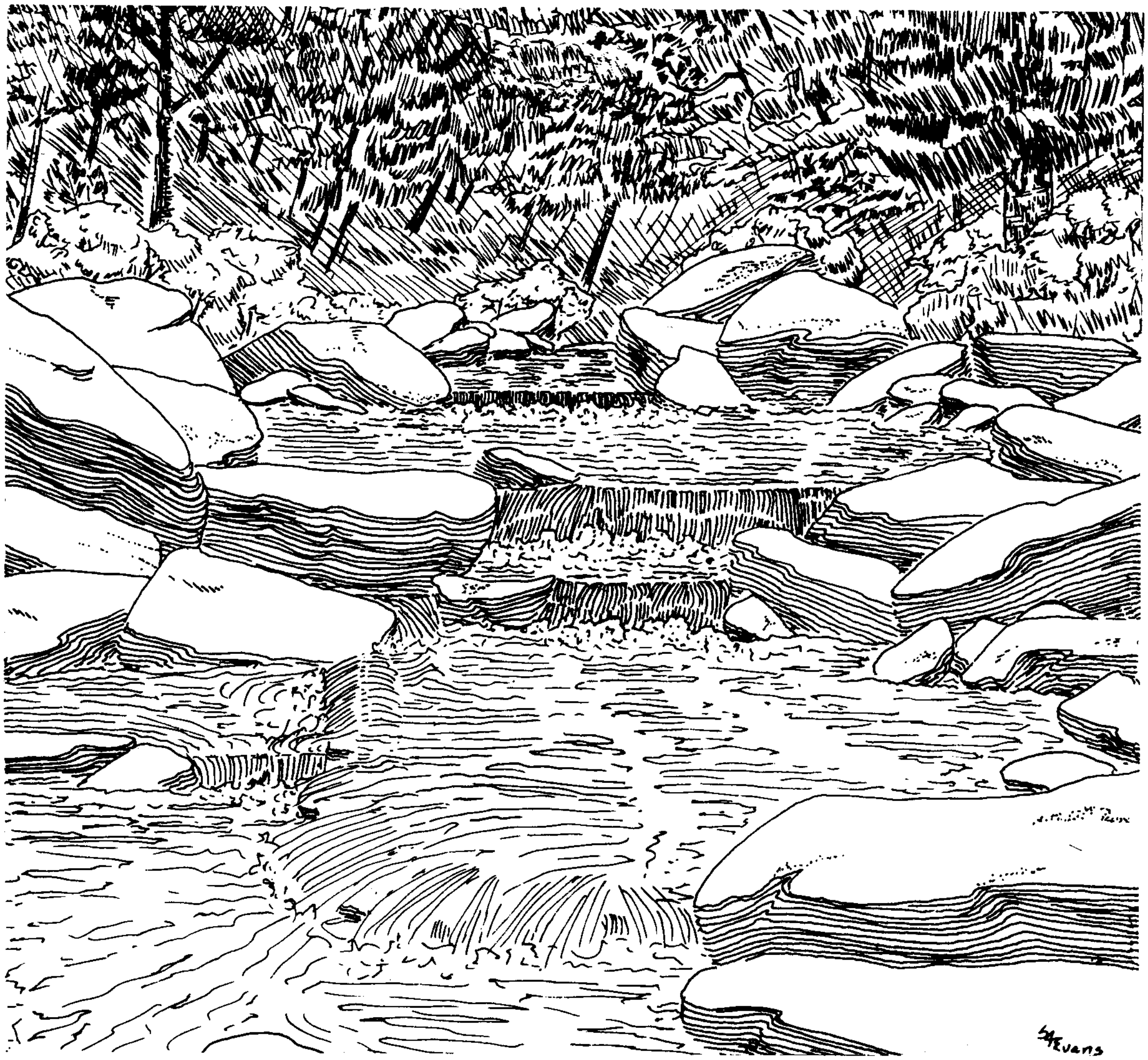
1986 KENTUCKY REPORT TO CONGRESS ON WATER QUALITY



Commonwealth of Kentucky
Kentucky Natural Resources and
Environmental Protection Cabinet
Division of Water

1986
KENTUCKY
REPORT TO CONGRESS
ON
WATER QUALITY

COMMONWEALTH OF KENTUCKY
NATURAL RESOURCES and
ENVIRONMENTAL PROTECTION CABINET
DEPARTMENT FOR ENVIRONMENTAL PROTECTION

DIVISION OF WATER

MAY, 1986

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Special recognition is given to the staff members of the Water Quality and Quantity Branch within the Division of Water for their significant contribution to the preparation of this report. Their dedication and persistence is to be commended.

EXECUTIVE SUMMARY

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This report has been prepared pursuant to Section 305(b) of the Federal Water Pollution Control Act of 1972 (P.L. 92-500), as amended by the Clean Water Act of 1977 (P.L. 95-217). This biennial report presents an assessment of Kentucky's water quality conditions and trends for the period 1984 through 1985. Also discussed are special water quality concerns and the status of the state water pollution control program.

Water Quality Assessment

The water quality assessment of rivers and streams in Kentucky's 1986 report is based on those waters depicted on the 1974 U.S. Geological Survey Hydrologic Unit Map of the state. Of the 18,500 stream miles displayed on this map, approximately 5,700 miles (30.8 percent) were assessed for the reporting period 1984-85.

Based on this assessment, 45 percent of the total miles assessed experienced some degree of use impairment. Uses were not supported in 675.3 miles (11.9 percent of the assessed miles), comprising 45 stream segments across the state. The major causes of use impairment were pollution contributions from coal mining activities, oil production operations, and municipal and industrial wastewater discharges. The water quality ranking of thirty-one hydrologic units encompassing most of the state reveal that the seven watersheds with the lowest water quality ranking contain 58 percent of the stream miles not supporting designated uses. These hydrologic units include: Mud River and Pond River within the Green River basin; the northern half of the Salt River basin; the upper mainstem of the Kentucky River basin including the Red River; Tug Fork and Blaine Creek within the Big Sandy River basin; and the Little Sandy River.

Results of a trend analysis performed on data collected at ambient monitoring stations since 1980 indicate that there were no stations with declining water quality over the assessed period. Five locations showed improving water quality: Pond Creek near Louisville, Kentucky River at Camp Nelson and below Frankfort, Nolin River at White Mills, and the South Fork of Cumberland River. Major pollutants of primary concern include heavy metals (iron, lead, copper, and zinc), fecal coliform bacteria, total suspended solids, phosphorus, PCBs, chlordane, and chloride.

The water quality assessment of lakes includes more than 90 percent of the publicly-owned lake acreage in Kentucky. Of the 362,403 acres assessed, 326,483 acres (90 percent) support designated uses. The five lakes constituting the 573 acres not supporting designated uses are McNeely, Carpenter, Corbin, Loch Mary, and Sympson.

Natural conditions contribute to 77 percent of the documented use non-support in lakes. This is largely due to impacts on domestic water supplies from hypolimnetic water released from large reservoirs which contains excessive levels of iron and manganese. Nonpoint sources are the second largest cause of use impairment (17 percent). Sedimentation from surface coal mining is by far the most significant nonpoint source pollutant. Another pollutant of growing concern is brine discharged from oil producing facilities. Major lakes threatened by brine pollution have a combined surface area of 20,921 acres.

There have been improvements in lake water quality over the reporting period. Reformatory Lake has become less eutrophic due to the implementation of better livestock waste handling practices within its watershed. McNeely Lake no longer has a duckweed problem because grass carp stocking has effectively controlled its growth.

As a result of the implementation of a toxics control strategy during 1984-85, a partial assessment was made regarding the extent of toxic substances in the state's waters. The results of acute and chronic toxicity tests below 15 municipal and industrial wastewater discharges indicate that a total of 155 stream miles are being adversely impacted. During 1985, fish consumption advisories were issued for two streams because of the presence of PCB's from industrial sources. The streams involved are 68.7 miles of the Mud River system in Logan, Butler and Muhlenberg counties, and 46.8 miles of the West Fork of Drakes Creek in Simpson and Warren counties. Another toxic pollutant that is emerging as a potential health threat is chlordane, which has been detected in fish tissue and sediment samples at a number of stream stations. Toxics are not considered to be a problem in any state lakes.

With some exceptions, the quality of Kentucky's groundwater is good. An increasing public awareness of groundwater and its vulnerability is serving to mitigate problems in many areas. Potentially serious problems are encountered in the karst areas. The Mammoth Cave system has been affected already, and conditions will only worsen unless stringent controls are imposed upon facilities located above karst aquifers.

Special State Concerns

The issue of brine discharges from oil production facilities intensified during the reporting period. Documented impacts to streams in the eastern oil production region indicate that uses are not fully supported in 191 stream miles due to brine discharges. A number of state and federal actions were initiated during 1984-85. The effect of a court-imposed settlement with the oil and gas industry and/or state and federal enforcement actions should be closely monitored over the coming year.

There are a number of groundwater contamination and depletion incidents that underscore the need for an effective groundwater management program. The PCB contamination incidents previously mentioned occurred in a karst region of the state. In the Drakes Creek watershed, the PCB's were originating from an industrial discharge to a sinkhole. Cities such as Elizabethtown and Georgetown are undergoing rapid economic development and depend on groundwater for community water supplies. These supplies come from karst aquifers which are very susceptible to pollution. The trend toward use of groundwater heat pump systems for large office buildings may cause a depletion of the Louisville aquifer. Bowling Green has a history of point and nonpoint source groundwater pollution problems associated with industrial, urban, and agricultural activities over major karst aquifers.

The loss of wetland resources and adverse impacts to remaining areas are of concern. It is estimated that half of Kentucky's original wetland acreage is gone. Nearly all of the remaining areas have been degraded by pesticides, acid mine drainage, siltation, oil brine, or domestic and industrial wastes. A major threat to Kentucky wetlands is their destruction by competing land use activities and poor land management practices.

Potential problem areas reflected in fecal coliform data from the monitoring network are streams not supporting the state's recreational use. A total of 323 stream miles significantly exceeded the water quality criteria associated with the primary contact recreation use during 1984-85. If future studies indicate that a significant health threat exists, advisories and posting of affected stream reaches will be considered during the recreational season.

During 1984-85, 62 fish kills attributed to pollution were reported, affecting approximately 154 miles of streams. Cutshin Creek in Leslie County has had recurring kills from oil production and mining operations over the last four years.

Water Pollution Control Programs

Significant strides were made during 1984-85 in reducing the backlog of unissued discharge permits. Efforts to incorporate toxicity-based effluent limits on new and reissued permits were increased. The Kentucky pretreatment program is well underway. A total of 49 Publicly-Owned Treatment Works have local programs approved by either federal or state authorities.

The Construction Grants Program has resulted in the construction of $113 million in wastewater projects which came on line during 1984-85. Twenty-two municipal wastewater projects were completed and an additional 42 projects are in various stages of construction. The Division of Water has been pursuing several approaches for meeting the current and projected wastewater treatment needs in Kentucky. Three such areas are: innovative treatment for small communities, cost control, and innovative financing mechanisms.

During 1984-85, enforcement activities resulted in 228 legally enforceable compliance orders and collection of $126,950 in civil penalties. Kentucky began implementation of a State Municipal Strategy in January, 1984, in accordance with EPA guidelines.

Kentucky's nonpoint source assessment was completed in April, 1984. The purpose of the assessment was to determine the extent and severity of pollution caused by agriculture, silviculture, mining and construction in waters of the state. A Nonpoint Source Pollution Program has been instituted in Kentucky. Education programs, incentives, and increased technical assistance will be used to encourage the implementation of appropriate best management practices. Although most of the state's program is voluntary, there is a strong commitment for implementation on the part of local and state government officials, the general public, the affected industries, and numerous private and public sector associations.

The development of a comprehensive groundwater management program was mandated by the Water Management Plan approved by the Governor in November, 1984. Since that time, the Division of Water has initiated such activities as: the development of a groundwater data base; implementation and administration of the state water well drillers program; identification and classification of Kentucky's aquifers; and development of a statewide groundwater policy/strategy.

Thirty-nine primary ambient monitoring stations were operated by the Division of Water during the reporting period which characterized approximately 1,777 stream miles. Biological monitoring was performed at 21 of these locations. In addition, a state lake monitoring program was initiated on six lakes for eutrophication trend assessment and on three lakes for acid precipitation trend assessment. Ten intensive surveys were conducted on 364 miles of streams for the purposes of evaluating industrial and municipal wastewater impacts and assessing use attainability.

The Water Watch Program was begun in 1985 to encourage public participation and volunteer support for various water pollution control efforts. The program trains local volunteers in water quality assessment, and the monitoring, protection and enhancement of streams, lakes and wetlands. Twenty-three training programs certifying 410 volunteers across the state were conducted in the latter part of 1985. Volunteers have adopted over 75 stream, lake, and wetland areas for monitoring.

BACKGROUND

BACKGROUND

This report was prepared to fulfill the requirements of Section 305(b) of the Federal Water Pollution Control Act of 1972 (P.L. 92-500) as amended by the Clean Water Act of 1977 (P.L. 95-217). Section 305(b) requires that states submit a report to the U.S. Environmental Protection Agency (EPA) every two years which addresses current water quality conditions. Other items to be addressed in the report include an assessment of the degree to which nonpoint sources of pollutants affect water quality, an assessment of state groundwater quality, an assessment of the extent to which the state's waters meet the fishable/swimmable goals of the Act, and recommendations on additional actions necessary to achieve the water quality objectives of the Act. EPA uses the reports from the states to apprise Congress of the current water quality of the Nation's waters and recommends actions which are necessary to achieve improved water quality. States use the reports to provide information on water quality conditions to the general public and other interested parties.

This report follows the guidance document that EPA provided to the states for the 1986 report. The stream water quality in this report is based on those streams shown on the U.S. Geological Survey's Hydrologic Unit Map of Kentucky (scale 1:500,000). The assessments were based on this map's approximately 1,300 streams and rivers which contain about 18,500 stream miles. Kentucky is divided into 42 cataloging units, 31 of which make up the 12 river basins assessed in this report. These drainage basins from east to west are the Big Sandy, Little Sandy, Tygarts, Licking, Kentucky, Upper Cumberland, Salt, Green, Tradewater, Lower Cumberland, Tennessee and Mississippi. The Ohio River Valley Water Sanitation Commission (ORSANCO) compiles a report on the Ohio River which is used as a supplement to the 305(b) reports submitted by the member states of the Commission. The assessment of lake conditions is based largely on data collected by the Division of Water in 1981-1983 under the Federal Clean Lakes Program. More recent data were utilized, when available, to update that information base. The 92 lakes which were assessed have a total area of 362,403 acres. This includes the total acres of Barkley, Kentucky and Dale Hollow lakes which are border lakes with Tennessee.

Kentucky's population, according to the 1980 census, is 3,660,257. The state has an approximate area of 40,598 square miles. It is estimated that there are approximately 40,000 miles of streams within the borders of Kentucky which ranks the state seventh in total length of streams within the contiguous United States. Kentucky has 849 miles of border rivers. The northern boundary of Kentucky is formed by the low water mark of the northern shore of the Ohio River and extends along the river from Catlettsburg in the east to the Ohio's confluence with the Mississippi River near Wickliffe in the west (a length of 664 miles). The southern boundary is formed by an extension of the Virginia-North Carolina 1780 Walker Line which extends due west to the Tennessee River. Following the acquisition of the Jackson Purchase in 1818, the 30°36' parallel was accepted as the southern boundary from the Tennessee River to the Mississippi River.

Kentucky's eastern boundary begins at the confluence of the Big Sandy River with the Ohio River at Catlettsburg and follows the main stem of the Big Sandy and Tug Fork southeasterly to Pine Mountain for a combined length of 121 miles, then follows the ridge of Pine and Cumberland mountains southwest to the Tennessee line. The western boundary follows the middle of the Mississippi River for a length of 64 miles and includes several of the islands in the Mississippi channel.

The climate of Kentucky is classified as continental temperate humid. Summers are warm and humid with an average temperature of 76°F, while winters are moderately cold with an average temperature of 34°F. Annual precipitation averages about 45 inches, but varies between 40 to 50 inches across the state. Maximum precipitation occurs during winter and spring with minimum precipitation occurring in late summer and fall.

CHAPTER I

WATER QUALITY ASSESSMENT

RIVERS AND STREAMS

Status

Water quality conditions reported for rivers and streams in Kentucky are based primarily on the following categories of information: (1) Primary Monitoring Network data, including chemical, physical, and biological assessments; (2) intensive watershed surveys; and (3) Kentucky Department of Fish and Wildlife Resources reports. Table 1 provides a summary of designated use support during the reporting period 1984-85. The table indicates that of the 5,682.8 miles assessed, approximately 45 percent experienced some degree of use impairment. It should be noted that all surface waters of the Commonwealth have been assigned an aquatic life use (either warmwater or coldwater aquatic habitat) and a recreational use (primary and secondary contact recreation). Therefore, the summary of designated use support in Table 1 also reflects the degree to which waters are meeting the fishable/swimmable goal of the Clean Water Act.

Table 1

Summary of Designated Use Support

Basin	Miles Assessed	Miles Supporting Use(s)	Miles Partially Supporting Uses	Miles Not Supporting Uses	Miles Not Assessed
Big Sandy	308.4	41.5	186.6	80.3	904.9
Little Sandy	83.9	23.8	32.1	28.0	276.3
Tygarts Creek	113.0	110.0	3.0	0.0	81.3
Licking	323.1	228.5	70.2	24.4	1,714.0
Kentucky	902.4	640.2	139.1	123.1	2,547.8
Upper Cumberland	520.1	343.6	151.9	24.6	1,641.3
Salt	747.8	336.6	305.6	105.6	804.2
Green	1,477.9	989.4	301.6	186.9	2,053.5
Tradewater	270.3	73.8	121.1	75.4	249.4
Lower Cumberland	30.6	30.6	0.0	0.0	665.6
Tennessee	48.1	22.4	25.7	0.0	320.4
Mississippi	16.5	0.0	16.5	0.0	355.6
Ohio (Minor tribs)	176.8	101.3	75.5	0.0	1,272.9
Ohio (Mainstem)*	663.9	188.4	448.5	27.0	0.0
STATE TOTAL	5,682.8	3,130.1	1,877.4	675.3	12,887.2

*Assessment provided in 1986 ORSANCO 305(b) Report.

Table 2 provides a more detailed listing of stream segments not supporting their designated uses. River basin maps displaying designated use support information are presented in Figures 1 through 8. A more extensive discussion of river basin and hydrologic unit characteristics and conditions is presented in Appendix B.

Table 2

List of Streams Not Supporting Uses

Basin	Hydrologic Unit #	Stream	Miles Not Supporting Uses	Cause
Big Sandy River	05070204	Big Sandy River	26.8	mining, oil brines
		Blaine Creek	53.5	oil brines
Little Sandy River	05090104	Newcombe Creek	12.0	oil brines
		Middle Fork Little Sandy	12.0	oil brines
		Left Fork, Middle Fork Little Sandy	4.0	oil brines
Licking River	05100101	Burning Fork	10.0	oil brines
		State Road Fork	5.1	oil brines
		Licking River	6.3	oil brines
	05100102	Brushy Fork	3.0	industrial waste
Kentucky River	05100202	Cutshin Creek	28.8	mining
		Polls Creek	5.5	mining
		Raccoon Creek	4.9	mining
	05100204	Millers Creek	6.4	oil brines
		Billey Fork	8.6	oil brines
		Big Sinking Creek	14.1	oil brines
		South Fork Red River	11.8	oil brines
		Sand Lick Creek	5.0	oil brines
	05100205	South Elkhorn Creek	26.7	municipal waste
		Town Branch	11.3	municipal waste

Table 2

List of Streams Not Supporting Uses (cont'd.)

Basin	Hydrologic Unit #	Stream	Miles Not Supporting Uses	Cause
Salt River	05140102	Pond Creek (including North Ditch, Southern Ditch, Fern Creek)	41.0	municipal & industrial waste
		Fishpool Creek	5.4	municipal & industrial waste
		Pennsylvania Run	6.4	municipal & industrial waste
		Cedar Creek	15.6	municipal & industrial waste
		Brooks Run	6.9	municipal & industrial waste
		Chenoweth Run	9.1	municipal & industrial waste
		Salt River	21.2	municipal & industrial waste
Green River	05110001	Little Pitman Creek	10.0	municipal & industrial waste
	05110002	Drakes Creek and W.F. Drakes Creek	46.9	industrial waste
	05110003	Mud River	68.0	industrial waste
		Pond Creek	16.2	mining
		Lewis Creek	13.9	mining
	05110006	Drakes Creek	21.3	mining
		Flat Creek	10.6	mining
Cumberland River	05130101	Yellow Creek	9.0	municipal waste
	05130104	Roaring Paunch Creek	15.6	mining & oil brines

Table 2

List of Streams Not Supporting Uses (cont'd.)

Basin	Hydrologic Unit #	Stream	Miles Not Supporting Uses	Cause
Tradewater River	05140205	Caney Creek	11.3	mining
		Buffalo Creek	7.8	mining
		Clear Creek	17.7	mining
		Lick Creek	18.1	mining
		Craborchard Creek	18.8	mining
		Smith Ditch	1.7	mining
Ohio River	05090203	Ohio River	27.0	municipal waste, nonpoint source
		STATE TOTAL	**675.3**	

Hydrologic Unit Water Quality Ranking

The purpose of the hydrologic unit water quality ranking is to compare each of the U.S. Geological Survey cataloging unit watersheds in terms of overall water quality. Various sources of information and data have been combined with appropriate weighting to give a rating which ranks the watersheds from best to worst. The composite rank formula utilized is:

WQR = a(PCHEM) + b(FISH) + c(SUDS) + d(BIOL)

where: a, b, c and d are weighting constants which sum to 1.0.

WQR	Water Quality Rank.
PCHEM	Physical Chemical Rank - determined from the evaluation of fixed network monitoring data.
FISH	Fish Rank - based on a modified Karr Index primarily using Kentucky Department of Fish and Wildlife Resources studies.
SUDS	Stream Use Designation Rank - based on professional assessment of the degree of impact determined from intensive surveys.
BIOL	Biological Assessment Rank - determined by assessment of biotic, physicochemical, and habitat data from fixed station networks.

The weighting constants may be modified to evaluate the influence of the different variables and to arrive at a formula which accurately represents the relative importance and dependability of the individual ranking variables. Further refinement can be anticipated as additional data become available. Weighting constants utilized in this application of the equation are based upon judgment and the relative abundance of information in each category. The assigned weights are: a=0.3, b=0.1, c=0.3, and d= 0.3.

The following is a brief discussion of the development of each of the four ranking variables.

1) Physical-Chemical Index (PCHEM)

Physical-chemical index values were calculated for each of the water quality monitoring stations operated by the Kentucky Division of Water, and some stations operated by the Ohio River Valley Water Sanitation Commission, U.S. Army Corps of Engineers, and the U.S. Geological Survey during 1984-1985. Station locations can be found elsewhere in this report under the monitoring program discussion. Data for the two year period were compiled by the Geological Survey hydrologic unit. Thirty-one of Kentucky's 42 hydrologic units were evaluated.

The physical-chemical index is the reciprocal of the severity index, an index method developed by EPA and also used in this report for trend analysis. The severity index is described in Appendix A. The PCHEM index values were sorted in descending order, and a rank was developed. Percent values were then determined by dividing the rank by the number of hydrologic units and multiplying by 100. The resulting PCHEM index rank can range from 0 to 100, where higher values indicate better water quality than lower values. The median rank of 50 was assigned to hydrologic units where monitoring data are not available.

2) Fisheries Rank (FISH)

Ecological integrity has been described as the capacity of a system to support and maintain "a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitat" within a given geographic region (Ballentine and Quarrie 1975. The Integrity of Water: A Symposium. U.S. Environmental Protection Agency). To assess the component of stream biotic integrity, a classification system was proposed by Karr (Fisheries. 6(6):21-27. 1981). This classification of biotic integrity employs 12 fish community parameters. These parameters reflect the variables of species composition and richness, and functional organization as expressed by trophic structure of the community.

River system fishery inventories of the Kentucky Department of Fish and Wildlife Resources served as the primary source of information used in the classification. These were supplemented with Kentucky Nature Preserves Commission reports, recent literature, and environmental impact statements.

In the classification system, numerical rankings are given to each parameter (i.e. 1=very poor to absent, 3=median level or average presence, 5= very good or exceptional presence). A total numerical ranking is then achieved from the summation of the individual parameter rankings. The total numerical ranking is then applied to a descriptive classification of stream biotic integrity (i.e., good, fair, poor). In the present 305(b) document, a numerical ranking of greater than 46 is considered good, a ranking of between 37 to 45 is fair, and a ranking of less than 37 is poor. This is a modification of Karr's classification which included a greater number of biotic integrity types (i.e., excellent, very poor, etc.). A maximum numerical ranking of 60 is possible. In the current evaluation, when two or more sites were located on the longitudinal axis of the same stream and the classification of these sites differed, the mid-point between the sites was arbitrarily chosen as the limit of a given segment.

The sum of stream miles in each category was determined for each hydrologic unit and a simple formula was used to give each watershed a respresentative point value.

$$\frac{\text{miles of good - miles of poor}}{\text{total of good, fair and poor}}$$

The point value equation results in a number which ranges from minus one to plus one depending on the number of stream miles in each group. A percent ranking was then developed, similar to the PCHEM rank, resulting in a Fish Rank of the U.S. Geological Survey hydrologic units. For watersheds where literature data were not available or were insufficient, the median rank of 50 was assigned.

A total of 2,259 stream miles was characterized. This evaluation resulted in the identification of 92 miles with poor biotic integrity. The rating of poor reflected degradation of one or more of the variables (flow regime, water quality, habitat structure, energy source) which influence the biotic integrity of aquatic communities (Karr and Dudley, Environmental Management. 5(1):55-68; 1981).

3) Stream Use Designation Rank (SUD)

During 1984-1985, ten intensive surveys evaluating 364 miles were conducted to determine if streams were supporting their designated uses. In addition, data were evaluated from 22 surveys conducted in 1982-1983 that assessed 902 miles of streams. Since no major changes are known to have occurred in those areas, it was judged that the stream conditions remained the same. A total of 1,266 stream miles were assessed for use support during the period of 1982-1985.

The streams were assessed by evaluating the biological, bacteriological, physicochemical, toxicological and habitat data in concert with direct observation and professional judgment. The stream mileages were grouped into unimpaired, partially impaired, and impaired uses, and an unknown category.

The streams were considered to support designated uses (unimpaired) if no impacts or only minor impacts to the biotic integrity, physical habitat and water quality were observed. Streams were determined to be partially impaired when the data indicated stressed biotic communities, minor violations of water quality standards or some physical impairment to aquatic habitats. Impaired or non-supporting streams were those indicating severe stress, such as sustained species deletions, trophic imbalances in the biotic communities, chronic violations of water quality standards and severely reduced or eliminated aquatic habitats.

Of the 1,266 miles of streams assessed, 518 miles (41 percent) supported their designated uses, 286 miles (23 percent) partially supported their uses, 462 miles (36 percent) did not support designated uses, and 386 miles were unknown or data were limited and an appropriate assessment could not be made.

As in the previous calculation, a simple formula was used to give each hydrologic unit a representative point value.

$$\frac{\text{miles unimpaired - miles impaired}}{\text{total miles studied}}$$

The same ranking procedure was used. Hydrologic units which had not been studied received the median rank of 50.

4) Biological Assessment Rank (BIOL)

Biological data for 1984-1985 were collected from 26 fixed stations throughout the state. Biotic, physicochemical and habitat data, along with direct observation and professional judgment, were used to make determinations on use support. In addition to the 1984-1985 data, some station assessments were made from biological data that spanned five or more years. Streams were considered unimpaired if information reflected no alterations in community structures or functional compositions for the available habitats, and if habitat conditions were relatively undisturbed for the miles assessed. Streams were categorized as partially impaired if information revealed that community structures were slightly altered, that functional feeding components were noticeably influenced, or if available habitats reflected some alterations and/or reductions for the miles assessed. Streams were considered impaired if information reflected sustained alterations or deletions in community structures, taxa richness and functional feeding types, or if available habitats were often severely reduced or eliminated for the miles assessed.

Of the 724 miles assessed by biological information, 265 miles (37 percent) were unimpaired and supporting their designated use, 322 miles (44 percent) were partially impaired and 137 miles (19 percent) were impaired and considered not to support their designated uses.

The BIOL value was determined using the same equation and percent ranking procedure as that used for SUDS.

The resultant hydrologic unit water quality ranking is presented in Table 3. This table lists the hydrologic units ranked from best to worst water quality, and provides the individual rankings for each of the four categories. In the case of ties, the average percent rank was used (for example, five hydrologic units have a value of 90.5 in the FISH category). There was a sufficient data base to perform the analysis on 31 hydrologic units representing most of the state as shown in Figure 9.

The seven hydrologic units reflecting the poorest water quality contain 58 percent of the streams listed in Table 2. These hydrologic units include: Mud River and Pond River within the Green River basin, the northern half of the Salt River basin, upper mainstem of the Kentucky River basin including the Red River, Tug Fork and Blaine Creek within the Big Sandy River basin, and the Little Sandy River.

It should be noted that Kentucky River segment 05100204 exhibited the most dramatic reversal in ranking from the previous 305(b) report. This hydrologic unit was ranked as the fourth best in the 1984 report and as the third worst in the 1986 report. The reason for this change is attributed to the expanded data base resulting from the Division of Water's focus on the oil and gas production impacts on streams in the Big Sinking Oil Field within this basin.

Further discussion concerning water quality impacts, causes, and agency actions can be found in latter sections of this report.

Trends in Water Quality

A water quality trend analyses was performed on an annual severity index for stations that have been regularly sampled since 1980. The annual severity index was developed by EPA for use by states in their reports to Congress. A description of this method and the parameters used in the analysis are presented in Appendix A.

A severity index was calculated for each year from 1980 to 1985. Stations with low or zero values indicate better water than those with the largest values, which indicate water quality problems. The series of values was then tested for trend, using Kendall's Tau Test. This test is a non-parametric statistical method that compares a data set to determine if the data tend to track together. The data, in this case the annual severity index, are compared over time to determine if the data have an increasing or decreasing tendency. The significance level of the test is measured using Kendall's K. If the significance level is greater than 0.05 (the 95 percent confidence limit), then the trend is not considered statistically significant. The magnitude of the trend is determined by finding the median of the slopes of straight lines fitted to all possible pairs of observations.

Table 3

Hydrologic Units Ranked in Order of Highest Water Quality

Hydrologic Unit	Ident.* No.	WQR	P. Chem. (wt=0.3)	Fish (wt=0.1)	SUDs (wt=0.3)	Biol. (wt=0.3)
05100203	1	75.0	84.6	71.4	50.0	91.7
05110001	2	73.2	73.1	76.2	73.3	72.2
05130102	3	71.2	65.4	90.5	100.0	41.7
05130205	4	65.0	100.0	50.0	50.0	50.0
05100101	5	65.0	34.6	52.4	86.7	77.8
05130104	6	63.3	80.8	90.5	50.0	50.0
05090103	7	63.0	50.0	50.0	93.3	50.0
05110002	8	61.8	76.9	57.1	60.0	50.0
05090201	9	61.3	50.0	38.1	50.0	91.7
05130103	10	60.9	96.2	90.5	26.7	50.0
05100205	11	57.7	42.3	50.0	66.7	66.7
05110004	12	56.7	30.8	50.0	66.7	91.7
05100202	13	55.5	88.5	14.3	50.0	41.7
05140205	14	54.1	92.3	19.0	40.0	41.7
05140203	15	54.0	50.0	90.5	50.0	50.0
06040006	16	53.3	69.2	50.0	50.0	41.7
08010201	17	52.1	15.4	50.0	50.0	91.7
05110005	18	50.6	57.7	33.3	50.0	50.0
05100201	19	48.7	50.0	61.9	50.0	41.7
05130101	20	48.7	53.8	50.0	50.0	41.7
05100102	21	48.6	15.4	50.0	80.0	50.0
05140202	22	46.0	50.0	9.5	50.0	50.0
05140103	23	42.3	25.0	47.6	50.0	50.0
05070203	24	40.0	25.0	50.0	50.0	41.7
05070204	25	37.8	3.8	66.7	50.0	41.7
05110006	26	37.5	15.4	28.6	50.0	50.0
05090104	27	36.4	50.0	23.8	13.3	50.0
05070201	28	34.8	7.7	50.0	50.0	41.7
05100204	29	32.2	46.2	90.5	20.0	11.1
05140102	30	27.0	38.5	4.8	33.3	16.7
05110003	31	26.4	61.5	42.9	6.7	26.4

*Identification number locates hydrologic unit on Figure 9.

Water Quality Rank by Hydrologic Unit

Numbers correspond with relative ranking shown in Table 3

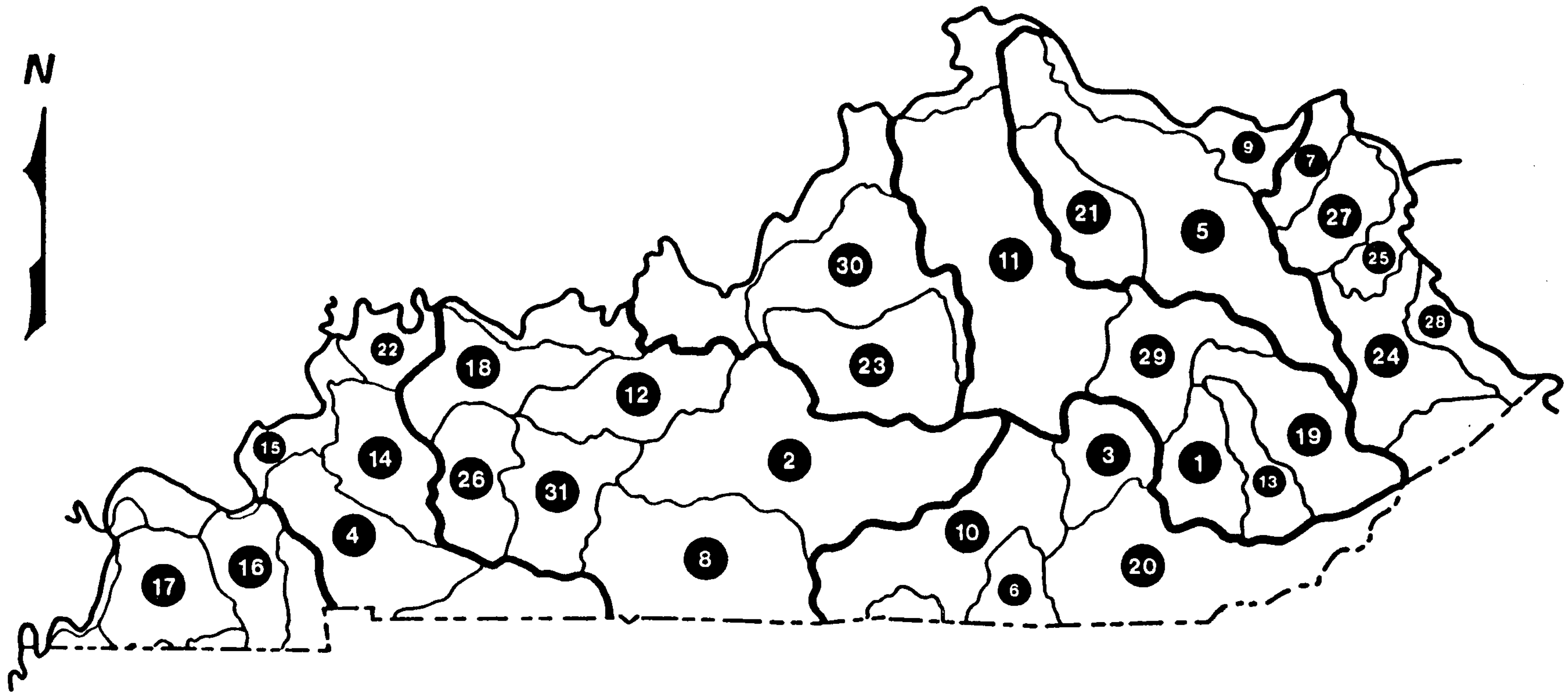

Figure 9

Results of the trend analysis presented in Table 4 indicate that there were no stations with declining water quality over the period assessed. Five stations show improving water quality during the past six years. Pond Creek near Louisville shows the most dramatic improvement in the state, yet this stream is still the poorest in quality of all the stations sampled. Total phosphorus is the most persistent problem in the basin, and shows the most improvement. This is likely the result of efforts by Jefferson County to eliminate package sewage treatment plants throughout the county. The Kentucky River at Camp Nelson and the Kentucky River below Frankfort indicate some improvement in phosphorus, fecal coliform bacteria, and iron. Suspended solids and iron show improvement in the Nolin River at White Mills. The South Fork of the Cumberland River shows improvement in cadmium and fecal coliform bacteria.

Several factors should be considered when reviewing this analysis. The six years (and thus six values) are the minimum number of values needed to perform this test. Stream flow can effect water quality and methods to account for this were not attempted in this report. Lastly, the severity index is based on a specified set of parameters. If there is an increase or a decrease in the number of parameters used, the index value will change accordingly. Thus the index value, standing alone, should not be used as an indicator of "good" or "poor" quality. With these limitations in mind, the severity index and trend analysis are considered accurate and reliable methods for comparing water quality conditions throughout Kentucky.

Relative Causes of Use Non-support

Table 5 provides a summary of the relative causes of use impairment statewide from various sources for the 675.3 miles of waters assessed as not supporting designated uses.

Table 5

Relative Causes of Use Non-support

Cause	Miles Not Supporting Uses	Percent
Municipal Sources	131.8	19.5
Mining	197.8	29.3
Oil Brine	170.0	25.2
Other Industrial Sources	175.7	26.0
TOTAL	675.3	100.0

Table 4

Water Quality Trend Analysis

Station	Severity Index						Stream Miles Assessed	Water Quality Trend	Problem Parameters
	1980	1981	1982	1983	1984	1985			
Hydrologic Unit 05070201									
Tug Fork at Freeburn	1.42	1.54	1.16	1.27	0.93	11.99	38	No trend	bacteria, iron, SS*
Tug Fork at Kermit	2.01	4.12	3.32	1.66	6.29	4.47	56	No trend	SS, bacteria, iron
Hydrologic Unit 05070203									
Levisa Fork at Pikeville	2.07	2.96	3.55	1.62	3.51	1.50	35	No trend	SS, bacteria, iron
Levisa Fork at Paintsville	1.01	2.61	2.71	2.11	6.59	4.43	25	No trend	bacteria, SS, iron
Hydrologic Unit 05070204									
Blaine Cr. at Fallsburg	3.81	3.20	3.93	1.63	4.23	ND	24	No trend	chloride, iron, SS
Big Sandy at Louisa	3.74	2.21	6.38	1.76	3.31	2.14	6.8	No trend	SS, bacteria, phosphorus
Hydrologic Unit 05100101									
North Fork Licking R. near Lewisburg	1.93	3.28	6.58	0.84	3.27	0.66	19.5	No trend	phosphorus, iron, bacteria
Licking R. at Butler	2.75	4.88	1.84	3.17	2.57	4.44	44.0	No trend	phosphorus, bacteria, SS
Hydrologic Unit 05100204									
Kentucky R. at Heidelberg	0.95	10.46	4.06	1.33	2.65	.69	33.7	No trend	iron, SS, phosphorus
Red R. at Hazel Green	3.52	3.95	1.65	1.33	2.60	2.43	29.0	No trend	bacteria, iron, SS
Hydrologic Unit 05100205									
Kentucky R. at Camp Nelson	3.32	2.40	2.93	1.52	1.62	0.79	37.7	Improving quality	phosphorus, iron, bacteria

Table 4

Water Quality Trend Analysis (continued)

Station	Severity Index 1980	1981	1982	1983	1984	1985	Stream Miles Assessed	Water Quality Trend	Problem Parameters
Hydrologic Unit 05100205 (continued)									
Kentucky R. above Frankfort	5.30	2.35	3.06	2.02	2.58	0.33	15.2	No trend	phosphorus, iron, SS, cadmium
Kentucky R. below Frankfort	3.60	3.33	3.21	3.12	2.49	0.78	23.0	Improving quality	phosphorus, iron, SS, cadmium
Kentucky R. Lockport	1.94	3.67	1.37	4.59	2.16	0.66	31.0	No trend	phosphorus, bacteria, SS
Eagle Cr. at Glencoe	2.00	3.01	2.05	2.36	3.93	3.03	27.2	No trend	phosphorus, iron, SS
Hydrologic Unit 05140102									
Salt R. at Shepherdsville	5.25	4.20	5.87	4.21	3.22	3.10	13.9	No trend	phosphorus, bacteria
Pond Cr. near Louisville	18.45	21.19	20.48	18.52	16.92	13.94	21.8	Improving quality	phosphorus, bacteria, iron, zinc
Hydrologic Unit 05140103									
Rolling Fork near Lebanon Junction	3.82	5.02	6.03	5.48	6.87	2.21	20.1	No trend	phosphorus, SS, bacteria
Hydrologic Unit 05110001									
Green R. at Greensburg	0.52	1.76	1.09	0.31	1.53	0.16	78.3	No trend	bacteria, iron
Green R. at Munfordville	0.55	2.32	1.16	0.42	1.43	0.28	37.8	No trend	bacteria, SS, iron
Nolin R. at White Mills	1.72	2.36	1.98	1.86	1.28	1.23	28.0	Improving quality	phosphorus, bacteria
Bacon Cr. near Priceville	0.74	0.42	ND	0.36	0.56	0.0	14.0	No trend	bacteria

Table 4

Water Quality Trend Analysis (continued)

Station	Severity Index						Stream Miles Assessed	Water Quality Trend	Problem Parameters
	1980	1981	1982	1983	1984	1985			
Hydrologic Unit 05110002									
Barren R. at Bowling Green	0.85	1.47	2.30	1.15	1.36	0.17	6.5	No trend	iron, copper, SS
Hydrologic Unit 05110003									
Green R. at Aberdeen	0.95	0.87	3.23	1.17	1.38	0.62	31.1	No trend	iron, phosphorus, SS
Mud R. near Lewisburg	2.80	5.48	4.69	2.12	1.43	2.04	21.4	No trend	phosphorus, SS, bacteria, DO
Hydrologic Unit 05110004									
Rough R. near Dundee	0.68	4.96	3.65	1.95	1.22	4.70	59.0	No trend	iron, SS, phosphorus
Hydrologic Unit 05110005									
Green R. near Beech Grove	1.96	1.17	1.24	4.24	1.52	0.0	54.0	No trend	SS, phosphorus, bacteria
Hydrologic Unit 05110006									
Pond R. near Apex	1.50	2.65	5.40	2.62	1.81	7.31	22.5	No trend	iron, SS, phosphorus
Pond R. near Sacramento	3.09	2.39	4.54	3.37	3.39	4.59	29.9	No trend	zinc, iron, phosphorus, SS

Table 4

Water Quality Trend Analysis (continued)

Station	Severity Index						Stream Miles Assessed	Water Quality Trend	Problem Parameters
	1980	1981	1982	1983	1984	1985			
Hydrologic Unit 05130101									
Cumberland R. at Pineville	2.42	2.71	4.94	4.17	2.39	2.06	75.0	No trend	bacteria, SS, iron, phosphorus
Cumberland R. at Cumberland Falls	1.23	3.61	3.05	2.18	2.77	0.66	21.2	No trend	SS, iron, phosphorus, bacteria
Hydrologic Unit 05130102									
Rockcastle R. at Billows	0.0	1.73	0.0	0.74	0.37	0.84	29.0	No trend	zinc, SS, copper, iron
Hydrologic Unit 05130103									
Cumberland R. at Burkesville	0.22	0.56	0.23	0.79	0.44	0.0	17.4	No trend	bacteria, zinc
Hydrologic Unit 0513103									
South Fork Cumberland R.	2.40	1.42	1.15	0.92	1.12	0.40	14.9	Improving quality	iron, SS, cadmium
Hydrologic Unit 05130205									
Cumberland R. near Grand Rivers	0.88	0.38	0.68	0.22	0.29	0.58	29.4	No trend	phosphorus, SS

*SS-Suspended Solids

Relative Assessment of Major Pollutants

Evaluation of physicochemical, biological and intensive survey data resulted in six categories of pollutants considered to be of major concern. The establishment of these categories and parameters of concern are based on violations of state water quality standards, recommended EPA criteria or Food and Drug Administration (FDA) action levels in fish tissues. The categories and specific parameters of concern are:

Category	Parameter
Heavy Metals	Iron, Lead, Copper, Zinc
Bacteria/Pathogens	Fecal Coliform
Turbidity/Total Suspended Solids	Total Suspended Solids
Nutrients	Total Phosphorus
Pesticides/Organics	Polychlorinated Biphenyls (PCB's), Chlordane
Salinity/Total dissolved solids	Chloride

- **Metals** - The metals listed as parameters of concern are based on their continued presence in concentrations above state water quality standards or recommended EPA water quality criteria. The sources of the metals are difficult to determine because metals are associated with both point and nonpoint sources. Iron is associated with sediment and is probably high in Kentucky waters because of surface disturbances from surface mining and agricultural activities.

- **Bacteria and Pathogens** - Violations of the fecal coliform standard during the primary contact recreation season (May-October) are of concern because the increased levels of fecal coliform are associated with an increase in waterborne illness. The primary causes for excessive (greater than 400 colonies per 100 milliliters) levels are improperly operating wastewater treatment plants, direct pipe discharges, septic tank leachate and agricultural runoff during wet weather events.

- **Suspended Solids** - The concentration of suspended solids in water is of concern because it affects light penetration, temperature, adsorbing and solubility capabilities, and habitat condition. Suspended solids can also damage aquatic life by mechanical and abrasive action. Major contributions can be attributed to the lack of nonpoint sediment controls and minor site-specific impacts from poorly treated point sources. The level of impact varies according to land use, gradient, vegetation and soil types.

- **Nutrients** - Phosphorus as phosphate is one of the major nutrients required for algal nutrition. Excess amounts can cause nuisance algal blooms and the proliferation of taste and odor producing algae in drinking water sources. Phosphorus occurs in municipal wastewater and nonpoint agricultural runoff.

- **Organics/Pesticides** - PCBs are of major concern because fish tissue concentrations exceeded FDA action levels of 2.0 mg/kg in 115 miles of streams. Sources of the PCBs were identified as two industrial discharges.

  Chlordane (a chlorinated hydrocarbon pesticide) has shown increased levels in fish tissue in urban streams and those streams draining urban areas. The source is thought to be pest control activities in urban areas.

- **Salinity/Dissolved Solids** - Chloride in oil brine has been identified as a major pollutant from oil production operations. Chloride levels greater than 600 mg/l in streams within the oil producing regions of the state are not uncommon. The elevated chloride levels have detrimental impacts on aquatic life and domestic water supplies.

An additional problem category not included in the above ranking is low pH from acid mine drainage. The regional impacts of low pH levels associated with acid mine drainage from coal mining occur predominantly in the western portion of the state. Acid mine drainage impacts on water quality in western Kentucky streams are assumed to remain unchanged. Although over 550 miles of stream in the western portion of the state were judged to be impacted by low pH levels in 1981, program priorities have not focused on this chronic water quality problem.

LAKES

The Division of Water began to monitor lakes in 1981 as a result of a three year federal grant funded through the Clean Lakes Program. Ninety lakes were trophically classified and a determination was made regarding which lakes needed restoration. The 1984 305(b) report summarized the trophic condition of these lakes and listed those lakes which were not supporting designated uses, their limnological problems and the probable causes of these problems.

In 1985 the Division of Water began to monitor lakes as an expansion of its ambient fixed station monitoring program. Six lakes were selected to be monitored to determine eutrophication trends. Previous reports from other agencies or Division data indicated that eutrophication might become a problem in these lakes. Three lakes were also chosen as long-term monitors of the potential impact of acid rain. Data from these three lakes are not yet available. A discussion of the results will be included in the next 305(b) report. The lakes sampled in the current monitoring program are listed in Chapter III in the discussion of the ambient monitoring program.

Designated Use Support in Lakes

Table 6 summarizes information on use support for Kentucky lakes. This information was gathered from published annual reports produced by the U.S. Army Corps of Engineers (COE) on reservoirs which they manage, from research reports by other investigators, and from Division of Water data bases. The total acres assessed are equal to the acres monitored. The large lakes are routinely monitored by the COE as are several of the smaller lakes. The Division of Water monitored the other lakes during its lake classification program conducted from 1981 to 1983 and monitors several lakes in its ambient monitoring program. The analysis is based on chemical data relating to iron, manganese and dissolved oxygen problems, and biological data relating to algal biomass (blooms), algae causing taste and odor, and macrophyte infestations. Fishery data were not utilized.

Table 6

Support of Designated Uses in Lakes

	Total Acres* Assessed	Acres Supporting Designated Use(s)	Acres Partially Supporting Designated Use(s)	Acres Not Supporting Designated Use(s)
Lakes Greater Than 5000 Acres in Area	339,600	315,914	23,686	0
Lakes Less Than 5000 Acres in Area	22,803	10,569	11,661	573
State Totals	362,403	326,483	35,347	573

*Total Kentucky Lake Acreage = 376,305

There are no published data on the total lake acreage in Kentucky. The total reported in Table 6 is based on the Division of Water's Dam Inventory Files and the acres inventoried in the lake classification program. The assessed acres represent well over 90 percent of the publicly-owned lake acreage in the state. The designated uses referred to in this analysis are domestic water supply, fishing, and primary and secondary contact recreation.

Ninety percent of the total acres assessed supported uses while 10 percent did not fully support uses. Six of the ten lakes over 5,000 acres in area fully supported uses. This contrasts with the small lakes where less than half of the lakes fully supported their designated uses (38 of 82).

Tables 7 and 8 list lakes according to whether their uses are not supported or are partially supported. They also indicate the criteria by which non-support or partial support was determined and the probable causes for the support not being achieved.

Table 7

Lakes Not Supporting Designated Uses

Lake	Use Not Supported	Criteria	Cause
McNeely	Fishing, secondary contact recreation	Nuisance algal blooms; severe oxygen depletion in hypolimnion; dissolved oxygen less than 5 mg/l in epilimnion, fish kills	Nutrient inflows from package sewage treatment plants
Carpenter	Fishing, secondary contact recreation	Excessive macrophyte development	Shallow lake basin
Corbin	Domestic water supply; fishing	Taste and odor complaints; nuisance algal blooms	Taste and odor producing algae; nutrients from point and nonpoint sources
Loch Mary	Domestic water supply	Elevated treatment costs due to hardness and manganese; taste and odor complaints	Acid mine drainage from abandoned lands; macrophyte decay
Sympson	Domestic water supply	Taste and odor complaints	Taste and odor producing algae fostered by nonpoint nutrient sources

Table 8
Lakes Partially Supporting Designated Uses

Lake	Use Partially Supported	Criteria	Probable Cause
Lakes 5000 Acres or Greater in Area			
Rough River	Domestic water supply	Occassional manganese treatment problems	Mn release from anoxic hypolimnion
Barren River	Downstream domestic water supply	Occassional Fe and Mn treatment problems	Hypolimnetic releases
Cave Run	Downstream domestic water supply	Seasonal Fe and Mn treatment problems	Hypolimnetic releases
Laurel River (headwaters)	Recreation, fishing	Excessive algal blooms	Nutrients from point and nonpoint sources
Lakes Less Than 5000 Acres in Area			
Taylorsville	Downstream domestic water supply	Taste and odor complaints	Nutrients from newly inundated land foster algal blooms
Martins Fork	Recreation, fishing	Sedimentation/turbidity	Surface mining
Carr Fork	Recreation, fishing	Sedimentation/turbidity	Surface mining
Buckhorn	Recreation, fishing	Sedimentation/turbidity	Surface mining
Dewey	Recreation, fishing	Sedimentation/turbidity	Surface mining
Fishtrap	Recreation, fishing	Sedimentation/turbidity	Surface mining
Wilgreen	Recreation, fishing	Excessive algal blooms, Severe hypolimnetic oxygen depletion	Nutrients from septic tank drainage
Briggs	Recreation, fishing	Excessive algal blooms, Dissolved oxygen less than 5 mg/l in epilimnion	Lake fertilization practices
Marion County	Recreation, fishing	Excessive algal blooms	Lake fertilization practices
Kingfisher	Recreation, fishing	Excessive algal blooms	Lake fertilization practices
Kincaid	Fishing	Dissolved oxygen less than 5 mg/l in epilimnion	Lake fertilization practices
Guist Creek	Domestic water supply	Taste and odor complaints	Taste and odor producing algae
Willisburg	Fishing	Dissolved oxygen less than 5 mg/l in epilimnion	Nutrients from nonpoint sources

Table 8 (continued)

Lake	Use Partially Supported	Criteria	Probable Cause
Shanty Hollow	Fishing	Dissolved oxygen less than 5 mg/l in epilimnion	Lake fertilization practices
Scenic	Fishing	Dissolved oxygen less than 5 mg/l in epilimnion	Nutrients from natural sources
A. J. Jolly	Fishing	Dissolved oxygen less than 5 mg/l in epilimnion	Nutrients from nonpoint sources
Beaver	Fishing	Localized excessive macrophyte and filamentous algal growth	Shallow lake basin
Hematite	Fishing	Dissolved oxygen less than 5 mg/l in epilimnion	Nutrients from natural sources
Morris	Domestic water supply	Occassional taste and odor complaints	Taste and odor producing algae
Liberty	Domestic water supply	Mn and Fe treatment problems during lake overturn	Releases from anoxic hypolimnion
Malone	Fishing	Dissolved oxygen less than 5 mg/l in epilimnion	Lake fertilization practices
Moffit	Fishing	Dissolved oxygen less than 5 mg/l in epilimnion	Nutrients from natural sources
General Butler	Recreation, fishing	Localized excessive macrophyte growth	Shallow lake basin
Shelby	Fishing	Dissolved oxygen less than 5 mg/l in epilimnion	Nutrients from nonpoint sources
Williamstown	Fishing	Dissolved oxygen less than 5 mg/l in epilimnion	Nutrients from nonpoint sources
Campbellsville City	Fishing	Dissolved oxygen less than 5 mg/l in epilimnion	Nutrients from nonpoint sources
Salem	Fishing, recreation	Localized excessive macrophyte growth	Shallow lake basin

Table 8 (continued)

Lake	Use Partially Supported	Criteria	Probable Cause
Caneyville	Domestic water supply; Fishing and recreation	Taste and odor complaints, Localized excessive macroscopic algal growth	Taste and odor producing algae; shallow lake basin
Beshear	Fishing	Dissolved oxygen less than 5 mg/l in epilimnion	Nutrients from natural sources
Metcalfe County	Fishing, recreation	Localized excessive macrophyte growth	Shallow lake basin
Laurel Creek	Domestic water supply	Taste and odor complaints	Taste and odor producing algae
Lewisburg	Fishing	Localized excessive macrophyte growth	Shallow lake basin
Stanford Reservoir	Domestic water supply	Taste and odor complaints	Taste and odor producing algae

Table 9 indicates the sources responsible for non-support of designated uses. Natural conditions cause the greatest percentage of non-support. This is due largely to hypolimnetic water released from large reservoirs which contains excessive concentrations of iron and manganese. Downstream cities use this water for domestic consumption and have resultant taste, odor and treatment problems. Nonpoint sources are the second largest contributor to non-support of uses.

Table 9

Causes of Non-Support of Designated Use

Source	Number of Lakes Affected	Acres	% Contribution (by Acres)
Natural conditions	19	25,436	77
Nonpoint	13	5,715	17
Other (lake fertilization)	6	1,213	4
Municipal	3	506	2
TOTALS	41	32,870	100.0

Nonpoint Source Pollution in Lakes

Table 10 lists lakes which are not fully supporting uses due to nonpoint sources of pollution and indicates the categories of nonpoint sources that produce the pollution. Surface mining for coal (resource extraction) is the greatest contributor to lake uses not being fully supported. Lake uses are impaired because lake waters become turbid after receiving runoff water laden with sediment from lands disturbed by surface mining activities. This reduces the incentive for fishing and recreational uses. Nutrients from agricultural sources are the next greatest contributor to lake uses not being supported. Algal productivity stimulated by nutrients often results in a proliferation of algae. This may cause taste and odor problems in lakes used for domestic water supplies. Dissolved oxygen can also be lowered in surface waters by very productive algal populations which stimulate microbial respiration.

Table 10

Extent of Nonpoint Source Pollution in Lakes

Nonpoint Source Category	Pollutant	Acres Impaired	% Contribution (by Acres)	Lakes Affected
Resource Extraction and Residue	a. Sedimentation	4,517	79.0	a. Martins Fork Carr Fork Buckhorn Dewey Fishtrap
	b. Acid Mine Drainage	135	2.0	b. Loch Mary
Agriculture	Nutrients	894	16.0	Sympson Willisburg A.J. Jolly, Shelby, Williamstown, Campbellsville
Land Disposal (septic tanks)	Nutrients	169	3.0	Wilgreen
TOTALS		5,715	100.0	

Threats to Lake Uses

Brine discharged to surface waters from oil producing facilities has become a problem in Kentucky. Certain lakes in oil producing regions of the State are threatened by this brine pollution. Concerns have been expressed for the following lakes: Grayson, Cave Run, and Paintsville in eastern Kentucky and Barren River in western Kentucky. These lakes have a combined surface area of 20,921 acres, representing a substantial resource. Yatesville Lake in the Blaine Creek watershed in eastern Kentucky is under construction and is not yet impounded. The lake is located in an oil producing area and the project environmental impact statement has documented real concerns about degraded lake water quality if brine pollution is not brought under control.

Trends in Use Support

There has been some improvement in lake water quality over the past two years. Reformatory Lake has become less eutrophic due to the implementation of better livestock waste handling practices in its watershed. It now fully supports its designated uses in contrast to previous years when it was judged to partially support its uses. McNeely Lake no longer has a duckweed problem due to the introduction of grass carp. The lake is, however, still highly eutrophic and a grass carp kill occurred last summer due to oxygen depletion in the surface waters. It is still considered to not support its uses. There are plans to pipe the discharges from package treatment plants in this watershed to the stream below the lake outlet structure. This should cause a noticeable improvement in water quality and restore uses for fishing and secondary contact recreation. Toxics are not considered to adversely affect any of the assessed lakes.

Trophic Status

Chlorophyll-a concentrations were converted to Carlson trophic state index (TSI) values to determine the trophic state of Kentucky lakes. Data from the growing season (April through October) were utilized and averaged to obtain a seasonal value for each lake. If lakes exhibited trophic gradients or embayment differences, those areas were analyzed separately.

Chlorophyll-a concentration data from the ambient monitoring program and the most current chlorophyll-a data collected during the spring through fall seasons by the U.S. Army Corps of Engineers (COE) on several reservoirs which they manage were used to update the trophic classifications of lakes for this report. In most COE managed lakes, new data were developed for 1982 through 1984. Other data were obtained from an ongoing study of Lake Barkley conducted by Dr. Joe M. King of Murray State University and from studies of Taylorsville and McNeely lakes conducted by Dr. G.C. Holdren of the University of Louisville. Taylorsville Lake is a newly impounded reservoir and was not included in the last 305(b) report. Paintsville Lake is also a newly impounded reservoir and one year of COE data from 1985 was available for trophic state analysis. Data averaged from water column depths of up to 20 feet were used in calculating TSI values. Table 11 contains the trophic state rankings of lakes of 5,000 acres or more in area and Table 12 lists and ranks the trophic state of lakes less than 5,000 acres in area. Lakes which have updated classifications are in bold face type.

A summarization of Tables 11 and 12 indicate that of the 92 lakes classified, 50 (54 percent) were eutrophic, 28 (31 percent) were mesotrophic and 14 (15 percent)

Table 11

Trophic State Rankings for Lakes 5,000 Acres or Greater in Area

by Carlson TSI(Chl-a) Values

Lake	TSI (Chl-a)*	Acres
	Eutrophic	
Barkley	**58**	**57,920**
Rough River	**51**	**5,100**
	Mesotrophic	
Kentucky	48	154,800
West Sandy Creek Embayment	64 (Eutrophic)	1,020
Big Sandy Creek Embayment	59 (Eutrophic)	4,480
Green River	**48**	**8,210**
Cave Run	**45**	**8,270**
Nolin	44	5,790
Barren River	**43**	**7,205**
Beaver Creek Arm	**62 (Eutrophic)**	**1,565**
Skaggs Creek Arm	**58 (Eutrophic)**	**1,230**
	Oligotrophic	
Cumberland	**38**	**49,364**
Lily Creek Embayment	**56 (Eutrophic)**	**144**
Beaver Creek Embayment	**52 (Eutrophic)**	**742**
Laurel River	34	4,990
Midlake-Laurel Arm	47 (Mesotrophic)	754
Headwaters-Laurel Arm	58 (Eutrophic)	316
Dale Hollow	33	27,700

*Scale:
0-40 Oligotrophic (nutrient poor, low algal biomass)
41-50 Mesotrophic (slightly nutrient rich, moderate amount of algal biomass)
51-69 Eutrophic (nutrient rich, high algal biomass)
70-100 Hypereutrophic (very high nutrient concentrations and algal biomass)

Bold Type = Updated Classifications

Table 12

Trophic State Rankings for Lakes Less Than 5,000 Acres in Area

by Carlson TSI(Chl-a) Values

Lake	TSI (Chl-a)	Acres
	Eutrophic	
Wilgreen	68	169
McNeely	**67**	**51**
Briggs	67	18
Carpenter	66	64
Marion County	65	21
Kingfisher	65	30
Bullock Pen	64	134
Kincaid	64	183
Guist Creek	64	317
Flat	64	38
Willisburg	62	126
Washburn	62	26
Honker	61	190
Boltz	61	92
Mauzy	61	84
Elmer Davis	60	149
Energy	60	370
Turner	60	61
Taylorsville	**60**	**3050**
Shanty Hollow	59	135
Greenbriar	59	66
Scenic	59	18
Sand Lick Creek	59	74
A.J. Jolly	58	204
Beaver	58	158
Grapevine	58	50
Corinth	57	96
Chenoa	57	37
Reformatory	**57**	**54**
Spurlington	57	36
Jericho	57	137
Carr Fork	**56**	**710**
Spa	56	240
Hematite	56	90
Herrington	56	2940
Corbin	55	139
Morris	55	170
Liberty	55	79

Table 12 (continued)

Lake	TSI (Chl-a)	Acres
Malone	54	826
Moffit	54	49
General Butler	54	29
Shelby	53	17
Carnico	53	114
Williamstown	52	300
Linville	52	273
Long Run	52	27
Campbellsville City	51	63
Mill Creek (Monroe County)	51	109
	Mesotrophic	
Luzerne	50	55
Salem	50	99
Pennyrile	50	47
Peewee	49	360
Paintsville	**49**	**1139**
Caneyville	49	75
Beshear	48	760
Fishpond	48	32
Freeman	48	160
Doe Run	48	51
Loch Mary	47	135
George	47	53
Blythe	47	89
Metcalfe County	47	22
Mill Creek (Powell County)	46	41
Bert Combs	46	36
Smokey Valley	45	36
Laurel Creek	45	42
Buckhorn	**44**	**1230**
Sympson	44	184
Pan Bowl	43	98
Greenbo	41	181
Lewisburg	41	51
	Oligotrophic	
Tyner	40	87
Campton	40	26
Stanford Reservoir	40	43
Grayson	37	1512
Martins Fork	37	334

Table 12 (continued)

Lake	TSI (Chl-a)	Acres
Cranks Creek	38	219
Wood Creek	35	672
Providence City	35	35
Dewey	34	1100
Cannon Creek	33	243
Fishtrap	32	1143

*Scale:	0-40	Oligotrophic	51-69	Eutrophic
	41-50	Mesotrophic	70-100	Hypereutrophic

Bold Type = Updated Classifications

were oligotrophic. This is based on the status of the major areas of lakes and does not account for the trophic gradient that exists in some reservoirs nor the trophic status of the embayments of others. The dynamic nature of these reservoirs makes it more difficult to assign them a single trophic state because their water residence times, the nature of major inflows, and their morphology can result in different trophic states in separate areas. The tables indicate that trophic gradients exist in Barren River and Laurel River lakes and that certain embayments of Kentucky Lake and Lake Cumberland are eutrophic while the main lake areas have a different status.

The 92 assessed lakes have a total area of 362,403 acres. Of the total, the greatest percentage of these surface waters were mesotrophic, 52 percent (190,005 acres), while 24 percent (84,930 acres) were eutrophic and 24 percent (87,468 acres) were oligotrophic.

<u>Trophic Trends</u>

A review of current lake data from the ambient monitoring program and data retrieval through STORET on COE-managed lakes and other reports resulted in an assessment of trophic trends at several lakes. A discussion of each lake follows:

Green River Lake. COE data from 1981 indicated that this lake might be changing from a mesotrophic to a eutrophic state. The lake was monitored in 1985 by the Division of Water and those data, plus 1982 data from COE stations, showed the lake was still mesotrophic except for the headwater area where it was eutrophic. Past data indicated the headwaters had usually been eutrophic. Based on the present data, it appears that the main lake area is not becoming eutrophic.

Barren River Lake. COE data from 1981 at the station nearest the dam on this lake indicated that it was eutrophic, while the period of record (1975-80) data indicated the lake in this area was mesotrophic. The Division of Water monitored the lake in 1985. Analysis of this data and COE data from 1982 showed that the lake was mesotrophic near the dam. No trend toward eutrophy was indicated. The Skaggs Creek and Beaver Creek arms of the lake have historically been eutrophic, but show no signs of accelerating eutrophy.

Rough River. COE data from 1981 indicated that the lake might be changing from a mesotrophic to a eutrophic state. Data from 1982 did not support this as the lake was mesotrophic, as it had been since 1975. The Division of Water monitored the lake in 1985 and analysis of that data showed that the lake was borderline eutrophic. The lake will be monitored in 1986 to determine if a eutrophic trend is occurring.

Nolin River. The Division of Water classified this lake as mesotrophic in its lake classification report, based on COE data collected from 1975 through 1981. Data collected since then indicated that the lake was mesotrophic in 1982. However, in June of 1983 and July of 1984, the lake was eutrophic. TSI values at those times were higher than the historic range and in the eutrophic category. The Division of Water will monitor the lake in 1987 to establish its present trophic state. It is currently classified as mesotrophic due to a lack of consistently collected seasonal data.

Carr Fork. This lake has historically been oligotrophic. However, a lake fertilization program conducted by the Kentucky Department of Fish and Wildlife Resources to increase fishery potential has caused the lake to become eutrophic since 1981.

Cave Run. This lake has historically been oligotrophic. However, data from 1983 and 1984 indicate that the major portion of the lake is now mesotrophic and that the headwater area has changed from a mesotrophic to a eutrophic state.

Lake Barkley. Lake Barkley was classified as eutrophic by the Division of Water, utilizing data from the main lake collected from 1978 to 1981. Recent work on the lake, conducted by Dr. Joe King of Murray State University, verifies that the lake is eutrophic. There does not appear to be a trend towards increasing eutrophy because the average TSI values collected from King's data for the main lake are the same as the long-term average found in 1981 (TSI=58). King also obtained data from the main embayments of the lake. Systematic embayment information has not previously been collected and this will provide an important baseline for future assessments. All of the embayments were eutrophic, with the Little River embayment being highest on the TSI scale.

Special Lake Studies

Lake Cumberland. The Division of Water began collecting data on this lake as part of the ambient monitoring program in 1985. The objective was to determine the trophic state of two embayments that are fed by streams receiving effluents from municipal sewage treatment plants. The embayments will be studied for a two-year period. The data from 1985 indicate that both embayments are eutrophic toward the areas receiving tributary runoff and that the areas near their juncture with the main lake are trophically similar to the main lake (oligotrophic).

Buckhorn Lake. Studies on this lake were initiated as part of the ambient monitoring program to determine if nuisance algal conditions develop in the headwater area. This condition had reportedly been linked to the discharge from a municipal wastewater treatment facility into a tributary stream. The 1985 data indicated that the upper lake was mesotrophic and that nuisance algal blooms did not occur. The lake will be monitored again in 1986.

Reformatory Lake. The Division of Water classified this lake as hypereutrophic in the last 305(b) report. It was the most eutrophic lake in the lake classification program data base. Its use as a recreational fishing resource was partially impaired due to severe hypolimnetic oxygen depletion and low dissolved oxygen in the epilimnion. Nutrients from livestock operations in the watershed were suspected of being the major cause of the lake's trophic state.

In order to alleviate what had become a potentially serious eutrophication problem, Division of Water staff met with the managers of the livestock operations and with assistance from staff of the University of Kentucky's Agriculture Extension Service, suggested that better waste handling practices be instituted. The managers were cooperative and steps were taken to handle the livestock waste in several of the suggested ways.

The Division began monitoring the lake in 1985 to determine if lake water quality had improved due to the implementation of these better management practices. Preliminary data from 1985 indicate that the measures taken by the farm managers have dramatically improved lake water quality. Average spring through fall data showed that in the surface waters, there was 77 percent less chlorophyl in 1985 than in 1981. This resulted in greater water clarity (the Secchi depth doubled) and a doubling of the depth of the euphotic zone. There was 78 percent less total phosphorus and a 59 percent decrease in total nitrogen. Dissolved oxygen remained above 5 mg/l in the upper water column in 1985 in contrast to 1981 when the concentration in the surface water declined to 2.4 mg/l. Hypolimnetic oxygen depletion occurred at a lower rate in 1985 and concentrations did not decline below 1.0 mg/l as they had in 1981. The lake is no longer considered to be hypereutrophic, based on an average TSI value decline of 15 points from 72 to 57. Analysis of water quality in 1986 will verify the improvements that have occurred.

Loch Mary. The 1984 Kentucky Report to Congress on Water Quality mentioned that an assessment of Loch Mary's water quality would be made in the next report. Loch Mary was monitored to judge the improvements in water quality brought about by abandoned mine reclamation efforts in its watershed. Monitoring was begun in April of 1981 and ended in June 1983 which covered the reclamation activity period. A report prepared by the Division of Water in 1984, entitled "Water Quality Aspects of the Loch Mary Reclamation Project, Hopkins County, Kentucky" indicated that the lake had shown no improvements in terms of the water treatment problems brought about by high non-carbonate hardness, sulfate and manganese concentrations. The 1985 raw water concentrations for these parameters were recently reviewed and showed no improvements. Macrophytes (water lotus) have added to the drinking water problems at this lake. They have increased in areal coverage and seasonal die-off has caused taste and odor problems in the finished water supply. The City of Earlington has been exploring ways to manage the macrophytes. It is doubtful that the water supply problems caused by acid mine drainage from abandoned mined lands will be resolved.

Sediment Studies

The Corps of Engineers sampled sediments in several Kentucky lakes by an elutriate test to determine levels of phenols, chlorinated pesticides and PCB's. These contaminants were either not present or were present below detection limits. The lakes sampled were Nolin, Cave Run, Dewey and Grayson.

TOXIC POLLUTANTS

Toxic pollutants are generally defined as substances which, when acting individually or in combination with other substances, can be expected to cause death, disease, behavioral aberrations, cancer, genetic mutations, physiological malfunctions and/or physical deformities in aquatic life, terrestrial life or humans. Although toxic pollutants are normally thought of in terms of a few U.S. EPA "priority" pollutants (e.g., mercury, polychlorinated biphenyls), many substances are toxic (e.g., ammonia, chlorides) when discharged in excessive amounts into water.

Assessment of the extent, presence and control of toxic substances in the Commonwealth is in its program infancy. The most significant strides have been toward establishing an acute and chronic bioassay testing capability, inclusion of biomonitoring in KPDES permits for industrial and municipal sources, establishing guidelines for bioassay testing in such permits, issuance of fish consumption advisories in areas of human health concern, and partial development of a strategy for future assessments.

During 1984-85, acute and chronic toxicity tests were conducted on a total of 15 sites. These sites consisted of seven municipal Wastewater Treatment Plants (WWTP), five industries, one mining operation, and two oil fields. Two WWTPs, four industries, one mining operation, and both oil fields produced toxic discharges impacting instream water quality. Stream miles impacted by these toxic discharges totalled 155 miles. It should be emphasized that these were assessments made on initial testing. As more data is acquired, better evaluations will be made. Impacts assessed by river basin are listed in Table 13, followed by a brief discussion.

Table 13

Stream Miles Impacted by Toxic Discharges, Based on the Results of Toxicity Tests

Basin	Stream(s) Affected		Miles Impacted	Cause
Green River	Town Branch		4.0	PCB
	Mud River		64.7	PCB
		Total	68.7	
Kentucky River	Town Branch		12.0	Chlorine, Ammonia, BOD
	South Elkhorn Creek		5.0	Chlorine, Ammonia, BOD
	Cedar Brook		3.5	Metals, Cyanide
	Bailey Run		1.5	Metals, Cyanide
	Miller's Creek		31.0	Chloride
		Total	53.0	
Licking River	Brushy Fork		2.5	Chloride, Chlorine
		Total	2.5	
Little Sandy River	Brier Fork		2.5	Chloride
	Newcombe Creek		12.0	Chloride
		Total	14.5	

Table 13 (continued)

Basin	Stream(s) Affected		Miles Impacted	Cause
Big Sandy River	Scott Creek		1.1	Drilling Polymers
	John's Creek		12.0	Drilling Polymers
		Total	13.1	
Ohio River	Limestone Creek		3.5	Metals, Sewage, Chlordane, Nonpoint Sources
		Total	3.5	
		State Total	155.3	

Green River Basin

Toxicity tests conducted in the Green River basin showed one toxic discharge from a metal dye-cast plant in Russellville. Discharge from this plant impacted 4.0 miles of Town Branch and 64.7 miles of Mud River. Sediment and water bioassays conducted on samples taken from throughout the Mud River drainage demonstrated toxic effects. The principal toxic pollutants were polychlorinated biphenyls (PCBs).

Kentucky River Basin

Tests conducted in the Kentucky River basin show three toxic discharges: one municipal, one industrial and one oil field. A municipal WWTP in Lexington produces a toxic effluent impacting 12.0 miles of Town Branch and at least 5.0 miles of South Elkhorn Creek. The principal toxic pollutants were chlorine, unionized ammonia, and carbonaceous and nitrogenous oxygen demanding substances.

A metal fabricating plant in Lawrenceburg discharges toxic effluents that impact 3.5 miles of Cedar Brook and 1.5 miles of Bailey Run. The principal toxic pollutants were metals and cyanide.

The oil field study shows at least 31.0 miles of stream in the Miller's Creek system to be impacted by chlorides from oil brine.

Licking River Basin

Toxicity tests in the Licking River basin show two toxic discharges: one municipal and one industrial. A textile dye plant and the WWTP in Carlisle produce toxic effluents impacting 2.5 miles of Brushy Fork. Bioassays were conducted on stream water from various locations in the Brushy Creek system. The toxic pollutants were chloride from the dye plant and chlorine from the WWTP.

Little Sandy River Basin

Toxicity tests in the Little Sandy River basin show 2.5 miles of Brier Fork and 12.0 miles of Newcombe Creek are impacted by brine discharges from one oil field.

Big Sandy River Basin

Toxicity tests in the Big Sandy River basin showed a mining operation impacting 1.1 miles of Scott Branch and 12.0 miles of John's Creek. The principal toxic pollutants were drilling polymers from a spill to the settling pond.

Ohio River Basin

Toxicity tests showed one industry producing a toxic discharge. A metal plating plant in Maysville produces toxic effluent, impacting 0.8 miles of Limestone Creek. The principal toxic pollutants are metals. The additional 2.7 miles of Limestone Creek are impacted by toxic discharges from other point and nonpoint sources.

Fish Consumption Advisories

The biomonitoring program focuses on the protection of aquatic life from toxic pollutants. However, one of the underlying themes of aquatic life protection is public health protection. During 1985, fish consumption advisories were issued and remain in effect for two streams because of the presence of PCBs in excess of the U.S. Food and Drug Administration (FDA) action level of 2.0 mg/kg. The advisories recommended that women of child-bearing age and pre-school children should not consume any fish from the streams, and that consumption by others should be infrequent. The streams involved are the Mud River in Logan, Butler and Muhlenberg counties and the West Fork of Drakes Creek in Simpson and Warren counties.

The West Fork of Drakes Creek was sampled in July and September, 1984 and in March 1985, after PCBs were found in the discharge from a spring draining an adhesives plant site near Franklin. Fish taken in the vicinity of the spring and at various locations downstream showed elevated PCB levels in whole body and fillets. The advisory includes a total of 46.8 miles from the mouth of Drakes Creek to the Franklin Dam.

The fish in Mud River were sampled and tested in July and September, 1985 after PCBs were found in an unpermitted discharge from a metal dye-cast plant into Town Branch in Russellville. Minnows collected in Town Branch contained 295 mg/kg PCBs, the highest level observed in the state. Subsequent fish samples from the Mud River showed contamination all the way to the mouth. A total of 64.7 miles of the Mud River and all of Town Branch are included in the advisory.

The presence of PCBs in stream sediments and fish tissue may be an emerging problem in the state, especially since the FDA action level has recently been reduced from 5 mg/kg to 2 mg/kg. Further study is needed to delineate the statewide extent of the problem.

Another toxic substance emerging as a public health concern is chlordane. Four stream basins have elevated levels of chlordane in fish and/or sediments: Pond Creek system in Jefferson County, Nolin River in Hardin County, Limestone Creek in Mason County, and the Kentucky River in Franklin County. Whole body tissue concentrations of chlordane from Blue Spring Ditch (a tributary of North Ditch, Pond Creek system) were 14.0 mg/kg in sunfish and 2.24 mg/kg in goldfish. Tissue concentrations in sunfish from the mouth (mile point 0.3) of Southern Ditch (Pond Creek system) were 3.45 mg/kg. In Pond Creek (milepoint 7.8), eight miles downstream from the confluence of Northern and Southern Ditches, tissue levels remained high at 1.8 mg/kg. Crappie taken from the Nolin River at White Mills had whole body tissue concentrations of 2.74 mg/kg. Wholebody tissue concentrations of chlordane from Limestone Creek (mile point 0.5) were 1.88 mg/kg in carp. Chlordane concentrations in fish from the Kentucky River below Frankfort (mile point 55.5) were also elevated. Buffalo were found to have 0.32 mg/kg and 0.44 mg/kg wholebody. The FDA action level for chlordane is 0.3 mg/kg. Although the action level is based on concentrations in fish fillets, concentrations in whole body samples that exceed that action level by 47 times indicate potential human health problems from consumption of contaminated fish. The problem could persist for years because of the high levels of chlordane in stream sediments, reaching levels of 27.07 mg/kg at one site on Northern Ditch.

Several problems in toxic pollutant evaluation have been addressed but require considerable future attention. One broad concern relates to the toxic effect of chlorinated wastewater effluent on the aquatic environment. Two wastewater treatment plants in the state utilize ozone rather than chlorine for disinfection of their final effluent. Toxicity tests demonstrated that the acute toxicity normally associated with chlorinated effluents were eliminated by ozonation. However, problems with operations and inconsistent disinfection still exist with ozone treatment.

Sediments serve as a sink for many toxic substances. To assess the toxic effects of contaminated sediments, sediment elutriate tests, as well as solid phase bioassays, were conducted. Initial results from both tests indicate that sediment-bound pollutants can remobilize and cause strong toxicity, particularly to sensitive life history stages such as fish eggs. Assessments will continue to be made with regard to the value and applicability of sediment testing. Chronic tests were determined to be necessary to demonstrate the toxic effects of certain pollutants. For example, PCBs were found to be generally non-toxic in acute bioassays, but extremely toxic in chronic tests. Additional toxic problems will undoubtedly emerge as the toxicity testing data base becomes more extensive.

GROUNDWATER QUALITY

Groundwater Use in Kentucky

Approximately 5.2 percent of the water used every day in Kentucky is groundwater. It should be noted, however, that over 83 percent of that total water use is for self-supplied thermoelectric power, and very little of that water is actually consumed. A more realistic appreciation of the importance of groundwater may be obtained by examining water use figures associated with rural and public supplies. Groundwater accounts for at least 30 percent of the water used in public supplies and 90 percent in rural domestic supplies. During periods of drought, groundwater provides the baseflow for surface streams, another important source of drinking water.

Groundwater Quality

With some exceptions, Kentucky's groundwater quality is good. An increasing public awareness of groundwater and its vulnerability to contamination is serving to mitigate problems in many areas.

Groundwater problems in Kentucky occur statewide. In the coalfields, mining activities influence the quality and quantity of groundwater. Particularly serious problems are encountered in the karst areas (which cover about 50 percent of Kentucky) where subsurface contamination travels quickly. The southern part of the Commonwealth is experiencing severe contamination of its solutioned limestone aquifers.

These and other aquifers are affected by faulty septic tank installation and maintenance, leaking underground storage tanks, improper application and disposal of pesticides and herbicides, improperly plugged oil and gas wells, poorly functioning injection wells, or improperly constructed and maintained landfills. Table 14 presents the major sources of groundwater contamination in the state and ranks the top four sources (number 1 being the most serious).

Table 14

Major Sources of Groundwater Contamination

Source	Statewide Problem	Rank
Septic tanks	X	1
Municipal landfills	X	
On-site industrial landfills (excluding pits, lagoons, (surface impoundments)		

Table 14 (continued)

Source	Statewide Problem	Rank
Other landfills, e.g., Maxey Flats	X	
Surface impoundments (excluding oil and gas brine pits)	X	
Oil and gas brine pits	X	
Underground storage tanks	X	4
Injection wells		
Abandoned hazardous waste sites	X	
Regulated hazardous waste sites	X	
Salt water intrusion		
Land application/treatment		
Agricultural activities	X	2
Road salting		
Other (specify) - Mining activities	X	3

Table 15 lists those substances contaminating groundwater in the Commonwealth due to the sources listed in Table 14.

Table 15

Substances Contaminating Groundwater in Kentucky

Organic chemicals:		Metals*	X
Volatile	X	Radioactive materials	X
Synthetic	X	Pesticides*	X
Inorganic chemicals:		Other (specify)	
Nitrates	X		
Fluorides	X		
Arsenic			
Brine/salinity	X		
Other			

*These substances should be checked in preference to the organic or inorganic category in which they are found.

CHAPTER II

SPECIAL STATE CONCERNS

OIL BRINE IMPACTS

Oil exploration and production in the United States increased during the late 1970's and early 1980's because of increased foreign oil costs. Drilling for oil and gas reached near record levels in 1984, with 81,665 wells completed nationwide. The 1984 figure is only one percent less than the all-time-high national record of 84,693 completions in 1982. With the favorable economic climate and the potential for enhanced profits from domestic sources, oil exploration and well completions also increased in Kentucky.

There are an estimated 16,400 oil wells in Kentucky that produced 7,788,000 barrels of oil in 1985. This production rate ranks twenty-second among the 32 oil producing states in the nation. Kentucky advanced from seventh to sixth nationally in reported well completions for both oil and gas in 1984. With 4,490 well completions, this represents an 11.3 percent increase over 1983. Oil well completions for 1984 were up 21 percent from 1,549 to 1,875.

Kentucky oil production generally occurs in two regions: the western portion of Kentucky (Illinois Basin region) and the eastern portion (Appalachian Basin region). The Illinois Basin region in Kentucky is composed of 34 counties. A total of 2,768 wells were completed in western Kentucky in 1984, a 15 percent increase over 1983. Included in this number were 1,048 new oil producers. Cumberland County is the leading producer in the entire Illinois Basin region, with reported well completions of 575, up 40 percent over 1983. Muhlenberg County ranked fourth in the region with 525 completions and Henderson County ranked ninth with 202 wells drilled. Other active western Kentucky counties with reported well completions for the year were: Christian-130, Ohio-115, McLean-97, and Hopkins-68. The average depth of an oil well in the western portion of the state is 1,312 feet. Based on the 1984 average cost of $30.13 per foot, the average cost per well would be $39,500.

The eastern portion of the state is contained in the Appalachian Basin region, which was the nation's most heavily drilled region in both 1983 and 1984. This region contains 36 counties in Kentucky. There were 1,722 oil and gas well completions for 1984, a six percent increase over 1983. Clinton County was rated fourth in the top 10 counties in the nation for well completions in 1984 with 725, of which 252 produced oil. Other top producing counties are Estill, Lee, Lincoln, Magoffin, Perry, Powell, Wayne, Whitley and Wolfe counties. The average eastern Kentucky oil well in 1984 had a depth of 1,567 ft. and cost $38.73 per foot, for an average of $60,700 per well.

The state's increased oil production resulted in a parallel increase in oil brine production. Approximately 77 percent of the state's producing oil wells are stripper wells, i.e., wells that produce less than 10 barrels of oil per day. The amount of brine production for the stripper well category varies from 1 to 10 barrels (42 to 420 gallons) of produced water brine for every barrel of oil. Methods for disposal of brine vary throughout the state. In the western portion of the state, the brine is usually reinjected into a suitable underground formation. In the eastern portion of the state, brine is usually discharged to surface waters.

Brines associated with oil production contain elevated concentrations of sodium, calcium, magnesium, potassium, chloride, bromide, sulfate, bicarbonates, iron and strontium. Oil brines may contain over ten times the amount of salt present in sea water; and it is well documented that these brines have adverse impacts on aquatic life, domestic and agricultural water supplies, and other aquatic uses. Typically, the above constituents are naturally present in streams of Kentucky, but usually at low levels which do not impact aquatic communities or the use of the water for drinking, agricultural or other uses.

The impact to Kentucky streams from oil brine has occurred since oil was first discovered in Kentucky in 1819. In more recent times (1958-1963), oil brines from the Greensburg oil field created major water quality problems in the Green River basin, which resulted in the destruction of fisheries in 100 miles of streams and seriously affected domestic and industrial use of the surface water, and contaminated many private wells and springs. The Green River oil brine problem was caused by an "oil boom" and the lack of regulatory controls to prevent oil brines from entering surface or groundwaters. Eventually, the Kentucky Water Pollution Control Commission ordered a stop to indiscriminant brine discharges to surface and groundwaters and required that brines be contained in pits or be injected into disposal wells below the freshwater zones. This practice is still implemented in western Kentucky, resulting in less surface water contamination. The impact to groundwater, however, is undetermined.

In the Appalachian region, reinjection is generally not considered an economically or technologically feasible method of brine disposal by the oil industry. The result is the discharge of significant quantities of brines to small tributary streams of the Kentucky, Licking, Upper Cumberland, Little Sandy and Big Sandy river basins. Documented impacts to these streams indicate that stream uses are not fully supported in 191 stream miles due to impairment from brine discharges. Table 16 summarizes stream use impairments in Kentucky streams attributable to brine discharges.

Table 16

Use Impairment in Kentucky
Streams Attributable to Brine Discharges

Stream System	USGS Hydrologic Unit	Total Stream Miles Assessed	Miles Supporting Uses	Miles Partially Supporting Uses	Miles Not Supporting Uses
Licking River Basin					
Burning Fk.	05100101	13	0	3	10
Kentucky River Basin					
Millers Cr.	05100204	26	0	0	26
South Fork Red R.	05100204	17	0	0	17
*Cow Cr.	05100204	6	3	0	3
*Walkers Br.	05100204	8	0	0	8
*Lower Devils Cr.	05100204	6	0	0	6
Big Sandy River Basin					
Blaine Cr.	05070204	66	0	18	48

Table 16 (continued)

Stream System	USGS Hydrologic Unit	Total Stream Miles Assessed	Miles Supporting Uses	Miles Partially Supporting Uses	Miles Not Supporting Uses
Little Sandy R. Basin					
Little Sandy R. (Headwaters)	05090104	38	7	3	28
Green River Basin					
*Greasy Cr.	05110005	7	7	0	0
*Slovers Cr.	05110004	3	3	0	0
Buck Cr.	05110002	5	5	0	0
Beaver Cr.	05110002	35	35	0	0
Upper Cumberland R. Basin					
Ill Will Cr.	05130105	5	0	5	0
Roaring Paunch Cr.	05130104	16	0	0	16
TOTAL		251	60	29	162

*Streams not included on the United States Geological Survey's Hydrologic Unit Map - 1974, State of Kentucky

Aquatic life impairment due to brine discharges to surface waters is reflected in a number of impacts. Algal communities are dominated by halophilic, brackish water forms. Algal species' diversity and equitability decrease as the chloride concentration increases; however, algal biomass does not appear to be reduced except in highly-stressed headwater streams. The macroinvertebrate community decreases in numbers of both taxa and organisms as the chloride concentration increases. At high chloride levels, the benthic (bottom dwelling) community consists of only the most tolerant forms. The nektonic (swimming organisms living in the water column) and neustonic (surface dwelling) organisms are also reduced, but generally occur in larger numbers than do benthic organisms. The fish community is also reduced in diversity and numbers as the chloride concentration increases and in severe cases is totally eliminated. The fish communities' Index of Biotic Integrity generally ranges from fair to very poor with increasing chloride levels.

In an effort to address this significant problem, the Commonwealth has taken several actions in the last few years. One such action was approval of a regulation which mandates underground injection or the transport and disposal off-site of produced water wherever economically feasible. Another action was the commission of a study to develop numerical criteria for chloride that would assure protection of warmwater aquatic species in Kentucky. These criteria would be used to establish water quality based effluent limitations for dischargers who are unable to utilize underground injection techniques or off-site disposal.

The study was conducted by the University of Kentucky in accordance with a Memorandum of Agreement between the Kentucky Natural Resources and Environmental Protection Cabinet and the University. The objective of the study was to perform both toxicity tests and monitoring studies to determine the effects of chloride on warmwater species of aquatic life and to recommend numerical criteria appropriate for protecting warmwater species in Kentucky. Direct toxicological monitoring was conducted in the field on both impacted and unimpacted waters and comparative acute toxicity tests were performed in the laboratory. In conducting side-by-side acute toxicity tests on an aquatic invertebrate using the same concentration of chloride in both reconstituted laboratory water and in natural stream water, chloride was found to be approximately twice as toxic in the laboratory water as in the natural water. An extensive field study, involving biotic surveys of a second order stream receiving a chloride effluent, also revealed that standard laboratory tests apparently overestimated the impact of chloride on the natural biotic communities.

Considering the field data and best overall interpretation of laboratory toxicity data, the Cabinet determined that the average concentration of chloride should not exceed 600 mg/l and the maximum concentration should not exceed 1,200 mg/l to protect freshwater aquatic life. Therefore, Kentucky adopted a 600 mg/l criterion for waters with a freshwater aquatic life designated use, which was subsequently approved by EPA.

On the day that the revised standards were adopted, a Johnson County Circuit Court judge issued an injunction prohibiting enforcement of the revisions to Kentucky's water quality standards regulations. The injunction was the result of a suit filed by several individuals claiming that portions of the regulations were not properly promulgated and were contrary to law. EPA determined that the court's injunction was inconsistent with federal regulations which implement the Clean Water Act and proceeded to issue administrative enforcement orders against a number of oil operators discharging brine into heavily impacted waters. They also proceeded to promulgate federal chloride criteria for the Commonwealth of Kentucky.

As of December 31, 1985, the Cabinet was negotiating with representatives of the oil and gas industry to settle the suit which enjoins the Cabinet from enforcing the state water quality regulations affecting brine discharges. The ultimate goal of this settlement is to provide for the implementation of a much-needed program for controlling brine discharges and also to provide for adequate consideration of any significant and widespread social and economic impact that could result from the implementation of this program in the oil and gas producing regions of the state.

GROUNDWATER CONTAMINATION AND DEPLETION

The Commonwealth of Kentucky has abundant water resources. Because of this, the need for a comprehensive water management program has not been critical. This situation, however, is changing rapidly. Some areas of the state already have experienced serious water supply and water quality problems. There is a constant and growing need by state and local agencies and private firms for water data.

The information need has never been more evident than the present demand for Kentucky's groundwater resource data. For example, in 1980, more than 1,148,000 Kentuckians, or 31 percent of the state's population, depended on groundwater for public and domestic use. Groundwater used for industrial purposes averaged more than 124 million gallons per day, or about 41 percent of all self-supplied industrial water used. This resource is especially important in rural areas where nearly all drinking water is withdrawn from groundwater, primarily because surface water supplies are either inadequate, not dependable (during droughts) or too contaminated for treatment by small communities or the individual homeowner.

There are a number of groundwater contamination and depletion incidents that underscore the need for an effective groundwater management program.

Louisville, Jefferson County

The trend toward use of groundwater heat pump systems for large office buildings may cause a depletion of the Louisville aquifer. Overuse of the aquifer has caused depletion incidents in the past. The economic incentive (25 to 30 percent savings on heating and cooling costs) is great. In 1985, an Interlocal Agreement on Groundwater Management was signed by officials of the City of Louisville, Jefferson County, and the Natural Resources and Environmental Protection Cabinet. The agreement allows Jefferson County to carry out a permitting program in cooperation with the Division of Water's program. The County is working on a Groundwater Management Plan mandated by the agreement.

The U.S. Geological Survey (USGS) is collecting groundwater data to develop a regional model of the Jefferson County area. Additional data for the model are being requested by conditions set forth in water withdrawal permits issued by the Division of Water for Jefferson County. It is anticipated that the regional model, coupled with additional detailed modeling of the high use areas, may be used as a permitting tool and as a basis for long-term management of the aquifer.

Elizabethtown and Georgetown

Elizabethtown and Georgetown are two cities in Kentucky undergoing rapid economic development and both depend upon groundwater for their water supplies. The cities' water supplies come from karst aquifers which are very susceptible to pollution. A pollutant may move through these aquifers to wells or springs at a rate approaching a thousand feet an hour during high discharge events.

In 1982, Elizabethtown contracted with the USGS for a groundwater basin delineation study. Small quantities of organic chemicals have been detected in the water by EPA. The Division of Water and the USGS are planning a joint study to locate the origin of these chemicals.

Georgetown receives its water from a large karst spring (Royal Spring). The recent announcement of the installation of a new major industry and the possibility of many spinoff industries makes protection planning for the spring essential. The Division of Water is encouraging a detailed basin study which could be used as a basis for future planning and development in the area.

Simpson County

In early 1984, PCBs were detected in the effluent of an oil-water separator at an industrial facility north of Franklin. This effluent was being discharged into a sinkhole behind the plant. A study was conducted to determine the extent of contamination. Over 20 miles of nearby Drakes Creek were found to be contaminated with PCB's below a karst spring which is approximately one mile from the sinkhole. PCB's have been removed from the site and cleanup of the spring and the creek is under study. A containment structure may be built to trap PCB-laden sediments which exit the karst spring.

Eastern and Western Coalfields

Many groundwater problems are occurring in the coal regions of the Commonwealth. The reasons are extremely complex and variable and include improper mining and reclamation techniques, as well as common problems such as improperly constructed wells and inadequate or improperly installed septic tank systems. Local outcry and misunderstanding of hydrologic processes has contributed to the installation of many federally funded, possibly unnecessary, water lines. Additional research might have indicated that only certain wells are contaminated, not the entire aquifer. Instead of constructing costly water lines to the area, the problem might have been resolved by reworking existing wells or drilling new ones.

Mining regulations, reclamation of abandoned mine lands, and new water well construction standards will begin to solve many of these problems. Plugging abandoned water wells, oil and gas wells, and reworking of problem wells should also help. Many areas in the coalfields do not have suitable soils for conventional septic tank systems and additional study is needed to find a solution.

Eastern and Western Oilfields

Kentucky has a great number of stripper oil wells. The brine is separated from the oil and, if not injected, is discharged to streams, sinkholes, or "evaporation pits." These are potential sources of groundwater pollution.

The use of "evaporation pits" is ubiquitous in the Commonwealth. Precipitation rates exceed evaporation rates in Kentucky and as a result, the pits overflow. Unlined pits allow brines to percolate downward and contaminate groundwater. The Division of Water began permitting the installation of pits in 1984, but because so many unlined pits already existed, they will continue to pose a threat to groundwater for many years.

Mammoth Cave Area

Incidents of groundwater pollution have plagued the Mammoth Cave region for many years. The mature karst development of the area allows pollutants to enter the ground via sinkholes and travel many miles before resurfacing. In light of this fact, the National Park Service has conducted studies to develop an understanding of these groundwater flow patterns. The result of these studies was the proposal of a regional sewer system. Construction of the system will begin during 1986 and many outdated and inadequate wastewater treatment plants will be retired. Areas which never had sewer hookups will be connected. This should alleviate groundwater problems caused by ineffective or non-existent septic systems and overloaded wastewater treatment plants that discharge overflow to sinkholes and degrade groundwater quality.

Bowling Green, Warren County

Bowling Green has a history of point and nonpoint source groundwater pollution problems associated with karst topography. The city covers parts of three major karst aquifers. Each aquifer has been contaminated by pollutants associated with agricultural, industrial, and urban activities.

The building of a large urban area on karst terrain presents many problems not normally associated with groundwater. Sediment from urban and agricultural areas has a severe impact on the ability of karst aquifers to transmit water through conduits (caves). This has resulted in the flooding of homes and businesses in some areas. Nonpoint stormwater runoff from urban and agricultural areas has contributed oil and grease, heavy metals, and bacterial waste to the aquifers. These wastes flow through the aquifer and emerge in surface streams. Typical contaminants detected in grab samples from the karst aquifer include total cynanide, lead, cadmium, chromium, copper, iron, nickel, zinc, and arsenic. Detectable levels have been in the range of 0.001-1.10 mg/l.

Point source pollution of groundwater in the Bowling Green area is a critical problem. A high density of industrial generators produce a diversity of wastes. Waste products from these industries range from domestic waste to heavy metals and complex synthetic organic compounds. Some industries have their own treatment facilities while others rely on commercial waste haulers to truck by-products (sludge, spent solvents, etc.) off-site. Unfortunately, because of contaminant leakage, sloppy practices (spillage) and/or intentional discharge into sinkholes, groundwater contamination by industrial by-products has occurred.

Gasoline leakage from holding tanks and poor handling practices has resulted in severe groundwater pollution problems. Gasoline fumes rising from the karst aquifer have been detected in over 30 homes, two elementary schools, a business, and a church. At times, the fumes have reached explosive levels and forced the evacuation of homes and schools. Both elementary schools and 10 of the homes have acquired permanent ventilation systems.

In early 1985, the National Center for Disease Control issued a health advisory for parts of Bowling Green, citing possible chronic health problems associated with the inhalation of volatile organic fumes. EPA has designated Bowling Green a Superfund site and has committed considerable financial and personnel resources. The state Division of Water, Department of Health Services, Western Kentucky University, the City of Bowling Green, and the city's Department of Fire Services have also made strong commitments to solving the fume problems. The city has developed an emergency response plan for reporting fume incidents, ranking potential problems, and recommending response actions.

Twenty-nine exploratory wells and 11 monitoring wells have been drilled in and around Bowling Green. Volatile organics have been detected from the monitoring wells and in the basements of homes at levels from 1-100 ug/l. These compounds include benzene, xylene, methylene chloride, 1,2-dichloroethene, carbon tetrachloride, bromodichloromethane, and 1,1,2-trichloroethylene, which are known carcinogens. Some fume problems have been traced to leaking gasoline tanks. Other problems are believed to originate from the illegal discharge of industrial waste into sinkholes. A number of industries have been cited for improper activities involving waste disposal.

A study of the groundwater hydrology in Bowling Green has resulted in the mapping of over eight miles of cave and a good delineation of the major karst aquifers. This information is important for proper emergency response and evaluation of groundwater pollution problems.

Progress has been made in the Forest Park area of Bowling Green, one of the most severely impacted areas. The detection and reporting of fumes in homes and monitoring wells is decreasing. In other parts of the city, the fume problems appear to be more persistent.

WETLAND LOSS

Wetlands are defined as areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. The importance of these lands is just being fully understood. Their value lies in several aspects which, when taken either partially or as a whole, often exceed the apparent economic value of the land itself. Wetlands are among the most productive of all ecosystems. They are vital for the existence of many species of fish, wildlife, and plants. A summary of primary values includes: (1) natural moderation of floods, (2) erosion control, (3) water quality enhancement, (4) groundwater recharge, (5) fish and wildlife habitat, (6) recreation, (7) education and scientific research, (8) aesthetic and open space, and (9) food and fiber productivity.

The loss of valuable wetland resources, and adverse impacts to remaining areas, are of special concern to Kentucky. Half of the original wetland acreage is gone. Nearly all of the areas that remain have been degraded by either pesticides, acid mine drainage, siltation, brine water, or domestic and industrial sewage. In addition, Kentucky still does not have a wetlands monitoring program (a problem identified in the 1984 305(b) report) and there continues to be a poor understanding of what once occurred, what is left, and current impacts and rates of loss.

The Commonwealth's first estimates of wetland acreage came in the early 1950's. This work by the U. S. Fish and Wildlife Service was not field checked and its purpose was limited to locating waterfowl habitat (as specified from U. S. Fish and Wildlife's Circular 39). Using aerial photos, it was estimated that a total of 273,000 acres were wetland in Kentucky. In 1977, the Ohio River Basin Commission (ORBC), Fish and Wildlife Work Group, in cooperation with the Kentucky Department of Fish and Wildlife Resources, released a report on wetlands along the Ohio River and its tributaries in Kentucky. Their work, which was field checked, revealed 73,000 remaining wetland acres for that area. In 1983, the U. S. Fish and Wildlife Service, in cooperation with the University of Louisville, mapped 113,370 wetland acres along the Green and Tradewater rivers (both tributaries to the Ohio River) in the western Kentucky coalfield. This increase in wetland acreage was most likely the result of professional judgment of what constitutes a wetland and differing methodologies. The ORBC study apparently failed to list many of the smaller (under 1,000 acres) wetlands and riparian zones mapped by U. S. Fish and Wildlife Service.

The U. S. Fish and Wildlife Service (1979) documented wetland losses along the Mississippi Alluvial Plain. Kentucky had four counties in the Mississippi Valley which accounted for 54,000 acres of wetlands in 1957. According to the report, by 1977 the total wetlands in these counties had dropped to 34,000 acres, a 37 percent reduction in 20 years. Of the estimated 273,000 wetland acres in Kentucky in the early 1950's, only 147,370 acres (54 percent) remain along the Ohio and Mississippi rivers and their tributaries.

According to the most recent (1979) U. S. Fish and Wildlife Service classification system, the majority of Kentucky's wetlands fall into the Palustrine System. Areas lying shoreward of rivers and lakes, including floodplains, oxbows, ponds, marshes, and swamps, are members of this category. The broad alluvial floodplains of the Ohio and Mississippi rivers and their tributaries in western Kentucky comprise the vast majority of Kentucky wetlands. Small ponds are common throughout the state and their area is difficult to assess. They are, however, very important and have value as ecological epicenters. The Riverine System includes all wetlands and deepwater habitats contained within a channel that experiences continuous or periodic moving water or connects two bodies of standing water. While wetlands of this type are not extensive, they provide a unique habitat for many rare or endangered species and are important ecologically. Lacustrine systems in Kentucky are limited to man-made lakes, their shorelines, and spillways. The Lacustrine systems are the least ecologically significant type of Kentucky wetland.

The major threat to Kentucky wetlands is their destruction from competing land use activities and poor land management practices. Both coal mining and agricultural practices are depleting this unique habitat. Strip mining operations in the western Kentucky coalfield are either totally destroying (by actually stripping coal from wetland areas), or drastically altering (by siltation and acid mine drainage), many of Kentucky's wetlands. The 1983, U.S. Fish and Wildlife Service study in the western Kentucky coalfield determined that 515 stream miles were affected by acid mine drainage. Problem parameters degrading water quality included manganese, sulfate, aluminum, conductivity, turbidity, dissolved oxygen, pH, and iron. It was concluded that nearly all of the wetlands in the coalfield have been adversely impacted by coal mining practices.

Logging and agricultural practices, such as channelizing, tile draining, burning, and otherwise altering the water regime to render the land tillable, are rapidly depleting wetland ecosystems. Other agricultural practices which cause erosion and chemical fertilizer and pesticide runoff, are also having adverse effects on the natural system. To a lesser extent and generally in localized situations, domestic and industrial sewage discharge, oil brine discharge, and urbanization are having detrimental effects on Kentucky wetlands.

There is a general lack of specific information on the extent, rate of loss, and quality (chemical and biological) of Kentucky wetlands. Other needs for Kentucky wetlands are: an increased public awareness of the value of these ecosystems, acquisition and protection of strategic wetlands, a definition of regulated wetlands, and regulations specifically addressing wetlands.

Recently, the U.S. Fish and Wildlife Service initiated a wetlands inventory in western Kentucky as part of the National Wetlands Inventory. Because of limited funds, they are unable to inventory the entire state. However, the Division of Water, in cooperation with the Kentucky Department of Fish and Wildlife Resources, is in the process of providing enough funding to ensure that the western third of the Commonwealth is mapped. Along with the mapping efforts, the Division of Water has entered into a Memorandum of Agreement with the Kentucky Nature Preserves Commission for the purpose of developing wetlands definitions and regulations, and has developed a public awareness program called "Water Watch" which includes wetlands.

RECREATIONAL USE IMPAIRMENT

Fecal coliform data from Kentucky's ambient monitoring network generally indicate that the bacteriological water quality is improving at more stations than are being degraded. No swimming beaches were closed at any of the state parks during 1984 or 1985 due to bacteriological contamination. Nine of the 39 stations assessed (23 percent) indicated impairment to recreational use, 18 stations (46 percent) indicated partial impairment, and 12 stations (31 percent) were not impaired by fecal pollution.

Of major concern are those streams that reflect significant recreational use impairment, because of the possibility that swimming in those locations could result in increased waterborne illness. In the mid 1960's, the National Technical Advisory Committee (NTAC) of the U. S. Department of the Interior observed that the density at which significant swimming associated gastrointestinal illnesses were observed was about 400 fecal coliform colonies per 100 ml. The Kentucky surface water criteria for primary contact recreation is based on this information.

Stations were assessed based on the number of times the fecal coliform criteria for primary contact recreation was exceeded and whether the geometric mean of the fecal coliform values exceeded the standard during the recreational season (May to October). Based on this assessment, a total of 323 stream miles were not supporting the primary contact recreation use during 1984-85. Table 17 summarizes this assessment based on stations from the ambient monitoring network and intensive surveys.

It was judged that the primary causes for the use impairment were (1): improperly operated wastewater treatment plants, (2) septic tank leachate, (3) untreated domestic waste, and (4) agricultural nonpoint source pollution.

Further studies should be conducted to determine if the elevated fecal coliform levels at the stations listed in Table 17 are caused by point and/or nonpoint sources, and if they are representative of the watersheds. If studies indicate the levels are consistent with the data, health advisories and posting of these stream reaches will be considered during the recreational season.

Table 17

Streams Not Supporting Primary Contact Recreation Use

Basin/Stream	Hydrologic Unit	% >400/100 ml	FC Geometric Mean	Miles Not Supporting Use
Big Sandy River Basin				
Tug Fork at Kermit	05070201	70	1588	94
Tug Fork at Freeburn	05070201	33	738	
Levisa Fork at Paintsville	05070203	90	1312	60
Levisa Fork at Pikeville	05070203	60	753	
Cumberland River Basin				
Cumberland R. Pineville	05070203	91	1132	75
Kentucky River Basin				
North Fork Kentucky R.	05110201	100	973	9
South Elkhorn Creek	05110205	75	231	25
*Millers Creek/Big Sinking Creek	05110204	58	514	21
Licking River Basin				
South Fork Licking R. at Cynthiana	05110101	50	220	11
Ohio River Basin				
*Limestone Creek	05090201	57	535	6
Salt River Basin				
Pond Creek, Louisville	05140102	92	878	22
			Total Miles	323

FC = Fecal Coliform
PCR = Primary Contact Recreation Season (May - Oct.)
*Based on Intensive Survey Bacteriological Data

POLLUTION-CAUSED FISH KILLS

During 1984-1985, 62 fish kills were reported, affecting over 154 miles of stream and 17 acres of lakes. Fish kills are investigated by the Kentucky Department of Fish and Wildlife Resources (the lead agency) and the Division of Water.

During 1984, 33 fish kills were reported (Table 18). Approximately 67 stream miles and 12.5 acres of lake were affected, resulting in an estimated kill of 106,514 fish. Of the reports containing counts of dead fish, five were light (less than 100), ten were moderate (100-1,000) and seven were major (more than 1,000). Mining or oil drilling operations were responsible for seven kills, agricultural operations for one kill, oil or chemical spills for nine kills and wastewater or sewage for four kills. Six of the kills were attributed to natural causes, usually dissolved oxygen (DO) depletion, and the causes of the other six kills were not determined. The largest kill resulted from a spill of agricultural liquid nitrogen fertilizer into Clear Creek (Shelby County) which killed not only fish, but also invertebrates, in nearly 36 miles of stream.

During 1985, 29 kills, affecting approximately 87 miles of stream and 4.5 acres of lake, were reported (Table 18). These incidents resulted in an estimated 59,499 fish killed. Of the reports containing counts of dead fish, five were light, seven moderate and five were major. Mining or oil drilling operations, wastewater or sewage, and oil or chemical spills were the most frequent causes. Two kills were attributed to agricultural operations, four to natural causes and seven were of unknown origin.

A more detailed summary of fish kills is contained in Appendix C.

Problem Areas

Cutshin Creek (Leslie County) has had recurring kills from oil drilling and mining operations over the last four years.

Table 18

Fish Kill Summary

		1984	1985	Total
Severity:	Light (<100)	5	5	10
	Moderate (100 - 1,000)	10	7	17
	Major (>1,000)	7	5	12
	Unknown	11	12	23
	Total	33	29	62
Cause:	Mining or Oil Operation	7	6	13
	Agricultural Operation Waste	1	2	3
	Oil or Chemical Spill	9	4	13
	Wastewater or Sewage	4	6	10
	Natural (low D.O. etc)	6	4	10
	Unknown	6	7	13
	Total	33	29	62

Table 18 (continued)

		1984	1985	Total
River Basin:	Big Sandy	3	2	5
	Little Sandy	0	0	-
	Tygarts Creek	0	1	1
	Licking	4	5	9
	Kentucky	5	9	14
	Salt	4	5	9
	Green	5	0	5
	Tradwater	0	1	1
	Upper Cumberland	1	3	4
	Lower Cumberland	1	0	1
	Tennessee	3	0	3
	Ohio	7	2	9
	Mississippi	0	1	1
	Total	33	29	62
Approximate No. of Stream Miles Affected		67	87	154
Estimated No. of Fish Killed		106,514	59,499	166,013

CHAPTER III

WATER POLLUTION CONTROL PROGRAMS

POINT SOURCE CONTROL PROGRAM

Wastewater Treatment Facility Permitting

As calendar year 1984 began, Kentucky had been administering its Kentucky Pollutant Discharge Elimination System (KPDES) program for a little over one year. Through 1984 and 1985, further progress was made in reducing the backlog of unissued discharge permits. By the end of 1985 the backlog was approximately 900 permits which included many small sewage plants and coal mine discharges. In response to EPA's renewed emphasis on permitting of stormwater point sources, the Division of Water had drafted a proposed general permit for some Group I discharges and all Group II discharges. Although the Division has yet to issue this permit, it has the potential to address high numbers of sources that may otherwise add to the backlog and severely tax the agency's resources.

As part of Kentucky's overall Water Management Plan, funds were allocated for an increase in staff within the industrial permitting area. Two new employees were hired; one to aid in drafting industrial-type discharge permits including stripper well discharges, while the other maintains the agency's oil and gas registration system and administers the remaining non-KPDES aspects of the oil and gas program.

The Division has stepped up its efforts to incorporate toxic-based effluent limits on new and reissued industrial (and some municipal) permits. In the last two years there has been an increased use of biomonitoring requirements, both as preliminary screening tools and enforceable effluent conditions. As mentioned in the last report, linked with this approach is the use of chemical-specific limits derived from applicable water quality standards. Although this has been accomplished to a large degree, Kentucky's new chloride criterion was not used during 1984-1985. The use of the criterion, which was part of the the Division's initiative for controlling oil stripper well discharges, was enjoined by court order (a more detailed discussion of this issue can be found in Chapter II of this report).

The Kentucky pretreatment program is well underway. A total of 49 Publicly-Owned Treatment Works (POTWs) have local programs approved by either federal or state authorities. Currently, there are six programs under review by state personnel and other POTWs may become eligible as new industries locate or existing industries change processes.

Due to the relatively new pretreatment program implementation at the state and local level, no data have been compiled indicating the degree of success of the program. Semi-annual reports are required from the POTWs which summarize local implementation. In the future, as reports become more representative and as the state data management capabilities become more sophisticated, it should be apparent how local pretreatment program implementation is affecting water quality. The mechanism exists to have a positive impact on water quality, but implementation and enforcement are the keys for program success.

Municipal Facilities

The Construction Grants Program has resulted in the construction of $113 million in wastewater projects which came on line during 1984-1985. The result has been the completion of 22 municipal wastewater projects. In addition, 42 projects are in various stages of construction. Table 19 provides a listing of projects which have been completed. Table 20 contains a listing of projects which have been funded, but are not yet completed. Significant improvements in water quality have been realized through the construction of new wastewater treatment facilities. A review has been made of facilities completed during calendar year 1984 and 1985 which had discharges to surface waters. The discharge monitoring reports indicate reductions in pollutants as shown in Table 21.

Table 19

Construction Grants Funded Projects Which Came On Line During Calendar Years 1984 and 1985

Project	Date on Line	Design Flow (MGD)	Treatment** Cost	Other Cost
Albany	Feb 84	0.450	$ 1,443,641	$ 436,649
Elizabethtown	Oct 85	4.600	$ 15,910,68	$ 3,270,260
Frankfort	Apr 84	sewers	$ 0	$ 3,189,148
Georgetown	Feb 85	0.240	$ 3,832,866	$ 1,490,567
*Hickman (east)	Dec 85	0.160		
Hickman (west)	Dec 85	0.160	$ 659,000	$ 502,000
Island	Apr 85	0.128	$ 654,000	$ 880,000
LaGrange	Oct 84	0.750	$ 1,614,026	$ 1,669,829
Lawrenceburg	Dec 84	1.971	$ 4,868,796	$ 430,756
Lex. West Hickman	Mar 85	16.800	$ 27,603.313	$ 442,183
Louisa	Jul 84	1.090	$ 1,147,971	$ 258,512
Louisville (Okolona)	Dec 84	sewers	$ 0	$ 100,904
Montgomery S.D. 2	Apr 84	0.284	$ 1,254,063	$ 1,880,187
Murray	Apr 84	3.500	$ 7,704,000	$ 1,911,000
New Castle	Nov 85	0.100	$ 492,415	$ 740,719
Owensboro	Oct 85	6.800	$ 8,346,000	$ 4,568,000
Princeton	Jun 85	1.070	$ 3,310,000	$ 1,530,000
Russellville	Oct 84	1.650	$ 1,605,000	$ 246,000
Scottsville	May 84	0.857	$ 2,464,946	$ 0
Shelbyville	Feb 85	1.100	$ 4,080,097	$ 242,040
Waverly	Jun 84	sewers	$ 0	$ 295,000
Whitesville	Jul 84	0.100	$ 800,000	$ 910,000
TOTALS		44.81	$ 87,790,702	$24,993,754

*Costs included in Hickman (west).
**Cost includes local share.

Table 20

Projects Which Have Received Construction Grants Funding But Construction Is Not Yet Complete

Project	Type Grant*		Total Cost
Alton WD	2/3	(sewers only)	$ 2,136,533
Berea	2/3		$ 10,535,057
Berry	2/3		$ 888,400
Bradsfordsville	2/3		$ 574,920
Carrollton	2/3		$ 3,605,348
Caveland S A**	2/3		$ 8,960,513
Centertown	2/3		$ 1,197,875
Central City**	2/3		$ 3,256,412
Elkton	2/3		$ 1,953,599
Flemingsburg	2/3		$ 4,127,660
Fleming-Neon	3	(sewers only)	$ 8,157,000
Florence	3		$ 8,862,885
Fountain Run	2/3		$ 1,792,954
Franklin	2/3		$ 5,491,029
Hanson	2/3		$ 1,261,408
Hardinsburg	2/3		$ 2,018,292
Hodgenville	2/3		$ 5,128,000
Inez	2/3		$ 3,735,776
Irvington	2/3		$ 2,335,914
Kevil	2/3		$ 481,118
LaCenter	2/3		$ 556,686
Lexington M/S	3	(sewers only)	$ 2,660,000
Lexington S/E	3	(sewers only)	$ 5,975,552
Lexington (Town Branch)**	3		$ 15,507,702
Livermore	3		$ 111,980
Louisville (Morris Foreman)**	3		$ 7,473,095
Louisville (West County)**	3		$ 14,526,593
Middlesboro	2/3		$ 12,017,978
Midway	2/3		$ 2,606,146
Milton	2/3		$ 1,033,633
Monticello	2/3		$ 6,397,794
Mt. Vernon	2/3		$ 1,927,407
Paintsville	2/3		$ 3,137,668
Radcliff	2/3		$ 8,187,910
Shelby County SD #1	2/3	(sewers only)	$ 2,058,584
Sacramento	2/3		$ 1,612,919
Sadieville	2/3		$ 3,373,442
Springfield	2/3		$ 2,303,230
Stanford	2/3		$ 2,397,101
Stanton	2/3		$ 1,342,255
Sturgis	2/3		$ 2,217,417
Vine Grove	2/3		$ 4,970,100
		TOTAL	$176,760,352

3 - Construction funding only
2/3 - Design and construction funding
** Segmented or phased project

Table 21

Reductions in Pollution Loadings as a Result of Municipal Wastewater Treatment Plant Construction During 1984-85

Pollutant	Previous Discharge (LBS/Yr)	Existing Discharge (LBS/Yr)	Improvement (LBS/Yr)	Percent Reduction
BOD	4,635,028	1,442,978	3,192,050	68.9
TSS	5,011,967	2,350,701	2,661,266	53.1

Note: BOD is the five day biochemical oxygen demand. TSS is total suspended solids.

Although significant improvements in water quality have been realized through the construction of new wastewater treatment facilities, there are numerous needs that remain to be addressed. The 1984 Needs Survey indicated that municipal dischargers continue to impair water quality and pose potential human health problems. State and federal minimum treatment requirements are not being met in every instance. The 1984 Needs Survey identified a capital investment need of $1.3 billion to construct and rehabilitate wastewater treatment facilities and components for Kentucky, based on the 1984 population. Backlog needs of $1.3 billion, coupled with long-range needs for publicly-owned treatment facilities, reveal a projected total need of over $1.96 billion through the year 2000. A detailed breakdown of investment needs is presented in Table 22.

Table 22

Investment Needs for Wastewater Treatment Facilities in Kentucky 1984-2000 (In January 1984 millions of dollars)

Facility	For Current 1984 Population	Projected Needs 2000 Population
Secondary Treatment	$ 277	$ 372
Advanced Secondary Treatment	$ 86	$ 114
Infiltration/Inflow	$ 80	$ 80
Major Rehabilitation of Sewers	$ 6	$ 6
New Collector Sewers	$ 487	$ 636
New Interceptor Sewers	$ 180	$ 551
Correction of Combined Sewer Overflows	$ 201	$ 201
TOTAL	$ 1,317	$ 1,960

The projected needs far exceed the funding capabilities of the Construction Grants Program. This problem is compounded by current proposals to phase out the program over the next four years. If the program is to cease, the remaining years of federal assistance could be better spent initiating a revolving loan program. Loan programs have been proposed by both the House and the Senate.

The Division of Water has been pursuing other approaches for meeting the current and projected wastewater treatment needs in Kentucky. Three such areas are innovative treatment for small communities, cost control, and innovative financing alternatives.

- Innovative Treatment

  Small communities are experiencing difficulties in providing affordable wastewater disposal that will meet state and federal water quality regulations. Conventional methods are generally too expensive to finance and operate. In cooperation with the Kentucky Division of Water, the Tennessee Valley Authority (TVA) has initiated projects in Benton, Hardin and Pembroke, Kentucky to demonstrate how small communities can treat their sewage much more cost effectively by using an artificial wetland. In addition to the potential benefits for small communities, TVA expects artificial wetlands to prove suitable for many industrial discharges of organic waste. A mechanical-type sewage treatment plant usually costs about $3 to $5 for each gallon-per-day plant capacity, while the preliminary cost estimate for an artificial wetlands system is only about $1 for each gallons-per-day.

- Cost Control

  Cost Control within the Construction Grants Program can mean significant dollar savings. During the facility design process, cost control efforts are implemented through the Value Improvement Program and Value Engineering. Over the past several years, Kentucky's savings have been consistent with the 10 percent national trends in net savings.

  A new initiative has been directed at the cost of engineering (about $13,000,000 annually). Savings so far are averaging over 27 percent and more may be possible. The Division's recently published Cost Control Report is providing grantees with better information, leading to more effective cost negotiations with consulting firms. Kentucky has begun to target limits to such fees beyond which eligibility for Title II funds will be in question. This approach appears to be successful to date.

  Construction costs are formally advertised and price competitive. The free market mechanism plays a substantial cost control role. However, Kentucky is looking at other alternatives in this area. A cap on change orders and tight restrictions on contract completion dates and follow-up activities are potential areas for further cost control.

- Innovative Financing Alternatives

  In view of the large sum of money needed for constructing POTWs in Kentucky and in view of the national trend to reduce and eliminate financial assistance for these projects, the Division evaluated innovative financing alternatives for meeting Kentucky's Publicly-Owned Treatment Works (POTWs) construction need. This evaluation resulted in the publication of the Water Infrastructure Report for the Commonwealth of Kentucky in December of 1985. The following financing scenarios were evaluated in the report: front end transactions, such as user fees; direct state general fund appropriations; infrastructure banks; a state revolving loan fund; grants; and private sector construction, operation and/or ownership.

It was concluded that the revolving loan fund concept ranked highest in terms of feasibility, equity, efficiency, effectiveness, and stability for the Commonwealth of Kentucky. Recommendations were made on how the fund would be established and operated in the Commonwealth. Draft legislation was included in the report to implement the recommendations of the report. Due to the late publication date and to competing priorities, the 1986 Kentucky General Assembly did not address the funding need for Kentucky's POTWs but is expected to study this issue in 1986 and 1987.

Enforcement

During 1984-85, enforced compliance with Water Quality Regulations resulted in a threefold increase from 1982-83 in the number of violations legally resolved. Enforcement activities consist of informal administrative actions and civil litigation before an administrative hearing officer which result in a legally enforceable order by the Secretary of the Natural Resources and Environmental Protection Cabinet. Most violations are resolved by Agreed Orders which contain compliance schedules and provide for penalty assessment; however, when informal negotiations fail, violations are referred to the Cabinet's Office of General Counsel for litigation. During Federal Fiscal Year 1984 and 1985, enforcement activities resulted in 228 legally enforceable compliance orders and collection of $126,950 in civil penalties.

Because of widespread pollution resulting from the production of crude oil and natural gas, new regulations specifically addressing that industry were adopted in January, 1984 and a major effort to enforce those regulations was initiated in August, 1984. From August, 1984 through April, 1985, approximately 150 individual oil production facilities were addressed by an order to comply with the new requirements. On April 8, 1985, certain representatives of the industry obtained a court order restraining further enforcement of the new regulation.

Kentucky began implementing a State Municipal Strategy in January, 1984, in accordance with EPA guidelines. The strategy is intended to ensure compliance of all POTWs with requirements of the Clean Water Act by July 1, 1988. Of the 34 facilities identified as being in violation, two are in compliance, 20 are under Agreed Order, five have been referred to the Office of General Counsel, and nine are still negotiating terms for compliance.

In a related effort, the COMPTRAIN Program was implemented, with the goal of improving operation of small POTWs through individual, on-site training with regard to operation and maintenance. The program consists of a thorough evaluation of existing treatment facilities and wastewater characteristics, specific recommendations for physical improvements, and intensive individual training for plant personnel in operational techniques that optimize removal of pollutants from the wastewater. Since the beginning of 1984, site-specific training has occurred at 20 POTWs. The documentation of the treatment capability of those facilities will simplify any enforcement action that may be necessary in the future.

NONPOINT SOURCE POLLUTION

Nonpoint source pollution (NPS) is a serious problem in many areas of Kentucky due to the land-disturbing activities of agriculture, mining, construction and silviculture (forestry). These pollution sources are responsible for use impairment and habitat modification of Kentucky's streams, lakes and wetlands. In many cases, there has been documentation of the serious water quality implications of sediment, nutrient, pesticide and acid mine drainage pollutants.

Since the passage of the Clean Water Act, significant achievements have been made in the control of point sources of pollution. However, the reduction of point sources of pollution has illuminated the nonpoint contribution to water quality problems. The pollutants carried in runoff have taken their toll on Kentucky waterways, including sediment and fertilizers (with consequent degradation of the breeding grounds of fish and other aquatic life), accelerated siltation in reservoirs and lakes, and increased costs for dredging. On a national level, nonpoint sources are responsible for as much as 73 percent of the total biochemical oxygen-demand loadings, 99 percent of the suspended solids, 84 percent of the phosphorus and 98 percent of bacteria loads. This is the primary reason that many streams still do not support designated uses. An assessment of the relative contribution of nonpoint source pollution in Kentucky's surface waters is presented in Chapter I of this report.

Kentucky's nonpoint source assessment was completed in April, 1984. The purpose of the assessment was to determine the extent and severity of agriculture, silviculture, mining and construction caused sediment, nutrient, and pesticide-related water pollution in Kentucky. This information is summarized in Table 23.

Soil Erosion

Cropland

Agricultural activites such as row cropping have been identified as the predominant nonpoint pollution source, with 57 percent of Kentucky's cropland needing conservation measures to reduce erosion rates to tolerable limits. Over 46 million tons of soil are eroded from the state's cropland at an estimated average rate of 9.93 tons/acre/year. Cropland in the eight county Purchase Major Land Resource Area (MLRA) has been eroding at the greatest rate (15/tons/acre/year).

Pastureland

Pastureland requiring conservation amounted to approximately 80 percent of the total resource. Erosion attributed to pastureland was approximately 36.8 million tons, with the Bluegrass MLRA containing most of the affected acreage. Among the river basins in the state, the Green River basin contained 250,000 acres and the Kentucky River basin had nearly 275,000 acres of pastureland prone to erosion.

Forestland

Commercial logging operations annually disturbed 122,000 acres of forestland which accounted for 14.8 million tons of soil loss or 1.6 tons/acre/year average. However, approximately 11.5 percent of the state's forestland is affected by livestock grazing which contributed to a soil loss rate of 8.2 tons/acre/year.

Table 23

Severity and Extent of Nonpoint Source Contributions

Type of NPS	Extent	Severity	Primary Parameters
Urban	L	M	SS/M/T/C
Agriculture (non-irrigated)	W	M	N/OD/P/SS/T
Animal wastes	M	M	N/OD/C
Silviculture	L	I	SS/T
Mining	L1./	S	M/SS/T/O
Construction	L	M	SS/T

---EXTENT ---

W = widespread (50 percent or more of the State's waters are affected)
M = moderate (25 percent to 50 percent of the State's waters are affected)
L = localized (less than 25 percent of the state's waters are affected)

---SEVERITY---

S = severe (des. use is impaired)
M = moderate (des. use is not precluded, partial support)
I = minor (des. use is almost always supported)

---PRIMARY PARAMETERS ---

C = coliforms
M = metals
N = nutrients
OD = oxygen demand
P = pesticides/herbicides
SS = suspended solids
T = turbidity
O = other (acid mine drainage-pH)

1./ Localized to two regions of state/in those regions problem is widespread.

Erosion in the Green River basin as the result of timber harvesting and livestock grazing accounted for approximately 202,000 and 245,000 acres, respectively, and in the Kentucky River basin 121,000 and 5,680 acres are impacted by the same two activities.

Construction

Soil losses due to construction were found in the highly urbanized Bluegrass MLRA and the 33 counties of the Eastern Coalfield. Erosion rates on construction sites in the Bluegrass and Eastern Coalfield MLRAs averaged 95.5 and 325.9 tons/acre/year, respectively.

As of 1983, the U.S. Soil Conservation Service (SCS) had determined that 2,090 acres and 972 miles of roads and railroad rights-of-way were eroding at excessive rates. The Western Coalfield, Pennyroyal and Eastern Coalfield MLRAs had the highest roadside and trackside soil erosion in terms of acres, miles and annual tons of eroded soil.

Acid Mine Drainage and Sedimentation from Mining Activities

According to studies conducted by the Kentucky Nature Preserves Commission, 70 stream segments were moderately degraded, degraded, or severly degraded, with 49 segments located in the Eastern Coalfields and 21 segments located in the Western Coalfields.

The criteria used to evaluate the stream segments were based on selected physicochemical and biological parameters. Those streams that were heavily impacted by fine sediment, silt, and/or coal deposits, had elevated values for physicochemical parameters and demonstrated low aquatic diversity and equitability were denoted as being severely degraded. Streams that had moderate to high aquatic community diversity and moderate equitability (but contained some limiting factors) were denoted as degraded.

Acid mine drainage studies conducted by the Division of Water concluded that the water uses most susceptible to impairment were aquatic life and domestic water supply. Water quality criteria most likely to be violated were alkalinity, pH, and total iron for aquatic life and total manganese, total sulfate, and total dissolved solids for domestic water supplies.

Pesticides

Of the 21 million pounds of pesticide active ingredients (PAI) applied commercially in 1979, 60 percent was applied to cropland and 15.5 percent to right-of-way soils. Private applicators used 19.9 million pounds of PAI in 1979. Nearly 99 percent of this amount was applied to farm crops. Forest-related pesticides were not widely used in the state.

Generally, the counties with concentrated agricultural crop production or urban population centers corresponded to the highest pesticide use. Sixty-one percent and 82.8 percent of the total pounds of pesticides applied by commercial and private applicators, respectively, were herbicides.

Fertilizer and Livestock Waste

Fertilizer used in Kentucky increased by 8.5 percent from 1976 through 1981. The greatest amount of commercial fertilizer was applied in the Pennyroyal region and the least amount in the eastern mountain area. Application rates of fertilizers were influenced by a number of factors, one being the type of crop grown. For example, in areas where soybeans were grown, less fertilizer was required because they are a nitrogen-fixing legume. However, in areas such as the Eastern Mountains, corn and tobacco were the most prevalent crops and they require greater fertilization. Due to this factor, application rates were lowest in the the Purchase, Western Coalfield and Bluegrass regions, and highest in the Eastern Mountains.

The state trend is toward higher inventories of livestock and larger herds per farm (animal density). Livestock waste is a potential pollutant because of its nutrient content and oxygen demanding properties. Thirty million tons of manure are produced annually with beef production accounting for 58 percent of the total. Dairy, hog, and poultry production account for approximately 16, 8 and 1 percent, respectively, of the total manure produced. The Pennyroyal, Bluegrass and Western Coalfield areas contain the most manure nitrogen and phosphorus. Potential water quality impacts are high in those areas because they have many confined livestock facilities that require improved manure handling systems. During the years 1975 through 1982, 33 fish kills resulting from livestock wastes or fertilizer contamination were reported. Livestock manure runoff was the cause of 90 percent of these fish kills. However, only three such fish kills were reported in 1984-1985.

Sediment Delivery in Kentucky Watersheds

A study conducted by the Division of Water that predicted the amount of sediment delivered to water courses, resulted in prioritization of the top 100 significantly impacted watersheds. They were ranked as low, moderate, high, and very high (see Appendix D).

The Green River basin (hydrologic units 05110001 through 05110006) contained both the greatest number and area of significant yield watersheds. Forty-three of the top 100 watersheds were located in the Green River basin. Within this basin, the Barren River (05110002), Rough River (05110004), and Pond River (05110006) subbasins contained many of the significant yield P.L. 566 watersheds. Land use in these watersheds was predominantly agriculture, but surface coal mining was also a sediment source.

The Kentucky River basin (hydrologic units 05100201 through 05100205) contained 20 significant yield P.L. 566 watersheds. Land use in all the watersheds was predominantly agricultural.

Only one watershed was affected by moderate sedimentation in the Big Sandy (05070203) and Licking (95100101) River basins. In the Big Sandy River basin, 12 percent of the watershed was surface mined for coal. However, it was determined that agriculture, at 27.6 percent of the land use, was the primary sediment source.

Watersheds in the Upper and Lower Cumberland River basin were also affected by moderate to low sedimentation. Finally, certain Ohio River tributaries were denoted in the high, moderate, and low sediment delivery classes.

Existing and/or Recommended Control Programs

The Natural Resources and Environmental Protection Cabinet utilizes a non-regulatory approach for controlling nonpoint sources of pollution (primarily soil erosion and sedimentation) that occur in conjunction with the production of food and fiber, timber and kindred products, and site preparation and building practices used in the light construction and housing industry. Surface mining, however, has been regulated under the authority of the Kentucky Department for Surface Mining Reclamation and Enforcement. This was made possible through Kentucky's gaining primacy of the Surface Mining Reclamation Control Program. Generalized information on Kentucky's current nonpoint source pollution control programs is summarized in Table 24. Although most of the state's NPS water quality program is voluntary in nature, there is a strong commitment for implemention on the part of local and state government officials, the general public, the affected industries and numerous private and public sector associations.

Table 24

Current Program Status and Effectiveness

Program	Administering Agencies: Local	Administering Agencies: State	Administering Agencies: Federal	Program: Type	Program: Extent	Nonpoint Source Activity	Water Quality Effectiveness
Kentucky Water Pollution Control Statute (KRS 224)		Kentucky Natural Resources and Environmental Protection Cabinet (NREPC)		Regulatory	Statewide	See Below[1]	See Below[1]
				Voluntary	Statewide	Agriculture	Locally/Partially
				Voluntary	Statewide	Silviculture	Locally/Partially
				Voluntary	Statewide	Construction	Locally/Partially
Soil and Water Conservation (KRS 146)		Kentucky Soil and Water Conservation Commission		Voluntary Incentive	Statewide	Agriculture Construction	Locally[2]
Soil and Water Conservation (KRS 262)	Kentucky's 121 Conservation Districts			Voluntary	Statewide	Agriculture Construction	Locally[2]
Pesticide Use and Application Act (KRS 217B)		Kentucky Department of Agriculture		Regulatory	Statewide	Commercial Agriculture Operations	Locally[2]
				Regulatory	Statewide	Commercial[3] Non-Agriculture	Locally[2]
				Regulatory	Statewide	Private Agricultural Operations[4]	Locally/Partially
Surface Coal Mining/ Abandoned Mine Lands (KRS 350)		NREPC		Regulatory	Statewide	Surface Coal Mining	Fully (Active surface mining) Partially (Abandoned mines)

Table 24 (continued)

Program	Administering Agencies Local	State	Federal	Type	Program Extent	Nonpoint Source Activity	Water Quality Effectiveness
Forestry Land Management (KRS 149)		NREPC					
o Private Land				Voluntary	Statewide	Silviculture	Locally
o State Forest Lands (38,000 acres)							Fully (State forests)

FOOTNOTES:

1. KRS 224 regulates water pollution from all sources, if they substantially reduce water quality or impair beneficial uses.
2. Programs are very effective but would not like to characterize them as "fully effective."
3. Commercial non-agriculture operators includes forestry applications of chemicals.
4. Private agriculture operators are required only for "restricted use" pesticides listed by the Commonwealth and EPA.

A nonpoint source pollution control program has been instituted by the Cabinet. Within the program, a work plan has been developed to prioritize objectives, establish target dates, and incorporate the diverse spectrum of NPS pollution categories including agriculture, construction, mining and silviculture. Education programs, incentives and increased technical assistance will be used to encourage the use of Best Management Practices (BMPs) for each of the four NPS pollution areas and they are the basis of the program. The specific objectives stated in the plan all revolve around these three basic aspects of the program.

The nonpoint source pollution control program consists of six functions designed to result in the long term reduction of nonpoint source pollution in the Commonwealth. The functions are: planning, education, agency coordination, problem assessment, implementation, and tracking and evaluation. Actions in each of the functions can occur simultaneously or independently (see Figure 10).

Planning primarily consists of developing water quality management plans (WQMP), as required by EPA, for agriculture, construction and silviculture. The WQMPs are part of the overall program to control nonpoint source pollution and include educational programs, incentives and technical assistance designed to promote the voluntary use of BMP's. In addition, the responsibilities of other agencies are outlined to aid in implementation. The WQMP's are an integral part of the NPS program, serving to document the planned direction of the program.

Education consists of developing educational materials with the aid of other agencies such as the state Division of Conservation, extension services, forestry organizations, etc. In addition, a packaging format is to be developed for distribution.

Agency coordination is an important function because the success or failure of the whole program is dependent upon its development. An important objective of this function is to develop cooperative agreements between the various agencies to aid in the implementation of the WQMPs. The agreements outline the responsibilties of the cooperating agencies. Another objective is the creation of coalitions among agriculture, builder, and forestry organizations with state and federal agencies.

Problem assessment is geared toward prioritizing the P.L. 566 watersheds in Kentucky. To date, the Commonwealth has delineated the top 100 watersheds believed to be affected by sedimentation. The watersheds were determined via modeling utilizing the Universal Soil Loss Equation (USLE) in conjunction with a Kentucky-specific sediment delivery curve. Watersheds with a "Very High," "High" and "Moderate" sediment delivery potential appear in Appendix D.

The priority ranking is intended to provide the basis for future watershed appraisal to determine stream uses that are impaired, the extent of the impairment, limiting parameters, contributing sources and appropriate remedies for correcting serious problems. The ranking will be further refined through field assessments and will eventually serve as a guide for allocating treatment funds if and when they become available. The Soil Conservation Service (USDA) and the state Division of Conservation are presently cooperating with the Division of Water to further prioritize the P.L. 566 NPS watersheds in western Kentucky. This process will then be extended to the other regions of Kentucky.

The field assessments will consist of sampling and monitoring activities that will be developed and coordinated with the Cabinet's Division of Environmental Services

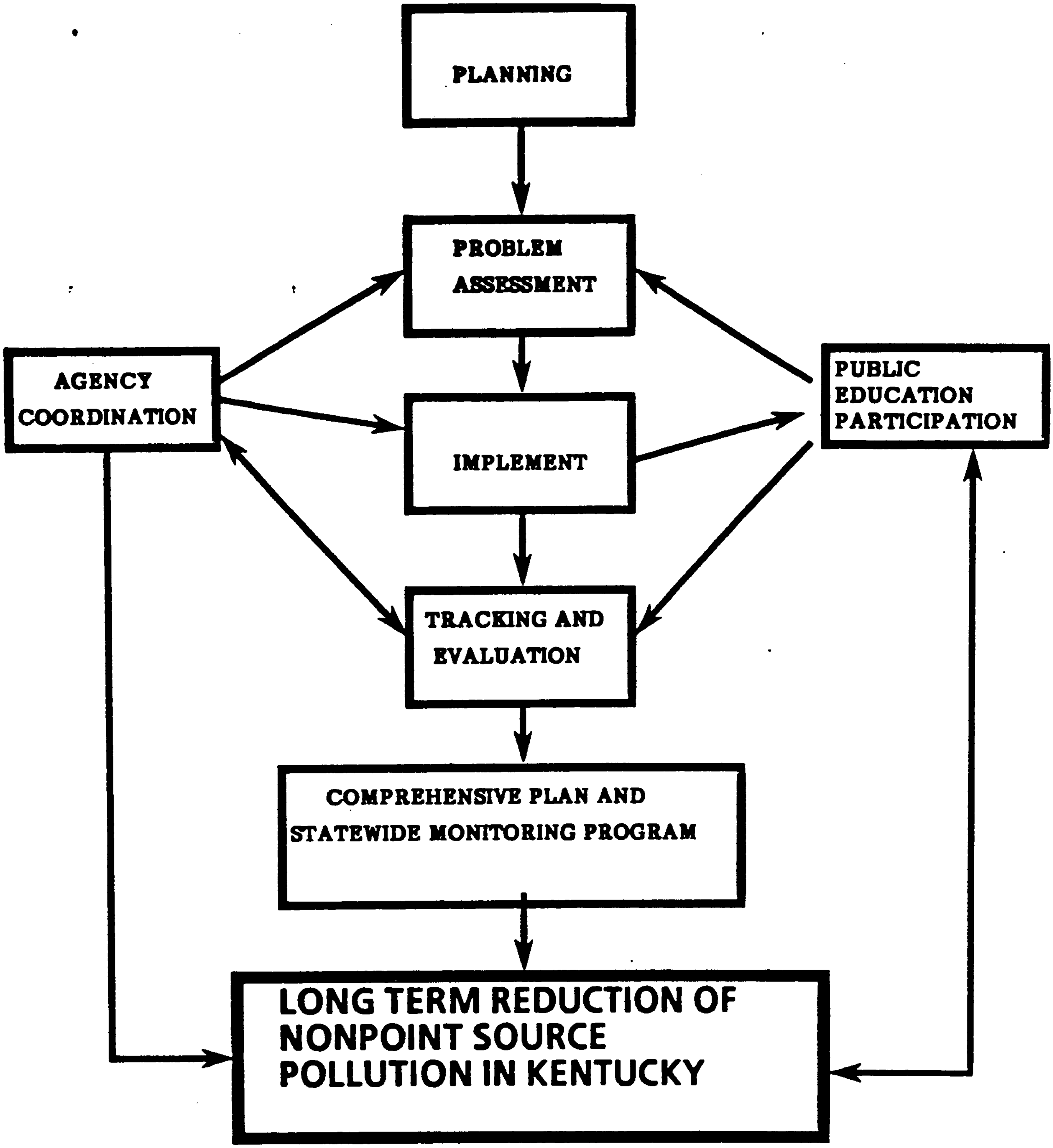

Figure 10

Interrelationship of State Nonpoint Source Pollution Control Program Functions and the Division of Water's Biological Analysis Section. During the field assessment process, watersheds will be selected where rapid improvements can be made through the application of specific BMPs. The actual implementation of these BMPs result in a noticeable improvement in the targeted watersheds.

Implementation consists of carrying out the requirements or terms of the WQMPs, cooperative agreements and other management aspects of the NPS program. Implementation will start with the targeted watersheds delineated during problem assessment. Agency coordination and public education, with financial incentives used when possible, will provide successful implementation.

Tracking and evaluation of both rates of implementation, and the results of that implementation, will evaluate the overall progress of the NPS Program.

The nonpoint source pollution program has made progress, but there is much more that needs to be done. BMP manuals for agriculture, construction, forestry and surface mining have been developed and are being distributed. The WQMP for agriculture is under final revision and review. A very important aspect of the program that is waiting for final approval is a cooperative agreement with the Division of Conservation. This cooperative agreement consists of four main tasks that the Division of Conservation has agreed to develop and implement. The first task will require them to coordinate activities of the agencies (U.S. Soil Conservation Service, Agricultural Stabilization and Conservation Service, etc.) cooperating in implementation of the WQMPs for agriculture and construction. The second task consists of evaluating existing cooperative agreements between assisting agencies to determine their effectiveness in meeting goals, objectives and implementation tasks of the WQMPs. The third task requires the organization of an education and information delivery program network involving agriculture agencies, environmental groups, builder and developer organizations, etc. Additionally, they will implement and coordinate an education program on a statewide basis to create water quality problem awareness and its relationship to soil erosion. The last task involves the development, with the Division of Water, of a monitoring and evaluation system to track the success of the voluntary program. A tracking system will be developed on a watershed basis through a pilot program beginning in 1986, with statewide implementation occurring in 1987. Cooperation between the Divisions of Water and Conservation is a necessary ingredient of the voluntary framework of the program.

While the Commonwealth intends to maintain its effort in controlling point sources, it also intends to mount an aggressive effort of education and technical assistance to increase acceptance and use of nonpoint source pollution control measures (BMPs). The estimated total installation cost for BMP application in Kentucky will be $2,630,085,631 (1981). For further delineation of cost needs, refer to the "1984 Kentucky Report To Congress On Water Quality." Additionally, the program intends to pursue the creation of state-supported economic incentives, such as BMP cost-sharing, to supplement the cost-sharing funds of federal conservation agencies operating in Kentucky.

GROUNDWATER PROTECTION PROGRAM

The development of a comprehensive groundwater management program was mandated by the Water Management Plan approved by Governor Martha Layne Collins in November, 1984. The primary mechanism for accomplishing this program is the Groundwater Advisory Council appointed by Governor Collins in August, 1985. The Council is comprised of representatives from state agencies concerned with groundwater. The primary duties of the Council are to assist in the promulgation of groundwater regulations, to recommend a strategy for groundwater protection, and to advise and monitor the Division of Water in the evolution of its groundwater program.

The Division of Water now has the responsibility to develop a comprehensive groundwater management program. Groundwater is addressed as a component of many solid and hazardous waste, mining, and surface water acts. As a result of this fragmentation of legislation, management and protection of this resource is difficult. Specific state acts relating to groundwater protection and/or management that the Cabinet implements include:

- Kentucky Environmental Protection Law (Kentucky Revised Statutes, Chapter 224, Environmental Protection, 1986, as amended).

- Kentucky Water Quality Standards (Kentucky Administrative Regulations, Title 401, Chapter 5, April, 1985).

- Kentucky Water Withdrawal Law (Kentucky Revised Statutes, Chapter 151, Environmental Protection, 1966, as amended).

- Control of Water Pollution from Oil and Gas Facilities (Kentucky Administrative Regulations, Title 401, 5:090, 1983).

- Kentucky Permanent Program Regulations for Surface Coal Mining and Reclamation Operations and Coal Exploration Operations (Kentucky Administrative Regulations, Title 405, Chapters 7 through 24, December 1983).

- Kentucky Water Well Construction Practices (Kentucky Revised Statutes, Chapter 223, Environmental Protection, 1985, as amended).

State acts relating to groundwater protection implemented by other state agencies include:

- Kentucky Mineral Conservation and Development Statutes (Kentucky Revised Statutes, Chapter 353, Oil and Gas Conservation, 1975, as amended).

- Kentucky Onsite Sewage Disposal Systems (Kentucky Administrative Regulations, Title 902, 10:085, 1985).

- Kentucky Fire Prevention and Protection (Kentucky Revised Statutes Chapter 227, Underground Storage Tanks, 1980, as amended).

o Kentucky Waste Management Regulations (Kentucky Administrative Regulations, Title 401, Chapters 34 and 35, December 1983, as amended).

The following agencies are involved in the regulation or protection of groundwater in Kentucky.

A. Division of Water - Groundwater Section

The Groundwater Section was formed in January 1985. It is staffed by three hydrologists, a program coordinator, a data manager, and a computer programmer. Its major tasks are to : develop a groundwater data base, implement and administer the water well drillers program, identify and classify Kentucky's aquifers, conduct ongoing assessments of problems and needs, and develop a statewide groundwater policy/strategy.

The section is providing some much-needed technical expertise to government agencies and the public. The water well drillers program is generating interest in Kentucky's groundwater resources and providing information to fill the large gaps in data presently on file.

Kentucky's karst regions, due to their vulnerability and widespread problems, are receiving special attention. Available expertise enables the section to design and implement studies to identify pollution sources and develop possible remedies for the situations. Many of these aquifers feed springs that serve as water supplies for thousands of Kentuckians. The rapid travel times associated with pollutants moving in karst conduit flow aquifers warrant concern. Careful attention will be paid to developing an ability to predict rates of flow and points of discharge.

B. Division of Water - Water Well Drillers Program

The 1984 Kentucky General Assembly passed legislation creating a water well driller certification program, presently administered by the Groundwater Section. All drillers of commercially constructed water wells must be certified and adhere to recently promulgated regulations setting forth standards and specifications for well construction and placement. A Certification Board was appointed to oversee the activities of the program and make administrative decisions. To date, 152 drillers have been grandfathered into the program and five have taken and passed the required examination.

Drillers are required to disinfect the well upon completion and supply the owner with information on sampling techniques for bacteriological analysis. A well owner's handbook is being developed by the Division of Water, detailing the methods for finding a water well driller, placing a well, disinfecting and sampling the well, and whom to contact for further information.

C. Division of Water - Groundwater Withdrawal Permitting

The Division of Water collects pump test information on most groundwater withdrawals in excess of 10,000 gallons per day. However, the data are supplied voluntarily from permit holders and are not mandated to be collected from all groundwater withdrawal permittees. While these data contribute to known groundwater information, they are far from sufficient to aid in permitting decisions.

D. Division of Waste Management - Solid and Hazardous Waste Management Program

The Division of Waste Management regulates groundwater monitoring program requirements for solid (non-hazardous) and hazardous waste facilities. The solid waste program has required approximately 40 facilities to install monitoring networks. Many other facilities have been closed or have provided the Division with sufficient information to be granted a waiver from monitoring. The remaining facilities are being brought into compliance through the Division's re-permitting procedures.

At present, most hazardous waste facilities in Kentucky subject to groundwater monitoring requirements under the Resource Conservation and Recovery Act (RCRA), have installed and are operating monitoring networks. Of these, results from only a few systems have indicated that contamination is leaving the facility boundary. Recently, RCRA compliance actions have forced facilities not previously required to install monitoring systems to do so. Those facilities most likely to contaminate groundwater, namely unlined disposal ponds or lagoons, are closing voluntarily, but will continue to monitor groundwater for the required amount of time. No contamination of drinking water wells or supplies by a hazardous waste facility has been documented to date. The RCRA regulations require immediate corrective action at any regulated facility whose monitoring system indicates a problem.

E. Cabinet for Human Resources - Department for Health Services

A bill passed by the 1986 Kentucky General Assembly and signed by the Governor gives the Cabinet for Human Resources statutory responsibility for sampling private water wells. County health departments, under the supervision of the Department for Health Services, will collect the samples and have them analyzed in the Cabinet's laboratory. A report of the results will be provided to the owner along with a recommendation for necessary action on the well, if any.

In 1985, the Department filed regulations entitled, "Kentucky Onsite Sewage Disposal Systems." According to the narrative, "(T)he function of this regulation is to assure the construction, installation, or alteration of onsite sewage disposal systems in such a manner as to protect public health and the environment." The regulation pertains to all onsite sewage disposal systems except those with a surface discharge. It is the most comprehensive criteria to date governing this issue. Improperly installed and maintained septic tanks are a major source of aquifer contamination in Kentucky.

F. Division of Oil and Gas - Underground Injection Control

The Division of Oil and Gas regulates the protection of "freshwater zones" during drilling, plugging and injection operations. Such protection is accomplished with casing and cement requirements.

The U.S. Environmental Protection Agency implemented the Underground Injection Control (UIC) program in Kentucky in May of 1984 for well classes I through V. The Division of Oil and Gas is seeking primacy for Class II wells, which are used to dispose of oil and gas drilling brines and to inject fluids (steam, solvents, etc.) for the enhanced recovery of petroleum products. Kentucky primacy for Class II wells, including any associated monitoring and enforcement requirements, is not expected to take place before the latter half of 1986.

G. Department for Surface Mining Reclamation and Enforcement

Mining regulations administered by the Department for Surface Mining Reclamation and Enforcement (DSMRE) require the mining permittee to monitor such things as groundwater levels, infiltration rates, subsurface flow and storage characteristics, and groundwater quality. This is to determine the effect of surface and underground mining on the recharge capacity of reclaimed lands and on the quantity and quality of water in groundwater systems in the permit area and adjacent areas. Monitoring results, plus findings from any additional tests specified and approved by the Department, including drilling, infiltration tests, and aquifer tests, are submitted to DSMRE and demonstrate compliance with these and other applicable regulations.

According to Departmental staff, about 60 percent of the mines have monitoring wells, but a permitted mine may only have one well whether the mine covers 2 or 2,000 acres. A computer file on groundwater quality data is being compiled from the pre-mine groundwater quality data submitted by the applicant, and monitoring results from active mining operations are maintained on file at the facility.

H. Kentucky Geological Survey - U.S. Geological Survey

The Water Resources Division of the U.S. Geological Survey (USGS), in cooperation with the Kentucky Geological Survey (KGS), collected and compiled groundwater quality data throughout the state in the past. Unfortunately, little groundwater quality data have been collected over the last several years because of budget cuts.

The concentration of current USGS-KGS groundwater efforts is the collection and compilation of continuously recorded and periodically measured groundwater level data from a permanent observation well network throughout the Commonwealth. Approximately one-third of these wells are in the Louisville area where rising groundwater levels are a major concern. These data reflect natural or artificial changes in groundwater storage and are published annually by the USGS as a part of "Water Resources Data" for the state.

The USGS also maintains observation wells at the Maxey Flats Radioactive Waste Burial site in Fleming County. Both water levels and radionuclides are monitored. Hydrogeologic studies of the site indicate that low-level radionuclides have moved laterally through fractured rock as much as 270 feet from the nearest burial trench.

A major baseline monitoring effort is being conducted in the Kentucky River Basin. In addition to examining the basic resource, efforts are being directed toward the cause-effect relationship between such water-impacting activities as coal extraction, oil and gas production, and groundwater and surface water quality and quantity. Major domestic water supply wells are being tested for certain parameters in selected areas.

MONITORING PROGRAM

An effective water monitoring program is essential for making sound pollution control decisions and for tracking water quality improvements. Specifically, Kentucky's ambient monitoring program provides monitoring data to identify priority waterbodies upon which to concentrate agency activities, to revise state water quality standards, to aid in the development of wasteload allocations, and to determine water quality trends in Kentucky surface waters. As outlined in Kentucky's current Water Quality Management Continuing Planning Process, the major objectives associated with the Ambient Monitoring Program are:

1. To operate a fixed-station monitoring network meeting chemical, physical, and biological data requirements of the state program and EPA's Basic Water Monitoring Program (BWMP);

2. To conduct intensive surveys on priority waterbodies in support of stream use designations, wasteload allocation model calibration/verification, and other agency needs;

3. To store data in EPA's STORET system, a computerized water quality data base,;and

4. To coordinate ambient monitoring activities with other agencies (EPA, Ohio River Valley Water Sanitation Commission, U.S. Geological Survey, U.S. Army Corps of Engineers, etc.).

Following is a discussion on components of the monitoring program (fixed-station monitoring, biological monitoring, intensive surveys).

Fixed-Station Monitoring Network

Fixed-station stream water quality monitoring sites active during 1984-1985 are listed in Table 25. Locations of these sites are depicted in Figure 11. Excluding the mainstem of the Ohio River, data generated by this monitoring network are used to characterize approximately 1,777 stream miles within the state.

For the reporting period (1984-1985), the Division of Water's physicochemical network consisted of 39 stream stations located in nine river basins. Water samples collected monthly at each station were analyzed according to the parameters shown in Table 26. In addition, the Division supports and uses data collected by the Ohio River Valley Water Sanitation Commission (ORSANCO) at twelve mainstem Ohio River stations and five major tributary stations. The Division also uses data from the U.S. Geological Survey's National Stream Quality Accounting Network (NASQAN) which is composed of four mainstem Ohio River stations and eight major tributary stations.

Table 25

Fixed Station Stream Monitoring Network

Map No.	Station Name	RMI	Location
1	Tug Fork-Kermit	35.1	KY 40
2	Tug Fork-Freeburn	77.8	Freeburn-Delorme Br.
3	Levisa Fork-Paintsville	69.4	US 23
4	Levisa Fork-Pikeville	117.3	KY 1426
5	Licking River-Sherburne	126.7	KY 11
6	North Fork Licking River-Lewisburg	50.4	KY 419
7	South Fork Licking River-Cynthiana	49.1	KY 36/356
8	Eagle Creek-Glencoe	21.5	US 127
9	Kentucky River-Kentucky Campground	55.5	Below Frankfort
10	Kentucky River-Frankfort	66.4	St. Clair St. Bridge
11	South Elkhorn Creek-Midway	27.5	US 62/421
12	Kentucky River-Camp Nelson	135.1	Old US 27
13	Red River-Hazel Green	72.6	KY 1010
14	Kentucky River-Heidelberg	249.0	KY 399
15	North Fork Kentucky River-Jackson	304.5	KY 1833
16	North Fork Kentucky River-Tallega	8.3	KY 708
17	South Fork Kentucky River-Booneville	12.1	KY 28
18	Salt River-Shepherdsville	22.9	KY 61
19	Floyds Fork-Crestwood	50.7	KY 1408
20	Pond Creek-Louisville	15.4	Manslick Rd. Bridge
21	Beech Fork-Maud	48.1	KY 55
22	Green River-Greensburg	279.7	Downstream US 68
23	Green River-Munfordsville	225.9	Upstream US 31W
24	Nolin River-White Mills	78.7	KY 84
25	Bacon Creek-Priceville	7.3	C. Avery Rd. Bridge
26	Barren River-Bowling Green	37.8	Bowling Green Mun. Intake
27	Green River-Morgantown	143.3	Morgantown Mun. Intake
28	Mud River-Lewisburg	44.5	KY 106
29	Pond River-Apex	62.8	KY 189
30	Pond River-Sacramento	12.4	KY 85
31	Rough River-Dundee	62.5	Davidson Rd. Bridge
32	Tradewater River-Olney	72.6	KY 1220
33	Cumberland River-Pineville	654.4	Pine St. Bridge
34	Cumberland River-Cumberland Falls	562.3	KY 90
35	Rockcastle River-Billows	24.4	Old KY 80
36	Big South Fork Cumberland River-Yamacraw	40.3	KY 92
37	Cumberland River-Burksville	427.0	Allen St. Boat Dock
38	Clarks River-Almo	53.5	Almo-Shiloh Rd. Bridge
39	Bayou de Chien-Clinton	15.1	US 51

Fixed - Station Monitoring Network
Stream Station Locations

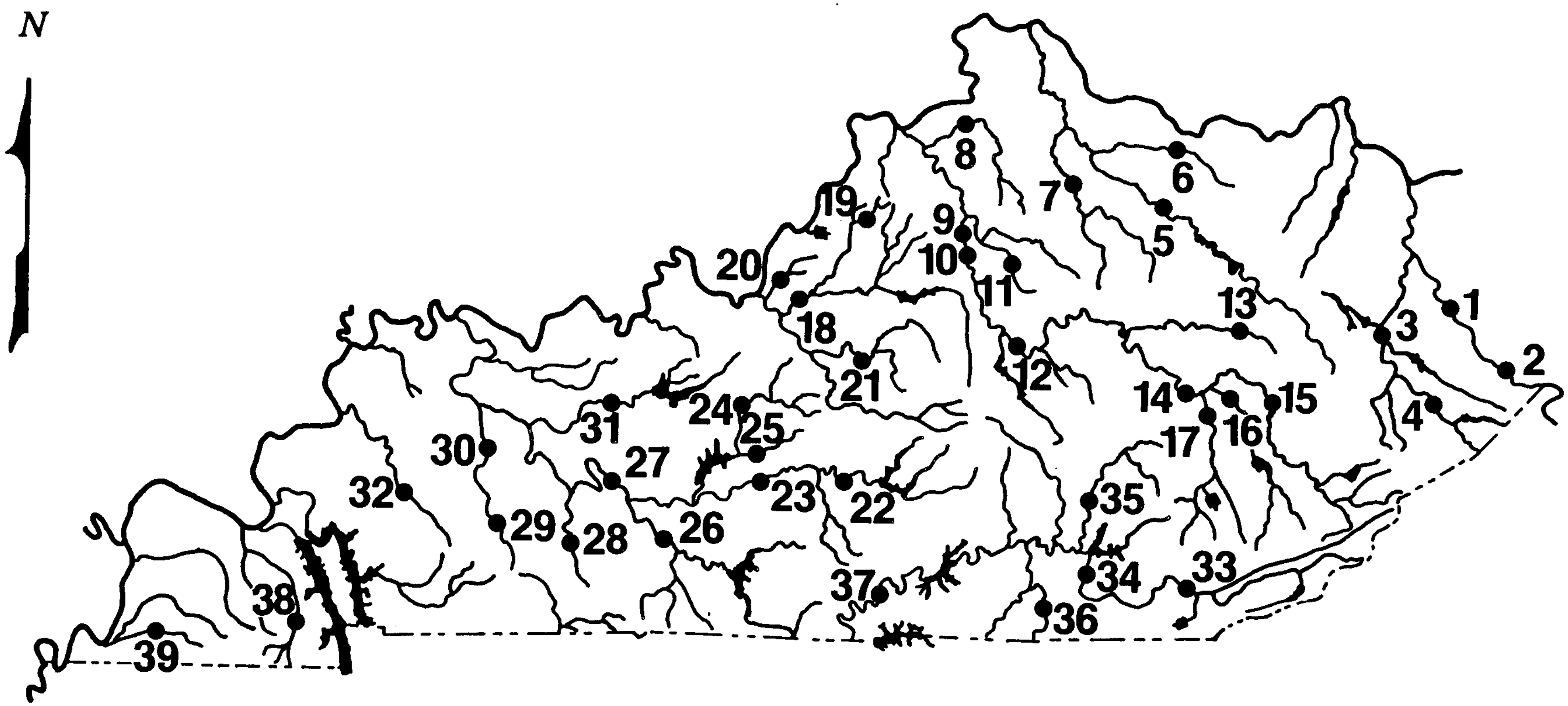

Figure 11

Table 26

Stream Fixed Station Parameter Coverage

Parameters	Parameters
Field Data	**Laboratory Data**
Weather Code	Acidity, mg/l
Air Temp, ^oC	Alkalinity, mg/l
Water Temp, ^oC	BOD, 5-day, mg/l
Depth, Feet	Chloride, mg/l
Right Bank, %	COD mg/l
Specific conductance uS/cm @ 25C	Dissolved Solids, mg/l
D.O., mg/l	Fluoride, mg/l
pH, S.U.	Sulfate, dissolved mg/l
Turbidity, N.T.U.	Suspended Solids mg/l
Flow, cfs	TOC, mg/l
Minerals, Total*	
Calcium, mg/l	
Magnesium, mg/l	**Metals, Total***
Potassium, mg/l	
Sodium, mg/l	Aluminum, ug/l
Hardness, mg/l	Arsenic, ug/l
	Barium, ug/l
Bacteria	Beryllium, ug/l
	Cadmium, ug/l
Fecal Coliform, colonies per 100 ml	Chromium, ug/l
	Copper, ug/l
	Iron, ug/l
Nutrients	Lead, ug/l
	Manganese, ug/l
NH_3-N, mg/l	Mercury, ug/l
NO_2 + NO_3-N, mg/l	Nickel, ug/l
TKN, mg/l	Selenium, ug/l
Total Phosphorus, mg/l	Silver, ug/l
	Zinc, ug/l

*Total as Total Recoverable

In 1984, the Division of Water assumed sole responsibility for 11 water quality monitoring stations which previously had been maintained through a cooperative agreement with the U.S. Geological Survey.

In 1985, the Division of Water initiated a lake ambient monitoring program. Lake monitoring was directed to address needs of two objectives. First, several lakes were sampled to evaluate problems of accelerated eutrophication. Secondly, three lakes were sampled to evaluate trends relating to potential acid precipitation impacts. Lakes in the ambient monitoring program are listed in Table 27 and the parameters measured are in Table 28.

Table 27

Lake Ambient Monitoring Network

Lake	Station Location
Eutrophication Trend Lakes	
Reformatory	Dam
Barren River	Dam
	Beaver Creek Arm
	Skaggs Creek Arm
Green River	Dam
	Corbin Bend Area
	KY 551 Bridge
Rough River	Dam
	KY 259 Bridge
	Walkers Creek Area
Cumberland	Big Lily Creek Embayment
	Beaver Creek Embayment
Buckhorn	Dam
	Midlake Area
	Upperlake Area
Acid Precipitation Trend Lakes	
Tyner	Dam
Cannon Creek	Dam
Bert Combs	Dam

Table 28

Lake Ambient Monitoring Parameters

Parameters	EUT[1]	ACP
Dissolved Oxygen	X	
Temperature	X	
pH	X	X
Specific Conductance	X	X
Depth of Euphotic Zone	X	
Acidity		X
Acid Neutralizing Capacity (Alkalinity)	X	X
T.[2] Aluminum		X
Extractable Aluminum		X
D.[3] Calcium		X
D. Chloride		X
T. Fluoride		X
D. Fluoride		X
D. Inorganic Carbon		X
D. Organic Carbon		X
D. Iron		X
D. Magnesium		X
D. Potassium		X
D. Silica		X
D. Sodium		X
D. Sulfate		X
T. Phosphorus	X	
T. Soluble Phosphorus	X	
Orthophosphate	X	
Ammonia-N	X	X
Nitrite & Nitrate-N	X	
T. Kjeldahl-N	X	
Chlorophyll-a	X	
Color		X

[1] EUT - lake eutrophication evaluation
ACP - lake acid precipitation evaluation

[2] Total

[3] Dissolved

Intensive Surveys

Kentucky uses the intensive survey to evaluate site-specific water quality problems. Information developed from intensive surveys are essential in providing a technical basis to:

- o Document the attainment/impairment of designated water uses,
- o Verify and justify construction grants decisions,
- o Address issues raised in petitions for water quality standard variances, or use redesignations, and
- o Document water quality improvements and progress resulting from water pollution control efforts.

For 1984-1985, ten intensive surveys were conducted on 364 miles of streams. The location and purpose of these surveys is summarized in Table 29.

Table 29

Intensive Surveys Conducted During 1984-1985

Location	USGS. Hydrologic Unit No.	Total Basin Stream Miles	Total Stream Miles Assessed	Purpose of Survey
Green River Basin				
Big Pitman Cr.	05110001	67	34	Municipal permit reissuance
West Fk. Drakes Cr.	05110002	122	78	PCB contamination
Mud R.	05110003	87	78	PCB contamination
Licking River Basin				
Brushy Cr.	05100102	18	18	Industrial/municipal permit reissuance
Burning Fork	05100101	8	8	Oil brine impact study
Kentucky River Basin				
Millers Creek	05100204	21	21	Oil brine impact study
South Fk. Red R.	05100204	32	32	Oil brine impact study
Salt River Basin				
Pond Creek	05140102	56	41	Industrial permit reissuance
Little Sandy River Basin				
Little Sandy R.	05090104	53	38	Oil brine impact study
Ohio River System				
Limestone Creek	05090201	6	6	Industrial permit variance request

Biological Monitoring

Kentucky's biological monitoring program currently consists of 21 stations in 10 river basins. The purpose of this monitoring effort is to develop a baseline of aquatic biological data to aid in the determination of water quality trends and to recognize instream water quality problem areas of toxic residues, bacteriological contamination and nuisance biological growths. Program emphasis is directed at evaluating biological impairments instream, determining toxic residues in fish tissue and sediments and evaluating municipal and industrial effluents for toxic conditions. The information from these monitoring efforts supports EPA's Basic Water Monitoring Program, provides information to state programs, and is used in developing the 305(b) report.

In 1984-1985, biological data from 26 sites were used to evaluate 725 miles of Kentucky streams. Biological monitoring station locations, and parameter coverage are outlined in Table 30.

Table 30
Biological Monitoring Station Locations and Sampling Coverage (1984-1985)

Station	U.S.G.S Hydrologic Unit No.	Algae	Macro-invertebrates	Fish Tissue		Sediments	
				Metals	Pesticides	Metals	Pesticides
Big Sandy River Basin							
Tug Fork	05070201	X	X		X	X	
Levisa Fork	05070203	X	X	X			
Kinniconnick Creek Basin							
Kinniconick Creek	05090201	X	X	X	X	X	X
Licking River Basin							
South Fork Licking River	05100102	X	X	X	X	X	X
North Fork Licking River	05100101	X	X	X	X	X	X
Licking River	05100101	X	X			X	X
Kentucky River Basin							
North Fork Kentucky River	05100201	X	X			X	X
Middle Fork Kentucky River	05100202	X	X			X	X
South Fork Kentucky River	05100203	X	X			X	X
Kentucky River, Lock 14	05100204	X	X			X	X
Red River	05100204	X	X	X	X	X	X
Kentucky River, Camp Nelson	05100205	X	X	X	X	X	X
Kentucky R. below Frankfort	05100205	X	X	X	X	X	X
South Elkhorn Creek	05100205	X	X			X	X
Eagle Creek	05100205	X	X	X	X	X	X
Upper Cumberland River Basin							
Cumberland River	05130101	X	X			X	X
Rockcastle River	05130102	X	X	X	X	X	X

Table 30 (continued)

Station	U.S.G.S Hydrologic Unit No.	Algae	Macro-invertebrates	Fish Tissue		Sediments	
				Metals	Pesticides	Metals	Pesticides
Green River Basin							
Nolin River	05110001	X	X	X	X	X	X
Bacon Creek	05110001	X	X	X	X	X	X
Mud River	05110003	X	X	X	X	X	X
Rough River	05110004	X		X	X		
Salt River Basin							
Beech Fork	05140103	X	X			X	X
Pond Creek	05140102	X	X			X	X
Tradewater River Basin							
Tradewater River	05140205	X	X			X	X
Tennessee River Basin							
Clarks River	06040006	X	X			X	X
Mississippi River Basin							
Bayou de Chien	08010201	X	X			X	X

PUBLIC PARTICIPATION AND EDUCATION

Public participation is integral to the wise management of Kentucky's natural resources. Therefore, Kentucky is committed to providing mechanisms that encourage the public to become aware of and involved in the protection of Kentucky's environment. Kentucky water regulations and federal regulations identify the significant role public participation plays in developing an effective, accessible, and accountable water management program.

Kentucky has three major objectives in its public participation plan for water management: public involvement, public awareness, and public education.

The public involvement objective meets the regulatory requirement of 40 CFR Part 25 by involving the public in the water management decision-making process. This includes public participation in: (1) formulating agency policies as they relate to water; (2) developing and revising plans and resulting programs; and (3) the rule-making process leading to the adoption of proposed regulations, standards and effluent limitations. The Cabinet fulfills its public involvement mandate through its interactions with the Environmental Quality Commission (an advisory group established under state law) and by conducting formal public hearings and informational meetings for the affected and general public.

The Division of Water's public awareness objective is to initiate the interest and concern of legislators, local governments, citizens groups and organizations, and the general public in the need to protect and improve the state's waters. A multi-media approach is used which addresses pertinent information concerning water resources, beneficial uses, availability, quality and special water problems.

The public education objective takes public awareness a step further by not only encouraging interest and concern for water in general, but by also addressing specific audiences and problems through training, demonstrating water awareness materials and utilizing individual response mechanisms. The audience to be addressed is the general public, regulated communities, elected and appointed government officials and school-age youth.

A program to encourage public participation and volunteer support for various water pollution control efforts was begun in 1985. Called Water Watch, the program trains local volunteers in water quality assessment and in stream, lake and wetland monitoring, protection and enhancement. Twenty-three training programs certifying 410 volunteers across the state were conducted in the latter part of 1985. Volunteers have adopted over 75 stream, lake, and wetland areas for monitoring.

CHAPTER IV

RECOMMENDATIONS

RECOMMENDATIONS

The actions listed below are recommended in order to achieve further progress in meeting the goals and objectives of the Clean Water Act.

- o Implement the elements of the toxics monitoring and control strategies that have been developed over the past two years, for both surface and groundwater resources.

- o Work with EPA in developing methods for evaluating toxic residues in tissues and sediments which are detrimental to aquatic life.

- o Develop a reference stream reach data base to determine baseline levels of water quality, aquatic ecological conditions, sediment characteristics, and habitat conditions for each of the aquatic ecoregions of the state by river basin, physiographic region, etc.

- o Implement studies to address problems identified in the current report.

  (1) Determine the source of high levels of chlordane in the Pond Creek watershed of the Salt River basin, and the apparent increase in chlordane levels in urban streams across the state.

  (2) Determine sources of increased fecal coliform levels in the Big Sandy River basin, North Fork of the Kentucky River and South Fork of the Licking River.

  (3) Evaluate the causes of persistent fish kills in Cutshin Creek within the Middle Fork of the Kentucky River watershed.

  (4) Evaluate the impact of wastewater treatment plant chlorine disinfection practices on stream quality, and reassess the disinfection policy with respect to achieving state and federal water quality objectives.

- o Continue with program activities assessing the extent of remaining wetlands in the state, rate of loss, and current condition. The development of regulatory scope and authority will be important for the implementation of an effective wetlands policy.

- o Implement the Nonpoint Source Pollution Control Program Work Plan through a multi-agency effort of cooperation and coordination. This effort will involve the U.S. Soil Conservation Service and Forest Service, the Kentucky Soil and Water Conservation Commission and Association of Conservation Districts, the Kentucky Divisions of Forestry, Conservation, Abandoned Lands and Pesticides; and the Kentucky Department of Surface Mining Reclamation and Enforcement. Seek additional sources of funding for full implementation of the plan. Use problem assessment procedures to target waterbodies most likely to benefit from intensive NPS management. Continue to use the state's adaptability, perspective and knowledge to develop site-specific solutions.

- o Continue implementation of the groundwater protection strategy in cooperation with other state and federal agencies.

- Monitor the effectiveness of permitting, compliance assurance, and enforcement activities associated with regulation of the oil production industry in Kentucky.

- Pursue implementation of revolving loan fund and other financing mechanisms in the Commonwealth to assist in the construction of POTWs. Support reallocation of federal construction grant dollars to revolving loan funds. The revolving funding concept can provide a perpetual source of low interest monies. Consider variable funding according to economic conditions such as median income in local communities. Otherwise, there will be a wide difference between sewer user charges in small communities and in large communities.

- Continue to explore the application of innovative treatment approaches such as artificial wetlands and hydrograph controlled releases in providing affordable wastewater disposal to citizens of the state.

- Evaluate the effectiveness of implementating the pretreatment program.

APPENDICES

APPENDIX A

ANNUAL SEVERITY INDEX METHODOLOGY

ANNUAL SEVERITY INDEX METHODOLOGY

The annual severity index was developed by the U.S. Environmental Protection Agency for use by the states in their reports to Congress. This method calculates a single "severity" value for each station. This single value is the sum of severity values calculated for selected parameters and criteria values (Table A-1). This group of parameters was chosen for several reasons: importance of parameter to water quality, availability of long term data, and reliability of this data. The severity value for each parameter is the percent over (or under) each measurement is from the criterion value, averaged over the time period of interest, multiplied by the percent of time that the criteria value was exceeded. Stations with low or zero severity values indicate better water quality than those with the largest values, which indicate water-quality problems.

The severity values calculated for each year from 1980 to 1985 were used in the trend analysis, while the reciprocal of the value obtained from 1984-85 was used for the hydrologic unit water quality ranking. The reciprocal was used because the lowest values would then indicate poor quality and the higher values would indicate better quality, which is compatible with the other components of the ranking.

Table A-1

Parameters and Criteria Values Used to Calculate the Annual Severity Index

Parameter	Criteria Value	Source
Dissolved Oxygen	4.0 mg/l	KWQS[1]
Temperature	30 °C	KWQS
pH	6 to 9 Units	KWQS
Total Suspended Solids	80 mg/l	NAS/NAE Blue Book[2] (moderate level of protection)
Chloride	250 mg/l	KWQS
Phosphorous	0.1 mg/l	NTAC[3]
Arsenic	50 ug/l	KWQS
Cadmium	12 ug/l	KWQS
Chromium	100 ug/l	KWQS
Copper	30 ug/l	EPA[4]
Iron	1000 ug/l	KWQS
Zinc	47 ug/l	KWQS
Fecal Coliform	200 colonies/100 ml	KWQS
Lead	8 ug/l	EPA[5]

1. Kentucky Water Quality Standards

2. National Academy of Sciences/National Academy of Engineering Water Quality Criteria, 1972.

3. National Technical Advisory Committee. Water Quality Criteria, 1968.

4. EPA. Ambient Water Quality Criteria for Copper, 1980. (Acute value used because ambient concentrations in several unpolluted waters of Kentucky are above the chronic value)

5. EPA. Ambient Water Quality Criteria for Lead, 1980. Chronic value. A hardness value of 136 mg/l (STORET mean for Kentucky waters) was used to determine the criteria level for lead and copper)

APPENDIX B

RIVER BASIN/HYDROLOGIC UNIT INFORMATION

(Flow data are not yet published by USGS
and are subject to revision)

BIG SANDY RIVER BASIN

The Big Sandy River basin lies in the rugged mountains of the Cumberland Plateau in eastern Kentucky and adjacent West Virginia and Virginia. The basin is underlain by sandstone, limestone and shale deposits of Pennsylvanian age. There are 1,213 miles of streams in the basin depicted on the USGS hydrologic unit map. The total drainage area is 4,280 square miles, 2,885 of which are in Kentucky.

The main stem of the Big Sandy River originates at the confluence of Levisa and Tug Forks at Louisa, Kentucky, and flows north 27 miles to enter the Ohio River at Catlettsburg, Kentucky. The Levisa Fork flows 156.8 miles in Kentucky with a drainage area of 1,471 square miles. Principal tributaries of the Levisa Fork include Paint Creek, Russell Fork, Beaver Creek, and Johns Creek. The Tug Fork forms the boundary between Kentucky and West Virginia for about 94 miles and has a drainage area within the state of 476 square miles. Principal tributaries to the Tug Fork within the state include Rockcastle Creek, Wolf Creek, and Big Creek.

The elevation of the Big Sandy River ranges from 2,400 feet above mean sea level (msl) at the head of Levisa Fork and 2,200 feet above msl at the head of Tug Fork to 498 feet above msl at its confluence with the Ohio River. The average main stem slope of the Big Sandy is 9.9 feet/mile, while many of its tributaries have average slopes of over 50 feet/mile.

Steep terrain and shallow soil depths account for the limited agriculture in the basin. Localized silviculture operations occur throughout the drainage. The mainstay of the economy lies in the vast coal reserves underlying the basin. Both surface and deep mining, and to a lesser extent several small petroleum fields, provide jobs for most of the residents.

Impacts

The principal impacts to the streams in the Big Sandy River basin are increased siltation and to a lesser extent increased nutrient enrichment. Acid mine drainage is limited to a few localized areas in the upper half of the drainage. The lower 12 miles of the mainstem receive at least five industrial discharges which impact this section of the stream. Oil and gas drilling have degraded the water quality in the Blaine Creek and Johnson Creek subbasins. Other impacts are road construction, domestic sewage, urban runoff and agriculture.

In portions of the basin, the biological communities have been reduced to a marginal level of existence by the effects of runoff and sedimentation from coal production, oil and gas operations and localized nutrient enrichments that have eliminated or reduced the available habitats and the reproductive capabilities.

Physicochemical Data

Six ambient monitoring stations were located in the Big Sandy River basin. The station locations and parameters measured are listed in the following table. Number of samples taken and the minimum, maximum, mean and median for each parameter measured during the 1984-1985 sampling period are given.

BIG SANDY RIVER BASIN

Parameter		Tug Fk. at Freeburn	Tug Fk. at Kermit	Levisa Fk. at Pikeville	Levisa Fk. near Paintsville	Big Sandy R. at Louisa	Blaine Crk. at Blaine		
Stream Flow (cfs)	minimum	Not Available	102	196	257	562 (1)	2.4 (1,2)		
	maximum		82200	42000	43400	16100	41		
	mean		1300	1240	2080	3050	19		
Dissolved Oxygen (mg/l)	# of samples	15	17	16	17	20	34		
	minimum	7.3	6.7	6.0	6.0	7.7	3.8		
	maximum	14.5	14.6	15.5	13.0	13.1	13.0		
	mean	9.4	8.8	9.3	8.6	10.2	7.8		
	median	8.2	8.2	8.6	7.8	9.5	7.6		
Temperature (Deg. C)	# of samples	16	19	19	19	20	2670		
	minimum	3.0	2.0	4.0	4.0	0.0	0.5		
	maximum	26.0	27.0	27.0	26.0	26.5	31.5		
	mean	13.5	15.0	16.0	16.0	13.0	13.0		
	median	13.0	15.0	17.0	16.0	12.0	13.5		
Total Hardness (mg/l as $CaCO_3$)	# of samples	17	20	20	20	Not Determined	115		
	minimum	84	90	111	102		47		
	maximum	264	285	266	258		1260		
	mean	144	161	177	173		372		
	median	149	149	164	165		276		
Specific Conductance (uS/cm)	# of samples	16	19	19	19	20	27		
	minimum	216	253	205	255	230	105		
	maximum	940	912	672	637	950	9210		
	mean	545	480	427	414	435	3750		
	median	432	385	422	392	380	2960		

(1) Flow measurements made in conjunction with water sampling.
(2) Only five flow measurements taken.

BIG SANDY RIVER BASIN

Parameter		Tug Fk. at Freeburn	Tug Fk. at Kermit	Levisa Fk. at Pikeville	Levisa Fk. near Paintsville	Big Sandy R. at Louisa	Blaine Crk. at Blaine		
pH (units)	# of samples	16	19	19	19	20	36		
	minimum	6.6	6.6	6.2	6.3	7.0	7.2		
	maximum	8.5	7.9	7.5	7.4	8.4	5.9		
	mean								
	median	7.6	7.3	7.0	7.0	7.8	6.5		
Alkalinity (mg/l as $CaCO_3$)	# of samples	17	20	20	20	5	98		
	minimum	56	44	7.8	35	84	1.0		
	maximum	263	219	92	101	170	189		
	mean	149	114	65	69	114	11.8		
	median	124	114	62	67	94	9.0		
Chloride (mg/l)	# of samples	17	20	20	20	11	97		
	minimum	1.2	1.8	6.2	7.5	4.8	2.0		
	maximum	35	90	29	28	29	5478		
	mean	11	25	14	16	14	905		
	median	8.9	18	12	16	12	556		
Sulfate (mg/l)	# of samples	16	20	20	19	16			
	minimum	60	68	72	80	67			
	maximum	176	204	200	171	190			
	mean	114	123	133	125	106	Not		
	median	105	118	124	124	94	Sampled		
Suspended Solids (mg/l)	# of samples	17	20	20	20	16	98		
	minimum	1.0	1.0	2.0	8.0	8.0	10		
	maximum	1200	942	678	782	570	1098		
	mean	91	112	71	114	147	181		
	median	14	16	25	30	74	72		

BIG SANDY RIVER BASIN

Parameter		Tug Fk. at Freeburn	Tug Fk. at Kermit	Levisa Fk. at Pikeville	Levisa Fk. near Paintsville	Big Sandy R. at Louisa	Blaine Crk. at Blaine		
Fecal Coliform (colonies per 100/mls)	# of samples	12	12	12	12	9	Not Sampled		
	minimum	20	40	50	40	480			
	maximum	2600	16000	5600	17000	8900			
	mean	851	3860	1580	3130	2660			
	median	400	950	590	770	1290			
Total Iron (ug/l)	# of samples	14	17	17	17	11	119		
	minimum	80	150	130	30	480	300		
	maximum	17900	9600	3710	12250	12000	48200		
	mean	1530	1975	978	2185	4023	3000		
	median	250	630	690	800	3800	1100		
Total Phosphorous (mg/l)	# of samples	17	20	20	20	12	125		
	minimum	.01	.02	.01	.02	.01	.01		
	maximum	.48	.28	.28	.36	.09	.27		
	mean	.08	.08	.05	.08	.04	.03		
	median	.05	.05	.03	.05	.04	.01		
Total Zinc (ug/l)	# of samples	14	17	17	17	Not Sampled	111		
	minimum	1.0	6.0	2.0	1.0		50		
	maximum	106	71.0	45.0	61.0		15320		
	mean	24.5	25.8	16.0	24.0		546		
	median	14.0	21.0	11.0	17.0		50		
Total Lead (ug/l)	# of samples	16	19	19	19	Not Sampled	Not Sampled		
	minimum	1.0	1.0	1.0	1.0				
	maximum	23.0	11.0	4.0	14.0				
	mean	3.2	3.0	1.8	3.3				
	median	1.0	2.0	1.0	1.0				

BIG SANDY RIVER BASIN

Parameter		Tug Fk. at Freeburn	Tug Fk. at Kermit	Levisa Fk. at Pikeville	Levisa Fk. near Paintsville	Big Sandy R. at Louisa	Blaine Crk. at Blaine		
Total Manganese (ug/l)	# of samples	14	17	17	17	Not Sampled	119		
	minimum	20	46	60	70		190		
	maximum	850	480	600	660		3130		
	mean	98	132	158	203		892		
	median	30	90	120	140		690		
Total Ammonia (mg/l as N)	# of samples	17	19	20	20	Not Sampled	114		
	minimum	.02	.05	.04	.05		.10		
	maximum	.11	.09	.12	.17		4.5		
	mean	.05	.05	.06	.08		.82		
	median	.05	.05	.05	.06		.50		
Nitrite + Nitrate-Nitrogen (mg/l as N)	# of samples	17	19	20	20	10	Not Utilized		
	minimum	.01	.12	.06	.14	.10			
	maximum	.58	.83	.58	.68	.62			
	mean	.23	.45	.30	.44	.42			
	median	.12	.49	.25	.42	.46			

Hydrologic Unit 05070201 - Tug Fork

A total of 288 miles of streams draining 1,559 square miles (476 square miles in Kentucky) comprise this hydrologic unit. The major urban center (in Kentucky) is Inez (pop. 469), with Williamson (pop 5,219) the major urban center in West Virginia. Two water quality monitoring stations are located in this hydrologic unit: Tug Fork at Kermit and Tug Fork at Freeburn.

Tug Fork at Kermit

Biological Assessment

Phytoplankton standing crop and chlorophyll-a were generally below average with regard to other biological monitoring stations, although chlorophyll-a was above average in 1984. The plankton community was dominated by pennate diatoms and green algal flagellates; Synedra ulna and Melosira varians were abundant. Diversity and equitability values were typical for streams in the biological monitoring program. Periphyton chlorophyll-a was consistently below average, while ash-free dry weight was above average in 1985 and below average in 1984. Diatom diversity and equitability values were typical for Kentucky streams.

The macroinvertebrate community at this location was not adequately represented by taxa richness or functional groupings. It is readily apparent that the community structure has been altered as a result of siltation which has eliminated most of the available habitats for invertebrates. The organisms collected by qualitative methods were either associated with a specific tolerance to the effects of silt, such as Caenis sp., a mayfly, or those that can exist in areas of the stream that are kept relatively free of silt by the flushing action of stream flow. The caddisflies Hydropsyche dicantha and Cheumatopsyche sp. frequent those areas in marginal numbers. The reduced taxa richness and community diversity indicate that habitats have been reduced by sedimentation. Coal mining activities appear to contribute most of the sediments since agricultural practices are limited in the region.

Because of the low primary production and reduced number of invertebrate taxa, Tug Fork is partially impaired at this site, primarily as a result of coal mining.

Hydrologic Unit 05070203 - Levisa Fork

A total of 572 miles of streams draining 1,228 square miles comprise this hydrologic unit. Major urban centers include Pikeville (pop. 4,756), Prestonsburg (pop. 4,011), and Paintsville (pop. 3,815). Recreation centers include Dewey Lake, Jenny Wiley State Park, and Paintsville. Three water quality monitoring stations are located in this hydrologic unit: Levisa Fork at Pikeville; Levisa Fork at Paintsville; and Paint Creek near Staffordsville.

Levisa Fork at Paintsville

Biological Assessment

Phytoplankton standing crop and chlorophyll-a were below average in comparison with other biological monitoring stations, while diversity and equitability were average. The plankton community was dominated by centric diatoms, notably Cyclotella pseudostelligera and Melosira varians. Diversity and equitability values were typical for Kentucky streams. Periphyton chlorophyll-a was average, while ash-free dry weight was below average in 1983 and above average in 1984. Diatom diversity, equitability, and taxa richness were below average.

No invertebrate collections were made at this site in 1984 or 1985.

The stream appears to be partially impaired as a result of coal mining activities and point and nonpoint source nutrient enrichment.

Hydrologic Unit 05070204 - Big Sandy Mainstem - Blaine Creek

A total of 189 miles of streams draining 337 square miles comprise this hydrologic unit. Major urban centers include Louisa (pop. 1,832) and Blaine (pop. 382). Three water quality monitoring stations are located in this hydrologic unit: two on the Big Sandy River at Louisa, and one on Blaine Creek at Blaine. The Blaine Creek subbasin has experienced severe impacts from oil and gas production. COE data, collected for the Environmental Impact Statement on Yatesville Reservoir which would impound Blaine Creek, documented existing brine pollution in the watershed. Fifty-three miles of streams in the subbasin do not support their designated uses.

LITTLE SANDY RIVER BASIN

The Little Sandy River basin is located in the northeastern portion of the state, lying within the Unglaciated Appalachian Plateau. The area is underlain with Pennsylvanian age sandstone, limestone and shale deposits. The river arises near Sandy Hook, Kentucky, and flows 87 miles to its confluence with the Ohio River at Greenup, Kentucky. Principal tributaries to the Little Sandy include the Little Fork, East Fork and Big Sinking Creek. The major impoundment of this area is Grayson Lake near Grayson, Kentucky. There are 360 miles of streams in the basin depicted on the USGS hydrologic unit map, draining an area of 721 square miles.

The topography in the headwater section is generally rugged, with no flat or undulating land present. Closer to the mouth, the terrain becomes less rugged with more bottomland available for agricultural practices. Elevations range from 1,300 feet above mean sea level (msl) in the headwater region near Sandy Hook to 479 feet above msl at the river's confluence with the Ohio. Average slope for the Little Sandy is 8.3 feet/mile.

Impacts

The major impacts in the Little Sandy River basin are coal mining and oil and gas production, which contribute increased sediment loads and brines to the receiving streams. Domestic sewage and agricultural runoff are minor impacts. Siltation resulting from coal mining operations has adversely affected the aquatic biota in the Little Sandy basin. No fish kills were reported in 1984 or 1985. There are no water quality monitoring stations located in this basin.

TYGARTS CREEK BASIN

The Tygarts Creek basin is located in the northeastern portion of the state, lying within the Unglaciated Allegheny Plateau region of the Appalachian Plateaus Province. The bedrock in the headwaters is Pennsylvanian sandstone, limestone and shale but as the stream flows northward it cuts into Mississippian limestone deposits. Tygarts Creek originates in southwestern Carter County, Kentucky and flows in a northeasterly direction for 89 miles, where it empties into the Ohio River at South Shore, Kentucky. The principal tributary is Buffalo Creek with a drainage area of 54 square miles. The entire basin has a drainage area of 339 square miles. There are 194 stream miles in the basin depicted on the USGS hydrologic unit map.

The topography for the watershed varies from steep hillsides and narrow valleys in the headwaters to broad, wide valleys near the mouth. Elevations range from 485 feet above mean sea level (msl) at its confluence with the Ohio River to 1300 feet above msl at the source. The average slope of Tygarts Creek is 6.9 feet/mile. The average stream channel width ranges from about 30 feet in the headwater reaches to over 200 feet near the mouth.

Impacts

Municipal sewage from the city of Olive Hill is the main impact on Tygarts Creek, with some minor impacts from mining and oil drilling operations. A segment of Tygarts Creek, which receives the discharge from the Olive Hill sewage treatment plant was assessed as partially supporting designated uses.

Tygarts Creek supports a diverse assemblage of aquatic organisms throughout the drainage. One fish kill occurred in 1985. There are no water quality monitoring stations located in this basin.

LICKING RIVER BASIN

The Licking River basin is located within the eastern portion of Kentucky in two major physiographic provinces, the Allegheny Plateaus and Interior Low Plateaus. It rises in southeastern Kentucky and flows northwesterly to the confluence with the Ohio River in the Covington-Newport, Kentucky area at an elevation of 420 feet above mean sea level (msl). There are 2,034 miles of streams in the basin depicted on the USGS hydrologic unit map. The total drainage area is 3,700 square miles. Principal tributaries are the North Fork and South Fork of the Licking. The major impoundment of this area is Cave Run Lake near Farmers, Kentucky.

The topography of the headwaters area is characteristic of the unglaciated region of the Appalachian Plateaus. This area is dissected into narrow ridges and steep sided valleys by a network of streams. The underlying rocks are Pennsylvanian Age sandstone, limestone and shale. Maximum elevation in the headwaters is 1,000 feet above msl. Average slope for the Licking River mainstem is 2.26 feet/mile.

Upon leaving the Appalachian Plateaus, the Licking flows through sections of the Interior Low Plateaus known as the Knobs and the Blue Grass. The Knobs are characterized by conical and flat-topped hills with broad valleys. The Blue Grass topography ranges from an area of gently rolling hills adjacent to the Knobs, to an area highly dissected by a network of streams which have formed V-shaped valleys and narrow ridges. Mississippian and Ordovician limestones underlie most of this section.

Impacts

In the upper portion of the drainage, coal mining and oil and gas drilling operations are the major impacts. These operations contribute increased silt loads and brines to the streams. In the lower river, agricultural runoff and domestic sewage increase nutrient levels. The last few miles drain a heavily industrialized area.

Physicochemical Data

Five ambient monitoring stations were located in the Licking River Basin. The station locations and parameters measured are listed in the following table. Number of samples taken and the minimum, maximum, mean and median for each parameter measured during the 1984-1985 sampling period are given.

LICKING RIVER BASIN

Parameter		Licking R. at Sherburne	N. Fk. Licking R. at Lewisburg	S. Fk. Licking R. at Cynthiana	Licking R. at Butler	Licking R. at Covington			
Stream Flow (cfs)	minimum	40 (1)	0.00	2.0	70	200 (2)			
	maximum	4440	4680	17900	39200	31100			
	mean	940	140	662	3640	4370			
Dissolved Oxygen (mg/l)	# of samples	18	23	18	12	15			
	minimum	6.2	6.8	5.7	4.7	5.0			
	maximum	13.8	13.8	15.0	13.4	11.7			
	mean	9.2	10.5	10.0	9.9	8.4			
	median	8.2	10.7	10.4	10.6	8.7			
Temperature (Deg. C)	# of samples	18	23	18	12.0	15			
	minimum	2.5	1.0	0.0	.50	0.0			
	maximum	27.0	26.0	28.5	24.5	25.0			
	mean	16.0	13.5	18.0	13.0	13.5			
	median	17.0	9.5	19.5	14.0	12.0			
Total Hardness (mg/l as $CaCO_3$)	# of samples	18	23	18	Not Determined	14			
	minimum	51	110	138		112			
	maximum	214	314	412		238			
	mean	88	179	210		152			
	median	75	176	194		144			
Specific Conductance (uS/cm)	# of samples	18	23	18	12	15			
	minimum	140	223	320	82	211			
	maximum	263	377	558	900	600			
	mean	200	296	414	387	370			
	median	194	294	409	280	360			

(1) Flow data from Licking River at Farmers, 1984 water-year.
(2) Flow measurements made in conjunction with water sampling.

LICKING RIVER BASIN

Parameter		Licking R. at Sherburne	N. Fk. Licking R. at Lewisburg	S. Fk. Licking R. at Cynthiana	Licking R. at Butler	Licking R. at Covington			
pH (units)	# of samples	18	23	18	12	15			
	minimum	6.5	6.7	6.1	6.6	7.2			
	maximum	9.6	7.8	8.7	8.3	8.2			
	mean								
	median	7.7	7.2	7.9	7.8	7.6			
Alkalinity (mg/l as $CaCO_3$)	# of samples	17	22	17	7				
	minimum	25	40	101	66				
	maximum	84	245	169	304				
	mean	45	126	145	172	Not Determined			
	median	45	126	148	116				
Chloride (mg/l)	# of samples	18	23	18	11	2			
	minimum	5.7	4.9	7.2	1.4	15			
	maximum	26	11	68	74	22			
	mean	11	7.3	21	24	18			
	median	9.6	6.7	17	11	15			
Sulfate (mg/l)	# of samples	18	23	18	11				
	minimum	19	19	21	25				
	maximum	34	40	56	59				
	mean	27	33	32	38	Not Determined			
	median	26	32	30	33				
Suspended Solids (mg/l)	# of samples	17	22	17	6	12			
	minimum	9.0	3.0	5.0	9.0	10			
	maximum	284	438	263	110	425			
	mean	41	49	31	49	107			
	median	19	13	13	43	47			

LICKING RIVER BASIN

Parameter		Licking R. at Sherburne	N. Fk. Licking R. at Lewisburg	S. Fk. Licking R. at Cynthiana	Licking R. at Butler	Licking R. at Covington			
Fecal Coliform (colonies per 100/mls)	# of samples	12	15	12	10	12			
	minimum	12	40	10.0	11	1.0			
	maximum	280	1800	4000	2000	8500			
	mean	94	433	900	557	1870			
	median	46	320	100	172	200			
Total Iron (ug/l)	# of samples	15	20	15		15			
	minimum	200	50	80		420			
	maximum	7090	6050	4790		16000			
	mean	1030	619	652	Not	3630			
	median	500	210	210	Sampled	1800			
Total Phosphorous (mg/l)	# of samples	18	.23	18	12	15			
	minimum	.02	.03	.14	.03	.04			
	maximum	.77	.94	.77	.67	.78			
	mean	.08	.14	.31	.19	.19			
	median	.03	.07	.23	.11	.14			
Total Zinc (ug/l)	# of samples	15	20	15		15			
	minimum	1.0	3.0	1.0		6.0			
	maximum	30.0	32.0	42		1000			
	mean	11.7	14.0	12.5	Not	86			
	median	10.0	12.0	7.0	Sampled	18.0			
Total Lead (ug/l)	# of samples	17	22	17		15			
	minimum	1.0	1.0	1.0		10.0			
	maximum	15.0	10.0	13.0		30.0			
	mean	3.4	2.0	3.8	Not	15.3			
	median	2.0	1.0	3.0	Sampled	14.0			

LICKING RIVER BASIN

Parameter		Licking R. at Sherburne	N. Fk. Licking R. at Lewisburg	S. Fk. Licking R. at Cynthiana	Licking R. at Butler	Licking R. at Covington			
Total Manganese (ug/l)	# of samples	15	20	15	Not Sampled	11			
	minimum	50	20	30		48			
	maximum	410	980	450		620			
	mean	120	126	134		218			
	median	100	60	100		170			
Total Ammonia (mg/l as N)	# of samples	18	23	18	Not Sampled	15			
	minimum	.05	.05	.05		.04			
	maximum	.07	.28	.98		.23			
	mean	.05	.07	.14		.13			
	median	.05	.05	.05		.12			
Nitrite + Nitrate-Nitrogen (mg/l as N)	# of samples	18	23	18	12	14			
	minimum	.02	.02	.01	.10	.01			
	maximum	1.65	4.5	5.0	4.4	2.9			
	mean	.62	1.7	1.8	1.85	.92			
	median	.47	1.8	.70	.82	.41			

Hydrologic Unit 051001001 - Licking River

A total of 1,439 miles of streams draining 2,780 square miles comprise this hydrologic unit. Major urban centers include Covington (pop. 49,563), Morehead (pop. 7,789), West Liberty (pop. 1,381) and Salyersville (pop. 1,352). Recreation centers include Cave Run Lake, Blue Lick State Park, Kincaid Lake, and Lake Carnico. Four water quality monitoring stations are located in this hydrologic unit: Licking River at Sherburne, North Fork Licking River near Lewisburg, Licking River at Butler, and Licking River at Covington.

North Fork Licking River at Hwy. 419 Bridge

Biological Assessment

Phytoplankton standing crop and chlorophyll-a were below average compared with other biological monitoring stations. The plankton community was characterized by green algal flagellates, centric and pennate diatoms, and blue-green algae. Diversity and equitability were above average. Periphyton chlorophyll-a and ash-free dry weight values were also above average in 1983. Periphytometers set in 1985 were lost as a result of high water conditions.

The invertebrate collections from this location were diverse in species composition and feeding types. The ephemeropterans, or mayflies, make up most of the taxa richness and the scraper functional group. The abundance of the scraper organisms throughout the community indicates the absence of adverse agricultural influences. Two species of unionid mussels occur in this portion of the stream, *Lampsilis r. siliquoidea* and *Alasmidonta viridis*. Both species are associated with headwater habitats. *A. viridis* has been observed most often and appears to be more abundant within the station vicinity.

This station is considered relatively unimpaired by the agricultural activities occurring in the basin.

Licking River at Sherburne

Biological Assessment

Phytoplankton standing crop and chlorophyll-a were below average compared with other biological monitoring stations. The plankton community was characterized by green algal flagellates, *Fragillaria crotonensis*, centric diatoms, and benthic pennate diatoms. Diversity and equitability were above average, probably a result of the numerous dislodged benthic diatom species present in the plankton. Periphyton chlorophyll-a and ash-free dry weight values were variable. Chlorophyll-a was below average in 1983, average in 1984, and above average in 1985. In contrast, ash-free dry weight values were below average in 1983 and 1985, but above average in 1984. Diatom diversity and equitability in 1985 were below average because *Cocconeis placentula* var. *euglypta*, a typical stream diatom, was extremely abundant. Halophilic taxa were present in the community.

The invertebrate collection at this location represented a community with good taxa richness and functional components. This mainstem site has an abundance of habitat types for macroinvertebrates. Most of the habitat partitioning has been expressed among the collector organisms such as *Caenis*, *Centropitum*, *Tricorythodes* and *Heptagenia*. Most of those organisms are also resistant to the effects of siltation.

The mussel collections have yielded four species living in the wadable areas of the stream. Relic shells indicate the possibility of twelve other species occurring in this vicinity of the stream. Nutrient enrichment and siltation are evident, but do not appear to alter the habitats or organisms at this location.

Biological trends based on water quality were difficult to discern because of considerable variability among parameters. The stream appears to be unimpaired at the sampling location.

Hydrologic Unit 05100102 - South Fork Licking River

A total of 595 miles of streams draining 927 square miles comprise this hydrologic unit. Major urban centers include Paris (pop. 7,935), Cynthiana (pop. 5,881), Mount Sterling (pop. 5,820) and Falmouth (pop. 2,482). One water quality monitoring station is located in this hydrologic unit: South Fork Licking River at Cynthiana.

South Fork Licking River at Cynthiana

Biological Assessment

Phytoplankton standing crop and chlorophyll-a were above average compared with other biological monitoring stations. The plankton community was dominated by centric diatoms, notably Skeletonema potamos and green algal flagellates. Diversity and equitability were below average because of the dominance of these taxa, which are characteristic of nutrient enriched conditions. Periphyton chlorophyll-a was above average while ash-free dry weight values were typical for monitored streams. Diatom diversity, equitability and taxa richness were average. Diatom communities on artifical substrates were characterized by typical stream taxa as well as halophilic species.

The invertebrate collections from this location were poorly represented by community composition and numbers of individuals because most of the natural invertebrate habitats have been removed. More than half of the nine species collected were dipterans, or midge fly larvae that exist in the mud bottom of this impounded stream that is used as a drinking water supply for Cynthiana. It appears that habitat restrictions affect the invertebrate community more than water quality conditions.

Nutrient and organic enrichment combined with the presence of eutrophic algal taxa suggest that this site is partially impaired. The occurrence of taste and odor diatoms may occassionally present water treatment problems for the Cynthiana WTP.

KENTUCKY RIVER BASIN

The Kentucky River basin drains 7,033 square miles in the Cumberland Plateau and Blue Grass sections. The mainstem of the Kentucky River is formed by the confluence of the North Fork, Middle Fork and South Fork near Beattyville, Kentucky. Flowing northwesterly for 255 miles, the river joins the Ohio River at Carrollton, Kentucky. A series of 14 U. S. Army Corps of Engineers Locks and Dams impound the river from the mouth to Beattyville. There are 3,450.2 miles of streams in the basin depicted on the USGS hydrologic unit map. The total drainage area is 6,966 square miles. Principal tributaries to the Kentucky River are Red River, Dix River, and Elkhorn and Eagle creeks. Major impoundments in this basin are Herrington, Buckhorn and Carr Fork lakes.

Watershed topography varies considerably. The upper third of the drainage lies on Pennsylvanian sandstones, limestones and shales of the Cumberland Plateau. This area is characterized by deeply dissected valleys, narrow ridge tops, and steep slopes. Average slope of the tributaries in that section ranges from 3 feet/mile to 7.2 feet/mile with the main stem averaging 0.9 feet/mile. The highest elevation in the basin is Pine Mountain, 2,273 feet above msl.

Adjacent to the mountainous area is the Interior Low Plateaus in which the Blue Grass and Knobs sections lie. These plateaus are underlain by limestones of the Ordovician, Devonian and Silurian periods. The Knobs form a narrow crescent separating the Blue Grass from the Cumberland Plateau and are characterized by hills with steep slopes. Topography of the Blue Grass varies from gently rolling terrain, to areas highly dissected by dendritic drainage systems with V-shaped valleys and narrow ridges, to broad undulating peneplains marked by karst areas. Average slope of the tributaries in the Blue Grass ranges from 3 feet/mile to 32 feet/mile. The main stem of the Kentucky averages 0.7 feet/mile. Maximum elevation in the Blue Grass approaches 1,000 feet above msl.

Impacts

The main impacts to the Kentucky River drainage are due to mining, oil and gas production and agricultural practices. Demand for fossil fuels in the past decade has greatly increased surface mining within the basin, causing a further increase in siltation of downstream areas. Cultivation of the narrow floodplains in the highlands and intensive farming throughout the Knobs and Blue Grass sections contribute to nutrient and sediment loading of the drainage.

Numerous municipal wastewater treatment plant discharges affect the water quality of the streams in the basin, primarily by nutrient enrichment and oxygen depletion.

Improper oil and gas drilling operations have become a serious water quality problem in portions of the drainage. Several streams have been extensively impacted by these operations, resulting in localized elimination of the aquatic fauna. Perturbations are so severe that they have adversely affected public water supplies as far downstream on the Kentucky River as Lexington.

The aquatic biota is generally good throughout most of the basin except in some tributaries that have been impacted by mining or oil drilling. Some Blue Grass streams have been impacted by municipal wastewater treatment plant effluents. There were five fish kills reported in 1984 and nine in 1985.

Physicochemical Data

Eleven ambient monitoring stations were located in the Kentucky River basin. The station locations and parameters measured are listed in the following table. Number of samples taken and the minimum, maximum, mean and median for each parameter measured during the 1984-1985 sampling period are given.

KENTUCKY RIVER BASIN

Parameter		N. Fk. KY R. at Jackson	Middle Fk. KY R. at Tallega	S. Fk. KY R. at Booneville	KY R. at Heidelberg	Red R. at Hazel Green	KY R. at Camp Nelson	KY R. at Frankfort	KY R. below Frankfort
Stream Flow (cfs)	minimum	42	24	10	104	0.00	127	153	Same as at Frankfort
	maximum	53500	6390	51600	94600	4330	79600	91700	
	mean	1270	634	985	3370	79	3160	6380	
Dissolved Oxygen (mg/l)	# of samples	18	18	18	23	23	22	23	21
	minimum	6.5	6.2	5.1	6.0	6.8	7.3	7.1	6.5
	maximum	13.5	13.5	13.5	13.6	13.7	14.4	14.4	14.7
	mean	9.1	8.9	8.6	10.0	10.3	10.6	10.2	9.9
	median	8.0	7.5	7.9	10.2	10.4	10.7	10.5	10.4
Temperature (Deg. C)	# of samples	18	18	18	23	23	23	23	23
	minimum	.10	.5	.5	.5	1.0	1.5	2.0	1.5
	maximum	26.5	30.0	28.0	27.0	25.0	29.0	27.0	27.0
	mean	17.0	16.0	17.5	14.5	13.5	15.5	15.0	15.0
	median	18.5	16.8	18.5	14.0	10.0	15.0	14.0	12.5
Total Hardness (mg/l as $CaCO_3$)	# of samples	18	18	18	23	22	23	23	23
	minimum	122	52	56	69	20	90	100	71
	maximum	552	201	164	355	84	273	339	230
	mean	257	100	101	168	48	151	156	148
	median	229	88	85	132	48	146	153	144
Specific Conductance (uS/cm)	# of samples	17	17	18	23	23	23	23	23
	minimum	273	138	145	165	55	222	228	265
	maximum	761	313	644	1039	185	995	544	636
	mean	510	226	267	423	111	411	360	371
	median	494	214	231	388	117	375	348	361

KENTUCKY RIVER BASIN

Parameter		S. Elkhorn Crk. near Midway	KY R. at Lockport	Eagle Crk. at Glencoe					
Stream Flow (cfs)	minimum maximum mean	15 2630 151	194 93400 7410	Not Available					
Dissolved Oxygen (mg/l)	# of samples minimum maximum mean median	18 2.4 12.0 6.3 5.7	17 4.5 13.1 8.6 8.8	23 6.5 15.0 10.3 11.0					
Temperature (Deg. C)	# of samples minimum maximum mean median	18 2.5 25.0 17.0 18.0	17 5.0 26.5 17.0 17.5	23 1.0 29.5 14.0 12.0					
Total Hardness (mg/l as $CaCO_3$)	# of samples minimum maximum mean median	18 187 425 242 221	Not Determined	23 124 452 195 168					
Specific Conductance (us/cm)	# of samples minimum maximum mean median	18 464 912 662 590	17 145 530 355 530	23 228 479 346 333					

KENTUCKY RIVER BASIN

Parameter		N. Fk. KY R. at Jackson	Middle Fk. KY R. at Tallega	S. Fk. KY R. at Booneville	KY R. at Heidelberg	Red R. at Hazel Green	KY R. at Camp Nelson	KY R. at Frankfort	KY R. below Frankfort
pH (units)	# of samples	17	17	17	23	22	22	23	21
	minimum	6.8	6.4	6.4	6.4	6.6	6.6	6.5	5.8
	maximum	8.5	8.0	8.0	8.1	7.4	8.6	8.6	8.5
	mean								
	median	7.6	7.2	7.1	7.3	7.1	7.4	7.3	7.4
Alkalinity (mg/l as $CaCO_3$)	# of samples	17	17	17	22	21	22	22	22
	minimum	35	16	15	23	8.0	29	44	54
	maximum	109	11	63	98	70	108	106	123
	mean	77	39	35	51	31	67	77	81
	median	78	37	35	44	26	67	77	79
Chloride (mg/l)	# of samples	18	18	18	23	22	23	23	23
	minimum	4.7	2.6	4.4	4.6	1.4	6.4	7.2	6.9
	maximum	17	11	111	211	8.9	175	72	87
	mean	8.5	5.5	17	45	5.2	36	24	23
	median	7.6	5.2	8.8	28	4.8	18	20	19
Sulfate (mg/l)	# of samples	18	17	18	23	23	23	23	23
	minimum	96	35	43	47	10	39	30	30
	maximum	247	79	108	155	27	106	94	95
	mean	161	57	62	91	16	67	53	53
	median	146	55	58	86	15	65	47	47
Suspended Solids (mg/l)	# of samples	17	17	17	22	21	22	22	22
	minimum	3.1	5.0	5.0	5.0	4.0	1.0	1.0	3.0
	maximum	173	70	57	540	591	246	291	227
	mean	36	24	18	55	72	40	39	38
	median	24	14	10	12	19	14	15	16

KENTUCKY RIVER BASIN

Parameter		S. Elkhorn Crk. near Midway	KY R. at Lockport	Eagle Crk. at Glencoe					
pH (units)	# of samples	18	17	23					
	minimum	6.4	7.1	6.6					
	maximum	7.9	8.3	7.6					
	mean	-							
	median	7.1	7.7	7.0					
Alkalinity (mg/l as $CaCO_3$)	# of samples	17	9	22					
	minimum	120	92	80					
	maximum	209	136	200					
	mean	164	110	137					
	median	171	106	126					
Chloride (mg/l)	# of samples	18	15	23					
	minimum	21	3.4	2.8					
	maximum	101	48	27					
	mean	51	21	7.3					
	median	41	21	6.4					
Sulfate (mg/l)	# of samples	18	15	23					
	minimum	28	23	20					
	maximum	107	96	78					
	mean	59	57	42					
	median	52	55	40					
Suspended Solids (mg/l)	# of samples	17	14	22					
	minimum	2.0	3.0	4.0					
	maximum	18.0	517	786					
	mean	9.6	67	69					
	median	9.0	26	15					

KENTUCKY RIVER BASIN

Parameter		N. Fk. KY R. at Jackson	Middle Fk. KY R. at Tallega	S. Fk. KY R. at Booneville	KY R. at Heidelberg	Red R. at Hazel Green	KY R. at Camp Nelson	KY R. at Frankfort	KY R. below Frankfort
Fecal Coliform (colonies per 100/mls)	# of samples	12	12	19	16	15	18	18	18
	minimum	90	24	6.0	2.0	20	2.0	6.0	2.0
	maximum	10000	760	1300	1500	1410	520	800	2000
	mean	2425	155	308	520	524	108	111	188
	median	760	76	125	320	470	18	28	40
Total Iron (ug/l)	# of samples	15	15	14	20	20	20	20	20
	minimum	240	240	190	100	220	10	40	40
	maximum	4180	1730	1590	4370	4870	3700	2630	2840
	mean	1010	766	517	786	1053	704	585	588
	median	720	690	345	520	710	420	280	310
Total Phosphorous (mg/l)	# of samples	18	18	17	23	23	23	23	23
	minimum	.05	.01	.01	.01	.01	.02	.03	.05
	maximum	.56	.07	.07	.36	.40	.30	.80	.67
	mean	.29	.02	.02	.05	.06	.08	.12	.14
	median	.31	.02	.02	.02	.03	.06	.08	.11
Total Zinc (ug/l)	# of samples	15	15	11	20	20	20	20	20
	minimum	5.0	1.0	1.0	1.0	1.0	1.0	2.0	1.0
	maximum	52.0	62.0	40.0	65.0	36.0	63.0	93.0	56.0
	mean	18.7	13.5	9.9	15.7	13.1	18.4	21.0	17.7
	median	15.0	9.0	7.0	12.0	11.0	13.0	13.0	13.0
Total Lead) (ug/l	# of samples	17	17	16	22	22	22	22	22
	minimum	1.0	1.0	2.0	1.0	1.0	1.0	1.0	1.0
	maximum	9.0	8.0	18.0	19.0	13.0	14.0	21.0	52.0
	mean	4.4	3.4	6.7	4.9	2.8	6.4	5.0	5.4
	median	4.0	3.0	6.0	4.0	1.0	6.0	4.0	2.0

KENTUCKY RIVER BASIN

Parameter		S. Elkhorn Crk. near Midway	KY R.at Lockport	Eagle Crk. at Glencoe					
Fecal Coliform (colonies per 100/mls)	# of samples	12	13	16					
	minimum	22	6.0	5.0					
	maximum	16000	780	1500					
	mean	1610	158	305					
	median	170	62	70					
Total Iron (ug/l)	# of samples	14	Not Sampled	20					
	minimum	90		10					
	maximum	530		4620					
	mean	313		923					
	median	320		370					
Total Phosphorous (mg/l)	# of samples	18	16	23					
	minimum	.69	.06	.03					
	maximum	4.2	.54	.78					
	mean	1.8	.15	.14					
	median	1.6	.11	.09					
Total Zinc (ug/l)	# of samples	15	Not Sampled	20					
	minimum	1.0		1.0					
	maximum	158		30					
	mean	24.0		13.5					
	median	15.0		11.0					
Total Lead (ug/l)	# of samples	17	Not Sampled	22					
	minimum	1.0		1.0					
	maximum	7.0		6.0					
	mean	2.6		2.1					
	median	1.0		1.0					

KENTUCKY RIVER BASIN

Parameter		N. Fk. KY R. at Jackson	Middle Fk. KY R. at Tallega	S. Fk. KY R. at Booneville	KY R. at Heidelberg	Red R. at Hazel Green	KY R. at Camp Nelson	KY R. at Frankfort	KY R. below Frankfort
Total Manganese (ug/l)	# of samples	15	15	14	20	20	20	20	20
	minimum	40	60	60	40	80	20	20	20
	maximum	240	170	200	640	540	270	620	450
	mean	111	109	127	188	190	89	92	89
	median	100	120	120	140	160	60	50	60
Total Ammonia (mg/l as N)	# of samples	18	18	17	22	23	23	23	23
	minimum	.04	.05	.05	.05	.05	.05	.05	.05
	maximum	.08	.06	.07	.18	.15	.21	.54	.15
	mean	.05	.05	.05	.06	.06	.07	.08	.06
	median	.05	.05	.05	.05	.05	.05	.05	.05
Nitrite + Nitrate-Nitrogen (mg/l as N)	# of samples	18	18	17	23	23	23	22	23
	minimum	.20	.06	.04	.08	.01	.07	.09	.33
	maximum	1.02	.48	.59	.63	.81	2.0	3.1	3.6
	mean	.51	.25	.31	.41	.41	.69	1.01	1.10
	median	.50	.24	.27	.44	.46	.54	.94	.92

KENTUCKY RIVER BASIN

Parameter		S. Elkhorn Crk. near Midway	KY R. at Lockport	Eagle Crk. at Glencoe					
Total Manganese (ug/l)	# of samples	15	Not Sampled	20					
	minimum	90		10					
	maximum	1210		480					
	mean	262		93					
	median	190		60					
Total Ammonia (mg/l as N)	# of samples	18	Not Sampled	23					
	minimum	1.12		.05					
	maximum	15.8		.50					
	mean	6.11		.08					
	median	3.84		.05					
Nitrite + Nitrate-Nitrogen (mg/l as N)	# of samples	18	14	23					
	minimum	.40	.24	.01					
	maximum	5.56	2.90	1.56					
	mean	3.67	1.12	.64					
	median	3.80	.93	.63					

Hydrologic Unit 05100201 - North Fork Kentucky River

A total of 622 miles of streams draining 1,319 square miles comprise this hydrologic unit. Major urban centers include Jackson (pop. 2,651), Hazard (pop. 5,371) and Whiteburg (pop. 1,525), and Hindman (pop. 876). Recreation centers include Carr Fork Lake, Fishpond Lake, and Pan Bowl Lake. One water quality monitoring station is located in this hydrologic unit: North Fork Kentucky River at Jackson.

North Fork Kentucky River at Jackson

Biological Assessment

Phytoplankton standing crop and chlorophyll-a were below average compared with other biological monitoring stations. The plankton community was dominated by benthic pennate diatoms, including facultative nitrogen heterotrophs, epipelic and halophilic species. Diversity and equitability values were above average. Periphyton chlorophyll-a and ash-free dry weight were above average. Diatom diversity, equitability, and taxa richness were below average. Diatom communities on artifical substrates were dominated by Cocconeis placentula var. euglypta and Achnanthes linearis.

The invertebrate collections from this location were diverse in taxa richness and species composition. The community structure was oriented toward the collector and filterer functional groups. Several mayflies tolerant of siltation, such as Caenis and Tricorythodes, were present. Others such as Ochrotrichia occurred in sufficient numbers to indicate nutrient enrichment. Taxa richness at this site was the highest of the three tributary sites (16 species).

Because of the habitat loss related to siltation, the stream was considered to be partially impaired at this location. Water quality trends based on biological data are unknown for this site because it was first sampled in 1985.

Hydrologic Unit 05100202 - Middle Fork Kentucky River

A total of 228 miles of streams draining 559 square miles comprise this hydrologic unit. The major urban center is Hyden (pop. 488). Buckhorn Lake is the primary recreation center. One water quality monitoring station is located in this hydrologic unit: Middle Fork Kentucky River at Tallega.

Middle Fork Kentucky River at Tallega

Biological Assessment

Phytoplankton standing crop and chlorophyll-a were below average compared with other biological monitoring stations. The plankton community was dominated by green algal flagellates, benthic pennate-diatoms, and blue-green algae. Diversity and equitability were above average. Periphyton chlorophyll-a and ash-free dry weight were below average, as were diatom diversity and equitability. Taxa richness was typical for Kentucky streams. Diatom communities on artifical substrates were dominated by Cocconeis placentula var. euglypta and Achnanthes linearis.

The invertebrate community was adequately represented by functional groups and species composition for the habitats. The community contained several species, such as Caenis and Tricorythodes, that are tolerant of siltation. Species differences within certain functional groups appeared at this location, which are related to a shift in the kinds of habitats. Taxa richness at this site was comparable to the North Fork and totalled 15 species. The community structure at this site is more typical of a shallow, free flowing stream than at the North Fork site.

Water quality trends based on biological data are unknown because the stream was first sampled in 1985. The stream appears to be partially impaired as a result of surface mining and point and nonpoint source nutrient enrichment.

Hydrologic Unit 05100203 - South Fork Kentucky River

A total of 332 miles of streams draining 748 square miles comprise this hydrologic unit. Major urban centers include Manchester (pop. 1,838) and Booneville (pop. 191). Bert Combs Lake is the primary recreation center. One water quality monitoring station is located in this hydrologic unit: South Fork Kentucky River at Booneville.

South Fork Kentucky River at Booneville

Biological Assessment

Phytoplankton standing crop and chlorophyll-a were below average compared with other biological monitoring stations. The plankton community was dominated by centric diatoms and benthic pennate diatoms. Diversity, equitability and taxa richness were above average. Periphyton chlorophyll-a and ash-free dry weight were below average, perhaps a result of the shaded nature of the sampling site. Diatom diversity, equitability, and taxa richness were above average. The diatom community was dominated by *Melosira varians* and *Achnanthes linearis*.

The macroinvertebrates species composition and functional groups were adequate, relative to available habitats. Most of the taxa collected were tolerant of sedimentation. However, taxa richness was the lowest of the tributary sites, with 11 species. Dipteran larvae made up half of the total number of species.

Based on the community structure of the algal and invertebrate populations, this site appears to be relatively unimpaired for aquatic life. Since this station was collected for the first time in 1985, trends in water quality based on biological data are unknown.

Hydrologic Unit 05100204 - Kentucky River from Beattyville to Red River

A total of 514 miles of streams draining 1,093 square miles located in this hydrologic unit. Major urban centers include Beattyville (pop. 1,068) Irvine (pop. 2,889), Stanton (pop. 2,691), and Clay City (pop. 1,276). Recreation centers include Red River Gorge, the Red River Wild River segment, and Natural Bridge State Park. Two water quality monitoring stations are located in this hydrologic unit: Kentucky River at Heidelberg and Red River at Hazel Green.

Kentucky River at Heidelberg

Biological Assessment

Phytoplankton standing crop and chlorophyll-a were consistently above average compared with other biological monitoring stations. The plankton community was characterized by Cyclotella pseudostelligera, Synedra spp., green algal flagellates, and Aulacosira distans var. alpigena. Diversity and equitability values ranged from average to below-average. Blue-green algal blooms have been periodically observed at this location. Periphyton chlorophyll-a and ash-free dry weight values were consistently above average. Diatom diversity and equitability were average while taxa richness was below average. Diatom communities on artifical substrates were dominated by Achnanthes linearis and Synedra delicatissima. Halophilic and epipelic taxa were present in the community.

The quantitative invertebrate collections from this site remained consistent with those from previous years in relation to species composition and functional groups. The influences of various point and nonpoint sources are not obvious. As in the other main stem Kentucky River sites, habitat restrictions have limited the invertebrate community to a greater extent than have water quality conditions.

No apparent water quality change has been noticed. The river appears to be partially impacted as a result of point source nutrient enrichment and nonpoint source factors including coal mining and oil-well operations, but this has not affected designated uses. Nutrient enrichment has been indicated by the presence of periodic algal blooms and above average algal standing crops.

Red River at Hwy. 746 Bridge

Biological Assessment

Phytoplankton standing crop and chlorophyll-a were consistently below average compared with other biological monitoring stations. The plankton community was dominated by benthic pennate diatoms. Diversity and equitability values were above average because of the presence of many dislodged epilithic and epipelic taxa. Periphyton chlorophyll-a and ash-free dry weight values were consistently below average. The low values may partially reflect the shaded nature of the stream site. Diatom diversity and equitability were average while taxa richness was above average. Diatom communities on artifical substrates were dominated by Achnanthes linearis and Cocconeis placentula var. euglypta.

Since 1980, the invertebrate community at this location has been drastically altered in community structure and total numbers because of severe habitat loss by sedimentation resulting from upstream mining and a stream relocation project. Fifteen mussel species have been documented in the Red River from Hazel Green through the Wild River segment, approximately 20 miles downstream. From all indications, the entire mussel community has been eliminated by the effects of sedimentation.

A reduction of numbers of fish species, (particularly darters) was seen during the 1985 sampling. This can be attributed to a loss of habitat from sedimentation.

Increased sedimentation from headwater surface mining activities has resulted in a reduction of aquatic microhabitats. The red alga Lemanea, formerly abundant at this site, was not observed in 1985, which is probably a result of the elimination of its habitat rather than adverse water quality. Similarly, mussel and fish habitat has been reduced by sedimentation to the extent that the stream has become impaired for aquatic life.

Hydrologic Unit 05100205 - Kentucky River from Red River to Mouth

A total of 1754.8 miles of streams draining 3,242 square miles comprise this hydrologic unit. Major urban centers include Lexington (pop. 204,165), Frankfort (pop. 25,973), Richmond (pop. 21,705), Georgetown (pop. 10,972), Danville (pop. 12,942), and Lancaster (pop. 3,365). Recreation centers include Herrington Lake, Boonesboro State Park, and Butler State Park. Six water quality monitoring stations are located in this hydrologic unit: Kentucky River at Camp Nelson, Kentucky River at Frankfort, Kentucky River below Frankfort, Eagle Creek at Glencoe, and South Elkhorn Creek near Midway and Kentucky River at Lockport.

Kentucky River at Camp Nelson

Biological Assessment

Phytoplankton standing crop and chlorophyll-a were above average compared with other biological monitoring stations. The plankton community was dominated by several species of green algal flagellates and centric diatoms which are indicative of eutrophic conditions. Diversity and equitability were below average as a result of the dominance of these algae. Periphyton chlorophyll-a and ash-free dry weight from artificial substrates were above average while diatom diversity, equitability, and taxa richness were below average. The diatom community was dominated by Cocconeis placentula var. euglypta and Achnanthes linearis.

The invertebrate collections from this location were the same as the upstream and downstream sites in relation to species composition. However, the multiplates were colonized by fish eggs, which most likely affected the taxa richness. At this location, the predatory caddisfly, Cyrnellus fraturnus dominated the collections, and the mayfly Tricorythodes was numerous. The invertebrate collection reflects ample community structure and composition for the habitat types.

The river appears to be partially impacted as result of upstream point and non-point sources, but its uses are fully supported. Taste and odor complaints regarding the Lexington water supply may be partially attributable to algal abundance in this section of the river.

Kentucky River below Frankfort

Biological Assessment

Phytoplankton standing crop and chlorophyll-a were above average in 1983 and 1985, but below average in 1984 compared with other biological monitoring stations. The plankton community was dominated by centric diatoms and Nitzschia palea, a facultative nitrogen heterotroph. Diversity and equitability were below average. Periphyton chlorophyll-a was below average in 1983 and above average 1984 and 1985. Diatom diversity, equitability, and taxa richness from artificial substrate communities were typical for Kentucky streams.

The invertebrate habitats at this site contained the same uniformity as the upstream sites. The species composition and functional groups also remained consistent. Taxa richess has shown some variation among years because of competition. For instance, multiplates placed for six weeks were colonized by the freshwater Bryozoan, Pectinatella, which crowds out other colonizers and reduces taxa richness.

Fish tissue samples of whole fish from 1984 contained chlordane residues of 0.32 mg/kg and 0.44 mg/kg, which are slightly above FDA action levels of 0.3 mg/kg.

There may be a trend toward increasing algal production in this section of the Kentucky River. This factor, combined with the detectable levels of chlordane in fish tissue samples from 1984 collections, indicates the river is partially impacted at this site, but its uses are not considered to be impaired.

South Elkhorn Creek at U.S. 421 Bridge

Biological Assessment

Phytoplankton chlorophyll-a was below average compared with other biological monitoring stations; however, standing crop values were above average. This suggests that the phytoplankton was in poor physiological condition at the time of collection. The plankton was dominated by green algal flagellates and pennate diatoms. Many of the plankton species found here are known to tolerate polluted waters. Facultative nitrogen heterotrophs were common in the community. Diversity and equitability values ranged from average to below average. Periphyton chlorophyll-a and ash-free dry weight values were considerably above average, corresponding with high nutrient values present during the periphytometer exposure period. Diatom diversity and taxa richness were below average. Diatom communities on artifical substrates were dominated by pollution tolerant taxa.

The invertebrate community at this location was severely impaired by water quality conditions. The only species collected here was Lirceus fontinalis (aquatic sowbug), even though the available habitats for invertebrates remained abundant. The loss of the entire invertebrate community except the above species indicates a toxic condition at this location. Town Branch, an upstream tributary and the largest wasteload contributer to the South Elkhorn system, has a chronic nuisance problem with the emergence of adult aquatic insects, primarily the midge-fly, Chironomus.

Water quality conditions are consistently poor at this site. Continuous monitoring of D.O. indicated extended periods of dissolved oxygen below 3.0 mg/l. The stream uses are impaired by the Lexington WWTP and various nonpoint sources.

Eagle Creek at Glencoe

Biological Assessment

Phytoplankton standing crop and chlorophyll-a were above average compared with other biological monitoring stations. The plankton community was characterized by Skeletonema potamos, other centric diatoms, green algal flagellates, and green algae (Order Chlorococcales). Diversity and equitability were below average because of the dominance of eutrophic species. Periphyton chlorophyll-a was below average while ash-free dry weight was above average. Diatom diversity, equitability and taxa richness were average. Diatom communities on artificial substrates were dominated by Cocconeis placentula var. euglypta.

An abundance of habitat types for invertebrates was indicated by the community structure and taxa richness. Habitat partitioning was most evident among the scraper organisms, particularily the ephemeropterans, or mayflies. Several members of that group have strict habitat requirements (undersides of rocks) that are sensitive to the smothering effects of siltation. Mussel collections by wading have yielded two species of unionid mussels and the Asiatic clam, *Corbicula fluminea*. Relic shells account for another eight species.

Although nutrient enrichment is apparent at this site, based on the presence of centric diatom species and above average chlorophyll-*a* values, the site appears to be relatively unimpaired based on the invertebrate and fish communities which were present.

UPPER CUMBERLAND RIVER BASIN

The Upper Cumberland River basin is located in southeastern Kentucky in the Appalachian Plateaus and Interior Low Plateaus Provinces, with the headwaters draining slopes of the Cumberland Mountains and the Pine Mountain overthrust. The river drains Pennsylvanian sandstones, limestones, and shales in the Appalachian Plateaus and Mississippian limestone deposits in the Interior Low Plateaus. The mainstem of the river is formed by the junction of Clover Fork, Martins Fork, and Poor Fork at Harlan, Kentucky. Flowing in a generally westward direction, the river cuts across the Cumberland Plateau and Pottsville Escarpment to enter the Interior Low Plateaus Province before turning south to enter Tennessee. There are four major impoundments in the basin; Cumberland, Dale Hollow, Laurel River and Martins Fork reservoirs. There are 2,161 miles of stream in the basin depicted on the USGS hydrologic unit map. Total drainage area in Kentucky is 5,077 square miles. Principal tributaries are the Big South Fork of the Cumberland River with a drainage area of 1,382 square miles and the Rockcastle River with a drainage area of 763 square miles. Other major tributaries include Clear Fork, Buck Creek, and the Laurel River.

Topography of the basin varies greatly. The eastern portion lies in the steep, rugged terrain of the Cumberland Mountains. The central portion lies in the Cumberland Plateau region which is characterized by steep undulating to rolling land. The northwestern tip of the basin is located in the Knobs region, an area of large hills with steep slopes. Extreme western portions of the basin are within the Pottsville Escarpment and the eastern subsection of the Highland Rim, which are generally upland plains with low relief and karst topography.

Average slope of the streams throughout the basin is 14 feet/mile with the main stem above Lake Cumberland averaging approximately 7 feet/mile.

Impacts

The Upper Cumberland River basin has been impacted by a variety of man's activities. The Cumberland Plateau portion of the basin has been heavily impacted by both deep and surface coal mining operations. Localized acid mine drainage, generally attributed to deep mining practices, has diminished in recent years due to an increase in surface mining. Acid mine drainage is now most prominent in portions of the Big South Fork of the Cumberland River.

Oil and natural gas drilling has occurred in the Big South Fork drainage since the late 1800's. In recent years, these operations have increased substantially in the Big South Fork subbasin and adjacent areas, resulting in an increase in brine impacts.

Impacts resulting from agricultural operations are limited on the Cumberland Plateaus, due to the lack of suitable land, but increase substantially as the river flows westward through the Interior Low Plateaus. Localized silvicultural operations are scattered through the basin, but are most abundant on the Cumberland Plateaus in and adjacent to the Daniel Boone National Forest. Silvicultural operations are also common in association with surface coal mining.

Domestic sewage pollution originates from small municipalities throughout the basin. These towns usually discharge treated effluents to small tributary streams that have low flows approaching zero. Generally, these streams are incapable of properly assimilating waste loads without a degradation of water quality. A notable example of this is Yellow Creek which flows through Middlesboro. This small stream has been historically impacted by a tannery and a municipal wastewater treatment plant, in addition to siltation from coal mining operations.

Coal mining operations, oil and gas drilling, and municipal effluent discharges have impacted the aquatic biota throughout a major portion of the drainage. However, in some areas the aquatic life is quite diverse. A number of endangered species of fish and freshwater mussels are found in the basin. One fish kill was reported in 1984 and three in 1985.

Physicochemical Data

Five ambient monitoring stations were located in the Upper Cumberland River basin. The station locations and parameters measured are listed in the following table. Number of samples taken and the minimum, maximum, mean and median for each parameter measured during the 1984-1985 sampling period are given.

UPPER CUMBERLAND RIVER BASIN

Parameter		Cumberland R. at Pineville	Cumberland R. at Cumberland Falls	Rockcastle R. at Billows	S. Fk. Cumberland at Yamacraw	Cumberland R. at Burkesville			
Stream Flow (cfs)	minimum	48	105	3.3	26	126 (1)			
	maximum	46800	58600	41100	62200	34600			
	mean	1270	2780	946	1680	8080			
Dissolved Oxygen (mg/l)	# of samples	22	22	20	22	23			
	minimum	7.0	7.2	7.3	6.1	7.2			
	maximum	11.6	12.5	12.4	12.4	12.6			
	mean	9.4	9.6	9.6	9.4	9.9			
	median	8.9	9.2	9.6	9.3	10.2			
Temperature (Deg. C)	# of samples	22	22	20	22	23			
	minimum	0.0	2.0	1.0	2.0	6.0			
	maximum	29.0	26.5	25.0	26.0	17.0			
	mean	14.5	15.0	13.0	15.5	11.5			
	median	12.5	13.0	10.0	14.0	11.0			
Total Hardness (mg/l as $CaCO_3$)	# of samples	22	22	21	22	23			
	minimum	74	73	52	31	58			
	maximum	366	278	207	155	152			
	mean	137	127	98	65	78			
	median	116	103	93	50	74			
Specific Conductance (uS/cm)	# of samples	22	22	20	22	23			
	minimum	175	190	130	66	115			
	maximum	755	534	335	340	180			
	mean	360	310	207	165	151			
	median	278	296	182	136	153			

(1) Flow data from Cumberland River near Rowena.

UPPER CUMBERLAND RIVER BASIN

Parameter		Cumberland R. at Pineville	Cumberland R. at Cumberland Falls	Rockcastle R. at Billows	S. Fk. Cumberland R. at Yamacraw	Cumberland R. at Burkesville			
pH (units)	# of samples	22	22	20	22	23			
	minimum	6.2	6.4	6.4	6.1	6.7			
	maximum	8.0	7.9	8.2	7.3	7.7			
	mean					-			
	median	7.2	7.2	7.2	6.8	7.1			
Alkalinity (mg/l as $CaCO_3$)	# of samples	21	20	19	21	22			
	minimum	37	28	30	7.8	34			
	maximum	162	130	106	30	60			
	mean	80	60	60	20	45			
	median	66	57	64	21	44			
Chloride (mg/l)	# of samples	21	21	20	22	23			
	minimum	0.5	2.6	3.1	2.4	2.6			
	maximum	18	52	7.3	15	5.1			
	mean	6.7	8.3	4.4	5.9	3.8			
	median	5.4	5.8	3.7	4.4	3.6			
Sulfate (mg/l)	# of samples	22	21	21	22	23			
	minimum	12	54	18	17	14			
	maximum	211	174	71	92	37			
	mean	89	91	34	45	28			
	median	68	84	29	36	26			
Suspended Solids (mg/l)	# of samples	22	19	21	19	22			
	minimum	3.0	1.0	2.0	1.0	1.0			
	maximum	242	266	158	235	51			
	mean	38	54	14	27	10			
	median	12	32	4.0	7.0	5.0			

UPPER CUMBERLAND RIVER BASIN

Parameter		Cumberland R. at Pineville	Cumberland R. at Cumberland Falls	Rockcastle R. at Billows	S. Fk. Cumberland R. at Yamacraw	Cumberland R. at Burkesville			
Fecal Coliform (colonies per 100/mls)	# of samples	15	15	14	15	15			
	minimum	240	1.0	2.0	1.0	16			
	maximum	20000	900	110	700	6600			
	mean	3420	178	35	72	674			
	median	990	12	20	20	45			
Total Iron (ug/l)	# of samples	19	18	18	19	20			
	minimum	110	20	20	60	10			
	maximum	2800	2870	480	3560	350			
	mean	796	753	148	710	121			
	median	590	360	90	470	90			
Total Phosphorous (mg/l)	# of samples	22	22	21	22	23			
	minimum	.02	.01	.01	.01	.01			
	maximum	.17	.27	.18	.15	.06			
	mean	.08	.07	.04	.04	.01			
	median	.07	.05	.03	.03	.01			
Total Zinc (ug/l)	# of samples	19	18	18	19	20			
	minimum	1.0	4.0	1.0	2.0	1.0			
	maximum	35.0	34.0	72.0	930	43.0			
	mean	13.6	15.2	17.2	60.0	9.4			
	median	12.0	12.0	7.0	10.0	4.0			
Total Lead (ug/l)	# of samples	20	20	18	21	22			
	minimum	1.0	1.0	1.0	1.0	1.0			
	maximum	27.0	9.0	10.0	6.0	10.0			
	mean	3.6	2.4	2.9	3.1	1.6			
	median	1.0	2.0	1.0	1.0	1.0			

UPPER CUMBERLAND RIVER BASIN

Parameter		Cumberland R. at Pineville	Cumberland R. at Cumberland Falls	Rockcastle R. at Billows	S. Fk. Cumberland R. at Yamacraw	Cumberland R. at Burkesville			
Total Manganese (ug/l)	# of samples	19	18	18	19	20			
	minimum	20	30	20	80	10.0			
	maximum	120	660	510	250	110			
	mean	74	152	91	129	34			
	median	80	130	55	130	20			
Total Ammonia (mg/l as N)	# of samples	22	22	20	22	23			
	minimum	.04	.05	.02	.01	.05			
	maximum	.11	.10	.09	.06	.06			
	mean	.06	.05	.05	.05	.05			
	median	.05	.05	.05	.05	.05			
Nitrite + Nitrate-Nitrogen (mg/l as N)	# of samples	22	22	21	22	23			
	minimum	.18	.01	.01	.01	.24			
	maximum	.68	.59	.81	.36	.55			
	mean	.44	.33	.37	.15	.44			
	median	.44	.33	.34	.14	.48			

Hydrologic Unit 05130101 - Upper Cumberland River above Rockcastle River

A total of 953 miles of streams draining 1,999 square miles in Kentucky comprise this hydrologic unit. Major urban centers include Cumberland (pop. 3,712), Harlan (pop. 3,024), Pineville (pop. 2,599), Barbourville (pop. 3,333), London (pop. 4,002), Corbin (pop. 8,075), Williamsburg (pop. 5,560), and Middlesboro (pop. 12,251). Recreation centers include Laurel River Lake, Levi Jackson State Park, Pine Mountain State Park, Cumberland Gap National Park, Martins Fork Lake, Kingdom Come State Park, Cumberland Falls State Park and the Cumberland River Wild River segment. Two water quality monitoring stations are located in this hydrologic unit: Cumberland River at Pineville and Cumberland River at the Falls.

Upper Cumberland River at Cumberland Falls

Biological Assessment

Phytoplankton standing crop and chlorophyll-a were below average in comparison with other biological monitoring stations. The plankton community was dominated by green algal flagellates, centric diatoms, and green algae (Order Chlorococcales). Diversity and equitability were typical for Kentucky streams. The occurrence of phytoplankton characteristic of eutrophic lakes suggests a trend towards nutrient enrichment which is not evident from the physicochemical data. Periphyton chlorophyll-a values were average while ash-free dry weight values were below average. Diatom diversity, equitability, and taxa richness were below average.

The quantitative invertebrate collections from the Cumberland River in 1984 did not contain the same taxa richness or functional complexity as previous annual collections because of high water conditions during the multiplate placement period. However, the qualitative collections (select picking) continued to exhibit considerable taxa richness and habitat partitioning among most of the functional groups, especially the filterer and scraper organisms.

This stream was considered partially impacted as a result of elevated turbidity and siltation which occur because of mining activities, however it uses are fully supported.

Hydrologic Unit 05130102 - Rockcastle River

A total of 399 miles of streams draining 763 square miles comprise this hydrologic unit. Major urban centers include Mt. Vernon (pop. 2,334), McKee (pop. 759), and Livingston (pop. 334). Recreation centers include Woods Creek Lake, Lake Linville and the Rockcastle Wild River segment. One water quality monitoring station is located in this hydrologic unit: Rockcastle River at Billows.

Rockcastle River at Billows

Biological Assessment

Phytoplankton standing crop and chlorophyll-a were below average in comparison with other biological monitoring stations. The plankton community was dominated by detached benthic diatoms (notably Achnanthes spp. and Nitzschia frustulum), as well as Melosira varians. Diversity, equitabililty, and taxa richness were above average compared with other biological monitoring stations. Periphyton chlorophyll-a values were below average in 1983 and 1984, while values in 1985 were above average. This variability was attributed to differences in stream flow, rather than nutrient enrichment. Values for ash-free dry weight were similar for all years sampled. Diatom diversity, equitability and taxa richness were typical for biological monitoring stations.

The macroinvertebrate collections have shown the benthic community to be diverse, with a complex community structure for the available habitats. Historical data on the mussel fauna at this location date back to 1947. These data provide a basis for the following interpretation of the changes that have occurred. It is obvious that adequate mussel habitats are still available at this site because total taxa have increased over the years. However, there has been a shift in species composition and a reduction in the numbers of individuals of most species at this site. Those observations indicate a loss or reduction in the recruitment capabilities of certain mussel species. Recruitment success of freshwater mussels is dependent upon the availability of host fishes during the parasitic larval stage. It appears that temporary losses or alterations of host fish spawning habitats due to siltation has a cumulative effect that has produced subtle, but permanent, changes in composition of both mussels and host fishes at this location. In spite of good water quality, the effects of siltation from agriculture and mining have partially impacted the biotic communities. The rivers designated uses, however, were fully supported.

Hydrologic Unit 05130103 - Cumberland River below Rockcastle River

A total of 589 miles of streams draining 1,753 square miles comprise this hydrologic unit. Major urban centers include Monticello (pop. 5,677), Jamestown (pop. 1,441), Somerset (pop. 10,641), Burkesville (pop. 2,051), and Russell Springs (pop. 1,831). Recreation centers include Lake Cumberland. One water quality monitoring station is located in this hydrologic unit: Cumberland River at Burkesville.

Hydrologic Unit 05130104 - Big South Fork Cumberland River

A total of 193 miles of streams draining 404 square miles comprise this hydrologic unit. The major urban center is Whitley City (pop. 1,683). Recreation centers include the Big South Fork and Rock Creek Wild River segments. One water quality monitoring station is located in this hydrologic unit: South Fork Cumberland River at Yamacraw.

SALT RIVER BASIN

The Salt River basin is the most centrally located basin in Kentucky. The mainstem of the Salt River originates in central Boyle County, Kentucky, and flows northward for 30 miles to the vicinity of Lawrenceburg. From there, the river flows in a westerly direction about 95 miles to its confluence with the Ohio River at West Point, Kentucky. Principal tributaries are Rolling Fork, Floyds Fork, Beech Fork, and Brashears Creek. There are 1,552 miles of streams in the basin depicted on the USGS hydrologic unit map. Total drainage area is 2,929 square miles.

The Salt River basin lies primarily within the Blue Grass section of the Interior Low Plateaus Province, with a small portion occurring in the Highland Rim section. The stream drains mainly Ordovician age limestone. Basin topography varies from irregular, steep-sided hills with V-shaped valleys to gently rolling hills with broad floodplains.

Average slope of the main stem of Salt River is 5.0 feet/mile, while Rolling Fork averages 6.0 feet/mile, Beech Fork averages 4.0 feet/mile, Brashears Creek averages 6.0 feet/mile, and Floyds Fork averages 7.0 feet/mile.

Impacts

Major impacts to the Salt River are agricultural runoff, including fertilizer and pesticides, and domestic sewage. This has led to high nutrient loads in some areas. The aquatic communities from the two streams that were sampled for biological data reflect these conditions. A general assessment of the entire basin's water quality cannot be made based on these two stations because of the severe impairment to Pond Creek. If planned oil shale operations in the Knobs area become reality, segments of the Salt River drainage could be impacted.

Physicochemical Data

Five ambient monitoring stations were located in the Salt River basin. The station locations and parameters measured are listed in the following table. Number of samples taken and the minimum, maximum, mean and median for each parameter measured during the 1984-1985 sampling period are given.

SALT RIVER BASIN

Parameter		Rolling Fk. near Lebanon Junction	Beech Fk. at Maud	Floyds Fk. near Crestwood	Salt R. at Shepherds-ville	Pond Crk. at Louisville			
Stream Flow (cfs)	minimum	3.0	0.00	0.00	15	6.6 (1)			
	maximum	60500	22300	3540	26200	2940			
	mean	1710	539	60	1360	115			
Dissolved Oxygen (mg/l)	# of samples	12	18	18	23	22			
	minimum	5.8	6.0	3.4	4.6	4.1			
	maximum	12.5	13.1	12.8	15.0	13.0			
	mean	8.4	9.2	8.2	9.8	8.6			
	median	7.6	8.3	7.6	10.2	8.1			
Temperature (Deg. C)	# of samples	12	18	18	23	22			
	minimum	0.50	3.0	2.0	1.0	0.5			
	maximum	23.5	27.5	25.0	27.0	30.0			
	mean	15.0	17.0	14.0	14.0	13.0			
	median	16.5	19.0	15.5	12.5	10.0			
Total Hardness (mg/l as $CaCO_3$)	# of samples	Not Determined	17	17	23	22			
	minimum		103	140	146	107			
	maximum		504	504	530	460			
	mean		203	234	200	231			
	median		183	235	195	226			
Specific Conductance (uS/cm)	# of samples	12	18	18	23	22			
	minimum	270	234	160	297	327			
	maximum	450	505	516	497	797			
	mean	370	383	407	398	626			
	median	380	375	403	386	622			

(1) Flow data for 1984 water-year only

SALT RIVER BASIN

Parameter		Rolling Fk. near Lebanon Junction	Beech Fk. at Maud	Floyds Fk. near Crestwood	Salt R. at Shepherds-ville	Pond Crk. at Louisville			
pH (units)	# of samples	12	18	18	23	22			
	minimum	7.2	6.4	6.9	6.9	6.5			
	maximum	8.0	8.4	8.7	8.6	8.5			
	mean								
	median	7.5	7.5	7.5	7.6	7.5			
Alkalinity (mg/l as $CaCO_3$)	# of samples	8	17	17	22	21			
	minimum	102	76	106	65	66			
	maximum	216	200	210	171	196			
	mean	159	150	173	141	148			
	median	148	147	177	145	151			
Chloride (mg/l)	# of samples	11	18	18	23	22			
	minimum	5.0	3.0	6.2	5.4	20			
	maximum	37	8.3	14	45	68			
	mean	11	5.3	8.3	12	43			
	median	8.9	4.8	7.8	10	40			
Sulfate (mg/l)	# of samples	11	18	18	23	22			
	minimum	26	14	17	.17	46			
	maximum	53	106	110	57	149			
	mean	39	35	33	33	92			
	median	36	28	26	32	88			
Suspended Solids (mg/l)	# of samples	8	17	17	22	21			
	minimum	19	9.0	4.0	5.0	20			
	maximum	848	72	29	122	268			
	mean	149	28	14	31	54			
	median	32	20	14	22	36			

SALT RIVER BASIN

Parameter		Rolling Fk. near Lebanon Junction	Beech Fk. at Maud	Floyds Fk. near Crestwood	Salt R. at Shepherds-ville	Pond Crk. at Louisville			
Fecal Coliform (colonies per 100/mls)	# of samples minimum maximum mean median	7 86 8700 1180 647	12 12 1600 281 90	12 12 1000 246 220	18 20 3800 780 90	17 2 16000 3000 1000			
Iron (ug/l)	# of samples minimum maximum mean median	Not Sampled	15 210 3100 880 410	14 100 960 320 210	20 80 1530 610 420	19 160 3850 1172 790			
Total Phosphorous (mg/l)	# of samples minimum maximum mean median	12 .09 .59 .21 .17	18 .05 .35 .16 .12	18 .04 .26 .09 .07	23 .09 .52 .24 .21	22 .59 3.25 1.32 1.05			
Total Zinc (ug/l)	# of samples minimum maximum mean median	Not Sampled	15 1.0 15 8.9 9.0	14 1.0 20 7.0 6.0	20 1.0 51 17 11	19 13 91 35 28			
Total Lead (ug/l)	# of samples minimum maximum mean median	Not Sampled	17 1.0 4.0 1.9 2.0	16 1.0 7.0 1.8 1.0	22 1.0 16 3.5 2.0	21 1.0 21.0 5.9 5.0			

SALT RIVER BASIN

Parameter		Rolling Fk. near Lebanon Junction	Beech Fk. at Maud	Floyds Fk. near Crestwood	Salt R. at Shepherds-ville	Pond Crk. at Louisville			
Total Manganese (ug/l)	# of samples	Not Sampled	15	14	20	19			
	minimum		40	30	40	100			
	maximum		250	310	200	260			
	mean		86	77	118	165			
	median		80	50	120	150			
Total Ammonia (mg/l as N)	# of samples	Not Sampled	18	18	23	21			
	minimum		.05	.05	.05	.14			
	maximum		.08	.14	.25	4.31			
	mean		.05	.07	.09	1.13			
	median		.05	.05	.06	.72			
Nitrite + Nitrate-Nitrogen (mg/l as N)	# of samples	10	18	18	23	22			
	minimum	.34	.05	.03	.39	1.40			
	maximum	2.90	1.96	3.6	3.9	3.80			
	mean	1.30	.80	1.4	1.9	2.49			
	median	1.40	.62	1.2	2.1	2.48			

Hydrologic Unit 05140102 - Salt River/Floyds Fork

A total of 776 miles of streams draining 1,471 square miles comprise this hydrologic unit. Major urban centers include Shelbyville (pop. 5,329), Shepherdsville (pop. 4,454), Fort Knox Military Reservation, Radcliff (pop. 14,519), as well as urban areas of southern and eastern Jefferson County. Recreation centers include Taylorsville Lake, Guist Creek Lake, McNeely Lake, Long Run Park and Bernheim Forest. Three water quality monitoring stations are located in this hydrologic unit: Salt River at Shepherdsville, Pond Creek at Louisville and Floyds Fork near Crestwood.

Pond Creek at Louisville

Biological Assessment

Phytoplankton standing crop was above average while chlorophyll-a was below average compared with other biological monitoring stations. This may suggest that the phytoplankton were in poor physiological condition at the time of collection. The plankton community was dominated by tolerant pennate diatoms, blue-green algae, and centric diatoms. Diversity, equitability, and taxa richness were typical for Kentucky streams. Epipelic and nitrogen heterotrophic species were abundant. Periphyton chlorophyll-a and ash-free dry weight values were considerably above average, corresponding with high nutrient values present during the periphytometer exposure period. Diatom diversity, equitability, and taxa richness were typical for Kentucky streams. Diatom communities on artifical substrates were dominated by *Gomphonema parvulum* and *Nitzschia palea*. Both species are recognized as pollution-tolerant taxa.

The invertebrate collections reflected a paucity of organisms and habitats resulting from the degraded water quality conditions at the site. The low numbers of individuals indicated a marginal existence for the organisms collected and possible toxic conditions for the entire benthic community.

The biotic community indicates that water quality is consistently poor at this site. The stream has its aquatic life use impaired by numerous point source and nonpoint-source discharges.

Hydrologic Unit 05140103 - Rolling Fork/Beech Fork/Chaplin River

A total of 776 miles of streams draining 1,449 square miles comprise this hydrologic unit. Major urban centers include Bardstown (pop. 6,155), Springfield (pop. 3,179), and Lebanon (pop. 6,590). Recreation centers include Beaver Creek Lake and Willisburg Lake. Two water quality monitoring stations are located in this hydrologic unit: Beech Fork at Maud and Rolling Fork near Lebanon Junction.

Beech Fork at Maud

Biological Assessment

Phytoplankton standing crop and chlorophyll-a ranged from below average to among the highest observed during the 1985 sampling season. The plankton community was characterized by centric diatoms, green algal flagellates, *Skeletonema potamos* and green algae (Order Chlorococcales). Diversity, equitability, and taxa richness ranged from below to above average. Periphyton chlorophyll-a and ash-free dry weight values were above average. Diatom diversity and equitability were slightly above average while taxa richness was typical for the biological monitoring stations. Diatom communities on artifical substrates were dominated by Cocconeis placentula var. euglypta and Achnanthes lanceolata var. dubia.

The invertebrate collections from this site were exceptional in relation to community structure and functional composition. Habitat partitioning was most evident within the scraper functional group. Some of the species in that group, such as Stenonema pulchellum and S. modestum, have strict habitat requirements and are affected by minimal amounts of siltation. Other species in the Ceratopogonidae (biting midges) are associated with high quality streams that reflect least disturbed conditions.

Based on biological collections, the stream appears to be unimpaired for aquatic life at this site. Nutrient enrichment from agricultural runoff may be a potential source of impairment. Water quality trends based on biological data for this site are unknown because it was first sampled in 1985.

GREEN RIVER BASIN

The Green River basin has the largest surface drainage area of the river basins in the Commonwealth of Kentucky. Flowing approximately 383 miles in a northwesterly direction from its headwaters to its confluence with the Ohio River above Henderson, Kentucky, the river drains an area of 8,821 square miles of west-central Kentucky and 408 square miles in north-central Tennessee. Principal tributaries include the Nolin, Barren, Mud, Rough and Pond rivers. There are 3,532 miles of stream in the basin depicted on the USGS hydrologic unit map. Major impoundments of this basin include Nolin, Barren, Rough and Green River lakes.

The Green River basin lies in the Interior Low Plateaus Province. The major section within this physiographic region is the Highland Rim or Pennyroyal. This area is generally a plateau of low relief, crossed by deeply entrenched streams and includes high, somewhat isolated, hills or outliers of rocks of adjoining sections or provinces. Karst topography and cavern networks are a common characteristic of the section, although normal surface drainage is predominant for most of the area. The Highland Rim is underlain by Mississippian limestone. The remainder of the basin lies in the Shawnee Hills or Western Kentucky Coalfield and is underlain by strata of Pennsylvanian age. This section can generally be characterized as an area with hills and ridges on an upland terrain with expansive, nearly flat floodplains occurring along the lower Green River and its main tributaries.

The main stem of the Green River flows into the Ohio River at 338 feet above mean sea level (msl) and is controlled by a series of six locks and dams for navigational purposes. Upstream of these structures the river rises at an average slope of 1.6 feet/mile, with tributaries having averages ranging from 0.8 feet/mile to 7.7 feet/mile and having a maximum elevation of 1,040 feet above msl.

Impacts

Since a large portion of the Green River lies in the Western Kentucky Coalfield, silt and acid mine drainage from coal mining operations are the major impacts. These impacts can be locally heavy, rendering some streams severly degraded. Agricultural runoff, including livestock feeding operations, contribute nutrient loading to some streams. Brine from oil drilling has caused increased chloride levels in portions of the river for many years.

The aquatic biota of the coalfields has been degraded by siltation and acid mine drainage. Brines have also impacted the aquatic biota in the oil and gas regions of the basin. However, many subbasins of the drainage support a diverse assemblage of aquatic organisms. Five fish kills were reported in 1984 and none in 1985. Because of the presence of PCBs above FDA action levels in fish tissues, advisories on the consumption of fish were posted throughout the Mud River and Drakes Creek systems. This problem is discussed in more detail in the toxicity section of this report.

Physicochemical Data

Eleven ambient monitoring stations were located in the Green River basin. The station locations and parameters measured are listed in the following table. Number of samples taken and the minimum, maximum, mean and median for each parameter measured during the 1984-1985 sampling period are given.

GREEN RIVER BASIN

Parameter		Green R. at Greensburg	Green R. at Munfordville	Nolin R. at White Mills	Bacon Crk. at Priceville	Barren R. at Bowling Green	Green R. at Morgantown	Mud R. near Lewisburg	Rough R. near Dundee
Stream Flow (cfs)	minimum	0.32	173	38	4.9	111	764 (1)	Not Available	57 (1)
	maximum	7870	65300	16400	6800	41400	101000		19800
	mean	1230	2960	475	59	2870	11200		1270
Dissolved Oxygen (mg/l)	# of samples	24	23	23	23	22	24	24	24
	minimum	6.6	7.2	6.2	6.8	6.4	6.3	2.4	5.3
	maximum	12.4	12.8	12.8	13.0	12.8	14.0	12.1	13.0
	mean	9.8	9.7	9.4	9.6	9.4	9.2	6.7	8.7
	median	9.8	9.5	8.8	9.8	8.8	9.0	6.6	8.8
Temperature (Deg. C)	# of samples	24	23	23	23	23	24	24	24
	minimum	3.0	3.5	5.0	4.0	3.8	3.0	2.0	2.0
	maximum	27.0	27.0	24.0	24.0	29.0	27.0	22.5	25.0
	mean	14.0	15.0	14.5	14.0	16.0	15.0	13.0	14.0
	median	13.5	14.0	14.0	13.5	16.0	13.5	11.0	13.0
Total Hardness (mg/l as $CaCO_3$)	# of samples	24	23	23	23	24	24	23	24
	minimum	39	69	98	111	91	60	113	55
	maximum	162	283	400	372	325	260	356	166
	mean	70	127	186	184	140	126	176	95
	median	60	107	166	173	114	120	175	93
Specific Conductance (uS/cm)	# of samples	24	23	22	23	23	24	24	24
	minimum	90	139	231	221	152	157	239	145
	maximum	202	449	490	349	360	359	544	280
	mean	131	264	349	310	245	247	355	204
	median	127	231	324	318	247	245	340	200

(1) Flow data for 1984 water-year only

GREEN RIVER BASIN

Parameter		Pond R. near Apex	Pond R. near Sacramento	Green R. near Beech Grove					
Stream Flow (cfs)	minimum	0.00 (1)	Not Available	755 (1, (2					
	maximum	35700		78200					
	mean	508		14260					
Dissolved Oxygen (mg/l)	# of samples	24	24	14					
	minimum	4.6	4.2	5.0					
	maximum	14.2	13.0	12.0					
	mean	8.7	8.2	8.5					
	median	8.5	8.0	7.9					
Temperature (Deg. C)	# of samples	24	24	17					
	minimum	1.0	1.0	3.0					
	maximum	27.0	27.5	27.5					
	mean	14.0	14.0	16.5					
	median	10.5	13.0	18.0					
Total Hardness (mg/l as $CaCO_3$)	# of samples	24	24	Not Sampled					
	minimum	72	62						
	maximum	290	1000						
	mean	132	372						
	median	124	265						
Specific Conductance (uS/cm)	# of samples	24	24	16					
	minimum	148	134	144					
	maximum	724	2057	500					
	mean	299	800	305					
	median	279	613	293					

(1) Flow data for 1984 water-year only
(2) Flow data from Green River at Lock 2.

GREEN RIVER BASIN

Parameter		Green R. at Greensburg	Green R. at Munford-ville	Nolin R. at White Mills	Bacon Crk. at Priceville	Barren R. at Bowling Green	Green R. at Morgantown	Mud R. near Lewisburg	Rough R. near Dundee
pH (units)	# of samples	24	23	23	23	23	24	24	24
	minimum	6.7	6.8	6.6	6.8	6.5	6.5	6.6	6.8
	maximum	7.6	7.5	7.6	7.7	8.1	8.2	7.8	7.6
	mean								
	median	7.1	7.1	7.1	7.1	8.0	7.4	7.0	7.2
Alkalinity (mg/l as $CaCO_3$)	# of samples	23	22	22	22	23	23	23	23
	minimum	26	59	83	93	51	45	90	32
	maximum	84	179	258	256	177	176	199	158
	mean	45	91	146	158	98	97	148	74
	median	43	82	138	159	88	95	147	72
Chloride (mg/l)	# of samples	24	23	23	23	24	24	24	24
	minimum	0.4	5.9	6.4	4.6	3.7	4.0	.60	2.5
	maximum	5.9	50	41	12	18	23	51	12
	mean	3.4	20	17	7.0	8.3	11	13	5.1
	median	3.4	12	13	6.4	6.9	8.8	11	5.0
Sulfate (mg/l)	# of samples	24	23	23	23	24	24	24	24
	minimum	5.0	7.7	3.5	2.0	6.4	9.5	9.8	3.5
	maximum	130	18	15	7.5	22	1160	1580	656
	mean	16	12	8.9	4.3	15	198	170	52
	median	11	13	8.8	4.3	15	17	18	19
Suspended Solids (mg/l)	# of samples	23	21	21	21	23	23	23	23
	minimum	3.0	3.0	7.0	6.0	9.0	8.0	5.0	15
	maximum	99	141	62	60	123	426	218	900
	mean	21	42	23	25	34	52	46	88
	median	14	25	18	23	22	34	29	44

GREEN RIVER BASIN

Parameter		Pond R. near Apex	Pond R. near Sacramento	Green R. near Beech Grove					
pH (units)	# of samples	24	24	16					
	minimum	6.6	5.9	6.9					
	maximum	8.1	8.0	7.9					
	mean								
	median	7.0	6.7	7.5					
Alkalinity (mg/l as $CaCO_3$)	# of samples	23	23	7					
	minimum	58	.10	72					
	maximum	136	91	124					
	mean	91	40	97					
	median	94	38	94					
Chloride (mg/l)	# of samples	24	24	15					
	minimum	6.5	5.7	2.9					
	maximum	33	85	20					
	mean	12	14	9.6					
	median	9.8	9.1	8.4					
Sulfate (mg/l)	# of samples	24	24	15					
	minimum	11	63	15					
	maximum	1800	2500	120					
	mean	114	425	62					
	median	33	266	56					
Suspended Solids (mg/l)	# of samples	23	23	11					
	minimum	7.0	4.0	18					
	maximum	3000	154	742					
	mean	192	47	153					
	median	50	32	73					

GREEN RIVER BASIN

Parameter		Green R. at Greensburg	Green R. at Munford-ville	Nolin R. at White Mills	Bacon Crk. at Priceville	Barren R. at Bowling Green	Green R. at Morgantown	Mud R. near Lewisburg	Rough R. at Dundee
Fecal Coliform (colonies per 100/mls)	# of samples	15	14	14	14	13	15	15	15
	minimum	18	30	44	42	0	33	37	10
	maximum	3250	2800	3000	2200	390	800	800	800
	mean	560	596	618	512	69	186	238	166
	median	105	250	340	210	36	103	200	100
Total Iron (ug/l)	# of samples	21	20	20	20	22	21	21	21
	minimum	50	40	10	70	70	90	90	170
	maximum	1510	1330	480	710	600	1450	1140	10,100
	mean	364	351	253	339	293	562	509	1274
	median	240	210	270	270	260	470	460	690
Total Phosphorous (mg/l)	# of samples	24	23	23	23	24	24	24	24
	minimum	.01	.03	.36	.01	.02	.03	.05	.02
	maximum	.10	.14	.06	.07	.12	.36	.27	.48
	mean	.03	.06	.13	.03	.05	.08	.13	.08
	median	.02	.05	.10	.03	.04	.07	.09	.05
Total Zinc (ug/l)	# of samples	20	21	20	20	21	21	21	21
	minimum	1.0	1.0	1.0	1.0	8.0	1.0	1.0	2.0
	maximum	65	32	42	24	56	93	122	93
	mean	15	10	11	9.1	19	18	21	21
	median	7.0	8.0	7.0	6.0	16	10	11	9.0
Total Lead (ug/l)	# of samples	22	22	22	22	23	23	23	23
	minimum	1.0	1.0	1.0	0	1.0	1.0	1.0	1.0
	maximum	11.0	87	50	59	24.0	8.0	9.0	17.0
	mean	2.1	5.7	7.5	4.1	5.7	2.7	2.9	2.6
	median	1.0	2.0	3.0	1.0	5.0	2.0	1.0	1.0

GREEN RIVER BASIN

Parameter		Pond R. near Apex	Pond R. near Sacramento	Green R. near Beech Grove					
Fecal Coliform (colonies per 100/mls)	# of samples	15	15	11					
	minimum	42	10	20					
	maximum	3300	400	1980					
	mean	429	184	302					
	median	133	125	74					
Total Iron (ug/l)	# of samples	22	21	No Data					
	minimum	40	260						
	maximum	8930	6110						
	mean	1270	1790						
	median	720	1420						
Total Phosphorous (mg/l)	# of samples	25	24	14					
	minimum	.01	.01	.01					
	maximum	.28	.16	.11					
	mean	.08	.06	.05					
	median	.07	.05	.04					
Total Zinc (ug/l)	# of samples	22	21	No Data					
	minimum	3.0	22						
	maximum	120	621						
	mean	23	118						
	median	8.0	54						
Total Lead (ug/l)	# of samples	24	23	No Data					
	minimum	1.0	1.0						
	maximum	17.0	7.0						
	mean	4.0	2.3						
	median	2.0	1.0						

GREEN RIVER BASIN

Parameter		Green R. at Greensburg	Green R. at Munford-ville	Nolin R. at White Mills	Bacon Crk. at Priceville	Barren R. at Bowling Green	Green R. at Morgantown	Mud R. near Lewisburg	Rough R. at Dundee
Total Manganese (ug/l)	# of samples	21	20	20	22	22	21	21	21
	minimum	10	10	30	30	30	40	70	130
	maximum	250	130	110	190	290	390	1290	1430
	mean	66	60	64	92	112	125	275	355
	median	50	50	60	80	100	100	180	240
Total Ammonia (mg/l as N)	# of samples	24	23	23	23	23	24	24	24
	minimum	.01	.05	.05	.04	.05	.04	.05	.05
	maximum	.17	.08	.27	.20	.25	.10	.51	.29
	mean	.06	.05	.08	.06	.08	.06	.11	.12
	median	.05	.05	.06	.05	.06	.05	.07	.09
Nitrite + Nitrate-Nitrogen (mg/l as N)	# of samples	24	23	23	23	24	24	24	24
	minimum	.06	.30	1.7	.25	.3	.43	.04	.22
	maximum	1.7	1.76	4.0	1.95	2.40	1.86	3.23	2.36
	mean	.70	.94	2.8	1.17	1.15	1.19	1.66	1.03
	median	.76	.99	2.8	1.26	1.18	1.22	1.62	.81

GREEN RIVER BASIN

Parameter		Pond R. near Apex	Pond R. near Sacramento	Green R. near Beech Grove					
Total Manganese (ug/l)	# of samples	22	20	No Data					
	minimum	70	180						
	maximum	840	7280						
	mean	214	1800						
	median	150	1360						
Total Ammonia (mg/l as N)	# of samples	25	24	No Data					
	minimum	.05	.06						
	maximum	.10	12.2						
	mean	.06	.86						
	median	.05	.27						
Nitrite + Nitrate-Nitrogen (mg/l as N)	# of samples	25	24	12					
	minimum	.02	.25	.55					
	maximum	2.1	1.5	2.0					
	mean	.72	.75	1.06					
	median	.60	.61	.96					

Hydrologic Unit 05110001 - Upper Green River and Nolin River

A total of 1,262 miles of streams draining 3,140 square miles comprise this hydrologic unit. Major urban centers include Elizabethtown (pop. 15,380), Campbellsville (pop. 8,715), Columbia (pop. 3,710), and Hodgenville (pop. 2,531). Recreation centers include Green River Lake, Nolin Lake, Mammoth Cave National Park, and the Green River Wild River segment. Four water quality monitoring stations are located in this hydrologic unit: Green River at Greensburg, Green River at Munfordsville, Nolin River at White Mills and Bacon Creek at Priceville.

Bacon Creek at Priceville

Biological Assessment

Phytoplankton standing crop and chlorophyll-a were below average compared with other biological monitoring stations. The plankton community was dominated by Melosira varians and benthic pennate diatoms; diversity and equitability values were among the highest observed at the biological monitoring stations because of the high abundances of these non-planktonic species. Periphyton chlorophyll-a and ash-free dry weight values were below average, as were values for diatom diversity and equitability, and taxa richness was typical. Diatom communities on artifical substrates were dominated by Achnanthes lanceolata var. dubia and Cocconeis placentula var. euglypta.

The invertebrate collections from this location were adequately represented by taxa richness and feeding types for the available habitats. Partitioning of habitats was most evident among the scraper organisms, which also indicates a minimal influence from the effects of siltation. The community structure reflects a consistent stability that is related to good water quality conditions. The stream appears to be relatively unimpaired at this site, with an aquatic community typical for streams of similar size in this drainage basin.

Nolin River at White Mills

Biological Assessment

Phytoplankton standing crop and chlorophyll-a were below average compared with other biological monitoring stations. The plankton community was dominated by green algal flagellates and benthic pennate diatoms. Diversity and equitability were among the highest observed at the monitoring stations because of the high abundances of non-planktonic species. Periphyton chlorophyll-a and ash-free dry weight were above average. Values for nutrients, notably nitrogen, were elevated during the periphytometer exposure period. Diatom diversity and equitability were below average while taxa richness was typical for Kentucky streams. Diatom communities on artificial substrates were dominated by both typical stream taxa and nitrogen-heterotrophic species.

The invertebrate collections from this location showed ample diversity in species composition and feeding types. Habitat partitioning was most evident among the filterer organisms. The community also contained a high number of predatory organisms. All of these factors are most likely related to the influences of nutrient enrichment. However, the mussel fauna in this portion of the river were eliminated prior to the first collections in 1984. Relic shells show that at least nine species occurred in the system in the recent past. Presently, mussel habitats are available at this location; however, no living mussels have been observed.

Chlordane concentrations of 2.0 mg/kg were detected in fish tisssue samples in 1984. The FDA action level is 0.3 mg/kg. In 1985, however, the chlordane concentrations were well below the FDA action levels.

Because of the effects of nutrient enrichment, the reduction of the mussel fauna and the high chlordane concentrations in the 1984 fish tissue samples, this station is considered partially impaired.

Hydrologic Unit 05110002 - Barren River

A total of 638 miles of streams draining 2,264 square miles comprise this hydrologic unit. Major urban centers include Bowling Green (pop. 40,450) and Glasgow (pop. 12,958), Scottsville (pop. 4,278), Tompkinsville (pop. 3,077), and Franklin (pop. 7,738). Recreation centers include Barren River Lake. One water quality monitoring station is located in this hydrologic unit: Barren River at Bowling Green.

Hydrologic Unit 05110003 - Green River from Barren River to Rough River

A total of 491 miles of streams draining 1,027 square miles are located in this hydrologic unit. Major urban centers include Morgantown (pop. 2,000), Greenville (pop. 4,631) and Russellville (pop. 7,520). Recreation centers include Lake Malone. Two water quality monitoring stations are located in this hydrologic unit: Green River at Morgantown and Mud River near Lewisburg.

Mud River near Lewisburg

Biological Assessment

The algal and macroinvertebrate collections were typical for streams influenced by agricultural practices. However, an industrial effluent containing PCBs has contaminated fish tissue for the length of the river. This problem is discussed further in the toxicity section of this report. Because of the presence of PCBs in fish tissue, this stream is considered impaired for aquatic life/fishable uses.

Hydrologic Unit 05110004 - Rough River

A total of 453 miles of streams draining 1,081 square miles comprise this hydrologic unit. The major urban centers are Beaver Dam (pop. 3,185) and Hartford (pop. 2,512). Recreation centers include Rough River Lake. One water quality monitoring station is located in this hydrologic unit: Rough River near Dundee.

Rough River at Dundee

Biological Assessment

Phytoplankton standing crop and chlorophyll-a values were below average compared with other biological monitoring stations. The plankton community was dominated by centric diatoms, green flagellate algae, and Synedra delicatissima, a pennate diatom. Diversity and equitability were typical for Kentucky streams. Periphyton chlorophyll-a and ash-free dry weight values were below average while diatom diversity, equitability, and taxa richness were above average. Diatom communities on artifical substrates were dominated by Melosira varians and Gyrosigma scalproides. Epipelic and halophilic taxa were present in the community, in addition to species typically found in iron-rich waters.

Invertebrates were not collected from this station in 1984 or 1985.

Hydrologic Unit 05110005 - Green River from Rough River to mouth)

A total of 362 miles of streams draining 919 square miles comprise this hydrologic unit. The major urban center is Owensboro (pop. 54,450). Two water quality monitoring station are located in this hydrologic unit: Green River near Beech Grove and Green River at Sebree.

Hydrologic Unit 05110006 - Pond River

A total of 327 miles of streams draining 799 square miles comprise this hydrologic unit. Major urban centers include Madisonville (pop. 16,979) and Central City (pop. 5,214). Two water quality monitoring stations are located in this hydrologic unit: Pond River near Sacramento and Pond River near Apex.

TRADEWATER RIVER BASIN

The Tradewater River basin is located in the western portion of the state within the Shawnee Hills Section of the Interior Low Plateaus Province. This area also contains the Western Kentucky Coalfield. The Tradewater River originates in northwestern Christian County and flows northwesterly for 132 miles to enter the Ohio River near Caseyville, Kentucky. Some of the principal tributaries to the river are Cany Creek, Buffalo Ceek, Piney Creek, Flynn Fork, Donaldson Creek, Clear Creek, Craborchard Creek (=Vaughn Ditch) and Cypress Creek (=Smith Ditch). There are 520 miles of streams in the basin depicted on the USGS hydrologic unit map. Lake Beshear is the major impoundment of this area. The Tradewater River drains an area of 943 square miles.

The main stem of the Tradewater River originates near the Dripping Springs Escarpment and flows primarily through the deep alluvial and Pennsylvanian deposits of the interior lowlands. The eastern tributaries, which also lie in Pennsylvanian strata, comprise some of the largest wetlands in the state. In contrast, smaller western tributaries are more upland in nature and flow through Mississippian deposits.

The basin is roughly elliptical in shape and averages approximately 32 miles in width. Elevations range from 320 feet above mean sea level (msl) at the mouth of the Tradewater River to 806 feet above msl just north of Hopkinsville, Kentucky. The main stem has an average slope of 0.6 feet/mile from its mouth to mile 73 at Olney. From Olney to its source, the average slope is 5.4 feet/mile. In areas where the gradient is slight, wide floodplains and swampy conditions are common.

Impacts

Portions of the Tradewater River system have been heavily impacted by acid mine drainage and silt from coal mining in the watershed. Many streams consistently exhibit pH's in the range of 3-4 units and are heavily silted. Agricultural runoff and domestic sewage discharges from small municipalities are secondary impacts.

The aquatic biota of the eastern tributaries and the mainstem of the Tradewater below Dawson Springs have been severely degraded by acid mine drainage and siltation. The western tributaries are presently serving as a refugia for the aquatic biota of the basin. Although no fish kills were officially reported during 1984 and one occurred in 1985, residents in the area indicate that localized fish kills frequently occur. The biological collections from one site (Tradewater River at Olney) are not sufficient to characterize the basin; however, the effects of sedimentation from coal production and oil and gas operations are obvious. Habitat conditions have been reduced or altered from of sedimentation throughout the basin.

Physicochemical Data

One ambient monitoring station is located in the Tradewater River basin. The station location and parameters measured are listed in the following table. Number of samples taken and minimum, maximum, mean and median for each parameter measured during the 1984-1985 sampling period are given.

TRADEWATER RIVER BASIN

Parameter		Tradewater R. at Olney							
Stream Flow (cfs)	minimum maximum mean	Not Available							
Dissolved Oxygen (mg/l)	# of samples minimum maximum mean median	18 3.1 12.4 6.5 5.5							
Temperature (Deg. C)	# of samples minimum maximum mean median	18 2.5 29.0 17.0 19.0							
Total Hardness (mg/l as $CaCO_3$)	# of samples minimum maximum mean median	17 48 306 177 186							
Specific Conductance (uS/cm)	# of samples minimum maximum mean median	18 117 816 367 333							

TRADEWATER RIVER BASIN

Parameter		Tradewater R. at Olney							
pH (units)	# of samples	18							
	minimum	5.1							
	maximum	7.0							
	mean								
	median	6.6							
Alkalinity (mg/l as $CaCO_3$)	# of samples	17							
	minimum	14							
	maximum	64							
	mean	25							
	median	24							
Chloride (mg/l)	# of samples	18							
	minimum	2.3							
	maximum	6.7							
	mean	4.3							
	median	3.9							
Sulfate (mg/l)	# of samples	18							
	minimum	30							
	maximum	273							
	mean	131							
	median	127							
Suspended Solids (mg/l)	# of samples	17							
	minimum	6.0							
	maximum	54							
	mean	18.6							
	median	15.0							

TRADEWATER RIVER BASIN

Parameter		Tradewater R. at Olney							
Fecal Coliform (colonies per 100/mls)	# of samples	8							
	minimum	1							
	maximum	185							
	mean	59							
	median	33							
Total Iron (ug/l)	# of samples	15							
	minimum	220							
	maximum	2750							
	mean	694							
	median	560							
Total Phosphorous (mg/l)	# of samples	18							
	minimum	.02							
	maximum	.12							
	mean	.04							
	median	.03							
Total Zinc (ug/l)	# of samples	15							
	minimum	16							
	maximum	44							
	mean	29							
	median	29							
Total Lead (ug/l)	# of samples	17							
	minimum	1.0							
	maximum	7.0							
	mean	2.0							
	median	1.0							

TRADEWATER RIVER BASIN

Parameter		Tradewater at Olney							
Total Manganese (ug/l)	# of samples minimum maximum mean median	15 270 3490 1563 1310							
Total Ammonia (mg/l as N)	# of samples minimum maximum mean median	18 .05 .92 .18 .08							
Nitrite + Nitrate-Nitrogen (mg/l as N)	# of samples minimum maximum mean median	18 .07 1.16 .41 .36							

Hydrologic Unit 05140205 - Tradewater River

A total of 520 miles of streams draining 943 square miles comprise this hydrologic unit. Major urban centers include Madisonville (pop. 16,979), Dawson Springs (pop. 3,275), Providence (pop. 4,434), and Sturgis (pop. 2,293). The major recreation centers include Lake Beshear and Pennyrile State Resort Park. One water quality monitoring station is located in the basin, Tradewater River at Olney.

Tradewater River at Olney

Biological Assessment

Phytoplankton standing crop and chlorophyll-*a* ranged from average to below average compared with other biological monitoring stations. The plankton community was characterized by *Aulacosira distans* var. *alpigena*, other centric diatoms, euglenoid and blue-green algae. Diversity and equitability ranged from average to above average. Periphyton chlorophyll-*a* and ash-free dry weight were below average. Diatom diversity, equitability, and taxa richness were also below average. Diatom communities on artifical substrates were domianted by *Gomphonema parvulum* and *Achnanthes minutissima*. Halophilic and epipelic taxa were present in the community.

The invertebrate collections contained an ample number of species for the available habitats. However, sedimentation has reduced or completely smothered areas of the bottom that provide habitats for many feeding types. The stream areas least affected by sediments (within the water column, on snags, etc.) provide habitats associated with the species collected, such as *Cheumatopsyche*, *Hydropsyche*, *Polycentropus*, and *Nyctiophylx* and showed most of the habitat partitioning. Based upon the biological data collected, aquatic life use at this site was judged to be partially impaired.

LOWER CUMBERLAND RIVER BASIN

The lower Cumberland River basin lies in the Highland Rim Section of the Interior Low Plateaus Province in southwestern Kentucky. The low to moderate gradient streams in the Kentucky portion of the basin drain Mississippian limestones. In Kentucky, the river flows northwesterly for 75 miles from the Tennessee border to the Ohio River near Smithland, Kentucky. Barkley Dam near Lake City, Kentucky, impounds 118 miles of the river, 44 miles of which are in Kentucky. There are two major subbasins in this region: the Little River with 601 square miles and the Red River with a total drainage area of 1,460 square miles, 688 of which are in Kentucky. The lower Cumberland River drains 2,084 square miles in Kentucky and receives drainage from another 15,830 square miles of the Cumberland River in Tennessee and southeastern Kentucky. There are 696 miles of streams in the Kentucky portion of the basin depicted on the USGS hydrologic unit map.

The basin lies in two subsections of the Highland Rim, the Pennyroyal Plain and the Western Highland Rim. The Pennyroyal area is a well-known karst region consisting of rough and hilly topography, with sinkholes, subsurface drainage, and limestone caverns. The Western Highland Rim subsection consists of a dissected upland plateau with some karst topography, but sinkhole plains are absent. Generally, this subsection is a ridge and valley area characterized by long, somewhat steep, slopes.

Elevations in the basin range from 302 feet above mean sea level (msl) at the confluence of the Cumberland and Ohio rivers to 863 feet at Pine Knob in Christian County. Slope of the main stem of the Cumberland River below Lake Barkley is 5.7 feet/mile to the point where Livingston Creek enters. The slope from Livingston Creek to the Ohio River is 2 feet/mile.

Impacts

Principal impacts to water quality of the basin include municipal wastewater treatment plant discharges and nonpoint source agricultural runoff. Mining impacts within the basin are limited to runoff from abandoned fluorspar mines and limestone quarries. Impacts from limestone quarries generally involve slight downstream increases in siltation and alkalinity. Industrial discharges have impacted the drainage, particularly in the Hopkinsville area.

The Kentucky portion of the Cumberland River supports a diverse aquatic biota typical of large rivers. It's aquatic life and recreational uses are fully supported. No fish kills were reported in the drainage in 1984; one was reported in 1985.

Physicochemical Data

One ambient monitoring station is located in the Lower Cumberland River basin. The station location and parameter measured are listed in the following table. Number of samples taken and minimum, maximum, mean and median for each parameter measured during the 1984-1985 sampling period are given.

LOWER CUMBERLAND RIVER BASIN

Parameter		Cumberland R. near Grand Rivers							
Stream Flow (cfs)	minimum maximum mean	4470 158000 35085							
Dissolved Oxygen (mg/l)	# of samples minimum maximum mean median	15 5.6 11.2 9.1 9.4							
Temperature (Deg. C)	# of samples minimum maximum mean median	18 3.0 28.5 16.0 15.0							
Total Hardness (mg/l as $CaCO_3$)	# of samples minimum maximum mean median	Not Determined							
Specific Conductance (uS/cm)	# of samples minimum maximum mean median	17 174 370 215 203							

LOWER CUMBERLAND RIVER BASIN

Parameter		Cumberland R. near Grand Rivers								
pH (units)	# of samples	17								
	minimum	7.1								
	maximum	8.2								
	mean									
	median	7.7								
Alkalinity (mg/l as $CaCO_3$)	# of samples	9								
	minimum	66								
	maximum	137								
	mean	99								
	median	100								
Chloride (mg/l)	# of samples	16								
	minimum	3.3								
	maximum	14								
	mean	5.8								
	median	5.2								
Sulfate (mg/l)	# of samples	16								
	minimum	6.4								
	maximum	51								
	mean	21								
	median	19								
Suspended Solids (mg/l)	# of samples	13								
	minimum	5.0								
	maximum	52								
	mean	23								
	median	19								

LOWER CUMBERLAND RIVER BASIN

Parameter		Cumberland R. near Grand Rivers							
Fecal Coliform (colonies per 100/mls)	# of samples minimum maximum mean median	12 2.0 122 24 5.0							
Total Iron (ug/l)	# of samples minimum maximum mean median	Not Sampled							
Total Phosphorous (mg/l)	# of samples minimum maximum mean median	15 .01 .23 .07 .06							
Total Zinc (ug/l)	# of samples minimum maximum mean median	Not Sampled							
Total Lead (ug/l)	# of samples minimum maximum mean median	Not Sampled							

LOWER CUMBERLAND RIVER BASIN

Parameter		Cumberland R. near Grand Rivers							
Total Manganese (ug/l)	# of samples minimum maximum mean median	Not Sampled							
Total Ammonia (mg/l as N)	# of samples minimum maximum mean median	Not Sampled							
Nitrite + Nitrate-Nitrogen (mg/l as N)	# of samples minimum maximum mean median	15 .10 1.0 .47 .35							

TENNESSEE RIVER BASIN

The Tennessee River basin drains the eastern half of the Jackson Purchase region in the far western corner of the state. Of its total drainage area (40,330 square miles), only 1,000 square miles are in Kentucky. Most of the 62 miles of the Tennessee River (mainstem) that lie in Kentucky are impounded within Kentucky Lake. There are 369 miles of streams in the Kentucky portion of the basin depicted on the USGS hydrologic unit map. The principal tributary in Kentucky is Clarks River, which has a total drainage area of 530 square miles.

The basin lies in the Eastern Gulf Coastal Plain area of the Coastal Plain Province. Underlying bedrock is composed of a variety of shales, clays, sandstones, and alluvium of Tertiary, Cretaceous and Quaternary age. Basin topography is characterized by strongly rolling to nearly flat terrain; the uplands are variable and often wooded, while valleys are generally wide with extensive cultivation. Slopes are steep in some areas along Kentucky Lake.

Elevations in the basin vary from 325 feet above msl south of Paducah to 640 feet above msl in southwestern Calloway County. The East Fork of Clarks River has an average slope of 4.6 feet/mile and the West Fork averages 7.0 feet/mile. The mainstem of the Tennessee River to Kentucky Lake Dam is influenced by Lock and Dam 52 on the Ohio River with a pool elevation of 302 feet above msl.

Impacts

Impacts to water quality within the Tennessee River basin include nutrient loading from domestic effluents, urban runoff and agricultural activities. Increased silt loads from cultivation of marginally hilly land immediately west of Kentucky Lake represent a threat to the aquatic life in streams of this area.

Industrial impacts are of special concern in the Tennessee River below Kentucky Lake, where a large chemical manufacturing complex has developed. Industrial impacts have also influenced water quality in the Paducah area of the lower Tennessee and in the East Fork of Clarks River below Benton and Murray. High levels of heavy metals have been found in sediments of the East Fork of Clarks River and pose a threat to the aquatic ecosystem. Three fish kills were reported in 1984, none were reported in 1985. Biological collections from the Clarks River reflected the influences of siltation from extensive agricultural practices.

Physicochemical Data

Two ambient monitoring stations were located in the Tennessee River basin. The station locations and parameters measured are listed in the following table. Number of samples taken and the minimum, maximum, mean and median for each parameter measured during the 1984-1985 sampling period are given.

TENNESSEE RIVER BASIN

Parameter		Clarks R. at Almo	Tennessee R. near Paducah						
Stream Flow (cfs)	minimum	2.8 (1)	18900 (1)						
	maximum	14500	344000						
	mean	250	69010						
Dissolved Oxygen (mg/l)	# of samples	18	12						
	minimum	3.9	5.2						
	maximum	13.2	14.1						
	mean	7.1	9.2						
	median	7.1	8.5						
Temperature (Deg. C)	# of samples	18	16						
	minimum	2.0	2.5						
	maximum	27.5	28.0						
	mean	17.0	17.0						
	median	20.0	16.5						
Total Hardness (mg/l as $CaCO_3$)	# of samples	18	Not Determined						
	minimum	20							
	maximum	81							
	mean	41							
	median	40							
Specific Conductance (uS/cm)	# of samples	18	17						
	minimum	54	80						
	maximum	248	210						
	mean	140	153						
	median	137	160						

(1) Flow data for 1984 water-year only.

TENNESSEE RIVER BASIN

Parameter		Clarks R. near Almo	Tennessee R. near Paducah						
pH (units)	# of samples	18	16						
	minimum	5.7	7.1						
	maximum	7.1	8.6						
	mean								
	median	6.7	7.5						
Alkalinity (mg/l as $CaCO_3$)	# of samples	17	10						
	minimum	13	36						
	maximum	43	138						
	mean	31	66						
	median	32	60						
Chloride (mg/l)	# of samples	18	15						
	minimum	3.1	2.4						
	maximum	17.7	10.0						
	mean	11.3	7.3						
	median	11.1	7.6						
Sulfate (mg/l)	# of samples	18	15						
	minimum	6.4	3.7						
	maximum	58	20.0						
	mean	14.4	13.6						
	median	10.7	14.0						
Suspended Solids (mg/l)	# of samples	17	13						
	minimum	3.0	7.0						
	maximum	377	85						
	mean	49.8	19.5						
	median	24.0	14.0						

TENNESSEE RIVER BASIN

Parameter		Clarks R. near Almo	Tennessee R. near Paducah						
Fecal Coliform (colonies per 100/mls)	# of samples	8	11						
	minimum	40	1						
	maximum	560	47						
	mean	284	13						
	median	160	8						
Total Iron (ug/l)	# of samples	15	Not Sampled						
	minimum	1.0							
	maximum	3470							
	mean	1064							
	median	840							
Total Phosphorous (mg/l)	# of samples	18	15						
	minimum	.19	.01						
	maximum	1.15	.11						
	mean	.48	.05						
	median	.36	.04						
Total Zinc (ug/l)	# of samples	15	Not Sampled						
	minimum	1.0							
	maximum	86							
	mean	18.5							
	median	17.0							
Total Lead (ug/l)	# of samples	17	Not Sampled						
	minimum	1.0							
	maximum	280							
	mean	21.8							
	median	3.0							

TENNESSEE RIVER BASIN

Parameter		Clarks R. near Almo	Tennessee R. near Paducah						
Total Manganese (ug/l)	# of samples minimum maximum mean median	15 190 630 315 280	Not Sampled						
Total Ammonia (mg/l as N)	# of samples minimum maximum mean median	18 .05 .96 .17 .09	Not Sampled						
Nitrite + Nitrate-Nitrogen (mg/l as N)	# of samples minimum maximum mean median	18 .94 4.8 2.2 1.9	15 .13 .58 .30 .24						

Hydrologic Unit 06040006 - Tennessee River/Clarks River

A total of 328 miles of streams draining 890 square miles comprise this hydrologic unit. Major urban centers include Paducah (pop. 29,315), Murray (pop. 14,248), and Benton (pop. 370). Recreation centers include the lower Tennessee River. Two water quality monitoring stations are located in this hydrologic unit: Tennessee River near Paducah and Clarks River at Almo.

Clarks River at Almo

Biological Assessment

Phytoplankton chlorophyll-a was above average while standing crop was slightly below average compared with other biological monitoring stations. The plankton community was characterized by Aulacosira granulata var. angustissima, other centric diatoms, pennate diatoms, and green algal flagellates. Diversity was average to above average while equitability was above average. Periphyton chlorophyll-a was below average while ash-free dry weight was above average. This suggests considerable heterotrophic activity (e.g. , bacteria, protozoans). Diatom diversity, equitability, and taxa richness were above average. Diatom communities on artifical substrates were dominated by Melosira varians, Navicula symmetrica, and Cyclotella striata var. ambigua. Halophilic, epipelic, and nitrogen heterotrophic species were common.

The invertebrate collections from this location were adequate in relation to the kinds of habitats available. Most members of the community are tolerant of siltation, such as Caenis, Stenacron and Oecetis. Others are associated with nutrient enrichment. A large assemblage of Coleopterans (beetles), and Dipterans (midgeflies), were also collected. It is apparent from the collections that siltation has reduced the diversity of organisms and their functional capabilities by a reduction in available habitats.

Water quality trends based on biological data are unknown because the stream was first sampled in 1985. The stream appears to be partially impaired as a result of point and nonpoint source factors.

MISSISSIPPI RIVER BASIN

The Mississippi River reaches its confluence with the Ohio River at Mississippi river mile 953.8 near Wickliffe, Kentucky and flows southward some 70 miles, forming the state boundary between Kentucky and Missouri. The basin drains a northern extension of the Mississippian Embayment within the far southwestern corner of the state, a physiographic province known as the Coastal Plain. The basin drains approximately 1,200 square miles of the state. Geology of the region is somewhat youthful, being composed of Tertiary and Quarternary age sands, gravels, and clays deposited during a recent subsidence of the Mississippi Embayment. Windblown deposits of loess blanket these Tertiary deposits and are especially well developed as bluffs just east of the river. Principal tributaries to the Mississippi include Mayfield Creek, Obion Creek, and Bayou de Chien. There are 372 miles of streams in the Kentucky portion of the basin depicted on the USGS hydrologic unit map. The Ohio River, the major tributary to the Mississippi River in this region, is discussed in another section.

Topography of the basin varies from strongly rolling to nearly flat terrain. Highest elevations occur along a northwest-southeast ridge which runs from western Calloway County to Ballard County and forms the divide betwen the Ohio, Mississippi, and Tennessee rivers. Uplands within the basin are smooth to rough with greatest variations in elevation occurring near streams. Extensive floodplain bottoms have developed along the principal tributaries and the Mississippi itself.

Impacts

Intensive cultivation of the basin area has led to serious sediment loadings to streams. Additional impacts to streams within the basin include agricultural nutrient runoff, domestic effluent discharges, logging, channelization, and, to a lesser extent, industrial waste influences. The tributary streams' aquatic biota have been impacted by siltation. One fish kill was reported from this basin in 1985 and none were reported in 1984.

A biological collection site on Bayou de Chien is used to characterize the basin. The biological collections reflected typical community structures and species compositions for a stream that is influenced by extensive agriculture practices.

Physicochemical Data

One ambient monitoring station is listed in the Mississippi River basin. The station location and parameters measured are listed in the following table. Number of samples taken and the minimum, maximum, mean and median for each parameter measured during the 1984-1985 sampling period are given.

MISSISSIPPI RIVER BASIN

Parameter		Bayou de Chien near Clinton							
Stream Flow (cfs)	minimum maximum mean	3.6 (1) 6920 1060							
Dissolved Oxygen (mg/l)	# of samples minimum maximum mean median	18 4.6 13.2 7.4 6.4							
Temperature (Deg. C)	# of samples minimum maximum mean median	18 0.5 25.0 15.5 17.0							
Total Hardness (mg/l as $CaCO_3$)	# of samples minimum maximum mean median	18 20 64 33 32							
Specific Conductance (uS/cm)	# of samples minimum maximum mean median	18 58 162 97 100							

(1) Instantaneous discharge measurements, 1984 water-year only.

MISSISSIPPI RIVER BASIN

Parameter		Bayou de Chien near Clinton							
pH (units)	# of samples	18							
	minimum	5.7							
	maximum	7.3							
	mean								
	median	6.8							
Alkalinity (mg/l as $CaCO_3$)	# of samples	17							
	minimum	15							
	maximum	39							
	mean	30							
	median	31							
Chloride (mg/l)	# of samples	18							
	minimum	2.7							
	maximum	8.4							
	mean	5.2							
	median	5.1							
Sulfate (mg/l)	# of samples	18							
	minimum	4.0							
	maximum	1420							
	mean	225							
	median	7.7							
Suspended Solids (mg/l)	# of samples	17							
	minimum	6.0							
	maximum	490							
	mean	61							
	median	30							

MISSISSIPPI RIVER BASIN

Parameter		Bayou de Chien near Clinton							
Fecal Coliform (colonies per 100/mls)	# of samples minimum maximum mean median	8 80 533 253 223							
Total Iron (ug/l)	# of samples minimum maximum mean median	15 500 6600 2544 1700							
Total Phosphorous (mg/l)	# of samples minimum maximum mean median	18 .03 .38 .14 .08							
Total Zinc (ug/l)	# of samples minimum maximum mean median	15 2.0 20.0 12.5 15.0							
Total Lead (ug/l)	# of samples minimum maximum mean median	17 1.0 9.0 2.9 1.0							

MISSISSIPPI RIVER BASIN

Parameter		Bayou de Chien near Clinton								
Total Manganese (ug/l)	# of samples minimum maximum mean median	15 100 790 334 280								
Total Ammonia (mg/l as N)	# of samples minimum maximum mean median	18 .05 .26 .10 .07								
Nitrite + Nitrate-Nitrogen (mg/l as N)	# of samples minimum maximum mean median	18 .05 1.18 .54 .48								

Hydrologic Unit 08010201 - Bayou de Chien

A total of 372 miles of streams draining 966 square miles comprise this hydrologic unit. Major urban centers include Mayfield (pop. 10,705), Fulton (pop. 3,137), Bardwell (pop. 988), and Clinton (pop. 1,720). Recreation centers include Murphy's Pond, the Mississippi River, Columbus-Belmont Battlefield State Park and numerous wetlands, which suport water fowl hunting. One water quality monitoring station is located in this hydrologic unit: Bayou de Chien near Clinton.

Bayou de Chien near Clinton

Biological Assessment

Phytoplankton standing crop and chlorophyll-a were below average compared with other biological monitoring stations. The plankton community was dominated by pennate and centric diatoms, as well as green algal flagellates. Diversity and equitability values were above average. Periphyton chlorophyll-a and ash-free dry weight were below average. Diatom diversity, equitability, and taxa richness were above average. Diatom communities on artifical substrates were dominated by *Gomphonema parvulum*, *Achnanthes lanceolata* var. *dubia*, and *Navicula* spp.

The invertebrate collections from this site were adequate in relation to species composition for the available habitats. The community structure was skewed toward filter organisms because the most abundant habitat type favored those organisms. Water quality conditions did not appear to limit the invertebrate community at this location.

Trends in water quality based on biological data are unknown because 1985 was the first year this station was sampled. The present biological community suggests that the stream is relatively unimpacted at this time. However, agricultural practices in the area may pose a potential threat to the biological integrity of the stream.

Ohio River Main Stem

The Ohio River forms the northern border of the Commonwealth of Kentucky for 664 miles. The river receives impacts from all the major drainages as well as numerous minor basins within the state. In addition, the Ohio receives drainage from large portions of Pennsylvania, Ohio, West Virginia, Indiana and Illinois.

The Division of Water maintains no water quality monitoring stations on the main stem of the Ohio River. Monitoring of the Ohio main stem and lower reaches of major tributaries is conducted by the USGS and the Ohio River Valley Water Sanitation Commission (ORSANCO), a compact of eight states in the Ohio River drainage basin. Information on water quality of the Ohio River main stem is contained in ORSANCO's Water Quality Report to Congress for the same reporting period.

Ohio River Minor Tributaries

There are 2,114 stream miles located in minor basins on the USGS hydrologic unit map within the state along the Ohio River. Drainage impacts occurring in these streams are largely unknown. There is one biological monitoring station on an Ohio River minor tributary, Kinniconick Creek.

Hydrologic Unit 05090201 - Ohio River Minor Tributaries

A total of 329 miles of streams draining 568 square miles comprise this hydrologic unit. Major urban centers include Vanceburg (pop. 1,939), Maysville (pop. 7,983), Brooksville (pop. 680), and Alexandria (pop. 4,735). One biological monitoring station is located in this hydrologic unit on Kinniconick Creek.

Kinniconick Creek near Camp Dix

Biological Assessment

Phytoplankton standing crop and chlorophyll-a were below average compared with other biological monitoring stations. The plankton community was characterized by green algal flagellates, benthic pennate-diatoms, *Cryptomonas*, and green algae (order Chlorococcales). Diversity, equitability, and taxa richness were above average. Moderate algal blooms were observed at several locations upstream from the sampling site. Periphyton chlorophyll-a and ash-free dry weight were below average. Diatom diversity and taxa richness were above average, while equitability was average. Diatom communities on artifical substrates were dominated by *Achnanthes linearis* and *Gomphonema parvulum*. Moderate to dense growths of *Tuomeya*, a rare red alga, were observed in riffle areas.

The invertebrate collections from the stream at this location reflected considerable diversity in species composition and functional groupings. Several sensitive members of the scraper functional group, which are intolerant of most environmental disturbances, were collected. Three species of mussels were collected from the limited mussel habitats at the collection site.

The invertebrate collections indicate that the water quality is exceptional and a diversity of habitat types are available. At this time, the site is considered relatively unimpaired. However, evidence such as observations of moderate algal blooms and the abundance of *G. parvulum* on the artifical substrates suggests that nutrient enrichment from agricultural and nonpoint sources may be a potential problem.

APPENDIX C

FISH KILL SUMMARY

Appendix C
1984 - 1985
Fish Kill Summary

1984

County	Stream	Date	Miles Affected	Cause	Number of Fish Killed
Allen	Buck Creek	Feb. 1	1.9	Animal Waste (hog lot)	2289
Allen	Sulphur Creek	Aug 20	1.0	Oil Drilling (brine water)	73
Bullitt	Wilson Creek	June 14	0.01	Low D.O.	-
Fayette	Cross-Keys Pond	Oct 26	5 acres	Unknown	1000
Fleming	Town Branch-Fleming Crk.	Sept 4	-	Municipal Sewage	75
Fleming	Fox Creek	Nov 1	0.25	Unknown	20
Franklin	South Fk Benson Crk	June 12	-	Municipal Sewage	150
Grayson	Caney Creek	July 5	1.0	Herbicide	300
Hardin	Valley Creek	June 27	1.5	Municipal Sewage	1000
Henderson	Wetland	June 26	6 acres	Oil drilling (ruptured oil line)	30
Henderson	Powells Lake	Nov 17	0.5 acre	Brine Water	-
Henry	White Sulphur Creek	June 26	4.0	Corn oil (Train derailment)	500
Jefferson	Chenoweth Run	June12	2.0	Unknown	200
Jefferson	Ohio River	June 14	2.0	Water lowered rapidly below dam	1500
Jefferson	Private Pond	Aug . 7	-	Low D.O.	-
Kenton	Banklick Creek	July 24	1.0	Municipal Sewage	500
Leslie	Laurel Fk., Rockhouse Crk., Cutshin Creek, North Fork Kentucky River and	June 1	4.0	Oil drilling (hydrochloric acid)	-
Leslie	Buckhorn Lake	Nov 20	-	Oil (Crude from storage tank)	100
Lewis	Cabin Creek	June 10	0.5	Herbicide (Bladex)	200
Lincoln	Hawkins Branch	May 18	7.0	Unknown	-
Magoffin	Litteral Fork	May 31	1.0	Crude Oil (High Grade Oil Co.)	-
Magoffin	Big Mine Creek	June 1	1.0	Oil	-
Marshall	Cypress Creek	May 24	-	Low D.O.	-
Marshall	East Fork Clarks River	June 19	-	Anhydrous Ammonia	-
Marshall	Camp Creek	July 13	0.3	Herbicide	500

Appendix C
1984 - 1985
Fish Kill Summary (con'td.)

1984

County	Stream	Date	Miles Affected	Cause	Number of Fish Killed
Mason	Lee Creek	June 2	0.01	Fertilizer & Herbicide	90
Monroe	Mill Creek	Aug. 27	0.2	Unknown	847
Nelson	Pond	Feb. 3	1·acre	Leachate from Sawmill -	
Oldham	Harrods Creek	June 7	1.0	Paraquat (herbicide)	-
Pike	Levisa Fork Cutoff	Jan 25	35 acres	Ice Cover	5000
Shelby	Clear Creek, Brashears Creek, Salt River	Apr 20	35.96	Agricultural Liquid Nitrogen	88640
Trigg	Barkley Lake	June 13	1.5	Disease	3000
Wayne	Town Creek	Oct 9	0.15	Unknown	500
			67.28		106,514

Appendix C
1984 - 1985
Fish Kill Summary (con'td.)

1985

County	Stream	Date	Miles Affected	Cause	Number of Fish Killed
Bell	Yellow Creek	June 21	4.0	Unknown	50
Bourbon	Hinkston Creek	Oct 24	12.0	Unknown	365
Boyle	Clarks Run	Apr 18	-	Unknown	-
Bullitt	Salt River	July 15	14.0	Natural	-
Carter	Tygarts Creek	Sept 17	0.1	Sewage	150
Clark	UT - Howards Creek	Feb. 25	0.5	Diesel Fuel (Train wreck)	-
Clark	Stoner Creek	Oct. 19	0.25	Low D.O.	219
Crittenden	Crooked Creek	May9	-	Unknown	-
Franklin	Elkhorn Creek	July 25	-	Unknown	30
Fulton	Lake No. 9	Oct. 13	-	Low D.O.	700
Hancock	Sandy Branch	Sept 16	0.3	Paper Slurry	-
Harrison	South Fork Licking River	Apr 18	-	Natural	-
Hopkins	Clear Creek	Mar 4	-	Mining (Acid Water)	300
Knott	Upper Mill Creek	Oct 16	1.0	Diesel Fuel	-
Laurel	Laurel Lake	June 25	4 acres	Unknown	250
Leslie	Laurel Fork & Greasy Crk	Feb. 19	10.0	Coal Mining (Blackwater,, Fines, Chemicals)	-
Leslie	Middle Fork Kentucky River	Mar 24	4.0	Mining (Blackwater)	-
Leslie	Cutshin Creek	June 27	2.0	Mining (Mine Waste)	-
Leslie	Cutshin Creek	Aug 22	5.0	Crude Oil Spill	-
Mercer	Salt River	Apr 27	6.02	Municipal Sewage	15916
Mercer	Salt River	May 16	11.46	Municipal Sewage	30402
Nelson	Pottinger Creek	May 12	-	Animal Waste (Hog Lot)	15
Nelson	Cox's Creek	July 23	0.75	Animal Waste (Hog Lot)	1859
Pendleton	Private Pond	Mar 14	0.5 acre	Animal Waste	500
Pike	John's Creek	Sept 14	13.0	Mining Chemicals	6686
Pike	Levisa Fork Diversion Lake	Nov 2	-	Sewage	-
Rowan	Dry Fork	Mar 4	2.0	Concrete	2000
Russell	Lilly Creek	May 15	0.5	Municipal Sewage	37
Woodford	South Elkhorn Creek	Apr 26	-	Unknown	-
			86.88		59499

APPENDIX D

PRIORITY P.L. 566 WATERSHEDS WITH SIGNIFICANT SEDIMENT DELIVERY POTENTIAL

Appendix D

Total Area, Percent Land Use of Primary Sediment Source of P.L. 566 Watersheds In Kentucky With Significant Sediment Delivery

WATERSHED NAME	Hydrologic Unit	P.L. 566 Watershed	Size Acres	Sediment Delivery Class	Potential Sediment-% Land Use Source
Green River Basin					
Hungry Creek	05110002	130	7,700	Very High	Agric. - 93.1%
Lick Creek	05110002	240	9,200	Very High	Agric. - 99.7%
Pond River	05110006	050	8,050	Very High	Mining - 80.1%
Meadow Creek	05110001	060	10,970	High	Agric. - 69.2%
Alexander Creek	05110001	240	14,380	High	Agric. - 72.9%
Indian Creek	05110001	270	8,850	High	Agric. - 75.7%
Difficult Creek	05110002	UNG[1]	10,880	High	Agric. - 83.0%
Clifty Creek	05110004	030	33,260	High	Agric. - 84.6%
Beaverdam Creek	05110001	230	12,160	Moderate	Agric. - 64.3%
Little Beaverdam Creek	05110001	250	6,900	Moderate	Agric. - 44.3%
Clay Lick Creek	05110001	300	6,250	Moderate	Agric. - 55.2%
Trammell Fork	05110002	340	37,540	Moderate	Agric. - 87.1%
Green River Main Stem	05110003	070	28,970	Moderate	Mining - 42.0%
Lewis Creek	05110003	090	23,840	Moderate	Agric. - 39.6%

Note:

1 UNG is an unnumbered watershed drained by Difficult Creek

Appendix D (continued)

Total Area, Percent Land Use of Primary Sediment Source of P.L. 566 Watersheds In Kentucky With Significant Sediment Delivery

WATERSHED NAME	Hydrologic Unit	P.L. 566 Watershed	Size Acres	Sediment Delivery Class	Potential Sediment-% Land Use Source
Green River Basin (continued)					
Meeting Creek	05110004	010	27,120	Moderate	Agric. - 78.3%
Little Clifty Creek	05110004	050	19,670	Moderate	Agric. - 65.1%
Muddy Prong	05110004	060	30,890	Moderate	Agric. - 70.0%
Fiddlers Creek	05110004	070	24,560	Moderate	Agric. - 65.9%
Unnamed Tributary Green River	05110005	080	6,620	Moderate	Agric. - 51.7%
Green River	05110001	050	50,690	Low	Agric. - 63.7%
Little Russell Creek	05110001	080	6,460	Low	Agric. - 42.1%
Walters Creek	05110001	160	33,980	Low	Agric. - 84.0%
McDougals Creek	05110001	170	33,860	Low	Agric. - 78.6%
East Fork Barren River	05110002	040	30,770	Low	Agric. - 55.3%
Mill Creek	05110002	050	20,040	Low	Agric. - 52.5%
Peter Creek	05110002	160	70,870	Low	Agric. - 76.5%
Falling Timber Creek	05110002	170	11,760	Low	Agric. - 48.8%
Skaggs Creek	05110002	180	111,090	Low	Agric. - 76.3%
Bay's Fork	05110002	200	31,250	Low	Agric. - 73.4%
W. Fk. Drakes Creek	05110002	230	47,630	Low	Agric. - 91.7%

Appendix D (continued)

Total Area, Percent Land Use of Primary Sediment Source of P.L. 566 Watersheds In Kentucky With Significant Sediment Delivery

WATERSHED NAME	Hydrologic Unit	P.L. 566 Watershed	Size Acres	Sediment Delivery Class	Potential Sediment-% Land Use Source
Green River Basin (continued)					
Little Muddy Creek	05110002	360	39,920	Low	Agric. - 66.4%
Rough River Lake	05110004	040	81,590	Low	Agric. - 62.0%
Rough River	05110004	080	16,020	Low	Agric. - 39.5%
Rock Lick Creek	05110004	090	26,320	Low	Agric. - 47.8%
Halls Creek	05110004	150	10,370	Low	Agric. - 35.2%
Muddy Creek	05110004	160	46,600	Low	Agric. - 31.0%
Barnett Creek	05110004	170	24,740	Low	Agric. - 41.0%
Falls Creek	05110005	040	26,200	Low	Agric. - 57.6%
N. Fk. Panther Creek	05110005	110	49,130	Low	Agric. - 72.2%
Twomile Creek	05110005	130	6,640	Low	Agric. - 56.8%
Rhodes Creek	05110005	140	18,040	Low	Agric. - 73.1%
W. Fk. Knoblick Creek	05110005	150	15,590	Low	Agric. - 49.2%
Flat Creek	05110006	050	18,380	Low	Mining - 26.4%
Kentucky River Basin					
Logan Creek	05100205	160	15,820	High	Agric. - 73.7%
Prear's Creek	05100205	200	15,990	High	Agric. - 90.3%

Appendix D (continued)

Total Area, Percent Land Use of Primary Sediment Source of P.L. 566 Watersheds In Kentucky With Significant Sediment Delivery

WATERSHED NAME	Hydrologic Unit	P.L. 566 Watershed	Size Acres	Sediment Delivery Class	Potential Sediment-% Land Use Source
Kentucky River Basin (continued)					
Tate Creek	05100205	080	23,160	Moderate	Agric. - 67.5%
Sugar Creek	05100205	110	27,050	Moderate	Agric. - 80.0%
Clark's Run	05100205	190	18,720	Moderate	Agric. - 83.9%
Upper Devil Creek	05100201	190	12,030	Low	Agric. - 34.7%
Lower Devil Creek	05100201	200	11,630	Low	Agric. - 38.3%
Crystal Creek	05100201	230	5,130	Low	Agric. - 37.9%
South Fork Kentucky River	05100203	060	25,760	Low	Agric. - 41.5%
Campbell Creek	05100204	090	5,520	Low	Agric. - 29.5%
Lulbergrud Creek	05100204	180	31,000	Low	Agric. - 61.0%
Stillwater Creek	05100204	130	14,750	Low	Agric. - 38.8%
Upper Howard Creek	05100205	010	25,370	Low	Agric. - 62.6%
Paint Lick Creek	05100205	100	70,900	Low	Agric. - 81.1%
Herrington Lake/Dix River	05100205	170	60,010	Low	Agric. - 85.9%
Harric Creek	05100205	180	61,870	Low	Agric. - 75.3%
Flat Creek	05100205	300	14,090	Low	Agric. - 56.4%
Severn Creek	05100205	320	21,410	Low	Agric. - 88.8%

Appendix D (continued)

Total Area, Percent Land Use of Primary Sediment Source of P.L. 566 Watersheds In Kentucky With Significant Sediment Delivery

WATERSHED NAME	Hydrologic Unit	P.L. 566 Watershed	Size Acres	Sediment Delivery Class	Potential Sediment-% Land Use Source
Kentucky River Basin (continued)					
Clarks Creek	05100205	380	21,230	Low	Agric. - 81.3%
Brush Creek	05100205	400	15,470	Low	Agric. - 95.3%
Ohio River Basin					
Yellow Creek	05140201	120	9,250	High	Agric. - 76.8%
#190 - Ohio River	05140201	190	640	High	Agric. - 98.4%
Big Bone Creek	05090203	195	4,490	Moderate	Agric. - 81.7%
Stephen's Creek	05090203	250	7,060	Moderate	Agric. - 89.5%
#140 - Ohio River	05140201	140	7,030	Moderate	Agric. - 94.9%
Blackford Creek	05140201	170	19,660	Moderate	Agric. - 74.7%
Pup Creek	95140201	210	25,050	Moderate	Agric. - 74.3%
Buck Creek	05140203	120	11,700	Moderate	Agric. - 83.2%
Twelvemile Creek	05090201	390	26,830	Low	Agric. - 80.2%
Middle Creek	05090203	150	9,770	Low	Agric. - 82.3%
Spring Creek	05140104	190	20,480	Low	Agric. - 47.4%
Lick Run	05140104	240	5,540	Low	Agric. - 47.7%

Appendix D (continued)

Total Area, Percent Land Use of Primary Sediment Source of P.L. 566 Watersheds In Kentucky With Significant Sediment Delivery

WATERSHED NAME	Hydrologic Unit	P.L. 566 Watershed	Size Acres	Sediment Delivery Class	Potential Sediment-% Land Use Source
Ohio River Basin (continued)					
Muddy Creek	05140201	060	15,950	Low	Agric. - 58.3%
Camp Creek	05140203	060	8,950	Low	Agric. - 54.9%
Cany Creek	05140203	190	14,210	Low	Agric. - 61.2%
Upper Cumberland River Basin					
Pond Creek	05130102	030	18,880	Moderate	Agric. - 62.7%
Big Clifty Creek	05130103	090	9,350	Moderate	Agric. - 66.2%
Spring Creek	05130105	210	35,180	Moderate	Agric. - 53.0%
Upper Cumberland River	05130101	180	22,290	Low	Agric. - 45.2%
Meadow Creek	05130101	240	12,040	Low	Agric. - 24.5%
Lower Cumberland River Basin					
Sugar Creek	05130205	270	6,840	Moderate	Agric. - 69.3%
Sandy Creek	05130205	280	19,430	Low	Agric. - 79.6%
Licking River Basin					
Blackwater Creek	05100101	090	24,620	Moderate	Agric. - 67.1%
Phillips Creek	05100101	260	13,610	Low	Agric. - 90.9%
Brushy Creek	05100102	030	19,100	Low	Agric. - 87.0%

Appendix D (continued)

Total Area, Percent Land Use of Primary Sediment Source of P.L. 566 Watersheds In Kentucky With Significant Sediment Delivery

WATERSHED NAME	Hydrologic Unit	P.L. 566 Watershed	Size Acres	Sediment Delivery Class	Potential Sediment-% Land Use Source
Licking River Basin (continued)					
Mill Creek	05100102	060	31,140	Low	Agric. - 52.0%
Twin Creek	05100102	070	17,130	Low	Agric. - 88.4%
Raven Creek	05100102	080	30,560	Low	Agric. - 72.8%
Big Sandy River Basin					
Daniel Creek	05070203	130	10,240	Moderate	Agric. - 27.6%
Tygarts Creek					
White Oak Creek	05090103	200	2,740	Low	Agric. - 28.8%
Tradewater River Basin					
Buffalo Creek	05140205	020	9,330	Low	Mining - 17.3%
Salt River Basin					
Sulfur Lick Creek	05140103	030	12,020	Moderate	Agric. - 62.1%
Jack's Creek	05140103	070	18,370	Low	Agric. - 58.8%
Tennessee River Basin					
Island Creek	0604006	070	6,850	Low	Agric. - 55.3%
Mississippi River Basin					
West Fork Mayfield Creek	08010201	020	46,740	Low	Agric. - 84.5%
Obion Creek	08010201	040	204,160	High	Agric. - 74.0%
Bayou De Chien	08010201	060	133,760	High	Agric. - 78.0%