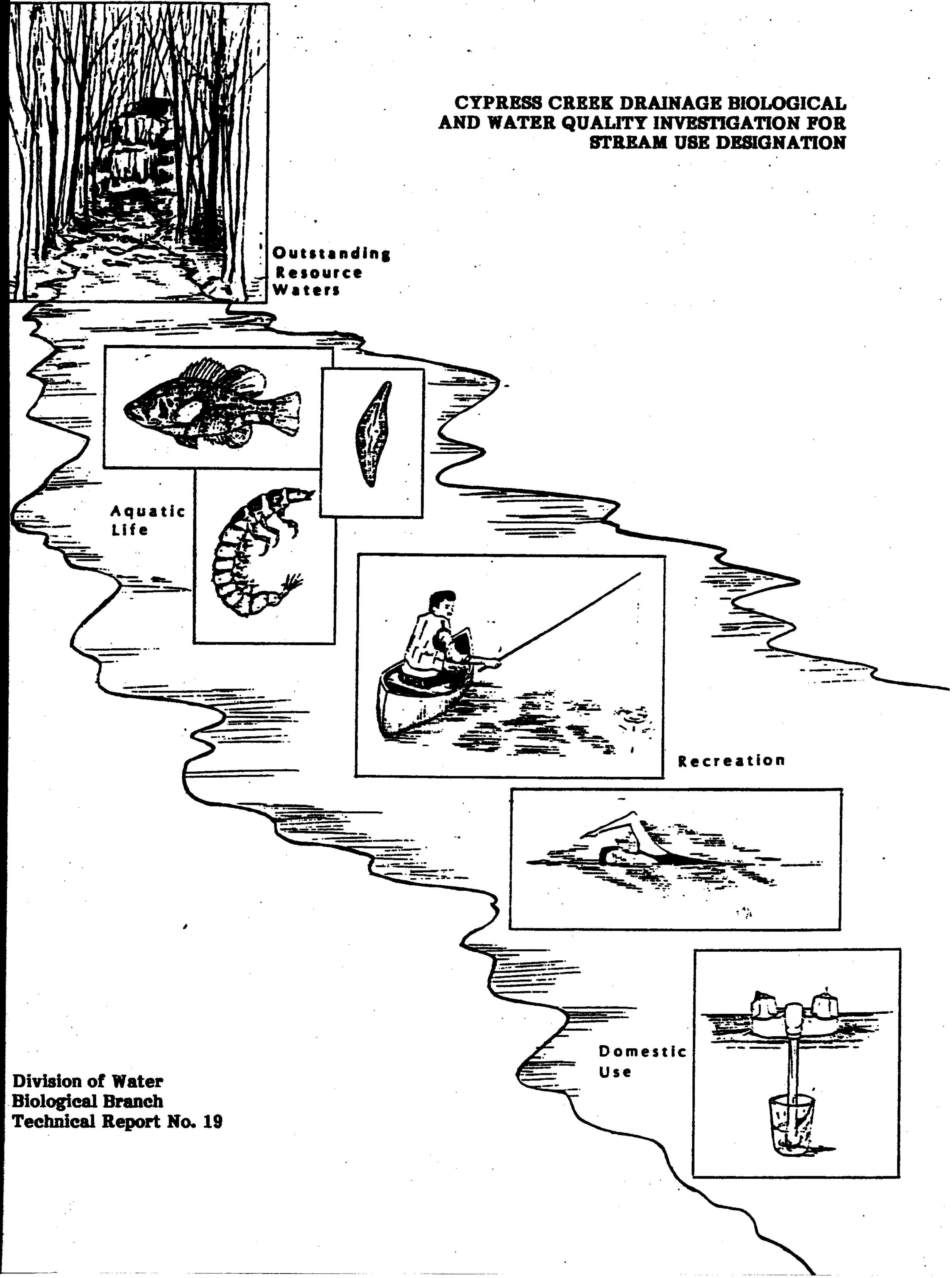
CYPRESS CREEK DRAINAGE BIOLOGICAL AND WATER QUALITY INVESTIGATION FOR STREAM USE DESIGNATION



Division of Water
Biological Branch
Technical Report No. 19

Cypress Creek Drainage
Biological and Water Quality Investigation
for Stream Use Designation

Kentucky Department for Environmental Protection
Division of Water

Biological Analysis Section
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Technical Report No. 19

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This report has been approved for release:

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Abstract

A water quality investigation of the Cypress Creek drainage, a fifth order stream system, was conducted in July, 1982 to determine the existing water quality, aquatic uses currently being achieved, causes of impairments of aquatic uses and what aquatic uses can be attained based on the physicochemical characteristics of the system. Biological data used in this report was collected by the Kentucky Nature Preserves Commission (KNPC) in October, 1978 and August, 1980. Data from this and KNPC reports indicate that 33 miles of the Cypress Creek system are partially supporting designated uses while 3 miles are unknown.

The Cypress Creek subbasin lies in the Ohio River Hills and Lowlands subsection of the Shawnee Hills, a physiographic region within the Interior Low Plateaus Province. The stream flows for 33.3 mi through low-lying hills in the headwaters and low, flat terrain downstream and drains an area of 153 mi^2. Wetlands (4374 acres) are common throughout the area and serve as refugia for a diversity of aquatic and terrestial plant and animal life. Extensive coal mining in the upper portions of the drainage and intensive agriculture operations have degraded both streams and wetlands of the Cypress Creek system. Municipal waste from Central City has impacted Little Cypress Creek. Historical, as well as current physicochemical and biological data support these statements. Violations of Kentucky Surface Water Standards, 401 KAR 5:031, Section 5, for alkalinity, dissolved oxygen, free cyanide, phthalate esters, iron and zinc were noted. The following parameters exceeded the United States Environmental Protection Agency's recommended criteria for the protection of freshwater life: copper and silver. Generally speaking, the Cypress Creek system supports a diversity of aquatic organisms.

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Recommendations

1. Based on the diversity of habitat and presence of aquatic life, it is recommended that segment 03005 of the Green River basin be designated for Aquatic Life/Warmwater Aquatic Habitat as per 401 KAR 5:031, Section 5(1) and that the criteria established by the section be applied throughout the segments without modifications.
2. Based on the fecal coliform levels and pH values observed during this survey, it is recommended that segment 03005 of the Green River basin be designated for primary and secondary contact recreation as per 401 KAR 5:031, Section 7 and those criteria be applied throughout the segments without modifications.
3. Based on the fact that no present or planned withdrawals for domestic water supply exist in this segment, it is not recommended that this segment be designated for Domestic Water Supply (401 KAR 5:031, Section 6).
4. It is recommended that a thorough biological and water quality study be conducted overtime to document specific impacts and evaluate corrective measure in order to protect the stream and associated wetland ecosystems.

Summary

1. The Cypress Creek subbasin, in Muhlenburg and McLean counties, constitutes a single segment designated as 03005. The stream is fifth order, flows 53.6 km (33.3 mi) and drains an area of 396 km^2 (153 mi^2).

2. Using the United States Geological Survey's hydrological map, which list 36 total stream miles for the Cypress Creek system, 33 miles of stream are partially supporting designated uses while 3 miles remain unknown.

3. The major impacts to streams of the subbasin are coal mining, agriculture and municipal waste.

4. The main channel of Cypress Creek and adjacent wetlands serve as a locally important sport fisheries resource. No domestic water withdrawals occur in the drainage. Extensive hunting for waterfowl also occurs along Cypress Creek and in the adjacent wetlands.

5. Violations for Kentucky Surface Water Standards, 401 KAR 5:031, Section 5 were noted for alkalinity, dissolved oxygen, free cyanide, phthalate esters, iron and zinc.

6. The United States Environmental Protection Agency's recommended chronic criteria for the protection of freshwater aquatic life for copper and silver were exceeded.

7. The Cypress Creek system supports a diverse assemblage of aquatic flora and fauna. One hundred thirty-nine taxa of algae, 76 taxa of macroinvertebrates and 34 species of fish have been reported from the drainage.

8. The adjacent wetlands (4374 acres) apparently serve as refugia for aquatic organisms from severe stream perturbations. The wetlands adjacent to Cypress Creek support a diverse assemblage of aquatic plants and animals. They also serve as loci for reinvasion when impacts are mitigated.

INTRODUCTION

The Cypress Creek subbasin lies within Muhlenberg and McLean counties, Kentucky. This drainage, including tributaries, from the headwaters to the confluence with Pond River, constitutes one segment (Weston, Inc. 1975) designated as 03 (Green River Basin) 005 (Cypress Creek segment).

A survey of Cypress Creek was undertaken by the Kentucky Department for Environmental Protection (DEP) in July, 1982. Two sampling stations were established (Figure 1) and sampled once during a low flow period. The location of these stations, dates sampled and parametric coverage are given in Appendix A. Biological data collected by the Kentucky Nature Preserves Commission in 1978, 1979 and 1980 (Harker et al. 1980, 1981) was utilized in this investigation.

The purposes of this investigation were as follows:

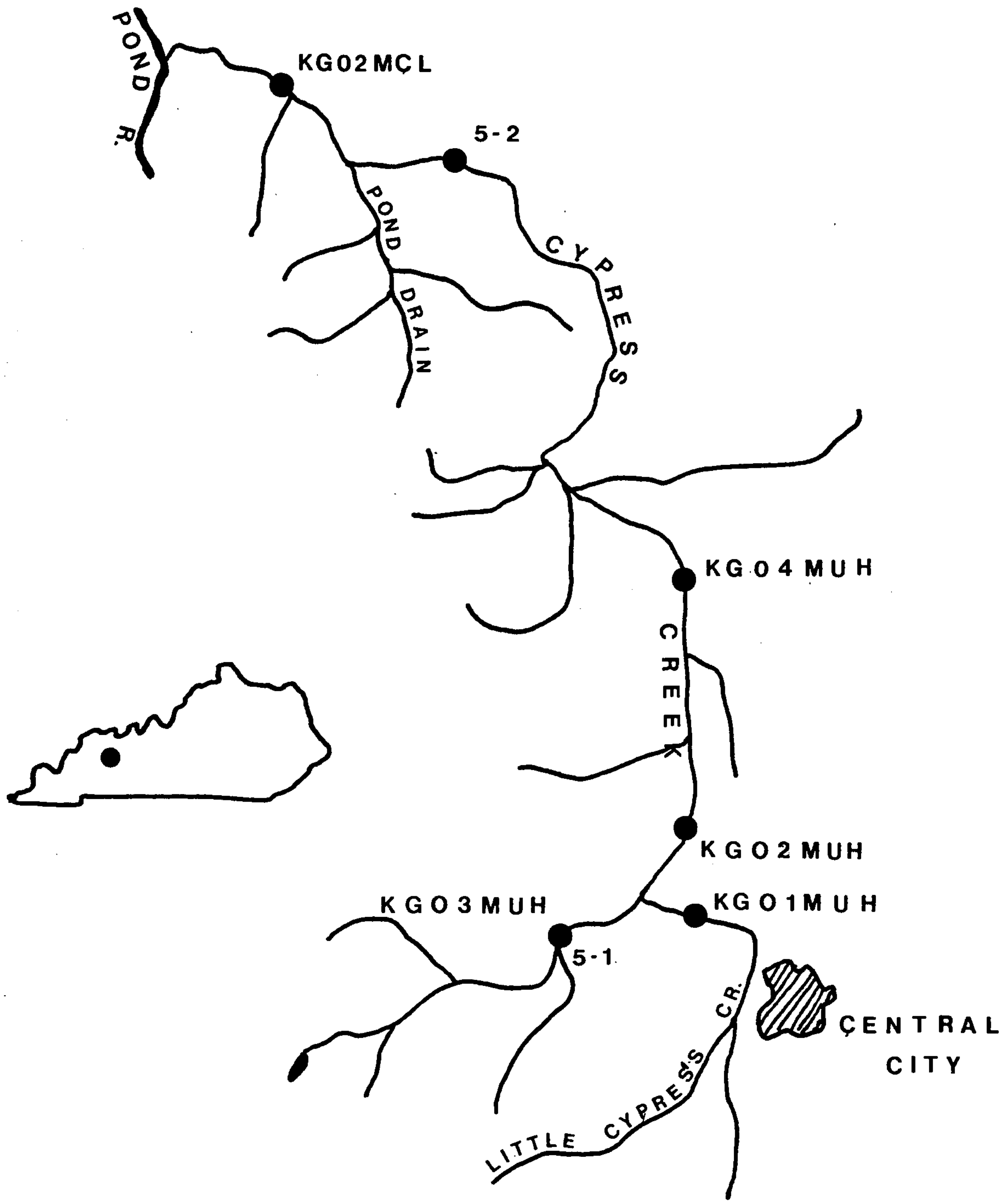
1. To determine the existing water quality of the basin.
2. To determine the aquatic uses currently being achieved in the drainage.
3. To determine the causes of any impairments of the aquatic uses.
4. To determine what aquatic uses can be attained based on the physical, chemical and biological characteristics of the watershed.

However, due to the study design and time constraints, it was not always possible to address specific sources of constituents which may be impairing the aquatic uses or to recommend remedies for problems. A more detailed, multi-discipline approach would be required to study those aspects and determine an appropriate management plan.

The United States Geological Survey's hydrologic unit map list a total of 36 miles in the Cypress Creek system. According to data from this and other studies the

Figure 1: Map of Cypress Creek

with Sampling Locations



Cypress Creek drainage has 33 miles that partially support designated uses while 3 miles remain unknown.

Literature Review

Water quality data on the Cypress Creek watershed have been reported by the United States Geological Survey (USGS) (1974, 1975, 1976, 1981, 1982), Weston, Inc. (1975), Kentucky Nature preserves Commission (KNPC) (1978), Harker et al. (1980, 1981), Axon (1980, 1981), Mitsch et al. (1983) and Division of Water (DOW) (1981).

Periphyton and macroinvertebrate data are presented by KNPC (1978), Harker et al. (1980, 1981). Fish investigations have been reported by KNPC (1978), Axon (1980, 1981), Warren (1980), Retzer (1980), and Harker et al. (1980, 1981).

Basin Impacts

Coal, oil and gas comprise the principal energy resources of the Cypress Creek watershed (Kehn 1968, 1971; Palmer 1969, 1972; Hansen 1972; Franklin 1973). Numerous coal beds have been deep and strip mined, with large active strip mines and land in various stages of revegetation or reclamation in the uplands and, in some cases, stream valleys and wetlands (Harker et al. 1981). In past years, Cypress Creek was significantly degraded by acid mine drainage; however, water quality has improved in recent years, resulting in a concommitant improvement in fish populations (Axon 1980). Numerous oil and gas wells have been drilled in the watershed.

Virtually all of the Cypress Creek system has been channelized to promote agriculture and reduce flooding caused by siltation; Cypress Creek was channelized in the 1920's and a section of Little Cypress Creek was rechannelized in 1980 (Harker et al. 1981).

There are 17 permitted dischargers located in the Cypress Creek watershed, with nine of these having design flow limits (Table 1). The major discharger is the Central City wastewater treatment plant (WWTP) with a design flow of 600,000 gallons per day (GPD). The present 201 facility plan calls for the plant to be expanded to 970,000 GPD utilizing an oxidation ditch.

Table 1: Segment 03005 Permitted Facilities

Facility #	Facility Name	Design Flow (GPD)
03005001	Island School	2,000
03005003	Central City, city of - WWTP	600,000
03005004	Carroll's Laundry	-
03005005	Bremen School	3,000
03005006	Peabody Coal - Prep Plant (River Queen)	-
03005007	Earl C. Clements Job Corps Center	21,000
03005008	Sacromento School	7,500
03005009	ICGRR - Central City	-
03005010	Peabody Coal - South Star Mine (Bath)	6,000
03005011	Peabody Coal - Moorman Mine (Bath)	3,250
03005012	The Lake	2,000
03005013	Peabody Coal Co. - Star North Mine	3,800
03005500	S and M Oil Co. - Paint Creek No. 2	-
03005501	S and M Oil Co. - New Cypress Point Ck. No. 1	-
03005502	Creek Oil Co. - Clell Vincent	-

Stream Uses

The main channel of Cypress Creek and adjacent wetlands are fished by local residents. The fishing pressure is considered moderate for bass and bluegill (Axon 1981).

No domestic water supply withdrawals occur in the watershed nor was any primary contact recreation observed during this study. However, the latter is assumed to occur in selected reaches of the Cypress Creek system.

Extensive hunting for waterfowl occurs along Cypress Creek and particularly in adjacent wetlands during the fall. Hunting for small mammals and deer also occurs throughout the watershed. Those game animals, as well as non-game species, utilize the various streams, wetlands and adjacent buffer zones for breeding, rearing young and feeding, as well as a water supply for drinking. Trapping for small mammals such as beaver, muskrats mink, etc., also occurs in rural sections of the drainage.

METHODS

Water samples were analyzed in accordance with the latest edition of Standard Methods for the Examination of Water and Wastewater (APHA 1981) and United States Environmental protection Agency's (U. S. EPA) Methods for Chemical Analysis of Water and Waste (U. S. EPA 1979). Field turbidity measurements were taken with an HF Instruments Model DRT-15 turbidimeter. Field conductivity was determined with a Yellow Springs Instrument Company (YSI) Model 33 S-C-T meter. Field measurements for dissolved oxygen (DO) and water temperature were conducted with a YSI Model 54A oxygen meter. An Analytical Measurements Model 707B pH meter was used for field pH.

Biological samples were collected utilizing a variety of techniques. These methods are outlined by Harker et al. (1980, 1981) and are not presented here. The trophic relationships for macroinvertebrates follow those outlined by Merritt and Cummins (1978) and Hawkins and Sedell (1982). Aquatic macroinvertebrates were placed into one of three pollution categories, (i.e. tolerant, facultative and intolerant), generally based on information presented by Weber (1973) and Hart and Fuller (1974). These categories are defined by Beck (1955) and Weber (1973) as follows: tolerant organisms are associated with gross organic contamination and are generally capable of thriving under anaerobic circumstances; facultative organisms are capable of tolerating a wide range of environmental conditions, including moderate levels of organic enrichment, but cannot exist under anaerobic conditions; intolerant organisms are sensitive to even moderate levels of organic enrichment and are generally unable to withstand even moderate reductions of dissolved oxygen.

Bacteriological samples were collected from directly below the water's surface in 250 ml, wide mouth, sterile nalgene jars, placed on wet ice and returned for analysis to the DOW biological laboratory within six hours. Analyses for fecal coliform and fecal streptococcocus bacteria were performed using the membrane filter techniques outlined by Bordner et al. (1978).

PHYSICAL EVALUATION

Cypress Creek, a fifth order stream, originates in west-central Muhlenberg County and flows 53.6 km (33.3 mi) north and then west through McLean County before discharging into the Pond River 1.6 km (1.0 mi) upstream from its confluence with the Green River. Tributaries include Little Cypress Creek, Harris Branch, Muddy Fork, and Pond Drain. According to Bower and Jackson (1981), this system drains 396 km^2 (153 mi^2).

The subbasin lies in the Ohio River Hills and Lowlands subsection of Shawnee Hills, a physiographic region within the Interior Low Plateaus Province (Quarterman and Powell 1978). The topography consists of low-lying hills in the headwaters and low, flat terrain downstream. Wetlands are common throughout the area. However, land use practices, i.e. strip mining and intensive agriculture, have severely reduced the quantity and quality of these wetlands.

Rock strata underlying the hills and upland areas include Pennsylvanian aged sandstone, siltstone, coal, and interbedded limestone and shale; alluvial deposits of siltstone and crossbedded sand or sandstone underlie the extensive lowland areas (McDowell et al. 1981). Elevations for Cypress Creek range from 107m (350 ft) above mean sea level (msl) at the mouth to 146m (480 ft) above msl in the headwaters. Average stream gradient is 0.7 m/km (3.9 ft/mi). The three major soil groups and their characteristics are given in Table 2.

Flow data for the drainage are limited. A USGS station on Cypress Creek near Calhoun (RMI 5.7) was maintained from August 1979 to September 1981 (USGS 1982). Average discharge for 1980 was 3.3 m^3/s (116 ft^3/s); maximum discharge, on November 26, 1979, was 59.5 m^3/s (2100 ft^3/s). According to Sullavan (1980), the seven day, ten year low flow (7Q10) at that station is 0.0 ft^3/s. Weston, Inc. (1975) determined the 7Q10 at RMI 0.0 to be 1.1 ft^3/s (primarily treated wastewater under low flow

Table 2: Soils of the Cypress Creek Basin

Soil Association(1)	Slope, % % (1,2)	Drainage Class (2)	Potential Sediment Runoff (1)	Infiltration(1)	Septic Tank Absorption Rating (1)
Karnak	Nearly level	-	ND	ND	Severe
McGary	1-3	Somewhat poorly-drained	Low	Slow	Severe
Melvin	0-1	Poorly drained	Low	Very slow	Severe
Loring	3-15	Well to moderately-well drained	Medium	Slow	Moderate
Grenada	2-10	Moderately well drained	Medium	Slow	Severe
Calloway	1-4	Somewhat poorly drained	Medium	Slow	Severe
Karnak	0-4	-	ND	ND	Severe
Falaya	0-3	Somewhat poorly	Medium	Slow	Severe
Bonnie	0-4	-	Medium	Very slow	Severe

(1) Weston, Inc. (1975)
(2) Bailey and Winsor (1964)
ND No Data

conditions). A USGS partial record station on Cypress Creek near Central City recorded an instantaneous stream flow on March 23, 1981 of 0.31 m^3/s (11 ft^3/s) and on June 25, 1981 of 0.28 m^3/s (9.8 ft^3/s) (USGS 1982). A USGS partial record station on Little Cypress Creek at Central City recorded an instantaneous stream flow on March 23, 1981 of 0.37 m^3/s (13 ft^3/s) and on June 25, 1981 of 0.22 m^3/s (7.6 ft^3/s) (USGS 1982).

Cypress Creek and Little Cypress Creek have been channelized. These streams typically consist of slow moving pools with only an occasional riffle. Substrate materials are primarily silt and debris covered cobble and gravel. Submerged roots and logs, as well as an abundance of dead timber, were common in the stream. Aquatic vegetation was also abundant throughout Cypress Creek (for a list of wetland plant species see Harker et al. 1981).

Palustrine wetlands associated with Cypress Creek are quite extensive (Mitsch et al. 1983). According to data supplied by KNPC, there are 1770 ha (4374 acres) of wetlands located in the Cypress Creek watersheds. Under natural conditions, fish and invertebrates flourish in this type of wetland (Greeson et al. 1979, Sather and Stuber 1984). However, due to extensive surface mining and agriculture, the water quality of the Cypress Creek system has been degraded (Harker et al. 1981, Mitsch et al. 1983). Wetlands can help improve water quality (Kadlec 1978, van der Valk 1978, Burton 1981, Oberts 1981) and have probably buffered Cypress Creek from the above impacts to some degree. They are also valuable for flood and sediment control (Novitzki 1981, Bedinger 1978). For a detailed site description, see Harker et al. (1981).

PHYSICOCHEMICAL EVALUATION

A total of 59 physicochemical parameters (Table 3) were analyzed from surface grab samples taken from two locations in the Cypress Creek drainage in July 1982 by DOW personnel. Additional physicochemical data for the drainage are provided by USGS (1974, 1975, 1976, 1981, 1982), Weston, Inc. (1976), KNPC (1978), Harker et al. (1980, 1981), Axon (1980, 1981), Mitsch et al. (1983) and DOW (1981).

Physicochemical data presented by (USGS 1974, 1975, 1976, 1981, 1982) Harker et al. (1980, 1981), Mitsch et al. (1980) and DOW (1981) and this report indicate that the Cypress Creek system has been severely impacted by coal mining operations. Generally speaking, those parameters associated with coal mining, such as sulfate, iron, conductivity, total dissolved solids, etc., are elevated in the Cypress Creek system. In addition, DOW (1981) documented acid mine drainage problems occurring in Little Cypress Creek.

A perusal of total hardness and total alkalinity data presented by USGS (1974, 1975, 1976, 1981, 1982), Axon (1980), Harker et al. (1980, 1981), Mitsch et al. (1983) and DOW (1981), as well as present data, indicates that alkalinity was variable while hardness was generally high. In fact, DOW (1981) presented data that showed alkalinity reached zero, a violation of Kentucky Surface Water Standards (KSWS), 401 KAR 5:031, Section 4 (1)(a). Using the hardness classification of Sawyer (1960), the waters of the Cypress Creek system would be generally classified as very hard.

Conductivity and total dissolved solids values reported in this and other studies may be detrimental to aquatic life. Conductivity data reported by USGS (1974, 1975, 1976, 1981, 1982), Harker et al. (1980, 1981), Mitsch et al. (1983), DOW (1981) and this study were considerably elevated above 500 µmhos/cm. Ellis (1937) observed that conductivity values of streams supporting well developed fish faunas ranged between 150 and 500 µmhos/cm. Total dissolved solids data reported by USGS (1981, 1982) and data from this report (at station 5-1) exceeded the 2000 mg/l value, which was reported by McCarraher and Thomas (1968) as inhibiting fish spawning.

Table 3: Physicochemical data for the Cypress Creek Drainage

Parameter	Stations 5-1	5-2
Conductivity (umhos/cm @ 25°C)	2422.5	1020.0
pH	6.9	7.1
Air temperature (°C)	27.0	24.0
Water temperature (°C)	24.0	24.0
Turbidity (NTU)	4.8	70.0
DO (mg/l)	7.1	6.6
Acidity (mg/l)	16.0	17.0
Alkalinity (mg/l)	43.4	78.0
BOD_5 (mg/l)	3.3	2.6
Chloride (mg/l)	18.5	9.3
COD (mg/l)	13.1	21.2
CN (free) (mg/l)	0.032	K0.01
Total Dissolved Solids (mg/l)	2086.0	796.0
Fluoride (mg/l)	0.60	0.31
Total Hardness (mg/l)	1386.0	501.2
Sulfide (mg/l)	K0.1	K0.1
Phenols (mg/l)	K0.1	K0.1
Sulfate (mg/l)	1425.0	557.0
Suspended Solids (mg/l)	5.0	99.0
NH_3-N (mg/l)	0.16	0.15
NO_2 + NO_3 - N (mg/l)	0.270	0.105
TKN (mg/l)	0.61	0.74
Phosphorous (total) (mg/l)	0.034	0.118
Phosphorous (dissolved) Ortho (mg/l)	0.006	0.034
Phthalate Esters (ug/l)	41.0	44.0
Benzyl butyl phthalate (ug/l)	38.0	16.0
Bis (2-ethylhexyl) phthalate (ug/l)	3.0	28.0
Di-n-butal phthalate (ug/l)	K1.0	K1.0
Di-n-octyl phthalate (ug/l)	K1.0	K1.0
Di-ethyl phthalate (ug/l)	K1.0	K1.0
Di-methyl phthalate (ug/l)	K1.0	K1.0
Al (total)) (ug/l)	152.0	527.0
As (total) (ug/l)	6.0	9.0
Ba (total) (ug/l)	37.0	121.0
Be (total) (ug/l)	3.0	2.0
Cd (total) (ug/l)	3.0	2.0
Ca (total) (mg/l)	270.0	96.0
Cr (total) (ug/l)	4.0	2.0
Cu (total) (ug/l)	22.0	10.0
Fe (total) (ug/l)	784.0	3228.0
Pb (total) (ug/l)	42.0	19.0
Mg (total) (mg/l)	139.0	48.0
Mn (total) (ug/l)	1470.0	714.0
Hg (total) (ug/l)	0.2	0.2
Ni (total) (ug/l)	34.0	18.0
K (total) (mg/l)	6.8	4.7
Se (total) (ug/l)	13.0	10.0
Ag (total) (ug/l)	5.0	2.0
Na (total) (mg/l)	57.5	34.5
Zn (total) (ug/l)	21.0	19.0

K - below detection limit

Dissolved oxygen (DO) data presented by Axon (1980), Harker et al. (1980, 1981), DOW (1981) and this report showed no violation of KSWS, but were generally below STORET (1979-1982) mean value of 8.87. However, Mitsch et al. (1983) reported DO concentrations from Cypress Creek wetland that violated KSWS, 401 KAR 5:031, Section 4 (1)(e)(1). Oxygen saturation was 83% and 78% at stations 5-1 and 5-2, respectively, during this study. This may be a normal phenomenon in the low gradient streams in this part of Kentucky. Normally, unpolluted streams will be at 100% saturation or slightly above; however sluggish waters may exhibit a greater variation, while the input of organic matter will cause oxygen concentrations to decrease (Whitton 1975). Ellis (1937), Thompson (1925) and Stroud (1967) reported 5 mg/l of DO as the lower limit for a "well rounded warmwater fish fauna". Reduction in the level of available oxygen has a marked effect on many physiological, biochemical and behavioral processes in fish (Davis 1975), such as increased toxicity of metallic salts and acid wastes (Ellis 1937) and the impairment of swimming performance at DO concentrations below 5-6 ppm (Dahlberg et al. 1968).

Biochemical oxygen demand (BOD_5) and chemical oxygen demand (COD) values observed in this study are considered acceptable for warmwater streams. At both stations, BOD and COD approached or exceeded STORET (1979-1982) mean values of 1.31 mg/l and 13.42 mg/l, respectively.

Generally speaking, sulfate values presented in this and other reports were considerably elevated, while chloride values were apparently near background for the area. Sulfate data presented by USGS (1974, 1975, 1976, 1981, 1982), Harker et al. (1980, 1981), Mitsch et al. (1983) and DOW (1981) and this report contain values that greatly exceed the 60 mg/l value reported by DOW (1981) as indicative of areas draining coal mining operations. Chloride values from USGS (1974, 1975, 1976, 1981), Mitsch et al. (1983) and this report were all similar to each other.

Free cyanide occasionally exceeded KSWS 401 KAR 5:031, Section 4 (1)(i)4, while phenols remained below detection limits. Cyanide values presented by USGS (1980) from Cypress Creek near Calhoun, Kentucky exceeded KSWS, as did the value at station 5-1 from this study.

Nutrient data for Cypress Creek are presented by USGS (1982) and this report. Un-ionized ammonia values from this report did not exceed KSWS and ammonia values were below the STORET (1979-1981) mean value of 0.23 mg/l. Nitrite + nitrate - nitrogen (NO_2+NO_3-) data reported by USGS (1981) were elevated in Little Cypress Creek, probably due to the WWTP discharge from Central City. The NO_2+NO_3-N values from this report were below the STORET (1979-1982) mean value of 0.69 mg/l. Patrick (1950) noted that healthy streams in the eastern United States should not exceeded 2.0 mg/l nitrate. Only the USGS (1982) data from Little Cypress Creek exceeded this value. The values observed for total Kjeldahl nitrogen during this study approached or slightly exceed the STORET (1979-1982) mean value of 0.61 mg/l. Total phosphorous (TP) reported here and by USGS (1981) indicate that TP in the Cypress Creek system generally remains low. According to the data from these two reports, TP has remained below the STORET (1979-1982) mean value of 0.156 mg/l. However, the TP concentration observed in this study from station 5-2 is slightly elevated. Elevated TP concentrations are of concern, since phosphorous is usually the nutrient most limiting to primary production (Wiebe 1931, Schindler 1971) and increased amounts generally accelerate eutrophication (Winger 1981). Concentrations of phosphorous are usually below 0.1 mg/l (NTAC 1968, Keup 1968), except in streams receiving agricultural runoff (Omernik 1977) and domestic waste (Wetzel 1975, Goodman and Horne 1983).

Phthalate esters exceeded Kentucky Surface Water Standards (KSWS) for warmwater aquatic habitat, 401 KAR 5:031, Section 4 (1)(i)(4), of 3 ug/l at both sampling stations. Phthalate esters are used as plasticizers and in some pesticides (U.

S. EPA 1976). According to U. S. EPA (1980a), phthalate ester concentrations as low as 940 ug/l can be acutely toxic to freshwater aquatic life and chronic toxicity may occur at 3.0 ug/l for more sensitive aquatic species.

Arsenic (As) exceeded the STORET (1979-1982) mean value of 4.24 µg/l at both sampling stations (Table 3). Compounds of As are ubiquitous in nature, insoluble in water and mainly occur as arsenides and arsenopyrides (U. S. EPA 1976). Arsenic exists in the trivalent and pentavalent states and the compounds may be either organic or inorganic (U. S. EPA 1976, 1980b). Analysis of 1,577 United States surface water samples showed arsenic present in 87 samples, with concentrations ranging from 5 to 336 ug/l and a mean level of 64 ug/l (Kopp 1969). According to U. S. EPA (1976), As is capable of being concentrated in aquatic organisms, but it is evidently not progressively concentrated along a food chain. They cite data that indicate fish food organisms are adversely affected by concentrations of As as low as 1.3 mg/l, and the mobility of the freshwater crustacean Daphnia is impaired by a concentration as low as 4.3 mg/l. The concentrations observed in this study were considerably lower than those listed above.

Barium (Ba) exceeded the STORET (1979-1982) mean value of 62.58 ug/l at station 5-2. The USGS (1982) and Mitsch et al. (1983) also reported Ba values in excess of STORET mean. Barium, an alkaline earth metal, occurs in nature chiefly as barite ($BaSO_4$) and witherite ($BaCO_3$), both of which are highly insoluble (U. S. EPA 1976). Experimental data indicate that the soluble Ba concentration in fresh or marine water generally would have to exceed 50 mg/l before toxicity to aquatic life would be expected (U. S. EPA 1976). The U. S. EPA (1976) speculated that in most natural waters there is sufficient sulfate and carbonate to precipitate the Ba present as a virtually insoluble, nontoxic compound. None of the studies reported Ba concentrations that closely approximated the 50 mg/l value presented by U. S. EPA (1976).

Beryllium (Be) exceed the STORET (1979-1982) mean value of 1.05 µg/l at both stations, but did not exceed KSWS (401 KAR 5:031, Section 4 (1)(i)(4)). However, Be in low concentrations may be toxic to aquatic life. The U. S. EPA (1980c) stated, "the available data for beryllium indicate that acute and chronic toxicities to freshwater aquatic life occur at concentrations as low as 130 and 5.3 ug/l, respectively, and would occur at lower concentrations among species that are more sensitive than those tested. Hardness has a substantial effect on acute toxicity." The major source of Be in the environment is the combustion of fossil fuels (Tepper 1972). Beryllium enters the waterways through weathering of rocks and soils, through atmospheric fallout and from industrial and municipal dischargers (U. S. EPA 1980c). However, Be is not likely to occur at significantly toxic levels in ambient natural waters (McKee and Wolf 1963). Hem (1970) estimated that the average concentrations of Be in fresh surface waters is less that 1 µg/l. Kopp and Kroner (1967) reported that for 1,577 surface water samples collected at a 130 locations in the United States, 85 samples (5.4%) contained from 0.01 to 1.22 µg/l with a mean of 0.19 µg/l. Though the concentration of Be is elevated above what would normally be expected, it is below the U. S. EPA (1980c) criteria discussed above.

The copper (Cu) concentration at station 5-1 exceeded the STORET (1979-1982) mean value of 7.25 ug/l, as well as the U. S. EPA (1980e) recommended criteria. In addition, USGS (1982) reported one sample in which Cu exceeded STORET and U. S. EPA (1980e) criteria. Copper is an essential nutrient of plants and animals; however, if the Cu concentration greatly exceeds that required for nutrition, it can be toxic to aquatic organisms (U. S. EPA 1980e). Copper is known to be particularly toxic to algae and mollusks (CWQC 1972). Data presented by Chakoumakos et al. (1979) and Howarth and Sprague (1978) indicate that the life stage may affect the susceptibility of fish to copper toxicity. Copper concentrations of 1 to 10 µg/l are usually reported for unpolluted surface waters in the United States, but concentrations in the vicinity of municipal and industrial discharges may be much higher (U. S. EPA 1980e). Copper concentrations in this study were 10 µg/l at both stations. Acute toxicity of copper to aquatic life depends on alkalinity, pH, organic compounds (U. S. EPA 1976), hardness, and temperature (U. S. EPA 1980e). At low levels, hardness does not appear to affect chronic toxicity (U. S. EPA 1980e). For total recoverable copper, the criterion to protect freshwater aquatic life is 5.6 ug/l as 24 hour average. Therefore, Cu concentrations observed in this study may pose a chronic toxicity problem to aquatic life.

The iron (Fe) concentration observed at station 5-2 exceeded KSWS for warmwater aquatic habitat, 401 KAR 5:031, Section 4 (1)(i)(4). Additional data presented by Mitsch et al. (1983) and USGS (1982) indicate that Fe consistently violate KSWS. Iron is an abundant and widespread constituent of rocks and soil, and concentrations of only a few tenths of a milligram per liter in water can render it unsuitable for some uses (Hem 1970). The U. S. EPA (1976) recommended a protective criterion of 1.0 mg/l (= 1000 ug/l), which is equivalent to KSWS, for the protection of aquatic life. However, concentrations of iron less than the 1.0 mg/l value may be toxic to aquatic life. Warnick and Bell (1969) derived a 96-hour LC_{50} of 320 ug/l of Fe for selected aquatic insects (i.e. certain mayflies, stoneflies and caddisflies), all of which are important fish food organisms. Therefore, iron concentrations at 5-2, as well as at other locations in the Cypress Creek drainage, have the potential to be limiting to aquatic life.

Manganese (Mn) concentrations at both stations were elevated above the STORET (1979-1982) mean value of 221.96 µg/l. Also, data presented by Mitsch et al. (1983) and USGS (1982) indicate that Mn is elevated throughout the drainage. Manganese is a micro-nutrient for both plants and animals (U. S. EPA 1976), occurring in natural waters at low levels as maneganous salts and precipitated in the presence of air as manganic oxide (CWQC 1972). Manganese determinations have traditionally been omitted from surface water analyses, except in streams subject to extensive pollution; therefore, there is little information on the normal loads of Mn in stream waters and how it may vary seasonally (Hem 1970).

Selenium (Se) exceeded the STORET (1979-1982) mean value of 1.64 µg/l. This is of particular importance because Se is known to enhance the toxicity of other metals. Biologically, Se is an essential, beneficial element, recognized as a metabolic requirement in trace amounts for animals, but toxic when ingested in amounts ranging from about 0.1 to 10 mg/kg of food (U. S. EPA 1976). The major source of Se in the environment is the weathering of rocks and soils (Rosenfeld and Beath 1964). Elemental Se must be oxidized to selenite or selenate before it is appreciably soluble in water (U. S. EPA 1976). U. S. EPA (1980f) criteria for aquatic life is based on inorganic selenite and inorganic selenate; the total Se concentrations observed in this study were well below the U. S. EPA (1980f) guidelines for either species.

Silver (Ag) concentrations at both sampling locations exceeded the STORET (1979-1982) mean value of 1.15 µg/l. Furthermore, the values observed exceeded the chronic toxicity level of 0.12 µg/l recommended by the U. S. EPA (1980g). Biologically, Ag is a nonessential, nonbeneficial element capable of causing localized skin discoloration in humans and being toxic to aquatic life (U. S. EPA 1976). Aub and Fairhall (1942) report that once Ag is absorbed, it is held indefinitely in the tissues. The U. S. EPA (1979) also notes that some silver is bioaccumulated. Silver occurs primarily in the form of the sulfide (Ag_2S) or intimately associated with other metal sulfides, especially those of lead and copper (U. S. EPA 1980g). Data presented by Kopp (1969) from 1,577 samples collected from 130 locations in the United States showed detectable concentrations in 104 samples, ranging from 1.0 to 38 µg/l with a median of 2.6 µg/l. In a study of ten U. S. rivers, Kharkar et al. (1968) detected Ag in concentrations ranging from 0.092 to 0.55 µg/l. Hem (1970) cites studies of public drinking water supplies and river waters which report median concentrations of 0.23 and 0.9 µg/l, respectively. Sorption and precipitation processes are effective in reducing the concentration of dissolved Ag and result in higher concentrations in the sediments than in the water column (U. S. EPA 1980g). However, the Ag concentrations observed may be chronically toxic to freshwater aquatic life in this drainage.

Zinc (Zn) concentrations observed approached the STORET (1979-1982) mean value of 22.25 μg/l. Zinc data presented by USGS (1982) consistently exceed the STORET mean and exceed KSWS for warmwater aquatic habitat 401 KAR 5:031 Section 4 (1)(i)4, as well as the recommended U.S. EPA (1980h) chronic toxicity level of 47 ug/l. Zinc is a common trace element in natural waters and is required in the metabolism of most organisms. The toxicity of Zn is influenced by hardness, DO, pH (U. S. EPA 1976), and ionic strength (U. S. EPA 1980h). However, the available toxicity data indicate that hardness effects are much less dramatic for chronic toxicity than for acute toxicity (U. S. EPA 1980h). Therefore, the Zn concentration reported by USGS (1982) may pose chronic toxicity problems for the aquatic life.

BIOLOGICAL EVALUATION

The Kentucky Nature Preserve Commission (KNPC) collected algae, macroinvertebrates and fish from three locations in the Cypress Creek system (refer to Harker et al. 1980, 1981): site KG01MUH was located on a slough east of Little Cypress Creek, 4.2 km northwest of Central City off Clarks Road and sampled in November, 1978; site KG02MUH is located 6.7 km west-northwest of Central City at Kentucky Route 81 bridge and was sampled twice; (November, 1978 and August, 1980); site KG02MCL was located at Kentucky Route 939 bridge, 5.0 km above the mouth and was sampled in August 1980. Kentucky Nature Preserve Commission station KG02MUH is equivalent to our station 5-2.

Generally speaking, the lowermost KNPC station (KG02MCL) exhibited the greatest biological diversity. This may be attributed to increased stream size and habitat diversity and possibly an improvement in water quality. This latter statement cannot be confirmed, since extensive physicochemical analyses were not performed by KNPC.

The biological data from the middle KNPC station (KG02MUH = DOW 5-2) seem to indicate that this portion of the stream is impacted by coal mining. This is supported by the physicochemical data discussed earlier in this report.

Also, the biological data from KNPC's Little Cypress Creek station (KG01MUH) indicate that this stream is impacted by municipal waste from Central City.

Bacteria

Of the two stations sampled, station 5-2 violated the fecal coliform (FC) standard (KSWS 5:031, Section 7) for primary contact recreation (i.e. swimming), while station 5-1 had an acceptable FC level (Table 4). Neither station violated the standard for secondary contact recreation (i.e. fishing). There were no violations of the standard for pH during this study.

Table 4: Cypress Creek Bacteriological Results

Date	Station/Source		FC	FS	FC/FS
July 15, 1982	05-1	Cypress Creek	230	152	1.5
July 15, 1982	05-2	Cypress Creek	470	430	1.1

FC = Fecal Coliforms per 100 ml
FS = Fecal Streptococci per 100 ml
FC/FS = Fecal Coliform/Fecal Streptococci Ratio

The FC/FS ratios are in the "grey" area of interpretation and do not clearly indicate the origin of the fecal pollution (man or animal). The largest potential threat to primary contact recreation within the segment is the Central City WWTP (600,000 gpd), which discharges into Little Cypress Creek. Because of the distance from the WWTP to Cypress Creek (2.65 mi), excessive FC levels, resulting from improper operation of the WWTP, should be reduced before reaching Cypress Creek. Besides the nine dischargers, the probable sources of fecal pollution are agricultural runoff and septic tank runoff.

It is recommended that Cypress Creek and its tributaries be designated for primary/secondary contact recreation use. Data from this study indicate that these uses are occurring or are attainable through proper point source pollution control technology.

Algae

In general, the Cypress Creek system supports a diverse algal flora, with more than 139 species reported by Harker et al. (1980, 1981). The Little Cypress Creek (KG01MUH) and upper Cypress Creek (KG02MUH) sites were essentially equal in total numbers of diatom species (83 and 85 species respectively) (Appendix C). The lower Cypress Creek (KG02MCL) site supported 51 diatom species. According to Harker et al. (1980), a nearly monotypic growth of *Cyclotella meneghiniana* occurred in the Little Cypress Creek channel. This species has been reported by Cholnoky (1968) as being a nitrogen heterotroph. The occurrence of this species is not surprising, since the effluent from Central City WWTP is discharged directly into Little Cypress Creek (Harker et al. 1980). The numerically abundant diatoms in Cypress Creek at KGO2MUH (= DOW 5-2) were species associated with high conductivity (Harker et al. 1981). This is a reflection of the water quality (i.e. high conductivity values). The lowermost station (KG02MCL) sampled by Harker et al. (1980) also had an elevated conductivity value (2849 μmhos). The most common taxa they encountered were *Navicula symmetrica*, *Navicula* sp. and two unidentified *Nitzschia* species; apparently these were also tolerant to high conductivities. The stream habitats were reasonably well developed at both KG02MUH and KG02MCL, particularily the lower station (KG02MCL). Both sites would be expected to support a more speciose flora; however, the stream perturbations arising from extensive coal mining operations in the drainage have apparently limited the floral diversity.

Macroinvertebrates

Generally speaking the macroinvertebrate fauna (Appendix D) observed from the Cypress Creek system is typical of lowland, low gradient streams. Harker et al. (1981) reported 76 taxa from the drainage. The vast majority of macroinvertebrates reported from Little Cypress Creek (KG01MUG) were taken from the adjacent wetland (S. Call pers. comm.); the creek did not support a diverse fauna, because of the lack of habitat and pollution from coal mining operation and the Central City WWTP. The fact that the macroinvertebrates present at all locations were either facultative or tolerant to a wide variety of environmental conditions supports the above statement.

The middle (KG02MUH) and lower (KG02MCL) KNPC sites supported a moderately diverse macroinvertebrate fauna. Part of the explanation for the lower numbers of macroinvertebrates observed at the middle station was the lack of riffle habitat, however, all other major habitat types were present. The lower station had all major habitat types present, therefore, something other than habitat restrictions must be responsible for depressing the macroinvertebrate fauna. There is little doubt that historical, as well as present water quality perturbations are responsible for the somewhat depauperate macroinvertebrate fauna.

Fish

Investigations of the Cypress Creek drainage ichthyofauna have been conducted by KNPC (1978), Axon (1980, 1981), Warren (1980), Retzer (1980) and Harker et al. (1980, 1981). Axon (1980) noted an improvement in water quality with a concomitant improvement in the sport fishery. Harker et al. (1980, 1981) reported 34 species from the drainage (Appendix E). Warren (1980) noted the occurrence of an apparent relict population of the banded pygmy sunfish (*Elassoma zonatum*) and the rare lake chubsucker (*Erimyzon sucetta*). The Kentucky Academy of Science - KNPC list these species as special concern (peripheral) and undetermined, respectively (Branson et al. 1981). KNPC (1978) observed heavy siltation below a large strip mine operation in an upstream area of Cypress Creek, with a correspondingly depauperate fish fauna.

Harker et al. (1980) noted the importance of wetlands surrounding portions of Cypress Creek serving as refugia during periods of acid flow and/or poorly treated municipal waste. They state that, "in light of the historical pollution of the stream system, these areas undoubtedly played a major role in the apparent rapid recovery of the fish diversity". Previous collection records, including those of Harker et al. (1980), indicate a total of 34 species known from the Cypress Creek system. Virtually all of the species recorded can be found in the adjacent wetland areas. In addition, the lower portions of the Cypress Creek basin are known to support at least 40 species of fish (Harker et al. 1981).

APPENDIX A

Site Information

Site No:	03005001
Stream:	Cypress Creek
County:	Muhlenberg
Location:	KY 70 bridge
Latitude:	37° 18' 10"
Longitude:	87° 11' 43"
USGS Topo Quad:	Central City West, KY
DOW Map No.:	7-23
RMI:	26.3
Sampling Dates:	7-14-82
Type Sampling:	Physicochemical
Stream Gradient:	Low
Pool Width:	3 to 6 m
Pool Depth:	1.2m
Pool Substrate:	Primarily fines and detritus
Riffle Width:	N/A
Riffle Depth:	N/A
Riffle Substrate:	N/A
Bank Height:	.3 to 1 m
Bank Slope:	Less than 30%
<u>Riparian Vegetation - %</u>	
Trees:	80
Shrubs:	10
Herbs:	10
Exposed:	0-5

	Site Information
Canopy over Stream - %	50 to 75
Bank Stability:	Good
Erosion:	Slight at site
Sedimentation:	Slight
Imbeddedness:	N/D
Periphyton Abundance:	Sparse
Stream Habitat:	Undercut banks, submerged roots and logs, extensive wetlands, drift piles
Hydraulic Structures:	Bridge abutment
Physical Impacts:	Complete channelization in the 1920's
Nonpoint Sources:	Surface coal mining, agriculture, Ky 70

ND - Not Determined

NA - Not Applicable

Site Information

Site No:	03005002
Stream:	Cypress Creek
County:	McLean
Location:	KY 81 (Vicker) bridge
Latitude:	37° 29' 25"
Longitude:	87° 14' 44"
USGS Topo Quad:	Livermore
DOW Map No.:	8-23
RMI:	8.37
Sampling Dates:	7-14-84
Type Sampling:	Physicochemical
Stream Gradient:	Low
Pool Width:	Approximately 5m
Pool Depth:	ND
Pool Substrate:	Primarily fines and detritus
Riffle Width:	N/A
Riffle Depth:	N/A
Riffle Substrate:	N/A
Bank Height:	.3 to 1m
Bank Slope:	Less than 30%
<u>Riparian Vegetation - %</u>	
Trees:	5
Shrubs:	5
Herbs:	90
Exposed:	0-5

	Site Information
Canopy over Stream - %	0 to 25
Bank Stability:	Fair
Erosion:	Slight at site
Sedimentation:	Moderate
Imbeddedness:	N/D
Periphyton Abundance:	Sparse
Stream Habitat:	Wetlands, submerged roots and logs
Hydraulic Structures:	Bridge abutment
Physical Impacts:	Complete channelization in the 1920's
Nonpoint Sources:	Surface mining for coal, agriculture

ND - Not Determined

NA - Not Applicable

APPENDIX B

Synoptic List of the Algae
Collected by the Kentucky Nature Preserves Commission
from the Cypress Creek system

	Stations			
	KG02MUH 1980	KG02MUH 1978	KG01MUH 1978	KG02MCL 1980
Charophyta				
Chara sp.	-	-	X	-
Chlorophycophyta				
Chlamydomonas sp.	-	X	-	-
Closterium acerosum	X	-	-	-
C. spp.	X	X	X	-
Cosmarium granatum	-	-	-	X
C. laeve	X	-	X	-
C. obtusatum	X	-	X	X
C. spp.	X	-	X	X
Coelastrum spp.	X	-	-	-
Mougeotia spp.	X	-	X	-
Oedogonium spp.	X	X	X	-
Scenedesmus arcuatus var. *platydisca*	X	-	-	-
S. dimorphus	-	-	-	X
S. spp.	X	X	X	X
Stigeoclonium sp.	-	-	-	X
Spirogyra spp.	X	-	X	-
Staurastrum turgescens	X	-	-	-
S. sp.	-	-	X	-
Chrysophycophyta				
Bacillariophyceae				
Achnanthes exigua var. *heterovalva*	-	-	-	X
A. hungarica	X	X	-	-
A. lanceolata	X	X	-	-
A. minutissima	-	-	X	-
A. sp.	X	-	-	-
Amphipleura pellucida	X	X	X	-
Amphora submontana	-	-	-	X
Anomoeoneis vitrea	X	X	X	X
Aulacosira sp.	X	-	-	-
Caloneis bacillum	-	-	-	X
C. lewisii var. *inflata*	-	-	-	X
C. spp.	X	-	-	-
Cocconeis placentula var. *lineata*	X	X	X	-
C. sp.	X	-	-	-
Cyclotella atomus	-	-	-	X
C. pseudostelligera	-	-	-	X
C. meneghiniana	X	X	X	X
Cymbella microcephala	X	X	X	-
C. minuta var. *pseudogracilis*	-	X	-	-
C. naviculiformis	X	-	-	-
C. triangulum	-	-	-	X

Synoptic List of the Algae
Collected by the Kentucky Nature Preserves Commission
from the Cypress Creek system

	Stations			
	KG02MUH 1980	KG02MUH 1978	KG01MUH 1978	KG02MCL 1980
Diploneis elliptica	-	X	-	X
D. ovalis	X	-	-	-
D. sp.	-	X	-	-
Entomoneis paludosa	-	X	X	-
Eunotia exigua	-	-	X	-
E. praerupta var. *bidens*	-	X	-	-
E. spp.	X	-	X	-
Fragilaria sp.	X	-	-	-
Frustulia rhomboides var. *saxonica*	-	-	X	X
F. vulgaris	X	X	-	-
Gomphonema acuminatum	-	X	-	-
G. affine	-	X	-	-
G. affine var. *insigne*	X	-	X	-
G. gracile	X	-	X	-
G. parvulum	X	X	-	X
G. spp.	X	-	X	-
Gyrosigma acuminatum	X	-	-	-
G. nodiferum	-	-	-	X
G. obscurum	-	X	-	-
G. sp.	-	-	X	-
Gyrosigma scalproides	-	-	-	X
G. spencerii	-	-	-	X
Mastogloia smithii var. *lacustris*	X	X	-	-
Melosira varians	-	X	-	X
Meridion circulare	-	X	X	-
M. circulare var. *constrictum*	X	-	-	-
Navicula auriculata	-	-	-	X
N. confervacea	X	X	-	-
N. cryptocephala	X	X	-	X
N. cuspidata	X	X	X	-
N. frugalis	-	-	-	X
N. lanceolata	X	-	-	-
N. mutica	-	-	-	X
N. pygmaea	-	-	-	X
N. radiosa	X	X	X	-
N. secreta var. *apiculata*	X	X	X	X
N. simplex	-	X	X	-
N. splendicula	-	-	-	X
N. symmetrica	X	X	-	X
N. viridula var. *rostellata*	X	X	X	X
N. spp.	X	X	X	X
Nitzschia acicularis	-	X	X	-
N. amphibia	X	X	X	-

Synoptic List of the Algae
Collected by the Kentucky Nature Preserves Commission
from the Cypress Creek system

	Stations			
	KG02MUH 1980	KG02MUH 1978	KG01MUH 1978	KG02MCL 1980
N. amplectens	-	-	-	X
N. biacrula	X	-	-	-
N. brevissima	X	-	-	X
N. calida	-	-	-	X
N. debilis	X	-	-	X
N. denticula	X	X	X	-
N. dissipata	X	X	-	-
N. filiformis	X	X	-	X
N. frustulum	X	-	X	-
N. gandersheimiensis	-	-	-	X
N. gracilis	X	X	-	X
N. hungarica	-	-	-	X
N. ignorata	X	X	X	-
N. intermedia	X	X	-	X
N. levidensis	-	-	-	X
N. microcephala	-	-	-	X
N. rautenbachiae	X	-	-	X
N. reversa	X	X	X	X
N. sigma	X	X	-	X
N. spp.	X	X	X	X
N. tryblionella var. *victoriae*	-	-	-	X
Pinnularia spp.	X	X	X	-
Pleurosigma delicatulum	-	X	X	-
P. sp.	X	-	-	-
Rhoicosphenia curvata	-	-	-	X
Rhopalodia gibba	-	X	X	-
Stauroneis phoenicenteron f. gracilis	X	X	X	-
Surirella angusta	X	X	-	-
S. moelleriana	X	X	X	-
S. ovata var. *pinnata*	-	-	-	X
S. spp.	X	X	X	-
Synedra acus	X	-	X	-
S. fasciculata	X	-	-	-
S. pulchella	X	X	X	-
S. ulna	X	-	-	-
S. spp.	X	-	-	-
Thalassiosira weissflogii	X	-	X	X
Chrysophyceae				
Mallomonas sp.	-	X	-	-
Cyanochloronta				
Agmenellum quadruplicatum	X	-	-	X
A. thermale	-	-	X	-
Anabaina licheniformis	-	-	-	X
A. oscillarioides	X	X	X	X
Anacystis dimidiata	X	X	X	-

Synoptic List of the Algae
Collected by the Kentucky Nature Preserves Commission
from the Cypress Creek system

	Stations			
	KG02MUH 1980	KG02MUH 1978	KG01MUH 1978	KG02MCL 1980
A. montana f. montana	X	-	X	-
Gomphosphaeria lacustris	X	-	-	-
Microcoleus irriguus	X	-	-	-
M. vaginatus	X	-	X	-
Oscillatoria princeps	X	-	-	-
Porphyrosiphon notarisii	X	-	-	-
P. splendidus	X	X	-	-
Schizothrix calcicola	-	X	X	X
Spirulina subsalsa	-	X	X	X
Euglenophycophyta				
Euglena acus var. *rigida*	-	X	-	-
E. spp.	X	X	X	X
Phacus spp.	-	X	-	X
Trachelomonas spp.	X	-	-	X
Pyrrhophycophyta				
Glenodinium sp.	-	-	X	-
Total Number of Taxa	83	62	57	56

APPENDIX C

Synoptic List of the Macroinvertebrate
Collected by the Kentucky Nature Preserves Commission
from the Cypress Creek system

Taxa	KG01MUH 1978	KG02MUH 1978	KG02MUH 1980	KG02MCL 1980
Oligochaeta				
Group A	-	-	-	X
Tubificidae				
Branchiura sowerbyi	-	-	-	X
Hirudinea				
Group A	X	-	-	-
Group B	X	-	-	-
Basommatophora				
Physidae				
Physella (= *Physa*) sp.	X	X	X	X
Heterodonta				
Corbiculidae				
Corbicula fluminea (= *leana*)	-	-	-	X
Sphaeriidae				
Sphaerium sp.	-	-	-	X
Isopoda				
Asellidae				
Asellus sp.	-	X	-	X
Lirceus sp.	-	-	-	X
Amphipoda				
Gammaridae				
Crangonyx sp.	X	-	-	-
Group A	X	-	-	-
Decapoda				
Palaemonidae				
Palaemonetes kadiakensis	-	-	X	X
Ephemeroptera				
Baetidae				
Baetis sp.	X	X	-	-
Callibaetis sp.	-	-	X	-
Caenidae				
Caenis sp.	-	-	X	-
Odonata				
Coenagrionidae				
Argia sp.	X	-	X	X
Enallagma spp.	X (2)	-	X (2)	X (1)
Ischnura sp.	X	X	X	X
Aeschnidae				
Anax sp.	X	-	-	-
Basiaeschna janata	-	-	X	-
Nasiaeschna pentachantha	-	-	X	-
Gomphidae				
Dromogomphus sp.	X	-	X	-

Synoptic List of the Macroinvertebrate Collected by the Kentucky Nature Preserves Commission from the Cypress Creek system

Taxa	Stations KG01MUH 1978	KG02MUH 1978	KG02MUH 1980	KG02MCL 1980
Libellulidae				
Erythemis sp.	X	X	-	-
Ladona sp.	X	-	-	-
Libellula sp.	X	-	X	-
Tetragoneuria sp.	X	-	X	-
Tramea sp.	X	-	-	-
Macromiidae				
Macromia sp.	X	-	-	-
Hemiptera				
Belostomatidae				
Belostoma sp.	X	-	X	-
Corixidae				
Trichocorixa sp.	X	X	X	X
Gerridae				
Limnogonus sp.	-	-	X	-
Rheumatobates palosa	-	-	-	X
R. sp.	-	-	X	-
Trepobates sp.	-	-	X	X
Mesolvelidae				
Mesovelia mulsanti	X	-	-	X
Notonectidae				
Notonecta irrorata	-	X	-	-
N. raleighi	X	X	-	-
Coleoptera				
Dytiscidae				
Agabus sp.	X	-	-	-
Anodocheilus sp.	-	-	X	-
Bidessonotus inconspicuus	-	-	X	-
Coptotomus loticus	-	-	X	-
C. lenticus	-	-	X	-
Hydroporus clypealis	-	-	X	-
H. undulatus (complex)	-	-	X	-
Hydroporus sp.	X	-	X	-
Laccophilus maculosus	X	X	-	-
Gyrinidae				
Dineutus sp.	-	-	X	-
Gyrinus sp.	-	X	X	X
Haliplidae				
Haliplus sp.	X	-	-	-
Peltodytes sp.	-	-	X	-
Helodidae				
Elodes sp.	-	-	-	X

Synoptic List of the Macroinvertebrate
Collected by the Kentucky Nature Preserves Commission
from the Cypress Creek system

Taxa	Stations			
	KG01MUH 1978	KG02MUH 1978	KG02MUH 1980	KG02MCL 1980
Hydrophilidae				
Enochrus sp.	-	-	X	-
Tropisternus lateralis	X	-	-	-
Elmidae				
Dubiraphia quadrinotata	-	-	-	X
Stenelmis sp. 1	-	-	-	X
S. sp. 2	-	-	-	X
S. sp. 3	-	-	-	X
Megaloptera				
Corydalidae				
Chauliodes sp.	-	X	-	-
Sialidae				
Sialis sp.	X	X	X	-
Diptera				
Chironomidae				
Misc. spp.	-	-	X (2)	X (4)
Culicidae				
Anopheles	X	-	-	-
Group A.	-	-	-	X
Ephydridae				
Group A.	-	-	-	X
Sciomyzidae				
Group A.	X	-	-	-
Stratiomyidae				
Stratiomys sp.	-	-	X	-
Group A.	X	-	-	-
Tabanidae				
Tabanus sp.		-	X	X
Tipulidae				
Tipula sp.	-	X	-	-
Trichoptera				
Hydropsychidae				
Cheumatopsyche sp.	-	X	X	X
Hydropsyche simulans	-	-	-	X
Leptoceridae				
Oecetis sp.	-	-	X	-
Philopotamidae				
Chimarra obscura	-	-	X	-
Total Number of Taxa	31	14	37	30

APPENDIX D

Synoptic List of the Fish
Collected by the Kentucky Nature Preserves Commission
from the Cypress Creek system

Taxa	Stations			
	KG01MUH 1978	KG02MUH 1978	KG02MUH 1980	KG02MCL 1980
Amiidae				
Amia calva bowfin	X	-	X	X
Clupeidae				
Dorosoma cepedianum gizzard shad	-	-	-	X
Esocidae				
Esox americanus vermiculatus grass pickerel	X	X	X	-
Cyprinidae				
Cyprinus carpio carp	-	-	-	X
Hybognathus nuchalis silver minnow	-	-	-	X
Notropis atherinoides emerald shiner	-	-	-	X
N. fumeus ribbon shiner	-	X	X	-
N. spilopterus spotfin shiner	-	-	-	X
N. whipplei steelcolor shiner	-	-	-	X
Phenacobius mirabilis suckermouth minnow	-	-	-	X
Pimephales notatus bluntnose minnow	-	-	X	-
P. vigilax bullhead minnow	-	-	-	X
Catostomidae				
Erimyzon sucetta lake chubsucker	X	X	-	-
Ictiobus bubalus smallmouth buffalo	-	-	-	X
Ictaluridae				
Ictalurus melas black bullhead	-	-	X	-
I. punctatus channel catfish	-	-	-	X
I. natalis yellow bullhead	-	-	X	-
Pylodictis olivaris flathead catfish	-	-	-	X

Synoptic List of the Fish
Collected by the Kentucky Nature Preserves Commission
from the Cypress Creek system

Taxa	Stations KG01MUH 1978	KG02MUH 1978	KG02MUH 1980	KG02MCL 1980
Aphredoderidae				
Aphredoderus sayanus pirate perch	-	X	X	X
Cyprinodontidae				
Fundulus notatus blackstrip top minnow	-	-	X	X
Poeciliidae				
Gambusia affinis mosquitofish	X	X	X	X
Atherinidae				
Labidesthes sicculus brook silverside	-	-	-	X
Centrarchidae				
Centrarchus macropterus flier	-	-	X	-
Elassoma zonatum banded pigmy sunfish	X	X	X	X
Lepomis cyanellus green sunfish	X	X	X	X
L. gulosus warmouth	X	X	X	X
L. macrochirus bluefill	X	X	X	X
L. megalotis longear sunfish	-	X	X	X
Micropterus salmoides largemouth bass	X	-	X	X
Pomoxis nigromaculatus black crappie	-	X	-	X
Percidae				
Etheostoma asprigene mud darter	-	-	X	X
E. gracile slough darter	-	X	X	X
Percina maculata blackside darter	-	-	X	-
P. phoxocephala slenderhead darter	-	-	-	X
Scaenidae				
Aplodinotus grunniens freshwater drum	-	-	X	X

Synoptic List of the Fish
Collected by the Kentucky Nature Preserves Commission
from the Cypress Creek system

Taxa	Stations			
	KG01MUH 1978	KG02MUH 1978	KG02MUH 1980	KG02MCL 1980
Total Number of Species	9	12	20	27
Total Number of Species Collected from the Drainage = 34				

APPENDIX E

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