.24	

Sodium (ug/L) — Station Number (WHI****)

Date	143A	SBR01	143E	143H	143B	SBR02	143L	143M	143I	NBC01	143P	143N	WHI024	143K	143J	143S	RDC01	SBR03	143Q	143R	WWTP
01/03/19	1.7	1.6	1.6	2.0	1.7	2.1	1.7	2.0	2.9	2.2	1.4	1.0	1.5	1.2	1.0	1.6	1.1	1.6	2.0	2.2	
01/05/01	5.1	2.9	2.1	2.5	2.6	2.8	4.2	2.2	5.6	2.4	2.3	1.9	2.1	1.8	2.0	2.6	2.4	2.6	2.3	2.1	
01/06/19	<0.12	<0.12	<0.12	<0.12	1.4	<0.12	<0.12	<0.12	9.4	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	82.3
01/08/27	2.6	1.8	1.9	3.0	3.3	2.5	2.0	2.6	11.0	2.4	2.4	1.5	0.9	0.8	0.5	2.3	1.3	1.8	2.0	2.1	81.6
01/11/06	3.2	2.4	3.2	6.0	3.9	3.2	2.9	3.3	14.9	2.4	3.1	3.2	1.9	2.7	2.1	2.5	2.0	1.6	2.4	2.0	59.8
02/01/22	1.5	1.5	2.0	2.3	2.1	2.4	1.9	1.9	3.3	1.8	1.4	0.9	1.5	1.3	1.2	1.7	1.8	2.2	1.6	1.7	62.0
02/01/24																					
02/03/12	1.0	0.8	1.1	1.2	1.1	1.2	1.3	1.0	1.1	1.0	0.8	0.8	1.2	1.1	0.8	1.1	1.4	1.1	1.2	1.2	
02/04/08	0.3	0.3	0.3	0.5	0.8	0.8	0.6	0.8	1.0	1.1	1.3	0.9	1.6	1.2	1.5	1.6	1.8	1.5	2.3	1.9	
02/04/29	0.9	1.1	1.4	1.3	1.1	1.8	1.0	1.1	1.9	1.3	1.0	0.9	1.2	0.8	1.0	1.3	1.4	1.1	1.2	1.5	56.5
02/06/17	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	2.8	1.9	1.7	1.7	1.7	1.5	1.6	1.9	1.9	2.1	2.0	2.0	64.0
02/08/26	1.6	1.2	1.9	2.1	2.2	1.7	1.6	1.7	6.8	1.9	1.6	0.6	1.5	0.4	0.9	0.8	1.5	1.7	1.9	1.8	
02/12/03	1.7	1.3	1.3	2.8	2.8	2.0	1.6		11.7	1.5	1.4	1.3	1.5	1.1	1.1	1.9	1.4		1.8	1.8	
03/02/24	0.9	1.3	2.0	<3.0	2.0	2.1	2.3	2.4	2.5	1.9	1.7	1.3		1.9	2.0	2.1	2.5	1.6	2.2	2.3	
03/03/19	1.4		1.5	1.8	1.7	1.6	1.7	1.6	2.5	1.6	1.6	1.2		1.4	1.5	2.3	1.9	2.0	3.1	3.6	
03/06/18	1.9		3.2	2.4	2.1	2.0	1.9	1.6	4.0	2.1	1.5	1.8		1.5	1.6	2.1	2.1	2.1	1.9	1.8	

Appendix WQ-2
Metals

Vanadium (ug/L)	Station Number (WHI****)																			
Date	143A	SBR01	143E	143H	143B	SBR02	143L	143M	143I	NBC01	143P	143N	WHI024	143K	143J	143S	RDC01	SBR03	143Q	143R	WWTP
01/03/19	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.1	<1.0	<1.0	<1.0	1.1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
01/05/01	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.3	1.3	1.4	1.3	1.5	1.1	1.1	1.1	<1.0	1.6	1.0	1.3	
01/06/19	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.1	<1.0	<1.0	<1.0	<1.0	1.1	<1.0	<1.0	1.7
01/08/27	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.5
01/11/06	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.0
02/01/22	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.4
02/01/24																					
02/03/12	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
02/04/08	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
02/04/29	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.4
02/06/17	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.2
02/08/26	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
02/12/03	<1.0	<1.0	<1.0	<1.0	<1.0	0.4	<1.0	<1.0	1.2	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
03/02/24	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
03/03/19	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
03/06/18	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.1	1.5	<1.0	1.1	<1.0		<1.0	<1.0	<1.0	<1.0	1.2	<1.0	<1.0	

Zinc (ug/L)	Station Number (WHI****)																			
Date	143A	SBR01	143E	143H	143B	SBR02	143L	143M	143I	NBC01	143P	143N	WHI024	143K	143J	143S	RDC01	SBR03	143Q	143R	WWTP
01/03/19	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.1	<1.0	1.3	<1.0	1.2	1.3	<1.0	<1.0	
01/05/01	2.1	3.6	2.1	2.2	2.9	2.8	2.7	3.0	3.0	2.5	1.5	1.8	1.9	1.5	4.1	2.7	1.8	<1.0	2.8	1.3	
01/06/19	1.1	<1.0	2.7	2.1	4.4	1.7	<1.0	8.3	1.6	<1.0	1.4	1.8	<1.0	3.2	1.8	<1.0	<1.0	<1.0	1.7	3.8	101.7
01/08/27	1.1	<1.0	1.9	2.2	2.4	1.1	1.4	2.4	3.2	1.0	1.9	3.7	2.7	<1.0	1.5	5.2	3.4	1.9	1.4	1.1	60.8
01/11/06	1.4	1.2	1.0	1.8	3.2	9.8	1.1	<1.0	3.0	<1.0	<1.0	<1.0	<1.0	1.1	<1.0	<1.0	<1.0	<1.0	2.4	1.0	69.4
02/01/22	2.9	1.4	2.2	1.1	<1.0	1.8	1.9	1.6	23.5	24.2	20.0	18.4	18.3	16.2	23.0	22.8	20.5	19.9	28.2	26.0	111.0
02/01/24	QA	QA	QA	QA	QA	QA	QA	QA	QA	QA	QA	QA	QA	QA	QA	QA	QA	QA	QA	QA	
02/03/12	10.8	8.3	8.5	9.2	11.4	13.6	12.7	13.3	6.6	8.4	6.6	12.7	12.3	10.1	11.1	6.9	12.3	13.1	8.3	10.3	
02/04/08	13.8	15.3	13.1	12.7	12.1	30.1	12.7	10.9	11.2	12.0	14.0	10.6	11.3	11.8	21.2	12.5	27.0	11.1	13.2	12.2	
02/04/29	QA	QA	QA	QA	QA	QA	QA	QA	QA	QA	QA	QA	QA	QA	QA	QA	QA	QA	QA	QA	QA
02/06/17	5.4	5.2	4.7	4.7	4.2	4.3	3.0	4.3	6.4	5.9	6.2	7.4	27.8	10.9	8.5	5.9	7.9	5.2	5.2	8.8	75.9
02/08/26	20.7	22.2	13.3	8.3	11.0	8.9	7.8	8.4	13.0	7.1	11.9	23.0	15.6	16.5	7.9	7.2	15.5	15.7	21.2	9.6	
02/12/03	8.4	7.7	5.0	7.7	10.5	14.3	12.0	14.7	8.0	34.8	8.1	10.1	9.3	41.7	7.8	8.8	38.4		12.2	37.7	
03/02/24	20.7	27.6	30.1	26.7	52.8	39.1	19.0	22.2	24.6	20.5	17.7	22.5		20.0	28.9	25.5	24.4	26.6	19.5	24.7	
03/03/19	7.1		2.9	<1.0	2.5	4.2	1.9	7.4	1.2	<1.0	3.1	1.3		3.7	<1.0	<1.0	<1.0	5.0	4.2	2.9	
03/06/18	<1.0		7.3	2.5	2.3	<1.0	<1.0	<1.0	1.8	1.1	<1.0	1.7		<1.0	<1.0	<1.0	<1.0	1.6	3.1	3.1	

APPENDIX GW-1

Ground water quality data collected from the
Strawberry River watershed, Arkansas.
2001 - 2003

Appendix GW-1

Ground water quality data from wells and springs collected during the Strawberry River Watershed survey.

Station_ID	Longitude	Latitude	Depth (feet)	pH	Temp. deg. C	Conductance µS/cm	Aluminum µg/L	Arsenic µg/L	Barium µg/L	Beryllium µg/L	Boron µg/L	Cadmium µg/L	Calcium mg/L
FUL100	-91.960703	36.274686	400	8.26	16.9	251	<127	<1	12.4	<0.11	<4.5	<0.14	27.4
FUL101	-91.945215	36.293131	280	5.90	16.0	58	<127	<1	12.6	<0.11	<4.5	<0.14	4.6
FUL102	-91.956683	36.315454	134	7.90	15.8	513	<127	<1	28.5	<0.11	<4.5	<0.14	55.0
FUL103	-91.964195	36.322513	142	7.82	15.8	527	<127	<1	39.2	<0.11	<4.5	<0.14	59.5
FUL104	-91.910371	36.296520	207	7.92	15.9	465	<127	<1	20.6	<0.11	<4.5	<0.14	52.0
FUL105	-91.890877	36.291274	175	7.58	16.2	652	<127	<1	24.9	<0.11	<4.5	<0.14	75.0
FUL106	-91.803347	36.315615	260	8.30	15.2	409	<127	<1	23.0	<0.11	<4.5	<0.14	46.6
FUL107	-91.970499	36.333050	Spring	7.08	15.0	496	282	<1	25.1	<0.11	<4.5	<0.14	57.4
FUL108	-91.973150	36.333824	284	7.31	17.0	555	314	<1	26.1	<0.11	<4.5	<0.14	64.9
IZA100	-91.693670	36.040741	150	7.34	17.9	366	<127	<1	18.4	<0.11	<4.5	<0.14	43.9
IZA101	-91.728258	36.094543	147	7.41	16.2	536	<127	<1	22.9	<0.11	7.30	<0.14	65.8
IZA102	-91.798866	36.167251	105	7.44	15.9	229	<127	<1	19.6	<0.11	<4.5	<0.14	22.1
IZA103	-91.733124	36.166441	70	7.16	16.5	576	<127	<1	41.7	<0.11	<4.5	<0.14	71.1
IZA104	-91.728239	36.165884	600	7.55	17.5	510	<127	<1	28.1	<0.11	<4.5	<0.14	61.1
IZA105	-91.766977	36.121344	230	7.60	16.3	452	<127	<1	23.5	<0.11	146.30	<0.14	46.3
IZA106	-91.779148	36.231220		7.40	17.1	569	<127	<1	30.7	<0.11	<4.5	<0.14	65.3
IZA107	-91.815923	36.234601	Spring	7.29	16.2	550	<127	<1	27.3	<0.11	<4.5	<0.14	59.6
IZA108	-91.812449	36.244577	263	7.40	15.8	558	<127	<1	25.6	<0.11	<4.5	<0.14	61.2
IZA109	-91.810006	36.226492		7.66	16.0	440	<127	<1	16.5	<0.11	<4.5	<0.14	47.7
IZA110	-91.825470	36.239224	107	7.99	15.6	567	<127	<1	25.6	<0.11	<4.5	<0.14	66.9
LAW100	-91.311811	36.032428		7.25	16.8	636	<127	<1	32.5	<0.11	30.40	<0.14	76.8
LAW101	-91.313687	35.952055	188	7.70	17.4	349	<127	<1	19.5	<0.11	<4.5	<0.14	48.8
LAW102	-91.248327	35.887480	65	7.02	16.4	716	<127	<1	473.2	<0.11	<4.5	<0.14	75.4
LAW103	-91.234166	35.884816	75	7.14	16.0	1264	<127	1.37	343.5	<0.11	112.10	<0.14	90.7
LAW104	-91.271044	35.888762	53	7.56	15.8	581	<127	<1	72.7	<0.11	5.27	<0.14	64.0
LAW105	-91.260794	35.890742	57	7.45	16.1	593	<127	1.71	309.0	<0.11	<4.5	<0.14	70.7
LAW106	-91.282979	35.894020	600	7.40	16.8	645	<127	<1	43.5	<0.11	22.31	<0.14	80.3
LAW107	-91.291651	35.904671	400	7.93	17.0	571	<127	<1	46.6	<0.11	11.50	0.2	73.8
LAW108	-91.277718	36.117533	200	8.06	16.5	592	<127	<1	31.3	<0.11	<4.5	<0.14	75.1
LAW109	-91.257035	36.143590	300	7.61	15.9	583	<127	<1	87.5	<0.11	<4.5	<0.14	58.1
LAW110	-91.257696	36.147195	80	7.75	16.2	686	293	<1	47.1	<0.11	<4.5	0.17	57.8
LAW111	-91.298151	35.905708	145	7.46	16.9	456	295	<1	34.3	<0.11	6.00	<0.14	54.2
SHA100	-91.560754	35.947133	188	7.26	16.6	254	<127	<1	12.0	<0.11	<4.5	<0.14	30.3
SHA101	-91.579603	36.169447	218	7.47	16.9	701	<127	<1	28.5	<0.11	7.00	<0.14	89.4
SHA102	-91.620220	36.232259	180	7.56	15.8	450	<127	<1	27.9	<0.11	<4.5	<0.14	51.2
SHA103	-91.632045	36.229889	203	7.50	16.0	557	<127	<1	26.0	<0.11	<4.5	<0.14	68.4
SHA104	-91.623746	36.217877	220	7.66	16.3	434	<127	<1	16.4	<0.11	<4.5	<0.14	51.2

Appendix GW-1

Ground water quality data from wells and springs collected during the Strawberry River Watershed survey.

Station_ID	Longitude	Latitude	Depth (feet)	pH	Temp. deg. C	Conductance µS/cm	Aluminum µg/L	Arsenic µg/L	Barium µg/L	Beryllium µg/L	Boron µg/L	Cadmium µg/L	Calcium mg/L
FUL100	-91.960703	36.274686	400	8.26	16.9	251	<127	<1	12.4	<0.11	<4.5	<0.14	27.4
FUL101	-91.945215	36.293131	280	5.90	16.0	58	<127	<1	12.6	<0.11	<4.5	<0.14	4.6
SHA105	-91.551787	36.257809	165	7.80	15.6	399	<127	<1	29.7	<0.11	<4.5	<0.14	44.5
SHA106	-91.402524	36.134449	173	7.06	15.4	740	<127	<1	37.5	<0.11	<4.5	<0.14	101.3
SHA107	-91.408499	36.147013	293	7.23	16.3	645	<127	<1	20.4	<0.11	7.40	<0.14	82.7
SHA108	-91.425680	36.070605	150	7.30		512	<127	<1	43.4	<0.11	<4.5	0.57	53.6
SHA109	-91.410761	36.072487	188	7.75	16.2	399	<127	<1	21.0	<0.11	<4.5	<0.14	46.5
SHA110	-91.411564	36.063330		7.56	16.3	486	<127	<1	21.7	<0.11	<4.5	0.41	57.2
SHA111	-91.389008	36.060286	134	7.50	16.1	363	<127	<1	22.8	<0.11	<4.5	0.62	41.0
SHA112	-91.354785	36.047803	278	7.52	17.3	651	<127	<1	22.4	<0.11	<4.5	0.18	78.1
SHA113	-91.489327	36.005664	400	7.75	17.4	448	<127	<1	17.2	<0.11	<4.5	0.25	52.7
SHA114	-91.485178	36.005709	Spring	7.92	16.4	373	<127	<1	13.7	<0.11	<4.5	<0.14	43.6
SHA115	-91.416758	36.006961	Spring	7.74	16.8	461	<127	<1	18.3	<0.11	<4.5	0.19	54.7
SHA116	-91.400680	36.011402	Spring	7.82	15.9	362	<127	<1	15.3	<0.11	<4.5	<0.14	42.1
SHA117	-91.421086	36.009264	1900	7.59	17.4	461	<127	1.12	76.4	<0.11	14.82	<0.14	53.7
SHA118	-91.425823	36.009805	1850	7.70	17.4	454	<127	<1	30.5	<0.11	7.63	<0.14	52.0
SHA119	-91.608617	36.057322	Spring	8.01	16.8	353	<127	<1	15.5	<0.11	<4.5	<0.14	41.7
SHA120	-91.607922	36.142616	308	7.45	16.9	476	<127	<1	22.1	<0.11	15.05	<0.14	59.9
SHA121	-91.578481	36.223559	288	7.41	15.5	614	<127	<1	27.0	<0.11	4.78	<0.14	74.2
SHA122	-91.618860	36.226301	293	7.53	16.1	496	<127	<1	16.2	<0.11	<4.5	<0.14	54.6
SHA123	-91.657617	36.203167	263	7.20	15.8	720	<127	<1	28.3	<0.11	<4.5	<0.14	84.6
SHA124	-91.618822	36.071833	Spring	7.59	19.4	451	<127	<1	34.8	<0.11	7.00	<0.14	52.9
SHA125	-91.375685	36.194869	218	8.10	15.4	518	<127	<1	27.6	<0.11	<4.5	<0.14	59.4
SHA126	-91.421135	36.171861	158	7.69	16.1	625	<127	<1	21.5	<0.11	<4.5	<0.14	83.4
SHA127	-91.417881	36.167033	Spring	7.65	19.0	557	<127	<1	27.0	<0.11	<4.5	<0.14	68.4
SHA128	-91.485269	36.043034	Spring	7.78	15.5	515	<127	<1	24.3	<0.11	<4.5	<0.14	62.3
SHA129	-91.380062	35.942729	115	7.43	16.0	236	<127	<1	10.3	<0.11	<4.5	<0.14	29.1

Appendix GW-1

Ground water quality data from wells and springs collected during the Strawberry River Watershed survey.

Station_ID	Longitude	Latitude	Depth (feet)	Chromium µg/L	Cobalt µg/L	Copper µg/L	Iron µg/L	Lead µg/L	Magnesium mg/L	Manganese µg/L	Nickel µg/L	Potassium mg/L
FUL100	-91.960703	36.274686	400	0.5	<0.5	0.88	20.0	0.6	15.0	<0.5	<2.0	<0.5
FUL101	-91.945215	36.293131	280	<0.4	<0.5	2.24	186.0	0.5	2.2	25.6	11.56	0.7
FUL102	-91.956683	36.315454	134	1.2	<0.5	0.62	70.4	<0.4	32.2	<0.5	2.15	0.6
FUL103	-91.964195	36.322513	142	1.4	<0.5	1.49	73.8	<0.4	33.9	<0.5	2.03	1.0
FUL104	-91.910371	36.296520	207	1.2	<0.5	2.09	66.3	<0.4	31.9	1.1	3.21	<0.5
FUL105	-91.890877	36.291274	175	1.7	<0.5	3.08	108.0	<0.4	41.8	4.6	2.98	0.5
FUL106	-91.803347	36.315615	260	1.1	<0.5	2.14	49.3	<0.4	25.2	<0.5	<2.0	<0.5
FUL107	-91.970499	36.333050	Spring	1.4	<0.5	<0.5	72.2	<0.4	32.0	<0.5	<2.00	0.8
FUL108	-91.973150	36.333824	284	1.4	<0.5	2.37	81.1	<0.4	36.0	<0.5	2.65	0.5
IZA100	-91.693670	36.040741	150	<0.4	<0.5	0.87	51.8	<0.4	19.2	<0.5	<2.0	0.7
IZA101	-91.728258	36.094543	147	<0.4	<0.5	1.09	90.6	<0.4	34.7	<0.5	2.33	1.3
IZA102	-91.798866	36.167251	105	<0.4	<0.5	4.67	106.0	<0.4	12.4	40.3	<2.0	<0.5
IZA103	-91.733124	36.166441	70	<0.4	<0.5	2.48	84.3	<0.4	33.6	<0.5	3.97	1.1
IZA104	-91.728239	36.165884	600	<0.4	0.5	<.5	2880.0	<0.4	31.6	26.6	3.14	1.4
IZA105	-91.766977	36.121344	230	<0.4	<0.5	0.77	70.5	<0.4	29.3	<0.5	<2.0	4.8
IZA106	-91.779148	36.231220		<0.4	<0.5	6.44	78.0	<0.4	37.7	<0.5	<2.0	<0.5
IZA107	-91.815923	36.234601	Spring	<0.4	<0.5	<.5	84.8	<0.4	36.8	9.3	<2.0	<0.5
IZA108	-91.812449	36.244577	263	<0.4	<0.5	3.04	82.3	<0.4	37.9	<0.5	<2.0	<0.5
IZA109	-91.810006	36.226492		<0.4	<0.5	0.79	62.1	<0.4	28.3	<0.5	<2.0	<0.5
IZA110	-91.825470	36.239224	107	1.4	<0.5	6.37	96.7	<0.4	38.4	<0.5	2.72	0.7
LAW100	-91.311811	36.032428		<0.4	<0.5	<.5	137.0	<0.4	40.9	2.3	2.85	2.2
LAW101	-91.313687	35.952055	188	<0.4	<0.5	<.5	51.3	<0.4	21.3	<0.5	<2.0	<0.5
LAW102	-91.248327	35.887480	65	<0.4	<0.5	0.51	6830.0	<0.4	35.6	983.0	<2.0	0.8
LAW103	-91.234166	35.884816	75	<0.4	<0.5	2.04	6090.0	0.9	40.8	649.5	<2.0	1.8
LAW104	-91.271044	35.888762	53	<0.4	<0.5	<.5	275.0	<0.4	30.4	22.6	<2.0	<0.5
LAW105	-91.260794	35.890742	57	<0.4	<0.5	<.5	2610.0	<0.4	33.2	1053.0	<2.0	<0.5
LAW106	-91.282979	35.894020	600	<0.4	<0.5	2.34	73.0	<0.4	39.0	<0.5	<2.0	0.6
LAW107	-91.291651	35.904671	400	1.4	<0.5	1.31	57.7	<0.4	33.1	<0.5	3.80	1.1
LAW108	-91.277718	36.117533	200	1.4	<0.5	5.04	70.1	<0.4	38.7	<0.5	2.44	0.8
LAW109	-91.257035	36.143590	300	0.8	<0.5	4.47	46.9	<0.4	27.9	<0.5	2.83	1.2
LAW110	-91.257696	36.147195	80	1.4	<0.5	1.71	73.7	<0.4	31.4	<0.5	2.00	<0.5
LAW111	-91.298151	35.905708	145	1.5	<0.5	0.87	61.1	<0.4	26.0	<0.5	2.96	<0.5
SHA100	-91.560754	35.947133	188	<0.4	<0.5	4.25	32.7	<0.4	14.6	2.4	<2.0	0.8
SHA101	-91.579603	36.169447	218	<0.4	<0.5	3.07	91.9	<0.4	44.5	<0.5	2.72	0.7
SHA102	-91.620220	36.232259	180	<0.4	<0.5	4.23	67.1	<0.4	29.1	<0.5	2.13	1.3
SHA103	-91.632045	36.229889	203	<0.4	<0.5	4.16	81.7	<0.4	36.6	<0.5	<2.0	0.6
SHA104	-91.623746	36.217877	220	<0.4	<0.5	1.06	63.8	<0.4	27.8	<0.5	17.03	0.5

Appendix GW-1

Ground water quality data from wells and springs collected during the Strawberry River Watershed survey.

Station_ID	Longitude	Latitude	Depth (feet)	Chromium µg/L	Cobalt µg/L	Copper µg/L	Iron µg/L	Lead µg/L	Magnesium mg/L	Manganese µg/L	Nickel µg/L	Potassium mg/L
FUL100	-91.960703	36.274686	400	0.5	<0.5	0.88	20.0	0.6	15.0	<0.5	<2.0	<0.5
FUL101	-91.945215	36.293131	280	<0.4	<0.5	2.24	186.0	0.5	2.2	25.6	11.56	0.7
SHA105	-91.551787	36.257809	165	<0.4	<0.5	6.58	73.3	<0.4	26.1	2.9	<2.0	<0.5
SHA106	-91.402524	36.134449	173	2.9	<0.5	14.66	127.0	0.5	57.9	<0.5	3.21	<0.5
SHA107	-91.408499	36.147013	293	<0.4	<0.5	2.02	89.2	<0.4	40.3	<0.5	3.21	1.4
SHA108	-91.425680	36.070605	150	<0.4	<0.5	5.79	79.8	<0.4	31.3	<0.5	<2.0	<0.5
SHA109	-91.410761	36.072487	188	<0.4	<0.5	3.9	66.2	<0.4	26.1	<0.5	<2.0	0.9
SHA110	-91.411564	36.063330		<0.4	<0.5	0.67	71.7	<0.4	30.3	<0.5	<2.0	<0.5
SHA111	-91.389008	36.060286	134	<0.4	<0.5	0.85	67.5	<0.4	23.8	0.9	2.21	<0.5
SHA112	-91.354785	36.047803	278	<0.4	<0.5	4.5	76.5	<0.4	44.4	7.8	<2.0	<0.5
SHA113	-91.489327	36.005664	400	<0.4	<0.5	4.91	49.7	1.6	27.9	<0.5	<2.0	<0.5
SHA114	-91.485178	36.005709	Spring	<0.4	<0.5	<.5	41.7	<0.4	22.7	<0.5	<2.0	<0.5
SHA115	-91.416758	36.006961	Spring	<0.4	<0.5	<.5	60.4	<0.4	28.4	<0.5	<2.0	<0.5
SHA116	-91.400680	36.011402	Spring	<0.4	<0.5	<.5	41.4	<0.4	22.2	<0.5	<2.0	<0.5
SHA117	-91.421086	36.009264	1900	<0.4	<0.5	1.07	52.7	<0.4	28.4	<0.5	<2.0	<0.5
SHA118	-91.425823	36.009805	1850	<0.4	<0.5	0.75	58.4	<0.4	27.9	<0.5	<2.0	<0.5
SHA119	-91.608617	36.057322	Spring	<0.4	<0.5	0.7	42.6	<0.4	20.8	<0.5	<2.0	<0.5
SHA120	-91.607922	36.142616	308	<0.4	<0.5	5.38	69.3	<0.4	33.6	<0.5	<2.0	0.6
SHA121	-91.578481	36.223559	288	<0.4	<0.5	3.97	76.6	<0.4	37.9	<0.5	<2.0	<0.5
SHA122	-91.618860	36.226301	293	<0.4	<0.5	7.32	69.7	<0.4	32.8	<0.5	<2.0	<0.5
SHA123	-91.657617	36.203167	263	<0.4	<0.5	2.43	96.5	<0.4	47.6	<0.5	2.45	<0.5
SHA124	-91.618822	36.071833	Spring	1.3	<0.5	1.95	52.7	<0.4	26.9	9.1	2.60	1.5
SHA125	-91.375685	36.194869	218	1.2	<0.5	1.65	55.5	<0.4	30.4	1.7	2.21	1.0
SHA126	-91.421135	36.171861	158	1.6	<0.5	3.49	74.8	<0.4	39.9	<0.5	2.83	0.6
SHA127	-91.417881	36.167033	Spring	1.6	<0.5	0.9	67.7	<0.4	36.0	<0.5	2.63	1.0
SHA128	-91.485269	36.043034	Spring	1.5	<0.5	0.82	62.8	<0.4	33.8	<0.5	2.35	0.5
SHA129	-91.380062	35.942729	115	0.7	<0.5	5.5	<15	0.7	12.4	<0.5	<2.0	4.1

Appendix GW-1

Ground water quality data from wells and springs collected during the Strawberry River Watershed survey.

Station_ID	Longitude	Latitude	Depth (feet)	Selenium µg/L	Sodium mg/L	Vanadium µg/L	Zinc µg/L	Hardness mg/L CaCO3	Silica mg/L	Alkalinity mg/L as CaCO3	Bromide mg/L
FUL100	-91.960703	36.274686	400	<3.0	1.8	<1.0	79.6	130	11.0	126.0	0.02
FUL101	-91.945215	36.293131	280	<3.0	1.4	<1.0	389.4	20	9.5	11.0	0.03
FUL102	-91.956683	36.315454	134	<3.0	2.5	<1.0	22.0	270	10.3	226.0	0.07
FUL103	-91.964195	36.322513	142	<3.0	3.1	<1.0	22.3	288	10.1	264.0	0.03
FUL104	-91.910371	36.296520	207	<3.0	1.2	<1.0	15.9	261	8.5	245.0	0.03
FUL105	-91.890877	36.291274	175	<3.0	2.7	<1.0	56.2	360	10.4	301.0	0.11
FUL106	-91.803347	36.315615	260	<3.0	3.5	<1.0	30.9	220	12.4	198.0	0.09
FUL107	-91.970499	36.333050	Spring	<3.0	2.0	<1.0	52.8	275		271.5	<0.01
FUL108	-91.973150	36.333824	284	<3.0	1.3	<1.0	44.7	310		301.2	<0.01
IZA100	-91.693670	36.040741	150	<3.0	3.3	<1.0	12.7	189	10.5	176.9	<0.01
IZA101	-91.728258	36.094543	147	<3.0	1.8	<1.0	45.4	307	11.3	286.7	0.07
IZA102	-91.798866	36.167251	105	<3.0	5.1	<1.0	39.4	106	14.0	100.9	0.08
IZA103	-91.733124	36.166441	70	<3.0	3.8	<1.0	47.7	316	11.9	277.0	<0.01
IZA104	-91.728239	36.165884	600	<3.0	1.6	<1.0	1808.0	283	10.1	271.0	0.03
IZA105	-91.766977	36.121344	230	<3.0	2.4	<1.0	13.7	236	10.5	241.0	<0.01
IZA106	-91.779148	36.231220		<3.0	2.0	<1.0	16.2	318	11.3	306.0	0.06
IZA107	-91.815923	36.234601	Spring	<3.0	1.9	<1.0	3.4	300	10.8	291.0	0.05
IZA108	-91.812449	36.244577	263	<3.0	1.0	<1.0	24.2	309	12.6	300.0	<0.01
IZA109	-91.810006	36.226492		<3.0	1.5	<1.0	8.6	236	10.1	235.0	<0.01
IZA110	-91.825470	36.239224	107	<3.0	1.2	<1.0	15.1	325	10.9	312.0	<0.01
LAW100	-91.311811	36.032428		<3.0	3.1	<1.0	17.2	360	12.2	336.0	0.05
LAW101	-91.313687	35.952055	188	<3.0	2.1	<1.0	34.8	210	13.7	209.6	0.04
LAW102	-91.248327	35.887480	65	<3.0	26.7	<1.0	<1.0	335	29.1	320.0	0.40
LAW103	-91.234166	35.884816	75	<3.0	116.0	2.5	14.6	394	23.5	360.0	1.82
LAW104	-91.271044	35.888762	53	<3.0	14.2	1.8	18.6	285	23.4	254.0	0.50
LAW105	-91.260794	35.890742	57	<3.0	9.2	<1.0	14.2	313	25.3	274.0	0.33
LAW106	-91.282979	35.894020	600	<3.0	5.4	<1.0	42.5	361	20.8	336.0	0.16
LAW107	-91.291651	35.904671	400	<3.0	6.0	<1.0	64.5	321	16.2	275.0	0.05
LAW108	-91.277718	36.117533	200	<3.0	2.3	<1.0	16.5	347	11.2	317.0	0.02
LAW109	-91.257035	36.143590	300	<3.0	21.9	<1.0	50.4	260	16.1	184.0	0.23
LAW110	-91.257696	36.147195	80	<3.0	31.2	1.2	71.7	274		203.1	0.28
LAW111	-91.298151	35.905708	145	<3.0	2.4	<1.0	34.0	242		244.6	0.15
SHA100	-91.560754	35.947133	188	<3.0	1.4	<1.0	15.7	136	11.3	135.8	<0.01
SHA101	-91.579603	36.169447	218	<3.0	1.3	<1.0	12.4	406	10.7	369.4	<0.01
SHA102	-91.620220	36.232259	180	<3.0	1.6	<1.0	24.5	248	11.7	244.1	<0.01
SHA103	-91.632045	36.229889	203	<3.0	1.6	<1.0	12.8	321	13.5	302.9	0.03
SHA104	-91.623746	36.217877	220	<3.0	1.1	<1.0	26.0	242	12.8	238.4	<0.01

Appendix GW-1

Ground water quality data from wells and springs collected during the Strawberry River Watershed survey.

Station_ID	Longitude	Latitude	Depth (feet)	Selenium µg/L	Sodium mg/L	Vanadium µg/L	Zinc µg/L	Hardness mg/L CaCO3	Silica mg/L	Alkalinity mg/L as CaCO3	Bromide mg/L
FUL100	-91.960703	36.274686	400	<3.0	1.8	<1.0	79.6	130	11.0	126.0	0.02
FUL101	-91.945215	36.293131	280	<3.0	1.4	<1.0	389.4	20	9.5	11.0	0.03
SHA105	-91.551787	36.257809	165	<3.0	3.3	<1.0	5.6	219	14.5	215.1	0.04
SHA106	-91.402524	36.134449	173	<3.0	1.3	<1.0	23.9	491	12.2	458.0	0.04
SHA107	-91.408499	36.147013	293	<3.0	1.2	<1.0	7.1	372	10.3	343.2	<0.01
SHA108	-91.425680	36.070605	150	<3.0	11.7	<1.0	136.4	263	12.2	257.3	0.07
SHA109	-91.410761	36.072487	188	<3.0	1.2	<1.0	41.0	224	13.3	225.9	<0.01
SHA110	-91.411564	36.063330		<3.0	2.9	<1.0	12.0	268	13.2	247.4	0.08
SHA111	-91.389008	36.060286	134	<3.0	1.6	<1.0	92.2	200	16.3	200.7	0.03
SHA112	-91.354785	36.047803	278	<3.0	1.3	<1.0	68.0	378	9.5	352.0	<0.01
SHA113	-91.489327	36.005664	400	<3.0	1.1	<1.0	415.9	246	9.8	241.0	<0.01
SHA114	-91.485178	36.005709	Spring	<3.0	1.0	<1.0	<1.0	202	9.7	204.0	0.04
SHA115	-91.416758	36.006961	Spring	<3.0	1.4	<1.0	35.1	253	10.4	248.0	<0.01
SHA116	-91.400680	36.011402	Spring	<3.0	1.3	<1.0	17.9	196	12.0	199.0	<0.01
SHA117	-91.421086	36.009264	1900	<3.0	1.4	<1.0	16.5	251	10.8	246.0	0.04
SHA118	-91.425823	36.009805	1850	<3.0	1.4	<1.0	222.1	245	10.4	242.0	<0.01
SHA119	-91.608617	36.057322	Spring	<3.0	1.2	<1.0	<1.0	190	9.3	194.0	<0.01
SHA120	-91.607922	36.142616	308	<3.0	1.5	<1.0	7.2	288	11.2	282.0	<0.01
SHA121	-91.578481	36.223559	288	<3.0	2.2	<1.0	52.6	341	11.9	326.0	0.05
SHA122	-91.618860	36.226301	293	<3.0	1.3	<1.0	26.7	271	10.0	263.0	0.04
SHA123	-91.657617	36.203167	263	<3.0	1.5	<1.0	38.7	407	9.2	370.0	<0.01
SHA124	-91.618822	36.071833	Spring	<3.0	3.6	<1.0	8.9	243	11.9	224.0	0.03
SHA125	-91.375685	36.194869	218	<3.0	6.0	1.0	4.5	273	12.2	226.0	0.47
SHA126	-91.421135	36.171861	158	<3.0	0.7	<1.0	10.7	372	9.9	328.0	<0.01
SHA127	-91.417881	36.167033	Spring	<3.0	1.4	<1.0	5.5	319	10.3	297.0	<0.01
SHA128	-91.485269	36.043034	Spring	<3.0	0.9	<1.0	9.3	295	10.4	277.0	<0.01
SHA129	-91.380062	35.942729	115	<3.0	3.0	<1.0	17.1	124	13.2	118.0	0.02

Appendix GW-1

Ground water quality data from wells and springs collected during the Strawberry River Watershed survey.

Station_ID	Longitude	Latitude	Depth (feet)	Chloride mg/L	Fluoride mg/L	Sulfate mg/L	Ammonia-N mg/L	Nitrate-N mg/L	Ortho-P mg/L	TDS mg/L
FUL100	-91.960703	36.274686	400	2.21	0.08	1.49	<0.005	1.41	<0.005	145
FUL101	-91.945215	36.293131	280	3.29	0.04	1.16	0.074	2.74	<0.005	57
FUL102	-91.956683	36.315454	134	13.69	0.07	5.65	<0.005	5.99	<0.005	288
FUL103	-91.964195	36.322513	142	5.66	0.06	5.76	<0.005	2.40	<0.005	293
FUL104	-91.910371	36.296520	207	2.68	0.07	10.98	<0.005	0.17	<0.005	256
FUL105	-91.890877	36.291274	175	17.26	0.10	2.99	<0.005	6.13	<0.005	359
FUL106	-91.803347	36.315615	260	11.33	0.12	5.64	<0.005	0.45	<0.005	230
FUL107	-91.970499	36.333050	Spring	5.43	0.09	4.49	<0.005	0.99	0.013	284
FUL108	-91.973150	36.333824	284	4.16	0.09	4.22	<0.005	1.15	0.013	314
IZA100	-91.693670	36.040741	150	8.44	0.09	4.17	<0.005	2.73	0.005	205
IZA101	-91.728258	36.094543	147	6.84	0.14	6.78	<0.005	0.18	<0.005	298
IZA102	-91.798866	36.167251	105	9.57	0.11	2.42	<0.005	1.74	<0.005	134
IZA103	-91.733124	36.166441	70	12.92	0.09	8.73	<0.005	3.81	0.016	329
IZA104	-91.728239	36.165884	600	1.73	0.12	9.40	<0.005	0.02	<0.005	277
IZA105	-91.766977	36.121344	230	2.69	0.35	8.84	0.137	0.05	<0.005	252
IZA106	-91.779148	36.231220		3.83	0.13	7.72	<0.005	0.53	0.008	320
IZA107	-91.815923	36.234601	Spring	5.05	0.12	5.03	<0.005	1.53	<0.005	311
IZA108	-91.812449	36.244577	263	3.69	0.13	4.52	<0.005	0.96	<0.005	312
IZA109	-91.810006	36.226492		1.91	0.13	6.93	<0.005	0.53	<0.005	242
IZA110	-91.825470	36.239224	107	1.63	0.07	2.42	<0.005	0.13	<0.005	309
LAW100	-91.311811	36.032428		4.29	0.16	13.80	<0.005	0.02	<0.005	354
LAW101	-91.313687	35.952055	188	3.37	0.13	3.00	<0.005	0.59	0.012	212
LAW102	-91.248327	35.887480	65	26.19	0.18	27.96	0.372	0.07	0.012	413
LAW103	-91.234166	35.884816	75	159.00	0.21	44.73	0.186	0.03	0.010	709
LAW104	-91.271044	35.888762	53	33.87	0.15	17.17	0.006	0.41	0.042	344
LAW105	-91.260794	35.890742	57	22.55	0.17	15.36	0.109	0.02	0.008	335
LAW106	-91.282979	35.894020	600	9.96	0.18	10.29	<0.005	0.35	0.018	375
LAW107	-91.291651	35.904671	400	10.72	0.09	14.90	<0.005	1.27	<0.005	327
LAW108	-91.277718	36.117533	200	2.53	0.08	6.68	<0.005	0.17	<0.005	324
LAW109	-91.257035	36.143590	300	35.25	0.07	15.73	<0.005	12.85	<0.005	343
LAW110	-91.257696	36.147195	80	46.90	0.09	27.40	<0.005	14.00	0.018	406
LAW111	-91.298151	35.905708	145	3.52	0.14	6.70	<0.005	0.19	0.020	263
SHA100	-91.560754	35.947133	188	2.28	0.09	3.95	<0.005	0.79	0.010	146
SHA101	-91.579603	36.169447	218	4.01	0.15	19.60	<0.005	0.23	0.006	399
SHA102	-91.620220	36.232259	180	3.77	0.11	4.26	<0.005	0.25	0.007	248
SHA103	-91.632045	36.229889	203	4.32	0.10	9.36	<0.005	0.50	0.007	310
SHA104	-91.623746	36.217877	220	2.54	0.11	1.67	<0.005	1.28	0.010	239

Appendix GW-1

Ground water quality data from wells and springs collected during the Strawberry River Watershed survey.

Station_ID	Longitude	Latitude	Depth (feet)	Chloride mg/L	Fluoride mg/L	Sulfate mg/L	Ammonia-N mg/L	Nitrate-N mg/L	Ortho-P mg/L	TDS mg/L
FUL100	-91.960703	36.274686	400	2.21	0.08	1.49	<0.005	1.41	<0.005	145
FUL101	-91.945215	36.293131	280	3.29	0.04	1.16	0.074	2.74	<0.005	57
SHA105	-91.551787	36.257809	165	2.56	0.13	7.23	<0.005	0.38	0.010	222
SHA106	-91.402524	36.134449	173	2.52	0.08	9.58	0.006	0.18	0.005	465
SHA107	-91.408499	36.147013	293	2.67	0.10	13.00	<0.005	0.64	<0.005	361
SHA108	-91.425680	36.070605	150	6.39	0.14	21.12	<0.005	0.42	0.006	286
SHA109	-91.410761	36.072487	188	1.81	0.11	3.44	<0.005	0.19	0.005	223
SHA110	-91.411564	36.063330		9.68	0.12	3.29	<0.005	1.41	0.009	264
SHA111	-91.389008	36.060286	134	3.46	0.10	1.64	<0.005	0.23	0.008	202
SHA112	-91.354785	36.047803	278	2.20	0.12	9.70	<0.005	0.60	<0.005	364
SHA113	-91.489327	36.005664	400	1.56	0.13	9.93	<0.005	0.11	<0.005	253
SHA114	-91.485178	36.005709	Spring	1.85	0.15	5.37	<0.005	0.47	0.005	215
SHA115	-91.416758	36.006961	Spring	2.46	0.14	6.79	<0.005	0.37	0.005	259
SHA116	-91.400680	36.011402	Spring	2.08	0.14	4.27	<0.005	0.34	0.010	206
SHA117	-91.421086	36.009264	1900	2.11	0.16	11.55	<0.005	0.12	<0.005	259
SHA118	-91.425823	36.009805	1850	2.05	0.15	7.29	<0.005	0.23	0.005	249
SHA119	-91.608617	36.057322	Spring	1.77	0.14	4.73	<0.005	0.48	0.007	200
SHA120	-91.607922	36.142616	308	3.46	0.14	8.95	<0.005	0.17	<0.005	297
SHA121	-91.578481	36.223559	288	5.46	0.10	4.08	<0.005	2.21	<0.005	346
SHA122	-91.618860	36.226301	293	1.61	0.11	10.84	<0.005	0.54	<0.005	276
SHA123	-91.657617	36.203167	263	11.80	0.14	14.05	<0.005	1.46	<0.005	414
SHA124	-91.618822	36.071833	Spring	6.08	0.09	5.00	<0.005	1.88	<0.005	256
SHA125	-91.375685	36.194869	218	33.00	0.07	2.73	<0.005	0.25	<0.005	281
SHA126	-91.421135	36.171861	158	2.46	0.07	6.85	<0.005	0.66	<0.005	346
SHA127	-91.417881	36.167033	Spring	1.90	0.07	6.91	<0.005	0.13	<0.005	302
SHA128	-91.485269	36.043034	Spring	3.27	0.08	3.89	<0.005	0.26	<0.005	286
SHA129	-91.380062	35.942729	115	3.42	0.08	1.70	<0.005	0.91	<0.005	142

APPENDIX GW-2

Results from Z-Test and statistical analysis from ground water data

Results from Z-Test
Statistical Analysis from Ground Water Data

z-Test: Two Sample for Means
Calcium: Op versus Ocjc

	Variable 1	*Variable 2*
Mean	56.9428571	63.6210526
Known Variance	478.3	170.4
Observations	21	19
Hypothesized Mean Difference	0	
z	-1.1852886	
P(Z<=z) one-tail	0.11795173	
z Critical one-tail	1.64485348	
P(Z<=z) two-tail	0.23590347	
z Critical two-tail	1.95996279	

z-Test: Two Sample for Means
Magnesium: Op versus Ocjc

	Variable 1	*Variable 2*
Mean	31.4285714	34.6421053
Known Variance	140.6	36.6
Observations	21	19
Hypothesized Mean Difference	0	
z	-1.0944353	
P(Z<=z) one-tail	0.13688209	
z Critical one-tail	1.64485348	
P(Z<=z) two-tail	0.27376417	
z Critical two-tail	1.95996279	

z-Test: Two Sample for Means
Calcium: Op versus Ose

	Variable 1	*Variable 2*
Mean	56.9428571	46.3583333
Known Variance	478.3	98.5
Observations	21	12
Hypothesized Mean Difference	0	
z	1.9015113	
P(Z<=z) one-tail	0.02861747	
z Critical one-tail	1.64485348	
P(Z<=z) two-tail	0.05723494	
z Critical two-tail	1.95996279	

z-Test: Two Sample for Means
Magnesium: Op versus Ose

	Variable 1	*Variable 2*
Mean	31.4285714	23.0166667
Known Variance	140.6	36.3
Observations	21	12
Hypothesized Mean Difference	0	
z	2.69808667	
P(Z<=z) one-tail	0.00348701	
z Critical one-tail	1.64485348	
P(Z<=z) two-tail	0.00697403	
z Critical two-tail	1.95996279	

z-Test: Two Sample for Means
Calcium: Ocjc versus Ose

	Variable 1	*Variable 2*
Mean	63.6210526	46.3583333
Known Variance	170.4	98.5
Observations	19	12
Hypothesized Mean Difference	0	
z	4.16522682	
P(Z<=z) one-tail	1.5561E-05	
z Critical one-tail	1.64485348	
P(Z<=z) two-tail	3.1123E-05	
z Critical two-tail	1.95996279	

z-Test: Two Sample for Means
Magnesium: Ocjc versus Ose

	Variable 1	*Variable 2*
Mean	34.6421053	23.0166667
Known Variance	36.6	36.3
Observations	19	12
Hypothesized Mean Difference	0	
z	5.22455173	
P(Z<=z) one-tail	8.7459E-08	
z Critical one-tail	1.64485348	
P(Z<=z) two-tail	1.7492E-07	
z Critical two-tail	1.95996279	

Results from Z-Test
Statistical Analysis from Ground Water Data

z-Test: Two Sample for Means
Sodium: Op versus Ocjc

	Variable 1	*Variable 2*
Mean	4.91380952	2.03
Known Variance	24	1.64
Observations	21	19
Hypothesized Mean Difference	0	
z	2.60111814	
P(Z<=z) one-tail	0.00464606	
z Critical one-tail	1.64485348	
P(Z<=z) two-tail	0.00929211	
z Critical two-tail	1.95996279	

z-Test: Two Sample for Means
Chloride: Op versus Ocjc

	Variable 1	*Variable 2*
Mean	8.81190476	6.08
Known Variance	62.1	54.9
Observations	21	19
Hypothesized Mean Difference	0	
z	1.12983038	
P(Z<=z) one-tail	0.1292739	
z Critical one-tail	1.64485348	
P(Z<=z) two-tail	0.2585478	
z Critical two-tail	1.95996279	

z-Test: Two Sample for Means
Sodium: Op versus Ose

	Variable 1	*Variable 2*
Mean	4.91380952	1.89308333
Known Variance	24	0.99
Observations	21	12
Hypothesized Mean Difference	0	
z	2.72885222	
P(Z<=z) one-tail	0.00317781	
z Critical one-tail	1.64485348	
P(Z<=z) two-tail	0.00635562	
z Critical two-tail	1.95996279	

z-Test: Two Sample for Means
Chloride: Op versus Ose

	Variable 1	*Variable 2*
Mean	8.81190476	3.34166667
Known Variance	62.1	2.11
Observations	21	12
Hypothesized Mean Difference	0	
z	3.09049242	
P(Z<=z) one-tail	0.00099919	
z Critical one-tail	1.64485348	
P(Z<=z) two-tail	0.00199839	
z Critical two-tail	1.95996279	

z-Test: Two Sample for Means
Sodium: Ocjc versus Ose

	Variable 1	*Variable 2*
Mean	2.03	1.89308333
Known Variance	1.64	0.99
Observations	19	12
Hypothesized Mean Difference	0	
z	0.33323437	
P(Z<=z) one-tail	0.36947875	
z Critical one-tail	1.64485348	
P(Z<=z) two-tail	0.73895751	
z Critical two-tail	1.95996279	

z-Test: Two Sample for Means
Chloride: Ocjc versus Ose

	Variable 1	*Variable 2*
Mean	6.08	3.34166667
Known Variance	54.9	2.11
Observations	19	12
Hypothesized Mean Difference	0	
z	1.56404528	
P(Z<=z) one-tail	0.05890348	
z Critical one-tail	1.64485348	
P(Z<=z) two-tail	0.11780695	
z Critical two-tail	1.95996279	

Results from Z-Test
Statistical Analysis from Ground Water Data

z-Test: Two Sample for Means
Sulfate: Op versus Ocjc

	Variable 1	*Variable 2*
Mean	8.59047619	7.26157895
Known Variance	28.8	18.5
Observations	21	19
Hypothesized Mean Difference	0	
z	0.86777979	
P(Z<=z) one-tail	0.1927574	
z Critical one-tail	1.64485348	
P(Z<=z) two-tail	0.3855148	
z Critical two-tail	1.95996279	

z-Test: Two Sample for Means
Bicarbonate: Op versus Ocjc

	Variable 1	*Variable 2*
Mean	302.584952	344.804105
Known Variance	13716	3530
Observations	21	19
Hypothesized Mean Difference	0	
z	-1.4576258	
P(Z<=z) one-tail	0.07247189	
z Critical one-tail	1.64485348	
P(Z<=z) two-tail	0.14494379	
z Critical two-tail	1.95996279	

z-Test: Two Sample for Means
Sulfate: Op versus Ose

	Variable 1	*Variable 2*
Mean	8.59047619	4.95833333
Known Variance	28.8	2.14
Observations	21	12
Hypothesized Mean Difference	0	
z	2.91763145	
P(Z<=z) one-tail	0.00176357	
z Critical one-tail	1.64485348	
P(Z<=z) two-tail	0.00352714	
z Critical two-tail	1.95996279	

z-Test: Two Sample for Means
Bicarbonate: Op versus Ose

	Variable 1	*Variable 2*
Mean	302.584952	251.309833
Known Variance	13716	56.5
Observations	21	12
Hypothesized Mean Difference	0	
z	1.99913832	
P(Z<=z) one-tail	0.02279662	
z Critical one-tail	1.64485348	
P(Z<=z) two-tail	0.04559325	
z Critical two-tail	1.95996279	

z-Test: Two Sample for Means
Sulfate: Ocjc versus Ose

	Variable 1	*Variable 2*
Mean	7.26157895	4.95833333
Known Variance	18.5	2.14
Observations	19	12
Hypothesized Mean Difference	0	
z	2.14590606	
P(Z<=z) one-tail	0.01594018	
z Critical one-tail	1.64485348	
P(Z<=z) two-tail	0.03188036	
z Critical two-tail	1.95996279	

z-Test: Two Sample for Means
Bicarbonate: Ocjc versus Ose

	Variable 1	*Variable 2*
Mean	344.804105	251.309833
Known Variance	3530	56.5
Observations	19	12
Hypothesized Mean Difference	0	
z	6.77391923	
P(Z<=z) one-tail	6.3031E-12	
z Critical one-tail	1.64485348	
P(Z<=z) two-tail	1.2606E-11	
z Critical two-tail	1.95996279	

Results from Z-Test
Statistical Analysis from Ground Water Data

z-Test: Two Sample for Means
TDS: Op versus Ocjc

	Variable 1	*Variable 2*
Mean	284.238095	300.605263
Known Variance	8760	2830
Observations	21	19
Hypothesized Mean Difference	0	
z	-0.6879086	
P(Z<=z) one-tail	0.24575511	
z Critical one-tail	1.64485348	
P(Z<=z) two-tail	0.49151022	
z Critical two-tail	1.95996279	

z-Test: Two Sample for Means
Ca/Mg ratio: Op versus Ocjc

	Variable 1	*Variable 2*
Mean	1.10459718	1.11132059
Known Variance	0.0061	0.0084
Observations	21	19
Hypothesized Mean Difference	0	
z	-0.2484057	
P(Z<=z) one-tail	0.40191033	
z Critical one-tail	1.64485348	
P(Z<=z) two-tail	0.80382066	
z Critical two-tail	1.95996279	

z-Test: Two Sample for Means
TDS: Op versus Ose

	Variable 1	*Variable 2*
Mean	284.238095	220.208333
Known Variance	8760	45.4
Observations	21	12
Hypothesized Mean Difference	0	
z	3.12089324	
P(Z<=z) one-tail	0.00090158	
z Critical one-tail	1.64485348	
P(Z<=z) two-tail	0.00180317	
z Critical two-tail	1.95996279	

z-Test: Two Sample for Means
Ca/Mg ratio: Op versus Ose

	Variable 1	*Variable 2*
Mean	1.10459718	1.23960995
Known Variance	0.0061	0.0113
Observations	21	12
Hypothesized Mean Difference	0	
z	-3.8463101	
P(Z<=z) one-tail	5.9977E-05	
z Critical one-tail	1.64485348	
P(Z<=z) two-tail	0.00011995	
z Critical two-tail	1.95996279	

z-Test: Two Sample for Means
TDS: Ocjc versus Ose

	Variable 1	*Variable 2*
Mean	300.605263	220.208333
Known Variance	2830	45.4
Observations	19	12
Hypothesized Mean Difference	0	
z	6.50543423	
P(Z<=z) one-tail	3.8926E-11	
z Critical one-tail	1.64485348	
P(Z<=z) two-tail	7.7852E-11	
z Critical two-tail	1.95996279	

z-Test: Two Sample for Means
Ca/Mg ratio: Ocjc versus Ose

	Variable 1	*Variable 2*
Mean	1.11132059	1.23960995
Known Variance	0.0084	0.0113
Observations	19	12
Hypothesized Mean Difference	0	
z	-3.4487235	
P(Z<=z) one-tail	0.00028167	
z Critical one-tail	1.64485348	
P(Z<=z) two-tail	0.00056334	
z Critical two-tail	1.95996279	

Results from Z-Test
Statistical Analysis from Ground Water Data

z-Test: Two Sample for Means
pH: Op versus Ocjc

	Variable 1	*Variable 2*
Mean	7.51761905	7.59578947
Known Variance	0.221	0.086
Observations	21	19
Hypothesized Mean Difference	0	
z	-0.6371951	
P(Z<=z) one-tail	0.26199882	
z Critical one-tail	1.64485348	
P(Z<=z) two-tail	0.52399765	
z Critical two-tail	1.95996279	

z-Test: Two Sample for Means
Nitrate: Op versus Ocjc

	Variable 1	*Variable 2*
Mean	2.46085714	0.83363158
Known Variance	9.95	0.85
Observations	21	19
Hypothesized Mean Difference	0	
z	2.25971652	
P(Z<=z) one-tail	0.01191939	
z Critical one-tail	1.64485348	
P(Z<=z) two-tail	0.02383878	
z Critical two-tail	1.95996279	

z-Test: Two Sample for Means
pH: Op versus Ose

	Variable 1	*Variable 2*
Mean	7.51761905	7.65
Known Variance	0.221	0.055
Observations	21	12
Hypothesized Mean Difference	0	
z	-1.0770462	
P(Z<=z) one-tail	0.14072985	
z Critical one-tail	1.64485348	
P(Z<=z) two-tail	0.28145969	
z Critical two-tail	1.95996279	

z-Test: Two Sample for Means
Nitrate: Op versus Ose

	Variable 1	*Variable 2*
Mean	2.46085714	0.76008333
Known Variance	9.95	0.795
Observations	21	12
Hypothesized Mean Difference	0	
z	2.31433245	
P(Z<=z) one-tail	0.01032472	
z Critical one-tail	1.64485348	
P(Z<=z) two-tail	0.02064944	
z Critical two-tail	1.95996279	

z-Test: Two Sample for Means
pH: Ocjc versus Ose

	Variable 1	*Variable 2*
Mean	7.59578947	7.65
Known Variance	0.086	0.055
Observations	19	12
Hypothesized Mean Difference	0	
z	-0.5679797	
P(Z<=z) one-tail	0.28502434	
z Critical one-tail	1.64485348	
P(Z<=z) two-tail	0.57004869	
z Critical two-tail	1.95996279	

z-Test: Two Sample for Means
Nitrate: Ocjc versus Ose

	Variable 1	*Variable 2*
Mean	0.83363158	0.76008333
Known Variance	0.85	0.795
Observations	19	12
Hypothesized Mean Difference	0	
z	0.22076823	
P(Z<=z) one-tail	0.41263649	
z Critical one-tail	1.64485348	
P(Z<=z) two-tail	0.82527298	
z Critical two-tail	1.95996279	

APPENDIX M-1

Habitat scores for aquatic macroinvertebrate samples collected during 2001 – 2003, Strawberry River watershed, Arkansas

Score	Rating
0 – 55	Poor
56 – 110	Marginal
111 – 165	Suboptimal
166 – 220	Optimal

Appendix M-1a. Habitat scores for aquatic macroinvertebrate samples collected during Fall 2001, Strawberry River Watershed, Arkansas.

	Instream/Riparian Habitat												Pebble Count					Channel Characteristics			
Station ID	**ES**	**EM/PS**	**VE/PV**	**SD**	**CF**	**CA**	**RF**	**LBS**	**RBS**	**LRV**	**RRV**	**TS**	**D15**	**D34**	**D50**	**D84**	**D95**	**MV**	**MD**	**CC**	**WW**
Mainstem Sites																					
UWSBR01	13	8	10	8	6	11	10	10	10	3	6	95	6	16	23	32	64	NC	0.05	100	NC
WHI0143B - A	13	15	10	13	8	16	10	16	11	6	1	119	8	16	23	128	180	0.49	0.30	0	17
WHI0143B - B	13	16	11	16	10	16	11	5	8	6	10	122	16	32	45	128	BR	0.86	0.35	0	17
UWSBR02	10	11	8	13	10	16	11	15	10	10	15	129	8	16	23	32	45	1.56	0.28	NC	25
WHI0143P	13	16	11	16	11	16	10	15	10	10	5	133	23	45	64	90	128	1.91	0.88	NC	30
WHI024	11	11	13	11	16	15	11	13	8	5	10	124	4	8	16	32	45	1.63	0.64	70	67
OH Tributaries																					
WHI0143M	13	16	10	16	10	16	11	13	16	11	11	143	8	23	32	90	180	0.06	0.05	95	19
UWNBC01 - A	13	16	10	16	15	16	13	13	16	3	16	147	32	64	90	180	256	0.47	0.50	35	31
UWNBC01 - B	15	16	10	16	13	16	13	13	16	5	16	149	11	32	64	128	180	1.00	0.27	10	22
WHI0143N - A	11	15	10	10	11	16	13	11	6	3	11	117	8	16	32	64	128	0.24	0.15	45	35
WHI0143N - B	13	13	13	3	8	16	13	11	8	5	5	108	23	45	90	128	180	0.49	0.24	45	26
WHI0143K - A	15	16	15	16	13	16	15	11	11	1	15	144	8	32	45	90	128	1.13	0.33	15	35
WHI0143K - B	15	16	16	16	15	16	15	11	11	1	3	135	16	32	64	128	256	0.78	0.35	15	25
Delta Tributaries																					
WHI0143J	10	10	10	6	16	15	11	13	10	5	3	109	NC	NC	NC	NC	NC	0.64	1.10	80	33
UWRDC01	11	8	8	11	18	13	13	11	11	15	15	134	NC	NC	NC	NC	NC	0.80	0.77	35	28
WHI0143S	10	11	13	11	13	15	13	8	5	3	5	107	NC	NC	NC	NC	NC	0.10	1.23	NC	21
WHI0143Q	13	8	13	8	18	11	11	8	10	6	6	112	NC	NC	NC	NC	NC	0.09	1.31	95	24
WHI0143R	8	6	6	5	10	10	11	8	10	6	5	85	NC	NC	NC	NC	NC	0.34	0.90	85	28

ES - Epifaunal substrate
EM/PS - Embeddedness/pool substrate
VE/PV - Velocity Regime/pool variability
SD - Sediment deposition
CF - Channel flow
CA - Channel alteration
RF - Riffle frequency
LBS - Left bank stability
RBS - Right bank stability
LRV - Left bank riparian vegetative zone
RRV - Right bank riparian vegatative zone
D15, D34, D50, D84, D95 - Represents cumulative percentage of channel materials greater than or equal to a specific size (mm)
MV - Mean velocity; MD - Mean depth; CC - Canopy cover; WW - Wetted width
TS - Total Score

Appendix M-1b. Habitat scores for aquatic macroinvertebrate samples collected during Spring 2002, Strawberry River Watershed, Arkansas.

	Instream/Riparian Habitat												Pebble Count					Channel Characteristics			
Station ID	ES	EM/PS	VE/PV	SD	CF	CA	RF	LBS	RBS	LRV	RRV	TS	D15	D34	D50	D84	D95	MV	MD	CC	WW
Mainstem Sites																					
WHI0143A-A	10	10	13	8	13	16	11	6	6	3	5	101	NC	NC	NC	NC	NC	1.19	0.39	0	32
WHI0143A-B	8	6	13	6	13	16	10	13	11	16	3	115	NC	NC	NC	NC	NC	1.05	0.33	15	24
UWSBR01-A	13	10	13	10	13	16	13	13	6	10	8	125	NC	NC	NC	NC	NC	1.62	0.70	NA	27
UWSBR01-B	13	13	13	11	15	16	13	13	13	11	11	142	NC	NC	NC	NC	NC	0.98	0.41	NA	41
WHI0143B - A	13	11	13	10	13	16	10	16	11	16	3	132	NC	NC	NC	NC	NC	0.51	1.38	0	22
WHI0143B - B	13	13	13	11	13	16	15	5	10	6	15	130	NC	NC	NC	NC	NC	1.60	0.40	0	25
UWSBR02 - A	15	15	15	11	15	16	13	16	11	16	11	154	NC	NC	NC	NC	NC	1.31	0.75	50	35
UWSBR02 - B	13	13	13	11	15	16	15	11	10	16	10	143	NC	NC	NC	NC	NC	1.19	0.66	88	34
WHI0143P	13	13	13	10	13	13	11	13	5	8	5	117	NC	NC	NC	NC	NC	1.82	1.18	72	42
WHI024	6	6	5	6	16	13	10	8	6	6	3	85	NC	NC	NC	NC	NC	1.40	1.37	60	72
OH Tributaries																					
WHI0143E-A	11	11	10	10	13	16	11	10	13	16	13	134	NC	NC	NC	NC	NC	0.88	0.26	60	39
WHI0143E-B	13	13	13	13	11	16	13	15	11	18	8	144	NC	NC	NC	NC	NC	1.05	0.27	90	38
WHI0143H-A	13	13	13	13	15	16	13	13	16	10	15	150	NC	NC	NC	NC	NC	0.81	0.63	NA	65
WHI0143H-B	11	13	13	11	15	16	13	13	15	8	10	138	NC	NC	NC	NC	NC	1.79	0.59	NA	58
UWNBC01 - A	15	13	13	11	16	16	15	13	16	6	16	150	NC	NC	NC	NC	NC	0.68	0.65	45	36
UWNBC01 - B	13	13	10	13	16	16	15	13	16	8	16	149	NC	NC	NC	NC	NC	0.69	0.30	40	67
WHI0143N - A	13	15	15	15	13	15	13	15	11	11	6	142	NC	NC	NC	NC	NC	1.36	0.39	75	51
WHI0143N - B	13	16	15	10	13	13	13	11	8	10	10	132	NC	NC	NC	NC	NC	1.55	0.39	3	32
WHI0143K - A	15	13	13	13	15	16	16	11	11	10	5	138	NC	NC	NC	NC	NC	0.89	0.28	NA	38
WHI0143K - B	15	13	13	13	15	16	13	11	10	6	5	130	NC	NC	NC	NC	NC	0.91	0.34	50	31
WHI0143L-A	11	10	10	10	15	13	8	11	13	16	15	132	NC	NC	NC	NC	NC	1.28	0.44	NA	28
WHI0143L-B	8	8	10	8	16	13	8	15	13	16	13	128	NC	NC	NC	NC	NC	1.48	0.63	NA	34
WHI0143M-A	15	13	13	15	15	13	13	13	15	13	11	149	NC	NC	NC	NC	NC	2.17	0.57	75	38
WHI0143M-B	15	15	15	15	15	11	13	11	16	13	11	150	NC	NC	NC	NC	NC	1.44	0.77	35	48
NBC WWTP	15	13	13	11	15	6	13	11	3	8	5	113	NC	NC	NC	NC	NC	1.39	0.50	5	28
WHI0143I-A	11	10	10	11	15	13	13	13	16	8	16	136	NC	NC	NC	NC	NC	0.52	0.58	NA	79
WHI0143I-B	13	13	13	13	15	15	15	13	10	11	18	149	NC	NC	NC	NC	NC	1.35	0.58	55	23
North Big Creek - A	13	13	13	13	15	16	15	8	13	15	15	149	NC	NC	NC	NC	NC	0.37	0.47	20	27
North Big Creek - B	13	15	10	11	16	16	15	10	8	16	16	146	NC	NC	NC	NC	NC	0.55	0.29	60	29
Delta Tributaries																					
WHI0143J	10	11	10	10	16	11	11	10	8	5	5	107	NC	NC	NC	NC	NC	0.86	0.80	96	34
UWRDC01	10	10	10	10	16	13	11	11	8	13	15	127	NC	NC	NC	NC	NC	0.78	0.61	50	30
WHI0143S	13	11	16	6	15	11	13	8	8	5	5	111	NC	NC	NC	NC	NC	0.31	0.81	100	27
WHI0143Q	11	10	10	10	15	8	10	10	10	5	5	104	NC	NC	NC	NC	NC	0.07	1.58	97	28
WHI0143R	13	13	10	11	16	10	11	10	10	8	8	120	NC	NC	NC	NC	NC	0.20	1.04	98	23

Note: Refer to Appenix M-1a for definition of abbreviations

Appendix M-1c. Habitat Scores for aquatic macroinvertebrate samples collected during Fall 2002, Strawberry River Watershed, Arkansas.

		Instream/Riparian Habitat											Pebble Count					Channel Characteristics			
Station ID	ES	EM/PS	VE/PV	SD	CF	CA	RF	LBS	RBS	LRV	RRV	TS	D15	D34	D50	D84	D95	MV	MD	CC	WW
Mainstem Sites																					
WHI0143E	15	16	10	11	10	16	10	18	15	13	3	137	11.3	16	32	64	128	0.61	0.40	0	14
WHI0143F	15	15	10	13	16	16	13	8	13	11	13	143	16	32	45	90	BR	NC	NC	NC	NC
UWSBR02	16	16	13	15	16	18	15	16	13	18	11	167	16	32	45	128	256	1.32	0.42	70	19
UWSBR02	13	15	10	15	15	18	11	16	13	18	13	157	11.3	32	45	64	90	0.62	0.49	80	24
WHI0143P	15	11	15	11	10	13	13	11	6	8	5	118	11.3	32	45	90	90	0.53	1.5	70	36
WHI024	10	10	10	6	18	11	6	13	5	11	5	105	8	16	16	32	45	1.22	0.83	20	72
OH Tributaries																					
WHI0143L	13	15	8	13	10	11	11	13	13	16	11	134	8	32	32	64	90	0.18	0.12	80	10
WHI0143L	10	11	10	13	8	11	10	10	13	18	11	125	4	11	16	23	32	0.12	0.05	80	15
WHI0143N	13	15	10	13	11	13	11	11	18	13	13	141	45	90	90	128	180	0.25	0.22	65	17
WHI0143N	13	16	10	15	10	10	10	11	18	10	10	133	6	16	32	64	90	0.06	0.47	60	38
UWNBC0	15	18	10	16	15	18	15	13	18	6	18	162	23	64	90	180	180	0.86	0.33	50	34
UWNBC0	15	16	10	16	13	18	15	13	18	10	18	162	23	32	45	90	128	0.58	0.34	40	21
WHI0143N	13	15	13	11	13	15	13	10	11	11	15	140	16	23	32	64	90	0.10	0.16	65	36
WHI0143N	13	13	15	6	8	16	13	6	10	5	3	108	16	32	45	128	180	0.16	0.09	55	16
WHI0143K	16	16	13	16	15	16	15	15	16	3	10	151	16	32	45	90	128	0.81	0.32	15	36
WHI0143K	15	16	10	16	15	18	15	13	15	3	6	127	16	32	45	128	BR	0.45	0.35	10	22
Delta Tributaries																					
WHI0143J	15	15	8	13	13	11	3	8	8	5	5	104	NA	NA	NA	NA	NA	0.42	0.85	80	35
UWRDC0	15	13	8	10	15	11	11	10	6	15	15	129	NA	NA	NA	NA	NA	0.18	1.40	75	33
WHI0143S	13	13	10	8	15	11	10	11	8	6	5	110	NA	NA	NA	NA	NA	0.04	1.89	80	22
WHI0143C	11	11	8	6	10	8	3	6	8	5	5	81	NA	NA	NA	NA	NA	0.12	1.50	95	25
WHI0143R	8	8	8	10	10	6	5	8	8	3	3	77	NA	NA	NA	NA	NA	0.14	1.49	85	35

Note: Refer to Appenix M-1a for definition of abbreviations

Appendix M-1d. Habitat scores for aquatic macroinvertebrate samples collected during Spring 2003, Strawberry River Watershed, Arkansas.

	Instream/Riparian Habitat												Pebble Count					Channel Characteristics			
Station ID	ES	EM/PS	VE/PV	SD	CF	CA	RF	LBS	RBS	LRV	RRV	TS	D15	D34	D50	D84	D95	MV	MD	CC	WW
Mainstem Sites																					
WHI0143A-A	11	8	13	13	13	15	11	11	10	5	5	115	NC	NC	NC	NC	NC	0.48	0.22	0	29
WHI0143A-B	11	8	10	10	13	18	11	15	8	18	5	127	NC	NC	NC	NC	NC	0.91	0.20	1	12
UWSBR01-A	11	8	10	8	13	8	13	3	6	3	10	93	NC	NC	NC	NC	NC	1.07	0.34	0	37
UWSBR01-B	13	13	13	11	13	16	13	11	8	10	10	131	NC	NC	NC	NC	NC	0.71	0.67	8	44
WHI0143B - A	13	11	13	11	13	13	11	16	11	15	3	130	NC	NC	NC	NC	NC	0.23	0.48	0	91
WHI0143B - B	13	13	13	11	13	13	13	8	11	10	10	128	NC	NC	NC	NC	NC	1.47	0.62	0	35
UWSBR02 - A	15	13	13	13	15	16	13	16	13	16	13	156	NC	NC	NC	NC	NC	1.89	0.90	55	43
UWSBR02 - B	13	11	13	10	15	16	13	16	10	16	11	144	NC	NC	NC	NC	NC	1.93	0.95	75	47
WHI0143P	13	11	13	11	16	13	11	11	6	8	8	121	NC	NC	NC	NC	NC	2.85	0.90	65	69
OH Tributaries																					
WHI0143E-A	13	13	10	13	11	15	11	11	11	16	10	134	NC	NC	NC	NC	NC	0.30	0.11	55	32
WHI0143E-B	13	13	13	13	11	15	11	16	10	16	6	137	NC	NC	NC	NC	NC	0.40	0.21	35	30
WHI0143H-A	11	8	10	11	10	16	13	11	16	8	13	127	NC	NC	NC	NC	NC	1.16	0.76	90	8
WHI0143H-B	13	11	10	11	10	16	13	11	18	8	15	136	NC	NC	NC	NC	NC	0.25	0.41	50	63
UWNBC01 - A	15	13	13	13	15	16	15	13	18	8	18	157	NC	NC	NC	NC	NC	0.84	0.53	36	37
UWNBC01 - B	15	13	11	13	15	18	15	10	8	10	18	146	NC	NC	NC	NC	NC	0.89	0.48	15	56
WHI0143N - A	11	11	10	10	13	16	13	13	11	11	6	125	NC	NC	NC	NC	NC	0.46	0.36	95	34
WHI0143N - B	15	15	15	8	13	11	11	5	8	8	8	117	NC	NC	NC	NC	NC	0.93	0.34	1	24
WHI0143K - A	15	15	13	13	16	16	15	13	15	3	5	139	NC	NC	NC	NC	NC	0.81	0.57	5	40
WHI0143K - B	15	15	13	13	16	16	16	11	13	3	10	141	NC	NC	NC	NC	NC	1.06	0.41	25	49
WHI0143L-A	8	8	11	8	13	8	11	11	13	16	13	120	NC	NC	NC	NC	NC	0.71	0.34	75	31
WHI0143M-A	15	13	15	11	15	13	15	13	18	15	13	156	NC	NC	NC	NC	NC	0.80	0.34	90	52
WHI0143M-B	15	13	10	11	15	13	15	13	18	13	13	149	NC	NC	NC	NC	NC	0.62	0.50	95	47
NBC WWTP	11	10	10	10	13	13	10	10	6	10	6	109	NC	NC	NC	NC	NC	0.68	0.24	0	19
WHI0143I-A	10	11	8	10	11	11	11	15	15	6	16	124	NC	NC	NC	NC	NC	0.25	0.62	8	77
WHI0143I-B	11	11	10	10	10	15	13	11	15	11	18	135	NC	NC	NC	NC	NC	0.72	0.30	50	20
North Big Creek - A	13	13	10	13	13	16	13	5	15	15	15	141	NC	NC	NC	NC	NC	0.49	0.52	36	26
North Big Creek - B	13	13	10	10	11	16	13	10	6	15	16	133	NC	NC	NC	NC	NC	0.64	0.17	35	34
Delta Tributaries																					
WHI0143J	10	8	10	10	18	11	11	11	10	8	8	115	NC	NC	NC	NC	NC	1.13	1.59	80	36
UWRDC01	11	10	10	8	16	11	11	13	8	15	15	128	NC	NC	NC	NC	NC	0.61	1.03	90	31
WHI0143S	13	15	15	11	18	13	13	10	8	6	6	128	NC	NC	NC	NC	NC	0.63	1.85	100	26
WHI0143Q	11	10	10	10	16	11	10	10	10	8	8	114	NC	NC	NC	NC	NC	0.18	1.26	100	28
WHI0143R	11	8	8	8	13	11	10	8	8	10	8	103	NC	NC	NC	NC	NC	0.53	0.65	97	16

Note: Refer to Appenix M-1a for definition of abbreviations

APPENDIX M-2

Selected aquatic macroinvertebrate metrics and descriptive statistics,
Strawberry River watershed, 2001 – 2003

Definitions of selected metrics and expected direction of metric response to increasing perturbation.

Category	Metric	Definition	Expected response to increasing perturbation
Richness Measures	No. of taxa	Measures the overall variety of the macroinvertebrate assemblage	Decrease
	No. of EPT taxa	Number of taxa in the insect orders Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies)	Decrease
	No. of Ephemeroptera taxa	Number of taxa of mayfly nymphs	Decrease
	No. of Plecoptera taxa	Number of taxa of stonefly nymphs	Decrease
	No. of Trichoptera taxa	Number of taxa of caddisfly larvae	Decrease
	No. of Coleoptera taxa	Number of beetle taxa (adult and larval)	Decrease
	No. of Diptera taxa	Number of taxa of classified as dipterans	Decrease
Composition Measures	Shannon-Weiner Index	Incorporates both richness and evenness in a measure of general diversity and composition	Decrease
	% dominant taxon	Measure the dominance of the single most abundant taxon	Increase
	% EPT	Percent of mayfly nymphs, stonefly nymphs and caddisfly larvae	Decrease
	% Ephemeroptera	Relative abundance of mayfly larvae	Decrease
	% Plecoptera	Relative abundance of stonefly larvae	Decrease
	% Trichoptera	Relative abundance of caddisfly larvae	Decrease
	% Diptera	Relative abundance of dipterans	Increase
	% Chironomidae	Relative abundance of midge larvae	Increase
	% Amphipoda	Relative abundance of amphipods	Decrease
	% Isopoda	Relative abundance of isopods	Increase
Tolerance Measures	Hilsenhoff Biotic Index	Tolerance value multiplied by number of organisms divided by total number of organisms	Increase
	No. Intolerant taxa	Number of taxa with a tolerance value < 3	Decrease
	% Tolerant taxa	Relative abundance of taxa with a tolerance value ≥ 7	Increase
Trophic Measures	% Shredders	Percent of the shredder functional feeding group	Decrease
	% Collectors	Percent of the collector functional feeding group	Variable
	% Filterers	Percent of the filterer functional feeding group	Decrease
	% Scrapers	Percent of the scraper functional feeding group	Decrease
	% Predator	Percent of the predator functional feeding group	Variable

Appendix M-2a. Selected aquatic macroinvertebrate metrics and descriptive statistics, Strawberry River Watershed, Fall 2001.

		Richness Measures							Composition Metrics								
Station ID	DB ID	No. Taxa	No. EPT	No. E	No. P	No. T	No. Col.	No. Dip.	% D.T.	% EPT	% E	% P	% T	% Dip.	% Chir.	% Amp.	% Isop.
Mainstem Sites																	
UWSBR01-A	ADEQ4G-7	18	6	4	0	2	4	3	23.86	56.81	27.27	0.00	29.54	18.18	17.04	0.00	0.00
WHI0143B - A	ADEQ4G-4	17	9	6	0	3	2	1	37.96	46.29	31.48	0.00	14.81	3.70	3.70	0.00	0.00
WHI0143B - B	ADEQ4G-3	23	10	6	0	4	3	1	15.12	51.26	26.05	0.00	25.21	15.12	15.12	0.00	0.00
UWSBR02 - A	ADEQ4G-6	14	5	4	0	1	3	2	50.64	73.07	71.15	0.00	1.92	1.28	0.00	0.00	0.00
WHI0143P	ADEQ4G-5	18	8	6	0	2	2	6	22.12	46.90	30.08	0.00	16.81	15.92	7.96	0.00	0.00
WHI024	ADEQ4G-8	19	10	7	1	2	3	1	26.31	59.21	46.71	1.31	11.18	3.94	3.94	0.00	0.00
Ozark Highland Tributaries																	
UWNBC01 - A	ADEQ4G-9	19	7	5	0	2	4	2	20.97	53.14	30.76	0.00	22.37	7.69	4.89	0.00	0.00
UWNBC01 - B	ADEQ4G-10	19	7	5	0	2	3	2	12.6	33.61	23.52	0.00	10.08	7.56	5.04	0.00	0.00
WHI0143N - A	ADEQ4G-12	17	7	5	0	2	4	1	34.95	70.87	66.99	0.00	3.88	0.97	0.97	0.00	0.00
WHI0143N - B	ADEQ4G-13	17	7	5	0	2	3	2	21.92	66.66	51.75	0.00	14.91	7.89	7.01	0.00	0.00
WHI0143K - A	ADEQ4G-14	22	8	4	0	4	5	4	15.78	56.14	31.57	0.00	24.56	17.98	0.87	0.00	0.00
WHI0143K - B	ADEQ4G-15	20	5	3	0	2	5	4	18.23	59.74	40.25	0.00	19.49	10.69	1.88	0.62	0.00
WHI0143M-A	ADEQ4G-11	16	4	4	0	0	4	2	38.7	56.98	56.98	0.00	0.00	2.15	1.07	0.00	0.00
Delta Tributaries																	
WHI0143J	ADEQ4G-19	29	6	5	0	1	6	5	30.35	9.82	8.92	0.00	0.89	19.64	14.28	0.00	0.00
UWRDC01	ADEQ4G-17	28	6	5	0	1	5	2	18.86	9.43	8.49	0.00	0.94	10.37	8.49	4.71	0.94
WHI0143S	ADEQ4G-16	21	2	2	0	0	9	3	30.61	3.06	3.06	0.00	0.00	32.65	30.61	0.00	2.04
WHI0143Q	ADEQ4G-18	25	3	3	0	0	8	3	29.29	5.05	5.05	0.00	0.00	15.15	13.13	37.17	12.82
WHI0143R	ADEQ4G-20	34	5	4	0	1	9	4	18.70	10.96	10.32	0.00	0.64	21.93	20.00	12.25	14.19
Descriptive Statistics																	
Mainstem & OH Tribs. (n = 13)																	
Minimum	NA	14	4	3	0	0	2	1	12.60	33.61	23.52	0.00	0.00	0.97	0.00	0.00	0.00
5th Percentile	NA	15	5	4	0	1	2	1	14.11	41.22	25.04	0.00	1.15	1.16	0.52	0.00	0.00
25th Percentile	NA	17	6	4	0	2	3	1	18.23	51.26	30.08	0.00	10.08	3.70	1.07	0.00	0.00
50th Percentile	NA	18	7	5	0	2	3	2	22.12	56.81	31.57	0.00	14.91	7.69	3.94	0.00	0.00
75th Percentile	NA	19	8	6	0	2	4	3	34.95	59.74	51.75	0.00	22.37	15.12	7.01	0.00	0.00
95th Percentile	NA	22	10	6	0	4	5	5	43.48	71.75	68.65	0.52	26.94	18.06	15.89	0.25	0.00
Maximum	NA	23	10	7	1	4	5	6	50.64	73.07	71.15	1.31	29.54	18.18	17.04	0.62	0.00
Delta Tributaries (n = 5)																	
Minimum	NA	21	2	2	0	0	5	2	18.70	3.06	3.06	0.00	0.00	10.37	8.49	0.00	0.00
5th Percentile	NA	22	2	2	0	0	5	2	18.73	3.46	3.46	0.00	0.00	11.33	9.42	0.00	0.19
25th Percentile	NA	25	3	3	0	0	6	3	18.86	5.05	5.05	0.00	0.00	15.15	13.13	0.00	0.94
50th Percentile	NA	28	5	4	0	1	8	3	29.29	9.43	8.49	0.00	0.64	19.64	14.28	4.71	2.04
75th Percentile	NA	29	6	5	0	1	9	4	30.35	9.82	8.92	0.00	0.89	21.93	20.00	12.25	12.82
95th Percentile	NA	33	6	5	0	1	9	5	30.56	10.73	10.04	0.00	0.93	30.51	28.49	32.19	13.92
Maximum	NA	34	6	5	0	1	9	5	30.61	10.96	10.32	0.00	0.94	32.65	30.61	37.17	14.19

Appendix M-2a. Selected aquatic macroinvertebrate metrics and descriptive statistics, Strawberry River Watershed, Fall 2001.

	Tolerance Measures			Trophic Measures				
Station ID	HBI	No. Intol.	% Tol. Taxa	% Shredder	% Collector	% Filterer	% Scraper	% Predator
Mainstem Sites								
UWSBR01-A	5.34	2	6.81	0.00	56.81	10.22	20.45	12.50
WHI0143B - A	5.12	3	7.40	0.00	27.77	10.18	57.40	4.62
WHI0143B - B	5.13	3	7.56	0.00	46.21	7.56	31.09	14.28
UWSBR02 - A	3.65	2	0.00	0.00	23.07	2.56	69.87	4.48
WHI0143P	4.77	4	4.42	0.00	38.93	7.96	39.82	13.27
WHI024	4.57	5	1.31	0.00	32.89	6.57	55.26	5.26
Ozark Highland Tributaries								
UWNBC01 - A	4.94	4	2.79	0.00	51.04	4.89	37.76	6.29
UWNBC01 - B	5.00	2	12.60	0.00	36.13	15.96	38.65	9.24
WHI0143N - A	4.12	4	14.56	0.00	36.89	3.88	50.48	8.73
WHI0143N - B	4.31	4	10.52	0.00	51.75	7.89	23.68	16.66
WHI0143K - A	3.77	8	1.75	0.00	38.15	25.00	33.77	3.07
WHI0143K - B	4.31	6	4.40	0.00	47.79	13.2	29.55	9.43
WHI0143M-A	4.28	3	12.90	0.00	20.43	2.15	51.61	25.80
Delta Tributaries								
WHI0143J	6.40	1	20.53	1.78	34.82	33.92	3.57	24.10
UWRDC01	6.84	0	41.50	0.00	26.41	9.43	0.94	57.54
WHI0143S	6.36	1	26.53	1.02	50.00	13.26	6.12	26.53
WHI0143Q	6.88	0	31.31	0.00	62.62	0.00	6.06	29.29
WHI0143R	6.73	2	37.41	0.00	57.41	1.29	4.51	34.19
Descriptive Statistics								
Mainstem & OH Tribs. (n = 13)								
Minimum	3.65	2	0.00	0.00	20.43	2.15	20.45	3.07
5th Percentile	3.72	2	0.79	0.00	22.01	2.40	22.39	3.92
25th Percentile	4.28	3	2.79	0.00	32.89	4.89	31.09	5.26
50th Percentile	4.57	4	6.81	0.00	38.15	7.89	38.65	9.24
75th Percentile	5.00	4	10.52	0.00	47.79	10.22	51.61	13.27
95th Percentile	5.21	7	13.56	0.00	53.77	19.58	62.39	20.32
Maximum	5.34	8	14.56	0.00	56.81	25.00	69.87	25.80
Delta Tributaries (n = 5)								
Minimum	6.36	0	20.53	0.00	26.41	0.00	0.94	24.10
5th Percentile	6.37	0	21.73	0.00	28.09	0.26	1.47	24.59
25th Percentile	6.40	0	26.53	0.00	34.82	1.29	3.57	26.53
50th Percentile	6.73	1	31.31	0.00	50.00	9.43	4.51	29.29
75th Percentile	6.84	1	37.41	1.02	57.41	13.26	6.06	34.19
95th Percentile	6.87	2	40.68	1.63	61.58	29.79	6.11	52.87
Maximum	6.88	2	41.50	1.78	62.62	33.92	6.12	57.54

Appendix M-2b. Selected aquatic macroinvertebrate metrics and descriptive statistics, Strawberry River Watershed, Spring 2002.

		Richness Measures							Composition Measures								
Station ID	**DB ID**	**No. Taxa**	**No. EPT**	**No. E**	**No. P**	**No. T**	**No. Col.**	**No. Dip.**	**% D.T.**	**% EPT**	**% E**	**% P**	**% T**	**% Dip.**	**% Chir.**	**% Amp.**	**% Isop.**
Mainstem Sites																	
WHI0143A-A	ADEQ4G-22	14	6	4	1	1	2	3	31.58	63.74	33.92	28.65	1.17	25.15	2.92	0.00	0.58
WHI0143A-B	ADEQ4G-23	13	8	4	3	1	2	2	51.55	90.06	35.4	54.04	0.62	5.59	1.86	0.00	0.00
UWSBR01-A	ADEQ4G-24	12	7	5	1	1	2	3	30.09	79.65	43.36	30.09	6.19	18.58	7.96	0.00	0.00
UWSBR01-B	ADEQ4G-25	15	7	4	1	2	3	2	52.47	38.96	16.88	15.58	6.49	58.96	6.49	0.00	0.00
WHI0143B - A	ADEQ4G-39	19	9	6	0	3	2	2	38.10	69.52	16.88	0.00	41.90	13.33	12.38	0.00	0.00
WHI0143B - B	ADEQ4G-41	23	7	4	1	2	4	5	38.66	61.34	18.49	0.84	42.02	17.65	14.29	0.00	0.00
UWSBR02 - A	ADEQ4G-46	17	8	4	0	4	3	2	18.80	72.65	45.30	0.00	27.35	17.09	14.53	0.00	0.00
UWSBR02 - B	ADEQ4G-47	22	12	7	1	4	3	4	26.88	77.50	46.25	0.63	30.63	13.75	10.63	0.00	0.00
WHI0143P	ADEQ4G-42	20	7	5	0	2	3	4	18.10	64.76	52.38	0.00	12.38	11.43	7.62	0.00	0.00
WHI024	ADEQ4G-43	20	11	7	1	3	3	3	28.71	70.30	50.50	1.98	17.82	16.83	12.87	0.00	0.00
OH Tributaries																	
WHI0143E-A	ADEQ4G-32	17	8	5	2	1	3	4	34.31	89.78	48.91	37.96	2.92	5.84	3.65	0.00	0.73
WHI0143E-B	ADEQ4G-33	14	8	4	2	2	1	4	27.22	68.33	32.78	28.33	7.22	24.44	2.78	0.00	0.00
WHI0143H-A	ADEQ4G-30	15	7	5	1	1	2	3	22.43	67.29	42.05	13.08	12.15	26.17	25.23	0.00	0.00
WHI0143H-B	ADEQ4G-31	16	9	6	2	1	1	4	35.9	53.85	30.77	8.55	14.53	43.59	38.46	0.00	0.00
UWNBC01 - A	ADEQ4G-51	26	10	5	1	4	6	3	19.70	52.27	30.30	0.76	21.21	21.97	19.70	0.76	0.00
UWNBC01 - B	ADEQ4G-52	18	8	4	0	4	4	1	21.95	47.15	30.08	0.00	17.07	11.38	11.38	0.00	0.00
WHI0143N - A	ADEQ4G-53	19	10	7	2	1	0	4	63.89	24.07	20.37	2.78	0.93	70.37	66.67	0.00	0.00
WHI0143N - B	ADEQ4G-54	15	10	6	2	2	0	4	73.00	22.00	16.00	4.00	2.00	77.00	73.00	0.00	0.00
WHI0143K - A	ADEQ4G-44	22	8	4	0	4	6	5	40.20	71.63	22.45	0.00	49.18	15.10	13.06	0.00	0.00
WHI0143K - B	ADEQ4G-45	24	9	4	0	5	4	4	45.30	74.03	19.34	0.00	54.70	12.15	9.39	2.21	0.55
WHI0143L-A	ADEQ4G-26	15	10	7	2	1	1	3	33.82	72.06	29.41	34.56	8.09	26.47	6.62	0.00	0.00
WHI0143L-B	ADEQ4G-27	9	6	4	1	1	1	2	43.69	86.41	39.81	43.69	2.19	12.62	11.65	0.00	0.00
WHI0143M-A	ADEQ4G-28	19	11	9	1	1	3	3	27.78	53.89	40.00	6.67	7.22	41.11	27.78	0.00	0.56
WHI0143M-B	ADEQ4G-29	15	10	7	2	1	1	3	31.03	37.93	22.41	8.05	7.47	60.34	29.31	0.00	0.00
NBC WWTP	ADEQ4G-40	23	12	8	2	2	3	4	32.05	60.90	17.31	16.67	26.92	33.97	32.69	0.00	0.64
WHI0143I-A	ADEQ4G-34	21	10	6	1	3	5	2	32.60	37.02	16.02	8.84	12.15	34.25	34.25	0.00	22.10
WHI0143I-B	ADEQ4G-55	23	11	8	1	2	3	2	27.08	39.06	17.71	11.46	9.90	21.88	21.88	0.00	27.08
NBC DS HWY354 - A	ADEQ4G-49	21	9	4	1	4	3	6	34.98	69.31	31.02	1.32	36.96	20.46	17.49	0.00	0.00
NBC DS HWY354 - B	ADEQ4G-50	27	12	6	1	5	6	5	28.44	55.45	20.38	0.47	34.60	26.54	20.38	0.00	2.37
Delta Tributaries																	
WHI0143J	ADEQ4G-35	26	8	3	1	4	7	2	45.92	13.27	8.16	1.02	4.08	51.02	51.02	0.00	0.00
UWRDC01	ADEQ4G-36	31	4	4	0	0	9	6	21.88	10.16	10.16	0.00	0.00	21.09	14.84	21.88	3.13
WHI0143S	ADEQ4G-38	31	8	5	0	3	7	4	12.82	32.05	28.21	0.00	3.85	19.23	16.67	8.97	0.00
WHI0143Q	ADEQ4G-37	22	2	1	0	1	6	6	30.30	5.05	1.01	0.00	4.04	17.17	13.13	30.30	11.11
WHI0143R	ADEQ4G-48	20	4	3	0	1	5	4	29.79	7.45	6.38	0.00	1.06	31.91	26.60	29.79	0.00

Appendix M-2b. Selected aquatic macroinvertebrate metrics and descriptive statistics, Strawberry River Watershed, Spring 2002.

		Richness Measures							Composition Measures								
Station ID	DB ID	No. Taxa	No. EPT	No. E	No. P	No. T	No. Col.	No. Dip.	% D.T.	% EPT	% E	% P	% T	% Dip.	% Chir.	% Amp.	% Isop.
Descriptive Statistics																	
Mainstem & OH Tribs. (n = 29)																	
Minimum	NA	9	6	4	0	1	0	1	18.10	22.00	16.00	0.00	0.62	5.59	1.86	0.00	0.00
5th Percentile	NA	12	6	4	0	1	0	2	19.16	29.25	16.36	0.00	1.03	8.06	2.84	0.00	0.00
25th Percentile	NA	15	8	4	1	1	2	2	27.22	52.27	19.34	0.63	6.49	13.75	7.96	0.00	0.00
50th Percentile	NA	19	9	5	1	2	3	3	32.05	64.76	30.30	6.67	12.15	21.88	13.06	0.00	0.00
75th Percentile	NA	22	10	7	2	4	3	4	38.66	72.06	40.00	16.67	27.35	33.97	25.23	0.00	0.55
95th Percentile	NA	25	12	8	2	5	6	5	59.32	88.43	49.86	41.40	46.32	66.36	55.39	0.46	14.21
Maximum	NA	27	12	9	3	5	6	6	73.00	90.06	52.38	54.04	54.70	77.00	73.00	2.21	27.08
Delta Tributaries (n = 5)																	
Minimum	NA	20	2	1	0	0	5	2	12.82	5.05	1.01	0.00	0.00	17.17	13.13	0.00	0.00
5th Percentile	NA	20	2	1	0	0	5	2	14.63	5.53	2.08	0.00	0.21	17.58	13.47	1.79	0.00
25th Percentile	NA	22	4	3	0	1	6	4	21.88	7.45	6.38	0.00	1.06	19.23	14.84	8.97	0.00
50th Percentile	NA	26	4	3	0	1	7	4	29.79	10.16	8.16	0.00	3.85	21.09	16.67	21.88	0.00
75th Percentile	NA	31	8	4	0	3	7	6	30.30	13.27	10.16	0.00	4.04	31.91	26.60	29.79	3.13
95th Percentile	NA	31	8	5	1	4	9	6	42.80	28.29	24.60	0.82	4.07	47.20	46.14	30.20	9.51
Maximum	NA	31	8	5	1	4	9	6	45.92	32.05	28.21	1.02	4.08	51.02	51.02	30.30	11.11

Appendix M-2b. Selected aquatic macroinvertebrate metrics and descriptive statistics, Strawberry River Watershed, Spring 2002.

	Tolerance Measures			Trophic Measures				
Station ID	**HBI**	**No. Intol.**	**% Tol. Taxa**	**% Shredder**	**% Collector**	**% Filterer**	**% Scraper**	**% Predator**
Mainstem Sites								
WHI0143A-A	4.37	1	2.34	1.17	40.35	21.05	8.77	28.65
WHI0143A-B	4.20	4	0.62	2.48	32.92	3.73	7.45	53.42
UWSBR01-A	4.17	4	3.54	0.00	46.02	8.85	13.27	31.86
UWSBR01-B	4.50	2	1.30	0.00	28.31	52.73	2.86	16.1
WHI0143B - A	5.59	5	8.57	0.00	76.19	2.86	19.05	1.90
WHI0143B - B	5.63	4	5.04	0.00	69.75	5.88	18.49	5.88
UWSBR02 - A	4.27	4	2.56	0.00	70.09	9.40	15.38	5.13
UWSBR02 - B	4.25	6	0.00	0.00	49.38	11.25	34.38	4.38
WHI0143P	4.46	4	5.71	0.00	60.00	4.76	30.48	4.76
WHI024	4.39	8	0.99	0.00	50.50	5.94	35.64	7.92
OH Tributaries								
WHI0143E-A	3.44	5	1.46	4.78	42.34	0.73	17.52	34.31
WHI0143E-B	4.31	4	2.78	1.67	38.33	18.89	11.11	30
WHI0143H-A	4.44	4	5.61	0.93	67.29	0	16.82	14.95
WHI0143H-B	4.78	5	3.42	1.71	73.5	4.27	11.97	8.55
UWNBC01 - A	5.03	6	6.82	0.00	60.61	6.82	30.3	2.27
UWNBC01 - B	4.98	6	23.58	0.00	40.65	22.76	35.77	0.81
WHI0143N - A	5.43	3	4.63	0.93	79.63	2.78	11.11	5.56
WHI0143N - B	5.51	4	5.00	1.00	87.00	1.00	5.00	6.00
WHI0143K - A	4.94	6	1.22	0.00	75.51	4.08	19.39	1.02
WHI0143K - B	5.22	8	0.55	0.00	73.48	4.97	16.57	4.42
WHI0143L-A	4.45	4	2.21	0.74	37.5	19.12	8.09	34.56
WHI0143L-B	4.28	2	0.00	0.00	50.49	0.97	4.85	43.69
WHI0143M-A	5.32	6	20.56	0.00	66.67	12.78	12.78	7.78
WHI0143M-B	5.09	3	9.77	0.57	56.32	31.03	4.02	8.05
NBC WWTP	5.46	8	7.05	1.92	72.44	1.92	6.41	17.31
WHI0143I-A	5.77	6	25.41	0.55	82.32	1.1	6.63	9.39
WHI0143I-B	5.71	6	31.25	0.00	73.44	1.04	14.06	11.46
NBC DS HWY354 - A	5.07	5	0.33	0.00	78.55	1.65	14.52	5.28
NBC DS HWY354 - B	5.12	8	2.84	0.00	70.14	9.95	15.64	4.27
Delta Tributaries								
WHI0143J	5.73	0	2.04	0.00	66.33	5.10	3.06	20.41
UWRDC01	5.99	1	4.69	0.00	54.69	2.34	14.06	28.91
WHI0143S	5.64	2	16.67	0.00	44.87	2.56	21.79	21.79
WHI0143Q	6.40	1	19.19	1.01	59.60	0.00	13.13	19.19
WHI0143R	6.15	3	9.57	2.13	71.28	4.26	4.26	18.09

Appendix M-2b. Selected aquatic macroinvertebrate metrics and descriptive statistics, Strawberry River Watershed, Spring 2002.

	Tolerance Measures			Trophic Measures				
Station ID	HBI	No. Intol.	% Tol. Taxa	% Shredder	% Collector	% Filterer	% Scraper	% Predator
Descriptive Statistics								
Mainstem & OH Tribs. (n = 29)								
Minimum	3.44	1	0.00	0.00	28.31	0.00	2.86	0.81
5th Percentile	4.18	2	0.13	0.00	34.75	0.83	4.35	1.37
25th Percentile	4.37	4	1.30	0.00	46.02	1.92	8.09	4.76
50th Percentile	4.94	5	3.42	0.00	66.67	4.97	14.06	7.92
75th Percentile	5.32	6	6.82	0.93	73.48	11.25	18.49	17.31
95th Percentile	5.68	8	24.68	2.26	81.24	27.72	35.14	40.04
Maximum	5.77	8	31.25	4.78	87.00	52.73	35.77	53.42
Delta Tributaries (n = 5)								
Minimum	5.64	0	2.04	0.00	44.87	0.00	3.06	18.09
5th Percentile	5.66	0	2.57	0.00	46.83	0.47	3.30	18.31
25th Percentile	5.73	1	4.69	0.00	54.69	2.34	4.26	19.19
50th Percentile	5.99	1	9.57	0.00	59.60	2.56	13.13	20.41
75th Percentile	6.15	2	16.67	1.01	66.33	4.26	14.06	21.79
95th Percentile	6.35	3	18.69	1.91	70.29	4.93	20.24	27.49
Maximum	6.40	3	19.19	2.13	71.28	5.10	21.79	28.91

Appendix M-2c. Selected aquatic macroinvertebrate metrics and descriptive statistics, Strawberry River Watershed, Fall 2002.

		Richness Measures							Composition Measures								
Station ID	**DB ID**	**No. Taxa**	**No. EPT**	**No. E**	**No. P**	**No. T**	**No. Col.**	**No. Dip.**	**% D.T.**	**% EPT**	**% E**	**% P**	**% T**	**% Dip.**	**% Chir.**	**% Amp.**	**% Isop.**
Mainstem Sites																	
WHI0143B - A	ADEQ4G-68	14	7	5	0	2	1	2	27.21	79.41	62.5	0.00	16.91	8.09	7.35	0.00	0.00
WHI0143B - B	ADEQ4G-69	19	7	4	0	3	3	1	23.62	70.08	60.63	0.00	9.45	2.36	0.00	0.00	0.00
UWSBR02 - A	ADEQ4G-66	17	9	5	1	3	1	3	24.46	82.07	64.13	1.09	16.85	6.52	3.80	0.00	0.00
UWSBR02 - B	ADEQ4G-67	19	9	5	1	3	3	2	48.08	82.07	64.13	1.09	16.85	6.52	3.80	0.00	0.00
WHI0143P	ADEQ4G-70	21	10	7	0	3	3	3	43.22	86.81	69.60	0.00	17.22	3.30	2.20	0.00	0.00
WHI024	ADEQ4G-71	17	10	6	1	3	2	1	65.53	94.41	88.82	0.62	4.97	0.93	0.93	0.00	0.00
OH Tributaries																	
UWNBC01 - A	ADEQ4G-56	16	6	4	0	2	4	2	22.86	68.57	54.29	0.00	14.29	2.14	1.43	0.00	0.00
UWNBC01 - B	ADEQ4G-57	17	4	3	0	1	4	2	23.16	45.26	40.00	0.00	5.26	2.11	1.05	0.00	0.00
WHI0143N - A	ADEQ4G-64	18	8	4	1	3	1	4	31.74	59.88	43.11	0.60	16.17	28.14	23.95	0.00	0.00
WHI0143N - B	ADEQ4G-65	22	8	5	0	3	4	6	24.62	59.30	45.73	0.00	13.57	30.15	26.13	0.00	0.00
WHI0143K - A	ADEQ4G-60	23	9	5	0	4	4	3	32.31	53.85	34.87	0.00	18.97	2.05	1.03	0.51	0.00
WHI0143K - B	ADEQ4G-61	17	7	4	0	3	3	3	29.73	85.14	51.35	0.00	33.78	5.41	1.35	0.68	0.00
WHI0143L-A	ADEQ4G-58	15	8	5	0	3	1	3	32.35	92.94	68.82	0.00	24.12	4.12	2.35	0.00	0.00
WHI0143L-B	ADEQ4G-59	15	5	3	0	2	2	4	55.21	89.57	80.37	0.00	9.20	4.91	3.07	0.00	0.00
WHI0143M-A	ADEQ4G-62	21	5	4	0	1	4	5	44.50	83.25	79.06	0.00	4.19	4.19	1.05	0.00	0.00
WHI0143M-B	ADEQ4G-63	14	7	4	0	3	2	3	34.82	75.89	63.39	0.00	12.50	15.18	13.39	0.00	0.00
Delta Tributaries																	
WHI0143J	ADEQ4G-75	25	6	4	0	2	6	3	34.88	7.75	5.43	0.00	2.33	36.43	35.66	0.00	0.00
UWRDC01	ADEQ4G-74	23	7	5	0	2	3	2	39.25	9.35	7.48	0.00	1.87	41.12	41.12	1.87	0.00
WHI0143S	ADEQ4G-76	27	2	2	0	0	7	7	36.36	4.04	4.04	0.00	0.00	44.44	39.39	3.03	2.02
WHI0143Q	ADEQ4G-72	21	4	3	0	1	5	3	44.14	5.41	4.50	0.00	0.90	15.32	13.51	8.11	44.14
WHI0143R	ADEQ4G-73	21	4	3	0	1	3	1	29.81	13.46	12.50	0.00	0.96	27.88	27.88	2.88	29.81
Descriptive Statistics																	
Mainstem & OH Tribs. (n = 16)																	
Minimum	NA	14	4	3	0	1	1	1	22.86	45.26	34.87	0.00	4.19	0.93	0.00	0.00	0.00
5th Percentile	NA	14	5	3	0	1	1	1	23.09	51.70	38.72	0.00	4.78	1.77	0.70	0.00	0.00
25th Percentile	NA	16	7	4	0	2	2	2	24.58	66.40	49.95	0.00	9.39	2.31	1.05	0.00	0.00
50th Percentile	NA	17	8	5	0	3	3	3	32.03	80.74	62.95	0.00	15.23	4.55	2.28	0.00	0.00
75th Percentile	NA	20	9	5	0	3	4	3	43.54	85.56	69.02	0.15	16.99	6.91	4.69	0.00	0.00
95th Percentile	NA	22	10	6	1	3	4	5	57.79	93.31	82.48	1.09	26.54	28.64	24.50	0.55	0.00
Maximum	NA	23	10	7	1	4	4	6	65.53	94.41	88.82	1.09	33.78	30.15	26.13	0.68	0.00
Delta Tributaries (n = 5)																	
Minimum	NA	21	2	2	0	0	3	1	29.81	4.04	4.04	0.00	0.00	15.32	13.51	0.00	0.00
5th Percentile	NA	21	2	2	0	0	3	1	30.82	4.31	4.13	0.00	0.18	17.83	16.38	0.37	0.00
25th Percentile	NA	21	4	3	0	1	3	2	34.88	5.41	4.50	0.00	0.90	27.88	27.88	1.87	0.00
50th Percentile	NA	23	4	3	0	1	5	3	36.36	7.75	5.43	0.00	0.96	36.43	35.66	2.88	2.02
75th Percentile	NA	25	6	4	0	2	6	3	39.25	9.35	7.48	0.00	1.87	41.12	39.39	3.03	29.81
95th Percentile	NA	27	7	5	0	2	7	6	43.16	12.64	11.50	0.00	2.24	43.78	40.77	7.09	41.27
Maximum	NA	27	9	5	1	4	7	7	55.21	92.94	80.37	0.60	33.78	44.44	41.12	8.11	44.14

Appendix M-2c. Selected aquatic macroinvertebrate metrics and descriptive statistics, Strawberry River Watershed, Fall 2002.

	Tolerance Measures			Trophic Measures				
Station ID	HBI	No. Intol.	% Tol. Taxa	% Shredder	% Collector	% Filterer	% Scraper	% Predator
Mainstem Sites								
WHI0143B - A	4.64	2	5.15	0.00	55.88	8.82	31.62	3.68
WHI0143B - B	4.58	2	2.36	0.00	47.24	11.02	33.86	7.87
UWSBR02 - A	4.22	4	4.35	0.00	50.54	16.30	26.63	6.52
UWSBR02 - B	4.09	4	1.28	0.00	33.33	5.77	53.85	7.05
WHI0143P	4.38	4	2.20	0.00	42.86	3.66	49.82	3.66
WHI024	4.91	5	0.31	0.00	72.98	0.62	24.22	2.17
OH Tributaries								
UWNBC01 - A	4.72	3	7.86	0.00	61.43	5.71	30.71	2.14
UWNBC01 - B	3.65	3	17.89	0.00	41.05	21.05	30.53	7.37
WHI0143N - A	4.28	4	4.79	3.59	38.32	14.37	35.93	7.78
WHI0143N - B	4.52	5	7.04	2.01	54.27	10.55	26.13	7.04
WHI0143K - A	3.52	9	0.51	0.00	41.03	1.54	53.85	3.59
WHI0143K - B	4.08	7	0.00	0.00	66.89	6.08	24.32	2.70
WHI0143L-A	4.54	3	4.12	1.18	58.24	2.94	34.71	2.94
WHI0143L-B	4.89	4	1.84	0.61	76.69	1.23	17.79	3.68
WHI0143M-A	4.02	5	2.62	0.52	40.84	2.09	51.31	5.24
WHI0143M-B	4.14	3	0.00	0.00	54.46	2.68	35.71	7.14
Delta Tributaries								
WHI0143J	6.52	1	27.91	0.00	53.49	13.18	3.10	27.13
UWRDC01	6.09	1	18.69	0.00	51.40	22.43	7.48	18.69
WHI0143S	6.48	0	30.30	2.02	56.57	11.11	13.13	15.15
WHI0143Q	6.87	0	55.86	0.00	72.97	0.00	8.11	15.32
WHI0143R	6.92	0	50.00	1.92	83.65	0.00	1.92	12.50
Descriptive Statistics								
Mainstem & OH Tribs. (n = 16)								
Minimum	3.52	2	0.00	0	33	1	18	2
5th Percentile	3.62	2	0.00	0	37	1	23	2
25th Percentile	4.09	3	1.09	0	41	3	27	3
50th Percentile	4.33	4	2.49	0	52	6	33	4
75th Percentile	4.60	5	4.88	1	59	11	39	7
95th Percentile	4.90	8	10.37	2	74	17	54	8
Maximum	4.91	9	17.89	4	77	21	54	8
Delta Tributaries (n = 5)								
Minimum	6.09	0	18.69	0	51	0	2	13
5th Percentile	6.17	0	20.53	0	52	0	2	13
25th Percentile	6.48	0	27.91	0	53	0	3	15
50th Percentile	6.52	0	30.30	0	57	11	7	15
75th Percentile	6.87	1	50.00	2	73	13	8	19
95th Percentile	6.91	1	54.69	2	82	21	12	25
Maximum	6.87	9	55.86	4	77	22	54	27

Appendix M-2d. Selected aquatic macroinvertebrate metrics and descriptive statistics, Strawberry River Watershed, Spring 2003.

		Richness Measures							Composition Measures								
Station ID	**DB ID**	**No. Taxa**	**No. EPT**	**No. E**	**No. P**	**No. T**	**No. Col.**	**No. Dip.**	**% D.T.**	**% EPT**	**% E**	**% P**	**% T**	**% Dip.**	**% Chir.**	**% Amp.**	**% Isop.**
Mainstem Sites																	
WHI0143A-A	ADEQ4G-83	20	10	4	3	3	4	5	41.52	75.44	25.73	47.37	2.34	7.60	2.34	0.00	0.00
WHI0143A-B	ADEQ4G-84	15	7	4	2	1	2	3	33.04	62.61	27.83	33.91	0.87	32.17	27.83	0.00	0.00
UWSBR01-A	ADEQ4G-81	25	14	9	3	2	1	6	26.09	73.91	41.74	28.70	3.48	20.00	6.09	0.00	0.00
UWSBR01-B	ADEQ4G-82	23	17	10	3	4	1	4	31.58	91.58	47.37	33.68	10.53	6.32	2.11	0.00	0.00
WHI0143B - A	ADEQ4G-85	27	13	10	1	2	4	4	23.65	65.54	54.73	7.43	3.38	12.84	6.08	0.00	0.00
WHI0143B - B	ADEQ4G-86	24	14	8	2	4	1	4	22.46	47.83	34.06	9.42	4.35	41.30	22.46	0.00	0.00
UWSBR02 - A	ADEQ4G-96	21	10	7	2	1	2	5	21.35	35.96	21.35	11.24	3.37	31.46	22.47	0.00	0.00
UWSBR02 - B	ADEQ4G-93	22	11	8	1	2	2	3	15.12	62.79	40.70	15.12	6.98	9.30	6.98	0.00	0.00
WHI0143P	ADEQ4G-99	27	11	8	1	2	4	5	18.33	42.50	31.67	4.17	6.67	19.17	12.50	0.00	0.00
OH Tributaries																	
WHI0143E-A	ADEQ4G-89	17	11	6	3	2	1	3	35.57	94.63	58.39	30.87	5.37	3.36	1.34	0.00	0.00
WHI0143E-B	ADEQ4G-90	21	12	6	3	3	2	5	30.49	87.80	46.34	34.76	6.71	7.32	3.05	0.00	0.00
WHI0143H-A	ADEQ4G-91	32	16	8	3	5	2	6	29.78	85.39	50.00	32.02	3.37	5.62	2.25	0.00	0.00
WHI0143H-B	ADEQ4G-92	27	14	8	2	4	1	3	32.04	79.61	38.83	36.89	3.88	6.80	3.88	0.00	0.00
UWNBC01 - A	ADEQ4G-87	27	10	7	2	1	4	7	22.52	61.59	54.30	5.30	1.99	15.23	8.61	0.00	0.00
UWNBC01 - B	ADEQ4G-88	31	13	8	2	3	5	4	23.01	52.65	45.58	4.42	2.65	3.10	2.21	0.00	0.00
WHI0143N - A	ADEQ4G-79	22	13	8	3	2	2	4	31.93	75.63	59.66	14.29	1.68	15.13	13.45	0.00	0.00
WHI0143N - B	ADEQ4G-80	23	13	8	4	1	3	7	25.96	71.15	63.46	6.73	0.96	25.96	15.38	0.00	0.00
WHI0143K - A	ADEQ4G-94	26	13	6	1	6	6	3	21.67	75.83	43.89	1.94	30.00	1.11	0.56	0.00	0.00
WHI0143K - B	ADEQ4G-95	20	9	4	1	4	3	3	33.18	81.57	40.09	2.30	39.17	4.61	3.23	0.00	0.00
WHI0143L-A	ADEQ4G-98	21	11	7	3	1	3	4	20.41	80.61	56.12	22.45	2.04	6.12	4.08	0.00	0.00
WHI0143M-A	ADEQ4G-102	29	14	9	2	3	5	6	16.30	62.77	57.88	2.17	2.72	13.86	7.34	0.00	0.00
WHI0143M-B	ADEQ4G-101	29	12	7	1	4	5	5	26.00	64.67	58.67	2.00	4.00	10.67	2.00	0.00	0.67
NBC WWTP	ADEQ4G-97	24	12	6	2	4	4	5	26.80	70.10	32.99	27.84	9.28	14.43	11.34	0.00	2.06
WHI0143I-A	ADEQ4G-77	28	12	7	3	2	6	3	48.84	70.54	17.83	50.39	2.33	7.75	6.98	0.00	2.33
WHI0143I-B	ADEQ4G-78	25	13	7	2	4	6	2	42.01	66.21	21.00	42.47	2.74	4.57	4.57	0.00	4.57
NBC DS HWY354 - A	ADEQ4G-103	27	16	9	4	3	3	4	31.91	78.72	43.26	33.69	1.77	5.32	4.61	0.00	1.42
NBC DS HWY354 - B	ADEQ4G-100	27	17	8	4	5	4	2	14.66	67.54	45.55	19.37	2.62	7.33	7.33	0.00	3.66
Delta Tributaries																	
WHI0143J	ADEQ4G-107	31	9	7	1	1	8	6	11.58	34.74	24.21	9.47	1.05	23.16	13.68	0.00	0.00
UWRDC01	ADEQ4G-108	29	8	5	1	2	9	2	13.67	23.02	15.11	5.76	2.16	7.19	7.19	2.16	0.00
WHI0143S	ADEQ4G-105	30	6	4	1	1	7	3	18.27	15.38	10.58	2.88	1.92	21.15	20.19	18.27	12.50
WHI0143Q	ADEQ4G-106	21	2	2	0	0	5	4	48.89	2.96	2.96	0.00	0.00	8.89	7.41	48.89	22.96
WHI0143R	ADEQ4G-104	19	4	2	1	1	5	1	29.46	19.38	8.53	0.78	10.08	10.08	10.08	29.46	15.50

Appendix M-2d. Selected aquatic macroinvertebrate metrics and descriptive statistics, Strawberry River Watershed, Spring 2003.

		Richness Measures							Composition Measures								
Station ID	DB ID	No. Taxa	No. EPT	No. E	No. P	No. T	No. Col.	No. Dip.	% D.T.	% EPT	% E	% P	% T	% Dip.	% Chir.	% Amp.	% Isop.
Descriptive Statistics																	
Mainstem & OH Tribs. (n = 27)																	
Minimum		15	7	4	1	1	1	2	14.66	35.96	17.83	1.94	0.87	1.11	0.56	0.00	0.00
5th Percentile		18	9	4	1	1	1	2	15.42	44.10	21.11	2.05	1.18	3.18	1.54	0.00	0.00
25th Percentile		22	11	7	2	2	2	3	21.87	62.78	33.53	6.02	2.34	5.87	2.70	0.00	0.00
50th Percentile		25	13	8	2	3	3	4	26.05	70.54	43.89	19.37	3.37	7.75	6.08	0.00	0.00
75th Percentile		27	14	8	3	4	4	5	31.93	79.17	54.52	33.69	6.02	15.18	9.98	0.00	0.00
95th Percentile		30	17	10	4	5	6	7	40.40	90.45	59.36	45.90	24.16	31.96	22.47	0.00	3.26
Maximum		32	17	10	4	6	6	7	48.84	94.63	63.46	50.39	39.17	41.30	27.83	0.00	4.57
Delta Tributaries (n = 5)																	
Minimum		19	2	2	0	0	5	1	11.58	2.96	2.96	0.00	0.00	7.19	7.19	0.00	0.00
5th Percentile		19	2	2	0	0	5	1	12.00	5.44	4.07	0.16	0.21	7.53	7.23	0.43	0.00
25th Percentile		21	4	2	1	1	5	2	13.67	15.38	8.53	0.78	1.05	8.89	7.41	2.16	0.00
50th Percentile		29	6	4	1	1	7	3	18.27	19.38	10.58	2.88	1.92	10.08	10.08	18.27	12.50
75th Percentile		30	8	5	1	1	8	4	29.46	23.02	15.11	5.76	2.16	21.15	13.68	29.46	15.50
95th Percentile		31	9	7	1	2	9	6	45.00	32.40	22.39	8.73	8.50	22.76	18.89	45.00	21.47
Maximum		31	9	7	1	2	9	6	48.89	34.74	24.21	9.47	10.08	23.16	20.19	48.89	22.96

Appendix M-2d. Selected aquatic macroinvertebrate metrics and descriptive statistics, Strawberry River Watershed, Spring 2003.

	Tolerance Measures			Trophic Measures				
Station ID	**HBI**	**No. Intol.**	**% Tol. Taxa**	**% Shredder**	**% Collector**	**% Filterer**	**% Scraper**	**% Predator**
Mainstem Sites								
WHI0143A-A	5.01	6	15.79	7.60	29.24	4.68	15.79	42.69
WHI0143A-B	5.63	4	20.87	0.87	54.78	0.87	4.35	39.13
UWSBR01-A	4.7	6	13.04	4.35	46.96	3.48	6.09	36.52
UWSBR01-B	3.73	9	1.05	2.11	41.05	9.47	5.26	36.84
WHI0143B - A	5.05	7	16.89	0.00	52.03	13.51	24.32	10.14
WHI0143B - B	4.71	7	5.80	2.17	52.90	21.01	12.32	11.59
UWSBR02 - A	4.68	5	7.87	1.12	42.70	11.24	31.46	13.48
UWSBR02 - B	4.01	6	3.49	0.00	33.72	4.65	43.02	18.60
WHI0143P	5.07	7	13.33	0.00	46.67	5.00	38.33	10.00
OH Tributaries								
WHI0143E-A	2.53	6	0.00	5.37	19.46	5.37	41.61	28.19
WHI0143E-B	3.3	7	3.66	5.49	27.44	4.27	27.44	35.37
WHI0143H-A	4.7	11	24.16	3.37	35.96	2.81	23.03	34.83
WHI0143H-B	4.33	9	16.50	4.85	31.07	6.80	23.30	33.98
UWNBC01 - A	4.62	6	5.30	1.99	52.98	1.32	32.45	11.26
UWNBC01 - B	4.1	9	3.10	0.88	47.79	1.77	43.36	6.19
WHI0143N - A	4.19	8	8.40	4.20	36.97	0.84	46.22	11.76
WHI0143N - B	4.38	10	6.73	3.85	41.35	3.85	40.38	10.58
WHI0143K - A	3.72	7	0.83	0.56	43.33	8.61	44.72	2.78
WHI0143K - B	4.52	5	2.76	0.46	58.53	4.61	33.64	2.76
WHI0143L-A	3.99	5	3.06	3.06	39.80	0.00	23.47	31.63
WHI0143M-A	3.82	6	4.89	0.82	57.88	6.52	30.71	4.08
WHI0143M-B	3.93	8	8.00	0.67	42.00	8.67	44.00	4.67
NBC WWTP	4.54	8	12.37	1.03	36.08	6.19	25.77	30.93
WHI0143I-A	4.69	7	12.40	2.33	27.91	1.55	15.50	52.71
WHI0143I-B	4.08	8	8.68	0.46	34.25	1.37	19.63	44.29
NBC DS HWY354 - A	3.67	11	3.90	1.42	34.04	1.42	29.08	34.04
NBC DS HWY354 - B	3.51	13	4.71	4.19	39.79	1.05	38.22	16.75
Delta Tributaries								
WHI0143J	5.56	3	16.84	6.32	41.05	1.05	8.42	32.63
UWRDC01	6.05	2	28.06	0.00	34.53	14.39	9.35	34.53
WHI0143S	6.14	1	21.15	0.00	73.08	1.92	13.46	8.65
WHI0143Q	6.82	1	28.15	0.00	86.67	0.00	3.7	5.93
WHI0143R	6.61	1	23.26	0.00	83.72	0.00	3.88	12.40

Appendix M-2d. Selected aquatic macroinvertebrate metrics and descriptive statistics, Strawberry River Watershed, Spring 2003.

	Tolerance Measures			Trophic Measures				
Station ID	HBI	No. Intol.	% Tol. Taxa	% Shredder	% Collector	% Filterer	% Scraper	% Predator
Descriptive Statistics								
Mainstem & OH Tribs. (n = 27)								
Minimum	2.53	4	0.00	0.00	19.46	0.00	4.35	2.76
5th Percentile	3.36	5	0.90	0.00	27.58	0.85	5.51	3.17
25th Percentile	3.88	6	3.58	0.75	34.15	1.49	21.33	10.36
50th Percentile	4.33	7	6.73	1.99	41.05	4.61	29.08	18.60
75th Percentile	4.70	8.5	12.72	4.02	47.38	6.66	39.36	35.10
95th Percentile	5.06	11	19.68	5.45	56.95	12.83	44.50	43.81
Maximum	5.63	13	24.16	7.60	58.53	21.01	46.22	52.71
Delta Tributaries (n = 5)								
Minimum	5.56	1	16.84	0.00	34.53	0.00	3.70	5.93
5th Percentile	5.66	1	17.70	0.00	35.83	0.00	3.74	6.47
25th Percentile	6.05	1	21.15	0.00	41.05	0.00	3.88	8.65
50th Percentile	6.14	1	23.26	0.00	73.08	1.05	8.42	12.40
75th Percentile	6.61	2	28.06	0.00	83.72	1.92	9.35	32.63
95th Percentile	6.78	3	28.13	5.06	86.08	11.90	12.64	34.15
Maximum	6.82	3	28.15	6.32	86.67	14.39	13.46	34.53

APPENDIX M-3

Taxa list for aquatic macroinvertebrates collected in the Strawberry River watershed, Arkansas, 2001 – 2003

Appendix M-3a. Taxa list for aquatic macroinvertebrates collected during Fall 2001, Strawberry River Watershed, Arkansas.

		Station ID								
Taxon Name	Tol. Value	UWSBR01-A	WHI0143B - A	WHI0143B - B	UWSBR02	WHI0143P	WHI024	UWNBC01 - A	UWNBC01 - B	WHI0143N - A
Acroneuria	0.0	0	0	0	0	0	0	0	0	0
Agabus	5.0	0	0	0	0	0	0	0	0	0
Agapetus	0.0	0	0	0	0	0	0	0	0	0
Amphiagrion	5.0	0	0	0	0	0	0	0	0	0
Amphinemura	3.4	0	0	0	0	0	0	0	0	0
Ancylidae	6.0	0	0	0	0	0	0	0	0	0
Ancyronyx	6.9	0	0	0	0	0	0	0	0	0
Ancyronyx (A)	6.9	0	0	0	0	0	0	0	0	0
Apatolestes	8.0	0	0	0	0	0	0	0	0	0
Argia	5.1	0	0	0	0	1	0	0	0	2
Arigomphus	5.0	0	0	0	0	0	0	0	0	0
Atherix	2.0	0	0	0	0	2	0	0	0	0
Baetis	3.1	0	0	7	3	1	7	5	3	0
Baetis #2	3.1	0	0	0	0	0	0	0	0	0
Baetisca	4.0	0	0	0	0	0	0	0	0	0
Basiaeschna	7.7	0	0	0	0	0	0	0	0	0
Belostoma	9.8	0	0	0	0	0	0	0	0	0
Berosus	8.6	0	0	0	0	0	0	0	0	0
Boyeria	6.3	0	0	0	0	0	0	0	0	0
Brachycentrus	2.2	0	0	0	0	0	0	0	0	0
Brachyprema	3.0	0	0	0	0	0	0	0	0	0
Caecidotea	6.0	0	0	0	0	0	0	0	0	0
Caenis	7.6	3	2	2	0	1	1	1	1	13
Calopteryx	8.3	0	0	0	0	0	0	0	0	0
Cambarinae	6.0	2	0	1	1	0	0	0	1	2
Carabidae	4.0	0	0	0	0	0	0	0	0	0
Ceratopsyche	3.0	0	0	0	0	0	0	0	0	0
Chaoborus	8.5	0	0	0	0	0	0	0	0	0
Cheumatopsyche	6.6	21	8	16	0	15	14	30	6	1
Chimarra	2.8	5	5	6	3	4	3	0	0	3
Chironomidae	6.0	14	4	18	0	8	6	7	6	1
Chironomidae (P)	6.0	1	0	0	0	1	0	0	0	0
Chlorotabanus	8.0	0	0	0	0	0	0	0	0	0
Chrysops	7.3	0	0	0	0	0	0	0	0	0
Cnephia	4.0	0	0	0	0	0	0	0	0	0
Corbicula	6.3	4	4	1	1	2	7	0	3	0
Corixidae	9.0	0	0	0	0	0	0	0	0	0
Corydalus	5.6	1	1	12	7	9	2	5	5	7
Culicoides	10.0	0	0	0	0	0	0	0	0	0
Cybister	5.0	0	0	0	0	0	0	0	0	0
Cyrnellus	7.4	0	0	0	0	0	0	0	0	0
Dasyhelea	5.7	0	0	0	1	0	0	0	0	0
Dasyhelea (P)	5.7	0	0	0	1	0	0	0	0	0
Dicranota	4.0	0	0	0	0	0	0	0	0	0
Dineutus	5.5	2	0	0	0	0	0	0	0	0
Dineutus (A)	5.5	0	0	0	0	0	0	0	0	0
Diptera	7.0	0	0	0	0	0	0	0	0	0
Diptera (P)	7.0	0	0	0	0	0	0	0	0	0
Dixella	1.0	0	0	0	0	0	0	0	0	0
Dolichopodidae	9.7	0	0	0	0	0	0	0	0	0
Dromogomphus	6.3	0	0	1	0	0	0	3	5	0

Appendix M-3a. Taxa list for aquatic macroinvertebrates collected during Fall 2001, Strawberry River Watershed, Arkansas.

		Station ID								
Taxon Name	Tol. Value	UWSBR01-A	WHI0143B - A	WHI0143B - B	UWSBR02	WHI0143P	WHI024	UWNBC01 - A	UWNBC01 - B	WHI0143N - A
Drunella	1.0	0	0	0	0	0	0	0	0	0
Dubiraphia	6.4	4	0	0	1	0	1	0	0	0
Dubiraphia (A)	6.4	0	0	0	0	0	0	0	0	2
Dytiscus	5.0	0	0	0	0	0	0	0	0	0
Ectopria	4.0	0	0	1	0	0	0	0	0	0
Empididae	8.1	0	0	0	0	0	0	0	0	0
Enallagma	9.0	3	4	4	0	0	1	0	1	0
Ephemerella	2.9	0	0	0	0	0	0	0	0	0
Ephoron	2.0	0	0	0	0	0	0	0	0	0
Ephydridae	6.0	0	0	0	0	0	0	0	0	0
Epiaeschna heros	7.1	0	0	0	0	0	0	0	0	0
Erpetogomphus	4.0	0	0	0	0	0	2	0	0	0
Eurylophella	2.1	0	0	0	0	0	0	0	0	0
Ferrissia	6.9	0	0	0	0	0	0	0	0	0
Forcipomyia	6.0	0	0	0	0	0	0	0	0	0
Gammarus	6.9	0	0	0	0	0	0	0	0	0
Gerris	5.0	0	0	0	0	0	0	0	0	0
Gomphus	4.9	4	0	0	0	0	0	0	0	0
Gomphurus	6.2	0	0	0	0	0	0	0	0	0
Gumaga	NK	0	0	0	0	0	0	0	0	0
Gyretes	5.0	0	0	0	0	0	0	0	0	0
Gyrinidae	5.0	0	0	0	0	0	0	0	0	0
Gyrinus	6.3	0	0	0	0	0	0	0	0	0
Hagenius	4.0	0	0	0	0	0	0	0	0	0
Helicopsyche	3.0	0	0	0	0	0	0	0	0	0
Hemerodromia	6.0	1	0	0	0	0	0	0	0	0
Hemerodromia (P)	6.0	0	0	0	0	0	0	0	0	0
Heptagenia	2.8	0	0	0	0	0	0	0	0	0
Heptageniidae	4.0	0	0	0	0	0	0	0	0	0
Hetaerina	6.2	0	0	0	0	0	0	1	0	0
Hexagenia	4.7	0	0	0	0	0	0	0	0	0
Hexatoma	4.7	0	0	0	0	0	0	0	0	0
Hirudinea	3.0	0	0	0	0	0	0	0	0	0
Hydrobiidae	8.0	0	0	0	0	0	0	0	0	0
Hydrobiomorpha	5.0	0	0	0	0	0	0	0	0	0
Hydrobius	5.0	0	0	0	0	0	0	0	0	0
Hydrometra	NK	0	0	0	0	0	0	0	0	0
Hydroporus (A)	8.9	0	0	0	0	0	0	0	0	0
Hydropsyche	4.0	0	3	7	0	0	0	2	6	0
Hydroptila	6.2	0	0	0	0	0	0	0	0	0
Ischnura	9.4	0	0	0	0	0	0	0	0	0
Isonychia	2.0	5	2	1	27	13	5	5	6	17
Lepidostoma	3.0	0	0	0	0	0	0	0	0	0
Leptophlebia	6.4	0	2	0	0	0	0	0	0	0
Leptotarsus	3.0	0	0	0	0	0	0	0	0	0
Leucrocuta	1.0	0	0	0	0	0	2	0	0	2
Limonia	10.0	0	0	0	0	0	0	0	0	0
Lirceus	7.7	0	0	0	0	0	0	0	0	0
Lutrochus	2.9	0	0	0	0	0	0	9	6	0
Lymnaeidae	6.0	0	0	0	0	0	0	0	0	0
Macromia	6.7	0	0	0	0	0	1	0	0	0
Macronychus	4.7	0	0	0	0	0	0	0	0	0

Appendix M-3a. Taxa list for aquatic macroinvertebrates collected during Fall 2001, Strawberry River Watershed, Arkansas.

		Station ID								
Taxon Name	ToL Value	UWSBR01-A	WHI0143B - A	WHI0143B - B	UWSBR02	WHI0143P	WHI024	UWNBC01 - A	UWNBC01 - B	WHI0143N - A
Macronychus (A)	4.7	0	0	0	0	0	0	0	0	0
Macrostemum	3.6	0	0	0	0	0	0	0	0	0
Mesovelia	NK	0	0	0	0	0	0	0	0	0
Microcylloepus	1.0	0	0	0	0	0	0	0	0	0
Microvelia	6.0	0	0	0	0	0	0	0	0	0
Molophilus	4.0	0	0	0	0	0	0	0	0	0
Neoelmis	4.0	0	0	0	0	0	0	0	0	0
Neoperla	1.6	0	0	0	0	0	2	0	0	0
Nigronia	2.0	0	0	0	0	0	0	0	0	0
Odontoceridae	0.0	0	0	0	0	0	0	0	0	0
Oligochaeta	10.0	0	0	1	0	0	0	0	0	1
Optioservus	2.7	0	0	0	0	0	0	0	0	0
Optioservus (A)	2.5	0	0	0	0	0	0	0	0	0
Oreodytes	5.0	0	0	0	0	0	0	0	0	0
Oreodytes (A)	5.0	0	0	0	0	0	0	0	0	0
Palaemonetes	4.0	0	0	0	0	0	0	0	0	0
Palpomyia	6.0	0	0	0	0	0	0	0	0	0
Paraleptophlebia	1.2	0	0	0	0	0	0	0	0	0
Peltodytes	8.5	0	0	0	0	0	0	0	0	0
Peltodytes (A)	8.5	0	0	0	0	0	0	0	0	0
Perlesta	4.9	0	0	0	0	0	0	0	0	0
Petrophila	2.5	0	0	1	0	0	0	2	0	0
Physa	4.0	0	0	0	0	0	0	0	0	0
Physidae	8.0	0	0	0	0	0	0	0	0	0
Pisidium	6.8	0	0	0	0	0	0	0	0	0
Planorbidae	7.0	0	0	0	0	0	0	0	0	0
Pleuroceridae	7.0	0	2	2	0	0	0	3	13	1
Polycentropus	3.5	0	0	0	0	0	0	0	0	0
Potamanthus	1.6	0	1	0	0	3	4	0	0	0
Prionocera	4.0	0	0	0	0	0	0	0	0	0
Probezzia	6.0	0	0	0	0	0	0	0	0	0
Procloeon	4.0	0	0	0	0	0	0	0	0	0
Progomphus	8.7	0	0	0	0	0	0	0	0	0
Prosimulium	2.6	0	0	0	0	0	0	0	0	0
Psephenus	2.0	0	0	0	0	0	0	1	0	6
Psephenus (A)	2.0	0	0	0	0	0	0	0	0	0
Pseudogoera	0.0	0	0	0	0	0	0	0	0	0
Pseudolimnophila	2.0	0	0	0	0	0	0	0	0	0
Psilotreta	0.0	0	0	0	0	0	0	0	0	0
Psychoda	10.0	0	0	0	0	0	0	0	0	0
Psychodidae	10.0	0	0	0	0	0	0	0	0	0
Quadrula cylindrica	8.0	0	0	0	0	0	0	0	0	0
Ranatra	7.5	0	0	0	0	0	0	0	0	0
Rhagovelia	6.0	0	0	0	0	0	0	0	0	0
Rhyacophila	0.9	0	0	0	0	0	0	0	0	0
Scirtes	7.0	0	0	0	0	0	0	0	0	0
Serratella	0.6	0	0	0	0	0	0	0	0	0
Silvius	8.0	0	0	0	0	3	0	0	0	0
Simulium	4.4	0	0	0	0	3	0	4	3	0
Simulium (P)	4.4	0	0	0	0	0	0	0	0	0
Sphaeriidae	3.0	0	0	0	0	0	0	0	0	0
Sphaerium	7.7	0	0	0	0	0	0	0	0	0

Appendix M-3a. Taxa list for aquatic macroinvertebrates collected during Fall 2001, Strawberry River Watershed, Arkansas.

		Station ID								
Taxon Name	Tol. Value	UWSBR01-A	WHI0143B - A	WHI0143B - B	UWSBR02	WHI0143P	WHI024	UWNBC01 - A	UWNBC01 - B	WHI0143N - A
Stenacron	3.1	1	0	1	0	0	0	0	0	0
Stenelmis	5.4	1	41	10	26	25	40	10	12	5
Stenelmis (A)	5.0	1	1	5	2	6	2	21	15	3
Stenonema	3.3	15	19	18	79	14	40	19	10	36
Stratiomyidae	NK	0	0	0	0	0	0	0	0	0
Strophopteryx	2.5	0	0	0	0	0	0	0	0	0
Stylurus	5.0	0	0	0	0	0	0	0	0	0
Tabanidae	8.0	0	0	0	0	0	0	0	0	0
Tabanus	9.7	0	0	0	0	0	0	0	0	0
Thermonectus	3.0	0	0	0	0	0	0	0	0	0
Tipula	7.7	0	0	0	0	0	0	0	0	0
Tipulidae	3.0	0	0	0	0	0	0	0	0	0
Trepobates	10.0	0	0	0	0	0	0	0	0	0
Trichoptera	NK	0	0	1	0	0	0	0	0	0
Tricorythodes	5.4	0	8	2	2	2	12	14	8	1
Tropisternus	9.8	0	0	0	0	0	0	0	0	0
Tropisternus (A)	9.8	0	0	0	0	0	0	0	0	0
Uvarus	5.0	0	0	0	0	0	0	0	0	0
Viviparidae	4.0	0	1	1	2	0	0	1	9	0
Wormaldia	0.4	0	0	0	0	0	0	0	0	0
Total	NA	88	108	119	156	113	152	143	119	103

Appendix M-3a. Taxa list for aquatic macroinvertebrates collected during Fall 2001, Strawberry River Watershed, Arkansas.

		Station ID								
Taxon Name	Tol. Value	WHI0143N - B	WHI0143K - A	WHI0143K - B	WHI0143M-A	WHI0143J	UWRDC01	WHI0143S	WHI0143Q	WHI0143R
Acroneuria	0.0	0	0	0	0	0	0	0	0	0
Agabus	5.0	0	0	0	0	0	0	0	0	0
Agapetus	0.0	0	0	0	0	0	0	0	0	0
Amphiagrion	5.0	0	0	0	0	0	0	0	0	0
Amphinemura	3.4	0	0	0	0	0	0	0	0	0
Ancylidae	6.0	0	0	0	0	0	0	0	0	0
Ancyronyx	6.9	0	0	0	0	0	0	0	0	0
Ancyronyx (A)	6.9	0	0	0	0	1	0	0	1	0
Apatolestes	8.0	0	0	0	0	0	0	0	0	0
Argia	5.1	7	0	0	0	0	0	0	0	0
Arigomphus	5.0	0	0	0	0	0	0	0	0	2
Atherix	2.0	0	0	0	0	0	0	0	0	0
Baetis	3.1	1	18	23	0	2	3	0	0	9
Baetis #2	3.1	0	0	0	0	0	0	0	0	0
Baetisca	4.0	0	0	0	0	0	0	0	0	0
Basiaeschna	7.7	0	0	0	0	0	0	0	0	2
Belostoma	9.8	0	0	0	0	0	0	0	0	0
Berosus	8.6	0	0	0	0	1	0	1	0	1
Boyeria	6.3	0	0	0	0	0	3	0	0	1
Brachycentrus	2.2	0	0	0	0	0	0	0	0	0
Brachyprema	3.0	0	0	0	0	0	0	0	0	0
Caecidotea	6.0	0	0	0	0	0	1	2	0	6
Caenis	7.6	10	0	0	3	2	1	2	0	3
Calopteryx	8.3	0	0	0	0	0	20	0	5	5
Cambarinae	6.0	4	1	4	0	1	0	2	1	2
Carabidae	4.0	0	0	0	0	0	0	0	0	0
Ceratopsyche	3.0	0	0	0	0	0	0	0	0	0
Chaoborus	8.5	0	0	0	0	0	0	0	0	0
Cheumatopsyche	6.6	9	21	29	0	0	1	0	0	1
Chimarra	2.8	8	18	2	0	0	0	0	0	0
Chironomidae	6.0	8	2	2	1	16	9	30	0	29
Chironomidae (P)	6.0	0	0	1	0	0	0	0	0	2
Chlorotabanus	8.0	0	0	0	0	0	0	0	0	1
Chrysops	7.3	0	0	0	0	3	0	0	0	0
Cnephia	4.0	0	0	0	0	0	0	0	0	0
Corbicula	6.3	0	0	0	0	34	1	0	0	0
Corixidae	9.0	0	0	0	0	0	1	0	0	0
Corydalus	5.6	7	2	9	10	1	0	0	0	0
Culicoides	10.0	0	0	0	0	0	0	1	0	0
Cybister	5.0	0	0	0	0	0	0	0	0	1
Cymellus	7.4	0	0	0	0	0	0	0	0	0
Dasyhelea	5.7	0	0	0	0	0	0	0	0	0
Dasyhelea (P)	5.7	0	0	0	0	0	0	0	0	0
Dicranota	4.0	0	0	0	0	0	0	0	0	0
Dineutus	5.5	0	0	0	0	0	0	0	0	1
Dineutus (A)	5.5	0	0	0	0	0	3	5	0	0
Diptera	7.0	0	0	0	0	0	0	1	0	0
Diptera (P)	7.0	0	0	0	0	0	0	0	0	0
Dixella	1.0	0	0	0	0	0	0	0	0	0
Dolichopodidae	9.7	0	0	0	0	0	0	0	0	0
Dromogomphus	6.3	0	0	0	4	5	8	4	2	6

Appendix M-3a. Taxa list for aquatic macroinvertebrates collected during Fall 2001, Strawberry River Watershed, Arkansas.

		Station ID								
Taxon Name	Tol. Value	WHI0143N - B	WHI0143K - A	WHI0143K - B	WHI0143M-A	WHI0143J	UWRDC01	WHI0143S	WHI0143Q	WHI0143R
Drunella	1.0	0	0	0	0	0	0	0	0	0
Dubiraphia	6.4	0	1	0	0	11	4	13	4	2
Dubiraphia (A)	6.4	0	0	0	0	1	0	0	1	0
Dytiscus	5.0	0	0	0	0	0	0	0	0	0
Ectopria	4.0	0	0	0	0	0	0	0	0	0
Empididae	8.1	0	0	0	0	0	0	0	0	0
Enallagma	9.0	0	0	0	6	9	6	12	9	6
Ephemerella	2.9	0	0	0	0	0	0	0	0	0
Ephoron	2.0	0	0	0	0	0	0	0	0	0
Ephydridae	6.0	0	0	0	0	0	0	0	0	0
Epiaeschna heros	7.1	0	0	0	0	1	1	0	0	0
Erpetogomphus	4.0	0	0	0	0	0	0	0	0	0
Eurylophella	2.1	0	0	0	0	0	0	0	0	0
Ferrissia	6.9	0	0	0	0	0	0	0	0	0
Forcipomyia	6.0	0	0	0	0	0	0	0	0	0
Gammarus	6.9	0	0	1	0	0	5	0	29	19
Gerris	5.0	0	0	0	0	0	1	0	1	0
Gomphus	4.9	4	0	0	0	0	0	0	0	0
Gomphurus	6.2	0	0	0	0	0	0	0	0	0
Gumaga	NK	0	0	0	0	0	0	0	0	0
Gyretes	5.0	0	0	0	0	0	0	0	0	0
Gyrinidae	5.0	0	0	0	0	0	0	2	0	0
Gyrinus	6.3	0	0	0	0	0	0	1	0	0
Hagenius	4.0	0	0	0	0	0	1	0	1	1
Helicopsyche	3.0	0	1	0	0	0	0	0	0	0
Hemerodromia	6.0	0	0	0	0	0	0	0	0	2
Hemerodromia (P)	6.0	0	0	0	0	0	0	0	0	0
Heptagenia	2.8	0	0	0	0	0	0	0	0	0
Heptageniidae	4.0	0	0	0	0	0	1	0	0	0
Hetaerina	6.2	0	1	0	0	1	0	0	0	0
Hexagenia	4.7	0	0	0	0	0	1	0	0	0
Hexatoma	4.7	0	0	0	0	0	0	0	0	0
Hirudinea	3.0	0	2	0	0	0	0	0	0	0
Hydrobiidae	8.0	0	0	0	0	0	0	0	0	0
Hydrobiomorpha	5.0	0	0	0	0	0	0	0	0	0
Hydrobius	5.0	0	0	0	0	0	0	0	0	0
Hydrometra	NK	0	0	0	0	0	0	0	0	0
Hydroporus (A)	8.9	0	0	0	0	0	0	0	0	0
Hydropsyche	4.0	0	16	0	0	0	0	0	0	0
Hydroptila	6.2	0	0	0	0	0	0	0	0	0
Ischnura	9.4	0	0	0	0	0	0	0	0	0
Isonychia	2.0	25	27	16	12	1	0	0	0	0
Lepidostoma	3.0	0	0	0	0	0	0	0	0	0
Leptophlebia	6.4	0	0	0	0	0	0	0	0	0
Leptotarsus	3.0	0	0	0	0	0	0	0	0	0
Leucrocuta	1.0	0	0	0	0	0	0	0	0	0
Limonia	10.0	0	0	0	0	1	0	0	0	0
Lirceus	7.7	0	0	0	0	0	0	0	10	16
Lutrochus	2.9	1	0	0	1	0	0	0	0	0
Lymnaeidae	6.0	0	0	0	0	0	0	0	0	0
Macromia	6.7	0	0	0	0	4	8	0	3	1
Macronychus	4.7	0	0	0	0	0	5	2	0	0

Appendix M-3a. Taxa list for aquatic macroinvertebrates collected during Fall 2001, Strawberry River Watershed, Arkansas.

		Station ID								
Taxon Name	Tol. Value	WHI0143N - B	WHI0143K - A	WHI0143K - B	WHI0143M-A	WHI0143J	UWRDC01	WHI0143S	WHI0143Q	WHI0143R
Macronychus (A)	4.7	0	0	0	0	1	1	0	0	0
Macrostemum	3.6	0	0	0	0	0	0	0	0	0
Mesovelia	NK	0	0	0	0	0	0	0	0	0
Microcylloepus	1.0	0	0	0	0	0	0	0	0	0
Microvelia	6.0	0	0	0	3	0	0	0	0	0
Molophilus	4.0	0	0	0	0	0	0	0	0	0
Neoelmis	4.0	0	0	0	0	0	0	0	0	0
Neoperla	1.6	0	0	0	0	0	0	0	0	0
Nigronia	2.0	0	0	5	0	0	0	0	0	0
Odontoceridae	0.0	0	0	0	0	0	0	0	0	0
Oligochaeta	10.0	0	0	0	0	0	0	0	1	0
Optioservus	2.7	0	25	9	0	0	0	0	0	0
Optioservus (A)	2.5	0	1	1	0	0	0	0	0	0
Oreodytes	5.0	0	0	0	0	1	0	0	1	0
Oreodytes (A)	5.0	0	0	0	0	0	0	0	2	0
Palaemonetes	4.0	0	0	0	0	0	0	0	0	1
Palpomyia	6.0	0	0	0	0	0	0	0	0	0
Paraleptophlebia	1.2	0	0	0	0	0	0	0	0	0
Peltodytes	8.5	0	0	0	0	0	0	0	0	0
Peltodytes (A)	8.5	0	0	0	0	0	0	1	0	0
Perlesta	4.9	0	0	0	0	0	0	0	0	0
Petrophila	2.5	0	0	0	0	0	0	0	0	0
Physa	4.0	0	0	0	0	0	0	0	0	0
Physidae	8.0	0	0	0	0	0	0	1	0	1
Pisidium	6.8	0	0	0	0	0	0	0	0	0
Planorbidae	7.0	0	0	0	0	0	0	0	0	0
Pleuroceridae	7.0	1	2	6	2	4	9	8	0	0
Polycentropus	3.5	0	0	0	0	1	0	0	0	0
Potamanthus	1.6	0	0	0	0	0	0	0	0	0
Prionocera	4.0	0	0	0	0	0	0	0	0	0
Probezzia	6.0	0	0	0	0	1	0	0	0	0
Procloeon	4.0	0	0	0	0	0	0	0	0	0
Progomphus	8.7	0	0	0	0	1	4	0	0	3
Prosimulium	2.6	0	1	0	0	0	0	0	0	0
Psephenus	2.0	3	10	1	7	0	0	0	0	0
Psephenus (A)	2.0	0	0	0	0	0	0	0	0	0
Pseudogoera	0.0	0	0	0	0	0	0	0	0	0
Pseudolimnophila	2.0	0	0	0	0	0	0	0	0	0
Psilotreta	0.0	0	0	0	0	0	0	0	0	0
Psychoda	10.0	0	0	0	0	0	0	0	0	0
Psychodidae	10.0	0	0	0	0	0	0	0	0	0
Quadrula cylindrica	8.0	0	0	0	0	0	0	0	0	0
Ranatra	7.5	0	0	0	0	1	0	0	0	1
Rhagovelia	6.0	0	0	0	0	0	2	0	0	0
Rhyacophila	0.9	0	0	0	0	0	0	0	0	0
Scirtes	7.0	0	0	0	0	0	0	0	1	1
Serratella	0.6	0	0	0	0	0	0	0	0	0
Silvius	8.0	0	2	1	1	0	0	0	0	0
Simulium	4.4	0	36	13	0	0	0	0	0	0
Simulium (P)	4.4	0	0	0	0	0	0	0	0	0
Sphaeriidae	3.0	0	0	0	0	0	0	5	0	2
Sphaerium	7.7	0	0	0	0	0	0	0	0	0

Appendix M-3a. Taxa list for aquatic macroinvertebrates collected during Fall 2001, Strawberry River Watershed, Arkansas.

		Station ID								
Taxon Name	Tol. Value	WHI0143N - B	WHI0143K - A	WHI0143K - B	WHI0143M-A	WHI0143J	UWRDC01	WHI0143S	WHI0143Q	WHI0143R
Stenacron	3.1	0	0	0	0	0	0	1	0	1
Stenelmis	5.4	2	14	9	1	0	0	0	0	2
Stenelmis (A)	5.0	0	0	1	3	0	0	1	4	0
Stenonema	3.3	22	26	25	36	3	0	0	0	3
Stratiomyidae	NK	0	0	0	0	0	0	0	0	0
Strophopteryx	2.5	0	0	0	0	0	0	0	0	0
Stylurus	5.0	0	0	0	0	0	0	0	0	0
Tabanidae	8.0	0	0	0	0	0	2	0	0	0
Tabanus	9.7	1	0	0	0	0	0	0	0	0
Thermonectus	3.0	0	0	0	0	0	0	0	0	3
Tipula	7.7	0	0	0	0	1	0	0	0	0
Tipulidae	3.0	0	0	0	0	0	0	0	0	0
Trepobates	10.0	0	0	0	0	0	0	0	0	0
Trichoptera	NK	0	0	0	0	0	0	0	0	0
Tricorythodes	5.4	1	1	0	2	2	3	0	0	0
Tropisternus	9.8	0	0	0	0	0	0	0	2	18
Tropisternus (A)	9.8	0	0	0	0	0	1	0	0	0
Uvarus	5.0	0	0	0	0	0	0	0	0	0
Viviparidae	4.0	0	0	1	1	1	0	3	0	0
Wormaldia	0.4	0	0	0	0	0	0	0	0	0
Total	NA	114	228	159	93	112	106	98	78	155

Appendix M-3b. Taxa list for aquatic macroinvertebrates collected during Spring 2002, Strawberry River Watershed, Arkansas.

		Station ID							
Taxon Name	Tol. Value	WHI0143A-A	WHI0143A-B	UWSBR01-A	UWSBR01-B	WHI0143B - A	WHI0143B - B	UWSBR02 - A	UWSBR02 - B
Acroneuria	0.0	0	0	0	0	0	0	0	0
Agabus	5.0	0	0	0	0	0	0	0	0
Agapetus	0.0	0	0	0	0	0	0	0	0
Amphiagrion	5.0	0	0	0	0	0	0	0	0
Amphinemura	3.4	0	2	0	0	0	0	0	0
Ancylidae	6.0	0	0	0	0	0	0	0	0
Ancyronyx	6.9	0	0	0	0	0	0	0	0
Ancyronyx (A)	6.9	0	0	0	0	0	0	0	0
Apatolestes	8.0	0	0	0	0	0	0	0	0
Argia	5.1	0	0	0	0	0	0	0	0
Arigomphus	5.0	0	0	0	0	0	0	0	0
Atherix	2.0	0	0	0	0	1	0	3	2
Baetis	3.1	54	45	31	46	9	11	0	1
Baetis #2	3.1	2	0	0	0	0	0	22	7
Baetisca	4.0	0	0	0	0	0	0	0	0
Basiaeschna	7.7	0	0	0	0	0	0	0	0
Belostoma	9.8	0	0	0	0	0	0	0	0
Berosus	8.6	0	0	0	0	0	0	0	0
Boyeria	6.3	0	0	0	1	0	0	0	0
Brachycentrus	2.2	0	0	0	0	0	0	0	0
Brachyprema	3.0	0	0	0	0	0	0	0	0
Caecidotea	6.0	0	0	0	0	0	0	0	0
Caenis	7.6	0	1	4	5	1	0	0	0
Calopteryx	8.3	0	0	0	0	0	0	0	0
Cambarinae	6.0	2	0	0	1	1	1	1	0
Carabidae	4.0	0	0	0	0	0	0	0	0
Ceratopsyche	3.0	0	0	0	0	0	0	0	0
Chaoborus	8.5	0	0	0	0	0	0	0	0
Cheumatopsyche	6.6	2	1	7	24	40	46	17	24
Chimarra	2.8	0	0	0	0	1	0	1	6
Chironomidae	6.0	5	3	9	25	13	16	17	17
Chironomidae (P)	6.0	0	0	0	0	0	1	0	0
Chlorotabanus	8.0	0	0	0	0	0	0	0	0
Chrysops	7.3	0	0	0	0	0	0	0	0
Cnephia	4.0	0	0	0	0	0	0	0	0
Corbicula	6.3	0	0	0	1	0	1	0	0
Corixidae	9.0	0	0	0	0	0	0	0	0
Corydalus	5.6	0	0	0	0	0	1	2	2
Culicoides	10.0	0	0	0	0	0	0	0	0
Cybister	5.0	0	0	0	0	0	0	0	0
Cyrnellus	7.4	0	0	0	0	0	0	0	0
Dasyhelea	5.7	0	0	0	0	0	0	0	0
Dasyhelea (P)	5.7	0	0	0	0	0	0	0	0
Dicranota	4.0	0	0	0	0	0	0	0	0
Dineutus	5.5	0	2	0	1	0	1	1	1
Dineutus (A)	5.5	0	0	0	0	0	0	0	0
Diptera	7.0	0	0	0	0	0	0	0	0
Diptera (P)	7.0	0	0	0	0	0	0	0	0
Dixella	1.0	0	0	0	0	0	0	0	0
Dolichopodidae	9.7	0	0	0	0	0	0	0	0

Appendix M-3b. Taxa list for aquatic macroinvertebrates collected during Spring 2002, Strawberry River Watershed, Arkansas.

		Station ID							
Taxon Name	Tol. Value	WHI0143A-A	WHI0143A-B	UWSBR01-A	UWSBR01-B	WHI0143B - A	WHI0143B - B	UWSBR02 - A	UWSBR02 - B
Dromogomphus	6.3	0	0	0	0	0	0	0	1
Drunella	1.0	0	0	0	0	0	0	0	0
Dubiraphia	6.4	0	0	0	0	0	0	0	0
Dubiraphia (A)	6.4	0	0	0	0	0	0	0	0
Dytiscus	5.0	0	0	0	0	0	0	0	0
Ectopria	4.0	0	0	0	0	0	0	0	0
Empididae	8.1	0	0	0	0	0	0	0	0
Enallagma	9.0	0	0	0	0	0	0	0	0
Ephemerella	2.9	0	0	0	0	0	0	0	0
Ephoron	2.0	0	0	0	0	1	0	0	2
Ephydridae	6.0	0	0	0	0	0	0	0	0
Epiaeschna heros	7.1	0	0	0	0	0	0	0	0
Erpetogomphus	4.0	0	0	0	0	0	0	0	0
Eurylophella	2.1	0	0	0	0	0	0	0	0
Ferrissia	6.9	0	0	0	0	0	0	0	0
Forcipomyia	6.0	0	0	0	0	0	0	0	0
Gammarus	6.9	0	0	0	0	0	0	0	0
Gerris	5.0	0	0	0	0	0	0	0	0
Gomphus	4.9	0	0	0	0	0	0	0	0
Gomphurus	6.2	0	0	0	0	0	0	0	0
Gumaga	NK	0	0	0	0	0	0	0	0
Gyretes	5.0	0	0	0	0	0	0	0	0
Gyrinidae	5.0	0	0	0	0	0	0	0	0
Gyrinus	6.3	0	0	0	0	0	0	0	0
Hagenius	4.0	0	0	0	0	1	0	0	0
Helicopsyche	3.0	0	0	0	0	0	0	0	0
Hemerodromia	6.0	0	0	0	0	0	1	0	0
Hemerodromia (P)	6.0	0	0	0	0	0	2	0	0
Heptagenia	2.8	0	8	1	0	0	0	0	0
Heptageniidae	4.0	0	0	0	0	0	0	0	0
Hetaerina	6.2	0	0	0	0	0	0	0	0
Hexagenia	4.7	0	0	0	0	0	0	0	0
Hexatoma	4.7	0	0	0	0	0	0	0	0
Hirudinea	3.0	0	1	0	0	0	0	0	0
Hydrobiidae	8.0	0	0	0	0	0	0	0	0
Hydrobiomorpha	5.0	0	0	0	0	0	0	0	0
Hydrobius	5.0	0	0	0	0	0	0	0	0
Hydrometra	NK	0	0	0	0	0	0	0	0
Hydroporus (A)	8.9	0	0	0	0	0	0	0	0
Hydropsyche	4.0	0	0	0	1	3	0	5	9
Hydroptila	6.2	0	0	0	0	0	0	0	0
Ischnura	9.4	0	0	0	0	0	0	0	0
Isonychia	2.0	0	0	0	0	1	1	17	11
Lepidostoma	3.0	0	0	0	0	0	0	0	0
Leptophlebia	6.4	0	0	0	0	0	0	0	0
Leptotarsus	3.0	0	0	0	0	0	0	0	0
Leucrocuta	1.0	0	0	12	7	0	0	0	2
Limonia	10.0	0	0	0	0	0	0	0	0
Lirceus	7.7	1	0	0	0	0	0	0	0
Lutrochus	2.9	0	0	0	0	0	0	0	0

Appendix M-3b. Taxa list for aquatic macroinvertebrates collected during Spring 2002, Strawberry River Watershed, Arkansas.

		Station ID							
Taxon Name	Tol. Value	WHI0143A-A	WHI0143A-B	UWSBR01-A	UWSBR01-B	WHI0143B - A	WHI0143B - B	UWSBR02 - A	UWSBR02 - B
Lymnaeidae	6.0	0	0	0	0	0	0	0	0
Macromia	6.7	0	0	0	0	0	0	0	0
Macronychus	4.7	0	0	0	0	0	0	0	0
Macronychus (A)	4.7	0	0	0	0	0	0	0	0
Macrostemum	3.6	0	0	0	0	0	4	9	10
Mesovelia	NK	0	0	0	0	0	0	0	0
Microcylloepus	1.0	0	0	0	0	0	0	0	0
Microvelia	6.0	0	0	0	0	0	0	0	0
Molophilus	4.0	0	0	0	0	0	0	0	1
Neoelmis	4.0	0	0	0	0	0	0	0	0
Neoperla	1.6	0	0	0	0	0	1	0	1
Nigronia	2.0	0	0	0	0	0	0	0	0
Odontoceridae	0.0	0	0	0	0	0	0	0	0
Oligochaeta	10.0	1	0	0	0	6	4	2	0
Optioservus	2.7	0	0	0	0	0	0	1	0
Optioservus (A)	2.5	0	0	0	0	0	0	0	0
Oreodytes	5.0	0	0	0	0	0	0	0	0
Oreodytes (A)	5.0	0	0	0	0	0	0	0	0
Palaemonetes	4.0	0	0	0	0	0	0	0	0
Palpomyia	6.0	0	0	0	0	0	0	0	0
Paraleptophlebia	1.2	0	0	0	0	0	0	0	0
Peltodytes	8.5	0	0	0	0	0	0	0	0
Peltodytes (A)	8.5	0	0	0	0	0	0	0	0
Perlesta	4.9	49	83	34	60	0	0	0	0
Petrophila	2.5	0	0	0	0	1	1	0	0
Physa	4.0	0	0	0	0	0	0	0	0
Physidae	8.0	0	0	0	0	0	0	0	0
Pisidium	6.8	0	0	0	0	0	0	0	0
Planorbidae	7.0	0	0	0	0	0	0	0	0
Pleuroceridae	7.0	0	0	0	0	2	1	1	0
Polycentropus	3.5	0	0	0	0	0	0	0	0
Potamanthus	1.6	0	0	0	0	0	0	0	0
Prionocera	4.0	0	0	0	0	0	0	0	0
Probezzia	6.0	0	0	2	0	0	0	0	0
Procloeon	4.0	0	0	0	0	0	0	0	0
Progomphus	8.7	0	0	0	0	0	0	0	0
Prosimulium	2.6	0	0	0	0	0	0	0	0
Psephenus	2.0	0	0	1	0	0	0	0	0
Psephenus (A)	2.0	0	0	0	0	0	0	0	0
Pseudogoera	0.0	0	0	0	0	0	0	0	0
Pseudolimnophila	2.0	0	0	0	0	0	0	0	0
Psilotreta	0.0	0	0	0	0	0	0	0	0
Psychoda	10.0	0	0	0	0	0	0	0	0
Psychodidae	10.0	0	0	0	0	0	0	0	0
Quadrula cylindrica	8.0	0	0	0	0	0	0	0	0
Ranatra	7.5	0	0	0	0	0	0	0	0
Rhagovelia	6.0	0	0	0	0	0	0	0	0
Rhyacophila	0.9	0	0	0	0	0	0	0	0
Scirtes	7.0	0	0	0	0	0	0	0	0
Serratella	0.6	1	3	1	7	0	0	0	0

Appendix M-3b. Taxa list for aquatic macroinvertebrates collected during Spring 2002, Strawberry River Watershed, Arkansas.

		Station ID							
Taxon Name	Tol. Value	WHI0143A-A	WHI0143A-B	UWSBR01-A	UWSBR01-B	WHI0143B - A	WHI0143B - B	UWSBR02 - A	UWSBR02 - B
Silvius	8.0	0	0	0	0	0	0	0	0
Simulium	4.4	36	6	10	202	0	0	0	2
Simulium (P)	4.4	0	0	0	0	0	0	0	0
Sphaeriidae	3.0	0	0	0	0	0	1	0	0
Sphaerium	7.7	0	0	0	0	0	0	0	0
Stenacron	3.1	0	0	0	0	0	0	0	0
Stenelmis	5.4	14	4	0	2	4	8	4	7
Stenelmis (A)	5.0	1	0	1	2	2	2	0	2
Stenonema	3.3	0	0	0	0	12	7	13	43
Stratiomyidae	NK	0	0	0	0	0	0	0	0
Strophopteryx	2.5	0	2	0	0	0	0	0	0
Stylurus	5.0	0	0	0	0	0	0	0	0
Tabanidae	8.0	0	0	0	0	0	0	0	0
Tabanus	9.7	0	0	0	0	0	1	0	0
Thermonectus	3.0	0	0	0	0	0	0	0	0
Tipula	7.7	2	0	0	0	0	0	0	0
Tipulidae	3.0	0	0	0	0	0	0	0	0
Trepobates	10.0	0	0	0	0	0	0	0	0
Trichoptera	NK	0	0	0	0	0	0	0	0
Tricorythodes	5.4	1	0	0	0	5	3	1	8
Tropisternus	9.8	0	0	0	0	0	0	0	0
Tropisternus (A)	9.8	0	0	0	0	0	0	0	0
Uvarus	5.0	0	0	0	0	0	0	0	0
Viviparidae	4.0	0	0	0	0	1	4	0	1
Wormaldia	0.4	0	0	0	0	0	0	0	0
Total	NA	171	161	113	385	105	119	117	160

Appendix M-3b. Taxa list for aquatic macroinvertebrates collected during Spring 2002, Strawberry River Watershed, Arkansas.

		Station ID								
Taxon Name	Tol. Value	WHI0143P	WHI024	WHI0143E-A	WHI0143E-B	WHI0143H-A	WHI0143H-B	UWNBC01 - A	UWNBC01 - B	WHI0143N - A
Acroneuria	0.0	0	0	0	0	0	0	0	0	0
Agabus	5.0	0	0	0	0	0	0	0	0	0
Agapetus	0.0	0	0	0	0	0	0	0	0	0
Amphiagrion	5.0	0	0	0	0	0	0	0	0	0
Amphinemura	3.4	0	0	0	0	0	2	0	0	0
Ancylidae	6.0	0	0	0	0	0	0	0	0	0
Ancyronyx	6.9	0	0	0	0	0	0	0	0	0
Ancyronyx (A)	6.9	0	0	0	0	0	0	0	0	0
Apatolestes	8.0	0	0	0	0	0	0	0	0	0
Argia	5.1	0	0	0	0	0	0	0	0	0
Arigomphus	5.0	0	0	0	0	0	0	0	0	0
Atherix	2.0	1	3	0	0	0	0	0	0	0
Baetis	3.1	10	4	29	44	17	17	7	0	4
Baetis #2	3.1	0	0	0	0	0	0	0	5	1
Baetisca	4.0	0	0	0	0	0	0	0	0	0
Basiaeschna	7.7	0	0	0	0	0	0	0	0	0
Belostoma	9.8	0	0	0	0	0	0	0	0	0
Berosus	8.6	0	0	0	0	0	0	0	0	0
Boyeria	6.3	0	0	0	0	0	0	0	0	0
Brachycentrus	2.2	0	0	0	0	0	0	0	0	0
Brachyprema	3.0	0	0	0	0	0	0	0	0	0
Caecidotea	6.0	0	0	0	0	0	0	0	0	0
Caenis	7.6	0	1	0	4	3	2	0	0	4
Calopteryx	8.3	0	0	0	0	0	0	0	0	0
Cambarinae	6.0	1	0	1	0	2	0	1	1	1
Carabidae	4.0	0	0	0	0	0	0	0	0	0
Ceratopsyche	3.0	0	0	0	0	0	0	0	0	0
Chaoborus	8.5	0	0	0	0	0	0	0	0	0
Cheumatopsyche	6.6	12	16	4	12	13	17	19	8	1
Chimarra	2.8	0	1	0	0	0	0	1	1	0
Chironomidae	6.0	8	13	5	5	24	42	26	14	69
Chironomidae (P)	6.0	0	0	0	0	3	3	0	0	3
Chlorotabanus	8.0	0	0	0	0	0	0	0	0	0
Chrysops	7.3	0	0	0	0	0	0	0	0	0
Cnephia	4.0	0	0	0	0	0	0	0	0	0
Corbicula	6.3	3	2	0	0	0	0	1	0	0
Corixidae	9.0	0	0	0	0	0	0	0	0	0
Corydalus	5.6	1	0	0	0	0	0	1	1	1
Culicoides	10.0	0	0	0	0	0	0	0	0	0
Cybister	5.0	0	0	0	0	0	0	0	0	0
Cyrnellus	7.4	0	0	0	0	0	0	0	0	0
Dasyhelea	5.7	0	0	0	0	0	0	0	0	0
Dasyhelea (P)	5.7	0	0	0	0	0	0	0	0	0
Dicranota	4.0	0	0	0	0	0	0	0	0	0
Dineutus	5.5	0	0	0	0	0	0	0	0	0
Dineutus (A)	5.5	0	0	0	0	0	0	0	0	0
Diptera	7.0	0	0	0	0	0	0	0	0	0
Diptera (P)	7.0	0	0	0	0	0	0	0	0	0
Dixella	1.0	0	0	0	0	0	0	0	0	0
Dolichopodidae	9.7	0	0	0	0	0	0	0	0	0

Appendix M-3b. Taxa list for aquatic macroinvertebrates collected during Spring 2002, Strawberry River Watershed, Arkansas.

		Station ID								
Taxon Name	Tol. Value	WHI0143P	WHI024	WHI0143E-A	WHI0143E-B	WHI0143H-A	WHI0143H-B	UWNBC01 - A	UWNBC01 - B	WHI0143N - A
Dromogomphus	6.3	0	0	0	0	0	0	0	0	0
Drunella	1.0	0	0	0	0	0	1	0	0	0
Dubiraphia	6.4	0	0	0	0	0	0	0	0	0
Dubiraphia (A)	6.4	0	0	1	0	0	0	2	0	0
Dytiscus	5.0	0	0	0	0	0	0	0	0	0
Ectopria	4.0	0	0	0	0	0	0	1	0	0
Empididae	8.1	0	0	0	0	0	0	0	0	0
Enallagma	9.0	0	0	0	0	0	0	0	0	0
Ephemerella	2.9	0	0	0	0	0	0	0	0	0
Ephoron	2.0	8	1	0	0	0	0	0	0	0
Ephydridae	6.0	0	0	0	0	0	0	0	0	0
Epiaeschna heros	7.1	0	0	0	0	0	0	0	0	0
Erpetogomphus	4.0	0	0	0	0	0	0	0	0	0
Eurylophella	2.1	0	0	0	0	0	0	0	0	0
Ferrissia	6.9	0	0	0	0	0	0	0	0	0
Forcipomyia	6.0	0	0	0	0	0	0	0	0	0
Gammarus	6.9	0	0	0	0	0	0	1	0	0
Gerris	5.0	0	0	0	0	0	0	0	0	0
Gomphus	4.9	0	0	0	0	0	0	0	0	2
Gomphurus	6.2	0	0	0	0	0	0	0	0	0
Gumaga	NK	0	0	0	0	0	0	0	0	0
Gyretes	5.0	0	0	0	0	0	0	0	0	0
Gyrinidae	5.0	0	0	0	0	0	0	0	0	0
Gyrinus	6.3	0	0	0	0	0	0	0	0	0
Hagenius	4.0	0	0	0	0	0	0	0	0	0
Helicopsyche	3.0	0	0	0	0	0	0	0	1	0
Hemerodromia	6.0	0	0	0	0	0	0	0	0	0
Hemerodromia (P)	6.0	0	0	0	0	0	0	0	0	0
Heptagenia	2.8	0	0	0	0	4	0	0	0	0
Heptageniidae	4.0	0	0	0	0	0	0	0	0	0
Hetaerina	6.2	0	0	0	0	0	0	0	0	0
Hexagenia	4.7	0	0	0	0	0	0	0	0	0
Hexatoma	4.7	0	0	0	0	0	0	0	0	0
Hirudinea	3.0	0	0	0	0	1	0	0	0	0
Hydrobiidae	8.0	0	0	0	0	0	0	0	0	0
Hydrobiomorpha	5.0	0	0	0	0	0	0	0	0	0
Hydrobius	5.0	0	0	0	0	0	0	0	0	0
Hydrometra	NK	0	0	0	0	0	0	0	0	0
Hydroporus (A)	8.9	0	0	0	0	0	0	0	0	0
Hydropsyche	4.0	0	1	0	0	0	0	7	11	0
Hydroptila	6.2	0	0	0	0	0	0	0	0	0
Ischnura	9.4	0	0	0	0	0	0	0	0	0
Isonychia	2.0	12	6	0	0	0	0	8	7	2
Lepidostoma	3.0	0	0	0	0	0	0	0	0	0
Leptophlebia	6.4	0	0	0	0	0	0	0	0	0
Leptotarsus	3.0	0	0	0	0	0	0	0	0	0
Leucrocuta	1.0	0	1	20	11	13	13	0	0	0
Limonia	10.0	0	0	0	0	0	0	0	0	0
Lirceus	7.7	0	0	1	0	0	0	0	0	0
Lutrochus	2.9	0	0	0	0	0	0	0	0	0

Appendix M-3b. Taxa list for aquatic macroinvertebrates collected during Spring 2002, Strawberry River Watershed, Arkansas.

		Station ID								
Taxon Name	ToL Value	WHI0143P	WHI024	WHI0143E-A	WHI0143E-B	WHI0143H-A	WHI0143H-B	UWNBC01 - A	UWNBC01 - B	WHI0143N - A
Lymnaeidae	6.0	0	0	0	0	0	0	0	0	0
Macromia	6.7	0	0	0	0	0	0	0	0	0
Macronychus	4.7	0	0	0	0	0	0	0	0	0
Macronychus (A)	4.7	0	0	0	0	0	0	0	0	0
Macrostemum	3.6	1	0	0	0	0	0	1	0	0
Mesovelia	NK	0	0	0	0	0	0	0	0	0
Microcylloepus	1.0	0	0	0	0	0	0	0	1	0
Microvelia	6.0	0	0	0	0	0	0	0	0	0
Molophilus	4.0	0	0	0	0	0	0	0	0	0
Neoelmis	4.0	2	0	0	0	0	0	0	0	0
Neoperla	1.6	0	2	0	0	0	0	1	0	0
Nigronia	2.0	1	2	0	0	0	0	0	0	0
Odontoceridae	0.0	0	0	0	0	0	0	0	0	0
Oligochaeta	10.0	4	0	0	4	2	1	4	1	0
Optioservus	2.7	0	0	0	0	0	0	0	0	0
Optioservus (A)	2.5	0	0	0	0	0	0	0	0	0
Oreodytes	5.0	0	0	0	0	0	0	0	0	0
Oreodytes (A)	5.0	0	0	0	0	0	0	0	0	0
Palaemonetes	4.0	0	0	0	0	0	0	0	0	0
Palpomyia	6.0	0	1	0	0	0	0	0	0	1
Paraleptophlebia	1.2	0	0	2	0	0	1	0	0	1
Peltodytes	8.5	0	0	0	0	1	0	0	0	0
Peltodytes (A)	8.5	0	0	0	0	0	0	0	0	0
Perlesta	4.9	0	0	47	49	14	8	0	0	2
Petrophila	2.5	0	0	0	0	0	0	0	0	0
Physa	4.0	0	0	0	0	0	0	1	0	0
Physidae	8.0	0	0	0	0	0	0	0	0	0
Pisidium	6.8	0	0	0	0	0	0	0	0	0
Planorbidae	7.0	0	0	0	0	0	0	0	0	1
Pleuroceridae	7.0	0	0	0	0	0	0	4	27	0
Polycentropus	3.5	0	0	0	0	0	0	0	0	0
Potamanthus	1.6	0	0	0	0	0	0	0	0	0
Prionocera	4.0	0	0	1	0	0	0	0	0	0
Probezzia	6.0	0	0	0	5	1	0	0	0	0
Procloeon	4.0	0	0	0	0	0	0	0	0	0
Progomphus	8.7	0	0	0	0	0	0	0	0	0
Prosimulium	2.6	0	0	0	0	0	0	0	0	0
Psephenus	2.0	0	0	1	0	0	0	1	1	0
Psephenus (A)	2.0	0	0	0	0	0	0	1	0	0
Pseudogoera	0.0	0	0	0	0	0	0	0	0	0
Pseudolimnophila	2.0	0	0	0	0	0	1	0	0	0
Psilotreta	0.0	0	0	0	0	0	0	0	0	0
Psychoda	10.0	0	0	0	0	0	0	0	0	0
Psychodidae	10.0	0	0	0	0	0	0	0	0	0
Quadrula cylindrica	8.0	0	1	0	0	0	0	0	0	0
Ranatra	7.5	0	0	0	0	0	0	0	0	0
Rhagovelia	6.0	0	0	0	0	0	0	0	0	0
Rhyacophila	0.9	0	0	0	0	0	0	0	0	0
Scirtes	7.0	0	0	0	0	0	0	0	0	0
Serratella	0.6	0	0	15	4	8	2	1	1	0

Appendix M-3b. Taxa list for aquatic macroinvertebrates collected during Spring 2002, Strawberry River Watershed, Arkansas.

		Station ID								
Taxon Name	Tol. Value	WHI0143P	WHI024	WHI0143E-A	WHI0143E-B	WHI0143H-A	WHI0143H-B	UWNBC01 - A	UWNBC01 - B	WHI0143N - A
Silvius	8.0	0	0	0	0	0	0	0	0	0
Simulium	4.4	1	0	1	33	0	5	2	0	3
Simulium (P)	4.4	0	0	0	0	0	0	0	0	0
Sphaeriidae	3.0	0	2	0	0	0	0	0	0	0
Sphaerium	7.7	0	0	0	0	0	1	0	1	0
Stenacron	3.1	0	0	0	0	0	0	0	0	2
Stenelmis	5.4	9	4	0	9	0	1	13	13	0
Stenelmis (A)	5.0	1	2	2	0	1	0	3	5	0
Stenonema	3.3	19	29	1	0	0	0	20	24	8
Stratiomyidae	NK	0	0	0	0	0	0	0	0	0
Strophopteryx	2.5	0	0	5	2	0	0	0	0	1
Stylurus	5.0	0	0	0	0	0	0	0	0	0
Tabanidae	8.0	0	0	0	0	0	0	0	0	0
Tabanus	9.7	2	0	0	0	0	0	1	0	0
Thermonectus	3.0	0	0	0	0	0	0	0	0	0
Tipula	7.7	0	0	1	1	0	0	0	0	0
Tipulidae	3.0	0	0	0	0	0	0	0	0	0
Trepobates	10.0	0	0	0	0	0	0	0	0	0
Trichoptera	NK	0	0	0	0	0	0	0	0	0
Tricorythodes	5.4	6	9	0	0	0	0	4	0	0
Tropisternus	9.8	0	0	0	0	0	0	0	0	0
Tropisternus (A)	9.8	0	0	0	0	0	0	0	0	0
Uvarus	5.0	0	0	0	0	0	0	0	0	0
Viviparidae	4.0	3	0	0	0	0	0	0	0	1
Wormaldia	0.4	0	0	0	1	0	0	0	0	0
Total	NA	105	101	137	184	107	117	132	123	108

Appendix M-3b. Taxa list for aquatic macroinvertebrates collected during Spring 2002, Strawberry River Watershed, Arkansas.

		Station ID							
Taxon Name	ToL Value	WHI0143N - B	WHI0143K - A	WHI0143K - B	WHI0143L-A	WHI0143L-B	WHI0143M-A	WHI0143M-B	NBC WWTP
Acroneuria	0.0	0	0	0	0	0	0	0	0
Agabus	5.0	0	0	0	0	0	0	0	0
Agapetus	0.0	0	0	0	0	0	0	0	0
Amphiagrion	5.0	0	0	0	0	0	0	0	0
Amphinemura	3.4	0	0	0	1	0	0	1	1
Ancylidae	6.0	0	0	0	0	0	0	0	0
Ancyronyx	6.9	0	0	0	0	0	0	0	0
Ancyronyx (A)	6.9	0	0	0	0	0	0	0	0
Apatolestes	8.0	0	0	0	0	0	0	0	0
Argia	5.1	0	0	0	0	0	0	0	0
Arigomphus	5.0	0	0	0	0	0	0	0	0
Atherix	2.0	0	0	0	0	0	0	0	0
Baetis	3.1	3	39	1	26	35	12	5	4
Baetis #2	3.1	3	0	17	0	1	0	1	0
Baetisca	4.0	0	0	0	0	0	0	0	0
Basiaeschna	7.7	0	0	0	0	0	0	0	0
Belostoma	9.8	0	0	0	0	0	0	0	0
Berosus	8.6	0	0	0	0	0	0	0	0
Boyeria	6.3	0	0	0	0	0	0	0	0
Brachycentrus	2.2	0	0	0	0	0	0	0	0
Brachyprema	3.0	0	0	0	0	0	0	0	1
Caecidotea	6.0	0	0	0	0	0	0	0	0
Caenis	7.6	3	0	0	2	0	36	17	9
Calopteryx	8.3	0	0	0	0	0	0	0	0
Cambarinae	6.0	0	0	1	0	0	0	0	1
Carabidae	4.0	0	0	0	0	0	0	0	0
Ceratopsyche	3.0	0	0	0	0	0	0	0	0
Chaoborus	8.5	0	0	0	0	0	0	0	0
Cheumatopsyche	6.6	1	197	82	11	3	13	13	39
Chimarra	2.8	1	7	6	0	0	0	0	3
Chironomidae	6.0	73	63	17	9	12	50	49	50
Chironomidae (P)	6.0	0	1	0	0	0	0	2	1
Chlorotabanus	8.0	0	0	0	0	0	0	0	0
Chrysops	7.3	0	0	0	0	0	0	0	0
Cnephia	4.0	0	0	0	0	0	0	0	0
Corbicula	6.3	0	0	0	0	0	0	0	0
Corixidae	9.0	0	0	0	0	0	0	0	0
Corydalus	5.6	1	2	1	0	0	1	1	1
Culicoides	10.0	0	0	0	0	0	0	0	0
Cybister	5.0	0	0	0	0	0	0	0	0
Cyrnellus	7.4	0	0	0	0	0	0	0	0
Dasyhelea	5.7	0	0	0	0	0	0	0	0
Dasyhelea (P)	5.7	0	0	0	0	0	0	0	0
Dicranota	4.0	0	0	0	0	0	0	0	0
Dineutus	5.5	0	0	0	0	0	0	0	0
Dineutus (A)	5.5	0	0	0	0	0	0	0	0
Diptera	7.0	0	0	0	0	0	0	0	0
Diptera (P)	7.0	0	0	0	0	0	0	0	0
Dixella	1.0	0	0	0	0	0	0	0	0
Dolichopodidae	9.7	0	0	0	0	0	0	0	0

Appendix M-3b. Taxa list for aquatic macroinvertebrates collected during Spring 2002, Strawberry River Watershed, Arkansas.

		Station ID							
Taxon Name	Tol. Value	WHI0143N - B	WHI0143K - A	WHI0143K - B	WHI0143L-A	WHI0143L-B	WHI0143M-A	WHI0143M-B	NBC WWTP
Dromogomphus	6.3	0	0	0	0	0	0	0	0
Drunella	1.0	0	0	0	0	0	0	0	0
Dubiraphia	6.4	0	0	0	0	0	0	0	0
Dubiraphia (A)	6.4	0	0	0	0	0	0	0	0
Dytiscus	5.0	0	0	0	0	0	0	0	0
Ectopria	4.0	0	1	0	0	0	0	0	0
Empididae	8.1	0	0	0	0	0	0	0	0
Enallagma	9.0	0	0	0	0	0	0	0	0
Ephemerella	2.9	0	0	0	0	1	0	0	0
Ephoron	2.0	0	0	0	0	0	0	0	0
Ephydridae	6.0	0	0	0	0	0	0	0	0
Epiaeschna heros	7.1	0	0	0	0	0	0	0	0
Erpetogomphus	4.0	0	0	0	0	0	0	0	0
Eurylophella	2.1	0	0	0	0	0	0	0	0
Ferrissia	6.9	0	0	0	0	0	0	0	0
Forcipomyia	6.0	0	0	0	0	0	0	0	0
Gammarus	6.9	0	0	4	0	0	0	0	0
Gerris	5.0	0	0	0	0	0	0	0	0
Gomphus	4.9	0	0	1	0	0	0	0	0
Gomphurus	6.2	0	0	0	0	0	0	0	0
Gumaga	NK	0	0	0	0	0	0	0	0
Gyretes	5.0	0	0	0	0	0	0	0	0
Gyrinidae	5.0	0	0	0	0	0	0	0	0
Gyrinus	6.3	0	0	0	0	0	0	0	0
Hagenius	4.0	0	0	0	0	0	0	0	0
Helicopsyche	3.0	0	0	2	0	0	0	0	0
Hemerodromia	6.0	0	2	1	0	0	0	0	0
Hemerodromia (P)	6.0	0	0	1	0	0	0	0	0
Heptagenia	2.8	0	0	0	2	0	1	0	0
Heptageniidae	4.0	0	0	0	0	0	0	0	0
Hetaerina	6.2	0	0	0	0	0	0	0	0
Hexagenia	4.7	0	0	0	0	0	0	0	0
Hexatoma	4.7	0	0	0	0	0	0	0	0
Hirudinea	3.0	0	0	0	0	0	0	0	0
Hydrobiidae	8.0	0	0	0	0	0	0	0	0
Hydrobiomorpha	5.0	0	0	0	0	0	0	0	0
Hydrobius	5.0	0	0	0	0	0	0	0	0
Hydrometra	NK	0	0	0	0	0	0	0	0
Hydroporus (A)	8.9	0	0	0	0	0	0	0	0
Hydropsyche	4.0	0	31	8	0	0	0	0	0
Hydroptila	6.2	0	0	0	0	0	0	0	0
Ischnura	9.4	0	0	0	0	0	0	0	0
Isonychia	2.0	0	12	2	1	0	4	3	1
Lepidostoma	3.0	0	0	0	0	0	0	0	0
Leptophlebia	6.4	0	0	0	0	0	0	0	0
Leptotarsus	3.0	0	0	0	0	0	0	0	0
Leucrocuta	1.0	3	0	0	7	4	7	1	2
Limonia	10.0	0	0	0	0	0	0	0	0
Lirceus	7.7	0	0	1	0	0	1	0	1
Lutrochus	2.9	0	0	0	0	0	0	0	0

Appendix M-3b. Taxa list for aquatic macroinvertebrates collected during Spring 2002, Strawberry River Watershed, Arkansas.

		Station ID							
Taxon Name	Tol. Value	WHI0143N - B	WHI0143K - A	WHI0143K - B	WHI0143L-A	WHI0143L-B	WHI0143M-A	WHI0143M-B	NBC WWTP
Lymnaeidae	6.0	0	0	0	0	0	0	0	0
Macromia	6.7	0	0	0	0	0	0	0	0
Macronychus	4.7	0	0	0	0	0	0	0	0
Macronychus (A)	4.7	0	0	0	0	0	0	0	0
Macrostemum	3.6	0	6	0	0	0	0	0	0
Mesovelia	NK	0	0	0	0	0	0	0	0
Microcylloepus	1.0	0	0	0	0	0	0	0	0
Microvelia	6.0	0	0	0	0	0	0	0	0
Molophilus	4.0	0	0	0	0	0	0	0	0
Neoelmis	4.0	0	0	0	0	0	0	0	0
Neoperla	1.6	0	0	0	0	0	0	0	0
Nigronia	2.0	0	0	4	0	0	0	0	0
Odontoceridae	0.0	0	0	1	0	0	0	0	0
Oligochaeta	10.0	0	5	0	1	0	0	0	0
Optioservus	2.7	0	39	4	0	0	0	0	0
Optioservus (A)	2.5	0	5	1	0	0	0	0	0
Oreodytes	5.0	0	0	0	0	0	0	0	0
Oreodytes (A)	5.0	0	0	0	0	0	0	0	0
Palaemonetes	4.0	0	0	0	0	0	0	0	0
Palpomyia	6.0	0	0	0	0	0	0	0	0
Paraleptophlebia	1.2	2	0	0	0	0	0	0	5
Peltodytes	8.5	0	0	0	0	0	0	0	0
Peltodytes (A)	8.5	0	0	0	0	0	0	0	0
Perlesta	4.9	3	0	0	46	45	12	13	25
Petrophila	2.5	0	0	0	0	0	0	0	0
Physa	4.0	0	0	0	0	0	0	0	0
Physidae	8.0	0	0	0	0	0	0	0	0
Pisidium	6.8	0	0	0	0	0	0	0	0
Planorbidae	7.0	0	0	0	0	0	0	0	0
Pleuroceridae	7.0	0	0	0	0	0	0	0	0
Polycentropus	3.5	0	0	0	0	0	0	0	0
Potamanthus	1.6	0	0	0	0	0	1	0	0
Prionocera	4.0	0	0	0	0	0	0	0	0
Probezzia	6.0	0	0	0	1	0	1	0	0
Procloeon	4.0	0	0	0	0	0	0	0	0
Progomphus	8.7	0	0	0	0	0	0	0	0
Prosimulium	2.6	0	0	0	0	0	0	0	0
Psephenus	2.0	0	3	0	0	0	2	0	1
Psephenus (A)	2.0	0	0	0	0	0	0	0	0
Pseudogoera	0.0	0	0	0	0	0	0	0	0
Pseudolimnophila	2.0	0	0	0	0	0	0	0	1
Psilotreta	0.0	0	0	0	0	0	0	0	0
Psychoda	10.0	1	0	0	0	0	0	0	0
Psychodidae	10.0	1	0	0	0	0	0	0	0
Quadrula cylindrica	8.0	0	0	0	0	0	0	0	0
Ranatra	7.5	0	0	0	0	0	0	0	0
Rhagovelia	6.0	0	0	0	0	0	0	0	0
Rhyacophila	0.9	0	0	0	0	0	0	0	0
Scirtes	7.0	0	0	0	0	0	0	0	0
Serratella	0.6	0	22	0	1	0	2	8	2

Appendix M-3b. Taxa list for aquatic macroinvertebrates collected during Spring 2002, Strawberry River Watershed, Arkansas.

		Station ID							
Taxon Name	Tol. Value	WHI0143N - B	WHI0143K - A	WHI0143K - B	WHI0143L-A	WHI0143L-B	WHI0143M-A	WHI0143M-B	NBC WWTP
Silvius	8.0	2	0	0	0	0	0	0	0
Simulium	4.4	0	7	3	26	1	23	54	0
Simulium (P)	4.4	0	0	0	0	0	0	0	0
Sphaeriidae	3.0	0	0	0	0	0	0	0	0
Sphaerium	7.7	0	0	0	0	0	0	0	0
Stenacron	3.1	0	0	0	0	0	0	0	1
Stenelmis	5.4	0	5	5	1	1	1	2	2
Stenelmis (A)	5.0	0	1	2	0	0	4	0	1
Stenonema	3.3	2	37	15	1	0	8	4	3
Stratiomyidae	NK	0	0	0	0	0	0	0	0
Strophopteryx	2.5	1	0	0	0	0	0	0	0
Stylurus	5.0	0	0	0	0	0	0	0	0
Tabanidae	8.0	0	0	0	0	0	0	0	0
Tabanus	9.7	0	1	0	0	0	0	0	0
Thermonectus	3.0	0	0	0	0	0	0	0	0
Tipula	7.7	0	0	0	0	0	0	0	1
Tipulidae	3.0	0	0	0	0	0	0	0	0
Trepobates	10.0	0	0	0	0	0	0	0	0
Trichoptera	NK	0	0	0	0	0	0	0	0
Tricorythodes	5.4	0	0	0	0	0	1	0	0
Tropisternus	9.8	0	0	0	0	0	0	0	0
Tropisternus (A)	9.8	0	0	0	0	0	0	0	0
Uvarus	5.0	0	0	0	0	0	0	0	0
Viviparidae	4.0	0	4	0	0	0	0	0	0
Wormaldia	0.4	0	0	0	0	0	0	0	0
Total	NA	100	490	180	136	103	180	174	156

Appendix M-3b. Taxa list for aquatic macroinvertebrates collected during Spring 2002, Strawberry River Watershed, Arkansas.

		Station ID								
Taxon Name	Tol. Value	WHI0143I-A	WHI0143I-B	DSHWY354 - A	DSHWY354 - B	WHI0143J	UWRDC01	WHI0143S	WHI0143Q	WHI0143R
Acroneuria	0.0	0	0	0	1	0	0	0	0	0
Agabus	5.0	0	0	0	0	0	0	0	0	0
Agapetus	0.0	0	0	0	0	0	0	0	0	0
Amphiagrion	5.0	0	0	0	0	0	0	0	1	0
Amphinemura	3.4	0	0	0	0	0	0	0	0	0
Ancylidae	6.0	0	0	0	0	0	0	0	0	0
Ancyronyx	6.9	0	0	0	0	0	0	0	1	0
Ancyronyx (A)	6.9	0	0	0	0	1	0	2	2	0
Apatolestes	8.0	0	0	0	0	0	0	0	0	0
Argia	5.1	0	0	0	0	7	0	0	0	0
Arigomphus	5.0	0	0	0	0	0	0	0	0	0
Atherix	2.0	0	0	3	3	0	0	0	0	3
Baetis	3.1	11	13	2	2	4	7	0	0	0
Baetis #2	3.1	6	1	71	27	0	0	0	0	0
Baetisca	4.0	0	0	0	0	0	0	0	0	0
Basiaeschna	7.7	0	0	0	0	0	0	0	0	0
Belostoma	9.8	0	0	0	0	0	0	0	0	0
Berosus	8.6	1	0	0	0	0	0	0	0	0
Boyeria	6.3	0	0	0	0	3	11	3	8	1
Brachycentrus	2.2	0	0	0	0	0	0	0	0	0
Brachyprema	3.0	0	0	0	0	0	0	0	0	0
Caecidotea	6.0	0	0	0	0	0	4	0	0	0
Caenis	7.6	3	4	0	1	0	1	9	1	2
Calopteryx	8.3	0	0	0	0	0	0	0	1	0
Cambarinae	6.0	1	1	1	1	5	1	1	0	4
Carabidae	4.0	0	0	0	0	0	0	0	0	0
Ceratopsyche	3.0	1	0	0	0	0	0	0	0	0
Chaoborus	8.5	0	0	0	0	0	0	0	0	0
Cheumatopsyche	6.6	20	18	106	60	1	0	1	0	0
Chimarra	2.8	1	1	3	5	45	0	0	0	0
Chironomidae	6.0	59	38	49	42	5	18	10	10	22
Chironomidae (P)	6.0	3	4	4	1	0	1	3	3	3
Chlorotabanus	8.0	0	0	0	0	0	0	0	0	0
Chrysops	7.3	0	0	0	0	0	2	0	1	0
Cnephia	4.0	0	0	0	0	0	0	0	0	0
Corbicula	6.3	0	0	0	1	3	1	1	0	0
Corixidae	9.0	0	0	0	0	0	0	0	0	0
Corydalus	5.6	0	0	0	0	0	0	0	0	0
Culicoides	10.0	0	0	0	0	0	0	0	0	0
Cybister	5.0	0	0	0	0	0	0	0	0	0
Cyrnellus	7.4	0	0	0	0	0	0	0	0	0
Dasyhelea	5.7	0	0	0	0	0	0	0	0	0
Dasyhelea (P)	5.7	0	0	0	0	0	0	0	0	0
Dicranota	4.0	0	0	0	0	0	0	0	0	0
Dineutus	5.5	0	0	0	0	1	3	0	0	0
Dineutus (A)	5.5	0	0	0	0	1	3	1	0	0
Diptera	7.0	0	0	0	0	0	0	0	0	0
Diptera (P)	7.0	0	0	0	0	0	0	0	0	0
Dixella	1.0	0	0	0	0	0	0	0	1	0
Dolichopodidae	9.7	0	0	0	0	0	0	0	0	0

Appendix M-3b. Taxa list for aquatic macroinvertebrates collected during Spring 2002, Strawberry River Watershed, Arkansas.

		Station ID								
Taxon Name	ToL Value	WHI0143I-A	WHI0143I-B	DSHWY354 - A	DSHWY354 - B	WHI0143J	UWRDC01	WHI0143S	WHI0143Q	WHI0143R
Dromogomphus	6.3	0	0	0	0	0	2	3	0	0
Drunella	1.0	0	0	0	0	0	0	0	0	0
Dubiraphia	6.4	0	0	0	0	2	3	0	1	5
Dubiraphia (A)	6.4	0	0	0	0	0	2	0	0	0
Dytiscus	5.0	0	0	0	0	0	0	0	0	0
Ectopria	4.0	0	0	0	1	0	0	0	0	0
Empididae	8.1	0	0	0	0	0	0	0	0	0
Enallagma	9.0	0	0	0	0	0	0	1	0	7
Ephemerella	2.9	0	0	0	0	0	0	0	0	0
Ephoron	2.0	0	0	0	0	0	0	0	0	0
Ephydridae	6.0	0	0	0	0	0	0	0	1	0
Epiaeschna heros	7.1	0	0	0	0	0	0	0	0	0
Erpetogomphus	4.0	0	0	0	0	0	0	0	0	0
Eurylophella	2.1	0	0	0	0	0	0	0	0	0
Ferrissia	6.9	0	0	0	0	0	0	0	0	0
Forcipomyia	6.0	0	0	0	0	0	0	1	0	0
Gammarus	6.9	0	0	0	0	0	28	7	30	28
Gerris	5.0	0	0	0	0	0	0	0	0	0
Gomphus	4.9	0	0	4	3	0	0	0	0	0
Gomphurus	6.2	0	0	0	0	0	0	0	0	0
Gumaga	NK	0	0	0	0	0	0	0	0	0
Gyretes	5.0	0	0	0	0	0	0	0	0	0
Gyrinidae	5.0	0	0	0	0	0	0	0	0	0
Gyrinus	6.3	0	0	0	0	1	0	0	0	0
Hagenius	4.0	0	0	1	0	0	0	1	1	0
Helicopsyche	3.0	0	0	0	1	0	0	0	0	0
Hemerodromia	6.0	0	0	0	0	0	4	0	0	0
Hemerodromia (P)	6.0	0	0	3	1	0	1	1	0	0
Heptagenia	2.8	0	0	0	0	0	0	0	0	0
Heptageniidae	4.0	0	0	0	0	0	0	0	0	0
Hetaerina	6.2	0	0	0	0	0	4	0	0	0
Hexagenia	4.7	0	0	0	0	0	0	2	0	0
Hexatoma	4.7	0	0	0	0	0	0	0	0	0
Hirudinea	3.0	0	0	0	0	0	0	0	0	0
Hydrobiidae	8.0	0	0	0	0	0	0	1	0	0
Hydrobiomorpha	5.0	0	0	0	0	0	0	0	0	0
Hydrobius	5.0	0	0	0	0	0	0	0	0	0
Hydrometra	NK	0	0	0	0	1	1	0	0	1
Hydroporus (A)	8.9	0	0	0	0	0	1	0	0	0
Hydropsyche	4.0	0	0	1	0	0	0	0	0	0
Hydroptila	6.2	0	0	2	0	1	0	0	0	0
Ischnura	9.4	0	0	0	0	0	0	0	3	0
Isonychia	2.0	0	2	4	5	0	0	0	0	0
Lepidostoma	3.0	0	0	0	0	0	0	0	0	1
Leptophlebia	6.4	0	0	0	0	0	0	0	0	0
Leptotarsus	3.0	0	0	0	0	0	0	0	0	0
Leucrocuta	1.0	3	6	0	0	0	0	0	0	0
Limonia	10.0	0	0	0	5	0	0	0	0	0
Lirceus	7.7	40	52	0	0	0	0	0	11	0
Lutrochus	2.9	0	0	0	0	0	0	0	0	0

Appendix M-3b. Taxa list for aquatic macroinvertebrates collected during Spring 2002, Strawberry River Watershed, Arkansas.

		Station ID								
Taxon Name	Tol. Value	WHI0143I-A	WHI0143I-B	DSHWY354 - A	DSHWY354 - B	WHI0143J	UWRDC01	WHI0143S	WHI0143Q	WHI0143R
Lymnaeidae	6.0	0	2	0	0	0	0	0	0	0
Macromia	6.7	0	0	0	0	3	4	2	0	0
Macronychus	4.7	0	0	0	0	3	0	0	2	0
Macronychus (A)	4.7	0	0	0	0	0	0	2	0	0
Macrostemum	3.6	0	0	0	6	1	0	1	0	0
Mesovelia	NK	0	0	0	0	0	1	0	1	0
Microcylloepus	1.0	0	0	0	1	0	0	1	0	0
Microvelia	6.0	0	0	0	0	0	0	0	0	1
Molophilus	4.0	0	0	0	0	0	0	0	0	0
Neoelmis	4.0	0	0	0	0	0	0	0	0	0
Neoperla	1.6	0	0	4	0	0	0	0	0	0
Nigronia	2.0	0	0	0	0	0	0	0	0	0
Odontoceridae	0.0	0	0	0	0	0	0	0	0	0
Oligochaeta	10.0	0	0	0	0	0	0	0	0	0
Optioservus	2.7	0	0	0	0	0	1	0	0	0
Optioservus (A)	2.5	0	0	0	0	0	0	0	0	0
Oreodytes	5.0	0	0	0	0	0	0	2	0	2
Oreodytes (A)	5.0	0	0	0	0	0	0	0	0	1
Palaemonetes	4.0	0	0	0	0	1	0	3	0	0
Palpomyia	6.0	0	0	0	0	0	1	0	0	0
Paraleptophlebia	1.2	3	1	0	0	0	0	1	0	0
Peltodytes	8.5	1	0	0	0	0	0	0	0	0
Peltodytes (A)	8.5	0	0	0	0	0	0	0	0	0
Perlesta	4.9	16	22	0	0	1	0	0	0	0
Petrophila	2.5	0	0	0	0	0	0	0	0	0
Physa	4.0	3	3	0	0	0	0	0	0	2
Physidae	8.0	0	0	0	0	0	0	0	0	0
Pisidium	6.8	0	0	0	0	0	1	0	0	0
Planorbidae	7.0	1	2	0	0	0	0	0	0	0
Pleuroceridae	7.0	0	1	0	0	1	1	0	0	0
Polycentropus	3.5	0	0	0	1	1	0	1	4	0
Potamanthus	1.6	0	0	0	0	0	0	0	0	0
Prionocera	4.0	0	0	0	0	0	0	0	0	0
Probezzia	6.0	0	0	0	0	0	0	0	0	4
Procloeon	4.0	0	0	0	0	0	0	0	0	0
Progomphus	8.7	0	0	0	0	0	0	1	0	0
Prosimulium	2.6	0	0	0	0	0	0	0	0	0
Psephenus	2.0	1	1	2	4	0	0	0	0	0
Psephenus (A)	2.0	0	0	0	1	0	0	0	0	0
Pseudogoera	0.0	0	0	0	0	0	0	0	0	0
Pseudolimnophila	2.0	0	0	0	0	0	0	0	0	0
Psilotreta	0.0	0	0	0	0	0	0	0	0	0
Psychoda	10.0	0	0	0	0	0	0	0	0	0
Psychodidae	10.0	0	0	0	0	0	0	0	0	0
Quadrula cylindrica	8.0	0	0	0	0	0	0	0	0	0
Ranatra	7.5	0	0	0	0	0	0	1	0	0
Rhagovelia	6.0	0	0	0	0	0	0	0	0	0
Rhyacophila	0.9	0	0	0	0	0	0	0	0	0
Scirtes	7.0	0	0	0	0	0	0	0	2	0
Serratella	0.6	3	6	0	0	0	0	0	0	0

Appendix M-3b. Taxa list for aquatic macroinvertebrates collected during Spring 2002, Strawberry River Watershed, Arkansas.

		Station ID								
Taxon Name	Tol. Value	WHI0143I-A	WHI0143I-B	DSHWY354 - A	DSHWY354 - B	WHI0143J	UWRDC01	WHI0143S	WHI0143Q	WHI0143R
Silvius	8.0	0	0	0	0	0	0	0	0	0
Simulium	4.4	0	0	2	9	0	0	0	0	0
Simulium (P)	4.4	0	0	0	0	0	0	0	0	0
Sphaeriidae	3.0	0	0	0	0	0	0	0	0	4
Sphaerium	7.7	0	1	0	0	0	0	0	0	0
Stenacron	3.1	0	0	0	0	1	2	7	0	1
Stenelmis	5.4	2	6	16	15	0	1	1	0	0
Stenelmis (A)	5.0	2	6	7	6	0	14	4	13	1
Stenonema	3.3	0	1	17	5	0	0	3	0	0
Stratiomyidae	NK	0	0	0	0	0	0	0	0	0
Strophopteryx	2.5	0	0	0	0	0	0	0	0	0
Stylurus	5.0	0	0	0	0	0	0	0	0	0
Tabanidae	8.0	0	0	0	0	0	0	0	0	0
Tabanus	9.7	0	0	1	0	0	0	0	0	0
Thermonectus	3.0	0	0	0	0	0	0	0	0	0
Tipula	7.7	0	0	0	0	0	0	0	0	0
Tipulidae	3.0	0	0	0	0	0	0	0	1	1
Trepobates	10.0	0	0	0	0	0	0	0	0	0
Trichoptera	NK	0	0	0	0	0	0	0	0	0
Tricorythodes	5.4	0	0	0	3	3	3	0	0	0
Tropisternus	9.8	0	0	0	0	1	1	0	0	0
Tropisternus (A)	9.8	0	0	0	0	0	0	0	0	0
Uvarus	5.0	0	0	0	0	0	0	0	0	0
Viviparidae	4.0	0	0	0	0	1	0	0	0	0
Wormaldia	0.4	0	0	0	0	0	0	0	0	0
Total	NA	181	192	303	211	98	128	78	99	94

Appendix M-3c. Taxa list for aquatic macroinvertebrates collected during Fall 2002, Strawberry River Watershed, Arkansas.

		Station ID						
Taxon Name	Tol. Value	WHI0143B - A	WHI0143B - B	UWSBR02 - A	UWSBR02 - B	WHI0143P	WHI024	UWNBC01 - A
Acroneuria	0.0	0	0	0	0	0	0	0
Agabus	5.0	0	0	0	0	0	0	0
Agapetus	0.0	0	0	0	0	0	0	0
Amphiagrion	5.0	0	0	0	0	0	0	0
Amphinemura	3.4	0	0	0	0	0	0	0
Ancylidae	6.0	0	0	0	0	0	0	0
Ancyronyx	6.9	0	0	0	0	0	0	0
Ancyronyx (A)	6.9	0	0	0	0	0	0	0
Apatolestes	8.0	0	0	0	0	0	0	0
Argia	5.1	4	3	0	1	1	0	0
Arigomphus	5.0	0	0	0	0	0	0	0
Atherix	2.0	0	0	1	0	0	0	0
Baetis	3.1	0	6	1	0	0	3	6
Baetis #2	3.1	0	0	3	0	2	0	0
Baetisca	4.0	0	0	0	0	0	0	0
Basiaeschna	7.7	0	0	0	0	0	0	0
Belostoma	9.8	0	0	0	0	0	0	0
Berosus	8.6	0	0	0	0	0	0	0
Boyeria	6.3	0	0	0	0	0	0	0
Brachycentrus	2.2	0	0	0	0	0	0	0
Brachyprema	3.0	0	0	0	0	0	0	0
Caecidotea	6.0	0	0	0	0	0	0	0
Caenis	7.6	1	0	0	1	3	1	0
Calopteryx	8.3	0	0	0	0	0	0	0
Cambarinae	6.0	0	1	1	0	0	1	0
Carabidae	4.0	0	0	0	0	0	0	0
Ceratopsyche	3.0	0	0	0	0	0	0	0
Chaoborus	8.5	0	0	0	0	0	0	0
Cheumatopsyche	6.6	13	9	11	9	39	13	18
Chimarra	2.8	10	2	19	3	7	1	0
Chironomidae	6.0	10	0	7	8	6	3	2
Chironomidae (P)	6.0	0	0	0	0	0	0	0
Chlorotabanus	8.0	0	0	0	0	0	0	0
Chrysops	7.3	0	0	0	0	0	0	0
Cnephia	4.0	0	0	0	0	0	0	0
Corbicula	6.3	0	8	0	2	1	1	0
Corixidae	9.0	0	0	0	0	0	0	0
Corydalus	5.6	1	5	9	5	3	1	1
Culicoides	10.0	0	0	0	0	0	0	0
Cybister	5.0	0	0	0	0	0	0	0
Cyrnellus	7.4	0	0	0	0	0	0	0
Dasyhelea	5.7	0	0	0	0	0	0	0
Dasyhelea (P)	5.7	0	0	0	0	0	0	0
Dicranota	4.0	0	0	0	0	0	0	0
Dineutus	5.5	0	0	0	0	0	0	0
Dineutus (A)	5.5	0	1	0	0	1	1	0
Diptera	7.0	0	0	0	0	0	0	0
Diptera (P)	7.0	0	0	0	0	0	0	0
Dixella	1.0	0	0	0	0	0	0	0
Dolichopodidae	9.7	0	0	0	0	0	0	0
Dromogomphus	6.3	0	1	0	2	3	3	0

Appendix M-3c. Taxa list for aquatic macroinvertebrates collected during Fall 2002, Strawberry River Watershed, Arkansas.

		Station ID						
Taxon Name	Tol. Value	WHI0143B - A	WHI0143B - B	UWSBR02 - A	UWSBR02 - B	WHI0143P	WHI024	UWNBC01 - A
Drunella	1.0	0	0	0	0	0	0	0
Dubiraphia	6.4	0	0	0	0	0	0	0
Dubiraphia (A)	6.4	0	0	0	0	0	0	0
Dytiscus	5.0	0	0	0	0	0	0	0
Ectopria	4.0	0	0	0	1	0	0	0
Empididae	8.1	0	0	0	0	0	0	0
Enallagma	9.0	0	0	0	0	0	0	2
Ephemerella	2.9	0	0	0	0	0	0	0
Ephoron	2.0	0	0	0	0	0	0	0
Ephydridae	6.0	0	0	0	0	0	0	0
Epiaeschna heros	7.1	0	0	0	0	0	0	0
Erpetogomphus	4.0	0	0	0	0	0	0	0
Eurylophella	2.1	0	0	0	0	0	0	0
Ferrissia	6.9	0	0	0	0	0	0	0
Forcipomyia	6.0	0	0	0	0	0	0	0
Gammarus	6.9	0	0	0	0	0	0	0
Gerris	5.0	0	0	0	0	0	0	0
Gomphus	4.9	0	0	0	0	0	0	0
Gomphurus	6.2	0	0	0	0	0	0	0
Gumaga	NK	0	0	0	0	0	0	0
Gyretes	5.0	0	0	0	0	0	0	0
Gyrinidae	5.0	0	0	0	0	0	0	0
Gyrinus	6.3	0	0	0	0	0	0	0
Hagenius	4.0	0	0	0	0	0	0	0
Helicopsyche	3.0	0	0	0	0	0	0	0
Hemerodromia	6.0	0	0	0	0	0	0	0
Hemerodromia (P)	6.0	0	0	0	0	0	0	0
Heptagenia	2.8	0	0	0	0	0	0	0
Heptageniidae	4.0	0	0	0	0	0	0	0
Hetaerina	6.2	0	0	0	0	0	0	0
Hexagenia	4.7	0	0	0	0	0	0	0
Hexatoma	4.7	0	0	0	0	0	0	0
Hirudinea	3.0	0	0	0	0	0	0	0
Hydrobiidae	8.0	0	2	1	0	0	0	0
Hydrobiomorpha	5.0	0	0	0	0	0	0	0
Hydrobius	5.0	0	0	0	0	0	0	0
Hydrometra	NK	0	0	0	0	0	0	0
Hydroporus (A)	8.9	0	0	0	0	0	0	0
Hydropsyche	4.0	0	1	1	1	0	0	0
Hydroptila	6.2	0	0	0	0	1	0	0
Ischnura	9.4	0	0	0	0	0	0	0
Isonychia	2.0	10	13	24	12	18	2	19
Lepidostoma	3.0	0	0	0	0	0	0	0
Leptophlebia	6.4	0	0	0	0	0	0	0
Leptotarsus	3.0	0	0	0	0	0	0	0
Leucrocuta	1.0	0	0	0	1	0	0	0
Limonia	10.0	0	0	0	0	0	0	0
Lirceus	7.7	0	0	0	0	0	0	0
Lutrochus	2.9	0	0	0	0	0	0	5
Lymnaeidae	6.0	0	0	0	0	0	0	0
Macromia	6.7	0	0	0	0	0	0	0

Appendix M-3c. Taxa list for aquatic macroinvertebrates collected during Fall 2002, Strawberry River Watershed, Arkansas.

		Station ID						
Taxon Name	Tol. Value	WHI0143B - A	WHI0143B - B	UWSBR02 - A	UWSBR02 - B	WHI0143P	WHI024	UWNBC01 - A
Macronychus	4.7	0	0	0	0	0	0	0
Macronychus (A)	4.7	0	0	0	0	0	0	0
Macrostemum	3.6	0	0	0	0	0	0	2
Mesovelia	NK	0	0	0	0	0	0	0
Microcylloepus	1.0	0	0	0	0	0	0	0
Microvelia	6.0	0	0	0	0	0	0	0
Molophilus	4.0	0	0	0	0	0	0	0
Neoelmis	4.0	0	0	0	0	0	0	0
Neoperla	1.6	0	0	2	3	0	2	0
Nigronia	2.0	0	0	0	0	0	0	0
Odontoceridae	0.0	0	0	0	0	0	0	0
Oligochaeta	10.0	0	0	0	0	0	0	0
Optioservus	2.7	0	0	0	0	0	0	0
Optioservus (A)	2.5	0	0	0	0	0	0	0
Oreodytes	5.0	0	0	0	0	0	0	0
Oreodytes (A)	5.0	0	0	0	0	0	0	0
Palaemonetes	4.0	0	0	0	0	0	0	0
Palpomyia	6.0	0	0	0	0	0	0	0
Paraleptophlebia	1.2	0	0	0	0	1	0	0
Peltodytes	8.5	0	0	0	0	0	0	0
Peltodytes (A)	8.5	0	0	0	0	0	0	0
Perlesta	4.9	0	0	0	0	0	0	0
Petrophila	2.5	0	1	0	0	0	0	0
Physa	4.0	0	0	0	0	0	0	0
Physidae	8.0	0	0	0	0	0	0	0
Pisidium	6.8	0	0	0	0	0	0	0
Planorbidae	7.0	0	0	0	0	0	0	0
Pleuroceridae	7.0	1	1	7	1	1	0	5
Polycentropus	3.5	0	0	0	0	0	0	0
Potamanthus	1.6	0	0	0	0	3	1	0
Prionocera	4.0	0	0	0	0	0	0	0
Probezzia	6.0	0	0	0	0	0	0	0
Procloeon	4.0	0	0	0	0	0	0	0
Progomphus	8.7	0	0	0	0	0	0	0
Prosimulium	2.6	0	0	0	0	0	0	0
Psephenus	2.0	0	0	0	0	0	0	1
Psephenus (A)	2.0	0	0	0	0	0	0	0
Pseudogoera	0.0	0	0	0	0	0	0	0
Pseudolimnophila	2.0	0	0	0	0	0	0	0
Psilotreta	0.0	0	0	0	0	0	2	0
Psychoda	10.0	0	0	0	0	0	0	0
Psychodidae	10.0	0	0	0	0	0	0	0
cylindrica	8.0	0	0	0	0	0	0	0
Ranatra	7.5	0	0	0	0	0	0	0
Rhagovelia	6.0	0	0	0	0	0	0	0
Rhyacophila	0.9	0	0	0	0	0	0	0
Scirtes	7.0	0	0	0	0	0	0	0
Serratella	0.6	0	0	0	0	0	0	0
Silvius	8.0	0	0	0	0	0	0	0
Simulium	4.4	1	3	4	3	1	0	1
Simulium (P)	4.4	0	0	0	0	0	0	0

Appendix M-3c. Taxa list for aquatic macroinvertebrates collected during Fall 2002, Strawberry River Watershed, Arkansas.

		Station ID						
Taxon Name	Tol. Value	WHI0143B - A	WHI0143B - B	UWSBR02 - A	UWSBR02 - B	WHI0143P	WHI024	UWNBC01 - A
Sphaeriidae	3.0	0	0	0	0	0	0	0
Sphaerium	7.7	5	0	0	0	0	0	4
Stenacron	3.1	1	0	0	0	0	0	0
Stenelmis	5.4	6	8	3	6	15	8	14
Stenelmis (A)	5.0	0	4	0	1	2	0	9
Stenonema	3.3	36	28	45	75	118	68	19
Stratiomyidae	NK	0	0	0	0	0	0	0
Strophopteryx	2.5	0	0	0	0	0	0	0
Stylurus	5.0	0	0	0	0	0	0	0
Tabanidae	8.0	0	0	0	0	0	0	0
Tabanus	9.7	0	0	0	0	2	0	0
Thermonectus	3.0	0	0	0	0	0	0	0
Tipula	7.7	0	0	0	0	0	0	0
Tipulidae	3.0	0	0	0	0	0	0	0
Trepobates	10.0	0	0	0	0	0	0	0
Trichoptera	NK	0	0	0	0	0	0	0
Tricorythodes	5.4	37	30	45	21	45	211	32
Tropisternus	9.8	0	0	0	0	0	0	0
Tropisternus (A)	9.8	0	0	0	0	0	0	0
Uvarus	5.0	0	0	0	0	0	0	0
Viviparidae	4.0	0	0	0	0	0	0	0
Wormaldia	0.4	0	0	0	0	0	0	0
Total	NA	136	127	184	156	273	322	140

Appendix M-3c. Taxa list for aquatic macroinvertebrates collected during Fall 2002, Strawberry River Watershed, Arkansas.

		Station ID					
Taxon Name	Tol. Value	UWNBC01 - B	WHI0143N - A	WHI0143N - B	WHI0143K - A	WHI0143K - B	WHI0143L-A
Acroneuria	0.0	0	0	0	0	0	0
Agabus	5.0	0	0	0	0	0	0
Agapetus	0.0	0	0	0	0	0	0
Amphiagrion	5.0	0	0	0	0	0	0
Amphinemura	3.4	0	0	0	0	0	0
Ancylidae	6.0	0	0	0	0	0	0
Ancyronyx	6.9	0	0	0	0	0	0
Ancyronyx (A)	6.9	0	0	0	0	0	0
Apatolestes	8.0	0	0	0	0	0	0
Argia	5.1	4	2	0	0	0	0
Arigomphus	5.0	0	0	0	0	0	0
Atherix	2.0	0	0	0	0	0	0
Baetis	3.1	2	0	1	0	0	0
Baetis #2	3.1	0	4	0	16	16	0
Baetisca	4.0	0	0	0	0	0	0
Basiaeschna	7.7	0	0	0	0	0	0
Belostoma	9.8	0	0	0	0	0	0
Berosus	8.6	0	0	0	0	0	0
Boyeria	6.3	0	0	0	0	0	0
Brachycentrus	2.2	0	0	0	0	0	0
Brachyprema	3.0	0	0	0	0	0	0
Caecidotea	6.0	0	0	0	0	0	0
Caenis	7.6	0	0	4	0	0	4
Calopteryx	8.3	0	0	0	0	0	0
Cambarinae	6.0	1	1	0	2	0	0
Carabidae	4.0	0	0	0	0	0	0
Ceratopsyche	3.0	0	0	0	0	0	0
Chaoborus	8.5	0	0	0	0	0	0
Cheumatopsyche	6.6	0	4	7	28	44	34
Chimarra	2.8	0	21	18	3	3	5
Chironomidae	6.0	1	39	49	2	2	4
Chironomidae (P)	6.0	0	1	3	0	0	0
Chlorotabanus	8.0	0	0	0	0	0	0
Chrysops	7.3	0	0	0	0	0	0
Cnephia	4.0	0	0	0	0	0	0
Corbicula	6.3	1	0	0	0	0	0
Corixidae	9.0	0	0	0	0	0	0
Corydalus	5.6	1	6	5	2	3	2
Culicoides	10.0	0	0	0	0	0	0
Cybister	5.0	0	0	0	0	0	0
Cyrnellus	7.4	0	0	0	0	0	0
Dasyhelea	5.7	0	0	0	0	0	0
Dasyhelea (P)	5.7	0	0	0	0	0	0
Dicranota	4.0	0	0	1	0	0	0
Dineutus	5.5	0	0	0	0	0	0
Dineutus (A)	5.5	0	0	0	0	0	0
Diptera	7.0	0	0	0	0	0	0
Diptera (P)	7.0	0	0	0	0	0	0
Dixella	1.0	0	0	0	0	0	0
Dolichopodidae	9.7	0	0	0	0	0	0
Dromogomphus	6.3	0	0	2	0	0	0

Appendix M-3c. Taxa list for aquatic macroinvertebrates collected during Fall 2002, Strawberry River Watershed, Arkansas.

		Station ID					
Taxon Name	Tol. Value	UWNBC01 - B	WHI0143N - A	WHI0143N - B	WHI0143K - A	WHI0143K - B	WHI0143L-A
Drunella	1.0	0	0	0	0	0	0
Dubiraphia	6.4	0	0	0	0	0	0
Dubiraphia (A)	6.4	0	0	0	0	0	0
Dytiscus	5.0	0	0	0	0	0	0
Ectopria	4.0	0	0	0	0	0	0
Empididae	8.1	0	0	0	0	0	0
Enallagma	9.0	0	0	5	0	0	1
Ephemerella	2.9	0	0	0	0	0	0
Ephoron	2.0	0	0	0	0	0	0
Ephydridae	6.0	0	0	0	0	0	0
Epiaeschna heros	7.1	0	0	0	0	0	0
Erpetogomphus	4.0	0	0	0	0	0	0
Eurylophella	2.1	0	0	0	0	0	0
Ferrissia	6.9	0	0	0	0	0	0
Forcipomyia	6.0	0	0	0	0	0	0
Gammarus	6.9	0	0	0	1	1	0
Gerris	5.0	0	0	0	0	0	0
Gomphus	4.9	0	0	0	1	0	0
Gomphurus	6.2	0	0	0	0	0	0
Gumaga	NK	0	0	0	0	0	0
Gyretes	5.0	0	0	0	0	0	0
Gyrinidae	5.0	0	0	0	0	0	0
Gyrinus	6.3	0	0	0	0	0	0
Hagenius	4.0	0	0	0	0	0	0
Helicopsyche	3.0	0	0	0	1	0	0
Hemerodromia	6.0	0	2	1	1	0	1
Hemerodromia (P)	6.0	0	0	0	0	0	0
Heptagenia	2.8	0	0	0	0	0	0
Heptageniidae	4.0	0	0	0	0	0	0
Hetaerina	6.2	0	0	0	0	0	0
Hexagenia	4.7	0	0	0	0	0	0
Hexatoma	4.7	0	0	0	0	0	0
Hirudinea	3.0	0	0	0	2	0	0
Hydrobiidae	8.0	0	0	0	0	0	0
Hydrobiomorpha	5.0	0	0	0	0	0	0
Hydrobius	5.0	0	0	0	0	0	0
Hydrometra	NK	0	0	0	0	0	0
Hydroporus (A)	8.9	0	0	0	0	0	0
Hydropsyche	4.0	0	0	2	5	3	0
Hydroptila	6.2	0	0	0	0	0	0
Ischnura	9.4	0	0	0	0	0	0
Isonychia	2.0	22	12	26	22	32	20
Lepidostoma	3.0	0	0	0	0	0	0
Leptophlebia	6.4	0	0	0	0	0	0
Leptotarsus	3.0	0	0	0	0	0	0
Leucrocuta	1.0	0	0	0	0	0	0
Limonia	10.0	0	5	4	0	0	2
Lirceus	7.7	0	0	0	0	0	0
Lutrochus	2.9	0	0	1	0	0	0
Lymnaeidae	6.0	0	0	0	0	0	0
Macromia	6.7	0	0	0	0	0	0

Appendix M-3c. Taxa list for aquatic macroinvertebrates collected during Fall 2002, Strawberry River Watershed, Arkansas.

		Station ID					
Taxon Name	Tol. Value	UWNBC01 - B	WHI0143N - A	WHI0143N - B	WHI0143K - A	WHI0143K - B	WHI0143L-A
Macronychus	4.7	0	0	0	0	0	0
Macronychus (A)	4.7	0	0	0	0	0	0
Macrostemum	3.6	5	0	0	0	0	0
Mesovelia	NK	0	0	0	0	0	0
Microcylloepus	1.0	13	0	1	0	0	0
Microvelia	6.0	0	1	0	0	0	0
Molophilus	4.0	0	0	0	0	0	0
Neoelmis	4.0	0	0	0	0	0	0
Neoperla	1.6	0	0	0	0	0	0
Nigronia	2.0	0	0	0	0	1	0
Odontoceridae	0.0	0	0	0	0	0	0
Oligochaeta	10.0	0	0	0	0	0	0
Optioservus	2.7	0	0	0	63	6	0
Optioservus (A)	2.5	0	0	0	1	0	0
Oreodytes	5.0	0	0	0	0	0	0
Oreodytes (A)	5.0	0	0	0	0	0	0
Palaemonetes	4.0	0	0	0	0	0	0
Palpomyia	6.0	0	0	0	0	0	0
Paraleptophlebia	1.2	0	0	0	0	0	0
Peltodytes	8.5	0	0	0	0	0	0
Peltodytes (A)	8.5	0	0	0	0	0	0
Perlesta	4.9	0	0	0	0	0	0
Petrophila	2.5	0	0	0	1	1	0
Physa	4.0	0	0	0	0	0	0
Physidae	8.0	0	0	0	0	0	0
Pisidium	6.8	0	0	0	0	0	0
Planorbidae	7.0	2	0	0	0	0	0
Pleuroceridae	7.0	13	3	1	0	0	0
Polycentropus	3.5	0	2	0	0	0	0
Potamanthus	1.6	0	0	0	0	0	0
Prionocera	4.0	0	0	0	0	0	0
Probezzia	6.0	0	0	0	0	0	0
Procloeon	4.0	0	0	0	0	0	0
Progomphus	8.7	2	0	0	0	0	0
Prosimulium	2.6	0	0	0	0	0	0
Psephenus	2.0	6	7	5	6	1	0
Psephenus (A)	2.0	0	0	0	0	0	0
Pseudogoera	0.0	0	0	0	0	0	0
Pseudolimnophila	2.0	0	0	0	0	0	0
Psilotreta	0.0	0	0	0	0	0	2
Psychoda	10.0	0	0	0	0	0	0
Psychodidae	10.0	0	0	0	0	0	0
cylindrica	8.0	0	0	0	0	0	0
Ranatra	7.5	0	0	0	0	0	0
Rhagovelia	6.0	0	0	0	0	0	0
Rhyacophila	0.9	0	0	0	0	0	0
Scirtes	7.0	0	0	0	0	0	0
Serratella	0.6	0	0	0	4	1	0
Silvius	8.0	0	0	0	0	0	0
Simulium	4.4	1	0	2	0	5	0
Simulium (P)	4.4	0	0	0	0	1	0

Appendix M-3c. Taxa list for aquatic macroinvertebrates collected during Fall 2002, Strawberry River Watershed, Arkansas.

		Station ID					
Taxon Name	Tol. Value	UWNBC01 - B	WHI0143N - A	WHI0143N - B	WHI0143K - A	WHI0143K - B	WHI0143L-A
Sphaeriidae	3.0	0	0	0	0	0	0
Sphaerium	7.7	0	0	0	0	0	0
Stenacron	3.1	0	0	0	1	0	1
Stenelmis	5.4	4	0	1	3	1	1
Stenelmis (A)	5.0	3	0	0	0	0	0
Stenonema	3.3	14	53	46	25	27	55
Stratiomyidae	NK	0	0	0	0	0	0
Strophopteryx	2.5	0	1	0	0	0	0
Stylurus	5.0	0	0	0	0	0	0
Tabanidae	8.0	0	0	0	0	0	0
Tabanus	9.7	0	0	0	1	0	0
Thermonectus	3.0	0	0	0	0	0	0
Tipula	7.7	0	0	0	0	0	0
Tipulidae	3.0	0	0	0	0	0	0
Trepobates	10.0	0	0	0	0	0	0
Trichoptera	NK	0	0	0	0	0	0
Tricorythodes	5.4	0	3	14	0	0	37
Tropisternus	9.8	0	0	0	0	0	0
Tropisternus (A)	9.8	0	0	0	0	0	0
Uvarus	5.0	0	0	0	0	0	0
Viviparidae	4.0	0	0	0	4	0	0
Wormaldia	0.4	0	0	0	0	0	0
Total	NA	95	167	199	195	148	169

Appendix M-3c. Taxa list for aquatic macroinvertebrates collected during Fall 2002, Strawberry River Watershed, Arkansas.

		Station ID							
Taxon Name	Tol. Value	WHI0143L-B	WHI0143M-A	WHI0143M-B	WHI0143J	UWRDC01	WHI0143S	WHI0143Q	WHI0143R
Acroneuria	0.0	0	0	0	0	0	0	0	0
Agabus	5.0	0	0	0	0	0	0	0	0
Agapetus	0.0	0	0	0	0	1	0	0	0
Amphiagrion	5.0	0	0	0	0	0	0	0	0
Amphinemura	3.4	0	0	0	0	0	0	0	0
Ancylidae	6.0	0	0	0	0	0	1	0	0
Ancyronyx	6.9	0	0	0	0	0	0	0	0
Ancyronyx (A)	6.9	0	0	0	0	0	1	0	0
Apatolestes	8.0	0	0	0	0	0	0	0	0
Argia	5.1	0	0	0	0	0	0	7	1
Arigomphus	5.0	0	0	0	0	0	0	0	0
Atherix	2.0	0	2	1	0	0	0	0	0
Baetis	3.1	0	0	1	2	2	0	1	2
Baetis #2	3.1	0	0	0	0	0	0	0	0
Baetisca	4.0	0	0	0	0	0	0	0	0
Basiaeschna	7.7	0	0	0	2	1	0	2	0
Belostoma	9.8	0	0	0	2	0	0	0	1
Berosus	8.6	0	0	0	0	0	0	0	0
Boyeria	6.3	0	0	0	0	0	2	0	0
Brachycentrus	2.2	0	0	0	0	0	0	0	0
Brachyprema	3.0	0	0	0	0	0	0	0	0
Caecidotea	6.0	0	0	0	0	0	0	0	0
Caenis	7.6	0	0	0	0	0	2	0	10
Calopteryx	8.3	0	0	0	0	4	0	3	2
Cambarinae	6.0	1	1	1	0	0	2	0	2
Carabidae	4.0	0	0	0	0	0	0	0	0
Ceratopsyche	3.0	0	0	0	0	0	0	0	0
Chaoborus	8.5	0	0	0	0	0	0	2	0
Cheumatopsyche	6.6	14	8	11	0	0	0	0	1
Chimarra	2.8	1	0	2	0	0	0	0	0
Chironomidae	6.0	5	2	15	45	42	36	13	29
Chironomidae (P)	6.0	0	0	0	1	2	3	2	0
Chlorotabanus	8.0	0	0	0	0	0	0	0	0
Chrysops	7.3	0	0	0	1	0	0	0	0
Cnephia	4.0	0	0	0	0	0	0	0	0
Corbicula	6.3	0	1	0	7	13	0	0	0
Corixidae	9.0	0	0	0	0	0	0	0	0
Corydalus	5.6	3	2	7	0	0	0	0	0
Culicoides	10.0	0	0	0	0	0	0	0	0
Cybister	5.0	0	0	0	0	0	0	0	1
Cyrnellus	7.4	0	0	0	0	0	0	0	0
Dasyhelea	5.7	0	0	0	0	0	0	0	0
Dasyhelea (P)	5.7	0	0	0	0	0	0	0	0
Dicranota	4.0	0	0	0	0	0	0	0	0
Dineutus	5.5	0	0	0	0	3	0	0	0
Dineutus (A)	5.5	0	0	0	0	0	1	0	0
Diptera	7.0	0	0	0	0	0	0	0	0
Diptera (P)	7.0	0	0	0	0	0	0	0	0
Dixella	1.0	0	0	0	0	0	0	0	0
Dolichopodidae	9.7	0	0	0	0	0	0	0	0
Dromogomphus	6.3	0	3	0	0	1	0	0	3

Appendix M-3c. Taxa list for aquatic macroinvertebrates collected during Fall 2002, Strawberry River Watershed, Arkansas.

		Station ID							
Taxon Name	Tol. Value	WHI0143L-B	WHI0143M-A	WHI0143M-B	WHI0143J	UWRDC01	WHI0143S	WHI0143Q	WHI0143R
Drunella	1.0	0	0	0	0	0	0	0	0
Dubiraphia	6.4	0	0	1	15	4	5	6	6
Dubiraphia (A)	6.4	0	1	0	0	0	0	0	0
Dytiscus	5.0	0	0	0	0	0	1	0	0
Ectopria	4.0	0	0	0	0	0	0	0	0
Empididae	8.1	0	0	0	0	0	0	0	0
Enallagma	9.0	0	2	0	18	3	6	0	0
Ephemerella	2.9	0	0	0	0	0	0	0	0
Ephoron	2.0	0	0	0	0	0	0	0	0
Ephydridae	6.0	0	0	0	0	0	0	0	0
Epiaeschna heros	7.1	0	0	0	0	0	0	0	0
Erpetogomphus	4.0	0	0	0	0	0	0	0	0
Eurylophella	2.1	0	0	0	0	0	0	0	0
Ferrissia	6.9	0	0	0	0	0	0	0	0
Forcipomyia	6.0	0	0	0	0	0	0	0	0
Gammarus	6.9	0	0	0	0	2	3	9	3
Gerris	5.0	0	0	0	0	0	0	0	1
Gomphus	4.9	2	0	0	0	0	0	0	0
Gomphurus	6.2	0	0	0	0	0	0	0	0
Gumaga	NK	0	0	0	0	0	0	0	0
Gyretes	5.0	0	0	0	1	0	0	0	0
Gyrinidae	5.0	0	0	0	0	0	0	0	0
Gyrinus	6.3	0	0	0	0	1	0	0	0
Hagenius	4.0	1	0	0	0	0	0	0	0
Helicopsyche	3.0	0	0	0	0	0	0	0	0
Hemerodromia	6.0	0	0	0	0	0	0	0	0
Hemerodromia (P)	6.0	0	0	0	0	0	0	0	0
Heptagenia	2.8	0	0	0	0	0	0	0	0
Heptageniidae	4.0	0	0	0	0	0	0	0	0
Hetaerina	6.2	0	0	0	5	1	0	0	0
Hexagenia	4.7	0	0	0	2	1	0	0	0
Hexatoma	4.7	0	0	0	0	0	1	0	0
Hirudinea	3.0	0	0	0	0	0	0	0	0
Hydrobiidae	8.0	0	0	0	0	0	2	1	0
Hydrobiomorpha	5.0	0	0	0	0	0	0	0	0
Hydrobius	5.0	0	0	0	0	0	0	0	0
Hydrometra	NK	0	0	0	0	0	0	0	0
Hydroporus (A)	8.9	0	0	0	0	0	0	0	0
Hydropsyche	4.0	0	0	1	0	0	0	0	0
Hydroptila	6.2	0	0	0	0	0	0	0	0
Ischnura	9.4	0	0	0	0	0	0	0	2
Isonychia	2.0	14	20	21	0	0	0	0	0
Lepidostoma	3.0	0	0	0	1	0	0	0	0
Leptophlebia	6.4	0	0	0	0	0	0	0	0
Leptotarsus	3.0	0	0	0	0	0	0	0	0
Leucrocuta	1.0	0	0	0	0	0	0	0	0
Limonia	10.0	1	1	0	0	0	1	0	0
Lirceus	7.7	0	0	0	0	0	2	49	31
Lutrochus	2.9	0	0	0	0	0	0	0	0
Lymnaeidae	6.0	0	0	0	0	0	0	0	0
Macromia	6.7	0	0	0	5	5	1	1	1

Appendix M-3c. Taxa list for aquatic macroinvertebrates collected during Fall 2002, Strawberry River Watershed, Arkansas.

		Station ID							
Taxon Name	Tol. Value	WHI0143L-B	WHI0143M-A	WHI0143M-B	WHI0143J	UWRDC01	WHI0143S	WHI0143Q	WHI0143R
Macronychus	4.7	0	0	0	1	0	0	0	0
Macronychus (A)	4.7	0	0	0	1	0	1	0	0
Macrostemum	3.6	0	0	0	0	0	0	0	0
Mesovelia	NK	0	0	0	0	0	0	0	0
Microcylloepus	1.0	0	0	0	0	0	0	0	0
Microvelia	6.0	0	0	0	0	0	0	0	0
Molophilus	4.0	0	0	0	0	0	0	0	0
Neoelmis	4.0	0	0	0	0	0	0	0	0
Neoperla	1.6	0	0	0	0	0	0	0	0
Nigronia	2.0	0	0	0	0	0	0	0	0
Odontoceridae	0.0	0	0	0	0	0	0	0	0
Oligochaeta	10.0	0	0	0	1	0	0	0	3
Optioservus	2.7	1	0	0	0	0	0	0	0
Optioservus (A)	2.5	0	0	0	0	0	0	0	0
Oreodytes	5.0	0	0	0	0	0	0	1	0
Oreodytes (A)	5.0	0	0	0	0	0	0	0	0
Palaemonetes	4.0	0	0	0	0	0	0	0	0
Palpomyia	6.0	0	0	0	0	0	1	0	0
Paraleptophlebia	1.2	0	0	0	0	0	0	0	0
Peltodytes	8.5	0	0	0	0	0	0	0	2
Peltodytes (A)	8.5	0	0	0	0	0	0	0	0
Perlesta	4.9	0	0	0	0	0	0	0	0
Petrophila	2.5	0	1	0	0	0	0	0	0
Physa	4.0	0	0	0	0	3	0	0	1
Physidae	8.0	0	0	0	0	0	0	0	0
Pisidium	6.8	0	0	0	0	0	0	0	0
Planorbidae	7.0	0	0	0	0	0	0	1	0
Pleuroceridae	7.0	0	1	0	10	11	11	0	0
Polycentropus	3.5	0	0	0	2	1	0	0	0
Potamanthus	1.6	0	1	0	0	0	0	0	0
Prionocera	4.0	0	0	0	0	0	0	0	0
Probezzia	6.0	0	0	0	0	0	0	0	0
Procloeon	4.0	0	0	0	0	0	0	0	0
Progomphus	8.7	0	0	0	0	0	1	1	0
Prosimulium	2.6	0	0	0	0	0	0	0	0
Psephenus	2.0	1	10	0	0	0	0	0	0
Psephenus (A)	2.0	0	0	0	0	0	0	0	0
Pseudogoera	0.0	0	0	0	0	0	0	1	0
Pseudolimnophila	2.0	0	0	0	0	0	0	0	0
Psilotreta	0.0	0	0	0	0	0	0	0	0
Psychoda	10.0	0	0	0	0	0	0	0	0
Psychodidae	10.0	0	0	0	0	0	0	0	0
cylindrica	8.0	0	0	0	0	0	0	0	0
Ranatra	7.5	0	0	0	0	0	0	0	1
Rhagovelia	6.0	0	0	0	0	0	0	0	0
Rhyacophila	0.9	0	0	0	0	0	0	0	0
Scirtes	7.0	0	0	0	1	0	0	3	0
Serratella	0.6	0	0	0	0	0	0	0	0
Silvius	8.0	0	1	0	0	0	0	0	0
Simulium	4.4	1	2	1	0	0	0	0	0
Simulium (P)	4.4	0	0	0	0	0	0	0	0

Appendix M-3c. Taxa list for aquatic macroinvertebrates collected during Fall 2002, Strawberry River Watershed, Arkansas.

		Station ID							
Taxon Name	Tol. Value	WHI0143L-B	WHI0143M-A	WHI0143M-B	WHI0143J	UWRDC01	WHI0143S	WHI0143Q	WHI0143R
Sphaeriidae	3.0	0	0	0	0	0	0	0	0
Sphaerium	7.7	1	0	0	1	1	3	0	0
Stenacron	3.1	0	0	0	0	2	2	3	1
Stenelmis	5.4	0	1	1	1	0	4	1	0
Stenelmis (A)	5.0	0	1	0	0	0	4	3	0
Stenonema	3.3	27	85	39	2	2	0	0	0
Stratiomyidae	NK	0	0	0	0	0	0	0	0
Strophopteryx	2.5	0	0	0	0	0	0	0	0
Stylurus	5.0	0	0	0	0	0	0	0	0
Tabanidae	8.0	0	0	0	0	0	0	0	0
Tabanus	9.7	1	0	0	0	0	1	0	0
Thermonectus	3.0	0	0	0	0	0	0	0	0
Tipula	7.7	0	0	0	0	0	1	0	0
Tipulidae	3.0	0	0	0	0	0	0	0	0
Trepobates	10.0	0	0	0	0	0	0	0	0
Trichoptera	NK	0	0	0	0	0	0	0	0
Tricorythodes	5.4	90	45	10	1	1	0	1	0
Tropisternus	9.8	0	0	0	0	0	0	0	0
Tropisternus (A)	9.8	0	0	0	0	0	0	0	0
Uvarus	5.0	0	0	0	0	0	0	0	0
Viviparidae	4.0	0	0	0	1	0	0	0	0
Wormaldia	0.4	0	0	0	0	0	0	0	0
Total	NA	164	191	112	129	107	99	111	104

Appendix M-3d. Taxa list for aquatic macroinvertebrates collected during Spring 2003, Strawberry River Watershed, Arkansas.

		Station ID								
Taxon Name	Tol. Value	WHI0143A-A	WHI0143A-B	UWSBR01-A	UWSBR01-B	WHI0143B - A	WHI0143B - B	UWSBR02 - A	UWSBR02 - B	WHI0143P
Acroneuria	0.0	0	0	0	0	0	0	0	0	0
Agabus	5.0	0	0	0	0	0	0	0	0	0
Agapetus	0.0	0	0	0	0	0	1	0	0	0
Amphiagrion	5.0	0	0	0	0	0	0	0	0	0
Amphinemura	3.4	9	0	1	1	0	2	0	0	0
Ancylidae	6.0	0	0	0	0	0	0	0	0	0
Ancyronyx	6.9	0	0	0	0	0	0	0	0	0
Ancyronyx (A)	6.9	0	0	0	0	0	0	0	0	0
Apatolestes	8.0	0	0	0	0	0	0	0	0	0
Argia	5.1	0	0	0	0	2	0	0	0	0
Arigomphus	5.0	0	0	0	0	0	0	0	0	0
Atherix	2.0	0	0	0	0	0	0	1	0	0
Baetis	3.1	17	5	23	25	1	4	2	2	1
Baetis #2	3.1	0	0	0	0	0	0	0	0	0
Baetisca	4.0	0	0	1	0	0	0	0	0	0
Basiaeschna	7.7	0	0	0	0	0	0	0	0	0
Belostoma	9.8	0	0	0	0	0	0	0	0	0
Berosus	8.6	0	0	0	0	0	0	0	0	0
Boyeria	6.3	0	0	0	0	0	0	0	0	0
Brachycentrus	2.2	0	0	0	0	0	0	0	0	0
Brachyprema	3.0	0	0	0	0	0	0	0	0	0
Caecidotea	6.0	0	0	0	0	0	0	0	0	0
Caenis	7.6	22	24	10	1	16	2	1	0	0
Calopteryx	8.3	0	0	0	0	0	0	0	0	0
Cambarinae	6.0	0	0	0	0	0	0	0	1	0
Carabidae	4.0	0	0	0	0	0	0	0	0	0
Ceratopsyche	3.0	0	0	0	0	0	0	0	0	0
Chaoborus	8.5	0	0	0	0	0	0	0	0	0
Cheumatopsyche	6.6	0	0	0	1	3	2	3	5	7
Chimarra	2.8	2	0	0	1	2	2	0	0	0
Chironomidae	6.0	1	31	5	1	9	31	19	5	14
Chironomidae (P)	6.0	3	1	2	1	0	0	1	1	1
Chlorotabanus	8.0	0	0	0	0	0	0	0	0	0
Chrysops	7.3	0	0	1	0	0	0	0	0	0
Cnephia	4.0	0	0	3	1	0	0	0	0	0
Corbicula	6.3	0	1	1	1	4	1	0	0	1
Corixidae	9.0	0	0	0	0	0	0	0	0	0
Corydalus	5.6	0	0	1	0	0	1	1	1	1
Culicoides	10.0	0	0	0	0	0	0	0	0	0
Cybister	5.0	0	0	0	0	0	0	0	0	0
Cyrnellus	7.4	0	0	0	0	0	0	0	0	0
Dasyhelea	5.7	0	0	0	0	0	0	0	0	0
Dasyhelea (P)	5.7	0	0	0	0	0	0	0	0	0
Dicranota	4.0	0	0	0	0	0	0	0	0	0
Dineutus	5.5	0	0	0	0	0	0	0	0	1
Dineutus (A)	5.5	0	0	0	0	0	0	0	0	0
Diptera	7.0	0	0	0	0	0	0	0	0	0
Diptera (P)	7.0	0	0	0	0	0	0	0	0	0
Dixella	1.0	0	0	0	0	0	0	0	0	0
Dolichopodidae	9.7	0	0	0	0	0	0	0	0	0
Dromogomphus	6.3	0	0	0	0	0	0	0	0	1

Appendix M-3d. Taxa list for aquatic macroinvertebrates collected during Spring 2003, Strawberry River Watershed, Arkansas.

		Station ID								
Taxon Name	Tol. Value	WHI0143A-A	WHI0143A-B	UWSBR01-A	UWSBR01-B	WHI0143B - A	WHI0143B - B	UWSBR02 - A	UWSBR02 - B	WHI0143P
Drunella	1.0	0	0	0	0	0	0	0	1	0
Dubiraphia	6.4	1	0	0	0	1	0	0	0	0
Dubiraphia (A)	6.4	2	0	0	0	0	0	0	0	0
Dytiscus	5.0	0	0	0	0	0	0	0	0	0
Ectopria	4.0	0	0	0	0	0	0	0	0	0
Empididae	8.1	0	0	0	0	0	0	0	0	0
Enallagma	9.0	0	0	0	0	0	0	0	0	1
Ephemerella	2.9	0	0	1	1	1	5	0	0	0
Ephoron	2.0	0	0	0	0	0	0	0	3	3
Ephydridae	6.0	0	0	0	0	0	0	0	0	0
Epiaeschna heros	7.1	0	0	0	0	0	0	0	0	0
Erpetogomphus	4.0	0	0	0	0	0	0	0	0	0
Eurylophella	2.1	0	0	0	0	0	0	0	0	0
Ferrissia	6.9	0	1	0	0	0	0	0	0	0
Forcipomyia	6.0	0	0	0	0	0	0	0	0	0
Gammarus	6.9	0	0	0	0	0	0	0	0	0
Gerris	5.0	0	0	0	0	0	0	0	0	0
Gomphus	4.9	0	0	0	0	0	0	0	0	0
Gomphurus	6.2	0	0	0	0	0	0	0	0	0
Gumaga	NK	0	0	0	0	0	0	0	0	0
Gyretes	5.0	0	0	0	0	0	0	0	0	0
Gyrinidae	5.0	0	0	0	0	0	0	0	0	0
Gyrinus	6.3	0	0	0	0	0	0	0	0	0
Hagenius	4.0	0	0	0	0	0	0	0	1	0
Helicopsyche	3.0	0	0	0	0	0	0	0	1	1
Hemerodromia	6.0	0	0	0	0	0	0	0	0	0
Hemerodromia (P)	6.0	0	0	0	0	1	4	0	0	0
Heptagenia	2.8	1	0	3	0	0	0	0	0	0
Heptageniidae	4.0	0	0	0	0	0	0	0	0	0
Hetaerina	6.2	0	0	0	0	0	0	0	0	0
Hexagenia	4.7	0	0	0	0	0	0	0	0	0
Hexatoma	4.7	0	0	0	0	0	0	0	0	0
Hirudinea	3.0	0	1	0	0	0	0	0	0	0
Hydrobiidae	8.0	1	0	0	0	0	0	1	0	0
Hydrobiomorpha	5.0	0	0	0	0	0	0	0	0	0
Hydrobius	5.0	0	0	0	1	0	0	0	0	0
Hydrometra	NK	0	0	0	0	0	0	0	0	0
Hydroporus (A)	8.9	0	0	0	0	0	0	0	0	0
Hydropsyche	4.0	0	0	0	0	0	0	0	0	0
Hydroptila	6.2	0	0	0	0	0	0	0	0	0
Ischnura	9.4	0	0	0	0	0	0	0	0	0
Isonychia	2.0	0	0	0	2	1	4	7	6	6
Lepidostoma	3.0	0	0	0	0	0	0	0	0	0
Leptophlebia	6.4	0	0	0	0	0	0	0	0	0
Leptotarsus	3.0	0	0	0	0	0	0	0	0	0
Leucrocuta	1.0	0	0	0	2	1	0	1	9	5
Limonia	10.0	0	0	0	0	0	0	0	0	0
Lirceus	7.7	0	0	0	0	0	0	0	0	0
Lutrochus	2.9	0	0	0	0	1	0	0	0	1
Lymnaeidae	6.0	0	0	0	0	0	0	0	0	0
Macromia	6.7	0	0	0	0	0	0	0	0	0
Macronychus	4.7	0	0	0	0	0	0	0	0	0

Appendix M-3d. Taxa list for aquatic macroinvertebrates collected during Spring 2003, Strawberry River Watershed, Arkansas.

		Station ID								
Taxon Name	Tol. Value	WHI0143A-A	WHI0143A-B	UWSBR01-A	UWSBR01-B	WHI0143B - A	WHI0143B - B	UWSBR02 - A	UWSBR02 - B	WHI0143P
Macronychus (A)	4.7	0	0	0	0	0	0	0	0	0
Macrostemum	3.6	0	0	0	0	0	0	0	0	0
Mesovelia	NK	0	0	0	0	0	0	0	0	0
Microcylloepus	1.0	0	0	0	0	0	0	0	0	0
Microvelia	6.0	0	0	0	0	0	0	0	0	0
Molophilus	4.0	0	0	0	0	0	0	0	0	0
Neoelmis	4.0	0	0	0	0	0	0	0	0	0
Neoperla	1.6	0	0	0	0	0	0	2	0	0
Nigronia	2.0	0	0	0	0	0	0	0	0	0
Odontoceridae	0.0	0	0	0	0	0	0	0	0	0
Oligochaeta	10.0	0	0	1	0	0	1	0	1	3
Optioservus	2.7	0	0	0	0	0	0	0	0	0
Optioservus (A)	2.5	0	0	0	0	0	0	0	0	0
Oreodytes	5.0	0	0	0	0	0	0	0	0	0
Oreodytes (A)	5.0	0	0	0	0	0	0	0	0	0
Palaemonetes	4.0	0	0	0	0	0	0	0	0	0
Palpomyia	6.0	0	0	0	0	0	0	0	0	2
Paraleptophlebia	1.2	4	2	0	2	1	1	0	0	0
Peltodytes	8.5	0	0	0	0	0	0	0	0	0
Peltodytes (A)	8.5	0	0	0	0	0	0	0	0	0
Perlesta	4.9	71	38	30	30	11	11	8	13	5
Petrophila	2.5	0	0	0	0	0	0	0	0	0
Physa	4.0	0	0	0	0	0	0	0	0	0
Physidae	8.0	0	0	0	0	0	0	0	0	0
Pisidium	6.8	0	0	0	0	0	0	0	0	0
Planorbidae	7.0	0	0	0	0	1	0	0	0	0
Pleuroceridae	7.0	0	0	0	0	6	4	4	2	0
Polycentropus	3.5	0	0	0	0	0	0	0	0	0
Potamanthus	1.6	0	0	0	0	0	0	0	0	1
Prionocera	4.0	0	0	0	0	0	0	0	0	0
Probezzia	6.0	0	5	10	3	1	0	0	0	0
Procloeon	4.0	0	0	3	5	0	0	0	0	0
Progomphus	8.7	0	0	0	0	0	0	0	0	0
Prosimulium	2.6	0	0	0	0	0	0	0	0	0
Psephenus	2.0	0	0	0	0	0	0	0	0	0
Psephenus (A)	2.0	0	0	0	0	0	0	0	0	0
Pseudogoera	0.0	0	0	0	0	0	0	0	0	0
Pseudolimnophila	2.0	0	0	0	0	0	0	0	0	0
Psilotreta	0.0	0	0	0	0	0	0	0	0	0
Psychoda	10.0	0	0	0	0	0	0	0	0	0
Psychodidae	10.0	0	0	0	0	0	0	0	0	0
cylindrica	8.0	0	0	0	0	0	0	0	0	0
Ranatra	7.5	0	0	0	0	0	0	0	0	0
Rhagovelia	6.0	0	0	0	0	0	0	0	0	0
Rhyacophila	0.9	1	0	1	1	0	0	0	0	0
Scirtes	7.0	0	0	0	0	0	0	0	0	0
Serratella	0.6	0	0	2	1	6	6	4	4	1
Silvius	8.0	0	0	0	0	0	0	0	0	0
Simulium	4.4	5	0	0	0	8	21	6	2	5
Simulium (P)	4.4	0	0	0	0	0	0	0	0	0
Sphaeriidae	3.0	0	0	0	0	0	0	0	0	0
Sphaerium	7.7	0	0	1	0	2	0	0	0	11

Appendix M-3d. Taxa list for aquatic macroinvertebrates collected during Spring 2003, Strawberry River Watershed, Arkansas.

		Station ID								
Taxon Name	Tol. Value	WHI0143A-A	WHI0143A-B	UWSBR01-A	UWSBR01-B	WHI0143B - A	WHI0143B - B	UWSBR02 - A	UWSBR02 - B	WHI0143P
Stenacron	3.1	0	0	0	0	3	0	0	0	0
Stenelmis	5.4	24	2	3	0	6	4	10	10	22
Stenelmis (A)	5.0	1	1	0	0	3	0	4	3	3
Stenonema	3.3	0	1	1	3	16	8	3	9	14
Stratiomyidae	NK	0	0	0	0	0	0	0	0	0
Strophopteryx	2.5	1	1	2	1	0	0	0	0	0
Stylurus	5.0	0	0	0	0	0	0	0	0	0
Tabanidae	8.0	0	0	0	0	0	0	0	0	0
Tabanus	9.7	1	0	0	0	0	0	0	0	1
Thermonectus	3.0	0	0	0	0	0	0	0	0	0
Tipula	7.7	3	0	2	0	0	1	1	0	0
Tipulidae	3.0	0	0	0	0	0	0	0	0	0
Trepobates	10.0	0	0	0	0	0	0	0	0	0
Trichoptera	NK	0	0	0	0	0	0	0	0	0
Tricorythodes	5.4	0	0	4	3	35	17	1	1	7
Tropisternus	9.8	0	0	0	0	0	0	0	0	0
Tropisternus (A)	9.8	0	0	0	0	0	0	0	0	0
Uvarus	5.0	0	0	0	0	0	0	0	0	0
Viviparidae	4.0	0	0	0	0	6	4	9	5	1
Wormaldia	0.4	1	0	3	7	0	1	0	0	0
Total	NA	171	114	115	95	148	138	89	86	120

Appendix M-3d. Taxa list for aquatic macroinvertebrates collected during Spring 2003, Strawberry River Watershed, Arkansas.

		Station ID								
Taxon Name	Tol. Value	WHI0143E-A	WHI0143E-B	WHI0143H-A	WHI0143H-B	UWNBC01 - A	UWNBC01 - B	WHI0143N - A	WHI0143N - B	WHI0143K - A
Acroneuria	0.0	0	0	0	0	0	0	0	0	0
Agabus	5.0	0	0	0	0	0	0	0	0	0
Agapetus	0.0	0	0	1	1	0	0	0	0	0
Amphiagrion	5.0	0	0	0	0	0	0	0	0	0
Amphinemura	3.4	2	2	3	5	2	2	1	2	0
Ancylidae	6.0	0	0	0	0	0	0	0	0	0
Ancyronyx	6.9	0	0	0	0	0	0	0	0	0
Ancyronyx (A)	6.9	0	0	0	0	0	0	0	0	0
Apatolestes	8.0	0	0	0	0	0	0	0	0	0
Argia	5.1	0	0	0	0	0	0	0	0	0
Arigomphus	5.0	0	0	0	0	0	0	0	0	0
Atherix	2.0	0	0	0	0	0	0	0	0	0
Baetis	3.1	5	13	8	6	9	11	2	3	24
Baetis #2	3.1	0	0	0	0	0	0	0	0	0
Baetisca	4.0	0	0	0	0	0	0	0	0	0
Basiaeschna	7.7	0	0	0	0	0	0	0	0	0
Belostoma	9.8	0	0	0	0	0	0	0	0	0
Berosus	8.6	0	0	0	0	0	0	0	0	0
Boyeria	6.3	0	0	0	0	0	0	0	0	0
Brachycentrus	2.2	0	0	0	0	0	0	0	0	0
Brachyprema	3.0	0	0	0	0	0	0	0	0	0
Caecidotea	6.0	0	0	0	0	0	0	0	0	0
Caenis	7.6	0	4	37	13	1	1	8	2	0
Calopteryx	8.3	0	0	0	0	0	0	0	0	0
Cambarinae	6.0	1	1	1	1	0	1	1	0	4
Carabidae	4.0	0	0	0	0	0	0	0	0	0
Ceratopsyche	3.0	0	0	0	0	0	0	0	0	0
Chaoborus	8.5	0	0	0	0	0	0	0	0	0
Cheumatopsyche	6.6	0	1	1	0	3	2	0	0	63
Chimarra	2.8	2	0	1	1	0	0	1	1	23
Chironomidae	6.0	2	5	4	3	12	4	12	15	2
Chironomidae (P)	6.0	0	0	0	1	1	1	4	1	0
Chlorotabanus	8.0	0	0	0	0	0	0	0	0	0
Chrysops	7.3	0	0	0	0	0	0	0	0	0
Cnephia	4.0	0	0	0	0	0	0	0	0	0
Corbicula	6.3	0	0	0	1	0	2	0	0	0
Corixidae	9.0	0	0	0	0	0	0	0	0	0
Corydalus	5.6	0	0	1	1	2	4	0	0	1
Culicoides	10.0	0	0	0	0	0	0	0	0	0
Cybister	5.0	0	0	0	0	0	0	0	0	0
Cyrnellus	7.4	0	0	0	0	0	0	0	0	0
Dasyhelea	5.7	0	0	0	0	0	0	0	0	0
Dasyhelea (P)	5.7	0	0	0	0	0	0	0	0	0
Dicranota	4.0	0	0	0	0	0	0	0	0	0
Dineutus	5.5	0	0	0	0	0	0	0	0	1
Dineutus (A)	5.5	0	0	0	0	0	0	0	0	0
Diptera	7.0	0	0	0	0	0	0	0	0	0
Diptera (P)	7.0	0	0	0	0	0	0	0	0	0
Dixella	1.0	0	0	0	0	0	0	0	0	0
Dolichopodidae	9.7	0	0	0	0	0	0	0	0	0
Dromogomphus	6.3	0	0	0	0	0	1	0	0	0

Appendix M-3d. Taxa list for aquatic macroinvertebrates collected during Spring 2003, Strawberry River Watershed, Arkansas.

		Station ID								
Taxon Name	Tol. Value	WHI0143E-A	WHI0143E-B	WHI0143H-A	WHI0143H-B	UWNBC01 - A	UWNBC01 - B	WHI0143N - A	WHI0143N - B	WHI0143K - A
Drunella	1.0	0	0	2	0	0	0	0	0	0
Dubiraphia	6.4	0	0	0	0	0	0	0	0	0
Dubiraphia (A)	6.4	0	0	0	0	0	0	0	0	0
Dytiscus	5.0	0	0	0	0	0	0	0	0	0
Ectopria	4.0	0	0	0	0	0	0	0	0	0
Empididae	8.1	1	0	1	0	0	0	0	0	0
Enallagma	9.0	0	0	0	0	2	0	0	0	0
Ephemerella	2.9	0	0	0	2	3	9	2	0	0
Ephoron	2.0	0	0	0	0	0	0	0	0	0
Ephydridae	6.0	0	0	0	0	0	0	0	0	0
Epiaeschna heros	7.1	0	0	0	0	0	0	0	0	0
Erpetogomphus	4.0	0	0	0	0	0	0	0	0	0
Eurylophella	2.1	0	0	0	0	0	0	0	0	0
Ferrissia	6.9	0	0	0	0	0	0	1	0	0
Forcipomyia	6.0	0	0	0	0	0	0	0	0	0
Gammarus	6.9	0	0	0	0	0	0	0	0	0
Gerris	5.0	0	0	0	0	0	0	0	0	0
Gomphus	4.9	0	0	0	0	0	0	0	0	0
Gomphurus	6.2	1	0	2	0	0	0	0	0	0
Gumaga	NK	0	0	0	0	0	0	0	0	1
Gyretes	5.0	0	0	0	0	0	0	0	0	0
Gyrinidae	5.0	0	0	0	0	0	0	0	0	0
Gyrinus	6.3	0	0	0	0	0	0	0	0	0
Hagenius	4.0	0	0	0	0	0	0	0	0	0
Helicopsyche	3.0	0	0	0	0	0	3	1	0	4
Hemerodromia	6.0	0	0	0	0	1	0	0	1	0
Hemerodromia (P)	6.0	0	1	0	0	5	1	0	2	0
Heptagenia	2.8	0	0	0	0	0	1	1	13	0
Heptageniidae	4.0	0	0	0	0	0	0	0	0	0
Hetaerina	6.2	0	0	0	0	0	0	0	0	0
Hexagenia	4.7	0	0	0	0	0	0	0	0	0
Hexatoma	4.7	0	0	0	0	0	0	0	0	0
Hirudinea	3.0	0	0	0	0	0	0	0	0	0
Hydrobiidae	8.0	0	0	0	0	0	0	0	0	0
Hydrobiomorpha	5.0	0	0	0	0	0	0	0	0	0
Hydrobius	5.0	0	0	0	0	0	0	0	0	0
Hydrometra	NK	0	0	0	0	0	0	0	0	0
Hydroporus (A)	8.9	0	0	0	0	0	0	0	0	0
Hydropsyche	4.0	0	0	0	0	0	0	0	0	9
Hydroptila	6.2	0	0	0	0	0	0	0	0	0
Ischnura	9.4	0	0	0	0	0	0	0	0	0
Isonychia	2.0	3	3	1	1	7	10	7	2	33
Lepidostoma	3.0	0	0	0	0	0	0	0	0	0
Leptophlebia	6.4	0	0	0	0	0	0	0	0	0
Leptotarsus	3.0	0	1	0	0	0	0	0	0	0
Leucrocuta	1.0	53	30	8	14	0	0	5	1	0
Limonia	10.0	0	0	0	0	0	0	0	0	0
Lirceus	7.7	0	0	0	0	0	0	0	0	0
Lutrochus	2.9	0	0	0	0	4	1	0	1	0
Lymnaeidae	6.0	0	0	0	1	0	0	0	0	0
Macromia	6.7	0	0	0	0	0	0	0	0	0
Macronychus	4.7	0	0	0	0	0	0	0	0	0

Appendix M-3d. Taxa list for aquatic macroinvertebrates collected during Spring 2003, Strawberry River Watershed, Arkansas.

		Station ID								
Taxon Name	Tol. Value	WHI0143E-A	WHI0143E-B	WHI0143H-A	WHI0143H-B	UWNBC01 - A	UWNBC01 - B	WHI0143N - A	WHI0143N - B	WHI0143K - A
Macronychus (A)	4.7	0	0	0	0	0	0	0	0	0
Macrostemum	3.6	0	0	0	0	0	1	0	0	8
Mesovelia	NK	0	0	0	0	0	0	0	0	0
Microcylloepus	1.0	0	0	0	0	2	17	0	1	0
Microvelia	6.0	0	0	0	0	0	0	0	0	0
Molophilus	4.0	0	0	0	0	0	0	0	0	0
Neoelmis	4.0	0	0	0	0	0	0	0	0	0
Neoperla	1.6	0	0	0	0	0	0	0	1	0
Nigronia	2.0	0	0	0	0	0	0	0	0	0
Odontoceridae	0.0	0	0	0	0	0	0	0	0	0
Oligochaeta	10.0	0	1	1	1	2	4	0	0	1
Optioservus	2.7	0	0	0	0	0	0	0	0	49
Optioservus (A)	2.5	0	0	0	0	0	0	0	0	2
Oreodytes	5.0	0	0	0	0	0	0	0	0	0
Oreodytes (A)	5.0	0	0	0	0	0	0	0	0	0
Palaemonetes	4.0	0	0	0	0	0	0	0	0	0
Palpomyia	6.0	0	0	0	0	0	0	0	0	0
Paraleptophlebia	1.2	0	0	0	1	0	0	0	1	0
Peltodytes	8.5	0	0	0	0	0	0	0	0	0
Peltodytes (A)	8.5	0	0	0	0	0	0	0	0	0
Perlesta	4.9	38	50	53	33	6	8	13	3	7
Petrophila	2.5	0	0	1	0	0	1	0	0	0
Physa	4.0	0	0	0	0	0	1	0	0	0
Physidae	8.0	0	0	0	0	0	0	0	0	0
Pisidium	6.8	0	0	0	0	0	0	0	0	0
Planorbidae	7.0	0	0	0	1	1	0	0	0	0
Pleuroceridae	7.0	0	0	1	1	0	0	0	0	0
Polycentropus	3.5	0	0	0	0	0	0	0	0	0
Potamanthus	1.6	0	0	0	0	0	0	0	0	0
Prionocera	4.0	0	0	0	0	0	0	0	0	0
Probezzia	6.0	2	4	1	0	0	0	0	0	0
Procloeon	4.0	0	0	0	0	0	0	0	0	0
Progomphus	8.7	0	0	0	0	0	0	0	0	0
Prosimulium	2.6	0	0	0	0	0	0	0	0	0
Psephenus	2.0	0	0	1	0	0	2	5	1	4
Psephenus (A)	2.0	0	0	0	0	0	0	0	0	0
Pseudogoera	0.0	0	0	0	0	0	0	0	0	0
Pseudolimnophila	2.0	0	0	0	0	0	0	0	0	0
Psilotreta	0.0	0	0	0	0	0	0	0	0	0
Psychoda	10.0	0	0	0	0	0	0	0	0	0
Psychodidae	10.0	0	0	0	0	0	0	0	0	0
cylindrica	8.0	0	0	0	0	0	0	0	0	0
Ranatra	7.5	0	0	0	0	0	0	0	0	0
Rhagovelia	6.0	0	0	0	0	0	0	0	0	0
Rhyacophila	0.9	0	3	1	1	0	0	0	0	0
Scirtes	7.0	0	0	0	0	0	0	0	0	0
Serratella	0.6	17	17	10	2	1	2	0	0	19
Silvius	8.0	0	0	0	0	0	0	0	0	0
Simulium	4.4	0	0	1	3	2	1	0	3	0
Simulium (P)	4.4	0	0	0	0	0	0	0	0	0
Sphaeriidae	3.0	0	0	0	0	0	0	0	0	0
Sphaerium	7.7	0	0	1	1	1	2	0	0	0

Appendix M-3d. Taxa list for aquatic macroinvertebrates collected during Spring 2003, Strawberry River Watershed, Arkansas.

		Station ID								
Taxon Name	Tol. Value	WHI0143E-A	WHI0143E-B	WHI0143H-A	WHI0143H-B	UWNBC01 - A	UWNBC01 - B	WHI0143N - A	WHI0143N - B	WHI0143K - A
Stenacron	3.1	0	0	4	0	0	0	0	0	3
Stenelmis	5.4	1	4	6	1	7	9	0	0	9
Stenelmis (A)	5.0	0	2	0	0	3	3	3	0	3
Stenonema	3.3	8	9	19	1	27	26	38	27	78
Stratiomyidae	NK	0	0	0	0	0	0	0	0	0
Strophopteryx	2.5	6	5	1	0	0	0	3	1	0
Stylurus	5.0	0	0	0	0	0	0	0	0	0
Tabanidae	8.0	0	0	0	0	0	0	0	0	0
Tabanus	9.7	0	0	1	0	1	0	1	4	1
Thermonectus	3.0	0	0	0	0	0	0	0	0	0
Tipula	7.7	0	1	2	0	0	0	1	1	1
Tipulidae	3.0	0	0	0	0	1	0	0	0	0
Trepobates	10.0	0	0	0	0	0	0	0	0	0
Trichoptera	NK	0	0	0	0	0	0	0	0	0
Tricorythodes	5.4	1	0	0	0	34	43	8	17	1
Tropisternus	9.8	0	0	0	0	0	0	0	0	0
Tropisternus (A)	9.8	0	0	0	0	0	0	0	0	0
Uvarus	5.0	0	0	0	0	0	0	0	0	0
Viviparidae	4.0	0	0	1	5	11	52	1	0	9
Wormaldia	0.4	6	7	2	1	0	0	0	0	0
Total	NA	149	164	178	103	151	226	119	104	360

Appendix M-3d. Taxa list for aquatic macroinvertebrates collected during Spring 2003, Strawberry River Watershed, Arkansas.

		Station ID								
Taxon Name	Tol. Value	WHI0143K - B	WHI0143L-A	WHI0143M-A	WHI0143M-B	NBC WWTP	WHI0143I-A	WHI0143I-B	DSHWY354 - A	DSHWY354 - B
Acroneuria	0.0	0	0	0	0	1	0	0	1	1
Agabus	5.0	0	0	0	0	0	0	1	0	0
Agapetus	0.0	0	0	0	1	0	0	0	0	1
Amphiagrion	5.0	0	0	0	0	0	0	0	0	0
Amphinemura	3.4	0	1	2	0	0	1	1	2	4
Ancylidae	6.0	0	0	0	0	0	0	0	0	0
Ancyronyx	6.9	0	0	0	0	0	0	0	0	0
Ancyronyx (A)	6.9	0	0	0	0	0	0	0	0	0
Apatolestes	8.0	0	0	0	0	0	0	0	0	0
Argia	5.1	0	0	0	0	0	0	1	0	0
Arigomphus	5.0	0	0	0	0	0	0	0	0	0
Atherix	2.0	0	0	0	1	0	0	0	0	0
Baetis	3.1	18	4	34	21	2	1	4	25	27
Baetis #2	3.1	0	0	0	0	0	0	0	0	0
Baetisca	4.0	0	0	0	0	0	0	0	0	0
Basiaeschna	7.7	0	0	0	0	0	0	0	0	0
Belostoma	9.8	0	0	0	0	0	0	0	0	0
Berosus	8.6	0	0	0	0	0	3	1	0	0
Boyeria	6.3	0	0	0	0	0	0	0	0	0
Brachycentrus	2.2	0	0	0	0	0	0	0	0	0
Brachyprema	3.0	0	0	0	0	0	0	0	0	0
Caecidotea	6.0	0	0	0	0	0	0	0	0	0
Caenis	7.6	0	2	3	1	8	5	8	6	2
Calopteryx	8.3	0	0	0	0	0	0	0	0	0
Cambarinae	6.0	0	0	0	0	1	1	0	0	0
Carabidae	4.0	0	0	0	0	0	0	0	0	0
Ceratopsyche	3.0	0	0	0	0	0	0	0	0	0
Chaoborus	8.5	0	0	0	0	0	0	0	0	0
Cheumatopsyche	6.6	72	0	6	3	2	2	1	0	0
Chimarra	2.8	8	0	2	1	4	0	3	0	1
Chironomidae	6.0	7	2	26	3	10	8	9	11	13
Chironomidae (P)	6.0	0	2	1	0	1	1	1	2	1
Chlorotabanus	8.0	0	0	0	0	0	0	0	0	0
Chrysops	7.3	0	0	0	0	0	0	0	0	0
Cnephia	4.0	0	0	0	0	0	0	0	0	0
Corbicula	6.3	0	0	1	1	0	0	0	0	0
Corixidae	9.0	0	0	0	0	0	0	0	0	0
Corydalus	5.6	1	1	5	1	1	1	1	1	0
Culicoides	10.0	0	0	0	0	0	0	0	0	0
Cybister	5.0	0	0	0	0	0	0	0	0	0
Cyrnellus	7.4	0	0	0	0	0	1	0	0	0
Dasyhelea	5.7	0	0	0	0	0	0	0	0	0
Dasyhelea (P)	5.7	0	0	0	0	0	0	0	0	0
Dicranota	4.0	0	0	0	0	0	0	0	0	0
Dineutus	5.5	0	0	0	0	0	0	0	0	0
Dineutus (A)	5.5	0	0	0	0	0	0	0	0	0
Diptera	7.0	0	0	0	0	0	0	0	0	0
Diptera (P)	7.0	0	0	0	0	0	0	0	0	0
Dixella	1.0	0	0	0	0	0	0	0	0	0
Dolichopodidae	9.7	0	0	0	0	0	0	0	0	0
Dromogomphus	6.3	0	0	0	0	0	0	0	0	0

Appendix M-3d. Taxa list for aquatic macroinvertebrates collected during Spring 2003, Strawberry River Watershed, Arkansas.

		Station ID								
Taxon Name	Tol. Value	WHI0143K - B	WHI0143L-A	WHI0143M-A	WHI0143M-B	NBC WWTP	WHI0143I-A	WHI0143I-B	DSHWY354 - A	DSHWY354 - B
Drunella	1.0	0	4	2	0	0	0	0	0	0
Dubiraphia	6.4	0	0	3	2	0	0	0	0	0
Dubiraphia (A)	6.4	0	0	0	0	0	0	0	0	0
Dytiscus	5.0	0	0	0	0	0	0	0	0	0
Ectopria	4.0	0	0	1	0	1	1	0	0	0
Empididae	8.1	0	0	0	0	0	0	0	0	0
Enallagma	9.0	0	0	0	0	0	0	0	0	0
Ephemerella	2.9	0	0	0	0	0	0	0	1	0
Ephoron	2.0	0	0	0	0	0	0	0	0	0
Ephydridae	6.0	0	0	0	0	0	0	0	0	0
Epiaeschna heros	7.1	0	0	0	0	0	0	0	0	0
Erpetogomphus	4.0	0	0	0	0	0	0	0	0	0
Eurylophella	2.1	0	0	0	0	0	0	0	0	0
Ferrissia	6.9	0	0	0	1	0	0	0	0	0
Forcipomyia	6.0	0	0	0	0	0	0	0	0	0
Gammarus	6.9	0	0	0	0	0	0	0	0	0
Gerris	5.0	0	0	0	0	0	0	0	0	0
Gomphus	4.9	0	0	0	0	0	0	0	0	0
Gomphurus	6.2	0	0	0	0	0	0	0	0	2
Gumaga	NK	0	0	0	0	0	0	0	0	0
Gyretes	5.0	0	0	0	0	0	0	0	0	0
Gyrinidae	5.0	0	0	0	0	0	0	0	0	0
Gyrinus	6.3	0	0	0	0	0	0	0	0	0
Hagenius	4.0	0	0	0	0	0	0	0	0	0
Helicopsyche	3.0	2	0	2	0	0	0	1	1	0
Hemerodromia	6.0	0	0	0	0	0	0	0	0	0
Hemerodromia (P)	6.0	0	1	0	0	0	0	0	0	0
Heptagenia	2.8	0	0	0	0	0	0	0	6	19
Heptageniidae	4.0	0	0	0	0	0	0	0	0	0
Hetaerina	6.2	0	0	0	0	0	0	0	0	0
Hexagenia	4.7	0	0	0	0	0	0	0	0	0
Hexatoma	4.7	0	0	0	0	0	0	0	0	0
Hirudinea	3.0	0	0	0	0	0	1	0	0	0
Hydrobiidae	8.0	0	0	0	0	0	0	0	0	0
Hydrobiomorpha	5.0	0	0	0	0	0	0	0	0	0
Hydrobius	5.0	0	0	0	0	0	0	0	0	0
Hydrometra	NK	0	0	0	0	0	0	0	0	0
Hydroporus (A)	8.9	0	0	0	0	0	0	0	0	0
Hydropsyche	4.0	3	0	0	0	0	0	0	0	0
Hydroptila	6.2	0	0	0	0	0	0	0	0	0
Ischnura	9.4	0	0	0	0	0	0	0	0	0
Isonychia	2.0	22	4	30	9	3	2	3	6	2
Lepidostoma	3.0	0	0	0	0	0	0	0	0	0
Leptophlebia	6.4	0	0	1	0	0	0	0	0	0
Leptotarsus	3.0	0	0	0	0	0	0	0	0	0
Leucrocuta	1.0	0	0	0	0	0	1	5	11	11
Limonia	10.0	0	0	0	0	0	0	0	0	0
Lirceus	7.7	0	0	0	1	2	3	10	4	7
Lutrochus	2.9	0	0	0	0	0	0	0	0	0
Lymnaeidae	6.0	0	0	0	0	0	0	0	0	0
Macromia	6.7	0	0	0	0	0	0	0	0	0
Macronychus	4.7	0	0	0	0	0	0	0	0	0

Appendix M-3d. Taxa list for aquatic macroinvertebrates collected during Spring 2003, Strawberry River Watershed, Arkansas.

		Station ID								
Taxon Name	Tol. Value	WHI0143K - B	WHI0143L-A	WHI0143M-A	WHI0143M-B	NBC WWTP	WHI0143I-A	WHI0143I-B	DSHWY354 - A	DSHWY354 - B
Macronychus (A)	4.7	0	0	0	0	0	0	0	0	0
Macrostemum	3.6	0	0	0	0	0	0	0	0	0
Mesovelia	NK	0	0	0	0	0	0	0	0	0
Microcylloepus	1.0	0	0	0	0	0	2	14	0	2
Microvelia	6.0	0	0	0	0	0	0	0	0	0
Molophilus	4.0	0	0	0	0	0	0	0	0	0
Neoelmis	4.0	0	0	0	0	0	0	0	0	0
Neoperla	1.6	0	0	0	0	0	0	0	0	0
Nigronia	2.0	0	0	0	0	0	0	0	0	0
Odontoceridae	0.0	0	0	0	0	0	0	0	0	0
Oligochaeta	10.0	1	0	0	0	0	0	0	0	0
Optioservus	2.7	9	0	9	1	0	0	0	0	0
Optioservus (A)	2.5	0	0	0	0	0	0	0	0	0
Oreodytes	5.0	0	0	0	0	0	0	0	0	0
Oreodytes (A)	5.0	0	0	0	0	0	0	0	0	0
Palaemonetes	4.0	0	0	0	0	0	0	0	0	0
Palpomyia	6.0	0	0	0	0	0	0	0	0	0
Paraleptophlebia	1.2	0	0	0	0	1	0	0	0	0
Peltodytes	8.5	0	0	0	0	0	0	0	0	0
Peltodytes (A)	8.5	0	0	0	0	0	0	0	0	0
Perlesta	4.9	0	20	6	3	26	63	92	90	28
Petrophila	2.5	0	0	0	0	0	0	0	0	0
Physa	4.0	0	1	0	0	0	4	6	0	1
Physidae	8.0	0	0	0	0	0	0	0	0	0
Pisidium	6.8	0	0	0	0	0	0	0	0	0
Planorbidae	7.0	1	0	0	0	0	2	0	0	0
Pleuroceridae	7.0	0	0	0	1	0	1	0	0	0
Polycentropus	3.5	0	0	0	0	0	0	0	0	0
Potamanthus	1.6	0	0	0	0	0	0	0	0	0
Prionocera	4.0	0	0	0	0	0	0	0	0	0
Probezzia	6.0	0	0	1	0	0	0	0	0	0
Procloeon	4.0	0	0	0	0	0	0	0	0	0
Progomphus	8.7	0	0	0	0	0	0	0	0	0
Prosimulium	2.6	0	0	0	0	0	0	0	0	0
Psephenus	2.0	0	1	0	10	2	4	14	10	14
Psephenus (A)	2.0	0	0	0	0	0	0	0	0	0
Pseudogoera	0.0	0	2	0	0	0	0	0	0	0
Pseudolimnophila	2.0	0	0	0	0	0	0	0	0	0
Psilotreta	0.0	0	0	0	0	0	0	0	0	1
Psychoda	10.0	0	0	0	0	0	0	0	0	0
Psychodidae	10.0	0	0	0	0	0	0	0	0	0
cylindrica	8.0	0	0	0	0	0	0	0	0	0
Ranatra	7.5	0	0	0	0	0	0	0	0	0
Rhagovelia	6.0	0	0	0	0	0	0	0	0	0
Rhyacophila	0.9	0	0	0	0	1	0	1	1	1
Scirtes	7.0	0	0	0	0	0	0	0	0	0
Serratella	0.6	3	9	60	6	4	10	24	41	19
Silvius	8.0	0	0	0	0	0	0	0	0	0
Simulium	4.4	2	0	21	9	0	0	0	1	0
Simulium (P)	4.4	0	0	0	0	0	0	0	0	0
Sphaeriidae	3.0	0	0	0	0	0	0	0	0	0
Sphaerium	7.7	1	0	13	6	0	0	0	0	0

Appendix M-3d. Taxa list for aquatic macroinvertebrates collected during Spring 2003, Strawberry River Watershed, Arkansas.

		Station ID								
Taxon Name	Tol. Value	WHI0143K - B	WHI0143L-A	WHI0143M-A	WHI0143M-B	NBC WWTP	WHI0143I-A	WHI0143I-B	DSHWY354 - A	DSHWY354 - B
Stenacron	3.1	0	0	1	1	0	0	0	1	0
Stenelmis	5.4	2	1	41	6	4	3	14	19	14
Stenelmis (A)	5.0	4	4	5	4	4	2	2	6	5
Stenonema	3.3	44	16	46	39	14	3	1	25	4
Stratiomyidae	NK	0	0	0	0	1	0	0	0	0
Strophopteryx	2.5	0	1	0	0	0	1	0	2	4
Stylurus	5.0	0	5	0	0	0	0	0	2	0
Tabanidae	8.0	0	0	0	0	0	0	0	0	0
Tabanus	9.7	0	0	1	2	1	0	0	1	0
Thermonectus	3.0	0	0	0	0	0	0	0	0	0
Tipula	7.7	1	1	1	1	1	1	0	0	0
Tipulidae	3.0	0	0	0	0	0	0	0	0	0
Trepobates	10.0	0	0	0	0	0	0	0	0	0
Trichoptera	NK	0	0	0	0	0	0	0	0	0
Tricorythodes	5.4	0	16	36	11	0	1	1	0	3
Tropisternus	9.8	0	0	0	0	0	0	0	0	0
Tropisternus (A)	9.8	0	0	0	0	0	0	0	0	0
Uvarus	5.0	0	0	0	0	0	0	0	0	0
Viviparidae	4.0	11	0	8	3	0	0	0	3	3
Wormaldia	0.4	0	0	0	1	2	0	0	3	1
Total	NA	212	98	368	150	97	129	219	282	191

Appendix M-3d. Taxa list for aquatic macroinvertebrates collected during Spring 2003, Strawberry River Watershed, Arkansas.

		Station ID				
Taxon Name	Tol. Value	WHI0143J	UWRDC01	WHI0143S	WHI0143Q	WHI0143R
Acroneuria	0.0	0	0	0	0	0
Agabus	5.0	0	0	0	0	0
Agapetus	0.0	0	0	0	0	0
Amphiagrion	5.0	0	0	0	0	0
Amphinemura	3.4	0	0	0	0	0
Ancylidae	6.0	0	0	0	0	0
Ancyronyx	6.9	0	1	0	0	0
Ancyronyx (A)	6.9	0	0	0	0	0
Apatolestes	8.0	0	0	0	0	0
Argia	5.1	6	5	0	0	4
Arigomphus	5.0	1	0	0	0	0
Atherix	2.0	0	0	0	0	0
Baetis	3.1	7	5	3	0	0
Baetis #2	3.1	0	0	0	0	0
Baetisca	4.0	0	0	0	0	0
Basiaeschna	7.7	0	0	0	0	0
Belostoma	9.8	0	0	0	0	0
Berosus	8.6	0	0	0	0	1
Boyeria	6.3	2	9	0	0	0
Brachycentrus	2.2	1	1	0	0	0
Brachyprema	3.0	0	0	0	0	0
Caecidotea	6.0	0	0	6	0	0
Caenis	7.6	4	9	5	1	7
Calopteryx	8.3	1	3	0	1	0
Cambarinae	6.0	8	15	4	2	9
Carabidae	4.0	2	0	0	0	0
Ceratopsyche	3.0	0	0	0	0	0
Chaoborus	8.5	0	0	0	0	0
Cheumatopsyche	6.6	0	2	2	0	13
Chimarra	2.8	0	0	0	0	0
Chironomidae	6.0	11	8	19	9	13
Chironomidae (P)	6.0	2	2	2	1	0
Chlorotabanus	8.0	0	0	0	0	0
Chrysops	7.3	0	0	0	0	0
Cnephia	4.0	0	0	0	0	0
Corbicula	6.3	0	0	0	0	0
Corixidae	9.0	0	0	0	0	0
Corydalus	5.6	0	0	0	0	0
Culicoides	10.0	0	0	0	0	0
Cybister	5.0	0	0	0	0	0
Cyrnellus	7.4	0	0	0	0	0
Dasyhelea	5.7	0	0	0	0	0
Dasyhelea (P)	5.7	0	0	0	0	0
Dicranota	4.0	0	0	0	0	0
Dineutus	5.5	1	1	1	1	3
Dineutus (A)	5.5	1	1	1	0	0
Diptera	7.0	1	0	0	0	0
Diptera (P)	7.0	1	0	0	0	0
Dixella	1.0	0	0	0	0	0
Dolichopodidae	9.7	1	0	0	0	0
Dromogomphus	6.3	0	5	0	0	2

Appendix M-3d. Taxa list for aquatic macroinvertebrates collected during Spring 2003, Strawberry River Watershed, Arkansas.

		Station ID				
Taxon Name	Tol. Value	WHI0143J	UWRDC01	WHI0143S	WHI0143Q	WHI0143R
Drunella	1.0	0	0	0	0	0
Dubiraphia	6.4	1	2	4	5	7
Dubiraphia (A)	6.4	0	1	1	0	0
Dytiscus	5.0	0	0	0	0	0
Ectopria	4.0	0	0	0	0	0
Empididae	8.1	0	0	1	0	0
Enallagma	9.0	4	8	0	1	0
Ephemerella	2.9	0	0	0	0	0
Ephoron	2.0	0	0	0	0	0
Ephydridae	6.0	0	0	0	0	0
Epiaeschna heros	7.1	0	0	0	0	0
Erpetogomphus	4.0	0	0	0	0	0
Eurylophella	2.1	1	1	1	0	0
Ferrissia	6.9	0	0	0	0	0
Forcipomyia	6.0	0	0	0	0	0
Gammarus	6.9	0	3	19	66	38
Gerris	5.0	0	0	0	0	0
Gomphus	4.9	0	0	0	0	0
Gomphurus	6.2	0	0	0	0	0
Gumaga	NK	0	0	0	0	0
Gyretes	5.0	0	0	0	0	0
Gyrinidae	5.0	0	0	0	0	0
Gyrinus	6.3	2	0	0	0	0
Hagenius	4.0	0	0	1	0	0
Helicopsyche	3.0	0	0	0	0	0
Hemerodromia	6.0	0	0	0	0	0
Hemerodromia (P)	6.0	0	0	0	0	0
Heptagenia	2.8	0	0	0	0	0
Heptageniidae	4.0	0	0	0	0	0
Hetaerina	6.2	0	0	0	0	0
Hexagenia	4.7	2	1	0	0	0
Hexatoma	4.7	0	0	0	0	0
Hirudinea	3.0	0	0	0	0	1
Hydrobiidae	8.0	0	0	2	0	0
Hydrobiomorpha	5.0	2	0	0	0	0
Hydrobius	5.0	0	0	0	0	0
Hydrometra	NK	0	0	0	0	0
Hydroporus (A)	8.9	0	0	0	0	0
Hydropsyche	4.0	0	0	0	0	0
Hydroptila	6.2	0	0	0	0	0
Ischnura	9.4	0	0	1	2	1
Isonychia	2.0	1	0	0	0	0
Lepidostoma	3.0	0	0	0	0	0
Leptophlebia	6.4	0	0	0	0	0
Leptotarsus	3.0	0	0	0	0	0
Leucrocuta	1.0	0	0	0	0	0
Limonia	10.0	0	0	0	0	0
Lirceus	7.7	0	0	7	31	20
Lutrochus	2.9	0	0	0	0	0
Lymnaeidae	6.0	0	0	0	1	0
Macromia	6.7	2	8	0	1	2
Macronychus	4.7	5	7	1	3	0

Appendix M-3d. Taxa list for aquatic macroinvertebrates collected during Spring 2003, Strawberry River Watershed, Arkansas.

		Station ID				
Taxon Name	Tol. Value	WHI0143J	UWRDC01	WHI0143S	WHI0143Q	WHI0143R
Macronychus (A)	4.7	0	1	0	1	0
Macrostemum	3.6	0	0	0	0	0
Mesovelia	NK	0	0	0	0	0
Microcylloepus	1.0	0	0	0	0	0
Microvelia	6.0	0	0	0	0	0
Molophilus	4.0	0	0	0	0	0
Neoelmis	4.0	0	0	0	0	0
Neoperla	1.6	0	0	0	0	0
Nigronia	2.0	0	0	0	0	0
Odontoceridae	0.0	0	0	0	0	0
Oligochaeta	10.0	0	0	0	0	0
Optioservus	2.7	0	0	0	0	0
Optioservus (A)	2.5	0	0	0	0	0
Oreodytes	5.0	0	0	0	0	1
Oreodytes (A)	5.0	0	0	0	0	0
Palaemonetes	4.0	0	0	2	0	0
Palpomyia	6.0	0	0	0	0	0
Paraleptophlebia	1.2	0	0	0	0	0
Peltodytes	8.5	0	0	0	0	0
Peltodytes (A)	8.5	0	0	0	0	0
Perlesta	4.9	9	8	3	0	1
Petrophila	2.5	0	0	0	0	0
Physa	4.0	0	4	5	1	0
Physidae	8.0	0	0	0	0	0
Pisidium	6.8	0	0	0	0	0
Planorbidae	7.0	0	0	1	0	0
Pleuroceridae	7.0	0	19	2	0	0
Polycentropus	3.5	0	0	0	0	0
Potamanthus	1.6	0	0	0	0	0
Prionocera	4.0	0	0	0	0	0
Probezzia	6.0	0	0	0	1	0
Procloeon	4.0	0	0	0	0	0
Progomphus	8.7	0	0	0	0	0
Prosimulium	2.6	0	0	0	0	0
Psephenus	2.0	0	0	0	0	0
Psephenus (A)	2.0	0	0	0	0	0
Pseudogoera	0.0	0	0	0	0	0
Pseudolimnophila	2.0	0	0	0	1	0
Psilotreta	0.0	0	0	0	0	0
Psychoda	10.0	0	0	0	0	0
Psychodidae	10.0	0	0	0	0	0
cylindrica	8.0	0	0	0	0	0
Ranatra	7.5	0	0	0	0	0
Rhagovelia	6.0	0	0	1	0	0
Rhyacophila	0.9	0	0	0	0	0
Scirtes	7.0	0	0	0	0	0
Serratella	0.6	0	0	0	0	0
Silvius	8.0	0	0	0	0	0
Simulium	4.4	0	0	0	0	0
Simulium (P)	4.4	0	0	0	0	0
Sphaeriidae	3.0	0	0	0	0	0
Sphaerium	7.7	0	0	4	2	1

Appendix M-3d. Taxa list for aquatic macroinvertebrates collected during Spring 2003, Strawberry River Watershed, Arkansas.

		Station ID				
Taxon Name	Tol. Value	WHI0143J	UWRDC01	WHI0143S	WHI0143Q	WHI0143R
Stenacron	3.1	0	0	0	3	0
Stenelmis	5.4	1	0	1	0	1
Stenelmis (A)	5.0	0	3	1	0	0
Stenonema	3.3	5	5	2	0	4
Stratiomyidae	NK	0	0	0	0	0
Strophopteryx	2.5	0	0	0	0	0
Stylurus	5.0	0	0	0	0	0
Tabanidae	8.0	0	0	0	0	0
Tabanus	9.7	0	0	0	0	0
Thermonectus	3.0	0	0	0	0	0
Tipula	7.7	6	0	0	0	0
Tipulidae	3.0	0	0	0	0	0
Trepobates	10.0	0	0	0	0	0
Trichoptera	NK	0	0	0	0	0
Tricorythodes	5.4	3	0	0	0	0
Tropisternus	9.8	0	0	0	0	0
Tropisternus (A)	9.8	0	0	0	0	0
Uvarus	5.0	0	1	0	1	0
Viviparidae	4.0	1	0	1	0	0
Wormaldia	0.4	0	0	0	0	0
Total	NA	95	139	104	135	129

APPENDIX F-1

Habitat scores for fish community samples collected during 2002, Strawberry River watershed, Arkansas.

APPENDIX F-1:
Fish Community Habitat Scores

Habitat	Parameter	SBR01	143H	Dry Fk	143L	143M	TNC	143N	Perkins	143K	143J
Riffle	Number Sampled	3	1	6	3	5	8	3	2	6	3
	Total Length	110	70	200	100	1240	420	95	90	245	55
	Substrate Score	7.3	14	9.8	7.7	10	22.3	10	13.5	13	10.7
	Instream Cover	6	18	6	2	33.6	5.3	4.7	0	10	7.3
	Embededness	13.3	14	14	13.3	5.2	13.5	9.3	13	11.7	13.3
	Total Habitat Score	26.7	46	29.8	23	48.8	41	24	26.5	34.7	31.3
	Index	29.3	32.2	59.7	23	605.1	172.2	22.8	23.9	84.9	17.2
Run	Number Sampled	5	4	4	4	3	7	4	2	6	4
	Total Length	400	590	430	1160	75	550	420	230	710	480
	Substrate Score	11	13.3	14	12	13.7	24.4	18.8	12.5	14	7.5
	Instream Cover	32.2	37	21	37	0	13.1	29.5	33	21.3	26.5
	Embededness	10.8	10	10.5	10.5	12.7	12	12	11	11.7	9.5
	Total Habitat Score	54	60.3	45.5	59.5	26.3	49.6	60.3	56.5	47	43.5
	Index	216	355.5	195.7	690.2	19.7	272.6	253.1	130	333.7	208.8
Pool	Number Sampled	4	5	3	4	3	3	2	2	4	4
	Total Length	370	850	280	780	145	730	840	400	395	175
	Substrate Score	11.5	12.2	13.7	13	17	32	23	8.5	15	5.5
	Instream Cover	37.5	32.8	41.3	42.8	15.3	27.7	42	50	35	28.5
	Embededness	10.5	9.6	9.3	9.5	9.3	11.3	5	8	9.5	10
	Total Habitat Score	59.5	54.6	64.3	65.3	41.7	71	70	66.5	59.5	44
	Index	220.2	464.1	180.1	509	60.4	518.3	588	266	235	77

Habitat	Parameter	143S	RDC01	Hwy 25	143Q	143R	143IA	143I	143IB	NBC01
Riffle	Number Sampled	5	0	0	1	2	4	5	2	7
	Total Length	125	0	0	18	65	70	200	170	260
	Substrate Score	6.6	0	0	2	5.5	12.3	23.2	10	15.1
	Instream Cover	13.4	0	0	14	15	10.5	9.2	0	7.4
	Embededness	12.4	0	0	14	14	14	12.4	14	13.7
	Total Habitat Score	32.4	0	0	30	34.5	36.8	44.8	24	36.3
	Index	40.5	0	0	5.4	22.4	25.7	89.6	40.8	94.3
Run	Number Sampled	6	5	6	4	7	3	3	4	8
	Total Length	260	1500	720	365	790	155	180	250	640
	Substrate Score	13.2	5.6	4.8	2.3	4.7	12	24.7	24.5	16.4
	Instream Cover	20	22.8	16	23	21	34	28	6.5	10.5
	Embededness	9.3	13.2	9.3	11	9.1	11.3	11.3	12	9.5
	Total Habitat Score	39.5	41.6	30.2	36.3	34.9	57.3	64	43	36.4
	Index	102.7	624	217.2	132.3	275.4	88.9	115.2	108	232.8
Pool	Number Sampled	4	1	5	4	4	3	3	4	4
	Total Length	370	20	810	840	260	700	260	1980	420
	Substrate Score	6.8	2	4	3.3	2.3	13.7	35.3	22	15.3
	Instream Cover	25.5	46	29.2	30	29.8	43.3	27.3	32.8	19
	Embededness	9	12	10.4	10.5	9.5	9.3	11.3	11	11
	Total Habitat Score	41.3	60	43.6	43.8	41.5	66.3	74	65.8	41.3
	Index	152.6	12	353.2	367.5	107.9	464.3	192.4	1302	173.6

APPENDIX F-2

Taxa list for fish communities collected in 2002 from the Strawberry River watershed, Arkansas

APPENDIX F-2:
Fish Community Taxa List

SCIENTIFIC NAME	COMMON NAME	SBR01	143H	Dry Fk	143L	143M	TNC	143N
Petromyzontidae	Lampreys							
Ichthyomyzon gagei	Southern Brook lamprey							
Ichthyomyzon sp.	Ammocoettes					3		
Lepisosteidae	Gars							
Lepisosteus oculatus	Spotted gar							
Lepisosteus osseus	Longnose gar							
Amiidae	Bowfins							
Amia calva	Bowfins							
Clupeidae	Shad							
Dorosoma cepedianum	Gizzard shad							
Hiodontidae	Mooneyes							
Hiodon tergisus	Mooneye							
Esocidae	Pickerel							
Esox americanus	Grass pickerel							
Cyprinidae	Minnows							
Campostoma anomalum	Central stoneroller	198	281	617	520	145	233	933
Cyprinella galactura	Whitetail shiner			9	22	12	19	
Cyprinella venustus	Blacktail shiner							
Cyprinella whipplei	Steelcolor shiner	10	2	49			42	1
Cyprinus carpio	Common carp							
Erimystax harryi	Streamline chub			15			3	
Hybognathus nuchalis	Silvery minnow							
Hybopsis amblops	Bigeye chub	25	17	80	70	1016	80	30
Luxilus chrysocephalus	Striped shiner	25	19	57	28	1	6	47
Luxilus zonatus	Bleeding shiner		16	296		74	195	339
Lythrurus umbratilis	Redfin shiner		1					
Notropis atherinoides	Emerald shiner						3	
Notropis boops	Bigeye shiner	83	35	107	54	4	45	8
Notropis nubilus	Ozark Minnow	33	47	52	27	5	6	156
Notropis ozarcanus	Ozark shiner			2	13		14	
Notropis rubellus	Rosyface shiner			10			33	8
Notropis sabinae	Sabine shiner							
Notropis telescopus	Telescope shiner			1	5	20	27	15
Notropis volucellus	Mimic shiner							
Pimephales notatus	Bluntnose minnow	75	27	33	38	6	68	31
Pimephales vigilax	Bullhead minnow							
Semotilus atromaculatus	Creek chub		3		6			3
Catostomidae	Suckers							
Erimyzon oblongus	Creek chubsucker	65	14	3	10	1	1	
Hypentelium nigricans	Northern hogsucker	22	36	13	25	6	25	7
Ictiobus bubalus	Smallmouth buffalo							
Minytrema melanops	Spotted sucker	8						
Moxostoma anisurum	Silver redhorse							
Moxostoma carinatum	River redhores			2				
Moxostoma duquesnei	Black redhorse	2	1	12	3	2	15	3
Mosostoma erythrurum	Golden redhorse			3	22	2	7	
Moxostoma macrolepidotum	Shorthead redhorse							
Ictaluridae	Catfishes							
Ameiurus melas	Black bullhead							
Ameiurus natalis	Yellow bullhead	8	3	2	6	1	1	2
Ictalurus punctatus	Channel catfish						8	
Noturus albater	Ozark madtom			81			211	
Noturus exilis	Slender madtom	2	6	17	8	8	1	8
Noturus gyrinus	Tadpole madtom							
Noturus miurus	Brindled madtom						1	

APPENDIX F-2:
Fish Community Taxa List

SCIENTIFIC NAME	COMMON NAME	SBR01	143H	Dry Fk	143L	143M	TNC	143N
Noturus nocturnus	Freckled madtom							
Pylodictis olivaris	Flathead catfish						1	
Aphredoderidae	Pirate Perches							
Aphredoderus sayanus	Pirate perch							1
Cyprinodontidae	Killifishes							
Fundulus catenatus	Northern studfish	1		5	12	2	1	27
Fundulus olivaceus	Blackspotted Topminnow	25	13	9	38	47	8	61
Poeciliidae	Live Bearers							
Gambusia affinis	Mosquitofish	6	18	3	5			8
Atherinidae	Silversides							
Labidesthes sicculus	Brook silverside	5		6	1			
Centrarchidae	Sunfishes							
Ambloplites ariommus	Shadow bass	10		27		9	27	4
Lepomis cyanellus	Green sunfish	39	45	9	48	16	8	64
Lepomis gulosus	Warmouth sunfish			1	5			
Lepomis macrochirus	Bluegill sunfish	6	11	4	20	9		
Lepomis megalotis	Longear sunfish	398	166	206	380	360	253	296
Lepomis microlophus	Redear sunfish							
Lepomis miniatus	Red spotted sunfish							
Micropterus dolomieui	Smallmouth bass			18		11	30	15
Micropterus punctulatus	Spotted bass	13	2		15			
Micropterus salmoides	Largemouth bass	9	1					
Pomoxis nigromaculatus	Black crappie							
Percidae	Perches							
Crystallaria asprella	Crystal darter							
Etheostoma asprigene	Mud darter							
Etheostoma blennioides	Greenside darter	25	21	98	27	51	95	50
Etheostoma caeruleum	Rainbow darter	455	227	906	217	24	102	117
Etheostoma clarum	Western sand Darter							
Etheostoma euzonum	Arkansas Saddle darter			136		1	60	21
Etheostoma flabellare	Fantail darter	5	15	13	1	2	20	10
Etheostoma fragile	Strawberry river darter		3		1			
Etheostoma nigrum	Johnny darter	2	1					
Etheostoma proeliare	Cypress darter							
Etheostoma stigmaeum	Speckled darter						1	
Etheostoma vivax	Scaly Sand darter							
Etheostoma zonale	Banded darter	10	3	196	17	47	150	9
Percina caprodes	Logperch	8	3	1			3	
Percina evides	Gilt darter						26	
Percina maculata	Blackside darter							
Percina ouachita	Saddleback darter							
Percina phoxocephala	Slenderhead darter							
Percina sciera	Dusky darter							
Stizostedion vitreum	Walleye							
Cottidae	Cottus							
Cottus carolinae	Banded sculpin	2	2	2	5	1		
Sciaenidai	Drums							
Aplodinotus grunniens	Freshwater durm			1			3	
	TOTAL SPECIES	30	30	39	31	29	39	28
	TOTAL NUMBERS	1575	1039	3102	1649	1886	1832	2274
	Effort (sec)	3736	4299	4400	4966	4060	2734	3863
	Catch/Effort	25.294	14.501	42.3	19.923	27.872	40.205	35.32

APPENDIX F-2:
Fish Community Taxa List

SCIENTIFIC NAME	COMMON NAME	Perkins	143K	143J	143S	RDC01	Hwy 25	143Q
Petromyzontidae	Lampreys							
Ichthyomyzon gagei	Southern Brook lamprey	1						
Ichthyomyzon sp.	Ammocoettes		1	2		10	1	7
Lepisosteidae	Gars							
Lepisosteus oculatus	Spotted gar	2					3	
Lepisosteus osseus	Longnose gar	3		2			1	
Amiidae	Bowfins							
Amia calva	Bowfins						1	
Clupeidae	Shad							
Dorosoma cepedianum	Gizzard shad	8					47	
Hiodontidae	Mooneyes							
Hiodon tergisus	Mooneye	1					1	
Esocidae	Pickerel							
Esox americanus	Grass pickerel							
Cyprinidae	Minnows							
Campostoma anomalum	Central stoneroller	780	406	126	90	152	293	4
Cyprinella galactura	Whitetail shiner			6		8		
Cyprinella venustus	Blacktail shiner	58		14	5	18	390	
Cyprinella whipplei	Steelcolor shiner	176		10	2		181	
Cyprinus carpio	Common carp	2						
Erimystax harryi	Streamline chub	33						
Hybognathus nuchalis	Silvery minnow			4		7	8	
Hybopsis amblops	Bigeye chub	78	9	7	5	3	103	
Luxilus chrysocephalus	Striped shiner	4		4				
Luxilus zonatus	Bleeding shiner	56	124	44	30	5		
Lythrurus umbratilis	Redfin shiner							
Notropis atherinoides	Emerald shiner	10		7		7	46	
Notropis boops	Bigeye shiner	15	7	1				
Notropis nubilus	Ozark Minnow	1						
Notropis ozarcanus	Ozark shiner	20					2	
Notropis rubellus	Rosyface shiner	5		8		1	2	
Notropis sabinae	Sabine shiner			8		3	28	
Notropis telescopus	Telescope shiner	1	10	141		15		
Notropis volucellus	Mimic shiner						13	
Pimephales notatus	Bluntnose minnow	94		1	3	22	193	18
Pimephales vigilax	Bullhead minnow						123	
Semotilus atromaculatus	Creek chub		17		2	18		1
Catostomidae	Suckers							
Erimyzon oblongus	Creek chubsucker							
Hypentelium nigricans	Northern hogsucker	24	15	62	40	68	13	30
Ictiobus bubalus	Smallmouth buffalo	1			1		8	
Minytrema melanops	Spotted sucker						3	7
Moxostoma anisurum	Silver redhorse						3	
Moxostoma carinatum	River redhores	6		1			4	
Moxostoma duquesnei	Black redhorse	6		3	6			
Mosostoma erythrurum	Golden redhorse	69		18	13	5	33	
Moxostoma macrolepidotum	Shorthead redhorse	2					20	
Ictaluridae	Catfishes							
Ameiurus melas	Black bullhead							
Ameiurus natalis	Yellow bullhead	1		1	1	10		3
Ictalurus punctatus	Channel catfish	11		1			1	
Noturus albater	Ozark madtom	120	4	1			110	
Noturus exilis	Slender madtom		6					
Noturus gyrinus	Tadpole madtom							
Noturus miurus	Brindled madtom						20	

APPENDIX F-2:
Fish Community Taxa List

SCIENTIFIC NAME	COMMON NAME	Perkins	143K	143J	143S	RDC01	Hwy 25	143Q
Noturus nocturnus	Freckled madtom					3		
Pylodictis olivaris	Flathead catfish	3						
Aphredoderidae	Pirate Perches							
Aphredoderus sayanus	Pirate perch			1	2	1		2
Cyprinodontidae	Killifishes							
Fundulus catenatus	Northern studfish			3		9	1	
Fundulus olivaceus	Blackspotted Topminnow	18	19	38	17	41	10	20
Poeciliidae	Live Bearers							
Gambusia affinis	Mosquitofish			2	1	14	3	2
Atherinidae	Silversides							
Labidesthes sicculus	Brook silverside	5					30	
Centrarchidae	Sunfishes							
Ambloplites ariommus	Shadow bass	13	1	2			1	
Lepomis cyanellus	Green sunfish	7	14	13	7	15	10	57
Lepomis gulosus	Warmouth sunfish	2						1
Lepomis macrochirus	Bluegill sunfish	23	7	34	2	5	11	93
Lepomis megalotis	Longear sunfish	259	38	120	105	53	151	6
Lepomis microlophus	Redear sunfish	8		5				8
Lepomis miniatus	Red spotted sunfish	6		1	9		3	2
Micropterus dolomieui	Smallmouth bass	4	5	3		1	2	
Micropterus punctulatus	Spotted bass	89		18	5	2	44	
Micropterus salmoides	Largemouth bass	10		3		1		8
Pomoxis nigromaculatus	Black crappie							
Percidae	Perches							
Crystallaria asprella	Crystal darter						1	
Etheostoma asprigene	Mud darter					22		20
Etheostoma blennioides	Greenside darter	20	53	19	14	10	47	11
Etheostoma caeruleum	Rainbow darter	233	209	20	45	10	24	
Etheostoma clarum	Western sand Darter						4	
Etheostoma euzonum	Arkansas Saddle darter	295		2			49	
Etheostoma flabellare	Fantail darter	1	29		7			
Etheostoma fragile	Strawberry river darter		5					
Etheostoma nigrum	Johnny darter							
Etheostoma proeliare	Cypress darter							1
Etheostoma stigmaeum	Speckled darter	4					11	
Etheostoma vivax	Scaly Sand darter	2		5			2	
Etheostoma zonale	Banded darter	123	14	29	5	19	66	3
Percina caprodes	Logperch	7			1		3	
Percina evides	Gilt darter	22					27	
Percina maculata	Blackside darter				1		1	
Percina ouachita	Saddleback darter			3			11	
Percina phoxocephala	Slenderhead darter						1	
Percina sciera	Dusky darter	7		8	3	16	18	
Stizostedion vitreum	Walleye						1	
Cottidae	Cottus							
Cottus carolinae	Banded sculpin		26			19		11
Sciaenidai	Drums							
Aplodinotus grunniens	Freshwater durm	6					5	
	TOTAL SPECIES	53	22	43	20	33	55	22
	TOTAL NUMBERS	2755	1019	801	422	593	2188	315
	Effort (sec)	5383	4178	4612	3739	4404	4593	2702
	Catch/Effort	30.708	14.634	10.421	6.7719	8.079	28.583	6.9948

APPENDIX F-2:
Fish Community Taxa List

SCIENTIFIC NAME	COMMON NAME	143R	143IA	143I	143IB	NBC01	Total
Petromyzontidae	Lampreys						
Ichthyomyzon gagei	Southern Brook lamprey				2		3
Ichthyomyzon sp.	Ammocoettes						25
Lepisosteidae	Gars						
Lepisosteus oculatus	Spotted gar	2					7
Lepisosteus osseus	Longnose gar	5					11
Amiidae	Bowfins						
Amia calva	Bowfins						1
Clupeidae	Shad						
Dorosoma cepedianum	Gizzard shad						55
Hiodontidae	Mooneyes						
Hiodon tergisus	Mooneye						2
Esocidae	Pickerel						
Esox americanus	Grass pickerel	1					1
Cyprinidae	Minnows						
Campostoma anomalum	Central stoneroller	146	365	707	228	102	6326
Cyprinella galactura	Whitetail shiner				1	4	81
Cyprinella venustus	Blacktail shiner	108					593
Cyprinella whipplei	Steelcolor shiner	47				7	527
Cyprinus carpio	Common carp						2
Erimystax harryi	Streamline chub				3	5	59
Hybognathus nuchalis	Silvery minnow	161					180
Hybopsis amblops	Bigeye chub	1			42	1	1567
Luxilus chrysocephalus	Striped shiner					2	193
Luxilus zonatus	Bleeding shiner		89	175	140	92	1675
Lythrurus umbratilis	Redfin shiner						1
Notropis atherinoides	Emerald shiner	3					76
Notropis boops	Bigeye shiner	1	82	6			448
Notropis nubilus	Ozark Minnow		6	2	9	2	346
Notropis ozarcanus	Ozark shiner						51
Notropis rubellus	Rosyface shiner					1	68
Notropis sabinae	Sabine shiner	1					40
Notropis telescopus	Telescope shiner			2			237
Notropis volucellus	Mimic shiner						13
Pimephales notatus	Bluntnose minnow	9	41	2	17		678
Pimephales vigilax	Bullhead minnow	18					141
Semotilus atromaculatus	Creek chub	1		2			53
Catostomidae	Suckers						
Erimyzon oblongus	Creek chubsucker		1	9	8		112
Hypentelium nigricans	Northern hogsucker	5	4	10	35	16	456
Ictiobus bubalus	Smallmouth buffalo						10
Minytrema melanops	Spotted sucker	7					25
Moxostoma anisurum	Silver redhorse						3
Moxostoma carinatum	River redhores						13
Moxostoma duquesnei	Black redhorse				2	1	56
Mosostoma erythrurum	Golden redhorse	8	3		3		186
Moxostoma macrolepidotum	Shorthead redhorse						22
Ictaluridae	Catfishes						
Ameiurus melas	Black bullhead	1					1
Ameiurus natalis	Yellow bullhead	1	9	27	1		77
Ictalurus punctatus	Channel catfish	67					88
Noturus albater	Ozark madtom				1		528
Noturus exilis	Slender madtom		3	3	1	4	67
Noturus gyrinus	Tadpole madtom	5					5
Noturus miurus	Brindled madtom						21

APPENDIX F-2:
Fish Community Taxa List

SCIENTIFIC NAME	COMMON NAME	143R	143IA	143I	143IB	NBC01	Total
Noturus nocturnus	Freckled madtom						3
Pylodictis olivaris	Flathead catfish						4
Aphredoderidae	Pirate Perches						
Aphredoderus sayanus	Pirate perch	1					8
Cyprinodontidae	Killifishes						
Fundulus catenatus	Northern studfish						61
Fundulus olivaceus	Blackspotted Topminnow	27	33	3	15	13	455
Poeciliidae	Live Bearers						
Gambusia affinis	Mosquitofish	23					85
Atherinidae	Silversides						
Labidesthes sicculus	Brook silverside	4	2				53
Centrarchidae	Sunfishes						
Ambloplites ariommus	Shadow bass		15	4	21	16	150
Lepomis cyanellus	Green sunfish	159	12	27	31	5	586
Lepomis gulosus	Warmouth sunfish	1					10
Lepomis macrochirus	Bluegill sunfish	12	3		13		253
Lepomis megalotis	Longear sunfish	65	157	82	187	86	3368
Lepomis microlophus	Redear sunfish	1					22
Lepomis miniatus	Red spotted sunfish	1					22
Micropterus dolomieui	Smallmouth bass		7	7	9	22	134
Micropterus punctulatus	Spotted bass	4		2	1		195
Micropterus salmoides	Largemouth bass		3				35
Pomoxis nigromaculatus	Black crappie	1					1
Percidae	Perches						
Crystallaria asprella	Crystal darter						1
Etheostoma asprigene	Mud darter						42
Etheostoma blennioides	Greenside darter	2	21	10	24	28	626
Etheostoma caeruleum	Rainbow darter	8	177	145	109	113	3141
Etheostoma clarum	Western sand Darter						4
Etheostoma euzonum	Arkansas Saddle darter				17	24	605
Etheostoma flabellare	Fantail darter		27	2	15	11	158
Etheostoma fragile	Strawberry river darter			2			11
Etheostoma nigrum	Johnny darter						3
Etheostoma proeliare	Cypress darter						1
Etheostoma stigmaeum	Speckled darter	3					19
Etheostoma vivax	Scaly Sand darter						9
Etheostoma zonale	Banded darter				16	66	773
Percina caprodes	Logperch						26
Percina evides	Gilt darter						75
Percina maculata	Blackside darter						2
Percina ouachita	Saddleback darter						14
Percina phoxocephala	Slenderhead darter						1
Percina sciera	Dusky darter	7					59
Stizostedion vitreum	Walleye						1
Cottidae	Cottus						
Cottus carolinae	Banded sculpin	5	12		2		87
Sciaenidai	Drums						
Aplodinotus grunniens	Freshwater durm						15
	TOTAL SPECIES	38	22	21	28	22	86
	TOTAL NUMBERS	922	1072	1229	953	621	26248
	Effort (sec)	3883	3617	3766	3598	4026	
	Catch/Effort	14.247	17.783	19.58	15.892	9.2548	

APPENDIX SB-1

List of unstable streambanks in the Strawberry River watershed, Arknasas.
2001 - 2003

Appendix SB-1
List of Unstable Streambanks

Site ID	Site Number	Lgth ft	Height (ft) Upper	Middle	Lower	County	HUC	Reach	Lat DD	Long DD	WaterBody
IZ01	Ox001	580	7	7	7	Izard	11010012	011	36.228364	-91.881689	Strawberry River
IZ02	Ox002	269	7	7	7	Izard	11010012	011	36.228333	-91.880569	Strawberry River
IZ03	Ox003	885	5	7	7	Izard	11010012	011	36.222956	-91.880569	Strawberry River
IZ04	Fkn001	210	6	6	6	Izard	11010012	011	36.208403	-91.858719	Strawberry River
IZ05	Fkn001b	85	6	6	6	Izard	11010012	011	36.215172	-91.868086	Strawberry River
IZ06	Fkn001c					Izard	11010012	011	36.215775	-91.868347	Strawberry River
IZ07	Fkn001d					Izard	11010012	011	36.216464	-91.839761	Strawberry River
IZ08	Fkn002a	180	5	5	5	Izard	11010012	011	36.216581	-91.839658	Strawberry River
IZ09	Fkn002b	180	7	7	7	Izard	11010012	011	36.216981	-91.836822	Strawberry River
IZ10	Fkn002c	365	8	8	8	Izard	11010012	011	36.217789	-91.835814	Strawberry River
IZ11	Fkn003	308	9	9	9	Izard	11010012	011	36.227761	-91.814178	Strawberry River
IZ12	Fkn004	225	6	6	8	Izard	11010012	009	36.233417	-91.812847	Strawberry River
IZ13	Fkn005	475	8	8	8	Izard	11010012	009	36.230716	-91.811011	Strawberry River
IZ14	Fkn006	250	8	10	10	Izard	11010012	009	36.229669	-91.811031	Strawberry River
IZ15	Fkn007	200	8	8	8	Izard	11010012	009	36.222528	-91.802900	Strawberry River
IZ16	Fkn008	210	4	4	4	Izard	11010012	009	36.226241	-91.800152	Strawberry River
IZ17	Fkn009	105	5	5	7	Izard	11010012	009	36.223806	-91.800559	Strawberry River
IZ18	Fkn010	210	10	10	10	Izard	11010012	009	36.225858	-91.799939	Strawberry River
IZ19	Fkn011	500	9	9	9	Izard	11010012	009	36.219771	-91.786311	Strawberry River
IZ20	Fkn012	365	8	8	8	Izard	11010012	009	36.218575	-91.782558	Strawberry River
IZ21	Fkn013	230	8	8	8	Izard	11010012	009	36.203237	-91.791596	Strawberry River
IZ22	Fkn014	450	9	9	9	Izard	11010012	009	36.202104	-91.788711	Strawberry River
IZ23	Fkn015	450	9	9	9	Izard	11010012	009	36.201959	-91.787045	Strawberry River
IZ24	6151	90	6 ft	12 ft	12 ft	Izard	11010012	009	36.173006	-91.742256	Strawberry River
IZ25	6152	250	3 ft	7 ft	3 ft	Izard	11010012	009	36.171642	-91.743646	Strawberry River
IZ26	6153	400	6 ft	8 ft	4 ft	Izard	11010012	009	36.171383	-91.743542	Strawberry River
IZ27	6154	325	6 ft	8 ft	5 ft	Izard	11010012	009	36.173966	-91.719679	Strawberry River
IZ28	6155	100	10 ft	12 ft	10 ft	Izard	11010012	009	36.170883	-91.718663	Strawberry River
IZ29	6156	100	12 ft	12 ft	12 ft	Izard	11010012	009	36.170604	-91.718451	Strawberry River
IZ30	6157	175	10 ft	10 ft	10 ft	Izard	11010012	009	36.154768	-91.721493	Strawberry River
IZ31	6158	200	11 ft	11 ft	6 ft	Izard	11010012	009	36.151259	-91.720470	Strawberry River
IZ32	6159	200	14 ft	12 ft	12 ft	Izard	11010012	009	36.149926	-91.721472	Strawberry River
FT01	6261	250	8 ft	8 ft	8 ft	Fulton	11010012	011	36.287093	-91.929431	Strawberry River
FT02	6262	200	6 ft	8 ft	8 ft	Fulton	11010012	011			Strawberry River
FT03	6263	150	7 ft	7 ft	7 ft	Fulton	11010012	011			Strawberry River
IZ33	6271	650	12 ft	12 ft	12 ft	Izard	11010012	009	36.164904	-91.704946	Strawberry River
IZ34	6272	300	12 ft	12 ft	6 ft	Izard	11010012	009	36.163478	-91.696030	Strawberry River
IZ35	6273	150	10 ft	10 ft	6 ft	Izard	11010012	009	36.161920	-91.696652	Strawberry River
IZ36	6274	200	12 ft	12 ft	12 ft	Izard	11010012	009	36.158874	-91.699562	Strawberry River
IZ37	6275	200	14 ft	14 ft	14 ft	Izard	11010012	009	36.145318	-91.705436	Strawberry River
SH01	6276	325	16 ft	14 ft	12 ft	Sharp	11010012	009	36.135847	-91.674066	Strawberry River
SH02	6277	1000	16 ft	12 ft	4 ft	Sharp	11010012	009	36.131445	-91.673950	Strawberry River
IZ38	6291	400	6 ft	8 ft	6 ft	Izard	11010012	009	36.199886	-91.757128	Strawberry River
IZ39	6292	100	6 ft	12 ft	6 ft	Izard	11010012	009	36.186898	-91.760664	Strawberry River
IZ40	6293	100	14 ft	14 ft	14 ft	Izard	11010012	009	36.179397	-91.751183	Strawberry River
IZ41	6294	325	6 ft	10 ft	10 ft	Izard	11010012	009	36.182023	-91.747197	Strawberry River
SH03	7051	300	6 ft	8 ft	12 ft	Sharp	11010012	009	36.129951	-91.673474	Strawberry River
SH04	7052	200	8 ft	8 ft	10 ft	Sharp	11010012	009	36.123695	-91.669262	Strawberry River
SH05	7053	400	15 ft	15 ft	15 ft	Sharp	11010012	009	36.126674	-91.660526	Strawberry River

Appendix SB-1
List of Unstable Streambanks

Site ID	Site Number	Lgth ft	Height (ft) Upper	Middle	Lower	County	HUC	Reach	Lat DD	Long DD	WaterBody
SH06	7054	300	12 ft	12 ft	12 ft	Sharp	11010012	009	36.108898	-91.644033	Strawberry River
SH07	7055	1000	14 ft	12 ft	8 ft	Sharp	11010012	009	36.105976	-91.635657	Strawberry River
SH08	7056	200	8 ft	8 ft	8 ft	Sharp	11010012	009	36.107130	-91.629088	Strawberry River
SH09	7057	150	8 ft	8 ft	6 ft	Sharp	11010012	009	36.112565	-91.623110	Strawberry River
SH10	7058	300	6 ft	10 ft	12 ft	Sharp	11010012	009	36.103049	-91.619604	Strawberry River
SH11	7059	400	8 ft	10 ft	12 ft	Sharp	11010012	009	36.101165	-91.615508	Strawberry River
SH12	7061	200	10 ft	12 ft	10 ft	Sharp	11010012	009	36.101787	-91.593060	Strawberry River
SH13	7062	800	10 ft	6 ft	14 ft	Sharp	11010012	009	36.103176	-91.591986	Strawberry River
SH14	7063	600	14 ft	12 ft	6 ft	Sharp	11010012	009	36.096626	-91.580540	Strawberry River
SH15	7064	250	6 ft	6 ft	12 ft	Sharp	11010012	009	36.103257	-91.576171	Strawberry River
SH16	7065	300	10 ft	12 ft	14 ft	Sharp	11010012	009	36.106152	-91.570151	Strawberry River
SH17	7066	1000	12 ft	12 ft	12 ft	Sharp	11010012	009	36.102889	-91.568169	Strawberry River
SH18	7067	200	12 ft	12 ft	12 ft	Sharp	11010012	009	36.092274	-91.566736	Strawberry River
SH19	7068	400	12 ft	12 ft	12 ft	Sharp	11010012	009	36.089616	-91.554537	Strawberry River
SH20	7069	200	15 ft	15 ft	15 ft	Sharp	11010012	008	36.084662	-91.553872	Strawberry River
SH21	7060	250	15 ft	15 ft	15 ft	Sharp	11010012	008	36.079007	-91.544869	Strawberry River
SH22	713a	1400	10 ft	10 ft	6 ft	Sharp	11010012	008	36.070853	-91.531813	Strawberry River
SH23	713b	200	16 ft	18 ft	20 ft	Sharp	11010012	008	36.072963	-91.522843	Strawberry River
SH24	713c	400	9 ft	13 ft	10 ft	Sharp	11010012	008	36.075879	-91.521849	Strawberry River
SH25	713e	1000	13 ft	13 ft	13 ft	Sharp	11010012	008	36.077853	-91.520557	Strawberry River
SH26	713f	150	20 ft	20 ft	20 ft	Sharp	11010012	008	36.081454	-91.524561	Strawberry River
SH27	713h	100	10 ft	10 ft	10 ft	Sharp	11010012	008	36.086671	-91.526331	Strawberry River
SH28	713i	150	7 ft	14 ft	11 ft	Sharp	11010012	008	36.085614	-91.504631	Strawberry River
SH29	713k	70	14 ft	14 ft	14 ft	Sharp	11010012	008	36.085844	-91.497702	Strawberry River
SH30	713l	200	10 ft	12 ft	10 ft	Sharp	11010012	008	36.087374	-91.498844	Strawberry River
SH31	713m	50	20 ft	20 ft	20 ft	Sharp	11010012	008	36.099482	-91.472791	Strawberry River
SH32	713n	100	12 ft	12 ft	10 ft	Sharp	11010012	008	36.096324	-91.483139	Strawberry River
SH33	713t	2000	10 ft	14 ft	10 ft	Sharp	11010012	008	36.093687	-91.482065	Strawberry River
SH34	713u	300	14 ft	14 ft	14 ft	Sharp	11010012	008	36.092085	-91.477751	Strawberry River
SH35	714a	300	10 ft	10 ft	12 ft	Sharp	11010012	008	36.107112	-91.471556	Strawberry River
SH36	714b	700	12 ft	12 ft	12 ft	Sharp	11010012	008	36.107601	-91.470962	Strawberry River
SH37	714c	300	6 ft	10 ft	8 ft	Sharp	11010012	006	36.108343	-91.465650	Strawberry River
SH38	714d	300	10 ft	10 ft	10 ft	Sharp	11010012	006	36.109429	-91.460953	Strawberry River
SH39	714e	100	10 ft	12 ft	10 ft	Sharp	11010012	006	36.110188	-91.457169	Strawberry River
SH40	714f	7000	16 ft	16 ft	16 ft	Sharp	11010012	006	36.107575	-91.446502	Strawberry River
SH41	714g	260	18 ft	18 ft	18 ft	Sharp	11010012	006	36.113611	-91.425031	Strawberry River
SH42	714h	400	14 ft	16 ft	16 ft	Sharp	11010012	006	36.107696	-91.427034	Strawberry River
SH43	714i	600	12 ft	10 ft	10 ft	Sharp	11010012	006	36.105658	-91.429893	Strawberry River
SH44	714j	1000	14 ft	12 ft	12 ft	Sharp	11010012	006	36.102686	-91.431791	Strawberry River
SH45	714k	150	16 ft	16 ft	16 ft	Sharp	11010012	006	36.098171	-91.427829	Strawberry River
SH46	714l	350	14 ft	14 ft	14 ft	Sharp	11010012	006	36.106119	-91.404223	Strawberry River
SH47	714m	425	14 ft	12 ft	16 ft	Sharp	11010012	006	36.101459	-91.396674	Strawberry River
SH48	817a	600	14 ft	12 ft	14 ft	Sharp	11010012	006	36.104128	-91.386151	Strawberry River
SH49	817b	1000	12 ft	12 ft	12 ft	Sharp	11010012	006	36.101769	-91.386212	Strawberry River
SH50	817c	1100	10 ft	12 ft	14 ft	Sharp	11010012	006	36.098721	-91.386205	Strawberry River
SH51	817d	400	12 ft	12 ft	12 ft	Sharp	11010012	006	36.093700	-91.387572	Strawberry River
SH52	817e	150	14 ft	14 ft	14 ft	Sharp	11010012	006	36.092800	-91.386116	Strawberry River
SH53	817f	200	16 ft	14 ft	16 ft	Sharp	11010012	006	36.089996	-91.380356	Strawberry River
SH54	817g	600	18ft	16ft	18ft	Sharp	11010012	006	36.089198	-91.379115	Strawberry River

Appendix SB-1
List of Unstable Streambanks

Site ID	Site Number	Lgth ft	Height (ft) Upper	Middle	Lower	County	HUC	Reach	Lat DD	Long DD	WaterBody
SH55	817h	300	12ft	10ft	12ft	Sharp	11010012	006	36.087623	-91.379903	Strawberry River
SH56	817i	100	14ft	12ft	12ft	Sharp	11010012	006	36.088689	-91.374579	Strawberry River
SH57	817j	800	12ft	14ft	12ft	Sharp	11010012	006	36.081403	-91.357721	Strawberry River
SH58	817k	1100	12ft	12ft	14ft	Sharp	11010012	006	36.062638	-91.338363	Strawberry River
LR01	817l	1000	16ft	16ft	18ft	Lawrence	11010012	006	36.058429	-91.334780	Strawberry River
LR02	817m	1000	16ft	16ft	16ft	Lawrence	11010012	006	36.054059	-91.332352	Strawberry River
LR03	817n	700	18ft	16ft	16ft	Lawrence	11010012	006	36.051956	-91.334187	Strawberry River
LR04	817o	400	12ft	10ft	10ft	Lawrence	11010012	006	36.051341	-91.331541	Strawberry River
LR05	817p	600	12ft	12ft	12ft	Lawrence	11010012	006	36.038529	-91.349078	Strawberry River
LR06	817q	700	16ft	16ft	16ft	Lawrence	11010012	006	36.036657	-91.346266	Strawberry River
LR07	817r	100	14ft	15ft	16ft	Lawrence	11010012	006	36.034932	-91.341984	Strawberry River
LR08	817s	500	16ft	16ft	12ft	Lawrence	11010012	006	36.036372	-91.337948	Strawberry River
LR09	817t	300	12ft	14ft	12ft	Lawrence	11010012	006	36.035249	-91.332874	Strawberry River
LR10	817u	1500	14ft	12ft	16ft	Lawrence	11010012	006	36.033086	-91.326292	Strawberry River
LR11	LAW01	315	15	21	20	Lawrence	11010012	006	36.026618	-91.324413	Strawberry River
LR12	LAW02	440	14	20	20	Lawrence	11010012	006	36.025964	-91.323191	Strawberry River
LR13	SBC01	500	16	20	22	Lawrence	11010012	013	36.020079	-91.320591	South Big Creek
LR14	SBC02	450	18	20	20	Lawrence	11010012	013	36.019201	-91.318834	South Big Creek
LR15	SBC03	380	15	18	18	Lawrence	11010012	013	36.018270	-91.320391	South Big Creek
LR16	SBC04	70	11	15	15	Lawrence	11010012	013	36.018433	-91.321170	South Big Creek
LR17	SBC05	175	12	14	14	Lawrence	11010012	013	36.018152	-91.322719	South Big Creek
LR18	LAW03	165	18	20	20	Lawrence	11010012	006	36.022543	-91.323199	Strawberry River
LR19	LAW04	700	13	15	15	Lawrence	11010012	005	36.021142	-91.313584	Strawberry River
LR20	LAW05	1300	17	22	20	Lawrence	11010012	005	36.019409	-91.314225	Strawberry River
LR21	LAW06	1500	18	22	20	Lawrence	11010012	004	36.017026	-91.310483	Strawberry River
LR22	LAW07	725	14	18	17	Lawrence	11010012	004	36.014933	-91.311858	Strawberry River
LR23	LAW08	600	14	19	18	Lawrence	11010012	002	36.009202	-91.300497	Strawberry River
LR24	LAW09	400	12	15	14	Lawrence	11010012	002	36.005776	-91.299562	Strawberry River
LR25	LAW10	800	14	18	18	Lawrence	11010012	002	36.002436	-91.298902	Strawberry River
LR26	LAW11	900	22	27	24	Lawrence	11010012	002	36.001168	-91.300568	Strawberry River
LR27	LAW12	400	10	14	13	Lawrence	11010012	002	36.000046	-91.299326	Strawberry River
LR28	LAW13	230	10	11	11	Lawrence	11010012	002	35.997167	-91.298451	Strawberry River
LR29	LAW14	1250	19	24	25	Lawrence	11010012	002	35.996048	-91.297944	Strawberry River
LR30	LAW15	1126	15	18	18	Lawrence	11010012	002	35.995443	-91.301151	Strawberry River
LR31	LAW16	850	14	14	15	Lawrence	11010012	002	35.991757	-91.282948	Strawberry River
LR32	LAW17	875	17	17	14	Lawrence	11010012	002	35.990972	-91.282560	Strawberry River
LR33	LAW18	325	14	18	12	Lawrence	11010012	002	35.990441	-91.284117	Strawberry River
LR34	LAW19	410	12	18	16	Lawrence	11010012	002	35.488946	-91.285518	Strawberry River
SH59	PFC01	209	12	18	18	Sharp	11010012	012	36.075489	-91.586509	Piney Fork Creek
SH60	PFC02	221	8	15	12	Sharp	11010012	012	36.076413	-91.572049	Piney Fork Creek
SH61	PFC03	945	14	25	25	Sharp	11010012	012	36.086727	-91.560818	Piney Fork Creek
SH62	PFC04	165	15	25	25	Sharp	11010012	012	36.087463	-91.559084	Piney Fork Creek
SH63	NBC10	105	10	10	10	Sharp	11010012	007	36.137879	-91.504271	North Big Creek
SH64	NBC11	650	15	20	20	Sharp	11010012	007	36.138024	-91.503312	North Big Creek
SH65	NBC12	440	14	15	17	Sharp	11010012	007	36.138115	-91.500661	North Big Creek
SH66	NBC13	790	12	18	10	Sharp	11010012	007	36.138447	-91.500788	North Big Creek
SH67	NBC14	981	8	10	6	Sharp	11010012	007	36.136425	-91.497712	North Big Creek
SH68	NBC15	450	8	8	8	Sharp	11010012	007	36.135886	-91.495356	North Big Creek
SH69	NBC16	1120	8	8	12	Sharp	11010012	007	36.134834	-91.495463	North Big Creek

Appendix SB-1
List of Unstable Streambanks

Site ID	Site Number	Lgth ft	Height (ft) Upper	Middle	Lower	County	HUC	Reach	Lat DD	Long DD	WaterBody
SH70	NBC17	673	15	19	4	Sharp	11010012	007	36.133110	-91.495350	North Big Creek
SH71	NBC18	70	10	10	10	Sharp	11010012	007	36.132992	-91.494199	North Big Creek
SH72	NBC19	445	6	8	10	Sharp	11010012	007	36.129637	-91.493816	North Big Creek
SH73	NBC20	750	10	8	4	Sharp	11010012	007	36.128450	-91.491428	North Big Creek
SH74	NBC22	535	8	9	9	Sharp	11010012	007	36.125118	-91.488180	North Big Creek
SH75	NBC23	300	3	13	14	Sharp	11010012	007	36.123005	-91.484690	North Big Creek
SH76	NBC24	150	6	6	6	Sharp	11010012	007	36.121651	-91.483865	North Big Creek
SH77	NBC25	675	10	12	6	Sharp	11010012	007	36.120548	-91.483739	North Big Creek
SH78	NBC26	423	4	6	6	Sharp	11010012	007	36.119990	-91.480441	North Big Creek
SH79	NBC27	622	6	8	8	Sharp	11010012	007	36.119149	-91.478541	North Big Creek
SH80	NBC28	625	10	8	8	Sharp	11010012	007	36.117617	-91.478089	North Big Creek
SH81	NBC29	285	8	10	6	Sharp	11010012	007	36.117517	-91.476105	North Big Creek
SH82	NBC30	150	10	10	9	Sharp	11010012	007	36.116974	-91.475446	North Big Creek
SH83	NBC31	675	8	10	10	Sharp	11010012	007	36.116411	-91.473850	North Big Creek
SH84	NBC32	1100	6	10	10	Sharp	11010012	007	36.113487	-91.470978	North Big Creek
SH85	NBC33A	600	9	10	14	Sharp	11010012	007	36.111787	-91.469307	North Big Creek
SH86	NBC33B	900	4	8	10	Sharp	11010012	007	36.111787	-91.469307	North Big Creek
SH87	NBC34	665	3	12	6	Sharp	11010012	007	36.111492	-91.471158	North Big Creek
SH88	NBC35	800	10	12	8	Sharp	11010012	007	36.109594	-91.469827	North Big Creek
SH89	NBC36	890	10	10	10	Sharp	11010012	007	36.108477	-91.469955	North Big Creek
SH90	NBC37	2000	20	20	20	Sharp	11010012	007	36.108535	-91.468117	North Big Creek
SH91	NBC38	600	35	33	33	Sharp	11010012	007	36.109377	-91.467771	North Big Creek
LR35	LAW20	640	34	34	34	Lawrence	11010012	002	35.981776	-91.280104	Strawberry River
LR36	LAW21	150	20	25	20	Lawrence	11010012	002	35.981517	-91.276983	Strawberry River
LR37	LAW22	950	23	20	20	Lawrence	11010012	002	35.970352	-91.278424	Strawberry River
LR38	LAW23	900	22	20	18	Lawrence	11010012	002	35.971895	-91.276813	Strawberry River
LR39	LAW24	400	22	20	18	Lawrence	11010012	002	35.968024	-91.275086	Strawberry River
LR40	LAW25	400	16	17	16	Lawrence	11010012	002	35.966685	-91.276225	Strawberry River
LR41	LAW26	200	16	16	16	Lawrence	11010012	002	35.966055	-91.277057	Strawberry River
LR42	LAW27	900	22	25	24	Lawrence	11010012	002	35.965444	-91.277508	Strawberry River
LR43	LAW28	450	18	22	22	Lawrence	11010012	002	35.962272	-91.276467	Strawberry River
LR44	LAW29	400	18	24	24	Lawrence	11010012	002	35.952359	-91.272536	Strawberry River
LR45	LAW30	250	17	17	15	Lawrence	11010012	002	35.938332	-91.259905	Strawberry River
LR46	LAW31	250	15	15	15	Lawrence	11010012	002	35.929175	-91.257391	Strawberry River
LR47	LAW32	350	27	25	17	Lawrence	11010012	002	35.925267	-91.251550	Strawberry River
LR48	LAW33	1300	20	19	9	Lawrence	11010012	002	35.922588	-91.251872	Strawberry River
LR49	LAW34	700	10	20	17	Lawrence	11010012	002	35.925718	-91.249214	Strawberry River
LR50	LAW35	300	16	12	8	Lawrence	11010012	002	35.924074	-91.246507	Strawberry River
LR51	LAW36	400	11	14	15	Lawrence	11010012	002	35.924181	-91.244276	Strawberry River
LR52	LAW37	900	27	14	15	Lawrence	11010012	002	35.920746	-91.243038	Strawberry River
LR53	LAW38	550	20	20	20	Lawrence	11010012	002	35.919187	-91.246015	Strawberry River
LR54	LAW39	2000	14	14	16	Lawrence	11010012	002	35.917238	-91.247887	Strawberry River