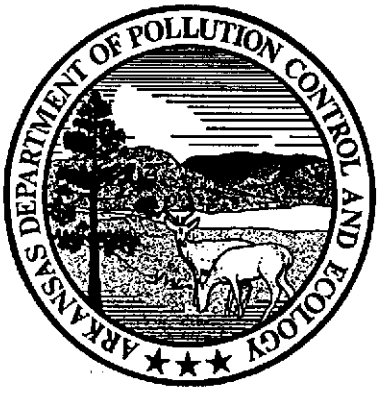
TMDL INVESTIGATION

OF WATER QUALITY IMPAIRMENTS

TO WHIG CREEK,

POPE COUNTY, ARKANSAS



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INTRODUCTION

A total maximum daily load (TMDL) establishes the maximum allowable loadings of a pollutant to a waterbody, thereby providing the basis for states to establish water quality-based controls. These controls provide the pollution reduction necessary for a waterbody to meet water quality standards. It is designed to provide more stringent water quality-based controls when technology-based controls are inadequate to achieve state water quality standards. In addition, TMDLs provide a mechanism to manage pollution from a combination of point and nonpoint sources.

A five step process is used to determine a TMDL. Step 1 calls for the identification of water quality-limited waters still requiring TMDLs. These are then placed in the 303(d) listing of impaired water bodies. Step 2 prioritizes ranking and targeting of those water bodies. The development of the TMDL occurs in Step 3 with implementation of control actions and assessment of water quality-based control actions in steps 4 and 5. TMDLs may be developed as an annual load limit on a specific pollutant or the determination of steps necessary to reach the appropriate level of biological integrity of a water body.

Whig Creek was first listed in the 303(d) list of the 1992 Water Quality Inventory Report (305B). In 1990, it was referenced as not supporting its fishable/swimmable use due to discharges from the City of Russellville waste water treatment facility.

In June 1996, an intensive investigation was conducted to verify the status of water quality, physical habitat, aquatic macroinvertebrates and fishes in Whig Creek. A reference stream was chosen to compare with Whig Creek.

Study Area

Whig Creek is located south of Russellville, Pope Co., Ark. in the Arkansas River Valley Ecoregion. The watershed is approximately 8 mi^2 and the stream gradient is approximately 17.6 ft/mi. Land use in the watershed consists mainly of urban development with some agriculture pasture land. It flows approximately 10.2 miles before entering the Arkansas River.

The reference stream, Baker's Creek, is located north east of Russellville, Ark. The watershed is approximately 8 mi^2 and the stream gradient is approximately 28.0 ft/mi. The land use is similar to Whig Creek, however, less of the watershed is urban. The stream flows approximately 8.0 miles before entering Illinois Bayou.

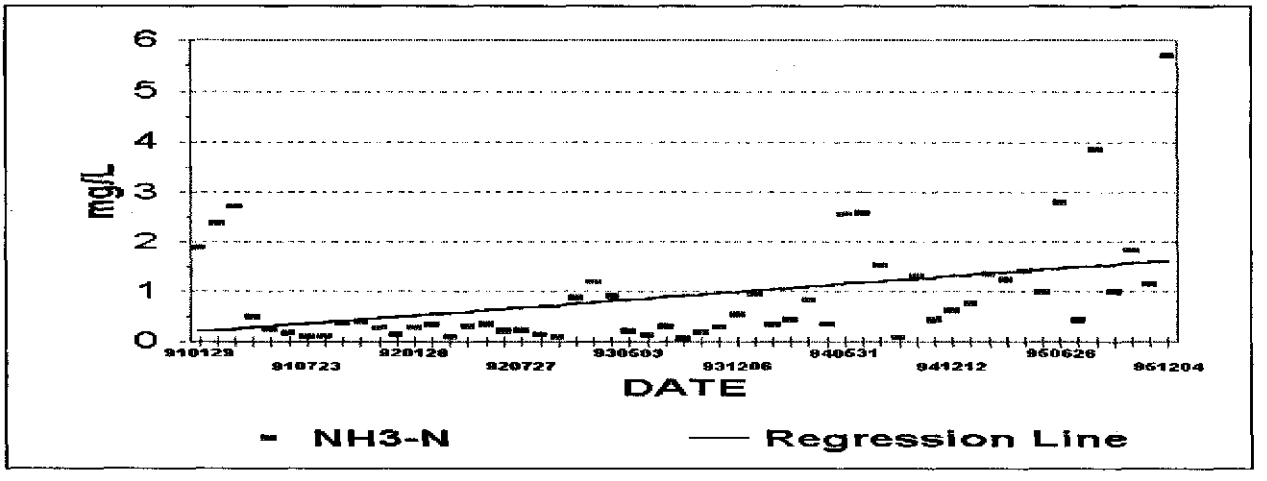
The two dischargers to Whig Creek are the City of Russellville waste water treatment plant (WWTP) and Grace Manufacturing Inc. Grace Manufacturing Inc. is a specialty metal fabricator and produces metal rulers, computer printer parts and chemical etchings. Their new NPDES permit is currently under review and they are operating under their old permit.

Previous Studies

In 1984, a stream assimilative capacity study was conducted to develop discharge limits for the City of Russellville WWTP. Permit limits for this discharger are 10/15/4/6 for May-October and 15/20/4/6 for November-April ($CBOD_5$/TSS/ NH_3-N/D.O.). Discharge Monitoring Reports (DMR's) from January 1991 to December 1995 show mean NH_3-N values at 0.29 mg/L and a maximum value of 3.06 mg/L. In the 5 year time period, no values greater than permitted were noted and on only three occasions were values greater than 1.0 mg/L. Five-day Carbonaceous biochemical oxygen demand ($CBOD_5$) during the same time period averaged 3.5 mg/L with a maximum of 8.82 mg/L.

Monthly sampling of Whig Creek at the ambient water quality monitoring station ARK67 (WIG04) has shown an increase in NH_3-N values since 1991 (Figure 1). Discharge Monitoring Reports from the Russellville WWTP do not show a similar trend. The discharge for Grace Manufacturing is below ARK67; therefore the affects of this outfall are not reflected in this station's data.

Figure 1. Regression analysis of NH_3-N at ARK67 (WIG04) in Whig Creek.



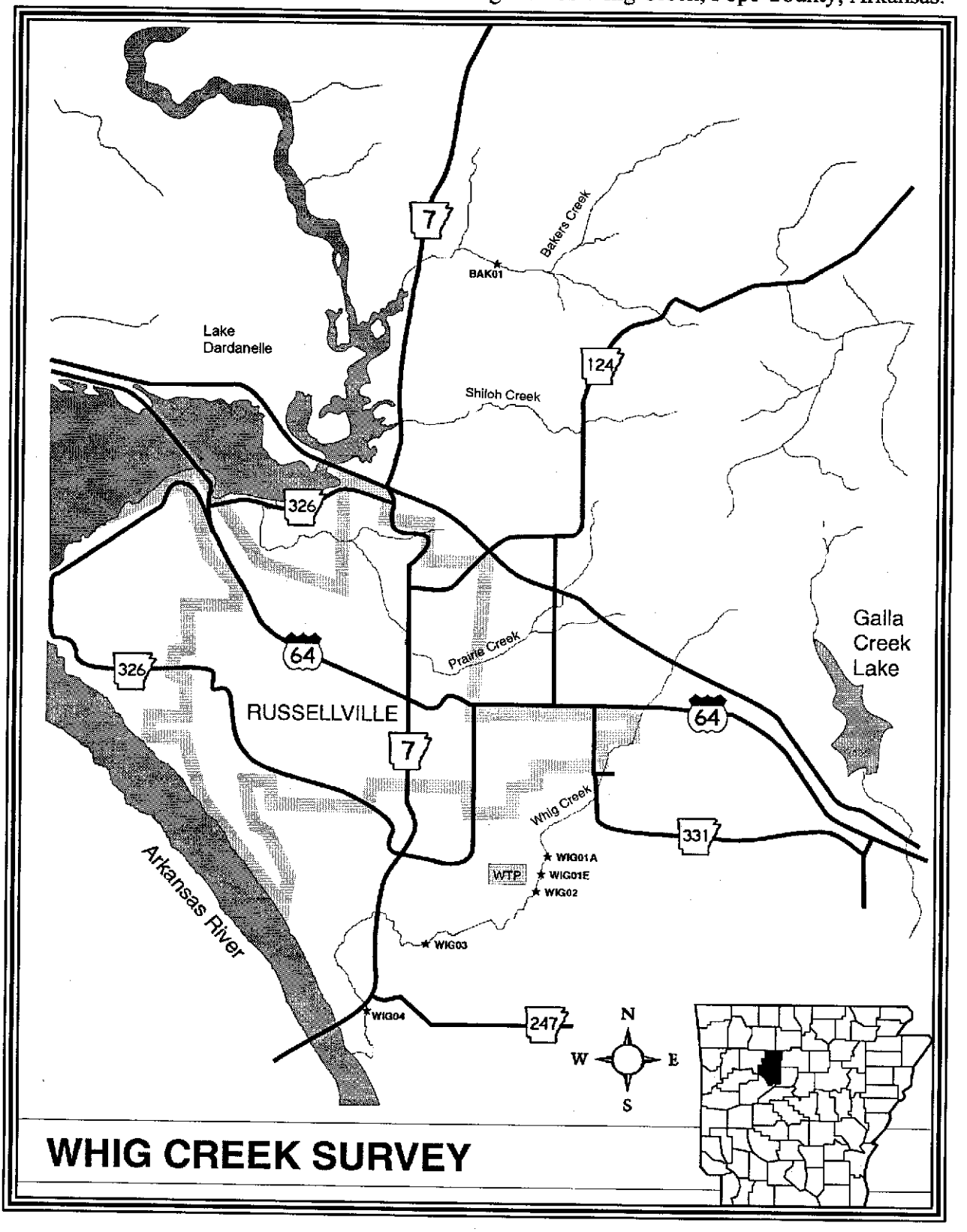
DATA COLLECTION METHODS

Station locations are shown in Figure 2. Station location descriptions are as follows:

BAK01 Bakers Creek at county road bridge, 0.75 mile E. of Hwy 7, 2.25 miles N. of I-40. Pope County. (Sec 16, T8N, R20W). Reference Stream.

WIG01A Whig Creek approximately 0.5 miles east of Hwy. 7 and Hwy. 7T interchange; county road bridge approximately 100 meters upstream of effluent ditch from City of Russellville treatment plant. Pope County (Sec.22 , T8N, R20W).

Figure 2. Station locations for the TMDL investigation of Whig Creek, Pope County, Arkansas.



WIG01E At Russellville WWTP effluent pipe, approximately 60 meters upstream from Whig Creek: immediately east of treatment facility, Pope County (Sec. 22, T8N, R20W).

WIG02 Approximately 50 meters downstream from effluent ditch (Sec. 22, T8N, R20W).

WIG03 Whig Creek approx. 1 mile below the WWTP, ¾ mile S. on county road E of Hwy 7-7T jct. Pope County. (Sec 21, T7N, R20W).

WIG04 Whig Creek at Hwy 7 bridge, just south of Hwy 247 jnct. Pope County. (Sec 29, T7N, R20W). Also ambient monitoring network station ARK 67.

Water Quality

Water quality samples were collected at all sites on 25 June. Water quality samples for conventional parameters were collected in 2.0 liter plastic jugs and water for dissolved metals was filtered and placed in 250 ml plastic bottles with 0.5 ml nitric acid for preservation. Analyses were performed in accordance with the 18th Edition of Standard Methods for Examination of Water and Wastewater and as described in ADPC&E's existing Quality Assurance Program. Instream dissolved oxygen and temperature were measured with an Orion Model 840 portable dissolved oxygen meter, which was calibrated according to the manufacturers instructions prior to use. In situ pH was measured with an Orion Model 230A portable pH meter, which was calibrated using buffer solutions of pH 4 and 7. Stream flow was measured using a Marsh-McBirney Model 2000 Flow Mate meter by obtaining a representative number of velocities and depths across suitable stream locations.

Diel Dissolved Oxygen

Hydrolab D.O. samplers were deployed at sites BAK01, WIG01A, WIG03 and WIG04 on 24 June and recovered 26 June. Data were recorded at 15-minute intervals and downloaded from samplers to a Quattro Pro™ spreadsheet program for analysis.

Aquatic Macroinvertebrates

Aquatic macroinvertebrates were collected on 24 June at sites BAK01, WIG03 and WIG04 with an aquatic macroinvertebrate dip net. Specimens were preserved in 70% ethanol and returned to the laboratory for subsampling and identification. Rapid bioassessments (RBA) require five minute sampling of all available microhabitats within the sample area. Attempts were made to collect the maximum number of taxa from the greatest number of niches.
In the lab, all organisms, organic and inorganic material were placed in a dissecting pan. A 10 cm (4 in.) ring was placed in the pan to delimit a subsample and all organisms were removed from within the ring area. This process was continued until 100 organisms were removed. In cases where additional organisms remained in the ring after removal of 100 organisms, the

additional organisms were placed in the subsample to prevent biasing the sample.

RBA scores from multi metric analyses were derived for each site. Each site's score was compared to the reference site score to determine percent comparable estimate (%CE) which determines the impairment status. Impairment categories are found in Table M-1.

Table M-1.

Biological Condition	%CE	Attributes
No significant impairment	>83%	Comparable to reference
Slight impairment	54-79%	Community structure less than reference. Taxa richness lower and tolerant forms increase.
Moderate Impairment	21-50%	Decline in community structure, loss of intolerant forms.
Severe Impairment	< 20%	Few taxa present. Community dominated by 1 or 2 tolerant taxa.

Scores used for comparisons found in Table M-1 are composite scores of six metrics. These metrics are listed and described as follows: (1)Taxa Richness compares the number of taxa at each site to show diversity of the community; (2) Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa abundances relate to the number of pollution "intolerant" organisms; (3) Percent contribution of dominant taxon compares the percent composition of the dominant taxon in the study sites with the reference site; (4) The EPT/(EPT+Chironomid) metric is a ratio of EPT taxa divided by the sum of EPT and chironomid taxa; (5) The Hilsenhoff Biotic Index (HBI) shows the tolerance level of the entire community to organic pollution in the water; (6) The Community Loss Index (CLI) relates to the number of organisms found at the reference but not at other sites.

Rapid bioassessments include biological and physical evaluations of each site. Physical evaluations are necessary to ensure that each site can physically support the community structure found at the reference or "least impacted" site. Physical parameters are compared to the reference and a %CE (Table M-2) is calculated to determine comparability of stations.

Table M-2.

Assessment Category	%CE	Attributes
Comparable to Reference	≥90%	Habitat same as reference.
Supporting	75-88%	Habitat lacking some characteristics of reference.
Partially Supporting	60-73%	Limited habitat for macroinvertebrate colonization.
Non-Supporting	≤58%	Little habitat available.

Fish

Fish community samples were collected at three stations 24-25 June. Samples were evaluated by comparing various community structure metrics and individual species relative abundance. The sample collected at BAK01 was used as the reference site for comparison with the sites located below the wastewater treatment facility.

A Smith-Root model 15-B backpack electrofishing device with pulsed DC current was used to collect fish from all sites. The device was used in the shallow pools and along the pool edges while wading upstream and dipping the stunned fishes from the water with dip nets. 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.

All fish species encountered were collected from all available habitats within the sample area until a representative sample of 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 10% formalin solution and returned to the lab for identification.

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) quality of substrate type based on fish use 4) quantity of in stream cover; and 5) sediment on substrate. Each parameter for substrate type and instream cover was scored 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 inversely related to the amount of sedimentation of the substrate.

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 like habitat types were averaged for each sampling station. The lengths of each habitat type were also summed giving a total length of habitat type sampled per sampling station. The total habitat type lengths were then divided by 100 and multiplied by the average habitat type score. This score is the Ichthyofauna Habitat Index (IHI).

RESULTS

Water Quality

Fifteen conventional parameters were selected to determine water quality in Whig Creek. A

tabulation of results is in Appendix A. In situ dissolved oxygen (D.O.), pH and water temperature taken with grab samples varied little between the reference site and Whig Creek sites (Figure WQ-1). Nitrate nitrogen and total phosphorus were substantially elevated in the WWTP effluent (19.9 and 7.26 mg/L, respectively) and remained elevated in the downstream stations. The majority of the phosphorus occurred in the reactive orthophosphate form (Figure WQ-2). Chlorides, sulfates and TDS were also elevated by the discharge (52.7, 41.3 and 324 mg/L, respectively) and remained elevated at the downstream stations in Whig Creek (Figure WQ-3). Although historical ammonia levels were frequently elevated at the routine monitoring station in Whig Creek (max = 3.06 mg/L), during this study, the ammonia level in the WWTP discharge was only slightly elevated (0.13 mg/L).

Dissolved Metals

The dissolved portion of 18 metals was sampled during this study. Seven metal concentrations were below detection levels at all stations. Boron, sodium, zinc, copper, potassium and calcium values increased noticeably in the effluent and were reduced only slightly at downstream sites (Figure WQ-4). None of the metals were at or above toxic concentrations.

Diel Dissolved Oxygen

Dissolved oxygen values were highest in the reference stream which also had the highest maximum daily fluctuation and percent saturation (147.7%) during the first day of sampling. The maximum D.O. at all Whig Creek stations ranged from 4.6 to 6.5 mg/L and the greatest maximum daily fluctuation was 4.2 mg/L (Table WQ-1). Maximum daily temperatures in Whig Creek ranged from 26.3 to 28.6 °C and the maximum daily fluctuation was 2.8 °C. Dissolved oxygen and temperature attained their highest values on 24 June at BAK01 and WIG01A (Figures WQ-5 and 6). The lower and somewhat erratic values at these sites in the late afternoon of 25 June was due to a substantial rainfall event. However, sites WIG03 and WIG04 did not show a similar pattern during the rainfall event. This was probably because the stream flow at these stations remained dominated by the WWTP flow which increased 2.4 times after the rainfall event.

Aquatic Macroinvertebrates

Physical habitat scores at the Whig Creek sites were comparable to the reference site (CE ≥90%) (Table M-2). Instream habitat consisted mainly of leaf packs or root wads against the banks at WIG03 and the substrate was hard clay. A short rip-rap riffle was located below the bridge at WIG04. The habitat at the reference site consisted of bedrock substrate with leaf packs and small woody debris in the riffle. Flows in Whig Creek were higher and bottom scour, sediment deposition and pool/riffle ratio were lower than in the reference.

Figure WQ-1. Dissolved oxygen, water temperature and pH at Whig and Baker's creek sites.

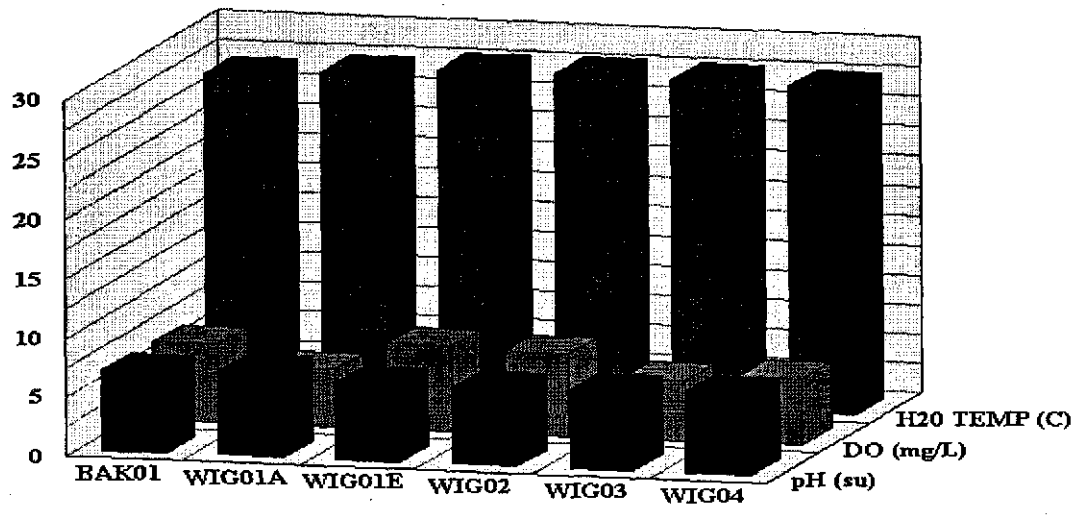


Figure WQ-2. Nutrients in Bakers and Whig creeks.

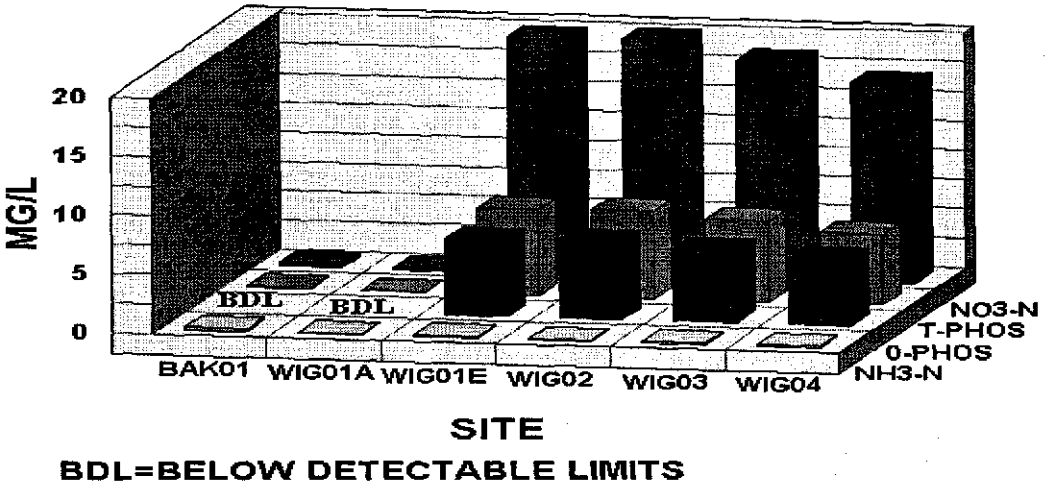


Figure WQ-3. Minerals from Whig and Baker's creeks.

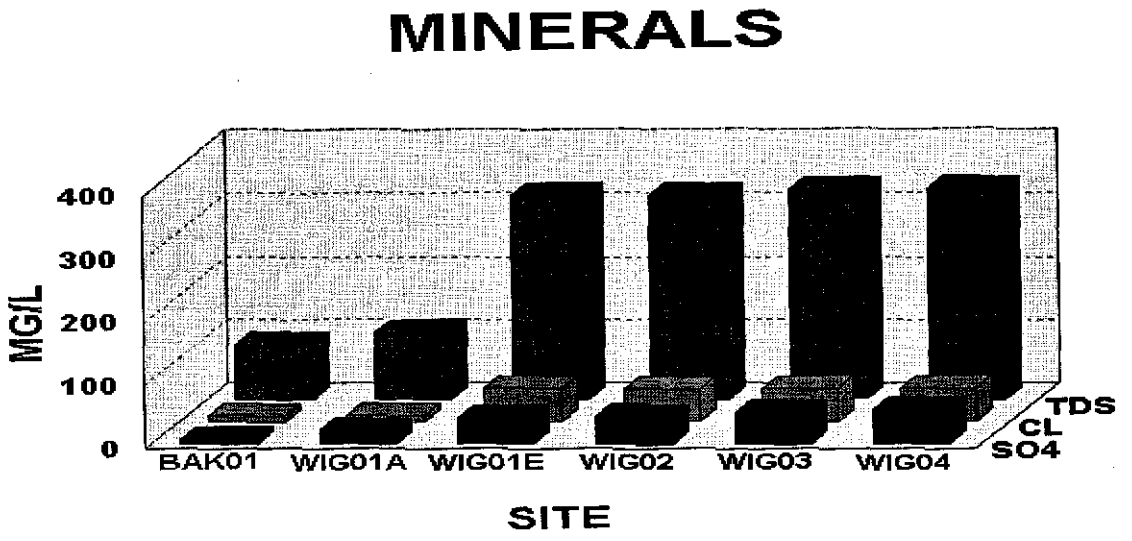
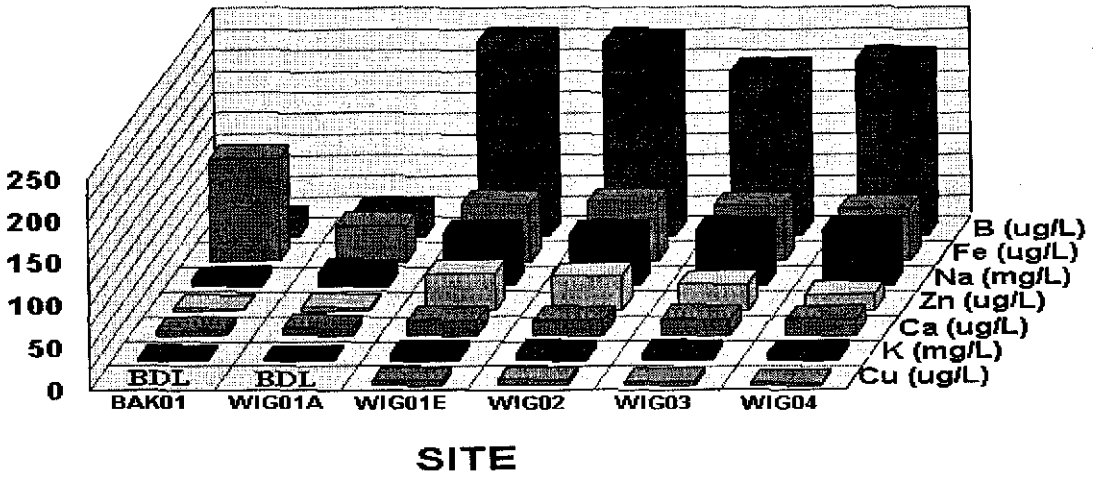


Figure WQ-4. Selected metals from Whig and Baker's creeks.



BDL = Below Detection Limits

Table WQ-1. Diel D.O. and Temperature Summary

Station ID	Date	Dissolved Oxygen			Temperature (°C)		
		Max	Min	M.D.F.*	Max	Min	M.D.F.*
BAK01	24June96	10.3	4.4	5.8	34.4	26.7	7.7
	25June96	7.5	5.6	1.9	29.9	24.2	5.7
	26June96	6.5	5.6	0.9	28.1	23.6	4.5
WIG01A	24June96	6.5	3.5	3.0	28.6	25.8	2.8
	25June96	6.2	2.7	3.5	27.5	25.4	2.1
	26June96	5.2	4.6	0.6	26.3	25.0	1.3
WIG03	24June96	4.7	3.6	1.1	28.0	27.0	1.0
	25June96	5.6	3.7	1.9	27.8	26.3	1.5
	26June96	4.6	3.5	1.1	26.4	26.0	0.4
WIG04	24June96	5.9	4.9	1.0	28.5	27.3	1.2
	25June96	7.6	4.2	3.4	28.0	26.6	1.4
	26June96	7.6	3.4	4.2	28.0	26.6	1.4

*Maximum Daily Fluctuation

Figure WQ-5. Diel dissolved oxygen values 24-26 June.

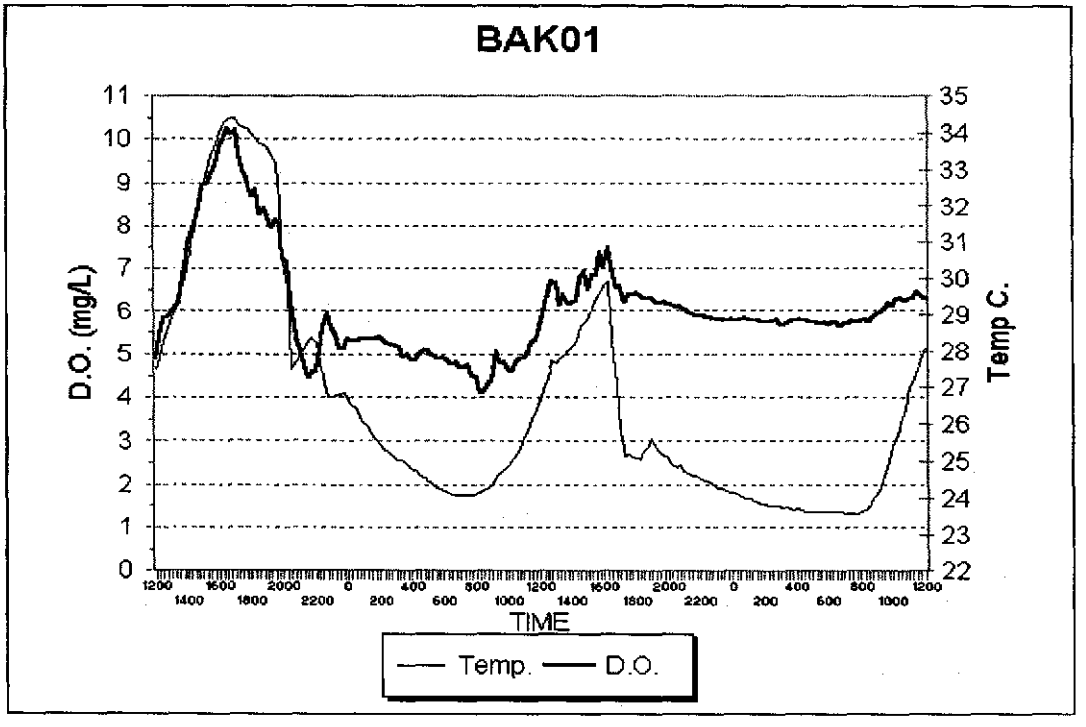


Figure WQ-6. Diel dissolved oxygen values 24-26 June.

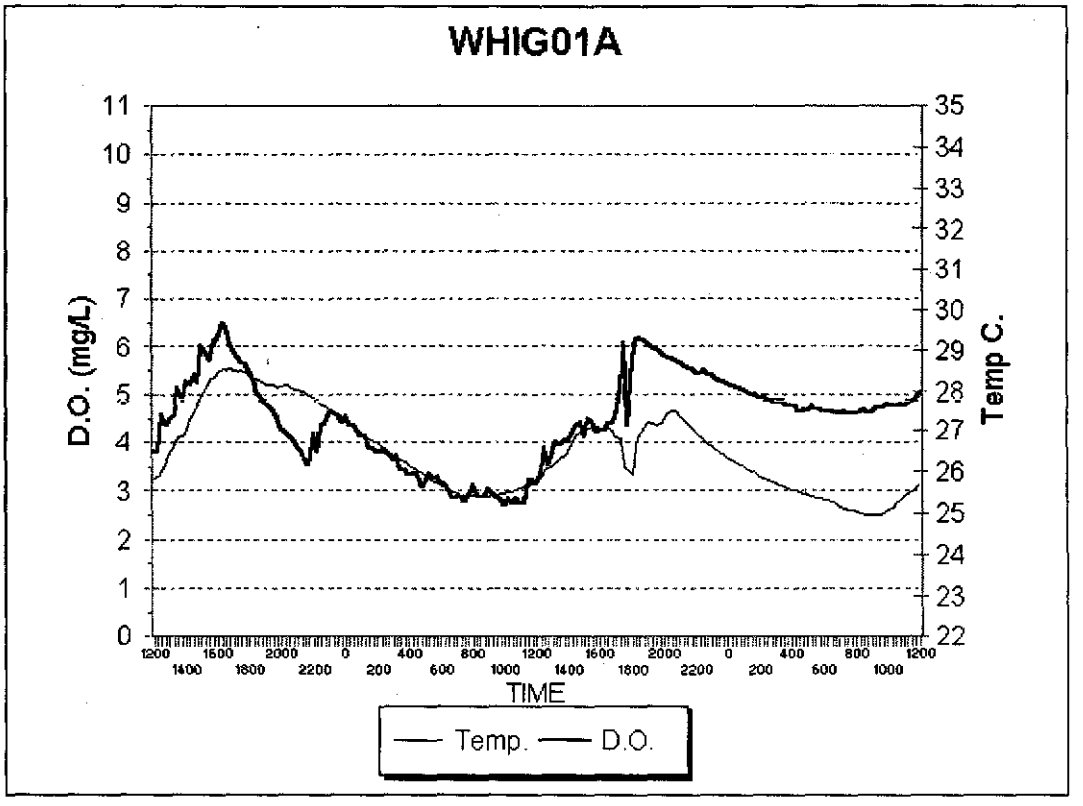


Figure WQ-7. Diel dissolved oxygen values 24-26 June.

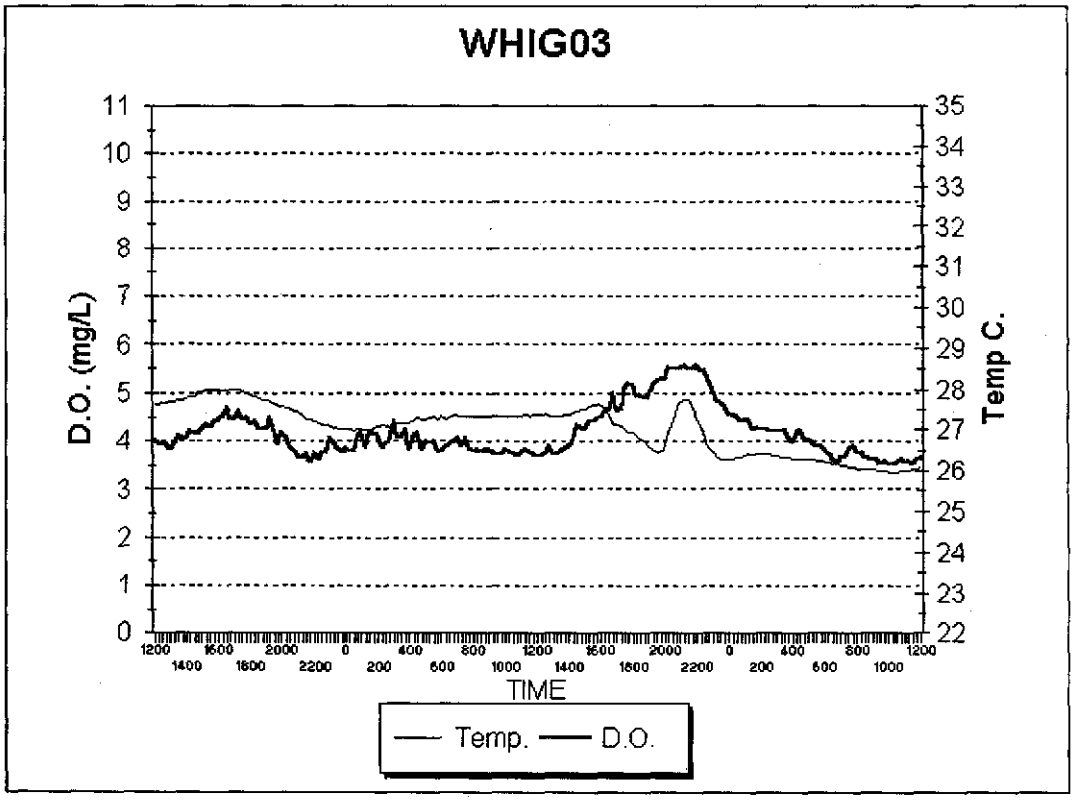
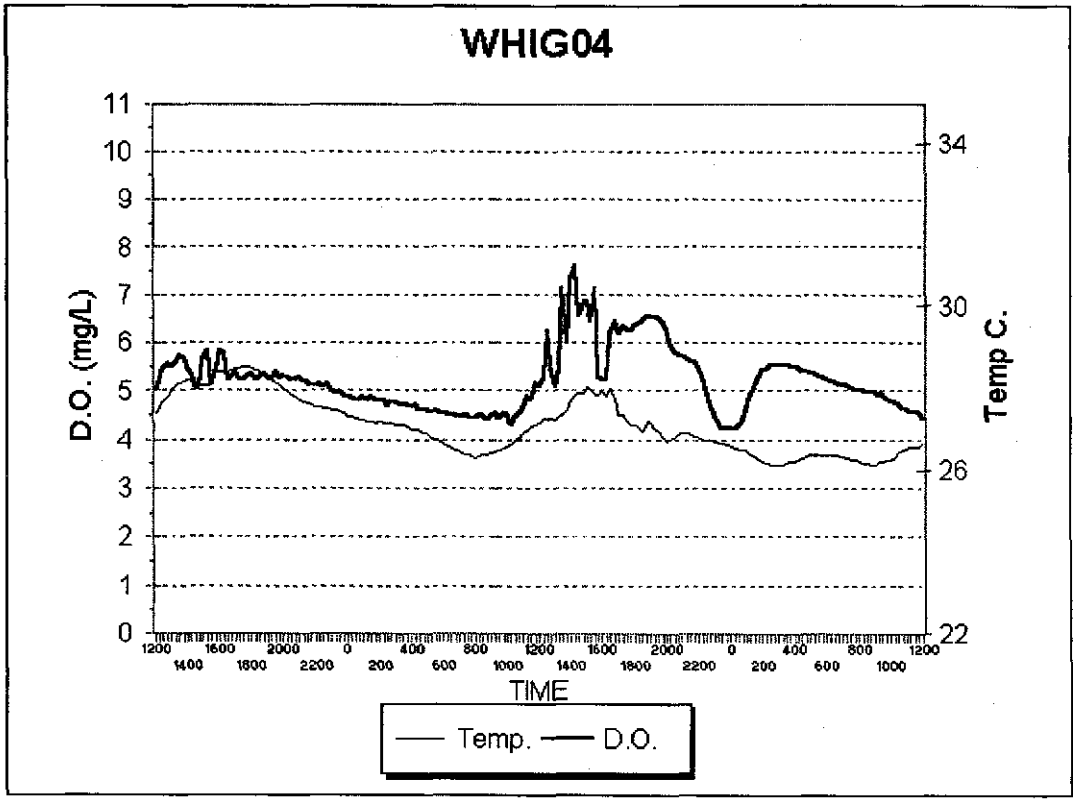


Figure WQ-8. Diel dissolved oxygen values 24-26 June.



Macroinvertebrate community score results show slight impairment at WIG03 but no significant impairment at WIG04 (Table M-3). WIG03 scored higher than the lower site in the percent contribution of dominant taxa and contained the most taxa of all sites sampled. The impairment found at WIG03 was based on decreased EPT taxa and a lower score of EPT/EPT+chironomid which was due to the high percentage of chironomids (39.8%) (Appendix M-1). The dominant taxon and third most abundant taxon at WIG03 consisted of organic tolerant chironomids. This community was also more organic pollution tolerant than the reference site.

The community at WIG04, while not significantly impaired, scored lower on the community loss index and contained more organic tolerant taxa than the reference site. Chironomids dominated the numerical standing crop by comprising 26.5% of the community. This reduced the EPT/EPT+ chironomid score.

Table M-3

Physical Habitat Percent Comparable Estimates (%CE)							
	Scoring Range						
Scoring Criteria	Excellent	Good	Fair	Poor	BAK01	WIG03	WIG04
Bottom Substrate	16-20	11-15	6-10	0-5	15	12	16
Embeddedness	16-20	11-15	6-10	0-5	15	16	16
Flow	16-20	11-15	6-10	0-5	7	11	12
Channel Alteration	12-15	8-11	4-7	0-3	14	14	8
Bottom Scour and Deposit	12-15	8-11	4-7	0-3	14	9	10
Pool/Riffle Ratio	12-15	8-11	4-7	0-3	10	5	6
Bank Stability	9-10	6-8	3-5	0-2	8	7	8
Bank Vegetative Stability	9-10	6-8	3-5	0-2	9	9	9
Stream Side Cover	9-10	6-8	3-5	0-2	6	5	6
Total Score	111-135	75-102	39-60	0-30	98	88	91
%CE						90	93

Table M-4

	SCORES					
	BAK01		WIG03		WIG04	
Metric	RAW	CE	RAW	CE	RAW	CE
Taxa Richness	10	6	17	6	11	6
EPT Index	4	6	3	2	4	6
% Contribution of Dominant Taxa	36	2	22	4	27	4
HBI	2.5	6	2.9	6	2.9	6
CLI	NA	6	0.4	6	0.5	4
EPT/EPT+Chironomid	0.91	6	0.08	0	0.56	4
CE Score		32		24		30
%CE		REF*		75		94

* = Reference

Fish

Table F-1 summarizes the fish habitat evaluations and includes the IHI for all stations sampled in the study area. Table F-2 lists species collected from each site, the number of specimens per species collected and the percent community composition of each species. Table F-3 depicts the family comparisons between sampling stations, percent and total sensitive, key and primary trophic levels species, and the diversity index of each sample based on the Shannon-Wiener diversity index (log base 2). Table F-4 lists similarity indices between sample sites based on species present and relative abundance of species between the two sites listed.

Table F-1

Fish Habitat Evaluation												
	Riffle				Run				Pool			
SITE	Number Sampled	Total Length	Average habitat Score	IHI*	Number Sampled	Total Length	Average habitat Score	IHI	Number Sampled	Total Length	Average habitat Score	IHI
WIG03					1	10	21	2.1	2	990	21.7	214.8
WIG04					2	908	25.5	229.5				
BAK01	2	40	24	9.6					2	1050	25.1	263.6

*Ichthyofauna Habitat Index - Total Length of habitat in hundredths multiplied by the Average Habitat Score.

TABLE F-2

FAMILY & SPECIES	COMMON NAME	SEN	TFL	KEY	WIG03		WIG04		BAK01	
					Num	% Com	Num	% Com	Num	% Com
Amiidae	Bowfins									
Amia calva	Bowfin				1	2.56				
Cyprinidae	Minnows									
Campostoma anomalum	Stoneroller		P				5	6.10	140	63.64
Cyprinus carpio	Carp		P		1	2.56				
Cyprinella lutrensis	Red shiner				3	7.69	27	32.93		
Cyprinella whipplei	Steelcolor shiner	S					9	10.98		
Lythrurus umbratilis	Redfin shiner				2	5.13				
Pimephales notatus	Bluntnose minnow		P	K					7	3.18
Ictaluridae	Freshwater catfishes									
Ameiurus natalis	Yellow bullhead			K					13	5.91
Cyprinodontidae	Killifishes									
Fundulus olivaceus	Blackspotted Topminnow				2	5.13			9	4.09
Poeciliidae	Livebearers									
Gambusia affinis	Mosquitofish						1	1.22	16	7.27

Table F-2 con't.

Centrarchidae	Sunfishes									
Lepomis cyanellus	Green sunfish				5	12.82	11	13.41	10	4.55
Lepomis gulosus	Warmouth sunfish				8	20.51	2	2.44		
Lepomis macrochirus	Bluegill sunfish				9	23.08	6	7.32	10	4.55
Lepomis megalotis	Longear sunfish			K	7	17.95	13	15.85	6	2.73
Micropterus salmoides	Largemouth bass				1	2.56	7	8.54	4	1.82
Percidae	Perches									
Etheostoma whipplei	Redfin darter			K					5	2.27
Percina sciera	Dusky darter	S					1	1.22		
	TOTAL SPECIES				10		10		10	
	TOTAL NUMBERS				39		82		220	
	Effort (sec)				3606		3450		NA	
	Catch/Minute				0.65		1.43			

TABLE F-3

COMMUNITY STRUCTURE (as percent total community)				
Family	WIG03	WIG04	BAK01	Mill Creek
Cyprinidae	15.38	50.00	66.82	28.90
Catostomatidae				
Ictaluridae	0.00	0.00	5.91	11.20
Centrarchidae	76.92	47.56	13.64	21.40
Percidae	0.00	1.22	2.27	11.40
Total Species Collected	10	10	10	28
No. Sensitive Species	0	2	0	4
No. Sensitive Individuals	0	10	0	83
% Sensitive Individuals	0	12.20	0	28.90
No. Primary TFL	1	5	147	187
% Primary TFL	2.56	6.10	66.82	27.58
No. Key Individuals	7	13	31	344
% Key Individuals	17.95	15.85	14.09	50.74
Diversity Index	2.92	2.80	2.06	3.74
Similarity Index*	0.46	0.33		

*based on species proportions and compared to BAK01 community

TABLE F-4

FISH COMMUNITY SIMILARITY INDICES		
Sample Sites	Species	Relative Abundance
WIG03/WIG04	0.600	0.617
WIG03/BAK01	0.600	0.464
WIG04/BAK01	0.500	0.330
BAK01/Mill Creek	0.368	0.354

The fish community below the wastewater treatment facility at WIG03 contained only ten species and 39 specimens. The Centrarchids dominated the community (approximately 77%) and the Cyprinids comprised slightly over 15% of the community. The only other specimens collected consisted of one bowfin and two topminnows. The distribution of sunfish species within the Centrarchid family was evenly divided between four species. Likewise, the Cyprinids were similarly distributed between three species. Because of this, the diversity index score of 2.92 was the highest among the three collections. Primary feeders comprised less than three percent (3%) of the community at WIG03. Key species were almost 18% of the community but this included only one species. There were no sensitive species present in this sample. The catch rate at this site was 0.65 fish per minute indicating a very low fish density.

The habitat at this site consisted of one short run approximately ten feet long and two pools approximately 1000 feet combined. This site seems to be most affected by the lack of quality fish habitat. The creek at this site is approximately 30 feet wide with little or no instream cover, a hard-pan clay bottom substrate and no riffle habitats.

The WIG04 site consisted of two runs totaling approximately 910 feet. In stream habitat was slightly more abundant at this site than at WIG03. Only 82 individuals were collected representing 10 species. The Cyprinid family and the Centrarchid family comprised 50% and 47.5% of the total community, respectively. The only other taxa present were one specimen each of the mosquitofish and dusky darter. The distribution of specimens within these families was not quite as evenly distributed as they were at WIG03, thus the diversity index was lower. Primary feeders comprised only six percent (6%) of the community; key individuals comprised almost 16% (all longear sunfish) and there was only one sensitive species present. The catch per unit effort was over twice that of WIG03. The lack of diverse, quality fish habitat seems to be limiting the fish community at this location as with site WIG03. The creek is approximately 50 feet wide with limited in stream cover, a muddy/silty bottom substrate, and little natural riffle habitats. There was a small riffle supporting some riffle species below the highway bridge.

The Bakers Creek site (BAK01) consisted of two riffles totaling approximately 40 feet in length

and two pool habitats approximately 1050 feet in total length. In-stream habitat was somewhat limited in the pools where bedrock dominated the substrate. Riffle habitat was dominated by water willow and the substrate was primarily gravel. There were 220 specimens collected representing 10 species. The Cyprinidae family, almost completely represented by the stoneroller, comprised almost 67% of the fish community. The centrarchids comprised almost 14% of the community and the ictalurids comprised 6% of the community. The yellow bullhead was the only ictalurid species present. Five specimens of the redfin darter were also collected. The distribution of specimens within the species was less evenly divided as compared to Whig Creek, particularly the dominance of stonerollers. This was reflected in the low diversity index score of 2.06. The primary trophic level comprised almost 67% of the community. This was dominated by stonerollers. Key individuals were represented by four species comprising over 14% of the community. The extensive bedrock substrate and somewhat limited fish habitat may be limiting the fish community in this creek. The presence of four Arkansas River Valley Ecoregion key species in the reference stream demonstrates that this fish community was somewhat typical for Arkansas River Valley streams; however, the large population of stonerollers, abundance of the yellow bullhead, absence of sensitive species and the distribution of centrarchid species indicates that some organic enrichment may exist in this stream. However, by comparing Baker's Creek with Mill Creek, an Arkansas River Valley Ecoregion reference stream, the community structure was quite different (Table F3). Only 29% of the Mill Creek community was composed of Cyprinids as compared to 67% of the Bakers Creek community. There was also a noticeable difference in the Percid and Catostomid. The lack of sensitive species in Bakers Creek and the domination of the community by primary feeders were two additional distinct differences between the communities. These factors, along with the low similarity index of 0.354 between these two sites, indicate that the fish community in Bakers Creek is not typical of Arkansas River Valley ecoregion least-disturbed reference streams. Most of these differences are probably driven by habitat differences, the small watershed size of Bakers Creek and the apparent nutrient enrichment that resulted in the stoneroller dominated community.

The similarity indices demonstrate that the WIG03-WIG04 fish communities are somewhat similar, and that the fish communities at WIG03-BAK01 are more similar than the communities at WIG04-BAK01. However, all of the comparisons must be considered to be dissimilar. Most of the differences between the communities in Bakers Creek and Whig Creek are most likely habitat driven.

Summary of Findings

Historical data from Whig Creek shows an increase in NH_3-N since 1991 at the ambient water quality monitoring station. However, discharge monitoring reports from the Russellville WWTP do not show an increasing trend in NH_3-N and the effluent from Grace Manufacturing is below the ARK67 site.

Dissolved oxygen, pH and water temperatures in Whig Creek were typical of Arkansas River

Valley streams during critical flows. Elevated nutrients, chlorides, sulfates and TDS were found below the WWTP. None of the dissolved metals that were analyzed were at toxic levels.

Dissolved oxygen concentrations and saturation values were highest in the reference stream. The photosynthesis processes aided by slightly elevated nutrient levels and low flows caused the supersaturation of oxygen values and the greatest maximum daily fluctuation of D.O. in this stream. Temperature extremes were also highest in the reference stream. A localized rain event noticeably affected D.O. and temperature in Whig Creek above the WWTP; however, below the discharge, the creek remained dominated by the plant discharge which also increased significantly after the rain event.

The aquatic macroinvertebrate and fish communities were the most diverse at WIG03 (below the WWTP), but this site contained the fewest number of individuals. The reference contained the greatest number of macroinvertebrates and fishes. WIG03 had the most impaired communities when compared to Baker's Creek according to macroinvertebrate and fish metric assessments, and the macroinvertebrate community at WIG03 contained more organic pollution tolerant organisms than BAK01. In contrast, the fish community at BAK01 was dominated by one species of primary trophic level feeder which was not present at WIG03. The fish population density of Whig Creek was inordinately low.

Recommendations

The most problematic area identified in this study area was the elevated nutrients discharged from the Russellville WWTP. At design discharge flow this facility may be discharging more than 380 lbs/day of total phosphorus and over 1000 lbs/day of nitrate-nitrogen. Although this discharge enters the Arkansas River which provides a very large dilution volume, the cumulative effects of this and numerous other discharges could result in future impacts on the Arkansas River. Therefore, actions should be taken to prevent additional nutrient loading from this source.

Appendix WQ-1. Water quality and dissolved metals from selected sites in Bakers and Whig creeks, June 1996.

WATER CHEMISTRY						
STATION	**BAK01**	**WIG01A**	**WIG01E**	**WIG02**	**WIG03**	**WIG04**
DO (mg/L)	6.7	4.9	7.3	7	5.1	5.6
pH (SU)	6.9	7.2	6.5	6.5	6.7	6.9
Water Temp (°C)	26.7	27.2	27.7	27.8	27.7	27.5
CBOD (mg/L)	2.2	0.6	1.6	0.8	0.2	0.3
NH3-N (mg/L)	0.22	0.05	0.13	0.06	0.12	0.08
CL (mg/L)	9.4	9.8	52.7	51.9	52.1	52.5
NO3-N (mg/L)	0.4	0.2	19.9	20	18.5	16.9
0-PHOS (mg/L)	<0.03	<0.03	6.41	6.51	6.08	5.58
T-PHOS (mg/L)	0.13	0.06	7.26	7.36	6.74	5.92
SO4 (mg/L)	8	21.1	41.3	43	48.9	54.2
TOC (mg/L)	8.1	4.2	7.4	7	6.4	6.7
TSS (mg/L)	27	4.5	5.5	23	9.5	13.5
TDS (mg/L)	88	108	324	323	333	334
Turbidity (NTU)	43	8.7	3.5	15	8	17
Hardness (mg/L)	35	42	61	61	70	73
Flow (cfs)*	0.21	0.1	4.64	Not Taken	5.23	4.0
DISSOLVED METALS						
Al (ug/L)	38.9	<16.0	<16.0	18	17.9	20.5
B (ug/L)	20.8	30.3	232.9	231.8	196.6	210.6
Ba (ug/L)	23.8	28	4	7.2	11.8	17.5
Be (ug/L)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Ca (mg/L)	6.2	8.5	18.2	18.1	19	18.9
Cd (ug/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Co (ug/L)	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Cr (ug/L)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cu (ug/L)	<2.0	<2.0	5.6	5.8	3.5	2.4
Fe (ug/L)	122	42	67.9	70.1	65.1	61.3
K (mg/L)	2.2	1.5	8	8	7.9	7.3
Mg (mg/L)	4.6	5	3.9	3.8	5.5	6.3
Mn (ug/L)	116	135	68.2	82.6	206	103
Na (mg/L)	7.3	16	62.1	61.5	65.3	66
Ni (ug/L)	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Pb (ug/L)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
V (ug/L)	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Zn (ug/L)	3.1	3.7	43.6	40.6	30.8	17.9

< = below detectable limits

* Flows were taken on different days and were affected by rainfall event.

Appendix M-1. List of taxa collected from selected Baker and Whig creek sites.

HBI	FEEDING GROUP	EPT	TAXON	LOCATION		
				Number Collected		
				BAK01	WIG03	WIG04
3	COL	N	Cambaridae (F)			1
3	COL	N	*Orconectes*		4	
3.5	COL	Y	*Siphlonurus*		1	8
3	SCR	Y	*Stenonema*	3		9
2	COL	Y	*Caenis*	32	1	11
1	PRE	Y	*Neoperla*	10	1	
2	PRE	N	*Gomphus*		4	
3	PRE	N	*Hetaerina*		3	
3	PRE	N	*Argia*		3	
4	PRE	N	*Enellagma*		1	
4.5	PRE	N	*Ischnura*		1	
2.8	PIE	N	*Tricocorixa*	1		
3	PRE	N	*Corydalus*			1
3	FIL	Y	*Cheumatopsyche*	3		21
2.5	COL	N	*Ancyronyx (A)*		15	
2.5	COL	N	*Ancyronyx (L)*		1	
3	SCR	N	*Stenelmis (A)*	36		
3	SCR	N	*Stenelmis (L)*	7	13	
3	COL	N	*Simulium*			7
2	SHR	N	*Tipula*	1		
3	COL	N	*Chrysops*			1
2	PRE	N	*Atherix*			1
3	PRE	N	Chironomini 1		1	12
3	PRE	N	Chironomini 2		14	
3	PRE	N	Tanypodini	5	18	26
4	SCR	N	*Physa*	2		
3	COL	N	Sphaeriidae		1	
3	FIL	N	*Corbicula*		1	
			TOTAL	100	83	98