WATER QUALITY SURVEY

OF

THE TYSON FOODS AND CITY OF WALDRON

WASTEWATER TREATMENT FACILITIES EFFLUENT

ON

THE POTEAU RIVER

BY

WATER DIVISION

OF

ARKANSAS DEPARTMENT OF POLLUTION CONTROL AND ECOLOGY

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INTRODUCTION

HISTORY AND PURPOSE OF STUDY

A water quality investigation was conducted on the Poteau River, which is the receiving stream of the wastewater from Tyson Foods and the City of Waldron municipal wastewater. The objective of the study was to determine the level of impact these discharges are having on the water quality and aquatic inhabitants of the receiving stream. The Poteau River has a history of poor water quality due to high nutrient concentrations, elevated metals and minerals, and low dissolved oxygen. Occasional fish kills have been reported in this stream in recent years. This investigation was initiated on May 19, 1994 with the installation of periphytometers and an evaluation of the fish communities above and below the discharges. Macroinvertebrates and water chemistry samples were collected on May 23 and 24, along with 24-hour dissolved oxygen profiles. The May survey was designed to evaluate the stream condition while under the influence of a non-point source dominated stream flow. A follow-up survey was conducted on August 29-31, 1994 to evaluate the stream under critical conditions of low flow when the effluent discharges were, in effect, the total stream flow. The same procedures were followed as in the May survey, but due to a break in the Waldron water main, the water chemistry samples collected on the last day of the survey were influenced by this discharge of almost 5 cfs into the Poteau River. As a result, an additional sampling event was conducted on September 7, 1994 when a minimal upstream flow was present.

PREVIOUS STUDIES

In September of 1986, ADPC&E performed a Use Attainability Analysis (UAA) on the Poteau River. This study was prompted by a 1984 wasteload assimilative capacity study which recommended advanced wastewater treatment effluent limits for maintenance of the dissolved oxygen standard for the stream. While recommending a re-classification of the Poteau River, the 1986 UAA also noted an impairment in water quality and associated impacts of the macroinvertebrate and fish communities below the point source discharges. On July 19, 1991 a fish kill was reported on the Poteau River by a landowner downstream from these discharges. This man stated that fish kills occur every year in that portion of the river. It was determined through follow-up sampling that a dissolved oxygen depletion from algae blooms was the causative

agent. High nutrients in the effluent ditch, in the river and downstream prompted a CSI (compliance sampling inspection) on the Tyson Foods facility. This was conducted on August 21, 1991 and revealed effluent nitrate-nitrogen concentrations of 79.5 mg/L and orthophosphate concentrations of 23.5 mg/L. As a result of the fish kill, elevated nutrients in the river, and the results of the CSI, ADPC&E issued a Request for Information to Tyson Foods and the City of Waldron, requiring detailed analyses on effluent nutrients, and resulting instream nutrient and flow conditions for a period of 12 months. This study was initiated in January 1992 and completed by January 1993. The results of the study verified the results indicated by previous studies--that Tyson Foods was discharging high phosphorus concentrations and Waldron was contributing high nitrate concentrations to the Poteau River.

DESCRIPTION OF WATERWAY

In the west central section of Arkansas, the Poteau River originates approximately 10 miles east of Waldron in Scott County. The stream flows westward where it receives the Square Rock Creek drainage of approximately 48 square miles. Jones Creek, with a drainage area of 91.0 square miles confluences with the Poteau River near Hon, Arkansas. From this point the river continues west approximately 22 miles into Oklahoma where it makes its way into Wister Lake, which is the drinking water supply for Poteau, Oklahoma and the northern two-thirds of LeFore County. The Poteau River eventually makes a loop and flows back into Arkansas near its confluence with the Arkansas, River. The total Poteau watershed, near Cauthron, Arkansas is about 203 sq. miles. The stream gradient at sampling stations East of Waldron is 18 to 20 ft/mile; however, stream gradients West of Waldron are 5 ft/mile or less.

The Poteau River drainage basin was initially placed in the Ouachita Mountains Ecoregion. However, biological, chemical and physical data from this basin and similar basins in the same area of the state demonstrate distinctive Arkansas River Valley Ecoregion characteristics.

The geology of the region is characterized by slightly to moderately folded shales and sandstones of Hartshorn and Atoka formations.

Soils range in consistency from sandy to clayey, and are slowly to moderately permeable. In general, as the clay content in the soil increases, the permeability and erodability decrease. However, multiple factors are involved in these processes which may change soil susceptibility to permeability and erosion. The soil will often form moderate to severe colloidal suspensions in water. Topography of the region is rolling with synclinal mountains and mesas, and often with wide, flat valleys, which provide a variety of reliefs and elevations.

Land around the Poteau River is primarily used in agricultural activities, with cattle and poultry farming being predominate. Silvaculture is another major use of the land, particularly in the upper watersheds of the region.

SAMPLE STATION LOCATIONS, DESCRIPTIONS AND ACTIVITIES

Eight sampling locations were established along the Poteau River, two stations along Jones Creek, and one at each discharge (Figure 1). The stations were spaced in a manner so as to collect data that would best represent the overall impact on the Poteau River ecosystem by the two discharges. Spacing was also particularly important in determining if a dissolved oxygen sag was being caused in the river due to the effluent loading on this stream. The sampling station location, physical characteristics, type and frequency of sampling are summarized below.

Key to Abbreviations:

W - Water sample
X - Metals sample
F - Fish sample
D - Drainage Area (sq. miles)
P - Periphyton sample
M - Macroinvertebrate sample
R - Relation to Discharge (+/- above or below discharge)
G - Stream Gradient (feet/mile)

Data Collection Dates:

Sp = Spring; May 24,1994
S1 = Summer; Aug. 31, 1994
S2 = Summer; Sept. 7, 1994

Station POT01A. Poteau River above St. Hwy. 80 bridge east of Waldron (Sec 27, T3N, R29W). D = 12.0; Sampling F(Sp); P(Sp); R(+2.9mi); G(20.0).

Station POT01. Poteau River above US Hwy. 71B bridge (Sec 21, T3N, R29W). D = 45.5; Sampling W(Sp); R(+1.2mi); G(18.0).

Station POT01B. Poteau River between US Hwy. 71 and 71B, upstream of the WTPs (Sec 17, T3N, R29W). D = 46.5; Sampling W(Sp, S1, S2); F(Sp, S1); M(Sp, S1); P(Sp, S1); X(S2); R(+0.1mi); G(3.5).

Station POTEW. Waldron effluent (Sec 17, T3N, R29W). Sampling W(S1, S2); X(S2).

Station POTET. Tyson effluent (Sec 17, T3N, R29W). Sampling W(S1, S2); X(S2).

Station POT02. Poteau River below US Hwy. 71 bridge (Sec 17, T3N, R29W). D = 47.0; Sampling W(Sp, S1, S2); P(Sp); X(S2); R(-0.1mi); G(3.5).

Station POT02B. Poteau River 0.5 miles below US Hwy. 71 bridge, above confluence of Square Rock Creek (Sec 17, T3N, R29W). D = 48.0; Sampling W(S1, S2); M(Sp, S1); F(Sp, S1); P(S1); R(-0.6mi); G(3.5).

Station POT04. Poteau River above St. Hwy 80 bridge near Hon (Sec 10, T3N, R30W). D = 73.5; Sampling W(Sp, S1, S2); R(-6.6mi); G(3.25).

Station JNC01. Jones Creek above St. Hwy 248 bridge (Sec 28, T3N, R30W). D = 70.1; Sampling W(Sp); G(5.28).

Station JNC02. Jones Creek approximately 0.25 miles above confluence of the Poteau River near Hon (Sec 15, T3N, R30W). D = 91.0; Sampling W(Sp, S1, S2); M(S1); F(S1); P(S1); G(4.75).

Station POT06. Poteau River below confluence of Jones Creek near Hon (Sec 10, T3N, R30W). D = 165.0; Sampling W(Sp); R(-6.9mi); G(3.25).

Station POT07. Poteau River off St. Hwy. 28 near Cauthron (Sec16, T3N, R31). D = 203.0; Sampling W(S1,S2); R(-16.9mi); G(4.25). USGS gauging station #07247000.

SAMPLING ACTIVITIES

WATER QUALITY

Eleven water quality sample sites were identified within the Poteau River watershed, seven on the main stem of the Poteau River, two in Jones Creek, and one each at the Tyson and City of Waldron Wastewater Treatment Plant (WTP) outfall. Figure 1 is a map depicting the sample site locations.

Water samples were collected from seven of the sites on May 24, 1994. Even though the spring was considered to be unusually wet, flows during this sample event were relatively low. Flows were not measured during this sample event, but stream flows were approximately 25% of bank full levels. Maximum daytime air temperatures were near 29° Celsius.

Two sampling events were conducted during late summer under critical, low flow conditions. Samples were taken on August 31, 1994 and September 7, 1994. On August 30, 1994 the City of Waldron's main water supply line ruptured sending treated drinking water directly into the Poteau River near the POT01 site. This

resulted in atypical flows and water quality in the Poteau River and made it necessary to resample the stations on September 7, 1994. Eight stations were collected during the two summer sampling events. During the August 31, 1994 sampling event, flows at the upstream stations, POT01B, POT02, and POT02B, were significantly elevated because of the water main break, but downstream station flows at POT04, POT07, and the JNC02 site were at typical, summer low-flow conditions. A storm event, which occurred between the two summer sampling events, increased the flows noticeably at the JNC02 and POT07 sites on September 7, 1994. All other station flows were only slightly elevated. Daytime high air temperatures were 35° Celsius.

The following list of water quality parameters were analyzed in the lab and measured in-situ.

Lab Analysis	In-Situ
Ammonia-Nitrogen	Water Temperature
Nitrate-Nitrite Nitrogen	Dissolved Oxygen
Total Phosphorus	pH
Ortho-Phosphorus	Flow
Chlorides	Diurnal instream DO flux
Sulfates	
Total Hardness	**Atmospheric Conditions**
Turbidity	Air Temperature
Total Suspended Solids	Cloud Cover
Total Dissolved Solids	Wind Condition
Total Organic Carbon	
Biochemical Oxygen Demand (5-Day)	

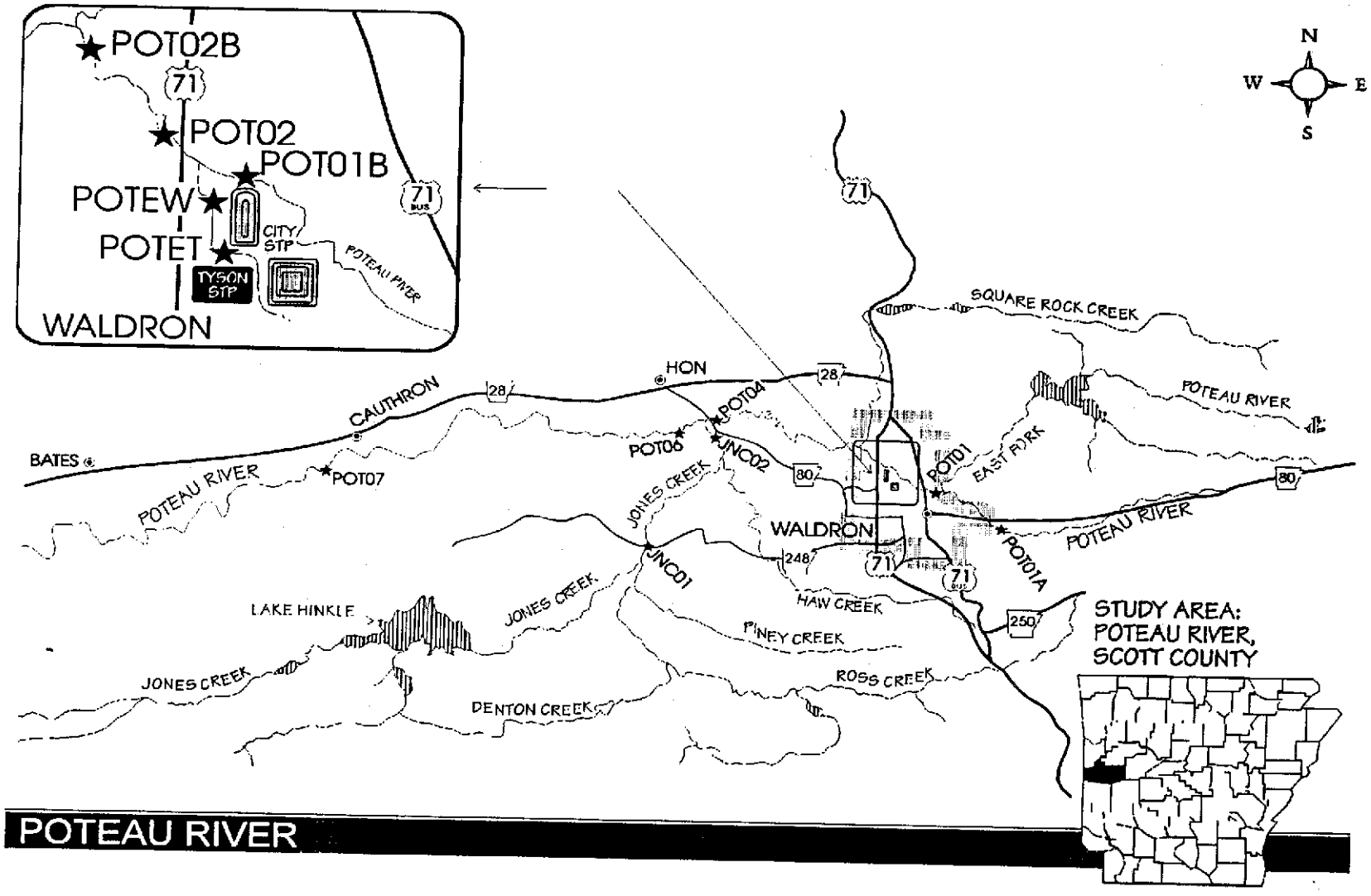
Dissolved Metals

Cadmium	Chromium	Copper
Lead	Zinc	

Instream continuous dissolved oxygen meters were placed at the POT01B and POT02B sites on May 23, 1994 and retrieved 24 hours later on May 24, 1994. Meters were also installed on August 29, 1994, at the POT01B, POT02B, and JNC02 sites and retrieved approximately 48 hours later on August 31, 1994. A duplicate meter was set up at the POT02B site.

Dissolved metals were collected from POT01B, POTEW, POTET, and POT02 sites on September 7, 1994.

FIGURE 1 MAP OF SAMPLE SITE LOCATIONS



The following is a list of the sampling equipment used during this survey:

Y.S.I Model 56 Continuous D.O. Meters
Orion Model 840 Portable D.O. Meters
Orion Model 230A Portable pH Meters
Marsh-McBirney Models 2000 & 201D Flow Meters and Rods
1/2 gal water sample bottles
Metal sampling bottles/syringes/filters/Nitric acid
Turtox Indestructible Benthos Net
Smith-Root Model 15-B Backpack Electrofishing Device
Periphyton Samplers (described in Periphyton Results Section)

PERIPHYTON

Periphyton samplers were deployed at the POT01A, POT01B and POT02 sample sites on May 19, 1994, and retrieved on May 31, 1994. On August 30, 1994 the samplers were again set out, but this time at the POT01B, POT02B, and JNC02 sample sites. The JNC02 site was chosen as a possible reference stream site, thus replacing the POT01A site where there was a lack of water during the summer sampling. The samplers were retrieved on September 7, 1994.

MACROINVERTEBRATES

Macroinvertebrate communities were sampled above the discharges (POT01B) and below the discharges (POT02B) on May 23, 1994. On August 30, 1994, macroinvertebrates were collected at the same sites above and below the discharges and in Jones Creek.

FISH COMMUNITY

On May 19, 1994, fish communities were sampled in the Poteau River above the city (POT01A), and above and below the discharge (POT01B and POT02B) sites. On August 29-30, 1994, sites above and below the discharges were resampled and Jones Creek (JNC02) was sampled as a possible control. Fish communities and macroinvertebrate communities were sampled at the same sites during both spring and summer sampling.

WATER QUALITY SAMPLING DATA

METHODOLOGY

Collection and analyses of stream samples were conducted according to ADPC&E's Quality Assurance Plan for Ambient Water Quality and Compliance Sampling. During collection of the samples, dissolved oxygen and stream temperature were measured using an Orion Model 840 portable dissolved oxygen meter. YSI Model 56 continuous dissolved oxygen meters were used to measure continuous temperature and dissolved oxygen values over a 24 to 48 hour period. The continuous meters were calibrated every 8 to 12 hours. Stream pH was analyzed using an Orion Model 230A portable pH meter, which was calibrated using buffer solutions of pH 4 and 7. Stream flow was measured using Marsh-McBirney Model 201 and 2000 flow meters by obtaining a representative number of velocities and depths across suitable stream locations.

DISSOLVED OXYGEN

Continuous dissolved oxygen (D.O.) meters were used to measure the diurnal fluctuation of both D.O. and temperature. On May 23, 1994 two meters were placed in the Poteau River; one above the Tyson and the Waldron discharges (POT01B) and one below the discharges (POT02B). On August 29, 1994 four meters were used for the study. Single meters were placed above the discharges and in Jones Creek (JNC02). Two meters were placed below the discharges (POT02B) in order to insure that the data collected was repeatable. The temperature and D.O. data collected from the duplicate meters was consistent.

Results of the May, 24-hour D.O. study show minimum D.O. concentrations of 6.0 mg/L (67.4 % saturated) and 5.7 mg/L (65.4 % saturated) above and below the discharges, respectively. Maximum D.O. concentrations were 8.6 mg/L above and 8.9 mg/L below the outfalls. Temperatures ranged from 21.0 °C to 25.5 °C for both sites. The D.O., percent saturation and temperature data from each meter is graphically represented in Figures 2 and 3. These data indicate very similar conditions above and below the discharges during the cool, spring conditions with significant flows.

During the August, 48-hour study, D.O. concentrations above the discharges ranged from less than 1.0 mg/L to 2.7 mg/L and water temperatures at the site ranged from 25.5 °C to 27.5 °C(Figure 4). Actual D.O. values were recorded below 0.5 mg/L; however the accuracy of the meters at the low end of the range is somewhat diminished. Typical, small-watershed reference streams from the Arkansas River Valley Ecoregion routinely decline to levels between 1 and 2 mg/L during low-flow, high temperature conditions. Upstream

FIGURE 2 SITE POT01B
May 23-24, 1994

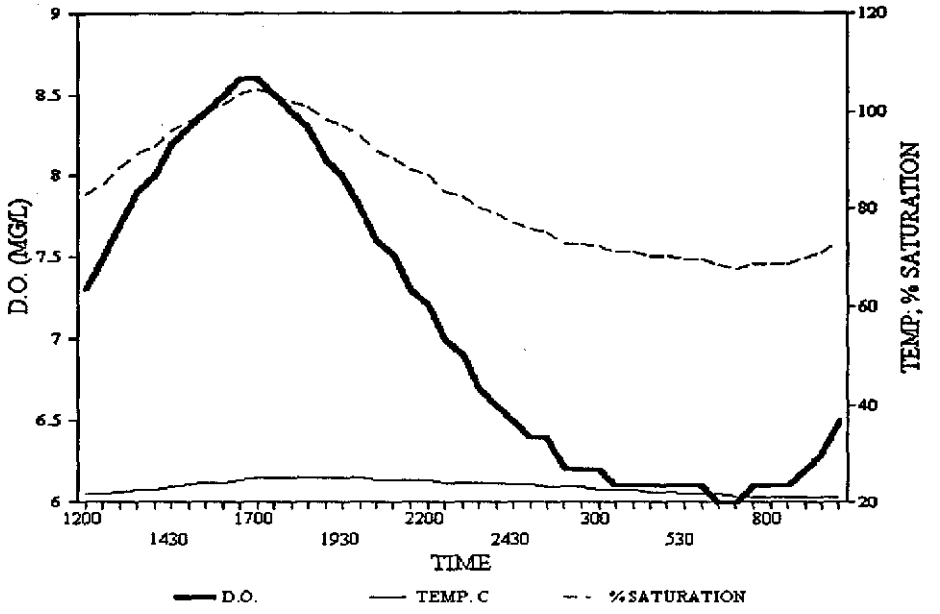


FIGURE 3 POT02B
May 23-24, 1994

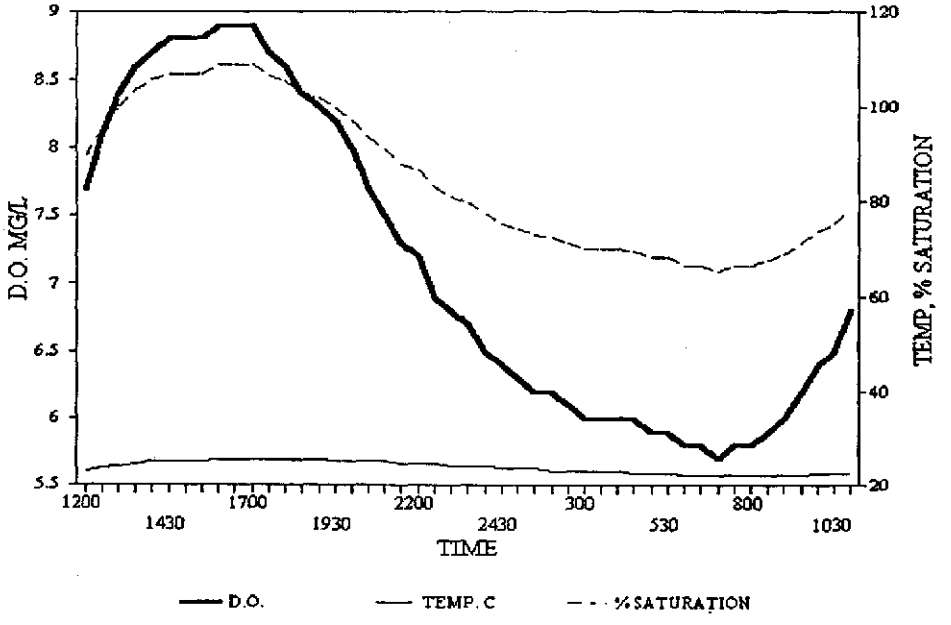
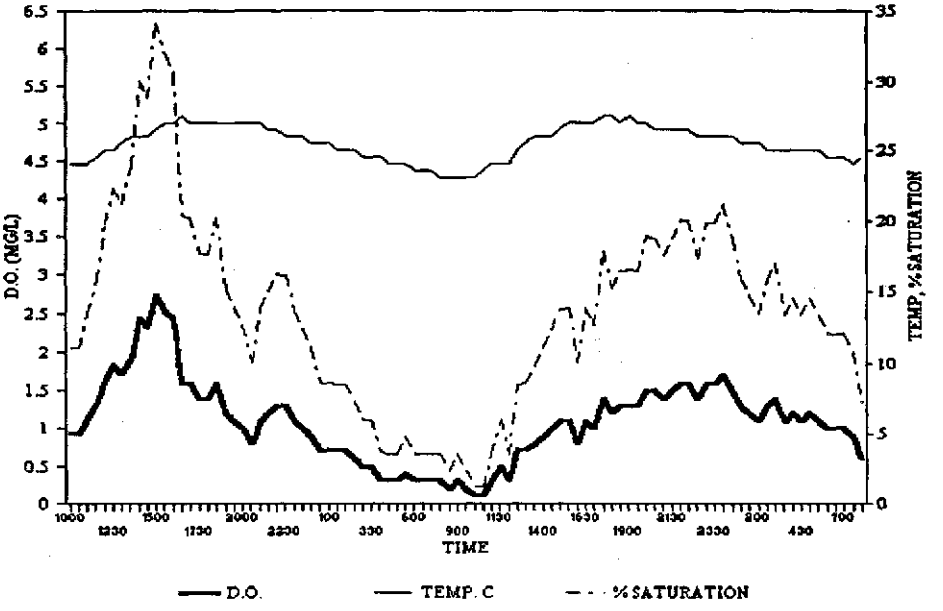


FIGURE 4 POT01B
August 29-31, 1994



impoundments on the Poteau River effectively reduce the summer flows in the river to the equivalent of a very small watershed. During the period this data was collected, flow in the river above the effluent discharges was near zero.

D.O. concentrations below the discharges ranged from 3.0 mg/L (37.1% saturated) to 6.1 mg/L (78.8 % saturated). Water temperatures ranged from 27.6 °C to 29.0 °C (Figure 5). Diurnal fluctuations of D.O. ranged between 2.5 mg/L and 2.8 mg/L. The D.O. values at the stations below the discharges were enhanced by the combined discharge flows of approximately 1.5 CFS and post-aeration of the discharges. There appeared to be no effect of the high nutrient levels from the discharges on the D.O. cycle immediately downstream.

D.O. concentrations in Jones Creek ranged from 3.0 mg/L (36.7 % saturated) to 6.1 mg/L (79.5 % saturated). Jones Creek temperatures ranged from 27.1 °C to 30.0 °C (Figure 6). Diurnal variations ranged between 2.8 mg/L and 3.0 mg/L. These values are typical of least-disturbed ecoregion streams in the Arkansas River Valley ecoregion.

FIGURE 5 POT02B
August 29-31, 1994

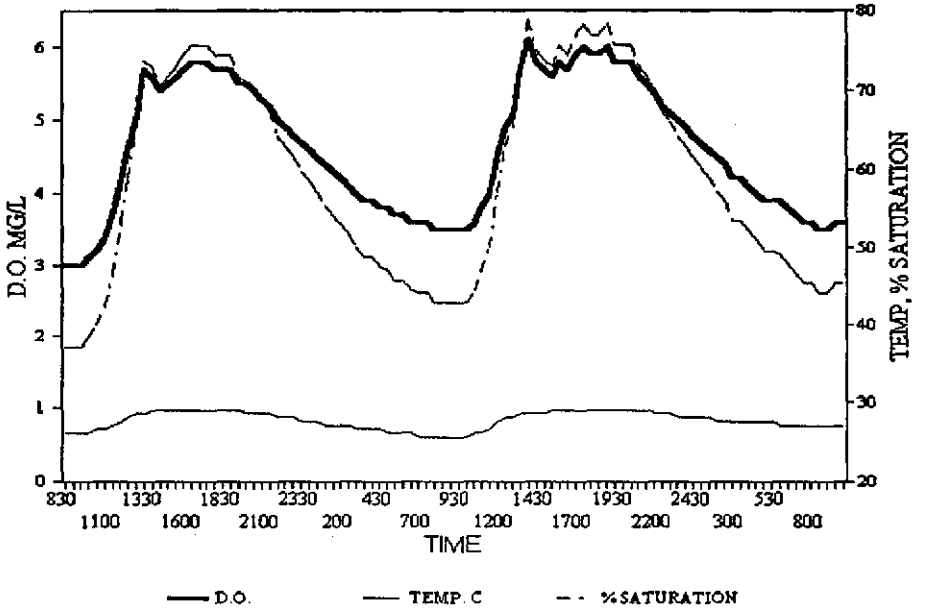
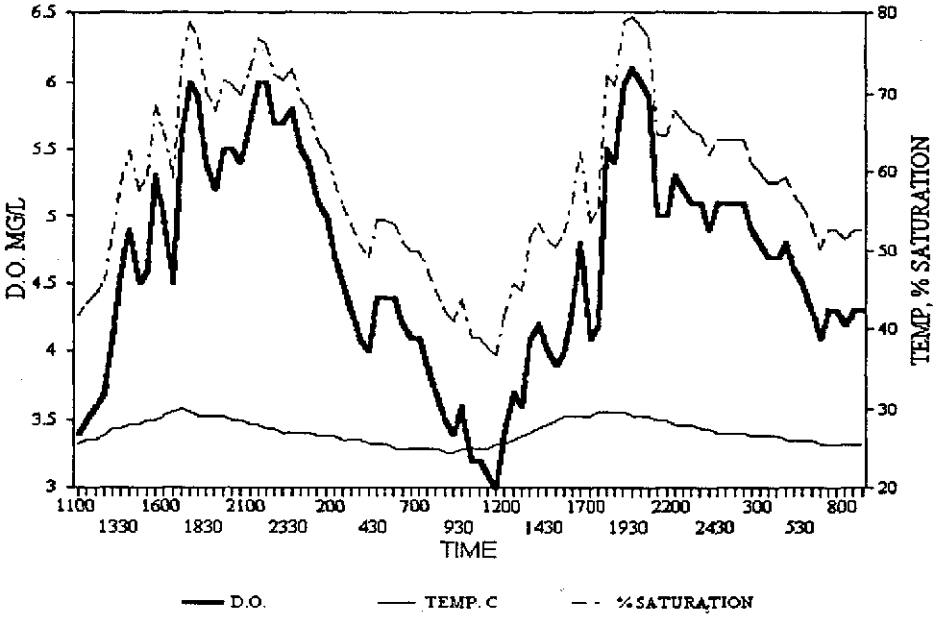


FIGURE 6 JNC02
August 29-31, 1994



pH AND TEMPERATURE

Stream pH values measured during the study were slightly higher than streams of comparable watershed size in the Arkansas River Valley Ecoregion. The May sampling event values ranged from 6.8 at JNC02 to 7.2 at POT04. The August sampling event pH values ranged from 7.0 at POT07 to 7.4 at POT02B. September pH values ranged from 7.0 at POT04 to 7.3 at POT02. Stream temperature values were typical of streams in the ecoregion. Table 1 provides data from all lab and in-situ analysis during the study.

CHLORIDES, SULFATES AND TOTAL DISSOLVED SOLIDS

ADPC&E's routine water monitoring network has established two stations on the Poteau River near Waldron, AR. Station ARK54 corresponds to POT01A and ARK55 corresponds to POT02. The 1994 Water Quality Inventory 305(b) Report summarized two years of sampling data from the two sites. Chloride concentrations at ARK54 (POT01A) ranged from 3 mg/L to 10 mg/L with a mean concentration of 5 mg/L. Chloride concentrations at ARK55 (POT02) ranged from 3 mg/L to 91 mg/L with a mean concentration of 31 mg/L. The ecoregion data indicates a "background" concentration of 5 mg/L for chlorides for watersheds of this size.

During this study, chloride concentrations in Jones Creek, the reference stream for the study, averaged 4 mg/L for the three sampling events. Instream chloride concentrations in the Poteau River ranged from 3 mg/L at POT01 in May to 93 mg/L at POT02B in August. The Waldron and Tyson discharges had average chloride concentrations of 40 mg/L and 107 mg/L respectively. As a result of the treatment system discharges, chloride concentrations are elevated above ecoregion and reference stream levels in the area immediately downstream from the discharges. The data suggests that the concentrations are returning to "background" concentrations further downstream.

Sulfate concentrations in the Poteau River watershed are higher than ecoregion background concentrations. Ecoregion reference streams have sulfate concentrations averaging 5 mg/L in the spring and 3 mg/L in the summer. The sulfate concentrations listed in the 305(b) report for ARK54 (POT01A) ranged from 5 mg/L to 20 mg/L with a mean of 11 mg/L. The sulfate concentrations for ARK55 (POT02) ranged from 6 mg/L to 64 mg/L. Sulfate concentrations in Jones Creek averaged 6 mg/L. Instream sulfate concentrations ranged from 7 mg/L at POT01 and POT01B in May to 40 mg/L below the discharges at POT02 in August. The Waldron and Tyson discharges had average sulfate concentrations of 34 mg/L and 47 mg/L, respectively.

TABLE 1 WATER QUALITY DATA

Spring

STATION	DATE	NH3-N mg/L	CL mg/L	NO3-N mg/L	O-PHOS mg/L	T-PHOS mg/L	SO4 mg/L	T-HARD mg/L	TOC mg/L	DO mg/L	BOD mg/L	PH std	W-TEMP Deg C	TURB NTU	TSS mg/L	TDS mg/L	FLOW cfs	
POT01	940524	<0.05	3	0.11	<0.03	0.07	7	19	4.2	7.4	1.6	6.9	21.3	17	12	53		
POT01B	940524	<0.05	3	0.10	<0.03	0.06	7	20	4.3	7.4	1.6	6.9	21.2	12	8	54		
POT02	940524	<0.05	23	1.04	2.17	2.78	19	28	4.6	7.4	1.8	7.1	22.5	15	13	137		
POT04	940524	<0.05	9	0.29	0.54	0.68	11	22	4.6	8.6	1.5	7.2	21.7	10	6	74		
JNC01	940524	<0.05	3	0.13	<0.03	<0.03	6	12	2.5	8.4	0.8	7.1	21.0	7	4	34		
JNC02	940524	<0.05	3	0.14	<0.03	0.04	6	12	2.6	7.0	1.4	6.8	21.1	14	12	39		
POT06	940524	<0.05	5	0.17	0.22	0.28	7	17	3.1	7.2	1.2	6.9	21.4	13	10	50		

Summer

STATION	DATE	NH3-N mg/L	CL mg/L	NO3-N mg/L	O-PHOS mg/L	T-PHOS mg/L	SO4 mg/L	T-HARD mg/L	TOC mg/L	DO mg/L	BOD mg/L	PH std	W-TEMP Deg C	TURB NTU	TSS mg/L	TDS mg/L	FLOW cfs	
POT01B	940831	0.06	7	0.05	0.19	0.15	13	68	7.4	1.1	3.9	7.3	24.0	4	7	99	4.7	
POT01B	940907	0.06	6	0.03	0.09	VOID	14	25	7.9	3.5	1.8	7.0	23.8	14	23	82	0.3	*
POTEW	940831	0.94	43	21.60	4.06	4.52	35	96	8.3	5.5	1.3	6.4	27.0	3	4	312	0.2	
POTEW	940907	0.38	37	19.70	3.13	VOID	34	67	8.5	6.6	1.4	6.0	26.4	3	3	262	0.4	
POTET	940831	0.95	109	0.11	11.40	11.90	43	58	10.7	7.0	2.6	7.3	31.2	3	4	457	1.3	
POTET	940907	0.30	105	0.06	19.20	VOID	52	44	13.1	6.8	4.1	7.3	30.9	3	5	442	1.3	
POT02	940831	0.18	79	3.80	7.79	7.72	34	68	10.3	4.5	1.8	7.4	27.5	6	7	340	6.1	*
POT02	940907	0.17	72	3.30	11.00	VOID	40	41	11.2	6.2	1.5	7.3	26.7	5	3	330	2.0	*
POT02B	940831	0.11	93	4.69	8.52	8.30	38	69	10.8	3.5	1.5	7.4	26.4	7	7	389	4.3	
POT02B	940907	0.10	56	3.33	5.51	VOID	33	40	11.3	4.7	1.7	7.2	24.7	9	4	269	2.1	
POT04	940831	0.12	64	0.73	4.08	3.88	30	54	9.5	3.2	1.1	7.2	26.0	3	<1	263	1.8	
POT04	940907	0.13	23	0.85	1.53	VOID	19	26	9.6	4.8	1.4	7.0	24.2	11	2	134	3.1	
JNC02	940831	0.09	4	0.06	0.03	0.08	5	43	5.7	4.3	VOID	7.0	25.5	5	2	50	0.3	
JNC02	940907	0.14	5	0.19	0.08	VOID	7	18	6.8	5.7	1.5	7.1	23.6	19	7	56	2.9	
POT07	940831	0.08	14	<0.02	0.10	0.11	9	49	6.2	4.5	1.9	7.0	27.0	7	7	85	1.1	
POT07	940907	0.14	6	0.27	0.32	VOID	9	15	7.8	4.5	2.0	7.1	25.5	50	11	71	8.5	

* Calculated value based on upstream flows

Total dissolved solids (TDS) concentrations for the Arkansas River Valley ecoregion reference streams averaged 46 mg/L in the spring and 59 mg/L in the summer. TDS concentrations above the discharges at ARK54 (POT01A) ranged from 46 mg/L to 193 mg/L and averaged 73 mg/L. TDS concentrations for ARK55 (POT02) ranged from 45 mg/L to 558 mg/L and averaged 221 mg/L. Jones Creek TDS concentrations averaged 45 mg/L. During this study, instream TDS concentrations in the Poteau River ranged from 53 mg/L at POT01 in May to 389 mg/L at POT02B in August. TDS concentrations in the Waldron and Tyson discharges averaged 287 mg/L and 450 mg/L respectively.

Overall, mineral concentrations are elevated considerably above ecoregion and reference stream concentrations in the area below the treatment system discharges. A decreasing trend in mineral concentrations is evident as one moves downstream from the discharges. This is a result of dilution from increased stream flows downstream.

Figure 7 demonstrates the mineral concentrations (Chlorides, Sulfates, TDS) in the Poteau River above and below the discharges during the May sampling period. Below the discharges (POT02) substantial increases are evident. Approximately 6.5 miles downstream from the discharges (POT04) mineral concentrations remain only slightly elevated. An additional 10 miles downstream, values have returned to near background levels, partially through the influence of Jones Creek flows.

The impact of the effluent discharges on the mineral concentrations in the Poteau River during the summer, low flow conditions is partially demonstrated in Figure 8. Although the relatively large dilution flows, from the water supply line rupture, resulted in greater dilution of the effluents (POTEW, POTET) at the stations immediately below the discharges, the remaining downstream stations continue to demonstrate the impact of the Tyson and Waldron effluents on the minerals concentration in the Poteau River during low flow conditions. The Jones Creek station (JNC02) exhibits typical mineral concentrations.

Figure 9 shows the effect of a more typical flow pattern of very low flows upstream with gradually increasing flows downstream. The flows are somewhat elevated downstream due to a storm event a few days prior to sampling. The effluent discharges noticeably elevate the minerals in the Poteau River (POT02, POT02B, POT04). Several miles below the influence of Jones Creek and with noticeably increased flows, the minerals concentrations at POT07 are near reference stream levels.

FIGURE 7 MINERALS CONCENTRATION
May 24, 1994

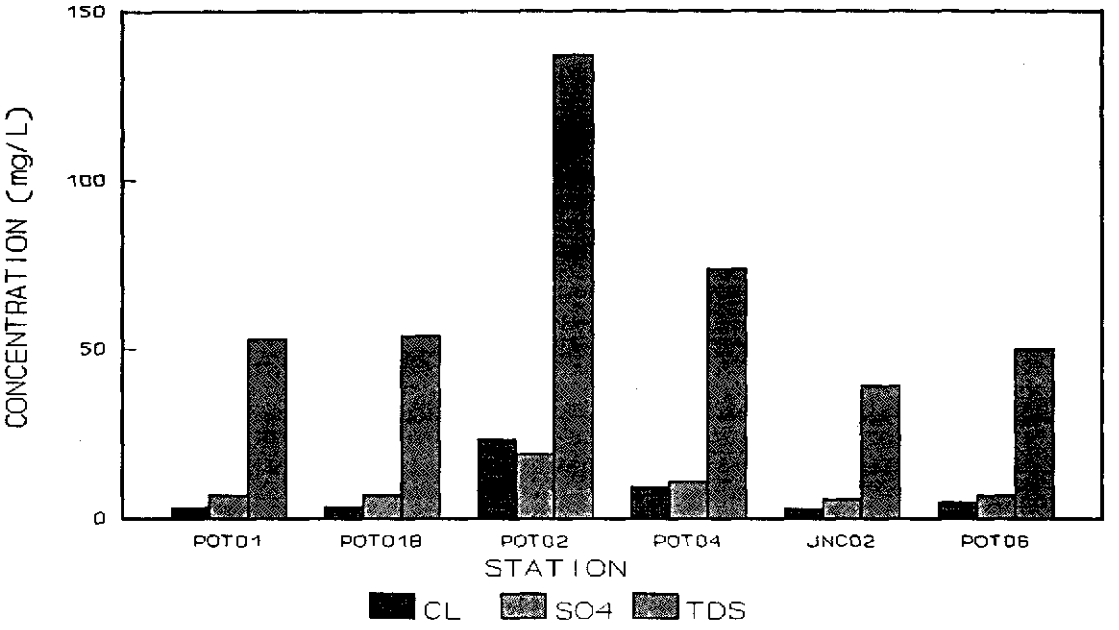


FIGURE 8 MINERALS CONCENTRATION
August 31, 1994

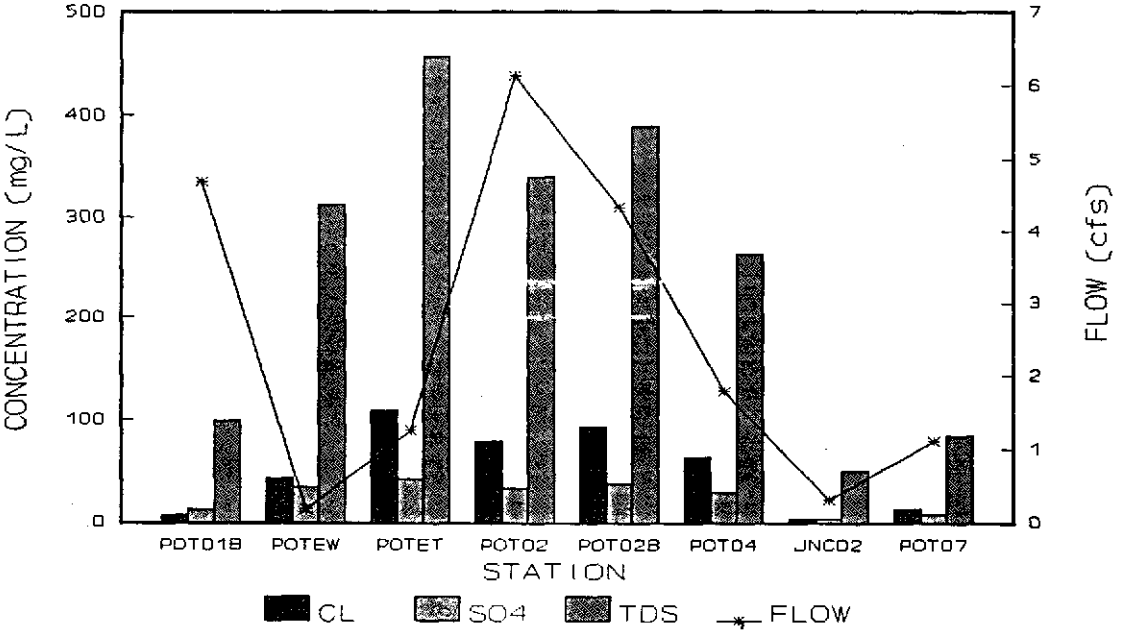
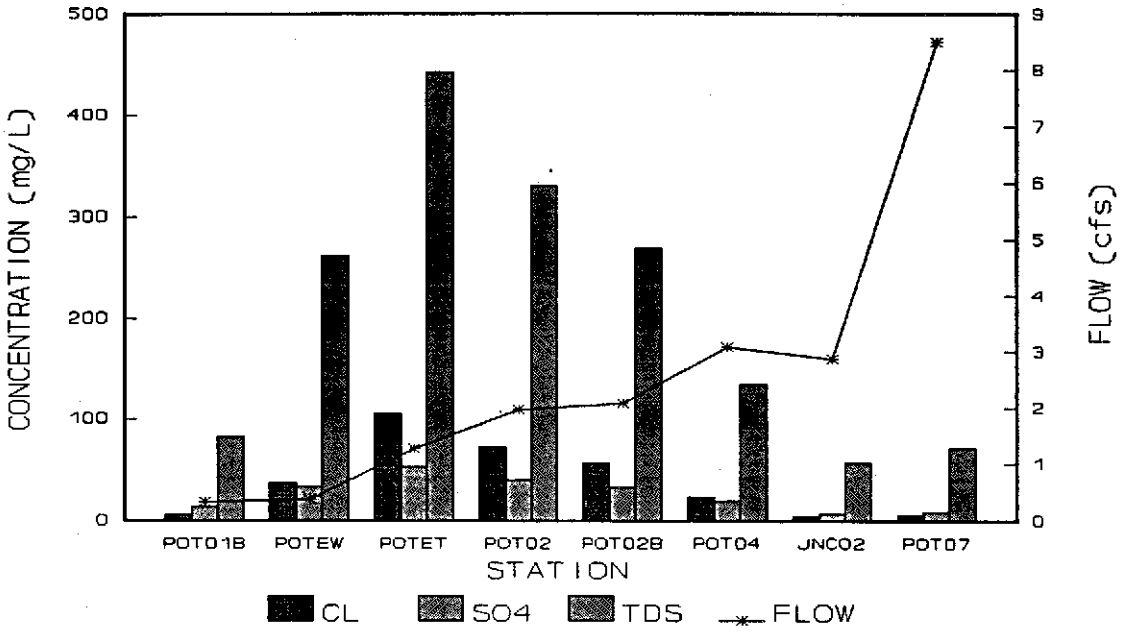


FIGURE 9 MINERALS CONCENTRATION
September 7, 1994



NUTRIENTS

Nutrient concentrations in the Poteau River followed the same general trend as mineral concentrations. Significantly higher concentrations were found below the discharges and a gradual decrease was apparent downstream. Instream ammonia-nitrogen at all stations sampled during the May study were at or below the detection level of 0.05 mg/L. During the two summer sampling events, ammonia-nitrogen concentrations in the stream stations ranged from 0.06 mg/L to 0.18 mg/L, including a value of 0.14 mg/L in Jones Creek. Ammonia-nitrogen concentrations were elevated, but remained below 1 mg/L in both effluent samples during the summer sampling.

Nitrate-nitrogen concentrations from the 1994 305(b) reporting period above the discharge (ARK54, POT01A) ranged from 0.03 mg/L to 0.29 mg/L with a mean of 0.12 mg/L. Concentrations below the discharges (ARK55, POT02) for the same period ranged from 0.03 mg/L to 24.20 mg/L with a mean of 4.32 mg/L. During this study, nitrate-nitrogen concentrations in Jones Creek ranged from 0.06 mg/L to 0.19 mg/L and averaged 0.13 mg/L for the three sampling events. As shown in Figure 10, nitrate-nitrogen concentrations during the May sampling event were only slightly elevated below the discharges (POT02) and returned to typical levels at station POT06. Higher dilution flows relative to the discharges caused these relatively low instream values in the Poteau River.

FIGURE 10 NITRATE CONCENTRATIONS
May 24, 1994

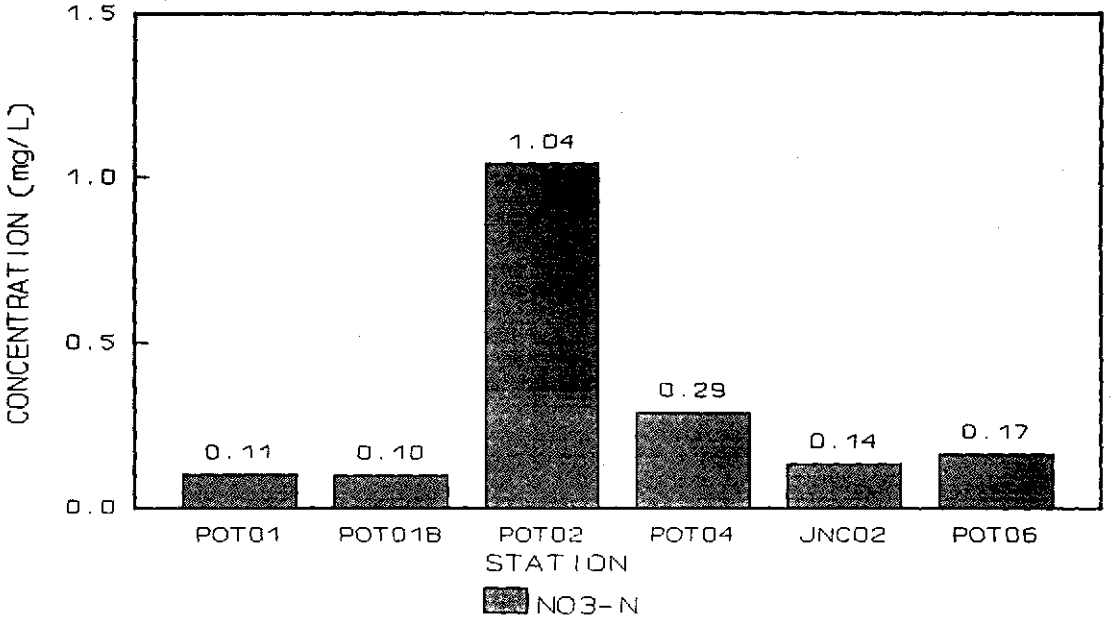


Figure 11 shows the impact of nitrate-nitrogen discharges from the city of Waldron waste treatment plant (WTP). During the August sampling the discharge from the Waldron WTP had a nitrate nitrogen concentration of 21.6 mg/L; the Tyson WTP discharge contained 0.11 mg/L nitrate-nitrogen. Even with the elevated flows from the water supply pipeline discharge into the river, noticeably elevated nitrates were measured below the discharge (POT02, POT02B). At POT04 slightly elevated levels were also measured.

A similar pattern of nitrate values was found in the September sampling as shown in Figure 12. Upstream flows were substantially lower during this period and the nitrate concentrations from both the Waldron and Tyson discharges were slightly lower. Downstream flows were, however, higher than during the August sampling.

During this study, ortho-phosphate concentrations in Jones Creek were below the laboratory detection limit of 0.03 mg/L in May, 0.03 mg/L in August and 0.08 mg/L in September. However, as shown in Figure 13, ortho-phosphate concentrations in the Poteau River in May were significantly increased below the discharges (POT02). Ortho-phosphate concentrations remained elevated as far downstream as POT06. The effects of the Tyson WTP ortho-phosphate discharges during the summer sampling are demonstrated in Figures 14 and 15. During the August sampling(Figure 14), the discharge from the Tyson

FIGURE 11 NITRATE CONCENTRATIONS
August 31, 1994

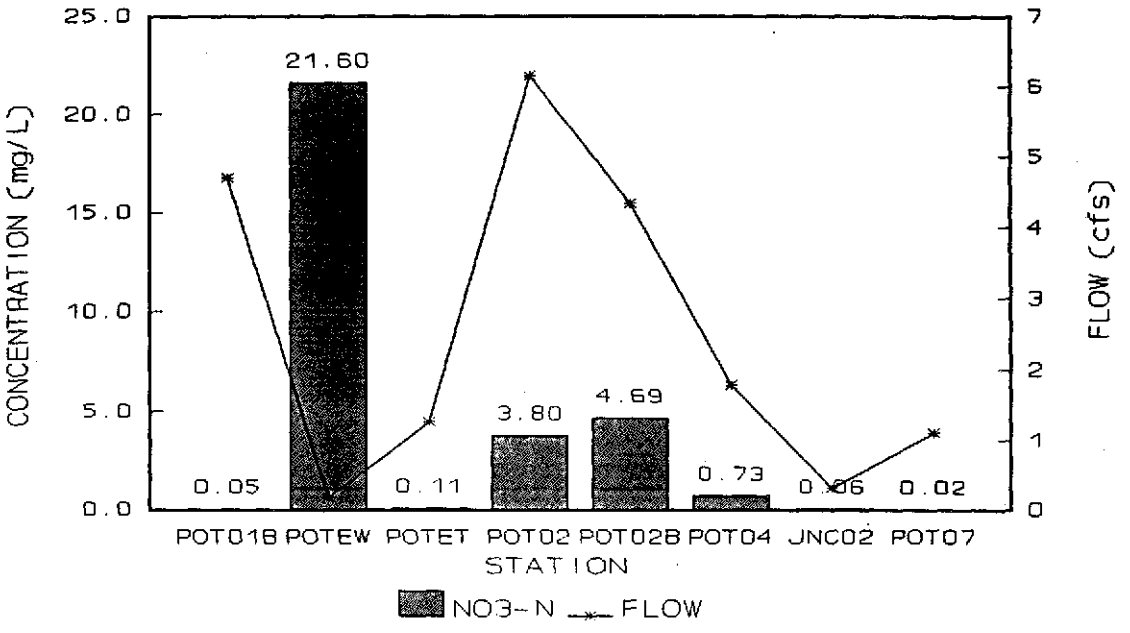


FIGURE 12 NITRATE CONCENTRATIONS
September 7, 1994

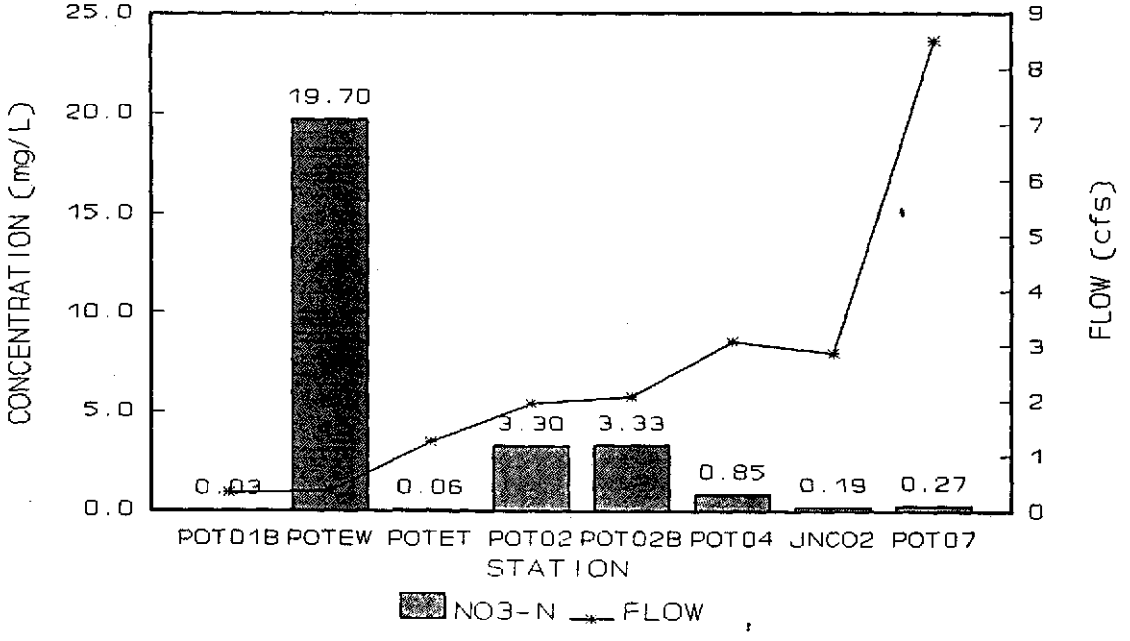
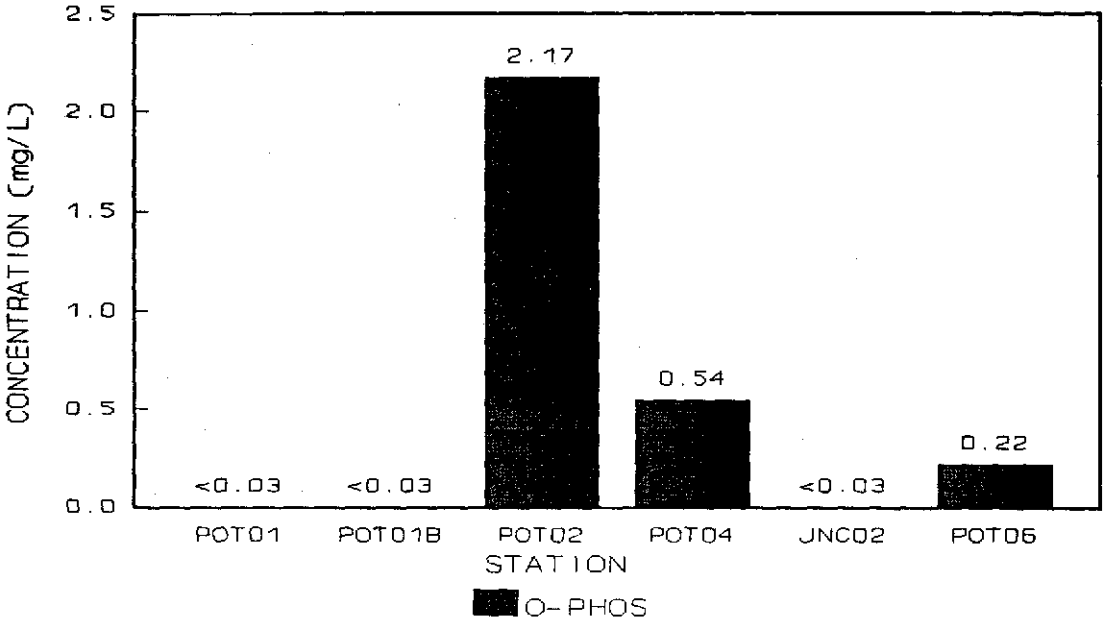


FIGURE 13 ORTHO-PHOSPHATE CONCENTRATIONS
May 24, 1994



WTP had a ortho-phosphate concentration of 11.40 mg/L; the ortho-phosphate concentration of the Waldron WTP discharge was measured at 4.06 mg/L. Elevated ortho-phosphorous concentrations were measured as far downstream as POT04.

Figure 15 demonstrates a similar pattern of values for the September sampling event. The ortho-phosphate concentration of the Tyson discharge was measured as 19.20 mg/L and the Waldron discharge had a concentration of 3.13 mg/L. Elevated levels were still apparent approximately 17 miles downstream at POT07.

Total phosphorous concentrations in Jones Creek ranged from below laboratory detection limits of 0.03 mg/L to 0.08 mg/L with an average concentration of 0.05 mg/L. Poteau River instream total-phosphorous concentrations in May ranged from 0.06 mg/L above the discharges at POT01B to 2.78 mg/L below the discharges at POT02. During the August sampling event, concentrations ranged from 0.11 mg/L to 8.30 mg/L. It is apparent from the data that the ortho-phosphate from the Waldron and Tyson discharges make up the majority of the total phosphorous in the river under the flow regimes which were monitored.

FIGURE 14 ORTHO-PHOSPHATE CONCENTRATIONS
August 31, 1994

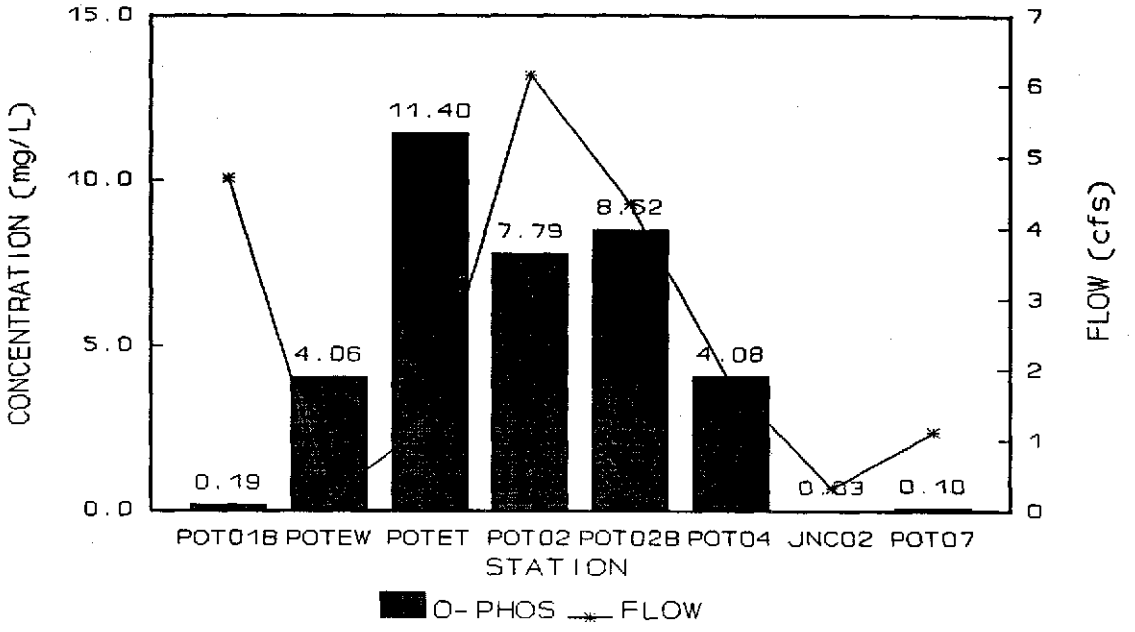
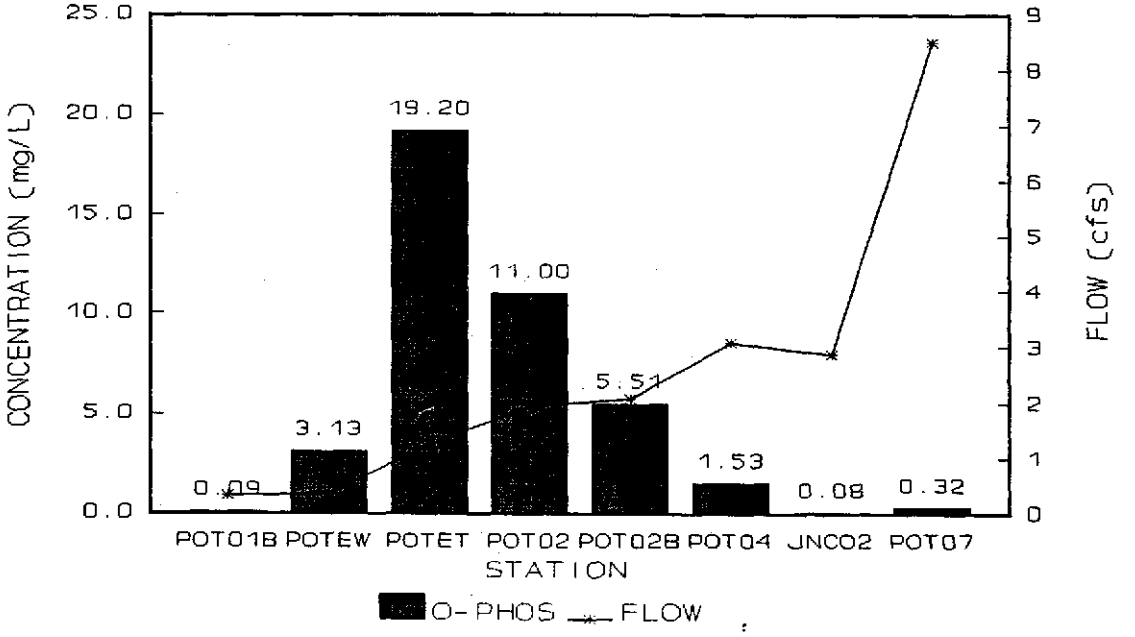


FIGURE 15 ORTHO-PHOSPHATE CONCENTRATIONS
September 7, 1994



Figures 16 and 17 illustrate the relationship of nutrient concentrations in the Waldron and Tyson WTP discharges for the August and September sampling event. The Waldron discharge is dominated by nitrates while the Tyson discharge is dominated by phosphates. It is also evident that ortho-phosphate (reactive phosphorous) comprises almost 90% of the total phosphorous from Waldron and over 95% of the phosphorous from the Tyson discharges.

TOTAL HARDNESS AND TOC

The average total hardness values reported for Arkansas River Valley ecoregion reference streams are 15 mg/L in the spring and 29 mg/L in the summer. Poteau River instream total hardness concentrations reported from the three sampling events ranged from 15 mg/L at POT07 to 69 mg/L at POT02B in August. Concentrations in Jones Creek ranged from 12 mg/L to 43 mg/L and had an average concentration of 21 mg/L. Total Hardness concentrations of the Waldron and Tyson discharges averaged 81 mg/L and 51 mg/L respectively.

Poteau River instream total organic carbon (TOC) concentrations ranged from 3.1 mg/L at POT06 in May to 11.3 mg/L at POT02B in September. TOC concentrations of the Waldron and Tyson discharges averaged 8.4 mg/L and 11.9 mg/L which is higher than upstream or least disturbed stream values. Jones Creek TOC concentrations ranged from 2.5 mg/L to 6.8 mg/L with an average concentration of 5.0 mg/L.

FIGURE 16 WALDRON & TYSON NUTRIENT CONCENTRATIONS
August 31, 1994

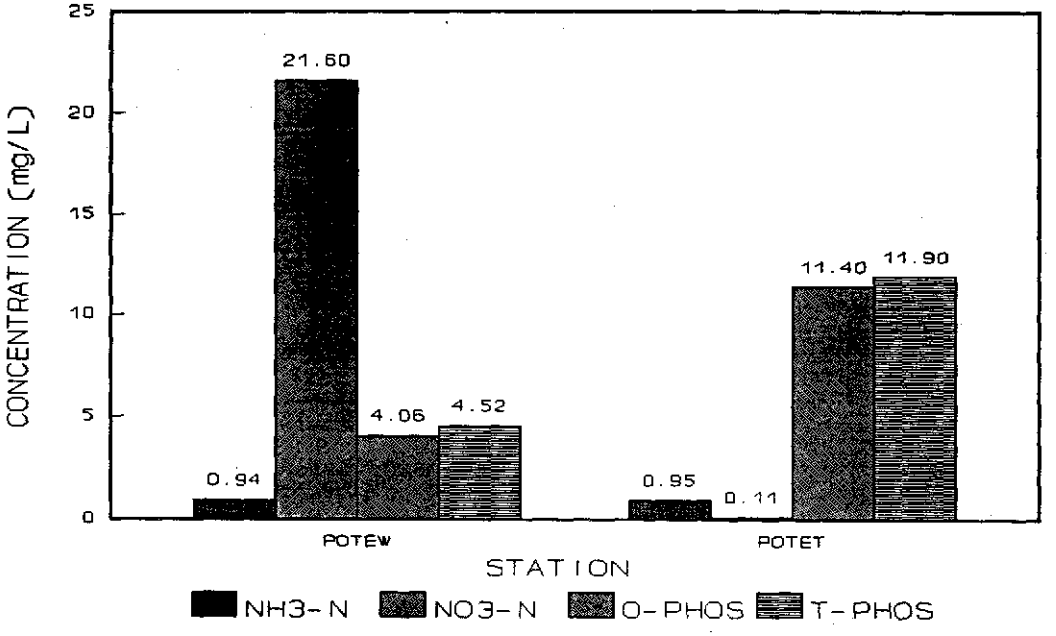
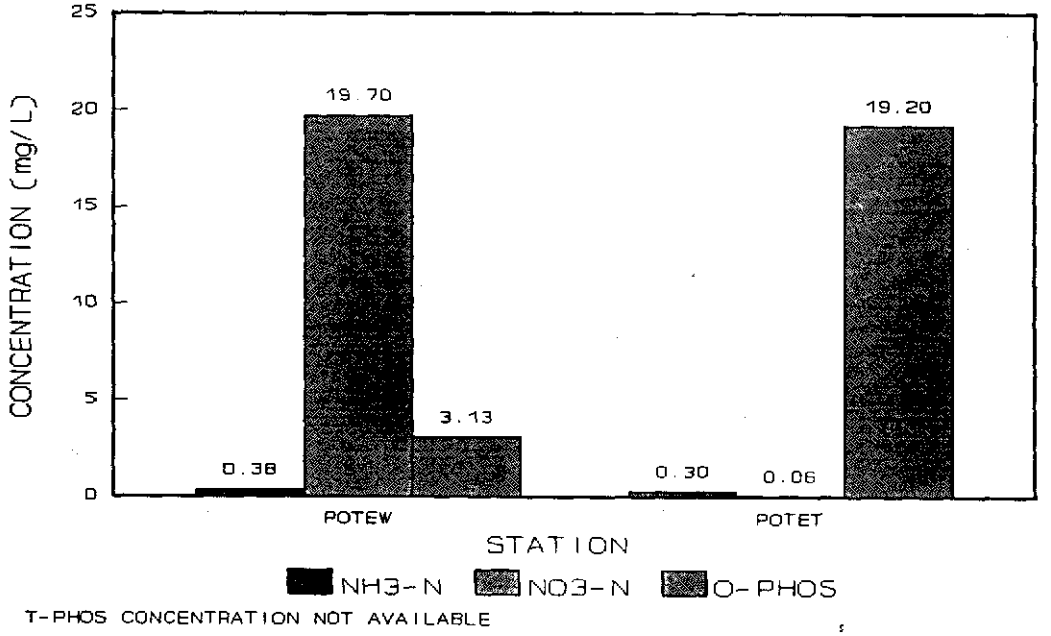


FIGURE 17 WALDRON & TYSON NUTRIENT CONCENTRATIONS
September 7, 1994



T-PHOS CONCENTRATION NOT AVAILABLE

TSS AND TURBIDITY

Total suspended solids (TSS) and turbidity values were relatively low during the study. Values in the effluent discharges are lower than instream values. Poteau River TSS concentrations ranged from <1 mg/L at POT04 in August to 23 mg/L at POT01B in September. TSS concentrations in Jones creek ranged from 2 mg/L to 12 mg/L with an average concentration of 6 mg/L. TSS concentrations in the Waldron and Tyson discharges averaged 3 mg/L and 5 mg/L respectively.

Instream turbidity values ranged from 4.2 NTU at POT01B in August to 50 NTU at POT07 in September. Turbidity values in Jones Creek ranged from 5 NTU to 19 NTU with an average of 11 NTU for all sampling events. Average turbidity values of the samples collected from the Waldron and Tyson discharges were each 3 NTU. All turbidity values except the downstream station on the Poteau River in September which had elevated summer flows, were within the water quality standard of 21 NTU for Arkansas River Valley ecoregion streams.

METALS

Samples were collected from POT01B, POTEW, POTET, and POT02 on September 7, 1994 for analyses of the dissolved portion of Cadmium (Cd), Chromium (Cr), Copper (Cu), Lead (Pb), and Zinc (Zn). Sample results are listed below in Table 2.

TABLE 2 DISSOLVED METALS CONCENTRATIONS

STATION	DATE	Cd ug/L	Cr ug/L	Cu ug/L	Pb ug/L	Zn ug/L
POT01B	940907	<.500	<1	<4	<2	15.0
POTEW	940907	<.500	<1	23.0	<2	200.0
POTET	940907	<.500	<1	5.00	<2	73.0
POT02	940907	2.50	3.80	9.00	<2	57.00

Figures 18, 19, and 20 compare the significant values of cadmium, copper, and zinc at the four sample points to the acute toxicity criteria listed in EPA's "Quality Criteria for Water 1986" (Gold Book) utilizing the criteria as dissolved values. Since the criteria are related to the water hardness, the hardness values at each sample point at the time of sampling was used to calculate the acute toxicity value.

FIGURE 18 CADMIUM
September 7, 1994

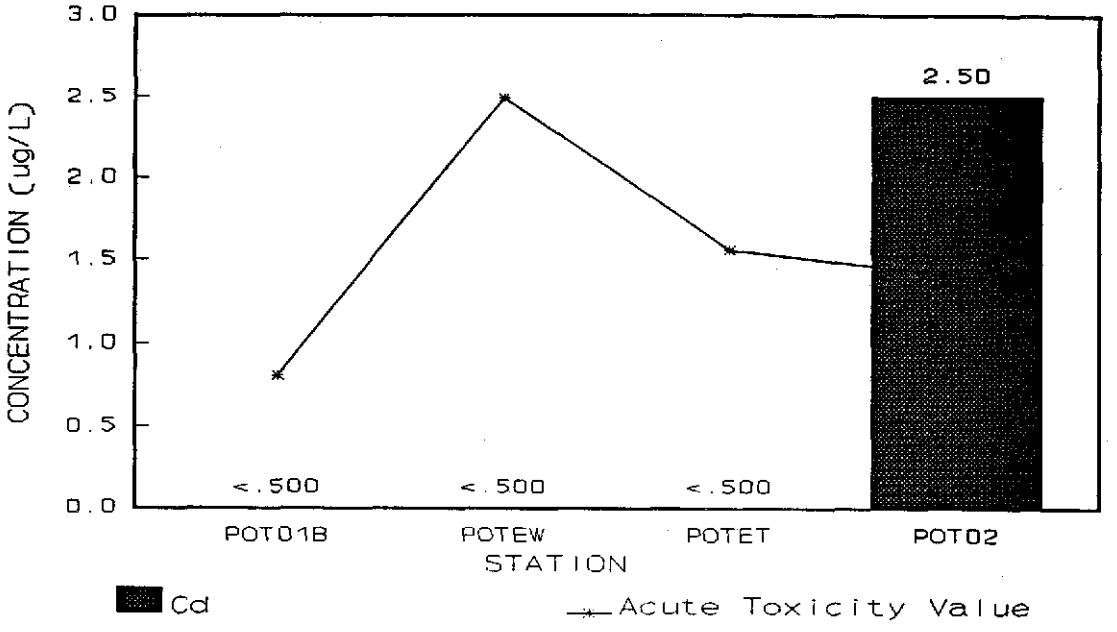


FIGURE 19 COPPER
September 7, 1994

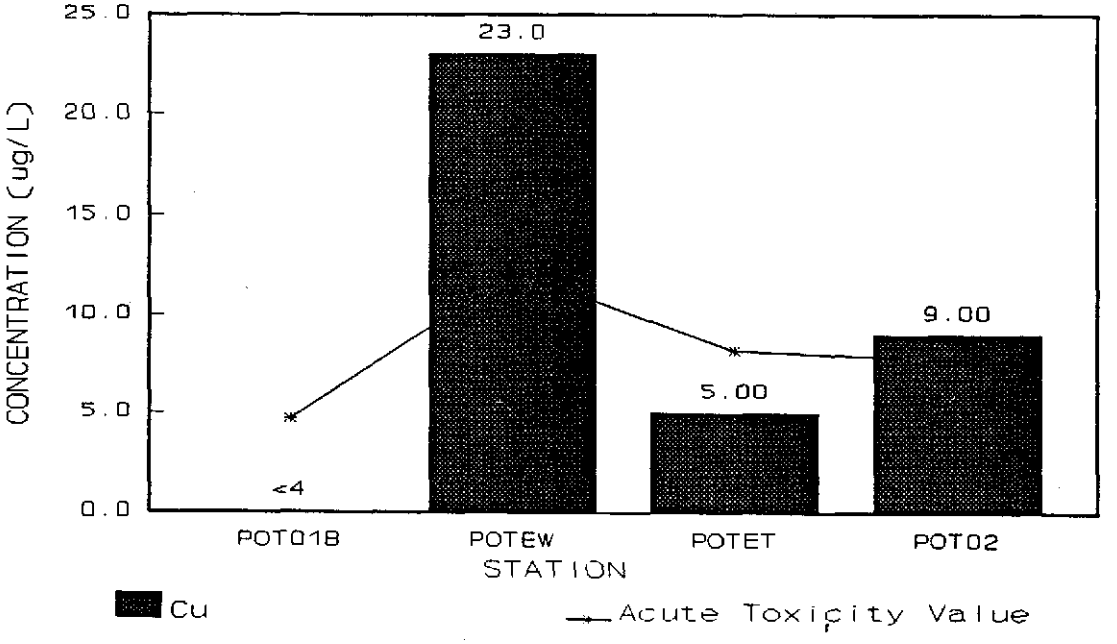
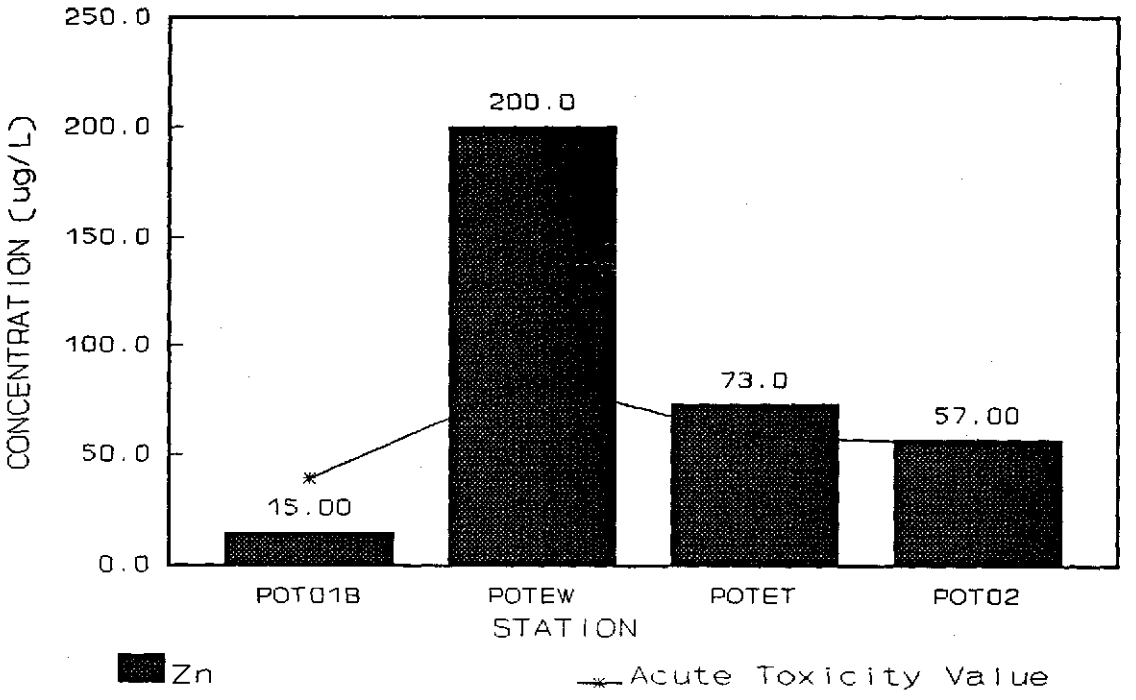


FIGURE 20 ZINC
September 7, 1994



Cadmium levels exceeded the criteria in the Poteau River below the discharges; however, Cadmium levels were below detection levels upstream and in each of the effluent discharges(Figure 18). A similar pattern is seen for Chromium values, although the level below the discharge is well below the acute toxic criteria for Chromium.

Dissolved copper values significantly exceeded the criteria in the City of Waldron discharge and slightly exceeded toxic values in the Poteau River below the discharge(Figure 19). Zinc levels significantly exceeded the toxicity criteria in the Waldron discharge and slightly exceeded the criteria in the Tyson discharge and downstream in the Poteau River(Figure 20).

PERIPHYTON

An attempt was made to measure the productivity of the Poteau River based on the growth of periphyton. Samplers were constructed by fitting concrete blocks with two aluminum microscope slide holders that would permit a total of 12 glass slides to be used with each sampler. Using this number of slides per sampler, six would be analyzed for Chlorophyll A and six for dry weight.

Many factors affect the growth of the periphytic community. All must be considered when choosing sample sites for comparison. These factors include availability of light, turbidity, substrate type, depth, water currents and velocity, and water chemistry. Since a comparison was to be made of the periphytic community above and below the discharges, great care was taken in choosing sample sites that were as similar as possible.

On May 19, 1994, two samplers were deployed at site POT01A. Because POT01A had been chosen as a duplicate site, these were placed in tandem in the river flow. Samplers were also placed at stations POT01B and POT02. On May 31, 1994, these were retrieved from the river, the glass slides were removed and preserved for transport to the laboratory for analysis.

Samplers were again deployed on August 30, 1994 at stations POT01B, POT02B, and JNC02. The JNC02 site was to be used as a possible reference site due to low water conditions at the POT01A site. During the spring sampling event, high flows in the Poteau River caused several samplers to be overturned, resulting in the loss of the slides. To reduce the risk of this occurring in August, three samplers were placed in tandem at each station. These were recovered on September 7, 1994 and returned to the laboratory for analysis.

As with the spring sampling event, several periphyton samplers were overturned due to high flow conditions in August. These occurrences, combined with the difficulty in finding the near identical conditions needed for sample placement has led to the decision that the data obtained did not meet our QA standards and was not used in this assessment.

MACROINVERTEBRATES

Two macroinvertebrate stations were established in the Poteau River above and below the point source discharges, for purpose of determining any impact on the benthic community from the Tyson Foods and Waldron wastewater effluents. One site was located approximately 300 yards above the effluent ditch confluence to the river (POT01B). The other site was located approximately 600 yards below the effluent discharges (POT02B). One additional site was established during the August survey. It was on Jones Creek approximately 400 yards above the confluence with the Poteau River.

These sites were sampled according to established rapid bioassessment protocol. A five minute riffle search was performed at each location. An indestructible Turtox benthos net was placed below a riffle area, then the substrate was agitated to dislodge the macroinvertebrates. From the five minute search, one hundred organisms were randomly selected and preserved in 70% ethyl alcohol. Identification was completed in the central laboratory.

The extent of impairment of the benthic community below the wastewater discharges was determined by use of the biometric scoring system. This system, which assigns scores to various characteristics of the benthic community, can define relative change between communities upstream and downstream of a pollutant source. The mean biometric score determines the extent of impairment ranging from none, minimal, substantial to excessive.

The biometrics, evaluated from the May and August survey data, focus primarily on community diversity, and consist of Dominants in Common (DIC), Common Taxa Index (CTI), Quantitative Similarity Index (QSI) and Taxa Richness (Shackleford, 1988). The DIC is defined as the number of dominants in common to both the upstream and downstream communities, regardless of their order of abundance. For this metric, the dominants are the five most abundant taxa, each of which usually have a relative abundance of greater than seven percent. The CTI is a qualitative metric since it deals only with the presence or absence of taxa and disregards relative abundance. The QSI focuses on percent similarity between two communities. This index not only taxonomically compares two communities in terms of presence or absence, but also takes relative abundance into account. Taxa Richness is used as a measure of community status where taxa refers to the lowest possible level of identification.

Community comparisons were made between the upstream Poteau River site and the downstream site below the discharges. As might be expected, the downstream Poteau River benthic community appears to be impacted more during August than in May. The stream flow was dominated by the poultry processing and municipal effluents in August, whereas during the May survey, the flow was dominated by watershed runoff.

A comparison of the August benthic community below the discharges to that located at the upstream site revealed fewer taxa downstream, a DIC value of 3 (minimal impairment), CTI of 0.35 (substantial impairment) and a QSI of 45 (substantial impairment). An evaluation of another metric, taxa richness, between these two sites indicates a difference of 42%, which is in the substantial impairment range. Several pollution tolerant organisms were present in the downstream community, but absent from the upstream site. Ephemeroptera taxa decreased from four upstream to one downstream, with an associated percentage shift from 18% to 4% of the total sample. It is interesting to note the absence of the

mayfly, Caenis, at the downstream site during both surveys. This genus is a common inhabitant of streams containing areas of sediment substrates, yet it was not collected at the downstream station. A toxic impact from the effluent discharges may be a factor in this case. Evidence of excessive nutrient impact is the shift of filtering collector taxa from 23% to 45% from the upstream to downstream sites during the August survey, and an associated community shift wherein three taxa comprised over 60% of the total community below the discharges. Another metric, Functional Group Percent Similarity (FGPS), was evaluated in order to detect the degree of change in community function relative to an impact source. A value of 73 was obtained from the August data, which equates to a "substantial impairment" rating. Diversity indices decreased from 4.11 at the upstream site having minimal flow to 3.11 at the downstream site, which was dominated by effluent flow. Table 3 provides the biometric scores used to evaluate the August macroinvertebrate communities above and below the Tyson Foods wastewater and Waldron municipal wastewater effluents into the Poteau River.

Table 3. August Macroinvertebrate Community Comparison

Metric	Upstream	Downstream	Score	Impairment
Taxa Rich. (# Taxa)	26	15	2	% chnge 42 substant.
Diversity Index	4.11	3.11		% chnge 24
DIC	3	3	3	minimal
CTI			2	substant.
QSI			2	substant.
FGPS			2	% simil.73 substant.
Mean score			2.2	substant.

The total biometric score for all evaluated metrics was 2.2, which places the downstream macroinvertebrate community in the substantially impaired aquatic life use status.

A comparison of the May 1994 community structure at the two stream sites does not show the same extent of effluent impact, yet the QSI index of 47 is still in the "substantial impairment" range, while the DIC and CTI biometrics are in the "minimal impairment" category. A functional feeding group shift is still evident, with the filtering collectors increasing from one to ten percent from upstream to downstream, and the mayfly taxa decreasing from four to

three taxa. Percentage mayfly composition of the total sample decreased from 27% to 12%. As was previously mentioned, the stream flow in May was dominated by watershed runoff, so the impact from point source pollutants is less distinguishable. The habitat changes from a low flow condition to a higher flow at the upstream site impacts the macroinvertebrate sample to some degree. At low flow, the riffle area is very constricted, with flow confined to a cut channel less than two feet wide and a few inches deep. The surrounding substrate of the riffle area contains a dense water willow growth. The sampling effort is confined to that constricted riffle at low flow. At higher stream flow, water is flowing through and over the water willows, as well as elevating the depth over the narrow low flow riffle area. The sample site downstream consists of a different situation. The stream channel is much wider than upstream, the riffle area is wide and shallow, and encompasses a major portion of the stream width. Elevated flow at this site does not affect the sampling efficiency to the same degree as upstream because the depth is not as pronounced over the habitat sampled. Because of the better habitat, more taxa were collected at the downstream location during the May survey. Table 4 provides the results of the biometrics for this sample.

Table 4. May Macroinvertebrate Community Comparison

Metric	Upstream	Downstream	Score	Impairment
Taxa Rich. (# Taxa)	17	21	4	none
Diversity Index	2.99	3.6		% chnge 17
DIC	3	3	3	minimal
CTI			3	minimal
QSI			2	substant.
FGPS			4	none
Mean Score			3.2	minimal

The biometric total score for all metrics evaluated was 3.2, which places the downstream macroinvertebrate community in the minimal impairment aquatic life use status for the May sampling event.

Because Jones Creek was predominantly "pooled" during the August survey, data comparisons were not made between the Poteau River sites and this site. Riffle flow was minimal, and due to the width, was basically in an inter-gravel condition during the sampling event. As a result the sample was dominated by organisms adapted to a pool habitat. Rapid bioassessments were not conducted at this location during the May survey. The benthic species lists

and associated biometrics generated from this survey are included as Appendix A.

FISH COMMUNITY SURVEY

Fish community surveys were accomplished during the spring survey event in late May and also during the summer survey event in late August. Below is a list and short description of the sample sites used during both of these sampling events:

POT01A Poteau River from Hwy 80 bridge upstream 300 yds. This site consisted of approximately 60% shallow pools of bedrock, boulders and gravel substrate. The typical pool was 40 feet long and 20 feet wide and approximately two feet deep. The typical riffle was 30 feet long, 15 feet wide with a bedrock/cobble/gravel substrate with aquatic vegetation. Fish cover was moderately abundant. This site was collected only on May 19, 1994.

POT01B Poteau River above WTP discharges to 1/4 mi. upstream. This site was dominated by shallow pools, approximately 9:1 pool to riffle ratio, with sandy/silty substrate over a bedrock bottom, roots, treetops/logs and aquatic vegetation. The typical pool in May was 200 feet long, 50 feet wide and 3 feet deep, while in August the typical pool was 90 feet long, 30 feet wide, and 2 feet deep. The short riffles substrate were mainly gravel/sand with abundant aquatic vegetation. The typical riffle in May was 60 feet long, 30 feet wide and one foot deep, while in August the typical riffle was five feet long, 1 foot wide and less than six inches deep. Fish habitat was abundant. Collections were made at this site on May 19, 1994 and August 30, 1994.

POT02B Poteau River 500 yds downstream of Hwy 71, upstream to the bridge. This site was dominated by pools, approximately 90%, with sandy/silty substrate, treetops/logs and aquatic vegetation. The typical pool was 200 feet long, 40 feet wide and 3 feet deep. The short riffles had a cobble/gravel/sand substrate with aquatic vegetation and were 10 feet long, three feet wide and six inches deep. Much of this reach was a long, moderately deep pool (3 to 4 feet deep) with a rip-rap bank along the outside of the stream bend. Fish habitat was moderate. Collections were made at this site on May 19, 1994 and August 30, 1994.

JNC02 Jones Creek from 1/2 mi. above confluence with the Poteau River, upstream 1/4 mi. This site was approximately 80% pools and 20% riffles. The pool substrate consisted

mainly of bedrock and boulders with some roots, treetops and aquatic vegetation. The typical pool was 60 feet long, 40 feet wide and two to three feet deep. The typical riffle was 15 feet long, 10 feet wide and had a substrate mainly of boulders and cobble/rubble with some terrestrial vegetation. The fish habitat was abundant. This site was collected only on August 29, 1994.

METHODOLOGY

A Smith-Root model 15-B backpack electrofishing device with pulsed DC current was used to collect fish from these sites. The device was used in the shallow pools and along the pools edges 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 overturned and the fish were herded into the seine or washed in by the current.

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 unidentifiable in the field were preserved in a ten percent (10%) formalin solution and returned to the lab for identification.

RESULTS

SPRING

Collections were made at POT01A, POT01B, and POT02B during the spring survey event. There were 16, 21, and 21 species of fishes collected at each station, respectively. A list of species and their relative abundance as percent community is in Table 5. Figure 21 shows a great similarity above and below the discharge among the primary family or groups of fishes.

The Cyprinidae family (minnows) immediately above the discharges comprised 42% of the total community (POT01B) and 44% just below the discharges (POT02B). Despite this similarity, the species dominance within the cyprinid family between these two sites were quite different. Above the discharges (POT01B) the minnow community was dominated by the bigeye shiner, Notropis boops, followed by the red shiner, Cyprinella lutrensis, and the stoneroller, Campostoma anomalum. Below the discharges (POT02B) the red shiner was dominant followed by the stoneroller and bigeye shiner (Figure 22). Also noticeable was an increase in the bluntnose minnow, Pimephales notatus, population below the discharges. These differences suggest that a shift towards a more herbivorous community was occurring downstream of the discharges.

The Centrarchidae family (sunfishes) was about 49% of the community upstream and 42% downstream of the discharges. This may not be a significant difference; however, a shift in the dominant species within the family occurs. Above the discharges, green sunfish, Lepomis cyanellus, and bluegill, Lepomis macrochirus, were dominate followed by longear, Lepomis megalotis, and warmouth, Lepomis gulosus (Figure 23). Downstream at POT02B, longear were dominate and green sunfish and bluegill subdominate. This seems to indicate a more nutrient enriched environment upstream rather than downstream.

This difference may also be explained by the difference in habitat between the two sites. A long, deep pool with a rip-rap bank exists below the WTPs. In this habitat, longear were very abundant.

Gars, buffalo, and redhorse made up about 3% of the total community at the POT01B site. In contrast, they accounted for almost 6% of the community at POT02B. This group of fishes is normally associated with nutrient rich, slightly turbid or mineralized environments.

The Percidae family (Darters) was more abundant downstream than above the discharges. Even though the orangethroat darter was dominant at both locations, its near total dominance at the downstream location might suggest some impairment. The orangethroat darter adapts more readily to harsher conditions such as higher turbidity, nutrient enrichment and habitat alteration.

Fishes collected from POT01A during the spring sampling event were not used in the comparison of fish communities due to the extreme differences in habitat between the sites. Also, the POT01A site was not collected during the summer sampling event because of the extreme low flow conditions.

TABLE 5

POTEAU RIVER FISH COMMUNITY (Spring 1994)

Fish Family & Species		POT01A		POT01B		POT02B	
		# spc	% com	# spc	% com	# spc	% com
Lepisosteidae	Gars						
Lepisosteus oculatus	Spotted gar			1	0.32	5	1.33
Lepisosteus osseus	Longnose gar					2	0.53
Cyprinidae	Minnows						
Campostoma anomalum	Stoneroller	131	20.93	23	7.28	45	11.94
Cyprinella lutrensis	Red shiner	130	20.77	41	12.97	73	19.36
Luxilus whipplei	Steelcolor shiner			6	1.90		
Lythrurus umbratilis	Redfin shiner	5	0.80	4	1.27	4	1.06
Notropis boops	Bigeye shiner	48	7.67	54	17.09	29	7.69
Pimephales notatus	Bluntnose minnow	39	6.23	1	0.32	8	2.12
Pimephales vigilax	Bullhead minnow	5	0.80	4	1.27	7	1.86
Catostomidae	Suckers						
Ictiobus bubalus	Smallmouth buffalo			3	0.95	14	3.71
Moxostoma erythrurum	Golden redhorse			6	1.90		
Ictaluridae	Freshwater catfishes						
Ameiurus natalis	Yellow bullhead	3	0.48				
Ictalurus punctatus	Channel catfish			1	0.32		
Cyprinodontidae	Topminnows						
Fundulus notatus	Blackstripe topminnow			1	0.32	2	0.53
Fundulus olivaceus	Blackspotted topminnow	5	0.80	3	0.95	3	0.80
Poeciliidae	Livebearers						
Gambusia affinis	Mosquitofish	1	0.16			3	0.80
Atherinidae	Silversides						
Labidesthes sicculus	Brook silverside	1	0.16	1	0.32	1	0.27
Centrarchidae	Sunfishes						
Lepomis cyanellus	Green sunfish	54	8.63	56	17.72	44	11.67
Lepomis gulosus	Warmouth sunfish			12	3.80	4	1.06
Lepomis macrochirus	Bluegill sunfish			48	15.19	38	10.08
Lepomis megalotis	Longear sunfish	95	15.18	36	11.39	67	17.77
Lepomis hybrid	Hybrid sunfish	1	0.16				
Micropterus salmoides	Largemouth bass	2	0.32	4	1.27	4	1.06
Pomoxis nigromaculatus	Black crappie					1	0.27
Percidae	Perches						
Etheostoma spectabile	Orangethroat darter	74	11.82	7	2.22	20	5.31
Etheostoma whipplei	Redfin darter	32	5.11	4	1.27	3	0.80
	Total Species	16		21		21	
	Total Specimens	626		316		377	
	Catch per Hour	1139		296		399	

FIGURE 21

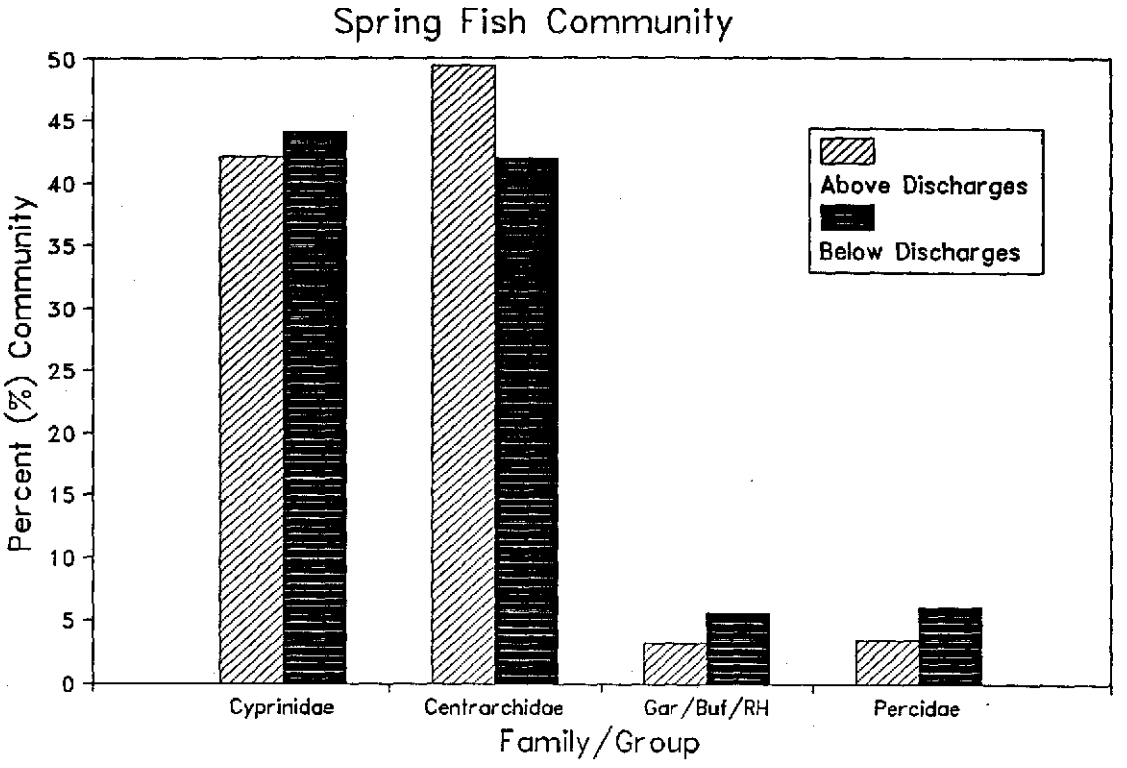


FIGURE 22

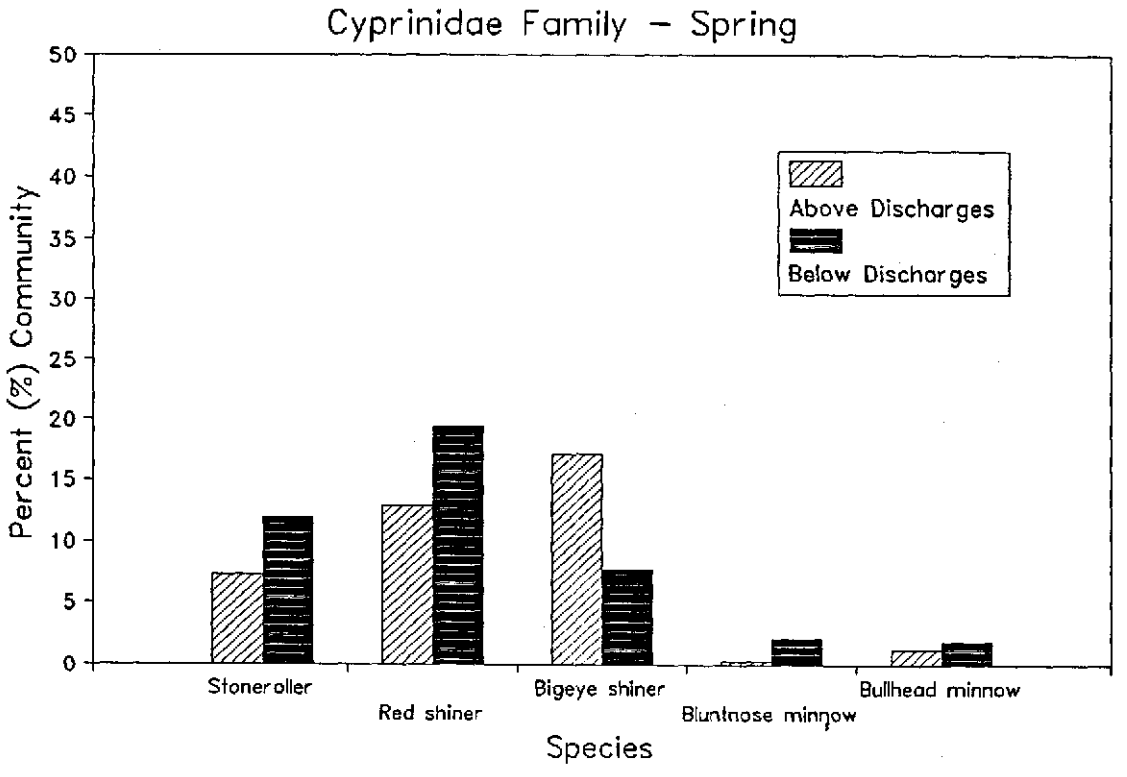
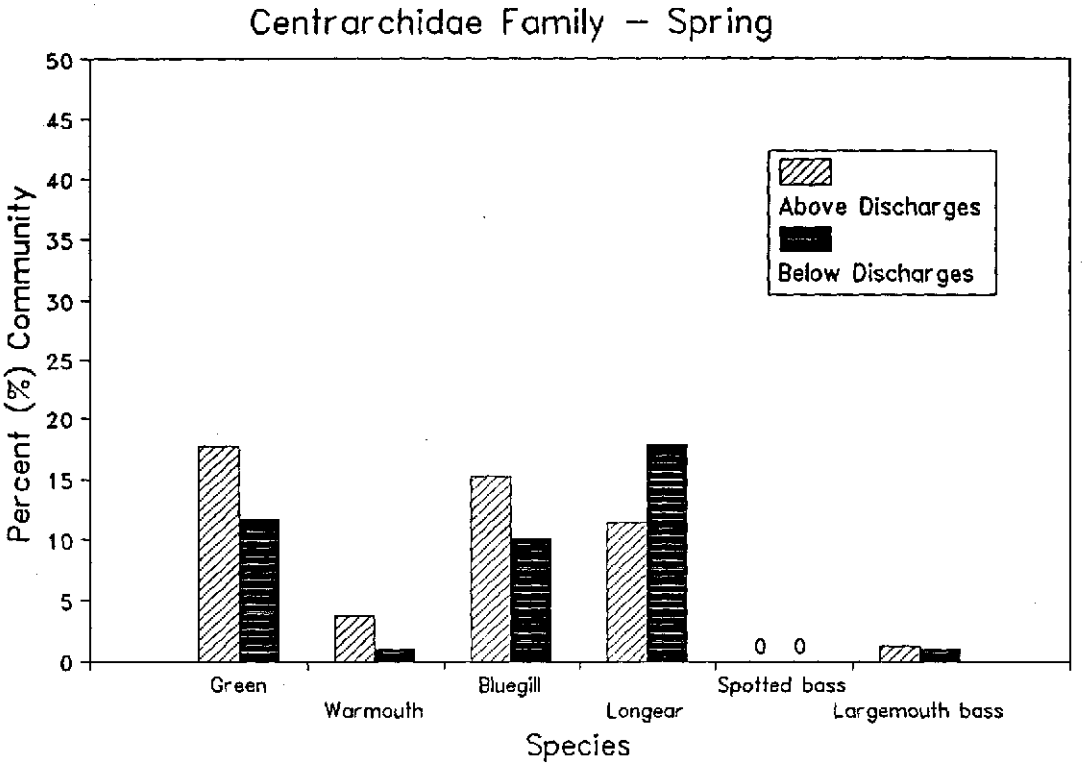


FIGURE 23



SUMMER

Fish community surveys were repeated at POT01B and POT02B during the summer sampling event. In addition, the Jones Creek site (JNC02) was sampled as an added reference. There were 30, 26, and 34 species collected from POT01B, POT02B, and JNC02, respectively. Table 6 list the species collected and their relative abundance as percent of total community.

Figure 24 shows the significant differences in the fish community above and below the discharges during the low flow, effluent dominated period. The Cyprinidae family made up only 20% to 30% of the total community above the discharges and in the Jones Creek reference, but they comprised over 60% of the community below the discharges. Conversely, the Centrarchidae family made up 48% to 58% of the communities in Jones Creek and upstream of the discharges. Below the discharge the sunfishes made up only about 26% of the community.

Stonerollers were the dominant minnow at all three sites during the summer period; however, it comprised almost 30% of the total community below the discharges. Above the discharges and in Jones Creek this species made up 17% and 19% of 'the community (See

Figure 25). The second dominant minnow species below the discharge was the red shiner at 12.2%. There was no clear second dominant minnow species in either the upstream or Jones Creek samples. For example, above the discharges the next most abundant minnow was the bluntnose minnow (5.1%) and the emerald shiner (2.3%). The minnow family below the discharges was notably dominated by minnows that prefer a more nutrient enriched environment.

The Centrarchidae community during the summer sampling made up 26% of the total community below the discharge; however, above the discharge and in Jones Creek, sunfishes were 48% and 58% of the total community(Figure 24). Below the discharge, the sunfish community declined from 61% of the total community during the spring sampling to only 26% of the total community during the summer sampling period. Within the sunfish family, longear sunfish were dominant at all three sites, although this species was 29% and 34% of the community above the discharges and in Jones Creek and only 13% below the discharge. Subdominant sunfishes at all sites were the green sunfish and bluegill (Figure 26). The substantial reduction in the sunfish population below the discharge strongly indicates an impairment.

Species adaptable to stressed conditions such as nutrient enrichment, high turbidity and highly mineralized environments include gar, buffalo and redhorses. These species were notably more abundant below the discharges than above or in Jones Creek, although they do not make up a significant part of the total population(Figure 24).

The Percidae family comprised 10% or less of the overall community at all sites. Above the discharge seven darter species made up 4.3% of the total community. The redfin darter was the dominant species followed by the orangethroat darter. Below the discharge, five darter species made up 6.3% of the community. The orangethroat darter was dominant followed by the redfin darter (Figure 27). In the Jones Creek sample, eight species of darters made up 10.2% of the community, and there were at least three co-dominant species. The dominance distribution among the species in the three samples and the strong dominance of the orangethroat darter below the discharges indicates stressed conditions in that area.

TABLE 6 POTEAU RIVER FISH COMMUNITY (Summer 1994)

Fish Family & Species		POT01B		POT02B		JNC02	
		# spc	% com	# spc	% com	# spc	% com
Lepisosteidae	Gars						
Lepisosteus oculatus	Spotted gar	2	0.24	10	0.88	3	0.34
Lepisosteus osseus	Longnose gar	1	0.12				
Cyprinidae	Minnows						
Campostoma anomalum	Stoneroller	139	16.59	332	29.23	158	19.24
Cyprinella lutrensis	Red shiner	13	1.55	138	12.15	4	0.46
Luxilus whipplei	Steelcolor shiner	2	0.24	4	0.35	28	3.21
Lythrurus umbratilis	Redfin shiner	3	0.36	5	0.44	2	0.23
Opsopoeodus emiliae	Pugnose minnow	7	0.80			1	0.11
Notropis atherinoides	Emerald shiner					20	2.29
Notropis boops	Bigeye shiner	37	4.42	98	8.63	14	1.60
Notropis fumeus	Ribbon shiner	2	0.24				
Notropis volucellus	Mimic shiner					2	0.23
Pimephales notatus	Bluntnose minnow	43	5.13	50	4.40	7	0.80
Pimephales vigilax	Bullhead minnow	12	1.43	69	6.07	2	0.23
Catostomidae	Suckers						
Ictiobus bubalus	Smallmouth buffalo			8	0.70		
Minytrema melanops	Spotted sucker	2	0.24				
Moxostoma erythrurum	Golden redhorse	3	0.36	10	0.88		
Ictaluridae	Freshwater catfishes						
Ameiurus natalis	Yellow bullhead	7	0.84	10	0.88		
Ictalurus punctatus	Channel catfish			3	0.26		
Noturus exilis	Slender madtom					45	5.15
Noturus nocturnus	Freckled madtom					7	0.80
Polydictus olivaris	Flathead catfish					2	0.23
Cyprinodontidae	Topminnows						
Fundulus olivaceus	Blackspotted topminnow	17	2.03	9	0.79	19	2.18
Poeciliidae	Livebearers						
Gambusia affinis	Mosquitofish	14	1.67	15	1.32	33	3.78
Atherinidae	Silversides						
Labidesthes sicculus	Brook silverside	15	1.79	5	0.44	5	0.57
Centrarchidae	Sunfishes						
Lepomis cyanellus	Green sunfish	155	18.50	99	8.71	63	7.22
Lepomis gulosus	Warmouth sunfish	8	0.95	4	0.35	10	1.15
Lepomis humilis	Orangespotted sunfish					3	0.34
Lepomis macrochirus	Bluegill sunfish	67	8.00	37	3.26	32	3.67
Lepomis megalotis	Longear sunfish	245	29.24	149	13.12	300	34.36
Lepomis hybrid	Hybrid sunfish	1	0.12	1	0.09	2	0.23
Micropterus punctulatus	Spotted bass					8	0.92
Micropterus salmoides	Largemouth bass	7	0.84	9	0.79		
Percidae	Perches						
Etheostoma blennioides	Greenside darter	1	0.12	10	0.88	4	0.46
Etheostoma flabellare	Fantail darter					5	0.57
Etheostoma proeliare	Cypress darter	1	0.12				
Etheostoma spectabile	Orangethroat darter	8	0.95	38	3.35	22	2.52
Eth11eostoma whipplei	Redfin darter	17	2.03	17	1.50	19	2.18
Etheostoma zonale	Banded darter	1	0.12	4	0.35	10	1.15
Percina caprodes	Logperch	6	0.72	2	0.18	20	2.29
Percina maculata	Blackside darter	2	0.24			4	0.46
Percina sciera	Dusky darter					5	0.57
Scianidae	Drums						
Aplodinotus grunniens	Freshwater drum					1	0.11
	Total Species	30		26		34	
	Total Specimens	838		1136		873	
	Catch per Hour	790		852		853	

FIGURE 24

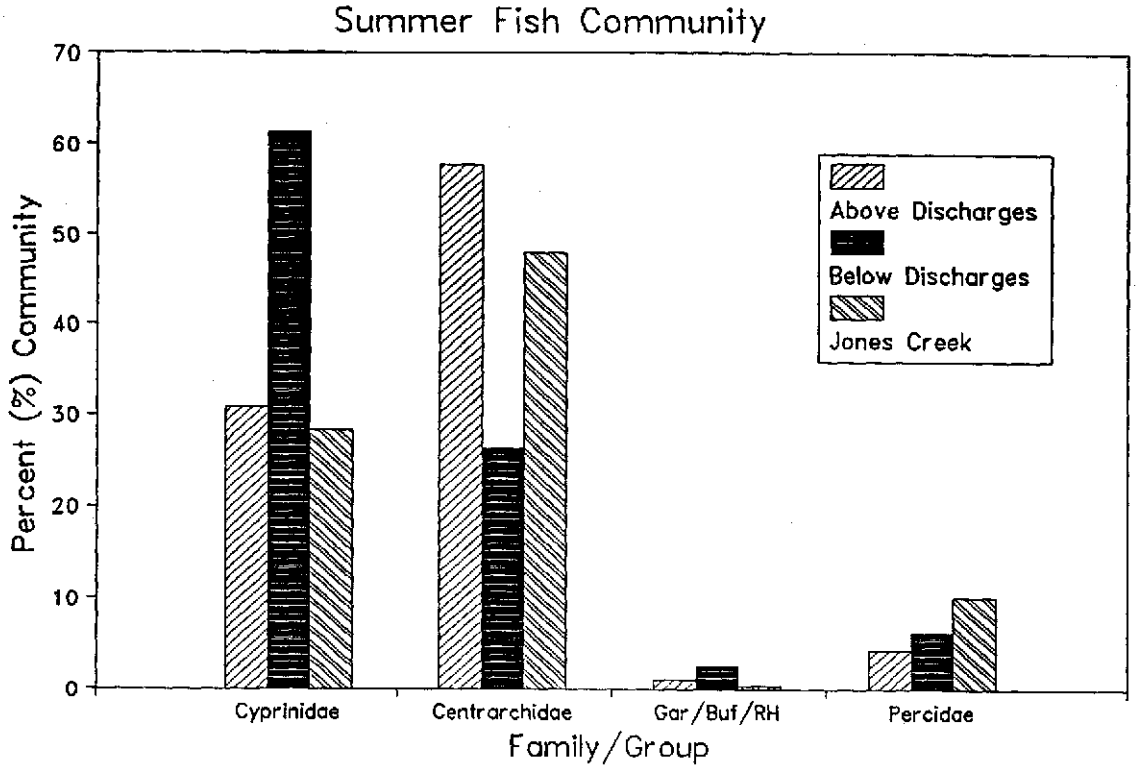


FIGURE 25

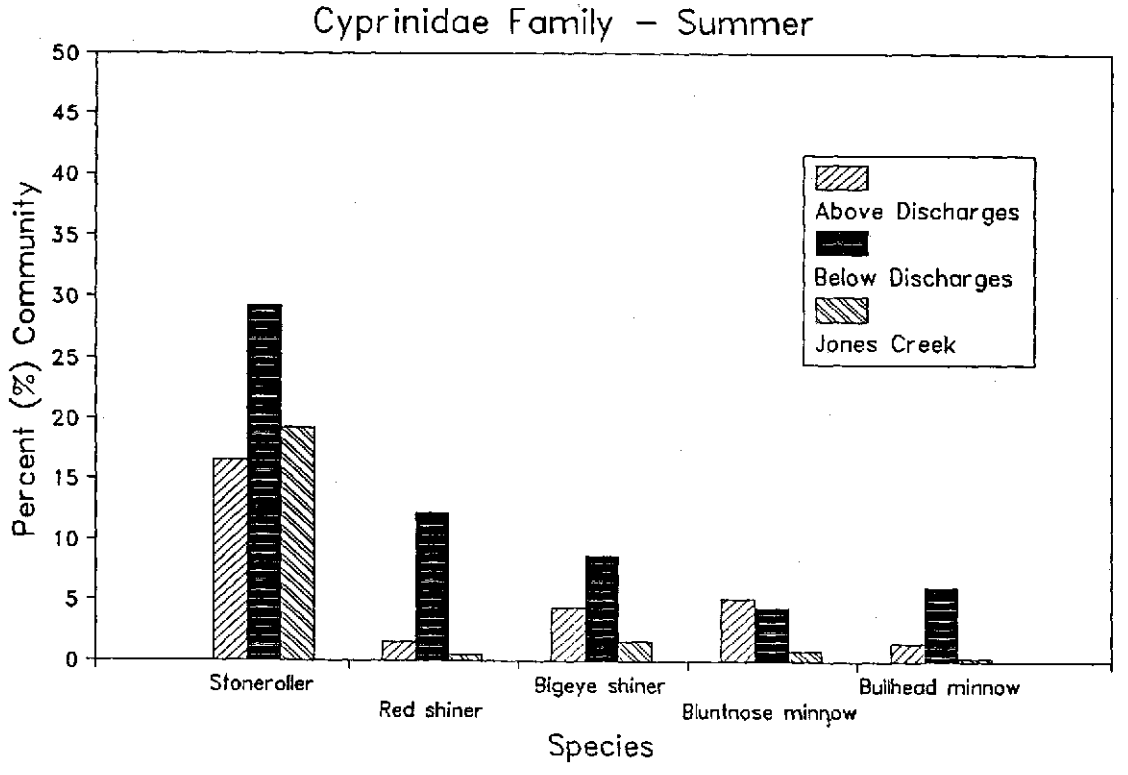


FIGURE 26

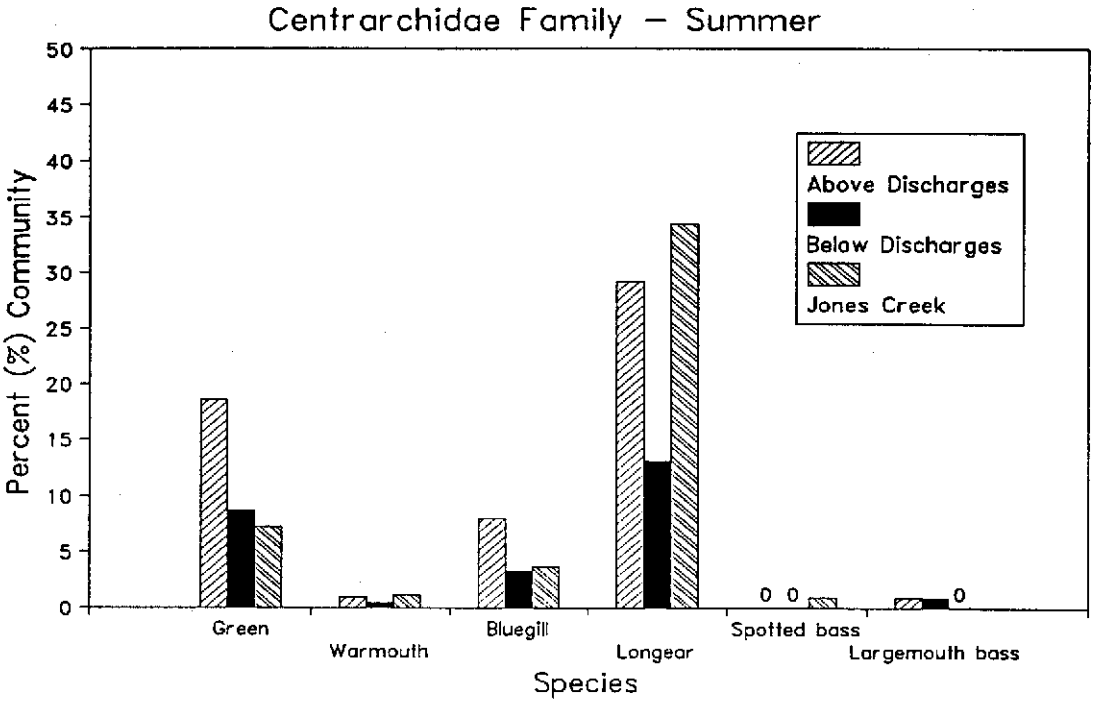
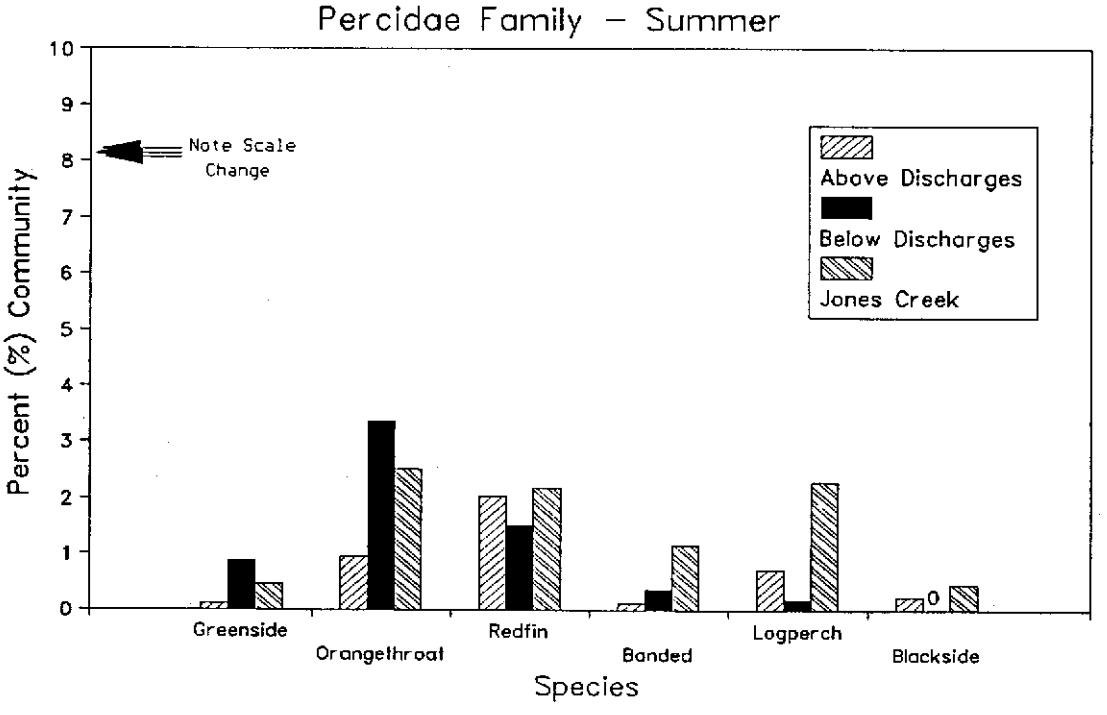


FIGURE 27



CONCLUSIONS

With consideration of the history of events, previous studies and the current study results, the following conclusions were developed concerning the impact of the City of Waldron and Tyson Foods effluent discharges on the Poteau River:

1. Investigations of the fish and macroinvertebrate communities eight to ten years ago indicated severe impairment of the Poteau River immediately downstream from the effluent discharges; however,conditions have improved significantly.

2. Periodic reports of fish kills in the Poteau River during the hot-summer, low-flow period have been received as recent as July 1991 and investigations indicate the cause was dissolved oxygen depletions from excess algal bloom die-off.

3. Historical, ambient water quality monitoring data, special studies and CSI inspections have shown very high nitrogen and phosphorous discharges from the City and Tyson wastewater treatment plants.

4. The current study identified phosphorous levels near 20 mg/L being discharged from the Tyson plant. Over 95% of this is ortho-phosphate-phosphorous. Nitrogen levels from both ammonia and nitrate are relatively low in this discharge.

5. The discharge from the City of Waldron had nitrate-nitrogen levels in excess of 20 mg/L and phosphorous levels in the range of 3 mg/L to 4 mg/L.

6. During the low-flow period of the river, chlorides, sulfates and total dissolved solids discharged from the treatment plants, elevate instream values from three to ten times over background levels.

7. Dilution flows from upstream storm events and from the larger watershed downstream significantly reduce the concentrations of both minerals and nutrients in the Poteau River.

8. During much of the summer period, the discharges from the treatment plants dominate the flows in the upper section of the Poteau River due to the relatively small size of the watershed above the discharge and the presence of upstream impoundments.

9. Dissolved oxygen values above the discharges were typical of a small watershed Arkansas River Valley Ecoregion stream. During high temperature periods when stream flow became intermittent, D.O. values declined to less than 1 mg/L overnight and due to limited sunlight penetrations of the

stream canopy, daylight values also remained very low. During the same period, the effluent discharge created measurable flows downstream. This condition, in addition to post treatment aeration of the effluent, produced D.O. values of 3 mg/L to 6 mg/L in the downstream area. Excessive diurnal, D.O. depletions were not observed within the first one-half mile below the discharges.

10. Dissolved metals concentrations indicate the possibility of toxic discharges of copper and zinc from the City of Waldron, and zinc from Tyson. Instream concentrations immediately below the discharges indicate potentially toxic levels of copper and zinc. Elevated levels of cadmium and chromium were also found in the river immediately below the discharges; however, these metals were not found in either discharge above detection levels.

11. A comparison of macroinvertebrate communities above and below the discharge indicates a minimal impairment during flow conditions dominated by watershed runoff, although the quantitative similarity index indicates the relative abundance of the major taxa within the communities is substantially impaired downstream. During the effluent dominated period, the downstream community showed substantial impairment of the majority of the biometrics measured. Dominance of certain species, absence of certain species and major shifts in functional feeding groups indicates impairment related to nutrient enrichment and/or toxicity.

12. Fish community comparisons above and below the discharges showed little difference in the major groups of fishes during the high-flow, springtime sampling. However, some noticeable shifts of species dominance within the groups indicated possible nutrient enrichment impacts. During the summer, effluent-dominated period, the downstream fish community showed a significantly lower composition of the Centrarchidae (sunfishes) family than above the discharge. Centrarchidae normally is the dominant family in Arkansas River Valley Ecoregion streams as it was above the discharges and in Jones Creek. The Cyprinidae (minnows) became the dominant group of fishes below the discharges. This is inconsistent with the communities above the discharges, in Jones Creek and in typical Arkansas River Valley streams. The species composition within the Cyprinidae below the discharges strongly indicates excessive nutrient enrichment due to the dominance of herbivorous or herbivorous adaptable species. It is not likely, however, that nutrient enrichment is the cause of the significant reduction of the Centrarchid community below the discharges.

Appendix A

Benthic Species List and Associated Biometrics

Benthic Bioassessment
Station # ARK0101
Poteau River 300 yards above Hwy 71 bridge
Eco Reg.# ARRV
Segment # 3I
Sample Date 94-05-23
Sample Time 0900
Sampling technique employed 5MR
Printed on 12-OCT-1994

# of Taxa = 17 # of organisms = 101 Biotic score = 0

			% Annelida	=	2.0
# Ephemeroptera	taxa =	4	% Ephemeroptera	=	26.7
# Trichoptera	taxa =	1	% Trichoptera	=	1.0
# Coleoptera	taxa =	2	% Coleoptera	=	3.0
# Chironomidae	taxa =	2	% Chironomidae	=	11.9

Diversity index = 2.9886913

Group summary

SH=	12	SC=	21	PR=	51	GC=	15	FC=	2
SH%=	11	SC%=	20	PR%=	50	GC%=	14	FC%=	1

Bio #	Name			Gr	Count	%
18020307005001	STONEFLY NYMPH	Perlesta	placida	PR	36	35.6
18020510007	MAYFLY NYMPH	Stenonema		SC	19	18.8
18021115087998	BLOODWORM	Polypedilu		SH	11	10.9
18020307003	STONEFLY NYMPH	Neoperla		PR	9	8.9
8021215020	RIFFLE BEETLE, ADULT	Stenelmis	adult	GC	7	6.9
18020508002	MAYFLY NYMPH	Baetis		GC	5	5.0
18020503002	MAYFLY NYMPH	Caenis		GC	2	2.0
17020301003004	LEECH	Moorobdel	microstoma	PR	2	2.0
19021207001000001	WHIRLIGIG BEETLE LAR	Dineutus	larvae	PR	2	2.0
18020408001	DAMSELFLY NAIAD	Amphiagrio		PR	1	1.0
18010302	CRAYFISH	Cambarinae		SH	1	1.0
18020704002	CADDISFLY LARVA	Cheumatops		FC	1	1.0
18020502002	MAYFLY NYMPH	Tricorytho		GC	1	1.0
19031002004	SNAIL	Lymnaea		SC	1	1.0
18021115089	BLOODWORM	Procladius		PR	1	1.0
18021101003	BLACK FLY LARVA	Simulium		FC	1	1.0
18021215020	BEETLE, ELMID, LARVA	Stenelmis		SC	1	1.0

Benthic Bioassessment
Station # ARK0100
Poteau River 600 yards below Hwy. 71 bridge
Eco Reg.# ARRV
Segment # 3I
Sample Date 94-05-23
Sample Time 1000
Sampling technique employed SMR
Printed on 12-OCT-1994

# of Taxa = 21 # of organisms = 100 Biotic score = 0
% Annelida = 15.0
# Ephemeroptera taxa = 3 % Ephemeroptera = 12.0
# Trichoptera taxa = 3 % Trichoptera = 9.0
# Coleoptera taxa = 3 % Coleoptera = 12.0
# Chironomidae taxa = 3 % Chironomidae = 14.0

Diversity index = 3.6340406

Group summary

SH= 12 SC= 19 PR= 49 GC= 10 FC= 10

SH%= 12 SC%= 19 PR%= 49 GC%= 10 FC%= 10

Bio #	Name			Gr	Count	%
18020307003	STONEFLY NYMPH	Neoperla		PR	23	23.0
17020301003004	LEECH	Moorobdel	microstoma	PR	13	13.0
18021115087998	BLOODWORM	Polypedilu		SH	10	10.0
18021215020	BEETLE, ELMID, LARVA	Stenelmis		SC	10	10.0
18020510007	MAYFLY NYMPH	Stenonema		SC	9	9.0
18020704002	CADDISFLY LARVA	Cheumatops		FC	7	7.0
18020307005001	STONEFLY NYMPH	Perlesta	placida	PR	6	6.0
8021215020	RIFFLE BEETLE, ADULT	Stenelmis	adult	GC	4	4.0
18021115094	BLOODWORM	Psectrotan		[illegible]	3	3.0
18020508002	MAYFLY NYMPH	Baetis		GC	2	2.0
17010101017	AQUATIC EARTHWORM	Branchiura		GC	2	2.0
18010302009	CRAYFISH	Orconectes		SH	2	2.0
18021209003000001	BEETLE, WATER SCAVEN	Berosus-le		PR	1	1.0
18020503002	MAYFLY NYMPH	Tricorytho		GC	1	1.0
18021117001001	SNIPEFLY LARVA	Atherix	variegata	PR	1	1.0
18020410002	DRAGONFLY NAIAD	Macromia		PR	1	1.0
18021115068	BLOODWORM	Orthocladi		GC	1	1.0
18021101003	BLACK FLY LARVA	Simulium		FC	1	1.0
18021209700100001	WHIRLIGIG BEETLE LAR	Dineutus	larvae	PR	1	1.0
18020704	CADDISFLY,LARVA	Hydropsych		FC	1	1.0
18020702001999	CADDISFLY LARVA	Chimarra		FC	1	1.0

Benthic Bioassessment
Station # ARK0101
Poteau River 300 yards above Hwy 71 bridge
Eco Reg.# ARRV
Segment # 3I
Sample Date 94-08-30
Sample Time 1200
Sampling technique employed SMR
Printed on 12-OCT-1994

# of Taxa = 26 # of organisms = 100 Biotic score = 0

		% Annelida	= 8.0
# Ephemeroptera taxa	= 4	% Ephemeroptera	= 18.0
# Trichoptera taxa	= 2	% Trichoptera	= 20.0
# Coleoptera taxa	= 5	% Coleoptera	= 8.0
# Chironomidae taxa	= 1	% Chironomidae	= 8.0

Diversity index = 4.1133795

Group summary

SH=	9	SC=	12	PR=	35	GC=	21	FC=	23
SH%=	9	SC%=	12	PR%=	35	GC%=	21	FC%=	23

Bio #	Name			Gr	Count	%
18020704002	CADDISFLY LARVA	Cheumatops		FC	18	18.0
18020503002	MAYFLY NYMPH	Caenis		GC	8	8.0
18020411002	DAMSELFLY NAIAD	Hetaerina		PR	8	8.0
17020101004	LEECH	Helobdella		PR	8	8.0
18021115087998	BLOODWORM	Polypedilu		SH	8	8.0
18020408004	DAMSELFLY NAIAD	Chromagrio		PR	8	8.0
18010201001001	SIDESWIMMER	Hyalella	azteca	SC	6	6.0
18020510007	MAYFLY NYMPH	Stenonema		SC	6	6.0
18020802001001	HELLGRAMMITE	Corydalus	cornutus	PR	3	3.0
18020403005	DRAGONFLY NAIAD	Gomphus		PR	3	3.0
18020502002	MAYFLY NYMPH	Tricorytho		GC	3	3.0
18021315020	BEETLE, ELMID, LARVA	Stenelmis		SC	3	3.0
18020408003	DAMSELFLY NAIAD	Argia		PR	2	2.0
18021209003C0002	BEETLE, WATER SCAVEN	Berosus		GC	2	2.0
19050404001001	CLAM	Corbicula	fluminia	FC	2	2.0
18020702001999	CADDISFLY LARVA	Chimarra		FC	2	2.0
18020404001	DRAGONFLY NAIAD	Aeshna		PR	1	1.0
18020608001	BUG, GIANT WATER	Belostoma		PR	1	1.0
18021317004001	WATER PENNY LARVA	Psephenus	herricki	SC	1	1.0
19031004004	SNAIL	Gyraulus		SC	1	1.0
19010502003	CRAYFISH	Orconectes		SH	1	1.0
18020510011005	MAYFLY NYMPH	Stenacron	interpunct	SC	1	1.0
18020611001	BUG, BR SHD WATERSTR	Rhagovelia		PR	1	1.0
19050430001	CLAM	Sphaerium		FC	1	1.0
18021209015	WATER SCAVENGER BEET	Helocares		GC	1	1.0
18021209010	PREDACIOUS DIV.BEETL	Deronus		GC	1	1.0

Benthic Bioassessment
Station # ARK0100
Poteau River 600 yards below Hwy. 71 bridge
Eco Reg.# ARRV
Segment # 3I
Sample Date 94-08-30
Sample Time 1100
Sampling technique employed SMR
Printed on 12-OCT-1994

# of Taxa = 15 # of organisms = 100 Biotic score = 0

			% Annelida	=	1.0
# Ephemeroptera	taxa =	1	% Ephemeroptera	=	4.0
# Trichoptera	taxa =	3	% Trichoptera	=	41.0
# Coleoptera	taxa =	1	% Coleoptera	=	3.0
# Chironomidae	taxa =	2	% Chironomidae	=	15.0

Diversity index = 3.1050851

Group summary

SH=	14	SC=	5	PR=	28	GC=	8	FC=	45
SH%=	14	SC%=	5	PR%=	28	GC%=	8	FC%=	45

Bio #	Name		Gr	Count	%
18020704002	CADDISFLY LARVA	Cheumatops	FC	32	32.0
18020802001001	HELLGRAMMITE	Corydalus cornutus	PR	16	16.0
18021115087998	BLOODWORM	Polypedilu	SH	14	14.0
18020702001999	CADDISFLY LARVA	Chimarra	FC	8	8.0
18020411002	DAMSELFLY NAIAD	Hetaerina	PR	6	6.0
19050430001	CLAM	Sphaerium	FC	5	5.0
18020502002	MAYFLY NYMPH	Tricorytho	GC	4	4.0
8021215020	RIFFLE BEETLE, ADULT	Stenelmis adult	GC	4	4.0
18021110002	CRANEFLY LARVA	Hexatoma	PR	3	3.0
18021215020	BEETLE, ELMID, LARVA	Stenelmis	SC	3	3.0
19031004004	SNAIL	Gyraulus	SC	1	1.0
18020712001001	CADDISFLY LARVA	Helicopsyc borealis	SC	1	1.0
18021115002	BLOODWORM	Ablabesmyi	PR	1	1.0
18021114001	BITING MIDGE LARVA	Bezzia	PR	1	1.0
17020301003004	LEECH	Moorobdel microstoma	PR	1	1.0

Benthic Bioassessment
Station # ARK0101
Poteau River 300 yards above Hwy 71 bridge
Eco Reg.# [illegible]
Segment # 31
Sample Date 94-10-28
Sample Time 0900
Sampling technique employed SMR
Printed on 12-OCT-1994

# of Taxa = 17	# of organisms = 101		Biotic score =	0	
		% Annelida	=	2.0	
# Ephemeroptera	taxa = 4	% Ephemeroptera	=	26.7	
# Trichoptera	taxa = 1	% Trichoptera	=	1.0	
# Coleoptera	taxa = 3	% Coleoptera	=	8.0	
# Chironomidae	taxa = 2	% Chironomidae	=	11.9	

Diversity Indx = [illegible]

[illegible]

Tax #	Name	T	I	%
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Benthic Bioassessment
Station # ARK0100
Poteau River 800 yards below Hwy. 71 bridge
Eco Reg.# ARRV
Segment # 3[illegible]
Sample Date 94-05-28
Sample Time 1000
Sampling technique employed SMR
Printed on 12-OCT-1994

# of Taxa = 21   # of organisms = 100   Biotic score = 0

		% Annelida	= 15.0
# Ephemeroptera taxa =	3	% Ephemeroptera	= 12.0
# Trichoptera taxa =	3	% Trichoptera	= 9.0
# Coleoptera taxa =	3	% Coleoptera	= 12.0
# Chironomidae taxa =	[illegible]	% Chironomidae	= 1[illegible]

Diversity index = [illegible]

[illegible]

[illegible]

[illegible]

[illegible]	[illegible]				
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]204	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	1[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] BEETLE, ADULT	[illegible]	[illegible]	[illegible]	4.[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	AQUATIC [illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	BEETLE, WATER [illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
18021117001001	[illegible]	[illegible]	[illegible]	1	[illegible]
1802041[illegible]002	DRAGONFLY NAIAD	Macromia	PR	1	[illegible]
18021115008	BLOODWORM	Orthocladi[illegible]	CG	1	[illegible]
18021101003	BLACK FLY LARVA	Simulium	FC	1	[illegible]
18021207010001	WHIRLIGIG BEETLE LAR	Dineutus [illegible]	PR	1	[illegible]
18020704	CADDISFLY,LARVA	Hydropsych[illegible]	FC	1	[illegible]
18020702001999	CADDISFLY LARVA	[illegible]	[illegible]	[illegible]	[illegible]

Benthic Bioassessment
Station # ARK0101
Poteau River 300 yards above Hwy 71 bridge
Eco Reg.# ARRV
Segment # 3
Sample Date 94-08-30
Sample Time 1200
Sampling technique employed SMR
Printed on 12-OCT-1994

# of Taxa = 26 # of organisms = 100 Biotic score = 0

		% Annelida =	3.0
# Ephemeroptera taxa =	4	% Ephemeroptera =	18.0
# Trichoptera taxa =	2	% Trichoptera =	20.0
# Coleoptera taxa =	5	% Coleoptera =	8.0
# Chironomidae taxa =	1	% Chironomidae =	8.0

Diversity index = 4.113789

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
18020711003	DAMSELFLY LARVA	Ischnura	TT	0	0.0	
18020711003	DAMSELFLY LARVA	Ischnura	TT	0	0.0	
18020411003	DAMSELFLY NAIAD	Argia	TT	0	0.0	
17020101004	LEECH	Helobdella	FA	0	0.0	
18021115007008	[illegible]	Physella	SN	0	0.0	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
18020403003	DAMSELFLY NAIAD	Argia	TT	0	0.0	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
18020702001103	CADDISFLY LARVA	Chimarra	FC	0	0.0	
18020404001	DRAGONFLY NAIAD	Hagenius	PR	1	1.0	
18020000002	BUG, GIANT WATER	Belostoma	PR	1	1.0	
18021217004701	WATER PENNY LARVA	Psephenus herricki	SC	1	1.0	
18030014004	SNAIL	Gyraulus	SC	1	1.0	
17011302003	CRAYFISH	Procambarus	CG	1	1.0	
18020510011005	MAYFLY NYMPH	Stenacron interpunct	SC	1	1.0	
18020611001	BUG, BACK SWIMMER	Rhagovelia	PR	1	1.0	
18050420001	CLAM	Sphaerium	FC	1	1.0	
18021209115	WATER BOATMEN BEET	Helocoris	SC	1	1.0	
18021209010	PREDACIOUS DIVING BEETL	Dytiscus	PR	1	1.0	

Benthic Bioassessment
Station # ARK0100
Poteau River 600 yards Below Hwy. 71 bridge
Eco Reg.# (ARK)
Segment # 01
Sample Date 94-08-01
Sample Time 1100
Sampling technique employed SMR
Printed on 10-OCT-1994

# of Taxa = 15	# of organisms = 100	Biotic score = 0	
		% Annelids	= 1.0
# Ephemeroptera taxa = 1		% Ephemeroptera	= 4.0
# Trichoptera taxa = 9		% Trichoptera	= 41.0
# Coleoptera taxa = 1		% Coleoptera	= 3.0
# Chiro. midge taxa = 2		% Chironomidae	= 15.0

[illegible]

[illegible]